

# **PACSystems™ VersaMax**

MICRO PLC & NANO PLC

USER MANUAL

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## Warnings, Caution Notes as Used in this Publication

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### Warning

Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury to exist in this equipment or may be associated with its use.

In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.

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### Caution

Caution notices are used where equipment might be damaged if care is not taken.

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**Notes:** Notes merely call attention to information that is especially significant to understanding and operating the equipment.

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These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met during installation, operation, and maintenance. The information is supplied for informational purposes only, and Emerson makes no warranty as to the accuracy of the information included herein. Changes, modifications, and/or improvements to equipment and specifications are made periodically and these changes may or may not be reflected herein. It is understood that Emerson may make changes, modifications, or improvements to the equipment referenced herein or to the document itself at any time. This document is intended for trained personnel familiar with the Emerson products referenced herein.

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# Chapter 1: Introduction

The VersaMax® PLC family of products includes a broad range of small-size programmable logic controllers (PLCs) with big-PLC features. The VersaMax family includes Nano PLCs (10 points), Micro PLCs (up to 176 I/O points), and Micro PLUS PLCs (up to 320 I/O points) using optional Expansion Units. These small PLCs are the perfect solution for applications such as packaging machines, dispensing machines, and relay replacement.

Figure 1



These versatile controllers provide powerful programming features such as built-in high-speed counter functionality, support for floating-point function blocks and subroutines, ability to assign passwords and privilege levels to control access, and override capability.

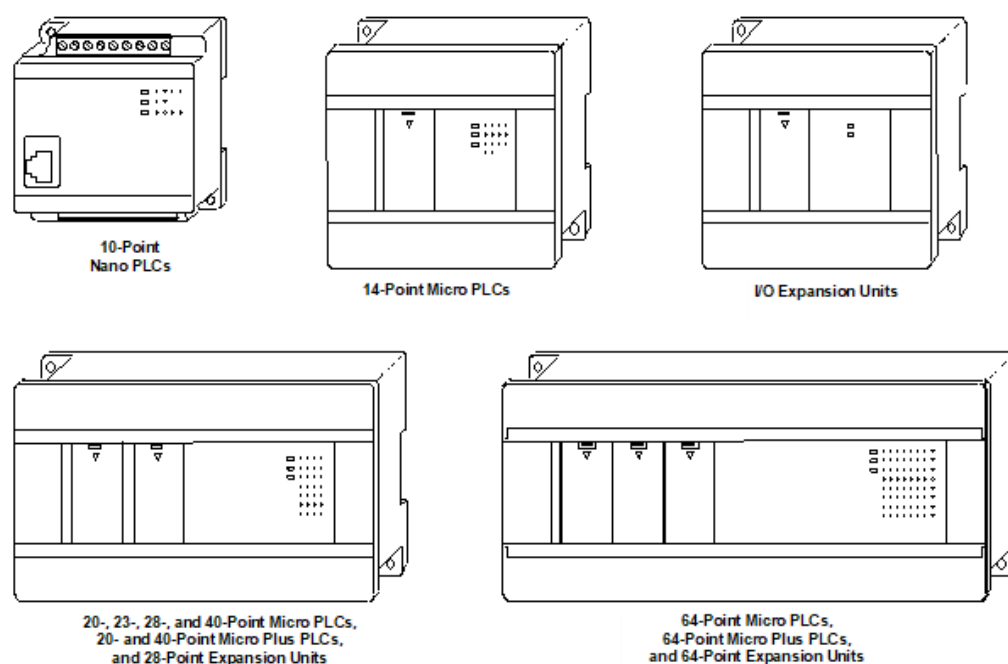
## 1.1 VersaMax Micro, Micro PLUS and Nano PLC Models

Versions of these compact, powerful controllers are available for AC and DC power, and with several different combinations of discrete and analog input and output points.

This chapter compares the features of the many VersaMax Nano, Micro and Micro PLUS PLC models that are available.

Micro PLUS 20/40/64 CPUs have enhanced memory compared to earlier versions of these CPUs. Firmware versions 4.00 and later cannot be used with the earlier hardware versions.

**Figure 2**



### 1.1.1 VersaMax Nano PLCs

VersaMax Nano PLCs have 10 points of discrete I/O. Two models also provide a 0V to 10V analog input.

| Model Number | Description                                                                   |
|--------------|-------------------------------------------------------------------------------|
| IC200NAL110  | 10 Point (6) 12Vdc In, (4) 12 Relay Out, (1) Analog Input, 12Vdc Power Supply |
| IC200NAL211  | 10 Point (6) 24Vdc In, (4) 24 Relay Out, (1) Analog Input, 24Vdc Power Supply |
| IC200NDD010  | 10 Point (6) 12Vdc In, (4) 12Vdc Out, 12Vdc Power Supply                      |
| IC200NDD101  | 10 Point (6) 24Vdc In, (4) 24Vdc Out, 24Vdc Power Supply                      |
| IC200NDR001  | 10 Point (6) 24Vdc In, (4) Relay Out, 24Vdc Power Supply                      |
| IC200NDR010  | 10 Point (6) 12Vdc In, (4) Relay Out, 12Vdc Power Supply                      |

## 1.1.2 VersaMax Micro and Micro PLUS PLCs

VersaMax Micro PLCs are available with 14 to 64 points of I/O.

Micro PLUS PLCs are available with 20, 40 or 64 points of I/O.

| Model Number | Description                                                                                                     |
|--------------|-----------------------------------------------------------------------------------------------------------------|
| IC200UAA003  | 14 Point (8) 120Vac In, (6) 120Vac Out, 120/240Vac Power Supply                                                 |
| IC200UAA007  | 28 Point (16) 120Vac In, (12) 120Vac Out, 120/240Vac Power Supply                                               |
| IC200UAL004  | 23 Point (13) 12Vdc In, (10) Relay Out, (2) Analog In and (1) Analog Out, 12Vdc Power Supply                    |
| IC200UAL005  | 23 Point (13) 24Vdc In, (1) 24Vdc Out, (9) Relay Out, (2) Analog In and (1) Analog Out, 24Vdc Power Supply      |
| IC200UAL006  | 23 Point (13) 24Vdc In, (9) Relay Out, (1) 24Vdc Out, (2) Analog In and (1) Analog Out, 120/240Vac Power Supply |
| IC200UAR014  | 14 Point (8) 120Vac In, (2) Relay Out at 10 Amp, (4) Relay Out at 2 Amp, 120/240Vac Power Supply                |
| IC200UAR028  | 28 Point (16) 120Vac In, (4) Relay Out at 10 Amp, (8) Relay Out at 2 Amp, 120/240Vac Power Supply               |
| IC200UDD020  | 20 Point (12) 24Vdc In, (4) 24Vdc Out with ESCP, (4) 24Vdc Out, 24Vdc Power Supply                              |
| IC200UDD040  | 40 Point (24) 24Vdc In, (16) 24Vdc Out (source), 24Vdc Power Supply                                             |
| IC200UDD064  | 64 Point (40) 24Vdc In, (24) 24Vdc Out with ESCP (source), 24Vdc Power Supply                                   |
| IC200UDD104  | 14 Point (8) 24Vdc In, (6) 24Vdc Out 2 at 1.0 Amp and 4 at 0.5 Amp, 24Vdc Power Supply                          |
| IC200UDD110  | 28 Point (16) 24Vdc In, (12) 24Vdc Out, 6 at 1.0 Amp and, 6 at 0.5 Amp, 24Vdc Power Supply                      |
| IC200UDD112  | 14 Point (8) 12Vdc In, (6) 12Vdc Out, 12Vdc Power Supply                                                        |
| IC200UDD120  | 28 Point (16) 24Vdc In, (12) 24Vdc Out with ESCP, 24Vdc Power Supply                                            |
| IC200UDD164  | 64 Point (40) 24Vdc In, (24) 24Vdc Out (sink), 24Vdc Power Supply                                               |
| IC200UDD212  | 28 Point (16) 12Vdc In, (12) 12Vdc Out, 12Vdc Power Supply                                                      |
| IC200UDD220  | 20 Point, (12) 24Vdc In, (8) 24Vdc Out (sink), 24Vdc Power Supply                                               |
| IC200UDD240  | 40 Point (24) 24Vdc In, (16) 24Vdc Out (sink), 24Vdc Power Supply                                               |
| IC200UDR001  | 14 Point (8) 24Vdc In, (6) Relay Out, 120/240Vac Power Supply                                                   |
| IC200UDR002  | 14 Point (8) 24Vdc In, (6) Relay Out, 24Vdc Power Supply                                                        |
| IC200UDR003  | 14 Point (8) 12Vdc In, (6) Relay Out, 12Vdc Power Supply                                                        |
| IC200UDR005  | 28 Point (16) 24Vdc In, (11) Relay Out, (1) 24Vdc Out, 120/240Vac Power Supply                                  |
| IC200UDR006  | 28 Point (16) 12Vdc In, (12) Relay Out, 12Vdc Power Supply                                                      |
| IC200UDR010  | 28 Point (16) 24Vdc In, (11) Relay Out, (1) 24Vdc Out, 24Vdc Power Supply                                       |
| IC200UDR020  | 20 Point, (12) 24Vdc In, (8) Relay Out, 24Vdc Power Supply                                                      |
| IC200UDR040  | 40 Point (24) 24Vdc In, (16) Relay Out, 24Vdc Power Supply                                                      |
| IC200UDR064  | 64 Point (40) 24Vdc In, (24) Relay Out, 24Vdc Power Supply                                                      |

| Model Number | Description                                                                  |
|--------------|------------------------------------------------------------------------------|
| IC200UDR120  | 20 Point (12) 24Vdc In, (8) Relay Out, 120/240Vac Power Supply               |
| IC200UDR140  | 40 Point (24) 24Vdc In, (16) Relay Out, 120/240Vac Power Supply              |
| IC200UDR164  | 64 Point (40) 24Vdc In, (24) Relay Out, 120/240Vac Power Supply              |
| IC200UDR228  | 28 Point (16) 24Vdc In, (11) Relay Out, (1) 24Vdc Out, 12/24Vdc Power Supply |
| IC200UDR440  | 40 Point (24) 24Vdc In, (16) Relay Out, 12/24Vdc Power Supply                |

### 1.1.3 VersaMax Micro PLC Expansion Units

VersaMax Micro PLC Expansion Units provide additional discrete points and analog I/O channels for the PLC system. Up to four VersaMax Micro PLC Expansion Units of any type can be connected to a VersaMax Micro PLC.

**Note:** The 64-point Expansion Units are supported on Micro PLUS PLCs (20/40/64 point PLCs with release 4.0 or later firmware).

| Model Number | Description                                                                               |
|--------------|-------------------------------------------------------------------------------------------|
| IC200UEC008  | 8 Point (4) 24Vdc In, (4) 24Vdc Out with ESCP, 24Vdc Power Supply                         |
| IC200UEC108  | 8 Point (4) 24Vdc In, (4) 24Vdc Out, 24Vdc Power Supply                                   |
| IC200UEC208  | 8 Point (4) 24Vdc In, (4) Relay Out, 24Vdc Power Supply                                   |
| IC200UEI008  | 8 Point (8) 24Vdc In, 24Vdc Power Supply                                                  |
| IC200UEI016  | 16 Point (16) 24Vdc In, 24Vdc Power Supply                                                |
| IC200UEO008  | 8 Point (8) 24Vdc Out with ESCP, 24Vdc Power Supply                                       |
| IC200UEO016  | 16 Point (16) 24Vdc Out with ESCP, 24Vdc Power Supply                                     |
| IC200UEO108  | 8 Point (8) 24Vdc Out, 24Vdc Power Supply                                                 |
| IC200UEO116  | 16 Point (16) 24Vdc Out, 24Vdc Power Supply                                               |
| IC200UER008  | 8 Point (8) Relay Out, 24Vdc Power Supply                                                 |
| IC200UER016  | 16 Point (16) Relay Out, 24Vdc Power Supply                                               |
| IC200UEX009  | 14 Point (8) 120Vac In, (2) Relay Out @ 10 Amps (4) Relay Out @ 2 Amps, 120/240Vac P.S.   |
| IC200UEX010  | 14 Point (8) 120Vac In, (6) 120Vac Out, 120/240Vac Power Supply                           |
| IC200UEX011  | 14 Point (8) 24Vdc In, (6) Relay Out, 120/240Vac Power Supply                             |
| IC200UEX012  | 14 Point (8) 24Vdc In, (6) Relay Out, 24Vdc Power Supply                                  |
| IC200UEX013  | 14 Point (8) 12Vdc In, (6) Relay Out, 12Vdc Power Supply                                  |
| IC200UEX014  | 14 Point (8) 24Vdc In, (6) 24Vdc Out, 24Vdc Power Supply                                  |
| IC200UEX015  | 14 Point (8) 12Vdc In, (6) 12Vdc Out, 12Vdc Power Supply                                  |
| IC200UEX064  | 64 point (40) 24Vdc In; (24) Relay Out, 24Vdc Power Supply                                |
| IC200UEX122  | 14 Point (8) 24Vdc In, (6) 24Vdc Out with ESCP, 24Vdc Power Supply                        |
| IC200UEX164  | 64 point (40) 24Vdc In; (24) Relay Out, 120/240Vac Power Supply                           |
| IC200UEX209  | 28 Point (16) 120Vac In, (4) Relay Out at 10 Amp, (8) Relay Out at 2 Amp, 120/240Vac P.S. |
| IC200UEX210  | 28 Point (16) 120Vac In, (12) 120Vac Out, 120/240Vac Power Supply                         |

| Model Number             | Description                                                                                      |
|--------------------------|--------------------------------------------------------------------------------------------------|
| IC200UEX211              | 28 Point (16) 24Vdc In, (12) Relay Out, 120/240Vac Power Supply                                  |
| IC200UEX212              | 28 Point (16) 24Vdc In, (12) Relay Out, 24Vdc Power Supply                                       |
| IC200UEX213              | 28 Point (16) 12Vdc In, (12) Relay Out, 12Vdc Power Supply                                       |
| IC200UEX214              | 28 Point (16) 24Vdc In, (12) 24Vdc Out, 6 at 1.0 Amp and, 6 at 0.5 Amp, 24Vdc Power Supply       |
| IC200UEX215              | 28 Point (16) 12Vdc In, (12) 12Vdc Out, 12Vdc Power Supply                                       |
| IC200UEX222              | 28 Point (16) 24Vdc In, (12) 24Vdc Out with ESCP, 24Vdc Power Supply                             |
| IC200UEX264              | 64-point (40) 24Vdc In; (24) 24Vdc Source Out, 24Vdc Power Supply                                |
| IC200UEX364              | 64-point (40) 24Vdc In; (24) 24Vdc Sink Out, 24Vdc Power Supply                                  |
| IC200UEX616              | 6 Point (4) Analog In and (2) Analog Out, 12Vdc Power Supply                                     |
| IC200UEX624              | 4 Point (4) Analog In, 24Vdc Power Supply                                                        |
| IC200UEX626              | 6 Point (4) Analog In and (2) Analog Out, 24Vdc Power Supply                                     |
| IC200UEX636              | 6 Point (4) Analog In and (2) Analog Out, 100-240Vac Power Supply                                |
| IC200UEX724              | 4 RTD, Pt 100 In, 24Vdc Power Supply                                                             |
| IC200UEX726              | 4 RTD, Pt 100 In and (2) Analog Out, 0 to 20mA, 4 to 20mA or 0 to 10Vdc, 24Vdc Power Supply      |
| IC200UEX734              | 4 RTD, Pt 100 In, 120/240Vac Power Supply                                                        |
| IC200UEX736              | 4 RTD, Pt 100 In and (2) Analog Out, 0 to 20mA, 4 to 20mA or 0 to 10Vdc, 120/240Vac Power Supply |
| IC200UEX824              | 4 Thermocouple Input, 24Vdc Power Supply                                                         |
| IC200UEX826              | 4 Thermocouple In and (2) Analog Out, 0 to 20mA or 0 to 10Vdc, 24Vdc Power Supply                |
| IC200UMM002 <sup>1</sup> | 2 Axis Servo Motion Module, 24Vdc Power Supply                                                   |
| IC200UMM102 <sup>1</sup> | 2 Axis Servo Motion Module, 120/240Vac Power Supply                                              |

## 1.1.4 Option Modules

Option Modules can be used to enhance the functionality of a 20, 40, or 64-point (release 3.6 or later) VersaMax Micro or Micro PLUS PLC.

| Model Number | Description                                          |
|--------------|------------------------------------------------------|
| IC200USB001  | RS232, Extra Port Option Module with 2 analog inputs |
| IC200USB002  | RS485, Extra Port Option Module with 2 analog inputs |
| IC200UMB001  | Memory Pack Module                                   |
| IC200UUB001  | USB / RS232 Conversion Option Module                 |
| IC200UEM001  | Ethernet Option Module                               |

<sup>1</sup> For Motion Module operating details, refer to the VersaMax Micro PLC MicroMotion Modules Manual, GFK-2471A.



## 1.2 Comparison of Program and Data Memory Available

The following table compares the amounts of program and data memory available with VersaMax Nano, Micro and Micro PLUS PLCs.

| Reference Type                       | Reference Range   | 10-Point<br>Nano<br>PLCs | 14-Point<br>Micro<br>PLCs | 23- and<br>28-Point<br>Micro<br>PLCs | 20-, 40-,<br>and 64-<br>Point<br>Micro/<br>Micro<br>PLUS PLCs |
|--------------------------------------|-------------------|--------------------------|---------------------------|--------------------------------------|---------------------------------------------------------------|
| User program logic                   | Not applicable    | 2K words                 | 9K words                  | 9K words                             | 24K words                                                     |
| Discrete inputs                      | %I0001 - %I0512   | 512 bits                 | 512 bits                  | 512 bits                             | 512 bits                                                      |
| Discrete outputs                     | %Q0001 - %Q0512   | 512 bits                 | 512 bits                  | 512 bits                             | 512 bits                                                      |
| Discrete global references           | %G0001 - %G1280   | 1280 bits                | 1280 bits                 | 1280 bits                            | 1280 bits                                                     |
| Discrete internal coils              | %M0001 - %M1024   | 1024 bits                | 1024 bits                 | 1024 bits                            | 1024 bits                                                     |
| Discrete temporary coils             | %T0001 - %T0256   | 256 bits                 | 256 bits                  | 256 bits                             | 256 bits                                                      |
| System status references             | %S0001 - %S0032   | 32 bits                  | 32 bits                   | 32 bits                              | 32 bits                                                       |
|                                      | %SA0001 - %SA0032 | 32 bits                  | 32 bits                   | 32 bits                              | 32 bits                                                       |
|                                      | %SB0001 - %SB0032 | 32 bits                  | 32 bits                   | 32 bits                              | 32 bits                                                       |
|                                      | %SC0001 - %SC0032 | 32 bits                  | 32 bits                   | 32 bits                              | 32 bits                                                       |
| System register references           | %R0001 - %R0256   | 256 words                | 256 words                 | 2K words                             | 32K words<br>32K words                                        |
| 10-pt, 14-pt PLCs                    | %R0001 - %R2048   |                          |                           |                                      |                                                               |
| 23-pt and 28-pt PLCs                 | %R0001 - %R16384  |                          |                           |                                      |                                                               |
| 20-pt and 40-pt PLCs                 | %R0001 - %R32640  |                          |                           |                                      |                                                               |
| 64-pt PLCs                           |                   |                          |                           |                                      |                                                               |
| Analog and High-Speed Counter inputs | %AI0001 - %AI0128 | 128 words                | 128 words                 | 128 words                            | 128 words                                                     |
| Analog outputs                       | %AQ0001 - %AQ0128 | 128 words                | 128 words                 | 128 words                            | 128 words                                                     |

## 1.3 Comparison of PLC Features

The table below compares the features of VersaMax Nano PLCs and Micro PLCs.

| Feature                                                              | 10-Point Nano PLCs           | 14-Point Micro PLCs | 23-Point Micro PLCs        | 28-Point Micro PLCs | 20-, 40-, and 64-Point Micro/ Micro PLUS PLCs   |
|----------------------------------------------------------------------|------------------------------|---------------------|----------------------------|---------------------|-------------------------------------------------|
| Run/Stop Mode Select Switch                                          |                              | ✓                   | ✓                          | ✓                   | ✓                                               |
| Connection for an external mode switch                               | ✓                            |                     |                            |                     |                                                 |
| Potentiometer Inputs (2)                                             |                              | ✓                   | ✓                          | ✓                   | optional                                        |
| Built-in Analog I/O                                                  | 1 voltage out on some models |                     | 2 in (V/C) and 1 out (V/C) |                     |                                                 |
| Capacitor memory backup time, minimum (Hardware version C and above) | 3 days                       | 3 days              | 30 minutes                 | 30 minutes          | 30 minutes                                      |
| External high capacity battery to back up RAM                        |                              |                     | optional                   | optional            | optional                                        |
| LEDs: PWR, RUN, OK, point status                                     | ✓                            | ✓                   | ✓                          | ✓                   | ✓                                               |
| Removable wiring terminal assemblies                                 |                              | ✓                   | ✓                          | ✓                   | ✓                                               |
| Accepts Up to 4 Expansion Units                                      |                              | ✓                   | ✓                          | ✓                   | ✓                                               |
| Maximum I/O Count with Expansion Units                               |                              | 126                 | 135                        | 140                 | 20-point: 276<br>40-point: 296<br>64-point: 320 |
| RS-232 Port 1 with RJ-45 Connector                                   | ✓                            | ✓                   | ✓                          | ✓                   | ✓                                               |
| SNP/SNPX Master                                                      |                              |                     |                            |                     | ✓                                               |
| SNP/SNPX Slave                                                       | ✓                            | ✓                   | ✓                          | ✓                   | ✓                                               |
| 2-Wire RTU Slave                                                     | ✓                            | ✓                   |                            |                     | ✓                                               |
| 4-Wire RTU Slave                                                     | ✓                            | ✓                   |                            |                     | ✓                                               |
| Configurable for Serial I/O                                          | ✓                            | ✓                   |                            |                     | ✓                                               |
| Modbus RTU Master                                                    |                              |                     |                            |                     | ✓                                               |
| Port 2                                                               |                              |                     | ✓                          | ✓                   | ✓                                               |
| SNP/SNPX Slave                                                       |                              |                     | ✓                          | ✓                   | ✓                                               |
| SNP/SNPX Master                                                      |                              |                     | ✓                          | ✓                   | ✓                                               |
| 2-Wire RTU Slave                                                     |                              |                     | ✓                          | ✓                   | ✓                                               |

| Feature                                                                        | 10-Point<br>Nano PLCs | 14-<br>Point<br>Micro<br>PLCs | 23-Point<br>Micro PLCs        | 28-Point<br>Micro<br>PLCs     | 20-, 40-, and<br>64-Point<br>Micro/<br>Micro PLUS<br>PLCs |
|--------------------------------------------------------------------------------|-----------------------|-------------------------------|-------------------------------|-------------------------------|-----------------------------------------------------------|
| 4-Wire RTU Slave                                                               |                       |                               | ✓                             | ✓                             | ✓                                                         |
| Modbus RTU Master                                                              |                       |                               | ✓<br>(rel. 2.02 and<br>later) | ✓<br>(rel. 2.02<br>and later) | ✓                                                         |
| Configurable for Serial I/O                                                    |                       |                               | ✓                             | ✓                             | ✓                                                         |
| RS-232, RS-485/422, USB,<br>and Memory Option<br>Modules                       |                       |                               |                               |                               | ✓                                                         |
| VersaMax Serial to Ethernet<br>support                                         | ✓                     | ✓                             | ✓                             | ✓                             | ✓                                                         |
| LD and Instruction List<br>programming                                         | ✓                     | ✓                             | ✓                             | ✓                             | ✓                                                         |
| Program Functions<br>compatible with Series 90-<br>30 and Series 90 Micro PLCs | ✓                     | ✓                             | ✓                             | ✓                             | ✓                                                         |
| Subroutines                                                                    | 8                     | 64                            | 64                            | 64                            | 64                                                        |
| Floating Point functions                                                       | ✓                     | ✓                             | ✓                             | ✓                             | ✓                                                         |
| 64-Point Expansion support                                                     |                       |                               |                               |                               | ✓<br>(Rel 4.0 or<br>later)                                |
| Ethernet Communications<br>module support                                      |                       |                               |                               |                               | ✓                                                         |
| Motion Module support                                                          |                       |                               |                               |                               | ✓                                                         |
| Online program changes                                                         |                       |                               |                               |                               | ✓<br>(Rel 4.0 or<br>later)                                |

## 1.4 Comparison of I/O and Power Features for PLCs

| Model Number              | Discrete Points | Input Power | DC Power for inputs and field devices | DC Inputs | AC Inputs | Analog Inputs | Relay Outputs   | DC Outputs        | AC Outputs | Analog Outputs |
|---------------------------|-----------------|-------------|---------------------------------------|-----------|-----------|---------------|-----------------|-------------------|------------|----------------|
| Nano PLCs                 |                 |             |                                       |           |           |               |                 |                   |            |                |
| NAL110                    | 10              | 12Vdc       |                                       | 6         |           | 1             | 4               |                   |            |                |
| NAL211                    | 10              | 24Vdc       |                                       | 6         |           | 1             | 4               |                   |            |                |
| NDD010                    | 10              | 12Vdc       |                                       | 6         |           |               |                 | 4                 |            |                |
| NDD101                    | 10              | 24Vdc       |                                       | 6         |           |               |                 | 4                 |            |                |
| NDR001                    | 10              | 24Vdc       |                                       | 6         |           |               | 4               |                   |            |                |
| NDR010                    | 10              | 12Vdc       |                                       | 6         |           |               | 4               |                   |            |                |
| Micro and Micro PLUS PLCs |                 |             |                                       |           |           |               |                 |                   |            |                |
| UAA003                    | 14              | 100/240Vac  |                                       |           | 8         |               |                 |                   | 6          |                |
| UAA007                    | 28              | 100/240Vac  |                                       |           | 16        |               |                 |                   | 12         |                |
| UAL004                    | 23              | 12Vdc       | ✓                                     | 13        |           | 2             | 10              |                   |            | 1              |
| UAL005                    | 23              | 24Vdc       | ✓                                     | 13        |           | 2             | 9               | 1                 |            | 1              |
| UAL006                    | 23              | 100/240Vac  | ✓                                     | 13        |           | 2             | 9               | 1                 |            | 1              |
| UAR014                    | 14              | 100/240Vac  | ✓                                     |           | 8         |               | 6 <sup>2</sup>  |                   |            |                |
| UAR028                    | 28              | 100/240Vac  | ✓                                     |           | 16        |               | 12 <sup>2</sup> |                   |            |                |
| UDD020                    | 20              | 24Vdc       | ✓                                     | 12        |           |               |                 | 4 LCDC,<br>4 ESCP |            |                |
| UDD040                    | 40              | 24Vdc       | ✓                                     | 24        |           |               |                 | 16                |            |                |
| UDD104                    | 14              | 24Vdc       | ✓                                     | 8         |           |               |                 | 6                 |            |                |
| UDD064                    | 64              | 24Vdc       | ✓                                     | 40        |           |               |                 | 24, ESCP          |            |                |
| UDD110                    | 28              | 24Vdc       | ✓                                     | 16        |           |               |                 | 12                |            |                |
| UDD112                    | 14              | 12Vdc       | ✓                                     | 8         |           |               |                 | 6                 |            |                |
| UDD120                    | 28              | 24Vdc       | ✓                                     | 16        |           |               |                 | 12, ESCP          |            |                |
| UDD164                    | 64              | 24Vdc       | ✓                                     | 40        |           |               |                 | 24                |            |                |
| UDD220                    | 20              | 24Vdc       | ✓                                     | 12        |           |               |                 | 8                 |            |                |
| UDD212                    | 28              | 12Vdc       | ✓                                     | 16        |           |               |                 | 12                |            |                |
| UDD240                    | 40              | 24Vdc       | ✓                                     | 24        |           |               |                 | 16                |            |                |
| UDR001                    | 14              | 100/240Vac  | ✓                                     | 8         |           |               | 6               |                   |            |                |
| UDR002                    | 14              | 24Vdc       | ✓                                     | 8         |           |               | 6               |                   |            |                |
| UDR003                    | 14              | 12Vdc       | ✓                                     | 8         |           |               | 6               |                   |            |                |
| UDR005                    | 28              | 100/240Vac  | ✓                                     | 16        |           |               | 11              | 1                 |            |                |
| UDR006                    | 28              | 12Vdc       | ✓                                     | 16        |           |               | 12              |                   |            |                |
| UDR010                    | 28              | 24Vdc       | ✓                                     | 16        |           |               | 11              | 1                 |            |                |
| UDR020                    | 20              | 100/240Vac  | ✓                                     | 12        |           |               | 8               |                   |            |                |

<sup>2</sup> Two outputs rated 10 Amps

| Model Number | Discrete Points | Input Power    | DC Power for inputs and field devices | DC Inputs | AC Inputs | Analog Inputs | Relay Outputs | DC Outputs | AC Outputs | Analog Outputs |
|--------------|-----------------|----------------|---------------------------------------|-----------|-----------|---------------|---------------|------------|------------|----------------|
| UDR040       | 40              | 24Vdc          | ✓                                     | 24        |           |               | 16            |            |            |                |
| UDR064       | 64              | 24Vdc          | ✓                                     | 40        |           |               | 24            |            |            |                |
| UDR120       | 20              | 100/240Vac     | ✓                                     | 12        |           |               | 8             |            |            |                |
| UDR140       | 40              | 100/240Vac     | ✓                                     | 24        |           |               | 16            |            |            |                |
| UDR164       | 64              | 100/240Vac     | ✓                                     | 40        |           |               | 24            |            |            |                |
| UDR228       | 28              | 24Vdc          | ✓                                     | 16        |           |               | 11            | 1          |            |                |
| UDR440       | 40              | 12Vdc<br>24Vdc | ✓                                     | 24        |           |               | 16            |            |            |                |

## 1.5 Comparison of I/O and Power Features for Expansion Units

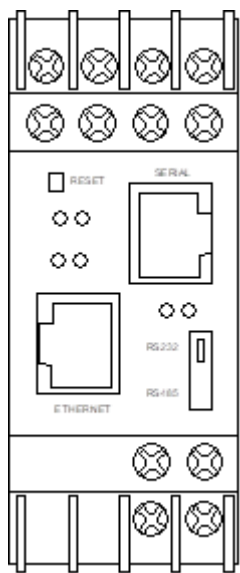
| Model Number | Total Points | Input Power | DC Power for inputs and field devices | DC Inputs | AC Inputs | Analog Inputs | Relay Outputs | DC Outputs | AC Outputs | Analog Outputs |
|--------------|--------------|-------------|---------------------------------------|-----------|-----------|---------------|---------------|------------|------------|----------------|
| UEC008       | 8            | 24Vdc       | ✓                                     | 4         |           |               |               | 4, ESCP    |            |                |
| UEC108       | 8            | 24Vdc       | ✓                                     | 4         |           |               |               | 4          |            |                |
| UEC208       | 8            | 24Vdc       | ✓                                     | 4         |           |               | 4             |            |            |                |
| UEI008       | 8            | 24Vdc       | ✓                                     | 8         |           |               |               |            |            |                |
| UEI016       | 16           | 24Vdc       | ✓                                     | 16        |           |               |               |            |            |                |
| UEO008       | 8            | 24Vdc       | ✓                                     |           |           |               |               | 8, ESCP    |            |                |
| UEO108       | 8            | 24Vdc       | ✓                                     | 8         |           |               | 8             |            |            |                |
| UEO016       | 16           | 24Vdc       | ✓                                     |           |           |               |               | 16, ESCP   |            |                |
| UEO116       | 16           | 24Vdc       | ✓                                     |           |           |               |               | 16         |            |                |
| UER008       | 8            | 24Vdc       | ✓                                     |           |           |               | 8             |            |            |                |
| UER016       | 16           | 24Vdc       | ✓                                     |           |           |               | 16            |            |            |                |
| UEX009       | 14           | 100/240Vac  | ✓                                     |           | 8         |               | 62            |            |            |                |
| UEX010       | 14           | 100/240Vac  | ✓                                     |           | 8         |               |               |            | 6          |                |
| UEX011       | 14           | 100/240Vac  | ✓                                     | 8         |           |               | 6             |            |            |                |
| UEX012       | 14           | 24Vdc       | ✓                                     | 8         |           |               | 6             |            |            |                |
| UEX013       | 14           | 12Vdc       | ✓                                     | 8         |           |               | 6             |            |            |                |
| UEX014       | 14           | 24Vdc       | ✓                                     | 8         |           |               |               | 6          |            |                |
| UEX015       | 14           | 12Vdc       | ✓                                     | 8         |           |               |               | 6          |            |                |
| UEX064       | 64           | 24Vdc       | ✓                                     | 40        |           |               | 24            |            |            |                |
| UEX122       | 14           | 24Vdc       | ✓                                     | 8         |           |               |               | 6, ESCP    |            |                |
| UEX164       | 64           | 24Vdc       | ✓                                     | 40        |           |               | 24            |            |            |                |
| UEX209       | 28           | 100/240Vac  |                                       |           | 16        |               | 122           |            |            |                |

| Model Number | Total Points | Input Power | DC Power for inputs and field devices | DC Inputs | AC Inputs | Analog Inputs | Relay Outputs | DC Outputs | AC Outputs | Analog Outputs |
|--------------|--------------|-------------|---------------------------------------|-----------|-----------|---------------|---------------|------------|------------|----------------|
| UEX210       | 28           | 100/240Vac  | ✓                                     |           | 16        |               |               |            | 12         |                |
| UEX211       | 28           | 100/240Vac  | ✓                                     | 16        |           |               | 12            | 1          |            |                |
| UEX212       | 28           | 24Vdc       | ✓                                     | 16        |           |               | 12            | 1          |            |                |
| UEX213       | 28           | 12Vdc       | ✓                                     | 16        |           |               | 12            |            |            |                |
| UEX214       | 28           | 24Vdc       | ✓                                     | 16        |           |               |               | 12         |            |                |
| UEX215       | 28           | 12Vdc       | ✓                                     | 16        |           |               |               | 12         |            |                |
| UEX222       | 28           | 24Vdc       | ✓                                     | 16        |           |               |               | 12, ESCP   |            |                |
| UEX264       | 64           | 24Vdc       | ✓                                     | 40        |           |               | 24            |            |            |                |
| UEX364       | 64           | 24Vdc       | ✓                                     | 40        |           |               | 24            |            |            |                |
| UEX616       | 6            | 12Vdc       |                                       |           |           | 4             |               |            |            | 2              |
| UEX624       | 4            | 24Vdc       |                                       |           |           | 4             |               |            |            |                |
| UEX626       | 6            | 24Vdc       |                                       |           |           | 4             |               |            |            | 2              |
| UEX636       | 6            | 100/240Vac  |                                       |           |           | 4             |               |            |            | 2              |
| UEX724       | 4            | 24Vdc       |                                       |           |           | 4 RTD         |               |            |            |                |
| UEX726       | 6            | 24Vdc       |                                       |           |           | 4 RTD         |               |            |            | 2              |
| UEX734       | 4            | 100/240Vac  |                                       |           |           | 4 RTD         |               |            |            |                |
| UEX736       | 6            | 100/240Vac  |                                       |           |           | 4 RTD         |               |            |            | 2              |
| UEX824       | 4            | 24Vdc       |                                       |           |           | 4 TC          |               |            |            |                |
| UEX826       | 6            | 24Vdc       |                                       |           |           | 4 TC          |               |            |            | 2              |
| UMM002       |              | 24Vdc       |                                       | ✓         |           |               |               |            |            |                |
| UMM102       |              | 100/240Vac  |                                       | ✓         |           |               |               |            |            |                |

## 1.6 VersaMax Serial to Ethernet Adapter

The VersaMax™ IC200SET001 Serial to Ethernet Adapter (VMSE) can be used to connect a VersaMax Micro, Micro PLUS or Nano PLC to an Ethernet network.

**Figure 3**



### 1.6.1 Firmware Options

By default, SRTP/SNP firmware is loaded in flash memory. Use SRTP/SNP to communicate with VersaPro™, CIMPLICITY™ HMI, Series 90-30™, Series 90-70™, and other Emerson products.

Additional firmware options are provided on the CD that is shipped with the VMSE. These include Modbus TCP/RTU, and Pass Thru firmware, which can be used to send serial communication via Ethernet.

### 1.6.2 Serial Interface

The RJ-45 port on the VMSE supports RS-232. The screw block port supports both RS-232 and RS 485/422. Setting the switch on the front of the VMSE and configuring the VMSE setup selects RS 232 or RS-485/422. Only one port can be used at a time.

### 1.6.3 Network Interface

The VMSE supports 10/100 Mbit Ethernet through its RJ-45 (10BaseT) connector.

### 1.6.4 Power Requirements

The required input voltage can vary between 9Vdc and 30Vdc (or 24Vac) with a maximum of 3 Watts. The VMSE can be powered from the 12- or 24-Volt supply on a VersaMax Micro or Micro PLUS PLC (200mA available), or an external supply can be used. For a Nano PLC, an external power supply is required.

## 1.7 Logic-Driven Read/Write Flash Memory Feature

Release 3.0 and later Micro and Micro PLUS PLCs support two Service Requests that can be used in the application program to read data from and write data to flash memory.

The Logic-Driven Read/Write Flash feature can:

- Write selected data to flash using Service Request (SVCREQ) logic in the application program
- Write / read one to ten consecutive Reference Variables of same type with one Service Request
  - Up to 10 words of %R, %AI, %AQ
  - Up to 10 bytes of %I, %Q, %M, %T, %G
- Up to 8k bytes of reference memory can be stored in flash. If a request is made to store more than 8k bytes in flash, a fault is logged in the PLC Fault Table.

See Chapter 24: for details and logic examples.

## 1.8 Online Program Changes

In release 4.0 or later Micro PLUS PLCs, you can perform online program changes to edit and download logic to the PLC without putting the PLC into Stop mode. Online program changes consist of:

- Word-for-word change
- Run mode store (RMS)

### 1.8.1 Word for Word Changes

Changes to the program that do not modify the size of the program are considered word-for-word changes. Examples include changing the type of contact or coil or changing a reference address used for an existing function block. Changing an operand is usually a word-for-word change. A word-for-word change can be made and downloaded to the PLC while online in programmer mode without having to download the entire block of logic.

### 1.8.2 Run Mode Store

Run Mode Store consists of downloading logic to a PLC while it is in Run mode. Changes in logic can account for the same or a different amount of memory as the original logic.

The Run Mode Store operation requires the modified logic block(s) size to be within the available free memory.

Example: In order to modify or add a logic block of 10 Kbytes and perform a Run Mode Store, at least 10 Kbytes of free memory should be available. A Run Mode Store with the maximum user logic (48K) is possible only when there is no user logic present in the PLC.



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**Note:** Online program changes should not be performed on active motion function blocks. Motion functionality is not guaranteed if user performs word for word change or Run Mode Store on active motion function blocks.

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## 1.9 Documentation

### VersaMax Manuals

|                                                                |          |
|----------------------------------------------------------------|----------|
| VersaMax PLC User's Manual                                     | GFK-1503 |
| VersaMax Modules, Power Supplies, and Carriers User's Manual   | GFK-1504 |
| VersaMax System DeviceNet Communications Modules User's Manual | GFK-1533 |
| VersaMax System Profibus Slave Modules User's Manual           | GFK-1534 |
| VersaMax System Genius Network Interface Unit User's Manual    | GFK-1535 |
| VersaMax I/O and Industrial Networking Application Guide       | GFK-1563 |
| VersaMax Micro PLCs and Nano PLCs User's Manual                | GFK-1645 |
| VersaPro Programming Software User's Guide                     | GFK-1670 |
| VersaMax System AS-i Network Master Module User's Manual       | GFK-1697 |
| VersaMax Serial to Ethernet Adapter User's Manual              | GFK-1852 |
| VersaMax System Ethernet Network Interface Unit User Manual    | GFK-1860 |
| VersaMax PLC Station Manager User's Manual                     | GFK-1876 |
| VersaMax IP Installation Manual                                | GFK-2307 |
| VersaMax MicroMotion Modules IC200UMM002/102                   | GFK-2471 |
| VersaMax PROFINET Scanner (PNS) Manual                         | GFK-2721 |
| VersaMax PROFIBUS Master Module, IC200BEM003                   | GFK-2740 |
| VersaMax Controllers Secure Deployment Guide                   | GFK-2955 |

In addition to these manuals, datasheets and product update documents describe individual modules and product revisions. The most recent PACSystems documentation is available on the Emerson support website <https://www.emerson.com/Industrial-Automation-Controls/support>.

## 1.10 Revisions in this Manual

| Rev | Date     | Description                                                                                                                                                                                                                              |
|-----|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| M   | Dec 2019 | Following Emerson's acquisition of this product, changes have been made to apply appropriate branding and registration of the product with required certification agencies. No changes to material, process, form, fit or functionality. |
| L   | Sep 2015 | Correction to figure in section 9.7.4                                                                                                                                                                                                    |

## Chapter 2: VersaMax Nano PLCs

This chapter describes the features and specifications of VersaMax Nano PLCs.

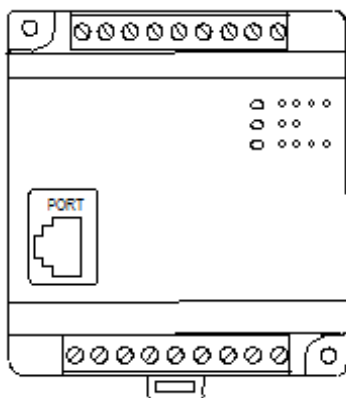
|             |                                                                                                                                     |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------|
| IC200NAL110 | Nano PLC with 10 Discrete-Points and 1 Analog Input:<br>11-Point (6) 12Vdc In, (4) Relay Out, 1 Analog input,<br>12Vdc Power Supply |
| IC200NAL211 | Nano PLC with 10 Discrete-Points and 1 Analog Input:<br>(6) 24Vdc In, (4) Relay Out, 1 Analog input,<br>24Vdc Power Supply          |
| IC200NDD010 | 10-Point Nano PLC: (6) 12Vdc In, (4) 12Vdc Out,<br>12Vdc Power Supply                                                               |
| IC200NDD101 | 10-Point Nano PLC: (6) 24Vdc In, (4) 24Vdc Out,<br>24Vdc Power Supply                                                               |
| IC200NDR001 | 10-Point Nano PLC: (6) 24Vdc In, (4) Relay Out,<br>24Vdc Power Supply                                                               |
| IC200NDR010 | 10-Point Nano PLC: (6) 12Vdc In, (4) Relay Out,<br>12Vdc Power Supply                                                               |

### 2.1 VersaMax Nano PLC Features

VersaMax Nano PLCs offer the perfect solution for smaller packaging machines, dispensing machines, and relay replacement applications with up to 6 inputs and 4 outputs. In spite of their small size, these versatile controllers provide powerful programming features such as built-in high-speed counter functionality, support for floating-point function blocks and subroutines, ability to assign passwords and privilege levels, and override capability.

---

**Figure 4**



All VersaMax Nano PLCs feature:

- Two non-removable recessed “box-style” terminal strips.
- An external Run/Stop switch can be wired to the Nano PLC. The switch can be configured as a run/stop switch, or a memory protect switch, and used for clearing faults when a fatal fault exists.
- Configurable to read configuration at power-up from either RAM or flash memory (ROM). Can also be configured to read application program from flash at power-up.
- Capacitor backs up RAM for at least 30 minutes on hardware revisions C or above.
- Full-featured programming Instruction Set with floating point math.
- 2K words of program memory, 256 words of registers.

## 2.1.1 Nano PLC General Specifications

|                                                    |                                                             |
|----------------------------------------------------|-------------------------------------------------------------|
| Typical Scan Rate                                  | 1.3 ms/K for Boolean logic (see Appendix A:)                |
| Output Power Supplies                              | +5Vdc on pin 7 of Serial Port, 100mA max                    |
| Maximum number of slave devices per RS-485 network | 8 (can be increased with a repeater). Requires IC200ACC415. |
| Real-time clock accuracy (for timer functions)     | ±0.5%                                                       |

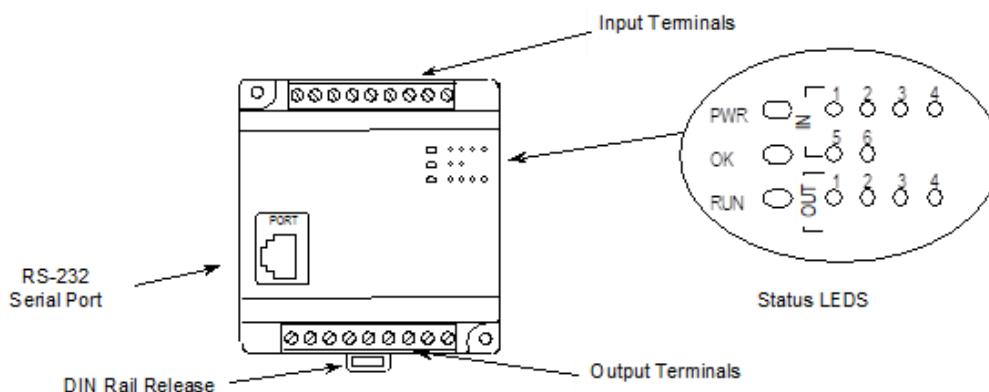
## 2.1.2 RS-232 Serial Port

The RS-232 serial port has an RJ-45 connector. The serial port defaults to SNP protocol, and can be configured for SNP/SNPX, slave or RTU slave using the configuration software. It can also be configured for Serial I/O and controlled using COMMREQs from the application program. The port automatically switches from RTU to SNP for programmer communications.

## 2.1.3 Status LEDs

LEDs provide quick visual verification of operating status. In addition to LEDs for Power, OK, and Run mode, there is an LED for each I/O point.

Figure 5



## 2.1.4 High-Speed Counters

A VersaMax Nano PLC can be configured to provide built-in high-speed counter and pulse operation.

When configured for High-Speed Counter operation, inputs can be set up as:

- Up to three Type A Counters or
- 1 Type A and 1 Type B Counter.

Each counter provides direct processing of rapid pulse signals up to 10 kHz for industrial control applications such as meter proving, turbine flowmeter, velocity measurement, material handling, motion control, and process control.

Each counter can be enabled independently. Type A counters can be configured for up or down counting (default is up) and for positive or negative edge detection (default is positive). The type B counter provides an A Quad B counting function.

Nano PLCs with DC outputs provide up to 3 High-Speed Counter outputs, and/or Pulse Train or Pulse-Width Modulated outputs.

Nano PLCs with relay outputs also provide up to 3 High-Speed Counter outputs. However, relay outputs cannot be used as Pulse Train or Pulse-Width Modulated outputs.

## 2.2 IC200NAL110 Nano PLCs with 10 Discrete Points and 1 Analog Input: (6) 12Vdc In, (4) Relay Out, 1 Analog Input, 12Vdc Power Supply

VersaMax Nano PLC IC200NAL110 has six DC inputs, one analog input, and four normally open 2-Amp relay outputs that can control 5Vdc to 30Vdc or 5Vac to 250Vac output devices. It uses +12Vdc nominal input power for PLC operation.

### 2.2.1 DC Inputs

The module's six configurable DC inputs can be used as positive or negative logic standard inputs or High-Speed Counter inputs. When used as standard inputs, the input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

### 2.2.2 Analog Input

Input IN1 can be used as an analog input (8-bit resolution), for analog signals in the 0V to 10V range. The analog input cannot be software calibrated.

## 2.2.3 Relay Outputs

The four Form A (SPST-single pole single throw) normally open relay outputs can control a wide range of devices such as motor starters, solenoids, and indicators. Power for the internal relay coils is provided by the +24-volt DC internal supply. An external source of AC or DC power must be supplied to operate field devices.

The relay outputs can be used as up to three High-Speed Counter outputs. They cannot be used as Pulse Train or Pulse-Width Modulated outputs. Connections and specifications for High-Speed Counter outputs are the same as for standard relay outputs.

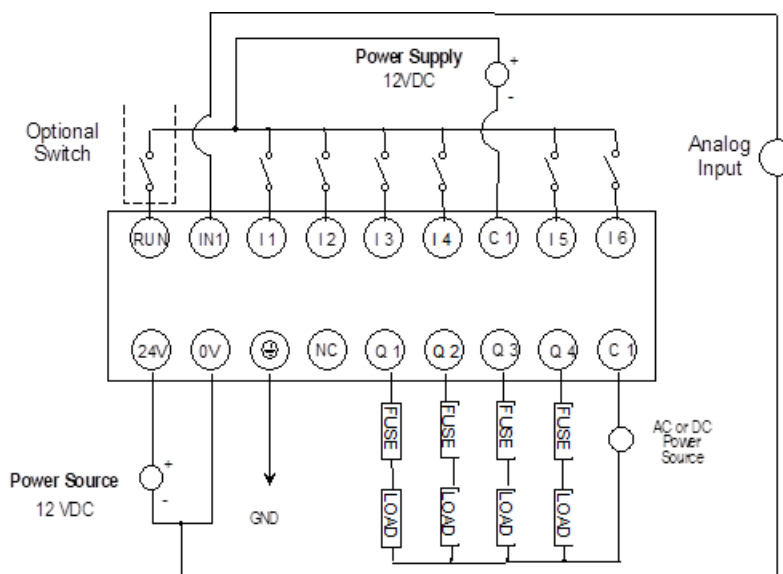
## 2.2.4 Nano PLC IC200NAL110 Specifications

|                                    |                                                                            |
|------------------------------------|----------------------------------------------------------------------------|
| Inputs                             | Six 12Vdc positive/negative logic inputs, one analog input, 0 to 10V       |
| Outputs                            | Four normally open 2 Amp relay circuits                                    |
| High-Speed Counters                | Three Type A or One Type A and One Type B                                  |
| <b>DC Power Specifications</b>     |                                                                            |
| Range                              | 9.6Vdc - 15Vdc                                                             |
| Hold-up                            | 3.0mS                                                                      |
| Inrush Current                     | 8A typical at 12Vdc                                                        |
| Inrush Time                        | 200mS typical                                                              |
| Input Current                      | 250mA typical at 12Vdc                                                     |
| Input Power Supply Rating          | 3W                                                                         |
| <b>DC Input Specifications</b>     |                                                                            |
| Number of Inputs                   | 6                                                                          |
| Rated Input Voltage                | 12 volts DC                                                                |
| Input Voltage Range                | 0 to 15 volts DC                                                           |
| Input Current                      | 9.0mA typical                                                              |
| Input Impedance                    | 1.3 k $\Omega$                                                             |
| Input Threshold Voltage            | ON: 9.5Vdc minimum, OFF: 2.5Vdc maximum                                    |
| Input Threshold Current            | ON: 6.5mA maximum, OFF: 1.6mA minimum                                      |
| Response Time                      | 0.5 to 20ms (user configurable) as regular input; 100 $\mu$ s as HSC input |
| Isolation Voltage                  | 1500V RMS field side to logic side, 500V RMS between group                 |
| <b>Analog Input Specifications</b> |                                                                            |
| Number of Analog Inputs            | 1, single                                                                  |
| Input range                        | 0 to 10 V (10.24 maximum)                                                  |
| Resolution                         | 8 bits                                                                     |
| Accuracy                           | 1% of full scale over temperature range                                    |
| Voltage input impedance            | 100k $\Omega$                                                              |
| Input filter time                  | 200ms to reach 1% error for step input                                     |
| <b>Relay Output Specifications</b> |                                                                            |

|                                                    |                                                                          |                                    |                               |
|----------------------------------------------------|--------------------------------------------------------------------------|------------------------------------|-------------------------------|
| Operating Voltage                                  | 5 to 30Vdc or 5 to 250Vac                                                |                                    |                               |
| Isolation                                          | 1500 V RMS between field side and logic side<br>500 V RMS between groups |                                    |                               |
| Leakage Current                                    | 15 mA at 240Vac maximum                                                  |                                    |                               |
| Maximum UL Pilot Duty Rating                       | 2 amps at 24Vdc and 240Vac                                               |                                    |                               |
| Maximum Resistive Load Rating                      | 2 amps at 24Vdc and 240Vac                                               |                                    |                               |
| Minimum Load                                       | 10 mA                                                                    |                                    |                               |
| Maximum Inrush                                     | 5 amps per half cycle                                                    |                                    |                               |
| On Response Time                                   | 15 ms maximum                                                            |                                    |                               |
| Off Response Time                                  | 15 ms maximum                                                            |                                    |                               |
| Fuse                                               | None                                                                     |                                    |                               |
| Contact Life: Mechanical                           | 20 x 10 <sup>6</sup> mechanical operations                               |                                    |                               |
| Contact Life: Electrical<br>240Vac, 120Vac, 24Vdc  | Current: Resistive<br>2A                                                 | Current: Lamp and<br>Solenoid 0.6A | Typical Operations<br>200,000 |
| High-Speed Counter Input and Output Specifications |                                                                          |                                    |                               |
| Maximum Counter Frequency                          | 10kHz                                                                    |                                    |                               |
| Input Voltage                                      | ON: 9V, OFF: 2.5V                                                        |                                    |                               |
| Count Pulse Width                                  | 20% to 80% duty cycle at 10kHz                                           |                                    |                               |
| Count Registers                                    | 16bits                                                                   |                                    |                               |
| Outputs                                            |                                                                          |                                    |                               |
| Load Voltage                                       | 12V                                                                      |                                    |                               |
| Number of Pulse Outputs                            | None                                                                     |                                    |                               |

## 2.2.5 Wiring Diagram, IC200NAL110

Figure 6



## 2.3 IC200NAL211

### Nano PLC with 10 Discrete Points and 1 Analog Input:

### (6) 12Vdc In, (4) Relay Out, 1 Analog Input, 24Vdc Power Supply

VersaMax Nano PLC IC200NAL211 has six DC inputs, one analog input, and four normally open 2 Amp relay outputs that can control 5 to 30Vdc or 5 to 250Vac output devices. It uses +24Vdc nominal input power for PLC operation.

#### 2.3.1 DC Inputs

The module's six configurable DC inputs can be used as positive or negative logic standard inputs. Whether used as a standard or HSC input, each DC input can have positive or negative logic characteristics. When used as standard inputs, the input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

#### 2.3.2 Analog Input

Input IN1 can be used as an analog input (8-bit resolution), for analog signals in the 0V to 10V range. The analog input cannot be software calibrated.

#### 2.3.3 Relay Outputs

The four Form A (SPST-single pole single throw) normally open relay outputs can control a wide range of devices such as motor starters, solenoids, and indicators. Power for the internal relay coils is provided by the +24-volt DC internal supply. An external source of AC or DC power must be supplied to operate field devices.

The relay outputs can be used as up to three High-Speed Counter outputs. They cannot be used as Pulse Train or Pulse-Width Modulated outputs. Connections and specifications for High-Speed Counter outputs are the same as for standard relay outputs.

## 2.3.4 Nano PLC IC200NAL211 Specifications

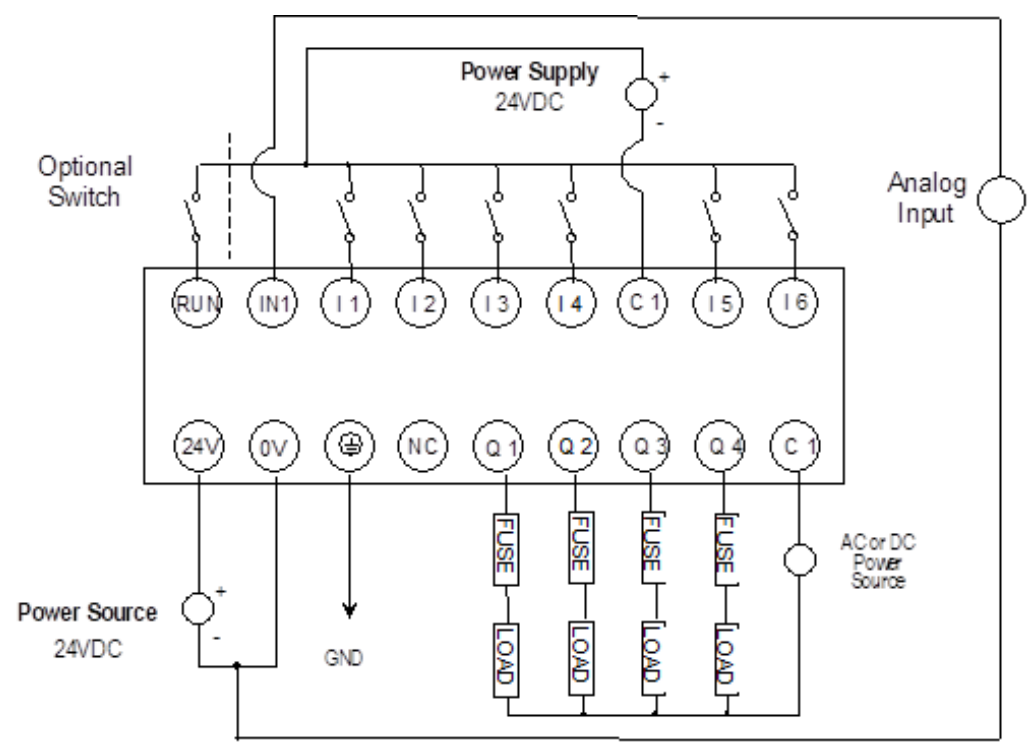
|                                    |                                                                            |
|------------------------------------|----------------------------------------------------------------------------|
| Inputs                             | Six 24Vdc positive/negative logic inputs, one analog input, 0 to 10V       |
| Outputs                            | Four normally open 2 Amp relay circuits                                    |
| High-Speed Counters                | Three Type A or One Type A and One Type B                                  |
| <b>DC Power Specifications</b>     |                                                                            |
| Range                              | 19.2Vdc - 30.0Vdc                                                          |
| Hold-up                            | 10mS at 19.2Vdc                                                            |
| Inrush Current                     | 1 Amp maximum at 30Vdc                                                     |
| Inrush Time                        | 10mS for 1 Amp                                                             |
| Input Current                      | 0.12 Amp typical at 24Vdc                                                  |
| Input Power Supply Rating          | 3W                                                                         |
| <b>DC Input Specifications</b>     |                                                                            |
| Number of Inputs                   | 6                                                                          |
| Rated Input Voltage                | 24 volts DC                                                                |
| Input Voltage Range                | 0 to 30 volts DC                                                           |
| Input Current                      | 7.5mA typical                                                              |
| Input Impedance                    | 2.8 k $\Omega$                                                             |
| Input Threshold Voltage            | ON: 15Vdc minimum, OFF: 5Vdc maximum                                       |
| Input Threshold Current            | ON: 4.5mA maximum, OFF: 1.5mA minimum                                      |
| Response Time                      | 0.5 to 20ms (user configurable) as regular input; 100 $\mu$ s as HSC input |
| Isolation Voltage                  | 1500V RMS field side to logic side, 500V RMS between group                 |
| <b>Analog Input Specifications</b> |                                                                            |
| Number of Analog Inputs            | 1, single                                                                  |
| Input range                        | 0 to 10 V (10.24 maximum)                                                  |
| Resolution                         | 8 bits                                                                     |
| Accuracy                           | 1% of full scale over temperature range                                    |
| Voltage input impedance            | 100k $\Omega$                                                              |
| Input filter time                  | 200ms to reach 1% error for step input                                     |
| <b>Relay Output Specifications</b> |                                                                            |
| Operating Voltage                  | 5 to 30Vdc or 5 to 250Vac                                                  |
| Isolation                          | 1500 V RMS between field side and logic side<br>500 V RMS between groups   |
| Leakage Current                    | 15 mA at 240Vac maximum                                                    |
| Maximum UL Pilot Duty Rating       | 2 amps at 24Vdc and 240Vac                                                 |
| Maximum Resistive Load Rating      | 2 amps at 24Vdc and 240Vac                                                 |
| Minimum Load                       | 10 mA                                                                      |
| Maximum Inrush                     | 5 amps per half cycle                                                      |



|                                                    |                                            |                                    |                               |
|----------------------------------------------------|--------------------------------------------|------------------------------------|-------------------------------|
| On Response Time                                   | 15 ms maximum                              |                                    |                               |
| Off Response Time                                  | 15 ms maximum                              |                                    |                               |
| Fuse                                               | None                                       |                                    |                               |
| Contact Life: Mechanical                           | 20 x 10 <sup>6</sup> mechanical operations |                                    |                               |
| Contact Life: Electrical<br>240Vac, 120Vac, 24Vdc  | Current: Resistive<br>2A                   | Current: Lamp and Solenoid<br>0.6A | Typical Operations<br>200,000 |
| High-Speed Counter Input and Output Specifications |                                            |                                    |                               |
| Maximum Counter Frequency                          | 10kHz                                      |                                    |                               |
| Input Voltage                                      | ON: 15V, OFF: 5V                           |                                    |                               |
| Count Pulse Width                                  | 20% to 80% duty cycle at 10kHz             |                                    |                               |
| Count Registers                                    | 16bits                                     |                                    |                               |
| Outputs                                            |                                            |                                    |                               |
| Load Voltage                                       | 12/24V                                     |                                    |                               |
| Number of Pulse Outputs                            | None                                       |                                    |                               |

## 2.3.5 Wiring Diagram, IC200NAL211

Figure 7



## 2.4 IC200NDD010

### 10 Point Nano PLC: (6) 12Vdc In, (4) 12Vdc Out, 12Vdc Power Supply

VersaMax Nano PLC IC200NDD010 has six 12Vdc inputs and four DC transistor outputs. It uses +12Vdc nominal input power for PLC operation.

#### 2.4.1 DC Inputs

The module's six configurable DC inputs can be used as standard inputs or High-Speed Counter inputs. Whether used as a standard or HSC input, each input can have positive or negative logic characteristics. When used as standard inputs, the input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

#### 2.4.2 Transistor Outputs

The four transistor output circuits can be used to switch devices like valves, lamps or contactors. External fusing should be provided to protect the outputs. Fast fuses are recommended.

The outputs can be configured as regular outputs or as outputs controlled by the High-Speed Counters. Then can also be used as Pulse Train and/or Pulse Width Modulation (PWM) outputs.

All outputs are isolated between field and logic and are switching positive voltage. The outputs have one common incoming supply (VC) and one common ground (COM). The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

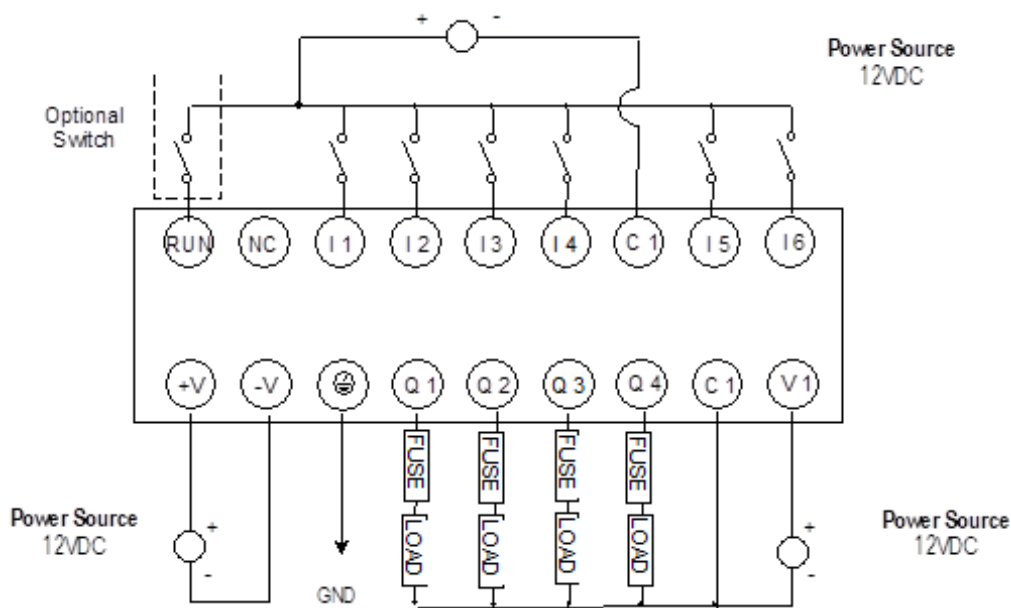
#### 2.4.3 Nano PLC IC200NDD010 Specifications

|                                |                                                  |
|--------------------------------|--------------------------------------------------|
| Inputs                         | Six 12Vdc positive/negative logic input circuits |
| Outputs                        | Four transistor outputs                          |
| High-Speed Counters            | Three Type A or One Type A and One Type B        |
| <b>DC Power Specifications</b> |                                                  |
| Range                          | 9.6Vdc - 15Vdc                                   |
| Hold-up                        | 3.0mS                                            |
| Inrush Current                 | 8A typical at 12Vdc                              |
| Inrush Time                    | 200mS typical                                    |
| Input Current                  | 250mA typical at 12Vdc                           |
| Input Power Supply Rating      | 3W                                               |
| <b>DC Input Specifications</b> |                                                  |
| Number of Inputs               | 6                                                |

|                                                           |                                                                                                                                     |
|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| Rated Input Voltage                                       | 12 volts DC                                                                                                                         |
| Input Voltage Range                                       | 0 to 15 volts DC                                                                                                                    |
| Input Current                                             | 9.0mA typical                                                                                                                       |
| Input Impedance                                           | 1.3 k $\Omega$                                                                                                                      |
| Input Threshold Voltage                                   | ON: 9.5Vdc minimum, OFF: 2.5Vdc maximum                                                                                             |
| Input Threshold Current                                   | ON: 6.5mA maximum, OFF: 1.6mA minimum                                                                                               |
| Response Time                                             | 0.5 to 20ms (user configurable) as regular input; 100 $\mu$ s as HSC input                                                          |
| Isolation Voltage                                         | 1500V RMS field side to logic side, 500V RMS between group                                                                          |
| <b>Transistor Output Specifications</b>                   |                                                                                                                                     |
| Voltage Range                                             | 12Vdc (12Vdc +20%, -20%)                                                                                                            |
| Maximum Load                                              | 0.7A per circuit, 4A per common                                                                                                     |
| Maximum Inrush Current                                    | 4A for 20ms                                                                                                                         |
| Output Voltage Drop                                       | 0.3V maximum                                                                                                                        |
| OFF state leakage                                         | 0.1mA maximum                                                                                                                       |
| Response                                                  | OFF to ON: 0.1mS maximum 12Vdc 0.2A<br>ON to OFF: 0.1mS maximum 12Vdc 0.2A                                                          |
| Isolation Voltage                                         | 1500V RMS field side to logic side, 500Vac between field side and logic side                                                        |
| External power supply                                     | 12Vdc +10%, -20%                                                                                                                    |
| Fuse                                                      | Outputs should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable. |
| <b>High-Speed Counter Input and Output Specifications</b> |                                                                                                                                     |
| Maximum Counter Frequency                                 | 10kHz                                                                                                                               |
| Input Voltage                                             | ON: 9V, OFF 2.5V                                                                                                                    |
| Count Pulse Width                                         | 20% to 80% duty cycle at 10kHz                                                                                                      |
| Count Registers                                           | 16bits                                                                                                                              |
| <b>Outputs</b>                                            |                                                                                                                                     |
| Number of Outputs                                         | Up to three HSC/PT and/or PWM outputs                                                                                               |
| Load Voltage                                              | 12V                                                                                                                                 |
| Maximum Pulse/PWM Frequency                               | 5kHz                                                                                                                                |

## 2.4.4 Wiring Diagram, IC200NDD010

Figure 8



## 2.5 IC200NDD101

### 10 Point Nano PLC: (6) 24Vdc In, (4) 12Vdc Out, 24Vdc Power Supply

VersaMax Nano PLC IC200NDD101 has six 24Vdc inputs and four DC transistor outputs. It uses +24Vdc nominal input power for PLC operation.

### 2.5.1 DC Inputs

Six configurable DC inputs can be used as standard inputs or High-Speed Counter inputs. Whether used as a standard or HSC input, each input can have positive or negative logic characteristics. When used as standard inputs, the input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

### 2.5.2 Transistor Outputs

The four transistor output circuits can be used to switch devices like valves, lamps or contactors. External fusing should be provided to protect the outputs. Fast fuses are recommended.

The outputs can be configured as regular outputs or as outputs controlled by the High-Speed Counters. They can also be used as Pulse Train and/or Pulse Width Modulation (PWM) outputs.

All outputs are isolated between field and logic and are switching positive voltage. The outputs have one common incoming supply (VC) and one common ground (COM). The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

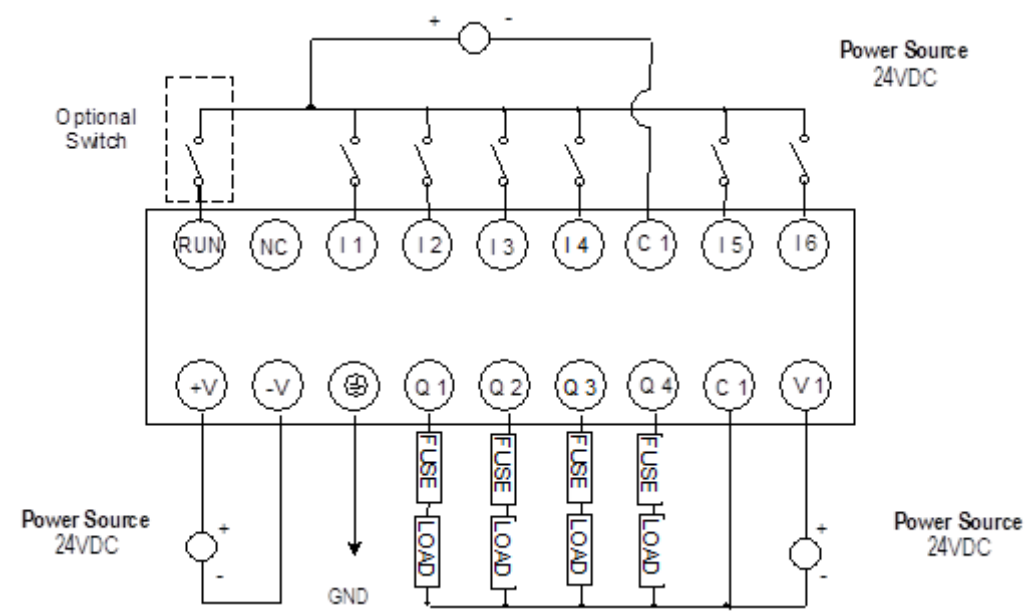
## 2.5.3 Nano PLC IC200NDD101 Specifications

|                                         |                                                                                                                   |
|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| Inputs                                  | Six 24Vdc positive/negative logic input circuits                                                                  |
| Outputs                                 | Four transistor outputs                                                                                           |
| High-Speed Counters                     | Three Type A or One Type A and One Type B                                                                         |
| <b>DC Power Specifications</b>          |                                                                                                                   |
| Range                                   | 19.2Vdc - 30.0Vdc                                                                                                 |
| Hold-up                                 | 10mS at 19.2Vdc                                                                                                   |
| Inrush Current                          | 1 Amp maximum at 30Vdc                                                                                            |
| Inrush Time                             | 10mS for 1 Amp                                                                                                    |
| Input Current                           | 0.12 Amp typical at 24Vdc                                                                                         |
| Input Power Supply Rating               | 3W                                                                                                                |
| <b>DC Input Specifications</b>          |                                                                                                                   |
| Number of Inputs                        | 6                                                                                                                 |
| Rated Input Voltage                     | 24 volts DC                                                                                                       |
| Input Voltage Range                     | 0 to 30 volts DC                                                                                                  |
| Input Current                           | 7.5mA typical                                                                                                     |
| Input Impedance                         | 2.8 kΩ                                                                                                            |
| Input Threshold Voltage                 | ON: 15Vdc minimum, OFF: 5Vdc maximum                                                                              |
| Input Threshold Current                 | ON: 4.5mA maximum, OFF: 1.5mA minimum                                                                             |
| Response Time                           | 0.5 to 20ms (user configurable) as regular input; 100μs as HSC input                                              |
| Isolation Voltage                       | 1500V RMS field side to logic side<br>500V RMS between group                                                      |
| <b>Transistor Output Specifications</b> |                                                                                                                   |
| Voltage Range                           | 12Vdc/24Vdc (24Vdc +10% / -43% input at V1,C1)                                                                    |
| Maximum Load                            | 0.75A per point (Q1 - Q4) at 24Vdc at 100 % ON duration<br>0.5A per point (Q1 - Q4) at 12Vdc at 100 % ON duration |
| Maximum Inrush Current                  | 8A for 20ms, 1 pulse (0.75A outputs)<br>4A for 20ms, 1 pulse (0.5A outputs)                                       |
| Output Voltage Drop                     | 0.3V maximum                                                                                                      |
| OFF state leakage                       | 100μA maximum                                                                                                     |
| Response                                | OFF to ON: 0.1mS maximum 24Vdc 0.2A<br>ON to OFF: 0.1mS maximum 24Vdc 0.2A                                        |
| Isolation Voltage                       | 1500V RMS field side to logic side, 500Vac between field side and logic side                                      |

|                                                           |                                                                                                                                     |
|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| External power supply                                     | 16-30Vdc required to power the outputs.                                                                                             |
| Fuse                                                      | Outputs should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable. |
| <b>High-Speed Counter Input and Output Specifications</b> |                                                                                                                                     |
| Maximum Counter Frequency                                 | 10kHz                                                                                                                               |
| Input Voltage                                             | ON: 15V, OFF: 5V                                                                                                                    |
| Count Pulse Width                                         | 20% to 80% duty cycle at 10kHz                                                                                                      |
| Count Registers                                           | 16bits                                                                                                                              |
| <b>High-Speed Counter Outputs</b>                         |                                                                                                                                     |
| Number of Outputs                                         | Up to three HSC/PT and/or PWM outputs                                                                                               |
| Load Voltage                                              | 12/24V                                                                                                                              |
| Maximum Pulse/PWM Frequency                               | 5kHz                                                                                                                                |

## 2.5.4 Wiring Diagram, IC200NDD101

Figure 9



## 2.6 IC200NDR001

10-Point Nano PLC: (6) 24Vdc In, (4) Relay Out, 24Vdc Power Supply

VersaMax Nano PLC IC200NDR001 has six 24Vdc inputs, and four normally-open 2-Amp relay outputs that can control 5 to 30Vdc or 5 to 250Vac output devices. It uses +12Vdc nominal input power for PLC operation.

### 2.6.1 DC Inputs

The module's six configurable DC inputs can be used as standard inputs or High-Speed Counter inputs. Whether used as a standard or High-Speed Counter input, each input can have positive or negative logic characteristics. When used as standard inputs, the input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

### 2.6.2 Relay Outputs

The four Form A (SPST-single pole single throw) normally open relay outputs can control a wide range of devices such as motor starters, solenoids, and indicators. Power for the internal relay coils is provided by the +24-volt DC internal supply. An external source of AC or DC power must be supplied to operate field devices.

Connections and specifications for HSC outputs are the same as for standard relay outputs.

### 2.6.3 Nano PLC IC200NDR001 Specifications

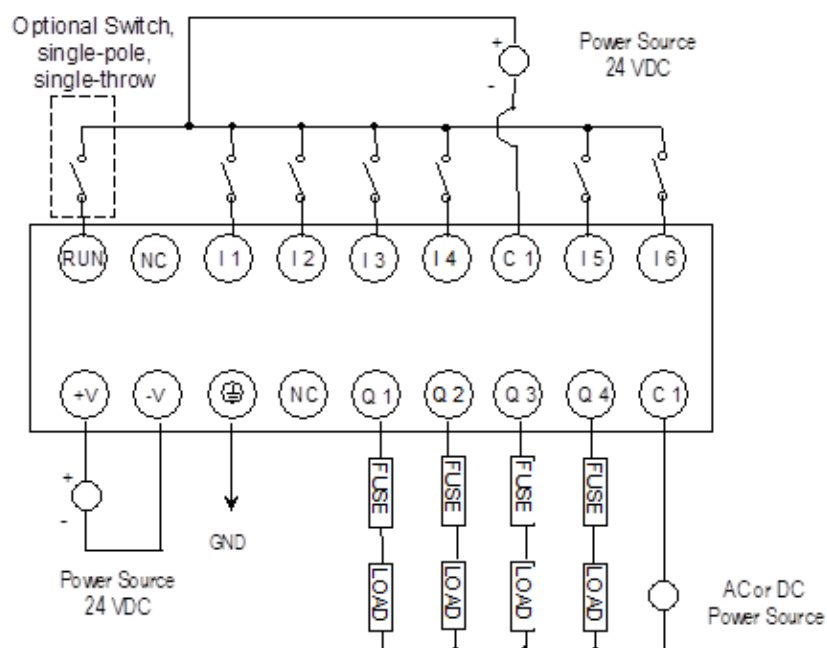
|                                |                                                  |
|--------------------------------|--------------------------------------------------|
| Inputs                         | Six 24Vdc positive/negative logic input circuits |
| Outputs                        | Four normally open 2 Amp relay circuits          |
| High-Speed Counters            | Three Type A or One Type A and One Type B        |
| <b>DC Power Specifications</b> |                                                  |
| Range                          | 24 –20%/+25%Vdc                                  |
| Hold-up                        | 10 ms at 19.2Vdc                                 |
| Inrush Current                 | 1A maximum at 24Vdc                              |
| Inrush Time                    | 10 ms for 1 A                                    |
| Input Current                  | 0.12A typical at 24Vdc                           |
| Input Power Supply Rating      | 3W                                               |
| <b>Input Specifications</b>    |                                                  |
| Number of Inputs               | 6                                                |
| Rated Input Voltage            | 24 volts DC                                      |
| Input Voltage Range            | 0 to 30 volts DC                                 |
| Input Current                  | 7.5mA typical                                    |
| Input Resistance               | 2.8 kΩ                                           |
| Input Threshold Voltage        | ON: 15Vdc minimum, OFF: 5Vdc maximum             |
| Input Threshold Current        | ON: 4.5mA maximum, OFF: 1.5mA minimum            |

|                                                    |                                                                        |                                    |                               |
|----------------------------------------------------|------------------------------------------------------------------------|------------------------------------|-------------------------------|
| Response Time                                      | 0.5 to 20ms configurable as regular input; 100μs as HSC input          |                                    |                               |
| Isolation Voltage                                  | 1500V RMS field side to logic side, 500V RMS between groups            |                                    |                               |
| Relay Output Specifications                        |                                                                        |                                    |                               |
| Operating Voltage                                  | 5 to 30Vdc or 5 to 250Vac                                              |                                    |                               |
| Isolation                                          | 1500 V RMS between field side and logic side, 500 V RMS between groups |                                    |                               |
| Leakage Current                                    | 15 mA at 240Vac maximum                                                |                                    |                               |
| Maximum UL Pilot Duty Rating                       | 2 amps at 24Vdc and 240Vac                                             |                                    |                               |
| Maximum Resistive Load Rating                      | 2 amps at 24Vdc and 240Vac                                             |                                    |                               |
| Minimum Load                                       | 10 mA                                                                  |                                    |                               |
| Maximum Inrush                                     | 5 amps per half cycle                                                  |                                    |                               |
| Response Time                                      | ON: 15 ms maximum, OFF: 15 ms maximum                                  |                                    |                               |
| Fuse                                               | None                                                                   |                                    |                               |
| Contact Life: Mechanical                           | 20 x 106 mechanical operations                                         |                                    |                               |
| Contact Life: Electrical<br>240Vac, 120Vac, 24Vdc  | Current: Resistive<br>2A                                               | Current: Lamp and Solenoid<br>0.6A | Typical Operations<br>200,000 |
| High-Speed Counter Input and Output Specifications |                                                                        |                                    |                               |
| Maximum Counter Frequency                          | 10kHz                                                                  |                                    |                               |
| Input Voltage                                      | ON: 15V, OFF: 5V                                                       |                                    |                               |
| Count Pulse Width                                  | 20% to 80% duty cycle at 10kHz                                         |                                    |                               |
| Count Registers                                    | 16bits                                                                 |                                    |                               |
| High-Speed Counter Outputs                         |                                                                        |                                    |                               |
| Load Voltage                                       | refer to relay output specifications                                   |                                    |                               |
| Number of Pulse Outputs                            | None                                                                   |                                    |                               |



## 2.6.4 Wiring Diagram, IC200NDR001

Figure 10



## 2.7 IC200NDR010

### 10 Point Nano PLC: (6) 24Vdc In, (4) Relay Out, 12Vdc Power Supply

VersaMax Nano PLC IC200NDR010 has six 24Vdc inputs, and four normally open 2-Amp relay outputs that can control 5 to 30Vdc or 5 to 250Vac output devices. It uses +12Vdc nominal input power for PLC operation.

#### 2.7.1 Inputs

The module's six configurable DC inputs can be used as standard inputs or High-Speed Counter inputs. Whether used as a standard or High-Speed Counter input, each input can have positive or negative logic characteristics. When used as standard inputs, the input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

#### 2.7.2 Relay Outputs

The four Form A (SPST-single pole single throw) normally open relay outputs can control a wide range of devices such as motor starters, solenoids, and indicators. Power for the internal relay coils is provided by the +24-volt DC internal supply. An external source of AC or DC power must be supplied to operate field devices.

Connections and specifications for High-Speed Counter outputs are the same as for standard relay outputs.

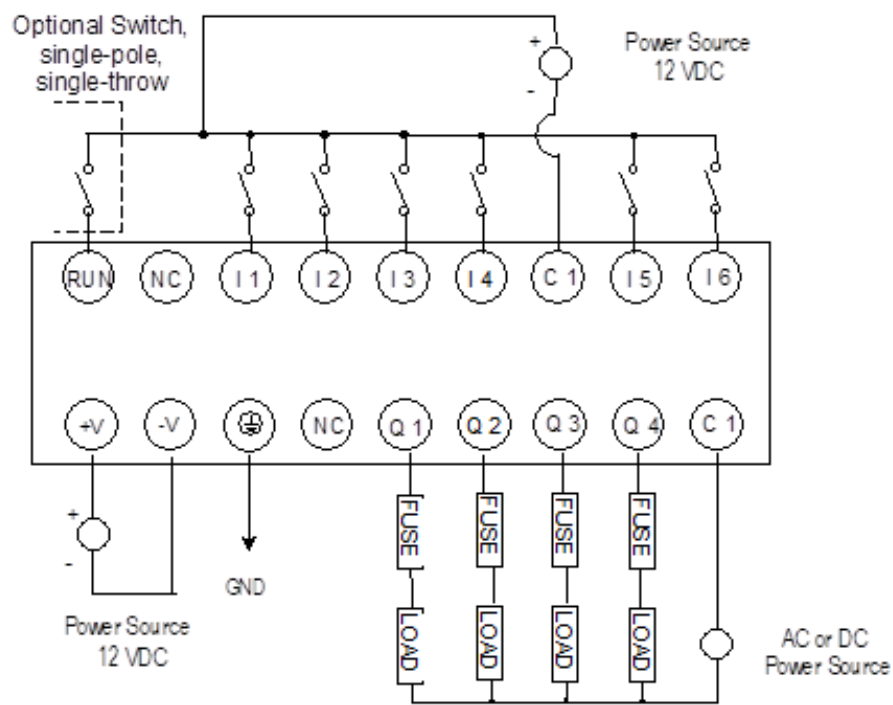
## 2.7.3 Nano PLC IC200NDR010 Specifications

| Item                                              | Description                                                            |                                    |                               |
|---------------------------------------------------|------------------------------------------------------------------------|------------------------------------|-------------------------------|
| Inputs                                            | Six 12Vdc positive/negative logic input circuits                       |                                    |                               |
| Outputs                                           | Four normally open 2 Amp relay circuits                                |                                    |                               |
| High-Speed Counters                               | Three Type A or One Type A and One Type B                              |                                    |                               |
| DC Power Specifications                           |                                                                        |                                    |                               |
| Range                                             | 9.6Vdc - 15Vdc                                                         |                                    |                               |
| Hold-up                                           | 3.0mS                                                                  |                                    |                               |
| Inrush Current                                    | 8A typical at 12Vdc                                                    |                                    |                               |
| Inrush Time                                       | 200mS typical                                                          |                                    |                               |
| Input Current                                     | 250mA typical at 12Vdc                                                 |                                    |                               |
| Input Power Supply Rating                         | 3W                                                                     |                                    |                               |
| Input Specifications                              |                                                                        |                                    |                               |
| Number of Inputs                                  | 6                                                                      |                                    |                               |
| Rated Input Voltage                               | 12 volts DC                                                            |                                    |                               |
| Input Voltage Range                               | 0 to 15 volts DC                                                       |                                    |                               |
| Input Current                                     | 9.0mA typical                                                          |                                    |                               |
| Input Resistance                                  | 1.3 kΩ                                                                 |                                    |                               |
| Input Threshold Voltage                           | ON: 9.5Vdc minimum, OFF: 2.5Vdc maximum                                |                                    |                               |
| Input Threshold Current                           | ON: 6.5mA maximum, OFF: 1.6mA minimum                                  |                                    |                               |
| Response Time                                     | 0.5 to 20ms configurable as regular input; 100μs as HSC input          |                                    |                               |
| Isolation Voltage                                 | 1500V RMS field side to logic side, 500V RMS between groups            |                                    |                               |
| Relay Output Specifications                       |                                                                        |                                    |                               |
| Operating Voltage                                 | 5 to 30Vdc or 5 to 250Vac                                              |                                    |                               |
| Isolation                                         | 1500 V RMS between field side and logic side, 500 V RMS between groups |                                    |                               |
| Leakage Current                                   | 15 mA at 240Vac maximum                                                |                                    |                               |
| Maximum UL Pilot Duty Rating                      | 2 amps at 24Vdc and 240Vac                                             |                                    |                               |
| Maximum Resistive Load Rating                     | 2 amps at 24Vdc and 240Vac                                             |                                    |                               |
| Minimum Load                                      | 10mA                                                                   |                                    |                               |
| Maximum Inrush                                    | 5 amps per half cycle                                                  |                                    |                               |
| Response Time                                     | ON: 15 ms maximum, OFF: 15 ms maximum                                  |                                    |                               |
| Fuse                                              | None                                                                   |                                    |                               |
| Contact Life: Mechanical                          | 20 x 106 mechanical operations                                         |                                    |                               |
| Contact Life: Electrical<br>240Vac, 120Vac, 24Vdc | Current: Resistive<br>2A                                               | Current: Lamp and Solenoid<br>0.6A | Typical Operations<br>200,000 |

| Item                                                      | Description                          |
|-----------------------------------------------------------|--------------------------------------|
| <b>High-Speed Counter Input and Output Specifications</b> |                                      |
| Maximum Counter Frequency                                 | 10kHz                                |
| Input Voltage                                             | ON: 9V, OFF: 2.5V                    |
| Count Pulse Width                                         | 20% to 80% duty cycle at 10kHz       |
| Count Registers                                           | 16bits                               |
| <b>Outputs</b>                                            |                                      |
| Load Voltage                                              | refer to relay output specifications |
| Number of Pulse Outputs                                   | None                                 |

## 2.7.4 Wiring Diagram, IC200NR010

Figure 11

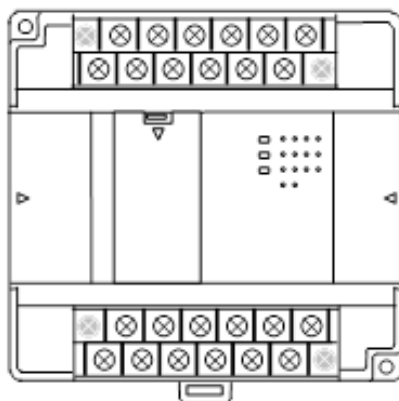


## Chapter 3: VersaMax 14-Point Micro PLCs

|                    |                                                                                                               |
|--------------------|---------------------------------------------------------------------------------------------------------------|
| <b>IC200UAA003</b> | 14 Point Micro PLC, (8) 120Vac In, (6) 120Vac Out, 120/240Vac Power Supply                                    |
| <b>IC200UAR014</b> | 14 Point Micro PLC, (8) 120Vac In, (2) Relay Out at 10 Amps, (4) Relay Out at 2 Amps, 120/240Vac Power Supply |
| <b>IC200UDD104</b> | 14 Point Micro PLC, (8) 24Vdc Source In, (6) 24Vdc Source Out, 24Vdc Power Supply                             |
| <b>IC200UDD112</b> | 14 Point Micro PLC, (8) 12Vdc In, (6) 12Vdc Out, 12Vdc Power Supply                                           |
| <b>IC200UDR001</b> | 14 Point Micro PLC, (8) 24Vdc In, (6) Relay Out, 120/240Vac Power Supply                                      |
| <b>IC200UDR002</b> | 14 Point Micro PLC, (8) 24Vdc In, (6) Relay Out, 24Vdc Power Supply                                           |
| <b>IC200UDR003</b> | 14 Point Micro PLC, (8) 12Vdc In, (6) Relay Out, 12Vdc Power Supply                                           |

### 3.1 VersaMax 14-Point Micro PLC Features

Figure 12



All VersaMax 14 Point Micro PLCs feature:

- Two removable screw-down “barrier-style” terminal strips with protective covers.
- RS-232 serial port that supports SNP/SNPX, RTU slave protocols, and Serial I/O.
- Run/Stop mode switch that can be configured as a run/stop switch, a memory protect switch, and also used for clearing faults when a fatal fault exists.
- Two analog potentiometers.
- Full-featured programming Instruction Set with floating point math. The application program can be either Ladder Diagram (LD) or Instruction List (IL) format.
- 9K words of program memory, 256 words of registers.
- Support for up to four Expansion Units in any combination.
- Flash memory (ROM) for non-volatile program storage and for system firmware.
- Configurable to read configuration at power-up from either RAM or flash memory (ROM). Can also be configured to read application program from flash at power-up.
- Capacitor backs up RAM for at least 3 days.

## 3.2 14-Point Micro PLC General Specifications

|                                                    |                                                             |
|----------------------------------------------------|-------------------------------------------------------------|
| Typical Scan Rate                                  | 1.3 ms/K for Boolean logic (see Appendix A:)                |
| Output Power Supplies                              | +5Vdc on pin 7 of Serial Port, 100mA max                    |
| Maximum number of slave devices per RS-485 network | 8 (can be increased with a repeater). Requires IC200ACC415. |
| Real-time clock accuracy (for timer functions)     | ± 0.5%                                                      |

## 3.3 High-Speed Counters

All VersaMax Micro with DC power can be configured to provide built-in high-speed counter and pulse operation.

When configured for High-Speed Counter operation, inputs can be set up as:

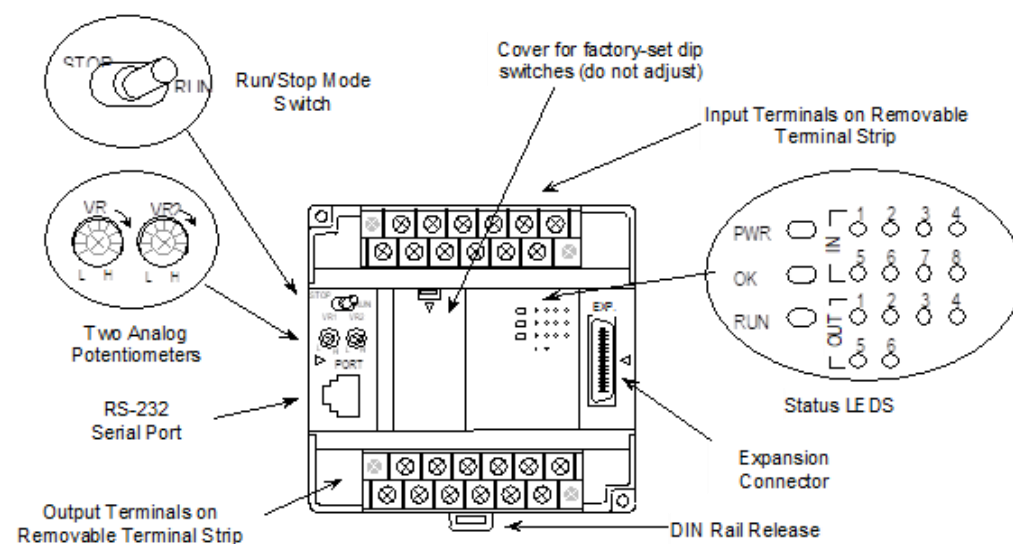
- Up to four Type A Counters or
- One Type A and one Type B Counter.

Each counter provides direct processing of rapid pulse signals up to 10 kHz for industrial control applications such as meter proving, turbine flowmeter, velocity measurement, material handling, motion control, and process control.

Each counter can be enabled independently. Type A counters can be configured for up or down counting (default is up) and for positive or negative edge detection (default is positive). The type B counter provides an A Quad B counting function.

Models with DC outputs can be configured to provide up to four counter, Pulse Train or PWM outputs.

Figure 13



## 3.4 IC200UAA003

### 14-Point Micro PLC, (8) 120Vac In, (6) 120Vac Out, 120/240Vac Power Supply

VersaMax Micro PLC model IC200UAA003 accepts eight AC inputs and provides six AC outputs. It uses 100Vac to 240Vac nominal input power.

#### 3.4.1 AC Inputs

The module's eight 120Vac input circuits are reactive (resistor/capacitor) inputs. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate the field devices must be supplied. The input circuits require an AC power source: they cannot be used with a DC power source.

#### 3.4.2 AC Outputs

The 120/240Vac, 0.5 Amp triac outputs are provided in isolated groups. The commons are not tied together inside the module. This allows each group to be used on different phases of the AC supply or to be powered from the same supply. Each group is protected with a replaceable 3.15-amp fuse for its common. Also, an RC snubber is provided for each output to protect against transient electrical noise on the power line.

This module provides a high degree of inrush current (10x the rated current) which makes the outputs suitable for controlling many types of inductive and incandescent loads. AC power to operate loads connected to outputs must be supplied from an external source.

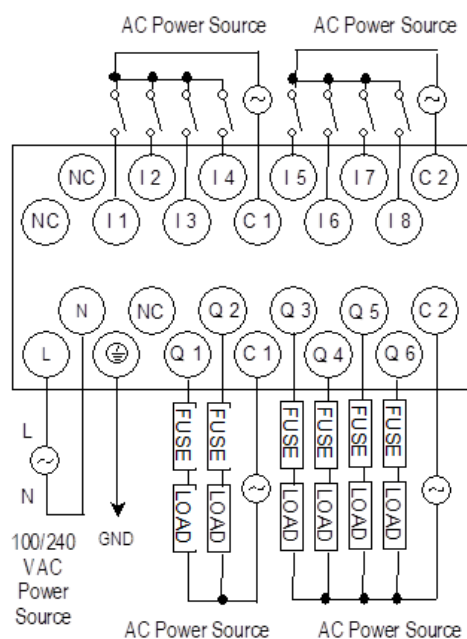
#### 3.4.3 Micro PLC IC200UAA003 Specifications

| Item                           | Description                                                                      |
|--------------------------------|----------------------------------------------------------------------------------|
| Inputs                         | Eight AC inputs                                                                  |
| Outputs                        | Six AC outputs                                                                   |
| High-Speed Counters            | None                                                                             |
| <b>AC Power Specifications</b> |                                                                                  |
| Range                          | 100 -15% to 240 +10%Vac                                                          |
| Frequency                      | 50 -5% to 60 +5% Hz                                                              |
| Hold-up                        | 10mS at 85 to 100Vac, 20mS at 100 to 264Vac                                      |
| Inrush Time                    | 2mS for 40 Amp                                                                   |
| Inrush Current                 | 18 Amp maximum at 120Vac<br>30 Amp maximum at 200Vac<br>40 Amp maximum at 265Vac |
| Input Current                  | 0.05 Amp typical at 200Vac, 0.10 Amp Typical at 100Vac                           |
| Input Power Supply Rating      | 11 VA                                                                            |
| <b>AC Input Specifications</b> |                                                                                  |
| Points/Common                  | 4 (I1-I4) and (I5-I8)                                                            |

| Item                            | Description                                                                    |
|---------------------------------|--------------------------------------------------------------------------------|
| Rated Load Voltage              | 85–132Vac, 50 -5% to 60 +5% Hz                                                 |
| Maximum Input Voltage           | 132V rms, 50/60 Hz                                                             |
| Input Current                   | 8mA rms (100Vac, 60 Hz)                                                        |
| Voltage                         | ON: minimum 80V rms, 4.5mA rms, OFF: maximum 30V rms, 2mA rms                  |
| Response Time                   | OFF to ON: maximum 25mS, ON to OFF: maximum 30mS                               |
| Isolation                       | 1500V rms field side to logic side, 500V rms between groups                    |
| <b>AC Output Specifications</b> |                                                                                |
| Rated Load Voltage              | 100 -15% to 240 +10%Vac, 50 -5% to 60 +5% Hz                                   |
| Maximum Resistive Load Current  | 0.5 Amp per point                                                              |
| Maximum UL Pilot Duty Rating    | 0.5 Amp per point at 240Vac<br>0.6 Amp maximum on C1<br>1.2 Amps maximum on C2 |
| Maximum Inrush Current          | 5A (1 period)/point, 10A (1 period)/common                                     |
| Maximum voltage drops when ON   | 1.5 V RMS                                                                      |
| Maximum leak current when OFF   | 1.8 mA RMS (115Vac), 3.5 mA RMS (230Vac)                                       |
| Response Time (Maximum)         | OFF to ON: 1 mS, ON to OFF: 1/2 cycle + 1 mS                                   |
| Isolation                       | 1500V RMS field side to logic side 500V RMS between groups                     |

### 3.4.4 Wiring Diagram, IC200UAA003

Figure 14



## 3.5 IC200UAR014

### 14-Point Micro PLC, (8) 120Vac In, (6) Relay Out, 120/240Vac Power Supply

VersaMax Micro PLC model IC200UAR014 accepts eight AC inputs and provides six relay outputs: 2 at 10 Amps and 4 at 2 Amps. It uses 100Vac to 240Vac nominal input power.

#### 3.5.1 Inputs

The module's 120Vac input circuits are reactive (resistor/capacitor) inputs. The input circuits require an AC power source: they cannot be used with a DC power source. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate the field devices must be supplied.

#### 3.5.2 Relay Outputs

The six normally open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. There are two individual 10 Amp relay outputs and one group of four 2-Amp relay outputs. Power for the internal relay coils is provided by the internal supply. Separate external sources of AC or DC power must be supplied to operate field output devices.

#### 3.5.3 Micro PLC IC200UAR014 Specifications

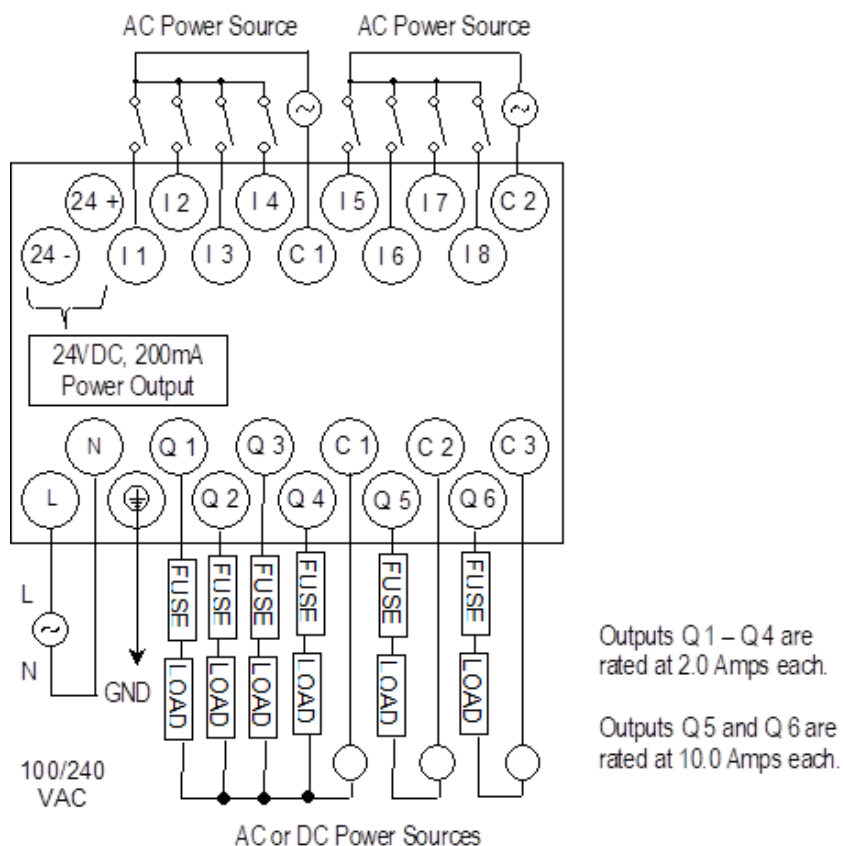
| Item                           | Description                                                                                      |
|--------------------------------|--------------------------------------------------------------------------------------------------|
| Inputs                         | Eight AC inputs                                                                                  |
| Outputs                        | Six Relay outputs                                                                                |
| High-Speed Counters            | None                                                                                             |
| Output Power Supplies          | 24Vdc for input circuits & user devices, 200mA max.<br>+5Vdc on pin 7 of Serial Port, 100mA max. |
| <b>AC Power Specifications</b> |                                                                                                  |
| Range                          | 100 -15% to 240 +10%Vac                                                                          |
| Frequency                      | 50 -5% to 60 +5% Hz                                                                              |
| Hold-up                        | 10mS at 85 to 100Vac, 20mS at 100 to 264Vac                                                      |
| Inrush Time                    | 2mS for 40 Amp                                                                                   |
| Inrush Current                 | 18 Amp maximum at 120Vac<br>30 Amp maximum at 200Vac<br>40 Amp maximum at 265Vac                 |
| Input Current                  | 0.05 Amp typical at 200Vac, 0.10 Amp Typical at 100Vac                                           |
| Input Power Supply Rating      | 11 VA                                                                                            |
| <b>AC Input Specifications</b> |                                                                                                  |
| Points/Common                  | 4 (I1–I4) and (I5–I8)                                                                            |
| Rated Load Voltage             | 85–132Vac, 50 -5% to 60 +5% Hz                                                                   |



| Item                              | Description                                                              |                                    |                                |
|-----------------------------------|--------------------------------------------------------------------------|------------------------------------|--------------------------------|
| Maximum Input Voltage             | 132V rms, 50/60 Hz                                                       |                                    |                                |
| Input Current                     | 8 mA rms (100Vac, 60 Hz)                                                 |                                    |                                |
| Voltage                           | ON: minimum 80V rms, 4.5 mA rms, OFF: maximum 30V rms, 2 mA rms          |                                    |                                |
| Response Time                     | OFF to ON: maximum 25mS, ON to OFF: maximum 30mS                         |                                    |                                |
| Isolation                         | 1500V rms field side to logic side, 500V rms between groups              |                                    |                                |
| Relay Output Specifications       |                                                                          |                                    |                                |
| Operating Voltage                 | 5 to 30Vdc or 5 to 250Vac                                                |                                    |                                |
| Isolation                         | 1500 V RMS between field side and logic side, 500 V RMS between groups   |                                    |                                |
| Leakage Current                   | 15 mA maximum                                                            |                                    |                                |
| Maximum UL Pilot Duty Rating      | Q1 – Q4: 2 amps at 24Vdc and 240Vac, Q5, Q6: 10 amps at 24Vdc and 240Vac |                                    |                                |
| Maximum Resistive Load Rating     | Q1 – Q4: 2 amps at 24Vdc and 240Vac, Q5, Q6: 10 amps at 24Vdc and 240Vac |                                    |                                |
| Minimum Load                      | 10 mA                                                                    |                                    |                                |
| Maximum Inrush                    | Q1 – Q4: 5 amps per half cycle, Q5, Q6: 14 amps per half cycle           |                                    |                                |
| Response Time                     | ON: 15 ms maximum, OFF: 15 ms maximum                                    |                                    |                                |
| Fuse                              | None                                                                     |                                    |                                |
| Contact Life: Mechanical          | 20 x 106 mechanical operations                                           |                                    |                                |
| Contact Life: Electrical Voltage: | Current: Resistive<br>2A                                                 | Current: Lamp and Solenoid<br>0.6A | Typical Operations:<br>200,000 |
|                                   | 10A                                                                      | 4A                                 | 100,000                        |
|                                   | 4 A                                                                      | 1A                                 | 200,000                        |

### 3.5.4 Wiring Diagram, IC200UAR014

Figure 15



## 3.6 IC200UDD104

### 14-Point Micro PLC, (8) 24Vdc In, (6) 24Vdc Source Out, 24Vdc Power Supply

VersaMax Micro PLC IC200UDD104 accepts eight DC inputs and provides four low-current and two high-current DC transistor outputs. It uses +24Vdc nominal input power for PLC operation.

#### 3.6.1 DC Power

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains its nominal voltage (24Vdc). The power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain the nominal voltage level (see power supply specifications for inrush requirements).

## 3.6.2 DC Inputs

The module's eight configurable DC inputs can be used as standard or High-Speed Counter inputs. Each input can have positive or negative logic characteristics. When used as standard inputs, they are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC DC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

## 3.6.3 Outputs

All outputs are isolated between field and logic and are switching positive voltage.

The outputs can be configured as regular outputs or as outputs controlled by the High-Speed Counters. Some outputs can be used as pulse train or pulse width modulation (PWM) outputs.

External fusing should be provided to protect the outputs. Fast fuses are recommended.

The outputs share one common incoming DC supply and one common ground. The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

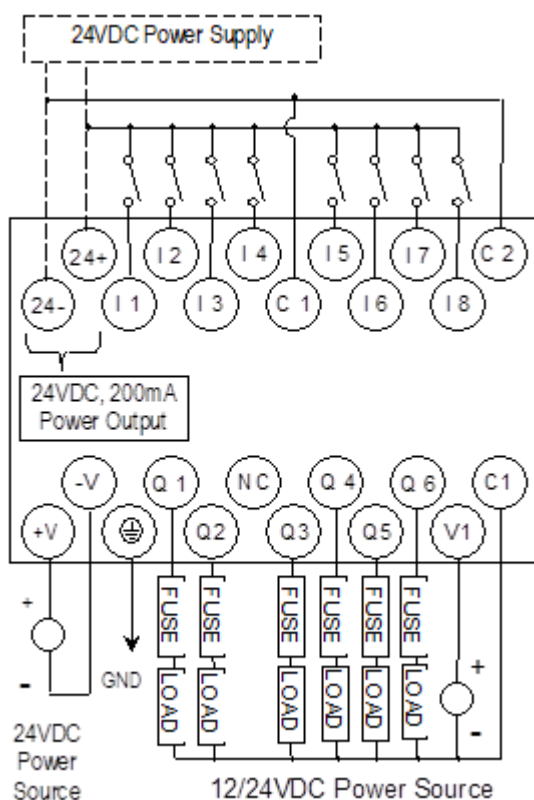
## 3.6.4 Micro PLC IC200UDD104 Specifications

| Item                           | Description                                                                                      |
|--------------------------------|--------------------------------------------------------------------------------------------------|
| Inputs                         | Eight 24Vdc positive/negative logic input circuits                                               |
| Outputs                        | Four low-current and two high-current DC output circuits                                         |
| High-Speed Counters            | Four Type A or One Type A and One Type B                                                         |
| Output Power Supplies          | 24Vdc for input circuits & user devices, 200mA max.<br>+5Vdc on pin 7 of Serial Port, 100mA max. |
| <b>DC Power Specifications</b> |                                                                                                  |
| Range                          | 19.2Vdc to 30Vdc                                                                                 |
| Hold-up                        | 10 ms at 19.2Vdc                                                                                 |
| Inrush Current                 | 1A maximum at 30Vdc                                                                              |
| Inrush Time                    | 10 ms for 1 A                                                                                    |
| Input Current                  | 0.16 A typical at 24Vdc                                                                          |
| Input Power Supply Rating      | 4W                                                                                               |
| <b>DC Input Specifications</b> |                                                                                                  |
| Number of Inputs               | 8                                                                                                |
| Rated Input Voltage            | 24 volts DC                                                                                      |
| Input Voltage Range            | 0 to 30 volts DC                                                                                 |
| Input Current                  | 7.5mA typical                                                                                    |
| Input Resistance               | 2.8 kΩ                                                                                           |

| Item                                                      | Description                                                                                                                                                                |
|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Input Threshold Voltage                                   | ON: 15Vdc minimum, OFF: 5Vdc maximum                                                                                                                                       |
| Input Threshold Current                                   | ON: 4.5mA maximum, OFF: 1.5mA minimum                                                                                                                                      |
| Response Time                                             | 0.5 to 20ms configurable as regular input; 100µs as HSC input                                                                                                              |
| Isolation Voltage                                         | 1500V RMS field side to logic side, 500V RMS between groups                                                                                                                |
| <b>Output Specifications</b>                              |                                                                                                                                                                            |
| Voltage Range                                             | 12Vdc/24Vdc (24Vdc +10% / -43% input at V1,C1)                                                                                                                             |
| Maximum Load                                              | 1.0A per point (Q1 - Q2) at 24Vdc at 100% ON duration<br>0.75A per point (Q3 - Q6) at 24Vdc at 100 % ON duration<br>0.5A per point (Q3 - Q6) at 12Vdc at 100 % ON duration |
| Maximum Inrush Current                                    | Q1, Q2: 8A for 20ms, 1 pulse<br>Q3, Q4, Q5, Q6: 4A for 20ms, 1 pulse                                                                                                       |
| Output Voltage Drop                                       | 0.3V maximum                                                                                                                                                               |
| OFF state leakage                                         | 100µA maximum                                                                                                                                                              |
| Response                                                  | OFF to ON: 0.1ms maximum (24Vdc, 0.2A), ON to OFF: 0.1ms maximum (24Vdc, 0.2A)                                                                                             |
| Isolation Voltage                                         | 1500V RMS field side to logic side, 500V RMS between groups                                                                                                                |
| Fuse                                                      | Outputs should be fused externally. Otherwise, a load short damage the module output transistor, which is not user replaceable.                                            |
| <b>High-Speed Counter Input and Output Specifications</b> |                                                                                                                                                                            |
| Maximum Counter Frequency                                 | 10kHz                                                                                                                                                                      |
| Input Voltage                                             | ON: 15V, OFF: 5V                                                                                                                                                           |
| Count Pulse Width                                         | 20% to 80% duty cycle at 10kHz                                                                                                                                             |
| Count Registers                                           | 16bits                                                                                                                                                                     |
| <b>Outputs</b>                                            |                                                                                                                                                                            |
| Load Voltage                                              | 12/24V                                                                                                                                                                     |
| Maximum Pulse/PWM Frequency                               | 5kHz                                                                                                                                                                       |
| Number of Pulse Outputs                                   | 4                                                                                                                                                                          |
| Types available                                           | HSC, PT, PWM                                                                                                                                                               |

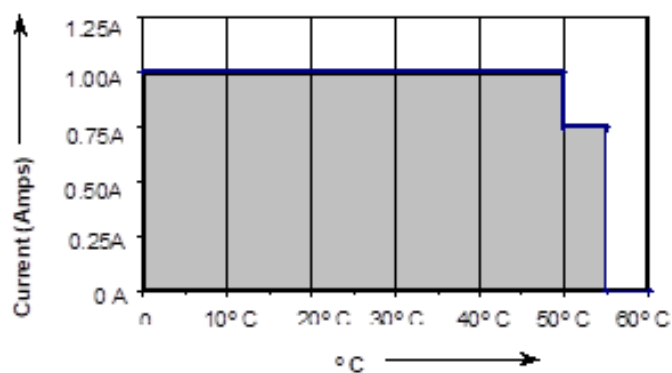
## 3.6.5 Wiring Diagram, IC200UDD104

Figure 16



The maximum current that can be used for output points Q1 and Q2 is lower for ambient temperatures above 50°C.

Figure 17



## 3.7 IC200UDD112

### 14 Point Micro PLC, (8) 12Vdc In, (6) 12Vdc Out, 12Vdc Power Supply

VersaMax Micro PLC IC200UDD112 accepts eight DC inputs and provides four low-current and two high-current DC transistor outputs. It uses +12Vdc nominal input power for PLC operation.

#### 3.7.1 DC Power

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains its nominal voltage. The power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain the nominal voltage level (see power supply specifications for inrush requirements).

#### 3.7.2 DC Inputs

Eight configurable DC inputs can be used as positive or negative logic standard or High-Speed Counter inputs. When used as standard inputs, they are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC DC supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

#### 3.7.3 Transistor Outputs

Micro PLC IC200UDD112 has two high-current transistor outputs (Q1 and Q2) and four low-current transistor outputs (Q3 to Q6). All outputs are isolated between field and logic and are switching positive voltage.

The outputs can be configured as regular outputs or as outputs controlled by the High-Speed Counters. Some outputs can be used as pulse train or pulse width modulation (PWM) outputs.

External fusing should be provided to protect the outputs. Fast fuses are recommended.

The outputs share one common incoming DC supply and one common ground. The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

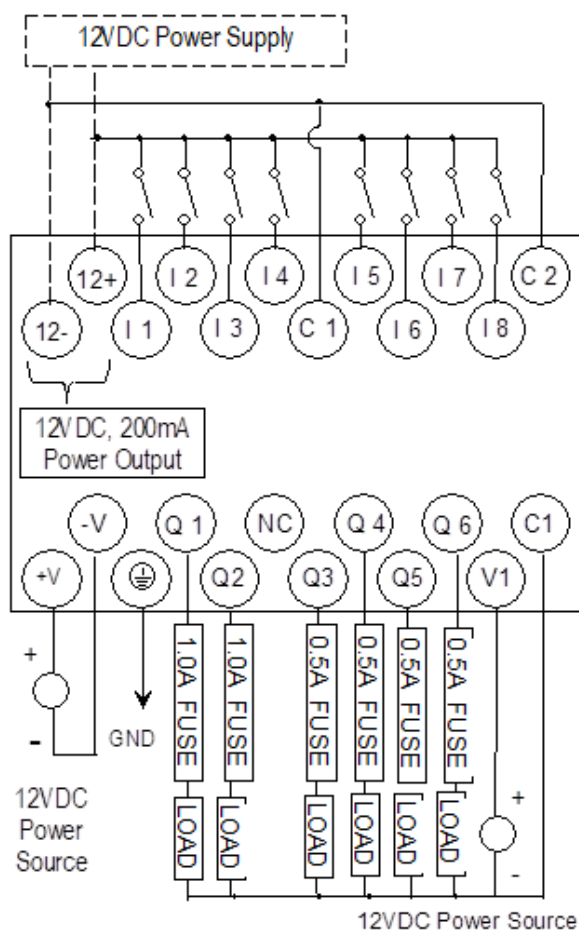
## 3.7.4 Micro PLC IC200UDD112 Specifications

| Item                                                      | Description                                                                                                                         |
|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| Inputs                                                    | Eight 12Vdc positive/negative logic input circuits                                                                                  |
| Outputs                                                   | Four low-current and two high-current DC output circuits                                                                            |
| High-Speed Counters                                       | Four Type A or One Type A and One Type B                                                                                            |
| Output Power Supplies                                     | 12Vdc for input circuits & user devices, 200mA max. +5Vdc on pin 7 of Serial Port, 100mA max.                                       |
| <b>DC Power Specifications</b>                            |                                                                                                                                     |
| Range                                                     | 9.6Vdc to 15Vdc                                                                                                                     |
| Hold-up                                                   | 3.0mS                                                                                                                               |
| Inrush Current                                            | 9.2A typical                                                                                                                        |
| Inrush Time                                               | 200mS typical                                                                                                                       |
| Input Current                                             | 300mA typical at 12Vdc                                                                                                              |
| Input Power Supply Rating                                 | 3W                                                                                                                                  |
| <b>DC Input Specifications</b>                            |                                                                                                                                     |
| Number of Inputs                                          | 8                                                                                                                                   |
| Rated Input Voltage                                       | 12 volts DC                                                                                                                         |
| Input Voltage Range                                       | 0 to 15 volts DC                                                                                                                    |
| Input Current                                             | 9.0mA typical                                                                                                                       |
| Input Resistance                                          | 1.3 k $\Omega$                                                                                                                      |
| Input Threshold Voltage                                   | ON: 9.5Vdc minimum, OFF: 2.5Vdc maximum                                                                                             |
| Input Threshold Current                                   | ON: 6.5mA maximum, OFF: 1.6mA minimum                                                                                               |
| Response Time                                             | 0.5 to 20ms configurable as regular input; 100 $\mu$ s as HSC input                                                                 |
| Isolation Voltage                                         | 1500V RMS field side to logic side, 500V RMS between groups                                                                         |
| <b>Output Specifications</b>                              |                                                                                                                                     |
| Voltage Range                                             | 12Vdc –20%, +20%                                                                                                                    |
| Maximum Load                                              | 0.7A per circuit, 4A per common                                                                                                     |
| Maximum Inrush Current                                    | 4A for 20mS                                                                                                                         |
| Output Voltage Drop                                       | 0.3V maximum                                                                                                                        |
| OFF state leakage                                         | 0.1mA maximum                                                                                                                       |
| Response                                                  | OFF to ON: 0.1mS maximum 12Vdc 0.2A, ON to OFF: 0.1mS maximum 12Vdc 0.2A                                                            |
| Isolation Voltage                                         | 1500V RMS field side to logic side, 500V RMS between groups                                                                         |
| Fuse                                                      | Outputs should be fused externally. Otherwise, a load short may damage the module output transistor, which is not user replaceable. |
| <b>High-Speed Counter Input and Output Specifications</b> |                                                                                                                                     |
| Maximum Counter Frequency                                 | 10kHz                                                                                                                               |
| Input Voltage                                             | ON: 15V, OFF: 5V                                                                                                                    |

| Item                        | Description                    |
|-----------------------------|--------------------------------|
| Count Pulse Width           | 20% to 80% duty cycle at 10kHz |
| Count Registers             | 16bits                         |
| <b>Outputs</b>              |                                |
| Load Voltage                | 12V                            |
| Maximum Pulse/PWM Frequency | 5kHz                           |
| Number of Pulse Outputs     | 4                              |
| Types available             | HSC, PT, PWM                   |

### 3.7.5 Wiring Diagram, IC200UDD112

Figure 18





## 3.8 IC200UDR001

### 14-Point Micro PLC, (8) 24Vdc In, (6) Relay Out, 120/240Vac Power Supply

VersaMax Micro PLC IC200UDR001 accepts eight DC inputs and provides six normally-open 2 Amp relay outputs that can control 5-30Vdc or 5-250Vac output devices. It uses 100Vac to 240Vac nominal input power.

#### 3.8.1 DC Inputs

Eight configurable DC inputs can be used as positive or negative logic standard or High-Speed Counter inputs. When used as standard inputs, they are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC provides a +24Vdc supply that can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

#### 3.8.2 Relay Outputs

The six Form A relay outputs (SPST-single pole single throw) normally-open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. Power for the internal relay coils is provided by the internal supply. An external source of AC or DC power must be supplied to operate field devices.

The relay outputs can be configured as up to four counter outputs. They cannot be used as Pulse Train or PWM outputs.

Connections and specifications for HSC outputs are the same as for standard relay outputs.

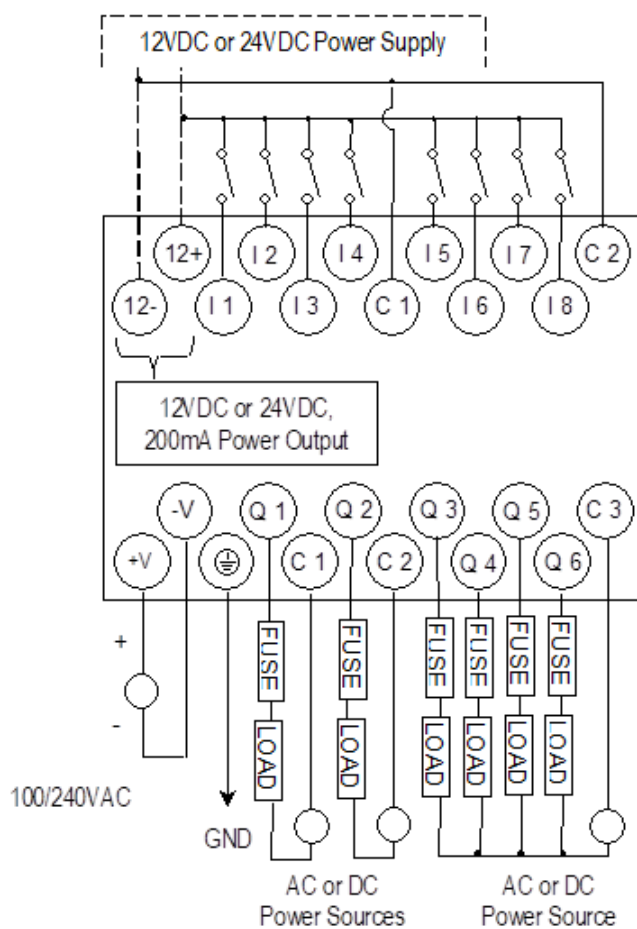
#### 3.8.3 Micro PLC IC200UDR001 Specifications

| Item                           | Description                                                                                      |
|--------------------------------|--------------------------------------------------------------------------------------------------|
| Inputs                         | Eight 24Vdc positive/negative logic input circuits                                               |
| Outputs                        | Six normally open 2 Amp relay circuits                                                           |
| High-Speed Counters            | Up to four Type A or one Type A and one Type B                                                   |
| Output Power Supplies          | 24Vdc for input circuits & user devices, 200mA max.<br>+5Vdc on pin 7 of Serial Port, 100mA max. |
| <b>AC Power Specifications</b> |                                                                                                  |
| Range                          | 100 -15% to 240 +10%Vac                                                                          |
| Frequency                      | 50 -5% to 60 +5% Hz                                                                              |
| Hold-up                        | 10mS at 85 to 100Vac. 20mS at 100 to 264Vac                                                      |
| Inrush Time                    | 2mS for 40A                                                                                      |
| Inrush Current                 | 18 Amp maximum at 120Vac<br>30 Amp maximum at 200Vac<br>40 Amp maximum at 265Vac                 |

| Item                                                      | Description                                                            |                                       |                               |
|-----------------------------------------------------------|------------------------------------------------------------------------|---------------------------------------|-------------------------------|
| Input Current                                             | 0.06 Amp typical at 200Vac, 0.10 Amp typical at 100Vac                 |                                       |                               |
| Input Power Supply Rating                                 | 13 VA                                                                  |                                       |                               |
| Isolation                                                 | 1500Vac RMS field-side to logic (power supply input).                  |                                       |                               |
| DC Input Specifications                                   |                                                                        |                                       |                               |
| Number of Inputs                                          | 8                                                                      |                                       |                               |
| Rated Input Voltage                                       | 24 volts DC                                                            |                                       |                               |
| Input Voltage Range                                       | 0 to 30 volts DC                                                       |                                       |                               |
| Input Current                                             | 7.5mA typical                                                          |                                       |                               |
| Input Resistance                                          | 2.8 kΩ                                                                 |                                       |                               |
| Input Threshold Voltage                                   | ON: 15Vdc minimum, OFF: 5Vdc maximum                                   |                                       |                               |
| Input Threshold Current                                   | ON: 4.5mA maximum, OFF: 1.5mA minimum                                  |                                       |                               |
| Response Time                                             | 0.5 to 20ms configurable as regular input; 100μs as HSC input          |                                       |                               |
| Isolation Voltage                                         | 1500V RMS field side to logic side, 500V RMS between groups            |                                       |                               |
| Relay Output Specifications                               |                                                                        |                                       |                               |
| Operating Voltage                                         | 5 to 30Vdc or 5 to 250Vac                                              |                                       |                               |
| Isolation                                                 | 1500 V RMS between field side and logic side, 500 V RMS between groups |                                       |                               |
| Leakage Current                                           | 15 mA at 240Vac maximum                                                |                                       |                               |
| Maximum UL Pilot Duty Rating                              | 2 amps at 24Vdc and 240Vac                                             |                                       |                               |
| Maximum Resistive Load Rating                             | 2 amps at 24Vdc and 240Vac                                             |                                       |                               |
| Minimum Load                                              | 10 mA                                                                  |                                       |                               |
| Maximum Inrush                                            | 5 amps per half cycle                                                  |                                       |                               |
| Response Time                                             | ON: 15 ms maximum, OFF: 15 ms maximum                                  |                                       |                               |
| Fuse                                                      | None                                                                   |                                       |                               |
| Contact Life: Mechanical                                  | 20 x 10 <sup>6</sup> mechanical operations                             |                                       |                               |
| Contact Life: Electrical Voltage<br>240Vac, 120Vac, 24Vdc | Current: Resistive<br>2A                                               | Current: Lamp and<br>Solenoid<br>0.6A | Typical Operations<br>200,000 |
| High-Speed Counter Input and Output Specifications        |                                                                        |                                       |                               |
| Available High-Speed Counters                             | Four Type A or One Type A and One Type B                               |                                       |                               |
| Maximum Counter Frequency                                 | 10kHz                                                                  |                                       |                               |
| Input Voltage                                             | ON: 15V, OFF: 5V                                                       |                                       |                               |
| Count Pulse Width                                         | 20% to 80% duty cycle at 10kHz                                         |                                       |                               |
| Count Registers                                           | 16 bits                                                                |                                       |                               |
| Outputs                                                   |                                                                        |                                       |                               |
| Available Pulse Outputs                                   | None                                                                   |                                       |                               |
| Load Voltage                                              | Refer to relay output specifications                                   |                                       |                               |

## 3.8.4 Wiring Diagram, IC200UDR001

Figure 19



## 3.9 IC200UDR002

### 14-Point Micro PLC, (8) 24Vdc In, (6) Relay Out, 24Vdc Power Supply

VersaMax Micro PLC IC200UDR002 accepts eight DC inputs and provides six normally open 2 Amp relay outputs that can control 5 to 30Vdc or 5 to 250Vac output devices. It uses +24Vdc nominal input power for PLC operation.

#### 3.9.1 DC Power

The DC power supply requires more current at startup voltage (approximately 4Vdc) than at rated input voltage. A minimum of 2.0 A is required to start up the DC power supply.

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 24Vdc. The 24Vdc power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 24Vdc voltage level (see power supply specifications for inrush requirements).

#### 3.9.2 DC Inputs

Eight configurable DC inputs can be used as positive or negative logic standard inputs or High-Speed Counter inputs. When used as standard inputs, they are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC 24Vdc supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

#### 3.9.3 Relay Outputs

Six Form A (SPST-single pole single throw) normally open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. Power for the internal relay coils is provided by the internal supply. An external source of AC or DC power must be supplied to operate field devices.

The relay outputs can be configured as HSC outputs. They cannot be used as Pulse Train or PWM outputs. Connections and specifications for HSC outputs are the same as for standard relay outputs.

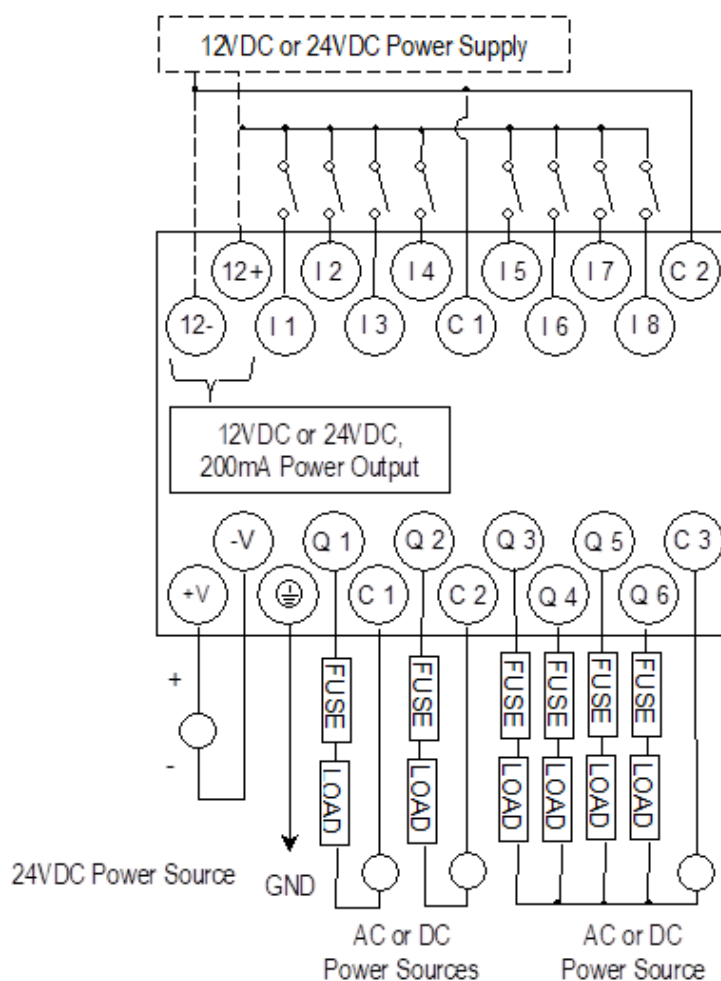
## 3.9.4 Micro PLC IC200UDR002 Specifications

| Item                                                      | Description                                                                                   |                                       |                               |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------|---------------------------------------|-------------------------------|
| Inputs                                                    | Eight 24Vdc positive/negative logic input circuits                                            |                                       |                               |
| Outputs                                                   | Six normally open 2 Amp relay circuits                                                        |                                       |                               |
| High-Speed Counters                                       | Up to four Type A or one Type A and one Type B                                                |                                       |                               |
| Output Power Supplies                                     | 24Vdc for input circuits & user devices, 200mA max. +5Vdc on pin 7 of Serial Port, 100mA max. |                                       |                               |
| DC Power Specifications                                   |                                                                                               |                                       |                               |
| Range                                                     | 24 –20%/+25%Vdc                                                                               |                                       |                               |
| Hold-up                                                   | 10 ms at 19.2Vdc                                                                              |                                       |                               |
| Inrush Current                                            | 1 A maximum at 30Vdc                                                                          |                                       |                               |
| Inrush Time                                               | 10 ms for 1 A                                                                                 |                                       |                               |
| Input Current                                             | 0.16 A typical at 24Vdc                                                                       |                                       |                               |
| Input Power Supply Rating                                 | 4W                                                                                            |                                       |                               |
| DC Input Specifications                                   |                                                                                               |                                       |                               |
| Number of Inputs                                          | 8                                                                                             |                                       |                               |
| Rated Input Voltage                                       | 24 volts DC                                                                                   |                                       |                               |
| Input Voltage Range                                       | 0 to 30 volts DC                                                                              |                                       |                               |
| Input Current                                             | 7.5mA typical                                                                                 |                                       |                               |
| Input Resistance                                          | 2.8 kΩ                                                                                        |                                       |                               |
| Input Threshold Voltage                                   | ON: 15Vdc minimum, OFF: 5Vdc maximum                                                          |                                       |                               |
| Input Threshold Current                                   | ON: 4.5mA maximum, OFF: 1.5mA minimum                                                         |                                       |                               |
| Response Time                                             | 0.5 to 20ms configurable as regular input; 100μs as HSC input                                 |                                       |                               |
| Isolation Voltage                                         | 1500V RMS field side to logic side, 500V RMS between groups                                   |                                       |                               |
| Relay Output Specifications                               |                                                                                               |                                       |                               |
| Operating Voltage                                         | 5 to 30Vdc or 5 to 250Vac                                                                     |                                       |                               |
| Isolation                                                 | 1500 V RMS between field side and logic side, 500 V RMS between groups                        |                                       |                               |
| Leakage Current                                           | 15 mA at 240Vac maximum                                                                       |                                       |                               |
| Maximum UL Pilot Duty Rating                              | 2 amps at 24Vdc and 240Vac                                                                    |                                       |                               |
| Maximum Resistive Load Rating                             | 2 amps at 24Vdc and 240Vac                                                                    |                                       |                               |
| Minimum Load                                              | 10 mA                                                                                         |                                       |                               |
| Maximum Inrush                                            | 5 amps per half cycle                                                                         |                                       |                               |
| Response Time                                             | ON: 15 ms maximum, OFF: 15 ms maximum                                                         |                                       |                               |
| Contact Life: Mechanical                                  | 20 x 106 mechanical operations                                                                |                                       |                               |
| Contact Life: Electrical Voltage<br>240Vac, 120Vac, 24Vdc | Current: Resistive<br>2A                                                                      | Current: Lamp and<br>Solenoid<br>0.6A | Typical Operations<br>200,000 |

| Item                                                      | Description                    |
|-----------------------------------------------------------|--------------------------------|
| <b>High-Speed Counter Input and Output Specifications</b> |                                |
| Maximum Counter Frequency                                 | 10kHz                          |
| Input Voltage                                             | ON: 15V, OFF: 5V               |
| Count Pulse Width                                         | 20% to 80% duty cycle at 10kHz |
| Count Registers                                           | 16 bits                        |
| <b>Outputs</b>                                            |                                |
| Available Pulse Outputs                                   | None                           |
| Load Voltage                                              | Refer to relay specifications  |

### 3.9.5 Wiring Diagram, IC200UDR002

Figure 20



## 3.10 IC200UDR003

### 14-Point Micro PLC, (8) 12Vdc In, (6) Relay Out, 12Vdc Power Supply

VersaMax Micro PLC IC200UDR003 accepts eight DC inputs and provides six normally open 2 Amp relay outputs that can control 5 to 30Vdc or 5 to 250Vac output devices. It uses +12Vdc nominal input power for PLC operation.

#### 3.10.1 DC Power

The DC power supply requires more current at startup voltage (approximately 4Vdc) than at rated input voltage. A minimum of 2.0 A is required to start up the DC power supply. If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 24Vdc. The 24Vdc power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 24Vdc voltage level (see power supply specifications for inrush requirements).

#### 3.10.2 DC Inputs

Eight configurable DC inputs can be used as positive or negative logic standard or High-Speed Counter inputs. When used as standard inputs, they are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC 12Vdc supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

#### 3.10.3 Relay Outputs

The six normally-open Form A relay outputs (SPST-single pole single throw) can control many types of devices such as motor starters, solenoids, and indicators. Power for the internal relay coils is provided by the internal supply. An external source of AC or DC power must be supplied to operate field devices.

The relay outputs can be configured as HSC outputs. They cannot be used as Pulse Train or PWM outputs. Connections and specifications for HSC outputs are the same as for standard relay outputs.

### 3.10.4 Micro PLC IC200UDR003 Specifications

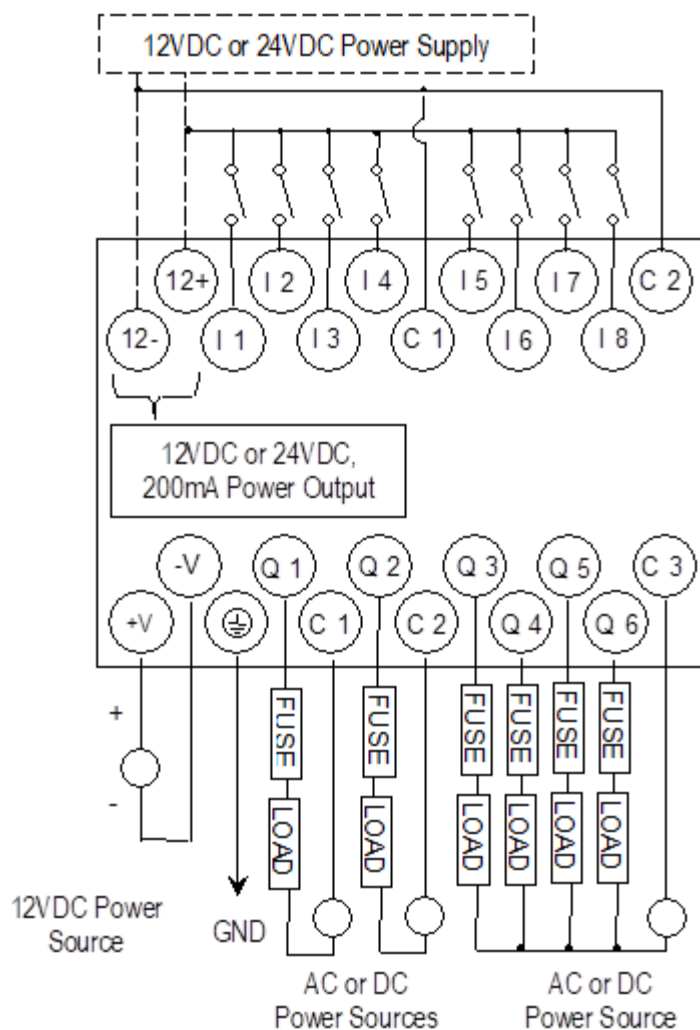
| Item                                                      | Description                                                                                      |                                       |                                  |
|-----------------------------------------------------------|--------------------------------------------------------------------------------------------------|---------------------------------------|----------------------------------|
| Inputs                                                    | Eight 12Vdc positive/negative logic input circuits                                               |                                       |                                  |
| Outputs                                                   | Six normally open 2 Amp relay circuits                                                           |                                       |                                  |
| High-Speed Counters                                       | Up to four Type A or one Type A and one Type B                                                   |                                       |                                  |
| Output Power Supplies                                     | 12Vdc for input circuits & user devices, 200mA max.<br>+5Vdc on pin 7 of Serial Port, 100mA max. |                                       |                                  |
| DC Power Specifications                                   |                                                                                                  |                                       |                                  |
| Range                                                     | 9.6Vdc - 15Vdc                                                                                   |                                       |                                  |
| Hold-up                                                   | 3.0mS                                                                                            |                                       |                                  |
| Inrush Current                                            | 9.2A typical at 12Vdc                                                                            |                                       |                                  |
| Inrush Time                                               | 200μS typical                                                                                    |                                       |                                  |
| Input Current                                             | 200mA typical at 12Vdc                                                                           |                                       |                                  |
| Input Power Supply Rating                                 | 3W                                                                                               |                                       |                                  |
| DC Input Specifications                                   |                                                                                                  |                                       |                                  |
| Number of Inputs                                          | 8                                                                                                |                                       |                                  |
| Rated Input Voltage                                       | 12 volts DC                                                                                      |                                       |                                  |
| Input Voltage Range                                       | 0 to 15 volts DC                                                                                 |                                       |                                  |
| Input Current                                             | 9.0mA typical                                                                                    |                                       |                                  |
| Input Resistance                                          | 1.3 kΩ                                                                                           |                                       |                                  |
| Input Threshold Voltage                                   | ON: 9.5Vdc minimum, OFF: 2.5Vdc maximum                                                          |                                       |                                  |
| Input Threshold Current                                   | ON: 6.5mA maximum, OFF: 1.6mA minimum                                                            |                                       |                                  |
| Response Time                                             | 0.5 to 20ms configurable as regular input; 100μs as HSC input                                    |                                       |                                  |
| Isolation Voltage                                         | 1500V RMS field side to logic side, 500V RMS between groups                                      |                                       |                                  |
| Relay Output Specifications                               |                                                                                                  |                                       |                                  |
| Operating Voltage                                         | 5 to 30Vdc or 5 to 250Vac                                                                        |                                       |                                  |
| Isolation                                                 | 1500 V RMS between field side and logic side<br>500 V RMS between groups                         |                                       |                                  |
| Leakage Current                                           | 15 mA at 240Vac maximum                                                                          |                                       |                                  |
| Maximum UL Pilot Duty Rating                              | 2 amps at 24Vdc and 240Vac                                                                       |                                       |                                  |
| Maximum Resistive Load Rating                             | 2 amps at 24Vdc and 240Vac                                                                       |                                       |                                  |
| Minimum Load                                              | 10 mA                                                                                            |                                       |                                  |
| Maximum Inrush                                            | 5 amps per half cycle                                                                            |                                       |                                  |
| Response Time                                             | ON: 15 ms maximum, OFF: 15 ms maximum                                                            |                                       |                                  |
| Contact Life: Mechanical                                  | 20 x 106 mechanical operations                                                                   |                                       |                                  |
| Contact Life: Electrical Voltage<br>240Vac, 120Vac, 24Vdc | Current: Resistive<br>2A                                                                         | Current: Lamp and<br>Solenoid<br>0.6A | Typical<br>Operations<br>200,000 |



| Item                                                      | Description                    |
|-----------------------------------------------------------|--------------------------------|
| <b>High-Speed Counter Input and Output Specifications</b> |                                |
| Maximum Counter Frequency                                 | 10kHz                          |
| Input Voltage                                             | ON: 9V, OFF: 2.5V              |
| Count Pulse Width                                         | 20% to 80% duty cycle at 10kHz |
| Count Registers                                           | 16 bits                        |
| <b>Outputs</b>                                            |                                |
| Available Pulse Outputs                                   | None                           |
| Load Voltage                                              | Refer to relay specifications  |

### 3.10.5 Wiring Diagram, IC200UDR003

Figure 21



## Chapter 4: VersaMax 20-Point Micro/Micro PLUS PLCs

This chapter describes the features, specifications, and field wiring for 20-point VersaMax Micro and VersaMax Micro PLUS PLCs.

|                    |                                                                                                        |
|--------------------|--------------------------------------------------------------------------------------------------------|
| <b>IC200UDD020</b> | 20-point, (12) 24Vdc In, (4) 24Vdc Outputs with ESCP, (4) 24Vdc Transistor Outputs, 24Vdc Power Supply |
| <b>IC200UDD220</b> | 20-point, (12) 24Vdc In, (8) 24Vdc Transistor Outputs, 24Vdc Power Supply                              |
| <b>IC200UDR020</b> | 20-point, (12) 24Vdc In, (8) Relay Out, 24Vdc Power Supply                                             |
| <b>IC200UDR120</b> | 20-point, (12) 24Vdc In, (8) Relay Out, 120/240Vac Power Supply                                        |

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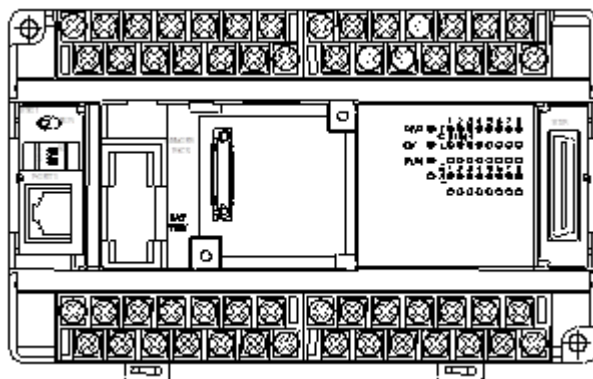
**Note:** Firmware releases 4.00 and later require a Micro PLUS CPU, which has enhanced memory. Firmware versions 4.00 cannot be used with the earlier hardware versions.

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- Micro and Micro PLUS PLCs support the same user logic memory size
- The specifications given in this chapter for Micro PLCs also apply to Micro PLUS PLCs.

### 4.1 Features of VersaMax 20-Point Micro PLCs

Figure 22

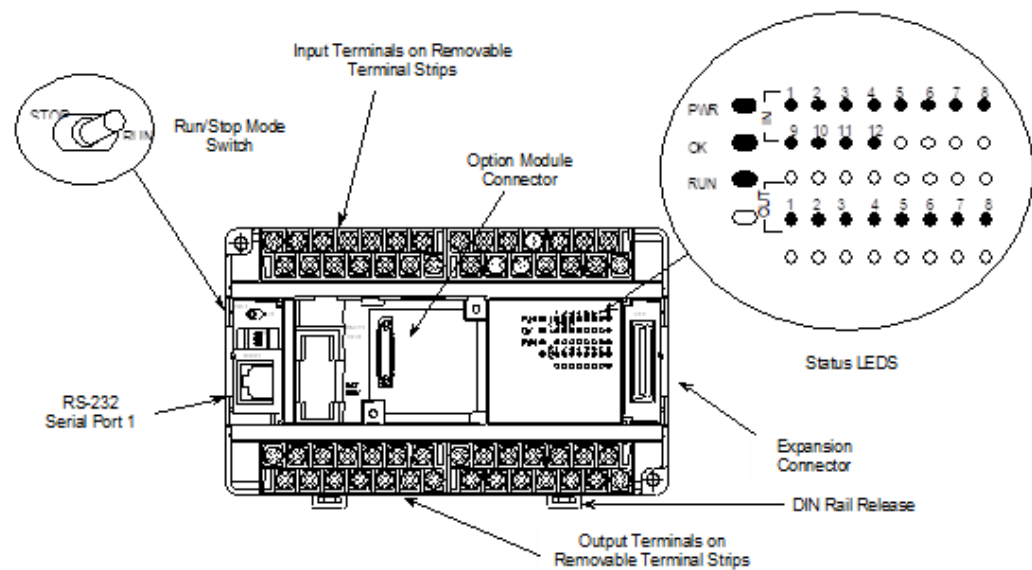


All VersaMax Micro-20 PLCs feature:

- Removable screw-down “barrier-style” terminal strips with protective covers.
- Built-in serial communications port that supports SNP/ SNPX master and slave, Modbus RTU master and slave, and Serial I/O.
- Removable Memory Pack Module available.
- Optional Port 2.
- Run/Stop mode switch that can be configured as a run/stop switch, a memory protect switch, and also used for clearing faults when a fatal fault exists.
- Full-featured programming Instruction Set with floating point math. The application program can be either Ladder Diagram (LD) or Instruction List (IL) format.

- 24K words of program memory, 32K words of registers.
- Flash memory (ROM) for non-volatile program storage and for system firmware.
- Configurable to read configuration and application program at power up from either RAM or flash memory (ROM).
- Capacitor backup for RAM and the Time-of-Day clock for at least 30 minutes at 25° C
- Optional lithium battery backup for RAM and real-time clock.
- Enhanced High-Speed Counter / Pulse Train commands for Jogging, Blending, and Homing, plus configurable 32-bit Counters /PTO/ and 32-bit function blocks.

Figure 23



### 4.1.1 Run/Stop Switch

The Run/Stop switch can be configured as a run/stop switch or a memory protect switch and used for clearing faults when a fatal fault exists.

### 4.1.2 Ports

Port 1 is a built-in RS-232 serial port with an RJ-45 connector.

A second port can be added to a Micro-20 PLC using one of the port Option Modules described in Chapter 14:. If a second port is installed, both ports can be used for programming. Only one port can be used at a time for programming, but both ports can be used for monitoring at the same time.

Port 1 and the optional Port 2 are individually configurable for SNP master/slave, RTU master/slave, and Serial I/O protocols. Both 4-wire and 2-wire RTU are supported when the RS-485 Port Option module is installed as port 2. Port 2 does not support hardware flow control. When either port is being used for RTU slave, it automatically switches to SNP slave mode when that port is being used by the programmer. If a port is configured for Serial I/O,

RTU Master, or SNP Master operation, that port defaults to SNP slave and automatically reverts to SNP slave when the CPU is in Stop mode.

Either port can be software-configured to set up communications between the CPU and various serial devices. An external device can obtain power from the port if it requires 200mA or less at 5Vdc.

### 4.1.3 Analog Inputs

The RS232 Option Module (IC200USB001) or the RS485 Option Module (IC200USB002) can provide two 0-10V analog inputs. See Chapter 14: for more information about option modules. The two inputs can be used to adjust the values in analog registers %AI016 (input 1) and %AI017 (input 2). An example use for the analog inputs would be to set threshold values for use in logical relationships with other inputs/outputs.

### 4.1.4 Removable Terminal Strips

The removable terminal assemblies are protected by hinged covers. After turning off power to the Micro PLC, a terminal assembly and attached field wiring can be separated from the Micro PLC by removing two screws.

### 4.1.5 Status LEDs

LEDs on the Micro PLC provide quick visual verification of operating status. In addition to LEDs for Power, OK, and Run mode, there is an LED for each I/O point.

### 4.1.6 Backup Battery

The Micro PLC uses a large value capacitor to provide memory retention current to the System/User RAM and the Time-of-Day clock when the power supply is either not present or not powered up. The capacitor retains memory contents for at least 30 minutes.

To maintain memory for longer than this, a replaceable battery assembly can be installed in the battery holder, as described in Chapter 15:. The Micro PLC reports the battery state to the PLC Fault Table and also uses Status Bits %SA011 and %S0014 to indicate the battery state.

## 4.2 General Specifications of 20-Point VersaMax Micro PLCs

|                                                                         |                                                                                                |
|-------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| Module Dimensions                                                       | Height: 90mm (3.6 inches)<br>Depth: 76mm (3.0 inches)<br>Width: 150mm (6.0 inches)             |
| Typical Scan Rate                                                       | 1.7 ms/K for Boolean logic (see Appendix A:)                                                   |
| Real Time Clock accuracy (for Timer contacts and Timer function blocks) | ±0.5%                                                                                          |
| Time-of-Day Clock accuracy                                              | ±5 sec/day @10°C, ±5 sec/day @25°C, and<br>±11 sec/day @ 55°C or across full temperature range |
| Maximum number of slave devices per RS-485 network                      | 8 (can be increased with a repeater)                                                           |
| +24Vdc Output Power Supply (for input circuits and user devices)        | 435mA maximum                                                                                  |
| +5Vdc output of Serial Ports                                            | 200mA per port, 400mA total for both ports, maximum                                            |

## 4.3 High-Speed Counters

All VersaMax Micro PLCs with DC power can be configured to provide built-in High-Speed Counter and pulse operation.

When configured for High-Speed Counter operation, inputs can be set up as:

- Up to four Type A Counters or
- One Type A and one Type B Counter.
- Up to four Type A\_32 Counters or
- One Type A and one Type B\_32 Counter

Each counter provides direct processing of rapid pulse signals up to 100 kHz for industrial control applications such as meter proving, turbine flow meter, velocity measurement, material handling, motion control, and process control.

Each counter can be enabled independently. Type A counters can be configured for up or down counting (default is up) and for positive or negative edge detection (default is positive). The type B counter provides an A Quad B counting function.

See Chapter 18: for information about High-Speed Counter features.

## 4.4 IC200UDD020

### 20-Point Micro PLC, (12) 24Vdc In, (4) 24Vdc Out with ESCP, (4) LCDC Out, 24Vdc Power Supply

VersaMax Micro PLC IC200UDD020 accepts twelve DC inputs and provides four ESCP outputs and four 24Vdc low-current outputs. It uses +24Vdc nominal input power for PLC operation.

#### 4.4.1 DC Power

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains its nominal voltage (24Vdc). The power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain the nominal voltage level (see power supply specifications for inrush requirements).

#### 4.4.2 DC Inputs

The twelve configurable DC inputs can be used as positive or negative logic standard inputs. Eight of these inputs can be used for High-Speed Counter inputs. When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC +24Vdc supply can be used for input devices and to power the DC input circuits at about 8mA per input. The combination of input circuit current and external device current must not exceed 435 mA.

#### 4.4.3 DC Outputs

Outputs 1 – 4 can be used as standard, High-Speed Counter, Pulse-Width Modulated, Pulse Train Outputs, or Pulse Train Outputs with Ramping. All standard outputs are all source-type. Outputs can be used to switch devices like valves, lamps or contactors.

Outputs 5 – 8 provide Electronic Short-Circuit Protection.

#### 4.4.4

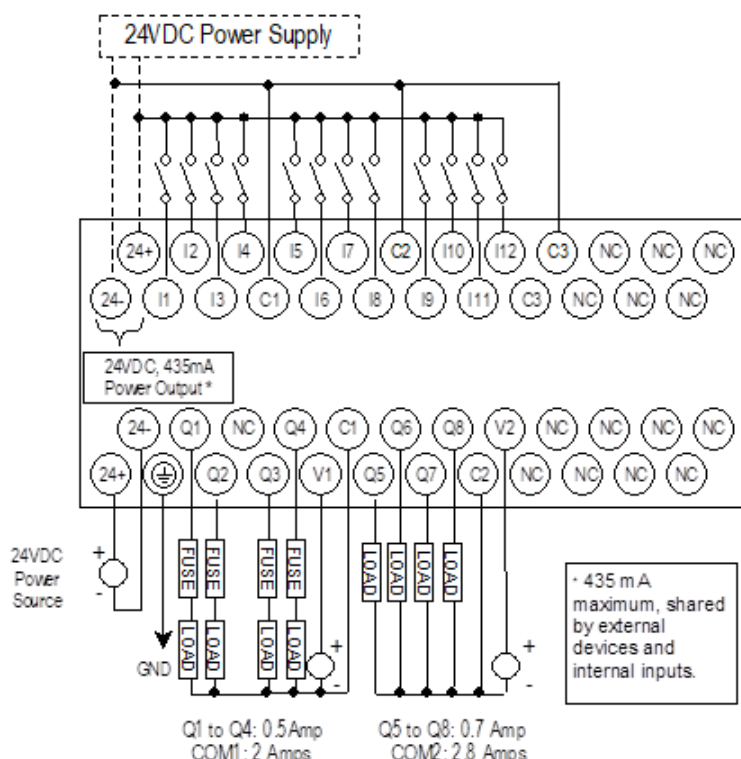
### Micro PLC IC200UDD020 Specifications

| Item                           | Description                                                                                                      |
|--------------------------------|------------------------------------------------------------------------------------------------------------------|
| Inputs                         | Twelve 24Vdc positive or negative logic inputs                                                                   |
| Outputs                        | Eight 24Vdc outputs. Outputs 5-8 with ESCP                                                                       |
| High-Speed Counters            | Up to four Type A or one Type A and one Type B, or four Type A_32, or one Type A_32 and one Type B_32            |
| <b>DC Power Specifications</b> |                                                                                                                  |
| Range                          | 19.2Vdc to 30Vdc                                                                                                 |
| Hold-up                        | 10mS at 19.2Vdc                                                                                                  |
| Inrush Current                 | 1 Amp maximum at 30Vdc                                                                                           |
| Inrush Time                    | 10mS for 1 Amp                                                                                                   |
| Input Current                  | 0.20 Amp typical at 24Vdc                                                                                        |
| Input Power Supply Rating      | 5W                                                                                                               |
| <b>DC Input Specifications</b> |                                                                                                                  |
| Rated Input Voltage            | 24 volts DC                                                                                                      |
| Input Voltage Range            | 0 to 30 volts DC                                                                                                 |
| Input Current at 24Vdc         | I1, I3, I5, I7: 8mA typical; Other inputs: 4.8mA typical                                                         |
| Input Impedance                | I1, I3, I5, I7: 2.7 kΩ; Other inputs: 4.7 kΩ                                                                     |
| Input Threshold Voltage        | ON: 18Vdc minimum, OFF: 5Vdc maximum                                                                             |
| Input Threshold Current        | I1, I3, I5, I7: ON 4.5mA maximum, OFF: 1.8mA minimum<br>Other Inputs: ON 3.3mA maximum, OFF: 1.6mA minimum       |
| Response Time                  | 0.5ms to 20ms configurable as regular input; 100μs as HSC input                                                  |
| Isolation Voltage              | 1500V RMS field side to logic side, 500V RMS between groups                                                      |
| <b>Output Specifications</b>   |                                                                                                                  |
| Voltage Range                  | 12Vdc / 24Vdc                                                                                                    |
| External Power Supply          | 12/24Vdc – 10%, +20%                                                                                             |
| Maximum Load Current           | 0.5A per point (Q1 – Q4) at 24Vdc at 100 % ON duration<br>0.7A per point (Q5 – Q8) at 24Vdc at 100 % ON duration |
| Minimum Switching Current      | 10mA                                                                                                             |
| Maximum Inrush Current         | Q1-Q4: 2A for 20ms, 1 pulse<br>Q5-Q8: 4A for 20ms, 1 pulse                                                       |
| Output Voltage Drop            | 0.3V maximum                                                                                                     |
| OFF state leakage current      | 0.1mA maximum                                                                                                    |
| Response Time                  | OFF to ON, ON to OFF: 1ms maximum (24Vdc)                                                                        |
| Isolation Voltage              | 1500V RMS between field side and logic side,<br>500V RMS between groups                                          |
| Fuse                           | None, outputs Q5 – Q8 are ESCP protected                                                                         |

| Item                                                      | Description                                              |
|-----------------------------------------------------------|----------------------------------------------------------|
| Under-voltage shutdown                                    | Q5 – Q8: 5V minimum, 8V maximum                          |
| DC short circuit current                                  | Q1 – Q4: 5A typical<br>Q5 – Q8: 0.7A minimum, 2A maximum |
| Peak short circuit current                                | Q5 – Q8: 4A maximum                                      |
| Delay time of peak short circuit current                  | 100 $\mu$ S                                              |
| Delay time of current limit                               | 100 $\mu$ S                                              |
| <b>High-Speed Counter Input and Output Specifications</b> |                                                          |
| Maximum Counter Frequency                                 | 100kHz                                                   |
| Input Voltage                                             | ON : 18V, OFF: 5V                                        |
| Count Pulse Width                                         | 20% to 80% of duty cycle at 100kHz                       |
| Count Registers                                           | 16/32 bits                                               |
| <b>Outputs</b>                                            |                                                          |
| Load Voltage                                              | 12/24Vdc                                                 |
| Maximum Pulse/Pulse Train with Ramping/PWM Frequency      | PWM and PTO: 65kHz<br>Pulse Train with Ramping: 65kHz    |
| Types available                                           | Up to four HSC, PTO, PTO with Ramping and/or PWM outputs |

## 4.4.5 Wiring Diagram, IC200UDD020

Figure 24





## 4.5 IC200UDD220

### 20-Point Micro PLC, (12) 24Vdc In, (8) 24Vdc Out (Sink), 24Vdc Power Supply

VersaMax Micro PLC IC200UDD220 accepts twelve DC inputs and provides eight DC outputs. It uses +24Vdc nominal input power for PLC operation.

#### 4.5.1 DC Power

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 24Vdc. The 24Vdc power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 24Vdc voltage level (see power supply specifications for inrush requirements).

#### 4.5.2 DC Inputs

Twelve configurable DC inputs can be used as positive or negative logic standard inputs. Eight of these inputs can be used for High-Speed Counter inputs. When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC +24Vdc supply can be used for input devices and to power the DC input circuits at about 8mA per input. The combination of input circuit current and external device current must not exceed 435mA.

#### 4.5.3 DC Outputs

Micro PLC IC200UDD220 has eight Sink-type DC outputs. All outputs are isolated between field and logic and are switching positive voltage. The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

DC outputs can be used as standard, High-Speed Counter, Pulse-Width Modulated, Pulse Train Outputs, or Pulse Train Outputs with Ramping.

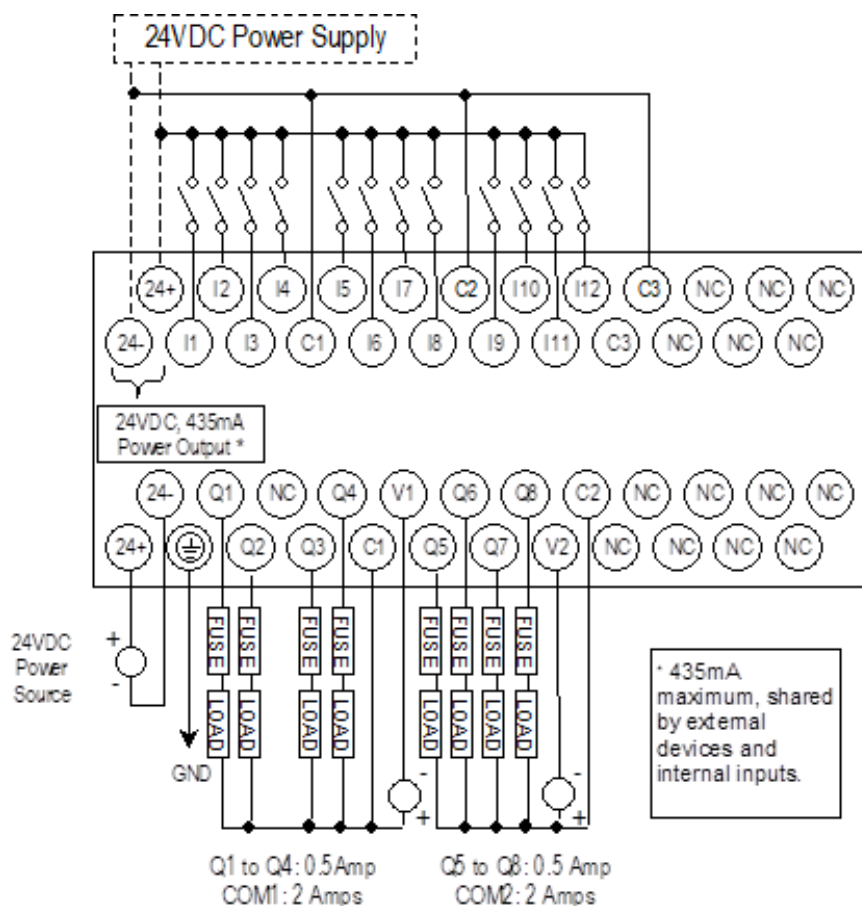
## 4.5.4 Micro PLC IC200UDD220 Specifications

| Item                                                      | Description                                                                                                |
|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| Inputs                                                    | Twelve 24Vdc positive or negative logic inputs                                                             |
| Outputs                                                   | Eight transistor outputs, 24Vdc.                                                                           |
| High-Speed Counters                                       | Up to four Type A or one Type A and one Type B, or four Type A_32, or one Type A_32 and one Type B_32      |
| <b>DC Power Specifications</b>                            |                                                                                                            |
| Range                                                     | 19.2Vdc to 30Vdc                                                                                           |
| Hold-up                                                   | 10mS at 19.2Vdc                                                                                            |
| Inrush Current                                            | 1 Amp maximum at 30Vdc                                                                                     |
| Inrush Time                                               | 10mS for 1 Amp                                                                                             |
| Input Current                                             | 0.20 Amp typical at 24Vdc                                                                                  |
| Input Power Supply Rating                                 | 5W                                                                                                         |
| <b>DC Input Specifications</b>                            |                                                                                                            |
| Rated Input Voltage                                       | 24 volts DC                                                                                                |
| Input Voltage Range                                       | 0 to 30 volts DC                                                                                           |
| Input Current at 24Vdc                                    | I1, I3, I5, I7: 8mA typical; Other inputs: 4.8mA typical                                                   |
| Input Impedance                                           | I1, I3, I5, I7: 2.7 k $\Omega$ ; Other inputs: 4.7 k $\Omega$                                              |
| Input Threshold Voltage                                   | ON: 18Vdc minimum, OFF: 5Vdc maximum                                                                       |
| Input Threshold Current                                   | I1, I3, I5, I7: ON 4.5mA maximum, OFF: 1.8mA minimum<br>Other Inputs: ON 3.3mA maximum, OFF: 1.6mA minimum |
| Response Time                                             | 0.5ms to 20ms configurable as regular input; 100 $\mu$ s as HSC input                                      |
| Isolation Voltage                                         | 1500V RMS field side to logic side, 500V RMS between groups                                                |
| <b>Output Specifications</b>                              |                                                                                                            |
| Voltage Range                                             | 12Vdc/24Vdc                                                                                                |
| External Power Supply                                     | 12/24Vdc –10%, +20%                                                                                        |
| Maximum Load Current                                      | 0.5A per point (Q1 – Q8) at 24Vdc                                                                          |
| Minimum Switching Current                                 | 10mA                                                                                                       |
| Maximum Inrush Current                                    | Q1-Q8: 2A for 20ms, 1 pulse                                                                                |
| Output Voltage Drop                                       | 0.3Vdc maximum                                                                                             |
| OFF state leakage current                                 | 0.1mA maximum                                                                                              |
| Response Time                                             | OFF to ON, ON to OFF: 1ms maximum @ 24Vdc                                                                  |
| Isolation Voltage                                         | 1500V RMS between field side and logic side, 500V RMS between groups                                       |
| <b>High-Speed Counter Input and Output Specifications</b> |                                                                                                            |
| Maximum Counter Frequency                                 | 100kHz                                                                                                     |
| Input Voltage                                             | ON : 18V, OFF: 5V                                                                                          |
| Count Pulse Width                                         | 20% to 80% of duty cycle at 100kHz                                                                         |
| Count Registers                                           | 16/32 bits                                                                                                 |

| Item                        | Description                                           |
|-----------------------------|-------------------------------------------------------|
| <b>Outputs</b>              |                                                       |
| Load Voltage                | 12/24Vdc                                              |
| Maximum Pulse/PWM Frequency | PWM and PTO: 65kHz<br>Pulse Train with Ramping: 65kHz |
| Types available             | Up to four HSC, PTO, PTO, and/or PWM outputs          |

#### 4.5.5 Wiring Diagram, IC200UDD220

### Figure 25



## 4.6 IC200UDR020

### 20-Point Micro PLC, (12) 24Vdc In, (8) Relay Out, 24Vdc Power Supply

VersaMax Micro PLC IC200UDR020 accepts twelve DC inputs and provides eight normally open 2 Amp relay outputs. It uses +24Vdc nominal input power for PLC operation.

#### 4.6.1 DC Inputs

Twelve configurable DC inputs can be used as positive or negative logic standard inputs. Eight of these inputs can be used for High-Speed Counter inputs. When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC +24Vdc supply can be used for input devices and to power the DC input circuits at about 8mA per input. The combination of input circuit current and external device current must not exceed 435mA.

#### 4.6.2 Relay Outputs

The eight normally open Form A relay outputs (SPST-single pole single throw) can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices.

The relay outputs can be configured as up to four HSC outputs. Relay outputs cannot be used as Pulse Train or PWM outputs.

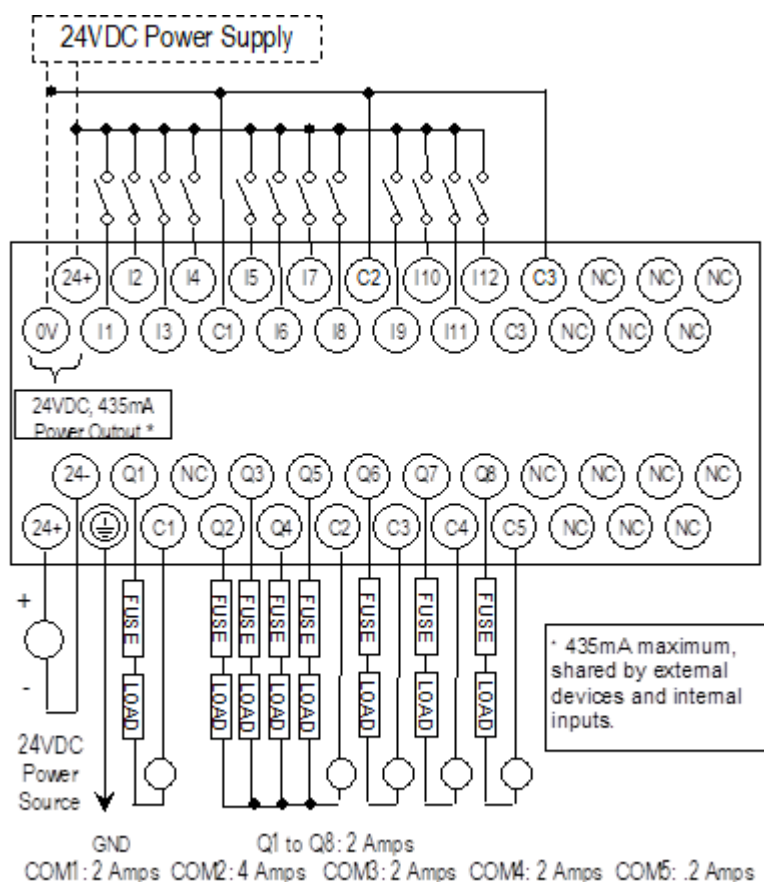
#### 4.6.3 Micro PLC IC200UDR020 Specifications

| Item                           | Description                                                                                           |
|--------------------------------|-------------------------------------------------------------------------------------------------------|
| Inputs                         | Twelve 24Vdc positive/negative logic input circuits                                                   |
| Outputs                        | Eight normally open 2 amp relay circuits                                                              |
| High-Speed Counters            | Up to four Type A or one Type A and one Type B, or four Type A_32, or one Type A_32 and one Type B_32 |
| +24Vdc Output Power Supply     | 435mA maximum (for input circuits and user devices)                                                   |
| +5Vdc output of Serial Port    | Serial Port 1, pin 7:100mA maximum                                                                    |
| <b>DC Power Specifications</b> |                                                                                                       |
| Range                          | 19.2Vdc to 30Vdc                                                                                      |
| Hold-up                        | 10mS at 19.2Vdc                                                                                       |
| Inrush Current                 | 1 Amp maximum at 30Vdc                                                                                |
| Inrush Time                    | 10mS for 1 Amp                                                                                        |
| Input Current                  | 0.20 Amp typical at 24Vdc                                                                             |
| Input Power Supply Rating      | 5W                                                                                                    |

| Item                                                      | Description                                                                                                |                                       |                               |
|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------|---------------------------------------|-------------------------------|
| DC Input Specifications                                   |                                                                                                            |                                       |                               |
| Rated Input Voltage                                       | 24 volts DC                                                                                                |                                       |                               |
| Input Voltage Range                                       | 0 to 30 volts DC                                                                                           |                                       |                               |
| Input Current at 24Vdc                                    | I1, I3, I5, I7: 8mA typical; other inputs 4.8mA typical                                                    |                                       |                               |
| Input Impedance                                           | I1, I3, I5, I7: 2.7 kΩ; other inputs: 4.7kΩ                                                                |                                       |                               |
| Input Threshold Voltage                                   | ON: 18Vdc minimum, OFF: 5Vdc maximum                                                                       |                                       |                               |
| Input Threshold Current                                   | I1, I3, I5, I7: ON 4.5mA maximum, OFF: 1.8mA minimum<br>Other inputs: ON 3.3mA maximum, OFF: 1.6mA maximum |                                       |                               |
| Response Time                                             | 0.5ms to 20ms configurable as regular input; 100μs as HSC input                                            |                                       |                               |
| Isolation Voltage                                         | 1500V RMS field side to logic side, 500V RMS between groups                                                |                                       |                               |
| Relay Output Specifications                               |                                                                                                            |                                       |                               |
| Operating Voltage                                         | 5 to 30Vdc or 5 to 250Vac                                                                                  |                                       |                               |
| Isolation                                                 | 1500 V RMS between field side and logic side, 500 V RMS between groups                                     |                                       |                               |
| Leakage Current                                           | 15 mA at 240Vac maximum                                                                                    |                                       |                               |
| Maximum UL Pilot Duty Rating                              | 2 amps at 24Vdc and 240Vac                                                                                 |                                       |                               |
| Maximum Resistive Load Rating                             | 2 amps at 24Vdc and 240Vac                                                                                 |                                       |                               |
| Minimum Load                                              | 10 mA                                                                                                      |                                       |                               |
| Maximum Inrush                                            | 1.5A,10ms                                                                                                  |                                       |                               |
| Response Time                                             | ON: 15 ms maximum, OFF: 15 ms maximum                                                                      |                                       |                               |
| Contact Life: Mechanical                                  | 20 x 106 mechanical operations                                                                             |                                       |                               |
| Contact Life: Electrical Voltage<br>240Vac, 120Vac, 24Vdc | Current: Resistive<br>2.0A                                                                                 | Current: Lamp and<br>Solenoid<br>0.6A | Typical Operations<br>200,000 |
| High-Speed Counter Input and Output Specifications        |                                                                                                            |                                       |                               |
| Maximum Counter Frequency                                 | 100kHz                                                                                                     |                                       |                               |
| Input Voltage                                             | ON: 18V, OFF: 5V                                                                                           |                                       |                               |
| Count Pulse Width                                         | 20% to 80% of duty cycle at 100kHz                                                                         |                                       |                               |
| Count Registers                                           | 16/32 bits                                                                                                 |                                       |                               |
| Outputs                                                   |                                                                                                            |                                       |                               |
| Load Voltage                                              | Q1: 5/12/24V, Q2-Q4: See relay output specifications                                                       |                                       |                               |
| Type available                                            | Up to four HSC outputs. Pulse outputs are not available.                                                   |                                       |                               |

## 4.6.4 Wiring Diagram, PLC IC200UDR020

Figure 26



## 4.7 IC200UDR120

### 20-Point Micro PLC, (12) 24Vdc In, (8) Relay Out, 120/240Vac Power Supply

VersaMax Micro PLC IC200UDR120 accepts twelve DC inputs and provides eight normally open 2 Amp relay outputs. It uses 100Vac to 240Vac nominal input power for PLC operation.

### 4.7.1 DC Inputs

Twelve configurable DC inputs can be used as positive or negative logic standard inputs. Eight of these inputs can be used for High-Speed Counter inputs. When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC +24Vdc supply can be used for input devices and to power the DC input circuits at about 8mA per input. The combination of input circuit current and external device current must not exceed 435mA.

## 4.7.2 Relay Outputs

The eight normally open Form A relay outputs (SPST-single pole single throw) can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices.

The relay outputs can be configured as up to four HSC outputs. Relay outputs cannot be used as Pulse Train or PWM outputs.

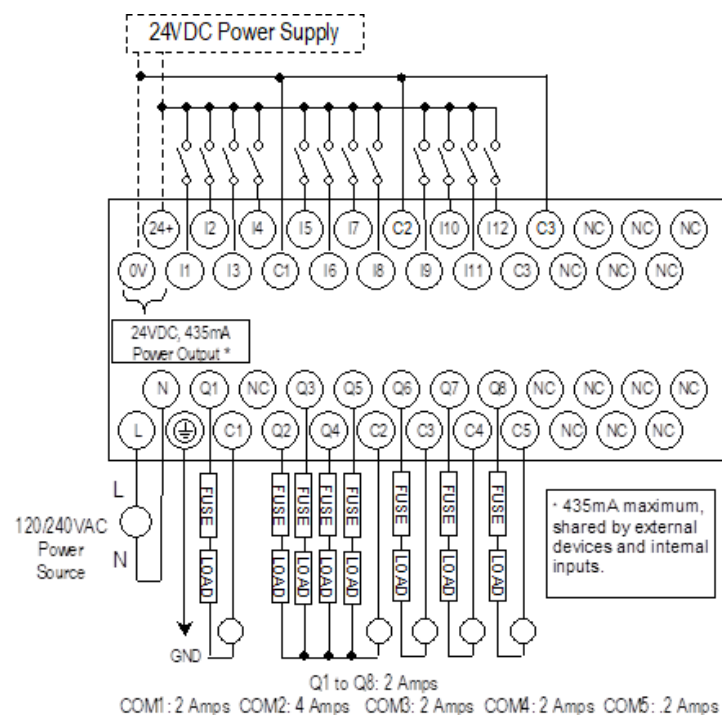
## 4.7.3 Micro PLC IC200UDR120, Specifications

| Item                               | Description                                                                                                |
|------------------------------------|------------------------------------------------------------------------------------------------------------|
| Inputs                             | Twelve 24Vdc positive/negative logic input circuits                                                        |
| Outputs                            | Eight normally open 2 amp relay circuits                                                                   |
| High-Speed Counters                | Up to four Type A or one Type A and one Type B, or four Type A_32, or one Type A_32 and one Type B_32      |
| +24Vdc Output Power Supply         | 435mA maximum (for input circuits and user devices)                                                        |
| +5Vdc output of Serial Port        | Serial Port 1, pin 7:100mA maximum                                                                         |
| <b>AC Power Specifications</b>     |                                                                                                            |
| Range                              | 100 -15% to 240 +10%Vac                                                                                    |
| Frequency                          | 50 -5% to 60 +5% Hz                                                                                        |
| Hold-up                            | 10mS at 85 to 100Vac, 20mS at 100 to 265Vac                                                                |
| Inrush Current                     | 30 Amp maximum at 200Vac, 40 Amp maximum at 265Vac                                                         |
| Inrush Time                        | 2 ms for 40Amp                                                                                             |
| Input Current                      | 0.20 Amp typical at 200Vac 0.10 Amp typical at 100Vac                                                      |
| Input Power Supply Rating          | 26 VA                                                                                                      |
| <b>DC Input Specifications</b>     |                                                                                                            |
| Rated Input Voltage                | 24 volts DC                                                                                                |
| Input Voltage Range                | 0 to 30 volts DC                                                                                           |
| Input Current at 24Vdc             | I1, I3, I5, I7: 8mA typical; other inputs 4.8mA typical                                                    |
| Input Impedance                    | I1, I3, I5, I7: 2.7 kΩ; other inputs: 4.7kΩ                                                                |
| Input Threshold Voltage            | ON: 18Vdc minimum, OFF: 5Vdc maximum                                                                       |
| Input Threshold Current            | I1, I3, I5, I7: ON 4.5mA maximum, OFF: 1.8mA minimum<br>Other inputs: ON 3.3mA maximum, OFF: 1.6mA maximum |
| Response Time                      | 0.5ms to 20ms configurable as regular input; 100μs as HSC input                                            |
| Isolation Voltage                  | 1500V RMS field side to logic side, 500V RMS between groups                                                |
| <b>Relay Output Specifications</b> |                                                                                                            |
| Operating Voltage                  | 5 to 30Vdc or 5 to 250Vac                                                                                  |
| Isolation                          | 1500 V RMS between field side and logic side, 500 V RMS between groups                                     |
| Leakage Current                    | 15 mA at 240Vac maximum                                                                                    |

| Item                                                      | Description                                              |                                       |                               |
|-----------------------------------------------------------|----------------------------------------------------------|---------------------------------------|-------------------------------|
| Maximum UL Pilot Duty Rating                              | 2 amps at 24Vdc and 240Vac                               |                                       |                               |
| Maximum Resistive Load Rating                             | 2 amps at 24Vdc and 240Vac                               |                                       |                               |
| Minimum Load                                              | 10 mA                                                    |                                       |                               |
| Maximum Inrush                                            | 9.4A, 20mSec                                             |                                       |                               |
| Response Time                                             | ON: 15 ms maximum, OFF: 15 ms maximum                    |                                       |                               |
| Contact Life: Mechanical                                  | 20 x 106 mechanical operations                           |                                       |                               |
| Contact Life: Electrical Voltage<br>240Vac, 120Vac, 24Vdc | Current: Resistive<br>2.0A                               | Current: Lamp and<br>Solenoid<br>0.6A | Typical Operations<br>200,000 |
| High-Speed Counter Input and Output Specifications        |                                                          |                                       |                               |
| Maximum Counter Frequency                                 | 100kHz                                                   |                                       |                               |
| Input Voltage                                             | ON: 18V, OFF: 5V                                         |                                       |                               |
| Count Pulse Width                                         | 20% to 80% of duty cycle at 100kHz                       |                                       |                               |
| Count Registers                                           | 16/32 bits                                               |                                       |                               |
| Outputs                                                   |                                                          |                                       |                               |
| Load Voltage                                              | Q1: 5/12/24V, Q2-Q4: See relay output specifications     |                                       |                               |
| Type available                                            | Up to four HSC outputs. Pulse outputs are not available. |                                       |                               |

## 4.7.4 Wiring Diagram, PLC IC200UDR120

Figure 27





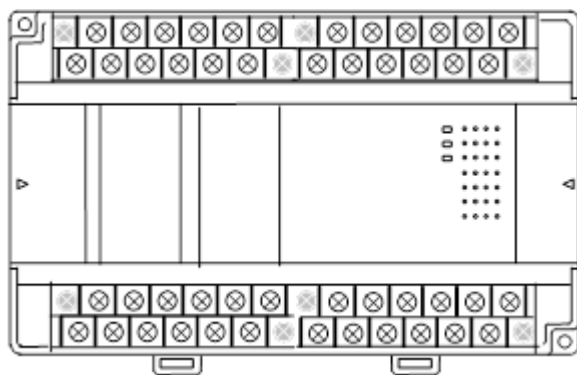
## Chapter 5: Micro PLCs with 23 Discrete Points and 3 Analog Channels

This chapter describes the features and specifications of the VersaMax Micro PLCs with 23 Discrete Points and 3 Analog Channels. It also provides additional information about analog operation and calibration.

- IC200UAL004** Micro PLC with 23 Discrete Points and 3 Analog Channels:  
(13) 12Vdc In, (10) Relay Out,  
(2) Analog In and (1) Analog Out, 12Vdc Power Supply
- IC200UAL005** Micro PLC with 23 Discrete Points and 3 Analog Channels:  
(13) 24Vdc In, (1) 24Vdc Out, (9) Relay Out,  
(2) Analog In and (1) Analog Out, 24Vdc Power Supply
- IC200UAL006** Micro PLC with 23 Discrete Points and 3 Analog Channels:  
(13) 24Vdc In, (1) 24Vdc Out, (9) Relay Out,  
(2) Analog In and (1) Analog Out, 120/240Vac Power Supply

### 5.1 VersaMax 23 Discrete / 3 Analog Micro PLC Features

Figure 28



- Supports up to four Expansion Units in any combination.
- Four removable screw-down “barrier-style” terminal strips with protective covers.
- Two Serial communications ports. Port 1 (RS-232) supports SNP/SNPX slave protocols. Port 2 (RS-485) supports SNP/ SNPX master and slave, RTU master and slave, and Serial I/O.
- Run/Stop mode switch that can be configured as a run/stop switch, a memory protect switch, and also used for clearing faults when a fatal fault exists.
- Time-of-Day Clock.

- Two analog potentiometers.
- Full-featured programming Instruction Set with floating point math. The application program can be either Ladder Diagram (LD) or Instruction List (IL) format.
- 9K words of program memory, 2048 words of registers.
- Flash memory (ROM) for non-volatile program storage and for system firmware.
- Configurable to read configuration at power-up from either RAM or flash memory (ROM). Can also be configured to read application program from flash at power-up.
- Capacitor backs up RAM and the Time-of-Day clock for at least 30 minutes.
- Optional lithium battery backup for RAM and real-time clock.

## 5.2 General Specifications for 23-Point VersaMax Micro PLCs

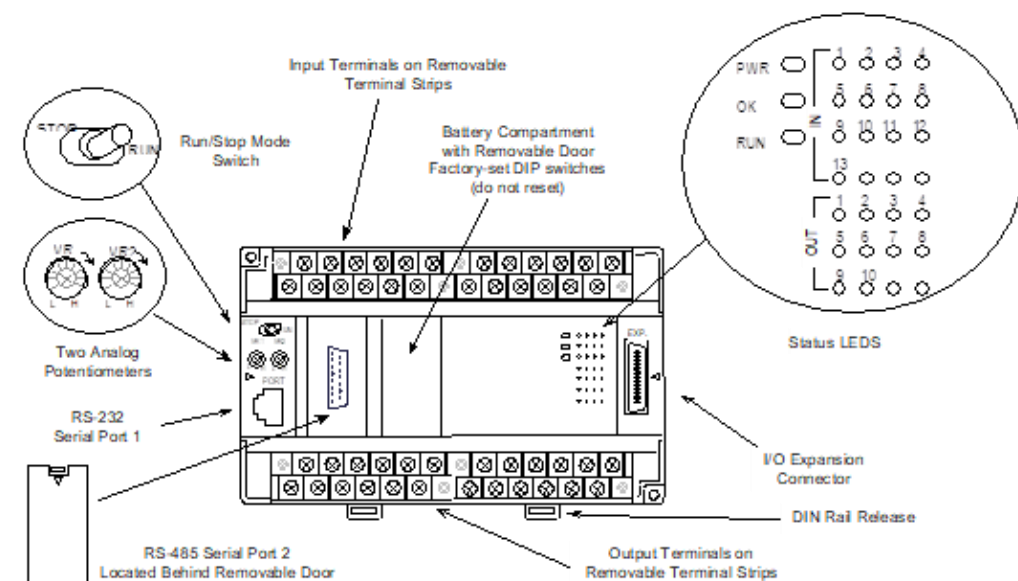
| Item                                                                       | Description                                                                                                                                       |
|----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Weight                                                                     | 600 grams (1.32lbs)                                                                                                                               |
| Module Dimensions                                                          | Height: 90mm (3.6 inches)<br>Depth: 76mm (3.0 inches)<br>Width: 150mm (6.0 inches)                                                                |
| Typical Scan Rate                                                          | 1.1 ms/K for Boolean logic (see Appendix A:)                                                                                                      |
| Real Time Clock accuracy<br>(for Timer contacts and Timer function blocks) | ±0.5%                                                                                                                                             |
| Time-of-Day Clock accuracy                                                 | ±5 sec/day @10°C, ±5 sec/day @25°C, and<br>±11 sec/day @55°C or across full temperature range                                                     |
| High-Speed Counters                                                        | Up to four Type A or one Type A and one Type B                                                                                                    |
| Maximum number of slave devices per RS-485 network                         | 8 (can be increased with a repeater)                                                                                                              |
| +5Vdc Output of Serial Ports                                               | Port 1, pin 7: 100mA maximum <sup>3</sup><br>Port 2, pin 5: 100mA maximum <sup>3</sup>                                                            |
| Lithium battery<br>(IC200ACC403)                                           | Storage: Up to 5 years typical at 30°C<br>Installed: Up to 3 years typical at 55°C<br>4 months battery backup time (powered down) minimum at 55°C |

<sup>3</sup> Combined port 1 and port 2 total not to exceed 100mA max.

## 5.2.1 Run/Stop Switch

The Run/Stop switch can be configured as a run/stop switch, a memory protect switch, and used for clearing faults when a fatal fault exists.

Figure 29



## 5.2.2 Serial Ports

Port 1 is an RS-232 serial port with an RJ-45 connector.

Port 2, located behind a removable door on the front of the Micro PLC, is an RS-485 serial port with a DB-15 connector.

Both ports can be used for programming. Only one port can be used at a time for programming, but both ports can be used for monitoring at the same time. Port 1 uses SNP slave protocol. Port 2 is software-configurable for SNP master/slave RTU slave or Serial I/O operation. CPUs with firmware version 2.02 or later support Modbus RTU Master on port 2. 4-wire and 2-wire RTU are supported. If Port 2 is being used for RTU, it automatically switches to SNP slave mode if necessary. Port 2 defaults to SNP slave and automatically reverts to SNP slave when the CPU is in Stop mode, if configured for Serial I/O.

Either port can be software-configured to set up communications between the CPU and various serial devices. An external device can obtain power from both ports if it requires 100mA or less at 5Vdc.

## 5.2.3 Analog Potentiometers

The two potentiometers can be used to adjust the values in analog registers %AI016 and %AI017. An example use would be to set thresholds for use in logical relationships with other inputs/outputs.

## 5.2.4 Removable Terminal Strips

The removable terminal assemblies are protected by hinged covers. After turning off power to the Micro PLC, a terminal assembly and attached field wiring can be separated from the Micro PLC by removing two screws.

## 5.2.5 Status LEDs

LEDs for Power, OK, and Run mode, plus individual LEDs for each I/O point.

## 5.2.6 Backup Battery

The Micro PLC uses a large value capacitor to provide memory retention current to the System/User RAM and the Time-of-Day clock when the power supply is either not present or not powered up. The capacitor retains memory contents for at least 30 minutes.

To maintain memory for longer than this, a lithium coin cell assembly (IC200ACC403) can be installed in the battery holder. The Micro PLC reports the battery state to the PLC Fault Table and also uses Status Bits %SA011 and %S0014 to indicate the battery state.

# 5.3 High-Speed Counters

These VersaMax Micro PLCs can be configured to provide built-in high-speed counter operation.

When configured for High-Speed Counter operation, inputs can be set up as:

- Up to four High-Speed Counters or
- One Type A and one Type B Counter.

Each counter provides direct processing of rapid pulse signals up to 10kHz for industrial control applications such as meter proving, turbine flowmeter, velocity measurement, material handling, motion control, and process control.

Each counter can be enabled independently. Type A counters can be configured for up or down counting (default is up) and for positive or negative edge detection (default is positive). The type B counter provides an A Quad B counting function.

The relay outputs of IC200UAL004 and IC200UAL005 can be configured as up to four counter outputs. They cannot be used as Pulse Train or PWM outputs.

## 5.3.1 Analog I/O

All VersaMax 23-Point Micro PLCs provide two analog input channels that can be configured to accept inputs from 0 to +10V or from 0 to 20mA or 4 to 20mA input signals. They also have one analog output configurable for the same voltage or current ranges. See Chapter 15 for information about configuring voltage/current operation and range. See Chapter 16 for details of analog operation, automatic gain and offset adjustment, automatic program reference configuration, and calibration procedures.

| Analog I/O Specifications                                                                                 |                                                                                                                                                |
|-----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| Input and output ranges                                                                                   | 0 to 10V (10.24V maximum)<br>0 to 20mA (20.5mA maximum)<br>4 to 20mA (20.5mA maximum)                                                          |
| Resolution                                                                                                | 12 bits over 0 to 10V range (1 LSB=2.5mV)<br>12 bits over 0 to 20mA range (1 LSB=5 $\mu$ A)<br>11+ bits over 4 to 20mA range (1 LSB=5 $\mu$ A) |
| Accuracy                                                                                                  | $\pm 1\%$ of full scale over full operating temperature range                                                                                  |
| <b>Analog Inputs</b>                                                                                      | <b>2, differential</b>                                                                                                                         |
| Factory calibrated to:                                                                                    | 2.50mV per count on 0 to 10V range<br>5.00 $\mu$ A per count on 0 to 20mA and 4 to 20mA ranges                                                 |
| Linearity                                                                                                 | $\pm 3$ LSB maximum                                                                                                                            |
| Isolation                                                                                                 | non-isolated                                                                                                                                   |
| Common mode voltage                                                                                       | $\pm 200$ V maximum                                                                                                                            |
| Current input impedance                                                                                   | 249 $\Omega$                                                                                                                                   |
| Voltage input impedance                                                                                   | 100 k $\Omega$                                                                                                                                 |
| Input filter time                                                                                         | 20ms to reach 1% error for step input                                                                                                          |
| <b>Analog Output</b>                                                                                      | <b>1, single-ended, non-isolated</b>                                                                                                           |
| Current: maximum terminal voltage<br>user load range<br>output load capacitance<br>output load inductance | 10V (at 20mA output)<br>0 to 500 $\Omega$<br>2000 pF maximum<br>1 Henry maximum                                                                |
| Voltage: output loading<br>output load capacitance                                                        | 2 k $\Omega$ minimum at 10 volts<br>1 $\mu$ F maximum                                                                                          |

## 5.4 IC200UAL004

### Micro PLC, 23 Discrete Points and 3 Analog Channels:

### (13) 12Vdc In, (10) Relay Out, (2) Analog In, (1) Analog Out, 12Vdc Power Supply

VersaMax Micro PLC IC200UAL004 accepts thirteen 12Vdc inputs and two analog inputs. It provides ten normally open 2 Amp relay outputs and one analog output. It uses +12Vdc nominal input power.

#### 5.4.1 DC Inputs

Thirteen configurable 12Vdc inputs can be used as positive or negative logic standard or High-Speed Counter inputs. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

## 5.4.2 Normally Open Relay Outputs

Ten Form A relay outputs (SPST-single pole single throw) can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each relay output is 2 amps. An external source of AC or DC power must be supplied for field devices. External fusing is recommended to protect the relay contacts. Relay outputs can be configured as regular outputs or as outputs controlled by High-Speed Counters. They cannot be used as Pulse Train or PWM outputs.

## 5.4.3 DC Power Supply

The DC power supply requires more current at startup voltage (approximately 4Vdc) than at rated input voltage. A minimum of 2.0 A is required to start up the DC power supply.

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 12Vdc. The 12Vdc power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 12Vdc voltage level (see power supply specifications for inrush requirements).

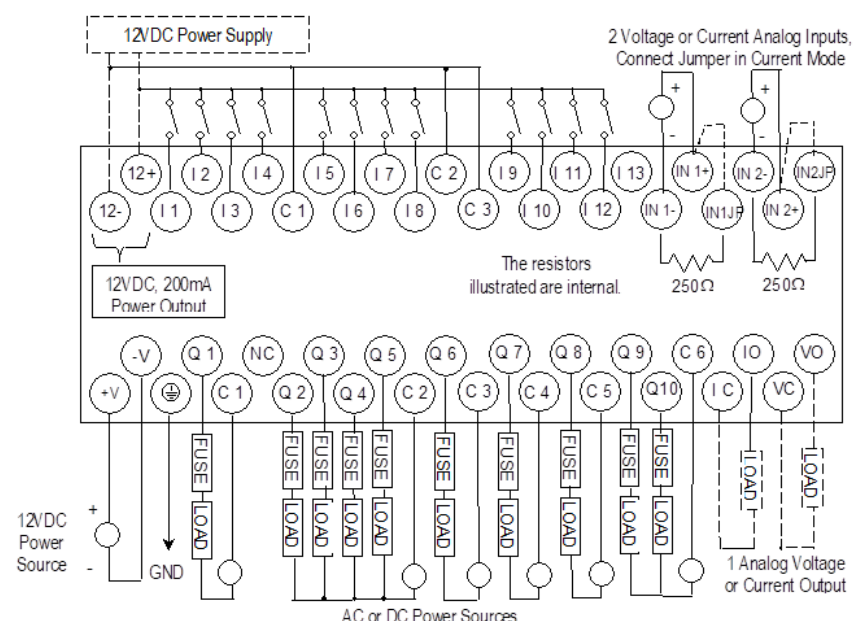
## 5.4.4 Micro PLC IC200UAL004 Specifications

| Item                           | Description                                                          |
|--------------------------------|----------------------------------------------------------------------|
| Inputs                         | 13 DC inputs and 2 Analog inputs                                     |
| Outputs                        | 10 relay outputs and 1 analog output                                 |
| +12Vdc Output Power Supply     | 200 mA maximum (for input circuits and user devices)                 |
| High-Speed Counters            | Up to four Type A or one Type A and one Type B                       |
| <b>DC Power Specifications</b> |                                                                      |
| Range                          | 9.6Vdc - 15Vdc                                                       |
| Hold-up                        | 3.0mS                                                                |
| Inrush Current                 | 9.6A typical at 12Vdc                                                |
| Inrush Time                    | 200mS typical                                                        |
| Input Current                  | 480mA typical at 12Vdc                                               |
| Input Power Supply Rating      | 8W                                                                   |
| <b>Input Specifications</b>    |                                                                      |
| Number of Inputs               | 13                                                                   |
| Rated Input Voltage            | 12 volts DC                                                          |
| Input Voltage Range            | 0 to 15 volts DC                                                     |
| Input Current                  | 9.0mA typical                                                        |
| Input Impedance                | 1.3 kΩ                                                               |
| Input Threshold Voltage        | ON: 9.5Vdc minimum, OFF: 2.5Vdc maximum                              |
| Input Threshold Current        | ON: 6.5mA maximum, OFF: 1.6mA minimum                                |
| Response Time                  | 0.5 to 20ms (user configurable) as regular input; 100μs as HSC input |

| Item                              | Description                                                            |                                    |                               |
|-----------------------------------|------------------------------------------------------------------------|------------------------------------|-------------------------------|
| Isolation Voltage                 | 1500V RMS field side to logic side, 500V RMS between groups            |                                    |                               |
| Relay Output Specifications       |                                                                        |                                    |                               |
| Operating Voltage                 | 5 to 30Vdc or 5 to 250Vac                                              |                                    |                               |
| Isolation                         | 1500 V RMS between field side and logic side, 500 V RMS between groups |                                    |                               |
| Leakage Current                   | 15 mA maximum                                                          |                                    |                               |
| Maximum UL Pilot Duty Rating      | 2 amps at 24Vdc and 240Vac                                             |                                    |                               |
| Maximum Resistive Load Rating     | 2 amps at 24Vdc and 240Vac                                             |                                    |                               |
| Minimum Load                      | 1 mA                                                                   |                                    |                               |
| Maximum Inrush                    | 5 amps per half cycle                                                  |                                    |                               |
| Response Time                     | ON: 15 ms maximum, OFF: 15 ms maximum                                  |                                    |                               |
| Contact Life: Mechanical          | 20 x 106 mechanical operations                                         |                                    |                               |
| Contact Life: Electrical Voltage  | Current: Resistive<br>2A                                               | Current: Lamp and Solenoid<br>0.6A | Typical Operations<br>200,000 |
| High-Speed Counter Specifications |                                                                        |                                    |                               |
| Maximum Counter Frequency         | 10kHz                                                                  |                                    |                               |
| Input Voltage                     | ON: 9V, OFF: Off: 2.5V                                                 |                                    |                               |
| Count Registers                   | 16 bits                                                                |                                    |                               |
| Available Pulse Outputs           | None                                                                   |                                    |                               |

## 5.4.5 Wiring Diagram, IC200UAL004

Figure 30



## 5.5 IC200UAL005

### Micro PLC, 23 Discrete Points and 3 Analog Channels:

### (13) 24Vdc In, (1) 24Vdc Out, (9) Relay Out, (2) Analog In, (1) Analog Out, 24Vdc Power Supply

VersaMax Micro PLC IC200UAL005 accepts thirteen 24Vdc inputs and two analog inputs. It provides one 24Vdc output, nine normally-open 2 Amp relay outputs, and one analog output. It uses +24Vdc nominal input power.

#### 5.5.1 DC Inputs

Thirteen configurable 24Vdc inputs can be used as positive or negative logic standard or High-Speed Counter inputs. Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The module provides +24Vdc output power available for field devices.

#### 5.5.2 DC Output (Q1)

The DC output circuit (Q1) can be configured to be a standard, High-Speed Counter, Pulse Train or PWM output.

#### 5.5.3 Normally Open Relay Outputs

Nine Form A relay outputs (SPST-single pole single throw). The nine isolated 2-Amp, normally open outputs can control many types of user-supplied load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. AC or DC power to operate field devices must be supplied from an external source. External fusing is recommended to protect the relay contacts. Relay outputs can be configured as regular outputs or as outputs controlled by High-Speed Counters. They cannot be used as Pulse Train or PWM outputs.

#### 5.5.4 DC Power Supply

The DC power supply requires more current at startup voltage (approximately 4Vdc) than at rated input voltage. A minimum of 2.0 A is required to start up the DC power supply.

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 24Vdc. The 24Vdc power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 24Vdc voltage level (see power supply specifications for inrush requirements).



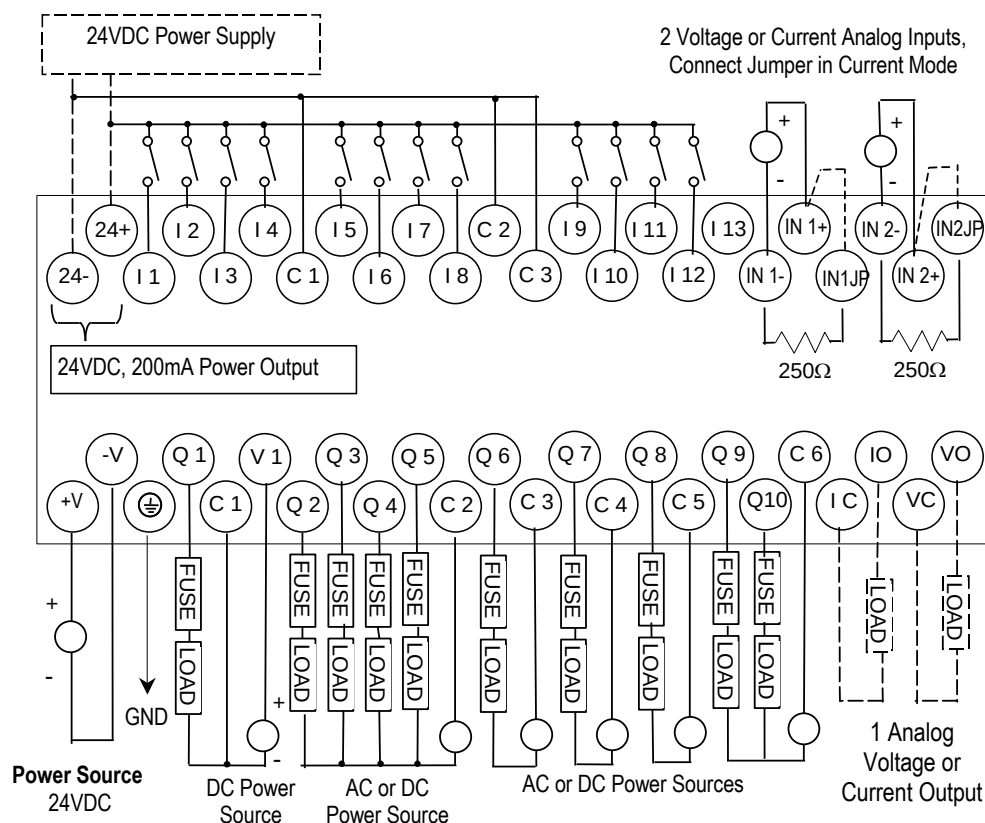
## 5.5.5 Micro PLC IC200UAL005 Specifications

| Item                                     | Description                                                             |
|------------------------------------------|-------------------------------------------------------------------------|
| Inputs                                   | 13 DC inputs and 2 analog inputs                                        |
| Outputs                                  | 9 relay outputs, 1 analog output, 1 24Vdc output                        |
| +24Vdc Output Power Supply               | 200 mA maximum (for input circuits and user devices)                    |
| <b>DC Power Specifications</b>           |                                                                         |
| Range                                    | 24 -20%, +25%Vdc                                                        |
| Hold-up                                  | 10mS at 19.2Vdc                                                         |
| Inrush Current                           | 1 Amp maximum at 30Vdc                                                  |
| Inrush Time                              | 10mS for 1 A                                                            |
| Input Current                            | 0.30 Amp typical at 24Vdc                                               |
| Input Power Supply Rating                | 8W                                                                      |
| <b>High-Speed Counter Specifications</b> |                                                                         |
| Available High-Speed Counters            | Up to four Type A or one Type A and one Type B                          |
| Maximum Counter Frequency                | 10kHz                                                                   |
| Input Voltage                            | ON: 15V, OFF: 5V                                                        |
| Count Pulse Width                        | 20% to 80% duty cycle at 10kHz                                          |
| Count Registers                          | 16 bits                                                                 |
| High-Speed Counter Outputs               | Up to four HSC outputs or one Pulse/PWM output plus three HSC outputs.  |
| Load Voltage                             | Q1: 5/12/24V                                                            |
| Maximum Pulse/PWM Frequency              | (Q1 only) 5kHz                                                          |
| <b>Input Specifications</b>              |                                                                         |
| Number of Inputs                         | 13                                                                      |
| Rated Input Voltage                      | 24 volts DC                                                             |
| Input Voltage Range                      | 0 to 30 volts DC                                                        |
| Input Current                            | 7.5mA typical                                                           |
| Input Resistance                         | 2.8 kΩ                                                                  |
| Input Threshold Voltage                  | ON: 15Vdc minimum, OFF: 5Vdc maximum                                    |
| Input Threshold Current                  | ON 4.5mA maximum, OFF: 1.5mA minimum                                    |
| Response Time                            | 0.5 to 20ms (user configurable) as regular input;<br>100μs as HSC input |
| Isolation Voltage                        | 1500V RMS field side to logic side, 500V RMS between groups             |
| <b>DC Output (Q1) Specifications</b>     |                                                                         |
| Output logic                             | Positive Logic                                                          |
| Operating Voltage                        | 24Vdc / 12Vdc / 5Vdc                                                    |
| Voltage Range                            | 24Vdc, +20%, -80%                                                       |
| Maximum UL Pilot Duty Rating             | 0.75A at 24Vdc                                                          |

| Item                                                      | Description                                                                                                                        |                                       |                               |
|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|-------------------------------|
| Maximum Resistive Load Rating                             | 0.75A at 24Vdc<br>0.5A at 12Vdc<br>0.25A at 5Vdc                                                                                   |                                       |                               |
| Output Voltage Drop                                       | 0.3Vdc maximum                                                                                                                     |                                       |                               |
| Response                                                  | ON                                                                                                                                 | 0.1ms maximum (24Vdc, 0.2A)           |                               |
|                                                           | OFF                                                                                                                                | 0.1ms maximum (24Vdc, 0.2A)           |                               |
| OFF state leakage                                         | 0.1mA maximum                                                                                                                      |                                       |                               |
| Isolation                                                 | 1500Vac between field side and logic side<br>500Vac between groups                                                                 |                                       |                               |
| Fuse                                                      | Output should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable. |                                       |                               |
| Relay Output Specifications                               |                                                                                                                                    |                                       |                               |
| Operating Voltage                                         | 5 to 30Vdc or 5 to 250Vac                                                                                                          |                                       |                               |
| Isolation                                                 | 1500 V RMS between field side and logic side<br>500 V RMS between groups                                                           |                                       |                               |
| Leakage Current                                           | 15 mA at 240Vac maximum                                                                                                            |                                       |                               |
| Maximum UL Pilot Duty Rating                              | 2 amps at 24Vdc and 240Vac                                                                                                         |                                       |                               |
| Maximum Resistive Load Rating                             | 2 amps at 24Vdc and 240Vac                                                                                                         |                                       |                               |
| Minimum Load                                              | 10 mA                                                                                                                              |                                       |                               |
| Maximum Inrush                                            | 5 amps per half cycle                                                                                                              |                                       |                               |
| On Response Time                                          | 15 ms maximum                                                                                                                      |                                       |                               |
| Off Response Time                                         | 15 ms maximum                                                                                                                      |                                       |                               |
| Contact Life: Mechanical                                  | 20 x 106 mechanical operations                                                                                                     |                                       |                               |
| Contact Life: Electrical Voltage<br>240Vac, 120Vac, 24Vdc | Current: Resistive<br>2A                                                                                                           | Current: Lamp and<br>Solenoid<br>0.6A | Typical Operations<br>200,000 |

## 5.5.6 Wiring Diagram, IC200UAL005

Figure 31



The resistors illustrated are internal.

## 5.6 IC200UAL006 Micro PLC, 23 Discrete Points and 3 Analog Channels: (13) 24Vdc In, (1) 24Vdc Out, (9) Relay Out, (2) Analog In, (1) Analog Out, 120/240Vac Power Supply

VersaMax Micro PLC IC200UAL006 accepts thirteen DC inputs and two analog inputs. It provides one DC output, nine normally open 2 Amp relay outputs, and one analog output. It uses 100Vac to 240Vac nominal input power.

## 5.6.1 DC Inputs

Thirteen configurable 24Vdc inputs can be used as positive or negative logic standard or High-Speed Counter inputs. Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate field devices and the input circuits is supplied by an isolated +24Vdc supply.

## 5.6.2 DC Output (Q1)

Output circuit Q1 is a 24Vdc transistor output. It can be used as a normal DC output or as a High-Speed Counter-controlled output, Pulse Train output, or Pulse Width Modulation (PWM) output.

## 5.6.3 Normally Open Relay Outputs

Nine isolated 2-amp, normally open Form A relay outputs (SPST-single pole single throw) can control many types of user-supplied load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. AC or DC power to operate field devices must be supplied from an external source. External fusing is recommended to protect the relay contacts. Relay outputs can be configured as regular outputs or as outputs controlled by High-Speed Counters. They cannot be used as Pulse Train or PWM outputs.

## 5.6.4 Micro PLC IC200UAL006 Specifications

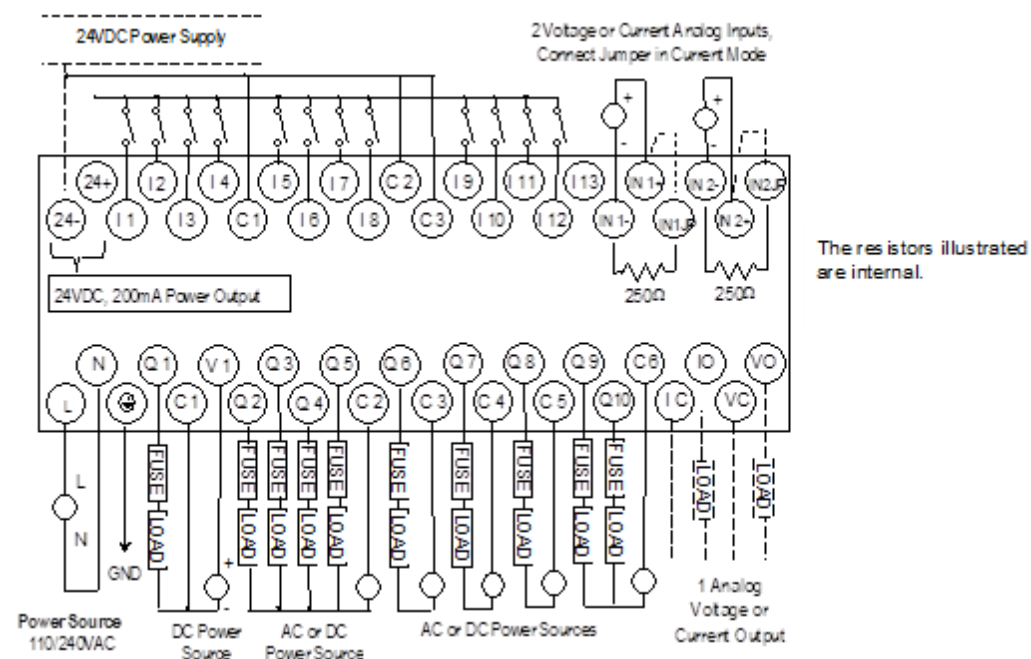
| Item                                                                | Description                                              |
|---------------------------------------------------------------------|----------------------------------------------------------|
| Inputs                                                              | 13 DC inputs and 2 Analog inputs                         |
| Outputs                                                             | 1 DC output, 9 relay outputs, 1 analog output            |
| High-Speed Counters                                                 | Up to four Type A or one Type A and one Type B           |
| +24Vdc Output Power Supply<br>(for input circuits and user devices) | 200 mA maximum                                           |
| <b>AC Power Specifications</b>                                      |                                                          |
| Range                                                               | 100 -15% to 240 +10%Vac                                  |
| Frequency                                                           | 50 -5% to 60 +5% Hz                                      |
| Hold-up                                                             | 10 ms at 85 to 100Vac, 20mS at 100 to 265Vac             |
| Inrush Time                                                         | 2mS for 40A                                              |
| Inrush Current                                                      | 35 Amp maximum at 200Vac<br>46 Amp maximum at 265Vac     |
| Input Current                                                       | 0.13 Amp typical at 200Vac<br>0.20 Amp typical at 100Vac |
| Input Power Supply Rating                                           | 34 VA                                                    |
| Isolation                                                           | 1500Vac rms field-side to logic (power supply input).    |
| <b>Input Specifications</b>                                         |                                                          |
| Number of Inputs                                                    | 13                                                       |
| Rated Input Voltage                                                 | 24 volts DC                                              |

| Item                                                      | Description                                                                                                                        |                                       |                                  |
|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|----------------------------------|
| Input Voltage Range                                       | 0 to 30 volts DC                                                                                                                   |                                       |                                  |
| Input Current                                             | 7.5mA typical                                                                                                                      |                                       |                                  |
| Input Resistance                                          | 2.8 kΩ                                                                                                                             |                                       |                                  |
| Input Threshold Voltage                                   | ON: 15Vdc minimum, OFF: 5Vdc maximum                                                                                               |                                       |                                  |
| Input Threshold Current                                   | ON: 4.5mA maximum, OFF: 1.5mA minimum                                                                                              |                                       |                                  |
| Response Time                                             | 0.5 to 20ms (user configurable) as regular input;<br>100μs as HSC input                                                            |                                       |                                  |
| Isolation Voltage                                         | 1500V RMS field side to logic side, 500V RMS between groups                                                                        |                                       |                                  |
| DC Output Specifications                                  |                                                                                                                                    |                                       |                                  |
| Output logic                                              | Positive Logic                                                                                                                     |                                       |                                  |
| Operating Voltage                                         | 24Vdc / 12Vdc / 5Vdc                                                                                                               |                                       |                                  |
| Voltage Range                                             | 24Vdc, +20%, -80%                                                                                                                  |                                       |                                  |
| Maximum UL Pilot Duty Rating                              | 0.75A at 24Vdc                                                                                                                     |                                       |                                  |
| Maximum Resistive Load Rating                             | 0.75A at 24Vdc<br>0.5A at 12Vdc<br>0.25A at 5Vdc                                                                                   |                                       |                                  |
| Output Voltage Drop                                       | 0.3Vdc maximum                                                                                                                     |                                       |                                  |
| Response Time                                             | ON: 0.1ms maximum (24Vdc, 0.2A), OFF: 0.1ms maximum (24Vdc, 0.2A)                                                                  |                                       |                                  |
| OFF state leakage                                         | 0.1mA maximum                                                                                                                      |                                       |                                  |
| Isolation                                                 | 1500Vac between field side and logic side, 500Vac between groups                                                                   |                                       |                                  |
| Fuse                                                      | Output should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable. |                                       |                                  |
| Relay Output Specifications                               |                                                                                                                                    |                                       |                                  |
| Operating Voltage                                         | 5 to 30Vdc or 5 to 250Vac                                                                                                          |                                       |                                  |
| Isolation                                                 | 1500 V RMS between field side and logic side, 500 V RMS between groups                                                             |                                       |                                  |
| Leakage Current                                           | 15 mA at 240Vac maximum                                                                                                            |                                       |                                  |
| Maximum UL Pilot Duty Rating                              | 2 amps at 24Vdc and 240Vac                                                                                                         |                                       |                                  |
| Maximum Resistive Load Rating                             | 2 amps at 24Vdc and 240Vac                                                                                                         |                                       |                                  |
| Minimum Load                                              | 10 mA                                                                                                                              |                                       |                                  |
| Maximum Inrush                                            | 5 amps per half cycle                                                                                                              |                                       |                                  |
| Response Time                                             | ON: 15 ms maximum, OFF: 15 ms maximum                                                                                              |                                       |                                  |
| Contact Life: Mechanical                                  | 20 x 106 mechanical operations                                                                                                     |                                       |                                  |
| Contact Life: Electrical Voltage<br>240Vac, 120Vac, 24Vdc | Current: Resistive<br>2A                                                                                                           | Current: Lamp and<br>Solenoid<br>0.6A | Typical<br>Operations<br>200,000 |

| Item                                     | Description                                                            |
|------------------------------------------|------------------------------------------------------------------------|
| <b>High-Speed Counter Specifications</b> |                                                                        |
| Maximum Counter Frequency                | 10kHz                                                                  |
| Input Voltage                            | ON: 15V, OFF: Off: 5V                                                  |
| Count Pulse Width                        | 20% to 80% duty cycle at 10kHz                                         |
| Count Registers                          | 16 bits                                                                |
| Available Pulse Outputs                  | None                                                                   |
| <b>Outputs</b>                           |                                                                        |
| Load Voltage                             | Q1: 5/12/24V                                                           |
| Maximum Pulse/PWM Frequency              | (Q1 only) 5kHz                                                         |
| Types available                          | Up to four HSC outputs or one Pulse/PWM output plus three HSC outputs. |

## 5.6.5 Wiring Diagram, IC200UAL006

Figure 32



## 5.7 Analog Operation

This section explains how a VersaMax Micro PLC with analog channels processes analog data.

### 5.7.1 Analog I/O Parameters

Each analog channel can be configured to operate in either voltage or current mode. If current mode operation is selected, the range can then be configured as either 4-20mA or 0-20mA.

| Parameter               | Choices          | Default Value |
|-------------------------|------------------|---------------|
| Voltage or current mode | Voltage, Current | Voltage       |
| Current range selection | 4–20mA, 0–20mA   | 4–20mA        |

### 5.7.2 Input/Output Values Compared to Process Data

The Micro PLC processes analog channels using gain and offset values for both current and voltage mode operation. Default gain and offset values are loaded into the Micro PLC flash memory at the factory. For these 23-point Micro PLCs (only) gain and offset can be recalibrated if necessary, as explained later in this section.

The table below shows the relationship between the analog input and output values used by the application program, and the actual analog input or output for each mode. These values include the automatic adjustments for offset and gain.

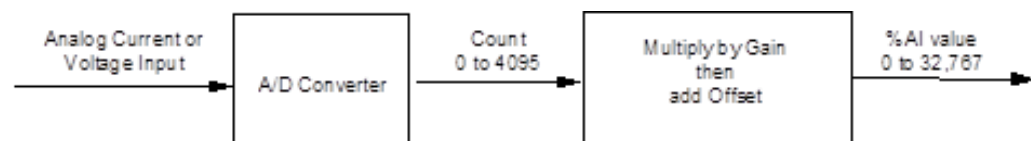
| In this Configured Mode: | This is the Analog Signal Range | This is the Equivalent Process Data %AI or %AQ Range | For the Default Calibration, the Value in the %AI or %AQ Reference Equals: |
|--------------------------|---------------------------------|------------------------------------------------------|----------------------------------------------------------------------------|
| Voltage 0 to +10V        | 0 to 10,000mV                   | 0 to 32000                                           | 3.2 x mV                                                                   |
| Current 0 to 20mA        | 0 to 20,000μA                   | 0 to 32000                                           | 1.6 x μA                                                                   |
| Current 4 to 20mA        | 4,000 to 20,000μA               | 0 to 32000                                           | 2 x μA – 8000                                                              |

The following pages explain how the Micro PLC performs the necessary data conversions between the analog signal levels and the numeric values used by the application program.

## 5.7.3 Analog Input Processing

The Micro PLC processes analog input channels with a 12-bit successive-approximation A/D converter. It converts the analog value into a digital count, calculates the %AI value as described below, then places the result into the configured %AI input reference.

**Figure 33**



### Automatic Conversion of Analog Voltage or Current to Counts

In voltage mode, the Micro PLC first converts the 0 to 10,000mV input signal to a count in the range of 0 to 4,000. The fixed multiplier for this conversion is 2.5.

In current mode, the Micro PLC first converts the 0 to 20,000μA input signal to a count value in the range of 0 to 4,000. The fixed multiplier for this conversion is 5. The conversion for both current modes (0-20mA and 4-20mA) is the same.

### Automatic Gain and Offset Adjustment for Analog Inputs

The Micro PLC then converts the A/D converter's input count value from the range of 0 to 4000 to a final %AI input value in the range of 0 to 32,000. It multiplies the count value by a stored gain value and adds an offset value to get the final analog input (%AI):

$$(\text{input count} \times \text{Gain}) + \text{Offset} = \%AI \text{ value}$$

The default input gain used for this conversion is 8 (32000 / 4000) and the default offset is 0. These can be changed as described later. Any calculated value above 32,767 is clamped at that maximum value. Any calculated value less than 0 is clamped at 0.

### Analog Input Conversion Summary

The table below summarizes the conversion of voltage or current inputs to counts and then to %AI values.

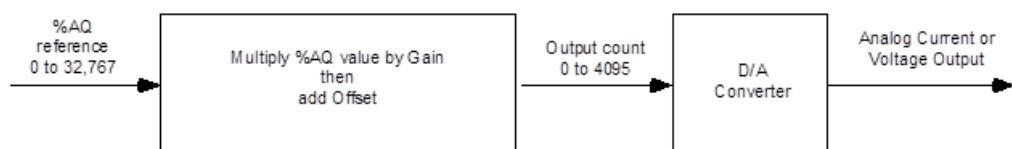
| Input Signal                         | Conversion Factor | A/D Converter Value | Default Gain | Default Offset | %AI Range |
|--------------------------------------|-------------------|---------------------|--------------|----------------|-----------|
| Voltage Mode (0–10,000mV)            | 2.5               | 0–4000 counts       | 8            | 0              | 0–32,000  |
| Current Mode (0–20mA)<br>or (4–20mA) | 5                 | 0–4000 counts       | 8            | 0              | 0–32,000  |



## 5.7.4 Analog Output Processing

To generate the analog output signal, the Micro PLC converts the value in the %AQ output reference into a count value for the 12-bit D/A converter, which then drives the analog output.

**Figure 34**



### Automatic Gain and Offset Adjustment for Analog Outputs

The application's %AQ output range of 0 to 32000 corresponds to the D/A converter's output count range of 0 to 4000. The Micro PLC first multiplies the %AQ value from the program by a gain value and adds a predefined offset to produce the count value for the D/A converter:

$$(\%AQ \times \text{Gain}) + \text{Offset} = \text{D/A count}$$

Any calculated value that exceeds 4095 (212-1) is clamped at that maximum value. Any calculated value less than 0 is clamped at 0. The range 0 to 4095 corresponds to %AQ values between 0 and 32,767.

The default output gain used for this conversion is 0.125 (4000 / 32000) and the default offset is 0. These can be changed as described later.

### Automatic Conversion of Counts to Analog Voltage or Current

In voltage mode, the D/A converter then converts the count value in the range of 0 to 4,000 counts to an analog signal from 0 to 10,000mV. The output voltage gain (ratio) for this conversion is 2.5.

In current mode, the D/A converter converts the count value to an analog signal from 0 to 20,000µA. The output current gain for this conversion is 5. The conversion for both current modes (0-20mA and 4-20mA) is the same.

### Analog Output Data Conversion Summary

The table below summarizes the conversion of %AQ values to counts and then to voltage or current levels.

| %AQ Range | Default Gain, %AQ to Counts | Default Offset | D/A Converter Range | Conversion Factor | Output Signal                        |
|-----------|-----------------------------|----------------|---------------------|-------------------|--------------------------------------|
| 0– 32,000 | 0.125                       | 0              | 0–4,000 counts      | 2.5               | Voltage Mode (0–10,000mV)            |
| 0–32,000  | 0.125                       | 0              | 0–4,000 counts      | 5                 | Current Mode (0–20mA)<br>or (4–20mA) |

## 5.7.5 Adjusting the Calibration of Analog Channels

For the 23-point Micro PLCs with analog channels, it is possible to adjust the calibration of the analog channels as described below. Analog channels on Expansion Units and 10-point Nano PLCs cannot be recalibrated. A set of default gains and offsets is maintained in the PLC firmware if you want to restore the original values.

To perform the calibration procedures, you will need a precision analog meter (1 mV voltage accuracy and 1 μA current accuracy). Do not try the procedures in this section unless you are familiar with the operation of D/A and A/D converters.

### Recalibrating Input Channels

1. Apply a reference voltage or current at a low range to the input. (The reference signal must be measured accurately by a precision analog meter.) Record the value.
2. For the channel being calibrated, read the %AI register and record the low value.
3. Apply a reference voltage or current at a high range to the input. Precisely measure the reference signal and record the value.
4. For the channel being calibrated, read the %AI register and record the high value.
5. Store the calculated gain and offset values in RAM or flash memory using SVCREQ functions 34 and 35 as instructed in Chapter 23:.

The Micro PLC automatically calculates the calibration gain and offset:

$$Gain = \frac{Meter_{High} - Meter_{Low}}{\%AI_{High} - \%AI_{Low}} \times DefaultGain$$

$$Offset = Meter_{High} - \frac{\%AI_{High} \times Gain}{DefaultGain}$$

### Recalibrating Output Channels

1. Write a low value to the %AQ register.
2. At the output, measure the voltage or current using a precision analog meter and record the value.
3. Write a high value to the %AQ register.
4. At the output, measure the voltage or current using a precision analog meter and record the value.
5. Store the calculated gain and offset values in RAM or flash memory using SVCREQ functions 34 and 35 as instructed in Chapter 23:.
6. The Micro PLC automatically calculates the calibration gain and offset:

$$Gain = \frac{\%AQ_{High} - \%AQ_{Low}}{Meter_{High} - Meter_{Low}} \times DefaultGain$$

$$Offset = \%AQ_{High} \times DefaultGain - Meter_{High} \times Gain$$

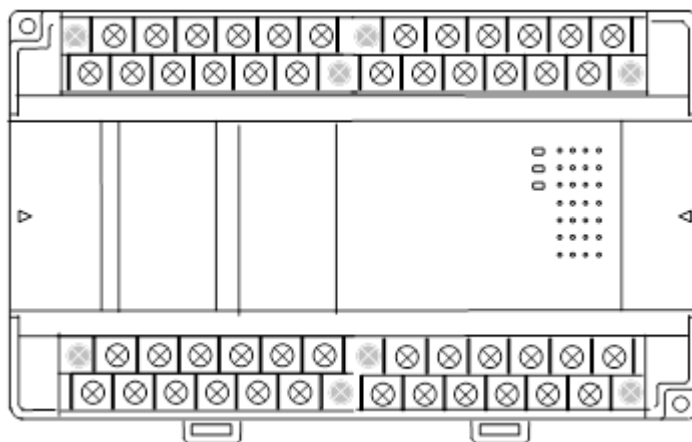
## Chapter 6: VersaMax 28-Point Micro PLCs

This chapter describes the features, specifications, and field wiring of these VersaMax Micro PLCs:

|                    |                                                                                                                 |
|--------------------|-----------------------------------------------------------------------------------------------------------------|
| <b>IC200UAA007</b> | 28 Point Micro PLC, (16) 120Vac In, (12) 120Vac Out, 120/240Vac Power Supply                                    |
| <b>IC200UAR028</b> | 28 Point Micro PLC, (16) 120Vac In, (2) Relay Out at 10 Amps, (10) Relay Out at 2 Amps, 120/240Vac Power Supply |
| <b>IC200UDD110</b> | 28 Point Micro PLC, (16) 24Vdc In, (12) 24Vdc Out, 24Vdc Power Supply                                           |
| <b>IC200UDD120</b> | 28 Point Micro PLC, (16) 24Vdc In, (12) 24Vdc Out with ESCP, 24Vdc Power Supply                                 |
| <b>IC200UDD212</b> | 28 Point Micro PLC, (16) 12Vdc In, (12) 12Vdc Out, 12Vdc Power Supply                                           |
| <b>IC200UDR005</b> | 28 Point Micro PLC, (16) 24Vdc In, (1) 24Vdc Out, (11) Relay Out, 120/240Vac Power Supply                       |
| <b>IC200UDR006</b> | 28 Point Micro PLC, (16) 12Vdc In, (12) Relay Out, 12Vdc Power Supply                                           |
| <b>IC200UDR010</b> | 28 Point Micro PLC, (16) 24Vdc In, (1) 24Vdc Out, (11) Relay Out, 24Vdc Power Supply                            |
| <b>IC200UDR228</b> | 28 Point Micro PLC, (16) 24Vdc In, (1) 24Vdc Out, (11) Relay Out, 12/24Vdc Power Supply                         |

### 6.1 Features of VersaMax 28-Point Micro PLCs

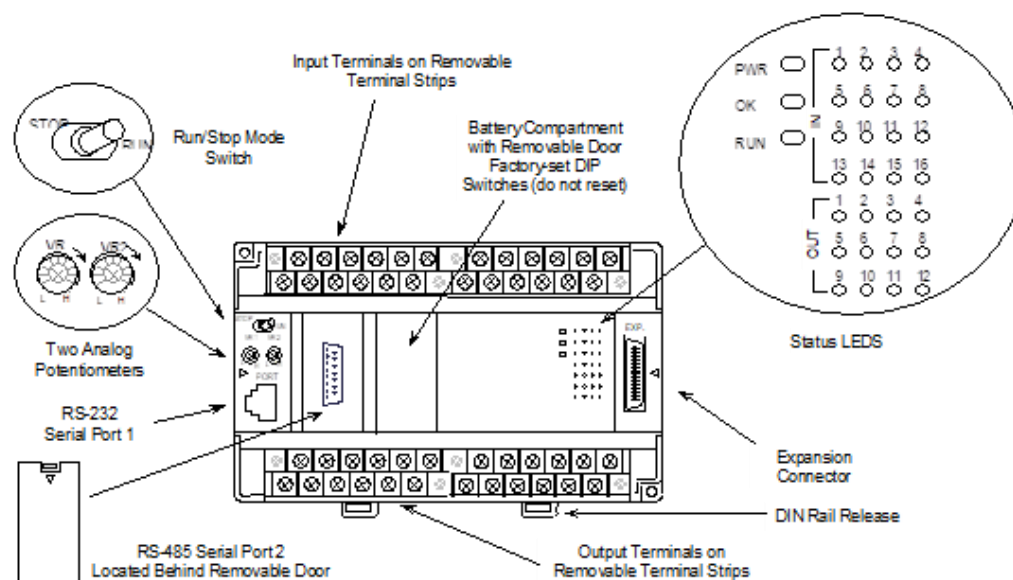
Figure 35



- Supports up to four Expansion Units in any combination.
- Four removable screw-down “barrier-style” terminal strips with protective covers.
- Two Serial communications ports. Port 1 (RS-232) supports SNP/SNPX slave protocols. Port 2 (RS-485) supports SNP/ SNPX master and slave, RTU master and slave protocol, and Serial I/O.
- Run/Stop mode switch that can be configured as a run/stop switch, a memory protect switch, and also used for clearing faults when a fatal fault exists.
- Time-of-Day Clock.
- Two analog potentiometers.

- Full-featured programming Instruction Set with floating point math. The application program can be either Ladder Diagram (LD) or Instruction List (IL) format.
- 9K words of program memory, 2048 words of registers.
- Flash memory (ROM) for non-volatile program storage and for system firmware
- Configurable to read configuration at power-up from either RAM or flash memory (ROM). Can also be configured to read application program from flash at power-up.
- Capacitor backs up RAM and the Time-of-Day clock for at least 30 minutes.
- Optional lithium battery backup for RAM and real-time clock.

Figure 36



### 6.1.1 Run/Stop Switch

The Run/Stop switch can be configured as a run/stop switch, a memory protect switch, and used for clearing faults when a fatal fault exists.

## 6.1.2 Serial Ports

Port 1 is an RS-232 serial port with an RJ-45 connector. Port 2, located behind a removable door, is an RS-485 serial port with a standard DB-15 connector. Both ports can be used for programming. Only one port can be used at a time for programming, but both ports can be used for monitoring at the same time. Port 1 uses SNP slave protocol. Port 2 is software-configurable for SNP master/slave or RTU slave operation. CPUs with firmware version 2.02 or later support Modbus RTU Master on port 2. 4-wire and 2-wire RTU are supported. If Port 2 is being used for RTU, it automatically switches to SNP slave mode if necessary. Port 2 defaults to SNP slave and automatically reverts to SNP slave when the CPU is in Stop mode, if configured for Serial I/O.

Either port can be software-configured to set up communications between the CPU and various serial devices. An external device can obtain power from both ports if it requires 100mA or less at 5Vdc.

## 6.1.3 Analog Potentiometers

The two potentiometers on the front of a Micro PLC can be used to adjust the values in analog registers %AI016 and %AI017. An example use for the potentiometers would be to set threshold values for use in logical relationships with other inputs/outputs.

## 6.1.4 Removable Terminal Strips

The removable terminal assemblies are protected by hinged covers. After turning off power to the Micro PLC, a terminal assembly and attached field wiring can be separated from the Micro PLC by removing two screws.

## 6.1.5 Status LEDs

LEDs on the Micro PLC provide quick visual verification of operating status. In addition to LEDs for Power, OK, and Run mode, there is an LED for each I/O point.

## 6.1.6 Backup Battery

The Micro PLC uses a large value capacitor to provide memory retention current to the System/User RAM and the Time-of-Day clock when the power supply is either not present or not powered up. The capacitor retains memory contents for at least 30 minutes.

To maintain memory for longer than this, a replaceable battery assembly can be installed in the battery holder, as described in Chapter 14:. The Micro PLC reports the battery state to the PLC Fault Table and also uses Status Bits %SA011 and %S0014 to indicate the battery state.

## 6.2 General Specifications for 28-Point VersaMax Micro PLCs

|                                                                         |                                                                                                                                |
|-------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| Module Dimensions                                                       | Height: 90mm (3.6 inches)<br>Depth: 76mm (3.0 inches)<br>Width: 150mm (6.0 inches)                                             |
| Typical Scan Rate                                                       | 1.1 ms/K for Boolean logic (see Appendix A:)                                                                                   |
| Real Time Clock accuracy (for Timer contacts and Timer function blocks) | ±0.5%                                                                                                                          |
| Time of Day Clock accuracy                                              | ±5 sec/day @10°C, ±5 sec/day @25°C, and ±11 sec/day @55°C or across full temp. range                                           |
| Maximum number of slave devices per network                             | 8 (can be increased with a repeater)                                                                                           |
| +5Vdc output of Serial Ports                                            | Serial Port 1, pin 7: 100mA maximum <sup>4</sup><br>Serial Port 2, pin 5: 100mA maximum <sup>4</sup>                           |
| Lithium battery (IC200ACC403):<br>shelf life<br>installed               | Up to 5 years typical at 30 °C, Up to 3 years typical at 55 °C<br>4 months battery backup time (powered down) minimum at 55 °C |

## 6.3 High-Speed Counters

VersaMax Micro PLCs with DC inputs can be configured to provide built-in high-speed counter and pulse operation.

When configured for High-Speed Counter operation, inputs I1 to I8 can be set up as:

- Up to four Type A Counters or
- One Type A and one Type B Counter.

Each counter provides direct processing of rapid pulse signals up to 10kHz for industrial control applications such as meter proving, turbine flowmeter, velocity measurement, material handling, motion control, and process control.

Each counter can be enabled independently. Type A counters can be configured for up or down counting (default is up) and for positive or negative edge detection (default is positive). The Type B counter provides an A Quad B counting function.

Models with DC outputs can be configured to provide up to a total of four counter, Pulse Train, or PWM outputs. Relay outputs cannot be used as Pulse Train or PWM outputs.

<sup>4</sup> Combined port 1 and port 2 total not to exceed 100mA max.

## 6.4 IC200UAA007

### 28-Point Micro PLC, (16) 120Vac In, (12) 120Vac Out, 120/240Vac Power Supply

VersaMax Micro PLC model IC200UAA007 accepts sixteen AC inputs and provides twelve AC outputs. It uses 100Vac to 240Vac nominal input power for PLC operation.

This module does not provide High-Speed Counter, PWM or Pulse Train operation.

#### 6.4.1 Inputs

The sixteen 120Vac input circuits are reactive (resistor/capacitor) inputs. The input circuits require an AC power source: they cannot be used with a DC power source.

Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate the field devices must be supplied.

#### 6.4.2 AC Outputs

The 120/240Vac, 0.5 Amp triac outputs are provided in isolated groups. The commons are not tied together inside the module. This allows each group to be used on different phases of the AC supply or to be powered from the same supply. Each group is protected with a replaceable 3.15 amp fuse for its common. Also, an RC snubber is provided for each output to protect against transient electrical noise on the power line.

AC power to operate loads connected to outputs must be supplied from an external source.

This module provides a high degree of inrush current (10x the rated current) which makes the outputs suitable for controlling many types of inductive and incandescent loads.

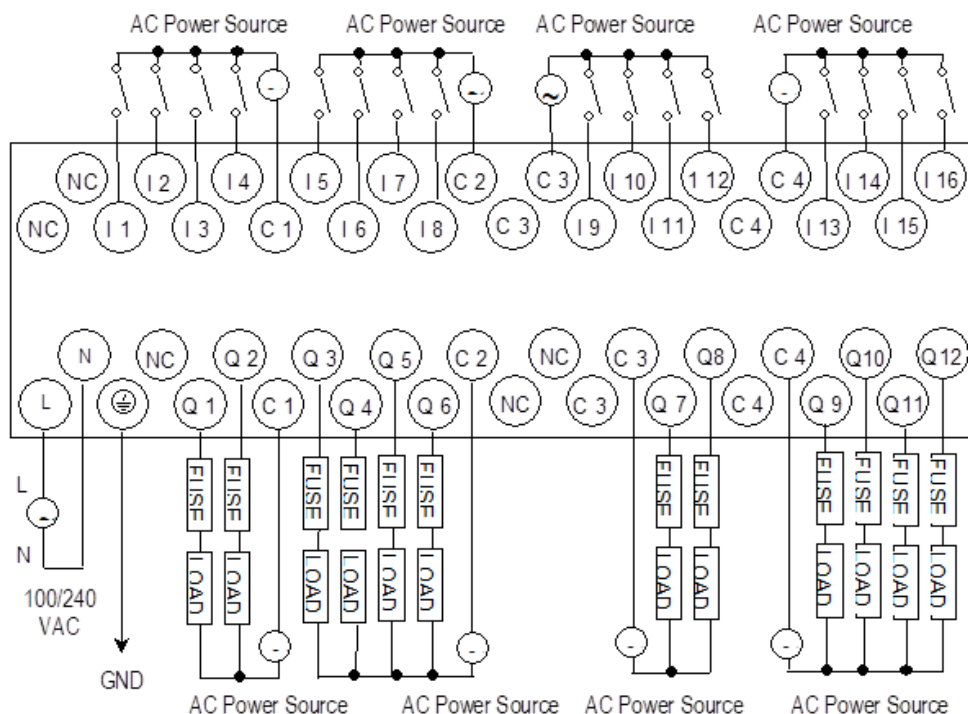
## 6.4.3 Micro PLC IC200UAA007 Specifications

| Item                            | Description                                                                                  |
|---------------------------------|----------------------------------------------------------------------------------------------|
| Weight                          | 600 grams (1.32 lbs.)                                                                        |
| Inputs                          | 16 AC inputs                                                                                 |
| Outputs                         | 12 AC outputs                                                                                |
| High-Speed Counters             | None                                                                                         |
| <b>AC Power Specifications</b>  |                                                                                              |
| Range                           | 100 -15% to 240 +10%Vac                                                                      |
| Frequency                       | 50 -5% to 60 +5% Hz                                                                          |
| Hold-up                         | 10mS at 85-100Vac, 20mS at 100-264Vac                                                        |
| Inrush Time                     | 2mS for 40 Amp                                                                               |
| Inrush Current                  | 30 Amp maximum at 200Vac, 40 Amp maximum at 265Vac                                           |
| Input Current                   | 0.10 Amp typical at 100Vac, 0.06 Amp typical at 200Vac                                       |
| Input Power Supply Rating       | 16 VA                                                                                        |
| <b>AC Input Specifications</b>  |                                                                                              |
| Points/Common                   | 4 (I1-I4) and (I5-I8)                                                                        |
| Rated Load Voltage              | 85-132Vac, 50 -5% to 60 +5% Hz                                                               |
| Maximum Input Voltage           | 132V rms, 50/60 Hz                                                                           |
| Input Current                   | 8 mA rms (100Vac, 60 Hz)                                                                     |
| Voltage                         | ON: minimum 80V rms, 4.5 mA rms, OFF: maximum 30V rms, 2 mA rms                              |
| Response Time                   | OFF to ON: maximum 25 ms, ON to OFF: maximum 30 ms                                           |
| Isolation                       | 1500V rms field side to logic side, 500V rms between groups                                  |
| <b>AC Output Specifications</b> |                                                                                              |
| Rated Load Voltage              | 100 -15% to 240 +10%Vac, 50 -5% to 60 +5% Hz                                                 |
| Maximum Resistive Load Current  | 0.5 Amp per point                                                                            |
| Maximum UL Pilot Duty Rating    | 0.5 Amp per point at 240Vac<br>0.6 Amp maximum on C1 and C3<br>1.2 Amps maximum on C2 and C4 |
| Maximum Inrush Current          | 5A (1 period)/point, 10A (1 period)/common                                                   |
| Maximum voltage drop when ON    | 1.5 V RMS                                                                                    |
| Maximum leak current when OFF   | 1.8 mA RMS (115Vac), 3.5 mA RMS (230Vac)                                                     |
| Response Time (Maximum)         | OFF to ON: 1ms, ON to OFF: 1/2 cycle + 1 ms                                                  |
| Isolation                       | 1500V RMS field side to logic side, 500V RMS between groups                                  |



## 6.4.4 Wiring Diagram IC200UAA007

Figure 37



## 6.5 IC200UAR028 28-Point Micro PLC, (16) 120Vac In, (2/10) Relay Out, 120/240Vac Power Supply

VersaMax Micro PLC model IC200UAR028 accepts sixteen AC inputs and provides two relay outputs at 10 Amps and ten relay outputs at 2 Amps. It uses 100Vac to 240Vac nominal input power for PLC operation.

This module does not provide High-Speed Counter, PWM or Pulse Train operation.

### 6.5.1 Inputs

The sixteen 120Vac input circuits are reactive (resistor/capacitor) inputs. The input circuits require an AC power source: they cannot be used with a DC power source.

Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate the field devices must be supplied.

### 6.5.2 Relay Outputs

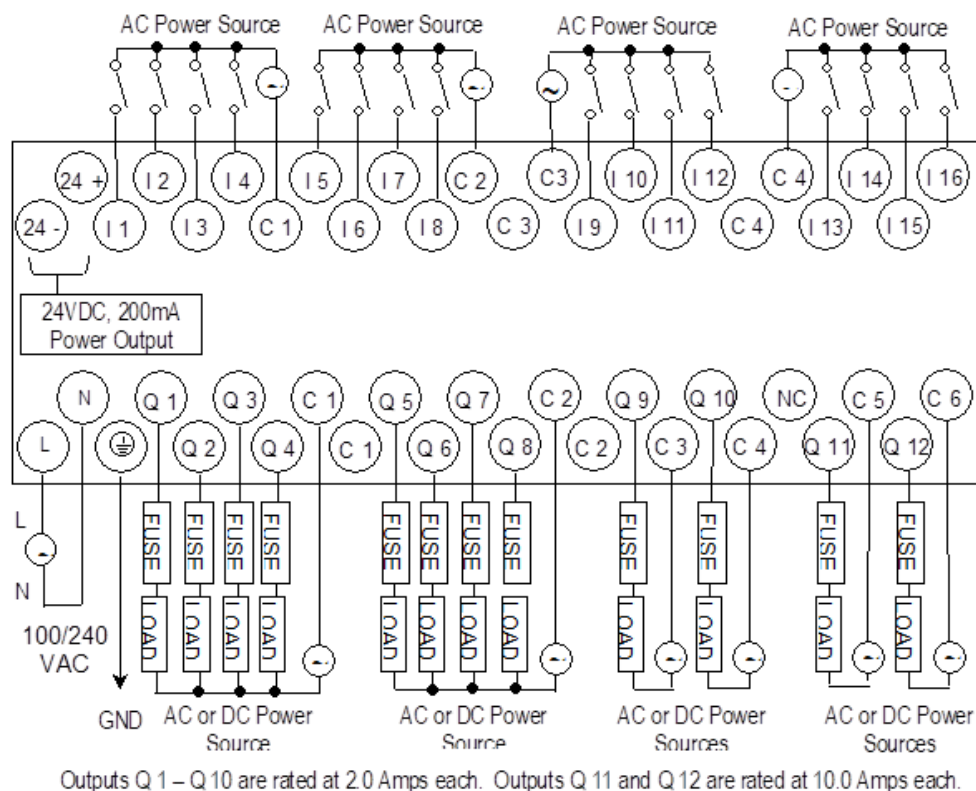
The Micro PLC relay outputs can control a wide range of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices.

## 6.5.3 Micro PLC IC200UAR028 Specifications

| Item                             | Description                                                            |                                                    |                                                     |
|----------------------------------|------------------------------------------------------------------------|----------------------------------------------------|-----------------------------------------------------|
| Weight                           | 600 grams (1.32 lbs.)                                                  |                                                    |                                                     |
| Inputs                           | 16 AC inputs                                                           |                                                    |                                                     |
| Outputs                          | 2 relay outputs at 10 Amps and 10 relay outputs at 2 Amps              |                                                    |                                                     |
| High-Speed Counters              | None                                                                   |                                                    |                                                     |
| +24Vdc Output Power Supply       | 200mA maximum (for input circuits and user devices)                    |                                                    |                                                     |
| AC Power Specifications          |                                                                        |                                                    |                                                     |
| Range                            | 100 -15% to 240 +10%Vac                                                |                                                    |                                                     |
| Frequency                        | 50 -5% to 60 +5% Hz                                                    |                                                    |                                                     |
| Hold-up                          | 10mS at 85-100Vac, 20mS at 100-264Vac                                  |                                                    |                                                     |
| Inrush Time                      | 2mS for 40 Amp                                                         |                                                    |                                                     |
| Inrush Current                   | 30 Amp maximum at 200Vac, 40 Amp maximum at 265Vac                     |                                                    |                                                     |
| Input Current                    | 0.10 Amp typical at 100Vac, 0.06 Amp typical at 200Vac                 |                                                    |                                                     |
| Input Power Supply Rating        | 16 VA                                                                  |                                                    |                                                     |
| AC Input Specifications          |                                                                        |                                                    |                                                     |
| Points/Common                    | 4 (I1–I4) and (I5–I8)                                                  |                                                    |                                                     |
| Rated Load Voltage               | 85–132Vac, 50 -5% to 60 +5% Hz                                         |                                                    |                                                     |
| Maximum Input Voltage            | 132V rms, 50/60 Hz                                                     |                                                    |                                                     |
| Input Current                    | 8 mA rms (100Vac, 60 Hz)                                               |                                                    |                                                     |
| Voltage                          | ON: minimum 80V rms, 4.5 mA rms, OFF: maximum 30V rms, 2 mA rms        |                                                    |                                                     |
| Response Time                    | OFF to ON: maximum 25 ms, ON to OFF: maximum 30 ms                     |                                                    |                                                     |
| Isolation                        | 1500V rms field side to logic side, 500V rms between groups            |                                                    |                                                     |
| Relay Output Specifications      |                                                                        |                                                    |                                                     |
| Operating Voltage                | 5 to 30Vdc or 5 to 250Vac                                              |                                                    |                                                     |
| Isolation                        | 1500 V RMS between field side and logic side, 500 V RMS between groups |                                                    |                                                     |
| Leakage Current                  | 15 mA at 240Vac maximum                                                |                                                    |                                                     |
| Maximum UL Pilot Duty Rating     | 2 amps at 24Vdc and 240Vac                                             | 10 amps at 24Vdc and 240Vac                        |                                                     |
| Maximum Resistive Load Rating    | 2 amps at 24Vdc and 240Vac                                             | 10 amps at 24Vdc and 240Vac                        |                                                     |
| Minimum Load                     | 10 mA                                                                  |                                                    |                                                     |
| Maximum Inrush                   | 5 amps per half cycle                                                  | 14 amps per half cycle                             |                                                     |
| Response Time                    | ON: 15 ms maximum, OFF: 15 ms maximum                                  |                                                    |                                                     |
| Contact Life: Mechanical         | 20 x 106 mechanical operations                                         |                                                    |                                                     |
| Contact Life: Electrical Voltage | Current: Resistive<br>2.0A<br>10.0A<br>4.0A                            | Current: Lamp and Solenoid<br>0.6A<br>4.0A<br>1.0A | Typical Operations<br>100,000<br>100,000<br>200,000 |

## 6.5.4 Wiring Diagram IC200UAR028

Figure 38



## 6.6 IC200UDD110 28-Point Micro PLC, (16) 24Vdc In, (12) 24Vdc Out, 24Vdc Power Supply

VersaMax Micro PLC model IC200UDD110 accepts sixteen DC inputs and provides twelve 24Vdc outputs. It uses +24Vdc nominal input power for PLC operation.

### 6.6.1 DC Power

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 24Vdc. The 24Vdc power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 24Vdc voltage level (see power supply specifications for inrush requirements).

## 6.6.2 DC Inputs

The module has sixteen configurable DC inputs that can be used as positive or negative logic standard inputs. As standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Eight of the inputs can be used for High-Speed Counter inputs.

The Micro PLC +24Vdc supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

## 6.6.3 Transistor Outputs

The module provides twelve transistor output circuits that can be used to switch devices like valves, lamps or contactors. External fusing should be provided to protect the outputs. Fast fuses are recommended.

The outputs can be configured as regular outputs or as outputs controlled by the High-Speed Counters. Some outputs can be used as pulse train or pulse width modulation (PWM) outputs.

All outputs are isolated between field and logic and are switching positive voltage. The outputs have one common incoming supply (VC) and one common ground (COM). The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

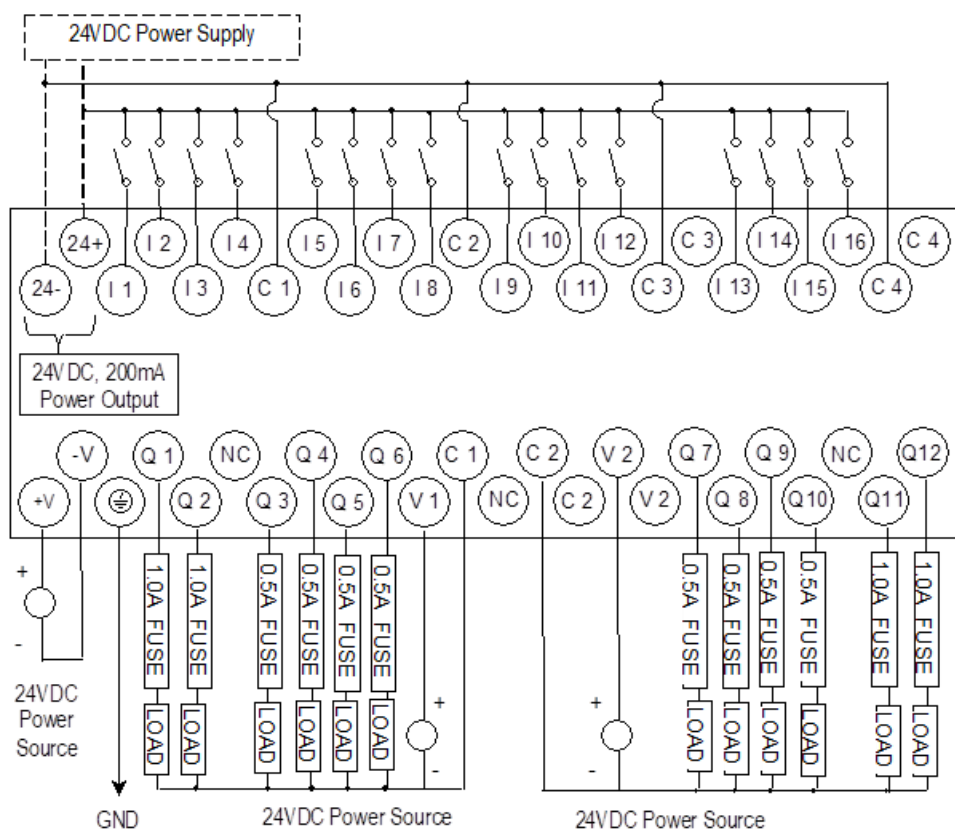
## 6.6.4 Micro PLC IC200UDD110 Specifications

| Item                           | Description                                                                                                                                                                                            |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Weight                         | 460 grams (1.01 lbs.)                                                                                                                                                                                  |
| Inputs                         | Sixteen 24Vdc positive logic inputs in four groups of four                                                                                                                                             |
| Outputs                        | Twelve transistor outputs, 24Vdc. Outputs are grouped in two groups with separated incoming supply. Each group contains 4 outputs with a maximum load of 0.5A and 2 outputs with a maximum load of 1A. |
| High-Speed Counters            | Up to four Type A or one Type A and one Type B                                                                                                                                                         |
| +24Vdc Output Power Supply     | 200mA maximum (for input circuits and user devices)                                                                                                                                                    |
| <b>DC Power Specifications</b> |                                                                                                                                                                                                        |
| Range                          | 19.2Vdc to 30Vdc                                                                                                                                                                                       |
| Hold-up                        | 10mS at 19.2Vdc                                                                                                                                                                                        |
| Inrush Current                 | 1 Amp maximum at 30Vdc                                                                                                                                                                                 |
| Inrush Time                    | 10mS for 1 Amp                                                                                                                                                                                         |
| Input Current                  | 0.20 Amp typical at 24Vdc                                                                                                                                                                              |
| Input Power Supply Rating      | 5W                                                                                                                                                                                                     |

| Item                                                                        | Description                                                                                                                                                                           |
|-----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>DC Input Specifications</b>                                              |                                                                                                                                                                                       |
| Rated Input Voltage                                                         | 24 volts DC                                                                                                                                                                           |
| Input Voltage Range                                                         | 0 to 30 volts DC                                                                                                                                                                      |
| Input Current                                                               | 7.5mA typical                                                                                                                                                                         |
| Input Resistance                                                            | 2.8 kΩ                                                                                                                                                                                |
| Input Threshold Voltage                                                     | ON: 15Vdc minimum, OFF: 5Vdc maximum                                                                                                                                                  |
| Input Threshold Current                                                     | ON: 4.5mA maximum, OFF: 1.5mA minimum                                                                                                                                                 |
| Response Time                                                               | 0.5 to 20ms configurable as regular input; 100μs as HSC input                                                                                                                         |
| Isolation Voltage                                                           | 1500V RMS field side to logic side, 500V RMS between groups                                                                                                                           |
| <b>Output Specifications</b>                                                |                                                                                                                                                                                       |
| Voltage Range                                                               | 12Vdc/24Vdc (24Vdc +10% / -43% input at V1, C1)                                                                                                                                       |
| Maximum Load Current                                                        | 1.0A per point (Q1, Q2, Q11, Q12) at 24Vdc at 100% ON duration<br>0.75A per point (Q3 - Q10) at 24Vdc at 100 % ON duration<br>0.5A per point (Q3 - Q10) at 12Vdc at 100 % ON duration |
| Maximum Inrush Current                                                      | Q1, Q2, Q15, Q16: 1A, Q3-Q13: 0.7A                                                                                                                                                    |
| Output Voltage Drop                                                         | 0.3V maximum                                                                                                                                                                          |
| OFF state leakage current                                                   | 100μA maximum                                                                                                                                                                         |
| Response Time                                                               | OFF to ON, ON to OFF 0.1ms maximum (24Vdc, 0.2A)                                                                                                                                      |
| Isolation Voltage                                                           | 1500V RMS between field side and logic side, 500V RMS between groups                                                                                                                  |
| Fuse                                                                        | Outputs should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable.                                                   |
| <b>High-Speed Counter Input / PWM and Pulse Train Output Specifications</b> |                                                                                                                                                                                       |
| Maximum Counter Frequency                                                   | 10kHz                                                                                                                                                                                 |
| Input Voltage                                                               | ON : 15V, OFF: 5V                                                                                                                                                                     |
| Count Pulse Width                                                           | 20% to 80% duty cycle at 10kHz                                                                                                                                                        |
| Count Registers                                                             | 16bits                                                                                                                                                                                |
| <b>Outputs</b>                                                              |                                                                                                                                                                                       |
| Load Voltage                                                                | Q1-Q4: 12/24Vdc                                                                                                                                                                       |
| Maximum Pulse/PWM Frequency                                                 | 5kHz                                                                                                                                                                                  |
| Types available                                                             | Up to four HSC, PT, and/or PWM outputs                                                                                                                                                |

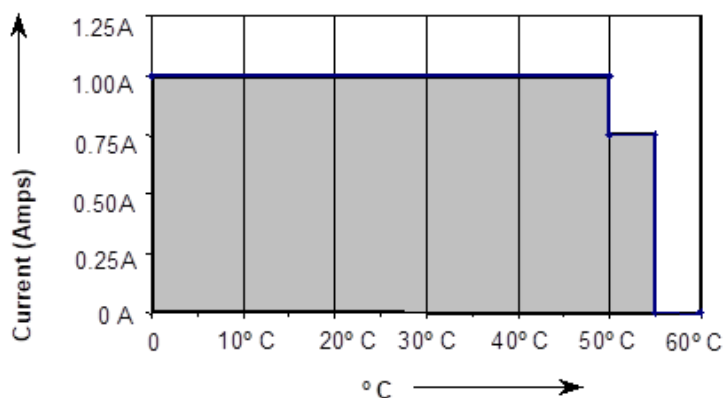
## 6.6.5 Wiring Diagram IC200UDD110

Figure 39



The maximum current that can be used for output points Q1, Q2, Q11 and Q12 is lower for ambient temperatures above 50°C

Figure 40



## 6.7 IC200UDD120

### 28-Point Micro PLC, (16) 24Vdc In, (12) 24Vdc Out with ESCP, 24Vdc Power Supply

VersaMax Micro PLC model IC220UDD120 accepts sixteen DC inputs and provide twelve 24Vdc outputs. The outputs have electronic short-circuit protection. The module uses +24Vdc nominal input power for PLC operation.

#### 6.7.1 DC Power

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 24Vdc. The 24Vdc power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 24Vdc voltage level (see power supply specifications for inrush requirements).

#### 6.7.2 DC Inputs

The module's sixteen configurable DC inputs can be used as positive or negative logic standard inputs. Eight of these inputs can be used for High-Speed Counter inputs.

When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC +24Vdc supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

#### 6.7.3 Transistor Outputs

The twelve transistor outputs can be configured as regular outputs or as outputs controlled by the High-Speed Counters. Some outputs can be used as pulse train or pulse width modulation (PWM) outputs.

The output circuits can be used to switch devices like valves, lamps or contactors.

Outputs require no fusing; they provide electronic short-circuit protection.

## 6.7.4 Micro PLC IC200UDD120 Specifications

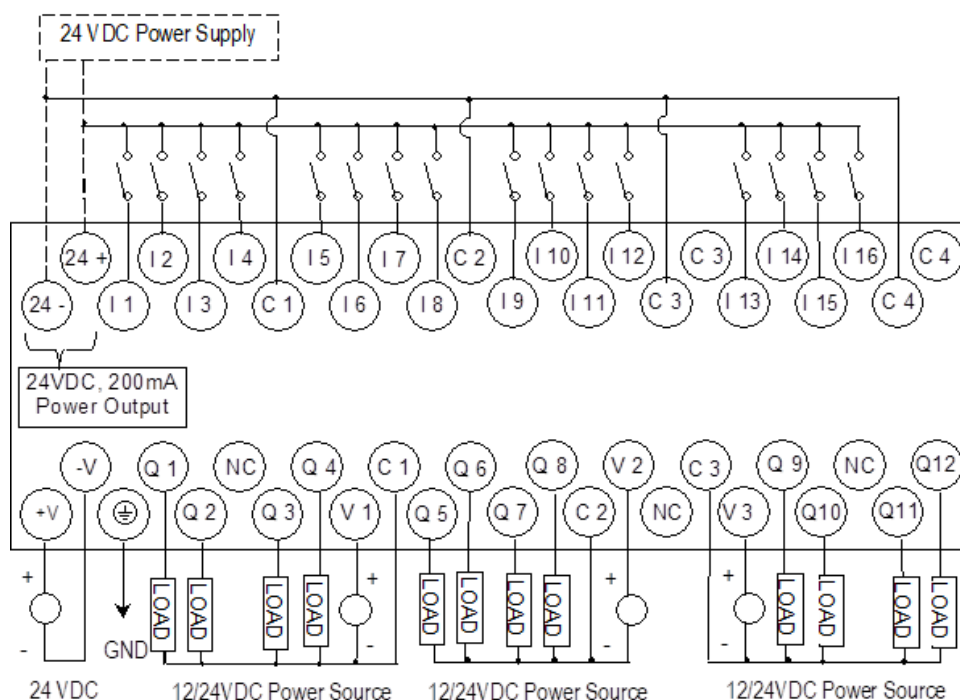
| Item                                                          | Description                                                                                                                                                                                            |
|---------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Weight                                                        | 460 grams (1.01 lbs.)                                                                                                                                                                                  |
| Inputs                                                        | Sixteen 24Vdc positive logic inputs in four groups of four                                                                                                                                             |
| Outputs                                                       | Twelve transistor outputs, 24Vdc. Outputs are grouped in two groups with separated incoming supply. Each group contains 4 outputs with a maximum load of 0.5A and 2 outputs with a maximum load of 1A. |
| High-Speed Counters                                           | Four Type A or One Type A and One Type B                                                                                                                                                               |
| +24Vdc Output Power Supply                                    | 200mA maximum (for input circuits and user devices)                                                                                                                                                    |
| <b>DC Power Specifications</b>                                |                                                                                                                                                                                                        |
| Range                                                         | 19.2Vdc to 30Vdc                                                                                                                                                                                       |
| Hold-up                                                       | 10mS at 19.2Vdc                                                                                                                                                                                        |
| Inrush Current                                                | 1 Amp maximum at 30Vdc                                                                                                                                                                                 |
| Inrush Time                                                   | 10mS for 1 Amp                                                                                                                                                                                         |
| Input Current                                                 | 0.20 Amp typical at 24Vdc                                                                                                                                                                              |
| Input Power Supply Rating                                     | 5W                                                                                                                                                                                                     |
| <b>DC Input Specifications</b>                                |                                                                                                                                                                                                        |
| Rated Input Voltage                                           | 24 volts DC                                                                                                                                                                                            |
| Input Voltage Range                                           | 0 to 30 volts DC                                                                                                                                                                                       |
| Input Current                                                 | 7.5mA typical                                                                                                                                                                                          |
| Input Resistance                                              | 2.8 k $\Omega$                                                                                                                                                                                         |
| Input Threshold Voltage                                       | ON: 15Vdc minimum, OFF: 5Vdc maximum                                                                                                                                                                   |
| Input Threshold Current                                       | ON: 4.5mA maximum, OFF: 1.5mA minimum                                                                                                                                                                  |
| Response Time                                                 | 0.5 to 20ms configurable as regular input; 100 $\mu$ s as HSC input                                                                                                                                    |
| Isolation Voltage                                             | 1500V RMS field side to logic side, 500V RMS between groups                                                                                                                                            |
| <b>DC Output Specifications</b>                               |                                                                                                                                                                                                        |
| Voltage Range                                                 | Q1 – Q12: 12/24Vdc +10%, -15%                                                                                                                                                                          |
| External Power Supply (for supplying power to the V terminal) | 12/24V -10%, +20%                                                                                                                                                                                      |
| Maximum Load Current                                          | Q1 and Q2: 1A per point, Q3 - Q12: 0.7A per point                                                                                                                                                      |
| Minimum Switching Current                                     | 10mA                                                                                                                                                                                                   |
| Maximum Inrush Current                                        | Q1, Q2, Q11, Q12: 8A for 20ms, 1 pulse, Q3-Q10: 4A for 20ms, 1 pulse                                                                                                                                   |
| Output Voltage Drop                                           | Q1 – Q12: 0.3V maximum                                                                                                                                                                                 |
| OFF state leakage current                                     | 0.1mA                                                                                                                                                                                                  |
| Response Time                                                 | OFF to ON, ON to OFF: 0.05mS maximum @ 24Vdc                                                                                                                                                           |
| Isolation Voltage                                             | 1500V RMS between field side and logic side, 500V RMS between groups                                                                                                                                   |



| Item                                                                        | Description                            |
|-----------------------------------------------------------------------------|----------------------------------------|
| Fuse                                                                        | Not required                           |
| Under-voltage shutdown                                                      | Q1 - Q12: 5V minimum, 8V maximum       |
| DC short circuit current                                                    | Q1 – Q12: 0.7A minimum, 2A maximum     |
| Peak short circuit current                                                  | 4A maximum                             |
| Delay time of peak short circuit current                                    | 100μS                                  |
| Delay time of current limit                                                 | 100μS                                  |
| <b>High-Speed Counter Input / PWM and Pulse Train Output Specifications</b> |                                        |
| Maximum Counter Frequency                                                   | 10kHz                                  |
| Input Voltage                                                               | ON : 15V, OFF: 5V                      |
| Count Pulse Width                                                           | 20% to 80% duty cycle at 10kHz         |
| Count Registers                                                             | 16bits                                 |
| <b>Outputs</b>                                                              |                                        |
| Load Voltage                                                                | Q1-Q4: 12/24Vdc                        |
| Maximum Pulse/PWM Frequency                                                 | 5kHz                                   |
| Types available                                                             | Up to four HSC, PT, and/or PWM outputs |

## 6.7.5 Wiring Diagram IC200UDD120

Figure 41



## 6.8 IC200UDD212

### 28-Point Micro PLC, (16) 12Vdc In, (12) 12Vdc Out, 12Vdc Power Supply

VersaMax Micro PLC model IC200UDD212 accepts sixteen 12Vdc inputs and provides twelve DC transistor outputs. It uses +12Vdc nominal input power for PLC operation.

#### 6.8.1 DC Power

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 12Vdc. The 12Vdc power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 12Vdc voltage level (see power supply specifications for inrush requirements).

#### 6.8.2 DC Inputs

Sixteen configurable DC inputs can be used as positive or negative logic standard inputs. Eight of the inputs can be configured as four Type A Counters or one Type A and one Type B Counter. When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC +12Vdc supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

#### 6.8.3 Transistor Outputs

Micro PLC IC200UDD212 has twelve transistor outputs (Q1 to Q12) with maximum output load of 0.7A per output.

All outputs are isolated between field and logic and are switching positive voltage.

The output circuits can be used to switch devices like valves, lamps or contactors. External fusing should be provided to protect the outputs. Fast fuses are recommended.

The outputs can be configured as regular outputs or as outputs controlled by the High-Speed Counters. Some outputs can be used as pulse train or pulse width modulation (PWM) outputs.

Each group of 6 outputs has one common incoming supply (V1, V2) and one common ground (C1, C2). The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

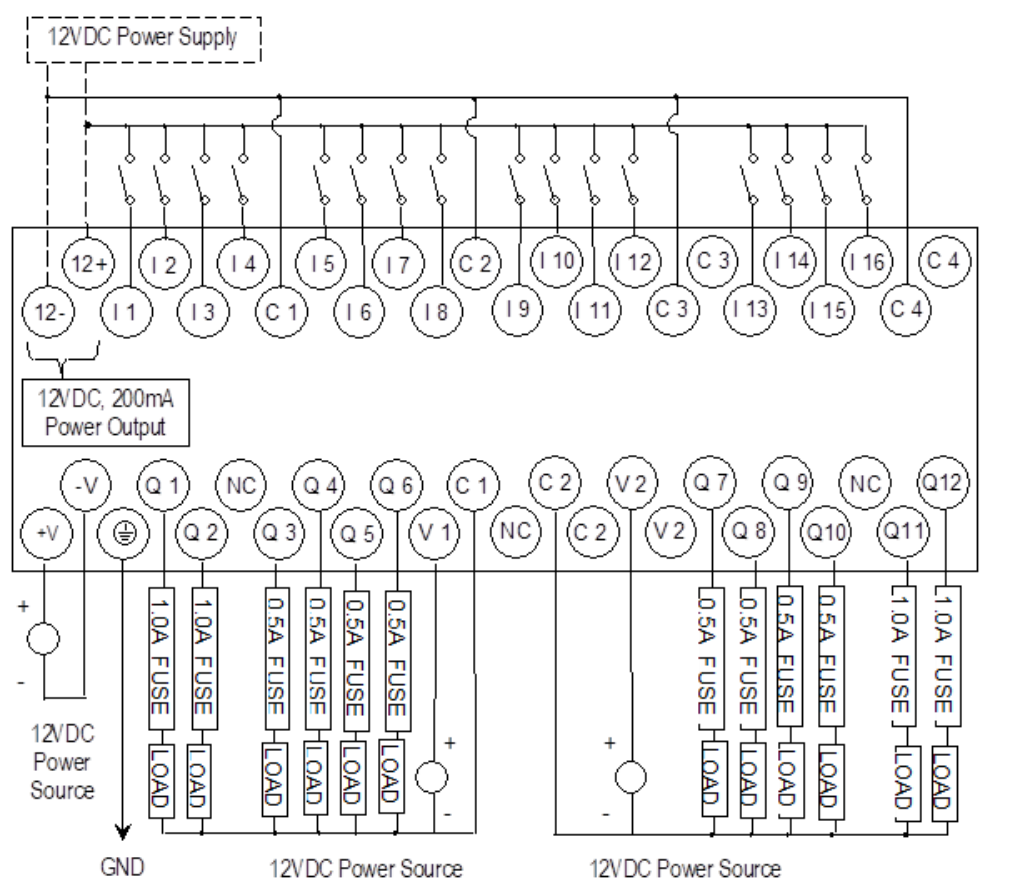
## 6.8.4 Micro PLC IC200UDD212 Specifications

| Item                            | Description                                                                                                                                                                                            |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Weight                          | 460 grams (1.01 lbs.)                                                                                                                                                                                  |
| Inputs                          | Sixteen 12Vdc positive logic inputs in four groups of four                                                                                                                                             |
| Outputs                         | Twelve transistor outputs, 12Vdc. Outputs are grouped in two groups with separated incoming supply. Each group contains 4 outputs with a maximum load of 0.5A and 2 outputs with a maximum load of 1A. |
| High-Speed Counters             | Up to four Type A or one Type A and one Type B                                                                                                                                                         |
| +12Vdc Output Power Supply)     | 200mA maximum (for input circuits and user devices                                                                                                                                                     |
| <b>DC Power Specifications</b>  |                                                                                                                                                                                                        |
| Range                           | 9.6Vdc to 15Vdc                                                                                                                                                                                        |
| Hold-up                         | 3.0mS                                                                                                                                                                                                  |
| Inrush Current                  | 9.6A typical at 12Vdc                                                                                                                                                                                  |
| Inrush Time                     | 200mS typical                                                                                                                                                                                          |
| Input Current                   | 480mA typical at 12Vdc                                                                                                                                                                                 |
| Input Power Supply Rating       | 8W                                                                                                                                                                                                     |
| <b>DC Input Specifications</b>  |                                                                                                                                                                                                        |
| Number of Inputs                | 16                                                                                                                                                                                                     |
| Rated Input Voltage             | 12 volts DC                                                                                                                                                                                            |
| Input Voltage Range             | 0 to 15 volts DC                                                                                                                                                                                       |
| Input Current                   | 9.0mA typical                                                                                                                                                                                          |
| Input Resistance                | 1.3 k $\Omega$                                                                                                                                                                                         |
| Input Threshold Voltage         | ON: 9.5Vdc minimum, OFF: 2.5Vdc maximum                                                                                                                                                                |
| Input Threshold Current         | ON: 6.5mA maximum, OFF: 1.6mA minimum                                                                                                                                                                  |
| Response Time                   | 0.5 to 20ms (user configurable) as regular input; 100 $\mu$ s as HSC input                                                                                                                             |
| Isolation Voltage               | 1500V RMS field side to logic side, 500V RMS between groups                                                                                                                                            |
| <b>DC Output Specifications</b> |                                                                                                                                                                                                        |
| Voltage Range                   | 12Vdc (+20%, -20%)                                                                                                                                                                                     |
| Maximum Load                    | 0.7A per point (Q1 - Q12) at 24Vdc at 100 % ON duration, 4A per common                                                                                                                                 |
| Maximum Inrush Current          | 4A for 20mS                                                                                                                                                                                            |
| Output Voltage Drop             | 0.3V maximum                                                                                                                                                                                           |
| OFF state leakage               | 0.1mA maximum                                                                                                                                                                                          |
| Response                        | OFF to ON: 0.1mS maximum (12Vdc), ON to OFF 0.1mS maximum (12Vdc)                                                                                                                                      |
| Isolation Voltage               | 1500V RMS between field side and logic side, 500V RMS between groups                                                                                                                                   |

| Item                                                                          | Description                                                                                                                         |
|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| Fuse                                                                          | Outputs should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable. |
| <b>High-Speed Counter Input / PWM &amp; Pulse-Train Output Specifications</b> |                                                                                                                                     |
| Maximum Counter Frequency                                                     | 10kHz                                                                                                                               |
| Input Voltage                                                                 | ON: 9V, OFF: 2.5V                                                                                                                   |
| Count Pulse Width                                                             | 20% to 80% duty cycle at 10kHz                                                                                                      |
| Count Registers                                                               | 16bits                                                                                                                              |
| <b>Outputs</b>                                                                |                                                                                                                                     |
| Load Voltage                                                                  | Q1-Q4: 12Vdc                                                                                                                        |
| Maximum Pulse/PWM Frequency                                                   | 5kHz                                                                                                                                |
| Types available                                                               | Up to four HSC, PT, and/or PWM outputs                                                                                              |

## 6.8.5 Wiring Diagram IC200UDD212

Figure 42



## 6.9 IC200UDR005

### 28-Point Micro PLC, (16) 24Vdc In, (1) 24Vdc Out, (11) Relay Out, 120/240Vac Power Supply

VersaMax Micro PLC IC200UDR005 accepts sixteen DC inputs and provides one 24Vdc output and eleven normally open 2 Amp relay outputs. It uses 100Vac to 240Vac nominal input power for PLC operation.

#### 6.9.1 DC Inputs

The sixteen configurable DC inputs can be used as positive or negative logic standard inputs, including up to four High-Speed Counter inputs. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches. The module provides +24Vdc output power for field devices, up to 200mA maximum.

#### 6.9.2 DC Output (Q1)

The DC output circuit (Q1) can be configured to be a standard, High-Speed Counter, pulse train, or PWM output.

#### 6.9.3 Relay Outputs (Q2 – Q12)

The module has eleven Form A relay outputs (SPST-single pole single throw). The normally open relay outputs can control a wide range of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices.

The relay outputs can be configured as up to three High-Speed Counter outputs. Relay outputs cannot be used as Pulse Train or PWM outputs.

#### 6.9.4 Micro PLC IC200UDR005 Specifications

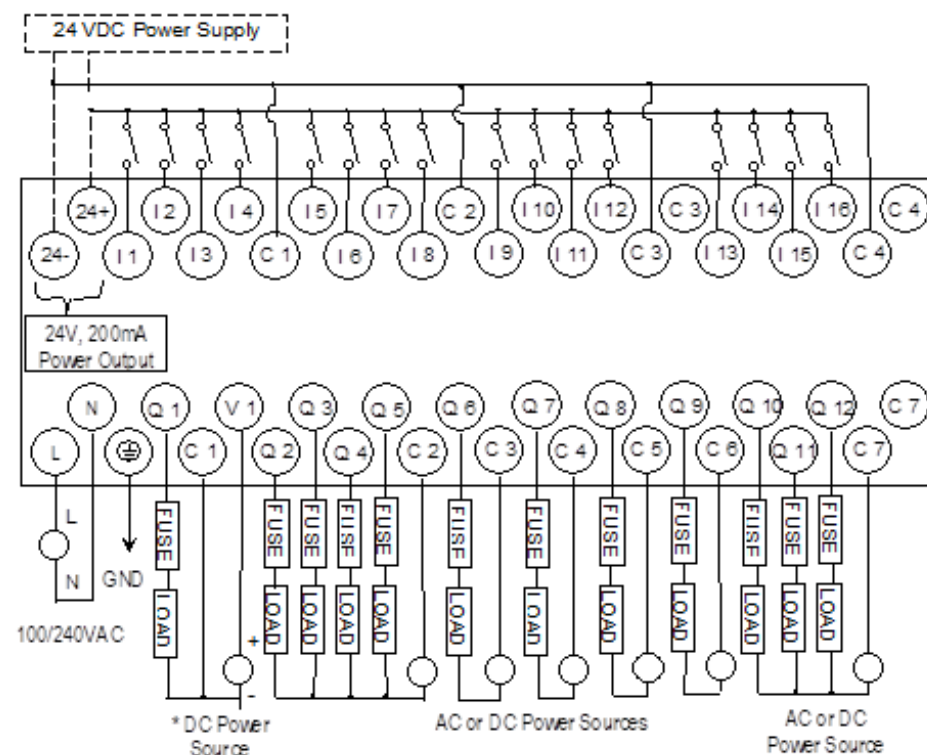
| Item                           | Description                                                      |
|--------------------------------|------------------------------------------------------------------|
| Weight                         | 580 grams (1.28lbs)                                              |
| Inputs                         | Sixteen 24Vdc positive/negative logic input circuits             |
| Outputs                        | Eleven normally open 2 amp relay circuits and One DC Output (Q1) |
| High-Speed Counters            | Up to four Type A or one Type A and one Type B                   |
| +24Vdc Output Power Supply     | 200mA maximum (for input circuits and user devices)              |
| <b>AC Power Specifications</b> |                                                                  |
| Range                          | 100 -15% to 240 +10%Vac                                          |
| Frequency                      | 50 -5% to 60 +5% Hz                                              |
| Hold-up                        | 10mS at 85 to 100Vac, 20mS at 100 to 265Vac                      |
| Inrush Current                 | 30 Amp maximum at 200Vac, 40 Amp maximum at 265Vac               |
| Inrush Time                    | 2 ms for 40Amp                                                   |

| Item                               | Description                                                                                                                        |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| Input Current                      | 0.20 Amp typical at 200Vac, 0.10 Amp typical at 100Vac                                                                             |
| Input Power Supply Rating          | 26 VA                                                                                                                              |
| <b>DC Input Specifications</b>     |                                                                                                                                    |
| Number of Inputs                   | 16                                                                                                                                 |
| Rated Input Voltage                | 24 volts DC                                                                                                                        |
| Input Voltage Range                | 0 to 30 volts DC                                                                                                                   |
| Input Current                      | 7.5mA typical                                                                                                                      |
| Input Resistance                   | 2.8 kΩ                                                                                                                             |
| Input Threshold Voltage            | ON: 15Vdc minimum, OFF: 5Vdc maximum                                                                                               |
| Input Threshold Current            | ON: 4.5mA maximum, OFF: 1.5mA minimum                                                                                              |
| Response Time                      | 0.5 to 20ms configurable as regular input; 100μs as HSC input                                                                      |
| Isolation Voltage                  | 1500V RMS field side to logic side, 500V RMS between groups                                                                        |
| <b>DC Output Specifications</b>    |                                                                                                                                    |
| Output logic                       | Positive Logic                                                                                                                     |
| Operating Voltage                  | 24Vdc / 12Vdc / 5Vdc                                                                                                               |
| Voltage Range                      | 24Vdc, +20%, -80%                                                                                                                  |
| Maximum UL Pilot Duty Rating       | 0.75A at 24Vdc                                                                                                                     |
| Maximum Resistive Load Rating      | 0.75A at 24Vdc<br>0.5A at 12Vdc<br>0.25A at 5Vdc                                                                                   |
| Output Voltage Drop                | 0.3Vdc maximum                                                                                                                     |
| Response                           | ON: 0.1ms maximum (24Vdc, 0.2A), OFF: 0.1ms maximum (24Vdc, 0.2A)                                                                  |
| OFF state leakage                  | 0.1mA maximum                                                                                                                      |
| Isolation                          | 1500Vac between field side and logic side, 500Vac between groups                                                                   |
| Fuse                               | Output should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable. |
| <b>Relay Output Specifications</b> |                                                                                                                                    |
| Operating Voltage                  | 5 to 30Vdc or 5 to 250Vac                                                                                                          |
| Isolation                          | 1500 V RMS between field side and logic side, 500 V RMS between groups                                                             |
| Leakage Current                    | 15 mA at 240Vac maximum                                                                                                            |
| Maximum UL Pilot Duty Rating       | 2 amps at 24Vdc and 240Vac                                                                                                         |
| Maximum Resistive Load Rating      | 2 amps at 24Vdc and 240Vac                                                                                                         |
| Minimum Load                       | 10 mA                                                                                                                              |
| Maximum Inrush                     | 5 amps per half cycle                                                                                                              |

| Item                                                           | Description                                                            |                                       |                               |
|----------------------------------------------------------------|------------------------------------------------------------------------|---------------------------------------|-------------------------------|
| Response Time                                                  | ON: 15 ms maximum, OFF: 15 ms maximum                                  |                                       |                               |
| Contact Life: Mechanical                                       | 20 x 106 mechanical operations                                         |                                       |                               |
| Contact Life: Electrical<br>Voltage<br>240Vac, 120Vac, 24Vdc   | Current:<br>Resistive<br>2.0A                                          | Current: Lamp and<br>Solenoid<br>0.6A | Typical Operations<br>200,000 |
| High-Speed Counter / PWM and Pulse Train Output Specifications |                                                                        |                                       |                               |
| Maximum Counter Frequency                                      | 10kHz                                                                  |                                       |                               |
| Input Voltage                                                  | ON: 15V, OFF: 5V                                                       |                                       |                               |
| Count Pulse Width                                              | 20% to 80% duty cycle at 10kHz                                         |                                       |                               |
| Count Registers                                                | 16bits                                                                 |                                       |                               |
| Outputs                                                        |                                                                        |                                       |                               |
| Type available                                                 | Up to four HSC outputs or three HSC outputs plus one PT or PWM output. |                                       |                               |
| Load Voltage                                                   | Q1: 5/12/24V, Q2-Q4: See relay output specifications                   |                                       |                               |
| Maximum Pulse/PWM Frequency                                    | 5kHz (Q1 only)                                                         |                                       |                               |

## 6.9.5 Wiring Diagram IC200UDR005

Figure 43



## 6.10 IC200UDR006

### 28-Point Micro PLC, (16) 12Vdc In, (12) Relay Out, 12Vdc Power Supply

VersaMax Micro PLC IC200UDR006 accepts sixteen 12Vdc inputs and provides twelve normally open 2 Amp relay outputs. It uses +12Vdc nominal input power.

#### 6.10.1 DC Power

The DC power supply requires more current at startup voltage (approximately 4Vdc) than at rated input voltage. A minimum of 2.0 A is required to start up the DC power supply.

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 12Vdc. The 12Vdc power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 12Vdc voltage level (see power supply specifications for inrush requirements).

#### 6.10.2 Inputs

The sixteen configurable 12Vdc inputs can be used as positive or negative logic standard inputs or High-Speed Counter inputs. Inputs are compatible with a wide range of devices such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC +12Vdc supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

#### 6.10.3 Relay Outputs (Q1 – Q12)

The module's twelve Form A relay outputs (SPST-single pole single throw) can be configured as normal or High-Speed Counter outputs. Relay outputs cannot be used as Pulse Train or PWM outputs. The 12 normally open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied for field devices.



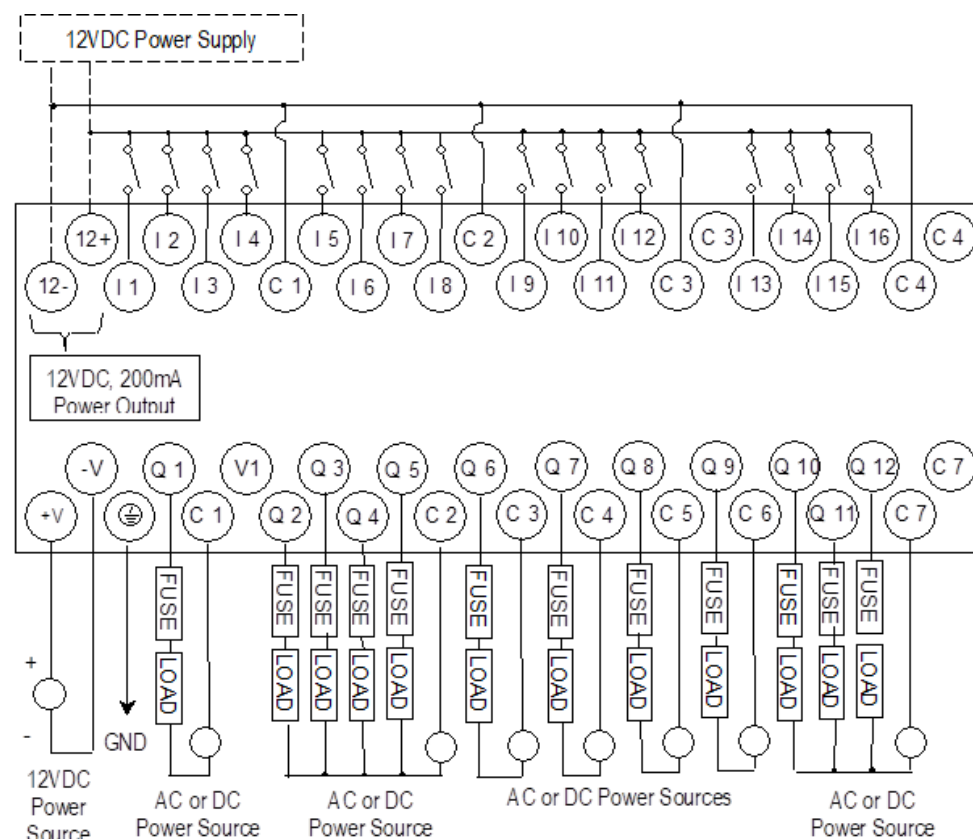
## 6.10.4 Micro PLC IC200UDR006 Specifications

| Item                               | Description                                                                |
|------------------------------------|----------------------------------------------------------------------------|
| Weight                             | 500 grams (1.10 lbs.)                                                      |
| Inputs                             | Sixteen 12Vdc positive/negative logic input circuits                       |
| Outputs                            | Twelve normally open 2 amp relay circuits                                  |
| High-Speed Counters                | Up to four Type A or one Type A and one Type B                             |
| +12Vdc Output Power Supply         | 200mA maximum (for input circuits and user devices)                        |
| <b>DC Power Specifications</b>     |                                                                            |
| Range                              | 9.6Vdc - 15Vdc                                                             |
| Hold-up                            | 3.0mS                                                                      |
| Inrush Current                     | 9.6A typical at 12Vdc                                                      |
| Inrush Time                        | 200mS typical                                                              |
| Input Current                      | 480mA typical at 12Vdc                                                     |
| Input Power Supply Rating          | 8W                                                                         |
| <b>DC Input Specifications</b>     |                                                                            |
| Number of Inputs                   | 16                                                                         |
| Rated Input Voltage                | 12 volts DC                                                                |
| Input Voltage Range                | 0 to 15 volts DC                                                           |
| Input Current                      | 9.0mA typical                                                              |
| Input Impedance                    | 1.3 k $\Omega$                                                             |
| Input Threshold Voltage            | ON: 9.5Vdc minimum, OFF: 2.5Vdc maximum                                    |
| Input Threshold Current            | ON: 6.5mA maximum, OFF: 1.6mA minimum                                      |
| Response Time                      | 0.5 to 20ms (user configurable) as regular input; 100 $\mu$ s as HSC input |
| Isolation Voltage                  | 1500V RMS field side to logic side, 500V RMS between groups                |
| <b>Relay Output Specifications</b> |                                                                            |
| Operating Voltage                  | 5 to 30Vdc or 5 to 250Vac                                                  |
| Isolation                          | 1500 V RMS between field side and logic side, 500 V RMS between groups     |
| Leakage Current                    | 15 mA maximum                                                              |
| Maximum UL Pilot Duty Rating       | 2 amps at 24Vdc and 240Vac                                                 |
| Maximum Resistive Load Rating      | 2 amps at 24Vdc and 240Vac                                                 |
| Minimum Load                       | 1 mA                                                                       |
| Maximum Inrush                     | 5 amps per half cycle                                                      |
| Response Time                      | ON: 15 ms maximum, OFF: 15 ms maximum                                      |
| Contact Life: Mechanical           | 20 x 106 mechanical operations                                             |

| Item                                                                 | Description                    |                                 |                            |
|----------------------------------------------------------------------|--------------------------------|---------------------------------|----------------------------|
| Contact Life: Electrical Voltage                                     | Current: Resistive 2A          | Current: Lamp and Solenoid 0.6A | Typical Operations 200,000 |
| High-Speed Counter Input / PWM and Pulse Train Output Specifications |                                |                                 |                            |
| Maximum Counter Frequency                                            | 10kHz                          |                                 |                            |
| Input Voltage                                                        | ON: 9V, OFF: 2.5V              |                                 |                            |
| Count Pulse Width                                                    | 20% to 80% duty cycle at 10kHz |                                 |                            |
| Count Registers                                                      | 16 bits                        |                                 |                            |
| Outputs                                                              |                                |                                 |                            |
| Available Pulse Outputs                                              | None                           |                                 |                            |
| Load Voltage                                                         | Refer to relay specifications  |                                 |                            |

## 6.10.5 Wiring Diagram IC200UDR006

Figure 44



## 6.11 IC200UDR010 28-Point Micro PLC, (16) 24Vdc In, (1) 24Vdc Out, (11) Relay Out, 24Vdc PS

## IC200UDR228 28-Point Micro PLC, (16) 24 VC In, (1) 24Vdc Out, (11) Relay Out, 12/24Vdc PS

VersaMax Micro PLCs IC200UDR010 and IC200UDR228 accept sixteen DC inputs and provide one DC output and eleven normally open 2 Amp relay outputs. The only differences between these modules are their power supplies and the output current rating of their Q1 DC output. Micro-28 IC200UDR010 uses +24Vdc nominal input power, and provides a 450mA, 24Vdc output. Micro-28 IC200UDR228 uses +12/24Vdc nominal input power, and provides a 100mA, 24Vdc output.

### 6.11.1 DC Power

The DC power supply requires more current at startup voltage (approximately 4Vdc) than at rated input voltage. A minimum of 2.0 A is required to start up the DC power supply.

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains nominal DC power. The power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain an adequateVdc voltage level (see specifications for inrush requirements).

### 6.11.2 DC Inputs

The sixteen configurable DC inputs can be used as positive or negative logic standard inputs or up to three High-Speed Counter inputs. Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC +24Vdc supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

### 6.11.3 DC Output (Q1)

The DC output circuit (Q1) can be configured to be a standard, High-Speed Counter, pulse train, or PWM output.

## 6.11.4 Relay Outputs (Q2 – Q12)

Eleven Form A relay outputs (SPST-single pole single throw) can control a wide range of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices. Relay outputs cannot be used as Pulse Train or PWM outputs.

## 6.11.5 Micro PLC IC200UDR010, IC200UDR228 Specifications

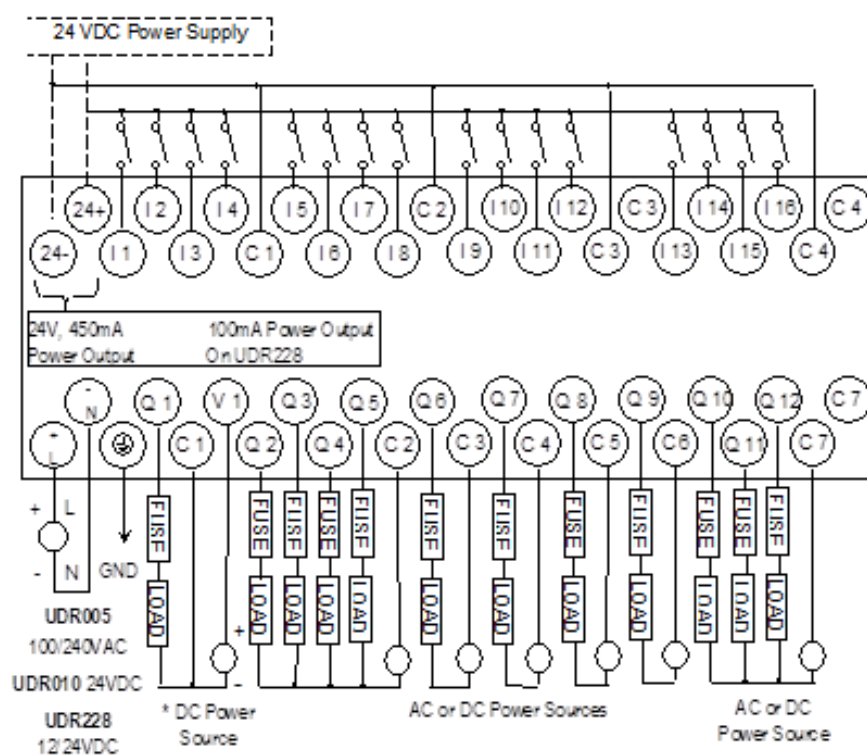
| Item                           | Description                                                                                                                                |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| Weight                         | 500 grams (1.10 lbs.)                                                                                                                      |
| Inputs                         | Sixteen 24Vdc positive/negative logic input circuits                                                                                       |
| Outputs                        | Eleven normally-open 2 amp relay circuits and One DC Output (Q1)                                                                           |
| High-Speed Counters            | Up to four Type A or one Type A and one Type B                                                                                             |
| +24Vdc Output Power Supply     | 200mA maximum (for input circuits and user devices)                                                                                        |
| Thermal Derating               | IC200UDR010: none. IC200UDR228: no derating to 45 degrees C. Above 45 degrees C, number of points on at the same time must not exceed 50%. |
| <b>DC Power Specifications</b> |                                                                                                                                            |
| Range                          | IC200UDR010: 24Vdc -20%, +25%<br>IC200UDR228: 9.2 to 30Vdc                                                                                 |
| Hold-up                        | IC200UDR010: 10ms at 19.2Vdc<br>IC200UDR028: 5ms                                                                                           |
| Inrush Current                 | IC200UDR010: 1 Amp maximum at 30Vdc<br>IC200UDR228: 13 Amps at 12Vdc, 27 Amps at 24Vdc                                                     |
| Inrush Time                    | 10mS for 1 A                                                                                                                               |
| Input Current                  | IC200UDR010: 0.30 Amp typical at 24Vdc<br>IC200UDR228: 1.1 Amp typical at 12Vdc; 0.55 Amp typical at 24Vdc                                 |
| Input Power Supply Rating      | 8W                                                                                                                                         |
| <b>DC Input Specifications</b> |                                                                                                                                            |
| Number of Inputs               | 16                                                                                                                                         |
| Rated Input Voltage            | 24 volts DC                                                                                                                                |
| Input Voltage Range            | 0 to 30 volts DC                                                                                                                           |
| Input Current                  | 7.5mA typical                                                                                                                              |
| Input Resistance               | 2.8 kΩ                                                                                                                                     |
| Input Threshold Voltage        | ON: 15Vdc minimum, OFF: 5Vdc maximum                                                                                                       |
| Input Threshold Current        | ON: 4.5mA maximum, OFF: 1.5mA minimum                                                                                                      |
| Response Time                  | 0.5 to 20ms configurable as regular input; 100μs as HSC input                                                                              |
| Isolation Voltage              | 1500V RMS field side to logic side, 500V RMS between groups                                                                                |

| Item                                                                 | Description                                                                                                                        |                                    |                               |
|----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|-------------------------------|
| DC Output Specifications                                             |                                                                                                                                    |                                    |                               |
| Output logic                                                         | Positive Logic                                                                                                                     |                                    |                               |
| Operating Voltage                                                    | IC200UDR010: 24Vdc / 12Vdc / 5Vdc; IC200UDR228: 24Vdc / 12Vdc                                                                      |                                    |                               |
| Voltage Range                                                        | IC200UDR010: 24Vdc, +20%, -80%; IC200UDR228: 23.5 - 24.5Vdc                                                                        |                                    |                               |
| Output Current                                                       | IC200UDR010: 450mA; IC200UDR228: 100mA                                                                                             |                                    |                               |
| Maximum UL Pilot Duty Rating                                         | 0.75A at 24Vdc                                                                                                                     |                                    |                               |
| Maximum Resistive Load Rating                                        | 0.75A at 24Vdc; 0.5A at 12Vdc; 0.25A at 5Vdc                                                                                       |                                    |                               |
| Output Voltage Drop                                                  | 0.3Vdc maximum                                                                                                                     |                                    |                               |
| Response                                                             | ON: 0.1ms maximum (24Vdc, 0.2A), OFF: 0.1ms maximum (24Vdc, 0.2A)                                                                  |                                    |                               |
| OFF state leakage                                                    | 0.1mA maximum                                                                                                                      |                                    |                               |
| Isolation                                                            | 1500Vac between field side and logic side, 500Vac between groups                                                                   |                                    |                               |
| Fuse                                                                 | Output should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable. |                                    |                               |
| Relay Output Specifications                                          |                                                                                                                                    |                                    |                               |
| Operating Voltage                                                    | 5 to 30Vdc or 5 to 250Vac                                                                                                          |                                    |                               |
| Isolation                                                            | 1500 V RMS between field side and logic side, 500 V RMS between groups                                                             |                                    |                               |
| Leakage Current                                                      | 15 mA at 240Vac maximum                                                                                                            |                                    |                               |
| Maximum UL Pilot Duty Rating                                         | 2 amps at 24Vdc and 240Vac                                                                                                         |                                    |                               |
| Maximum Resistive Load Rating                                        | 2 amps at 24Vdc and 240Vac                                                                                                         |                                    |                               |
| Minimum Load                                                         | 1 mA                                                                                                                               |                                    |                               |
| Maximum Inrush                                                       | 5 amps per half cycle                                                                                                              |                                    |                               |
| Response Time                                                        | ON: 15 ms maximum, OFF: 15 ms maximum                                                                                              |                                    |                               |
| Contact Life: Mechanical                                             | 20 x 106 mechanical operations                                                                                                     |                                    |                               |
| Contact Life: Electrical Voltage<br>240Vac, 120Vac, 24Vdc            | Current: Resistive<br>2A                                                                                                           | Current: Lamp and Solenoid<br>0.6A | Typical Operations<br>200,000 |
| High-Speed Counter Input / PWM and Pulse-Train Output Specifications |                                                                                                                                    |                                    |                               |
| Maximum Counter Frequency                                            | 10kHz                                                                                                                              |                                    |                               |
| Input Voltage                                                        | ON: 15V, OFF: 5V                                                                                                                   |                                    |                               |
| Count Pulse Width                                                    | 20% to 80% duty cycle at 10kHz                                                                                                     |                                    |                               |
| Count Registers                                                      | 16bits                                                                                                                             |                                    |                               |

| Item                        | Description                                                                                |
|-----------------------------|--------------------------------------------------------------------------------------------|
| <b>Outputs</b>              |                                                                                            |
| Load Voltage                | Q1: IC200UDR010 = 5/12/24V; IC200UDR228 = 12/24V<br>Q2-Q4: See Relay output specifications |
| Maximum Pulse/PWM Frequency | (Q1 only) 5kHz                                                                             |
| Types available             | Up to four HSC outputs or three HSC outputs plus one PT/PWM output.                        |

## 6.11.6 Wiring Diagram IC200UDR010, IC200UDR228

Figure 45



## Chapter 7: VersaMax 40-Point Micro/Micro PLUS PLCs

This chapter describes the features, specifications, and field wiring for 40-point VersaMax Micro and VersaMax Micro PLUS PLCs.

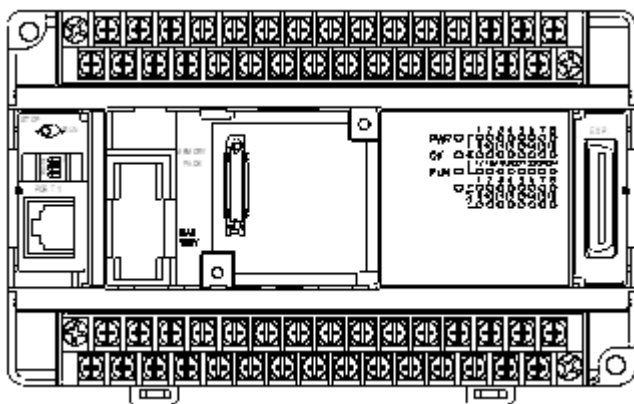
|                    |                                                                                                   |
|--------------------|---------------------------------------------------------------------------------------------------|
| <b>IC200UDD040</b> | 40 Point Micro PLC, (24) 24Vdc In, (16) 24Vdc Out (Source), 24Vdc Power Supply                    |
| <b>IC200UDD240</b> | 40 Point Micro PLC, (24) 24Vdc In, (12) 24Vdc Out with ESCP, (4) 24V LCDC Out, 24Vdc Power Supply |
| <b>IC200UDR040</b> | 40 Point Micro PLC, (24) 24Vdc In, (16) Relay Out, 24Vdc Power Supply                             |
| <b>IC200UDR140</b> | 40 Point Micro PLC, (24) 24Vdc In, (16) Relay Out, 120/240Vac Power Supply                        |
| <b>IC200UDR440</b> | 40 Point Micro PLC, (24) 24Vdc In, (16) Relay Out, 12/24Vdc Power Supply                          |

**Note:** Firmware releases 4.00 and later require a Micro PLUS CPU, which has enhanced memory. Firmware versions 4.00 cannot be used with the earlier hardware versions.

- Micro and Micro PLUS PLCs support the same user logic memory size.
- The specifications given in this chapter for Micro PLCs also apply to Micro PLUS PLCs.

### 7.1 Features of VersaMax 40-Point Micro PLCs

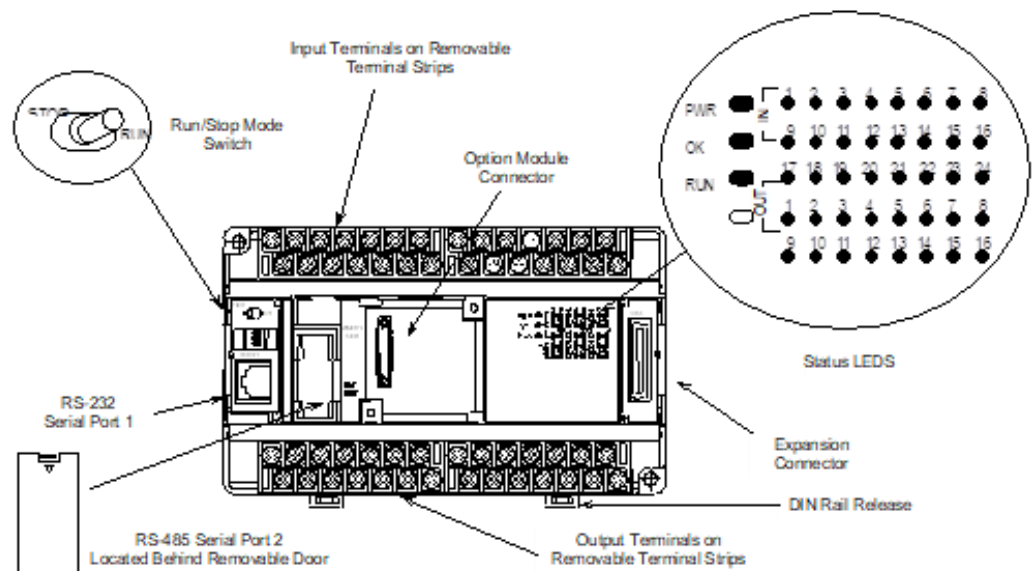
Figure 46



- Supports up to four Expansion Units in any combination.
- Removable screw-down “barrier-style” terminal strips with protective covers.
- Built-in serial communications port supports SNP/ SNPX master and slave, Modbus RTU master and slave, and Serial I/O.
- Removable Memory Pack Module available.
- Optional Port 2.
- Run/Stop mode switch that can be configured as a run/stop switch, a memory protect switch, and also used for clearing faults when a fatal fault exists.
- Resettable calendar clock.

- Full-featured programming Instruction Set with floating point math. The application program can be either Ladder Diagram (LD) or Instruction List (IL) format.
- 24K words of program memory, 32K words of registers.
- Flash memory (ROM) for non-volatile program storage and for system firmware.
- Configurable to read configuration and application program at power-up from either RAM or flash memory (ROM).
- Capacitor backs up RAM and the Time-of-Day clock for at least 30 minutes at 25 degrees C
- Optional lithium battery backup for RAM and real-time clock.
- Enhanced High-Speed Counter / Pulse Train commands for Jogging, Blending, and Homing, plus configurable 32-bit Counters /PTO/ and 32-bit function blocks.

Figure 47



### 7.1.1 Run/Stop Switch

The Run/Stop switch can be configured as a run/stop switch or a memory protect switch and used for clearing faults when a fatal fault exists.

### 7.1.2 Ports

Port 1 is a built-in RS-232 serial port with an RJ-45 connector.

A second port can be added to a 40-Point Micro PLC using one of the port Option Modules described in Chapter 14:. If a second port is installed, both ports can be used for programming. Only one port can be used at a time for programming, but both ports can be used for monitoring at the same time.

Port 1 and the optional Port 2 are individually configurable for SNP master/slave, RTU master/slave, and Serial I/O protocols. Both 4-wire and 2-wire RTU are supported when the



RS-485 Port Option module is installed as port 2. Port 2 does not support hardware flow control. When either port is being used for RTU slave, it automatically switches to SNP slave mode when that port is being used by the programmer. If a port is configured for Serial I/O, RTU Master, or SNP Master operation, that port defaults to SNP slave and automatically reverts to SNP slave when the CPU is in Stop mode.

Either port can be software-configured to set up communications between the CPU and various serial devices. An external device can obtain power from the port if it requires 200mA or less at 5Vdc.

### 7.1.3 Analog Inputs

The RS232 Option Module (IC200USB001) or the RS485 Option Module (IC200USB002) can provide two 0-10V analog inputs. See Chapter 14: for more information about option modules. The two inputs can be used to adjust the values in analog registers %AI016 (input 1) and %AI017 (input 2). An example use for the analog inputs would be to set threshold values for use in logical relationships with other inputs/outputs.

### 7.1.4 Removable Terminal Strips

The removable terminal assemblies are protected by hinged covers. After turning off power to the Micro PLC, a terminal assembly and attached field wiring can be separated from the Micro PLC by removing two screws.

### 7.1.5 Status LEDs

LEDs on the Micro PLC provide quick visual verification of operating status. In addition to LEDs for Power, OK, and Run mode, there is an LED for each I/O point.

### 7.1.6 Backup Battery

The Micro PLC uses a large value capacitor to provide memory retention current to the System/User RAM and the Time-of-Day clock when the power supply is either not present or not powered up. The capacitor retains memory contents for at least 30 minutes.

To maintain memory for longer than this, a replaceable battery assembly can be installed in the battery holder, as described in Chapter 15:. The Micro PLC reports the battery state to the PLC Fault Table and also uses Status Bits %SA011 and %S0014 to indicate the battery state.

## 7.2 General Specifications of 40-Point VersaMax Micro PLCs

|                                                                         |                                                                                                |
|-------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| Module Dimensions                                                       | Height: 90mm (3.6 inches), Depth: 76mm (3.0 inches)<br>Width: 150mm (6.0 inches)               |
| Typical Scan Rate                                                       | 1.7 ms/K for Boolean logic (see Appendix A:)                                                   |
| Real Time Clock accuracy (for Timer contacts and Timer function blocks) | ±0.5%                                                                                          |
| Time-of-Day Clock accuracy                                              | ±5 sec/day @10°C, ±5 sec/day @25°C, and<br>±11 sec/day @ 55°C or across full temperature range |
| Maximum number of slave devices per RS-485 network                      | 8 (can be increased with a repeater)                                                           |
| +24Vdc Output Power Supply (for input circuits and user devices)        | 435mA maximum                                                                                  |
| +5Vdc output of Serial Ports                                            | 200mA per port, 400mA total for both ports, maximum                                            |

## 7.3 High-Speed Counters

VersaMax 40-Point Micro PLCs can be configured to provide built-in High-Speed Counter and pulse operation. When configured for High-Speed Counter operation, inputs I1 to I8 can be set up as:

- Up to four Type A Counters or
- One Type A and one Type B Counter or
- Up to four Type A\_32 Counters or
- One Type A and one Type B\_32 Counter

Each counter provides direct processing of rapid pulse signals up to 100kHz for industrial control applications such as meter proving, turbine flow meter, velocity measurement, material handling, motion control, and process control.

Each counter can be enabled independently. Type A counters can be configured for up or down counting (default is up) and for positive or negative edge detection (default is positive). The type B counter provides an A Quad B counting function.

See Chapter 18: for information about High-Speed Counter operation.

## 7.4 IC200UDD040

### 40-Point Micro PLC, (24) 24Vdc In, (12) 24Vdc Out with ESCP, (4) LCDC Out, 24Vdc Power Supply

VersaMax Micro PLC IC200UDD040 accepts twenty-four DC inputs and provides twelve 24V ESCP outputs and four 24Vdc low current outputs. It uses +24Vdc nominal input power for PLC operation.

#### 7.4.1 DC Power

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 24Vdc. The 24Vdc power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 24Vdc voltage level (see power supply specifications for inrush requirements).

#### 7.4.2 DC Inputs

The twenty-four configurable DC inputs can be used as positive or negative logic standard inputs. Eight of these inputs can be used for High-Speed Counter inputs. When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC +24Vdc supply can be used for input devices and to power the DC input circuits at about 8mA per input. The combination of input circuit current and external device current must not exceed 435 mA.

#### 7.4.3 DC Outputs

Outputs 1 – 4 can be used as standard, High-Speed Counter, Pulse-Width Modulated, Pulse Train Outputs, or Pulse Train Outputs with Ramping. All standard outputs are all source-type. Outputs can be used to switch devices like valves, lamps or contactors.

Outputs 5 – 16 provide Electronic Short-Circuit Protection.

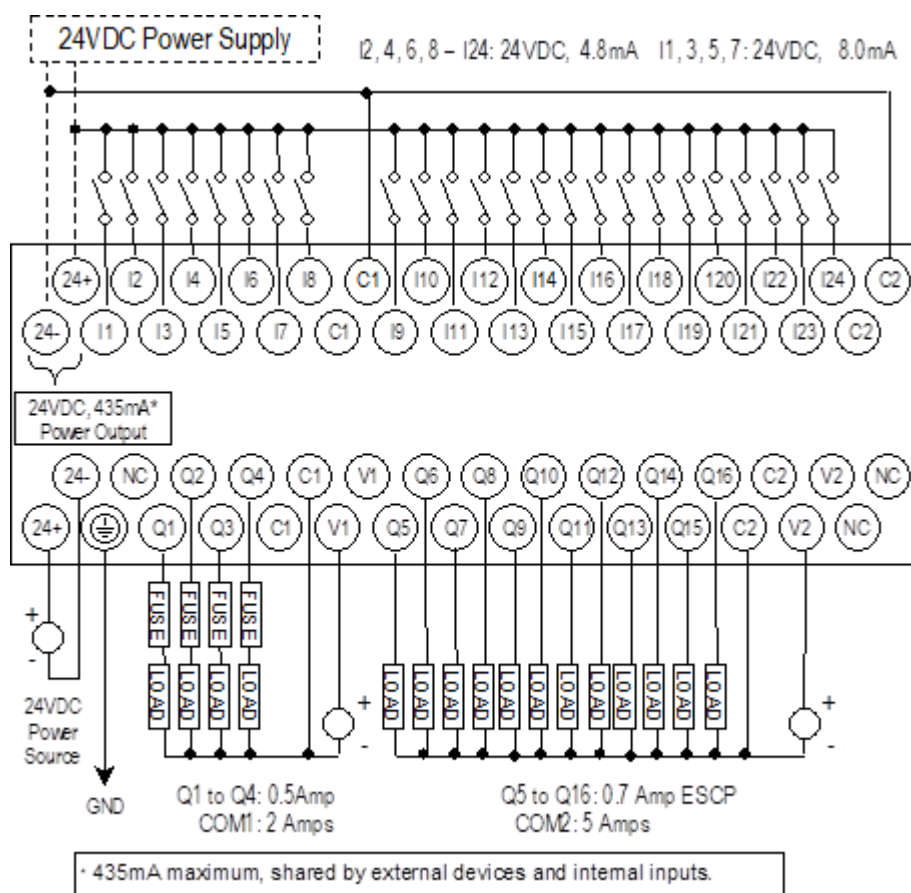
## 7.4.4 Micro PLC IC200UDD040 Specifications

| Item                           | Description                                                                                                       |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------|
| Inputs                         | Twenty-four 24Vdc positive or negative logic inputs                                                               |
| Outputs                        | Sixteen 24Vdc outputs. Outputs 5-16 with ESCP                                                                     |
| High-Speed Counters            | Up to four Type A or one Type A and one Type B, or four Type A_32, or one Type A_32 and one Type B_32             |
| <b>DC Power Specifications</b> |                                                                                                                   |
| Range                          | 19.2Vdc to 30Vdc                                                                                                  |
| Hold-up                        | 10mS at 19.2Vdc                                                                                                   |
| Inrush Current                 | 1 Amp maximum at 30Vdc                                                                                            |
| Inrush Time                    | 10mS for 1 Amp                                                                                                    |
| Input Current                  | 0.20 Amp typical at 24Vdc                                                                                         |
| Input Power Supply Rating      | 5W                                                                                                                |
| <b>DC Input Specifications</b> |                                                                                                                   |
| Rated Input Voltage            | 24 volts DC                                                                                                       |
| Input Voltage Range            | 0 to 30 volts DC                                                                                                  |
| Input Current at 24Vdc         | I1, I3, I5, I7: 8mA typical; other inputs 4.8mA typical                                                           |
| Input Impedance                | I1, I3, I5, I7: 2.7 k $\Omega$ ; other inputs: 4.7k $\Omega$                                                      |
| Input Threshold Voltage        | ON: 18Vdc minimum, OFF: 5Vdc maximum                                                                              |
| Input Threshold Current        | I1, I3, I5, I7: ON 4.5mA maximum, OFF: 1.8mA minimum<br>Other inputs: ON 3.3mA maximum, OFF: 1.6mA maximum        |
| Response Time                  | 1ms to 20ms configurable as regular input; 100 $\mu$ s as HSC input                                               |
| Isolation Voltage              | 1500V RMS field side to logic side, 500V RMS between groups                                                       |
| <b>Output Specifications</b>   |                                                                                                                   |
| Voltage Range                  | 12Vdc / 24Vdc                                                                                                     |
| External Power Supply          | 12/24Vdc $\pm$ 10%, $\pm$ 20%                                                                                     |
| Maximum Load Current           | 0.5A per point (Q1 – Q4) at 24Vdc at 100 % ON duration<br>0.7A per point (Q5 – Q16) at 24Vdc at 100 % ON duration |
| Minimum Switching Current      | 10mA                                                                                                              |
| Maximum Inrush Current         | Q1-Q4: 2A for 20ms, 1 pulse<br>Q5-Q16: 4A for 20ms, 1 pulse                                                       |
| Output Voltage Drop            | 0.3V maximum                                                                                                      |
| OFF state leakage current      | 0.1mA maximum                                                                                                     |
| Response Time                  | OFF to ON, ON to OFF: 1 ms maximum (24Vdc)                                                                        |
| Isolation Voltage              | 1500V RMS between field side and logic side<br>500V RMS between groups                                            |
| Fuse                           | None, outputs 5-16 are ESCP protected                                                                             |
| Under-voltage shutdown         | Q5 – Q16: 5V minimum, 8V maximum                                                                                  |
| DC short circuit current       | Q1 – Q4: 5A maximum<br>Q5 - Q16: 0.7A maximum ESCP                                                                |

| Item                                                      | Description                                              |
|-----------------------------------------------------------|----------------------------------------------------------|
| Peak short circuit current                                | Q5 - Q16:4A maximum                                      |
| Delay time of peak short circuit current                  | 100 $\mu$ S                                              |
| Delay time of current limit                               | 100 $\mu$ S                                              |
| <b>High-Speed Counter Input and Output Specifications</b> |                                                          |
| Maximum Counter Frequency                                 | 100kHz                                                   |
| Input Voltage                                             | ON : 18V, OFF: 5V                                        |
| Count Pulse Width                                         | 20% to 80% of duty cycle at 100kHz                       |
| Count Registers                                           | 16/32 bits                                               |
| <b>Outputs</b>                                            |                                                          |
| Load Voltage                                              | 12/24Vdc                                                 |
| Maximum Pulse/Pulse Train with Ramping/PWM Frequency      | PWM and PTO: 65kHz<br>Pulse Train with Ramping: 65kHz    |
| Types available                                           | Up to four HSC, PTO, PTO with Ramping and/or PWM outputs |

### 7.4.5 Wiring Diagram, IC200UDD040

### Figure 48



## 7.5 IC200UDD240

### 40 Point Micro PLC, (24) 24Vdc In, (16) 24Vdc Out (Sink), 24Vdc Power Supply

VersaMax Micro PLC IC200UDD240 accepts twenty-four DC inputs and provides sixteen DC outputs. It uses +24Vdc nominal input power for PLC operation.

#### 7.5.1 DC Power

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 24Vdc. The 24Vdc power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 24Vdc voltage level (see power supply specifications for inrush requirements).

#### 7.5.2 DC Inputs

Twenty-four configurable DC inputs can be used as positive or negative logic standard inputs. Eight of these inputs can be used for High-Speed Counter inputs. When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC +24Vdc supply can be used for input devices and to power the DC input circuits at about 8mA per input. The combination of input circuit current and external device current must not exceed 435mA.

#### 7.5.3 DC Outputs

Micro PLC IC200UDD240 has 16 Sink-type DC outputs. All outputs are isolated between field and logic and are switching positive voltage. The outputs have one common incoming supply (VC) and one common ground (COM). The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

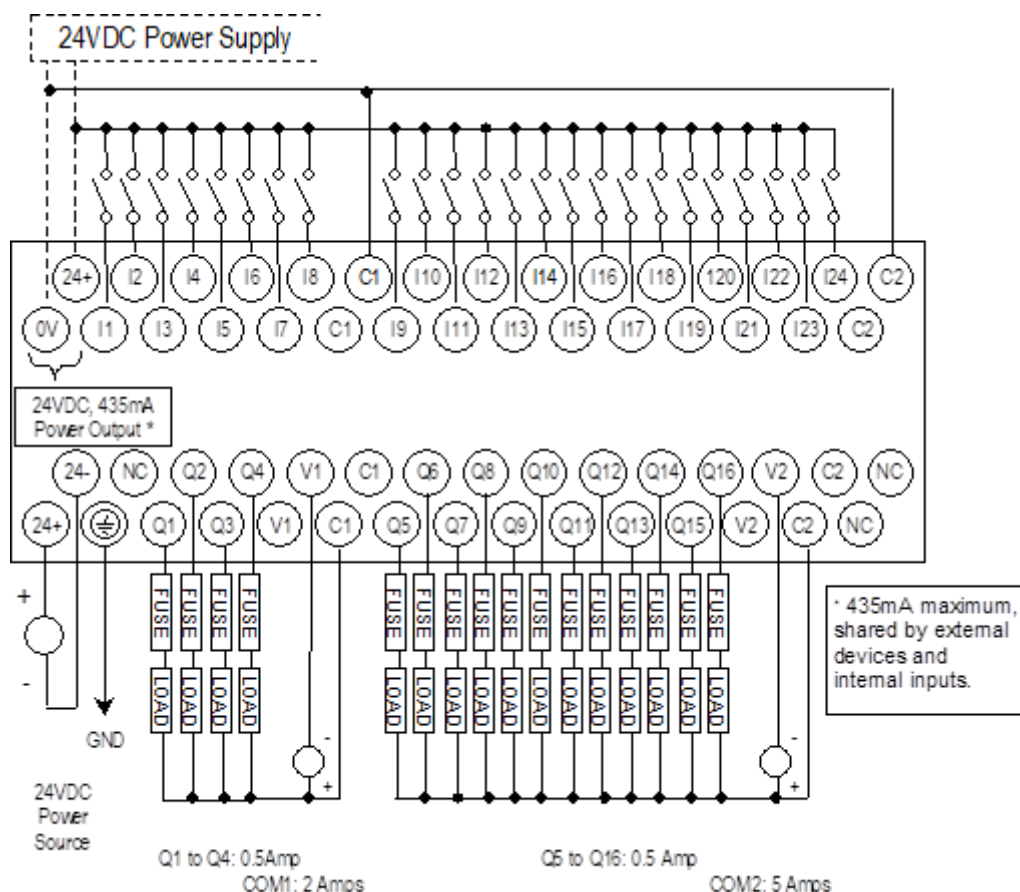
DC outputs can be used as standard, High-Speed Counter, Pulse-Width Modulated, Pulse Train Outputs, or Pulse Train Outputs with Ramping.

## 7.5.4 Micro PLC IC200UDD240 Specifications

| Item                           | Description                                                                                                |
|--------------------------------|------------------------------------------------------------------------------------------------------------|
| Inputs                         | Twenty-four 24Vdc positive or negative logic inputs                                                        |
| Outputs                        | Sixteen transistor outputs, 24Vdc.                                                                         |
| High-Speed Counters            | Up to four Type A or one Type A and one Type B, or four Type A_32, or one Type A_32 and one Type B_32      |
| <b>DC Power Specifications</b> |                                                                                                            |
| Range                          | 19.2Vdc to 30Vdc                                                                                           |
| Hold-up                        | 10mS at 19.2Vdc                                                                                            |
| Inrush Current                 | 1 Amp maximum at 30Vdc                                                                                     |
| Inrush Time                    | 10mS for 1 Amp                                                                                             |
| Input Current                  | 0.20 Amp typical at 24Vdc                                                                                  |
| Input Power Supply Rating      | 5W                                                                                                         |
| <b>DC Input Specifications</b> |                                                                                                            |
| Rated Input Voltage            | 24 volts DC                                                                                                |
| Input Voltage Range            | 0 to 30 volts DC                                                                                           |
| Input Current at 24Vdc         | I1, I3, I5, I7: 8mA typical; other inputs 4.8mA typical                                                    |
| Input Impedance                | I1, I3, I5, I7: 2.7 kΩ; other inputs: 4.7kΩ                                                                |
| Input Threshold Voltage        | ON: 18Vdc minimum, OFF: 5Vdc maximum                                                                       |
| Input Threshold Current        | I1, I3, I5, I7: ON 4.5mA maximum, OFF: 1.8mA minimum<br>Other inputs: ON 3.3mA maximum, OFF: 1.6mA maximum |
| Response Time                  | 1ms to 20ms configurable as regular input; 100μs as HSC input                                              |
| Isolation Voltage              | 1500V RMS field side to logic side, 500V RMS between groups                                                |
| <b>Output Specifications</b>   |                                                                                                            |
| Voltage Range                  | 12Vdc/24Vdc                                                                                                |
| External Power Supply          | 12/24Vdc –10%, +20%                                                                                        |
| Maximum Load Current           | 0.5A per point (Q1 – Q24) at 24Vdc                                                                         |
| Minimum Switching Current      | 10mA                                                                                                       |
| Maximum Inrush Current         | Q1-Q16: 2A for 20ms, 1 pulse                                                                               |
| Output Voltage Drop            | Q1– Q16: 0.3Vdc                                                                                            |
| OFF state leakage current      | 0.1mA                                                                                                      |
| Response Time                  | OFF to ON, ON to OFF: 1 mS maximum @ 24Vdc                                                                 |
| Isolation Voltage              | 1500V RMS between field side and logic side, 500V RMS between groups                                       |
| Fuses                          | None                                                                                                       |
| Under-voltage shutdown         | Q1 – Q16: 5V minimum, 8V maximum                                                                           |
| DC short circuit current       | Q1 – Q16: 0.7A minimum, 2A maximum                                                                         |

| Item                                                      | Description                                              |
|-----------------------------------------------------------|----------------------------------------------------------|
| <b>High-Speed Counter Input and Output Specifications</b> |                                                          |
| Maximum Counter Frequency                                 | 100kHz                                                   |
| Input Voltage                                             | ON : 18V, OFF: 5V                                        |
| Count Pulse Width                                         | 20% to 80% of duty cycle at 100kHz                       |
| Count Registers                                           | 16/32 bits                                               |
| <b>Outputs</b>                                            |                                                          |
| Load Voltage                                              | 12/24Vdc                                                 |
| Maximum Pulse/PWM Frequency                               | PWM and PTO: 65kHz<br>Pulse Train with Ramping: 65kHz    |
| Types available                                           | Up to four HSC, PTO, PTO with Ramping and/or PWM outputs |

Figure 49





## 7.6 **IC200UDR040** **40 Point Micro PLC, (24) 24Vdc In, (16) Relay Out, 24Vdc Power Supply**

## **IC200UDR140** **40 Point Micro PLC, (24) 24Vdc In, (16) Relay Out, 120/240Vac Power Supply**

## **IC200UDR440** **40 Point Micro PLC, (24) 24Vdc In, (16) Relay Out, 12/24Vdc Power Supply**

VersaMax Micro PLCs IC200UDR040, IC200UDR140, and IC200UDR440 each accept twenty-four DC inputs and provide sixteen normally open 2 Amp relay outputs.

- IC200UDR040 uses +24Vdc nominal input power for PLC operation.
- IC200UDR140 uses 100Vac to 240Vac nominal input power for PLC operation.
- IC200UDR440 uses +12/24Vdc nominal input power for PLC operation.

### 7.6.1 **DC Inputs**

Twenty-four configurable DC inputs can be used as positive or negative logic standard inputs. Eight of these inputs can be used for High-Speed Counter inputs. When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC +24Vdc supply can be used for input devices and to power the DC input circuits at about 8mA per input. The combination of input circuit current and external device current must not exceed 435mA.

### 7.6.2 **Relay Outputs**

The sixteen normally open Form A relay outputs (SPST-single pole single throw) can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices.

The relay outputs can be configured as up to four HSC outputs. Relay outputs cannot be used as Pulse Train or PWM outputs.

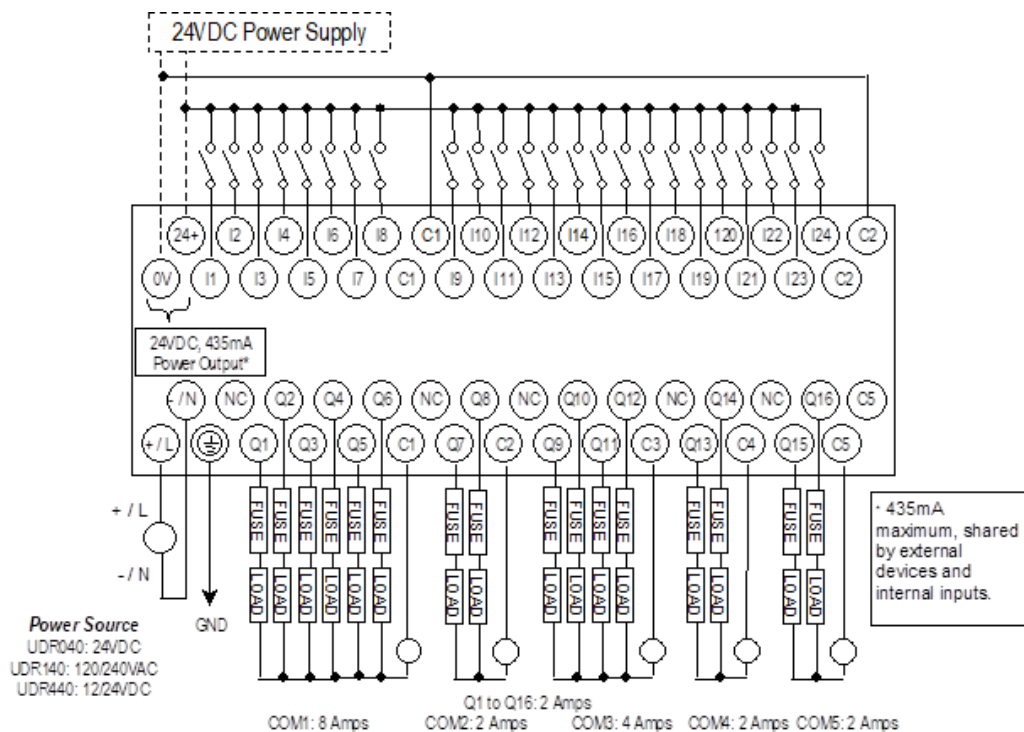
## 7.6.3 Micro PLC IC200UDR040, IC200UDR140, IC200UDR440 Specifications

| Item                                                      | Description                                                                                                                  |
|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| Inputs                                                    | Twenty-four 24Vdc positive/negative logic input circuits                                                                     |
| Outputs                                                   | Sixteen normally open 2-amp relay circuits                                                                                   |
| High-Speed Counters                                       | Up to four Type A or one Type A and one Type B, or four Type A_32, or one Type A_32 and one Type B_32                        |
| +24Vdc Output Power Supply                                | 435mA maximum (for input circuits and user devices)                                                                          |
| +5Vdc output of Serial Port                               | Serial Port 1, pin 7: 100mA maximum                                                                                          |
| <b>Power Supply Specifications</b>                        |                                                                                                                              |
| Range                                                     | IC200UDR040, IC200UDR440: 19.2Vdc to 30Vdc<br>IC200UDR140: 100 -15% to 240 +10%Vac                                           |
| Frequency                                                 | IC200UDR140: 50 -5% to 60 +5% Hz                                                                                             |
| Hold-up                                                   | IC200UDR040, IC200UDR440: 10mS at 19.2Vdc<br>IC200UDR140: 10mS at 85 to 100Vac, 20mS at 100 to 265Vac                        |
| Inrush Current                                            | IC200UDR040, IC200UDR440: 1 Amp maximum at 30Vdc<br>IC200UDR140: 30 Amp maximum at 200Vac,<br>40 Amp maximum at 265Vac       |
| Inrush Time                                               | IC200UDR040, IC200UDR440: 10mS for 1 Amp<br>IC200UDR140: 2 ms for 40Amp                                                      |
| Input Current                                             | IC200UDR040, IC200UDR440: 0.20 Amp typical at 24Vdc<br>IC200UDR140: 0.20 Amp typical at 200Vac<br>0.10 Amp typical at 100Vac |
| Input Power Supply Rating                                 | IC200UDR040, IC200UDR440: 5W<br>IC200UDR140: 26 VA                                                                           |
| <b>DC Input Specifications</b>                            |                                                                                                                              |
| Rated Input Voltage                                       | 24 volts DC                                                                                                                  |
| Input Voltage Range                                       | 0 to 30 volts DC                                                                                                             |
| Input Current at 24Vdc                                    | I1, I3, I5, I7: 8mA typical; other inputs 4.8mA typical                                                                      |
| Input Impedance                                           | I1, I3, I5, I7: 2.7 k $\Omega$ ; other inputs: 4.7k $\Omega$                                                                 |
| Input Threshold Voltage                                   | ON: 18Vdc minimum, OFF: 5Vdc maximum                                                                                         |
| Input Threshold Current                                   | I1, I3, I5, I7: ON 4.5mA maximum, OFF: 1.8mA minimum<br>Other inputs: ON 3.3mA maximum, OFF: 1.6mA maximum                   |
| Response Time                                             | 1ms to 20ms configurable as regular input; 100 $\mu$ s as HSC input                                                          |
| Isolation Voltage                                         | 1500V RMS field side to logic side, 500V RMS between groups                                                                  |
| <b>High-Speed Counter Input and Output Specifications</b> |                                                                                                                              |
| Maximum Counter Frequency                                 | 100kHz                                                                                                                       |
| Input Voltage                                             | ON: 18V, OFF: 5V                                                                                                             |
| Count Pulse Width                                         | 20% to 80% of duty cycle at 100kHz                                                                                           |

| Item                                                      | Description                                                            |                                       |                               |
|-----------------------------------------------------------|------------------------------------------------------------------------|---------------------------------------|-------------------------------|
| Count Registers                                           | 16/32 bits                                                             |                                       |                               |
| Outputs                                                   |                                                                        |                                       |                               |
| Load Voltage                                              | Q1: 5/12/24V, Q2-Q4: See relay output specifications                   |                                       |                               |
| Type available                                            | Up to four HSC outputs. Pulse outputs not available.                   |                                       |                               |
| Relay Output Specifications                               |                                                                        |                                       |                               |
| Operating Voltage                                         | 5 to 30Vdc or 5 to 250Vac                                              |                                       |                               |
| Isolation                                                 | 1500 V RMS between field side and logic side, 500 V RMS between groups |                                       |                               |
| Leakage Current                                           | 15 mA at 240Vac maximum                                                |                                       |                               |
| Maximum UL Pilot Duty Rating                              | 2 amps at 24Vdc and 240Vac                                             |                                       |                               |
| Maximum Resistive Load Rating                             | 2 amps at 24Vdc and 240Vac                                             |                                       |                               |
| Minimum Load                                              | 10 mA                                                                  |                                       |                               |
| Maximum Inrush                                            | IC200UDR040: 1.5A, 10ms<br>IC200UDR140: 9.4A, 20ms                     |                                       |                               |
| Response Time                                             | ON: 15 ms maximum, OFF: 15 ms maximum                                  |                                       |                               |
| Contact Life: Mechanical                                  | 20 x 106 mechanical operations                                         |                                       |                               |
| Contact Life: Electrical Voltage<br>240Vac, 120Vac, 24Vdc | Current: Resistive<br>2.0A                                             | Current: Lamp and<br>Solenoid<br>0.6A | Typical Operations<br>200,000 |

## 7.6.4 Wiring Diagram, IC200UDR040, IC200UDR140, IC200UDR440

Figure 50



## Chapter 8: VersaMax 64-Point Micro/Micro PLUS PLCs

This chapter describes the features, specifications, and field wiring for 64-Point VersaMax Micro and VersaMax Micro PLUS PLCs.

|                    |                                                                                |
|--------------------|--------------------------------------------------------------------------------|
| <b>IC200UDD064</b> | 64 Point Micro PLC, (40) 24Vdc In, (24) 24Vdc Out (Source), 24Vdc Power Supply |
| <b>IC200UDD164</b> | 64 Point Micro PLC, (40) 24Vdc In, (24) 24Vdc Out (Sink), 24Vdc Power Supply   |
| <b>IC200UDR064</b> | 64 Point Micro PLC, (40) 24Vdc In, (24) Relay Out, 24Vdc Power Supply          |
| <b>IC200UDR164</b> | 64 Point Micro PLC, (40) 24Vdc In, (24) Relay Out, 120/240Vac Power Supply     |

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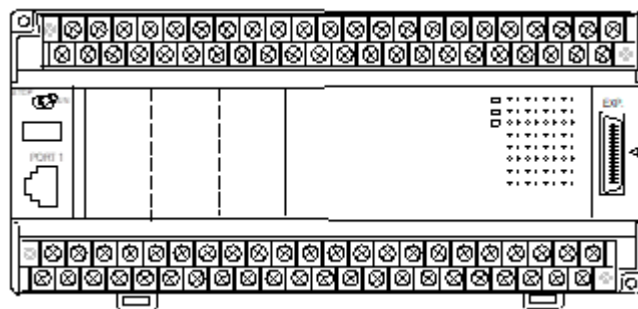
**Note:** Firmware releases 4.00 and later require a Micro PLUS CPU, which has enhanced memory. Firmware versions 4.00 cannot be used with the earlier hardware versions.

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- Micro and Micro PLUS PLCs support the same user logic memory size.
- The specifications given in this chapter for Micro PLCs also apply to Micro PLUS PLCs.

### 8.1 Features of VersaMax 64-Point Micro PLCs

Figure 51



- Supports up to four Expansion Units in any combination.
- Removable screw-down “barrier-style” terminal strips with protective covers.
- Built-in serial communications port supports SNP/ SNPX master and slave, Modbus RTU master and slave, and Serial I/O.
- Removable Memory Pack Module available.
- Optional Port 2.
- Run/Stop mode switch that can be configured as a run/stop switch, a memory protect switch, and also used for clearing faults when a fatal fault exists.
- Resettable calendar clock.
- Full-featured programming Instruction Set with floating point math. The application program can be either Ladder Diagram (LD) or Instruction List (IL) format.
- 24K words of program memory, 32K words of registers.
- Flash memory (ROM) for non-volatile program storage and for system firmware.

- Configurable to read configuration and application program at power-up from either RAM or flash memory (ROM).
- Capacitor backs up RAM and the Time-of-Day clock for at least 30 minutes at 25 degrees C
- Optional lithium battery backup for RAM and real-time clock.
- Release 3.6 and later Micro-64 PLCs support enhanced High-Speed Counter / Pulse Train commands for Jogging, Blending, and Homing, plus configurable 32-bit Counters /PTO/ and 32-bit function blocks.

## 8.2 General Specifications of 64-Point VersaMax Micro PLCs

|                                                                         |                                                                                                |
|-------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| Module Dimensions                                                       | Height: 90mm (3.6 inches), Depth: 76mm (3.0 inches)<br>Width: 195mm (7.68 inches)              |
| Typical Scan Rate                                                       | 1.7 ms/K for Boolean logic (see Appendix A:)                                                   |
| Real Time Clock accuracy (for Timer contacts and Timer function blocks) | ±0.5%                                                                                          |
| Time-of-Day Clock accuracy                                              | ±5 sec/day @10°C, ±5 sec/day @25°C, and<br>±11 sec/day @ 55°C or across full temperature range |
| Maximum number of slave devices per RS-485 network                      | 8 (can be increased with a repeater)                                                           |
| +24Vdc Output Power Supply (for input circuits and user devices)        | 435mA maximum                                                                                  |
| +5Vdc output of Serial Ports                                            | 200mA per port, 400mA total for both ports, maximum                                            |

## 8.3 High-Speed Counters

VersaMax 64-Point Micro PLCs can be configured to provide built-in high-speed counter and pulse operation. When configured for High-Speed Counter operation, inputs I1 to I8 can be set up as:

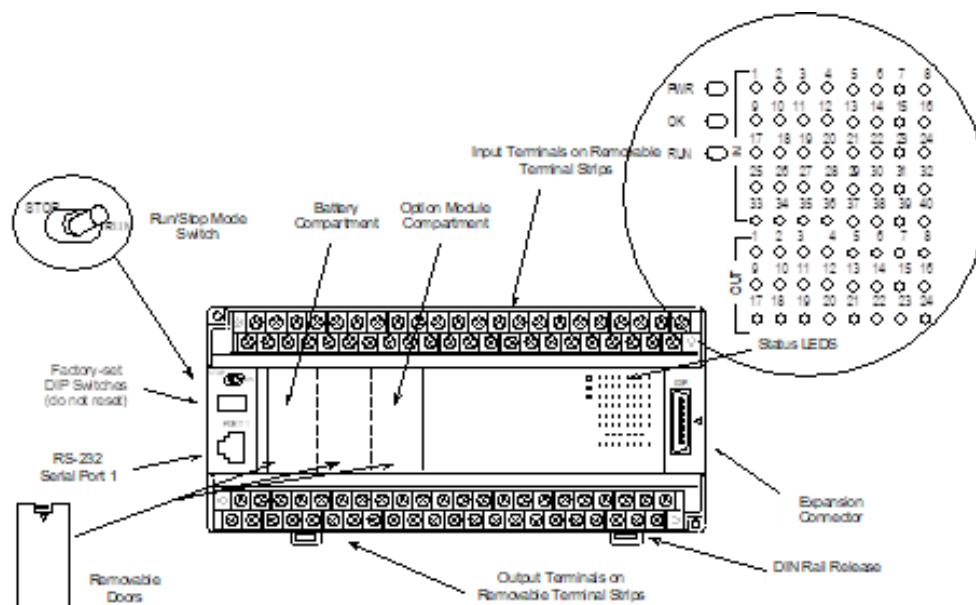
- Up to four Type A Counters or
- One Type A and one Type B Counter or
- Up to four Type A\_32 Counters or
- One Type A and one Type B\_32 Counter

Each counter provides direct processing of rapid pulse signals up to 100kHz for industrial control applications such as meter proving, turbine flow meter, velocity measurement, material handling, motion control, and process control.

Each counter can be enabled independently. Type A counters can be configured for up or down counting (default is up) and for positive or negative edge detection (default is positive). The type B counter provides an A Quad B counting function.

The DC output (Q1) can be configured as a counter, Pulse Train, Pulse Train with Ramp, or PWM output. The relay outputs can be configured as up to four HSC outputs. Relay outputs cannot be used as Pulse Train, Pulse Train with Ramp, or PWM outputs.

Figure 52



### 8.3.1 Run/Stop Switch

The Run/Stop switch can be configured as a run/stop switch, a memory protect switch, and used for clearing faults when a fatal fault exists.

### 8.3.2 Ports

Port 1 is a built-in RS-232 serial port with an RJ-45 connector.

A second port can be added to a 64-Point Micro PLC using one of the port Option Modules described in this section. If a second port is installed, both ports can be used for programming. Only one port can be used at a time for programming, but both ports can be used for monitoring at the same time.

Port 1 and the optional Port 2 are individually-configurable for SNP master/slave, RTU master/slave, and Serial I/O protocols. Both 4-wire and 2-wire RTU are supported when the RS-485 Port Option module is installed as port 2. Port 2 does not support hardware flow control. When either port is being used for RTU slave, it automatically switches to SNP slave mode when that port is being used by the programmer. If a port is configured for Serial I/O, RTU Master, or SNP Master operation, that port defaults to SNP slave and automatically reverts to SNP slave when the CPU is in Stop mode.

Either port can be software-configured to set up communications between the CPU and various serial devices. An external device can obtain power from the port if it requires 200mA or less at 5Vdc.

### 8.3.3 Analog Inputs

If an Option Module with analog inputs is installed as described in this section, the two inputs can be used to adjust the values in analog registers %AI016 (input 1) and %AI017 (input 2). An example use for the analog inputs would be to set threshold values for use in logical relationships with other inputs/outputs.

### 8.3.4 Removable Terminal Strips

The removable terminal assemblies are protected by hinged covers. After turning off power to the Micro PLC, a terminal assembly and attached field wiring can be separated from the Micro PLC by removing two screws.

### 8.3.5 Status LEDs

LEDs on the Micro PLC provide quick visual verification of operating status. In addition to LEDs for Power, OK, and Run mode, there is an LED for each I/O point.

### 8.3.6 Backup Battery

The Micro PLC uses a large value capacitor to provide memory retention current to the System/User RAM and the Time-of-Day clock when the power supply is either not present or not powered up. The capacitor retains memory contents for at least 30 minutes.

To maintain memory for longer than this, a replaceable battery assembly can be installed in the battery holder, as described in Chapter 15:. The Micro PLC reports the battery state to the PLC Fault Table and also uses Status Bits %SA011 and %S0014 to indicate the battery state.

## 8.4 IC200UDD064 64 Point Micro PLC, (40) 24Vdc In, (24) 24Vdc Out (Source), 24Vdc Power Supply

VersaMax Micro PLC IC200UDD064 accepts forty DC inputs and provides twenty-four DC outputs. It uses +24Vdc nominal input power for PLC operation.

### 8.4.1 DC Power

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 24Vdc. The 24Vdc power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 24Vdc voltage level (see power supply specifications for inrush requirements).



## 8.4.2 DC Inputs

The forty configurable DC inputs can be used as positive or negative logic standard inputs. Eight of these inputs can be used for High-Speed Counter inputs. When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC +24Vdc supply can be used for input devices and to power the DC input circuits at about 8mA per input. The combination of input circuit current and external device current must not exceed 435 mA.

## 8.4.3 Transistor Outputs

Outputs 1 – 4 can be used as standard, High-Speed Counter, Pulse-Width Modulated, Pulse Train Outputs, or Pulse Train Outputs with Ramping. All standard outputs are source-type. Outputs can be used to switch devices like valves, lamps or contactors.

Outputs 5 – 24 provide Electronic Short-Circuit Protection. No external fuses are required.

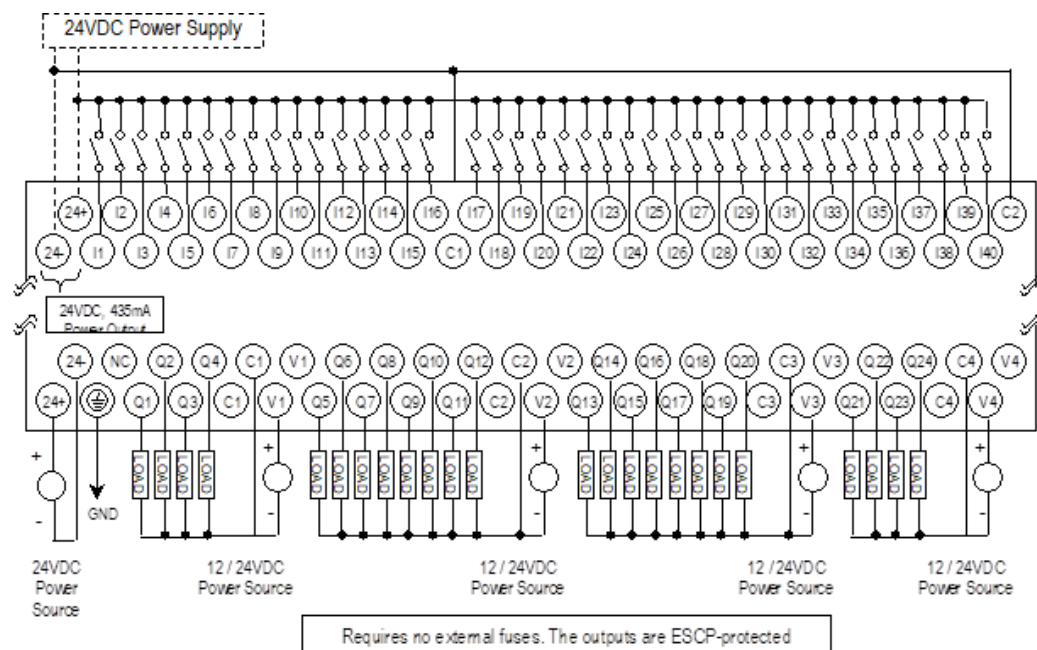
## 8.4.4 Micro PLC IC200UDD064 Specifications

| Item                           | Description                                                                                                |
|--------------------------------|------------------------------------------------------------------------------------------------------------|
| Inputs                         | Forty 24Vdc positive or negative logic inputs                                                              |
| Outputs                        | Twenty-four transistor outputs, 24Vdc.                                                                     |
| High-Speed Counters            | Up to four Type A or one Type A and one Type B, or four Type A_32, or one Type A_32 and one Type B_32      |
| <b>DC Power Specifications</b> |                                                                                                            |
| Range                          | 19.2Vdc to 30Vdc                                                                                           |
| Hold-up                        | 10mS at 19.2Vdc                                                                                            |
| Inrush Current                 | 1 Amp maximum at 30Vdc                                                                                     |
| Inrush Time                    | 10mS for 1 Amp                                                                                             |
| Input Current                  | 0.20 Amp typical at 24Vdc                                                                                  |
| Input Power Supply Rating      | 5W                                                                                                         |
| <b>DC Input Specifications</b> |                                                                                                            |
| Rated Input Voltage            | 24 volts DC                                                                                                |
| Input Voltage Range            | 0 to 30 volts DC                                                                                           |
| Input Current at 24Vdc         | I1,I3,I5,I7: 8mA typical, Others : 4.8 mA typical                                                          |
| Input Impedance                | I1,I3,I5,I7 2.7 kΩ, Others: 4.7 kΩ                                                                         |
| Input Threshold Voltage        | ON: 18Vdc minimum, OFF: 5Vdc maximum                                                                       |
| Input Threshold Current        | I1, I3, I5, I7: ON 4.5mA maximum, OFF: 1.8mA minimum<br>Other Inputs: ON 3.3mA maximum, OFF: 1.6mA minimum |
| Response Time                  | 1ms to 20ms configurable as regular input; 100μs as HSC input                                              |
| Isolation Voltage              | 1500V RMS field side to logic side, 500V RMS between groups                                                |

| Item                                                      | Description                                                                                                                                                                  |
|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Output Specifications</b>                              |                                                                                                                                                                              |
| Voltage Range                                             | 12Vdc/24Vdc                                                                                                                                                                  |
| External Power Supply                                     | 12/24Vdc –10%, +20%                                                                                                                                                          |
| Maximum Load Current                                      | 0.5A per point (Q1 – Q4) at 24Vdc at 100 % ON duration<br>0.7A per point (Q5 – Q20) at 24Vdc at 100 % ON duration<br>1.0A per point (Q21 – Q24) at 24Vdc at 100% ON duration |
| Minimum Switching Current                                 | 10mA                                                                                                                                                                         |
| Maximum Inrush Current                                    | Q1-Q4: 2A for 20ms, 1 pulse<br>Q5-Q20: 4A for 20ms, 1 pulse<br>Q21-Q24: 8A for 20ms, 1 pulse                                                                                 |
| Output Voltage Drop                                       | 0.3V maximum                                                                                                                                                                 |
| OFF state leakage current                                 | 0.1mA maximum                                                                                                                                                                |
| Response Time                                             | OFF to ON, ON to OFF: 1ms maximum (24Vdc)                                                                                                                                    |
| Isolation Voltage                                         | 1500V RMS between field side and logic side,<br>500V RMS between groups                                                                                                      |
| Fuse                                                      | None, outputs 5–24 are ESCP protected                                                                                                                                        |
| Under-voltage shutdown                                    | Q5 – Q20: 5V minimum, 8V maximum                                                                                                                                             |
| DC short circuit current                                  | Q1 – Q4, Q21 – Q24: 5A typical<br>Q5 – Q20: 0.7A minimum, 2A maximum                                                                                                         |
| Peak short circuit current                                | Q5 – Q20: 4A maximum                                                                                                                                                         |
| Delay time of peak short circuit current                  | 100 $\mu$ S                                                                                                                                                                  |
| Delay time of current limit                               | 100 $\mu$ S                                                                                                                                                                  |
| <b>High-Speed Counter Input and Output Specifications</b> |                                                                                                                                                                              |
| Maximum Counter Frequency                                 | 100kHz                                                                                                                                                                       |
| Input Voltage                                             | ON: 18V, OFF: 5V                                                                                                                                                             |
| Count Pulse Width                                         | 20% to 80% of duty cycle at 100kHz                                                                                                                                           |
| Count Registers                                           | 16/32 bits                                                                                                                                                                   |
| <b>Outputs</b>                                            |                                                                                                                                                                              |
| Load Voltage                                              | 12/24Vdc                                                                                                                                                                     |
| Maximum Pulse/Pulse Train with Ramping/PWM Frequency      | PWM and PTO: 65kHz<br>Pulse Train with Ramping: 65kHz                                                                                                                        |
| Types available                                           | Up to four HSC, PTO, PTO with Ramping and/or PWM outputs                                                                                                                     |

## 8.4.5 Wiring Diagram, IC200UDD064

Figure 53



## 8.5 IC200UDD164

### 64 Point Micro PLC, (40) 24Vdc In, (24) 24Vdc Out (Sink), 24Vdc Power Supply

VersaMax Micro PLC IC200UDD164 accepts forty DC inputs and provides twenty-four DC outputs. It uses +24Vdc nominal input power for PLC operation.

### 8.5.1 DC Power

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 24Vdc. The 24Vdc power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 24Vdc voltage level (see power supply specifications for inrush requirements).

### 8.5.2 DC Inputs

Forty configurable DC inputs can be used as positive or negative logic standard inputs. Eight of these inputs can be used for High-Speed Counter inputs. When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC +24Vdc supply can be used for input devices and to power the DC input circuits at about 8mA per input. The combination of input circuit current and external device current must not exceed 435mA.

## 8.5.3 DC Outputs

Micro PLC IC200UDD164 has 24 Sink-type DC outputs. All outputs are isolated between field and logic and are switching positive voltage. The outputs have one common incoming supply (VC) and one common ground (COM). The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

DC outputs can be used as standard, High-Speed Counter, Pulse-Width Modulated, Pulse Train Outputs, or Pulse Train Outputs with Ramping.

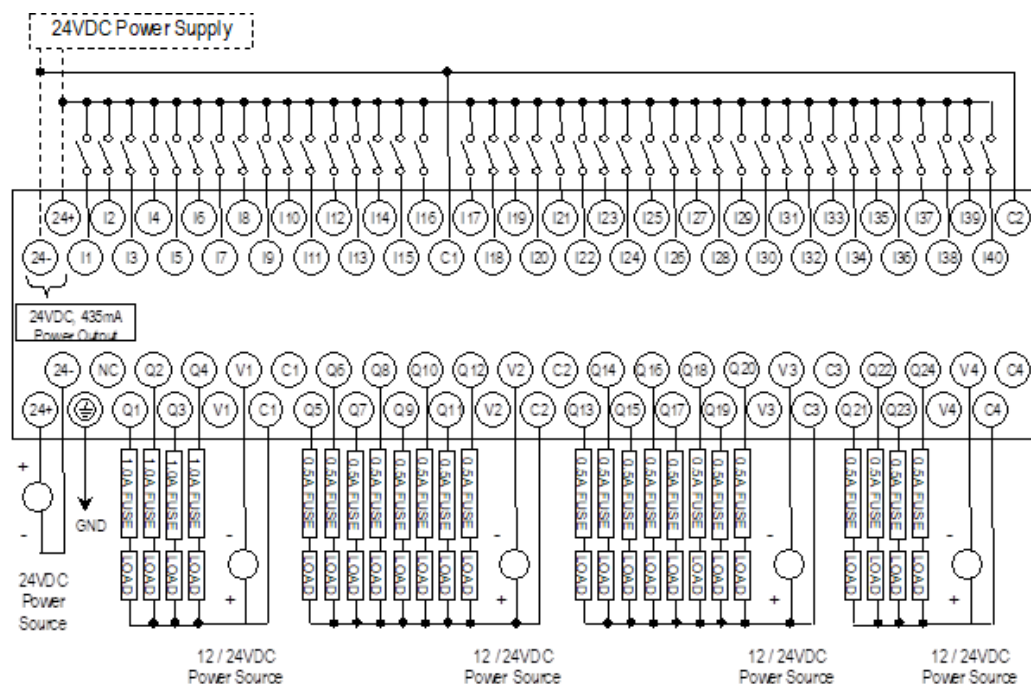
## 8.5.4 Micro PLC IC200UDD164 Specifications

| Item                           | Description                                                                                                |
|--------------------------------|------------------------------------------------------------------------------------------------------------|
| Inputs                         | Forty 24Vdc positive or negative logic inputs                                                              |
| Outputs                        | Twenty-four transistor outputs, 24Vdc.                                                                     |
| High-Speed Counters            | Up to four Type A or one Type A and one Type B or four Type A_32 or one Type A_32 and one Type B_32        |
| <b>DC Power Specifications</b> |                                                                                                            |
| Range                          | 19.2Vdc to 30Vdc                                                                                           |
| Hold-up                        | 10mS at 19.2Vdc                                                                                            |
| Inrush Current                 | 1 Amp maximum at 30Vdc                                                                                     |
| Inrush Time                    | 10mS for 1 Amp                                                                                             |
| Input Current                  | 0.20 Amp typical at 24Vdc                                                                                  |
| Input Power Supply Rating      | 5W                                                                                                         |
| <b>DC Input Specifications</b> |                                                                                                            |
| Rated Input Voltage            | 24 volts DC                                                                                                |
| Input Voltage Range            | 0 to 30 volts DC                                                                                           |
| Input Current at 24Vdc         | I1, I3, I5, I7: 8mA typical; Other inputs: 4.8mA typical                                                   |
| Input Impedance                | I1, I3, I5, I7: 2.7 kΩ; Other inputs: 4.7 kΩ                                                               |
| Input Threshold Voltage        | ON: 18Vdc minimum, OFF: 5Vdc maximum                                                                       |
| Input Threshold Current        | I1, I3, I5, I7: ON 4.5mA maximum, OFF: 1.8mA minimum<br>Other Inputs: ON 3.3mA maximum, OFF: 1.6mA minimum |
| Response Time                  | 1ms to 20ms configurable as regular input; 100μs as HSC input                                              |
| Isolation Voltage              | 1500V RMS field side to logic side, 500V RMS between groups                                                |
| <b>Output Specifications</b>   |                                                                                                            |
| Voltage Range                  | 12Vdc/24Vdc                                                                                                |
| External Power Supply          | 12/24Vdc –10%, +20%                                                                                        |
| Maximum Load Current           | 0.5A per point (Q1 – Q24) at 24Vdc                                                                         |
| Minimum Switching Current      | 10mA                                                                                                       |
| Maximum Inrush Current         | Q1–Q24: 2A for 20ms, 1 pulse                                                                               |

| Item                                                      | Description                                                          |
|-----------------------------------------------------------|----------------------------------------------------------------------|
| Output Voltage Drop                                       | Q1– Q24: 0.3Vdc                                                      |
| OFF state leakage current                                 | 0.1mA                                                                |
| Response Time                                             | OFF to ON, ON to OFF: 1 mS maximum @ 24Vdc                           |
| Isolation Voltage                                         | 1500V RMS between field side and logic side, 500V RMS between groups |
| Fuses                                                     | None                                                                 |
| Under-voltage shutdown                                    | Q1–Q24: 5V minimum, 8V maximum                                       |
| DC short circuit current                                  | Q1–Q24: 0.7A minimum, 2A maximum                                     |
| <b>High-Speed Counter Input and Output Specifications</b> |                                                                      |
| Maximum Counter Frequency                                 | 100kHz                                                               |
| Input Voltage                                             | ON: 18V, OFF: 5V                                                     |
| Count Pulse Width                                         | 20% to 80% of duty cycle at 100kHz                                   |
| Count Registers                                           | 16/32 bits                                                           |
| <b>Outputs</b>                                            |                                                                      |
| Load Voltage                                              | 12/24Vdc                                                             |
| Maximum Pulse/PWM Frequency                               | PWM and PTO: 65kHz                                                   |
| Types available                                           | Up to four HSC, PTO, PTO with Ramping and/or PWM outputs             |

## 8.5.5 Wiring Diagram, IC200UDD164

Figure 54



## 8.6 IC200UDR064

### 64 Point Micro PLC, (40) 24Vdc In, (24) Relay Out, 24Vdc Power Supply

VersaMax Micro PLC IC200UDR064 accepts forty DC inputs and provides twenty-four normally open 2 Amp relay outputs. It uses +24Vdc nominal input power for PLC operation.

#### 8.6.1 DC Inputs

Forty configurable DC inputs can be used as positive or negative logic standard inputs. Eight of these inputs can be used for High-Speed Counter inputs. When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC +24Vdc supply can be used for input devices and to power the DC input circuits at about 8mA per input. The combination of input circuit current and external device current must not exceed 435mA.

#### 8.6.2 Relay Outputs

The twenty-four normally open Form A relay outputs (SPST-single pole single throw) can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices.

The relay outputs can be configured as up to four HSC outputs. Relay outputs cannot be used as Pulse Train or PWM outputs.

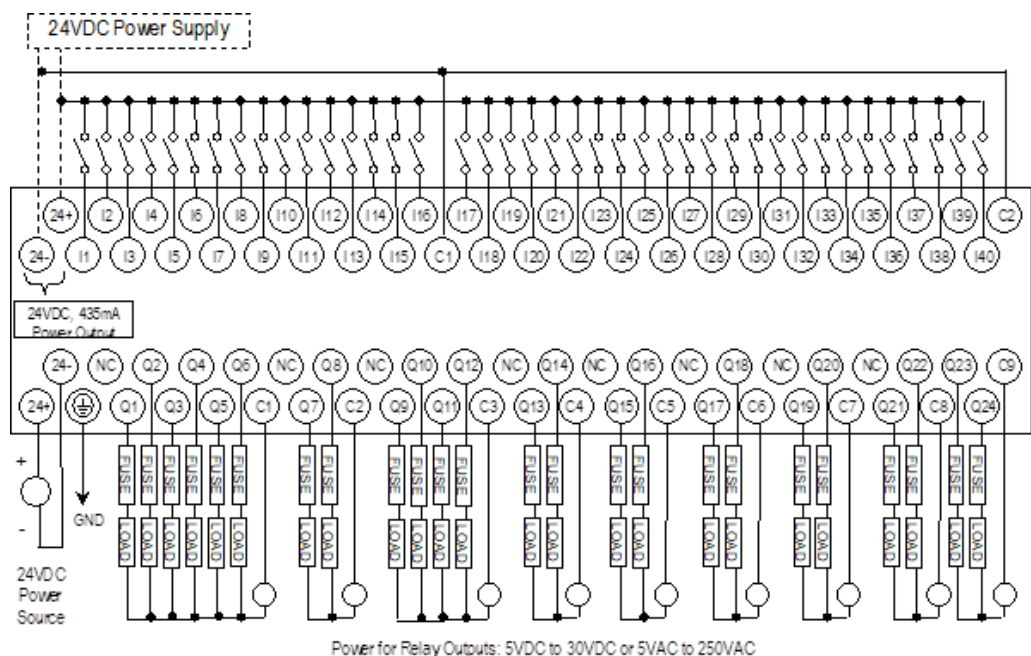
#### 8.6.3 Micro PLC IC200UDR064 Specifications

| Item                           | Description                                                                                         |
|--------------------------------|-----------------------------------------------------------------------------------------------------|
| Weight                         | 580 grams (1.28lbs)                                                                                 |
| Inputs                         | Forty 24Vdc positive/negative logic input circuits                                                  |
| Outputs                        | Twenty-four normally open 2 amp relay circuits                                                      |
| High-Speed Counters            | Up to four Type A or one Type A and one Type B or four Type A_32 or one Type A_32 and one Type B_32 |
| +24Vdc Output Power Supply     | 200mA maximum (for input circuits and user devices)                                                 |
| +5Vdc output of Serial Port    | Serial Port 1, pin 7:100mA maximum                                                                  |
| <b>DC Power Specifications</b> |                                                                                                     |
| Range                          | 19.2Vdc to 30Vdc                                                                                    |
| Hold-up                        | 10mS at 19.2Vdc                                                                                     |
| Inrush Current                 | 1 Amp maximum at 30Vdc                                                                              |

| Item                                                      | Description                                                                                                |                                    |                               |
|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------|------------------------------------|-------------------------------|
| Inrush Time                                               | 10mS for 1 Amp                                                                                             |                                    |                               |
| Input Current                                             | 0.20 Amp typical at 24Vdc                                                                                  |                                    |                               |
| Input Power Supply Rating                                 | 5W                                                                                                         |                                    |                               |
| DC Input Specifications                                   |                                                                                                            |                                    |                               |
| Rated Input Voltage                                       | 24 volts DC                                                                                                |                                    |                               |
| Input Voltage Range                                       | 0 to 30 volts DC                                                                                           |                                    |                               |
| Input Current at 24Vdc                                    | I1, I3, I5, I7: 8mA typical; Other inputs: 4.8mA typical                                                   |                                    |                               |
| Input Impedance                                           | I1, I3, I5, I7: 2.7 kΩ; Other inputs: 4.7 kΩ                                                               |                                    |                               |
| Input Threshold Voltage                                   | ON: 18Vdc minimum, OFF: 5Vdc maximum                                                                       |                                    |                               |
| Input Threshold Current                                   | I1, I3, I5, I7: ON 4.5mA maximum, OFF: 1.8mA minimum<br>Other Inputs: ON 3.3mA maximum, OFF: 1.6mA minimum |                                    |                               |
| Response Time                                             | 1ms to 20ms configurable as regular input; 100μs as HSC input                                              |                                    |                               |
| Isolation Voltage                                         | 1500V RMS field side to logic side, 500V RMS between groups                                                |                                    |                               |
| Relay Output Specifications                               |                                                                                                            |                                    |                               |
| Operating Voltage                                         | 5 to 30Vdc or 5 to 250Vac                                                                                  |                                    |                               |
| Isolation                                                 | 1500 V RMS between field side and logic side, 500 V RMS between groups                                     |                                    |                               |
| Leakage Current                                           | 15 mA at 240Vac maximum                                                                                    |                                    |                               |
| Maximum UL Pilot Duty Rating                              | 2 amps at 24Vdc and 240Vac                                                                                 |                                    |                               |
| Maximum Resistive Load Rating                             | 2 amps at 24Vdc and 240Vac                                                                                 |                                    |                               |
| Minimum Load                                              | 10 mA                                                                                                      |                                    |                               |
| Maximum Inrush                                            | 5 amps per half cycle                                                                                      |                                    |                               |
| Response Time                                             | ON: 15 ms maximum, OFF: 15 ms maximum                                                                      |                                    |                               |
| Contact Life: Mechanical                                  | 20 x 10 <sup>6</sup> mechanical operations                                                                 |                                    |                               |
| Contact Life: Electrical Voltage<br>240Vac, 120Vac, 24Vdc | Current: Resistive<br>2.0A                                                                                 | Current: Lamp and Solenoid<br>0.6A | Typical Operations<br>200,000 |
| High-Speed Counter Input and Output Specifications        |                                                                                                            |                                    |                               |
| Maximum Counter Frequency                                 | 100kHz                                                                                                     |                                    |                               |
| Input Voltage                                             | ON: 18V, OFF: 5V                                                                                           |                                    |                               |
| Count Pulse Width                                         | 20% to 80% of duty cycle at 100kHz                                                                         |                                    |                               |
| Count Registers                                           | 16/32 bits                                                                                                 |                                    |                               |
| Outputs                                                   |                                                                                                            |                                    |                               |
| Load Voltage                                              | Q1: 5/12/24V, Q2-Q4: See relay output specifications                                                       |                                    |                               |
| Type available                                            | Up to four HSC outputs. Pulse outputs are not available.                                                   |                                    |                               |

## 8.6.4 Wiring Diagram, PLC IC200UDR064

Figure 55



## 8.7 IC200UDR164

### 64 Point Micro PLC, (40) 24Vdc In, (24) Relay Out, 120/240Vac Power Supply

VersaMax Micro PLC IC200UDR164 accepts forty DC inputs and provides twenty-four normally open 2 Amp relay outputs. It uses 100Vac to 240Vac nominal input power for PLC operation.

### 8.7.1 DC Inputs

Forty configurable DC inputs can be used as positive or negative logic standard inputs. Eight of these inputs can be used for High-Speed Counter inputs. When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC +24Vdc supply can be used for input devices and to power the DC input circuits at about 8mA per input. The combination of input circuit current and external device current must not exceed 435mA.

### 8.7.2 Relay Outputs

The twenty-four normally open Form A relay outputs (SPST-single pole single throw) can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices.



The relay outputs can be configured as up to four HSC outputs. Relay outputs cannot be used as Pulse Train or PWM outputs.

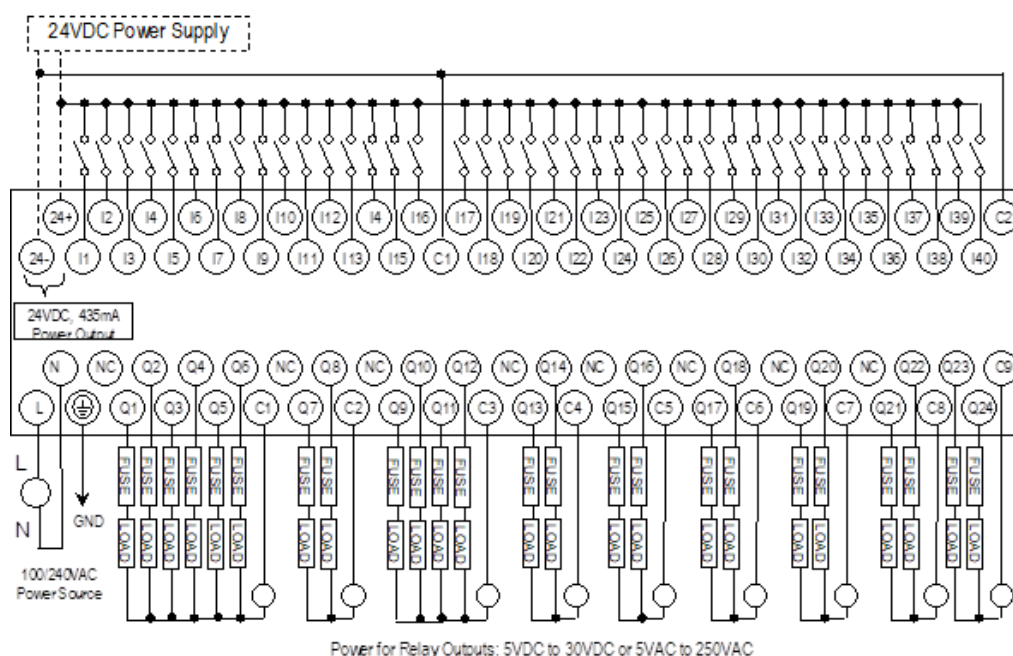
### 8.7.3 Micro PLC IC200 UDR164, Specifications

| Item                               | Description                                                                                                |
|------------------------------------|------------------------------------------------------------------------------------------------------------|
| Weight                             | 580 grams (1.28lbs)                                                                                        |
| Inputs                             | Forty 24Vdc positive/negative logic input circuits                                                         |
| Outputs                            | Twenty-four normally open 2-amp relay circuits                                                             |
| High-Speed Counters                | Up to four Type A or one Type A and one Type B or four Type A_32 or one Type A_32 and one Type B_32        |
| +24Vdc Output Power Supply         | 435mA maximum (for input circuits and user devices)                                                        |
| +5Vdc output of Serial Port        | Serial Port 1, pin 7:100mA maximum                                                                         |
| <b>AC Power Specifications</b>     |                                                                                                            |
| Range                              | 100 -15% to 240 +10%Vac                                                                                    |
| Frequency                          | 50 -5% to 60 +5% Hz                                                                                        |
| Hold-up                            | 10mS at 85 to 100Vac, 20mS at 100 to 265Vac                                                                |
| Inrush Current                     | 30 Amp maximum at 200Vac, 40 Amp maximum at 265Vac                                                         |
| Inrush Time                        | 2 ms for 40Amp                                                                                             |
| Input Current                      | 0.20 Amp typical at 200Vac 0.10 Amp typical at 100Vac                                                      |
| Input Power Supply Rating          | 26 VA                                                                                                      |
| <b>DC Input Specifications</b>     |                                                                                                            |
| Rated Input Voltage                | 24 volts DC                                                                                                |
| Input Voltage Range                | 0 to 30 volts DC                                                                                           |
| Input Current at 24Vdc             | I1, I3, I5, I7: 8mA typical; Other inputs: 4.8mA typical                                                   |
| Input Impedance                    | I1, I3, I5, I7: 2.7 kΩ; Other inputs: 4.7 kΩ                                                               |
| Input Threshold Voltage            | ON: 18Vdc minimum, OFF: 5Vdc maximum                                                                       |
| Input Threshold Current            | I1, I3, I5, I7: ON 4.5mA maximum, OFF: 1.8mA minimum<br>Other Inputs: ON 3.3mA maximum, OFF: 1.6mA minimum |
| Response Time                      | 1ms to 20ms configurable as regular input; 100μs as HSC input                                              |
| Isolation Voltage                  | 1500V RMS field side to logic side, 500V RMS between groups                                                |
| <b>Relay Output Specifications</b> |                                                                                                            |
| Operating Voltage                  | 5 to 30Vdc or 5 to 250Vac                                                                                  |
| Isolation                          | 1500 V RMS between field side and logic side, 500 V RMS between groups                                     |
| Leakage Current                    | 15 mA at 240Vac maximum                                                                                    |
| Maximum UL Pilot Duty Rating       | 2 amps at 24Vdc and 240Vac                                                                                 |

| Item                                                         | Description                                              |                                    |                               |
|--------------------------------------------------------------|----------------------------------------------------------|------------------------------------|-------------------------------|
| Maximum Resistive Load Rating                                | 2 amps at 24Vdc and 240Vac                               |                                    |                               |
| Minimum Load                                                 | 10 mA                                                    |                                    |                               |
| Maximum Inrush                                               | 5 amps per half cycle                                    |                                    |                               |
| Response Time                                                | ON: 15 ms maximum, OFF: 15 ms maximum                    |                                    |                               |
| Contact Life: Mechanical                                     | 20 x 10 <sup>6</sup> mechanical operations               |                                    |                               |
| Contact Life: Electrical<br>Voltage<br>240Vac, 120Vac, 24Vdc | Current: Resistive<br>2.0A                               | Current: Lamp and Solenoid<br>0.6A | Typical Operations<br>200,000 |
| High-Speed Counter Input and Output Specifications           |                                                          |                                    |                               |
| Maximum Counter Frequency                                    | 100kHz                                                   |                                    |                               |
| Input Voltage                                                | ON: 18V, OFF: 5V                                         |                                    |                               |
| Count Pulse Width                                            | 20% to 80% of duty cycle at 100kHz                       |                                    |                               |
| Count Registers                                              | 16/32 bits                                               |                                    |                               |
| Outputs                                                      |                                                          |                                    |                               |
| Load Voltage                                                 | Q1: 5/12/24V, Q2-Q4: See relay output specifications     |                                    |                               |
| Type available                                               | Up to four HSC outputs. Pulse outputs are not available. |                                    |                               |

## 8.7.4 Wiring Diagram, IC200UDR164

Figure 56



## Chapter 9: VersaMax Micro PLC 8-, 14-, and 16-Point Expansion Units

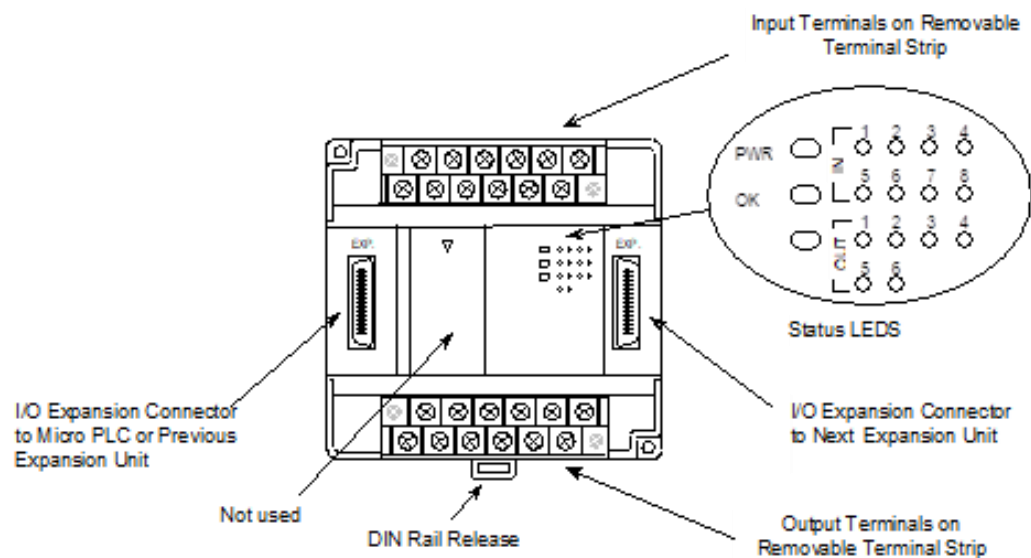
This chapter consists of module datasheets for the following VersaMax Micro PLC Expansion Units:

|                    |                                                                                                      |
|--------------------|------------------------------------------------------------------------------------------------------|
| <b>IC200UEC008</b> | 8 Points, (4) 24Vdc In, (4) 24Vdc Out with ESCP, 24Vdc Power Supply                                  |
| <b>IC200UEC108</b> | 8 Points, (4) 24Vdc In, (4) 24Vdc Transistor Out, 24Vdc Power Supply                                 |
| <b>IC200UEC208</b> | 8 Points, (4) 24Vdc In (4) Relay Out 24Vdc Power Supply                                              |
| <b>IC200UEI008</b> | 8 Points, (8) 24Vdc In, 24Vdc Power Supply                                                           |
| <b>IC200UEI016</b> | 16 Points, (16) 24Vdc In, 24Vdc Power Supply                                                         |
| <b>IC200UEO008</b> | 8 Points, (8) 24Vdc Output with ESCP, 24Vdc Power Supply                                             |
| <b>IC200UEO108</b> | 8 Points, (8) 24Vdc Transistor Out, 24Vdc Power Supply                                               |
| <b>IC200UEO016</b> | 16 Points, (16) 24Vdc Output with ESCP, 24Vdc Power Supply                                           |
| <b>IC200UEO116</b> | 16 Points, (16) 24Vdc Transistor Out, 24Vdc Power Supply                                             |
| <b>IC200UER008</b> | 8 Points, (8) Relay Outputs, 24Vdc Power Supply                                                      |
| <b>IC200UER016</b> | 16 Points, Relay Outputs, 24Vdc Power Supply                                                         |
| <b>IC200UEX009</b> | 14 Points, (8) 120Vac In, (2) Relay Out at 10 Amps, (4) Relay Out at 2 Amps, 120/240Vac Power Supply |
| <b>IC200UEX010</b> | 14 Points, (8) 120Vac In, (6) 120Vac Out, 120/240Vac Power Supply                                    |
| <b>IC200UEX011</b> | 14 Points, (8) 24Vdc In, (6) Relay Out, 120/240Vac Power Supply                                      |
| <b>IC200UEX012</b> | 14 Points, (8) 24Vdc In, (6) Relay Out, 24Vdc Power Supply                                           |
| <b>IC200UEX013</b> | 14 Points, (8) 12Vdc In, (6) Relay Out, 12Vdc Power Supply                                           |
| <b>IC200UEX014</b> | 14 Points, (8) 24Vdc In, (6) 24Vdc Out, 24Vdc Power Supply                                           |
| <b>IC200UEX015</b> | 14 Points, (8) 12Vdc In, (6) 12Vdc Out, 12Vdc Power Supply                                           |
| <b>IC200UEX122</b> | 14 Points, (8) 24Vdc In, (6) 24Vdc Out with ESCP, 24Vdc Power Supply                                 |

## 9.1 Features of VersaMax 8-, 14-, and 16-Point Expansion Units

Modular Expansion Units can be used to increase the total I/O count of a Micro PLC. Up to 4 Expansion Units in any combination can be used with any 14-point to 64-point Micro PLC. Expansion Units can be located up to 2 meters from the Micro PLC.

Figure 57



### 9.1.1 Removable Terminal Strips

VersaMax Expansion Units provide the wiring flexibility of removable terminal assemblies. After turning off power to the Micro PLC, a terminal assembly and attached field wiring can be separated from the Micro PLC by loosening two screws.

### 9.1.2 Expansion Connector

The connector on the left side of the Expansion Unit is used to connect to the Micro PLC or to the outgoing connector on the previous Expansion Unit. The connector on the right side of the Expansion Unit can be used to attach to the next Expansion Unit.

### 9.1.3 Status LEDs

LEDs on the Expansion Unit provide quick visual verification of operating status. In addition to LEDs for Expansion Unit local Power and OK mode, there is an LED for each I/O point.

### 9.1.4 Cables

A 0.1-meter ribbon cable (IC200CBL501) is provided with each Expansion Unit. Cables are also available in 0.5-meter (IC200CBL505) and 1 meter (IC200CBL510) lengths.

## 9.2 IC200UEC008

### 8 Point Expansion Unit, (4) 24Vdc Inputs, (4) 24Vdc Outputs with ESCP, 24Vdc Power Supply

VersaMax Micro PLC Expansion Unit IC200UEC008 accepts four 24Vdc inputs and provides four 24Vdc source-type transistor outputs with Electronic Short Circuit Protection. The module requires +24Vdc nominal input power.

#### 9.2.1 DC Inputs

The four 24 volt DC input circuits can have positive or negative logic characteristics. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The built-in +24Vdc supply can be used for input devices and to power the DC input circuits. The combination of input circuit current and external device current must not exceed 200 mA.

#### 9.2.2 Transistor Outputs

Expansion Unit IC200UEC008 has four source-type high-current transistor outputs. All outputs are isolated between field and logic and are switching positive voltage.

All outputs have electronic short-circuit protection; no fuses are needed to protect the outputs.

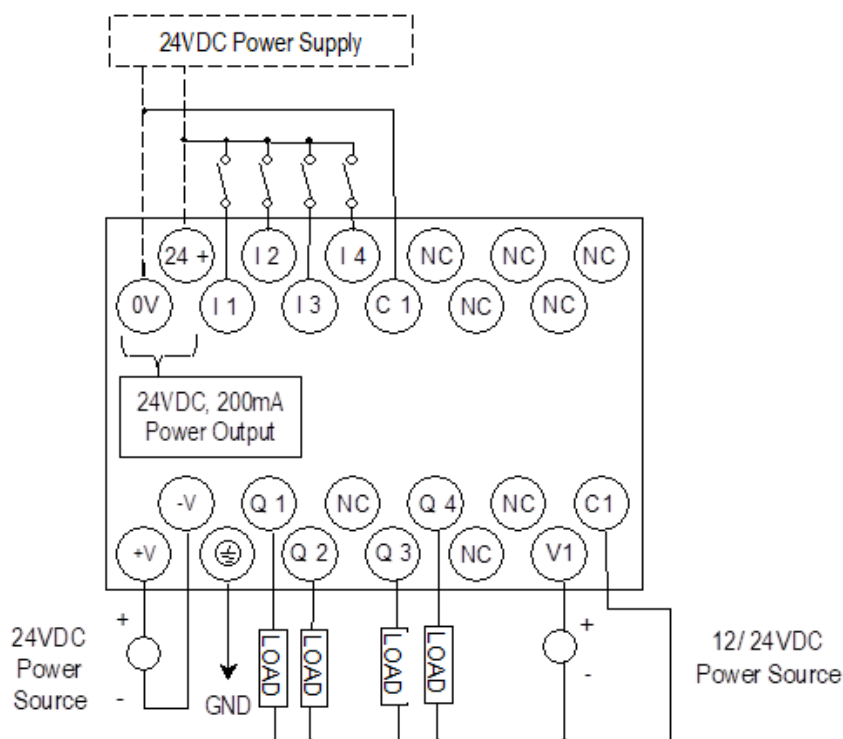
An external source of 12/24Vdc power must be provided to power the outputs. The outputs share this common incoming 24Vdc supply and one common ground. The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

## 9.2.3 Expansion Unit IC200UEC008 Specifications

| Item                            | Description                                                                  |
|---------------------------------|------------------------------------------------------------------------------|
| Inputs                          | Four 24Vdc input circuits                                                    |
| Outputs                         | Four 24Vdc source-type transistor outputs with ESCP                          |
| +24Vdc Output Power Supply      | 200mA maximum(for input circuits and user devices)                           |
| <b>DC Power Specifications</b>  |                                                                              |
| Range                           | 24 –20%/+25%Vdc                                                              |
| Hold-up                         | 3ms                                                                          |
| Inrush Current                  | 1 A maximum at 30Vdc                                                         |
| Inrush Time                     | 10 ms for 1 Amp                                                              |
| Input Current                   | 0.16 A typical at 24Vdc                                                      |
| Input Power Supply Rating       | 4W                                                                           |
| <b>DC Input Specifications</b>  |                                                                              |
| Rated Input Voltage             | 24 volts DC                                                                  |
| Input Voltage Range             | 0 to 30 volts DC                                                             |
| Input Current                   | 7.5mA typical                                                                |
| Input Resistance                | 2.8 kΩ                                                                       |
| Input Threshold Voltage         | ON: 15Vdc minimum, OFF: 5Vdc maximum                                         |
| Input Threshold Current         | ON: 4.5mA maximum, OFF: 1.5mA minimum                                        |
| Response Time                   | OFF to ON or ON to OFF: 4ms typical                                          |
| Isolation Voltage               | 1500V RMS field side to logic side, 500V RMS between groups                  |
| <b>DC Output Specifications</b> |                                                                              |
| Voltage Range                   | 12/24Vdc +10%/-15% (at VC)                                                   |
| Maximum Load Current            | 0.7A per point, 3A per common                                                |
| Maximum Inrush Current          |                                                                              |
| Output Voltage Drop             | 0.3V                                                                         |
| OFF state Leakage Current       | 0.1mA                                                                        |
| Response Time                   | OFF to ON or ON to OFF: 0.05ms maximum at 24Vdc 0.2A                         |
| Isolation Voltage               | 1500V RMS field side to logic side, 500Vac between field side and logic side |
| External power supply           | 12/24Vdc –10%, +20%                                                          |
| Fuse                            | Not required                                                                 |
| Minimum switching current       | 10mA                                                                         |

## 9.2.4 Wiring Diagram, IC200UEC008

Figure 58



## 9.3 IC200UEC108

### 8 Point Expansion Unit, (4) 24Vdc Inputs, (4) 24Vdc Transistor Outputs, 24Vdc Power Supply

VersaMax Micro PLC Expansion Unit IC200UEC108 accepts four 24Vdc inputs and provides four 24Vdc sink-type transistor outputs. It requires +24Vdc nominal input power.

### 9.3.1 DC Inputs

The four 24-volt DC input circuits can have positive or negative logic characteristics. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The built-in +24Vdc supply can be used for input devices and to power the DC input circuits. The combination of input circuit current and external device current must not exceed 200 mA.

## 9.3.2 Transistor Outputs

Expansion Unit IC200UEC108 has four sink-type high-current transistor outputs. All outputs are isolated between field and logic and are switching positive voltage.

External fusing should be provided to protect the outputs. Otherwise, a load short can damage the module output transistor, which is not user replaceable. Fast fuses are recommended.

The outputs share one common incoming 24Vdc supply and one common ground. The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

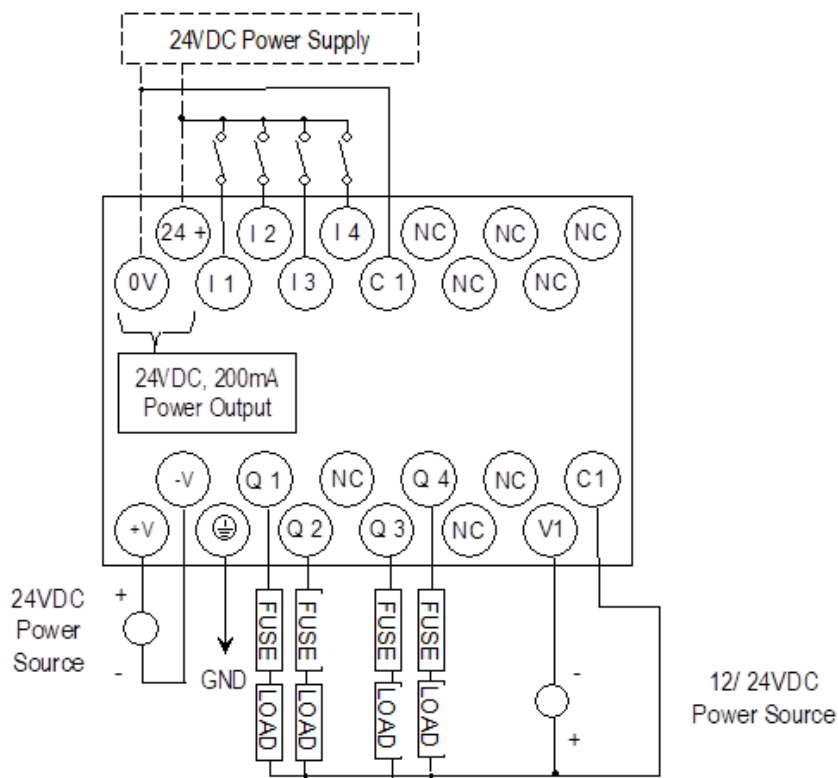
## 9.3.3 Expansion Unit IC200UEC108 Specifications

| Item                                    | Description                                                 |
|-----------------------------------------|-------------------------------------------------------------|
| Inputs                                  | Four 24Vdc input circuits                                   |
| Outputs                                 | Four 24Vdc sink-type transistor outputs                     |
| +24Vdc Output Power Supply              | 200mA maximum (for input circuits and user devices)         |
| <b>DC Power Specifications</b>          |                                                             |
| Range                                   | 24 -20%/+25%Vdc                                             |
| Hold-up                                 | 10ms at 19.2Vdc                                             |
| Inrush Current                          | 1 A maximum at 30Vdc                                        |
| Inrush Time                             | 10 ms for 1 Amp                                             |
| Input Current                           | 0.16 A typical at 24Vdc                                     |
| Input Power Supply Rating               | 4W                                                          |
| <b>DC Input Specifications</b>          |                                                             |
| Rated Input Voltage                     | 24 volts DC                                                 |
| Input Voltage Range                     | 0 to 30 volts DC                                            |
| Input Current                           | 7.5mA typical                                               |
| Input Resistance                        | 2.8 k $\Omega$                                              |
| Input Threshold Voltage                 | ON: 15Vdc minimum, OFF: 5Vdc maximum                        |
| Input Threshold Current                 | ON: 4.5mA maximum, OFF: 1.5mA minimum                       |
| Response Time                           | OFF to ON or ON to OFF: 4ms typical                         |
| Isolation Voltage                       | 1500V RMS field side to logic side, 500V RMS between groups |
| <b>Transistor Output Specifications</b> |                                                             |
| Voltage Range                           | 12/24Vdc +10%/-15% (at VC)                                  |
| Maximum Load                            | 0.7A per point, 3A per common                               |
| Maximum Inrush Current                  |                                                             |
| Output Voltage Drop                     | 0.3V                                                        |
| OFF state leakage                       | 0.1mA                                                       |
| Response                                | OFF to ON or ON to OFF: 0.05ms maximum at 24Vdc 0.2A        |



| Item                      | Description                                                                  |
|---------------------------|------------------------------------------------------------------------------|
| Isolation Voltage         | 1500V RMS field side to logic side, 500Vac between field side and logic side |
| External power supply     | 12/24Vdc –10%, +20%                                                          |
| Fuses                     | Not required                                                                 |
| Minimum Switching Current | 10mA                                                                         |

Figure 59



## 9.4 IC200UEC208

### 8 Point Expansion Unit, (4) 24Vdc Inputs, (4) Relay Outputs, 24Vdc Power Supply

VersaMax Micro PLC Expansion Unit IC200UEC208 accepts four 24Vdc inputs and provides four normally open 2 Amp relay outputs that can control 5 to 30Vdc or 5 to 250Vac output devices. It requires +24Vdc nominal input power.

#### 9.4.1 DC Inputs

The four DC inputs can be used as positive or negative logic standard inputs. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Expansion Unit's +24Vdc supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

## 9.4.2 Relay Outputs

Four Form A (SPST: single-pole, single-throw) normally open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. An external source of AC or DC power must be supplied to operate field devices.

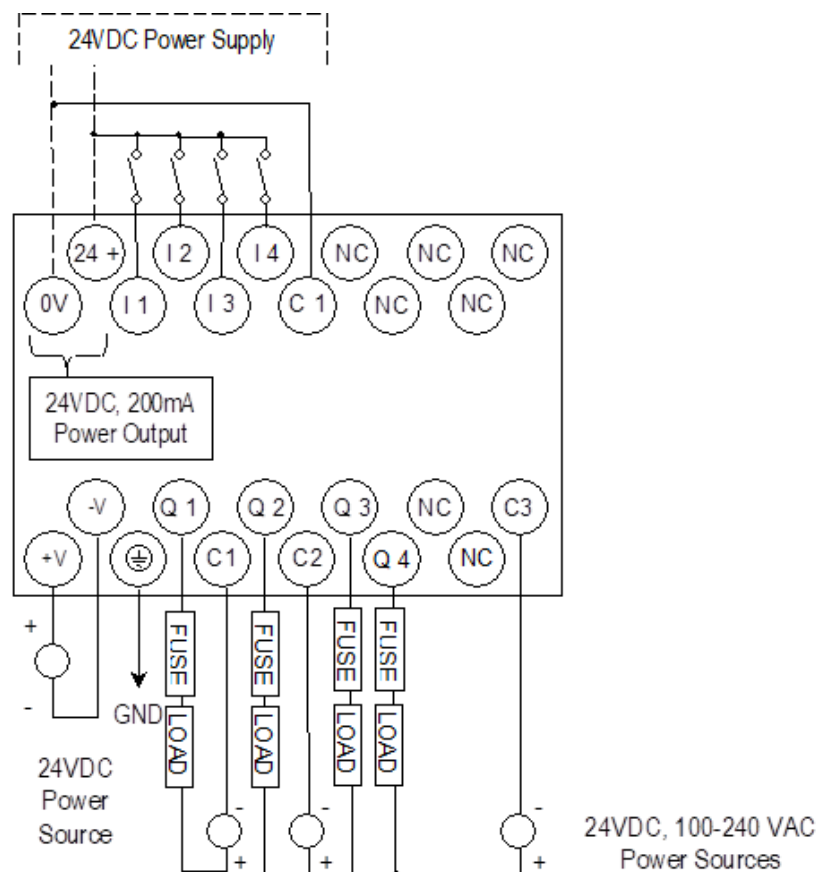
## 9.4.3 Expansion Unit IC200UEC208 Specifications

| Item                               | Description                                                              |
|------------------------------------|--------------------------------------------------------------------------|
| Inputs                             | Four 24Vdc positive/negative logic input circuits                        |
| Outputs                            | Four normally open 2 amp relay circuits                                  |
| +24Vdc Output Power Supply         | 200mA maximum (for input circuits and user devices)                      |
| <b>DC Power Specifications</b>     |                                                                          |
| Range                              | 24Vdc -20% / +25%                                                        |
| Hold-up                            | 10 ms at 19.2Vdc                                                         |
| Inrush Current                     | 1 Amp maximum at 30Vdc                                                   |
| Inrush Time                        | 10 ms for 1 Amp                                                          |
| Input Current                      | 0.16 Amp typical at 24Vdc                                                |
| Input Power Supply Rating          | 4W                                                                       |
| <b>DC Input Specifications</b>     |                                                                          |
| Rated Input Voltage                | 24 volts DC                                                              |
| Input Voltage Range                | 0 to 30 volts DC                                                         |
| Input Current                      | 7.5mA typical                                                            |
| Input Resistance                   | 2.8 kΩ                                                                   |
| Input Threshold Voltage            | ON: 15Vdc minimum, OFF: 5Vdc maximum                                     |
| Input Threshold Current            | ON: 4.5mA maximum, OFF: 1.5mA minimum                                    |
| Response Time                      | OFF to ON or ON to OFF: 4ms typical                                      |
| Isolation Voltage                  | 1500V RMS field side to logic side, 500V RMS between groups              |
| <b>Relay Output Specifications</b> |                                                                          |
| Operating Voltage                  | 5 to 30Vdc or 5 to 250Vac                                                |
| Isolation                          | 1500 V RMS between field side and logic side<br>500 V RMS between groups |
| Leakage Current                    | 15 mA maximum                                                            |
| Maximum Load Current               | 2 Amps per point, 5 Amps per common                                      |
| Maximum Resistive Load Rating      | 2 amps at 24Vdc and 240Vac                                               |
| Response Time                      | ON to OFF, or OFF to ON: 15 ms maximum                                   |
| Contact Life: Mechanical           | 20 x 10 <sup>6</sup> mechanical operations                               |

| Item                                                    | Description           |                                 |                            |
|---------------------------------------------------------|-----------------------|---------------------------------|----------------------------|
| Contact Life: Electrical Voltage, 240Vac, 120Vac, 24Vdc | Current: Resistive 2A | Current: Lamp and Solenoid 0.6A | Typical Operations 200,000 |

## 9.4.4 Wiring Diagram, IC200UEC208

Figure 60



## 9.5 IC200UEI008 8 Point Expansion Unit, (8) 24Vdc Inputs, 24Vdc Power Supply

## IC200UEI016 16 Point Expansion Unit, (16) 24Vdc Inputs, 24Vdc Power Supply

VersaMax Micro PLC Expansion Units IC200UEI008 and IC200UEI016 accept 24Vdc inputs. The modules require +24Vdc nominal input power.

### 9.5.1 DC Inputs

The DC inputs can be used as positive or negative logic standard inputs. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Expansion Unit's +24Vdc supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

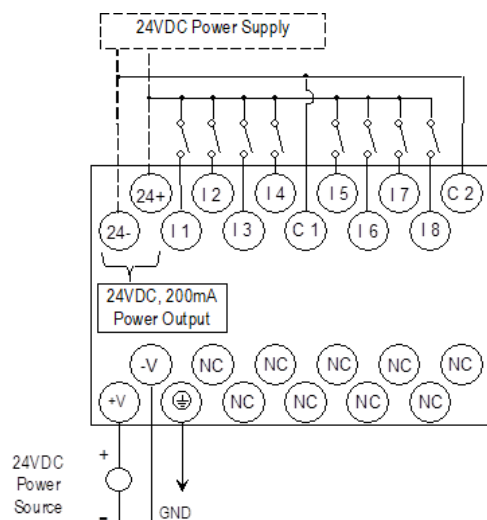
### 9.5.2 Expansion Units IC200UEI008 and IC200UEI016 Specifications

| Item                           | Description                                                                                                                         |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| Inputs                         | IC200UEI008: Eight 24Vdc positive/negative logic input circuit<br>IC200UEI016: Sixteen 24Vdc positive/negative logic input circuits |
| Outputs                        | None                                                                                                                                |
| +24Vdc Output Power Supply     | 200mA maximum (for input circuits and user devices)                                                                                 |
| <b>DC Power Specifications</b> |                                                                                                                                     |
| Range                          | 24Vdc -20% / +25%                                                                                                                   |
| Hold-up                        | 10 ms at 19.2Vdc                                                                                                                    |
| Inrush Current                 | 1 Amp maximum at 30Vdc                                                                                                              |
| Inrush Time                    | 10 ms for 1 Amp                                                                                                                     |
| Input Current                  | 0.16 Amp typical at 24Vdc                                                                                                           |
| Input Power Supply Rating      | 4W                                                                                                                                  |
| <b>DC Input Specifications</b> |                                                                                                                                     |
| Rated Input Voltage            | 24 volts DC                                                                                                                         |
| Input Voltage Range            | 0 to 30 volts DC                                                                                                                    |
| Input Current                  | 4.8mA typical                                                                                                                       |
| Input Resistance               | 4.8 kΩ                                                                                                                              |

| Item                    | Description                                                 |
|-------------------------|-------------------------------------------------------------|
| Input Threshold Voltage | ON: 15Vdc minimum, OFF: 5Vdc maximum                        |
| Input Threshold Current | ON: 3.0mA maximum, OFF: 1.5mA minimum                       |
| Response Time           | ON to OFF or OFF to ON: 2ms typical                         |
| Isolation Voltage       | 1500V RMS field side to logic side, 500V RMS between groups |

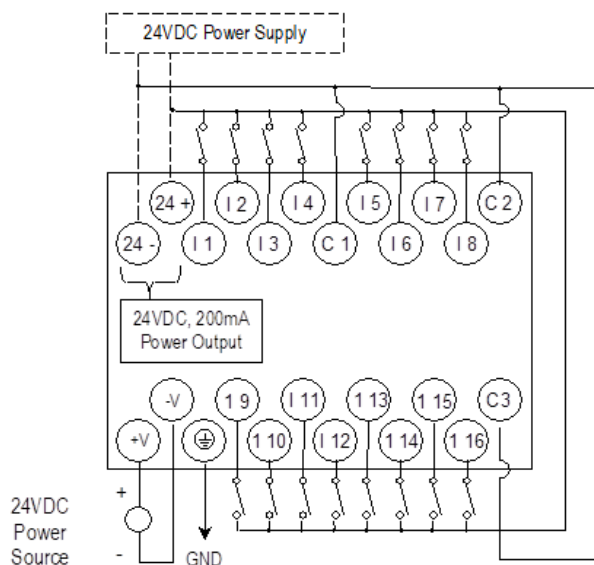
## 9.5.3 Wiring Diagram, IC200UEI008

Figure 61



## 9.5.4 Wiring Diagram, IC200UEI016

Figure 62



## 9.6 IC200UEO008 8 Point Expansion Unit, (8) 24Vdc Outputs with ESCP, 24Vdc Power Supply

### IC200UEO016 16 Point Expansion Unit, (16) 24Vdc Outputs with ESCP, 24Vdc Power Supply

VersaMax Micro PLC Expansion Units IC200UEO008 and IC200UEO016 provide 8 or 16 DC source-type high-current transistor outputs, respectively. Outputs have Electronic Short Circuit Protection. The modules require +24Vdc nominal input power.

#### 9.6.1 Transistor Outputs

All outputs are isolated between field and logic and are switching positive voltage. Outputs have electronic short-circuit protection; no fuses are needed to protect the outputs.

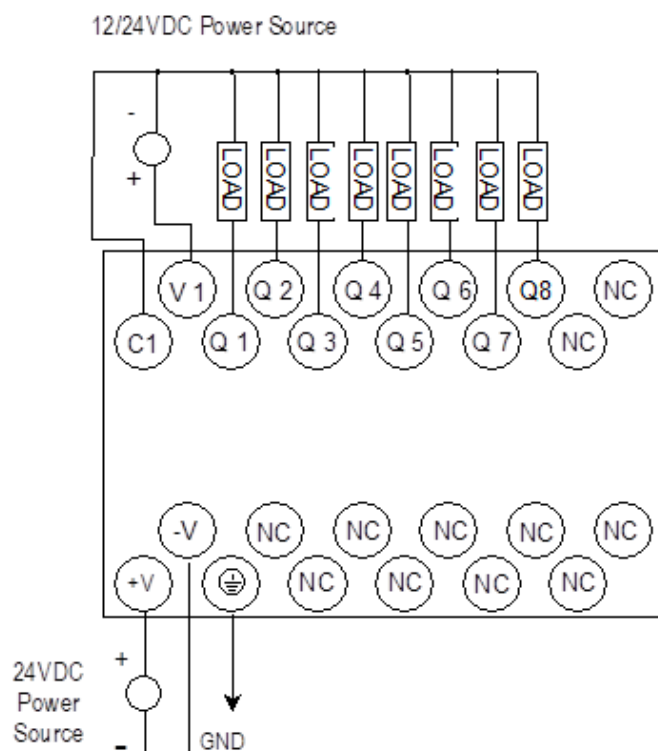
An external source of 12/24Vdc power must be provided to power the outputs. The outputs share one common incoming 24Vdc supply and one common ground. The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

## 9.6.2 Expansion Units IC200UEO008 and IC200UEO016 Specifications

| Item                                    | Description                                                                                                                                              |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Inputs                                  | None                                                                                                                                                     |
| Outputs                                 | IC200UEO008: Eight source-type 24Vdc transistor output circuits with ESCP<br>IC200UEO016: Sixteen source-type 24Vdc transistor output circuits with ESCP |
| <b>DC Power Specifications</b>          |                                                                                                                                                          |
| Range                                   | 24 –20%/+25%Vdc                                                                                                                                          |
| Hold-up                                 | 10ms at 19.2Vdc                                                                                                                                          |
| Inrush Current                          | 1 A maximum at 30Vdc                                                                                                                                     |
| Inrush Time                             | 10 ms for 1 Amp                                                                                                                                          |
| Input Current                           | 0.16 A typical at 24Vdc                                                                                                                                  |
| Input Power Supply Rating               | 4W                                                                                                                                                       |
| <b>Transistor Output Specifications</b> |                                                                                                                                                          |
| Voltage Range                           | 12/24Vdc +10%/-15% (at VC)                                                                                                                               |
| Maximum Load                            | 0.7A per point , 3A per common                                                                                                                           |
| Maximum Inrush Current                  | 5.6 Amps                                                                                                                                                 |
| Output Voltage Drop                     | 0.3V maximum                                                                                                                                             |
| OFF state leakage                       | 0.1mA                                                                                                                                                    |
| Response                                | OFF to ON or ON to OFF: 0.05ms maximum at 24Vdc 0.2A                                                                                                     |
| Isolation Voltage                       | 1500V RMS field side to logic side, 500Vac between field side and logic side                                                                             |
| External power supply                   | 12/24Vdc –10%, +20%                                                                                                                                      |
| Fuses                                   | Not required                                                                                                                                             |
| Minimum switching current               | 10mA                                                                                                                                                     |

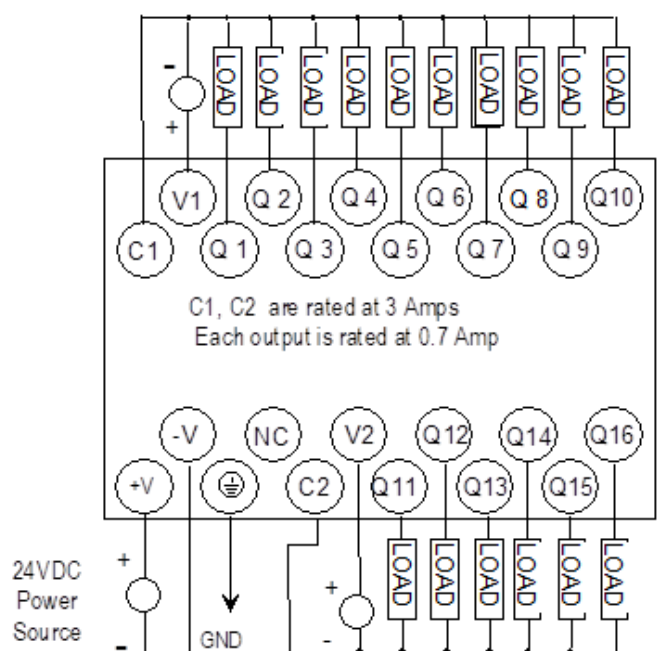
## 9.6.3 Wiring Diagram, IC200UEO008

Figure 63



## 9.6.4 Wiring Diagram, IC200UEO016

Figure 64





## 9.7 IC200UEO108 8 Point Expansion Unit, (8) 24Vdc Transistor Outputs, 24Vdc Power Supply

## IC200UEO116 16 Point Expansion Unit, (16) Transistor Outputs, 24Vdc Power Supply

VersaMax Micro PLC Expansion Units IC200UEO108 and IC200UEO116 provide 8 and 16 DC sink-type outputs, respectively. These modules require +24Vdc nominal input power.

### 9.7.1 Transistor Outputs

The sink-type transistor outputs are isolated between field and logic and are switching positive voltage.

External fusing should be provided to protect the outputs. Otherwise, a load short can damage the module output transistor, which is not user replaceable. Fast fuses are recommended.

The outputs share one common incoming 24Vdc supply and one common ground. The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

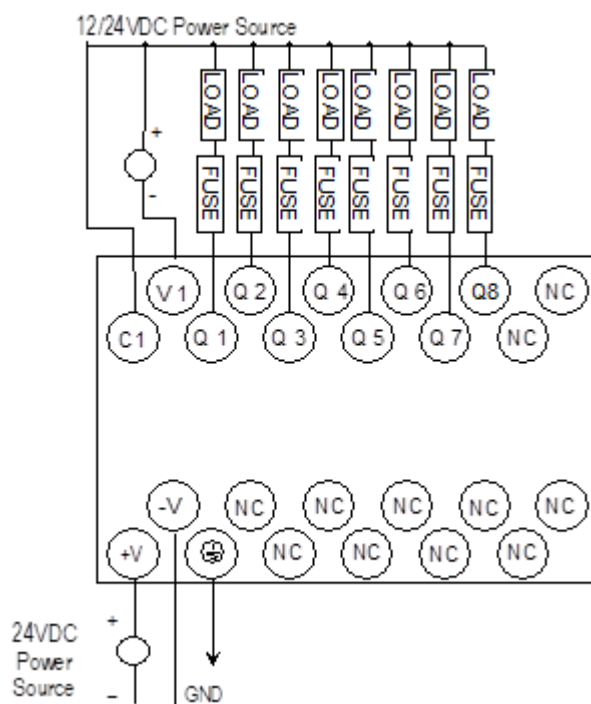
### 9.7.2 Expansion Units IC200UEO108 and IC200UEO116 Specifications

| Item                                    | Description                                                                                                                |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| Inputs                                  | None                                                                                                                       |
| Outputs                                 | IC200UEO108: Eight sink-type DC transistor output circuits<br>IC200UEO116: Sixteen sink-type DC transistor output circuits |
| <b>DC Power Specifications</b>          |                                                                                                                            |
| Range                                   | 24 –20%/+25%Vdc                                                                                                            |
| Hold-up                                 | 10ms at 19.2Vdc                                                                                                            |
| Inrush Current                          | 1 A maximum at 30Vdc                                                                                                       |
| Inrush Time                             | 10 ms for 1 Amp                                                                                                            |
| Input Current                           | 0.16 A typical at 24Vdc                                                                                                    |
| Input Power Supply Rating               | 4W                                                                                                                         |
| <b>Transistor Output Specifications</b> |                                                                                                                            |
| Voltage Range                           | 12/24Vdc +10%/-15% (at VC)                                                                                                 |
| Maximum Load                            | 0.5A per point, 3A per common                                                                                              |

| Item                      | Description                                                                  |
|---------------------------|------------------------------------------------------------------------------|
| Maximum Inrush Current    | 5.6 Amps                                                                     |
| Output Voltage Drop       | 0.3V maximum                                                                 |
| OFF state leakage         | 0.1mA maximum                                                                |
| Response                  | OFF to ON or ON to OFF: 0.5ms                                                |
| Isolation Voltage         | 1500V RMS field side to logic side, 500Vac between field side and logic side |
| External power supply     | 10-30Vdc required to power the outputs.                                      |
| Fuses                     | Outputs should be fused externally.                                          |
| Minimum Switching Current | 1mA                                                                          |

### 9.7.3 Wiring Diagram, IC200UEO108

Figure 65



### Figure 66



## 9.8 IC200UER008 8 Point Expansion Unit, (8) Relay Outputs, 24Vdc Power Supply

## IC200UER016 16 Point Expansion Unit, (16) Relay Outputs, 24Vdc Power Supply

VersaMax Micro PLC Expansion Units IC200UER008 and IC200UER016 provide 8 or 16 normally-open 2 Amp relay outputs, respectively. The outputs can control 5 to 30Vdc or 5 to 250Vac output devices. The unit requires +24Vdc nominal input power.

### 9.8.1 Relay Outputs

The Form A (SPST: single-pole, single-throw) normally-open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. An external source of AC or DC power must be supplied to operate field devices.

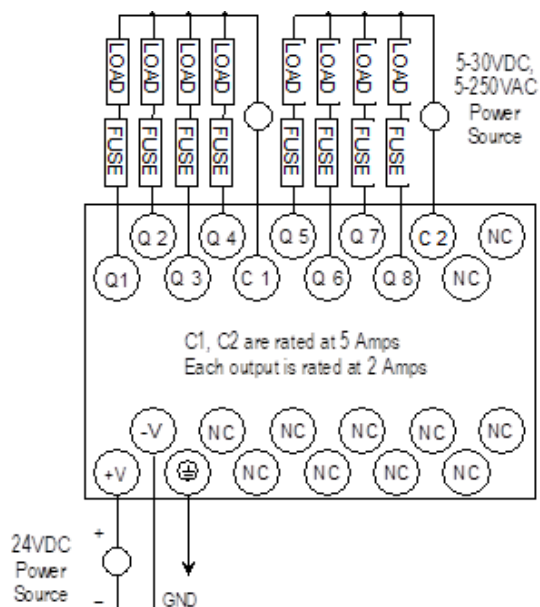
### 9.8.2 Expansion Units IC200UER008 and IC200UER016 Specifications

| Item                               | Description                                                                                                      |
|------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Inputs                             | None                                                                                                             |
| Outputs                            | IC200UER008: Eight normally open 2 amp relay circuits<br>IC200UER016: Sixteen normally open 2 amp relay circuits |
| <b>DC Power Specifications</b>     |                                                                                                                  |
| Range                              | 24 –20%/+25%Vdc                                                                                                  |
| Hold-up                            | 10ms at 19.2Vdc                                                                                                  |
| Inrush Current                     | 1 A maximum at 30Vdc                                                                                             |
| Inrush Time                        | 10 ms for 1 Amp                                                                                                  |
| Input Current                      | 0.16 A typical at 24Vdc                                                                                          |
| Input Power Supply Rating          | 4W                                                                                                               |
| <b>Relay Output Specifications</b> |                                                                                                                  |
| Operating Voltage                  | 5 to 30Vdc or 5 to 250Vac                                                                                        |
| Isolation                          | 1500 V RMS between field side and logic side<br>500 V RMS between groups                                         |
| Leakage Current                    | 15 mA maximum                                                                                                    |
| Maximum Load Current               | 2 Amps per point, 5 Amps per common                                                                              |
| Maximum Resistive Load Rating      | 2 amps at 24Vdc and 240Vac                                                                                       |
| Response Time                      | ON to OFF, or OFF to ON: 15 ms maximum                                                                           |

| Item                                                       | Description                    |                                    |                               |
|------------------------------------------------------------|--------------------------------|------------------------------------|-------------------------------|
| Contact Life: Mechanical                                   | 20 x 106 mechanical operations |                                    |                               |
| Contact Life: Electrical Voltage,<br>240Vac, 120Vac, 24Vdc | Current:<br>Resistive 2A       | Current: Lamp and<br>Solenoid 0.6A | Typical Operations<br>200,000 |

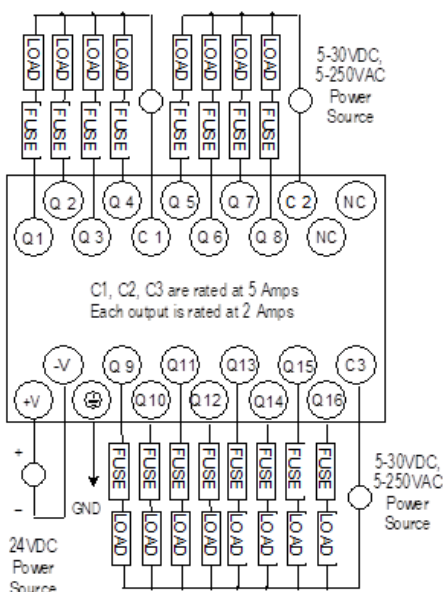
### 9.8.3 Wiring Diagram, IC200UER008

Figure 67



### 9.8.4 Wiring Diagram, IC200UER016

Figure 68



## 9.9 IC200UEX009

### 14 Point Expansion Unit, (8) 120Vac In, (2) Relay Out at 10 Amps, (4) Relay Out at 2 Amps, 120/240Vac Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX009 accepts eight AC inputs and provides six relay outputs: 2 at 10 Amps and 4 at 2 Amps. It requires 100Vac to 240Vac nominal input power.

#### 9.9.1 AC Inputs

The 120Vac input circuits are reactive (resistor/capacitor) inputs. The input circuits require an AC power source: they cannot be used with a DC power source. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate the field devices must be supplied.

#### 9.9.2 Relay Outputs

The six normally open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. There are two individual 10 Amp relay outputs and one group of four 2-Amp relay outputs. Power for the internal relay coils is provided by the internal supply. Separate external sources of AC or DC power must be supplied to operate field output devices.

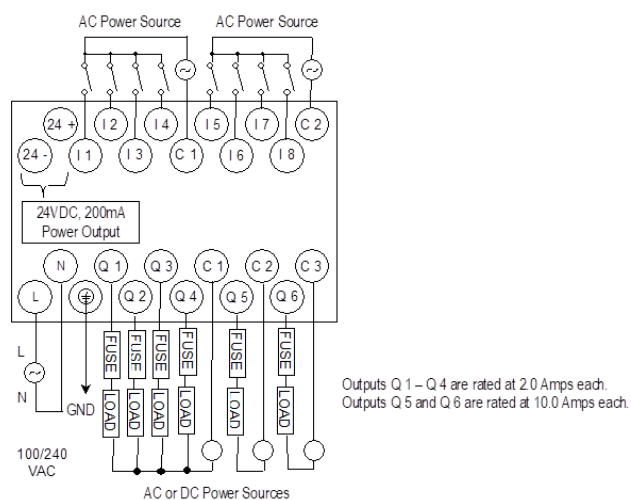
#### 9.9.3 Expansion Unit IC200UEX009 Specifications

| Item                           | Description                                                            |
|--------------------------------|------------------------------------------------------------------------|
| Inputs                         | Eight AC inputs                                                        |
| Outputs                        | Six relay outputs                                                      |
| +24Vdc Output Power Supply     | 200mA maximum (for input circuits and user devices)                    |
| <b>AC Power Specifications</b> |                                                                        |
| Range                          | 100 -15% to 240 +10%Vac                                                |
| Frequency                      | 50 -5% to 60 +5% Hz                                                    |
| Hold-up                        | 10 ms at 85 to 100Vac                                                  |
| Inrush Time                    | 2 ms for 40Amp                                                         |
| Inrush Current                 | 18 A maximum at 120Vac, 30 A maximum at 200Vac, 40 A maximum at 265Vac |
| Input Current                  | 0.05 A typical at 200Vac, 0.10 A typical at 100Vac                     |
| Input Power Supply Rating      | 11 VA                                                                  |
| <b>AC Input Specifications</b> |                                                                        |
| Points/Common                  | 4 (I1-I4) and (I5-I8)                                                  |
| Rated Load Voltage             | 85-132Vac, 50 -5% to 60 +5% Hz                                         |

| Item                             | Description                                                            |                                                    |                                                     |
|----------------------------------|------------------------------------------------------------------------|----------------------------------------------------|-----------------------------------------------------|
| Maximum Input Voltage            | 132V rms, 50/60 Hz                                                     |                                                    |                                                     |
| Input Current                    | 8 mA rms (100Vac, 60 Hz)                                               |                                                    |                                                     |
| Voltage                          | ON: minimum 80V rms, 4.5 mA rms, OFF: maximum 30V rms, 2 mA rms        |                                                    |                                                     |
| Response Time                    | OFF to ON: maximum 25mS, ON to OFF: maximum 30mS                       |                                                    |                                                     |
| Isolation                        | 1500V rms field side to logic side, 500V rms between groups            |                                                    |                                                     |
| Relay Output Specifications      |                                                                        |                                                    |                                                     |
| Operating Voltage                | 5 to 30Vdc or 5 to 250Vac                                              |                                                    |                                                     |
| Isolation                        | 1500 V RMS between field side and logic side, 500 V RMS between groups |                                                    |                                                     |
| Leakage Current                  | 15 mA maximum                                                          |                                                    |                                                     |
| Maximum UL Pilot Duty Rating     | 2 amps at 24Vdc and 240Vac                                             | 10 amps at 24Vdc and 240Vac                        |                                                     |
| Maximum Resistive Load Rating    | 2 amps at 24Vdc and 240Vac                                             | 10 amps at 24Vdc and 240Vac                        |                                                     |
| Minimum Load                     | 10 mA                                                                  |                                                    |                                                     |
| Maximum Inrush                   | 5 amps per half cycle                                                  |                                                    |                                                     |
| On Response Time                 | 15 ms maximum                                                          |                                                    |                                                     |
| Off Response Time                | 15 ms maximum                                                          |                                                    |                                                     |
| Fuse                             | None                                                                   |                                                    |                                                     |
| Contact Life: Mechanical         | 20 x 10 <sup>6</sup> mechanical operations                             |                                                    |                                                     |
| Contact Life: Electrical Voltage | Current: Resistive<br>2.0A<br>10.0A<br>4.0A                            | Current: Lamp and Solenoid<br>0.6A<br>4.0A<br>1.0A | Typical Operations<br>200,000<br>100,000<br>200,000 |

## 9.9.4 Wiring Diagram, IC200UEX009

Figure 69



## 9.10 IC200UEX010

### 14 Point Expansion Unit, (8) 120Vac In, (6) 120Vac Out, 120/240Vac Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX010 accepts eight AC inputs and provides six AC outputs. The module requires 100Vac to 240Vac nominal input power.

#### 9.10.1 AC Inputs

The eight 120Vac input circuits are reactive (resistor/capacitor) inputs. The input circuits require an AC power source: they cannot be used with a DC power source. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate the field devices must be supplied.

#### 9.10.2 AC Outputs

The six 120/240Vac, 0.5 Amp triac outputs are provided in isolated groups. The commons are not tied together inside the module. This allows each group to be used on different phases of the AC supply or to be powered from the same supply. Each group is protected with a replaceable 3.15 amp fuse for its common. Also, an RC snubber is provided for each output to protect against transient electrical noise on the power line.

AC power to operate loads connected to outputs must be supplied from an external source.

This module provides a high degree of inrush current (10x the rated current) which makes the outputs suitable for controlling a wide range of inductive and incandescent loads.

#### 9.10.3 Expansion Unit IC200UEX010 Specifications

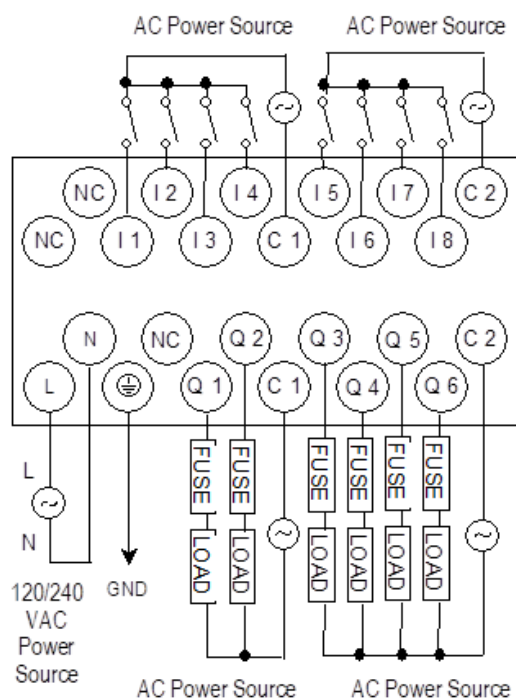
| Item                           | Description                                                            |
|--------------------------------|------------------------------------------------------------------------|
| Inputs                         | Eight AC inputs                                                        |
| Outputs                        | Six AC outputs                                                         |
| <b>AC Power Specifications</b> |                                                                        |
| Range                          | 100 -15% to 240 +10%Vac                                                |
| Frequency                      | 50 -5% to 60 +5% Hz                                                    |
| Hold-up                        | 10 ms at 85 to 100Vac, 20 ms at 100 to 264Vac                          |
| Inrush Time                    | 2 ms for 40Amp                                                         |
| Inrush Current                 | 18 A maximum at 120Vac, 30 A maximum at 200Vac, 40 A maximum at 265Vac |
| Input Current                  | 0.05 A typical at 200Vac, 0.10 A typical at 100Vac                     |
| Input Power Supply Rating      | 11 VA                                                                  |
| <b>AC Input Specifications</b> |                                                                        |
| Points/Common                  | 4 (I1–I4) and (I5–I8)                                                  |
| Rated Load Voltage             | 85–132Vac, 50 -5% to 60 +5% Hz                                         |



|                                 |                                                                            |
|---------------------------------|----------------------------------------------------------------------------|
| Maximum Input Voltage           | 132V rms, 50/60 Hz                                                         |
| Input Current                   | 8 mA rms (100Vac, 60 Hz)                                                   |
| Voltage                         | ON: minimum 80Vac rms, 4.5 mA rms, OFF: maximum 30Vac rms, 2 mA rms        |
| Response Time                   | OFF to ON: maximum 25mS, ON to OFF maximum 30mS                            |
| Isolation                       | 1500V rms field side to logic side, 500V rms between groups                |
| <b>AC Output Specifications</b> |                                                                            |
| Rated Load Voltage              | 100 -15% to 240 +10%Vac, 50 -5% to 60 +5% Hz                               |
| Maximum Resistive Load Current  | 0.5 Amp per point                                                          |
| Maximum UL Pilot Duty Rating    | 0.5 Amp per point at 240Vac, 0.6 Amp maximum on C1, 1.2 Amps maximum on C2 |
| Maximum Inrush Current          | 5A (1 period)/point, 10A (1 period)/common                                 |
| Maximum voltage drop when ON    | 1.5 V RMS                                                                  |
| Maximum leak current when OFF   | 1.8 mA RMS (115Vac), 3.5 mA RMS (230Vac)                                   |
| Response Time (Maximum)         | OFF to ON: 1 mS, ON to OFF: 1/2 cycle + 1 mS                               |
| Isolation                       | 1500V RMS field side to logic side, 500V RMS between groups                |

## 9.10.4 Wiring Diagram, IC200UEx010

Figure 70



## 9.11 IC200UEX011

### 14-Point Expansion Unit with AC Power, (8) 24Vdc Inputs, (6) Relay Outputs

VersaMax Micro PLC Expansion Unit IC200UEX011 accepts eight DC inputs and provides six normally-open 2 Amp relay outputs that can control 5-30Vdc or 5-250Vac output devices. The module requires 100Vac to 240Vac nominal input power.

#### 9.11.1 DC Inputs

The eight DC inputs can be used as positive or negative logic standard inputs. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

Isolated +24Vdc output power is available for field devices, up to 200mA maximum.

#### 9.11.2 Relay Outputs

The six Form A (SPST: single-pole, single-throw) normally open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. Power for the internal relay coils is provided by the 24Vdc internal supply. An external source of AC or DC power must be supplied to operate field devices.

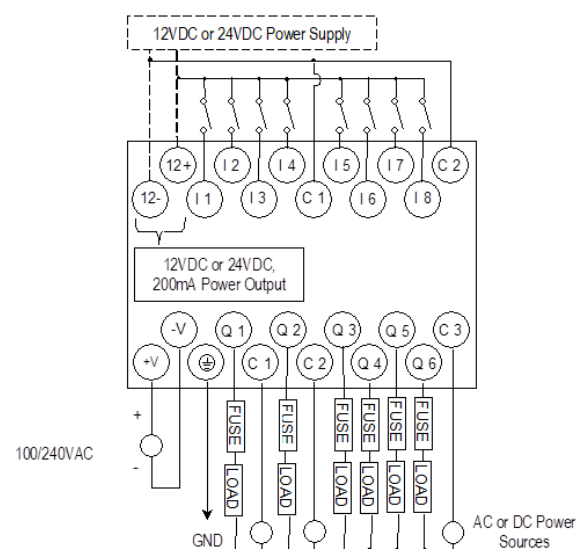
#### 9.11.3 Expansion Unit IC200UEX011 Specifications

| Item                               | Description                                                            |
|------------------------------------|------------------------------------------------------------------------|
| Inputs                             | Eight 24Vdc positive/negative logic input circuits                     |
| Outputs                            | Six normally open 2 Amp relay circuits                                 |
| +24Vdc Output Power Supply         | 200mA maximum (for input circuits and user devices)                    |
| <b>Relay Output Specifications</b> |                                                                        |
| Range                              | 100 -15% to 240 +10%Vac                                                |
| Frequency                          | 50 -5% to 60 +5% Hz                                                    |
| Hold-up                            | 10 ms at 85 to 100Vac                                                  |
| Inrush Time                        | 2 ms for 40Amp                                                         |
| Inrush Current                     | 18 A maximum at 120Vac, 30 A maximum at 200Vac, 40 A maximum at 265Vac |
| Input Current                      | 0.05 A typical at 200Vac, 0.10 A typical at 100Vac                     |
| Input Power Supply Rating          | 13 VA                                                                  |
| <b>DC Input Specifications</b>     |                                                                        |
| Rated Input Voltage                | 24 volts DC                                                            |
| Input Voltage Range                | 0 to 30 volts DC                                                       |
| Input Current                      | 7.5mA typical                                                          |

| Item                                                   | Description                                                                                                           |                                 |                            |
|--------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|---------------------------------|----------------------------|
| Input Resistance                                       | 2.8 kΩ                                                                                                                |                                 |                            |
| Input Threshold Voltage                                | ON: 15Vdc minimum, OFF: 5Vdc maximum                                                                                  |                                 |                            |
| Input Threshold Current                                | ON: 4.5mA maximum, OFF: 1.5mA minimum                                                                                 |                                 |                            |
| Response Time                                          | 0.5 to 20ms                                                                                                           |                                 |                            |
| Isolation Voltage                                      | 1500V RMS field side to logic side, 500V RMS between groups, if one group is powered by an external 24V power supply. |                                 |                            |
| Relay Output Specifications                            |                                                                                                                       |                                 |                            |
| Operating Voltage                                      | 5 to 30Vdc or 5 to 250Vac                                                                                             |                                 |                            |
| Isolation                                              | 1500 V RMS between field side and logic side, 500 V RMS between groups                                                |                                 |                            |
| Leakage Current                                        | 15 mA at 240Vac maximum                                                                                               |                                 |                            |
| Maximum UL Pilot Duty Rating                           | 2 amps at 24Vdc and 240Vac                                                                                            |                                 |                            |
| Maximum Resistive Load Rating                          | 2 amps at 24Vdc and 240Vac                                                                                            |                                 |                            |
| Minimum Load                                           | 1mA                                                                                                                   |                                 |                            |
| Maximum Inrush                                         | 5 amps per half cycle                                                                                                 |                                 |                            |
| On Response Time                                       | 15 ms maximum                                                                                                         |                                 |                            |
| Off Response Time                                      | 15 ms maximum                                                                                                         |                                 |                            |
| Contact Life: Mechanical                               | 20 x 106 mechanical operations                                                                                        |                                 |                            |
| Contact Life: Electrical Voltage 240Vac, 120Vac, 24Vdc | Current: Resistive 2A                                                                                                 | Current: Lamp and Solenoid 0.6A | Typical Operations 200,000 |

## 9.11.4 Wiring Diagram, IC200UEX011

Figure 71



## 9.12 IC200UEx012

### 14-Point Expansion Unit with 24DC Power, (8) 24Vdc Inputs, (6) Relay Outputs

VersaMax Micro PLC Expansion Unit IC200UEx012 accepts eight DC inputs and provides six normally open 2 Amp relay outputs that can control 5 to 30Vdc or 5 to 250Vac output devices. The module requires +24Vdc nominal input power.

#### 9.12.1 DC Inputs

The eight DC inputs can be used as positive or negative logic standard inputs. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Expansion Unit's isolated +24Vdc supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

#### 9.12.2 Relay Outputs

The six Form A (SPST: single-pole, single-throw) normally-open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. An external source of AC or DC power must be supplied to operate field devices.

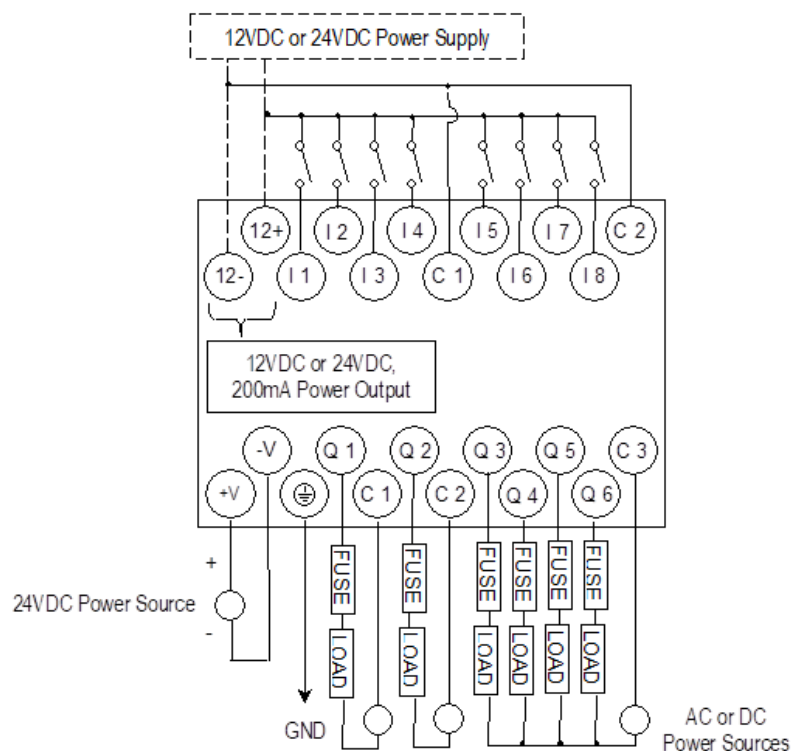
#### 9.12.3 Expansion Unit IC200UEx012 Specifications

| Item                           | Description                                         |
|--------------------------------|-----------------------------------------------------|
| Inputs                         | Eight 24Vdc positive/negative logic input circuits  |
| Outputs                        | Six normally open 2 amp relay circuits              |
| +24Vdc Output Power Supply     | 200mA maximum (for input circuits and user devices) |
| <b>DC Power Specifications</b> |                                                     |
| Range                          | 24Vdc –20% / +25%                                   |
| Hold-up                        | 10 ms at 19.2Vdc                                    |
| Inrush Current                 | 1 Amp maximum at 30Vdc                              |
| Inrush Time                    | 10 ms for 1 Amp                                     |
| Input Current                  | 0.16 Amp typical at 24Vdc                           |
| Input Power Supply Rating      | 4W                                                  |
| <b>DC Input Specifications</b> |                                                     |
| Rated Input Voltage            | 24 volts DC                                         |
| Input Voltage Range            | 0 to 30 volts DC                                    |
| Input Current                  | 7.5mA typical                                       |
| Input Resistance               | 2.8 kΩ                                              |
| Input Threshold Voltage        | ON: 15Vdc minimum, OFF: 5Vdc maximum                |

| Item                                                    | Description                                                              |                                 |                            |
|---------------------------------------------------------|--------------------------------------------------------------------------|---------------------------------|----------------------------|
| Input Threshold Current                                 | ON: 4.5mA maximum, OFF: 1.5mA minimum                                    |                                 |                            |
| Response Time                                           | 0.5 to 20ms                                                              |                                 |                            |
| Isolation Voltage                                       | 1500V RMS field side to logic side, 500V RMS between groups              |                                 |                            |
| Relay Output Specifications                             |                                                                          |                                 |                            |
| Operating Voltage                                       | 5 to 30Vdc or 5 to 250Vac                                                |                                 |                            |
| Isolation                                               | 1500 V RMS between field side and logic side<br>500 V RMS between groups |                                 |                            |
| Leakage Current                                         | 15 mA at 240Vac maximum                                                  |                                 |                            |
| Maximum UL Pilot Duty Rating                            | 2 amps at 24Vdc and 240Vac                                               |                                 |                            |
| Maximum Resistive Load Rating                           | 2 amps at 24Vdc and 240Vac                                               |                                 |                            |
| Minimum Load                                            | 1mA                                                                      |                                 |                            |
| Maximum Inrush                                          | 5 amps per half cycle                                                    |                                 |                            |
| On Response Time                                        | 15 ms maximum                                                            |                                 |                            |
| Off Response Time                                       | 15 ms maximum                                                            |                                 |                            |
| Contact Life: Mechanical                                | 20 x 106 mechanical operations                                           |                                 |                            |
| Contact Life: Electrical Voltage, 240Vac, 120Vac, 24Vdc | Current: Resistive 2A                                                    | Current: Lamp and Solenoid 0.6A | Typical Operations 200,000 |

## 9.12.4 Wiring Diagram, IC200UEx012

Figure 72



## 9.13 IC200UEX013 14-Point Expansion Unit with 12Vdc Power, (8) 12Vdc Inputs, (6) Relay Outputs

VersaMax Micro PLC Expansion Unit IC200UEX013 accepts eight 12Vdc inputs and provides six normally-open 2 Amp relay outputs that can control 5 to 30Vdc or 5 to 250Vac output devices. The module requires +12Vdc nominal input power.

### 9.13.1 DC Inputs

The eight 12Vdc inputs can be used as positive or negative logic standard inputs. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Expansion Unit's isolated +12Vdc supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

### 9.13.2 Relay Outputs

The six Form A (SPST: single-pole, single-throw) normally-open relay outputs can control many types of devices such as motor starters, solenoids, and indicators. Power for the internal relay coils is provided by the internal supply. An external source of AC or DC power must be supplied to operate field devices.

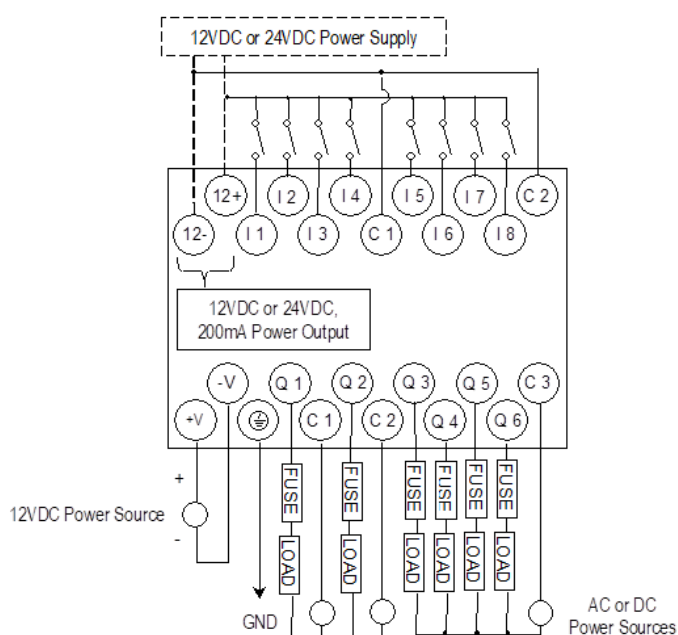
### 9.13.3 Expansion Unit IC200UEX013 Specifications

| Item                           | Description                                         |
|--------------------------------|-----------------------------------------------------|
| Inputs                         | Eight 12Vdc positive/negative logic input circuits  |
| Outputs                        | Six normally open 2 amp relay circuits              |
| +12Vdc Output Power Supply     | 200mA maximum (for input circuits and user devices) |
| <b>DC Power Specifications</b> |                                                     |
| Range                          | 9.6Vdc - 15Vdc                                      |
| Hold-up                        | 3.0mS                                               |
| Inrush Current                 | 9.2A typical at 12Vdc                               |
| Inrush Time                    | 200ms typical                                       |
| Input Current                  | 300mA typical at 12Vdc                              |
| Input Power Supply Rating      | 4W                                                  |
| <b>DC Input Specifications</b> |                                                     |
| Number of Inputs               | 8                                                   |
| Rated Input Voltage            | 12 volts DC                                         |
| Input Voltage Range            | 0 to 15 volts DC                                    |

| Item                             | Description                                                              |                                    |                               |
|----------------------------------|--------------------------------------------------------------------------|------------------------------------|-------------------------------|
| Input Current                    | 9.0mA typical                                                            |                                    |                               |
| Input Impedance                  | 1.3 kΩ                                                                   |                                    |                               |
| Input Threshold Voltage          | ON: 9.5Vdc minimum, OFF: 2.5Vdc maximum                                  |                                    |                               |
| Input Threshold Current          | ON: 6.5mA maximum, OFF: 1.6mA minimum                                    |                                    |                               |
| Response Time                    | 0.5 to 20ms (user configurable)                                          |                                    |                               |
| Isolation Voltage                | 1500V RMS field side to logic side, 500V RMS between groups              |                                    |                               |
| Relay Output Specifications      |                                                                          |                                    |                               |
| Operating Voltage                | 5 to 30Vdc or 5 to 250Vac                                                |                                    |                               |
| Isolation                        | 1500 V RMS between field side and logic side<br>500 V RMS between groups |                                    |                               |
| Leakage Current                  | 15 mA maximum                                                            |                                    |                               |
| Maximum UL Pilot Duty Rating     | 2 amps at 24Vdc and 240Vac                                               |                                    |                               |
| Maximum Resistive Load Rating    | 2 amps at 24Vdc and 240Vac                                               |                                    |                               |
| Minimum Load                     | 10 mA                                                                    |                                    |                               |
| Maximum Inrush                   | 5 amps per half cycle                                                    |                                    |                               |
| On Response Time                 | 15 ms maximum                                                            |                                    |                               |
| Off Response Time                | 15 ms maximum                                                            |                                    |                               |
| Contact Life: Mechanical         | 20 x 10 <sup>6</sup> mechanical operations                               |                                    |                               |
| Contact Life: Electrical Voltage | Current: Resistive<br>2A                                                 | Current: Lamp and<br>Solenoid 0.6A | Typical Operations<br>200,000 |

## 9.13.4 Wiring Diagram, IC200UEx013

Figure 73



## 9.14 IC200UEX014

### 14-Point Expansion Unit with 24DC Power, (8) 24DC Inputs, (2) High-Current and (4) Low-Current Transistor Outputs

VersaMax Micro PLC Expansion Unit IC200UEX014 accepts eight DC inputs and provides two low-current and four high-current DC transistor outputs. It requires +24Vdc nominal input power.

#### 9.14.1 DC Inputs

The eight 24 volt DC input circuits can have positive or negative logic characteristics. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The built-in isolated +24Vdc supply can be used for input devices and to power the DC input circuits. The combination of input circuit current and external device current must not exceed 200 mA.

#### 9.14.2 Transistor Outputs

Expansion Unit UEX014 has two high-current transistor outputs (Q1 and Q2) and four low-current transistor outputs (Q3 to Q6). All outputs are isolated between field and logic and are switching positive voltage.

External fusing should be provided to protect the outputs. Otherwise, a load short can damage the module output transistor, which is not user replaceable. Fast fuses are recommended.

The outputs share one common incoming 24Vdc supply and one common ground. The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

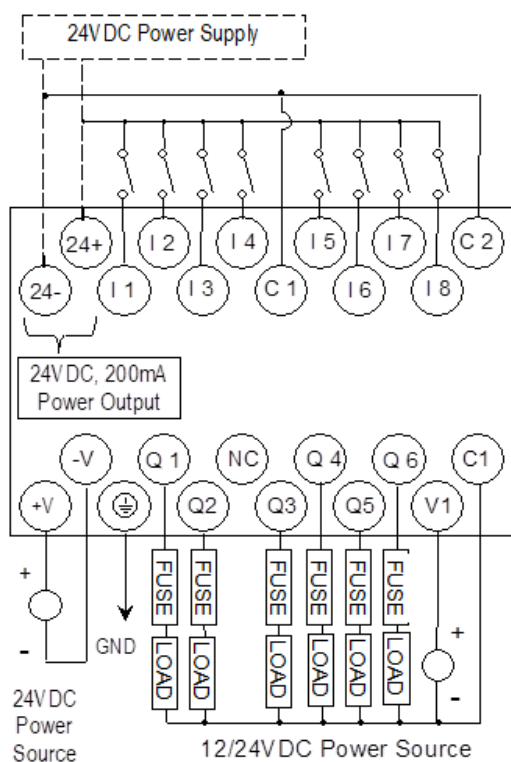


## 9.14.3 Expansion Unit IC200UEx014 Specifications

| Item                                    | Description                                                                                                                                                               |
|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Inputs                                  | Eight 24Vdc positive/negative logic input circuits                                                                                                                        |
| Outputs                                 | Four low-current and two high-current DC transistor output circuits                                                                                                       |
| +24Vdc Output Power Supply              | 200mA maximum, (for input circuits and user devices)                                                                                                                      |
| <b>DC Power Specifications</b>          |                                                                                                                                                                           |
| Range                                   | 24 –20%/+25%Vdc                                                                                                                                                           |
| Hold-up                                 | 10ms at 19.2Vdc                                                                                                                                                           |
| Inrush Current                          | 1 A maximum at 30Vdc                                                                                                                                                      |
| Inrush Time                             | 10 ms for 1 Amp                                                                                                                                                           |
| Input Current                           | 0.16 A typical at 24Vdc                                                                                                                                                   |
| Input Power Supply Rating               | 4W                                                                                                                                                                        |
| <b>DC Input Specifications</b>          |                                                                                                                                                                           |
| Rated Input Voltage                     | 24 volts DC                                                                                                                                                               |
| Input Voltage Range                     | 0 to 30 volts DC                                                                                                                                                          |
| Input Current                           | 7.5mA typical                                                                                                                                                             |
| Input Resistance                        | 2.8 kΩ                                                                                                                                                                    |
| Input Threshold Voltage                 | ON: 15Vdc minimum, OFF: 5Vdc maximum                                                                                                                                      |
| Input Threshold Current                 | ON: 4.5mA maximum, OFF: 1.5mA minimum                                                                                                                                     |
| Response Time                           | 0.5 to 20ms                                                                                                                                                               |
| Isolation Voltage                       | 1500V RMS field side to logic side, 500V RMS between groups                                                                                                               |
| <b>Transistor Output Specifications</b> |                                                                                                                                                                           |
| Voltage Range                           | 12/24Vdc +10%/-15% (at VC)                                                                                                                                                |
| Maximum Load (see below)                | 1A per point (Q1 - Q2) at 100 % ON duration at 24Vdc<br>0.5A per point (Q3 - Q6) at 100 % ON duration at 12Vdc<br>0.75A per point (Q3 - Q6) at 100 % ON duration at 24Vdc |
| Maximum Inrush Current                  | Q1, Q2: 8A for 20ms, 1 pulse, Q3, Q4, Q5, Q6: 4A for 20ms, 1 pulse                                                                                                        |
| Output Voltage Drop                     | 0.5V maximum                                                                                                                                                              |
| OFF state leakage                       | 100μA maximum                                                                                                                                                             |
| Response                                | OFF to ON or ON to OFF: 0.1ms maximum at 24Vdc, 0.2A                                                                                                                      |
| Isolation Voltage                       | 1500V RMS field side to logic side, 500Vac between field side and logic side                                                                                              |
| External power supply                   | 10-30Vdc required to power the outputs.                                                                                                                                   |
| Fuses                                   | Outputs should be fused externally.                                                                                                                                       |

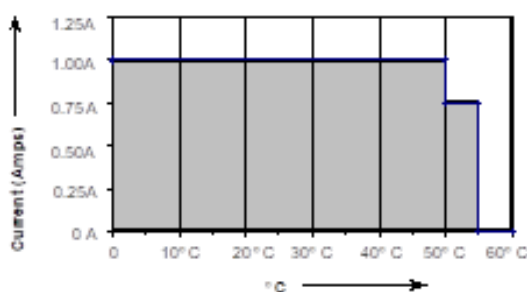
## 9.14.4 Wiring Diagram, IC200UEx014

Figure 74



The maximum current that can be used for output points Q1 and Q2 is lower for ambient temperatures above 50°C.

Figure 75



## 9.15 IC200UEX015 14-Point Expansion Unit with 12DC Power, (8) 12DC Inputs, (6) 12Vdc Outputs

VersaMax Micro PLC Expansion Unit IC200UEX015 accepts eight DC inputs and provides six DC transistor outputs. It requires +12Vdc nominal input power.

### 9.15.1 DC Inputs

The eight 12 volt DC inputs can have positive or negative logic characteristics. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The built-in isolated +12Vdc supply can be used for input devices and to power the DC input circuits. The combination of input circuit current and external device current must not exceed 200 mA.

### 9.15.2 Transistor Outputs

All outputs are isolated between field and logic and are switching positive voltage.

External fusing should be provided to protect the outputs. Otherwise, a load short can damage the module output transistor, which is not user replaceable. Fast fuses are recommended.

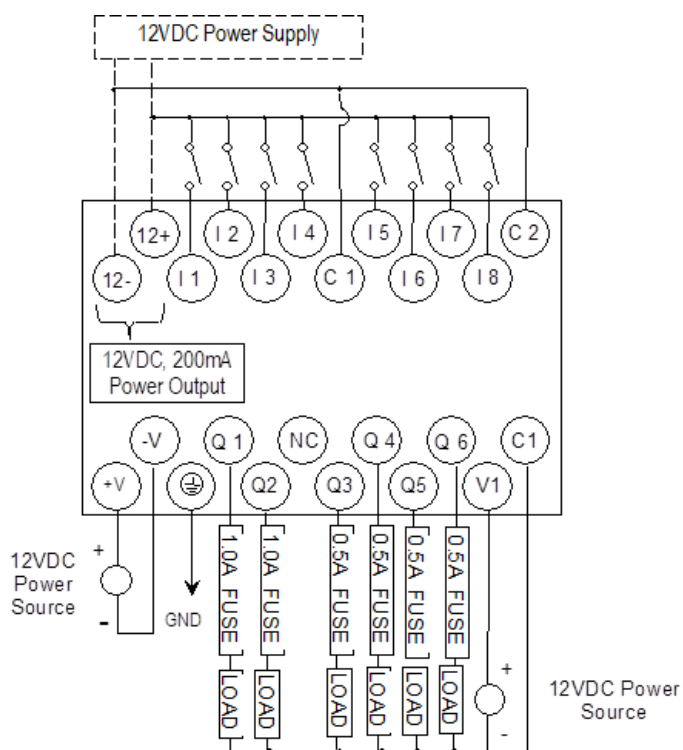
The outputs share one common incoming 12Vdc supply and one common ground. The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

## 9.15.3 Expansion Unit IC200UEx015 Specifications

| Item                                    | Description                                                                  |
|-----------------------------------------|------------------------------------------------------------------------------|
| Inputs                                  | Eight 12Vdc positive/negative logic input circuits                           |
| Outputs                                 | Six 12Vdc output circuits                                                    |
| +12Vdc Output Power Supply              | 200mA maximum (for input circuits and user devices)                          |
| <b>DC Power Specifications</b>          |                                                                              |
| Range                                   | 9.6Vdc to 15Vdc                                                              |
| Hold-up                                 | 3.0mS                                                                        |
| Inrush Current                          | 9.2A typical at 12Vdc                                                        |
| Inrush Time                             | 200ms typical                                                                |
| Input Current                           | 300mA typical at 12Vdc                                                       |
| Input Power Supply Rating               | 4W                                                                           |
| <b>DC Input Specifications</b>          |                                                                              |
| Number of Inputs                        | 8                                                                            |
| Rated Input Voltage                     | 12 volts DC                                                                  |
| Input Voltage Range                     | 0 to 15 volts DC                                                             |
| Input Current                           | 9.0mA typical                                                                |
| Input Impedance                         | 1.3 k $\Omega$                                                               |
| Input Threshold Voltage                 | ON: 9.5Vdc minimum, OFF: 2.5Vdc maximum                                      |
| Input Threshold Current                 | ON: 6.5mA maximum, OFF: 1.6mA minimum                                        |
| Response Time                           | 0.5 to 20ms (user configurable)                                              |
| Isolation Voltage                       | 1500V RMS field side to logic side, 500V RMS between groups                  |
| <b>Transistor Output Specifications</b> |                                                                              |
| Voltage Range                           | 12Vdc +20%, -20%                                                             |
| Maximum Load                            | 0.7A per circuit, 4A per common                                              |
| Maximum Inrush Current                  | 4A for 20mS                                                                  |
| Output Voltage Drop                     | 0.3V maximum                                                                 |
| OFF state leakage                       | 0.1mA                                                                        |
| Response                                | OFF to ON or ON to OFF: 0.1ms maximum 12Vdc 0.2A                             |
| Isolation Voltage                       | 1500V RMS field side to logic side, 500Vac between field side and logic side |
| External power supply                   | 12Vdc required to power the outputs.                                         |
| Fuse                                    | Outputs should be fused externally.                                          |

## 9.15.4 Wiring Diagram, IC200UEx015

Figure 76



## 9.16 IC200UEX122

### 14-Point Expansion Unit with 24DC Power, (8) 24DC Inputs, (2) High-Current and (4) Low-Current Transistor Outputs with ESCP

VersaMax Micro PLC Expansion Unit IC200UEX122 accepts eight DC inputs and provides two low-current and four high-current DC transistor outputs. The outputs have electronic short circuit protection. The module requires +24Vdc nominal input power.

#### 9.16.1 DC Inputs

The 24 volt DC input circuits can have positive or negative logic characteristics. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

The built-in isolated +24Vdc supply can be used for input devices and to power the DC input circuits. The combination of input circuit current and external device current must not exceed 200 mA.

#### 9.16.2 Outputs

Expansion Unit UEX122 has two high-current transistor outputs (Q1 and Q2) and four low-current transistor outputs (Q3 to Q6). They can be used as positive or negative logic standard inputs.

All outputs are isolated between field and logic and are switching positive voltage.

All six outputs have electronic short-circuit protection; no fuses are needed to protect the outputs.

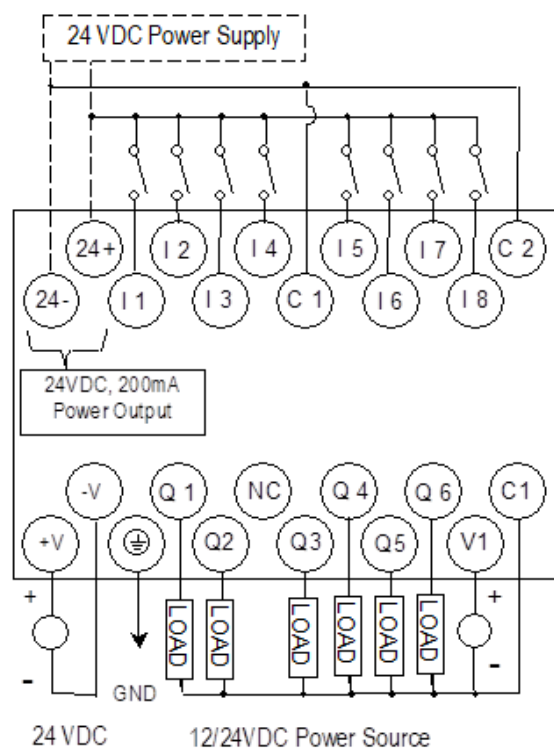
An external source of 12/24Vdc power must be provided to power the outputs. The outputs share this common incoming 24Vdc supply and one common ground. The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

## 9.16.3 Expansion Unit IC200UEx122 Specifications

| Item                            | Description                                                                   |
|---------------------------------|-------------------------------------------------------------------------------|
| Inputs                          | Eight 24Vdc positive/negative logic input circuits                            |
| Outputs                         | Four low-current and two high-current DC transistor output circuits with ESCP |
| +24Vdc Output Power Supply      | 200mA maximum (for input circuits and user devices)                           |
| <b>DC Power Specifications</b>  |                                                                               |
| Range                           | 19.2Vdc to 30Vdc                                                              |
| Hold-up                         | 10ms at 19.2Vdc                                                               |
| Inrush Current                  | 1 A maximum at 30Vdc                                                          |
| Inrush Time                     | 10 ms for 1 Amp                                                               |
| Input Current                   | 0.16 A typical at 24Vdc                                                       |
| Input Power Supply Rating       | 4W                                                                            |
| <b>DC Input Specifications</b>  |                                                                               |
| Input Voltage Range             | 0 to 30 volts DC                                                              |
| Input Current                   | 7.5mA typical                                                                 |
| Input Impedance                 | 2.8 k $\Omega$                                                                |
| Input Threshold Voltage         | ON: 15Vdc minimum, OFF: 5Vdc maximum                                          |
| Input Threshold Current         | ON: 4.5mA maximum, OFF: 1.5mA minimum                                         |
| Response Time                   | 0.5 to 20ms                                                                   |
| Isolation Voltage               | 1500V RMS field side to logic side, 500V RMS between groups                   |
| <b>DC Output Specifications</b> |                                                                               |
| Voltage Range                   | 12/24Vdc +10%/-15% (at VC)                                                    |
| Maximum Load Current            | Q1 and Q2: 1A, 3.4A per common, Q3 to Q6: 0.7A per point, 3.4A per common     |
| Maximum Inrush Current          | Q1, Q2: 8A for 20ms, 1 pulse, Q3, Q4, Q5, Q6: 4A for 20ms, 1 pulse            |
| Output Voltage Drop             | 0.3V                                                                          |
| OFF state Leakage Current       | 0.1mA                                                                         |
| Response Time                   | OFF to ON or ON to OFF: 0.05ms maximum at 24Vdc                               |
| Isolation Voltage               | 1500V RMS field side to logic side, 500Vac between field side and logic side  |
| External power supply           | 12/24Vdc –10%, +20%                                                           |
| Fuse                            | Not required                                                                  |
| Minimum switching current       | 10mA                                                                          |

## 9.16.4 Wiring Diagram, IC200UEX122

Figure 77





# Chapter 10: VersaMax Micro PLC 28-Point Expansion Units

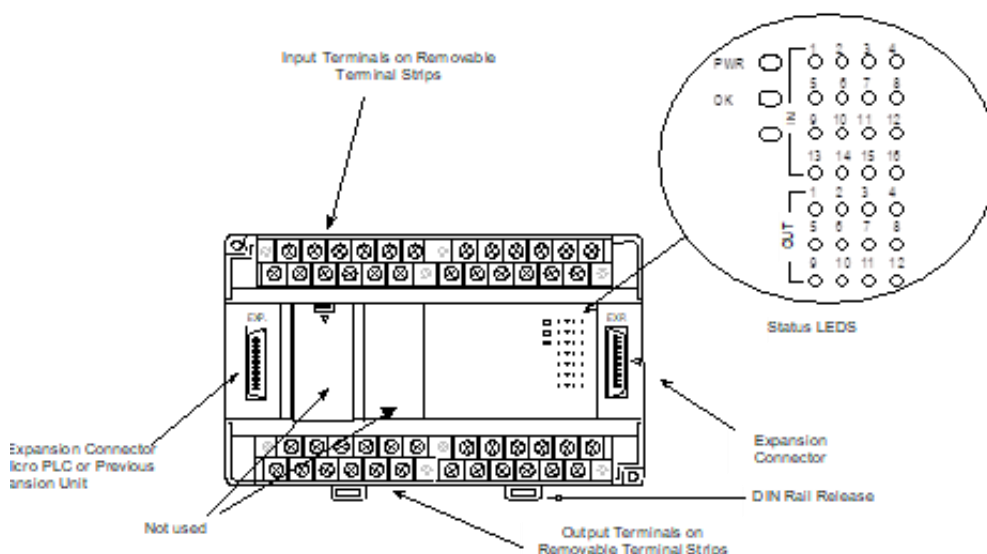
This chapter consists of module datasheets for the following VersaMax Micro PLC Expansion Units:

|                    |                                                                                                                      |
|--------------------|----------------------------------------------------------------------------------------------------------------------|
| <b>IC200UEX209</b> | 28 Point Expansion Unit, (16) 120Vac In, (2) Relay Out at 10 Amps, (10) Relay Out at 2 Amps, 120/240Vac Power Supply |
| <b>IC200UEX210</b> | 28 Point Expansion Unit, (16) 120Vac In, (12) 120Vac Out, 120/240Vac Power Supply                                    |
| <b>IC200UEX211</b> | 28 Point Expansion Unit, (16) 24Vdc In, (12) Relay Out, 120/240Vac Power Supply                                      |
| <b>IC200UEX212</b> | 28 Point Expansion Unit, (16) 24Vdc In, (12) Relay Out, 24Vdc Power Supply                                           |
| <b>IC200UEX213</b> | 28 Point Expansion Unit, (16) 12Vdc In, (12) Relay Out, 12Vdc Power Supply                                           |
| <b>IC200UEX214</b> | 28 Point Expansion Unit, (16) 24Vdc In, (12) 24Vdc Out, 24Vdc Power Supply                                           |
| <b>IC200UEX215</b> | 28 Point Expansion Unit, (16) 12Vdc In, (12) 12Vdc Out, 12Vdc Power Supply                                           |
| <b>IC200UEX222</b> | 28 Point Expansion Unit, (16) 24Vdc In, (12) 24Vdc Out with ESCP, 24Vdc Power Supply                                 |

## 10.1 Features of VersaMax 28-Point Micro PLC Expansion Units

Modular 28-point Expansion Units can be used to increase the total I/O count of a Micro PLC. Expansion Units can be used with any 14- to 64-point Micro PLC. Expansion Units can be located up to 2 meters from the Micro PLC.

Figure 78



### 10.1.1 Removable Terminal Strips

The removable terminal assemblies are protected by hinged covers. After turning off power to the Expansion Unit, a terminal assembly and attached field wiring can be separated from the Expansion Unit by removing two screws.

### 10.1.2 Expansion Connector

The connector on the left side of the Expansion Unit is used to connect to the Micro PLC or to the outgoing connector on the previous Expansion Unit. The connector on the right side of the Expansion Unit can be used to attach to the next Expansion Unit.

### 10.1.3 Status LEDs

LEDs on the Expansion Unit provide quick visual verification of operating status. In addition to LEDs Expansion Unit local Power and OK mode, there is an LED for each I/O point.

### 10.1.4 Cables

A 0.1 meter ribbon cable (IC200CBL501) is provided with each Expansion Unit. Cables are also available in 0.5 meter (IC200CBL505) and 1 meter (IC200CBL510) lengths.

## 10.2 **IC200UEX209 28 Point Micro PLC Expansion Unit, (16) 120Vac In, (2/10) Relay Out, 120/240Vac Power Supply**

VersaMax Micro PLC Expansion Unit IC200UEX209 accepts sixteen AC inputs and provides two relay outputs at 10 Amps and ten relay outputs at 2 Amps. It uses 100Vac to 240Vac nominal input power.

### 10.2.1 AC Inputs

The 120Vac input circuits are reactive (resistor/capacitor) inputs. The input circuits require an AC power source: they cannot be used with a DC power source. Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate the field devices must be supplied.

### 10.2.2 Relay Outputs

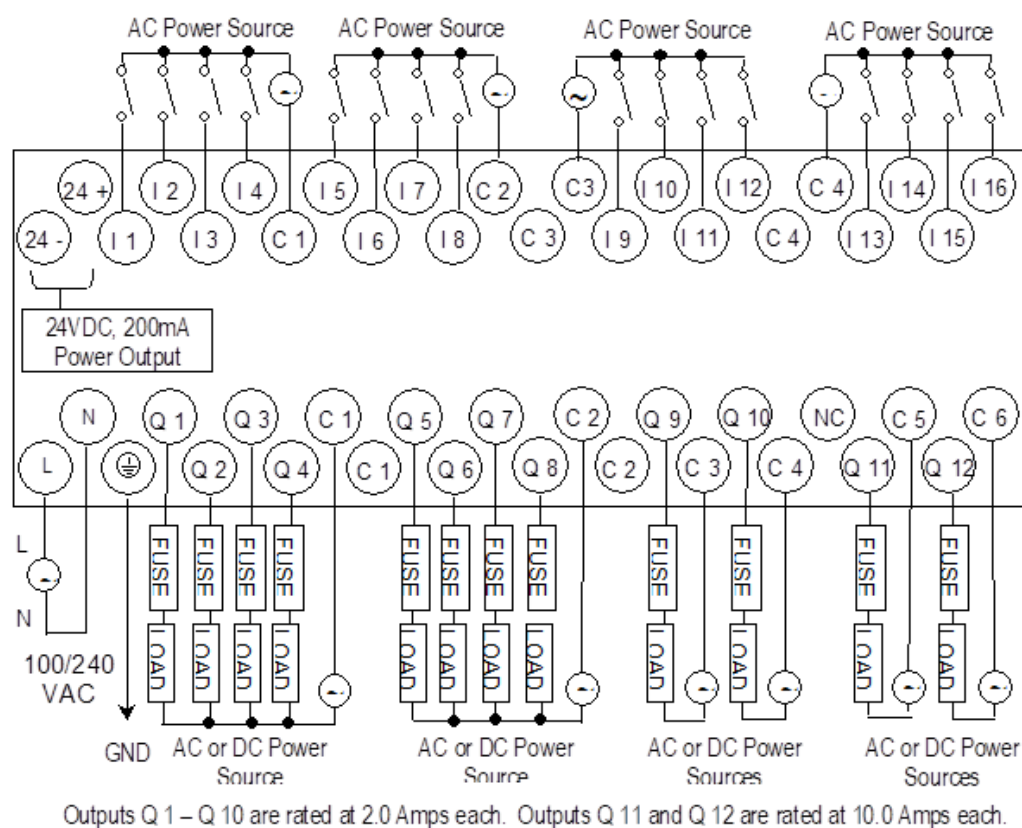
The relay outputs can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices.

## 10.2.3 Expansion Unit IC200UEx209 Specifications

|                                  |                                                                          |                                                    |                                                     |
|----------------------------------|--------------------------------------------------------------------------|----------------------------------------------------|-----------------------------------------------------|
| Inputs                           | 16 AC inputs                                                             |                                                    |                                                     |
| Outputs                          | 2 relay outputs at 10 Amps, 10 relay outputs at 2 Amps                   |                                                    |                                                     |
| +24Vdc Output Power Supply       | 200mA maximum (for input circuits and user devices)                      |                                                    |                                                     |
| AC Power Specifications          |                                                                          |                                                    |                                                     |
| Range                            | 100 –15% to 240 +10%Vac                                                  |                                                    |                                                     |
| Frequency                        | 50 –5% to 60 +5% Hz                                                      |                                                    |                                                     |
| Hold-up                          | 10ms at 85-100Vac, 20ms at 100-264Vac                                    |                                                    |                                                     |
| Inrush Time                      | 2ms for 40 Amp                                                           |                                                    |                                                     |
| Inrush Current                   | 30 Amp maximum at 200Vac, 40 Amp maximum at 265Vac                       |                                                    |                                                     |
| Input Current                    | 0.10 Amp typical at 100Vac, 0.06 Amp typical at 200Vac                   |                                                    |                                                     |
| Input Power Supply Rating        | 16 VA                                                                    |                                                    |                                                     |
| AC Input Specifications          |                                                                          |                                                    |                                                     |
| Points/Common                    | 4 (I1–I4) and (I5–I8)                                                    |                                                    |                                                     |
| Rated Load Voltage               | 85–132Vac, 50 -5% to 60 +5% Hz                                           |                                                    |                                                     |
| Maximum Input Voltage            | 132V rms, 50/60 Hz                                                       |                                                    |                                                     |
| Input Current                    | 8 mA rms (100Vac, 60 Hz)                                                 |                                                    |                                                     |
| Voltage                          | ON: minimum 80V rms, 4.5 mA rms, OFF: maximum 30V rms, 2 mA rms          |                                                    |                                                     |
| Response Time                    | OFF to ON: maximum 25 ms, ON to OFF: maximum 30 ms                       |                                                    |                                                     |
| Isolation                        | 1500V rms field side to logic side, 500V rms between groups              |                                                    |                                                     |
| Relay Output Specifications      |                                                                          |                                                    |                                                     |
| Operating Voltage                | 5 to 30Vdc or 5 to 250Vac                                                |                                                    |                                                     |
| Isolation                        | 1500 V RMS between field side and logic side<br>500 V RMS between groups |                                                    |                                                     |
| Leakage Current                  | 15 mA at 240Vac maximum                                                  |                                                    |                                                     |
| Maximum UL Pilot Duty Rating     | 2 amps at 24Vdc and 240Vac                                               | 10 amps at 24Vdc and 240Vac                        |                                                     |
| Maximum Resistive Load Rating    | 2 amps at 24Vdc and 240Vac                                               | 10 amps at 24Vdc and 240Vac                        |                                                     |
| Minimum Load                     | 10 mA                                                                    |                                                    |                                                     |
| Maximum Inrush                   | 5 amps per half cycle                                                    | 14 amps per half cycle                             |                                                     |
| On Response Time                 | 15 ms maximum                                                            |                                                    |                                                     |
| Off Response Time                | 15 ms maximum                                                            |                                                    |                                                     |
| Contact Life: Mechanical         | 20 x 106 mechanical operations                                           |                                                    |                                                     |
| Contact Life: Electrical Voltage | Current: Resistive<br>2.0A<br>10.0A<br>4.0A                              | Current: Lamp and Solenoid<br>0.6A<br>4.0A<br>1.0A | Typical Operations<br>100,000<br>100,000<br>200,000 |

## 10.2.4 Wiring Diagram, IC200UEx209

Figure 79



## 10.3 IC200UEX210

### 28 Point Micro PLC Expansion Unit, (16) 120Vac In, (12) 120Vac Out, 120/240Vac Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX210 accepts sixteen AC inputs and provides twelve AC outputs. It uses 100Vac to 240Vac nominal input power.

#### 10.3.1 AC Inputs

The 120Vac input circuits are reactive (resistor/capacitor) inputs. The input circuits require an AC power source: they cannot be used with a DC power source. Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate the field devices must be supplied.

#### 10.3.2 AC Outputs

The 120/240Vac, 0.5 Amp triac outputs are provided in isolated groups. The commons are not tied together inside the module. This allows each group to be used on different phases of the AC supply or to be powered from the same supply. Each group is protected with a replaceable 3.15 amp fuse for its common. Also, an RC snubber is provided for each output to protect against transient electrical noise on the power line.

AC power to operate loads connected to outputs must be supplied from an external source.

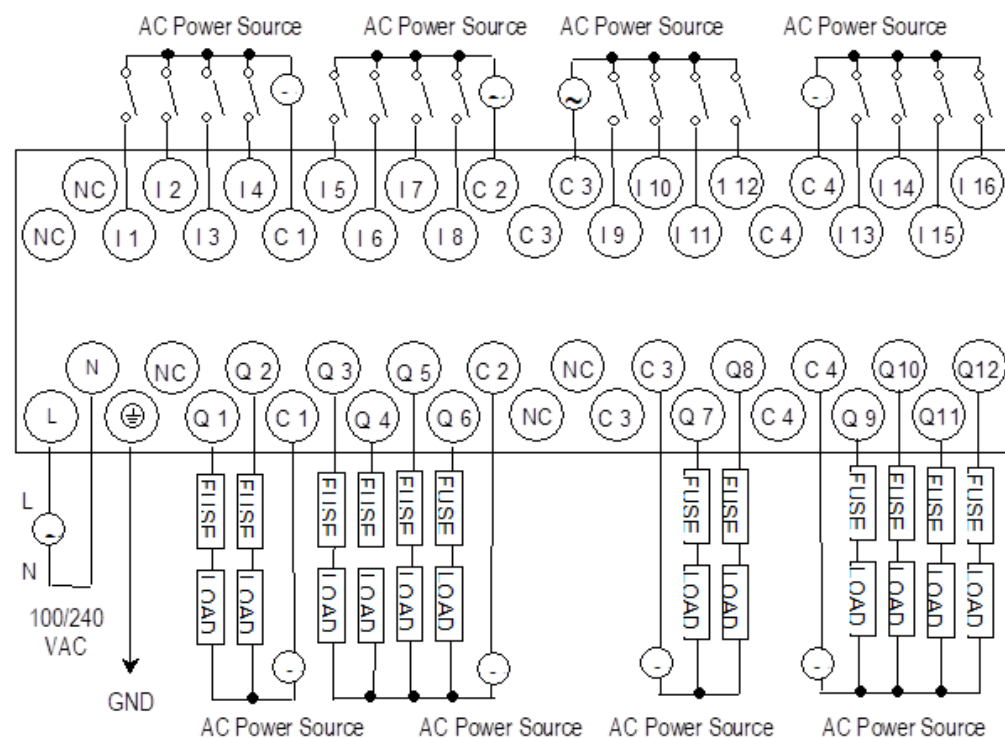
This module provides a high degree of inrush current (10x the rated current) which makes the outputs suitable for controlling a wide range of inductive and incandescent loads.

### 10.3.3 Expansion Unit IC200UEx210 Specifications

| Item                            | Description                                                                                  |
|---------------------------------|----------------------------------------------------------------------------------------------|
| Inputs                          | 16 AC inputs                                                                                 |
| Outputs                         | 12 AC outputs                                                                                |
| <b>AC Power Specifications</b>  |                                                                                              |
| Range                           | 100 -15% to 240 +10%Vac                                                                      |
| Frequency                       | 50 -5% to 60 +5% Hz                                                                          |
| Hold-up                         | 10ms at 85-100Vac, 20ms at 100-264Vac                                                        |
| Inrush Time                     | 2ms for 40 Amp                                                                               |
| Inrush Current                  | 30 Amp maximum at 200Vac, 40 Amp maximum at 265Vac                                           |
| Input Current                   | 0.10 Amp typical at 100Vac, 0.06 Amp typical at 200Vac                                       |
| Input Power Supply Rating       | 16 VA                                                                                        |
| <b>AC Input Specifications</b>  |                                                                                              |
| Points/Common                   | 4 (I1-I4) and (I5-I8)                                                                        |
| Rated Load Voltage              | 85-132Vac, 50 -5% to 60 +5% Hz                                                               |
| Maximum Input Voltage           | 132V rms, 50/60 Hz                                                                           |
| Input Current                   | 8 mA rms (100Vac, 60 Hz)                                                                     |
| Voltage                         | ON minimum 80V rms, 4.5 mA rms, OFF: maximum 30V rms, 2 mA rms                               |
| Response Time                   | OFF to ON: maximum 25 ms< ON to OFF: maximum 30 ms                                           |
| Isolation                       | 1500V rms field side to logic side, 500V rms between groups                                  |
| <b>AC Output Specifications</b> |                                                                                              |
| Rated Load Voltage              | 100 -15% to 240 +10%Vac, 50 -5% to 60 +5% Hz                                                 |
| Maximum Resistive Load Current  | 0.5 Amp per point                                                                            |
| Maximum UL Pilot Duty Rating    | 0.5 Amp per point at 240Vac<br>0.6 Amp maximum on C1 and C3<br>1.2 Amps maximum on C2 and C4 |
| Maximum Inrush Current          | 5A (1 period)/point, 10A (1 period)/common                                                   |
| Maximum voltage drop when ON    | 1.5 V RMS                                                                                    |
| Maximum leak current when OFF   | 1.8 mA RMS (115Vac), 3.5 mA RMS (230Vac)                                                     |
| Response Time (Maximum)         | OFF to ON: 1 mS, ON to OFF: 1/2 cycle + 1 ms                                                 |
| Isolation                       | 1500V RMS field side to logic side, 500V RMS between groups                                  |

## 10.3.4 Wiring Diagram, IC200UEx210

Figure 80



## 10.4 IC200UEx211

### 28 Point Micro PLC Expansion Unit, (16) 24Vdc In, (12) Relay Out, 120/240Vac Power Supply

VersaMax Micro PLC Expansion Unit IC200UEx211 accepts sixteen DC inputs and provides twelve normally-open 2 Amp relay outputs. It uses 100Vac to 240Vac nominal input power.

### 10.4.1 DC Inputs

The sixteen configurable DC inputs can be used as positive or negative logic inputs. Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. The +24Vdc supply can be used for input devices and to power the DC input circuits. The combination of input circuit current and external device current must not exceed 200 mA.

### 10.4.2 Relay Outputs (Q1 – Q12)

The twelve Form A (SPST-single pole single throw) normally open relay outputs can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices.

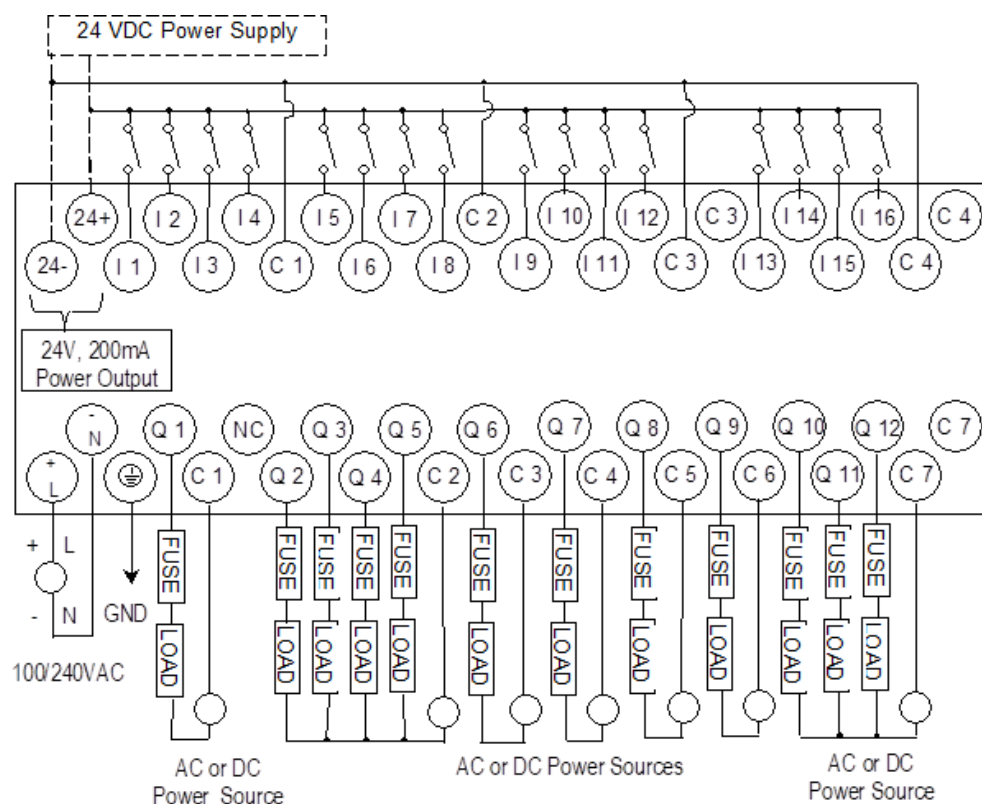
## 10.4.3 Expansion Unit IC200UEx211 Specifications

| Item                                                      | Description                                                            |                                    |                                  |
|-----------------------------------------------------------|------------------------------------------------------------------------|------------------------------------|----------------------------------|
| Inputs                                                    | Sixteen 24Vdc positive/negative logic input circuits                   |                                    |                                  |
| Outputs                                                   | Twelve normally open 2 amp relay circuits                              |                                    |                                  |
| +24Vdc Output Power Supply                                | 200mA maximum (for input circuits and user devices)                    |                                    |                                  |
| AC Power Specifications                                   |                                                                        |                                    |                                  |
| Range                                                     | 100 -15% to 240 +10%Vac                                                |                                    |                                  |
| Frequency                                                 | 50 -5% to 60 +5% Hz                                                    |                                    |                                  |
| Hold-up                                                   | 10ms at 85 to 100Vac, 20ms at 100 to 265Vac                            |                                    |                                  |
| Inrush Current                                            | 30 Amp maximum at 200Vac, 40 Amp maximum at 265Vac                     |                                    |                                  |
| Inrush Time                                               | 2 ms for 40Amp                                                         |                                    |                                  |
| Input Current                                             | 0.20 Amp typical at 200Vac, 0.10 Amp typical at 100Vac                 |                                    |                                  |
| Input Power Supply Rating                                 | 26 VA                                                                  |                                    |                                  |
| DC Input Specifications                                   |                                                                        |                                    |                                  |
| Number of Inputs                                          | 16                                                                     |                                    |                                  |
| Rated Input Voltage                                       | 24 volts DC                                                            |                                    |                                  |
| Input Voltage Range                                       | 0 to 30 volts DC                                                       |                                    |                                  |
| Input Current                                             | 7.5mA typical                                                          |                                    |                                  |
| Input Resistance                                          | 2.8 kΩ                                                                 |                                    |                                  |
| Input Threshold Voltage                                   | ON: 15Vdc minimum, OFF: 5Vdc maximum                                   |                                    |                                  |
| Input Threshold Current                                   | ON: 4.5mA maximum, OFF: 1.5mA minimum                                  |                                    |                                  |
| Response Time                                             | 0.5 to 20ms configurable                                               |                                    |                                  |
| Isolation Voltage                                         | 1500V RMS field side to logic side, 500V RMS between groups            |                                    |                                  |
| Relay Output Specifications                               |                                                                        |                                    |                                  |
| Operating Voltage                                         | 5 to 30Vdc or 5 to 250Vac                                              |                                    |                                  |
| Isolation                                                 | 1500 V RMS between field side and logic side, 500 V RMS between groups |                                    |                                  |
| Leakage Current                                           | 15 mA at 240Vac maximum                                                |                                    |                                  |
| Maximum UL Pilot Duty Rating                              | 2 amps at 24Vdc and 240Vac                                             |                                    |                                  |
| Maximum Resistive Load Rating                             | 2 amps at 24Vdc and 240Vac                                             |                                    |                                  |
| Minimum Load                                              | 10 mA                                                                  |                                    |                                  |
| Maximum Inrush                                            | 5 amps per half cycle                                                  |                                    |                                  |
| Response Time                                             | ON, OFF: 15 ms maximum                                                 |                                    |                                  |
| Contact Life: Mechanical                                  | 20 x 10 <sup>6</sup> mechanical operations                             |                                    |                                  |
| Contact Life: Electrical Voltage<br>240Vac, 120Vac, 24Vdc | Current: Resistive<br>2.0A                                             | Current: Lamp and Solenoid<br>0.6A | Typical<br>Operations<br>200,000 |



## 10.4.4 Wiring Diagram, IC200UEX211

Figure 81



## 10.5 IC200UEX212

### 28 Point Micro PLC Expansion Unit, (16) 24Vdc In, (12) Relay Out, 24Vdc Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX212 accepts sixteen DC inputs and provides twelve normally-open 2 Amp relay outputs. It uses +24Vdc nominal input power.

#### 10.5.1 DC Power

The 24Vdc power source must have enough transient current capability to support the inrush current of the power supply and to maintain a 24Vdc voltage. The +24Vdc supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

#### 10.5.2 DC Inputs

Sixteen configurable DC inputs can be used as positive or negative logic inputs. Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

#### 10.5.3 Relay Outputs (Q1 – Q12)

Twelve Form A (SPST-single pole single throw) normally-open relay outputs can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2A. An external source of AC or DC power must be supplied to operate field devices.

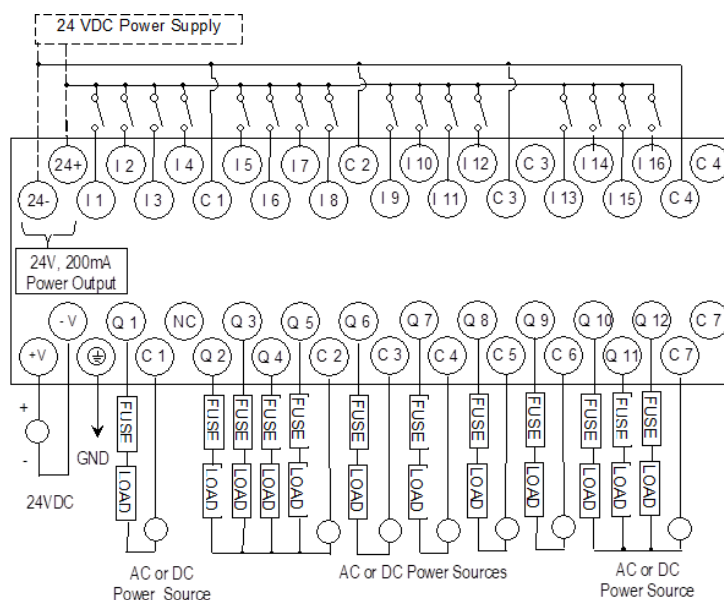
#### 10.5.4 Expansion Unit IC200UEX212 Specifications

| Item                           | Description                                          |
|--------------------------------|------------------------------------------------------|
| Inputs                         | Sixteen 24Vdc positive/negative logic input circuits |
| Outputs                        | Twelve normally open 2 amp relay circuits            |
| <b>DC Power Specifications</b> |                                                      |
| Range                          | 24 -20%, +25%Vdc                                     |
| Hold-up                        | 10ms at 19.2Vdc                                      |
| Inrush Current                 | 1 Amp maximum at 30Vdc                               |
| Inrush Time                    | 10ms for 1 A                                         |
| Input Current                  | 0.30 Amp typical at 24Vdc                            |
| Input Power Supply Rating      | 8W                                                   |
| +24Vdc Output Power Supply     | 200mA maximum (for input circuits and user devices)  |
| <b>DC Input Specifications</b> |                                                      |
| Number of Inputs               | 16                                                   |
| Rated Input Voltage            | 24 volts DC                                          |

| Item                                                      | Description                                                              |                                    |                               |
|-----------------------------------------------------------|--------------------------------------------------------------------------|------------------------------------|-------------------------------|
| Input Voltage Range                                       | 0 to 30 volts DC                                                         |                                    |                               |
| Input Current                                             | 7.5mA typical                                                            |                                    |                               |
| Input Resistance                                          | 2.8 kΩ                                                                   |                                    |                               |
| Input Threshold Voltage                                   | ON: 15Vdc minimum, OFF: 5Vdc maximum                                     |                                    |                               |
| Input Threshold Current                                   | ON: 4.5mA maximum, OFF: 1.5mA minimum                                    |                                    |                               |
| Response Time                                             | 0.5 to 20ms configurable                                                 |                                    |                               |
| Isolation Voltage                                         | 1500V RMS field side to logic side, 500V RMS between groups              |                                    |                               |
| Relay Output Specifications                               |                                                                          |                                    |                               |
| Operating Voltage                                         | 5 to 30Vdc or 5 to 250Vac                                                |                                    |                               |
| Isolation                                                 | 1500 V RMS between field side and logic side<br>500 V RMS between groups |                                    |                               |
| Leakage Current                                           | 15 mA at 240Vac maximum                                                  |                                    |                               |
| Maximum UL Pilot Duty Rating                              | 2 amps at 24Vdc and 240Vac                                               |                                    |                               |
| Maximum Resistive Load Rating                             | 2 amps at 24Vdc and 240Vac                                               |                                    |                               |
| Minimum Load                                              | 1 mA                                                                     |                                    |                               |
| Maximum Inrush                                            | 5 amps per half cycle                                                    |                                    |                               |
| Response Time                                             | ON, OFF: 15 ms maximum                                                   |                                    |                               |
| Contact Life: Mechanical                                  | 20 x 106 mechanical operations                                           |                                    |                               |
| Contact Life: Electrical Voltage<br>240Vac, 120Vac, 24Vdc | Current: Resistive<br>2A                                                 | Current: Lamp and<br>Solenoid 0.6A | Typical Operations<br>200,000 |

## 10.5.5 Wiring Diagram, IC200UEX212

Figure 82



## 10.6 IC200UEX213

### 28 Point Micro PLC Expansion Unit, (16) 12Vdc In, (12) Relay Out, 12Vdc Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX213 accepts sixteen 12Vdc inputs and provides twelve normally open 2 Amp relay outputs. It uses +12Vdc nominal input power.

#### 10.6.1 DC Power

The 12Vdc power source must have enough transient current capability to support the inrush current of the power supply and to maintain a 12Vdc voltage level.

#### 10.6.2 DC Inputs

Sixteen configurable 12Vdc inputs can be used as positive or negative logic standard inputs. Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The 12Vdc supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

#### 10.6.3 Relay Outputs (Q1 – Q12)

Twelve Form A (SPST-single pole single throw) normally open relay outputs can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices.

#### 10.6.4 Expansion Unit IC200UEX213 Specifications

| Item                           | Description                                          |
|--------------------------------|------------------------------------------------------|
| Inputs                         | Sixteen 12Vdc positive/negative logic input circuits |
| Outputs                        | Twelve normally open 2 amp relay circuits            |
| <b>DC Power Specifications</b> |                                                      |
| Range                          | 9.6Vdc - 15Vdc                                       |
| +12Vdc Output Power Supply     | 200mA maximum (for input circuits and user devices)  |
| Hold-up                        | 3.0mS                                                |
| Inrush Current                 | 9.6A typical at 12Vdc                                |
| Inrush Time                    | 200ms typical                                        |
| Input Current                  | 480mA typical at 12Vdc                               |
| Input Power Supply Rating      | 8W                                                   |
| <b>DC Input Specifications</b> |                                                      |
| Number of Inputs               | 16                                                   |

| Item                             | Description                                                              |                                    |                               |
|----------------------------------|--------------------------------------------------------------------------|------------------------------------|-------------------------------|
| Rated Input Voltage              | 12 volts DC                                                              |                                    |                               |
| Input Voltage Range              | 0 to 15 volts DC                                                         |                                    |                               |
| Input Current                    | 9.0mA typical                                                            |                                    |                               |
| Input Impedance                  | 1.3 kΩ                                                                   |                                    |                               |
| Input Threshold Voltage          | ON : 9.5Vdc minimum, OFF: 2.5Vdc maximum                                 |                                    |                               |
| Input Threshold Current          | ON: 6.5mA maximum , OFF: 1.6mA minimum                                   |                                    |                               |
| Response Time                    | 0.5 to 20ms (user configurable)                                          |                                    |                               |
| Isolation Voltage                | 1500V RMS field side to logic side, 500V RMS between groups              |                                    |                               |
| Relay Output Specifications      |                                                                          |                                    |                               |
| Operating Voltage                | 5 to 30Vdc or 5 to 250Vac                                                |                                    |                               |
| Isolation                        | 1500 V RMS between field side and logic side<br>500 V RMS between groups |                                    |                               |
| Leakage Current                  | 15 mA maximum                                                            |                                    |                               |
| Maximum UL Pilot Duty Rating     | 2 amps at 24Vdc and 240Vac                                               |                                    |                               |
| Maximum Resistive Load Rating    | 2 amps at 24Vdc and 240Vac                                               |                                    |                               |
| Minimum Load                     | 1 mA                                                                     |                                    |                               |
| Maximum Inrush                   | 5 amps per half cycle                                                    |                                    |                               |
| On Response Time                 | 15 ms maximum                                                            |                                    |                               |
| Off Response Time                | 15 ms maximum                                                            |                                    |                               |
| Contact Life: Mechanical         | 20 x 106 mechanical operations                                           |                                    |                               |
| Contact Life: Electrical Voltage | Current: Resistive<br>2A                                                 | Current: Lamp and<br>Solenoid 0.6A | Typical Operations<br>200,000 |



## 10.7 IC200UEX214

### 28 Point Micro PLC Expansion Unit, (16) 24Vdc In, (12) 24Vdc Out, 24Vdc Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX214 accepts sixteen DC inputs and provides four low-current and eight high-current DC transistor outputs. It uses +24Vdc nominal input power.

#### 10.7.1 DC Power

The 24Vdc power source must have enough transient current capability to support the inrush current of the power supply and to maintain a 24Vdc voltage level.

#### 10.7.2 DC Inputs

Sixteen configurable DC inputs can be used as positive or negative logic inputs. The inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The 24Vdc supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

#### 10.7.3 Transistor Outputs

Twelve positive-logic transistor output circuits can be used to switch devices like valves, lamps or contactors. External fusing should be provided to protect the outputs. Otherwise, a load short could damage the module output transistor, which is not user replaceable. Fast fuses are recommended.

Outputs are grouped in two groups with separated incoming supply. Each group contains 4 outputs with a maximum load of 0.5A and 2 outputs with a maximum load of 1A.

All outputs are isolated between field and logic and are switching positive voltage. The outputs have one common incoming supply (VC) and one common ground (COM). The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

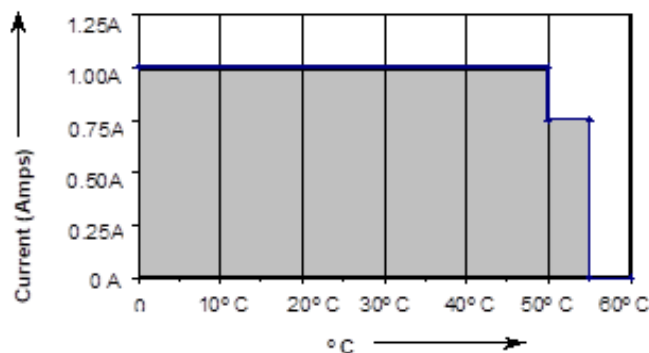
## 10.7.4 Expansion Unit IC200UEx214 Specifications

| Item                                    | Description                                                                                                                                                                           |
|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Inputs                                  | Sixteen 24Vdc positive logic inputs in four groups of four                                                                                                                            |
| Outputs                                 | Twelve transistor outputs, 24Vdc.                                                                                                                                                     |
| <b>DC Power Specifications</b>          |                                                                                                                                                                                       |
| Range                                   | 24 -20%, +25%Vdc                                                                                                                                                                      |
| Hold-up                                 | 10ms at 19.2Vdc                                                                                                                                                                       |
| +24Vdc Output Power Supply              | 200mA maximum (for input circuits an user devices)                                                                                                                                    |
| Inrush Current                          | 1 Amp maximum at 30Vdc                                                                                                                                                                |
| Inrush Time                             | 10ms for 1 Amp                                                                                                                                                                        |
| Input Current                           | 0.20 Amp typical at 24Vdc                                                                                                                                                             |
| Input Power Supply Rating               | 5W                                                                                                                                                                                    |
| <b>DC Input Specifications</b>          |                                                                                                                                                                                       |
| Rated Input Voltage                     | 24 volts DC                                                                                                                                                                           |
| Input Voltage Range                     | 0 to 30 volts DC                                                                                                                                                                      |
| Input Current                           | 7.5mA typical                                                                                                                                                                         |
| Input Resistance                        | 2.8 k $\Omega$                                                                                                                                                                        |
| Input Threshold Voltage                 | ON: 15Vdc minimum, OFF: 5Vdc maximum                                                                                                                                                  |
| Input Threshold Current                 | ON: 4.5mA maximum, OFF: 1.5mA minimum                                                                                                                                                 |
| Response Time                           | 0.5 to 20ms                                                                                                                                                                           |
| Isolation Voltage                       | 1500V RMS field side to logic side, 500V RMS between groups                                                                                                                           |
| <b>Transistor Output Specifications</b> |                                                                                                                                                                                       |
| Voltage Range                           | 12Vdc/24Vdc (24Vdc +10% / -43% input at V1,C1)                                                                                                                                        |
| Maximum Load (See below)                | 1.0A per point (Q1, Q2, Q11, Q12) at 24Vdc at 100% ON duration<br>0.75A per point (Q3 - Q10) at 24Vdc at 100 % ON duration<br>0.5A per point (Q3 - Q10) at 12Vdc at 100 % ON duration |
| Maximum Inrush Current                  | Q1,Q2,Q11,Q12: 8A for 20ms, 1 pulse, Q3-Q10: 4A for 20ms, 1 pulse                                                                                                                     |
| Output Voltage Drop                     | 0.3V maximum                                                                                                                                                                          |
| OFF state leakage                       | 100 $\mu$ A maximum                                                                                                                                                                   |
| Response Time                           | OFF to ON : 0.1ms maximum (24Vdc, 0.2A)<br>ON to OFF : 0.1ms maximum (24Vdc, 0.2A)                                                                                                    |
| Isolation Voltage                       | 1500V RMS between field side and logic side, 500V RMS between groups                                                                                                                  |
| External Fuse                           | Recommended                                                                                                                                                                           |



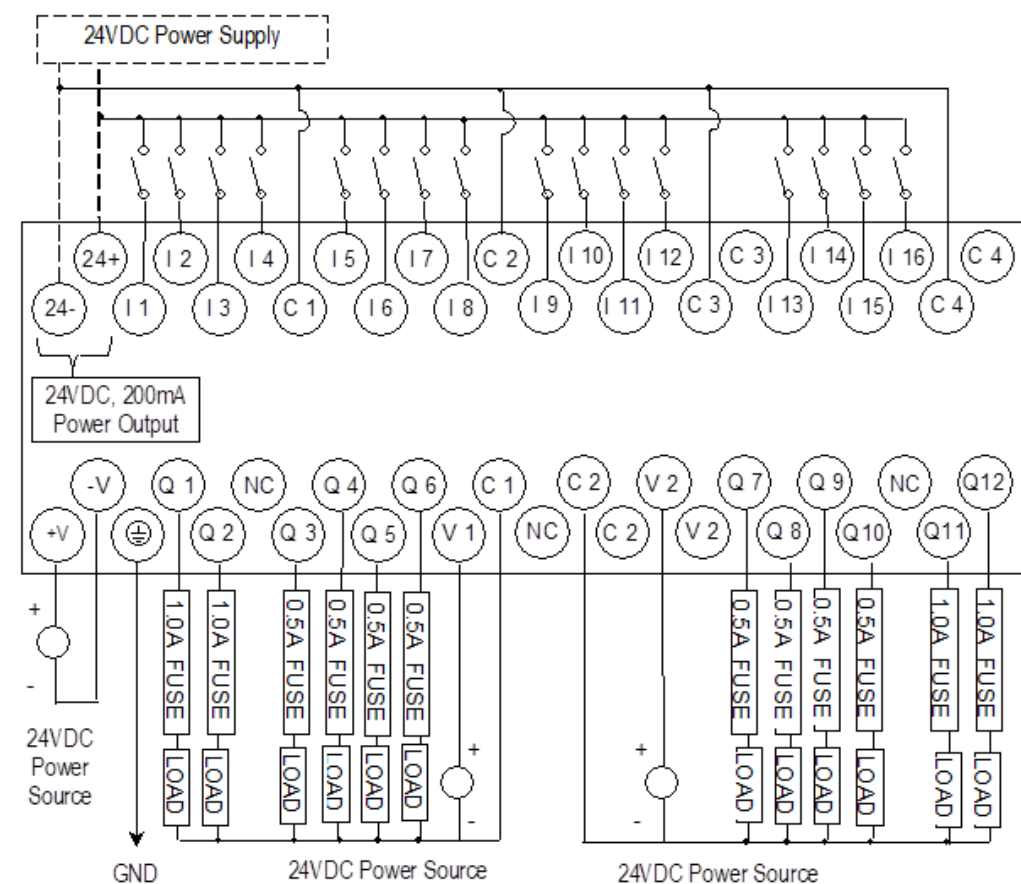
The maximum current that can be used for output points Q1, Q2, Q11 and Q12 is lower for ambient temperatures above 50°C, as indicated in the following figure:

Figure 84



## 10.7.5 Wiring Diagram, IC200UEx214

Figure 85



## 10.8 IC200UEX215

### 28 Point Micro PLC Expansion Unit, (16) 12Vdc In, (12) 12Vdc Out, 12Vdc Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX215 accepts sixteen 12Vdc inputs and provides twelve DC transistor outputs. It requires +12Vdc nominal input power.

#### 10.8.1 DC Power

The 12Vdc power source must have enough transient current capability to support the inrush current of the power supply and to maintain a 12Vdc voltage level.

#### 10.8.2 DC Inputs

Sixteen configurable DC inputs can be used as positive or negative logic inputs. The inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The 12Vdc supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

#### 10.8.3 Transistor Outputs

Expansion Unit IC200UEX215 has four high-current transistor outputs (Q1, Q2, Q11, and Q12) and eight low-current transistor outputs (Q3 to Q10). All outputs are isolated between field and logic and are switching positive voltage.

Outputs are grouped in two groups with separated incoming supply. Each group contains 4 outputs with a maximum load of 0.5A and 2 outputs with a maximum load of 1A. Each group of 6 outputs has one common incoming supply (V1, V2) and one common ground (C1, C2). The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

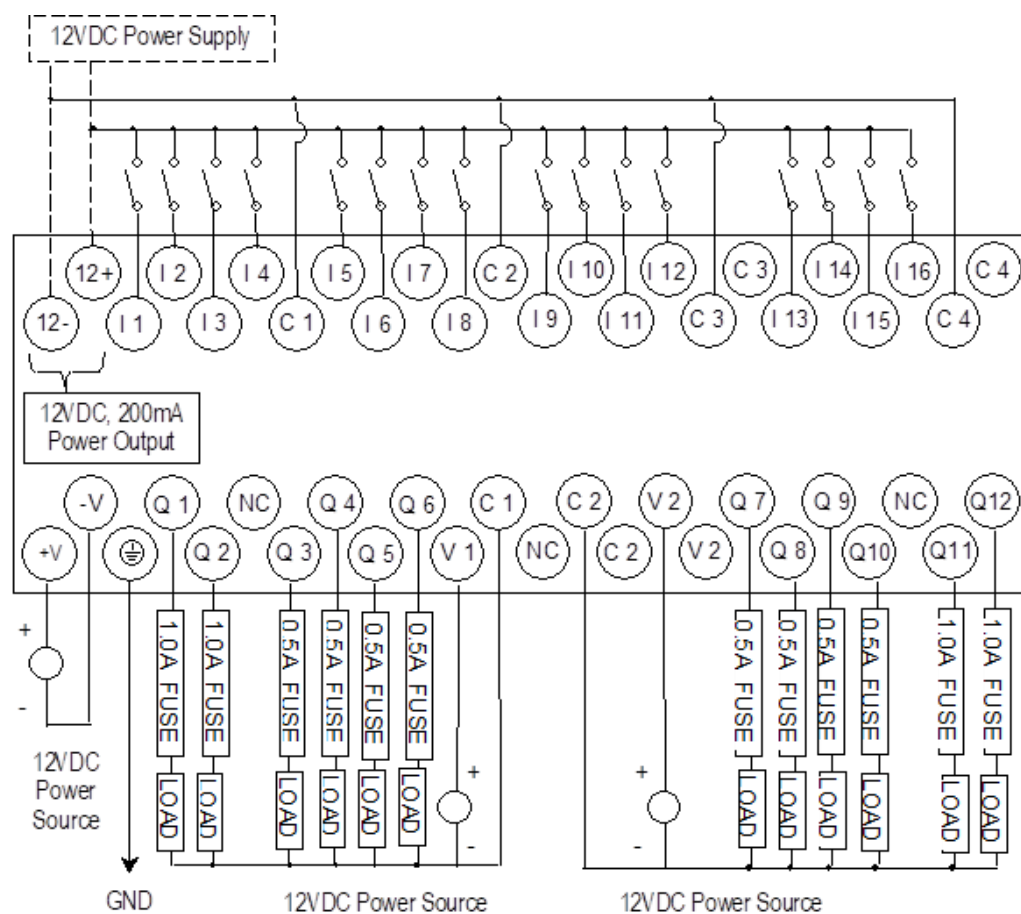
Outputs should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable. Fast fuses are recommended.

## 10.8.4 Expansion Unit IC200UEx215 Specifications

| Item                            | Description                                                            |
|---------------------------------|------------------------------------------------------------------------|
| Inputs                          | Sixteen 12Vdc positive logic inputs in four groups of four             |
| Outputs                         | Twelve transistor outputs, 12Vdc.                                      |
| +12Vdc Output Power Supply      | 200mA maximum (for input circuits and user devices)                    |
| <b>DC Power Specifications</b>  |                                                                        |
| Range                           | 9.6Vdc to 15Vdc                                                        |
| Hold-up                         | 3.0mS                                                                  |
| Inrush Current                  | 9.6A typical at 12Vdc                                                  |
| Inrush Time                     | 200ms typical                                                          |
| Input Current                   | 480mA typical at 12Vdc                                                 |
| Input Power Supply Rating       | 8W                                                                     |
| <b>DC Input Specifications</b>  |                                                                        |
| Number of Inputs                | 16                                                                     |
| Rated Input Voltage             | 12 volts DC                                                            |
| Input Voltage Range             | 0 to 15 volts DC                                                       |
| Input Current                   | 9.0mA typical                                                          |
| Input Resistance                | 1.3 k $\Omega$                                                         |
| Input Threshold Voltage         | ON: 9.5Vdc minimum, OFF: 2.5Vdc maximum                                |
| Input Threshold Current         | ON: 6.5mA maximum , OFF: 1.6mA minimum                                 |
| Response Time                   | 0.5 to 20ms (user configurable)                                        |
| Isolation Voltage               | 1500V RMS field side to logic side, 500V RMS between groups            |
| <b>DC Output Specifications</b> |                                                                        |
| Voltage Range                   | 12Vdc (+20%, -20%)                                                     |
| Maximum Load                    | 0.7A per point (Q1 - Q12) at 24Vdc at 100 % ON duration, 4A per common |
| Maximum Inrush Current          | 4A for 20mS                                                            |
| Output Voltage Drop             | 0.3V maximum                                                           |
| OFF state leakage               | 0.1mA maximum                                                          |
| Response Time                   | OFF to ON or ON to OFF : 0.1ms maximum (12Vdc)                         |
| Isolation Voltage               | 1500V RMS between field side and logic side, 500V RMS between groups   |
| Fuse                            | Outputs should be fused externally.                                    |

## 10.8.5 Wiring Diagram, IC200UEx215

Figure 86



## 10.9 IC200UEX222

### 28 Point Micro PLC Expansion Unit, (16) 24Vdc In, (12) 24Vdc Out with ESCP, 24Vdc Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX222 accepts sixteen DC inputs and provides twelve 24Vdc outputs. The outputs have electronic short circuit protection. The module uses +24Vdc nominal input power.

#### 10.9.1 DC Power

The 24Vdc power source must have enough transient current capability to support the inrush current of the power supply and to maintain a 24Vdc voltage level. 24Vdc output power is available for field devices, up to 200mA maximum.

#### 10.9.2 DC Inputs

Sixteen configurable DC inputs can be used as positive or negative logic inputs. The inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The +24Vdc supply can be used for input devices and to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 200 mA.

#### 10.9.3 Transistor Outputs

Twelve positive-logic DC outputs can be used to switch devices like valves, lamps or contactors. Outputs provide electronic short-circuit protection.

Outputs are grouped in three groups with separated incoming supply. Each group contains 4 outputs with a maximum load of 0.5A and 4 outputs with a maximum load of 1A.

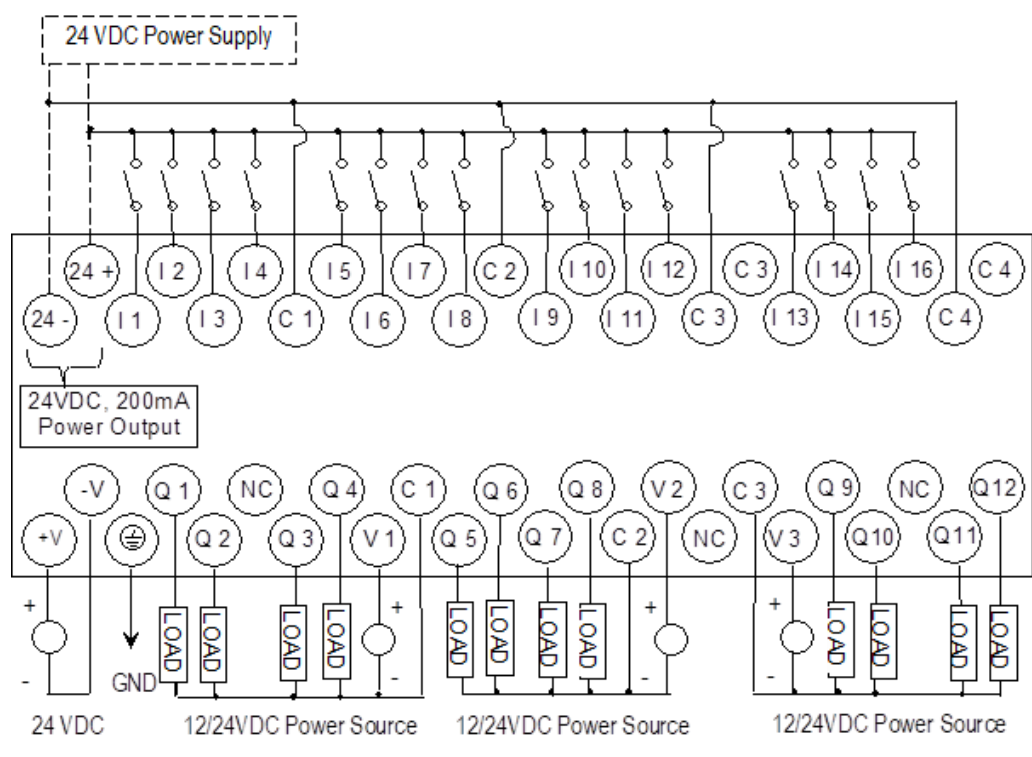
## 10.9.4 Expansion Unit IC200UEx222 Specifications

| Item                                                          | Description                                                            |
|---------------------------------------------------------------|------------------------------------------------------------------------|
| Inputs                                                        | Sixteen 24Vdc positive logic inputs in four groups of four             |
| Outputs                                                       | Twelve transistor outputs, 24Vdc                                       |
| <b>DC Power Specifications</b>                                |                                                                        |
| Range                                                         | 19.2Vdc to 30Vdc                                                       |
| Hold-up                                                       | 10ms at 19.2Vdc                                                        |
| 24Vdc Output Power Supply                                     | 200mA maximum (for input circuits and user devices)                    |
| Inrush Current                                                | 1 Amp maximum at 30Vdc                                                 |
| Inrush Time                                                   | 10ms for 1 Amp                                                         |
| Input Current                                                 | 0.20 Amp typical at 24Vdc                                              |
| Input Power Supply Rating                                     | 5W                                                                     |
| <b>DC Input Specifications</b>                                |                                                                        |
| Rated Input Voltage                                           | 24 volts DC                                                            |
| Input Voltage Range                                           | 0 to 30 volts DC                                                       |
| Input Current                                                 | 7.5mA typical                                                          |
| Input Resistance                                              | 2.8 kΩ                                                                 |
| Input Threshold Voltage                                       | ON: 15Vdc minimum, OFF: 5Vdc maximum                                   |
| Input Threshold Current                                       | ON: 4.5mA maximum, OFF: 1.5mA minimum                                  |
| Response Time                                                 | 0.5 to 20ms.                                                           |
| Isolation Voltage                                             | 1500V RMS field side to logic side, 500V RMS between groups            |
| <b>DC Output Specifications</b>                               |                                                                        |
| Voltage Range                                                 | Q1 – Q12: 12/24Vdc +10%, -15%                                          |
| External Power Supply (for supplying power to the V terminal) | 12/24V -10%, +20%                                                      |
| Maximum Load Current                                          | Q1 and Q2: 1A per point, Q3 - Q12: 0.7A per point                      |
| Minimum Switching Current                                     | 10mA                                                                   |
| Maximum Inrush Current                                        | Q1, Q2,Q11,Q12: 8A for 20ms, 1 pulse, Q3-Q10: 4A for 20ms, 1 pulse     |
| Output Voltage Drop                                           | Q1– Q12: 0.3V maximum                                                  |
| OFF state leakage current                                     | 0.1mA                                                                  |
| Response Time                                                 | OFF to ON or ON to OFF: 0.05ms maximum @ 24Vdc                         |
| Isolation Voltage                                             | 1500V RMS between field side and logic side<br>500V RMS between groups |
| Fuses                                                         | Not required                                                           |
| Under-voltage shutdown                                        | Q1 - Q12: 5V minimum, 8V maximum                                       |
| DC short circuit current                                      | Q1 – Q12: 0.7A minimum, 2A maximum                                     |

| Item                                     | Description |
|------------------------------------------|-------------|
| Peak short circuit current               | 4A maximum  |
| Delay time of peak short circuit current | 100μS       |
| Delay time of current limit              | 100μS       |

## 10.9.5 Wiring Diagram, IC200UEx222

Figure 87



# Chapter 11: VersaMax Micro PLC 64-Point Expansion Units

This chapter consists of module datasheets for the following VersaMax Micro PLC Expansion Units:

|                    |                                                                                                                         |
|--------------------|-------------------------------------------------------------------------------------------------------------------------|
| <b>IC200UEX064</b> | 64-point (40) 24Vdc In; (24) Relay Out; 24Vdc Power Supply                                                              |
| <b>IC200UEX164</b> | 64-point (40) 24Vdc In; (24) Relay Out; 120/240Vac Power Supply                                                         |
| <b>IC200UEX264</b> | 64-point (40) 24Vdc In; (4) LCDC 24Vdc Out; (16) LCDC 24Vdc Out with ESCP; (4) HCDC 24Vdc with ESCP; 24Vdc Power Supply |
| <b>IC200UEX364</b> | 64-point (40) 24Vdc In; (24) LCDC 24Vdc Out, 24Vdc Power Supply                                                         |

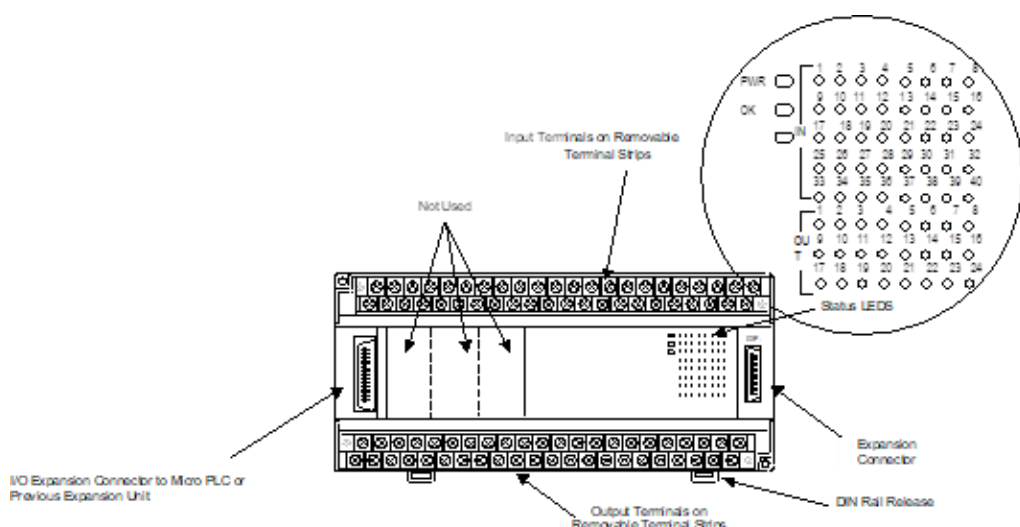
**Note:** The 64-point Expansion Units are supported on Micro PLUS PLCs (20/40/64-point Micro PLCs with release 4.0 or later firmware).

## 11.1 Features of VersaMax 64-Point Micro PLC Expansion Units

Modular 64-point Expansion Units can be used to increase the total I/O count of a Micro PLC. The 64-point Expansion Units can be used with any 20, 40 or 64-point Micro PLC. Expansion Units can be located up to 2 meters from the Micro PLC.

Input filtering is not supported for 64-point Expansion Units.

**Figure 88**



### 11.1.1 Removable Terminal Strips

The removable terminal assemblies are protected by hinged covers. After turning off power to the Expansion Unit, a terminal assembly and attached field wiring can be separated from the Expansion Unit by removing two screws.



## 11.1.2 Expansion Connector

The connector on the left side of the Expansion Unit is used to connect to the Micro PLC or to the outgoing connector on the previous Expansion Unit. The connector on the right side of the Expansion Unit can be used to attach to the next Expansion Unit.

## 11.1.3 Status LEDs

LEDs on the Expansion Unit provide quick visual verification of operating status. In addition to LEDs Expansion Unit local Power and OK mode, there is an LED for each I/O point.

## 11.1.4 Cables

A 0.1 meter ribbon cable (IC200CBL501) is provided with each Expansion Unit. Cables are also available in 0.5 meter (IC200CBL505) and 1 meter (IC200CBL510) lengths.

# 11.2 IC200UEX064 64 Point Micro PLC Expansion Unit, (40) 24Vdc In, (24) Relay Out, 24Vdc Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX064 accepts forty DC inputs and provides twenty-four relay outputs. It uses 24Vdc nominal input power.

## 11.2.1 DC Inputs

The forty configurable DC inputs can be used as positive or negative logic standard inputs. When used as standard inputs, they are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC +24Vdc supply can be used for input devices and to power the DC input circuits at about 8mA per input. The combination of input circuit current and external device current must not exceed 435mA.

## 11.2.2 Relay Outputs

The relay outputs can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices.

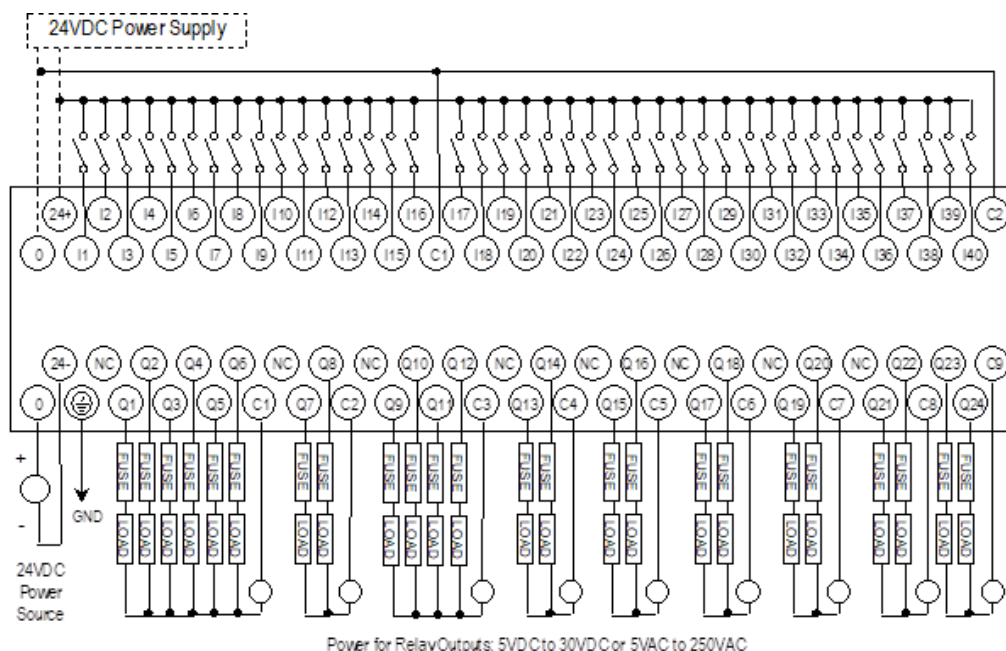
## 11.2.3 Expansion Unit IC200UEx064 Specifications

| Item                               | Description                                                                                                  |
|------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Inputs                             | Forty 24Vdc positive or negative logic inputs                                                                |
| Outputs                            | Twenty-four normally open 2-Amp relay circuits                                                               |
| <b>DC Power Specifications</b>     |                                                                                                              |
| Range                              | 19.2Vdc to 30Vdc                                                                                             |
| Hold-up                            | 10mS at 19.2Vdc                                                                                              |
| Inrush Current                     | 1 Amp maximum at 30Vdc                                                                                       |
| Inrush Time                        | 10mS for 1 Amp                                                                                               |
| Input Current                      | 0.20 Amp typical at 24Vdc                                                                                    |
| Input Power Supply Rating          | 5W                                                                                                           |
| <b>DC Input Specifications</b>     |                                                                                                              |
| Rated Input Voltage                | 24 volts DC                                                                                                  |
| Input Voltage Range                | 0 to 30 volts DC                                                                                             |
| Input Current at 24Vdc             | I1, I3, I5, I7: 8mA typical<br>Other inputs: 4.8mA typical                                                   |
| Input Impedance                    | I1, I3, I5, I7: 2.7 k $\Omega$<br>Other inputs: 4.7 k $\Omega$                                               |
| Input Threshold Voltage            | ON: 18Vdc minimum, OFF: 5Vdc maximum                                                                         |
| Input Threshold Current            | I1, I3, I5, I7: ON: 4.5mA maximum, OFF: 1.8mA minimum<br>Other inputs: ON: 3.3mA maximum, OFF: 1.6mA maximum |
| Response Time (Input Lag)          | I1, I3, I5, I7: 1.5ms maximum<br>Other inputs: 2ms maximum                                                   |
| Isolation Voltage                  | 1500V RMS field side to logic side,<br>500V RMS between groups                                               |
| <b>Relay Output Specifications</b> |                                                                                                              |
| Operating Voltage                  | 5 to 30Vdc or 5 to 250Vac                                                                                    |
| Isolation                          | 1500 V RMS between field side and logic side, 500 V RMS between groups                                       |
| Leakage Current                    | 15 mA at 240Vac maximum                                                                                      |
| Maximum UL Pilot Duty Rating       | 2 amps at 24Vdc and 240Vac                                                                                   |
| Maximum Resistive Load Rating      | 2 amps at 24Vdc and 240Vac                                                                                   |
| Minimum Load                       | 10 mA                                                                                                        |
| Maximum Inrush                     | 5 amps per half cycle                                                                                        |
| Response Time                      | ON: 15 ms maximum, OFF: 15 ms maximum                                                                        |
| Contact Life: Mechanical           | 20 x 10 <sup>6</sup> mechanical operations                                                                   |

| Item                                                         | Description                |                                       |                                  |
|--------------------------------------------------------------|----------------------------|---------------------------------------|----------------------------------|
| Contact Life: Electrical<br>Voltage<br>240Vac, 120Vac, 24Vdc | Current: Resistive<br>2.0A | Current: Lamp and<br>Solenoid<br>0.6A | Typical<br>Operations<br>200,000 |

## 11.2.4 Wiring Diagram, IC200UEx064

Figure 89



## 11.3 IC200UEx164

### 64 Point Micro PLC Expansion Unit, (40) 24Vdc In, (24) Relay Out, 120/240Vac Power Supply

VersaMax Micro PLC Expansion Unit IC200UEx164 accepts forty DC inputs and provides twenty-four relay outputs. It uses 100Vac to 240Vac nominal input power.

### 11.3.1 DC Inputs

The forty configurable DC inputs can be used as positive or negative logic standard inputs. They are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC +24Vdc supply can be used for input devices and to power the DC input circuits at about 8mA per input. The combination of input circuit current and external device current must not exceed 435 mA.

## 11.3.2 Relay Outputs

The relay outputs can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. An external source of AC or DC power must be supplied to operate field devices.

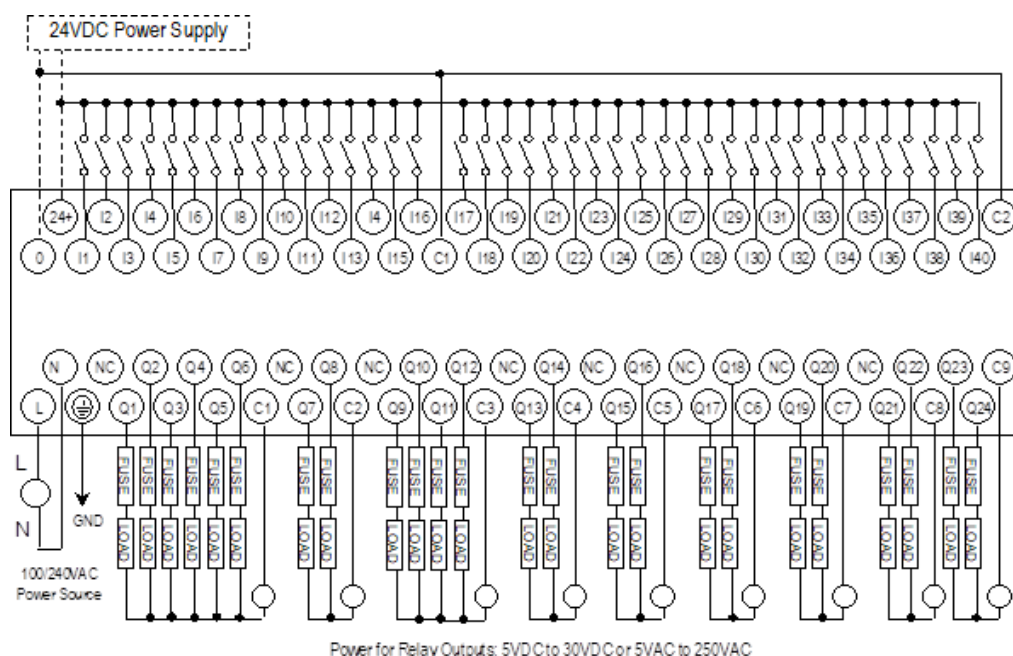
## 11.3.3 Expansion Unit IC200UEX164 Specifications

| Item                               | Description                                                                                                |
|------------------------------------|------------------------------------------------------------------------------------------------------------|
| Inputs                             | Forty 24Vdc positive or negative logic inputs                                                              |
| Outputs                            | Twenty-four relay outputs                                                                                  |
| <b>AC Power Specifications</b>     |                                                                                                            |
| Range                              | 100 -15% to 240 +10%Vac                                                                                    |
| Frequency                          | 50 -5% to 60 +5% Hz                                                                                        |
| Hold-up                            | 10ms at 85–100Vac, 20ms at 100–265Vac                                                                      |
| Inrush Time                        | 2ms for 40 Amp                                                                                             |
| Inrush Current                     | 30 Amp maximum at 200Vac, 40 Amp maximum at 265Vac                                                         |
| Input Current                      | 0.10 Amp typical at 100Vac, 0.20 Amp typical at 200Vac                                                     |
| Input Power Supply Rating          | 26 VA                                                                                                      |
| <b>DC Input Specifications</b>     |                                                                                                            |
| Rated Input Voltage                | 24 volts DC                                                                                                |
| Input Voltage Range                | 0 to 30 volts DC                                                                                           |
| Input Current at 24Vdc             | I1, I3, I5, I7: 8mA typical<br>Other inputs: 4.8mA typical                                                 |
| Input Impedance                    | I1, I3, I5, I7: 2.7 k $\Omega$<br>Other inputs: 4.7 k $\Omega$                                             |
| Input Threshold Voltage            | ON: 18Vdc minimum, OFF: 5Vdc maximum                                                                       |
| Input Threshold Current            | I1, I3, I5, I7: ON 4.5mA maximum, OFF: 1.8mA minimum<br>Other inputs: ON 3.3mA maximum, OFF: 1.6mA maximum |
| Response Time (Input Lag)          | I1, I3, I5, I7: 1.5ms maximum<br>Other inputs: 2ms maximum                                                 |
| Isolation Voltage                  | 1500V RMS field side to logic side, 500V RMS between groups                                                |
| <b>Relay Output Specifications</b> |                                                                                                            |
| Operating Voltage                  | 5 to 30Vdc or 5 to 250Vac                                                                                  |
| Isolation                          | 1500 V RMS between field side and logic side, 500 V RMS between groups                                     |
| Leakage Current                    | 15 mA at 240Vac maximum                                                                                    |
| Maximum UL Pilot Duty Rating       | 2 amps at 24Vdc and 240Vac                                                                                 |
| Maximum Resistive Load Rating      | 2 amps at 24Vdc and 240Vac                                                                                 |
| Minimum Load                       | 10 mA                                                                                                      |
| Maximum Inrush                     | 5 amps per half cycle                                                                                      |

| Item                                                      | Description                                |                                       |                                  |
|-----------------------------------------------------------|--------------------------------------------|---------------------------------------|----------------------------------|
| Response Time                                             | ON: 15 ms maximum, OFF: 15 ms maximum      |                                       |                                  |
| Contact Life: Mechanical                                  | 20 x 10 <sup>6</sup> mechanical operations |                                       |                                  |
| Contact Life: Electrical Voltage<br>240Vac, 120Vac, 24Vdc | Current: Resistive<br>2.0A                 | Current: Lamp and<br>Solenoid<br>0.6A | Typical<br>Operations<br>200,000 |

## 11.3.4 Wiring Diagram, IC200UEx164

Figure 90



## 11.4 IC200UEx264

### 64 Point Micro PLC Expansion Unit, (24) 24Vdc In, (4) LCDC, (16) LCDC with ESCP, (4) HCDC with ESCP Out, 24Vdc Power Supply

VersaMax Micro PLC Expansion Unit IC200UEx264 accepts forty DC inputs and provides twenty-four transistor outputs. It uses 24Vdc nominal input power.

### 11.4.1 DC Inputs

The forty configurable DC inputs can be used as positive or negative logic inputs. Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. The +24Vdc supply can be used for input devices and to power the DC input circuits. The combination of input circuit current and external device current must not exceed 200 mA.

## 11.4.2 DC Outputs

Outputs 1 – 4 are standard LCDC source-type outputs. Outputs can be used to switch devices like valves, lamps or contactors.

Outputs 5 – 20 are low current (LCDC) source-type outputs with ESCP.

Outputs 21 – 24 are high current (HCDC) source-type outputs with ESCP.

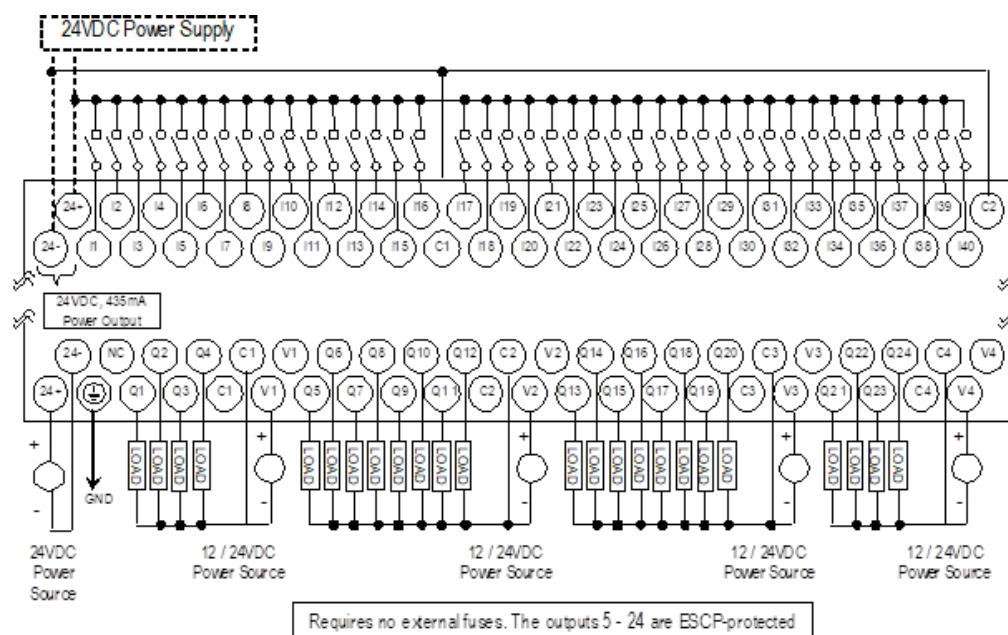
## 11.4.3 Expansion Unit IC200UEX264 Specifications

| Item                           | Description                                                                                                                                                                |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Inputs                         | Forty 24Vdc positive or negative logic inputs                                                                                                                              |
| Outputs                        | Twenty-four transistor outputs, 24Vdc.                                                                                                                                     |
| <b>DC Power Specifications</b> |                                                                                                                                                                            |
| Range                          | 19.2Vdc to 30Vdc                                                                                                                                                           |
| Hold-up                        | 10mS at 19.2Vdc                                                                                                                                                            |
| Inrush Current                 | 1 Amp maximum at 30Vdc                                                                                                                                                     |
| Inrush Time                    | 10mS for 1 Amp                                                                                                                                                             |
| Input Current                  | 0.20 Amp typical at 24Vdc                                                                                                                                                  |
| Input Power Supply Rating      | 5W                                                                                                                                                                         |
| <b>DC Input Specifications</b> |                                                                                                                                                                            |
| Rated Input Voltage            | 24 volts DC                                                                                                                                                                |
| Input Voltage Range            | 0 to 30 volts DC                                                                                                                                                           |
| Input Current at 24Vdc         | I1, I3, I5, I7: 8mA typical<br>Other inputs: 4.8mA typical                                                                                                                 |
| Input Impedance                | I1, I3, I5, I7: 2.7 kΩ<br>Other inputs: 4.7 kΩ                                                                                                                             |
| Input Threshold Voltage        | ON: 18Vdc minimum, OFF: 5Vdc maximum                                                                                                                                       |
| Input Threshold Current        | I1, I3, I5, I7: ON 4.5mA maximum, OFF: 1.8mA minimum<br>Other inputs: ON 3.3mA maximum, OFF: 1.6mA maximum                                                                 |
| Response Time (Input Lag)      | I1, I3, I5, I7: 1.5ms maximum<br>Other inputs: 2ms maximum                                                                                                                 |
| Isolation Voltage              | 1500V RMS field side to logic side, 500V RMS between groups                                                                                                                |
| <b>Output Specifications</b>   |                                                                                                                                                                            |
| Voltage Range                  | 12Vdc/24Vdc                                                                                                                                                                |
| External Power Supply          | 12/24Vdc –10%, +20%                                                                                                                                                        |
| Maximum Load Current           | 0.5A per point (Q1 – Q4) at 24Vdc at 100% ON duration<br>0.7A per point (Q5 – Q20) at 24Vdc at 100% ON duration<br>1.0A per point (Q21 – Q24) at 24Vdc at 100% ON duration |
| Minimum Switching Current      | 10mA                                                                                                                                                                       |

| Item                                     | Description                                                                                  |
|------------------------------------------|----------------------------------------------------------------------------------------------|
| Maximum Inrush Current                   | Q1-Q4: 2A for 20ms, 1 pulse<br>Q5-Q20: 4A for 20ms, 1 pulse<br>Q21-Q24: 8A for 20ms, 1 pulse |
| Output Voltage Drop                      | 0.3V maximum                                                                                 |
| OFF state leakage current                | 0.1mA maximum                                                                                |
| Response Time (OFF-to-ON and ON-to-OFF)  | Q1-Q4: 5μs maximum, 24Vdc<br>Q5-Q20: 0.5ms maximum, 24Vdc<br>Q21-Q24: 0.5ms maximum, 24Vdc   |
| Isolation Voltage                        | 1500V RMS between field side and logic side,<br>500V RMS between groups                      |
| Fuse                                     | None, outputs 5-24 are ESCP protected                                                        |
| Under-voltage shutdown                   | Q5 - Q20: 5V minimum, 8V maximum                                                             |
| DC short circuit current                 | Q1 - Q4, Q21 - Q24: 5A typical<br>Q5 - Q20: 0.7A minimum, 2A maximum                         |
| Peak short circuit current               | Q5 - Q20: 4A maximum                                                                         |
| Delay time of peak short circuit current | 100 μS                                                                                       |
| Delay time of current limit              | 100 μS                                                                                       |

## 11.4.4 Wiring Diagram, IC200UEx264

Figure 91



## 11.5 IC200UEX364 64 Point Micro PLC Expansion Unit, (40) 24Vdc In, (24) LCDC Out, 24Vdc Power Supply

VersaMax Micro PLC Expansion Unit IC200UEX364 accepts forty DC inputs and provides twenty-four low current (LCDC) transistor outputs. It uses 24Vdc nominal input power.

### 11.5.1 DC Power

The 24Vdc power source for the Expansion Unit must have enough transient current capability to support the inrush current of the power supply and to maintain a 24Vdc voltage level (see power supply specifications for inrush requirements).

### 11.5.2 DC Inputs

Forty configurable DC inputs can be used as positive or negative logic standard inputs. They are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The Micro PLC Expansion Unit's +24Vdc supply can be used for input devices and to power the DC input circuits at about 8mA per input. The combination of input circuit current and external device current must not exceed 435mA.

### 11.5.3 DC Outputs

The Micro PLC Expansion Unit IC200UEX364 has 24 sink-type DC outputs. All outputs are isolated between field and logic and are switching positive voltage. The outputs have one common incoming supply (VC) and one common ground (COM). The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

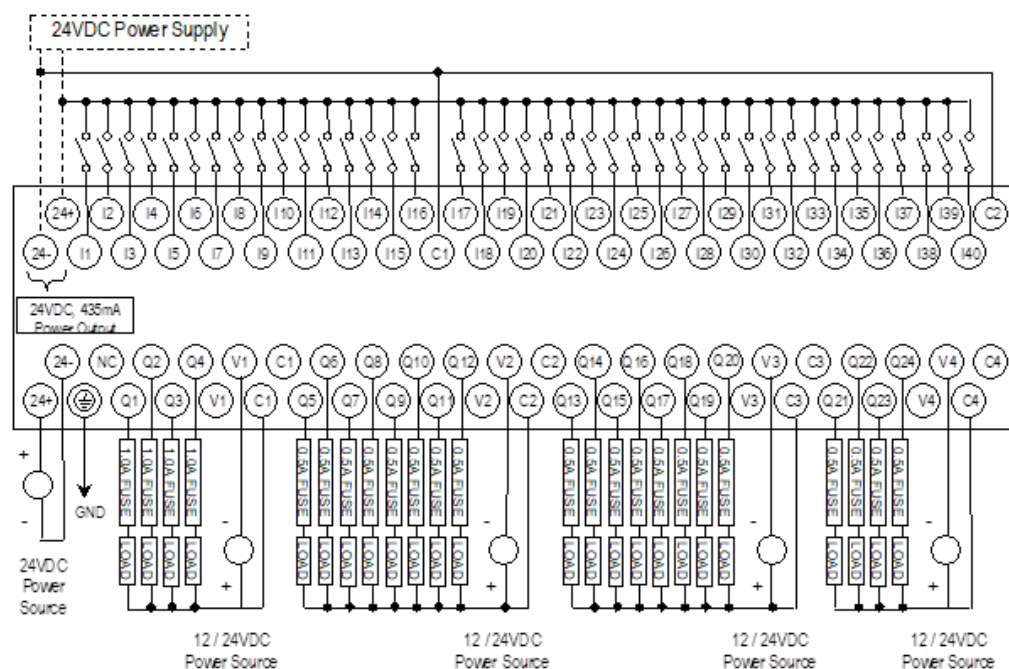


## 11.5.4 Expansion Unit IC200UEx364 Specifications

| Item                                    | Description                                                                                                |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------|
| Inputs                                  | Forty 24Vdc positive or negative logic inputs                                                              |
| Outputs                                 | Twenty-four transistor outputs, 24Vdc.                                                                     |
| <b>DC Power Specifications</b>          |                                                                                                            |
| Range                                   | 19.2Vdc to 30Vdc                                                                                           |
| Hold-up                                 | 10mS at 19.2Vdc                                                                                            |
| Inrush Current                          | 1 Amp maximum at 30Vdc                                                                                     |
| Inrush Time                             | 10mS for 1 Amp                                                                                             |
| Input Current                           | 0.20 Amp typical at 24Vdc                                                                                  |
| Input Power Supply Rating               | 5W                                                                                                         |
| <b>DC Input Specifications</b>          |                                                                                                            |
| Rated Input Voltage                     | 24 volts DC                                                                                                |
| Input Voltage Range                     | 0 to 30 volts DC                                                                                           |
| Input Current at 24Vdc                  | I1, I3, I5, I7: 8mA typical<br>Other inputs: 4.8mA typical                                                 |
| Input Impedance                         | I1, I3, I5, I7: 2.7 k $\Omega$<br>Other inputs: 4.7 k $\Omega$                                             |
| Input Threshold Voltage                 | ON: 18Vdc minimum, OFF: 5Vdc maximum                                                                       |
| Input Threshold Current                 | I1, I3, I5, I7: ON 4.5mA maximum, OFF: 1.8mA minimum<br>Other inputs: ON 3.3mA maximum, OFF: 1.6mA maximum |
| Response Time (Input Lag)               | I1, I3, I5, I7: 1.5ms maximum<br>Other inputs: 2ms maximum                                                 |
| Isolation Voltage                       | 1500V RMS field side to logic side, 500V RMS between groups                                                |
| <b>Output Specifications</b>            |                                                                                                            |
| Voltage Range                           | 12Vdc/24Vdc                                                                                                |
| External Power Supply                   | 12/24Vdc –10%, +20%                                                                                        |
| Maximum Load Current                    | 0.5A per point (Q1 – Q24) at 24Vdc                                                                         |
| Minimum Switching Current               | 10mA                                                                                                       |
| Maximum Inrush Current                  | Q1-Q24: 2A for 20ms, 1 pulse                                                                               |
| Output Voltage Drop                     | Q1– Q24: 0.3Vdc                                                                                            |
| OFF state leakage current               | 0.1mA                                                                                                      |
| Response Time (OFF-to-ON and ON-to-OFF) | 1mS maximum @ 24Vdc                                                                                        |
| Isolation Voltage                       | 1500V RMS between field side and logic side, 500V RMS between groups                                       |
| Fuses                                   | None                                                                                                       |
| Under-voltage shutdown                  | Q1 – Q24: 5V minimum, 8V maximum                                                                           |
| DC short circuit current                | Q1 – Q24: 0.7A minimum, 2A maximum                                                                         |

## 11.5.5 Wiring Diagram, IC200UEX364

Figure 92



## Chapter 12: Analog Expansion Units

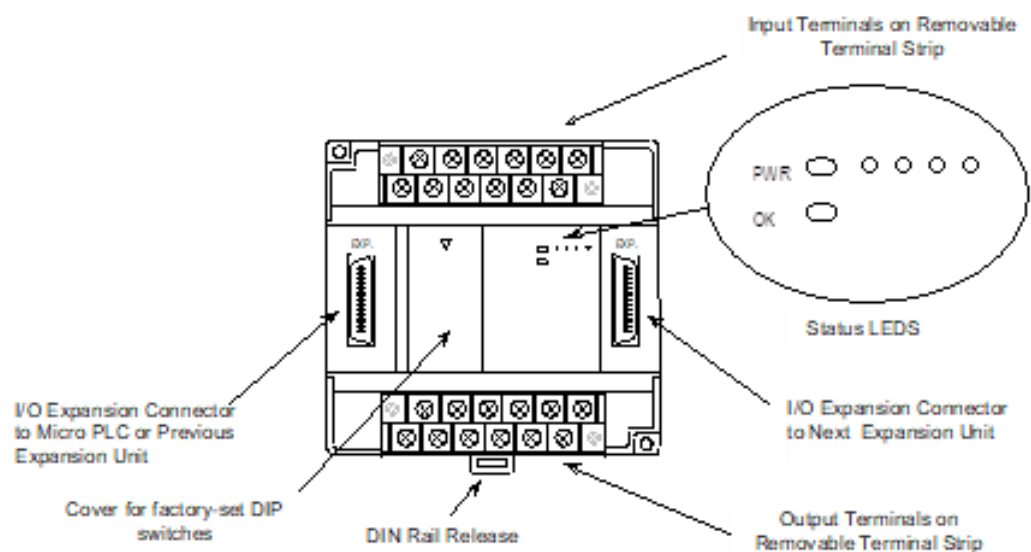
This chapter describes the following VersaMax Micro PLC Analog Expansion Units:

- IC200UEX616** 6 Point Analog Expansion Unit, (4) Analog In and (2) Analog Out, 12Vdc Power Supply
- IC200UEX624** 4 Point Analog Expansion Unit, (4) Analog In, 24Vdc Power Supply
- IC200UEX626** 6 Point Analog Expansion Unit, (4) Analog In and (2) Analog Out, 24Vdc Power Supply
- IC200UEX636** 6 Point Analog Expansion Unit, (4) Analog In and (2) Analog Out, 100/240Vac Power Supply

### 12.1 Features of Analog Expansion Units

Analog, Expansion Units have the features shown below. Expansion Units can be located up to 2 meters from the Micro PLC.

Figure 93



#### 12.1.1 Removable Terminal Strips

The removable terminal assemblies are protected by hinged covers. After turning off power to the Expansion Unit, a terminal assembly and attached field wiring can be separated from the Expansion Unit by removing two screws.

#### 12.1.2 Expansion Connector

The connector on the left side of the Expansion Unit is used to connect to the Micro PLC or to the outgoing connector on the previous Expansion Unit. The connector on the right side of the Expansion Unit can be used to attach to the next Expansion Unit.

## 12.1.3 Status LEDs

LEDs on the Expansion Unit provide quick visual verification of operating status. Expansion Unit LEDs indicate local Power and OK mode.

## 12.1.4 Cables

A 0.1-meter ribbon cable (IC200CBL501) is provided with each Expansion Unit. Cables are also available in 0.5-meter (IC200CBL505) and 1 meter (IC200CBL510) lengths.

# 12.2 Analog Expansion Unit Specifications

|                   |                                                              |
|-------------------|--------------------------------------------------------------|
| Module Dimensions | Height: 90mm (3.6"), Depth: 76mm (3.0") Width: 150mm (6.0 ") |
| Inputs            | 4 analog inputs                                              |
| Outputs           | 2 analog outputs (all models except UEX624)                  |

## 12.2.1 Power Specifications for Analog Expansion Units

|                           | IC200UEX616       | IC200UEX624,<br>UEX626 | IC200UEX636                              |
|---------------------------|-------------------|------------------------|------------------------------------------|
| Power voltage             | 12Vdc             | 24Vdc                  | 100/110/120/200/210/220V<br>(50/60Hz)Vac |
| Range                     | 9.6Vdc - 15Vdc    | 19.2Vdc to 30Vdc       | 85 to 264Vac                             |
| Hold-up                   | 10.1ms at 9.6V    | 24.5ms at 19.2V        | 223ms at 85V                             |
| Inrush Current/Time       | 0.9A / 1ms at 15V | 2.5V / 1ms at 30V      | 4A / 5ms at 264V                         |
| Input Current             | 0.15A at 15V      | 0.1A at 30V            | 0.06A at 264V                            |
| Input Power Supply Rating | 2.25W             | 3W                     | 15VA                                     |

The DC power source must have enough transient current capability to support the inrush current of the power supply and to maintain the nominal voltage level.

## 12.2.2 Input and Output Specifications

| Item                                | Description                                                                                                                             |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Analog Input Channels (IC200UEX6**) | 4, differential                                                                                                                         |
| Input ranges                        | 0 to 10V (10.23V maximum)<br>-10V to +10V (-10.23V min. and +10.23V max.)<br>0 to 20mA (20.47mA maximum)<br>4 to 20mA (20.47mA maximum) |
| Resolution                          | 12 bits                                                                                                                                 |
| Accuracy                            | ±1% of full scale over full operating temperature range                                                                                 |
| Linearity                           | ±3 LSB maximum                                                                                                                          |
| Isolation                           | non-isolated                                                                                                                            |
| Common mode voltage                 | ±40 V maximum                                                                                                                           |
| Current input impedance             | 249 Ω                                                                                                                                   |

| Item                                                                                                      | Description                                                                             |
|-----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| Voltage input impedance                                                                                   | 200 k $\Omega$                                                                          |
| Input filter time                                                                                         | 20ms to reach 1% error for step input                                                   |
| Analog Output Channels                                                                                    | 2, single-ended, non-isolated                                                           |
| Output ranges                                                                                             | 0 to 10V (10.23V maximum)<br>0 to 20mA (20.47mA maximum)<br>4 to 20mA (20.47mA maximum) |
| Resolution                                                                                                | 12 bits                                                                                 |
| Accuracy                                                                                                  | $\pm 1\%$ of full scale over operating temperature range                                |
| Current: maximum terminal voltage<br>user load range<br>output load capacitance<br>output load inductance | 10V (at 20mA output)<br>10 to 500 $\Omega$<br>2000 pF maximum<br>1 Henry maximum        |
| Voltage: output loading<br>output load capacitance                                                        | 10 k $\Omega$ minimum at 10 volts<br>1 $\mu$ F maximum                                  |

## 12.3 Analog Operation

This section explains how a VersaMax Micro PLC Expansion Unit with analog channels processes analog data. Unlike discrete expansion units, if one analog unit fails all subsequent analog expansion units will stop communicating. However, expansion units before the failed unit continue to be available. If an analog expansion fails at power up, no expansion units (discrete or analog) will be functional.

### 12.3.1 Analog I/O Parameters

Each analog channel can be configured to operate in either voltage or current mode. If current mode operation is selected, the range can then be configured as either 4-20mA or 0-20mA. If voltage mode operation is selected (inputs only), the range can then be configured as either 0-10V or -10V to +10V.

| Parameter                             | Choices          | Default Value |
|---------------------------------------|------------------|---------------|
| Voltage or current mode               | Voltage, Current | Voltage       |
| Current range selection               | 4–20mA, 0–20mA   | 4–20mA        |
| Voltage range selection (Inputs Only) | 0-10V, -10-+10V  | 0-10V         |

## 12.3.2 Input/Output Values Compared to Process Data

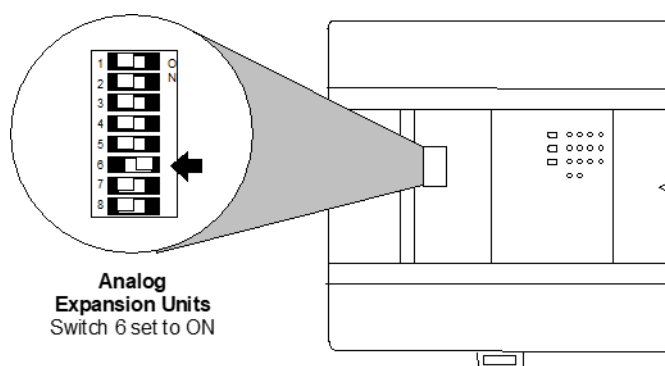
The Expansion Unit processes analog channels using fixed conversion values for both current and voltage mode operation. The table below shows the relationship between the analog input and output values used by the application program, and the actual analog input or output for each mode. These values include the automatic adjustments for gain.

| In this Configured Mode:          | This is the Analog Signal Range | This is the Equivalent Process Data %AI or %AQ Range | For the Default Calibration, the Value in the %AI or %AQ Reference Equals: |
|-----------------------------------|---------------------------------|------------------------------------------------------|----------------------------------------------------------------------------|
| Voltage 0 to +10V                 | 0 to 10,000mV                   | 0 to 32000                                           | 3.2 x mV                                                                   |
| Voltage -10 to +10V (Inputs Only) | -10,000mv to +10,000mV          | -32000 to 32000                                      | 3.2 x mV                                                                   |
| Current 0 to 20mA                 | 0 to 20,000μA                   | 0 to 32000                                           | 1.6 x μA                                                                   |
| Current 4 to 20mA                 | 4,000 to 20,000μA               | 0 to 32000                                           | 2 x μA -8000                                                               |

## 12.3.3 Count Resolution for Analog Expansion Units

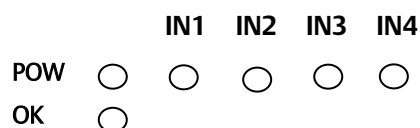
For analog expansion units, count resolution is controlled by a DIP switch 6, which is set to ON by default. If unexpected results are observed, check the position of switch 6. If switch 6 is not ON, power down the system and set switch 6 to ON, as shown in the following figure. Do NOT change any of the other switches.

Figure 94



## 12.3.4 LED Indications

The module's LEDs indicate the status of the module and of the analog inputs.

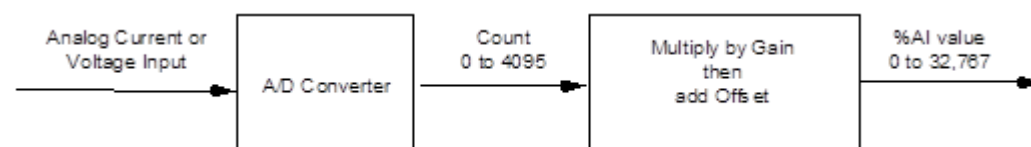


If an initialization error occurs, the OK LED blinks rapidly. During normal operation, the analog input LEDs should be off.

## 12.3.5 Analog Input Processing

The Expansion Unit processes analog input channels with a 12-bit successive-approximation A/D converter. It converts the analog value into a digital count, calculates the %AI value as described below, then places the result into the appropriate %AI input reference (these references are described in Chapter 22:).

**Figure 95**



### Automatic Conversion of Analog Voltage or Current to Counts

In voltage mode, the Expansion Unit first converts the 0 to 10,000mV input signal to a count in the range of 0 to 4,000 (or -10,000mV to 10,000mV signal to a range of -4,000 to 4,000). The fixed multiplier for this conversion is 2.5.

In current mode, the Expansion Unit first converts the 0 to 20,000μA input signal to a count value in the range of 0 to 4,000. The fixed multiplier for this conversion is 5. The conversion for both current modes (0-20mA and 4-20mA) is the same.

### Automatic Gain and Offset Adjustment for Analog Inputs

The Expansion Unit then converts the A/D converter's input count value from the range of 0 to 4000 to a final %AI input value in the range of 0 to 32,000. It multiplies the count value by 8 (32000 / 4000) to get the final analog input (%AI):

$$(\text{input count} \times 8) = \%AI \text{ value}$$

Any calculated value above 32,767 is clamped at that maximum value. Any calculated value less than 0 is clamped at 0.

### Analog Input Conversion Summary

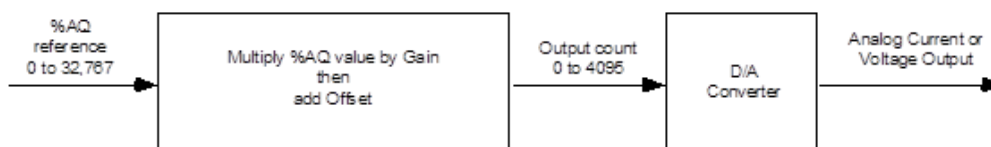
The table below summarizes the conversion of voltage or current inputs to counts and then to %AI values.

| Input Signal                       | Conversion Factor | A/D Converter Value  | Gain Factor | %AI Range         |
|------------------------------------|-------------------|----------------------|-------------|-------------------|
| Voltage Mode (0 to 10,000mV)       | 2.5               | 0-4000 counts        | 8           | 0-32,000          |
| Voltage Mode (-10,000 to 10,000mV) | 2.5               | -4000 to 4000 counts | 8           | -32,000 to 32,000 |
| Current Mode (0-20mA) or (4-20mA)  | 5                 | 0-4000 counts        | 8           | 0-32,000          |

## 12.3.6 Analog Output Processing

To generate the analog output signal, the Expansion Unit converts the value in the %AQ output reference into a count value for the 12-bit D/A converter, which then drives the analog output.

**Figure 96**



### Automatic Gain and Offset Adjustment for Analog Outputs

The application's %AQ output range of 0 to 32000 corresponds to the D/A converter's output count range of 0 to 4000. The Expansion Unit first multiplies the %AQ value from the program by .125 (4000 / 32000) to produce the count value for the D/A converter:

$$(\%AQ \times .125) = \text{D/A count}$$

Any calculated value that exceeds 4095 (2<sup>12</sup>-1) is clamped at that maximum value. Any calculated value less than 0 is clamped at 0. The range 0 to 4095 corresponds to %AQ values between 0 and 32,767.

### Automatic Conversion of Counts to Analog Voltage or Current

In voltage mode, the D/A converter then converts the count value in the range of 0 to 4,000 counts to an analog signal from 0 to 10,000mV. The output voltage gain (ratio) for this conversion is 2.5.

In current mode, the D/A converter converts the count value to an analog signal from 0 to 20,000μA. The output current gain for this conversion is 5. The conversion for both current modes (0-20mA and 4-20mA) is the same.

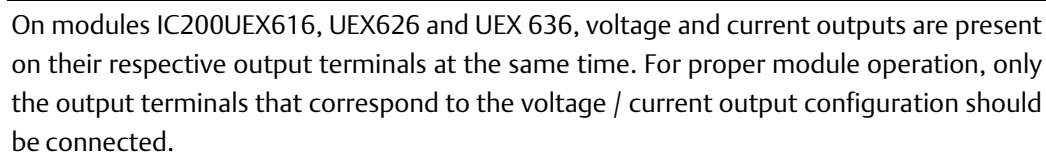
### Analog Output Data Conversion Summary

The table below summarizes the conversion of %AQ values to counts and then to voltage or current levels.

| %AQ Range | Gain Factor | D/A Converter Range | Conversion Factor | Output Signal                        |
|-----------|-------------|---------------------|-------------------|--------------------------------------|
| 0– 32,000 | 0.125       | 0–4,000 counts      | 2.5               | Voltage Mode (0–10,000mV)            |
| 0–32,000  | 0.125       | 0–4,000 counts      | 5                 | Current Mode (0–20mA)<br>or (4–20mA) |



### Figure 97



# Chapter 13: RTD and Thermocouple Expansion Units

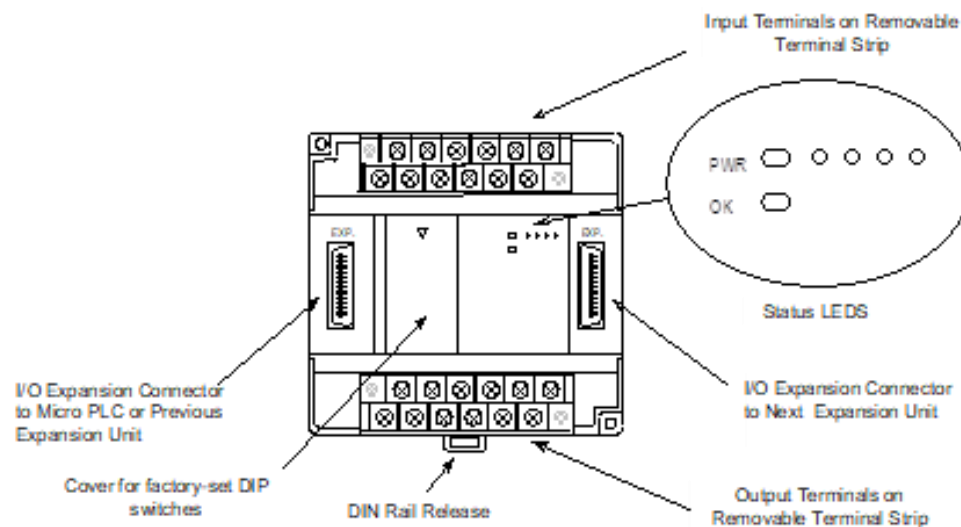
This chapter describes the following VersaMax Micro PLC RTD and Thermocouple Expansion Units:

|             |                                                                                                   |
|-------------|---------------------------------------------------------------------------------------------------|
| IC200UEX724 | 4 RTD, Pt 100 In,<br>24Vdc Power Supply                                                           |
| IC200UEX726 | 4 RTD, Pt 100 In and 2 Analog Out,<br>0 – 20mA, 4 – 20mA or 0 – 10Vdc,<br>24Vdc Power Supply      |
| IC200UEX734 | 4 RTD, Pt 100 In,<br>100/240Vac Power Supply                                                      |
| IC200UEX736 | 4 RTD, Pt 100 In and 2 Analog Out,<br>0 – 20mA, 4 – 20mA or 0 – 10Vdc,<br>100/240Vac Power Supply |
| IC200UEX824 | 4 Thermocouple Inputs,<br>24Vdc Power Supply                                                      |
| IC200UEX826 | 4 Thermocouple Inputs and 2 Analog Out,<br>0 – 20mA or 0 – 10Vdc,<br>24Vdc Power Supply           |

## 13.1 Description of RTD and Thermocouple Modules

RTD and Thermocouple Expansion Units have the features shown below. Expansion Units can be located up to 2 meters from the Micro PLC.

Figure 98



## 13.1.1 Removable Terminal Strips

The removable terminal assemblies are protected by hinged covers. After turning off power to the Expansion Unit, a terminal assembly and attached field wiring can be separated from the Expansion Unit by removing two screws.

## 13.1.2 Expansion Connector

The connector on the left side of the Expansion Unit is used to connect to the Micro PLC or to the outgoing connector on the previous Expansion Unit. The connector on the right side of the Expansion Unit can be used to attach to the next Expansion Unit.

## 13.1.3 Status LEDs

LEDs on the Expansion Unit provide quick visual verification of operating status. Expansion Unit LEDs indicate local Power and OK mode.

The input channel LEDs should be OFF during proper operation.

## 13.1.4 Cables

A 0.1-meter ribbon cable (IC200CBL501) is provided with each Expansion Unit. Cables are also available in 0.5-meter (IC200CBL505) and 1 meter (IC200CBL510) lengths.

# 13.2 RTD Expansion Modules

VersaMax Micro PLC RTD Expansion Units are used for applications that require temperature monitoring and control. Four types are available:

|             |                                                                                               |
|-------------|-----------------------------------------------------------------------------------------------|
| IC200UEX724 | 4 RTD, Pt 100 In,<br>24Vdc Power Supply                                                       |
| IC200UEX726 | 4 RTD, Pt 100 In and<br>2 Analog Out, 0 – 20mA, 4 – 20mA, or 0 – 10Vdc,<br>24Vdc Power Supply |
| IC200UEX734 | 4 RTD, Pt 100 In,<br>100/240Vac Power Supply                                                  |
| IC200UEX736 | 4 RTD, Pt 100 In and<br>2 Analog Out, 0 – 20mA, 4 – 20mA, or 0 – 10Vdc, 100/240Vac Power      |

Typical applications include oven control, motor monitoring, refrigerant control, and environmental control. One VersaMax Micro PLC can monitor up to sixteen RTDs (four RTDs per expansion module, four expansion modules per Micro PLC).

---

### Note:

- RTD Expansion Modules support DOIO for inputs and outputs.
  - If an RTD Expansion module is auto configured with DIP switch 3 OFF (Compatibility Mode), it reports its identity as a standard analog expansion module (IC200UEX616/626/636). This has no effect on module operation.
  - For Micro release 4.0 and later, if the RTD Expansion module is auto-configured with DIP switch 3 ON (High-Accuracy Mode), it reports as IC200UEX726/736.
-

## 13.2.1 Compatibility

RTD Expansion Units are compatible with Micro PLCs having a firmware version of 2.01 or greater.

They are compatible with Logic Developer 2.60 or above and with VersaPro software 2.03 and above. Some compatible software versions do not list these modules separately but allow them to be configured as analog expansion units. Current software versions list these modules by number and description.

## 13.2.2 RTD Module General Specifications

|                                            |                                                                                                             |                                       |
|--------------------------------------------|-------------------------------------------------------------------------------------------------------------|---------------------------------------|
| Module Dimensions                          | Height: 90mm (3.6 inches)<br>Depth: 76mm (3.0 inches)<br>Width: 150mm (6.0 inches)                          |                                       |
| Inputs                                     | 4 RTD inputs                                                                                                |                                       |
| Outputs                                    | 2 analog outputs (all models except UEX724 and UEX734)                                                      |                                       |
| Power Supply Type                          | DC Power Supply <sup>5</sup>                                                                                | AC Power Supply                       |
| Power voltage                              | 24Vdc                                                                                                       | 100/110/120/200/210/220Vac (50/60Hz)  |
| Range                                      | 19.2Vdc to 30Vdc                                                                                            | 85 to 264Vac                          |
| Allowable momentary power failure          | 10ms                                                                                                        | 85 to 100V: 10ms<br>100 to 264V: 20ms |
| Operating ambient temperature              | 0 to 55 C (Storage ambient temperature –10 to 75 C)                                                         |                                       |
| Operating ambient humidity                 | 5 to 95 % RH (no condensation)<br>(Storage ambient humidity 5 to 95 % RH (no condensation))                 |                                       |
| Vibration resistance                       | Complies with JIS C 0911                                                                                    |                                       |
| Noise resistance                           | Noise voltage 1500 Vpp; Noise pulse width 100 ns, 1 micro sec<br>Static noise: 3000 V at metal exposed area |                                       |
| Insulation resistance                      | 20 MΩ or more between the AC external terminal and case ground (PE) terminal<br>(based on 500 VDC mega)     |                                       |
| Dielectric withstand voltage               | 500V DC                                                                                                     | 1500Vac                               |
| Grounding                                  | Class D (100Ω) independent grounding                                                                        |                                       |
| Usage environment                          | No corrosive gases, no excessive dirt                                                                       |                                       |
| Structure                                  | Attaches to an open wall                                                                                    |                                       |
| Cooling                                    | Natural air cooling                                                                                         |                                       |
| Protection against electrical shock hazard | Class 1 equipment                                                                                           |                                       |
|                                            | Open equipment                                                                                              |                                       |

<sup>5</sup> The DC power source must have enough transient current capability to support the inrush current of the power supply and to maintain the nominal voltage level.

## 13.2.3 RTD Module Input Specifications

|                              | Compatible                                                                                                                                                                      | High Accuracy                                                                                                                                                                   |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RTD Input Channels           | 4, differential                                                                                                                                                                 |                                                                                                                                                                                 |
| Input Sensor Types           | 2- and 3-wire types, PT 100                                                                                                                                                     |                                                                                                                                                                                 |
| Input ranges                 | -100.0 to +600.0°C<br>-150.0 to +1050.0°F                                                                                                                                       | -100.0 to +600.0°C<br>-148 to +1112.0°F                                                                                                                                         |
| Input Resolution             | 0.2°C / 0.3°F                                                                                                                                                                   | 0.1°C / 0.1°F                                                                                                                                                                   |
| Accuracy                     | ±0.5% of full scale over operating temperature range                                                                                                                            |                                                                                                                                                                                 |
| Data Format                  | 0 to 32000 for °F, or 0 to 28000 for °C                                                                                                                                         |                                                                                                                                                                                 |
| Constant Current             | Approximately 1mA                                                                                                                                                               |                                                                                                                                                                                 |
| Channel Update Time          | 141/563ms (selectable) for all channels                                                                                                                                         |                                                                                                                                                                                 |
| Diagnostics                  | LED on module blinks when input values at -100°C (-150°F) or less, or 600°C (+1050°F) or more (includes cable disconnection)<br>Also, the channel input data will contain 7FF8H | LED on module blinks when input values at -110°C (-166°F) or less, or 610°C (+1130°F) or more (includes cable disconnection)<br>Also, the channel input data will contain 7FFFH |
| Digital Resolution           | 15 bits + sign                                                                                                                                                                  |                                                                                                                                                                                 |
| Open Circuit Detection Time  | 141ms or 563ms, excluding logic execution                                                                                                                                       |                                                                                                                                                                                 |
| Channel to Channel Isolation | None                                                                                                                                                                            |                                                                                                                                                                                 |
| Maximum Lead Resistance      | 100Ω                                                                                                                                                                            |                                                                                                                                                                                 |
| Converter Type               | Successive approximation                                                                                                                                                        |                                                                                                                                                                                 |
| Excitation                   | Current Source 1.0mA                                                                                                                                                            |                                                                                                                                                                                 |

## 13.2.4 RTD Module Output Specifications

Only modules IC200UEx 726 and UEx736 have outputs.

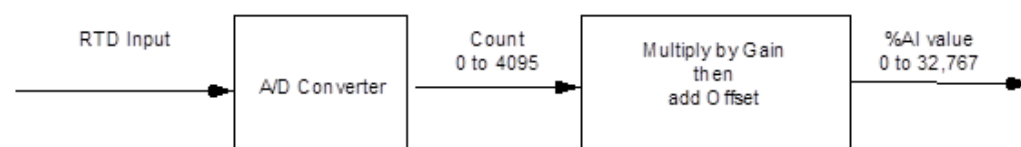
|                                                                                                           |                                                                                         |
|-----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| Analog Output Channels                                                                                    | 2, single-ended, non-isolated                                                           |
| Output ranges                                                                                             | 0 to 10V (10.23V maximum)<br>0 to 20mA (20.47mA maximum)<br>4 to 20mA (20.47mA maximum) |
| Resolution                                                                                                | 12 bits                                                                                 |
| Accuracy                                                                                                  | ±1% of full scale over operating temperature range                                      |
| Current: maximum terminal voltage<br>user load range<br>output load capacitance<br>output load inductance | 10V (at 20mA output)<br>10 to 500 Ω<br>2000 pF maximum<br>1 Henry maximum               |
| Voltage: output loading<br>output load capacitance                                                        | 10 kΩ minimum at 10 volts<br>1 μF maximum                                               |
| Response Time                                                                                             | 8.8ms                                                                                   |

## 13.2.5 Scaling

### Scaling for RTD Inputs

An RTD Expansion Unit (in the Compatible mode) processes input channels with a 12-bit successive-approximation A/D converter. It converts the input value into a digital count, calculates the %AI value as described below, then places the result into the appropriate %AI input reference (these references are described in Chapter 22:).

**Figure 99**



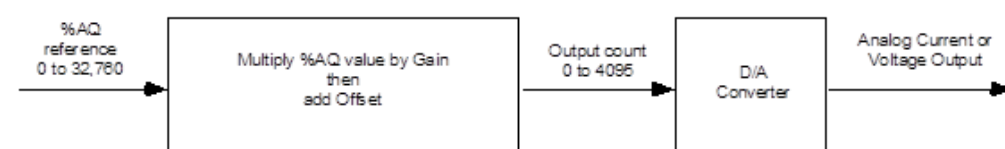
The table below lists equivalent decimal and hexadecimal conversion values for Celsius and Fahrenheit inputs.

| Input Signal                       | A/D Converter Value | Gain Factor | %AI Range |
|------------------------------------|---------------------|-------------|-----------|
| Celsius Mode (-100°C to 600°C)     | 0 – 3500 counts     | 8           | 0 - 28000 |
| Fahrenheit Mode (-150 F to 1050°F) | 0 – 4000 counts     | 8           | 0 - 32000 |

### Scaling for Analog Outputs

To generate the analog output signal, the RTD Expansion Unit converts the value in the %AQ output reference into a count value for the 12-bit D/A converter, which then drives the analog output.

**Figure 100**



### Automatic Gain and Offset Adjustment for Analog Outputs

If DIP switch 6 is in the ON position (default) the D/A Converter's output range is 4,000 counts. If this DIP switch is set to the OFF position, the output range is 4,096 counts.

The application's %AQ output range of 0 to 32000 corresponds to the D/A converter's output count range. The Expansion Unit first multiplies the %AQ value from the program by (output range / 32000) to produce the count value for the D/A Converter:

$$\text{Compatible resolution mode: } \left( \%AQ \times \frac{4000}{32000} \right) = (\%AQ \times 0.125) = \text{D/A count}$$

$$\text{Maximum resolution mode: } \left( \%AQ \times \frac{4096}{32000} \right) = (\%AQ \times 0.128) = \text{D/A count}$$

Any calculated value that exceeds 4095 ( $2^{12}-1$ ) is clamped at that maximum value. Any calculated value less than 0 is clamped at 0. The range 0 to 4095 corresponds to %AQ values between 0 and 32,760.

### Automatic Conversion of Counts to Analog Voltage or Current

In voltage mode, the D/A Converter converts the count value in the range of 0–4,000 or 0–4,096 counts to an analog signal from 0 to 10,000mV. The output voltage gain (ratio) for this conversion is 2.5.

In compatible resolution mode (D/A Converter range is 0–4,000), loading a count value of 32760 results in an analog output value of 10.23V.

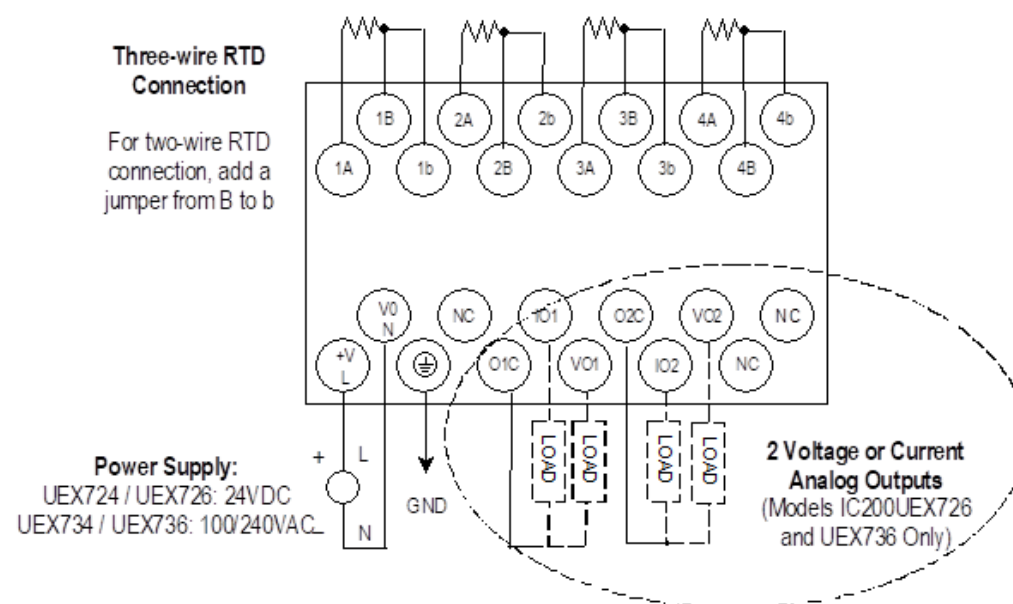
In maximum resolution mode (D/A Converter range is 0–4,096), loading a count value of 32760 results in an analog output value of 10.00V.

In current mode, the D/A converter converts the count value to an analog signal from 0 to 20,000 $\mu$ A. The output current gain for this conversion is 5. The conversion for both current modes (0-20mA and 4-20mA) is the same.

| Range  | 0000 | 2000 H07D0 | 4000 H0FA0 | 4095 H0FFF |
|--------|------|------------|------------|------------|
| 0-10V  | 0V   | 5V         | 10V        | 10.23V     |
| 0-20mA | 0mA  | 10mA       | 20mA       | 20.47mA    |
| 4-20mA | 4mA  | 12mA       | 20mA       | 20.38mA    |

## 13.2.6 Wiring for RTD Expansion Modules

Figure 101



On modules IC200UEX726 and UEX736, voltage and current outputs are present on their respective output terminals at the same time. For proper module operation, only the output terminals that correspond to the voltage / current output configuration should be connected.

## 13.3 Module Installation

1. To avoid risk of electric shock, turn off power to the Micro PLC and disconnect the main power before connecting the RTD expansion modules.
2. Loosen the screws on the terminal block and attach unit power, RTD wires and analog outputs. Tighten all screws securely. The RTD wires should be the same type and length (except for the jumper used in a two-wire RTD) to ensure accuracy. Do not use the shield or drain wire for the third connection.
3. If all RTD channels are not used, a 100 to 300  $\Omega$  resistor can be connected across terminal A to B with a jumper connected from B to b. The resistor will disable the diagnostics and stop the channel LED from flashing.
4. Connect the expansion cable to the Micro PLC or expansion unit to the left of the RTD Expansion Unit.
5. Turn power on. Check the LEDs as shown on the next page. The Power and OK LEDs should be ON. The LEDs for channels 1 to 4 should be OFF during normal operation if the RTDs are connected properly.

### 13.3.1 DIP Switches

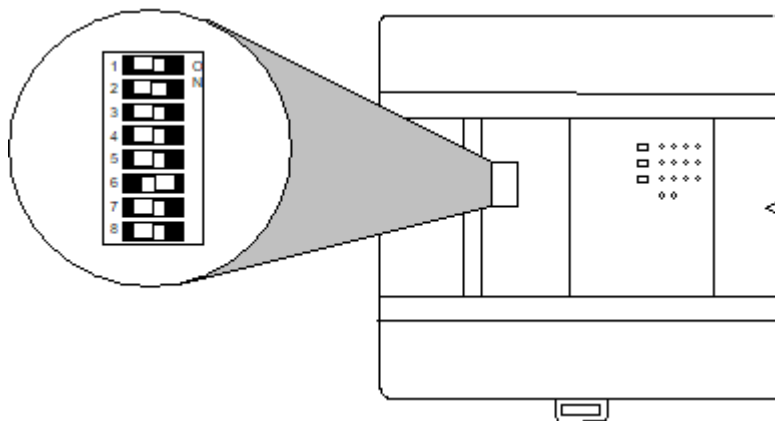
The default DIP switch settings for the RTD units are switches 1-5 and 7-8 OFF and switch 6 ON.

For RTD expansion units, DIP switch 2 selects the RTD channels update rate. In the factory default OFF position, switch 2 selects a 562ms update rate. The update rate can be changed to 141ms by moving switch 2 to the ON position.

From Release 4.0 and above, DIP Switch 3 can be used to select between Compatible (Switch 3 OFF) and High Accuracy (Switch 3 ON) modes. In the PME configuration of RTD module, selection for “Conversion mode” parameter should match this DIP switch selection.

### Default DIP Switch Settings for RTD Expansion Module

Figure 102





---

**Note:**

- Do NOT change the settings of any of the other DIP switches.
  - The module must be powered OFF before changing the DIP switch settings.
- 

## 13.3.2 LED Indications

The module's LEDs indicate the status of the module and of the RTD inputs.

|     |   | RTD1 | RTD2 | RTD3 | RTD4 |
|-----|---|------|------|------|------|
| POW | ○ | ○    | ○    | ○    | ○    |
| OK  | ○ |      |      |      |      |

If an initialization error occurs, the OK LED blinks rapidly.

During normal operation, the RTD input LEDs should be off. If an RTD input is outside the range of -100°C (-150°F) to +600°C (1050°F), its LED blinks.

## 13.3.3 Data Conversion for RTD Expansion Units (in Compatible mode)

Individual channels on an RTD Expansion Units can be individually configured for either Celsius or Fahrenheit

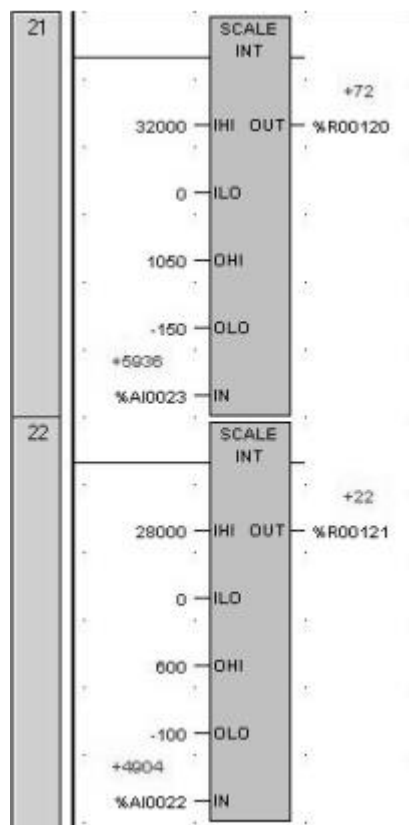
If Celsius is configured, the range of data for a channel is 0 to 28,000.

If Fahrenheit is configured, the range of data for the channel is 0 to 32,000.

- Values below 0 indicate shorted cable.
- Values above 28,000 (when configured for Celsius) or 32,000 (when configured for Fahrenheit) indicate disconnected (open) or shorted cable.

## Basic Temperature Conversion Logic

Figure 103

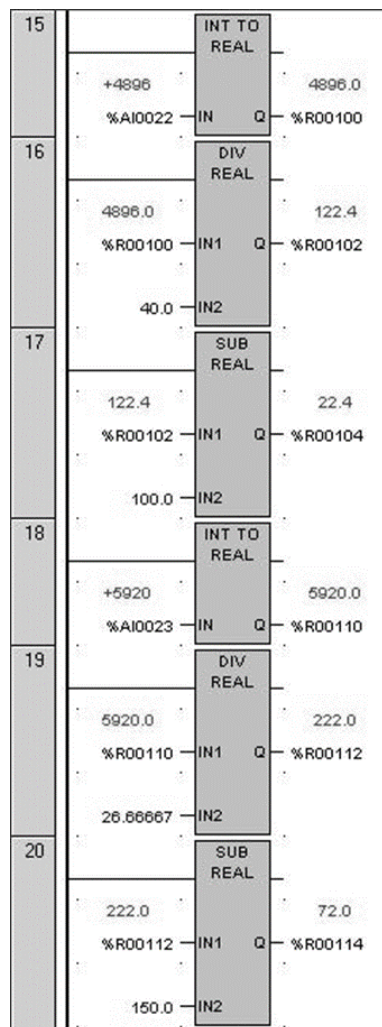


The Scaling function (see Chapter 23:) can be use in the application program to convert the raw counts value for a channel to a temperature measurement in degrees. The ranges are 100 to +600 degrees C and 150 to +1050 degrees F. The example logic shown here applies to Compatible mode only.

## High-Resolution Temperature Conversion Logic for RTD Units

For accuracy in tenths of degrees, the Data Type Conversion functions (see Chapter 23:) can be added to the program logic. See the examples (for the Compatible mode) below.

Figure 104



### Celsius Conversion

Line 15: Converts RTD to Real Value. Data will be stored in two consecutive Registers 100 and 101

Line 16: Divides the raw value by 40.0 (28000/700) 700 comes from the full temperature range of 600 to –100 C. Result is placed in R102 and R103

Line 17: Subtracts 100 for conversion. This is to offset the –100 and the result is in R104 and R105

### Fahrenheit Conversion

Line 18: Converts RTD to Real Value. Data will be stored in two consecutive Registers 110 and 111

Line 19: Divides the raw value by 26.66667 (32,000/1200) 1200 comes from the full temperature range of 1050 to –150 F. Result is placed in R112 and R113

Line 20: Subtracts 150 for conversion. This is to offset the –150 and the result is in R114 and R115

## 13.4 Thermocouple Expansion Modules

VersaMax Micro PLC Thermocouple Expansion modules are used for applications such as food and beverage production, process control, and environmental control. The following types of Thermocouple expansion module are available:

- IC200UEX824 4 Thermocouple Inputs, 24Vdc Power Supply
- IC200UEX826 4 Thermocouple Inputs and 2 Analog Outputs, 24Vdc Power Supply

One VersaMax Micro PLC can monitor up to sixteen thermocouples (four thermocouples per expansion module, four expansion modules per Micro PLC).

---

### Note:

- Thermocouple Expansion modules support DOIO for inputs and outputs.
  - If a Thermocouple Expansion module is auto configured with DIP switch 6 OFF (Compatibility Mode), it reports its identity as a standard analog expansion module (IC200UEX616/626/636). This has no effect on module operation.
  - For Micro release 4.0 and later, if the Thermocouple Expansion module is auto-configured with DIP switch 6 ON (High-Accuracy Mode), it reports as IC200UEX826.
- 

### 13.4.1 Compatibility

Thermocouple Expansion modules are compatible with:

- VersaMax Micro-20, -40, and -60 CPUs version 3.81 or later.
- VersaMax Micro-23 and –28 CPUs version 3.55 or later.
- VersaMax Micro-14 CPUs version 3.56 or later.

They are configurable using Logic Developer 5.70 and above. Some compatible software versions do not list these modules separately but allow them to be configured as RTD expansion units, as described later in this section.

## 13.4.2 Thermocouple Module General Specifications

|                                            |                                                                                                          |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------|
| Module Dimensions                          | Height: 90mm (3.6 inches)<br>Depth: 76mm (3.0 inches)<br>Width: 150mm (6.0 inches)                       |
| Inputs                                     | 4 Thermocouple inputs                                                                                    |
| Outputs                                    | Model IC200UEx826 only: 2 analog outputs                                                                 |
| Power voltage                              | 24Vdc                                                                                                    |
| Range                                      | 19.2Vdc to 30Vdc                                                                                         |
| Inrush Current/Time                        | 2.5A / 1ms at 30V                                                                                        |
| Input Current                              | 0.1A at 30V                                                                                              |
| Input Power Supply Rating                  | 3W                                                                                                       |
| Allowable momentary power failure          | 10ms                                                                                                     |
| Operating ambient temperature              | 0°C to 55°C (Storage ambient temperature –10°C to 75°C)                                                  |
| Operating ambient humidity                 | 5 to 95 % RH (no condensation)<br>(Storage ambient humidity 5 to 95 % RH (no condensation))              |
| Vibration resistance                       | Complies with JIS C 0911                                                                                 |
| Noise resistance                           | Noise voltage 1500 Vpp Noise pulse width 100 ns, 1 $\mu$ s<br>Static noise: 3000 V at metal exposed area |
| Insulation resistance                      | 20 M $\Omega$ or more between the AC external terminal and case ground (PE) terminal                     |
| Dielectric withstand voltage               | 500V DC                                                                                                  |
| Grounding                                  | Class D (100 $\Omega$ ) independent grounding                                                            |
| Usage environment                          | No corrosive gases, no excessive dirt                                                                    |
| Structure                                  | Attaches to an open panel                                                                                |
| Cooling                                    | Natural air cooling                                                                                      |
| Protection against electrical shock hazard | Class 1 equipment                                                                                        |
|                                            | Open equipment                                                                                           |

## 13.4.3 Analog Output Specifications (Model IC200UEx826)

|                        |                                                                                                                                                           |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Analog Output Channels | 2, single                                                                                                                                                 |
| Output Ranges          | 0-10 V (10.24 V maximum), 0-20 mA (20.48 mA maximum)                                                                                                      |
| Resolution             | 0-10 V, 12 bits, 0-20 mA, 12 bits                                                                                                                         |
| Accuracy               | $\pm 1\%$ of full scale over temperature range                                                                                                            |
| Current Outputs        | Max. Voltage at 20 mA: 10 V<br>User Load Range: 10 to 500 $\Omega$<br>Output Load Capacitance: 2000 pF Maximum<br>Output Load Inductance: 1 Henry Maximum |
| Voltage Outputs        | Output Loading: 10 k $\Omega$ Minimum at 10 V<br>Output Load Inductance: 1 $\mu$ F Maximum                                                                |
| Response time          | 8.8 ms                                                                                                                                                    |

## 13.4.4 Thermocouple Module Input Specifications

|                                                         |                        |                                                                                               |                                                                        |
|---------------------------------------------------------|------------------------|-----------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| Input Channels                                          |                        | 4, differential                                                                               |                                                                        |
| Sensor type                                             |                        | Following JIS C 1602-1995<br>Type K, J, E, S, T, B, N, $\pm 50\text{mV}$ , $\pm 100\text{mV}$ |                                                                        |
| Temperature range and accuracy ( $\pm\%$ ) at 0 to 55°C | Type                   | Accuracy range <sup>6</sup>                                                                   | Input range <sup>7</sup>                                               |
|                                                         | K                      | -200 to 1200°C (-328 to 2192°F)<br>0.4%(FS)                                                   | -270 to 1370°C (-454 to 2498°F)                                        |
|                                                         | J                      | -40 to 750°C (-40 to 1382°F)<br>0.3%(FS)                                                      | -210 to 1200°C (-316 to 2192°F)                                        |
|                                                         | E                      | -200 to 900°C (-328 to 1652°F)<br>0.3%(FS)                                                    | -270 to 1000°C (-454 to 1832°F)                                        |
|                                                         | S                      | 0 to 1600°C (32 to 2912°F) 1.0%(FS)                                                           | -50 to 1760°C (-58 to 3200°F)                                          |
|                                                         | T                      | -200 to 350°C (-328 to 662°F)<br>0.8%(FS)                                                     | -270 to 400°C (-454 to 752°F)                                          |
|                                                         | B                      | 600 to 1700°C (1112 to 3092°F)<br>1.0%(FS)                                                    | 0 to 1820°C (32 to 3308°F)                                             |
|                                                         | N                      | -200 to 1200°C (-328 to 2192°F)<br>0.4%(FS)                                                   | -270 to 1300°C (-454 to 2372°F)                                        |
|                                                         | $\pm 50\text{mV}$      | -50 to 50mV 0.5%(FS)                                                                          | -50 to 50mV                                                            |
|                                                         | $\pm 100\text{mV}$     | -100 to 100mV 0.5%(FS)                                                                        | -100 to 100mV                                                          |
| TC mode                                                 |                        | High Accuracy Mode                                                                            | Compatible Mode                                                        |
| Resolution                                              | K,J,E,T,N              | 0.1°C/0.2°F                                                                                   | 0.5°C/1°F                                                              |
|                                                         | B,S                    | 1.0°C/1.0°F                                                                                   | 1.0°C/1°F                                                              |
|                                                         | $\pm 50\text{mV}$      | 0.01mV                                                                                        | 0.025mV                                                                |
|                                                         | $\pm 100\text{mV}$     | 0.02mV                                                                                        | 0.05mV                                                                 |
| Units of data output                                    |                        | 0.1°C/0.1°F<br>0.01mV                                                                         | 0.5°C/1°F<br>0.025mV, 0.05mV                                           |
| Conversion data                                         |                        | 15 bits + sign                                                                                |                                                                        |
| Cold junction compensation accuracy                     |                        | Less than $\pm 2^\circ\text{C}$ (ambient temperature is 0 to 55°C)                            |                                                                        |
| Cold junction input range                               |                        | -20°C to 80°C                                                                                 |                                                                        |
| Diagnostics (Broken Wire/Under or Over range reporting) |                        | LED indication (per channel)<br>Channel input data is 7FFF hexadecimal                        | LED indication (per channel)<br>Channel input data is 7FF8 hexadecimal |
| Conversion time                                         | K, J, E, T, N, B, S    | 563ms (4ch. total)                                                                            |                                                                        |
|                                                         | $\pm 50, 100\text{mV}$ | 141ms (4ch. total)                                                                            |                                                                        |

<sup>6</sup> Accuracy Range represents measurements within which operation of the module is guaranteed.

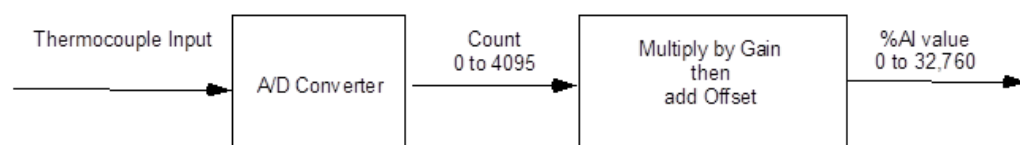
<sup>7</sup> The Input Range represents an extended range for which operation cannot always be guaranteed.

## 13.4.5 Scaling for Thermocouple Module Data

### Scaling for Inputs

A Thermocouple Expansion Unit (in the Compatibility mode) processes input channels with a 12-bit successive-approximation A/D converter. It converts the input value into a digital count, calculates the %AI value as described below, then places the result into the appropriate %AI input reference (these references are described in Chapter 22:).

**Figure 105**



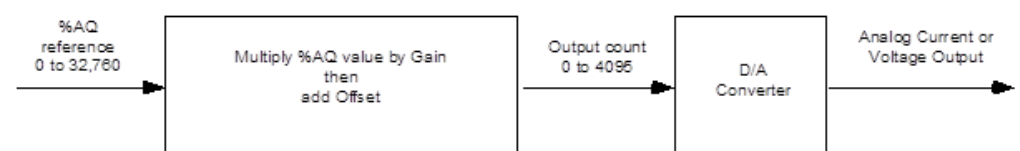
The table below lists equivalent decimal and hexadecimal conversion values for Celsius and Fahrenheit inputs.

| Input Signal                       | A/D Converter Counts Value | Gain Factor | %AI Range   |
|------------------------------------|----------------------------|-------------|-------------|
| Celsius mode (-249.5°C to 1760°C)  | 1 – 4020 counts            | 8           | 8 - 32160   |
| Fahrenheit mode (-499°F to 3308°F) | 1 – 3808 counts            | 8           | 8 - 30464   |
| Voltage mode (±50mV)               | 48 – 4048 counts           | 8           | 384 – 32384 |
| Voltage mode (±100mV)              | 48 – 4048 counts           | 8           | 384 - 32384 |

## 13.4.6 Scaling for Analog Outputs (Model IC200UEX826)

To generate the analog output signal, the Thermocouple Expansion Unit converts the value in the %AQ output reference into a count value for the 12-bit D/A converter, which then drives the analog output.

**Figure 106**



### Automatic Gain and Offset Adjustment for Analog Outputs

The application's %AQ output range of 0 to 32000 corresponds to the D/A converter's output count range of 0 to 4000. The Expansion Unit first multiplies the %AQ value from the program by 0.125 (=4000/32000) to produce the count value for the D/A converter:

$$(\%AQ \times 0.125) = \text{D/A count}$$

Any calculated value that exceeds 4095 (212-1) is clamped at that maximum value. Any calculated value less than 0 is clamped at 0. The range 0 to 4095 corresponds to %AQ values between 0 and 32,760.

### Automatic Conversion of Counts to Analog Voltage or Current

In voltage mode, the D/A converter then converts the count value in the range of 0 to 4,000 counts to an analog signal from 0 to 10,000mV. The output voltage gain (ratio) for this conversion is 2.5.

In current mode, the D/A converter converts the count value to an analog signal from 0 to 20,000 $\mu$ A. The output current gain for this conversion is 5.

| Range  | 0000 | 2000<br>H07D0 | 4000<br>H0FA0 | 4095<br>H0FFF |
|--------|------|---------------|---------------|---------------|
| 0-10V  | 0V   | 5V            | 10V           | 10.24V        |
| 0-20mA | 0mA  | 10mA          | 20mA          | 20.48mA       |

## 13.4.7 Thermocouple Module Configuration

Micro PLC firmware versions 4.0 and above provide complete support to Thermocouple modules including the High-Accuracy mode. Also PME versions 6.0 SIM1 and above completely support the Thermocouple modules (i.e. no workaround with RTD modules needed for thermocouple configuration). Each channel of a Thermocouple Expansion Unit can be individually configured for Sensor selection, Mode (Celsius or Fahrenheit) and Cold Junction Compensation (Enable or Disable)

The following description of this section is applicable only for CPU and PME versions prior to that of the above mentioned.

With Logic Developer (PME) 5.70 and above, Thermocouple module can easily be configured by selecting the corresponding RTD module in the Module window.

| Thermocouple Module | Corresponding RTD Module |
|---------------------|--------------------------|
| IC200UEX824         | IC200UEX724              |
| IC200UEX826         | IC200UEX726              |

The Input Channel Mode for each of the Thermocouple channels can be configured as Celsius or Fahrenheit.

For IC200UEX826, the Output Channel Mode parameter can be used to configure the Voltage/Current values of a Thermocouple module.

- If the selection is Voltage, the Output Channel Range is not available.
- If the selection is Current, the Output Channel Range MUST be 0 to 20 mA.



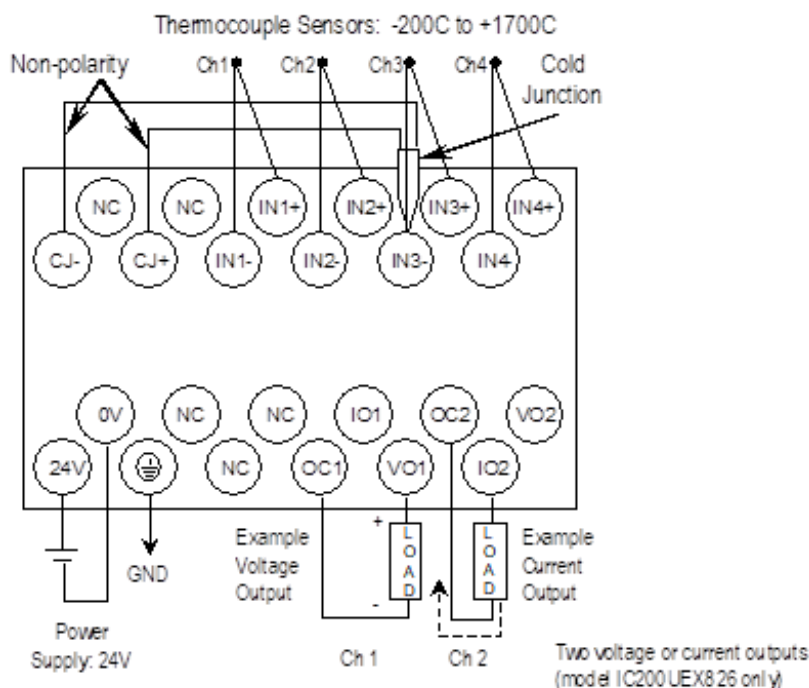
Figure 107

| Analog I/O Settings   Wiring |               |
|------------------------------|---------------|
| Parameters                   | Values        |
| Length:                      | 4             |
| Input Channel 1 Mode:        | Celsius       |
| Input Channel 1 Range:       | -100C, +600C  |
| Input Channel 2 Mode:        | Celsius       |
| Input Channel 2 Range:       | -100C, +600C  |
| Input Channel 3 Mode:        | Celsius       |
| Input Channel 3 Range:       | -100C, +600C  |
| Input Channel 4 Mode:        | Fahrenheit    |
| Input Channel 4 Range:       | -150F, +1050F |
| Reference Address:           | %AQ0015       |
| Length:                      | 2             |
| Output Channel 1 Mode:       | Voltage       |
| Output Channel 1 Range:      | N/A           |
| Output Channel 2 Mode:       | Current       |
| Output Channel 2 Range:      | 0,20 mA       |

Also, for versions earlier than 4.0, the Cold Junction Compensation is always enabled by default and cannot be disabled either through PME or through DIP switch settings.

## 13.4.8 Wiring for Thermocouple Expansion Modules

Figure 108



On module IC200UEX826, voltage and current outputs are present on their respective output terminals at the same time. For proper module operation, only the output terminals that correspond to the voltage / current output configuration should be connected.

## 13.5 Module Installation

1. To avoid risk of electric shock, turn off power to the Micro PLC and disconnect the main power before connecting Thermocouple expansion modules.
2. Connect the expansion cable to the Micro PLC or expansion unit to the left of the Thermocouple Expansion Unit.
3. Check the DIP switch settings as shown on the next page.
4. Turn power on. Check the LEDs as shown on the next page. The Power and OK LEDs should be ON. The LEDs for channels 1 to 4 should be OFF during normal operation if the thermocouple inputs are connected properly.
5. Connect the Cold Junction sensor. If that is not done, all four module LEDs flash continuously.

### 13.5.1 DIP Switch Settings

Micro PLC firmware versions 4.0 and above provide complete support to Thermocouple modules including the High-Accuracy mode. DIP Switch 6 can be used to select between Compatible (Switch6 OFF) and High Accuracy (Switch 6 ON) modes. In the PME configuration of Thermocouple module, selection for “Conversion mode” parameter should match this DIP switch selection. As PME versions 6.0 SIM1 and above completely support the Thermocouple modules, (when the Micro PLC firmware version is 4.0 and above) Sensor/ mV selection should be done using PME instead of through DIP Switches as PME settings always override the DIP switch settings. Hence the following description applies only to the CPU and PME versions prior to that of the above mentioned.

The sensor selection for all input channels can be configured ONLY using DIP switches 1 to 3, it cannot be done using Logic Developer. If DIP switches 1-3 are set for mV selection (all On), the settings take precedence over the Logic Developer configuration of Input Channel Mode and Range. The module must be powered OFF before changing the DIP switch settings.

| Switch | Default | Function                                                    | K           | J   | E   | S   | T           | B   | N   | mV |
|--------|---------|-------------------------------------------------------------|-------------|-----|-----|-----|-------------|-----|-----|----|
| 1      | off     | Input Sensor selection (Ch1-4)                              | off         | on  | off | on  | off         | on  | off | on |
| 2      | off     |                                                             | off         | off | on  | on  | off         | off | on  | on |
| 3      | off     |                                                             | off         | off | off | off | on          | on  | on  | on |
| 4      | off     | mV selection<br>(Valid when DIP Switches 1,2,3 are all On.) | Off => 50mV |     |     |     | On => 100mV |     |     |    |

Do NOT change settings of any of the other DIP switches. The default setting for all other DIP switches is Off.

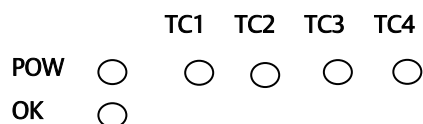
For Thermocouple units, setting switch 6 to On causes a System Configuration Mismatch fault in the PLC Fault Table. For these modules, auto-configuration with specified switch On will flash error code 12-2 on the CPU's OK LED. If this error occurs, the CPU OK LED will repeatedly follow the sequence:

- Blink 12 times
- Go Off (short)
- Blink 2 times
- Go Off (long pause)

To restore normal functionality, turn off power to the PLC and expansion units and set the DIP switch to Off. Turn On power to the PLC and expansion units again.

## 13.5.2 LED Indications

The module's LEDs indicate the status of the module and the inputs.



1. If an initialization error occurs, the OK LED blinks rapidly.
2. If an input signal is out of range or the cable is disconnected, its corresponding LED blinks every 1 second with almost equal On and Off time. In addition, in this case the channel input data contains the value 7FF8 (7FFF in High Accuracy mode).
3. If cold junction signal is out of range or the cable is disconnected, all four LEDs blink simultaneously every 1 second with a short on time and longer Off time.

During normal operation, the thermocouple input LEDs should be Off. If any of the four LEDs is On, it indicates a communication error with the PLC CPU.

If multiple errors occur, input signal errors (2 above) have priority over cold junction signal errors (3 above). For example:

Input signal for channel 2 is out of range, for channel 3 cable is disconnected and the cold junction compensation signal is out of range. In this case, LEDs 2 and 3 blink with almost equal On and Off time. LEDs 1 and 4 blink with shorter On time and longer Off time.

### 13.5.3 Basic Temperature Conversion Logic

The Scaling function (see Chapter 23:) can be use in the application program to convert the raw counts value for a channel to a temperature measurement in degrees. The example logic shown here applies to Compatible mode only.

Figure 109

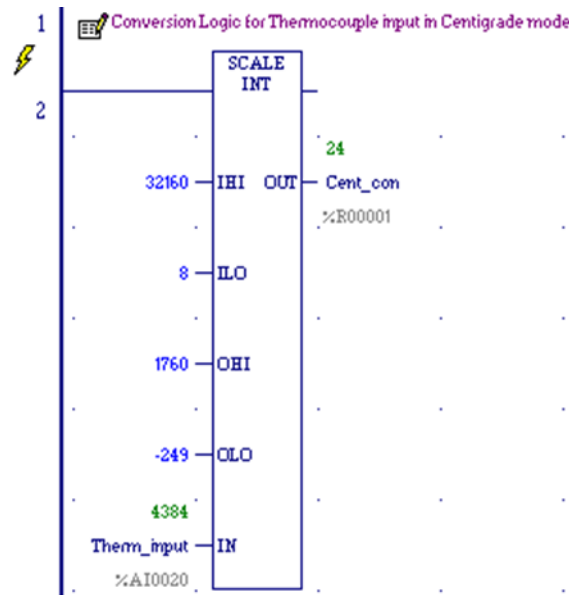
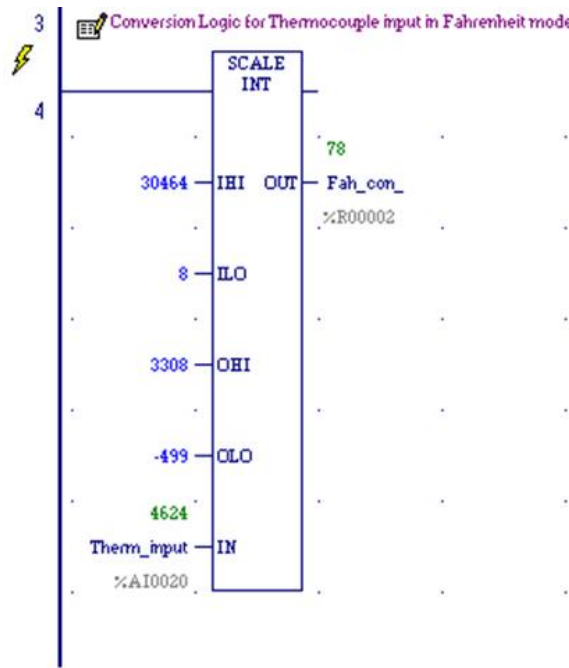


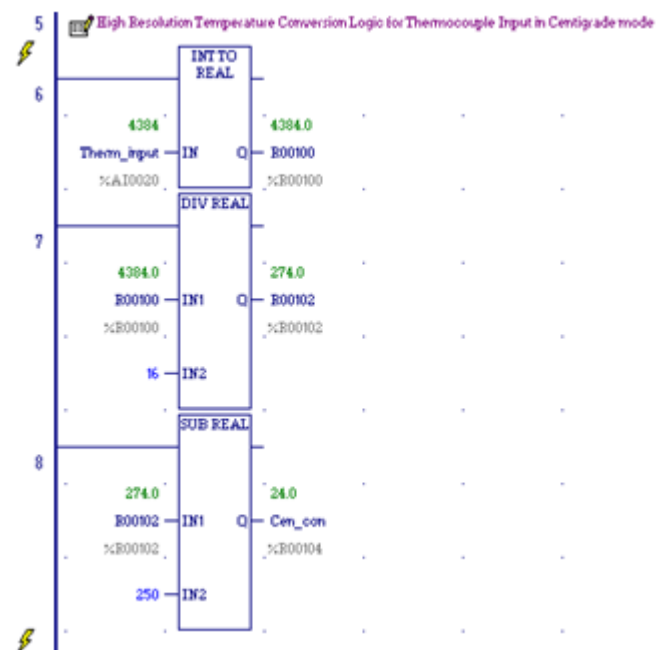
Figure 110



## 13.5.4 High-Resolution Temperature Conversion Logic for Thermocouple Units

For accuracy in tenths of degrees, the Data Type Conversion functions (see Chapter 23:) can be added to the program logic. See the examples (for the Compatible mode) below.

Figure 111



### Celsius Conversion

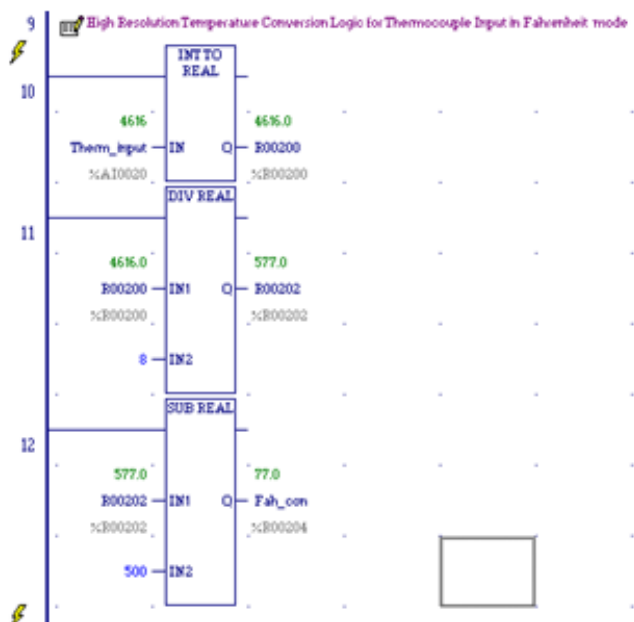
Line 6: Converts thermocouple input to Real Value. Data will be stored in two consecutive Registers 100 and 101

Line 7: Divides the raw value by 16.0  $((32160-8)/2009.5)$ .

The value 2009.5 comes from the full temperature range of 1760 to -249.5 C. Result is placed in R102 and R103

Line 8: Subtracts 250 for conversion. This is to offset the -250 and the result is in R104 and R105

Figure 112



#### Fahrenheit Conversion

Line 10: Converts thermocouple input to Real Value. Data will be stored in two consecutive Registers 200 and 201

Line 11: Divides the raw value by 8  $((30464-8)/(3807))$

The value 3807 comes from the full temperature range of 3308 to -449 F. Result is placed in R202 and R203

Line 12: Subtracts 500 for conversion. This is to offset the -500 and the result is in R204 and R205

## Chapter 14: CPU Option Modules

This chapter describes option modules for 20, 40 and 64-Point VersaMax Micro PLCs.

|             |                                            |
|-------------|--------------------------------------------|
| IC200UMB001 | Memory Pack Module                         |
| IC200USB001 | RS232, Extra Port Option Module            |
| IC200USB002 | RS485, Extra Port Option Module            |
| IC200UUB001 | USB/RS232 Conversion Option Module         |
| IC200UEM001 | 10/100 Mbit Ethernet Communications Module |

### 14.1 Using Option Modules

Option Modules can be used to enhance the functionality of a 20-, 40-, or 64-Point VersaMax Micro PLC. These option modules install in the front of the Micro PLC. One Port module (UEM001, USB001, USB002, or UUB001), and/or a Memory Pack module (UMB001) can be installed.

Option modules, except the Memory Pack Module, are configured using the Machine Edition software. The Memory Pack Module does not require software configuration. If the configuration and installed option modules are different, the PLC logs a fault in the Fault Table (System Configuration Mismatch).

---

**Note:** *If the configured module is RS232/USB and the physically connected module is Ethernet communication module (upon downloading configuration), a system configuration mismatch fault will not be logged. The converse is also true.*

---

### 14.2 IC200UMB001 Memory Pack Module

The VersaMax Micro PLC Memory Pack Module, IC200UMB001, can be used to store and update the configuration, application program, and reference table data of a 20, 40, or 64-Point Micro PLC.

---

**Figure 113**



The Memory Pack Module plugs directly into port 2 on the Micro PLC. Power for the device comes from port 2.

A programmer and PLC CPU are used to initially write data to the Memory Pack Module. In addition to writing data to the Memory Pack, the programmer can read data already stored on the Memory Pack and can compare that data with files already present in the programmer.

After the data is stored on the Memory Pack, the data can be copied to one or more other PLC CPUs of the same type, with no programmer needed. To do that, the Memory Pack Module is removed from the Micro PLC, and installed on another Micro PLC (Micro PLCs must be powered down to remove or install an option module). When the second Micro PLC is powered up, all of the data on the Memory Pack is written into the corresponding PLC reference addresses.

## 14.2.1 Features

- Store 128kB of data.
- Read the data at Power up.
- Read/Write/Verify the data through programmer command.

With the programmer present, the PLC CPU can read, write, or verify a program, configuration and tables in the Memory Pack Module. When reading or verifying data, it is possible to select hardware configuration, logic, and/or reference tables data. However, when writing data to the Memory Pack Module, all the data (logic, configuration and reference tables) must be written. Individual data types cannot be selected for writing.

### Reading Data from the Memory Pack Module at Startup

If the Memory Pack Module is connected to the port 2 when the PLC is switched on, the PLC automatically reads all the data (program, configuration, and tables) in the Memory Pack Module. The Micro PLC stores the data in its RAM/FLASH and flash based on the options that have been set in the hardware configuration.

The OK LED keeps blinking while the data is being transferred from the Memory Pack Module to the PLC. Wait until the OK LED stops blinking to do any further operations.

### Data Read, Write, Verify Operations Using the Programming Software

Read/Write/Verify operations can be done on the Memory Pack Module using the programming software. The PLC must be placed in Stop mode.

The path for write /read/ verify through programming software is:

Targets -> online commands -> Flash/EEPROM

The popup window for write/read/verify appears. Select the memory storage board option from the two choices (memory storage board or flash memory) to transfer data between the Memory Pack module and the CPU. Then select the write/read/verify operation. The programming software shows the status of the data transfer.

The Memory Pack Module and PLC must both have either no OEM key password or the same OEM key password for the data to be transferred. The Memory Pack Module does not perform special processing for other type of passwords.



## Write Protect Switch

Figure 114



The Write Protect switch on the Memory Pack Module prevents writing data to the module when it is in the ON position.

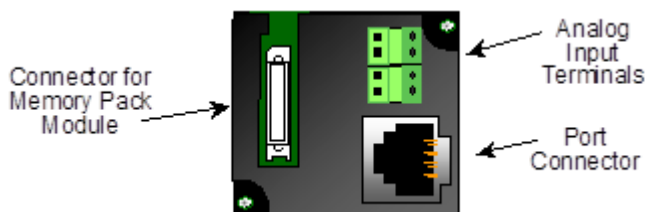
### ⚠ CAUTION

If the Write Protect switch is in ON position and the programming software tries to write data to the Memory Pack Module, the data is NOT written to the module. However, no error message is generated, and there is no indication that the data has not been written. This should be considered before setting the Write Protect switch.

## 14.3 IC200USB001 RS232 Extra Port Option Module with 2 Analog Inputs

VersaMax Micro PLC Option Module IC200USB001 can be used with a 20, 40, or 64-Point Micro PLC to provide an extra RS232 Port and two analog inputs.

Figure 115



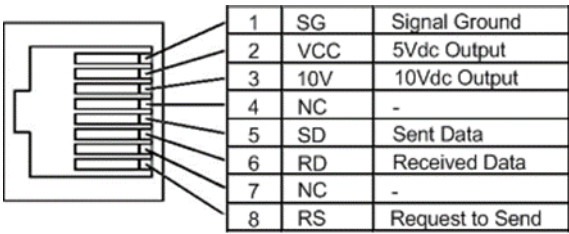
When installed on the Micro PLC, the RS232 Port Option Module becomes port 2. It supports the following communications protocols:

- Modbus Master/Slave
- Serial Read/Write
- SNP/SNPX Master/Slave

Use of the Port Option module as port 2, and the protocol selection must be set up in the configuration software. After making those selections, the communications parameters can also be configured.

Pin assignments for Port 2 are

Figure 116



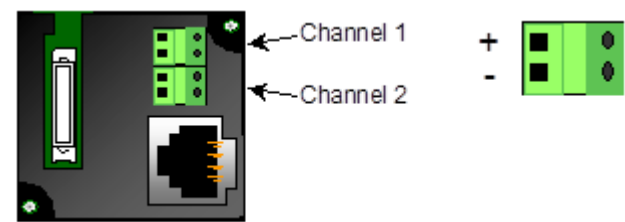
An external device can obtain power from the 5Vdc output pin if it requires 200mA or less at 5Vdc.

### 14.3.1 Analog Inputs

The terminals on the Port Option Module can be used for analog inputs with the following characteristics:

|                         |                                                                                                                    |
|-------------------------|--------------------------------------------------------------------------------------------------------------------|
| Input Ranges            | 0-10 V (10.24 V Max)                                                                                               |
| Resolution              | 0-10 V, 10 bits                                                                                                    |
| Accuracy                | ±1%                                                                                                                |
| Linearity               | ±3 LSB Maximum                                                                                                     |
| Voltage Input Impedance | 100kΩ                                                                                                              |
| Isolation               | Channel to channel: none<br>CPU to analog signal: none                                                             |
| Analog Terminal Wiring  | Solid wire: 0.14mm <sup>2</sup> to 1.5mm <sup>2</sup><br>Stranded wire: 0.14mm <sup>2</sup> to 0.10mm <sup>2</sup> |

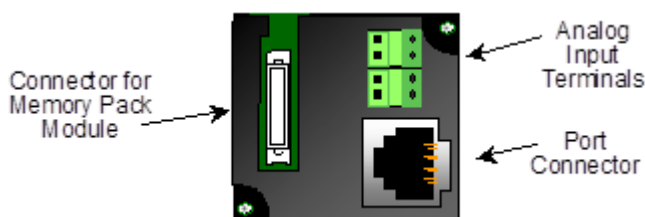
Figure 117



## 14.4 IC200USB002 RS-422/485 Extra Port Option Module with 2 Analog Inputs

VersaMax Micro PLC Option Module IC200USB002 can be used with a 20, 40, or 64-Point Micro PLC to provide an extra RS-422/485 Port and two analog inputs.

**Figure 118**



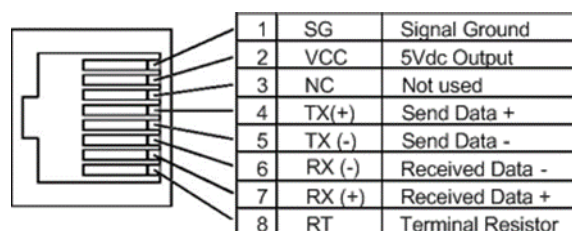
When installed on the Micro PLC, the RS-422/485 Port Option Module becomes port 2. It supports the following communications protocols:

- Modbus Master/Slave
- Serial Read/Write
- SNP/SNPX Master/Slave

Use of the Port Option module as port 2, and the protocol selection must be set up in the configuration software. After making those selections, the communications parameters can also be configured.

Pin assignments for Port 2 are:

**Figure 119**



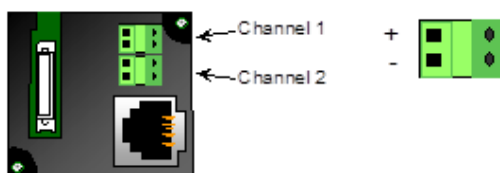
An external device can obtain power from the 5Vdc output pin if it requires 200mA or less at 5Vdc.

## 14.4.1 Analog Inputs

The terminals on the Port Option Module can be used for analog inputs with the following characteristics:

|                         |                                                                                                                    |
|-------------------------|--------------------------------------------------------------------------------------------------------------------|
| Input Ranges            | 0-10 V (10.24 V maximum)                                                                                           |
| Resolution              | 0-10 V, 10 bits                                                                                                    |
| Accuracy                | ±1%                                                                                                                |
| Linearity               | ±3 LSB Maximum                                                                                                     |
| Voltage Input Impedance | 100kΩ                                                                                                              |
| Isolation               | Channel to channel: none<br>CPU to analog signal: none                                                             |
| Analog Terminal Wiring  | Solid wire: 0.14mm <sup>2</sup> to 1.5mm <sup>2</sup><br>Stranded wire: 0.14mm <sup>2</sup> to 0.10mm <sup>2</sup> |

Figure 120



## 14.5 IC200UUB001 USB / RS232 Conversion Option Module

VersaMax Micro PLC Option Module IC200UUB001 can be used with a 20, 40, or 64-Point Micro PLC to provide a USB Port.

Figure 121



Characteristics of the USB Port are:

|                      |                                                                                                                       |
|----------------------|-----------------------------------------------------------------------------------------------------------------------|
| Connector            | Straight B type                                                                                                       |
| USB version          | 2.0                                                                                                                   |
| Power                | Self-powered                                                                                                          |
| Baud Rates Supported | 4800 through 38400 only.<br>Do not configure other baud rates for Port 2 when using the USB Conversion Option Module. |

Connecting to the USB board from windows should automatically download the correct driver from Microsoft. To download directly, go to <http://www.ftdichip.com/Drivers/FT232-FT245Drivers.htm>

## 14.6 IC200UEM001 RJ-45, 10/100 Mbit Ethernet Communications Module

The VersaMax Micro PLC Option Module IC200UEM001 can be used with a Micro 20, 40, or 64-Point PLC to provide an Ethernet Port.

Figure 122



When installed on the PLC, the Ethernet Port Option Module becomes Port 2. It supports the following communications protocols:

- SRTP Server
- Modbus Server/Client (separate download)
- Pass-through port (separate download).

Protocol options are available on <https://www.emerson.com/Industrial-Automation-Controls/support>

### 14.6.1 Module Specifications

|                                 |                                                                                     |
|---------------------------------|-------------------------------------------------------------------------------------|
| Processor Speed                 | DSTni-EX CPU, 48MHz                                                                 |
| Memory                          | 256 kByte RAM, 512 kByte FLASH                                                      |
| Connection Type                 | RJ 45 10Base-T/100Base-TX Ethernet                                                  |
| Entity Type                     | Server/Client                                                                       |
| Bus Speed                       | 10/100Mbaud                                                                         |
| Number of Connections Supported | Supports up to 8 TCP/IP connections (4 for SRTP, 8 for Modbus TCP, 1 for Tunneling) |
| Mode                            | Full Duplex                                                                         |

## 14.6.2 Status LEDs

|                  |                                                                                                                                                 |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| Link LED (Amber) | Solid Amber: Connection to Micro 64 established and network is connected                                                                        |
| Activity (Green) | Flashing Green when there is any activity on the network                                                                                        |
| Status (Red)     | OFF: No errors<br>Red ON: Duplicate IP address present or network controller error<br>Red BLINK (2x/sec): No DHCP response or Setup menu active |

## 14.6.3 Configuration Options

The option port should be configured for Ethernet. Configuration options are:

| Protocol                  | Parameters                                | Value                                                                                             |
|---------------------------|-------------------------------------------|---------------------------------------------------------------------------------------------------|
| SRTP Server               | Port Mode                                 | SNP                                                                                               |
|                           | Port Type                                 | Slave                                                                                             |
|                           | Data Rate                                 | 19.2, 38.4 or 175.0 kbps (default)                                                                |
|                           | Flow Control                              | None                                                                                              |
|                           | Parity                                    | Odd (default), Even, None                                                                         |
|                           | Stop bits                                 | 1 (default), 2                                                                                    |
|                           | Time Out                                  | Long                                                                                              |
|                           | Turnaround Time                           | 0                                                                                                 |
| Modbus TCP Client/Server  | Port Mode                                 | RTU                                                                                               |
|                           | Port Type                                 | Slave                                                                                             |
|                           | Data Rate                                 | 19.2, 38.4 or 175.0 kbps (default)                                                                |
|                           | Flow Control                              | None                                                                                              |
|                           | Parity                                    | Odd (default), Even, None                                                                         |
|                           | Station Address                           | 0–247. Default = 1.                                                                               |
|                           | Modbus/TCP Client Support (see page 252). | Disabled (default) or Enabled. Enabling Modbus/TCP Client Support sets the %I00488 status bit ON. |
| Pass-Through or Tunneling | Port Mode                                 | Serial I/O                                                                                        |
|                           | Data Rate                                 | 19.2, 38.4 or 175.0 kbps (default)                                                                |
|                           | Flow Control                              | None                                                                                              |
|                           | Parity                                    | Odd (default), Even, None                                                                         |
|                           | Stop bits                                 | 1 (default), 2                                                                                    |
|                           | Bits/Characters                           | 7 or 8                                                                                            |
|                           | Station Address (Byte 1 to Byte 8)        | 0 (default) –FF                                                                                   |

For detailed information on the Telnet configuration of the Ethernet Option Module for each protocol, refer to GFK-2436E or later.

## 14.6.4 Enhanced Data Throughput

The versions 3.83 of Micro and later, and versions 2.0 and later of the Ethernet Option Module firmware provide Enhanced Data Throughput on Port 2 with the Ethernet Option Module.

- Data rates supported for the Ethernet Option Module are: 19,200bps, 38,400bps and 175,000bps. Firmware releases 3.82 and earlier supported data rates 300bps through 38400 on Ethernet Module. Release 3.83 and later do not support 300bps through 9,600bps data rates, but support for a higher data rate of 175,000bps is added.
- The default baud rate for Port 2 with the Ethernet Option module is 175000bps. This is the baud rate for which the Micro Port 2 will be configured during auto-configuration with Ethernet module connected.
- When 175,000bps data rate is selected, a value of 2ms is automatically selected internally for SNP T1 timer value (default T1 value is 5 ms). This will result in increased throughput for communication with SNP protocol.

## 14.6.5 Setting the IP Address

There are two steps to setting the module's IP address, as described in the datasheet that is packaged with the module:

- First, a temporary IP address and the MAC address must be entered using PAC Machine Edition Logic Developer.
- Second, the permanent IP address must be set using Ethernet commands.

The permanent IP address setting must be saved to the Flash on the Ethernet board or it will be lost during power cycle.

## 14.6.6 Downloading Ethernet Drivers

The Ethernet drivers for the Ethernet Option Module are downloaded from <https://www.emerson.com/Industrial-Automation-Controls/support>. Filenames and passwords are listed in the module datasheet. Downloading is done using the PumpKIN utility, which is included.

## 14.6.7 Modbus/TCP Client Support

The versions 3.83 and later of the Micro PLC firmware and version 2.0 of the Ethernet Option Module provide Modbus TCP Client Support, which allows you to generate read or write requests to the Modbus TCP server device. To use this feature, the CPU's Port 2 must be configured for Modbus RTU Slave. The Ethernet Option Module acts as Modbus RTU master on serial side. Because the Micro PLC is configured as RTU Slave, it cannot send the commands directly to the Ethernet Module. For this reason Micro updates, the Modbus TCP request at a specified reference memory location, which is read by the Ethernet module to process the command sent.

The Ethernet module reads the Modbus command framed by the Micro PLC. The Ethernet module then communicates with the server device and updates the response back to the Micro PLC, along with the status. In the Ethernet module, one channel can be configured for Modbus TCP Client. The remaining channels are used for Modbus TCP Server. The server should not use the channel configured for client. Similarly, the client should not reclaim the channels configured for server. Channels should not be switched between client/server dynamically until you reconfigure the Ethernet module.

To trigger the Modbus/TCP Client request, complete the following steps.

1. Hardware configuration in Machine Edition. This creates the Sequence and Command data address configurations.
2. Configure Modbus/TCP Client and serial parameters in TELNET.
3. Create logic in Machine Edition to process the Read/Write request.

---

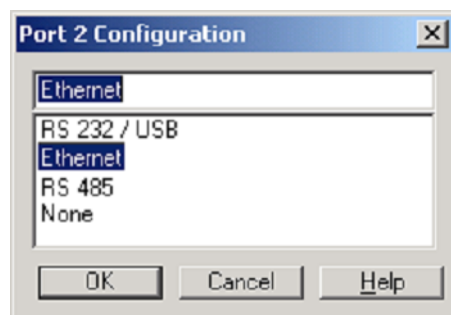
**Note:** The `MODBUS_TCP_RW` function block should be triggered in the logic only when %I00488 is on. (When on, the status bit %I488 indicates the Ethernet Option Module is configured for Modbus Client operation and is ready to accept Modbus Client commands.) Otherwise error “85B0H” will be output in the function block status.

---

## Hardware Configuration

In the CPU Settings, set Port 2 Configuration to Ethernet.

Figure 123



On the Port 2 (Ethernet) tab, set the parameters as follows:

|                                 |                                                                                                                                       |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Port Mode:                      | RTU                                                                                                                                   |
| Port Type:                      | Slave                                                                                                                                 |
| Data Rate:                      | Select data rate (Max: 175000bps).<br>For details on data rates supported on Port 2, refer to “Enhanced Data Throughput” on page 252. |
| Modbus/TCP Client Support:      | Enabled                                                                                                                               |
| Sequence Numbers Start Address: | Assign %R memory. Occupies 5 words                                                                                                    |
| Command Data Start Address:     | Assign %R memory. Occupies 12 words                                                                                                   |

---

**Note:** Sequence Number and Command Data addresses should not overlap or conflict with any other variables used in the logic.

---



## Telnet Configuration

**Note:** The Ethernet option module will be power cycled and reset under the following conditions:

- A connection to the Ethernet option module is established through TELNET and disconnected immediately.
- A connection to the Ethernet option module through is established through TELNET, the configuration is edited, and you press "Q" (Quit without Save).

1. Connect the PLC with Port 2 to the Ethernet Option Module in the network.
2. Type TELNET <Ethernet Option Module IP: x.x.x.x> 9999 at the command prompt.
3. Configure the Modbus/TCP to RTU Bridge as follows:

### Sample Modbus/TCP to RTU Bridge Setup

#### 1) Network/IP Settings:

IP Address..... <x.x.x.x>  
Default Gateway ..... <x.x.x.x>  
Netmask ..... <x.x.x.x>  
SNMP is enabled

#### 2) Serial & Mode Settings:

Protocol .....Modbus/RTU, Slave(s) attached  
Modbus/TCP Client ..... disabled  
Serial Interface ..... 175000,8,O,1

#### 4) Advanced Modbus Protocol settings:

Slave Addr/Unit Id Source: Modbus/TCP header  
Modbus Serial Broadcasts  
Disabled (Id=0 auto-mapped to 1)  
MB/TCP Exception Codes  
Yes (return 00AH and 00BH)  
Char, Message Timeout .....  
00050msec, 05000msec  
D)efault settings, S)ave, Q)uit without save

Select Command or parameter set (1..4) to change: 2

Attached Device (1=Slave 2=Master) 1

Modbus/TCP Client Enabled (N)Y

Close Idle TCP sockets after (3-60 sec, 0=leave open)  
10 Press Enter

Serial Protocol (1=Modbus/RTU 2=Modbus/ASCII) 1  
Press Enter

Enter serial parameters (38400,8,0,1) 175000,8,0,1

### Modbus/TCP to RTU Bridge Setup

After entering all the values, the Modbus/TCP to RTU Bridge Setup screen appears showing the configured values.

#### 1) Network/IP Settings:

IP Address 3.212.218.12

Default Gateway 003.212.218.001

Netmask 255.000.000.000

SNMP is enabled

#### 2) Serial & Mode Settings:

Protocol Modbus/RTU, Slave(s) attached

Modbus/TCP Client enabled

Serial Interface 175000,8,0,1

#### 4) Advanced Modbus Protocol settings:

Slave Addr/Unit Id Source Modbus/TCP header

Modbus Serial Broadcasts

Disabled (Id=0 auto-mapped to 1)

MB/TCP Exception Codes

Yes (return 00AH and 00BH)

Char, Message Timeout 00050msec, 05000msec

D)efault settings, S)ave, Q)uit without save

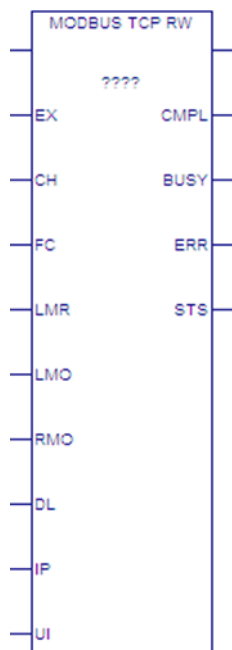
Select Command or parameter set (1..4) to change: S

To save the parameters, press S.

Logic to Process Read/Write Requests

The MODBUS\_TCP\_RW function block is used to process read/write requests.

Figure 124



### Parameters of MODBUS\_TCP\_RW

| Parameter | Data Type, Memory Area    | Description                                                                                                                               |
|-----------|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Inputs    |                           |                                                                                                                                           |
| ????      | DWord, R                  | Control word. Requires two bytes in %R memory. Do not write or clear this memory during operation of the MODBUS_TCP_RW function.          |
| Enable    | Flow                      | When the function is enabled, the operation is performed.                                                                                 |
| EX        | Flow                      | Execute. A low to high transition starts command processing.                                                                              |
| CH        | Word, Constant            | Channel number on which the request will be processed. Should be 1.                                                                       |
| FC        | Word, AI, AQ, R, Constant | Function code. Modbus RTU function to be carried out. See page 258 for valid function codes.                                              |
| LMR       | Word, AI, AQ, R, Constant | Segment selector for Local reference memory type. Destination memory type for a Read operation; Source memory type for a Write operation. |
|           | <b>LMR Value</b>          | <b>Description</b>                                                                                                                        |
|           | 18                        | %Q discrete output memory (Byte mode)                                                                                                     |
|           | 72                        | %Q discrete output memory (Bit mode)                                                                                                      |
|           | 8                         | %R register memory (Word mode)                                                                                                            |

| Parameter      | Data Type, Memory Area    | Description                                                                                                                                                                                                        |
|----------------|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| LMO            | Word, AI, AQ, R, Constant | Local PLC reference memory address for Modbus/TCP Client device's location. Destination for a read operation; Source for a write operation.                                                                        |
| RMO            | Word, AI, AQ, R, Constant | Remote PLC reference memory address for Modbus/TCP Server device's location. Source for a read operation this memory; Destination for a write operation.                                                           |
| DL             | Word, AI, AQ, R, Constant | For valid lengths refer to the comments in the table "Modbus/TCP Function Codes Supported by VMNM PLCs" on page 258.                                                                                               |
| IP             | Word, AI, AQ, R           | IP Start address. This is the IP Address of the Server device. Starting from this address, four words would contain four octets of the IP.                                                                         |
| UI             | Word, AI, AQ, R, Constant | Unit Identifier. A control code used in a Modbus/TCP message. This value is 1 for most Modbus/TCP devices except for an Ethernet to Serial bridge used to multi-drop to Modbus RTU devices.<br>Valid values: 0–255 |
| <b>Outputs</b> |                           |                                                                                                                                                                                                                    |
| ENO            | Flow                      | Enable output.                                                                                                                                                                                                     |
| CMPL           | Bool, I, Q, M, G, T       | Complete. Set when the read or write operation has been successfully completed.                                                                                                                                    |
| BUSY           | Bool, I, Q, M, G, T       | Busy. Set when the read or write process is in operation and has not been completed.                                                                                                                               |
| ERR            | Bool, I, Q, M, G, T       | Error. Set when an error is identified during operation.                                                                                                                                                           |
| STS            | Word, AI, AQ, R           | Status. May include the following:<br>Remote Server exceptions<br>Function block parameter errors<br>Client application errors<br>For a list of status/error codes, refer to page 258.                             |

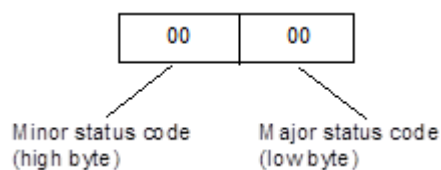
## MODBUS/TCP Function Codes Supported by VersaMax Micro PLCs

| Function                    | Function Code | Server Reference Memory Type | Data Unit Size         | Comments                        |
|-----------------------------|---------------|------------------------------|------------------------|---------------------------------|
| Read Coils                  | 1             | Coils                        | Bit                    | Read up to 2,000 bits           |
| Read Input Discrete         | 2             | Discrete Inputs              | Bit                    | Read up to 2,000 bits           |
| Read Multiple Registers     | 3             | Register                     | Register (16-bit word) | Read up to 125 words            |
| Read Analog Input Registers | 4             | Analog Input Registers       | Register (16-bit word) | Read up to 125 words            |
| Write Coil                  | 5             | Coil                         | Bit                    | Write one bit                   |
| Write Single Register       | 6             | Register                     | Register (16-bit word) | Write one word                  |
| Read Exception Status       | 7             | -NA-                         | Byte                   | -NA-                            |
| Write Multiple coils        | 15            | Coil                         | Bit                    | Write multiple bits, up to 2000 |
| Write Multiple Registers    | 16            | Register                     | Register (16-bit word) | Write to a maximum of 100 words |

## Status/Error Codes

Status codes are reported in the following format:

Figure 125



## Major Status Codes

| Error Status (Hex) | Major Status Description                                                                                                                                |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| 01H                | Successful completion. No minor status code (value can be ignored.)                                                                                     |
| 91H                | Modbus TCP Status codes at the server. An error was detected at the Modbus TCP server. See the table on page 259 for the associated Minor Status Codes. |
| B0H                | Client Application Error. See the table on page 259 for the associated Minor Status Codes.                                                              |
| B1H                | Serial link error codes between Micro and Ethernet Module. See the table on page 261 for the associated Minor Status Codes.                             |

## Minor Status Codes for Major Status 91H

The following table lists minor status codes that can be reported for status code 91H, Remote Server Device error.

| Error Status (Hex) | Error Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0191H              | Illegal Function. The function code received in the request is not allowed for the server. Causes may be:<br>The function code is not implemented in the unit selected. For example, it may be a function that applies only to newer controllers.<br>The server is in the wrong state to process a request of this type, for example because it was not configured and is being asked to return register status. Modbus exception code 01H.                                                                                |
| 0291H              | Illegal data address. The data address received in the query is not an allowable address for the server. More specifically, the combination of reference number and transfer length is invalid. MODBUS exception code 02.                                                                                                                                                                                                                                                                                                  |
| 0391H              | Illegal data value. A value contained in the query data field is not an allowable value for server. This indicates a fault in the structure of the remainder of a complex request, such as that the implied length is incorrect. It specifically does NOT mean that a data item submitted for storage in a register has a value outside the expectation of the application program, since the MODBUS protocol is unaware of the significance of any particular value of any particular register. MODBUS exception code 03. |
| 0491H              | Slave Device Failure. An unrecoverable error occurred while the server was attempting to perform the requested action.                                                                                                                                                                                                                                                                                                                                                                                                     |
| 0691H              | Slave Device Busy. Server service request queue full. MODBUS exception code 06.                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 0791H              | Negative Acknowledge. Internal server error occurred. MODBUS exception code 07                                                                                                                                                                                                                                                                                                                                                                                                                                             |

## Minor Status Codes for Major Status B0H

The following table lists minor status codes that can be reported for status code B0H, Client Application Error.

| Error Status (Hex) | Error Description                                                                                                                                                                                                                 |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 85B0H              | Client device not yet ready to send the request.                                                                                                                                                                                  |
| 86B0H              | Server unit data size of zero is not allowed. The data unit size for read/write operations should be greater than zero.                                                                                                           |
| 87B0H              | Server unit data size is too large. The data unit size for read/write operations should not cross the maximum value.<br>Example: If the data length specified for Read/Write coil is greater than 1, this error code is returned. |
| 88B0H              | Invalid Channel Number                                                                                                                                                                                                            |
| 8BB0H              | This error will be triggered when the server reference memory address is zero, which is not allowed.                                                                                                                              |

| Error Status (Hex) | Error Description                                                                                                                                                                                                                                                                                                           |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8CB0H              | Invalid Client Memory Type. This error is triggered when the specified client reference memory type is invalid. Refer to page 256 for valid memory types.                                                                                                                                                                   |
| 8EB0H              | Invalid IP address integer. All four octets of the IP address should be in the range 0 to 255.                                                                                                                                                                                                                              |
| 8FB0H              | Invalid IP address class.                                                                                                                                                                                                                                                                                                   |
| 90B0H              | Insufficient TCP connection resources to perform request.                                                                                                                                                                                                                                                                   |
| 91B0H              | Zero local starting address is not allowed, The starting address of the client PLC memory location should be greater than zero.                                                                                                                                                                                             |
| 95B0H              | Internal Error. This problem may occur due to the Ethernet Interface being asked to perform beyond its capacity.                                                                                                                                                                                                            |
| 96B0H              | Underlying TCP connection aborted (reset) by server end point. The server is not responding within the timeout value.                                                                                                                                                                                                       |
| 97B0H              | Underlying TCP connection aborted (reset) by Client end point.                                                                                                                                                                                                                                                              |
| 9CB0H              | Invalid frame format. Data response did not arrive in a proper order.                                                                                                                                                                                                                                                       |
| 9DB0H              | Data response had unexpected size. For example received more data than expected.                                                                                                                                                                                                                                            |
| 9FB0H              | Invalid Client PLC Memory reference address.                                                                                                                                                                                                                                                                                |
| B6B0H              | Unrecognized Function code. The Client device does not support the function code or operation.                                                                                                                                                                                                                              |
| B7B0H              | Invalid Unit Identifier.                                                                                                                                                                                                                                                                                                    |
| A0B0H              | Invalid Server Reference Memory Address.                                                                                                                                                                                                                                                                                    |
| A2B0H              | Failed to update the Micro reference memory. Ethernet Module was unable to write to the Client memory specified in the command data.                                                                                                                                                                                        |
| A7B0H              | Unable to connect to remote device after successful channel establishment.                                                                                                                                                                                                                                                  |
| AAB0H              | An attempt to establish a TCP connection with a remote server failed. This error can be caused by the following conditions:<br>Server is not turned on<br>Cables are not properly connected<br>If using a switch, switch is not turned on<br>This error can occur while establishing the connection with the server device. |
| ACB0H              | A protocol error occurred while communicating with the local PLC. This error can occur when a break in the frame or check sum error occurred.                                                                                                                                                                               |
| ADB0H              | A TCP timeout occurred while communicating with the remote PLC.                                                                                                                                                                                                                                                             |

## Minor Status Codes for Major Status B1H

The following table lists the minor status codes that can be reported for the major status code B1H, which indicates a Serial Link error in the communications between the Ethernet module and the Micro PLC.

If communication between the Ethernet Module and the Micro CPU is not functional, the Ethernet Module indicates the problem by LED blink patterns and through the TELNET connection. If the error codes reported by the Ethernet Module, by LEDs or through TELNET, are different, the Serial Link error code has the highest priority.

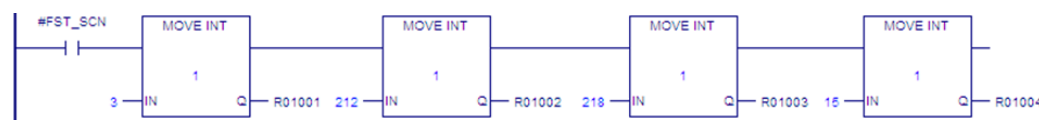
| Error Status (Hex) | Error Description                                                                                               |
|--------------------|-----------------------------------------------------------------------------------------------------------------|
| 01B1H              | Unable to read the Sequence Number Data Structure.                                                              |
| 02B1H              | Unable to read the Command Data Structure                                                                       |
| 03B1H              | Unable to read/write Client PLC reference memory (segment selector/offset specified in command data structure). |
| 04B1H              | Unable to update the response status/sequence number                                                            |
| 05B1H              | Serial Communication error (Parity, Baud rate, framing, Over run etc.) with the Micro CPU.                      |

## Examples for MODBUS\_TCP\_RW

For the following examples:

1. The IP address is stored as integer values in the four words starting at %R1001.

Figure 126



2. When %I00488 is on, the MODBUS\_TCP\_RW function block is executed on the rising transition of %T0001. For parameter definitions, refer to page 256.



| Function                                                                                                                                                                              | Sample Rung |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <p>Reading Coils (FC=1)</p> <p>Reads a coil at offset 10 (RMO=10) in the remote Modbus TCP server and store the value at the location %Q10 (LMR=72, LMO=10).</p>                      |             |
| <p>Reading Discrete Inputs (FC=2)</p> <p>Read nine discrete inputs from offset 5 (RMO=5) in the remote Modbus TCP server and store the values in bit mode at %Q3 (LMR=72, LMO=3).</p> |             |

| Function                                                                                                                                                                                                                                     | Sample Rung |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <p>Reading Multiple Registers (FC=3)<br/>Read 125 registers from the remote server device. The Remote server reference address is %R0101 (LMR=8, LMO=101). The Client or Local PLC reference memory address is %R5001 (LMR=8, RMO=5001).</p> |             |
| <p>Reading Analog Inputs (FC=4)<br/>Read nine analog input registers at offset 200 (RMO=200) in the remote Modbus TCP device and store the values in the Client PLC memory location %R0020 (LMR=8, LMO=20).</p>                              |             |

| Function                                                                                                                                                                   | Sample Rung                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Writing a Coil (FC=5)</p> <p>Write the value at %Q4 (LMR=72, LMO=4) in the Client PLC memory location to coil %Q5 (RMO=5) in the remote Modbus TCP device.</p>          | <p>The diagram shows a ladder logic rung for writing a coil. It starts with two normally open contacts: 'I00488' and '#ALW_ON'. These are connected to the 'MODBUS TCP RW' block. The block has several inputs and outputs. The 'EX' input is connected to 'T00001'. The 'R01005' input is connected to 'R01001'. The 'UI' input is connected to '1'. The 'CH' output is connected to '1'. The 'FC' output is connected to '5'. The 'LMR' output is connected to '72'. The 'LMO' output is connected to '4'. The 'RMO' output is connected to '5'. The 'DL' output is connected to '1'. The 'IP' output is connected to 'R01001'. The 'STS' output is connected to 'R01007'. The 'ERR' output is connected to 'T00004'. The 'BUSY' output is connected to 'T00003'. The 'CMPL' output is connected to 'T00002'.</p>              |
| <p>Writing a Single Register (FC=6)</p> <p>Write one register from %R10 (LMR=8, LMO=10) to a holding register at offset 200 (RMO=200) in the remote Modbus TCP server.</p> | <p>The diagram shows a ladder logic rung for writing a single register. It starts with two normally open contacts: 'I00488' and '#ALW_ON'. These are connected to the 'MODBUS TCP RW' block. The block has several inputs and outputs. The 'EX' input is connected to 'T00001'. The 'R01005' input is connected to 'R01001'. The 'UI' input is connected to '1'. The 'CH' output is connected to '1'. The 'FC' output is connected to '6'. The 'LMR' output is connected to '8'. The 'LMO' output is connected to '10'. The 'RMO' output is connected to '200'. The 'DL' output is connected to '1'. The 'IP' output is connected to 'R01001'. The 'STS' output is connected to 'R01007'. The 'ERR' output is connected to 'T00004'. The 'BUSY' output is connected to 'T00003'. The 'CMPL' output is connected to 'T00002'.</p> |

| Function                                                                                                                                                                                                          | Sample Rung                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Reading Status (FC=7)</p> <p>Read the Status from the remote Modbus TCP server and store the Status data in bit mode at location %Q4 (LMR=72, LMO=4).</p>                                                      | <p>The diagram shows a ladder logic rung for the 'Reading Status' function. It starts with two normally open contacts: 'I00488' and '#ALW_ON'. These are connected to the 'MODBUS TCP RW' block. The block has several inputs and outputs. The 'EX' input is connected to 'T00001'. The 'R01005' input is connected to 'T00002'. The 'CH' output is connected to 'T00003'. The 'FC' output is connected to 'T00004'. The 'LMR' output is connected to 'R01007'. The 'LMO' output is connected to 'R01001'. The 'RMO' output is connected to 'R01001'. The 'DL' output is connected to 'R01001'. The 'UI' output is connected to 'R01001'. The 'STS' output is connected to 'R01007'.</p>         |
| <p>Writing Multiple Coils (FC=15)</p> <p>Write the eight values starting from %Q1 (LMR=72, LMO=1) in the Client reference memory to eight coils starting at offset 1 (RMO=1) in the Remote Modbus TCP device.</p> | <p>The diagram shows a ladder logic rung for the 'Writing Multiple Coils' function. It starts with two normally open contacts: 'I00488' and '#ALW_ON'. These are connected to the 'MODBUS TCP RW' block. The block has several inputs and outputs. The 'EX' input is connected to 'T00001'. The 'R01005' input is connected to 'T00002'. The 'CH' output is connected to 'T00003'. The 'FC' output is connected to 'T00004'. The 'LMR' output is connected to 'R01007'. The 'LMO' output is connected to 'R01001'. The 'RMO' output is connected to 'R01001'. The 'DL' output is connected to 'R01001'. The 'UI' output is connected to 'R01001'. The 'STS' output is connected to 'R01007'.</p> |

| Function                                                                                                                                                                                           | Sample Rung |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <p>Writing Multiple Registers<br/>(FC=16)</p> <p>Write 100 registers from the Client reference memory address %R5001 (LMR=8, LMO=5001) to the remote server reference address %R101 (RMO=101).</p> |             |

## 14.6.8 Security Settings for the Ethernet Option Module

Security settings can be changed to prevent unauthorized entry into Ethernet Option Module configuration mode.

Two security settings are supported for the Ethernet Option Module (firmware version 2.0 and later): Password support for Telnet configuration and SNMP (Enable/Disable) configuration.

Security settings are provided for the three protocols: SNP/SRTP, Modbus TCP and Tunneling.

For Modbus TCP and SRTP protocols, these security settings options are present in the "Network/IP Settings" menu for. For Tunneling (Pass-through), these security settings are present in the "basic parameters/server" menu.

By default, there is no password and Simple Network Management Protocol (SNMP) is enabled.

Disabling or Enabling the SNMP is configurable.

The maximum password length is 16 characters. These characters can be alphanumeric or special characters. The password requires a minimum length of 8 characters.

A password set on a particular protocol's firmware remains in effect if the firmware is changed to that of a different protocol. For example, if a password is set on Modbus TCP firmware and later the firmware is changed to SNP/SRTP, the same password set on Modbus TCP firmware will still apply.

If the password is set, it will be required before entering to the Telnet configuration Setup Mode. After prompting for password, if the password is not entered within 30 seconds, the Telnet session will expire.

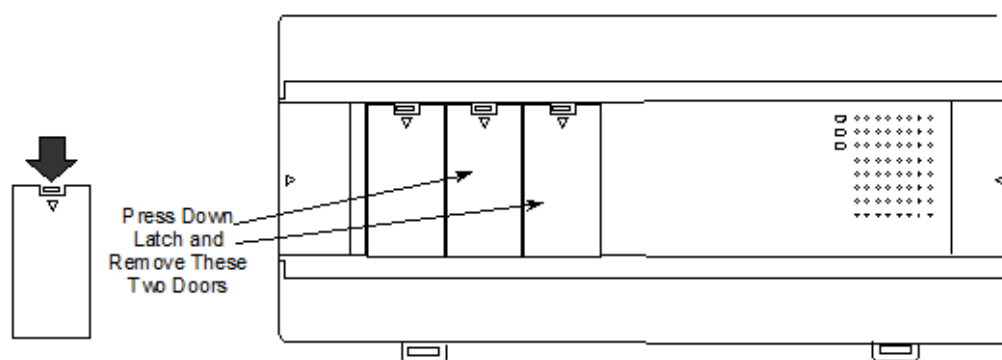
## 14.7 Installing Option Modules

### ⚠ CAUTION

Power to the VersaMax Micro PLC MUST BE TURNED OFF when installing or removing Option Modules.

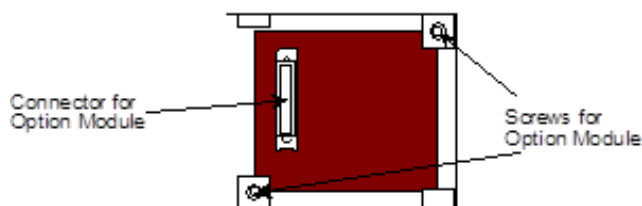
1. Access the option connector on the front of the unit, as shown below for a Micro-64 PLC.

Figure 127



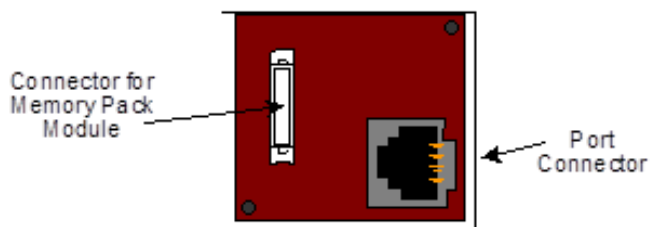
2. If a port-type Option Module is being installed, orient the connector on the Option Module with the connector in the Micro PLC. Be careful to avoid contact with the exposed components in the module.

Figure 128



3. Press the Option Module downward until it clicks into place.
4. Install the screws provided with the Option Module into the corners as shown above.

Figure 129



5. If a Memory Pack Module is being installed, orient the connector on the back of the Memory Pack Module with the connector on the Micro PLC or port-type Option Module. Press the Memory Pack Module downward until it clicks into place.
6. Install the protective cover(s). If only the Memory Pack Module is used, both covers may be installed. If a port module is used, the right-hand cover is not installed, and the port connector remains accessible.

# Chapter 15: Installation Instructions

This chapter describes the procedures for installing a VersaMax Nano PLC or VersaMax Micro PLC and preparing the system for use. Included in this chapter are instructions for unpacking, inspecting, and installing the PLC. Instructions are also provided for connecting cables to programming devices.

- Pre-installation check
- Agency Approvals, Standards, and General Specifications
- Immunity and Emission Specifications, Relevant Standards, and Level Passed
- Installation Guidelines
- Mounting Dimensions
- Grounding the Equipment
- Installing a PLC or Expansion Unit on a DIN Rail
- Connecting an Expansion Unit to a Micro PLC
- System Wiring Guidelines
- Starting Up the PLC
- Adjusting the Analog Potentiometers
- DIP Switches
- Installing/Replacing a Backup Battery
- Serial Port Connections
- RS485 Port Isolator
- RS-232 to RS-485 Adapter
- Replacing AC Output Module Fuses

## 15.1 Preinstallation Check

Carefully inspect all shipping containers for damage during shipping. If any part of the system is damaged, notify the delivery service immediately. The damaged shipping container should be saved as evidence for inspection by the delivery service. As the consignee, it is your responsibility to register a claim with the delivery service for damage incurred during shipment. However, Emerson will fully cooperate with you, should such action be necessary. After unpacking the equipment, record all serial numbers. Serial numbers are required if you should need to contact Product Service during the warranty period of the equipment. All shipping containers and all packing material should be saved should it be necessary to transport or ship any part of the system.

Keep Micro PLC modules in their boxes during storage and transport.



## 15.2 Agency Approvals, Standards, and General Specifications

The Micro PLC products supplied by Emerson are global products designed and manufactured for use throughout the world. They should be installed and used in conformance with product-specific guidelines as well as the following agency approvals, standards and general specifications:

| Agency Approvals                                         |                               | Comments                                                                   |
|----------------------------------------------------------|-------------------------------|----------------------------------------------------------------------------|
| Industrial Control Equipment [Safety]                    | UL508, CSA C22.2 No 142-M1987 | Certification by Underwriters Laboratories for Revision B and later models |
| Hazardous Locations [Safety] Class I, Div II, A, B, C, D | UL1604 CSA C22.2 No 142-M1987 | Certification by Underwriters Laboratories for Revision B and later models |
| European EMC & LVD Directives                            | CE Mark                       | All models                                                                 |

| Environmental                   |                      | Conditions                                                 |
|---------------------------------|----------------------|------------------------------------------------------------|
| Vibration                       | IEC68-2-6, JISC0911  | 1G @57-500Hz, 0.15mm p-p @10-57Hz                          |
| Shock                           | IEC68-2-27, JISC0912 | 15G, 11ms                                                  |
| Operating Temperature           |                      | 0°C to 55°C [ambient]                                      |
| Storage Temperature             |                      | -10°C to +75°C                                             |
| Humidity                        |                      | 5% to 95%, non-condensing                                  |
| Enclosure Protection            | IEC529               | Enclosure per IP54; protection from dust & splashing water |
| Isolation: Dielectric Withstand | UL508, UL840, IEC664 | 1.5kV for modules rated from 51V to 250V                   |

## 15.2.1 Immunity and Emission Specifications, Relevant Standards, and Level Passed

| Description                                           | Standards             | Specifications                                                                         |
|-------------------------------------------------------|-----------------------|----------------------------------------------------------------------------------------|
| Electrostatic Discharge                               | EN 61000-4-2          | ± 4.0 kV (Contact); ± 8.0 kV (Air)                                                     |
| RF Susceptibility                                     | EN 61000-4-3          | 10 V/m (unmodulated), 80-1000 MHz, 80% AM, 1 kHz sine wave                             |
| RF Susceptibility from Digital Radio Telephones       | ENV 50204             | 10 V/m (unmodulated), 900±5MHz, 100% AM (200 Hz square wave, 50% duty cycle)           |
| Fast Transient                                        | EN 61000-4-4          | ± 2.2 kV (PS); ± 1.1 kV (I/O)                                                          |
| Voltage Surge                                         | EN 61000-4-5          | ± 2.2 kV, common mode (PS)<br>± 1.1 kV, differential (PS)                              |
| Conducted RF                                          | EN 61000-4-6          | 10 Vrms, 0.15-80 MHz, 80% AM, 1 kHz sine wave (PS, I/O)                                |
| Voltage Dip<br>Voltage Interrupt<br>Voltage Variation | EN 61000-4-11         | 30% Nom., 10 ms<br>>95% Nom., 10ms<br>20% Nom., 10 sec.                                |
| Radiated Emissions                                    | EN 55011 <sup>8</sup> | 30 dBμV/m, 30 – 230 MHz (measured @ 30m)<br>37 dBμV/m, 230 – 1000 MHz (measured @ 30m) |
| Conducted Emissions                                   | EN 55011 <sup>8</sup> | 79/66 dBμV, 0.15 – 0.5 MHz<br>73/60 dBμV, 0.5 – 30 MHz                                 |

## 15.3 Installation Guidelines

- This equipment is intended for use in typical industrial environments that utilize anti-static materials such as concrete or wood flooring. If the equipment is used in an environment that contains static material such as carpets, personnel should discharge themselves by touching a safely grounded surface before accessing the equipment.
- If the AC mains are used to provide power for I/O, these lines should be suppressed prior to distribution to the I/O so that immunity levels for the I/O are not exceeded. Suppression for the AC I/O power can be made using line-rated MOVs that are connected line-to-line, as well as line-to-ground. A good high-frequency ground connection must be made to the line-to-ground MOVs.
- Installation should be indoors with primary facility surge protection on the incoming AC power lines.

<sup>8</sup> EN 55011 limits are equivalent to limits specified in EN 55022, CISPR 11, CISPR 22, and 47 CFR 15.

### 15.3.1 CE Mark Installation Requirement

For compliance to the Low Voltage Directive, VersaMax Nano and VersaMax Micro systems are considered 'open equipment' (i.e. live electrical parts may be accessible to users) and must be installed in an enclosure. IEC 1131-2:1991 (sect. 4.2, item 2) states: "Open equipment is not required to meet IP2x requirement.... Opening of the enclosure shall only be possible by means of a key or tool." The PLC equipment should be installed in a location that meets the specifications listed on the previous page.

### 15.3.2 UL Requirements for Class I Div 2 Installations

Equipment labeled with reference to Class 1 Div. 2 Groups A, B, C & D, hazardous locations is suitable for use in Class 1, Division 2, Groups A, B, C, D or non-hazardous locations only.

Equipment labeled with reference to Class 1 Zone 2 Groups A, B, C & D, hazardous locations is suitable for use in Class 1, Zone 2, Groups A, B, C, D or non-hazardous locations only.

#### **WARNING**

- Explosion hazard - substitution of components may impair suitability for Class 1, Division 2.
- Explosion hazard - do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

### 15.3.3 Additional Environmental Guidelines

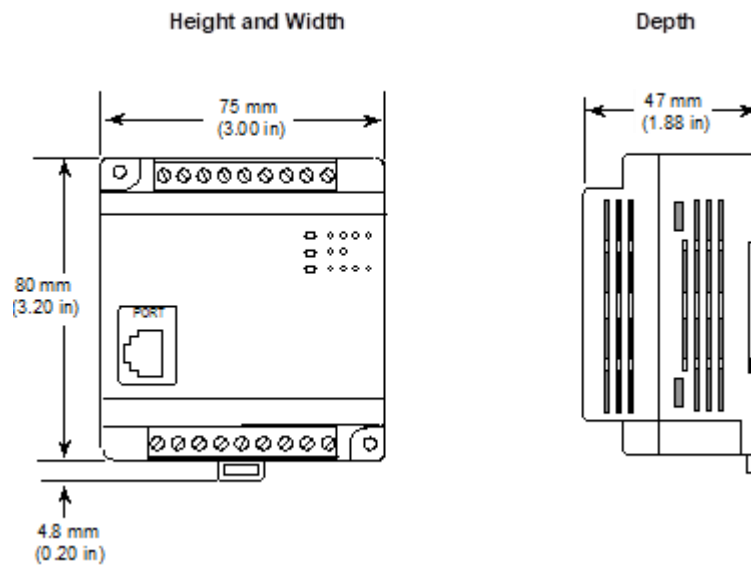
- The temperature must not change so rapidly that condensation could form on or inside the unit.
- There should be no combustible, corrosive or flammable gases.
- The environment should not have excessive dust, salty air, or conductive materials (iron powder, etc.) that could cause internal shorts.
- The PLC should not be installed where it will be exposed to direct sunlight.
- The PLC should not be exposed to water, oil or chemicals.
- Provide adequate ventilation space. Recommended minimum space allowances are approximately: 50mm (2 inches) top, sides and bottom.
- The PLC should not be installed above equipment that generates a large amount of heat.
- If the ambient temperature exceeds 55°C, provide a ventilation fan or air conditioner.
- The equipment should not be installed within 200mm (8 inches) of any high voltage (more than 1000V) or high current (more than 1A) line (except for outputs controlled by the PLC).
- For ease of maintenance and safety, locate the PLC equipment as far away from high voltage equipment and power generation equipment as possible.

- Take appropriate measures when installing systems in locations:
  - subject to static electricity or other forms of noise.
  - subject to strong electromagnetic fields.
  - close to power supplies.

## 15.4 Mounting Dimensions

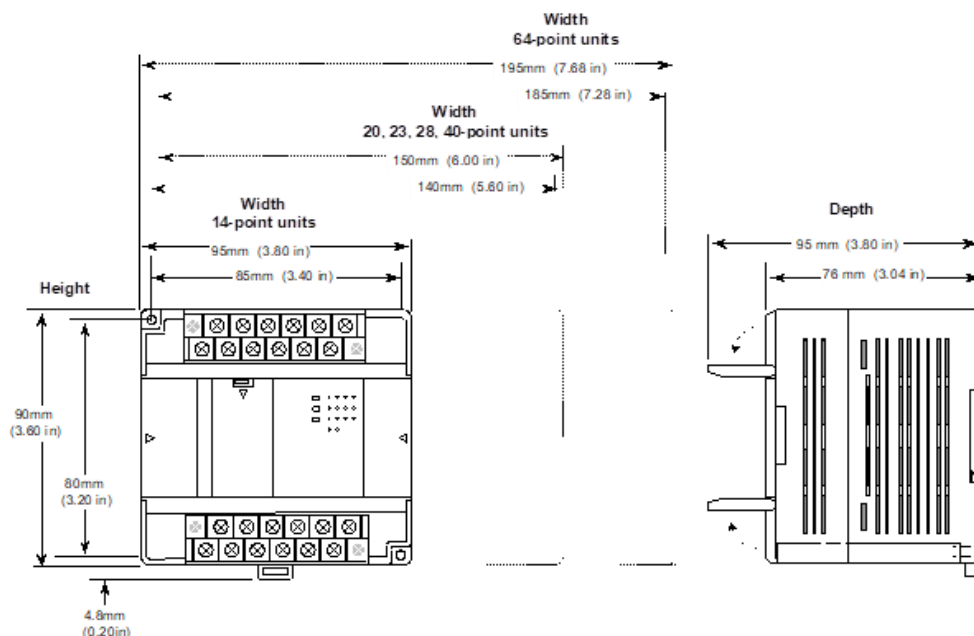
### 15.4.1 Dimensions of Nano PLCs

Figure 130



## 15.4.2 Dimensions of 14-, 20-, 23-, 28-, 40-, and 64-Point Micro PLCs and Expansion Units

Figure 131



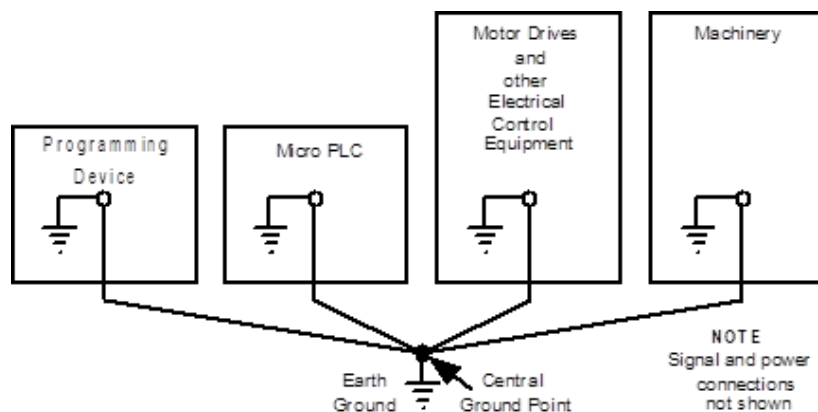
## 15.5 Grounding the Equipment

Equipment grounding procedures must be properly followed for safe operation of your PLC equipment.

The maximum recommended resistance to ground is 200mΩ (equivalent to 100 feet of AWG #12 – 3.29mm<sup>2</sup> – copper cable).

- Grounding installation must conform to National Electrical Code (NEC) standards.
- Ground conductors should be connected with separate branches routed to a central earth ground point.

Figure 132



- Ground conductors should be as short and as large in size as possible. Braided straps or ground cables – AWG #12 (3.29mm<sup>2</sup>) or larger – can be used to minimize resistance. Conductors must always be large enough to carry the maximum short circuit current of the path being considered.
- Install an external earth leakage breaker and take other safety measures according to external wiring standards.

### 15.5.1 Grounding the Programmer

For proper operation, the computer for the programming software must have a ground connection in common with the PLC. Normally, this common ground connection is provided by connecting the programmer's power cord to the same power source (with the same ground reference point) as the PLC. If that is not possible, use a port isolator (IC690ACC903) between the programmer PLC serial connection. If the programmer ground is at a different potential than the PLC ground, a shock hazard could exist. Also, damage to the ports or converter (if used) could occur when the programmer serial cable is connected between the two.

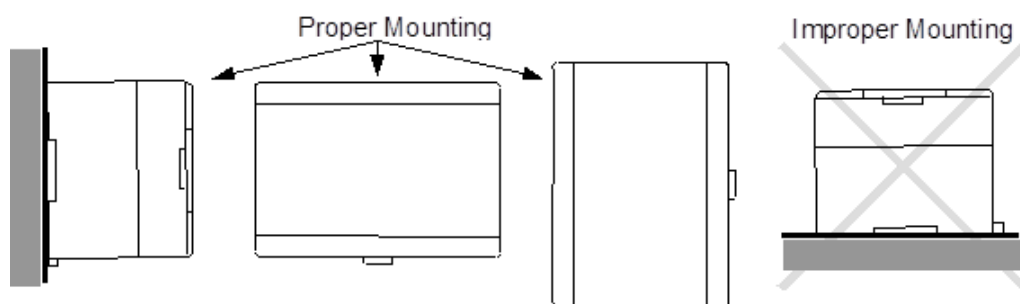
#### **⚠ WARNING**

Failure to follow programmer grounding recommendations could result in personal injury, equipment damage, or both.

## 15.6 Installing a PLC or Expansion Unit on a DIN Rail

VersaMax Nano PLC and Micro PLC equipment can be mounted on a 35mm DIN rail as described below, or mounted on a metal panel using screws as described on the next page. The equipment must be mounted on a vertical surface. Do not mount it on a horizontal surface.

**Figure 133**



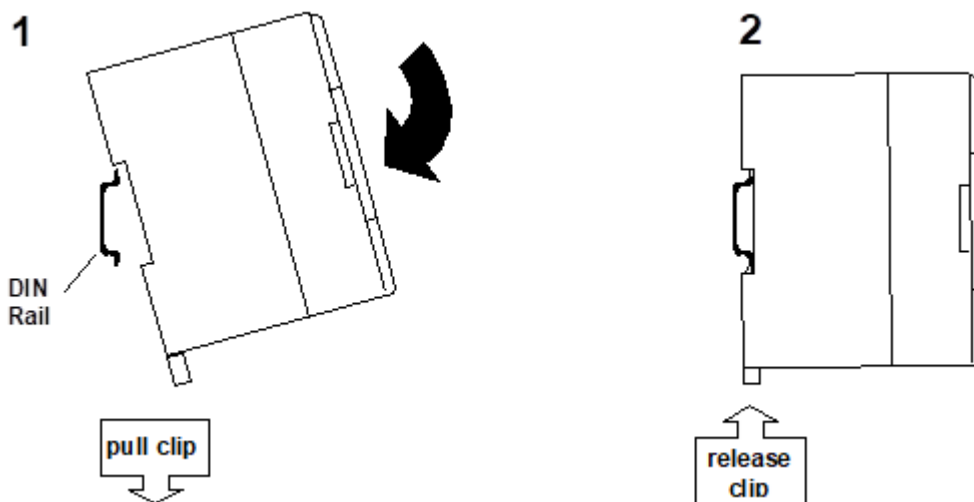
The DIN rail must be electrically grounded to provide EMC protection as described on the next page. DIN rails compliant with DIN EN50032 are preferred.

For vibration resistance, the DIN rail should be installed on a panel using screws spaced approximately 5.24cm (6 inches) apart.

## 15.6.1 Mounting the PLC on a DIN Rail

Units mount on a 35 mm DIN rail as shown below. Using a small flat screwdriver or similar tool, pull out the retaining clip on the bottom of the unit. Press the unit back and release the retaining clip. Be sure the clip is holding the unit securely.

Figure 134



## 15.6.2 Removing the PLC from a DIN Rail

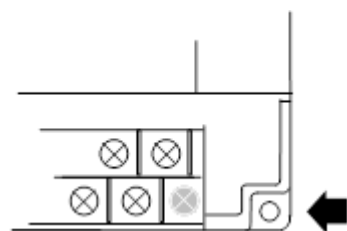
Pull down the retaining clip on the bottom of the module then pull the unit away from the DIN rail.

## 15.6.3 Panel-Mounting

For greatest resistance to mechanical vibration and shock, units should be installed on a metal panel.

Following the dimensions shown in this chapter or using the module itself as a template, mark the location of the module's panel-mount holes on the panel. Drill the hole in the panel. Install the module using 65x70 M4 (#8-32) screws at least 20mm (0.79 in.) long in the panel-mount holes.

Figure 135



1.1 to 1.4Nm (10 to 12 in/lbs) of torque should be applied to M4 (#8-32) steel screws threaded into material containing internal threads and having a minimum thickness of 2.4mm (0.093in).

## 15.6.4 Grounding the Metal Panel or DIN Rail

To prevent the risk of electric shock, the metal panel on which the PLC is installed must be properly grounded to protective earth.

Connect the ground wire to the metal panel using a star washer. Where connections are made to a painted panel, the paint should be removed so clean, bare metal is exposed.

Connect the metal plate, duct, pipe, door and sideboard etc. to protective earth.

## 15.7 Connecting an Expansion Unit to a Micro PLC

Up to four expansion units can be connected in series to a Micro PLC.

### ⚠ CAUTION

Power down the Micro PLC before connecting an Expansion Unit. Connecting an Expansion Unit with the Micro PLC powered up will damage the unit.

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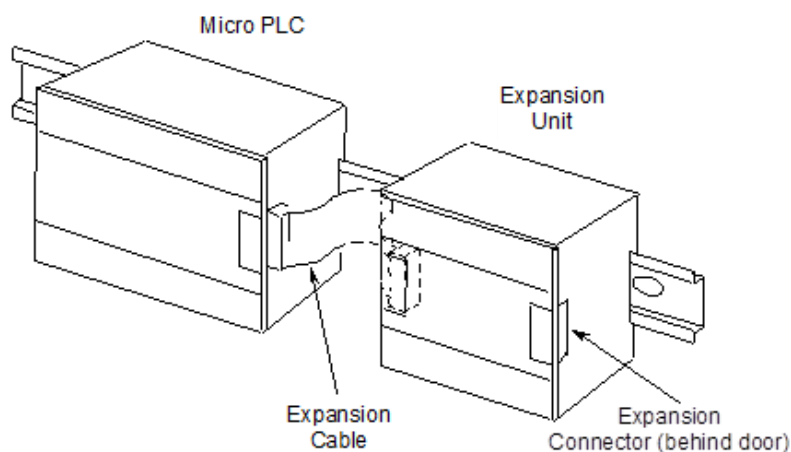
**Note:** The Micro PLC and Expansion Unit(s) should be wired to a common power source and powered up together. If an attached Expansion Unit is left unpowered, the Micro PLC may not power up properly.

---

### 15.7.1 The Expansion Cable

A 0.1-meter ribbon cable (IC200CBL501) is provided with each expansion unit. Cables are also available in 0.5-meter (IC200CBL505) and 1 meter (IC200CBL510) lengths. The maximum total overall length is 2 meters. This cable has keyed connectors to prevent incorrect installation. Powering up the system with the cable improperly installed can damage the Expansion Unit. Do not substitute a different cable. If you need to order replacements, expansion cables are available in various lengths. Connect the units as shown below.

Figure 136



The Expansion Unit(s) and Micro PLC must be connected in the same orientation. Connecting an Expansion Unit “upside down” will damage the DC input circuit when the system is powered up. After installing the ribbon cable on a unit, close the hinged door.



## 15.8 System Wiring Guidelines

In addition to the following wiring suggestions, we strongly urge that you follow all wiring and safety codes that apply to your area or to your type of equipment. Failure to do so could lead to personal injury or death, property damage or destruction, or both.

Four types of wiring may be encountered in a typical factory installation:

- Power wiring – the plant power distribution, and high-power loads such as high horsepower motors. These circuits may be rated from tens to thousands of kVA at 220Vac or higher.
- Control wiring – usually either low voltage DC or 120Vac of limited energy rating. Examples are wiring to start/stop switches, contactor coils, and machine limit switches. This is generally the interface level of discrete I/O.
- Analog wiring – transducer outputs and analog control voltages. This is the interface level to I/O analog blocks.
- Communications and signal wiring – the communications network that ties everything together, including computer LANs, MAP, and field busses.

These four types of wiring should be separated as much as possible to reduce the hazards from insulation failure, miss-wiring, and interaction (noise) between signals. A typical control system may require some mixing of the latter three types of wiring, particularly in cramped areas inside motor control centers and on control panels.

Wiring which is external to equipment and in cable trays should be separated following National Electrical Code practices.

### 15.8.1 Safety Measures

Appropriate emergency stop circuitry, interlock circuitry and similar safety measures should be added to the system in accordance with accepted practices.

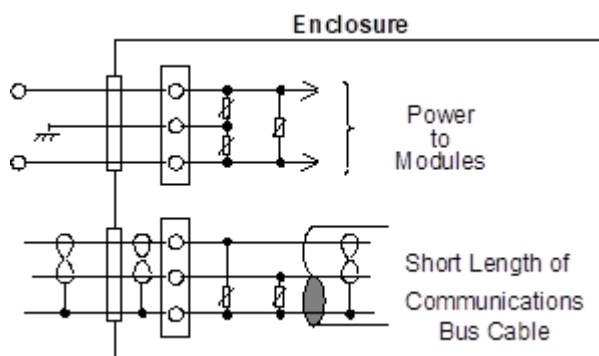
Appropriate safety measures should be included in the design of the overall system to ensure safety in the event of incorrect, missing or abnormal signals caused by broken signal lines, momentary power interruptions or other causes.

### 15.8.2 Installing Additional Suppression

External MOV suppression can be installed at the power line input of a system enclosure (see below). The axial leaded ZA series of MOVs from Harris is often used. The MOV should be able to handle most line transients. Measurement of actual transients may be required in extreme cases to decide what MOV is best.

Ideally, MOVs should be used at each cabinet in the system for maximum protection. The following illustration shows suppression on both power lines and a communications bus entering an enclosure.

Figure 137



## Periodic Inspection and Replacement of MOVs

MOVs do a good job of absorbing transients on communications, control, and power lines, provided the total energy of those transients does not exceed the rating of the device. However, if the energy of the transient exceeds the rating of the device, the MOV may be either damaged or destroyed. This failure may not be visibly or electrically evident. MOVs should be regularly inspected for signs of damage to assure continued protection against transients. For some applications, periodic replacement of critical MOVs is recommended, even if they do not show signs of damage.

## 15.9 I/O Installation and Wiring

Wiring diagrams are located in the individual module sections of this manual.

### ⚠ WARNING

- The PLC must be grounded to minimize electrical shock hazard. Failure to do so could result in injury to personnel.
- You should calculate the maximum current for each wire and observe proper wiring practices. Failure to do so could cause injury to personnel or damage to equipment.

### ⚠ CAUTION

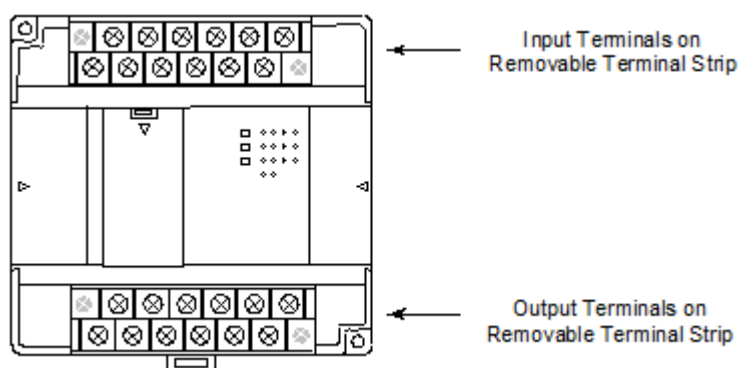
When connecting stranded conductors, ensure that there are no projecting strands of wire. These could cause a short circuit, thereby damaging equipment or causing it to malfunction.

## 15.9.1 Wiring for Power Supply and I/O Connections

- Each terminal can accept solid or stranded wires, but the wires into any given terminal must be of the same type and size.
- Use copper conductors rated for 75°C (167°F) for all wiring.
- Micro PLC wire sizes: one AWG #14 (2.1 mm<sup>2</sup>) conductor or two smaller conductors – AWG #16 (1.3 mm<sup>2</sup>) through AWG #20 (0.36mm<sup>2</sup>) per terminal. The suggested torque for the terminal connections is 5 in-lbs (5.76 kg-cm).
- Nano PLC wire sizes: each terminal accommodates one AWG #14 (avg. 2.1mm<sup>2</sup> cross section) to AWG #22 wire (avg. 0.36mm<sup>2</sup> cross section), or two wires up to AWG #18 (avg. 0.86mm<sup>2</sup> cross section). The suggested torque for the terminal connections is 3 in-lbs (3.75 kg-cm).

## 15.9.2 Removable Wiring Terminals

Figure 138



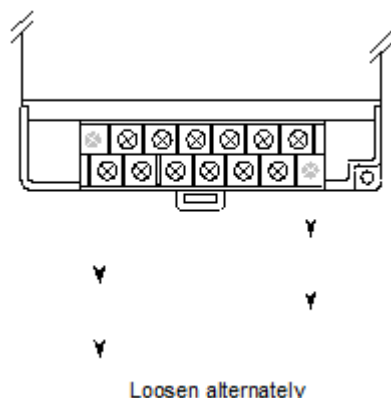
The terminal block assemblies of a Micro PLC can be removed to perform wiring. For example, a 14-point unit (shown above) has two removable terminal assemblies.

### ⚠ CAUTION

Do not insert or remove a terminal assembly with power applied to the PLC/Expansion Unit OR TO FIELD DEVICES. Injury to personnel and damage to the equipment may result. Potentially dangerous voltages from field devices may be present on the screw terminals even though power to the PLC or Expansion Unit is turned off. Care must be taken any time you handle the removable terminal assembly, or any wires connected to it.

A new Micro PLC or Expansion Unit is shipped with its terminal block assemblies firmly installed. To remove a terminal assembly, use a small Phillips or flat screwdriver to alternately loosen the two captive retaining screws. Hold onto the terminal assembly; when the screws have been backed out of the holes, the terminal assembly is completely detached from the module.

Figure 139



When re-installing terminal assemblies, be sure to place each one in the correct location to avoid miss-wiring the module. The terminal assemblies are not keyed or labeled.

### 15.9.3 General Wiring Procedures

Follow the procedures below when routing and connecting field wiring from user devices to the PLC inputs and outputs. The individual PLC and Expansion Unit sections of this manual provide detailed wiring information for connecting input and output devices and power sources.

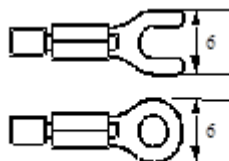
- Turn off power to the PLC before connecting field wiring.
- All low-level signal wires should be run separately from other field wiring.
- All channels must be fed from the same phase for AC power lines.
- Install AC power cables and signal or data lines in separate cable trays or bunches from DC field wiring.
- Field wiring should not be routed close to any device that could be a potential source of electrical interference.
- Route the signal and data lines as close as possible to grounded surfaces such as cabinet elements, metal bars and cabinets panels.
- If severe noise problems are present, additional power supply filtering or an isolation transformer may be required.
- Ensure that proper grounding procedures are followed to minimize potential safety hazards to personnel.
- Label all wires to and from I/O devices.
- Do not attempt to disassemble, repair or modify any part of the PLC.
- Do not pull on cables or bend cables beyond their natural limit. The lines may break.
- Always use the power supply voltage listed in the module specifications. Using other voltages may damage the equipment.
- Do not apply voltages to the inputs in excess of the rated input voltage. The equipment may be damaged if the rated voltage is exceeded.

- Do not use voltages with outputs in excess of the maximum switching capacity. The PLC may be damaged if the maximum switching capacity is exceeded.
- Use shielded cable for analog inputs and outputs and connect shields to a functional earth ground.

## Wiring Connections

The following types of wiring terminals are recommended for use with VersaMax Micro PLC modules:

Figure 140



When using wiring terminals, be sure to tighten screws adequately, so the wiring terminals will not become loose.

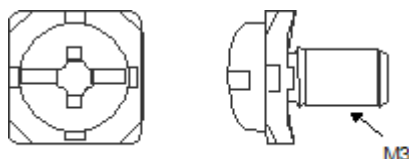
Alternatively, each module screw can accept:

- One wire, size AWG14 to AWG22 (2.1 to 0.36 mm<sup>2</sup>) or:
- Two wires, size AWG16 to AWG22 (1.3 to 0.36 mm<sup>2</sup>)

## Terminal Screws

Should any of the terminal screws be lost or damaged, they can be replaced with M3 x 0.6mm pitch screws of the type shown below.

Figure 141

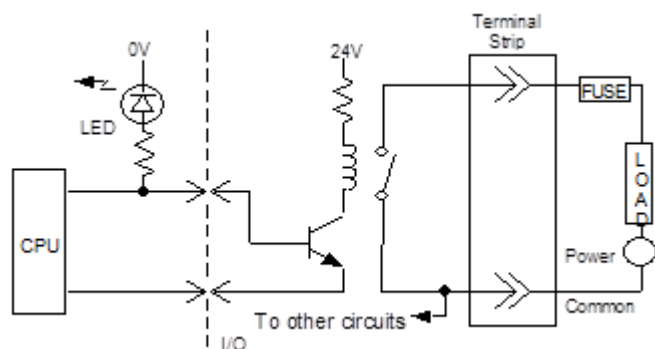


### 15.9.4 Providing Fusing for Outputs

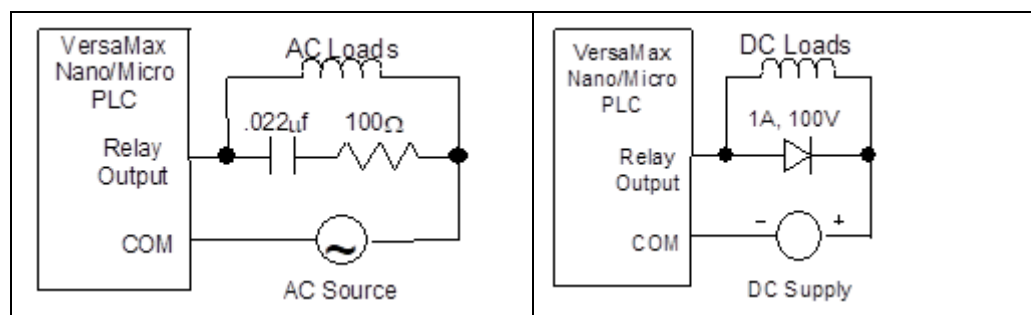
Outputs with electronic short-circuit protection are available on several Micro PLCs and Expansion Units. All other module outputs should be externally fused (1 Amp to 2 Amp fuse) to protect the output point contacts. For lighter loads, the internal common fuse (3.15 Amp) can be replaced with a 1 amp fuse to protect the output point without adding the external fusing.

## 15.9.5 Providing Suppression Circuits for Inductive Loads

Figure 142: Typical Relay Output Circuit



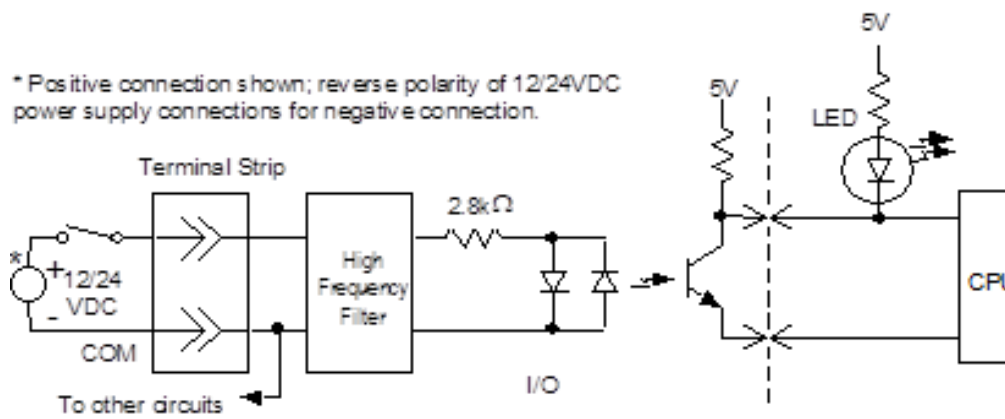
Installing suitable suppression across inductive loads enhances reliability of relay contacts. When switching inductive loads, relay contact life approaches resistive load contact life if suppression circuits are used. The 1A, 100V diode shown in the typical DC load suppression circuit is an industry standard 1N4934.



## 15.9.6 Typical DC Input Circuits

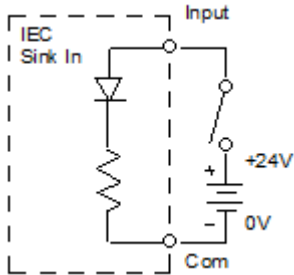
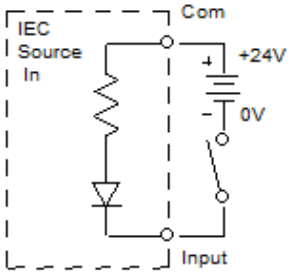
All DC inputs can be connected as either positive or negative logic.

Figure 143: Typical 12/24Vdc Positive/Negative Logic Input Circuit



## Positive and Negative Logic Definitions

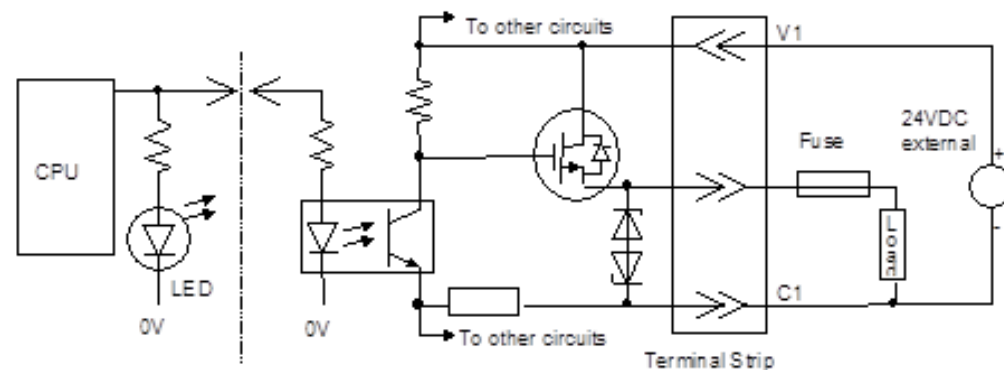
The IEC definitions for positive logic and negative logic, as applied to the PLC I/O circuits, are shown below.

| Input Points– Positive Logic                                                                                                                                                                                                                                                                                                                                                                                              | Input Points – Negative Logic                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <ul style="list-style-type: none"> <li>• Equivalent to IEC sink input points.</li> <li>• Sink current from the input device to the user common or negative power bus.</li> </ul> <p>The input device is connected between the positive power bus and the input terminal. The negative bus is connected to the input circuit common.</p> |  <ul style="list-style-type: none"> <li>• Equivalent to IEC source inputs.</li> <li>• Source current through the input device to the user common or positive power bus.</li> </ul> <p>The input device is connected between the negative power bus and the input terminal. The positive bus is connected to the input circuit common.</p> |

### 15.9.7 Typical DC Output Circuits

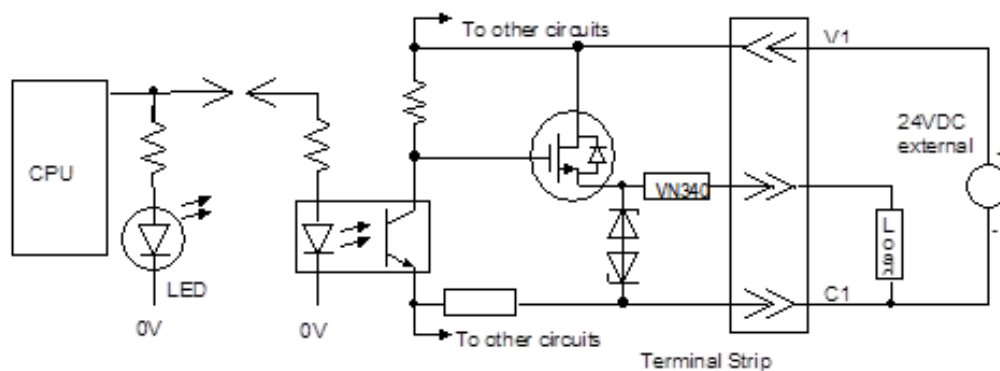
#### Typical Transistor Output Circuit 12Vdc

Figure 144



## Typical Transistor Output Circuit 24Vdc

Figure 145

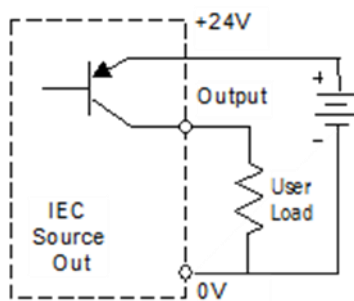


For Micro 10-, 14-, 23- and 28- PLCs, when using the outputs as PWM or Pulse Train Outputs, and for duty cycles in the lower ranges (5% and lower), a pulldown resistor must be connected between the output point (Q1-Q3) and the common terminal (C1). A 1.5 k $\Omega$ , 0.5-watt resistor is recommended.

Micro 20-, 40-, and 64- PLCs **do not** require a pulldown resistor.

## Output Points – Positive Logic

Figure 146



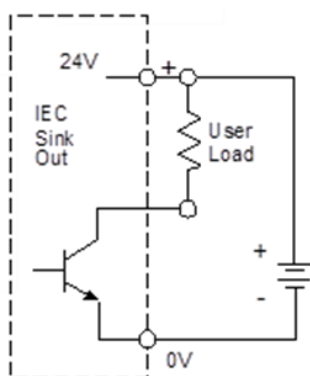
- Equivalent to IEC source output points.
- Source current to the loads from the user common or positive power bus.

The load is connected between the negative power bus and the module output.



## Output Points – Negative Logic

Figure 147

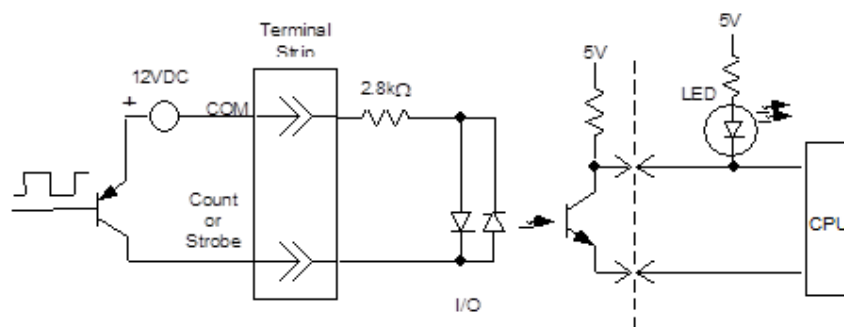


- Equivalent to IEC sink output points
- Load is connected between positive power bus and module output.

## 15.9.8 Typical High-Speed Counter Connections

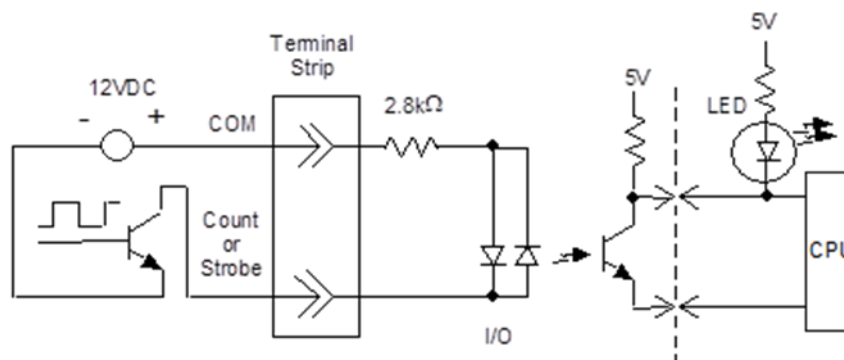
### High-Speed Counter Circuit – Positive Logic Connection

Figure 148



### High-Speed Counter Circuit – Negative Logic Connection

Figure 149



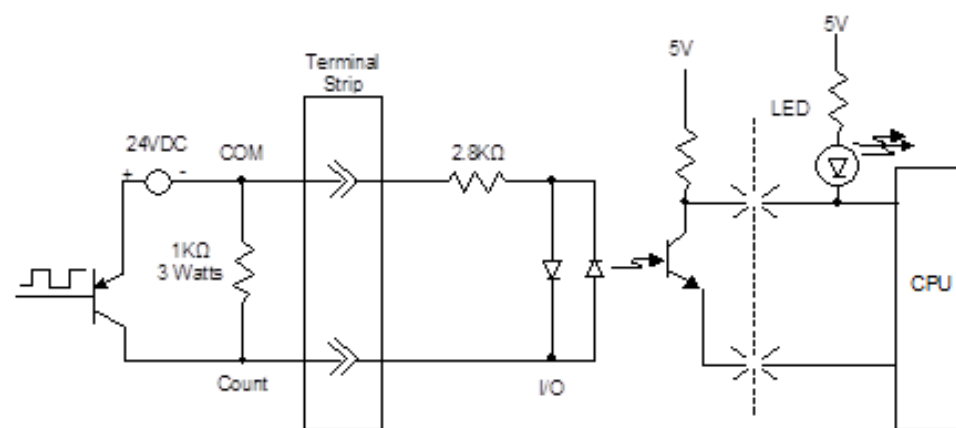
When I1-I6 on a Micro PLC are used as High-Speed Counter inputs, the input switches should be solid state to prevent switch bouncing, which could cause unintended High-Speed counter counts or strobe input signals.

## 15.9.9 Added Resistance for 20-, 40-, and 64-Point Micro PLCs at Higher Count Rates

When using count rates about 30kHz on a 20-, 40-, or 64-Point Micro PLC, a 1k $\Omega$ , 3W resistor should added between the common and the Count input as shown below.

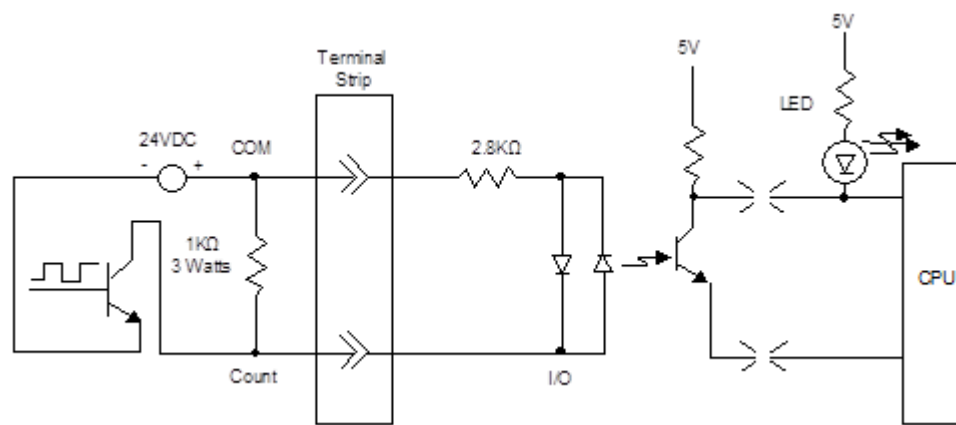
### High-Speed Counter Circuit – Positive Logic Connection

Figure 150



### High-Speed Counter Circuit – Negative Logic Connection

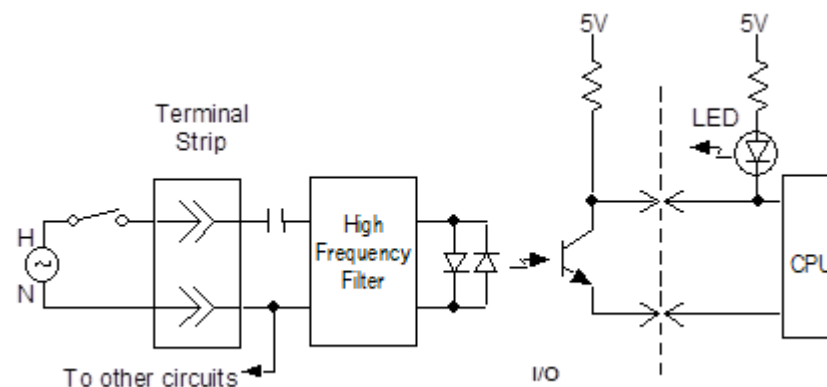
Figure 151



## 15.9.10 Typical AC Input and Output Circuits

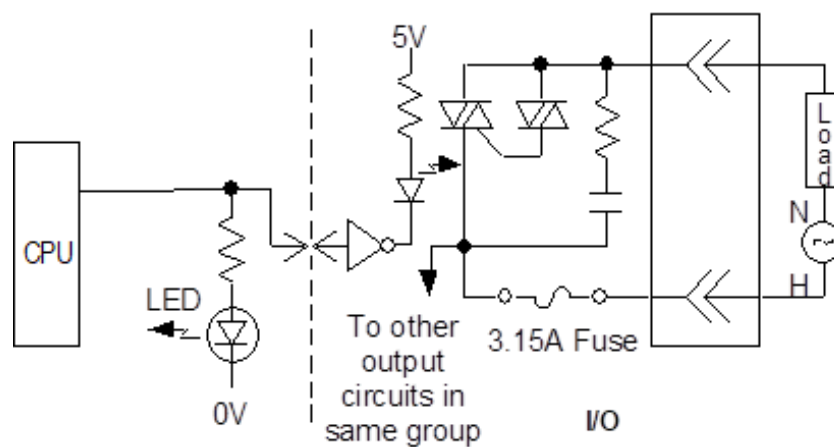
### Typical 120Vac Input Circuit

Figure 152



### Typical 120/240Vac Triac Output Circuit

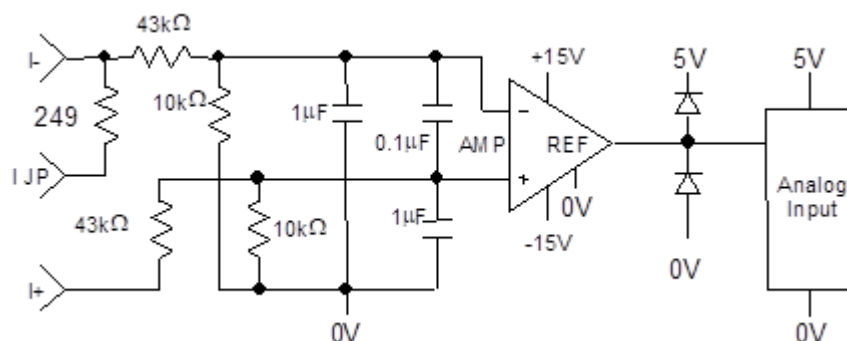
Figure 153



## 15.9.11 Typical Analog Input and Output Circuits

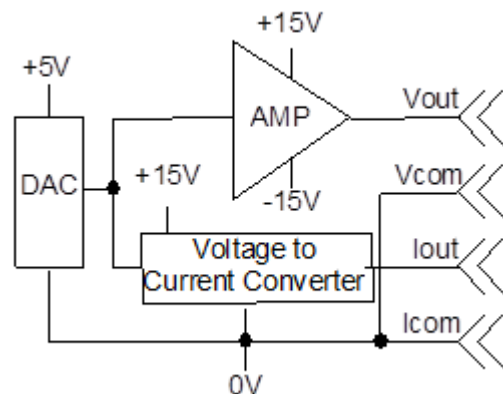
### Analog Input Circuit

Figure 154



### Analog Output Circuit

Figure 155



## 15.10 Starting Up the PLC

Before applying power to the PLC:

- Be sure all mounting screws, terminal screws, cables and other items are properly tightened and secured.

### WARNING

- On a Micro PLC CPU or Expansion Unit, be sure the protective covers are installed over terminals when power is applied to the unit. The covers protect against accidental shock hazard that could cause severe or fatal injury.
- Double-check all wiring. Faulty wiring may damage the PLC.
- Do not turn on the power supply to a broken PLC.
- Be sure that Expansion Units connected to the Micro PLC are wired to the same power source and that the PLC and Expansion Units will power up together. If an attached Expansion Unit is left unpowered, the Micro PLC may not power up properly.

### WARNING

Always turn off the power supply to the PLC before attempting any of the following. Performing any of these acts may result in electrical shock, damage to the PLC or faulty operation.

- A. Assembling the PLC.
- B. Connecting or disconnecting cables or wiring.
- C. Connecting a Frame Ground (earth) terminal to the metal plate or metal case.

### 15.10.1 Turning off Power to the PLC

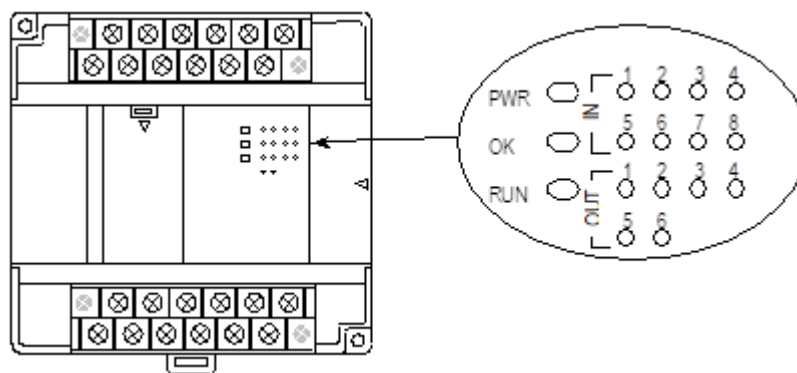
#### CAUTION

During a gradual power down, when the input power supply voltage is below the minimum operating voltage, the PLC may power off and then power on again until the input voltage drops low enough to prevent power on again. You should take precautions if this type of behavior cannot be tolerated in your application.

## 15.10.2 Normal Power-up Sequence

Apply the required power to the power inputs and observe the LEDs. A 14-point Micro PLC is shown below. Other PLC models and expansion units have different LEDs.

**Figure 156**



- The PWR LED should light.
- The OK LED blinks during power-up diagnostics. (Micro PLCs that do not have expansion units can be configured to skip power-up diagnostics, as explained in Chapter 16:.) When diagnostics have successfully completed, the OK LED changes to a steady on state. The RUN LED goes ON if the unit is configured to run on power-up. If the Run LED does not light when you go to Run mode, the cause could be invalid configuration or a fatal error in the CPU fault table.
- If any input points have been wired to field devices that energize those circuits, the corresponding input LEDs should also be ON. (On Analog, RTD and Thermocouple Expansion Units, the input 1-4 LEDs should be OFF during normal operation). Refer to Chapter 12: for details of LED operation for analog expansion units. Refer to Chapter 13: for details of LED operation for RTD and Thermocouple units.
- If the RUN LED on the Micro PLC CPU is not ON, all output LEDs should be OFF (in STOP with I/O Disabled mode).
- After power-up and program download, check the program for proper execution.

## Micro PLC LEDs

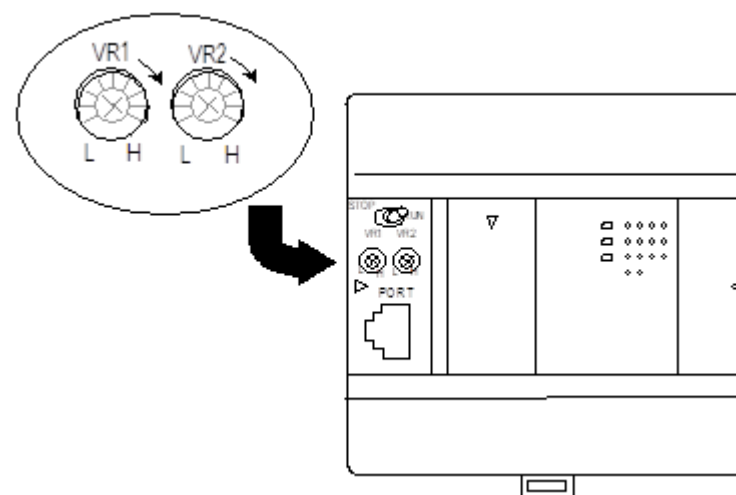
| Symptom                                      | Action                                                                                                                                                          |
|----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PWR LED does not light.                      | 1. Check that the proper power source is provided and is on.<br>2. With power supply off, check wiring to the module unit to be sure it is connected correctly. |
| PWR LED is ON<br>OK LED is OFF               | (This indicates that the power source is good and that the CPU has detected an internal fault. Be sure all the DIP switches are in the "OFF" position (down).   |
| PWR LED is ON.<br>OK and RUN blink together. | The PLC is in system bootloader mode and is awaiting a system firmware download from the WinLoader tool.                                                        |
| PWR LED is ON.<br>OK is blinking.            | The PLC features built-in blink codes to assist in troubleshooting.                                                                                             |

## 15.11 Adjusting the Analog Potentiometers

Two potentiometers located behind the left door of a 14-, 23-, or 28-point Micro PLC can be adjusted to lower or raise the values in analog registers %AI16 and %AI17. The left potentiometer, labeled VR1, adjusts the value in register %AI16. The right potentiometer, VR2, adjusts the value in %AI17.

To adjust the potentiometers, use a small screwdriver. Turning a potentiometer clockwise increases the value.

Figure 157

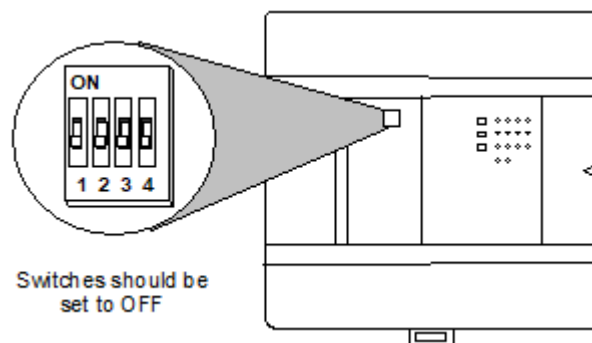


## 15.12 DIP Switches

### 15.12.1 4-Position DIP Switches on Micro PLC CPUs

The DIP switches located behind the removable door on the front of a 14-, 20-, 23-, 28-, 40-, or 64-point Micro PLC are factory-set to OFF (down position) as shown below, and should not be changed.

Figure 158



### 15.12.2 DIP Switches on an Analog Expansion Module Select Count Resolution

For analog expansion units, count resolution is controlled by DIP switch 6, which should be set to ON by default. If unexpected results are observed, check the position of switch 6. If switch 6 is not ON, power down the system and set switch 6 to ON. Do NOT change any of the other switches.

For details, refer to “Count Resolution for Analog Expansion Units” in Chapter 12:.

### 15.12.3 DIP Switches on an RTD Expansion Module Select Update Rate

For RTD expansion units, DIP switch 2 can be changed to select channel update rate. For firmware versions 4.0 and higher, DIP switch 3 can be used to select between Compatible and High Accuracy modes.

For IC200UEX726 and UEX736 modules with firmware version 4.0 and higher, DIP switch 6 can be used to select output range.

For details, refer to “DIP Switches” in Chapter 13:.



## 15.12.4 DIP Switches on a Thermocouple Expansion Module Select Input Sensors/Mode

On Thermocouple modules, DIP switches 1–3 can be used to select input sensors for channels 1–4.

On Thermocouple modules with firmware versions 4.0 and higher, DIP switch 6 can be used to select between Compatible and High Accuracy modes.

If these settings are configured using Machine Edition software version 6.0 or later, the software configuration will override the DIP switch setting.

For details, refer to “DIP Switches” in Chapter 13:.

## 15.13 Installing/Replacing a Backup Battery

For 20-, 23-, 28-, 40-, and 64-point Micro PLCs, a backup battery can be installed to protect the RAM memory contents of the PLC when the PLC power supply is removed or turned off. It also backs up the CPU’s real-time clock. Note: Use of another battery type may present a risk of fire or explosion.

Important: The Micro PLC power must be OFF when installing/replacing the battery.

| IC200ACC414                                                             | Nominal Voltage 3.6Vdc @ 790 mAh                                                                          |                                                                                                           |
|-------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| Battery shelf life, not installed                                       | Up to 5 years typical at 30 °C<br>Up to 3 years typical at 55 °C                                          |                                                                                                           |
| Backup time with battery installed, Micro PLC continuously powered down | For units with serial number before 07000069274<br>13 months minimum at 70°C<br>30 months minimum at 20°C | For units with serial number after 07000069274<br>19 months minimum at 70°C<br>121 months minimum at 20°C |

This battery replaces an earlier coin-type battery, IC200ACC403.

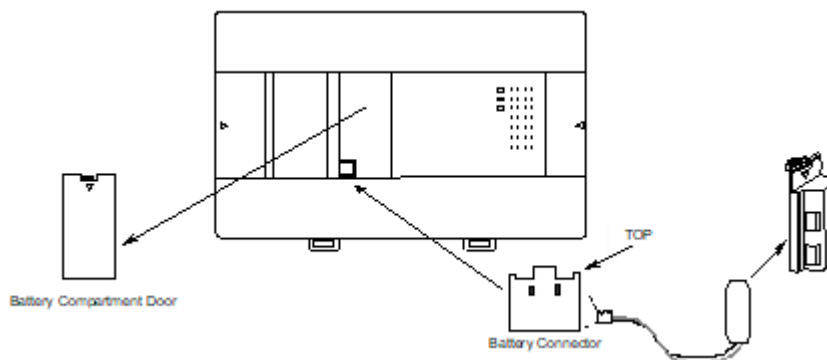
### 15.13.1 CPU Battery Consumption Data

| Power | Battery Consumption per Hour                      |                                                  |                                       |
|-------|---------------------------------------------------|--------------------------------------------------|---------------------------------------|
|       | Micro PLC with a serial number before 07000069274 | Micro PLC with a serial number after 07000069274 | 20-, 40-, and 64-Point Micro PLCs     |
| ON    | 30 $\mu$ A                                        | 3 $\mu$ A                                        | 0 $\mu$ A                             |
| OFF   | 83 $\mu$ A @ 70°C<br>36 $\mu$ A @ 20°C            | 56 $\mu$ A @ 70°C<br>9 $\mu$ A @ 20°C            | 31 $\mu$ A @ 55°C<br>3 $\mu$ A @ 25°C |

To replace a previously-installed battery, open the battery compartment door and remove the old battery assembly.

Insert the battery plug into the connector at the bottom of the battery compartment. Press it in until it clicks. Do not force the connection – the plug is keyed to prevent accidentally installing the battery in a reverse polarity.

Figure 159



For a **cylinder-type battery**, tuck in the wires and snap the battery holder (see the illustration above) onto the VersaMax Micro PLC. The original battery compartment door is no longer needed.

For a **coin-type battery**, place the battery into the holder on the left side of the battery compartment and tuck in the wires. Close the battery compartment door securely.

### ⚠CAUTION

Battery may explode if mistreated.

Do not recharge, disassemble, heat above 100°C (212°F), or incinerate.

## 15.14 Serial Port Connections

### 15.14.1 Providing Power to an External Device from Port 1 or 2

If either port is set up for communications with a serial device that requires 100mA or less at 5Vdc, the device can obtain power from either Port 1 or Port 2. The total current drawn from both ports added together cannot exceed 100mA.

### 15.14.2 Short Circuit Protection on 5Vdc for Units Later than June 2005

In the event that a short occurs across 5Vdc on any serial port on a VersaMax Micro or Nano PLC manufactured after June 2005, date code 523 (the date code is a three-digit code located on side of unit) the unit will power down until the short is removed. By removing the short, the unit will recover fully.

Micro and Nano PLCs prior to date code 523 have a non-replaceable internal fuse for 5Vdc. On those units, if the fuse blows, the RS-232 continues to function but the port no longer provides 5Vdc to external devices. The 5Vdc is also lost on the RS-485 port.

### 15.14.3 Cable Lengths and Baud Rates

Maximum cable lengths (the total number of feet from the CPU to the last device attached to the cable) are:

Port 1 (RS-232) = 15 meters (50 ft.)

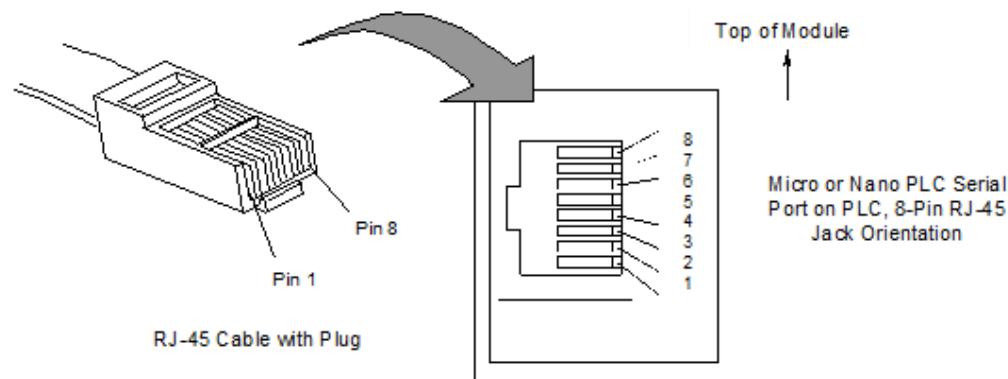
Port 2 (RS-485) = 1200 meters (4000 ft.)

Both ports support configurable baud rates from 300 to 19.2k bps (4800 bps to 38.4k bps for Micro 20/40/64 PLCs).

### 15.14.4 Port 1: RS-232

Port 1 is an RS-232 port with an 8-pin RJ-45 vertical jack. In addition to be a general serial communications port, this port is also used as the boot loader port for upgrading the PLC firmware.

**Figure 160**



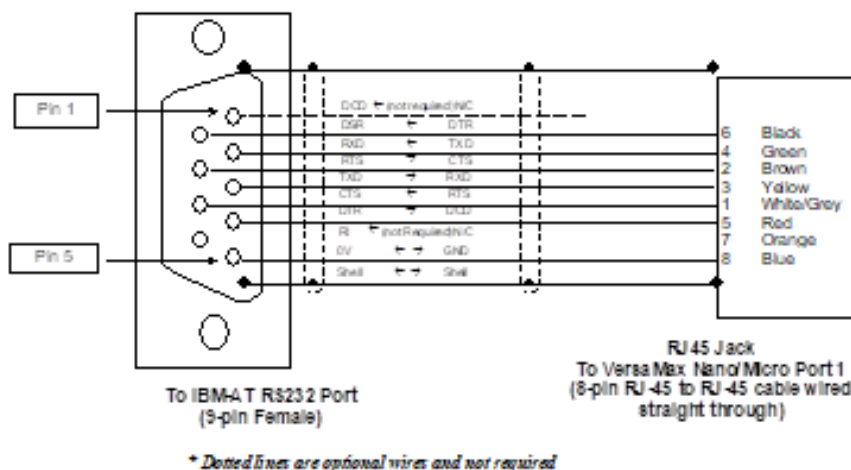
**Note:** There is no shield or frame-ground or shield pin on this connector.

| Pin | Signal | Direction | Function                                           |
|-----|--------|-----------|----------------------------------------------------|
| 1   | RTS    | Output    | Request to Send output                             |
| 2   | CTS    | Input     | Clear to Send input                                |
| 3   | RXD    | Input     | Receive Data input                                 |
| 4   | TXD    | Output    | Transmit Data output                               |
| 5   | DCD    | Input     | Data Carrier Detect input                          |
| 6   | DTR    | Output    | Data Terminal Ready output                         |
| 7   | +5V    | Output    | +5Vdc output to power external protocol converters |
| 8   | GND    | --        | 0V/Gnd signal reference                            |

## Port 1 Cable Wiring to a 9-pin D-sub PC-style RS-232 Port

An RJ-45 to DB9F adapter can be used to connect Port 1 to the standard 9-pin D-Sub port found on most PCs. Programmer wiring to an RJ-45 to DB9F adapter is shown below. For a PC that is not used as a programmer, only the Transmit, Receive, and Ground wires are needed on Port 1 and Port 2.

Figure 161



## RJ-45 to DB9F Adapter Wiring

The color codes shown below are standard for most RJ-45 to DB9F adapter kits but be sure to review your kit's particular documentation. Wire the adapter kit following the pin numbers as shown.

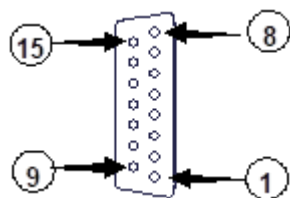
| Adapter Wire Color | DB9F pin | RJ45 pin | Micro PLC signal | DB9F (PC Serial Port) signal |
|--------------------|----------|----------|------------------|------------------------------|
| n/c                | 1        | -        | n/c              | DCD (in)                     |
| Green              | 2        | 4        | TxD (out)        | RxD (in)                     |
| Yellow             | 3        | 3        | RxD (in)         | TxD (out)                    |
| Red                | 4        | 5        | DCD (in)         | DTR (out)                    |
| Blue               | 5        | 8        | Ground           | Ground                       |
| Black              | 6        | 6        | DTR (out)        | DSR (in)                     |
| Brown              | 7        | 2        | CTS (in)         | RTS (out)                    |
| White              | 8        | 1        | RTS (out)        | CTS (in)                     |
| Orange             | 9        | 7        | +5V (out)        | RI (in)                      |

## 15.14.5 Port 2 on 23-Point and 28-Point Micro PLCs: RS-485

### Pin Assignments for Port 2

Port 2 on 23-point and 28-point VersaMax Micro PLCs is an RS-485 port with a 15-pin female D-sub connector.

Figure 162



This can be attached directly to an RS-485 to RS-232 adapter (IC693ACC901 or similar).

| Pin     | Signal | Direction | Function                                                                           |
|---------|--------|-----------|------------------------------------------------------------------------------------|
| 1       | SHLD   | --        | Cable Shield Drain wire connection                                                 |
| 2, 3, 4 | n/c    |           |                                                                                    |
| 5       | P5V    | Output    | +5Vdc to power external devices (100mA max.)                                       |
| 6       | RTSA   | Output    | Request to Send (A) output                                                         |
| 7       | GND    | --        | 0V/GND reference signal                                                            |
| 8       | CTSB'  | Input     | Clear to Send (B) input                                                            |
| 9       | RT     | --        | Resistor Termination (120Ω) for RDA'                                               |
| 10      | RDA'   | Input     | Receive Data (A) input                                                             |
| 11      | RDB'   | Input     | Receive Data (B) input                                                             |
| 12      | SDA    | Output    | Transmit Data (A) output                                                           |
| 13      | SDB    | Output    | Transmit Data (B) output                                                           |
| 14      | RTSB   | Output    | Request to Send (B) output                                                         |
| 15      | CTSA'  | Input     | Clear to Send (A) input                                                            |
| Shell   | SHLD   | --        | Cable Shield wire connection / 100% (Continuous) shielding cable shield connection |

## Connector and Cable Specifications for Port 2 on 23-Point and 28-Point Micro PLCs

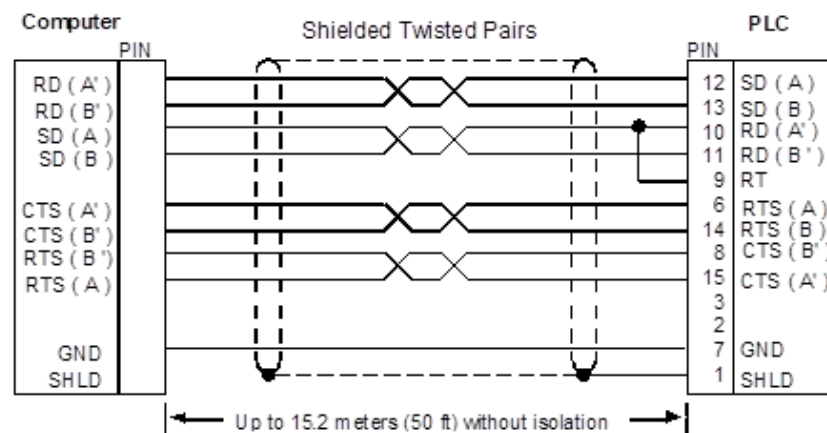
Vendor Part numbers below are provided for reference only. Any part that meets the same specification can be used.

|                        |                                                                                                                                                                                                                                                                                                                                                                                                                          |                              |                                  |                                 |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------------------------|---------------------------------|
| Cable:<br>Belden 8105  | Low Capacitance Computer cable, overall braid over foil shield<br>5 Twisted-pairs <sup>9</sup><br>Shield Drain Wire <sup>9</sup><br>30 Volt / 80°C (176°F)<br>24 AWG tinned copper, 7x32 stranding<br>Velocity of Propagation = 78%<br>Nominal Impedance = 100Ω <sup>9</sup>                                                                                                                                             |                              |                                  |                                 |
| 15 Pin Male Connector: | Type:<br>Crimp                                                                                                                                                                                                                                                                                                                                                                                                           | Vendor:<br>ITT/Cannon<br>AMP | Plug:<br>DAA15PK87F0<br>205206-1 | Pin:<br>030-2487-017<br>66506-9 |
|                        | Solder                                                                                                                                                                                                                                                                                                                                                                                                                   | ITT/Cannon<br>AMP            | ZDA15P<br>747908-2               | --<br>--                        |
| Connector Shell:       | Kit <sup>10</sup> – ITT Cannon DA121073-50 [15-pin size backshell kit]:<br>Metal-Plated Plastic (Plastic with Nickel over Copper) <sup>9</sup><br>Cable Grounding Clamp (included)<br>40° cable exit design to maintain low-profile installation<br>Plus – ITT Cannon 250-8501-009 [Extended Jackscrew]:<br>Threaded with (metric) M3x0.5 for secure attachment <sup>9</sup><br>Order Qty 2 for each cable shell ordered |                              |                                  |                                 |

## RS-485 Point to Point Connection with Handshaking

In point-to-point configuration, two devices are connected to the same communication line. For RS-485, the maximum cable length is 1200 meters (4000 feet). Modems can be used for longer distances.

Figure 163



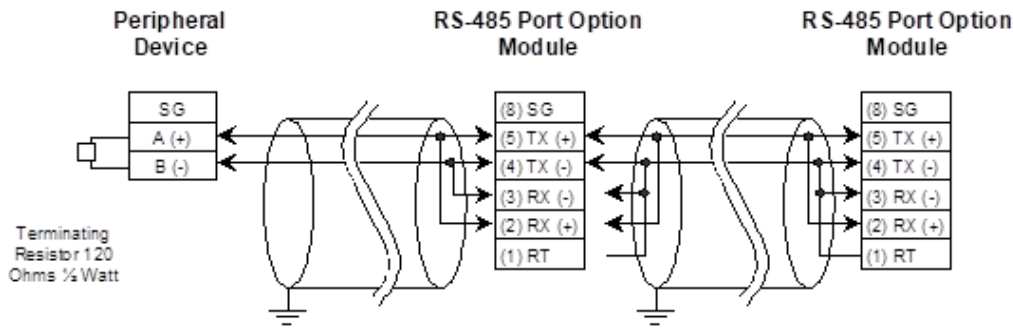
<sup>9</sup> Critical Information – any other part selected should meet or exceed this criteria.

<sup>10</sup> Use of this kit maintains the 70mm (2.76in) installed depth.

### 15.14.6 Port 2 RS-485 Option Module on 20-/ 40-/ 64-Point Micro PLCs

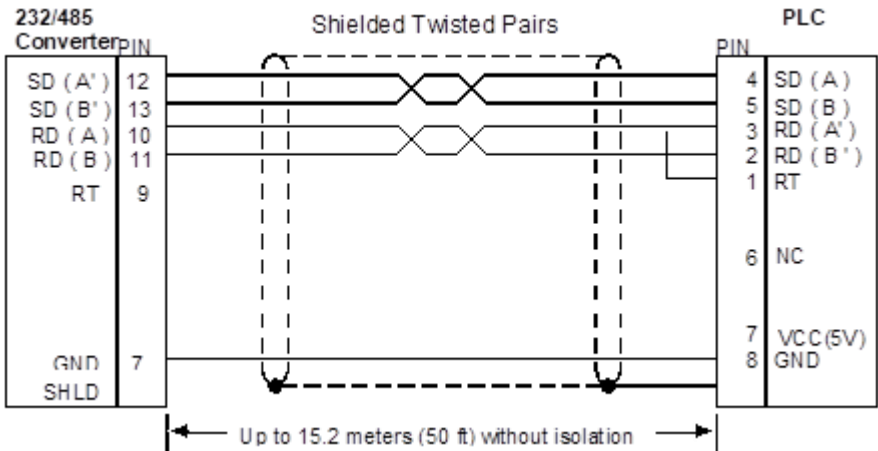
See Chapter 13: for more information about communications option modules.

Figure 164



### Connections: Peripheral Device to RS-485 Option Module

Figure 165

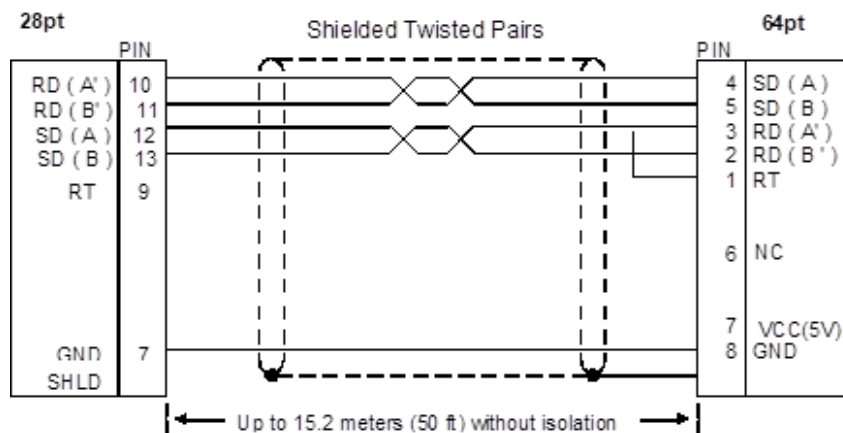


**Note:**

- The connection to peripheral device is through 232/485 converter. Diagram gives the RS 485 communication part of the PLC with the converter.
- On the RS-232 side of the converter peripheral device needs to be connected.

## Connections: Micro 28- PLC to Micro20-, 40- or -64- PLC Master/Slave

Figure 166

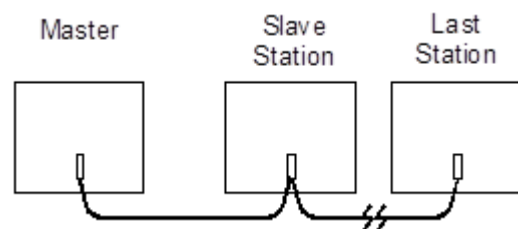


### 15.14.7 RS-485 Multidrop Serial Connections

The Micro PLC supports a maximum of eight devices on a single serial link per network. This number can be increased with the use of a repeater. For additional information on serial communications, refer to the Series 90 PLC Serial Communications User's Manual, GFK-0582.

In the multi-drop configuration, the host device is configured as the master and one or more PLCs are configured as slaves. The maximum distance between the master and any slave may not exceed 4000 feet (1200 meters). Any installation with PLCs over 50 feet (15.2 meters) apart must include optical isolation.

Figure 167



The RS-485 line must include handshaking and use wire type specified earlier. Reflections on the transmission line can be reduced by daisy-chaining the cable as shown. Make connections inside the connector to be attached to the PLC. Avoid using terminal strips to other types of connectors along the length of the transmission line.

Termination resistance for the Receive Data (RD) signal must be connected only on units at the ends of lines. This termination is made at the CPU by connecting a jumper between pin 9 and pin 10 inside the D-shell connector.

Ground Potential: Multiple units not connected to the same power source must have common ground potential or ground isolation for proper operation of the system.

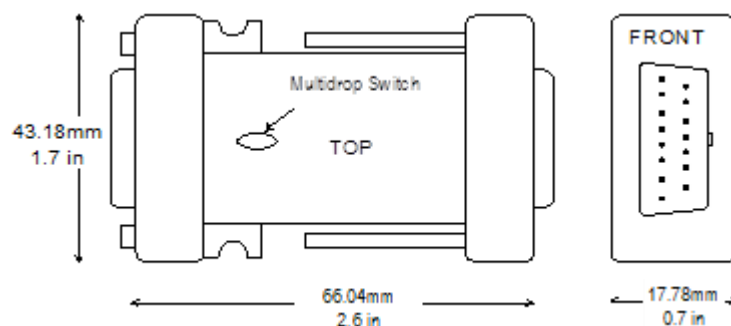


## 15.14.8 RS-485 Port Isolator

The IC690ACC903 RS-485 Port Isolator can be connected directly to the Micro PLC RS-485 serial port, or panel-mounted and connected to the Micro PLC using a short extender cable. The extender cable is intended for use in applications where direct connection to the port is obstructed by surrounding equipment or where it is not acceptable for the device to protrude from the Micro PLC. The Port Isolator can operate in either single- or multi-drop mode, which is selected by a slide switch on the top of the module. The Port Isolator provides the following features:

- Four opto-isolated signal channels: SD, RD, RTS, and CTS
- Electrical compatibility with RS-485
- Single- or multi-drop operation
- Input termination consistent with standard for serial channels
- A 5V DC/DC converter for power isolation
- Hot insertion is supported

**Figure 168**



## Port Isolator Specifications

| Mechanical            |                                                                                                                                                                                       |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RS-485                | 15-pin D shell male for direct mounting to serial port on the CPU<br>15-pin D shell female for communication cable                                                                    |
| Installation Hardware | Two M3 thread connector thumbscrews. Recommended torque: 8 in./lbs. (supplied with Isolator). Two #6/32 thread panel mounting screws. Recommended torque: 12 in./lbs. (user supplied) |
| Electrical            |                                                                                                                                                                                       |
| Voltage Supply        | +5Vdc (supplied by port)                                                                                                                                                              |
| Typical Current       | 25 mA; 100 mA available for external equipment                                                                                                                                        |
| Ground Isolation      | 500 Volts                                                                                                                                                                             |
| Conformance           | EIA-422/485 Balanced Line                                                                                                                                                             |
| Operating Temperature | 0°C - 70°C (32°F - 158°F)                                                                                                                                                             |
| Baud Rate             | Those supported by PLC                                                                                                                                                                |

## Port Isolator Connectors

The Isolator has two connectors, one 15-pin male D-type (PL1) and one 15-pin female D-type (PL2). The pin assignments are identical, except that pin 4 on PL2 is connected to the module ID resistor.

### RS-485 Connector Pin Assignments

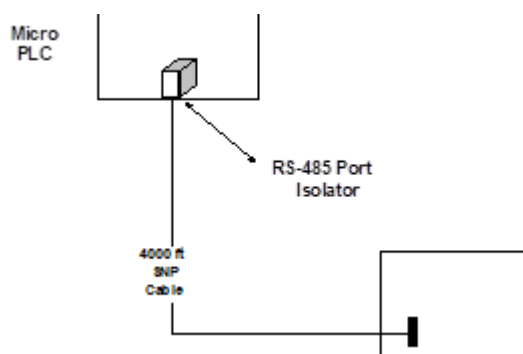
|     | Pin | Pin Name | Pin Type | Description           |
|-----|-----|----------|----------|-----------------------|
| PL1 | 1   | SHLD     | -        | Chassis Ground        |
|     | 2   | NC       | -        |                       |
|     | 3   | NC       | -        |                       |
|     | 4   | NC       | -        |                       |
|     | 5   | 5V       | -        | +5V power             |
|     | 6   | RTS (A)  | In       | Request to send -     |
|     | 7   | 0V       | -        | Signal Ground         |
|     | 8   | CTS (B') | Out      | Clear to send +       |
|     | 9   | NC       | -        |                       |
|     | 10  | RD (A')  | Out      | Read data -           |
|     | 11  | RD (B')  | Out      | Read data +           |
|     | 12  | SD (A)   | In       | Send data -           |
|     | 13  | SD (B)   | In       | Send data +           |
|     | 14  | RTS (B)  | In       | Request to send +     |
|     | 15  | CTS (A') | Out      | Clear to send -       |
| PL2 | 1   | NC       | -        |                       |
|     | 2   | NC       | -        |                       |
|     | 3   | NC       | -        |                       |
|     | 4   | TESTID   | -        | ID resistor           |
|     | 5   | 5V       | -        | +5V power             |
|     | 6   | RTS (A)  | Out      | Request to send -     |
|     | 7   | 0V       | -        | Signal Ground         |
|     | 8   | CTS (B') | In       | Clear to send +       |
|     | 9   | RT       | -        | Terminating Resistor* |
|     | 10  | RD (A')  | In       | Read data -           |
|     | 11  | RD (B')  | In       | Read data +           |
|     | 12  | SD (A)   | Out      | Send data -           |
|     | 13  | SD (B)   | Out      | Send data +           |
|     | 14  | RTS (B)  | Out      | Request to send +     |
|     | 15  | CTS (A') | In       | Clear to send -       |

- Use the terminating resistor if the Port Isolator is used in port-to-port mode or at the end of a multi-drop configuration. To terminate the RD balanced line, place a jumper wire from pin 9 to pin 10.
- A denotes – and B denotes +. A and B denote outputs and A' and B' denote inputs.

## Installing the Port Isolator

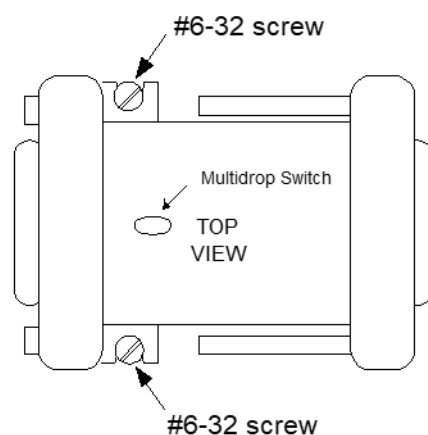
The Isolator is packaged in a contoured plastic enclosure designed for either direct attachment to a serial port or through a 12" extender cable for panel-mounted equipment. Two M3 thumbscrews secure the device to its mating connector. It can be easily inserted into an existing communication channel with no additional hardware.

Figure 169



When installing the Port Isolator on a panel, you will need to provide two #6-32 mounting screws.

Figure 170



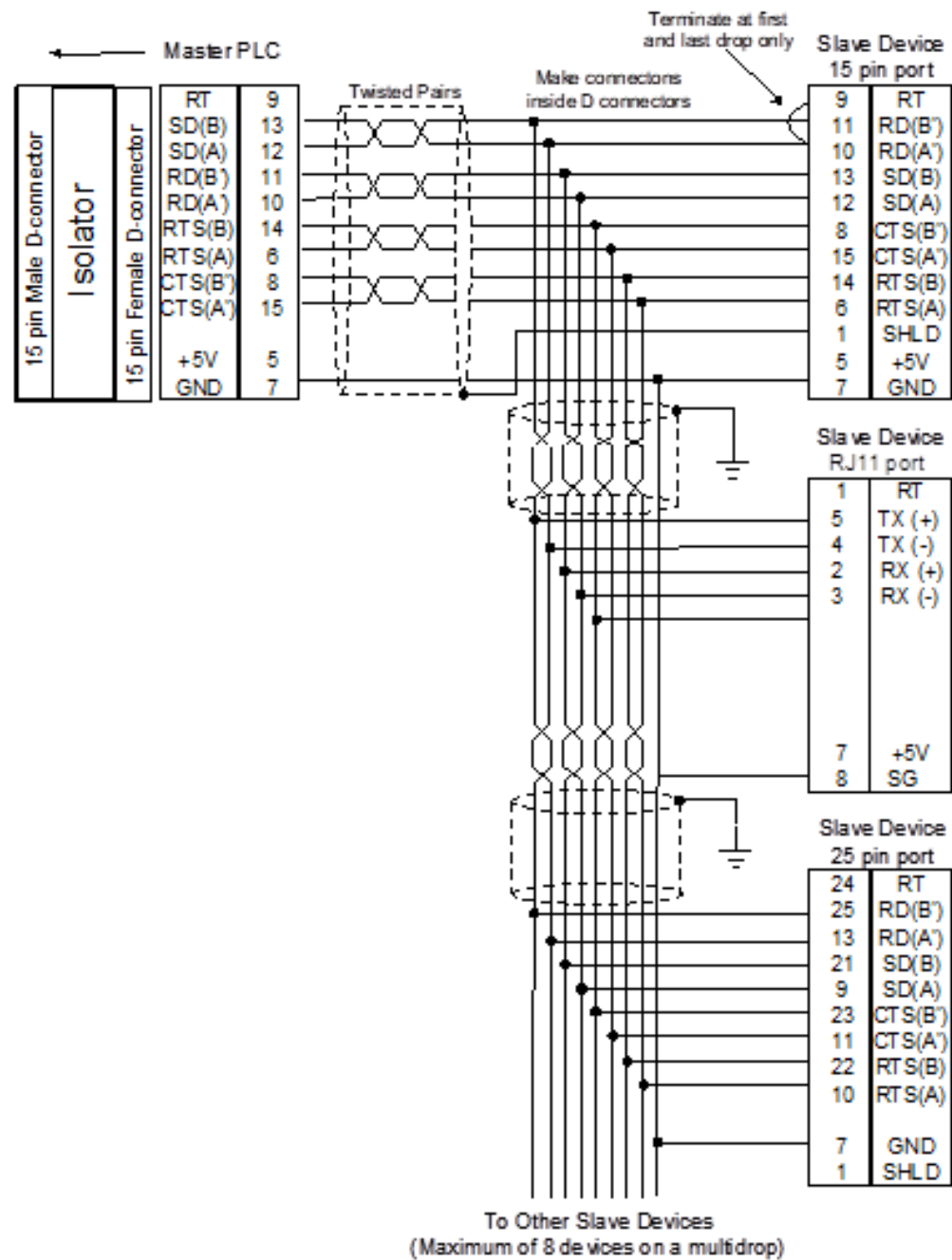
When installing the Isolator, tighten the connector screws and panel mounting screws (if used) to the following torque values:

| Screws                                         | Type  | Torque    |
|------------------------------------------------|-------|-----------|
| Connector Thumbscrews (supplied with Isolator) | M3    | 8 in/lbs  |
| Panel Mounting Screws (user-supplied)          | #6/32 | 12 in/lbs |

The RS-485 Port Isolator supports both port-to-port and multi-drop configurations.

Multi-drop Cable Connecting Devices with 15-Pin Ports and 25-Pin Ports

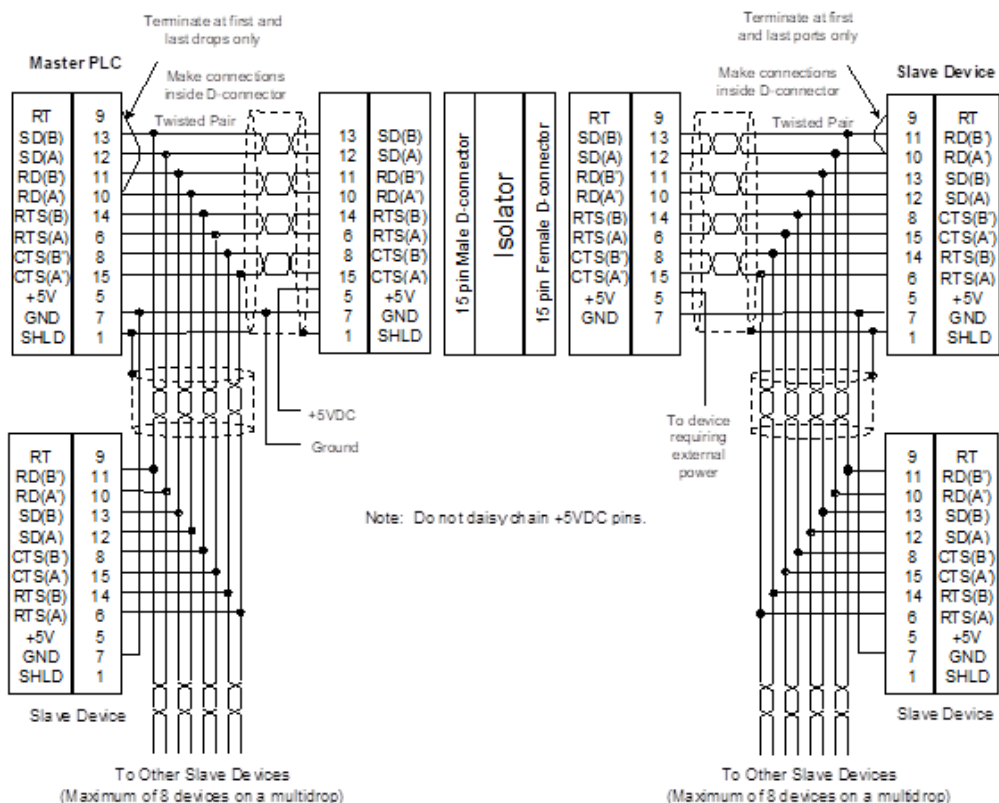
Figure 171



## Cable for Supplying External Power Through the Port Isolator

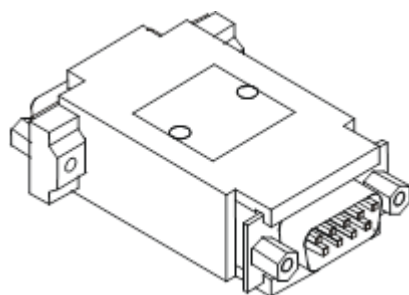
If the Isolator is powered by a source other than the host port, you will need to build a custom cable as shown below.

Figure 172



## 15.14.9 RS-232 to RS-485 Adapter

Figure 173



The RS-232 to RS-485 Adapter (IC200ACC415) connects a VersaMax Nano PLC or VersaMax Micro PLC to an RS-485 communications bus. It supports RS-485 multi-drop connections.

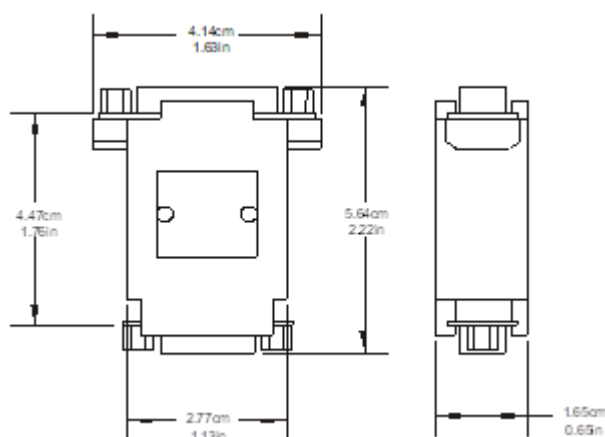
In conjunction with an RJ45 to DB9 Female cable (IC200CBL500), the adapter converts from the RS-232 (9-pin D-sub male) connector on the Nano/Micro PLC to an RS-485 (15-pin D-sub female) connector.

Two LEDs on the adapter indicate activity on the transmit and receive lines.

Power for this adapter is provided by the Micro/Nano PLC.

Dimensions of the Adapter are shown below.

Figure 174



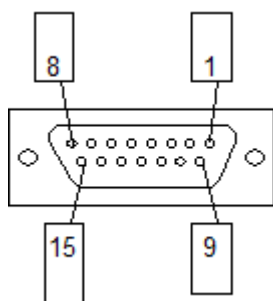
## Specifications

|                      |                                                                                                            |
|----------------------|------------------------------------------------------------------------------------------------------------|
| Temperature Rating   | 0°C to 55°C                                                                                                |
| Storage Temp. Rating | -10°C to 75°C                                                                                              |
| Humidity             | 5 to 95%                                                                                                   |
| Shock                | MIL-STD 810C, 15G                                                                                          |
| Noise Immunity       | ANSI/EE C37.90A, 801.2 ESD L3, 801.3 L3, 801.6 RF, 801.4 Fast Transient L3, 801.5 Surge, EN55011 Emissions |
| Agency Approvals     | UL (Class 1, Div 2) for Nano/Micro PLC version B and higher , CUL and CE                                   |

## Adapter 15-pin RS-485 Port Connector

The adapter's RS-485 port is a standard SNP Port (15-pin D-sub female) connector. It supports EIA/TIA-485 (RS-485) compatible signal levels. The pin assignments of the RS-485 connector are shown below.

Figure 175



## Adapter RS-485 Port Pin Assignments

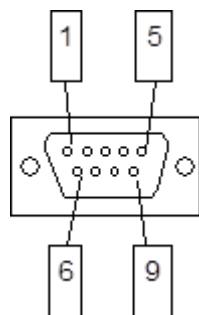
| Pin | Function           | Dir. | Pin     | Function                   | Dir. |
|-----|--------------------|------|---------|----------------------------|------|
| 1   | Shield / Frame GND | -    | 9       | RT (RD Term) <sup>11</sup> | -    |
| 2   | N/C                |      | 10      | RD(A')                     | In   |
| 3   | N/C                |      | 11      | RD(B')                     | In   |
| 4   | N/C                |      | 12      | SD(A)                      | Out  |
| 5   | +5Vdc              | Out  | 13      | SD(B)                      | Out  |
| 6   | RTS(A)             | Out  | 14      | RTS(B)                     | Out  |
| 7   | GND                | -    | 15      | CTS(A')                    | In   |
| 8   | CTS(B')            | In   | [Shell] | Frame GND                  |      |

<sup>11</sup> RT pin is connected with a 120Ω resistor to pin 11: RD(B') to provide a simple end-of-line termination through a jumper in the back shell between pin 10 and pin 9.

## Adapter 9-pin RS-232 (D-sub Male) Port Connector

The Adapter's RS-232 port matches the industry standard PC 9-pin male serial port. This port accepts the same cable (IC200CBL500) used to communicate directly from the Micro/Nano's RJ-45 jack to a PC. This port supports EIA/TIA-232 (RS-232) compatible signal levels. The +5Vdc output from the Nano/Micro PLC is routed to pin 9 on this cable and is used to power the converter.

Figure 176



### Adapter RS-232 Port Pin Assignments

| Pin   | Signal | Dir.   | Function                     |
|-------|--------|--------|------------------------------|
| 1     | DCD    | Input  | (No Connect)                 |
| 2     | RXD    | Input  | Receive Data                 |
| 3     | TXD    | Output | Transmit Data                |
| 4     | DTR    | Output | (No Connect)                 |
| 5     | GND    | --     | 0V/Gnd signal                |
| 6     | DSR    | Input  | (No Connect)                 |
| 7     | RTS    | Output | Request to Send              |
| 8     | CTS    | Input  | Clear to Send                |
| 9     | +5V    | Input  | +5Vdc power in               |
| SHELL | SHLD   | --     | Cable Shield wire connection |



## 15.15 Replacing AC Output Module Fuses

### ⚠ CAUTION

There are no user-replaceable parts in the DC In/Relay Out or DC In/DC Out Micro PLCs.

The AC In/AC Out model Micro PLCs (IC200UAA003/IC200UAA007) provide user-replaceable fuses for their AC output points. Because each output fuse is on the common of several circuits, a blown fuse will prevent the entire group associated with it from working.

### ⚠ WARNING

Remove power from the unit before removing field wiring or removing the front cover. Failure to remove power from the unit before disassembling it could cause severe or fatal injury to personnel.

### ⚠ CAUTION

Do not attempt to remove the circuit boards from the Micro PLC assembly, or to replace fuses on the power supply board. Any disassembly beyond removing the front cover and replacing AC output fuses could damage the unit and will invalidate the warranty.

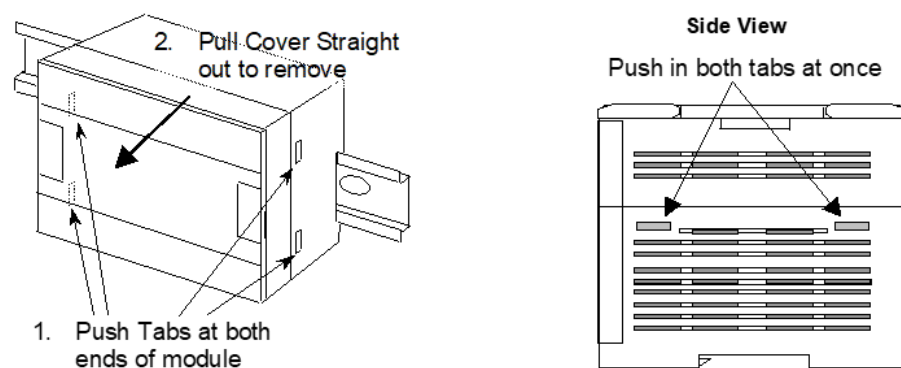
**Fuse replacement should only be performed by qualified service personnel.**

The plug-in fuses are located on the I/O circuit board, which is accessible after removing the Micro PLC front cover. To replace these fuses:

1. Remove power from the unit and I/O devices.
2. Remove terminal blocks with attached field wiring from the module
3. Remove front cover from the unit. (Gently press inward on both tabs on the sides of the unit and pull the cover straight off.

**Note:** The CPU board assembly should remain captive inside the front cover as you remove it.)

Figure 177



4. Replace each blown fuse with the appropriate fuse type.

Figure 178: 14-Point Micro PLC (IC200UAA003)

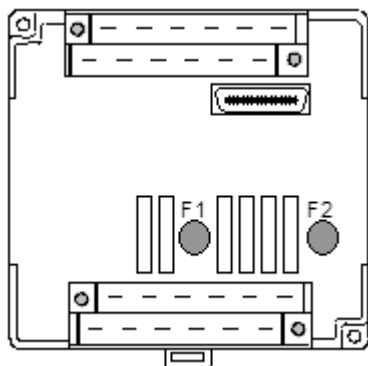
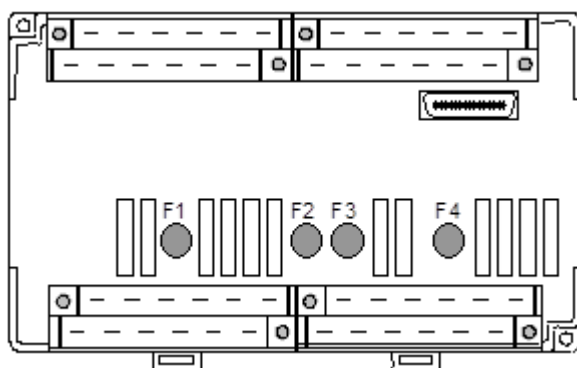


Figure 179: 28-Point Micro PLC (IC200UAA007)



## 15.15.1 AC Output Fuse Specifications

|                          |    |                                                                                          |
|--------------------------|----|------------------------------------------------------------------------------------------|
| IC200UAA003/007          | F1 | Q1-Q2                                                                                    |
|                          | F2 | Q3-Q6                                                                                    |
| IC200UAA007              | F3 | Q7-Q8                                                                                    |
|                          | F4 | Q9-Q12                                                                                   |
| Rated Load Voltage       |    | 250 V                                                                                    |
| Current Rating           |    | 3.15 A                                                                                   |
| Manufacturer             |    | WICKMANN USA, Inc. <a href="http://www.wickmannusa.com/">http://www.wickmannusa.com/</a> |
| Manufacturer Part Number |    | TR5-F-373 series, 3.15A / 250V, Short Leads                                              |

**Note:** The fuses listed above are only for the output points on the AC In/AC Out Micro PLCs (IC200UAA003/IC200UAA007). Do not attempt to replace any other parts in any other Micro PLC unit.

# Chapter 16: Configuration

This chapter explains how a VersaMax Nano PLC or Micro PLC is configured.

- Configuration Overview
- CPU Configuration
- Port 1 Configuration
- Port 2 Configuration
- Configuring Analog I/O Parameters
- Configuring High-Speed Counter, PWM or Pulse Output Operation

Configuration selects the characteristics of module operation. It also establishes program references that will be used for each I/O point.

The PLC supports either auto-configuration or storing a configuration from a programmer.

## 16.1 Configuration Overview

### 16.1.1 Autoconfiguration

A VersaMax Nano or Micro PLC automatically configures its default parameters every time it is powered on if no expansion modules are connected. If expansion modules are connected, auto configuration occurs the first time it is powered on and is then disabled after the initial auto configuration completes. Auto configuration may be re-enabled in a system that was previously auto configured with expansion modules by turning the Micro PLC and expansion modules off, disconnecting all expansion modules, and turning the Micro PLC on.

Auto configuration is also disabled when the Nano or Micro PLC receives a valid configuration from Logic Developer. Once auto configuration is disabled, it remains disabled and configuration is retained at power on until configuration is cleared with Logic Developer or the PLC is powered on with the battery removed and the memory backup capacitor discharged.

### 16.1.2 Software Configuration

Most PLC systems use a customized configuration that is created using configuration software and stored to the CPU from a programmer.

The CPU retains a software configuration across power cycles. After a software configuration is stored to the CPU, the CPU will not auto-configure when power-cycled.

The configuration software can be used to:

- Create a new configuration
- Store (write) a configuration to the CPU
- Load (read) an existing configuration from a CPU

- Compare the configuration in a CPU with a configuration file stored in the programmer
- Clear a configuration that was previously stored to the CPU

The CPU stores a software configuration in its non-volatile RAM. Storing a configuration disables auto-configuration, so the PLC will not overwrite the configuration during subsequent startups.

However, actually clearing a configuration from the programmer does cause a new auto-configuration to be generated. In that case, auto-configuration is enabled until a configuration is stored from the programmer again.

For a Nano or Micro PLC, one of the parameters that can be controlled by the software configuration is whether the CPU reads the configuration and program from Flash at power-up, or from RAM. If Flash is the configured choice, the CPU will read a previously-stored configuration from its Flash memory at power-up. If RAM is the choice, the CPU will read a configuration and application program from its RAM memory at power-up.

## 16.2 Storing a Configuration from a Programmer

A configuration can be stored from a programmer via the CPU port. The configuration takes place whether I/O scanning is enabled or not.

Storing a configuration disables auto-configuration.

---

**Note:** *If a hardware configuration is stored to the CPU, the configuration for the serial port to which the programmer is connected is not actually installed until the programmer is removed. After removal of the programmer, there is a delay before the new protocol begins operating. This delay is equal to the configured T3' time.*

---

Clearing a configuration from the programmer causes a new auto-configuration to be generated. Auto-configuration will be enabled until the configuration is stored from the programmer again.

When a programmer is first connected to a Nano or Micro PLC, the PLC communicates using the default communications parameters: 19,200 baud, odd parity, one start bit, one stop bit, and eight data bits. If these parameters are re-configured, the new settings will be used at power-up instead.

## 16.3 CPU Configuration

CPU configuration establishes the basic operating characteristics of the PLC, such as whether it scans I/O while in Stop mode and how it behaves at power-up.

| Feature                       | Description                                                                                                                                                                                                                                                         | Default                        | Choices                   |
|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|---------------------------|
| I/O Scan-Stop                 | Determines whether I/O is to be scanned while the PLC is in STOP mode.                                                                                                                                                                                              | No                             | Yes, No                   |
| Power-up Mode                 | Power-up mode for Nano PLC Power-up mode for Micro PLC                                                                                                                                                                                                              | Stop Last                      | Stop, Run Last, Stop, Run |
| Logic/ Configuration from     | Source of program and configuration when the Micro PLC is powered up.                                                                                                                                                                                               | Flash for Nano, RAM for others | RAM, Flash                |
| Registers                     | Selects source of register data when PLC is powered up.                                                                                                                                                                                                             | Flash for Nano, RAM for others | RAM, Flash                |
| Passwords                     | Determines whether passwords are enabled or disabled. (If passwords are disabled, the only way to enable them is to clear the Micro PLC memory.)                                                                                                                    | Enabled                        | Enabled, Disabled         |
| Checksum Words                | The number of words in the program to be checksummed each sweep. Entering 0 disables the checksum function.                                                                                                                                                         | 8                              | 8 to 32                   |
| Default Modem Turnaround Time | Modem turnaround time (10ms/unit) This is the time required for the modem to start data transmission after receiving the transmit request.                                                                                                                          | 0mS                            | 0–255mS                   |
| Default Idle Time             | Time (in seconds) the CPU waits to receive the next message from the programming device before it assumes that the programming device has failed and proceeds to its base state. Communication with the programmer is terminated and will have to be reestablished. | 10                             | 1–60                      |
| SNP ID                        | The ID used for SNP communications if a serial port is configured for RTU Slave or Serial I/O. SNP communications will occur between the programmer and the CPU when the CPU is in Stop mode.                                                                       |                                | Editable value            |
| Switch Run/Stop               | Determines whether the switch will control Run/Stop mode operation.                                                                                                                                                                                                 | Enabled                        | Enabled, Disabled         |
| Switch Memory Protect         | Determines whether the switch will control RAM memory protection.                                                                                                                                                                                                   | Disabled                       | Enabled, Disabled         |

| Feature              | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Default  | Choices                          |
|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|----------------------------------|
| Diagnostics          | Micro PLCs can be configured to power up more quickly by turning off the normal power-up diagnostics. However, unless your application requires unusually fast power up, leave this setting ENABLED. The DISABLED setting causes the Micro PLC to power up without running diagnostics. If power-up diagnostics are disabled, no expansion units can be used. (If expansion units are connected while power-up diagnostics are disabled, faults are logged in the I/O tables.) Micro PLC IC200UDR010 is guaranteed to power up within 100mS when power-up diagnostics is disabled. | Enabled  | Enabled, Disabled                |
| Fatal Fault Override | If the PLC powers up with fatal faults, it automatically sets fault references. If this parameter is set to Disabled, the CPU will then go to Stop mode. If this parameter is set to Enabled, the CPU can then be power cycled from Stop/Fault mode and it will go to Run/Stop mode.                                                                                                                                                                                                                                                                                               | Disabled | Enabled, Disabled                |
| Memory Board         | (for 20/40/64-Point Micro PLCs only) Sets up use of an optional memory module in the 64 Point Micro PLC.                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | RAM Only | RAM and Flash                    |
| Port 2 Configuration | (for 20/40/64-Point Micro PLCs only) Sets up the use of a Port 2 option module in the PLC. The port 2 options can then be configured.                                                                                                                                                                                                                                                                                                                                                                                                                                              | None     | RS232/USB, Ethernet, RS485. None |
| Sweep Mode           | Normal: sweep runs until it is complete.<br>Constant: sweep runs for time specified in Sweep Timer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Normal   | Normal, Constant                 |
| Constant Sweep Time  | If Constant Sweep mode was selected, a Constant Sweep Time (in milliseconds) can be specified.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 100mS    | 5–200mS                          |

## 16.4 Port 1 Configuration

Port 1, an RS-232 compatible serial port, is used to communicate with the programmer or for other communications. Configuration options for Port 1 are described below. See Chapter 24: for more information about port protocols for the Micro PLC. Note that VersaMax Micro PLC and Nano PLC models prior to Release 3.0 do not support all port modes.

| Feature           | Description                                                                                                           | Default | Choices                                        |
|-------------------|-----------------------------------------------------------------------------------------------------------------------|---------|------------------------------------------------|
| Port Mode         | Defines the protocol for Port 1. This selection determines which of the additional parameters below are configurable. | SNP     | SNP, RTU only, Serial I/O                      |
| Port Type         | SNP, RTU: Configures the serial port as the slave or master device.                                                   | Slave   | Master, Slave                                  |
| Data Rate (bps)   | Data transmission rate (in bits per second).                                                                          | 19200   | 300, 600, 1200, 2400, 4800, 9600, 19200, 38400 |
| Flow Control      | The type of flow control used on the port. Not editable.                                                              | None    | None                                           |
| Parity            | Determines whether parity is added to words                                                                           | Odd     | Odd, Even, None                                |
| Stop Bits         | Number of stop bits used in transmission. (Most serial devices use one stop bit; slower devices use two.)             | 1       | 1, 2                                           |
| Bits / Character  | Determines whether the CPU recognizes 8-bit or 7-bit characters.                                                      | 8 bits  | 7 bits, 8 bits                                 |
| Timeout           | SNP only: Specifies the timeout value used by the protocol.                                                           | Long    | Long, Medium, Short, None                      |
| Turn Around Delay | SNP only: Turnaround delay time in ms                                                                                 | 0       | 0-255                                          |
| SNP ID            | SNP only: 8-byte network identifier for Port 1.                                                                       | (none)  | (none)                                         |
| Station Address   | RTU: Station address of the slave on the RTU network                                                                  | 1       | 1 to 247                                       |
|                   | Serial I/O: A hexadecimal identifier used for Serial I/O protocol.                                                    | 0       | 0 to FF hex                                    |

### 16.4.1 Timing Note for RTU Communications

When using RTU communications, it may be necessary to increase the RTU timeout configured on the master device as the PLC slave scan time increases. It is not necessary to change the configuration of the VersaMax CPU when the port is used in RTU slave mode.

## 16.5 Port 2 Configuration

On 23- and 28-point Micro PLCs, the built-in Port 2 provides general-purpose communications using SNP, SNPX, RTU slave and Serial I/O protocols. Port 2 can also be configured as an SNP/SNPX master. On 20-, 40-, and 64-point Micro PLCs, an optional RS-232, RS-485, or USB port module can be installed and configured as Port 2.

Port 2 configuration can be changed through the configuration utility, or by using the COMMREQ (communications request) function block within a logic program.

| Feature           | Description                                                                                                                                                                                                                                                                             | Default | Choices                                                                                                 |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------------------------------------------------------------------------------------------------------|
| Port Mode         | Defines the protocol for Port 2. This selection determines which of the additional parameters below are configurable.                                                                                                                                                                   | SNP     | RS232/USB: SNP, Serial I/O, RTU Only<br>RS485: SNP, Serial I/O, RTU Only                                |
| Port Type         | For Port Modes SNP and RTU Only: Configures the serial port as a slave (the responding device) or a master (the initiating device) in a master/slave system.                                                                                                                            | Slave   | Slave, Master                                                                                           |
| Data Rate (bps)   | Data transmission rate (in bits per second).                                                                                                                                                                                                                                            | 19200   | RS-232/USB and RS-485: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400<br>Ethernet: 19200, 38400, 175000 |
| Flow Control      | The type of flow control used on the port. Not editable.                                                                                                                                                                                                                                | None    | None                                                                                                    |
| Parity            | Determines whether parity is added to words                                                                                                                                                                                                                                             | Odd     | Odd, Even, None                                                                                         |
| Stop Bits         | For SNP, Serial I/O and Modbus with RS-485: Number of stop bits used in transmission. (Most serial devices use one stop bit; slower devices use two.)<br>For Modbus RTU, when using no parity, Stop Bits should be set to 2. If using Even or Odd parity, Stop Bits should be set to 1. | 1       | 1, 2                                                                                                    |
| Bits / Character  | For Serial I/O: Determines whether the CPU recognizes 8-bit or 7-bit characters.                                                                                                                                                                                                        | 8 bits  | 7 bits, 8 bits                                                                                          |
| Timeout           | For SNP: Specifies the timeout value used by the protocol.                                                                                                                                                                                                                              | Long    | Long, Medium, Short, None                                                                               |
| Turn Around Delay | For SNP: Turnaround delay time in ms                                                                                                                                                                                                                                                    | 0       | 0-255                                                                                                   |
| SNP ID            | For SNP and RTU only: 8-byte network identifier for Port 2.                                                                                                                                                                                                                             | (none)  | 1 to 247                                                                                                |
| Station Address   | For Serial I/O: A hexadecimal identifier used for Serial I/O protocol.                                                                                                                                                                                                                  | 0       | 0 to FF                                                                                                 |



| Feature     | Description          | Default        | Choices                        |
|-------------|----------------------|----------------|--------------------------------|
| Duplex Mode | For RS485 RTU        | 2-Wire         | 2-Wire, 4-Wire                 |
|             | For RS485 Serial I/O | Point to Point | 2-Wire, 4-Wire, Point to Point |

## 16.6 Configuring Analog I/O Parameters

For Micro PLC and Expansion Units with analog I/O, each analog channel can be individually configured to operate in either voltage or current mode. If current mode operation is selected, the range can then be configured as either 4-20mA or 0-20mA.

For Nano PLCs with one analog input, the mode is always voltage. Reference addresses can also be selected as described above.

| Mode                                               | Parameters                           | Default       |
|----------------------------------------------------|--------------------------------------|---------------|
| Voltage or current mode                            | Voltage, Current                     | Voltage       |
| Current range selection                            | 4–20mA<br>0–20mA                     | 4–20mA        |
| Voltage range selection<br>(Expansion Inputs Only) | 0 to 10,000mV<br>-10,000 to 10,000mV | 0 to 10,000mV |

## 16.7 Configuring High-Speed Counter, PWM or Pulse Train

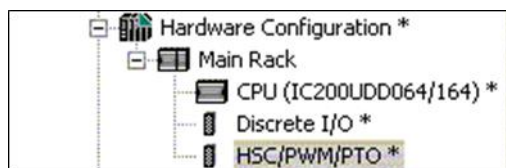
All Nano PLCs and Micro PLCs with DC inputs are configurable for a mix of High-Speed Counting features. Nano PLCs and Micro PLCs with DC outputs can also be configured with Pulse-Width Modulation and Pulse Train/Ramping Pulse Train features (only for 20-, 40-, or 64-point Micro PLC).

Configuring High-Speed Counter, Pulse Train, Ramping Pulse Train, Motion Support, or PWM operation enables specific features and assigns them to dedicated references on the PLC. You can mix high-speed counting and regular I/O functions on the same Micro PLC, as long as there are references available.

### 16.7.1 HSC, PWM, and PTO Settings

First, the basic High-Speed Counter, Pulse-Width Modulated, or Pulse Train Output Settings should be selected by double-clicking on HSC/PWM/PTO\*.

**Figure 180**



## Selecting the Counter Type

Selecting a Counter Type sets up how the module's internal High-Speed Counter features will be used. The choice for Counter Type determines which of the subsequent parameters can be configured. Counter Type choices depend on the type of Micro or Nano PLC being configured:

| PLC                                     | Counter Type Configuration for PLC Module |          |                    |                   |                       | Configurable for Each Channel |         |     |             |                       |                   |
|-----------------------------------------|-------------------------------------------|----------|--------------------|-------------------|-----------------------|-------------------------------|---------|-----|-------------|-----------------------|-------------------|
|                                         | 3 Type A                                  | 4 Type A | 1 Type A, 1 Type B | 4 Type A 32       | 1 Type A, 1 Type B 32 | Standard                      | Counter | PWM | Pulse Train | Pulse Train with Ramp | Motion Support    |
| All Nano PLCs                           | Yes                                       | -        | Yes                | -                 | -                     | Yes                           | Yes     | Yes | Yes         | -                     | -                 |
| All Micro PLCs except UAA003 and UAA007 | -                                         | Yes      | Yes                | -                 | -                     | Yes                           | Yes     | Yes | Yes         | -                     | -                 |
| UAA003, 007                             | Feature Not Available                     |          |                    |                   |                       |                               |         |     |             |                       |                   |
| 20-/40-/64-Point Micro PLCs             | -                                         | Yes      | Yes                | Yes <sup>12</sup> | Yes <sup>12</sup>     | Yes                           | Yes     | Yes | Yes         | Yes                   | Yes <sup>12</sup> |

The Counter Type selection made for the module determines, in turn, the features that can be configured for the channels.

- 3 Type A (for Nano PLCs only). Configures a Nano PLC High-Speed Counter functionality as three separate channels. Each channel can then be configured as a Type A Counter, OR as a standard, Pulse Train, or Pulse-Width Modulated output.
- 1 Type A / 1 Type B. Combines the functionality of channels 1, 2, and 3 into one Type B counter. For Micro PLCs, channel 4 can then be independently configured as a Type A Counter, OR as a standard, Pulse Train, or Pulse-Width Modulated output. Micro-20, -40, and -64 PLCs also provide Pulse Train with Ramp channel configuration.
- 4 Type A (for all Micro PLCs). Configures the Micro PLC High-Speed Counter functionality as four separate channels. Each channel can then be configured as a Type A Counter, OR as a standard, Pulse Train, or Pulse-Width Modulated output. Micro-20, -40, and -64 PLCs also provide Pulse Train with Ramp channel configuration.
- 1 Type A / 1 Type B\_32 (for all Micro-20 and Micro-40 PLCs, and for Release 3.60 or later Micro-64 PLCs only). Combines the functionality of channels 1, 2, and 3 into one Type B counter. Channel 4 can then be independently configured as a Type A Counter, OR as a standard, Pulse Train, Pulse-Width Modulated, or Motion Support output.
- 4 Type A\_32 (for all Micro-20 and Micro-40 PLCs, and for Release 3.60 or later Micro-64 PLCs only). Configures the Micro PLC High-Speed Counter functionality as four

<sup>12</sup> Rel. 3.6 or later.

separate channels. Each channel can then be configured as a Type A Counter, OR as a standard, Pulse Train, Pulse-Width Modulated, or Motion Support output.

## Output Stop Mode

This setting determines what outputs will do when the system is in Stop mode.

Normal means that High-Speed Counter outputs continue to respond to the counter inputs and standard outputs turn off. Preset outputs continue to operate as though the CPU were present, changing state to reflect the counter Accumulators. Ramp Pulse and Motion outputs (for Micro-20, -40, and -64 PLCs) stop immediately when the PLC is put into Stop Mode.

Force Off means all Preset outputs are turned off and remain off until the CPU returns to normal operation.

Hold Last means Preset outputs retain current levels and do not reflect the counter Accumulators.

## Reference Address, Length

The range of CPU memory references that will be used by the High-Speed Counter features. Many of these memory references have specific defined functions as described in Chapter 17:. They can be used by the application program to send parameters and commands to a High-Speed Counter, and to monitor counter operation.

### 16.7.2 Channel #1, 2, 3, 4 Parameters

After selecting the Counter Type on the HSC/PWM/PTO Settings tab, each channel can be configured on its Channel tab:

**Figure 181**

| HSC/PWM/PTO Settings         | Channel 1        | Channel 2 | Channel 3 | Channel 4 |
|------------------------------|------------------|-----------|-----------|-----------|
| <b>Parameters</b>            | <b>Values</b>    |           |           |           |
| Channel Function:            | Counter          |           |           |           |
| Counter Status:              | Disabled         |           |           |           |
| Count Direction:             | Up               |           |           |           |
| Count Mode:                  | Continuous       |           |           |           |
| Preload / Strobe:            | Preload          |           |           |           |
| Preload / Strobe Input Edge: | Zero to Positive |           |           |           |
| Count Input Edge:            | Zero to Positive |           |           |           |
| Time Base (mSec):            | 1000             |           |           |           |
| High Limit:                  | 32767            |           |           |           |
| Low Limit:                   | 0                |           |           |           |
| On Preset:                   | 32767            |           |           |           |
| Off Preset:                  | 0                |           |           |           |
| Preload Value:               | 0                |           |           |           |

The Channel Functions that can be configured here depend on the Counter Type and Micro PLC type, as explained previously. Parameters for all Channel Functions are described below.

## Channel Function: Counter

In Counter mode, the channel will operate as a High-Speed Counter (Type A or Type B). See Chapter 17: for a description of this feature. The following additional parameters can then be configured:

Counter Status: specifies whether the counter output is enabled.

Count Direction: for a Type A Counter only, this specifies whether count inputs increment (Up) or decrement (Down) the accumulator.

Count Mode: defines whether the counter wraps if the count limit is reached (Continuous) or if it stops at the counter limit (Single Shot).

Preload/Strobe: selects the function of the Preload/Strobe Input.

Preload/Strobe Input Edge: for Type A counters only. This non-editable parameter specifies that the Zero to Positive transition is used for a preload or strobe input.

Count Input Edge: for Type A counters only, this parameter specifies which transition of the counter is used as the count input. Zero to Positive is a low-to-high transition. Positive to Zero is a high-to-low transition.

Time Base (mSec): specifies the timebase for the Counts-per-Timebase register: The default is 1000mS. Range is 10mS to 65530mS.

High Limit: the counter's upper limit. It must be greater than the low limit.

Low Limit: the counter's lower limit.

ON Preset: defines the counter's ON preset.

OFF Preset: defines the counter's OFF preset.

Preload Value: the Preload value for the counter.

## Channel Function: PWM

Selecting PWM as the Channel Function sets up the channel as a Pulse-Width Modulated output. See Chapter 17: for a description of this feature.

The Counter Status parameter enables or disables the channel's PWM output.

## Channel Function: Pulse Train

Selecting Pulse Train as the Channel Function sets up the channel as a Pulse-Train output. See Chapter 17: for a description of this feature.

The Counter Status parameter enables or disables the channel's Pulse Train Output.

## Channel Function: Standard

Selecting Standard as the Channel Function sets up the channel as a standard output.

The Counter Status parameter enables or disables the Standard output.

## Channel Function: Pulse Train with Ramp

(Micro-20, Micro-40, and Micro-64 PLCs). If the Counter Type is configured as either 4 Type A or 1 Type A / 1 Type B (this choice is not available for 4 Type A\_32 or 1 Type A / 1 Type B\_32), selecting Pulse Train with Ramp sets up the channel as a Pulse Train output with the ability to accelerate and decelerate. See Chapter 17: for a description of this feature.

The Counter Status parameter enables or disables the pulse output.

PTR Acceleration sets up the Pulse Train acceleration rate, from stop to full speed. For channels 1, 2, and 3, the range is 10 through 1,000,000. For channel 4, the range is 90 to 1,000,000.

PTR Deceleration sets up the Pulse Train deceleration rate, from full speed to stop. For channels 1, 2, and 3, the range is 10 through 1,000,000. For channel 4, the range is 90 to 1,000,000.

## Channel Function: Motion Support

(Micro-20, -40, and -64 PLCs only. This feature requires Machine Edition version 5.5 SP2, Sim2 or later). Selecting Motion Support as the Channel Function sets up the channel as a Pulse Train output with the ability to accelerate and decelerate. See Chapter 18: for a description of this feature.

The Counter Status parameter enables or disables the pulse output.

The User Units and Counts parameters set up a scaling factor for the Acceleration and Deceleration parameters of a motion profile. The possible ratio of User Units to Counts is 1:16 through 8:1.

# Chapter 17: PLC Operation

This chapter describes the operating modes of the VersaMax Nano and Micro PLCs and shows the relationship between the application program execution and other tasks performed by the PLC CPU.

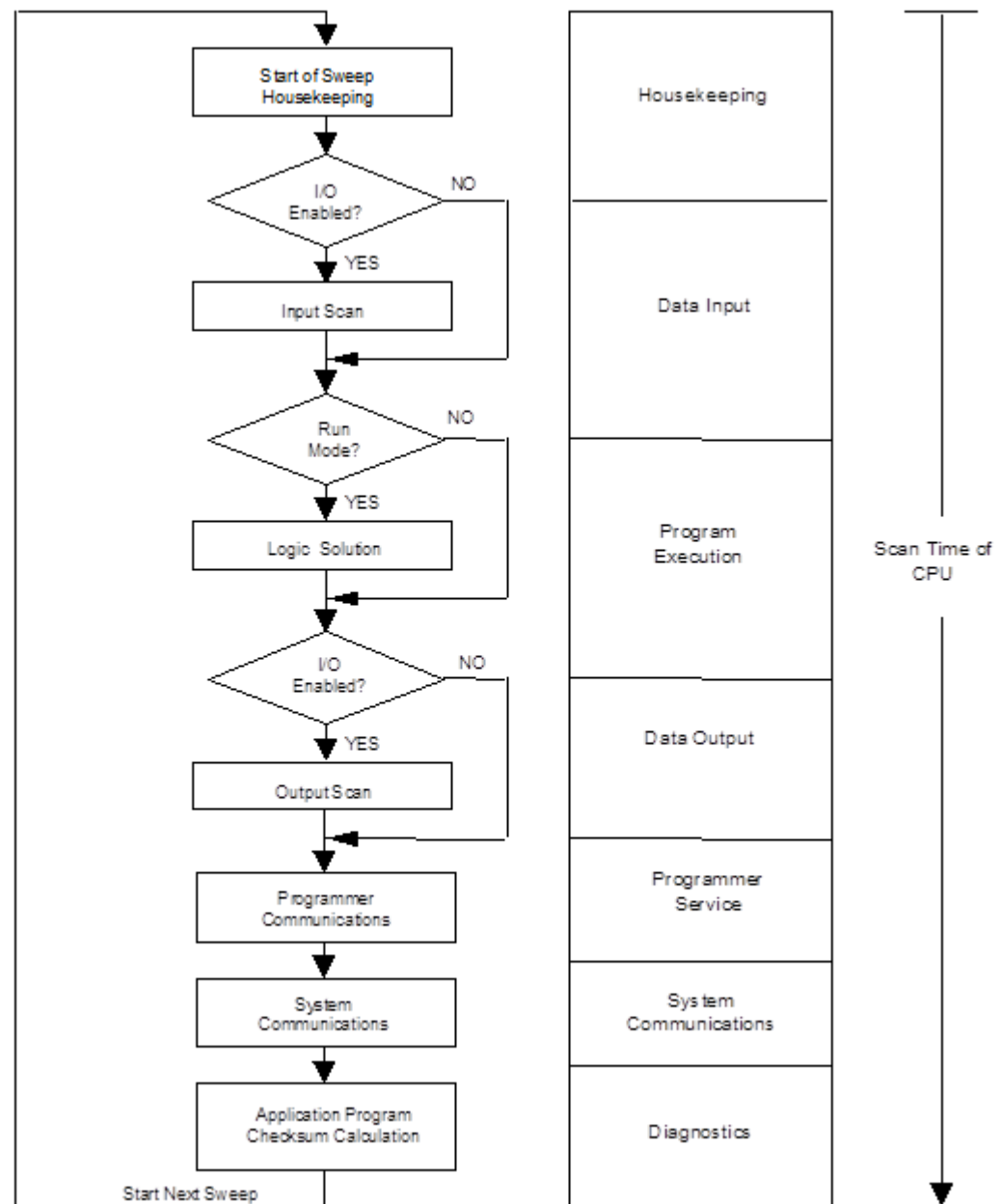
## 17.1 Operating Modes

The application program in a PLC executes repeatedly. In addition to executing the application program, the PLC regularly obtains data from input devices, sends data to output devices, performs internal housekeeping, and performs communications tasks. This sequence of operations is called the sweep.

- The basic operating mode of the PLC is called Standard Sweep mode. In this mode, the CPU performs all parts of its sweep normally. Each sweep executes as quickly as possible with a different amount of time consumed each sweep.
- The PLC may instead operate in Constant Sweep Time mode. In this mode, the CPU performs the same series of actions but each sweep takes the same amount of time.
- The PLC may also be in either of two Stop modes:
  - Stop with I/O Disabled mode
  - Stop with I/O Enabled mode

## 17.2 Parts of the CPU Sweep

Figure 182



| Parts of the CPU Sweep                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Start of Sweep<br>Housekeeping         | <p>Housekeeping includes the tasks necessary to prepare for the start of the sweep. Before starting the actual sweep, the CPU:</p> <ul style="list-style-type: none"> <li>calculates the sweep time</li> <li>Schedules the start of the next sweep</li> <li>Determines the mode of the next sweep</li> <li>Updates the fault reference tables</li> <li>Resets the Watchdog timer</li> </ul> <p>If the PLC is in Constant Sweep Time mode, the sweep is delayed until the required sweep time elapses. If the required time has already elapsed, the OV_SWP %SA0002 contact is set, and the sweep continues without delay. Next, the CPU updates timer values (hundredths, tenths, and seconds).</p> |
| Input Scan                             | <p>When the sweep starts, the CPU first scans inputs in ascending reference address order. The CPU stores this new input data in the appropriate memories.</p> <p>If the CPU has been configured to not scan I/O in Stop mode, the input scan is skipped when the CPU is in Stop mode.</p>                                                                                                                                                                                                                                                                                                                                                                                                          |
| Application<br>Program Logic<br>Scan   | <p>Next, the CPU solves the application program logic. It always starts with the first instruction in the program. It ends when the END instruction is executed. Solving the logic creates a new set of output data.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Output Scan                            | <p>Immediately after the logic solution, the CPU scans all outputs in ascending reference address order. The output scan is completed when all output data has written.</p> <p>If the CPU has been configured to not scan I/O in Stop mode, the output scan is also skipped when the CPU is in Stop mode.</p>                                                                                                                                                                                                                                                                                                                                                                                       |
| Programmer<br>Communications<br>Window | <p>If there is a programming device attached, the CPU next executes the programmer communications window.</p> <p>In the default limited window mode, each sweep the CPU honors one service request. The time limit for programmer communications is 6 ms. If the programmer makes a request that requires more than 6 ms to process, the processing is spread out over multiple sweeps.</p> <p>In Run to Completion mode, the length of the system communications window is limited to 50 ms. If a module makes a request that requires more than 50 ms to process, the request is spread out over multiple sweeps</p>                                                                              |
| System<br>Communications<br>Window     | <p>Next, the CPU processes communications requests. In default ("Run to Completion") mode, the length of the system communications window is limited to 200 ms. If a request requires more than 200 ms to process, the request is spread out over multiple sweeps.</p> <p>In Limited mode, if a request requires more than 6 ms to process, the processing is spread out over multiple sweeps. The result is that communications using the system window have less impact on sweep time, but response is slower.</p>                                                                                                                                                                                |



| Parts of the CPU Sweep             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Logic Program Checksum Calculation | <p>A checksum calculation is performed on the application program at the end of every sweep. You can specify the number of words from 8 to 32 to be checksummed.</p> <p>If the calculated checksum does not match the reference checksum, the program checksum failure exception flag is raised. This causes a fault entry to be inserted into the PLC fault table and the PLC mode to be changed to Stop. If the checksum calculation fails, the programmer communications window is not affected.</p> |

## 17.3 Standard CPU Sweep Operation

Standard Sweep operation is the normal operating mode of the PLC CPU. In Standard Sweep operation, the CPU repeatedly executes the application program, updates I/O, and performs communications and other tasks shown in the diagram:

1. The CPU performs its start-of-sweep housekeeping tasks.
2. It reads inputs.
3. It executes the application program.
4. It updates outputs
5. If a programming device is present, the CPU communicates with it.
6. It communicates with other devices.
7. It performs diagnostics

Except for communicating with a programmer, all these steps execute every sweep. Programmer communications occur only when needed.

In this mode, the CPU performs all parts of its sweep normally. Each sweep executes as quickly as possible with a different amount of time consumed each sweep.

### 17.3.1 The Sweep Windows

The programmer communications window and the system communications window have two operating modes:

|                        |                                                                                                                                                                                                                                      |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Limited Mode           | The execution time of the window is 6ms. The window terminates when it has no more tasks to complete or when 6ms has elapsed.                                                                                                        |
| Run to Completion Mode | Regardless of the time assigned to a particular window, the window runs until all tasks within that window are completed (up to 200ms for the System Communications Window and up to 50ms for the Programmer Communications Window). |

SVCREQ 2 can be used in the application program to obtain the current times for each window.

### 17.3.2 The Watchdog Timer

When the CPU is in Standard Sweep mode, the watchdog timer catches failure conditions that could cause an unusually long sweep. The length of the watchdog timer is 200ms. It restarts from zero at the beginning of each sweep.

If the sweep takes longer than 200mS, the OK LED on the CPU module goes off. The CPU resets, executes its power-up logic, generates a watchdog failure fault, and goes to Stop mode. Communications are temporarily interrupted.

## 17.4 Constant Sweep Time Operation

If the application requires that each CPU sweep take the same amount of time, the CPU can be configured to operate in Constant Sweep Time mode. This operating mode assures that the inputs and outputs in the system are updated at constant intervals. This mode can also be used to implement a longer sweep time.

### 17.4.1 Changing the Configured Default for Constant Sweep Mode

If the PLC is in STOP mode, its Configured Constant Sweep mode can be edited. After this is done, the configuration must be stored to the CPU for the change to take effect. Once stored, Constant Sweep Time mode becomes the default sweep mode.

### 17.4.2 The Constant Sweep Timer

During operation in Constant Sweep Time mode, the CPU's constant sweep timer controls the length of the sweep. The timer length can be 5 to 200 ms. The time should be at least 10 ms longer than the CPU's sweep time when it is in Standard Sweep mode, to prevent extraneous over-sweep faults.

If the constant sweep timer expires before the sweep completes, the CPU still completes the entire sweep, including the windows. However, it automatically provides notice that a too-long sweep has occurred. On the next sweep after the over-sweep, the CPU places an over-sweep alarm in the PLC fault table. Then, at the beginning of the following sweep, the CPU sets the OV\_SWP fault contact (%SA0002). The CPU automatically resets the OV\_SWP contact when the sweep time no longer exceeds the Constant Sweep Timer. The CPU also resets the OV\_SWP contact if it is not in Constant Sweep Time mode.

As with other fault contacts, the application program can monitor this contact to keep informed about the occurrence of over-sweep conditions.

### 17.4.3 Enabling/Disabling Constant Sweep Time, Reading or Setting the Length of the Timer

SVCREQ 1 can be included in the application program to enable or disable Constant Sweep Time mode, change the length of the Constant Sweep Time, read whether Constant Sweep Time is currently enabled, or read the Constant Sweep Time length.

## 17.5 CPU Stop Modes

The Nano or Micro PLC may be in either of two Stop modes:

- Stop with I/O Disabled mode
- Stop with I/O Enabled mode

When the PLC is in Stop mode, the CPU does not execute the application program logic. You can configure whether or not the I/O will scanned during Stop mode. Communications with the programmer and intelligent option modules continue in Stop mode. In addition, faulted board polling and board reconfiguration execution continue in Stop mode.

SVCREQ 13 can be used in the application program to stop the PLC at the end of the next sweep. All I/O will go to the OFF state and a diagnostic message will be placed in the PLC Fault Table.

## 17.6 Controlling the Execution of a Program

The VersaMax CPU Instruction Set contains several powerful Control functions that can be included in an application program to limit or change the way the CPU executes the program and scans I/O.

### 17.6.1 Calling a Subroutine Block

The CALL function can be used to cause program execution to go to a specific subroutine. Conditional logic placed before the Call function controls the circumstances under which the CPU performs the subroutine logic. After the subroutine is finished, program execution resumes at the point in the logic directly after the CALL instruction.

### 17.6.2 Creating a Temporary End of Logic

The END function can be used to provide a temporary end of logic. It can be placed anywhere in a program. No logic beyond the END function is executed, and program execution goes directly back to the beginning. This ability makes the END function useful for debugging a program.

The END function should not be placed in logic associated with or called by a Sequential Function Chart control structure. If this occurs, the PLC will be placed in STOP/FAULT mode at the end of the current sweep and an SFC\_END fault will be logged.

### 17.6.3 Executing Rungs of Logic without Logical Power Flow

The nested Master Control Relay can be used to execute a portion of the program logic with no logical power flow. Logic is executed in a forward direction and coils in that part of the program are executed with negative power flow. Master Control Relay functions can be nested to 8 levels deep.

## 17.6.4 Jumping to Another Part of the Program

The Jump function can be used to cause program execution to move either forward or backward in the logic. When a nested Jump function is active, the coils in the part of the program that is skipped are left in their previous states (not executed with negative power flow, as they are with a Master Control Relay). Jump functions can also be nested.

Jumps cannot span blocks, SFC actions, SCF transitions, or SFC pre- or post-processing logic.

## 17.7 Privilege Levels and Passwords

Passwords are an optional configurable feature of the Micro PLC (passwords are not available on Nano PLCs). Passwords provide different levels of access privilege to the PLC when the programmer is in Online or Monitor mode. Passwords are not used if the programmer is in Offline mode. Passwords can restrict:

- Changing I/O and PLC configuration data
- Changing programs
- Reading PLC data
- Reading programs

There is one password for each privilege level in the PLC. Each password may be unique or the same password can be used for more than one level. Passwords are one to seven ASCII characters in length.

By default, there is no password protection. Passwords are set up, changed, or removed using the programming software. After passwords have been set up, access to the PLC is restricted unless the proper password is entered. Entering a correct password allows access to the requested level and to all lower levels. For example, the password for level 3 allows access to levels 1, 2, and 3. If PLC communications are suspended, protection automatically returns to the highest unprotected level. For example: If a password is set at levels 2 & 3, but none at level 4, if the software disconnects and reconnects, the access level is 4. Privilege level 1 is always available because no password can be set for this level.

| Level             | Access Description                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4 Least Protected | <ul style="list-style-type: none"> <li>• Write to all configuration or logic. Configuration may only be written in Stop mode; logic may be written in Stop or Run mode (if run-mode store is supported).</li> <li>• Set or delete passwords for any level.</li> <li>• Plus all access from levels 3,2 and 1</li> </ul> <p><b>Note:</b> This is the default if no passwords are defined.</p>                            |
| 3                 | <ul style="list-style-type: none"> <li>• Write to all configuration and logic when the CPU is in Stop mode, including word-for-word changes (when supported), the addition/deletion of program logic, and the overriding of discrete I/O.</li> <li>• Read/Write/Verify user flash.</li> <li>• Store reference/override tables.</li> <li>• Change sweep mode.</li> <li>• Plus all access from levels 2 and 1</li> </ul> |

| Level            | Access Description                                                                                                                                                                                                                                                                                                                                                            |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2                | <ul style="list-style-type: none"> <li>• Write to any data memory, but this does not include storing tables.</li> <li>• This includes the toggle/force of reference values but does not include overriding discrete I/O.</li> <li>• The PLC can be started or stopped.</li> <li>• PLC and I/O fault tables can be cleared.</li> <li>• Plus all access from level 1</li> </ul> |
| 1 Most Protected | Read any PLC data except for passwords. This includes reading fault tables, current status, performing datagrams, verifying logic/config, and loading program and configuration from the PLC. No PLC memory may be changed.                                                                                                                                                   |

### 17.7.1 Protection Level Request from Programmer

Upon connection to the CPU, the programming software automatically requests the CPU to move to the highest unprotected level. That gives the programmer access to the highest unprotected level without having to specifically request a particular level.

A privilege change may be to a lower level or to a higher level. The privilege level is changed from the programmer by entering the new level and the correct password for that level. If the wrong password is entered, the change is denied and a fault is logged in the PLC fault table. A request to change to a privilege level that is not password-protected is made by supplying the new level and an empty password.

#### Notes on Using Passwords

To re-enable passwords after passwords have been disabled, the PLC must be power-cycled with the battery removed for long enough to completely discharge the super-capacitor and erase the PLC memory.

If the passwords prevent changing the run/stop mode, firmware upgrades cannot be performed if the PLC is in run mode.

The Run/Stop switch (if configured) will place the PLC in run or stop mode regardless of the passwords.

### 17.7.2 The OEM Protection Feature

The OEM protection feature is similar to the passwords and privilege levels and provides an even higher level of security. The feature is enabled or disabled using a 1 to 7 character password called the OEM key. When OEM protection is enabled, no write-access to the PLC program and configuration is permitted. Reading the configuration from the PLC is permitted. In this mode, no user flash operations are allowed.

When the OEM key password has been created, the OEM key can be locked in two ways: by choosing the locked setting from the programming software or by power-cycling the PLC. (The OEM key locked status does not change when PLC communications are suspended.)

### 17.7.3 Clearing All Memory

It is possible to Clear All memory from the programmer with the CPU at any privilege level, even with the OEM key locked. Operators can clear CPU memory and store a new application program to the CPU without knowing passwords.

If passwords and/or the OEM key have been set and written to flash, a read from flash updates the protection level. In this case, it is not necessary to re-enter the password to gain access to a particular level. A Clear All does not clear user flash.

## 17.8 Run/Stop Mode Switch Operation

The CPU Run/Stop mode switch on a VersaMax Micro PLC can be used as a Run/Stop switch, as a memory protect switch, and for clearing faults when a fatal fault exists.

A 10-Point VersaMax Nano PLC can provide the same functionality by adding a Single Pole, Single Throw (SPST) switch. An external switch on a Nano PLC is read as a normal 24Vdc input. The specifications for the RUN input are the same as the other DC inputs on the Nano PLC.

### 17.8.1 Run/Stop Mode Operation

If Run/Stop operation is enabled, the Run/Stop switch is used to control the operating mode of the PLC. The PLC monitors the state of the Run/Stop switch and stores the current state in status bit %S0022. The application program can check the state of this bit if necessary, and activate logic based on its setting (in Run mode, the bit is =1, and in Stop mode, it is =0).

If Run/Stop mode switch operation is enabled, the switch can be used to place the Micro PLC CPU in Run mode if a fatal fault condition exists in the CPU. Note that the switch overrides any restrictions on mode selection that have been set up using password protection.

- If the CPU has non-fatal faults and is not in Stop/Fault mode, placing the switch in Run position causes the CPU to go to Run mode. Faults are NOT cleared.
- If the CPU has fatal faults and is in Stop/Fault mode and Run/Stop Enabled is configured, placing the switch in Run position causes the Run LED to blink for 5 seconds. While the Run LED is blinking, the CPU switch can be used to clear the fault table and put the CPU in Run mode. After the switch has been in Run position for at least ½ second, move it to Stop position for at least ½ second. Then move it back to Run position. The faults are cleared and the CPU goes to Run mode. The LED stops blinking and stays on. This can be repeated if necessary.
- If the switch is not toggled as described, after 5 seconds the Run LED goes off and the CPU remains in Stop/Fault mode. Faults stay in the fault table.
- If Run/Stop operation is NOT enabled by configuration and a fatal fault occurs, it is not possible to restore operation using the switch as described above. The CPU remains in Stop/Fault mode and faults stay in the fault table.

## 17.8.2 Configurable Memory Protection

Operation of the Micro PLC Run/Stop switch (or Nano Run/Stop input) can be configured to prevent writing to program memory and configuration, and to prevent forcing or overriding discrete data.

### 17.8.3 Configuration Parameters and Switch Position for Run/Stop Modes

| Switch Run/Stop Enabled Configuration | I/O Scan Stop Configuration | Switch Position                | Allowed Mode          | PLC Operation                         |
|---------------------------------------|-----------------------------|--------------------------------|-----------------------|---------------------------------------|
| Disabled                              | has no effect               | has no effect                  | All                   | PLC Programmer modes operate the same |
| Enabled                               | has no effect               | Run/On                         | All                   | PLC Programmer modes operate the same |
| Enabled                               | No                          | Stop/Off                       | Stop/ No I/O          | PLC not allowed to go to Run mode.    |
| Enabled                               | Yes                         | Stop/Off                       | Stop/No I/O, Stop I/O | PLC not allowed to go to Run mode.    |
| Enabled                               | has no effect               | Toggle Switch from Stop to Run | n/a                   | PLC goes to Run mode                  |
| Enabled                               | No                          | Toggle switch from Run to Stop | n/a                   | PLC goes to STOP-NO IO                |
| Enabled                               | Yes                         | Toggle switch from Run to Stop | n/a                   | PLC goes to STOP-IO                   |

### 17.8.4 Configuration Parameters and Switch Position for Memory Protection

| Memory Protect Enabled Configuration | Switch Position | PLC Operation                              |
|--------------------------------------|-----------------|--------------------------------------------|
| Off                                  | n/a             | Normal PLC operation                       |
| On                                   | Protect/On      | No storing/clearing/loading of PLC allowed |
| On                                   | Protect/Off     | Normal PLC operation                       |

## 17.8.5 Configuration Parameters and Switch Position for Simultaneous Run/Stop Operation and Memory Protection

| Memory Protect Configuration | Run/Stop Configuration | Switch Position        | PLC Operation                                                                            |
|------------------------------|------------------------|------------------------|------------------------------------------------------------------------------------------|
| Enabled                      | Disabled               | Toggled from OFF to ON | Memory Protected                                                                         |
| Enabled                      | Enabled                | Toggled from OFF to ON | Memory Protected<br>PLC is in Run Mode                                                   |
| Enabled                      | Enabled                | Toggled from ON to OFF | Memory Protected<br>PLC is in Stop Mode<br>PLC cannot be put in Run Mode with Programmer |

## 17.8.6 Configuration Parameters and Switch Position for Fault Operations

| Run/Stop Enabled Configuration | Switch Position                                                                                                                                  | Faults Present in the PLC | PLC Operation                                    |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|--------------------------------------------------|
| Disabled                       | n/a                                                                                                                                              | n/a                       | Normal PLC operation                             |
| Enabled                        | Toggle Switch from Stop to Run                                                                                                                   | Non-fatal                 | Places PLC in Run mode<br>Faults are NOT cleared |
| Enabled                        | Toggle Switch from Stop to Run                                                                                                                   | Fatal                     | Run LED blinks for 5 sec                         |
| Enabled                        | While the Run LED is blinking and ON for at least ½ second, toggled from Run to Stop, and then, after another ½ second, toggled from Stop to Run | Fatal                     | PLC goes to Run mode and all faults are cleared  |

## 17.9 Power-Up and Power-Down Sequence

### 17.9.1 Power-Up Sequence

The power-up sequence for the Nano/Micro PLC consists of the following events:

1. The CPU runs self-diagnostics. This includes checking a portion of RAM to determine whether or not the RAM is functional. (For DC Micro PLCs, power-up diagnostics can be disabled by configuration. It is recommended that you not use this feature unless your application requires unusually rapid power-up. For details, see “Installation Instructions”.)
2. The hardware configuration is compared with the software configuration. Any mismatches detected constitute faults and are alarmed.
3. If there is no software configuration, the CPU uses the default configuration.



- The mode of the first sweep is determined based on CPU configuration. The PLC can either copy the program from flash memory into RAM (see below), or power up in Stop or Run mode. See “Flash Memory”.

|                             | Nano PLC or 14-Point Micro PLC | 23-Point or 28-Point Micro PLC |                         |
|-----------------------------|--------------------------------|--------------------------------|-------------------------|
|                             |                                | No Backup Battery              | Backup Battery          |
| Default Power-up Mode       | Stop Mode                      | Stop Mode                      | Last Mode               |
| Configurable Power-up Modes | Run Mode or Stop Mode          | Run Mode or Stop Mode          | Run, Stop, or Last Mode |

## 17.9.2 Flash Memory

A VersaMax Nano or Micro PLC provides non-volatile flash memory to store the application program and system firmware.

Only one application program at a time can be present in non-volatile flash memory. Separate copies of the user data (program, configuration, and retentive data) are maintained in FLASH memory.

During configuration of a Nano or Micro PLC, you can choose whether, in the future, the PLC will read its user data from flash or from RAM.

In addition, Micro PLCs that use the optional backup battery can read their user data from RAM if the unit has been powered down for an extended period of time. If there is no battery backup, RAM may be invalid on power-up. In that case, the default program is installed, or the user data must be read from flash.

|                             | User Data     |         |                               |
|-----------------------------|---------------|---------|-------------------------------|
|                             | Configuration | Program | Retentive Data                |
| <b>Default Settings</b>     |               |         |                               |
| Read From RAM               | X             | X       | X                             |
| Read From FLASH             | –             | --      | –                             |
| <b>Recommended Settings</b> |               |         |                               |
| Read From RAM               | –             | --      | X                             |
| Read From FLASH             | X             | X       | X<br>(If battery is not used) |

If the application uses SVCREQ 53 to write additional data to flash memory (supported in firmware rev 3.0), retentive data will be updated. If the retentive data is read from flash on power-up, these updated values will be used instead of the original data values.

## 17.9.3 Default Conditions for Micro PLC Output Points

At power-up, output points default to off. They stay off until the first output scan.

## 17.9.4 Power-Down Conditions

System power-down occurs automatically if the power supply detects that incoming AC power has dropped. The minimum hold time is one half cycle.

---

**Note:** *During a gradual power down, when the input power supply voltage drops below the minimum operating voltage, the PLC will transition to a state where all outputs are disabled. In this state, the Run LED and the OK LED are also turned off. The PLC remains in this state until power is lost completely (the PLC shuts off), or until power is restored (above the minimum operating voltage). In the latter case, the PLC will reset itself and start the normal power-up sequence.*

---

## 17.9.5 Power Cycle

The table below lists the effects that a power cycle can have on Micro PLC operation under specific conditions.

| Condition                                                                                                                                                                                                                                                                                                                       | Effects                                                                                                                                                                                                                                                                                                                                                        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PLC loses power while storing a program to RAM from either the programming software or flash memory.                                                                                                                                                                                                                            | On the ensuing power-up the program will be deleted from RAM. You will need to store the program again from the programmer.                                                                                                                                                                                                                                    |
| PLC loses power while storing a configuration to RAM from either the programming software or flash memory.                                                                                                                                                                                                                      | On the ensuing power-up, the configuration will be deleted from RAM. You will need to store the configuration again from the programmer.                                                                                                                                                                                                                       |
| PLC loses power while storing the reference tables to RAM from either the programming software or flash memory.                                                                                                                                                                                                                 | On the ensuing power-up, the reference table data will be deleted from RAM. You will need to store the data again from the programmer.                                                                                                                                                                                                                         |
| PLC loses power while storing a program, configuration, or reference table data to flash memory.                                                                                                                                                                                                                                | The flash memory area used to store the program, configuration, or reference table data will be considered invalid. You will need to store the program, configuration, or reference tables to flash memory again.                                                                                                                                              |
| If system includes expansion unit(s):<br>Micro PLC base unit loses power before the expansion unit(s)<br>Expansion unit(s) lose power before the Micro PLC base unit while Micro PLC is scanning I/O<br>Micro PLC base unit powers up before the expansion unit(s)<br>Expansion unit(s) power up before the Micro PLC base unit | Expansion units will be reset (all outputs will be set to zero)<br>A Loss of Expansion Module fault may be logged.<br><br>If expansion units do not power up at the same time as the Micro PLC, a Loss of Expansion Module fault may be logged.<br><br>Expansion unit outputs remain off until the Micro base unit completes power-up and begins scanning I/O. |

If the application uses SVCREQ 53 to write additional data to flash memory (supported in firmware rev 3.0), retentive data will be updated. If the retentive data is read from flash on power-up, these updated values will be used instead of the original data values.

## 17.10 Input Filters

### 17.10.1 Discrete Input Filtering

Nano and Micro PLCs with DC inputs can provide discrete input filtering, to compensate for switch bounce and other application conditions. This input filtering also applies to discrete expansion units connected to the PLC.

#### Filter Control Reference

Discrete input filter time can be changed on the fly by simply adjusting the value in reserved reference %AQ11. The filter time can be 0.5mS to 20mS in 0.5mS increments. The value in %AQ11 represents the number of 0.5mS increments in the total filter time.

For 20/40/64-point Micro PLCs, input filtering is configurable in 1ms increments only. Use the values shown below (1ms = 2, 2ms = 4, 3ms = 6 and so on).

Note that input filtering is not provided for 64-point expansion units.

| Filter Time in mS | Value to Put in %AQ11 | Filter Time in mS | Value to Put in %AQ11 | Filter Time in mS | Value to Put in %AQ11 | Filter Time in mS | Value to Put in %AQ11 |
|-------------------|-----------------------|-------------------|-----------------------|-------------------|-----------------------|-------------------|-----------------------|
| 0.5mS             | 1                     | 5.5mS             | 11                    | 10.5mS            | 21                    | 15.5mS            | 31                    |
| 1.0mS             | 2                     | 6.0mS             | 12                    | 11.0mS            | 22                    | 16.0mS            | 32                    |
| 1.5mS             | 3                     | 6.5mS             | 13                    | 11.5mS            | 23                    | 16.5mS            | 33                    |
| 2.0mS             | 4                     | 7.0mS             | 14                    | 12.0mS            | 24                    | 17.0mS            | 34                    |
| 2.5mS             | 5                     | 7.5mS             | 15                    | 12.5mS            | 25                    | 17.5mS            | 35                    |
| 3.0mS             | 6                     | 8.0mS             | 16                    | 13.0mS            | 26                    | 18.0mS            | 36                    |
| 3.5mS             | 7                     | 8.5mS             | 17                    | 13.5mS            | 27                    | 18.5mS            | 37                    |
| 4.0mS             | 8                     | 9.0mS             | 18                    | 14.0mS            | 28                    | 19.0mS            | 38                    |
| 4.5mS             | 9                     | 9.5mS             | 19                    | 14.5mS            | 29                    | 19.5mS            | 39                    |
| 5.0mS             | 10                    | 10.0mS            | 20                    | 15.0mS            | 30                    | 20.0mS            | 40                    |

The input filter recognizes signals that have a duration within  $\pm 0.5\text{mS}$  ( $\pm 1.0\text{mS}$  for 20-/40-/64-point Micro PLCs) of the filter time. For example, if the filtering time is 5mS, any input that lasts more than 4.5mS (5.0mS for 20-/40-/64-point Micro PLCs) is recognized. What will be read on an input is not only based on the input filter setting. It is also based on the scan time. An input will always be seen if it is longer than both the scan time and the filter time.

Because %AQ11 is used to control the discrete input filtering time, it should not be used for any other purpose.

## 17.11 Hardware R/C Filters

In addition to Discrete Input Filters, all the VersaMax Nano/Micro modules have simple Hardware R/C Filters for the inputs. The following table provides the filter constants of the simple hardware R/C filter present on each module.

| Module      | I1 to I4 | I5 to I6 | I7 to I8 | I9 to I12 | I13  | I14 to I16 | I17 to I24 | I25 to I40 |
|-------------|----------|----------|----------|-----------|------|------------|------------|------------|
| IC200NDR001 | 200nS    | 1μS      |          |           |      |            |            |            |
| IC200NAL211 | 200nS    | 1μS      |          |           |      |            |            |            |
| IC200NDD101 | 200nS    | 1μS      |          |           |      |            |            |            |
| IC200NDR010 | 200nS    | 1μS      |          |           |      |            |            |            |
| IC200NAL110 | 200nS    | 1μS      |          |           |      |            |            |            |
| IC200NDD010 | 200nS    | 1μS      |          |           |      |            |            |            |
| IC200UAR014 | 20 mS    | 20 mS    | 20 mS    |           |      |            |            |            |
| IC200UAA003 | 20 mS    | 20 mS    | 20 mS    |           |      |            |            |            |
| IC200UDR001 | 200nS    | 1μS      | 1μS      |           |      |            |            |            |
| IC200UDR002 | 200nS    | 1μS      | 1μS      |           |      |            |            |            |
| IC200UDD104 | 200nS    | 1μS      | 1μS      |           |      |            |            |            |
| IC200UDR003 | 200nS    | 1μS      | 1μS      |           |      |            |            |            |
| IC200UDD112 | 200nS    | 1μS      | 1μS      |           |      |            |            |            |
| IC200UDR120 | 100nS    | 100nS    | 100nS    | 5μS       |      |            |            |            |
| IC200UDR020 | 100nS    | 100nS    | 100nS    | 5μS       |      |            |            |            |
| IC200UDD220 | 100nS    | 100nS    | 100nS    | 5μS       |      |            |            |            |
| IC200UDD020 | 100nS    | 100nS    | 100nS    | 5μS       |      |            |            |            |
| IC200UAL006 | 200nS    | 1μS      | 1μS      | 1μS       | 1μS  |            |            |            |
| IC200UAL005 | 200nS    | 1μS      | 1μS      | 1μS       | 1μS  |            |            |            |
| IC200UAL004 | 200nS    | 1μS      | 1μS      | 1μS       | 1μS  |            |            |            |
| IC200UAR028 | 20mS     | 20mS     | 20mS     | 20mS      | 20mS | 20mS       |            |            |
| IC200UAA007 | 20mS     | 20mS     | 20mS     | 20mS      | 20mS | 20mS       |            |            |
| IC200UDR005 | 200nS    | 1μS      | 1μS      | 1μS       | 1μS  | 1μS        |            |            |
| IC200UDR010 | 200nS    | 1μS      | 1μS      | 1μS       | 1μS  | 1μS        |            |            |
| IC200UDD110 | 200nS    | 1μS      | 1μS      | 1μS       | 1μS  | 1μS        |            |            |
| IC200UDD120 | 200nS    | 1μS      | 1μS      | 1μS       | 1μS  | 1μS        |            |            |
| IC200UDR006 | 200nS    | 1μS      | 1μS      | 1μS       | 1μS  | 1μS        |            |            |
| IC200UDD212 | 200nS    | 1μS      | 1μS      | 1μS       | 1μS  | 1μS        |            |            |
| IC200UDR228 | 200nS    | 1μS      | 1μS      | 1μS       | 1μS  | 1μS        |            |            |
| IC200UDR140 | 100nS    | 100nS    | 100nS    | 5μS       | 5μS  | 5μS        | 5μS        |            |
| IC200UDR040 | 100nS    | 100nS    | 100nS    | 5μS       | 5μS  | 5μS        | 5μS        |            |
| IC200UDD240 | 100nS    | 100nS    | 100nS    | 5μS       | 5μS  | 5μS        | 5μS        |            |
| IC200UDD040 | 100nS    | 100nS    | 100nS    | 5μS       | 5μS  | 5μS        | 5μS        |            |
| IC200UDR440 | 100nS    | 100nS    | 100nS    | 5μS       | 5μS  | 5μS        | 5μS        |            |

| Module      | I1 to I4 | I5 to I6 | I7 to I8 | I9 to I12 | I13  | I14 to I16 | I17 to I24 | I25 to I40 |
|-------------|----------|----------|----------|-----------|------|------------|------------|------------|
| IC200UDR164 | 100nS    | 100nS    | 100nS    | 5μS       | 5μS  | 5μS        | 5μS        | 5μS        |
| IC200UDR064 | 100nS    | 100nS    | 100nS    | 5μS       | 5μS  | 5μS        | 5μS        | 5μS        |
| IC200UDD164 | 100nS    | 100nS    | 100nS    | 5μS       | 5μS  | 5μS        | 5μS        | 5μS        |
| IC200UDD064 | 100nS    | 100nS    | 100nS    | 5μS       | 5μS  | 5μS        | 5μS        | 5μS        |
| IC200UEX009 | 20mS     | 20mS     | 20mS     |           |      |            |            |            |
| IC200UEX010 | 20mS     | 20mS     | 20mS     |           |      |            |            |            |
| IC200UEX011 | 200nS    | 1μS      | 1μS      |           |      |            |            |            |
| IC200UEX012 | 200nS    | 1μS      | 1μS      |           |      |            |            |            |
| IC200UEX014 | 200nS    | 1μS      | 1μS      |           |      |            |            |            |
| IC200UEX122 | 200nS    | 1μS      | 1μS      |           |      |            |            |            |
| IC200UEX013 | 200nS    | 1μS      | 1μS      |           |      |            |            |            |
| IC200UEX015 | 200nS    | 1μS      | 1μS      |           |      |            |            |            |
| IC200UEI016 | 3mS      | 3mS      | 3mS      | 3mS       | 3mS  | 3mS        |            |            |
| IC200UEX209 | 20mS     | 20mS     | 20mS     | 20mS      | 20mS | 20mS       |            |            |
| IC200UEX210 | 20mS     | 20mS     | 20mS     | 20mS      | 20mS | 20mS       |            |            |
| IC200UEX211 | 200nS    | 1μS      | 1μS      | 1μS       | 1μS  | 1μS        |            |            |
| IC200UEX212 | 200nS    | 1μS      | 1μS      | 1μS       | 1μS  | 1μS        |            |            |
| IC200UEX214 | 200nS    | 1μS      | 1μS      | 1μS       | 1μS  | 1μS        |            |            |
| IC200UEX222 | 200nS    | 1μS      | 1μS      | 1μS       | 1μS  | 1μS        |            |            |
| IC200UEX213 | 200nS    | 1μS      | 1μS      | 1μS       | 1μS  | 1μS        |            |            |
| IC200UEX215 | 200nS    | 1μS      | 1μS      | 1μS       | 1μS  | 1μS        |            |            |
| IC200UEX164 | 100nS    | 100nS    | 100nS    | 5μS       | 5μS  | 5μS        | 5μS        | 5μS        |
| IC200UEX064 | 100nS    | 100nS    | 100nS    | 5μS       | 5μS  | 5μS        | 5μS        | 5μS        |
| IC200UEX364 | 100nS    | 100nS    | 100nS    | 5μS       | 5μS  | 5μS        | 5μS        | 5μS        |
| IC200UEX264 | 100nS    | 100nS    | 100nS    | 5μS       | 5μS  | 5μS        | 5μS        | 5μS        |
| IC200UEI008 | 3mS      | 3mS      | 3mS      |           |      |            |            |            |
| IC200UEC208 | 200nS    | 1μS      | 1μS      |           |      |            |            |            |
| IC200UEC108 | 200nS    | 1μS      | 1μS      |           |      |            |            |            |
| IC200UEC008 | 200nS    | 1μS      | 1μS      |           |      |            |            |            |

## 17.12 Analog Potentiometer Input Filtering

### 17.12.1 Input Settings

VersaMax Micro-14, Micro-23, and Micro-28 PLCs have two potentiometers, located below the Run/Stop switch, that can be used to manually set input values that are stored in %AI16 and %AI17. The left potentiometer controls %AI16, and the right one controls %AI17.

#### Filter Control Reference

Due to the nature of analog input, the values seen in %AI16 and %AI17 will have some fluctuation. This variation could make these inputs less suitable for certain applications. The Micro PLC uses an averaging filter that samples the values of these inputs once per sweep. When a selected number of samples has been read, it averages them and stores the result in %AI16 and %AI17.

The value in memory reference %AQ1 controls the number of samples to be averaged, calculated as follows:

$$\text{Number of samples} = 2^{\%AQ1}$$

The value in %AQ1 can be from 0 to 7 (indicating 0 through 128 samples).

For example, if 4 is placed in %AQ1, 16 samples are averaged to determine the values to place in %AI16 and %AI17. If 5 is placed in %AQ1, 32 samples are averaged.

The analog value from the potentiometer is not reported until the number of sweeps determined by the value in AQ1 has occurred. If you want to receive a value from the potentiometer on every sweep, including the first sweep, %AQ1 must contain 0.

### 17.12.2 Default Filter Time

The default value in %AQ1 is 4, meaning that 16 samples will be averaged.

### 17.12.3 Limitations of Analog Potentiometer Input Filtering

As with any filter, the longer the filter time (i.e., the more samples that are taken), the longer the response time. Although the maximum value of 7 could be used in %AQ1, this value might cause a long response time on larger programs. For example, if the sweep time of a program is 100ms, and if the potentiometer value is changed, the new value would not show up for 12.8 seconds.

# Chapter 18: High-Speed Counter, PWM, and Pulse Train Operation

This chapter describes the configuration and operation of the High-Speed Counter, Pulse-Width Modulated Output, and Pulse Train Output features of VersaMax Micro and Nano PLCs.

- Overview
- HSC/PWM/PTO Channels
- Type A Counter Operation
- Type B Counter Operation
- High-Speed Counter Outputs
- PWM Outputs
- Pulse Train Outputs
- Pulse Train with Ramp
- COMMREQs for HSC/PWM/PTO Functions
- HSC Application Examples

For a Micro-20, Micro-40, or Micro-64 (Release 3.6 or later) PLC, individual channels can perform the basic Motion Control functions of: Jogging, Homing, Blended Move, and Stop Motion. Details of these features are provided in Chapter 19:.

## 18.1 Overview

All VersaMax Nano PLCs and Micro PLCs with DC inputs are configurable for a mix of High-Speed Counting features. Nano PLCs and Micro PLCs with DC outputs can also be configured with Pulse-Width Modulation, Pulse Train, and Pulse Train with Ramp features.

For added flexibility, the operating parameters of these features can be fine-tuned during operation by including special function blocks in the application program.

Micro-20, Micro-40 and Release 3.6 and later Micro-64 PLCs provide Jog, Homing, and Blended (multi-velocity move) functionality commanded by function blocks in the application program. They also feature configurable 32-bit resolution for both Type A and Type B counters.

## 18.1.1 Operation at Power-up and Mode Change

High-Speed Counters (except PTO with Ramp) run independently of the PLC application program. When the PLC goes from Run to Stop mode, the High-Speed Counters continue to operate (as specified in the configuration). High-Speed Counters remain in running mode through a power cycle. If a High-Speed Counter is running when power is lost, it will start again as soon as power is restored. When power is cycled or the PLC is placed in Run mode, the Accumulator register is loaded with the configured Preload value.

If the PLC goes into Stop mode when the PTO with Ramp is running, the ramp output stops immediately.

If a new configuration has been stored to the PLC, the PLC continues with the existing HSC/PTO/PWM/Pulse Train with Ramp/Motion Features configuration. When the PLC is switched to Run mode, the HSC begins using the new configuration and the Preload value is placed in the Accumulator register.

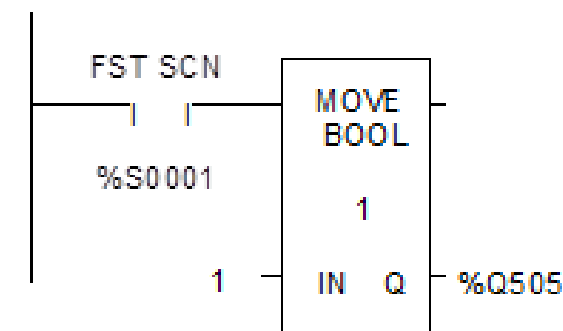
## 18.1.2 Basic Setup

There are three basic steps to setting up High-Speed Counter, PWM, and Pulse Train features.

- With the configuration software, enable each feature you want to use.
- If you want a counter to control an output you must enable the output, also using the configuration software.
- Finally, you can provide application program control over operation of the output by setting or clearing its associated Enable Output bit from the program or in the data tables. For example, if a High-Speed Counter is configured with its output enabled and its Output Enable bit is set, it will control the output. The Output Enable bits are assigned to fixed reference addresses: Q505 through Q508.

A sample ladder logic rung that sets the Output Enable bit for a High-Speed Counter is shown below.

Figure 183





## 18.2 HSC/PWM/PTO Channels

A Micro PLC (which has 14 – 64 points) can be set up to have either four 16-bit Type A counters, or one 16-bit Type A counter and one 16-bit Type B counter. Micro-20, -40, and -64 PLCs can also be set up to have either four 32-bit Type A counters, or one 32-bit Type A and one 32-bit Type B counter.

A Nano PLC (which has 10 points) can be set up to have either three 16-bit Type A counters, or one 16-bit Type A counter and one 16-bit Type B counter).

- Each channel can be configured for High-Speed Counter, PWM, Standard, Pulse Train, Pulse Train with Ramping operation (in 16-bit mode) or Motion support (in 32-bit mode).
- A channel that uses High-Speed Counter inputs can use its associated output(s) as either High-Speed Counter or standard output(s).
- A channel that uses PWM or Pulse Train or Pulse Train with Ramping or Motion support outputs can use its associated inputs as standard inputs.
- High-Speed Counter inputs cannot be mixed with PWM, PTO, PTO with Ramping or Motion support outputs on the same channel.

### 18.2.1 HSC/PWM/PTO Channels for Micro PLCs (14 Point/ 28 Point)

| Channel Configuration Choice | Creates this Number of Channels | Number of Type A Counters Configured | Number of Type B Counters | Number of PWM / Pulse Train Outputs |
|------------------------------|---------------------------------|--------------------------------------|---------------------------|-------------------------------------|
| Four Type A                  | Four                            | 4                                    | 0                         | 0                                   |
|                              |                                 | 3                                    | 0                         | 1                                   |
|                              |                                 | 2                                    | 0                         | 2                                   |
|                              |                                 | 1                                    | 0                         | 3                                   |
|                              |                                 | 0                                    | 0                         | 4                                   |
| One Type A and One Type B    | Two                             | 1                                    | 1                         | 0                                   |
|                              |                                 | 0                                    | 1                         | 1                                   |

For Micro PLCs that have only one DC output, only one PWM or Pulse Train output can be configured.

## 18.2.2 HSC/PWM/PTO Channels for Micro-20, -40, or -64 PLC

The following HSC/PWM/PTO features are available for Micro-20, Micro-40, or Micro-64 (Release 3.6 or later) PLCs:

| Channel Configuration Choice | Creates this Number of Channels | Number of Type A Counters Configured | Number of Type B Counters | Number of PWM / Pulse Train/Ramp Pulse Train/Motion Support |
|------------------------------|---------------------------------|--------------------------------------|---------------------------|-------------------------------------------------------------|
| Four Type A                  | Four                            | 4                                    | 0                         | 0                                                           |
|                              |                                 | 3                                    | 0                         | 1                                                           |
|                              |                                 | 2                                    | 0                         | 2                                                           |
|                              |                                 | 1                                    | 0                         | 3                                                           |
|                              |                                 | 0                                    | 0                         | 4                                                           |
| One Type A and One Type B    | Two                             | 1                                    | 1                         | 0                                                           |
|                              |                                 | 0                                    | 1                         | 1                                                           |
| Four Type A_32               | Four                            | 4                                    | 0                         | 0                                                           |
|                              |                                 | 3                                    | 0                         | 1                                                           |
|                              |                                 | 2                                    | 0                         | 2                                                           |
|                              |                                 | 1                                    | 0                         | 3                                                           |
|                              |                                 | 0                                    | 0                         | 4                                                           |
| One Type A and One Type B_32 | Two                             | 1                                    | 1                         | 0                                                           |
|                              |                                 | 0                                    | 1                         | 1                                                           |

For Micro PLCs that have only one DC output, only one PWM or Pulse Train/Ramp Pulse Train Or Motion output can be configured.

Ramp Pulse Train Outputs are available for Four Type A / One Type A and One Type B. Motion Support is available for Four Type A / One Type A and One Type B in 32-bit mode.

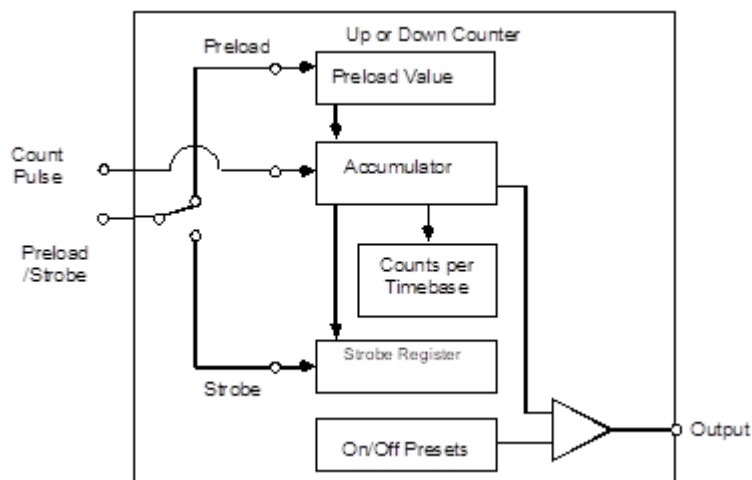
## 18.2.3 HSC/PWM/PTO Channels for Nano PLCs

| Channel Configuration Choice | Creates this Number of Channels | Number of Type A Counters Configured | Number of Type B Counters | Number of PWM / Pulse Train Outputs |
|------------------------------|---------------------------------|--------------------------------------|---------------------------|-------------------------------------|
| Three Type A                 | Three                           | 3                                    | 0                         | 0                                   |
|                              |                                 | 2                                    | 0                         | 1                                   |
|                              |                                 | 1                                    | 0                         | 2                                   |
|                              |                                 | 0                                    | 0                         | 3                                   |
| One Type A and One Type B    | Two                             | 1                                    | 1                         | 0                                   |
|                              |                                 | 0                                    | 1                         | 1                                   |

## 18.3 Type A Counter

The Type A counter is one counter that can count up or down. Configurable high and low limits set the counter's range. The Type A counter has an Accumulator register, a Counts per Timebase register, a Strobe register, high limit, low limit, and ON/OFF Preset values. These are signed numbers. The values selected for the Preload, Accumulator, On Preset, and Off Preset registers must be within the counter limits.

Figure 184



### 18.3.1 Type A Counter Program References

The following program references are used for Type A Counter data. The Clear Strobe and Clear Preload output bits are used to clear (reset) the Strobe and Preload status bits within the module (they do not initiate a strobe or preload to the counter).

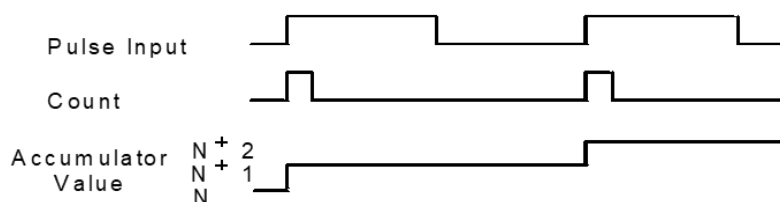
|                                    | Counter 1 | Counter 2 | Counter 3  | Counter 4 |
|------------------------------------|-----------|-----------|------------|-----------|
| Count Input                        | I0001     | I0003     | I0005      | I0007     |
| Preload or Strobe Input            | I0002     | I0004     | I0006      | I0008     |
| Strobe Status Bits                 | I0497     | I0498     | I0499      | I0500     |
| Preload Status                     | I0501     | I0502     | I0503      | I0504     |
| Output Status                      | I0505     | I0506     | I0507      | I0508     |
| Counter Output                     | Q0001     | Q0002     | Q0003      | Q0004     |
| Clear Strobe Bits                  | Q0497     | Q0498     | Q0499      | Q0500     |
| Clear Preload Bits                 | Q0501     | Q0502     | Q0503      | Q0504     |
| Enable Output                      | Q0505     | Q0506     | Q0507      | Q0508     |
| Counts per Timebase Register       | AI002     | AI003     | AI004      | AI005     |
| Accumulator Registers: 16-Bit mode | AI006     | AI008     | AI010      | AI012     |
| 32-Bit mode                        | AI006-007 | AI010-011 | AI020-021  | AI024-025 |
| Strobe Registers : 16-Bit mode     | AI007     | AI009     | AI011      | AI013     |
| 32-Bit mode                        | AI008-009 | AI012-013 | AI 022-023 | AI026-027 |

## 18.3.2 Type A Counter Operation

The counter can either count continuously within its limits, or count to either limit then stop (one-shot mode). In continuous counting, the Accumulator wraps when the count limit is reached and continues counting. For example, if the Count Direction is up, when the count exceeds the High Limit by 1, the Accumulator value wraps to the Low Limit. In one-shot mode, the counter stops at Limit N+1 for up counters or N-1 for down counters if within the range.

In the example below, the counter has been configured to count on the low to high transition of the Pulse input. The Count signal represents an internal signal that indicates where counting occurs with respect to the pulse input.

Figure 185



High-Speed Counters run independently of the application program. When the PLC goes from Run to Stop mode, its High-Speed Counters continue to operate. High-Speed Counters remain in run mode through a power cycle. If a High-Speed Counter is running when power is lost, it will start again as soon as power is restored. Counters will stop on a store of logic or configuration and a write to the user storage device. When power is cycled or the PLC is placed in Run mode, the Accumulator is loaded with the Preload value and the registers start updating.

## 18.3.3 Type A High-Speed Counter Operation Details

The Count Pulse input increments or decrements the counter's accumulator. The count input can be configured to be positive or negative edge-sensitive. The configured **On/Off Preset** values determine when the counter **output** is activated or deactivated. For example:

Lo Limit = 0      Hi Limit = 200  
On Preset = 150      Off Preset = 160

Figure 186: Count Direction = Up

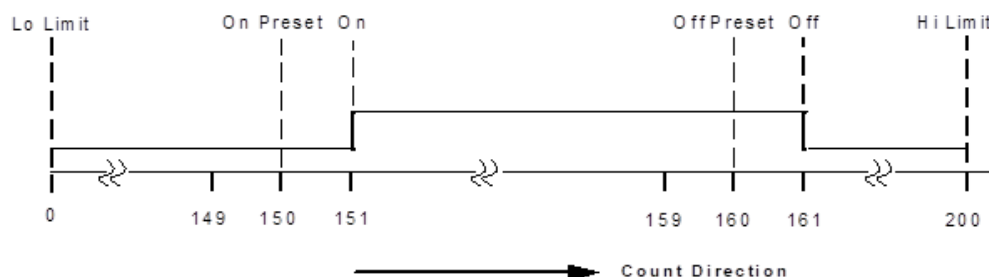
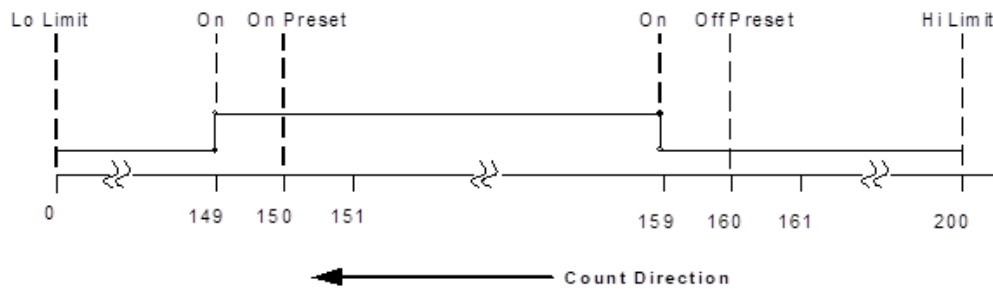


**Figure 187: Count Direction = Down**



Depending on the configuration for Preload/Strobe, the Preload/Strobe Input can either preload a value into the Accumulator or strobe the accumulator value into a register. Preload/Strobe signals are always positive edge-sensitive.

- If the Preload/Strobe input is configured as a Preload input, the configured Preload value is transferred to the Accumulator Register when the input transitions from low to high. When a preload occurs, the PLC sets the Preload Status bit. The application program can reset the bit before the next preload.

The Preload input always loads the Accumulator regardless of the state of the Preload Status bit. The value in the Preload register can be configured to any value in the counter's range. This selection is part of the PLC configuration. However, the value can be changed during operation using a COMMREQ function in the program. Also, The program can also use a COMMREQ to load an adjustment value to the Accumulator register. The adjustment value can be between -128 and +127.

- If the Preload/Strobe Input is configured as a Strobe input, when its Strobe input signal goes active the PLC places the current value in that counter's Accumulator into its Strobe register. The PLC sets the associated Strobe Status bit to indicate that a Strobe value was captured. The Strobe value remains in the Strobe register until the Strobe signal goes active again, at which time it is overwritten by a new value. The Strobe status bit stays on until the program clears it.

The Strobe input always loads the Strobe register with the Accumulator value regardless of the state of the Strobe bit. Strobe inputs can be used as Pulse Capture Inputs by using the Strobe status bits as a latch.

**Timebase** is a span of time used to measure the rate of counting. For example, the program could monitor the number of counts that occur in 30 seconds. Timebase is configurable in 1mS increments from 10mS to 65530mS. The **Counts-per-Timebase** register contains the number of counts that occurred during the last completed timebase interval. The number of counts is a signed number. The sign indicates up (+) or down (-) counts. If the configured timebase is too large, the Counts per Timebase register will lose the overflow values.

**Error Status and Status Code:** The program should monitor the Error Status bit %I0512 to check for error conditions. When this bit is 1, the program can look at the Status Code register %AI001 to learn what caused the error. After taking any necessary corrective action, the program logic should clear the error status by clearing the Clear Error output bit (%Q0512). See “Command Word Error Responses” later in this chapter for more information.

## 18.4 Type B Counter

The Type B counter uses two counter input signals for A-Quad-B counting. The phase relationship between the counter inputs (A & B) determines whether the accumulator is incremented or decremented on a transition of either counter input.

**Figure 188: The count direction is up if A leads B.**

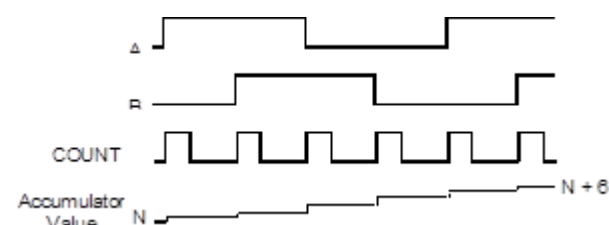
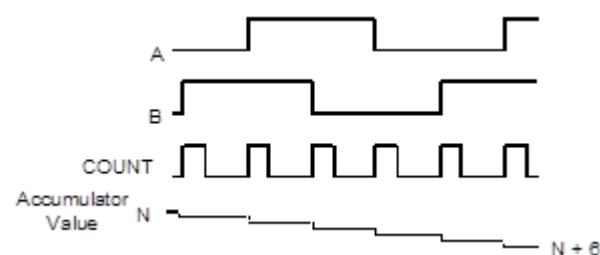
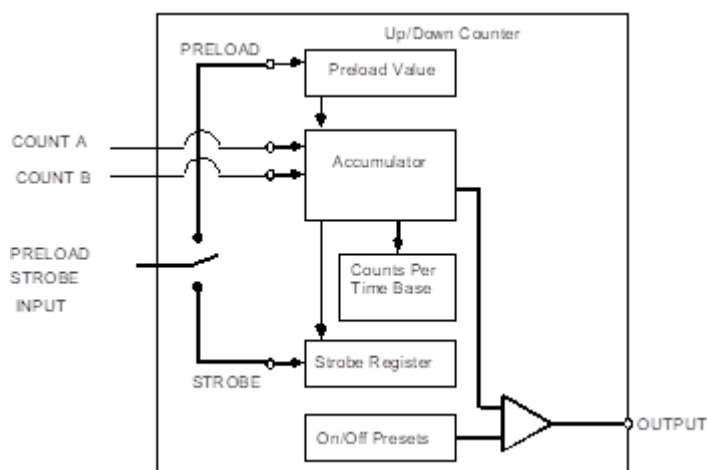


**Figure 189: The count direction is down if A lags B.**



The Type B counter can have one output that is activated based on selected On and Off preset values.

**Figure 190**



The counter counts continuously within its limits. The Accumulator wraps when the count limit is reached and continues counting. For example, if the Count Direction is up, when the count exceeds the High Limit by 1, the Accumulator value wraps to the Low Limit.

## 18.4.1 Type B Counter Program References

The following program references are used for Type B Counter data. The Clear Strobe and Clear Preload output bits are used to clear (reset) the Strobe and Preload status bits within the module (they do not initiate a strobe or preload to the counter).

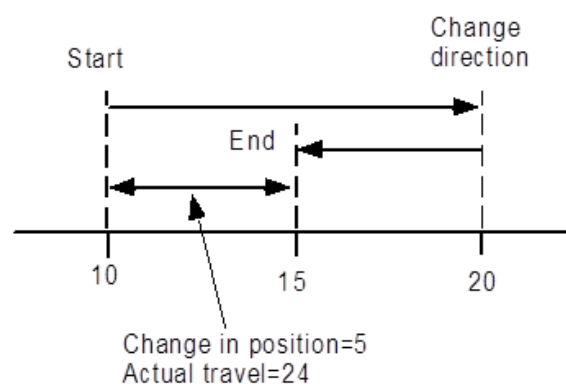
|                                    | Type B Counter                   |
|------------------------------------|----------------------------------|
| Count Inputs                       | Phase 1: I0001<br>Phase 2: I0003 |
| Preload or Strobe Input            | I0006                            |
| Strobe Status Bit                  | I0497                            |
| Preload Status Bit                 | I0501                            |
| Counter Output                     | Q0003                            |
| Clear Strobe Bit                   | Q0497                            |
| Clear Preload Bits                 | Q0501                            |
| Counts per Timebase Register       | AI002                            |
| Accumulator Registers: 16-Bit mode | AI006                            |
| 32-Bit mode                        | AI006-007                        |
| Strobe Registers : 16-Bit mode     | AI007                            |
| 32-Bit mode                        | AI008-009                        |

## 18.4.2 Type B Counter Operation

The Type B counter has a Strobe register, an Accumulator and a Counts-per-Timebase register. Except for the Counts per Timebase Register, these operate as described for Type A counters.

For a B-type counter, the Counts per Timebase value represents the relative shift over the sample time, not an exact number of counts. For example, if the counter starts at 10, counts up to 20, and then counts back to 15, the resulting counts per timebase value is 5.

Figure 191



## Type B Counter Examples

Low Limit = 0      High Limit = 200

On Preset = 150      Off Preset = 160

Figure 192

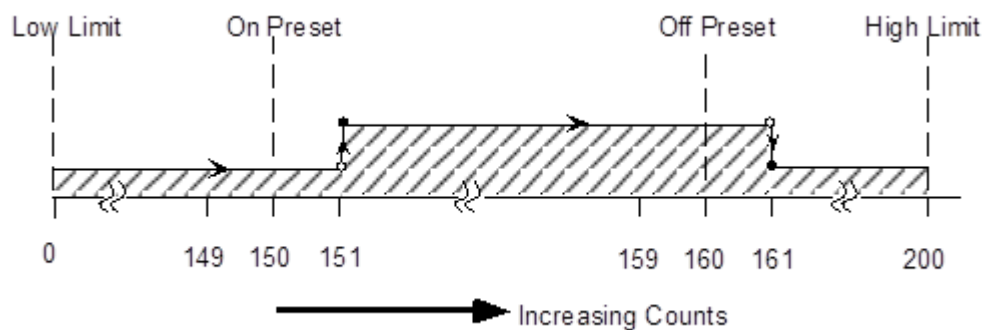


Figure 193

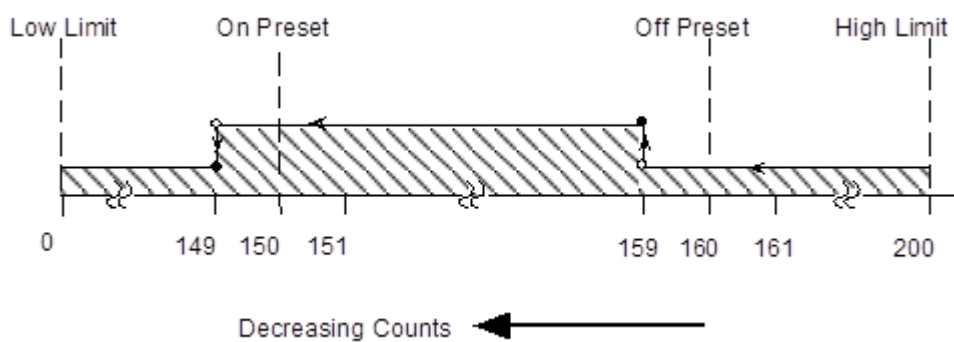
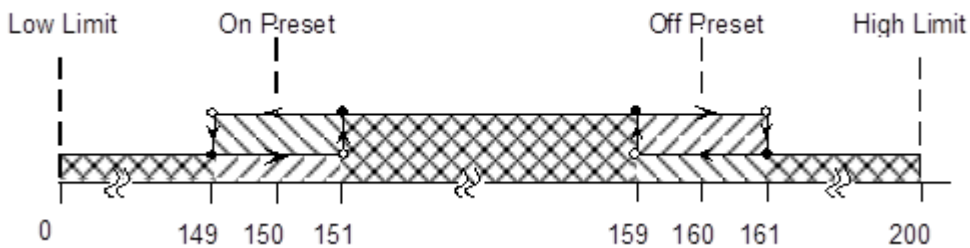


Figure 194





## 18.5 High-Speed Counter Outputs

Four high-speed outputs (three for a Nano PLC) can be individually configured as High-Speed Counter outputs, PWM outputs, or Pulse Train outputs.

When the Counter Type configured is both Type A and Type B, PWM and Pulse Train outputs 1-3 are not available because A-QUAD-B counting uses output channels 1–3, as shown earlier in this chapter.

If the configurations are changed for HSC, PWM, and Pulse outputs, the new outputs take effect when the PLC changes from Stop to Run mode and the enable output bit is ON. When the transition to Run mode occurs, the currently configured output stops running and the new configuration takes over.

Results vary with temperature, but the maximums and minimums shown below apply across the entire operating range for the unit (both temperature and DC output voltage).

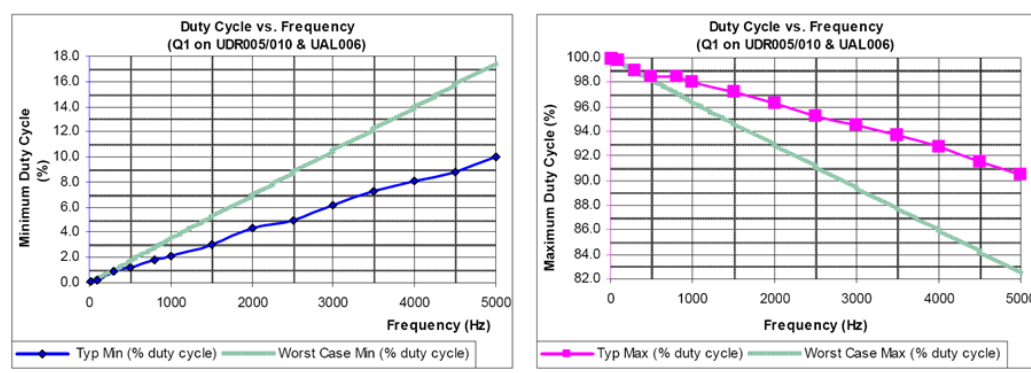
### 18.5.1 Pulldown Resistor

For Micro -10, -14, -23 and -28 PLCs, a pulldown resistor, connected between the output (Q1, 2, 3, or 4) and Common, is required for high frequency Pulse and PWM (up to 5kHz) outputs and for duty cycles in the lower ranges (5% and lower). A 1.5 k $\Omega$ , 0.5-watt resistor is recommended.

Micro -20, -40, and -64 do not require a pulldown resistor.

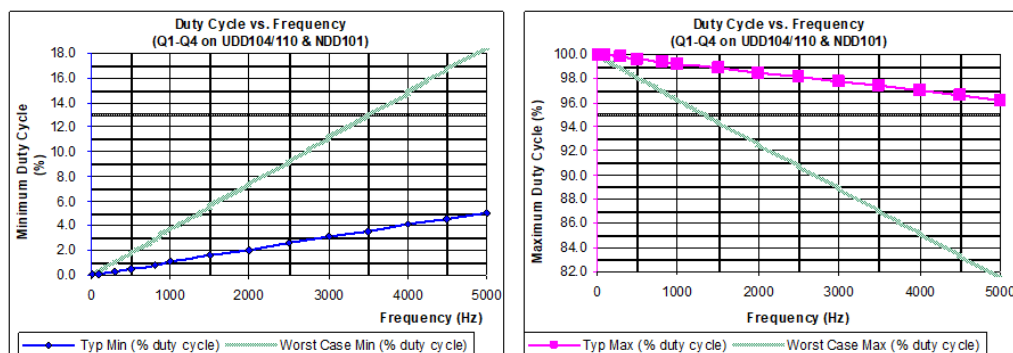
### 18.5.2 Duty Cycle Limits: with 1.5k $\Omega$ pulldown resistor - UDR005/006/010 & UAL004/005/006

Figure 195



### 18.5.3 Duty Cycle Limits: with 1.5k $\Omega$ pulldown resistor - UDD104/110 & NDD101

Figure 196

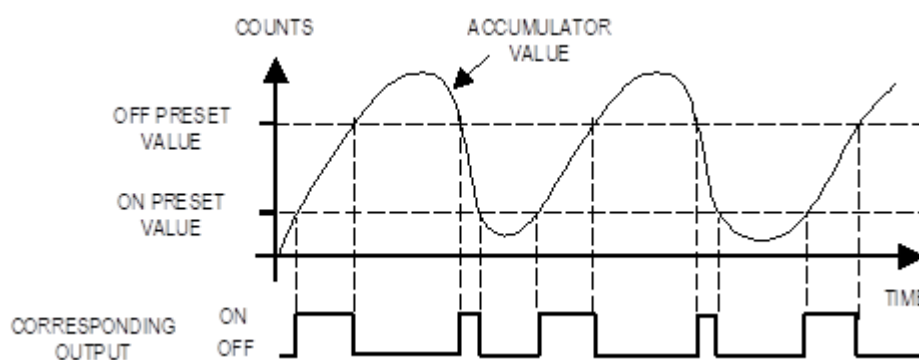


### 18.5.4 Counter Output Presets

Each counter output has a Preset on and off point. Both points must lie between the counter's configured high and low limits. Both the Presets and the High/Low limits are initially set up as part of the PLC configuration. The Presets can be changed during operation by using a COMMREQ function as explained later in this chapter.

The output state indicates when the Accumulator value is between the Preset on and off points. For example, using the Type B counter:

Figure 197



If the output is enabled for the High-Speed Counter being used, the output turns on as described in the Type A and Type B counter sections.

The minimum span that should be configured between the On and Off Presets depends on the count frequency.

| For this Count Frequency: | Minimum Span Between On Preset and Off Preset Should Be: |
|---------------------------|----------------------------------------------------------|
| 100kHz                    | 100 counts                                               |
| 90kHz                     | 90 counts                                                |
| 80kHz                     | 80 counts                                                |
| 70kHz                     | 70 counts                                                |
| 60kHz                     | 60 counts                                                |
| 50kHz                     | 50 counts                                                |
| 40kHz                     | 40 counts                                                |
| 30kHz                     | 30 counts                                                |
| 25kHz                     | 25 counts                                                |
| 20kHz                     | 20 counts                                                |
| 15kHz                     | 15 counts                                                |
| 10kHz                     | 10 counts                                                |
| 5kHz                      | 5 counts                                                 |
| 2kHz                      | 2 counts                                                 |
| 1kHz                      | 1 count                                                  |
| less than 1kHz            | no gap required                                          |

**Note:** Count frequencies above 10 kHz are supported only on 20-, 40-, and 64-point Micro PLCs.

## 18.6 PWM Outputs

Pulse Width-Modulated outputs can be used to control DC and stepper motors. Channels are set up for PWM output operation in the PLC configuration by setting the Channel Function to PWM. If a channel is configured as a PWM output, then references %I0001 through %I0008, which are normally reserved for High-Speed Counter inputs, can be used as standard inputs in the application.

### 18.6.1 Enabling and Disabling a PWM Output

A PWM output is turned on from the application program by setting its Enable Output bit to 1. The output is turned off by setting its Enable Output bit to 0.

When a PWM output starts operating, it continues until a new configuration is received, a store occurs (logic and/or configuration), a write to the user storage device occurs, or the Output Enable bit is cleared. A PWM output stops if an invalid frequency or duty cycle value is commanded.

If a PWM output is running when power is lost and the Output Enable bit remains set to 1, the output starts again as soon as power is restored and the PLC transitions to Run mode.

|                | Channel 1 | Channel 2 | Channel 3 | Channel 4 |
|----------------|-----------|-----------|-----------|-----------|
| PWM Frequency  | AQ002     | AQ004     | AQ006     | AQ008     |
| PWM Duty Cycle | AQ003     | AQ005     | AQ007     | AQ009     |
| Enable Output  | Q0505     | Q0506     | Q0507     | Q0508     |

## 18.6.2 PWM Frequency

The frequency of a PWM output (15Hz to 65kHz for Micro-20, -40, and -64 PLCs and 15Hz to 5kHz for other models) is specified from the application program by writing a value (15 to 65000 for Micro-20, -40, -64 PLC or 15 to 5000 for other Micro PLCs) to the associated frequency reference, as shown above. The actual frequency output can have a tolerance of 1%.

## 18.6.3 PWM Duty Cycle

The PWM duty cycle is set up by writing a value (0 to 10000) to the channel's Duty Cycle reference, as shown above. Both frequency and duty cycle can be changed while the output is enabled. The minimum and maximum duty cycle values depend on the frequency.

## 18.6.4 Load Correction for PWM Outputs

The PLC optical isolators can skew the duty cycle, depending on temperature and load. To compensate for this, the Micro PLC automatically applies an additional load correction time to the zero-output time of each pulse. The default load correction time is: 2 $\mu$ S for 20/40/64-point Micro PLCs with DC outputs, 35 $\mu$ S for other Micro PLCs with DC outputs, 10 $\mu$ S for 20/40/64-point Micro PLCs with relay outputs, or 85 $\mu$ S for other Micro PLCs with relay outputs.

## Changing the Load Correction Time

The Load Correction time can be changed within the range 0 to 200µS by sending the new value in a COMMREQ, as explained later in this chapter.

An example is illustrated below.

In the diagram, T0 is the OFF Time, which is

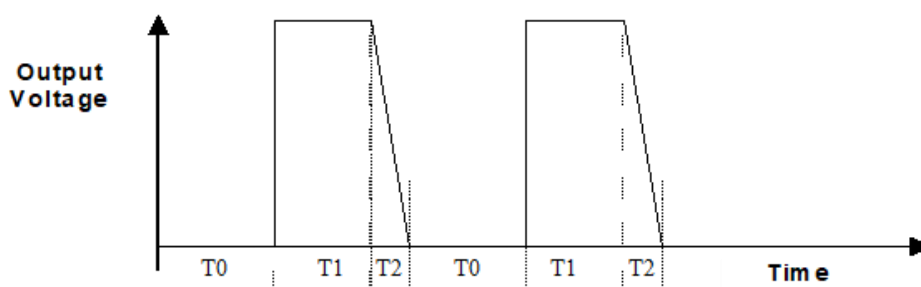
$$\frac{1}{2f} + \text{Correction},$$

where  $f$  is the pulse frequency.  $T1 = \frac{1}{2f}$ ,

T2 = Optical Isolator Delay,

and T1+T2 = ON Time.

Figure 198



## 18.7 Pulse Train Outputs

Pulse Train Outputs can be used to control stepper motors.

### 18.7.1 Configuring a Pulse Train Output

Configuring a channel as a Pulse Train Output is done by setting the Channel Function to Pulse Train in the PLC configuration.

### 18.7.2 Program References for Pulse Train Outputs

The following program references are assigned for use by Pulse Train Outputs.

Pulse Train Complete

Enable Output

Start Pulse Train

Frequency: 16 Bit Mode

32 Bit Mode

Number of Pulses: 16 bit mode

32 Bit Mode

| Channel 1  | Channel 2 | Channel 3 | Channel 4  |
|------------|-----------|-----------|------------|
| I0494      | I0495     | I0496     | I0511      |
| Q0505      | Q0506     | Q0507     | Q0508      |
| Q0494      | Q0495     | Q0496     | Q0511      |
| AQ123      | AQ125     | AQ127     | AQ121      |
| AQ120      | AQ123     | AQ126     | AQ117      |
| AQ124      | AQ126     | AQ128     | AQ122      |
| AQ 121-122 | AQ124-125 | AQ127-128 | AQ 118-119 |

## 18.7.3 Enabling and Disabling Pulse Train Operation

Pulse Train operation starts when the channel's Enable Output bit is set to 1 and the channel's Start Pulse Train bit transitions from 0 to 1. This automatically clears the Pulse Train Complete bit to 0. Pulse Train operation continues until the specified number of pulses have occurred. A Pulse Train Output can be stopped before the requested number of pulses has been completed by setting its Enable Output bit to 0. If the Enable Output bit transitions from 1 to 0, the Pulse Train stops immediately. When the last pulse is completed, the channel's Pulse Train Complete bit goes to 1.

A Pulse Train Output continues to operate when the Micro PLC goes from Run mode to Stop mode. If a Pulse Train Output is running when power is lost, it will restart after power is restored when the PLC transitions with Run mode if both the Enable Output bit and the Start Pulse Train output bits are set to 1.

## 18.7.4 Setting Up the Pulse Frequency

The application program sets up the frequency of a Pulse Train Output by writing a value to the channel's Frequency reference. The frequency range is 15Hz to 65kHz for Micro 20-/40-/64- PLCs, and 15Hz to 5kHz for other models).

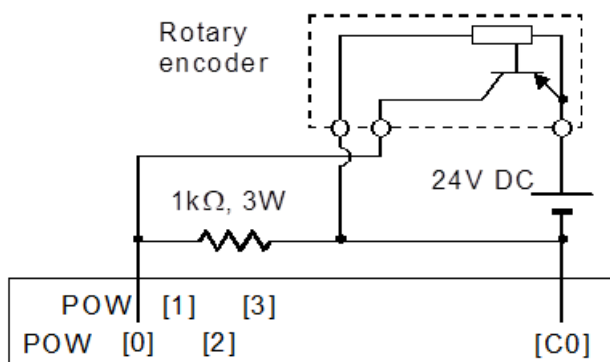
The sum total of frequency configured for all Pulse Train Outputs on a Micro PLC should be less than or equal to 65kHz (this frequency is available for a Micro-20/40/64 only). The minimum frequency that can be configured on each channel is 15Hz. For example: If all the channels are to be configured for Pulse Train with Ramp for maximum possible frequency, the frequencies on each channel can be 15kHz, 15kHz, 15kHz, and 20kHz.

The frequency of a Pulse Train Output can be changed while the Pulse Train is operating. One application of this feature would be to ramp up at the beginning of the Pulse Train operation, and ramp down at the end. For a Micro-20, -40, -64 PLC, Pulse Ramping can also be done by configuring the channel for Pulse Train with Ramp.

The actual frequency output can have a tolerance of 1%.

If the maximum count speed is more than 30 kHz for a Type B Counter, or more than 60 kHz for Type A, resistance must be added to the encoder input as shown in the example below:

Figure 199



## 18.7.5 Setting Up the Number of Pulses

The application program sets up the number of pulses to be output (0 to 65535) by writing the value to the channel's Number of Pulses reference.

## 18.7.6 Load Correction Time

Pulse Train Outputs have a nominal duty cycle of 50%, but the PLC optical isolators can skew the duty cycle, depending on temperature and load. To compensate for this, the PLC applies an additional load correction time to the zero-output time of each pulse. The default load correction time depends on the Micro PLC type. The default times are: 2μS for 20-/40-/64-point Micro PLCs with DC outputs, 35μS for other Micro PLCs with DC outputs, 10μS for 20-/40-/64-point Micro PLCs with relay outputs, or 85μS for other Micro PLCs with relay outputs

### Changing the Load Correction Time

The Load Correction time can be changed within the range 0 to 200μS by sending the new value in a COMMREQ, as explained later in this chapter.

An example is illustrated below.

In the diagram, T0 is the OFF Time, which is

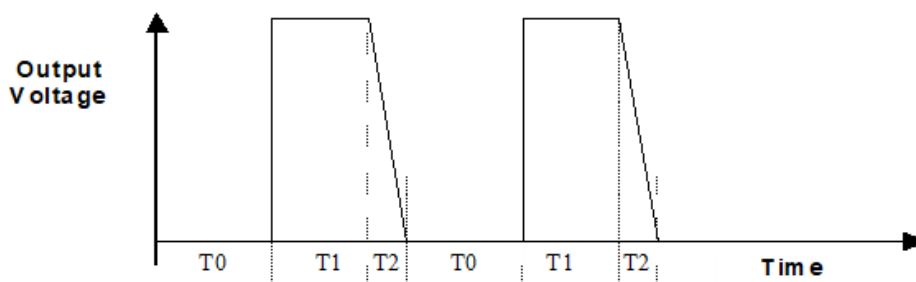
$$\frac{1}{2f} + \text{Correction},$$

where  $f$  is the pulse frequency.  $T1 = \frac{1}{2f}$ ,

T2 = Optical Isolator Delay, and

T1+T2 = ON Time.

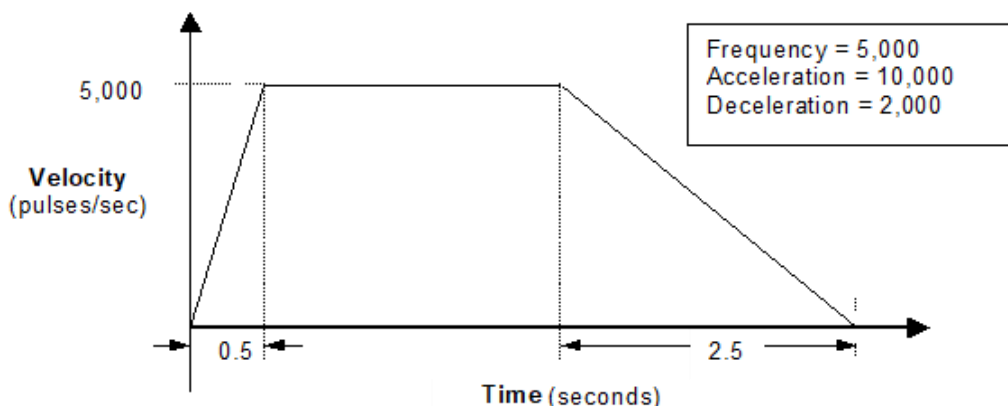
Figure 200



## 18.8 Pulse Train with Ramp

The Pulse Train with Ramp feature of Micro-20, -40, and -64 PLCs combines the basic operation of a Pulse Train Output with configurable acceleration and deceleration times to produce Pulse-Train profile like the example shown below.

Figure 201



### 18.8.1 Configuring Pulse Train with Ramp

An output can be set up as a Pulse Train with Ramp by selecting 4 Type A or 1 Type A / 1 Type B as the Counter Type and selecting Pulse Train with Ramp as the Channel Function.

A Pulse Train with Ramp has configurable acceleration and deceleration rates. The default for both is 1,000,000 (the maximum). Both acceleration and deceleration can be selected during configuration from the range of 90 to 1,000,000. Acceleration and deceleration do not need to be the same. Appropriate values depend on the application and the capability of the stepper motor being driven by the module. Acceleration and Deceleration can also be temporarily changed from the application program.

### 18.8.2 Program References for Pulse Train with Ramp Outputs

The following program references are used by Pulse Train with Ramp Outputs (Can only be configured in 4TypeA/1TypeA 1TypeB configuration).

|                      | Output 1 | Output 2 | Output 3 | Output 4 |
|----------------------|----------|----------|----------|----------|
| Pulse Train Complete | I0494    | I0495    | I0496    | I0511    |
|                      |          |          |          |          |
| Start Pulse Train    | Q0494    | Q0495    | Q0496    | Q0511    |
| Enable Output        | Q0505    | Q0506    | Q0507    | Q0508    |
| Frequency            | AQ123    | AQ125    | AQ127    | AQ121    |
| Number of pulses     | AQ124    | AQ126    | AQ128    | AQ122    |



### 18.8.3 Setting Up the Pulse Frequency for Pulse Train with Ramp

The application program sets up the frequency of a Pulse Train with Ramp by writing a value to the channel's Frequency reference. The frequency range is 15Hz to 65kHz.

The sum total of frequency configured for Pulse Train with Ramp channels should be less than or equal to 65kHz. The minimum frequency that can be configured on each channel is 15Hz. For example: If all the channels are to be configured for Pulse Train with Ramp for maximum possible frequency, the frequencies on each channel can be 15kHz, 15kHz, 15kHz, and 20kHz.

The frequency, acceleration, deceleration, and number of counts of a Pulse Train with Ramp cannot be changed when the ramp output has started. If the frequency is changed in the %AQ references after the ramp output has started, the new frequency is used for the next ramp that is generated.

The actual frequency output can have a tolerance of 1%.

### 18.8.4 Setting Up the Number of Pulses

The application program sets up the number of pulses to be output (0 to 65535) by writing the value to the channel's Number of Pulses reference.

### 18.8.5 Changing the Acceleration and Deceleration

Acceleration and deceleration are set up in the channel configuration. The configured acceleration and deceleration can also be temporarily changed in the range of 90 to 1,000,00 using a COMMREQ in the application program, as explained later in this chapter. Acceleration and deceleration cannot be changed while the function is operating.

### 18.8.6 Controlling Operation of a Pulse Train with Ramp Output

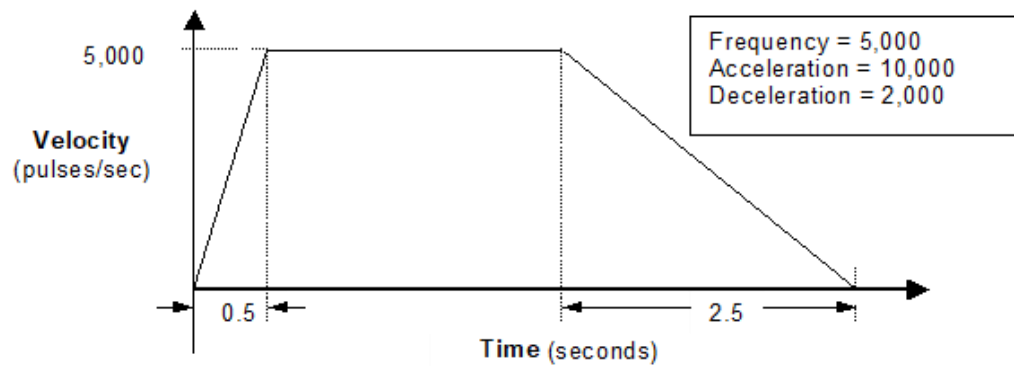
A Pulse Train with Ramp starts when the channel's Enable Output bit is 1 and the channel's Start Pulse Train bit transitions from 0 to 1.

When the Pulse Train begins, the channel's Pulse Train Complete bit is set to 0. The channel outputs the specified number of pulses in varying pulse widths, to produce a velocity profile similar to the one shown below. After the last pulse is completed, the channel's Pulse Train Complete bit is set to 1.

After a Pulse Train with Ramp function has started, it continues until either all of its pulses have been generated or its Output Enable bit changes from 1 to 0.

The ramp up or ramp down motion occurs in steps of 100ms; so the velocity gradient changes every 100ms until the desired frequency is reached (provided there is a sufficient number of pulses to ramp up to the desired frequency).

Figure 202



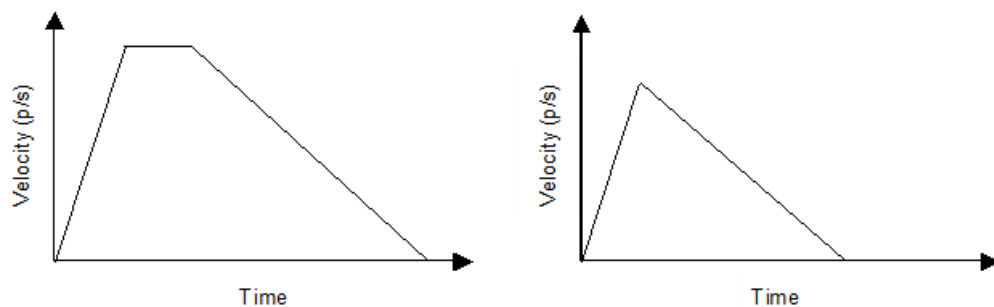
For the example above, the ramp up time is 500ms (1/2 second), so the ramp up takes place in 5 steps: 100ms, 200ms, 300ms, 400ms, 500ms with frequencies of 1kHz, 2kHz, 3kHz, 4kHz, and 5kHz respectively.

The application program can stop a Pulse Train with Ramp before the requested number of pulses has been completed by setting its Enable Output bit to 0. When the Enable Output bit transitions from 1 to 0, the output starts decelerating. The channel outputs a number of pulses based on: (1) the configured deceleration and (2) the velocity at the time the Enable Output bit goes Off. When the last pulse is completed, the channel's Pulse Train Complete bit is set to 1.

## Stop Ramp with Deceleration

If the Enable Bit set to 0 during the “at velocity” part of the Pulse Train, the output ramps down normally as shown at left below. If the Enable Bit is set 0 during the acceleration phase, ramping up stops and ramping down begins immediately as shown at right. The deceleration occurs at the configured or commanded rate.

Figure 203



If the Ramp output is already decelerating (because the number of pulses has been reached) when the Enable Output bit transitions from 1 to 0, the Pulse Train output continues decelerating at the same rate.

## Stop Ramping Immediately

When the Micro PLC powers up or receives a new configuration, it automatically sets up all Ramp channels to decelerate when the Output Enable bit goes to 0.

If a Pulse Train with Ramp output should stop immediately, a COMMREQ can be used, as described later in this chapter.

## 18.9 COMMREQs for the HSC/PWM/PTO Functions

The application program can use the COMMREQ function to provide data or send the following commands to High-Speed Counters, Pulse Train outputs, or PWM outputs that are currently enabled:

- Load Accumulator
- Load High and Low Limits
- Load Accumulator Increment
- Set Counter Direction
- Load Timebase
- Load ON and Off Presets
- Load Preload
- Load Stop Mode or Resume Decelerate Mode (for Micro-20, -40, -64 CPUs only)
- Load Acceleration and Load Deceleration (for Micro-20, -40, -64 CPUs only)
- Load Correction

Program logic should be set up to assure that the command is sent to the module once, not repeatedly. These changes are temporary; they lost when the PLC is powered down and when a new configuration is stored from the programmer.

## 18.9.1 The COMMREQ Command Block

The command data must be placed in the correct order (in a command block) in CPU memory before the command is executed. The command block is composed of 14 words as shown below. All values are hexadecimal unless otherwise indicated. The command block can be placed in any word-oriented area of memory that is not reserved (see Chapter 22: for a list of reserved areas).

| Offset      | Data       | Description                                                                                                                                          |
|-------------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| address     | 0004       | Always 0004                                                                                                                                          |
| address +1  | don't care | Not used (always zero). The Micro PLC ignores the Wait flag for all COMMREQ junctions.                                                               |
| address +2  | don't care | not used                                                                                                                                             |
| address +3  | don't care | not used                                                                                                                                             |
| address +4  | don't care | not used                                                                                                                                             |
| address +5  | don't care | not used                                                                                                                                             |
| address +6  | don't care | not used                                                                                                                                             |
| address +7  | don't care | not used                                                                                                                                             |
| address +8  | 0008       | Data type (8 = registers)                                                                                                                            |
| address +9  | 000A       | Start location of Command Word –1 (%R0011)                                                                                                           |
| address +10 | nnnn       | Command Word (see next page)                                                                                                                         |
| address +11 | nnnn       | LS Data Word                                                                                                                                         |
| address +12 | nnnn       | MS Data Word used only for ramping in 4 Type A 32-bit or One Type A, One Type B 32-bit mode in Micro 20-/40-/64-CPU.<br>Not used by other Micro PLCs |

### Contents of the Command

The last three words of the Command contain the command parameters. These words are treated as independent bytes. They can be entered in hexadecimal or decimal format. The format for the last three words is:

**Figure 204**

|                 | MSB | LSB |                                                            |
|-----------------|-----|-----|------------------------------------------------------------|
| command word    | 0n  | cc  | where: n=counter 1-4<br>cc=subcommand code<br>dd=data type |
| data word (LSW) | dd  | dd  |                                                            |
| data word (MSW) | dd  | dd  |                                                            |

The Command Word, located at “address +10” of the command, identifies the action to be performed. The MSB of the command word specifies the channel number (1 – 4 for Type A, always 1 for Type B).

Example: To set Counter 1 to 1234H, load command registers with:

Command word: 0101  
LS data word: 1234  
MS data word: 0

Example: To set Counter 1 to 200,000 (30D40H) in 32-bit mode, load command registers with:

Command word: 0101  
LS data word: 0D40  
MS data word: 0003

Negative values must be entered in 32-bit two's complement format.

Example: To set the Load Preload to a value of –1000 decimal, enter the hex value FFFF FC18 for command word 01nF.

| Command Word (hex) | Command                    | Description                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0n01               | Load Accumulator           | Loads any value within a counter's limits directly into the Accumulator. If a count is received at the same time, the count is lost.                                                                                                                                                                                                                                                     |
| 0n02               | Load High Limit            | Sets the High and Low limit to any value in the counter range. Move the Low Limit first when shifting down or the High Limit first when shifting up. Loading limits in the wrong order can cause an error. The command is successful if all parameters are within the new range.                                                                                                         |
| 0n03               | Load Low Limit             |                                                                                                                                                                                                                                                                                                                                                                                          |
| 0n04               | Load Accumulator Increment | Offsets a counter Accumulator by up to +127 or –128 counts. Only the LSB data is used with this command. This can be done at any time, even while the counter is counting at maximum rate. However, if a count is received at the same time the CPU updates the Accumulator value, the count is lost. If the offset causes the counter to exceed its limits, this parameter is rejected. |
| 0n05               | Set Counter Direction      | (Type A only) Changes the count direction. Only the LSB of the first data word is used for this command (00 = up, 01 = down).                                                                                                                                                                                                                                                            |
| 0n06               | Load Timebase              | Changes the time interval used for the counts/timebase word data. The range is 10 to 1000mS in 10mS intervals.                                                                                                                                                                                                                                                                           |
| 0n0B               | Load ON Preset             | Sets up the output turn on points within the counter range. There is one output associated with each counter. See the previous information about Presets for appropriate settings.                                                                                                                                                                                                       |
| 0n15               | Load OFF Preset            | Sets up the output turn off points within the counter range. There is one output associated with each counter. See the previous information about Presets for appropriate settings.                                                                                                                                                                                                      |
| 0n1F               | Load Preload               | Changes the count value loaded into the counter Accumulator when the Preload input is activated.                                                                                                                                                                                                                                                                                         |

| Command Word (hex) | Command                                    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0n3B               | Load Stop Mode (or Resume Decelerate Mode) | (Micro-20/40/64 CPU only) Changes a Pulse Train output's deceleration to stop the Ramp immediately when the Output Enable bit goes Off. The Ramp function must be enabled.<br>The same command can be used to reset the output to Decelerate mode (the default) by entering the value 0001 in the LS data word.                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 0n3C               | Load Acceleration                          | (Micro-20/40/64 CPU only) Changes a Pulse Train output's acceleration. The Pulse Train with Ramp function must be enabled. For channels 1 – 3, acceleration and deceleration can be selected from the range of 10 p/s <sup>2</sup> to 1,000,000 p/s <sup>2</sup> . For channel 4, the range is 90 p/s <sup>2</sup> to 1,000,000 p/s <sup>2</sup> . The default for both is 1,000,000.<br>In the acceleration and deceleration commands, the data value is a 32-bit number. These are the ONLY Data Commands that should have any value other than 0 in the MS data word.<br>Example: to change the acceleration rate of Pulse Train output 1 to 200,000 (30D40H),<br>load:<br>Command word: 013C<br>LS data word: 0D40<br>MS data word: 0003 |
| 0n3D               | Load Deceleration                          | (Micro-20/40/64 CPU only) Changes a Pulse Train output's deceleration. The Ramp function must be enabled. See Load Acceleration above for details.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 0n3E               | Load Correction                            | Sets the change (in $\mu$ S) that should be applied to the duty cycle of a Pulse Train output to compensate for the slow turn-off time of the optical isolator circuit (35 $\mu$ S – DC outputs; 85 $\mu$ S relay outputs). The range is 0 to 200 $\mu$ S.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

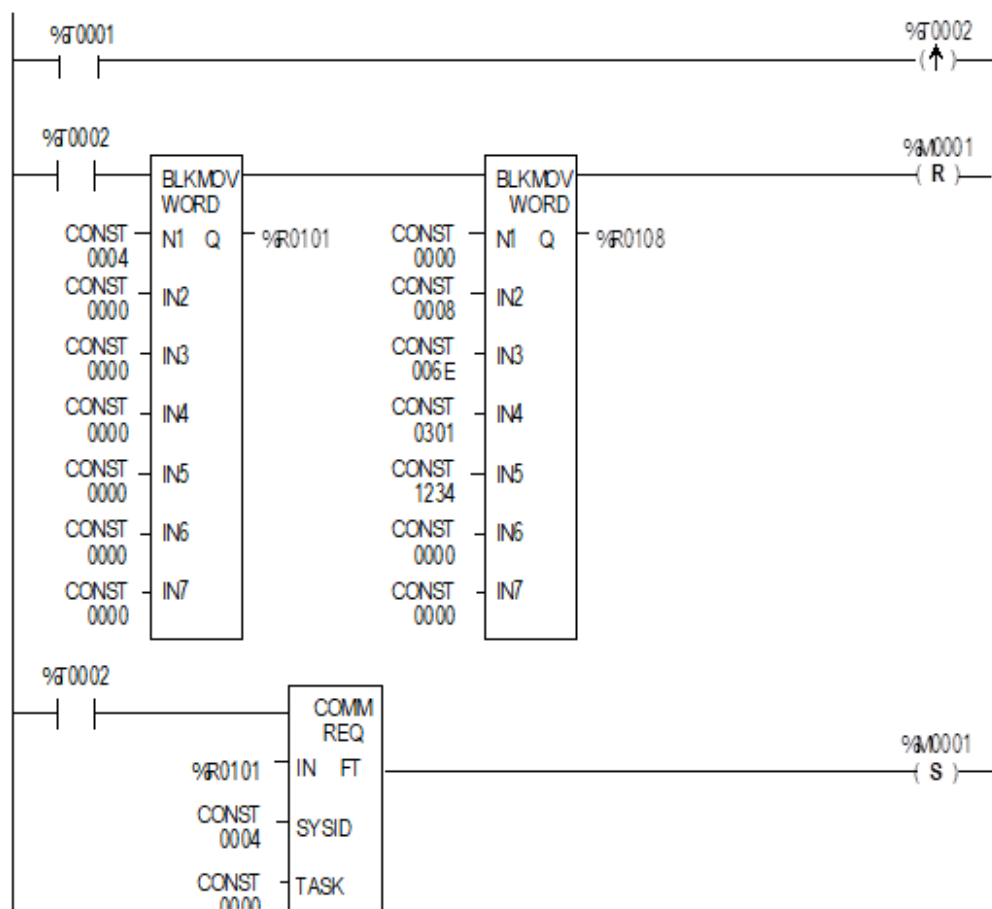
**Note:**

1. If a Load Accumulator command is executed with the ON Preset value, the Preset will be turned on for that instance only.
2. If a Load Accumulator command is executed with the OFF Preset value, the Preset will be turned off for that instance only.

## 18.9.2 COMMREQ Example

The example uses a COMMREQ to load the value 1234 into the Accumulator for Counter 3.

Figure 205



The first rung in the example includes a one-shot coil (%T0002) that executes the COMMREQ once. This prevents multiple messages from being sent.

The next rung uses a Block Move Word function to load the commands. In this example, %R0101 through %R0114 are used for the COMMREQ Command Block. Any registers can be used.

The COMMREQ function has four inputs and one output.

| Parameter | Description                                                                                                                         |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------|
| enable    | %T0002 to enables the COMMREQ function.                                                                                             |
| IN        | Points to the starting address of the Command Block, which is %R0101.                                                               |
| SYSID     | Indicates which rack and slot to send the message to (physical location of HSC module). The SYSID is always 0004 for the Micro PLC. |
| TASK      | This parameter is ignored and should be set to zero.                                                                                |
| FT        | This output is energized if an error is detected during processing of the COMMREQ.                                                  |

## Command Word Error Responses

If the module receives an invalid command parameter in a Command Word, it returns an error code in the first word of its word input (AI) data. The following error codes are used for High-Speed Counter COMMREQs:

**Note:** *If the program issues a COMMREQ that changes count direction, the counter will go immediately into the new mode. Remember that the output does not change states at exactly the same points on an Up-counter as it does on a Down-counter.*

| Error Code |     | Description                          | Definition                                                                                                                                                                                   |
|------------|-----|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Decimal    | Hex |                                      |                                                                                                                                                                                              |
| 3          | 3   | Invalid Command                      | Command number received was invalid for the HSC.                                                                                                                                             |
| 6          | 6   | Invalid Counter Number or Channel    | Counter number in the Data Command Word was not a valid counter based on the current configuration.                                                                                          |
| 11         | 0b  | Counter/Channel 1 Limit Error        | Invalid Low or High limit value                                                                                                                                                              |
| 12         | 0c  | Counter/Channel 2 Limit Error        | New limit places Preload value out of range                                                                                                                                                  |
| 13         | 0d  | Counter/Channel 3 Limit Error        | New limit places Off Preset out of range                                                                                                                                                     |
| 14         | 0e  | Counter/Channel 4 Limit Error        | New limit places Accumulator value out of range<br>Accumulator value is out of range<br>Preload value is out of range<br>On Preset value is out of range<br>Off Preset value is out of range |
| 19         | 13  | Load Stop Mode/Reset Decelerate Mode | Invalid value. Must be 1 (decelerate) or 2 (stop).                                                                                                                                           |
| 20         | 14  | Load Acceleration                    | Acceleration too low. Must be > 10 for channels 1-3 and >90 for channel 4.                                                                                                                   |
| 21         | 15  | Load Acceleration                    | Acceleration too high. Must be < 1,000,000                                                                                                                                                   |
| 22         | 16  | Load Deceleration                    | Deceleration too low. Must be > 10. for channel 1-3 and >90 for channel 4.                                                                                                                   |
| 23         | 17  | Load Deceleration                    | Deceleration too high. Must be < 1,000,000                                                                                                                                                   |



## 18.10 HSC Application Examples

### 18.10.1 RPM Indicator

The HSC can be used as a position/motion indicator when connected to a feedback device (such as an encoder) that is coupled to a rotary motion. RPM indication can be obtained directly from the counter's Counts/Timebase register (CTB) or derived from it by a simple calculation.

The RPM calculation is:

$$RPM = \frac{CTB}{PPR \times T}$$

where: CTB = counts/timebase reading from the counter

PPR = pulses/revolution produced by the feedback device

T = timebase expressed in minutes

If the number of pulses per revolution is an integer power of 10, setting the timebase for 6, 60, 600, 6000, or 60,000 produces a direct reading of RPM in the Counts per Timebase register with an assumed decimal placement.

#### Example

If feedback produces 1000 pulses/revolution, CTB reading = 5210, and the timebase is configured for 60ms, which gives:

$$T = 60/60000 = .0001 \text{ and } 1/T = 1000.$$

The Counts per Timebase reading equals 521 and

$$RPM = \frac{521}{1000} \times 1000 = 521$$

CTB reading is RPM with 1 RPM resolution.

#### Input Capture

The High-Speed Counter strobe inputs can act as pulse catch inputs for inputs 2, 4, 6, and 8 by using the Strobe Status bits as a latch.

To use this feature:

1. Configure a Type A Counter on any channel.
2. Set the Preload//Strobe parameter to "Strobe".

The corresponding Strobe Status bit will be latched if there is a pulse of at least 100 µsec in width. The Reset Strobe bits can be used as clear functions for the latched status bits.

# Chapter 19: Motion Control Functions

Micro-20, Micro-40 and Micro-64 PLCs (release 3.6 or later) can perform basic Motion Control functions of Jogging, Homing, Blended Move, and Stop Motion. This chapter describes the use of motion control functions.

- **Overview**
  - Program References for Motion Features
  - Position Registers
  - Function Block Instance Registers
  - Error Codes for Motion Features
- **Finding a Home Position**
  - Find Home Function Block
  - Stopping Find Home
  - Example Program Logic for Find Home
- **Moving to the Home Position**

Go Home Function Block

Stopping Go Home

Example Program Logic for Go Home

- **Jogging**
  - Jogging Function Block
  - Stopping Jogging
  - Example Program Logic for Jogging
- **Blending**
  - Blending Function Block
  - Stopping Blending
  - Example Program Logic for Blending
  - Examples of Blended Moves
- **Stopping Motion on an Axis**
  - Stop Motion Function Block
  - Example Program Logic for Stop Motion

## 19.1 Overview

The High-Speed Counter outputs of a Micro-20, Micro-40, or Micro-64 PLC can be independently configured for motion support. Use of these features requires PAC Machine Edition version 5.5, SP2, SIM 6 or later.

The channel's configured HSC/PWM/PTO setting must be either 4 Type A\_32, or 1 Type A / 1 Type B\_32. The channel's Counter Function must be configured as Motion Support. Configuration is described in Chapter 16:.

Function blocks can be used in the application program to set up and control motion operations. The same function blocks supply additional parameters for the operation.

### 19.1.1 Program References for Motion Features

|                                         | Output 1  | Output 2  | Output 3  | Output 4  |
|-----------------------------------------|-----------|-----------|-----------|-----------|
| Position Register (REAL)                | AI006-007 | AI010-011 | AI020-021 | AI024-025 |
| Mode Select Bit (BOOL)                  | Q497      | Q498      | Q499      | Q500      |
| Rotary Mode High Limit Register (DWORD) | AQ117-118 | AQ121-122 | AQ125-126 | AQ113-114 |
| Rotary Mode Low Limit Register (REAL)   | AQ119-120 | AQ123-124 | AQ127-128 | AQ115-116 |
| Motion Enable (BOOL)                    | Q505      | Q506      | Q507      | Q508      |
| Axis error register (WORD)              | AI002     | AI003     | AI004     | AI005     |
| Axis error reset bits (BOOL)            | Q489      | Q490      | Q491      | Q492      |

### 19.1.2 Position Registers

The Micro PLC stores the cumulative motor position in the channel's Position Register, where it can be read from the application program. The capacity of the Position Register is a 32-bit real value. When used for motion support, the 32-bit Position Registers are used as shown in the table above.

All commanded moves increment or decrement the value in the Position Register, so it reflects the actual motor position. For example, the Position Register is set at 0. A 10,000-count move is commanded in the forward direction. At the end of this move, the Position Register contains the value 10,000. Now a 2,000-count move is commanded in the reverse direction. At the end of this move, the Position Register contains the value 8,000 (10,000–2,000).

The Position Register is automatically cleared: at power-up, when a new configuration is downloaded, when PLC memory is cleared, when the configuration is cleared, and when the CPU transitions from STOP to RUN mode. It is set to zero after a successful Find Home operation. When the Position Register is cleared, the cleared value appears in the reference memory window only when the PLC is put into RUN mode.

## Operating Modes of the Position Registers

The position register can function in either Rotary mode or Linear Mode.

### Rotary Mode Operation of the Position Registers

In Rotary mode, the Position Register wraps when the configured high limit or low limit is reached and continues incrementing or decrementing based on the direction of operation. Rotary mode is selected by setting output bit %Q497, Q498, Q499, or Q500 to 1, for channel 1, 2, 3, or 4, respectively. The high limit and the low limits for Rotary mode can be set up using the references shown on the previous page.

Position Register transitions for both clockwise and counterclockwise motions always start at the configured low limit. For example, if the low limit = -100.0 and the high limit = +100.0, a movement of 5 units in the clockwise direction sets the Position Register value to -95.0, and a movement of 5 units in the counter-clockwise direction sets the position register value to +96.

If the configured High Limit is less than the Low Limit, the error is displayed in %AI0001/2/3/4 memory for each of the channels and the High Limit defaults to the Low Limit +1.

### Linear Mode Operation of the Position Registers

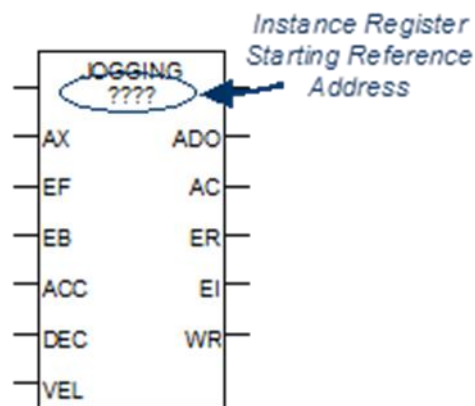
In Linear mode, any configured Rotary limits are not used. The Position Registers increment or decrement from zero after power-up, and on every Stop to Run transition. At other times, the Position Registers increment or decrement from the last move position.

Output bits %Q0497-Q0500 can be used to provide inputs for this mode for each of the four channels respectively. A value of 0 selects Linear mode and 1 selects Rotary mode.

Limits of the Position Register value in Linear mode are +3.4e38 and -3.4e38. If either limit is reached, the value stops changing.

## 19.1.3 Function Block Instance Registers

Figure 206



Each instance of a motion function block in the program requires a separate memory area for its internal status and control data. This must be set up by assigning two contiguous words of %R memory during programming. The reference address location is initially indicated by ???? in the function block.

During operation, the data in these assigned status and control references should not be overwritten by user logic. Overlapping reference addresses may cause erratic operation of the motion function block.

Each instance of a motion function block in the program requires a separate memory area for its internal status and control data. This must be set up by assigning two contiguous words of %R memory during programming. The reference address location is initially indicated by ???? in the function block.

During operation, the data in these assigned status and control references should not be overwritten by user logic. Overlapping reference addresses may cause erratic operation of the motion function block.

The first word of this data area is used for 16 status and control bits. As the table below shows, the Find Home, Go Home, Blending, and Stop Motion function blocks use the same bit definitions. Jogging uses some different bit definitions. Most of this data is for internal use only; it is not of interest to the application program. The exceptions to this are bit 1 (Active output), which can be monitored for a Jogging function block, and bit 2 (Done output), which can be monitored for the other function block types. See the function block descriptions in this chapter for more information.

| Bit                           | Description                                                                     | Find Home, Go Home, Blending, Stop Motion | Jogging  |
|-------------------------------|---------------------------------------------------------------------------------|-------------------------------------------|----------|
| <b>Least significant word</b> |                                                                                 |                                           |          |
| 0                             | Execute input, previous execution                                               | ■                                         | reserved |
| 1                             | Active output                                                                   | ■                                         | ■        |
| 2                             | Done output                                                                     | ■                                         | reserved |
| 3                             | Error output                                                                    | ■                                         | ■        |
| 4                             | Warning output                                                                  | ■                                         | ■        |
| 5                             | Motion Started                                                                  | reserved                                  | reserved |
| 6                             | Enable input, previous execution                                                | ■                                         | ■        |
| 7                             | Execute Triggered                                                               | reserved                                  | reserved |
| 8                             | Jogging, Enable Backward active = 1                                             | reserved                                  | ■        |
| 9                             | Jogging, Enable Forward active = 1                                              | reserved                                  | ■        |
| 10                            | Previous Enable Backward Value                                                  | reserved                                  | ■        |
| 11                            | Previous Enable Forward Value                                                   | reserved                                  | ■        |
| 12                            | Runtime Error Occurred                                                          | reserved                                  | ■        |
| 13-15                         | Not Used                                                                        | reserved                                  | reserved |
| <b>Most significant word</b>  |                                                                                 |                                           |          |
| <b>Word</b>                   | Error ID / Warning ID of the function block error that occurred. See next page. |                                           |          |

## 19.1.4 Error Codes and Warnings for Motion Features (Hexadecimal)

The following error codes are used for the motion function blocks. These error codes appear in word 2 of the function block's 2 words of instance data, as described on the previous page. They also appear in each function block's Error ID output and in the channel, error references: %AI002, 003, 004, and 005 for channels 1, 2, 3, and 4 respectively. The application program should monitor error status using those references.

| Error Code (hex) | Error Description                                                                                                                                                                           |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 14               | Specified acceleration below minimum limit of 10 for channels 1, 2, 3 or below minimum limit of 90 for channel 4                                                                            |
| 15               | Specified acceleration above maximum limit of 1,000,000                                                                                                                                     |
| 16               | Specified deceleration is below minimum limit of 10 for channels 1, 2, 3, or below minimum limit of 90 for channel 4                                                                        |
| 17               | Specified deceleration above maximum limit of 1,000,000                                                                                                                                     |
| 18               | Specified Velocity is below minimum limit of 10                                                                                                                                             |
| 19               | Specified Velocity is above maximum limit of 65000                                                                                                                                          |
| 1B               | Specified home offset is negative, which is not valid                                                                                                                                       |
| 1D               | Axis not configured for motion In the hardware configuration for HSC/PWM/PTO settings, channel function should be selected as 'Motion Support' to be able to initiate any motion command.   |
| 1E               | Axis busy with Ramping. User logic issued a motion command on a channel that had Ramping already in progress.                                                                               |
| 1F <sup>13</sup> | Axis busy with Jogging.<br>Only one motion function block is allowed to be active at a time, but user logic has issued another motion command while jogging command is still in progress.   |
| 21 <sup>13</sup> | Axis busy with Blending.<br>Only one motion function block is allowed to be active at a time, but user logic has issued another motion command while blending command is still in progress. |
| 22               | Find Home cannot be started because Final Home velocity is greater than Find Home velocity                                                                                                  |
| 23               | Home switch Input is already on at the time of triggering Find Home command.                                                                                                                |
| 24               | Go Home function block triggered without a previously successful Find Home being completed.                                                                                                 |
| 25               | Specified number of profiles is above the maximum limit of 4.                                                                                                                               |
| 26               | Specified number of profiles is below the minimum limit of 1.                                                                                                                               |
| 27               | Configured pulse count is less than the minimum limit of 2.                                                                                                                                 |
| 29 <sup>13</sup> | Axis busy with Find Home.<br>Only one motion function block is allowed to be active at a time but user logic has issued another motion command while Find Home is still in progress.        |

<sup>13</sup> If an active (not complete) function block instance is re-enabled while motion is still in progress, this condition is recorded as a warning. If a different function block is enabled while motion is in progress, this condition is recorded as an error.

| Error Code (hex) | Error Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2A <sup>13</sup> | Axis busy with Go Home.<br>Only one motion function block is allowed to be active at a time, but user logic has issued another motion command while Go Home is still in progress.                                                                                                                                                                                                                                                                                                                                         |
| 2B               | Motion function block issued before the axis was enabled (i.e. %Q0505, 506,507,508 bits are low on respective axis)..                                                                                                                                                                                                                                                                                                                                                                                                     |
| 2C               | No motion is in progress when Stop motion function block triggered.                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 2E               | Channel not configured to support motion function blocks. For the motion features to be supported, the counter type should be either 4 Type A_32 or 1 Type A / 1 Type B_32 counters on settings tab.                                                                                                                                                                                                                                                                                                                      |
| 2F               | In continuous/rotary mode operation of the position register, high limit is less than or equal to low limit.                                                                                                                                                                                                                                                                                                                                                                                                              |
| 30               | Blending motion parameters array exceeds reference memory size. For example: Each profile in blending contains four parameters (acceleration, deceleration, velocity, and distance). Each parameter occupies two words. So, for each profile 8 words of memory is required. Suppose %AI120 is assigned for blending motion parameters input. If the number of profiles is 4, then 32 words of memory, starting from %AI120, needs to be reserved for blending motion parameters. But %AI memory can only be up to %AI128. |
| 31               | Stop motion function block is re-triggered before function block has finished stopping motion. This is a warning.                                                                                                                                                                                                                                                                                                                                                                                                         |
| 33               | Both enable forward, enable backward inputs are high on Jogging, which is invalid.                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 34               | Motion cannot be started for the following reasons:<br>Either motion function block was triggered while Stop Motion function block is still active (not complete), or the axis is blocked by the Stop Motion function block (Execute input on Stop Motion function block is high). Axis error.                                                                                                                                                                                                                            |
| 35               | Stop Motion function block is issued while another motion function block is pending to start on same axis. This error occurs if a motion function block (Jogging, Blending, or Homing) is triggered on an axis and a Stop Motion function block is triggered before motion can start on that axis.                                                                                                                                                                                                                        |
| 37               | More than one instance of Stop motion function block triggered on the same axis.                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 38               | Motion stopped due to stop mode (PLC has transitioned from Run mode to Stop mode), or power fail. Axis error.                                                                                                                                                                                                                                                                                                                                                                                                             |
| 39               | Axis error present on the channel. Check %AI002, 3, 4, and 5 for axis error details on respective channel. Axis errors can be cleared by a low-to-high transition of output bits %Q489, 490,491, or 492 for channels 1, 2, 3, or 4 respectively.                                                                                                                                                                                                                                                                          |

## Axis and Function Block Errors

Of the errors listed above, errors 2B, 34, and 38 are axis errors. All other errors are function block errors. If any axis error is present on an axis, no motion can be initiated on that axis by any function block.

## Clearing Axis Errors

Axis errors can be cleared by a low-to-high transition of output bits %Q489, 490, 491, or 492 for channel 1, 2, 3, or 4.

Axis errors are also cleared by any of the following:

- clearing/downloading a hardware configuration
- clearing/ downloading logic
- clearing of all memory
- clearing of initial values

After axis errors are cleared in %AI memory, motion can be started by any function block.

## Operation of the Instance Registers

While the function block's Enable input is receiving power flow, function block inputs are stored to the Instance Registers, and function block outputs are updated continuously.

When the function block's Enable is not receiving power flow, the function block outputs are not updated. However, they are still updated to the Instance Registers.

The next time Enable receives power flow, the output status data stored in the Instance Registers is updated to function block outputs.

The Instance Register references should not be overwritten by user logic. Overlapping reference addresses may cause erratic function block operation.

## Motion Function Block Operation in PLC Run-Stop-Run Transition or Loss of Power

If power is lost or if the Micro PLC goes to Linear mode while a motion function is being executed, the motion stops immediately.

When power returns or when the Micro PLC goes to Run mode, the error 0x38 (see above) is logged in the channel's %AI memory reference. The same error is generated on the function block output when its Enable input receives power flow. Error 0x38 is an axis error; no motion will occur on the axis until the error is cleared.



## 19.1.5 Avoiding Abrupt Start/Stop of Motion

The following condition must be satisfied in order to avoid abrupt start/stop of motion:

$n \geq 1$ , where

$$n = \frac{10 \times \text{Velocity}}{\text{Acceleration}} \text{ or } n = \frac{10 \times \text{Velocity}}{\text{Deceleration}}$$

If  $n < 1$ , abrupt start/stop of motion can happen.

### Example:

For the Find Home function:

Find Home Velocity = 1000

Final Home Velocity = 500

Acceleration = 10000

Deceleration = 10000

Offset = 0

With these parameters, the values for Final Home Velocity and Deceleration yield a value of  $n=0.5$ , which does not satisfy the requirement  $n \geq 1$ . Instead of decelerating to home position, the axis goes immediately to zero velocity. To avoid this, select values for Velocity, Acceleration and Deceleration that satisfy the above condition.

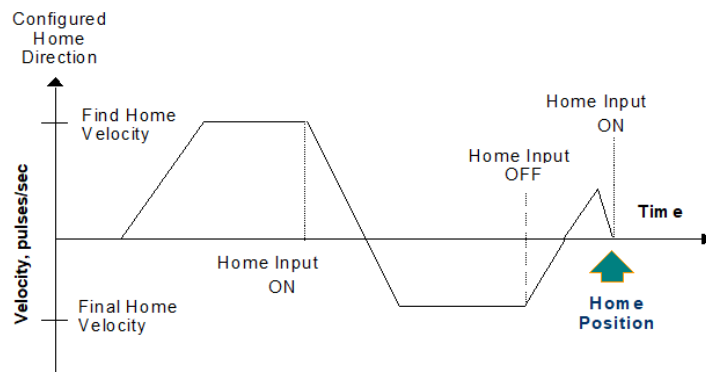
## 19.2 Finding a Home Position

The Find Home function defines a Home (zero) position for the axis, relative to a physical location on a machine. The location is represented by a Home Switch, which is connected to a specific input on the Micro PLC. The Home Switch input must come from a normally open contact. A normally closed contact cannot be used.

The Home Switch input is assigned to input reference %I002, %I004, %I006, or %I008 depending on the channel. The input reference cannot be used as a standard input when the channel is used for Homing.

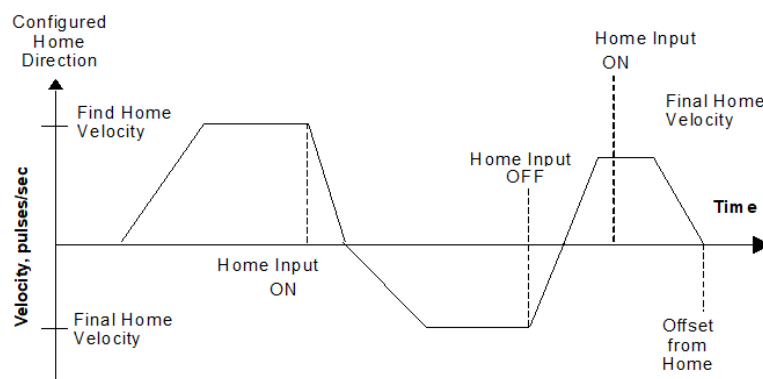
When a Find Home Cycle is requested, the following sequence is executed:

Figure 207



1. After accelerating to the configured Find Home Velocity, the axis moves in the specified direction until the Home Input signal is detected.
2. When the rising edge of Home Input signal is detected, the axis decelerates at the deceleration rate and stops.
3. The axis then accelerates in the opposite direction at the Final Home Velocity until the Home Input signal goes to 0.
4. Once the falling edge of the Home Input signal is detected (Home Input off as shown above), the axis decelerates and stops.
5. At the falling edge of the Home Input, the CPU starts capturing the motor position value. This continues until the motion stops and the axis makes a final move to the Home switch or to the Home Offset.
6. Zero Home Offset: the axis accelerates to the Final Home velocity. It then decelerates and stops at the edge transition of the Home Input. This is the Home position. The position register is automatically zeroed upon completion of the Find Home cycle.
7. Non-zero Home Offset: Depending on the value of the Home Offset and the motor position captured by the CPU, the axis accelerates to the Final Home Velocity in either forward or reverse direction. The axis moves until it decelerates again to reach the Home Offset position. The position register is set to 0 when the axis reaches the Home Offset position.

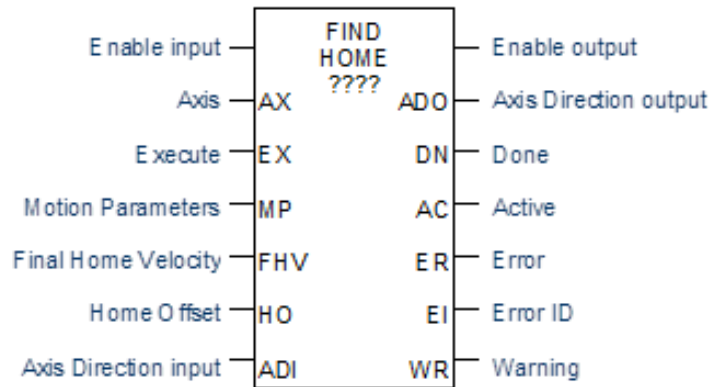
**Figure 208**



## 19.2.1 Find Home Function Block

The application program uses the following function block to set up and control a Find Home operation.

Figure 209



The channel's Output Enable bit (for example, Q0505 for channel 1) must be set to 1 to use this or any other motion function block on the channel. If the Output Enable bit is not 1, the function will not execute, and a Channel Enable error will be reported.

When the Enable input receives power flow and the Execute input transitions to 1, the function block parameters are loaded. If the parameters are not valid, a warning is generated, and the function does not start. If the parameters are valid, the motion starts in the direction (CW or CCW) specified by Axis Direction input, and the Active output is set to 1. Active returns to 0 when the function complete, or is stopped.

If the Enable input continues passing power flow after the motion completes, Find Home can be restarted with the same parameters by again generating a low to high transition on the Execute input. To execute the function block with different parameters, the Enable input must stop passing power flow. After changing the parameter values, the function block can be executed by again passing power flow to the Enable input and generating a low to high transition on the Execute input.

The function block's Enable output remains high as long as Enable Input is high.

If the Enable input stops receiving power flow while motion is in progress, the function block's Done output will not indicate when motion stops. In this case, the application program should monitor the Done output bit (bit 2) at address +0 of the function block's assigned Instance data to determine when the motion is completed.

Transitions of the Execute input are only monitored while the Enable input is receiving power flow. While the Enable input receives power flow, the Execute input is monitored for a change in its status from the previous logic scan; if Enable and Execute transition in the same scan, the transition of Execute is not detected. Therefore, the application logic must not set both Enable and Execute either low or high in the same scan. If Enable and Execute were made low in the same scan, the Find Home function block would still see the Execute as high. If Execute and Enable were made high in the same scan, the Find Home function block would not see the transition in Execute status and motion would not start.

## Stopping Find Home

Find Home can be stopped by:

- Executing a Stop Motion function block, as described later in this chapter. This stops any motion on the channel while leaving the channel active.
- Disabling the channel by setting its High-Speed Counter enable output bit to 0. No motion functions will operate on the channel while it is disabled.

### **⚠CAUTION**

To avoid abrupt starting and stopping of motion, the ratio of Velocity/Acceleration or Velocity/Deceleration must be  $\geq 0.1$ . For details, refer to page 420.

## Inputs to the Find Home Function Block

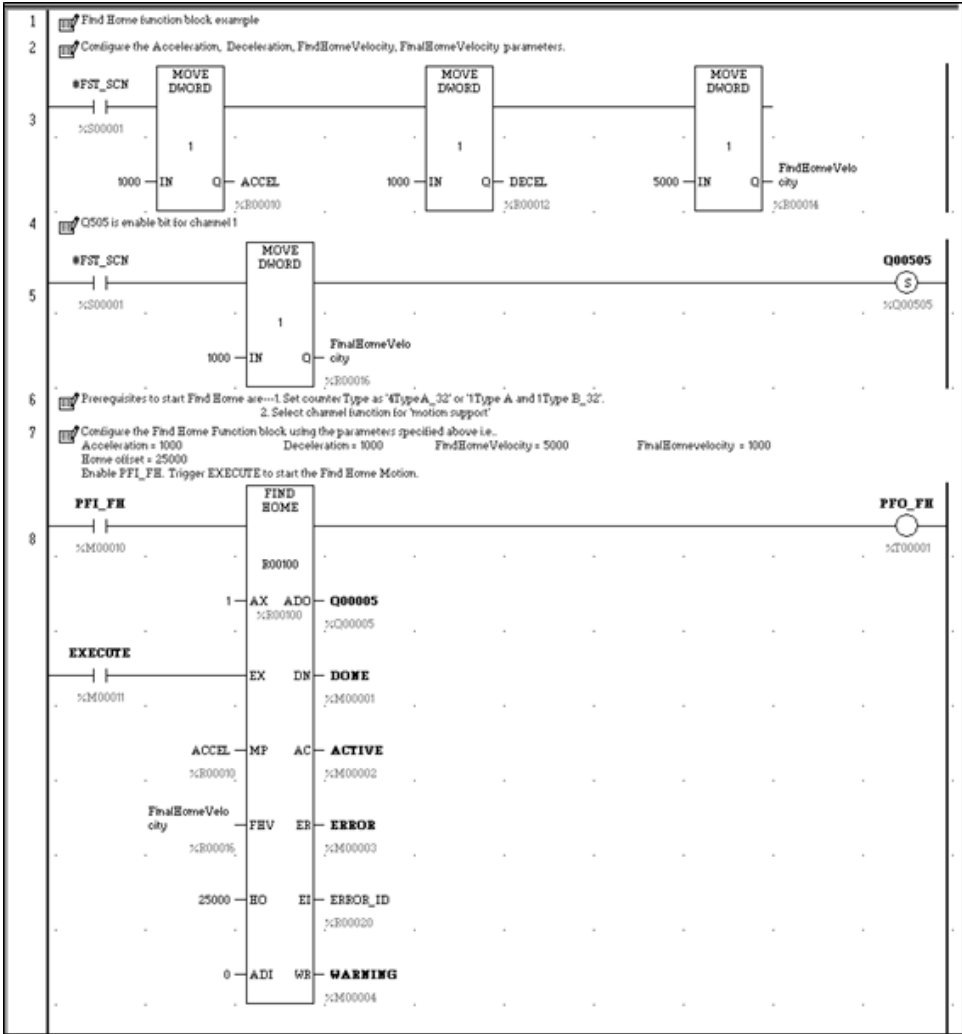
|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Enable               | The Enable input provides power flow to the function block.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Axis                 | A Constant representing the channel (1, 2, 3, or 4) on which Find Home will be done.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Execute              | Power flow to this input controls execution of the function.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Motion Parameters    | Starting address of 6-word reference location in AI, AQ, or R memory for the motion speeds, which are specified in the channel's configured units: <ul style="list-style-type: none"> <li>Words 1, 2    Homing acceleration: <ul style="list-style-type: none"> <li>10 to 1,000,000 for channels 1, 2, and 3</li> <li>90 to 1,000,000 for channel 4.</li> </ul> </li> <li>Words 3, 4    Homing deceleration: <ul style="list-style-type: none"> <li>10 to 1,000,000 for channels 1, 2, and 3</li> <li>90 to 1,000,000 for channel 4</li> </ul> </li> <li>Word 5, 6    Find Home velocity, from 15 to 65,000. . The velocity used to reach Home position, the Find Home velocity is usually high, to reach Home position quickly. The sum of velocities on all channels must not exceed 65,000.</li> </ul> |
| Final Home Velocity  | Dword variable (%AI, AQ, R) or Constant representing the velocity used after the home switch is detected once. Final Home Velocity ranging from 15 to 65,000 is slower than the Find Home velocity, for greater precision in arriving at the final Home Position.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Home Offset          | Real variable (%AI, AQ, R) or constant representing the Offset from the Home Switch.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Axis Direction Input | Boolean variable (%I, Q, M, G, T) or Constant specifying the axis direction. 0 = Clockwise (CW), 1 = Counter-Clockwise (CCW). Note that the actual direction depends on the field connections and drive settings.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

## Outputs of the Find Home Function Block

|                       |                                                                                                                                                                                                                                                                                                              |
|-----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Enable output         | Power flow output, passes power flow when it receives power flow from the Enable input.                                                                                                                                                                                                                      |
| Axis Direction Output | Boolean variable (Q0005 to Q0024). The Micro PLC output point for which direction is to be set. 0 = clockwise, 1 = counterclockwise. The actual direction depends on the field connections and drive settings. The application program should not override the direction output during the Homing operation. |
| Done                  | Boolean variable (%I, Q, M, G, T) for the Find Home completion status. Goes to 1 when motion is completed. If the Execute input is a pulse, rather than staying continuously on, done remains 1/on for one scan after motion completes.                                                                      |
| Active                | Boolean variable (%I, Q, M, G, T). Set to 1 when motion starts on the channel. Resets to 0 when motion stops.                                                                                                                                                                                                |
| Error                 | Boolean variable (%I, Q, M, G, T) . Set to 1 if an error has occurred within function block. See Error ID below.                                                                                                                                                                                             |
| Error ID              | Word variable (%AI, AQ, R). If Error (ER) =1, this is an error ID. If Warning (WR) =1, this is the Warning ID. See the list of error definitions on page 371.                                                                                                                                                |
| Warning               | Optional parameter. Boolean variable (%I, Q, M, G, T). Set to 1 when a warning has occurred. See Error ID above. Warning is generated when the same motion is triggered again while it is already in progress.                                                                                               |

## 19.2.2 Example Program Logic for Find Home

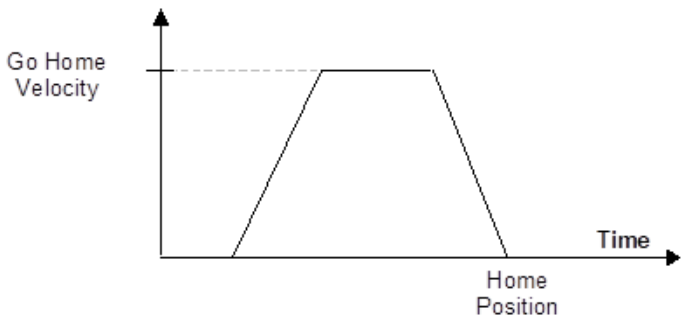
Figure 210



## 19.3 Moving to the Home Position

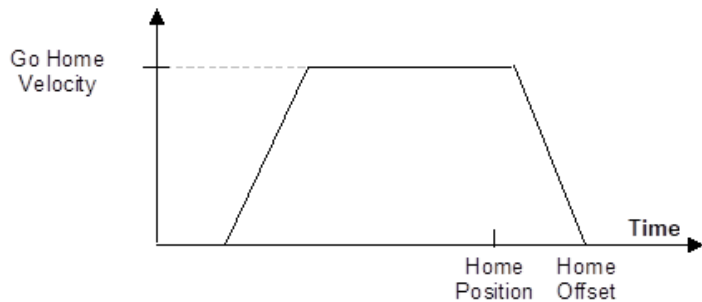
The Go Home function moves the motor to a Home position that has been defined by the Find Home function.

Figure 211



If a Home Offset was set up during execution of the Find Home function, the Go Home function causes the motor to move to the Home Offset position instead.

Figure 212

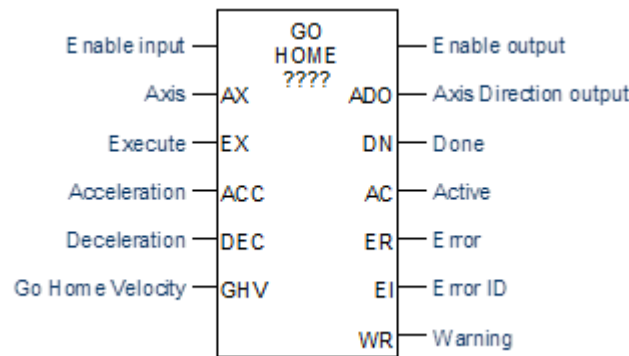


The number of pulses or the distance and the direction of motion are automatically detected based on the Position Register value.

### 19.3.1 Go Home Function Block

The application program uses the following function block to set up and control a Go Home operation:

Figure 213



The channel's Output Enable bit (for example, Q0505 for channel 1) must be set to 1 to use this or any other motion function block. If the Output Enable bit is not 1, the function will not execute, and a Channel Enable error will be reported.

When the Enable input receives power flow and the Execute input transitions to 1, the function's parameters are loaded. If the parameters are not valid, an error code is generated, and the function does not start. If the parameters are valid, function execution starts and sets the Active output to 1. Active returns to 0 when the function complete, or is stopped.

If the Enable input continues passing power flow after the function completes, Go Home can be restarted with the same parameters by generating a low to high transition on Execute input again. To execute the function block with different parameters, first stop motion and then stop passing power flow to the Enable input. Then, change the parameter values. The function block can then be executed by passing power flow to the Enable input and generating a low-to-high transition on the Execute input.

The function block's Enable output remains high as long as Enable Input is high.

If the Enable input stops receiving power flow while motion is in progress, the function block's Done output will not indicate when motion stops. In this case, the application program should monitor the Done output bit (bit 2) at address +0 of the function block's assigned Instance data to determine when the motion is completed.

Transitions of the Execute input are monitored only while the Enable input is receiving power flow. While the Enable input receives power flow, the Execute input is monitored for a change in its status from the previous logic scan; if Enable and Execute transition in the same scan, the transition of Execute is not detected. Therefore, the application logic must not set both Enable and Execute either low or high in the same scan. If Enable and Execute were made low in the same scan, the Go Home function block would still see the Execute as high. If Execute and Enable were made high in the same scan, the Go Home function block would not see the transition in Execute and motion would not start.

## Stopping Go Home

Go Home can be stopped by:

- Executing a Stop Motion function block, as described later in this chapter. This stops any motion on the channel while leaving the channel active.
- Disabling the channel by setting its High-Speed Counter enable output bit to 0. No motion functions will operate on the channel while it is disabled.

### CAUTION

To avoid abrupt starting and stopping of motion, the ratio of Velocity/Acceleration or Velocity/Deceleration must be  $\geq 0.1$ . For details, refer to page 374.

---



## Inputs to the Go Home Function Block

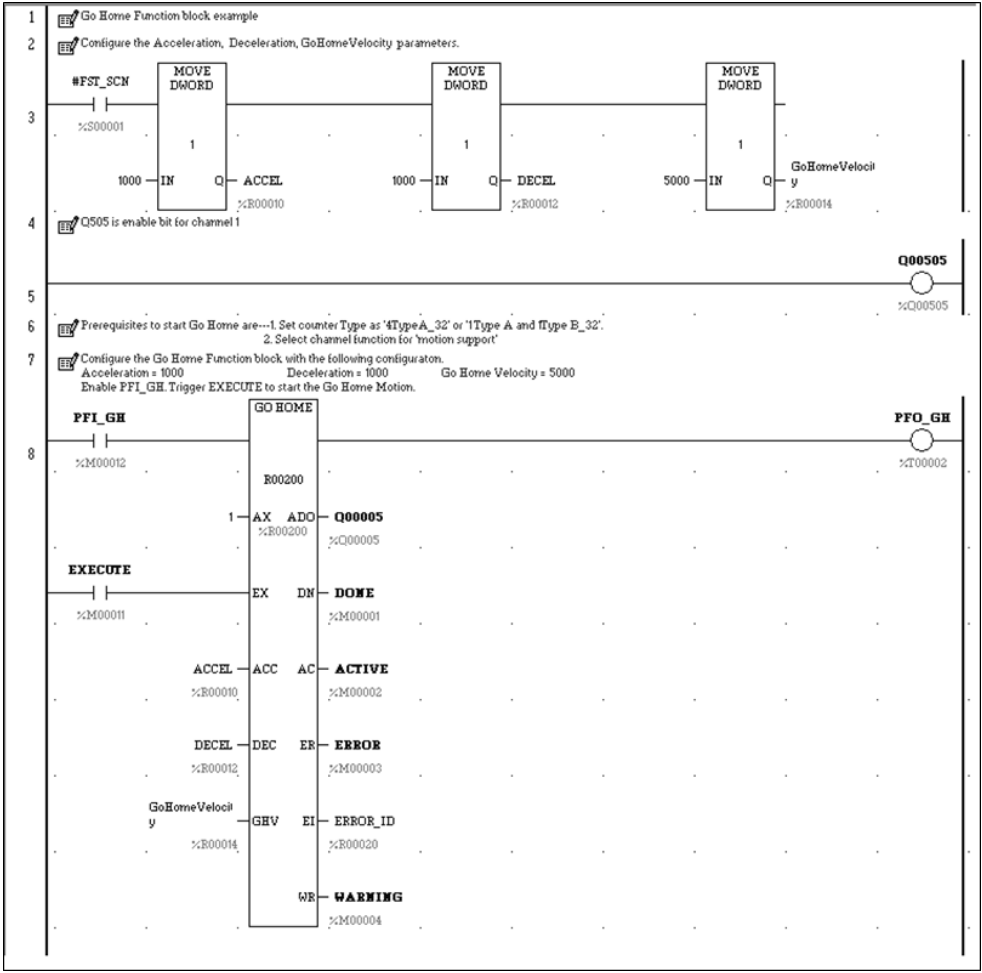
|                  |                                                                                                                                                                                           |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Enable           | The Enable input provides power flow to the function block.                                                                                                                               |
| Axis             | A Constant representing the channel (1, 2, 3, or 4) on which Go Home will be done.                                                                                                        |
| Execute          | Power flow to this input controls execution of the function. Rising edge is detected to load the parameters and start execution of the function block.                                    |
| Acceleration     | Dword variable or Constant representing the acceleration rate, from 10 to 1,000,000. 90 to 1,000,000 for channel 4.                                                                       |
| Deceleration     | Dword variable or Constant representing the deceleration rate, from 10 to 1,000,000. 90 to 1,000,000 for channel 4.                                                                       |
| Go Home Velocity | Dword variable or Constant representing the velocity at which the Go Home function is to be carried out. From 15 to 65,000. The sum of velocities on all channels must not exceed 65,000. |

## Outputs of the Go Home Function Block

|                       |                                                                                                                                                                                                                                                                                                                           |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Enable output         | Power flow output, passes power flow when it receives power flow from the Enable input.                                                                                                                                                                                                                                   |
| Axis Direction Output | Boolean variable (Q0005 to Q0024). The Micro PLC output point for which direction is to be set. 0 = clockwise, 1 = counterclockwise. The actual direction depends on the field connections and drive settings. The application program should not override the direction output during the Homing operation.              |
| Done                  | Boolean variable (%I, Q, M, G, T) for the GO Home completion status. Goes to 1 when motion is completed and remains 1 until the next homing cycle is started and Execute is continuously on. If the Execute input is a pulse, rather than staying continuously on, Done remains 1/on for one scan after motion completes. |
| Active                | Boolean variable (%I, Q, M, G, T) for the Go Home Active status. 1 = Homing in progress. 0 if motion is complete or has been stopped.                                                                                                                                                                                     |
| Error                 | Boolean variable (%I, Q, M, G, T) for the Go Home function block error status. Set to 1 if an error has occurred within function block. See Error ID below.                                                                                                                                                               |
| Error ID              | Word variable. If Error (ER) = 1, this is an Error ID. If Warning (WR) = 1, this is the Warning ID. See the list of error definitions on page 371.                                                                                                                                                                        |
| Warning               | Optional parameter. Boolean variable (%I, Q, M, G, T). Set to 1 when a warning has occurred. See Error ID above. Warning is generated when the same motion is triggered again while it is already in progress.                                                                                                            |

### 19.3.2 Example Program Logic for Go Home

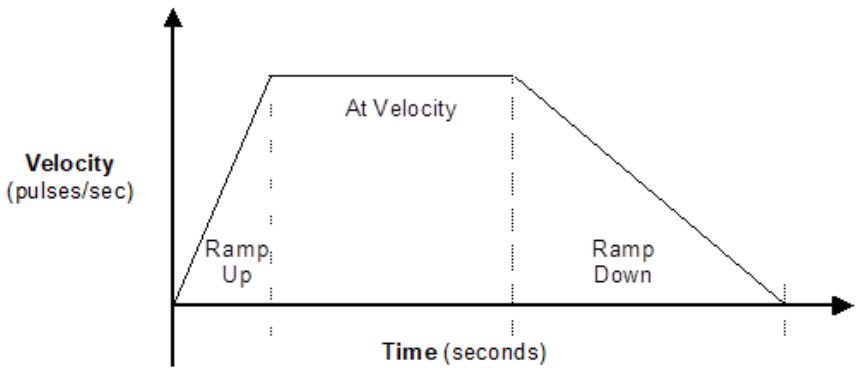
Figure 214



## 19.4 Jogging

A jogging move consists of Ramp Up (acceleration), At Velocity and Ramp Down (deceleration) velocities.

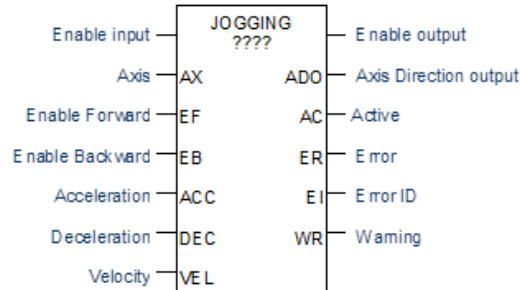
Figure 215



## 19.4.1 Jogging Function Block

The application program uses the following function block to set up and control Jogging.

**Figure 216**



The channel's Output Enable bit (for example, Q0505 for channel 1) must be set to 1 to use this or any other motion function block. If the Output Enable bit is not 1, the function will not execute, and a Channel Enable error will be reported.

When the Enable input receives power flow, if no motion is active on the channel and either Enable Forward (EF) or Enable Backward (EB) begins passing power flow, the function's parameters are loaded. If the parameters are not valid, an error code is generated, and the function does not start. If the parameters are valid and the Enable input is high, execution starts in the forward (clockwise) direction if Enable Forward is high, or in the reverse (counterclockwise) direction if Enable backward is high. The Active output is set to 1. Motion starts at the specified input Acceleration value and continues at the specified input Velocity until power flow is removed from EF or EB. The axis then decelerates at the Deceleration value. Active returns to 0 when the function is fully stopped.

If both Enable Forward and Enable Backward pass power flow, an error is returned. When either input subsequently goes low, motion starts in the other direction and the error clears automatically.

If the Enable input continues passing power flow, Jogging can be restarted with the same parameters by passing power flow to the EF or EB input again. To execute the function block with different parameters, first stop motion. The Enable Forward or Enable Backward input must stop passing power flow. After changing the parameter values, the application logic can again pass power flow to the Enable Forward or Enable Backward input.

Enable Forward / Backward input level is not monitored unless the Enable input is receiving power flow. The Enable Forward / Enable Backward inputs are level-triggered, not edge-triggered.

The function block's Enable output transitions to 0 automatically when EN input becomes 0.

If the Enable input stops receiving power flow while motion is in progress, the function block's Active output will not indicate when motion stops. In this case, the application program should monitor the Active output bit (bit 1) at address +0 of the function block's assigned Instance data to determine when the motion is completed.

## Stopping Jogging

Jogging can be stopped by:

- Executing a Stop Motion function block, as described later in this chapter. This stops any motion on the channel while leaving the channel active.
- Disabling the channel by setting its High-Speed Counter enable output bit to 0. No motion functions will operate on the channel while it is disabled.

### **⚠CAUTION**

To avoid abrupt starting and stopping of motion, the ratio of Velocity/Acceleration or Velocity/Deceleration must be  $\geq 0.1$ . For details, refer to page 374.

## Inputs to the Jogging Function Block

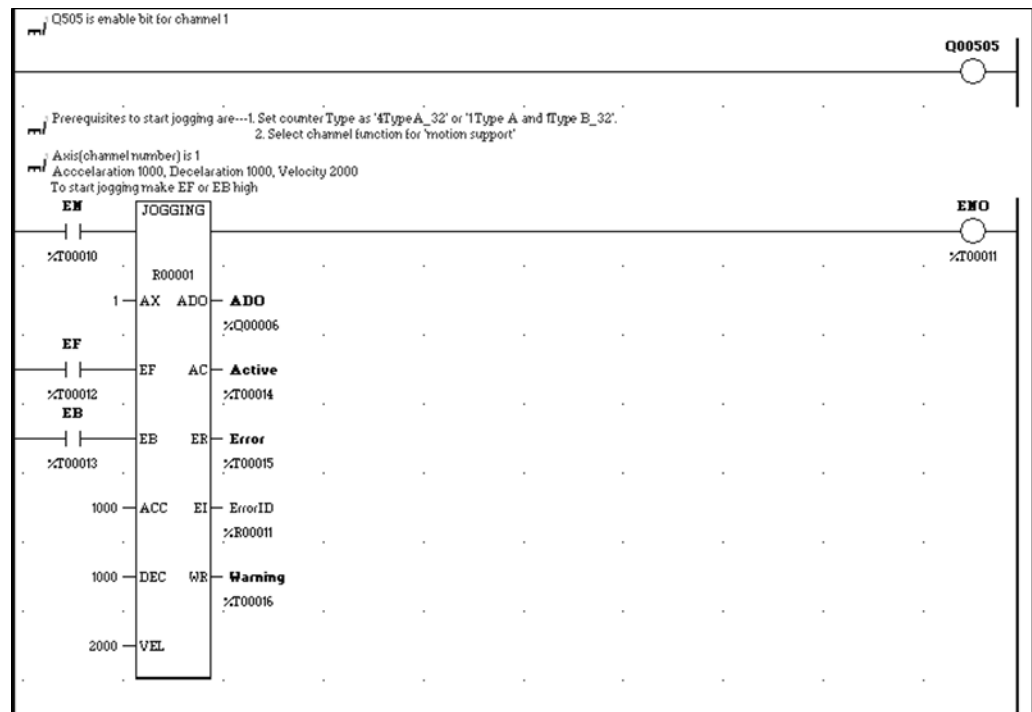
|                 |                                                                                                                                                                                                                                            |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Enable          | The Enable input provides power flow to the function block.                                                                                                                                                                                |
| Axis            | A Constant representing the channel (1, 2, 3, or 4) on which Jogging will be done.                                                                                                                                                         |
| Enable Forward  | If the Enable input is passing power flow, power flow to EF enables forward motion (clockwise) of the specified axis and starts the Jogging operation. If Jogging is already in progress, removing power flow to EF stops motion.          |
| Enable Backward | If the Enable input is passing power flow, power flow to EB enables backward motion (counter-clockwise) of the specified axis and starts the jogging operation. If Jogging is already in progress, removing power flow to EB stops motion. |
| Acceleration    | Dword variable (AI, AQ, R) or Constant representing the jogging acceleration rate, between 10 and 1,000,000 for channel 1 to 3 and 90 to 1,000,000 for channel 4.                                                                          |
| Deceleration    | Dword variable (AI, AQ, R) variable or Constant representing the jogging deceleration rate, between 10 and 1,000,000 for channel 1 to 3 and 90 to 1,000,000 for channel 4.                                                                 |
| Velocity        | Dword variable (AI, AQ, R) or Constant representing the velocity rate, between 15 and 65,000. The sum of velocities on all channels must not exceed 65,000.                                                                                |

## Outputs of the Jogging Function Block

|                       |                                                                                                                                                                                                                                                                                                              |
|-----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Enable output         | Power flow output passes power flow when it receives power flow from the Enable input.                                                                                                                                                                                                                       |
| Axis Direction Output | Boolean Variable (Q0005 to Q0024). The Micro PLC output point for which direction is to be set. 0 = clockwise, 1 = counterclockwise. The actual direction depends on the field connections and drive settings. The application program should not override the direction output during the motion operation. |
| Active                | Boolean variable (%I, Q, M, G, T) for the Jogging Active status. 1 = Jogging in progress. 0 = Jogging complete or stopped,                                                                                                                                                                                   |
| Error                 | Boolean variable (%I, Q, M, G, T) for the error status. Set to 1 if an error has occurred within function block. See Error ID below.                                                                                                                                                                         |
| Error ID              | Word variable (%AI, AQ, R). If Error (ER) = 1, this is an Error ID. If Warning (WR) = 1, this is the Warning ID. See the list of error definitions on page 371.                                                                                                                                              |
| Warning               | Optional parameter. Boolean variable (%I, Q, M, G, T). Set to 1 when a warning has occurred. See Error ID above. Warning is generated when the same motion is triggered again while it is already in progress.                                                                                               |

### 19.4.2 Example Program Logic for Jogging

Figure 217

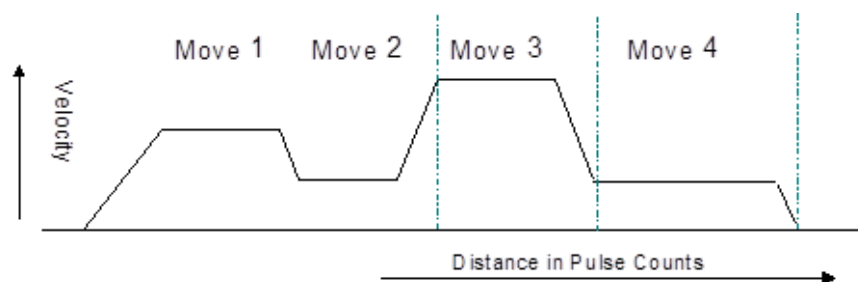


## 19.5 Blending

A Blended Move consists of up to four successive moves that are executed without the output value returning to zero between moves. The speed (pulse rate) and distance (number of pulses) for each of the blended moves can be defined. Transition to the speed of the next move uses ramping. At the end of each blended move, when the motor has moved the defined number of pulses, the motor must be at the speed set for the next move in the sequence.

The simplest form of blended move is shown below.

**Figure 218**



Because each Blend profile is equal to a normal ramping profile, a Pulse train with Ramp can be done using a Blended move with just one blending profile. Use this method if the hardware configuration selected is 4 Type A\_32 or 1 Type A/1 Type B\_32.

Each move can use any of the combinations of Ramp up (acceleration), At Velocity and Ramp Down (deceleration) states. These combinations depend on velocity of the next move in the sequence.

The parameters of each profile are used until the velocity of the next move is reached.

Based upon the Number of Pulses and the input parameters, the acceleration, deceleration and the flat regions of the profile are calculated in order to reach the target frequency of next profile. The motion is then performed with the calculated parameters.

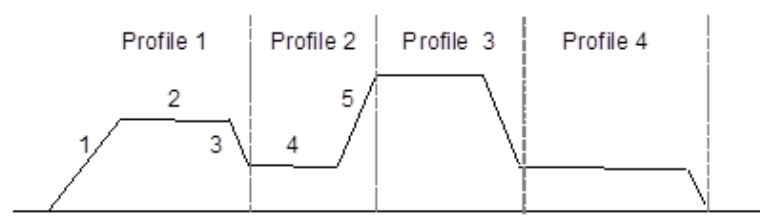
### 19.5.1 Examples of Blended Moves

This section describes some different Blended Move operations.

#### Example 1

In this example, all of the moves have sufficient number of pulses and acceleration to reach the desired velocity.

**Figure 219**



In this example, segments 1, 2, and 3 use the profile 1 parameters:

- The number of pulses for segments 1, 2, and 3 are from distance 1.
- Segment 1 accelerates at acceleration 1.
- Segment 2 moves at velocity 1.
- Segment 3 decelerates at deceleration 1. For segment 3, while calculating the number of pulses, the velocity of profile 2 (segment 4) is taken as the final velocity.

Segments 4 and 5 use the profile 2 parameters:

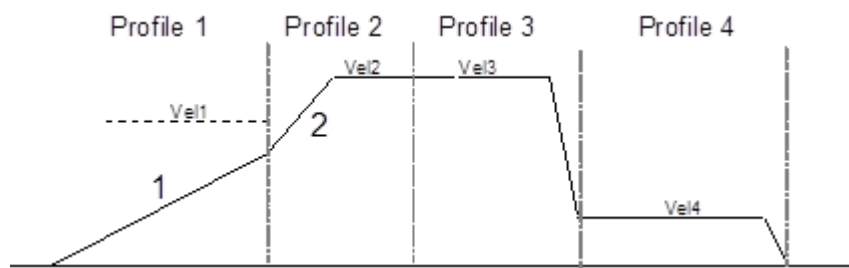
- Segment 4 moves at velocity 2.
- Segment 5 accelerates at acceleration 2.

The final aim of each move is to reach the next move desired velocity. So in Profile 1, first the acceleration pulses are calculated for segment 1, then the deceleration pulses are calculated for segment 3. The remaining pulses are generated at the profile 1 desired velocity.

## Example 2

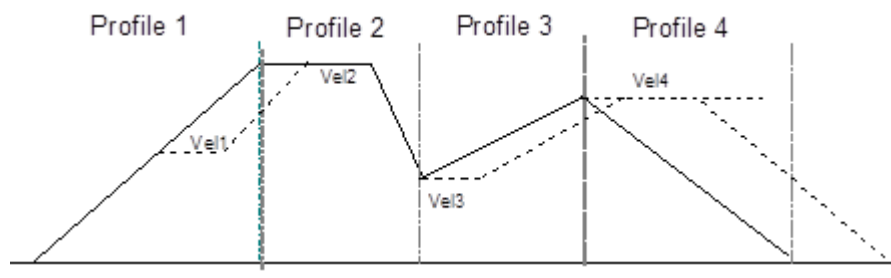
In this example, the distance 1 value in profile 1 is not enough to reach velocity 1. So in profile 2 (segment 2), accel2 and pulses2 are used to reach velocity 2. Velocity 2 and velocity 3 are configured as equal.

Figure 220



## Example 3

Figure 221



In this example, for profile 1:

1. The acceleration to reach velocity 1 is calculated,
2. Then the acceleration needed to reach velocity 2 from velocity 1 is calculated.
3. The remainder of profile 1 is run at velocity 1. In this example, all of profile 1 is required for acceleration, so there is no constant velocity (dotted line) in profile 1.

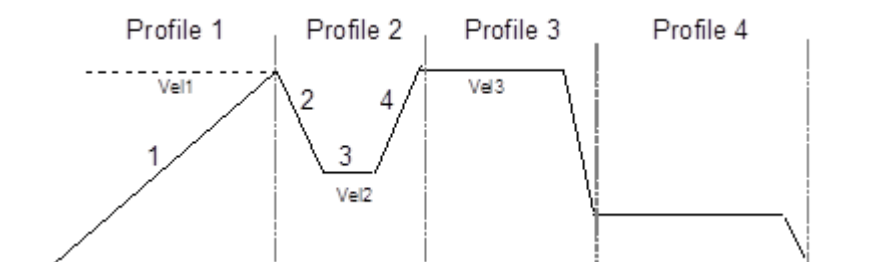
Profile 3 – Like profile 1, distance 3 is just sufficient to accelerate to velocity 4, so profile 3 has no motion at velocity 3.

Profile 4 consists entirely of deceleration.

### Example 4

In this example, in Profile 1, the acceleration is just enough to reach velocity 1. In profile 2, segment 2, deceleration 2 is used to reach velocity 2. Segment 3 of profile 2 is at velocity 2. Segment 4, ramps up at acceleration 2 to reach velocity 3.

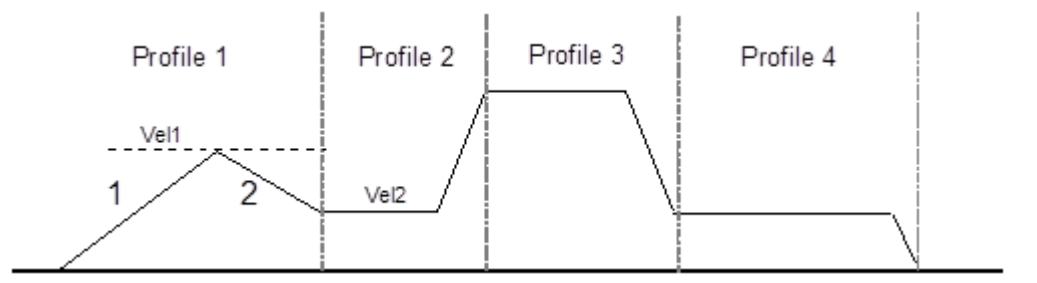
Figure 222



### Example 5

In profile 1, segment 1 accelerates from zero to velocity 1 then decelerates down to velocity 2 from velocity 1 in segment 2. Since the distance is just enough for these segments, profile 1 has no motion at velocity 1.

Figure 223

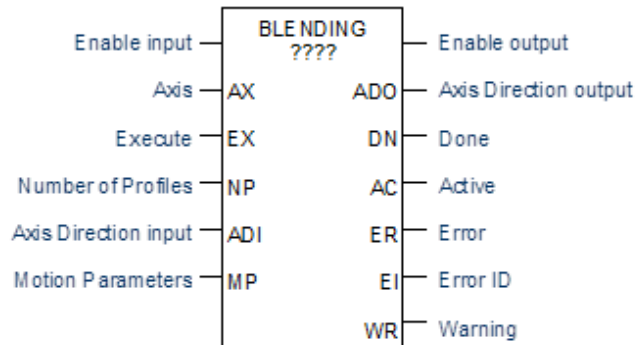




## 19.5.2 Blending Function Block

The application program uses the following function block to set up and control Blended Moves operation:

**Figure 224**



The channel's Output Enable bit (for example, Q0505 for channel 1) must be set to 1 to use this or any other motion function block. If the Output Enable bit is not 1, the function will not execute, and a Channel Enable error will be reported.

When the Enable input receives power flow, if the Execute input is set to 1, the function's parameters are loaded. If the parameters are not valid, an error code is generated, and the Blending function does not start. If the parameters are valid, the function block starts execution and sets the Active output to 1. The Active output returns to 0 when the function completes, or is stopped.

If the Enable input continues passing power flow, Blending can be restarted with the same parameters by generating a low to high transition on Execute input again. To execute the function block with different parameters, stop the motion. Then, remove power flow from the Enable input. After changing the parameter values, the function can be executed by reapplying power flow to the Enable input and generating a low to high transition on the Execute input.

The function block's Enable output transitions to 0 automatically when EN input becomes low.

Transitions of the Execute input are only monitored while the Enable input is receiving power flow. While the Enable input receives power flow, the Execute input is monitored for a change in its status from the previous logic scan; if Enable and Execute transition in the same scan, the transition of Execute is not detected. Therefore, the application logic must not set both Enable and Execute either low or high in the same scan. If Enable and Execute were made low in the same scan, the Blending function block would still see the Execute input as high. If Execute and Enable were made high in the same scan, the Blending function block would not see the transition in Execute status and motion would not start.

The motion status can be monitored by the Active output of the function block. If the Active output is 1, motion is in progress. While motion is in progress, the Done, Error, and Warning outputs should be 0. After the completion of the motion, the Active output is set to 0 and the Done output is set to 1.

If the Enable input stops receiving power flow while motion is in progress, the function block's Done output will not indicate when motion stops. In this case, the application program should monitor the Done output bit (bit 2) at address +0 of the function block's assigned Instance data to determine when the motion is completed.

When there is any error during the motion or at the start of the motion, the Error indication and the Error Number are updated to the Error output and the Error ID specified in the function block.

## Stopping Blending

Blending can be stopped by:

- When the PLC has gone through Run-Stop transition. After coming back to Run mode, an axis error (0x38) is logged into the %AI002 register and also at the Blending function block's Error ID output. The error in %AI002 must be cleared using the predefined reset bits for any other motion to start on that axis.
- When the PLC is power cycled.
- Executing a Stop Motion function block, as described later in this chapter. This stops any motion on the channel while leaving the channel active.
- Disabling the channel by setting its enable output bit to 0. No motion functions will operate on the channel while it is disabled.

### CAUTION

To avoid abrupt starting and stopping of motion, the ratio of Velocity/Acceleration or Velocity/Deceleration must be  $\geq 0.1$ . For details, refer to page 374.

## Inputs to the Blending Function Block

Because some of the profiles in a Blended Move may not have Ramp Up, At Velocity, and Ramp Down segments, some parameters may not be used.

|                      |                                                                                                                                                                                                          |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Enable               | The Enable input provides power flow to the function block.                                                                                                                                              |
| Axis                 | A Constant representing the channel (1, 2, 3, 4) on which the Blended Move will be done.                                                                                                                 |
| Execute              | Power flow to this input starts execution of the function. Rising edge is detected to load the parameters and start execution of the function block.                                                     |
| Number of Profiles   | Word variable or Constant representing the number of profiles (1, 2, 3, or 4). Data for each profile must be present in the Motion Parameters references (below).                                        |
| Axis Direction Input | Boolean variable (%I, Q, M, G, T) or a Constant specifying the axis direction. 0 = Clockwise (CW), 1 = Counter-Clockwise (CW). The actual direction depends on the field connections and drive settings. |

|                    |                                                                                                                                                                                                                             |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Motion Parameter s | Starting address of 32-word reference location in AI, AQ, or R memory that will be used for the Motion Parameters of each profile. Acceleration, deceleration and velocity are specified in the channel's configured units. |
| Words 1, 2         | Profile 1 acceleration, from 10 to 1,000,000 for channels 1, 2, and 3; 90 to 1,000,000 for channel 4                                                                                                                        |
| Words 3, 4         | Profile 1 deceleration, from 10 to 1,000,000 for channels 1, 2, and 3; 90 to 1,000,000 for channel 4                                                                                                                        |
| Words 5, 6         | Profile 1 velocity, from 15 to 65,000                                                                                                                                                                                       |
| Words 7, 8         | Real value. Distance in user units for profile 1                                                                                                                                                                            |
| Words 9 to 16      | Profile 2 acceleration, deceleration, velocity, and distance, as above for Profile 1                                                                                                                                        |
| Words 17 to 24     | Profile 3 acceleration, deceleration, velocity, and distance, as above for Profile 1                                                                                                                                        |
| Words 25 to 32     | Profile 4 acceleration, deceleration, velocity, and distance, as above for Profile 1                                                                                                                                        |

## Outputs of the Blended Moves Function Block

|                       |                                                                                                                                                                                                                                                    |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Enable Output         | Power flow output, passes power flow when it receives power flow from the Enable input.                                                                                                                                                            |
| Axis Direction Output | Boolean variable (Q0005 to Q0024). The Micro PLC output point for which direction is to be set. 0 = clockwise, 1 = counterclockwise. The application program should not override the direction output during the motion operation.                 |
| Done                  | Boolean variable (%I, Q, M, G, T) for the Blending completion status. Goes to 1 or passes power flow when motion is complete. If the Execute input is a pulse, rather than continuously on, Done remains 1/on for one scan after motion completes. |
| Active                | Boolean variable (%I, Q, M, G, T). Set to 1 when motion starts on the channel. Resets to 0 when motion stops.                                                                                                                                      |
| Error                 | Boolean variable (%I, Q, M, G, T). Set to 1 if an error has occurred within function block. See Error ID below.                                                                                                                                    |
| Error ID              | Word variable (%AI, AQ, R). If Error (ER) =1, this is an Error ID. If Warning (WR) =1, this is the Warning ID. See the list of error definitions on page 371.                                                                                      |
| Warning               | Optional parameter. Boolean variable (%I, Q, M, G, T). Set to 1 when a warning has occurred. See Error ID above. Warning is generated when the same motion is triggered again while it is already in progress.                                     |

### 19.5.3 Example Program Logic for Blending

1 Blended move function block example

2 Motion parameters for all four profiles are configured here.  
In blending each profile has Acceleration, Deceleration, Velocity, and Distance.  
Accel1 means acceleration for profile 1 and so on.

3 MOVE DWORD  
#FST\_SCN 1  
1000 IN Q Accel1  
1000 IN Q Decel1  
2000 IN Q Vel1

4 MOVE REAL  
#FST\_SCN 1  
10000 IN Q Distance1  
1500 IN Q Accel2  
1500 IN Q Decel2

5 MOVE DWORD  
#FST\_SCN 1  
3000 IN Q Vel2  
20000 IN Q Distance2  
1500 IN Q Accel3

6 MOVE DWORD  
#FST\_SCN 1  
1500 IN Q Decel3  
2500 IN Q Vel3  
3000 IN Q Distance3

7 MOVE DWORD  
#FST\_SCN 1  
1000 IN Q Accel4  
1000 IN Q Decel4  
1500 IN Q Vel4

8 MOVE REAL  
#FST\_SCN 1  
20000 IN Q Distance4

9 Q0505 is enable bit for channel 1

10 Q00505

11 Prerequisites to start blending are---1. Set counter Type as 'tType\_A\_32' or 'tType\_A' and tType\_B\_32.  
2. Select channel function for 'motion support'.

12 Axis number(channel number) is configured as 1. Number of profile(NP) is 4. Axis direction input(ADI) is 0 i.e. clockwise direction.  
Motion Parameter(MP) takes inputs starting from %R00001 in this example.  
Parameters for each profile (as given above) are as follows.  
Profile 1 1000, 1000, 2000, 10000  
profile 2 1500, 1500, 3000, 20000  
profile 3 1500, 1500, 2500, 20000  
profile 4 1000, 1000, 1500, 20000  
Enable EN. By providing low to high transition on 'Execute' input, blending function block execution starts.

13 BLENDING  
EW 1  
%T00001  
R00052  
1 AX ADO ADO  
%R00052  
%Q00005  
Execute EX DN Done  
%T00003  
%T00004  
4 NP AC Active  
%T00005  
0 ADI ER Error  
%T00006  
Accel1 MP EI ErrorID  
%R00001  
%R00050  
WR Warning  
%T00007

EWO  
%T00002

## 19.6 Stopping Motion on an Axis

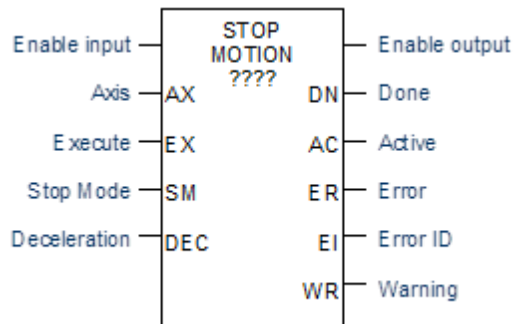
As mentioned for the individual functions, motion can be stopped by:

- Disabling the channel by setting its High-Speed Counter enable output bit to 0. This stops all motion functions on the channel.
- Executing a Stop Motion function block as described below. This stops any motion on the channel while leaving the channel active.

### 19.6.1 Stop Motion Function Block

The application program can use the Stop Motion function block to stop any motion operation:

Figure 226



When the Execute input receives power flow and the Enable input is high, and there is no stop motion instance on the axis, the parameters are loaded. If the parameters are valid, a low to high transition on the Execute input starts execution, stops the axis with the specified input deceleration value (or immediately) based on the value of Stop mode input, and sets the Active output to 1. The Done output goes to 1 when the axis stops and the Active output returns to 0. Done remains high until the Execute input transitions low. If Execute is a pulse, Done remains high for one scan after the axis stops (Active becomes low). If the parameters are not valid, an error code is generated, and the function does not start.

To execute the function block with different parameters, remove power flow from the Enable and Execute inputs. Then, change the parameters. The function block will execute with the new parameters when power flow is applied to the Enable input and a low to high transition occurs on the Execute input.

Execute input transitions are not monitored unless the Enable input is receiving power flow. When the Enable input receives power flow, the Execute input is monitored for a change in status from the previous logic scan. Therefore, Enable and Execute should not be made low in the same scan or be made high in the same scan. If both Enable and Execute were set to low in the same logic scan, the change to the Execute state would not be seen by the Stop Motion function block because Enable is already low. So although the function block's Execute input is low, it still controls the axis and no motion can occur on that axis.

If the Enable input stops receiving power flow while motion is in progress, the function block's Done output will not indicate when motion stops. In this case, the application

program should monitor the Done output bit (bit 2) at address +0 of the function block's assigned Instance data to determine when the motion is completed.

## More than One Stop Motion Function Block for an Axis

If the application logic contains more than one Stop Motion function block for an axis, the state of the Execute input of the last Stop Motion function block in the scan that has positive power flow determines whether the Stop Motion function block controls motion on the axis.

For example, suppose the logic contains two Stop Motion function blocks for the same axis, and jogging is running on that axis. Execute is triggered for the first Stop Motion function block, but the Execute input of the second Stop Motion function block is 0. The first instance of the Stop Motion function block takes control of the axis and stops the current jogging. After jogging stops, because the Execute input of second (or last) Stop Motion function block is still 0, Stop Motion is not controlling the axis and jogging can again be started on the axis.

### CAUTION

To avoid abrupt starting and stopping of motion, the ratio of Velocity/Acceleration or Velocity/Deceleration must be  $\geq 0.1$ . For details, refer to page 374.

## Inputs to the Stop Motion Function Block

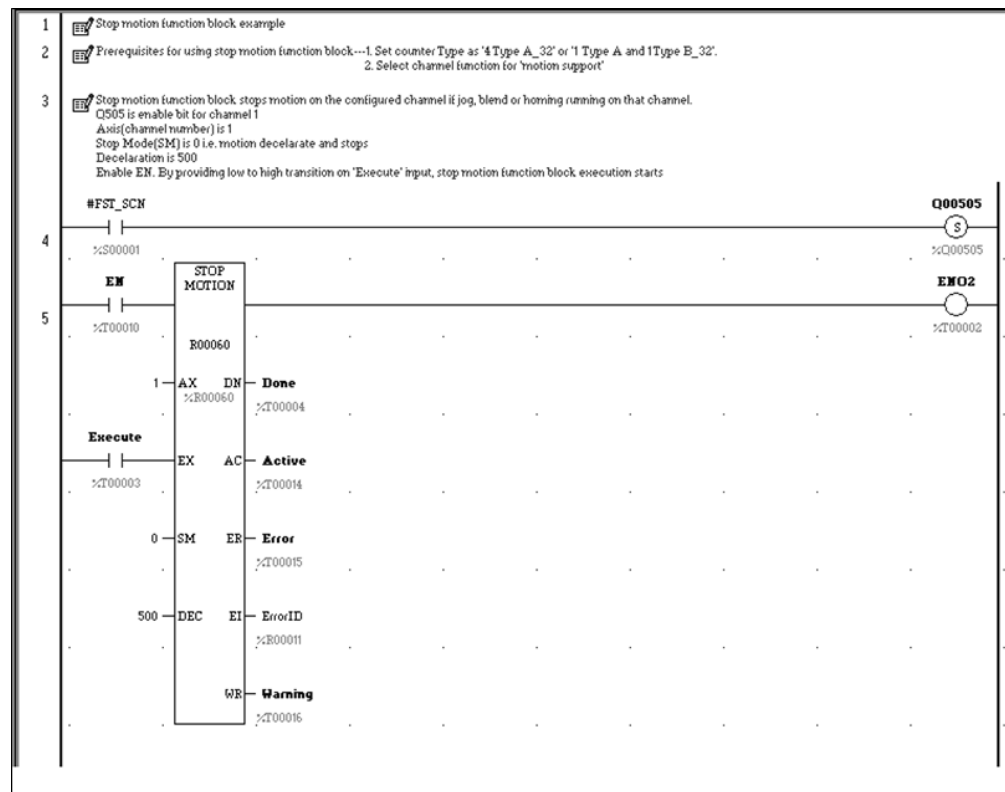
|              |                                                                                                                                                                   |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Enable       | The Enable input provides power flow to the function block.                                                                                                       |
| Axis         | A Constant representing the channel (1, 2, 3, or 4) on which motion will stop.                                                                                    |
| Execute      | Power flow to this input controls execution of the Function Block.                                                                                                |
| Stop Mode    | Boolean variable (%I, Q, T, M, G) or Constant to control the Stop Mode. 0 = decelerate to stop (normal stop mode). 1 = stop immediately.                          |
| Deceleration | Optional Dword variable or Constant representing the jogging deceleration rate, between 10 and 1,000,000 for channels 1, 2, and 3. 90 to 1,000,000 for channel 4. |

## Outputs from the Stop Motion Block

|               |                                                                                                                                                                                                                |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Enable output | Boolean power flow output, passes power flow when it receives power flow from the Enable input.                                                                                                                |
| Done          | Boolean variable (%I, Q, M, G, T). Goes to 1 when motion is has stopped. If the Execute input is a pulse, rather than continuously on, Done remains 1/on for one scan.                                         |
| Active        | Boolean variable (%I, Q, M, G, T) for the function status. 1 = Stopping in progress.                                                                                                                           |
| Error         | Boolean variable (%I, Q, M, G, T). Set to 1 if an error has occurred within function block. See Error ID below.                                                                                                |
| Error ID      | Word variable (%AI, AQ, R). If Error (ER) =1, this is an Error ID. If Warning (WR) =1, this is the Warning ID . See the list of error definitions on page 374.                                                 |
| Warning       | Optional parameter. Boolean variable (%I, Q, M, G, T). Set to 1 when a warning has occurred. See Error ID above. Warning is generated when the same motion is triggered again while it is already in progress. |

### 19.6.2 Example Program Logic for Stop Motion

Figure 227



# Chapter 20: Fault Handling

This chapter discusses how the Micro PLC handles system faults.

## 20.1 Faults and Fault Handling

A fault is a failure or condition that can affect the operation and performance of the system. A fault may impair the ability of the PLC to control a machine or process.

### 20.1.1 Fault Handling

When a fault is detected, the PLC processes the fault and sets the corresponding system bit(s) (See 'System Bit Reference Table'). The PLC logs the fault into a fault table. There are two different fault tables:

- The I/O Fault Table
- The PLC Fault Table

Contents of the fault tables can be monitored and cleared from the programmer.

### 20.1.2 Classes of Faults

The Micro PLC detects several classes of faults, including:

- Internal Failures
  - Non-responding circuit boards
  - Memory checksum errors
- External Failures
  - Sequence fault
- Operational Failures
  - Communication failures
  - Configuration failures
  - Password access failures

## 20.2 System Responses to Faults

Some faults can be tolerated, while others require that the PLC shut down. I/O failures may be tolerated by the PLC, but not be acceptable for the application. Operational failures can normally be tolerated.



## 20.2.1 Fault Actions

The PLC categorizes different groups of faults as:

- Informational
- Diagnostic
- Fatal

The PLC logs all faults in the appropriate fault table. For diagnostic and fatal faults, the PLC sets any associated diagnostic variables. The following table lists the fault action, associated fault table, and diagnostic variables for different types of faults. In addition, if the fault is a fatal fault, the PLC halts the system (STOP/FAULTED mode) to prevent possible damage to the equipment, or personal injury.

| Fault Group                           | Action     | Fault Table     | Diagnostic Variables |               |                |                |
|---------------------------------------|------------|-----------------|----------------------|---------------|----------------|----------------|
| System Configuration Mismatch         | Fatal      | PLC Fault Table | sy_flt(%SC10)        | any_flt(%SC9) | sy_pres(%SC12) | cfg_mm(%SA9)   |
| Expansion Unit Configuration Mismatch | Fatal      | PLC Fault Table | sy_flt(%SC10)        | any_flt(%SC9) | sy_pres(%SC12) | cfg_mm(%SA9)   |
| PLC CPU Hardware Failure              | Fatal      | PLC Fault Table | sy_flt(%SC10)        | any_flt(%SC9) | sy_pres(%SC12) | hrd_cpu(%SA10) |
| PLC Software Failure (see below)      | Fatal      | PLC Fault Table | sy_flt(%SC10)        | any_flt(%SC9) | sy_pres(%SC12) | sft_cpu(%SB13) |
| PLC Store Failure (see below)         | Fatal      | PLC Fault Table | sy_flt(%SC10)        | any_flt(%SC9) | sy_pres(%SC12) | stor_er(%SB14) |
| Program Checksum Failure              | Fatal      | PLC Fault Table | sy_flt(%SC10)        | any_flt(%SC9) | sy_pres(%SC12) | pb_sum(%SA1)   |
| No User Program on Power-up           | Diagnostic | PLC Fault Table | sy_flt(%SC10)        | any_flt(%SC9) | no_prog(%SB9)  |                |
| Corrupted User RAM                    | Fatal      | PLC Fault Table | sy_flt(%SC10)        | any_flt(%SC9) | sy_pres(%SC12) | bad_ram(%SB10) |
| Unknown PLC Fault                     | Fatal      | PLC Fault Table | sy_flt(%SC10)        | any_flt(%SC9) | sy_pres(%SC12) |                |
| Unknown I/O Fault                     | Fatal      | I/O Fault Table | io_flt(%SC11)        | any_flt(%SC9) | io_pres(%SC13) |                |
| PLC Fault Table Full                  | Diagnostic | -               | sy_flt(%SC10)        |               |                |                |
| I/O Fault Table Full                  | Diagnostic | -               | io_full(%S10)        |               |                |                |
| Application Fault                     | Diagnostic | PLC Fault Table | sy_flt(%SC10)        | any_flt(%SC9) | sy_pres(%SC12) | apl_flt(%SA3)  |
| Password Access Failure               | Diagnostic | PLC Fault Table | sy_flt(%SC10)        | any_flt(%SC9) | sy_pres(%SC12) | bad_pwd(%SB11) |
| Constant Sweep Time Exceeded          | Diagnostic | PLC Fault Table | sy_flt(%SC10)        | any_flt(%SC9) | sy_pres(%SC12) | ov_swp(%SA2)   |
| Loss of Expansion Unit                | Diagnostic | I/O Fault Table | io_flt(%SC11)        | any_flt(%SC9) | io_pres(%SC13) | los_iom(%SA14) |
| Addition of Expansion Unit            | Diagnostic | I/O Fault Table | io_flt(%SC11)        | any_flt(%SC9) | io_pres(%SC13) | add_iom(%SA19) |

|                      |                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PLC Software Failure | If a PLC Software Failure is logged, the PLC immediately goes into Error Sweep mode. The only way to clear this condition is to cycle power.                                                                                                                                                                                                                                                                  |
| PLC Store Failure    | A <b>sequence store</b> is the storage of program blocks and other data preceded by the special Start-of-Sequence command and ending with the End-of-Sequence command. If communications with the programmer are interrupted or if any other failure terminates the download, the PLC Store Failure fault is logged. As long as this fault is present in the system, the PLC will not transition to Run mode. |

## 20.3 Fault References

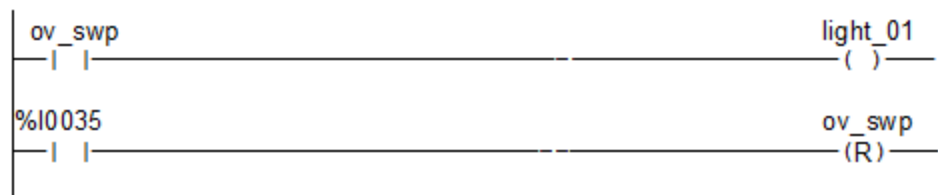
The PLC defines a set of special fault references that can be included in the application program to check for fault conditions, and allow appropriate action to be taken should one of these faults occur.

These special fault references remain set until the PLC is cleared or until the application program clears the fault.

### 20.3.1 Example Program Logic for Fault References

This example ladder logic shows how the fault reference `ov_swp` can be programmed to check for an over-sweep condition, then cleared. In this example, an indicator `light_01` is turned on to alert the operator that an over-sweep has occurred. After fixing any problem in the application, the operator presses a pushbutton. This causes program input `%I0035` contact to pass power flow to the `ov_swp` reference, which clears the associated memory location.

Figure 228



# Chapter 21: Elements of an Application Program

This chapter provides basic information about the application program.

- Structure of an application program
- Subroutines
- Program languages
- Instruction set

## 21.1 Structure of an Application Program

The application program consists of all the logic needed to control the operation of the Nano or Micro PLC.

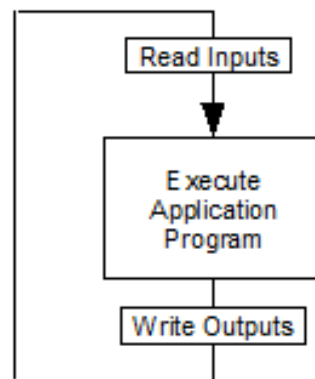
Application programs are created using the programming software and transferred to the PLC. Programs are stored in non-volatile memory.

During the CPU Sweep (described in Chapter 17:), the Micro PLC reads input data and stores the data in its configured input memory locations. The Micro PLC then executes the entire application program once, utilizing this fresh input data. Executing the application program creates new output data that is placed in the configured output memory locations.

After completing the end of the application program, the CPU provides the output data to the output points.

---

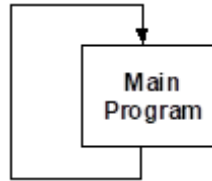
**Figure 229**



## 21.2 Subroutines

The program can consist of one Main program that executes completely during each CPU sweep.

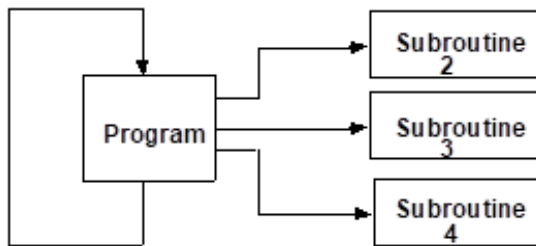
Figure 230



Or a program can be divided into subroutines. The maximum size of a main program block or subroutine block is 16K bytes. A Nano PLC application program can include up to 8 subroutine declarations. A Micro PLC application program can include up to 64 subroutine declarations.

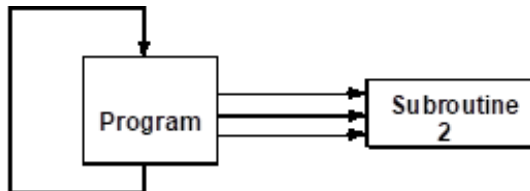
Subroutines can simplify programming and reduce the overall amount of logic. Each subroutine can be called as needed. The main program might serve primarily to sequence the subroutine blocks.

Figure 231



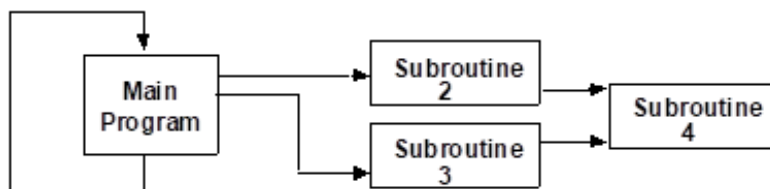
A subroutine block can be called many times as the program executes. Logic that should be repeated can be placed in a subroutine block, reducing total program size.

Figure 232



In addition to being called from the program, subroutine blocks can also be called by other subroutine blocks. A subroutine block can even call itself.

Figure 233



The main program is level 1. The program can include up to eight additional nested call levels.

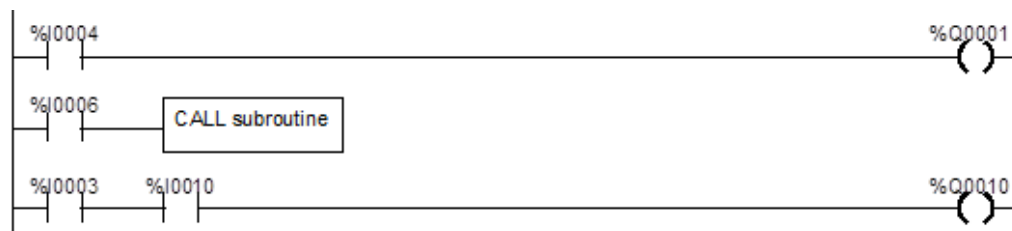
## 21.2.1 Declaring a Subroutine

A subroutine must be declared through the block declaration editor of the programming software.

## 21.2.2 Calling a Subroutine

A subroutine invoked in the program is using a CALL instruction. Up to 64 subroutine block declarations are allowed for Micro CPUs. Up to 8 subroutine block declarations are allowed for NANO CPUs. Regardless of the CPU model, 64 CALL instructions are allowed for each block in the program.

Figure 234



## 21.2.3 Locking/Unlocking Subroutines

Subroutine blocks can be locked and unlocked from the programming software. There are four levels of locking:

| Type of Lock | Description                                                       |
|--------------|-------------------------------------------------------------------|
| View         | When locked, the subroutine cannot be viewed.                     |
| Edit         | When locked, the information in the subroutine cannot be changed. |
| Perm View    | The subroutine is permanently locked and cannot be unlocked.      |
| Perm Edit    | The subroutine is permanently locked and cannot be unlocked.      |

Permanently locked subroutines cannot be unlocked, even if the program is copied, backed up, or restored. A previously view-locked or edit-locked subroutine can be unlocked.

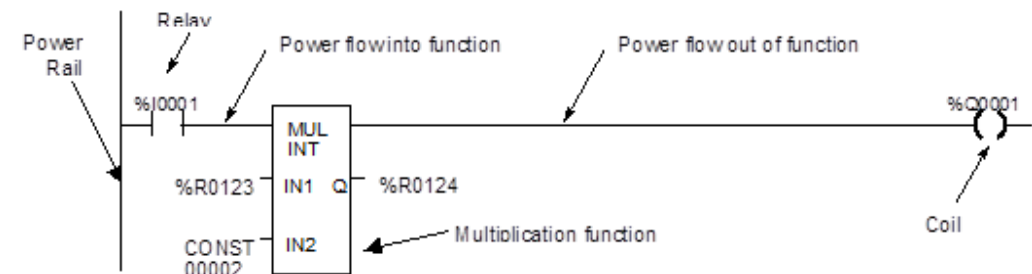
## 21.3 Program Languages

Application programs for VersaMax Nano PLCs and Micro PLCs can be created in Ladder Diagram or Instruction List format.

### 21.3.1 Ladder Diagram

This traditional PLC programming language, with its rung-like structure, executes from top to bottom. The logic execution is thought of as “power flow”, which proceeds down along the left “rail” of the ladder, and from left to right along each rung in sequence.

Figure 235



The flow of logical power through each rung is controlled by a set of simple program functions that work like mechanical relays and output coils. Whether or not a relay passes logical power flow along the rung depends on the content of a memory location with which the relay has been associated in the program. For instance, a relay might pass power flow if its associated memory location contained the value 1. The same relay would not pass power flow if the memory location contained the value 0.

If a relay or other function in a rung does not pass logical power flow, the rest of that rung is not executed. Power then flows down along the left rail to the next rung.

A rung contains complex functions that can be used for operations like moving data stored in memory, performing math operations, and controlling communications between the Micro PLC and other devices in the system.

Some program functions, such as the Jump function and Master Control Relay, can be used to control the execution of the program itself.

Together, this large group of Ladder Diagram relays, coils, and functions is called the “Instruction Set” of the Micro PLC.

## 21.4 The Instruction Set

A VersaMax Nano PLC or Micro PLC provides a powerful Instruction Set for building application programs.

As a guide to the programming capabilities of the VersaMax Micro PLC, all of the relays, coils, functions, and other elements of the Instruction Set are listed on the following pages. Complete reference information is included in Chapter 23: and in the online help for the programming software.

## 21.4.1 Contacts

|       |                 |                                                                         |
|-------|-----------------|-------------------------------------------------------------------------|
| –   – | Normally Open   | Passes power if the associated reference is ON.                         |
| – / – | Normally Closed | Passes power if the associated reference is OFF.                        |
| – + – | Continuation    | Passes power to the right if the preceding continuation coil is set ON. |

## 21.4.2 Coils

|        |                     |                                                                                                                                                                                                                  |
|--------|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| –( )–  | Normally Open       | Sets the associated reference ON if the coil receives power. Otherwise OFF.                                                                                                                                      |
| –(/)–  | Negated             | Sets the associated discrete reference ON if the coil does not receive power. Otherwise OFF.                                                                                                                     |
| –(□)–  | Positive Transition | If power flow was OFF to this coil the last time it was executed and is ON this time, then the coil is turned ON. Otherwise, the coil is turned OFF.                                                             |
| –(◻)–  | Negative Transition | If power flow was ON to this coil the last time it was executed and is OFF this time, then the coil is turned ON. Otherwise, the coil is turned OFF.                                                             |
| –(S)–  | SET                 | Sets the associated discrete reference ON if the coil receives power. It remains set until reset by an –(R)– coil.                                                                                               |
| –(R)–  | RESET               | Sets the associated discrete reference OFF if the coil receives power. It remains reset until set by an –(S)– coil.                                                                                              |
| –(SM)– | Retentive SET       | Sets the associated reference ON if the coil receives power. The reference remains set until reset by an –(RM)– coil. Its state is retained through power failure and <b>STOP-TO-RUN</b> transition.             |
| –(RM)– | Retentive RESET     | Resets the associated discrete reference OFF if the coil receives power. The reference remains reset until set by an –(SM)– coil. Its state is retained through power failure and <b>STOP-TO-RUN</b> transition. |
| –(/M)– | Negated Retentive   | Sets the associated discrete reference ON if the coil does not receive power. The state is retained through power failure and <b>STOP-TO-RUN</b> transition. Otherwise OFF.                                      |
| –(M)–  | Retentive           | Sets the associated discrete reference ON if the coil receives power. The state is retained through power failure and <b>STOP-TO-RUN</b> transition. Otherwise OFF.                                              |
| –(+ )– | Continuation        | If power to the coil is ON, the continuation coil sets the next continuation contact ON. If power is OFF, the continuation coil sets the next continuation contact OFF.                                          |

## 21.4.3 Timers and Counters

|              |                          |                                                                                                                 |
|--------------|--------------------------|-----------------------------------------------------------------------------------------------------------------|
| <b>ONDTR</b> | On-Delay Stopwatch Timer | Accumulates time while receiving power. The current value is reset to zero when the reset input receives power. |
| <b>OFDT</b>  | Off-Delay Timer          | Accumulates time while NOT receiving power. The current value is reset to zero when there is power flow.        |
| <b>TMR</b>   | On-Delay Timer           | Accumulates time while receiving power. The current value is reset to zero when there is no power flow.         |
| <b>UPCTR</b> | Up Counter               | Increments by 1 each time the function receives transitional power.                                             |
| <b>DNCTR</b> | Down Counter             | Counts down from a preset value every time the function receives transitional power.                            |

## 21.4.4 Math Functions

|              |                    |                                                                    |
|--------------|--------------------|--------------------------------------------------------------------|
| <b>ADD</b>   | Addition           | Adds two numbers.                                                  |
| <b>SUB</b>   | Subtraction        | Subtracts one number from another.                                 |
| <b>MUL</b>   | Multiplication     | Multiplies two numbers.                                            |
| <b>DIV</b>   | Division           | Divides one number by another, yielding a quotient.                |
| <b>MOD</b>   | Modulo Division    | Divides one number by another, yielding a remainder.               |
| <b>EXPT</b>  | Power of X         | Raises X to the power specified by IN and places the result in Q.  |
| <b>SIN</b>   | Sine               | Finds the trigonometric sine of a real number.                     |
| <b>COS</b>   | Cosine             | Finds the trigonometric cosine of a real number.                   |
| <b>TAN</b>   | Tangent            | Finds the trigonometric tangent of a real number.                  |
| <b>ASIN</b>  | Inverse Sine       | Finds the inverse sine of a real number.                           |
| <b>ACOS</b>  | Inverse Cosine     | Finds the inverse cosine of a real number.                         |
| <b>ATAN</b>  | Inverse Tangent    | Finds the inverse tangent of a real number.                        |
| <b>DEG</b>   | Convert to Degrees | Performs a RAD_TO_DEG conversion on a real radian value.           |
| <b>RAD</b>   | Convert to Radians | Performs a DEG_TO_RAD conversion on a real degree value.           |
| <b>SCALE</b> | Scaling            | Scales an input constant or word value.                            |
| <b>SQRT</b>  | Square Root        | Finds the square root of an integer or real value.                 |
| <b>LOG</b>   | Base 10 Logarithm  | Finds the base 10 logarithm of a real value.                       |
| <b>LN</b>    | Natural Logarithm  | Finds the natural logarithm base of a real number.                 |
| <b>EXP</b>   | Power of e         | Raises the natural logarithm base to the power specified by input. |



## 21.4.5 Relational Functions

|              |                          |                                                               |
|--------------|--------------------------|---------------------------------------------------------------|
| <b>EQ</b>    | Equal                    | Tests for equality between two numbers.                       |
| <b>NE</b>    | Not Equal                | Tests for non-equality between two numbers.                   |
| <b>GT</b>    | Greater Than             | Tests whether one number is greater than another.             |
| <b>GE</b>    | Greater Than or Equal To | Tests whether one number is greater than or equal to another  |
| <b>LT</b>    | Less Than                | Tests whether one number is less than another.                |
| <b>LE</b>    | Less Than or Equal To    | Tests whether one number is greater than or equal to another. |
| <b>RANGE</b> | Range                    | Test the input value against a range of two numbers.          |

## 21.4.6 Bit Operation Functions

|                  |                      |                                                                                   |
|------------------|----------------------|-----------------------------------------------------------------------------------|
| <b>AND</b>       | Logical AND          | Performs Logical AND of two bit strings.                                          |
| <b>OR</b>        | Logical OR           | Performs Logical OR of two bit strings.                                           |
| <b>XOR</b>       | Logical Exclusive OR | Performs Logical Exclusive OR of two bit strings.                                 |
| <b>NOT</b>       | Logical Invert       | Performs a logical inversion of a bit string.                                     |
| <b>SHL</b>       | Shift Left           | Shifts a bit string left.                                                         |
| <b>SHR</b>       | Shift Right          | Shifts a bit string right.                                                        |
| <b>ROL</b>       | Rotate Left          | Rotates a bit string left.                                                        |
| <b>ROR</b>       | Rotate Right         | Rotates a bit string right.                                                       |
| <b>BIT_TEST</b>  | Bit Test             | Test a bit within a bit string to determine whether that bit is currently 1 or 0. |
| <b>BIT_SET</b>   | Bit Set              | Sets one bit within a string to true.                                             |
| <b>BIT_CLR</b>   | Bit Clear            | Sets one bit within a string to false.                                            |
| <b>BIT_POS</b>   | Bit Position         | Locates a bit set to true within a bit string.                                    |
| <b>MASK_COMP</b> | Masked Compare       | Performs a masked compare of two arrays.                                          |

## 21.4.7 Data Move Functions

|                |                       |                                                                     |
|----------------|-----------------------|---------------------------------------------------------------------|
| <b>MOVE</b>    | Move                  | Moves one or more bits of data.                                     |
| <b>BLKMOV</b>  | Block Move            | Moves a block of up to 7 constants.                                 |
| <b>BLK_CLR</b> | Block Clear           | Clears to zero one or more bytes/words of memory.                   |
| <b>SHFR</b>    | Shift Register        | Shifts one or more words or bits of data through a block of memory. |
| <b>BIT_SEQ</b> | Bit Sequencer         | Sequences a 1 through a group of bits in PLC memory.                |
| <b>COMMREQ</b> | Communication Request | Sends a communications request.                                     |

## 21.4.8 Table Functions

|            |                              |                                                                                        |
|------------|------------------------------|----------------------------------------------------------------------------------------|
| ARRAY_MOVE | Array Move                   | Copies a specified number of data elements from a source array to a destination array. |
| SEARCH_EQ  | Search Equal                 | Searches array for values equal to a specified value.                                  |
| SEARCH_NE  | Search Not Equal             | Searches array for values not equal to a specified value.                              |
| SEARCH_GT  | Search Greater Than          | Searches array for values greater than a specified value.                              |
| SEARCH_GE  | Search Greater Than or Equal | Searches array for values greater than or equal to a specified value.                  |
| SEARCH_LT  | Search Less Than             | Searches array for values less than a specified value.                                 |
| SEARCH_LE  | Search Less Than or Equal    | Searches array for values less than or equal to a specified value.                     |

## 21.4.9 Conversion Functions

|                                                             |                                                 |                                                                                     |
|-------------------------------------------------------------|-------------------------------------------------|-------------------------------------------------------------------------------------|
| INT_TO_BCD4                                                 | Convert to BCD-4 (From INT)                     | Converts a number to 4-digit BCD format.                                            |
| REAL_TO_WORD                                                | Convert to Word (From REAL)                     | Converts a Real value to Word format.                                               |
| BCD4_TO_INT<br>BCD4_TO_REAL                                 | Convert to INT (From BCD-4 or REAL)             | Converts a number to signed integer format.                                         |
| BCD4_TO_DINT<br>REAL_TO_DINT                                | Convert to DINT (From BCD-4 or REAL)            | Converts a number to double precision integer format.                               |
| INT_TO_REAL<br>DINT_TO_REAL<br>BDC4_TO_REAL<br>WORD_TO_REAL | Convert to Real (From INT, DINT, BCD-4 or WORD) | Converts a value to real value format.                                              |
| REAL_TO_INT                                                 | Truncate to INT (from REAL)                     | Truncates to a 16-bit signed number. The range is -32,768 to +32,767.               |
| REAL_TO_INT                                                 | Truncate to Double Precision INT (from REAL)    | Truncates to a 32-bit signed number. The range is -2,147,483,648 to +2,147,483,647. |

## 21.4.10 Control Functions

|         |                           |                                                                                                                                                                                                                            |
|---------|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CALL    | Call                      | Causes a program execution to go to a specified subroutine block.                                                                                                                                                          |
| DO_IO   | Do I/O                    | Serves a specified range of inputs or outputs immediately (all inputs or outputs on a module will be serviced if any addresses on that module are included in the function – partial I/O module updates are not performed) |
| PID_IND | Independent PID Algorithm | Selects the non-interacting independent PID algorithm.                                                                                                                                                                     |
| PID_JSA | ISA PID Algorithm         | Selects the ISA PID algorithm.                                                                                                                                                                                             |
| END     | Temporary End of Logic    | The program executes from the first rung to the last rung or the END instruction, whichever is encountered first. This instruction is useful for debugging purposes.                                                       |
| COMMENT | Comment                   | A rung explanation.                                                                                                                                                                                                        |

|               |                          |                                                                                                                                                                       |
|---------------|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>SVCREQ</b> | Service Request          | A special PLC service function.                                                                                                                                       |
| <b>MCRN</b>   | Master Control Relay     | Starts a master control relay range. An MCR causes all rungs between the MCR and its subsequent ENDMCR to be executed with no power flow. Up to 8 MCRs can be nested. |
| <b>ENDMCR</b> | End Master Control Relay | Ends a master control relay range.                                                                                                                                    |
| <b>JUMP</b>   | Jump                     | Jumps to a specified location indicated by a LABEL in the logic.                                                                                                      |
| <b>LABEL</b>  | Label                    | The target location of a JUMP instruction. Multiple jump instructions can reference the same label.                                                                   |
| <b>DRUM</b>   | Drum Sequencer           | Operates like a mechanical drum sequencer, selecting a 16-bit output pattern from an array of stored patterns, and sending it to a set of outputs.                    |

### 21.4.11 Communication Function

|               |                       |                                                                 |
|---------------|-----------------------|-----------------------------------------------------------------|
| MODBUS_TCP_RW | MODBUS/TCP read/write | Processes read and write requests for MODBUS/TCP Client support |
|---------------|-----------------------|-----------------------------------------------------------------|

### 21.4.12 Motion Functions

|             |             |                                                                                                                      |
|-------------|-------------|----------------------------------------------------------------------------------------------------------------------|
| FIND_HOME   | Find Home   | Defines a Home (zero) position for an axis.                                                                          |
| GO_HOME     | Go Home     | Moves the motor to a position that has been defined by the Find Home function.                                       |
| JOGGING     | Jogging     | Jogs the axis backward or forward at the specified acceleration and velocity.                                        |
| BLENDING    | Blending    | Executes up to four successive moves without the distance and velocity output values retuning to zero between moves. |
| STOP_MOTION | Stop Motion | Stops all motion on the channel while leaving the channel active.                                                    |

# Chapter 22: Program Data and References

This chapter describes the types of data that can be used in an application program, and explains how that data is stored in memory by a VersaMax Nano PLC or VersaMax Micro PLC.

- Data memory references
- Fixed I/O map locations
- Retentiveness of data
- System status references
- Time tick contacts
- How program functions handle numerical data

## 22.1 Data Memory References

Data in PLC programs is referenced by memory addresses that specify both a memory type and a precise address within that memory type. For example:

%I00001 specifies address 1 in Input memory.

%R00256 specifies address 256 in Register memory.

The letter prefix indicates where data is stored in PLC memory.

### 22.1.1 Memory Allocation

The following table shows the types and sizes of available memory in VersaMax Micro and Nano PLCs. (See Appendix B: for a further comparison with the Series 90 Micro PLC.)

| Reference Type             | Reference Range                       | 10-Point<br>Nano PLCs | 14-<br>Point<br>Micro<br>PLCs | 23- and<br>28-Point<br>Micro<br>PLCs | 20-/40-<br>/64-Point<br>Micro<br>PLCs |
|----------------------------|---------------------------------------|-----------------------|-------------------------------|--------------------------------------|---------------------------------------|
| User program logic         | Not applicable                        | 2K words              | 9K words                      | 9K words                             | 48K bytes                             |
| Discrete inputs            | %I0001 - %I0512                       | 512 bits              | 512 bits                      | 512 bits                             | 512 bits                              |
| Discrete outputs           | %Q0001 - %Q0512                       | 512 bits              | 512 bits                      | 512 bits                             | 512 bits                              |
| Discrete global references | %G0001 - %G1280                       | 1280 bits             | 1280 bits                     | 1280 bits                            | 1280 bits                             |
| Discrete internal coils    | %M0001 - %M1024                       | 1024 bits             | 1024 bits                     | 1024 bits                            | 1024 bits                             |
| Discrete temporary coils   | %T0001 - %T0256                       | 256 bits              | 256 bits                      | 256 bits                             | 256 bits                              |
| System status references   | %S0001 - %S0032                       | 32 bits               | 32 bits                       | 32 bits                              | 32 bits                               |
|                            | %SA0001 - %SA0032                     | 32 bits               | 32 bits                       | 32 bits                              | 32 bits                               |
|                            | %SB0001 - %SB0032                     | 32 bits               | 32 bits                       | 32 bits                              | 32 bits                               |
|                            | %SC0001 - %SC0032                     | 32 bits               | 32 bits                       | 32 bits                              | 32 bits                               |
| System register references | %R0001 - %R0256 or<br>%R0001 - %R2042 | 256 words             | 256 words                     | 2K words                             | 32640<br>(close to<br>32k) words      |

| Reference Type                          | Reference Range      | 10-Point<br>Nano PLCs | 14-<br>Point<br>Micro<br>PLCs | 23- and<br>28-Point<br>Micro<br>PLCs | 20-/40-<br>/64-Point<br>Micro<br>PLCs |
|-----------------------------------------|----------------------|-----------------------|-------------------------------|--------------------------------------|---------------------------------------|
| Analog and High-Speed<br>Counter inputs | %AI0001 - %AI0128    | 128 words             | 128<br>words                  | 128 words                            | 128 words                             |
| Analog outputs                          | %AQ0001 -<br>%AQ0128 | 128 words             | 128<br>words                  | 128 words                            | 128 words                             |

\* For viewing only; cannot be referenced in a user logic program.

## 22.1.2 Word Memory References

Each word memory address (reference) is on a 16-bit word boundary. The PLC uses three types of references for data stored in word memory.

**%AI** Normally used for analog inputs

**%AQ** Normally used for analog outputs.

**%R** Registers are normally used to store program data in word format.

An example is represented below. The example shows ten addresses. Each has 16 bits that together contain one value. The PLC cannot directly access individual bits in word memory.

| %R Addresses | Example Value |
|--------------|---------------|
| 0001         | 12467         |
| 0002         | 12004         |
| 0003         | 231           |
| 0004         | 359           |
| 0005         | 14            |
| 0006         | 882           |
| 0007         | 24            |
| 0008         | 771           |
| 0009         | 735           |
| 0010         | 0000          |

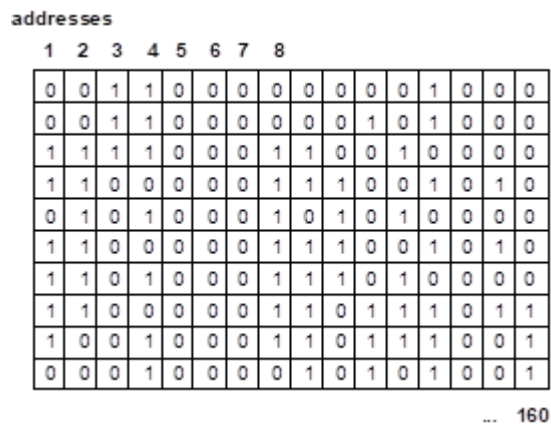
### 22.1.3 Bit Memory References

The PLC uses six types of references for data stored in bit memory.

|    |                                                                                                                                                                                                                                                                                                                                              |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| %I | Normally used for discrete inputs, and viewable in the Input Status Table.                                                                                                                                                                                                                                                                   |
| %Q | Normally used for physical output references, and viewable in the Output Status Table. A %Q reference may be either retentive or non-retentive, depending on its use in the program.                                                                                                                                                         |
| %M | Normally used to represent internal references. A specific %M reference may be either retentive or non-retentive, depending on its use in the program.                                                                                                                                                                                       |
| %T | Used for temporary references that can be used many times in a program. Data with %T references is not retained through loss of power or RUN-TO-STOP-TO-RUN transitions. %T references cannot be used with retentive coils.                                                                                                                  |
| %S | System status references, which have specific predefinitions.<br>%S, %SA, %SB, and %SC can be used for any type of logic contact.<br>%SA, %SB, and %SC can be used for retentive coils.<br>%S can be used as inputs to functions or function blocks.<br>%SA, %SB, and %SC can be used as inputs or outputs of functions and function blocks. |
| %G | Used for Global Data. Data in %G references is retained through power loss. %G references can be used with contacts and retentive coils, but not on non-retentive coils.                                                                                                                                                                     |

Each bit memory address (reference) is on a bit boundary. Data is stored in bit memory as represented below. The example shows 160 individually addressed bits, with address 1 in the upper left and address 160 in the lower right.

**Figure 236**



## Transition Bits and Override Bits

%I, %Q, %M, and %G references have associated transition and override bits.

%T, %S, %SA, %SB, and %SC references have associated transition bits only.

The CPU uses transition bits for transitional coils. When override bits are set, the associated references can only be changed from the programmer.

## 22.2 Fixed I/O Map Locations

A Nano/Micro PLC automatically reserves some memory locations for specific functions. Use of these addresses for other purposes is not recommended.

### 22.2.1 Reserved Bit Memory Locations: %I

|         | Micro PLCs (14- thru 64-Point) |                                                                                            |                                                | Nano PLCs (10-Point)      |                                          |                       |                                   |
|---------|--------------------------------|--------------------------------------------------------------------------------------------|------------------------------------------------|---------------------------|------------------------------------------|-----------------------|-----------------------------------|
| Address | Standard Inputs                | 4 Type A Counters                                                                          | 1 Type A and 1 Type B                          | Standard Inputs           | 3 Type A Counters                        | 1 Type A and 1 Type B |                                   |
| %I      | 0001                           | Input 1                                                                                    | Count 1                                        | Type B counter (Phase 1)  | Input 1                                  | Count 1               | Type B counter (Phase 1)          |
|         | 0002                           | Input 2                                                                                    | Preload/Strobe 1 or Home Input 1 <sup>14</sup> | Not used                  | Input 2                                  | Preload/Strobe 1      | Not used                          |
|         | 0003                           | Input 3                                                                                    | Count 2                                        | Type B counter (Phase 2)  | Input 3                                  | Count 2               | Type B counter (Phase 2)          |
|         | 0004                           | Input 4                                                                                    | Preload/Strobe 2 or Home Input 2 <sup>14</sup> | Not used                  | Input 4                                  | Preload/Strobe 2      | Preload/Strobe for Type B counter |
|         | 0005                           | Input 5                                                                                    | Count 3                                        | Not used                  | Input 5                                  | Count 3               | Type A counter: Count Input       |
|         | 0006                           | Input 6                                                                                    | Preload/Strobe 3 or Home Input 3 <sup>14</sup> | Preload/Strobe for Type B | Input 6                                  | Preload/Strobe 3      | Type A counter: Preload/Strobe    |
|         | 0007                           | Input 7                                                                                    | Count 4                                        | Type A counter: Count 4   | --                                       |                       |                                   |
|         | 0008                           | Input 8                                                                                    | Preload/Strobe 4 or Home Input 4 <sup>14</sup> | Preload/Strobe 4          | --                                       |                       |                                   |
|         | 0009-16                        | Inputs for 23-/28-point Micros, Default first discrete input for 14-pt PLCs, configurable. |                                                |                           |                                          |                       |                                   |
|         | 0017                           | Default first discrete input from expansion unit (28/23pt PLCs), can be reconfigured.      |                                                |                           |                                          |                       |                                   |
|         | 0488                           | Micro 20-, 40-, 60-: Ethernet Option Module configured for Modbus/TCP Client operation.    |                                                |                           | NA                                       |                       |                                   |
|         | 0494 to 0496                   | Pulse Train Complete for channels 1 to 3                                                   |                                                |                           | Pulse Train Complete for channels 1 to 3 |                       |                                   |
|         | 0497 to 0499                   | Strobe status bits for channels 1 to 3                                                     |                                                |                           | Strobe status bits for channels 1 to 3   |                       |                                   |
|         | 00500                          | Strobe status bit for channels 4                                                           |                                                |                           | --                                       |                       |                                   |
|         | 0501 to 0503                   | Preload status bits for channels 1 to 3                                                    |                                                |                           | Preload status bits for channels 1 to 3  |                       |                                   |
|         | 0504                           | Preload status bit for channel 4                                                           |                                                |                           | --                                       |                       |                                   |
|         | 0505 to 0507                   | Output status bits for channels 1 to 3                                                     |                                                |                           | Output status bits for channels 1 to 3   |                       |                                   |
|         | 0508                           | Output status bit for channel 4                                                            |                                                |                           | --                                       |                       |                                   |
|         | 0511                           | Pulse Train Complete for channel 4                                                         |                                                |                           | --                                       |                       |                                   |
|         | 0512                           | Counter Error status                                                                       |                                                |                           |                                          |                       |                                   |

<sup>14</sup> %I0002, I0004, I0006, and I0008 are reserved as Home Inputs only for Micro-20, -40, and -64 CPUs that are configured for 32-bit counter operation (either 4 Type A Counters, 32 bits, or 1 Type A and 1 Type B counter 32 bits).

## 22.2.2 Reserved Bit Memory Locations: %Q

|         | Micro PLCs (14- thru 64-Point) |                                                                                                              |                             | Nano PLCs (10-Point)  |                   |                             |                       |
|---------|--------------------------------|--------------------------------------------------------------------------------------------------------------|-----------------------------|-----------------------|-------------------|-----------------------------|-----------------------|
| Address | Standard Outputs               | 4 Type A Counters                                                                                            | 1 Type A and 1 Type B       | Standard Outputs      | 3 Type A Counters | 1 Type A and 1 Type B       |                       |
| %Q      | 0001                           | Output 1                                                                                                     | Counter 1<br>Output/PWM/PT1 |                       | Output 1          | Counter 1<br>Output/PWM/PT1 | Type B Counter Output |
|         | 0002                           | Output 2                                                                                                     | Counter 2<br>Output/PWM/PT2 |                       | Output 2          | Counter 2<br>Output/PWM/PT2 | Standard Output 2     |
|         | 0003                           | Output 3                                                                                                     | Counter 3<br>Output/PWM/PT3 | Standard Output 3     | Output 3          | Counter 3<br>Output/PWM/PT3 | Type A Counter Output |
|         | 0004                           | Output 4                                                                                                     | Counter 4<br>Output/PWM/PT4 | Type A Counter Output | Output 4          | Standard                    | Standard Output 4     |
|         | 0005                           | Output 5                                                                                                     |                             |                       |                   |                             |                       |
|         | 0006                           | Output 6                                                                                                     |                             |                       |                   |                             |                       |
|         | 0007-0009                      | Outputs 7-9                                                                                                  |                             |                       |                   |                             |                       |
|         | 0007-0016                      | Outputs for 23- and 28-point Micro PLCs, Default first discrete output for 14-pt PLCs (can be reconfigured). |                             |                       |                   |                             |                       |
|         | 0017                           | Default first discrete output for expansion unit (28/23pt PLCs), can be reconfigured.                        |                             |                       |                   |                             |                       |
|         | 0489-0492                      | Input Direction for Channel 1 to Channel 4                                                                   |                             |                       | Reserved          |                             |                       |
|         | 0493                           | Reserved                                                                                                     |                             |                       |                   |                             |                       |
|         | 0494                           | Start Q1 Pulse Train                                                                                         |                             |                       |                   |                             |                       |
|         | 0495                           | Start Q2 Pulse Train                                                                                         |                             |                       |                   |                             |                       |
|         | 0496                           | Start Q3 Pulse Train                                                                                         |                             |                       |                   |                             |                       |
|         | 0497                           | Clear Strobe bit for HSC 1                                                                                   |                             |                       |                   |                             |                       |
|         | 0498                           | Clear Strobe bit for HSC 2                                                                                   |                             |                       |                   |                             |                       |
|         | 0499                           | Clear Strobe bit for HSC 3                                                                                   |                             |                       |                   |                             |                       |
|         | 0500                           | Clear Strobe bit for HSC 4                                                                                   |                             |                       | Reserved          |                             |                       |
|         | 0501                           | Reset Preload bit HSC 1                                                                                      |                             |                       |                   |                             |                       |
|         | 0502                           | Reset Preload bit HSC 2                                                                                      |                             |                       |                   |                             |                       |
|         | 0503                           | Reset Preload bit HSC 3                                                                                      |                             |                       |                   |                             |                       |
|         | 0504                           | Reset Preload bit HSC 4                                                                                      |                             |                       | Reserved          |                             |                       |
|         | 0505                           | Enable Output HSC 1/PTO/PTM                                                                                  |                             |                       |                   |                             |                       |
|         | 0506                           | Enable Output HSC 2/PTO/PTM                                                                                  |                             |                       |                   |                             |                       |
|         | 0507                           | Enable Output HSC 3/PTO/PTM                                                                                  |                             |                       |                   |                             |                       |
|         | 0508                           | Enable Output HSC 4/PTO/PTM                                                                                  |                             |                       | Reserved          |                             |                       |
|         | 0509-510                       | Not used but unavailable                                                                                     |                             |                       |                   |                             |                       |
|         | 0511                           | Start Q4 Pulse Train                                                                                         |                             |                       | Reserved          |                             |                       |
|         | 0512                           | Clear Error (all counters)                                                                                   |                             |                       |                   |                             |                       |



## 22.2.3 Reserved Word Memory Locations: %AI

| Address | Micro PLCs (14- thru 64-Point)                      |                                                                                | Nano PLCs (10-Point)                                         |                       |                          |  |
|---------|-----------------------------------------------------|--------------------------------------------------------------------------------|--------------------------------------------------------------|-----------------------|--------------------------|--|
|         | 4 Type A Counter or<br>1 Type A / 1 Type B: 16 Bits | 4 Type A Counter 32 Bits<br>1 Type A / 1 Type B:<br>32 Bits (Micro-20/-40/-64) | Standard<br>Outputs                                          | 3 Type A<br>Counters  | 1 Type A and<br>1 Type B |  |
| %AI     | 001                                                 | Module Status code                                                             |                                                              |                       |                          |  |
|         | 002                                                 | Counts per timebase HSC 1                                                      |                                                              |                       |                          |  |
|         | 003                                                 | Counts per timebase HSC 2                                                      |                                                              |                       |                          |  |
|         | 004                                                 | Counts per timebase HSC 3                                                      |                                                              |                       |                          |  |
|         | 005                                                 | Counts per timebase HSC 4                                                      |                                                              |                       |                          |  |
|         | 006                                                 | Accumulator HSC 1 channel 1                                                    | Accumulator or Position<br>Register, channel 1               | Accumulator HSC 1     |                          |  |
|         | 007                                                 | Strobe Register HSC 1 channel 2                                                |                                                              | Strobe Register HSC 1 |                          |  |
|         | 008                                                 | Accumulator HSC 2 channel 3 or<br>Position Register, channel 1                 | Strobe Register HSC 1                                        | Accumulator HSC 2     |                          |  |
|         | 009                                                 | Strobe Register HSC 2 channel 4                                                |                                                              | Strobe Register HSC 2 |                          |  |
|         | 010                                                 | Accumulator HSC 3                                                              | Accumulator or Position<br>Register, channel 2               | Accumulator HSC 3     |                          |  |
|         | 011                                                 | Strobe Register HSC 3                                                          |                                                              | Strobe Register HSC 3 |                          |  |
|         | 012                                                 | Accumulator HSC 4                                                              | Strobe Register HSC 2                                        |                       |                          |  |
|         | 013                                                 | Strobe Register HSC 4                                                          |                                                              |                       |                          |  |
|         | 014                                                 | Not used (set to 0)                                                            |                                                              |                       |                          |  |
|         | 015                                                 | Not used (set to 0)                                                            |                                                              |                       |                          |  |
|         | 016                                                 | Analog potentiometer 1                                                         |                                                              |                       |                          |  |
|         | 017                                                 | Analog potentiometer 2                                                         |                                                              |                       |                          |  |
|         | 018                                                 | Analog input channel 1                                                         |                                                              |                       |                          |  |
|         | 019                                                 | Analog input channel 2                                                         |                                                              |                       |                          |  |
|         | 020-021                                             | Inputs 1 - 4 from 1st analog<br>expansion unit <sup>15</sup>                   | Accumulator or Position<br>Register, channel 3               |                       |                          |  |
|         | 022-023                                             |                                                                                | Strobe Register HSC 3                                        |                       |                          |  |
|         | 024-025                                             | Inputs 1 - 4 from 2nd analog<br>expansion unit <sup>15</sup>                   | Accumulator or Position<br>Register, channel 4               |                       |                          |  |
|         | 026-027                                             |                                                                                | Strobe Register HSC 4                                        |                       |                          |  |
|         | 028-029                                             | Inputs 1 - 4 from 3rd analog<br>expansion unit <sup>15</sup>                   | Inputs 1 - 4 from 1st analog<br>expansion unit <sup>15</sup> |                       |                          |  |
|         | 030-031                                             |                                                                                |                                                              |                       |                          |  |
|         | 032-033                                             | Inputs 1 - 4 from 4th analog<br>expansion unit <sup>15</sup>                   | Inputs 1 - 4 from 2nd analog<br>expansion unit <sup>15</sup> |                       |                          |  |
|         | 034-035                                             |                                                                                |                                                              |                       |                          |  |
|         | 036-039                                             | Available references                                                           | Inputs 1 - 4 from 3rd analog<br>expansion unit <sup>15</sup> |                       |                          |  |
|         | 040-043                                             |                                                                                | Inputs 1 - 4 from 4th analog<br>expansion unit <sup>15</sup> |                       |                          |  |

<sup>15</sup> can be reconfigured.

| Address | Micro PLCs (14- thru 64-Point)                      |                                                                                | Nano PLCs (10-Point) |                      |                          |
|---------|-----------------------------------------------------|--------------------------------------------------------------------------------|----------------------|----------------------|--------------------------|
|         | 4 Type A Counter or<br>1 Type A / 1 Type B: 16 Bits | 4 Type A Counter 32 Bits<br>1 Type A / 1 Type B:<br>32 Bits (Micro-20/-40/-64) | Standard<br>Outputs  | 3 Type A<br>Counters | 1 Type A and<br>1 Type B |
| 044-128 | Available references                                |                                                                                |                      |                      |                          |

## 22.2.4 Reserved Word Memory Locations: %AQ

| Address | Micro PLCs (14- thru 64-Point)                         |                                                                                | Nano PLCs (10-Point) |                      |                             |
|---------|--------------------------------------------------------|--------------------------------------------------------------------------------|----------------------|----------------------|-----------------------------|
|         | 4 Type A Counter or<br>1 Type A / 1 Type B:<br>16 Bits | 4 Type A Counter 32 Bits<br>1 Type A / 1 Type B:<br>32 Bits (Micro-20/-40/-64) | Standard<br>Outputs  | 3 Type A<br>Counters | 1 Type A<br>and<br>1 Type B |
| %AQ     | 001                                                    | Controls the number of input samples for analog potentiometer input filtering. | Available            |                      |                             |
|         | 002                                                    | PWM Frequency Q1                                                               | Available            | PWM Frequency Q1     |                             |
|         | 003                                                    | PWM Duty Cycle Q1                                                              | Available            | PWM Duty Cycle Q1    |                             |
|         | 004                                                    | PWM Frequency Q2                                                               | Available            | PWM Frequency 2      | Available                   |
|         | 005                                                    | PWM Duty Cycle Q2                                                              | Available            | PWM Duty Cycle 2     | Available                   |
|         | 006                                                    | PWM Frequency Q3                                                               | Available            | PWM Frequency 3      | Available                   |
|         | 007                                                    | PWM Duty Cycle Q3                                                              | Available            | PWM Duty Cycle 3     | Available                   |
|         | 008                                                    | PWM Frequency Q4                                                               | Available            |                      |                             |
|         | 009                                                    | PWM Duty Cycle Q4                                                              | Available            |                      |                             |
|         | 011                                                    | Discrete input filtering time value                                            | Available            |                      |                             |
|         | 012                                                    | Analog output channel 1                                                        | Available            |                      |                             |
|         | 013,014                                                | Outputs 1, 2 for 1st analog expansion unit, can be reconfigured                | Available            |                      |                             |
|         | 015,016                                                | Outputs 1, 2 for 2nd analog expansion unit, can be reconfigured                | Available            |                      |                             |
|         | 017,018                                                | Outputs 1, 2 for 3rd analog expansion unit, can be reconfigured                | Available            |                      |                             |
|         | 019,020                                                | Outputs 1, 2 for 4th analog expansion unit, can be reconfigured                | Available            |                      |                             |
|         | 117-120                                                | Available                                                                      | Available            |                      |                             |
|         | 121                                                    | Frequency of Q4 pulse train                                                    | Available            |                      |                             |
|         | 122                                                    | Number of pulses to send to Q4 output (0 to 65535)                             |                      |                      |                             |
|         | 123                                                    | Frequency of Q1 pulse train                                                    | Available            | PT Frequency Q1      |                             |
|         | 124                                                    | Number of pulses to send to Q1 output (0 to 65535)                             | Available            | Number of Pulses Q1  |                             |
|         | 125                                                    | Frequency of Q2 pulse train                                                    | Available            | Frequency 2          | Available                   |
|         | 126                                                    | Number of pulses to send to Q2 output (0 to 65535)                             | Available            | Pulses 2             | Available                   |
|         | 127                                                    | Frequency of Q3 pulse train                                                    | Available            | Frequency 3          | Available                   |
|         | 128                                                    | Number of pulses to send to Q3 output (0 to 65535)                             | Available            | Pulses 3             | Available                   |

## 22.3 Retentiveness of Data

Data is called “retentive” if it is automatically saved when the PLC is stopped. Retentive data is also saved when the PLC is power cycled on units that have capacitor or battery-backed memory. The following data is retentive:

- Program logic
- Fault tables and diagnostics
- Overrides
- Word data (%R, %AI, %AQ)
- Bit data (%I, %SC, %G, fault bits and reserved bits)
- Word data stored in %Q and %M.
- Data in %Q or %M references that are used as function block outputs or with retentive coils:
  - (M)- retentive coils
  - (/M)- negated retentive coils
  - (SM)- retentive SET coils
  - (RM)- retentive RESET coils

The last time a %Q or %M reference is used with a coil, the coil type determines whether the data is retentive or non-retentive. For example, if %Q0001 was last programmed as the reference of a retentive coil, the %Q0001 data is retentive. However, if %Q0001 was last programmed on a non-retentive coil, then the %Q0001 data is non-retentive.

- %Q or %M references that have been made retentive by specifically declaring them to be retentive. %Q and %M references default to non-retentive.

The following data is non-retentive:

- %T data
- %S, %SA, and %SB data (but %SC bit data IS retentive).
- %Q and %M references that have not been declared to be retentive.
- %Q and %M references that are used with non-retentive coils:
  - ( )- coils
  - (/)- negated coils
  - (S)- SET coils
  - (R)- RESET coils

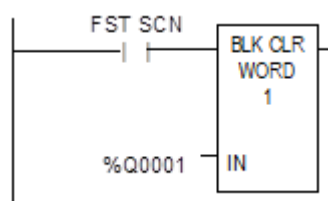
## 22.4 System Status References

The Nano/Micro PLC stores status and other system data in predefined references in %S, %SA, %SB, and %SC memory. Tables on the following pages list all of the System Status References.

### 22.4.1 Using the System Status References

System status references can be used as needed in application programs. For easier programming, each system status reference has a descriptive nickname. For example, the following function block uses the FST\_SCN (first scan) status reference to control power flow to a Block Clear function.

**Figure 237**



Other system status reference nicknames include T\_10MS, T\_100MS, T\_SEC, and T\_MIN (see below), FST\_SCN, ALW\_ON, and ALW\_OFF.

### 22.4.2 Time-Tick References

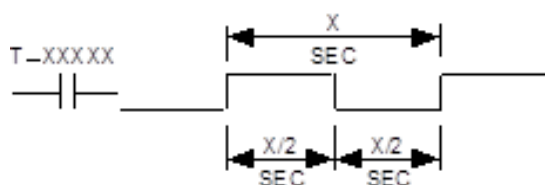
Time-tick contacts represent specific locations in %S memory. They can be used to provide regular pulses of power flow to other program functions. The four time-tick contacts have time durations of 0.01 second, 0.1 second, 1.0 second, and 1 minute.

The state of these contacts does not change during the execution of the sweep. These contacts provide a pulse having an equal on and off time duration.

The contacts are referenced as T\_10MS (0.01 second), T\_100MS (0.1 second), T\_SEC (1.0 second), and T\_MIN (1 minute).

The following timing diagram represents the on/off time duration of these contacts.

**Figure 238**



## 22.4.3 %S References

References in %S memory are read only.

| Reference  | Nickname | Definition                                                                                                                                    |
|------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| %S0001     | FST_SCN  | Set to 1 when the current sweep is the first sweep.                                                                                           |
| %S0002     | LST_SCN  | Reset from 1 to 0 when the current sweep is the last sweep.                                                                                   |
| %S0003     | T_10MS   | 0.01 second timer contact.                                                                                                                    |
| %S0004     | T_100MS  | 0.1 second timer contact.                                                                                                                     |
| %S0005     | T_SEC    | 1.0 second timer contact.                                                                                                                     |
| %S0006     | T_MIN    | 1.0-minute timer contact.                                                                                                                     |
| %S0007     | ALW_ON   | Always ON.                                                                                                                                    |
| %S0008     | ALW_OFF  | Always OFF.                                                                                                                                   |
| %S0009     | SY_FULL  | Set when the PLC fault table fills up. Cleared when an entry is removed and when the PLC fault table is cleared.                              |
| %S0010     | IO_FULL  | Set when the I/O fault table fills up. Cleared when an entry is removed from the I/O fault table and when the I/O fault table is cleared.     |
| %S0011     | OVR_PRE  | Set when an override exists in %, %Q, %M, or %G memory.                                                                                       |
| %S0012     |          | reserved                                                                                                                                      |
| %S0013     | PRG_CHK  | Set when background program check is active. Cleared when the background program check is inactive.                                           |
| %S0014     | PLC_BAT  | Set to indicate a bad battery in the CPU. The contact reference is updated once per sweep. This bit is supported by 28-point Micro PLCs only. |
| %S0015, 16 |          | reserved                                                                                                                                      |
| %S0017     | SNPXACT  | SNP-X host is actively attached to CPU port 1. (Port 2 defaults to disabled and must be activated with a CRQ).                                |
| %S0018     | SNPX_RD  | SNP-X host has read data from CPU port 1.                                                                                                     |
| %S0019     | SNPX_WT  | SNP-X host has written data to CPU port 1.                                                                                                    |
| %S0020     |          | Set ON when a relational function using REAL data executes successfully. It is cleared when either input is NaN (Not a Number).               |
| %S0021     | FF_OVR   | Set to report a Fatal Fault Override.                                                                                                         |
| %S0022     | USR_SW   | Set to reflect the state of the CPU mode switch.<br>1 = Run/On<br>0 = Stop/Off                                                                |
| %S0023-32  |          | reserved                                                                                                                                      |

## 22.4.4 %SA, %SB, and %SC References

References in %SA, %SB, and %SC memory can be both read and written to.

| Reference  | Nickname | Definition                                                                                                                                                                                                                                                                                               |
|------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| %SA0001    | PB_SUM   | Set when a checksum calculated on the application program does not match the reference checksum. If the fault was due to a temporary failure, the discrete bit can be cleared by again storing the program to the Micro PLC. If the fault was due to a hard RAM failure, the Micro PLC must be replaced. |
| %SA0002    | OV_SWP   | Set when a Micro PLC in CONSTANT SWEEP mode detects that the previous sweep took longer than the time specified. Cleared when the PLC detects that the previous sweep did not take longer than specified. Also cleared during transition from STOP to RUN mode.                                          |
| %SA0003    | APL_FLT  | Set when an application fault occurs. Cleared when the Micro PLC transitions from STOP to RUN mode.                                                                                                                                                                                                      |
| %SA0004-8  |          | reserved                                                                                                                                                                                                                                                                                                 |
| %SA0009    | CFG_MM   | Set when a configuration mismatch is detected during power-up or a configuration store. Cleared by powering up the Micro PLC after correcting the condition.                                                                                                                                             |
| %SA0010    | HRD_CPU  | Set when the diagnostics detects a problem with the Micro PLC TOD clock.<br>This bit is not supported by Nano and 14-point Micro PLCs.                                                                                                                                                                   |
| %SA0011    | LOW_BAT  | Set when a low battery fault occurs. Cleared by replacing the battery then powering up the Micro PLC.<br>This bit is not supported by Nano and 14-point Micro PLCs.                                                                                                                                      |
| %SA0012,13 |          | reserved                                                                                                                                                                                                                                                                                                 |
| %SA0014    | LOS_IOM  | Set when an expansion module stops communicating with the CPU. Cleared by replacing the module and cycling system power.                                                                                                                                                                                 |
| %SA0015-18 |          | reserved                                                                                                                                                                                                                                                                                                 |
| %SA0019    | ADD_IOM  | Set when an expansion module is added. Cleared by cycling PLC power and when the configuration matches the hardware after a store.                                                                                                                                                                       |
| %SA0020-31 |          | reserved                                                                                                                                                                                                                                                                                                 |
| %SB0001-8  |          | reserved                                                                                                                                                                                                                                                                                                 |
| %SB0009    | NO_PROG  | Set when an attempt is made to put the PLC in Run mode when there is no executable application program stored in the CPU. Cleared by storing an application program to the CPU and putting the PLC in Run mode.                                                                                          |
| %SB0010    | BAD_RAM  | Set when the Micro PLC detects corrupted RAM memory at power-up. Cleared when RAM memory is valid at power-up.                                                                                                                                                                                           |
| %SB0011    | BAD_PWD  | Set when a password access violation occurs. Cleared when the PLC fault table is cleared.                                                                                                                                                                                                                |
| %SB0012    |          | reserved                                                                                                                                                                                                                                                                                                 |
| %SB0013    | SFT_CPU  | Set when the Micro PLC detects an unrecoverable error in the software. Cleared by clearing the PLC fault table.                                                                                                                                                                                          |

| Reference | Nickname | Definition                                                                                                                                      |
|-----------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| %SB0014   | STOR_ER  | Set when an error occurs during a programmer store operation. Cleared when a store operation is completed successfully.                         |
| %SC0001-8 |          | reserved                                                                                                                                        |
| %SC0009   | ANY_FLT  | Set when any fault occurs. Cleared when both fault tables are cleared.                                                                          |
| %SC0010   | SY_FLT   | Set when any fault occurs that causes an entry to be placed in the PLC fault table. Cleared when the PLC fault table is cleared.                |
| %SC0011   | IO_FLT   | Set when any fault occurs that causes an entry to be placed in the I/O fault table. Cleared when the I/O fault table is cleared.                |
| %SC0012   | SY_PRES  | Set as long as there is at least one entry in the PLC fault table. Cleared when the PLC fault table has no entries.                             |
| %SC0013   | IO_PRES  | Set as long as there is at least one entry in the I/O fault table. Cleared when the I/O fault table has no entries.                             |
| %SC0014   | HRD_FLT  | Set when a hardware fault occurs. Cleared when both fault tables have no entries.<br>This bit is not supported by Nano and 14-point Micro PLCs. |
| %SC0015   | SFT_FLT  | Set when a software fault occurs. Cleared when both fault tables have no entries.                                                               |

## 22.5 How Program Functions Handle Numerical Data

Regardless of where data is stored in memory—in one of the bit memories or one of the word memories—the application program can handle it as different data types.

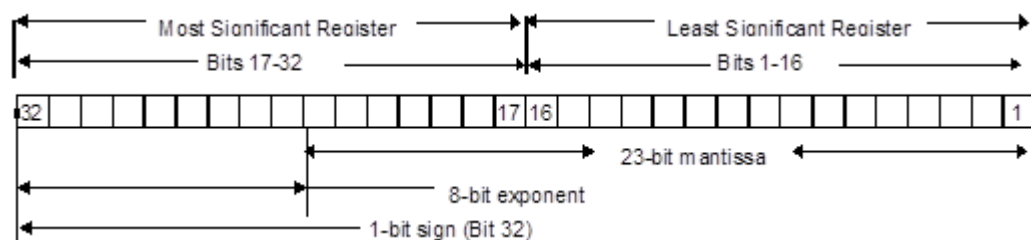
| Type  | Name                            | Description                                                                                                                                                                                                                               | Data Format                                                                      |
|-------|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| BIT   | Bit                             | A Bit data type is the smallest unit of memory. It has two states, 1 or 0.                                                                                                                                                                |                                                                                  |
| BYTE  | Byte                            | A Byte data type has an 8-bit value. The valid range is 0 to 255 (0 to FF in hexadecimal).                                                                                                                                                |                                                                                  |
| WORD  |                                 | A Word data type uses 16 consecutive bits of data memory that are not separately addressable to hold a value in the range of 0 to +65,535 (FFFF).                                                                                         | <p>Word 1</p> <p>16 bit positions</p> <p>16 1</p>                                |
| DWORD | Double Word                     | Has the same characteristics as a single word data type, except that it uses 32 consecutive bits in data memory instead of only 16 bits.                                                                                                  | <p>Word 2 Word 1</p> <p>32 17 16 1</p> <p>32 bit positions</p>                   |
| BCD-4 | Four-Digit Binary Coded Decimal | Four-digit BCD numbers use 16-bit data memory locations. Each BCD digit uses four bits and can represent numbers between 0 and 9. This BCD coding of the 16 bits has a value range of 0 to 9999.                                          | <p>Word 1</p> <p>4 3 2 1 4 BCD Digits</p> <p>16 13 9 5 1 Bit Positions</p>       |
| REAL  | Floating-Point                  | Real numbers use two consecutive 16-bit memory locations. The range of numbers that can be stored in this format is $\pm 1.401298\text{E-}45$ to $\pm 3.402823\text{E+}38$ . See the next page for more information.                      | <p>Word 2 Word 1</p> <p>32 17 16 1</p> <p>8 bit exponent 23 bit mantissa</p>     |
| INT   | Signed Integer                  | Signed integer data uses 16-bit memory locations. Signed integers are represented in 2's complement notation. Bit 16 is the sign bit, (0 = positive, 1 = negative). Range is -32,768 to +32,767.                                          | <p>Word 1</p> <p>16 bit positions</p> <p>16 1</p> <p>Two's Complement Values</p> |
| DINT  | Double Precision Signed Integer | Double precision signed integers data uses two consecutive 16-bit memory locations. They are represented in 2's complement notation. Bit 32 is the sign bit, (0 = positive, 1 = negative). The range is -2,147,483,648 to +2,147,483,647. | <p>Word 2 Word 1</p> <p>32 17 16 1</p> <p>Two's Complement Values</p>            |



## 22.5.1 Real Numbers (Floating Point)

The REAL data type, which can be used for some Math functions and Numerical functions, is actually floating point data. Floating-point numbers are stored in single precision IEEE-standard format. This format requires 32 bits, which occupy two (adjacent) 16-bit PLC words.

**Figure 239**



For example, if the floating-point number occupies registers %R0005 and %R0006, then %R0005 is the least significant register and %R0006 is the most significant register.

The range of numbers that can be stored in this format is from  $\pm 1.401298E-45$  to  $\pm 3.402823E+38$  and the number zero.

## 22.5.2 Errors in Real Numbers and Operations

Overflow occurs when a number greater than  $3.402823E+38$  or less than  $-3.402823E+38$  is generated by a REAL function. The ok output of the function is set OFF; and the result is set to positive infinity (for a number greater than  $3.402823E+38$ ) or negative infinity (for a number less than  $-3.402823E+38$ ). You can determine where this occurs by testing the sense of the ok output.

POS\_INF = 7F800000h – IEEE positive infinity representation in hex.

NEG\_INF = FF800000h – IEEE negative infinity representation in hex.

If the infinities produced by overflow are used as operands to other REAL functions, they may cause an undefined result. This result is referred to as NaN (Not a Number). For example, the result of adding positive infinity to negative infinity is undefined. When the ADD\_REAL function is invoked with positive infinity and negative infinity as its operands, it produces NaN for its result.

# Chapter 23: Instruction Set Reference

This section is a reference to the functions in the VersaMax Nano PLC and Micro PLC Instruction Set:

## Bit Operation Functions

- Logical AND, Logical OR
- Exclusive OR, Logical Invert (NOT)
- Shift Right/Shift Left
- Rotate Right/Rotate Left
- Bit Test, Bit Set, Bit Clear
- Masked Compare
- Bit Position
- Bit Sequencer

## Control Functions

- Do I/O
- Call
- End
- Comment
- Jump
- Master Control Relay
- Drum Sequencer
- Service Request (see Chapter 24:)
- PID (see Chapter 26:)

## Communication

- MODBUS\_TCP\_RW (see Chapter 14:)

## Data Move Functions

- Move
- Block Move
- Block Clear
- Shift Register
- Communication Request

## Data Type Conversion Functions

- Convert to BCD-4
- Convert to Signed Integer
- Convert to Double Precision Signed Integer
- Convert to Real
- Convert Real to Word
- Truncate Real Number

## Math and Numerical Functions

- Add, Subtract, Multiply, divide
- Modulo Division
- Scaling
- Square Root
- Trigonometric Functions
- Logarithmic/Exponential Functions
- Convert Radians / Degrees

## Motion Functions (See Chapter 19:)

- Find Home
- Go Home
- Jogging
- Blending
- Stop Motion

## Relational Functions

- Equal
- Not Equal
- Greater Than
- Less Than
- Greater or Equal
- Less or Equal
- Range

## Relay Functions

- Contacts, Coils
- Fault and No Fault Contacts
- Alarm Contacts

## Table Functions

- Array Move
- Search

## Timer and Counter Functions

- Time-tick Contacts
- On Delay Stopwatch Timer
- On Delay Timer
- Off Delay Timer
- Up Counter
- Down Counter

## 23.1 Bit Operation Functions

The Bit Operation functions perform comparison, logical, and move operations on bit strings. The Bit Operation functions are:

- Logical AND
- Logical OR
- Exclusive OR
- Logical Invert (NOT)
- Shift Right/Shift Left
- Rotate Right/Rotate Left
- Bit Test
- Bit Set, Bit Clear
- Masked Compare
- Bit Position
- Bit Sequencer

### 23.1.1 Data Lengths for the Bit Operation functions

The Logical AND, OR, XOR, and NOT (Invert) functions operate on a single word of data. The other Bit Operation functions may operate on up to 256 words.

All Bit Operation functions require Word-type data. However, they operate on data as a continuous string of bits, with bit 1 of the first word being the Least Significant Bit (LSB). The last bit of the last word is the Most Significant Bit (MSB). For example, if you specified three words of data beginning at reference %R0100, it would be operated on as 48 contiguous bits.

|        |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |               |
|--------|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---------------|
| %R0100 | 16    | 15 | 14 | 13 | 12 | 11 | 10 | 9  | 8  | 7  | 6  | 5  | 4  | 3  | 2  | 1  | ← bit 1 (LSB) |
| %R0101 | 32    | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | ■             |
| %R0102 | 48    | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 40 | 39 | 38 | 37 | 36 | 35 | 34 | 33 | ■             |
| ■      | ↑     | ■  | ■  | ■  | ■  | ■  | ■  | ■  | ■  | ■  | ■  | ■  | ■  | ■  | ■  | ■  | ■             |
| ■      | (MSB) | ■  | ■  | ■  | ■  | ■  | ■  | ■  | ■  | ■  | ■  | ■  | ■  | ■  | ■  | ■  | ■             |

Overlapping input and output reference address ranges in multi-word functions is not recommended, it can produce unexpected results.

## 23.1.2 Bit Operation Functions

### Logical AND, Logical OR

Each scan that power is received, a Logical AND or Logical OR function examines each bit in bit string IN1 and the corresponding bit in bit string IN2, beginning at the least significant bit in each. A string length of 256 words can be selected.

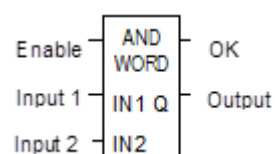
#### Logical AND

If both bits examined by the Logical AND function are 1, a 1 is placed in the corresponding location in output string Q. If either or both bits are 0, a 0 is placed in string Q in that location. The Logical AND function can be used to build masks or screens, where only certain bits are passed through (bits opposite a 1 in the mask), and all other bits are set to 0. The Logical AND function can also be used to clear an area of word memory by ANDing the bits with another bit string known to contain all 0s. The IN1 and IN2 bit strings specified may overlap.

#### Logical OR

If either or both bits examined by the Logical OR function is 1, a 1 is placed in the corresponding location in output string Q. If both bits are 0, a 0 is placed in string Q in that location. The Logical OR function can be used to combine strings or to control many outputs with one simple logical structure. The Logical OR function is the equivalent of two relay contacts in parallel multiplied by the number of bits in the string. It can be used to drive indicator lamps directly from input states, or to superimpose blinking conditions on status lights.

Figure 240



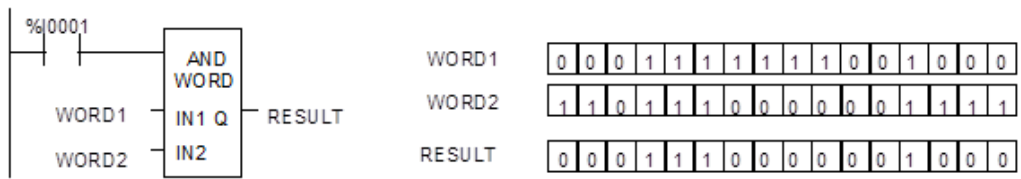
Parameters of the Logical AND and Logical OR Functions

| Input/<br>Output | Choices                                      | Description                                                    |
|------------------|----------------------------------------------|----------------------------------------------------------------|
| enable           | flow                                         | When the function is enabled, the operation is performed.      |
| I1               | I, Q, M, T, S, G, R, AI, AQ, constant        | Constant or reference for the first word of the first string.  |
| I2               | I, Q, M, T, S, G, R, AI, AQ, constant        | Constant or reference for the first word of the second string. |
| ok               | flow, none                                   | The OK output is energized whenever enable is energized.       |
| Q                | I, Q, M, T, SA, SB, SC (not S), G, R, AI, AQ | Output Q contains the result of the operation.                 |

Example of the Logical AND Function

In the example, when input %I0001 is set, the 16-bit strings represented by nicknames WORD1 and WORD2 are examined. The results of the Logical AND are placed in output string RESULT.

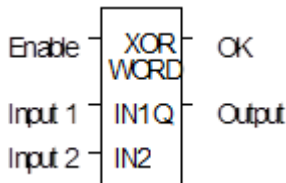
Figure 241



23.1.3 Bit Operation Functions  
Exclusive OR

The Exclusive OR function compares each bit in bit string IN1 with the corresponding bit in string IN2. If the bits are different, a 1 is placed in the corresponding position in the output bit string.

Figure 242



Each scan that power is received, the Exclusive OR function examines each bit in string IN1 and the corresponding bit in string IN2, beginning at the least significant bit in each. For each two bits examined, if only one is 1, then a 1 is placed in the corresponding location in bit string Q. The Exclusive OR function passes power flow to the right whenever power is received.

If string IN2 and output string Q begin at the same reference, a 1 placed in string IN1 will cause the corresponding bit in string IN2 to alternate between 0 and 1, changing state with each scan as long as power is received. Longer cycles can be programmed by pulsing the power flow to the function at twice the desired rate of flashing; the power flow pulse should be one scan long (one-shot type coil or self-resetting timer).

The Exclusive OR function is useful for quickly comparing two-bit strings, or to blink a group of bits at the rate of one ON state per two scans.

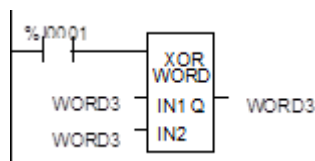
## Parameters of the Exclusive OR Function

| Input/<br>Output | Choices                                      | Description                                               |
|------------------|----------------------------------------------|-----------------------------------------------------------|
| enable           | flow                                         | When the function is enabled, the operation is performed. |
| IN1              | I, Q, M, T, S, G, R, AI, AQ, constant        | Constant or reference for the first word to be XORed.     |
| IN2              | I, Q, M, T, S, G, R, AI, AQ, constant        | Constant or reference for the second word to be XORed.    |
| ok               | flow, none                                   | The OK output is energized whenever enable is energized.  |
| Q                | I, Q, M, T, SA, SB, SC (not S), G, R, AI, AQ | Output Q contains the result of the operation.            |

### Example

In the example, whenever %I0001 is set, the bit string represented by the nickname WORD3 is cleared (set to all zeros).

Figure 243



|             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|-------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IN1 (WORD3) | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| IN2 (WORD3) | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| Q (WORD3)   | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

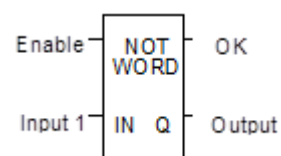
## 23.1.4 Bit Operation Functions

### Logical Invert (NOT)

The Logical Invert (NOT) function sets the state of each bit in the output bit string Q to the opposite of the state of the corresponding bit in bit string IN1.

All bits are altered on each scan that power is received, making output string Q the logical complement of IN1. The function passes power flow to the right whenever power is received. A length of 256 words can be selected.

Figure 244



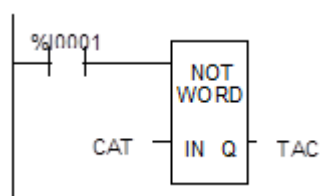
## Parameters of the Logical Invert Function

| Input/<br>Output | Choices                                      | Description                                               |
|------------------|----------------------------------------------|-----------------------------------------------------------|
| enable           | flow                                         | When the function is enabled, the operation is performed. |
| IN               | I, Q, M, T, S, G, R, AI, AQ, constant        | Constant or reference for the word to be negated.         |
| ok               | flow, none                                   | The OK output is energized whenever enable is energized.  |
| Q                | I, Q, M, T, SA, SB, SC (not S), G, R, AI, AQ | Output Q contains the result of the operation.            |

### Example

In the example, whenever input %I0001 is set, the bit string represented by the nickname TAC is set to the inverse of bit string CAT.

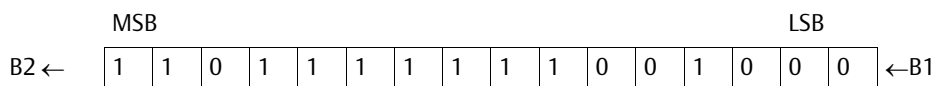
Figure 245



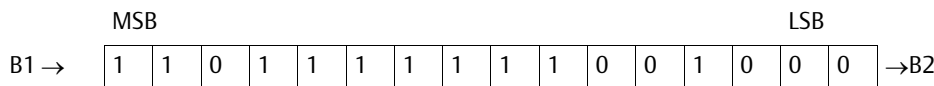
## 23.1.5 Bit Operation Functions

### Shift Bits Right, Shift Bits Left

The Shift Left function shifts all the bits in a word or group of words to the left by a specified number of places. When the shift occurs, the specified number of bits is shifted out of the output string to the left. As bits are shifted out of the high end of the string, the same number of bits is shifted in at the low end.

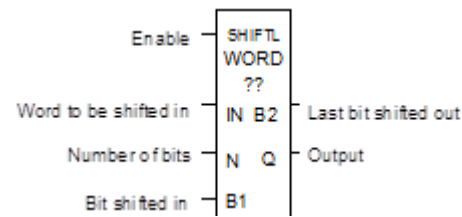


The Shift Right function is used to shift all the bits in a word or group of words a specified number of places to the right. When the shift occurs, the specified number of bits is shifted out of the output string to the right. As bits are shifted out of the low end of the string, the same number of bits is shifted in at the high end.



A string length of 1 to 256 words can be selected for either function.

**Figure 246**



If the number of bits to be shifted (N) is greater than the number of bits in the array \* 16, the array (Q) is filled with copies of the input bit (B1), and the input bit is copied to the output power flow (B2). If the number of bits to be shifted is zero, then no shifting is performed; the input array is copied into the output array; and input bit (B1) is copied into the power flow.

The bits being shifted into the beginning of the string are specified via input parameter B1. If a length greater than 1 has been specified as the number of bits to be shifted, each of the bits is filled with the same value (0 or 1). This can be:

- The Boolean output of another program function.
- All 1s. To do this, use the special reference nickname ALW\_ON as a permissive to input B1.
- All 0s. To do this, use the special reference nickname ALW\_OFF as a permissive to input B1.

The function passes power flow to the right, unless the number of bits specified to be shifted is zero.

Output Q is the shifted copy of the input string. If you want the input string to be shifted, the output parameter Q must use the same memory location as the input parameter IN. The entire shifted string is written on each scan that power is received. Output B2 is the last bit shifted out. For example, if four bits were shifted, B2 would be the fourth bit shifted out.



Bit Operation Functions  
Shift Bits Right, Shift Bits Left

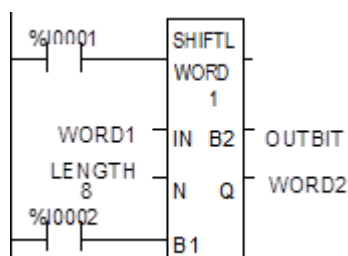
## Parameters of the Shift Right / Left Functions

| Input/<br>Output | Choices                              | Description                                                             |
|------------------|--------------------------------------|-------------------------------------------------------------------------|
| enable           | flow                                 | When the function is enabled, the shift is performed.                   |
| IN               | I, Q, M, T, S, G, R, AI, AQ          | IN contains the first word to be shifted.                               |
| N                | I, Q, M, T, G, R, AI, AQ, constant   | N contains the number of places (bits) that the array is to be shifted. |
| B1               | flow                                 | B1 contains the bit value to be shifted into the array.                 |
| B2               | flow, none                           | B2 contains the bit value of the last bit shifted out of the array.     |
| Q                | I, Q, M, T, SA, SB, SC, G, R, AI, AQ | Output Q contains the first word of the shifted array.                  |

### Example

In the example, whenever input %I0001 is set, the output bit string contained in the memory location represented by the nickname WORD2 is made a copy of the bits in location WORD1. The output string is left-shifted by 8 bits, as specified by the input LENGTH. The resulting open bits at the beginning of the output string are set to the value of %I0002.

Figure 247



## 23.1.6 Bit Operation Functions

### Rotate Bits Right, Rotate Bits Left

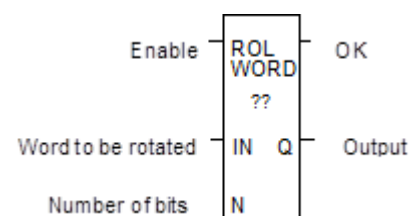
The Rotate Left function rotates all the bits in a string a specified number of places to the left. When rotation occurs, the specified number of bits is rotated out of the input string to the left and back into the string on the right.

The Rotate Right function rotates the bits in the string to the right. When rotation occurs, the specified number of bits is rotated out of the input string to the right and back into the string on the left.

A length of 1 to 256 words can be selected for either function. The number of places to rotate must be more than zero and less than the number of bits in the string.

The Rotate Bits function passes power flow to the right, unless the number of bits specified to be rotated is greater than the total length of the string or is less than zero. The result is placed in output string Q. If you want the input string to be rotated, the output parameter Q must use the same memory location as the input parameter IN. The entire rotated string is written on each scan that power is received.

Figure 248



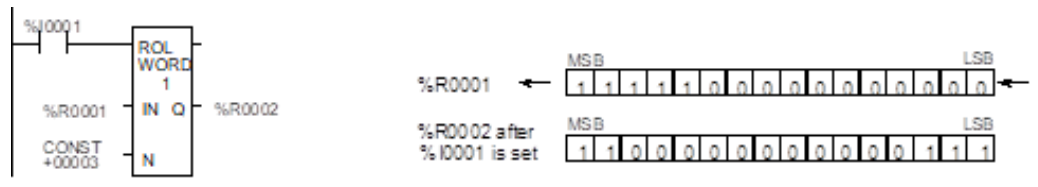
### Parameters of the Rotate Bits Right / Left Functions

| Input/<br>Output | Choices                              | Description                                                                                                            |
|------------------|--------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| enable           | flow                                 | When the function is enabled, the rotation is performed.                                                               |
| IN               | I, Q, M, T, S, G, R, AI, AQ          | IN contains the first word to be rotated.                                                                              |
| N                | I, Q, M, T, G, R, AI, AQ, constant   | N contains the number of places the array is to be rotated.                                                            |
| ok               | flow, none                           | The OK output is energized when the rotation is energized, and the rotation length is not greater than the array size. |
| Q                | I, Q, M, T, SA, SB, SC, G, R, AI, AQ | Output Q contains the first word of the rotated array.                                                                 |

### Example

In the example, whenever input %I0001 is set, the input bit string in location %R0001 is rotated 3 bits. The result is placed in %R0002. The input bit string %R0001 is not changed by the function. If the same reference is used for IN and Q, a rotation will occur in place.

Figure 249



## 23.1.7 Bit Operation Functions

### Bit Test

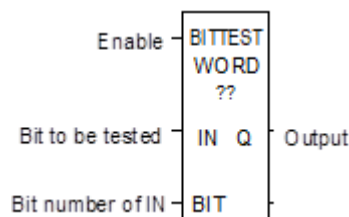
The Bit Test function tests a bit within a bit string to determine whether that bit is currently 1 or 0. The result of the test is placed in output Q.

Each sweep power is received, the Bit Test function sets its output Q to the same state as the specified bit. If a register rather than a constant is used to specify the bit number, the same function block can test different bits on successive sweeps.

If the value of BIT is outside the range  $(1 < \text{BIT} < (16 * \text{length}))$ , then Q is set OFF.

A string length of 1 to 256 words can be selected.

Figure 250



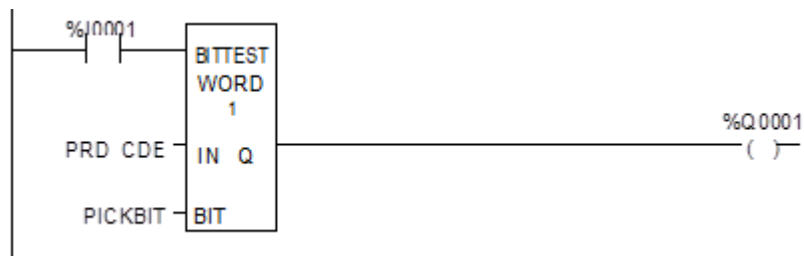
### Parameters of the Bit Test Function

| Input/Output | Choices                            | Description                                                                                                         |
|--------------|------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| enable       | flow                               | When the function is enabled, the bit test is performed.                                                            |
| IN           | I, Q, M, T, S, G, R, AI, AQ        | IN contains the first word of the data to be operated on.                                                           |
| BIT          | I, Q, M, T, G, R, AI, AQ, constant | BIT contains the bit number of IN that should be tested. Valid range is $(1 < \text{BIT} < (16 * \text{length}))$ . |
| Q            | flow, none                         | Output Q is energized if the bit tested was a 1.                                                                    |

### Example

In the example, whenever input %I0001 is set, the bit at the location contained in reference PICKBIT is tested. The bit is part of string PRD\_CDE. If it is 1, output Q passes power flow and the coil %Q0001 is turned on.

Figure 251



## 23.1.8 Bit Operation Functions

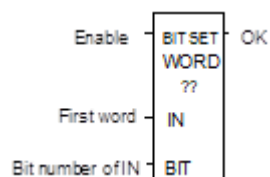
### Bit Set and Bit Clear

The Bit Set function sets a bit in a bit string to 1. The Bit Clear function sets a bit in a string to 0.

Each sweep that power is received, the function sets the specified bit. If a variable (register) rather than a constant is used to specify the bit number, the same function block can set different bits on successive sweeps.

A string length of 1 to 256 words can be selected. The function passes power flow to the right, unless the value for BIT is outside the range  $(1 < \text{BIT} < (16 * \text{length}))$ ; then, OK is set OFF.

Figure 252



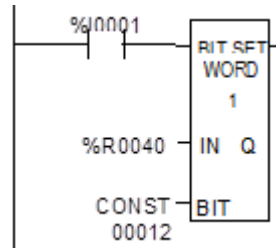
### Parameters of the Bit Set and Bit Clear Functions

| Input/Output | Choices                              | Description                                                                                                                 |
|--------------|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| enable       | flow                                 | When the function is enabled, the bit operation is performed.                                                               |
| IN           | I, Q, M, T, SA, SB, SC, G, R, AI, AQ | IN contains the first word of the data to be operated on.                                                                   |
| BIT          | I, Q, M, T, G, R, AI, AQ, constant   | BIT contains the bit number of IN that should be set or cleared. Valid range is $(1 < \text{BIT} < (16 * \text{length}))$ . |
| ok           | flow, none                           | The OK output is energized whenever the bit input is valid and enable is energized.                                         |

### Example

In the example, whenever input %I0001 is set, bit 12 of the string beginning at reference %R0040 is set to 1.

Figure 253

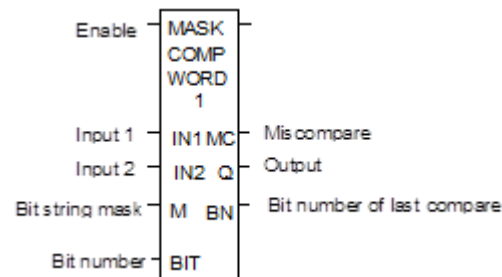


## 23.1.9 Bit Operation Functions

### Masked Compare

The Masked Compare function compares the contents of two separate bit strings. It provides the ability to mask selected bits. Input string 1 might contain the states of outputs such as solenoids or motor starters. Input string 2 might contain their input state feedback, such as limit switches or contacts.

Figure 254



When the function receives power flow, it begins comparing the bits in the first string with the corresponding bits in the second string. Comparison continues until a miss-compare is found or until the end of the string is reached.

The BIT input stores the bit number where the next comparison should start (a 0 indicates the first bit in the string). The BN output stores the bit number where the last comparison occurred (where a 1 indicates the first bit in the string). Using the same reference for BIT and BN causes the compare to start at the next bit position after a miss-compare; or, if all bits compared successfully upon the next invocation of the function block, the compare starts at the beginning.

To start the next comparison at some other location in the string, you can enter different references for BIT and BN. If the value of BIT is a location that is beyond the end of the string, BIT is reset to 0 before starting the next comparison.

## Parameters of the Masked Compare Function

| Input/<br>Output | Choices                                                  | Description                                                                      |
|------------------|----------------------------------------------------------|----------------------------------------------------------------------------------|
| enable           | flow                                                     | Permissive logic to enable the function.                                         |
| IN1              | R, AI, AQ<br>For WORD only: I, Q, M, T, S, G             | Reference for the first bit string to be compared.                               |
| IN2              | R, AI, AQ<br>For WORD only: I, Q, M, T, S, G             | Reference for the second bit string to be compared.                              |
| M                | R, AI, AQ<br>For WORD only: I, Q, M, T, SS,<br>SB, SC, G | Reference for the bit string mask.                                               |
| BIT              | I, Q, M, T, S, G, R, AI, AQ,<br>constant                 | Reference for the bit number where the next comparison should start.             |
| MC               | flow, none                                               | User logic to determine if a miscompare has occurred.                            |
| Q                | R, AI, AQ<br>For WORD only: I, Q, M, T, SA,<br>SB, SC, G | Output copy of the mask (M) bit string.                                          |
| BN               | I, Q, M, T, S, G, R, AI, AQ                              | Bit number where the last miscompare occurred.                                   |
| length           | Constant                                                 | The number of words in the bit string. Max. is 4095 for WORD and 2047 for DWORD. |

## Operation of the Masked Compare

If all corresponding bits in strings IN1 and IN2 match, the function sets the “miss-compare” output MC to 0 and BN to the highest bit number in the input strings. The comparison then stops. On the next invocation of a Masked Compare Word, it is reset to 0. When the two bits currently being compared are not the same, the function checks the correspondingly numbered bit in string M (the mask). If the mask bit is a 1, the comparison continues until it reaches another miss-compare or the end of the input strings. If a miss-compare is detected and the corresponding mask bit is a 0, the function does the following:

1. Sets the corresponding mask bit in M to 1.
2. Sets the miss-compare (MC) output to 1.
3. Updates the output bit string Q to match the new content of mask string M
4. Sets the bit number output (BN) to the number of the miss-compared bit.
5. Stops the comparison.

## Example

In the example, after first scan the Masked Compare Word function executes. It compares %M0001–16 with %M0017–32. %M0033–48 contains the mask. The value in %R0001 determines the bit position in the two input strings where the comparison starts.

Figure 255



Before the function block is executed, the contents of the above references are:

Figure 256

(IN1) – %M0001 = 6C6Ch = 0 1 1 0 1 1 0 0 1 1 0 0 1 1 0 0  
(IN2) – %M0017 = 606Fh = 0 1 1 0 1 1 0 1 0 1 1 0 1 1 1 1  
(M/Q) – %M0033 = 000Fh = 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1  
(BIT/BN) – %R0001 = 0  
(MC) – %Q0001 = OFF

The contents of these references after the function block executes are:

Figure 257

(IN1) – %M0001 = (same) 0 1 1 0 1 1 0 0 0 1 1 0 1 1 0 0  
(IN2) – %M0017 = (same) 0 1 1 0 1 1 0 1 0 1 1 0 1 1 1 1  
(M/Q) – %M0033 (BIT/BN) – %R0001 = 8 0 0 0 0 0 0 0 1 0 0 0 0 1 1 1  
(MC) – %Q0001 = ON

In this example, contact %T1 and coil %M100 force one and only one execution; otherwise the function would repeat with possibly unexpected results.

## 23.1.10 Bit Operation Functions

### Bit Position

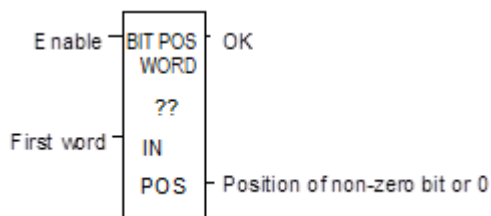
The Bit Position function locates a bit set to 1 in a bit string.

Each sweep that power is received, the function scans the bit string starting at IN. When the function stops scanning, either a bit equal to 1 has been found or the entire length of the string has been scanned.

POS is set to the position within the bit string of the first non-zero bit; POS is set to zero if no non-zero bit is found.

A string length of 1 to 256 words can be selected. The function passes power flow to the right whenever enable is ON.

Figure 258



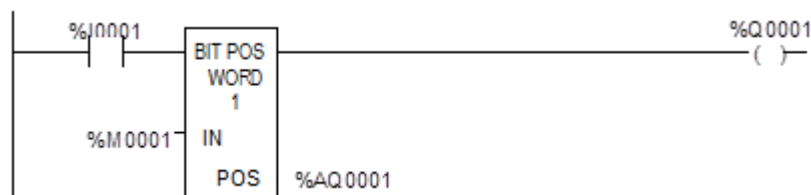
## Parameters for the Bit Position Function

| Input/Output | Choices                     | Description                                                                           |
|--------------|-----------------------------|---------------------------------------------------------------------------------------|
| enable       | flow                        | When the function is enabled, a bit search operation is performed.                    |
| IN           | I, Q, M, T, S, G, R, AI, AQ | IN contains the first word of the data to be operated on.                             |
| ok           | flow, none                  | The OK output is energized whenever enable is energized.                              |
| POS          | I, Q, M, T, G, R, AI, AQ    | The position of the first non-zero bit found, or zero if a non-zero bit is not found. |

### Example

In the example, if %I0001 is set, the bit string starting at %M0001 is searched until a bit equal to 1 is found. Coil %Q0001 is turned on. If a bit equal to 1 is found, its location within the bit string is written to %AQ001. If %I0001 is set, bit %M0001 is 0, and bit %M0002 is 1, then the value written to %AQ001 is 2

Figure 259



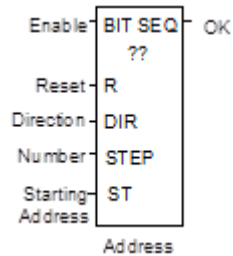


## 23.1.11 Bit Operation Functions

### Bit Sequencer

The Bit Sequencer function performs a bit sequence shift through an array of bits.

Figure 260



The operation of the function depends on the previous value of the parameter EN:

| R Current Execution | EN Previous Execution | EN Current Execution | Bit Sequencer Execution                   |
|---------------------|-----------------------|----------------------|-------------------------------------------|
| OFF                 | OFF                   | OFF                  | Bit sequencer does not execute.           |
| OFF                 | OFF                   | ON                   | Bit sequencer increments/decrements by 1. |
| OFF                 | ON                    | OFF                  | Bit sequencer does not execute.           |
| OFF                 | ON                    | ON                   | Bit sequencer does not execute.           |
| ON                  | ON/OFF                | ON/OFF               | Bit sequencer resets.                     |

The reset input (R) overrides the enable (EN) and always resets the sequencer. When R is active, the current step number is set to the value passed in via the step number parameter. If no step number is passed in, step is set to 1. All of the bits in the sequencer are set to 0, except for the bit pointed to by the current step, which is set to 1.

When Enable is active and Reset is not active, the bit pointed to by the current step number is cleared. The current step number is incremented or decremented, based on the direction parameter. Then, the bit pointed to by the new step number is set to 1.

The parameter ST is optional. If it is not used, the Bit Sequencer function operates as described above, except that no bits are set or cleared. The function just cycles the current step number through its legal range.

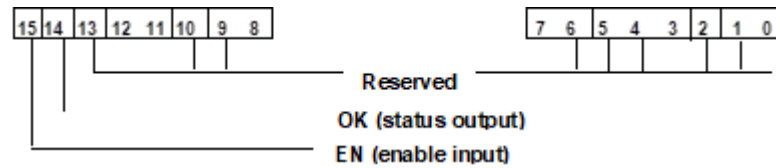
### Memory Required for a Bit Sequencer

Each bit sequencer uses three words (registers) of %R memory to store the information:

|        |                              |
|--------|------------------------------|
| word 1 | current step number          |
| word 2 | length of sequence (in bits) |
| word 3 | control word                 |

Word 3 (the control word) stores the state of the Boolean inputs and outputs of its associated function block, in the following format:

Figure 261



## Parameters for the Bit Sequencer Function

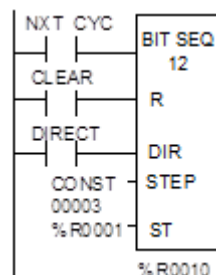
| Input/<br>Output | Choices                                    | Description                                                                                                                                                                         |
|------------------|--------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| address          | R                                          | Address is the location of the bit sequencer's current step, length, and the last enable and OK status.                                                                             |
| enable           | flow                                       | When the function is enabled, if it was not enabled on the previous sweep and if R is not energized, the bit sequence shift is performed.                                           |
| R                | flow                                       | When R is energized, the bit sequencer's step number is set to the value in STEP (default = 1), and the bit sequencer is filled with zeros, except for the current step number bit. |
| DIR              | flow                                       | When DIR is energized, the bit sequencer's step number is incremented prior to the shift. Otherwise, it is decremented.                                                             |
| STEP             | I, Q, M, T, G, R, AI, AQ, constant, none   | When R is energized, the step number is set to this value.                                                                                                                          |
| ST               | I, Q, M, T, SA, SB, SC, G, R, AI, AQ, none | ST contains the first word of the bit sequencer. Optional.                                                                                                                          |
| ok               | flow, none                                 | The OK output is energized whenever the function is enabled.                                                                                                                        |

### Example

In the example, the Bit Sequencer operates on register memory %R0001. Its static data is stored in registers %R0010–12. When CLEAR is active, the sequencer is reset and the current step is set to step number 3. The first 8 bits of %R0001 are set to zero.

When NXT\_CYC is active and CLEAR is not active, the bit for step number 3 is cleared and the bit for step number 2 or 4 (depending on whether DIR is energized) is set.

Figure 262



## 23.2 Control Functions

This section describes the control functions, which may be used to limit program execution and to change the way the CPU executes the application program.

- Service specified I/O: DO IO
- Go to a subroutine block: CALL
- Temporary program end: END
- Execute a group of logic rungs without power flow: MCR
- Go to a specified location in the program: JUMP, LABEL
- Place a text explanation in the program logic: COMMENT
- Provide predefined On/Off patterns to a set of 16 discrete outputs in the manner of a mechanical DRUM SEQUENCER.

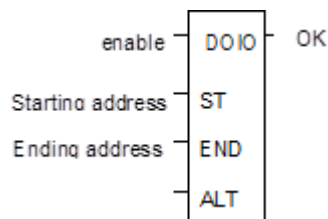
The more complex Control Functions; Service Request and the PID algorithms, are described in other chapters of this manual.

### 23.2.1 Control Functions Do I/O

The Do I/O function updates inputs or outputs for one scan while the program is running. The Do I/O function can also be used to update selected I/O during the program in addition to the normal I/O scan.

---

**Figure 263**



---

Execution of the function continues until all inputs in the selected range have reported or all outputs have been serviced. Program execution then returns to the next function.

The function passes power to the right whenever power is received, unless:

- Not all references of the type specified are present within the selected range.
- The Micro PLC is not able to properly handle the temporary list of I/O created by the function.
- The range specified includes modules associated with a "Loss of I/O" fault.

## Using DO I/O with Expansion Units

The Do I/O function always correctly updates the reference addresses of the I/O being scanned, even if some I/O addresses have been skipped in auto-configuring the PLC. If a 14-point Micro PLC with attached expansion I/O is auto-configured, I/O addresses I0009 through I0016 and Q0009 through Q0016 are skipped and the I/O addresses of the first expansion unit will start at I0017 and Q0017. The Do I/O function updates these I/O correctly, without reserving the skipped memory areas. The reference memory at the Do I/O ALT parameter contains 16 points of data: 8 points for the module and 8 points for the expansion unit.

---

**Note:** Using DO\_IO with the ALT parameter to expansion modules IC200UDD06, UEC208, UEI016, UEO008, and UER016 is not supported.

---

## Parameters of the Do I/O Function

| Input/Output | Choices                        | Description                                                                                                                                                                                                                           |
|--------------|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| enable       | flow                           | When the function is enabled, a limited input or output scan is performed.                                                                                                                                                            |
| ST           | I, Q, AI, AQ                   | The starting address of the I/O to be serviced.                                                                                                                                                                                       |
| END          | I, Q, AI, AQ                   | The ending address of the I/O to be serviced.                                                                                                                                                                                         |
| ALT          | I, Q, M, T, G, R, AI, AQ, none | For the input scan, ALT specifies the address to store scanned input point/word values. For the output scan, ALT specifies the address to get output point/word values from. If a constant value is specified for ALT, it is ignored. |
| ok           | flow, none                     | OK is energized when the scan completes normally.                                                                                                                                                                                     |

## Do I/O for Inputs

**If input references are specified**, when the function receives power flow, the PLC scans input points from the starting reference (ST) to the END reference. If a reference is specified for ALT, copies of the new input values are placed in memory beginning at that reference, and the real input values are not updated. ALT must be the same size as the reference type scanned. If a discrete reference is used for ST and END, ALT must also be discrete.

If no reference is specified for ALT, the real input values are updated. This allows inputs to be scanned one or more times during the program execution portion of the CPU sweep.

### Example Do I/O for Inputs:

In this example, when the function receives power flow, the PLC scans references %I0001-64 and %Q0001 is turned on. Copies of the scanned inputs are placed in internal memory from %M0001-64. Because a reference is specified for ALT, the real inputs are not updated. This allows the current values of inputs to be compared with their values at the beginning of the scan.

Figure 264



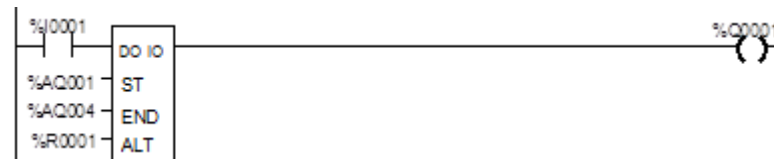
### Do I/O for Outputs

If output references are specified, when the function receives power flow, the PLC writes the latest output values from the starting reference (ST) to the END reference to the output points. If outputs should be written to the output points from internal memory other than %Q or %AQ, the beginning reference can be specified for ALT.

### Example Do I/O For Outputs:

In the next example, when the function receives power flow, the PLC writes values from references %R0001-0004 to analog output channels %AQ001-004 and %Q0001 is turned on. Because a reference is entered for ALT, the values at %AQ001-004 are not written to.

Figure 265

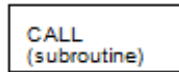


If no reference were specified for ALT, the PLC would write values at references %AQ001-004 to analog output channels.

## 23.2.2 Control Functions Call

The Call function causes program execution to go to a specified subroutine block.

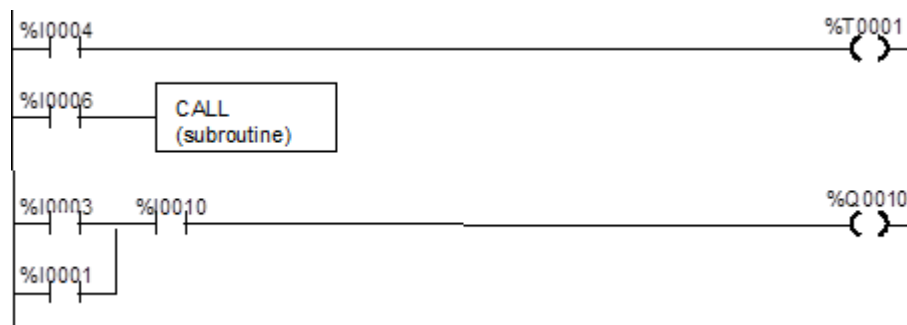
**Figure 266**



When the Call function receives power flow, it causes the scan to go immediately to the designated subroutine block and execute it. After the subroutine block execution is complete, control returns to the point in the logic immediately following the Call instruction.

### Example

**Figure 267**



## 23.2.3 Control Functions End of Logic

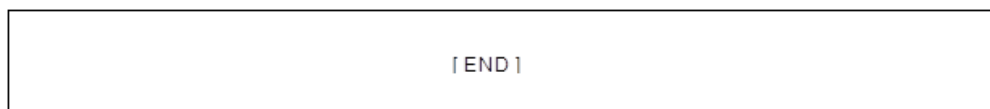
The End of Logic function provides a temporary end of logic. The program executes from the first rung to the last rung or the End of Logic function, whichever is encountered first.

The End of Logic function unconditionally terminates program execution. There can be nothing after the end function in the rung. No logic beyond the End of Logic function is executed, and control is transferred to the beginning of the program for the next sweep.

The End of Logic function is useful for debugging purposes because it prevents any logic which follows from being executed.

The programming software provides an [ END OF PROGRAM LOGIC ] marker to indicate the end of program execution. This marker is used if no End of Logic function is programmed in the logic.

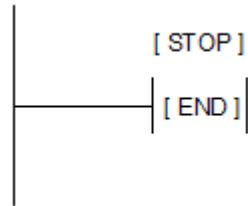
**Figure 268**



### Example

In the example, an End of Logic function is programmed to terminate the end of the current sweep.

Figure 269



## 23.2.4 Control Functions

### Master Control Relay (MCR) / End MCR

All rungs between an active Master Control Relay (MCRN) and its corresponding End Master Control Relay (ENDMCRN) function are executed without power flow to coils. The ENDMCRN associated with the Master Control Relay is used to resume normal program execution. Unlike Jump functions, Master Control Relays can only move forward; the ENDMCRN must appear after its corresponding Master Control Relay instruction in a program.

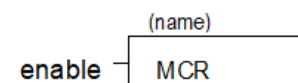
### Nested MCR

A Nested Master Control Relay function can be nested completely within another MCRN/ENDMCRN pair.

There can be multiple Master Control Relay functions with a single ENDMCRN.

The Master Control Relay function has an enable input and a name. This name is used again with the ENDMCRN. The Master Control Relay has no outputs; there can be nothing after it in a rung.

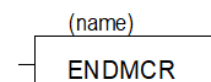
Figure 270



With a Master Control Relay, function blocks within the scope of the Master Control Relay are executed without power flow, and coils are turned off.

The ENDMCRN function must be tied to power rail; there can be no logic before it in the rung. The name of the ENDMCRN associates it with the corresponding Master Control Relay(s). The ENDMCRN function has no outputs; there can be nothing after it in a rung.

Figure 271

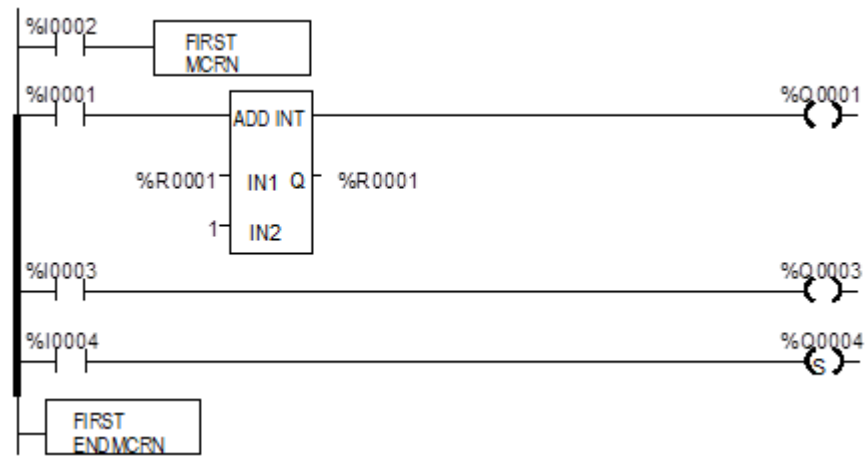


### Example Master Control Relay and ENDMCRN Functions

In the example, when %I0002 is ON, the Master Control Relay is enabled. When the Master Control Relay is enabled--even if %I0001 is ON--the Addition function block is executed without power flow (i.e., it does not add 1 to %R0001), and %Q0001 is turned OFF.

If %I0003 and %I0004 are ON, %Q0003 is turned OFF and %Q0004 remains ON.

Figure 272



## 23.2.5 Control Functions Jump, Label

The Nested Jump instruction causes a portion of the program logic to be bypassed. Program execution continues at the Label specified. When the Jump is active, all coils within its scope are left at their previous states. This includes coils associated with timers, counters, latches, and relays.

The Nested Jump instruction has the form ----->>LABEL01, where LABEL01 is the name of the corresponding nested Label instruction.

A nested Jump can be placed anywhere in a program.

There can be multiple nested Jump instructions corresponding to a single nested Label. Nested Jumps can be either forward or backward Jumps.

There can be nothing after the Jump instruction in the rung. Power flow jumps directly from the instruction to the rung with the named label.

### ⚠ CAUTION

To avoid creating an endless loop with forward and backward Jump instructions, a backward Jump must contain a way to make it conditional.



## Label

The Label instruction is the target of a Jump. Use the Label instruction to resume normal program execution. There can be only one Label with a particular name in a program.

The Label instruction has no inputs and no outputs; there can be nothing either before or after a Label in a rung.

### Example Jump and Label Instructions

In the example, whenever Jump TEST1 is active, power flow is transferred to Label TEST1.

With a Jump, any function blocks between the Jump and the Label are not executed, and coils are not affected. In the example, when %I0002 is ON, the Jump is taken. Since the logic between the Jump and the Label is skipped, %Q0001 is unaffected (if it was ON, it remains ON; if it was OFF, it remains OFF).

Figure 273



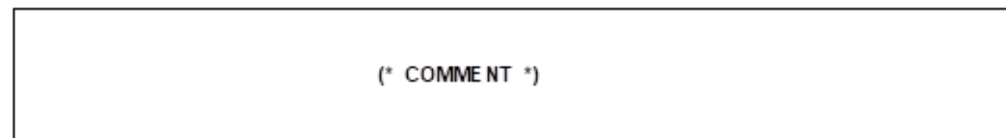
## 23.2.6 Control Functions

### Comment

The Comment function is used to enter a comment (rung explanation) in the program. A comment can have up to 2048 characters of text. Longer text can be included in printouts using an annotation text file.

It is represented in the ladder logic like this:

Figure 274

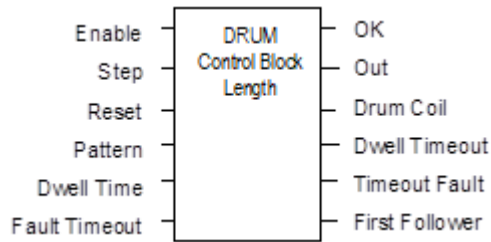


## 23.2.7 Control Functions

### Drum Sequencer

The Drum Sequencer function is a program instruction that operates like a mechanical drum sequencer. The Drum Sequencer steps through a set of potential output bit patterns and selects one based on inputs to the function block. The selected value is copied to a group of 16 discrete output references.

Figure 275



Power flow to the Enable input causes the Drum Sequencer to copy the content of a selected reference to the Out reference.

Power flow to the Reset input or to the Step input selects the reference to be copied.

The Control Block input is the beginning reference for the Drum Sequencer function's parameter block, which includes information used by the function.

### Parameters of the Drum Sequencer Function

| Input/<br>Output | Choices   | Description                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| enable           | flow      | The Enable input controls execution of the function.                                                                                                                                                                                                                                                                                                                                                      |
| Step             | flow      | The Step input can be used to go one step forward in the sequence. When the Enable input receives power flow and the Step input makes an Off to on transition, the Drum Sequencer moves one step. When Reset is active, the function ignores the Step input.                                                                                                                                              |
| Reset            | flow      | The Reset input can be used to select a specific step in the sequence. When Enable and Reset both receive power flow, the function copies the Preset Step value in the Control Block to the active Step reference, also in the Control Block. Then the function block copies the value in the Preset Step reference to the Out-reference bits. When Reset is active, the function ignores the Step input. |
| Pattern          | R, AI, AQ | The starting address of an array of words, each representing one step of the Drum Sequencer. The value of each word represents the desired combination of outputs for a particular value of Active Step. The number of elements in the array is equal to the length input.                                                                                                                                |

| Input/<br>Output  | Choices                  | Description                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dwell<br>Time     | R, AI, AQ, none          | This optional input array of words has one element for each element in the Pattern array. Each value in the array represents the dwell time for the corresponding step of the Drum Sequencer in 0.1 second units. When the dwell time expires for a given step the Dwell Timeout bit is set.<br>If a Dwell Time is specified, the drum cannot sequence into its next step until the Dwell Time has expired. |
| Fault<br>Timeout  | R, AI, AQ, none          | This optional input array of words has one element for each element in the Pattern array. Each value in the array represents the fault timeout for the corresponding step of the Drum Sequencer in 0.1 second units. When the fault timeout has expired the Fault Timeout bit is set.                                                                                                                       |
| Control<br>Block  | R                        | The beginning reference address of the function's parameter block. The length of the Control Block is 5 words. A more complete description of what is contained within this block is listed below.                                                                                                                                                                                                          |
| Length            | CONST                    | Value between 1 and 128 that specifies the number of steps.                                                                                                                                                                                                                                                                                                                                                 |
| ok                | flow, none               | OK is energized if Enable is On and no error condition is detected. If Enable is Off, this output will always be Off.                                                                                                                                                                                                                                                                                       |
| OUT               | I, Q, M, T, G, R, AI, AQ | A word of memory containing the element of the Pattern Array that corresponds to the current Active Step.                                                                                                                                                                                                                                                                                                   |
| Drum<br>Coil      | I, Q, M, T, G, none      | This optional bit reference is set whenever the function block is enabled, and Active Step is not equal to Preset Step.                                                                                                                                                                                                                                                                                     |
| Dwell<br>Timeout  | I, Q, M, T, G, none      | This optional bit reference is set if the dwell time for the current step has expired.                                                                                                                                                                                                                                                                                                                      |
| Timeout<br>Fault  | I, Q, M, T, G, none      | This optional bit reference is set if the drum has been in a particular step longer than the step's specified Fault Timeout.                                                                                                                                                                                                                                                                                |
| First<br>Follower | I, Q, M, T, G, none      | This optional array of bits has one element for each step of the Drum Sequencer. No more than one bit in the array is On at any time and that bit corresponds to the value of the Active Step                                                                                                                                                                                                               |

## Parameter Block for the Drum Sequencer Function

The parameter block (control block) for the Drum Sequencer function contains information needed to operate the Drum Sequencer.

|             |               |
|-------------|---------------|
| address     | Active Step   |
| address + 1 | Preset Step   |
| address + 2 | Step Control  |
| address + 3 | Timer Control |

**Active Step** The active step value specifies the element in the Pattern array to copy to the Out output memory location. This is used as the array index into the Pattern, Dwell Time, Fault Timeout, and First Follower arrays.

**Preset Step** A word input that is copied to the Active Step output when the Reset is On.

**Step Control** A word that is used to detect Off to On transitions on both the Step input and the Enable input. The Step Control word is reserved for use by the function block, and must not be written to.

**Timer Control** Two words of data that hold values needed to run the timer. These values are reserved for use by the function block and must not be written to.

### Notes on Using the Drum Sequencer Function

1. The Dwell Timeout Output bit is cleared the first time the drum is in a new step. This is true:
  - Whether the drum is introduced to a new step by changing the Active Step or by using the Step Input.
  - Regardless of the Dwell Time Array value associated with the step (even if it is 0).
  - During the first sweep the Active Step is initialized.
2. The Active and Preset Step of the Drum Sequencer's control block must be initialized for the Drum Sequencer to work or to pass power flow. Even if the Active Step is in the correct range (between 1 and length of the Pattern array) and the Preset Step is not used, the drum will not function if the Preset Step is not in the proper range.

## 23.3 Data Move Functions

The Data Move functions of the Instruction Set provide basic data move capabilities.

- **MOVE Data.** This function copies data as individual bits, so the new location does not have to be the same data type.
- **Block Move.** This function places constants into seven specified memory locations.
- **Block Clear.** This function fills an area of memory with zeros.
- **Shift Register.** This function shifts one or more data words or data bits from a reference location into a specified area of memory. Data already in the area is shifted out.
- **Communication Request (COMMREQ).** This important function allows the CPU to communicate with intelligent modules in the system, for example, communications modules. The basic format of the COMMREQ function is shown in this chapter. The detailed parameters needed to program specific communications tasks are provided in the documentation for each module.

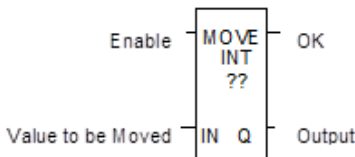
### 23.3.1 Data Move Functions

#### Move Data

The MOVE function copies data as individual bits from one location to another. Because the data is copied in bit format, the new location does not need to be the same data type as the original.

When the Move function receives power flow, it copies data from input parameter IN to output parameter Q as bits. If data is moved from one location in discrete memory to another, (for example, from %I memory to %T memory), the transition information associated with the discrete memory elements is updated to indicate whether or not the Move operation caused any discrete memory elements to change state. Data at the input parameter does not change unless there is an overlap in the source and destination.

Figure 276

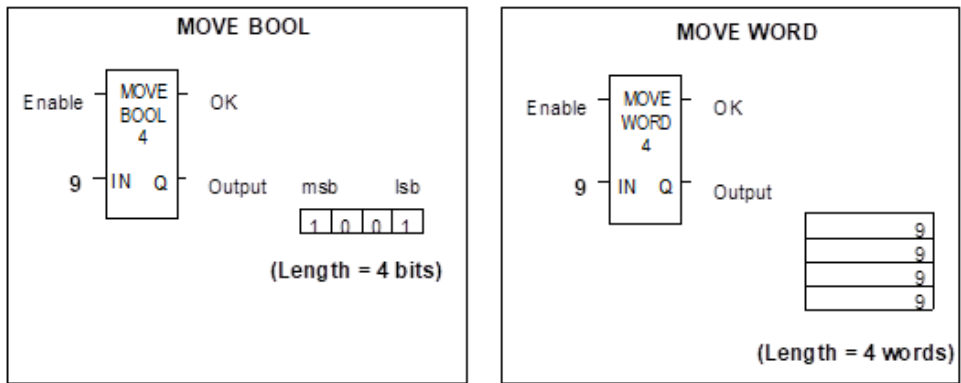


Note that if an array of Bit-type data specified in the Q parameter does not include all the bits in a byte, the transition bits associated with that byte (which are not in the array) are cleared when the Move function receives power flow.

The input IN can be either a reference for the data to be moved or a constant. If a constant is specified, then the constant value is placed in the location specified by the output reference. For example, if a constant value of 4 is specified for IN, then 4 is placed in the memory location specified by Q. If the length is greater than 1 and a constant is specified, then the constant is placed in the memory location specified by Q and the locations following, up to the length specified. Do not allow overlapping of IN and Q parameters.

The result of the Move depends on the data type selected for the function, as shown below. For example, if the constant value 9 is specified for IN and the length is 4, then 9 is placed in the bit memory location specified by Q and the three locations following:

Figure 277



The function passes power to the right whenever power is received.

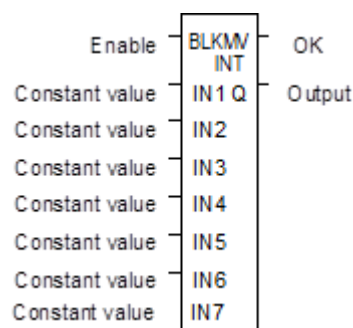
## Parameters for the Move Data Function

| Input/<br>Output | Choices                                                                                              | Description                                                                                                                                                                                                                                                                                    |
|------------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| enable           | flow                                                                                                 | When the function is enabled, the move is performed.                                                                                                                                                                                                                                           |
| Length           |                                                                                                      | The number of bits, words, or double words of data to be copied. This is the length of IN. Length must be from 1 to 256 for all types except BOOL. If IN is a constant and Q is type BOOL, the length must be between 1 and 16. If IN is type BOOL, the length must be between 1 and 256 bits. |
| IN               | I, Q, M, T, G, R, AI, AQ,<br>constant<br>For bit or word data<br>only: S<br>For real data: R, AI, AQ | IN contains the value to be moved. For MOVE BOOL, any discrete reference may be used; it does not need to be byte aligned. However, 16 bits, beginning with the reference address specified, are displayed online.                                                                             |
| ok               | flow, none                                                                                           | The OK output is energized whenever the function is enabled.                                                                                                                                                                                                                                   |
| Q                | I, Q, M, T, G, R, AI, AQ,<br>For bit/ word data: SA,<br>SB, SC<br>For real data: R, AI, AQ           | When the move is performed, the value at IN is written to Q. For MOVE BOOL, any discrete reference may be used; it does not need to be byte aligned. However, 16 bits, beginning with the reference address specified, are displayed online.                                                   |

### 23.3.2 Data Move Functions Block Move

The Block Move function copies a block of seven constants to a specified location. When the Block Move function receives power flow, it copies the constant values into consecutive locations beginning at the destination specified in output Q. The function passes power to the right whenever power is received.

Figure 278



## Parameters of the Block Move Function

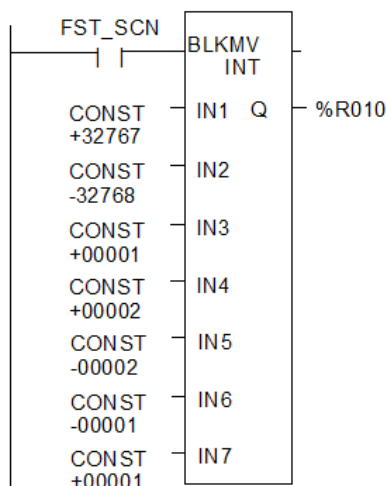
| Input/<br>Output | Choices                                                                           | Description                                                                |
|------------------|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| enable           | flow                                                                              | When the function is enabled, the block move is performed.                 |
| IN1 to<br>IN7    | constant                                                                          | IN1 through IN7 contain seven constant values.                             |
| ok               | flow, none                                                                        | The OK output is energized whenever the function is enabled.               |
| Q                | I, Q, M, T, G, R, AI, AQ<br>For Word data: SA, SB, SC<br>For Real data: R, AI, AQ | Output Q contains the first element of the moved array. IN1 is moved to Q. |

Revision 2.6 and later Micro-64 PLCs, Micro-20 PLCs and Micro-40 PLCs support both DWORD and DINT data types for a Block Move. Other Micro PLC models do not support 32-bit data types.

### Example

In the example, when the enabling input represented by the nickname FST\_SCN is ON, the Block Move function copies the input constants into memory locations %R0010–16.

Figure 279



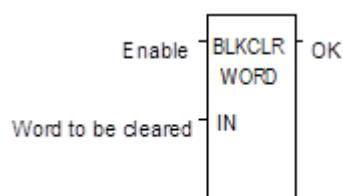
## 23.3.3 Data Move Functions

### Block Clear

The Block Clear function fills a specified block of data with zeros. When the function receives power flow, it writes zeros into the memory location beginning at the reference specified by IN. When the data to be cleared is from discrete memory (%I, %Q, %M, %G, or %T), the transition information associated with the references is also cleared.

The function passes power to the right whenever power is received.

Figure 280



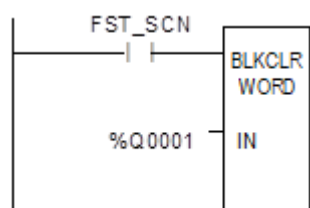
### Parameters of the Block Clear Function

| Input/<br>Output | Choices                              | Description                                                                                              |
|------------------|--------------------------------------|----------------------------------------------------------------------------------------------------------|
| enable           | flow                                 | When the function is enabled, the array is cleared.                                                      |
| IN               | I, Q, M, T, SA, SB, SC, G, R, AI, AQ | IN contains the first word of the array to be cleared. The length of IN must be between 1 and 256 words. |
| Length           |                                      | The number of words that will be cleared. This is the length of IN.                                      |
| ok               | flow, none                           | The OK output is energized whenever the function is enabled.                                             |

### Example

In the example, at power-up, 32 words of %Q memory (512 points) beginning at %Q0001 are filled with zeros. %Q is defined as WORD of length 32.

Figure 281





## 23.3.4 Data Move Functions

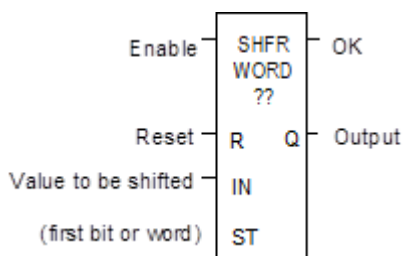
### Shift Register

The Shift Register function shifts one or more data words or data bits from a reference location into a specified area of memory. For example, one word might be shifted into an area of memory with a specified length of five words. As a result of this shift, another word of data would be shifted out of the end of the memory area.

The reset input (R) takes precedence over the function enable input. When the reset is active, all references beginning at the shift register (ST) up to the length specified for LEN, are filled with zeros.

If the function receives power flow and reset is not active, each bit or word of the shift register is moved to the next highest reference. The last element in the shift register is shifted into Q. The highest reference of the shift register element of IN is shifted into the vacated element starting at ST. The contents of the shift register are accessible throughout the program because they are overlaid on absolute locations in logic addressable memory.

Figure 282



### Parameters of the Shift Register Function

| Input/Output | Choices                               | Description                                                                                                                                                                  |
|--------------|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| enable       | flow                                  | When enable is energized and R is not, the shift is performed.                                                                                                               |
| Length       | 1 to 256 bits or words.               | The length of the shift register in bits or words. Length is defined as the length of IN.                                                                                    |
| R            | flow                                  | When R is energized, the shift register located at ST is filled with zeros.                                                                                                  |
| IN           | I, Q, M, T, S, G, R, AI, AQ, constant | IN contains the value to be shifted into the first bit or word of the shift register. For SHFR BIT, any discrete reference may be used; it does not need to be byte aligned. |
| ST           | I, Q, M, T, SA, SB, SC, G, R, AI, AQ  | ST contains the first bit or word of the shift register. For SHFR BIT, any discrete reference may be used; it does not need to be byte aligned.                              |
| ok           | flow, none                            | OK is energized whenever the function is enabled and R is not enabled.                                                                                                       |
| Q            | I, Q, M, T, SA, SB, SC, G, R, AI, AQ  | Output Q contains the bit or word shifted out of the shift register. For SHFR BIT, any discrete reference may be used; it does not need to be byte aligned.                  |

**⚠CAUTION**

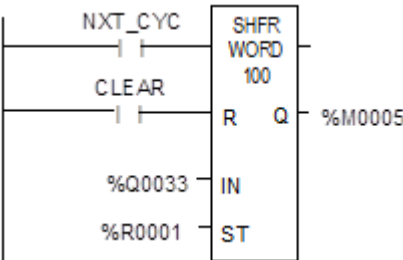
The use of overlapping input and output reference address ranges in multi-word functions is not recommended; it may produce unexpected results.

**Example 1:**

In the example, the shift register operates on register memory locations %R0001 through %R0100. (%R0001 is defined as type Word of length 100). When the reset reference CLEAR is active, the Shift Register words are set to zero.

When the NXT\_CYC reference is active and CLEAR is not active, the word from output status table location %Q0033 is shifted into the Shift Register at %R0001. The word shifted out of the Shift Register from %R0100 is stored in output %M0005.

**Figure 283**

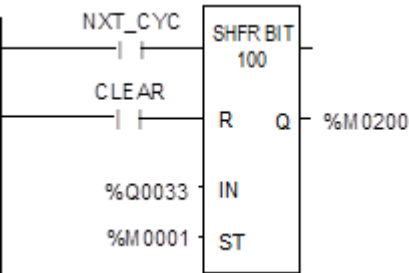


**Example 2:**

In this example, the Shift Register operates on memory locations %M0001 through %M0100. (%M0001 is defined as type Boolean of length 100). When the reset reference CLEAR is active, the Shift Register function fills %M0001 through %M0100 with zeros.

When NXT\_CYC is active and CLEAR is not, the Shift Register function shifts the data in %M0001 to %M0100 down by one bit. The bit in %Q0033 is shifted into %M0001 while the bit shifted out of %M0100 is written to %M0200.

**Figure 284**



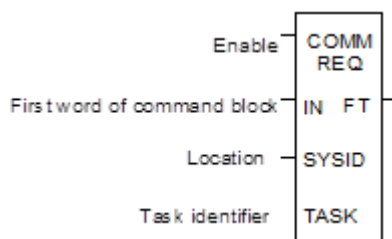
## 23.3.5 Data Move Functions

### Communication Request

The Communication Request (COMMREQ) function is use for specialized communications. Many types of COMMREQs have been defined. The information below describes only the basic format of the function.

When the function receives power flow, a command block of data is sent to the specified module. After sending the COMMREQ, the program can either suspend execution, and wait for a reply for a maximum waiting period specified in the command, or resume immediately.

**Figure 285**



### Parameters of the COMMREQ Function

| Input/<br>Output | Choices                            | Description                                                                                                                                                                                                                                                                              |
|------------------|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| enable           | flow                               | When the function is energized, the communications request is performed.                                                                                                                                                                                                                 |
| IN               | R, AI, AQ                          | IN contains the first word of the command block.                                                                                                                                                                                                                                         |
| SYSID            | I, Q, M, T, G, R, AI, AQ, constant | SYSID contains the rack number (most significant byte) and slot number (least significant byte) of the target device.                                                                                                                                                                    |
| TASK             | R, AI, AQ, constant                | TASK contains the task ID of the process on the target device.                                                                                                                                                                                                                           |
| FT               | flow, none                         | FT is energized if an error is detected processing the COMMREQ:<br>The specified target address is not present (SYSID).<br>The specified task is not valid for the device (TASK).<br>The data length is 0.<br>The device's status pointer address (in the command block) does not exist. |

## Command Block for the COMMREQ Function

The Command Block starts at the reference specified in COMMREQ parameter IN. The length of the Command Block depends on the amount of data sent to the device.

The Command Block contains the data to be communicated to the other device, plus information related to the execution of the COMM REQ. The Command Block has the following structure:

|                                 |                            |
|---------------------------------|----------------------------|
| address                         | Length (in words)          |
| address + 1                     | Wait/No Wait Flag          |
| address + 2                     | Status Pointer Memory      |
| address + 3                     | Status Pointer Offset      |
| address + 4                     | Idle Timeout Value         |
| address + 5                     | Maximum Communication Time |
| address + 6 to<br>address + 133 | Data Block                 |

### Example

In the example, when enabling input %M0020 is ON, a Command Block starting at %R0016 is sent to communications task 1 in the device located at rack 1, slot 2 of the PLC. If an error occurs processing the COMMREQ, %Q0100 is set.

Figure 286



## 23.4 Data Type Conversion Functions

The Data Type Conversion functions are used to change a data item from one number type to another. Many programming instructions, such as math functions, must be used with data of one type.

- Convert data to BCD-4
- Convert data to signed integer
- Convert data to double-precision integer
- Convert data to Real
- Convert data to Word
- Round a Real number toward zero (TRUN)

### 23.4.1 Data Type Conversion Functions

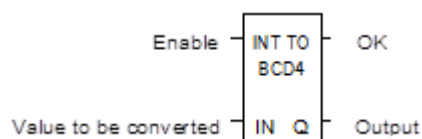
#### Convert Signed Integer Data to BCD-4

The Convert to BCD-4 function outputs the four-digit BCD equivalent of signed integer data. The original data is not changed by this function. The output data can be used directly as input for another program function.

Data can be converted to BCD format to drive BCD-encoded LED displays or presets to external devices such as high-speed counters.

When the function receives power flow, it performs the conversion, making the result available via output Q. The function passes power flow when power is received, unless the specified conversion would result in a value that is outside the range 0 to 9999.

Figure 287



#### Parameters of the Convert to BCD-4 Function

| Input/<br>Output | Choices                            | Description                                                              |
|------------------|------------------------------------|--------------------------------------------------------------------------|
| enable           | flow                               | When the function is enabled, the conversion is performed.               |
| IN               | I, Q, M, T, G, R, AI, AQ, constant | IN contains a reference for the integer value to be converted to BCD-4.  |
| OK               | flow, none                         | The OK output is energized when the function is performed without error. |
| Q                | I, Q, M, T, G, R, AI, AQ           | Output Q contains the BCD-4 form of the original value in IN.            |

### Example

In the example, whenever input %I0002 is set and no errors exist, the integer at input location %I0017 through %I0032 is converted to four BCD digits, and the result is stored in memory locations %Q0033 through %Q0048. Coil %Q1432 is used to check for successful conversion.

Figure 288



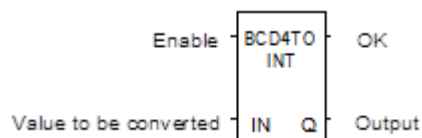
## 23.4.2 Data Type Conversion Functions

### Convert to Signed Integer

The Convert to Signed Integer function outputs the integer equivalent of BCD-4 or Real data. The original data is not changed by this function. The output data can be used as input for another program function.

When the function receives power flow, it performs the conversion, making the result available via output Q. The function always passes power flow when power is received, unless the data is out of range.

Figure 289



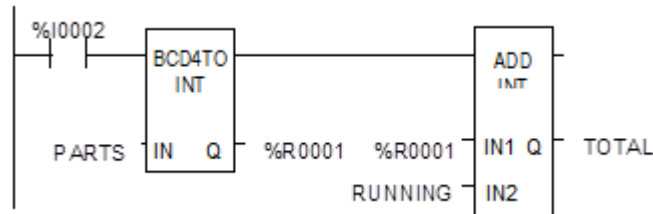
### Parameters of the Convert to Signed Integer Function

| Input/Output | Choices                                                                 | Description                                                                                                     |
|--------------|-------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| enable       | flow                                                                    | When the function is enabled, the conversion is performed.                                                      |
| IN           | For BCD-4: I, Q, M, T, G, R, AI, AQ,<br>constant<br>For REAL: R, AI, AQ | IN contains a reference for the BCD-4, REAL, or Constant value to be converted to integer.                      |
| ok           | flow, none                                                              | The OK output is energized whenever enable is energized, unless the data is out of range or NaN (Not a Number). |
| Q            | For BCD-4: I, Q, M, T, G, R, AI, AQ<br>For REAL: R, AI, AQ              | Output Q contains the integer form of the original value in IN.                                                 |

### Example

In the example, whenever input %I0002 is set, the BCD-4 value in PARTS is converted to a signed integer and passed to the Addition function, where it is added to the signed integer value represented by the reference RUNNING. The sum is output by the Addition function to the reference TOTAL.

Figure 290



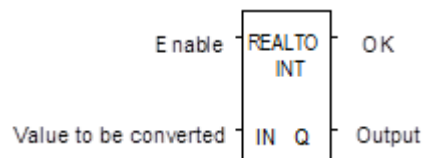
## 23.4.3 Data Type Conversion Functions

### Convert to Double Precision Signed Integer

The Convert to Double Precision Signed Integer function outputs the double precision signed integer equivalent of real data. The original data is not changed by this function. The output data can be used directly as input for another program function.

When the function receives power flow, it performs the conversion, making the result available via output Q. The function always passes power flow when power is received, unless the real value is out of range.

Figure 291



Note that loss of precision can occur when converting from Real-type data to Double-Precision Integer, because Real data has 24 significant bits.

### Parameters of the Convert to Double Precision Signed Integer Function

| Input/Output | Choices                            | Description                                                                             |
|--------------|------------------------------------|-----------------------------------------------------------------------------------------|
| enable       | flow                               | When the function is enabled, the conversion is performed.                              |
| IN           | I, Q, M, T, G, R, AI, AQ, constant | Constant or reference for the value to be converted                                     |
| ok           | flow, none                         | OK is energized whenever enable is energized, unless the real value is out of range.    |
| Q            | R, AI, AQ                          | Reference that contains the double precision signed integer form of the original value. |

### Example

In the example, whenever input %I0002 is set, the integer value at input location %I0017 is converted to a double precision signed integer and the result is placed in location %R0001. The output %Q1001 is set whenever the function executes successfully.

Figure 292



## 23.4.4 Data Type Conversion Functions

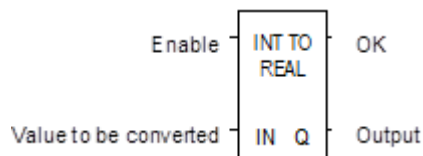
### Convert to Real Data

The Convert to Real function outputs the real value equivalent of the input data. The original data is not changed by this function. The output data can be used directly as input for another program function.

When the function receives power flow, it performs the conversion, making the result available via output Q. The function passes power flow when power is received, unless the specified conversion would result in a value that is out of range.

Note that loss of precision can occur when converting from Double-Precision Integer to Real data, because since the number of significant bits is reduced to 24.

Figure 293



### Parameters of the Convert to Real Function

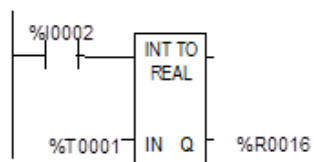
| Input/Output | Choices                                            | Description                                                            |
|--------------|----------------------------------------------------|------------------------------------------------------------------------|
| enable       | flow                                               | When the function is enabled, the conversion is performed.             |
| IN           | R, AI, AQ, constant<br>For INT only: I, Q, M, T, G | IN contains a reference for the integer value to be converted to Real. |
| ok           | flow, none                                         | OK is energized when the function is performed without error.          |
| Q            | R, AI, AQ                                          | The Real form of the original value in IN.                             |



### Example

In the example, the integer value of input IN is 678. The result value placed in %T0016 is 678.000.

Figure 294



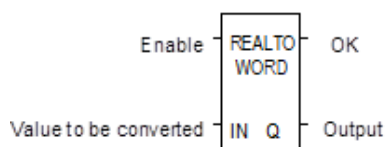
## 23.4.5 Data Type Conversion Functions

### Convert Real Data to Word Data

The Convert to Word function outputs the Word equivalent of Real data. The original data is not changed by this function.

When the function receives power flow, it performs the conversion, making the result available via output Q. The function passes power flow when power is received, unless the specified conversion would result in a value that is outside the range 0 to FFFFh.

Figure 295

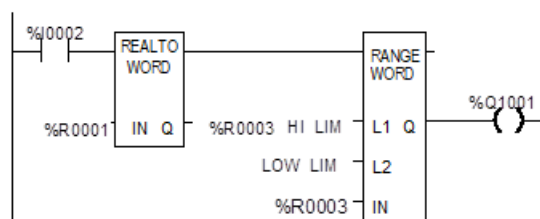


### Parameters of the Convert to Word Function

| Input/Output | Choices                  | Description                                                         |
|--------------|--------------------------|---------------------------------------------------------------------|
| enable       | flow                     | When the function is enabled, the conversion is performed.          |
| IN           | R, AI, AQ, constant      | IN contains a reference for the value to be converted to Word type. |
| ok           | flow, none               | OK is energized when the function is performed without error.       |
| Q            | I, Q, M, T, G, R, AI, AQ | Contains the unsigned integer form of the original value in IN.     |

### Example

Figure 296



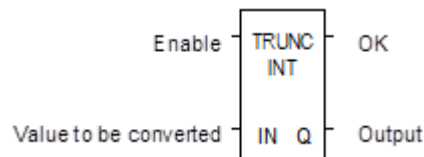
## 23.4.6 Data Type Conversion Functions

### Truncate Real Number

The Truncate function copies a Real number and rounds the copied number down to an integer or double precision integer. The original data is not changed by this function. The output data can be used directly as input for another program function.

When the function receives power flow, it performs the conversion, making the result available via output Q. The function passes power flow when power is received, unless the specified conversion would result in a value that is out of range or unless IN is not a number.

Figure 297



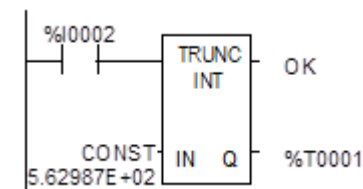
### Parameters of the Truncate Function

| Input/Output | Choices                                      | Description                                                                                                             |
|--------------|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| enable       | flow                                         | When the function is enabled, the conversion is performed.                                                              |
| IN           | R, AI, AQ, constant                          | IN contains a reference for the real value to be truncated.                                                             |
| ok           | flow, none                                   | The OK output is energized when the function is performed without error, unless the value is out of range or IN is NaN. |
| Q            | R, AI, AQ<br>For integer only: I, Q, M, T, G | Q contains the truncated INT or DINT value of the original value in IN.                                                 |

### Example

In the example, the displayed constant is truncated, and the integer result 562 is placed in %T0001.

Figure 298



## 23.5 Math and Numerical Functions

This section describes the Math and Numerical functions of the Instruction Set:

- Standard Math Functions: Addition, Subtraction, Multiplication, Division
- Modulo Division
- Scaling Function
- Square Root
- Trigonometric functions
- Logarithmic/Exponential functions
- Convert to Degrees
- Convert to Radians

### 23.5.1 Converting Data for the Math and Numerical Functions

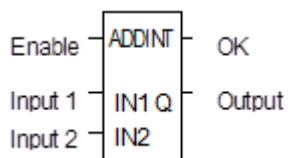
The program may need to include logic to convert data to a different type before using a Math or Numerical function. The description of each function includes information about appropriate data types. The section Data Type Conversion Functions explains how to convert data to a different type.

### 23.5.2 Math and Numerical Functions Add, Subtract, Multiply, Divide

The standard math functions are Addition, Subtraction, Multiplication, and Division. The Division function rounds down; it does not round to the closest integer. (For example, 24 DIV 5 = 4.)

When a math function receives power flow, the appropriate operation is performed on input parameters IN1 and IN2. Parameters IN1, IN2, and the output Q must be the same data type.

**Figure 299**



The standard math functions pass power if there is no math overflow. If an overflow occurs, the result is the largest value with the proper sign and no power flow.

## Parameters of the Standard Math Functions

| Input/<br>Output | Choices                                                                        | Description                                                                                                                                                                                                                                               |
|------------------|--------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| enable           | flow                                                                           | When the function is enabled, the operation is performed.                                                                                                                                                                                                 |
| IN1              | All data types: R, AI, AQ,<br>constant<br>INT data type only: I, Q,<br>M, T, G | IN1 contains a constant or reference for the first value used in the operation. (IN1 is on the left side of the mathematical equation, as in $IN1 + IN2$ ).<br>Range for constants in double-precision signed integer operations is minimum/maximum DINT. |
| IN2              | All data types: R, AI, AQ,<br>constant<br>INT data type only: I, Q,<br>M, T, G | IN2 contains a constant or reference for the second value used in the operation. (IN2 is on the right side of the mathematical equation, as in $IN1 + IN2$ ). Range for constants in double-precision signed integer operations is minimum/maximum DINT.  |
| ok               | flow, none                                                                     | The OK output is energized when the function is performed without overflow, unless an invalid operation occurs.                                                                                                                                           |
| Q                | All data types: R, AI, AQ<br>INT only: I, Q, M, T, G                           | Output Q contains the result of the operation.                                                                                                                                                                                                            |

## Data Types for Standard Math Functions

Standard math functions operate on these types of data:

|      |                                 |
|------|---------------------------------|
| INT  | Signed integer                  |
| DINT | Double precision signed integer |
| REAL | Floating Point                  |

The input and output parameter data types must be the same (16 bits or 32 bits).

### 23.5.3 Math and Numerical Functions Add, Subtract, Multiply, Divide

#### Avoiding Overflows

Be careful to avoid overflows when using Multiplication and Division functions.

If you have to convert Integer to Double-Precision Integer values, remember that the CPU uses standard 2's complement with the sign extended to the highest bit of the second word. You must check the sign of the low 16-bit word and extend it into the second 16 bit word. If the most significant bit in a 16-bit INT word is 0 (positive), move a 0 to the second word. If the most significant bit in a 16-bit word is -1 (negative), move a -1 or hex 0FFFFh to the second word.

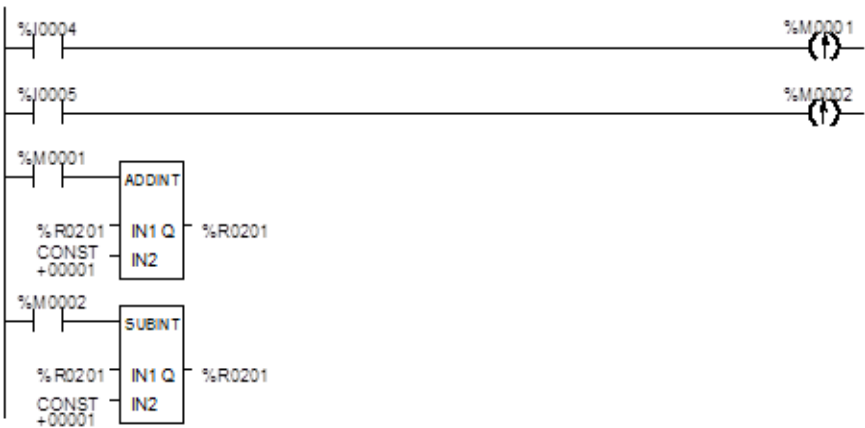
Converting from Double-Precision Integer to Integer data is easier, because the low 16-bit word (first register) is the integer portion of a Double-Precision Integer 32-bit word. The upper 16 bits or second word should be either a 0 (positive) or -1 (negative) value or the Double-Precision Integer number will be too big to convert to 16 bits.

Example

This example uses the Addition and Subtraction functions to keep track of the number of parts in a temporary storage area. Each time a part enters the storage area, power flows through relay %I0004 to a positive transition coil with reference %M0001. Relay %M0001 then enables the Addition function, adding the (constant) value 1 to the current total value in %R0201.

Each time a part leaves the storage area, power flows through relay %I0005 to a positive transition coil with reference %M0002. Relay %M0002 then enables the Subtraction function, subtracting the (constant) value 1 from the current total value in %R0201.

Figure 300



23.5.4 Math and Numerical Functions  
Modulo Division

The Modulo Division function divides one value by another of the same data type, to obtain the remainder. The sign of the result is always the same as the sign of input parameter IN1. The Modulo function operates on these types of data:

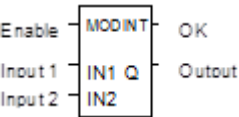
|      |                                 |
|------|---------------------------------|
| INT  | Signed integer                  |
| DINT | Double precision signed integer |

When the function receives power flow, it divides input IN1 by input IN2. These parameters must be the same data type. Output Q is calculated using the formula:

$$Q = IN1 - ((IN1 \text{ DIV } IN2) * IN2)$$

The division produces an integer number. Q is the same data type as inputs IN1 and IN2. OK is always ON when the function receives power flow, unless there is an attempt to divide by zero. In that case, it is set OFF.

Figure 301



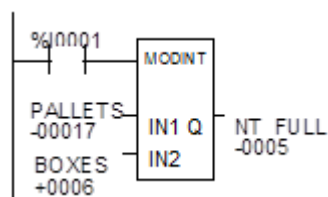
## Parameters of the Modulo Division Function

| Input/<br>Output | Choices                                                                        | Description                                                                                                                                                           |
|------------------|--------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| enable           | flow                                                                           | When the function is enabled, the operation is performed.                                                                                                             |
| IN1              | All data types: R, AI, AQ,<br>constant<br>INT data type only: I, Q,<br>M, T, G | IN1 contains a constant or reference for the value to be divided by IN2. Range for constants in double precision signed integer operations is minimum/maximum DINT.   |
| IN2              | All data types: R, AI, AQ,<br>constant<br>INT data type only: I, Q,<br>M, T, G | IN2 contains a constant or reference for the value to be divided into IN1. Range for constants in double precision signed integer operations is minimum/maximum DINT. |
| ok               | flow, none                                                                     | The OK output is energized when the function is performed without overflow.                                                                                           |
| Q                | All data types: R, AI, AQ<br>INT data type only: I, Q,<br>M, T, G              | Output Q contains the result of dividing IN1 by IN2 to obtain a remainder.                                                                                            |

### Example

In the example, the remainder of the integer division of BOXES into PALLETS is placed into NT\_FULL whenever %I0001 is ON.

Figure 302

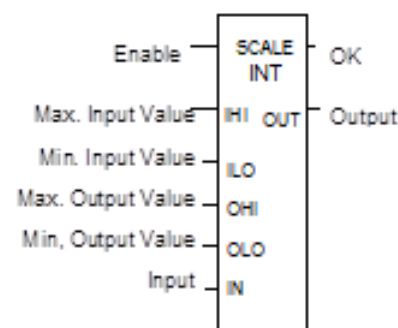


## 23.5.5

## Math and Numerical Functions Scaling

The Scaling function scales an input parameter and places the result in an output location. For integer-type data, all parameters must be integer-based (signed). For word-type data, all parameters must be word-based (unsigned).

Figure 303



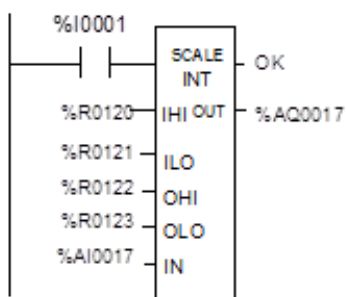
## Parameters of the Scaling Function

| Input/<br>Output | Choices                | Description                                                                                                                                                                                                                                   |
|------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| enable           | flow                   | When the function is enabled, the operation is performed.                                                                                                                                                                                     |
| IHI<br>ILO       | R, AI, AQ,<br>constant | IHI and ILO contain a constant or reference for the upper and lower limits of the unscaled data. These limits, together with the values for OHI and OLO, are used to calculate the scaling factor that will be applied to the input value IN. |
| OHI<br>OLO       | R, AI, AQ,<br>constant | OHI and OLO contain a constant or reference for the upper and lower limits of the scaled data.                                                                                                                                                |
| IN               | R, AI, AQ,<br>constant | IN contains a constant or reference for the actual value to be scaled.                                                                                                                                                                        |
| ok               | flow, none             | The OK output is energized when the function is performed without overflow.                                                                                                                                                                   |
| OUT              | R, AI, AQ              | Output OUT contains the scaled equivalent of the input value.                                                                                                                                                                                 |

### Example

In the example, the registers %R0120 through %R0123 are used to store the high and low scaling values. The input value to be scaled is analog input %AI0017. The scaled output data is used to control analog output %AQ0017. The scaling is performed whenever %I0001 is ON.

Figure 304



## 23.5.6 Math and Numerical Functions Square Root

The Square Root function finds the square root of a value. When the function receives power flow, the value of output Q is set to the integer portion of the square root of the input IN. The output Q must be the same data type as IN.

The Square Root function operates on these types of data:

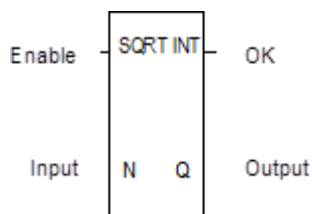
|      |                                 |
|------|---------------------------------|
| INT  | Signed integer                  |
| DINT | Double precision signed integer |
| REAL | Floating Point                  |

OK is set ON if the function is performed without overflow, unless one of these invalid REAL operations occurs:

- $IN < 0$
- IN is NaN (Not a Number)

Otherwise, OK is set OFF.

Figure 305



### Parameters of the Square Root Function

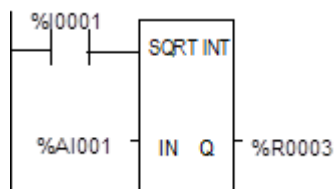
| Input/Output | Choices                                                                  | Description                                                                                                                                                                                                                              |
|--------------|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| enable       | flow                                                                     | When the function is enabled, the operation is performed.                                                                                                                                                                                |
| IN           | All data types: R, AI, AQ, constant<br>INT data type only: I, Q, M, T, G | A constant or reference for the value whose square root is to be calculated. If IN is less than zero, the function will not pass power flow. Range for constants is minimum/maximum DINT for double precision signed integer operations. |
| ok           | flow, none                                                               | The OK output is energized when the function is performed without overflow, unless an invalid operation occurs.                                                                                                                          |
| Q            | All data types: R, AI, AQ<br>INT data type only: I, Q, M, T, G           | Output Q contains the square root of IN.                                                                                                                                                                                                 |



### Example

In the example, the square root of the integer number located at %AI001 is placed into the result located at %R0003 whenever %I0001 is ON.

Figure 306



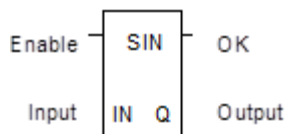
## 23.5.7 Math and Numerical Functions Trigonometric Functions

There are six Trigonometric functions: Sine, Cosine, Tangent, Inverse Sine, Inverse Cosine, and Inverse Tangent.

### Sine, Cosine, and Tangent

When a Sine, Cosine, or Tangent function receives power flow, it operates on IN, whose units are radians, and stores the result in output Q. Both IN and Q are floating-point values.

Figure 307



The Sine, Cosine, and Tangent functions accept a broad range of input values, where

$$-263 < IN < +263, (263 = 9.22 \times 10^{18})$$

## Inverse Sine, Cosine, and Tangent

When an Inverse Sine, Cosine, or Tangent function receives power flow, it operates on IN and stores the result in output Q, whose units are radians. Both IN and Q are floating-point values.

The Inverse Sine and Cosine functions accept a narrow range of input values, where

$$-1 < \text{IN} < 1.$$

Given a valid value for the IN parameter, the Inverse Sine Real function produces a result Q such that:

$$\text{ASIN}(\text{IN}) = -\pi/2 \leq Q \leq \pi/2.$$

The Inverse Cosine Real function produces a result Q such that:

$$\text{ACOS}(\text{IN}) = 0 \leq Q \leq \pi.$$

The Inverse Tangent function accepts the broadest range of input values, where

$$-\infty \leq \text{IN} \leq +\infty.$$

Given a valid value for the IN parameter, the Inverse Tangent Real function produces a result Q such that:

$$\text{ATAN}(\text{IN}) = -\pi/2 \leq Q \leq \pi/2.$$

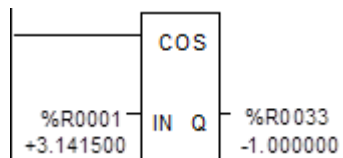
## Parameters of the Trigonometric Functions

| Input/Output | Choices             | Description                                                                                                           |
|--------------|---------------------|-----------------------------------------------------------------------------------------------------------------------|
| enable       | flow                | When the function is enabled, the operation is performed.                                                             |
| IN           | R, AI, AQ, constant | IN contains the constant or reference real value to be operated on.                                                   |
| ok           | flow, none          | OK is energized when the function is performed without overflow, unless an invalid operation occurs and/or IN is NaN. |
| Q            | R, AI, AQ           | Output Q contains the trigonometric value of IN.                                                                      |

### Example

In the example, the Cosine of the value in %R0001 is placed in %R0033.

Figure 308



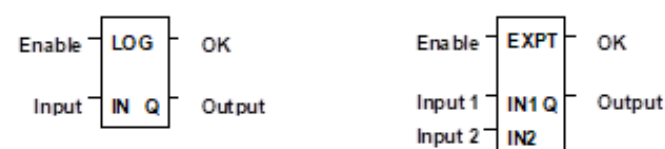
## 23.5.8 Math and Numerical Functions Logarithmic / Exponential Functions

When a Logarithmic or Exponential function receives power flow, it performs the appropriate logarithmic/exponential operation on the Real value in input IN and places the result in output Q.

- For the Base 10 Logarithm (LOG) function, the base 10 logarithm of IN is placed in Q.
- For the Natural Logarithm (LN) function, the natural logarithm of IN is placed in Q.
- For the Power of E (EXP) function, e is raised to the power specified by IN and the result is placed in Q.
- For the Power of X (EXPT) function, the value of input IN1 is raised to the power specified by the value IN2 and the result is placed in output Q. (The EXPT function has three input parameters and two output parameters.)

The OK output receives power flow unless the input is NaN (Not a Number) or is negative.

Figure 309



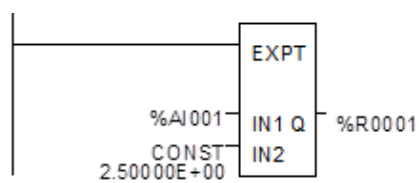
### Parameters of the Logarithmic/Exponential Functions

| Input/Output   | Choices             | Description                                                                                                                                                                 |
|----------------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| enable         | flow                | When the function is enabled, the operation is performed.                                                                                                                   |
| IN or IN1, IN2 | R, AI, AQ, constant | For EXP, LOG, and LN, IN contains the real value to be operated on. The EXPT function has two inputs, IN1 and IN2. For EXPT, IN1 is the base value and IN2 is the exponent. |
| ok             | flow, none          | OK is energized when the function is performed without overflow, unless an invalid operation occurs and/or IN is NaN or is negative.                                        |
| Q              | R, AI, AQ           | Output Q contains the logarithmic/exponential value of IN.                                                                                                                  |

### Example of the EXPT Function

In the example, the value of %AI001 is raised to the power of 2.5 and the result is placed in %R0001.

Figure 310

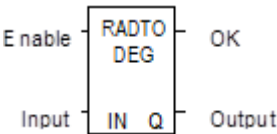


## 23.5.9 Math and Numerical Functions Radian Conversion Functions

When Degree/Radian Conversion function receives power flow, the appropriate conversion (radians to degrees or degrees to radians) is performed on the Real value in input IN and the result is placed in output Q.

The OK output will receive power flow unless IN is NaN (Not a Number).

Figure 311



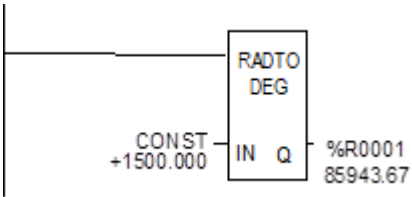
Parameters of the Radian Conversion Function

| Input/Output | Choices             | Description                                                                                   |
|--------------|---------------------|-----------------------------------------------------------------------------------------------|
| enable       | flow                | When the function is enabled, the operation is performed.                                     |
| IN           | R, AI, AQ, constant | IN contains the real value to be operated on.                                                 |
| ok           | flow, none          | The OK output is energized when the function is performed without overflow, unless IN is NaN. |
| Q            | R, AI, AQ           | Output Q contains the converted value of IN.                                                  |

### Example

In the example, +1500 is converted to DEG and is placed in %R0001.

Figure 312



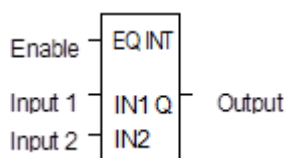
## 23.6 Relational Functions

The Relational functions can be used to compare two numbers and to determine whether a number lies within a specified range.

- Equal Test two numbers for equality
- Not Equal Test two numbers for non-equality
- Greater Than Test whether one number is greater than another
- Greater Than or Equal Test whether one number is greater than or equal to another
- Less Than Test whether one number is less than another
- Less Than or Equal Test whether one number is less than or equal to another
- Range Tests whether one number lies between two other numbers

When the function receives power flow, it compares input IN1 to input IN2. These parameters must be the same data type.

**Figure 313**



If inputs IN1 and IN2 match the specified relational condition, output Q receives power flow and is set ON (1); otherwise, it is set OFF (0).

### 23.6.1 Data Types for Relational Functions

Relational functions operate on these types of data:

|      |                                 |
|------|---------------------------------|
| INT  | Signed integer                  |
| DINT | Double precision signed integer |
| REAL | Floating Point                  |

The %S0020 bit is set ON when a relational function using Real data executes successfully. It is cleared when either input is NaN (Not a Number).

## 23.6.2 Relational Functions Equal, Not Equal, Less Than, Less/Equal, Greater Than, Greater/Equal

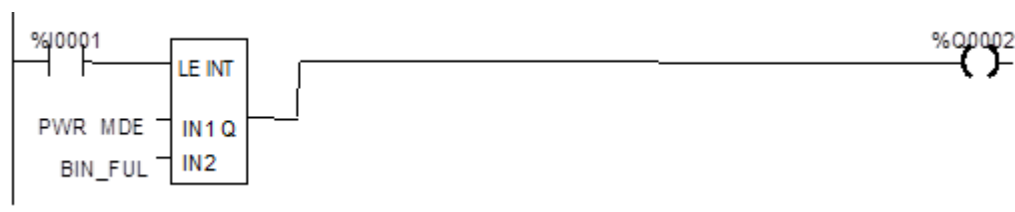
### Parameters for the Relational Functions

| Input/Output | Choices                                                 | Description                                                                                                                                                                                                                                               |
|--------------|---------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| enable       | flow                                                    | When the function is enabled, the operation is performed.                                                                                                                                                                                                 |
| IN1          | R, AI, AQ, constant<br>For INT data only: I, Q, M, T, G | IN1 contains a constant or reference for the first value to be compared. IN1 must be a valid number. Constants must be integers for double precision signed integer operations. IN1 is on the left side of the relational equation, as in $IN1 < IN2$ .   |
| IN2          | R, AI, AQ, constant<br>For INT data only: I, Q, M, T, G | IN2 contains a constant or reference for the second value to be compared. IN2 must be a valid number. Constants must be integers for double precision signed integer operations. IN2 is on the right side of the relational equation, as in $IN1 < IN2$ . |
| Q            | flow, none                                              | Output Q is energized when IN1 and IN2 match the specified relation.                                                                                                                                                                                      |

### Example

In the example, two double precision signed integers are tested for equality. When the relay %I0001 passes power flow to the LE (Less or Equal) function, the value presently in the reference nicknamed PWR\_MDE is compared to the value presently in the reference BIN\_FUL. If the value in PWR\_MDE is less than or equal to the value in BIN\_FUL, coil %Q0002 is turned on.

Figure 314



## 23.6.3 Relational Functions Range

The Range function determines if a value is within the range of two numbers.

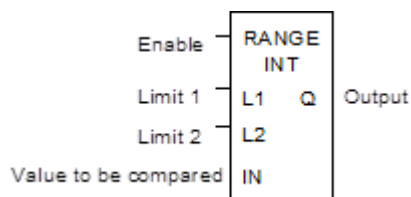
### Data Types for the Range Function

The Range function operates on these types of data:

|      |                                  |
|------|----------------------------------|
| INT  | Signed integer (default).        |
| DINT | Double precision signed integer. |
| WORD | Word data type.                  |

When the Range function is enabled, it compares the value of input IN against the range specified by limits L1 and L2. Either L1 or L2 can be the high or low limit. When the value is within the range specified by L1 and L2, inclusive, output parameter Q is set ON (1). Otherwise, Q is set OFF (0).

Figure 315



### Parameters for the Range Function

| Input/Output | Choices                                                 | Description                                                                                                                   |
|--------------|---------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| enable       | flow                                                    | When the function is enabled, the operation is performed.                                                                     |
| L1           | R, AI, AQ, constant<br>INT and WORD only: I, Q, M, T, G | L1 contains the start point of the range.<br>Constants must be integer values for double precision signed integer operations. |
| L2           | R, AI, AQ, constant<br>INT and WORD only: I, Q, M, T, G | L2 contains the end point of the range.<br>Constants must be integer values for double precision signed integer operations.   |
| IN           | R, AI, AQ<br>INT and WORD only: I, Q, M, T, G           | IN contains the value to be compared against the range specified by L1 and L2.                                                |
| Q            | flow, none                                              | Output Q is energized when the value in IN is within the range specified by L1 and L2, inclusive.                             |

### Example

In this example, when the Range function receives power flow from relay %I0001, the function determines whether the value in %AI001 is within the range 0 to 100.

%R0001 contains the value 100. %R2 contains the value 0.

**Figure 316**



Output coil %Q0001 is On only if the value presently in %AI0001 is within the range 0 to 100.

| IN Value %AI001 | Q State %Q0001 |
|-----------------|----------------|
| < 0             | OFF            |
| 0 – 100         | ON             |
| > 100           | OFF            |

## 23.7 Relay Functions

|                          |         |
|--------------------------|---------|
| Normally Open Contact    | –   –   |
| Normally Closed Contact  | – / –   |
| Normally Open Coil       | –( )–   |
| Retentive SET Coil       | –(SM)–  |
| Retentive RESET Coil     | –(RM)–  |
| Negated Retentive Coil   | –(/M)–  |
| Negated Coil             | –(/)–   |
| Retentive Coil           | –(M)–   |
| SET Coil                 | –(S)–   |
| RESET Coil               | –(R)–   |
| Positive Transition Coil | –(↑)–   |
| Negative Transition Coil | –(↓)–   |
| Vertical Link vert       |         |
| Horizontal Link horz     | –       |
| Continuation Coil        | ----<+> |
| Continuation Contact     | <+>---- |



Each relay contact and coil has one input and one output. Together, they provide logic flow through the contact or coil.

Input → ---- | | ---- ← Output

## 23.7.1 Relay Functions Normally open, Normally-closed, Continuation Contacts

A contact is used to monitor the state of a reference. Whether the contact passes power flow depends on the state or status of the reference being monitored and on the contact type. A reference is ON if its state is 1; it is OFF if its state is 0.

| Type of Contact      | Display   | Contact Passes Power to Right:                |
|----------------------|-----------|-----------------------------------------------|
| Normally Open        | -     -   | When reference is ON.                         |
| Normally Closed      | -   /   - | When reference is OFF.                        |
| Continuation Contact | <+>---    | If the preceding continuation coil is set ON. |

### Normally Open Contact - | | -

A normally open contact acts as a switch that passes power flow if the associated reference is ON (1).

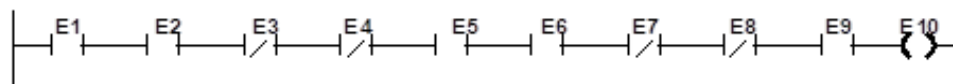
### Normally Closed Contact - | / | -

A normally closed contact acts as a switch that passes power flow if the associated reference is OFF (0).

### Example

The example shows a rung with 10 elements having nicknames from E1 to E10. Coil E10 is ON when reference E1, E2, E5, E6, and E9 are ON and references E3, E4, E7, and E8 are OFF.

Figure 317



## Continuation Coils and Contacts

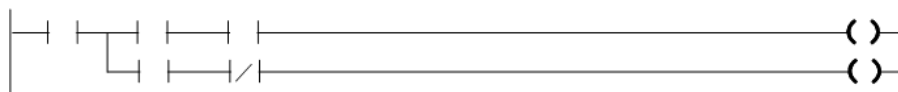
Continuation coils and continuation contacts are used to continue relay ladder rung logic beyond the last column. The state of the last executed continuation coil is the flow state used on the next executed continuation contact. If the flow of logic does not execute a continuation coil before it executes a continuation contact, the state of the contact is no flow. There can be only one continuation coil and contact per rung; the continuation contact must be in column 1, and the continuation coil must be in the last column.

## 23.7.2 Relay Functions Coils

Coils are used to control discrete references. Conditional logic must be used to control the flow of power to a coil. Coils cause action directly; they do not pass power flow to the right. If additional logic in the program should be executed as a result of the coil condition, an internal reference for the coil, or a continuation coil/contact combination may be used.

Coils are always located at the rightmost position of a line of logic:

Figure 318



### References and Coil Checking

When the level of coil checking is set to “single”, you can use a specific %M or %Q reference with only one Coil, but you can use it with one Set Coil and one Reset Coil simultaneously. When the level of coil checking is “warn multiple” or “multiple”, each reference can be used with multiple Coils, Set Coils, and Reset Coils. With multiple usage, a reference could be turned On by either a Set Coil or a normal Coil and could be turned Off by a Reset Coil or by a normal Coil.

### Power Flow and Retentiveness

The following table summarizes how power flow to different types of coils affects their reference. The states of retentive coils are saved when power is cycled or when the PLC goes from Stop to Run mode. The states of non-retentive coils are set to zero when power is cycled, or the PLC goes from Stop to Run mode.

| Type of Coil        | Symbol    | Power to Coil | Result                                                                                                       |
|---------------------|-----------|---------------|--------------------------------------------------------------------------------------------------------------|
| Normally Open       | -( )-     | ON<br>OFF     | Sets reference ON, non-retentive.<br>Sets reference OFF, non-retentive.                                      |
| Negated             | -( / )-   | ON<br>OFF     | Sets reference OFF, non-retentive.<br>Sets reference ON, non-retentive.                                      |
| Retentive           | -(M)-     | ON<br>OFF     | Sets reference ON, retentive.<br>Sets reference OFF, retentive.                                              |
| Negated Retentive   | -( / M )- | ON<br>OFF     | Sets reference OFF, retentive.<br>Sets reference ON, retentive.                                              |
| Positive Transition | -(P)-     | OFF to ON     | If power flow into the coil was OFF the previous sweep and is On this sweep, sets the coil ON.               |
| Negative Transition | -(N)-     | ON to OFF     | If power flow into the coil was ON the previous sweep and is OFF this sweep, sets the coil ON.               |
| SET                 | -(S)-     | ON to OFF     | Sets reference ON until reset OFF by ( R ), non-retentive.<br>Does not change the coil state, non-retentive. |

| Type of Coil      | Symbol  | Power to Coil | Result                                                                                                   |
|-------------------|---------|---------------|----------------------------------------------------------------------------------------------------------|
| RESET             | -(R)-   | ON to OFF     | Sets reference OFF until set ON by (S), non-retentive.<br>Does not change the coil state, non-retentive. |
| Retentive SET     | -(SM)-  | ON to OFF     | Sets reference ON until reset OFF by (RM), retentive.<br>Does not change the coil state.                 |
| Retentive RESET   | -(RM)-  | ON to OFF     | Sets reference OFF until set ON by (SM)-, retentive.<br>Does not change the coil state.                  |
| Continuation Coil | ----<+> | ON<br>OFF     | Sets next continuation contact ON.<br>Sets next continuation contact OFF.                                |

A coil sets a discrete reference ON while it receives power flow. It is non-retentive; therefore, it cannot be used with system status references (%SA, %SB, %SC, or %G).

### Example

In the example, coil E3 is ON when reference E1 is ON and reference E2 is OFF.

Figure 319



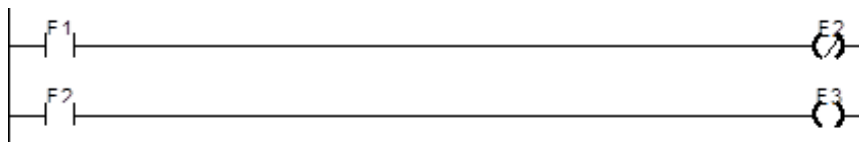
## Negated Coil

A negated coil sets a discrete reference ON when it does not receive power flow. It is not retentive, so it cannot be used with system status references (%SA, %SB, %SC, or %G).

### Example

In the example, coil E3 is ON when reference E1 is OFF.

Figure 320



## Retentive Coil

Like a normally open coil, the retentive coil sets a discrete reference ON while it receives power flow. The state of the retentive coil is retained across power failure. Therefore, it cannot be used with references from strictly non-retentive memory (%T).

## Negated Retentive Coil

The negated retentive coil sets a discrete reference ON when it does not receive power flow. The state of the negated retentive coil is retained across power failure. Therefore, it cannot be used with references from strictly non-retentive memory (%T).

## Positive Transition Coil

If the reference associated with a positive transition coil was OFF, when the coil receives power flow it is set to ON until the next time the coil is executed. (If the rung containing the coil is skipped on subsequent sweeps, it will remain ON.) This coil can be used as a one-shot.

Transitional coils can be used with references from either retentive or non-retentive memory (%Q, %M, %T, %G, %SA, %SB, or %SC).

## Negative Transition Coil

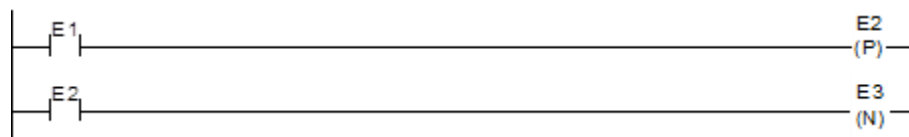
If the reference associated with this coil is OFF, when the coil stops receiving power flow the reference is set to ON until the next time the coil is executed.

Transitional coils can be used with references from either retentive or non-retentive memory (%Q, %M, %T, %G, %SA, %SB, or %SC).

## Example

In the example, when reference E1 goes from OFF to ON, coils E2 and E3 receive power flow, turning E2 ON for one logic sweep. When E2 goes from ON to OFF, power flow is removed from E2 and E3, turning coil E3 ON for one sweep.

Figure 321



## SET Coil

SET and RESET are non-retentive coils that can be used to keep (“latch”) the state of a reference either ON or OFF. When a SET coil receives power flow, its reference stays ON (whether or not the coil itself receives power flow) until the reference is reset by another coil.

SET coils write an undefined result to the transition bit for the given reference.

## RESET Coil

The RESET coil sets a discrete reference OFF if the coil receives power flow. The reference remains OFF until the reference is set by another coil. The last-solved SET coil or RESET coil of a pair takes precedence.

RESET coils write an undefined result to the transition bit for the given reference.

### Example

In the example, the coil represented by E1 is turned ON whenever reference E2 or E6 is ON. The coil represented by E1 is turned OFF whenever reference E5 or E3 is ON.

Figure 322



### Retentive SET Coil

Retentive SET and RESET coils are similar to SET and RESET coils, but they are retained across power failure or when the PLC transitions from to Run mode. A retentive SET coil sets a discrete reference ON if the coil receives power flow. The reference remains ON until reset by a retentive RESET coil.

Retentive SET coils write an undefined result to the transition bit for the given reference.

### Retentive RESET Coil

This coil sets a discrete reference OFF if it receives power flow. The reference remains OFF until set by a retentive SET coil. The state of this coil is retained across power failure or when the PLC transitions from Stop to Run mode.

Retentive RESET coils write an undefined result to the transition bit for the given reference.

## 23.8 Table Functions

The Table functions are used to:

- Copy array data: ARRAY MOVE
- Search for values in an array

The maximum length allowed for these functions is 32,767 for any type.

- **Data Types for the Table Functions**

Table functions operate on these types of data:

|                   |                                 |
|-------------------|---------------------------------|
| INT               | Signed integer                  |
| DINT              | Double precision signed integer |
| BIT <sup>16</sup> | Bit data type                   |
| BYTE              | Byte data type                  |
| WORD              | Word data type                  |

### 23.8.1 Table Functions Array Move

The Array Move function copies a specified number of elements from a source array to a destination array. When the function receives power flow, it copies the number of elements specified from the input array, starting at the indexed location. The function then writes the copied elements to the output array starting with the indexed location.

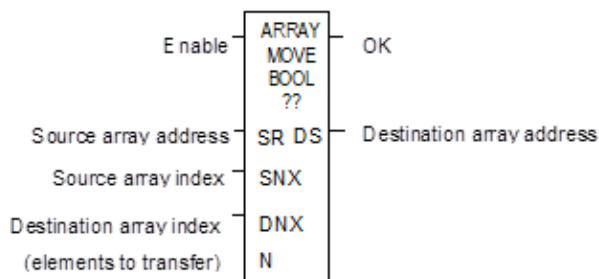
For bit data, when word-oriented memory is selected for the parameters of the source array and/or destination array starting address, the least significant bit of the specified word is the first bit of the array.

The indices in an Array Move instruction are 1-based. In using an Array Move, no element outside either the source or destination arrays (as specified by their starting address and length) may be referenced.

The OK output receives power flow unless one of the following occurs:

- Enable is OFF.
- $(N + SNX - 1)$  is greater than (length).
- $(N + DNX - 1)$  is greater than (length).

Figure 323



<sup>16</sup> Applies to Array Move only.

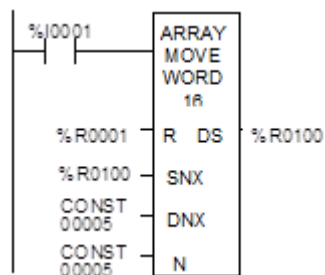
## Parameters for the Array Move Function

| Input/Output | Choices                                                                                           | Description                                                                                                                               |
|--------------|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| enable       | flow                                                                                              | When the function is enabled, the operation is performed.                                                                                 |
| SR           | For all: R, AI, AQ<br>For INT, BIT, BYTE, WORD: I, Q, M, T, G,<br>For BIT, BYTE, WORD: SA, SB, SC | SR contains the starting address of the source array. For ARRAY_MOVE_BIT, any reference may be used; it does not need to be byte aligned. |
| SNX          | I, Q, M, T, G, R, AI, AQ, constant                                                                | SNX contains the index of the source array.                                                                                               |
| DNX          | I, Q, M, T, G, R, AI, AQ, constant                                                                | DNX contains the index of the destination array.                                                                                          |
| N            | I, Q, M, T, G, R, AI, AQ, constant                                                                | N provides a count indicator.                                                                                                             |
| ok           | flow, none                                                                                        | OK is energized whenever enable is energized.                                                                                             |
| DS           | For all: SA, SB, SC, R, AI, AQ<br>For INT, BIT, BYTE, WORD: I, Q, M, T, G                         | The starting address of the destination array. For ARRAY_MOVE_BIT, any reference may be used; it does not need to be byte aligned.        |
| length       |                                                                                                   | The number of elements starting at SR and DS that make up each array. It is defined as the length of SR+DS.                               |

### Example 1:

In this example, if %R100=3 then %R0003 - %R0007 of the array %R0001 - %R0016 is read and is written into %R0104 - %R0108 of the array %R0100 - %R0115. (%R001 and %R0100 are declared as type WORD of length 16.)

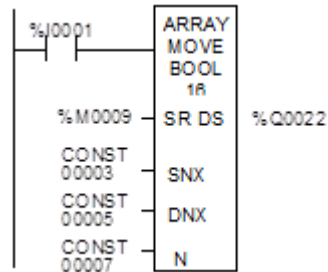
Figure 324



### Example 2:

Using bit memory for SR and DS, %M0011 - %M0017 of the array %M0009 - %M0024 is read and then written to %Q0026 - %Q0032 of the array %Q0022 - %Q0037. (%M009 and %Q0022 are declared as type BOOL of length 16).

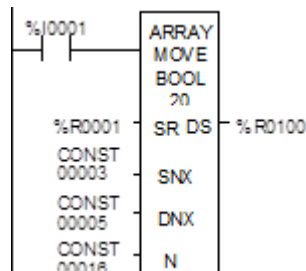
Figure 325



### Example 3:

Using word memory, for SR and DS, the third least significant bit of %R0001 through the second least significant bit of %R0002 of the array containing all 16 bits of %R0001 and four bits of %R0002 is read and then written into the fifth least significant bit of %R0100 through the fourth least significant bit of %R0101 of the array containing all 16 bits of %R0100 and four bits of %R0101. 0001 and %R0100 are declared as type BOOL of length 20).

Figure 326





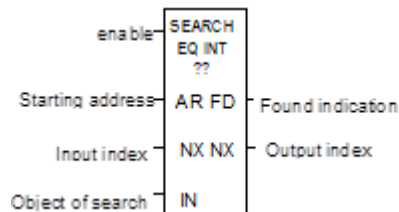
## 23.8.2 Table Functions Search for Array Values

Use the Search functions listed below to search for values in an array.

- Search Equal
- Search Not Equal
- Search Greater Than
- Search Greater Than or Equal
- Search Less Than
- Search Less Than or Equal
- Equal to a specified value.
- Not equal to a specified value.
- Greater than a specified value.
- Greater than or equal to a specified value.
- Less than a specified value.
- Less than or equal to a specified value.

When the Search function receives power, it searches the specified array. Searching begins at the starting address (AR) plus the index value (NX).

**Figure 327**



The search continues until the array element of the search object (IN) is found or until the end of the array is reached. If an array element is found, the Found Indication (FD) is set ON and the Output Index (output NX) is set to the relative position of this element within the array. If no array element is found before the end of the array is reached, the Found Indication (FD) is set OFF and the Output Index (output NX) is set to zero.

The valid values for input NX are 0 to (length - 1). NX should be set to zero to begin searching at the first element. This value increments by one at the time of execution. The values of output NX are 1 to (length). If the value of input NX is out-of-range, (i.e. < 0 or > length), its value is set to the default value of zero.

## Parameters of the Search Functions

| Input/Output | Choices                                                                                    | Description                                                                        |
|--------------|--------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| enable       | flow                                                                                       | When the function is enabled, the search is performed.                             |
| AR           | For all: R, AI, AQ<br>For INT, BYTE, WORD: I, Q,<br>M, T, G<br>For BYTE, WORD: S           | Contains the starting address of the array.                                        |
| Input NX     | I, Q, M, T, G, R, AI, AQ,<br>constant                                                      | Contains the zero-based index into the array at which to begin the search.         |
| IN           | For all: R, AI, AQ, constant<br>For INT, BYTE, WORD: I, Q,<br>M, T, G<br>For BYTE, WORD: S | IN contains the object of the search.                                              |
| Output NX    | I, Q, M, T, G, R, AI, AQ                                                                   | Holds the one-based position within the array of the search target.                |
| FD           | flow, none                                                                                 | FD indicates that an array element has been found and the function was successful. |
| length       | 1 to 32,767 bytes or words.                                                                | The number of elements starting at AR that make up the array to be searched.       |

### Example 1:

The array AR is defined as memory addresses %R0001 - %R0005. When EN is ON, the portion of the array between %R0004 and %R0005 is searched for an element whose value is equal to IN. If %R0001 = 7, %R0002 = 9, %R0003 = 6, %R0004 = 7, %R0005 = 7, and %R0100 = 7, then the search will begin at %R0004 and conclude at %R0004 when FD is set ON and a 4 is written to %R0101.

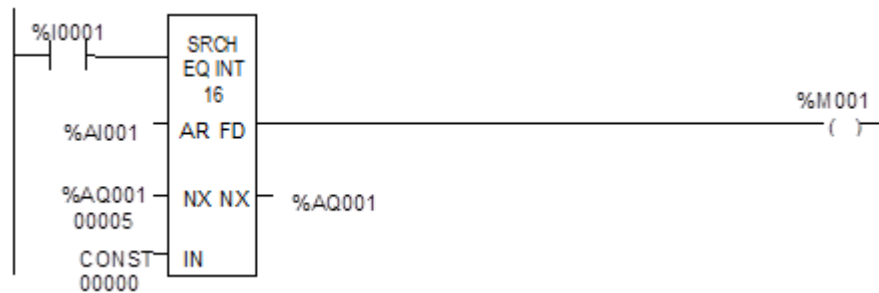
Figure 328



### Example 2:

Array AR is defined as memory addresses %AI001 - %AI016. The values of the array elements are 100, 20, 0, 5, 90, 200, 0, 79, 102, 80, 24, 34, 987, 8, 0, and 500. Initially, %AQ001 is 5. When EN is ON, each sweep will search the array looking for a match to the IN value of 0. The first sweep will start searching at %AI006 and find a match at %AI007, so FD is ON and %AQ001 is 7. The second sweep will start searching at %AI008 and find a match at %AI015, so FD remains ON and %AQ001 is 15. The next sweep will start at %AI016. Since the end of the array is reached without a match, FD is set OFF and %AQ001 is set to zero. The next sweep will start searching at the beginning of the array.

Figure 329



## 23.9 Timer and Counter Functions

This section describes the timing and counting functions of the Instruction Set. The data associated with these functions is retentive through power cycles.

- OnDelay Stopwatch Timer
- Off-Delay Timer
- On-Delay Timer
- Up Counter
- Down Counter

### 23.9.1 Time-Tick Contacts

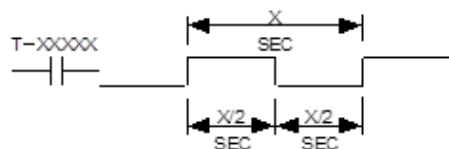
In addition to the Timer functions of the Instruction Set, the VersaMax PLC has four time-tick contacts. These contacts can be used to provide regular pulses of power flow to other program functions. The four time-tick contacts have time durations of 0.01 second, 0.1 second, 1.0 second, and 1 minute.

The state of these contacts does not change during the execution of the sweep. These contacts provide a pulse having an equal on and off time duration.

The contacts are referenced as T\_10MS (0.01 second), T\_100MS (0.1 second), T\_SEC (1.0 second), and T\_MIN (1 minute).

The following timing diagram represents the on/off time duration of these contacts.

Figure 330



These time-tick contacts represent specific locations in %S memory.

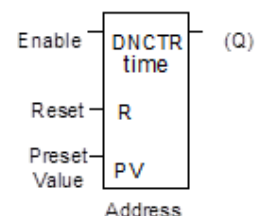
## 23.9.2 Function Block Data Required for Timers and Counters

Each timer or counter uses three words (registers) of %R memory to store the following information:

|                    |        |
|--------------------|--------|
| current value (CV) | word 1 |
| preset value (PV)  | word 2 |
| control word       | word 3 |

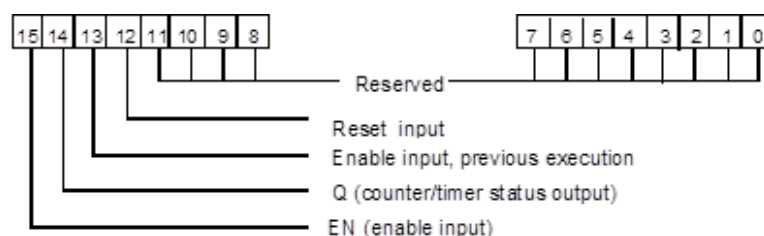
When you enter a timer or counter, you must enter a beginning address for these three words (registers). Do not use consecutive registers for the 3-word timer/counter blocks. Timers and counters will not work if you place the current value of a block on top of the preset for the previous block.

Figure 331



The control word stores the state of the Boolean inputs and outputs of its associated function block in the following format:

Figure 332



Bits 0 through 11 are used for timer accuracy; not for counters.

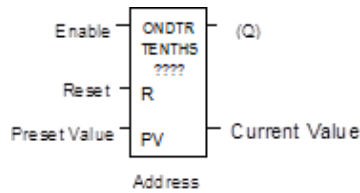
If the Preset Value (PV) is not a constant, PV is normally set to a different location than the second word. Some applications use the second word address for the PV, such as using %R0102 when the bottom data block starts at %R0101. It is then possible to change the Preset Value while the timer or counter is running. The first (CV) and third (Control) words can be read but should not be written, or the function will not work.

## 23.9.3 Timer and Counter Functions On Delay Stopwatch Timer

A retentive On-Delay Stopwatch Timer (ONDTR) increments while it receives power flow and holds its value when power flow stops. Time may be counted in tenths (0.1), hundredths (0.01), or thousandths (0.001) of a second. The range is 0 to +32,767-time units. The state of this timer is retentive on power failure; no automatic initialization occurs at power-up.

When this function first receives power flow, it starts accumulating time (current value). When this timer is encountered in the ladder logic, its current value is updated.

Figure 333



When the current value equals or exceeds the preset value PV, output Q is energized. As long as the timer continues to receive power flow, it continues accumulating until the maximum value is reached. Once the maximum value is reached, it is retained, and output Q remains energized regardless of the state of the enable input.

If multiple occurrences of the same timer with the same reference address are enabled during a CPU sweep, the current values of the timers will be the same.

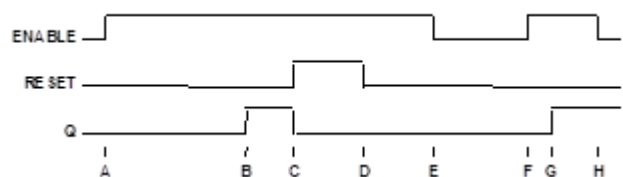
### Parameters of the On-Delay Stopwatch Timer Function

| Input/Output | Choices                                  | Description                                                                                                                                                                                                                                                                                                                                                                                |
|--------------|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| address      | R                                        | <p>The function uses three consecutive words (registers) of %R memory to store the following:</p> <ul style="list-style-type: none"> <li>Current value (CV) = word 1.</li> <li>Preset value (PV) = word 2.</li> <li>Control word = word 3.</li> </ul> <p>Do not use this address with other instructions.</p> <p><b>Careful:</b> Overlapping references cause erratic timer operation.</p> |
| enable       | flow                                     | When enable receives power flow, the timer's current value increments.                                                                                                                                                                                                                                                                                                                     |
| R            | flow                                     | When R receives power flow, it resets the current value to zero.                                                                                                                                                                                                                                                                                                                           |
| PV           | I, Q, M, T, G, R, AI, AQ, constant, none | The Preset Value, which is used when the timer is enabled or reset.                                                                                                                                                                                                                                                                                                                        |
| Q            | flow, none                               | Output Q is energized when the current value of the timer is greater than or equal to the preset value.                                                                                                                                                                                                                                                                                    |

| Input/<br>Output | Choices                                                            | Description                                                           |
|------------------|--------------------------------------------------------------------|-----------------------------------------------------------------------|
| time             | tenths (0.1), hundredths (0.01), or thousandths (0.001) of seconds | Time increment for the low bit of the PV preset and CV current value. |

## Operation of the On-Delay Timer Function

Figure 334



- ENABLE goes high; timer starts accumulating
- Current value reaches preset value PV; Q goes high
- RESET goes high; Q goes low, accumulated time is reset (CV=0)
- RESET goes low; timer then starts accumulating again
- ENABLE goes low; timer stops accumulating. Whatever time has been accumulated remains.
- ENABLE goes high again; timer starts accumulating time from the earlier accumulated value.
- Current value becomes equal to preset value PV; Q goes high. Timer continues to accumulate time until ENABLE goes low, RESET goes high or current value becomes equal to the maximum time
- ENABLE goes low; timer stops accumulating time.

When power flow to the timer stops, the current value stops incrementing and is retained. Output Q, if energized, will remain energized. When the function receives power flow again, the current value again increments, beginning at the retained value. When reset R receives power flow, the current value is set back to zero and output Q is de-energized unless PV equals zero.

### Example

In the example, a retentive On-Delay Timer is used to create a signal (%Q0011) that turns on 8.0 seconds after %Q0010 turns on, and turns off when %Q0010 turns off.

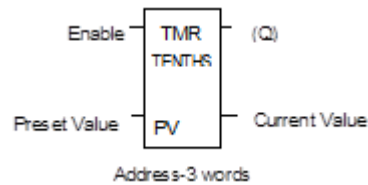
Figure 335



## 23.9.4 Timer and Counter Functions On Delay Timer

The On-Delay Timer (TMR) increments while it receives power flow and resets to zero when power flow stops. Time may be counted in tenths of a second (the default selection), hundredths of a second, or thousandths of a second. The range is 0 to +32,767-time units. The state of this timer is retentive on power failure; no automatic initialization occurs at power-up.

Figure 336



When the On-Delay Timer function receives power flow, the timer starts accumulating time (current value). The current value is updated when it is encountered in the logic to reflect the total elapsed time the timer has been enabled since it was last reset.

If multiple occurrences of the same timer with the same reference address are enabled during a CPU sweep, the current values of the timers will be the same.

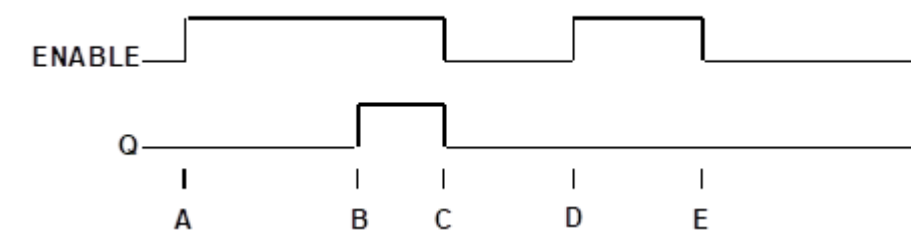
This update occurs as long as the enabling logic remains ON. When the current value equals or exceeds the preset value PV, the function begins passing power flow to the right. The timer continues accumulating time until the maximum value is reached. When the enabling parameter transitions from ON to OFF, the timer stops accumulating time, and the current value is reset to zero.

## Parameters for the On Delay Timer Function

| Input/<br>Output | Choices                                                            | Description                                                                                                                                                                                                                                                                                                                                                              |
|------------------|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| address          | R                                                                  | The function uses three consecutive words (registers) of %R memory to store the following: <ul style="list-style-type: none"> <li>Current value (CV) = word 1.</li> <li>Preset value (PV) = word 2.</li> <li>Control word = word 3.</li> </ul> Do not use this address with other instructions.<br>Careful: Overlapping references cause erratic operation of the timer. |
| enable           | flow                                                               | When enable receives power flow, the timer's current value is incremented. When the TMR is not enabled, the current value is reset to zero and Q is turned off.                                                                                                                                                                                                          |
| PV               | I Q, M, T, G, R, AI, AQ, constant, none                            | PV is the value to copy into the timer's preset value when the timer is enabled or reset.                                                                                                                                                                                                                                                                                |
| Q                | flow, none                                                         | Output Q is energized when TMR is enabled and the current value is greater than or equal to the preset value.                                                                                                                                                                                                                                                            |
| time             | tenths (0.1), hundredths (0.01), or thousandths (0.001) of seconds | Time increment for the low bit of the PV preset and CV current value.                                                                                                                                                                                                                                                                                                    |

## Operation of the On-Delay Timer Function

Figure 337



- ENABLE goes high; timer begins accumulating time.
- Current value reaches preset value PV; Q goes high, and timer continues accumulating time.
- ENABLE goes low; Q goes low; timer stops accumulating time and current time is cleared.
- ENABLE goes high; timer starts accumulating time.
- ENABLE goes low before current value reaches preset value PV; Q remains low; timer stops accumulating time and is cleared to zero (CV=0).

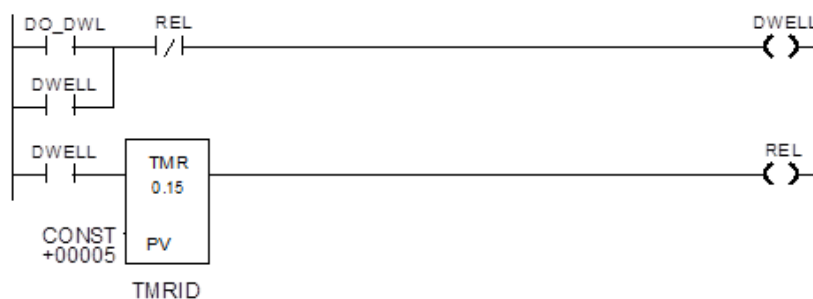


### Example

In the example, a delay timer (with address) TMRID is used to control the length of time that coil is on. This coil has been assigned the Nickname DWELL. When the normally open (momentary) contact with the Nickname DO\_DWL is on, coil DWELL is energized.

The contact of coil DWELL keeps coil DWELL energized (when contact DO\_DWL is released), and also starts the timer TMRID. When TMRID reaches its preset value of one-half second, coil REL energizes, interrupting the latched-on condition of coil DWELL. The contact DWELL interrupts power flow to TMRID, resetting its current value and de-energizing coil REL. The circuit is then ready for another momentary activation of contact DO\_DWL.

Figure 338

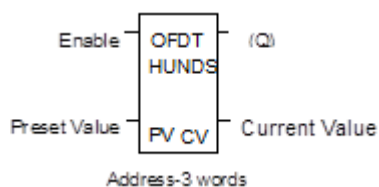


## 23.9.5

### Timer and Counter Functions Off Delay Timer

The Off-Delay Timer increments while power flow is off, and resets to zero when power flow is on. Time may be counted in tenths (0.1), hundredths (0.01), or thousandths (0.001) of a second. The range is 0 to +32,767-time units. The state of this timer is retentive on power failure; no automatic initialization occurs at power-up.

Figure 339



When the Off-Delay Timer first receives power flow, it passes power to the right, and the current value (CV) is set to zero. The function uses word 1 as its CV storage location. The output remains on as long as the function receives power flow. If the function stops receiving power flow from the left, it continues to pass power to the right, and the timer starts accumulating time in the current value.

If multiple occurrences of the same timer with the same reference address are enabled during a CPU sweep, the current values of the timers will be the same.

The Off-Delay Timer does not pass power flow if the preset value is zero or negative.

Each time the function is invoked with the enabling logic set to OFF, the current value is updated to reflect the elapsed time since the timer was turned off. When the current value (CV) is equal to the preset value (PV), the function stops passing power flow to the right.

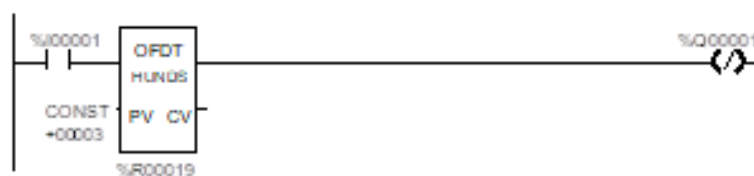
When that occurs, the timer stops accumulating. When the function receives power flow again, the current value resets to zero.

When the Off-Delay Timer is used in a program block that is not called every sweep, the timer accumulates time between calls to the program block unless it is reset. This means that it functions like a timer operating in a program with a much slower sweep than the timer in the main program block. For program blocks that are inactive for a long time, the timer should be programmed to allow for this catch-up feature. For example, if a timer in a program block is reset and the program block is not called (is inactive) for four minutes, when the program block is called, four minutes of time will already have accumulated. This time is applied to the timer when enabled, unless the timer is first reset.

### Example

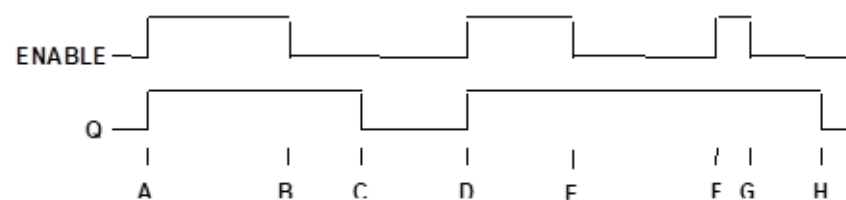
In the example, an Off-Delay Timer is used to turn off an output (%Q00001) whenever an input (%I00001) turns on. The output is turned on again 0.3 seconds after the input goes off.

Figure 340



## Operation of the Off-Delay Timer Function

Figure 341



- A. ENABLE and Q both go high; timer is reset (CV = 0).
- B. ENABLE goes low; timer starts accumulating time.
- C. CV reaches PV; Q goes low, and timer stops accumulating time.
- D. ENABLE goes high; timer is reset (CV = 0).
- E. ENABLE goes low; timer starts accumulating time.
- F. ENABLE goes high; timer is reset (CV = 0).
- G. ENABLE goes low; timer begins accumulating time.
- H. CV reaches PV; Q goes low, and timer stops accumulating time.

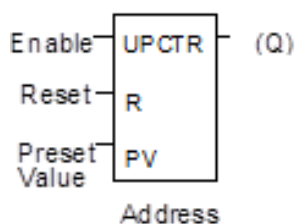
## Parameters of the Off-Delay Timer Function

| Input/<br>Output | Choices                                                            | Description                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| address          | R                                                                  | <p>The function uses three consecutive words (registers) of %R memory to store the following:</p> <ul style="list-style-type: none"> <li>• Current value (CV) = word 1.</li> <li>• Preset value (PV) = word 2.</li> <li>• Control word = word 3.</li> </ul> <p>Do not use this address with other instructions.</p> <p>Careful: Overlapping references cause erratic operation of the timer.</p> |
| enable           | flow                                                               | When enable receives power flow, the timer's current value is reset to 0.                                                                                                                                                                                                                                                                                                                        |
| PV               | I Q, M, T, G, R, AI, AQ, constant, none                            | PV is the value to copy into the timer's preset value when the timer is enabled or reset. For a register (%R) OV reference, the PV parameter is specified as the second word of the address parameter. For example, an address parameter of %R0001 would use %R0002 as the PV parameter.                                                                                                         |
| Q                | flow, none                                                         | Output Q is energized when the current value is less than the preset value. The Q state is retentive on power failure; no automatic initialization occurs at power-up.                                                                                                                                                                                                                           |
| time             | tenths (0.1), hundredths (0.01), or thousandths (0.001) of seconds | Time increment for the low bit of the PV preset and CV current value.                                                                                                                                                                                                                                                                                                                            |

## 23.9.6 Timer and Counter Functions Up Counter

The Up-Counter function counts up to a designated value. The range is 0 to +32,767 counts. When the Up-Counter reset is ON, the current value of the counter resets to 0. Each time the enable input transitions from OFF to ON, the current value increments by 1. The current value can be incremented past the preset value PV. The output is ON whenever the current value is greater than or equal to the preset value. The state of the CTU is retentive on power failure; no automatic initialization occurs at power-up.

Figure 342



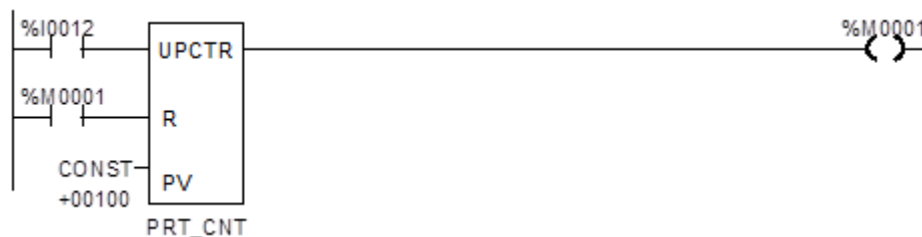
## Parameters of the Up-Counter Function

| Input/Output | Choices                                  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| address      | R                                        | <p>The function uses three consecutive words (registers) of %R memory to store the following:</p> <ul style="list-style-type: none"> <li>Current value (CV) = word 1.</li> <li>Preset value (PV) = word 2.</li> <li>Control word = word 3.</li> </ul> <p>Do not use this address with another up counter, down counter, or any other instruction or improper operation will result.</p> <p>Careful: Overlapping references cause erratic operation of the counter.</p> |
| enable       | flow                                     | On a positive transition of enable, the current count is incremented by one.                                                                                                                                                                                                                                                                                                                                                                                           |
| R            | flow                                     | When R receives power flow, it resets the current value back to zero.                                                                                                                                                                                                                                                                                                                                                                                                  |
| PV           | I, Q, M, T, G, R, AI, AQ, constant, none | PV is the value to copy into the counter's preset value when the counter is enabled or reset.                                                                                                                                                                                                                                                                                                                                                                          |
| Q            | flow, none                               | Output Q is energized when the current value is greater than or equal to the preset value.                                                                                                                                                                                                                                                                                                                                                                             |

### Example of the Up-Counter Function

In the example, every time input %I0012 transitions from OFF to ON, up counter PRT\_CNT counts up by 1; internal coil %M0001 is energized when 100 parts have been counted. When %M0001 is ON, the accumulated count is reset to zero.

Figure 343

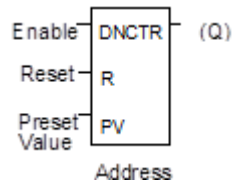


## 23.9.7 Timer and Counter Functions Down Counter

The Down Counter function counts down from a preset value. The minimum preset value is zero; the maximum present value is +32,767 counts. The minimum current value is – 32,768. When reset, the current value of the counter is set to the preset value PV. When the enable input transitions from OFF to ON, the current value is decremented by one. The output is ON whenever the current value is less than or equal to zero.

The current value of the Down Counter is retentive on power failure; no automatic initialization occurs at power-up.

Figure 344



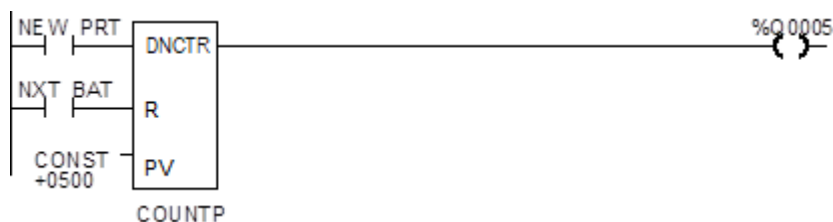
### Parameters of the Down Counter Function

| Input/<br>Output | Choices                                  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------------|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| address          | R                                        | <p>The function uses three consecutive words (registers) of %R memory to store the following:</p> <ul style="list-style-type: none"> <li>Current value (CV) = word 1.</li> <li>Preset value (PV) = word 2.</li> <li>Control word = word 3.</li> </ul> <p>Do not use this address with another down counter, up counter, or any other instruction or improper operation will result.</p> <p>Careful: Overlapping references will result in erratic counter operation.</p> |
| enable           | flow                                     | On a positive transition of enable, the current value is decremented by one.                                                                                                                                                                                                                                                                                                                                                                                             |
| R                | flow                                     | When R receives power flow, it resets the current value to the preset value.                                                                                                                                                                                                                                                                                                                                                                                             |
| PV               | I, Q, M, T, G, R, AI, AQ, constant, none | PV is the value to copy into the counter's preset value when the counter is enabled or reset.                                                                                                                                                                                                                                                                                                                                                                            |
| Q                | flow, none                               | Output Q is energized when the current value is less than or equal to zero.                                                                                                                                                                                                                                                                                                                                                                                              |

### Example 1

In the example, the down counter identified as COUNTP counts 500 new parts before energizing output %Q0005.

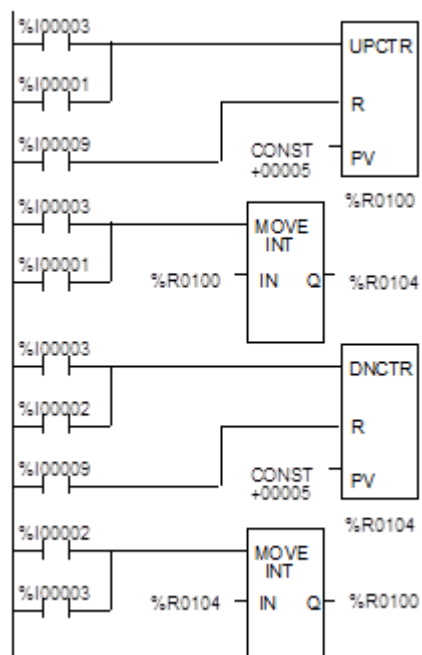
Figure 345



### Example 2

The following example shows how the PLC can keep track of the number of parts in a temporary storage area. It uses an up/down counter pair with a shared register for the accumulated or current value. When parts enter the storage area, the up counter increases the current value of the parts in storage by 1. When a part leaves the storage area, the down counter decrements by 1, decreasing the inventory storage value by 1. The two counters use different register addresses. When a register counts, its current value must be moved to the current value register of the other counter.

Figure 346



See the pages on Math functions for an example of using the Addition and Subtraction functions to provide storage tracking.

# Chapter 24: Service Request Function

This chapter explains the Service Request (SVCREQ) function, which requests a special PLC service. It describes SVCREQ parameters for the VersaMax Nano PLC and Micro PLC.

- SVCREQ Function Numbers
- Format of the SVCREQ Function
- SVCREQ 1: Change/Read Constant Sweep Timer
- SVCREQ 2: Read Window Times
- SVCREQ 3: Change Programmer Communications Window Mode
- SVCREQ 4: Change System Communications Window Mode
- SVCREQ 6: Change/Read Number of Words to Checksum
- SVCREQ 7: Read or Change the Time-of-Day Clock
- SVCREQ 8: Reset Watchdog Timer
- SVCREQ 9: Read Sweep Time from Beginning of Sweep
- SVCREQ 10: Read Folder Name
- SVCREQ 11: Read PLC ID
- SVCREQ 13: Shut Down (Stop) PLC
- SVCREQ 14: Clear Fault
- SVCREQ 15: Read Last-Logged Fault Table Entry
- SVCREQ 16: Read Elapsed Time Clock
- SVCREQ 18: Read I/O Override Status
- SVCREQ 23: Read Master Checksum
- SVCREQ 26/30: Interrogate I/O
- SVCREQ 34: Enter Analog Calibration Mode
- SVCREQ 35: Execute Analog Calibration
- SVCREQ 52: Read from Flash
- SVCREQ 53: Write to Flash

## 24.1 SVCREQ Functions

Each Service Request has its own function number, as listed in the following table.

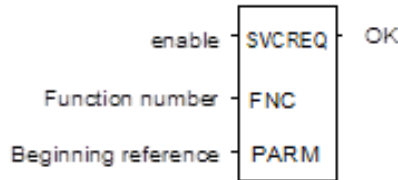
| Function # | Description                                           |
|------------|-------------------------------------------------------|
| 1          | Change/Read Constant Sweep Timer                      |
| 2          | Read Window Times                                     |
| 3          | Change Programmer Communications Window Mode and Time |
| 4          | Change System Communications Window Mode and Time     |
| 5          | reserved                                              |
| 6          | Change/Read Number of Words to Checksum               |
| 7          | Change/Read Time-of-Day Clock                         |
| 8          | Reset Watchdog Timer                                  |
| 9          | Read Sweep Time from Beginning of Sweep               |
| 10         | Read Folder Name                                      |
| 11         | Read PLC ID                                           |
| 12         | reserved                                              |
| 13         | Shut Down the PLC                                     |
| 14         | Clear Fault Tables                                    |
| 15         | Read Last-Logged Fault Table Entry                    |
| 16         | Read Elapsed Time Clock                               |
| 17         | reserved                                              |
| 18         | Read I/O Override Status                              |
| 19-22      | reserved                                              |
| 23         | Read Master Checksum                                  |
| 26, 30     | Interrogate I/O                                       |
| 27, 28     | reserved                                              |
| 29         | Read Elapsed Power Down Time                          |
| 31-33      | reserved                                              |
| 34         | Enter Analog Calibration mode                         |
| 35         | Execute Analog Calibration                            |
| 36-51      | reserved                                              |
| 52         | Read from Flash                                       |
| 53         | Write to Flash                                        |
| 53-255     | reserved                                              |



## 24.2 Format of the SVCREQ Function

The SVCREQ function has three inputs and one output.

Figure 347



When the SVCREQ receives power flow, the PLC is requested to perform the function number (FNC) indicated. Parameters for the function are located beginning at the reference given for PARM. This is the beginning of the “parameter block” for the function. The number of 16-bit references required depends on the SVCREQ function being used.

Parameter blocks may be used as both inputs for the function and the location where data may be output after the function executes. Therefore, data returned by the function is accessed at the same location specified for PARM.

The SVCREQ function passes power flow unless an incorrect function number, incorrect parameters, or out-of-range references are specified. Specific SVCREQ functions have additional causes for failure.

### 24.2.1 Parameters of the SVCREQ Function

| Input/<br>Output | Choices                           | Description                                                                         |
|------------------|-----------------------------------|-------------------------------------------------------------------------------------|
| enable           | flow                              | When enable is energized, the service request is performed.                         |
| FNC              | I, Q M, T, G, R, AI, AQ, constant | Contains the constant or reference for the requested service.                       |
| PARM             | I, Q M, T, G, R, AI, AQ           | Contains the beginning reference for the parameter block for the requested service. |
| ok               | flow, none                        | OK is energized when the function is performed without error.                       |

#### Example of the SVCREQ Function

In the example, when the enabling input %I0001 is ON, SVCREQ function number 7 is called, with the parameter block located starting at %R0001. Output coil %Q0001 is set ON if the operation succeeds.

Figure 348



## 24.3 SVCREQ 1: Change/Read Constant Sweep Timer

Use SVCREQ 1 to enable or disable Constant Sweep Time mode, change the length of the Constant Sweep Time, read whether Constant Sweep Time is currently enabled, or read the Constant Sweep Time length.

### 24.3.1 Input Parameter Block for SCVREQ 1

For this function, the parameter block has a length of two words.

### 24.3.2 Disable Constant Sweep Mode

To disable Constant Sweep mode, enter SVCREQ function #1 with this parameter block:

|             |         |
|-------------|---------|
| address     | 0       |
| address + 1 | ignored |

### 24.3.3 Enable Constant Sweep Mode

To enable Constant Sweep mode, enter SVCREQ function #1 with this parameter block:

|             |                  |
|-------------|------------------|
| address     | 1                |
| address + 1 | 0 or timer value |

---

**Note:** If the timer should use a new value, enter it in the second word. If the timer value should not be changed, enter 0 in the second word. If the timer value does not already exist, entering 0 causes the function to set the OK output to OFF.

---

### 24.3.4 Change the Constant Sweep Time

To change the timer value without changing the selection for sweep mode state, enter SVCREQ function #1 with this parameter block:

|             |                 |
|-------------|-----------------|
| address     | 2               |
| address + 1 | new timer value |

### 24.3.5 Read the Constant Sweep State and Time

To read the current timer state and value without changing either, enter SVCREQ function #1 with this parameter block:

|             |         |
|-------------|---------|
| address     | 3       |
| address + 1 | ignored |

Successful execution will occur, unless:

1. A number other than 0, 1, 2, or 3 is entered as the requested operation:
2. The sweep time value is greater than 500ms (0.5 seconds).
3. Constant sweep time is enabled with no timer value programmed or with an old value of 0 for the timer.

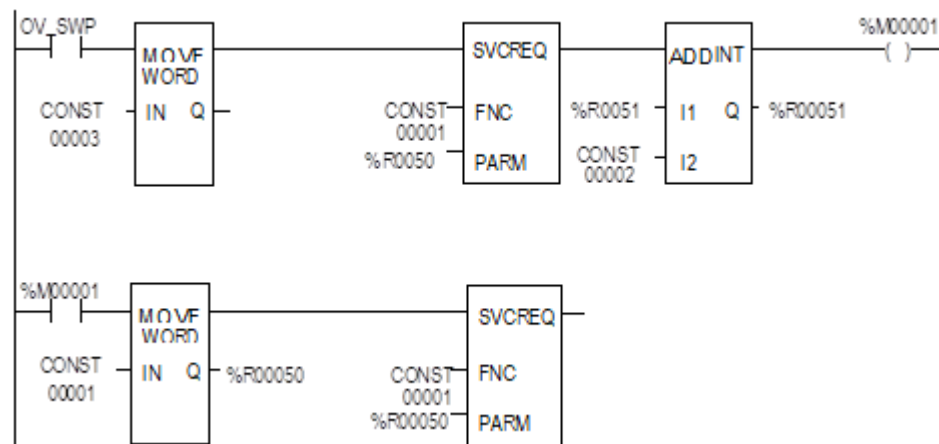
After the function executes, the function returns the timer state and value in the same parameter block references:

|             |                     |
|-------------|---------------------|
|             | 0 = disabled        |
| address     | 1 = enabled         |
| address + 1 | current timer value |

### Example of SVCREQ 1

In this example, if contact OV\_SWP is set, the Constant Sweep Timer is read, the timer is increased by two milliseconds, and the new timer value is provided to the CPU. The parameter block is in local memory at location %R0050. Because the MOVE and ADD functions require three horizontal contact positions, the example logic uses discrete internal coil %M00001 as a temporary location to hold the successful result of the first rung line. On any sweep in which OV\_SWP is not set, %M00001 is turned off.

Figure 349



## 24.4 SVCREQ 2: Read Window Times

SVCREQ 2 can be used to read the times of the programmer communications window and the system communications window. These windows can operate in Limited or Run to Completion Mode.

| Mode Name              | Value | Description                                                                                                                           |
|------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------|
| Limited Mode           | 0     | The execution time of the window is limited to 6ms. The window terminates when it has no more tasks to complete or after 6ms elapses. |
| Run to Completion Mode | 2     | Regardless of the time assigned to a window, it runs until all tasks within that window are completed (up to 400ms).                  |

A window is disabled when the time value is zero.

### 24.4.1 Output Parameter Block for SVCREQ 2

The parameter block has a length of three words:

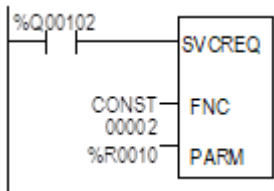
|             | High Byte    | Low Byte     |                              |
|-------------|--------------|--------------|------------------------------|
| address     | Mode         | Value in ms  | Programmer Window            |
| address + 1 | Mode         | Value in ms  | System Communications Window |
| address + 2 | must be zero | must be zero | reserved                     |

All parameters are output parameters. It is not necessary to enter values in the parameter block to program this function.

#### Example of SVCREQ 2

In the following example, when enabling output %Q00102 is set, the Micro PLC CPU places the current time values of the windows in the parameter block starting at location %R0010.

Figure 350



# 24.5 SVCREQ 3: Change Programmer Communications Window Mode

Use SVCREQ 3 to change the programmer communications window mode (Limited or Run-to-Completion). The change occurs during the next CPU sweep after the function is called. The time of the window cannot be changed; it is always 6ms.

SVCREQ 3 passes power flow to the right unless a mode other than 0 (Limited) or 2 (Run-to-Completion) is selected.

The parameter block has a length of one word.

## 24.5.1 Changing the Programmer Communications Window Mode

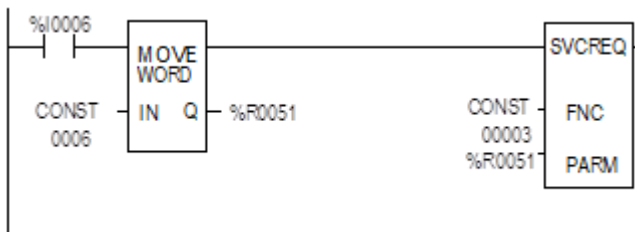
To change the programmer window, enter SVCREQ 3 with this parameter block:

|         | High Byte | Low Byte |
|---------|-----------|----------|
| address | Mode      | 6        |

### Example of SVCREQ 3

In the following example, when enabling input %I006 goes ON, the programmer communications window is enabled and assigned a value of 6ms. The parameter block is in reference memory location %R0051.

Figure 351



# 24.6 SVCREQ 4: Change System Communications Window Mode

Use SVCREQ 4 to change the system communications window mode (Limited or Run-to-Completion). The change occurs during the next CPU sweep after the function is called. The time of the window cannot be changed; it is always 6ms.

SVCREQ 4 passes power flow to the right unless a mode other than 0 (Limited) or 2 (Run-to-Completion) is selected.

The parameter block has a length of one word.

## 24.6.1 Changing the System Communications Window Mode

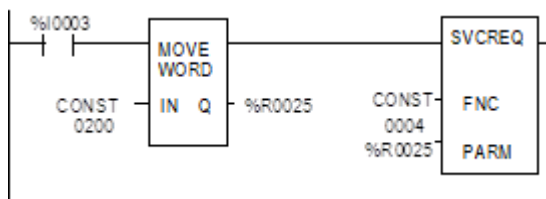
To change the programmer window, enter SVCREQ 4 with this parameter block:

|         | High Byte | Low Byte |
|---------|-----------|----------|
| address | Mode      | 6        |

### Example of SVCREQ 4

In the following example, when enabling input %I0003 is ON the system communications window is changed to Run-to-Completion mode. The parameter block is at location %R0025.

Figure 352



## 24.7 SVCREQ 6: Change/Read Number of Words to Checksum

Use SVCREQ 6 to read or change the number of words in the program to be checksummed. The function is successful unless some number other than 0 or 1 is entered as the requested operation.

### 24.7.1 Parameter Block Formats for SVCREQ 6

The parameter block has a length of 2 words. To read the word count, the first word of the parameter block must contain a zero:

|             |                     |
|-------------|---------------------|
| address     | 0 (read word count) |
| address + 1 | ignored             |

The function returns the current word count in the second word of the parameter block.

|             |                    |
|-------------|--------------------|
| address     | 0                  |
| address + 1 | current word count |

To change the word count, the first word of the parameter block must contain a one:

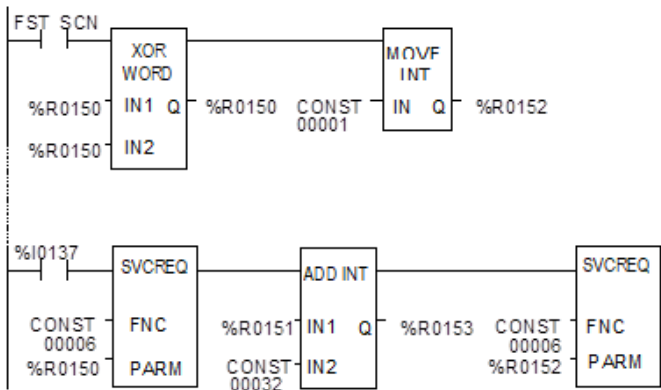
|             |                          |
|-------------|--------------------------|
| address     | 1 (change word count)    |
| address + 1 | new word count (0 to 32) |

The PLC will change the number of words to be checksummed to the new value.

Example of SVCREQ 6

In the example, when enabling contact FST\_SCN is set, the parameter blocks for the checksum function are built. Later in the program, if input %I0137 turns on, the SVCREQ reads the number of words being checksummed. The parameter block for the Read function is located at %R0150-151. The ADD function adds 32 to the current word count in %R0151 and places the result in %R0153. The parameter block for the Change function is located at %R00152-153. The second SVCREQ then changes to the new word count specified in %R0153.

Figure 353



24.8 SVCREQ 7: Read or Change the Time-of-Day Clock

Use SVCREQ 7 to read or change the time of day clock in the PLC. The data can be either BCD or ASCII. Either 2-digit-year or 4-digit-year format is available. The function is successful unless some number other than 0 (read) or 1 (change) is entered for the requested operation, or an invalid data format is specified, or data is provided in an unexpected format.

24.8.1 Parameter Block Format for SVCREQ 7

For the date/time functions, the length of the parameter block depends on the data format. The data block is either BCD or ASCII. BCD format requires 6 words; packed ASCII requires 12 words (13 words for 4-digit year). For both data types:

Hours are stored in 24-hour format.

Day of the week is a numeric value from 1 (Sunday) to 7 (Saturday).

|                    | 2-Digit Year Format                             | 4-Digit Year Format                             |
|--------------------|-------------------------------------------------|-------------------------------------------------|
| address            | 0 = read time and date<br>1 = set time and date | 0 = read time and date<br>1 = set time and date |
| address + 1        | 1 = BCD format<br>3 = packed ASCII format       | 81h = BCD format<br>83h = packed ASCII format   |
| address + 2 to end | data                                            | data                                            |

Words 3 to the end of the parameter block contain output data returned by a read function, or new data being supplied by a change function. In both cases, format of these data words is the same. When reading the date and time, words (address + 2) to the end of the parameter block are ignored on input.

## 24.9 SVCREQ 7 Parameter Block Content: BCD Format

In BCD format, each time and date item occupy one byte, so the parameter block has six words.

### 24.9.1 2-Digit Year

The last byte of the sixth word is not used. When setting the date and time, this byte is ignored; when reading date and time, the function returns 00.

**Parameter Block Format:**  
**High Byte:      Low Byte**

|                           |              |             |
|---------------------------|--------------|-------------|
| 1 = change or<br>0 = read |              | address     |
| 1 (BCD format)            |              | address + 1 |
| month                     | year         | address + 2 |
| hours                     | day of month | address + 3 |
| seconds                   | minutes      | address + 4 |
| (null)                    | day of week  | address + 5 |

**Example:**  
**Read Date and Time in BCD format**  
**(Sun., July 3, 1998, at 2:45:30 p.m.)**

|                |              |
|----------------|--------------|
| 0 (read)       |              |
| 1 (BCD format) |              |
| 07 (July)      | 98 (year)    |
| 14 (hours)     | 03 (day)     |
| 30 (seconds)   | 45 (minutes) |
| 00             | 06 (Friday)  |

### 24.9.2 4-Digit Year

The parameter block has six words. All bytes are used.

**Parameter Block Format:**  
**High Byte:      Low Byte**

|                           |         |             |
|---------------------------|---------|-------------|
| 1 = change or<br>0 = read |         | address     |
| 81h (BCD format, 4-digit) |         | address + 1 |
| year                      | year    | address + 2 |
| day of month              | month   | address + 3 |
| minutes                   | hours   | address + 4 |
| day of week               | seconds | address + 5 |

**Example:**  
**Read Date and Time in BCD format**  
**(Sun., July 3, 1998, at 2:45:30 p.m.)**

|              |                    |
|--------------|--------------------|
| 00           | 00 (read)          |
| 00           | 81h (BCD, 4-digit) |
| 19 (year)    | 98 (year)          |
| 03 (day)     | 07 (July)          |
| 45 (minutes) | 14 (hours)         |
| 06 (Friday)  | 30 (seconds)       |



# 24.10 SVCREQ 7 Parameter Block Content: Packed ASCII Format

In Packed ASCII format, each digit of the time and date items is an ASCII formatted byte. Spaces and colons are embedded into the data to format it for printing or display. ASCII format requires 12 words in the parameter block (13 words for 4-digit year).

## 24.10.1 2-Digit Year

**Parameter Block Format:**  
**High Byte      Low Byte**

|                           |              |              |
|---------------------------|--------------|--------------|
| 1 = change or<br>0 = read |              | address      |
| 3 (ASCII format)          |              | address + 1  |
| year                      | year         | address + 2  |
| month                     | (space)      | address + 3  |
| (space)                   | month        | address + 4  |
| day of month              | day of month | address + 5  |
| hours                     | (space)      | address + 6  |
| :                         | hours        | address + 7  |
| minutes                   | minutes      | address + 8  |
| seconds                   | :            | address + 9  |
| (space)                   | seconds      | address + 10 |
| day of week               | day of week  | address + 11 |

**Example:**  
**Read Date and Time in Packed ASCII  
Format (Mon, Oct. 5, 1998 at  
11:13:00pm)**

|                  |                |
|------------------|----------------|
| 0 (read)         |                |
| 3 (ASCII format) |                |
| 38 (8)           | 39 (9)         |
| 31 (1)           | 20 (space)     |
| 20 (space)       | 30 (0)         |
| 35 (5)           | 30 (leading 0) |
| 31 (1)           | 20 (space)     |
| 3A (:)           | 31 (1)         |
| 33 (3)           | 31 (1)         |
| 30 (0)           | 3A (:)         |
| 20 (space)       | 30 (0)         |
| 32 (2: Mon.)     | 30 (leading 0) |

## 24.10.2 4-Digit Year

**Parameter Block Format:**  
**High Byte      Low Byte**

|                           |                     |              |
|---------------------------|---------------------|--------------|
| 1 = change or<br>0 = read |                     | address      |
| 83h (ASCII 4 digit)       |                     | address + 1  |
| year (hundreds)           | year (thousands)    | address + 2  |
| year (ones)               | year (tens)         | address + 3  |
| month (tens)              | (space)             | address + 4  |
| (space)                   | month (ones)        | address + 5  |
| day of month (ones)       | day of month (tens) | address + 6  |
| hours (tens)              | (space)             | address + 7  |
| : (colon)                 | hours (ones)        | address + 8  |
| minutes (ones)            | minutes (tens)      | address + 9  |
| seconds (tens)            | : (colon)           | address + 10 |
| (space)                   | seconds (ones)      | address + 11 |
| day of week (ones)        | day of week (tens)  | address + 12 |

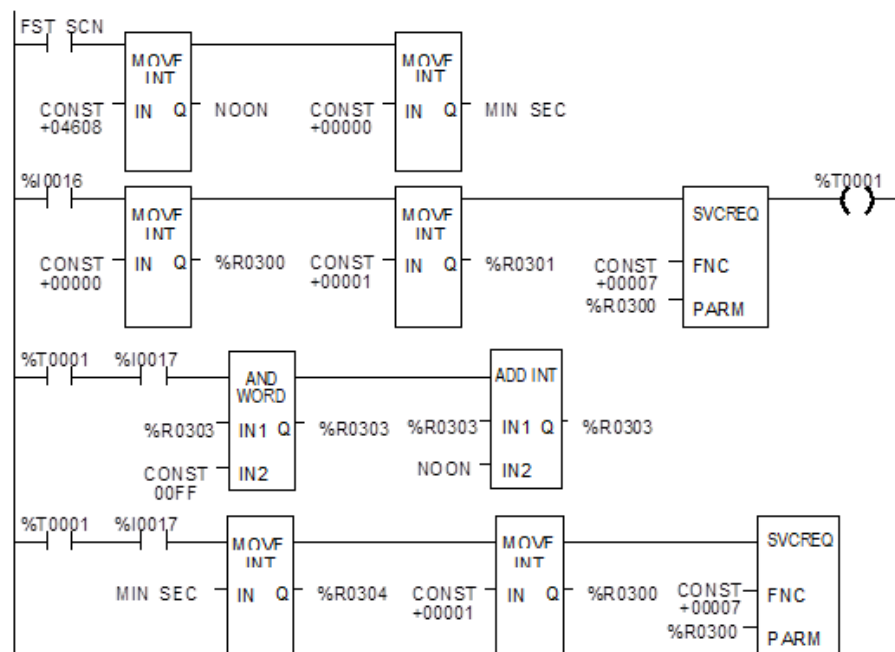
**Example:**  
**Read Date and Time in Packed  
ASCII Format (Mon, Oct. 5,  
1998 at 11:13:00pm)**

|                     |                |
|---------------------|----------------|
| 0 (read)            |                |
| 83h (ASCII 4 digit) |                |
| 39 (9)              | 31 (1)         |
| 38 (8)              | 39 (9)         |
| 31 (1)              | 20 (space)     |
| 20 (space)          | 30 (0)         |
| 35 (5)              | 30 (leading 0) |
| 31 (1)              | 20 (space)     |
| 3A ( : )            | 31 (1)         |
| 33 (3)              | 31 (1)         |
| 30 (0)              | 3A ( : )       |
| 20 (space)          | 30 (0)         |
| 32 (2: Mon.)        | 30 (leading 0) |

### Example of SVCREQ 7

In the example, when called for by previous logic, a parameter block for the time-of-day clock is built. It requests the current date and time, then sets the clock to 12 noon using BCD format. The parameter block is located at location %R0300. Array NOON has been set up elsewhere in the program to contain the values 12, 0, and 0. (Array NOON must also contain the data at %R0300.) BCD format requires six contiguous memory locations for the parameter block.

Figure 354



## 24.11 SVCREQ 8: Reset Watchdog Timer

Use SVCREQ 8 to reset the watchdog timer during the sweep. Ordinarily, when the watchdog timer expires the PLC shuts down without warning. SVCREQ 8 allows the timer to keep going during a time-consuming task (for example, while waiting for a response from a communications line).

### ⚠ CAUTION

Be sure that resetting the watchdog timer does not adversely affect the controlled process.

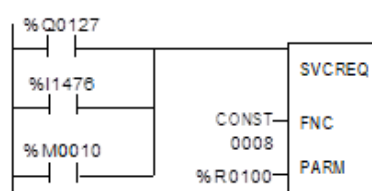
### 24.11.1 Parameter Block Format for SVCREQ 8

This function has no associated parameter block.

#### Example of SVCREQ 8

In this example, power flow through enabling output %Q0027 or input %I1476 or internal coil %M0010 causes the watchdog timer to be reset.

Figure 355



# 24.12 SVCREQ 9: Read Sweep Time from Beginning of Sweep

Use SVCREQ 9 to read the time in milliseconds since the start of the sweep. The data format is unsigned 16-bit integer.

## 24.12.1 Output Parameter Block Format for SVCREQ 9

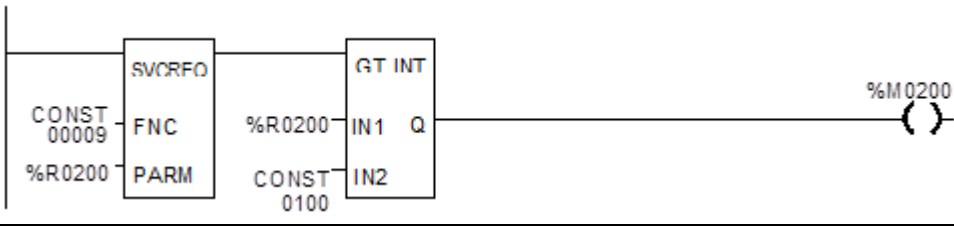
The parameter block is an output parameter block only; it has a length of one word.

|         |                           |
|---------|---------------------------|
| address | time since start of sweep |
|---------|---------------------------|

### Example of SVCREQ 9

In the following example, the elapsed time from the start of the sweep is always read into location %R0200. If it is greater than 100ms, internal coil %M0200 is turned on.

Figure 356



## 24.13 SVCREQ 10: Read Folder Name

Use SVCREQ 10 to read the name of the currently executing folder.

### 24.13.1 Output Parameter Block Format for SVCREQ 10

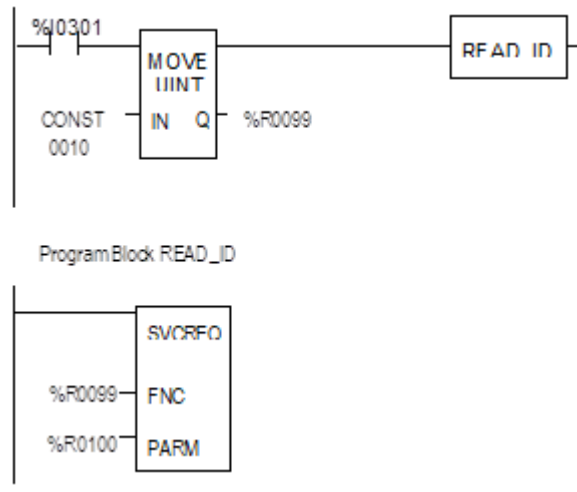
The output parameter block has a length of four words. It returns eight ASCII characters; the last is a null character (00h). If the program name has fewer than seven characters, null characters are added to the end.

|             | Low Byte    | High Byte   |
|-------------|-------------|-------------|
| address     | character 1 | character 2 |
| address + 1 | character 3 | character 4 |
| address + 2 | character 5 | character 6 |
| address + 3 | character 7 | 00          |

#### Example of SVCREQ 10

In this example, when enabling input %I0301 goes OFF, register location %R0099 is loaded with the value 10, which is the function code for the Read Folder Name function. The Program Block READ\_ID is then called to retrieve the folder name. The parameter block is located at address %R0100.

Figure 357



## 24.14 SVCREQ 11: Read PLC ID

Use SVCREQ 11 to read the name of the PLC executing the program.

### 24.14.1 Output Parameter Block Format for SVCREQ 11

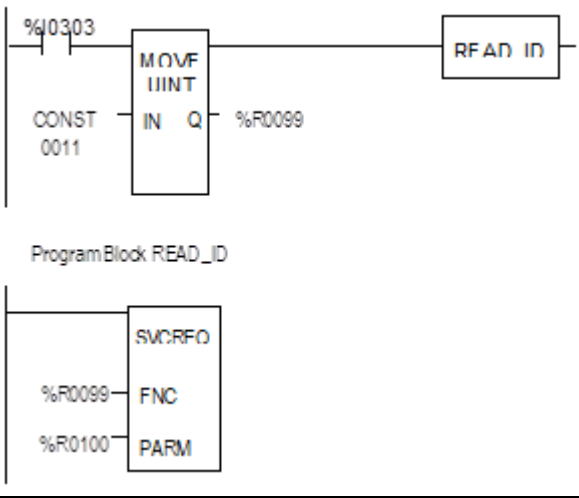
The output parameter block has a length of four words. It returns eight ASCII characters; the last is a null character (00h). If the PLC ID has fewer than seven characters, null characters are added to the end.

|             | Low Byte    | High Byte   |
|-------------|-------------|-------------|
| address     | character 1 | character 2 |
| address + 1 | character 3 | character 4 |
| address + 2 | character 5 | character 6 |
| address + 3 | character 7 | 00          |

#### Example of SVCREQ 11

In this example, when enabling input %I0302 goes OFF, register location %R0099 is loaded with the value 11, which is the function code for the Read PLC ID function. The program block READ\_ID is then called to retrieve the ID. The parameter block is located at address %R0100.

Figure 358



## 24.15 SVCREQ 13: Shut Down (Stop) PLC

Use SVCREQ 13 to stop the Micro PLC at the end of the next sweep. All outputs go to the OFF state at the start of the next PLC sweep. An informational “Shut Down PLC” fault is placed in the PLC Fault Table. The I/O scan continues as configured.

### 24.15.1 Parameter Block for SVCREQ 13

This function has no parameter block.

#### Example of SVCREQ 13

In the example, when %T0001 is set SVCREQ 13 executes. The PARM input is not used.

This example uses a JUMP to the end of the program to force a shutdown if the Shutdown PLC function executes successfully. This JUMP and LABEL are needed because the transition to Stop mode does not occur until the end of the sweep in which the function executes.

Figure 359



## 24.16 SVCREQ 14: Clear Fault

Use SVCREQ 14 to clear either the PLC fault table or the I/O fault table. The SVCREQ output is set ON unless some number other than 0 or 1 is entered as the requested operation.

### 24.16.1 Input Parameter Block for SVCREQ 14

For this function, the parameter block has a length of 1 word. It is an input parameter block only. There is no output parameter block.

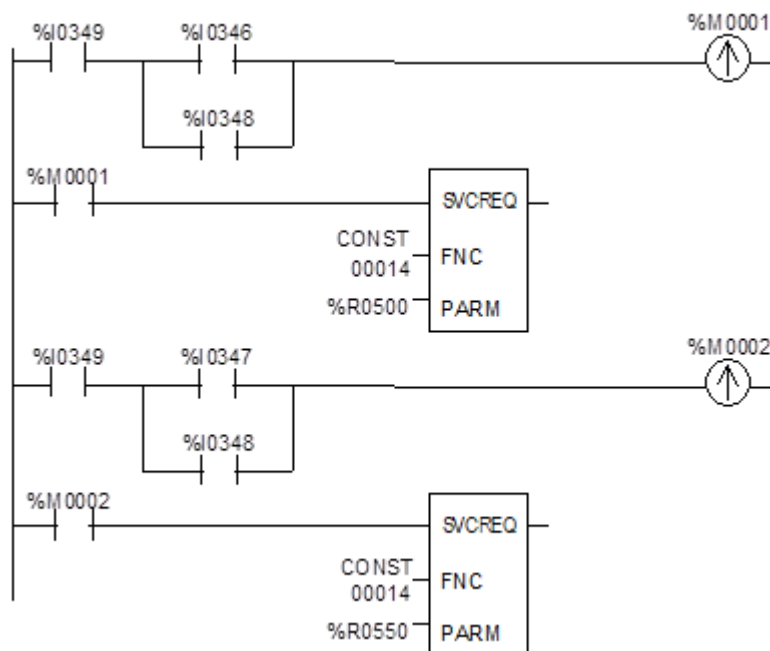
0 = clear PLC fault table.  
1 = clear I/O fault table.

#### Example of SVCREQ 14

In the example, when input %I0346 is on and input %I0349 is on, the PLC fault table is cleared. When input %I0347 is on and input %I0349 is on, the I/O fault table is cleared. When input %I0348 is on and input %I0349 is on, both are cleared. A positive transition coil should be used to trigger SVCREQ14.

The parameter block for the PLC fault table is located at %R0500; for the I/O fault table the parameter block is located at %R0550. Both parameter blocks are set up elsewhere in the program.

Figure 360





# 24.17 SVCREQ 15: Read Last-Logged Fault Table Entry

Use SVCREQ 15 to read the last entry logged in either the PLC fault table or the I/O fault table. The SVCREQ output is set ON unless some number other than 0 or 1 is entered as the requested operation or the fault table is empty.

## 24.17.1 Input Parameter Block for SVCREQ 15

For this function, the parameter block has a length of 22 words. The input parameter block has this format:

|         | 2-Digit Year Format       | 4-Digit Year Format       |
|---------|---------------------------|---------------------------|
| address | 0 = Read PLC fault table. | 8 = Read PLC fault table. |
|         | 1 = Read I/O fault table. | 9 = Read I/O fault table. |

The format of the output parameter block depends on whether the function reads data from the PLC fault table or the I/O fault table.

### PLC Fault Table Output Format

| High Byte           | Low Byte    |              |
|---------------------|-------------|--------------|
| 0                   |             |              |
| spare               | long/short  | address + 1  |
| spare               | spare       | address + 2  |
| slot                | rack        | address + 3  |
|                     | task        | address + 4  |
| fault action        | fault group | address + 5  |
| error code          |             | address + 6  |
| fault specific data |             | address + 7  |
|                     |             | address + 8  |
|                     |             | to           |
|                     |             | address + 18 |
| minutes             | seconds     | address + 19 |
| day of month        | hour        | address + 20 |

|                     |       |       |              |
|---------------------|-------|-------|--------------|
| 2-Digit Year Format | year  | month | address + 21 |
| or                  |       |       |              |
| 4-Digit Year Format | spare | month | address + 21 |
|                     | year  |       | address + 22 |

### I/O Fault Table Output Format

| High Byte           | Low Byte          |  |
|---------------------|-------------------|--|
| 1                   |                   |  |
| memory type         | long/short        |  |
| offset              |                   |  |
| slot                | rack              |  |
| block               | bus               |  |
| point               |                   |  |
| fault action        | fault group       |  |
| fault type          | fault category    |  |
| fault specific data | fault description |  |
|                     |                   |  |
| minutes             | seconds           |  |
| day of month        | hour              |  |

|       |       |  |
|-------|-------|--|
| year  | month |  |
|       |       |  |
| spare | month |  |
| year  |       |  |

## Long/Short Value

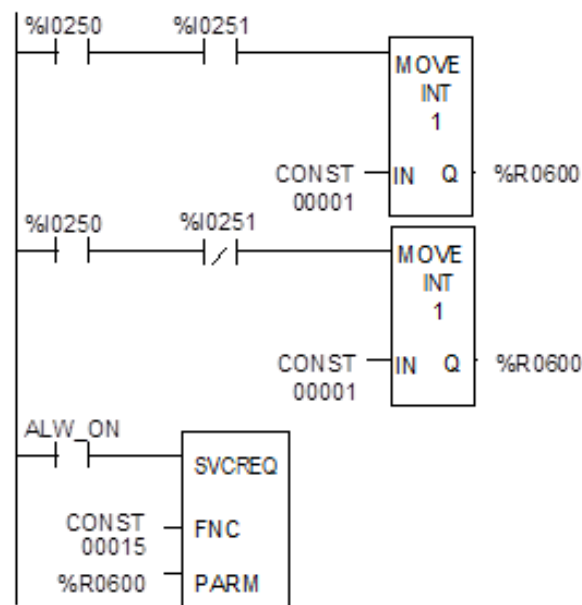
The first byte of word address +1 contains a number that indicates the length of the fault-specific data in the fault entry. These possible values are:

|                 |                                              |
|-----------------|----------------------------------------------|
| PLC fault table | 00 = 8 bytes (short)<br>01 = 24 bytes (long) |
| I/O fault table | 02 = 5 bytes (short)<br>03 = 21 bytes (long) |

## Example of SVCREQ 15

When inputs %I0250 and %I0251 are both on, the first Move function places a zero (read PLC fault table) into the parameter block for SVCREQ 15. When input %I0250 is on and input %I0251 is off, the Move instruction instead places a one (read I/O fault table) in the SVCREQ parameter block. The parameter block is located at location %R0600.

Figure 361



## 24.18 SVCREQ 16: Read Elapsed Time Clock

Use SVCREQ 16 to read the system's elapsed time clock. The elapsed time clock measures the time in seconds since the Micro PLC was powered on.

### 24.18.1 Output Parameter Block for SVCREQ 16

This function has an output parameter block only. Its length is 3 words.

|             |                                    |
|-------------|------------------------------------|
| address     | seconds from power on (low order)  |
| address + 1 | seconds from power on (high order) |
| address + 2 | 100 $\mu$ s ticks                  |

The first two words are the elapsed time in seconds. The last word is the number of 100  $\mu$ s ticks in the current second.

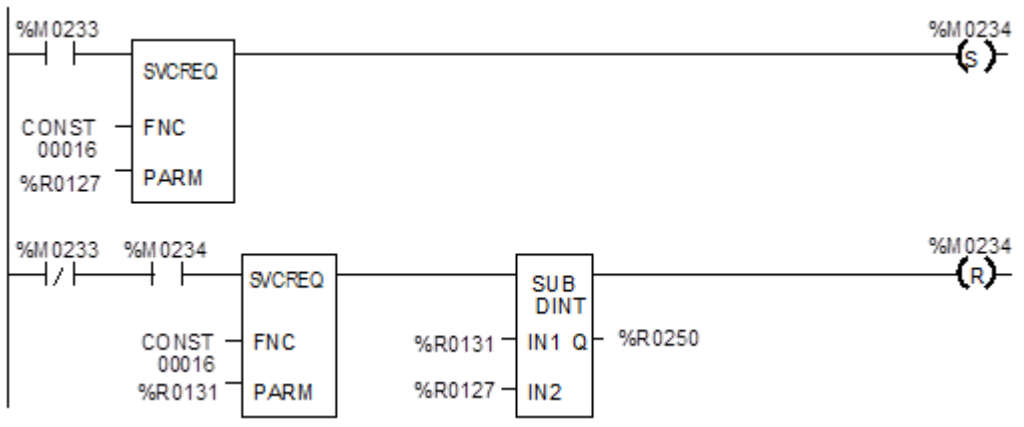
#### Example of SVCREQ 16

In the example, when internal coil %M0233 is on, the SVCREQ with a parameter block located at %R0127 reads the system's elapsed time clock and sets internal coil %M0234. When coil %M0233 is off, the SVCREQ with a parameter block at %R0131 reads the elapsed time clock again.

The subtraction function finds the difference between the first and second readings, which have been stored in the SVCREQ parameter blocks. The subtraction ignores the hundred microsecond ticks.

The difference between the two readings is placed in memory location %R0250.

Figure 362



## 24.19 SVCREQ 18: Read I/O Override Status

Use SVCREQ 18 to check for any overrides in the Micro PLC 's %I and %Q memories.

### 24.19.1 Output Parameter Block for SVCREQ 18

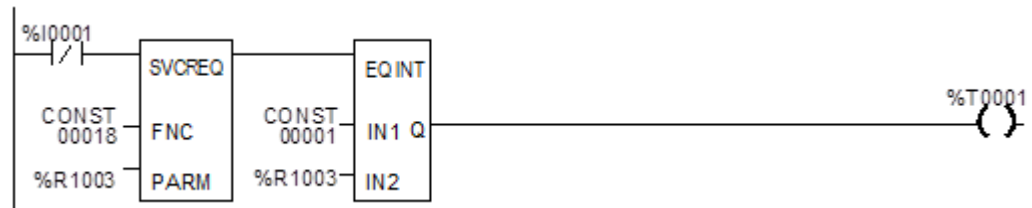
This function has an output parameter block only. Its length is 1 word.

|         |                                                     |
|---------|-----------------------------------------------------|
| address | 0 = No overrides are set.<br>1 = Overrides are set. |
|---------|-----------------------------------------------------|

#### Example of SVCREQ 18

The following SVCREQ reads the status of I/O overrides memory into location %R1003. The equality function checks %R1003 to see if it is equal to (the constant) 1. If it is, the equality function turns on output %T0001.

Figure 363



## 24.20 SVCREQ 23: Read Master Checksum

Use SVCREQ 23 to read the master checksums of the application program and the configuration. The SVCREQ output is always ON if the function is enabled.

### 24.20.1 Output Parameter Block for SVCREQ 23

For this function, the output parameter block has a length of 12 words with this format:

The first two items in the output parameter block indicate when the program and configuration checksums are valid. (Program checksums may not be valid during a Run Mode Store.)

|              |                                                                |
|--------------|----------------------------------------------------------------|
| address      | Master Program Checksum Valid (0 = not valid, 1 = valid)       |
| address + 1  | Master Configuration Checksum Valid (0 = not valid, 1 = valid) |
| address + 2  | Number of Program Blocks (including _MAIN)                     |
| address + 3  | Size of User Program in Bytes (DWORD data type)                |
| address + 5  | Program Additive Checksum                                      |
| address + 6  | Program CRC Checksum (DWORD data type)                         |
| address + 8  | Size of Configuration Data in Bytes                            |
| address + 9  | Configuration Additive Checksum                                |
| address + 10 | Configuration CRC Checksum (DWORD data type)                   |

### Example of SVCREQ 23

In the example, when input %I0251 is ON, the master checksum information is placed into the parameter block at %R0050 and the output coil (%Q0001) is turned on.

Figure 364



## 24.21 SVCREQ 26/ SVCREQ 30: Interrogate I/O

Use SVCREQ 26 and SVCREQ30 to check whether the installed modules match the software configuration. If not, these SVCREQs place appropriate addition, loss, and mismatch faults in the PLC and/or I/O fault tables. SVCREQ 26 and SVCREQ 30 both perform the same function.

The more configuration faults there are, the longer it takes these SVCREQs longer to execute.

These SVCREQs have no parameter block. They always output power flow.

### Example of SVCREQ 26

In the example, when input %I0251 is ON, the SVCREQ checks the installed modules and compares them to the software configuration. Output %Q0001 is turned on after the SVCREQ is complete.

Figure 365



## 24.22 SVCREQ 29: Read Elapsed Power Down Time

Use SVCREQ 29 to read the amount of time elapsed between the last power-down and the most recent power-up. If the watchdog timer expired before power-down, the PLC is not able to calculate the power down elapsed time, so the time is set to 0.

The SVCREQ output is always ON.

### 24.22.1 Output Parameter Block for SVCREQ 29

This function has an output parameter block only. The parameter block has a length of 3 words.

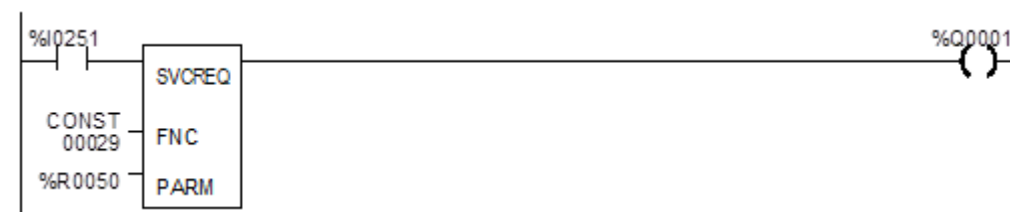
|             |                                         |
|-------------|-----------------------------------------|
| address     | Power-Down Elapsed Seconds (low order)  |
| address + 1 | Power-Down Elapsed Seconds (high order) |
| address + 2 | zero                                    |

The first two words are the power-down elapsed time in seconds. The last word is always 0.

#### Example of SVCREQ 29

In the example, when input %I0251 is ON, the Elapsed Power-Down Time is placed into the parameter block that starts at %R0050. The output coil (%Q0001) is turned on.

Figure 366



## 24.23 SVCREQ 34: Enter Analog Calibration Mode

The final step of calibrating an analog channel (see the complete process description in Chapter 5:) consists of storing the calibration values in flash memory. This step requires the use of two SVCREQ functions, SVCREQ 34 and 35.

SVCREQ 34 places the Micro PLC in calibration mode. When SVCREQ 34 is executed, the PLC uses default gain and offset so that you can start the calibration process. No parameter block is needed with SVCREQ 34.

**Note:** This calibration procedure applies to analog channels on 23-point Micro PLCs only. Software calibration of Analog Expansions and Nano PLCs is not available.

### Example of SVCREQ 34

In the following example, when enabling input %I0251 goes ON, the analog calibration defaults are restored and output coil %Q0001 is turned on.

Figure 367



## 24.24 SVCREQ 35: Store Analog Calibration

SVCREQ 35 stores the previously computed analog calibration in the Micro PLC. The calibration can be stored in either volatile or non-volatile memory.

SVCREQ 35 uses an input parameter block containing the new calibration data and control data. Contents of the parameter block are shown on the next page. When the SVCREQ is successfully completed, the new calibration values take effect.

After the SVCREQ function executes, the PLC returns the function status and the number of tries available to the 2 words of the output parameter block.

### Example of SVCREQ 35

In the example, when contact %I0003 is on, the SVCREQ with a parameter block located at %R0127 stores the analog calibration to the memory type specified in the parameter block and sets coil %Q00234.

Figure 368



## 24.24.1 Input Parameter Block for SVCREQ 35

The input parameter block for SVCREQ 35 contains the following 32 input words. For parameter explanations, refer to Parameter Definitions below.

|              |                                                                     |
|--------------|---------------------------------------------------------------------|
| Address      | Password ("CA" 4143H)                                               |
| address + 1  | Password ("LB" 424CH)                                               |
| address + 2  | Destination Control: 0 for RAM, 1 for flash                         |
| address + 3  | Select Control AI Ch 1 Vol: 0: last, 1: new, 2: default, 3: factory |
| address + 4  | Input Channel 1 %AI0018 High Value, Voltage                         |
| address + 5  | Input Channel 1 %AI0018 Low Value, Voltage                          |
| address + 6  | Input Channel 1 Meter High Value, Voltage (mV)                      |
| address + 7  | Input Channel 1 Meter Low Value, Voltage (mV)                       |
| address + 8  | Select Control AI Ch 1 Cur: 0: last, 1: new, 2: default, 3: factory |
| address + 9  | Input Channel 1 %AI0018 High Value, Current                         |
| address + 10 | Input Channel 1 %AI0018 Low Value, Current                          |
| address + 11 | Input Channel 1 Meter High Value, Current (mA)                      |
| address + 12 | Input Channel 1 Meter Low Value, Current (mA)                       |
| address + 13 | Select Control AI Ch 2 Vol: 0: last, 1: new, 2: default, 3: factory |
| address + 14 | Input Channel 2 %AI0019 High Value, Voltage                         |
| address + 15 | Input Channel 2 %AI0019 Low Value, Voltage                          |
| address + 16 | Input Channel 2-Meter-High Value, Voltage (mV)                      |
| address + 17 | Input Channel 2 Meter Low Value, Voltage (mV)                       |
| address + 18 | Select Control AI Ch 2 Cur: 0: last, 1: new, 2: default, 3: factory |
| address + 19 | Input Channel 2 %AI0019 High Value, Current                         |
| address + 20 | Input Channel 2 %AI0019 Low Value, Current                          |
| address + 21 | Input Channel 2-Meter-High Value, Current (mA)                      |
| address + 22 | Input Channel 2 Meter Low Value, Current (mA)                       |
| address + 23 | Select Control AQ Ch 1 Vol: 0: last, 1: new, 2: default, 3: factory |
| address + 24 | Output Channel 1 %AQ0012 High Value, Voltage                        |
| address + 25 | Output Channel 1 %AQ0012 Low Value, Voltage                         |
| address + 26 | Output Channel 1 Meter High Value, Voltage (mV)                     |
| address + 27 | Output Channel 1 Meter Low Value, Voltage (mV)                      |
| address + 28 | Select Control AQ Ch 1 Cur: 0: last, 1: new, 2: default, 3: factory |
| address + 29 | Output Channel 1 %AQ0012 High Value, Current                        |
| address + 30 | Output Channel 1 %AQ0012 Low Value, Current                         |
| address + 31 | Output Channel 1 Meter High Value, Current (mA)                     |
| address + 32 | Output Channel 1 Meter Low Value, Current (mA)                      |
| address + 33 | Status                                                              |
| address + 34 | Number of tries available                                           |



## 24.24.2 Output Parameter Block for SVCREQ 35

The output parameter block for SVCREQ 35 contains the following two output words:

|             |                           |
|-------------|---------------------------|
| address     | Status                    |
| address + 1 | Number of tries available |

### Parameter Definitions

**Password** (address and address +1) must be CALB. If an invalid password is provided, the service request returns error 3 in the status word.

**Destination Control** (at address +2), determines whether to write the constants in flash or in RAM. You can select the RAM option (0) and calibrate as many times as necessary without burning the calibration constants into the flash memory. When you are satisfied with the calibration, you can select the flash option (1) and finalize the calibration. When the flash option is selected, the calibration data is copied into RAM as well as burned into flash memory. It is important to issue a SVCREQ with the flash option selected in the Destination Control parameter field once the desired calibration state is reached. Otherwise, the new calibration values will be lost when the unit is powered off.

**Select Control** (address +3). Allows you to calibrate a particular channel in a specific mode. Four choices are allowed for each channel:

- 0: Last user calibration. The last calibration in flash is used for the channel and for the mode. (If no user calibration exists, the last factory calibration is used.)
- 1: New. The PLC calculates new gain and offset using the values supplied in the next four words. New calibration value will replace the value in the RAM or flash as determined by the **Destination Control** field.
- 2: Default. If this option is specified, the default calibration value is used.
- 3: Factory. If this option is specified, the last factory calibration value is used.

**Status** (address +33). A status word is returned by the service request:

- 1=Complete
- 2=Out of tries
- 3=Invalid password
- 4=Not in calibration mode
- 5=Calibration values checksum bad
- 6=Invalid calibration data

**Number of Tries Available** (address +34). Indicates the number of tries remaining.

## 24.25 SVCREQ 52: Read from Flash

This Service Request is available with Release 3.0 and later Micro PLCs.

Service Request 52 reads Reference Variables that were previously written into flash memory using Service Request 53 and stores the variables in CPU reference memory. Each execution of Service Request 52 can read:

- 1 to 10 words of %R, %AI, or %AQ reference data.
- 1 to 10 bytes of %I, %Q, %M, %T, or %G reference data.

SVCREQ 52 uses an input parameter block containing the reference memory to be read. After SVCREQ 52 executes, the PLC returns the function status to the two words of the output parameter block.

### Example of SVCREQ 52

In this example, when enabling input %M0003 goes on, the Service Request reads the flash memory location specified in the Parameter Block located at %R00040 and places the data into the intended destination. It then sets coil %M0004.

Figure 369



## 24.25.1 Input Parameter Block for SVCREQ 52

The input parameter block for SVCREQ 52 contains the following 5 input words.

|             |                                                                                                                                  |         |     |
|-------------|----------------------------------------------------------------------------------------------------------------------------------|---------|-----|
| Address     | Memory type (number) of the flash memory location of the first byte or word of data to be read. Numbers are:                     |         |     |
|             | Memory                                                                                                                           | Decimal | Hex |
|             | %I (byte)                                                                                                                        | 16      | 10  |
|             | %Q (byte)                                                                                                                        | 18      | 12  |
|             | %T (byte)                                                                                                                        | 20      | 14  |
|             | %M (byte)                                                                                                                        | 22      | 16  |
|             | %G (byte)                                                                                                                        | 56      | 38  |
|             | %R (word)                                                                                                                        | 8       | 08  |
|             | %AI (word)                                                                                                                       | 10      | 0A  |
|             | %AQ (word)                                                                                                                       | 12      | 0C  |
| address + 1 | Offset of the requested data within the memory type in flash memory                                                              |         |     |
| address + 2 | Length of data to be read, 1 – 10 bytes or words.                                                                                |         |     |
| address + 3 | Memory type of the PLC reference memory type where the requested data should be placed. See the numbers above.                   |         |     |
| address + 4 | Offset to place the requested data within the requested memory type in PLC reference memory.                                     |         |     |
| address + 5 | Memory type of the PLC reference memory type for the completion status. See the numbers above. For example, %R1 = memory type 8. |         |     |
| address + 6 | Offset in PLC Memory to write completion status (zero based). For example, %R1 = offset 0.                                       |         |     |

## 24.25.2 Status Data for SVCREQ 52

SVCREQ 52 returns one of the following status indications:

| Word 0               |     |                       |                                                                                                                  |
|----------------------|-----|-----------------------|------------------------------------------------------------------------------------------------------------------|
| Hex                  | Dec | Status                | Definition                                                                                                       |
| 0x0001               | 1   | Full Success          | All requested data was successfully read                                                                         |
| 0x0101               | 257 | Partial Success       | Less than requested data length was read. Can occur if all data requested was not present in flash.              |
| 0x0102               | 258 | Insufficient Dest Mem | Can occur if the PLC reference memory location specified is not sufficient to store all the data read from flash |
| 0x0202               | 514 | Invalid Length        | Length is beyond minimum 1 and maximum 10                                                                        |
| 0x0302               | 770 | Source/Dest Mem Wrong | Wrong source or destination reference memory specified in the SVCREQ.                                            |
| Word 1               |     |                       |                                                                                                                  |
| Number of bytes read |     |                       |                                                                                                                  |

## 24.26 SVCREQ 53: Write to Flash

This Service Request is available with Release 3.0 and later Micro PLCs.

Service Request 53 stores requested PLC reference data in flash memory. Each execution of Service Request 53 can write:

- 1 to 10 words of %R, %AI, or %AQ reference data.
- 1 to 10 bytes of %I, %Q, %M, %T, or %G reference data.

SVCREQ 53 uses an input parameter block containing the reference memory requested to be written. After SVCREQ 53 executes, the PLC returns the function status and the amount of user flash memory still available to the output parameter block.

### Example of SVCREQ 53

In the example, when enabling input %M0003 goes on, the Service Request reads the PLC memory location specified in the Parameter Block located at %R00040 and writes the data to flash. It then sets coil %M0004.

Figure 370



## 24.26.1 Input Parameter Block for SVCREQ 53

The input parameter block for SVCREQ 53 contains the following 5 input words.

|             |                                                                                                                                  |         |     |
|-------------|----------------------------------------------------------------------------------------------------------------------------------|---------|-----|
| Address     | Memory type (number) of the PLC memory location of the first byte or word of data to be written. Numbers are:                    |         |     |
|             | Memory                                                                                                                           | Decimal | Hex |
|             | %I (byte)                                                                                                                        | 16      | 10  |
|             | %Q (byte)                                                                                                                        | 18      | 12  |
|             | %T (byte)                                                                                                                        | 20      | 14  |
|             | %M (byte)                                                                                                                        | 22      | 16  |
|             | %G (byte)                                                                                                                        | 56      | 38  |
|             | %R (word)                                                                                                                        | 8       | 08  |
|             | %AI (word)                                                                                                                       | 10      | 0A  |
|             | %AQ (word)                                                                                                                       | 12      | 0C  |
| address + 1 | Offset of the requested data within the memory type in PLC memory                                                                |         |     |
| address + 2 | Length of data to be read, 1 – 10 bytes or words.                                                                                |         |     |
| address + 3 | Memory type of the PLC reference memory type for the completion status. See the numbers above. For example, %R1 = memory type 8. |         |     |
| address + 4 | Offset in PLC Memory to write completion status (zero based).<br>For example, %R1 = offset 0.                                    |         |     |

## 24.26.2 Status Data for SVCREQ 53

SVCREQ 53 returns one of the following status indications:

| Word 1                             |     |                                 |                                                                                                                            |
|------------------------------------|-----|---------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| Hex                                | Dec | Status                          | Definition                                                                                                                 |
| 0x0001                             | 1   | Full Success                    | All requested data was successfully written                                                                                |
| 0x0101                             | 257 | Partial Success                 | Less than requested data length was written. Can occur if some requested data is already in flash.                         |
| 0x0102                             | 258 | Insufficient Destination Memory | Flash memory area full, connect with the programmer and write all data to flash in order to erase and store latest values. |
| 0x0202                             | 514 | Invalid Length                  | Length is beyond minimum 1 and maximum 10                                                                                  |
| 0x0302                             | 770 | Source/Dest Mem Wrong           | Wrong source or destination reference memory specified in the SVCREQ.                                                      |
| Word 2                             |     |                                 |                                                                                                                            |
| Number of bytes written            |     |                                 |                                                                                                                            |
| Word 3                             |     |                                 |                                                                                                                            |
| Number of bytes remaining in flash |     |                                 |                                                                                                                            |

## Chapter 25: Serial I/O, SNP & RTU Protocols

This chapter describes the VersaMax Micro PLC Serial I/O feature, which can be used to control the read/write activities of one of the Micro PLC ports directly from the application program.

This chapter also contains instructions for using COMMREQs to configure the CPU serial ports for SNP, RTU, or Serial I/O protocol.

- Format of the COMMREQ Function
- Configuring Serial Ports Using the COMMREQ Function
  - RTU Slave/SNP Slave Operation with a Programmer Attached
  - COMMREQ Command Block for Configuring SNP Protocol
  - COMMREQ Command Block for Configuring RTU Protocol
  - COMMREQ Command Block for Configuring Serial I/O
- Serial I/O COMMREQ Commands
  - Initialize Port
  - Set Up Input Buffer
  - Flush Input Buffer
  - Read Port Status
  - Write Port Control
  - Cancel Operation
  - Autodial
  - Write Bytes
  - Read Bytes
  - Read String

Details of RTU and SNP protocol are described in the Serial Communications User's Manual (GFK-0582). For additional information about Modbus Master communications, please refer to the document Modbus RTU Master Communications (GFK-2220).

At higher sweep times, serial communication throughput is less and response times are larger. As a result of this, a communication request takes longer to complete.

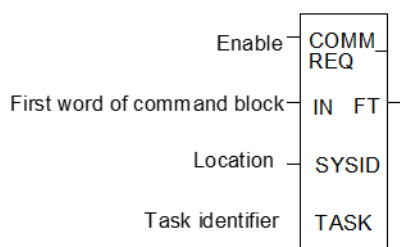
## 25.1 Format of the Communication Request Function

Serial I/O is implemented through the use of Communication Request (COMMREQ) functions. The operations of the protocol, such as transmitting a character through the serial port or waiting for an input character, are implemented through the COMMREQ function block.

The COMMREQ requires that all its command data be placed in the correct order (in a command block) in PLC memory before it is executed. The COMMREQ should then be executed by a contact of a one-shot coil to prevent sending the data multiple times. A series of Block Move (BLKMV) commands should be used to move the words to create a command block in the Register tables.

The COMMREQ function has three inputs and one output. When the function receives power flow, a command block of data is sent to the specified module.

Figure 371



### 25.1.1 Parameters of the COMMREQ Function

| Input/<br>Output | Choices                            | Description                                                                                                                                                                                                                                                                                                                                                                              |
|------------------|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| enable           | flow                               | When the function is energized, the communications request is performed.                                                                                                                                                                                                                                                                                                                 |
| IN               | R, AI, AQ                          | IN contains the first word of the command block.                                                                                                                                                                                                                                                                                                                                         |
| SYSID            | I, Q, M, T, G, R, AI, AQ, constant | SYSID contains the rack number (most significant byte) and slot number (least significant byte) of the target device. For the CPU, SYSID must specify rack/slot 0.                                                                                                                                                                                                                       |
| TASK             | R, AI, AQ, constant                | TASK specifies the port for which the operation is intended:<br>task 19 for port 1<br>task 20 for port 2                                                                                                                                                                                                                                                                                 |
| FT               | flow, none                         | FT is energized if an error is detected processing the COMMREQ: <ul style="list-style-type: none"> <li>The specified target address is not present (SYSID).</li> <li>The specified task is not valid for the device (TASK).</li> <li>The data length is 0.</li> <li>The device's status pointer address (in the command block) does not exist. (applies only to HSC COMMREQs)</li> </ul> |

## 25.1.2 Command Block for the COMMREQ Function

The Command Block starts at the reference specified in COMMREQ parameter IN. The length of the Command Block depends on the amount of data sent to the device.

The Command Block contains the data to be communicated to the other device, plus information related to the execution of the COMMREQ. The Command Block has the following structure:

|                                 |                            |
|---------------------------------|----------------------------|
| address                         | Length (in words)          |
| address + 1                     | Wait/No Wait Flag          |
| address + 2                     | Status Pointer Memory      |
| address + 3                     | Status Pointer Offset      |
| address + 4                     | Idle Timeout Value         |
| address + 5                     | Maximum Communication Time |
| address + 6 to<br>address + 133 | Data Block                 |

### Example of the COMMREQ Function

In the example, when %M0021 is ON, a Command Block located starting at %R0032 is sent to port 2 (communications task 20) of the CPU (rack 0, slot 0). If an error occurs processing the COMMREQ, %Q0110 is set.

Figure 372





## 25.2 Configuring Serial Ports Using the COMMREQ Function

The following tables list the command block values required for setting up a Serial Port for SNP, RTU, and Serial I/O. All values are in hexadecimal unless otherwise indicated. The BLKMOV commands that are used to create the command block are described in the example.

### 25.2.1 Timing

If a port configuration COMMREQ is sent to a serial port that currently has an SNP/SNPX master (for example, the programmer) connected to it, the serial port configuration specified by the COMMREQ does not take effect until the Micro PLC detects a loss of the SNP/SNPX master. This occurs after the configured T3' times out, once the master disconnects. The COMMREQ status word for the port configuration COMMREQ is updated as soon as the CPU verifies that the specified configuration is valid. That means a COMMREQ Successful value may be returned by the Port Configuration COMMREQ before the specified configuration is actually installed.

### 25.2.2 Sending Another COMMREQ to the Same Port

The application program must wait at least 2 seconds after a new serial port protocol is installed before sending any COMMREQs specific to that protocol to the port. This applies to a new protocol installed by Storing a new hardware configuration or by a port configuration COMMREQ. If the port is configured for Serial I/O, this waiting period must also follow any Stop to Run mode transition of the Micro PLC.

### 25.2.3 Invalid Port Configurations

COMMREQs to configure protocols for the port(s) of the Micro PLC are limited to the supported protocols for the given port. Any COMMREQs that request invalid port configurations will be rejected.

---

**Note:** For all Nano and Micro PLC CPUs, care must be taken setting timeouts and message lengths when operating at 4800 bps or lower. Messages at this rate are longer in duration and may cause various timeouts within a system. This can become worse on the Micro-64 CPU because the scan times on this unit are typically slightly longer.

---

## 25.2.4 RTU Slave/SNP Slave Operation with Programmer Attached

A programmer (an SNP/SNPX master device) can be attached to port 1 or port 2 while RTU Slave mode is active on the port. For multi-drop connections, the Micro PLC must have been configured to use an appropriate PLC ID. Note that for a multi-drop SNP connection with the port currently configured for RTU Slave, the SNP ID associated with the Micro PLC settings must match the multi-drop ID.

The programmer must use the same serial communications parameters (baud rate, parity, stop bits, etc.) as the currently active RTU Slave protocol for it to be recognized.

When the Micro PLC recognizes the programmer, the Micro PLC removes the RTU Slave protocol from the port and installs SNP Slave as the currently active protocol. The SNP ID, modem turnaround time, and default idle time for this new SNP Slave session are obtained from the configured Micro PLC settings, not the port 1 or port 2 configurations. Connection should be established within 12 seconds. When the programmer connection has been enabled, normal programmer communications can take place. (Failure of the programmer to establish communications within 12-seconds is treated as a Loss of Programmer Communications).

The programmer may send a new protocol via configuration or a Serial Port Setup COMMREQ. (COMMREQs not supported by SNP Slave protocol are rejected). If a new protocol is received, it will not take effect until the programmer is disconnected.

After the programmer is removed, there is a slight delay (equal to the configured SNP T3' timeout) before the Micro PLC recognizes its absence. During this time, no messages are processed on the port. The Micro PLC detects removal of the programmer as an SNP Slave protocol timeout. Therefore, it is important to be careful when disabling timeouts used by the SNP Slave protocol.

When the Micro PLC recognizes the disconnect, it reinstalls the RTU Slave protocol, unless a new protocol has been received. In that case, the Micro PLC installs the new protocol instead.

---

**Note:** *If an RTU slave receives a message with length greater than 265 bytes it responds with an error code 0x03 indicating "Invalid Data Field"*

---

### Example

1. Port 1 is running RTU Slave protocol at 9600 baud.
2. A programmer is attached to port 1. The programmer is using 9600 baud.
3. The Micro PLC installs SNP Slave on port 1 and the programmer communicates normally.
4. The programmer stores a new configuration to port 1. The new configuration sets the port for SNP Slave at 4800 baud (it will not take effect until the port loses communications with the programmer).
5. When the Micro PLC loses communications with the programmer, the new configuration takes effect.

## 25.2.5 COMMREQ Command Block for Configuring SNP Protocol

|              | Values                                                                                                                                       | Meaning                          |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| Address      | 10H                                                                                                                                          | Data Block Length                |
| Address + 1  | 0 = No Wait                                                                                                                                  | WAIT/NOWAIT Flag                 |
| Address + 2  | 0008 = %R, register memory                                                                                                                   | Status Word Pointer Memory Type  |
| Address + 3  | Zero-based number that gives the address of the COMMREQ status word (for example, a value of 99 gives an address of 100 for the status word) | Status Word Pointer Offset       |
| Address + 4  | 0 (Only used in Wait/No Wait mode)                                                                                                           | Idle Timeout Value               |
| Address + 5  | 0 (Only used in Wait/No Wait mode)                                                                                                           | Maximum Communication Time       |
| Address + 6  | FFF0H                                                                                                                                        | Command Word (serial port setup) |
| Address + 7  | 0001                                                                                                                                         | Protocol: 1=SNP                  |
| Address + 8  | 0000=Slave, 0001=Master                                                                                                                      | Port Mode                        |
| Address + 9  | 10=175000, 7=38400, 6=19200, 5=9600, 4=4800, 3=2400, 2=1200, 1=600, 0=300                                                                    | Data Rate (bps)                  |
| Address + 10 | 0 = None, 1 = Odd, 2 = Even                                                                                                                  | Parity                           |
| Address + 11 | 1 = None                                                                                                                                     | Flow Control                     |
| Address + 12 | 0 = None, 1 = 10ms, 2 = 100ms, 3 = 500ms                                                                                                     | Turnaround Delay                 |
| Address + 13 | 0 = Long, 1 = Medium, 2 = Short, 3 = None                                                                                                    | Timeout                          |
| Address + 14 | 1 = 8 bits                                                                                                                                   | Bits Per Character               |
| Address + 15 | 0 = 1 Stop Bit, 1 = 2 Stop bits                                                                                                              | Stop Bits                        |
| Address + 16 | not used                                                                                                                                     | Interface                        |
| Address + 17 | not used                                                                                                                                     | Duplex Mode                      |
| Address + 18 | user-provided <sup>17</sup>                                                                                                                  | Device identifier bytes 1 and 2  |
| Address + 19 | user-provided <sup>17</sup>                                                                                                                  | Device identifier bytes 3 and 4  |
| Address + 20 | user-provided <sup>17</sup>                                                                                                                  | Device identifier bytes 5 and 6  |
| Address + 21 | user-provided <sup>17</sup>                                                                                                                  | Device identifier bytes 7 and 8  |

<sup>17</sup> The device identifier for SNP Slave ports is packed into words with the least significant character in the least significant byte of the word. For example, if the first two characters are "A" and "B," the Address + 18 will contain the hex value 4241.

## 25.2.6 COMMREQ Command Block for Configuring RTU Protocol

|                            | Values                                                                             | Meaning                                                                          |
|----------------------------|------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| First 6 words              |                                                                                    | Reserved for COMMREQ use.                                                        |
| Address + 6                | FFF0H                                                                              | Command                                                                          |
| Address + 7                | 3                                                                                  | Protocol: 0003=RTU                                                               |
| Address + 8                | 0                                                                                  | Port Mode: 0000=Slave                                                            |
| Address + 9                | 10=175000, 7=38400,<br>6=19200, 5=9600, 4=4800,<br>3=2400, 2=1200, 1=600,<br>0=300 | Data Rate                                                                        |
| Address + 10               | 0 = None, 1 = Odd, 2 = Even                                                        | Parity                                                                           |
| Address + 11               | 0 = Hardware, 1 = None                                                             | Flow Control                                                                     |
| Address + 12               | 0-255 (units of 10ms.<br>For example, 10=100ms)                                    | Turnaround delay. For release 2.02 and later CPUs only.<br>0 for all other CPUs. |
| Address + 13               | not used                                                                           | Timeout                                                                          |
| Address + 14               | not used                                                                           | Bits per Character                                                               |
| Address + 15               | 0 = 1, 1 = 2                                                                       | Stop Bits                                                                        |
| Address + 16               | not used                                                                           | Interface                                                                        |
| Address + 17               | 0 = 2-wire, 1 = 4-wire                                                             | Duplex Mode                                                                      |
| Address + 18               | Station Address (1-247)                                                            | Device Identifier                                                                |
| Address + 19 - 21          | not used                                                                           | Device Identifier                                                                |
| Address + 22 <sup>18</sup> | 0 -255 (units of 10ms)                                                             | Receive to Transmit Delay                                                        |
| Address + 23 <sup>18</sup> | 0-255 (units of 10ms)                                                              | RTS Drop Delay                                                                   |

<sup>18</sup> Release 2.02 and later Micro PLC CPUs support Receive to Transmit Delay and RTS Drop Delay functionality for RTU and Serial IO through the Serial Port Setup COMMREQ. Both of these optional parameters are described in Receive to Transmit Delay and RTS Drop Delay. When configuring the protocol, these two optional parameters can be added to the port setup COMMREQ. The data block length (Address + 0) for a COMMREQ that includes the Receive to Transmit Delay and RTS Drop Delay parameters should be 12H, not 10H. Either length (10H or 12H) is valid for this COMMREQ.

## Receive to Transmit Delay and RTS Drop Delay

Release 2.02 and later Micro PLC CPUs support Receive to Transmit Delay and RTS Drop Delay functionality for RTU and Serial IO through the Serial Port Setup COMMREQ.

When configuring the protocol, these two optional parameters can be added to the port setup COMMREQ. The data block length (Address + 0) for a COMMREQ that includes the Receive to Transmit Delay and RTS Drop Delay parameters should be 12H, not 10H. Either length (10H or 12H) is valid for this COMMREQ.

**Receive to transmit delay** - This is the time interval that defines the end of each received response message. It is measured from the end of the last received character. RTS is off and the transmitter is silent during this interval. If a new query is ready for transmission, RTS is asserted no earlier than the end of this interval.

Zero specifies the default, defined as 3.5 character times at the specified data rate, assuming 11 bits per character.

| Data Rate | Default (10ms Units) | Data Rate | Default (10ms Units) |
|-----------|----------------------|-----------|----------------------|
| 1200      | 322                  | 19200     | 21                   |
| 2400      | 161                  | 38400     | 10                   |
| 4800      | 80                   | 57600     | 7                    |
| 9600      | 40                   | 115200    | 3                    |

If the required delay is greater than the default value at the current data rate, increase the specified value to required delay in 10ms units. If the required delay is less than the default at the current data rate, no additional delay is necessary.

**RTS Drop Delay** - This is the time from the end of the last transmitted character to the time when RTS is turned off (dropped). The RTS Drop Delay is also specified in 10ms units. The receiver is disabled during transmission and remains disabled during the RTS drop delay time.

| Data Rate | Default (10ms Units) | Data Rate | Default (10ms Units) |
|-----------|----------------------|-----------|----------------------|
| 1200      | 92                   | 19200     | 6                    |
| 2400      | 46                   | 38400     | 3                    |
| 4800      | 23                   | 57600     | 2                    |
| 9600      | 12                   | 115200    | 1                    |

## 25.2.7 COMMREQ Command Block for Configuring Serial I/O Protocol

|                            | Values                                                                          | Meaning                                                                       |
|----------------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| First 6 words              |                                                                                 | Reserved for COMMREQ use.                                                     |
| Address + 6                | FFF0H                                                                           | Command                                                                       |
| Address + 7                | 0005                                                                            | Protocol: 0005=Serial IO                                                      |
| Address + 8                | 0 = Slave                                                                       | Port Mode                                                                     |
| Address + 9                | 10=175000, 7=38400,<br>6=19200, 5=9600, 4=4800,<br>3=2400, 2=1200, 1=600, 0=300 | Data Rate (bps)                                                               |
| Address + 10               | 0 = None, 1 = Odd, 2 = Even                                                     | Parity                                                                        |
| Address + 11               | 0 = Hardware, 1 = None                                                          | Flow Control                                                                  |
| Address + 12               | 0-255 (units of 10ms). For example, 10 = 100ms).                                | Turnaround Delay. For release 2.02 and later CPUs only. 0 for all other CPUs. |
| Address + 13               | 0 = Long                                                                        | Timeout                                                                       |
| Address + 14               | 0=7 bits, 1=8 bits                                                              | Bits per Character                                                            |
| Address + 15               | 0 = 1 stop bit, 1 = 2 stop bits                                                 | Stop Bits                                                                     |
| Address + 16               | must be set to 0                                                                | Interface                                                                     |
| Address + 17               | 0 = 2-wire, 1 = 4-wire                                                          | Duplex Mode                                                                   |
| Address + 18–21            | not used                                                                        | Device Identifier                                                             |
| Address + 22 <sup>19</sup> | 0-255 (units of 10ms)                                                           | Receive to transmit delay / RTS Drop Delay                                    |

<sup>19</sup> Release 2.02 and later Micro PLC CPUs support Receive to Transmit Delay and RTS Drop Delay functionality for RTU and Serial IO through the Serial Port Setup COMMREQ. Both of these optional parameters are described in Receive to Transmit Delay and RTS Drop Delay. When configuring the protocol, these two optional parameters can be added to the port setup COMMREQ. The data block length (Address + 0) for a COMMREQ that includes the Receive to Transmit Delay and RTS Drop Delay parameters should be 12H, not 10H. Either length (10H or 12H) is valid for this COMMREQ.

## 25.3 Calling Serial, I/O COMMREQs from the PLC Sweep

Implementing a serial protocol using Serial I/O COMMREQs may be restricted by the Micro PLC sweep time. For example, if the protocol requires that a reply to a certain message from the remote device be initiated within 5ms of receiving the message, this method may not be successful if the sweep time is 5mS or longer, since timely response is not guaranteed.

When using Serial, I/O protocol with a VersaMax Nano or 14 point Micro PLC, the user switch must be configured. A Nano PLC requires an external switch connection. When a Nano PLC or 14-Point Micro PLC is in Run mode, Serial I/O protocol is active; after a Run-to-Stop transition, the Nano PLC or 14-Point Micro PLC automatically reverts to SNP. An SNP master device (VersaPro, for instance) is not able to communicate with a Nano PLC or 14-Point Micro PLC that is configured for Serial I/O when it is in Run mode.

Since the Serial I/O is completely driven by the application program, in STOP mode a port configured as Serial I/O automatically reverts to SNP slave, to facilitate programmer communication. Therefore, while in Stop mode, Serial I/O protocol is not active; it is only active when the PLC is in Run mode.

Calling the Serial, I/O from a Timed Interrupt Block

The protocol can also be implemented from within a timed interrupt block. Whenever the interrupt block executes, the status of the previous COMMREQ or the status of the port is queried to determine if the last requested action is complete. If it is, a new port command can be initiated with a COMMREQ function block.

### 25.3.1 Compatibility

The COMMREQ function blocks supported by Serial I/O are not supported by other currently existing protocols (such as SNP slave, SNP master, and RTU slave). Errors are returned if they are attempted for a port configured for one of those protocols

## 25.3.2 Status Word for Serial I/O COMMREQs

A value of 1 is returned in the COMMREQ status word upon successful completion of the COMMREQ. Any other value returned is an error code where the low byte is a major error code and the high byte is a minor error code.

| Major Error Code | Description                                                                                                                                                       |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 (01h)          | Successful Completion (the expected completion value in the COMMREQ status word).                                                                                 |
| 12 (0Ch)         | Local error —Error processing local command. Minor error code identifies the specific error.                                                                      |
| 1 (01h)          | Wait-type command is not permitted. Use No-Wait command.                                                                                                          |
| 2 (02h)          | COMMREQ command is not supported.                                                                                                                                 |
| 5 (05h)          | Error writing COMMREQ status word to PLC memory.                                                                                                                  |
| 6 (06h)          | Invalid PLC memory type specified.                                                                                                                                |
| 7 (07h)          | Invalid PLC memory offset specified.                                                                                                                              |
| 8 (08h)          | Unable to access PLC memory.                                                                                                                                      |
| 12 (0Ch)         | COMMREQ data block length too small.                                                                                                                              |
| 14 (0Eh)         | COMMREQ data is invalid.                                                                                                                                          |
| 13 (0Dh)         | Remote error — Error processing a remote command. Minor error code identifies the error.                                                                          |
| 2 (02h)          | Number of bytes to read exceeds input buffer size, or more than 250 bytes requested to be written.                                                                |
| 3 (03h)          | COMMREQ data block length is too small. String data is missing or incomplete.                                                                                     |
| 4 (04h)          | Receive timeout awaiting serial reception of data                                                                                                                 |
| 8 (08h)          | Unable to access PLC memory.                                                                                                                                      |
| 12 (0Ch)         | COMMREQ data block length too small.                                                                                                                              |
| 48 (30h)         | Serial output timeout. The port was unable to transmit the string. (Could be missing CTS signal when the serial port is configured to use hardware flow control.) |
| 50 (32h)         | COMMREQ timeout. The COMMREQ did not complete within 20-second time limit.                                                                                        |
| 14 (0Eh)         | Autodial Error — An error occurred while attempting to send a command string to an attached external modem. The minor error code identifies the specific error.   |
| 2 (02h)          | The modem command string length exceeds end of reference memory type.                                                                                             |
| 3 (03h)          | COMMREQ Data Block Length too small. Output command string data missing or incomplete.                                                                            |
| 4 (04h)          | Serial output timeout. The port was unable to transmit the modem autodial output.                                                                                 |
| 5 (05h)          | Response was not received from modem. Check modem and cable.                                                                                                      |
| 6 (06h)          | Modem responded with BUSY. Modem is unable to complete the requested connection. The remote modem is already in use; retry the connection request later.          |
| 7 (07h)          | Modem responded with NO CARRIER. Modem is unable to complete the requested connection. Check the local and remote modems and the telephone line.                  |
| 8 (08h)          | Modem responded with NO DIALTONE. Modem is unable to complete the requested connection. Check the modem connections and the telephone line.                       |
| 9 (09h)          | Modem responded with ERROR. Modem is unable to complete the requested command. Check the modem command string and modem.                                          |



| Major Error Code |          | Description                                                                                                                                        |
|------------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------|
|                  | 10 (0Ah) | Modem responded with RING; the modem is being called by another modem. Modem is unable to complete the requested command. Retry the command later. |
|                  | 11 (0Bh) | Unknown response from modem. Modem unable to complete the command. Check modem command string and modem. Response should be CONNECT or OK.         |
|                  | 50 (32h) | COMMREQ timeout. The COMMREQ did not complete within 20 seconds.                                                                                   |

## 25.4 Serial I/O COMMREQ Commands

The following COMMREQs are used to implement Serial I/O:

- Local COMMREQs - do not receive or transmit data through the serial port.
  - Initialize Port (4300)
  - Set Up Input Buffer (4301)
  - Flush Input buffer (4302)
  - Read port status (4303)
  - Write port control (4304)
  - Cancel Operation (4399)
- Remote COMMREQs - receive and/or transmit data through the serial port.
  - Autodial (4400)
  - Write bytes (4401)
  - Read bytes (4402)
  - Read String (4403)

### 25.4.1 Overlapping COMMREQs

Some of the Serial I/O COMMREQs must complete execution before another COMMREQ can be processed. Others can be left pending while others are executed.

#### COMMREQs that Must Complete Execution

- Autodial (4400)
- Initialize Port (4300)
- Set Up Input Buffer (4301)
- Flush Input buffer (4302)
- Read port status (4303)
- Write port control (4304)
- Cancel Operation (4399)
- Serial Port Setup (FFF0)

## COMMREQs that Can be Pending While Others Execute

The table below shows whether Write Bytes, Read Bytes and Read String COMMREQs can be pending when other COMMREQs are executed.

| Currently-pending COMMREQs | New COMMREQ     |                    |                        |                            |                           |                         |                           |                   |                    |                         |                          |
|----------------------------|-----------------|--------------------|------------------------|----------------------------|---------------------------|-------------------------|---------------------------|-------------------|--------------------|-------------------------|--------------------------|
|                            | Autodial (4400) | Write bytes (4401) | Initialize Port (4300) | Set Up Input Buffer (4301) | Flush Input buffer (4302) | Read port status (4303) | Write port control (4304) | Read bytes (4402) | Read String (4403) | Cancel Operation (4399) | Serial Port Setup (FFF0) |
| Write bytes (4401)         | No              | No                 | Yes                    | Yes                        | Yes                       | Yes                     | Yes                       | Yes               | Yes                | Yes                     | No                       |
| Read bytes (4402)          | No              | Yes                | Yes                    | No                         | No                        | Yes                     | Yes                       | No                | No                 | Yes                     | No                       |
| Read String (4403)         | No              | Yes                | Yes                    | No                         | No                        | Yes                     | Yes                       | No                | No                 | Yes                     | No                       |

### 25.4.2 Initialize Port Function (4300)

This function causes a reset command to be sent to the specified port. It also cancels any COMMREQ currently in progress and flushes the internal input buffer. RTS is set to inactive.

#### Example Command Block for the Initialize Port Function

|            | Value (decimal) | Value (hexadecimal) | Meaning                              |
|------------|-----------------|---------------------|--------------------------------------|
| address    | 0001            | 0001                | Data block length                    |
| address +1 | 0000            | 0000                | NOWAIT mode                          |
| address +2 | 0008            | 0008                | Status word memory type (%R)         |
| address +3 | 0000            | 0000                | Status word address minus 1 (%R0001) |
| address +4 | 0000            | 0000                | Not used                             |
| address +5 | 0000            | 0000                | Not used                             |
| address +6 | 4300            | 10CC                | Initialize port command              |

### Operating Notes

**Note:** COMMREQs that are cancelled due to this command executing do not have their respective COMMREQ status words updated.

#### ⚠ CAUTION

If this COMMREQ is sent when a Write Bytes (4401) COMMREQ is transmitting a string from a serial port, transmission is halted. The position within the string where the transmission is halted is indeterminate. In addition, the final character received by the device the Micro PLC is sending to is also indeterminate.

## 25.4.3 Set Up Input Buffer Function (4301)

This function can be used to change the size of the internal memory buffer where input data will be placed as it is received. By default, the buffer is set to a maximum of 2K bytes. As data is received from the serial port it is placed in the input buffer. If the buffer becomes full, any additional data received from the serial port is discarded and the Overflow Error bit in the Port Status word (See Read Port Status Function) is set.

### Retrieving Data from the Buffer

Data can be retrieved from the buffer using the Read String or Read Bytes function. It is not directly accessible from the application program.

If data is not retrieved from the buffer in a timely fashion, some characters may be lost.

### Example Command Block for the Set Up Input Buffer Function

|            | Value<br>(decimal) | Value(hexadecimal) | Meaning                              |
|------------|--------------------|--------------------|--------------------------------------|
| address    | 0002               | 0002               | Data block length                    |
| address +1 | 0000               | 0000               | NOWAIT mode                          |
| address +2 | 0008               | 0008               | Status word memory type (%R)         |
| address +3 | 0000               | 0000               | Status word address minus 1 (%R0001) |
| address +4 | 0000               | 0000               | Not used                             |
| address +5 | 0000               | 0000               | Not used                             |
| address +6 | 4301               | 10CD               | Setup input buffer command           |
| address +7 | 0064               | 0040               | Buffer length (in words)             |

### Operating Notes

It is not possible to set the buffer length to zero. If zero is entered as the buffer length, the buffer size will be set to the 2K bytes default.

If a length greater than 2K bytes is specified, an error is generated.

## 25.4.4 Flush Input buffer Function (4302)

This operation empties the input buffer of any characters received through the serial port but not yet retrieved using a read command. All such characters are lost.

### Example Command Block for the Flush Input Buffer Function

|            | Value<br>(decimal) | Value<br>(hexadecimal) | Meaning                              |
|------------|--------------------|------------------------|--------------------------------------|
| address    | 0001               | 0001                   | Data block length                    |
| address +1 | 0000               | 0000                   | NOWAIT mode                          |
| address +2 | 0008               | 0008                   | Status word memory type (%R)         |
| address +3 | 0000               | 0000                   | Status word address minus 1 (%R0001) |
| address +4 | 0000               | 0000                   | Not used                             |
| address +5 | 0000               | 0000                   | Not used                             |
| address +6 | 4302               | 10CE                   | Flush input buffer command           |

## 25.4.5 Read port status Function (4303)

This function returns the current status of the port. The following events can be detected:

1. A read request was initiated previously, and the required number of characters has now been received or the specified time-out has elapsed.
2. A write request was initiated previously and transmission of the specified number of characters is complete or a time-out has elapsed.

The status returned by the function indicates the event or events that have completed. More than one condition can occur simultaneously, if both a read and a write were initiated previously.

### Example Command Block for the Read Port Status Function

|            | Value<br>(decimal) | Value<br>(hexadecimal) | Meaning                              |
|------------|--------------------|------------------------|--------------------------------------|
| address    | 0003               | 0003                   | Data block length                    |
| address +1 | 0000               | 0000                   | NOWAIT mode                          |
| address +2 | 0008               | 0008                   | Status word memory type (%R)         |
| address +3 | 0000               | 0000                   | Status word address minus 1 (%R0001) |
| address +4 | 0000               | 0000                   | Not used                             |
| address +5 | 0000               | 0000                   | Not used                             |
| address +6 | 4303               | 10CF                   | Read port status command             |
| address +7 | 0070               | 0046                   | Port status memory type (%I)         |
| address +8 | 0001               | 0001                   | Port status memory offset (%I0001)   |

## Port Status

The port status consists of a status word and the number of characters in the input buffer that have not been retrieved by the application (characters which have been received and are available).

|        |                                          |
|--------|------------------------------------------|
| word 1 | Port status word (see below)             |
| word 2 | Characters available in the input buffer |

The Port Status Word can be:

| Bit   | Name | Definition            | Meaning |                                                                                   |
|-------|------|-----------------------|---------|-----------------------------------------------------------------------------------|
| 15    | RI   | Read In progress      | Set     | Read Bytes or Read String invoked                                                 |
|       |      |                       | Cleared | Previous Read bytes or String has timed out, been canceled, or finished           |
| 14    | RS   | Read Success          | Set     | Read Bytes or Read String has successfully completed                              |
|       |      |                       | Cleared | New Read Bytes or Read String invoked                                             |
| 13    | RT   | Read Time-out         | Set     | Receive timeout occurred during Read Bytes or Read String                         |
|       |      |                       | Cleared | New Read Bytes or Read String invoked                                             |
| 12    | WI   | Write In progress     | Set     | New Write Bytes invoked                                                           |
|       |      |                       | Cleared | Previously invoked Write Bytes has timed out, been canceled, or finished          |
| 11    | WS   | Write Success         | Set     | Previously invoked Write Bytes has successfully completed                         |
|       |      |                       | Cleared | New Write Bytes invoked                                                           |
| 10    | WT   | Write Time-out        | Set     | Transmit timeout during Write Bytes                                               |
|       |      |                       | Cleared | New Write Bytes invoked                                                           |
| 9     | CA   | Character Available   | Set     | Unread characters are in the buffer                                               |
|       |      |                       | Cleared | No unread characters in the buffer                                                |
| 8     | OF   | OverFlow error        | Set     | Overflow error occurred on the serial port or internal buffer                     |
|       |      |                       | Cleared | Read Port Status invoked                                                          |
| 7     | FE   | Framing Error         | Set     | Framing error occurred on the serial port                                         |
|       |      |                       | Cleared | Read Port Status invoked                                                          |
| 6     | PE   | Parity Error          | Set     | Parity error occurred on the serial port                                          |
|       |      |                       | Cleared | Read Port Status invoked                                                          |
| 5     | CT   | CTS is active         | Set     | CTS line on the serial port is active or the serial port does not have a CTS line |
|       |      |                       | Cleared | CTS line on the serial port is not active                                         |
| 4 - 0 | U    | not used, should be 0 |         |                                                                                   |

## 25.4.6 Write port control Function (4304)

This function forces RTS for the specified port:

### Example Command Block for the Write Port Control Function

|            | Value<br>(decimal) | Value<br>(hexadecimal) | Meaning                              |
|------------|--------------------|------------------------|--------------------------------------|
| address    | 0002               | 0002                   | Data block length                    |
| address +1 | 0000               | 0000                   | NOWAIT mode                          |
| address +2 | 0008               | 0008                   | Status word memory type (%R)         |
| address +3 | 0000               | 0000                   | Status word address minus 1 (%R0001) |
| address +4 | 0000               | 0000                   | Not used                             |
| address +5 | 0000               | 0000                   | Not used                             |
| address +6 | 4304               | 10D0                   | Write port control command           |
| address +7 | xxxx               | xxxx                   | Port control word                    |

### Port Control Word

|     |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   |
|-----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|
| 15  | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| RTS | U  | U  | U  | U  | U  | U | U | U | U | U | U | U | U | U | U |

The Port Control Word can be:

- 15      **RTS**      Commanded state of the **RTS** output
  - 1 = Activates RTS
  - 0 = Deactivates RTS
- 0-14    **U**      Unused (should be zero)

### Operating Note

For Micro PLC port 2 (RS-485), the RTS signal is also controlled by the transmit driver. Therefore, control of RTS is dependent on the current state of the transmit driver. If the transmit driver is not enabled, asserting RTS with the Write Port Control COMMREQ will not cause RTS to be asserted on the serial line. The state of the transmit driver is controlled by the protocol and is dependent on the current Duplex Mode of the port. For 2-wire and 4-wire Duplex Mode, the transmit driver is only enabled during transmitting. Therefore, RTS on the serial line will only be seen active on port 2 (configured for 2-wire or 4-wire Duplex Mode) when data is being transmitted. For point-to-point Duplex Mode, the transmit driver is always enabled. Therefore, in point-to-point Duplex Mode, RTS on the serial line will always reflect what is chosen with the Write Port Control COMMREQ.

## 25.4.7 Cancel COMMREQ Function (4399)

This function cancels the current operations in progress. It can be used to cancel both read operations and write operations. If a read operation is in progress and there are unprocessed characters in the input buffer, those characters are left in the input buffer and available for future reads. The serial port is not reset.

### Example Command Block for the Cancel COMMREQ Function

|            | Value<br>(decimal) | Value<br>(hexadecimal) | Meaning                                                                                                                                              |
|------------|--------------------|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| address    | 0002               | 0002                   | Data block length                                                                                                                                    |
| address +1 | 0000               | 0000                   | NOWAIT mode                                                                                                                                          |
| address +2 | 0008               | 0008                   | Status word memory type (%R)                                                                                                                         |
| address +3 | 0000               | 0000                   | Status word address minus 1 (%R0001)                                                                                                                 |
| address +4 | 0000               | 0000                   | Not used                                                                                                                                             |
| address +5 | 0000               | 0000                   | Not used                                                                                                                                             |
| address +6 | 4399               | 112F                   | Cancel operation command                                                                                                                             |
| address +7 | 0001               | 0001                   | Transaction type to cancel <ul style="list-style-type: none"> <li>1 All operations</li> <li>2 Read operations</li> <li>3 Write operations</li> </ul> |

### Operating Notes

This function does not update the status of words of the cancelled COMMREQs.

#### **⚠ CAUTION**

If this COMMREQ is sent in either Cancel All or Cancel Write mode when a Write Bytes (4401) COMMREQ is transmitting a string from a serial port, transmission is halted. The position within the string where the transmission is halted is indeterminate. In addition, the final character received by the device the Micro PLC is sending to is also indeterminate.

## 25.4.8 Autodial Function (4400)

This feature allows the VersaMax Micro PLC to automatically dial a modem and send a specified byte string.

To implement this feature, the port must be configured for Serial I/O.

For example, pager enunciation can be implemented by three commands, requiring three COMMREQ command blocks:

- **Autodial:** 04400 (1130h) Dials the modem.
- **Write Bytes:** 04401 (1131h) Specifies an ASCII string, from 1 to 250 bytes in length, to send from the serial port.
- **Autodial:** 04400 (1130h) It is the responsibility of the Micro PLC application program to hang up the phone connection. This is accomplished by reissuing the autodial command and sending the hang up command string.

### Autodial Command Block

The Autodial command automatically transmits an Escape sequence that follows the Hayes convention. If you are using a modem that does not support the Hayes convention, you may be able to use the Write Bytes command to dial the modem.

Examples of commonly used command strings for Hayes-compatible modems are listed below:

| Command String        | Length   | Function                                               |
|-----------------------|----------|--------------------------------------------------------|
| ATDP15035559999<CR>   | 16 (10h) | Pulse dial the number 1-503-555-9999                   |
| ATDT15035559999<CR>   | 16 (10h) | Tone dial the number 1-503-555-9999                    |
| ATDT9,15035559999<CR> | 18 (12h) | Tone dial using outside line with pause                |
| ATH0<CR>              | 5 (05h)  | Hang up the phone                                      |
| ATZ <CR>              | 4 (04h)  | Restore modem configuration to internally saved values |



## Example Autodial Command Block

This example COMMREQ command block dials the number 234-5678 using a Hayes-compatible modem.

| Word | Definition    | Values                                             |
|------|---------------|----------------------------------------------------|
| 1    | 0009h         | CUSTOM data block length (includes command string) |
| 2    | 0000h         | NOWAIT mode                                        |
| 3    | 0008h         | Status word memory type (%R)                       |
| 4    | 0000h         | Status word address minus 1 (Register 1)           |
| 5    | 0000h         | not used                                           |
| 6    | 0000h         | not used                                           |
| 7    | 04400 (1130h) | Autodial command number                            |
| 8    | 00030 (001Eh) | Modem response timeout (30 seconds)                |
| 9    | 0012 (000Ch)  | Number of bytes in command string                  |
| 10   | 5441h         | A (41h), T (54h)                                   |
| 11   | 5444h         | D (44h), T (54h)                                   |
| 12   | 3332h         | Phone number: 2 (32h), 3 (33h)                     |
| 13   | 3534h         | 4 (34h), 5 (35h)                                   |
| 14   | 3736h         | 6 (36h), 7 (37h)                                   |
| 15   | 0D38h         | 8 (38h) <CR> (0Dh)                                 |

### 25.4.9 Write bytes Function (4401)

This operation can be used to transmit one or more characters to the remote device through the specified serial port. The character(s) to be transmitted must be in a word reference memory. They should not be changed until the operation is complete.

Up to 250 characters can be transmitted with a single invocation of this operation. The status of the operation is not complete until all of the characters have been transmitted or until a timeout occurs (for example, if hardware flow control is being used and the remote device never enables the transmission).

Example Command Block for the Write Bytes Function

|            | Value<br>(decimal) | Value<br>(hexadecimal) | Meaning                                         |
|------------|--------------------|------------------------|-------------------------------------------------|
| address    | 0006               | 0006                   | Data block length (includes characters to send) |
| address +1 | 0000               | 0000                   | NOWAIT mode                                     |
| address +2 | 0008               | 0008                   | Status word memory type (%R)                    |
| address +3 | 0000               | 0000                   | Status word address minus 1 (%R0001)            |
| address +4 | 0000               | 0000                   | Not used                                        |
| address +5 | 0000               | 0000                   | Not used                                        |
| address +6 | 4401               | 1131                   | Write bytes command                             |

|             | Value<br>(decimal) | Value<br>(hexadecimal) | Meaning                                         |
|-------------|--------------------|------------------------|-------------------------------------------------|
| address +7  | 0030               | 001E                   | Transmit time-out (30 seconds). See note below. |
| address +8  | 0005               | 0005                   | Number of bytes to write                        |
| address +9  | 25960              | 6568                   | 'h' (68h), 'e' (65h)                            |
| address +10 | 27756              | 6C6C                   | 'l' (6Ch), 'l' (6Ch)                            |
| address +11 | 0111               | 006F                   | 'o' (6Fh)                                       |

Although printable ASCII characters are used in this example, there is no restriction on the values of the characters that can be transmitted.

## Operating Notes

**Note:** Specifying zero as the Transmit time-out sets the time-out value to the amount of time actually needed to transmit the data, plus 4 seconds.

### ⚠ CAUTION

If an Initialize Port (4300) COMREQ is sent or a Cancel Operation (4399) COMMREQ is sent in either Cancel All or Cancel Write mode while this COMMREQ is transmitting a string from a serial port, transmission is halted. The position within the string where the transmission has halted is indeterminate. In addition, the final character received by the device the Micro PLC is sending to is also indeterminate.

## 25.4.10 Read bytes Function (4402)

This function causes one or more characters to be read from the specified port. The characters are read from the internal input buffer and placed in the specified input data area.

The function returns both the number of characters retrieved and the number of unprocessed characters still in the input buffer. If zero characters of input are requested, only the number of unprocessed characters in the input buffer is returned.

If insufficient characters are available to satisfy the request and a non-zero value is specified for the number of characters to read, the status of the operation is not complete until either sufficient characters have been received or the time-out interval expires. In either of those conditions, the port status indicates the reason for completion of the read operation. The status word is not updated until the read operation is complete (either due to timeout or when all the data has been received).

If the time-out interval is set to zero, the COMMREQ remains pending until it has received the requested amount of data, or until it is cancelled.

If this COMMREQ fails for any reason, no data is returned to the buffer. Any data that was already in the buffer remains and can be retrieved with a subsequent read request.

## Example Command Block for the Read Bytes Function

|             | Value<br>(decimal) | Value<br>(hexadecimal) | Meaning                              |
|-------------|--------------------|------------------------|--------------------------------------|
| address     | 0005               | 0005                   | Data block length                    |
| address +1  | 0000               | 0000                   | NOWAIT mode                          |
| address +2  | 0008               | 0008                   | Status word memory type (%R)         |
| address +3  | 0000               | 0000                   | Status word address minus 1 (%R0001) |
| address +4  | 0000               | 0000                   | Not used                             |
| address +5  | 0000               | 0000                   | Not used                             |
| address +6  | 4402               | 1132                   | Read bytes command                   |
| address +7  | 0030               | 001E                   | Read time-out (30 seconds)           |
| address +8  | 0005               | 0005                   | Number of bytes to read              |
| address +9  | 0008               | 0008                   | Input data memory type (%R).         |
| address +10 | 0001               | 0001                   | Input data memory address (%R0001)   |

## Return Data Format for the Read Bytes Function

The return data consists of the number of characters actually read, the number of characters still available in the input buffer after the read is complete (if any), and the actual input characters.

|             |                                                                  |
|-------------|------------------------------------------------------------------|
| Address     | Number of characters actually read                               |
| Address + 1 | Number of characters still available in the input buffer, if any |
| Address + 2 | first two characters (first character is in the low byte)        |
| Address + 3 | third and fourth characters (third character is in the low byte) |
| Address + n | subsequent characters                                            |

## Operating Note

If the input data memory type parameter is specified to be a word memory type and an odd number of bytes are actually received, then the high byte of the last word to be written with the received data is set to zero.

As data is received from the serial port it is placed in the internal input buffer. If the buffer becomes full, then any additional data received from the serial port is discarded and the Overflow Error bit in the Port Status word (See Read Port Status Function) is set.

## 25.4.11 Read String Function (4403)

This function causes characters to be read from the specified port until a specified terminating character is received. The characters are read from the internal input buffer and placed in the specified input data area.

The function returns both the number of characters retrieved and the number of unprocessed characters still in the input buffer. If zero characters of input are requested, only the number of unprocessed characters in the input buffer is returned.

If the terminating character is not in the input buffer, the status of the operation is not complete until either the terminating character has been received or the time-out interval expires. In either of those conditions, the port status indicates the reason for completion of the read operation.

If the time-out interval is set to zero, the COMMREQ remains pending until it has received the requested string, terminated by the specified end character.

If this COMMREQ fails for any reason, no data is returned to the buffer. Any data that was already in the buffer remains and can be retrieved with a subsequent read request.

### Example Command Block for the Read String Function

|             | Value<br>(decimal) | Value<br>(hexadecimal) | Meaning                                                                                    |
|-------------|--------------------|------------------------|--------------------------------------------------------------------------------------------|
| address     | 0005               | 0005                   | Data block length                                                                          |
| address +1  | 0000               | 0000                   | NOWAIT mode                                                                                |
| address +2  | 0008               | 0008                   | Status word memory type (%R)                                                               |
| address +3  | 0000               | 0000                   | Status word address minus 1 (%R0001)                                                       |
| address +4  | 0000               | 0000                   | Not used                                                                                   |
| address +5  | 0000               | 0000                   | Not used                                                                                   |
| address +6  | 4403               | 1133                   | Read string command                                                                        |
| address +7  | 0030               | 001E                   | Read time-out (30 seconds)                                                                 |
| address +8  | 0013               | 000D                   | Terminating character (carriage return):<br>must be between 0 and 255 (0xFF),<br>inclusive |
| address +9  | 0008               | 0008                   | Input data memory type (%R)                                                                |
| address +10 | 0001               | 0001                   | Input data memory address (%R0001)                                                         |

## Return Data Format for the Read String Function

The return data consists of the number of characters actually read, the number of characters still available in the input buffer after the read is complete (if any), and the actual input characters:

|             |                                                                  |
|-------------|------------------------------------------------------------------|
| Address     | Number of characters actually read                               |
| Address + 1 | Number of characters still available in the input buffer, if any |
| Address + 2 | first two characters (first character is in the low byte)        |
| Address + 3 | third and fourth characters (third character is in the low byte) |
| Address + n | subsequent characters                                            |

## Operating Note

If the input data memory type parameter is specified to be a word memory type and an odd number of bytes are actually received, then the high byte of the last word to be written with the received data is set to zero.

As data is received from the serial port it is placed in the internal input buffer. If the buffer becomes full, then any additional data received from the serial port is discarded and the Overflow Error bit in the Port Status word (See Read Port Status Function) is set.

## Example

The following Block Move will set up values to perform a serial I/O port configuration. In this example, port 2 is being configured. The entries of the first Block Move set up the following:

- IN1 Length of the data block, which is always 16 for a configuration COMMREQ
- IN2 Wait/No Wait flag: 0 for No Wait
- IN3 Status Word pointer: 8 signifies %R
- IN4 Status word pointer offset; this number is zero based, so 0 points to %R1
- IN5 Idle timeout value; not used with No Wait mode
- IN6 Maximum communication time; not used with No Wait mode
- IN7 Command Word; FFF0 hex is the command for serial port setup

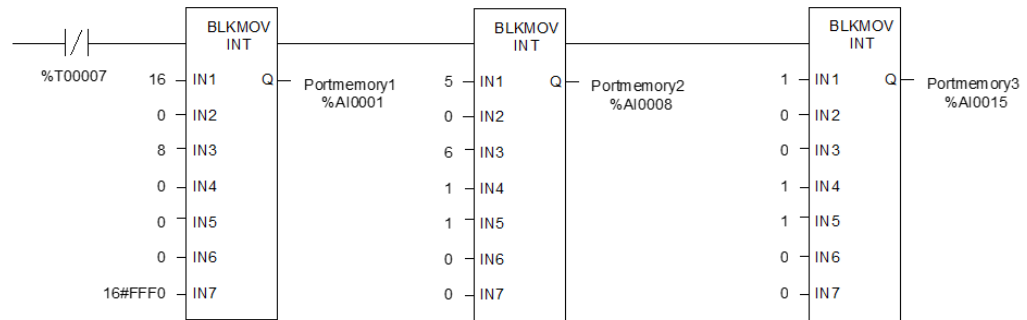
In the second Block Move:

- IN1 Protocol selector; 5 selects Serial I/O
- IN2 Port mode; 0 selects slave mode
- IN3 Data rate; 6 selects 19200
- IN4 Parity; 1 selects odd
- IN5 Flow control; 1 selects none
- IN6 Turnaround delay; 0 selects none
- IN7 Timeout; 0 selects none

In the third Block Move:

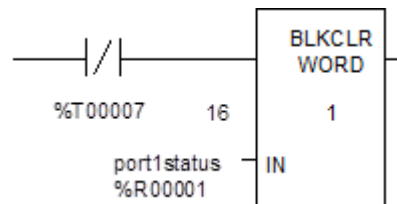
- IN1 Bits per character; 1 chooses 8 bits per character
- IN2 Stop bits; 0 selects 1 stop bit
- IN3 Interface; not used so set to 0
- IN4 Duplex mode; 1 selects 4-wire
- IN5 – IN7 Not used

Figure 373



%R1 is used as the status word for the COMMREQ. The following rung clears the word before the COMMREQ is issued:

Figure 374



The following logic issues a COMMREQ for port 2. The SYSID is set to rack 0 slot 1. The TASK ID of 20 defines port 2. The IN-parameter points to %AI1 which is where all the configuration data was placed with the Block Move statements. If an error occurs, the bit COMMREQP1bad (%T6) will be set.

Figure 375



The following rung sets the bit COMMREQ Complete (%T7), which keeps the COMMREQ from being issued more than once and keeps the status from being overwritten.

**Figure 376**



# Chapter 26: PID Function

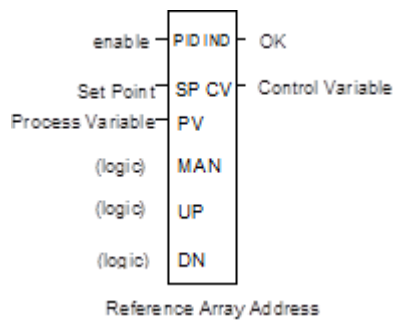
This chapter describes the PID (Proportional plus Integral plus Derivative) function, which is used for closed-loop process control. The PID function compares feedback from a process variable with a desired process set point and updates a Control Variable based on the error.

- Format of the PID Function
- Operation of the PID Function
- Parameter Block for the PID Function
- PID Algorithm Selection
- Determining the Process Characteristics
- Setting Parameters Including Tuning Loop Gains
- Sample PID Call

## 26.1 Format of the PID Function

The PID function uses PID loop gains and other parameters stored in an array of 40 16 bit words to solve the PID algorithm at the desired time interval. All parameters are 16-bit integer words. This allows %AI memory to be used for input Process Variables and %AQ to be used for output Control Variables.

**Figure 377**



The PID function does not pass power flow if there is an error in the configurable parameters. It can be monitored using a temporary coil while modifying data.



## 26.1.1 Parameters of the PID Function

| Input/<br>Output | Choices                            | Description                                                                                                                                                                                     |
|------------------|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| enable           | flow                               | When enabled through a contact, the PID algorithm is performed.                                                                                                                                 |
| SP               | I, Q, M, T, G, R, AI, AQ, constant | The control loop or process set point. Set using process variable counts, the PID function adjusts the output control variable so that the process variable matches the set point (zero error). |
| PV               | I, Q, M, T, G, R, AI, AQ           | Process Variable input from the process being controlled, often a %AI input.                                                                                                                    |
| MAN              | flow                               | When energized to 1 (through a contact), the PID block is in manual mode. If the PID block is on manual off, the PID block is in automatic mode.                                                |
| UP               | flow                               | If energized along with MAN, it adjusts the control variable up by 1 CV per solution. <sup>20</sup>                                                                                             |
| DN               | flow                               | If energized along with MAN, it adjusts the control variable down by 1 CV per solution. <sup>20</sup>                                                                                           |
| Address          | R                                  | Location of the PID control block information (user and internal parameters). Uses 40 %R words that cannot be shared.                                                                           |
| ok               | flow, none                         | OK is energized when the function is performed without error. It is Off if errors exist.                                                                                                        |
| CV               | I, Q, M, T, G, R, AI, AQ           | The control variable output to the process, often a %AQ output.                                                                                                                                 |

As scaled 16 integer numbers, many parameters must be defined in either Process Variable (PV) counts or units or Control Variable (CV) counts or units. For example, the Set Point (SP) input must be scaled over the same range as the Process Variable as the PID block calculates the error by subtracting these two inputs. The Process Variable and Control Variable Counts may be -32000 or 0 to 32000 matching analog scaling or from 0 to 10000 to display variables as 0.00% to 100.00%. The Process Variable and Control Variable Counts do not have to have the same scaling, in which case there will be scale factors included in the PID gains.

<sup>20</sup> Incremented (UP parameter) or decremented (DN parameter) by one (1) per access of the PID function.

## 26.2 Operation of the PID Function

### 26.2.1 Automatic Operation

The PID function can be called every sweep by providing power flow to Enable and no power flow to Manual input contacts. The block compares the current PLC elapsed time clock with the last PID solution time stored in the internal RefArray. If the difference is greater than the sample period defined in the third word (%Ref+2) of the RefArray, the PID algorithm is solved using the time difference. Both the last solution time and Control Variable output are updated. In Automatic mode, the output Control Variable is placed in the Manual Command parameter %Ref+13.

### 26.2.2 Manual Operation

The PID block is placed in Manual mode by providing power flow to both the Enable and Manual input contacts. The output Control Variable is set from the Manual Command parameter %Ref+13. If either the UP or DN inputs have power flow, the Manual Command word is incremented or decremented by one CV count every PID solution. For faster manual changes of the output Control Variable, it is also possible to add or subtract any CV count value directly to/from the Manual Command word

The PID block uses the CV Upper and CV Lower Clamp parameters to limit the CV output. If a positive Minimum Slew Time is defined, it is used to limit the rate of change of the CV output. If either the CV amplitude or rate limit is exceeded, the value stored in the integrator is adjusted so that CV is at the limit. This anti-reset windup feature means that even if the error tried to drive CV above (or below) the clamps for a long period of time, the CV output will move off the clamp as soon as the error term changes sign.

This operation, with the Manual Command tracking CV in Automatic mode and setting CV in Manual mode, provides a bumpless transfer between Automatic and Manual modes. The CV Upper and Lower Clamps and the Minimum Slew Time still apply to the CV output in Manual mode and the internal value stored in the integrator is updated. This means that if you were to step the Manual Command in Manual mode, the CV output will not change any faster than the Minimum Slew Time (Inverse) rate limit and will not go above or below the CV Upper or CV Lower Clamp limits.

## 26.2.3 Time Interval for the PID Function

The PID will not execute more often than once every 10 milliseconds. If it is set up to execute every sweep and the sweep is under 10 ms, the PID function will not run until enough sweeps have occurred to accumulate an elapsed time of 10 ms. For example, if the sweep time is 9 ms, the PID function executes every other sweep, so the overall elapsed time between executions is 18 ms. A specific PID function should not be called more than once per sweep.

The longest possible interval between executions is 10.9 minutes. The PID function compensates for the actual time elapsed since the last execution within 100 $\mu$ S.

The PID algorithm is solved only if the current Micro PLC elapsed time clock is at or later than the last PID solution time plus the sample period. If the sample period is set to 0, the function executes each time it is enabled; however, it is restricted to a minimum of 10 ms as noted above.

## 26.2.4 Scaling Input and Outputs

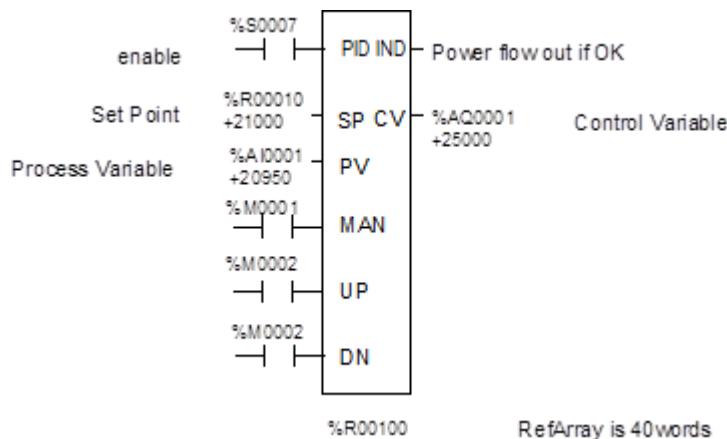
All parameters of the PID function are 16 bit integer words for compatibility with 16 bit analog process variables. Some parameters must be defined in either process variable counts or units or control variable counts or units.

The set point input must be scaled over the same range as process variable, because the PID function calculates error by subtracting these two inputs. The process variable and control variable counts do not have to use the same scaling. Either may be -32000 or 0 to 32000 to match analog scaling, or from 0 to 10000 to display variables as 0.00% to 100.00%. If the process and control variables do not use the same scaling, scale factors are included in the PID gains.

### Example of the PID Function

The example shown below includes typical inputs.

Figure 378



## 26.3 Parameter Block for the PID Function

The parameter block for the PID function occupies 40 words of %R memory. Many of the 40 words are used by the Micro PLC and not configurable. Every PID function call must use a different 40-word memory area even if all 13 configurable parameters are the same.

The first 13 words of the parameter block must be specified before executing the PID function. Zeros can be used for most default values. Once suitable PID values have been chosen, they can be defined as constants in a BLKMOV so they can be changed by the program as needed.

### 26.3.1 Internal Parameters in RefArray

The PID function reads 13 parameters and uses the rest of the 40-word RefArray for internal PID storage. Normally you would not change these values. If you call the PID block in Auto mode after a long delay, you may want to use SVCREQ 16 to load the current PLC elapsed time clock into %Ref+23 to update the last PID solution time to avoid a step change on the integrator. If you have set the Override low bit of the Control Word (%Ref+14) to 1, the next four bits of the Control Word must be set to control the PID block input contacts, and the Internal SP and PV must be set as you have taken control of the PID block away from the ladder logic.

|                        | Parameter                       | Low Bit Units | Range                                                  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------------------|---------------------------------|---------------|--------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Address                | Loop Number                     | Integer       | 0 to 255.                                              | Optional number of the PID block. It provides a common identification in the PLC with the loop number defined by an operator interface device.                                                                                                                                                                                                                                                                                                                                                                                                              |
| Address +1             | Algorithm                       | -             | Set by the PLC                                         | 1 = ISA algorithm<br>2 = independent algorithm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Address+2              | Sample Period                   | 10ms          | 0 (every sweep) to 65535 (10.9 Min) At least 10ms.     | The shortest time, in 10mS increments, between solutions of the PID algorithm. For example, use a 10 for a 100mS sample period.                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Address+3<br>Address+4 | Deadband +<br>and<br>Deadband - | PV Counts     | 0 to 32000<br>(+ never negative)<br>(- never positive) | INT values defining the upper (+) and lower (-) Deadband limits in PV Counts. If no Deadband is required, these values must be 0. If the PID Error (SP - PV) or (PV - SP) is above the (-) value and below the (+) value, the PID calculations are solved with an Error of 0. If non-zero, the (+) value must greater than 0 and the (-) value less than 0 or the PID block will not function.<br><br>Leave these at 0 until the PID loop gains are set up or tuned. A Deadband might be added to avoid small CV output changes due to variations in error. |

|                         | Parameter                                                          | Low Bit Units   | Range                                      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------|--------------------------------------------------------------------|-----------------|--------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Address+5               | Proportional Gain -Kp<br>(Controller gain, Kc, in the ISA version) | 0.01 CV%/PV%    | 0 to 327.67%                               | Change in the control variable in CV Counts for a 100 PV Count change in the Error term. A Kp entered as 450 is displayed as 4.50 and results in a $K_p * \text{Error} / 100$ or $450 * \text{Error} / 100$ contribution to the PID Output. Kp is generally the first gain set when adjusting a PID loop.                                                                                                                                                             |
| Address+6               | Derivative Gain-Kd                                                 | 0.01 seconds    | 0 to 327.67 sec                            | Change in the control variable in CV Counts if the Error or PV changes 1 PV Count every 10ms. Entered as a time with the low bit indicating 10ms. For example, a Kd entered as 120 is displayed as 1.20 Sec and results in a $K_d * \text{delta Error} / \text{delta time}$ or $120 * 4 / 3$ contribution to the PID Output if Error was changing by 4 PV Counts every 30ms. Kd can be used to speed up a slow loop response but is very sensitive to PV input noise. |
| Address+7               | Integral Rate-Ki                                                   | Repeat/1000 Sec | 0 to 32.767 repeat/sec                     | Change in the control variable in CV Counts if the Error were a constant 1 PV Count. Displayed as 0.000 Repeats/Sec with an implied decimal point of 3. For example, a Ki entered as 1400 is displayed as 1.400 Repeats/Sec and results in a $K_i * \text{Error} * dt$ or $1400 * 20 * 50 / 1000$ contribution to PID Output for an Error of 20 PV Counts and a 50ms PLC sweep time (Sample Period of 0). Ki is usually the second gain set after Kp.                 |
| Address+8               | CV Bias/ Output Offset                                             | CV Counts       | -32000 to 32000 (add to integrator output) | Number of CV Counts added to the PID Output before the rate and amplitude clamps. It can be used to set non-zero CV values if only Kp Proportional gains are used, or for feed forward control of this PID loop output from another control loop.                                                                                                                                                                                                                     |
| Address+9<br>Address+10 | CV Upper and Lower Clamps                                          | CV Counts       | -32000 to 32000<br>(>%Ref+10)              | Number of CV Counts that define the highest and lowest value for CV. These values are required. The Upper Clamp must have a more positive value than the Lower Clamp, or the PID block will not work. These are usually used to define limits based on physical limits for a CV output. They are also used to scale the Bar Graph display for CV. The block has anti-reset windup to modify the integrator value when a CV clamp is reached.                          |

|            | Parameter         | Low Bit Units       | Range                                  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------|-------------------|---------------------|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Address+11 | Minimum Slew Time | Seconds/Full Travel | 0 (none) to 32000 sec to move 32000 CV | <p>Minimum number of seconds for the CV output to move from 0 to full travel of 100% or 32000 CV Counts. It is an inverse rate limit on how fast the CV output can be changed.</p> <p>If positive, CV cannot change more than 32000 CV Counts times Delta Time (seconds) divided by Minimum Slew Time. For example, if the Sample Period is 2.5 seconds and the Minimum Slew Time is 500 seconds, CV cannot change more than <math>32000 * 2.5 / 500</math> or 160 CV Counts per PID solution. The integrator value is adjusted if the CV rate limit is exceeded. If Minimum Slew Time is 0, there is no CV rate limit. Set Minimum Slew Time to 0 while tuning or adjusting PID loop gains.</p> |

|            | Parameter   | Low Bit Units   | Range | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------|-------------|-----------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Address+12 | Config Word | Low 6 bits used |       | <p>The low 6 bits of this word are used to modify six default PID settings. The 10 high-order bits should be set to 0.</p> <p>Bit 0: Error Polarity. Setting this bit to 1 modifies the standard PID Error Term from the normal (SP – PV) to (PV – SP), reversing the sign of the feedback term. This is for Reverse Acting controls where the CV must go down when the PV goes up.</p> <p>Bit 1: Output Polarity: Setting this bit to 1 inverts the Output Polarity so that CV is the negative of the output rather than the normal positive value.</p> <p>Bit 2: Setting this bit to 1 removes the setpoint from the Derivative calculation.</p> <p>Bit 3: Deadband Action: When this bit is 0, no deadband action is chosen. If the error is within the deadband limits, the error is to be zero. Otherwise the error is not affected by the deadband limit. If this bit is 1, the deadband action is chosen. If the error is within the deadband limits, the error is forced to be zero. If, however, the error is outside the deadband limits, the error is reduced by the deadband limit (error = error – deadband limit).</p> <p>Bit 4: Anti-reset windup action. When this bit is 0, the anti-reset windup action uses a reset back calculation. When the output is clamped, this replaces the accumulated Y remainder value with whatever value is necessary to produce the clamped output exactly.</p> <p>When the bit is 1, this replaces accumulated Y term with the value of the Y term at the start of the calculation. In this way, the pre-clamp Y value is held as long as the output is clamped.</p> <p>Bit 5: Enable derivative filtering. When this bit is set to 0, no filtering is applied to the derivative term.</p> <p>When bit 5 is set to 1, a first order filter is applied. This limits the effects of higher frequency process disturbances on the derivative term.</p> |

| Parameter  | Low Bit Units  | Range                                       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |     |            |          |                                                    |   |   |          |                                                                |
|------------|----------------|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------------|----------|----------------------------------------------------|---|---|----------|----------------------------------------------------------------|
|            |                |                                             | <p>Bit 0 – Bit 5: Remember that the bits are set in powers of 2.</p> <p>To set bit 0, add 1 to the Config Word parameter value.</p> <p>To set bit 1, add 2.</p> <p>To set bit 2, add 4.</p> <p>To set bit 3, add 8.</p> <p>To set bit 4, add 16.</p> <p>To set bit 5, add 32.</p> <p>For example, set Config Word to 0 for default PID configuration. Add 1 to change the Error Term from SP - PV to PV - SP, add 2 to change the Output Polarity from CV = PID Output to CV = – PID Output, or add 4 to change Derivative Action from Error rate of change to PV rate of change, etc.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |     |            |          |                                                    |   |   |          |                                                                |
| Address+13 | Manual Command | CV Counts                                   | <p>Tracks CV in Auto or Sets CV in Manual</p> <p>Set to the current CV output while the PID block is in Automatic mode. When the block is switched to Manual mode, this value is used to set the CV output and the internal value of the integrator within the Upper and Lower Clamp and Slew Time limits.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |            |          |                                                    |   |   |          |                                                                |
| Address+14 | Control Word   | Maintained by the PLC, unless Bit 1 is set. | <p>PLC maintained unless set otherwise: low bit sets Override if 1.</p> <p>If the Override low bit is set to 1, this word and other internal SP, PV and CV parameters must be used for remote operation of this PID block (see below). This allows remote operator interface devices, such as a computer, to take control away from the PLC program.</p> <div style="background-color: yellow; padding: 5px; margin: 10px 0;"> <p><b>⚠CAUTION</b></p> </div> <p>If you do not want this to happen, make sure the Control Word is set to 0. If the low bit is 0, the next 4 bits can be read to track the status of the PID input contacts as long as the PID Enable contact has power.</p> <p>A discrete data structure with the first five bit positions in the following format:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr style="background-color: #e1f5fe;"> <th>Bit</th><th>Word Value</th><th>Function</th><th>Status or External Action if Override bit set to 1</th></tr> </thead> <tbody> <tr> <td>0</td><td>1</td><td>Override</td><td>If 0, monitor block contacts below. If 1, set them externally.</td></tr> </tbody> </table> | Bit | Word Value | Function | Status or External Action if Override bit set to 1 | 0 | 1 | Override | If 0, monitor block contacts below. If 1, set them externally. |
| Bit        | Word Value     | Function                                    | Status or External Action if Override bit set to 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |     |            |          |                                                    |   |   |          |                                                                |
| 0          | 1              | Override                                    | If 0, monitor block contacts below. If 1, set them externally.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |            |          |                                                    |   |   |          |                                                                |



|                          | Parameter                    | Low Bit Units                 | Range            | Description                                                                                                                                                                                                                                                                                                                                          |    |              |                                                                       |
|--------------------------|------------------------------|-------------------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|--------------|-----------------------------------------------------------------------|
|                          |                              |                               |                  | 1                                                                                                                                                                                                                                                                                                                                                    | 2  | Manual /Auto | If 1, block is in Manual mode; other numbers it is in Automatic mode. |
|                          |                              |                               |                  | 2                                                                                                                                                                                                                                                                                                                                                    | 4  | Enable       | Should normally be 1; otherwise block is never called.                |
|                          |                              |                               |                  | 3                                                                                                                                                                                                                                                                                                                                                    | 8  | UP /Raise    | If 1 and Manual (Bit 1) is 1, CV is being incremented every solution. |
|                          |                              |                               |                  | 4                                                                                                                                                                                                                                                                                                                                                    | 16 | DN /Lower    | If 1 and Manual (Bit 1) is 1, CV is being incremented every solution. |
| Address+15               | Internal SP                  | Set and maintained by the PLC | Non-configurable | Tracks SP in; must be set externally if Override = 1.                                                                                                                                                                                                                                                                                                |    |              |                                                                       |
| Address+16               | Internal CV                  | "                             | "                | Tracks CV out.                                                                                                                                                                                                                                                                                                                                       |    |              |                                                                       |
| Address+17               | Internal PV                  | "                             | "                | Tracks PV in; must be set externally if Override bit = 1.                                                                                                                                                                                                                                                                                            |    |              |                                                                       |
| Address+18               | Output                       | "                             | "                | Signed word value representing the output of the function block before the optional inversion. If no output inversion is configured and the output polarity bit in the control word is set to 0, this value equals the CV output. If inversion is selected and the output polarity bit is set to 1, this value equals the negative of the CV output. |    |              |                                                                       |
| Address+19               | Diff Term Storage            |                               |                  |                                                                                                                                                                                                                                                                                                                                                      |    |              |                                                                       |
| Address+20               | Int Term Storage             |                               |                  | Used internally for storage of intermediate values. Do not write to these locations                                                                                                                                                                                                                                                                  |    |              |                                                                       |
| Address+21               |                              |                               |                  |                                                                                                                                                                                                                                                                                                                                                      |    |              |                                                                       |
| Address+22               | Slew Term Storage            |                               |                  |                                                                                                                                                                                                                                                                                                                                                      |    |              |                                                                       |
| Address+23 to Address+25 | Clock                        |                               |                  | Internal elapsed time storage (time last PID executed). Do not write to these locations                                                                                                                                                                                                                                                              |    |              |                                                                       |
| Address+26               | Y Remainder Storage          |                               |                  | Holds remainder for integrator division scaling for 0 steady state error.                                                                                                                                                                                                                                                                            |    |              |                                                                       |
| Address+27 to Address+28 | SP, PV Lower and Upper Range | PV Counts                     | -32000 to 32000  | Optional INT values in PV Counts that define high and low display values. (Ref +27 must be lower than Ref+28)                                                                                                                                                                                                                                        |    |              |                                                                       |
| Address+29 to Address+39 | Reserved                     | N/A                           | Non-configurable | 29-34 are reserved for internal use; 35-39 are reserved for external use. Do not use these references.                                                                                                                                                                                                                                               |    |              |                                                                       |

## 26.4 PID Algorithm Selection (PIDISA or PIDIND) and Gains

The PID block can be programmed selecting either the Independent (PID\_IND) term or standard ISA (PID\_ISA) versions of the PID algorithm. The only difference in the algorithms is how the Integral and Derivative gains are defined.

### 26.4.1 Error Term

The Independent (PID\_IND) term and standard ISA (PID\_ISA) versions of the PID algorithm both calculate the Error Term as:

$$\text{Error Term (in Normal Mode)} = \text{Set Point (SP)} - \text{Process Variable (PV)}$$

#### Error Term in Reverse-Action Mode

The Error Term calculation can be changed to Reverse Action mode:

$$\text{Error Term (in Reverse Action Mode)} = \text{Process Variable (PV)} - \text{Set Point (SP)}$$

by setting the Error Term (low bit 0 in the Config Word %Ref+12) to 1.

#### Effect of the Process Variable on the Control Variable

In Normal mode, the Control Variable (CV) responds to changes in the Process Variable (PV) by moving in the same direction. In Reverse-Action mode, when the Process Variable goes up, the Control Variable goes down.

### 26.4.2 Derivative Term

The Derivative term is the time rate of change of the Error term in the interval since the last PID solution.

$$\text{Derivative} = \Delta \text{Error} / \text{Delta time (dt)} = (\text{Error} - \text{previous Error}) / \text{Delta time (dt)}$$

where

$$\text{Delta time (dt)} = \text{Current PLC elapsed time} - \text{PLC elapsed time at previous PID solution.}$$

In Normal Mode (without Reverse-Action mode), this is equal to the change in the Error term.

$$\begin{aligned} (\text{Error} - \text{previous Error}) &= (\text{SP} - \text{PV}) - (\text{previous SP} - \text{previous PV}) \\ &= (\text{previous PV} - \text{PV}) - (\text{previous SP} - \text{SP}) \end{aligned}$$

However, when the Reverse-Action mode bit (bit 0) in the Config Word is set, the sign of the change in the Error term is reversed.

$$\begin{aligned} (\text{Error} - \text{previous Error}) &= (\text{PV} - \text{SP}) - (\text{previous PV} - \text{previous SP}) \\ &= (\text{PV} - \text{previous PV}) - (\text{SP} - \text{previous SP}) \end{aligned}$$

The change in the Error term depends on changes in both the Set Point and the Process Variable. If the Set Point is constant, the difference between SP and the previous SP is zero

and has no effect on the output. However, Set Point changes can cause large changes in the Derivative term and in the output.

## Removing Set Point Changes from the Derivative Calculation

Loop stability can be improved by eliminating the effect of Set Point changes on the Derivative term. Set the third bit (bit 2) of the Config Word to 1 to calculate the derivative based only on the change in PV.

For bit 2 set in normal mode (bit 0 = 0),

$$(\text{Error} - \text{previous Error}) = (\text{previous PV} - \text{PV}),$$

and with bit 2 set in Reverse-Action mode (bit 0 = 1),

$$(\text{Error} - \text{previous Error}) = (\text{PV} - \text{previous PV}).$$

### 26.4.3 Delta Time

The dt (or Delta Time) is determined by subtracting the last PID solution clock time for this block from the current PLC elapsed time clock.

$$\text{dt} = \text{Current PLC Elapsed Time clock} - \text{PLC Elapsed Time Clock at Last PID solution}$$

$$\text{Derivative} = (\text{Error} - \text{previous Error})/\text{dt} \text{ or } (\text{PV} - \text{previous PV})/\text{dt} \text{ if 3rd bit of Config Word set to 1}$$

The Independent term PID (PID\_IND) algorithm calculates the output as:

$$\text{PID Output} = K_p * \text{Error} + K_i * \text{Error} * \text{dt} + K_d * \text{Derivative} + \text{CV Bias}$$

The standard ISA (PID\_ISA) algorithm has a different form:

$$\text{PID Output} = K_c * (\text{Error} + \text{Error} * \text{dt}/T_i + T_d * \text{Derivative}) + \text{CV Bias}$$

where  $K_c$  is the controller gain, and  $T_i$  is the Integral time and  $T_d$  is the Derivative time. The advantage of ISA is that adjusting the  $K_c$  changes the contribution for the integral and derivative terms as well as the proportional one, which may make loop tuning easier. If you have PID gains in terms of  $T_i$  and  $T_d$ , use

$$K_p = K_c \quad K_i = K_c/T_i \quad \text{and} \quad K_d = K_c/T_d$$

to convert them to use as PID User Parameter inputs.

The CV Bias term above is an additive term separate from the PID components. It may be required if you are using only Proportional  $K_p$  gain and you want the CV to be a non-zero value when the PV equals the SP and the Error is 0. In this case, set the CV Bias to the desired CV when the PV is at the SP. CV Bias can also be used for feed forward control where another PID loop or control algorithm is used to adjust the CV output of this PID loop.

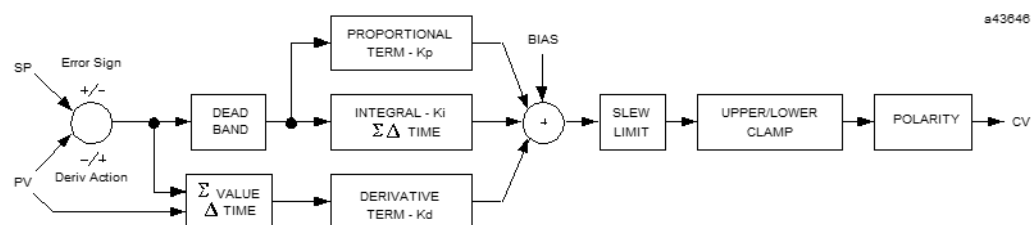
If an Integral  $K_i$  gain is used, the CV Bias would normally be 0 as the integrator acts as an automatic bias. Just start up in Manual mode and use the Manual Command word (%Ref+13) to set the integrator to the desired CV, then switch to Automatic mode. This also works if  $K_i$

is 0, except the integrator will not be adjusted based on the Error after going into Automatic mode.

## 26.4.4 Independent Term Algorithm (PIDIND)

The following diagram shows how the PID algorithms work:

Figure 379



The ISA Algorithm (PIDISA) is similar except the Kp gain is factored out of Ki and Kd so that the integral gain is Kp \* Ki and derivative gain is Kp \* Kd. The Error sign, DerivAction and Polarity are set by bits in the Config Word user parameter.

## CV Amplitude and Rate Limits

The block does not send the calculated PID Output directly to CV. Both PID algorithms can impose amplitude and rate of change limits on the output Control Variable. The maximum rate of change is determined by dividing the maximum 100% CV value (32000) by the Minimum Slew Time, if specified as greater than 0. For example, if the Minimum Slew Time is 100 seconds, the rate limit will be 320 CV counts per second. If the dt solution time was 50 ms, the new CV output cannot change more than  $320 * 50 / 1000$  or 16 CV counts from the previous CV output.

The CV output is then compared to the CV Upper and CV Lower Clamp values. If either limit is exceeded, the CV output is set to the clamped value. If either rate or amplitude limits are exceeded modifying CV, the internal integrator value is adjusted to match the limited value to avoid reset windup.

Finally, the block checks the Output Polarity (2nd bit of the Config Word %Ref+12) and changes the sign of the output if the bit is 1.

$$CV = \begin{cases} \text{Clamped PID Output or} \\ \text{- Clamped PID Output if Output Polarity bit set} \end{cases}$$

If the block is in Automatic mode, the final CV is placed in the Manual Command %Ref+13. If the block is in Manual mode, the PID equation is skipped as CV is set by the Manual Command, but all the rate and amplitude limits are still checked. That means that the Manual Command cannot change the output above the CV Upper Clamp or below the CV Lower Clamps and the output cannot change faster than the Minimum Slew Time allowed.

## 26.4.5 Sample Period and PID Block Scheduling

The PID block is a digital implementation of an analog control function, so the  $dt$  sample time in the PID Output equation is not the infinitesimally small sample time available with analog controls. The majority of processes being controlled can be approximated as a gain with a first or second order lag, possibly with a pure time delay. The PID block sets a CV output to the process and uses the process feedback PV to determine an Error to adjust the next CV output. A key process parameter is the total time constant, which is how fast does the PV respond when the CV is changed. As discussed in the Setting Loop Gains section below, the total time constant,  $T_p + T_c$ , for a first order system is the time required for PV to reach 63% of its final value when CV is stepped. The PID block will not be able to control a process unless its Sample Period is well under half the total time constant. Larger Sample Periods will make it unstable.

The Sample Period should be no bigger than the total time constant divided by 10 (or down to 5, worst case). For example, if PV seems to reach about  $2/3$  of its final value in 2 seconds, the Sample Period should be less than 0.2 seconds, or 0.4 seconds worst case. On the other hand, the Sample Period should not be too small, such as less than the total time constant divided by 1000, or the  $K_i * \text{Error} * dt$  term for the PID integrator will round down to 0. For example, a very slow process that takes 10 hours or 36000 seconds to reach the 63% level should have a Sample Period of 40 seconds or longer.

Unless the process is very fast, it is not usually necessary to use a Sample Period of 0 to solve the PID algorithm every PID sweep. If many PID loops are used with a Sample Period greater than the sweep time, there may be wide variations in PLC sweep time if many loops end up solving the algorithm at the same time. The simple solution is to sequence a one or more 1 bits through an array of bits set to 0 that is being used to enable power flow to individual PID blocks.

## 26.5 Determining the Process Characteristics

The PID loop gains,  $K_p$ ,  $K_i$  and  $K_d$ , are determined by the characteristics of the process being controlled. Two key questions when setting up a PID loop are:

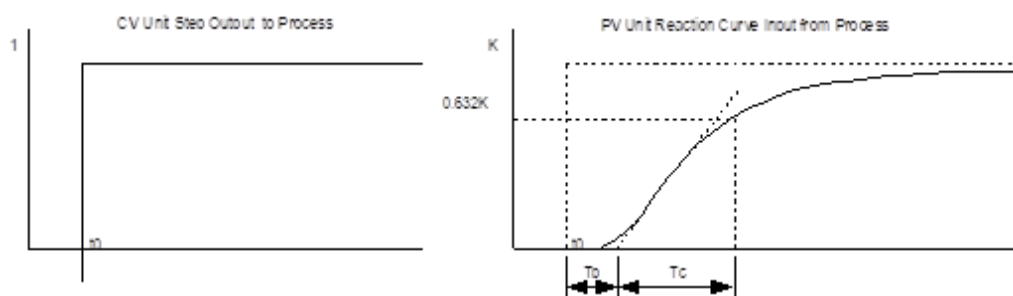
1. How big is the change in PV when we change CV by a fixed amount, or what is the open loop gain?
2. How fast does the system respond, or how quickly does PV change after the CV output is stepped?

Many processes can be approximated by a process gain, first or second order lag and a pure time delay. In the frequency domain, the transfer function for a first order lag system with a pure time delay is:

$$PV(s)/CV(s) = G(s) = K * e^{-(T_p s)} / (1 + T_c s)$$

Plotting a step response at time  $t_0$  in the time domain provides an open loop unit reaction curve:

**Figure 380**



The following process model parameters can be determined from the PV unit reaction curve:

|       |                                                                                                    |
|-------|----------------------------------------------------------------------------------------------------|
| K     | Process open loop gain = final change in PV/change in CV at time $t_0$<br>(Note no subscript on K) |
| $T_p$ | Process or pipeline time delay or dead time after $t_0$ before the process output PV starts moving |
| $T_c$ | First order Process time constant, time required after $T_p$ for PV to reach 63.2% of the final PV |

Usually the quickest way to measure these parameters is by putting the PID block in Manual mode and making a small step in CV output, by changing the Manual Command %Ref+13, and plotting the PV response over time. For slow processes, this can be done manually, but for faster processes a chart recorder or computer graphic data logging package will help. The CV step size should be large enough to cause an observable change in PV, but not so large that it disrupts the process being measured. A good size may be from 2 to 10% of the difference between the CV Upper and CV Lower Clamp values.

## 26.6 Setting Parameters Including Tuning Loop Gains

As all PID parameters are totally dependent on the process being controlled, there are no predetermined values that will work; however, it is usually simple to find acceptable loop gain.

1. Set all the User Parameters to 0, then set the CV Upper and CV Lower Clamps to the highest and lowest CV expected. Set the Sample Period to the estimated process time constant (above)/10 to 100.
2. Put block in Manual mode and set Manual Command (%Ref+13) at different values to check if CV can be moved to Upper and Lower Clamp. Record PV value at some CV point and load it into SP.
3. Set a small gain, such as  $100 * \text{Maximum CV} / \text{Maximum PV}$ , into Kp and turn off Manual mode. Step SP by 2 to 10% of the Maximum PV range and observe PV response. Increase Kp if PV step response is too slow or reduce Kp if PV overshoots and oscillates without reaching a steady value.
4. Once a Kp is found, start increasing Ki to get overshooting that dampens out to a steady value in 2 to 3 cycles. This may require reducing Kp. Also try different step sizes and CV operating points.
5. After suitable Kp and Ki gains are found, try adding Kd to get quicker responses to input changes providing it doesn't cause oscillations. Kd is often not needed and will not work with noisy PV.
6. Check gains over different SP operating points and add Deadband and Minimum Slew Time if needed. Some Reverse Acting processes may need setting Config Word Error Sign or Polarity bits.

## 26.6.1 Setting Loop Gains Using the Ziegler and Nichols Tuning Approach

Once the three process model parameters, K, Tp and Tc, are determined, they can be used to estimate initial PID loop gains. The following approach provides good response to system disturbances with gains producing an amplitude ratio of 1/4. The amplitude ratio is the ratio of the second peak over the first peak in the closed loop response.

1. Calculate the Reaction rate:

$$R = K/T_c$$

2. For Proportional control only, calculate Kp as:

$$K_p = 1/(R * T_p) = T_c/(K * T_p)$$

For Proportional and Integral control, use:

$$K_p = 0.9/(R * T_p) = 0.9 * T_c/(K * T_p)$$

$$K_i = 0.3 * K_p/T_p$$

For Proportional, Integral and Derivative control, use:

$$K_p = G/(R * T_p) \text{ where } G \text{ is from } 1.2 \text{ to } 2.0$$

$$K_i = 0.5 * K_p/T_p$$

$$K_d = 0.5 * K_p * T_p$$

3. Check that the Sample Period is in the range

$$(T_p + T_c)/10 \text{ to } (T_p + T_c)/1000$$

## 26.6.2 The Ideal Tuning Method

The "Ideal Tuning" procedure provides the best response to SP changes, delayed only by the Tp process delay or dead time.

$$K_p = 2 * T_c/(3 * K * T_p)$$

$$K_i = T_c$$

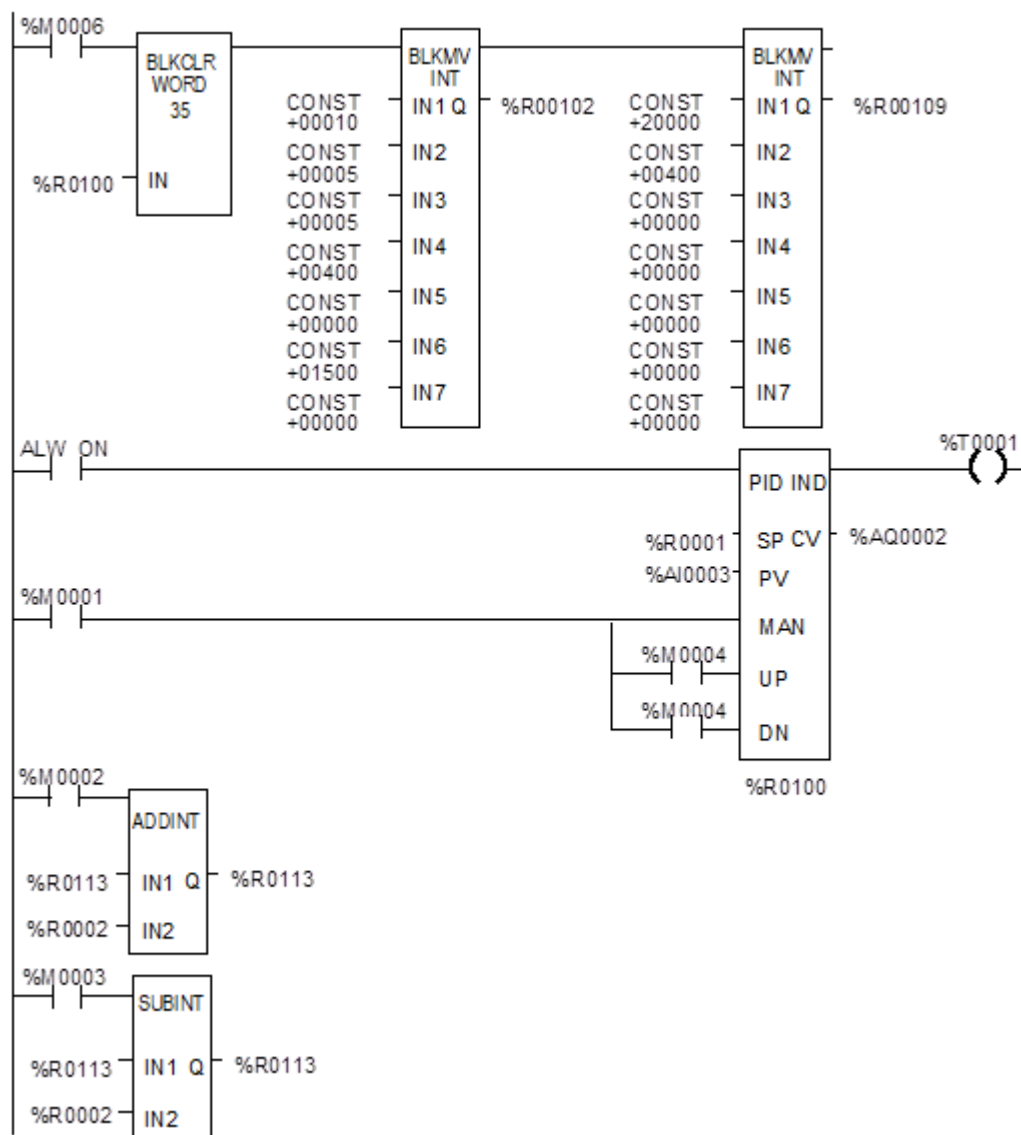
$$K_d = K_i/4$$

if Derivative term is used

Once initial gains are determined, convert them to integers. Calculate the Process gain K as a change in input PV Counts divided by the output step change in CV Counts and not in process PV or CV engineering units. Specify all times in seconds. Once Kp, Ki and Kd are determined, Kp and Kd can be multiplied by 100 and entered as integer while Ki can be multiplied by 1000 and entered into the User Parameter %RefArray.



The following PID example has a sample period of 100Ms, a Kp gain of .400 and a Ki gain of 1.500. The set point is stored in %R0001, the control variable output in %AQ0002, and the process variable is returned in %AI0003. CV Upper and CV Lower Clamps must be set, in this case to 20000 and 4000, and an optional small Deadband of +5 and -5 has been included. The 40-word RefArray starts in %R0100. Normally User Parameters are set in the RefArray, but %M0006 can be set to reinitialize the 14 words starting at %R0102 (%Ref+2) from constants stored in logic (a useful technique).



# Chapter 27: Reading and Writing Data in Flash Memory

For Release 3.0 and later VersaMax Micro PLCs, two Service Request commands can be used to read or write flash memory during run time:

- SVCREQ 52: Reads from Flash Memory into Reference Memory
- SVCREQ 53: Writes from Reference Memory into Flash Memory

Chapter 22: gives details of using use these Service Request commands in the application program.

This chapter describes the Logic-driven Write to Flash feature, and gives application program examples.

## 27.1 Logic-Driven Write to Flash

For a VersaMax Micro PLC, one of the configuration choices is whether the CPU will read the initial values from flash or RAM at power-up. If RAM is the choice, the CPU will read the reference tables data from its RAM memory at power-up.

If “Read from flash” is the configured choice, the CPU will read previously stored reference tables from flash memory at power-up. In addition, Release 3.0 and later VersaMax Micro PLCs (which includes all 20-, 40-, and 64-Point Micro PLCs) will also read from flash all data that has been stored to flash using Service Request 53. This feature is called “Logic-drive write to flash”.

The logic-driven flash data area is cleared using the programmer. When storing an application to the PLC, if “Write All To Flash” is configured, all data that has been written to flash using Service Request 53 is automatically deleted. The data area can also be cleared by using the flash-EEPROM tab and selecting Write All Data to Flash. This option is not available during Run mode due to the time required to erase flash.

### 27.1.1 Data Quantities

For 20-, 40-, or 64-point Micro PLCs, the flash memory used for the Logic-driven write to flash feature has a total size of 8192 bytes. Of this, 8 bytes are reserved and cannot be used. So the maximum available capacity is 8184 bytes. For 14, 23, and 28-point Micro PLCs, the Logic-driven user flash memory is 64kB (65536 bytes) and the maximum available capacity is 65528 after 8 bytes are reserved.

Each execution of Service Request 52 or 53 can transfer:

- 1 to 10 words of %R, %AI, or %AQ reference data plus 6 bytes of command data. That means a 1-word write to flash requires 8 bytes of flash memory, while a 10-word write to flash requires 26 bytes of flash memory ((10 words X 2 bytes per word) + 6 bytes of command data).

- 1 to 10 bytes of %I, %Q, %M, %T, or %G reference data plus 6 bytes of command data. A 1-byte write to flash requires 7 bytes of flash memory, while a 10-byte write to flash occupies 16 bytes of flash memory.

Therefore, because each request requires 6 bytes of command data, the most efficient use of flash is by transferring data in 10-word increments.

## 27.1.2 If Flash Memory Becomes Full

If Service Request 53 attempts to write more data to flash memory than the maximum available, a fault is logged in the PLC Fault Table.

|               |                             |     |
|---------------|-----------------------------|-----|
| Fault Group   | APPLICATION_FLT             | 22  |
| Fault Action  | DIAGNOSTIC                  | 2   |
| Error Code    | USERFLASH_FULL              | 204 |
| Error Message | Logic Driven Userflash Full |     |

If a Logic Driven Userflash Full fault is logged in the PLC Fault Table, the PLC must be power cycled.

After power-cycling the PLC, if another Logic Driven Userflash Full fault is logged, the contents of flash memory must be completely erased by downloading new logic with 'Write All To Flash' selected during download to PLC. After power-cycling the PLC, data can again be stored in flash until the Logic Driven Userflash Full "fault is logged again.

The same configuration and application program must be stored on RAM and PLC flash to use this feature. It should not be done with configuration stored with 'Read from flash' set and ladder program on RAM. If the program on RAM calls Service Request 53 to store reference memory on flash, then the PLC is power-cycled, if the configuration says to read data from flash, the data will be read but the application program may not be the same one that called Service Request 53.

## 27.1.3 Important Note

Service request 53 (Logic driven write to flash) should be performed with caution after an operation is performed that makes the application in RAM not equal to the application in flash. The following are few such operations:

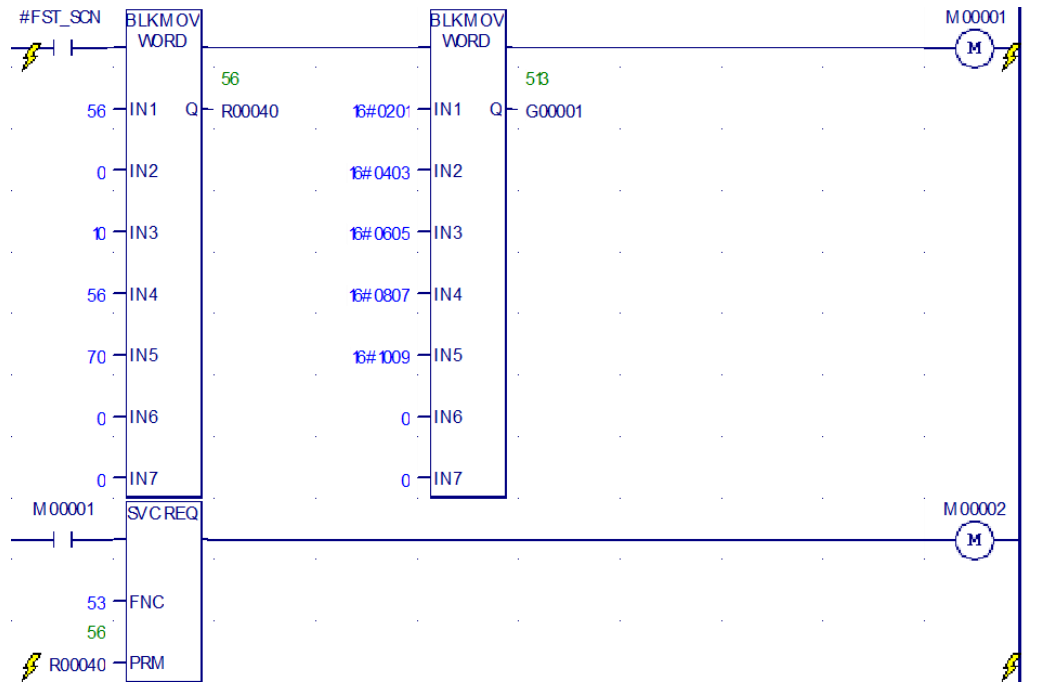
- Word for word change or Run Mode store
- Stop mode store of logic to RAM only
- Logic and Registers stored to Flash during Stop mode store, but CPU is configured to read Logic from RAM and Registers from Flash on power up.

Such operations may make the data stored by Service request 53 incompatible with the application in flash and hence need to be used carefully.

## Example 1: Writing Data to Flash Memory

This example writes 10 continuous bytes from PLC references %G0001 through %G0080 into flash memory. In this example, the segment selector (56) is for byte access and so are the offsets and lengths.

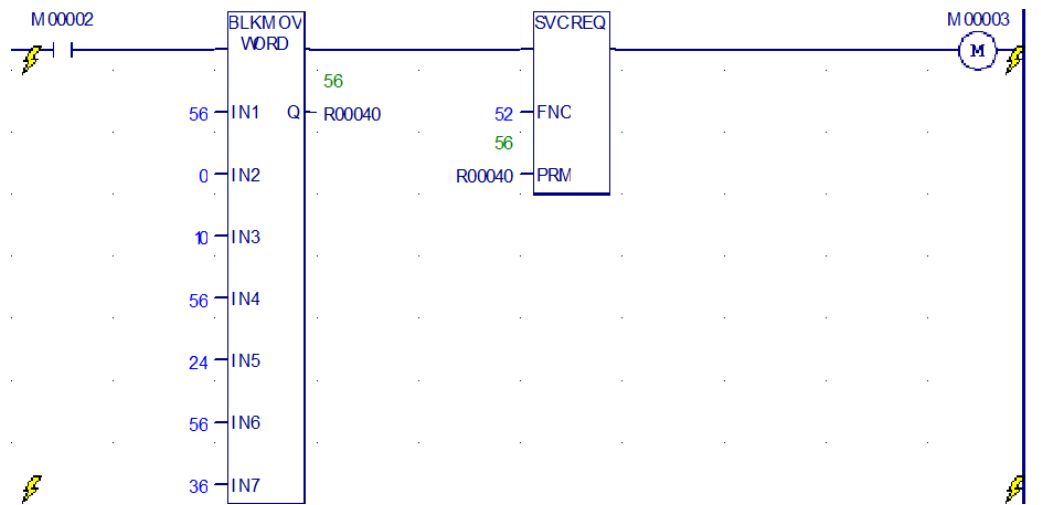
Figure 382



## Example 2: Reading Data from Flash Memory

This example reads the same 10 continuous bytes from %G0001 through %G0080 from flash into %G reference memory into the PLC.

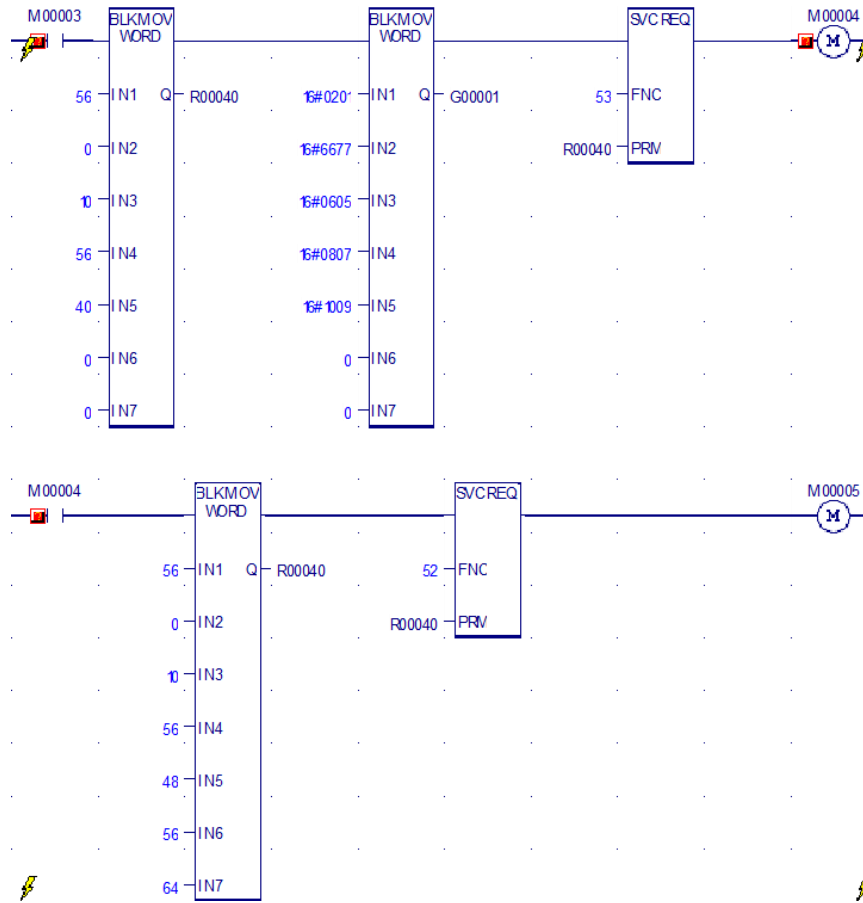
Figure 383



## Example 3: Writing Over Data in Reference Memories

By changing values, the same logic can be used to write over some data in the same reference memories.

Figure 384



## Results of Example 3

In this example, the status words returned for Service Request begin at PLC reference %G00321.

Figure 385

|  | <--      |          |          |          | %G00001  |          | Address  |          |         |
|--|----------|----------|----------|----------|----------|----------|----------|----------|---------|
|  | 00001000 | 00000111 | 00000110 | 00000101 | 01100110 | 01110111 | 00000010 | 00000001 | %G00001 |
|  | 00001010 | 00000000 | 00000000 | 00000000 | 00000000 | 00000000 | 00010000 | 00001001 | %G00065 |
|  | 00000000 | 00000000 | 00000000 | 00000000 | 00000000 | 00011111 | 11101000 | 00000000 | %G00129 |
|  | 00001000 | 00000111 | 00000110 | 00000101 | 00000100 | 00000011 | 00000010 | 00000001 | %G00193 |
|  | 00000000 | 00001010 | 00000000 | 00000001 | 00000000 | 00001010 | 00010000 | 00001001 | %G00257 |
|  | 00000000 | 00000000 | 00011111 | 11011010 | 00000000 | 00001000 | 00000001 | 00000001 | %G00321 |
|  | 00001000 | 00000111 | 00000110 | 00000101 | 01100110 | 01110111 | 00000010 | 00000001 | %G00385 |
|  | 00000000 | 00000000 | 00000000 | 00000000 | 00000000 | 00000000 | 00010000 | 00001001 | %G00449 |
|  | 00000000 | 00000001 | 00000000 | 00000000 | 00000000 | 00001010 | 00000000 | 00000001 | %G00513 |
|  | 00000000 | 00000000 | 00000000 | 00000000 | 00011111 | 11101000 | 00000000 | 00001010 | %G00577 |
|  | 00000000 | 00000000 | 00000000 | 00000000 | 00000000 | 00000000 | 00000000 | 00000000 | %G00641 |
|  | 00000000 | 00000000 | 00000000 | 00000000 | 00000000 | 00000000 | 00000000 | 00000000 | %G00705 |

## Example 4: Multiple Writes and Reads

This four-part example shows how to perform multiple reads and writes on a 64-point CPU.

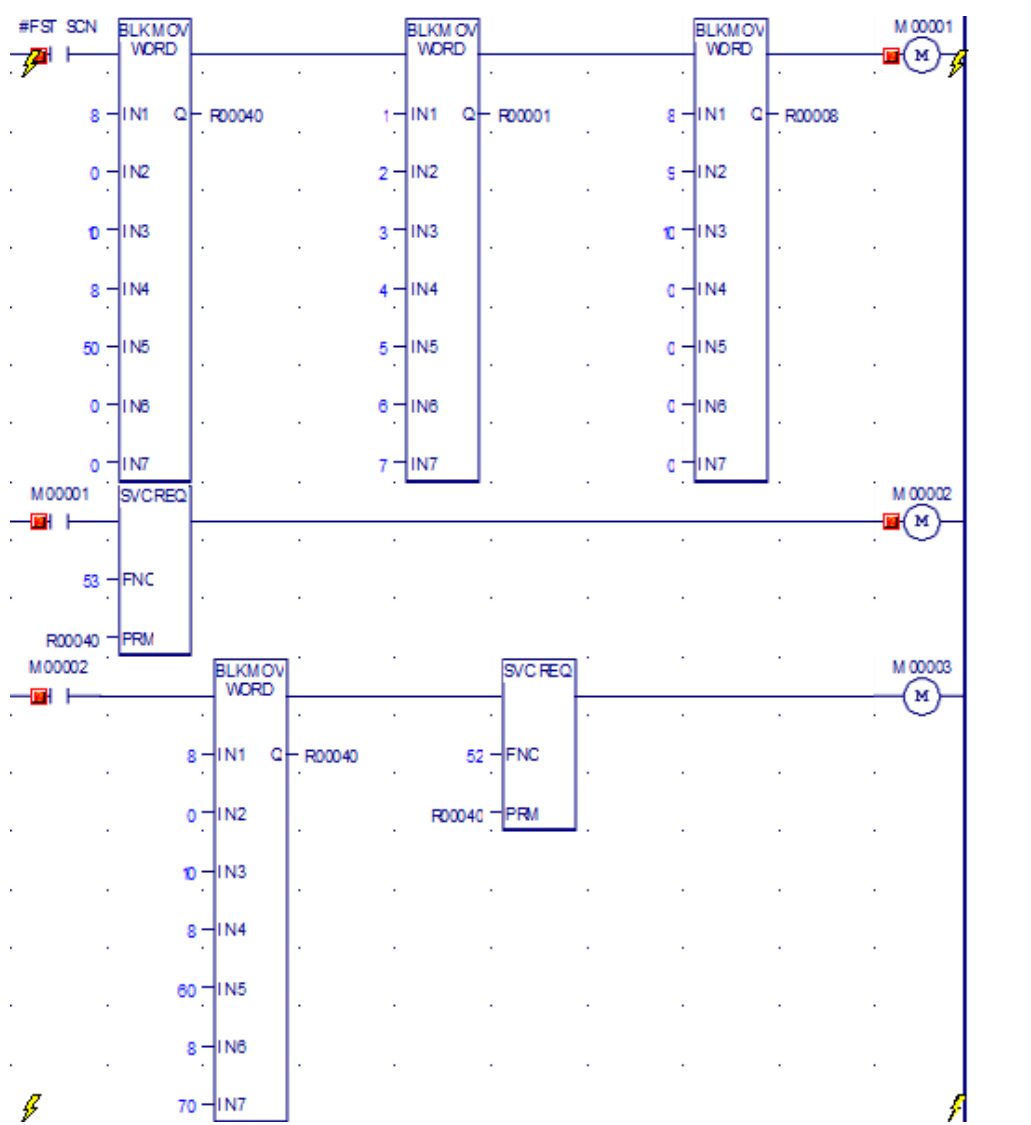
### Example 4, Part 1

The first part of this example:

Writes %R0001 through %R0010 from PLC reference memory to flash. Return Write status data to PLC references starting at %R0051.

Reads back %R0001 through %R0010 from flash into CPU references %R0061 through %R0070. It returns status data into PLC references starting at %R0071.

Figure 386



## Results of Example 4, Part 1

Looking at the references used by this part of Example 4:

- %R0051 shows the Write status as 1. That means all data was successfully written.
- %R0052 shows that 10 words of data have been written to flash.
- %R0053 shows the remaining available flash memory as 8158 bytes. Note: The available memory will be 65518 for 14, 23, or 28-point Micro PLCs.

The Read status references are not shown here.

**Figure 387**

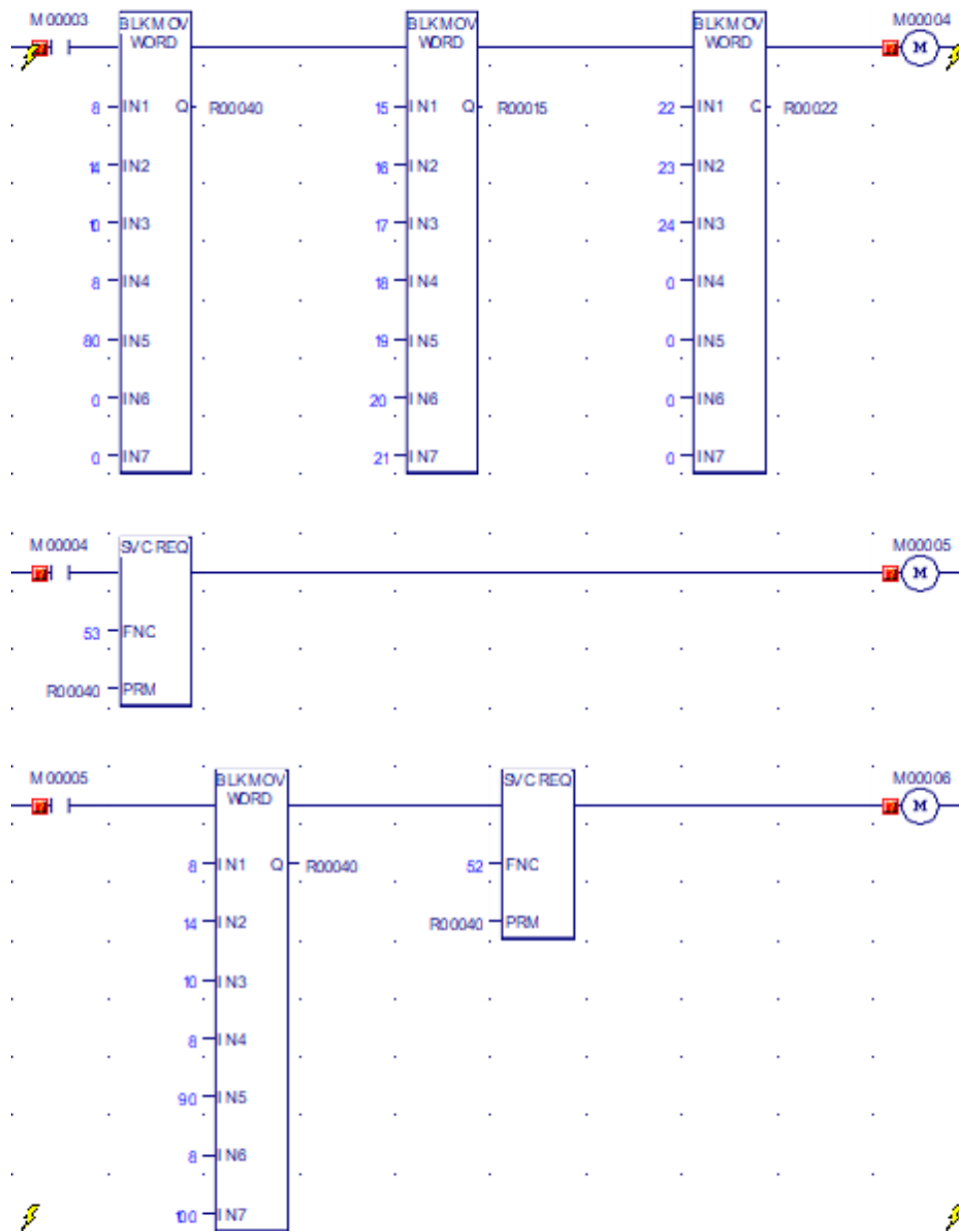
|     |    |    |      |      |      |      |      |    |    |         |
|-----|----|----|------|------|------|------|------|----|----|---------|
| +10 | +9 | 8  | 7    | 6    | 5    | 4    | 3    | 2  | 1  | %R00001 |
| +0  | +0 | +0 | 1717 | 1616 | 1515 | 14   | 13   | 12 | 11 | %R00011 |
| +0  | +0 | +0 | +0   | +0   | +0   | +24  | 23   | 22 | +0 | %R00021 |
| +8  | +0 | +0 | +0   | +0   | 0    | 0    | 0    | 0  | 0  | %R00031 |
| +0  | +0 | +0 | +0   | +170 | +8   | +160 | 8    | 10 | 20 | %R00041 |
| +0  | +0 | +0 | 0    | 0    | 0    | 0    | 8158 | 10 | 1  | %R00051 |

## Example 4, Part 2

The next part of Example 4:

1. Writes the contents of PLC references %R0015 through %R0024 into flash. It returns Write status data to PLC references starting at %R0081.
2. Reads flash references %R0015 through %R0024 into PLC references %R0091 through %R0100 and returns Read status information to PLC references starting at %R0101.

Figure 388





## Results of Example 4, Part 2

For Example 4, Part 2, the Write status references start at %R0081:

- %R0081 shows status as 1 signifying full success (all data written)
- %R0082 shows that 10 words of data have been stored
- %R0083 shows that the available flash memory is 8132

The Read status references, which start at %R101, are not shown here. However, the Write status references from part 1 of this example, starting at %R0051, are shown.

Figure 389

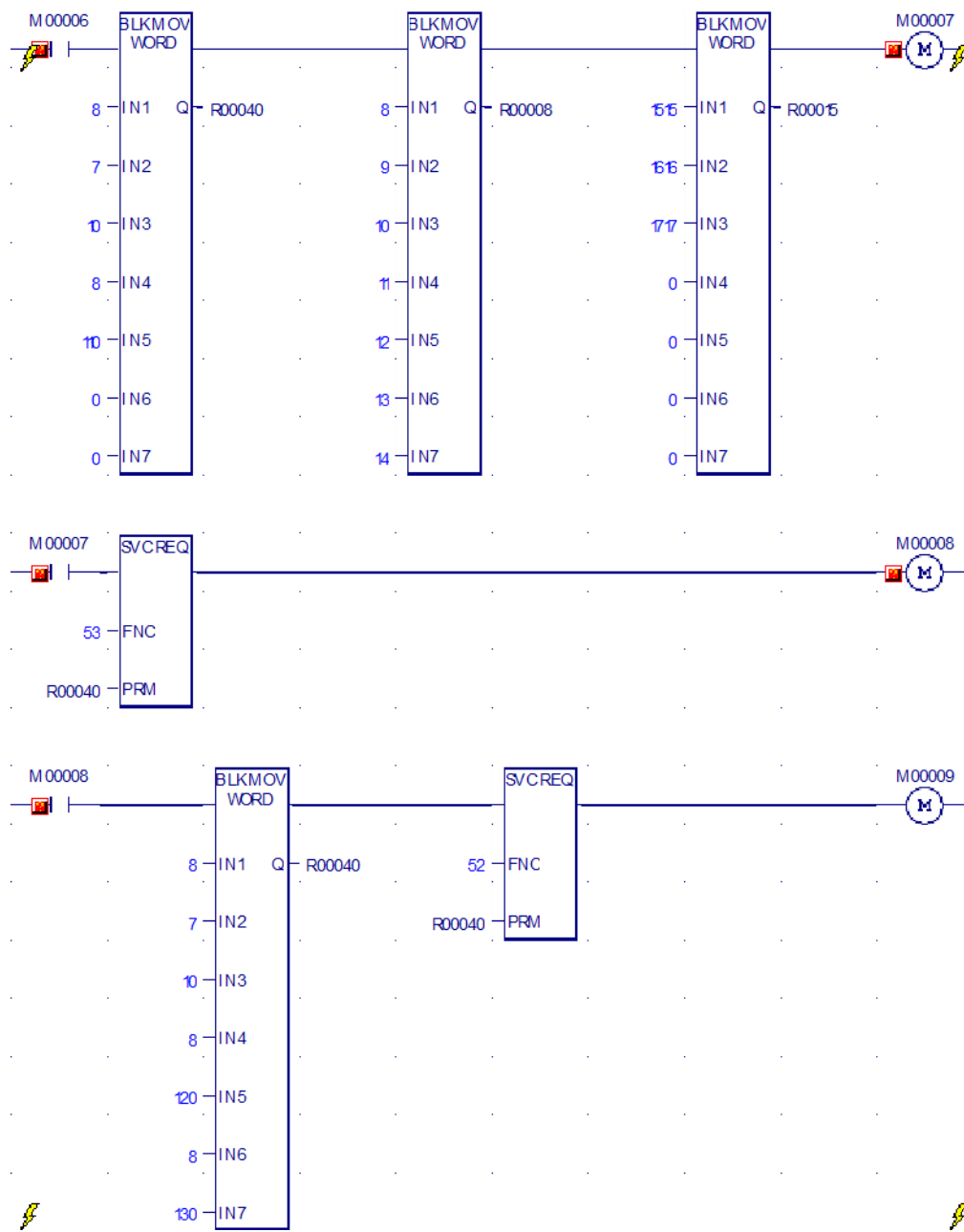
|     |    |    |      |      |      |      |      |    |    |         |
|-----|----|----|------|------|------|------|------|----|----|---------|
| +10 | +9 | 8  | 7    | 6    | 5    | 4    | 3    | 2  | 1  | %R00001 |
| +0  | +0 | +0 | 1717 | 1616 | 1515 | 14   | 13   | 12 | 11 | %R00011 |
| +0  | +0 | +0 | +0   | +0   | +0   | +24  | 23   | 22 | +0 | %R00021 |
| +8  | +0 | +0 | +0   | +0   | 0    | 0    | 0    | 0  | 0  | %R00031 |
| +0  | +0 | +0 | +0   | +170 | +8   | +160 | 8    | 10 | 20 | %R00041 |
| +0  | +0 | +0 | 0    | 0    | 0    | 0    | 8158 | 10 | 1  | %R00051 |
| +10 | +9 | +8 | +7   | 6    | 5    | 4    | 3    | 2  | 1  | %R00061 |
| +0  | +0 | +0 | +0   | +0   | +0   | +0   | 0    | 10 | 1  | %R00071 |
| +0  | +0 | +0 | +0   | 0    | +0   | +0   | 8132 | 10 | 1  | %R00081 |

## Example 4, Part 3

This part of Example 4:

- Writes PLC references %R0008 through %R0017 to flash and returns Write status data to PLC references starting at %R0111. This single Service Request:
  - Overwrites the values in %R0008 through %R0010 that were written in Example 4 Part 1.
  - Writes new data into %R0011 through %R0014.
  - Overwrites the values in %R0015 through %R0017 that were written in Example 4 Part 2.
- Reads %R0008 through %R017 from flash into PLC references %R0121 through %R0130 and returns Read status data to PLC references starting at %R0131.

Figure 390



## Results of Example 4, Part 3

For Example, 4, Part 3, the Write status references start at %R0111:

- The value in status reference %R0111 is 257 (0x0101). That indicates partial success, because not all 10 bytes of data were written to flash. Error 257 may occur if some requested data is already stored in user flash, as was done in this example.
- %R0112 shows that only 7 words of data were stored, not the 10 words requested.
- %R0113 shows that the remaining available flash memory is 8112 bytes.

The Read status references start at %R0131:

- %R0131 shows that the Read Service Request completed successfully.
- %R0132 shows that 10 words of data were read.

Figure 391

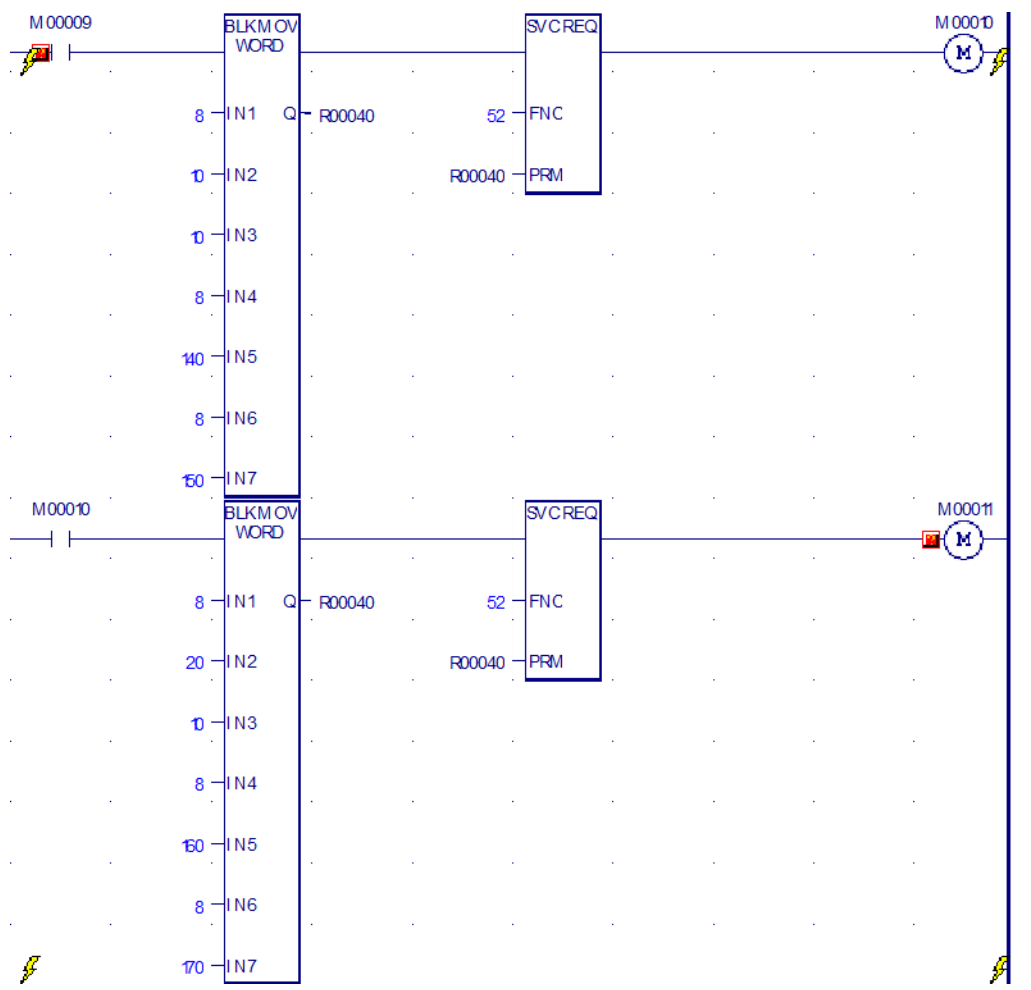
|       |       |       |      |      |      |      |      |     |     |         |
|-------|-------|-------|------|------|------|------|------|-----|-----|---------|
| +10   | +9    | 8     | 7    | 6    | 5    | 4    | 3    | 2   | 1   | %R00001 |
| +0    | +0    | +0    | 1717 | 1616 | 1515 | 14   | 13   | 12  | 11  | %R00011 |
| +0    | +0    | +0    | +0   | +0   | +0   | +24  | 23   | 22  | +0  | %R00021 |
| +8    | +0    | +0    | +0   | +0   | 0    | 0    | 0    | 0   | 0   | %R00031 |
| +0    | +0    | +0    | +0   | +170 | +8   | +160 | 8    | 10  | 20  | %R00041 |
| +0    | +0    | +0    | 0    | 0    | 0    | 0    | 8158 | 10  | 1   | %R00051 |
| +10   | +9    | +8    | +7   | 6    | 5    | 4    | 3    | 2   | 1   | %R00061 |
| +0    | +0    | +0    | +0   | +0   | +0   | +0   | 0    | 10  | 1   | %R00071 |
| +0    | +0    | +0    | +0   | 0    | +0   | +0   | 8132 | 10  | 1   | %R00081 |
| +24   | +23   | +22   | +21  | +20  | +19  | +18  | +17  | +16 | +15 | %R00091 |
| +0    | +0    | +0    | +0   | +0   | +0   | +0   | +0   | +10 | +1  | %R00101 |
| +0    | +0    | +0    | +0   | +0   | +0   | +0   | 8112 | 7   | 257 | %R00111 |
| +1717 | +1616 | +1515 | +14  | +13  | +12  | +11  | +10  | +9  | +8  | %R00121 |
| +0    | +0    | +0    | +0   | +0   | +0   | +0   | +0   | +10 | +1  | %R00131 |

### Example 4, Part 4

This part of the example program logic:

1. Reads flash references %R0011 through %R0020 into PLC references %R0141 through %R0150 and returns Read status information to PLC memory starting at %R0151.
2. Reads flash references %R0021 through %R0030 into PLC references %R0161 through %R0170 and returns Read status information to PLC memory starting at %R0171.

Figure 392



## Results of Example 4, Part 4

For Example 4, Section 4, the Read status references start at %R0151 and %R0171:

- The value in Read status reference %R0151 is 1. The Read operation was successful.
- %R0152 shows that all 10 words of data were read into PLC memory.
- The value in Read status reference %R0171 is 257 (0x0101). That indicates partial success, because not all 10 bytes of data were written to flash. That can occur if not enough memory is available in the selected PLC reference area for the data that has been read from flash.
- %R0172 shows that only 4 words of data were read.

Figure 393

| <- Unsigned Decimal 00000010000001 %R00111 |       |       |       |       |       |      |      |     |     | Address |
|--------------------------------------------|-------|-------|-------|-------|-------|------|------|-----|-----|---------|
| +10                                        | +9    | 8     | 7     | 6     | 5     | 4    | 3    | 2   | 1   | %R00001 |
| +0                                         | +0    | +0    | 1717  | 1616  | 1515  | 14   | 13   | 12  | 11  | %R00011 |
| +0                                         | +0    | +0    | +0    | +0    | +0    | +24  | 23   | 22  | +0  | %R00021 |
| +8                                         | +0    | +0    | +0    | +0    | 0     | 0    | 0    | 0   | 0   | %R00031 |
| +0                                         | +0    | +0    | +0    | +170  | +8    | +160 | 8    | 10  | 20  | %R00041 |
| +0                                         | +0    | +0    | 0     | 0     | 0     | 0    | 8158 | 10  | 1   | %R00051 |
| +10                                        | +9    | +8    | +7    | 6     | 5     | 4    | 3    | 2   | 1   | %R00061 |
| +0                                         | +0    | +0    | +0    | +0    | +0    | +0   | 0    | 10  | 1   | %R00071 |
| +0                                         | +0    | +0    | +0    | 0     | +0    | +0   | 8132 | 10  | 1   | %R00081 |
| +24                                        | +23   | +22   | +21   | +20   | +19   | +18  | +17  | +16 | +15 | %R00091 |
| +0                                         | +0    | +0    | +0    | +0    | +0    | +0   | +0   | +10 | +1  | %R00101 |
| +0                                         | +0    | +0    | +0    | +0    | +0    | +0   | 8112 | 7   | 257 | %R00111 |
| +1717                                      | +1616 | +1515 | +14   | +13   | +12   | +11  | +10  | +9  | +8  | %R00121 |
| +0                                         | +0    | +0    | +0    | +0    | +0    | +0   | +0   | +10 | +1  | %R00131 |
| +20                                        | +19   | +18   | +1717 | +1616 | +1515 | +14  | +13  | +12 | +11 | %R00141 |
| +0                                         | +0    | +0    | +0    | +0    | +0    | +0   | +0   | +10 | +1  | %R00151 |
| +0                                         | +0    | +0    | +0    | +0    | +0    | +24  | +23  | +22 | +21 | %R00161 |
| +0                                         | +0    | +0    | +0    | +0    | +0    | +0   | +0   | 4   | 257 | %R00171 |
| +0                                         | +0    | +0    | +0    | +0    | +0    | +0   | +0   | +0  | +0  | %R00181 |
| %R00094                                    |       |       |       |       |       |      |      |     |     |         |
| %R - Register                              |       |       |       |       |       |      |      |     |     |         |

# Appendix A: Instruction Timing

This appendix contains tables listing the memory size in bytes and the execution times in microseconds for each function supported by a VersaMax Nano PLC or Micro PLC.

- Notes on Timing Information
- Typical Execution Times for Boolean Contacts
- Typical Execution Times for Release 4.0 CPUs
- Typical Execution Times for Release 3.8 CPUs
- Typical Execution Times for Release 3.0 CPUs
- Typical Execution Times for Release 2.0 CPUs
- Typical Execution Times for Release 1.1 CPUs
- Typical Execution Times for Release 1.0 CPUs

## A-1 Notes on the Timing Information

### A-1.1 Execution Times with Function Block Enabled or Disabled

Two execution times are shown for each type of function block, labeled "enabled" and "disabled".

For each instance of the function block in the logic program:

- the value in the "enabled" column represents a range of typical contribution times when the function block receives power flow during that sweep.
- the value in the "disabled" column represents the typical contribution time when the function block is not receiving power flow during that sweep and/or there is power flow to reset of the function block.
- All timing values represent typical execution time. Actual execution time may vary with input and error conditions.

### A-1.2 Additional Notes

1. Timers and counters are updated each time they are encountered in the logic; timers by the amount of time consumed by the last sweep and counters by one count.
2. For bit operation functions, L = the number of bits. For bit position, N = the bit that is set. For data move functions, N = the number of bits or words. B = the number of bits shifted more than 1 (that is, not counting the first bit). W = the number of words.
3. Memory size refers to the number of bytes required by the function in a ladder diagram application program.
4. For table functions, increment is in units of length specified.
5. Enabled time for single length units of type %R, %AI, and %AQ.

6. The DO I/O function block timing represents execution on 8 points (%I0001 to %I0008).

## A-2 Typical Execution Times for Boolean Contacts

Boolean contact execution times for Boolean logic are as follows:

|                                            | CPU Releases |          |           |          |          |          |
|--------------------------------------------|--------------|----------|-----------|----------|----------|----------|
|                                            | 3.8          | 3.0      | 2.0, 1.10 | 1.07     | 1.05     | 1.0      |
| 10-point Nano PLCs                         | 1.4 ms/K     | 1.3 ms/K | 1.3 ms/K  | N/A      | N/A      | 1.2 ms/K |
| 14-point Micro PLCs                        | 1.5 ms/K     | 1.1 ms/K | 1.1 ms/K  | N/A      | N/A      | 1.0 ms/K |
| 20-point Micro PLCs                        | 1.7 ms/K     | N/A      | N/A       | N/A      | N/A      | N/A      |
| 23-point Micro PLCs                        | 1.5 ms/K     | 1.1 ms/K | 1.1 ms/K  | N/A      | N/A      | 1.0 ms/K |
| 28-point Micro PLCs                        | 1.5 ms/K     | 1.1 ms/K | 1.1 ms/K  | N/A      | 1.0 ms/K | 1.0 ms/K |
| 40-point Micro PLCs                        | 1.7 ms/K     | N/A      | N/A       | N/A      | N/A      | N/A      |
| 28-point Micro PLC with ESCP (IC200UDD120) | 1.3 ms/K     | 1.0 ms/K | 1.0 ms/K  | 1.0 ms/K | N/A      | N/A      |
| 64-point Micro PLC                         | 1.7 ms/K     | 1.7 ms/K | N/A       | N/A      | N/A      | N/A      |

### A-2.1 Sweep Times for Micro-64 CPUs

No expansion units connected = 2.9ms to 3.1ms

With 1 expansion unit = 3.5ms to 3.8ms

With 2 expansion unit = 3.8ms to 4ms

With 3 expansion unit = 4.3ms to 4.5ms

With 4 expansion unit = 4.4ms to 5ms

## A-3 Typical Execution Times for Release 4.0 CPUs

The following table details function block timing for Release 4.0, Micro PLCs.

For each instance of a function block, the table shows typical execution times when the function block is enabled (receiving power flow) or disabled (not receiving power flow).

|               |                        |            | Execution Time<br>(Range in $\mu$ sec.) |          |
|---------------|------------------------|------------|-----------------------------------------|----------|
|               |                        |            | 20-/40-/64-Point                        |          |
| Group         | Function               | Size bytes | Enabled                                 | Disabled |
| Timers        | Off Delay Timer        | 15         | 93                                      | 63       |
|               | On Delay Timer         | 15         | 97                                      | 70       |
|               | Elapsed Timer          | 15         | 70                                      | 51       |
| Counters      | Up Counter             | 13         | 64                                      | 59       |
|               | Down Counter           | 13         | 59                                      | 57       |
| Math          | Addition (INT)         | 13         | 39                                      | 9        |
|               | Addition (DINT)        | 19         | 52                                      | 9        |
|               | Addition (REAL)        | 17         | 138                                     | 9        |
|               | Subtraction (INT)      | 13         | 34                                      | 9        |
|               | Subtraction (DINT)     | 19         | 40                                      | 9        |
|               | Subtraction (REAL)     | 17         | 153                                     | 9        |
|               | Multiplication (INT)   | 13         | 43                                      | 9        |
|               | Multiplication (DINT)  | 13         | 33                                      | 9        |
|               | Multiplication (REAL)  | 17         | 145                                     | 9        |
|               | Division (INT)         | 13         | 58                                      | 9        |
|               | Division (DINT)        | 19         | 43                                      | 9        |
|               | Division (REAL)        | 17         | 237                                     | 9        |
|               | Modulo Division (INT)  | 13         | 57                                      | 9        |
|               | Modulo Division (DINT) | 19         | 59                                      | 9        |
|               | Square Root (INT)      | 10         | 55                                      | 9        |
|               | Square Root (DINT)     | 13         | 46                                      | 9        |
|               | Square Root (REAL)     | 11         | 557                                     | 9        |
| Trigonometric | SIN (REAL)             | 11         | 1534                                    | 9        |
|               | COS (REAL)             | 11         | 1630                                    | 9        |
|               | TAN (REAL)             | 11         | 2316                                    | 12       |
|               | ASIN (REAL)            | 11         | 1638                                    | 9        |
|               | ACOS (REAL)            | 11         | 1638                                    | 9        |
|               | ATAN (REAL)            | 11         | 951                                     | 9        |
| Logarithmic   | LOG (REAL)             | 11         | 1001                                    | 9        |
|               | LN (REAL)              | 11         | 915                                     | 9        |



|               |                           |            | Execution Time<br>(Range in $\mu$ sec.) |          |
|---------------|---------------------------|------------|-----------------------------------------|----------|
|               |                           |            | 20-/40-/64-Point                        |          |
| Group         | Function                  | Size bytes | Enabled                                 | Disabled |
| Exponential   | Power of e                | 11         | 703                                     | 9        |
|               | Power of X                | 11         | 368                                     | 9        |
| Radian Conv   | Convert RAD to DEG        | 11         | 379                                     | 9        |
|               | Convert DEG to RAD        | 17         | 79                                      | 9        |
| Relational    | Equal (INT)               | 10         | 35                                      | 9        |
|               | Equal (DINT)              | 16         | 25                                      | 9        |
|               | Equal (REAL)              | 14         | 40                                      | 9        |
|               | Not Equal (INT)           | 10         | 22                                      | 9        |
|               | Not Equal (DINT)          | 16         | 38                                      | 9        |
|               | Not Equal (REAL)          | 14         | 46                                      | 9        |
|               | Greater Than (INT)        | 10         | 31                                      | 9        |
|               | Greater Than (DINT)       | 16         | 30                                      | 9        |
|               | Greater Than (REAL)       | 14         | 41                                      | 10       |
|               | Greater Than/Equal (INT)  | 10         | 22                                      | 9        |
|               | Greater Than/Equal (DINT) | 16         | 24                                      | 9        |
|               | Greater Than/Equal (REAL) | 14         | 36                                      | 9        |
|               | Less Than (INT)           | 10         | 22                                      | 9        |
|               | Less Than (DINT)          | 16         | 24                                      | 9        |
|               | Less Than (REAL)          | 14         | 36                                      | 9        |
|               | Less Than/Equal (INT)     | 10         | 21                                      | 9        |
|               | Less Than/Equal (DINT)    | 16         | 24                                      | 9        |
|               | Less Than/Equal (REAL)    | 14         | 40                                      | 9        |
|               | Range (INT)               | 13         | 26                                      | 9        |
|               | Range (DINT)              | 22         | 29                                      | 9        |
|               | Range (WORD)              | 13         | 26                                      | 9        |
| Bit Operation | Logical AND               | 13         | 33                                      | 9        |
|               | Logical OR                | 13         | 32                                      | 9        |
|               | Logical Exclusive OR      | 13         | 33                                      | 9        |
|               | Logical Invert, NOT       | 10         | 28                                      | 9        |
|               | Shift Bit Left            | 16         | 204                                     | 10       |
|               | Shift Bit Right           | 16         | 139                                     | 10       |
|               | Rotate Bit Left           | 16         | 88                                      | 9        |
|               | Rotate Bit Right          | 16         | 106                                     | 9        |
|               | Bit Position              | 13         | 57                                      | 9        |
|               | Bit Clear                 | 13         | 57                                      | 9        |
|               | Bit Test                  | 13         | 35                                      | 9        |

|           |                             |            | Execution Time<br>(Range in $\mu$ sec.) |          |
|-----------|-----------------------------|------------|-----------------------------------------|----------|
|           |                             |            | 20-/40-/64-Point                        |          |
| Group     | Function                    | Size bytes | Enabled                                 | Disabled |
|           | Bit Set                     | 13         | 52                                      | 9        |
|           | Mask Compare (WORD)         | 25         | 129                                     | 9        |
|           | Mask Compare (DWORD)        | 25         | 113                                     | 9        |
| Data Move | Move (INT)                  | 10         | 27                                      | 9        |
|           | Move (BOOL)                 | 13         | 62                                      | 9        |
|           | Move (WORD)                 | 10         | 26                                      | 9        |
|           | Move (REAL)                 | 13         | 41                                      | 9        |
|           | Block Move (INT)            | 28         | 34                                      | 9        |
|           | Block Move (WORD)           | 28         | 34                                      | 9        |
|           | Block Move (REAL)           | 13         | 61                                      | 11       |
|           | Block Clear (WORD)          | 11         | 59                                      | 9        |
|           | Shift Register (BIT)        | 16         | 103                                     | 10       |
|           | Shift Register (WORD)       | 16         | 85                                      | 10       |
|           | Bit Sequencer               | 16         | 97                                      | 93       |
|           | COMMREQ                     | 13         | 1035                                    | 245      |
| Table     | Array Move (INT)            | 22         | 83                                      | 9        |
|           | Array Move(DINT)            | 22         | 71                                      | 9        |
|           | Array Move (BOOL)           | 22         | 116                                     | 9        |
|           | Array Move (BYTE)           | 22         | 77                                      | 9        |
|           | Array Move (WORD)           | 22         | 83                                      | 9        |
|           | Search Equal (INT)          | 19         | 70                                      | 9        |
|           | Search Equal (DINT)         | 22         | 62                                      | 9        |
|           | Search Equal (BYTE)         | 19         | 56                                      | 9        |
|           | Search Equal (WORD)         | 19         | 70                                      | 9        |
|           | Search Not Equal (INT)      | 19         | 61                                      | 9        |
|           | Search Not Equal (DINT)     | 22         | 71                                      | 9        |
|           | Search Not Equal (BYTE)     | 19         | 55                                      | 9        |
|           | Search Not Equal (WORD)     | 19         | 68                                      | 9        |
|           | Search Greater/Equal (INT)  | 19         | 65                                      | 9        |
|           | Search Greater/Equal (DINT) | 22         | 70                                      | 9        |
|           | Search Greater/Equal (BYTE) | 19         | 44                                      | 9        |
|           | Search Greater/Equal (WORD) | 19         | 61                                      | 9        |
|           | Search Greater Than (INT)   | 19         | 82                                      | 9        |
|           | Search Greater Than (DINT)  | 22         | 82                                      | 9        |
|           | Search Greater Than (BYTE)  | 19         | 55                                      | 9        |
|           | Search Greater Than (WORD)  | 19         | 70                                      | 9        |

|            |                          |            | Execution Time<br>(Range in $\mu$ sec.) |          |
|------------|--------------------------|------------|-----------------------------------------|----------|
|            |                          |            | 20-/40-/64-Point                        |          |
| Group      | Function                 | Size bytes | Enabled                                 | Disabled |
|            | Search Less Than (INT)   | 19         | 66                                      | 9        |
|            | Search Less Than (DINT)  | 22         | 78                                      | 9        |
|            | Search Less Than (BYTE)  | 19         | 43                                      | 9        |
|            | Search Less Than (WORD)  | 19         | 64                                      | 9        |
|            | Search Less/Equal (INT)  | 19         | 64                                      | 9        |
|            | Search Less/Equal (DINT) | 22         | 60                                      | 9        |
|            | Search Less/Equal (BYTE) | 19         | 56                                      | 9        |
|            | Search Less/Equal (WORD) | 19         | 64                                      | 9        |
| Conversion | Convert INT to REAL      | 10         | 53                                      | 9        |
|            | Convert REAL to INT      | 13         | 766                                     | 9        |
|            | Convert DINT to REAL     | 13         | 45                                      | 9        |
|            | Convert REAL to DINT     | 13         | 757                                     | 9        |
|            | Convert WORD to REAL     | 10         | 35                                      | 9        |
|            | Convert REAL to WORD     | 13         | 757                                     | 9        |
|            | Convert BDC to INT       | 10         | 40                                      | 9        |
|            | Convert INT to BCD       | 10         | 109                                     | 9        |
|            | Convert BCD to REAL      | 10         | 47                                      | 9        |
|            | Truncate to INT          | 13         | 175                                     | 9        |
|            | Truncate to DINT         | 13         | 156                                     | 9        |
| Control    | Call a Subroutine        | 7          | 36                                      | 7        |
|            | Do I/O                   | 13         | 275                                     | 9        |
|            | Service Request #6       | 10         | 90                                      | 9        |
|            | Service Request #7 Read  | 10         | 426                                     | 9        |
|            | Service Request #7 Write | 10         | 1012                                    | 9        |
|            | Service Request #9       | 10         | 145                                     | 9        |
|            | Service Request #14      | 10         | 315                                     | 9        |
|            | Service Request #15      | 10         | 25                                      | 9        |
|            | Service Request #16      | 10         | 162                                     | 9        |
|            | Service Request #18      | 10         | 81                                      | 9        |
|            | Service Request #23      | 10         | 316                                     | 9        |
|            | Service Request #26, #30 | 10         | 510                                     | 9        |
|            | Service Request #29      | 10         | 92                                      | 9        |
|            | Service Request #34      | 10         | 11                                      | 9        |
|            | Service Request #35      | 10         | 19                                      | 17       |
|            | Service Request #52      | 10         | 420                                     | 9        |
|            | Service Request #53      | 10         | 1082                                    | 9        |

|               |                             |            | Execution Time<br>(Range in $\mu$ sec.) |          |
|---------------|-----------------------------|------------|-----------------------------------------|----------|
|               |                             |            | 20-/40-/64-Point                        |          |
| Group         | Function                    | Size bytes | Enabled                                 | Disabled |
|               | Nested MCR/ENDMCR           | 4          | 5                                       | 5        |
|               | PID-ISA Algorithm           | 16         | 236                                     | 59       |
|               | PID-IND Algorithm           | 16         | 236                                     | 59       |
| Communication | MODBUS_TCP_RW <sup>21</sup> | 41         | 214                                     | 40       |

## A-4 Typical Execution Times for Release 3.8 CPUs

The following table details function block timing for Release 3.8, Micro PLCs.

For each instance of a function block, the table shows typical execution times when the function block is enabled (receiving power flow) or disabled (not receiving power flow).

|          |                        |            | Execution Time (Range in $\mu$ sec.)<br>per PLC Type |          |
|----------|------------------------|------------|------------------------------------------------------|----------|
|          |                        |            | 20-/40-/64-Point                                     |          |
| Group    | Function               | Size bytes | Enabled                                              | Disabled |
| Timers   | Off Delay Timer        | 15         | 68-76                                                | 49-56    |
|          | On Delay Timer         | 15         | 70-78                                                | 55-62    |
|          | Elapsed Timer          | 15         | 69-74                                                | 36-42    |
| Counters | Up Counter             | 13         | 44-51                                                | 40-47    |
|          | Down Counter           | 13         | 64-71                                                | 62-69    |
| Math     | Addition (INT)         | 13         | 33-38                                                | 4-10     |
|          | Addition (DINT)        | 19         | 45-51                                                | 4-10     |
|          | Addition (REAL)        | 17         | 134-139                                              | 4-10     |
|          | Subtraction (INT)      | 13         | 24-29                                                | 3-8      |
|          | Subtraction (DINT)     | 19         | 29-34                                                | 3-8      |
|          | Subtraction (REAL)     | 17         | 104-109                                              | 3-8      |
|          | Multiplication (INT)   | 13         | 37-42                                                | 4-10     |
|          | Multiplication (DINT)  | 13         | 28-33                                                | 4-10     |
|          | Multiplication (REAL)  | 17         | 134-139                                              | 4-10     |
|          | Division (INT)         | 13         | 54-59                                                | 4-10     |
|          | Division (DINT)        | 19         | 42-47                                                | 5-10     |
|          | Division (REAL)        | 17         | 220-225                                              | 5-10     |
|          | Modulo Division (INT)  | 13         | 45-50                                                | 5-10     |
|          | Modulo Division (DINT) | 19         | 54-60                                                | 5-10     |
|          | Square Root (INT)      | 10         | 29-34                                                | 3-8      |
|          | Square Root (DINT)     | 13         | 34-39                                                | 3-8      |

<sup>21</sup> For the MODBUS\_TCP\_RW function block, time between Execute ON to busy ON is 720  $\mu$ Sec.

|               |                           |            | Execution Time (Range in $\mu$ sec.)<br>per PLC Type |          |
|---------------|---------------------------|------------|------------------------------------------------------|----------|
|               |                           |            | 20-/40-/64-Point                                     |          |
| Group         | Function                  | Size bytes | Enabled                                              | Disabled |
|               | Square Root (REAL)        | 11         | 453-459                                              | 3-8      |
| Trigonometric | SIN (REAL)                | 11         | 1142-1148                                            | 3-8      |
|               | COS (REAL)                | 11         | 1328-1333                                            | 4-10     |
|               | TAN (REAL)                | 11         | 1633-1639                                            | 3-8      |
|               | ASIN (REAL)               | 11         | 1633-1639                                            | 5-10     |
|               | ACOS (REAL)               | 11         | 1633-1639                                            | 4-10     |
|               | ATAN (REAL)               | 11         | 850-856                                              | 4-10     |
| Logarithmic   | LOG (REAL)                | 11         | 889-894                                              | 5-10     |
|               | LN (REAL)                 | 11         | 820-825                                              | 4-10     |
| Exponential   | Power of e                | 11         | 618-623                                              | 4-10     |
|               | Power of X                | 11         | 339-344                                              | 4-10     |
| Radian Conv   | Convert RAD to DEG        | 11         | 347-353                                              | 5-10     |
|               | Convert DEG to RAD        | 17         | 78-84                                                | 4-10     |
| Relational    | Equal (INT)               | 10         | 25-30                                                | 4-10     |
|               | Equal (DINT)              | 16         | 19-25                                                | 4-10     |
|               | Equal (REAL)              | 14         | 36-41                                                | 4-10     |
|               | Not Equal (INT)           | 10         | 17-22                                                | 4-10     |
|               | Not Equal (DINT)          | 16         | 33-38                                                | 5-10     |
|               | Not Equal (REAL)          | 14         | 45-51                                                | 4-10     |
|               | Greater Than (INT)        | 10         | 28-33                                                | 4-10     |
|               | Greater Than (DINT)       | 16         | 22-27                                                | 4-10     |
|               | Greater Than (REAL)       | 14         | 48-53                                                | 4-10     |
|               | Greater Than/Equal (INT)  | 10         | 17-22                                                | 4-10     |
|               | Greater Than/Equal (DINT) | 16         | 19-24                                                | 5-10     |
|               | Greater Than/Equal (REAL) | 14         | 37-42                                                | 4-10     |
|               | Less Than (INT)           | 10         | 17-22                                                | 4-10     |
|               | Less Than (DINT)          | 16         | 19-24                                                | 4-10     |
|               | Less Than (REAL)          | 14         | 37-42                                                | 4-10     |
|               | Less Than/Equal (INT)     | 10         | 17-22                                                | 4-10     |
|               | Less Than/Equal (DINT)    | 16         | 19-24                                                | 4-10     |
|               | Less Than/Equal (REAL)    | 14         | 37-42                                                | 5-10     |
|               | Range (INT)               | 13         | 21-26                                                | 4-10     |
|               | Range (DINT)              | 22         | 23-29                                                | 4-10     |
|               | Range (WORD)              | 13         | 21-26                                                | 5-10     |
| Bit Operation | Logical AND               | 13         | 33-38                                                | 4-10     |
|               | Logical OR                | 13         | 34-39                                                | 4-10     |

|           |                         |            | Execution Time (Range in $\mu$ sec.)<br>per PLC Type |          |
|-----------|-------------------------|------------|------------------------------------------------------|----------|
|           |                         |            | 20-/40-/64-Point                                     |          |
| Group     | Function                | Size bytes | Enabled                                              | Disabled |
|           | Logical Exclusive OR    | 13         | 28-33                                                | 3-8      |
|           | Logical Invert, NOT     | 10         | 29-35                                                | 4-10     |
|           | Shift Bit Left          | 16         | 158-164                                              | 4-10     |
|           | Shift Bit Right         | 16         | 102-108                                              | 4-10     |
|           | Rotate Bit Left         | 16         | 98-103                                               | 5-10     |
|           | Rotate Bit Right        | 16         | 88-93                                                | 5-10     |
|           | Bit Position            | 13         | 48-53                                                | 4-10     |
|           | Bit Clear               | 13         | 51-56                                                | 4-10     |
|           | Bit Test                | 13         | 32-37                                                | 4-10     |
|           | Bit Set                 | 13         | 43-48                                                | 4-10     |
|           | Mask Compare (WORD)     | 25         | 122-127                                              | 4-9      |
|           | Mask Compare (DWORD)    | 25         | 97-102                                               | 4-10     |
| Data Move | Move (INT)              | 10         | 22-27                                                | 5-10     |
|           | Move (BOOL)             | 13         | 53-58                                                | 4-10     |
|           | Move (WORD)             | 10         | 22-27                                                | 4-10     |
|           | Move (REAL)             | 13         | 31-37                                                | 5-10     |
|           | Block Move (INT)        | 28         | 28-34                                                | 5-10     |
|           | Block Move (WORD)       | 28         | 28-34                                                | 4-10     |
|           | Block Move (REAL)       | 13         | 51-57                                                | 4-10     |
|           | Block Clear (WORD)      | 11         | 47-52                                                | 4-10     |
|           | Shift Register (BIT)    | 16         | 89-94                                                | 4-10     |
|           | Shift Register (WORD)   | 16         | 63-69                                                | 4-10     |
|           | Bit Sequencer           | 16         | 82-91                                                | 78-87    |
|           | COMMREQ                 | 13         | 845                                                  | 210-215  |
| Table     | Array Move (INT)        | 22         | 74-79                                                | 4-10     |
|           | Array Move(DINT)        | 22         | 65-71                                                | 4-10     |
|           | Array Move (BOOL)       | 22         | 105-110                                              | 4-10     |
|           | Array Move (BYTE)       | 22         | 68-74                                                | 4-10     |
|           | Array Move (WORD)       | 22         | 73-79                                                | 5-10     |
|           | Search Equal (INT)      | 19         | 60-66                                                | 5-10     |
|           | Search Equal (DINT)     | 22         | 61-67                                                | 5-10     |
|           | Search Equal (BYTE)     | 19         | 43-48                                                | 5-10     |
|           | Search Equal (WORD)     | 19         | 62-67                                                | 5-10     |
|           | Search Not Equal (INT)  | 19         | 45-50                                                | 3-8      |
|           | Search Not Equal (DINT) | 22         | 52-58                                                | 3-8      |
|           | Search Not Equal (BYTE) | 19         | 29-35                                                | 3-8      |
|           | Search Not Equal (WORD) | 19         | 45-51                                                | 3-8      |

|            |                             |            | Execution Time (Range in $\mu$ sec.)<br>per PLC Type |          |
|------------|-----------------------------|------------|------------------------------------------------------|----------|
|            |                             |            | 20-/40-/64-Point                                     |          |
| Group      | Function                    | Size bytes | Enabled                                              | Disabled |
|            | Search Greater/Equal (INT)  | 19         | 49-54                                                | 5-10     |
|            | Search Greater/Equal (DINT) | 22         | 51-56                                                | 5-10     |
|            | Search Greater/Equal (BYTE) | 19         | 48-53                                                | 5-10     |
|            | Search Greater/Equal (WORD) | 19         | 58-63                                                | 5-10     |
|            | Search Greater Than (INT)   | 19         | 51-57                                                | 3-8      |
|            | Search Greater Than (DINT)  | 22         | 54-59                                                | 3-8      |
|            | Search Greater Than (BYTE)  | 19         | 45-50                                                | 3-8      |
|            | Search Greater Than (WORD)  | 19         | 45-50                                                | 3-8      |
|            | Search Less Than (INT)      | 19         | 42-47                                                | 3-8      |
|            | Search Less Than (DINT)     | 22         | 51-57                                                | 3-8      |
|            | Search Less Than (BYTE)     | 19         | 43-49                                                | 3-8      |
|            | Search Less Than (WORD)     | 19         | 57-63                                                | 3-8      |
|            | Search Less/Equal (INT)     | 19         | 53-58                                                | 3-8      |
|            | Search Less/Equal (DINT)    | 22         | 55-60                                                | 3-8      |
|            | Search Less/Equal (BYTE)    | 19         | 42-47                                                | 3-8      |
|            | Search Less/Equal (WORD)    | 19         | 44-49                                                | 3-8      |
| Conversion | Convert INT to REAL         | 10         | 33-39                                                | 4-10     |
|            | Convert REAL to INT         | 13         | 723-729                                              | 4-10     |
|            | Convert DINT to REAL        | 13         | 29-34                                                | 4-10     |
|            | Convert REAL to DINT        | 13         | 741-747                                              | 5-10     |
|            | Convert WORD to REAL        | 10         | 38-43                                                | 4-10     |
|            | Convert REAL to WORD        | 13         | 728-733                                              | 4-10     |
|            | Convert BCD to INT          | 10         | 51-56                                                | 4-10     |
|            | Convert INT to BCD          | 10         | 107-112                                              | 4-10     |
|            | Convert BCD to REAL         | 10         | 51-56                                                | 4-10     |
|            | Truncate to INT             | 13         | 149-155                                              | 3-8      |
|            | Truncate to DINT            | 13         | 142-147                                              | 3-8      |
| Control    | Call a Subroutine           | 7          | 31-36                                                | 2-7      |
|            | Do I/O                      | 13         | 248-253                                              | 5-10     |
|            | Service Request #6          | 10         | 51-56                                                | 3-8      |

|       |                          |            | Execution Time (Range in $\mu$ sec.)<br>per PLC Type |          |
|-------|--------------------------|------------|------------------------------------------------------|----------|
|       |                          |            | 20-/40-/64-Point                                     |          |
| Group | Function                 | Size bytes | Enabled                                              | Disabled |
|       | Service Request #7 Read  | 10         | 296-301                                              | 3-9      |
|       | Service Request #7 Write | 10         | 1372-1378                                            | 1-5      |
|       | Service Request #9       | 10         | 82-88                                                | 3-8      |
|       | Service Request #14      | 10         | 245-251                                              | 3-8      |
|       | Service Request #15      | 10         | 146-151                                              | 3-8      |
|       | Service Request #16      | 10         | 71-77                                                | 3-8      |
|       | Service Request #18      | 10         | 65-70                                                | 3-8      |
|       | Service Request #23      | 10         | 212-217                                              | 3-8      |
|       | Service Request #26, #30 | 10         | 323-328                                              | 3-8      |
|       | Service Request #29      | 10         | 39-44                                                | 3-8      |
|       | Service Request #34      | 10         | n/a                                                  | n/a      |
|       | Service Request #35      | 10         | n/a                                                  | n/a      |
|       | Service Request #52      | 10         | 364-369                                              | 3-8      |
|       | Service Request #53      | 10         | 1012-1016                                            | 9        |
|       | Nested MCR/ENDMCR        | 4          | 4                                                    | 4        |
|       | PID-ISA Algorithm        | 16         | 213-221                                              | 46-54    |
|       | PID-IND Algorithm        | 16         | 217-219                                              | 52-53    |



## A-5 Typical Execution Times for Release 3.0 CPUs

The following table details function block timing for Release 3.0, Micro PLCs.

For each instance of a function block, the table shows typical execution times when the function block is enabled (receiving power flow) or disabled (not receiving power flow).

| Group         | Function               | Size bytes | Execution Time (Range in $\mu$ sec.) per PLC Type |          |               |          |            |          |           |          |
|---------------|------------------------|------------|---------------------------------------------------|----------|---------------|----------|------------|----------|-----------|----------|
|               |                        |            | 64-Point                                          |          | 14-/23-/28-pt |          | 28-pt ESCP |          | Nano      |          |
|               |                        |            | Enabled                                           | Disabled | Enabled       | Disabled | Enabled    | Disabled | Enabled   | Disabled |
| Timers        | Off Delay Timer        | 15         | 68-76                                             | 49-56    | 64-71         | 35-41    | 55-60      | 31-36    | 61-67     | 33-38    |
|               | On Delay Timer         | 15         | 70-78                                             | 55-62    | 79-85         | 43-49    | 63-69      | 37-42    | 71-76     | 40-45    |
|               | Elapsed Timer          | 15         | 69-74                                             | 36-42    | 66-71         | 53-58    | 49-53      | 39-43    | 60-64     | 49-53    |
| Counters      | Up Counter             | 13         | 44-51                                             | 40-47    | 57-63         | 54-61    | 41-46      | 39-45    | 53-59     | 50-55    |
|               | Down Counter           | 13         | 64-71                                             | 62-69    | 48-55         | 47-53    | 41-47      | 39-45    | 42-48     | 40-46    |
| Math          | Addition (INT)         | 13         | 33-38                                             | 4-10     | 30-35         | 4-9      | 27-31      | 4-8      | 28-33     | 4-8      |
|               | Addition (DINT)        | 19         | 45-51                                             | 4-10     | 41-47         | 4-9      | 35-39      | 4-8      | 38-43     | 4-8      |
|               | Addition (REAL)        | 17         | 134-139                                           | 4-10     | 109-114       | 4-9      | 87-91      | 4-8      | 114-119   | 4-8      |
|               | Subtraction (INT)      | 13         | 24-29                                             | 3-8      | 26-31         | 4-9      | 21-25      | 3-7      | 24-29     | 4-8      |
|               | Subtraction (DINT)     | 19         | 29-34                                             | 3-8      | 31-36         | 4-9      | 24-28      | 3-7      | 29-33     | 4-8      |
|               | Subtraction (REAL)     | 17         | 104-109                                           | 3-8      | 125-130       | 4-9      | 88-91      | 3-7      | 113-117   | 4-8      |
|               | Multiplication (INT)   | 13         | 37-42                                             | 4-10     | 34-39         | 4-9      | 30-34      | 4-8      | 31-36     | 4-8      |
|               | Multiplication (DINT)  | 13         | 28-33                                             | 4-10     | 25-30         | 4-9      | 23-27      | 4-8      | 23-27     | 4-8      |
|               | Multiplication (REAL)  | 17         | 134-139                                           | 4-10     | 126-131       | 4-9      | 101-104    | 4-8      | 106-110   | 4-8      |
|               | Division (INT)         | 13         | 54-59                                             | 4-10     | 43-48         | 4-9      | 37-41      | 4-8      | 44-49     | 4-8      |
|               | Division (DINT)        | 19         | 42-47                                             | 5-10     | 27-32         | 4-9      | 25-28      | 4-8      | 37-42     | 4-8      |
|               | Division (REAL)        | 17         | 220-225                                           | 5-10     | 206-211       | 4-9      | 165-169    | 4-8      | 184-188   | 4-8      |
|               | Modulo Division (INT)  | 13         | 45-50                                             | 5-10     | 43-49         | 4-9      | 38-42      | 4-8      | 45-50     | 4-8      |
|               | Modulo Division (DINT) | 19         | 54-60                                             | 5-10     | 41-46         | 4-9      | 36-39      | 4-8      | 49-53     | 4-8      |
|               | Square Root (INT)      | 10         | 29-34                                             | 3-8      | 32-37         | 4-9      | 24-28      | 3-7      | 29-34     | 4-8      |
|               | Square Root (DINT)     | 13         | 34-39                                             | 3-8      | 36-42         | 4-9      | 30-34      | 3-7      | 34-39     | 4-8      |
|               | Square Root (REAL)     | 11         | 453-459                                           | 3-8      | 498-504       | 4-9      | 336-340    | 3-7      | 449-454   | 4-8      |
| Trigonometric | SIN (REAL)             | 11         | 1142-1148                                         | 3-8      | 1246-1251     | 4-9      | 869-873    | 3-7      | 1131-1135 | 4-8      |
|               | COS (REAL)             | 11         | 1328-1333                                         | 4-10     | 1212-1217     | 4-9      | 964-967    | 4-8      | 1088-1092 | 4-8      |
|               | TAN (REAL)             | 11         | 1633-1639                                         | 3-8      | 1634-1639     | 4-9      | 1290-1293  | 3-7      | 1634-1639 | 4-8      |
|               | ASIN (REAL)            | 11         | 1633-1639                                         | 5-10     | 1634-1639     | 4-9      | 1383-1387  | 4-8      | 1581-1586 | 4-8      |
|               | ACOS (REAL)            | 11         | 1633-1639                                         | 4-10     | 1634-1639     | 4-9      | 1354-1358  | 4-8      | 1537-1542 | 4-8      |
|               | ATAN (REAL)            | 11         | 850-856                                           | 4-10     | 782-788       | 4-9      | 616-620    | 4-8      | 704-709   | 4-8      |
|               | LOG (REAL)             | 11         | 889-894                                           | 5-10     | 826-831       | 4-9      | 650-654    | 4-8      | 744-749   | 4-8      |

| Group         | Function                  | Size bytes | Execution Time (Range in $\mu$ sec.) per PLC Type |          |               |          |            |          |         |          |
|---------------|---------------------------|------------|---------------------------------------------------|----------|---------------|----------|------------|----------|---------|----------|
|               |                           |            | 64-Point                                          |          | 14-/23-/28-pt |          | 28-pt ESCP |          | Nano    |          |
|               |                           |            | Enabled                                           | Disabled | Enabled       | Disabled | Enabled    | Disabled | Enabled | Disabled |
| Logarithmic   | LN (REAL)                 | 11         | 820-825                                           | 4-10     | 757-762       | 4-9      | 597-600    | 4-8      | 690-694 | 4-8      |
|               |                           |            |                                                   |          |               |          |            |          |         |          |
| Exponential   | Power of e                | 11         | 618-623                                           | 4-10     | 562-568       | 4-9      | 442-446    | 4-8      | 512-517 | 4-8      |
|               | Power of X                | 11         | 339-344                                           | 4-10     | 327-332       | 4-9      | 254-258    | 4-8      | 294-299 | 4-8      |
| Radian Conv   | Convert RAD to DEG        | 11         | 347-353                                           | 5-10     | 319-324       | 4-9      | 252-256    | 34-38    | 295-300 | 4-8      |
|               | Convert DEG to RAD        | 17         | 78-84                                             | 4-10     | 78-83         | 4-9      | 63-67      | 4-8      | 75-79   | 4-8      |
| Relational    | Equal (INT)               | 10         | 25-30                                             | 4-10     | 22-28         | 4-9      | 20-24      | 4-8      | 21-26   | 4-8      |
|               | Equal (DINT)              | 16         | 19-25                                             | 4-10     | 18-23         | 4-9      | 17-20      | 4-8      | 16-21   | 4-8      |
|               | Equal (REAL)              | 14         | 36-41                                             | 4-10     | 31-36         | 4-9      | 27-31      | 4-8      | 34-39   | 4-8      |
|               | Not Equal (INT)           | 10         | 17-22                                             | 4-10     | 15-21         | 4-9      | 15-18      | 4-8      | 14-19   | 4-8      |
|               | Not Equal (DINT)          | 16         | 33-38                                             | 5-10     | 29-35         | 4-9      | 26-29      | 4-8      | 28-32   | 4-8      |
|               | Not Equal (REAL)          | 14         | 45-51                                             | 4-10     | 35-40         | 4-9      | 30-34      | 4-8      | 35-39   | 4-8      |
|               | Greater Than (INT)        | 10         | 28-33                                             | 4-10     | 26-31         | 4-9      | 22-26      | 4-8      | 24-29   | 4-8      |
|               | Greater Than (DINT)       | 16         | 22-27                                             | 4-10     | 19-25         | 4-9      | 18-21      | 4-8      | 18-23   | 4-8      |
|               | Greater Than (REAL)       | 14         | 48-53                                             | 4-10     | 34-39         | 4-9      | 30-33      | 4-8      | 32-37   | 4-8      |
|               | Greater Than/Equal (INT)  | 10         | 17-22                                             | 4-10     | 16-21         | 4-9      | 14-18      | 4-8      | 15-19   | 4-8      |
|               | Greater Than/Equal (DINT) | 16         | 19-24                                             | 5-10     | 17-23         | 4-9      | 16-20      | 4-8      | 16-20   | 4-8      |
|               | Greater Than/Equal (REAL) | 14         | 37-42                                             | 4-10     | 34-39         | 4-9      | 29-33      | 4-8      | 21-26   | 4-8      |
|               | Less Than (INT)           | 10         | 17-22                                             | 4-10     | 15-21         | 4-9      | 14-18      | 4-8      | 14-19   | 4-8      |
|               | Less Than (DINT)          | 16         | 19-24                                             | 4-10     | 17-22         | 4-9      | 16-20      | 4-8      | 16-20   | 4-8      |
|               | Less Than (REAL)          | 14         | 37-42                                             | 4-10     | 23-29         | 4-9      | 22-25      | 4-8      | 22-26   | 4-8      |
|               | Less Than/Equal (INT)     | 10         | 17-22                                             | 4-10     | 15-21         | 4-9      | 15-19      | 4-8      | 15-19   | 4-8      |
|               | Less Than/Equal (DINT)    | 16         | 19-24                                             | 4-10     | 17-22         | 4-9      | 16-20      | 4-8      | 16-20   | 4-8      |
|               | Less Than/Equal (REAL)    | 14         | 37-42                                             | 5-10     | 24-29         | 4-9      | 22-25      | 4-8      | 22-26   | 4-8      |
|               | Range (INT)               | 13         | 21-26                                             | 4-10     | 19-25         | 4-9      | 18-22      | 4-8      | 18-22   | 4-8      |
|               | Range (DINT)              | 22         | 23-29                                             | 4-10     | 21-27         | 4-9      | 20-24      | 4-8      | 20-24   | 4-8      |
|               | Range (WORD)              | 13         | 21-26                                             | 5-10     | 19-24         | 4-9      | 18-21      | 4-8      | 18-23   | 4-8      |
| Bit Operation | Logical AND               | 13         | 33-38                                             | 4-10     | 31-36         | 4-9      | 27-31      | 4-8      | 28-32   | 4-8      |
|               | Logical OR                | 13         | 34-39                                             | 4-10     | 30-35         | 4-9      | 27-31      | 4-8      | 28-32   | 4-8      |
|               | Logical Exclusive OR      | 13         | 28-33                                             | 3-8      | 30-35         | 4-9      | 23-27      | 3-7      | 28-33   | 4-8      |
|               | Logical Invert, NOT       | 10         | 29-35                                             | 4-10     | 27-32         | 4-9      | 24-27      | 4-8      | 25-29   | 4-8      |
|               | Shift Bit Left            | 16         | 158-164                                           | 4-10     | 118-123       | 5-10     | 127-131    | 4-8      | 161-166 | 5-9      |
|               | Shift Bit Right           | 16         | 102-108                                           | 4-10     | 113-118       | 5-10     | 80-84      | 4-8      | 103-107 | 5-9      |
|               | Rotate Bit Left           | 16         | 98-103                                            | 5-10     | 84-89         | 4-9      | 67-71      | 4-8      | 76-81   | 4-8      |
|               | Rotate Bit Right          | 16         | 88-93                                             | 5-10     | 88-93         | 4-9      | 71-75      | 4-8      | 80-84   | 4-8      |
|               | Bit Position              | 13         | 48-53                                             | 4-10     | 43-48         | 4-9      | 38-41      | 4-8      | 40-44   | 4-8      |
|               | Bit Clear                 | 13         | 51-56                                             | 4-10     | 46-52         | 4-9      | 34-38      | 3-7      | 43-47   | 4-8      |

|           |                             |            | Execution Time (Range in $\mu$ sec.) per PLC Type |          |               |          |            |          |         |          |
|-----------|-----------------------------|------------|---------------------------------------------------|----------|---------------|----------|------------|----------|---------|----------|
|           |                             |            | 64-Point                                          |          | 14-/23-/28-pt |          | 28-pt ESCP |          | Nano    |          |
| Group     | Function                    | Size bytes | Enabled                                           | Disabled | Enabled       | Disabled | Enabled    | Disabled | Enabled | Disabled |
|           | Bit Test                    | 13         | 32-37                                             | 4-10     | 29-35         | 4-9      | 26-29      | 4-8      | 27-32   | 4-8      |
|           | Bit Set                     | 13         | 43-48                                             | 4-10     | 39-44         | 4-9      | 34-38      | 4-8      | 37-41   | 4-8      |
|           | Mask Compare (WORD)         | 25         | 122-127                                           | 4-9      | 108-113       | 4-9      | 89-93      | 3-7      | 99-104  | 3-8      |
|           | Mask Compare (DWORD)        | 25         | 97-102                                            | 4-10     | 94-99         | 3-9      | 77-81      | 3-7      | 80-84   | 4-8      |
| Data Move | Move (INT)                  | 10         | 22-27                                             | 5-10     | 20-25         | 4-9      | 18-22      | 4-8      | 18-23   | 4-8      |
|           | Move (BOOL)                 | 13         | 53-58                                             | 4-10     | 49-54         | 4-9      | 42-46      | 4-8      | 45-50   | 4-8      |
|           | Move (WORD)                 | 10         | 22-27                                             | 4-10     | 20-25         | 4-9      | 18-22      | 4-8      | 18-23   | 4-8      |
|           | Move (REAL)                 | 13         | 31-37                                             | 5-10     | 28-33         | 4-9      | 26-29      | 4-8      | 26-31   | 4-8      |
|           | Block Move (INT)            | 28         | 28-34                                             | 5-10     | 26-31         | 4-9      | 24-27      | 4-8      | 24-28   | 4-8      |
|           | Block Move (WORD)           | 28         | 28-34                                             | 4-10     | 25-31         | 4-9      | 24-27      | 4-8      | 24-28   | 4-8      |
|           | Block Move (REAL)           | 13         | 51-57                                             | 4-10     | 47-52         | 4-9      | 43-47      | 4-8      | 51-55   | 10-14    |
|           | Block Clear (WORD)          | 11         | 47-52                                             | 4-10     | 43-48         | 4-9      | 38-42      | 4-8      | 40-45   | 4-8      |
|           | Shift Register (BIT)        | 16         | 89-94                                             | 4-10     | 95-100        | 5-10     | 69-72      | 4-8      | 87-92   | 5-9      |
|           | Shift Register (WORD)       | 16         | 63-69                                             | 4-10     | 73-78         | 5-10     | 54-58      | 4-8      | 67-71   | 5-9      |
|           | Bit Sequencer               | 16         | 82-91                                             | 78-87    | 71-79         | 67-75    | 59-65      | 56-62    | 73-81   | 70-77    |
|           | COMMREQ                     | 13         | 82-87                                             | 16-21    | 75-80         | 12-17    | 62-66      | 11-15    | 65-70   | 16-21    |
| Table     | Array Move (INT)            | 22         | 74-79                                             | 4-10     | 67-72         | 4-9      | 58-61      | 4-8      | 62-66   | 4-8      |
|           | Array Move (DINT)           | 22         | 65-71                                             | 4-10     | 60-65         | 4-9      | 52-56      | 4-8      | 54-58   | 4-8      |
|           | Array Move (BOOL)           | 22         | 105-110                                           | 4-10     | 90-95         | 4-9      | 75-79      | 4-8      | 83-87   | 4-8      |
|           | Array Move (BYTE)           | 22         | 68-74                                             | 4-10     | 63-68         | 4-9      | 54-58      | 4-8      | 58-62   | 4-8      |
|           | Array Move (WORD)           | 22         | 73-79                                             | 5-10     | 66-72         | 4-9      | 58-61      | 4-8      | 62-66   | 4-8      |
|           | Search Equal (INT)          | 19         | 60-66                                             | 5-10     | 58-63         | 4-9      | 49-53      | 4-8      | 53-58   | 4-8      |
|           | Search Equal (DINT)         | 22         | 61-67                                             | 5-10     | 53-58         | 4-9      | 45-49      | 4-8      | 48-52   | 4-8      |
|           | Search Equal (BYTE)         | 19         | 43-48                                             | 5-10     | 49-54         | 4-9      | 42-46      | 4-8      | 45-50   | 4-8      |
|           | Search Equal (WORD)         | 19         | 62-67                                             | 5-10     | 58-63         | 4-9      | 49-53      | 4-8      | 54-58   | 4-8      |
|           | Search Not Equal (INT)      | 19         | 45-50                                             | 3-8      | 59-64         | 4-9      | 44-48      | 3-7      | 54-59   | 4-8      |
|           | Search Not Equal (DINT)     | 22         | 52-58                                             | 3-8      | 52-57         | 4-9      | 41-44      | 3-7      | 48-53   | 4-8      |
|           | Search Not Equal (BYTE)     | 19         | 29-35                                             | 3-8      | 41-46         | 4-9      | 31-35      | 3-7      | 38-43   | 4-8      |
|           | Search Not Equal (WORD)     | 19         | 45-51                                             | 3-8      | 59-64         | 4-9      | 44-48      | 3-7      | 54-59   | 4-8      |
|           | Search Greater/Equal (INT)  | 19         | 49-54                                             | 5-10     | 53-58         | 4-9      | 40-44      | 3-7      | 49-54   | 4-8      |
|           | Search Greater/Equal (DINT) | 22         | 51-56                                             | 5-10     | 54-59         | 4-9      | 40-44      | 3-7      | 51-55   | 4-8      |
|           | Search Greater/Equal (BYTE) | 19         | 48-53                                             | 5-10     | 38-43         | 4-9      | 30-34      | 3-7      | 34-39   | 4-8      |

|            |                             |            | Execution Time (Range in $\mu$ sec.) per PLC Type |          |               |          |            |          |         |          |
|------------|-----------------------------|------------|---------------------------------------------------|----------|---------------|----------|------------|----------|---------|----------|
|            |                             |            | 64-Point                                          |          | 14-/23-/28-pt |          | 28-pt ESCP |          | Nano    |          |
| Group      | Function                    | Size bytes | Enabled                                           | Disabled | Enabled       | Disabled | Enabled    | Disabled | Enabled | Disabled |
|            | Search Greater/Equal (WORD) | 19         | 58-63                                             | 5-10     | 50-55         | 4-9      | 38-42      | 3-7      | 46-50   | 4-8      |
|            | Search Greater Than (INT)   | 19         | 51-57                                             | 3-8      | 55-60         | 4-9      | 42-46      | 3-7      | 51-56   | 4-8      |
|            | Search Greater Than (DINT)  | 22         | 54-59                                             | 3-8      | 49-54         | 4-9      | 38-41      | 3-7      | 46-51   | 4-8      |
|            | Search Greater Than (BYTE)  | 19         | 45-50                                             | 3-8      | 47-52         | 4-9      | 36-40      | 3-7      | 44-48   | 4-8      |
|            | Search Greater Than (WORD)  | 19         | 45-50                                             | 3-8      | 49-54         | 4-9      | 38-42      | 3-7      | 46-51   | 4-8      |
|            | Search Less Than (INT)      | 19         | 42-47                                             | 3-8      | 57-62         | 4-9      | 42-46      | 3-7      | 53-57   | 4-8      |
|            | Search Less Than (DINT)     | 22         | 51-57                                             | 3-8      | 66-72         | 4-9      | 49-53      | 3-7      | 61-66   | 4-8      |
|            | Search Less Than (BYTE)     | 19         | 43-49                                             | 3-8      | 38-43         | 4-9      | 30-33      | 3-7      | 36-40   | 4-8      |
|            | Search Less Than (WORD)     | 19         | 57-63                                             | 3-8      | 55-60         | 4-9      | 41-45      | 3-7      | 50-54   | 4-8      |
|            | Search Less/Equal (INT)     | 19         | 53-58                                             | 3-8      | 55-60         | 4-9      | 41-45      | 3-7      | 52-56   | 4-8      |
|            | Search Less/Equal (DINT)    | 22         | 55-60                                             | 3-8      | 58-63         | 4-9      | 43-46      | 3-7      | 54-58   | 4-8      |
|            | Search Less/Equal (BYTE)    | 19         | 42-47                                             | 3-8      | 32-37         | 4-9      | 25-29      | 3-7      | 30-34   | 4-8      |
|            | Search Less/Equal (WORD)    | 19         | 44-49                                             | 3-8      | 42-47         | 4-9      | 32-36      | 3-7      | 39-43   | 4-8      |
| Conversion | Convert INT to REAL         | 10         | 33-39                                             | 4-10     | 34-39         | 4-9      | 29-32      | 4-8      | 28-33   | 4-8      |
|            | Convert REAL to INT         | 13         | 723-729                                           | 4-10     | 683-688       | 4-9      | 543-547    | 4-8      | 629-634 | 4-8      |
|            | Convert DINT to REAL        | 13         | 29-34                                             | 4-10     | 35-41         | 4-9      | 30-34      | 4-8      | 25-29   | 4-8      |
|            | Convert REAL to DINT        | 13         | 741-747                                           | 5-10     | 671-676       | 4-9      | 532-535    | 4-8      | 610-615 | 4-8      |
|            | Convert WORD to REAL        | 10         | 38-43                                             | 4-10     | 31-36         | 4-9      | 23-27      | 3-7      | 26-30   | 4-8      |
|            | Convert REAL to WORD        | 13         | 728-733                                           | 4-10     | 666-671       | 4-9      | 529-533    | 4-8      | 612-616 | 4-8      |
|            | Convert BCD to INT          | 10         | 51-56                                             | 4-10     | 29-34         | 4-9      | 25-29      | 4-8      | 26-31   | 4-8      |
|            | Convert INT to BCD          | 10         | 107-112                                           | 4-10     | 86-91         | 4-9      | 74-78      | 4-8      | 78-82   | 4-8      |
|            | Convert BCD to REAL         | 10         | 51-56                                             | 4-10     | 37-42         | 4-9      | 31-35      | 4-8      | 47-52   | 4-8      |
|            | Truncate to INT             | 13         | 149-155                                           | 3-8      | 168-173       | 4-9      | 117-121    | 3-7      | 148-152 | 4-8      |
|            | Truncate to DINT            | 13         | 142-147                                           | 3-8      | 161-166       | 4-9      | 113-117    | 3-7      | 141-145 | 4-8      |
| Control    | Call a Subroutine           | 7          | 31-36                                             | 2-7      | 28-33         | 2-7      | 26-30      | 2-6      | 25-29   | 2-6      |
|            | Do I/O                      | 13         | 248-253                                           | 5-10     | 207-212       | 4-9      | 166-170    | 4-8      | 167-171 | 4-8      |
|            | Service Request #6          | 10         | 51-56                                             | 3-8      | 59-64         | 4-9      | 43-47      | 3-7      | 53-57   | 4-8      |
|            | Service Request #7 Read     | 10         | 296-301                                           | 3-9      | 308-313       | 4-9      | 221-225    | 3-7      | 0-0     | 0-0      |

|       |                          |            | Execution Time (Range in $\mu$ sec.) per PLC Type |          |               |          |            |          |         |          |
|-------|--------------------------|------------|---------------------------------------------------|----------|---------------|----------|------------|----------|---------|----------|
|       |                          |            | 64-Point                                          |          | 14-/23-/28-pt |          | 28-pt ESCP |          | Nano    |          |
| Group | Function                 | Size bytes | Enabled                                           | Disabled | Enabled       | Disabled | Enabled    | Disabled | Enabled | Disabled |
|       | Service Request #7 Write | 10         | 1372-1378                                         | 1-5      | 281-286       | 1-6      | 194-198    | 1-4      | 0-0     | 0-0      |
|       | Service Request #9       | 10         | 82-88                                             | 3-8      | 102-107       | 4-9      | 72-76      | 3-7      | 90-95   | 4-8      |
|       | Service Request #14      | 10         | 245-251                                           | 3-8      | 258-263       | 4-9      | 208-212    | 4-8      | 104-109 | 4-8      |
|       | Service Request #15      | 10         | 146-151                                           | 3-8      | 156-161       | 4-9      | 126-130    | 4-8      | 132-136 | 4-8      |
|       | Service Request #16      | 10         | 71-77                                             | 3-8      | 91-96         | 4-9      | 74-77      | 4-8      | 71-75   | 4-8      |
|       | Service Request #18      | 10         | 65-70                                             | 3-8      | 67-72         | 4-9      | 59-63      | 4-8      | 55-59   | 4-8      |
|       | Service Request #23      | 10         | 212-217                                           | 3-8      | 236-242       | 4-9      | 173-177    | 3-7      | 207-212 | 4-8      |
|       | Service Request #26, #30 | 10         | 323-328                                           | 3-8      | 342-347       | 4-9      | 279-283    | 4-8      | 293-298 | 4-8      |
|       | Service Request #29      | 10         | 39-44                                             | 3-8      | 56-61         | 4-9      | 47-51      | 4-8      | 40-44   | 4-8      |
|       | Service Request #34      | 10         | n/a                                               | n/a      | 57-62         | 4-9      | n/a        | n/a      | n/a     | n/a      |
|       | Service Request #35      | 10         | n/a                                               | n/a      | 494-499       | 4-9      | n/a        | n/a      | n/a     | n/a      |
|       | Service Request #52      | 10         | 364-369                                           | 3-8      | 333-338       | 4-9      | 281-285    | 4-8      | n/a     | n/a      |
|       | Service Request #53      | 10         | 3-4                                               | 2-4      | 3-5           | 1-5      | 3-4        | 2-4      | 3-4     | 1-4      |
|       | Nested MCR/ENDMCR        | 4          | 213-222                                           | 46-55    | 196-204       | 42-50    | 155-162    | 37-43    | 191-198 | 50-57    |
|       | PID-ISA Algorithm        | 16         | 213-221                                           | 46-54    | 196-204       | 42-50    | 155-161    | 37-43    | 191-198 | 50-58    |
|       | PID-IND Algorithm        | 16         | 82-87                                             | 16-21    | 75-80         | 12-17    | 62-66      | 11-15    | 65-70   | 16-21    |

## A-6 Typical Execution Times for Release 2.0 CPUs

The following table details function block timing for Release 2.0, Micro PLCs and Nano PLCs. PLCs are grouped by similar types: Nano PLCs, 14/23/28 Point Micro PLCs, and 28-Point Micro PLCs with ESCP.

For each instance of a function block, the table shows typical execution times when the function block is enabled (receiving power flow) or disabled (not receiving power flow).

| Group         | Function               | Size<br>(bytes) | Execution Time (Range in $\mu\text{sec.}$ ) |               |           |                   |               |       |
|---------------|------------------------|-----------------|---------------------------------------------|---------------|-----------|-------------------|---------------|-------|
|               |                        |                 | Function Enabled                            |               |           | Function Disabled |               |       |
|               |                        |                 | 14-/23-/28-pt                               | 28-pt<br>ESCP | Nano      | 14-/23-/28-pt     | 28-pt<br>ESCP | Nano  |
| Timers        | Off Delay Timer        | 15              | 64-112                                      | 54-75         | 63-93     | 46-76             | 39-53         | 44-67 |
|               | On Delay Timer         | 15              | 63-120                                      | 66 - 79       | 61-100    | 45-83             | 40-58         | 42-71 |
|               | Elapsed Timer          | 15              | 58-114                                      | 59-75         | 56-96     | 34-75             | 40-52         | 32-66 |
| Counters      | Up Counter             | 13              | 67-69                                       | -50-53        | 89-136    | 63-64             | 48-48         | 47-74 |
|               | Down Counter           | 13              | 47-82                                       | 57-63         | 43-79     | 39-77             | 50-60         | 37-75 |
| Math          | Addition (INT)         | 13              | 30-63                                       | 27-45         | 28-55     | 6-10              | 5-8           | 6-10  |
|               | Addition (DINT)        | 19              | 41-57                                       | 35-43         | 38-54     | 6-10              | 5-8           | 6-10  |
|               | Addition (REAL)        | 17              | 89-121                                      | -77-91        | 87-118    | 6-10              | 5-8           | 6-10  |
|               | Subtraction (INT)      | 13              | 26-62                                       | 24-45         | 26-55     | 6-10              | 5-8           | 6-10  |
|               | Subtraction (DINT)     | 19              | 36-57                                       | 27-44         | 30-53     | 6-10              | 5-8           | 6-10  |
|               | Subtraction (REAL)     | 17              | 96-112                                      | -83-90        | 100-117   | 6-10              | 5-8           | 6-9   |
|               | Multiplication (INT)   | 13              | 34-66                                       | 30-47         | 31-57     | 6-10              | 5-8           | 6-10  |
|               | Multiplication (DINT)  | 13              | 25-56                                       | 23-44         | 24-53     | 6-10              | 5-8           | 6-10  |
|               | Multiplication (REAL)  | 17              | 106-149                                     | 97-114        | 109-141   | 6-10              | 5-8           | 6-10  |
|               | Division (INT)         | 13              | 42-77                                       | 34-55         | 39-67     | 6-10              | 5-8           | 6-10  |
|               | Division (DINT)        | 19              | 27-65                                       | 28-50         | 26-61     | 6-10              | 5-8           | 6-10  |
|               | Division (REAL)        | 17              | 187-241                                     | 152-186       | 179-229   | 6-10              | 5-8           | 6-10  |
|               | Modulo Division (INT)  | 13              | 46-86                                       | 38-61         | 40-75     | 6-10              | 5-8           | 6-10  |
|               | Modulo Division (DINT) | 19              | 41-72                                       | 38-55         | 38-68     | 6-10              | 5-8           | 6-10  |
|               | Square Root (INT)      | 10              | 43-82                                       | 38-64         | 41-79     | 6-9               | 5-8           | 6-10  |
|               | Square Root (DINT)     | 13              | 51-83                                       | 34-77         | 34-96     | 6-10              | 5-8           | 5-10  |
|               | Square Root (REAL)     | 11              | 437-534                                     | 351-406       | 420-506   | 6-10              | 5-8           | 6-10  |
| Trigonometric | SIN (REAL)             | 11              | 1103-1523                                   | 919-1156      | 1064-1446 | 6-10              | 5-8           | 6-10  |
|               | COS (REAL)             | 11              | 1091-1519                                   | 908-1192      | 1048-1444 | 6-10              | 5-8           | 5-9   |
|               | TAN (REAL)             | 11              | 1691-2256                                   | 1370-1708     | 1622-2144 | 8-12              | 5-9           | 7-10  |
|               | ASIN (REAL)            | 11              | 1528-1638                                   | 1274-1479     | 1507-1639 | 6-10              | 5-8           | 6-10  |
|               | ACOS (REAL)            | 11              | 1528-1639                                   | 1220-1442     | 1507-1638 | 6-10              | 5-8           | 6-9   |
|               | ATAN (REAL)            | 11              | 695-867                                     | 564-671       | 678-822   | 6-10              | 5-8           | 6-10  |

| Group         | Function                  | Size<br>(bytes) | Execution Time (Range in $\mu$ sec.) |               |         |                   |               |      |
|---------------|---------------------------|-----------------|--------------------------------------|---------------|---------|-------------------|---------------|------|
|               |                           |                 | Function Enabled                     |               |         | Function Disabled |               |      |
|               |                           |                 | 14-/23-/<br>28-pt                    | 28-pt<br>ESCP | Nano    | 14-/23-<br>/28-pt | 28-pt<br>ESCP | Nano |
| Logarithmic   | LOG (REAL)                | 11              | 734-926                              | 599-710       | 709-878 | 6-10              | 5-8           | 6-10 |
|               | LN (REAL)                 | 11              | 672-866                              | 555-659       | 646-821 | 6-10              | 5-8           | 6-10 |
| Exponential   | Power of e                | 11              | 516-623                              | 411-472       | 497-591 | 6-10              | 5-8           | 6-10 |
|               | Power of X                | 11              | 292-379                              | 226-287       | 276-359 | 6-10              | 5-8           | 6-10 |
| Radian Conv   | Convert RAD to DEG        | 11              | 288-326                              | 238-252       | 274-308 | 6-10              | 5-8           | 6-10 |
|               | Convert DEG to RAD        | 17              | 70-100                               | 59-77         | 66-95   | 6-10              | 5-8           | 6-10 |
| Relational    | Equal (INT)               | 10              | 25-36                                | 21-28         | 24-34   | 8-12              | 7-9           | 7-11 |
|               | Equal (DINT)              | 16              | 21-44                                | 19-34         | 20-42   | 8-12              | 7-9           | 7-10 |
|               | Equal (REAL)              | 14              | 33-57                                | 29-44         | 31-54   | 8-12              | 7-9           | 7-11 |
|               | Not Equal (INT)           | 10              | 18-36                                | 17-28         | 18-34   | 8-12              | 7-9           | 7-11 |
|               | Not Equal (DINT)          | 16              | 32-42                                | 27-32         | 30-39   | 8-12              | 7-9           | 7-11 |
|               | Not Equal (REAL)          | 14              | 37-57                                | 32-44         | 34-54   | 8-12              | 7-9           | 7-11 |
|               | Greater Than (INT)        | 10              | 28-36                                | 24-28         | 27-34   | 8-12              | 7-9           | 7-11 |
|               | Greater Than (DINT)       | 16              | 22-42                                | 20-32         | 21-40   | 8-12              | 7-9           | 7-11 |
|               | Greater Than (REAL)       | 14              | 37-58                                | 31-44         | 34-54   | 8-12              | 7-9           | 7-11 |
|               | Greater Than/Equal (INT)  | 10              | 19-36                                | 17-28         | 17-34   | 8-12              | 7-9           | 7-11 |
|               | Greater Than/Equal (DINT) | 16              | 20-42                                | 19-32         | 19-39   | 8-12              | 7-9           | 7-11 |
|               | Greater Than/Equal (REAL) | 14              | 29-57                                | 32-44         | 34-54   | 8-12              | 7-9           | 7-11 |
|               | Less Than (INT)           | 10              | 19-36                                | 16-28         | 18-34   | 8-12              | 7-9           | 7-11 |
|               | Less Than (DINT)          | 16              | 20-42                                | 18-32         | 19-39   | 8-12              | 7-9           | 7-11 |
|               | Less Than (REAL)          | 14              | 36-58                                | 23-44         | 24-54   | 8-12              | 7-9           | 7-11 |
|               | Less Than/Equal (INT)     | 10              | 18-36                                | 17-28         | 17-34   | 8-12              | 7-9           | 7-11 |
|               | Less Than/Equal (DINT)    | 16              | 20-42                                | 18-32         | 19-39   | 8-12              | 7-9           | 7-11 |
|               | Less Than/Equal (REAL)    | 14              | 26-58                                | 23-44         | 24-54   | 8-12              | 7-9           | 7-11 |
|               | Range (INT)               | 13              | 22-44                                | 20-34         | 20-42   | 8-12              | 7-9           | 7-11 |
|               | Range (DINT)              | 22              | 24-51                                | 20-39         | 22-48   | 8-12              | 7-9           | 7-11 |
|               | Range (WORD)              | 13              | 22-43                                | 20-33         | 20-41   | 8-12              | 7-9           | 7-11 |
| Bit Operation | Logical AND               | 13              | 30-55                                | 27-42         | 29-52   | 6-10              | 5-8           | 6-10 |
|               | Logical OR                | 13              | 30-55                                | 27-42         | 28-52   | 6-10              | 5-8           | 6-10 |
|               | Logical Exclusive OR      | 13              | 31-55                                | 27-42         | 28-52   | 6-10              | 5-8           | 6-10 |
|               | Logical Invert, NOT       | 10              | 27-45                                | 24-35         | 25-43   | 6-10              | 5-8           | 6-10 |
|               | Shift Bit Left            | 16              | 109-130                              | 90-101        | 102-123 | 7-11              | 6-8           | 7-11 |
|               | Shift Bit Right           | 16              | 108-120                              | 88-93         | 102-113 | 7-11              | 6-8           | 7-11 |
|               | Rotate Bit Left           | 16              | 77-108                               | 64-83         | 72-102  | 6-10              | 5-8           | 6-10 |

| Group     | Function                   | Size<br>(bytes) | Execution Time (Range in $\mu$ sec.) |               |         |                   |               |       |
|-----------|----------------------------|-----------------|--------------------------------------|---------------|---------|-------------------|---------------|-------|
|           |                            |                 | Function Enabled                     |               |         | Function Disabled |               |       |
|           |                            |                 | 14-/23-/<br>28-pt                    | 28-pt<br>ESCP | Nano    | 14-/23-<br>/28-pt | 28-pt<br>ESCP | Nano  |
|           | Rotate Bit Right           | 16              | 82-109                               | 64-71         | 78-103  | 6-10              | 5-8           | 6-10  |
|           | Bit Position               | 13              | 43-72                                | 36-55         | 40-68   | 6-10              | 5-9           | 6-10  |
|           | Bit Clear                  | 13              | 45-67                                | 38-51         | 43-63   | 6-10              | 5-8           | 6-10  |
|           | Bit Test                   | 13              | 32-54                                | 28-42         | 29-51   | 8-12              | 7-8           | 7-11  |
|           | Bit Set                    | 13              | 38-66                                | 34-50         | 36-62   | 6-10              | 5-8           | 6-10  |
|           | Mask Compare (WORD)        | 25              | 90-145                               | 83-113        | 82-137  | 8-12              | 7-9           | 7-11  |
|           | Mask Compare (DWORD)       | 25              | 92-145                               | 77-112        | 88-137  | 8-12              | 7-9           | 7-11  |
| Data Move | Move (INT)                 | 10              | 20-42                                | 19-32         | 19-40   | 6-10              | 5-8           | 6-10  |
|           | Move (BOOL)                | 13              | 47-75                                | 37-47         | 45-71   | 6-10              | 5-8           | 6-10  |
|           | Move (WORD)                | 10              | 20-42                                | 18-32         | 19-40   | 6-10              | 5-8           | 6-10  |
|           | Move (REAL)                | 13              | 28-56                                | 26-44         | 26-53   | 6-10              | 5-8           | 6-10  |
|           | Block Move (INT)           | 28              | 26-58                                | 24-44         | 24-54   | 6-10              | 5-8           | 6-10  |
|           | Block Move (WORD)          | 28              | 26-58                                | 24-44         | 24-54   | 6-10              | 5-8           | 6-10  |
|           | Block Move (REAL)          | 13              | 47-108                               | 44-82         | 46-103  | 7-10              | 6-8           | 7-10  |
|           | Block Clear (WORD)         | 11              | 43-90                                | 38-70         | 40-85   | 6-10              | 5-8           | 6-9   |
|           | Shift Register (BIT)       | 16              | 92-125                               | 73-98         | 87-119  | 7-11              | 6-9           | 7-10  |
|           | Shift Register (WORD)      | 16              | 67-111                               | 51-88         | 65-106  | 7-11              | 6-9           | 7-11  |
|           | Bit Sequencer              | 16              | 111-142                              | 97-140        | 109-134 | 86-104            | 68-107        | 78-98 |
|           | COMMREQ                    | 13              | 616-762                              | 489-541       | 405-456 | 6-10              | 5-8           | 6-10  |
| Table     | Array Move (INT)           | 22              | 61-106                               | 53-83         | 57-100  | 6-10              | 5-8           | 6-10  |
|           | Array Move (DINT)          | 22              | 54-95                                | 48-72         | 51-90   | 6-10              | 5-8           | 6-10  |
|           | Array Move (BOOL)          | 22              | 77-130                               | 67-101        | 72-123  | 6-10              | 5-8           | 6-10  |
|           | Array Move (BYTE)          | 22              | 58-104                               | 51-79         | 53-98   | 6-10              | 5-8           | 6-10  |
|           | Array Move (WORD)          | 22              | 62-106                               | 53-83         | 57-100  | 6-10              | 5-8           | 6-10  |
|           | Search Equal (INT)         | 19              | 51-85                                | 42-66         | 47-81   | 8-12              | 7-10          | 7-11  |
|           | Search Equal (DINT)        | 22              | 41-81                                | 46-63         | 38-77   | 8-12              | 7-10          | 7-11  |
|           | Search Equal (BYTE)        | 19              | 50-80                                | 35-62         | 46-76   | 8-12              | 7-9           | 7-11  |
|           | Search Equal (WORD)        | 19              | 51-85                                | 42-66         | 48-81   | 8-12              | 7-9           | 7-11  |
|           | Search Not Equal (INT)     | 19              | 64-93                                | 42-72         | 59-88   | 8-12              | 7-9           | 7-11  |
|           | Search Not Equal (DINT)    | 22              | 67-101                               | 65-80         | 65-97   | 8-12              | 7-9           | 7-11  |
|           | Search Not Equal (BYTE)    | 19              | 50-80                                | 33-55         | 42-66   | 8-12              | 7-9           | 7-11  |
|           | Search Not Equal (WORD)    | 19              | 44-77                                | 38-60         | 49-73   | 8-12              | 6-9           | 7-11  |
|           | Search Greater/Equal (INT) | 19              | 55-83                                | 49-66         | 52-80   | 8-11              | 7-9           | 7-11  |



| Group      | Function                    | Size<br>(bytes) | Execution Time (Range in $\mu$ sec.) |               |         |                   |               |      |
|------------|-----------------------------|-----------------|--------------------------------------|---------------|---------|-------------------|---------------|------|
|            |                             |                 | Function Enabled                     |               |         | Function Disabled |               |      |
|            |                             |                 | 14-/23-/<br>28-pt                    | 28-pt<br>ESCP | Nano    | 14-/23-<br>/28-pt | 28-pt<br>ESCP | Nano |
|            | Search Greater/Equal (DINT) | 22              | 50-81                                | 49-63         | 47-77   | 8-12              | 7-9           | 7-11 |
|            | Search Greater/Equal (BYTE) | 19              | 44-80                                | 40-62         | 43-76   | 8-12              | 7-9           | 7-11 |
|            | Search Greater/Equal (WORD) | 19              | 48-86                                | 40-66         | 46-81   | 8-12              | 7-9           | 7-11 |
|            | Search Greater Than (INT)   | 19              | 56-89                                | 46-72         | 53-86   | 8-12              | 7-9           | 7-11 |
|            | Search Greater Than (DINT)  | 22              | 57-87                                | 44-69         | 53-83   | 8-12              | 7-9           | 7-11 |
|            | Search Greater Than (BYTE)  | 19              | 46-93                                | 48-67         | 44-82   | 8-12              | 7-9           | 7-11 |
|            | Search Greater Than (WORD)  | 19              | 55-91                                | 52-72         | 52-88   | 8-12              | 7-9           | 7-11 |
|            | Search Less Than (INT)      | 19              | 54-78                                | 38-61         | 50-74   | 8-12              | 7-9           | 7-11 |
|            | Search Less Than (DINT)     | 22              | 66-103                               | 47-80         | 62-98   | 8-12              | 7-9           | 7-12 |
|            | Search Less Than (BYTE)     | 19              | 40-71                                | 38-55         | 36-67   | 8-12              | 7-9           | 7-11 |
|            | Search Less Than (WORD)     | 19              | 43-79                                | 48-61         | 40-74   | 8-12              | 7-9           | 7-11 |
|            | Search Less/Equal (INT)     | 19              | 43-78                                | 46-61         | 40-73   | 8-12              | 7-9           | 7-11 |
|            | Search Less/Equal (DINT)    | 22              | 41-81                                | 48-63         | 38-77   | 8-12              | 7-9           | 7-11 |
|            | Search Less/Equal (BYTE)    | 19              | 48-71                                | 36-55         | 45-67   | 8-12              | 7-9           | 7-11 |
|            | Search Less/Equal (WORD)    | 19              | 55-78                                | 45-61         | 60-74   | 8-12              | 7-9           | 7-11 |
| Conversion | Convert INT to REAL         | 10              | 37-56                                | 29-42         | 30-52   | 6-10              | 5-8           | 6-10 |
|            | Convert REAL to INT         | 13              | 616-705                              | 507-547       | 585-668 | 6-10              | 5-8           | 6-10 |
|            | Convert DINT to REAL        | 13              | 37-58                                | 28-44         | 32-54   | 6-10              | 5-8           | 6-9  |
|            | Convert REAL to DINT        | 13              | 605-695                              | 507-539       | 567-659 | 6-10              | 5-8           | 6-9  |
|            | Convert WORD to REAL        | 10              | 34-55                                | 28-42         | 28-52   | 6-10              | 5-8           | 6-10 |
|            | Convert REAL to WORD        | 13              | 607-663                              | 501-513       | 576-628 | 6-10              | 5-8           | 6-10 |
|            | Convert BDC to INT          | 10              | 28-53                                | 25-40         | 27-50   | 6-10              | 5-8           | 6-10 |
|            | Convert INT to BCD          | 10              | 80-170                               | 76-130        | 76-161  | 6-10              | 5-8           | 6-10 |
|            | Convert BCD to REAL         | 10              | 41-68                                | 33-52         | 33-64   | 6-10              | 5-8           | 6-10 |
|            | Truncate to INT             | 13              | 152-190                              | 134-146       | 145-179 | 6-10              | 5-8           | 6-10 |
|            | Truncate to DINT            | 13              | 150-181                              | 113-140       | 137-171 | 6-10              | 5-9           | 6-10 |
| Control    | Call a Subroutine           | 7               | 28-56                                | 27-44         | 26-52   | 4-6               | 3-4           | 4-5  |
|            | Do I/O                      | 13              | 183-206                              | 149-205       | 168-186 | 6-10              | 5-10          | 6-10 |

| Group | Function                    | Size<br>(bytes) | Execution Time (Range in $\mu$ sec.) |               |         |                    |               |       |
|-------|-----------------------------|-----------------|--------------------------------------|---------------|---------|--------------------|---------------|-------|
|       |                             |                 | Function Enabled                     |               |         | Function Disabled  |               |       |
|       |                             |                 | 14-/23-/<br>28-pt                    | 28-pt<br>ESCP | Nano    | 14-/23-<br>/28-pt  | 28-pt<br>ESCP | Nano  |
|       | Service Request #6          | 10              | 57-71                                | 41-55         | 53-67   | 6-12               | 5-8           | 6-10  |
|       | Service Request #7<br>Read  | 10              | 289-427 <sup>22</sup>                | 236-315       | N/A     | 6-10 <sup>22</sup> | 5-8           | N/A   |
|       | Service Request #7<br>Write | 10              | 519-520 <sup>22</sup>                | 393-406       | N/A     | 6-10 <sup>22</sup> | 5-8           | N/A   |
|       | Service Request #9          | 10              | 76-112                               | 65-86         | 105-123 | 5-10               | 5-7           | 5-9   |
|       | Service Request #14         | 10              | 250-363                              | 199-274       | 103-149 | 7-10               | 5-8           | 6-10  |
|       | Service Request #15         | 10              | 66-92                                | 65-72         | 64-87   | 6-10               | 5-8           | 6-10  |
|       | Service Request #16         | 10              | 78-103                               | 64-79         | 71-97   | 6-10               | 5-8           | 6-10  |
|       | Service Request #18         | 10              | 56-141                               | 52-107        | 52-133  | 6-10               | 5-8           | 6-10  |
|       | Service Request #23         | 10              | 206-433                              | 186-325       | 163-210 | 6-10               | 5-8           | 6-10  |
|       | Service Request #26,<br>#30 | 10              | 269-362                              | 201-283       | 249-343 | 6-10               | 5-8           | 6-10  |
|       | Service Request #29         | 10              | 48-69                                | 41-53         | 45-65   | 6-10               | 5-8           | 6-10  |
|       | Nested MCR/ENDMCR           | 4               | 4                                    | 3             | 4       | 3                  | 3             | 3     |
|       | PID-ISA Algorithm           | 16              | 166-194                              | 135-149       | 155-185 | 50-79              | 43-61         | 47-74 |
|       | PID-IND Algorithm           | 16              | 164-194                              | 135-150       | 155-184 | 50-80              | 43-61         | 47-74 |

<sup>22</sup> Not applicable for 14-Point CPUs.

## A-7 Typical Execution Times for Release 1.1 CPUs

Depending upon the application, release 1.1 CPUs show the following estimated reductions in program execution times when compared with release 1.0 CPUs:

Nano PLCs: 20% - 28%

14-Pt Micro PLCs: 28%

28-Pt Micro PLCs: 28%

The following table details function block timing for a Release 1.1, 28-Point Micro PLC CPU with ESCP, model IC200UDD120. For each instance of a function block, the table shows typical execution times when the function block is enabled (receiving power flow) or disabled (not receiving power flow).

| Group    | Function               | Size<br>(bytes) | Rel. 1.07 / 1.1 28-Point CPU with ESCP |                    |
|----------|------------------------|-----------------|----------------------------------------|--------------------|
|          |                        |                 | Function Enabled                       | Function Disabled  |
|          |                        |                 | Time, Range (μS)                       | Time, Typical (μS) |
| Timers   | Off Delay Timer        | 15              | 60 - 70                                | 56                 |
|          | On Delay Timer         | 15              | 66 - 77                                | 56                 |
|          | Elapsed Timer          | 15              | 62 - 72                                | 50                 |
| Counters | Up Counter             | 13              | 40 - 60                                | 58                 |
|          | Down Counter           | 13              | 60                                     | 54                 |
| Math     | Addition (INT)         | 13              | 30 - 40                                | 7                  |
|          | Addition (DINT)        | 19              | 40                                     | 9                  |
|          | Addition (REAL)        | 17              | 89 - 100                               | 8                  |
|          | Subtraction (INT)      | 13              | 30 - 40                                | 6                  |
|          | Subtraction (DINT)     | 19              | 30 - 40                                | 7                  |
|          | Subtraction (REAL)     | 17              | 91 - 100                               | 9                  |
|          | Multiplication (INT)   | 13              | 29 - 42                                | 7                  |
|          | Multiplication (DINT)  | 13              | 24 - 40                                | 8                  |
|          | Multiplication (REAL)  | 17              | 80 - 108                               | 8                  |
|          | Division (INT)         | 13              | 40 - 50                                | 6                  |
|          | Division (DINT)        | 19              | 31 - 49                                | 10                 |
|          | Division (REAL)        | 17              | 150 - 182                              | 9                  |
|          | Modulo Division (INT)  | 13              | 48 - 60                                | 7                  |
|          | Modulo Division (DINT) | 19              | 44 - 51                                | 10                 |
|          | Square Root (INT)      | 10              | 39 - 60                                | 7                  |
|          | Square Root (DINT)     | 13              | 34 - 74                                | 10                 |
|          | Square Root (REAL)     | 11              | 351 - 404                              | 8                  |

| Group             | Function                  | Size<br>(bytes) | Rel. 1.07 / 1.1 28-Point CPU with ESCP |                    |
|-------------------|---------------------------|-----------------|----------------------------------------|--------------------|
|                   |                           |                 | Function Enabled                       | Function Disabled  |
|                   |                           |                 | Time, Range (μS)                       | Time, Typical (μS) |
| Trigonometric     | SIN (REAL)                | 11              | 898 - 1149                             | 9                  |
|                   | COS (REAL)                | 11              | 867 - 1155                             | 9                  |
|                   | TAN (REAL)                | 11              | 1138 - 1710                            | 1                  |
|                   | ASIN (REAL)               | 11              | 1242 - 1474                            | 10                 |
|                   | ACOS (REAL)               | 11              | 1220 - 1435                            | 10                 |
|                   | ATAN (REAL)               | 11              | 552 - 655                              | 10                 |
| Logarithmic       | LOG (REAL)                | 11              | 587 - 697                              | 8                  |
|                   | LN (REAL)                 | 11              | 545 - 655                              | 8                  |
| Exponential       | Power of e                | 11              | 407 - 466                              | 10                 |
|                   | Power of X                | 17              | 226 - 283                              | 10                 |
| Radian Conversion | Convert RAD to DEG        | 11              | 228 - 246                              | 10                 |
|                   | Convert DEG to RAD        | 17              | 65 - 72                                | 9                  |
| Relational        | Equal (INT)               | 10              | 20 - 30                                | 10                 |
|                   | Equal (DINT)              | 16              | 20 - 30                                | 10                 |
|                   | Equal (REAL)              | 14              | 30 - 40                                | 10                 |
|                   | Not Equal (INT)           | 10              | 20 - 24                                | 10                 |
|                   | Not Equal (DINT)          | 16              | 20 - 30                                | 10                 |
|                   | Not Equal (REAL)          | 14              | 30 - 40                                | 10                 |
|                   | Greater Than (INT)        | 10              | 20 - 22                                | 10                 |
|                   | Greater Than (DINT)       | 16              | 20 - 30                                | 10                 |
|                   | Greater Than (REAL)       | 14              | 40                                     | 10                 |
|                   | Greater Than/Equal (INT)  | 10              | 23 - 30                                | 10                 |
|                   | Greater Than/Equal (DINT) | 16              | 20 - 30                                | 10                 |
|                   | Greater Than/Equal (REAL) | 14              | 39 - 40                                | 10                 |
|                   | Less Than (INT)           | 10              | 20 - 22                                | 10                 |
|                   | Less Than (DINT)          | 16              | 30                                     | 10                 |
|                   | Less Than (REAL)          | 14              | 36 - 40                                | 10                 |
|                   | Less Than/Equal (INT)     | 10              | 21 - 23                                | 10                 |
|                   | Less Than/Equal (DINT)    | 16              | 30 - 40                                | 10                 |
|                   | Less Than/Equal (REAL)    | 14              | 40 - 55                                | 10                 |
|                   | Range (INT)               | 13              | 21 - 30                                | 10                 |
|                   | Range (DINT)              | 22              | 26 - 38                                | 10                 |
|                   | Range (WORD)              | 13              | 25 - 30                                | 10                 |
| Bit               | Logical AND               | 13              | 36 - 40                                | 4                  |

| Group     | Function              | Size<br>(bytes) | Rel. 1.07 / 1.1 28-Point CPU with ESCP |                    |
|-----------|-----------------------|-----------------|----------------------------------------|--------------------|
|           |                       |                 | Function Enabled                       | Function Disabled  |
|           |                       |                 | Time, Range (μS)                       | Time, Typical (μS) |
| Operation | Logical OR            | 13              | 30 - 40                                | 5                  |
|           | Logical Exclusive OR  | 13              | 30 - 40                                | 5                  |
|           | Logical Invert, NOT   | 10              | 30                                     | 4                  |
|           | Shift Bit Left        | 16              | 85 - 96                                | 9                  |
|           | Shift Bit Right       | 16              | 90                                     | 10                 |
|           | Rotate Bit Left       | 16              | 61 - 80                                | 4                  |
|           | Rotate Bit Right      | 16              | 70 - 80                                | 5                  |
|           | Bit Position          | 13              | 50                                     | 4                  |
|           | Bit Clear             | 13              | 34 - 50                                | 6                  |
|           | Bit Test              | 13              | 30 - 40                                | 10                 |
|           | Bit Set               | 13              | 36 - 47                                | 4                  |
|           | Mask Compare (WORD)   | 25              | 80 - 109                               | 10                 |
|           | Mask Compare (DWORD)  | 25              | 70 - 106                               | 10                 |
| Data Move | Move (INT)            | 10              | 27 - 30                                | 4                  |
|           | Move (BOOL)           | 13              | 40 - 55                                | 4                  |
|           | Move (WORD)           | 10              | 27 - 30                                | 4                  |
|           | Move (REAL)           | 13              | 40                                     | 4                  |
|           | Block Move (INT)      | 28              | 30 - 40                                | 4                  |
|           | Block Move (WORD)     | 28              | 30 - 40                                | 4                  |
|           | Block Move (REAL)     | 13              | 37 - 83                                | 8                  |
|           | Block Clear (WORD)    | 11              | 37 - 65                                | 4                  |
|           | Shift Register (BIT)  | 16              | 77 - 93                                | 9                  |
|           | Shift Register (WORD) | 16              | 55 - 83                                | 10                 |
|           | Bit Sequencer         | 16              | 92 - 108                               | 83                 |
|           | COMMREQ               | 13              | 470 - 485                              | 135                |
| Table     | Array Move            |                 |                                        |                    |
|           | INT                   | 22              | 51 - 79                                | 4                  |
|           | DINT                  | 22              | 50 - 70                                | 4                  |
|           | BOOL                  | 22              | 70 - 96                                | 5                  |
|           | BYTE                  | 22              | 46 - 75                                | 5                  |
|           | WORD                  | 22              | 51 - 79                                | 4                  |
|           | Search Equal          |                 |                                        |                    |
|           | INT                   | 19              | 46 - 60                                | 10                 |
|           | DINT                  | 22              | 50 - 60                                | 10                 |
|           | BYTE                  | 19              | 40 - 60                                | 10                 |
|           | WORD                  | 19              | 46 - 60                                | 10                 |

| Group | Function                  | Size<br>(bytes) | Rel. 1.07 / 1.1 28-Point CPU with ESCP |                          |
|-------|---------------------------|-----------------|----------------------------------------|--------------------------|
|       |                           |                 | Function Enabled                       | Function Disabled        |
|       |                           |                 | Time, Range ( $\mu$ S)                 | Time, Typical ( $\mu$ S) |
|       | Search Not Equal          |                 |                                        |                          |
|       | INT                       | 19              | 46 - 68                                | 10                       |
|       | DINT                      | 22              | 69 - 75                                | 10                       |
|       | BYTE                      | 19              | 39 - 50                                | 10                       |
|       | WORD                      | 16              | 47 - 68                                | 10                       |
|       | Search Greater Than/Equal |                 |                                        |                          |
|       | INT                       | 19              | 51 - 60                                | 10                       |
|       | DINT                      | 22              | 50 - 60                                | 10                       |
|       | BYTE                      | 19              | 42 - 60                                | 10                       |
|       | WORD                      | 19              | 46 - 60                                | 10                       |
|       | Search Greater Than       |                 |                                        |                          |
|       | INT                       | 19              | 50 - 70                                | 10                       |
|       | DINT                      | 22              | 48 - 65                                | 10                       |
|       | BYTE                      | 19              | 50 - 61                                | 10                       |
|       | WORD                      | 19              | 55 - 69                                | 10                       |
|       | Search Less Than          |                 |                                        |                          |
|       | INT                       | 19              | 40 - 57                                | 10                       |
|       | DINT                      | 22              | 50 - 75                                | 10                       |
|       | BYTE                      | 19              | 40 - 50                                | 10                       |
|       | WORD                      | 19              | 50 - 58                                | 10                       |
|       | Search Less Than/Equal    |                 |                                        |                          |
|       | INT                       | 19              | 50 - 58                                | 10                       |
|       | DINT                      | 22              | 50 - 60                                | 10                       |
|       | BYTE                      | 19              | 40 - 50                                | 10                       |
|       | WORD                      | 19              | 50 - 58                                | 10                       |

| Group      | Function                     | Size<br>(bytes) | Rel. 1.07 / 1.1 28-Point CPU with ESCP |                    |
|------------|------------------------------|-----------------|----------------------------------------|--------------------|
|            |                              |                 | Function Enabled                       | Function Disabled  |
|            |                              |                 | Time, Range (μS)                       | Time, Typical (μS) |
| Conversion | Convert INT to REAL          | 10              | 28 - 40                                | 4                  |
|            | Convert REAL to INT          | 13              | 495 - 537                              | 4                  |
|            | Convert DINT to REAL         | 13              | 30 - 40                                | 4                  |
|            | Convert REAL to DINT         | 13              | 496 - 534                              | 5                  |
|            | Convert WORD to REAL         | 10              | 30 - 40                                | 3                  |
|            | Convert REAL to WORD         | 13              | 490 - 506                              | 4                  |
|            | Convert BDC to INT           | 10              | 30 - 38                                | 4                  |
|            | Convert INT to BCD           | 10              | 80 - 124                               | 4                  |
|            | Convert BCD to REAL          | 10              | 36 - 50                                | 4                  |
|            | Convert BCD to REAL          | 13              | 132 - 142                              | 4                  |
|            | Truncate to INT              | 13              | 113 - 134                              | 4                  |
|            | Truncate to DINT             |                 |                                        |                    |
| Control    | Call a Subroutine            | 7               | 30 - 40                                | 0                  |
|            | Do I/O                       | 13              | 142 - 144                              | 4                  |
|            | Service Request              |                 |                                        |                    |
|            | #6                           | 10              | 46 - 50                                | 8                  |
|            | #7 (read)                    | 10              | 153 - 165                              | 6                  |
|            | #7 (set)                     | 10              | 384 - 387                              | 5                  |
|            | #9                           | 10              | 65 - 86                                | 7                  |
|            | #14                          | 10              | 97 - 125                               | 5                  |
|            | #15                          | 10              | 66 - 69                                | 4                  |
|            | #16                          | 10              | 70 - 75                                | 5                  |
|            | #18                          | 10              | 56 - 103                               | 5                  |
|            | #23                          | 10              | 183 - 322                              | 4                  |
|            | #26,#30                      | 10              | 196 - 243                              | 4                  |
|            | #29                          | 10              | 40 - 50                                | 5                  |
|            | Nested MCR/ENDMCR (combined) | 4               | 40 - 50                                | 5                  |
|            | PID-ISA Algorithm            | 16              | 131 - 149                              | 62                 |
|            | PID-IND Algorithm            | 16              | 131 - 150                              | 62                 |

## A-8 Typical Execution Times for Release 1.0 CPUs

| Group                | Function               | Size<br>(bytes) | Execution Time (μsec.)  |                                |                         |                                |
|----------------------|------------------------|-----------------|-------------------------|--------------------------------|-------------------------|--------------------------------|
|                      |                        |                 | Function Enabled        |                                | Function Disabled       |                                |
|                      |                        |                 | Nano PLC<br>(10 points) | Micro PLC<br>(14-, 23-, 28-pt) | Nano PLC<br>(10-points) | Micro PLC<br>(14-, 23-, 28-pt) |
| Coils/Relays         | Coils/Relays           | 3               | 1.2ms/K                 | 1.0ms/K                        |                         |                                |
| Timers               | Off Delay Timer        | 15              | 95                      | 100                            | 64                      | 70                             |
|                      | On Delay Timer         | 15              | 100                     | 106                            | 70                      | 73                             |
|                      | Elapsed Timer          | 15              | 90                      | 99                             | 60                      | 70                             |
| Counters             | Up Counter             | 13              | 76                      | 80                             | 70                      | 80                             |
|                      | Down Counter           | 13              | 77                      | 82                             | 71                      | 80                             |
| Math                 | Addition (INT)         | 13              | 50                      | 60                             | 10                      | 10                             |
|                      | Addition (DINT)        | 19              | 50                      | 59                             | 10                      | 10                             |
|                      | Addition (REAL)        | 17              | 119                     | 127                            | 10                      | 10                             |
|                      | Subtraction (INT)      | 13              | 50                      | 60                             | 10                      | 10                             |
|                      | Subtraction (DINT)     | 19              | 50                      | 52                             | 10                      | 10                             |
|                      | Subtraction (REAL)     | 17              | 119                     | 128                            | 10                      | 10                             |
|                      | Multiplication (INT)   | 13              | 53                      | 60                             | 10                      | 10                             |
|                      | Multiplication (DINT)  | 13              | 50                      | 60                             | 10                      | 10                             |
|                      | Multiplication (REAL)  | 17              | 133                     | 137                            | 10                      | 10                             |
|                      | Division (INT)         | 13              | 65                      | 70                             | 10                      | 10                             |
|                      | Division (DINT)        | 19              | 60                      | 60                             | 10                      | 10                             |
|                      | Division (REAL)        | 17              | 213                     | 223                            | 10                      | 10                             |
|                      | Modulo Division (INT)  | 13              | 70                      | 80                             | 10                      | 10                             |
|                      | Modulo Division (DINT) | 19              | 65                      | 70                             | 10                      | 10                             |
|                      | Square Root (INT)      | 10              | 80                      | 81                             | 10                      | 10                             |
|                      | Square Root (DINT)     | 13              | 89                      | 94                             | 10                      | 10                             |
|                      | Square Root (REAL)     | 11              | 472                     | 491                            | 10                      | 10                             |
| Trigonometric        | SIN (REAL)             | 11              | 1337                    | 1399                           | 10                      | 10                             |
|                      | COS (REAL)             | 11              | 1342                    | 1396                           | 10                      | 10                             |
|                      | TAN (REAL)             | 11              | 1993                    | 2077                           | 10                      | 20                             |
|                      | ASIN (REAL)            | 11              | 1712                    | 1783                           | 10                      | 10                             |
|                      | ACOS (REAL)            | 11              | 1663                    | 1740                           | 10                      | 10                             |
|                      | ATAN (REAL)            | 11              | 761                     | 795                            | 10                      | 10                             |
| Logarithmic          | LOG (REAL)             | 11              | 814                     | 848                            | 10                      | 10                             |
|                      | LN (REAL)              | 11              | 760                     | 790                            | 10                      | 10                             |
| Exponential          | Power of e             | 11              | 542                     | 569                            | 10                      | 10                             |
|                      | Power of X             | 17              | 332                     | 351                            | 10                      | 10                             |
| Radian<br>Conversion | Convert RAD to DEG     | 11              | 289                     | 300                            | 10                      | 10                             |
|                      | Convert DEG to RAD     | 17              | 89                      | 97                             | 10                      | 10                             |
| Relational           | Equal (INT)            | 10              | 30                      | 40                             | 10                      | 10                             |
|                      | Equal (DINT)           | 16              | 40                      | 40                             | 10                      | 10                             |
|                      | Equal (REAL)           | 14              | 50                      | 52                             | 10                      | 10                             |
|                      | Not Equal (INT)        | 10              | 30                      | 31                             | 10                      | 10                             |



| Group         | Function                  | Size<br>(bytes) | Execution Time (μsec.)  |                                |                         |                                |
|---------------|---------------------------|-----------------|-------------------------|--------------------------------|-------------------------|--------------------------------|
|               |                           |                 | Function Enabled        |                                | Function Disabled       |                                |
|               |                           |                 | Nano PLC<br>(10 points) | Micro PLC<br>(14-, 23-, 28-pt) | Nano PLC<br>(10-points) | Micro PLC<br>(14-, 23-, 28-pt) |
|               | Not Equal (DINT)          | 16              | 40                      | 40                             | 10                      | 10                             |
|               | Not Equal (REAL)          | 14              | 50                      | 51                             | 10                      | 10                             |
|               | Greater Than (INT)        | 10              | 30                      | 32                             | 10                      | 10                             |
|               | Greater Than (DINT)       | 16              | 40                      | 40                             | 10                      | 10                             |
|               | Greater Than (REAL)       | 14              | 50                      | 52                             | 10                      | 10                             |
|               | Greater Than/Equal (INT)  | 10              | 30                      | 31                             | 10                      | 10                             |
|               | Greater Than/Equal (DINT) | 16              | 40                      | 40                             | 10                      | 10                             |
|               | Greater Than/Equal (REAL) | 14              | 50                      | 55                             | 10                      | 10                             |
|               | Less Than (INT)           | 10              | 30                      | 32                             | 10                      | 10                             |
|               | Less Than (DINT)          | 16              | 40                      | 40                             | 10                      | 10                             |
|               | Less Than (REAL)          | 14              | 50                      | 59                             | 10                      | 10                             |
|               | Less Than/Equal (INT)     | 10              | 30                      | 31                             | 10                      | 10                             |
|               | Less Than/Equal (DINT)    | 16              | 40                      | 40                             | 10                      | 10                             |
|               | Less Than/Equal (REAL)    | 14              | 50                      | 55                             | 10                      | 10                             |
|               | Range (INT)               | 13              | 40                      | 40                             | 10                      | 10                             |
|               | Range (DINT)              | 22              | 45                      | 50                             | 10                      | 10                             |
|               | Range (WORD)              | 13              | 40                      | 40                             | 10                      | 10                             |
| Bit Operation | Logical AND               | 13              | 50                      | 51                             | 10                      | 10                             |
|               | Logical OR                | 13              | 50                      | 51                             | 10                      | 10                             |
|               | Logical Exclusive OR      | 13              | 50                      | 51                             | 10                      | 10                             |
|               | Logical Invert, NOT       | 10              | 40                      | 43                             | 10                      | 10                             |
|               | Shift Bit Left            | 16              | 110                     | 118                            | 10                      | 10                             |
|               | Shift Bit Right           | 16              | 99                      | 109                            | 10                      | 10                             |
|               | Rotate Bit Left           | 16              | 90                      | 99                             | 10                      | 10                             |
|               | Rotate Bit Right          | 16              | 89                      | 98                             | 10                      | 10                             |
|               | Bit Position              | 13              | 61                      | 70                             | 10                      | 10                             |
|               | Bit Clear                 | 13              | 60                      | 70                             | 10                      | 10                             |
|               | Bit Test                  | 13              | 50                      | 52                             | 10                      | 10                             |
|               | Bit Set                   | 13              | 60                      | 70                             | 10                      | 10                             |
|               | Mask Compare (WORD)       | 25              | 129                     | 138                            | 10                      | 10                             |
|               | Mask Compare (DWORD)      | 25              | 128                     | 138                            | 10                      | 10                             |
| Data Move     | Move (INT)                | 10              | 40                      | 40                             | 10                      | 10                             |
|               | Move (BOOL)               | 13              | 79                      | 80                             | 10                      | 10                             |
|               | Move (WORD)               | 10              | 40                      | 40                             | 10                      | 10                             |
|               | Move (REAL)               | 13              | 50                      | 58                             | 10                      | 10                             |
|               | Block Move (INT)          | 28              | 50                      | 52                             | 10                      | 10                             |
|               | Block Move (WORD)         | 28              | 50                      | 52                             | 10                      | 10                             |
|               | Block Move (REAL)         | 13              | 99                      | 108                            | 10                      | 10                             |
|               | Block Clear (WORD)        | 11              | 89                      | 99                             | 10                      | 10                             |
|               | Shift Register (BIT)      | 16              | 118                     | 127                            | 10                      | 10                             |

| Group | Function                  | Size<br>(bytes) | Execution Time (μsec.)  |                                |                         |                                |
|-------|---------------------------|-----------------|-------------------------|--------------------------------|-------------------------|--------------------------------|
|       |                           |                 | Function Enabled        |                                | Function Disabled       |                                |
|       |                           |                 | Nano PLC<br>(10 points) | Micro PLC<br>(14-, 23-, 28-pt) | Nano PLC<br>(10-points) | Micro PLC<br>(14-, 23-, 28-pt) |
|       | Shift Register (WORD)     | 16              | 101                     | 109                            | 10                      | 10                             |
|       | Bit Sequencer             | 16              | 121                     | 127                            | 89                      | 10                             |
|       | COMMREQ                   | 13              | 600                     | 590                            | 144                     | 155                            |
| Table | Array Move                |                 |                         |                                |                         |                                |
|       | INT                       | 22              | 98                      | 101                            | 10                      | 10                             |
|       | DINT                      | 22              | 89                      | 97                             | 10                      | 10                             |
|       | BOOL                      | 22              | 127                     | 133                            | 10                      | 10                             |
|       | BYTE                      | 22              | 98                      | 100                            | 10                      | 10                             |
|       | WORD                      | 22              | 98                      | 101                            | 10                      | 10                             |
|       | Search Equal              |                 |                         |                                |                         |                                |
|       | INT                       | 19              | 79                      | 80                             | 10                      | 10                             |
|       | DINT                      | 22              | 70                      | 80                             | 10                      | 10                             |
|       | BYTE                      | 19              | 70                      | 80                             | 10                      | 10                             |
|       | WORD                      | 19              | 79                      | 80                             | 10                      | 10                             |
|       | Search Not Equal          |                 |                         |                                |                         |                                |
|       | INT                       | 19              | 86                      | 90                             | 10                      | 10                             |
|       | DINT                      | 22              | 98                      | 100                            | 10                      | 10                             |
|       | BYTE                      | 19              | 60                      | 70                             | 10                      | 10                             |
|       | WORD                      | 16              | 87                      | 90                             | 10                      | 10                             |
|       | Search Greater Than/Equal |                 |                         |                                |                         |                                |
|       | INT                       | 19              | 80                      | 81                             | 10                      | 10                             |
|       | DINT                      | 22              | 70                      | 80                             | 10                      | 10                             |
|       | BYTE                      | 19              | 70                      | 80                             | 10                      | 10                             |
|       | WORD                      | 19              | 79                      | 80                             | 10                      | 10                             |
|       | Search Greater Than       |                 |                         |                                |                         |                                |
|       | INT                       | 19              | 79                      | 90                             | 10                      | 10                             |
|       | DINT                      | 22              | 79                      | 89                             | 10                      | 10                             |
|       | BYTE                      | 19              | 79                      | 83                             | 10                      | 10                             |
|       | WORD                      | 19              | 80                      | 89                             | 10                      | 10                             |
|       | Search Less Than          |                 |                         |                                |                         |                                |
|       | INT                       | 19              | 70                      | 78                             | 10                      | 10                             |
|       | DINT                      | 22              | 90                      | 99                             | 10                      | 10                             |
|       | BYTE                      | 19              | 60                      | 70                             | 10                      | 10                             |
|       | WORD                      | 19              | 70                      | 80                             | 10                      | 10                             |
|       | Search Less Than/Equal    |                 |                         |                                |                         |                                |
|       | INT                       | 19              | 70                      | 78                             | 10                      | 10                             |
|       | DINT                      | 22              | 70                      | 80                             | 10                      | 10                             |
|       | BYTE                      | 19              | 60                      | 70                             | 10                      | 10                             |
|       | WORD                      | 19              | 70                      | 80                             | 10                      | 10                             |

| Group      | Function                        | Size<br>(bytes) | Execution Time (μsec.)  |                                |                         |                                |
|------------|---------------------------------|-----------------|-------------------------|--------------------------------|-------------------------|--------------------------------|
|            |                                 |                 | Function Enabled        |                                | Function Disabled       |                                |
|            |                                 |                 | Nano PLC<br>(10 points) | Micro PLC<br>(14-, 23-, 28-pt) | Nano PLC<br>(10-points) | Micro PLC<br>(14-, 23-, 28-pt) |
| Conversion | Convert INT to REAL             | 10              | 50                      | 51                             | 10                      | 10                             |
|            | Convert REAL to INT             | 13              | 50                      | 647                            | 10                      | 10                             |
|            | Convert DINT to REAL            | 13              | 50                      | 59                             | 10                      | 10                             |
|            | Convert REAL to DINT            | 13              | 611                     | 641                            | 10                      | 10                             |
|            | Convert WORD to REAL            | 10              | 50                      | 51                             | 10                      | 10                             |
|            | Convert REAL to WORD            | 13              | 583                     | 606                            | 10                      | 10                             |
|            | Convert BDC to INT              | 10              | 50                      | 50                             | 10                      | 10                             |
|            | Convert INT to BCD              | 10              | 156                     | 166                            | 10                      | 10                             |
|            | Convert BCD to REAL             | 10              | 60                      | 70                             | 10                      | 10                             |
|            | Truncate to INT                 | 13              | 169                     | 179                            | 10                      | 10                             |
|            | Truncate to DINT                | 13              | 161                     | 173                            | 10                      | 10                             |
| Control    | Call a Subroutine               | 7               | 46                      | 51                             | 10                      | 10                             |
|            | Do I/O                          | 13              | 173                     | 185                            | 10                      | 10                             |
|            | Service Request                 |                 |                         |                                |                         |                                |
|            | #6                              | 10              | 70                      | 71                             | 10                      | 10                             |
|            | #7 (read)                       | 10              | 163                     | 173                            | 10                      | 10                             |
|            | #7 (set)                        | 10              | 143                     | 150                            | 10                      | 10                             |
|            | #9                              | 10              | 107                     | 112                            | 10                      | 9                              |
|            | #14                             | 10              | 157                     | 167                            | 10                      | 10                             |
|            | #15                             | 10              | 84                      | 90                             | 10                      | 10                             |
|            | #16                             | 10              | 98                      | 100                            | 10                      | 10                             |
|            | #18                             | 10              | 134                     | 139                            | 10                      | 10                             |
|            | #23                             | 10              | 222                     | 476                            | 10                      | 10                             |
|            | #26,#30                         | 10              | 298                     | 310                            | 10                      | 10                             |
|            | #29                             | 10              | 69                      | 70                             | 10                      | 10                             |
|            | Nested MCR/ENDMCR<br>(combined) | 4               | 3                       | 4                              | 10                      | 10                             |
|            | PID-ISA Algorithm               | 16              | 188                     | 194                            | 12.8                    | 3.2                            |
|            | PID-IND Algorithm               | 16              | 186                     | 195                            | 70                      | 73                             |

## Appendix B: Feature Comparison

Information in this appendix is arranged to provide a convenient means of comparing the capabilities of the VersaMax Micro PLC and the Series 90 Micro PLC.

**Operating Differences:** Lists ways in which the VersaMax Nano and Micro PLCs operate differently than earlier PLCs.

**Program Functions Supported:** This section compares the program functions supported by VersaMax Nano PLCs and Micro PLCs with functions supported by Series 90 Micro PLCs.

**Program References:** Compares the program references used by VersaMax and Series 90 Micro PLCs.

### B-1 Operating Differences

1. Subroutines are available on the VersaMax Nano and Micros. The maximum of subroutines is 64 for Micro PLCs and 8 for Nano PLCs.
2. The VersaMax Nano and Micros have several functions that the Series 90 Micro did not support.
  - PID
  - Nested JUMP, LABEL, and MCR. Use of JUMP, LABEL, and MCR functions in Series 90 programs must be changed to nested.
  - Scaling
  - Floating point data types
  - Override capability
3. Word-for-word changes are not allowed by VersaMax Nano & Micro PLCs. The Series 90 Micro allowed word-for-word changes in STOP mode.
4. The VersaMax 14-point Micro PLCs support expansion units; the Series 90 14-point Micro PLCs did not.
5. When a serial port is configured for RTU slave it will revert to SNP when a programmer is attached.
6. VersaMax Nano/Micros support Serial I/O protocol.
7. VersaMax 20, 23, 28, 40, and 64 point units feature a time of day clock.
8. The VersaMax Nano and Micros support Break-free SNP communications for greater compatibility with modems.
9. All VersaMax Nano/Micros support auto-configuration capability.
10. High-Speed Counter/PWM/Pulse Train differences:
  - VersaMax Nano/Micro PLCs do not support negative edge triggering for High-Speed Counter Preload/Strobe inputs. This is different from the Series 90 Micro PLC.
  - VersaMax Nano/Micro PLCs have 4 PTO channels where the Series 90 Micro PLC had 3 PTO channels.

- VersaMax Nano/Micro PLCs output for PTO are on Q1, Q2, Q3, and Q5. While the Series 90 Micro PLCs output PTO on Q1, Q3, Q5. Wiring changes will be required when a VersaMax Nano/Micro is used to replace a Series 90 PLC.
- The PTO #4 Complete bit is I511 and Start is Q511.
- For VersaMax Micro PLCs and Nano PLCs, the High-Speed Counter PWM and PTO features use different %AQ settings than in the Series 90 Micro PLC. A Series 90 Micro PLC folder containing these features will not function properly if converted directly to a VersaMax Micro PLC folder. The logic which calculates the %AQ frequencies and/or duty cycles must be changed before being used on a VersaMax Micro or Nano PLC. Series 90 Micro programs which used the PWM and PTO features needed to calculate values to put into the %AQ registers, based on the desired frequency and duty cycle. For the VersaMax Nano and Micro PLCs, this calculation is not necessary; the frequency and duty cycle must be input directly into the %AQ registers.
- Frequency limits for the VersaMax HSC/Pulse outputs have been improved

|                              | HSC<br>Frequency Limits | PTO/PWM<br>Frequency Limits |
|------------------------------|-------------------------|-----------------------------|
| Series 90 Micro              | 19Hz – 5kHz             | 19Hz - 2kHz                 |
| VersaMax<br>Nano             | 15Hz – 10kHz            | 15Hz - 5kHz                 |
| Micro 14- point / 28- point  | 15Hz – 10kHz            | 15Hz - 5kHz                 |
| Micro 20-, 40-, and 64-point | 15Hz – 100kHz           | 15Hz - 65kHz                |

- For VersaMax Nano and Micro PLCs, the frequency of Pulse Train outputs can be changed while the Pulse Train is operating. This is different from the Series 90 Micro PLC, which continues at the previous frequency until the start of the next Pulse Train.
- New COMMREQ for load correction value for pulse train outputs. Sets the change (in  $\mu$ S) that should be applied to the duty cycle of a Pulse Train output to compensate for the slow turn-off time of the optical isolator circuit (see below). The range is 0 to 200 $\mu$ S.  
 35 $\mu$ S - DC outputs for Nano/ 14-point/ 28point;  
 02 $\mu$ S - DC outputs for Micro 64-point;  
 85 $\mu$ S relay outputs for Nano/ 14-point/ 28-point;  
 10 $\mu$ S relay outputs for micro 64-point.
- HSC/PWM/PTO stops during Store or Clear
- PTO/PWM use enable bits (Q0505 to Q0508). A Series 90 PLC did not use bits to enable the PTO/PWM. These bits must be enabled for the PTO/PWM feature to work in the VersaMax Nano/Micros.

## B-2 VersaMax Nano/Micro PWM/Pulse Outputs

Operating parameters for PWM and Pulse Train outputs are specified from the application program by writing a value to the associated %AQ reference. For VersaMax Nano/Micro PLCs, you need only to write the desired value to the %AQ reference. Series 90 Micro PLCs require a mathematical conversion to determine the values to be written to the %AQ references for PWM frequency, PWM duty cycle, and Pulse Train frequency. Therefore, these values will be incorrect if you convert a Series 90 Micro application to a VersaMax Nano/Micro application. You will need to change your application program so that it writes the correct values to the %AQ references.

### B-2.1 %AQ References for PWM

The frequency of the PWM output (15Hz to 5kHz for Nano/14-Point/28-Point; 15Hz – 65kHz for 20-, 40-, and 64-Point) is specified from the application program by writing a value to the associated Frequency register. The PWM duty cycle (0 to 100%) is selected using the associated Duty Cycle register. The number of PWM/PTO channels available varies according to the Nano/Micro model.

| Output 1 | Output 2 | Output 3 | Output 4 | Description                                                                                                                                      |
|----------|----------|----------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| AQ002    | AQ004    | AQ006    | AQ008    | PWM Frequency (15 to 5000): Nano<br>PWM Frequency (15 to 5000): 14-pt<br>PWM Frequency (15 to 5000): 28-pt<br>PWM Frequency (15 to 65000): 64-pt |
| AQ003    | AQ005    | AQ007    | AQ009    | PWM Duty Cycle (0 – 10000)                                                                                                                       |
| Q0505    | Q0506    | Q0507    | Q0508    | Enable Output                                                                                                                                    |

If you don't know the PWM frequency and duty cycle specified by the Series 90 Micro application, you can calculate them from the %AQ reference values. See the formulas that follow.

## B-2.2 %AQ References for Pulse Train

The pulse frequency (15Hz to 5kHz for Nano/14-Point/28-Point; 15Hz – 65kHz for 20-, 40-, or 64-Point) can be controlled from the application program by writing a value to the associated Frequency register, as shown below. The number of pulses to be output (0 to 65535) is selected using the associated Number of Pulses register. The number of PWM/PTO channels available varies according to the Nano/Micro model.

| Output 1 | Output 2 | Output 3 | Output 4 | Description                                                                                                                                              |
|----------|----------|----------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| AQ123    | AQ125    | AQ127    | AQ121    | PWM Frequency (15 to 5000): Nano<br>PWM Frequency (15 to 5000): 14-pt<br>PWM Frequency (15 to 5000): 28-pt<br>PWM Frequency (15 to 65000): 20-/40-/64-pt |
| AQ124    | AQ126    | AQ128    | AQ122    | Number of pulses to send to output (0 to 65535)                                                                                                          |
| Q0505    | Q0506    | Q0507    | Q0508    | Enable Output                                                                                                                                            |
| Q0494    | Q0495    | Q0496    | Q00511   | Start Pulse Train                                                                                                                                        |
| I0494    | I0495    | I0496    | I00511   | Pulse Train Complete                                                                                                                                     |

If you don't know the pulse frequency specified by the Series 90 Micro application, you can calculate them from the %AQ reference values .

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**Note:** Number of Pulses does not require conversion.

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## B-2.3 Enabling Outputs

The output for a channel must be enabled before its PWM or Pulse Train function can be used. A PWM or Pulse Train output is enabled from the application program by setting its Output Enable bit to one. The output is disabled by setting its Output Enable bit to zero.

| Output 1 | Output 2 | Output 3 | Output 4 | Description   |
|----------|----------|----------|----------|---------------|
| Q0505    | Q0506    | Q0507    | Q0508    | Enable Output |

## B-2.4 Load Correction

PWM duty cycles are configurable and Pulse-train outputs have a nominal duty cycle of 50%, but the PLC optical isolators skew the duty cycle to something greater than 50%, depending on temperature and loading due to the output. To compensate for this, the PLC applies load correction to correct the pulse width (duty cycle) of each pulse. The default Load Correction is 40μS, which approximates the correction needed for an output tied directly to an input at 50% duty cycle. The Load Correction can be changed within the range 0 to 200μS by sending the new value in a COMMREQ.

## B-2.5 Formulas for Converting Series 90 Micro Frequencies and Duty Cycles

For additional information about these parameters, refer to the Series 90 Micro User's Manual, GFK-1065.

## B-3 Functions Supported

| Function                         | VersaMax<br>Nano PLC, Micro PLC | Series 90<br>Micro PLC |
|----------------------------------|---------------------------------|------------------------|
| <b>Contacts</b>                  |                                 |                        |
| Normally Open Contact            | all                             | all                    |
| Normally Closed Contact          | all                             | all                    |
| Continuation Contact <+>-        | all                             | all                    |
| <b>Coils</b>                     |                                 |                        |
| Normally Open Coil               | all                             | all                    |
| Negated Retentive Coil           | all                             | all                    |
| Negated Coil                     | all                             | all                    |
| Retentive Coil                   | all                             | all                    |
| SET Coil                         | all                             | all                    |
| Retentive SET Coil               | all                             | all                    |
| RESET Coil                       | all                             | all                    |
| Retentive RESET Coil             | all                             | all                    |
| Positive Transition Coil         | all                             | all                    |
| Negative Transition Coil         | all                             | all                    |
| Continuation Coil -<+>           | all                             | all                    |
| <b>Links</b>                     |                                 |                        |
| Horizontal link                  | all                             | all                    |
| Vertical link                    | all                             | all                    |
| <b>Timers and Counters</b>       |                                 |                        |
| Elapsed Timer                    | all                             | all                    |
| On-Delay Timer                   | all                             | all                    |
| Off-Delay Timer                  | all                             | all                    |
| Up Counter                       | all                             | all                    |
| Down Counter                     | all                             | all                    |
| <b>Math</b>                      |                                 |                        |
| Addition                         | all                             | all                    |
| Addition, double precision       | all                             | all                    |
| Addition, Floating Point         | all                             | not supported          |
| Subtraction                      | all                             | all                    |
| Subtraction, double precision    | all                             | all                    |
| Subtraction, Floating point      | all                             | not supported          |
| Multiplication                   | all                             | all                    |
| Multiplication, double precision | all                             | all                    |
| Multiplication, floating point   | all                             | not supported          |



| Function                                   | VersaMax<br>Nano PLC, Micro PLC | Series 90<br>Micro PLC |
|--------------------------------------------|---------------------------------|------------------------|
| Division                                   | all                             | all                    |
| Division, double precision                 | all                             | all                    |
| Division, Floating Point                   | all                             | not supported          |
| Modulo Division                            | all                             | all                    |
| Modulo Division, double precision          | all                             | all                    |
| Scaling                                    | all                             | not supported          |
| Square Root                                | all                             | all                    |
| Power of x                                 | all                             | not supported          |
| Power of e                                 | all                             | not supported          |
| Trigonometric sine                         | all                             | not supported          |
| Trigonometric cosine                       | all                             | not supported          |
| Trigonometric tangent                      | all                             | not supported          |
| Inverse sine                               | all                             | not supported          |
| Inverse cosine                             | all                             | not supported          |
| Inverse tangent                            | all                             | not supported          |
| Convert to Degrees                         | all                             | not supported          |
| Convert to Radians                         | all                             | not supported          |
| Logarithm, base 10                         | all                             | not supported          |
| Logarithm, natural                         | all                             | not supported          |
| Square Root, double prec.                  | all                             | all                    |
| <b>Relational</b>                          |                                 |                        |
| Equal                                      | all                             | all                    |
| Not Equal                                  | all                             | all                    |
| Less Than or Equal To                      | all                             | all                    |
| Greater Than or Equal To                   | all                             | all                    |
| Less Than                                  | all                             | all                    |
| Greater Than                               | all                             | all                    |
| Equal, double precision                    | all                             | all                    |
| Not Equal, double precision                | all                             | all                    |
| Less Than or Equal To, double precision    | all                             | all                    |
| Greater Than or Equal To, double precision | all                             | all                    |
| Less Than, double precision                | all                             | all                    |
| Greater Than, double precision             | all                             | all                    |
| Range, signed integer                      | all                             | all                    |
| Range, double precision signed integer     | all                             | all                    |
| Range, word                                | all                             | all                    |
| Range, double word                         | all                             | all                    |

| Function                        | VersaMax<br>Nano PLC, Micro PLC | Series 90<br>Micro PLC |
|---------------------------------|---------------------------------|------------------------|
| <b>Bit Operation</b>            |                                 |                        |
| Bit Set                         | all                             | all                    |
| Logical AND                     | all                             | all                    |
| Bit Clear                       | all                             | all                    |
| Logical OR                      | all                             | all                    |
| Bit Test                        | all                             | all                    |
| Logical Exclusive OR            | all                             | all                    |
| Bit Position                    | all                             | all                    |
| Logical Invert                  | all                             | all                    |
| Shift Left                      | all                             | all                    |
| Shift Right                     | all                             | all                    |
| Rotate Left                     | all                             | all                    |
| Rotate Right                    | all                             | all                    |
| Masked Compare, word            | all                             | all                    |
| Masked Compare, double word     | all                             | all                    |
| <b>Data Move</b>                |                                 |                        |
| Multiple Integer Move           | all                             | all                    |
| Constant Block Move, Integer    | all                             | all                    |
| Multiple Bit Move               | all                             | all                    |
| Multiple Word Move              | all                             | all                    |
| Constant Block Move             | all                             | all                    |
| Block Clear                     | all                             | all                    |
| Shift Register Word             | all                             | all                    |
| Shift Register Bit              | all                             | all                    |
| Bit Sequencer                   | all                             | all                    |
| Communication Request           | all                             | all                    |
| <b>Table Functions</b>          |                                 |                        |
| Search equal to                 | all                             | all                    |
| Search not equal to             | all                             | all                    |
| Search less than                | all                             | all                    |
| Search less than or equal to    | all                             | all                    |
| Search greater than             | all                             | all                    |
| Search greater than or equal to | all                             | all                    |
| Array move                      | all                             | all                    |
| <b>Conversion</b>               |                                 |                        |
| Integer to BCD                  | all                             | all                    |
| BCD to integer                  | all                             | all                    |

| Function                              | VersaMax<br>Nano PLC, Micro PLC         | Series 90<br>Micro PLC |
|---------------------------------------|-----------------------------------------|------------------------|
| <b>Control</b>                        |                                         |                        |
| Comment                               | all                                     | all                    |
| End                                   | all                                     | all                    |
| no operation                          | all                                     | all                    |
| Nested Jump                           | all                                     | not supported          |
| Non-Nested Jump                       | not supported                           | All                    |
| Nested master control relay           | all                                     | not supported          |
| Target number for jump                | all                                     | all                    |
| Nested endmcr                         | all                                     | not supported          |
| Master Control Relay (non-nested)     | not supported                           | all                    |
| End Master Control Relay (non-nested) | not supported                           | all                    |
| Do I/O update                         | all                                     | Rel. 3.00              |
| PID-ISA algorithm                     | all                                     | all                    |
| PID-IND algorithm                     | all                                     | all                    |
| Service Request                       | all                                     | all                    |
| Drum Sequencer                        | all                                     | all                    |
| <b>Communication</b>                  |                                         |                        |
| Modbus_TCP_RW                         | Micro 20, 40, 64<br>Rel. 3.83 and later | not supported          |
| <b>Motion</b>                         |                                         |                        |
| Find Home                             | Micro 20, 40, 64<br>Rel. 3.60 and later | not supported          |
| Go Home                               | Micro 20, 40, 64<br>Rel. 3.60 and later | not supported          |
| Jogging                               | Micro 20, 40, 64<br>Rel. 3.60 and later | not supported          |
| Blending                              | Micro 20, 40, 64<br>Rel. 3.60 and later | not supported          |
| Stop Motion                           | Micro 20, 40, 64<br>Rel. 3.60 and later | not supported          |

## B-4 Program References

The table below compares reference sizes for VersaMax and Series 90 Micro PLCs with similar numbers of I/O points.

| Reference Type                       | Reference Range           | VersaMax 10-Point Nano PLCs | VersaMax 14-Point Micro PLCs | VersaMax 23- and 28-Point Micro PLCs | Series 90 14-Point Micro PLCs | Series 90 23- and 28-Point Micro PLCs |
|--------------------------------------|---------------------------|-----------------------------|------------------------------|--------------------------------------|-------------------------------|---------------------------------------|
| User program logic                   | Not applicable            | 2K words                    | 9K words                     | 9K words                             | 3K words                      | 6K words                              |
| Register references                  | %R0001 - %R0256 or %R2048 | 256 words                   |                              | 2K words                             | 256 words                     | 2K words                              |
| Discrete inputs                      | %I0001 - %I0512           | 512 bits                    |                              |                                      |                               |                                       |
| Discrete outputs                     | %Q0001 - %Q0512           | 512 bits                    |                              |                                      |                               |                                       |
| Discrete global references           | %G0001 - %G1280           | 1280 bits                   |                              |                                      |                               |                                       |
| Discrete internal coils              | %M0001 - %M1024           | 1024 bits                   |                              |                                      |                               |                                       |
| Discrete temporary coils             | %T0001 - %T0256           | 256 bits                    |                              |                                      |                               |                                       |
| System status references             | %S0001 - %S0032           | 32 bits                     |                              |                                      |                               |                                       |
|                                      | %SA0001 - %SA0032         | 32 bits                     |                              |                                      |                               |                                       |
|                                      | %SB0001 - %SB0032         | 32 bits                     |                              |                                      |                               |                                       |
|                                      | %SC0001 - %SC0032         | 32 bits                     |                              |                                      |                               |                                       |
| Analog and High-Speed Counter inputs | %AI0001 - %AI0128         | 128 words                   |                              |                                      |                               |                                       |
| Analog outputs                       | %AQ0001 - %AQ0128         | 128 words                   |                              |                                      |                               |                                       |

## Appendix C: Battery Backup Options

Backup battery options are available for 20-, 23-, 28-, 40-, and 64-point VersaMax Micro PLCs. A backup battery protects the RAM memory contents of the PLC when the PLC power is removed or turned off. The battery also backs up the CPU's real-time clock.

### C-1 CPU Battery Consumption

The battery consumption of the Micro PLC depends on whether the power is on or off and on the serial number of the Micro PLC. Consumption with the power off is greater at higher temperatures.

| Controller Status | Battery Consumption per Hour                                                            |
|-------------------|-----------------------------------------------------------------------------------------|
| Power ON          | PLCs with serial number prior to 07000069274: 30 $\mu$ A                                |
|                   | PLCs with serial number after 07000069274: 3 $\mu$ A                                    |
| Power OFF         | PLCs with serial number prior to 07000069274:<br>83 $\mu$ A @ 70°C<br>36 $\mu$ A @ 20°C |
|                   | PLCs with serial number after 07000069274:<br>56 $\mu$ A @ 70°C<br>9 $\mu$ A @ 20°C     |
|                   | 20-, 40-, and 64-Pt Micro PLCs:<br>31 $\mu$ A @ 55°C<br>3 $\mu$ A @ 25°C                |

### C-2 Backup Batteries for VersaMax Micro PLCs

Two types of backup battery are available, IC200ACC403 and IC200ACC414.

| Part Number | Battery Type  | Battery Capacity | Memory Backup at 70C (power OFF continuous)            | Memory Backup at 20C (power OFF continuous)             |
|-------------|---------------|------------------|--------------------------------------------------------|---------------------------------------------------------|
| IC200ACC403 | Coin Type     | 3.0 Vdc @ 210mAh | 3.5 months <sup>23</sup><br>5.2 months <sup>24</sup>   | 8.1 months <sup>23</sup><br>32.4 months <sup>24</sup>   |
| IC200ACC414 | Cylinder Type | 3.6 Vdc @ 790mAh | 13.2 months <sup>23</sup><br>19.6 months <sup>24</sup> | 30.4 months <sup>23</sup><br>121.9 months <sup>24</sup> |

The High Capacity battery (IC200ACC414) is provided with a special battery holder that is compatible with all 20-, 23-, 28-, 40- and 64-point VersaMax Micro PLCs.

<sup>23</sup> Units with serial number prior to 07000069274 (manufactured before November 2002)

<sup>24</sup> Units with serial number after 07000069274 (manufactured after November 2002)

## C-3 Calculating the Life of a Battery

This example compares typical battery longevity for the two types of Micro PLC backup battery, for VersaMax Micro PLCs with a serial number after 07000069274.

In this example, a machine sits at the OEM facility for 30 days with the battery attached to the Micro PLC CPU, prior to shipment to the end user. No power is applied.

- CPU battery consumption during 30 days with no power: 40,320  $\mu$ A:

24 hours x 56  $\mu$ A per hour = 1,344 x 30 days = 40,320  $\mu$ A (worst case of 70°C storage temperature)

After the machine is shipped and installed, the end user maintains power on the machine 24 hours a day but shuts down the machine during the weekends.

- Power ON: 24 hours x 3  $\mu$ A = 72  $\mu$ A/day
- Power ON: 5 days x 72  $\mu$ A = 360  $\mu$ A/5 days
- Power OFF: 48 hours x 32.5  $\mu$ A (45°C cabinet temperature) = 1560  $\mu$ A/weekend
- Total weekly usage: 1,920  $\mu$ A

### C-3.1 For Standard Backup Battery IC200ACC403

Standard Backup Battery has 210,000  $\mu$ A available. In this example, subtracting the CPU battery consumption during the 30 days at the OEM facility (40,320, see above), would leave 169,680  $\mu$ A still available. Therefore, the battery would last approximately 1.7 years (88 weeks) at the end-user location before needing replacement:

169,680 divided by 1,920 total weekly usage (see above) = 88 weeks

### C-3.2 For High Capacity Battery IC200ACC414

High-capacity Backup Battery has 790,000  $\mu$ A available. In the example, subtracting the CPU battery consumption at the OEM facility (40,320) would leave 749,680  $\mu$ A still available. Therefore, the battery would last approximately 7.5 years (390 weeks) at the end user location before needing replacement:

749,680 divided by 1,920 weekly usage (see above) = 390 weeks.

## Appendix D: Input Simulators

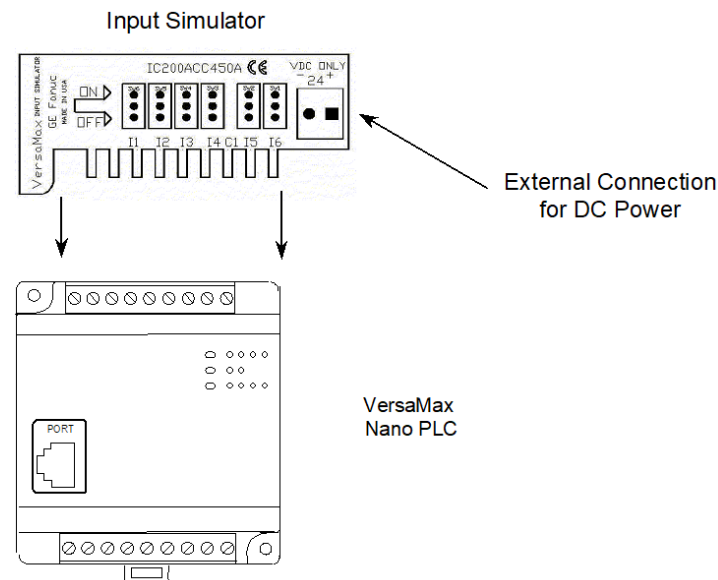
This section describes input simulators that can be used to easily turn on or off any DC input point on a VersaMax Nano PLC or VersaMax Micro PLC.

- IC200ACC450 Input Simulator for DC-powered VersaMax Nano PLCs
- IC200ACC451 Input Simulator for DC-powered VersaMax Micro PLCs and Expansion Units

### D-1 IC200ACC450 Input Simulator for DC-powered VersaMax Nano PLCs

The six-position DC input simulator connects directly to the input terminals on a VersaMax Nano PLC. An external connection for the 12Vdc or 24Vdc is required.

Figure 394



#### D-1.1 Compatibility

Input Simulator IC200ACC450 is compatible with any DC input VersaMax Nano PLC. The input simulator is not to be used with AC Inputs.

## D-1.2 Installation Instructions

### ⚠ WARNING

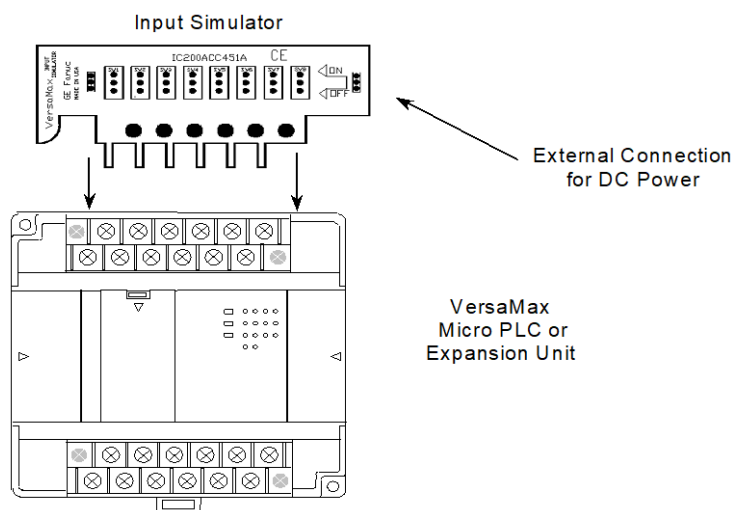
To avoid a risk of electric shock, turn off power to the VersaMax Nano PLC and disconnect the main power before attaching the Input Simulator.

1. Loosen all screws on the input terminal block.
2. Insert the Input Simulator as shown above.
3. Tighten all screws on the input terminal block.
4. Turn power on and turn switches on the simulator ON and OFF. The corresponding LEDs on the VersaMax Nano PLC should light up, showing proper installation. If the LEDs do not light, power down and recheck the screws to make sure they are tight.

## D-2 IC200ACC451 Input Simulator for DC-powered VersaMax Micro PLCs and Expansion Units

The eight position DC input simulator connects directly to the input terminals of a VersaMax Micro PLC or Expansion Unit. The connection takes advantage of the 24Vdc provided by the Micro PLC or Expansion Unit; no external wiring is required.

Figure 395



### D-2.1 Compatibility

Input Simulator IC200ACC451 is compatible with any VersaMax DC input:

- 14-point, 23-point, or 28-point Micro PLC
- 14-point or 28-point Expansion Unit

The input simulator is not to be used with AC Inputs.



## D-2.2 Installation Instructions

### **WARNING**

To avoid a risk of electric shock, turn off power to the VersaMax Micro PLC or Expansion Unit, and disconnect the main power before attaching the Input Simulator.

1. Loosen all screws on the input terminal block.
2. Insert the Input Simulator as shown above.
3. Tighten all screws on the input terminal block.
4. Turn power on and turn switches on the simulator ON and OFF. The corresponding LEDs on the Micro PLC or Expansion Unit should light up, showing proper installation. If the LEDs do not light, power down and recheck the screws to make sure they are tight.

## Appendix E: Relay Contact Ratings

This section shows relay contact ratings for modules with output relays.

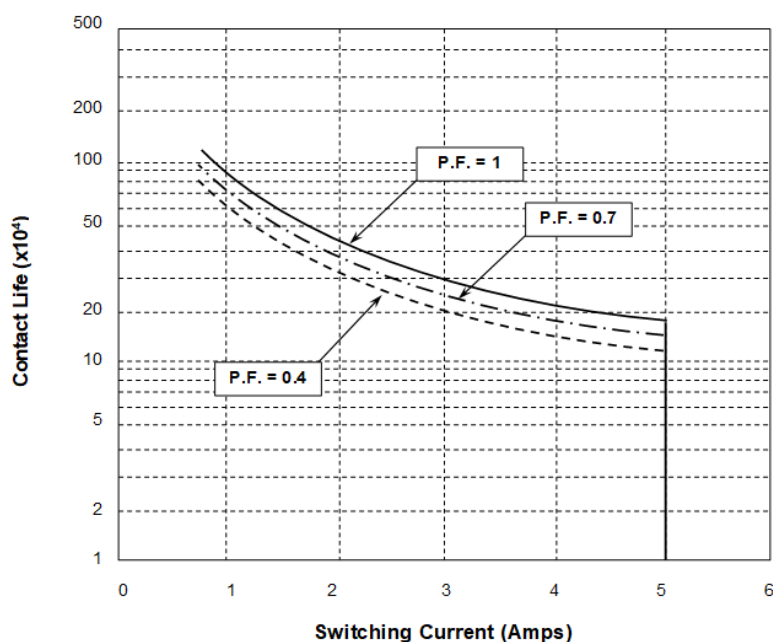
| Load Condition |            | Current (Amps) |
|----------------|------------|----------------|
| 125Vac         | P.F. = 1   | 0.6            |
|                | P.F. = 0.7 | 0.4            |
|                | P.F. = 0.4 | 0.2            |
| 250Vac         | P.F. = 1   | 0.9            |
|                | P.F. = 0.7 | 0.6            |
|                | P.F. = 0.4 | 0.3            |
| 30Vdc          | L/R = 1ms  | 0.6            |
|                | L/R = 7mS  | 0.3            |
|                | L/R = 15mS | 0.15           |

P.F. = power factor for AC inductive loads

L/R = time constant for DC inductive loads

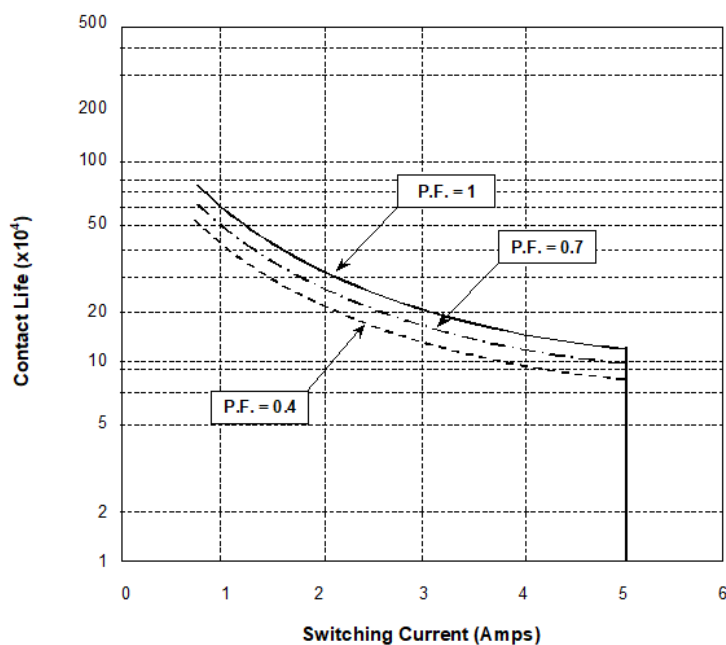
### E-1 125Vac

Figure 396



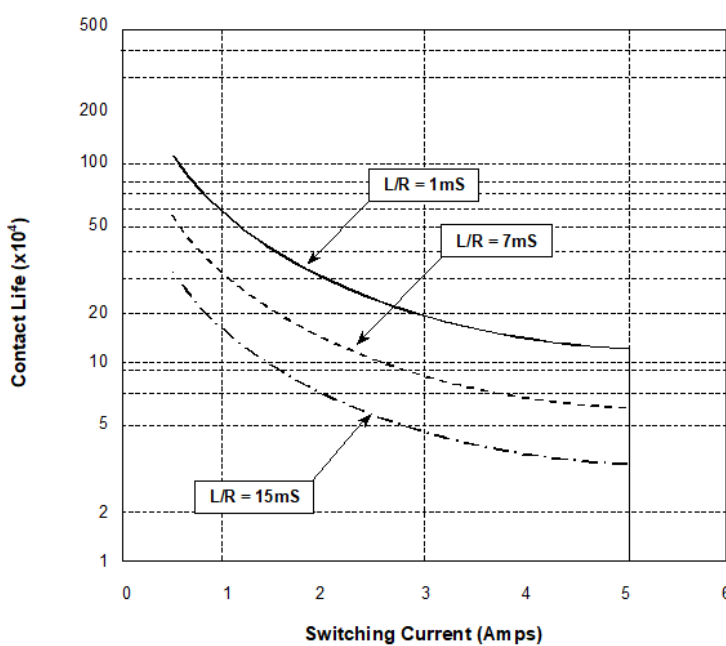
## E-2 250Vac

Figure 397



## E-3 30Vdc

Figure 398



## Technical Support & Contact Information

Home link: <http://www.Emerson.com/Industrial-Automation-Controls>

Knowledge Base: <https://www.emerson.com/Industrial-Automation-Controls/support>

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