iT300 Series
Intelligent Configurable Transmitters
Installation and Operating Manual

Models iT300 and iT301

Please read this manual thoroughly before making electrical connections and applying power to the module. Following the instructions in this manual will ensure the transmitter delivers optimum performance.

Newer versions of firmware may occasionally be released to address known bugs or add new features. Make sure you always use the latest firmware version and product documentation. Both can be found at www.wilcoxon.com.

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1 Introduction

This document contains information on the installation, configuration and operation of the iT300 Series of Intelligent Transmitters. The vibration transmitters are designed and manufactured in the USA by Wilcoxon Sensing Technologies, Germantown, Maryland.

2 Description

The iT300 Series of configurable transmitter modules perform acquisition and processing of dynamic vibration signals. The transmitters are field configurable. Configurable parameters include: input signal type, measurement bandwidth, detector type, output type, English or metric measurement units, 4-20 mA driving source and full-scale range. Configuration may be performed in the field, using a common web browser. No custom or proprietary software is required. There are no hardware jumpers to set.

The iT300/301 transmitters accept vibration signals from piezoelectric (IEPE-type) accelerometers, piezovelocity transducers (PVT™) and other sensors with comparable electrical characteristics. They also feature an input for connection to a Model 786T-type (or compatible) temperature sensor.

The iT300/301 transmitter module conditions, digitizes and processes the input signal using powerful DSP technology. All filtering, frequency selection, sub-sampling and power detection is performed digitally, for consistent, reliable results. Selected measurement results are then scaled and converted to dual 4-20 mA analog outputs. On iT301 models, measurement results and operational status are also mapped to Modbus digital outputs.

iT300/301 transmitters are housed in a durable plastic enclosure with a 35 mm DIN rail mount. The transmitter front panel features multiple LEDs, a BNC connector for the buffered sensor output, a "factory restore" push-button switch, and a standard RJ45 jack for the Ethernet connection. The LEDs provide at-a-glance operational status and indicate when power, sensor and 4-20 mA loops are correctly connected to the transmitter and working properly. Removable, uniquely-keyed terminal blocks allow for easy wiring and ensure correct terminal block installation into the various transmitter IO ports.

3 Key features

3.1 General features (all models)

- Field configurable via standard web browser
- 0.2 Hz – 20 kHz signal bandwidth (-3.0 dB, -0.1 dB)
- 20 V p-p sensor input range, >90 dB dynamic range
- DSP signal processing with 1,600-line FFT
- Built-in 4.5 mA constant current source for IEPE sensors
- Buffered sensor output on the front-panel BNC connector
- Buffered, dynamic signal outputs on terminal block
- RMS, peak and peak-to-peak detection
- Fast, true-peak detector for capturing short transients and impulses
- Dual, 4-20 mA active current loop outputs with diagnostic test mode
- Two configurable frequency bands
- Digital acceleration-to-velocity or velocity-to-displacement conversion, based on sensor type
- Selectable English or metric measurement units
- 6-way isolated (500 VAC) IO ports to prevent ground loops
- Wide, 11-32 VDC power supply input with reverse polarity and transient protection
- TBUS power and data buses
- ESD and short circuit protection on all ports
- Pluggable, individually-keyed terminal blocks with screw terminals on all ports
- Multiple front panel LED status indicators
- Front panel factory restore switch
- Auto-MDIX 10/100 Ethernet with HTTP web server
- Field upgradable firmware
- 35 mm DIN rail mounting, stackable on TBUS
- 4-terminal wide (22.5 mm) modular housing
- Wide operating temperature range of -40 °C to +70 °C
- CE approvals, RoHS compliant

3.2 iT301 advanced features

- Configurable alarms
- Relay output with NO/NC contacts and test mode
- Modbus over RS485
- Modbus TCP over Ethernet

4 Abbreviations used in this manual

ASCII	American Standard Code for Information Interchange
BOV	Bias Output Voltage (DC)
BPS	Bits Per Second
DCS	Distributed Control System
DHCP	Dynamic Host Configuration Protocol
DIN	Deutsches Institut für Normung
DSP	Digital Signal Processor/Processing
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
FFT	Fast Fourier Transform
HTTP	Hypertext Transfer Protocol
IEEE	Institute of Electrical and Electronics Engineers
IEPE	Integrated Electronics Piezo Electric
IO	Input-Output
IPS	Inches Per Second
LAN	Local Area Network
LED	Light Emitting Diode
mA	milliamps
ms	milliseconds
mV	millivolts
MDIX	Medium Dependent Interface Crossover
NC	Normally closed
NO	Normally open
PLC	Programmable Logic Controller
RMS	Root-mean-square
RoHS	Restriction of Hazardous Substances Directive
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SNR	Signal-to-Noise-Ratio
UI	User Interface

5 Safety Regulations and Installation Notes

WARNING: This symbol indicates a caution or warning that, if ignored, could cause damage to the product or connected equipment.

This symbol indicates a technical tip or advice on operation that provides helpful information on how to use or configure the module.

WARNING: Risk of electric shock

- During operation, certain parts of this device may carry hazardous voltages. Disregarding this warning may result in damage to equipment and/or serious personal injury.
- Provide a switch/circuit breaker close to the device, which is labeled as the disconnect device for this device or the entire control cabinet.
- Provide overcurrent protection (I ≤ 6 A) in the installation.
- Disconnect the device from all power sources during maintenance work and configuration (the device can remain connected to SELV or PELV circuits).

5.1 Safety summary

- Because this product is designed to be used in an industrial environment, personnel involved with the installation, operation and maintenance of this instrument should be familiar with all plant safety requirements before using this product. Only qualified personnel should perform installation and service.
- The transmitter must not be opened. There are no user serviceable parts within the product. Do not attempt to repair or modify the module. Replace the module only with an equivalent device.
- The IP20 ingress protection rating (IEC 60529/EN 60529) implies the module is intended for installation and use only in a clean and dry environment. The module must not be subjected to stresses or thermal conditions which exceed the specified limits.
- The device is not designed for use in atmospheres with a danger of dust explosions. If dust is present, the module must be installed within an approved housing, whereby the surface temperature of the housing must be taken into consideration.
- Use common sense and avoid haste during installation and operation of this product.

5.2 Declaration of conformity

This product complies with the standards for:

- Electrical safety according to EN61010-1
- Limits and methods of measurement of radio disturbance characteristics
- Limits for harmonic current emissions
- RoHS Directive, 2011/65/EU

6 iT300 family overview

iT300 Base model. Accepts input from IEPE accelerometers or velocity transducers. Temperature sensor input.

iT301 Same as iT300, but adds: alarm capability, signal relay output, Modbus over RS485, Modbus-TCP.

7 System diagrams

7.1 Major system components

Figure 1 - Major system components

#	Description
1	Sensor/transducer inputs
2	(Empty)
3	Buffered, dynamic outputs
4	Signal relay contacts*
5	4-20 mA current loop outputs
6	Power input / RS485 serial interface*
7	LED indicators
8	Factory restore / alarm clear button
9	Ethernet connection
10	Buffered sensor output BNC connection
11	TBUS card-edge connector
12	DIN rail

*iT301 only

7.2 Basic circuit diagram

Shown below are the major functional blocks of the transmitter.

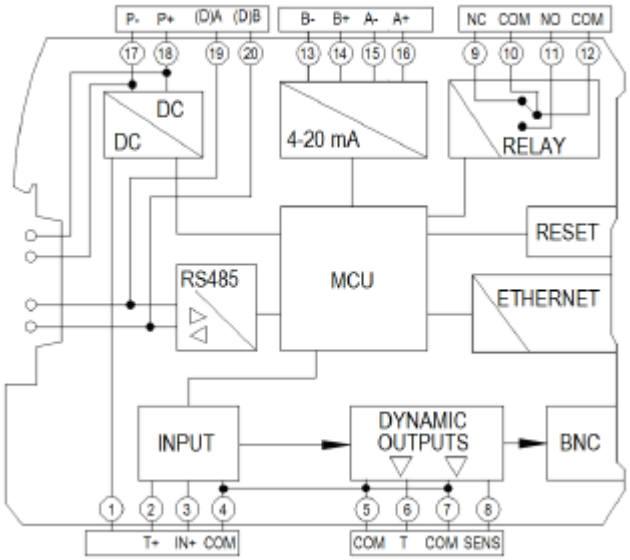


Figure 2 - Basic circuit diagram

7.3 Isolation diagram

The transmitter features 500 VAC functional isolation between six zones: 1.) power input, 2.) sensor input, 3.) 4-20 mA outputs, 4.) Ethernet-LAN, 5.) RS485, 6.) signal relay. Figure 3 shows the isolation zones.

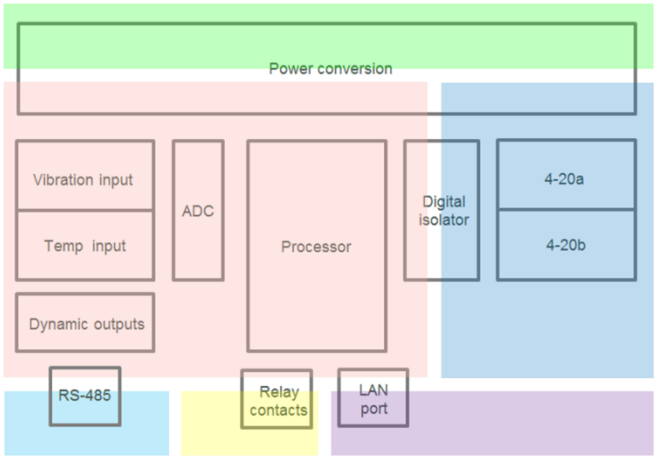


Figure 3 - Isolation diagram

CAUTION! Functional or operational isolation is necessary only for the correct functioning of the product. It does **not** protect or isolate against electrical shock.

8 Front panel LEDs

8.1 Operating modes

Multiple LEDs, located on the front panel, indicate the module's operating modes.

PWR
The green PWR LED indicates power and test mode status.

○	OFF	Unit not powered
●	ON	Normal operating mode
✳	BLINKING	One or more test modes active (4-20 mA loops or signal relay)

RLY (iT301)
The yellow RLY LED indicates the relay status.

○	OFF	Relay not energized (NO contacts = open, NC contacts = closed)
●	ON	Relay energized (NO contacts = closed, NC contacts = open)

ERR
The red ERR LED indicates system and connection faults.

○	OFF	No faults – normal operation
●	ON	Sensor fault (priority)
✳	BLINKING	4-20 mA loop fault

See section 20 "Troubleshooting" for information about correcting fault conditions.

RS485 (iT301)
The yellow RS485 LED indicates RS485 data activity.

○	OFF	Non-matching address/RS485 idle
✳	FLASH	RS485 Modbus packet with matching slave address received

The RS485 LED will flash each time the module receives a Modbus packet that contains a matching slave address. Data packets not addressed to the module are ignored and do not cause LED activity.

Ethernet Status
Green and yellow LEDs, located on the RJ45 jack, provide status of the Ethernet interface.

Yellow (Link speed)

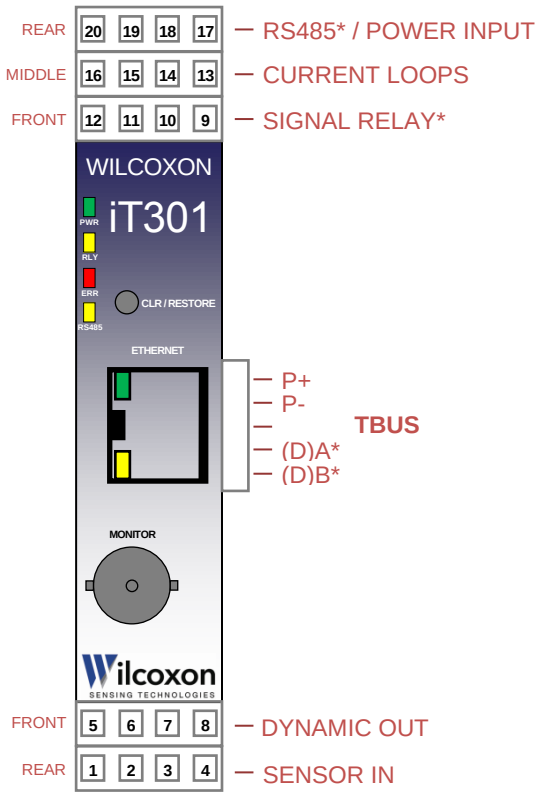
○	OFF	10 Mbps
●	ON	100 Mbps

Green (Link/activity)

○	OFF	No link
●	ON	Link established (blinks with link activity)

9 IO ports and signal assignments

9.1 Terminal block locations and pin numbers



*iT301 only

Figure 4 - IO port and terminal block locations

9.2 Terminal block pin and signal assignments

IO Port	Terminal numbers and signal assignments
Vibration sensor	1 – No connection 2 – Temperature sensor in (T+) 3 – Signal in / Sensor Power (IN+) 4 – Circuit Common (COM)
Temperature dynamic output	5 – Circuit Common (COM) 6 – Temperature out (T)
Sensor dynamic output	7 – Circuit Common (COM) 8 – Sensor out (SENS)
Signal relay*	9 – Normally closed (NC) 10 – Relay common (COM) 11 – Normally open (NO) 12 – Relay common (COM)
4-20 mA Loop B	13 – B- 14 – B+
4-20 mA Loop A	15 – A- 16 – A+
Power input	17 – P- 18 – P+
RS485*	19 – (D)A 20 – (D)B

* iT301 only

Table 1 - Terminal numbers and signal assignments

10 Electrical connections and wiring

10.1 ESD precaution

CAUTION! electrostatic discharge

Although the transmitter contains ESD suppression devices on all IO ports, components still can be damaged or destroyed by large magnitude electrostatic discharge. When handling the module or making electrical connections, observe the necessary safety precautions against ESD according to EN 61340-5-1 and IEC 61340-5-1. This will reduce the possibility of damage caused by ESD.

10.2 Pluggable terminal blocks

CAUTION! Electrical connections should not be made with power applied to the module.

All electrical connections to the transmitter are made using pluggable terminal blocks. The removable terminal blocks have screw terminals for easy wiring and are uniquely keyed to ensure correct installation into the various transmitter IO ports.

The terminal blocks accept 12 AWG through 24 AWG size wire (cable cross section: 0.2...2.5 mm²).

To make a connection to a terminal block:

1. Strip wire to 0.25" (6.4 mm)
2. Optionally, install a ferrule onto the wire and crimp securely
3. Insert the wire into the terminal block
4. Use a flat-blade screwdriver to tighten the screw to a torque of 0.6 Nm (2.1 oz/in)

10.3 Sensor/transducer connections

Connect the IEPE vibration sensor as shown in "Figure 5 - Sensor connections".

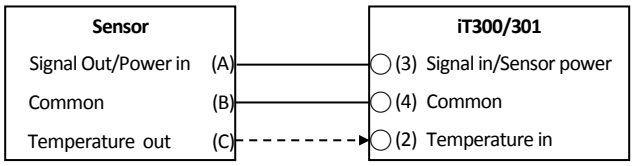


Figure 5 - Sensor connections

A 786T accelerometer with a temperature output utilizes the temperature input on terminal #2. The temperature portion of the sensor is powered by the accelerometer circuit.

Note: Connection of a temperature sensor is optional.

10.4 4-20 mA current loop connections

Route the Loop A and Loop B 4-20 mA outputs to a compatible monitoring system as shown, being careful to use a properly sized load resistor. The transmitter sources the voltage and current for both loops.

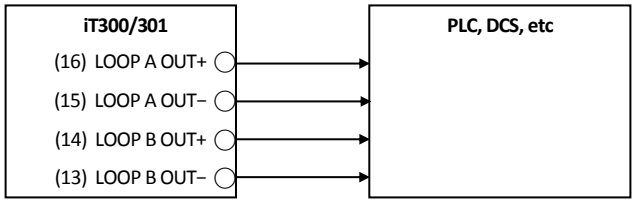


Figure 6 - 4-20 mA current loop connections

Caution: The 4-20 mA outputs will not work with externally powered loops.

Tech tip! If a 4–20 mA output is not required by the application or is to remain unconnected, the loop must be disabled, via the UI, to prevent a current loop fault from being indicated by the transmitter. **By default, Loop A is enabled and Loop B is disabled**. See section 18.7, "4-20 mA current loops" for information on how to configure the current loop outputs.

10.5 Dynamic output connections

A buffered, unfiltered version of the AC vibration sensor signal, riding on the BOV, is available as a terminal block output. This output is in parallel with the front-panel BNC connector.

A buffered and low-pass-filtered version of temperature sensor signal is also available as a terminal block output.

All dynamic outputs are short circuit protected and have a 50 Ω output impedance.

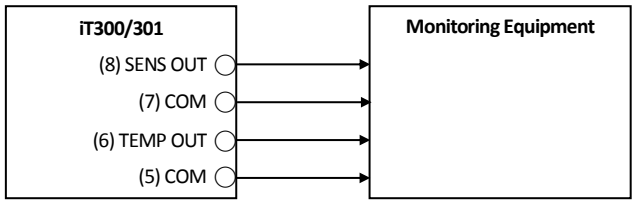


Figure 7 - Dynamic output connections

10.6 Signal relay connections (iT301)

A mechanical relay provides both normally open (NO) and normally closed (NC) contacts on a single terminal block. The contacts can be wired to the monitoring equipment, as required by the application. The operation of the relay is configured via the UI.

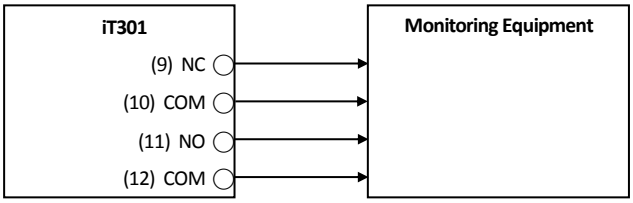


Figure 8 - Relay connections

The relay contacts are rated 30 volts DC, 2A and are electrically isolated from all other internal circuits.

Tech tip! The relay "COM" terminals are simply the center pole of the relay contacts. They are not connected to any other circuit "common."

10.7 Power supply input connections

Connect a 24-volt DC (11 – 32 volts, allowable) power source to the power input terminals, as shown. Optionally, the module may be powered via the TBUS.

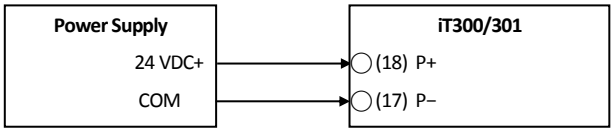


Figure 9 - Power supply connections

WARNING: The supply voltage must not exceed 33 volts or damage to the module may occur.

WARNING: The maximum current handling capacity of the power supply input terminals is 4 amps. When using these terminals to supply power to the TBUS, do not exceed the 4-amp rating.

WARNING: The iT300 TBUS is NOT compatible with older Wilcoxon Research iT100/200, iT401 or iT501 series modules. When connecting modules via the TBUS, connect only iT300 series modules together on the same bus. Do not connect any other types of modules or devices to an iT300 TBUS. Doing so may result in damage to the modules.

10.8 Cable shielding and earth ground connections

Shielding and proper earth grounding are important for the mitigation of interference and proper operation of the transmitter. A good shield connection prevents egress of transmitted signals and ingress of interfering sources. Faulty shield connections, along with the presence of external sources of interference, can adversely affect signal integrity. Ensure all cable shields are properly terminated and connected correctly, as required by the application.

There is no "shield" or earth ground connection on the transmitter module. Cable shields should be properly connected to protective earth (PE) ground external to the transmitter, as called for by the application. For best electrical performance, cable shields should be terminated as close as possible to the transmitter.

Wilcoxon provides enclosures with integrated grounding bus bars that are located in proximity with the DIN rail. The bus bar should be connected to a central earthing point using short, low-impedance connections with a large surface area.

To facilitate connecting cable shields to earth ground, DIN-mount shield connection clamps and grounding terminal blocks are available from Wilcoxon. See section 25, "Accessories" for a complete list of items to complement the installation and operation of the transmitter.

The type of shield connection should be determined by the expected operating environment:

- Connecting the shield at only one equipment end works to suppress interference caused by electrical fields.

- Connecting the shield at both equipment ends works to suppress interference caused by dynamic magnetic fields. When connecting the shield at both ends, the possibility of ground loops must be considered; galvanic disturbances along the reference potential can interfere with the signal, thereby reducing the effectiveness of the shielding.

11 Power-up

After all wires are connected, power can be applied to the module. The module begins its power-up sequence immediately after power is applied. There is no on-off switch.

During power-up, all front-panel LED indicators will illuminate for three seconds while a self-check is performed. After the unit has completed its self-check, the green PWR LED will remain on. If the transmitter passes its self-test and the sensor and primary 4-20 mA loop are connected correctly, the red ERR LED will be off.

See section 8, "Front panel LEDs" for detailed explanation of LEDs and unit operating status.

12 IO ports – detailed description

12.1 Vibration sensor input

The transmitter has been designed to accept signals from piezoelectric (IEPE-type) accelerometers, velocity transducers and other compatible sensors that have a BOV of approximately 12 volts. This allows the maximum input signal swing without clipping. If the BOV deviates significantly from 12 volts, the maximum allowable input signal swing and dynamic range will be reduced accordingly. The analog input circuitry is powered by +24 VDC.

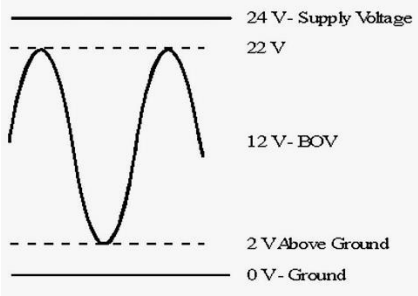
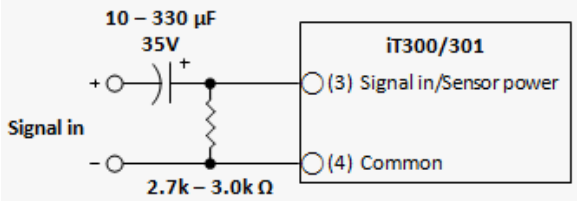


Figure 10 - Maximum input signal swing with 12V BOV

12.1.1 Constant current IEPE power source

The built-in current source (IEPE Power) is enabled by default and supplies a nominal 4.5 mA to the attached sensor. The current source can be disabled, via the UI, to allow the connection of an external voltage.

Tech tip! In all cases, the input signal must have a DC bias of at least +5.5 volts. Signal sources not compliant with this requirement can use the biasing circuit shown below. If more information is required, contact Wilcoxon technical support.



Capacitance	-3dB frequency
10 µF	6 Hz
47 µF	1.2 Hz
100 µF	0.6 Hz
330 µF	0.2 Hz

Figure 11 - RC coupling circuit

12.1.2 BOV acceptable range and sensor fault detection

The module continuously monitors and reports the BOV of the sensor signal. If the DC level falls outside the acceptable range, a sensor fault will be indicated. When a sensor fault is detected, the UI will display "**Fault**" next to the BOV reading and the front-panel **ERR** LED ● will illuminate. **A sensor fault will cause the 4-20 mA loop current to be set to 2 mA on each enabled loop.** A loop current of less than 4 mA conveys the fault condition to the 4-20 mA monitoring equipment. This complies with NAMUR NE43.

For the iT300, ***the acceptable range for the BOV is 5 to 16 volts and is not user adjustable.*** For the iT301, the acceptable range for the sensor BOV can be adjusted via UI.

If a sensor fault is indicated, the sensor BOV should be checked with an isolated (hand-held) DC voltmeter at the BNC connector and verified it is within the acceptable range. The BOV is also displayed on the UI. See section 20, "Troubleshooting" for more information on sensor faults.

12.2 Temperature sensor input

The transmitter supports a 786T-type (or similar) accelerometer with temperature sensor with a sensitivity of 10 mV/°C. The input range for the temperature signal is 0 VDC to +1.2 VDC. Before being passed to the processing circuitry and dynamic output terminals, the temperature input signal is low-pass filtered to remove noise and high frequency content.

Connection of a temperature sensor is optional. If a temperature sensor is not connected, the transmitter will read a temperature of approximately 0 °C (32 °F).

12.3 4-20 mA current loop outputs

The transmitter provides two analog, 4-20 mA current loop outputs. The outputs are usually wired to a Programmable Logic Controller (PLC) or a Distributed Control System (DCS). The loop current is proportional to the measurement result that is mapped as the loop driving source. Measurement results (process variables) are mapped to the current loops via the UI.

Both current loop outputs are "active." That is, the outputs source the voltage and current for the loops and are designed to be connected to a passive, resistive load. The total loop resistance, including the load resistor, should not exceed 500 Ω.

If the loop resistance is too high or if an output is unconnected, a loop fault will be detected by the module. When a loop fault is detected, "**Fault**" will be displayed in the Level (mA) field on the UI and the ERR LED on the front panel will blink. If a loop is not needed in the application or is to remain unconnected, it should be disabled via the UI. Disabling the loop will set the current to 0 mA and prevent a loop fault from being indicated. **By default, the primary loop (Loop A) is enabled and the secondary loop (Loop B) is disabled.** These settings may be changed via the UI.

Loop compliance voltage is 15 volts, ±5%. The current loop outputs are electrically isolated from all other internal circuitry and are protected from short circuits.

Caution: The 4-20 mA outputs will not work with externally powered loops.

12.3.1 Loop error state when sensor fault detected

The transmitter complies with Namur NE43 recommendations for indicating a sensor fault to a control system by means of the 4-20 mA signal. If the transmitter detects a fault with the vibration sensor input, the current in the enabled loops will be set to 2 mA. This conveys the condition of a sensor fault to the 4-20 mA monitoring equipment. See section 12.1.2, "BOV acceptable range and sensor fault detection".

12.3.2 Loop force mode (test mode)

A loop test function is provided to allow loop current to be forced to any value between zero and 20 mA. This feature permits testing of the loops and receiving equipment using various, user-defined currents. When either loop is placed in test mode, a green indicator on the UI and the **PWR** LED on the front panel will both blink. Test mode is controlled via the UI. See section 18.7.5 for details.

12.4 Power supply input

A 24-volt DC power source is normally used to power the transmitter. To provide greater installation flexibility, the power source voltage may range from 11 volts to 32 volts DC. This allows the use of power supplies with outputs other than 24 volts. The power inputs are protected from a reverse polarity condition and are electrically isolated from all other internal circuitry.

WARNING: The power supply voltage must not exceed 33 volts or damage to the module may occur.

WARNING: The maximum current handling capacity of the power supply input terminals is 4 amps. When using these terminals to supply power to the TBUS, do not exceed the 4-amp rating.

12.5 BNC dynamic signal output

A buffered sensor output is available on the front-panel BNC connector. This allows live, on-line signal analysis and testing of the sensor. This analog output is a buffered version of the raw, unfiltered sensor signal allowing full spectrum analysis.

The BNC output is short circuit protected and has an output impedance of 50 Ω.

Note: When connecting a portable data collector or online monitoring system to the dynamic outputs the external meter's internal constant current source, if so equipped, should be turned off. Failure to do so may result in a corrupted waveform.

13 TBUS

The TBUS allows multiple modules to be interconnected without the need for external wiring. Connection to the TBUS is made via a recessed board-edge connector, located on the rear of the module, and a IT032 connector. The board-edge fingers plug directly into the connector.

WARNING: The iT300 TBUS is NOT compatible with older iT100/200, iT401 or iT501 series modules. When connecting modules via the TBUS, connect only iT300 series modules together on the same bus. Do not connect any other types of modules or devices to an iT300 TBUS. Doing so may result in damage to the modules.

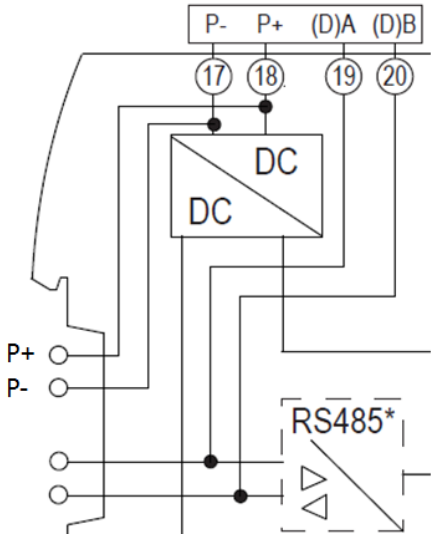
13.1 Stacking modules

Multiple modules can be connected together through the TBUS. This allows power to be supplied to all modules on the bus. For iT301 models, the RS485 serial interface is also available on the TBUS.

Figure 12 - Stacking modules

13.2 Powering via the TBUS

Power can be bused to all modules via shared P+ and P- supply rails on the TBUS card-edge connector. This allows one module to supply power to other modules on the bus. The location of the terminal is shown below. The positive TBUS terminal (P+) is nearest the power input terminal block.



WARNING: The maximum current handling capacity of the power supply input terminals is 4 amps. When using these terminals to supply power to the TBUS, ensure the 4 amp rating is not exceeded.

14 DIN rail assembly and removal

14.1 Requirements for installation

To protect the module from harsh conditions, it is recommended to install the unit in a suitable enclosure (NEMA 4 type, or equivalent) with the appropriate degree of environmental protection. In all cases, the enclosure must meet the requirements of the installation.

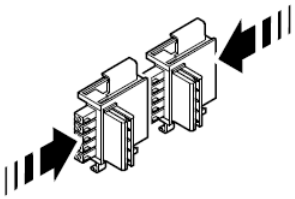
14.2 DIN rail mounting

The iT300 Series of modules are designed to mount to a standard 35 mm DIN rail. The rear of the module has a spring-loaded metal foot catch that holds the module securely in place. The module is installed onto the rail by simply snapping it into place.

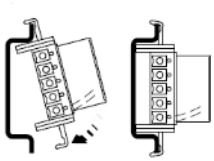
Each module is 22.5 mm wide and therefore occupies 22.5 mm of DIN rail space.

14.3 Preparing the DIN rail TBUS connectors

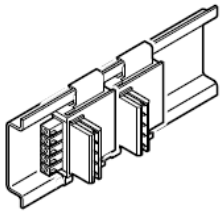
Connect the required number of connectors by pushing them together, as shown.



Attach the connectors to the DIN rail by hooking the latch of the connectors over the top of the rail and then snapping the bottom of the connectors onto the rail.

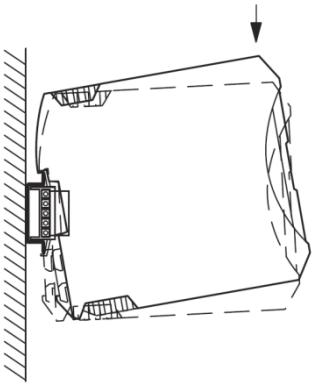


The completed connector assembly on the rail.



14.4 Installing the module onto the DIN rail

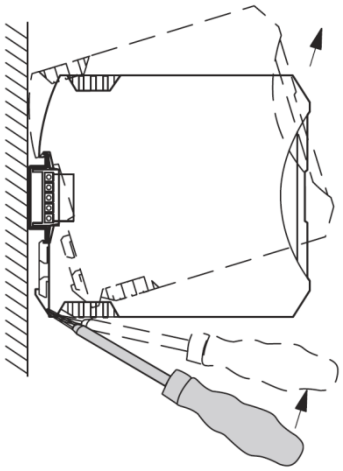
With the module tilted up, as shown, hook the top lip of the module onto the top of the rail while carefully aligning the DIN rail connector with the card edge slot on the rear of the module. Gently push the module downward and toward the rail. Firmly seat the module so the DIN TBUS connector fully engages the module card edge connector. The metal foot catch should audibly snap onto the rail. The module is now mechanically secured to the rail.



⚠ WARNING: The iT300 TBUS is NOT compatible with older iT100/200, iT401 and iT501 series modules. When connecting modules via the TBUS, connect only iT300 series modules together on the same bus. Do not connect any other types of modules or devices to an iT300 TBUS. Doing so may result in damage to the modules.

14.5 Removing the module from the DIN rail

Locate the metal foot catch on the bottom rear of the module. The catch is spring loaded. To remove the module from the rail, insert a small, flat-blade screwdriver or other suitable tool into the foot catch slot. (The blade must be less than ¼ inch (6 mm) in width to fit into the slot on the latch.) Using the screwdriver as a lever, gently push the screwdriver upward, as shown, to release the locking mechanism. With the catch released, tilt the module upward and remove it from the rail and connector.



15 HTTP web server

The transmitter is field-configurable via a built-in HTTP web server. The server features an intuitive, easy-to-use, one-page interface that can be accessed with any modern web browser. No custom or proprietary software is required.

15.1 10/100 Ethernet

Connection to a 10/100 Ethernet device or network is made via a standard RJ45 connector located on the front panel of the unit. To eliminate cabling complications, the Ethernet transceiver utilizes an Auto-MDIX function to detect the type of cable being used (straight-through or crossover). The transceiver will automatically swap the transmit and receive pairs, as necessary, to ensure the proper transmission and reception of data in accordance with IEEE 802.3 auto-negotiation and crossover specifications.

The transmitter supports four different Ethernet protocols: 10 Mb/s Half Duplex, 10 Mb/s Full Duplex, 100 Mb/s Half Duplex, and 100 Mb/s Full Duplex. The transceiver is configured for Auto-Negotiation. The Auto-Negotiation function provides a mechanism for exchanging configuration information between two ends of a link segment to automatically select the highest performance mode of operation supported by both devices. It ensures that the highest performance protocol will be selected based on the advertised ability of the Link Partner (the Ethernet device connected to the transmitter).

If the Link Partner does not support Auto-Negotiation or it has been administratively disabled, the transmitter still can determine and match speed with the Link Partner. **However, the presence of full duplex cannot be detected, so the transmitter will default to half duplex.** In this case, the Link Partner should also be configured for half duplex operation.

For optimum performance, the Link Partner should have Auto-Negotiation enabled.

For further details regarding Auto-Negotiation, refer to Clause 28 of the IEEE 802.3u specification.

15.2 Browser support

The following browsers are supported and have been verified compatible with the web server:

- Mozilla Firefox
- Microsoft Internet Explorer
- Google Chrome

The most recent version of each browser, at time of firmware release, has been tested. As newer firmware revisions are released, additional browser support may be added. Visit www.wilcoxon.com for the latest firmware revision and downloads.

CAUTION! Proper functionality and operability cannot be guaranteed with older versions of the supported browsers or browsers not listed.

15.3 Establishing a network connection (PC, Laptop)

iT300 series modules support the Internet Protocol version 4 (IPv4) network addressing architecture. The default IPv4 network settings are as follows:

IP address	192.168.0.100
Subnet mask	255.255.255.0
Default gateway	192.168.0.1

Only static IP addressing is permitted. The module does not support DHCP.

To establish a connection between the iT300/301 and a standalone PC or laptop computer, the computer's network settings will, most likely, need to be adjusted. The IPv4 connection must be configured by disabling DHCP (if enabled) and manually entering the IP address and subnet mask. This is because the PC must belong to the same subnet as the iT300/301 and have the same network prefix. The prefix occupies the most-significant bits of the address. In this case, the prefix is 192.168.0.

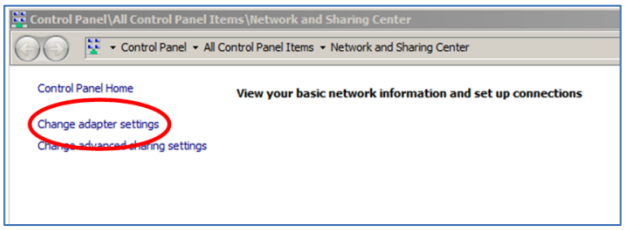
If the networking settings are not correct, communication with the transmitter will not be possible. An example of how to configure the network settings on a PC running the Windows operating system is presented in the next section.

15.3.1 Adjusting network adapter settings

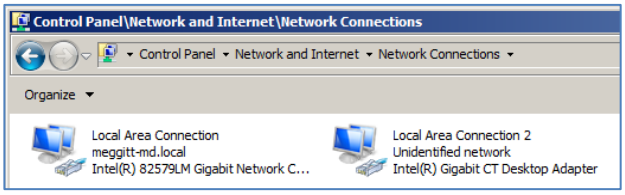
In the following example, we will adjust a PC's network adapter settings to be compatible with the iT300/301. The operating system is Windows 7. The procedure will differ for other operating systems. Consult a network administrator if you are unsure about making changes to network settings.

To adjust the network adapter settings:

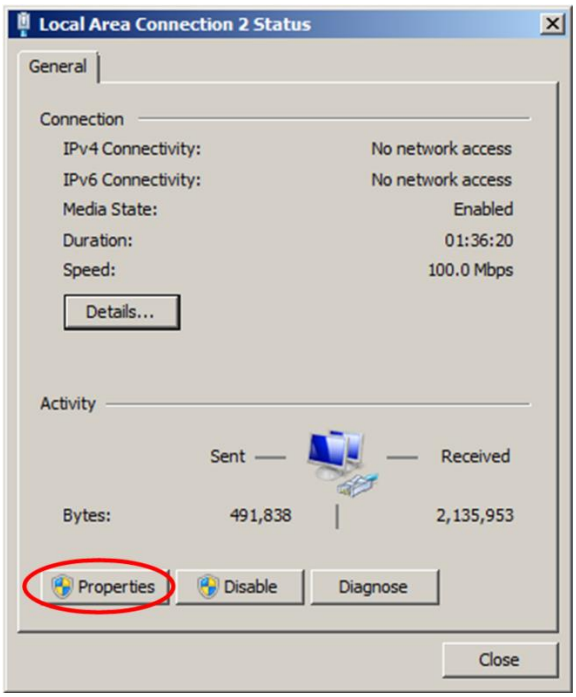
Open the **Control Panel** and access the **Network and Sharing Center**. Then click on **Change Adapter Settings**:



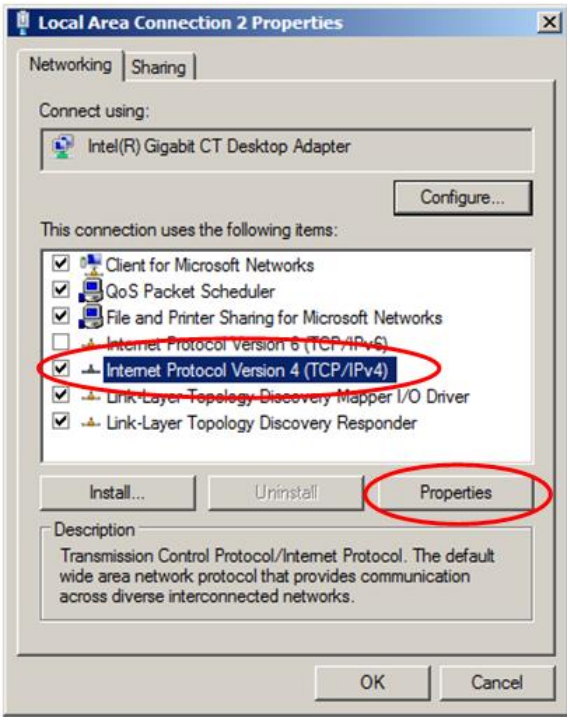
If more than one network adapter or LAN connection is available, choose the desired connection which to modify. In this example, we will modify *Local Area Connection 2*:



After selecting the desired network connection to modify, click **Properties**:

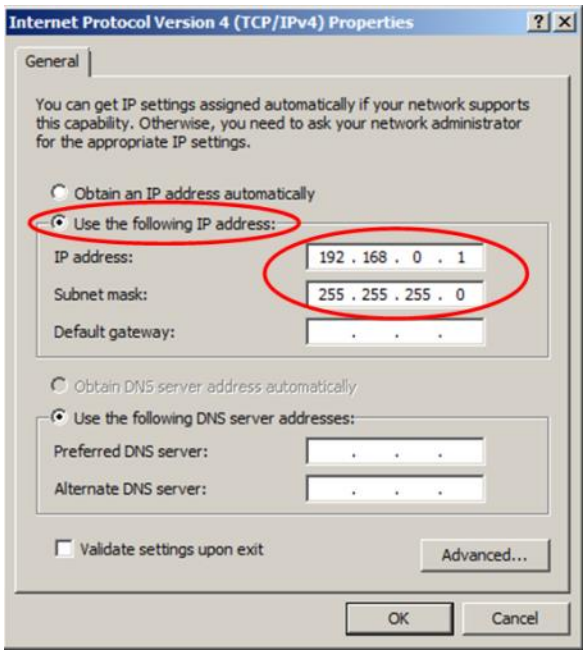


Select **Internet Protocol Version 4 (TCP/IPv4)** and then click **Properties**.



Select "**Use the following IP address:**"
Change the IP address to **192.168.0.1**.
Change the Subnet mask to **255.255.255.0**.
The Default gateway field should be left blank.

NOTE: Enabling 'Use the following IP address' will disable your PC from communicating with other networks.



Save the changes by clicking "OK."

15.4 Establishing a network connection

The transmitter also may be accessed via a LAN or other network. If the module is intended to be connected to a network, consult the network administrator to obtain information regarding the proper network settings.

15.5 Accessing the web server

After ensuring the network settings of the Link Partner are correct, a connection to the web server can be established. To access the web server, launch the web browser on your computer and enter the module's IP address (default is 192.168.0.100) in the Address field. Then, press **Enter**.

Upon establishing a connection to the web server, the User Interface (UI) is displayed.

16 User Interface (UI)

16.1 Overview

The transmitter is field-configurable via the built-in web server and User Interface (UI). The UI allows configuration to be performed in the field or from a remote location, using any common web browser.

16.2 Layout

For simplicity and ease-of-use, the UI consists of a single web page. The layout of the page positions the various fields in an intuitive, logical order. Configurable parameters are grouped into nine sections:

1. Machine Information
2. Sensor Input Configuration
3. Frequency Range
4. Band Configuration
5. Measurement Results and Alarms
6. 4-20 mA Loops
7. Network Configuration
8. Modbus/RS485
9. User-action Controls.

In addition to allowing configuration of the transmitter, the UI also displays all measurement results and current status in real time.

16.3 Sample UI

A representative sample of the iT301 User Interface is shown in Figure 13. Actual page layout will vary by model.

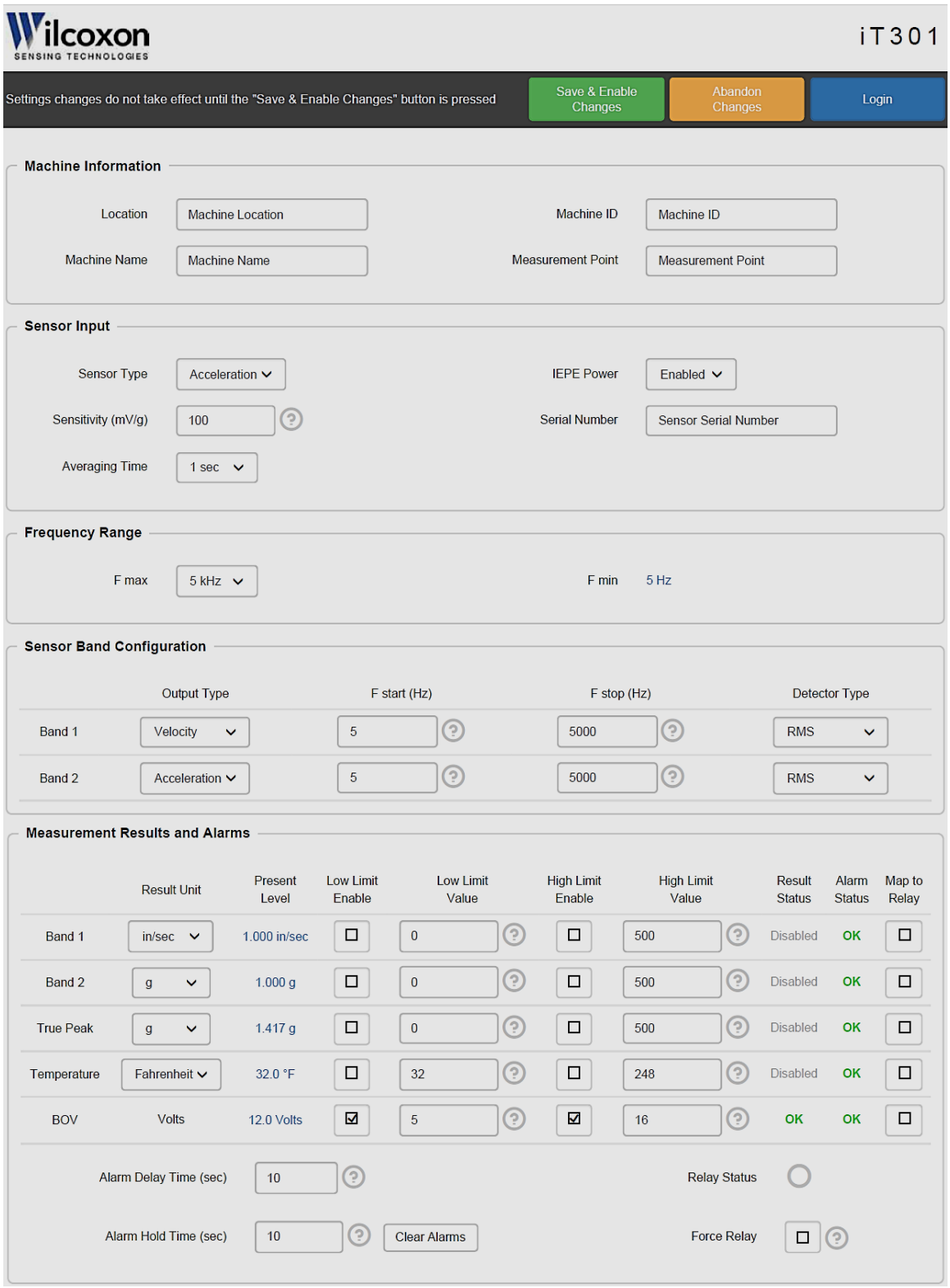
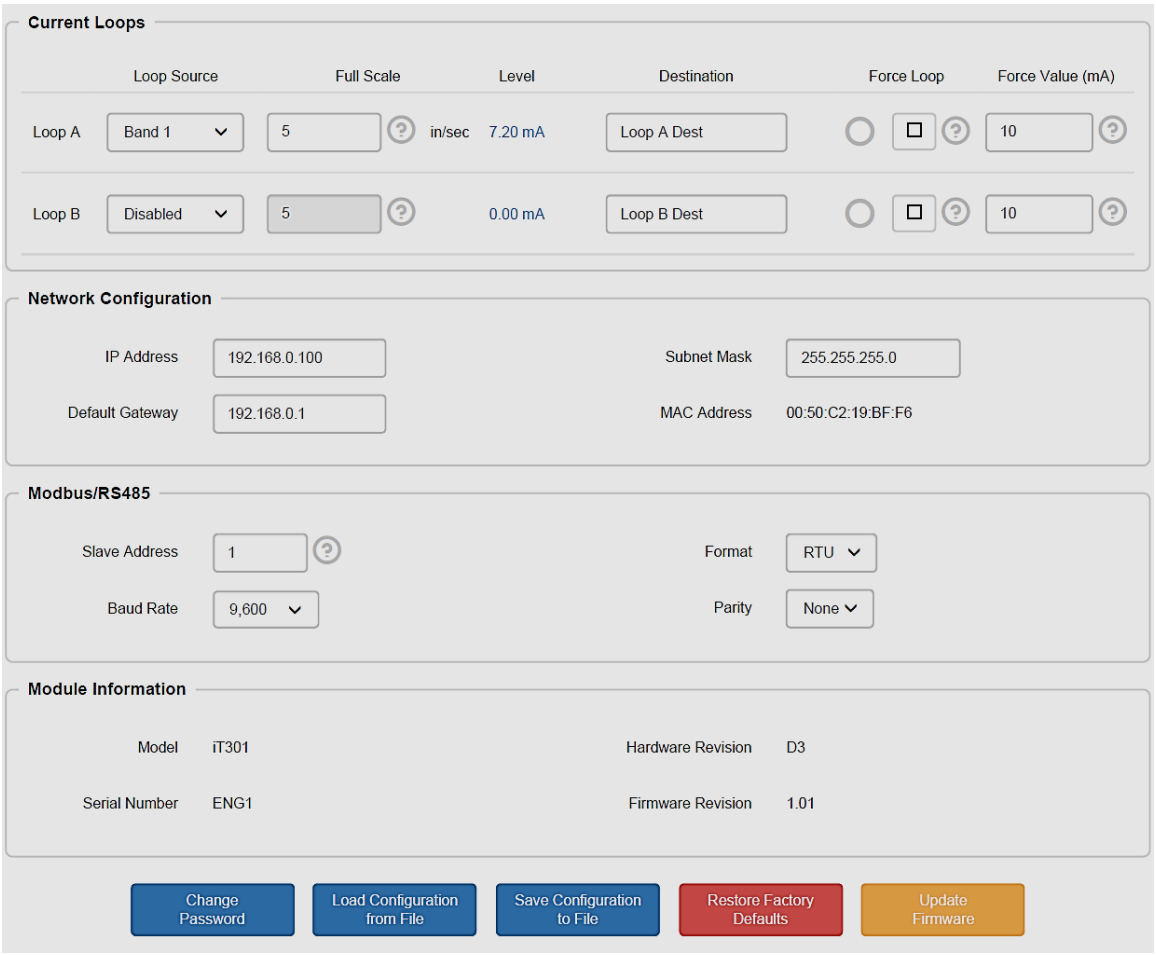


Figure 13 - User Interface (1 of 2)

User interface (continued)



16.4 Configurable parameters

Machine information
- Machine location (Free text)
- Machine name (Free text)
- Machine ID (Free text)
- Measurement point (Free text)

Sensor input
- Sensor type (Selection)
- Sensor sensitivity (User entry)
- Sensor serial number (Free text)
- Averaging time (Selection)
- IEPE power enabled/disabled (Selection)

Measurement frequency range
- $F_{MAX,}$ (Highest measurable frequency) (Selection)

Sensor Band Configuration
- Output type (Selection)
- F_{START} (User entry)
- F_{STOP} (User entry)
- Detector type (Selection)

Alarms and signal relay (iT301)
- Alert low and high limits (User entry)
- Alerts enable/disable (Selection)
- Alarm delay time and hold time (User entry)
- Relay source mapping (Selection)
- Relay test (Selection)

4-20 mA current loop outputs
- Loop Source (Selection)
- Full-scale range (User entry)
- Destination/connected equipment name (Free text)
- Force Mode (Selection)
- Test current level (User entry)

Network
- IP address (User entry)
- Subnet mask (User entry)
- Default gateway (User entry)

Access Control
- User name (User entry)
- Password (User entry)

Modbus over serial RS485 (iT301)
- RTU or ASCII format (Selection)
- Slave address (User entry)
- Baud rate (Selection)
- Parity (Selection)

16.5 Default configuration

The default configuration has been chosen to be compatible, "out-of-the-box," with the most common sensor and vibration monitoring configurations. Since the transmitter is field configurable, settings can be easily changed to suit the particular application.

Factory Default Configuration	
Username	user
Password	admin
IP address	192.168.0.100
Subnet mask	255.255.255.0
Default gateway	192.168.0.1
Sensor type	Accelerometer
Sensor sensitivity	100 mV/g
Averaging time	1 second
IEPE power source	Enabled
F_{MAX} (Highest measurable frequency)	5 kHz
F_{MIN} (Lowest measurable frequency)	5 Hz
Band 1 passband	5 Hz - 5 kHz
Band 1 output type	Velocity (ips)
Band 1 detector type	RMS
Band 2 passband	5 Hz - 5 kHz
Band 2 output type	Acceleration (g)
Band 2 detector type	RMS
4-20 mA Loop A	Enabled
Loop A source variable	Band 1
Loop A full-scale output	5 ips
4-20 mA Loop B	Disabled
Alarms*	Disabled[1]
Signal relay*	Disabled
Modbus over serial RS485*	
Format	RTU
Slave address	1
Baud rate	9600
Parity	None

*iT301 only

[1] BOV alarm is enabled by default

Table 2 - Factory default settings

17 Configuring the transmitter

Tech tip! For changes to take effect, always remember to press the "Save & Enable Changes" button!

17.1 Access control

To enable changes to the current configuration, a valid user name and password must be entered. This helps prevent changes to the system by unauthorized personnel.

The default user name is **user**. The default password is **admin**.

Both username and password are case sensitive. There is no limit to the number of invalid entry attempts.

Tech tip! The access control mechanism has been designed to provide a modest level of security. It is not intended to provide absolute protection from unauthorized changes to the configuration.

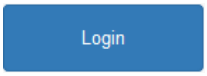
Tech tip! If the user name or password is not known, both can be reset to factory default via the front-panel pushbutton. See section 17.2, "Restoring factory defaults" for more information.

17.2 Restoring factory defaults

The factory default settings may be restored at any time either by using the UI or front-panel pushbutton. See section, 19.5 "Restoring factory default settings" for instructions on restoring the default configuration.

17.3 Typical configuration flow

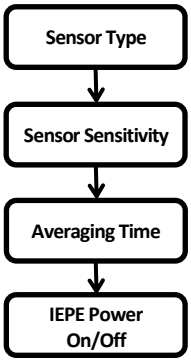
This section shows the typical steps for configuring a unit.

1. Log in 

To enable changes to the current configuration, a valid User Name and Password must be entered. Use the Login button and enter valid credentials into the User Name and Password fields. The default user name is **user**. The default password is **admin**.

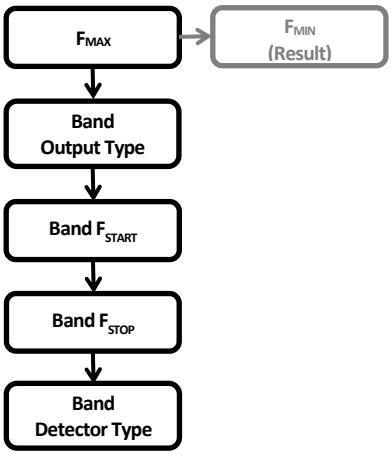
2. Configure the sensor parameters

Parameters under "Sensor Input Configuration" should typically be the first configured, since these are global parameters that affect all subsequent configurations steps.



3. Configure frequency range and bands

After setting up the sensor input, select the system frequency range (highest and lowest measurable frequencies) by adjusting F_{MAX}. Then, configure the two processing bands by selecting the desired output type, start and stop frequencies, and detector type for each band.

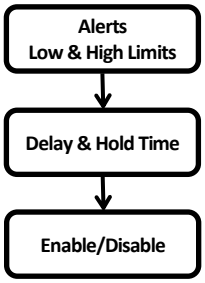


4. Choose engineering units for measurement results

Next, select either English or metric engineering units for each measurement result.

5. Configure alarms (iT301)

On models with alarm capability, alarm parameters are adjacent to the measurements results. Set the low and high alert limits for each result, as required by the application. Next, configure the alarm delay and hold times. Finally, enable or disable each alert limit, as desired, by using the check boxes.

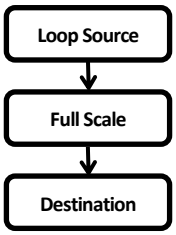


6. Configure signal relay output (iT301)

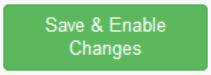
On models with a signal relay output, select those alarms that should be "mapped" to the relay output. Alarms are mapped to the relay in a logical "OR" fashion.

7. Configure the 4-20 mA loops

Next, configure the two 4-20 mA current loop outputs. For each loop, select the desired measurement result to be "mapped" as the loop's driving source. If a current loop output is not needed or is to remain unconnected, be sure to disable that loop using the drop-down menu. After the loop driving sources are selected, enter the desired full scale values. Two, 16-character "Destination" fields are provided for descriptive information about the loop end point or receiving equipment.

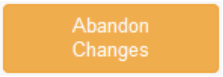


8. Save & enable changes



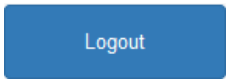
When finished making changes to the configuration, review all settings for correctness. After verifying the settings, click the "Save & Enable Changes" button to commit the settings. **Changes do not take effect until the "Save & Enable Changes" button is pressed.** If there are errors in any manually entered parameters, an error message will appear.

Optionally, changes may be discarded by using the "Abandon Changes" button.



Abandoning changes will cause all altered settings to revert to their previous values.

9. Log out



Finally, log out by clicking the Logout button.

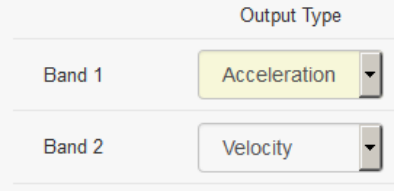
Tech tip! The user will be automatically logged out after 30 minutes of UI inactivity.

17.4 Parameter interdependencies

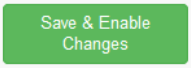
During the configuration process, as various settings are changed, it will occur that the changing of one setting will affect one or more other settings. As described in the next section, all affected settings will be highlighted to indicate they have been automatically adjusted and may require further user attention.

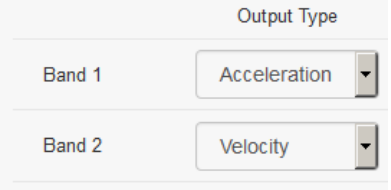
17.5 Highlighting of altered settings

To indicate a field/parameter has been changed (either directly, by the user, or automatically by the UI), the field will be highlighted. Highlighting is applied to all affected fields, including drop-down menus, manual entry boxes, and check boxes. In the example shown below, the Band 2 Output Type is highlighted, indicating its value has been changed.



After Saving & Enabling changes, the new settings will take effect and highlighting will be removed.





18 User-configurable parameters

This section contains detailed descriptions of each user-configurable parameter. Where applicable, a Help icon appears next to the parameter. Click the icon to see suggested values and other helpful information.

18.1 Machine information

Four fields are provided for descriptive information about the monitored equipment and sensor attachment point. This information can be useful for record keeping and machine identification purposes. Up to 24 characters can be entered into each field.

18.2 Sensor input and averaging time

Tech tip! Parameters in this section should typically be the first configured, since these are global parameters that affect all subsequent configurations steps.

18.2.1 Sensor type

Select the type of sensor from the drop-down list. The type must match that of the connected sensor. Default is "Accelerometer".

18.2.2 Sensitivity

Enter the sensitivity of the connected sensor into the "Sensitivity" field. Click the Help icon for a list of the most common sensitivity values. The units of measure are mV/g for acceleration and mV/in/sec for velocity. Therefore, 1 V/g would be entered as 1000, 5 V/g would be entered as 5000, and 10 V/g would be entered as 10000, etc. The acceptable range is 9.0 – 11000.0 (mV/g or mV/in/sec).

Tech tip! If the exact sensitivity of the sensor is known (e.g. 103.5 mV/g), use that value. This will yield the most accurate measurement results.

18.2.3 Averaging time

The signal processor averages the input signal over a period of time to produce an accurate rendition of the true RMS power level. This has the effect of delaying the true RMS level until an adequate number of averages have been processed. The averaging time determines the number of blocks of sampled data over which the results will be calculated. Longer averaging times result in "smoother" results with slower transition times. Select the desired averaging time from the drop-down list. The default is one second.

Tech tip! The averaging time is the equivalent of an RC (resistor-capacitor) time constant. The vibration measurement results will take approximately five time constants to settle to within 98 percent of their final values after a step change is applied to the input (F_{MAX} = 20 kHz).

18.2.4 Sensor power source

The sensor input has a built-in 4.5 mA constant current source to supply power to the sensor or vibration transducer. The current source is enabled by default. This is the desired setting for most applications. For non-standard applications, an option to disable the power source is provided.

18.2.5 Serial number

A 24-character field is provided for the serial number of the connected sensor. This information can be useful for record keeping purposes.

18.3 Frequency range

18.3.1 F_{MAX}

The highest measurable frequency, F_{MAX}, sets the upper frequency limit of the system. It can be set from 200 Hz to 20 kHz. This parameter effectively determines the frequency resolution by setting the bin width of the FFT spectrum. It also determines the lowest measurable frequency, F_{MIN}. Changing F_{MAX} also affects the available ranges for F_{START} and F_{STOP} for Band 1 and Band 2.

Tech tip! For best performance, set F_{MAX} no higher than required by the application.

Tech tip! As F_{MAX} is reduced, so too is the effective sampling rate. Lowering F_{MAX} increases the time needed to collect and process a "block" of data. This has the effect of lengthening the amount of time for the RMS detectors to settle to their final values.

18.3.2 F_{MIN}

The lowest measurable frequency, F_{MIN}, is calculated from F_{MAX}, according to the formula given below:

$$F_{MIN} = \frac{Fmax}{1000}$$

F_{MIN} changes with F_{MAX} and cannot be directly set by the user. To measure lower frequencies, reduce F_{MAX}.

18.4 Processing bands

18.4.1 Output type

The signal processor can perform a single-stage mathematical integration of the input signal, resulting in a velocity output from an acceleration input or a displacement output from a velocity input. Use the "Output Type" menu to select a non-integrated or integrated output for each Band result. The default setting for the output type is the same as the sensor type.

Tech tip! Integration works best over small bandwidths, i.e. $\left(\frac{FStop}{FStart}\right) \leq 100$, and high input signal levels (>20 mV).

Tech tip! Performance of the integrator will be improved by using a high sensitivity sensor (≥500 mV/g or ≥500 mV/ips) to increase the input signal level.

Tech tip! In most applications, it will not be practical or useful to integrate over the full 20 kHz bandwidth, as velocity and displacement energy decreases rapidly as frequencies increase. The practical upper limit for velocity measurements is approximately 5 kHz, as very little velocity energy is present above 5 kHz. The same is true for displacement, as very little motion is detectable above 500 Hz.

18.4.2 FSTART

FSTART determines the lowest measurable frequency for the band and sets the cutoff frequency of the digital high-pass filter. FSTART can be anywhere in the range of FMIN to FMAX, but must be less than FSTOP. For lower FSTART frequencies, reduce FMAX. (See section 18.3.1)

18.4.3 FSTOP

FSTOP determines the highest measurable frequency for the band and sets the cutoff frequency of the digital low-pass filter. FSTOP can be anywhere in the range of FMIN to FMAX, but must be greater than FSTART. For higher FSTOP frequencies, increase FMAX. (See section 18.3.1)

Tech tip! Together, FSTART and FSTOP determine the measurement bandwidth for each respective band.

18.4.4 Detector type

Three types of power detectors are available: RMS, peak and peak-to-peak. Select the desired type of power detector from the drop-down menu. The properties and behavior of each type of detector are explained in the following sections:

RMS

The RMS power detectors operate on frequency domain (FFT) data. They compute the RMS power level of the input signal by summing the power levels of all FFT bins in the measurement bandwidth. Due to averaging, the RMS detectors are relatively insensitive to brief spikes of vibration and other transients and tend to smooth the signal response.

RMS detection is a very accurate method of determining the total power contained in a signal. It is used in vibration detection where it is desired to know the total amount of true vibration energy exhibited by a machine. The digital signal processor always calculates the true RMS power level of the input signal and derives peak and peak-to-peak values from the RMS value.

Peak ("equivalent" peak)

Peak detection can be selected when it is desired to know the peak value of the vibration. The peak value is calculated by multiplying the detected RMS power level by $\sqrt{2}$. This method of conversion results in an "equivalent" peak power value of the input signal. It is accurate only when the input signal consists of a pure sinusoidal waveform. Since, in many cases, the vibration energy is primarily due to a single, high-level, sinusoidal vibration, this method of peak detection works well.

Many vibration transmitters develop a peak value for vibration by using this method. The iT300 Series transmitters have this method available for detection to provide comparable results to other vibration transmitter modules in use. It is also useful where users simply wish to have the signal output be in terms of peak vibration, rather than RMS.

Peak-to-peak

Peak-to-peak is simply two times the peak value. It is best used for displacement measurements. Select this option when plant maintenance records are in peak-to-peak units.

Tech tip! The choice of RMS versus equivalent peak detection is usually a matter of user preference. Both work from the same basic detection method. The choice is usually determined by local convention. Additionally, historical vibration data may be in terms of either RMS or peak vibration, and therefore the setting of vibration units will be in line with the plant's historical data.

18.5 True peak detection

18.5.1 Overview

All iT300 series transmitters feature a "True Peak" detector. In contrast to the RMS power detectors, which operate on band-limited frequency domain (FFT) data, the true peak detector operates on full bandwidth time domain waveform data. The true peak detector captures peaks in the raw data from the analog-to-digital converter. This allows the true peak detector to accurately respond to short transients and impulses.

True peak detection is beneficial where it is desirable to capture short transient vibration events or where non-sinusoidal waveforms are causing large errors in the equivalent peak calculation. A large discrepancy between the equivalent peak result and true peak result may indicate a non-sinusoidal input waveform. If the true peak result is showing an erratic response, but the RMS trend remains relatively constant, there may be problems developing. High frequency energy is causing transient peaks to be present in the time waveform. Some common mechanical causes of this type of energy are early bearing wear, chipped teeth in a gear set or mechanical faults capable of creating momentary impacts.

18.5.2 True peak detector response and decay times

With true peak detection, the response of the transmitter is near-instantaneous. Figure 14 illustrates the rapid response of the transmitter to a transient event that would otherwise be missed by most vibration transmitters.

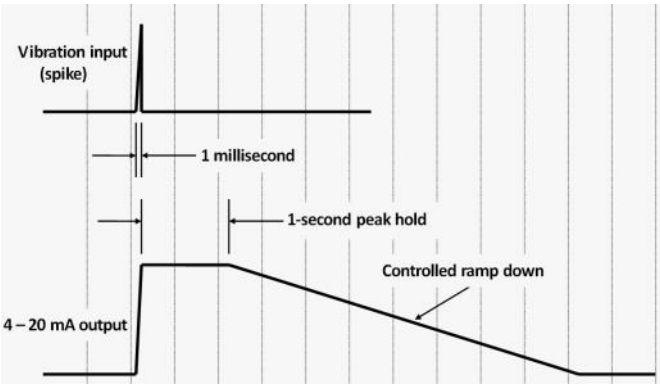


Figure 14 - True Peak detector behavior

Demonstrated in the figure is the response of the true peak detector when the sensor input is presented with a very short-duration pulse (spike). Here, the pulse is less than a millisecond in duration, yet the module is able to accurately capture, and hold, the peak level.

In this example, the true peak measurement result is mapped to a 4-20 mA current loop output. The output of the true peak detector holds at the captured peak level for one second to allow for the typical DCS/PLC system, scanning at one-sample-per-second, to be able to accurately detect and record the peak of the signal. If no additional peaks appear at that level, or higher, the output of the peak detector begins to ramp down at a controlled rate.

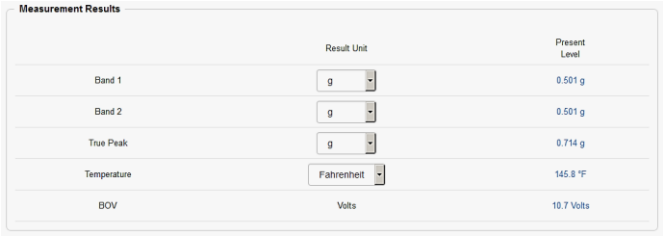
This response can be contrasted easily to the response of the RMS detector. Since the total energy contained in the spike is miniscule, the RMS detector will not see a change in total signal power.

Tech tip! The True Peak detector always operates over a bandwidth of 10 Hz to 25 kHz and is not affected by any frequency or averaging time settings.

Note: The True Peak output type is always the same as the sensor type. An integrated True Peak result is not available.

18.6 Measurement results

Measurement results are displayed in blue font to make them easily distinguishable from user-configurable parameters.



18.6.1 Vibration measurement results

Use the drop-down menus to select either English or metric engineering units for each vibration measurement result.

18.6.2 Temperature measurement

Temperature can be measured in either degrees Fahrenheit or Celsius. If no temperature sensor is connected, the measurement result will read 32 °F or 0 °C, ±0.5 degrees.

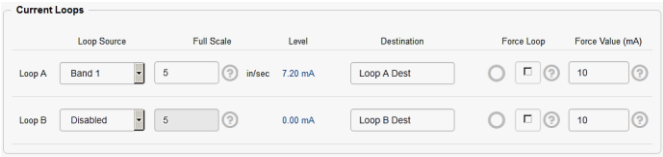
18.6.3 BOV monitor

The transmitter continuously monitors and reports the BOV of the sensor signal. The BOV is displayed on the UI as a measurement result. If the BOV falls outside the acceptable range, a sensor fault will be indicated. When a sensor fault is detected, the UI will display "**Fault**" next to the BOV reading and the front-panel **ERR** LED ● will illuminate. **A sensor fault will cause the 4-20 mA loop current to be set to 2 mA on each enabled loop.**

For the iT300, ***the acceptable range for the BOV is 5 to 16 volts and is not user adjustable***. For the iT301, the acceptable range for the sensor BOV can be adjusted via the UI.

If a sensor fault is indicated, the sensor BOV should be checked with an isolated (hand-held) DC voltmeter at the BNC connector and verified it is within the acceptable range. See section 20, "Troubleshooting" for more information on sensor faults.

18.7 4-20 mA current loops



The transmitter features two independent 4-20 mA current loop outputs, referred to as "Loop A" and "Loop B." Loop current is proportional to the magnitude of the process variable mapped as the loop driving source.

18.7.1 Loop driving source

Use the drop-down menus to select one of five measurement results (process variables) to be mapped to each 4-20 mA output. There also is an option to disable each loop.

- **Disabled** – loop is disabled and current is set to 0 mA. If a 4-20 mA output is not required by the application and is to remain unconnected, this option *must* be selected to prevent a current loop fault from being indicated by the transmitter. A loop fault is indicated by "**Fault**" on the UI and a blinking ERR LED ✹ on the front panel.
- **Band 1** – loop current is proportional to the detected power level of Band 1. Select this option to monitor the vibration level in the Band 1 measurement bandwidth.
- **Band 2** – loop current is proportional to the detected power level of Band 2. Select this option to monitor the vibration level in the Band 2 measurement bandwidth.
- **True Peak** – loop current is proportional to the True Peak detector output. Select this option to monitor the true peak vibration level over the full bandwidth of the system.
- **Temperature** – loop current is proportional to the temperature signal input. Select this option to monitor temperature *only if a temperature sensor is connected*.
- **BOV** – loop current is proportional to the sensor BOV. Select this option to monitor the DC bias of the attached sensor. Although the BOV conveys no vibration information, this option can be useful for monitoring "sensor health."

18.7.2 Loop full scale

Use the Full Scale field to enter the level (magnitude) of the mapped measurement result (process variable) that should correspond to the full 20.0 mA loop current. Click the Help icon for a list of the most commonly used values.

The magnitude of the loop current (I) is defined by the following equation:

$$I = \left(\frac{input\ level}{full\ scale} \bullet 16\right) + 4\ mA$$

Example:

Sensor type	= accelerometer
Sensitivity	= 100 mV/g
Band 1 output type	= acceleration
Loop source variable	= Band 1
Full scale =	= 5 g (50 m/sec^2)

In this example, when the Band 1 vibration level (input level) is equal to 5 g (500 mV), the loop current will be 20.0 mA. When the vibration level is equal to 1 g (100 mV), the loop current will be 7.2 mA.

Tech tip! Ensure the full scale setting is appropriate for the expected range of vibration. If the full scale is set too high, the 4-20 mA output may not respond adequately to low vibration levels. If the full scale is set too low, the loop may saturate at 20 mA.

When the selected loop source variable is temperature, the scaling is fixed:

For °C: $I = \left(\frac{T}{120} \bullet 16\right) + 4\ mA$ or 120 °C = 20.0 mA

For °F: $I = \left(\frac{T-32}{216} \bullet 16\right) + 4\ mA$ or 248 °F = 20.0 mA

When the selected loop source variable is BOV, the scaling is fixed:

$I = \left(\frac{BOV}{24} \bullet 16\right) + 4\ mA$ or 24 V = 20.0 mA

A BOV of 12 volts will produce a loop current of 12 mA when BOV is selected as the loop source variable.

18.7.3 Destination

Fields are provided for descriptive information about the loop destination or 4-20 mA monitoring device (PLC, DCS, etc.) This information can be useful for record keeping and maintenance operations. Up to 16 characters can be entered.

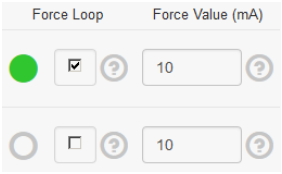
18.7.4 Loop status

The transmitter monitors the level of the loop current and will indicate a fault condition if the set point current cannot be achieved. If the loop resistance is too high (>500 ohms) or if a loop output is left unconnected, a loop fault will be detected by the module. When a loop fault is detected, "**Fault**" will be displayed in the Level (mA) field on the UI and the ERR LED on the front panel will blink.

If a loop is not needed in the application or is to remain unconnected, it must be disabled via the UI. (See section 18.7.1,"Loop driving source"). Disabling the loop will set the current to 0 mA and prevent a loop fault from being indicated. **By default, Loop A is enabled and Loop B is disabled**.

See section 20, "Troubleshooting" for information about resolving loop faults.

18.7.5 Testing the loops using force mode



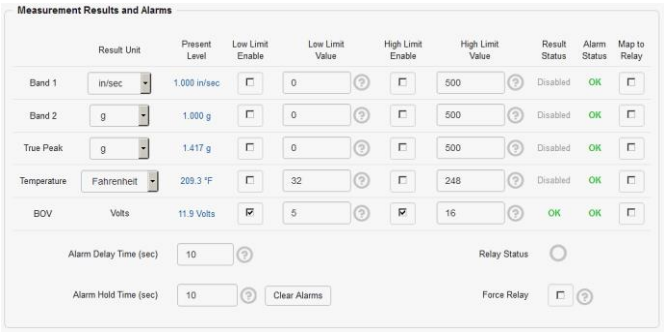
Each loop features a diagnostic test mode that allows the loop current to be forced to any value between 0 mA and 20 mA, without modifying any other settings or mappings. This feature can be used to test the 4-20 mA receiving equipment, loop integrity and maximum resistance compliance. Force mode and mA level are controlled independently for each loop.

Force mode loop current is set via the "Force Value" field. To activate force mode, first enter the desired current (any value between 0 mA and 20.0 mA) into the "Level" field. Next, check the "Force" box for the respective loop. Finally, press the "Save & Enable Changes" button. The green indicator on the UI and **PWR** LED on the front panel will both blink when either loop is in force mode. Force mode may be enabled even if the loop is disabled.

The transmitter will indicate a loop fault if the forced current level cannot be achieved. See section 20, "Troubleshooting" for information about resolving loop faults.

Tech tip! Always remember to exit force mode when testing is complete by unchecking the "Force" box and pressing the "Save & Enable Changes" button!

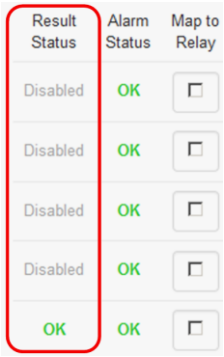
18.8 Alerts and alarms (iT301)



18.8.1 Overview

iT301 models provide both and "Alert" and "Alarm" indications for each measurement result. Alerts (Result Status) provide immediate indication of measurement results exceeding defined limits. Both low and high limits can be set independently for each measurement result. If an alert persists for a defined period of time, an alarm will be triggered. Alarm delay and hold times are configured on a global basis. Each alarm can be mapped to drive the signal relay output. Alert and alarm status are also mapped to Modbus registers.

18.8.2 Result status alerts



Each of the five measurement results may be monitored for acceptable levels. The acceptable range is set by entering a low and high alert limit for each measurement result. Real-time status of each measurement is displayed on the UI under the "Result Status" column. Alert status is also mapped to Modbus registers.

18.8.3 Alert limits

Both a low and a high alert limit can be set for each measurement result. The low and high limits can be enabled and disabled independently, via check boxes. Check the box to enable the respective limit. Uncheck the box to disable the limit.

If either limit is enabled, an alert condition will be indicated if the respective measurement result falls either below the low limit or exceeds the high limit. Limit value engineering units are the same as those selected for the respective measurement result.

The four Alert states are:

Disabled Neither the low nor the high alert limit is enabled.

OK No alert condition exists. Either or both of the alert limits is enabled and the measurement result is within the limit(s).

Low An alert condition exists. The low alert limit is enabled and the measurement result is below the limit. If this condition persists for longer than the Alarm Delay time, the alarm will be activated.

High An alert condition exists. The high alert limit is enabled and the measurement result is above the limit. If this condition persists for longer than the Alarm Delay time, the alarm will be activated.

Tech tip! To prevent undesired alarm "trips" during configuration changes, disable all alert limits BEFORE adjusting other settings. After making adjustments to all other transmitter settings and allowing the measurement results to stabilize, re-enable the desired alert limits.

18.8.4 Alarm Delay time

The Alarm Delay Time sets the amount of time, in seconds, that an alert condition must persist for the respective alarm to "trip". An alarm will not trip unless the alert condition persists for a time greater than the Alarm Delay Time.

Delay time applies to all alarms and should be set to meet the requirements of the application. Increase the delay time to prevent "nuisance" alarms due to brief anomalies in measurement results. Decrease the delay time to allow shorter duration alerts to trip an alarm.

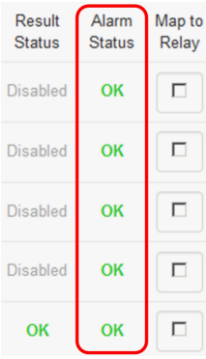
Tech tip! Care should be exercised when setting the Delay Time. A delay time that is too small may cause unwanted "nuisance" alarm trips. A delay time that is too long may cause short duration alerts to not trigger an alarm condition.

18.8.5 Alarm Hold time

The Alarm Hold time sets the minimum amount of time, in seconds, that alarms will remain active after a "trip." For example, a hold time of two seconds will ensure an alarm condition will persist for at least two seconds, even if the alert condition lasts for a shorter time. This would allow for the typical DCS/PLC system, scanning at only one-sample-per-second, to be able to detect the alarm. Hold time applies to all alarms and should be set according to the requirements of the application.

Tech tip! Care should be exercised when setting Alarm Hold Time. The hold time should be only long enough to ensure an alarm is detected by the scanning equipment or system maintenance personnel. An excessively long hold time may cause an alarm to persist for a undesirably long period of time after the measurement result has returned to normal.

18.8.6 Alarm Status



Real-time status of alarms is displayed on the UI under the "Alarm Status" column. Alarm status is also mapped to Modbus registers.

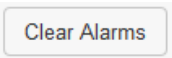
There are two alarm states:

OK Normal condition. Alarm is not "tripped"

Alarm An alarm condition for the respective measurement result exists (alarm is tripped). The alarm will persist for a minimum duration, as determined by the Alarm Hold Time, or until manually cleared.

Tech tip! For alarm hold times greater than zero seconds, the "Alarm Status" may indicate an alarm condition even though the "Result Status" indicates OK. This indicates a tripped alarm for which the hold time has not yet expired.

18.8.7 Clearing alarms

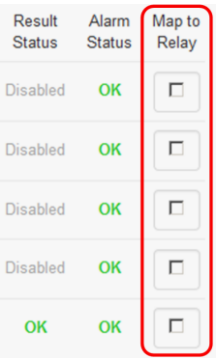


An alarm condition may be "cleared" at any time either by clicking the "Clear Alarms" button on the UI, or by briefly pressing the "CLR/RESTORE" button located on the module front panel. This feature allows alarms to be cleared before the hold time has expired.

Tech tip! The user does NOT have to be logged in to clear alarms.

18.9 Signal relay (iT301)

18.9.1 Mapping alarms to the relay



The five alarms can be independently mapped to the signal relay output. Use the check boxes to select those alarms that, when activated, should cause the relay to energize. Alarms are mapped to the relay in a logic "OR" fashion. That is, when one or more selected alarms is active (alarm condition exists), the relay will be energized. When energized, the NO relay contacts are closed and the NC contacts are open. An energized condition is indicated by a yellow ● "Relay Status" annunciator on the UI and by the yellow RLY LED ● on the front panel.

18.9.2 Testing the relay using force mode

To facilitate system setup and wiring verification, the signal relay can be forced to an energized condition via the UI. To energize the relay, first check the "Force Relay" box, then click the "Save & Enable Changes" button. A force condition is indicated on the UI by a blinking green "Relay Status" indicator ✳ and by a blinking green **PWR** LED ✳ on the front panel. The yellow RLY LED ● on the front panel illuminates when the relay coil is energized.

Tech tip! Always remember to exit force mode when testing is complete by unchecking the "Force" box and pressing the "Save & Enable Changes" button!

18.9.3 Example – Alarm behavior

The following example shows Alarm behavior for a Delay Time of 5 seconds and Hold Time of 10 seconds.

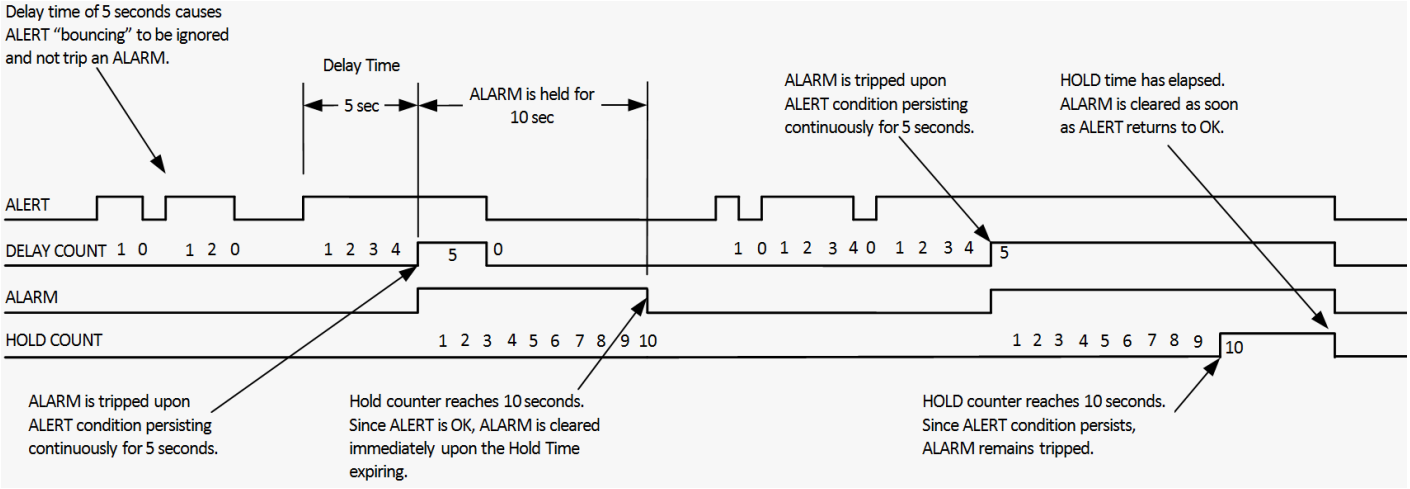


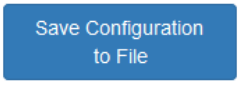
Figure 15 - Effect of Alarm Delay and Hold times on alarm behavior

19 User-action controls

19.1 Overview

Five "user-action" buttons may be used to invoke advanced functions such as saving and loading configuration files, restoring factory defaults, changing the user name and password, and updating the module's firmware. These functions are explained in the following sections.

19.2 Saving the current configuration to a file



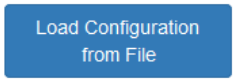
Tech tip! The user does not have to be logged in to perform this function.

All settings for the current configuration may be saved to a file on an external device. After pressing the button, follow the prompts and instructions that appear.

The default name of the configuration file is:
Wilcoxon *Model SN*.json, where "*Model*" is the model number of the unit and "*SN*" is the serial number of the unit. This gives each configuration file a unique name that can be easily matched to its originating module.

Tech tip! The configuration file is of a plaintext format. Parameter values may be edited, if required, using any text editor. Only parameter values should be edited. Parameter names, formatting or syntax must not be altered. Doing so will corrupt the file. Refer to "Modbus Register Tables, Holding Registers (4X references) - User configurable parameters " for key to parameter values.

19.3 Loading a configuration from a file



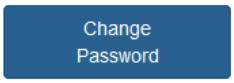
Configuration settings may be loaded (imported) from a file. This is convenient when several iT300/301 modules need to have similar or identical configurations. After pressing the "Load Configuration from File" button, follow the prompts and instructions that appear.

After loading a configuration file, carefully review all settings. Settings that have been changed will be highlighted. New settings will not take effect until the "Save & Enable Changes" button is pressed. This provides an opportunity to adjust the new settings before committing them.

After reviewing and approving the imported settings, press the "Save & Enable Changes" button to enable the new settings and write them to non-volatile system memory. If the imported settings are not desired, use the "Abandon Changes" button to revert all settings to their previous values.

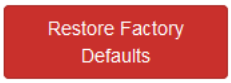
CAUTION! It is especially important to take note of any changes made to the Network Configuration settings. If the imported network settings are different from the current configuration, connection to the UI may be lost. To ensure browser communications can be reestablished, it is best to record the Network Configuration settings both before and after loading a configuration file.

19.4 Changing the user name and password



The current user name and password may be changed by using the "Change Password" button. After pressing the button, follow the prompts that appear.

19.5 Restoring factory default settings



The factory default settings may be restored, via the UI, by using the "Restore Factory Defaults" button. After clicking the button, an opportunity to proceed or cancel will be provided.

The factory default settings may also be restored by using the pushbutton located on the module front panel. The button is recessed to prevent inadvertent activation. To restore the factory default settings, use a small, slender object, such as the tip of a ballpoint pen, to depress the button. **Press and hold the button continuously, for a minimum of 30 seconds, until all front-panel LEDs slowly blink.**

CAUTION! If the current network settings are different from the default values, Ethernet communications with the module may be lost after performing a factory restore. The module's IP address, subnet mask, and default gateway will revert to their factory default values. These values will need to be used to reestablish communications with the module after performing a factory restore.

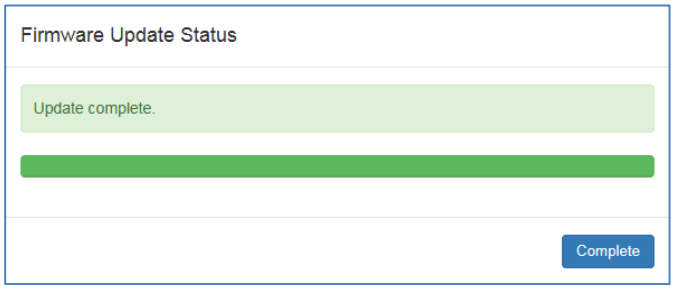
(iT301) CAUTION! After restoring factory default settings, Modbus communications, both serial and TCP, may be lost. The slave address, mode, and RS485 settings all will revert to their factory default values. To reestablish Modbus communications, the values of these settings may need to be adjusted after performing a factory restore.

Tech tip! To quickly create a convenient reference of all current settings, save the configuration to a file before performing a factory restore.

19.6 Updating the module firmware

Newer versions of firmware may occasionally be released to address known bugs or add new features. Firmware may be downloaded from ***www.wilcoxon.com***. Firmware files have a ".isupdate" extension. After downloading and saving the file, use the "Update Firmware" button to initiate the update. After pressing the button, follow the prompts and instructions that appear. **Do not disturb the module or remove power while a firmware update is in process.**

Wait for the update to complete. This could take several minutes.



After the firmware update is complete, click the blue "Complete" button to refresh the browser window.

Caution! During a firmware update, the module will automatically reboot, during which time all functionality (measurement results, communications, inputs, outputs, alarms, relay, etc.) will be temporarily interrupted.

Tech tip! The current configuration settings are retained after a firmware update.

20 Troubleshooting

This section contains a list of problems that may be encountered while using transmitter and recommended techniques for resolving the problems.

20.1 Fault conditions

The red ERR LED ● is on

Problem: Sensor fault (BOV out of range)

Possible causes:
1. Sensor not connected
2. IEPE power disabled
3. Damaged/faulty sensor
4. Incompatible sensor
5. Shorted sensor wiring
6. Incorrect BOV alarm settings (iT301)

- Verify a compatible sensor is connected.
- Use an isolated DC voltmeter to check the DC voltage at the front-panel BNC connector. The DC bias must be in the range of 5 to 16 volts (iT300). If outside this range, check sensor wiring and ensure IEPE Power is enabled.
- (iT301) Verify the BOV alert trip limits are set correctly for the attached sensor.

The red ERR LED ✳ is blinking

Problem: Current loop fault

Possible causes:
1. One or both 4-20 mA outputs not connected (loop open)
2. Loop resistance too high

- Use the UI to disable all unconnected loops.
- Ensure all enabled loops are connected to a valid load.
- Use an ohmmeter to measure the loop resistance. Total resistance should be less than 500 ohms.

20.2 Unexpected behavior

The green PWR LED ✳ is blinking

Description: One or more "Test modes" is active

Causes:
1. One or both current loops in "Force Mode"
2. Signal relay in "Force mode" (iT301)

- The PWR LED will blink when any force mode is active.
- Use the UI to check the status of both current loops and signal relay.
- Disable all force modes to revert to normal operation.

Erroneous measurement results

Description: Measurement results are not as expected

Possible causes:
1. Incorrect sensor type
2. Incorrect sensitivity
3. Incorrect frequency settings
4. Incorrect detector type
5. Incorrect units

- Ensure the sensor type setting matches that of the attached sensor.
- Ensure the sensitivity setting matches that of sensor.
- Verify F_{START} and F_{STOP} are appropriate for the speed of the machinery being monitored
- Verify the power detector type for Band 1 and Band 2.
- Verify the desired measurement units, English or metric, are selected.

Troubleshooting *(continued)*

Incorrect 4-20 mA loop current

Description: 4-20 mA loop current is not as expected

Possible causes:
1. Wrong source mapped to loop
2. "Force mode" active

- Verify the intended measurement result (process variable) is mapped to the intended current loop output.
- Verify loop is not in force mode. Use the UI to disable force mode and revert to normal operation.

Current loop output(s) "stuck" at 2 mA

Description: Current in one or both loops remains at 2 mA

Possible causes:
1. Sensor fault

- Check for BOV "**Fault**" indication on the UI and front panel
- Verify a compatible sensor is connected.
- Ensure IEPE Power is enabled.
- Check sensor/transducer wiring.
- Use an isolated DC voltmeter to check the DC voltage at the front-panel BNC connector. Ensure the sensor DC bias is within the acceptable range.

4-20 mA output(s) "stuck" at 20 mA

Description: Current in one or both loops remains at 20 mA

Possible causes:
1. Full scale set too low
2. Loop "Force mode" enabled

- Set the full scale to a higher value.
- Ensure the loop is not in force mode.

Erroneous integration results

Description: Velocity result (from acceleration input) or displacement result (from velocity input) too high, unstable or otherwise not as expected

Possible causes:
1. High level of low frequency energy
2. Measurement bandwidth too large
3. Sensor signal too low

Integration works best over small measurement bandwidths, i.e. $\left(\frac{FStop}{FStart}\right) \leq 100,$ and with high input signal levels (>20 mV).

- Increase F_{START} to reduce low frequency content.
- Reduce the measurement bandwidth by increasing F_{START} and decreasing F_{STOP}.
- Use a high sensitivity sensor (≥500 mV/g) to increase input signal level.

Cannot connect to web server/UI

Description: Unable to establish network connection with module

Possible causes:
1. Incorrect IP address
2. Incorrect network settings

- Verify the IP address of the module. If required, perform a "Factory Restore" to reset the IP address to the default value.
- Verify the iT300/301 and Link Partner network settings are correct. See section 15.3, "Establishing a network connection (PC, Laptop)" for details on network settings.
- Ensure Auto-Negotiation is enabled on the Link Partner. Consult a network administrator to obtain the proper settings for both the iT300/301 and the local network equipment. If necessary, perform a "Factory Restore" to reset all network settings to their default values.

UI malfunctioning

Description: UI not responding properly or functioning erratically

Possible causes:
1. Non-supported or out-of-date web browser
2. More than one user logged in
3. More than two simultaneous connections exist
4. Too many browser windows/tabs open

- Ensure the browser is supported and its version is current. Check for newer version of firmware and update, if required.
- Only one user should be logged in at any given time.
- Do not attempt to establish more than two simultaneous connections to the web server.
- Close all additional browser windows/tabs while connected to the web server

21 Application example

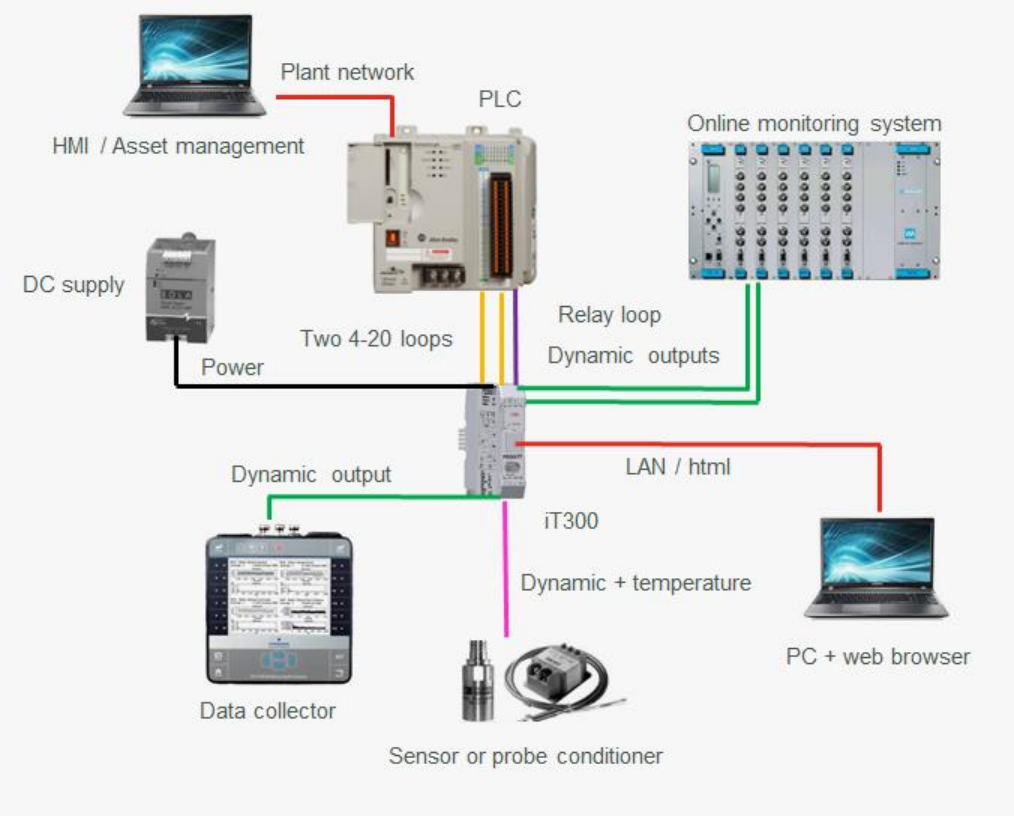


Figure 16 - Application example

22 Maintenance and calibration

The iT300 series intelligent transmitters contain no user-serviceable parts. All units are factory-calibrated and require no field adjustment or service. The units have been designed to provide years of continuous, trouble free service under normal operating conditions.

23 Warranty

Visit the Wilcoxon web site at www.wilcoxon.com for warranty information.

24 Technical assistance and customer service

24.1 Module information

When calling for technical support or warranty information, have ready the following information: Model number, serial number, hardware and firmware version. This information can be found under "Module Information" on the User Interface.

24.2 Technical assistance

For technical assistance, please contact Wilcoxon's technical support department:
Phone: 301-330-8811
Fax: 301-330-8873
email: info@wilcoxon.com

24.3 Customer service

To obtain a return materials authorization (RMA) number, please contact customer service at 301-330-8811, or fax to 301-330-8873.

25 Accessories

Spring shield connection clamp
– Phoenix Contact SKS 8-SNS35, Order No. 3062786

Grounding terminal block
– Phoenix Contact UT 2,5/1P-PE, Order No. 3045033

Appendix A: Technical data

Mechanical	
Mounting	35 mm DIN rail, snap fit
Housing dimensions (W / H / D)	22.5 mm / 99.2 mm / 114.5 mm
Housing material	Polyamide
Housing color	Light gray
Weight, including terminal blocks	147.2 grams (5.19 oz.)
Environmental	
Operating temperature range	-40 °C to +70 °C (-40 °F to +158 °F)
Storage temperature range	-40 °C to +85 °C (-40 °F to +185 °F)
Humidity, non-condensing	0 – 95%
Altitude limit, operating	0 – 3000 meters
Degree of protection	IP20, (touch-safe) per IEC60529
Inflammability class	V0, according to UL 94
Terminal blocks	
Connection method	Screw terminals
Conductor cross section, solid and flexible	0.2 mm² … 2.5 mm²
Conductor gauge	12 – 24 AWG
Stripping length	0.25” (6.4 mm)
Tightening torque	0.6 Nm
Power input	
Supply voltage range	11 – 32 VDC, reverse polarity protected
Absolute maximum ratings	±33 VDC
Current consumption, max.	158 mA @ 24 VDC, (350 mA @ 11 VDC, 118 mA @ 32 VDC)
Power consumption, max.	3.8 W
TBUS current rating	4 A
Surge voltage category	II
Isolation	500 VAC
Sensor input	
Input type	Singled-ended, DC coupled
Sensitivity range	9.0 – 11,000.0 mV/g or mV/in/sec
Frequency response	0.2 Hz – 20 kHz (-3 dB, -0.1 dB)
Frequency response (True Peak)	10 Hz – 24 kHz (-3 dB)
Full-scale input range	+12 VDC ±10 volts (20 volts peak-to-peak)
Dynamic range	>90 dB
IEPE power source	+24 VDC ±5% @ 4.5 mA ±25% (25 °C). No damage from continuous short.
Analog-to-digital converter	24 bits, ΔΣ
ADC sampling rate	48.828 kbps
Initial accuracy	±1% of full scale, 5 Hz – 5 kHz, Bands 1&2, acceleration input
Number of FFT lines	1,600
FFT window type	Hanning

Technical data (*continued*)

Temperature input	
Sensor type	786T / 787T
Sensitivity	10 mV/°C
Input range	0 – 1.2 VDC
Initial error	±2 °C
Sensor and temperature dynamic outputs	
Coupling	DC
Output impedance	50 Ω
Minimum load resistance	10k Ω
Short circuit protection	No damage from continuous short
4-20 mA current loop outputs	
Current range	0 – 20.0 mA
Initial accuracy	±0.3% of full scale (Force mode)
Sensor fault indication	NAMUR NE43 compliant
Compliance voltage	15 V, ±5%
Maximum loop resistance	500 Ω
Short circuit protection	No damage from continuous short
Isolation	500 VAC
Relay*	
Number of contacts	2
Type of contacts	Form C, (NO - Normally open, NC - normally closed), break-before-make
Contact rating	30 VDC, 2A, resistive load
Contact material	PdRu, gold plated
Endurance	min. $5x10^5$ operations (1A, 30 VDC)
Isolation	500 VAC
RS485*	
Mode of operation	2-wire, half-duplex
Baud rate	600 – 256000 bps
Termination network	120 Ω, switchable via DIP switch
Isolation	500 VAC
Ethernet	
Physical interface	10/100 Mbps MDIX autocross
Connector	RJ45 with integrated magnetics and LEDs
Isolation	1500 VRMS, min., per IEEE 802.3 requirement

* iT301 only

Technical data (*continued*)

LEDs		
PWR (green)	No illumination: Illuminated: Blinking:	input power removed. Unit not powered. input power applied and normal operation. current loop (and/or relay) “Force Mode” active.
RLY* (yellow)	No illumination: Illuminated:	relay de-energized. relay energized.
ERR (red)	No illumination: Illuminated: Blinking:	normal operation. No faults present. sensor fault (priority). current loop fault.
RS485* (yellow)	No illumination: Flash:	Module not being addressed via RS485, or bus idle. RS485 Modbus packet with matching slave address received.
RJ45 (green)	No illumination: Illuminated:	no link established. link established, link activity.
RJ45 (yellow)	No illumination: Illuminated:	10 Mbps link (or no link). 100 Mbps link.

* iT301 only

Certification	
Conformance	
Safety	• EN61010-1:2001 – Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements • UL508 – Safety standard for industrial control equipment • EN50178 – Electronic equipment for use in power installations
EMC	• EN61000-6-2:2005 Electromagnetic compatibility (EMC), Generic standards – Immunity for industrial environments • EN61000-6-4:2007 Electromagnetic compatibility (EMC), Generic standards – Emission standard for industrial environments • EN61326-1:2006 Electrical equipment for measurement, control and laboratory use - EMC requirements – General Requirements • EN61326-2-3:2006 Electrical equipment for measurement, control and laboratory use - EMC requirements - Particular Requirements - Test configuration • NAMUR NE 21 EMC recommendations

Appendix B: Modbus (iT301)

Overview

Modbus is a serial communications protocol that has become the de facto protocol for connecting industrial electronic devices. It enables communication among many devices connected to the same network and is often used to connect a supervisory computer with a remote terminal unit (RTU) in SCADA systems. There are a number of hardware configurations and protocol variants used for Modbus networks. The variants supported by the iT301 are:

- Modbus TCP
- Modbus RTU over RS485
- Modbus ASCII over RS485

Modbus-TCP

Modbus TCP/IP, or simply Modbus TCP, uses a TCP-socket-based interface between a Master device (client) and slave device (server) to carry what otherwise is Modbus RTU communication. The format of the payload data and the set of operations is the same, other than the replacement of the serial interface with the TCP socket. The TCP/IP protocol handles the framing of messages and delivery to the destination device, making the Modbus address field embedded in the message unnecessary for the actual transmission. The Modbus address is converted to a network node address and routing path by the originating controller or its network adapter. Connection is over port 502.

Tech tip! The iT301 supports up to two concurrent Modbus TCP slave sessions.

RS485 serial interface modes

RTU mode

In RTU mode, each 8-bit byte in a message contains two 4-bit hexadecimal characters. The main advantage of this mode is that, for the same baud rate, its greater character density allows better data throughput than ASCII. However, each message must be transmitted in a continuous stream. If not carefully controlled, inter-character delay times may cause errors.

RTU Message Format	
Coding	8-bit binary. Two hex characters contained in each 8-bit field of the message.
Bits per byte (character)	11 1 start bit 8 data bits 1 parity bit (optional) 1 stop bit if even/odd parity, 2 stop bits if no parity
Parity	None, even, odd
Error checking	CRC
Baud rates	600, 1200, 2400, 4800, 9600, 14400, 19200, 38400, 57600, 115200, 256000
End of message*	Idle line for 3.5 or more character times (600-14400 baud) Idle line for at least 1.8 ms (19200 baud and above)

*After receiving a slave response, the master should not send another query before the end-of-message idle time has expired.

ASCII mode

In ASCII mode, each 8-bit byte in a message is sent as two ASCII characters. Advantages of this mode are that it has well-defined start and end delimiters for each packet, and time intervals of up to one second between characters will not cause an error.

ASCII Message Format	
Coding	7-bit binary with parity. One hexadecimal character contained in each ASCII character of the message.
Bits per byte (character)	10 1 start bit 7 data bits 1 parity bit 1 stop bit
Parity	Even, odd (No parity is not permitted)
Error checking	LRC
Baud rates	600, 1200, 2400, 4800, 9600, 14400, 19200, 38400, 57600, 115200, 256000
Timeout	One second

RS485 serial data bus

The RS485 bus is a two-wire, half-duplex serial interface. The interface operates with a baud rate up to 256 kbps and is electrically isolated from all other circuits. The operating parameters for the RS485 interface are configured via the UI.

Refer to, "*Modbus Serial Line Protocol and Implementation Guide V1.02,*" available at modbus.org, for complete information regarding the installation and operation of Modbus on the RS485 physical layer interface.

RS485 connections

Multiple modules (32 or more, depending on the quality of the bus) can be networked via the RS485 bus. Use high quality, shielded twisted pair cable to connect modules on the bus. Connect the shield of the bus cable as required by the application, preferably at one point only for the entire bus. Generally, this point is on or near the master device or on its tap. See section 10.8, "Cable shielding and earth ground connections" for more information regarding shield connections.

Because the RS485 transceivers are electrically isolated, no "third wire" or common connection is necessary.

If collocated, modules also may be connected to the RS485 bus via the TBUS connector. The TBUS permits inter-module communications without the need for external wiring via the terminal blocks.

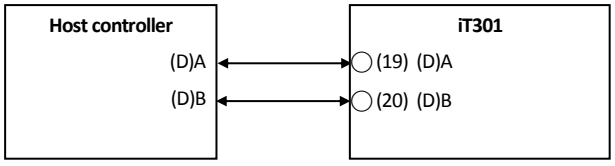


Figure 17 - RS485 terminal block connections

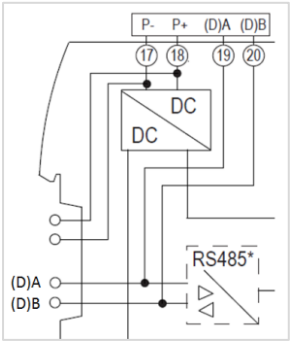


Figure 18 - RS485 TBUS terminal locations

Activating the RS485 termination resistor

To ensure reliable bus communications, it is important to properly terminate the RS485 bus. Locate and verify the physical position of all RS485 devices connected to the bus. For correct bus operation and to prevent signal reflections on the line, resistive terminations are required at the two furthest bus end units.

Normally, the host controller (master) terminates one end of the bus, as shown in the example below. On the furthest iT301 module, activate its termination resistor by setting both DIP switches to the "ON" position. Deactivate the termination on all other modules. Exactly two termination resistors should be activated. All other configurations may compromise data integrity

Tech tip! If the host controller does not offer bus termination, activate the termination resistor on the iT301 module closest to the controller.

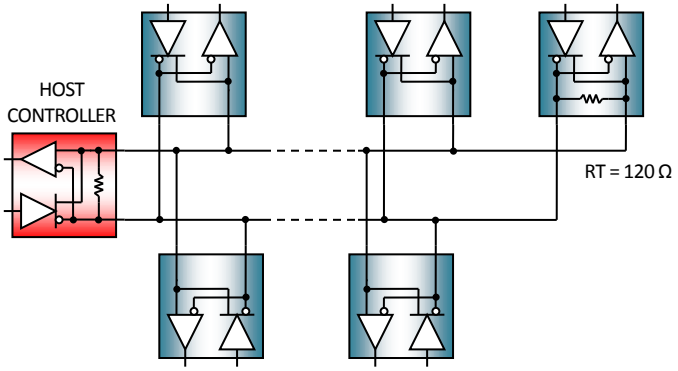


Figure 19 - Proper RS485 terminations

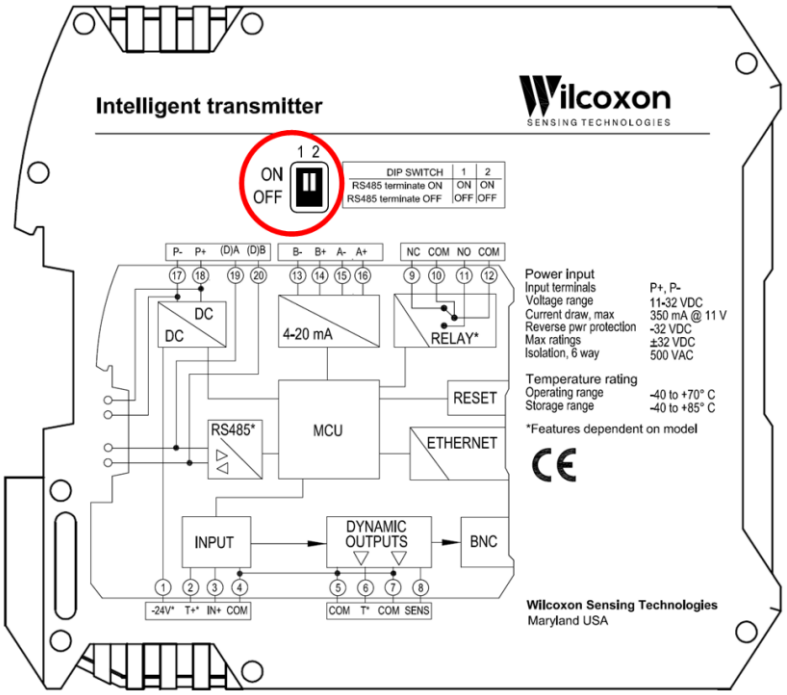


Figure 20 - RS485 termination DIP switch location

Line Polarization

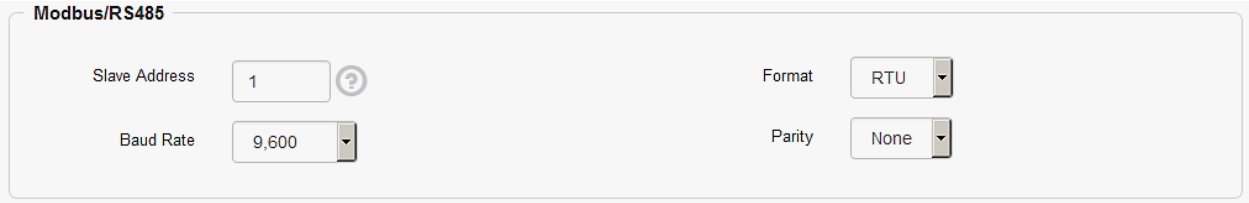
When there is no data activity on the RS485 bus, the lines are not driven. If the lines are allowed to float, the bus may be susceptible to external noise or interference. The iT301 receiver has fail-safe inputs that ensure its output is high during line-idle conditions, when no driver on the bus is enabled. However, other devices on the bus or operation in an electrically noisy environment may require the lines to be biased to ensure all receivers remain in a known state when no data signal is present. This biasing is known as "line polarization."

The transmitter does not implement line polarization. When required, the polarization of the data line pair must be implemented at only one location on the bus. Generally, this point is on or near the master device or on its tap. Refer to, "*Modbus Serial Line Protocol and Implementation Guide V1.02*," available at modbus.org, for more information regarding line polarization.

In RTU mode, the iT301 enables its transmitter and forces the bus into an idle line state for 3.5 character times prior to transmitting. This action forces termination of any noise generated messages and improves message frame synchronization.

RS485 serial interface configuration

Serial transmission parameters are configurable via the Modbus instrument panel on the UI.



Slave address

Valid slave device addresses are in the range of 1 - 247 decimal, inclusive. Individual slave devices should each be assigned a unique address in this range. The default slave address is 1.

Tech tip! Address 0 is reserved for the broadcast address and is not supported by the iT301.

RTU/ASC II format

The transmission format (mode) determines how information will be packed into the Modbus message fields and decoded. Select either RTU or ASCII format. The default is RTU.

Baud rate

Use the drop-down menu to set the baud rate of the RS485 interface. The default is 9600 bps.

Parity

Use the drop-down menu to set the parity of the data frame. The options are:

- None (RTU only)
- Odd
- Even (default for ASCII)

Tech tip! ASCII mode must have either odd or even parity. No parity is not permitted.

Stop bits

The iT301 normally transmits one stop bit. In RTU mode, two stop bits are transmitted if no parity is selected. The receiver is compatible with either one or two stop bits.

Object types

The table below lists the object types supported by an iT301 Modbus slave device.

Object Type	Access	Size	Supported
Discrete input	Read only	1 bit	Yes
Input register	Read only	16 bits	Yes
Holding register	Read only	16 bits	Yes

Table 3 – Supported Modbus object types

Discrete Inputs

The "Discrete Input" object type (1X references) is used for single-bit alert and alarm status reporting as listed in the register table.

Input Registers

The "Input Register" object type (3X references) is used for measurement results reporting as listed in the register table.

Holding Registers

The "Holding Register" object type (4X references) is used for device configuration parameters as listed in the register table.

A request (query) containing a non-supported object type will cause an exception response to be returned.

Function Codes

The function code part of a Modbus message defines the action to be taken by the slave. The Modbus function codes supported by the iT301 are:

02 - Read input status

Reads single bit inputs (1X references)

03 - Read holding registers

Reads the contents of one or more holding registers (4X references)

04 - Read input registers

Reads the contents of one or more 16-bit input registers (3X references)

Queries containing non-supported function codes will cause an exception response to be returned.

Data types

The format of data in an input register or holding register can be one of five types:

Boolean

The value of the register can take on only one of two values: 1 or 0, indicating "True/On" or "False/Off", respectively.

Binary

Binary data can be stored as:

- Two, 8-bit unsigned integers
- A single, 16-bit unsigned integer
- A single, 32-bit unsigned integer (comprising two concatenated registers)

Bitwise

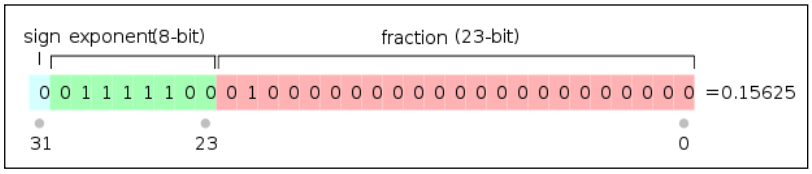
Each bit in the register is independent and assigned to a unique system variable or function. A 1 indicates the variable is "True." A 0 indicates the variable is "False."

ASCII

Register data is encoded in ASCII (American Standard Code for Information Interchange) format and represents standard alphanumeric characters. Each register contains two ASCII characters.

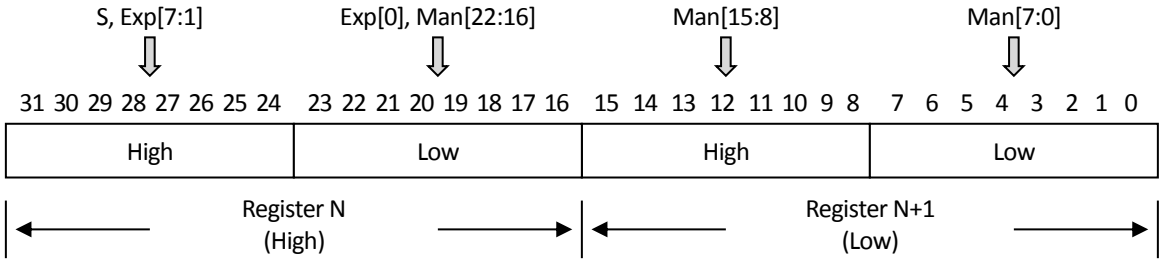
Floating point

Register data is encoded as a 32-bit floating point number in IEEE 754 32-bit format: 1 sign bit, 8 exponent bits, 23 fractional bits. Floating point variables comprise concatenated data contained in two consecutive 16-bit registers.



Byte ordering

Input registers and holding registers comprise 16 bits. Data is packed as two bytes per register, with the binary contents right justified within each byte. Bytes are organized in **Big Endian** fashion - the first byte contains the high order bits and the second byte contains the low order bits (i.e. most significant byte first). This also applies to multi-register parameters - the first register address (starting address) contains the high order bytes and subsequent addresses contain the lower order bytes.



Floating point format shown: S = sign bit Exp = exponent Man = mantissa (fraction)

Figure 21 - Big endian byte ordering

Examples – reading Modbus registers

The following examples show the query/response format for various functions.

Reading a discrete input

The following example returns the status of the signal relay (discrete input #19) on slave device 5.

Query	
Field name	**Field Value (hex)**
Slave address	05
Function	02
Starting address high	00
Starting address low	12
No. of points high	00
No. of points low	01
Error check	---

Response	
Field name	**Field Value (hex)**
Slave address	05
Function	02
Byte count	01
Data	01
Error check	---

Response data field

Data	Data							
Hex	0				1			
Binary	0	0	0	0	0	0	0	1
Input	x	x	x	x	x	x	x	19

The response data field consists of a single byte, with the least significant bit indicating input #19 status. Because the requested/returned input quantity is not a multiple of eight, the seven upper bits in the data byte are padded with zeros.

Reading discrete inputs

The following example reads all 21 discrete inputs, starting at "ALERT – band 1 low" (input #1 , address 0) from slave device 18.

Query	
Field name	**Field Value (hex)**
Slave address	12
Function	02
Starting address high	00
Starting address low	00
No. of points high	00
No. of points low	15
Error check	---

Response	
Field name	**Field Value (hex)**
Slave address	12
Function	02
Byte count	03
Data 1 (inputs 8:1)	00
Data 2 (inputs 16:9)	00
Data 3 (inputs 24:17)	08
Error check	---

Response data field

Data	Data 3								Data 2								Data 1							
Hex	0				8				0				0				0				0			
Binary	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Input #	x	x	x	21	**20**	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

The response data field consists of three bytes. Each input is mapped to a single bit of the data field: 1 = on; 0 = off. The LSb of the first data byte contains the input addressed in the query. The other inputs follow toward the high order end of this byte, and from 'low order to high order' in subsequent bytes. "The Byte count" field specifies the quantity of complete bytes of data. In this example, DATA 3 = 08 (hex), which indicates a 'Current Loop A fault' (input #20 = 1). Because the requested/returned input quantity is not a multiple of eight, the three upper bits in the last data byte (Data 3) are padded with zeros.

Reading input registers

The following example retrieves the temperature from slave 10. Since temperature is a 32-bit floating point variable, two registers need to be read. Therefore, the "Number of points" must be set to 2. When requesting floating point data, always make sure the "Starting Address" does not fall in the middle of the variable. If the starting address or number of points is not correct, erroneous data will be returned.

Query	
Field name	**Field Value (hex)**
Slave address	0A
Function	04
Starting address high	00
Starting address low	08
No. of points high	00
No. of points low	02
Error check	---

Response	
Field name	**Field Value (hex)**
Slave address	0A
Function	04
Byte count	04
Data hi word, hi byte	42
Data hi word, lo byte	90
Data lo word, hi byte	99
Data lo word, lo byte	9A
Error check	---

The response data field consists of four bytes: 42_90_99_9A (hex) = 72.3 degrees.

Tech tip! Web-based applications that convert binary numbers to floating point are widely available.

Reading holding registers

The following example returns the signal relay source mapping (address 115) on slave device 32.

Query	
Field name	**Field Value (hex)**
Slave address	20
Function	03
Starting address high	00
Starting address low	73
No. of points high	00
No. of points low	01
Error check	---

Response	
Field name	**Field Value (hex)**
Slave address	20
Function	03
Byte count	02
Data hi	00
Data lo	16
Error check	---

Response data field

Data	Hi								Lo							
Hex	0				0				1				6			
Binary	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0
Bit #	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

The response data field consists of two bytes. From the register table, we know the "Map to relay" register is a bit-wise register, with each of the lower six bits indicating a relay source variable. Mapping of bits 5:0 is: 5=gap, 4=true peak, 3=temperature, 2=band 2, 1=band 1, and 0=BOV. Therefore, the following alarms are mapped to the relay: True peak, Band 2, Band 1.

Reading holding registers

The following example returns the driving source (process variable) for Current Loop A (address 117) on slave device 32.

Query	
Field name	**Field Value (hex)**
Slave address	20
Function	03
Starting address high	00
Starting address low	75
No. of points high	00
No. of points low	01
Error check	---

Response	
Field name	**Field Value (hex)**
Slave address	20
Function	03
Byte count	02
Data hi	00
Data lo	05
Error check	---

Response data field

Data	Hi								Lo							
Hex	0				0				0				5			
Binary	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Bit #	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

The response data field consists of two bytes. From the register table, we know the "Loop A source" register is a binary-encoded register. A value of 5 (decimal) indicates "Temperature" is mapped to Current Loop A.

Reading the module IP address

The following example retrieves the IP address of slave device 10. The device IP address comprises four bytes, each an unsigned integer, starting at address 40150. Therefore, two registers must be read (Number of points = 2).

Query	
Field name	**Field Value (hex)**
Slave address	0A
Function	03
Starting address high	00
Starting address low	96
No. of points high	00
No. of points low	02
Error check	---

Response	
Field name	**Field Value (hex)**
Slave address	0A
Function	03
Byte count	04
Data hi word, hi byte	C0
Data hi word, lo byte	A8
Data lo word, hi byte	00
Data lo word, lo byte	64
Error check	---

The response data field consists of four bytes: C0.A8.00.64 (hex) = 192.168.0.100. The same query format is used to retrieve the subnet mask and default gateway.

Reading the module IP address via Modbus-TCP

The previous example is repeated here using Modbus-TCP. Modbus-TCP uses the Modbus application protocol (MBAP) in the application layer. A Modbus-TCP frame consists of a seven-byte MBAP header followed by the usual Function Code and Data Bytes. The bytes in the MBAP header are described in the table below.

Header Byte	Description
0	Transaction identifier, hi byte. Echoed by the slave.
1	Transaction identifier, lo byte. Echoed by the slave.
2	Protocol identifier, hi byte. Always 0.
3	Protocol identifier, lo byte. Always 0.
4	Length field, hi byte. Always 0.
5	Length field, lo byte. Indicates the total number of bytes following this byte.
6	Unit identifier (slave address)

Query	
Field name	**Field Value (hex)**
Header byte 0	00
Header byte 1	00
Header byte 2	00
Header byte 3	00
Header byte 4	00
Header byte 5	06
Header byte 6	0A
Function	03
Starting address high	00
Starting address low	96
No. of points high	00
No. of points low	02

Response	
Field name	**Field Value (hex)**
Header byte 0	00
Header byte 1	00
Header byte 2	00
Header byte 3	00
Header byte 4	00
Header byte 5	07
Header byte 6	0A
Function	03
Byte count	04
Data hi word, hi byte	C0
Data hi word, lo byte	A8
Data lo word, hi byte	00
Data lo word, lo byte	64

Note that the CRC (or LRC) bytes are NOT required in Modbus-TCP. Instead, the TCP/IP and link layers verify packet integrity.

RS485 Modbus troubleshooting guide

The following are helpful hints and suggestions for when problems arise with Modbus operation.

1. Verify correct RS485 wiring and termination:
   - The (D)A terminals of all devices on the network should be connected together
   - The (D)B terminals of all devices on the network should be connected together
   - Termination: Only one RS485 slave device should have its termination resistor activated
   - Provide data line polarization (biasing), if required.
   - All interconnecting cables should be properly grounded and shielded, as called for by the application.
2. Verify the baud rate, parity, and Modbus format are correct and the same for all devices on the network.
3. ASCII format uses seven data bits and requires even or odd parity. RTU format uses eight data bits.
4. In RTU mode, ensure the minimum time between polls and response timeout are set properly on the master.
5. In RTU mode, ensure the master waits for the line idle time, minimum, before sending another query.
6. Verify each slave device on the network has unique address and is the same as the master is expecting.
   a. Use the front-panel RS485 LED to verify the module is receiving queries with a matching address
   b. Troubleshooting is easiest on a minimal network, i.e. a network consisting only of one master and one slave. If the network operates correctly with only one slave device connected, but fails when additional slave devices are added, it could indicate an address conflict.
7. Verify the data format of the requested slave register(s): binary, Boolean, ASCII, bit-wise or floating point. Each data type must be interpreted differently. It is up to the master to understand how the slave stores data and decode it properly.
8. When requesting floating-point variables (register pairs):
   a. Ensure the starting address and number of points are correct so that floating point variables aren't "split" when read.
   b. Verify the floating-point byte order expected by the master is "big endian" (most significant byte first).
9. Verify the correct configuration and operation of any RS232/USB-to-RS485 converters.
10. Use a software-based Modbus tester, such as *Modbus Poll* from modbustools.com, to aid troubleshooting.
11. Visit modbus.org for technical references on Modbus installation and operation.

Modbus Register tables

Note: Not all registers are applicable to all product models.

Discrete Inputs (1X references) - Alerts, Alarms, Status

Read with function code 02

Input #	Register (decimal)	Address (hex)	Parameter Name	Notes
1	10000	0000	ALERT - band 1 low	
2	10001	0001	ALERT - band 1 high	
3	10002	0002	ALERT - band 2 low	
4	10003	0003	ALERT - band 2 high	
5	10004	0004	ALERT - true peak low	
6	10005	0005	ALERT - true peak high	
7	10006	0006	ALERT - temperature low	
8	10007	0007	ALERT - temperature high	
9	10008	0008	ALERT - BOV low	
10	10009	0009	ALERT - BOV high	
11	10010	000A	ALERT - gap low	
12	10011	000B	ALERT - gap high	
13	10012	000C	ALARM - band 1	
14	10013	000D	ALARM - band 2	
15	10014	000E	ALARM - true peak	
16	10015	000F	ALARM - temperature	
17	10016	0010	ALARM - BOV	
18	10017	0011	ALARM - gap	
19	10018	0012	Relay energized	
20	10019	0013	Loop A fault	
21	10020	0014	Loop B fault	

Input Registers (3X references) - Measurement results, module information

Read with function code 04

Register (decimal)	Address (hex)	Parameter Name	Data type	# of registers	Notes
30000	0000	Fmin	Float	2	Hertz
30002	0002	Band 1 level	Float	2	
30004	0004	Band 2 level	Float	2	
30006	0006	True Peak level	Float	2	
30008	0008	Temperature	Float	2	°F or °C
30010	000A	BOV	Float	2	Volts
30012	000C	Loop A level	Float	2	mA
30014	000E	Loop B level	Float	2	mA
30016	0010	Gap	Float	2	mils or mm
30018	0012	Gap voltage	Float	2	Volts
30020	0014	MAC address	8-bit binary (6x)	3	
30023	0017	Firmware revision	Float	2	

Holding Registers (4X references) - User configurable parameters

Read with function code 03

Register (decimal)	Address (hex)	Parameter Name	Data type	# of registers	Notes
40000	0000	Machine location	ASCII	12	Text, 24 characters
40012	000C	Machine name	ASCII	12	Text, 24 characters
40024	0018	Machine ID	ASCII	12	Text, 24 characters
40036	0024	Measurement point	ASCII	12	Text, 24 characters
40048	0030	Sensor type	Binary	1	0=accel, 1=vel, 2=disp
40049	0031	Sensor sensitivity	Float	2	
40051	0033	Averaging time	Float	2	Seconds
40053	0035	IEPE power enabled	Boolean	1	
40054	0036	Sensor serial number	ASCII	12	Text, 24 characters
40066	0042	Fmax	Float	2	Hertz
40068	0044	Band 1 output type	Binary	1	0=accel, 1=vel, 2=disp
40069	0045	Band 1 start frequency	Float	2	Hertz
40071	0047	Band 1 stop frequency	Float	2	Hertz
40073	0049	Band 1 detector type	Binary	1	0=RMS, 1=peak, 2=p-p
40074	004A	Band 2 output type	Binary	1	0=accel, 1=vel, 2=disp
40075	004B	Band 2 start frequency	Float	2	Hertz
40077	004D	Band 2 stop frequency	Float	2	Hertz
40079	004F	Band 2 detector type	Binary	1	0=RMS, 1=peak, 2=p-p
40080	0050	Band 1 eng. units	Binary	1	0=g, 1=m/s^2, 2=in/sec, 3=mm/sec, 4=mils, 5=mm
40081	0051	Band 2 eng. units	Binary	1	0=g, 1=m/s^2, 2=in/sec, 3=mm/sec, 4=mils, 5=mm
40082	0052	True peak eng. units	Binary	1	0=g, 1=m/s^2, 2=in/sec, 3=mm/sec, 4=mils, 5=mm
40083	0053	Temperature eng. units	Binary	1	0=Fahrenheit, 1=Celsius
40084	0054	Gap eng. units	Binary	1	4=mils, 5=mm
40085	0055	Band 1 low limit	Float	2	
40087	0057	Band 1 high limit	Float	2	
40089	0059	Band 2 low limit	Float	2	
40091	005B	Band 2 high limit	Float	2	
40093	005D	True peak low limit	Float	2	
40095	005F	True peak high limit	Float	2	
40097	0061	Temperature low limit	Float	2	
40099	0063	Temperature high limit	Float	2	
40101	0065	BOV low limit	Float	2	Volts
40103	0067	BOV high limit	Float	2	Volts
40105	0069	Gap low limit	Float	2	
40107	006B	Gap high limit	Float	2	

Continued on next page...

Holding registers (continued)

Register (decimal)	Address (hex)	Parameter Name	Data type	# of registers	Notes
40109	006D	Alert low limit enables	Bitwise [5:0]	1	Bit 5: gap Bit 4: true peak Bit 3: temperature Bit 2: band 2 Bit 1: band 1 Bit 0: BOV
40110	006E	Alert high limit enables	Bitwise [5:0]	1	Bit 5: gap Bit 4: true peak Bit 3: temperature Bit 2: band 2 Bit 1: band 1 Bit 0: BOV
40111	006F	Delay Time	Float	2	Seconds
40113	0071	Hold time	Float	2	Seconds
40115	0073	Map to relay	Bitwise [5:0]	1	Bit 5: gap Bit 4: true peak Bit 3: temperature Bit 2: band 2 Bit 1: band 1 Bit 0: BOV
40116	0074	Force relay	Boolean	1	1=forced, 0=normal
40117	0075	Loop A source	Binary	1	6=gap, 5=temperature 4=BOV, 3=true peak, 2=band 2, 1=band 1, 0=disabled
40118	0076	Loop A full scale	Float	2	
40120	0078	Loop A destination	ASCII	8	Text, 16 characters
40128	0080	Loop A force mode current	Float	2	mA
40130	0082	Loop A force mode	Boolean	1	1=forced, 0=normal
40131	0083	Loop B source	Binary	1	6=gap, 5=temperature 4=BOV, 3=true peak, 2=band 2, 1=band 1, 0=disabled
40132	0084	Loop B full scale	Float	2	
40134	0086	Loop B destination	ASCII	8	Text, 16 characters
40142	008E	Loop B force mode current	Float	2	mA
40144	0090	Loop B force mode	Boolean	1	1=forced, 0=normal
40145	0091	Modbus RTU mode	Boolean	1	1=RTU, 0=ASCII
40146	0092	Modbus slave address	8-bit binary	1	
40147	0093	RS485 baud rate	32-bit binary	2	
40149	0095	RS485 parity	Binary	1	0=none, 1=odd, 2=even
40150	0096	IP address	8-bit binary (4x)	2	
40152	0098	Subnet mask	8-bit binary (4x)	2	
40154	009A	Default gateway	8-bit binary (4x)	2	

Revision History

DATE	REV	PAGE	SECTION	DESCRIPTION
6/17	B	30	Alerts and alarms	Revised descriptions of alerts, alarms. Updated images.
		31	Loop full scale	Corrected equation for Fahrenheit full scale
		41	RS485 serial interface modes	Added information on RTU and ASCII byte formats.
		48, 51	Modbus examples	Updated example for "Reading discrete inputs". Added example for Modbus-TCP.
		53	Modbus register tables	Changed data type of "Firmware revision" from ASCII to float. Updated all tables.
8/17	C	-	Document	Change to Wilcoxon format.
8/20	C.2	41	Technical data	Removed shock and vibration limits ("Environmental" section)

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.