



Level



Pressure



Flow



Temperature



Liquid
Analysis



Registration



Systems
Components



Services



Solutions

Operating Instructions

Liquiphant FailSafe FTL8x

Vibronic

Point level switch for liquids

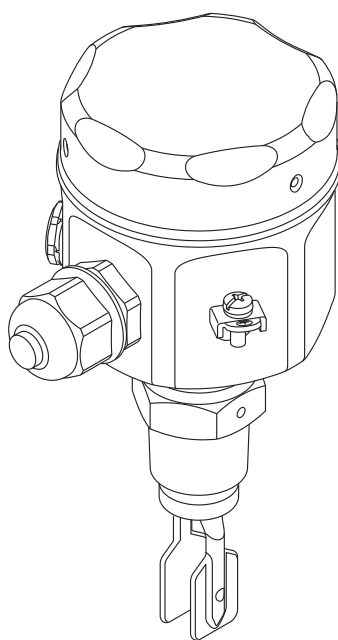


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1 Important document information

1.1 About this document

1.1.1 Document function

These Operating Instructions contain all the information that is required in the various phases of the life cycle of the device: from product identification, incoming acceptance and storage, to mounting, connection, operation and commissioning through to troubleshooting, maintenance and disposal.

1.1.2 Additional standard device documentation

Document	Purpose and content of the document
TI01026F	Technical Information (planning aid for your device) The document contains all the technical data on the device and provides an overview of the accessories and other products that can be ordered for the device.
TI00426F	Weld-in adapter and flanges
SD00350F	Functional Safety Manual

1.1.3 Safety Instructions (XA) for the device

Depending on the device approval Safety Instructions (XA) are supplied with the device. These are considered an integral part of the Operating Instructions.



Note!

The document types listed are available at: www.endress.com → Download

Document number	Documents according to type of protection
XA00648F	ATEX II 1G Ex ia IIC T6 Ga, ATEX II 1/2G Ex ia IIC T6 Ga/Gb, IECEX Ex ia IIC T6 Ga, IECEX Ex ia IIC T6 Ga/Gb, ATEX/IECEX Ex ia ATEX II 1/2G Ex ia IIC T6 Ga/Gb IECEX Ex ia IIC T6 Ga/Gb
XA00649F	ATEX II 1/2G Ex d IIC T6 Ga/Gb, IECEX Ex d IIC T6 Ga/Gb, ATEX/IECEX Ex d ATEX II 1/2G Ex d IIC T6 Ga/Gb IECEX Ex d IIC T6 Ga/Gb
XA00650F	ATEX II 1/2G Ex de IIC T6 Ga/Gb, IECEX Ex de IIC T6 Ga/Gb
XA00651F	ATEX II 1/3G Ex nA IIC T6 Ga/Gc, IECEX Ex nA IIC T6 Ga/Gc
XA00652F	ATEX Ex ia G/D ATEX II 1/2G Ex ia IIC T6 Ga/Gb ATEX II 1/2D Ex ia IIIC Da/Db, IECEX Ex ia G/D IECEX Ex ia IIC T6 Ga/Gb IECEX Ex ia IIIC Da/Db
XA00653F	ATEX Ex d / Ex ta ATEX II 1/2G Ex d IIC T6 Ga/Gb ATEX II 1/2D Ex ta IIIC Da/Db, IECEX Ex d/Ex t IECEX Ex d IIC T6 Ga/Gb IECEX Ex t IIIC Da/Db

Document number	Documents according to type of protection
XA00654F	ATEX Ex ia / Ex d ATEX II 1/2G Ex ia IIC T6 Ga/Gb ATEX II 1/2G Ex d IIC T6 Ga/Gb, IECEX Ex ia / Ex d IECEX Ex ia IIC T6 Ga/Gb IECEX Ex d IIC T6 Ga/Gb
XA00604F	CSA C/US IS Cl I,II,III Div.1 Gr.A-G T6, Cl. 1 Zone 0, AEx/Ex ia IIC T6 Ga Single/DualSeal
XA00676F	CSA C/US NI Cl.I,II,III Div.2 Gr.A-G, T6 Cl. I, Zone 2, AEx/Ex nA IIC T6 Gc Single/DualSeal
XA00655F	CSA C/US XP Cl.I,II,III Div.1 Gr.A-G T6, Cl.I Zone 1 AEx/Ex d IIC T6 Gb NI Cl.I,II,III Div.2 Gr. A-G T6, Cl.I Zone 2 AEx/Ex nA IIC T6 Gc Single/DualSeal
XA00605F	FM C/US IS Cl.I,II,III Div.1 Gr.A-G T6 Cl. 1, Zone 0, AEx/Ex ia IIC T6,
XA00675F	FM C/US NI Cl.I Div.2 Gr.A-D T6 DIP Cl. II,III Div.2 Gr. E,F,G T6 Cl. I, Zone 2 AEx/Ex nA IIC T6
XA00656F	FM C/US XP Cl.I Div.1 Gr.A-G T6 XP Cl.I Div. 1 Gr.B-D T6 DIP II,III Div.1 Gr.E,F,G T6 NI Cl.1 Div.2 Gr. A-D T6 Cl. I, Zone 1, AEx/Ex d IIC T6 Cl. I, Zone 2, AEx/Ex nA IIC T6
XA00657F	FM/CSA C/US IS + XP IS Cl.I,II,III Div.1 Gr.A-G T6, XP Cl.I,II,III Div.1 Gr.A-G T6, Cl.I Zone 0 AEx/Ex ia IIC T6 Ga, Cl.I Zone 1 AEx/Ex d IIC T6 Gb, Single/DualSeal
XA00658F	NEPSI Zone 0 Ex ia IIC T6 Ga, NEPSI Zone 0/1 Ex ia IIC T6 Ga/Gb
XA00659F	NEPSI Zone 0/1 Ex d IIC T6 Ga/Gb
XA00660F	NEPSI Zone 0/1 Ex de IIC T6 Ga/Gb

1.2 Notes on safety conventions and icons

In order to highlight safety-related or alternative operating procedures in the manual, the following conventions have been used, each indicated by a corresponding icon in the margin.

Safety instructions	
	Warning! Indicates an action or procedure which, if not performed correctly, can result in serious personal injury, a safety hazard or the destruction of the device.
	Caution! Indicates an action or procedure which, if not performed correctly, can result in personal injury or the incorrect operation of the device.
	Note! Indicates an action or procedure which, if not performed correctly, can have an indirect effect on operation or trigger an unexpected response on the part of the device.
Type of protection	
	Explosion-protected, type-examined equipment If this symbol appears on the nameplate of the device, the device can be used in hazardous or non-hazardous areas according to its approval.
	Hazardous area This symbol is used in the drawings of these Operating Instructions to indicate hazardous areas. Devices in hazardous areas, or cables for such devices, must have an appropriate type of protection.
	Safe area (non-hazardous area) This symbol is used in the drawings of these Operating Instructions to indicate non-hazardous areas. Devices in the non-hazardous area also have to be certified if connecting cables lead into the hazardous area.
Electrical symbols	
	Direct current A terminal at which DC voltage is present or through which direct current flows.
	Alternating current A terminal at which alternating voltage (sinusoidal) is present or through which alternating current flows.
	Ground connection A grounded terminal which, from the viewpoint of the user, is grounded via a grounding system.
	Protective ground connection A terminal which must be connected to ground prior to establishing any other connections.
	Connecting cable immunity to temperature change Indicates that the connecting cables must be able to withstand temperatures of at least 85 °C.
LED symbols	
	Not relevant
	Off
	Flashing
	Lit

2 Basic safety instructions

2.1 Personnel requirements

The personnel for installation, commissioning, diagnostics and maintenance must fulfill the following requirements:

- Trained, qualified specialists must have a relevant qualification for this specific function and task
- Be instructed and authorized according to the requirements of the task by the facility's owner-operator
- Are familiar with federal/national regulations
- Before beginning work, the specialist staff must have read and understood the instructions in the Operating Instructions and supplementary documentation as well as in the certificates (depending on the application)
- Follow instructions and comply with conditions
- Follow the instructions in these Operating Instructions

2.2 Designated use

Functional Safety Manual



Caution!

Pay close attention to the information in the separate SIL documentation SD00350F for functional safety requirements in accordance with IEC 61508.

Application and media

The measuring device described in this manual is intended only for the point level measurement of liquids. Depending on the version ordered, the measuring device can also measure potentially explosive, flammable, poisonous and oxidizing media.

In compliance with the limit values specified in the "Technical data" section and the general conditions indicated in the manual and supplementary documentation, the measuring device may only be used for the following measurements:

- Measured variable: point level

To ensure that the measuring device remains in proper operating condition for its service life:

- Only use the measuring devices for media to which the process-wetted materials are adequately resistant.
- Comply with the limit values in the "Technical data" section.

Incorrect use

The manufacturer is not liable for damage resulting from improper or non-designated use.

Clarification of borderline cases:

With regard to special media and media used for cleaning, Endress+Hauser will be happy to assist in clarifying the corrosion-resistant properties of wetted materials but does not accept any warranty or liability.

Residual risks

During operation heat from the process can cause the electronics housing, and the modules it contains, to reach temperatures of up to 80 °C (176 °F).



Caution!

- Hot surfaces can present a burn hazard!
For elevated medium temperatures, ensure adequate protection against contact to prevent burns.
- Pay close attention to the information in the separate SIL documentation SD00350F for functional safety requirements in accordance with IEC 61508.

2.3 Occupational safety

When working on or with the device, always wear the necessary personal protective equipment as defined in national regulations.

2.4 Operational safety



Caution!

Risk of injury.

- Only operate the device if it is in a perfect technical condition free from errors and faults.
- The operator is responsible for the trouble-free operation of the device.

Conversions to the device

Unauthorized modifications to the device are not permitted and can lead to unforeseeable dangers. If, despite this, modifications are required, consult with Endress+Hauser.

Repair

To ensure operational safety:

- Only perform repair work on the device if this is expressly permitted.
- Comply strictly with national regulations concerning the repair of electrical equipment.
- Only use genuine Endress+Hauser spare parts and accessories.

Hazardous area

To exclude any risks to individuals or the facility when operating the device in the hazardous areas (e.g. explosion protection, pressure equipment safety):

- Based on the nameplate, check whether the ordered device is permitted for the intended use in the hazardous area.
- Comply with the instructions in the separate supplementary documentation, which is an integral part of this manual.

2.5 Product safety

This measuring device is designed to meet state-of-the-art safety requirements in accordance with sound engineering practice, has been tested and left the factory in a condition in which it is safe to operate.

It meets general safety standards and legal requirements. Furthermore, it complies with the EC directives which are listed in the device-specific EC Declaration of Conformity. Endress+Hauser confirms this by affixing the CE mark to the device.

3 Product description

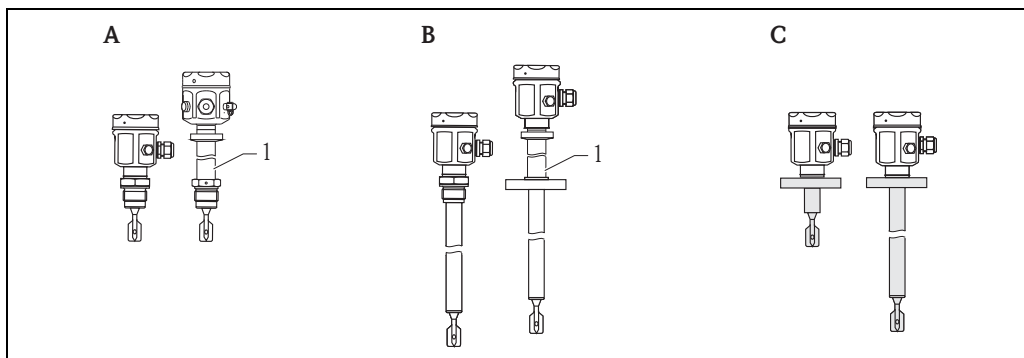
The Liquiphant FailSafe is a point level switch for minimum or maximum detection (MIN/MAX) which can be used in liquids:

- Process temperature: -50 to $+150$ °C (-58 to $+300$ °F)
- Process temperature for high-temperature versions: -60 to $+280$ °C (-76 to $+536$ °F)
- Ambient temperatures: -60 to $+70$ °C (-76 to $+158$ °F)
- For highly corrosive media
- Pressures up to 100 bar (1450 psi)
- Viscosity up to 10000 mPa·s
- Density from 0.4 g/cm³ (0.4 SGU)

Liquiphant FailSafe is the reliable point level switch for MIN or MAX safety applications up to SIL3, in accordance with IEC 61508 Ed.2.0 / IEC 61511-1 / ISA 84-1. Outstanding features of the point level switch are its fail-safe design and its high availability. A permanent LIVE signal also monitors function safety.

3.1 Product structure

Structure of the Liquiphant FailSafe



A FTL80: compact design, also for pipes and confined installation conditions

B FTL81: with pipe extensions up to 3 m (9.8 ft)

C FTL85: with high corrosion-resistant coating made of enamel, ECTFE and various PFA materials

1 High-temperature version

3.1.1 Terminals

To connect the supply voltage for the MIN or MAX detection operating mode.

3.1.2 Rotary switches

Two rotary switches for setting the density range (ρ_{Low} and ρ_{High}).

3.1.3 Proof test button

To confirm configuration changes and to activate the proof test.

3.1.4 Light emitting diodes (LEDs)

The light emitting diodes are used to indicate different operating states.

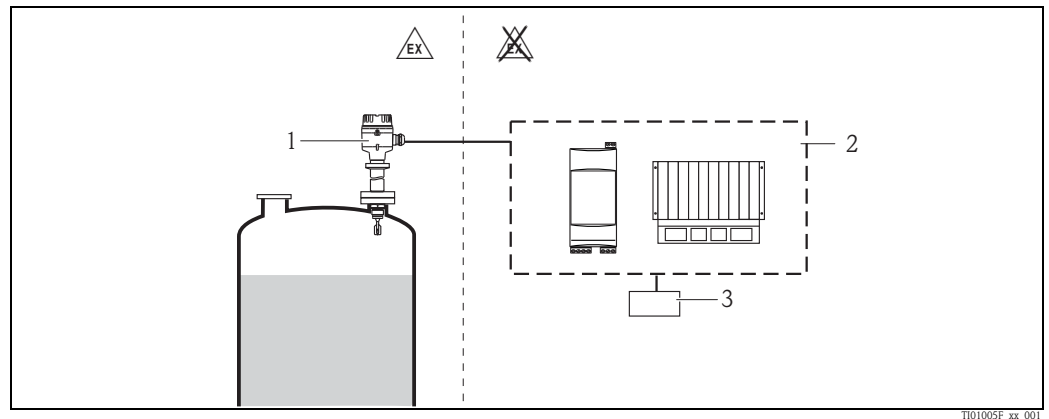


Note!

For further information, see → 26.

3.2 System components

The measuring system consists of several components, examples of which are illustrated in the graphic below:



- 1 Liquiphant FailSafe FTL8x with FEL85 electronic insert (4-20 mA)
- 2 Separate switching unit:
 - Nivotester FailSafe FTL825
 - PLC
 - Safety PLC
 - ...
- 3 Actuator

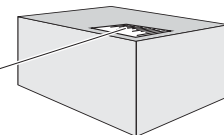
4 Incoming acceptance and product identification

4.1 Incoming acceptance

Is the order code on the delivery note (1) identical to the order code on the product sticker (2)?

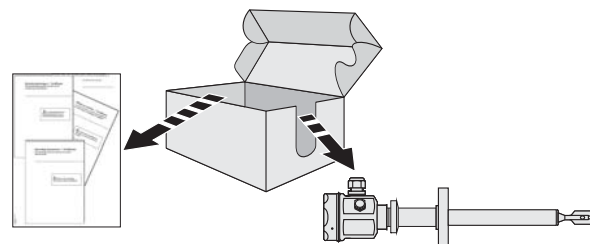


A0015502



1 = 2

A0016870

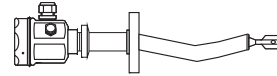
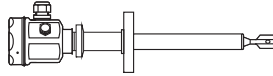


A0018000

Goods undamaged?



A0015502

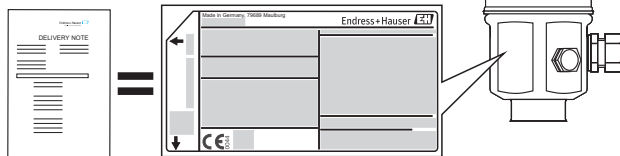


A0018001

Do the data on the nameplate match the order data and the delivery note?



A0015502



A0018228

4.2 Product configuration: www.endress.com

Detailed ordering information is available:

- In the Product configurator on the Endress+Hauser website: www.endress.com → Select country → Instruments → Select device → Product page function: Configure this product
- From your Endress+Hauser sales center: www.endress.com/worldwide



Note! Product configurator - the tool for individual product configuration

- Up-to-date configuration data
- Direct entry of data specific to the measuring point, such as the measuring range or operating language, depending on the device
- Exclusion criteria automatically checked
- Automatic order code generation with code breakdown output in PDF or Excel format
- Possible to order directly in the Endress+Hauser online shop

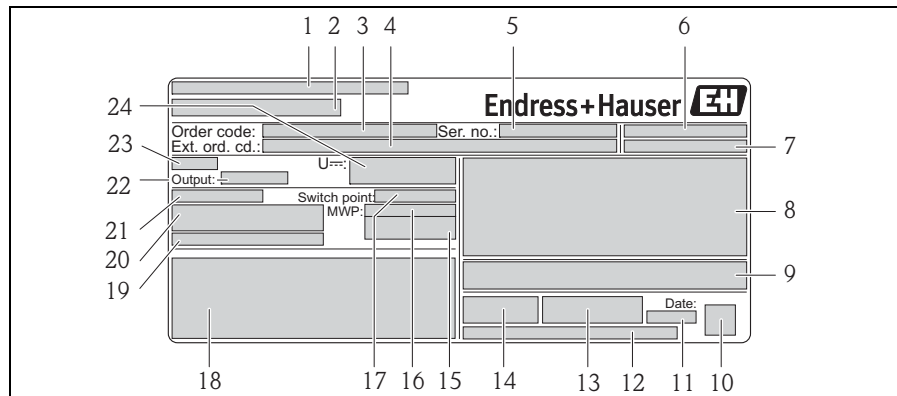
4.3 Product identification

It is possible to identify the measuring device in the following ways:

- Using the nameplate specifications
- Using the order code with a breakdown of the device features on the delivery note
- By entering the serial number on the nameplates into the W@M Device Viewer (www.endress.com/deviceviewer): All the information pertaining to the measuring device is displayed.

For an overview of the scope of the technical documentation supplied with the device, enter the serial number on the nameplates into the W@M Device Viewer (www.endress.com/deviceviewer)

4.3.1 Nameplate (example)



A0018002

- 1 Manufacturer's address
- 2 Device name
- 3 Order code
- 4 Extended order code (Ext. ord. cd.)
- 5 Serial number
- 6 Degree of protection: e.g. IP
- 7 Degree of protection: e.g. NEMA
- 8 Certificate- and approval-specific data
- 9 Information on certificates and approvals
- 10 Data Matrix code
- 11 Date of manufacture: year-month
- 12 Warnings
- 13 Document numbers of Safety Instructions: e.g. XA, ZD, ZE
- 14 Symbol for instructions
- 15 Symbol for cables
- 16 Process pressure
- 17 Switch point from sealing surface
- 18 Certificate symbols
- 19 Electrical connection
- 20 Temperature ranges: process and ambient temperature range
- 21 Nominal length
- 22 Output
- 23 Electronic insert
- 24 Connection data

5 Storage and transport

5.1 Storage conditions

- Permitted storage temperature: -50 to $+80$ °C (-58 to $+176$ °F)
- Use the original packaging

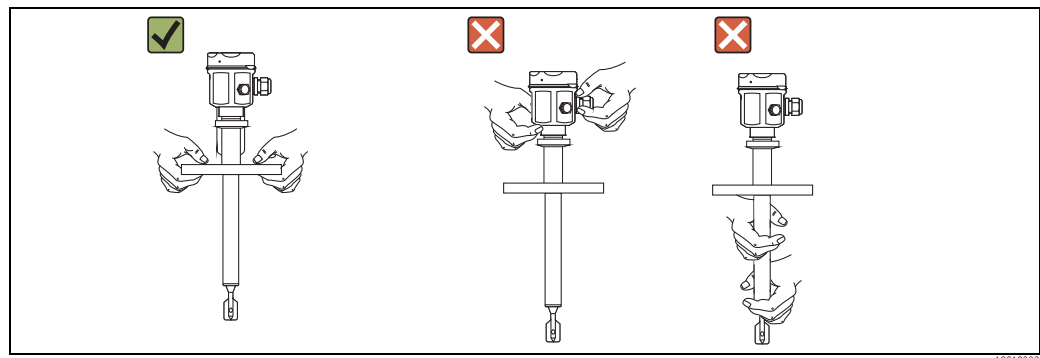
5.2 Transporting the product



Warning!

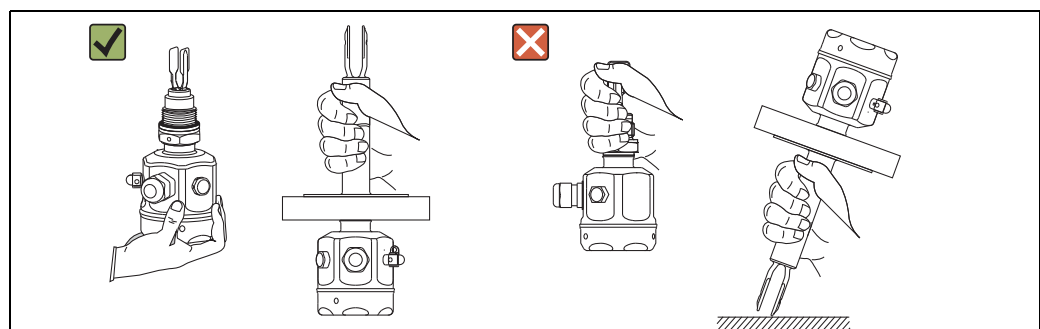
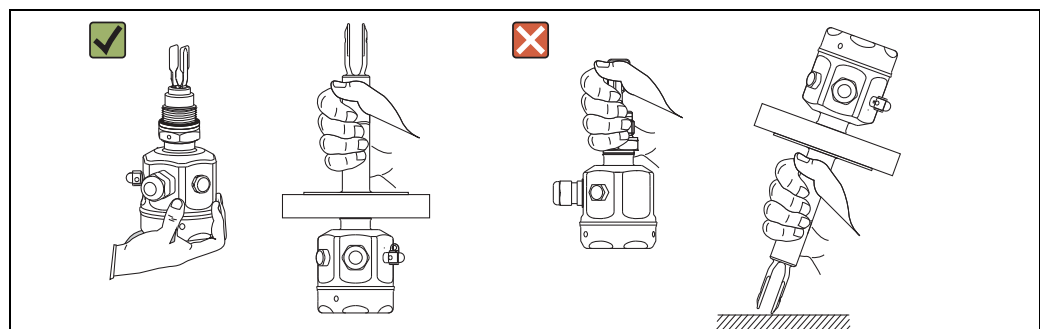
Risk of injury. Housing can slip!

- Transport the measuring device to the measuring point in its original packaging or by the process connection.
- Follow the safety instructions and transport conditions for devices weighing more than 18 kg (39.6 lbs).



Caution!

- Do not hold the measuring device by the fork tines!
- Do not damage the fork tines during installation!
- Do not damage the coating on the sensor (FTL85)!

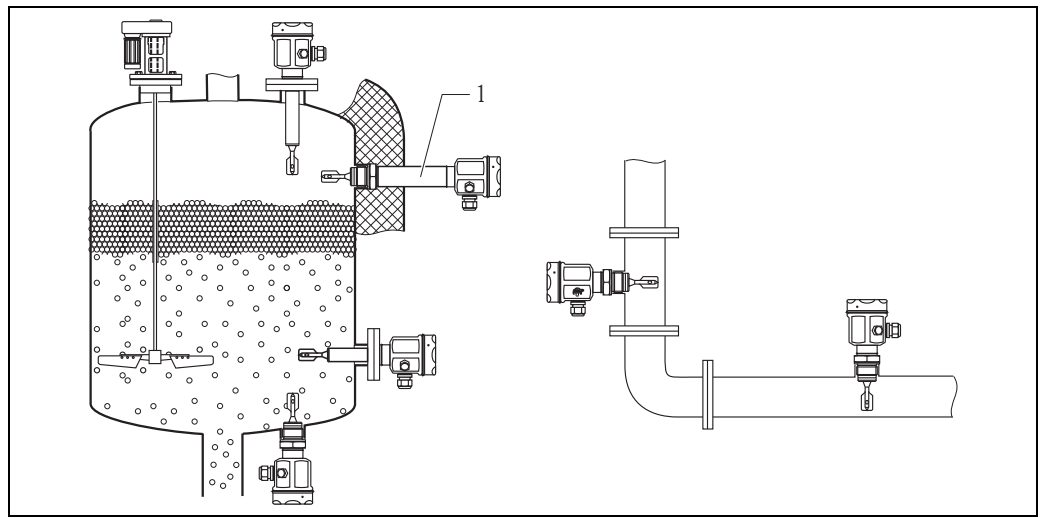


6 Installation

6.1 Installation conditions

6.1.1 Selecting the installation position

A horizontal or vertical installation position can be selected.



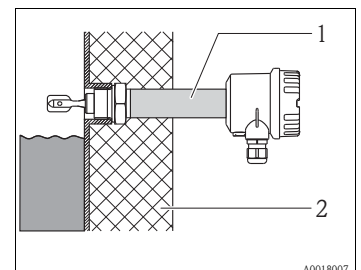
A0018006

1 Temperature spacer

6.1.2 Installation in insulating material

Provides sealed insulation for the vessel and a normal ambient temperature for the housing.

- 1: Temperature spacer with pressure-tight feedthrough
- 2: Insulation



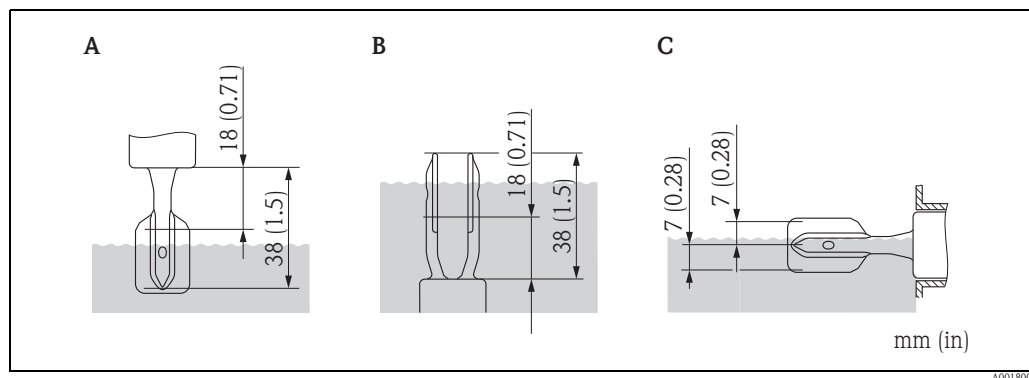
A0018007

6.1.3 Distance from wall

In safety applications a minimum distance of 10 mm (0.39 in) must be observed between the tuning fork of Liquiphant FailSafe FTL8x and the wall of the vessel (e.g. tank, pipe) containing the medium.

6.1.4 Switch point

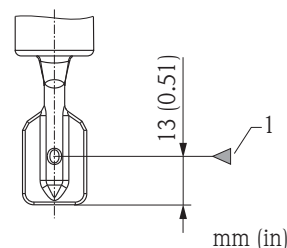
The switch point depends on the installation location and is in the range of the fork tine.



- A** Mounting from above
B Mounting from below
C Mounting from the side

Reference operating conditions

Operating mode: MAX
 Ambient temperature: 23 ± 5 °C (73 ± 41 °F)
 Medium temperature: 23 °C (73 °F)
 Medium density: 1 g/cm³ (water), 1 SGU (water)
 Viscosity: 1 mPa·s
 Medium pressure: 1 bar abs. (15 psi)
 Sensor mounting: vertical from above
 Low density switch to 0.7 g/cm³ (0.7 SGU)
 High density switch to >2.0 g/cm³, (2.0 SGU)



- 1) Switch point at reference operating conditions

6.1.5 Operating mode

Minimum/maximum detection (MIN/MAX) is selected by connection coding on the electronic insert.

MAX = maximum detection:

The output switches in a safety-oriented manner when the probe is covered (demand mode).

For use with overfill protection for example

A jammed fork results in a "covered" signal (demand mode).

MIN = minimum detection:

The output switches in a safety-oriented manner when the probe is uncovered (demand mode).

For use with dry running protection, pump protection for example

Foam is not detected.

6.1.6 Viscosity depending on the operating mode



Note!

- With regard to the viscosity of the medium, the restrictions for applications in the safety-related mode, as outlined in the Functional Safety Manual, must be taken into consideration.
- Position the fork so that the narrow edge of the tines is vertical to ensure that the liquid can run off easily.

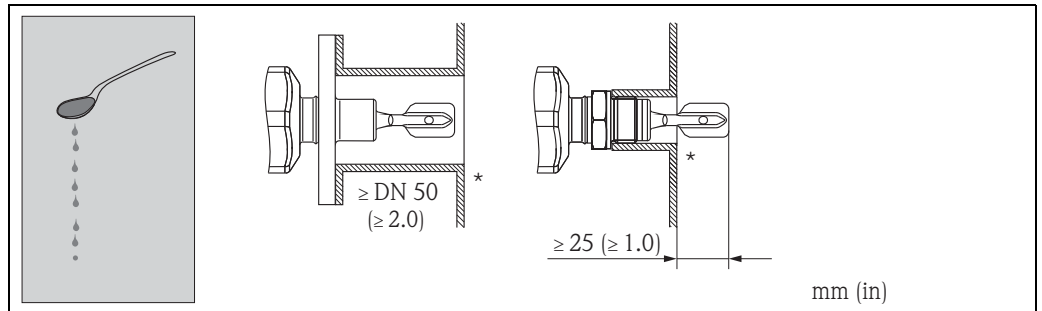
MAX: ≤ 10000 mPa·s

MIN: ≤ 350 mPa·s

MIN: coating, high temperature ($230/280$ °C ($450/536$ °F)) ≤ 100 mPa·s

Low-viscosity media

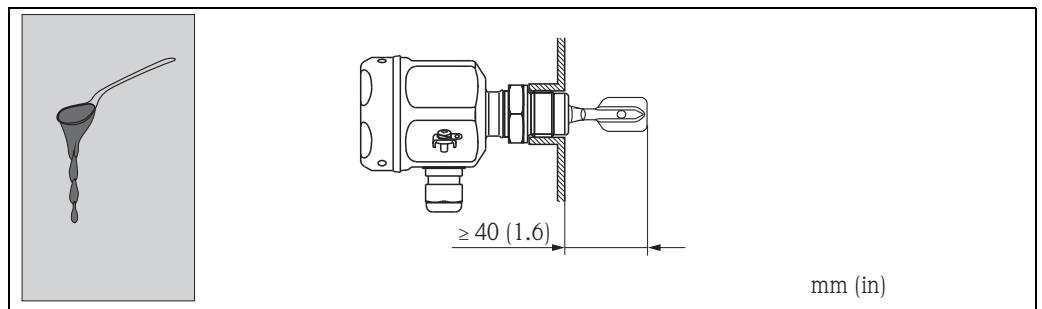
When working with low-viscosity media, the fork tines may be located in the socket.



* Deburr the edges!

High-viscosity media

When working with high-viscosity media, the fork tines may not be located in the socket!

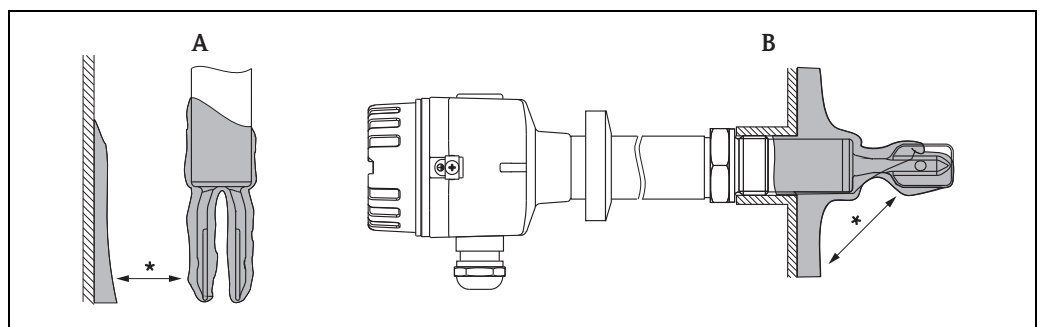


6.1.7 Installation in the event of buildup



Caution!

If buildup occurs, the restrictions for applications in the safety-related mode, as outlined in the Functional Safety Manual, must be taken into consideration.



A Vertical installation

B Horizontal installation

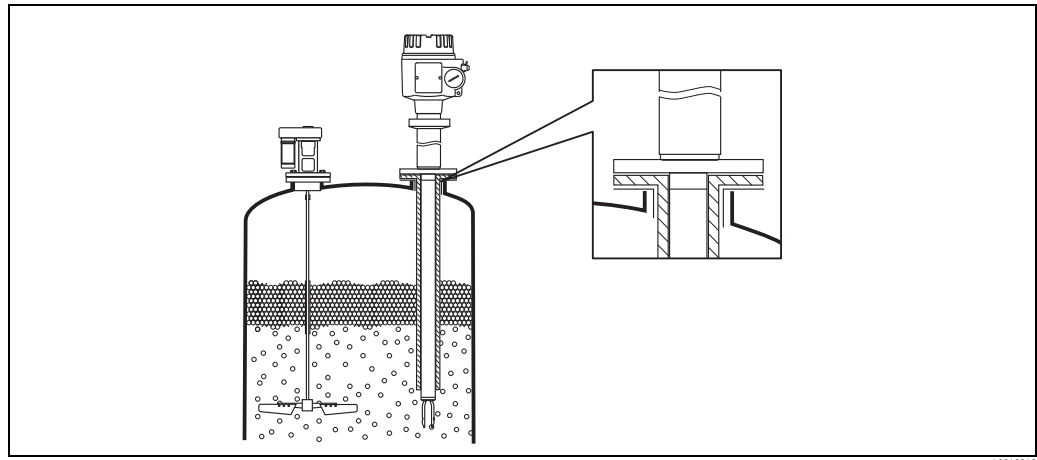
* Ensure that there is sufficient distance between the buildup expected on the tank wall and the fork.

6.1.8 Installation in the event of dynamic load



Caution!

The pipe extension must be supported in the event of dynamic load!



A0018013

6.2 Mounting the measuring device

6.2.1 Mounting tools

Screwdriver

Open-ended wrench: AF 32 or AF 41

Allen screw

6.2.2 Seals

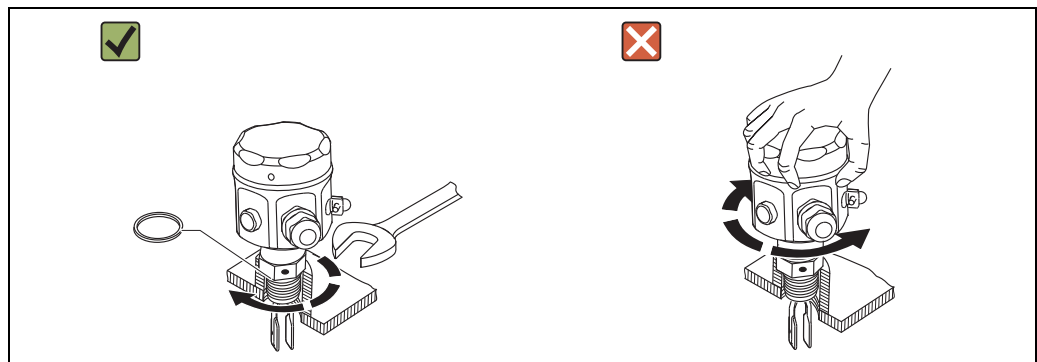
- G-threads are supplied with a seal.
- NPT and R-threads are not supplied with a seal.
Use a suitable sealing tape!
- Flanges (uncoated and enamel-coated) are not supplied with a seal.
A seal must be provided by the customer!
- Flanges (plastic-coated) are supplied with a PTFE seal.

6.2.3 Screwing in the measuring device



Caution!

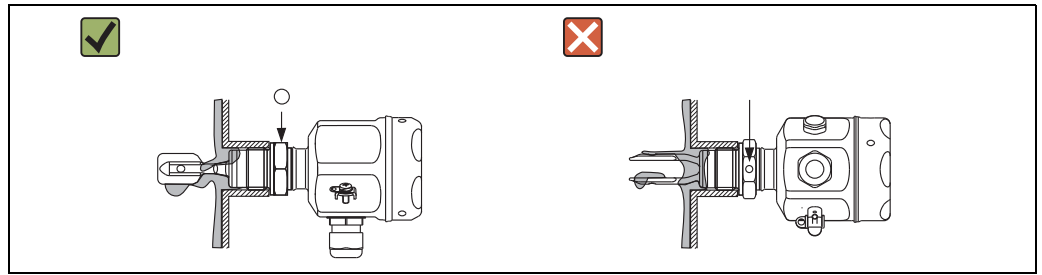
Do not turn the housing when mounting the device as this may damage the measuring device!



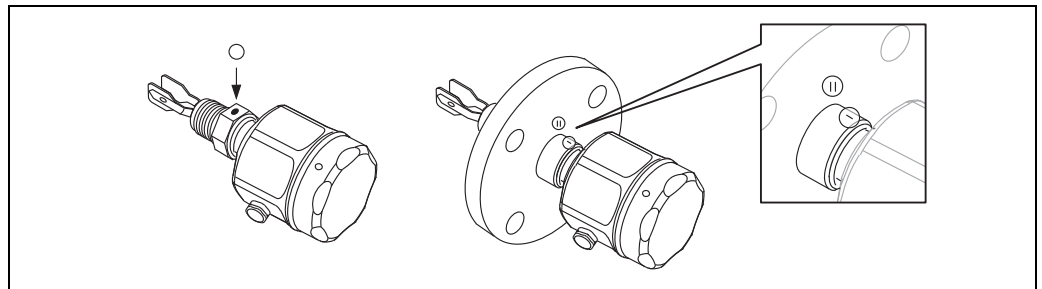
A0018014

6.2.4 Mounting horizontally

Pay close attention to the special marking if aligning the device horizontally!



A0018015



A0018016

6.2.5 Installing in pipes

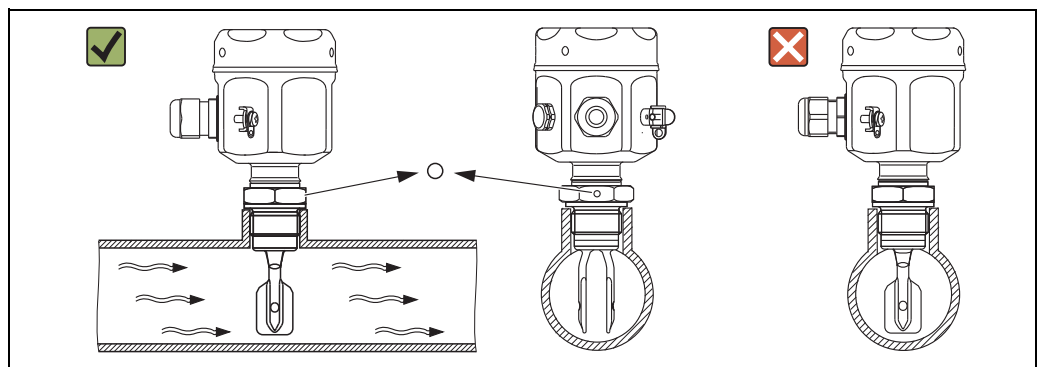
The point level switch bears a special marking that indicates the position of the fork tines. When installing the measuring device in pipes, pay attention to the position of the fork tines in order to avoid turbulence in the pipe.



Note!

Pipe diameter: ≥ 50 mm (≥ 2 ")

Flow velocity: < 5 m/s (< 200 in/s)



A0018017

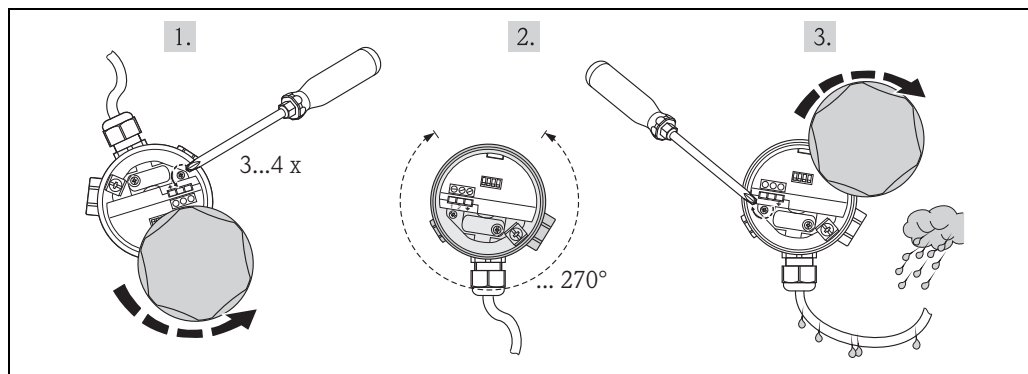
6.2.6 Aligning the cable entry

For housing F15, F27

The electronics housing can be aligned using an adjusting screw. Proceed as follows to align the housing:

- Open the housing cover
- Release the adjusting screw
- Turn the housing to the right position
- Note! Observe the maximum tightening torque of 0.9 Nm!
Tighten the adjusting screw again

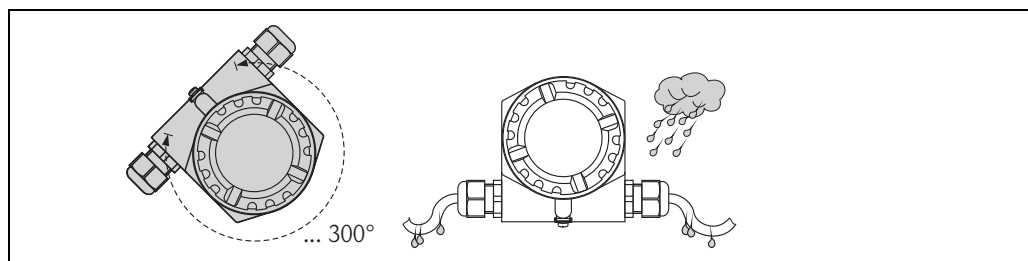
- Close the housing cover



A0018018

For housing F16, F13, F17, T13

The electronics housing can be aligned by hand.



A0018022

6.3 Sealing the housing

When installing the probe, connecting the electronic insert and during subsequent device operation, it is important that moisture does not enter the probe housing. For this reason the housing cover and cable entries must always be sealed securely.



Caution!

The O-ring seal on the housing cover is already coated with a lubricant when delivered. **Never** use a mineral oil-based lubricant! This would destroy the O-ring. Syntheso Glep 1, for example, is a recommended lubricant.

6.4 Post-installation check

- ☐ Is the device undamaged (visual inspection)?
- Does the device meet the specifications of the measuring point?
 - ☐ ■ Process temperature
 - ☐ ■ Process pressure
 - ☐ ■ Ambient temperature range
 - ☐ ■ Density range
 - ☐ ■ Viscosity
- ☐ Are the measuring point identification and labeling correct (visual inspection)?
- ☐ Are the securing screw and securing clamp securely tightened?

7 Electrical connection

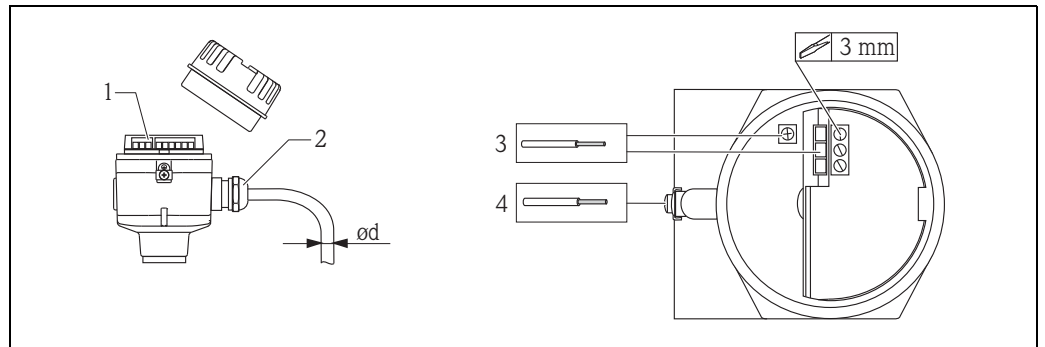


Caution!
Comply with national standards and regulations!

7.1 Cable diameter and wire cross-section

Cable gland	Permitted cable diameter $\varnothing d$	Permitted wire cross-section
Nickel-plated brass	7 to 10.5 mm (0.28 to 0.41 in)	Maximum 2.5 mm ² (14 AWG)
Plastic	5 to 10 mm (0.2 to 0.38 in)	
Stainless steel	7 to 12 mm (0.28 to 0.47 in)	

The electronic inserts can be connected using commercially available instrument cables.
When using shielded cables, it is recommended to connect the shielding at both ends to optimize the shielding effect (if potential equalization present).
Cable maximum 25 Ohm per wire and 100 nF (typically 1000 m (3281 ft)).



A0018023

- 1 FEL85
- 2 M20x1.5 (cable entry)
- 3 $\leq 2.5 \text{ mm}^2$ (14 AWG)
- 4 $\leq 4 \text{ mm}^2$ (12 AWG)

7.2 Connection data

7.2.1 Power supply

Nominal supply voltage: DC 24 V
Supply voltage range: DC 12 to 30 V
Power consumption: < 660 mW
Reverse polarity protection: yes

7.2.2 Connectable load

$R = (U - 12 \text{ V}) / 22 \text{ mA}$
U = supply voltage range: DC 12 to 30 V

7.2.3 Galvanic isolation

Between sensor and power supply



Note!
The device shall be connected to a source with isolation for the working voltage suitable for the application.

Pollution Degree 2, Overvoltage Category II.

7.3 Connecting the device

When connecting the device, you choose the MIN or MAX terminal to specify which operating mode applies for the device.

7.3.1 Operating mode

Minimum/maximum detection (MIN/MAX) is selected by connection coding on the electronic insert.

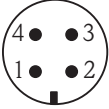
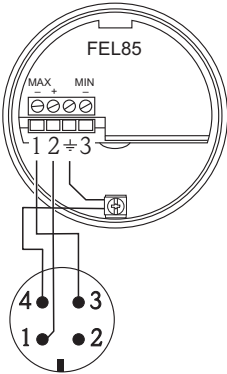
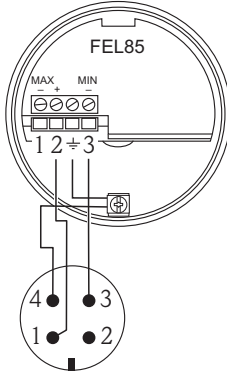
MAX = maximum detection:
The output switches in a safety-oriented manner when the probe is covered (demand mode).
For use with overfill protection for example
A jammed fork results in a "covered" signal (demand mode).

MIN = minimum detection:
The output switches in a safety-oriented manner when the probe is uncovered (demand mode).
For use with dry running protection, pump protection for example
Foam is not detected.

7.3.2 Connection via M12 connector

If using the MAX operating mode with an M12 connector, the housing does not need to be opened to connect the signal cable.

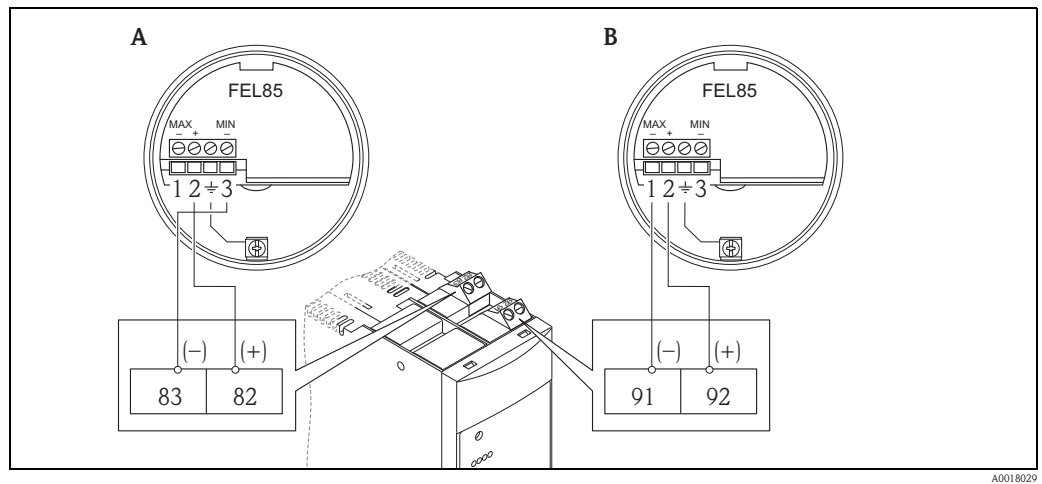
PIN assignment for M12 connector

M12 connector		FEL85 Operating mode: MAX (factory setting)	FEL85 Operating mode: MIN
 A0018024			
PIN	Wire (color)	Terminal	Terminal
1	+ (brown)	2	2
2	Not assigned (white)	-	-
3	- (blue)	1	3
4	PML (black)	Ground connection (PML)	Ground connection (PML)

7.3.3 Connecting to the Nivotester FailSafe FTL825

A: Minimum detection (dry running protection)

B: Maximum detection (overflow protection)



A0018029

7.4 Post-connection check

- ☐ Are cables or the device undamaged (visual inspection)?
- ☐ Do the cables used comply with the requirements?
- ☐ Do the mounted cables have adequate strain relief?
- ☐ Are all the cable glands installed, firmly tightened and leak-tight?
- ☐ Does the supply voltage match the specifications on the nameplate?
- ☐ Is the terminal assignment correct?
- ☐ If required: has the protective ground connection been established?
- ☐ Has the correct operating mode been selected?
- ☐ If power is supplied, is the device ready for operation and is an LED lit on the electronic insert?
- ☐ Are all housing covers mounted and firmly tightened?
- ☐ Is the securing clamp securely tightened?

8 Operation in control systems

8.1 Connection and interfaces

The Liquiphant FailSafe FTL8x is suitable for connection to a programmable logic controller (PLC), a safety PLC (SPLC) or AI modules 4-20 mA as per EN 61131-2 and NE06, NE043.

In the "Good" state (MIN covered/MAX exposed) the current output is in the range between 12 mA and 20 mA (MIN: 18.5 mA or MAX: 13.5 mA). Two different current ranges are used.

- Minimum detection (MIN): 17.5 to 19.5 mA
- Maximum detection (MAX): 12.5 to 14.5 mA



Note!

- To meet SIL3 requirements, the current values must be monitored when the device is integrated into a PLC. A current value outside the current range is invalid (demand mode).
- If the device used in SIL1 or SIL2 applications, it suffices to program 12 mA as the current threshold.
 - Demand mode: < 12 mA (MIN exposed/MAX covered)
 - "Good" state: > 12 mA (MIN covered/MAX exposed)

In addition, the PLC can monitor the LIVE signal which Liquiphant permanently sends. The LIVE signal is a square-wave signal of 0.25 Hz and ± 0.5 mA amplitude which is modulated to the "Good" state (MIN: 18.5 mA or MAX: 13.5 mA), (the signal changes by 1 mA every 2000 ms).

This ensures that the correct sensor (Liquiphant FailSafe) is connected. Furthermore, the LIVE signal can help detect an error in the downstream components (PLC).

In the "Demand" mode (MIN exposed/MAX covered) the current output is in the range between 4 mA and 12 mA (MIN: 9 mA or MAX: 6 mA). Two different current ranges are used:

- Minimum detection (MIN): 8.0 to 10.0 mA
- Maximum detection (MAX): 5.0 to 7.0 mA

8.1.1 Response of device to errors (alarm and warning)

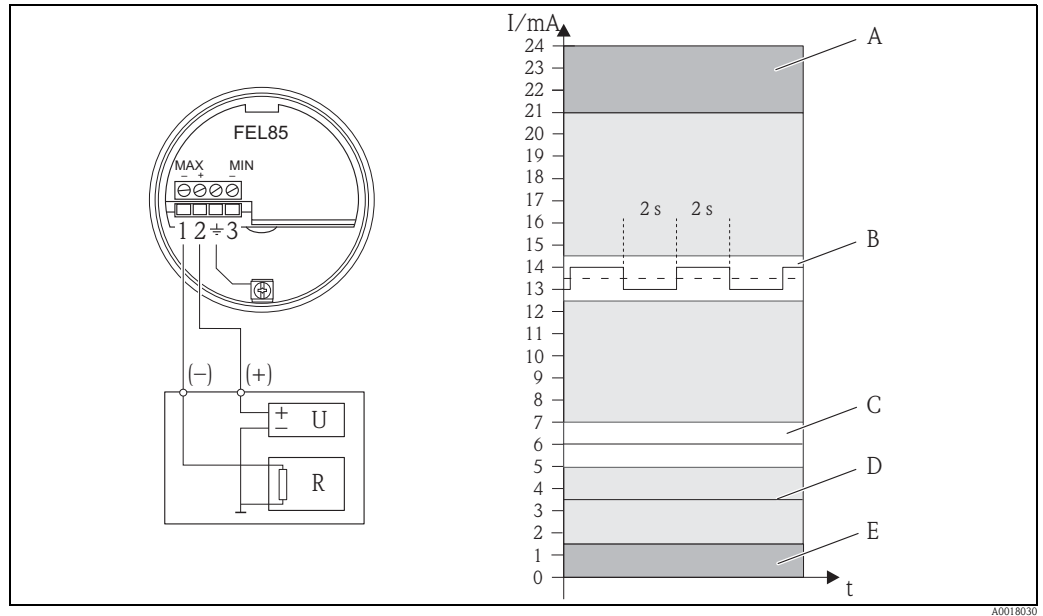
If an error occurs the current output is in the range below 3.6 mA.

Short-circuits are the exception: if these occur the current output is in the range above 21 mA.

To monitor alarms, the logic unit must be able to detect both HI alarms (≥ 21.0 mA) and LO alarms (≤ 3.6 mA). No distinction is made between alarm and warnings.

8.1.2 Maximum detection (overflow protection)

Connection and current output



Signal processing (e.g. analog PLC input card)

U Nominal supply voltage DC 24 V

R Resistor

Current output:

A Short-circuit: ≥ 21.0 mA

B MAX detection exposed: current range 12.5 to 14.5 mA and LIVE signal 13.5 mA $\pm$ 0.5 mA (0.25 Hz)

C MAX detection covered: current range 5.0 to 7.0 mA (6.0 mA)

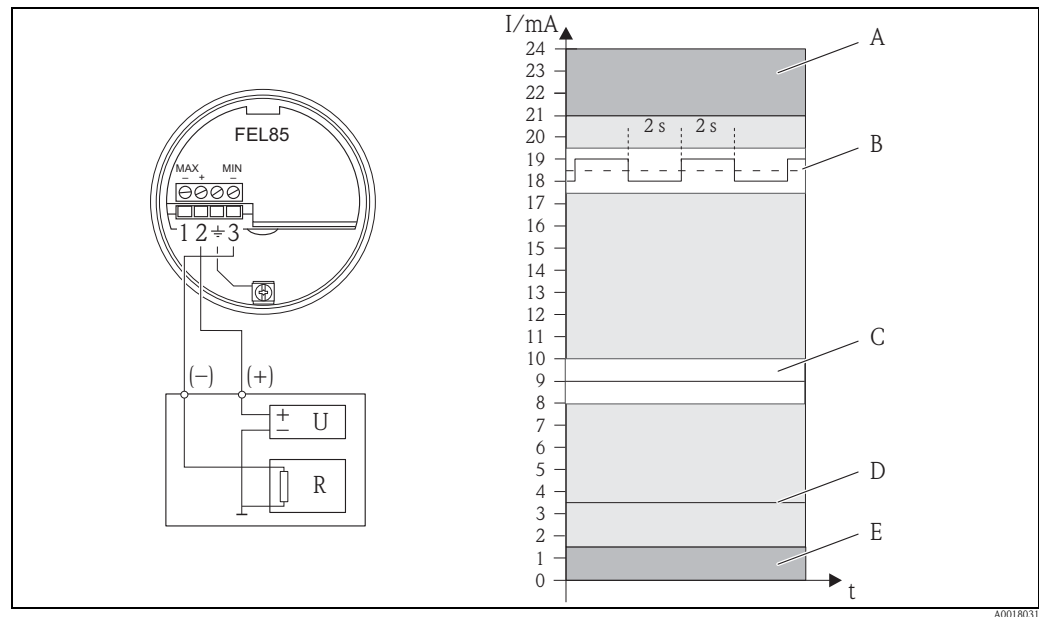
D Sensor error: ≤ 3.6 mA

E Cable open circuit: ≤ 1.5 mA

A0018030

8.1.3 Minimum detection (dry running protection)

Connection and current output



Signal processing (e.g. analog PLC input card)

U Nominal supply voltage DC 24 V

R Resistor

Current output:

A Short-circuit: ≥ 21.0 mA

B MIN detection covered: current range 17.5 to 19.5 mA and LIVE signal 18.5 mA ± 0.5 mA (0.25 Hz)

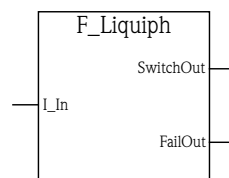
C MIN detection exposed: current range 8.0 to 10.0 mA (9.0 mA)

D Sensor error: ≤ 3.6 mA

E Cable open circuit: ≤ 1.5 mA

8.2 Integration into control systems

Liquiphant FailSafe can also be connected to a PLC or SPLC. This chapter helps you to integrate Liquiphant FailSafe into a PLC.



FB_01

The function block "F_Liquiph" has a current input (I_{in}), a switch output (SwitchOut) and a failure output (failout).

This block is an example for MAX-detection and was divided for a better understanding into three individual functional blocks.

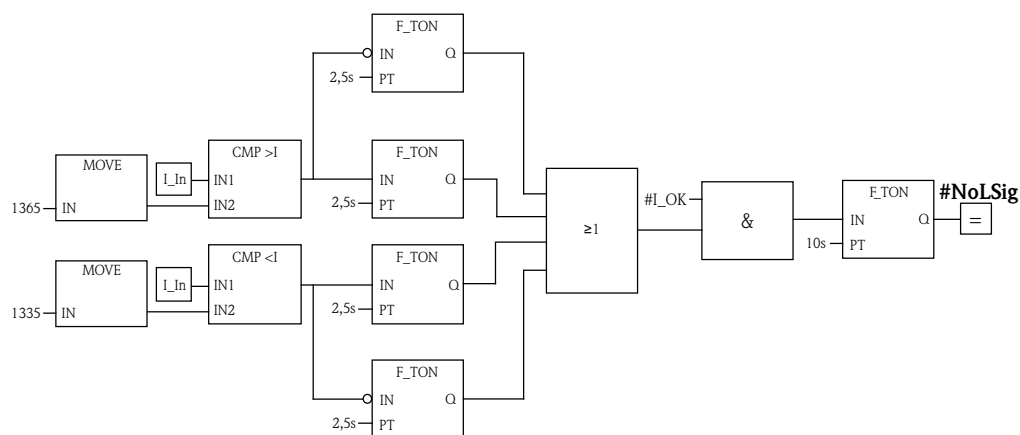
- Error analysis
- LIVE signal analysis
- Switch output

The " I_{in} " current input must be a standardized integer value of between 0 and 2000 (0...20 mA e.g. 12,5 mA $\hat{=}$ 1250). The template to create a function module was developed and tested using

the example of a Siemens PLC. To keep the response times of the overall system to a minimum, a cycle time of 100 ms is recommended.

8.2.1 LIVE signal analysis

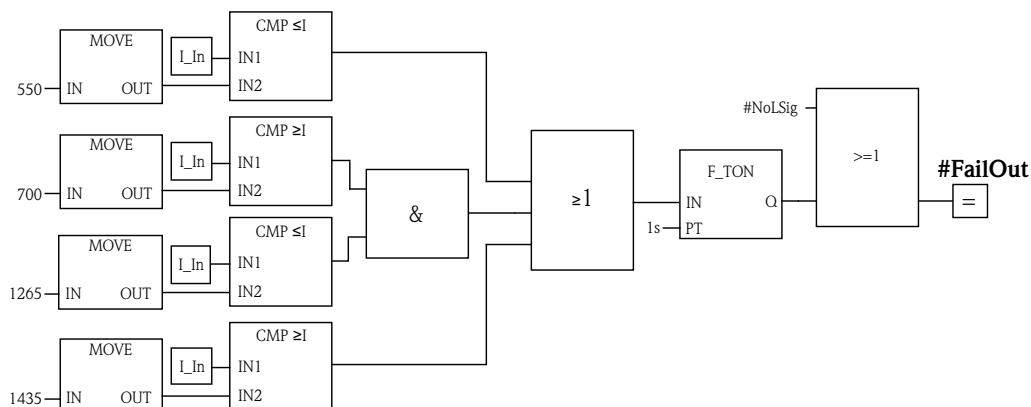
As an option, it is possible to analyze the LIVE signal (0.25 Hz frequency, ± 0.5 mA amplitude). This function block monitors the dynamic signal which is sent by the Liquiphant FailSafe in the "Good" state (MIN covered / MAX exposed). To make the system less sensitive to interference (e.g.: EMC), an error is only output if the Liquiphant does not send a LIVE signal within 12 seconds.



FB_02

8.2.2 Error current analysis

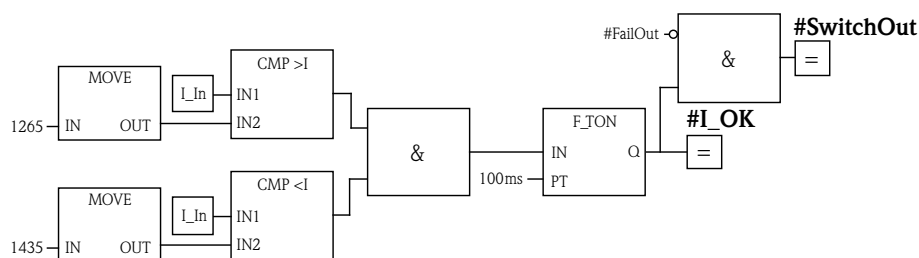
The invalid current ranges are monitored in this part of the function block. An error is signaled if the Liquiphant outputs an error current or if it is not configured correctly (MIN/MAX). An error also affects the switch output. If the LIVE signal analysis function is not implemented, a logical "0" must be configured instead of "#NoLSig".



FB_03

8.2.3 Switch output

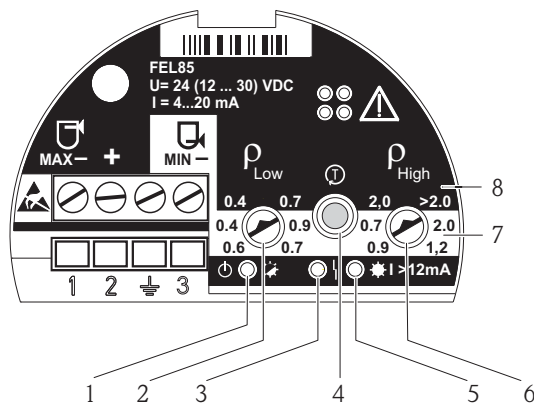
The switch output is only "high" if an error is not present and the current status is "Good".



FB_04

9 Operating options

9.1 Human interface



A0018032

Number	Description	Function
1	LED green, operation	Initialization (lit), Normal operation (flashing), Error (off) or green LED and red LED flash alternately
2	Density ρ_{Low} (rotary switch)	Setting for the lower limit of the density range
3	LED red, error	Sensor error (lit constantly), Operating error and electronic insert error (flashing)
4	Proof test button	To confirm configuration changes and to activate the proof test.
5	LED yellow, current output	MAX (exposed) lit (13.5 mA), MIN (covered) lit (18.5 mA)
6	Density ρ_{High} (rotary switch)	Setting for the upper limit of the density range
7	MIN	A white background indicates the density range that can be set in the MIN detection operating mode
8	MAX	A black background indicates the density range that can be set in the MAX detection operating mode

9.2 Operating concept

- MIN or MAX detection via connection wiring
- Density range set via two rotary switches, confirmation via proof test button

10 Commissioning

10.1 Function check

Make sure that the post-installation and post-connection checks have been completed before you commission the measuring point:

- Checklist for "Post-installation check" →  18
- Checklist for "Post-connection check" →  21

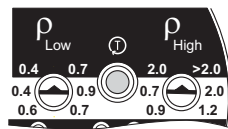


Note!

- The decision to operate in the MIN or MAX detection mode is made when wiring the device.
- The device is not ready for operation in the as-delivered state. The density range must be set before the device is put into operation as the device would otherwise start with an error message.

10.2 Setting the density range

The density of the medium under the given process conditions dictates the density range to be set. The density ranges that can be selected at the electronics are predefined by typical media groups (e.g. liquefied gas, alcohol, water, acid) under the maximum permitted process parameters. The position of the rotary switches is not valid in the as-delivered state.



As-delivered state

A0018033

The rotary switches are surrounded by scales that indicate the individual density ranges (MIN detection: white, MAX detection: black). To select a valid density range the rotary switches must be parallel to one another. The pointer of the left rotary switch (Density low) must point to the lower density value of the selected range, while the pointer of the right rotary switch (Density high) must point to the upper density value of the selected range.



Caution!

If the rotary switches are not parallel to one another, the selected density range is not valid and the red error LED and the green LED flash alternately. See also →  32 "Troubleshooting".

10.2.1 Sensor pass

The sensor pass is a plug-in card that is stored in the housing of the Liquiphant FailSafe. We recommend you indicate the set density range on the sensor pass and then put the pass back in the housing for safe keeping.

Liquiphant FEL85

Endress+Hauser

1.	2.	3.																				
MAX U-:1 U+:2	<table><tr><td>Set (x)</td><td>ρ_{Low} g/cm³</td><td>type of liquid</td><td>ρ_{High} g/cm³</td></tr><tr><td></td><td>0.4 </td><td>liquified gas</td><td>2.0 </td></tr><tr><td></td><td>0.7 </td><td>other liquids</td><td>>2.0 </td></tr></table>	Set (x)	ρ_{Low} g/cm ³	type of liquid	ρ_{High} g/cm ³		0.4	liquified gas	2.0		0.7	other liquids	>2.0	Press								
Set (x)	ρ_{Low} g/cm ³	type of liquid	ρ_{High} g/cm ³																			
	0.4	liquified gas	2.0																			
	0.7	other liquids	>2.0																			
MIN U-:3 U+:2	<table><tr><td>Set (x)</td><td>ρ_{Low} g/cm³</td><td>type of liquid</td><td>ρ_{High} g/cm³</td></tr><tr><td></td><td>0.4 </td><td>liquified gas</td><td>0.7 </td></tr><tr><td></td><td>0.6 </td><td>e.g. alcohol</td><td>0.9 </td></tr><tr><td></td><td>0.7 </td><td>e.g. water</td><td>1.2 </td></tr><tr><td></td><td>0.9 </td><td>e.g. acid</td><td>2.0 </td></tr></table>	Set (x)	ρ_{Low} g/cm ³	type of liquid	ρ_{High} g/cm ³		0.4	liquified gas	0.7		0.6	e.g. alcohol	0.9		0.7	e.g. water	1.2		0.9	e.g. acid	2.0	Press
Set (x)	ρ_{Low} g/cm ³	type of liquid	ρ_{High} g/cm ³																			
	0.4	liquified gas	0.7																			
	0.6	e.g. alcohol	0.9																			
	0.7	e.g. water	1.2																			
	0.9	e.g. acid	2.0																			

250003055

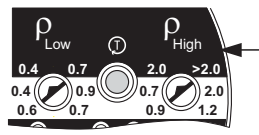
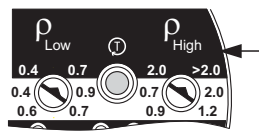
A0018034

Sensor pass

10.2.2 Settings for the MIN detection operating mode

Type of liquid	Low density ρ_{Low} g/cm ³ (SGU)	High density ρ_{High} g/cm ³ (SGU)	MIN detection operating mode (white area on the electronics label)
e.g. liquefied gas	0.4 (0.4)	0.7 (0.7)	A0018037
e.g. alcohol	0.6 (0.6)	0.9 (0.9)	A0018038
e.g. water	0.7 (0.7)	1.2 (1.2)	A0018039
e.g. acid	0.9 (0.9)	2.0 (2.0)	A0018040

10.2.3 Settings for the MAX detection operating mode

Type of liquid	Low density ρ_{Low} g/cm ³ (SGU)	High density ρ_{High} g/cm ³ (SGU)	MAX detection operating mode (black area on the electronics label)
e.g. liquefied gas	0.4 (0.4)	2.0 (2.0)	
Other liquids	0.7 (0.7)	> 2.0 (> 2.0)	

Example

Settings for liquefied gas in MIN detection mode:

- Set the rotary switch for low density ρ_{Low} to the 0.4 g/cm³ (0.4 SGU) position
- Set the rotary switch for high density ρ_{High} to the 0.7 g/cm³ (0.7 SGU) position
- The density range can only be saved if the rotary switches ρ_{Low} and ρ_{High} are parallel to one another.



Note!

- The device switches to the alarm condition during initial commissioning and when the density configuration is changed. The output current is ≤ 3.6 mA and the red LED starts flashing. This status is changed by confirming the configuration.
- An incorrect choice of density range can result in an unsafe device status.

10.3 Confirming the configuration

The configuration can be confirmed in either of two ways:

- By pressing the proof test button on the Liquiphant FailSafe FTL80, FTL81, FTL85
- By disconnecting the measuring system (FailSafe) from the supply voltage (restart)



Caution!

If the red LED continues to flash (for longer than 3 seconds) after the configuration has been confirmed, this could be due to any of the following:

- The tuning fork is blocked in the MIN operating mode
- The density range combination is not permitted
Example: MIN operating mode from 0.4 g/cm³ to 1.2 g/cm³
- No density range is selected (as-delivered state)
Both rotary switches point vertically upwards
- The operating mode selected via the terminals does not match the selected density combination
(→ 14ff, "Operating mode")

Terminal assignment → 20 "Connecting the device".

10.4 Proof test



Note!

- The function test may only be started from the "Good" state.
- Always refer to the Functional Safety Manual ("Proof test" chapter) for applications in the safety-related mode.

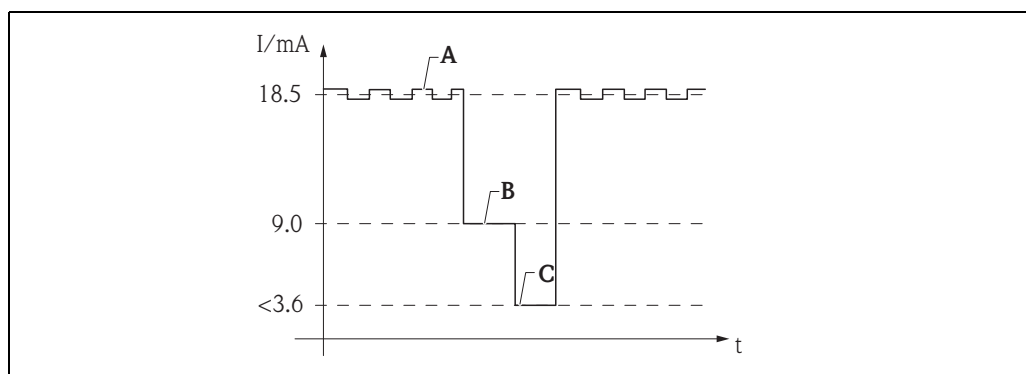
The proof test button can be used to simulate the demand current. Here, the output is set in such a way that the 6 mA / 9 mA and ≤ 3.6 mA currents are visible externally on the customer's side.

10.4.1 Performing a proof test

- A Regular operation → the current point level is displayed.
- B Press the proof test button → the point level alarm is triggered ($\text{MAX} = 6\text{mA}/\text{MIN} = 9\text{mA}$)
- C Release the proof test button → the system is restarted with $\leq 3.6\text{mA}$ and regular operation (A) commences

MIN detection

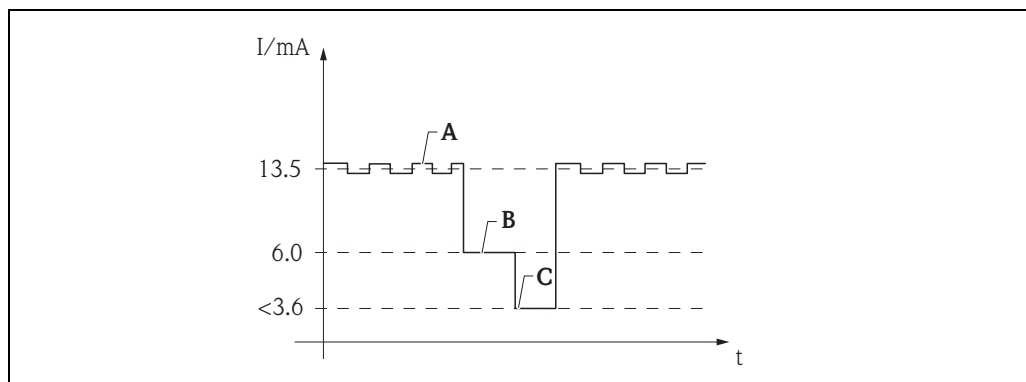
Proof test routine for MIN detection mode.



- A** Regular operation (sensor covered)
- B** Proof test button pressed (simulation: demand mode, sensor exposed)
- C** Proof test button released (device restarted)

MAX detection

Proof test routine for MAX detection mode.



- A** Regular operation (sensor exposed)
- B** Proof test button pressed (simulation: demand mode, sensor covered)
- C** Proof test button released (device restarted)

10.5 Device behavior during operation



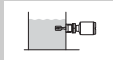
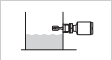
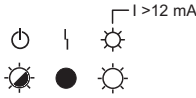
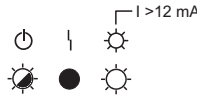
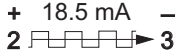
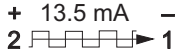
Note!

- Please refer to the Functional Safety Manual for applications with functional safety requirements in accordance with IEC 61508 (SIL) → 3.
- LED signaling (off, on, flashing, not relevant): for the meaning of the LEDs please see → 5, "Notes on safety conventions and icons"

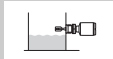
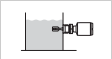
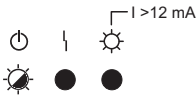
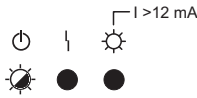
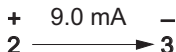
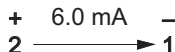
10.5.1 Device behavior during power-up

When the power supply is switched on, the output assumes the alarm signal. The device is operational after a maximum of 4 seconds.

10.5.2 Device behavior in the "Good" state

MIN	MAX
	
LED signaling  <i>☼ on, ● off, ✨ flashing</i>	LED signaling  <i>☼ on, ● off, ✨ flashing</i>
Output signal 	Output signal 

10.5.3 Device behavior in demand mode

MIN	MAX
	
LED signaling  <i>☼ on, ● off, ✨ flashing</i>	LED signaling  <i>☼ on, ● off, ✨ flashing</i>
Output signal 	Output signal 

11 Troubleshooting



Note!

- Please refer to the Functional Safety Manual for applications with functional safety requirements in accordance with IEC 61508 (SIL) → 3.
- LED signaling (off, on, flashing, not relevant): for the meaning of the LEDs please see → 5, "Notes on safety conventions and icons"

11.1 Response of outputs to errors

In the event of an error, the output current I is < 3.6 mA (error current as per NAMUR NE43).

11.2 Troubleshooting

The following section explains possible causes of errors, how these errors are signaled and remedial measures.

LED signaling	Description
	Cause of error No power supply, incorrect wiring or defective device. Measures Check the power supply and wiring. Replace the electronic insert.
	Cause of error Sensor error or corrosion. Measures Restart the electronics. Replace the device.
	Cause of error Electronics error Measures Replace the electronics. Restart the electronics.
	Cause of error 1. Change of density range has not been confirmed. 2. Connection coding and density range for MIN or MAX detection do not match. 3. For MIN detection, the medium density is higher than the set density range. Measures 1. Confirm the change of density range. 2. Match the connection coding with the density range. 3. Adjust the density range on the FEL85 electronics insert.

12 Technical data

For technical data, please refer to the Technical Information, Liquiphant FailSafe FTL8x → 3, "Additional standard device documentation".

13 Repair

The devices should only ever be repaired by Endress+Hauser.

If repair work is performed by another party, there is no longer any guarantee for the safety-related functions.

Exception:

The customer may replace the following components if genuine spare parts are used, the repair technician has received appropriate training from Endress+Hauser beforehand and the repair instructions are followed:

- Cover
- Cover seal
- Cable gland
- Electronic insert



Note!

If one of the components mentioned above is replaced on devices deployed in SIL-certified areas, a new proof test must be performed. For further information on proof tests, see the Functional Safety Manual → 3.

The replaced component must be returned to Endress+Hauser for fault analysis.

If a SIL-rated Endress+Hauser device that was operated in a protective system fails, the device must be returned along with the "Declaration of Hazardous Material and Decontamination" which must contain the information "Used as SIL-instrument in Protective System". See → 35 "Return".

13.1 Repairing Ex-certified devices

The following information also has to be taken into account when repairing Ex-certified devices:

- Ex-certified devices may only be repaired by experienced, skilled staff or by Endress+Hauser Service.
- Applicable standards, national regulations as well as the Safety Instructions (XA) and certificates must be observed.
- Only genuine Endress+Hauser spare parts may be used.
- When ordering spare parts, please check the device designation on the nameplate. Only identical parts may be used as replacements.
- Carry out repairs according to the instructions. Following the repair, the individual tests specified for the device must be carried out.
- A certified device may only be converted to another certified device version by Endress+Hauser Service.
- All repairs and modifications must be documented.

13.2 Replacing the electronic insert

After replacing the electronic insert, a complete commissioning routine, along with a proof test, must be performed → 27 "Commissioning".

13.3 Replacing the device

See post-installation check, post-connection check, operating options and commissioning.

13.4 Spare parts

Information on the spare parts that are available for your measuring device is provided on the Internet site

"www.endress.com". Proceed as follows here:

1. Select "www.endress.com" and then select the country.
2. Click "Instruments"



3. Enter the product name in the "Product name" field.

Endress+Hauser Produkt Suche

4. Select the measuring device.
5. Switch to the "Accessories/spare parts" tab

6. Select the spare parts (also use the overview drawings on the right-hand side of the screen).

When ordering a spare part, always indicate the serial number that is indicated on the nameplate. Where necessary, replacement instructions are provided with the spare parts.

14 Maintenance

The measuring system is a maintenance-free system.

Depending on the individual operating conditions, however, it is wise to visually inspect the tuning forks, cable entries and cover seal for external damage, such as deformation, corrosion, buildup etc. The Liquiphant FailSafe FTL8x should never be cleaned with abrasive media.

Exterior cleaning

When cleaning the exterior, only use cleaning agents that do not corrode the surface of the housing or the seals.

15 Accessories



Caution!

If sliding sleeves are used, the restrictions for applications in the safety-related mode, as outlined in the Functional Safety Manual, must be taken into consideration.

A detailed list of the accessories is provided in the Technical Documentation TI01026F (see also → 3).

- Sliding sleeves for unpressurized operation
For continuous adjustment of the switch point of a Liquiphant FailSafe FTL81
- High-pressure sliding sleeves
For continuous adjustment of the switch point of a Liquiphant FTL81. Also for use in hazardous areas.
- Weather protection cover
For housing F16 and for housing F13, F17 and F27
- Cover with sight glass for polyester housing
- Cover with sight glass for stainless steel housing F15

16 Return

The following procedures must be carried out before a level transmitter requiring repair or calibration, for example, is returned to Endress+Hauser:

- Remove all residues of medium, paying special attention to the grooves for seals and crevices which could contain residues. This is particularly important if the substance is hazardous to health, e.g. flammable, toxic, caustic, carcinogenic, etc.
- Always enclose a fully completed "Declaration of Contamination" form with the device (a copy of the "Declaration of Contamination" can be found at the end of these Operating Instructions). Only then can Endress +Hauser examine and repair a returned device.
- Enclose special handling instructions if necessary, for example a safety data sheet as per EN 91/155/EEC.

In addition, specify the following:

- The chemical and physical properties of the medium
- A description of the application
- A description of the error that occurred (specify error code if possible)
- The length of time the device was in operation

17 Disposal

When disposing, separate and recycle the device components based on the materials.

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