

# Technical Information

## Solicap M

### FTI56

Capacitance

#### Point level switch for bulk solids



#### Application

For applications with very high tensile loads up to 60 kN (13 488 lbf). Fieldgate and Solicap represent a solution for material provisioning and logistical optimization (inventory control).

- Process connections: flanges and threads
- International explosion protection certificates, SIL

#### Benefits

- Extremely robust design for harsh process conditions
- Cost savings thanks to easy and fast commissioning as calibration is performed at the press of a button
- Universal application thanks to wide range of certificates and approvals
- Two-stage overvoltage protection against static discharges from the silo
- Increased safety due to permanent automatic monitoring of electronics
- Reduction in storage costs thanks to easy-to-shorten rope model (for partial and full insulation)

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## Document information

### Document conventions

#### Safety symbols

##### **DANGER**

This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

##### **WARNING**

This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

##### **CAUTION**

This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.

##### **NOTICE**

This symbol contains information on procedures and other facts which do not result in personal injury.

#### Electrical symbols



Alternating current



Direct current and alternating current



Direct current



Ground connection

A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.

##### **Protective earth (PE)**

Ground terminals that must be connected to ground prior to establishing any other connections.

The ground terminals are located on the interior and exterior of the device:

- Interior ground terminal: protective earth is connected to the mains supply.
- Exterior ground terminal: device is connected to the plant grounding system.

#### Tool symbols



Phillips head screwdriver



Flat blade screwdriver



Torx screwdriver



Allen key



Open-ended wrench

#### Symbols for certain types of information and graphics

##### **Permitted**

Procedures, processes or actions that are permitted

##### **Preferred**

Procedures, processes or actions that are preferred

##### **Forbidden**

Procedures, processes or actions that are forbidden

##### **Tip**

Indicates additional information



Reference to documentation



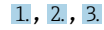
Reference to page



Reference to graphic



Notice or individual step to be observed



Series of steps



Result of a step



Help in the event of a problem



Visual inspection



Operation via operating tool



Write-protected parameter

1, 2, 3, ...

Item numbers

A, B, C, ...

Views



**Hazardous area**

Indicates the hazardous area



**Safe area (non-hazardous area)**

Indicates the non-hazardous area



**Safety instructions**

Observe the safety instructions contained in the associated Operating Instructions



**Temperature resistance of the connection cables**

Specifies the minimum value of the temperature resistance of the connection cables

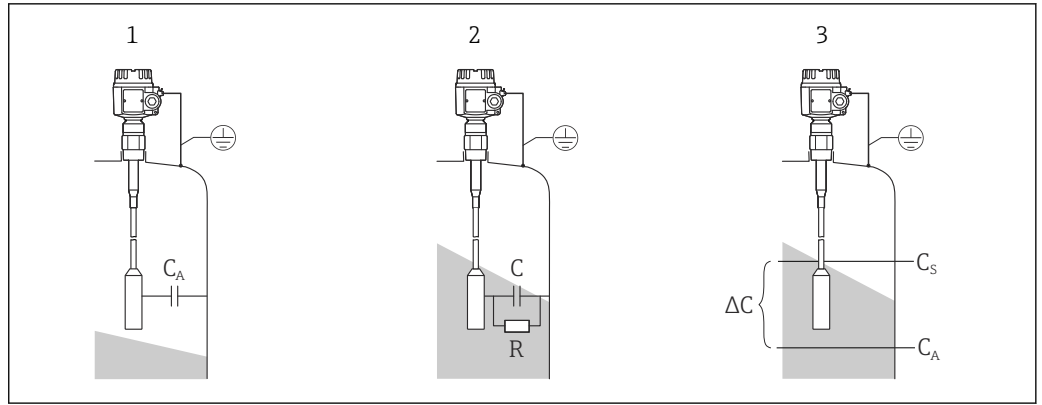
## Function and system design

### Measuring principle

The principle of capacitance point level detection is based on the change in capacitance of a capacitor as a result of the probe being covered by bulk solids. The probe and container wall (conductive material) form an electric capacitor. When the probe is in air (1), a certain low initial capacitance is measured. If the container is being filled, the capacitance of the capacitor increases as more of the probe is covered (2), (3). The point level switch switches when the capacitance  $C_S$  specified during calibration is reached. In addition, a probe with inactive length ensures that the effects of medium buildup or condensate near the process connection are avoided. A probe with active buildup compensation compensates for the effects of buildup on the probe in the area of the process connection.



A ground tube is used as a counter electrode for containers made of non-conductive materials.



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1 Measuring principle of capacitance point level detection

- 1 The probe in the air
- 2 The probe covered by the solid
- 3 The probe covered by the solid (switching mode)
- R Conductivity of the solid
- C Capacitance of the solid
- $C_A$  Initial capacitance when the probe is not covered
- $C_S$  Switching capacitance
- $\Delta C$  Change in capacitance

**Function** The selected electronic insert of the probe determines the change in capacitance on how much the probe is covered and thereby allows precise switching at the calibrated point level.

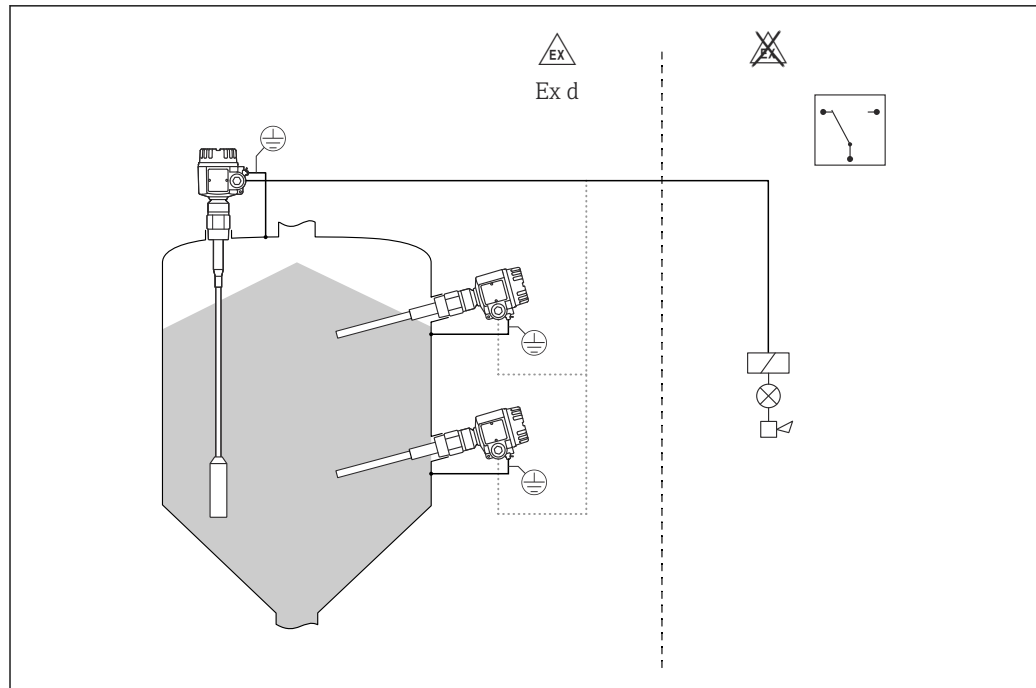
**Application examples** The probe is dedicated for all bulk solids with a relative dielectric constant  $\epsilon_r \geq 2.5$ , like:

- sand
- glass aggregate
- gravel
- molding sand
- lime
- crushed ore
- plaster
- aluminium shavings
- cement
- grain
- pumice
- flour
- dolomite
- sugar beet
- kaolin
- fodder and similar bulk solids

**Measuring system** The type of the measuring system depends to the selected electronic insert.

**Point level switch**

The complete measuring system consists of the point level switch Solicap M FTI56 and an electronic insert FEI51, FEI52 or FEI54.



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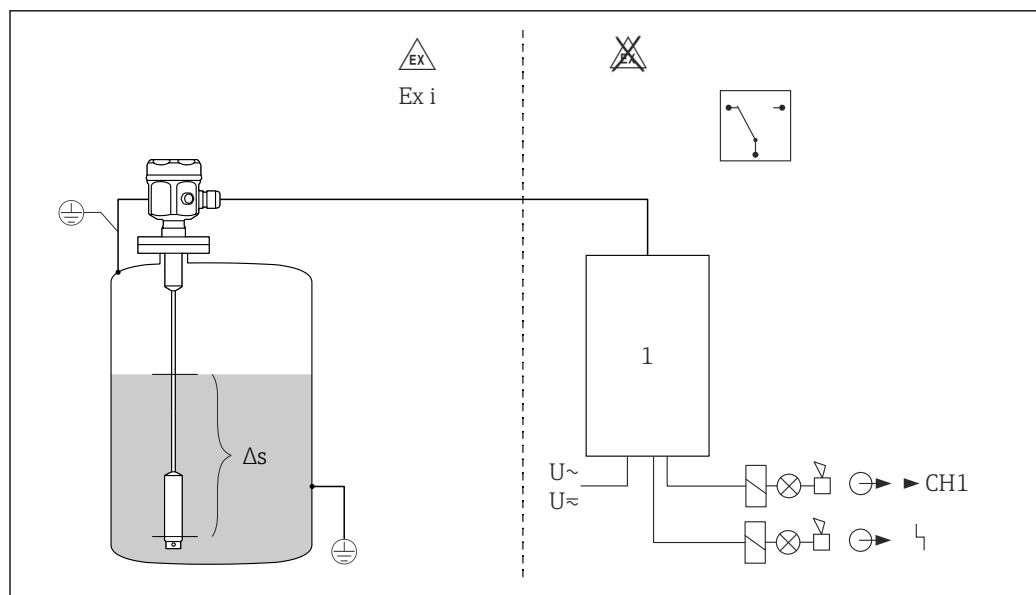
2 Probes as a point level switch

### Point level switch and separate switching unit

The Solicap M FTI56 can be used as sensor for the separate switching unit.

The complete measuring system consists of:

- the point level switch Solicap M FTI56
- an electronic insert:
  - FEI53 - non Ex areas
  - FEI57S - Ex-i areas
  - FEI58 - Ex-i areas
- a transmitter power supply unit e.g. FTC325, FTL325N



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3 Probe as the separate switching unit

1 A transmitter power supply unit

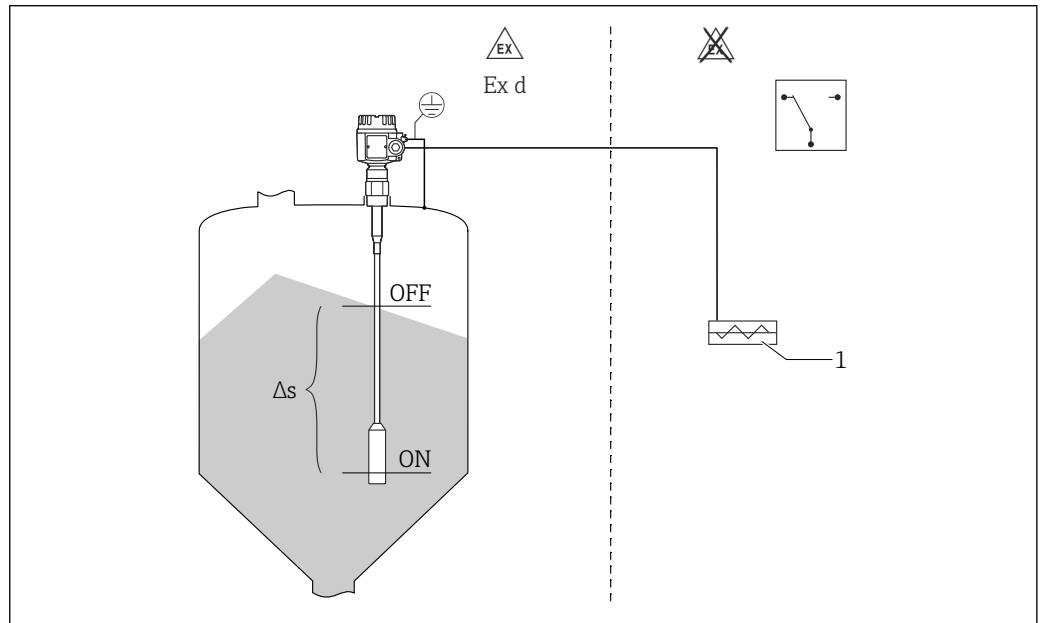
$\Delta s$  Two-point control

### Two-point control ( $\Delta s$ function)

 Use the partially insulated probes only in conjunction with non-conductive bulk solids.

The complete measuring system consists of: The device including electronic insert FE51, FEI52 oder FEI54.

The point level switch can also be used to control a screw conveyor where the on and off values can be freely defined.



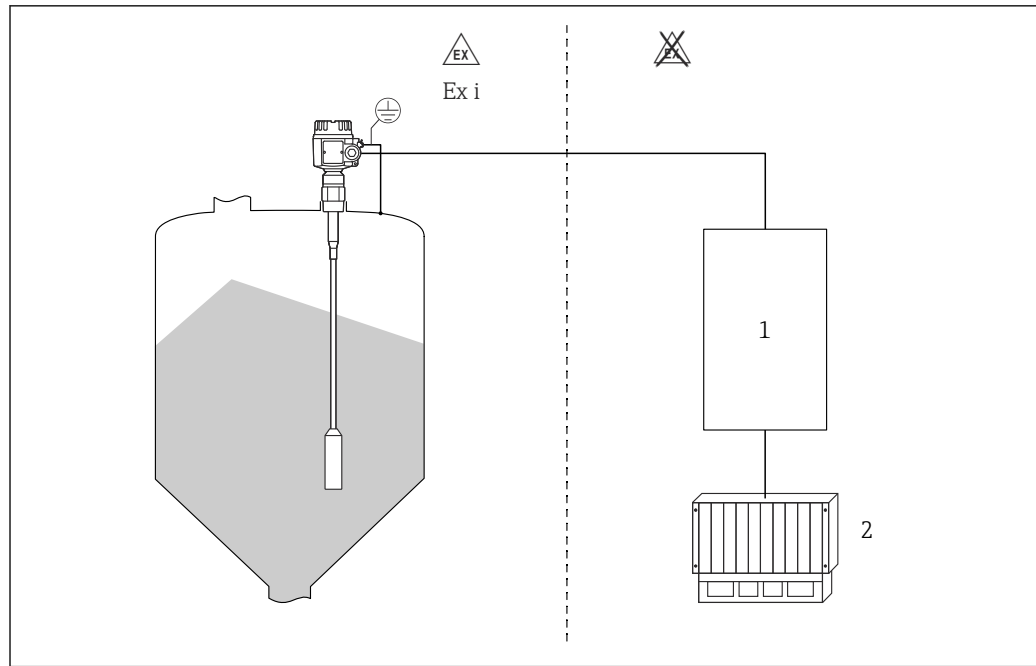
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$\Delta s$  Two-point control  
1 Screw conveyor

### Point level switch 8 mA or 16 mA

The complete measuring system consists of:

- the point level switch Solicap M FTI56
- the FEI55 electronic insert
- a transmitter power supply unit, e.g. RMA42



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4 The probe powered by external power supply unit

1 The transmitter power supply unit

2 PLC

## Electronic inserts

### FEI51

Two-wire AC connection

- Load switched directly into the power supply circuit via the thyristor
- Point level adjustment directly at the point level switch

### FEI52

3-wire direct current version

- Switch the load via the transistor (PNP) and separate supply voltage connection
- Point level adjustment directly at the point level switch

### FEI53

3-wire direct current version with 3 to 12 V signal output

- For separate switching unit, Nivotester FTC325 3-WIRE
- Point level adjustment directly at the switching unit

### FEI54

Universal current version with relay output

- Switch the loads via 2 floating changeover contacts (DPDT)
- Point level adjustment directly at the point level switch

### FEI55

Signal transmission 8 mA or 16 mA on two-wire cable

- SIL2 approval for the hardware
- SIL3 approval for the software
- For separate switching unit, e.g. RMA42
- Point level adjustment directly at the point level switch

### FEI57S

PFM signal transmission (current pulses are superimposed on the supply current)

- For separate switching unit with PFM signal transmission e.g. Nivotester FTC325 PFM
- Self-test from the switching unit without changing levels
- Point level adjustment directly at the point level switch
- Cyclical checking from the switching unit

### FEI58 (NAMUR)

Signal transmission H-L edge 2.2 to 3.5 or 0.6 to 1.0 mA as per IEC 60947-5-6 on two-wire cable

- For a separate switching unit, e.g. Nivotester FTL325N
- Point level adjustment directly at the point level switch
- Test the connection cables and slaves by pressing the button on the electronic insert



**System integration via Fieldgate****Vendor managed inventory**

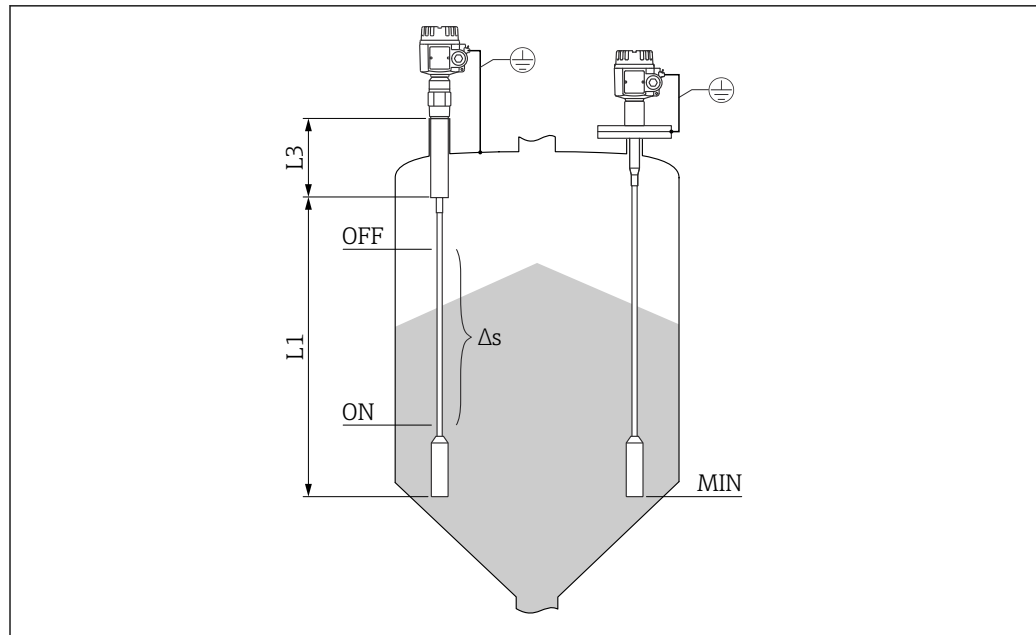
The remote interrogation of tank or silo levels via Fieldgate enables suppliers of raw materials to gather information about the current inventories of their regular customers at any time and, for example, to take this into account in their own production planning. The Fieldgate monitors the configured point levels and automatically triggers the next order as required. Here, the range of possibilities ranges from simple requisitioning by e-mail through to fully automatic order processing by incorporating XML data into the planning systems on both sides.

**Remote maintenance of measuring systems**

Not only does Fieldgate transmit the current measured values, it also alerts the standby personnel responsible by e-mail or SMS as required. Fieldgate forwards the information transparently. In this way, all options of the operating software in question are available remotely. By using remote diagnosis and remote configuration some onsite service operations can be avoided and all others can at least be planned and prepared better.

## Input

<b>Measured variable</b>	Measurement of the change in capacitance between the probe and the tank wall, depending on the level of the bulk solids.
<b>Measuring range</b>	<p><b>Measuring frequency</b> 500 kHz</p> <p><b>Span</b></p> <ul style="list-style-type: none"> <li>▪ <math>\Delta C = 5</math> to 1 600 pF</li> <li>▪ FEI58 <math>\Delta C = 5</math> to 500 pF</li> </ul> <p><b>Final capacitance</b> <math>C_E =</math> maximum 1 600 pF</p> <p><b>Adjustable initial capacitance</b></p> <ul style="list-style-type: none"> <li>▪ range 1 - factory setting <math>C_A = 5</math> to 500 pF</li> <li>▪ range 2 - not available with FEI58 <math>C_A = 5</math> to 1 600 pF</li> </ul>
<b>Input signal</b>	<p>Probe covered -&gt; high capacitance</p> <p>Probe not covered -&gt; low capacitance</p>
<b>Measuring conditions</b>	<p>When installing in a nozzle, use inactive length (L3). probes can be used to control a screw conveyor (<math>\Delta s</math> mode). The on-value and off-value are determined by the empty and full calibration. Partially insulated probes are only suitable for nonconductive bulk solids.</p> <ul style="list-style-type: none"> <li>▪ <math>DK &gt; 10</math>: measuring range up to 4 m (13 ft)</li> <li>▪ <math>5 &lt; DK &lt; 10</math>: measuring range up to 12 m (39 ft)</li> <li>▪ <math>2 &lt; DK &lt; 5</math>: measuring range up to 20 m (66 ft)</li> </ul> <p>The minimum capacitance change for point level detection must be <math>\geq 5</math> pF.</p>



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5 Measuring conditions

- L1* Active length  
*L3* Inactive length  
*Δs* Two-point control  
*MIN* Minimum measuring level

**Minimum probe length for nonconductive media < 1 μS/cm**

The minimum probe length can be calculated using the formula:

$$l_{\min} = \frac{\Delta C_{\min}}{C_s \cdot (\epsilon_r - 1)}$$

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$l_{\min}$	minimum probe length
$\Delta C_{\min}$	5 pF
$C_s$	probe capacitance in air
$\epsilon_r$	relative dielectric constant, e.g. for dried grain = 3.0

## Output

### Switch behavior

Binary or  $\Delta s$  operation.



The pump control is not possible with FEI58.

### Switch-on behaviour

When the power supply is switched on, the switching status of the outputs corresponds to the signal on the alarm.

The correct switch condition is reached after a maximum of 3 s.

### Fail-safe mode

Minimum and maximum quiescent current safety can be switched at the electronic insert <sup>1)</sup>.

1) For FEI53 and FEI57S only on the associated Nivotester: FTC325.

**MIN**

Minimum safety: the output switches safety-oriented when the probe is uncovered <sup>2)</sup> (signal on alarm).

**MAX**

Maximum safety: the output switches safety-oriented when the probe is covered <sup>3)</sup> (signal on alarm).

**Switching delay****FEI51, FEI52, FEI54, FEI55**

Can be adjusted incrementally at the electronic insert: 0.3 to 10 s.

**FEI53, FEI57S**

Depends on the connected Nivotester (transmitter): FTC325.

**FEI58**

Can be adjusted alternately at the electronic insert: 1 s or 5 s

**Galvanic isolation****FEI51 and FEI52**

between the probe and power supply

**FEI54**

between the probe, power supply and load

**FEI53, FEI55, FEI57S and FEI58**

see connected switching device <sup>4)</sup>

## Power supply

**Electrical connection**

Depending on explosion protection, the connection compartment is available in the following variants:

**Standard protection, Ex ia protection**

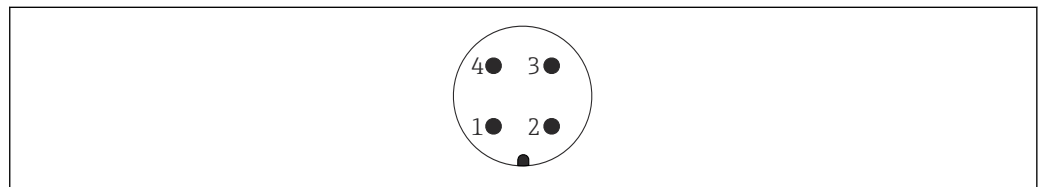
- polyester housing F16
- stainless steel housing F15
- aluminum housing F17
- aluminum housing F13 with gas-tight process seal
- stainless steel housing F27 with gas-tight process seal
- aluminum housing T13 with a separate connection compartment

**Ex d protection, Gas-tight process seal**

- aluminum housing F13 with gas-tight process seal
- stainless steel housing F27 with gas-tight process seal
- aluminum housing T13 with a separate connection compartment

**Connector**

For the version with a connector M12, the housing does not have to be opened for connecting the signal line.

**PIN assignment for M12 connector**

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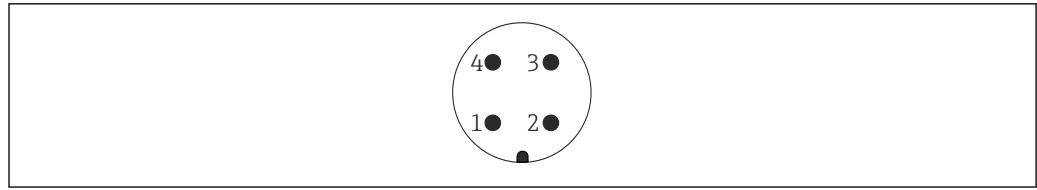
6 M12 connector with 2-wire-electronic insert FEI55, FEI57, FEI58, FEI57C

- 1 Positive potential
- 2 Not used
- 3 Negative potential
- 4 Ground

2) E.g. for dry running protection and pump protection.

3) E.g. for use with overflow protection.

4) Functional galvanic isolation in the electronic insert.



A0011175

7 M12 connector with 3-wire-electronic insert FEI52, FEI53

- 1 Positive potential
- 2 Not used
- 3 Negative potential
- 4 External load / signal

## Cable entry

### Cable gland

M20x1.5 for Ex d only cable entry M20  
Two cable glands are included in scope of delivery.

### Cable entry

- G $\frac{1}{2}$
- NPT $\frac{1}{2}$
- NPT $\frac{3}{4}$
- M20 thread

## Performance characteristics

### Reference operating conditions

Temperature: 20 °C (68 °F)  $\pm$ 5 °C ( $\pm$ 8 °F)  
Pressure: 1013 mbar (407 inH<sub>2</sub>O) abs.  $\pm$ 20 mbar ( $\pm$ 8.03 inH<sub>2</sub>O)  
Humidity: 65 %  $\pm$ 20 %  
Medium: water from mains (conductivity 180  $\mu$ S/cm)

### Switch point

Uncertainty as per DIN 61298-2: max.  $\pm$ 0.3 %  
Non-repeatability (reproducibility) as per DIN 61298-2: max.  $\pm$ 0.1 %

### Ambient temperature effect

#### Electronic insert

< 0.06 % per 10 K related to the full-scale value

#### Separate housing

capacitance change of connecting cable per meter 0.15 pF per 10 K

## Installation

### Mounting requirements

#### General notes and precautions

##### NOTICE

#### Filling the silo.

- ▶ The filling stream must not be directed onto the probe.

##### NOTICE

#### Angle of material flow.

- ▶ Take care to the expected angle of the material flow and the outlet funnel when determining the mounting location or probe length.

##### NOTICE

#### Distance between probes.

- ▶ The minimum distance of 500 mm (19.7 in) between the probes must be observed.

**NOTICE**

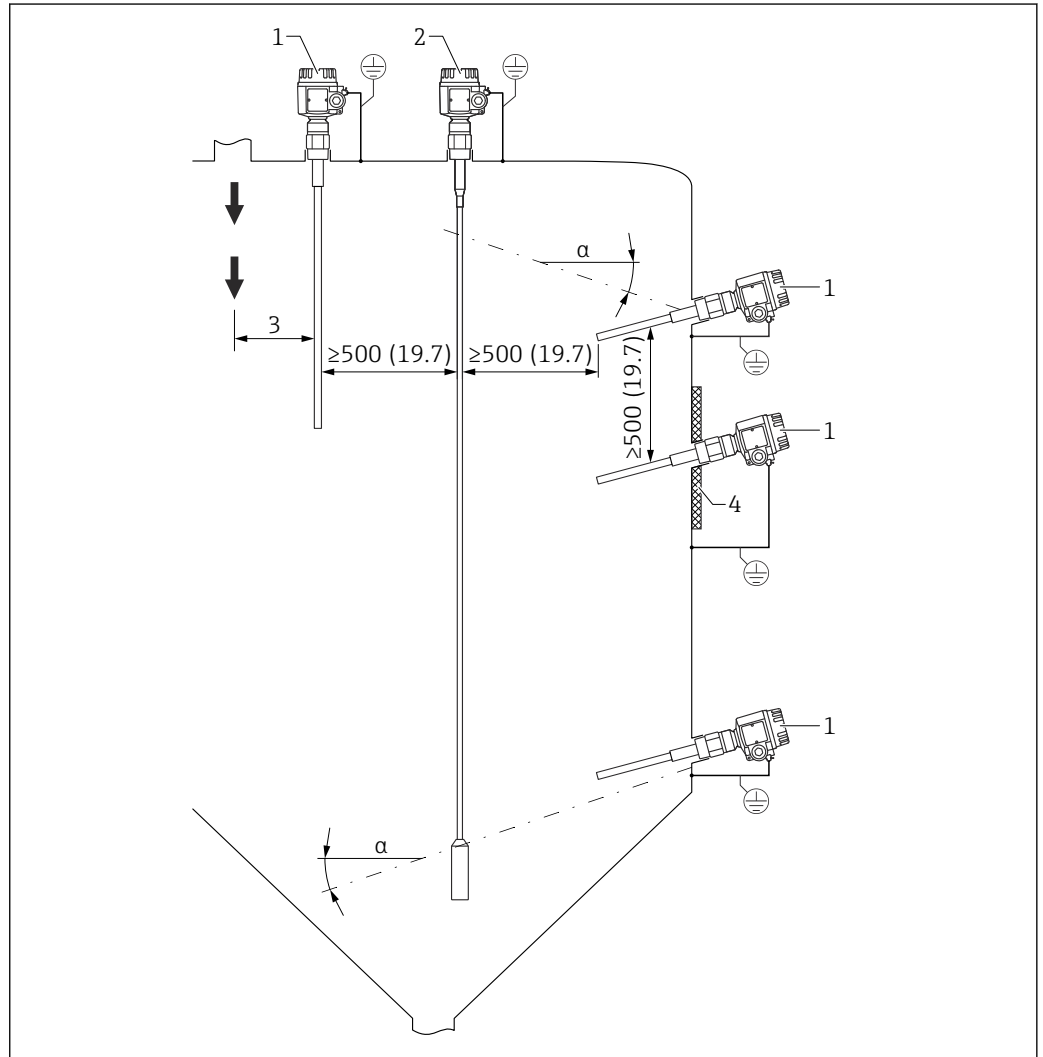
**Threaded coupling for mounting.**

- ▶ The threaded coupling must be as short as possible. Condensation or product residue can occur in a long threaded coupling and interfere with the correct operation of the probe.

**NOTICE**

**Heat insulation**

- ▶ Insulate the external silo wall to avoid exceeding the permitted temperature of the Solicap M housing.
- ▶ Insulate the silo wall to prevent the condensation and reduce buildup in the threaded coupling area.



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8 Mounting examples. Unit of measurement mm (in)

- a* Angle of the slope
- 1 FTI55
- 2 FTI56
- 3 Distance from the loading point
- 4 Heat insulation

**Mounting the sensor**

**NOTICE**

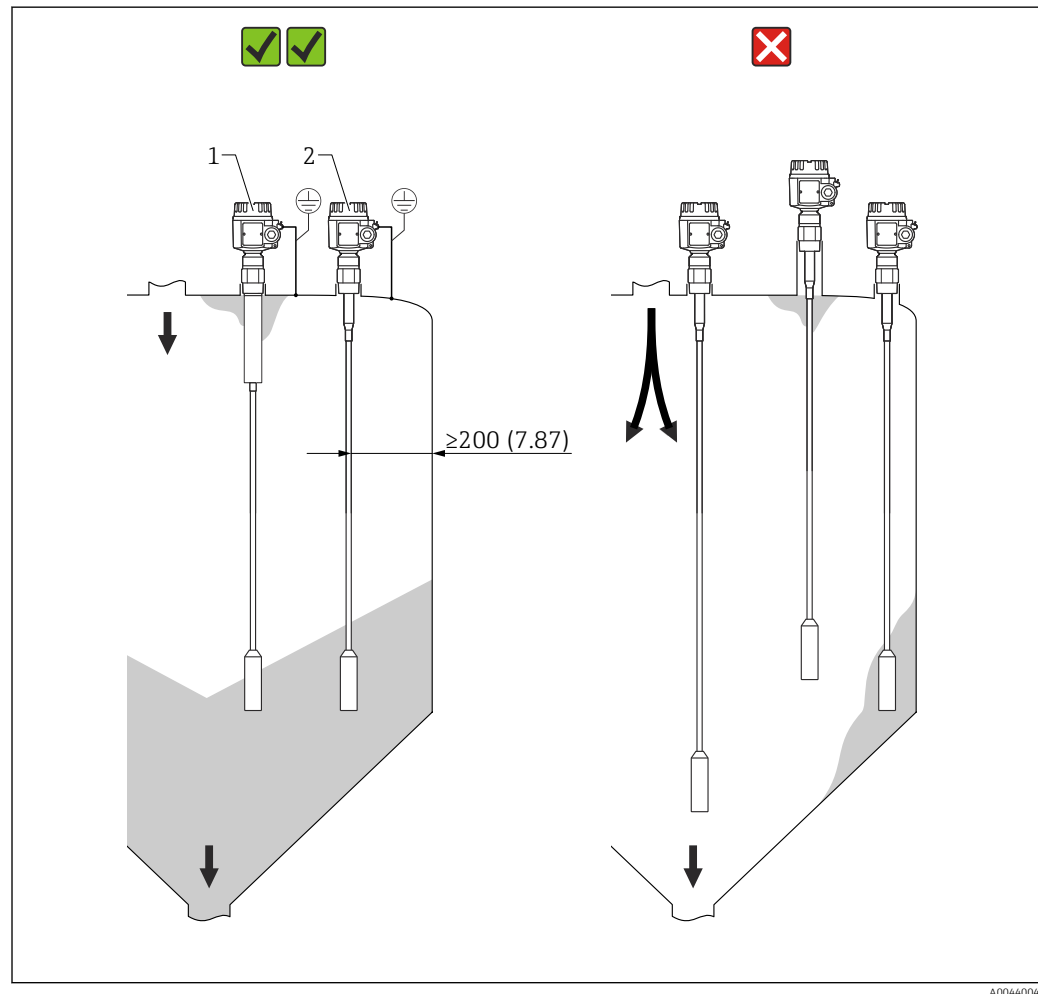
**Mounting the probe rope in the loading curtain area can cause an incorrect device operation!**

- ▶ Mount the probe away from the loading curtain.

**NOTICE**

**The probe rope cannot touch the metal container wall!**

- Make sure that the probe rope is insulated from the metal container wall.



9 Mounting examples. Unit of measurement mm (in)

- 1 FTI56 with inactive length in the event of condensation and material buildup
- 2 The correct distance from the silo wall, the material inlet and the material outlet

#### Silo roof

Ensure that the silo roof is of a sufficiently stable construction. High tensile forces can occur when material is being extracted, particularly in the case of heavy and powdery bulk solids which have a tendency to form buildup.

#### Coarse-grained bulk solids

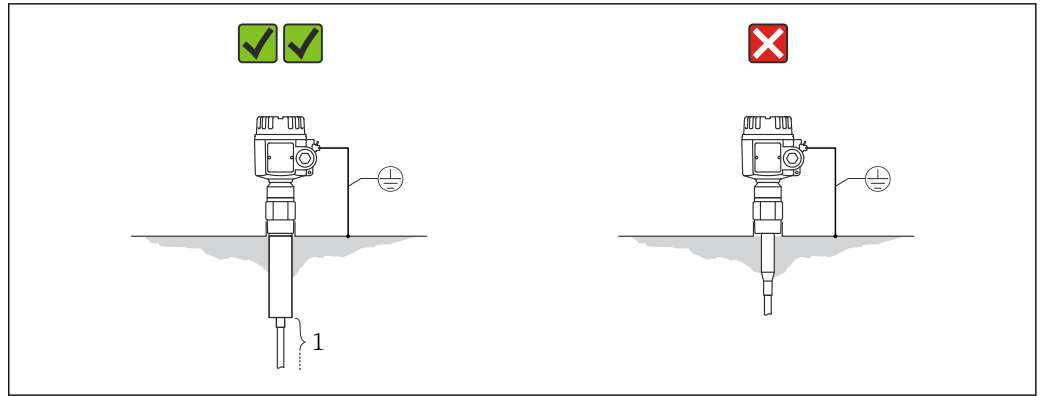
In silos with extremely coarse-grained or extremely abrasive bulk solids, the use of a Solicap M FTI56 is recommended only for maximum detection.

#### Distance between the rope probes

To rule out mutual probe interference, you must maintain a minimum distance of 0.5 m between the rope probes. This also applies if you are installing several Solicap M units in adjacent silos with nonconductive walls.

#### Installation in the case of condensation

Use the Solicap M with inactive length. The inactive length prevents moisture and buildup forming between the active part of the probe and the silo roof.

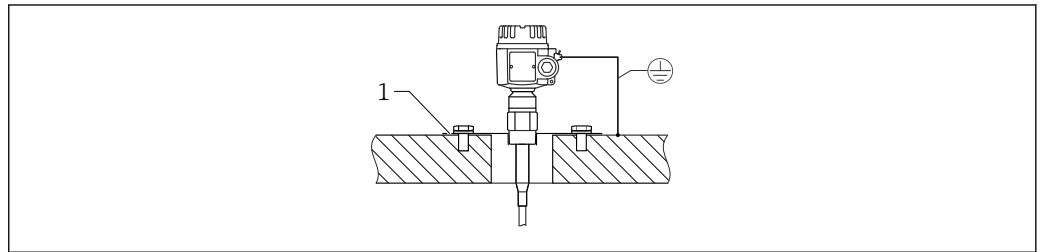


10 Silo with walls that conduct electricity

1 Active part of the probe

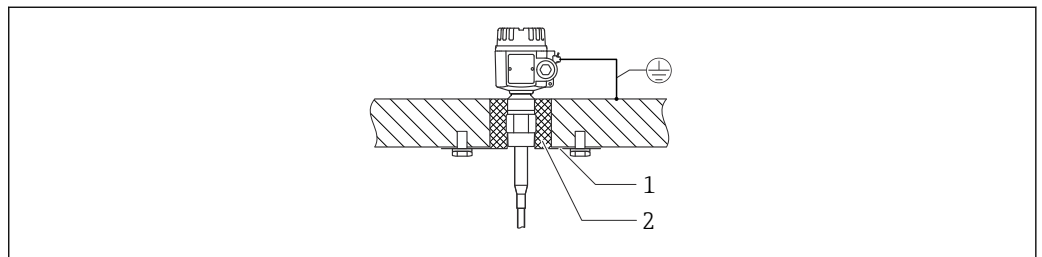
The threaded coupling must be projected into the silo to reduce the effects of condensation and buildup. The maximum thread length is 25 mm (0.98 in).

Heat insulation reduces condensation and therefore buildup on the steel plate.



11 Mounting in the concrete silo wall

1 Steel plate connected to the reinforcing steel

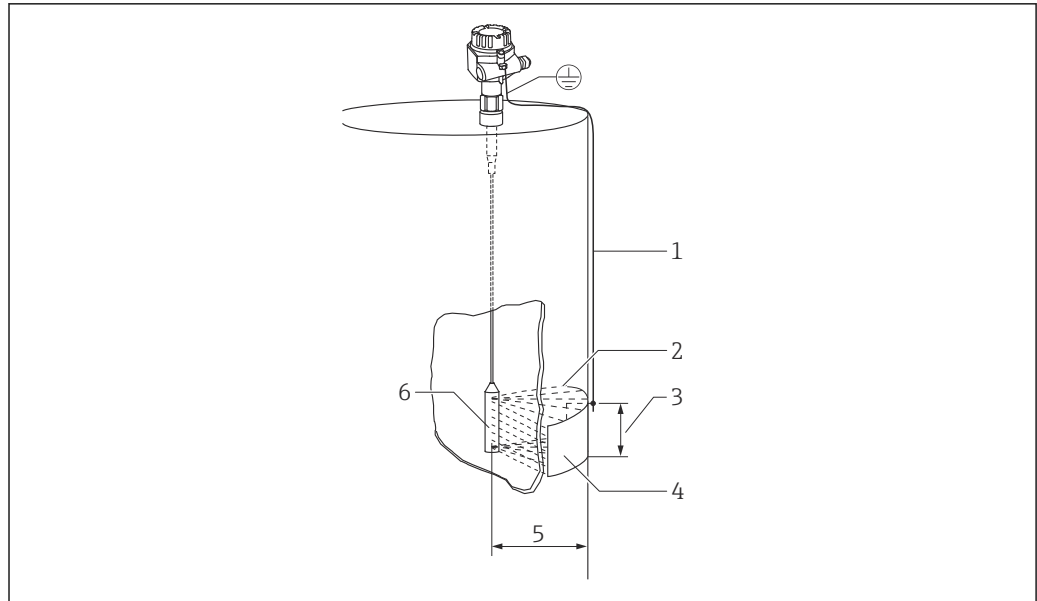


12 Mounting in the concrete silo wall in case of condensation

1 Steel plate  
2 Heat insulation

*Installation in plastic tanks*

If installing in a silo made of plastic, a counter electrode must be mounted on the silo exterior at the same height as the tensioning weight. The length of the edge of the metal counter electrode should be approximately the same length as the distance between the tensioning weight and the silo wall.



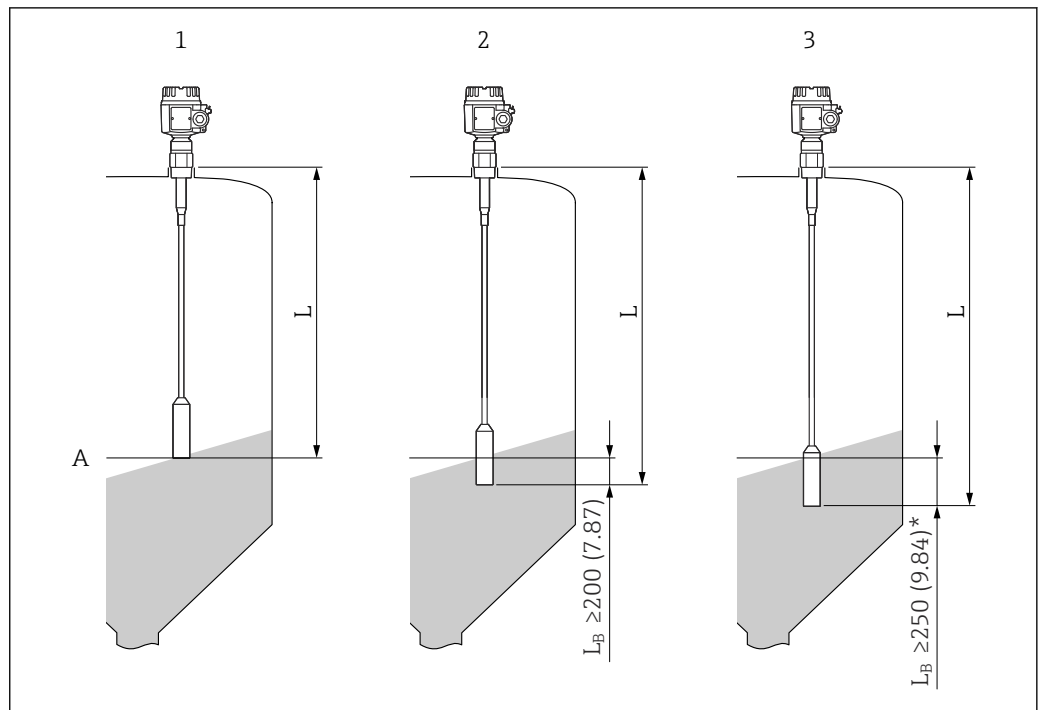
A0044009

13 Mounting the probe in plastic tanks

- 1 Ground connection
- 2 Electrical HF field
- 3 Surface area e.g.  $1 \text{ m}^2$  (10.7  $\text{ft}^2$ )
- 4 Metal counter electrode
- 5 Distance of 1 m (3.3 ft)
- 6 Tensioning weight



## Range of sensor lengths



A0044010

14 Rope length in correlation with the material. Unit of measurement mm (in)

A Level

$L_B$  Covered length

1 Rope length (L) for electrically conductive bulk solids, e.g. coal

2 Rope length (L) for bulk solids with high dielectric constant, e.g. rock salt

3 Rope length (L) for bulk solids with low dielectric constant, e.g. dried grain

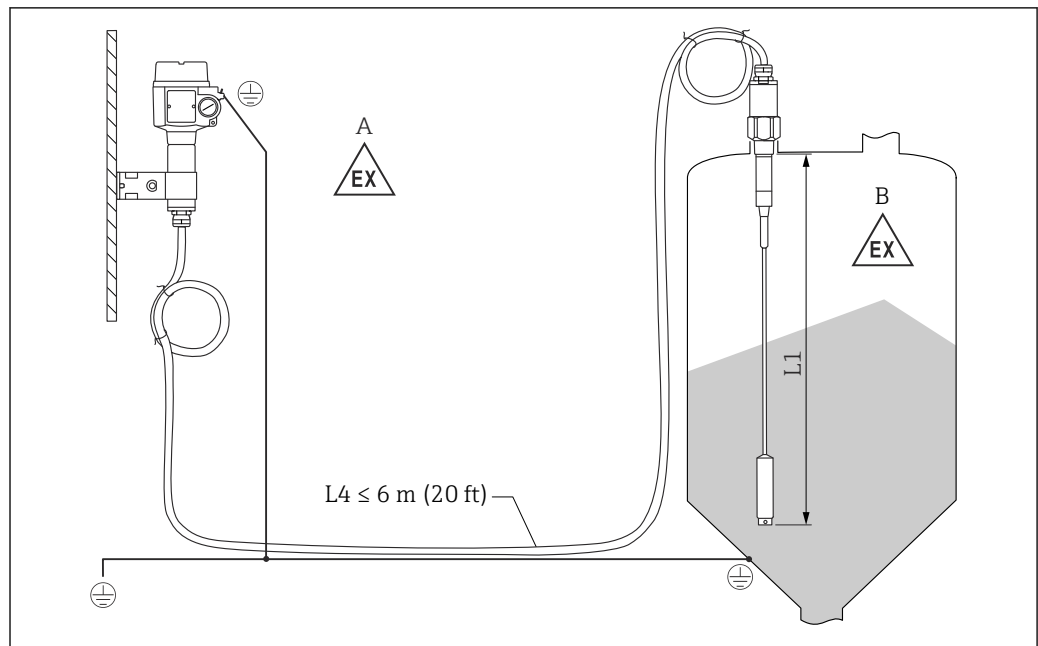


The covered length ( $L_B$ ) must be 5 % longer than the distance between the tank roof and the limit level, and no shorter than 250 mm (9.84 in) for non-conductive bulk solids with a low dielectric constant ( $\epsilon_r$ ).

## Rope shortening

Both versions of the rope probes can be shortened. The weight must be removed from the rope first. See Operating Instructions.

### Probe with separate housing



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15 Connection of the probe and separate housing

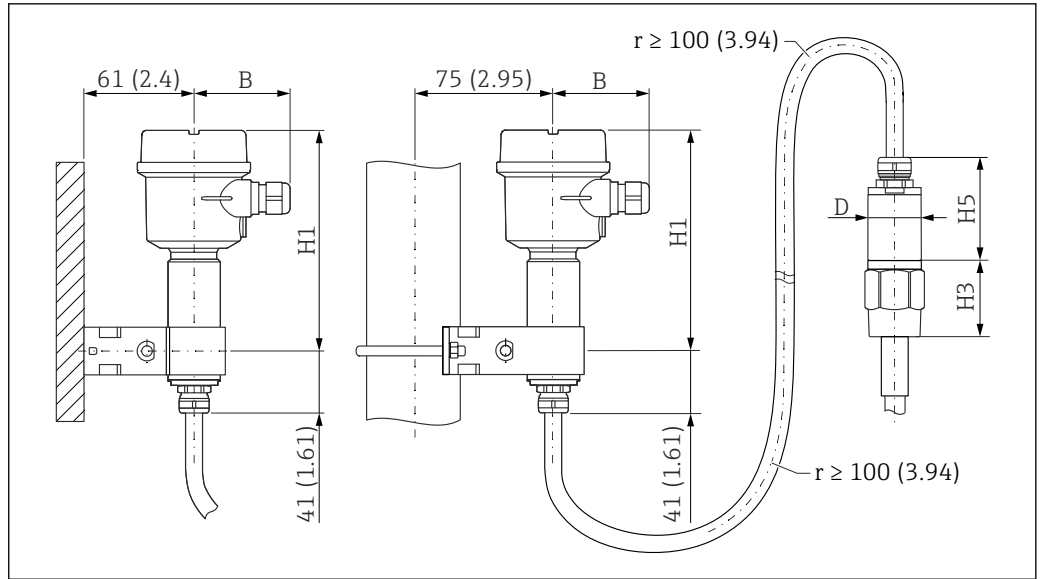
- A Explosive zone 1  
 B Explosive zone 0  
 L1 Rope length: max. 19.7 m (65 ft)  
 L4 Cable length

The maximum cable length  $L4$  and rope length  $L1$  cannot exceed 20 m (66 ft).

- i** The maximum cable length between the probe and separate housing is 19.7 m (65 ft).
- The required cable length must be indicated in the ordering process of a Liquicap M with separate housing.
- If the cable connection has to be shortened or led through a wall, then it must be separated from the process connection.

#### Extension heights: separate housing

- i** The cable has:
  - a minimum bending radius of  $r \geq 100 \text{ mm (3.94 in)}$
  - $\varnothing 10.5 \text{ mm (0.14 in)}$
  - outer jacket made of silicone, notch resistance



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16 Housing side: wall mounting, pipe mounting, and sensor side. Unit of measurement mm (in)

Values of parameters <sup>5)</sup>:

**B parameter**

- polyester housing (F16): 76 mm (2.99 in)
- stainless steel housing (F15): 64 mm (2.52 in)
- aluminum housing (F17): 65 mm (2.56 in)

**H1 parameter**

- polyester housing (F16): 172 mm (6.77 in)
- stainless steel housing (F15): 166 mm (6.54 in)
- aluminum housing (F17): 177 mm (6.97 in)

**D parameter**

∅ 50 mm (1.97 in)


**H5 parameter**

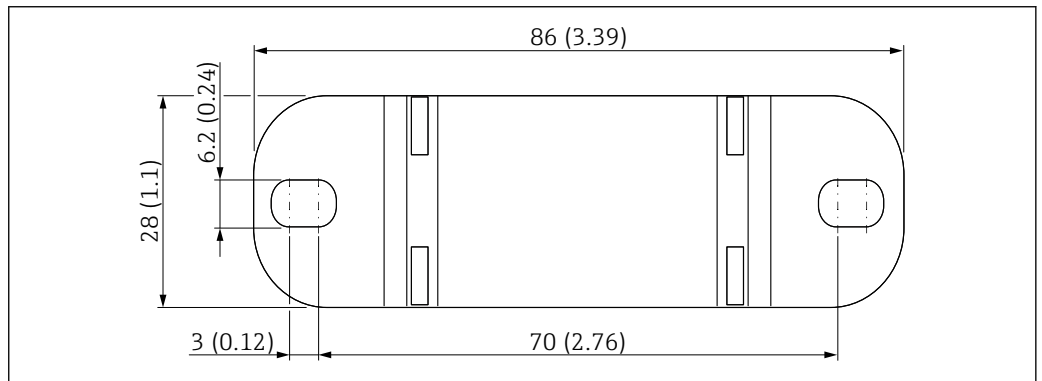
∅62 mm (2.44 in)

**H3 parameter value**

The height H3 depends on the type of process connection.

*Wall bracket*

-  The wall bracket is a part of the scope of delivery.
- To use the wall bracket as a drill template, the wall bracket must be first screwed to the separate housing.
- The distance between the holes is reduced by screwing it to the separate housing.



A0033881

17 Wall bracket overview. Unit of measurement mm (in)

5) See parameters on the drawings.


*Wall mounting*

Wall mounting is possible, see Operating Instructions.

*Pipe mounting*

Pipe mounting is possible, see Operating Instructions.

## Environment

<b>Ambient temperature range</b>	<ul style="list-style-type: none"> <li>■ F16 housing: -40 to +70 °C (-40 to +158 °F)</li> <li>■ remaining housing: -50 to +70 °C (-58 to +158 °F)</li> <li>■ observe derating</li> <li>■ use a protective cover, when operating outdoors</li> </ul>
<b>Storage temperature</b>	-50 to +85 °C (-58 to +185 °F)
<b>Climate class</b>	DIN EN 60068-2-38/IEC 68-2-38: Z/AD check
<b>Vibration resistance</b>	DIN EN 60068-2-64/IEC 68-2-64: 20 to 2 000 Hz, 0.01 g <sup>2</sup> /Hz
<b>Cleaning</b>	<p><b>Housing</b></p> <p>Make sure that the cleaning agent used does not corrode the housing surface or the seals.</p> <p><b>Probe</b></p> <p>Depending on the application, buildup (contamination and soiling) can form on the probe rope. A high degree of material buildup can affect the measurement result. If the medium tends to create a high degree of buildup, regular cleaning is recommended. When cleaning, it is important to make sure that the insulation of the probe rope is not damaged. Make sure the material is resistant to used cleaning agent.</p>
<b>Electromagnetic compatibility (EMC)</b>	<p>Interference emission to EN 61326, Electrical Equipment Class B. Interference immunity to EN 61326, Annex A (Industrial) and NAMUR Recommendation NE 21 (EMC).</p> <p>A usual commercial instrument cable can be used.</p>
<b>Shock resistance</b>	DIN EN 60068-2-27/IEC 68-2-27: 30 g acceleration
<b>Degree of protection</b>	<p> All protection degree regarding EN60529.</p> <p>Type4X protection degree regarding NEMA250.</p> <p><b>Polyester housing F16</b></p> <p>Protection degree:</p> <ul style="list-style-type: none"> <li>■ IP66</li> <li>■ IP67</li> <li>■ Type4X</li> </ul> <p><b>Stainless steel housing F15</b></p> <p>Protection degree:</p> <ul style="list-style-type: none"> <li>■ IP66</li> <li>■ IP67</li> <li>■ Type4X</li> </ul> <p><b>Aluminum housing F17</b></p> <p>Protection degree:</p> <ul style="list-style-type: none"> <li>■ IP66</li> <li>■ IP67</li> <li>■ Type4X</li> </ul>

**Aluminum housing F13 with gas-tight process seal**

Protection degree:

- IP66
- IP68 <sup>6)</sup>
- Type4X

**Stainless steel housing F27 with gas-tight process seal**

Protection degree:

- IP66
- IP67
- IP68 <sup>6)</sup>
- Type4X

**Aluminum housing T13 with gas-tight process seal and separate connection compartment (Ex d)**

Protection degree:

- IP66
- IP68 <sup>6)</sup>
- Type4X

**Separate housing**

Protection degree:

- IP66
- IP68 <sup>6)</sup>
- Type4X

## Process

---

**Process temperature range**

The following process temperature ranges only apply for standard applications outside hazardous areas.



Regulations for use in hazardous areas are provided in the Supplementary Documentation that is available for the product and can be selected via the Product Configurator at [www.endress.com](http://www.endress.com).

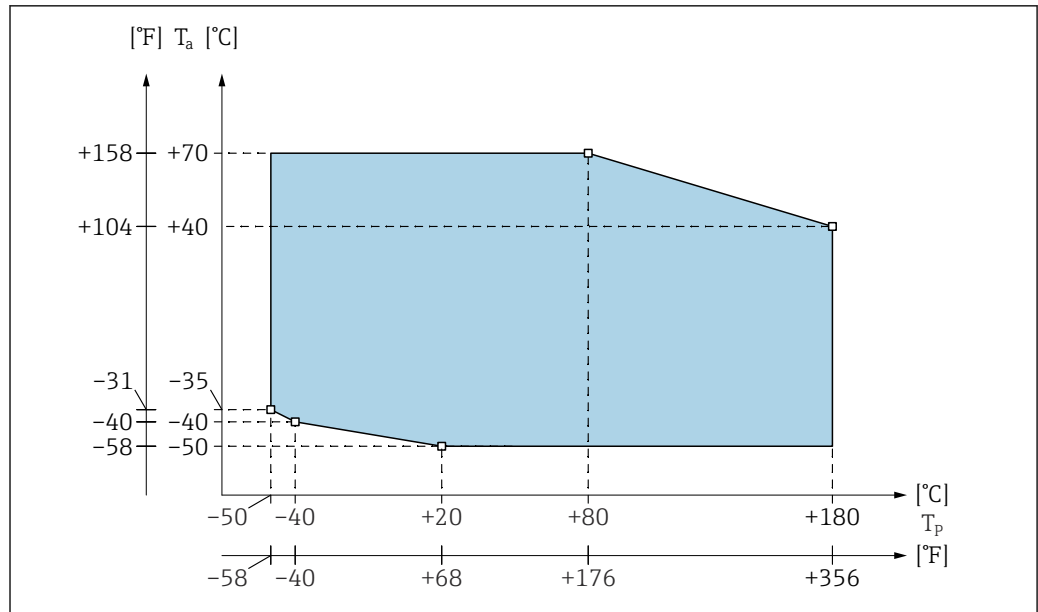
Permitted ambient temperature  $T_a$  at the housing depending on the process temperature  $T_p$  in the tank.

**Rope probe**

Partially insulated (PTFE)

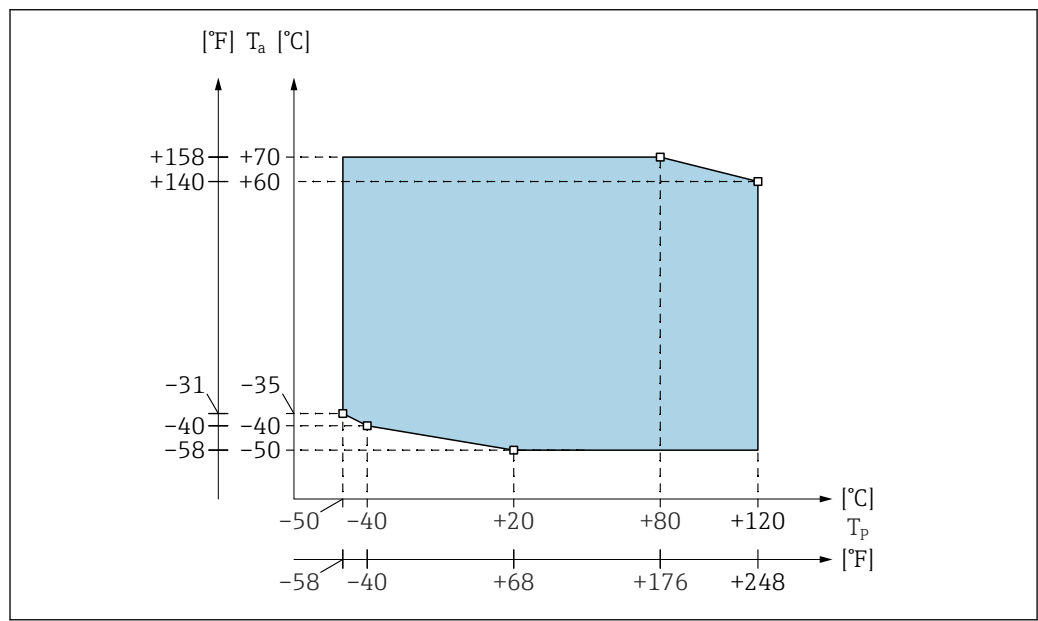
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6) Only with M20 cable entry or G½ thread.



18 Process temperature range diagram: partially insulated probe

Fully insulated (PA)



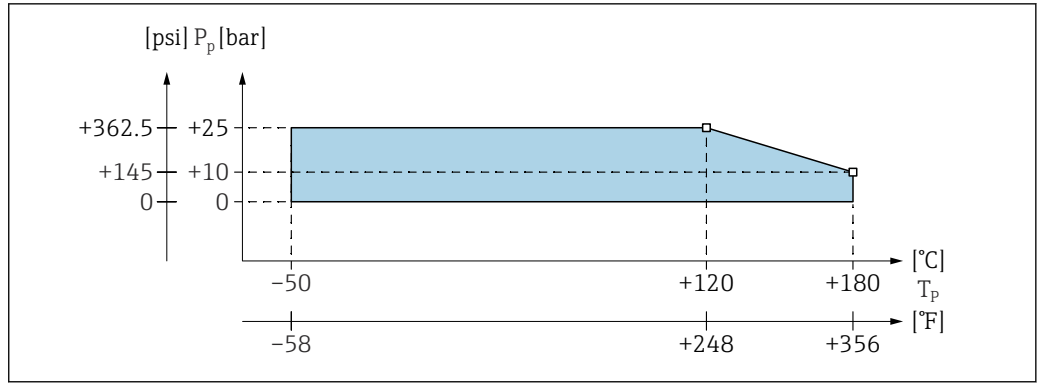
19 Process temperature range diagram: fully insulated probe

**Process pressure and temperature derating**

The lowest value from the derating curves of the device and the selected flange applies. In the case of flange process connections, the maximum pressure is limited by the nominal pressure of the flange.

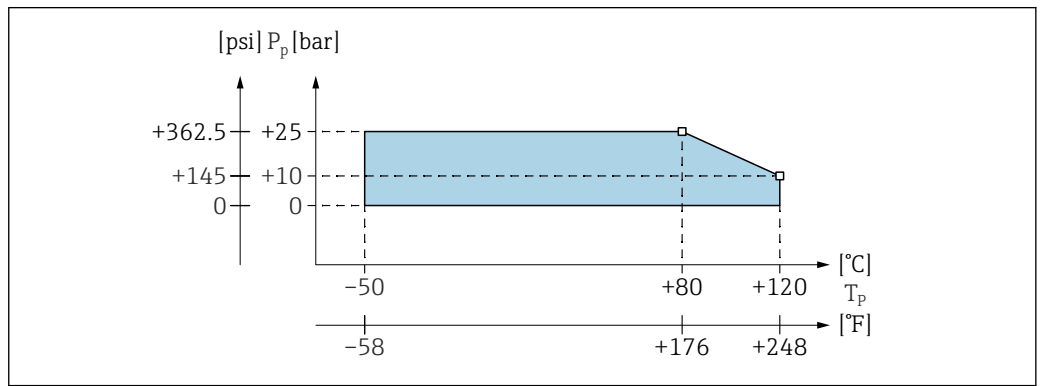
**Rope probe**

Partially insulated (PTFE)



20 Process pressure and temperature derating diagram: partially insulated probe

Fully insulated (PA)



21 Process pressure and temperature derating diagram: Fully insulated probe

**Process pressure limits**


Process pressure limits: -1 to 25 bar (-14.5 to 362.5 psi).

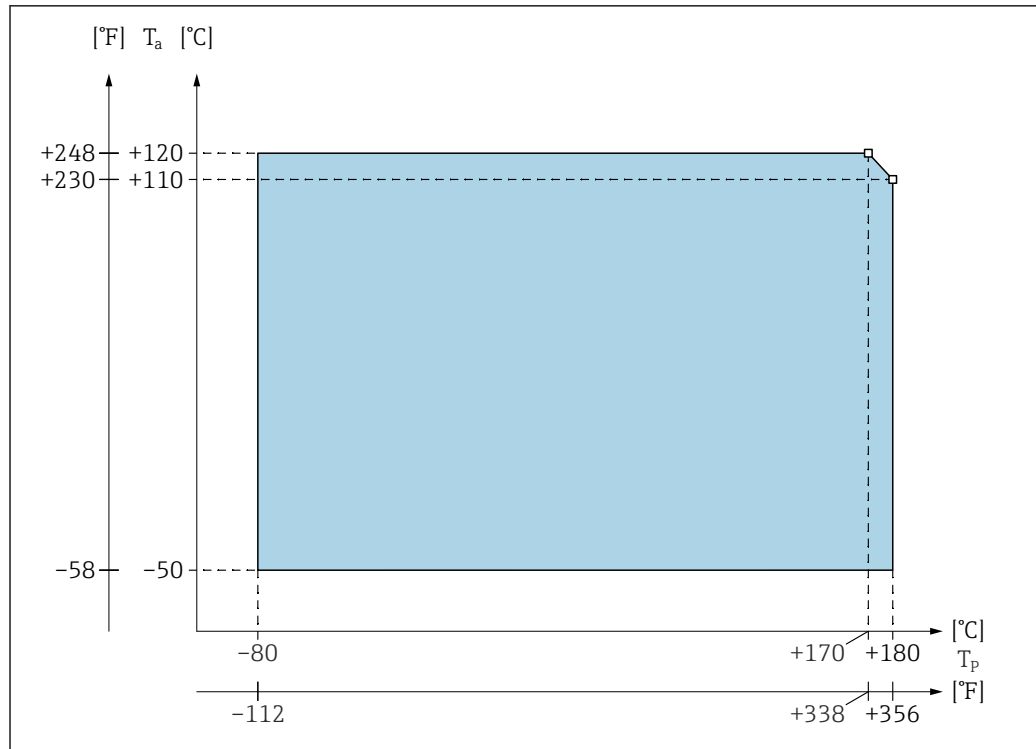
The lowest value from the derating curves of the device and the selected flange applies.

Refer to the following standards for the pressure values permitted at higher temperatures:

- pR EN 1092-1: 2005 Table, Appendix G2  
With regard to its resistance and temperature property, the material 1.4435 is identical to 1.4404 (AISI 316L) which is grouped under 13E0 in EN 1092-1 Tab. 18. The chemical make-up of the two materials can be identical.
- ASME B 16.5a - 1998 Tab. 2-2.2 F316
- ASME B 16.5a - 1998 Tab. 2.3.8 N10276
- JIS B 2220

**Temperature-derating separate housing**

 The temperature at the separate housing must not exceed 70 °C (158 °F).



A0044013

22 Process pressure range diagram

$T_a$  Ambient temperature

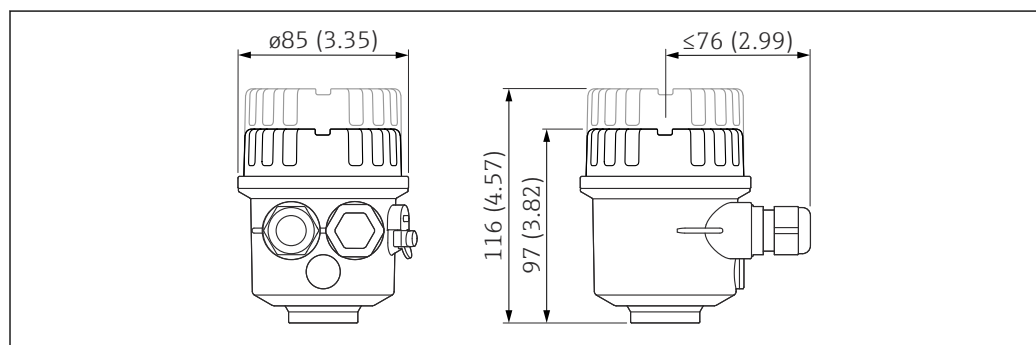
$T_p$  Process temperature

The maximum connection length between the probe and the separate housing is 6 m (L4). When ordering a device with a separate housing, the desired length must be specified. If the connecting cable is to be shortened or passed through a wall, it must be separated from the process connection, see operating instructions.

## Mechanical construction

### Housing

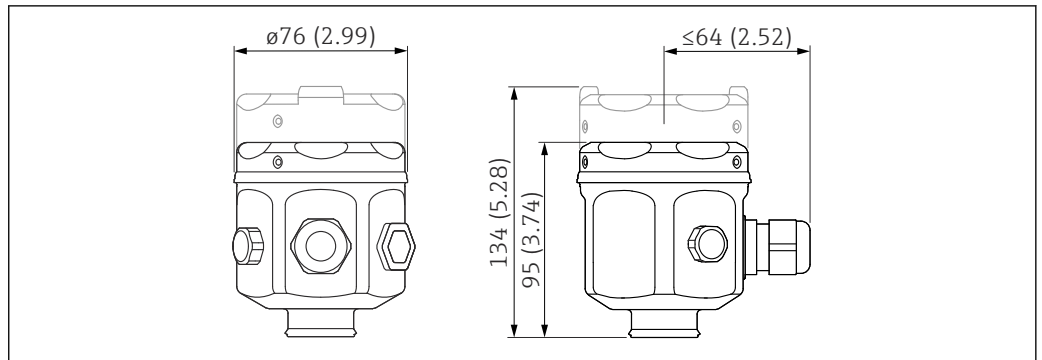
#### Polyester housing F16



A0040691



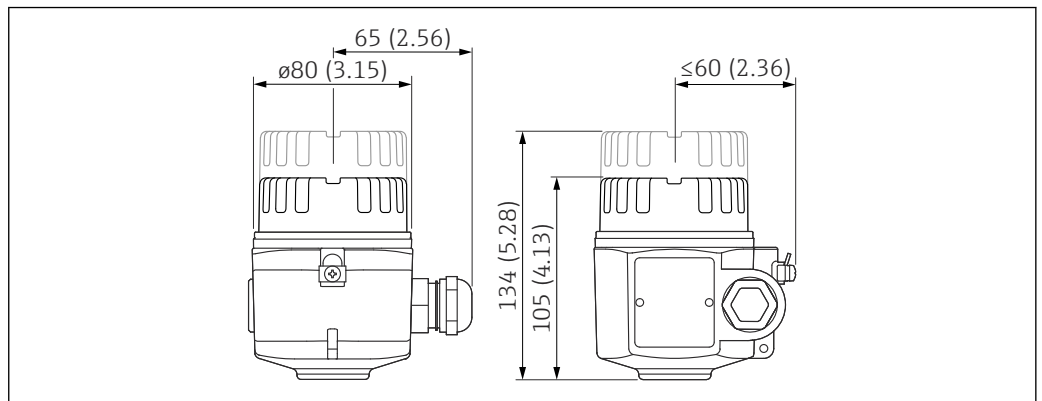
**Stainless steel housing F15**



A0040692

Unit of measurement mm (in)

**Aluminium housing F17**

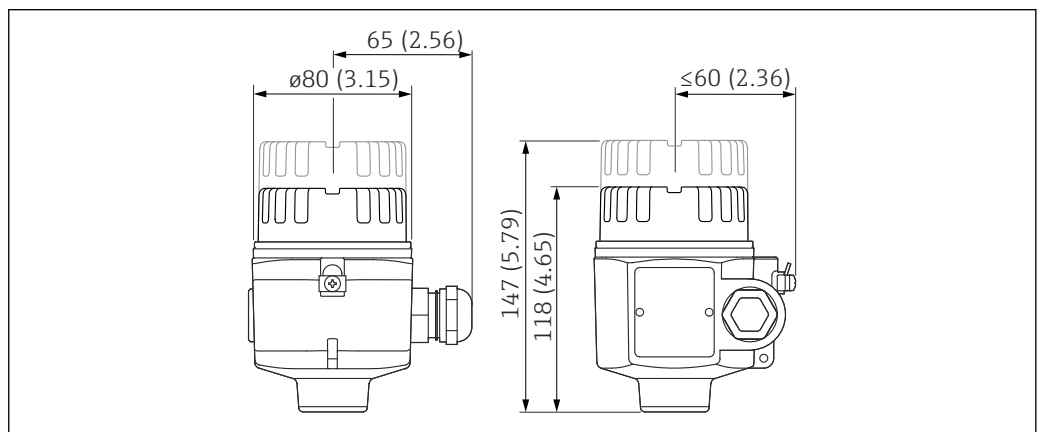


A0040693

Unit of measurement mm (in)

**Aluminum housing F13**

With the gas-tight process seal.

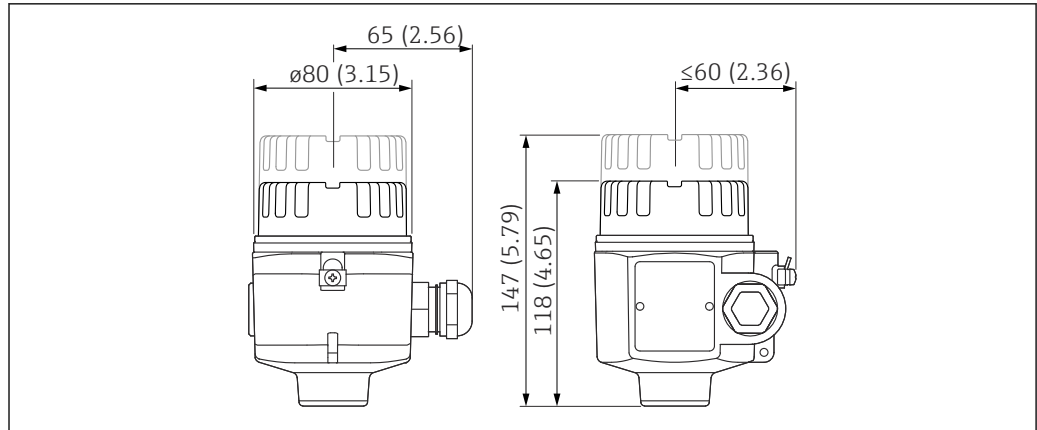


A0040694

Unit of measurement mm (in)

**Stainless steel housing F27**

With the gas-tight process seal.

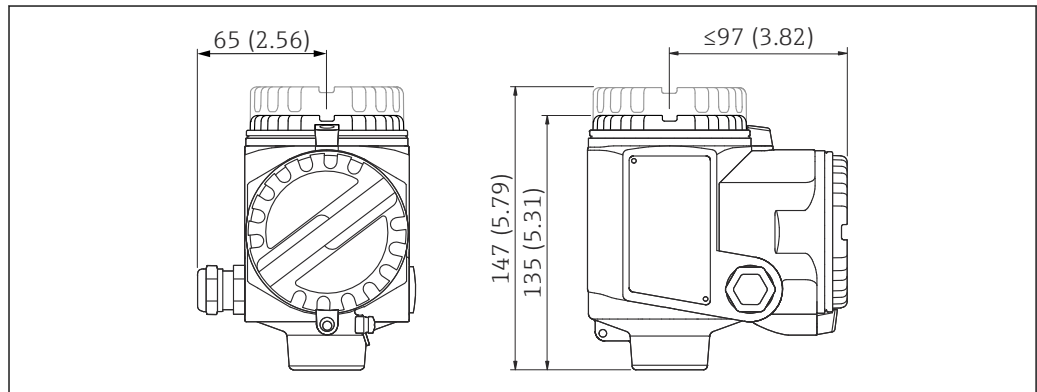


A0040694

Unit of measurement mm (in)

### Aluminum housing T13

With separate connection compartment and gas-tight process seal.



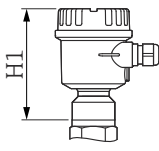
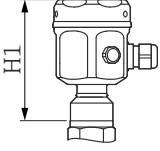
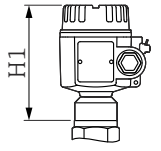
A0040695

Unit of measurement mm (in)

**Housing heights with adapter**

**List of abbreviations:**

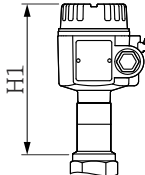
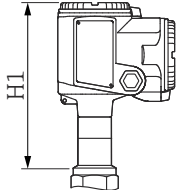
- G - order code
- H1 - height

A <sup>1)</sup>	B <sup>2)</sup>	C <sup>3)</sup>
 <small>A0044020</small>	 <small>A0044021</small>	 <small>A0044022</small>
G: 2	G: 1	G: 3
125 mm (4.92 in)	121 mm (4.76 in)	131 mm (5.16 in)

- 1) Polyester housing F16
- 2) Stainless steel housing F15
- 3) Aluminum housing F17

**List of abbreviations:**

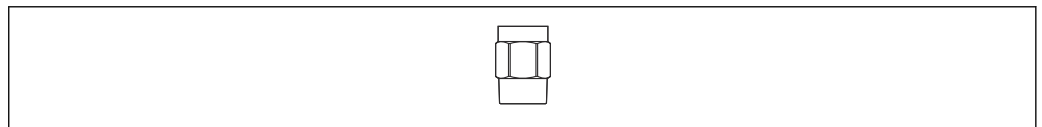
- G - order code
- H1 - height

D <sup>1)</sup>	F <sup>2)</sup>
 <small>A0044023</small>	 <small>A0044024</small>
G: 4	G: 5
177 mm (6.97 in)	194 mm (7.64 in)

- 1) Aluminum housing F13 with gas-tight process seal
- 2) Aluminum housing with separate connection compartment T13 and gas-tight process seal

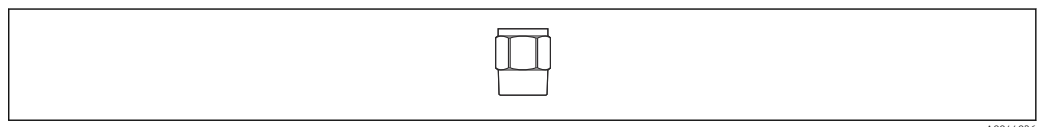
**Process connections and flanges**

**Thread: R 1½ - DIN EN 10226-1**



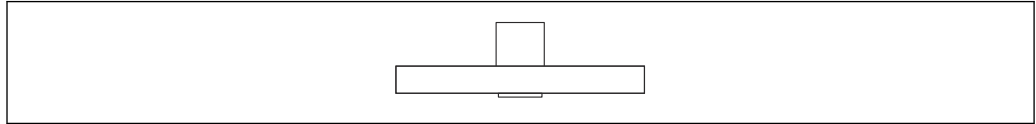
- p<sub>max</sub>: 25 bar (362.5 psi)
- Order code
  - 316L: **RVJ**
  - steel: **RV1**

**Thread: NPT 1½ - ANSI B 1.20.1**



- $p_{\max}$ : 25 bar (362.5 psi)
- Order code
  - 316L: **RGJ**
  - steel: **RG1**

#### Flanges



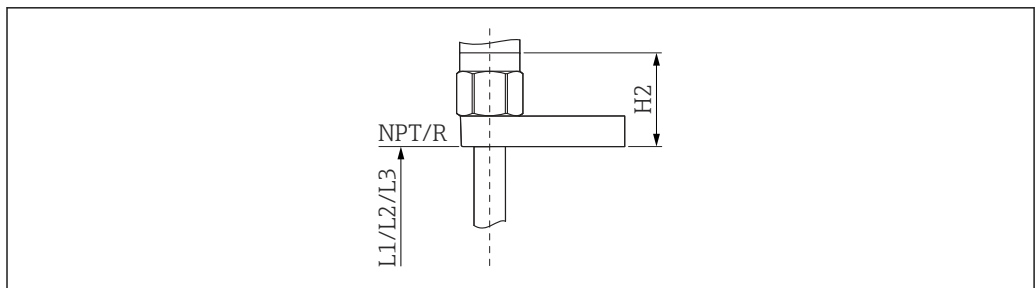
A0044027

- $p_{\max}$ : 25 bar (362.5 psi) <sup>7)</sup>
- Order code
  - ASME B16.5, NPS 2" Cl.150 RF, 316/316L: **AFJ**
  - ASME B16.5, NPS 3" Cl.150 RF, 316/316L: **AGJ**
  - ASME B16.5, NPS 4" Cl.150 RF, 316/316L: **AHJ**
  - EN1092-1, DN80 PN10/16 A, 316L: **BSJ**
  - EN1092-1, DN100 PN10/16 A, 316L: **BTJ**
  - EN1092-1, DN50 PN25/40 A, 316L: **B3J**
  - JIS B2220, 10K 50A RF, 316L: **KFJ**
  - JIS B2220, 10K 80A RF, 316L: **KGJ**
  - JIS B2220, 10K 100A RF, 316L: **KHJ**

#### Rope probes FTI56

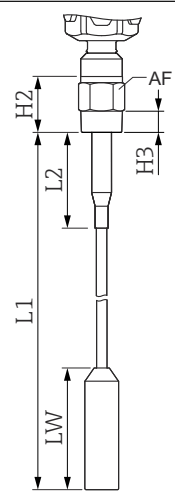
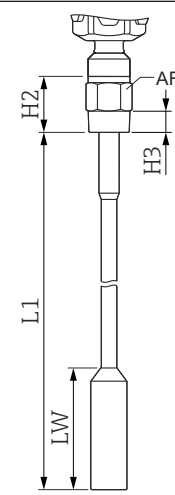
**i** Total length of the probe measured from the start of the thread:  
without active buildup compensation:  $L = L1 + L3$

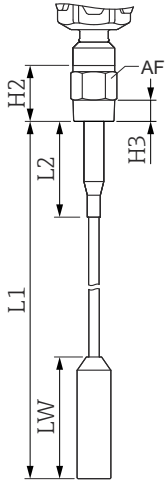
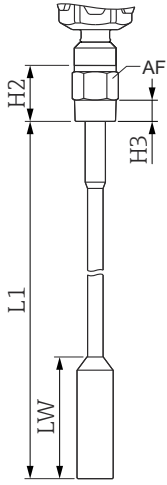
- i** Length tolerance:
- up to 1 m (3.3 ft): 0 to -10 mm (0 to -0.39 in)
  - > 1 to 3 m (3.3 to 9.8 ft): 0 to -20 mm (0 to -0.79 in)
  - > 3 to 6 m (9.8 to 20 ft): 0 to -30 mm (0 to -1.18 in)
  - > 6 m (20 ft): 0 to -40 mm (0 to -1.57 in)



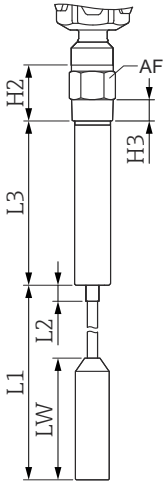
A0044028

7) Depends on flange

A <sup>1)</sup>		B <sup>2)</sup>	
			
<small>A0044033</small>		<small>A0044034</small>	
<b>H2</b>			
66 mm (2.60 in)		66 mm (2.60 in)	
<b>H3</b>			
25 mm (0.98 in)		25 mm (0.98 in)	
<b>AF</b>			
50		50	
<b>Total length (L)</b>			
500 to 20000 mm (19.7 to 787 in)		500 to 20000 mm (19.7 to 787 in)	
<b>Active rope length (L1)</b>			
500 to 20000 mm (19.7 to 787 in)		500 to 20000 mm (19.7 to 787 in)	
<b>Length of partial insulation (L2) <sup>3)</sup></b>			
500 mm (19.7 in)		-	
<b>Inactive length (L3)</b>			
-		-	
<b>Inactive length diameter</b>			
-		-	
<b>Probe rope diameter</b>			
6 mm (0.24 in)	12 mm (0.47 in)	6 mm (0.24 in)	12 mm (0.47 in)
<b>Probe rope diameter with insulation</b>			
8 mm (0.31 in)	14 mm (0.55 in)	8 mm (0.31 in)	14 mm (0.55 in)
<b>Tensioning weight diameter <sup>4)</sup></b>			
30 mm (1.18 in)	40 mm (1.57 in)	30 mm (1.18 in)	40 mm (1.57 in)
<b>Length of tensioning weight (LW)</b>			
150 mm (5.91 in)	250 mm (9.84 in)	150 mm (5.91 in)	250 mm (9.84 in)
<b>Tensile loading capacity of the probe rope at 20 °C (68 °F)</b>			
30 kN (6744 lbs)	60 kN (13488 lbs)	300 Nm (221 lbf ft)	
<b>Maximum process temperature</b>			
180 °C (356 °F)		120 °C (248 °F)	
<b>Probe can be used in mounting nozzles</b>			
-		-	

A <sup>1)</sup>	B <sup>2)</sup>
	
<small>A0044033</small>	<small>A0044034</small>
<b>Probe can be used in the event of condensate on tank ceiling</b>	
-	-

- 1) Rope probe with partially insulated rope
- 2) Rope probe with fully insulated rope.
- 3) The length of the partial insulation extends, at maximum, to the tensioning weight.
- 4) The tension weight is always uninsulated.

C <sup>1)</sup>	C <sup>2)</sup>
	
<small>A0044035</small>	
<b>H2</b>	66 mm (2.60 in)
<b>H3</b>	25 mm (0.98 in)
<b>AF</b>	50
<b>Total length (L)</b>	700 to 20000 mm (27.6 to 787 in)
<b>Active rope length (L1)</b>	500 to 19800 mm (19.7 to 780 in)
<b>Length of partial insulation (L2)<sup>3)</sup></b>	

C <sup>1)</sup>	C <sup>2)</sup>
A0044035	
500 mm (19.7 in)	-
<b>Inactive length (L3)</b>	
200 to 2 000 mm (7.87 to 78.7 in)	
<b>Inactive length diameter</b>	
43 mm (1.69 in)	
<b>Probe rope diameter</b>	
6 mm (0.24 in)	12 mm (0.47 in)
<b>Probe rope diameter with insulation</b>	
8 mm (0.31 in)	14 mm (0.55 in)
<b>Tensioning weight diameter<sup>4)</sup></b>	
30 mm (1.18 in)	40 mm (1.57 in)
<b>Length of tensioning weight (LW)</b>	
150 mm (5.91 in)	250 mm (9.84 in)
<b>Tensile loading capacity of the probe rope at 20 °C (68 °F)</b>	
300 Nm (221 lbf ft)	
<b>Maximum process temperature</b>	
180 °C (356 °F)	120 °C (248 °F)
<b>Probe can be used in mounting nozzles</b>	
✓	
<b>Probe can be used in the event of condensate on tank ceiling</b>	
✓	

- 1) Rope probe with inactive length and partially insulated rope
- 2) Rope probe with inactive length and fully insulated rope
- 3) The length of the partial insulation extends, at maximum, to the tensioning weight.
- 4) The tension weight is always uninsulated.

**Materials**

**Housing**

- Aluminum housing F17, F13, T13: GD-Al Si 10 Mg, DIN 1725, with plastic coating (blue and gray)
- Polyester housing F16: PBT-FR fiberglass reinforced polyester (blue and gray)
- Stainless steel housing F15: corrosion-resistant steel 316L (1.4404 or 1.4405), uninsulated

**Housing cover and seals**

- Aluminum housing F17, F13, T13: EN-AC-ALSi10Mg, plastic-coated, cover seal: EPDM
- Polyester housing F16: cover made of PBT-FR or cover with sight glass made of PA12, cover seal: EPDM
- Stainless steel housing F15: AISI 316L, cover seal: silicone

**Probe material**

- Process connection, tensioning weight for rope probe: 1.4404, 316L or steel
- Inactive length: 1.4404 or 316L
- Probe rope partially insulated: PTFE, 1.4401 (AISI 316)
- Probe rope fully insulated: PA, galvanized steel

**Weight**

Housing with process connection:

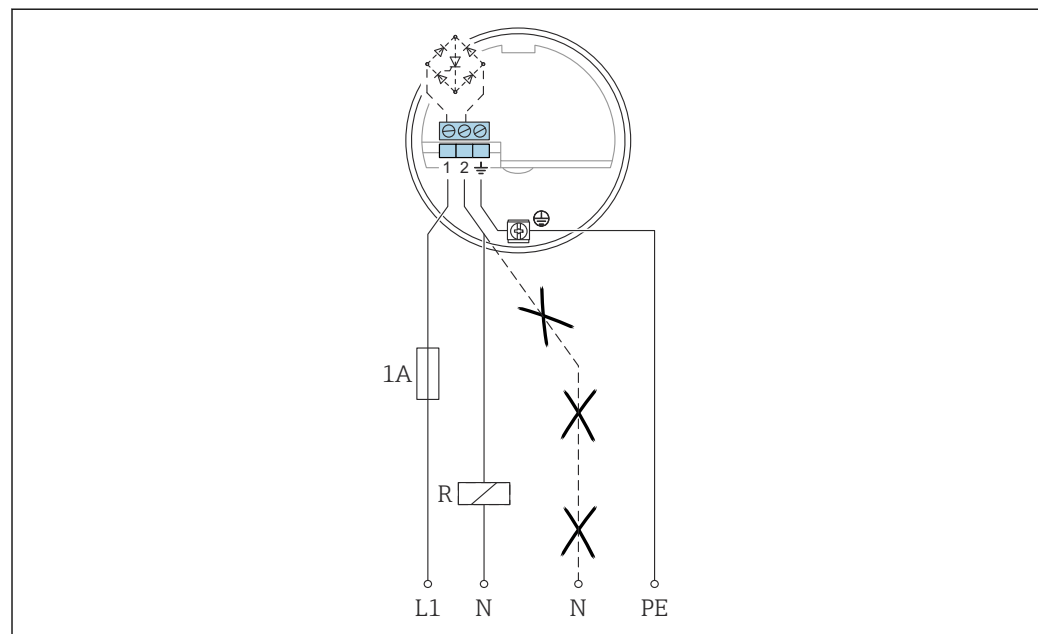
- F15, F16, F17, F13 approximately 4.00 kg (8.82 lb)
  - + flange weight or process connection
  - probe rope 0.180 kg/m (0.12 lb/ft) (for  $\varnothing 6$  mm (0.24 in) probe rope)
  - probe rope 0.550 kg/m (0.37 lb/ft) (for  $\varnothing 12$  mm (0.48 in) probe rope)
- T13 approximately 4.50 kg (9.92 lb)
  - + flange weight or process connection
  - probe rope 0.180 kg/m (0.12 lb/ft) (for  $\varnothing 6$  mm (0.24 in) probe rope)
  - probe rope 0.550 kg/m (0.37 lb/ft) (for  $\varnothing 12$  mm (0.48 in) probe rope)

**Operability****2-wire AC electronic insert  
FEI51****Power supply**

- Supply voltage: 19 to 253 V<sub>AC</sub>
- Power consumption: < 1.5 W
- Residual current consumption: < 3.8 mA
- Short-circuit protection
- Overvoltage category: II

**Electrical connection**

 Connect the electronic insert in series with an external load.



A0042387

L1 L1 phase cable  
 N Neutral cable  
 PE Grounding cable  
 R External load

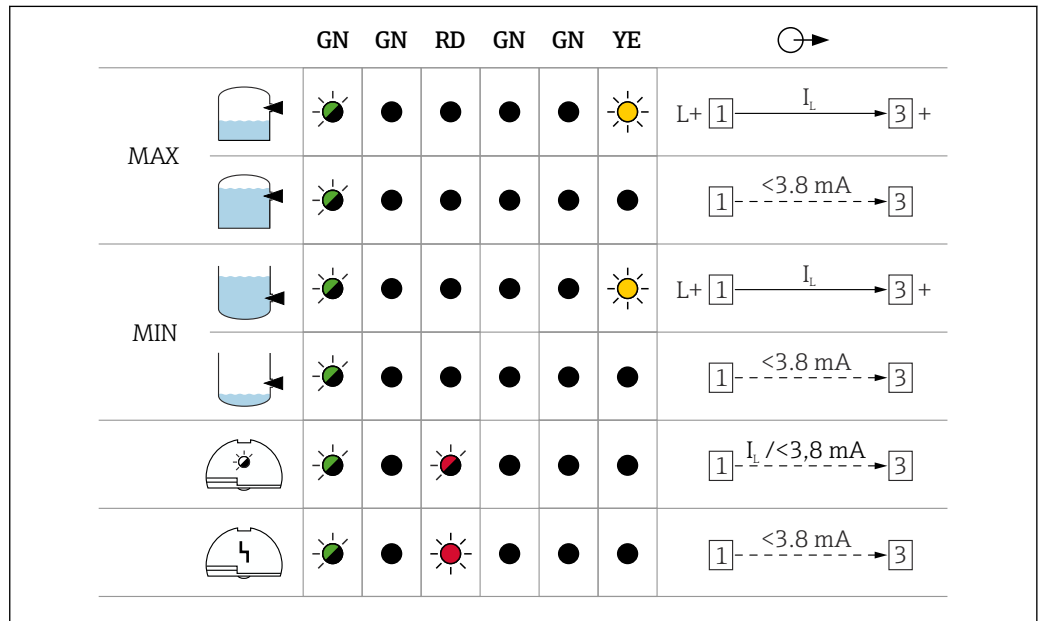


Make sure that:

- the residual current consumption is in blocked state.
- for low voltage:
  - voltage drop across the load is such that the minimum terminal voltage at the electronic insert 19 V when blocked is not undershot
  - voltage drop across the electronics when switched through is observed (up to 12 V)
- a relay cannot de-energize with holding power below 1 mA<sup>8)</sup>

When selecting the relay, pay attention to the holding power and rated power.

**Signal on alarm**



A0042586

**Output signal**

Output signal on power failure or in the event of damage to the sensor: < 3.8 mA

**Connectable load**

- For relays with a minimum holding power or rated power:
  - > 2.5 VA at 253 V<sub>AC</sub> (10 mA)
  - > 0.5 VA at 24 V<sub>AC</sub> (20 mA)
- Relays with a lower holding power or rated power can be operated by means of an RC module connected in parallel.
- For relays with a maximum holding power or rated power:
  - < 89 VA at 253 V<sub>AC</sub>
  - < 8.4 VA at 24 V<sub>AC</sub>
- Voltage drop across FEI51: maximum 12 V
- Residual current with blocked thyristor: 3.8 mA
- Load switched directly into the power supply circuit via the thyristor.

**DC PNP electronic insert FEI52**

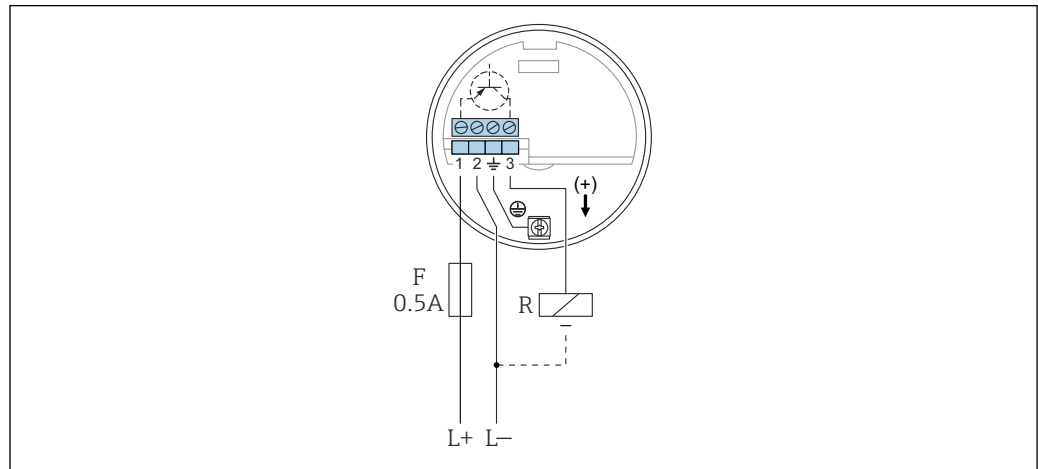
**Power supply**

- Supply voltage: 10 to 55 V<sub>DC</sub>
- Ripple:
  - maximum 1.7 V
  - 0 to 400 Hz
- Current consumption: < 20 mA
- Power consumption without load: maximum 0.9 W
- Power consumption with full load (350 mA): 1.6 W

8) If not: A resistor should be connected parallel to the relay (RC module available on request).

- Reverse polarity protection: yes
- Separation voltage: 3.7 kV
- Overvoltage category: II

**Electrical connection**



A0042388

- L+ Power input +
- L- Power input -
- F Fuse 0.5 A
- R External load:  $I_{max} = 350 \text{ mA}$   $U_{max} = 55 \text{ V}_{DC}$

Preferably in conjunction with programmable logic controllers (PLC), DI modules in accordance with EN 61131-2.

Positive signal present at the switch output of the electronic system (PNP).

**Output signal**

		GN	GN	RD	GN	GN	YE	
MAX								$L+ \text{ [1] } \xrightarrow{I_L} \text{ [3] } +$
								$\text{ [1] } \text{---} \xrightarrow{I_R} \text{ [3] }$
MIN								$L+ \text{ [1] } \xrightarrow{I_L} \text{ [3] } +$
								$\text{ [1] } \text{---} \xrightarrow{I_R} \text{ [3] }$
								$\text{ [1] } \text{---} \xrightarrow{I_L / I_R} \text{ [3] }$
								$\text{ [1] } \text{---} \xrightarrow{I_R} \text{ [3] }$

A0042587

**Signal on alarm**

Output signal on power failure or in the event of device failure:  
 $I_R < 100 \mu\text{A}$

**Connectable load**

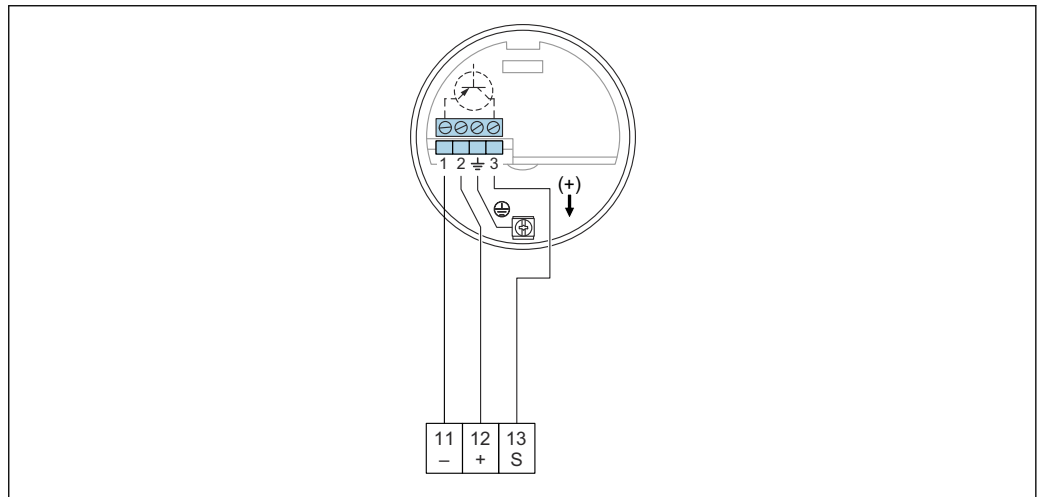
- Load switched via transistor and separate PNP connection: maximum 55 V
- Load current: maximum 350 mA cyclical overload and short-circuit protection
- Residual current: < 100 µA with transistor blocked
- Capacitance load:
  - maximum 0.5 µF at 55 V
  - maximum 1 µF at 24 V
- Residual voltage: < 3 V for transistor switched through

**3-wire electronic insert  
FEI53**

**Power supply**

- Supply voltage: 14.5 V<sub>DC</sub>
- Current consumption: < 15 mA
- Power consumption: maximum 230 mW
- Reverse polarity protection: yes
- Separation voltage: 0.5 kV

**Electrical connection**



A0042389

- 11 The negative terminal in Nivotester FTC325
- 12 The positive terminal in Nivotester FTC325
- S Signal terminal in Nivotester FTC325

3 to 12 V signal.

For connecting to the switching unit, Nivotester FTC325 3-WIRE from Endress+Hauser.

Switching between minimum and maximum Safety in the Nivotester FTC325 3-WIRE.

Point level adjustment directly at the Nivotester.

**Output signal**

	GN	RD	⊕ →
			3 3 ... 12 V
			3 3 ... 12 V
			3 <2.7 V

A0042588

**Signal on alarm**

Voltage at terminal 3 opposite terminal 1: < 2.7 V


**Connectable load**

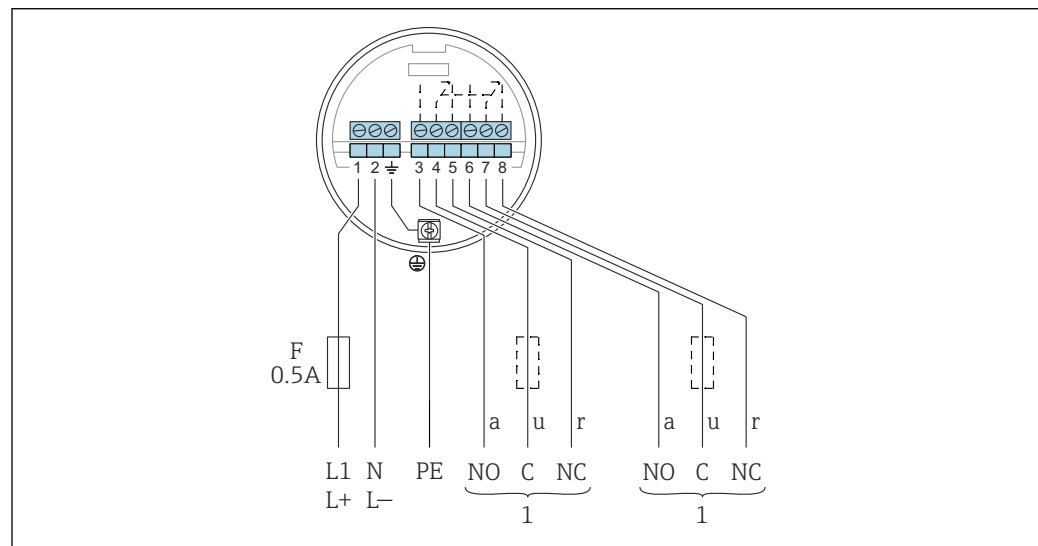
- Floating relay contacts in the connected switching unit Nivotester FTC325 3-WIRE
- For the contact load capacity, refer to the technical data of the switching device

**AC and DC with relay output electronic insert FEI54****Power supply**

- Supply voltage:
  - 19 to 253 V<sub>AC</sub> 50 to 60 Hz
  - 19 to 55 V<sub>DC</sub>
- Power consumption: 1.6 W
- Reverse polarity protection: yes
- Separation voltage: 3.7 kV
- Overvoltage category: II

**Electrical connection**

 Please note the different voltage ranges for AC and DC.









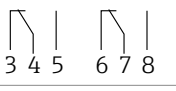







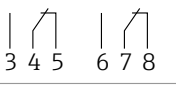







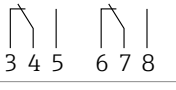







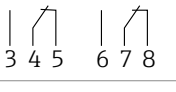














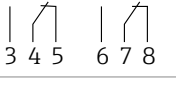


A0042390

- F* Fuse 0.5 A  
*L1* Phase (AC) terminal  
*L+* The positive (DC) terminal  
*N* Neutral (AC) terminal  
*L-* The negative (DC) terminal  
*PE* Grounding cable  
*1* Refer also to connectable load

When connecting an instrument with high inductance, provide a spark arrester to protect the relay contact. A fine-wire fuse (depending on the load connected) protects the relay contact on short-circuiting. Both relay contacts switch simultaneously.

**Output signal**

		GN	GN	RD	GN	GN	YE	
MAX								
								
MIN								
								
								
								

A0042528

**Signal on alarm**

Output signal on power failure or in the event of device failure: relay de-energized

**Connectable load**

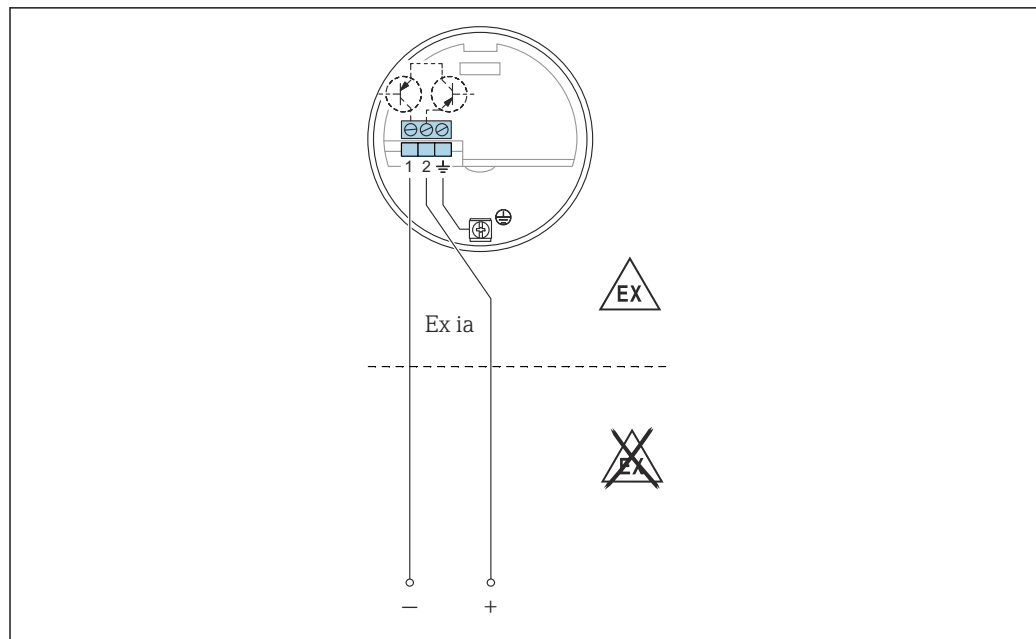
- Loads switched via 2 floating changeover contacts (DPDT)
- maximum values (AC):
  - $I_{max} = 6 \text{ A}$
  - $U_{max} = 253 \text{ V}_{AC}$
  - $P_{max} = 1500 \text{ VA}$  at  $\cos\varphi = 1$
  - $P_{max} = 750 \text{ VA}$  at  $\cos\varphi > 0.7$
- maximum values (DC):
  - $I_{max} = 6 \text{ A}$  at  $30 \text{ V}_{DC}$
  - $I_{max} = 0.2 \text{ A}$  at  $125 \text{ V}_{DC}$
- The following applies when connecting a functional low-voltage circuit with double isolation as per IEC 1010:
  - sum of voltages of relay output and power supply maximum 300 V

**SIL2 / SIL3 electronic insert  
FEI55**

**Power supply**

- Supply voltage: 11 to 36  $V_{DC}$
- Power consumption: < 600 mW
- Reverse polarity protection: yes
- Separation voltage: 0.5 kV

### Electrical connection



A0042391

Connect the insert to programmable logic controllers (PLC), AI modules 4 to 20 mA in accordance with EN 61131-2.

The point level signal is sent via an output signal jump from 8 to 16 mA.

### Output signal

		GN	GN	RD	GN	GN	YE	
MAX								+ 2 → ~16 mA → 1
								+ 2 → ~8 mA → 1
MIN								+ 2 → ~16 mA → 1
								+ 2 → ~8 mA → 1
								+ 2 → ~8/16 mA → 1
								+ 2 → < 3.6 mA → 1

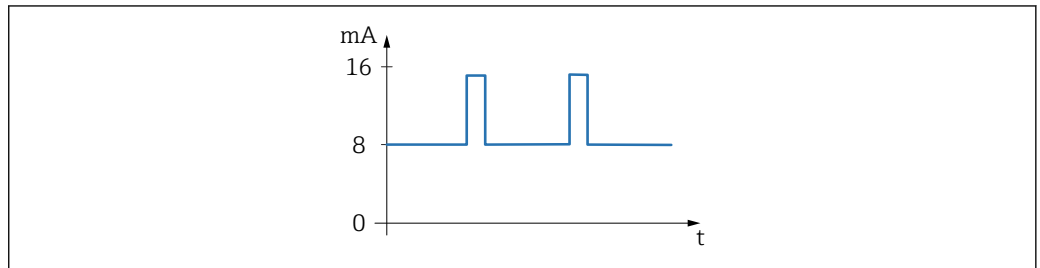
A0042529

### Signal on alarm

Output signal on power failure or in the event of device failure: < 3.6 mA

### Connectable load

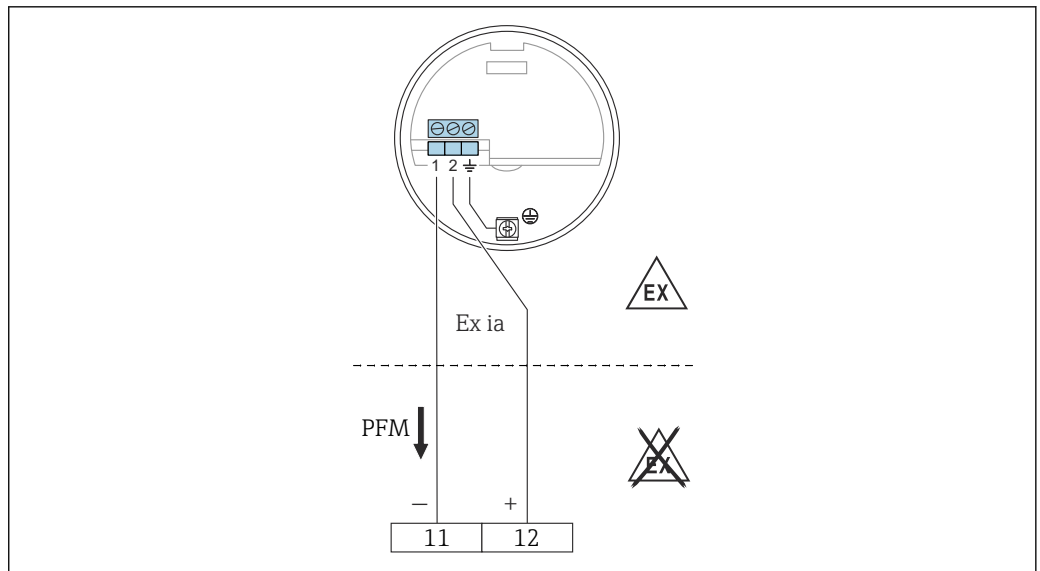
- U:
  - 11 to 36 V<sub>DC</sub> for non-hazardous area and Ex ia
  - 14.4 to 30 V<sub>DC</sub> for Ex d
- I<sub>max</sub> = 16 mA

**PFM electronic insert FEI57S Power supply**


A0051934

23 PFM signal with frequency 17 to 185 Hz

- Supply voltage: 9.5 to 12.5 V<sub>DC</sub>
- Power consumption: < 150 mW
- Reverse polarity protection: yes
- Separation voltage: 0.5 kV

**Electrical connection**


A0050141

11 The negative terminal in Nivotester FTC325

12 The positive terminal in Nivotester FTC325

For connecting to switching unit Nivotester FTC325 from Endress+Hauser.

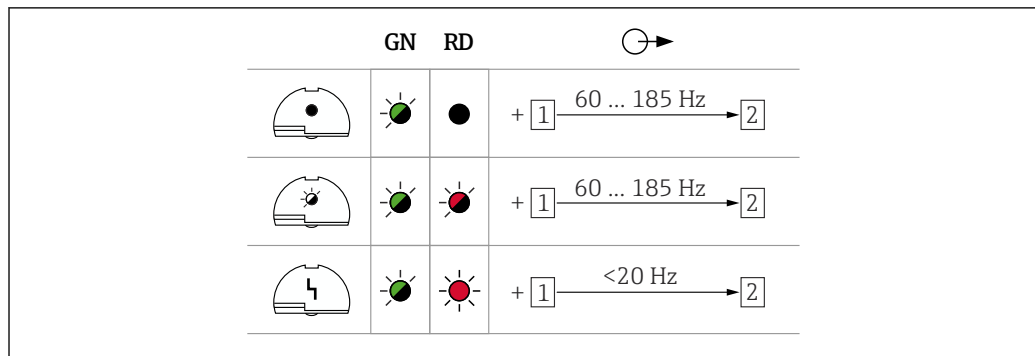
PFM signal 17 to 185 Hz.

Switching between minimum and maximum safety in the Nivotester.

**Output signal**

PFM 60 to 185 Hz.

## Signal on alarm



A0042589

## Connectable load

- Floating relay contacts in the connected switching unit Nivotester: FTC325 PFM
- For the contact load capacity, refer to the technical data of the switching device.

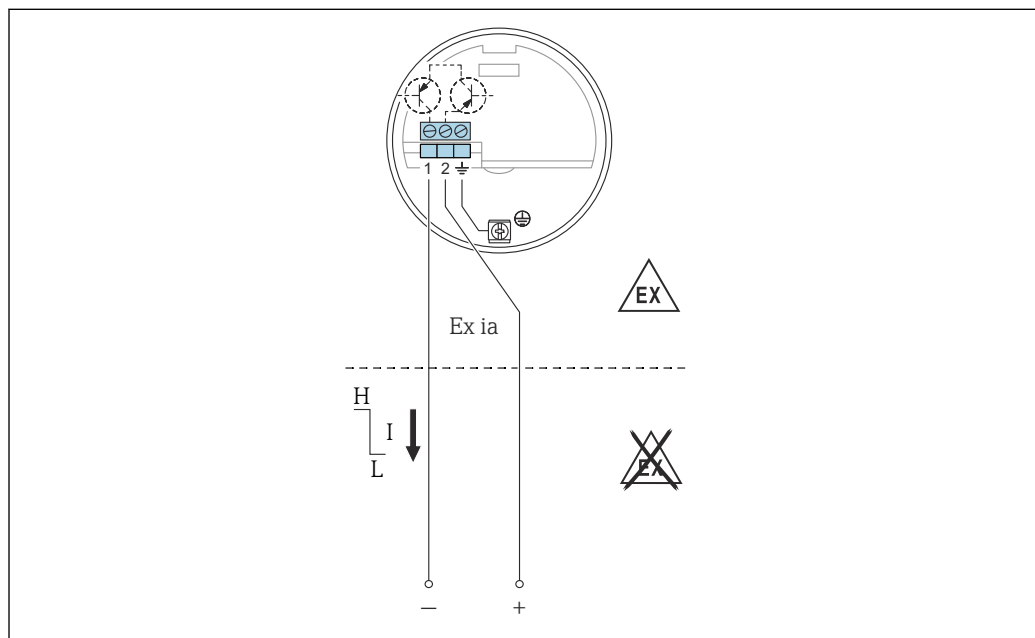
NAMUR electronic insert  
FEI58

## Power supply

- Power consumption:
  - < 6 mW at  $I < 1 \text{ mA}$
  - < 38 mW at  $I = 2.2 \text{ to } 4 \text{ mA}$
- Interface connection data: IEC 60947-5-6

## Electrical connection

- In the case of Ex-d operation, the additional function can only be used if the housing is not exposed to an explosive atmosphere.



A0042393

24 Terminals must be connected to isolating amplifier (NAMUR) IEC 60947-5-6



For connecting to isolating amplifiers as per NAMUR (IEC 60947-5-6), e.g. Nivotester FTL325N from Endress+Hauser. Change in output signal from high to low current in event of point level detection.

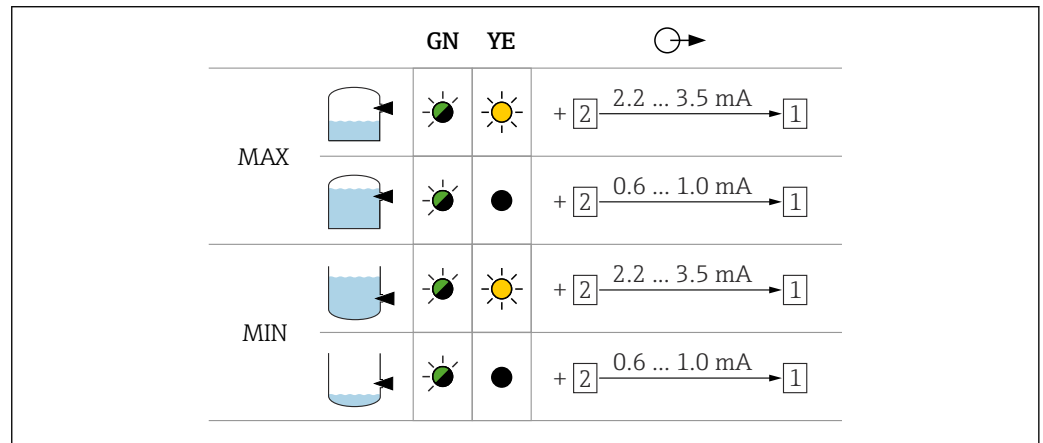
Additional function:

Test key on the electronic insert. Pressing the key interrupts the connection to the isolating amplifier.

Connection to Multiplexer:

Set 3 s as the cycle time at least.

### Output signal



### Signal on alarm

Output signal in the event of damage to the sensor: < 1.0 mA

### Connectable load

- The technical data of the connected isolating amplifier as per IEC 60947-5-6 (NAMUR).
- Connection also to isolating amplifiers which have special safety circuits I > 3.0 mA.

## Certificates and approvals

Current certificates and approvals for the product are available at [www.endress.com](http://www.endress.com) on the relevant product page:

1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Downloads**.

Other certificates and approvals for the product are available under <https://www.endress.com>-> Downloads.

## Ordering information

Detailed ordering information is available from your nearest sales organization [www.addresses.endress.com](http://www.addresses.endress.com) or in the Product Configurator at [www.endress.com](http://www.endress.com):



1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Configuration**.




### **Product Configurator - the tool for individual product configuration**

- Up-to-the-minute configuration data
- Depending on the device: direct input of information specific to the measuring point, such as the measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop


## Accessories

Protective cover	<b>Protective cover for F13, F17 and F27 housing (without display)</b> order number: 71040497
	<b>Protective cover for F16 housing</b> order number: 71127760
Seal set for stainless steel housing	Seal set for stainless steel housing F15 with 5 sealing rings Part number: 52028179
Surge arresters	<b>HAW562</b>  <ul style="list-style-type: none"> <li>▪ For supply lines: BA00302K.</li> <li>▪ For signal lines: BA00303K.</li> </ul>
	<b>HAW569</b>  <ul style="list-style-type: none"> <li>▪ For signal lines in field housing: BA00304K.</li> <li>▪ For signal or supply lines in field housing: BA00305K.</li> </ul>
Technical information	<b>Nivotester FTC325</b> TI00380F

## Documentation

-  For an overview of the scope of the associated Technical Documentation, refer to the following:
- *Device Viewer* ([www.endress.com/deviceviewer](http://www.endress.com/deviceviewer)): Enter the serial number from the nameplate
  - *Endress+Hauser Operations app*: Enter serial number from nameplate or scan matrix code on nameplate.

**Document function** The following documentation may be available depending on the version ordered:

Document type	Purpose and content of the document
Technical Information (TI)	<b>Planning aid for your device</b> 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.
Brief Operating Instructions (KA)	<b>Guide that takes you quickly to the 1st measured value</b> The Brief Operating Instructions contain all the essential information from incoming acceptance to initial commissioning.
Operating Instructions (BA)	<b>Your reference document</b> The 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.
Description of Device Parameters (GP)	<b>Reference for your parameters</b> The document provides a detailed explanation of each individual parameter. The description is aimed at those who work with the device over the entire life cycle and perform specific configurations.
Safety Instructions (XA)	Depending on the approval, safety instructions for electrical equipment in hazardous areas are also supplied with the device. The Safety Instructions are an integral part of the Operating Instructions.  Information on the Safety Instructions (XA) relevant to the device is provided on the nameplate.
Supplementary device-dependent documentation (SD/FY)	Always comply strictly with the instructions in the relevant supplementary documentation. The supplementary documentation is an integral part of the device documentation.



[www.addresses.endress.com](http://www.addresses.endress.com)

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