

# Technical Information

## Nivotester FTC325

### Capacitance

Point level switch with intrinsically safe signal circuit for connection to capacitance sensors



#### Application

- Point level detection in liquid tanks and bulk solids silos, also in hazardous areas
- For sensors in Zone 0 or Zone 20
- Liquid detection in pipes for dry-running protection of pumps
- Overfill prevention in tanks with flammable or non-flammable water-polluting liquids
- Two-point control ( $\Delta s$  with 3-WIRE) and point level detection with a switching unit
- International explosion protection certificates, overfill prevention, WHG

#### Your benefits

- Intrinsically safe signal circuit [Ex ia] for use of sensors in hazardous areas
- Compact housing for simple side-by-side installation on standard DIN rails in cabinet
- Calibration at the touch of a button
- High degree of functional safety thanks to fail-safe PFM or 3-WIRE technology of the verifiable relay function
- Easy wiring thanks to plug-in terminal blocks
- Limit value and fault-signaling relay



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## About this document

### Document conventions

### Symbols for certain types of information

Symbol	Meaning
	<b>Tip</b> Indicates additional information.
	<b>Reference to page</b> Refers to the corresponding page number.

### Symbols for graphics

Symbol	Meaning
1, 2, 3 ...	Item numbers
A, B, C, ...	Views

## Function and system design

### Function

The probe and vessel (or ground tube/counterpotential) form a capacitor whose capacitance is influenced by the level.

#### PFM (pulse-frequency modulation)

The FEI57 electronic insert converts the change in capacitance to a change in frequency, which switches the output relay in the Nivotester FTC325 PFM.

#### 3-WIRE

The FEI53 electronic insert converts the change in capacitance to a voltage signal, which switches the output relay in the Nivotester FTC325 3-WIRE.

### Signal transmission

The signal input of the Nivotester is galvanically isolated from the mains and the output.

#### PFM

The Nivotester supplies intrinsically safe direct current to the capacitance sensor via a two-wire cable. From the sensor, it receives a frequency which signals whether or not the point level has been reached. The sensor superimposes current pulses (PFM signals) with a pulse width of approx. 200 µs and a current strength of approx. 10 mA on the supply current. The measuring capacitance is in the range from 5 to 500 pF or 5 to 1 600 pF. This corresponds to a transmission frequency of 185 to 60 Hz.

#### 3-WIRE

The Nivotester supplies direct current to the capacitance sensor via a two-wire cable. Via a third wire, the Nivotester receives a voltage signal, which signals whether or not the point level has been reached. The measuring capacitance is in the range from 10 to 350 pF. This corresponds to a voltage of 3 to 12 V.

### Signal evaluation

The Nivotester evaluates the frequency or the voltage signal, and switches the output relay for the level alarm. The switching state of the relay (energized or de-energized) is indicated by two yellow light emitting diodes on the front panel of the Nivotester.

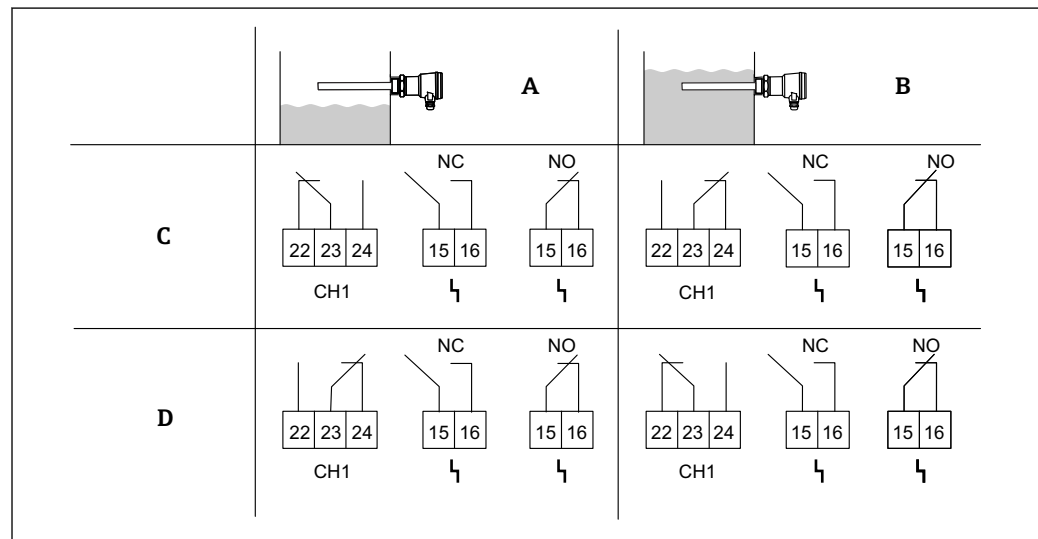
### Fail-safe mode

The choice of fail-safe mode ensures that the relay always works with quiescent current safety.

- **MAX** = maximum safety: the relay de-energizes when the level exceeds the switch point (probe is covered), a fault occurs or the power supply fails. Used for overfill prevention, for instance.
- **MIN** = minimum safety: the relay de-energizes when the level falls below the switch point (probe is free), a fault occurs or the power supply fails. Used for dry running protection or pump protection, for instance.

### PFM

Point level detection depending on the level and fail-safe mode

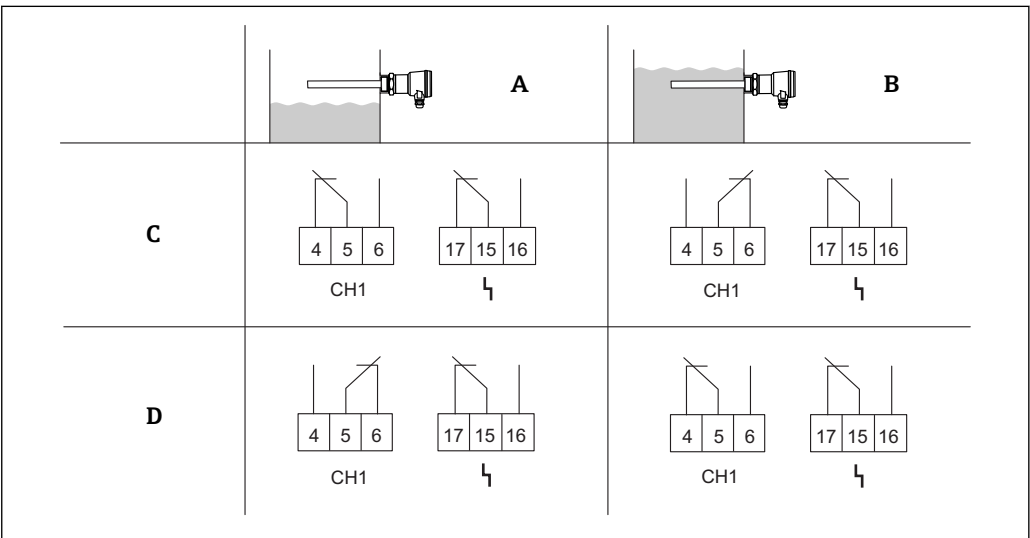


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- A** Level indication: probe is free  
**B** Level indication: probe is covered  
**C** MAX fail-safe mode  
**D** MIN fail-safe mode

3-WIRE

Point level detection depending on the level and fail-safe mode



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- A Level indication: probe is free  
B Level indication: probe is covered  
C MAX fail-safe mode  
D MIN fail-safe mode

Function monitoring

To increase operational safety, the Nivotester is equipped with a function monitoring system. A fault causes the relay for the level alarm and the alarm relay to de-energize and is indicated by the red light emitting diode (LED).

A fault is reported if the Nivotester no longer receives a measuring signal. This can occur, for example, if:

- A short circuit occurs
- The signal line to the sensor is interrupted
- The sensor electronics are defective
- The input circuit of the Nivotester is defective

After calibration, every additional change to the device configuration causes the relay to de-energize. A fault message is indicated by the red LED.

Calibration button (red)

Calibration is carried out automatically by pressing the calibration button. Settings do not need to be made via the rotary switch.

Test button/correction button (green) only for FTC325 PFM

- Function checking of the output relay and fault-signaling relay
- Confirms a change in the operating mode, e.g. if the switching delay changes after initial calibration. This corrects the operating mode without the need to perform a recalibration. The modified settings are saved by pressing the button.

Additional switch functions

- Adjustable switching delay 0 to 45 s: allows the delayed switching of the relay when the probe is covered or uncovered. In the opposite direction, each switching delay is 0.2 s.
- Two-point control ( $\Delta s$ , 3-WIRE)) → 6
- Potentiometer (rotary switch) for shifting the switch point: enables the safe operation of the system, even with media that are prone to form buildup.

**Measuring system**

A simple measuring system consists of a capacitance sensor, a Nivotester FTC325 and a control or signal unit. The following electronic inserts (FEIx) can be used in conjunction with the sensors listed:

FEI57S with FTC325 PFM	FEI53 with FTC325 3-WIRE
Liquicap M FTI51, FTI52	
Solicap M FTI55, FTI56	
Solicap S FTI77	

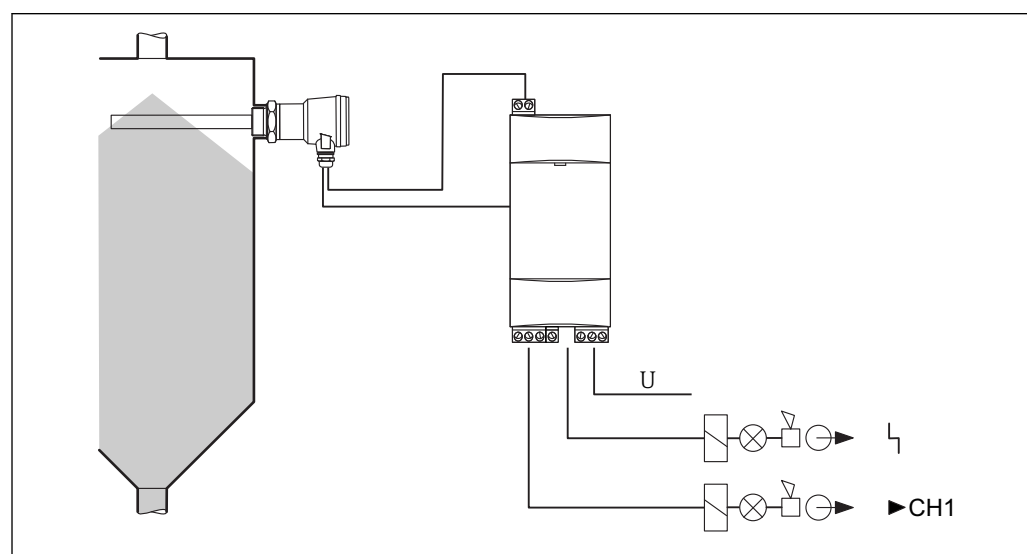
**Probe design**

Examples of media	$\epsilon_r$	Conductivity	Build-up	Probe design			
				Full insulation	Partial insulation	With ground tube	Without ground tube
Solvents fuels	< 3	low	low	✓	✓	✓	—
Dry bulk solids	< 3	low	low	—	✓	—	✓
Moist bulk solids	> 3	average	average	✓	✓	—	✓
Aqueous liquids and alcohols	> 3	high	low	✓	✓	—	✓
			strong	—	✓	—	✓
Sludge	> 3	high	very strong	—	✓	—	✓

**Nivotester FTC325 PFM**

The measuring system consists of the following components:

- Sensor
  - Capacitance probe
  - Electronic insert FEI57S
- Nivotester FTC325 PFM
- Control or signal units

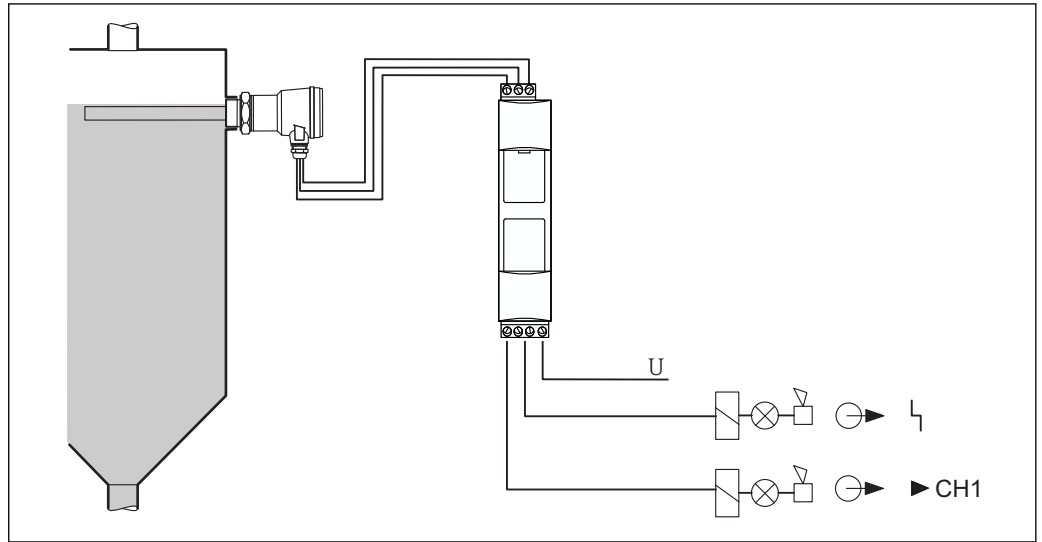


1 Partially or fully insulated probe

**Nivotester FTC325 3-WIRE**

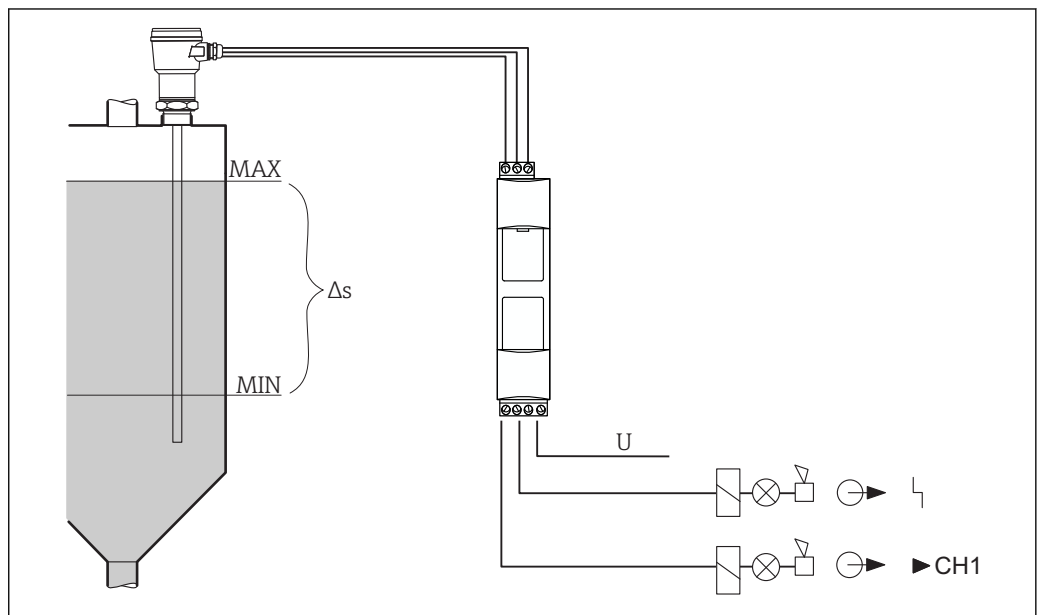
The measuring systems consist of the following components:

- Sensor
  - 1 to 2 capacitance probes
  - Electronic insert FEI53
- Nivotester FTC325 3-WIRE
- Control or signal units



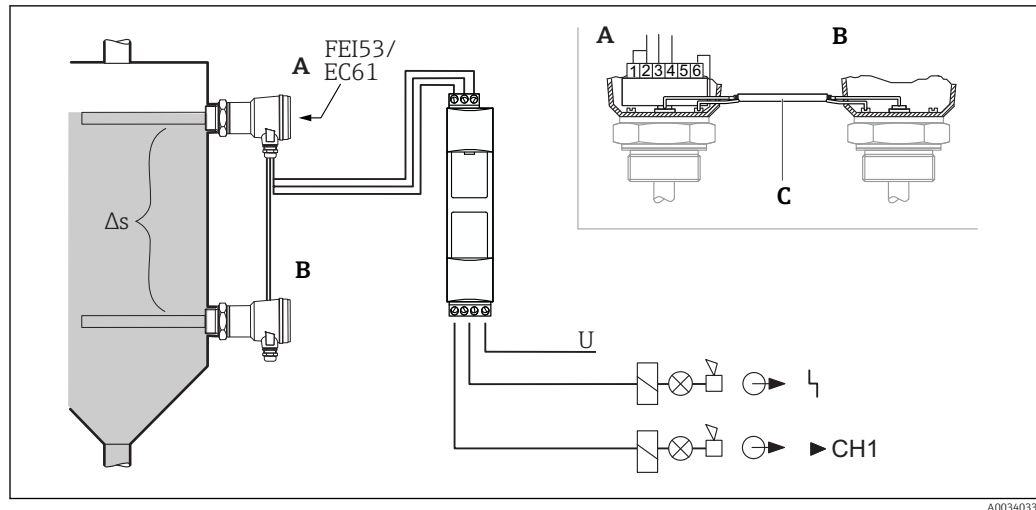
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2 Partially or fully insulated probe



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3 Two-point control with fully insulated probe



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4 Two-point control with two fully insulated or partially insulated probes (A, B) and an electronic insert FEI53. The probes are connected by a coaxial cable (C).

## Input


Measured variable	The point level signal is triggered at MIN level or MAX level, depending on the setting.
Measuring range	The measuring range depends on the installation location of the sensors.
Input signal	<p><b>FTC325 PFM</b></p> <ul style="list-style-type: none"> <li>Galvanically isolated from power supply and output</li> <li>Type of protection: intrinsic safety [Ex ia] IIC</li> <li>Connectable sensors and electronic insert FEI57S: <ul style="list-style-type: none"> <li>Liquicap M FTI51, FTI52</li> <li>Solicap M FTI55, FTI56</li> <li>Solicap S FTI77</li> </ul> </li> <li>Sensors powered by Nivotester FTC325 PFM</li> <li>Connection cable: two-wire Shielding not required, except in the event of strong electromagnetic interference (see also "Electromagnetic compatibility" → 12)</li> <li>Cable length/cable resistance: 1000 m (3 281 ft)/max. 25 <math>\Omega</math> per wire</li> <li>Signal transmission: pulse-frequency modulation (PFM)</li> </ul> <p><b>FTC325 3-WIRE</b></p> <ul style="list-style-type: none"> <li>Galvanically isolated from power supply and output</li> <li>Type of protection: version for non-hazardous area</li> <li>Connectable sensors and electronic insert FEI53: <ul style="list-style-type: none"> <li>Liquicap M FTI51, FTI52</li> <li>Solicap M FTI55, FTI56</li> <li>Solicap S FTI77</li> </ul> </li> <li>Sensors powered by Nivotester FTC325 3-WIRE</li> <li>Connection cable: three-wire Shielding not required, except in the event of strong electromagnetic interference (see also "Electromagnetic compatibility" → 12)</li> <li>Cable length/cable resistance: 1000 m (3 281 ft)/max. 25 <math>\Omega</math> per wire</li> <li>Signal transmission: voltage change is transmitted via a separate wire</li> </ul> <p><b>i</b> Please refer to the relevant certificates for additional information on the use of the sensors in the hazardous area → 16.</p>



## Output

<b>Output signal</b>	<ul style="list-style-type: none"> <li>Relay output: a potential-free changeover contact for the level alarm</li> <li>Quiescent current fail-safe mode: MIN/MAX safety can be selected with DIL switch</li> <li>Fault-signaling relay: potential-free changeover contact for fault signaling; only two contacts are available with the PFM version (specify NC (normally closed contact) or NO (normally open contact) when ordering a PFM device)</li> <li>Switching delay: approx. 0 to 45 s Depending on the setting, the relay switches when the probe is covered or uncovered</li> <li>Relay contact switching capacity: <ul style="list-style-type: none"> <li><b>Alternating voltage (AC)</b> <ul style="list-style-type: none"> <li>U ~ maximum 250 V</li> <li>I ~ maximum 2 A</li> <li>P ~ maximum 500 VA at <math>\cos \varphi \geq 0.7</math></li> </ul> </li> <li><b>Direct current (DC)</b> <ul style="list-style-type: none"> <li>U = maximum 40 V</li> <li>I = maximum 2 A</li> <li>P = maximum 80 W</li> </ul> </li> </ul> </li> <li>Operating life: at least <math>10^5</math> switching operations with maximum contact load</li> <li>Function indicators: LEDs for operation, level alarm and fault Is lit as long as the probe is covered.</li> </ul>
<b>Overvoltage category according to EN 61010</b>	II
<b>Protection class</b>	II (double or reinforced insulation)
<b>Signal on alarm</b>	Level relay per channel dropped out; fault signaled by red LEDs, fault-signaling relay dropped out
<b>Galvanic isolation</b>	All input and output channels and relay contacts are galvanically isolated from each other. If the power supply circuit or the fault-signaling relay contacts is/are simultaneously connected to functional extra-low voltage, safe galvanic isolation is guaranteed up to a voltage of 150 V <sub>AC</sub> .

## Power supply

<b>Electrical connection</b>	<p><b>Sensor operation in the hazardous area</b></p> <p>Observe all national explosion protection regulations concerning the type and installation of intrinsically safe signal cabling.</p> <p>Please refer to the Safety Instructions for the maximum permissible values for capacitance and inductance →  16.</p> <p><b>Connecting the sensors</b></p> <p>The removable terminal blocks are color-coded into intrinsically safe and non-intrinsically safe terminals. This difference helps to ensure safe wiring.</p> <p><i>Blue terminal blocks at top for hazardous area</i></p> <p>Two-wire connection cable between the Nivotester and sensor, e.g. commercially available instrument cable or cores in a multi-core cable for measurement purposes.</p> <p>Use a shielded cable in the event of strong electromagnetic interference, e.g. from machines or radio equipment. Only connect the shield to the grounding terminal in the sensor. Do not connect it to the Nivotester.</p>
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### Connecting the signal and control units

*Gray terminal blocks at bottom for the non-hazardous area*

The relay function depends on the level and fail-safe mode. If a device with high inductance is connected (e.g. contactor or solenoid valve), a spark arrester must be provided to protect the relay contact.

### Connecting the supply voltage

*Green terminal block at bottom*

A fuse is integrated into the power supply circuit. An additional fine-wire fuse is not necessary. The Nivotester is equipped with reverse polarity protection.

#### Supply voltage

##### Alternating current version

Voltage range: 85 to 253 V<sub>AC</sub>, 50/60 Hz

##### Low voltage versions

- Voltage range: 20 to 30 V<sub>AC</sub>/ 20 to 60 V<sub>DC</sub>
- D/C power supply: maximum 100 mA
- Permissible residual ripple within tolerance: U<sub>ss</sub> = maximum 2 V

#### Power consumption

##### AC

Maximum 6.0 VA

##### DC

Maximum 2.0 W (with U<sub>min</sub> 20 V)


## Performance characteristics

#### Switch-on behavior

Correct switch state after power-up: 10 to 40 s, depends on the connected sensor.

## Installation

#### Mounting location

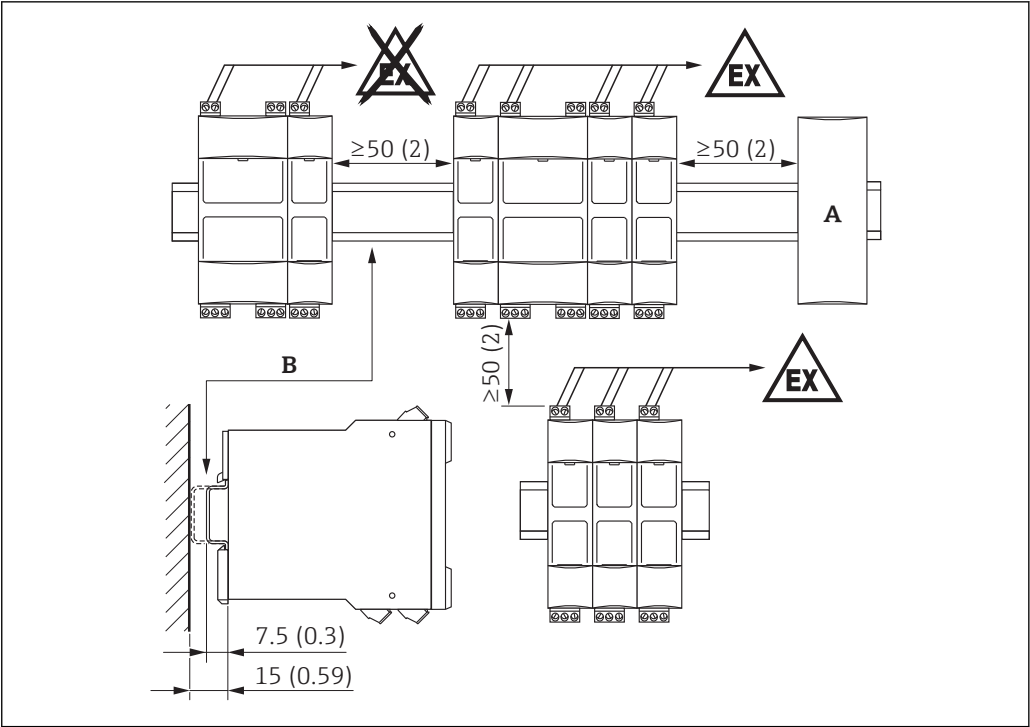
- The device must be housed in a cabinet or protective housing outside the hazardous area.
- Mount the devices so that they are protected against weather and impact. Avoid exposure to direct sunlight.
- A protective housing (IP66) for up to 4 Nivotester FTC325 3-WIRE or 2 FTC325 PFM devices is available for outdoor installation →  15.

#### Orientation

##### Horizontal orientation



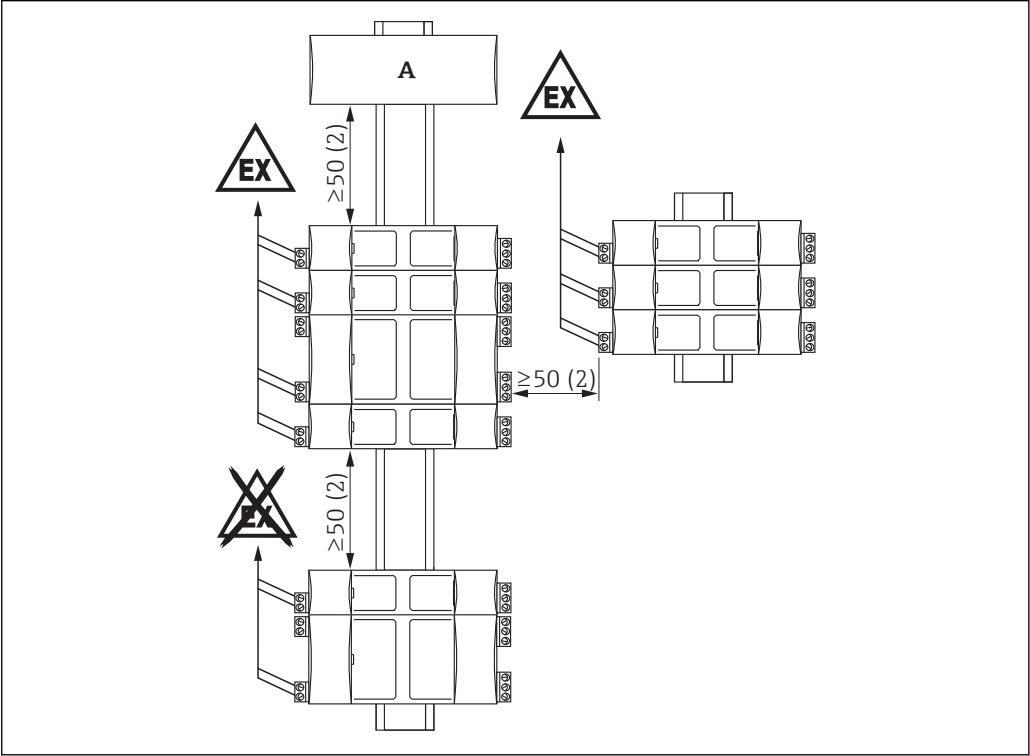
Horizontal installation ensures better dissipation of heat and is therefore the preferred orientation.



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- Dimensions mm (in)
- A Connection of another device type
- B DIN rail in accordance with EN 60715 TH35-7.5/15

Vertical orientation




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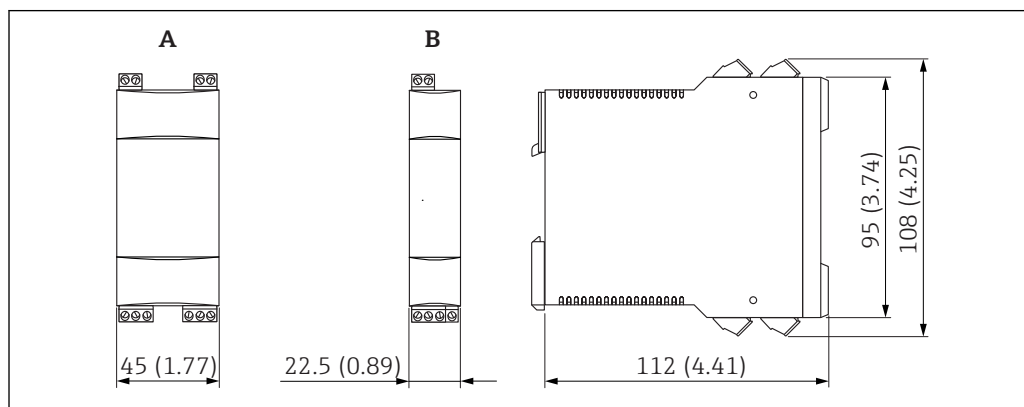
- Dimensions mm (in)
- A Connection of another device type

## Environment

<b>Ambient temperature range</b>	<ul style="list-style-type: none"> <li>■ For single installation: -20 to +60 °C (-4 to 140 °F)</li> <li>■ For side-by-side installation without lateral spacing: -20 to +50 °C (-4 to +122 °F)</li> <li>■ For installation in protective housing: -20 to +40 °C (-4 to +104 °F) A maximum of 4 FTC325 3-WIRE or 2 FTC325 PFM devices may be installed in a protective housing.</li> <li>■ Storage temperature: -25 to +85 °C (-13 to 185), preferably at 20 °C (68 °F)</li> </ul>
<b>Climate and mechanical application class</b>	3K3 and 3M2 in accordance with IEC/EN 60721-3-3
<b>Degree of protection</b>	<ul style="list-style-type: none"> <li>■ IP20 (as per IEC/EN 60529)</li> <li>■ IK06 (as per IEC/EN 62262)</li> </ul>
<b>Shock resistance</b>	DIN EN 60068-2-27:2008: a = 150 m/s <sup>2</sup> t = 11 ms, 3 axes x 2 directions x 3 shocks
<b>Vibration resistance</b>	DIN EN 60068-2-64:2009: a(RMS) = 28 m/s <sup>2</sup> , f = 5 to 2000 Hz, t = 3 axes x 2 h
<b>Electromagnetic compatibility (EMC)</b>	<ul style="list-style-type: none"> <li>■ Interference emission according to EN 61326, Class A equipment.</li> <li>■ Interference immunity according to EN 61326; Annex A (Industrial) and NAMUR Recommendation NE21 (EMC)</li> </ul>

## Mechanical construction

<b>Design, dimensions</b>	<p><b>Dimensions</b></p> <p> Exact dimensions are available in the Product Configurator on the Endress+Hauser website: <a href="http://www.endress.com">www.endress.com</a> → Product finder → On the product page, click the "Configure" button to the right of the product photo.</p>
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*Dimensions mm (in)*

A Nivotester FTC325 PFM

B Nivotester FTC325 3-WIRE

<b>Weight</b>	<ul style="list-style-type: none"> <li>■ PFM: approx. 250 g (8.81 oz)</li> <li>■ 3-WIRE: approx. 148 g (5.22 oz)</li> </ul>
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<b>Materials</b>	<ul style="list-style-type: none"> <li>■ Housing: polycarbonate PC</li> <li>■ Front cover: polypropylene PP</li> <li>■ Fixing slide to secure to DIN rail: polyamide PA6</li> </ul>
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## Terminals

### PFM

- 2 screw terminals: sensor power supply
- 3 screw terminals: level relay
- 2 screw terminals: fault-signaling relay
- 2 screw terminals: power supply

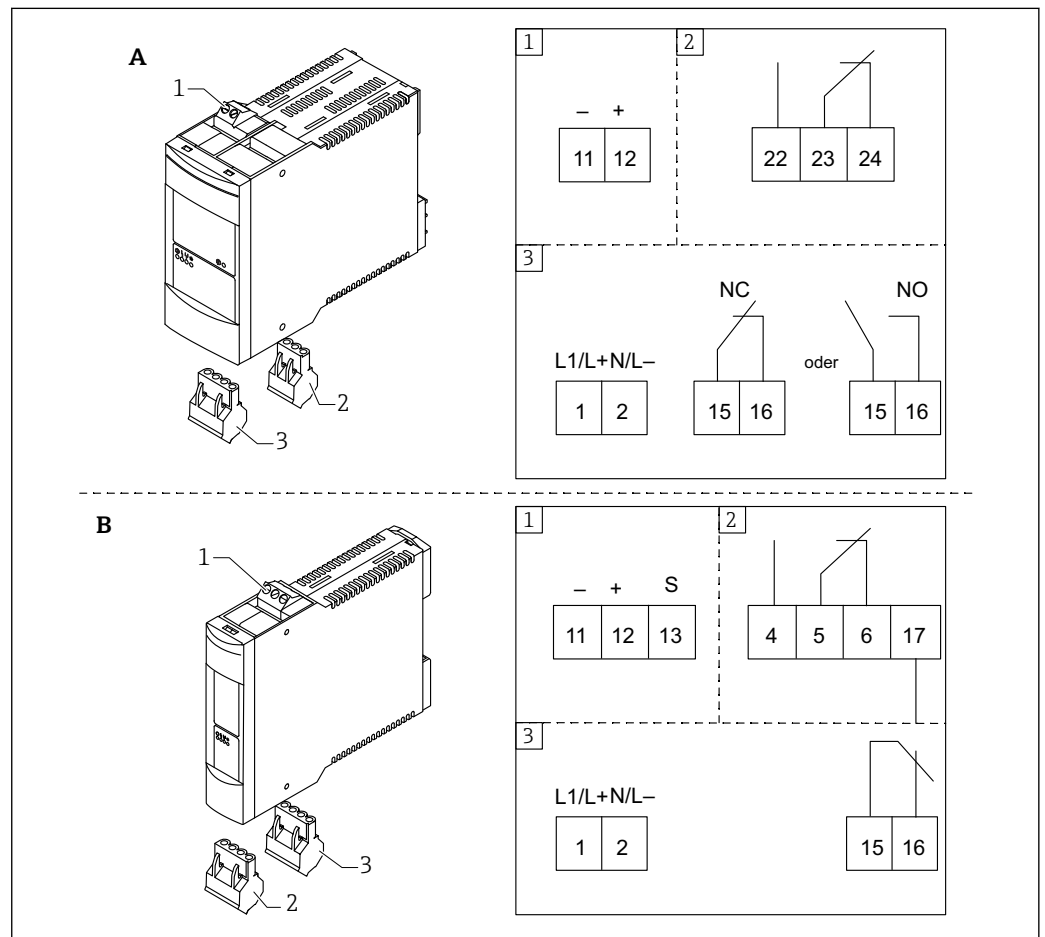
### 3-WIRE

- 3 screw terminals: sensor power supply + signal
- 4 screw terminals:
  - 3 limit relays
  - 1 for contact 3 of the fault-signaling relay
- 4 screw terminals:
  - 2 AC/DC power supply
  - 2 fault-signaling relays

### Connection cross-section

Maximum 1 x 2.5 mm<sup>2</sup> (14 AWG) or 2 x 1.5 mm<sup>2</sup> (16 AWG)

### Terminal assignment



A0034037

- A PFM  
 B 3-WIRE  
 1 Sensor power supply  
 2 Level relay  
 3 Power supply / fault-signaling relay

## Operability

### Operating concept

Onsite configuration with DIL switches behind fold-down front panel

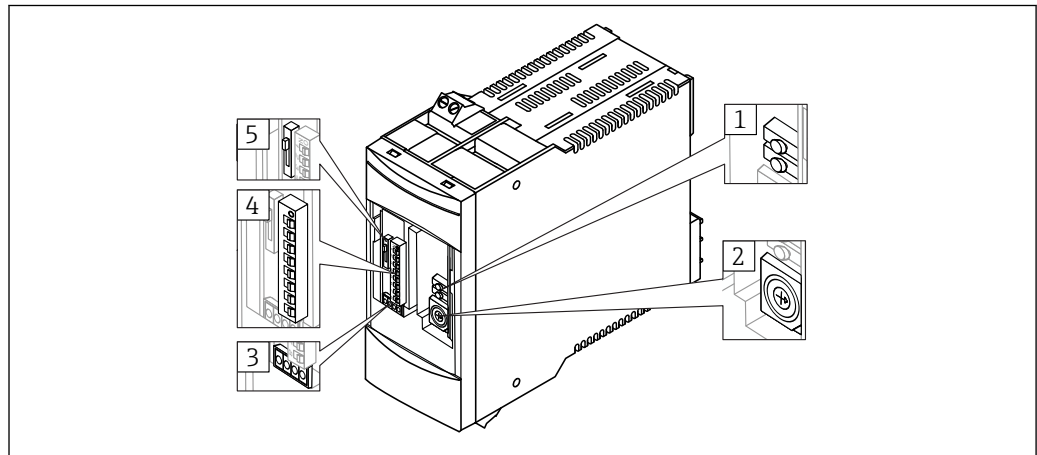
### Display elements

#### Light emitting diodes (LEDs)

- Green LED: ready for operation
  - Red LED: fault signalling
  - Yellow LED (left): level relay energized
  - Yellow LED (right): probe free or covered
- Level signalling independent of the selected fail-safe mode

### Operating elements

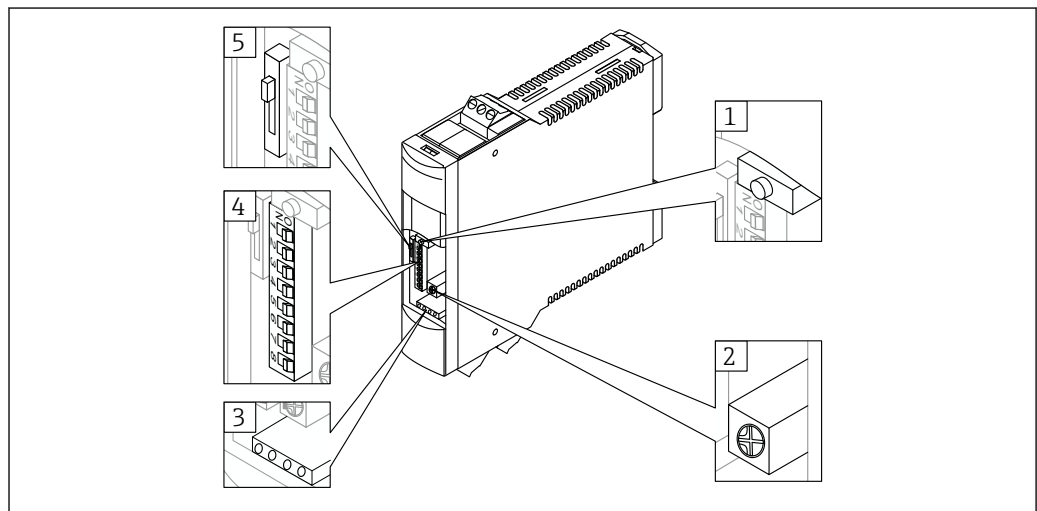
#### PFM



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- 1 Calibration button (red, top); correction button (green, bottom)
- 2 Switch point shift for buildup compensation (16-stage)
- 3 Light emitting diodes (LEDs)
- 4 DIL switches: switching delay (3 s, 6 s, 12 s, 24 s) = max. 45 s (1-4); delay when the probe is covered or uncovered (5); no function (6); min/max fail-safe mode (7); no function (8)
- 5 Calibration with probe covered or uncovered

#### 3-WIRE



A0036546

- 1 Calibration button (red)
- 2 Switch point shift for buildup compensation (continuously)
- 3 Light emitting diodes (LEDs)
- 4 DIL switches: switching delay (3 s, 6 s, 12 s, 24 s) = max. 45 s (1-4); delay when the probe is covered or uncovered (5); min/max fail-safe mode (6); two-point controller operation (ON/OFF) (7); calibration switch points (upper/lower) for operation as two-point controller (8)
- 5 Calibration with probe covered or uncovered

## Ordering information

Detailed ordering information is available from the following sources:

- In the Product Configurator on the Endress+Hauser website: [www.endress.com](http://www.endress.com) -> Click "Corporate" -> Select your country -> Click "Products" -> Select the product using the filters and search field -> Open product page -> The "Configure" button to the right of the product image opens the Product Configurator.
- From your Endress+Hauser Sales Center: [www.addresses.endress.com](http://www.addresses.endress.com)



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

- Up-to-the-minute configuration data
- Depending on the device: Direct input of measuring point-specific information such as 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

## Certificates and approvals



Currently available certificates and approvals can be called up via the product configurator.

<b>CE mark</b>	The measuring device meets the legal requirements of the applicable EU Directives. These are listed in the corresponding EU Declaration of Conformity along with the standards applied.  Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.
<b>RCM-Tick mark</b>	The measuring device complies with the EMC requirements of the "Australian Communications and Media Authority (ACMA)".
<b>Ex approval</b>	The Endress+Hauser sales center can provide information on the hazardous area versions currently available. All the data that are relevant for explosion protection are provided in separate documents which can be supplied on request
<b>Type of protection</b>	<b>Applies for PFM</b> <ul style="list-style-type: none"> <li>■ II(1)G [Ex ia Ga] IIC</li> <li>■ II(1)D [Ex ia Da] IIIC</li> </ul>
<b>Overfill prevention</b>	WHG (FTC325 PFM only)
<b>Other standards and guidelines</b>	The applicable European guidelines and standards can be found in the relevant EU Declarations of Conformity. <ul style="list-style-type: none"> <li>■ IEC/EN 60721-3-3: Classification of environmental conditions</li> <li>■ IEC/EN 60529: Degrees of protection provided by enclosures (IP code)</li> <li>■ IEC/EN 61010: Safety requirements for electrical equipment for measurement, control and laboratory use</li> <li>■ IEC/EN 61326: Interference emission (class A equipment), interference immunity (Appendix A - Industrial)</li> </ul>

## Accessories

<b>Protective housing</b>	The protective housing with IP66 protection is fitted with an integrated DIN rail. The protective housing can be closed with a transparent cover and lead-sealed. <ul style="list-style-type: none"> <li>■ Dimensions in mm (in) B/H/D: 180/182/165 (7.1/7.2/6.5)</li> <li>■ Part number: 52010132</li> </ul>
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## Supplementary documentation



The following document types are also available in the Download Area of the Endress+Hauser website: [www.endress.com](http://www.endress.com) → Download

### Operating Instructions

Document code	Contents
KA00221F/00/A6	Nivotester FTC325 PFM
KA00222F/00/A6	Nivotester FTC325 3-WIRE

### Technical Information

Document code	Contents
TI00417F/00/EN	Liquicap M FTI51, FTI52, sensor for point level detection in liquids
TI00418F/00/EN	Solicap M FTI55, FTI56, sensor for point level detection in bulk solids
TI00433F/00/EN	Solicap S FTI77, sensor for point level detection for bulk solids also in combination with very high temperatures

### Certificate

Depending on the approval, Safety Instructions are also supplied with the device. They are an integral part of the Operating Instructions. The options in question can be selected in the product structure, "Approval" order code.

Document code	Approval	Option
XA00195F/00/	ATEX II (1) G [Ex ia Ga] IIC, WHG ATEX II (1) D [Ex ia Da] IIIC, WHG	C
XA01351F/00	INMETRO: [Ex ia Ga] IIC/IIIB	1
XA01679F/00	EAC [Ex ia Ga] IIC	8



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