

## Technical Information

# Nivotester FTC325

Level limit switch

With Intrinsically Safe Signal Circuit for Connection to a Capacitance Sensor



### Applications

- Level limit detection in tanks containing liquids and silos containing bulk solids. For capacitance level probes, which may also be applied in hazardous areas of category ATEX II (1) GD
- Overspill protection for tanks containing flammable or non-flammable fluids hazardous to water
- Dry running protection for pumps
- Two-point control ( $\Delta s$  with 3-WIRE)

### Your benefits

- Intrinsically safe signal circuit [EEx ia] IIC for using sensors in hazardous areas
- Calibration using operating keys
- High functional safety thanks to:
  - fail-safe pulse-frequency modulation (PFM) or 3-WIRE technology
  - Checkable relay function
- Compact housing for easy series mounting on a standard DIN rail in the cabinet
- Pluggable terminal blocks make wiring easy
- Can be used with EC16Z (PFM), EC17Z (PFM) and EC61 (3-WIRE)
- Limit value and alarm relay
- WHG approval (PFM)
- Protection against maloperation and manipulation
  - each change of the device configuration leads to signalling via the red LED and a fault message

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## Function and system design

### Measuring principle

#### Function

Probe and tank (or ground tube/counterpotential) form a capacitor whose capacitance changes with the level of the product.

PFM	3-WIRE
The electronic insert EC16Z or EC17Z converts the change of capacitance into a change of frequency, which switches the output relay in the Nivotester FTC325 PFM.	The electronic insert EC61 converts the change of capacitance into a voltage signal, which switches the output relay in the Nivotester FTC325 3-WIRE.

#### Signal transmission

The signal input of the Nivotester FTC325 limit switch is galvanically isolated from the mains and from the output.

PFM	3-WIRE
The Nivotester supplies the capacitance sensor with intrinsically safe direct current via a two-wire cable and from there receives a frequency, which signals whether the level limit has been reached or not. Here, the transmitter superimposes current impulses (PFM signals) with a pulse width of approx. 200 µs and a current intensity of approx. 10 mA on the supply current. The measuring capacitance lies in the range from 20 pF... 350pF. This corresponds to a transmission frequency of 185 Hz...116 Hz.	The Nivotester supplies the capacitance sensor with direct current via a two-wire cable and receives the voltage signal via a third wire, which signals whether the level limit has been reached or not. The measuring capacitance lies in the range from 10 pF...350 pF. This corresponds to a voltage of 3 V...12 V.

#### Signal evaluation

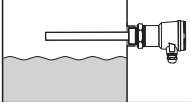
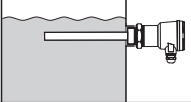
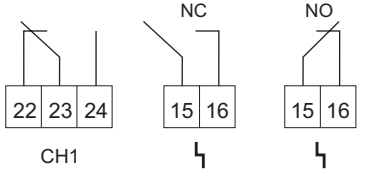
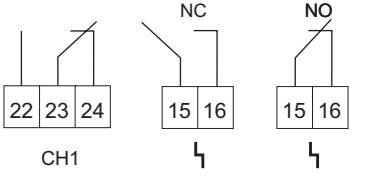
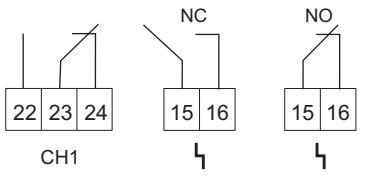
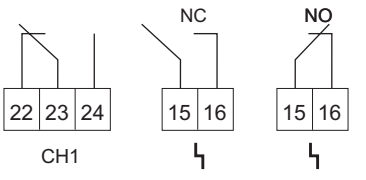
The Nivotester analyses the frequency or the voltage signal, and switches the output relay for the level alarm. The switching state of the relay (energised or de-energised) is displayed on the front panel of the Nivotester by means of two yellow LEDs.

#### Fail-safe circuit

Selecting the correct fail-safe circuit ensures that the relay always works in quiescent current fail-safe mode.

- Maximum fail-safe mode: the relay de-energises when the level rises above the switch point (sensor covered), a fault occurs or the power fails.
- Minimum fail-safe mode: the relay de-energises when the level falls below the switch point (sensor uncovered), a fault occurs or the power fails.

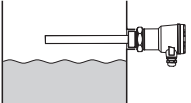
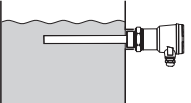
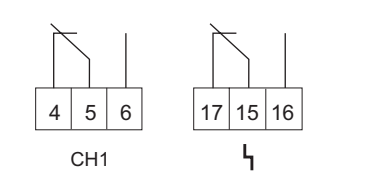
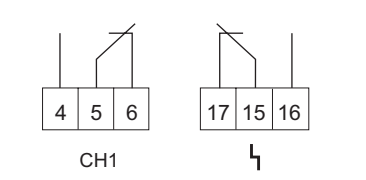
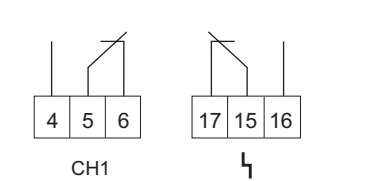
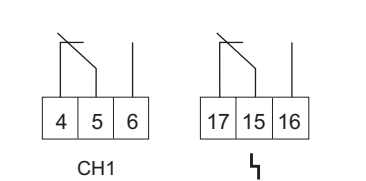
**PFM**

Level	 Probe uncovered	 Probe covered
Maximum safety circuit	 CH1      NC      NO 22 23 24    15 16    15 16 ⚡      ⚡	 CH1      NC      NO 22 23 24    15 16    15 16 ⚡      ⚡      ⚡
Minimum safety circuit	 CH1      NC      NO 22 23 24    15 16    15 16 ⚡      ⚡	 CH1      NC      NO 22 23 24    15 16    15 16 ⚡      ⚡      ⚡

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Function of the limit indicator dependent on the level and fail-safe circuit.

**3-WIRE**

Level	 Probe uncovered	 Probe covered
Maximum safety circuit	 CH1      NC      NO 4 5 6      17 15 16 ⚡      ⚡	 CH1      NC      NO 4 5 6      17 15 16 ⚡      ⚡      ⚡
Minimum safety circuit	 CH1      NC      NO 4 5 6      17 15 16 ⚡      ⚡	 CH1      NC      NO 4 5 6      17 15 16 ⚡      ⚡      ⚡

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Function of the limit indicator dependent on the level and fail-safe circuit.

### Function monitoring

To increase operational safety the Nivotester is equipped with a function monitoring facility.

A fault is displayed by the red light emitting diode and de-energises the relay for the level alarm and the alarm relay. A fault is reported if the Nivotester is no longer receiving a measuring signal. This occurs, for example, when:

- there is a short-circuit
- the signal line to the sensor is interrupted
- the sensor electronics are defective
- the Nivotester's input switching is defective

After calibration, every further change to the device configuration de-energises the relay.

A fault message is signalled via the red LED.

### Calibration key (red)

Calibration is carried out automatically by means of operating keys. This makes setting via rotary switches inapplicable.

### The test/correction key (green - FTC325 PFM only):

- allows for a function check of the output relay and alarm relay.
- confirms a change in the operating mode - e.g. by changing the switching delay after initial calibration. This enables a correction of the operating mode without requiring recalibration. The changed settings are saved by pressing the operating key.

### Additional switch functions

- An adjustable switching delay of 0...45 s allows for the relay to be switched with a delay when covering or uncovering the probe. In the opposite direction, each switching delay is 0.2 s.
- Two-point control ( $\Delta s$  function, FTC325 3-WIRE), see page 7
- A potentiometer (rotary switch) for shifting the operating point allows safe operation of the system, even with media that are prone to build-up.

**Measuring device**

A simple measuring system consists of a capacitance sensor, a Nivotester FTC325 and the control or signal instruments.

The following sensors can be used in conjunction with the electronic inserts (EC) listed.

	FTC325 PFM	FTC325 3-WIRE
Solicap M with	EC17Z	EC61
Multicap T with	EC17Z	EC61
Multicap Classic with	EC16Z, EC17Z	EC61
Multicap EA with	EC17Z	
High-temperature probes T12656, T12892 with	EC17Z	EC61
High-temperature probe 11500 with	EC17Z	
Double rod probe 11304 with	EC17Z	

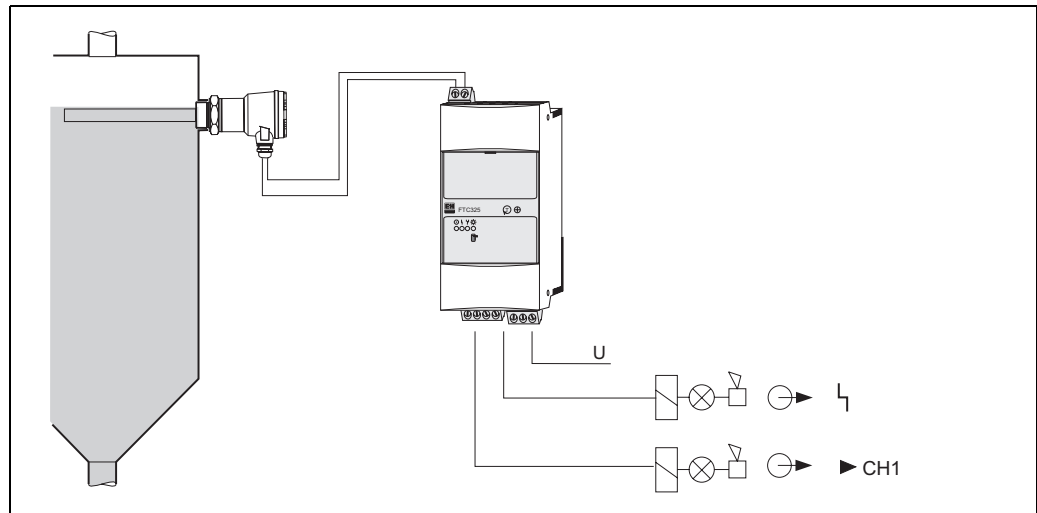
**Probe construction**

Example: Material	$\epsilon_r$	Conductivity	Build-up	Type of probe mounting			
				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	strong	low	✓	✓	-	✓
			strong	-	✓	-	✓
Sludge	> 3	strong	very strong	-	✓	-	✓

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Nivotester FTC325 PFM	Nivotester FTC325 3-WIRE
The measuring system consists of: <ul style="list-style-type: none"> <li>■ Sensor                             <ul style="list-style-type: none"> <li>- capacitance probe</li> <li>- electronic insert                                     <ul style="list-style-type: none"> <li>- EC16Z, EC17Z</li> </ul> </li> </ul> </li> <li>■ Nivotester FTC325 PFM</li> <li>■ Control or signal instruments</li> </ul>	The measuring system consists of: <ul style="list-style-type: none"> <li>■ Sensor                             <ul style="list-style-type: none"> <li>- one or two capacitance probes</li> <li>- electronic insert                                     <ul style="list-style-type: none"> <li>- EC61</li> </ul> </li> </ul> </li> <li>■ Nivotester FTC325 3-WIRE</li> <li>■ Control or signal instruments</li> </ul>

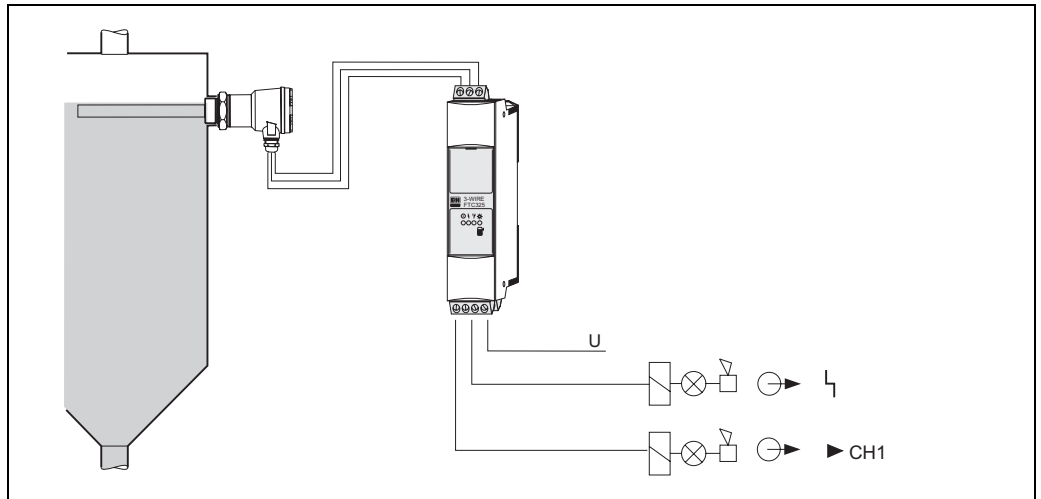
**Level limit detection with FTC325 PFM**



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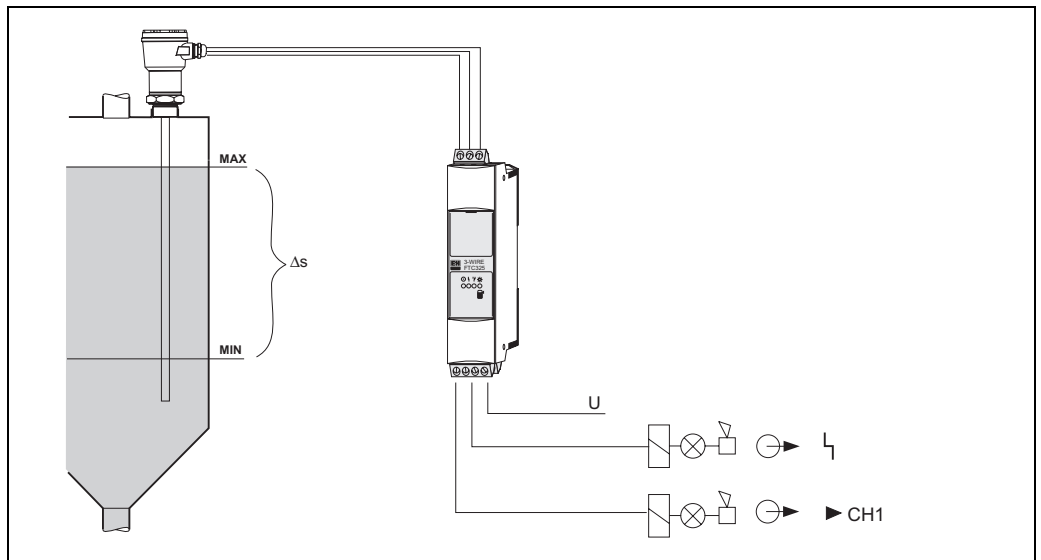
Partially or fully insulated probe

Level limit detection with FTC325 3-WIRE



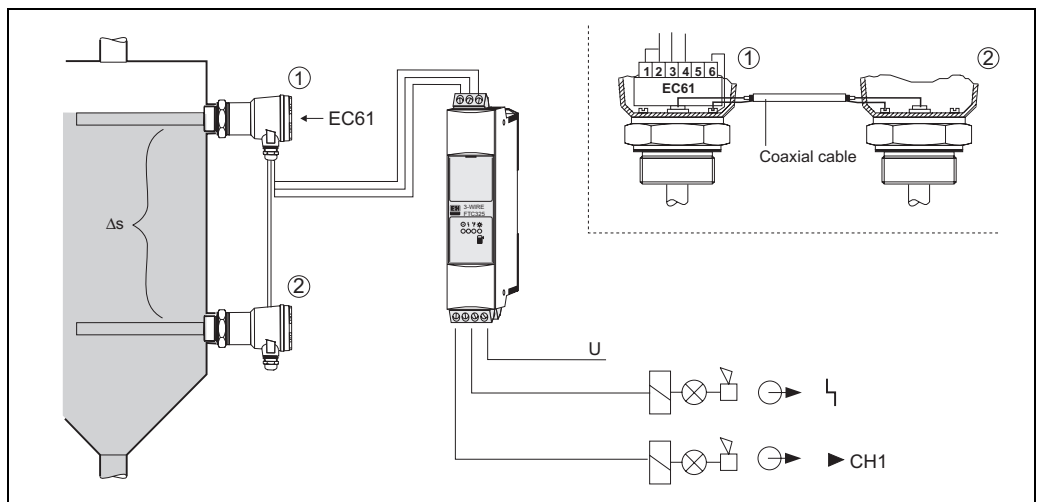
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Partially or fully insulated probe



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Two-point control with fully insulated probe



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Two-point control with two fully or partially insulated probes and an electronic insert EC61. The probes are connected by a coaxial cable.

## Input parameters

<b>Measured variable</b>	The limit signal is generated at minimum or maximum level, depending on the selection
<b>Measuring range</b>	The measuring range is dependent on the mounting location of the probes.
<b>Input signal</b>	<p><b>FTC325 PFM</b></p> <ul style="list-style-type: none"> <li>■ FTC325 PFM input: galvanically isolated from power supply and output</li> <li>■ Type of protection: intrinsic safety [EEx ia] IIC</li> <li>■ Connectable sensors: <ul style="list-style-type: none"> <li>Solicap M with EC17Z</li> <li>Multicap T with EC17Z</li> <li>Multicap Classic with EC16Z, EC17Z</li> <li>Multicap EA with EC17Z</li> <li>High-temperature probes 11500, T12656, T12892 with EC17Z</li> <li>Double rod probe 11304 with EC17Z</li> </ul> </li> <li>■ Sensor's power supply: from Nivotester FTC325 PFM</li> <li>■ Connecting cable: two-wire, shielded wire not required, except for strong electromagnetic interferences (see also Electromagnetic Compatibility (EMC) on page 12)</li> <li>■ Cable resistance: 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>■ FTC325 3-WIRE input: galvanically isolated from power supply and output</li> <li>■ Type of protection: version for non-hazardous areas</li> <li>■ Connectable sensors: <ul style="list-style-type: none"> <li>Solicap M with EC61</li> <li>Multicap T with EC61</li> <li>Multicap Classic with EC61</li> <li>High-temperature probes T12656, T12892 with EC61</li> </ul> </li> <li>■ Sensor's power supply: from Nivotester FTC325 3-WIRE</li> <li>■ Connecting cable: three-wire, shielded wire not required, except for strong electromagnetic interferences (see also Electromagnetic Compatibility (EMC) on page 12)</li> <li>■ Cable resistance: max. 25 <math>\Omega</math> per wire</li> <li>■ Signal transmission: voltage change is transmitted via a separate wire</li> </ul>



## Output parameters

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<b>Output signal</b>	<p><b>FTC325 PFM and FTC325 3-WIRE</b></p> <ul style="list-style-type: none"> <li>■ Relay output: a potential-free change-over contact for the level alarm</li> <li>■ Quiescent current fail-safe circuit: minimum/maximum fail-safe mode can be selected using the DIL switch</li> <li>■ Alarm relay: potential-free change-over contact for fault indication; with the PFM version, only two contacts brought out (state type of contact NC or NO when ordering a PFM device)</li> <li>■ Switching delay: 0...45 s Relay switches when covering or uncovering the probe, depending on the setting</li> <li>■ Switching capacity of relay contacts: <ul style="list-style-type: none"> <li>U~ maximum 253 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 style="margin-top: 10px;">U- maximum 40 V</li> <li>I- maximum 2 A</li> <li>P- maximum 80 W</li> </ul> <ul style="list-style-type: none"> <li>■ Service life: at least <math>10^5</math> switching cycles at maximum contact load</li> <li>■ Function indicators: light emitting diodes for operation, level alarm, fault and level signal (lights up as long as the probe is covered)</li> </ul>
<b>Signal on alarm</b>	Limit relay de-energised; fault indication via red LED, alarm relay de-energised
<b>Galvanic isolation</b>	All input and output channels and relay contacts are provided with secure galvanic isolation from each other. In the case of simultaneous connection of the power supply circuit or the alarm relay contacts to the functional extra-low voltage, the secure galvanic isolation is guaranteed up to a voltage of 150 V AC.
<b>Overvoltage category as per EN 61010</b>	II
<b>Protection class</b>	II (double or increased insulation)

## Power supply

### Electrical connection

#### Terminal blocks

The removable terminal blocks are isolated after intrinsically safe connections (top of device) and non-intrinsically safe connections (bottom of device). Furthermore, the terminal blocks are also colour-coded. Blue is for the intrinsically safe area and grey for the non-intrinsically safe area. These distinctions allow for safe cable routing.

#### Sensor connection

(To the upper, blue/grey terminal blocks).

Use a usual commercial instrument cable or multi-core cable for measuring purposes for the connecting cable between the Nivotester FTC325 and the sensor. Cable resistance of maximum 25  $\Omega$  per wire.

If strong electromagnetic interferences have to be expected, e.g. from machines or radios, a screened cable must be used. Only connect the screening to the grounding connection in the sensor, not to the Nivotester.

#### Use of measuring cell in potentially explosive atmospheres

Compliance with the national explosion protection regulations for the design and laying of intrinsically safe signal line is mandatory.

High-reliability values for capacitance and inductance are contained in Safety Instructions XA 195F.

#### Connection of signal and control instruments

(To the lower, grey terminal blocks)

The relay function must be observed dependent on the level and fail-safe circuit.

If a device with high inductance (e.g. contactor, solenoid valve, etc.) is connected, a spark suppressor must be added to protect the relay contact.

#### Supply voltage connection

(To the lower, grey terminal blocks)

For the voltage versions, see the Ordering information on page 17.

A fuse (T 200 mA) is built into the power supply circuit, so that it is not necessary to pre-connect a fine-wire fuse. The Nivotester is equipped with reverse polarity protection.

### Supply voltage

#### Alternating current version (AC):

- Voltage ranges: 85...253 V, 50/60 Hz

#### Direct current version (DC):

- Voltage range: 20...60 V
- Power supply direct current: maximum 100 mA
- Permitted residual ripple within the tolerance:  $U_{ss} = \text{maximum } 2 \text{ V}$

### Power consumption

#### AC version

maximum 6.0 VA

#### DC version

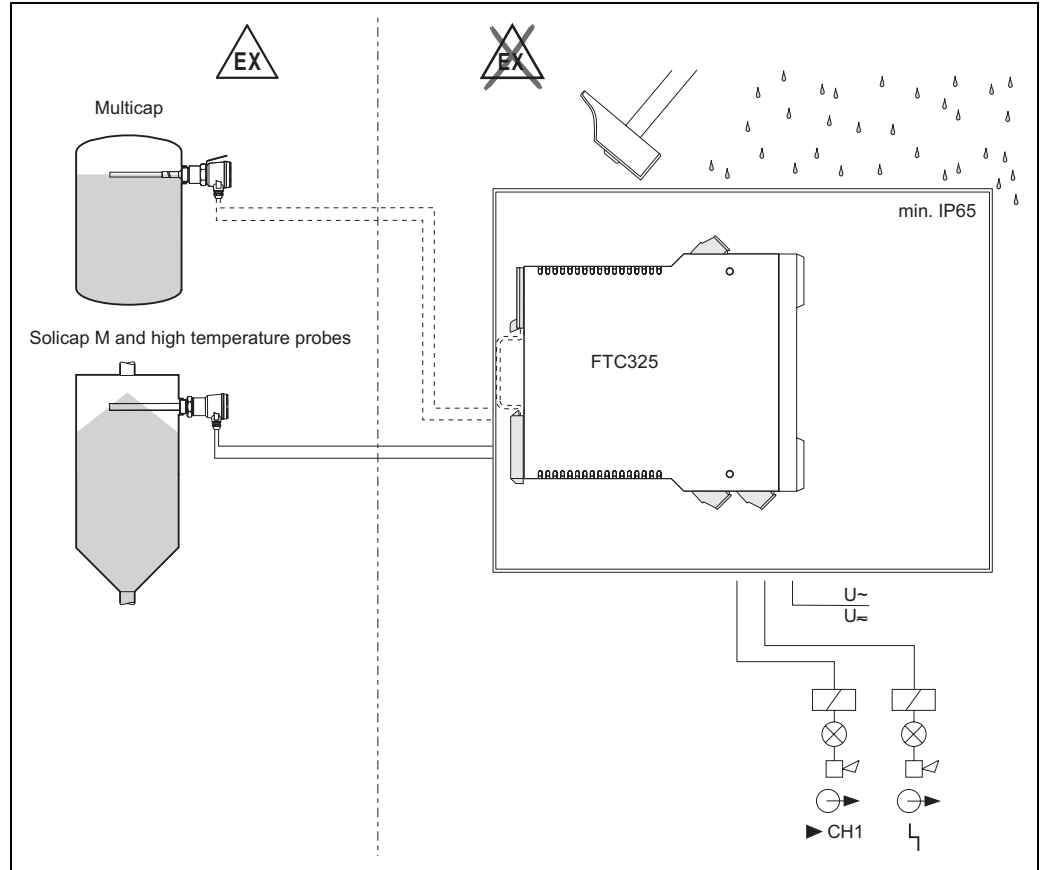
maximum 2.0 W (at  $U_{min}$  20 V)

## Operating conditions (installation conditions)

### Installation instructions

### Installation location

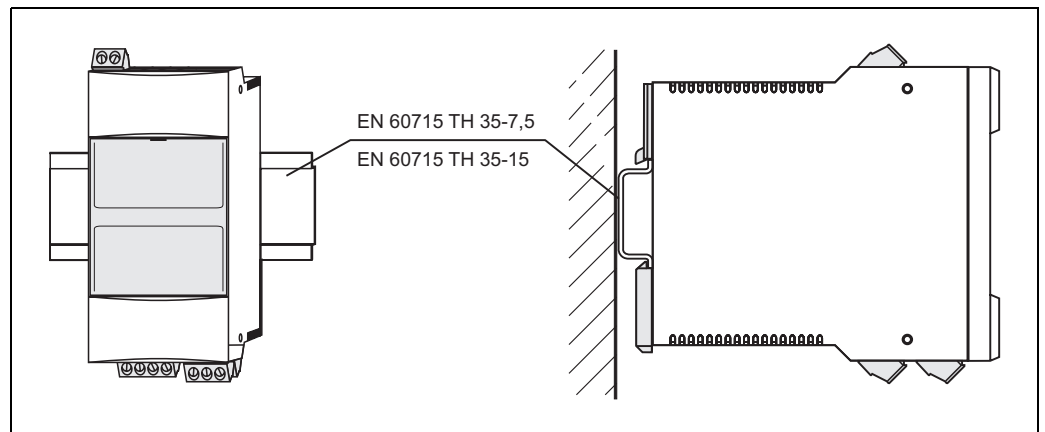
The Nivotester must be housed outside of hazardous areas in a cabinet. For installation outdoors, there is also a protective housing (IP65) for up to three Nivotester FTC325 available.



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### Orientation

Vertical on DIN rail (EN 60715 TH 35).



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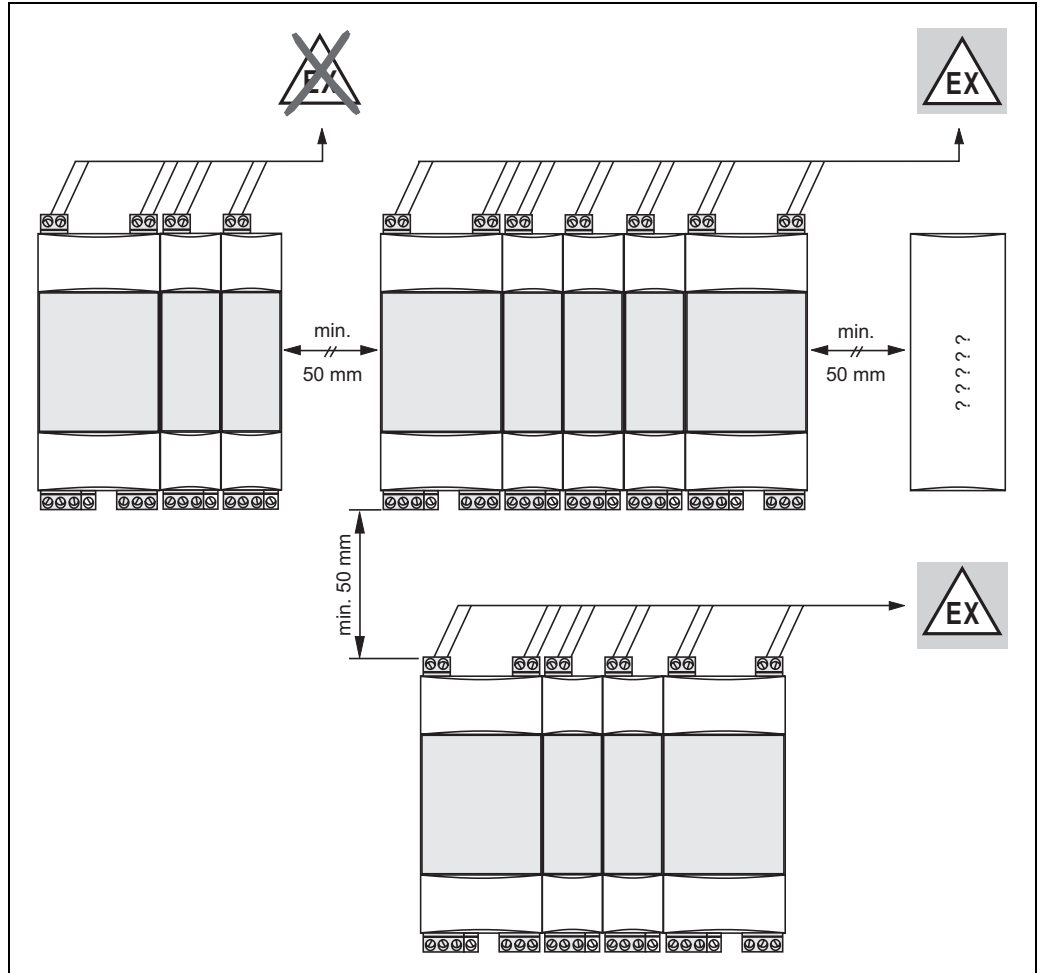
## Operating conditions (environmental conditions)

<b>Installation location</b>	Cabinet or protective housing
<b>Permitted ambient temperatures</b>	<p><b>For single mounting</b></p> <ul style="list-style-type: none"> <li>■ -20 °C...+60 °C</li> </ul> <p><b>For series mounting without lateral spacing</b></p> <ul style="list-style-type: none"> <li>■ -20 °C...+50 °C</li> </ul> <p><b>Storage temperature</b></p> <ul style="list-style-type: none"> <li>■ -25 °C...+85 °C (preferably at +20 °C)</li> </ul> <p><b>Installation in protective housing</b></p> <ul style="list-style-type: none"> <li>■ -20 °C...+40 °C</li> <li>■ No more than three Nivotesters can be installed into one protective housing</li> </ul>
	<p> <b>Caution!</b> The devices should be installed in locations which are protected from direct solar radiation, weather and impacts. This is of particular importance in hot climates.</p>
<b>Climatic and mechanical application class</b>	<p>3K3 In acc. with DIN EN 60721-3-3</p> <p>3M2 In acc. with DIN EN 60721-3-3</p>
<b>Degree of protection</b>	IP20
<b>Electromagnetic compatibility (EMC)</b>	<p>Interference Emission to EN 61326; Electrical Equipment Class B</p> <p>Interference Immunity to EN 61326; Annex A (Industrial) and NAMUR Recommendation NE 21 (EMC)</p>

## Mechanical construction

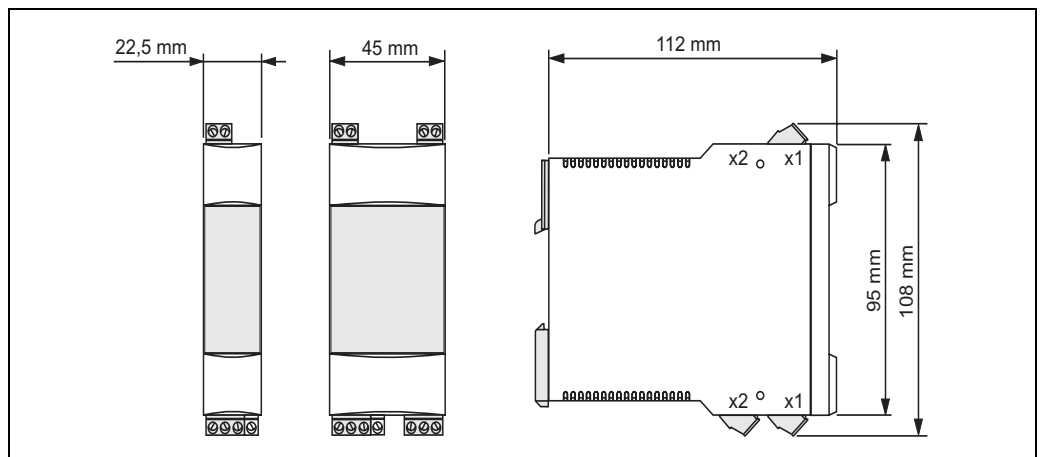
### Design, dimensions

- Housing: row housing made of plastic
- Mounting: on DIN rail as per EN 60715 TH 35-7.5 or EN 60715 TH 35-15
- Degree of protection as per EN 60529; IP20



L00-FTxxxxxx-06-06-xx-xx-002

Dimensions:      3-WIRE      PFM



L00-FTxxxxxx-06-06-xx-xx-004



Note!  
100 mm = 3.94 in

**Weight** approx. 250 g

**Materials**

**Housing**

- Polycarbonate  
Colour: light grey, RAL 7035

**Front cover**

- Polypropylene PPN  
Colour: blue

**Fixing bracket (for securing on the DIN rail)**

- Polyamide PA6  
Colour: black, RAL 9005

**Terminals**

**Nivotester FTC325 PFM**

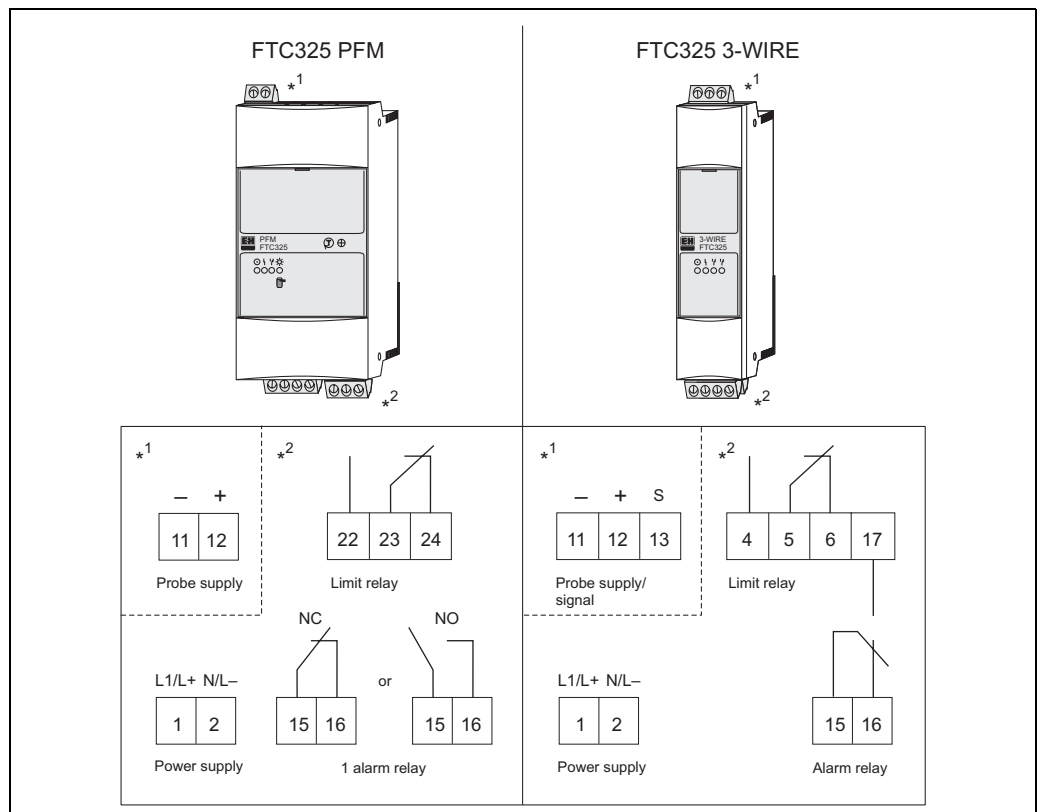
- 2 screw terminals: probe supply
- 3 screw terminals: limit relay
- 2 screw terminals: alarm relay
- 2 screw terminals: power supply

**Nivotester FTC325 3-WIRE**

- 3 screw terminals: probe supply + signal
- 4 screw terminals:
  - 3 limit value relay
  - 1 for contact 3 of the alarm relay
- 4 screw terminals:
  - 2 AC/DC supply (power supply)
  - 2 alarm relay

**Connection cross-section**

maximum 1 x 2.5 mm or 2 x 1.5 mm



## User interface

### Display elements

1. red light emitting diode: fault indication
2. green light emitting diode: standby
3. yellow light emitting diode (left): "limit relay energised"
4. yellow light emitting diode (right): "probe uncovered/covered" level indication independent of the selected fail-safe circuit

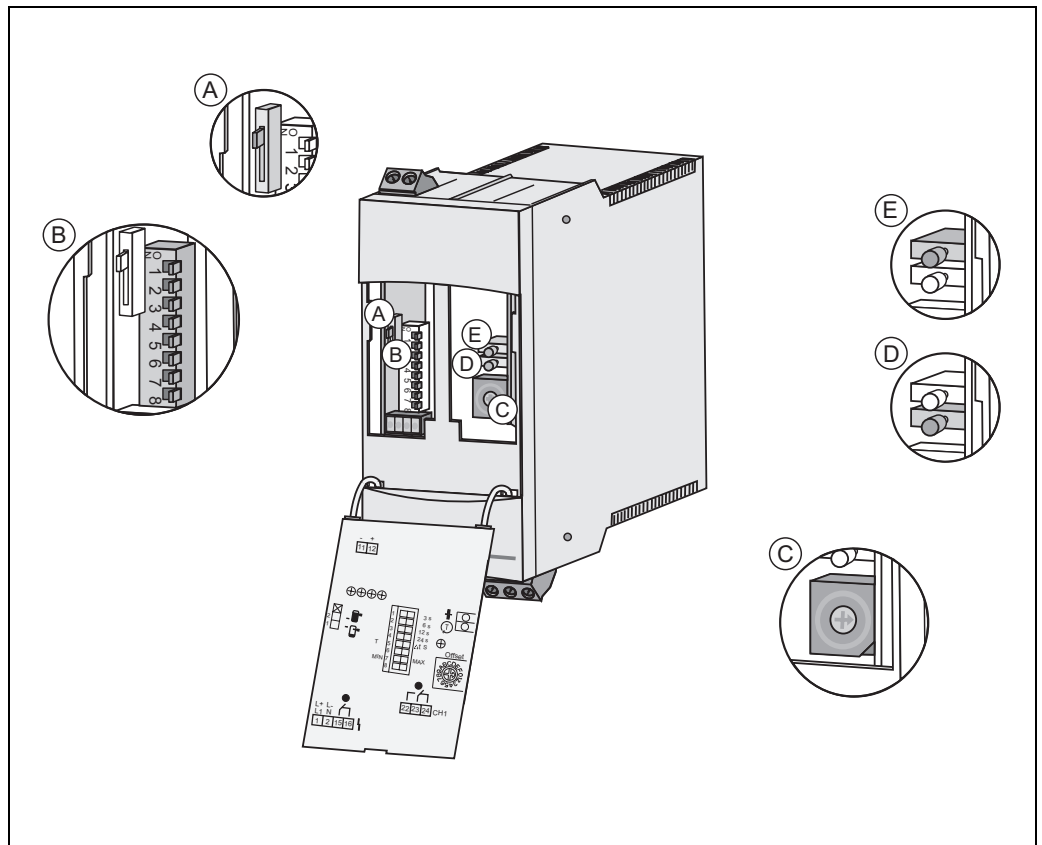
### Operating elements

#### Operating concept

On-site configuration with switches behind the folding front panel

#### Nivotester FTC325 PFM

- A Calibration for covered or uncovered probe
- B DIL switch 1-4: switching delay (3 s, 6 s, 12 s, 24 s) = max. 45 s  
DIL switch 5: delay when covering or uncovering the probe  
DIL switch 6: no function  
DIL switch 7: min/max fail-safe mode  
DIL switch 8: no function
- C Switch point shift for build-up compensation (16-stage)
- D Correction key (green)
- E Calibration key (red)

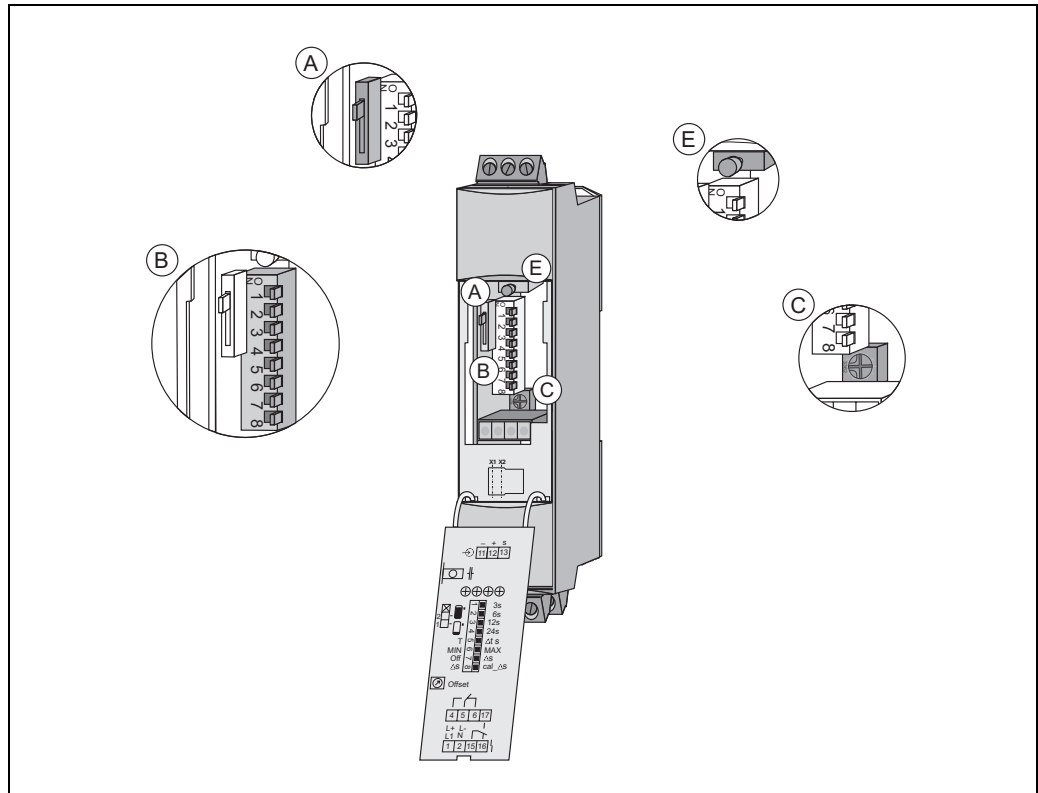


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Operating elements

Nivotester FTC325 3-WIRE

- A Calibration for covered or uncovered probe
- B DIL switch 1-4: switching delay (3 s, 6 s, 12 s, 24 s) = max. 45 s  
DIL switch 5: delay when covering or uncovering the probe  
DIL switch 6: min/max fail-safe mode  
DIL switch 7: two-point controller mode (ON/OFF)  
DIL switch 8: calibration switch point (upper/lower), operation as two-point controller
- C Switch point shift for build-up compensation (infinitely variable)
- E Calibration key (red)



100-FTC325xx-03-06-06-xx-002



## Certificates and approvals

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<b>CEmark</b>	The Nivotester meets all the statutory requirements arising from EC directives. Endress+Hauser confirms the successful testing of the device by affixing the CE-symbol.
<b>Ex approval</b>	Endress+Hauser Sales Centers provide information about the currently available versions for use in hazardous areas (ATEX EEx ia IIC; FM IS; CSA IS) All the relevant data for explosion protection is contained in separate Ex documentation (see: Supplementary Documentation), which can be requested.
<b>Type of protection</b>	[EEx ia] IIC (only for FTC325 PFM)
<b>Overspill protection</b>	WHG (only for FTC325 PFM)
<b>Other standards and regulations</b>	Other standards and regulations which were complied with during the conception and development of the Nivotester FTC325. <ul style="list-style-type: none"><li>■ EN 60529 Degrees of protection through housing (IP code)</li><li>■ EN 61010 Safety regulations for electrical control and instrumentation devices and laboratory instruments</li><li>■ EN 61326 Interference emission (Equipment Class B), interference immunity (Annex A - Industrial)</li></ul>

## Ordering information

### Nivotester FTC325 PFM

<b>10</b>	<b>Certificates</b>		
	A	For non-hazardous areas	
	B	For non-hazardous areas, WHG	
	C	ATEX II (1) GD (EEx ia) IIC, WHG	
	D	FM IS Cl.I,II,III Div1 Group A-G	
	E	CSA IS Cl.I,II,III Div1 Group A-G	
	F	CSA General Purpose	
	Y	Special version	
<b>20</b>	<b>Input</b>		
	1	2-wire PFM rail mounting 45 mm	
	9	Special version	
<b>30</b>	<b>Power supply</b>		
	A	Power supply 85... 253 V AC, 50/60 Hz	
	B	Power supply 20... 30 V AC / 20... 60 V DC	
	Y	Special version	
<b>40</b>	<b>Output</b>		
	1	1 x level SPDT + 1 x alarm SPST NC (normally closed)	
	2	1 x level SPDT + 1 x alarm SPST NO (normally open)	
	9	Special version	
<b>50</b>	<b>Additional options</b>		
	1	Additional options not selected	
	9	Special version	
FTC325 PFM			Complete product name

### Nivotester FTC325 3-WIRE

<b>10</b>	<b>Certificates</b>		
	A	For non-hazardous areas	
	F	CSA General Purpose	
	Y	Special version	
<b>20</b>	<b>Input</b>		
	2	3-WIRE analogue rail mounting 22.5 mm	
	9	Special version	
<b>30</b>	<b>Power supply</b>		
	A	Power supply 85... 253 V AC, 50/60 Hz	
	B	Power supply 20... 30 V AC / 20... 60 V DC	
	Y	Special version	
<b>40</b>	<b>Output</b>		
	3	1 x level SPDT + 1 x alarm SPDT	
	9	Special version	
<b>50</b>	<b>Additional options</b>		
	1	Additional options not selected	
	9	Special version	
FTC325 3-WIRE			Complete product name

## Accessories

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### Protective housing

The protective housing in protection class IP66 is equipped with an integrated DIN rail and closed by a transparent cover, which can also be lead-sealed.

#### Dimensions:

W: 180 / H: 182 / D: 165

#### Technical Data:

- Ingress protection (EN 60529): IP66
- Lower housing section: fibre-glass reinforced polycarbonate, grey
- Upper housing section: polycarbonate, transparent
- Cover screws: PA, 4 pieces, 2 of which are sealing
- Seal: PU seal
- Top-hat rail (EN 50022): galvanized
- Cable entries: 5 pieces M 20x1,5
- Part number: 52010132

## Supplementary Documentation

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### System Information (SI)

- Capacitance level measurement  
SI 001F/00

### Technical Information (TI)

#### Capacitance level probes

- Solicap M  
FTC51, FTC52, FTC53  
TI 362F/00
- Multicap T (America)  
DC12TA, DC11/16/21/26TAN, DC11/16/21/26TAS  
TI 239F/00
- Multicap T (Europe)  
DC12TE, DC11/16/21/26TEN, DC11/16/21/26TES  
TI 240F/00
- Multicap Classic  
DC11  
TI 169F/00
- Multicap Classic  
DC16  
TI 096F/00
- Multicap Classic  
DC21  
TI 208F/00
- High-temperature probe (HT)  
11500ZM  
TI 161F/00
- High-temperature probe (HT)  
T12656  
TI 117F/00
- High-temperature probe (HT)  
T12892  
TI 118F/00
- Double rod probe  
11304Z  
TI 052F/00

**Electronic inserts**

- EC16Z (PFM)  
TI 170F/00
- EC17Z (PFM)  
TI 268F/00
- EC61 (3-WIRE)  
TI 267F/00

**Protective housing**

- Protective housing  
TI 367F/00

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**Operating manual (KA)**

- Nivotester  
FTC325 PFM  
KA 221F/00
- Nivotester  
FTC325 3-WIRE  
KA 222F/00

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**Certificates (only for PFM)**

**ATEX:**

- Nivotester  
FTC325, FTC625  
XA 195F/00

**WHG (DIBt):**

- Nivotester  
FTC325  
ZE 211F/00

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