



Füllstand



Druck



Durchfluss



Temperatur

Flüssigkeits-  
analyse

Registrierung

Systeme  
Komponenten

Services



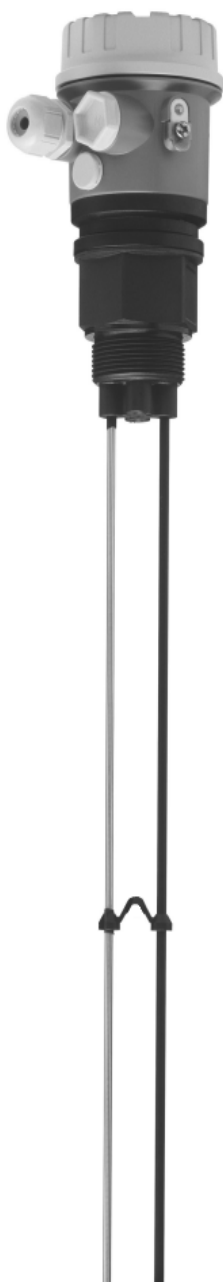
Solutions

## Technical Information

# Liquicap T FMI21

Capacitive level measurement

Two-rod probe for continuous measurement in liquids



### Application

The Liquicap T sensor is used in conductive liquids (as of 30  $\mu\text{S}/\text{cm}$ ) for continuous level measurement and is preconfigured from factory 0 %...100 % to probe length ordered.

As of a conductivity of 30  $\mu\text{S}/\text{cm}$ , the measurement is independent of the dc-value (dielectric constant) of the liquid. It can also be deployed in Ex area, Zone 2.

The Liquicap T is particularly suited to the following applications:

- Small measuring ranges (as of 150 mm)
- Cistern measurements
- Aggressive liquids such as acids and alkalis
- Independent of the tank material (plastic, stainless steel or concrete) or the tank shape

Used in conjunction with the Fieldgate FXA320 (remote measured value interrogation using Internet technology), Liquicap T is an ideal solution for inventorying material and optimising logistics (inventory control).

### Your benefits

- Safe function regardless of tank geometry thanks to probe design
- No calibration necessary (preconfigured from factory 0 %...100 % to probe length ordered)
- High quality, non-corrosive materials (carbon fibre, stainless steel) for use in aggressive liquids and liquids which present a hazard to water (WHG-approved (German Water Resources Law))
- No moving parts in tank – long operating life – dependable function without wear
- Cost-effective solution for continuous measurement of levels in conductive liquids
- Optimised storage by simply shortening the probe rods on site (probe shortening set)

## Table of contents

<b>Function and system design</b> .....	<b>3</b>	<b>Mechanical construction</b> .....	<b>10</b>
Measuring principle .....	3	Design, dimensions .....	10
Measuring system .....	3	Probe shortening set .....	10
Operating medium .....	4	Weight .....	11
Applications .....	4	Material .....	11
		Fitted electrodes .....	11
<b>Input</b> .....	<b>5</b>	<b>Human interface</b> .....	<b>12</b>
Measured variable .....	5	Operating elements .....	12
Measuring range .....	5	Display elements .....	12
Input signal .....	5		
<b>Output</b> .....	<b>5</b>	<b>Certificates and approvals</b> .....	<b>13</b>
Electronic insert FEI20 (4...20 mA) .....	5	CE mark .....	13
		Overfill protection .....	13
<b>Power supply</b> .....	<b>6</b>	Other standards and guidelines .....	13
Electrical connection (wiring diagram) .....	6	Ex approval .....	13
Transmitter power supply units from Endress+Hauser .....	6	Type of protection .....	13
Supply voltage (FEI20) .....	6		
Power consumption .....	6	<b>Ordering information</b> .....	<b>14</b>
Current consumption .....	6	Liquicap T FMI21 .....	14
Cable entries .....	6		
Cable specifications .....	7	<b>Accessories</b> .....	<b>14</b>
		Liquicap T .....	14
<b>Performance characteristics</b>		Spare parts .....	14
<b>with installed electronic insert</b> .....	<b>7</b>		
Reference operating conditions .....	7	<b>Documentation</b> .....	<b>15</b>
Maximum measured error .....	7	Technical Information .....	15
Repeatability .....	7	Operating Instructions .....	15
Start-up settling time .....	7	Certificates .....	15
Influence of ambient temperature .....	7		
Integration time .....	7		
Factory calibration .....	7		
<b>Installation</b> .....	<b>8</b>		
Installation instructions .....	8		
<b>Environment</b> .....	<b>8</b>		
Ambient temperature range .....	8		
Ambient temperature limits .....	8		
Storage temperature .....	8		
Climate class .....	8		
Degree of protection .....	8		
Shock resistance .....	8		
Vibration resistance (with min. rod length 150 mm) .....	8		
Electromagnetic compatibility .....	8		
<b>Process</b> .....	<b>9</b>		
Environment .....	9		
Conductivity of medium .....	9		
Process pressure .....	9		

## Function and system design

### Measuring principle

The probe, medium and ground rod (counter electrode) form an electric capacitor.

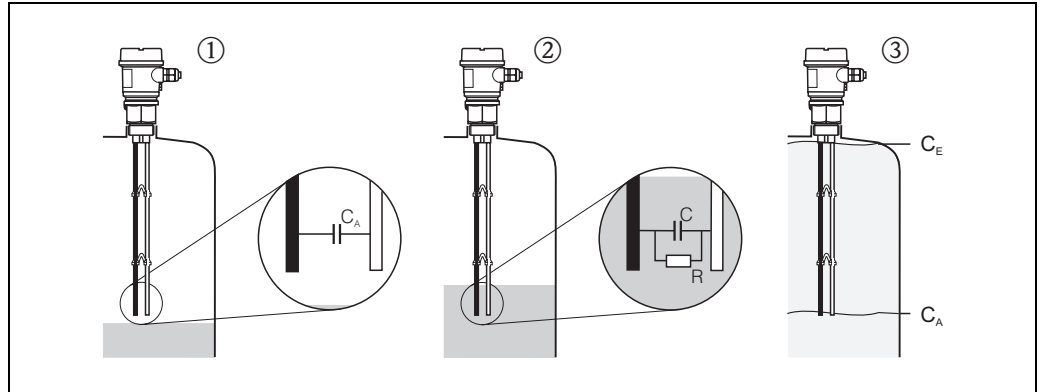
If the probe is in the air ①, a certain low initial capacitance is measured.

When the tank is filled, the capacitance of the capacitor increases the more the probe is covered ② ③.

As of a conductivity of 30  $\mu\text{S}/\text{cm}$ , the measurement does not depend on the dc-value of the liquid.

The electronic insert of the probe converts the capacitance measured to a current, in proportion to the level, in the range of 4...20 mA, thus making it possible to interpret the level.

All input and output channels are safely galvanically isolated from one another.



L00-FMI21-xxxx-15-05-xx-xx-001

$C_A$  : Initial capacitance (probe exposed)

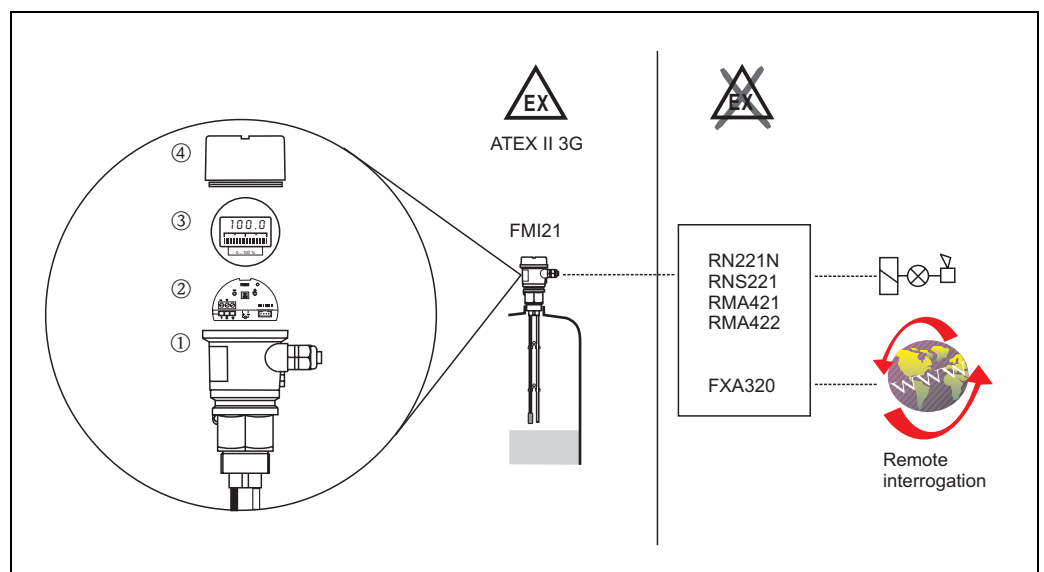
$C_E$  : Final capacitance (probe covered)

### Measuring system

#### Probe with integrated electronic insert

The measuring system consists of:

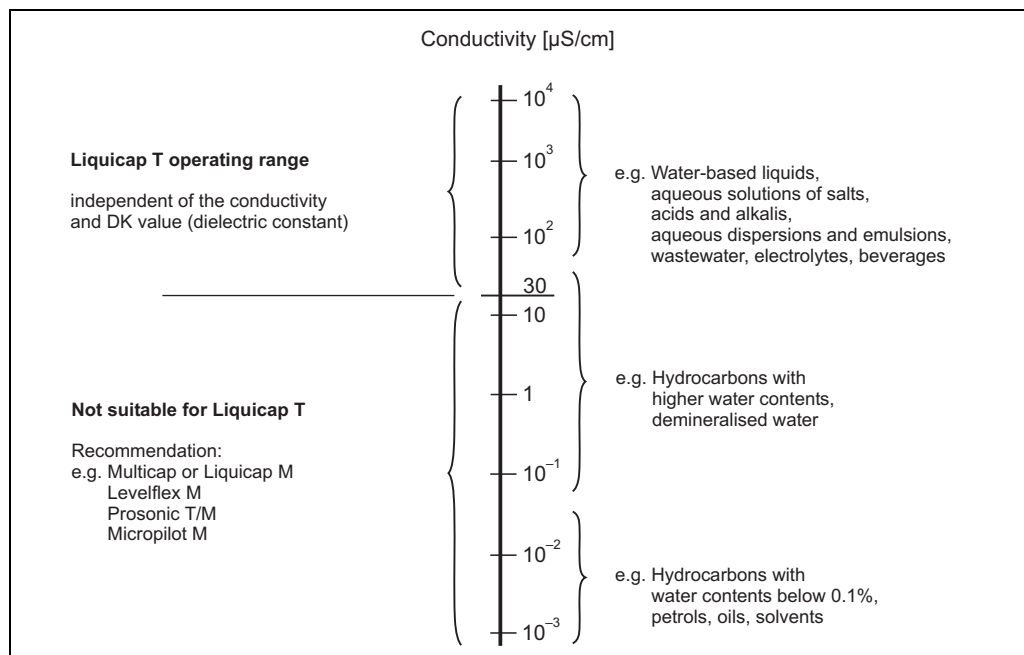
- The components of a capacitive probe Liquicap T FMI21:
  - ① Housing with two probe rods (one probe rod fully insulated and the second uninsulated (ground potential))
  - ② Electronic insert FEI20
  - ③ Display (optional)
  - ④ Housing cover (optional: cover with sight glass in conjunction with display)
- A transmitter power supply unit



L00-FMI21-xxxx-14-05-xx-xx-en-000

## Operating medium

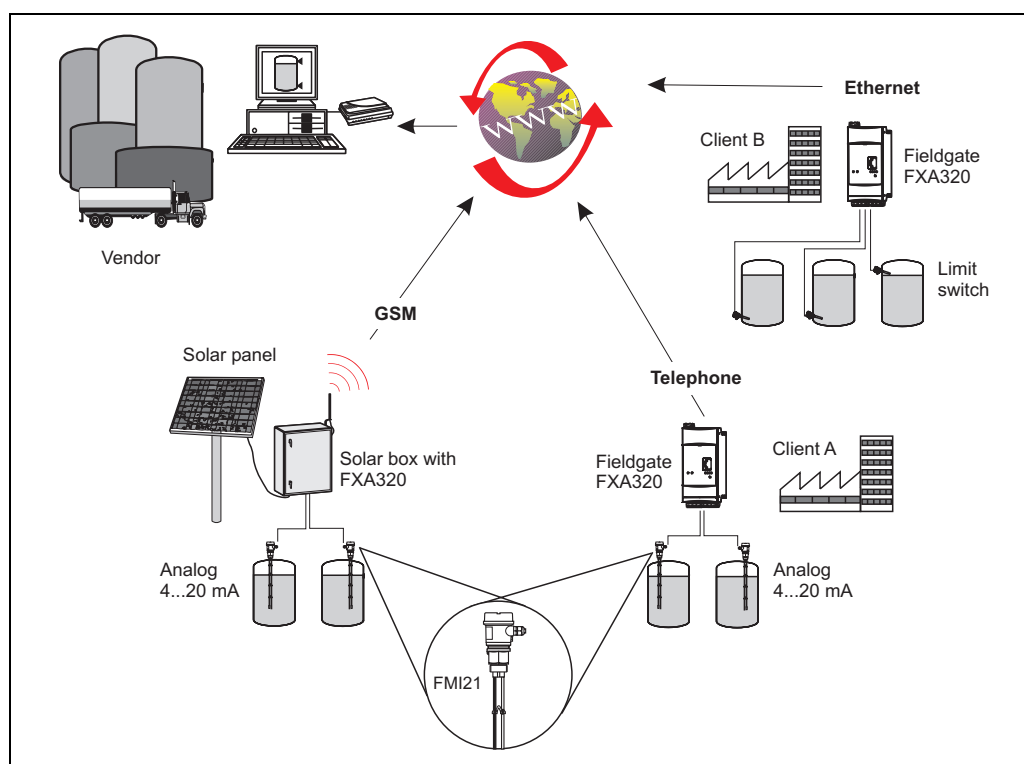
Due to the probe design, the Liquicap T FMI21 can be used as a conductivity of 30  $\mu\text{S}/\text{cm}$ . The measurement is independent of the dc-value and the conductivity of the liquid.



## Applications

### 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, take this into account in their own production planning. The Fieldgate monitor the configured level limits and automatically trigger the next delivery as required. Here, the spectrum of possibilities ranges from a simple purchasing requisition by e-mail through to fully automatic order processing by incorporating XML data into the planning systems on both sides.



## Input

<b>Measured variable</b>	Continuous measurement of the change in capacitance between two probe rods depending on the level of a conductive liquid. Maximum viscosity = 2000 cst
<b>Measuring range</b>	<p>The measuring range is between 150...2500 mm, depending on the probe length ordered.</p> <ul style="list-style-type: none"><li>■ Probe length: 150...2500 mm</li><li>■ Adjustable initial capacitance: <math>C_A = 0...2000</math> pF</li><li>■ Permitted span: <math>\Delta C = 25...2000</math> pF</li><li>■ End capacitance: <math>C_E = \text{max. } 2100</math> pF</li><li>■ Measuring frequency: 250 kHz</li></ul>
<b>Input signal</b>	<p>Probes covered =&gt; high capacitance Probes exposed =&gt; low capacitance</p>

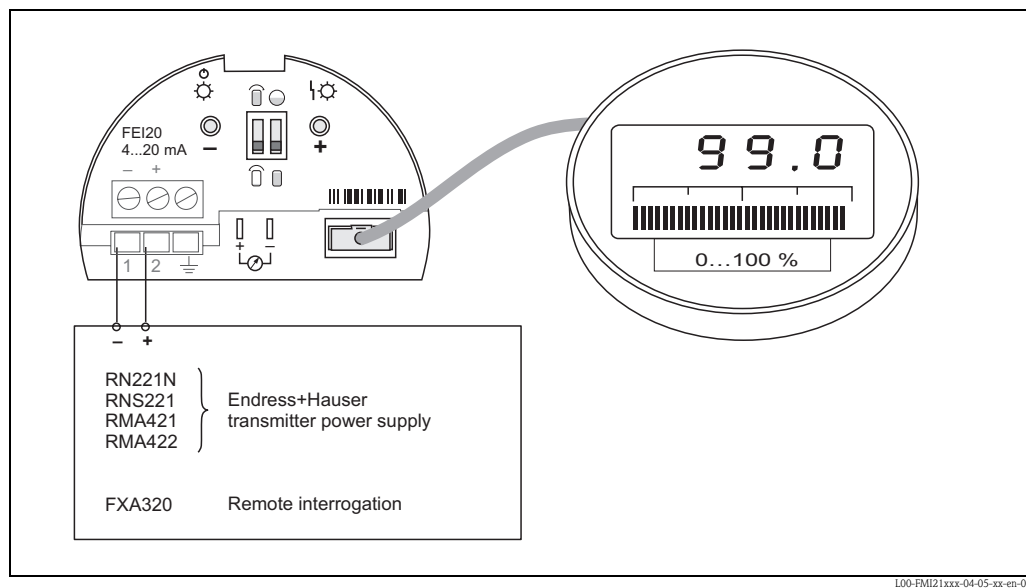
## Output

<b>Electronic insert FEI20 (4...20 mA)</b>	<p><b>Output signal</b> 3.8...20.5 mA</p> <p><b>Switch-on current</b> Max. 20 mA (&lt; 500 ms)</p> <p><b>Signal on alarm</b> &gt; 21 mA</p>
--	---

## Power supply

### Electrical connection (wiring diagram)

FMI21 with electronic insert FEI20 for connection to transmitter power supply units from Endress+Hauser.



Connection of the electronic insert FEI20

### Transmitter power supply units from Endress+Hauser

#### RNS221

Supply unit for supplying power to two 2-wire sensors or transmitters in the "non-Ex area".

#### RN221N

Active barrier with power supply for intrinsically safe separation of 4...20 mA standard signal circuits.

#### RMA421

Multi-functional 1-channel top-hat rail device with universal input, transmitter power supply, limit value monitoring and analog output.

#### RMA422

Multi-functional 1-2-channel top-hat rail device with intrinsically safe current inputs and transmitter power supply, limit value monitoring, mathematics functions and 1-2 analog outputs.

#### FXA320

Gateway to remote interrogation of sensors and actuators via Internet technology.

### Supply voltage (FEI20)

- Connection voltage:  $U = 10...30 \text{ V DC}$
- Reverse polarity protection (integrated)

### Power consumption

- $P < 0.7 \text{ W}$

### Current consumption

- $I < 22 \text{ mA}$

### Cable entries

#### M 20x1.5

- Degree of protection: IP66
- Number in F16 housing: 2 cable entries (1 cable gland included in scope of delivery)

#### NPT ½

- Number in F16 housing: 2 cable entries with dummy plugs

**Cable specifications**

Use usual commercial two-core or multi-core cable (25  $\Omega$  per core).  
Cable cross-section (incl. ferrule): max. 2.5 mm<sup>2</sup>



Note!

Use a screened cable in the event of strong, electromagnetic EMC condition.

## Performance characteristics with installed electronic insert

**Reference operating conditions**

- Ambient temperature: 23 °C
- Medium temperature: 23 °C
- Medium viscosity: medium must expose probe again (drain off < 2000 cst)
- Atmospheric pressure
- Probe installation: vertical from above

**Maximum measured error**

≤ 1 % of full scale value (active rod probe)

**Repeatability**

0.25 % of full scale value (range 0...2000 pF)

**Start-up settling time**

< 2 s (stable measured value after switch-on process)

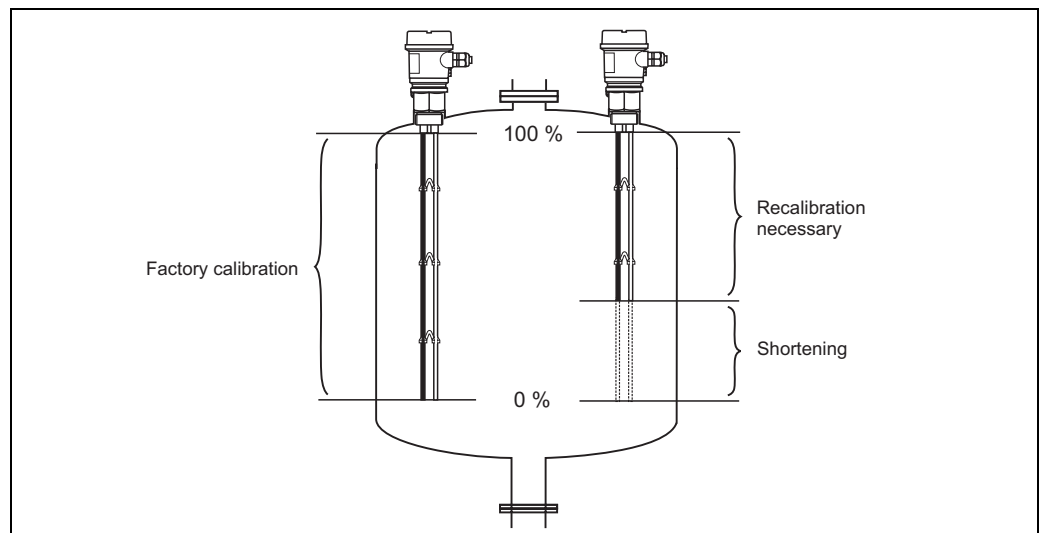
**Influence of ambient temperature**

< 0.01 %/K (−40°C...+70 °C) probe length 1 m

**Integration time**

$\tau = 1$  s (fixed)

The integration time affects the speed at which the display and the current output react to changes in the fluid level.

**Factory calibration**

L00-FMI21.xxx-15-05-xx-en-000

Factory calibration: medium conductivity  $\geq 30 \mu\text{S/cm}$

Calibration accuracy 100 % max. −5 mm; 0 % max. −5 mm

In an installed state, recalibration is only necessary if

- The probe rods have been shortened
- The 0 % and 100 % value should be adjusted to suit customer specifications
- The electronic insert was changed

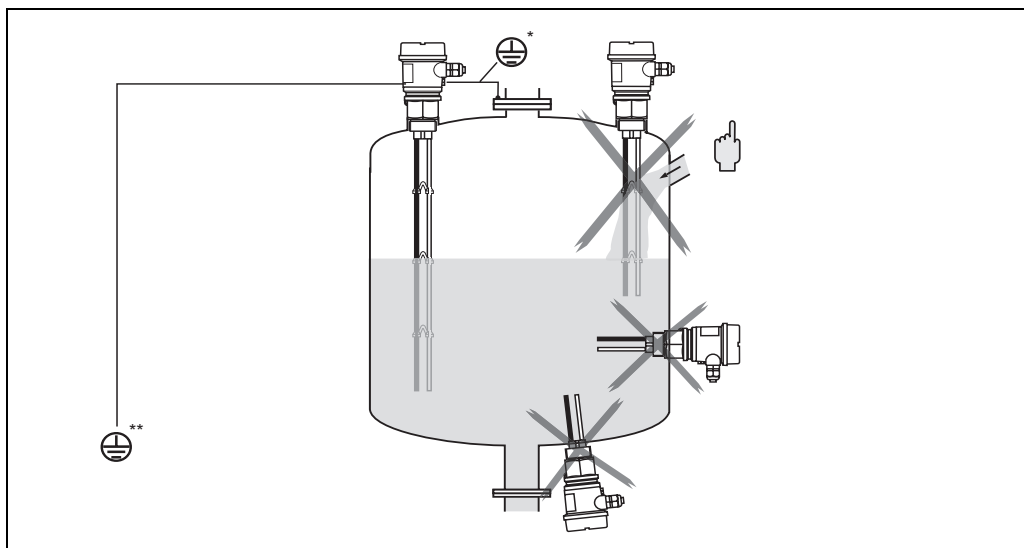
## Installation

### Installation instructions

#### Mounting location

e.g. storage area and buffer tank.

#### Orientation (vertical)



\* Metal tank

\*\* Plastic tank



Note!

The probe rods should never be in contact with the tank.



Note!

In the case of elevated electromagnetic radiation: protective ground should be attached to the device by a possibly short line.

## Environment

### Ambient temperature range

Ambient temperature for the electronic: -40...70 °C

The functionality of the display may be limited for temperatures  $T_a < -20$  °C and  $T_a > +60$  °C

### Ambient temperature limits

-40...80 °C (in limit range: restricted accuracy)

### Storage temperature

-40...80 °C

### Climate class

Suitable for the tropics as per DIN IEC 68 Part 2-38

### Degree of protection

IP66

### Shock resistance

DIN EN 60068-2-27 / IEC 68-2-27: 30 g

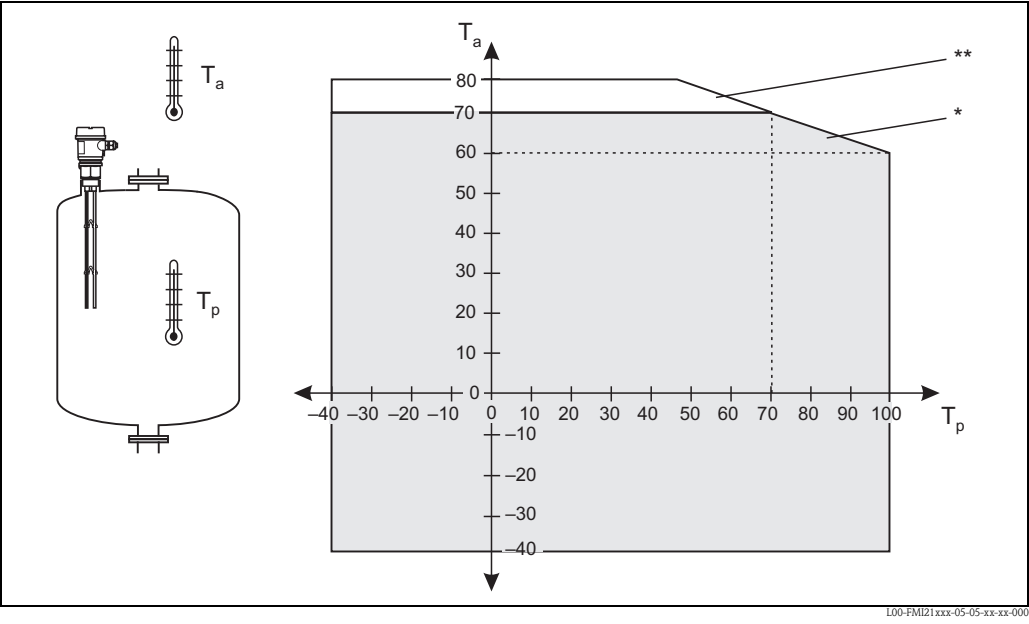
### Vibration resistance (with min. rod length 150 mm)

DIN EN 60068-2-64 / IEC 68-2-64: 20...2000 Hz, 1 (m/s<sup>2</sup>)<sup>2</sup>/Hz

### Electromagnetic compatibility

Interference emission to EN 61326, Electrical equipment Class B;  
Interference immunity to EN 61326, Annex A (Industrial)

Process

Environment	<p>Permitted ambient temperature <math>T_a</math> at the housing depending on the process temperature <math>T_p</math> in the tank:</p> <div><p>The diagram shows a cross-section of the Liquicap T FMI21 sensor installed in a tank. The sensor has a top connection for ambient temperature <math>T_a</math> and a lower probe for process temperature <math>T_p</math>. To the right is a graph of <math>T_a</math> (y-axis, -40 to 80) versus <math>T_p</math> (x-axis, -40 to 100). A shaded gray area represents the permitted work range. The upper boundary of this range is 80°C for <math>T_p</math> from -40°C to 45°C, then decreases linearly to 60°C at <math>T_p = 100°C</math>. The lower boundary is constant at -40°C. A dashed line at <math>T_a = 60°C</math> intersects the upper boundary at <math>T_p = 70°C</math>. The region above the upper boundary and below the dashed line is labeled with **, and the region below the dashed line is labeled with *.</p><p>* Permitted work range ** Work range with restricted accuracy</p><p>L00-FMI21 xxx-05-05-xx-xx-000</p></div>
Conductivity of medium	<p><math>\geq 30 \mu\text{S}/\text{cm}</math></p>
Process pressure	<p>-1...10 bar</p>

## Mechanical construction

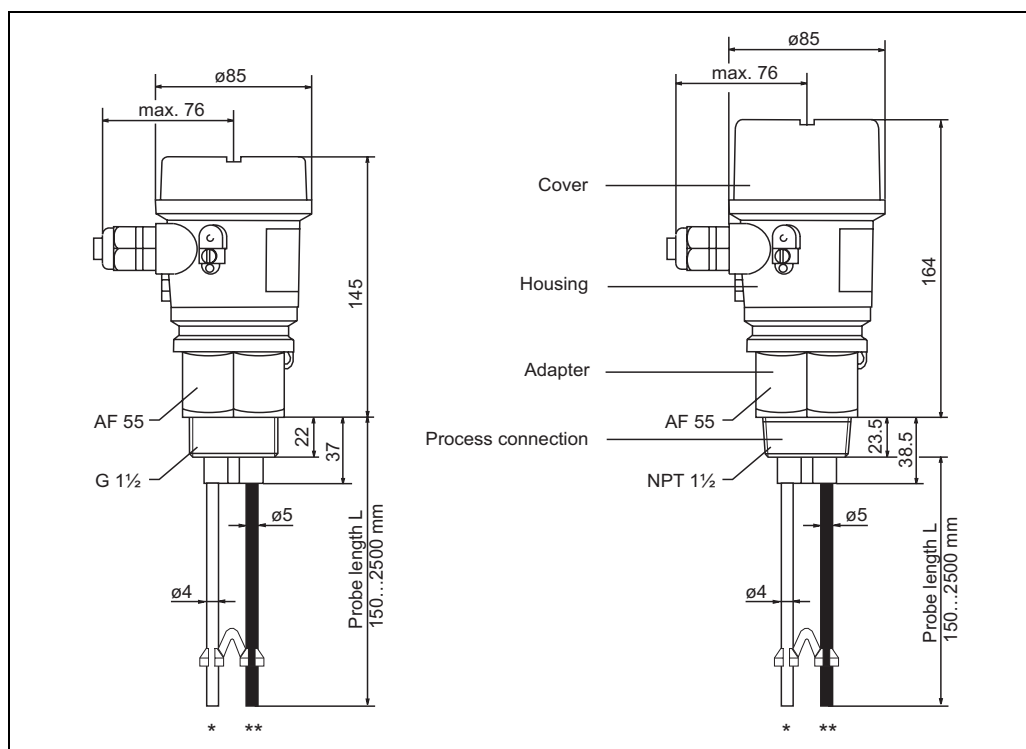


Note!  
All dimensions in mm (100 mm = 3.94 in)

### Design, dimensions

#### Rod probe

Process connection with parallel thread G 1½ or with tapered thread NPT 1½.

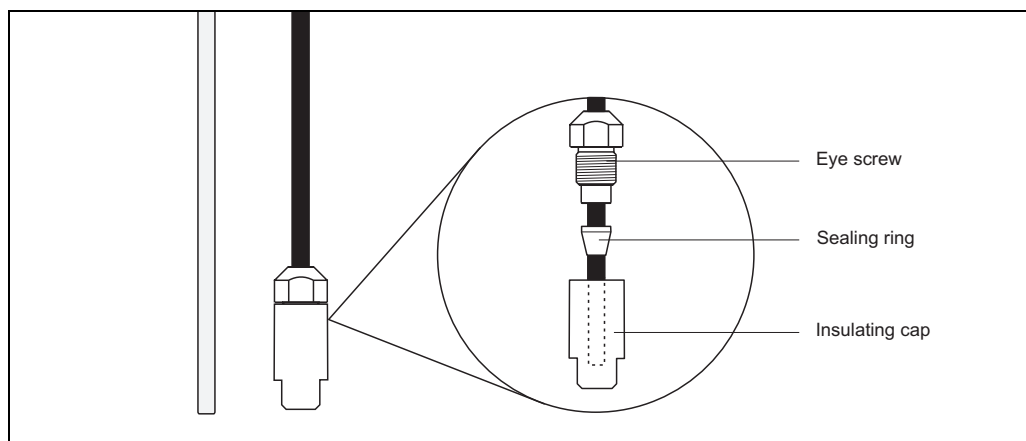


L00-FMI21xxx-06-05-xx-en-000

\* Ground rod (uninsulated)

\*\* Probe rod insulated

### Probe shortening set



L00-FMI21xxxx-17-06-xx-en-000



Note!  
If shortening the probe rods, the insulation above the cut must not be damaged!  
Recalibration is always necessary after shortening the probe. The active rod probe begins above the probe shortening set. Therefore the zero balance should be carried out at this place. Only the insulated rod must be insulated with the shortening set. The ground rod remains uninsulated.

**Weight****Rod 1 m length**FMI21 = 600 g

---

**Material****Probe rods**

- Rod: 1.4404/316L – (use in water-based media, alkalis ...)  
Optional: carbon fibre CFC/rod retainer silver (Ag) – (use in acids e.g. hydrochloric acid)
- Insulation: PP
- Spacer: PP
- Probe shortening set: PP

**Housing F16**

- Housing: PBT-FR
- Cover: PBT
- Cover with sight glass: PA
- Cable gland: PA
- Adapter: PBT
- Dummy plug: PBT

**Process connections**

- G 1½ A (PPS, DIN ISO 228/1)
- NPT 1½ (PPS, ANSI B 1.20.1)

**Seals**

- Seal between housing and process connection: EPDM
  - Seal for plastic housing cover F16: EPDM
  - Sealing ring for process connection G 1½ A: elastomer fibre asbestos-free (resistant to oils, solvents, steam, weak acids and alkalis)
- 

**Fitted electrodes****Rod probe with two rods**

- Rod diameter without insulation: 4 mm
- Maximum rod length: 2500 mm
- Minimum rod length: 150 mm
- Insulation thickness: 0.5 mm
- Extraction forces (parallel probe rod): 1000 N
- Lateral loading capacity: 2 Nm

## Human interface

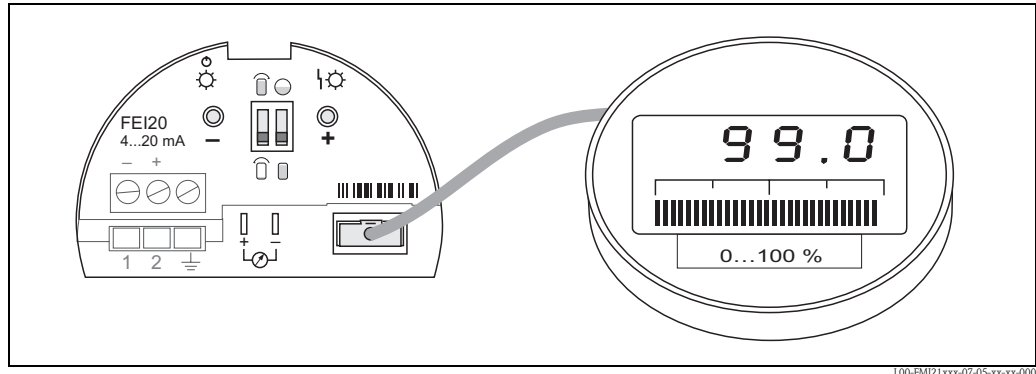
### Operating elements



#### Electronic insert FEI20

Note!

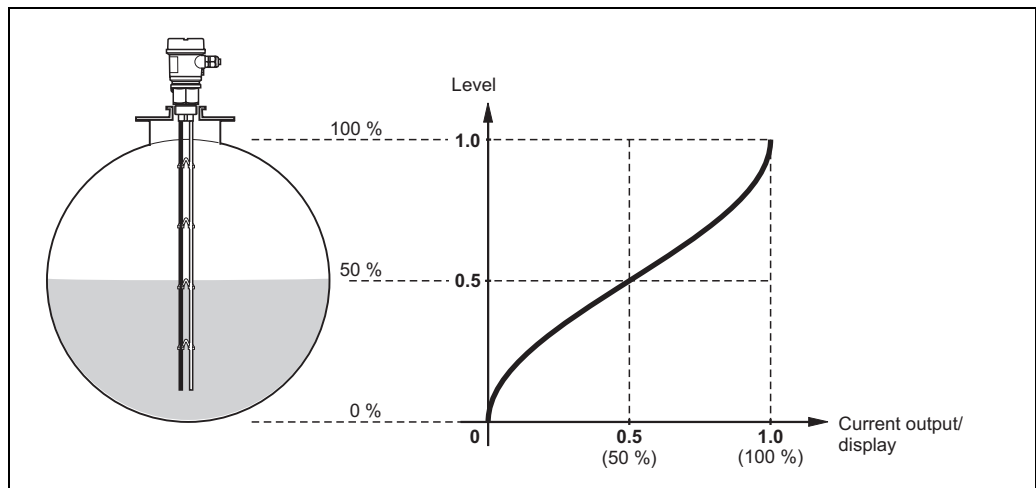
The display indicates no comma, if the probe length is < 200 mm.



L00-FMI21xxx-07-05-xx-xx-000

- Key (-)
- Key (+)
- 4...20 mA current pick-off, e.g. for full/empty calibration with multimeter.  
(No need to disconnect circuit!)
- Display connection
- DIL switch (left) to determine calibration type (full/empty) of probe
- DIL switch (right) to switch linearisation on and off (only for horizontal cylindrical tanks)

**Linearisation** (for cylindrically lying tanks):



L00-FMI21xxx-15-05-xx-en-001



Note!

In cylindrically lying tanks the current output and display are in proportion to the volume.

### Display elements

#### FEI20

- A red light emitting diode: as alarm or warning (flashing)
- A green light emitting diode: to indicate operational status (flashes every 5 sec. approx.) or to confirm key entries
- Display (optional) for measured value in %, bargraph for minimum and maximum probe capacitance.

## Certificates and approvals

---

<b>CE mark</b>	<p>The Liquicap T is in conformity with the statutory requirements of the EC Directives. Endress+Hauser confirms that the device has been tested successfully by applying the CE mark.</p> <p>CSA/US; General Purpose (GP) Kanada, USA</p>
<b>Overfill protection</b>	<p>Approvals</p> <ul style="list-style-type: none"><li>■ German Water Resources Law (WHG) - see commissioning notes in ZE263F (Z. 65.xx - xxx)</li></ul>
<b>Other standards and guidelines</b>	<ul style="list-style-type: none"><li>■ Low Voltage Directive (73/23/EEC)</li><li>■ DIN EN 61010 Part 1, 2001 Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures. Part 1: General Requirements</li><li>■ CAN/CSA-C22.2 No. 1010.1-92 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use; Part 1: General Requirements (Includes Amendment 1)</li><li>■ UL Std No. 61010C-1 Process Control Equipment; Part 1: General Requirements</li><li>■ EN 61326 Electrical Equipment for Measurement, Control and Laboratory Use EMC Requirements</li><li>■ EN 50021 Electrical Apparatus for Potentially Explosive Atmospheres Specification for Electrical Apparatus with Type of Protection "N"</li></ul>
<b>Ex approval</b>	<p>ATEX II 3 G EEx nA IIC T6</p> <p>All explosion protection data are given in a separate documentation (see: Documentation) which is available upon request.</p>
<b>Type of protection</b>	EEx nA IIC T6 (non-sparking equipment)

## Ordering information

### Liquicap T FMI21

10	Approval:				
	A	Non-hazardous area			
	B	Non-hazardous area, WHG			
	C	ATEX II 3 G EEx nA IIC T6, WHG			
	D	CSA General Purpose, CSA C US			
	Y	Special version			
20	Process Connection:				
	1	Thread ISO228 G 1½, PPS			
	2	Thread ANSI NPT 1½, PPS			
	9	Special version			
30	Probe Length; Material; 150...2500 mm (6...100 inch):				
	A	... mm L, PP 316L			
	B	... mm L, PP carbon fiber (< 1000 mm)			
	C	... mm L, PP carbon fiber (> 1000 mm)			
	D	... inch L, PP 316L			
	E	... inch L, PP carbon fiber (< 40 inch)			
	F	... inch L, PP carbon fiber (> 40 inch)			
	Y	Special version			
40	Housing; Cable Entry:				
	1	F16 polyester IP66 NEMA4X; gland M20			
	2	F16 polyester IP66 NEMA4X; thread NPT ½			
	3	F16 polyester IP66 NEMA4X; thread G ½			
	9	Special version			
50	Electronics; Output:				
	A	None			
	B	FEI20; 4...20 mA			
	C	FEI20; 4...20 mA + display			
	Y	Special version			
60	Additional Option:				
	1	Basic version			
	2	Shortening kit PP			
	9	Special version			
FMI21					Complete product designation

## Accessories

### Liquicap T

- Mounting nut G 1½  
Hexagon head, AF 60  
PN 52014146
- Shortening kit FMI21  
PN 52024300

### Spare parts

- Electronics FEI20  
PN 52025603
- Cover F16 high, transparent, with gasket  
PN 52025605
- Cover F16 grey, PBTP, with gasket  
PN 52025606
- Digital display, with holder  
PN 52025604
- Spacer probe rods, 5 pieces  
(5 pieces are included in the scope of delivery)  
PN 52025607

## Documentation

---



Note!

The specified documentations are available under [www.endress.com](http://www.endress.com).

---

### Technical Information

- Gateways / interfaces  
Fieldgate FXA320  
TI369F/00
- Process transmitter  
Preline RMA422  
TI072R/09
- Process transmitter  
Preline RMA421  
TI064R/09
- Transmitter power supply unit  
Preline RNS221  
TI081R/09
- Active barrier  
Preline RN221N  
TI073R/09

---

### Operating Instructions

- Liquicap T FMI20  
KA233F/00

---

### Certificates

#### WHG (German Water Resources Law)

- Liquicap T  
ZE263F/00

#### ATEX

- Liquicap T  
II 3 G EEx nA IIC T6  
XA320F/00

#### International Head Quarter

Endress+Hauser  
GmbH+Co. KG  
Instruments International  
Colmarer Str. 6  
79576 Weil am Rhein  
Deutschland

Tel. +49 76 21 9 75 02  
Fax +49 76 21 9 75 34 5  
[www.endress.com](http://www.endress.com)  
[info@ii.endress.com](mailto:info@ii.endress.com)

**Endress+Hauser**   
People for Process Automation