

Technical Information

Liquicap M FMI51, FMI52

Capacitance level measurement

For continuous measurement in liquids



Application

The Liquicap M FMI5x compact transmitter is used for the continuous level measurement of liquids.

Thanks to its robust and tried-and-tested construction, the probe can be used both in vacuums and in overpressure up to 100 bar. The materials used allow operating temperatures in the medium container of $-80\text{ }^{\circ}\text{C}$ to $+200\text{ }^{\circ}\text{C}$.

Used in conjunction with Fieldgate (remote measured value interrogation via the Internet), Liquicap M provides an ideal solution for inventorying materials and optimizing logistics (inventory control).

Your benefits

- No adjustment necessary for media with a conductivity of $100\text{ }\mu\text{S}/\text{cm}$ and higher. The probes are adjusted to the ordered probe length on leaving the factory (0 % to 100 %). This makes easy and fast commissioning possible.
- Menu-guided local configuration via plain text display (optional)
- Universal application thanks to wide range of certificates and approvals
- Use also in safety systems requiring functional safety to SIL2 in accordance with IEC 61508
- Corrosion-resistant, FDA-listed materials in contact with the process
- Can be switched for media forming buildup
- Short reaction times
- No need for readjustment after replacing electronics
- Automatic monitoring of electronics and possible damage to insulation, as well as rod breaking or rope tearing
- Suitable for interface measurement

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Function and system design

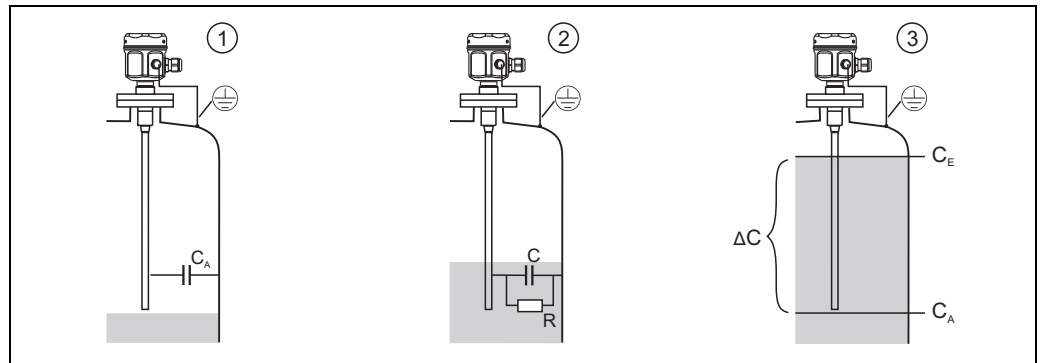
Measuring principle

The principle of capacitance level measurement is based on the change in capacitance of the capacitor due to the change in the level. 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. When the container is filled, the capacitance increases the more the probe is covered (2), (3). As a conductivity of $100 \mu\text{s}/\text{cm}$, the measurement is independent of the value for the dielectric constant (DK) of the liquid. As a result, fluctuations in the DK value do not affect the measured value display. Furthermore, the system also prevents the effect of medium buildup or condensate near the process connection for probes with an inactive length.



Note!

A ground tube is used as a counterelectrode for containers made of nonconductive materials.



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R : Conductivity of the liquid

C : Capacitance of the liquid

C_A : Initial capacitance (probe not covered)

C_E : Final capacitance (probe covered)

ΔC : Change in capacitance

Function

The selected electronic insert of the probe (e.g. FEI50H 4 to 20 mA HART) converts the measured change in capacitance of the liquid to a signal that is proportional to the level.

Phase-selective measurement

The evaluation of the container capacitance works along the principle of phase-selective measurement. In this process, the amount of alternating current and the phase shift between the voltage and current is measured. With these two characteristic quantities, the capacitance idle current can be calculated by the medium capacitor and the real current by the medium resistance. Conductive buildup stuck to the probe rod/rope acts like additional medium resistance and causes an error in measurement. As the size of the medium resistance can be determined with phase-selective measurement, the system compensates for the buildup on the probe.

Interface measurement

A prior adjustment also ensures a certain and definite measured value even if the emulsion layer is of varying thickness. In this process, the average value of the emulsion film is always measured. The adjustment values for empty and full adjustment can be calculated with the FieldCare operating program from Endress+Hauser.



1.) Water, for example (the medium must be conductive $\geq 100 \mu\text{S}/\text{cm}$)

2.) Emulsion

3.) Oil, for example (nonconductive medium $< 1 \mu\text{S}/\text{cm}$)

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Measuring system

PFM output (FEI57C)

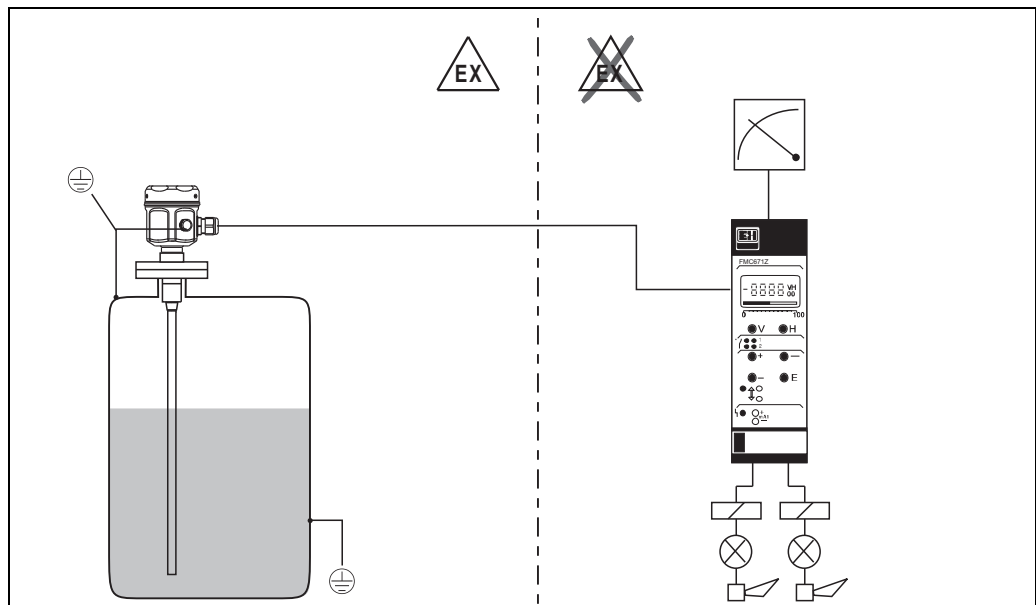
The complete measuring system consists of:

- The capacitance Liquicap M FMI51 or FMI52 level probe
- The FEI57C electronic insert
- A transmitter power supply unit



Note!

- The twin-core feeder is also used for PFM signal transmission.
- In combination with a power supply unit the FEC57C will only run in a 1-channel-mode and without an automatic alignment correction.



Level measurement

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4 to 20 mA output with HART protocol (FEI50H)

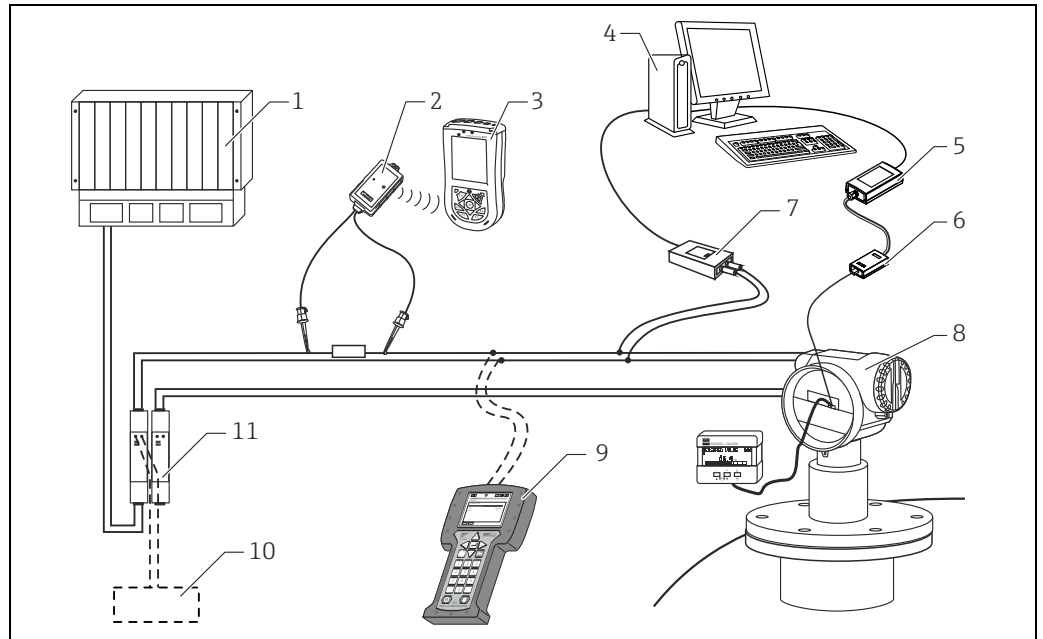
The complete measuring system consists of:

- The capacitance Liquicap M FMI51 or FMI52 level probe
- The FEI50H electronic insert
- A transmitter power supply unit (e.g. RN221N, RNS221, RMA421, RMA422)



Note!

DC voltage must be supplied to the electronic insert. The twin-core feeder is also used for HART protocol signal transmission.



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- 1 PLC (programmable logic controller)
- 2 VIATOR Bluetooth modem with connecting cable
- 3 Field Xpert
- 4 Computer with operating tool (z.B. FieldCare)
- 5 Commubox FXA291
- 6 ToF Adapter FXA291
- 7 Commubox FXA195 (USB)
- 8 Micropilot with display module
- 9 Field Communicator 475
- 10 FXA195 oder Field Communicator 475
- 11 Transmitter power supply unit RN221N (with communication resistor)

Local operation

- Standard - via keys and switches on the electronic insert
- Optional - via display and operating module

Remote operation

- With HART handheld terminal DXR375/475
- With a personal computer, Commubox FXA195 and the operating program FieldCare.



Note!

FieldCare is a graphic operating program and is used to support commissioning, data backup, signal analysis and documentation of the measuring point.

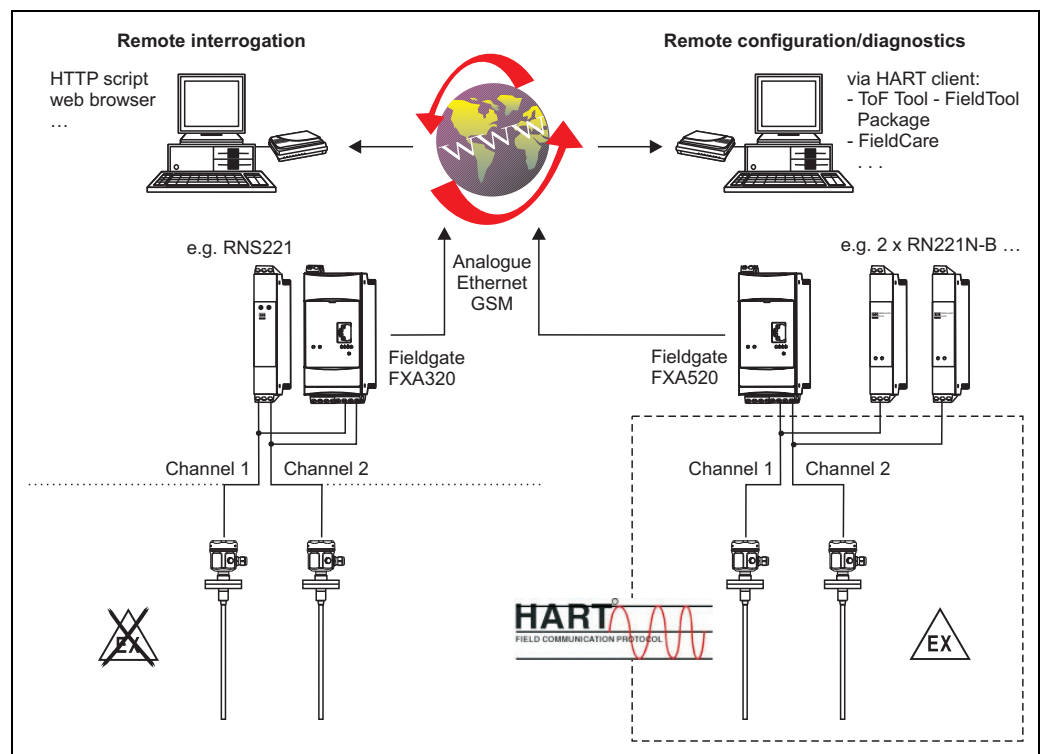
System integration via Fieldgate

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, take this into account in their own production planning. The Fieldgate monitors the configured level limits 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. Service technicians can diagnose and configure the connected HART devices remotely in the event of an alarm or also for routine checks. All that is required for this is the appropriate HART operating software (e.g. FieldCare) for the connected device. 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.



Operating conditions: Installation

Installation instructions

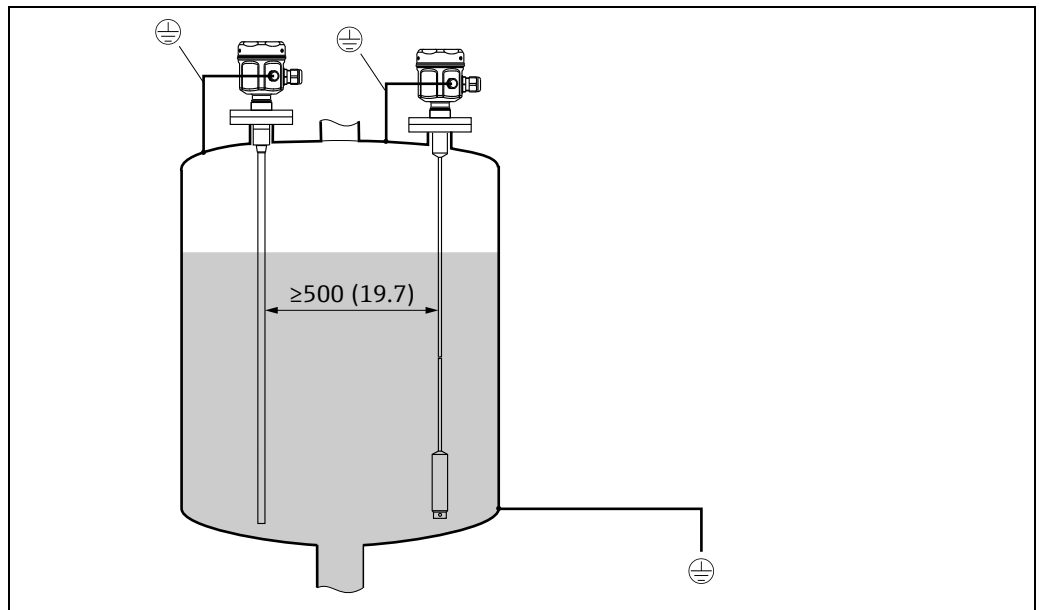


Liquicap M FMI51 (rod probe) can be installed vertically from above or below.
Liquicap M FMI52 (rope probe) can be installed vertically from above.

Note!

- The probe may not come into contact with the container wall! Do not install probes in the area of the filling curtain!
- When using in agitating tanks, make sure you install at a safe distance from the agitator.
- If multiple probes are mounted next to each other, a minimum distance of 500 mm (19.7 in) between the probes must be observed.
- Rod probes with a ground tube should be used in the event of severe lateral load.
- When mounting, ensure there is a good electrically conductive connection between the process connection and the tank. Use an electrically conductive sealing band for example.

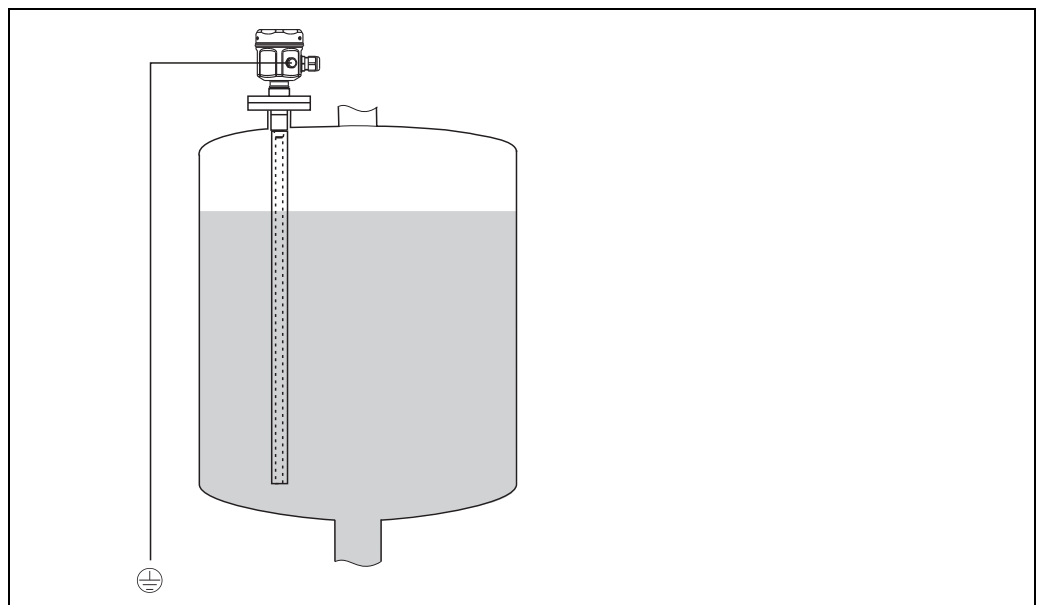
For containers that conduct electricity e.g. steel tanks



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Dimensions mm (in)

For containers that do not conduct electricity e.g. plastic tanks



L00-FMI5xxxx-11-06-xx-xx-002

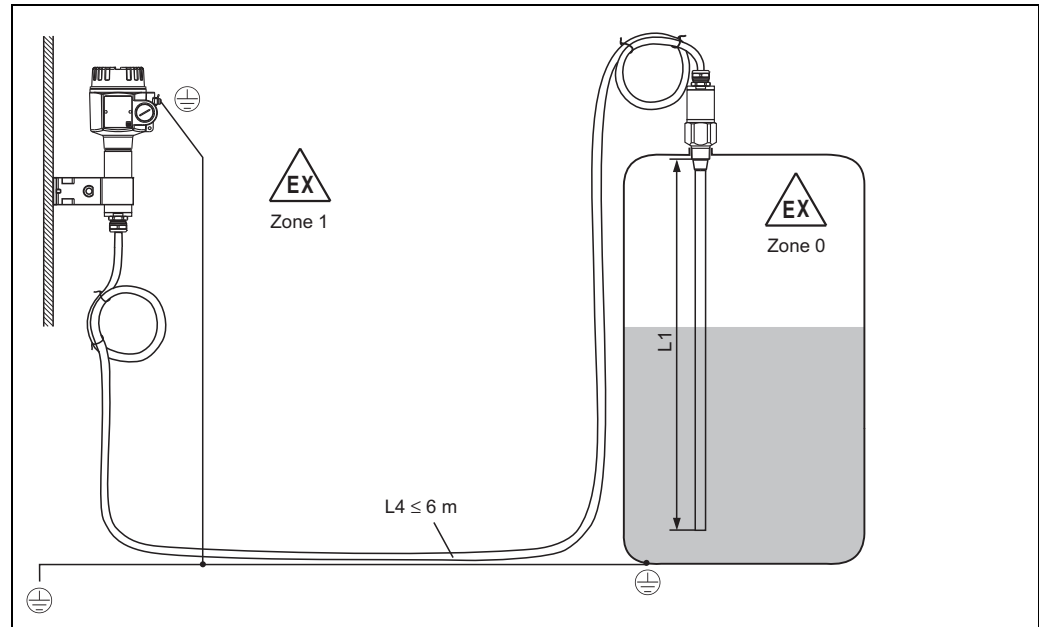
Probe with ground tube and grounding

With separate housing



Note!

- The maximum connection length between the probe and the separate housing is 6 m (L4). The desired length must be quoted when ordering a Liquicap M with a separate housing.
- The overall length $L = L1 + L4$ may not exceed 10 m.
- If the connecting cable is to be shortened or passed through a wall, it must be separated from the process connection.



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Rod length L1 max. 4 m

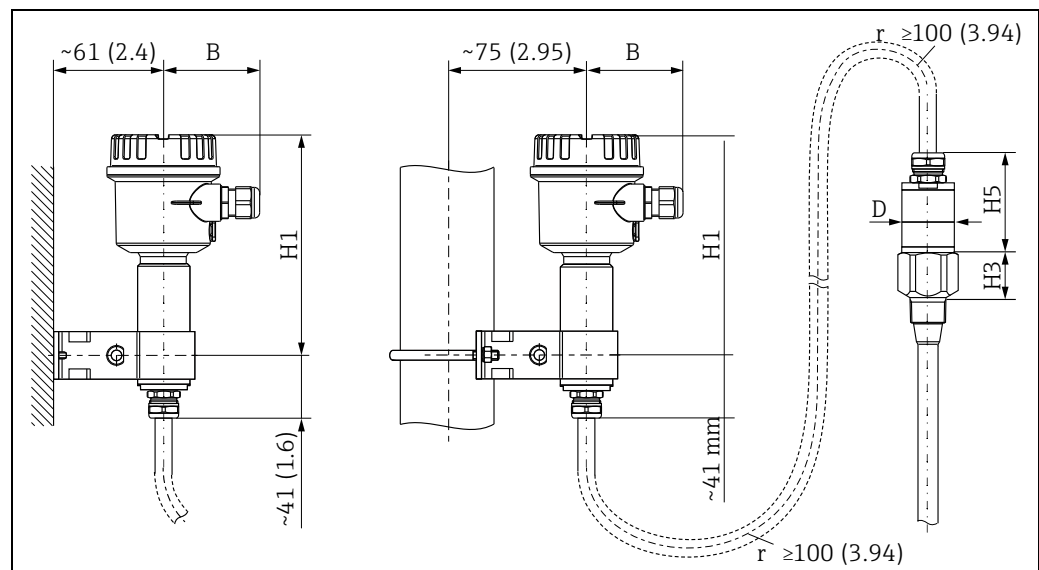
Rope length L1 max. 9.7 m (the maximum total length of L1 + L4 should not exceed 10 m).

Extension heights

Housing side: wall mounting

Housing side: pipe mounting

Sensor side



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Dimensions mm (in)



Note!

- The cable has a bending radius of $r \geq 100$ mm
- Connecting cable: $\varnothing 10.5$ mm
- Outer jacket: silicone, notch-resistant

	Polyester housing (F16)	Stainless steel housing (F15)	Aluminum housing (F17)
B (mm)	76	64	65
H1 (mm)	172	166	177

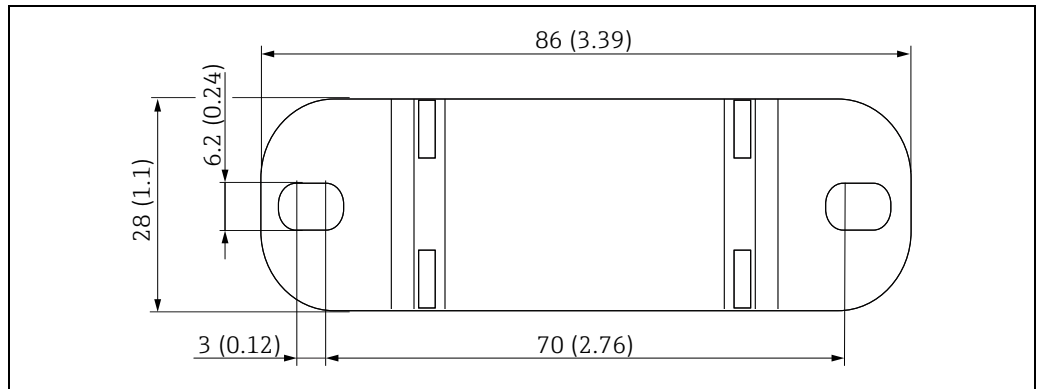
		H5 (mm)	D (mm)
Probes Ø10 mm rod		66	38
Probes Ø16 mm rod or rope (without fully insulated inactive length)	G ^{3/4} ", G1", NPT ^{3/4} ", NPT1", Clamp 1", Clamp 1½", Universal Ø44, flange <DN 50, ANSI 2", 10K50	66	38
	G1½", NPT1½", Clamp 2", DIN 11851, flanges ≥DN 50, ANSI 2", 10K50	89	50
Probes Ø 22 mm rod or rope (with fully insulated inactive length)		89	38

Wall holder unit



Note!

- The wall holder unit is part of the scope of supply for device versions with a separate housing.
- The wall holder unit first has to be screwed to the separate housing before you can use it as a drilling template. The distance between the holes is reduced by screwing it to the separate housing.



Dimensions mm (in)

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Operating conditions: Environment

Ambient temperature range	<ul style="list-style-type: none"> ■ -50 to +70 °C ■ -40 to +70 °C (with F16 housing) ■ Observe restrictions (derating) → 11 ■ If operating outdoors, use a protective cover! → 33
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Storage temperature	-50 to +85 °C
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Climate class	DIN EN 60068-2-38/IEC 68-2-38: test Z/AD
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Vibration resistance	DIN EN 60068-2-64/IEC 68-2-64: 20 Hz– 2000 Hz; 0.01 g ² /Hz
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Shock resistance	DIN EN 60068-2-27/IEC 68-2-27: 30 g acceleration
-------------------------	--

Cleaning	<p>Housing: When cleaning, make sure that the cleaning agent used does not attack or corrode the housing surface or seals.</p>
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Probe:
Depending on the application, buildup (contamination and soiling) can form on the probe rod. 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 rod is not damaged.

Degree of protection

	IP66*	IP67*	IP68*	NEMA4X**
Polyester housing F16	X	X	-	X
Stainless steel housing F15	X	X	-	X
Aluminum housing F17	X	X	-	X
Aluminum housing F13 with gas-tight process seal	X	-	X***	X
Stainless steel housing F27 with gas-tight process seal	X	X	X***	X
Aluminum housing T13 with gas-tight process seal and separate connection compartment (Ex d)	X	-	X***	X
Separate housing	X	-	X***	X

* as per EN60529

** as per NEMA 250

*** Only with M20 cable entry or G1/2 thread

Electromagnetic compatibility (EMC)	<ul style="list-style-type: none"> ■ Interference emission to EN 61326, Electrical Equipment Class B Interference immunity to EN 61326, Annex A (Industrial) and NAMUR Recommendation NE 21 (EMC) Error current in accordance with Namur NE43: FEI50H = 22mA ■ A usual commercial instrument cable can be used.
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Operating conditions: Process

Process temperature range

The following diagrams apply for:

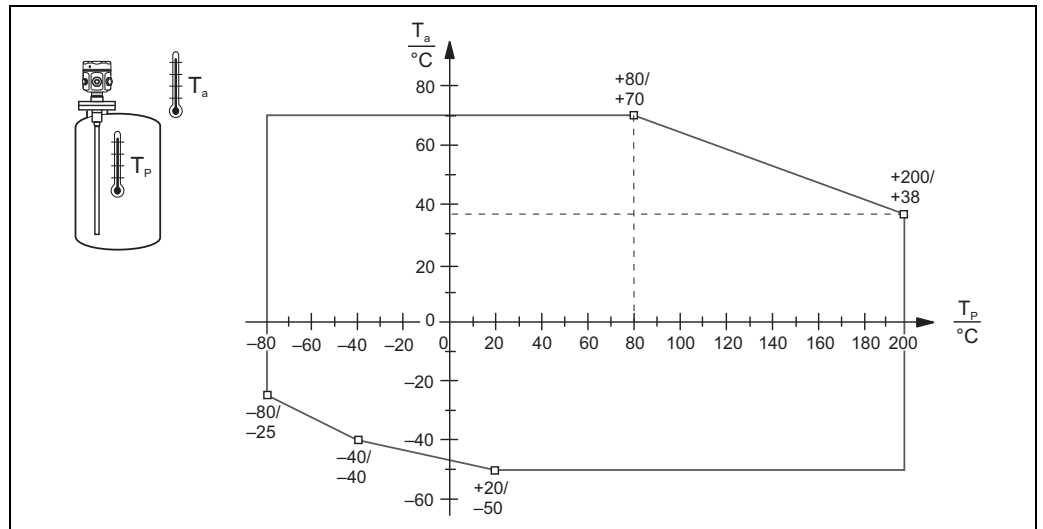
- Rod and rope version
- Insulation: PTFE, PFA, FEP
- Standard applications outside hazardous areas



Note!

The temperature is restricted to $T_a -40\text{ }^\circ\text{C}$ if the polyester housing F16 is used or if additional option B is selected (free from paint-wetting impairment substances, only FMI51).

With compact housing

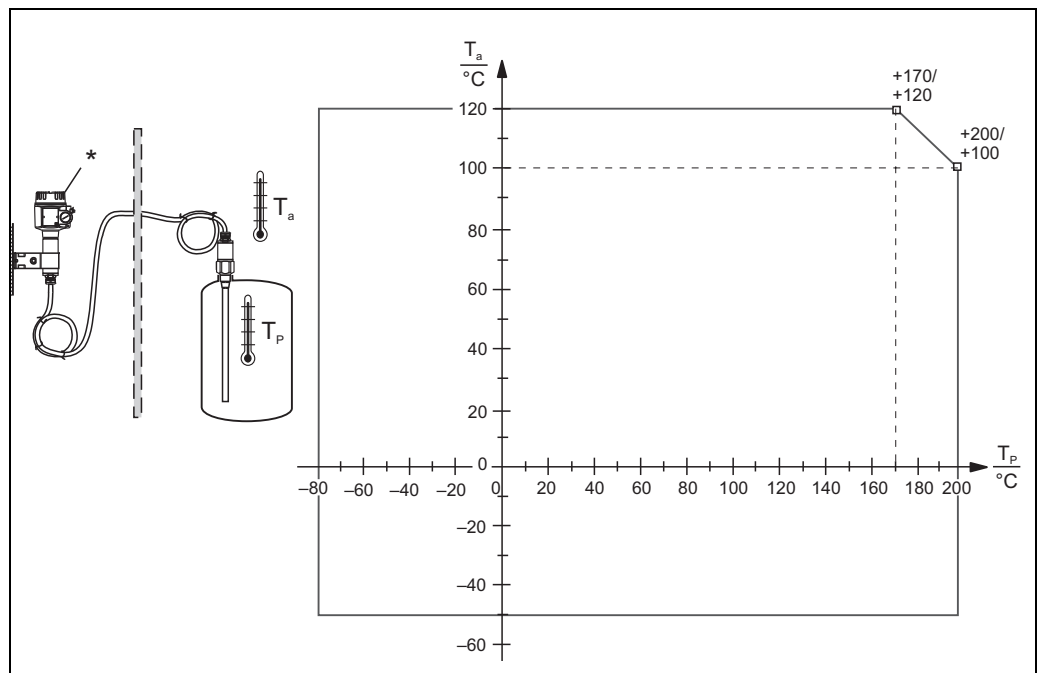


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T_a : Ambient temperature

T_P : Process temperature

With separate housing



L00-FMI5xxxx-05-05-xxxx-011

T_a : Ambient temperature

T_P : Process temperature

* The permitted ambient temperature at the separate housing is the same as indicated for the compact housing.

Influence of process temperature Error in case of fully insulated probes typically 0.13%/K related to the full scale value.

Process pressure limits

Probe $\varnothing 10$ mm (including insulation)

-1 to 25 bar (observe dependencies: process temperature and process connection → 11 and → 17).

Probe $\varnothing 16$ mm (including insulation)

- -1 to 100 bar (observe dependencies: process temperature and process connection → 11 and → 17)
- In the event of an inactive length, the maximum permitted process pressure is 63 bar
- In the event of CRN approval and inactive length, the maximum permitted process pressure is 32 bar

Probe $\varnothing 22$ mm (including insulation)

-1 to 50 bar (observe dependencies: process temperature and process connection → 11 and → 17).

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

- EN 1092-1: 2005 Table, Appendix G2
With regard to its resistance/temperature property, the material 1.4435 is identical to 1.4404 which is grouped under 13E0 in EN 1092-1 Tab. 18. The chemical composition 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

In each case it applies to the lowest value from the derating curves of the device and the selected flange.

Pressure and temperature derating

For process connections $\frac{1}{2}$ ", $\frac{3}{4}$ ", 1", flanges < DN50, < ANSI 2", < JIS 50A (10 mm rod)

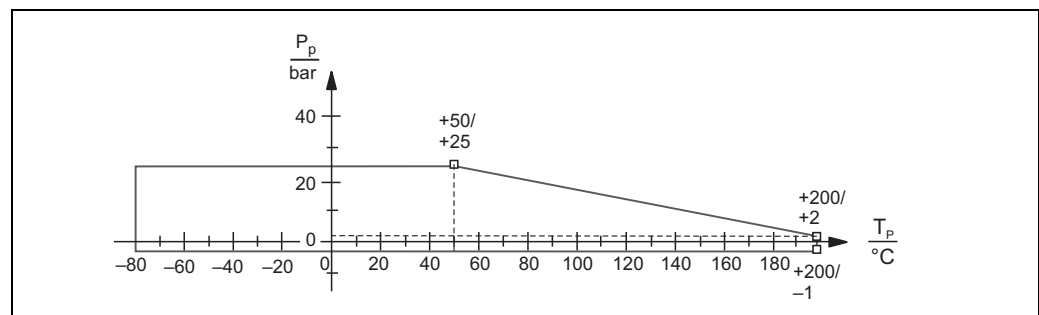
For process connections $\frac{3}{4}$ ", 1", flanges < DN50, < ANSI 2", < JIS 50A (16 mm rod)

Rod insulation: PTFE, PFA

Rope insulation: FEP, PFA

Note!

See also "Process connections" → 17.



P_p : Process pressure
 T_p : Process temperature

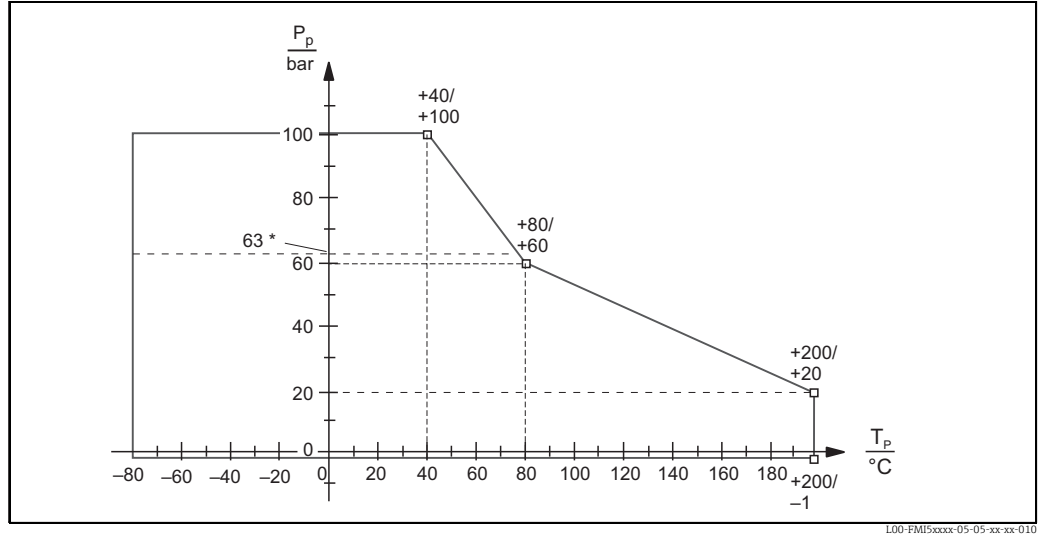
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For process connections 1½", flanges ≥ DN50, ≥ ANSI 2", ≥ JIS 50A (16 mm rod)

Rod insulation: PTFE, PFA
 Rope insulation: FEP, PFA

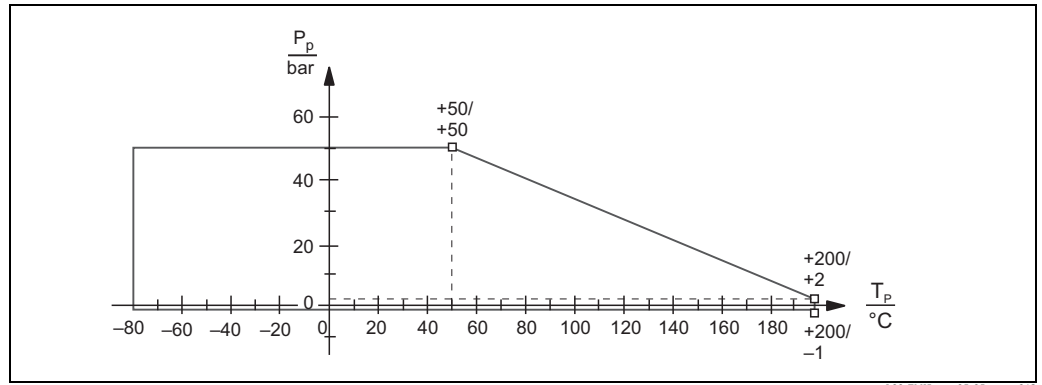


Note!
 See also "Process connections" → 17



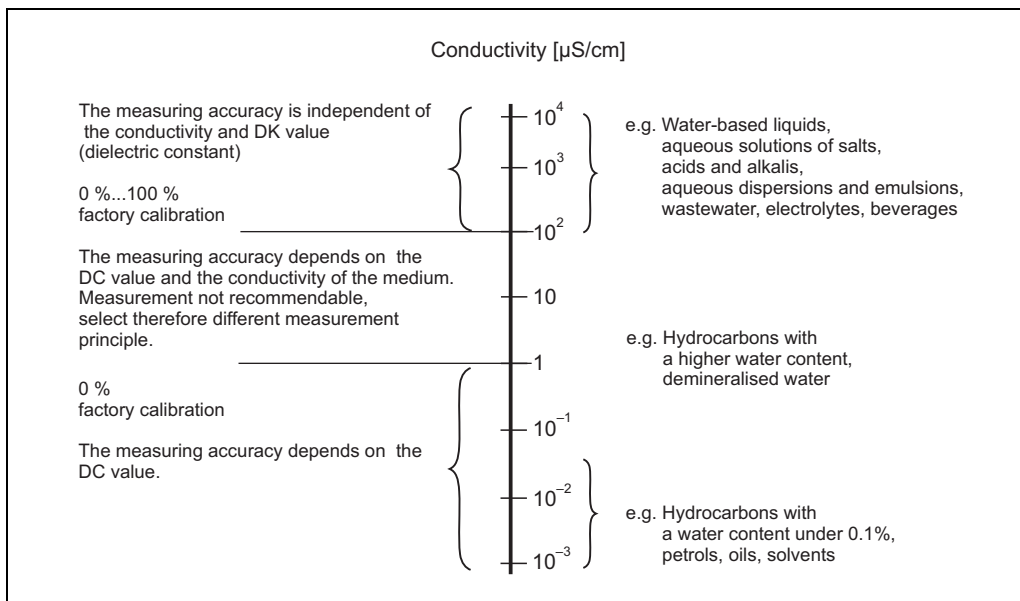
P_p : Process pressure
 T_p : Process temperature
 * For probes with an inactive length.

With a fully insulated inactive length (22 mm rod):



P_p : Process pressure
 T_p : Process temperature

Liquicap M operational range



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Typical DK values (dielectric constant)	
Air	1
Vacuum	1
General liquefied gases	1.2 - 1.7
Gasoline	1.9
Cyclohexane	2
Diesel fuel	2.1
General oils	2 - 4
Methyl ether	5
Butanol	11
Ammonia	21
Latex	24
Ethanol	25
Caustic soda	22 - 26
Acetone	20
Glycerine	37
Water	81



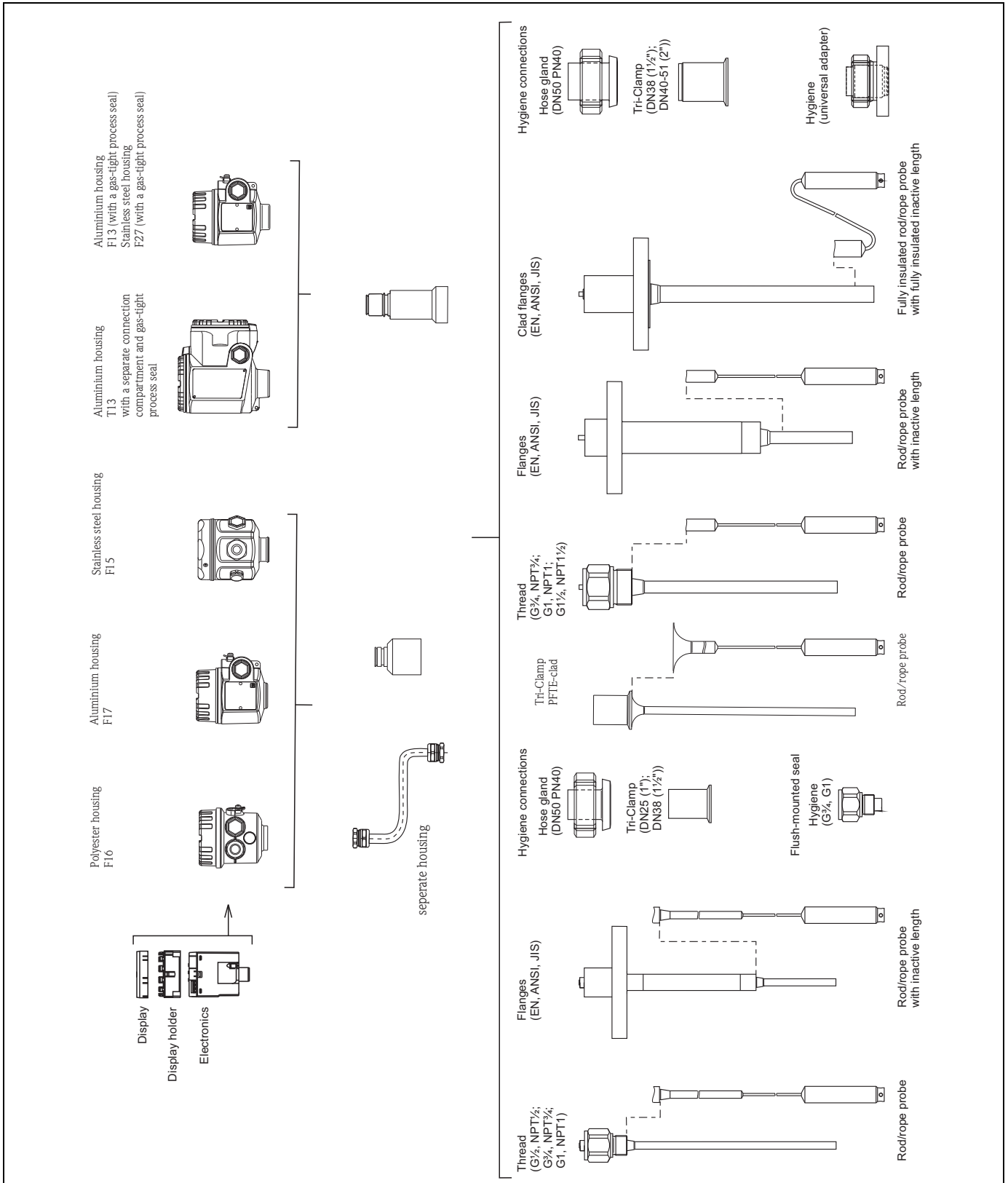
Note!
 Further information and dielectric constants (DC values) in the Download Area of the Endress+Hauser web site:

- the Endress+Hauser DC manual (CP01076F)
- the Endress+Hauser "DC Values App" (available for Android and iOS)

Mechanical construction



Note!
The dimensions on the following pages are indicated in mm.



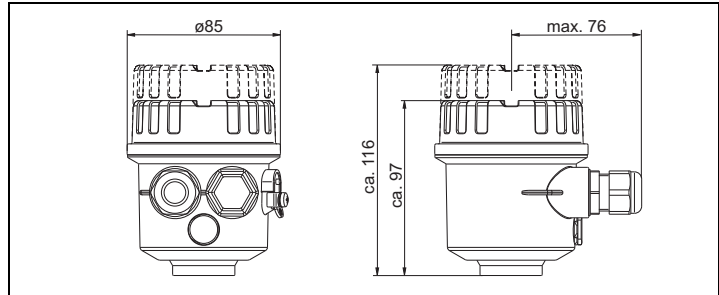
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Housing



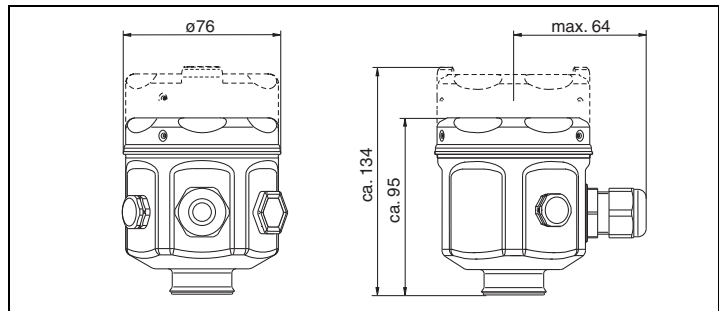
Note!
High cover for display (optional).

Polyester housing F16



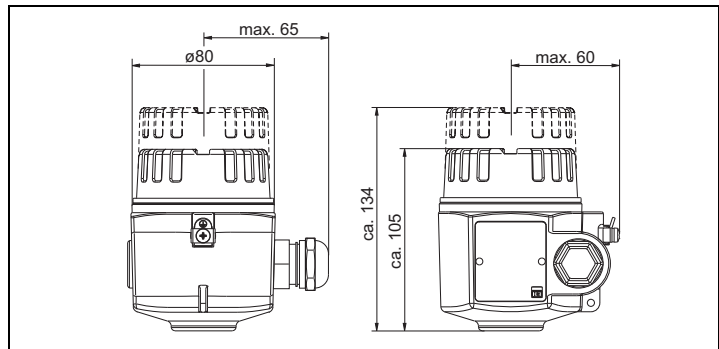
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Stainless steel housing F15



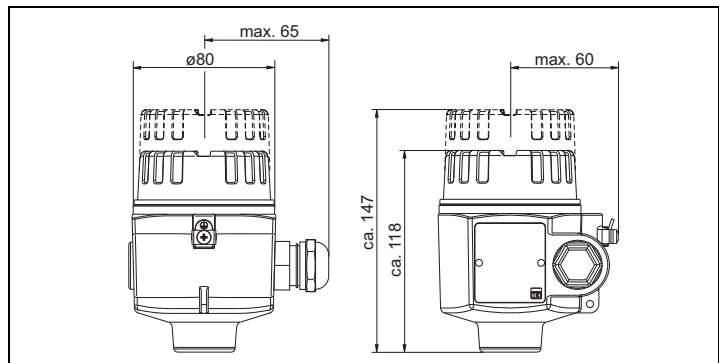
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Aluminum housing F17



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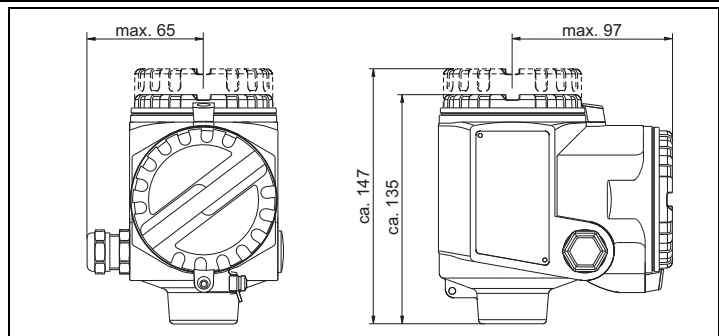
Aluminum housing F13
With gas-tight process seal



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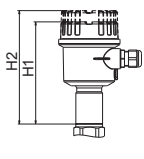
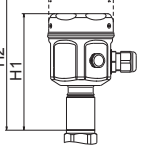
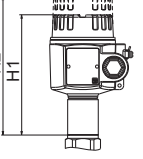
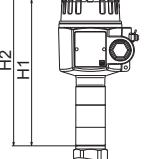
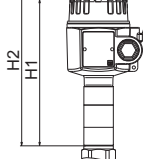
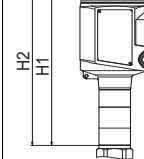
Stainless steel housing F27
with gas-tight process seal

Aluminum housing T13
With separate connection compartment and gas-tight process seal

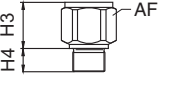
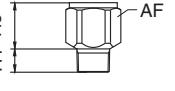
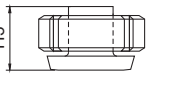

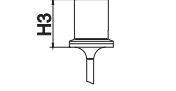


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Extension height of housing with adapter

	Polyester housing F16	Stainless steel housing F15	Aluminum housing F17	Aluminum housing F13	Stainless steel housing F27	Aluminum housing T13
	 L00-FMI5xxxx-06-05-xx-xx-044	 L00-FMI5xxxx-06-05-xx-xx-046	 L00-FMI5xxxx-06-05-xx-xx-045	 L00-FMI5xxxx-06-05-xx-xx-048	 L00-FMI5xxxx-06-05-xx-xx-048	 L00-FMI5xxxx-06-05-xx-xx-047
Order code	2	1	3	4	6	5
H1 (without display)	143	141	150	194	194	210
H2 (with display)	162	179	179	223	223	223

Process connections

	Thread G		Thread NPT		Threaded pipe joint	Tri-Clamp	Tri-Clamp clad		
	 L00-FMI5xxxx-06-05-xx-en-007 (DIN EN ISO 228-1)		 L00-FMI5xxxx-06-05-xx-en-008 (ANSI B 1.20.1)		 L00-FMI5xxxx-06-05-xx-xx-040 (DIN11851)	 L00-FMI5xxxx-06-05-xx-xx-111 (ISO2852)	 L00-FMI5xxxx-06-05-xx-xx-103 (ISO2852)		
Rod probes Ø 10, rope probes									
For pressures up to	25 bar		25 bar		25 bar	25 bar**		-	
Version / order code	G ½ / GCJ G ¾ / GDJ G 1 / GEJ		NPT ½ / RCJ NPT ¾ / RDJ NPT 1 / REJ		DN50 PN40 / MRJ	DN25 (1") / TCJ DN38 (1½") / TJJ		--	
Dimensions	H3 = 38 H4 = 19 AF = 41		H3 = 38 H4 = 19 AF = 41		H3 = 57	H3 = 57		-	
Surface roughness***	-		-		≤ 0.8 µm	≤ 0.8 µm		-	
Additional information	Seal: elastomer		-		-	EHEDG*, 3A*		-	
Rod probes Ø16, rope probes									
For pressures up to	25 bar	100 bar	25 bar	100 bar	40 bar	25 bar**	40 bar**	16 bar**	16 bar**
Version / order code	G ¾ / GDJ G 1 / GEJ	G 1½ / GGJ	NPT ¾ / RDJ NPT 1 / REJ	NPT 1½ / RGJ	DN50 PN40 / MRJ	DN38 / TNJ (1½")	DN40-51 / TDJ (2")	DN38 / TJK (1½")	DN40-51 / TDK (2")
Dimensions	H3 = 38 H4 = 19 AF = 41	H3 = 41 H4 = 25 AF = 55	H3 = 38 H4 = 19 AF = 41	H3 = 41 H4 = 25 AF = 55	H3 = 66	H3 = 98****	H3 = 66	H2 = 66	
Surface roughness***	-		-		≤ 0.8 µm	≤ 0.8 µm		≤ 0.8 µm	
Additional information	Seal: elastomer		-		-	EHEDG*, 3A*		EHEDG, 3A*	
Rod probes Ø 22, rope probes									
For pressures up to	50 bar		50 bar		-	-		-	
Version / order code	G1½ / GGJ		NPT1½ / RGJ		-	-		-	

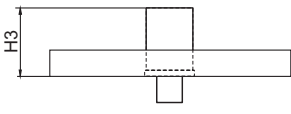
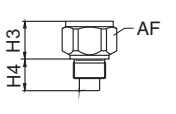
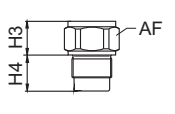
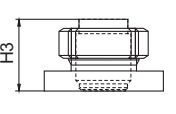
	Thread G	Thread NPT	Threaded pipe joint	Tri-Clamp	Tri-Clamp clad
Dimensions	H3 = 85 H4 = 25 AF = 55	H3 = 85 H4 = 25 AF = 55	-	-	
Additional information	Seal: elastomer	-	-	-	

* EHEDG, 3A: Certificate only applies for probes without an inactive length and with a fully insulated probe rod.

** In the event of CRN approval, the maximum permitted process pressure is 11 bar.

*** Not in conjunction with inactive length.

**** Process connection: Tri-Clamp (47 mm) with seal (2 mm) and removable clamp (49 mm).

	Flanges	Hygiene connection	Hygiene connection	Hygiene connection
	 <p>(EN1092-1) (ANSI B 16.5) (JIS B2220)</p>	 <p>Thread with flush-mounted seal</p>	 <p>Thread with flush-mounted seal</p>	 <p>Adapter 44 mm with flush-mounted seal</p>
Rod probes Ø10, rope probes				
For pressures up to	Max. 25 bar (depends on flange)	25 bar	25 bar	-
Version / order code	EN / B## ANSI / A## JIS / K##	G¾ / GQJ	G1 / GWJ	-
Dimensions	H3 = 57	H3 = 31 H4 = 26 AF = 41	H3 = 30 H4 = 27 AF = 41	-
Additional information	Also clad (PTFE)	Weld-in adapter see "Accessories" Page 33 EHEDG*, 3A*	Weld-in adapter see "Accessories" Page 33 EHEDG*, 3A*	-
Rod probes Ø16, rope probes				
For pressures up to	Max. 100 bar (depends on flange)	-	-	16 bar (tightening torque 10 Nm)
Version / order code	EN / B## ANSI / A## JIS / K##	-	-	Universal adapter / UPJ
Standard dimensions: Dimensions with inactive length:	H3 = 66 H3 = 56	- -	- -	H3 = 57 -
Additional information	Also clad (PTFE)	-	-	Universal adapter see "Accessories" → 34
Rod probes Ø22, rope probes				
For pressures up to	Max. 50 bar (depends on flange)	-	-	-
Version / order code	EN / B## ANSI / A## JIS / K##	-	-	-
Dimensions	H3 = 111	-	-	-
Additional information	Only clad (PTFE)	-	-	-

* EHEDG, 3A: Certificate only applies for probes without an inactive length and with a fully insulated probe rod.

Rod probes FMI51



Note!

- The active probe rod is always fully insulated (dimension L1).
- Total length of probe from sealing surface: $L = L1 + L3$
- Thickness of insulation for probe rod diameter: 10 mm = 1 mm; 16 mm = 2 mm; 22 mm = 2 mm
- The insulation is welded at the tip of the probe. Measurement cannot be performed in this area.
 Probe rod diameter 10 mm: approx. 10 mm
 Probe rod diameter 16 and 22 mm: approx. 15 mm
- For conductive liquids ($>100 \mu\text{S/cm}$), the probe is adjusted at the factory to the probe length ordered (0 % to 100 %). For nonconductive liquids ($<1 \mu\text{S/cm}$), 0% adjustment is performed at the factory. The 100% adjustment has to be carried out on site.
- Length tolerances L1, L3: <1 m: 0 to -5 mm, 1 to 3 m: 0 to -10 mm, 3 to 6 m: 0 to -20 mm

	Rod probe		Rod probe with ground tube		Rod probe with inactive length		Rod probe with inactive length and ground tube		Rod probe with fully insulated inactive length
<p style="text-align: center; font-size: small;">L00-FMI5xxxx-06-05-xx-xx-102</p>									<p style="text-align: center; font-size: small;">L00-FMI5xxxx-06-05-xx-xx-051</p>
Total length (L)	100...4000		100...4000		200...6000		200...6000		300...4000
Active rod length (L1)	100...4000		100...4000		100...4000		100...4000		150...3000
Inactive rod length (L3)	-		-		100...2000		100...2000		150...1000
Ø Probe rod	10	16	10	16	10	16	10	16	22**
Height of the cone at the end of the active rod length (L1), depending on the probe diameter	10	13	10	13	10	13	10	13	-
Ø Ground tube with or without inactive length	-	-	22	43	22	43	22	43	22**
Lateral loading capacity (Nm) at 20 °C	<15	<30	<40	<300	<30	<60	<40	<300	<25
For use in agitating tanks	-	-	-	X	-	-	-	X	-
For conductive liquids >100 µS/cm	X	-	-	-	X	-	-	-	X
For nonconductive liquids <1 µS/cm	-	-	X	-	-	-	X	-	-
For aggressive liquids	X	-	-	-	-	-	-	-	X
For high-viscosity liquids	X	-	-	-	X	-	-	-	X
For use in plastic tanks	-	-	X	-	-	-	X	-	-
For use in mounting nozzles	-	-	-	-	X	-	X	-	X
In the event of condensate on tank ceiling	-	-	-	-	X	-	X	-	X

* H4 = Thread height (important for calculating the exact probe length for process connections with a thread.) → 17

** Probe tube

Rod probes FMI51 for hygiene applications



Note!

- Total length of probe from sealing surface: $L = L1$
- Thickness of insulation with probe rod diameter 16 mm = 2 mm
- Length tolerances L1: <1 m: 0 to -5 mm, 1 to 3 m: 0 to -10 mm, 3 to 6 m: 0 to -20 mm

	Rod probe with clad Tri-Clamp
Total length (L)	100...4000
Active rod length (L1)	100...4000
Probe rod diameter	16
∅ Ground tube	--
∅ Inactive length	--
Lateral loading capacity (Nm) at 20 °C	<30
For use in agitating tanks	--
For conductive liquids >100 μS/cm	X
For high-viscosity conductive liquids	--
For nonconductive liquids <1 μS/cm	X
For aggressive liquids	X
For high-viscosity liquids	X
For use in plastic tanks	--
For use in mounting nozzles	--
In the event of condensate on tank ceiling	--

FMI52 rope probes



Note!

- The active probe length is always fully insulated (dimension L1).
- Total length of probe from sealing surface: $L = L1 + L3$
- All rope probes are prepared for tensioning in containers (tensioning weight / anchor hole)
 - In case of media $< 1 \text{ mS/cm}$, appropriate measures must be taken, e.g. a metallic reference point or a metallic tank.
 - Back-and-forth swinging of the rope directly influences the switch point. The probe must therefore be tightened.
- For conductive liquids ($> 100 \text{ } \mu\text{S/cm}$), the probe is adjusted at the factory to the probe length ordered (0 % to 100 %). For nonconductive liquids ($< 1 \text{ } \mu\text{S/cm}$), 0% adjustment is performed at the factory. Only the 100% adjustment must be carried out on site.
- Not suitable for agitator tanks, high-viscosity liquids and plastic tanks.
- Thickness of rope insulation 0.75 mm
- In the range of the anchor weight the measurement is not linear.
- Length tolerances L1, L3: $< 1 \text{ m}$: 0 to -10 mm, 1 to 3 m: 0 to -20 mm, 3 to 6 m: 0 to -30 mm, 6 to 12 m: 0 to -40 mm

	Rope probe	Rope probe with clad Tri-Clamp	Rope probe with inactive length (uninsulated)	Rope probe with fully insulated inactive length
<p style="text-align: center; font-size: small;">L00-FMI5xxxx-06-05-xx-xx-070</p>				<p style="text-align: center; font-size: small;">L00-FMI5xxxx-06-05-xx-xx-036</p>
Total length (L)	420...10000	420...10000	570...10000	570...10000
Active rope length (L1)	420...10000	420...9850	420...9850	420...9850
Inactive length (L3)	--	--	150...2000	150...1000
Ø Inactive length	--	--	22/43*	22**
Ø Probe rope	4	4	4	4
Ø Anchor weight	22	22	22	22
Ø Anchor hole	5	5	5	5
Tensile loading capacity (N) of probe rope at 20 °C	200	200	200	200
For aggressive liquids	X	X	--	X

	Rope probe	Rope probe with clad Tri-Clamp	Rope probe with inactive length (uninsulated)	Rope probe with fully insulated inactive length
For use in mounting nozzles	--		X	X
For conductive liquids >100 $\mu\text{S}/\text{cm}$	X		X	X
For aggressive liquids	X		--	X
For high-viscosity liquids	--		--	--
For nonconductive liquids <1 $\mu\text{S}/\text{cm}$	--		X	X
In the event of condensate on tank ceiling	--		X	X

* The \varnothing value of the inactive length depends on the process connection selected
 $\varnothing 22$: GDJ, GEJ, RDJ, REJ, TCJ, TJJ; Flansche: ASME B16.5: NPS $\leq 1\frac{1}{2}$ ", EN1092-1: \leq DN40, JIS: \leq 10K40
 $\varnothing 43$: GGJ, RGJ, TDJ, MRJ; Flansche: ASME B16.5: NPS ≥ 2 ", EN1092-1: \geq DN50, JIS: \geq 10K50

** probe tube

Weight	Housing with process connection:
	<ul style="list-style-type: none"> ■ F15, F16, F17, F13 approx. 4.0 kg ■ T13 approx. 4.5 kg ■ F27 approx. 5.5 kg
	+ Flange weight
	+ Probe rod \varnothing 10 mm: 0.5 kg/m,
	+ Probe rod \varnothing 22 mm: 0.8 kg/m
	+ Probe rod \varnothing 16 mm: 1.1 kg/m
	+ Probe rope: 0.04 kg/m

Technical data: probe

Capacitance values of probe

- Basic capacitance: approx. 18 pF

Additional capacitance

- Mount the probe with a minimum distance of 50 mm from a conductive container wall:
 Probe rod: approx. 1.3 pF/100 mm in air
 Probe rope: approx. 1.0 pF/100 mm in air
- Fully insulated probe rod in water:
 Approx. 38 pF/100 mm (16 mm rod)
 Approx. 45 pF/100 mm (10 mm rod)
 Approx. 50 pF/100 mm (22 mm rod)
- Insulated probe rope in water: approx. 19 pF/100 mm
- Rod probe with ground tube:
 - Insulated probe rod: in air approx. 6.4 pF/100 mm
 - Insulated probe rod: in water approx. 38 pF/100 mm (16 mm rod)
 - Insulated probe rod: in water approx. 45 pF/100 mm (10 mm rod)

Probe lengths for continuous measurement in conductive liquids

- Rod probe (range 0 to 2000 pF for \leq 4000 mm)
- Rope probe < 6 m (range 0 to 2000 pF)
- Rope probe > 6 m (range 0 to 4000 pF)


Material

Material specifications as per AISI and DIN-EN.

In contact with the process

- Probe rod, ground tube, inactive length, tensioning weight for rope probe: 316L (1.4435)
- Probe rope: 316 (1.4401)
- Probe rod insulation
 - If PFA selected: PFA (FDA 21 CFR 177.1550)
 - If PTFE selected: PTFE and PFA (FDA 21 CFR 177.1550)
- Probe rope insulation
 - If FEP selected: FEP, PTFE and PFA (FDA 21 CFR 177.1550)
 - If PFA selected: PTFE and PFA (FDA 21 CFR 177.1550)
- Process connection: 316L (1.4435 or 1.4404)
- Flat seal for process connection G ¾ or G 1: elastomer fiber, asbestos-free
- Sealing ring for process connection G ½, G ¾, G 1, G 1½: Elastomer fiber, asbestos-free, resistant to lubricants, solvents, steam, weak acids and alkalis; to 300 °C and to 100 bar

Not in contact with the process

- Ground terminals on housing (exterior): 304 (1.4301)
- Nameplate on housing (exterior): 304 (1.4301)
- Cable glands
 - Housing F13, F15, F16, F17, F27: polyamide (PA)
 - With C, D, E, F, H, M, J, P, S, 1, 4, 5 approval (→  33 ordering information): nickel-plated brass
 - Housing T13: nickel-plated brass
- Polyester housing F16: PBT-FR with cover made of PBT-FR or with sight glass made of PA12,
 - Cover seal: EPDM
 - Adhesive nameplate: polyester foil (PET)
 - Pressure compensation filter: PBT-GF20
- Stainless steel housing F15: 316L (1.4404)
 - Cover seal: silicone
 - Cover clamp: 304 (1.4301)
 - Pressure compensation filter: PBT-GF20, PA
- Aluminum housing F17/F13/T13: EN-AC-ALSi10Mg, plastic-coated,
 - Cover seal: EPDM
 - Cover clamp: nickel-plated brass
 - Pressure compensation filter: silicone (not T13)
- Stainless steel housing F27: 316L (1.4435)
 - Cover seal: FVMQ (optional: EPDM seal available as spare part)
 - Cover clamp: 316L (1.4435)

Input

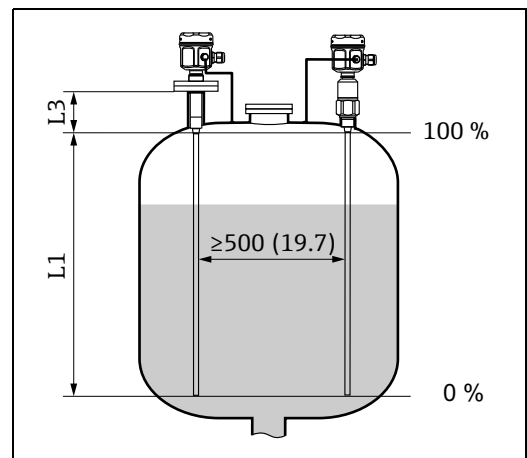
Measured variable	Continuous measurement of change in capacitance between probe rod and container wall or ground tube, depending on the level of a liquid. Probe covered => high capacitance Probe not covered => low capacitance
--------------------------	---

Measuring range	<ul style="list-style-type: none"> ■ Measuring frequency: 500 kHz ■ Span: $\Delta C = 25$ to 4000 pF recommended (2 to 4000 pF possible) ■ Final capacitance: $C_E = \text{max. } 4000 \text{ pF}$ ■ Adjustable initial capacitance: <ul style="list-style-type: none"> - $C_A = 0$ to 2000 pF (<6 m probe length) - $C_A = 0$ to 4000 pF (>6 m probe length)
------------------------	--

Measuring condition	<ul style="list-style-type: none"> ■ Measuring range L1 possible from the tip of the probe to the process connection. ■ Particularly suited for small containers.
----------------------------	---

Note!
When installing in a nozzle, use inactive length (L3).

The 0 %, 100 % adjustment can be inverted.



L00-FMI5xxxx-15-05-xx-xx-002

Dimensions mm (in)

Output

Output signal	<p>FEI50H (4 to 20mA/HART Version 5.0) 3.8 to 20.5 mA with HART protocol</p> <p>FEI57C (PFM) The transmitter superimposes current pulses (PFM signal 60 to 2800 Hz) with a pulse width of approx. 100 μs and a current strength of approx. 8 mA on the supply current (approx. 8 mA).</p>
----------------------	---

Signal on alarm	<p>FEI50H</p> <p>Fault diagnosis can be called up as follows:</p> <ul style="list-style-type: none"> ■ Via the local display: Red LED ■ Via the local display showing: <ul style="list-style-type: none"> - Error symbol - Plain text display ■ Via the current output: 22 mA (in accordance with NE43) ■ Via the digital interface (HART status error message)
------------------------	---

FEI57C	<p>Fault diagnosis can be called up as follows:</p> <ul style="list-style-type: none"> ■ Via the local display: Red LED ■ Local display at switching unit
---------------	---

Linearization**FEI50H**

The Liquicap M linearization function enables conversion of the measured value into any desired length or volume units. Linearization tables for volume calculation of horizontal cylindrical tanks and spherical tanks are pre-programmed. Any other tables with up to 32 value pairs can be input manually or semi-automatically.

FEI57C

With FEI57C, linearization takes place in the switching units.

Power supply

Electrical connection**Connection compartment**

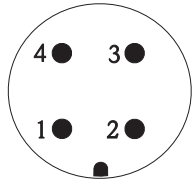
Six housings with the following protection classes are available:

Housing	Standard	Ex ia	Ex d	Gas-tight process seal
Polyester housing F16	X	X	-	-
Stainless steel housing F15	X	X	-	-
Aluminum housing F17	X	X	-	-
Aluminum housing F13	X	X	X	X
Stainless steel housing F27	X	X	X	X
Aluminum housing T13 (with separate connection compartment)	X	X	X	X

M12 connector

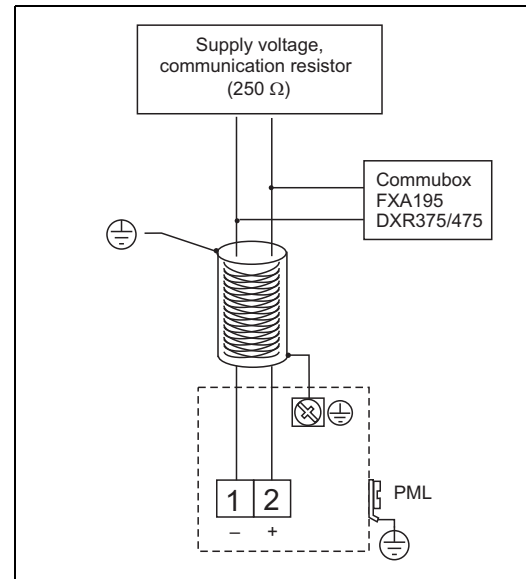
For the version with an M12 connector, the housing does not have to be opened to connect the signal line.

PIN assignment for M12 connector

 <p style="text-align: center; font-size: small;">100-FTI5xxxx-04-06-xx-xx-015</p>	PIN	2-wire electronic inserts: FEI50H, FEI57C
	1	+
	2	Not assigned
	3	-
4	Ground	

Terminal assignment**2-wire, 4 to 20 mA with HART**

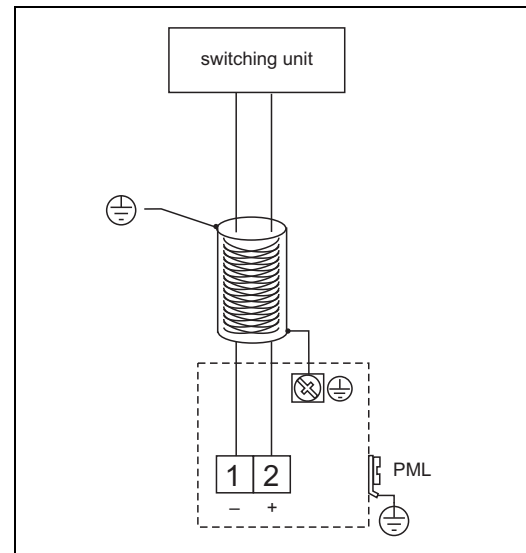
The twin-core connecting cable is connected to the screw terminals (conductor cross-section 0.5 to 2.5 mm) in the connection compartment at the electronic insert. If the superimposed communication signal (HART) is used, a shielded cable must be used and the shielding connected at the sensor and power supply. Protective circuits against reverse polarity, HF-influences and overvoltage peaks are integrated (see TI00241F "EMC test procedures").



L00-FMI5xxxx-04-00-00-en-002

2-wire, PFM

The twin-core, shielded connecting cable with a cable resistance of max. 25 Ω per core is connected to the screw terminals (conductor cross-section 0.5 to 2.5 mm) in the connection compartment. The shielding must be connected at the sensor and power supply. Protective circuits against reverse polarity, HF-influences and overvoltage peaks are integrated (see TI00241F "EMC test procedures").



L00-FMI5xxxx-04-00-00-en-003

Supply voltage

All of the following voltages are terminal voltages directly at the device:

FEI50H:

- 12.0 to 36 VDC (in the non-hazardous area)
- 12.0 to 30 VDC (in hazardous areas EEx ia)
- 14.4 to 30 VDC (in hazardous areas EEx d)

FEI57C:

14.8 VDC from associated supply unit.



Note!

Both electronic inserts have integrated reverse polarity protection.

Cable entry

- Cable gland: M20x1.5 (for EEx d only cable entry)
Two cable glands are included in scope of delivery.
- Cable entry: G ½ or ½ NPT

Power consumption**FEI50H**

Min. 40 mW, max. 800 mW

FEI57C

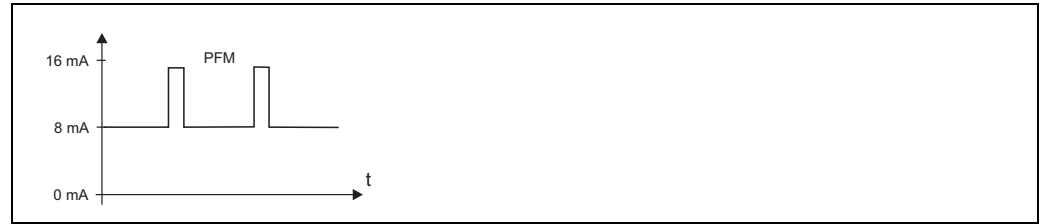
Max. 250 mW

Current consumption

FEI50H (4 to 20 mA/HART)

- Current consumption: 3.8 to 22 mA
- HART multidrop operation: 4 mA
- Residual ripple HART: 47 to 125 Hz: $U_{ss} = 200 \text{ mV}$ (with 500Ω)
- Noise HART (FEI50H): 500 Hz to 10 kHz: $U_{eff} < 2.2 \text{ mV}$ (with 500Ω)

FEI57C



L00-FMI5xxxx-05-05-xx-xx-005

Frequency: 60 to 2800 Hz

Performance characteristics

Reference operating conditions

- Room temperature: $+20 \text{ }^\circ\text{C} \pm 5 \text{ }^\circ\text{C}$
 - Span: $\Delta C = 25$ to 4000 pF recommended (2 to 4000 pF possible)

Maximum measured error

- Non-repeatability (reproducibility) as per DIN 61298-2: max. $\pm 0.1 \%$
- Non-linearity for limit point setting (linearity) as per DIN 61298-2: max. $\pm 0.5 \%$

Influence of ambient temperature

Electronic insert

$< 0.06 \%$ / 10 K related to the full scale value

Separate housing

Change in capacitance of connecting cable 0.015 pF/m per K

Influence of process pressure

In the case of fully insulated probes in conductive liquids: $< 10.0 \%$ related to the full scale value

Switch-on behavior

FEI50H

14 s (stable measured value after switch-on procedure). Start-up in safe state (22 mA).

FEI57C

1.5 s (stable measured value after switch-on procedure). Start-up in safe state (22 mA).

Measured value reaction time

FEI50H

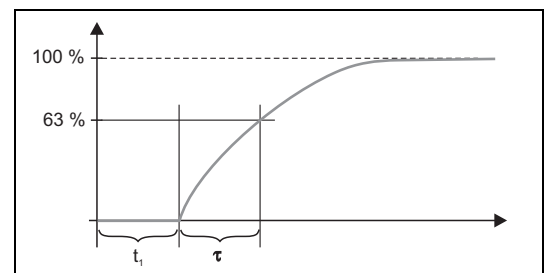
$t_1 \leq 0.3 \text{ s}$
 $t_1 \leq 0.5 \text{ s}$ for operating mode SIL

FEI57C

$t_1 = 0.3 \text{ s}$

Note!

Observe integration time of switching unit



L00-FMI5xxxx-05-05-xx-xx-009

$\tau = \text{Integration time}$
 $t_1 = \text{Dead time}$

Integration time**FEI50H**

$\tau = 1$ s (factory setting) 0 to 60 s can be set.

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

Accuracy of factory adjustment

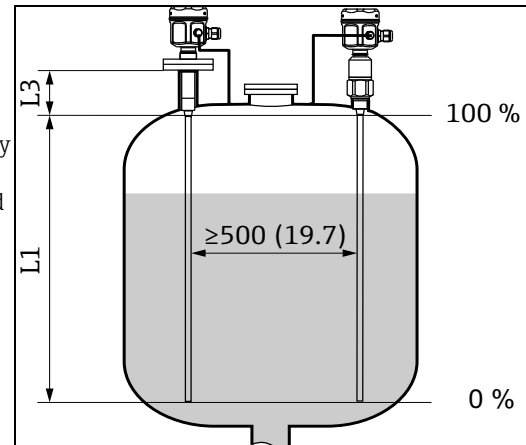
	Probe length <2 m	Probe length >2 m
Empty adjustment (0 %)	≤ 5 mm	Approx. 2 %
Full adjustment (100 %)	≤ 5 mm	Approx. 2 %

Medium conductivity $\geq 100 \mu\text{S}/\text{cm}$
Minimum distance to container wall = 250 mm

Note!

In an installed state, readjustment is only necessary if:

- The 0 % or the 100 % value have to be adjusted specifically for the customer.
- The liquid is not conductive.
- The distance from probe to tank wall is <250 mm



L00-FMI5xxxx-15-05-xx-xx-002

Resolution**FEI50H**

Analog in % (4 to 20 mA)

- FMI51, FMI52: 11 bit/2048 steps, 8 μA
- The resolution of the electronics can be directly converted to units of length of the probe FMI51 or FMI52. e.g. active probe rod 1000 mm
Resolution = 1000 mm/2048 = 0.48 mm

FEI57C

- Zero frequency f_0 60 Hz:

Sensitivity of the electronic insert = 0.685 Hz/pF

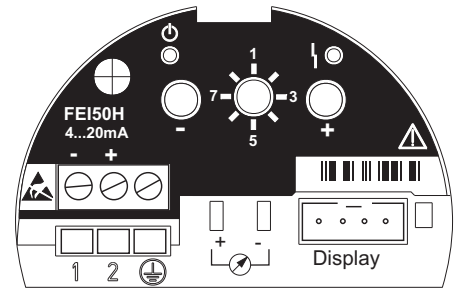
Entry in switching unit FMC671 under V3H5 and V3H6 or V7H5 and V7H6

Human interface

Electronic inserts

FEI50H

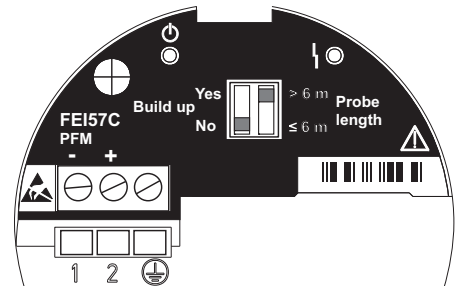
- Green LED (⊕ operational status)
- Red LED (⊖ fault message)
- Key (-)
- Key (+)
- Mode switch
 - 1 : Operation
 - 2 : Empty adjustment
 - 3 : Full adjustment
 - 4 : Measuring modes (buildup)
 - 5 : Measuring range
 - 6 : Self-test
 - 7 : Reset (factory settings)
 - 8 : Upload sensor EEPROM
- 4 to 20 mA current pick-off, e.g. for full/empty adjustment with multimeter.
- Display connection



L00-FMI5xxxx-07-05-xx-xx-000

FEI57C

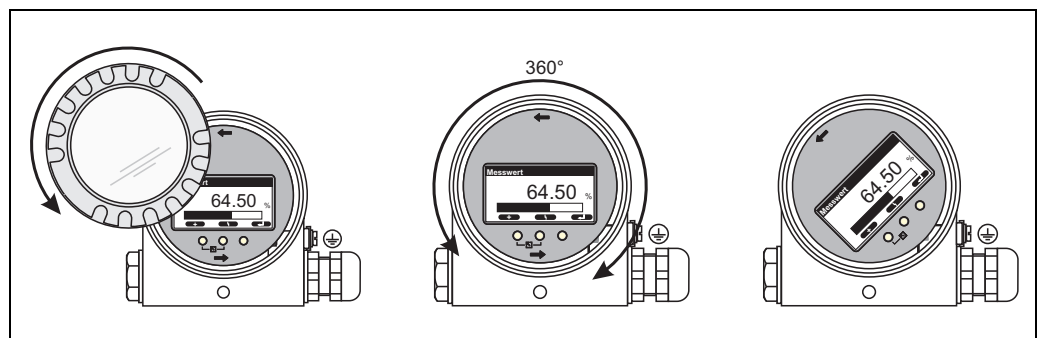
- Green LED (⊕ operational status)
- Red LED (⊖ fault message)
- DIP switch, buildup (YES/NO)
- DIP switch, probe length (probe length >6 m/≤6 m)



L00-FMI5xxxx-07-05-xx-xx-002

Local operation with display

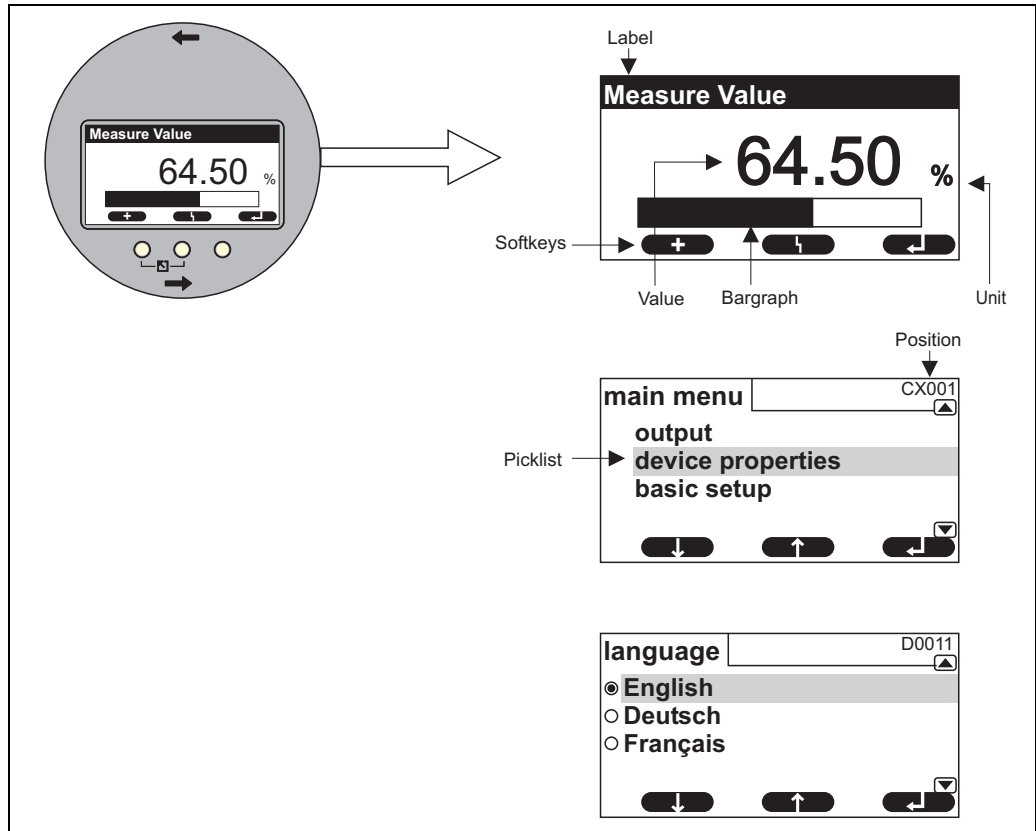
The optional display can be used to configure via 3 keys directly at the device. All device functions can be set via menu operation. The menu consists of function groups and functions. Application parameters can be read or set in the functions.



L00-FMI5xxxx-07-05-xx-xx-en-002

Graphic display with operating keys: can be rotated 360°

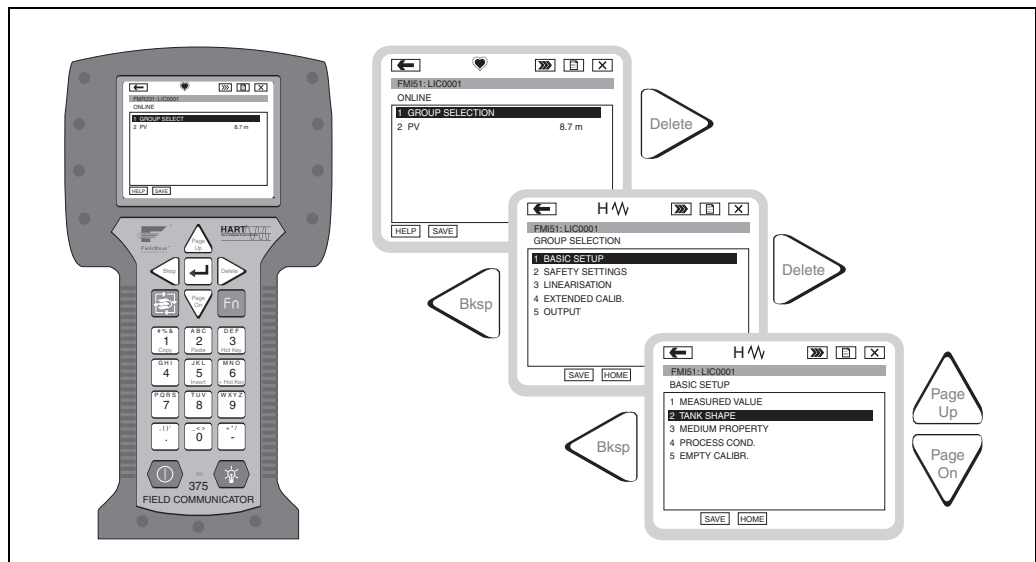
The menu guidance with integrated help texts ensures quick and safe commissioning. For accessing the display, the cover of the electronics compartment can also be opened in hazardous areas (EEx ia).



L00-FMIxxxx-07-00-00-en-002

Remote operation with handheld terminal

The handheld terminals FieldXpert or Field Communicator DXR375/475 can be used to set all device functions via menu operation.



L00-FMI5xxxx-07-00-00-xx-007

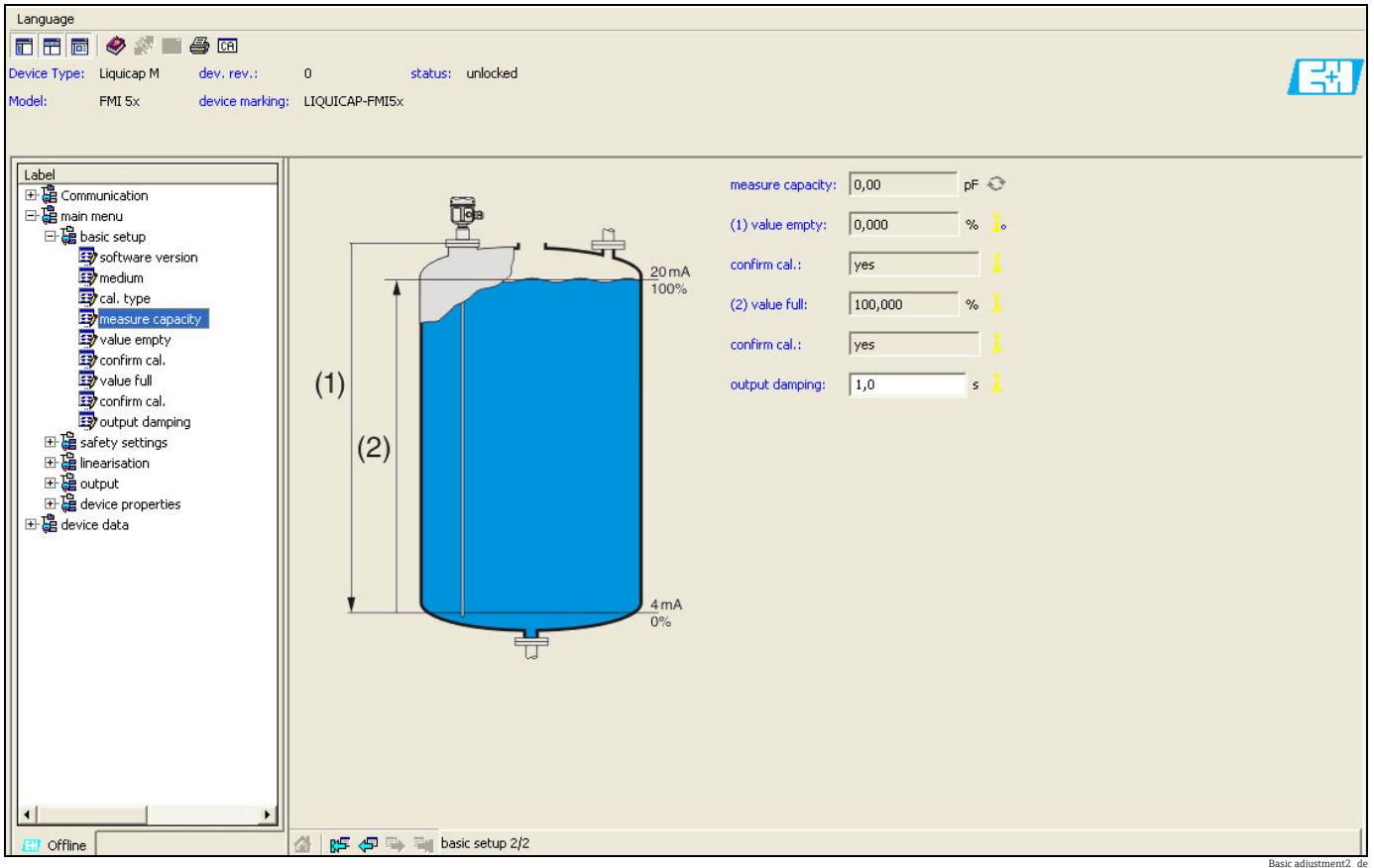
Remote operation via FieldCare Device Setup

FieldCare is a graphic operating program and is used to support commissioning, data backup, signal analysis and documentation of the devices. The following operating systems are supported: Windows 2000, Windows XP, Windows Vista and Windows 7.

FieldCare supports the following functions:

- Configuration of transmitters in online operation
- Tank linearization
- Loading and saving device data (upload/download)
- Documentation of the measuring point

Menu guided commissioning



Connection options






- HART with Commubox FXA195



Note!

The latest version of FieldCare is available at: www.de.endress.com ® Search for: FieldCare.

Certificates and approvals

CE mark	The measuring system meets the legal requirements of the applicable EC guidelines. These are listed in the corresponding EC Declaration of Conformity together with the standards applied. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.
RoHS	The measuring system complies with the substance restrictions of the Restriction on Hazardous Substances Directive 2011/65/EU (RoHS 2).
RCM-Tick marking	The supplied product or measuring system meets the ACMA (Australian Communications and Media Authority) requirements for network integrity, interoperability, performance characteristics as well as health and safety regulations. Here, especially the regulatory arrangements for electromagnetic compatibility are met. The products are labelled with the RCM- Tick marking on the name plate.
Ex approval	<ul style="list-style-type: none"> ▪ ATEX ▪ IECEx ▪ CSA ▪ FM ▪ NEPSI ▪ INMETRO ▪ EAC <p>See "Ordering information" from →  33</p>
EAC conformity	The measuring system meets the legal requirements of the applicable EAC guidelines. These are listed in the corresponding EAC Declaration of Conformity together with the standards applied. Endress+Hauser confirms successful testing of the device by affixing to it the EAC mark.
Other standards and guidelines	<p>EN 60529 Degrees of protection by housing (IP code)</p> <p>EN 61010 Protection measures for electrical equipment for measurement, control, regulation and laboratory procedures</p> <p>EN 61326 Interference emission (Class B equipment), interference immunity (Annex A - Industrial).</p> <p>NAMUR Association for Standards for Control and Regulation in the Chemical Industry</p> <p>IEC 61508 Functional safety</p>
CRN approval	Versions with a CRN approval (Canadian Registration Number) are listed in the corresponding registration documents. CRN-approved devices are labeled with registration number CRN OF1988.7C on the nameplate. You can find further details on the maximum pressure values in the Download Area of the Endress+Hauser website.
Additional approvals	<ul style="list-style-type: none"> ▪ See also Certificates →  34 ▪ TSE Certificate of Suitability (FMI51) The following applies to wetted device components: <ul style="list-style-type: none"> - They do not contain any materials derived from animals. - No additives or operating materials derived from animals are used in production or processing. <p> Note! The wetted device components are listed in the "Mechanical construction" (→  15 ff) and "Ordering information" (→  33) sections.</p> ▪ AD2000 The wetted material (316L) corresponds to AD2000 - W0/W2

**Druckgeräterichtlinie
2014/68/EU (DGRL)****Pressure equipment with allowable pressure \leq 200 bar (2 900 psi)**

Pressure instruments with a flange and threaded boss that do not have a pressurized housing do not fall within the scope of the Pressure Equipment Directive, irrespective of the maximum allowable pressure.

Reasons:

According to Article 2, point 5 of EU Directive 2014/68/EU, pressure accessories are defined as "devices with an operational function and having pressure-bearing housings".

If a pressure instrument does not have a pressure-bearing housing (no identifiable pressure chamber of its own), there is no pressure accessory present within the meaning of the Directive.

Ordering information

Ordering information

Detailed ordering information is available from the following sources:

- In the Product Configurator on the Endress+Hauser web site: www.endress.com → Choose your country → Products → Select measuring technology, software or components → Select product (picklists: measurement method, product family etc.) → Device support (right-hand column): Configure the selected product → The Product Configurator for the selected product is opened.
- From your Endress+Hauser Sales Center: 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

Accessories

Protective cover

For F13, F17 and F27 housing (without display)
Order number: 71040497

For F16 housing
Order number: 71127760

Shortening kit for FMI52

Once the rope is shortened, the device loses its hygiene approval: EHEDG, 3A.
Order number: 942901-0001

Commubox FXA195 HART

For intrinsically safe HART communication with FieldCare via a USB port.

**Overvoltage protection
HAW56x****Overvoltage protection HAW56x**

Surge arrester for limiting overvoltage in signal lines and components.

Note!

For detailed information about overvoltage protection please refer to the following documents:

- TI01012K: HAW562 Overvoltage protective for installation on housing M20x1,5
- TI01013K: HAW569 Overvoltage protective for installation on housing in cabinet

**Weld-in adapter**

All the weld-in adapters available are described in the document TI00426F.
This is available in the Download Area of the Endress+Hauser web site: www.endress.com → Download



Documentation

Note!

The following document types are also available in the Download Area of the Endress+Hauser web site: www.endress.com → Download

Technical Information

- Fieldgate FXA320, FXA520
TI00369F/00/EN

Operating Instructions

- Liquicap M FMI51, FMI52 (PFM)
BA00297F/00/en
- Liquicap M FMI51, FMI52 (HART)
BA00298F/00/en

Certificates

ATEX safety instructions

- Liquicap M FMI51, FMI52
ATEX II 1/2 G Ex ia IIC/IIB T3...T6, II 1/2 D IP65 T90 °C
XA00327F/00/A3
- Liquicap M FMI51, FMI52
ATEX II 1/2 G Ex d [ia] IIC/IIB T3...T6, Ex de [ia Ga] IIC/IIB T3...T6 Ga/Gb,
Ex iaD 20 Txx°C/Ex tD A21 IP6x Txx°C
XA00328F/00/A3
- Liquicap M FMI51, FMI52
Ga/Gb Ex ia IIC T6...T3; Ex ia D 20 / Ex tD A21 IP65 T90°C
XA00423F/00/A3
- Liquicap M FMI51, FMI52
II 3 G Ex nA/nC IIC T6; Ex tc IIIC T100 °C Dc
XA00346F/00/A3

INMETRO safety instructions

- Liquicap M FMI51, FMI52
Ex d [ia Ga] IIC/IIB T3...T6 Ga/Gb; Ex de [ia Ga] IIC T3...T6 Ga/Gb
XA01171F/00/A3
- Liquicap M FMI51, FMI52
Ex ia IIC/IIB T3...T6 Ga/Gb; Ex ia IIIC T90°C Da/Db IP65
XA01172F/00/A3

NEPSI safety instructions

- Liquicap M FMI51, FMI52
Ex ia IIC/IIB T3...T6 Ga/Gb
XA00417F/00/A3
- Liquicap M FMI51, FMI52
Ex d [ia] IIC/IIB T3/T4/T6 Ga/Gb, Ex de ia IIC/IIB T3/T4/T6
XA00418F/00/A3
- Liquicap M FMI51, FMI52
Ex nA IIC T3...T6 Gc, Ex nC IIC T3...T6 Gc
XA00430F/00/A3

Overfill protection DIBt (WHG)

- Liquicap M FMI51, FMI52
ZE00265F/00/de

Functional safety (SIL2)

- Liquicap M FMI51, FMI52
SD00198F/00/en

Control Drawings (CSA and FM)

- Liquicap M FMI51, FMI52
FM IS
ZD00220F/00/en
- Liquicap M FMI51, FMI52
CSA IS
ZD00221F/00/en
- Liquicap M FMI51, FMI52
CSA XP
ZD00233F/00/en



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www.addresses.endress.com
