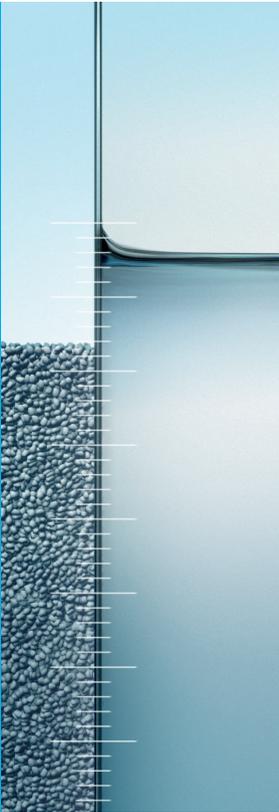


Continuous level measurement in liquids and bulk solids

Selection and engineering guide
for the process industry

Level



Legend

- Continuous level measurement in liquids starting page 3

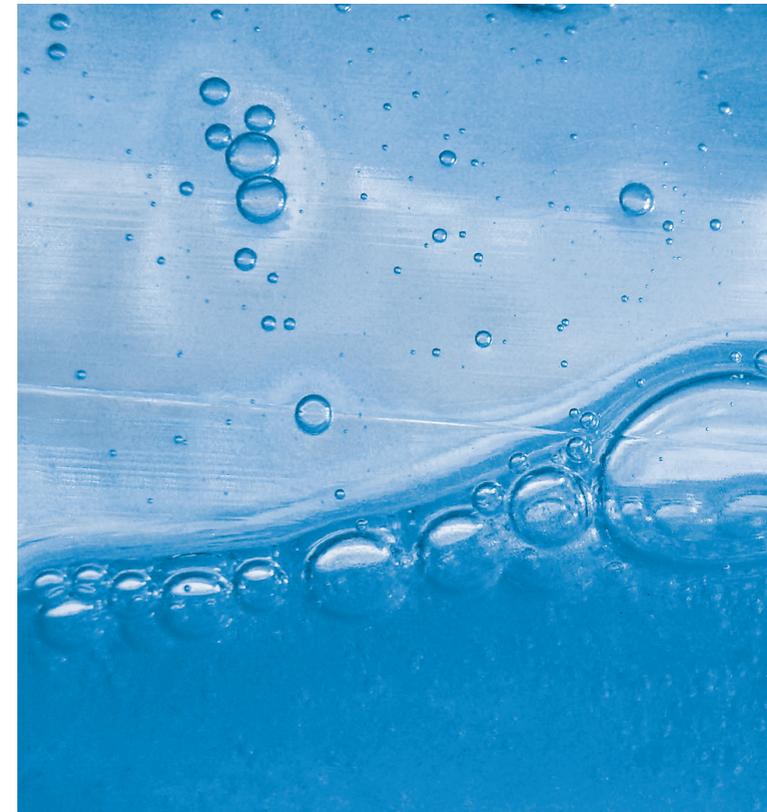


- Continuous level measurement in solids starting page 99



Continuous level measurement in liquids

Selection and engineering guide for the process industry



Step by step

This selection and engineering guide provides information on different measuring principles for continuous level/interface measurement in liquids as well as their application and installation.

The pamphlet contains two separate chapters: Level measurement in liquids and Level measurement in solids.

The first chapter specifically covers continuous measurement in liquids. A separate selection guide is available for point level detection (see the supplementary documentation CPO0007F).

A

Overview of measuring principles

First of all, we show you an overview of the Endress+Hauser measuring principles for continuous level/interface measurement in liquids in diagrams on the first pages. Subsequently, you are introduced to the mode of functioning of the measuring principle and the respective product family.

Checklist

You should be aware of the application requirements for the correct selection of a suitable instrument. The checklist provides an overview and is supposed to help you to consider or record this data as completely as possible.

B

Selection of the measuring principle

The appropriate measuring principle is first selected according to the application and its criteria (tank, bypass, stilling well, etc.). Select the principle which meets, if possible, all of the criteria required by you or your plant. The measuring principles are classified according to „non-contact“ and „contact“ criteria.

The ideal measuring principle/instrument is stated first and in a blue frame. Max. technical data is always used.

C

Instrument selection

Now change to the area of the selected measuring principle where you can choose the appropriate instrument from a product family. Compare your application and process data with the instrument data.

Engineering

After the selection of the optimum instrument check the installation instructions at the end of the respective measuring principle. They contain basic directions for the safe installation and use of the instrument. You will find more extensive engineering instructions in the respective Technical Information of the instrument.

Contents

1. Overview of measuring principles	6
2. Checklist	12
3. Selection of the measuring principle according to the application	14
■ Horizontal cylindrical storage tank	14
■ Vertical storage tank	16
■ Buffer tank	18
■ Recipient tank (e. g. bottling facilities)	20
■ Process tank with agitator	22
■ Stilling well	24
■ Bypass	26
■ Pump shaft / overfall construction / rain water basin	28
■ Channel measurement (free flowing)	30
■ Interface measurement	32
■ IIoT Radar (not included in this selection guide): Cloud based IIoT level sensor for mobile applications or remote measuring points for liquids and bulk solids. Data transmission via cellular communication (NB-IoT, LTE-M and 2G fallback). Data management in SupplyCare Hosting and Netilion (E+H cloud services). Detailed information is available from our application specialists or at www.endress.com/FWR30 .	
4. Instrument selection within the measuring principle	34
■ Radar	34
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■ Hydrostatics (pressure/differential pressure)	88
■ Radiometry: The radiometric measuring principle is not considered in this section. Please contact our application consultants in your country for detailed information.	

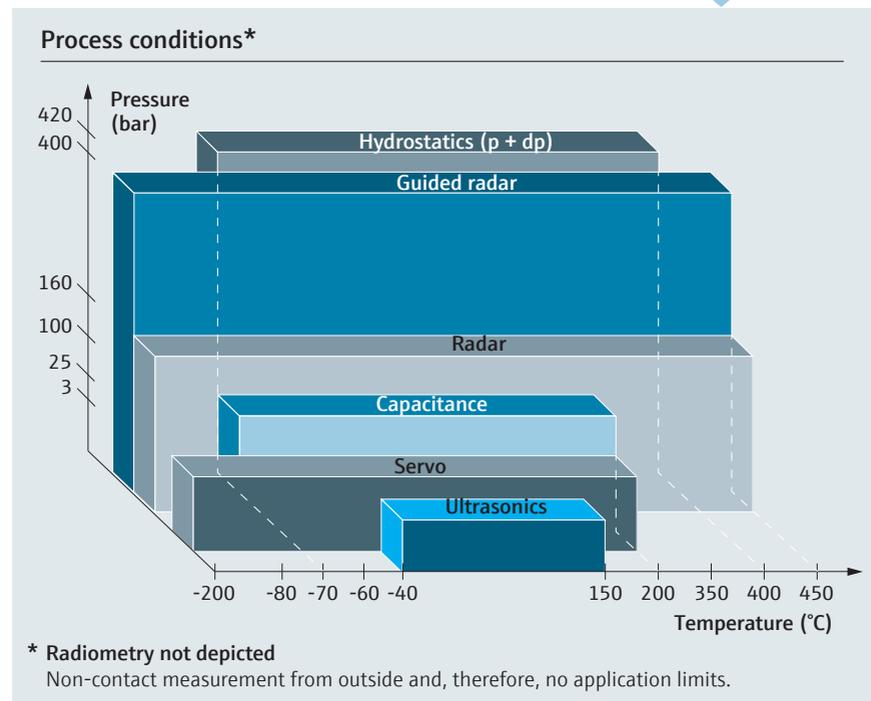
A

B

C

1. Overview of the measuring principles

Segmentation		
	Point level	Continuous
Liquids	Vibronics Conductive Capacitance Float switch Radiometrics Hydrostatics	Radar Guided radar Ultrasonics Servo Hydrostatics (p + dp) Capacitance Radiometrics
Bulk solids	Vibronics Capacitance Paddle Microwave barrier Radiometrics	Radar Guided radar Ultrasonics Electromechanical level system Radiometrics

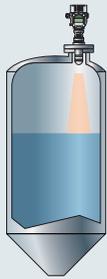


Endress+Hauser offers you a solution adapted to your application and tailored to your process requirements. You can select the best technology for your application from the wide product range of Endress+Hauser.

„You only pay what you really need.“

Endress+Hauser takes this statement seriously and offers a large number of different measuring principles which vary in price and functionality.

1. Overview of the measuring principles

**Radar**

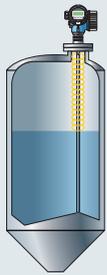
Micropilot works with either pulses or with Frequency Modulated Continuous Wave (FMCW). Pulse: High-frequency radar pulses which are emitted by an antenna and reflected from the product surface. The time between pulse launching and receiving is measured and analyzed by the instrument and constitutes a direct measure for the distance between the antenna and the surface of the medium. FMCW: Works with an FMCW continuous electromagnetic wave which is emitted from an antenna and reflected by the product surface.

The frequency change " Δf " is measured and the time and distance are calculated.

Micropilot

Non-contact, maintenance-free measurement also under extreme conditions. Unaffected by density, temperature, conductivity and humidity. No impairment by vapor pressure.

- Process temperatures up to +450°C/+842°F
- Process pressures up to 160bar/2,320psi

**Guided radar**

Levelflex works with high-frequency radar pulses which are guided along a probe. As the pulse impacts the medium surface, the characteristic impedance changes and part of the emitted pulse is reflected. The time between pulse launching and receiving is measured and analyzed by the instrument and constitutes a direct measure for the distance between the process connection and the product surface.

Levelflex

Reliable and maintenance-free measurement in liquids, also in turbulent media and foam. Unaffected by density, temperature, conductivity and humidity. No impairment by vapor pressure. Measurement of interface and level.

- Process temperatures up to +450°C/+842°F
- Process pressures up to 400bar/5,800psi

**Ultrasonics**

Ultrasonic measurement is based on the Time-of-Flight principle. A sensor emits ultrasonic pulses, the surface of the media reflects the signal and the sensor detects it again. The Time-of-Flight of the reflected ultrasonic signal is directly proportional to the distance traveled. With the known tank geometry the level can be calculated.

Prosonic

Non-contact and maintenance-free measurement without impairment by product properties, e. g. dielectric constant, conductivity, density or humidity.

- Process temperatures up to +105°C/+221°F
- Process pressures up to 4bar/58psi

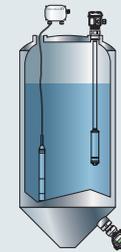
**Servo**

A small displacer is accurately positioned in a liquid medium using a servo motor. The displacer is then suspended on a measuring wire which is wound onto a finely grooved drum. When the displacer is lowered and touches a liquid, the weight of the displacer is reduced by liquid buoyancy force. As a result, torque in the magnetic coupling changes, which is measured by 6 Hall sensors.

Proservo

The measurement is unaffected by medium properties like conductivity or dielectric constant and used for custody transfer applications

- Process temperatures up to +200°C/+392°F
- Process pressures up to 25bar/362psi

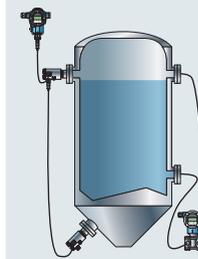
**Hydrostatics (pressure)**

Hydrostatic level measurement in open tanks is based on the determination of the hydrostatic pressure which is generated by the height of the liquid column. The obtained pressure is thus a direct measure for the level.

Cerabar, Deltapilot

Unaffected by dielectric constant, foam, turbulence and obstacles. Condensate-proof, watertight and long-term stable Contite measuring cell with optimized temperature shock behavior (Deltapilot).

- Process temperatures up to +400°C/+752°F

**Hydrostatics (differential pressure)**

In closed, pressurized tanks, the hydrostatic pressure of the liquid column causes a difference in pressure. The same leads to a deflection of the measuring element which is proportional to the hydrostatic pressure.

Deltabar

Unaffected by dielectric constant, foam, turbulence and obstacles. High overload resistance.

- Process temperatures up to +400°C/+752°F
- Process pressures up to 420bar/6,090psi
- Unaffected by ambient temperatures (Deltabar electronic dp)

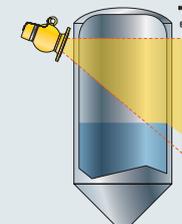
**Capacitance**

The principle of capacitive level measurement is based on the capacitance change of a capacitor. The probe and the tank wall form a capacitor whose capacitance is dependent on the amount of product in the tank: an empty tank has a lower, a filled tank a higher capacitance.

Liquicap

Exact measurement from the end of the probe to the process connection without any blocking distance. Very fast response times. Unaffected by density, turbulence and vapor pressure.

- Process temperatures up to +200°C/+392°F
- Process pressures up to 100bar/1,450psi

**Radiometry**

The gamma source, a cesium or cobalt isotope, emits radiation which is attenuated as it passes through materials.

The measuring effect results from the absorption of radiation by the product to be measured which is caused by level changes.

The measuring system consists of a source and a compact transmitter as a receiver.

Gammapilot

Compact transmitters in different measuring lengths, adaptable measuring ranges.

Non-contact measurement from outside for all extreme applications, e. g. very corrosive, aggressive and abrasive media.

- Unaffected by media
- Any process temperature
- Any process pressure
- Unaffected by gammagraphy (Modulator)

1. Overview of the measuring principles

	Radar	Tank Gauging radar	Guided radar	Ultrasonics	Servo	Capacitance	Radiometrics	Hydrostatics (pressure + differential pressure)
								
Process temperature	-196 to +450°C/ -321 to +842°F	-40 to +200°C/ -40 to +392°F	-196 to +450°C/ -321 to +842°F	-40 to +105°C/ -40 to +221°F	-200 to +200°C/ -329 to +392°F	-80 to +200°C/ -112 to +392°F	Unaffected by temperature and pressure	-70 to +400°C/ -94 to +752°F/ Ambient pressure
Process pressure	-1 to +160bar/ -14.5 to +2,320psi	-1 to +40bar/ -14.5 to +580psi	-1 to +400bar/ -14.5 to +5,800psi	+0.7 to +4bar/ +10 to +58psi	0 to +25bar/ 0 to +362.5psi	-1 to +100bar/ -14.5 to +1,450psi		420bar/6,090psi (dp)
Measuring range	0.1 to 80m/ 0.3 to 262ft	0.8 to 70m/ 2.6 to 230ft	0.3 to 45m/1 to 148ft (longer upon request)	0.07 to 25m/ 0.2 to 82ft	up to 47m/154ft	0.1 to 10m/0.3 to 32ft	0.05 to 20m/0.16 to 66ft	■ Upt to 0,01 m (10mbar/0,145 to 700bar/10.150)
Instrument accuracy	<ul style="list-style-type: none"> 6GHz: ±6mm ±0.24" 26GHz: ±2mm ±0.08" 80GHz: ±1mm/ ±0.04" 	<ul style="list-style-type: none"> 6GHz: ±0.5mm/±0.02" 26GHz: ±1mm/0.04" 80GHz: ±0.5mm/ ±0.02" 	<ul style="list-style-type: none"> < 15m: ±2mm < 49ft: ±0.08" > 15m: ±10mm > 49ft: ±0.4" of distance 	<ul style="list-style-type: none"> ±2 mm/±0.08", ±0,2 % of distance 	<ul style="list-style-type: none"> ±4mm/0.02" 	<ul style="list-style-type: none"> ±1% of measuring distance 	<ul style="list-style-type: none"> ±1% of measuring distance 	<ul style="list-style-type: none"> Up to ±0.025% of the set span
Function may be affected by	<ul style="list-style-type: none"> Foam Extreme turbulent surfaces 	<ul style="list-style-type: none"> Turbulent surfaces Foam 	<ul style="list-style-type: none"> Extreme build-up formation 	<ul style="list-style-type: none"> Foam Extreme turbulent, boiling surfaces Strong build-up or strong condensate at the sensor 	<ul style="list-style-type: none"> Extreme turbulent surface (use stilling well) High viscose medium 	<ul style="list-style-type: none"> Plastic tank Extreme conductive build-up 	<ul style="list-style-type: none"> External radiation (gammagraphy), solution with Gamma Modulator 	<ul style="list-style-type: none"> Turbulent surfaces
Accuracy may be affected by	<ul style="list-style-type: none"> Interfering reflections/obstacles in the signal beam 	<ul style="list-style-type: none"> Obstacles Wall effects Bad stilling well quality 	<ul style="list-style-type: none"> Interfering reflections by obstacles near the probe (not for coaxial probe) 	<ul style="list-style-type: none"> Higher vapor pressure may change the Time-of-Flight Temperature layers in the gas phase Interfering reflections Fast temperature change 	<ul style="list-style-type: none"> Viscose medium Build-up 	<ul style="list-style-type: none"> Conductivity < 30µS/cm: changing dielectric constants Conductive build-up 	<ul style="list-style-type: none"> Extreme pressure fluctuations Extreme build-up 	<ul style="list-style-type: none"> Density change Very fast temperature change Dynamic pressure, e. g. caused by agitator (dp)
Application limits	<ul style="list-style-type: none"> DC < 1.2 	<ul style="list-style-type: none"> DC < 1.4 Measurement up to 0%² Lateral installation or from below 	<ul style="list-style-type: none"> Measurement up to 0%² DC < 1.4 Agitator applications Lateral installation or from below Extreme foam formation 	<ul style="list-style-type: none"> Measurement up to abs. 0%¹ Vapor pressure Blocking distance³ Lateral installation or from below 	<ul style="list-style-type: none"> Viscosity > 5000mPa s Lateral installation or from below 	<ul style="list-style-type: none"> Agitator blade Changing, non-conductive media or conductivity between 1 to 100µS/cm DC < 2.0 Media diffusing through PTPE, e. g. chlorine 	<ul style="list-style-type: none"> Non-contact measurement from outside and, therefore, no application limits Observe radiation protection regulations 	<ul style="list-style-type: none"> Curing build-up Strong density fluctuations

¹ E. g. dish bottom, conical outlet

² Measurement only up to the probe end

³ Measurement is possible up to the blocking distance (BD) of the sensor

2. Checklist

You should be familiar with all of the requirements of your application for the selection of the right instrument. The checklist on page 9 provides an overview of relevant process data and will help you to take the same into consideration. If we have not included all of the details, please supplement the list by your criteria.

The checklist is required both for the selection of the measuring principle and the selection of the instrument.

Radiometry is not included in detail in the following chapters. For specific information please contact our sales team.



TIP

Copy this checklist and complete it to have all relevant data at your disposal in the selection process.

The following table compares the individual measuring methods and is supposed to assist in a first preselection.

Selection guide	Radar	Guided radar	Ultrasonics	Hydrostatic	Capacitance
Condensate	+	+	0	+	+
Foam formation	+	+	0	+	0
Conductivity 1 to 100µS/cm	+	+	+	+	0
Changing media (density)	+	+	+	-	+
Low DC	+	0	+	+	0
Viscosity	+	0	+	+	0
Build-up formation	+	0	+	0	0
Small tank (blocking distance)	+	-	0	+	+
Hygienic application (cleanability)	+	+	+	+	+
Pressurization	+	+	0	+	+
Simple maintenance (disassembly)	+	0	+	0	0
Independent of installation site	0	+	0	0	+
Unaffected by obstacles	0	+	0	+	+
Small tank (fast level change)	+	-	0	+	+
Vapor pressure > 50mbar/+20°C, > 0.73psi/+68°F)	+	+	0	+	+
CIP/SIP temperature cycles	+	+	+	+	+

+ = recommended **0** = restricted (observe limits) **-** = not recommended

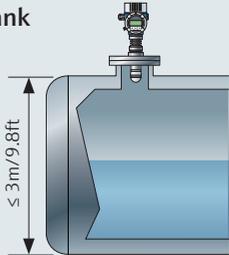
		Please complete		Notes
Details of medium	Medium			
	Density	g/cm ³		
	Conductivity	µS/cm		
	Dielectric constant (DC)			
	Resistance/e. g. coating			
Non-contact measurement		yes	no	
Process data	Process temperature	min.	max.	
	Process pressure	min.	max.	
	Vapor pressure	min.	max.	
Process connection	Type of connection/size			
Installation	Tank (height, Ø)	yes	no	
	Nozzle dimensions	mm/inch		
	Assembly position (from above/from below) ¹⁾			
	Free space	min.	max.	
	Bypass (Ø)	yes	no	
	Stilling well (Ø)	yes	no	
Electric connection	2-wire	yes	no	
	4-wire	yes	no	
Digital communication	HART®, PROFIBUS®, Ethernet-APL, FOUNDATION™ fieldbus, relay			
Approvals	Ex (Ex ia/Ex d)	yes	no	
	WHG	yes	no	
	Shipbuilding	yes	no	
	EHEDG	yes	no	
	3-A	yes	no	
Certificates/ manufacturer declarations	3.1	yes	no	
	NACE	yes	no	
	FDA-listed material	yes	no	
	SIL	yes	no	
	Calibration certificates	yes	no	
Special requirements				

¹⁾ Only applicable to level measurement by pressure instruments

3. Selection of the measuring principle according to the application

✓ Horizontal cylindrical storage tank

- Calm surface (e. g. bottom filling, filling via immersion tube or rare free filling from above)
- Accuracy 3 to 10mm/0.12 to 0.4"
- Measurement without stilling well, top mounted
- Tank diameter up to 3m/9.8ft
- Changing media
- Installation from above



Non-contact

Our proposal		Our proposal	
Radar Micropilot		Radar Micropilot	
 <p>FMR60B/FMR62B/FMR63B</p>		 <p>FMR10B/FMR20B/FMR30B</p>	
Advantages	<ul style="list-style-type: none"> ■ Resistant against aggressive media ■ For highly viscous media ■ Not affected by changing media properties like e.g. density ■ Heartbeat Technology ■ Remote access via Bluetooth® 	<ul style="list-style-type: none"> ■ High resistance ■ Heartbeat Technology ■ Remote access via Bluetooth® ■ LED indicator / color touch display for fast status detection 	
Technical data	<ul style="list-style-type: none"> ■ Connection: 2-wire (HART®, PA, Ethernet-APL) ■ Accuracy: ±1mm/±0.04" ■ Process temperature: -196 to +450°C/-321 to +842°F ■ Process pressure: -1 to +160bar/-14.5 to +2,320psi ■ Process connection: Threads, flanges (DIN, ASME, JIS), hygienic connections ■ Maximum measuring range: 80m/262ft 	<ul style="list-style-type: none"> ■ Connection: 2-wire (HART®) ■ Accuracy: ±2mm/±0.08" ■ Process temperature: -40 to +80°C/-40 to +176°F ■ Process pressure: -1 to +3bar/+14.5 to +43psi ■ Process connection: Threads, flanges (DIN, ANSI, JIS) ■ Maximum measuring range: 30m/98ft 	
Application limits	<ul style="list-style-type: none"> ■ Strong formation of foam → guided radar, hydrostatics ■ Many obstacles → guided radar, capacitance, hydrostatics ■ Low DC value (< 1.2) → hydrostatics 	<ul style="list-style-type: none"> ■ Strong formation of foam → guided radar, hydrostatics ■ Many obstacles → guided radar, capacitance, hydrostatics ■ Low DC value (< 1.8) → hydrostatics 	

Contact

Our proposal		Our proposal		Our proposal	
Guided radar Levelflex		Hydrostatics Deltapilot		Capacitance Liquicap	
 <p>FMP5x (coax)</p>		 <p>FMB5x</p>		 <p>FMI5x</p>	
Advantages	<ul style="list-style-type: none"> ■ Unaffected by changing media ■ No impairment by the installations of <ul style="list-style-type: none"> ■ Tank baffles ■ Nozzle dimensions ■ Double reflection ■ Coaxial probe ■ Heartbeat Technology 	<ul style="list-style-type: none"> ■ Unaffected by foam ■ Unaffected by installation situation ■ Unaffected by DC value 	<ul style="list-style-type: none"> ■ Ground tube probe ■ Unaffected by nozzle dimensions and tank obstacles ■ Calibration not required in conductive liquids ■ No blocking distance 		
Technical data	<ul style="list-style-type: none"> ■ Connection: 2-wire (HART®, PA, FF), 4-wire HART® ■ Accuracy: ±2mm/±0.08" ■ Process temperature: -196 to +450°C/-321 to +842°F ■ Process pressure: -1 to +400bar/-14.5 to +5,800psi ■ Process connection: Threads, flanges (DIN, ANSI, JIS), hygienic connections ■ Maximum measuring range: 10m/33ft (rod), 45m/148ft (rope), 6m/20ft (coax), longer upon request 	<ul style="list-style-type: none"> ■ Connection: 2-wire (HART®, PA, FF) ■ Accuracy: ±0.1% (typ. 3 to 10mm/0.12" to 0.4") ■ Process temperature: -10 to +80°C/+14 to +176°F ■ Process pressure: Ambient pressure ■ Process connection: Threads, flanges (DIN, ANSI, JIS), hygienic connections ■ Maximum measuring range: Typically up to 100m/328ft (10bar/145psi) 	<ul style="list-style-type: none"> ■ Connection: 2-wire (HART®) ■ Accuracy: ±1.0% ■ Process temperature: -80 to +200°C/-112 to +392°F ■ Process pressure: -1 to +100bar/-14.5 to +1,450psi ■ Process connection: Threads, flanges (DIN, ANSI, JIS), hygienic connections ■ Maximum measuring range: 4m/13ft (rod), 10m/32ft (rope) 		
Application limits	<ul style="list-style-type: none"> ■ Strong build-up formation (e. g. high viscosity, crystallizing media, etc.) → radar, ultrasonics ■ Low DC value (< 1.4) → hydrostatics 	<ul style="list-style-type: none"> ■ Density change → guided radar, radar, ultrasonics ■ Strong build-up formation → radar, ultrasonics 	<ul style="list-style-type: none"> ■ Changing, non-conductive media or conductivity between 1 to 100µS/cm → guided radar, radar, ultrasonics ■ Strong, conductive build-up formation → radar, ultrasonics 		

➔ Please note: Radar continued on Page 34

➔ Please note: Guided radar continued on Page 68

➔ Please note: Hydrostatics continued on Page 88

➔ Please note: Capacitance continued on Page 90

3. Selection of the measuring principle according to the application

Vertical storage tank

- Calm surface (e. g. bottom filling, filling via immersion tube or rare free filling from above)
- Accuracy 3 to 10mm/0.12 to 0.4"
- Measurement without stilling well/bypass



Non-contact

Our proposal

Radar Micropilot



FMR60B/FMR62B/FMR63B

Radar Micropilot



FMR10B/FMR20B/FMR30B

Advantages

- Resistant against aggressive media
- For highly viscous media
- Not affected by changing media properties like e.g. density
- Heartbeat Technology
- Remote access via Bluetooth®

- High resistance
- Heartbeat Technology
- Remote access via Bluetooth®
- LED indicator / color touch display for fast status detection

Technical data

- Connection
- Accuracy
- Process temperature
- Process pressure
- Process connection

2-wire (HART®, PA, Ethernet-APL)
 ±1mm/±0.04"
 -196 to +450°C/-321 to +842°F
 -1 to +160bar/-14.5 to +2,320psi
 Threads, flanges (DIN, ASME, JIS),
 hygienic connections
 80m/262ft

2-wire (HART®)
 ±2mm/±0.08"
 -40 to +80°C/-40 to +176°F
 -1 to +3bar/+14.5 to +43psi
 Threads, flanges (DIN, ANSI, JIS)

30m/98ft

Application limits

- Strong formation of foam → guided radar, hydrostatics
- Many obstacles → guided radar, capacitance, hydrostatics
- Low DC value (< 1.2) → hydrostatics

- Strong formation of foam → guided radar, hydrostatics
- Many obstacles → guided radar, capacitance, hydrostatics
- Low DC value (< 1.8) → hydrostatics

Contact

Our proposal

Hydrostatics Deltapilot, Cerabar, Deltabar



- Unaffected by DC values
- Unaffected by tank baffles
- Unaffected by foam
- Remote access via Bluetooth®
- Heartbeat Technology

2-wire (analog, HART®, PA, FF)
 ±0.025% of the set span
 -70 to +400°C/-94 to +752°F
 up to +700bar/+10,500psi
 Threads, flanges (DIN, ANSI, JIS),
 hygienic connections
 Typically up to 100m/328ft

- Density change → guided radar, radar, ultrasonics
- Strong build-up formation → radar, ultrasonics

Guided radar Levelflex



FMP5x

- Unaffected by nozzle dimensions and tank obstacles
- Heartbeat Technology

2-wire (HART®, PA, FF), 4-wire HART®
 ±2mm/±0.08"
 -196 to +450°C/-321 to +842°F
 -1 to +400bar/-14.5 to +5,800psi
 Threads, flanges (DIN, ANSI, JIS),
 hygienic connections
 10m/33ft (rod), 45m/148ft (rope),
 6m/20ft (coax), longer upon request

- Strong build-up formation (e. g. high viscosity, crystallizing media, etc.) → radar, ultrasonics
- Low DC value (< 1.4) → hydrostatics

Capacitance Liquicap



FMI5x

- Unaffected by nozzle dimensions and tank obstacles
- Calibration not required in conductive liquids
- No blocking distance

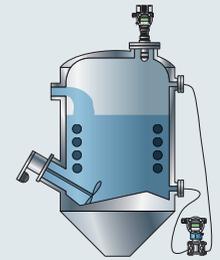
2-wire (HART®)
 ±1.0%
 -80 to +200°C/-112 to +392°F
 -1 to +100bar/-14.5 to +1,450psi
 Threads, flanges (DIN, ANSI, JIS),
 hygienic connections
 4m/13ft (rod), 10m/32ft (rope)

- Changing, non-conductive media or conductivity between 1 to 100µS/cm → guided radar, radar, ultrasonics
- Strong, conductive build-up formation → radar, ultrasonics

3. Selection of the measuring principle according to the application

✓ Buffer tank

- Agitated surface (e. g. permanent free filling from above, mixing jets, slowly turning mixer, lateral installation)
- Measurement without stilling well
- Foam spots, islands
- Pressurized
- Fast temperature changes (cleaning)



Non-contact

Our proposal

Radar Micropilot



FMR60B/FMR62B/FMR63B

Radar Micropilot



FMR20B/FMR30B

Radar Micropilot



FMR43

Advantages

- Unaffected by head pressures
- Small beam angle
- Not affected by changing media properties like e.g. density
- Heartbeat Technology
- Remote access via Bluetooth®

- High resistance
- Heartbeat Technology
- Remote access via Bluetooth®
- LED indicator / color touch display for fast status detection

- Compact and hygienic design
- Heartbeat Technology
- Remote access via Bluetooth®
- LED indicator / color touch display

Technical data

- Connection
- Accuracy
- Process temperature
- Process pressure
- Process connection
- Maximum measuring range

2-wire (HART®, PA, Ethernet-APL)
±1mm/±0.04"
-196 to +450°C/
-321 to +842°F
-1 to +160bar/
-14.5 to +2,320psi
Threads, flanges (DIN, ASME, JIS), hygienic connections
80m/262ft

2-wire (HART®)
±2mm/±0.08"
-40 to +80°C/
-40 to +176°F
-1 to +3bar/
+14.5 to +43psi
Threads, flanges (DIN, ANSI, JIS)
30m/98ft

2-wire (HART®, IO-Link)
±1mm/±0.04"
-40 to +150°C/
-40 to +302°F
-1 to +20bar/
-14.5 to +290psi
Threads, hygienic connections
15m/49ft

Application limits

- Strong formation of foam
- Many obstacles in the radar beam

→ guided radar, hydrostatics
→ guided radar, capacitance, hydrostatics

Contact

Hydrostatics Cerabar, Deltabar

FMD71/FMD72 (electronic dp)



PMD55B, PMD75B, PMD78B

Guided radar Levelflex



FMP5x

Capacitance Liquicap



FMI5x

- Unaffected by foam
- Unaffected by installation situation
- Unaffected by DC value
- Electronic dp
- Remote access via Bluetooth®
- Heartbeat Technology

- Unaffected by nozzle dimensions and tank obstacles
- Unaffected by agitated surfaces
- Heartbeat Technology

- For small tanks with fast filling and discharging operations
- Unaffected by nozzle dimensions and tank obstacles
- No blocking distance

2-wire (HART®, PA, FF)
±0.035% of the set span
-70 to +400°C/
-94 to +752°F
up to +40bar/+580psi

2-wire (HART®, PA, FF), 4-wire HART®
±2mm/±0.08"
-196 to +450°C/
-321 to +842°F
-1 to +400bar/
-14.5 to +5,800psi
Threads, flanges (DIN, ANSI, JIS), hygienic connections
10m/33ft (rod), 45m/148ft (rope), 6m/20ft (coax), longer upon request

2-wire (HART®)
±1.0%
-80 to +200°C/
-112 to +392°F
-1 to +100bar/
-14.5 to +1,450psi
Threads, flanges (DIN, ANSI, JIS), hygienic connections
4m/13ft (rod), 10m/32ft (rope)

- Density change
 - Strong build-up formation
- guided radar, radar, ultrasonics
→ radar, ultrasonics, bubble system

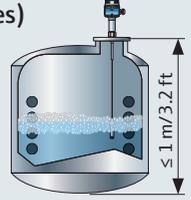
- Strong lateral load
 - Strong build-up formation
- radar, ultrasonics, hydrostatics
→ radar, ultrasonics

- Changing media
 - Strong, conductive build-up formation
 - Strong lateral load
- guided radar, radar, ultrasonics
→ radar, ultrasonics
→ radar, ultrasonics, hydrostatics

3. Selection of the measuring principle according to the application

✓ Recipient tank (e. g. bottling facilities)

- Pressurized
- Fast temperature changes (cleaning)
- Fast filling and discharging operations
- Tank < 1m/3.2ft in height
- Strongly foaming surface



Non-contact

Our proposal

**Radar
Micropilot**



FMR43

Advantages

- Compact and hygienic design
- Heartbeat Technology
- Remote access via *Bluetooth*[®]
- LED indicator / color touch display for fast status detection

Technical data

- Connection
 - Accuracy
 - Process temperature
 - Process pressure
 - Process connection
 - Maximum measuring range
- 2-wire (HART[®], IO-Link)
±1mm/±0.04"
-40 to +150°C/-40 to +302°F
-1 to +20bar/-14.5 to +290psi
Threads, hygienic connections
15m/49ft

Application limits

- Strong formation of foam
 - Many obstacles in the radar beam
 - Low DC value (< 1.2)
- guided radar, hydrostatics
→ guided radar, capacitance, hydrostatics
→ hydrostatics

Contact

Our proposal

**Capacitance
Liquicap**



FMI5x

**Guided radar
Levelflex**



FMP5x

**Hydrostatics
Deltapilot, Deltabar, Cerabar**



FMD71/FMD72
2 x PMC/PMP51B,
2 x PMC/PMP71B

- Fastest response times during filling and discharging operations
- Maximum tank exploitation – no blocking distance
- Unaffected by nozzle dimensions and tank baffles

- Unaffected by nozzle dimensions and tank obstacles
 - Unaffected by product properties (conductivity, density)
 - Heartbeat Technology
- 2-wire (HART[®])
±1.0%
-80 to +200°C/-112 to +392°F
-1 to +100bar/-14.5 to +1,450psi
Threads, flanges (DIN, ANSI, JIS), hygienic connections
4m/13ft (rod), 10m/32ft (rope)

- Changing, non-conductive media or conductivity between 1 to 100µS/cm
- hydrostatics

- Extremely fast filling and discharging operations (response times < 0.7sec)
 - Highly accurate measurements in the lower and upper area
 - DC starting at 1.4
- capacitance
→ capacitance
→ hydrostatics

- Electronic dp
 - Unaffected by foam
 - Unaffected by installation situation
 - Unaffected by DC value
 - Fast response times
 - Unaffected by ambient temperatures
- 2-wire (HART[®], PA, FF)
±0.05% of the set span
-40 to +150°C/-40 to +302°F
up to +40bar/+580psi
Threads, flanges (DIN, ANSI, JIS), hygienic connections
Typically up to 100m/328ft

- Density change
 - Electronic dp-ratio head pressure to level max. 6:1
- capacitance
→ capacitance, guided radar

3. Selection of the measuring principle according to the application

✓ Process tank with agitator

- Agitated surface
- Single-stage agitator (< 60 RPM)
- Pressurized
- Free space measurement (without stilling well/bypass)
- Foam formation is possible depending on the application



Non-contact

Our proposal

**Radar
Micropilot**



**Radar
Micropilot**



Advantages

- | | |
|--|---|
| <ul style="list-style-type: none"> ■ Unaffected by head pressures ■ Small beam angle ■ Not affected by changing media properties like e.g. density ■ Heartbeat Technology ■ Remote access via <i>Bluetooth</i>® | <ul style="list-style-type: none"> ■ Compact and hygienic design ■ Heartbeat Technology ■ Remote access via <i>Bluetooth</i>® ■ LED indicator / color touch display for fast status detection |
|--|---|

Technical data

- | | |
|---|--|
| <ul style="list-style-type: none"> ■ Connection ■ Accuracy ■ Process temperature ■ Process pressure ■ Process connection | <p>2-wire (HART®, PA, Ethernet-APL)
±1mm/±0.04"</p> <p>-196 to +450°C/-321 to +842°F</p> <p>-1 to +160bar/-14.5 to +2,320psi</p> <p>Threads, flanges (DIN, ASME, JIS), hygienic connections</p> <p>80m/262ft</p> |
| <ul style="list-style-type: none"> ■ Maximum measuring range | <p>15m/49ft</p> |

Application limits

- | | | |
|--|---|----------------|
| <ul style="list-style-type: none"> ■ Strong formation of foam ■ Many obstacles ■ Low DC value (< 1.2) ■ Extreme turbulences | } | → hydrostatics |
|--|---|----------------|

Contact

Our proposal

**Hydrostatics
Deltabar**



Advantages

- Unaffected by DC values
- Unaffected by tank baffles
- Unaffected by foam
- Unaffected by strongly fluctuating ambient temperatures
- Remote access via *Bluetooth*®
- Heartbeat Technology

- 2-wire (HART®, PA, FF)
±0.035% of the set span
-70 to +400°C/-94 to +752°F
up to +40bar/+580psi
Threads, flanges (DIN, ANSI, JIS), hygienic connections
Typically up to 100m/328ft

- Density change
- Strong build-up formation

- | |
|---|
| <ul style="list-style-type: none"> → radar, ultrasonics → radar, ultrasonics, bubble system |
|---|

3. Selection of the measuring principle according to the application

✓ Stilling well

- Measurement in metal pipes (installed in the tank)
e. g. immersion tube
- Nominal width typ. DN 40 to DN 150/1.5" to 6"



Non-contact

Our proposal

**Radar
Micropilot**



FMR62B
with 80mm/3" PTFE clad antenna

**Radar
Micropilot**



FMR54

Advantages

- Unaffected by head pressures
- Resistant against aggressive media
- Useable for ball valves (full bore)
- Not affected by changing media properties like e.g. density
- Heartbeat Technology
- Remote access via *Bluetooth*®

- Unaffected by head pressures
- Useable for ball valves (full-bore)
- Not affected by changing media properties e.g. density
- Remote access via *Bluetooth*®
- Heartbeat Technology

Technical data

- Connection
- Accuracy
- Process temperature
- Process pressure
- Process connection

2-wire (HART®, PA, Ethernet APL)
±1mm/±0.04"
-196 to +450°C/-321 to +842°F
-1 to +160bar/-14.5 to +2,320psi
Flanges (DIN, ASME, JIS)

2-wire (HART®, PA, FF), 4-wire HART®
±6mm/±0.24"
-60 to +400°C/-76 to +752°F
-1 to +160bar/-14.5 to +2,320psi
Flanges (DIN, ASME, JIS)

- Maximum measuring range

80m/262ft

20m/65ft; Planar antenna in stilling well: 38m (125ft)

Application limits

- Large changes in the stilling well cross section → guided radar, capacitance
- Arrangement, size of equalizing openings → guided radar, capacitance
- Plastic stilling wells → ultrasonics, guided radar
- DC starting at 1.4 → float
- Stilling well > 12 m → FMR54

- Large changes in the stilling well cross section → guided radar, capacitance
- Arrangement, size of equalizing openings → guided radar, capacitance
- Plastic stilling wells → ultrasonics, guided radar
- DC starting at 1.4 → float

Contact

Our proposal

**Guided radar
Levelflex**



FMP5x

**Capacitance
Liquicap**



FMI5x

- Divisible rod probe
- Heartbeat Technology

- Unaffected by the stilling well geometry

2-wire (HART®, PA, FF), 4-wire HART®
±2mm/±0.08"
-196 to +450°C/-321 to +842°F
-1 to +400bar/-14.5 to +5,800psi
Threads, flanges (DIN, ANSI, JIS),
hygienic connections
10m/33ft (rod), 45m/148ft (rope),
longer upon request

2-wire (HART®)
±1.0%
-80 to +200°C/-112 to +392°F
-1 to +100bar/-14.5 to +1,450psi
Threads, flanges (DIN, ANSI, JIS),
hygienic connections
4m/13ft (rod), 10m/32ft (rope)

- Contact between probe and stilling well → radar, ultrasonics
- Highly viscous products (> 1000cst) → radar, ultrasonics
- Max. stilling well length 10m/33ft → float
- DC starting at 1.4 → float

- Changing, non-conductive media or conductivity between 1 to 100µS/cm → guided radar, radar, ultrasonics

3. Selection of the measuring principle according to the application

✓ Bypass/bridle

- Measurement in metal pipes (installed outside the tank)
- Replacement of displacer or float vessels, compensation vessels
- Nominal width typ. DN 40 to DN 150/1.5" to 6"



Non-contact

Our proposal

**Radar
Micropilot**



FMR62B
with 80mm/3" PTFE clad antenna

**Radar
Micropilot**



FMR54

Advantages

- Unaffected by head pressures
- Resistant against aggressive media
- Useable for ball valves (full bore)
- Not affected by changing media properties like e.g. density
- Heartbeat Technology
- Remote access via *Bluetooth*®

- Unaffected by head pressures
- Resistant against aggressive media
- Useable for ball valves (full bore)
- Not affected by changing media properties like e.g. density
- Heartbeat Technology
- Remote access via *Bluetooth*®

Technical data

- Connection
- Accuracy
- Process temperature
- Process pressure
- Process connection
- Maximum measuring range

2-wire (HART®, PA, Ethernet-APL)
±1mm/±0.04"
-196 to +450°C/-321 to +842°F
-1 to +160bar/-14.5 to +2,320psi
Flanges (DIN, ASME, JIS),
hygienic connections
80m/262ft

2-wire (HART®, PA, FF), 4-wire (HART®)
±6mm/±0.24"
-60 to +400°C/-76 to +752°F
-1 to +160bar/-14.5 to +2,320psi
Flanges (DIN, ASME, JIS)

20m/65ft; Planar antenna in stilling well:
38m (125ft)

Application limits

- Strong formation of foam → guided radar, hydrostatics
- Low DC value (< 1.4) → hydrostatics
- Bypass > 12 m → FMR54

- Strong formation of foam → guided radar, hydrostatics
- Many obstacles → guided radar, capacitance, hydrostatics
- Low DC value (< 1.4) → hydrostatics

Contact

Our proposal

**Guided radar
Levelflex**



FMP5x

**Capacitance
Liquicap**



FMI5x

Advantages

- No impairment by bypass connections
- Unaffected by changing media
- Safe operation in case of filling via upper connection ("coaxial probe")
- Heartbeat Technology

- For small tanks with fast filling and discharging operations
- Unaffected by nozzle dimensions and tank obstacles
- No blocking distance

Technical data

2-wire (HART®, PA, FF), 4-wire HART®
±2mm/±0.08"
-196 to +450°C/-321 to +842°F
-1 to +400bar/-14.5 to +5,800psi
Threads, flanges (DIN, ANSI, JIS),
hygienic connections
10m/33ft (rod), 45m/148ft (rope),
longer upon request

2-wire (HART®)
±1.0%
-80 to +200°C/-112 to +392°F
-1 to +100bar/-14.5 to +1,450psi
Threads, flanges (DIN, ANSI, JIS),
hygienic connections
4m/13ft (rod), 10m/32ft (rope)

Application limits

- Strong build-up formation (e. g. high viscosity, crystallizing media, etc.) → radar
- Low DC value (< 1.4) → hydrostatics

- Changing, non-conductive media or conductivity between 1 to 100µS/cm → guided radar, radar
- Strong, conductive build-up formation → radar, hydrostatics

3. Selection of the measuring principle according to the application

✓ Pump shaft/overfall construction/ rain water basin

- Many obstacles
- Risk of flooding, foam formation and turbulent surfaces
- Build-up on the sensor and contacting obstacles (ice formation in winter, suspended solids)
- Installation at open basins or underground
- Sludge formation due to suspended solids



Non-contact		Contact		
Our proposal		Our proposal		
	<p>Ultrasonics Prosonic (separated)</p>  <p>FMU90 FDU9x</p>	<p>Radar Micropilot</p>  <p>FMR10B/FMR20B/FMR30B</p>	<p>Hydrostatics Deltapilot/Waterpilot</p>  <p>FMB53 FMX21</p>	<p>Control unit</p> <p>FlexView</p>  <p>FMA90</p>
Advantages	<ul style="list-style-type: none"> ■ Overspill-protected, heated sensors with self-cleaning effect ■ Universal use due to flexible measuring range ■ Operation and display at easily accessible mounting locations possible incl. integrated point level relay and integrated control functions 	<ul style="list-style-type: none"> ■ Non-contact ■ Small beam angle ■ Heartbeat Technology ■ Remote access via <i>Bluetooth</i>® ■ LED indicator / color touch display for fast status detection 	<ul style="list-style-type: none"> ■ Unaffected by tank baffles, mounting situation and foam ■ Operation and display possible at easily accessible mounting locations 	<ul style="list-style-type: none"> ■ Compatible with radar, ultrasonic and hydrostatic level sensors ■ Remote access via Wi-Fi or integrated web server ■ Advanced pump control with up to eight switching outputs ■ Digital inputs for pump feedback and failure monitoring
Technical data	<ul style="list-style-type: none"> ■ Connection <p>2-/4-wire (HART®, DP)</p> <ul style="list-style-type: none"> ■ Accuracy ■ Process temperature ■ Process pressure ■ Process connection <p>±2mm/±0.08", +0.2% of the distance -40 to +105°C/-40 to +221°F +0.7 to +4bar/+10 to +58psi Threads, Tri-Clamp, flanges (DIN, ANSI, JIS)</p> <ul style="list-style-type: none"> ■ Maximum measuring range <p>25m/82ft</p>	<ul style="list-style-type: none"> ■ Connection <p>2-wire (HART®)</p> <ul style="list-style-type: none"> ■ Accuracy ■ Process temperature ■ Process pressure ■ Process connection <p>±2mm/±0.08" -40 to +80°C/-40 to +176°F -1 to +3bar/+14.5 to +43psi Threads, flanges (DIN, ANSI, JIS)</p> <ul style="list-style-type: none"> ■ Maximum measuring range <p>30m/98ft</p>	<ul style="list-style-type: none"> ■ Connection <p>2-wire (analog, HART®, PA, FF)</p> <ul style="list-style-type: none"> ■ Accuracy ■ Process temperature ■ Process pressure ■ Process connection <p>±0.1% -10 to +80°C/+14 to +176°F +0,1 to +20bar/1.45 to 290psi Mounting clamp, cable mounting screw</p> <ul style="list-style-type: none"> ■ Maximum measuring range <p>200m/656ft (20bar/290psi)</p>	<ul style="list-style-type: none"> ■ Connection <p>4-20 mA/HART level sensors</p> <p>See the corresponding sensor information</p>
Application limits	<ul style="list-style-type: none"> ■ Strong formation of foam ■ Many obstacles <p>} → hydrostatics</p>	<ul style="list-style-type: none"> ■ Strong formation of foam → guided radar, hydrostatics ■ Many obstacles → guided radar, capacitance, hydrostatics ■ Low DC value (< 1.8) → hydrostatics 	<ul style="list-style-type: none"> ■ Risk of sludge formation/pollution (build-up) → ultrasonics, radar 	<p>See the corresponding sensor information</p>

➔ Please note: Ultrasonics continued on Page 74

➔ Please note: Radar continued on Page 34

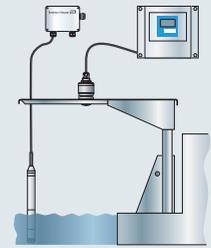
➔ Please note: Hydrostatics continued on Page 88

➔ Please note: Capacitance continued on Page 80

3. Selection of the measuring principle according to the application

✓ Channel measurement (free flowing)

- Risk of flooding, foam formation
- Obstacles
- Condensate formation (icing in winter) on sensor and instrument
- Build-up on the sensor and contacting obstacles (ice formation in winter, suspended solids)
- Installation at open basins or underground



Non-contact

Our proposal

Radar Micropilot



FMR10B/FMR20B/FMR30B

Ultrasonics Prosonic

(separated)



FMU90

FDU9x

Advantages

- Flow curves integrated in the device
- Easy commissioning with guided wizards
- Heartbeat Technology
- Remote access via *Bluetooth*®
- LED indicator / color touch display for fast status detection

- **No flow impairment**
- **Overspill-protected, heated sensors with self-cleaning effect**
- **Operation and display at easily accessible mounting locations possible incl. integrated point level relay and preprogrammed flow curves**

Technical data

■ Connection

2-wire (HART®)

2-/4-wire (HART®, DP)

- Accuracy
- Process temperature
- Process pressure
- Process connection

±2mm/±0.08"
-40 to +80°C/-40 to +176°F
-1 to +3bar/+14.5 to +43psi
Threads, flanges (DIN, ANSI, JIS)
30m/98ft

±2mm/±0.08", +0.2% of the distance
-40 to +105°C/-40 to +221°F
+0.7 to +4bar/+10 to +58psi
Threads, Tri-Clamp, flanges (DIN, ANSI, JIS)
25m/82ft

Application limits

- Strong formation of foam

→ hydrostatics

- Strong formation of foam
- Many obstacles

} → hydrostatics

Contact

Hydrostatics Deltapilot/Waterpilot



FMX21

FMB53

Advantages

- Unaffected by obstacles / installation situation
- Unaffected by foam formation
- Simple commissioning, calibration is not required

Technical data

2-wire (analog, HART®, PA, FF)

±0.1%
-10 to +80°C/+14 to +176°F
+0,1 to +20bar/1.45 to 290psi
Mounting clamp, cable mounting screw
200m/656ft (20bar/290psi)

- Risk of sludge accumulation/pollution (build-up formation)
- Restricted installation in flowing water

→ ultrasonics, radar

→ ultrasonics, radar

Control unit

Our proposal

FlexView



FMA90

Advantages

- Compatible with radar, ultrasonic and hydrostatic level sensors
- Remote access via Wi-Fi or integrated web server
- Flow measurement at open channels, weirs and pipes
- Totalizer function and backwater detection
- Easy selection of predefined weirs and channel shapes

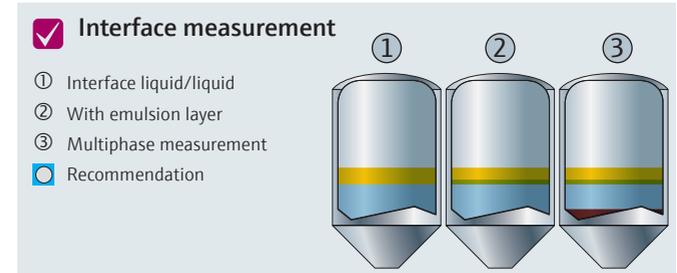
Technical data

4-20 mA/HART level sensors

See the corresponding sensor information

See the corresponding sensor information

3. Selection of the measuring principle according to the application



Contact

	<p>① Guided radar Levelflex FMP51/52/54</p>	<p>① ② Multiparameter Levelflex FMP55</p>	<p>① ② Capacitance Liquicap FMI51/52</p>
Advantages	<ul style="list-style-type: none"> ■ Simultaneous acquisition of interface layer and total level ■ Not affected by the density of the medium ■ No wet calibration required ■ Direct replacement of displacers in existing displacer chambers ■ Probes can be shortened (rod) 	<ul style="list-style-type: none"> ■ Simultaneous acquisition of interface layer and overall level, also in case of emulsions ■ Precise and reliable measurement ■ Independent of medium density ■ Wet calibration not required ■ PTFE-coated probe 	<ul style="list-style-type: none"> ■ Tried and tested instrumentation ■ No wet calibration required ■ Not affected by the density of the medium ■ Unproblematic use in emulsion layers ■ Ideal for very small measuring ranges ■ Extremely fast response time
Technical data	<ul style="list-style-type: none"> ■ Connection: 2-wire (HART®/PA), 4-wire ■ Accuracy: ±2mm/±0.08" (overall level); ±10mm/±0.39" (interface level) ■ Process temperature: -196 to +450°C/-321 to +842°F ■ Process pressure: -1 to +400bar/-14.5 to +5,800psi ■ Process connection: Threads, flanges (DIN, ANSI, JIS), hygiene connections ■ Maximum measuring range: 6m/20ft (coax), 10m/33ft (rope/rod), longer upon request 	<ul style="list-style-type: none"> ■ Connection: 2-wire (HART®/PA), 4-wire ■ Accuracy: ±2mm/±0.08" (overall level); ±10mm/±0.39" (interface level) ■ Process temperature: -50 to +200°C/-58 to +392°F ■ Process pressure: -1 to +40bar/-14.5 to +580psi ■ Process connection: Threads, flanges (DIN, ANSI, JIS), hygiene connections ■ Maximum measuring range: 6m/20ft (coax), 10m/33ft (rope), 4m/13ft (rod), longer upon request 	<ul style="list-style-type: none"> ■ Connection: 2-wire (HART®) ■ Accuracy: ±1% ■ Process temperature: -80 to +200°C/-112 to +392°F ■ Process pressure: -1 to +100bar/-14.5 to +1,450psi ■ Process connection: Threads, flanges (DIN, ANSI, JIS), hygiene connections ■ Maximum measuring range: 4m/13ft (rod), 10m/32ft (rope)
Application limits	<ul style="list-style-type: none"> ■ Dielectric constant (DC value) of the upper medium must be determined ■ DC value changes of the upper medium influence accuracy ■ DC value of the upper medium may be max. 10 ■ Difference of the DCs between the two media must be >10 ■ For interface measurement, the thickness of the upper phase must be min. 60mm/2.36" ■ Emulsion layers up to max. 50mm/1.97" allowable 	<ul style="list-style-type: none"> ■ Dielectric constant (DC value) of the upper medium must be determined ■ DC value changes of the upper medium influence accuracy ■ DC value of the upper medium may be max. 10 ■ Difference of the DCs between the two media must be >10 ■ For interface measurement, the thickness of the upper phase must be min. 60mm/2.36" 	<ul style="list-style-type: none"> ■ Difference of the dielectric constant (DC value) between the two media must be >10. The upper medium may not be conductive ■ Accuracy impairment in case of nonconductive build-up on the probe ■ The smaller the vessel the higher the influence of DC changes in the upper medium ■ The bigger the quotient DC(below) / DC(above) the better the accuracy ■ The total level is not measured

Non-contact

	<p>① ② ③ Radiometrics Gammapiilot FMG50</p>
Advantages	<ul style="list-style-type: none"> ■ Non-invasive and maintenance-free measuring method ■ Unaffected by pressure and temperature ■ Only slight influence by build-up ■ Unproblematic use in emulsion layers ■ Solutions for multiphase measurements using several detectors
Technical data	<ul style="list-style-type: none"> ■ Connection: 2-wire (HART®) ■ Accuracy: ±1% of measuring distance ■ Process temperature: Independent (non-invasive) ■ Process pressure: Independent (non-invasive) ■ Process connection: Independent (non-invasive) ■ Maximum measuring range: Adaptable to application
Application limits	<ul style="list-style-type: none"> ■ Medium density changes influence the accuracy ■ The overall level is not measured (possible with a further source and detector) ■ Calibration with the medium is required ■ Observe radiation protection regulations

4. Instrument selection within the measuring principle

Radar

Required application data

- Pressure and temperature
- Dielectric constant of the medium (DC)/media group
- Required material compatibility
- Nozzle diameter/nozzle height
- Measuring range
- Required accuracy
- For stilling well/bypass:
Internal pipe diameter

Application limits for radar level measurement

- Temperature up to $-196^{\circ}\text{C}/-321^{\circ}\text{F}$
- Temperature up to $+450^{\circ}\text{C}/+842^{\circ}\text{F}$
- Pressure up to 160bar/2320psi
- Measuring range up to 80m/262ft
- Dielectric constant from 1,2
- Process connection from $\frac{3}{4}$ "

Advantages

- Non-contact, maintenance-free measurement
- Unaffected by medium properties like density and conductivity
- For high temperatures up to $+450^{\circ}\text{C}/+842^{\circ}\text{F}$
- Measurement from outside of the tank

Dielectric constant (DC)

The reflection properties of a medium are determined by the dielectric constant (DC). The following table shows the allocation of different DC values to media groups. If the dielectric constant of a medium is not known, we recommend to use a DC value of 1.9 for sizing in order to maintain a safe measurement.

Absorption

The following media can absorb the radar signal from 80 GHz sensors depending on pressure, temperature and the concentration of the respective medium:

- Aceton (Dimethylketon)
- Dichloromethane/Methylene Chloride
- Ethylene oxide
- Methyl Ethyl Ketone
- Methyl Isobutyl Ketone (MIBK)
- Propylene oxide
- SMR (Xylene 30 %, Toluene 30 %, Acetone 40 %)
- Silicon tetrachloride
- Trichlorosilane
- Tetrafluoroethane
- Toluol
- VCM (Vinyl Chloride Monomer)
- Ammonia
- Ethyl Acetate
- Acetic Acid
- Acrylnitril

As an alternative radars with lower frequencies (6GHz and 26GHz) or guided radar can be used.

Endress+Hauser DC App

The app offers comfortable access to several thousand DC values for all kinds of different media. You can search by the name of the medium or the chemical formula. The autocomplete functionality helps you if you don't know the exact spelling of the name of your medium.



Dielectric constant (DC value)
Compendium



Media group	DC value	Examples
AO	1.2 to 1.4	Butane, liquid nitrogen, liquefies hydrogen
A	1.4 to 1.9	non-conducting liquids, e. g. liquified gas ¹⁾
B	1.9 to 4	non-conductive liquids, e. g. benzene, oil, toluene, ...
C	4 to 10	e. g. concentrated acid, organic solvents, esters, aniline, alcohol, acetone, ...
D	> 10	conducting liquids, e.g. aqueous solutions, diluted acids and alkalis

- Measuring range:
 - Micropilot FMR10B/FMR20B/FMR30B up to 30m/98ft
 - Micropilot FMR5x up to 40m/131ft. Larger than 40m/131ft → Micropilot with option "advanced dynamics" max. measuring range 70m/229ft
 - Micropilot FMR6xB up to 80m/262ft
 - Accuracy: More precise than 1mm/0.04" → Micropilot FMR6xB, or on request

¹⁾ Treat ammonia (NH₃) like a medium of group A, i.e. measurement in stilling wells always with FMR54. Alternatively, measurement with guided radar FMP54 respectively FMP51 including option "gastight feedthrough"

4. Instrument selection within the measuring principle

Radar

	 <p>Micropilot FMR10B 80GHz</p>	 <p>Micropilot FMR20B, FMR30B 80GHz</p>	 <p>Micropilot FMR43 80GHz/180GHz</p>	 <p>Micropilot FMR51 26GHz</p>	 <p>Micropilot FMR52 26GHz</p>
Technical data					
<ul style="list-style-type: none"> Process pressure Process temperature Accuracy Process connection 	-1 to +3bar/-14.5 to +43.5psi -40 to +60°C/-40 to +140°F ±5mm/±0.2" G 1", NPT 1", G 1½", NPT 1½"	-1 to +3bar/-14.5 to +43.5psi -40 to +80°C/-40 to +176°F ±2mm/±0.08" G 1", NPT 1", G 1½", NPT 1½", DN 50 to DN 150/2" to 6"	-1 to +20bar/-14.5 to +290psi -40 to +150°C/-40 to +302°F ±1mm/±0.04" M24, G/MNPT 3/4", G 1", G/MNPT 1½", Clamp 1½" to 2", NEUMO Bio Control D50 PEEK, PTFE, 316L	-1 to +160bar/-14.5 to +2320psi -196 to +450°C/-321 to +842°F ±2mm/±0.08" R 1½", NPT 1½", DN 50 to DN 150/ 2" to 6", Tri-Clamp 2" to 3"	-1 to +25bar/-14.5 to +362.5psi -196 to +200°C/-321 to +392°F ±2mm/±0.08" DN 50 to DN 150/2" to 6", Tri-Clamp 2" to 4", hygienic connections
<ul style="list-style-type: none"> Wetted parts Measuring ranges Gastight feedthrough Technical Information 	PVDF 10m/33ft — TI01805F	PVDF 30m/98ft — TI01796F/TI01806F	— 15m/49ft — TI01728F/TI01729F	316L/1.4435, Alloy C, PTFE, sealings 40m/131ft Optional TI01040F	PTFE-cladded 40m/131ft Optional TI01040F
Applications					
Horizontal storage tank cyl.	0	+	+	+	+
Vertical storage tank	+	+	+	+	+
Buffer tank	-	+	+	+	+
Recipient tank	-	-	+	-	-
Process tank	-	0	0	+	+
Stilling well	-	-	-	+	+
Bypass	-	-	-	0	+
Pump shaft	0	+	+	+	+
Channel measurement	0	+	+	0	0
Application limits	<ul style="list-style-type: none"> Low DC value (< 1.8) → FMR6xB Turbulent surfaces → FMR6xB Ammoniacal gas phase → FMR54 in stilling well → FMR67B with air purge → FMR62B → NMR8x Strong build-up formation → FMR67B with air purge → FMR62B Only PTFE resistant → FMR62B Custody transfer measurement → NMR8x 	<ul style="list-style-type: none"> Low DC value (< 1.8) → FMR6xB Turbulent surfaces → FMR6xB Ammoniacal gas phase → FMR54 in stilling well → FMR67B with air purge → FMR62B → NMR8x Strong build-up formation → FMR67B with air purge → FMR62B Only PTFE resistant → FMR62B Custody transfer measurement → NMR8x 	<ul style="list-style-type: none"> Ammoniacal gas phase → FMR54 in stilling well Strong build-up formation → FMR67B with air purge → NMR8x Custody transfer measurement → NMR8x 	<ul style="list-style-type: none"> Ammoniacal gas phase → FMR54 in stilling well Strong build-up formation → FMR67B with air purge → FMR63B → NMR8x Hygiene requirements → FMR63B Custody transfer measurement → NMR8x 	<ul style="list-style-type: none"> Ammoniacal gas phase → FMR54 in stilling well Strong build-up formation rate → FMR67B with air purge → FMR62B Small connections with low DC → FMR62B Low DC and high nozzle → FMR62B Custody transfer measurement → NMR8x

+ = recommended

0 = restricted (observe limits)

- = not recommended

4. Instrument selection within the measuring principle

Radar				
	 Micropilot FMR54 6GHz	 Micropilot FMR60B 80GHz	 Micropilot FMR62B 80GHz	 Micropilot FMR63B 80GHz
Technical data				
<ul style="list-style-type: none"> Process pressure Process temperature Accuracy Process connection 	-1 to +160bar/-14.5 to +2320psi -196 to +400°C/-321 to +752°F ±6mm/0.24"	-1 bis +20bar/-14.5 to +290psi -40 bis +200°C/-40 to +392°F ±1mm/0.04" G and NPT ¾" and 1-½", UNI flange 3" to 6"	-1 bis +160bar/-14.5 to +2,321psi -196 bis +450°C/-321 to +842°F ±1mm/0.04" G, MNPT ¾", 1-½", DN 50 to DN 150/2" to 6"	-1 bis +25bar/-14.5 to +363.6psi -40 bis +200°C/-40 to +392°F ±1mm/0.04" Tri-Clamp, DIN 11851, NEUMO, M24 thread
<ul style="list-style-type: none"> Wetted parts Measuring ranges Gastight feedthrough Technical Information 	316L/1.4435, Alloy C, PTFE, ceramics, graphite, sealings 20m/65ft Standard TI01041F	50m/164ft Optional TI01683F	80m/262ft Optional TI01684F	80m/262ft Optional TI01685F
Applications				
Horizontal storage tank cyl.	-	+	+	+
Vertical storage tank	0	+	+	+
Buffer tank	0	+	+	+
Recipient tank	-	0	+	+
Process tank	+	+	+	+
Stilling well	+	-	0	-
Bypass	0	-	0	-
Pump shaft	-	0	0	-
Channel measurement	-	0	0	-
Application limits	<ul style="list-style-type: none"> Free space with nozzle < DN 150/6" → FMR51, 52, 60B, 62B → FMR51, 52 Stilling well with ball valve → FMR63B Hygiene requirements 	<ul style="list-style-type: none"> Bypass/stilling well → FMR62B High pressure/high temperature → FMR62B high temperature 	<ul style="list-style-type: none"> Bypass/stilling well >12m/39ft → FMR54 	

+ = recommended

0 = restricted (observe limits)

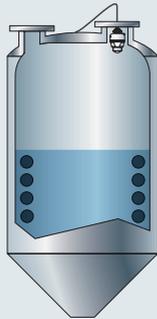
- = not recommended

4. Instrument selection within the measuring principle

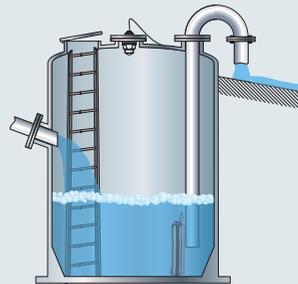
Measuring range in dependence on the type of tank

Process conditions and medium for Micropilot FMR10B/FMR20B/FMR30B

Storage tank (vertical)
Calm surface
(e. g. bottom filling)



Pump shaft
Agitated surface
(e. g. permanent free filling from above)



Channel
Calm surface
(e. g. bottom filling with slightly moving surface)



	Antenna diameter								
FMR10B	40mm/1.5"	—	—	40mm/1.5"	—	—	40mm/1.5"	—	—
FMR20B	—	40mm/1.5"	80mm/3"	—	40mm/1.5"	80mm/3"	—	40mm/1.5"	80mm/3"
FMR30B	—	40mm/1.5"	80mm/3"	—	40mm/1.5"	80mm/3"	—	40mm/1.5"	80mm/3"
	Measuring range in m/ft								
Media group	A, B, C, D	A, B, C, D	A, B, C, D	A, B, C, D	A, B, C, D	A, B, C, D	A, B, C, D	A, B, C, D	A, B, C, D
A: DC = 1.4 to 1.9	10/33	10/33	12/39	7/23	7/23	7.5/25	10/33	10/33	12/39
B: DC = 1.9 to 4				13/43	13/43	15/49			
C: DC = 4 to 10						28/92			23/75
D: DC = > 10		20/66	23/75	20/66	20/66	30/98		20/66	30/98
Standard: Max. measuring range = 30m/98ft			30/98						

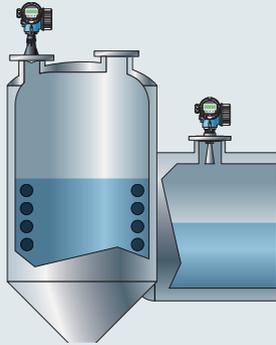
4. Instrument selection within the measuring principle

Measuring range in dependence on the type of tank

Process conditions and medium for Micropilot FMR51/FMR52

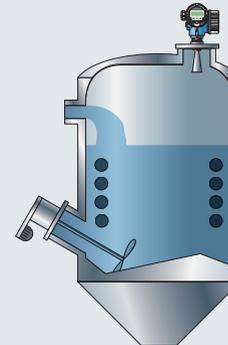
Storage tank / Channel measurement

Calm surface
(e. g. bottom filling, filling via immersion tube or rare free filling from above)



Buffer tank / Pump shafts / Open basins

Agitated surface
(e. g. permanent free filling from above, mixing jets, slowly turning mixer, lateral installation)



	Horn/antenna diameter							
FMR51	40mm/1.5"	50mm/2"	80mm/3"	100mm/4"	40mm/1.5"	50mm/2"	80mm/3"	100mm/4"
FMR52	–	50mm/2"	80mm/3"	–	–	50mm/2"	80mm/3"	–

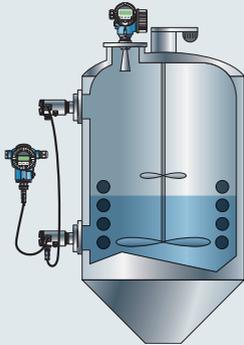
	Measuring range in m/ft							
Media group A: DC = 1.4 to 1.9 B: DC = 1.9 to 4 C: DC = 4 to 10 D: DC = > 10	A		B		C		D	
	3/9.9 5/16	5/16 8/26	10/32 15/49	15/49 25/82	4/13 8/26	8/26 12/39	15/49 25/82	35/110 40/131
Standard: Max. measuring range = 40m/131ft	A		B		C		D	
	10/32 15/49	15/49 25/82	25/82 30/99	30/99 40/131	8/26 10/32	15/49 20/65	40/131 45/148	60/197 70/229
With application package "Advanced dynamics": Max. measuring range = 70m/229ft Min. measuring range = 5m/16ft	A		B		C		D	
	2.5 5/16	5/16 10/32	10/32 15/49	15/49 25/85	2/6.6 4/13 5/16	7.5/25 10/33	10/32 15/49	5/16 7.5/25 10/32 15/49
Standard: Max. measuring range = 40m/131ft	A		B		C		D	
	5/16 7.5/25	10/32 15/49	15/49 25/82	25/82 35/110	2.5 5/16	5/16 10/32	10/32 15/49	15/49 25/82 35/110
With application package "Advanced dynamics": Max. measuring range = 70m/229ft Min. measuring range = 5m/16ft	A		B		C		D	
	5/16 7.5/25	10/32 15/49	15/49 25/82	25/82 35/110	2.5 5/16	5/16 10/32	10/32 15/49	15/49 25/82 35/110

4. Instrument selection within the measuring principle

Measuring range in dependence on the type of tank

Process conditions and medium for Micropilot FMR51/FMR52

Tank with single-stage propeller agitator
Turbulent surface,
single-stage agitator
< 60 RPM



Stilling well



Bypass



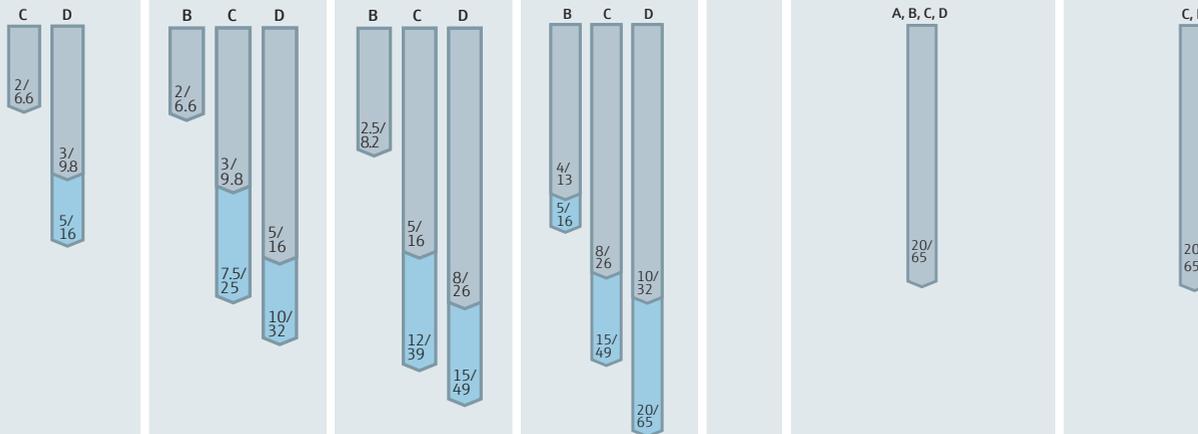
	Horn/antenna diameter					
FMR51	40mm/1.5"	50mm/2"	80mm/3"	100mm/4"	40 to 100mm/1.5 to 4"	40 to 100mm/1.5 to 4"
FMR52	–	50mm/2"	80mm/3"	–	50 to 80mm/2 to 3"	50 to 80mm/2 to 3"

Measuring range in m/ft

Media group
A: DC = 1.4 to 1.9
B: DC = 1.9 to 4
C: DC = 4 to 10
D: DC = > 10

Standard:
Max. measuring range = 40m/131ft

With application package "Advanced dynamics":
Max. measuring range = 70m/229ft
Min. measuring range = 5m/16ft



For media groups A and B use Levelflex with coax probe.

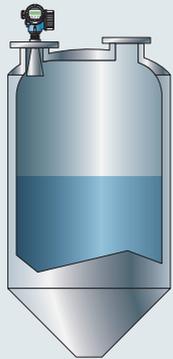
4. Instrument selection within the measuring principle

Measuring range in dependence on the type of tank

Process conditions and medium for Micropilot FMR54

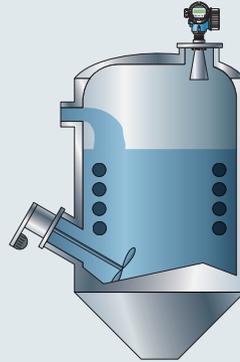
Storage tank¹⁾

Calm surface
(e. g. bottom filling, filling via immersion tube or rare free filling from above)



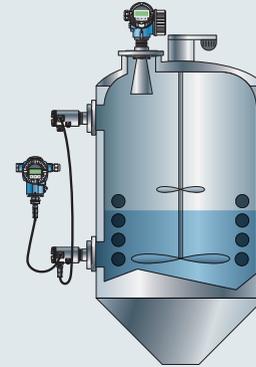
Buffer tank¹⁾

Agitated surface
(e. g. permanent free filling from above, mixing jets)

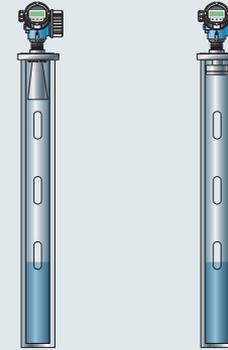


Tank with single-stage propeller agitator¹⁾

Turbulent surface,
single-stage agitator
< 60 RPM



Stilling well



Bypass



	Horn/antenna diameter																	
FMR54	150mm/6"	200mm/8" 250mm/10"	150mm/6"	200mm/8" 250mm/10"	150mm/6"	200mm/8" 250mm/10"	80 to 250mm/ 3 to 10"	Planar antenna 150 to 300mm/6 to 12"	80 to 250mm/ 3 to 10 ²⁾									
	Measuring range in m/ft																	
Media group A: DC = 1.4 to 1.9 B: DC = 1.9 to 4 C: DC = 4 to 10 D: DC = > 10	<p>B C D</p>		<p>B C D</p>		<p>B C D</p>		<p>B C D</p>		<p>B C D</p>		<p>B C D</p>		<p>A, B, C, D</p>		<p>A, B, C, D</p>		<p>C, D</p>	

¹⁾ For media group A use stilling well (20m/65ft).

²⁾ Possible for media groups A and B, e. g. with a stilling well in the bypass.

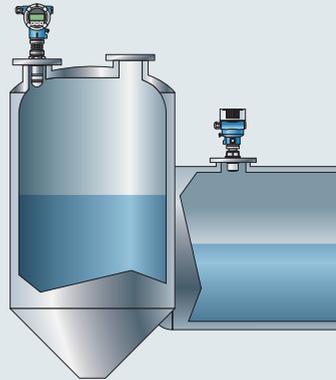
4. Instrument selection within the measuring principle

Measuring range in dependence on the type of tank

Process conditions and medium for Micropilot FMR60B

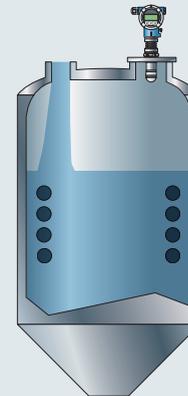
Storage tank

Calm product surface
(e.g. intermittent filling, filling from bottom, immersion tubes)



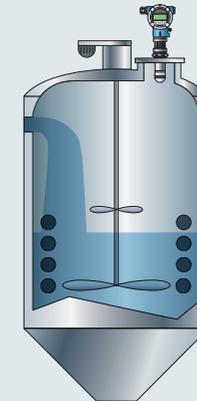
Buffer tank

Moving surface
(e.g. continuous filling from above, mixing jets)



Process tank with agitator

Turbulent surface
(e.g. filling from above, agitators, baffles)



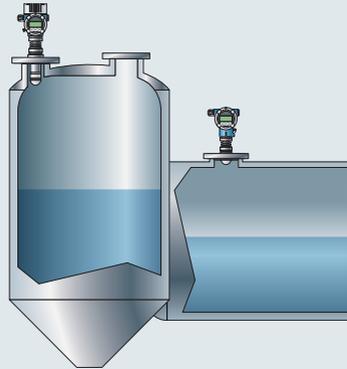
		Antenna diameter																																																							
FMR60B		Integrated, PEEK, 40mm/1.5in				Encapsulated, PVDF, 40mm/1.5in				Drip-off, PTFE, 50mm/2in				Integrated, PEEK, 40mm/1.5in				Encapsulated, PVDF, 40mm/1.5in				Drip-off, PTFE, 50mm/2in				Integrated, PEEK, 20mm/0.75in				Integrated, PEEK, 40mm/1.5in				Encapsulated, PVDF, 40mm/1.5in				Drip-off, PTFE, 50mm/2in																			
Media group (DC)		A0 A B C D				A0 A B C D				A0 A B C D				A0 A B C D				A0 A B C D				A0 A B C D				A B C D				A0 A B C D				A0 A B C D				A0 A B C D				A0 A B C D															
A0: 1.2 to 1.4		1.5/5 2.5/8 5/16 8/26 10/33				3/10 6/20 11/36 15/49 22/72				7/23 15/49 30/98 40/131 40/131				7/23 12/39 23/75 40/131 50/164				1.5/5 3/10 6/20 13/43 20/66				4/13 7.5/25 15/49 25/82 35/115				4/13 7/23 13/43 28/92 44/144				1/3.3 1.5/5 3/10 5/16				1/3.3 1.5/5 3/10 7/23 11/36				2/6.6 4/13 5/16 15/49 20/66				2/7 4/13 7/23 15/49 25/82															
A: 1.4 to 1.9																																																									
B: 1.9 to 4																																																									
C: 4 to 10																																																									
D: > 10																																																									

4. Instrument selection within the measuring principle

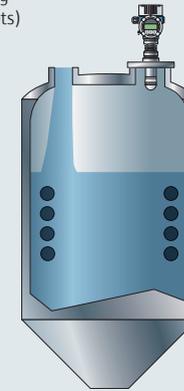
Measuring range in dependence on the type of tank

Process conditions and medium for Micropilot FMR62B

Storage tank
Calm product surface
(e. g. intermittent filling, filling from bottom, immersion tubes)



Buffer tank
Moving surface
(e. g. continuous filling from above, mixing jets)



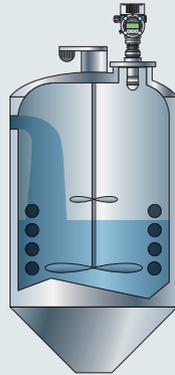
	Storage tank				Buffer tank			
	Antenna diameter				Antenna diameter			
FMR62B	Drip-off, PTFE, 50mm/2in	PTFE cladded flush mount, 50mm/2in	PTFE cladded flush mount, 80mm/3in	Horn, 316L, 65mm/2.6 in	Drip-off, PTFE, 50mm/2in	PTFE cladded flush mount, 50mm/2in	PTFE cladded flush mount, 80mm/3in	Horn, 316L, 65mm/2.6in
	Measuring range in m/ft				Measuring range in m/ft			
Media group A0: DC = 1.2 to 1.4 A: DC = 1.4 to 1.9 B: DC = 1.9 to 4 C: DC = 4 to 10 D: DC = > 10								

4. Instrument selection within the measuring principle

Measuring range in dependence on the type of tank

Process conditions and medium for Micropilot FMR62B

Process tank with agitator
Turbulent surface
(e.g. filling from above,
agitators, baffles)



Stilling well
Calm medium surface (e.g. bottom filling,
filling via immersion tube or rare filling
from above)



Bypass
Moving medium surface (e.g. permanent
free filling from above, mixing jets)



		Horn/antenna diameter								PTFE cladded flush mount, 80mm/3in											
FMR62B		Drip-off, PTFE, 50mm/2in	PTFE cladded flush mount, 50mm/2in	PTFE cladded flush mount, 80mm/3in	Horn, 316L, 65mm/2.6in																
		Measuring range in m/ft																			
Media group A0: DC = 1.2 to 1.4 A: DC = 1.4 to 1.9 B: DC = 1.9 to 4 C: DC = 4 to 10 D: DC = > 10																					

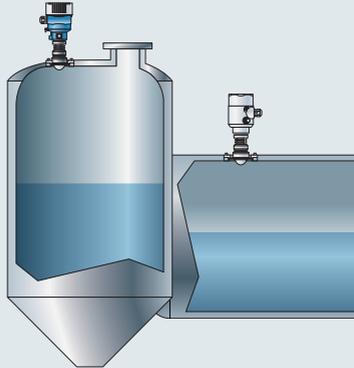
4. Instrument selection within the measuring principle

Measuring range in dependence on the type of tank

Process conditions and medium for Micropilot FMR63B

Storage tank

Calm medium surface (e.g. bottom filling, filling via immersion tube or rare filling from above)



Buffer tank

Moving surface (e.g. continuous filling from above, mixing jets)



		Antenna									
FMR63B		Integrated, PEEK, 20mm/0.75in	Cladded, PEEK, 20mm/0.75in	Cladded, PEEK, 40mm/1.5in	PTFE cladded flush mount, 50mm/2in	PTFE cladded flush mount, 80mm/3in	Integrated, PEEK, 20mm/0.75in	Cladded, PEEK, 20mm/0.75in	Cladded, PEEK, 40mm/1.5in	PTFE cladded flush mount, 50mm/2in	PTFE cladded flush mount, 80mm/3in
		Messbereich in m									
Media group (DC)	A0	1.5/5	3/10	7/23	12/39	22/72	1/3.3	1.5/5	1.5/5	4/13	12/39
	A	2.5/8	6/20	12/39	23/75	40/131	3.3	5	3/10	7/23	23/75
	B	5/16	11/36	23/75	40/131	50/164	5	10	13/43	28/92	45/148
	C	8/26	15/49	40/131	50/164	65/231	6/20	20	20/66	44/144	60/197
	D	10/33	22/72	50/164	80/262		8/26				70/230

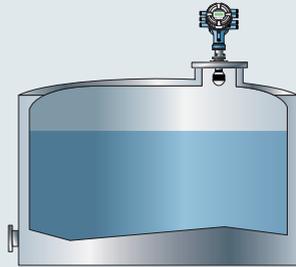
A0: 1.2 to 1.4
 A: 1.4 to 1.9
 B: 1.9 to 4
 C: 4 to 10
 D: > 10

4. Instrument selection within the measuring principle

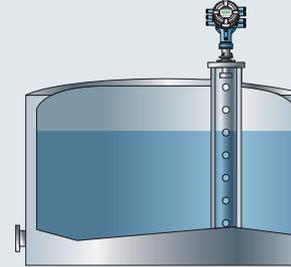
Measuring range in dependence on the type of tank

Process conditions and medium for Micropilot NMR81//NMR84

Storage tank
Highly accurate measurement,
custody transfer



Stilling well
Highly accurate measurement,
custody transfer



	Storage tank			Stilling well
Antenna diameter				
NMR81	50mm/2"	80mm/3"	100mm/4"	
NMR84				100mm/150mm/200mm/250mm/300mm 4"/6"/8"/10"/12"
Measuring range in m/ft				
Media group A: DC = 1.4 to 1.9 B: DC = 1.9 to 4 C: DC = 4 to 10 D: DC = > 10	A: DC = 1.4 to 1.9 B: DC = 1.9 to 4 C: DC = 4 to 10 D: DC = > 10			
	A: 4/13 B: 8/26 C: 20/66 D: 30/98	A: 15/49 B: 30/98 C ¹⁾ : 60/197 D ¹⁾ : 70/230	A: 25/82 B ¹⁾ : 50/164 C, D ¹⁾ : 70/230	A, B, C, D: 40/131

Standard:
Max. measuring
range =
30m/97ft

²⁾ For devices with Weight+Measure approval:
Maximum measuring range: 30m (97ft)

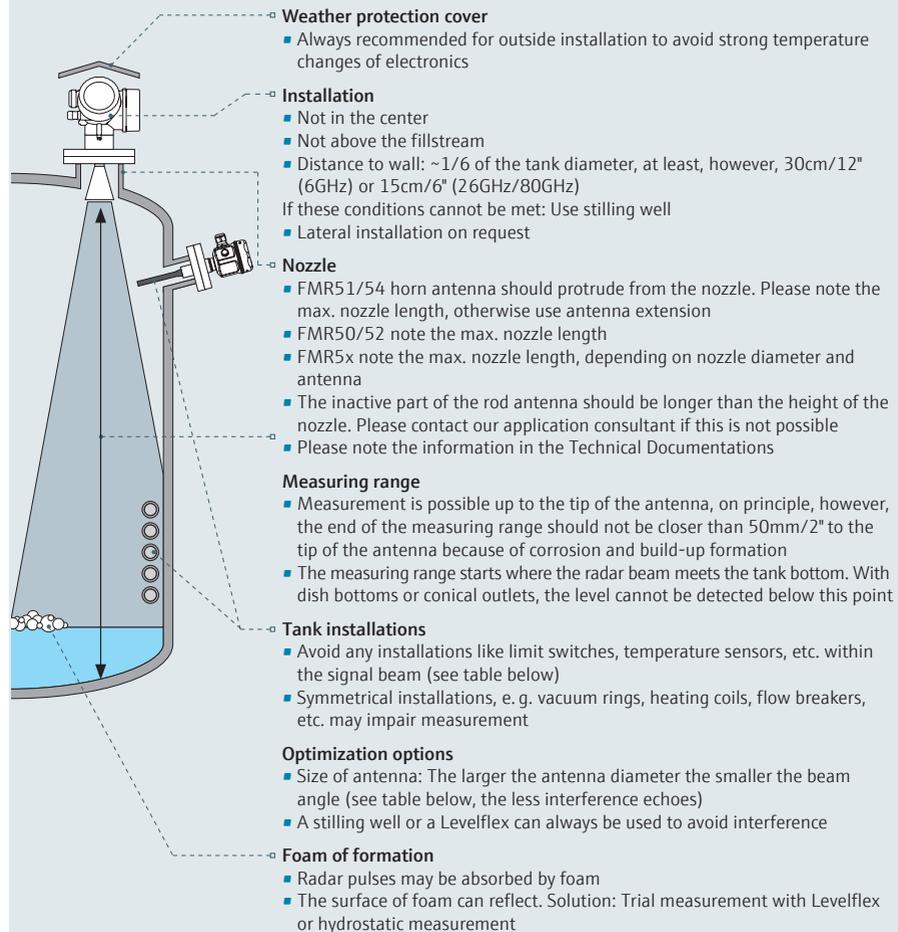
Custody transfer with NMi and PTB
30m/98ft

Custody transfer with NMi
35m/115ft

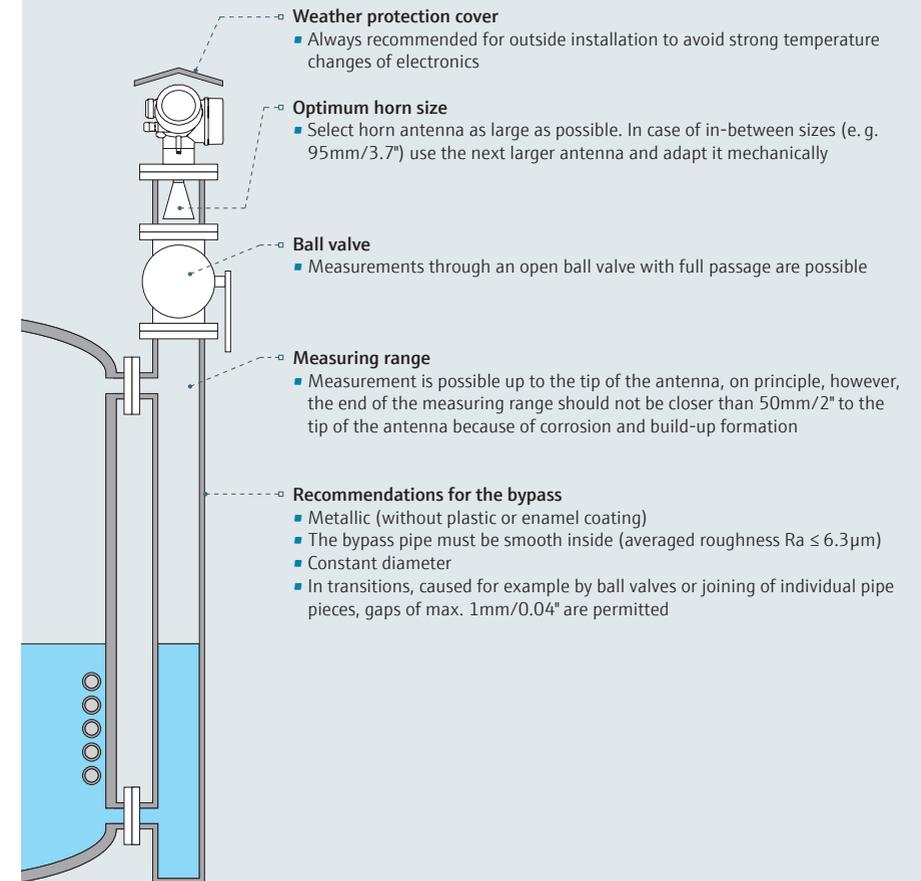
Custody transfer with PTB
30m/98ft

4. Instrument selection within the measuring principle

Installation instructions radar – free space

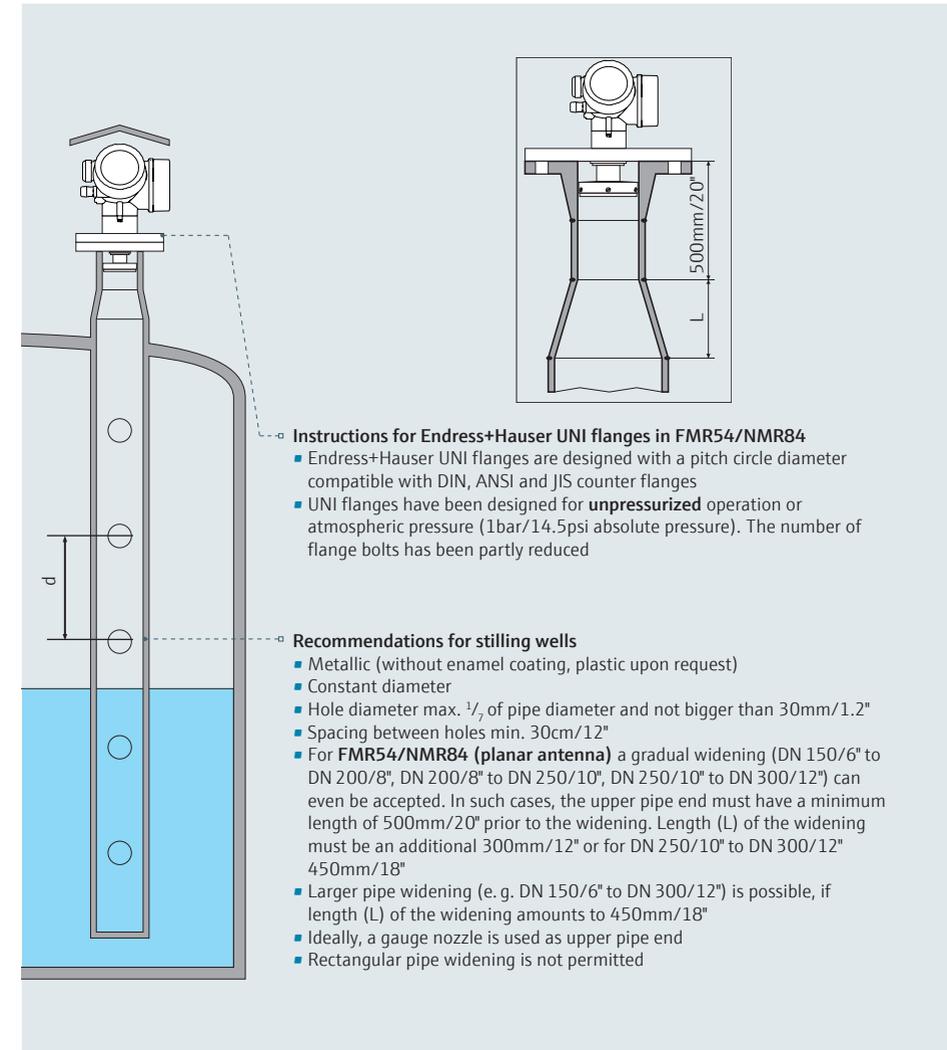
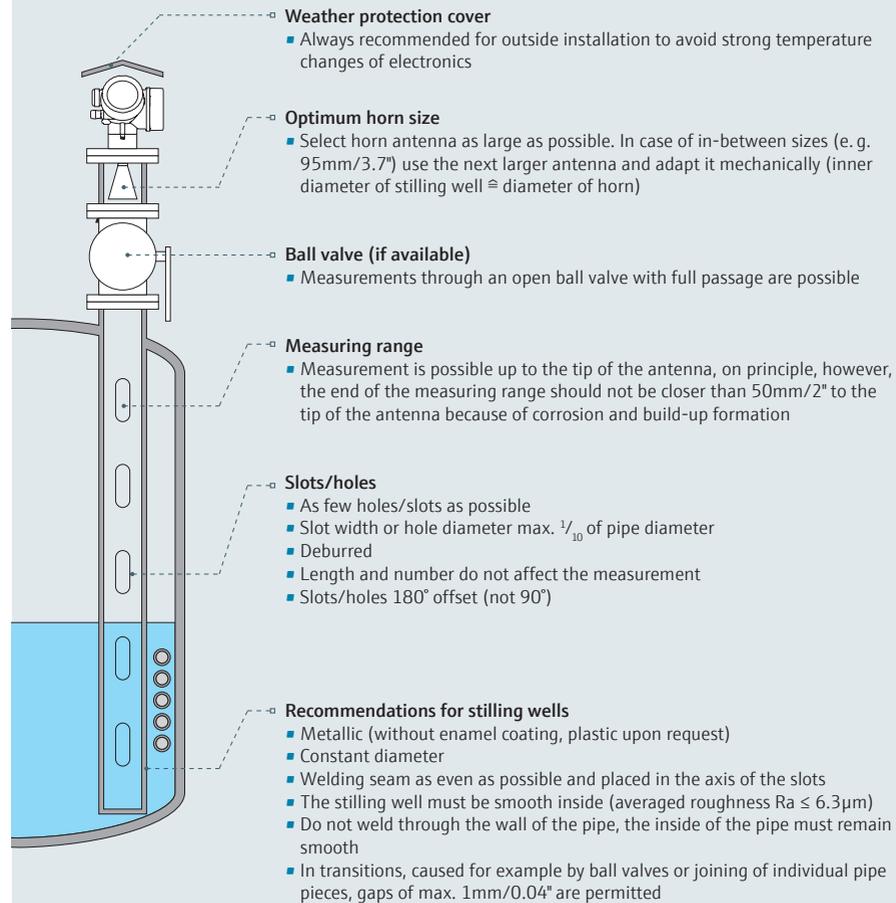


Installation instructions radar – bypass



4. Instrument selection within the measuring principle

Installation instructions radar – stilling well



4. Instrument selection within the measuring principle

Guided radar

Required application data

Level measurement

- Pressure and temperature
- Dielectric constant (DC) of the medium
- Required material compatibility
- Nozzle diameter: DN, PN, nozzle height
- Measuring range

Additional for interface measurement

- Dielectric constant (DC) of both liquids

Application limits for guided level radar

- Temperature up to -196°C/-321°F
- Temperature up to +450°C/+842°F
- Pressure up to +400bar/+5,800psi
- Measuring range up to 45m/148ft (longer upon request)
- Dielectric constant from 1.4
- Process connection from ¾"
- Measuring range up to 10m/32ft for interface measurement (upon request)

Dielectric constant (DC)

The reflection properties of a medium are determined by the dielectric constant (DC). The following table shows the allocation of different DC values to media groups. If the dielectric constant of a medium is not known, we recommend to use a DC value of 1.9 for sizing in order to maintain a safe measurement.

Advantages

- Unaffected by medium surface (agitated surface, foam)
- Unaffected by tank obstacles
- Additional measuring safety through End-of-Probe (EoP) recognition
- DC starting at 1.6 without stilling well (1.4 for coax probe)

Media group	DC	Typical liquids	Max. measuring ranges					
			FMP50	FMP51	FMP52	FMP53	FMP54	FMP55
1	1.4 to 1.6	<ul style="list-style-type: none"> ■ Liquified gases, e. g. N₂, CO₂ 	4m/13ft	6m/20ft not with rope	—	4m/13ft	6m/20ft not with rope	6m/20ft not with rope
2	1.6 to 1.9	<ul style="list-style-type: none"> ■ Liquified gas, e. g. propane ■ Solvent ■ Frigen / Freon ■ Palm oil 	12m/39ft	25 to 30m/ 82 to 98ft	12 to 15m/ 39 to 49ft	6m/20ft	25 to 30m/ 82 to 98ft	10m/33ft
3	1.9 to 2.5	<ul style="list-style-type: none"> ■ Mineral oils ■ Fuel 	12m/39ft	30 to 45m/ 98 to 148ft	15 to 25m/ 49 to 82ft	6m/20ft	30 to 45m/ 98 to 148ft	10m/33ft
4	2.5 to 4	<ul style="list-style-type: none"> ■ Benzene, styrene, toluol ■ Furan ■ Naphthalene 	12m/39ft	45m/148ft	25 to 35m/ 82 to 115ft	6m/20ft	45m/148ft	10m/33ft
5	4 to 7	<ul style="list-style-type: none"> ■ Chlorobenzene, chloroform ■ Nitrocellulose lacquer ■ Isocyan, aniline 	12m/39ft	45m/148ft	35 to 45m/ 115 to 148ft	6m/20ft	45m/148ft	10m/33ft
6	>7	<ul style="list-style-type: none"> ■ Aqueous solutions ■ Alcohols ■ Acids, lyes 	12m/39ft	45m/148ft	45m/148ft	6m/20ft	45m/148ft	10m/33ft

4. Instrument selection within the measuring principle

Guided radar

	 Levelflex FMP50	 Levelflex FMP51	 Levelflex FMP52	 Levelflex FMP53	 Levelflex FMP54	 Levelflex FMP55
Technical data						
■ Process pressure	-1 to +6bar/ -14.5 to +87psi	-1 to +40bar/ -14.5 to +580psi	-1 to +40bar/ -14.5 to +580psi	-1 to +16bar/ -14.5 to +232psi	-1 to +400bar/ -14.5 to +5,800psi	-1 to +40bar/ -14.5 to +580psi
■ Process temperature	-20 to +80°C/ -4 to +176°F	-40 to +200°C/ -40 to +392°F	-50 to +200°C/ -58 to +392°F	-20 to +150°C/ -4 to +302°F	-196 to +450°C/ -321 to +842°F	-50 to +200°C/ -58 to +392°F
■ Accuracy	< 15m/49ft: ±2mm/0.08"	< 15m/49ft: ±2mm/0.08"; > 15m/49ft: ±10mm/0.4"	< 15m/49ft: ±2mm/0.08"; > 15m/49ft: ±10mm/0.4"	< 15m/49ft: ±2mm/0.08"	< 15m/49ft: ±2mm/0.08"; > 15m/49ft: ±10mm/0.4", ±5mm/±0.02" (coax)	< 10m/33ft: ±2mm/0.08"
■ Process connection	G/NPT ¾"	G/NPT ¾" and 1½", DN 40 to DN 200/1.5" to 8"	Tri-Clamp 1½" to 3", DIN 11851, DN 40 to DN 150/1.5" to 6"	Tri-Clamp, DIN 11851, SMS, DIN 11864, NEUMO 316L/1.4435, PEEK	G/NPT 1½", DN 50 to DN 100/2" to 4"	DN 50 to DN 150/2" to 6"
■ Wetted parts	Rope/rod: 316L, PPS	Rope: 316, rod and coax: 316L, Alloy C (C22/2.4602), ceramics	PTFE, PFA		Rope: 316, rod and coax: 316L, ceramics, graphite, Alloy C (C22/2.4602)	PTFE, PFA
■ Measuring ranges	0.3 to 4m/1 to 13ft (rod), 0.3 to 12m/1 to 39ft (rope)	0.3 to 10m/1 to 33ft (rod), 1 to 45m/3.2 to 148ft (rope), 0.3 to 6m/1 to 20ft (coax)	0.3 to 4m/1 to 13ft (rod), 1 to 45m/3.2 to 148ft (rope)	0.3 to 6m/1 to 20ft (rod)	0.3 to 10m/1 to 33ft (rod), 1 to 45m/3.2 to 148ft (rope), 0.3 to 6m/1 to 20ft (coax)	0.3 to 4m/1 to 13ft (rod), 1 to 10m/3.2 to 33ft (rope), 0.3 to 6m/1 to 20ft (coax)
■ Gastight feedthrough	—	Optional TiO1001F	Optional TiO1001F	—	Standard TiO1001F	Standard TiO1003F
■ Technical Information	TiO1000F	TiO1001F	TiO1001F	TiO1002F	TiO1001F	TiO1003F
Applications						
Horizontal storage tank cyl.	0	+*	0	0	+*	—
Vertical storage tank	+	+	+	+	+	+
Buffer tank	0	+	+	+	+	—
Recipient tank	+	0	0	+	—	—
Process tank	—	—	—	—	—	—
Stilling well	+	+	0	—	+	+
Bypass	0	+	0	—	+	+
Pump shaft	—	—	—	—	—	—
Channel measurement	—	—	—	—	—	—
Interface measurement	—	+**	+**	—	+**	+***
Application limits	<ul style="list-style-type: none"> Aggressive media → FMP52 High pressure/temperatures > 80°C/176°F; 6bar/87psi → FMP51, FMP54 	<ul style="list-style-type: none"> Aggressive media → FMP52 Interface with emulsion → FMP55 	<ul style="list-style-type: none"> High process temperatures (> 150°C) → Possible diffusion through the probe coating → Limited lifetime → FMP54 Interface with emulsion → FMP55 	<ul style="list-style-type: none"> Aggressive media → FMP52 	<ul style="list-style-type: none"> Interface with emulsion → FMP55 	

+ = recommended

0 = restricted (observe limits)

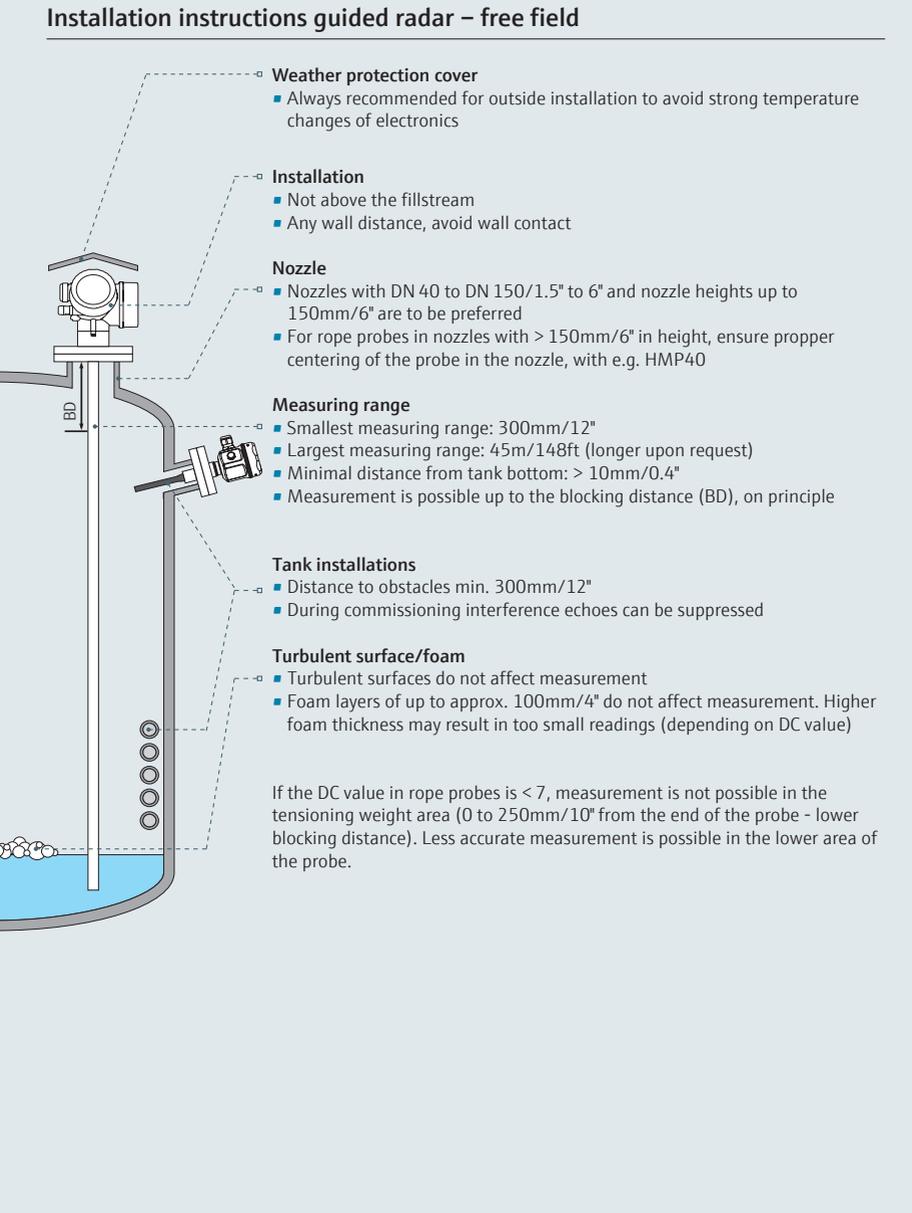
— = not recommended

* = use coax probe

** = use coax system in favor
(coax probe, bypass, stilling well)*** = coax system required
(coax probe, bypass, stilling well)

4. Instrument selection within the measuring principle

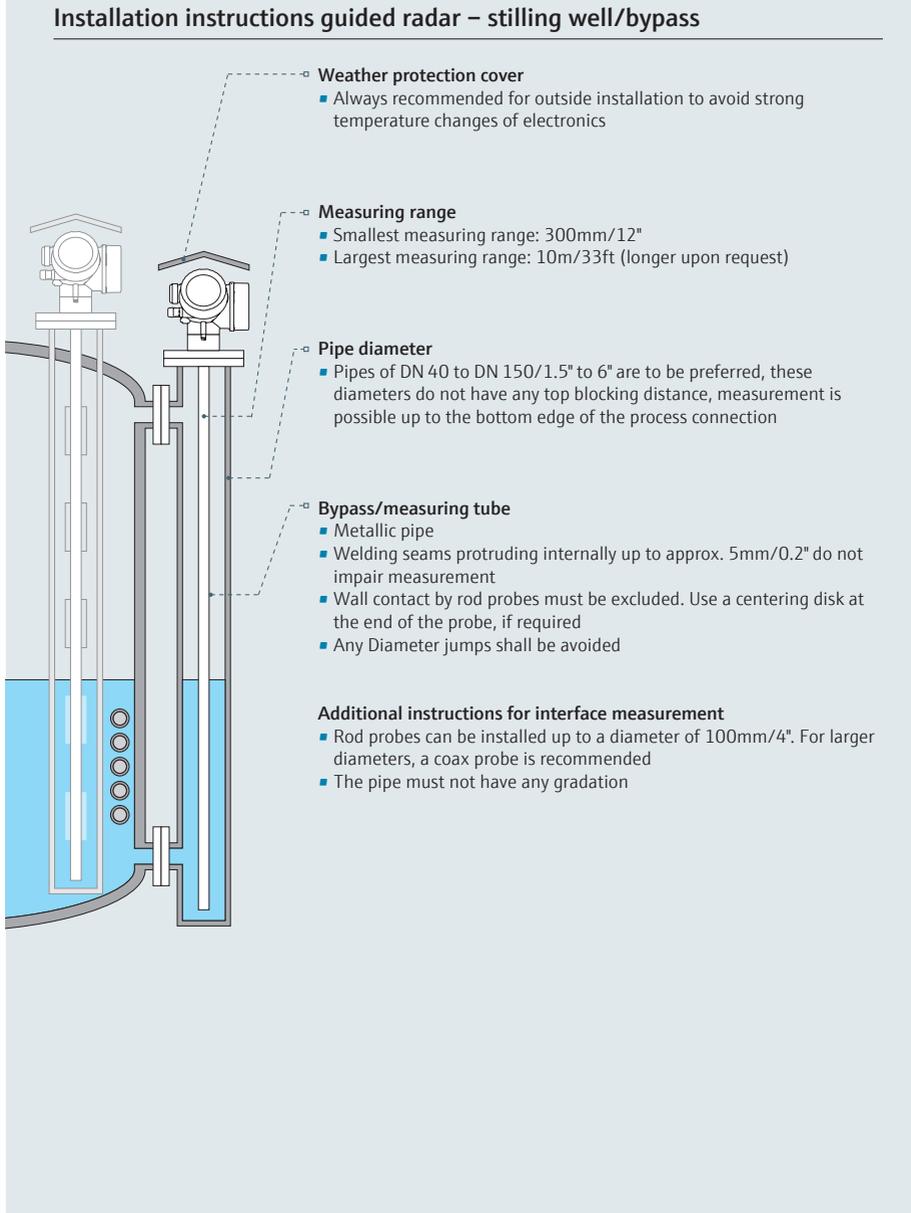
Installation instructions guided radar – free field



- Weather protection cover**
 - Always recommended for outside installation to avoid strong temperature changes of electronics
- Installation**
 - Not above the fillstream
 - Any wall distance, avoid wall contact
- Nozzle**
 - Nozzles with DN 40 to DN 150/1.5" to 6" and nozzle heights up to 150mm/6" are to be preferred
 - For rope probes in nozzles with > 150mm/6" in height, ensure proper centering of the probe in the nozzle, with e.g. HMP40
- Measuring range**
 - Smallest measuring range: 300mm/12"
 - Largest measuring range: 45m/148ft (longer upon request)
 - Minimal distance from tank bottom: > 10mm/0.4"
 - Measurement is possible up to the blocking distance (BD), on principle
- Tank installations**
 - Distance to obstacles min. 300mm/12"
 - During commissioning interference echoes can be suppressed
- Turbulent surface/foam**
 - Turbulent surfaces do not affect measurement
 - Foam layers of up to approx. 100mm/4" do not affect measurement. Higher foam thickness may result in too small readings (depending on DC value)

If the DC value in rope probes is < 7, measurement is not possible in the tensioning weight area (0 to 250mm/10" from the end of the probe - lower blocking distance). Less accurate measurement is possible in the lower area of the probe.

Installation instructions guided radar – stilling well/bypass



- Weather protection cover**
 - Always recommended for outside installation to avoid strong temperature changes of electronics
- Measuring range**
 - Smallest measuring range: 300mm/12"
 - Largest measuring range: 10m/33ft (longer upon request)
- Pipe diameter**
 - Pipes of DN 40 to DN 150/1.5" to 6" are to be preferred, these diameters do not have any top blocking distance, measurement is possible up to the bottom edge of the process connection
- Bypass/measuring tube**
 - Metallic pipe
 - Welding seams protruding internally up to approx. 5mm/0.2" do not impair measurement
 - Wall contact by rod probes must be excluded. Use a centering disk at the end of the probe, if required
 - Any Diameter jumps shall be avoided

Additional instructions for interface measurement

- Rod probes can be installed up to a diameter of 100mm/4". For larger diameters, a coax probe is recommended
- The pipe must not have any gradation

4. Instrument selection within the measuring principle

Ultrasonics

Required application data

- Pressure and temperature
- Vapor pressure of the medium (at 20°C/68°F)
- Required material compatibility
- Nozzle diameter/nozzle height
- Measuring range
- Required accuracy
- For bypass/stilling well: Internal pipe diameter

Application limits for ultrasonic level measurement in liquids

- Temperature up to -40°C/-40°F
- Temperature up to 105°C/221°F
- Pressure from +0.7bar/+10psi up to +4bar/58psi
- Measuring range up to 25m/82ft
- Vapor pressure up to 50mbar/0.73psi (20°C/68°F)
- Process connection from 1½"
- Strong temperature fluctuations in the measuring range can affect the accuracy

Vapor pressure of the medium (20°C/68°F)

The vapor pressure of the medium at 20°C/68°F is an indication for the accuracy of ultrasonic level measurement. If the vapor pressure at 20°C/68°F is lower than 50mbar/0.73psi, ultrasonic measurement is recommended. If the vapor pressure at 20°C/68°F is above 50mbar/0.73psi, the accuracy of the measurement will be affected. To achieve the highest accuracy results, radar level measurement is recommended.

Advantages

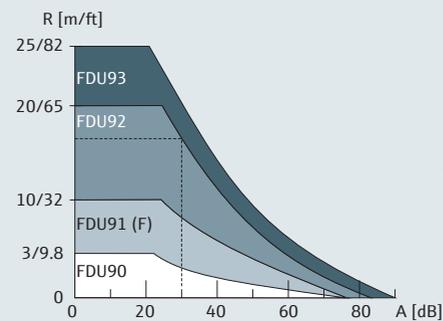
- Non-contact, maintenance-free measurement
- Unaffected by product properties, e.g. DC, density, etc.
- Calibration without filling or discharging
- Self-cleaning effect due to vibrating sensor diaphragm

Damping caused by process

Surface of liquid		Filling curtain in the detection range		Δ-Temp. sensor ↔ medium surface	
Calm	0dB	None	0dB	Up to 20°C/68°F	0dB
Waves	5 to 10dB	Small quantities	5 to 10 dB (FDU9x = 5 dB)	Up to 40°C/104°F	5 to 10dB
Strong turbulence	10 to 20dB	Large quantities	10 to 40 dB (FDU9x = 5 to 20 dB)	Up to 80°C/176°F	10 to 20dB
Foam	Ask Endress+Hauser	–	–	–	–

For applications, the sum of dampings (dB) and thus the range (m/ft) can be determined in the diagram from the table.

Range calculation and sensor selection Prosonic S FDU9x



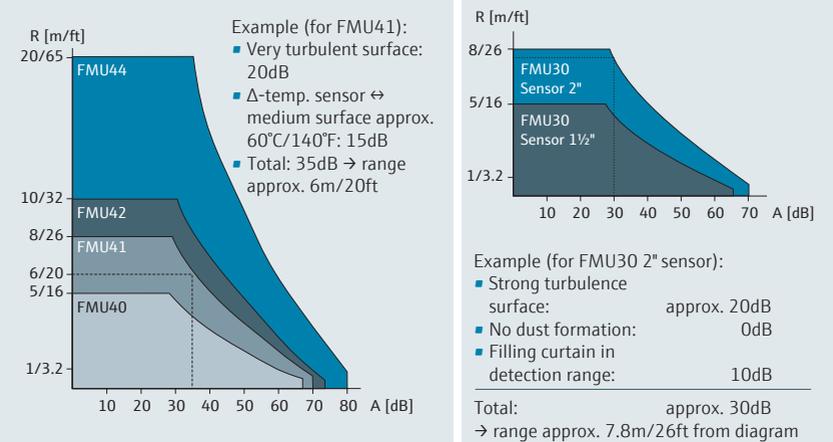
Example (for FDU92):

- Very turbulent surface: 20dB
- Small quantities of filling curtain in the detection range: 5dB
- Δ-Temperature up to 40°C/104°F: 10dB

Total: 35dB
→ range approx. 15m/49ft from diagram

Vapor pressure	Examples
< 50mbar/0.73psi (20°C/68°F)	Water, water solutions, water-solids solutions, dilute acids (hydrochloric acid, sulphuric acid, ...), dilute lyes (caustic soda solution, ...), oils, fats, lime water, sludges, pastes, ...
> 50mbar/0.73psi (20°C/68°F)	Ethanol, acetone, ammonia, ... For best accuracy results → radar

Range calculation and selection of sensor for Prosonic M FMU4x and FMU30



4. Instrument selection within the measuring principle

Ultrasonics

	Prosonic FMU30 		Prosonic FMU40/41 		Prosonic FMU42, FMU44 		Prosonic FMU90/95, FDU90 		Prosonic FMU90/95, FDU91 		Prosonic FMU90/95, FDU91F 		Prosonic FMU90/95, FDU92 	
Technical data														
■ Process pressure	+0.7 to +3bar/ +10 to +44psi		+0.7 to +3bar/ +10 to +44psi		+0.7 to +2.5bar/ +10 to +36psi		+0.7 to +4bar/ +10 to +58psi		+0.7 to +4bar/ +10 to +58psi		+0.7 to +4bar/ +10 to +58psi		+0.7 to +4bar/ +10 to +58psi	
■ Process temperature	-20 to +60°C/-4 to +140°F		-40 to +80°C/-40 to +176°F		-40 to +80°C/-40 to +176°F		-40 to +80°C/-40 to +176°F		-40 to +80°C/-40 to +176°F		-40 to +105°C/-40 to +221°F		-40 to +95°C/-40 to +203°F	
■ Accuracy	±3mm/±0.12" or 0.2% of distance		±2mm/±0.08" or 0.2% of distance		±4mm/±0.16" or 0.2% of distance		±2mm/±0.08" or +0.17% of distance		±2mm/±0.08" or +0.17% of distance		±2mm/±0.08" or +0.17% of distance		±2mm/±0.08" or 0.2% of distance	
■ Process connection	G/NPT 1½" or 2"		G/NPT 1½" or 2"		DN 80/100/150/200, ANSI 3"/4"/6"/8", JIS 10K/80 (100)/100 (150/200)		rear side thread 1" G/NPT or ceiling mounting option, front side thread 1½" G/NPT		G/NPT 1" (accessory flange FAX50)		G/NPT 1" (accessory flange FAX50), Tri-Clamp DN 80 316L		G/NPT 1" (accessory flange FAX50)	
■ Wetted parts	PP/EPDM		PVDF/EPDM		PVDF/EPDM/Viton		PVDF		PVDF		PVDF		PVDF	
■ Measuring ranges	0.25 to 5m/0.8 to 16ft (1½") 0.35 to 8m/1.1 to 26ft (2")		0.25 to 5m/0.8 to 16ft (FMU40) 0.35 to 8m/1.1 to 26ft (FMU41)		0.4 to 10m/1.3 to 32ft (FMU42) 0.5 to 20m/1.6 to 65ft (FMU44)		0.07 to 3m/0.2 to 9.6ft		0.3 to 10m/1 to 32ft		0.3 to 10m/1 to 32ft		0.4 to 20m/1.3 to 65ft	
■ Point level detection	—		—		—		1, 3 or 6 relays		1, 3 or 6 relays		1, 3 or 6 relays		1, 3 or 6 relays	
■ Technical Information	TI00440F		TI01456F/TI01457F		TI01458F/TI01460F		TI00397F/TI00398F/TI01469F		TI00397F/TI00398F/TI01470F		TI00397F/TI00398F/TI01471F		TI00397F/TI00398F/TI01472F	
Applications	1½"	2"	FMU40	FMU41	FMU42	FMU44								
Horizontal storage tank cyl	+	0	+	0	0	-	+	+	+	+	+	0		
Vertical storage tank	+	+	+	+	+	+	+	+	+	+	+	+		
Buffer tank	-	-	+	0	-	-	+	+	+	+	+	-		
Recipient tank	-	-	-	-	-	-	-	-	-	-	-	-		
Process tank	0	0	+	+	+	+	+	+	+	+	+	+		
Stilling well	0	0	+	+	+	+	+	+	+	+	+	+		
Bypass	-	-	-	-	-	-	-	-	-	-	-	-		
Pump shaft	0	0	0	0	0	0	+	+	+	+	0	+		
Channel measurement	0	0	0	0	0	0	+	+	+	+	0	+		
Application limits	<ul style="list-style-type: none"> ■ For higher resistance → FMU42, FDU9x ■ Foam/strong turbulence possible → FMU30 (2"), FMU42, FDU91 ■ Fast filling and discharging rate → FMU90 + FDU9x ■ Point level detection → FMU90 + FDU9x 		<ul style="list-style-type: none"> ■ For higher resistance → FMU42, FDU9x ■ Foam/strong turbulence possible → FMU41, FMU42/ FDU91 ■ Fast filling and discharging rate → FMU90 + FDU9x ■ Point level detection → FMU90 + FDU9x 		<ul style="list-style-type: none"> ■ Foam/strong turbulence possible → FMU44/ FDU92 ■ Fast filling and discharging rate → FMU90 + FDU9x ■ Point level detection → FMU90 + FDU9x 		<ul style="list-style-type: none"> ■ Foam/strong turbulence possible → FDU91 ■ For tank farm → Scanner FMU95 		<ul style="list-style-type: none"> ■ Foam/strong turbulence possible → FDU92 ■ Flange-flush assembly → FDU91F ■ For tank farm → Scanner FMU95 		<ul style="list-style-type: none"> ■ If foam/strong turbulence possible → FDU92 ■ For tank farm → Scanner FMU95 		<ul style="list-style-type: none"> ■ For tank farm → Scanner FMU95 	

+ = recommended

0 = restricted (observe limits)

- = not recommended

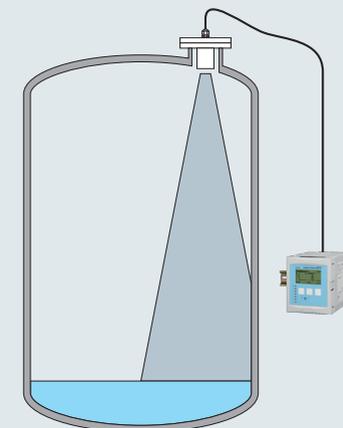
4. Instrument selection within the measuring principle

Installation instructions ultrasonics – free space

- Weather protection cover**
 - Always recommended for outside installation to avoid strong temperature changes of electronics
- Installation**
 - Not in the center
 - Not above the fillstream
 - Distance to wall: $\sim \frac{1}{6}$ of the tank diameter (min. 30cm/12")
 - If these conditions cannot be met: Check stilling well
- Nozzle**
 - The sensor membrane should be below the nozzle, if this is not possible, please compare the dimensions of the nozzle with the table below
 - Please contact Endress+Hauser if nozzle dimensions are different
- Measuring range**
 - Measurement is possible up to the blocking distance (BD) of the sensor
 - The measuring range begins where the ultrasonic beam meets the tank bottom. With dish bottoms or conical outlets, the level cannot be detected below this point
- Tank installations**
 - Avoid any installations like limit switches, temperature sensors, etc. within the signal beam (see table)
 - Symmetrical installations, i. e. heating coils, flow breakers, etc. can also interfere with the measurement
- Optimization options**
 - Use a sensor with a smaller beam angle
 - A stilling well or a sound guiding tube can always be used to avoid interference. Please clarify build-up tendency of the medium
- Formation of foam**
 - Ultrasonic signals may be absorbed by foam
 - The surface of foam can reflect. Solution: Trial measurement with ultrasonics or e. g. hydrostatic measurement

- Weather protection cover**
 - Always recommended for outside installation to avoid strong temperature changes of electronics
- Measuring range**
 - Measurement is possible up to the blocking distance (BD) of the sensor
- Slots/holes (for stilling wells)**
 - Slot width or diameter of holes max. 1/10 of pipe diameter
 - Deburred
 - Length and number do not affect the measurement
 - At least one ventilation hole ($> 10\text{mm}/0.4\text{"}$) is to be provided in the blocking distance of the sensor
- Recommendations for stilling wells**
 - Any rigid pipe (metal, glass, plastics, ...)
 - The stilling well must be smooth inside
 - Constant diameter
 - Applicable to stilling wells: Do not weld through the wall of the pipe, the inside of the pipe must remain smooth
 - The assembly of individual pipe pieces may only cause a gap of max. 1mm/0.04"
 - Recommended minimum inner diameter $> 80\text{mm}/3\text{"}$.
 - Please observe sensor dimensions to choose the right inner diameter

Separate instrumentation with FMU9x



Max. nozzle length (mm/")	Sensor type							
	FMU40 FMU30 (1½")	FMU41 FMU30 (2")	FMU42	FMU44	FDU90	FDU91	FDU91F	FDU92
DN 50 /2"	80				50 ²			
DN 80 /3"	240	240	250		340 ¹ /250 ²	340	250	
DN 100 /4"	300	300	300		390 ¹ /300 ²	390	300	
DN 150 /6"	400	400	400	400	400 ¹ /300 ²	400	300	400
Beam angle	11°	11°	9°	11°	12°	9°	12°	11°
BD (m/ft)	0.25/0.8	0.35/1.15	0.4/1.3	0.5/1.6	0.07/0.23	0.3/1	0.3/1	0.4/1.3

Recommended nozzle dimensions, nozzle length from sensor diaphragm, beam angle (3 dB)

¹Mounted at backside thread

²Mounted at frontside thread

4. Instrument selection within the measuring principle

Capacitance

Required application data

- Pressure and temperature
- Conductivity/dielectric constant of the medium (DC)/media group
- Required material compatibility
- Measuring range
- Required accuracy
- Mounting position

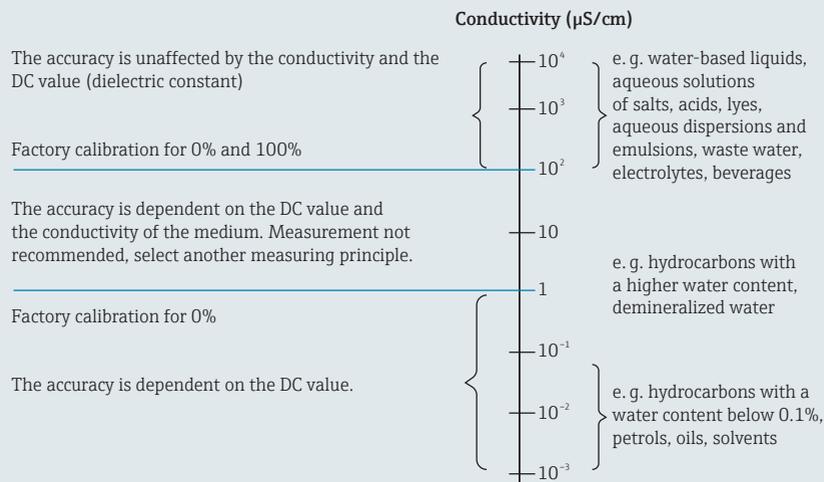
Starting from a conductivity of 100µS/cm the measured value is not affected by the dielectric constant and the conductivity of the medium. The following table describes different media.

For reliable measurement: Provide proper ground connection between process connection and tank. If required, establish ground connection by potential compensation line. In plastic tanks, use probe with a ground tube or double rod probe Liquicap T, if possible.

Application limits for capacitance level measurement

- Temperature up to -80°C/-112°F
- Temperature up to +200°C/+392°F
- Pressure up to 100bar/1,450psi
- Measuring range up to 10m/3.2ft

Operating range of Liquicap



Capacitance



Technical data	Liquicap FM151	Liquicap FM152	Liquicap FM121
■ Process pressure	-1 to +100bar/ -14.5 to +1,450psi	-1 to +100bar/ -14.5 to +1,450psi	-1 to +10bar/ -14.5 to +145psi
■ Process temperature	-80 to +200°C/ -112 to +392°F	-80 to +200°C/ -112 to +392°F	-40 to +100°C/ -40 to +212°F
■ Accuracy	±1%	±1%	±1%
■ Process connection	Thread ½" to 1½", flanges EN, ANSI, JIS, hygienic	Thread ½" to 1½", flanges EN, ANSI, JIS, hygienic	Thread 1½"
■ Wetted parts	316L, PFA, PTFE	316L, PFA, FEP	316L, PP, carbon fiber
■ Measuring ranges	Rod probe up to 4m/13ft	Rope probe up to 10m/32ft	up to 2.5m/8.2ft
■ Gastight feedthrough	Optional TI00401F	Optional TI00401F	-
■ Technical Information	-	-	TI00393F
Applications			
Horizontal storage tank cyl.	+	0	+
Vertical storage tank	+	+	+
Buffer tank	+	-	-
Recipient tank	+	-	-
Process tank	+	-	-
Stilling well	+	0	-
Bypass	+	0	-
Pump shaft	0	0	0
Channel measurement	-	-	-
Interface measurement	+	+	-
Application limits	<ul style="list-style-type: none"> ■ Insufficient clearance towards ceiling ■ Changing, non-conductive media or conductivity between 1 to 100µS/cm 	<ul style="list-style-type: none"> ■ Changing, non-conductive media or conductivity between 1 to 100µS/cm 	<ul style="list-style-type: none"> ■ Changing, non-conductive media or conductivity between 1 to 100µS/cm ■ Highly viscous liquids > 2000cst

+ = recommended

0 = restricted (observe limits)

- = not recommended

4. Instrument selection within the measuring principle

Servo (tank gauging)

Required application data

- Pressure and temperature
- Medium density
- Required material compatibility
- Nozzle diameter
- Measuring range
- Required accuracy
- For stilling well: Internal pipe diameter

Application limits for servo level measurement

- Temperature up to -200°C/-328°F
- Temperature up to +200°C/+392°F
- Pressure up to 25bar/362.5psi
- Process connection from 3"
- Viscosity from 5000mPS s

Advantages

- Unaffected by dielectric constant
- Unaffected by conductivity
- Multiparameter measurement: Level, density, interface

 **For reliable measurement**

Use a stilling well whenever possible.

Servo – Tank Gauging

	Proservo NMS80	Proservo NMS81	Proservo NMS83
			
Technical data	<ul style="list-style-type: none"> ■ Process pressure: 0.2 to +6bar/3 to +87psi ■ Process temperature: -200 to +200°C/-328 to +392°F ■ Accuracy: ±0.4mm/0.02" ■ Process connection: DN 80 to DN 150/3" to 6" ■ Wetted parts: 316L, Alloy C276, PTFE ■ Measuring ranges: 36m/118ft ■ Gastight feedthrough: Standard ■ Technical Information: TI01248G 	<ul style="list-style-type: none"> ■ Process pressure: 0 to +25bar/0 to +362.5psi ■ Process temperature: -200 to +200°C/-328 to +392°F ■ Accuracy: ±0.4mm/0.02" ■ Process connection: DN 80 to DN 150/3" to 6" ■ Wetted parts: 316L, Alloy C276, PTFE ■ Measuring ranges: 47m/154ft ■ Gastight feedthrough: Standard ■ Technical Information: TI01249G 	<ul style="list-style-type: none"> ■ Process pressure: 0 to +6bar/0 to +87psi ■ Process temperature: -200 to +200°C/-328 to +392°F ■ Accuracy: ±0.4mm/0.02" ■ Process connection: DN 80 to DN 150/3" to 6" ■ Wetted parts: 316L, 316 polished, PTFE ■ Measuring ranges: 22m/72ft ■ Gastight feedthrough: Standard ■ Technical Information: TI01250G
Applications			
Horizontal storage tank cyl.	+	+	+
Vertical storage tank	+	+	+
Buffer tank	-	-	-
Recipient tank	-	-	-
Process tank	-	-	-
Stilling well	+	+	+
Bypass	-	-	-
Pump shaft	-	-	-
Channel measurement	-	-	-
Application limits	<ul style="list-style-type: none"> ■ Turbulent condition → Guide wires or stilling well ■ High viscosity → PTFE displacer or NMR81 ■ Requires min. difference of 0.100g/ml between layers 	<ul style="list-style-type: none"> ■ Turbulent condition → Guide wires or stilling well ■ High viscosity → PTFE displacer or NMR81 ■ Requires min. difference of 0.100g/ml between layers 	<ul style="list-style-type: none"> ■ Turbulent condition → Guide wires or stilling well ■ High viscosity → PTFE displacer or NMR81 ■ Requires min. difference of 0.100g/ml between layers

+ = recommended

0 = restricted (observe limits)

- = not recommended

4. Instrument selection within the measuring principle

Hydrostatics

	Cerabar PMC51B 	Cerabar PMP51B 	Deltapilot FMB50 		Cerabar PMC71B 	Cerabar PMP71B 	Deltapilot FMB70 
Technical data							
▪ Process pressure	100mbar to 40bar/ 0.15 to 600psi	400mbar to 400bar/ 6 to 6,000psi	100mbar to 10bar/ 1.5 to 145psi		100mbar to 40bar/ 1.5 to 600psi	400mbar to 700bar/ 6 to 10,500psi	100mbar to 10bar/ 1.5 to 145psi
▪ Process temperature	-40 to +100°C/ -40 to +212°F	-70 to +400°C/ -94 to +752°F	-10 to +100°C/ +14 to +212°F		-40 to +150°C/ -40 to +302°F	-70 to +400°C/ -94 to +752°F	-10 to +100°C/ +14 to +212°F
▪ Accuracy	±0.075% (0.055% optional)	±0.075% (0.055% optional)	±0.2% (0.1% optional)		±0.05% (0.025% optional)	±0.05% (0.025% optional)	±0.1% (0.075% optional)
▪ Process connection	Thread, flange, hygienic connections	Thread, flange, hygienic connections	Thread, flange, hygienic connections		Thread, flange, hygienic connections	Thread, flange, hygienic connections	Thread, flange, hygienic connections
▪ Wetted parts	316L, Al ₂ O ₃ , sealings, PVDF	316L, Alloy, Tantal, Monel, Gold	316L, Alloy		316L, Al ₂ O ₃ , sealings, PVDF	316L, Alloy, Tantal, Monel, Gold	316L, Alloy
▪ Gastight feedthrough	—	—	—		Standard	Standard	Standard
▪ Measuring cell	Ceramics	Metal welded	Contite, condensate-proof, water-tight, metal welded		Ceramics	Metal welded	Contite, condensate-proof, water-tight, metal welded
▪ Technical Information	TI01506P	TI01508P	TI00437P		TI01507P	TI01509P	TI00416P
Applications							
Horizontal storage tank cyl.	0	0	0		0	0	0
Vertical storage tank	+	+	+		+	+	+
Buffer tank	0	0	0		0	0	0
Recipient tank	+	-	0		+	-	0
Process tank	0	0	0		0	0	0
Stilling well	-	-	-		-	-	-
Bypass	-	-	-		-	-	-
Pump shaft	-	-	-		-	-	-
Channel measurement	-	-	-		-	-	-
Application limits	▪ If pressurized, possibly use differential pressure measurement with two pressure transmitters (electronic dp). Observe ratio head pressure to hydrostatic pressure	▪ If pressurized, possibly use differential pressure measurement with two pressure transmitters (electronic dp). Observe ratio head pressure to hydrostatic pressure	▪ If pressurized, possibly use differential pressure measurement with two pressure transmitters. Observe ratio head pressure to hydrostatic pressure		▪ If pressurized, possibly use differential pressure measurement with two pressure transmitters (electronic dp). Observe ratio head pressure to hydrostatic pressure	▪ If pressurized, possibly use differential pressure measurement with two pressure transmitters (electronic dp). Observe ratio head pressure to hydrostatic pressure	▪ If pressurized, possibly use differential pressure measurement with two pressure transmitters. Observe ratio head pressure to hydrostatic pressure

+ = recommended

0 = restricted (observe limits)

- = not recommended

4. Instrument selection within the measuring principle

Hydrostatics

	Waterpilot FMX11/FMX21	Deltapilot FMB51/52/53	Deltabar PMD55B		Deltabar FMD71/FMD72	Deltabar PMD75B	Deltabar PMD78B
Technical data							
■ Process pressure	100mbar to 20bar 0.15 to 290psi	100mbar to 10bar/ 0.07 to 150psi	30mbar to 40bar/ 0.45 to 600psi		100mbar to 40bar/ 1.5 to 600psi	10mbar to 250bar/ 0.15 to 3,750psi	100mbar to 40bar/ 1.5 to 600psi
■ Process temperature	-10 to +70°C/ +14 to +158°F	-10 to +85°C/ +14 to +185°F	-40 to +110°C/ -40 to +230°F		-40 up to +150°C/ -40 up to +302°F	-40 to +110°C/ -40 to +230°F	-40 to +400°C/ -40 to +752°F
■ Accuracy	±0.2% (0.1% optional)	±0.2% (0.1% optional)	±0.075% (0.055% optional)		Single sensor ±0.05% System ±0.07%	±0.05% (0.035% optional)	±0.1%
■ Process connection	Mounting clamp, cable mounting screw	Thread, flange	Oval flange (¼ to 18 NPT), IEC 61518		Thread, flange, flush-mounted hygienic connections	Oval flange (¼ to 18 NPT), IEC 61518	Thread, flange, hygienic connections
■ Wetted parts	316L, Al ₂ O ₃ , FKM, EPDM, PE, FEP, PUR	316L, Alloy, PE, FEP	316L, Alloy		316L, Alloy C276	316L, Alloy, Monel, Tantal, Gold	316L, Alloy, Monel, Tantal, PTFE, Gold
■ Gastight feedthrough	—	—	—		Standard	Standard	Standard
■ Measuring cell	Ceramics	Contite, condensate-proof, water-tight, metal welded	Metal welded		Metal welded, Ceraphire ceramics	Metal welded	Metal welded
■ Technical Information	TI00351P/TI00431P	TI00437P	TI01510P		TI01033P	TI01511P	TI01512P
Applications							
Horizontal storage tank cyl.	-	+	0		0	0	0
Vertical storage tank	-	+	0		+	0	0
Buffer tank	-	0	+		0	+	+
Recipient tank	-	0	-		0	-	-
Process tank	-	-	+		+	+	+
Stillling well	0	-	-		-	-	-
Bypass	-	-	0		-	0	0
Pump shaft	+	+	-		-	-	-
Channel measurement	+	+	-		-	-	-
Application limits	■ Pressurized tanks	■ Pressurized tanks ■ FMB51: Rope variant FMB52: Rod variant	■ Impulse-piping required ■ If pressurized, possibly use Deltabar FMD71/FMD72 electronic dp. Observe ratio head pressure to hydrostatic pressure		■ Observe ratio head pressure to hydrostatic pressure	■ Impulse-piping required ■ If pressurized, possibly use Deltabar FMD71/FMD72 electronic dp. Observe ratio head pressure to hydrostatic pressure	■ Possibly use Deltabar FMD71/ FMD72 electronic dp. Observe ratio head pressure to hydrostatic pressure

+ = recommended

0 = restricted (observe limits)

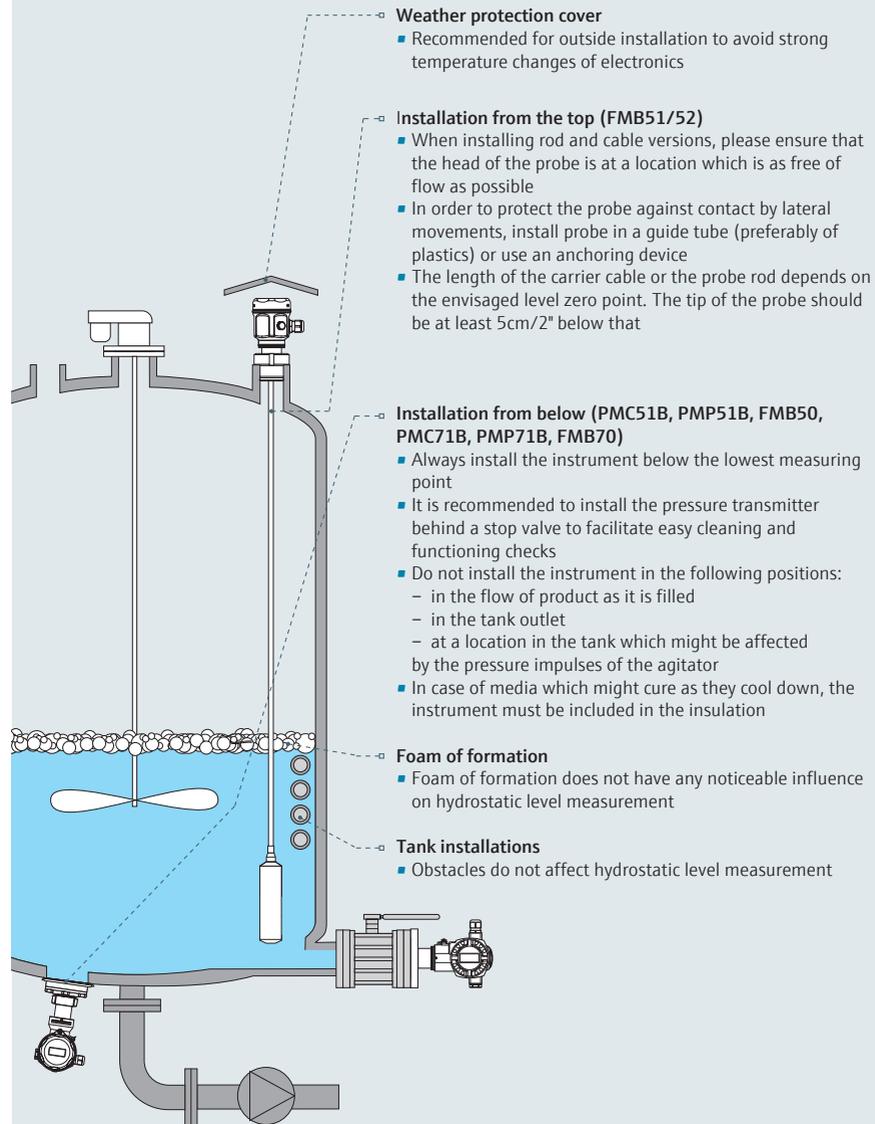
- = not recommended

*with blank flange

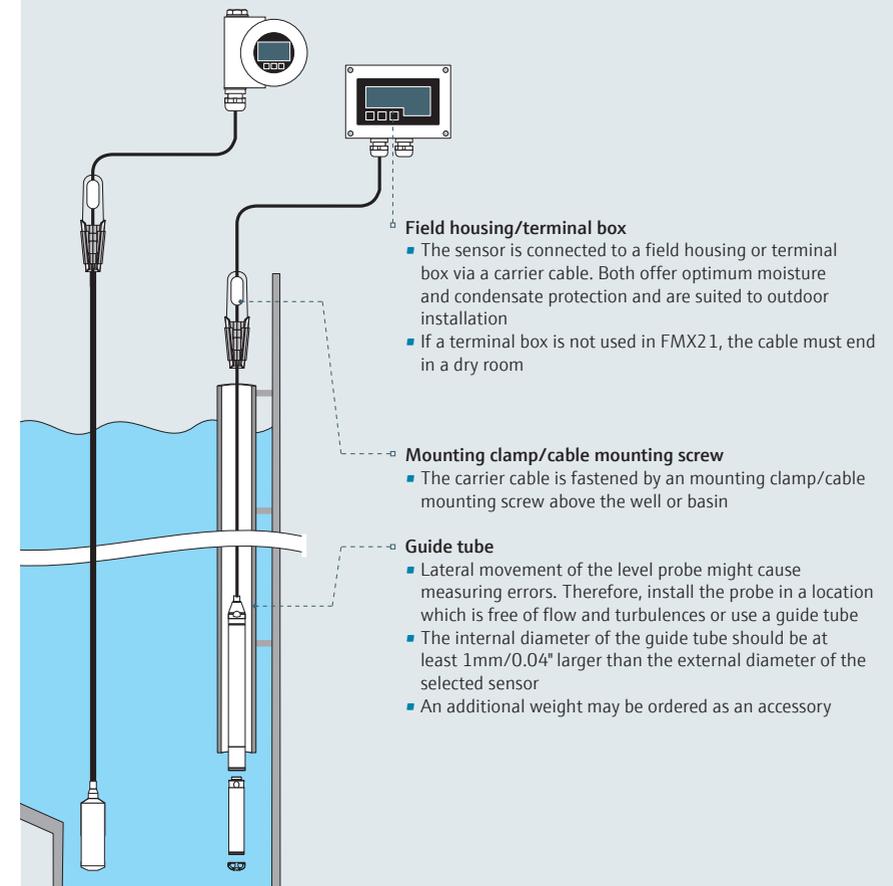
4. Instrument selection within the measuring principle

Installation instructions hydrostatics (pressure)

Open tanks

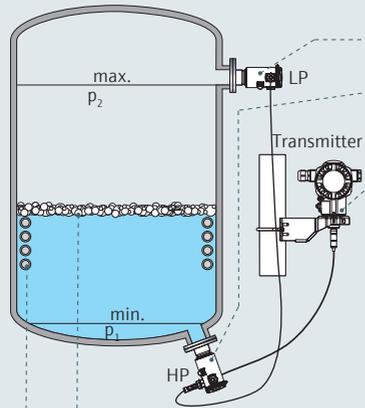


Open wells or basins (FMB53/FMX21)



4. Instrument selection within the measuring principle

Installation instructions hydrostatics (differential pressure)

**Closed tanks with Deltabar FMD71/FMD72 electronic dp**

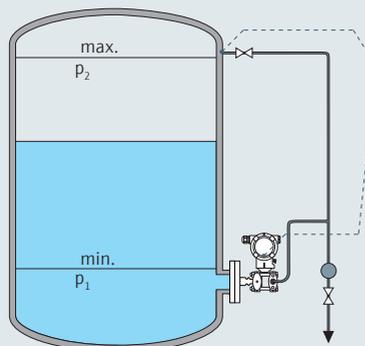
- LP (low pressure) install sensor above the maximum measuring point
- HP (high pressure) if possible, install sensor below the minimum measuring point
- In case of outdoor installation it is recommended to mount the transmitter at a position where it is protected against the environment
- It is recommended to install the pressure transmitter behind a stop valve to facilitate easy cleaning and functioning checks
- Do not install the instrument in the following positions:
 - in the flow of product as it is filled
 - in the tank outlet
 - at a location in the tank which might be affected by the pressure impulses of the agitator
- In case of media which might cure as they cool down, the instrument must be included in the insulation

Foam of formation

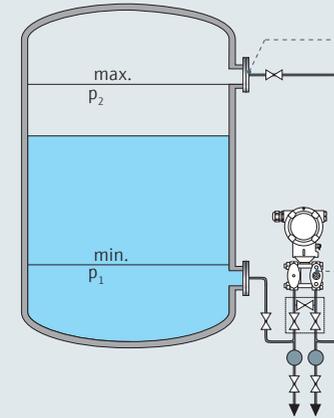
- Foam of formation does not have any noticeable influence on hydrostatic level measurement

Tank installations

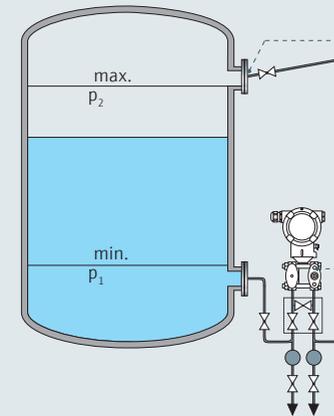
- Obstacles do not affect hydrostatic level measurement

**Closed tanks with PMD78B (diaphragm seal plus side)**

- Always connect the minus side above the maximum level
- Install Deltabar PMD78B directly at the tank below the lower measuring connection
- Generally speaking, the installation of separators and discharge valves makes sense to collect deposits, pollution or liquids in the upper pressure piping and to remove them
- Calibrate at operating temperature

**Closed tanks with PMD75B/PMD55B (pressure piping)**

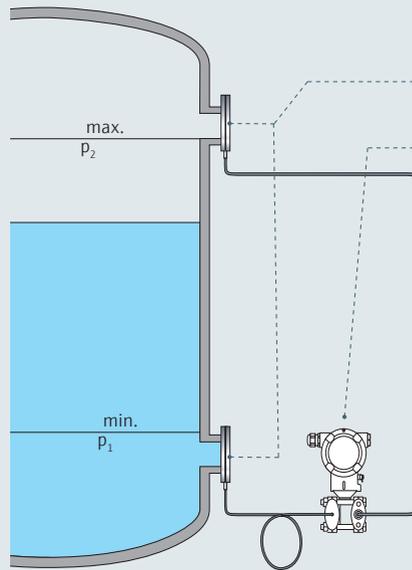
- Always connect the minus side above the maximum level
- Always install Deltabar PMD75B/Deltabar PMD55B below the lower measuring connection so that the lower pressure piping is always filled with liquid
- Generally speaking, the installation of separators and discharge valves makes sense to collect deposits, pollution or liquids in pressure piping and to remove them
- Calibrate at operating temperature

**Closed vapor-pressurized tanks with PMD75B/PMD55B (pressure piping)**

- Always connect the minus side above the maximum level
- The filled condensate vessel safeguards constant pressure on the minus side
- Always install Deltabar PMD75B/Deltabar PMD55B below the lower measuring connection so that the lower pressure piping is always filled with liquid
- In case of measurements in media with a solids content, e. g. polluted liquids, the installation of separators and discharge valves makes sense to collect deposits and remove them
- Calibrate at operating temperature

4. Instrument selection within the measuring principle

Installation instructions hydrostatics (differential pressure)



Closed tanks with FMD78 (capillary diaphragm seal)

- Level measurement is only safeguarded between the upper edge of the lower and the lower edge of the upper diaphragm seal
- In vacuum applications, it is recommended to install the pressure transmitter below the lower diaphragm seal. This will avoid a vacuum load of the diaphragm seal caused by the presence of filling oil in the capillaries

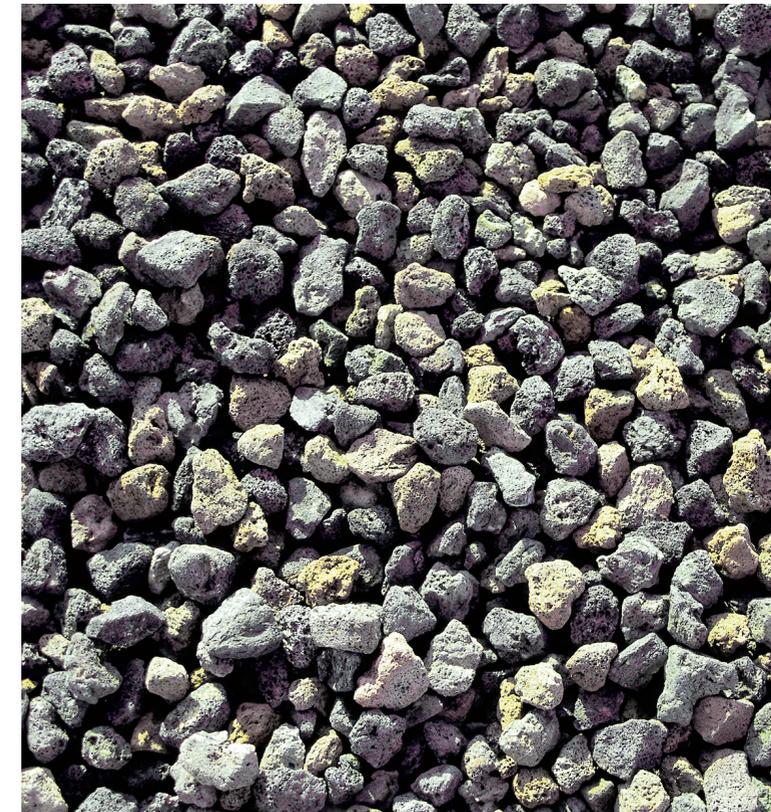
Endress+Hauser Applicator

Further installation instructions are presented in the "Sizing Diaphragm Seal" Applicator



Continuous level measurement in bulk solids

Selection and engineering guide for the process industry



Step by step

This selection and engineering guide provides information on different measuring principles for continuous level measurement in Bulk solids as well as their application and installation.

The pamphlet contains two separate chapters: Level measurement in liquids and Level measurement in solids.

The second chapter specifically covers continuous measurement in bulk solids. A separate selection guide is available for point level detection (see the supplementary documentation CP00007F).

A

Overview of measuring principles

First of all, we show you an overview of the Endress+Hauser measuring principles for continuous level measurement in solids in diagrams on the first pages. Subsequently, you are introduced to the mode of functioning of the measuring principle and the respective product family.

Checklist

You should be aware of the application requirements for the correct selection of a suitable instrument. The checklist provides an overview and is supposed to help you to consider or record this data as completely as possible.

B

Selection of the measuring principle

The appropriate measuring principle is first selected according to the application and its criteria (Silo/bunker, slim/narrow silos, mechanical conveyor systems, crusher and stockpiles). Select the principle which meets, if possible, all of the criteria required by you or your plant. The measuring principles are classified according to „non-contact“ and „contact“ criteria. The ideal measuring principle/instrument is stated first and in a blue frame. Max. technical data is always used.

C

Instrument selection

Now change to the area of the selected measuring principle where you can choose the appropriate instrument from a product family. Compare your application and process data with the instrument data.

Engineering

After the selection of the optimum instrument check the installation instructions at the end of the respective measuring principle. They contain basic directions for the safe installation and use of the instrument. You will find more extensive engineering instructions in the respective Technical Information of the instrument.

Contents

1. Overview of measuring principles	102
2. Checklist	108
3. Selection of the measuring principle according to the application	110
■ Silo/bunker	110
■ Slim, narrow silos (ratio H/D ≥ 8)	112
■ Stockpiles	114
■ Mechanical conveyor systems (e. g. conveyor belt)	115
■ Crusher	116
■ IIoT Radar (not included in this selection guide): Cloud based IIoT level sensor for mobile applications or remote measuring points for liquids and bulk solids. Data transmission via cellular communication (NB-IoT, LTE-M and 2G fallback). Data management in SupplyCare Hosting and Netilion (E+H cloud services). Detailed information is available from our application specialists or at www.endress.com/FWR30 .	
4. Instrument selection within the measuring principle	118
■ Radar	118
■ Guided radar	122
■ Ultrasonics	126
■ Electromechanical level system	132
■ Radiometry: The radiometric measuring principle is not considered in this section. Please contact our application consultants in your country for detailed information.	

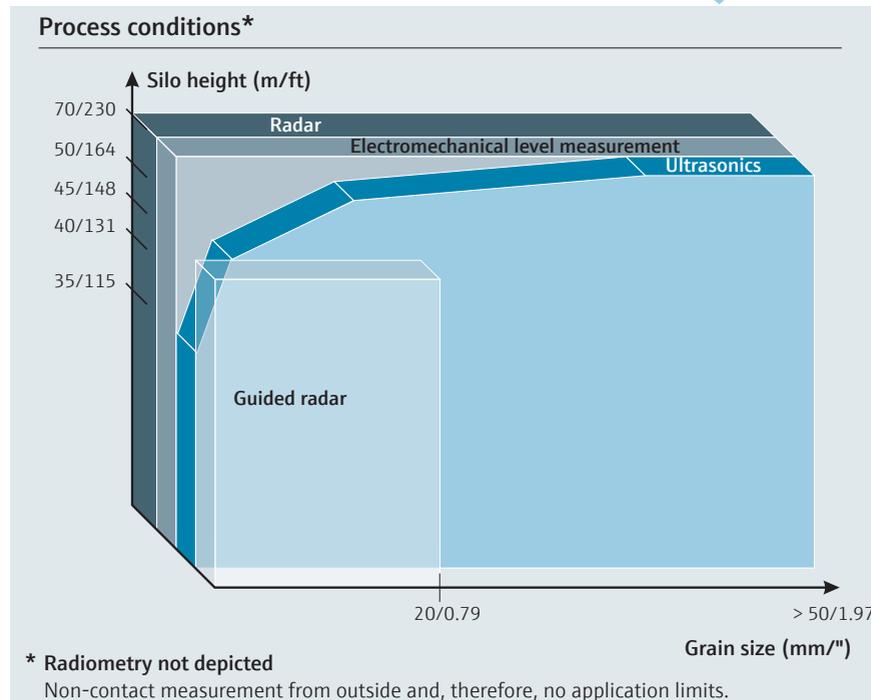
A

B

C

1. Overview of the measuring principles

Segmentation		
	Point level	Continuous
Liquids	Vibronics Conductive Capacitance Float switch Radiometrics	Radar Guided radar Ultrasonics Hydrostatics (p + dp) Capacitance Radiometrics
Bulk solids	Vibronics Capacitance Paddle Microwave barrier Radiometrics	Radar Guided radar Ultrasonics Electromechanical level system Radiometrics



Endress+Hauser offers you a solution adapted to your application and tailored to your process requirements. You can select the best technology for your application from the wide product range of Endress+Hauser.

„You only pay what you really need.“

Endress+Hauser takes this statement seriously and offers a large number of different measuring principles which vary in price and functionality.

1. Overview of the measuring principles

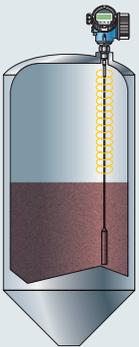


Radar

Micropilot works with either pulses or with Frequency Modulated Continuous Wave (FMCW). FMCW: Works with an FMCW continuous electromagnetic wave which is emitted from an antenna and reflected by the product surface. The frequency change " Δf " is measured and the time and distance are calculated.

Micropilot

Non-contact, maintenance-free measurement also under extreme conditions. Unaffected by the density of bulk solids, temperature, dust formation and humidity.



Guided radar

Levelflex works with radar pulses guided along a probe. As the pulses meet the medium surface, part of the emitted pulse is reflected due to a change of the DC value between the air and the medium. The time between pulse launching and receiving is measured and analyzed by the instrument and constitutes a direct measure for the distance between the process connection and the product surface.

Levelflex

Robust, non-maintenance measurement in solids. Unaffected by the density of bulk solids, temperature, dust formation and humidity and almost unaffected by baffles.



Ultrasonics

Prosonic works with ultrasonic pulses which are emitted by a sensor, reflected by the surface of the medium due to a change of the density between the air and the medium and again acquired by the sensor. The required Time-of-Flight is a measure for the distance travelled in the empty part of the silo. This value is deducted from the overall height of the silo to yield the level.

Prosonic

Non-contact measurement free of maintenance without impairment by product properties, e. g. dielectric constant or humidity. Unaffected by build-up due to the self-cleaning effect of sensors using diaphragm vibration.

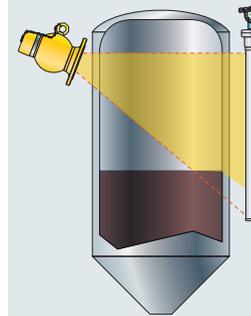


Electromechanical level system

A weight is lowered on a measuring tape. As it meets the surface of the bulk solids, the tensile force of the weight is reduced. This change is recognized, the instrument reverses the sense of rotation of the motor and rewinds the tape. A pulse generator counts the rotations in a non-contact manner as the weight is lowered. Each counted pulse corresponds to an exactly defined distance. If this distance is deducted from the overall distance (height of the vessel), the level results.

Silopilot

Robust system for safe measurements also in extremely dusty environments and low density media. Unaffected by product properties and DC value.



Radiometry

The gamma source, a cesium or cobalt isotope, emits radiation which is attenuated as it passes through materials. The measuring effect results from the absorption of radiation by the product as the level changes. The measuring system consists of a source and a compact transmitter as a receiver.

Gammapiilot

Compact transmitter in different measuring lengths, adaptable to the measuring range. Non-contact measurement from outside, for all extreme applications, e. g. very abrasive, corrosive and aggressive media:

- Unaffected by media
- Any process temperature
- Any process pressure
- Unaffected by gammagraphy (Modulator)

1. Overview of the measuring principles

- Overview of application areas
- Limits of operating conditions

	 <p>Radar</p>	 <p>Guided radar</p>	 <p>Ultrasonics</p>	 <p>Electromechanical level system</p>	 <p>Radiometrics</p>
Process temperature* Process pressure	-40 to +450°C/ -40 to +842°F -1 to +16bar/ -14.5 to +232psi	-40 to +150°C/ -40 to +302°F -1 to +16bar/ -14.5 to +232psi	-40 to +150°C/ -40 to +302°F +0.7 to +3bar/ +10 to +44psi	-20 to +230°C/ -4 to +446°F +0.8 to +3bar/ +11.6 to +44psi	Unaffected by process temperature and pressure
Measuring range	0.3 to 125m/1 to 410ft	0.2 to 45m/0.7 to 148ft	0.07 to 45m/0.2 to 148ft	0.85 to 70m/2,8 to 230ft (special design up to 90m/295ft)	0.05 to 20m/0.16 to 66ft,
Instrument accuracy Surfaces of bulk solids affect accuracy	<ul style="list-style-type: none"> Up to 1.5m/59": ±20mm/0.8" From 1.5m/59": ±3mm/0.12" 	<ul style="list-style-type: none"> < 15m/49ft: ±2mm/0.08" > 15m/49ft: ±10mm/0.4" 	<ul style="list-style-type: none"> ±2mm/0.08", ±0.2% of measuring distance 	<ul style="list-style-type: none"> ±5cm/2" (FMM50) ±2.5cm/1" (FMM20) 	<ul style="list-style-type: none"> ±1% of measuring distance
Function may be affected by	<ul style="list-style-type: none"> Strong build-up formation Surface of bulk solids (grain size/angled surface) Conductive build-up on the antenna Strong fluidization Baffles causing interfering reflections 	<ul style="list-style-type: none"> Build-up formation Baffles in the immediate vicinity of the probe Strong fluidization 	<ul style="list-style-type: none"> Extreme dust formation Extreme filling noise Strong build-up formation Surface of bulk solids (grain size/angled surface) Fluidization Baffles causing interfering reflections 	<ul style="list-style-type: none"> Strong build-up formation Wear due to abrasion of mech. components Burying due to collapsing product accumulation 	<ul style="list-style-type: none"> Extreme build-up formation Extreme pressure fluctuation External radiation (gammagraphy), solution with Gamma Modulator
Application limits	<ul style="list-style-type: none"> DC < 1.6 Baffles in the beam cone Filling curtain in the beam cone Angled surface/funnel with a reflecting, smooth surface 	<ul style="list-style-type: none"> DC < 1.4 Coarse-grained (> 20mm/0.8") and abrasive media Extreme tensile forces Measurement in the filling curtain 	<ul style="list-style-type: none"> Blocking distance Baffles in the sonic cone Filling curtain in the sonic cone Angled surface/funnel with a reflecting, smooth surface 	<ul style="list-style-type: none"> Extreme tensile forces if the risk of collapsing product accumulation on walls prevails Measurement during filling 	<ul style="list-style-type: none"> Non-contact measurement from outside and, therefore, no application limits Observe radiation protection laws

*At the process connection

3. Selection of the measuring principle according to the application

✓ Silos/bunkers

- Filling via mechanical or pneumatic conveyance
- Free field measurement
- Fluidization possible



Non-contact

Our proposal

	<p>Radar Micropilot</p>  <p>FMR66B FMR67B</p>	<p>Radar Micropilot</p>  <p>FMR10B/FMR20B/ FMR30B</p>	<p>Radar Micropilot</p>  <p>FMR43</p>
Advantages	<ul style="list-style-type: none"> ■ For corrosive and abrasive media ■ Easy installation for large measuring ranges ■ Remote access via <i>Bluetooth</i>® ■ Heartbeat Technology ■ Air purge connection available 	<ul style="list-style-type: none"> ■ Easy installation and commissioning ■ Heartbeat Technology ■ Remote access via <i>Bluetooth</i>® ■ LED indicator/color touch display 	<ul style="list-style-type: none"> ■ Compact and hygienic design ■ Heartbeat Technology ■ Remote access via <i>Bluetooth</i>® ■ LED indicator/color touch display
Technical data	<ul style="list-style-type: none"> ■ Connection: 2-wire (HART®, PA, Ethernet-APL) ■ Accuracy: ±3mm/±0.12" ■ Process temperature*: -196 to +450°C/-321 to +842°F ■ Process pressure: -1 to +160bar/-14.5 to +2,320psi ■ Min. DC value ■ Process connection: Threads, flanges (DIN, ASME, JIS) ■ Maximum measuring range: 125m/410ft 	<ul style="list-style-type: none"> ■ Connection: 2-wire (HART®) ■ Accuracy: ±4mm/±0.16" ■ Process temperature*: -40 to +80°C/-40 to +176°F ■ Process pressure: -1 to +3bar/+14.5 to +43psi ■ Min. DC value: 1.6 ■ Process connection: Threads, flanges ■ Maximum measuring range: 30m/98ft 	<ul style="list-style-type: none"> ■ Connection: 2-wire (HART®, IO-Link) ■ Accuracy: ±3mm/±0.12" ■ Process temperature*: -40 to +150°C/-40 to +302°F ■ Process pressure: -1 to +20bar/-14.5 to +290psi ■ Min. DC value ■ Process connection: Threads, hygienic connections ■ Maximum measuring range: 15m/49ft
Application limits	<ul style="list-style-type: none"> ■ DC value < 1.6 → ultrasonics, electrom. level system ■ Risk of strong build-up formation → use of purge air ■ Angled surface/funnel with a reflecting, smooth surface → ultrasonics → guided radar, electrom. level system 	<ul style="list-style-type: none"> ■ DC value < 1.6 → ultrasonics, electrom. level system ■ Risk of strong build-up formation → radar with purge air ■ Angled surface/funnel with a reflecting, smooth surface → guided radar, electrom. level system 	<ul style="list-style-type: none"> → ultrasonics, electrom. level system → radar with purge air → guided radar, electrom. level system

Contact

Our proposal

	<p>Guided radar Levelflex</p>  <p>FMP56 FMP57</p>	<p>Electromechanical level system Silopilot</p>  <p>FMM50 FMM20</p>
Advantages	<ul style="list-style-type: none"> ■ Unaffected by silo geometries and the shape of the angled surfaces ■ Unaffected by the density of bulk solids, temperature, humidity and filling noise ■ Unaffected by dust, e.g. in pneumatic filling ■ Heartbeat Technology 	<ul style="list-style-type: none"> ■ Unaffected by low density of bulk solids and DC value ■ Easy installation
Technical data	<ul style="list-style-type: none"> ■ Connection: 2-wire (HART®, PA, FF), 4-wire HART® ■ Accuracy: < 15m/49ft: ±2mm/0.08"; > 15m/49ft: ±10mm/0.4" ■ Process temperature*: -40 to +150°C/-40 to +302°F ■ Process pressure: -1 to +16bar/-14.5 to +232psi ■ Min. DC value: 1.4 ■ Process connection: ¾", 1½", DN 40 to DN 150 ■ Maximum measuring range: 45m/148ft 	<ul style="list-style-type: none"> ■ Connection: 4-wire, 4-20mA, relay ■ Accuracy: ±2.5cm/±1" (FMM20), ±5cm/±2" (FMM50) ■ Process temperature*: -20 to +230°C/-4 to +446°F ■ Process pressure: +0.8 to +3bar/+11.6 to +44psi ■ Min. DC value: - ■ Process connection: DN 100 PN 16 (hole size) ■ Maximum measuring range: 70m/230ft (special design up to 90m/295ft)
Application limits	<ul style="list-style-type: none"> ■ Abrasive, grained, lumpy products → radar, ultrasonics ■ Max. tensile forces on the rope = 35kN (observe ceiling load) → radar, ultrasonics, electrom. level system ■ Extreme build-up formation → radar with purge air, ultrasonics ■ High temperatures 150°C/302°F → radar, electrom. level system ■ DC < 1.4 → ultrasonics, electrom. level system ■ Measuring range > 45m/148ft powdery products → radar, electrom. level system 	<ul style="list-style-type: none"> ■ Risk of weight being buried → radar, ultrasonics ■ Strong mechanical wear to be expected → radar, ultrasonics ■ Measurement during filling → guided radar, radar, ultrasonics

* At the process connection

➔ Please note: Radar continued on Page 118

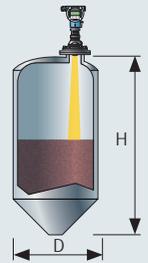
➔ Please note: Guided radar continued on Page 122

➔ Please note: Electrom. level system continued on Page 132

3. Selection of the measuring principle according to the application

✓ Slim, narrow silos, vessels

- Filling via mechanical or pneumatic conveyance
- Fluidization possible
- Ratio H/D ≥ 8



Non-contact

Our proposal



Advantages

- Unaffected by the density of bulk solids, temperature, humidity and filling noise
- For corrosive and abrasive media
- Easy installation for large measuring ranges
- Remote access via *Bluetooth*®
- Heartbeat Technology

- Easy installation and commissioning
- Heartbeat Technology
- Remote access via *Bluetooth*®
- LED indicator/color touch display for fast status detection

Technical data

■ Connection

2-wire (HART®, PA, Ethernet-APL)

2-wire (HART®)

- Accuracy ±3mm/±0.12"
- Process temperature* -196 to +450°C/-321 to +842°F
- Process pressure -1 to +160bar/-14.5 to +2,320psi
- Min. DC value 1,6
- Process connection flanges (DIN, ASME, JIS)
- Maximum measuring range 125m/410ft

±3mm/±0.12"
-196 to +450°C/-321 to +842°F
-1 to +160bar/-14.5 to +2,320psi
1,6
flanges (DIN, ASME, JIS)
125m/410ft

±4mm/±0.16"
-40 to +80°C/-40 to +176°F
-1 to +3bar/+14.5 to +43psi
1.6
Threads, flanges
30m/98ft

Application limits

- DC value < 1.6 → ultrasonics, electrom. level system
- Risk of strong build-up formation → use of purge air
- Angled surface/funnel with a reflecting, smooth surface → ultrasonics
- guided radar, electrom. level system

- DC value < 1.6 → ultrasonics, electrom. level system
- radar with purge air
- Risk of strong build-up formation → radar with purge air
- Angled surface/funnel with a reflecting, smooth surface → guided radar, electrom. level system

Contact

Our proposal



- Unaffected by silo geometries and the shape of the angled surfaces
- Unaffected by the density of bulk solids, temperature, humidity and filling noise
- Unaffected by dust, e. g. in pneumatic filling
- Heartbeat Technology

- Unaffected by low density of bulk solids and DC value
- Easy installation

2-wire (HART®, PA, FF), 4-wire HART®
< 15m/49ft: ±2mm/0.08"; > 15m/49ft: ±10mm/0.4"

4-wire, 4-20mA, relay
±2.5cm/±1" (FMM20), ±5cm/±2" (FMM50)

-40 to +150°C/-40 to +302°F
-1 to +16bar/-14.5 to +232psi
1.4
¾", 1½", DN 40 to DN 150
45m/148ft

-20 to +230°C/-4 to +446°F
+0.8 to +3bar/+11.6 to +44psi
-
DN 100 PN 16 (hole size)
70m/230ft (special design up to 90m/295ft)

- Abrasive, grained, lumpy products (> 20 mm/0.8"), probe damage → radar, ultrasonics
- Max. tensile forces on the rope = 35kN (observe ceiling load) → radar, ultrasonics, electrom. level system
- Extreme build-up formation on the probe → radar with purge air, ultrasonics
- High temperatures 150°C/302°F → radar, electrom. level system
- DC < 1.4 → ultrasonics, electrom. level system
- Measuring range > 45m/148ft powdery products → radar, electrom. level system
- Low density (< 10g/l) → electrom. level system

- Risk of weight being buried → radar, ultrasonics
- Strong mechanical wear to be expected → radar, ultrasonics
- Measurement during filling → guided radar, radar, ultrasonics

* At the process connection

➔ Please note: Radar continued on Page 118

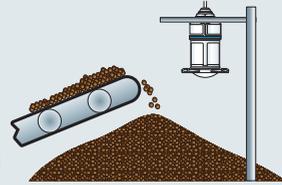
➔ Please note: Guided radar continued on Page 122

➔ Please note: Electrom. level system continued on Page 132

3. Selection of the measuring principle according to the application

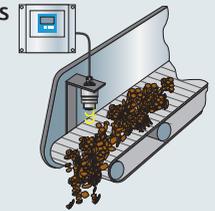
✓ Stockpiles

- Filling via conveyor belts/derrick-type belts
- Level measurement for conveyor belt control
- The most varied grain sizes
- May be exposed to environmental conditions (e. g. wind)



✓ Mechanical conveyor systems (e. g. conveyor belts)

- Monitoring of belt load
- Monitoring of feed points
- Strong abrasion (→ non-contact)
- Fast response times required
- Vibration possible



Non-contact

Our proposal

Radar Micropilot



FMR20B FMR30B

Radar Micropilot



FMR66B

Advantages

- | | |
|--|--|
| <ul style="list-style-type: none"> ■ Easy installation and commissioning ■ Heartbeat Technology ■ Remote access via Bluetooth® ■ LED indicator/color touch display for fast status detection | <ul style="list-style-type: none"> ■ Unaffected by the density of bulk solids, temperature, humidity, filling noise and weather impairment ■ Easy installation with alignment sealings ■ Remote access via Bluetooth® ■ Heartbeat Technology |
|--|--|

Technical data

- | | | |
|---|---|---|
| <ul style="list-style-type: none"> ■ Connection ■ Accuracy ■ Process temperature* ■ Process pressure ■ Min. DC value ■ Process connection | <p>2-wire (HART®)
±4mm/±0.16"
-40 to +80°C/-40 to +176°F
-1 to +3bar/+14.5 to +43psi
1.6
Threads, flanges</p> | <p>2-wire (HART®, PA, Ethernet-APL)
±3mm/±0.12"
-40 to +130°C/-40 to +266°F
-1 to +16bar/-14.5 to +232psi
1.6
Threads, flanges (UNI)
mounting bracket
50m/164ft</p> |
|---|---|---|

Application limits

- | | | | |
|--|---|---|---|
| <ul style="list-style-type: none"> ■ DC value < 1.6 ■ Risk of strong build-up formation | <p>→ ultrasonics, electrom. level system
→ use of purge air
→ ultrasonics</p> | <ul style="list-style-type: none"> ■ DC value < 1,6 ■ Risk of strong build-up formation ■ Poor access to the instrument | <p>→ ultrasonics
→ use of purge air
→ ultrasonics

→ ultrasonics, separated instrumentation</p> |
|--|---|---|---|

Non-contact

Our proposal

Radar Micropilot



FMR20B FMR30B

Radar Micropilot



FMR66B

Ultrasonics Prosonic



FDU93/95 FMU90/95 FMU4x

Advantages

- | | | |
|--|---|---|
| <ul style="list-style-type: none"> ■ Easy installation and commissioning ■ Heartbeat Technology ■ Remote access via Bluetooth® ■ LED indicator/color touch display for fast status detection | <ul style="list-style-type: none"> ■ Easy installation with alignment sealings ■ Remote access via Bluetooth® ■ Heartbeat Technology | <ul style="list-style-type: none"> ■ Separate instrumentation ■ Self-cleaning effect of sensors ■ Robust sensor (vibration) ■ Relay output for point levels |
|--|---|---|

Technical data

- | | | | |
|---|--|---|--|
| <ul style="list-style-type: none"> ■ Connection ■ Accuracy ■ Process temperature* ■ Process pressure ■ Min. DC value ■ Process connection | <p>2-wire (HART®)
±4mm/±0.16"
-40 to +130°C/
-40 to +266°F
-1 to +3bar/
+14.5 to +43psi
1.6
Threads, flanges (UNI)</p> | <p>2-wire (HART®, PA, Ethernet-APL)
±3mm/±0.12"
-40 to +130°C/
-40 to +266°F
-1 to +16bar/
-14.5 to +232psi
1.6
Threads, flanges (UNI)
mounting bracket</p> | <p>2-/4-wire
(4-20mA HART®, DP)
±2mm/±0.08", ±0.2%
of measured distance
-40 to +150°C/
-40 to +302°F
+0.7 to +3bar/
+10 to +44psi
—
Threads, flanges (DIN, ANSI, JIS),
wall and assembly arm, assembly
bracket
45m/148ft</p> |
|---|--|---|--|

Application limits

- | | | |
|--|---|---|
| <ul style="list-style-type: none"> ■ DC value < 1.6 ■ Risk of strong build-up formation | <p>→ ultrasonics, electrom. level system
→ use of purge air
→ ultrasonics</p> | <ul style="list-style-type: none"> ■ Observe blocking distance ■ Strong vibration, please use separated instrumentation |
|--|---|---|

* At the process connection

➔ Please note: Radar continued on Page 118

* At the process connection

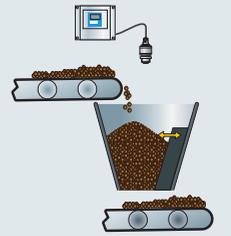
➔ Please note: Radar continued on Page 118

➔ Please note: Ultrasonics continued on Page 126

3. Selection of the measuring principle according to the application

✓ Crusher

- Monitoring of crusher level
- Strong abrasion (→non-contact)
- High mechanical load (→non-contact)
- Fast response times required
- Vibration possible



Non-contact

Our proposal

	Radar Micropilot  FMR20B/FMR30B	Radar Micropilot  FMR67B FMR66B	Ultrasonics Prosonic (separated)  FMU90/95 FDU93 FDU92
Advantages	<ul style="list-style-type: none"> ■ Easy installation and commissioning ■ Heartbeat Technology ■ Remote access via Bluetooth® ■ LED indicator/color touch display for fast status detection 	<ul style="list-style-type: none"> ■ Unaffected by the density of bulk solids, temperature, humidity, filling noise and weather impairment ■ Purge air connection is standard (FMR67B) ■ Easy installation with alignment facility ■ Remote access via Bluetooth® ■ Heartbeat Technology 	<ul style="list-style-type: none"> ■ Separate instrumentation recommended ■ Attractive measuring point price ■ Self-cleaning effect of sensors, unaffected by build-up ■ Additional point levels, programmable ■ Robust sensor (vibration) ■ Easy assembly under conveyor belt derricks (overall size) and above the conveyor belt/crusher
Technical data	<ul style="list-style-type: none"> ■ Connection: 2-wire (HART®) ■ Accuracy: ±4mm/±0.16" ■ Process temperature*: -40 to +80°C/-40 to +176°F ■ Process pressure: -1 to +3bar/+14.5 to +43psi ■ Min. DC value: 1.6 ■ Process connection: Threads, Flanges (DIN, ASME, JIS) 	<ul style="list-style-type: none"> ■ Connection: 2-wire (HART®, PA, Ethernet-APL) ■ Accuracy: ±3mm/±0.12" ■ Process temperature: -40 to +450°C/-40 to +842°F ■ Process pressure: -1 to +16bar/-14.5 to +232psi ■ Min. DC value: 1.6 ■ Process connection: DN80, DN100, DN150, DN200, DN250, assembly bracket 	<ul style="list-style-type: none"> ■ Connection: 2-/4-wire (4-20mA HART®, DP) ■ Accuracy: ±2mm/±0.08", ±0.2% of measured distance ■ Process temperature: -40 to +150°C/-40 to +302°F ■ Process pressure: +0.7 to +3bar/+10 to +44psi ■ Min. DC value: - ■ Process connection: Threads, flanges (DIN, ANSI, JIS), wall and assembly arm, assembly bracket
Application limits	<ul style="list-style-type: none"> ■ DC value < 1.6 → ultrasonics, electrom. level system ■ Risk of strong build-up formation → use of purge air → ultrasonics 	<ul style="list-style-type: none"> ■ Risk of build-up formation → use of purge air 	<ul style="list-style-type: none"> ■ Possibly protection against mechanical damage (e. g. mount higher or protect by a grid)

* At the process connection

➔ Please note: Radar continued on Page 118

➔ Please note: Ultrasonics continued on Page 126

4. Instrument selection within the measuring principle

Radar

Required application data

- Measuring range (min/max)
- DC value of the medium (DC)/ media group
- Grain size
- Nozzle diameter/nozzle height
- Pressure and temperature

Dielectric constant (DC)

The reflection properties of a medium are determined by the DC value. The following table describes the allocation of different DC values to groups of media. For very loose or loosened bulk solids, the respectively lower group is applicable.

Application limits for level measurement by radar instruments in bulk solids

- Temperature up to -40°C/-40°F
- Temperature up to +450°C/+842°F
- Pressure up to +16bar/+232psi
- Measuring range up to 125m/410ft
- Dielectric constant from 1.6 e. g. Aerosil, Perlite
- Process connection from DN 80/3"

Endress+Hauser App für DK-Werte

Die App bietet einen bequemen Zugang zu mehreren tausend DK-Werten für viele unterschiedliche Medien.



Dielectric constant (DC value) Compendium



Media group	DC value	Examples
A	1.6 to 1.9	Plastic granulate, white lime, special cement, sugar
B	1.9 to 2.5	Cement, gypsum
C	2.5 to 4	Cereal, seeds, ground stones, sand
D	4 to 7	Naturally moist (ground) stones, ores, salt
E	> 7	Metal powder, carbon black, carbon dust

Reduction of the max. possible measuring range by:

- Media with poor reflection properties (low DC value)
- Large angle of repose
- Extremely loose surface of bulk solids, e. g. bulk solids with a low density in pneumatic filling. Please use the respectively lower media group in this case
- Build-up formation (particularly if moisture is present in the process)

✓ Radar

- Non-contact, maintenance-free measurement
- Unaffected by product properties like density
- Unaffected by temperature, filling noise and dust development
- Unaffected by vessel materials
- Freely adjustable measuring range

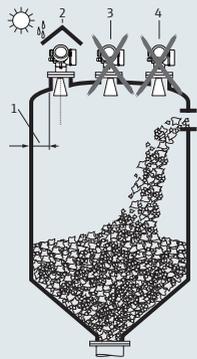
Non-contact

	Micropilot	Micropilot PVDF antenna	Micropilot Horn/Drip-off/Flush mount antenna
	 FMR10B/FMR20B/FMR30B	 FMR66B	 FMR67B
Typical applications	<ul style="list-style-type: none"> Smaller silos, vessels, bunkers, stockpiles, crusher, conveyor belts, mixing towers up to max. measuring range 30m/98ft 	<ul style="list-style-type: none"> Smaller silos, vessels, bunkers, stockpiles up to max. measuring range 50m/164ft Very abrasive bulk solids 	<ul style="list-style-type: none"> High and narrow silos Large bunkers with measuring ranges up to 125m/410ft Open stockpiles with high dust High temperature up to 450°C/842°F
Special features	<ul style="list-style-type: none"> Optional adjustable seal Optional mounting bracket 	<ul style="list-style-type: none"> Optional alignment seal Optional assembly bracket 	<ul style="list-style-type: none"> Innovative drip-off or flush-mounted antenna Optional alignment device Purge air possibility Improved focusing and small beam angle
Technical data	<ul style="list-style-type: none"> Process pressure: -1 to +3bar/ -14.5 to +43psi Process temperature*: -40 to +80°C/ -40 to +176°F Antenna type: Horn, plated with PVDF Max. Measuring range: 30m/98ft DC value: ≥1.6 Accuracy: ±4 mm/0.16" Process connection: G 1", NPT 1", G 1½", NPT 1½", DN 50 to DN 150 / 2" - 6" Process-contacting materials: PVDF 	<ul style="list-style-type: none"> Process pressure: -1 to +3bar/ -14.5 to +232psi Process temperature*: -40 to +130°C/ -40 to +266°F Antenna type: PVDF and PTFE Drip-Off DN50/2" antenna 50m/164ft Max. Measuring range: 50m/164ft DC value: ≥1.6 Accuracy: ±3mm/0.12" Process connection: Threads G 1 1/2", NPT 1 1/2", flanges 3"-6" (UNI) Process-contacting materials: PVDF, PTFE, 316L, PP, sealings 	<ul style="list-style-type: none"> Process pressure: -1 to +16bar/ -14.5 to +232psi Process temperature*: -40 bis +450 °C -40 to +842°F Antenna type: PTFE drip-off DN50/2" flush-mounted DN80/3" 125m/410ft Max. Measuring range: 125m/410ft DC value: ≥1.6 Accuracy: ±3mm/0.12" Process connection: Flanges DN 80 to DN 250/3" to 10" (DIN, ASME, JIS) Process-contacting materials: 316L, 1.4435, PTFE (PP, Alu) sealings

* At the process connection

4. Instrument selection within the measuring principle

Installation instructions – radar



Installation

- Not centered [3]
- Not above filling curtain [4]
- Distance to the wall [1]: ~ 1/6 of vessel diameter, at least however 20cm/7.9"

Weather protection cover

- Always recommended for installation outside solar radiation and rain [2]

Connection for purge air or plating

- Connection for purge air:
In case of strong dust generation, clogging of the antenna is avoided. Not possible for FMR66B, FMR67B with optional adapter or integrated

Baffles in vessels

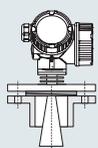
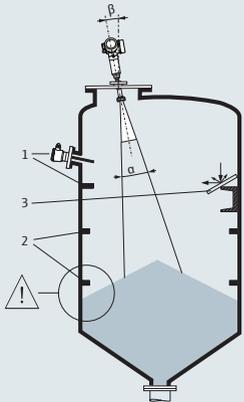
- Make sure that baffles [1] like limit switches, struts, etc. are not within the beam cone (see also the beam angle table in this respect (next page))
- Symmetrically arranged baffles [2], e.g. discharge aids etc. may impair measurements

Optimizing measures

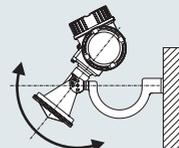
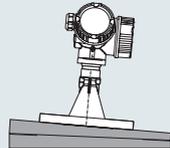
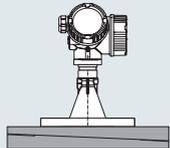
- Size of antenna: The larger the antenna the smaller the beam angle and the lower the interfering echoes
- Interference echo suppression: Electronic suppression of interfering echoes optimizes the measurement
- Inclined installed metallic plates [3] disperse the radar signals and reduce interfering echoes

Alignment

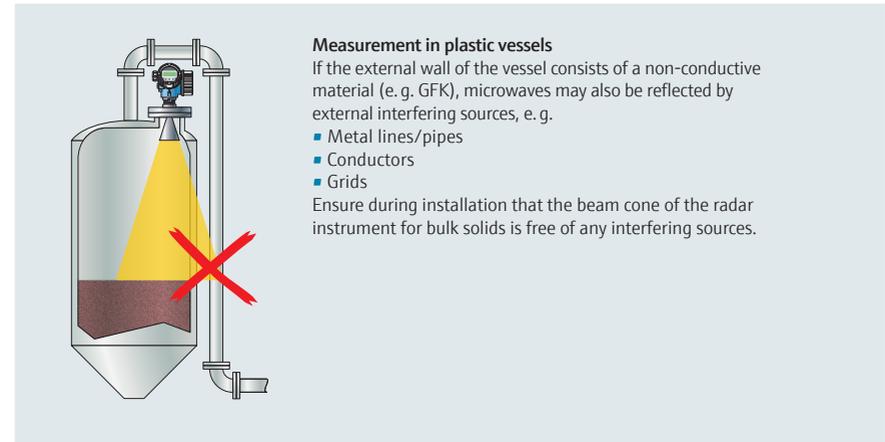
- Serves the avoidance of interfering reflection and improved measurement since the measurement can be aligned to the angle of repose
- An alignment of the instrument is recommended FMR66B, FMR51 with optional alignment seal or assemble bracket FMR67B with optional alignment seal, device or alignment



Variable alignment with optional alignment seal



Assemble bracket



Measurement in plastic vessels

If the external wall of the vessel consists of a non-conductive material (e.g. GFK), microwaves may also be reflected by external interfering sources, e.g.

- Metal lines/pipes
- Conductors
- Grids

Ensure during installation that the beam cone of the radar instrument for bulk solids is free of any interfering sources.

4. Instrument selection within the measuring principle

Guided radar

Required application data

Level measurement

- Measuring range
- Consider ceiling load by max. tensile force at the point of measurement
- Calculation of tensile force by Endress+Hauser
- DC value (DC) of the product
- Pressure and temperature
- Resistance requirements
- Existing nozzle diameter: DN, PN, nozzle height

Application limits for guided level radar

- $T < -40^{\circ}\text{C}/-40^{\circ}\text{F}$ and $T > 150^{\circ}\text{C}/302^{\circ}\text{F}$ (higher temperatures upon request)
- $p > 16\text{bar}/232\text{psi}$
- Measuring range $> 45\text{m}/148\text{ft}$ (longer upon request)
- Dielectric constant < 1.4

Dielectric constant (DC)

The reflection properties of a medium are determined by the dielectric constant (DC).

Media group	DC	Typical bulk solids	Max. measuring range	
			Metallic uninsulated probes	PA-coated rope probes
1*	1.4 to 1.6	<ul style="list-style-type: none"> Plastic powder 	20 to 25m/ 66 to 82ft	—
2	1.6 to 1.9	<ul style="list-style-type: none"> Plastic granulates White lime, special cement Sugar 	25 to 30m/ 82 to 99ft	12 to 15m/ 39 to 49ft
3	1.9 to 2.5	<ul style="list-style-type: none"> Cement, gypsum 	30 to 45m/ 99 to 148ft	—
		<ul style="list-style-type: none"> Flour 	—	15 to 25m/ 49 to 82ft
4	2.5 to 4	<ul style="list-style-type: none"> Cereal, seeds 	—	25 to 30m/ 82 to 99ft
		<ul style="list-style-type: none"> Ground stones Sand 	45m/148ft	25 to 30m/ 82 to 99ft
5	4 to 7	<ul style="list-style-type: none"> Naturally moist (ground) stones, ores Salt 	45m/148ft	35m/110ft
6	> 7	<ul style="list-style-type: none"> Metal powder Carbon black Carbon dust 	45m/148ft	35m/110ft

For very loose or loosened bulk solids, the respectively lower group is applicable.
Reduction of the max. possible measuring range by:

- Extremely loose surface of bulk solids, e.g. bulk solids with a low density in case of pneumatic filling
- Build-up formation, particularly of humid products.

*Media group 1: Take into account restrictions for strongly damping media e.g. ground material, wheat bran, silicic acid

Guided radar

- Unaffected by product surface (e.g. angled surface)
- Unaffected by baffles in the silo
- Additional safety for measurements by EoP** evaluation
- Safe measurements also during filling

Contact

	Levelflex FMP56	Levelflex FMP57
Typical applications	<ul style="list-style-type: none"> Powdery solids Plastic granulates High and narrow silos Reflecting surfaces 	<ul style="list-style-type: none"> Powdery and grained bulk solids Plastic granulates High and narrow silos Reflecting surfaces
Special features	<ul style="list-style-type: none"> Exchangeable probes (rope) Coated rope probes (for cereal, flour) Measurement during filling 	<ul style="list-style-type: none"> Exchangeable probes (rope) Coated rope probes (for cereal, flour) Measurement during filling
Technical data	<ul style="list-style-type: none"> Process pressure: -1 to +16bar/ -14.5 to +232psi Process temperature*: -40 to +120°C/-40 to +248°F Max. Measuring range: rope probe 12m/39ft, rod probe — DC value: 1.4 Accuracy: $< 15\text{m}/49\text{ft}: \pm 2\text{mm}/0.08''$; $> 15\text{m}/49\text{ft}: \pm 10\text{mm}/0.4''$ Process connection: $\frac{3}{4}''$ (G, NPT), adapter flange Process-contacting materials: 304, 1.4301 	<ul style="list-style-type: none"> Process pressure: -1 to +16bar/ -14.5 to +580psi Process temperature*: -40 to +150°C/-40 to +302°F Max. Measuring range: rope probe 45m/148ft, rod probe 4m/13ft DC value: 1.4 Accuracy: $< 15\text{m}/49\text{ft}: \pm 2\text{mm}/0.08''$; $> 15\text{m}/49\text{ft}: \pm 10\text{mm}/0.4''$ Process connection: $1\frac{1}{2}''$ (G, NPT), flange Process-contacting materials: 304, 1.4301

* At the process connection

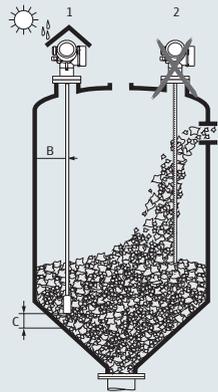
**The patented End-of-Probe (EoP) algorithm enables Levelflex to provide accurate and reliable level measurement in media with a low DC value (flour, cement, lime, PE granulates, PP granulates and various powders) also during pneumatic filling and fluidized discharge

4. Instrument selection within the measuring principle

Installation instructions – guided radar

Probe selection

- Use rope probes for bulk solids in normal circumstances. Rod probes are only suited to short measuring ranges up to approx. 2m/6.5ft in bulk solids. This is particularly true for applications in which the probe is installed laterally and inclined and only for light and free-flowing bulk solids
- In case of large silos, the lateral load on the rope may be so high that a rope with a plastic jacket must be used. We recommend a PA-coated rope for milled products like cereal, wheat and flour

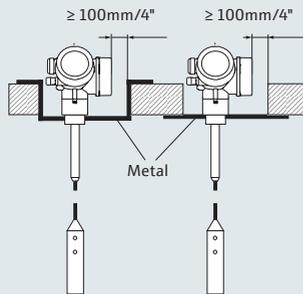


Installation

- Do not install rod and rope probes in the filling curtain [2]
- Install rod and rope probes at a distance to the wall [B], so that in case of build-up on the wall a distance to the probe of at least 100mm/4" remains
- Install rod and rope probes with the largest possible distance to baffles. In case of distances < 300mm/12", an interference echo suppression must be included in commissioning
- When rod and rope probes are installed in plastic vessels, the minimum distance of 300mm/12" is also applicable to metallic parts outside of the vessel
- Rod and rope probes may not contact metal vessel walls or bottoms. The minimum distance of the probe end to the bottom of the vessel is applicable [C]: > 10mm/0.4". For exceptions see the section "Fixation of rope probes"
- Avoid bending the rope probe sharply during installation or operation (e. g. by product movements against the wall of the silo) by the selection of a suitable point of installation

Weather protection cover

- Always recommended for installation outside (solar radiation and rain) [1]



Installation in concrete silos

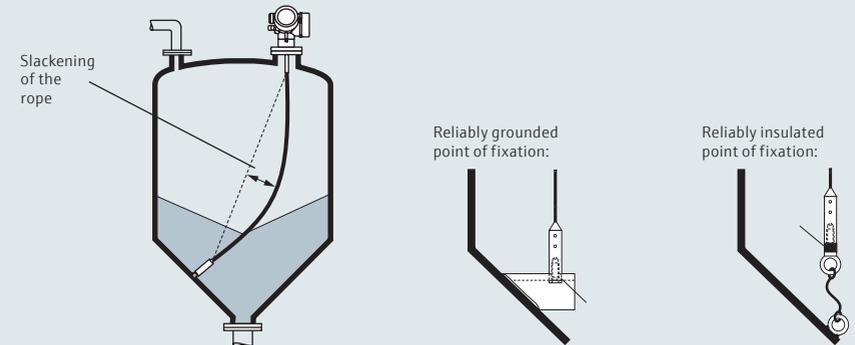
- In concrete silos, the largest possible distance of the probe to the concrete wall - min. 0.5m/19.7" - is to be observed. Optimum $\geq 1\text{m}/39"$
- The installation into a concrete ceiling must be flush with its bottom edge

Expansion of rope probes by tension and temperature

- 6mm/0.23" rope probe
 - Elongation by tension: At max. permissible tensile load (30kN) = 13mm (0.5")/m rope length
 - Elongation by temperature increase from 30°C/86°F to 150°C/302°F = 2mm (0.08")/m (ft) rope length
- 4mm/0.16" rope probe
 - Elongation by tension: At max. permissible tensile load (12kN) = 11mm (0.4")/m rope length
 - Elongation by temperature increase from 30°C/86°F to 150°C/302°F = 2mm (0.08")/m rope length

Fixation of rope probes

- The fixation of the probe end may be required if otherwise the probe contacts the silo wall, the cone, the baffles/struts or other parts at times or if the probe converges closer than 0.5m/19.7" to a concrete wall. The probe weight provides an internal thread for this purpose:
 - 4mm/0.16" rope: M 14
 - 6mm/0.23" rope: M 20
- Please use preferably the 6mm/0.23" rope probe because of its higher tensile-loaded capacity when fixing a rope probe
- The point of fixation must either be reliably grounded or reliably insulated. If a fixation with reliable grounding is not possible, the insulated lug offered as an accessory may be used
- The rope must be loose to avoid extremely high tensile loads and the risk of breakage. Adjust the rope to a length which exceeds the required measuring range so that the rope slackens



Tensile load

- Bulk solids exert tensile forces on rope probes. Their intensity increases with:
 - The length of the probe or max. cover
 - The density of the product
 - The diameter of the silo and
 - The diameter of the probe rope
- The diagrams in the Technical Information TI01004F show typical loads in frequently occurring bulk solids as reference values. The calculations take the following conditions into account:
 - Freely suspended probe (end of probe not fixed)
 - Freely flowing bulk solids (mass flow). The core flow cannot be calculated.
 In case of collapsing product accumulation on walls higher loads may occur
- The tensile force values contain a safety factor of 2 (compensation of the fluctuation range in freely flowing bulk solids)
- Since the tensile forces largely depend on the flow properties of the product, a higher safety factor is required for sluggishly flowing products and if a risk of product accumulation on walls exists. Use rather a 6mm/0.23" rope than 4mm/0.16" in critical cases
- The same forces also act on the ceiling of silos. The tensile forces are larger on fixed ropes, but they cannot be calculated. Please observe the tensile-loaded capacity of the probes or ensure that this capacity is not exceeded
- If the max. tensile load is exceeded, please verify whether a non-contact ultrasonic or level radar instrument should be used for the application

4. Instrument selection within the measuring principle

Ultrasonics

Required application data

- Measuring range
- Product grain size
- Product surface (soft, hard)
- Dust-generating product (strong, low)
- Filling curtain in the measuring range
- Nozzle diameter/nozzle height
- Pressure and temperature

Application limits for ultrasonic level measurement in solids

- Temperature up to $-40^{\circ}\text{C}/-40^{\circ}\text{F}$
- Temperature up to $+150^{\circ}\text{C}/+302^{\circ}\text{F}$ (higher temperatures on request)
- Pressure from $+0.7\text{bar}/+10\text{psi}$ up to $+3\text{bar}/44\text{psi}$ (relative)
- Measuring range up to $45\text{m}/148\text{ft}$ (ideal conditions)
- Process connection from $1\frac{1}{2}''$
- Strong temperature fluctuations in the measuring range can affect the accuracy

Sensor alignment

- Angled surfaces are formed in silos for bulk solids. These cause the ultrasonic signal to be laterally reflected which can lead to a reduced signal intensity

Remedial measures:

- The sensors should be aligned as vertically as possible in relation to the product surface
- This is facilitated by the FAU40 alignment device or the assembly bracket

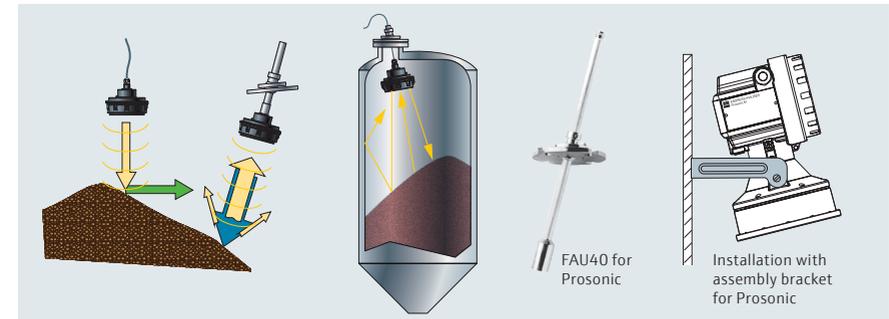
Advantages

- Non-contact, maintenance-free measurement
- Unaffected by product properties, e.g. DC value, density, etc.
- Calibration without filling or discharging
- Self-cleaning effect of sensors due to moved sensor diaphragm
- Separate instrumentation options in rough ambient conditions
- Cost-effective instrumentation for silo farms with FMU95 multichannel system

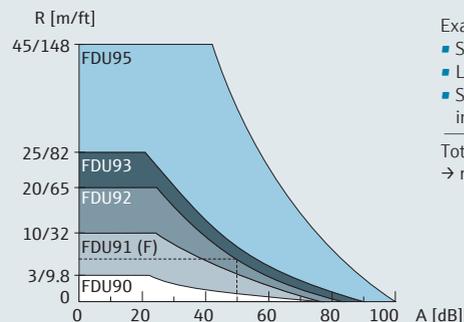
Damping caused by process

Product surface		Filling curtain in the detection range	
Hard, rough (e.g. gravel)	40dB	None	0dB
Soft (e.g. peat, dust-covered clinker)	40 to 60dB	Small quantities	5dB
		Big quantities	5 to 20dB
Dust		Δ -Temp. sensor ↔ product surface	
No dust generation	0dB	Up to $20^{\circ}\text{C}/68^{\circ}\text{F}$	0dB
Low dust generation	5dB	Up to $40^{\circ}\text{C}/104^{\circ}\text{F}$	5 to 10dB
Strong dust generation	5 to 20dB	Up to $80^{\circ}\text{C}/176^{\circ}\text{F}$	10 to 20dB

For different applications, the max. measuring distance can be estimated from the sum of dampings (dB) and the range diagram (see also example below).



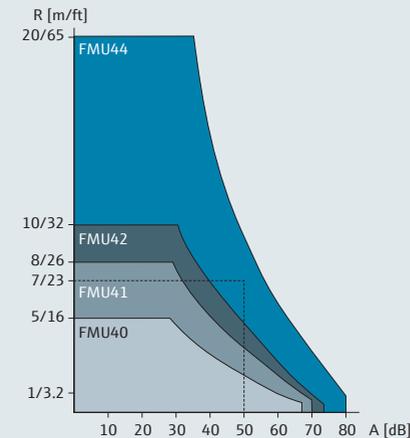
Range calculation and sensor selection Prosonic S FDU9x



Example (for FDU91):

- Silo with rubble: +40dB
 - Low dust generation: +5dB
 - Small quantities of filling curtain in the detection range: +5dB
- Total: +50dB
→ range approx. 5m/16ft from diagram

Range calculation and sensor selection Prosonic M FMU4x



Example (for FMU43):

- Product surface hard, rough: +40dB
 - Low dust generation: +5dB
 - Small quantities of filling curtain in the detection range: +5dB
- Total: +50dB
→ range approx. 7m/23ft from diagram

4. Instrument selection within the measuring principle

✓ Ultrasonics

- Non-contact, maintenance-free measurement
- Unaffected by dielectric constant, density or humidity
- Unaffected by build-up due to the self-cleaning effect of sensors by diaphragm vibration

Prosonic S FMU9x

Typical applications

- Coarse to fine-grained materials in silos, on belts, stockpiles and in crushers
- Rough process conditions (vibration, build-up, corrosion, abrasion)
- Low structural heights

Special features

- Separate instrumentation up to 300m/984ft
- Up to 6 additional point level, alarm outputs
- Automatic recognition of connected sensors
- Up to 10 sensors can be connected → attractive price in silo farms
- 4 to 20mA HART® or PROFIBUS® DP

Technical data	FDU90	FDU91	FDU91F	FDU92	FDU93	FDU95
■ Process pressure from +0.7 to			+4bar/ +58psi		+3bar/ +43.5psi	+1.5bar/ +22psi
■ Process temperature* from -40 to	+80°C/ +176°F	+80°C/ +176°F	+105°C/ +221°F	+95°C/ +203°F	+95°C/ +203°F	+150°C/ +302°F
■ Max. Measuring range	1.2m/ 3.9ft	5m/ 16ft	5m/16ft	10m/ 32ft	15m/ 49ft	45m/ 150ft
■ Blocking distance	0.07m/ 0.23ft	0.3m/ 1ft	0.3m/1ft	0.4m/ 1.3ft	0.6m/ 2ft	0.7m/2.3ft (0.9m//2.9ft**)
■ Accuracy	±2mm/0.08", ±0.2% of measuring distance					
■ Process connection rear side	1"	1"	1", Tri-Clamp, collar flange	1"	1"	1"
■ Process-connection front side	1½"					
■ Process-contacting materials	PVDF	PVDF	316L	PVDF	UP, Alu, PTFE	UP, 316L**, PE
■ Beam angle α	12°	9°	12°	11°	4°	5°

* At the process connection

** High temperature = 150°C/302°F

Prosonic M FMU4x

Typical applications

- Coarse to fine-grained materials in recipient tanks, on belts at feed points
- Measuring range up to 10m/32ft

Special features

- Compact instrumentation (2 or 4-wire)
- Attractive price
- Robust aluminum housing
- 4 to 20mA HART®, PROFIBUS® PA or FF

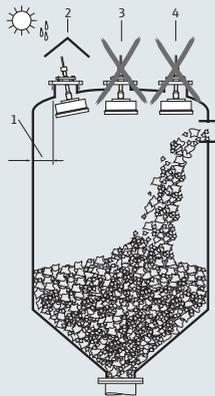
Technical data	FMU40	FMU41	FMU42	FMU44
■ Process pressure	+0.7 to +3bar/ +10 to +43.5psi		+0.7 to +2.5bar/+10 to +36psi	
■ Process temperature*	-40 to +80°C/-40 to +176°F			
■ Max. Measuring range (solid)	2m/6ft	3.5m/11ft	5m/16ft	10m/32ft
■ Blocking distance	0.25m/ 0.8ft	0.35m/ 1.15ft	0.4m/1.3ft	0.5m/1.6ft
■ Accuracy	±2mm/0.08" or ±0.2% of measuring distance***		±4mm/0.15" or ±0.2% of measuring distance***	
■ Process connection	1.5"	2"	DN 80/3"; DN 100/4"; assembly bracket	DN 100/4"; DN 150/6"; DN 200/8" assembly bracket
■ Process-contacting materials	PVDF, EPDM	PVDF, EPDM	PVDF, EPDM or Viton, flange PP, PVDF, 316L	PVDF, EPDM or Viton, flange PP, 316L
■ Beam angle α	11°	11°	9°	11°

* At the process connection

*** The higher value is applicable

4. Instrument selection within the measuring principle

Installation instructions – ultrasonics



Installation

- Not centered [3]
- Not above filling curtain [4]
- Distance to wall: ~ 1/6 of the vessel diameter, at least however 20cm/7.9" [1]
- If 2 or several sensors are used in one vessel, please use separate instrumentation (FMU90/95 + FDU9x)

Weather protection cover

- Always recommended for installation outside (solar radiation and rain) [2]

Nozzle

- The sensor diaphragm should protrude from the nozzle. If this is not possible, please compare the dimensions of the nozzle with the table: Nozzle length (next page)

Measuring range

- Measurement is possible up to the blocking distance (BD) on principle
- The measuring range starts where the ultrasonic lobe meets the bottom of the silo. In dished or torispherical heads or conical outlets, levels below this point cannot be detected

Silo baffles

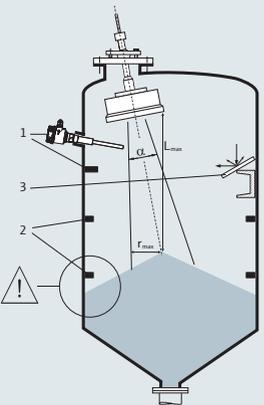
- Make sure that baffles [1] like limit switches, struts, etc. are not within the beam cone (see also the beam angle table in this respect [a])
- Symmetrically arranged baffles [2], e.g. discharge aids etc. may impair measurements

Optimizing measures

- Use a sensor with a smaller beam angle. → The smaller the beam angle the lower the occurrence of interfering echoes
- Interference echo suppression: Electronic suppression of interfering echoes optimizes the measurement
- Plates installed in an inclined manner [3] disperse the signal and can avoid interfering echoes

Alignment

- Serves the avoidance of interfering reflections and improved measurements since the measurement can be aligned to the angled surface (accessory FAU40 or assembly bracket)



	FMU 40	FMU 41	FMU 42	FMU 44	FDU 90	FDU 91	FDU 91F	FDU 92	FDU 93	FDU 95
Beam angle α	11°	11°	9°	11°	12°	9°	12°	11°	4°	5°
L_{max} (m/ft)	2/ 6	3.5/ 11	5/ 16	10/ 32	1.2/ 3.9	5/ 16	5/ 16	10/ 32	15/ 49	45/ 150
r_{max} (m/ft)	0.19/ 0.6	0.34/ 1.1	0.39/ 1.3	1.96/ 6.4	0.13/ 0.4	0.39/ 1.3	0.53/ 1.7	0.96/ 3.1	0.52/ 1.7	1.96/ 6.4
Blocking distance (m/ft)	0.25/ 0.8	0.35/ 1.15	0.4/ 1.3	0.5/ 1.6	0.07/ 0.23	0.3/ 1	0.3/ 1	0.4/ 1.3	0.6/ 2	0.7/2.3 (0.9/ 2.9*)

* High temperature = 150°C/302°F

Nozzle ϕ	Max. nozzle length in mm/inch (L)										
	FMU 40	FMU 41	FMU 42	FMU 44	FDU 90	FDU 91	FDU 91F	FDU 92	FDU 93	FDU 95	FDU 96
DN50/ 2"	80/ 3.15				50 ²⁾ / 1.97 ²⁾						
DN80/ 3"	240/ 9.45	240/ 9.45	250/ 9.84		390 ¹⁾ , 250 ²⁾ / 15.4 ¹⁾ , 9.84 ²⁾	340/ 13.4	250/ 9.84*				
DN100/ 4"	300/ 11.8	300/ 11.8	300/ 11.8		390 ¹⁾ , 300 ²⁾ / 15.4 ¹⁾ , 11.8 ²⁾	390/ 15.4	300/ 11.8*				
DN150/ 6"	400/ 15.8	400/ 15.8	400/ 15.8	400/ 15.8	400 ¹⁾ , 300 ²⁾ / 15.8 ¹⁾ , 11.8 ²⁾	400/ 15.8	300/ 11.8*	400/ 15.8			
DN200/ 8"	400/ 15.8	400/ 15.8	400/ 15.8	400/ 15.8	400 ¹⁾ , 300 ²⁾ / 15.8 ¹⁾ , 11.8 ²⁾	400/ 15.8	300/ 11.8*	400/ 15.8	520/ 20.5		
DN250/ 10"	400/ 15.8	400/ 15.8	400/ 15.8	400/ 15.8	400 ¹⁾ , 300 ²⁾ / 15.8 ¹⁾ , 11.8 ²⁾	400/ 15.8	300/ 11.8*	400/ 15.8	520/ 20.5	630/ 24.8	
DN300/ 12"	400/ 15.8	400/ 15.8	400/ 15.8	400/ 15.8	400 ¹⁾ , 300 ²⁾ / 15.8 ¹⁾ , 11.8 ²⁾	400/ 15.8	300/ 11.8*	400/ 15.8	520/ 20.5	630/ 24.8	800/ 31.5
Beam angle α	11°	11°	9°	11°	12°	9°	12°	11°	4°	5°	6°
Blocking distance (m/ft)	0.25/ 0.8	0.35/ 1.15	0.4/ 1.3	0.5/ 1.6	0.07/ 0.23	0.3/ 1	0.3/ 1	0.4/ 1.3	0.6/ 2	0.7/ 2.3	1.6/ 5.2

* Applicable to flush flange installation, for assembly via G/NPT 1" starting DN100 see FDU91

¹⁾ Mounted at backside thread of the Sensor FDU90

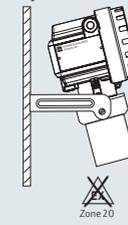
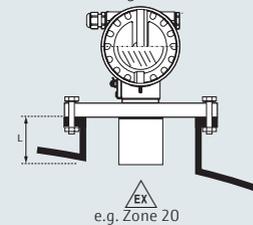
²⁾ Mounted at frontside thread of the Sensor FDU90

Options for installation

Prosonic M FMU4x

Universal flange installation

Assembly bracket installation



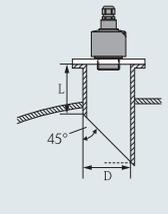
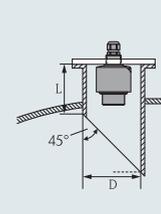
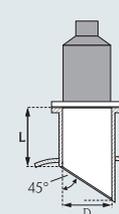
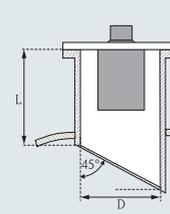
Prosonic S FDU9x

FDU9x

FDU91F

FDU90¹⁾

FDU90²⁾



4. Instrument selection within the measuring principle

Electromechanical level system

Required application data

- Measuring range
- Consider ceiling load by max. tensile force at the point of measurement
- Product grain size
- Pressure and temperature
- Resistance requirements
- Nozzle height

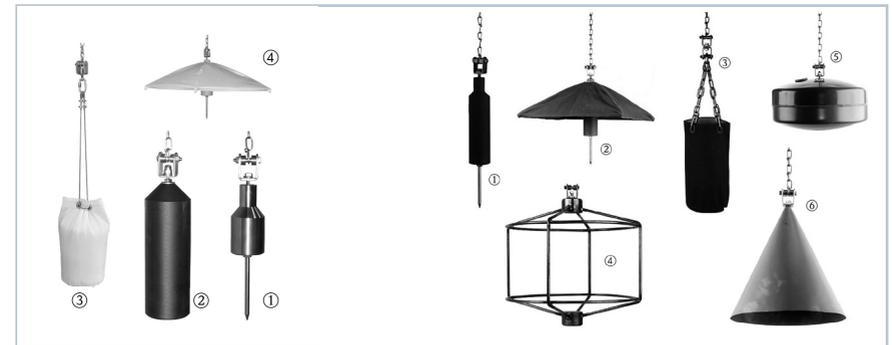
Application limits for the electromechanical level system

- Temperature up to -20°C/-4°F
- Temperature up to +230°C/+446°F
- Pressure up to 3bar/43.5psi
- Measuring range up to 70m/230ft (optional 90m/295ft)
- Tensile force max 500N

Recommendation concerning the selection

The following aspects should be observed in the selection of the sensing weight:

- The sensing weight may neither sink into the product nor slide off the angled surface during the measuring operation
- The sensing weight must be able to withstand the chemical properties of the product and the temperature prevailing in the bunker/silo



Sensing weights FMM20

- 1 Stainless steel sensing weight
- 2 Plastic sensing weight
- 3 Bag weight
- 4 Umbrella weight

Sensing weights FMM50

- 1 Cylindrical sensing weight with spike
- 2 Umbrella weight
- 3 Bag weight
- 4 Cage weight
- 5 Oval float
- 6 Bell weight

Model	Sensing weight	Application	Temperature	Materials	Weight	Ex	Special features
FMM50	Normal weight, cylindrical with removable spike	Coarse bulk solids, e. g. coal, ore or stones and granulates	Complete temperature range	Steel, stainless steel	3.5kg/8lbs	Yes	In case of downstream crusher or mill facility → use "tape breakage" signal function or cage weight
FMM50	Umbrella weight	Very light and loose bulk solids, e. g. flour or carbon dust	Max. 150°C/302°F	Steel or stainless steel with Polyester	3.8kg/8.3lbs, 3.9kg/8.6lbs	Yes	Large square surface → avoids deep immersion into the product
FMM50	Bag weight	Bunkers with mills downstream	Max. 150°C/302°F	Bag made of Polyester, stainless steel	0.25kg/0.5lbs (empty), 3.5kg/8lbs (full)	Yes	Tie the bag so that the content cannot escape
FMM50	Cage weight	Fine-grained bulk solids	Complete temperature range	Steel, stainless steel	3.5kg/8lbs	Yes	Avoids subsequent damage since the weight cannot enter the discharging facility
FMM50	Oval float	Granulates	Max. 60°C/140°F	Rigid PVC	3.5kg/8lbs (full)	Yes	
FMM50	Bell weight	Light and loose bulk solids	Complete temperature range	Stainless steel	4.3kg/9.5lbs	Yes	If the umbrella cannot be used any more in high temperatures or special product properties
FMM20	Normal weight, cylindrical with removable spike	Granulates and compacted bulk solids	Max. 150°C/302°F	Steel, stainless steel	1.5kg/3.3lbs	Yes	In case of downstream crusher or mill facility → use "tape breakage" signal function
FMM20	Normal weight, cylindrical	Granulates and compacted bulk solids	Max. 70°C/158°F	Plastics	1.5kg/3.3lbs	Dust-Ex not permitted	In case of downstream crusher or mill facility → use "tape breakage" signal function
FMM20	Umbrella weight	Very light and loose bulk solids, e. g. flour or carbon dust	Max. 150°C/302°F	Steel or stainless steel with Polyester	1.5kg/3.3lbs	Yes	Large square surface → avoids deep immersion into the product
FMM20	Bag weight	Bunkers with mills downstream	Max. 150°C/302°F	Polyester, stainless steel	0.25kg/0.5lbs (empty), 1.5kg/3.3lbs (full)	Yes	Tie the bag so that the content cannot escape

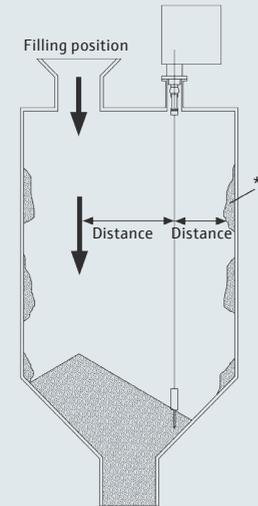
4. Instrument selection within the measuring principle

✓ Electromechanical level system

- Unaffected by product properties
- Light bulk solids
- Unaffected by DC value

	Silopilot FMM50	Silopilot FMM20
Typical applications	<ul style="list-style-type: none"> ■ Bunkers and silos with powdery, fine-grained or coarse-grained bulk solids 	<ul style="list-style-type: none"> ■ Bunkers and silos for light bulk solids, e.g. cereals, plastics granulate, powder
Special features	<ul style="list-style-type: none"> ■ Easy commissioning 	<ul style="list-style-type: none"> ■ Easy commissioning
Technical data	<ul style="list-style-type: none"> ■ Process pressure +0.8 to +3bar/+12 to +43.5psi ■ Process temperature* -20 to +230°C/-4 to +446°F ■ Max. Measuring range 70m/230ft ■ Accuracy ±5cm/±2" or ±1 pulse ■ Tensile force Max. 500N ■ Process connection On counterflange DN100 PN16 ■ Process-contacting material Alu, steel or stainless steel (301 modified, 304, 316, 316Ti), Polyester, PVC ■ Ambient temperature -40 to +70°C/-40 to +158°F ■ Electronics 4 to 20mA / relay ■ Approvals ATEX II 1/2D ■ Ingress protection IP67 	<ul style="list-style-type: none"> ■ Process pressure +0.8 to +1.1bar/+12 to +16psi ■ Process temperature* -20 to +150°C/-4 to +302°F ■ Max. Measuring range 32m/105ft ■ Accuracy ±2.5cm/±1" or. ±1 pulse ■ Tensile force Max. 150N ■ Process connection On counterflange DN100 PN16 ■ Process-contacting material Alu, steel or stainless steel (301 modified, 304, 316, 316Ti) plastic, polyester ■ Ambient temperature -40 to +60°C/-40 to +140°F ■ Electronics 0/4 to 20mA / relay ■ Approvals ATEX II 1/2D ■ Ingress protection IP67

Installation instructions – electromechanical level system



Installation

- Not in the filling curtain or in the area of collapsing product accumulation on walls
- Measuring point as close to the center of the slope as possible
- The sensing weight may neither sink into the product nor slide off the angled surface during the measuring operation
- Max. angle of inclination 2°

Weather protection cover

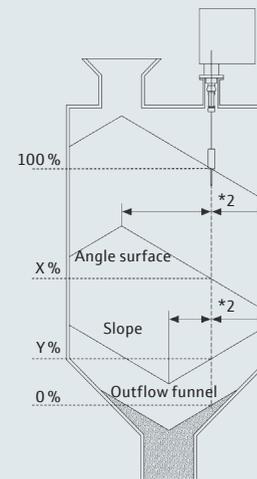
- Always recommended for installation outside (solar radiation and rain)

Compressed air connection

- Already integrated and the penetration of dust can be avoided in case of strong dust generation

Tank baffles

- The measurement section should not pass baffles and struts at too close a distance. The measuring tape must not touch any baffles and struts



*1 Accumulation (product build-up on the wall of the vessel)

*2 Choose a measuring point located approximately in the middle of the slope

* At the process connection



Applicator Selection Software
Product selection guide
www.endress.com/applicator

www.addresses.endress.com

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