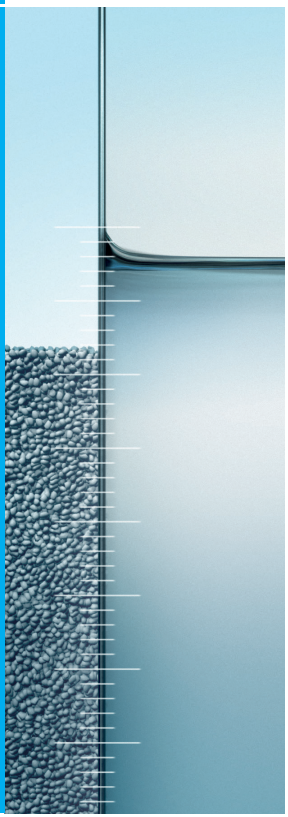
Continuous level measurement in liquids and bulk solids

Selection and engineering guide for the process industry

Level



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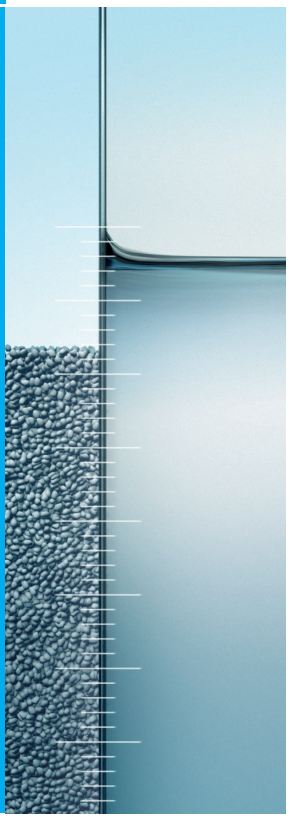
Legend

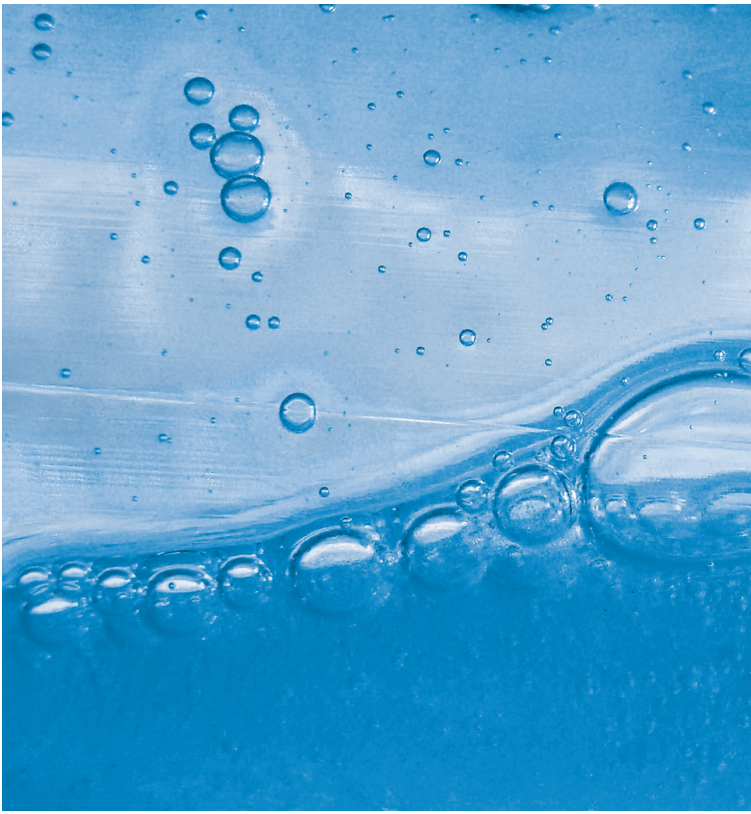
- Continuous level measurement in liquids
  starting page 3

- Continuous level measurement in solids
  starting page 99

Continuous level measurement in liquids

Selection and engineering guide for the process industry





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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 CP00007F).

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 chose 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

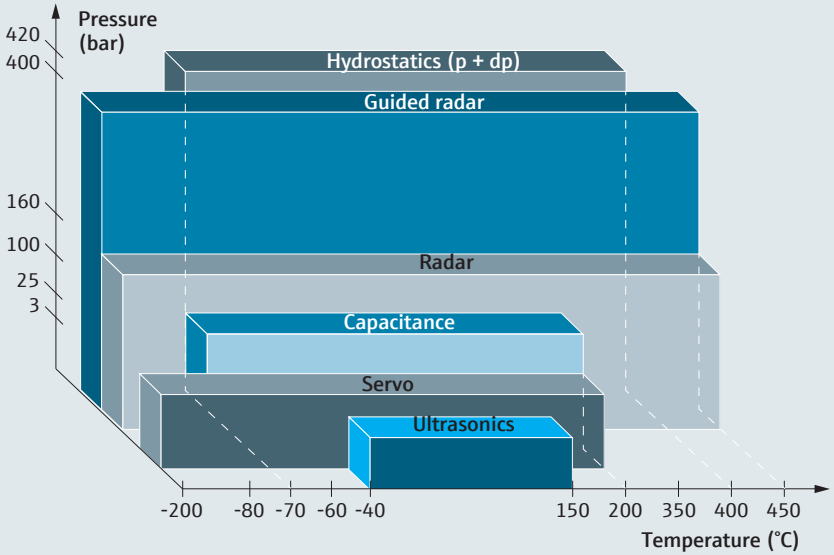
1. Overview of the measuring principles

A

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

Process conditions*



* **Radiometry not depicted**
Non-contact measurement from outside and, therefore, no application limits.

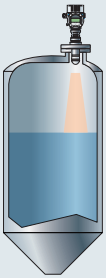
Endress+Hauser offers you a solution adapted to your application and tailored to your process requirements.
You can select the best technology for your application from the wide product range of Endress+Hauser.

„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.

A

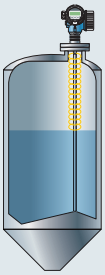
1. Overview of the measuring principles



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, conductibility and humidity. No impairment by vapor pressure.

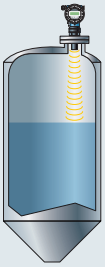
- Process temperatures up to +450°C/+842°F
- Process pressures up to 160bar/2,320psi



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, conductibility and humidity. No impairment by vapor pressure. Measurement of interface and level.

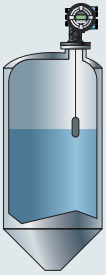
- Process temperatures up to +450°C/+842°F
- Process pressures up to 400bar/5,800psi



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.

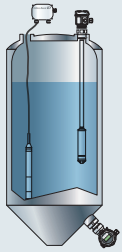
- Process temperatures up to +105°C/+221°F
- Process pressures up to 4bar/58psi



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

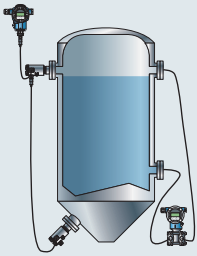
- Process temperatures up to +200°C/+392°F
- Process pressures up to 25bar/362psi



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).

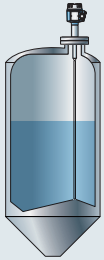
- Process temperatures up to +400°C/+752°F



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.

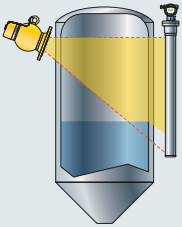
- Process temperatures up to +400°C/+752°F
- Process pressures up to 420bar/6,090psi
- Unaffected by ambient temperatures (Deltabar electronic dp)



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

A

	Radar	Tank Gauging radar	Guided radar	Ultrasonics
				
Process temperature Process pressure	−196 to +450°C/ −321 to +842°F −1 to +160bar/ −14.5 to +2,320psi	−40 to +200°C/ −40 to +392°F -1 to +40bar/ -14.5 to +580psi	−196 to +450°C/ −321 to +842°F −1 to +400bar/ −14.5 to +5,800psi	−40 to +105°C/ −40 to +221°F +0.7 to +4bar/ +10 to +58psi
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
Instrument accuracy	▪ 6GHz: ±6mm ±0.24" ▪ 26GHz: ±2mm ±0.08" ▪ 80GHz: ±1mm/ ±0.04"	▪ 6GHz: ±0.5mm/±0.02" ▪ 26GHz: ±1mm/0.04" ▪ 80GHz: ±0.5mm/ ±0.02"	▪ < 15m: ±2mm < 49ft: ±0.08" ▪ > 15m: ±10mm > 49ft: ±0.4" of distance	▪ ±2 mm/±0.08", ±0,2 % of distance
Function may be affected by	▪ Foam ▪ Extreme turbulent surfaces	▪ Turbulent surfaces ▪ Foam	▪ Extreme build-up formation	▪ Foam ▪ Extreme turbulent, boiling surfaces ▪ Strong build-up or strong condensate at the sensor
Accuracy may be affected by	▪ Interfering reflections/ obstacles in the signal beam	▪ Obstacles ▪ Wall effects ▪ Bad stilling well quality	▪ Interfering reflections by obstacles near the probe (not for coaxial probe)	▪ Higher vapor pressure may change the Time-of-Flight ▪ Temperature layers in the gas phase ▪ Interfering reflections ▪ Fast temperature change
Application limits	▪ DC < 1.2	▪ DC < 1.4 ▪ Measurement up to 0%[2] ▪ Lateral installation or from below	▪ Measurement up to 0%[2] ▪ DC < 1.4 ▪ Agitator applications ▪ Lateral installation or from below ▪ Extreme foam formation	▪ Measurement up to abs. 0%[1] ▪ Vapor pressure ▪ Blocking distance[3] ▪ Lateral installation or from below

[1] E. g. dish bottom, conical outlet

[2] Measurement only up to the probe end

A

	Servo	Capacitance	Radiometrics	Hydrostatics (pressure + differential pressure)
				
	−200 to +200°C/ −329 to +392°F 0 to +25bar/ 0 to +362.5psi	−80 to +200°C/ −112 to +392°F −1 to +100bar/ −14.5 to +1,450psi	Unaffected by temperature and pressure	−70 to +400°C/ −94 to +752°F/ Ambient pressure 420bar/6,090psi (dp)
	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)
	▪ ±4mm/0.02"	▪ ±1% of measuring distance	▪ ±1% of measuring distance	▪ Up to ±0.025% of the set span
	▪ Extreme turbulent surface (use stilling well) ▪ High viscose medium	▪ Plastic tank ▪ Extreme conductive build-up	▪ External radiation (gammagraphy), solution with Gamma Modulator	▪ Turbulent surfaces
	▪ Viscose medium ▪ Build-up	▪ Conductivity < 30µS/cm: changing dielectric constants ▪ Conductive build-up	▪ Extreme pressure fluctuations ▪ Extreme build-up	▪ Density change ▪ Very fast temperature change ▪ Dynamic pressure, e. g. caused by agitator (dp)
	▪ Viscosity > 5000mPa s ▪ Lateral installation or from below	▪ Agitator blade ▪ Changing, non-conductive media or conductivity between 1 to 100µS/cm ▪ DC < 2.0 ▪ Media diffusing through PTPE, e. g. chlorine	▪ Non-contact measurement from outside and, therefore, no application limits ▪ Observe radiation protection regulations	▪ Curing build-up ▪ Strong density fluctuations

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

2. Checklist

A

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

+ = recommended **O = restricted (observe limits)** **– = not recommended**

		Please complete		Notes
Details of medium	Medium			
	Density	g/cm³		
	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

B

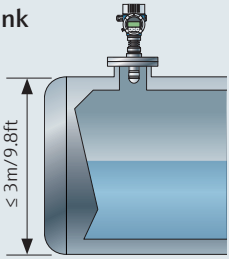
Non-contact

	Our proposal	
	Radar **Micropilot**  FMR60B/FMR62B/FMR63B	**Radar** **Micropilot**  FMR10B/FMR20B/FMR30B
Advantages	▪ Resistant against aggresive 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 ▪ 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
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

Please note:
Radar continued on Page 34

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



Contact

Our proposal

Guided radar Levelflex	Hydrostatics Deltapilot	Capacitance Liquicap
FMP5x (coax) 	FMB5x 	FMI5x 
▪ Unaffected by changing media ▪ No impairment by the installations of ▪ Tank baffles ▪ Nozzle dimensions ▪ Double reflection ▪ Coaxial probe ▪ Heartbeat Technology	▪ Unaffected by foam ▪ Unaffected by installation situation ▪ Unaffected by DC value	▪ Ground tube probe ▪ Unaffected by nozzle dimensions and tank obstacles ▪ Calibration not required in conductive liquids ▪ No blocking distance
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®, PA, FF) ±0.1% (typ. 3 to 10mm/0.12" to 0.4") −10 to +80°C/+14 to +176°F Ambient pressure Threads, flanges (DIN, ANSI, JIS), hygienic connections Typically up to 100m/328ft (10bar/145psi)	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)
▪ Strong build-up formation (e. g. high viscosity, crystallizing media, etc.) → radar, ultrasonics ▪ Low DC value (< 1.4) → hydrostatics	▪ Density change → guided radar, radar, ultrasonics ▪ Strong build-up formation → radar, ultrasonics	▪ Changing, non-conductive media or conductivity between 1 to 100µS/cm → guided radar, radar, ultrasonics ▪ Strong, conductive build-up formation → radar, ultrasonics

Please note: Guided radar continued on Page 68

Please note: Hydrostatics continued on Page 88

Please note: Capacitance continued on Page 80

3. Selection of the measuring principle according to the application

B

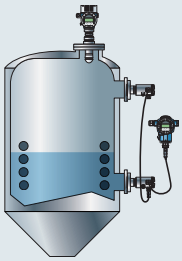
Non-contact

	Our proposal	
	Radar **Micropilot**  FMR60B/FMR62B/FMR63B	**Radar** **Micropilot**  FMR10B/FMR20B/FMR30B
Advantages	▪ Resistant against aggresive 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 ▪ 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
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

Please note:
Radar continued on Page 34

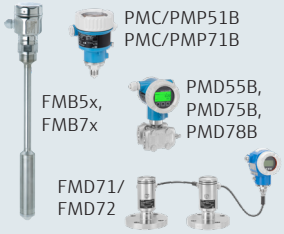
Vertical storage tank

- 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



Contact

Our proposal

Hydrostatics Deltapilot, Cerabar, Deltabar	Guided radar Levelflex	Capacitance Liquicap
		
▪ Unaffected by DC values ▪ Unaffected by tank baffles ▪ Unaffected by foam ▪ Remote access via *Bluetooth*® ▪ Heartbeat Technology	▪ Unaffected by nozzle dimensions and tank obstacles ▪ Heartbeat Technology	▪ Unaffected by nozzle dimensions and tank obstacles ▪ Calibration not required in conductive liquids ▪ No blocking distance
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	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 → guided radar, radar, ultrasonics ▪ Strong build-up formation → radar, ultrasonics	▪ Strong build-up formation (e. g. high viscosity, crystallizing media, etc.) → radar, ultrasonics ▪ Low DC value (< 1.4) → hydrostatics	▪ Changing, non-conductive media or conductivity between 1 to 100µS/cm → guided radar, radar, ultrasonics ▪ Strong, conductive build-up formation → radar, ultrasonics

Please note: Hydrostatics continued on Page 88

Please note: Guided radar continued on Page 68

Please note: Capacitance continued on Page 80

3. Selection of the measuring principle according to the application

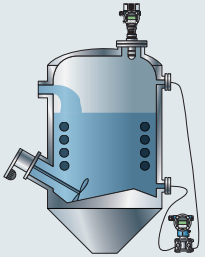
Non-contact

	Our proposal **Radar** **Micropilot**	**Radar** **Micropilot**	**Radar** **Micropilot**
	 FMR60B/FMR62B/FMR63B	 FMR20B/FMR30B	 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	

Please note:
Radar continued on Page 34

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)



Contact

Hydrostatics Cerabar, Deltabar	Guided radar Levelflex	Capacitance Liquicap
FMD71/FMD72 (electronic dp)  PMD55B, PMD75B, PMD78B	 FMP5x	 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 Threads, flanges (DIN, ANSI, JIS), hygienic connections Typically up to 100m/328ft	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 → guided radar, radar, ultrasonics ▪ Strong build-up formation → radar, ultrasonics, bubble system	▪ Strong lateral load → radar, ultrasonics, hydrostatics ▪ Strong build-up formation → radar, ultrasonics	▪ Changing media → guided radar, radar, ultrasonics ▪ Strong, conductive build-up formation → radar, ultrasonics ▪ Strong lateral load → radar, ultrasonics, hydrostatics

Please note: Hydrostatics continued on Page 88

Please note: Guided radar continued on Page 68

Please note: Capacitance continued on Page 80

3. Selection of the measuring principle according to the application

Non-contact

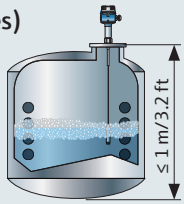
	Our proposal		
	Radar **Micropilot**  FMR43		
Advantages	▪ Compact and hygienic design ▪ Heartbeat Technology ▪ Remote access via *Bluetooth*® ▪ LED indicator / color touch display for fast status detection		
Technical data ▪ Connection ▪ Accuracy ▪ Process temperature ▪ Process pressure ▪ Process connection ▪ 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	

Please note: Radar continued on Page 34

B

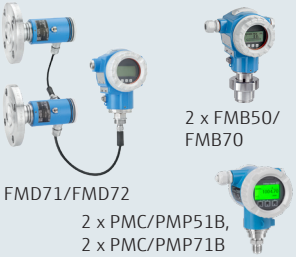
Recipient tank (e. g. bottling facilities)

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



Contact

Our proposal

Capacitance Liquicap		Guided radar Levelflex		Hydrostatics Deltapilot, Deltabar, Cerabar
 FMI5x		 FMP5x		 2 x FMB50/ FMB70 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		▪ Electronic dp ▪ Unaffected by foam ▪ Unaffected by installation situation ▪ Unaffected by DC value ▪ Fast response times ▪ Unaffected by ambient temperatures
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)		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®, 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
▪ 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	▪ Density change ▪ Electronic dp-ratio head pressure to level max. 6:1	→ capacitance → capacitance, guided radar

→ Please note: Capacitance continued on Page 80

→ Please note: Guided radar continued on Page 68

→ Please note: Hydrostatics continued on Page 88

B

3. Selection of the measuring principle according to the application

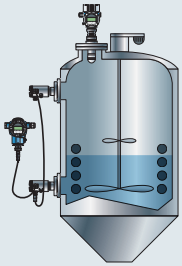
Non-contact

	Our proposal			
	Radar **Micropilot**  FMR62B FMR60B FMR63B		**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*®		▪ 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®, 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®, 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 ▪ Low DC value (< 1.2) ▪ Extreme turbulences	→ hydrostatics	▪ Strong formation of foam ▪ Many obstacles in the radar beam ▪ Low DC value (< 1.2)	→ guided radar, hydrostatics → guided radar, capacitance, hydrostatics → hydrostatics

Please note:
Radar continued on Page 34

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



Contact

Our proposal

Hydrostatics
Deltabar

FMD71/FMD72
(electronic dp)

PMD55B,
PMD75B,
PMD78B

- 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	→ radar, ultrasonics → radar, ultrasonics, bubble system

Please note:
Hydrostatics continued on Page 88

B

3. Selection of the measuring principle according to the application

B

Non-contact

	Our proposal	
	Radar **Micropilot**  FMR62B with 80mm/3" PTFE cladded antenna	**Radar** **Micropilot**  FMR54
Advantages	▪ Unaffected by head pressures ▪ Resistant against aggresive 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 ▪ 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) 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	▪ 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

Please note:
Radar continued on Page 34

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"

Contact

Our proposal

Guided radar Levelflex	Capacitance Liquicap
 FMP5x	 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 → radar, ultrasonics ▪ DC starting at 1.4 → float	▪ Changing, non-conductive media or conductivity between 1 to 100µS/cm → guided radar, radar, ultrasonics

Please note: Guided radar continued on Page 68

Please note: Capacitance continued on Page 80

3. Selection of the measuring principle according to the application

Non-contact

	Our proposal			
	Radar **Micropilot**  FMR62B with 80mm/3" PTFE cladded antenna		**Radar** **Micropilot**  FMR54	
Advantages	▪ Unaffected by head pressures ▪ Resistant against aggresive 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 aggresive 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 ▪ Low DC value (< 1.4) ▪ Bypass > 12 m	→ guided radar, hydrostatics → hydrostatics → FMR54	▪ Strong formation of foam ▪ Many obstacles ▪ Low DC value (< 1.4)	→ guided radar, hydrostatics → guided radar, capacitance, hydrostatics → hydrostatics

Please note:
Radar continued on Page 34

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"

B

Contact

Our proposal

	Guided radar Levelflex	Capacitance Liquicap
	 FMP5x	 FMI5x
	▪ 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
	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)
	▪ 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

Please note:
Guided radar continued on Page 68

Please note:
Capacitance continued on Page 80

3. Selection of the measuring principle according to the application

Non-contact

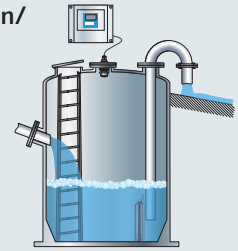
Our proposal

	Ultrasonics Prosonic (separated)		Radar Micropilot	
	 FMU90	 FDU9x	 FMR10B/FMR20B/FMR30B	
Advantages	▪ 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		▪ Non-contact ▪ Small beam angle ▪ Heartbeat Technology ▪ Remote access via *Bluetooth*® ▪ LED indicator / color touch display for fast status detection	
Technical data ▪ Connection	2-/4-wire (HART®, DP)		2-wire (HART®)	
▪ Accuracy ▪ Process temperature ▪ Process pressure ▪ Process connection	±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)		±2mm/±0.08" –40 to +80°C/–40 to +176°F -1 to +3bar/+14.5 to +43psi Threads, flanges (DIN, ANSI, JIS)	
▪ Maximum measuring range	25m/82ft		30m/98ft	
Application limits	▪ Strong formation of foam ▪ Many obstacles	→ hydrostatics	▪ Strong formation of foam ▪ Many obstacles ▪ Low DC value (< 1.8)	→ guided radar, hydrostatics → guided radar, capacitance, hydrostatics → hydrostatics

Please note:
Ultrasonics continued on Page 74

Please note:
Radar continued on Page 34

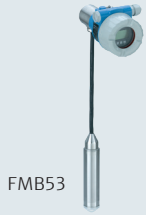
Pump shaft/overfall construction/ rain water basin



- 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

Contact

Our proposal

Hydrostatics Deltapilot/Waterpilot	Capacitance Liquicap
 FMB53  FMX21	 FMI5x
▪ Unaffected by tank baffles, mounting situation and foam ▪ Operation and display possible at easily accessible mounting locations	▪ For small tanks with fast filling and discharging operations ▪ Unaffected by nozzle dimensions and tank obstacles ▪ No blocking distance
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)	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)
▪ Risk of sludge formation/pollution (build-up) → ultrasonics, radar	▪ Changing, non-conductive media or conductivity between 1 to 100µS/cm → guided radar, radar ▪ Strong, conductive build-up formation → radar, hydrostatics

Please note: Hydrostatics continued on Page 88

Please note: Capacitance continued on Page 80

3. Selection of the measuring principle according to the application

Non-contact

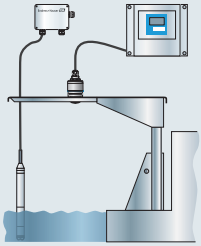
	Our proposal	
	Ultrasonics **Prosonic** (separated)   FMU90 FDU9x	**Radar** **Micropilot**  FMR10B/FMR20B/FMR30B
Advantages	▪ No flow impairment ▪ Overspill-protected, heated sensors with self-cleaning effect ▪ Operation and display at easily accessible mounting locations possible incl. integrated point level relay and preprogrammed flow curves	▪ 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
Technical data ▪ Connection	2-/4-wire (HART®, DP)	2-wire (HART®)
▪ Accuracy ▪ Process temperature ▪ Process pressure ▪ Process connection ▪ Maximum measuring range	±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	±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 ▪ Many obstacles → hydrostatics	▪ Strong formation of foam → hydrostatics

Please note:
Ultrasonics continued on Page 74

Please note:
Radar continued on Page 34

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



Contact

Hydrostatics
Waterpilot/Deltapilot

FMX21 FMB53

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

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)	→ ultrasonics, radar
▪ Restricted installation in flowing water	→ ultrasonics, radar

Please note:
Hydrostatics continued on Page 88

B

3. Selection of the measuring principle according to the application

B

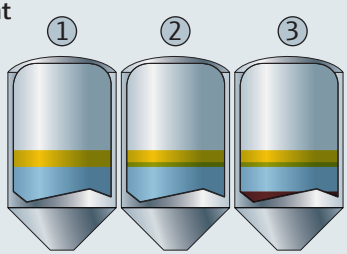
Contact

	① Guided radar Levelflex	① ② Multiparameter Levelflex
	 FMP51/52/54	 FMP55
Advantages	▪ 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)	▪ 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
Technical data ▪ Connection ▪ Accuracy ▪ Process temperature ▪ Process pressure ▪ Process connection ▪ Maximum measuring range	 2-wire (HART®/PA), 4-wire ±2mm/±0.08" (overall level); ±10mm/±0.39" (interface level) −196 to +450°C/−321 to +842°F −1 to +400bar/−14.5 to +5,800psi Threads, flanges (DIN, ANSI, JIS), hygiene connections 6m/20ft (coax), 10m/33ft (rope/rod), longer upon request	 2-wire (HART®/PA), 4-wire ±2mm/±0.08" (overall level); ±10mm/±0.39" (interface level) −50 to +200°C/−58 to +392°F −1 to +40bar/−14.5 to +580psi Threads, flanges (DIN, ANSI, JIS), hygiene connections 6m/20ft (coax), 10m/33ft (rope), 4m/13ft (rod), longer upon request
Application limits	▪ 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	▪ 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"

Please note:
Guided radar continued on Page 68

Interface measurement

① Interface liquid/liquid
② With emulsion layer
③ Multiphase measurement
◯ Recommendation



Non-contact

① ②

Capacitance
Liquicap

FMI51/52

- 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

2-wire (HART®)
±1%

−80 to +200°C/−112 to +392°F
−1 to +100bar/−14.5 to +1,450psi
Threads, flanges (DIN, ANSI, JIS), hygiene connections
4m/13ft (rod), 10m/32ft (rope)

- 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

① ② ③

Radiometrics
Gammapilot

FMG50

- 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

2-wire (HART®)
±1% of measuring distance

Independent (non-invasive)
Independent (non-invasive)
Independent (non-invasive)

Adaptable to application

- 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

Please note:
Capacitance continued on Page 80

B

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°C/−321°F
- Temperature up to +450°C/+842°F
- Pressure up to 160bar/2320psi
- Measuring range up to 80m/262ft
- Dielectric constant from 1,2
- Process connection from ¾“

Advantages
- Non-contact, maintenance-free measurement
- Unaffected by medium properties like density and conductivity
- For high temperatures up to +450°C/+842°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
A0	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 (NH_3) 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

	Micropilot FMR10B 80GHz		Micropilot FMR20B, FMR30B 80GHz	
			 	
Technical data				
▪ Process pressure	−1 to +3bar/−14.5 to +43.5psi		−1 to +3bar/−14.5 to +43.5psi	
▪ Process temperature	−40 to +60°C/−40 to +140°F		−40 to +80°C/−40 to +176°F	
▪ Accuracy	±5mm/±0.2"		±2mm/±0.08"	
▪ Process connection	G 1", NPT 1", G 1½", NPT 1½"		G 1", NPT 1", G 1½", NPT 1½", DN 50 to DN 150/2" to 6"	
▪ Wetted parts	PVDF		PVDF	
▪ Measuring ranges	10m/33ft		30m/98ft	
▪ Gastight feedthrough	–		–	
▪ Technical Information	TI01805F		TI01796F/TI01806F	
Applications				
Horizontal storage tank cyl.	O		+	
Vertical storage tank	+		+	
Buffer tank	–		+	
Recipient tank	–		–	
Process tank	–		O	
Stilling well	–		–	
Bypass	–		–	
Pump shaft	O		+	
Channel measurement	O		+	
Application limits	▪ Low DC value (< 1.8)	→ FMR6xB	▪ Low DC value (< 1.8)	→ FMR6xB
	▪ Turbulent surfaces	→ FMR6xB	▪ Turbulent surfaces	→ FMR6xB
	▪ Ammoniacal gas phase	→ FMR54 in stilling well	▪ Ammoniacal gas phase	→ FMR54 in stilling well
	▪ Strong build-up formation	→ FMR67B with air purge	▪ Strong build-up formation	→ FMR67B with air purge
	▪ Only PTFE resistant	→ FMR62B	▪ Only PTFE resistant	→ FMR62B
	▪ Custody transfer measurement	→ NMR8x	▪ Custody transfer measurement	→ NMR8x

+ = recommended O = restricted (observe limits) – = not recommended

C

	Micropilot FMR43 80GHz/180GHz		**Micropilot FMR51 26GHz**		**Micropilot FMR52 26GHz**	
						
	−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 15m/49ft – TI01728F/TI01729F		−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" 316L/1.4435, Alloy C, PTFE, sealings 40m/131ft Optional TI01040F		−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 PTFE-cladded 40m/131ft Optional TI01040F	
	+		+		+	
	+		+		+	
	+		+		+	
	+		–		–	
	O		+		+	
	–		+		+	
	–		O		+	
	+		+		+	
	+		O		O	
	▪ Ammoniacal gas phase ▪ Strong build-up formation ▪ Custody transfer measurement	→ FMR54 in stilling well → FMR67B with air purge → NMR8x	▪ Ammoniacal gas phase ▪ Strong build-up formation ▪ Hygiene requirements ▪ Custody transfer measurement	→ FMR54 in stilling well → FMR67B with air purge → FMR63B → NMR8x	▪ Ammoniacal gas phase ▪ Strong build-up formation rate ▪ Small connections with low DC ▪ Low DC and high nozzle ▪ Custody transfer measurement	→ FMR54 in stilling well → FMR67B with air purge → FMR62B → FMR62B → NMR8x

C

4. Instrument selection within the measuring principle

Radar

	Micropilot FMR54 6GHz		Micropilot FMR60B 80GHz	
				
Technical data				
▪ Process pressure	−1 to +160bar/−14.5 to +2320psi		−1 bis +20bar/-14.5 to +290psi	
▪ Process temperature	−196 to +400°C/−321 to +752°F		−40 bis +200°C/-40 to +392°F	
▪ Accuracy	±6mm/0.24"		±1mm/0.04"	
▪ Process connection	DN 80 to DN 250/3" to 10"		G and NPT ¾" and 1-½", UNI flange 3" to 6"	
▪ Wetted parts	316L/1.4435, Alloy C, PTFE, ceramics, graphite, sealings		PVDF, PTFE or PEEK, sealings	
▪ Measuring ranges	20m/65ft		50m/164ft	
▪ Gastight feedthrough	Standard		Optional	
▪ Technical Information	TI01041F		TI01683F	
Applications				
Horizontal storage tank cyl.	–		+	
Vertical storage tank	O		+	
Buffer tank	O		+	
Recipient tank	–		0	
Process tank	+		+	
Stilling well	+		–	
Bypass	O		–	
Pump shaft	–		0	
Channel measurement	–		0	
Application limits	▪ Free space with nozzle < DN 150/6"	→ FMR51, 52, 60B, 62B → FMR51, 52	▪ Bypass/stilling well ▪ High pressure/ high temperature	→ FMR62B → FMR62B high temperature
	▪ Stilling well with ball valve	→ FMR63B		
	▪ Hygiene requirements			

+ = recommended O = restricted (observe limits) – = not recommended

C

	Micropilot FMR62B 80GHz	Micropilot FMR63B 80GHz
		
	−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" PTFE, 316L, sealings 80m/262ft Optional TI01684F	−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 PTFE, PEEK, sealings 80m/262ft Optional TI01685F
	+	+
	+	+
	+	+
	+	+
	+	+
	0	–
	0	–
	0	–
	0	–
	▪ Bypass/ stilling well >12m/39ft → FMR54	

C

4. Instrument selection within the measuring principle

Radar – Tank Gauging

	Micropilot NMR81 80GHz		Micropilot NMR84 6GHz	
				
Technical data				
▪ Process pressure	Vacuum to +16bar/vacuum to +232psi		Vacuum to +25bar/vacuum to +362psi	
▪ Process temperature	−40 to +200°C/−40 to +392°F		−40 to +150°C/−40 to +302°F	
▪ Accuracy	±0.5mm/0.02"		±0.5mm/0.02"	
▪ Process connection	DN 80 to DN 250/3" to 10"		DN 100 to DN 300/4" to 12"	
▪ Wetted parts	316L, PTFE		316L, PTFE	
▪ Measuring ranges	70m/230ft		40m/131ft	
▪ Gastight feedthrough	Standard		Standard	
▪ Technical Information	TI01252G		TI01253G	
Applications				
Horizontal storage tank cyl.	–		–	
Vertical storage tank	+		+	
Buffer tank	–		–	
Recipient tank	–		–	
Process tank	–		–	
Stilling well	–		+	
Bypass	–		–	
Pump shaft	–		–	
Channel measurement	–		–	
Application limits	▪ Stilling well ▪ DC <1.9	→ NMR84 → Proservo NMS8x	▪ Free space ▪ DC <1.4 ▪ Existing stilling wells with non-ideal measuring conditions	→ NMR81 → Proservo NMS8x → Proservo NMS8x

+ = recommended O = restricted (observe limits) – = not recommended

C

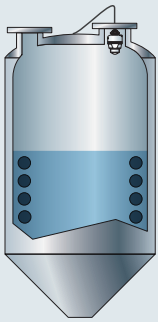
Notes

4. Instrument selection within the measuring principle

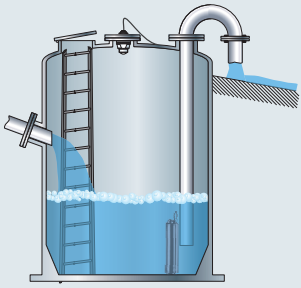
Measuring range in dependence on the type of tank

Process conditions and medium for Micropilot FMR10B/FMR20B/FMR30B

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



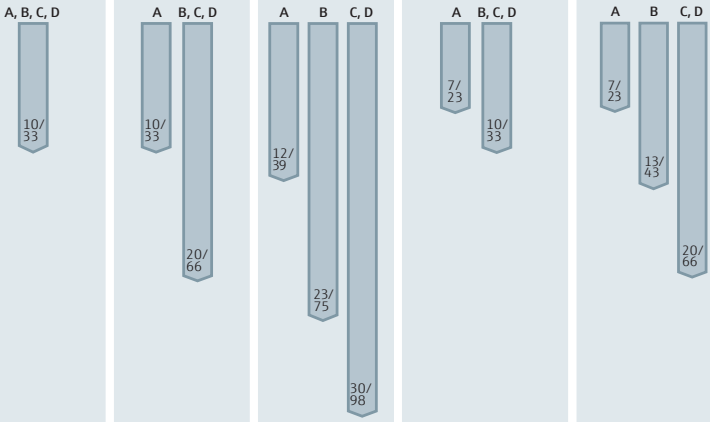
Pump shaft
Agitated surface
(e. g. permanent free filling from above)



	Antenna diameter				
FMR10B	40mm/1.5"	–	–	40mm/1.5"	–
FMR20B	–	40mm/1.5"	80mm/3"	–	40mm/1.5"
FMR30B	–	40mm/1.5"	80mm/3"	–	40mm/1.5"
	Measuring range in m/ft				

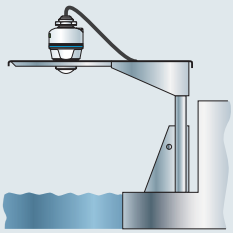
Media group
A:
DC = 1.4 to 1.9
B:
DC = 1.9 to 4
C:
DC = 4 to 10
D:
DC = > 10

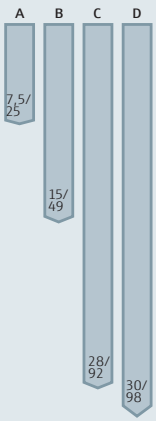
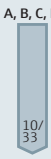
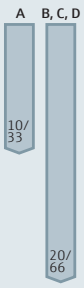
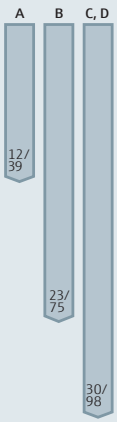
Standard:
Max. measuring range = 30m/98ft



C

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



	–	40mm/1.5"	–	–
	80mm/3"	–	40mm/1.5"	80mm/3"
	80mm/3"	–	40mm/1.5"	80mm/3"
				

C

4. Instrument selection within the measuring principle

Measuring range in dependence on the type of tank

Process conditions and medium for Micropilot FMR43

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

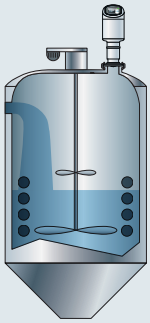
Buffer tank
Moving surface (e. g. continuous filling from above, mixing jets)

	Antenna diameter					
FMR43	Tri-Clamp connec-tions	180 GHz connec-tions	MNPT/G ¾, G 1, M24, 80 GHz	MNPT/G 1½, NEUMO BioControl D50, 80 GHz	MNPT/G ¾, G 1, M24, 80 GHz	Tri-Clamp 1½, Tri-Clamp 2, 80 GHz
	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 15/49	A, B, C, D 10/33	A: 2.5/8 B: 5/16 C: 8/26 D: 10/33	A: 6/20 B: 11/36 C, D: 15/49	A: 1.5/5 B: 3/10 C: 6/20 D: 8/26	A: 7/23 B: 13/43 C, D: 15/49

Standard: Max. measuring range = 15m/49ft

C

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



	½ and M24, 180 GHz	MNPT/G 1½, NEUMO BioControl D50	MNPT/G ¾, G 1, M24, 80 GHz	Tri-Clamp 1½, Tri-Clamp 2, 80 GHz	½ and M24, 180 GHz	MNPT/G 1½, NEUMO BioControl D50
	A: 7/23 B, C, D: 10/33	A: 3/10 B: 6/20 C: 13/43 D: 15/49	A: 1/3.3 B: 1.5/5 C: 3/10 D: 5/16	A: 4/13 B: 7/23 C, D: 15/49	A: 4/13 B: 7/23 C, D: 10/33	A: 1.5/5 B: 3/10 C: 7/23 D: 11/36

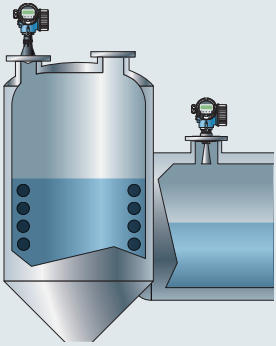
C

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)

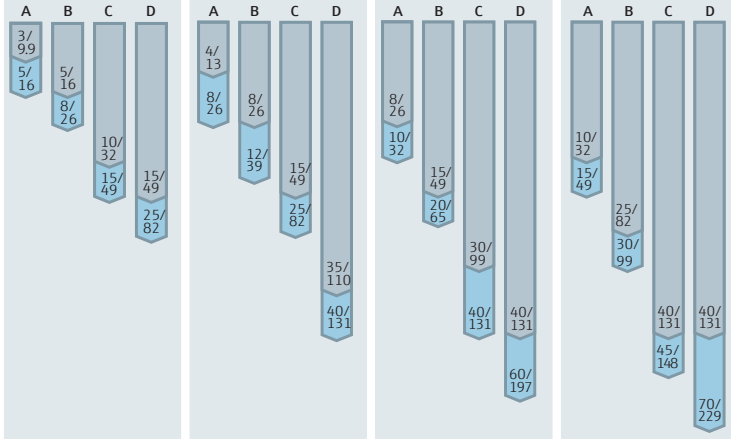


	Horn/antenna diameter			
FMR51	40mm/1.5"	50mm/2"	80mm/3"	100mm/4"
FMR52	–	50mm/2"	80mm/3"	–
	Measuring range in m/ft			

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

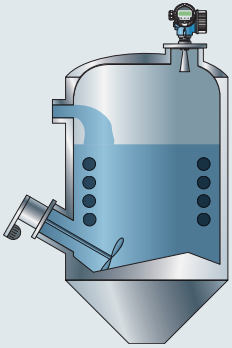
Standard: Max. measuring range = 40m/131ft

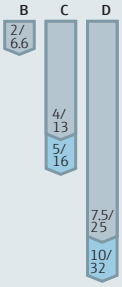
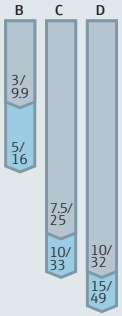
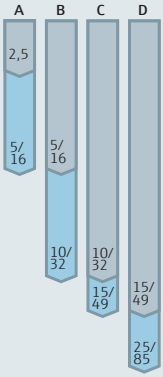
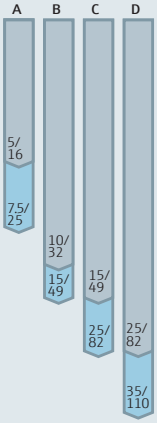
With application package "Advanced dynamics": Max. measuring range = 70m/229ft
Min. measuring range = 5m/16ft



C

Buffer tank / Pump shafts / Open basins
Agitated surface
(e. g. permanent free filling from above, mixing jets, slowly turning mixer, lateral installation)



	40mm/1.5"	50mm/2"	80mm/3"	100mm/4"
	–	50mm/2"	80mm/3"	–
				

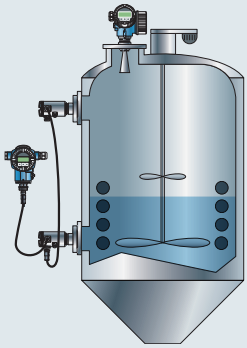
C

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

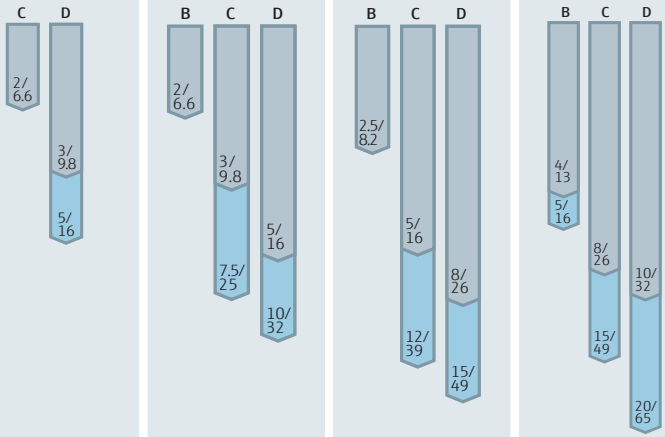


	Horn/antenna diameter			
FMR51	40mm/1.5"	50mm/2"	80mm/3"	100mm/4"
FMR52	–	50mm/2"	80mm/3"	–
	Measuring range in m/ft			

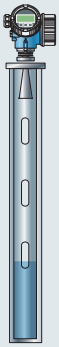
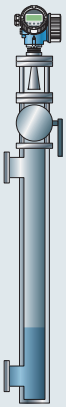
Media group
A: DC = 1.4 to 1.9
B: DC = 1.9 to 4
C: DC = 4 to 10
D: DC = > 10

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

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



C

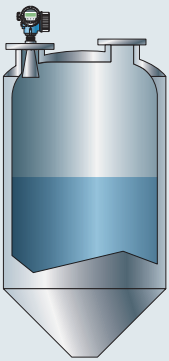
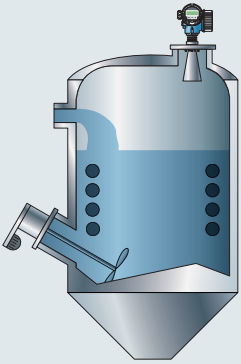
	Stilling well	Bypass
		
	40 to 100mm/1.5 to 4"	40 to 100mm/1.5 to 4"
	50 to 80mm/2 to 3"	50 to 80mm/2 to 3"
	A, B, C, D 	C, D 
		For media groups A and B use Levelflex with coax probe.

C

4. Instrument selection within the measuring principle

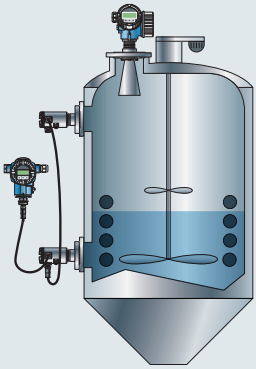
Measuring range in dependence on the type of tank

Process conditions and medium for Micropilot FMR54

	Storage tank[1] Calm surface (e. g. bottom filling, filling via immersion tube or rare free filling from above)		**Buffer tank**[1] Agitated surface (e. g. permanent free filling from above, mixing jets)	
				
	Horn/antenna diameter			
FMR54	150mm/6"	200mm/8" 250mm/10"	150mm/6"	200mm/8" 250mm/10"
	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	B 10/32 C 15/49 D 20/65	B 15/49 C 20/65 D 20/65	B 5/16 C 7.5/25 D 10/32	B 7.5/25 C 10/32 D 12.5/41

[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.

C

	Tank with single-stage propeller agitator[1] Turbulent surface, single-stage agitator < 60 RPM		**Stilling well**		**Bypass**
					
	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]
	B 4/ 13; C 6/ 20; D 8/ 26	B 6/ 20; C 8/ 26; D 10/ 32	A, B, C, D 20/ 65	A, B, C, D 20/ 65	C, D 20/ 65

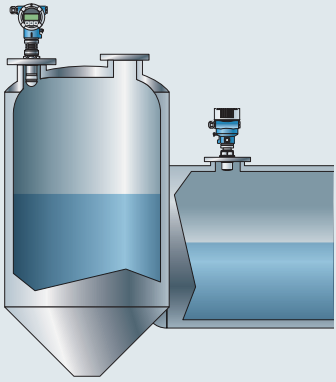
C

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)

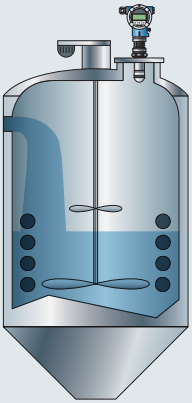


Buffer tank
Moving surface
(e. g. continuous filling from above, mixing jets)

	Antenna diameter				
FMR60B		Integrated, PEEK, 40mm/1.5in	Encapsulated, PVDF, 40mm/1.5in	Drip-off, PTFE, 50mm/2in	Integrated, PEEK, 40mm/1.5in
	Measuring range in m/ft				
Media group (DC) **A0:** 1.2 to 1.4 **A:** 1.4 to 1.9 **B:** 1.9 to 4 **C:** 4 to 10 **D:** > 10	A0 1.5/5; A 2.5/8; B 5/16; C 8/26; D 10/33	A0 3/10; A 6/20; B 11/36; C 15/49; D 22/72	A0 7/23; A 15/49; B 30/98; C 40/131; D 40/131	A0 7/23; A 12/39; B 23/75; C 40/131; D 50/164	A0 1.5/5; A 3/10; B 6/20; C 13/43; D 20/66

C

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



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
A0 4/13 A 7.5/25 B 15/49 C 25/82 D 35/115	A0 4/13 A 7/23 B 13/43 C 28/92 D 44/144	A 1/3.3 B 1.5/5 C 3/10 D 5/16	A0 1/3.3 A 1.5/5 B 3/10 C 7/23 D 11/36	A0 2/6.6 A 4/13 B 5/16 C 15/49 D 20/66	A0 2/7 A 4/13 B 7/23 C 15/49 D 25/82

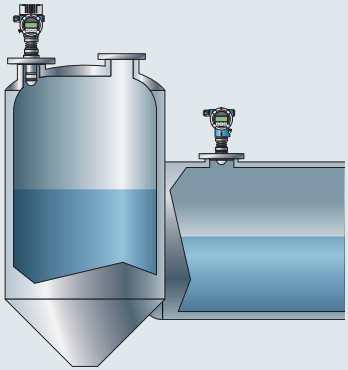
C

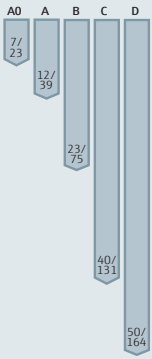
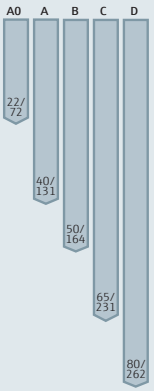
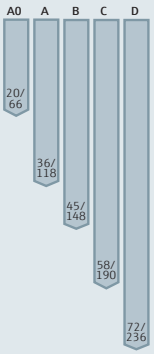
4. Instrument selection within the measuring principle

Measuring range in dependence on the type of tank

Process conditions and medium for Micropilot FMR62B

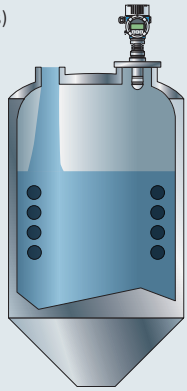
Storage tank
Calm product surface
(e. g. intermittent filling, filling from bottom, immersion tubes)

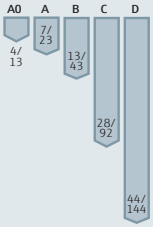
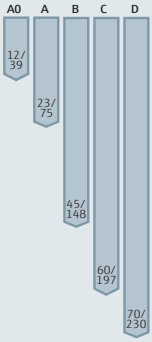
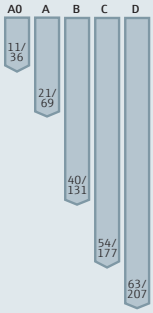


	Antenna diameter			
FMR62B	Drip-off, PTFE, 50mm/2in	PTFE cladded flush mount, 50mm/2in	PTFE cladded flush mount, 80mm/3in	Horn, 316L, 65mm/2.6 in
	Measuring range in m/ft			
Media group **A0:** DC = 1.2 to 1.4 **A:** DC = 1.4 to 1.9 **B:** DC = 1.9 to 4 **C:** DC = 4 to 10 **D:** DC = > 10				

C

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



	Drip-off, PTFE, 50mm/2in	PTFE cladded flush mount, 50mm/2in	PTFE cladded flush mount, 80mm/3in	Horn, 316L, 65mm/2.6in
				

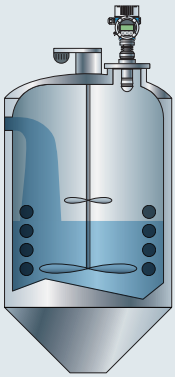
C

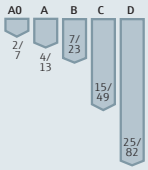
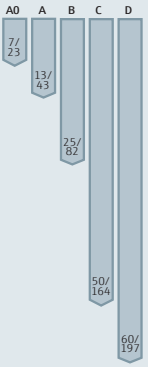
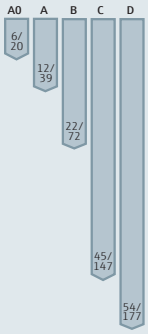
4. Instrument selection within the measuring principle

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)



	Horn/antenna diameter			
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				

C

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)

PTFE cladded flush mount, 80mm/3in

A0, A, B, C, D

15/
49

A0, A, B, C, D

20/
66

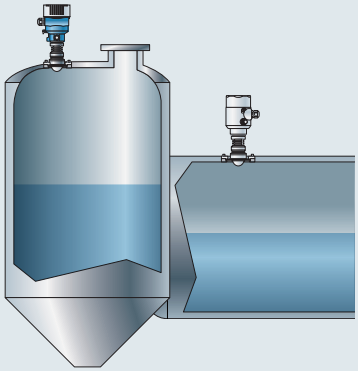
C

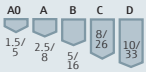
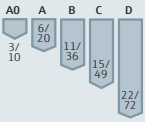
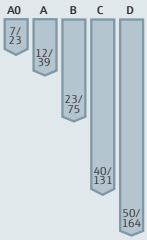
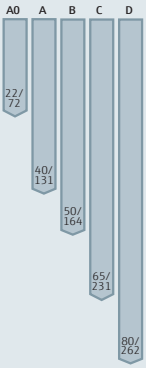
4. Instrument selection within the measuring principle

Measuring range in dependence on the type of tank

Process conditions and medium for Micropilot FMR63B

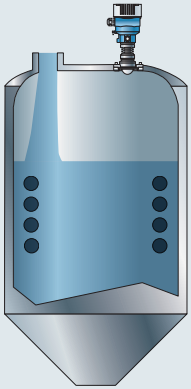
Storage tank
Calm medium surface (e.g. bottom filling, filling via immersion tube or rare filling from above)

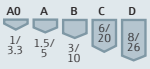
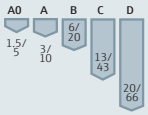
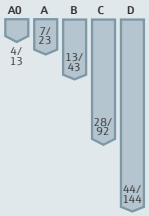
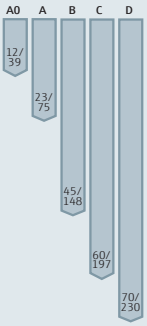


	Antenna				
FMR63B	Integrated, PEEK, 20mm/0.75in	Cladded, PEEK, 20mm/0.75in	Cladded, PEEK, 40mm/1.5in	PTFE cladded flush mount, 50mm/2in	PTFE cladded flush mount, 80mm/3in
	Messbereich in m				
Media group (DC) **A0:** 1.2 to 1.4 **A:** 1.4 to 1.9 **B:** 1.9 to 4 **C:** 4 to 10 **D:** > 10					

C

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



	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
					

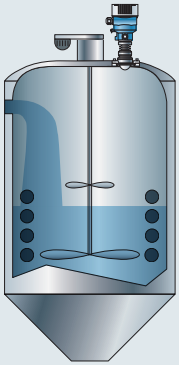
C

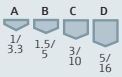
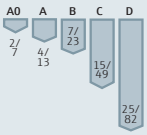
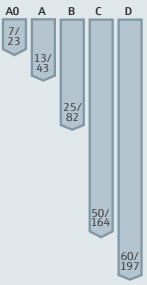
4. Instrument selection within the measuring principle

Measuring range in dependence on the type of tank

Process conditions and medium for Micropilot FMR63B

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



	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
	Measuring range in m/ft				
Media group (DC) **A0:** 1.2 to 1.4 **A:** 1.4 to 1.9 **B:** 1.9 to 4 **C:** 4 to 10 **D:** > 10					

C

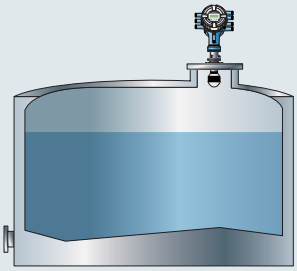
Notes

4. Instrument selection within the measuring principle

Measuring range in dependence on the type of tank

Process conditions and medium for Micropilot NMR81//NMR84

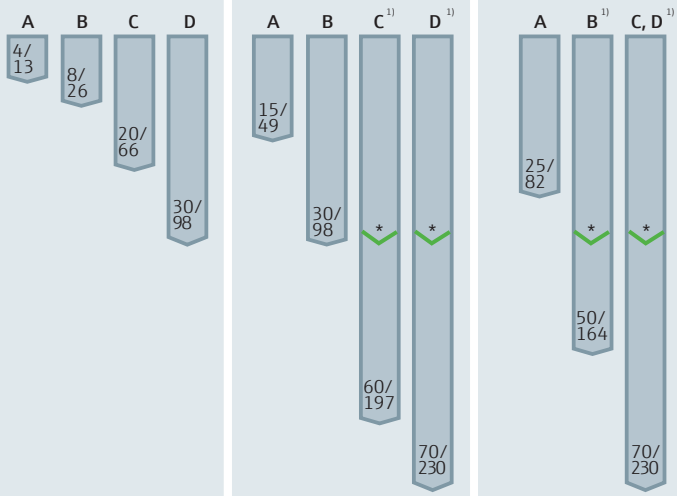
Storage tank
Highly accurate measurement, custody transfer



	Antenna diameter		
NMR81	50mm/2"	80mm/3"	100mm/4"
NMR84			
	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 = 30m/97ft

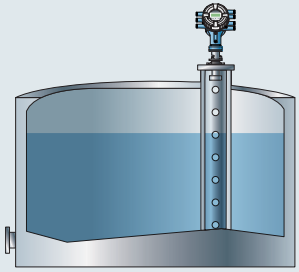


[2] For devices with Weight+Measure approval: Maximum measuring range: 30m (97ft)

* Custody transfer with NMi and PTB 30m/98ft

C

Stilling well
Highly accurate measurement,
custody transfer



100mm/150mm/200mm/250mm/300mm
4"/6"/8"/10"/12"

A, B, C, D

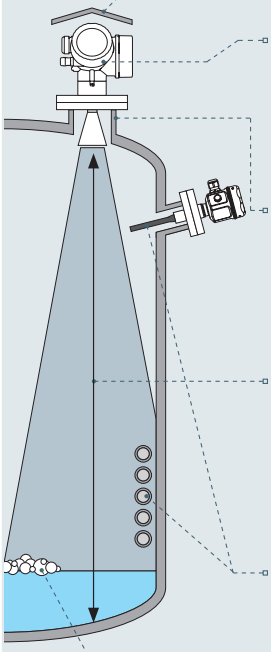
C

* Custody transfer with NMi
35m/115ft

* Custody transfer with PTB
30m/98ft

4. Instrument selection within the measuring principle

Installation instructions radar – 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: ~1/6 of the tank diameter, at least, however, 30cm/12" (6GHz) or 15cm/6" (26GHz/80GHz)

If these conditions cannot be met: Use stilling well
- Lateral installation on request

Nozzle
- FMR51/54 horn antenna should protrude from the nozzle. Please note the max. nozzle length, otherwise use antenna extension
- FMR50/52 note the max. nozzle length
- FMR5x note the max. nozzle length, depending on nozzle diameter and antenna
- The inactive part of the rod antenna should be longer than the height of the nozzle. Please contact our application consultant if this is not possible
- Please note the information in the Technical Documentations

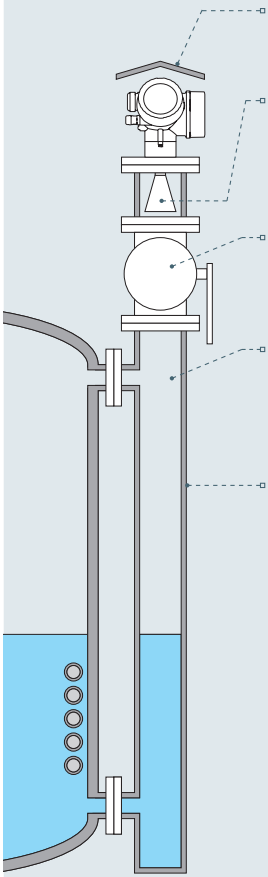
Measuring range
- Measurement is possible up to the tip of the antenna, on principle, however, the end of the measuring range should not be closer than 50mm/2" to the tip of the antenna because of corrosion and build-up formation
- The measuring range starts where the radar beam meets the tank bottom. 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 below)
- Symmetrical installations, e. g. vacuum rings, heating coils, flow breakers, etc. may impair measurement

Optimization options
- Size of antenna: The larger the antenna diameter the smaller the beam angle (see table below, the less interference echoes)
- A stilling well or a Levelflex can always be used to avoid interference

Foam of formation
- Radar pulses may be absorbed by foam
- The surface of foam can reflect. Solution: Trial measurement with Levelflex or hydrostatic measurement

Installation instructions radar – bypass



Weather protection cover
- Always recommended for outside installation to avoid strong temperature changes of electronics

Optimum horn size
- Select horn antenna as large as possible. In case of in-between sizes (e. g. 95mm/3.7") use the next larger antenna and adapt it mechanically

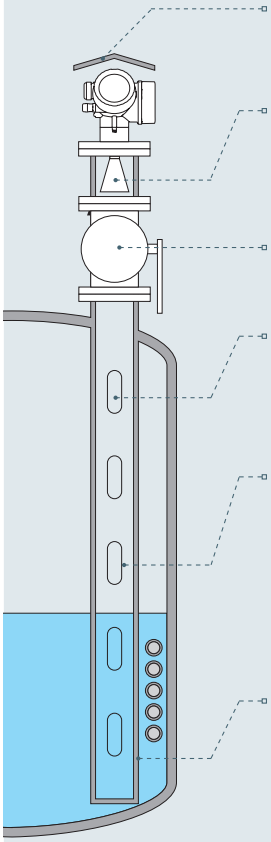
Ball valve
- Measurements through an open ball valve with full passage are possible

Measuring range
- Measurement is possible up to the tip of the antenna, on principle, however, the end of the measuring range should not be closer than 50mm/2" to the tip of the antenna because of corrosion and build-up formation

Recommendations for the bypass
- Metallic (without plastic or enamel coating)
- The bypass pipe must be smooth inside (averaged roughness Ra ≤ 6.3µm)
- Constant diameter
- In transitions, caused for example by ball valves or joining of individual pipe pieces, gaps of max. 1mm/0.04" are permitted

4. Instrument selection within the measuring principle

Installation instructions radar – stilling well



Weather protection cover
- Always recommended for outside installation to avoid strong temperature changes of electronics

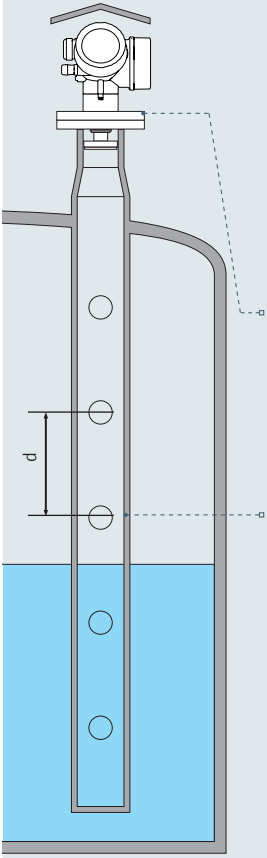
Optimum horn size
- Select horn antenna as large as possible. In case of in-between sizes (e. g. 95mm/3.7") use the next larger antenna and adapt it mechanically (inner diameter of stilling well ≙ diameter of horn)

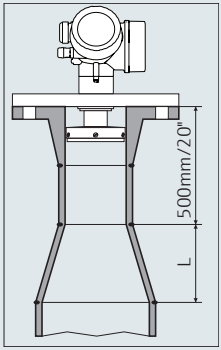
Ball valve (if available)
- Measurements through an open ball valve with full passage are possible

Measuring range
- Measurement is possible up to the tip of the antenna, on principle, however, the end of the measuring range should not be closer than 50mm/2" to the tip of the antenna because of corrosion and build-up formation

Slots/holes
- As few holes/slots as possible
- Slot width or hole diameter max. $^{1}/_{10}$ of pipe diameter
- Deburred
- Length and number do not affect the measurement
- Slots/holes 180° offset (not 90°)

Recommendations for stilling wells
- Metallic (without enamel coating, plastic upon request)
- Constant diameter
- Welding seam as even as possible and placed in the axis of the slots
- The stilling well must be smooth inside (averaged roughness Ra ≤ 6.3µm)
- Do not weld through the wall of the pipe, the inside of the pipe must remain smooth
- In transitions, caused for example by ball valves or joining of individual pipe pieces, gaps of max. 1mm/0.04" are permitted





Instructions for Endress+Hauser UNI flanges in FMR54/NMR84

- Endress+Hauser UNI flanges are designed with a pitch circle diameter compatible with DIN, ANSI and JIS counter flanges
- UNI flanges have been designed for **unpressurized** operation or atmospheric pressure (1bar/14.5psi absolute pressure). The number of flange bolts has been partly reduced

Recommendations for stilling wells

- Metallic (without enamel coating, plastic upon request)
- Constant diameter
- Hole diameter max. $^{1}/_{7}$ of pipe diameter and not bigger than 30mm/1.2"
- Spacing between holes min. 30cm/12"
- For **FMR54/NMR84 (planar antenna)** a gradual widening (DN 150/6" to DN 200/8", DN 200/8" to DN 250/10", DN 250/10" to DN 300/12") can even be accepted. In such cases, the upper pipe end must have a minimum length of 500mm/20" prior to the widening. Length (L) of the widening must be an additional 300mm/12" or for DN 250/10" to DN 300/12" 450mm/18"
- Larger pipe widening (e. g. DN 150/6" to DN 300/12") is possible, if length (L) of the widening amounts to 450mm/18"
- Ideally, a gauge nozzle is used as upper pipe end
- Rectangular pipe widening is not permitted

C

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.

Media group	DC	Typical liquids	FMP50	FMP51
1	1.4 to 1.6	▪ Liquified gases, e. g. N_2, CO_2	4m/13ft	6m/20ft not with rope
2	1.6 to 1.9	▪ Liquified gas, e. g. propane ▪ Solvent ▪ Frigen / Freon ▪ Palm oil	12m/39ft	25 to 30m/ 82 to 98ft
3	1.9 to 2.5	▪ Mineral oils ▪ Fuel	12m/39ft	30 to 45m/ 98 to 148ft
4	2.5 to 4	▪ Benzene, styrene, toluol ▪ Furan ▪ Naphthalene	12m/39ft	45m/148ft
5	4 to 7	▪ Chlorobenzene, chloroform ▪ Nitrocellulose lacquer ▪ Isocyan, aniline	12m/39ft	45m/148ft
6	>7	▪ Aqueous solutions ▪ Alcohols ▪ Acids, lyes	12m/39ft	45m/148ft

C

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)

	Max. measuring ranges			
	FMP52	FMP53	FMP54	FMP55
	–	4m/13ft	6m/20ft not with rope	6m/20ft not with rope
	12 to 15m/ 39 to 49ft	6m/20ft	25 to 30m/ 82 to 98ft	10m/33ft
	15 to 25m/ 49 to 82ft	6m/20ft	30 to 45m/ 98 to 148ft	10m/33ft
	25 to 35m/ 82 to 115ft	6m/20ft	45m/148ft	10m/33ft
	35 to 45m/ 115 to 148ft	6m/20ft	45m/148ft	10m/33ft
	45m/148ft	6m/20ft	45m/148ft	10m/33ft

C

4. Instrument selection within the measuring principle

Guided radar

	 Levelflex FMP50		 Levelflex FMP51		 Levelflex FMP52	
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	
▪ 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	
▪ 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"	
▪ 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"	
▪ Wetted parts	Rope/rod: 316L, PPS		Rope: 316, rod and coax: 316L, Alloy C (C22/2.4602), ceramics		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)	
▪ Gastight feedthrough	–		Optional		Optional	
▪ Technical Information	TI01000F		TI01001F		TI01001F	
Applications						
Horizontal storage tank cyl.	O		+*		O	
Vertical storage tank	+		+		+	
Buffer tank	O		+		+	
Recipient tank	+		O		O	
Process tank	–		–		–	
Stilling well	+		+		O	
Bypass	O		+		O	
Pump shaft	–		–		–	
Channel measurement	–		–		–	
Interface measurement	–		+**		+**	
Application limits	▪ Aggressive media ▪ High pressure/ temperatures >80°C/ 176°F; 6bar/87psi	→ FMP52 → FMP51, FMP54	▪ Aggressive media ▪ Interface with emulsion	→ FMP52 → FMP55	▪ High process temperatures (> 150°C) → Possible diffusion through the probe coating → Limited lifetime ▪ Interface with emulsion	→ FMP54 → FMP55

+ = recommended O = restricted (observe limits) – = not recommended

C

	Levelflex FMP53	Levelflex FMP54	Levelflex FMP55
			
	−1 to +16bar/ −14.5 to +232psi −20 to +150°C/ −4 to +302°F < 15m/49ft: ±2mm/0.08"	−1 to +400bar/ −14.5 to +5,800psi −196 to +450°C/ −321 to +842°F < 15m/49ft: ±2mm/0.08"; > 15m/49ft: ±10mm/0.4", ±5mm/±0.02" (coax)	−1 to +40bar/ −14.5 to +580psi −50 to +200°C/ −58 to +392°F < 10m/33ft: ±2mm/0.08"
	Tri-Clamp, DIN 11851, SMS, DIN 11864, NEUMO 316L/1.4435, PEEK	G/NPT 1½", DN 50 to DN 100/2" to 4" Rope: 316, rod and coax: 316L, ceramics, graphite, Alloy C (C22/2.4602)	DN 50 to DN 150/2" to 6" PTFE, PFA
	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)
	– TI01002F	Standard TI01001F	Standard TI01003F
	0	+*	–
	+	+	+
	+	+	–
	+	–	–
	–	–	–
	–	+	+
	–	+	+
	–	–	–
	–	–	–
	–	+**	+***
	▪ Aggressive media → FMP52	▪ Interface with emulsion → FMP55	

* = use coax probe

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

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

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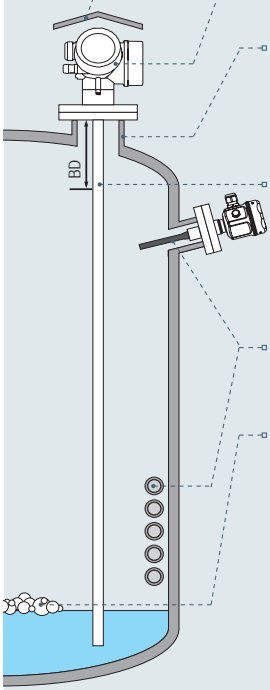
4. Instrument selection within the measuring principle

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 propper centering of the probe in the nozzle, with e.g. HMP40

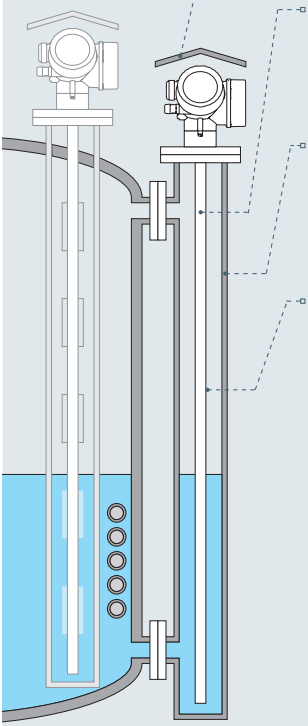
Measuring range
- Smallest measuring range: 300mm/12"
- Largest measuring range: 45m/148ft (longer upon request)
- Minimal distance from tank bottom: > 10mm/0.4"
- Measurement is possible up to the blocking distance (BD), on principle

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

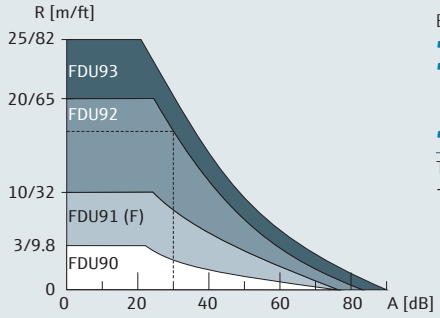
Application limits for ultrasonic level measurement in liquids
- Temperature up to –40°C/–40°F
- Temperature up to 105°C/221°F
- Pressure from +0.7bar/+10psi up to +4bar/58psi
- Measuring range up to 25m/82ft
- Vapor pressure up to 50mbar/0.73psi (20°C/68°F)
- Process connection from 1½"
- Strong temperature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

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

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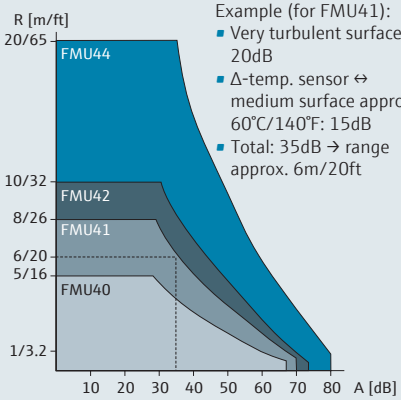
Vapor pressure of the medium (20°C/68°F)
The vapor pressure of the medium at 20°C/68°F is an indication for the accuracy of ultrasonic level measurement. If the vapor pressure at 20°C/68°F is lower than 50mbar/0.73psi, ultrasonic measurement is recommended. If the vapor pressure at 20°C/68°F is above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

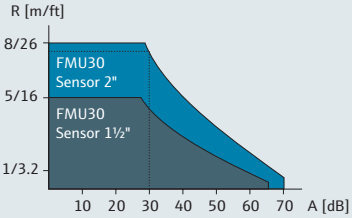
Advantages
- Non-contact, maintenance-free measurement
- Unaffected by product properties, e. g. DC, density, etc.
- Calibration without filling or discharging
- Self-cleaning effect due to vibrating sensor diaphragm

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



Example (for FMU41):
- Very turbulent surface: 20dB
- Δ-temp. sensor ↔ medium surface approx. 60°C/140°F: 15dB
- Total: 35dB → range approx. 6m/20ft



Example (for FMU30 2" sensor):

▪ Strong turbulence surface:	approx. 20dB
▪ No dust formation:	0dB
▪ Filling curtain in detection range:	10dB
Total:	approx. 30dB

→ range approx. 7.8m/26ft from diagram

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4. Instrument selection within the measuring principle

Ultrasonics

	Prosonic FMU30 		Prosonic FMU40/41 		Prosonic FMU42, FMU44 	
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	
▪ Process temperature ▪ Accuracy	−20 to +60°C/−4 to +140°F ±3mm/±0.12" or 0.2% of distance		−40 to +80°C/−40 to +176°F ±2mm/±0.08" or 0.2% of distance		−40 to +80°C/−40 to +176°F ±4mm/±0.16" 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)	
▪ Wetted parts	PP/EPDM		PVDF/EPDM		PVDF/EPDM/Viton	
▪ 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)	
▪ Point level detection	–		–		–	
▪ Technical Information	TI00440F		TI01456F/TI01457F		TI01458F/TI01460F	
Applications	1½"	2"	FMU40	FMU41	FMU42	FMU44
Horizontal storage tank cyl	+	O	+	O	O	–
Vertical storage tank	+	+	+	+	+	+
Buffer tank	–	–	+	O	–	–
Recipient tank	–	–	–	–	–	–
Process tank	O	O	+	+	+	+
Stilling well	O	O	+	+	+	+
Bypass	–	–	–	–	–	–
Pump shaft	O	O	O	O	O	O
Channel measurement	O	O	O	O	O	O
Application limits	▪ 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		▪ For higher resistance → FMU42, FDU9x ▪ Foam/ strong turbulence possible → FMU41, FMU42/ FDU91 ▪ Fast filling and discharging rate → FMU90 + FDU9x ▪ Point level detection → FMU90 + FDU9x		▪ Foam/ strong turbulence possible → FMU44/ FDU92 ▪ Fast filling and discharging rate → FMU90 + FDU9x ▪ Point level detection → FMU90 + FDU9x	

+ = recommended O = restricted (observe limits) – = not recommended

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	Prosonic **FMU90/95, FDU90** 	**Prosonic** **FMU90/95, FDU91** 	**Prosonic** **FMU90/95, FDU91F** 	**Prosonic** **FMU90/95, FDU92** 
	+0.7 to +4bar/ +10 to +58psi −40 to +80°C/−40 to +176°F ±2mm/±0.08" or +0.17% of distance rear side thread 1" G/NPT or ceiling mounting option, front side thread 1½" G/NPT PVDF 0.07 to 3m/0.2 to 9.6ft	+0.7 to +4bar/ +10 to +58psi −40 to +80°C/−40 to +176°F ±2mm/±0.08" or +0.17% of distance G/NPT 1" (accessory flange FAX50) PVDF 0.3 to 10m/1 to 32ft	+0.7 to +4bar/ +10 to +58psi −40 to +105°C/−40 to +221°F ±2mm/±0.08" or +0.17% of distance G/NPT 1" (accessory flange FAX50), Tri-Clamp DN 80 316L 0.3 to 10m/1 to 32ft	+0.7 to +4bar/ +10 to +58psi −40 to +95°C/−40 to +203°F ±2mm/±0.08" or 0.2% of distance G/NPT 1" (accessory flange FAX50) PVDF 0.4 to 20m/1.3 to 65ft
	1, 3 or 6 relays TI00397F/TI00398F/ TI01469F	1, 3 or 6 relays TI00397F/TI00398F/ TI01470F	1, 3 or 6 relays TI00397F/TI00398F/ TI01471F	1, 3 or 6 relays TI00397F/TI00398F/ TI01472F
	+	+	+	O
	+	+	+	+
	+	+	+	–
	–	–	–	–
	+	+	+	+
	+	+	+	+
	–	–	–	–
	+	+	O	+
	+	+	O	+
	▪ Foam/ strong turbulence possible ▪ For tank farm → FDU91 → Scanner FMU95	▪ Foam/ strong turbulence possible ▪ Flange-flush assembly ▪ For tank farm → FDU92 → FDU91F → Scanner FMU95	▪ If foam/ strong turbulence possible ▪ For tank farm → FDU92 → Scanner FMU95	▪ For tank farm → Scanner FMU95

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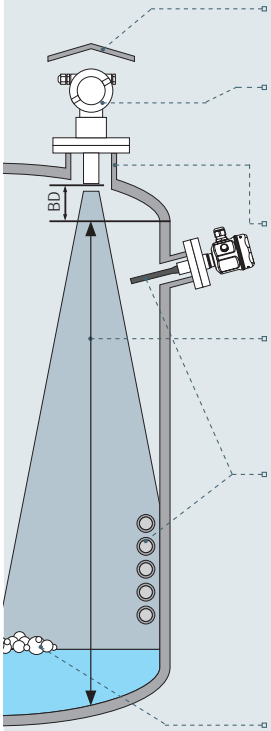
4. Instrument selection within the measuring principle

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: ~$^1/_6$ 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

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)
[1]Mounted at backside thread [2]Mounted at frontside thread

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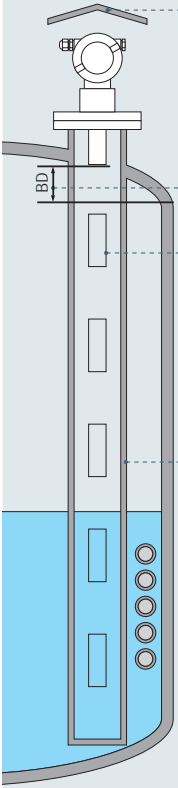


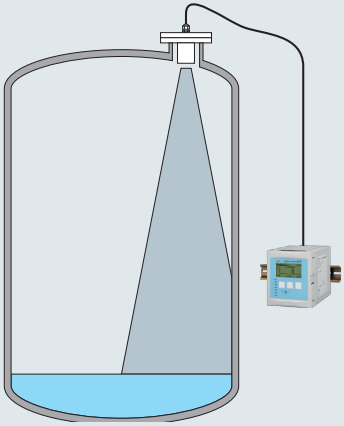
Weather protection cover
- Always recommended for outside installation to avoid strong temperature changes of electronics

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 (> 10mm/0.4") 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 > 80mm/3". Please observe sensor dimensions to choose the right inner diameter

Separate instrumentation with FMU9x



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4. Instrument selection within the measuring principle

Capacitance

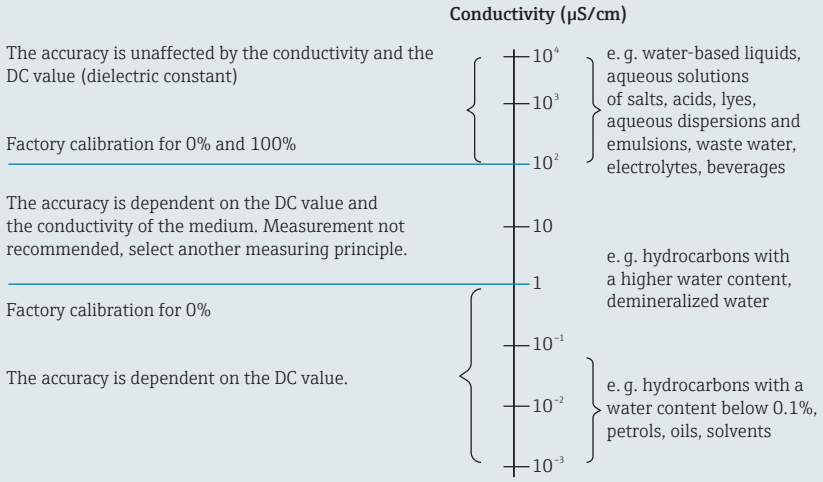
Required application data
- Pressure and temperature
- Conductivity/dielectric constant of the medium (DC)/media group
- Required material compatibility
- Measuring range
- Required accuracy
- Mounting position

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



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Capacitance

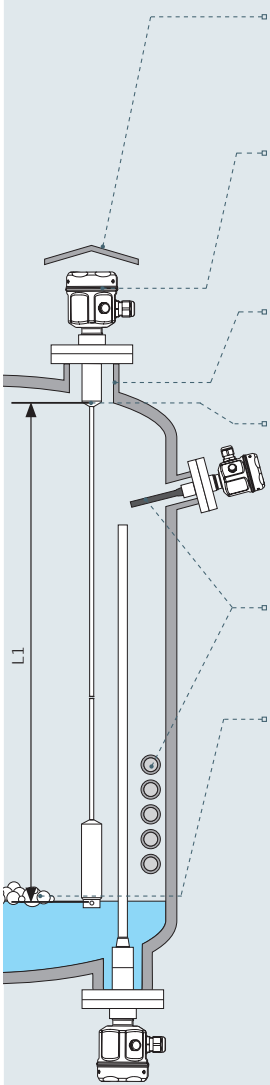
	Liquicap FMI51	Liquicap FMI52	Liquicap FMI21
			
Technical data			
▪ Process pressure	–1 to +100bar/ -14.5 to +1,450psi	–1 to +100bar/ -14.5 to +1,450psi	–1 to +10bar/ -14.5 to +145psi
▪ Process temperature	–80 to +200°C/ –112 to +392°F	–80 to +200°C/ –112 to +392°F	–40 to +100°C/ –40 to +212°F
▪ Accuracy	±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	Optional	–
▪ Technical Information	TI00401F	TI00401F	TI00393F
Applications			
Horizontal storage tank cyl.	+	O	+
Vertical storage tank	+	+	+
Buffer tank	+	–	–
Recipient tank	+	–	–
Process tank	+	–	–
Stilling well	+	O	–
Bypass	+	O	–
Pump shaft	O	O	O
Channel measurement	–	–	–
Interface measurement	+	+	–
Application limits	▪ Insufficient clearance towards ceiling ▪ Changing, non-conductive media or conductivity between 1 to 100µS/cm	▪ Changing, non-conductive media or conductivity between 1 to 100µS/cm	▪ Changing, non-conductive media or conductivity between 1 to 100µS/cm ▪ Highly viscous liquids > 2000cst

+ = recommended O = restricted (observe limits) – = not recommended

C

4. Instrument selection within the measuring principle

Installation instructions capacitance



Weather protection cover
- Always recommended for outside installation to avoid strong temperature changes of electronics

Installation
- Not above the fillstream
- Establish proper ground connection between sensor and tank wall
- Use ground tube in non-conductive tanks (e. g. of plastic material)

Nozzle
- Use inactive length for installation in a nozzle

Measuring range
- Measuring range L1 possible from the tip of the probe to the process connection
- Particularly suited to small tanks in fast filling and discharging operations

Tank installations
- Obstacles do not affect the measurement

Foam of formation
- In slight foam formation, the „Build-up compensation" mode may be selected

C

Notes

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

Technical data
- Process pressure
- Process temperature
- Accuracy
- Process connection
- Wetted parts
- Measuring ranges
- Gastight feedthrough
- Technical Information

Applications

Horizontal storage tank cyl.

Vertical storage tank

Buffer tank

Recipient tank

Process tank

Stilling well

Bypass

Pump shaft

Channel measurement

Application limits

C

	Proservo NMS80		Proservo NMS81		Proservo NMS83	
						
	0.2 to +6bar/3 to +87psi −200 to +200°C/−328 to +392°F ±0.4mm/0.02" DN 80 to DN 150/3" to 6" 316L, Alloy C276, PTFE 36m/118ft Standard TI01248G		0 to +25bar/0 to +362.5psi −200 to +200°C/−328 to +392°F ±0.4mm/0.02" DN 80 to DN 150/3" to 6" 316L, Alloy C276, PTFE 47m/154ft Standard TI01249G		0 to +6bar/0 to +87psi −200 to +200°C/−328 to +392°F ±0.4mm/0.02" DN 80 to DN 150/3" to 6" 316L, 316 polished, PTFE 22m/72ft Standard TI01250G	
	+		+		+	
	+		+		+	
	−		−		−	
	−		−		−	
	−		−		−	
	+		+		+	
	−		−		−	
	−		−		−	
	−		−		−	
	▪ Turbulent condition ▪ High viscosity ▪ Requires min. difference of 0.100g/ml between layers	→ Guide wires or stilling well → PTFE displacer or NMR81	▪ Turbulent condition ▪ High viscosity ▪ Requires min. difference of 0.100g/ml between layers	→ Guide wires or stilling well → PTFE displacer or NMR81	▪ Turbulent condition ▪ High viscosity ▪ Requires min. difference of 0.100g/ml between layers	→ Guide wires or stilling well → PTFE displacer or NMR81

+ = recommended O = restricted (observe limits) − = not recommended

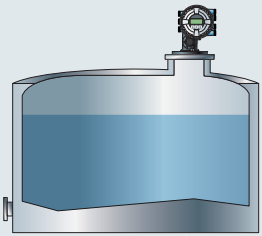
C

4. Instrument selection within the measuring principle

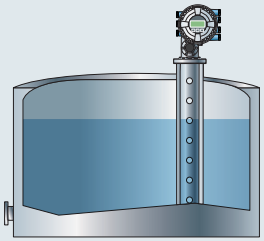
Measuring range in dependence on the type of tank

Process conditions and medium for Proservo NMS80/NMS81/NMS83

Storage tank
Highly accurate measurement, custody transfer



Stilling well
Highly accurate measurement, custody transfer



	NMS80	NMS81	NMS83
	Measuring range in m/ft		
Measuring wire material **A:** 316L **B:** Alloy 276C **C:** PFA > 316L	A B C 16/52 22/72 36/118	A B C 16/52 22/72 40/131 * 55/180	B C 16/52 22/72

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

*) Custody transfer range

C

Notes

4. Instrument selection within the measuring principle

Hydrostatics (pressure / differential pressure)

Required application data
- Pressure and temperature
- Medium density
- Required material compatibility
- Process connection
- Measuring range
- Required accuracy
- Ambient conditions (temperature change, moisture, ...)

Application limits for hydrostatic level measurement
- Temperature up to −70°C/−94°F or
  Temperature up to +400°C/+752°F
- Pressure up to +420bar/+6,090psi

Advantages
- Unaffected by surface foam
- Unaffected by tank obstacles/tank geometries
- Simple engineering
- Established technology
- Remote access via *Bluetooth*®
- Heartbeat Technology

Notes

4. Instrument selection within the measuring principle

Hydrostatics

	Cerabar PMC51B	Cerabar PMP51B	Deltapilot FMB50
			
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
▪ 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
▪ Accuracy	±0.075% (0.055% optional)	±0.075% (0.055% optional)	±0.2% (0.1% optional)
▪ Process connection	Thread, flange, hygienic connections	Thread, flange, hygienic connections	Thread, flange, hygienic connections
▪ Wetted parts	316L, Al_2O_3, sealings, PVDF	316L, Alloy, Tantal, Monel, Gold	316L, Alloy
▪ Gastight feedthrough	–	–	–
▪ Measuring cell	Ceramics	Metal welded	Contite, condensate-proof, water-tight, metal welded
▪ Technical Information	TI01506P	TI01508P	TI00437P
Applications			
Horizontal storage tank cyl.	O	O	O
Vertical storage tank	+	+	+
Buffer tank	O	O	O
Recipient tank	+	–	O
Process tank	O	O	O
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

+ = recommended O = restricted (observe limits) – = not recommended

C

	Cerabar PMC71B	Cerabar PMP71B	Deltapilot FMB70
			
	100mbar to 40bar/ 1.5 to 600psi –40 to +150°C/ –40 to +302°F ±0.05% (0.025% optional) Thread, flange, hygienic connections 316L, Al_2O_3, sealings, PVDF Standard Ceramics TI01507P	400mbar to 700bar/ 6 to 10,500psi –70 to +400°C/ –94 to +752°F ±0.05% (0.025% optional) Thread, flange, hygienic connections 316L, Alloy, Tantal, Monel, Gold Standard Metal welded TI01509P	100mbar to 10bar/ 1.5 to 145psi –10 to +100°C/ +14 to +212°F ±0.1% (0.075% optional) Thread, flange, hygienic connections 316L, Alloy Standard Contite, condensate-proof, water-tight, metal welded TI00416P
	O	O	O
	+	+	+
	O	O	O
	+	–	O
	O	O	O
	–	–	–
	–	–	–
	–	–	–
	–	–	–
	▪ 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

C

4. Instrument selection within the measuring principle

Hydrostatics

	Waterpilot FMX11/FMX21	Deltapilot FMB51/52/53	Deltabar PMD55B
			
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
▪ 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
▪ Accuracy	±0.2% (0.1% optional)	±0.2% (0.1% optional)	±0.075% (0.055% optional)
▪ Process connection	Mounting clamp, cable mounting screw	Thread, flange	Oval flange (¼ to 18 NPT), IEC 61518
▪ Wetted parts	316L, Al_2O_3, FKM, EPDM, PE, FEP, PUR	316L, Alloy, PE, FEP	316L, Alloy
▪ Gastight feedthrough	–	–	–
▪ Measuring cell	Ceramics	Contite, condensate-proof, water-tight, metal welded	Metal welded
▪ Technical Information	TI00351P/TI00431P	TI00437P	TI01510P
Applications			
Horizontal storage tank cyl.	–	+	O
Vertical storage tank	–	+	O
Buffer tank	–	O	+
Recipient tank	–	O	–
Process tank	–	–	+
Stilling well	O	–	–
Bypass	–	–	O
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

+ = recommended O = restricted (observe limits) – = not recommended

C

	Deltabar FMD71/FMD72	Deltabar PMD75B	Deltabar PMD78B
			
	100mbar to 40bar/ 1.5 to 600psi –40 up to +150°C/ –40 up to +302°F Single sensor ±0.05% System ±0.07% Thread, flange, flush-mounted hygienic connections 316L, Alloy C276 Standard Metal welded, Ceraphire ceramics TI01033P	10mbar to 250bar/ 0.15 to 3,750psi –40 to +110°C/ –40 to +230°F ±0.05% (0.035% optional) Oval flange (¼ to 18 NPT), IEC 61518 316L, Alloy, Monel, Tantal, Gold Standard Metal welded TI01511P	100mbar to 40bar/ 1.5 to 600psi –40 to +400°C/ –40 to +752°F ±0.1% Thread, flange, hygienic connections 316L, Alloy, Monel, Tantal, PTFE, Gold Standard Metal welded TI01512P
	O	O	O
	+	O	O
	O	+	+*
	O	–	–
	+	+	+
	–	–	–
	–	O	O
	–	–	–
	–	–	–
	▪ 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

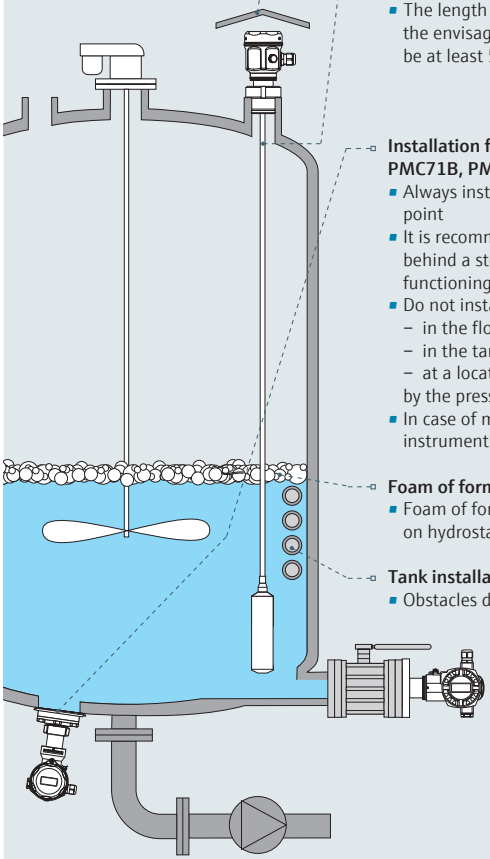
*with blank flange

C

4. Instrument selection within the measuring principle

Installation instructions hydrostatics (pressure)

Open tanks



Weather protection cover
- Recommended for outside installation to avoid strong temperature changes of electronics

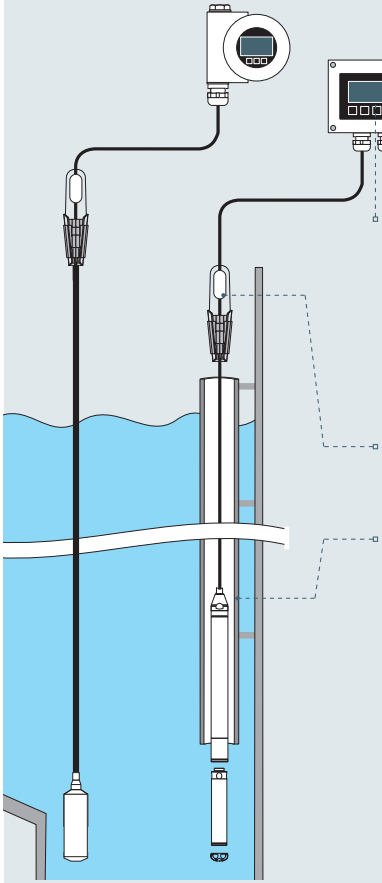
Installation from the top (FMB51/52)
- When installing rod and cable versions, please ensure that the head of the probe is at a location which is as free of flow as possible
- In order to protect the probe against contact by lateral movements, install probe in a guide tube (preferably of plastics) or use an anchoring device
- The length of the carrier cable or the probe rod depends on the envisaged level zero point. The tip of the probe should be at least 5cm/2" below that

Installation from below (PMC51B, PMP51B, FMB50, PMC71B, PMP71B, FMB70)
- Always install the instrument below the lowest measuring point
- 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

Open wells or basins (FMB53/FMX21)



Field housing/terminal box

- The sensor is connected to a field housing or terminal box via a carrier cable. Both offer optimum moisture and condensate protection and are suited to outdoor installation
- If a terminal box is not used in FMX21, the cable must end in a dry room

Mounting clamp/cable mounting screw

- The carrier cable is fastened by an mounting clamp/cable mounting screw above the well or basin

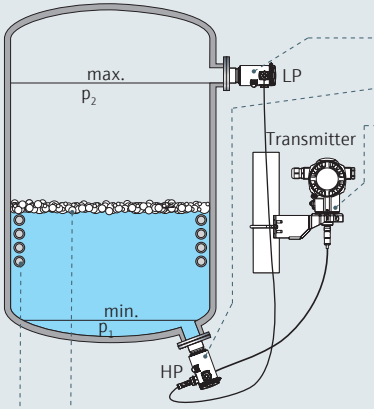
Guide tube

- Lateral movement of the level probe might cause measuring errors. Therefore, install the probe in a location which is free of flow and turbulences or use a guide tube
- The internal diameter of the guide tube should be at least 1mm/0.04" larger than the external diameter of the selected sensor
- An additional weight may be ordered as an accessory

C

4. Instrument selection within the measuring principle

Installation instructions hydrostatics (differential pressure)



Closed tanks with Deltabar FMD71/FMD72 electronic dp

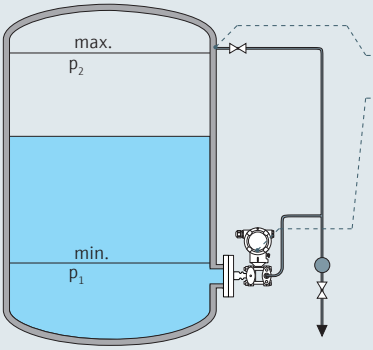
- LP (low pressure) install sensor above the maximum measuring point
- HP (high pressure) if possible, install sensor below the minimum measuring point
- In case of outdoor installation it is recommended to mount the transmitter at a position where it is protected against the environment
- It is recommended 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

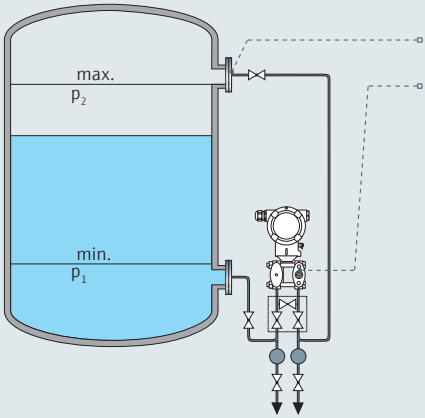
- Obstacles do not affect hydrostatic level measurement



Closed tanks with PMD78B (diaphragm seal plus side)

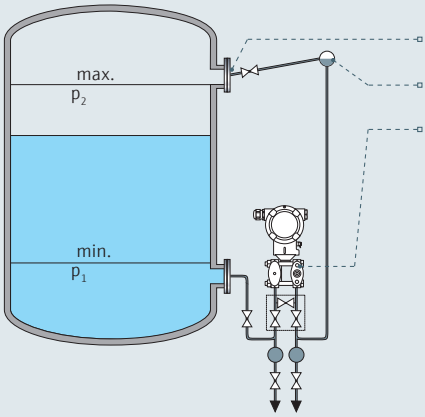
- Always connect the minus side above the maximum level
- Install Deltabar PMD78B directly at the tank below the lower measuring connection
- Generally speaking, the installation of separators and discharge valves makes sense to collect deposits, pollution or liquids in the upper pressure piping and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

C



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

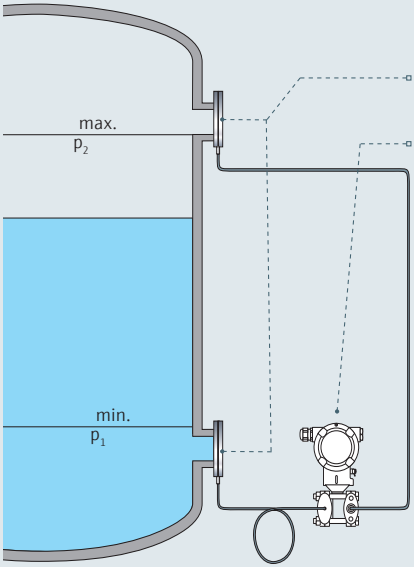


Closed vapor-pressurized tanks with PMD75B/ PMD55B (pressure piping)

- 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

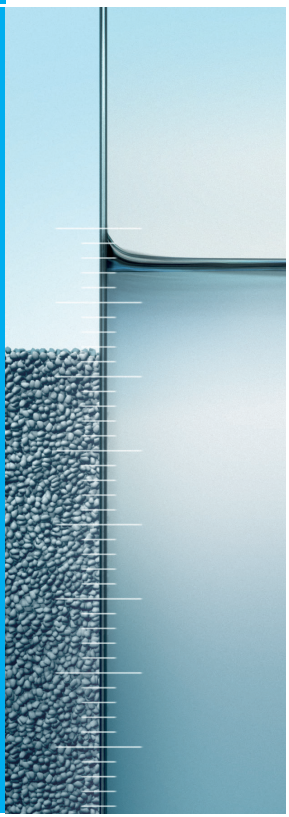
Endress+Hauser Applicator

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

C

Continuous level measurement in bulk solids

Selection and engineering guide for the process industry



Endress+Hauser
People for Process Automation

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 chose 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

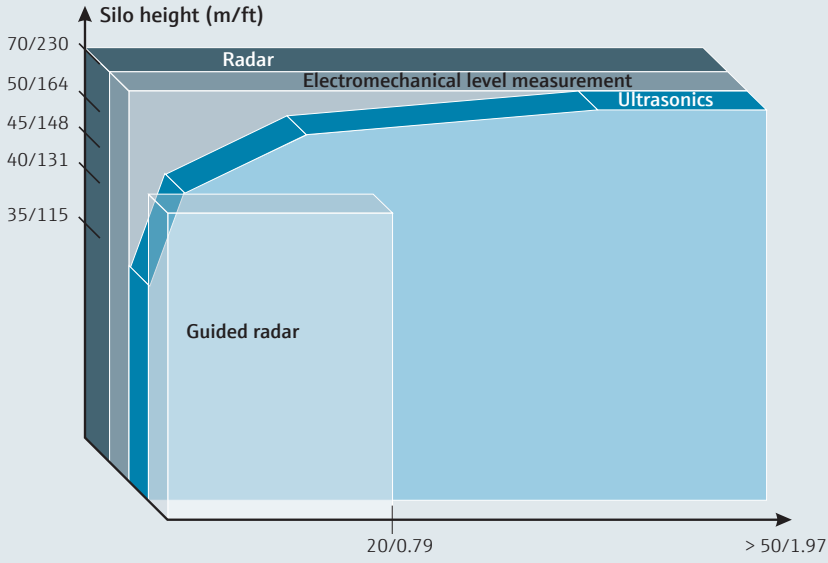
1. Overview of the measuring principles

A

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**

Process conditions*



*** Radiometry not depicted**
Non-contact measurement from outside and, therefore, no application limits.

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.“

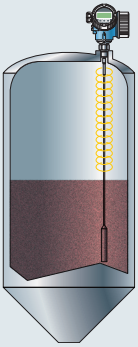
Endress+Hauser takes this statement seriously and offers a large number of different measuring principles which vary in price and functionality.

1. Overview of the measuring principles

A

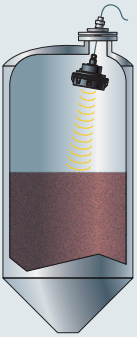
Radar
Micropilot works with either pulses or with Frequency Modulated Continuous Wave (FMCW). FMCW: Works with an FMCW continuous electromagnetic wave which is emitted from an antenna and reflected by the product surface. The frequency change "Δf" is measured and the time and distance are calculated.

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



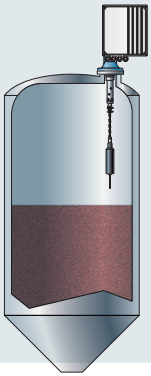
Guided radar
Levelflex works with radar pulses guided along a probe. As the pulses meet the medium surface, part of the emitted pulse is reflected due to a change of the DC value between the air and the medium. The time between pulse launching and receiving is measured and analyzed by the instrument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



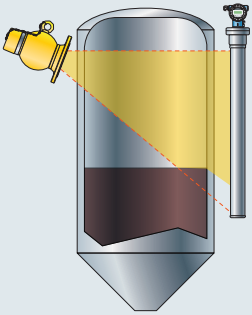
Ultrasonics
Prosonic works with ultrasonic pulses which are emitted by a sensor, reflected by the surface of the medium due to a change of the density between the air and the medium and again acquired by the sensor. The required Time-of-Flight is a measure for the distance travelled in the empty part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

Gammapilot
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

A

	Radar	Guided radar
	 FMR67B  FMR66B  FMR67B  FMR10B/20B/30B	 FMP56  FMP57
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
Measuring range	0.3 to 125m/1 to 410ft	0.2 to 45m/0.7 to 148ft
Instrument accuracy Surfaces of bulk solids affect accuracy	▪ Up to 1.5m/59": ±20mm/0.8" ▪ From 1.5m/59": ±3mm/0.12"	▪ < 15m/49ft: ±2mm/0.08" ▪ > 15m/49ft: ±10mm/0.4"
Function may be affected by	▪ Strong build-up formation ▪ Surface of bulk solids (grain size/angled surface) ▪ Conductive build-up on the antenna ▪ Strong fluidization ▪ Baffles causing interfering reflections	▪ Build-up formation ▪ Baffles in the immediate vicinity of the probe ▪ Strong fluidization
Application limits	▪ DC < 1.6 ▪ Baffles in the beam cone ▪ Filling curtain in the beam cone ▪ Angled surface/funnel with a reflecting, smooth surface	▪ DC < 1.4 ▪ Coarse-grained (> 20mm/0.8") and abrasive media ▪ Extreme tensile forces ▪ Measurement in the filling curtain

*At the process connection

- Overview of application areas
- Limits of operating conditions

A

	Ultrasonics	Electromechanical level system	Radiometrics
	 FMU4x  FMU9x  FDU9x	 FMM50  FMM20	 FMG50
	−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
	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,
	▪ ±2mm/0.08", ±0.2% of measuring distance	▪ ±5cm/2" (FMM50) ▪ ±2.5cm/1" (FMM20)	▪ ±1% of measuring distance
	▪ Extreme dust formation ▪ Extreme filling noise ▪ Strong build-up formation ▪ Surface of bulk solids (grain size/ angled surface) ▪ Fluidization ▪ Baffles causing interfering reflections	▪ Strong build-up formation ▪ Wear due to abrasion of mech. components ▪ Burying due to collapsing product accumulation	▪ Extreme build-up formation ▪ Extreme pressure fluctuation ▪ External radiation (gammagraphy), solution with Gamma Modulator
	▪ Blocking distance ▪ Baffles in the sonic cone ▪ Filling curtain in the sonic cone ▪ Angled surface/funnel with a reflecting, smooth surface	▪ Extreme tensile forces if the risk of collapsing product accumulation on walls prevails ▪ Measurement during filling	▪ Non-contact measurement from outside and, therefore, no application limits ▪ Observe radiation protection laws

2. Checklist

You need to know your specific application requirements for a correct selection. The checklist opposite provides an overview of relevant process data and is supposed to help you to take these into consideration. If we have not included all of the data, please supplement this list with your criteria.

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

TIP

Copy this checklist and complete it to have all relevant data readily available for the selection.

Notes

Name of medium		Please complete		Notes
Medium	Density	g/l (kg/m³)		
	Grain size (min/max)	mm/inch		
	Rel. dielectric constant (DC)			
	Tacky/build-up forming	yes	no	
	Extreme dust formation	yes	no	
	Abrasive	yes	no	
	Condensate formation	yes	no	
	Corrosive	yes	no	
Non-contact measurement		yes	no	
Applications Drawing available	Silos/bunkers	yes	no	
	Slim, narrow silos (H/D ≥ 8)	yes	no	
	Stockpiles	yes	no	
	Mechanical conveyor systems (e. g. conveyor belt)	yes	no	
	Crusher	yes	no	
Process conditions	Fluidization	yes	no	
	Pneumatic filling	yes	no	
	Product accumulation on walls	yes	no	
	Formation of angled surfaces, outflow funnels	yes	no	
	Max. measuring distance	m/feet		
Process data	Process pressure	min.	max.	
	Temperature at the housing	min.	max.	
	Temperature at the process connection	min.	max.	
	Process temperature	min.	max.	
Process connection	Threaded connection	yes	no	
	Flange	yes	no	
	Size	Ø		
	Pressure requirements	min.	max.	
	Hygiene requirements	yes	no	
Installation Observe max. ceiling load in contacting measuring methods	Concrete ceiling	yes	no	
	Thickness of concrete ceiling	mm/inch		
Electric connection	2-wire 4 to 20mA	yes	no	
	4-wire DC, AC	yes	no	
Surface requirements	FDA-listed materials	yes	no	
Approvals	Ex (dust/gas)	yes	no	
Special requirements	Extreme external vibration	yes	no	
Digital communication	PROFIBUS® PA, PROFIBUS® DP, HART®, FOUNDATION™ fieldbus, Ethernet-APL			
Other items				

3. Selection of the measuring principle according to the application

Non-contact

	Our proposal			
	Radar **Micropilot**  FMR66B FMR67B		**Radar** **Micropilot**  FMR10B/FMR20B/ FMR30B	**Radar** **Micropilot**  FMR43
Advantages	▪ For corrosive and abrasive media ▪ Easy installation for large measuring ranges ▪ Remote access via *Bluetooth*® ▪ Heartbeat Technology ▪ Air purge connection available		▪ Easy installation and commissioning ▪ Heartbeat Technology ▪ Remote access via *Bluetooth*® ▪ LED indicator/color touch display	▪ Compact and hygienic design ▪ Heartbeat Technology ▪ Remote access via *Bluetooth*® ▪ LED indicator/ color touch display
Technical data ▪ Connection ▪ Accuracy ▪ Process temperature* ▪ Process pressure ▪ Min. DC value ▪ Process connection ▪ Maximum measuring range	2-wire (HART®, PA, Ethernet-APL) ±3mm/±0.12" −196 to +450°C/ −321 to +842°F −1 to +160bar/ −14.5 to +2,320psi Threads, flanges (DIN, ASME, JIS) 125m/410ft		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 30m/98ft	2-wire (HART®, IO-Link) ±3mm/±0.12" −40 to +150°C/ −40 to +302°F −1 to +20bar/ −14.5 to +290psi Threads, hygienic connections 15m/49ft
Application limits	▪ DC value < 1.6 ▪ Risk of strong build-up formation ▪ Angled surface/ funnel with a reflecting, smooth surface	→ ultrasonics, electrom. level system → use of purge air → ultrasonics → guided radar, electrom. level system	▪ DC value < 1.6 ▪ Risk of strong build-up formation ▪ Angled surface/ funnel with a reflecting, smooth surface	→ ultrasonics, electrom. level system → radar with purge air → guided radar, electrom. level system

* At the process connection

Please note:
Radar continued on Page 118

Silos/bunkers

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

Contact

Our proposal

Guided radar
Levelflex


FMP56


FMP57

- 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

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

▪ 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

Electromechanical level system
Silopilot


FMM50


FMM20

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

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

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

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

Non-contact

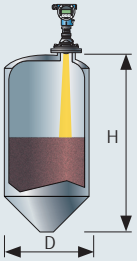
	Our proposal	
	Radar **Micropilot**   FMR67B FMR67B	**Radar** **Micropilot**   FMR20B/FMR30B
Advantages	▪ Unaffected by the density of bulk solids, temperature, humidity and filling noise ▪ For corrosive and abrasive media ▪ Easy installation for large measuring ranges ▪ Remote access via *Bluetooth*® ▪ Heartbeat Technology	▪ Easy installation and commissioning ▪ Heartbeat Technology ▪ Remote access via *Bluetooth*® ▪ LED indicator/color touch display for fast status detection
Technical data ▪ Connection ▪ Accuracy ▪ Process temperature* ▪ Process pressure ▪ Min. DC value ▪ Process connection ▪ Maximum measuring range	2-wire (HART®, PA, Ethernet-APL) ±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	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 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 ▪ Risk of strong build-up formation → radar with purge air ▪ Angled surface/ funnel with a reflecting, smooth surface → guided radar, electrom. level system

* At the process connection

Please note:
Radar continued on Page 118

Slim, narrow silos, vessels

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



Contact

Our proposal

Guided radar
Levelflex


FMP56


FMP57

- 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

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

−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

▪ 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

Electromechanical level system
Silopilot


FMM50


FMM20

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

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

−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)

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

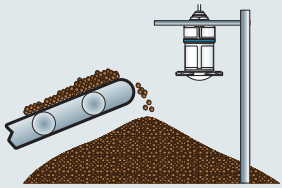
Please note:
Guided radar continued on Page 122

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)



B

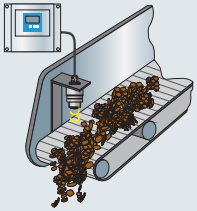
Non-contact

	Our proposal		
	Radar Micropilot		**Radar** Micropilot
	 FMR20B	 FMR30B	 FMR66B
Advantages	▪ Easy installation and commissioning ▪ Heartbeat Technology ▪ Remote access via *Bluetooth*® ▪ LED indicator/color touch display for fast status detection		▪ 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 ▪ Connection ▪ Accuracy ▪ Process temperature* ▪ Process pressure ▪ Min. DC value ▪ Process connection ▪ Maximum measuring range	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 30m/98ft		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
Application limits	▪ DC value < 1.6 ▪ Risk of strong build-up formation	→ ultrasonics, electrom. level system → use of purge air → ultrasonics	▪ DC value < 1,6 ▪ Risk of strong build-up formation ▪ Poor access to the instrument	→ ultrasonics → use of purge air → ultrasonics → ultrasonics, separated instrumentation

* At the process connection

Please note: Radar continued on Page 118

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

	Radar Micropilot		Radar Micropilot	Our proposal: Ultrasonics Prosonic
	 FMR20B	 FMR30B	 FMR66B	(separated) FDU93/95  FMU90/95 (compact)  FMU4x
Advantages	▪ Easy installation and commissioning ▪ Heartbeat Technology ▪ Remote access via *Bluetooth*® ▪ LED indicator/color touch display for fast status detection		▪ Easy installation with alignment sealings ▪ Remote access via *Bluetooth*® ▪ Heartbeat Technology	▪ Separate instrumentation ▪ Self-cleaning effect of sensors ▪ Robust sensor (vibration) ▪ Relay output for point levels
Technical data				
▪ Connection	2-wire (HART®)		2-wire (HART®, PA, Ethernet-APL)	2-/4-wire (4-20mA HART®, DP)
▪ Accuracy	±4mm/±0.16"		±3mm/±0.12"	±2mm/±0.08", ±0.2% of measured distance
▪ Process temperature*	–40 to +130°C/ –40 to +266°F		–40 to +130°C/ –40 to +266°F	–40 to +150°C/ –40 to +302°F
▪ Process pressure	-1 to +3bar/ +14.5 to +43psi		–1 to +16bar/ –14.5 to +232psi	+0.7 to +3bar/ +10 to +44psi
▪ Min. DC value	1.6		1.6	–
▪ Process connection	Threads, flanges (UNI)		Threads, flanges (UNI) mounting bracket	Threads, flanges (DIN, ANSI, JIS), wall and assembly arm, assembly bracket
▪ Maximum measuring range	50m/164ft		50m/164ft	45m/148ft
Application limits	▪ DC value < 1.6 ▪ Risk of strong build-up formation		→ ultrasonics, electrom. level system → use of purge air → ultrasonics	▪ Observe blocking distance ▪ Strong vibration, please use separated instrumentation

* At the process connection

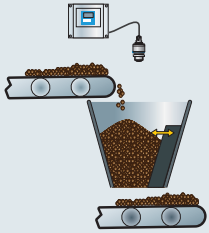
Please note: Radar continued on Page 118

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



B

Non-contact

Our proposal

	Radar Micropilot FMR20B/FMR30B		Radar Micropilot FMR67B FMR66B	
Advantages	▪ Easy installation and commissioning ▪ Heartbeat Technology ▪ Remote access via *Bluetooth*® ▪ LED indicator/color touch display for fast status detection		▪ 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	
Technical data ▪ Connection ▪ Accuracy ▪ Process temperature* ▪ Process pressure ▪ Min. DC value ▪ Process connection ▪ Maximum measuring range	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 (DIN, ASME, JIS) 30m/98ft		2-wire (HART®, PA, Ethernet-APL) ±3mm/±0.12" −40 to +450°C/−40 to +842°F −1 to +16bar/−14.5 to +232psi 1.6 DN80, DN100, DN150, DN200, DN250, assembly bracket 125m/410ft	
Application limits	▪ DC value < 1.6 ▪ Risk of strong build-up formation	→ ultrasonics, electrom. level system → use of purge air → ultrasonics	▪ Risk of build-up formation	→ use of purge air

* At the process connection

Please note: Radar continued on Page 118

Ultrasonics
Prosonic

(separated)



FMU90/95 FDU93 FDU92

- 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

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

- Possibly protection against mechanical damage (e. g. mount higher or protect by a grid)

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

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"

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.

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

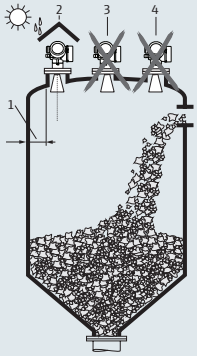
	Micropilot  FMR10B/FMR20B/FMR30B	Micropilot PVDF antenna  FMR66B	Micropilot Horn/Drip-off/Flush mount antenna  FMR67B
Typical applications	▪ Smaller silos, vessels, bunkers, stockpiles, crusher, conveyor belts, mixing towers up to max. measuring range 30m/98ft	▪ Smaller silos, vessels, bunkers, stockpiles up to max. measuring range 50m/164ft ▪ Very abrasive bulk solids	▪ 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	▪ Optional adjustable seal ▪ Optional mounting bracket	▪ Optional alignment seal ▪ Optional assembly bracket	▪ Innovative drip-off or flush-mounted antenna ▪ Optional alignment device ▪ Purge air possibility ▪ Improved focusing and small beam angle
Technical data			
▪ Process pressure	−1 to +3bar/ −14.5 to +43psi	−1 to +3bar/ −14.5 to +232psi	−1 to +16bar/ −14.5 to +232psi
▪ Process temperature*	−40 to +80°C/ −40 to +176°F	−40 to +130°C/ −40 to +266°F	−40 bis +450 °C −40 to +842°F
▪ Antenna type	Horn, plated with PVDF	PVDF and PTFE Drip-Off DN50/2" antenna	PTFE drip-off DN50/2" flush-mounted DN80/3"
▪ Max. Measuring range	30m/98ft	50m/164ft	125m/410ft
▪ DC value	≥1.6	≥1,6	≥1.6
▪ Accuracy	±4 mm/0.16"	±3mm/0.12"	±3mm/0.12"
▪ Process connection	G 1", NPT 1", G 1½", NPT 1½", DN 50 to DN 150 / 2" - 6"	Threads G 1 1/2, NPT 1 1/2", flanges 3"-6" (UNI)	Flanges DN 80 to DN 250/3" to 10" (DIN, ASME, JIS)
▪ Process-contacting materials	PVDF	PVDF, PTFE,316L, PP, sealings	316L, 1.4435, PTFE (PP, Alu) sealings

* At the process connection

C

4. Instrument selection within the measuring principle

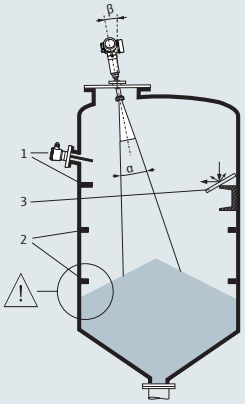
Installation instructions – radar



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]

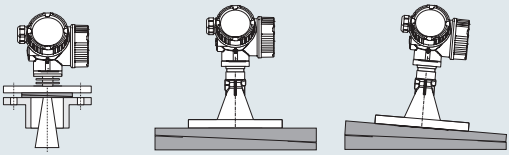
Connection for purge air or plating
- Connection for purge air:
  In case of strong dust generation, clogging of the antenna is avoided. Not possible for FMR66B. FMR67B with optional adapter or integrated



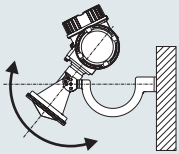
Baffles in vessels
- Make sure that baffles [1] like limit switches, struts, etc. are not within the beam cone (see also the beam angle table in this respect (next page))
- Symmetrically arranged baffles [2], e. g. discharge aids etc. may impair measurements

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

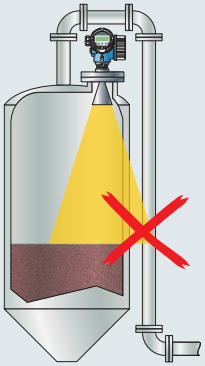


Variable alignment with optional alignment seal



Assemble bracket

C



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°C/−40°F and T > 150°C/302°F (higher temperatures upon request)
- p > 16bar/232psi
- Measuring range > 45m/148ft (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	▪ Plastic powder	20 to 25m/ 66 to 82ft	–
2	1.6 to 1.9	▪ 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	▪ Cement, gypsum	30 to 45m/ 99 to 148ft	–
		▪ Flour	–	15 to 25m/ 49 to 82ft
4	2.5 to 4	▪ Cereal, seeds	–	25 to 30m/ 82 to 99ft
		▪ Ground stones ▪ Sand	45m/148ft	25 to 30m/ 82 to 99ft
5	4 to 7	▪ Naturally moist (ground) stones, ores ▪ Salt	45m/148ft	35m/110ft
6	> 7	▪ 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

C

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	Levelflex
	 FMP56	 FMP57
Typical applications	▪ Powdery solids ▪ Plastic granulates ▪ High and narrow silos ▪ Reflecting surfaces	▪ Powdery and grained bulk solids ▪ Plastic granulates ▪ High and narrow silos ▪ Reflecting surfaces
Special features	▪ Exchangeable probes (rope) ▪ Coated rope probes (for cereal, flour) ▪ Measurement during filling	▪ Exchangeable probes (rope) ▪ Coated rope probes (for cereal, flour) ▪ Measurement during filling
Technical data		
▪ Process pressure	−1 to +16bar/ −14.5 to +232psi	−1 to +16bar/ −14.5 to +580psi
▪ Process temperature*	−40 to +120°C/−40 to +248°F	−40 to +150°C/−40 to +302°F
▪ Max. Measuring range rope probe rod probe	 12m/39ft –	 45m/148ft 4m/13ft
▪ DC value	1.4	1.4
▪ Accuracy	< 15m/49ft: ±2mm/0.08"; > 15m/49ft: ±10mm/0.4"	< 15m/49ft: ±2mm/0.08"; > 15m/49ft: ±10mm/0.4"
▪ Process connection	¾" (G, NPT), adapter flange	1½" (G, NPT), flange
▪ Process-contacting materials	304, 1.4301	304, 1.4301

C

* At the process connection

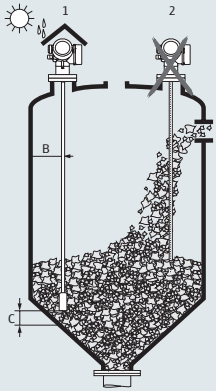
** The patented End-of-Probe (EoP) algorithm enables Levelflex to provide accurate and reliable level measurement in media with a low DC value (flour, cement, lime, PE granulates, PP granulates and various powders) also during pneumatic filling and fluidized discharge

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

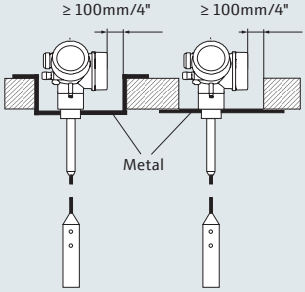


Installation

- 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

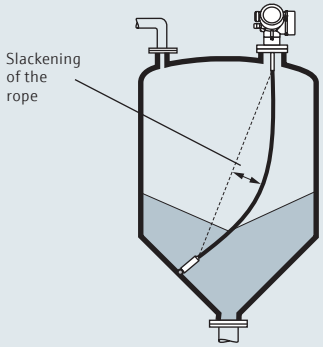
- In concrete silos, the largest possible distance of the probe to the concrete wall - min. 0.5m/19.7" - is to be observed. Optimum ≥ 1m/39"
- The installation into a concrete ceiling must be flush with its bottom edge

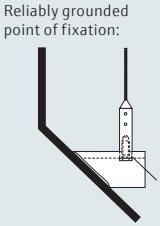
Expansion of rope probes by tension and temperature

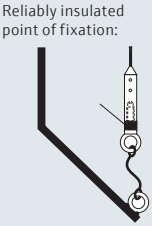
- 6mm/0.23" rope probe
  - Elongation by tension: At max. permissible tensile load (30kN) = 13mm (0.5")/m rope length
  - Elongation by temperature increase from 30°C/86°F to 150°C/302°F = 2mm (0.08")/m (ft) rope length
- 4mm/0.16" rope probe
  - Elongation by tension: At max. permissible tensile load (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°C/−40°F
- Temperature up to +150°C/+302°F (higher temperatures on request)
- Pressure from +0.7bar/+10psi up to +3bar/44psi (relative)
- Measuring range up to 45m/148ft (ideal conditions)
- Process connection from 1½"
- Strong temperature fluctuations in the measuring range can affect the accuracy

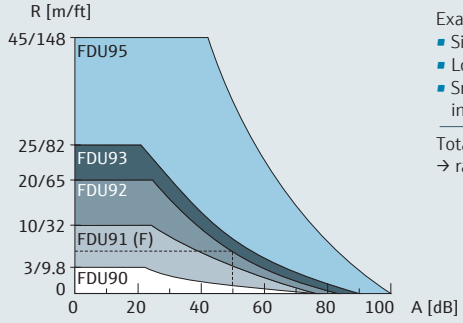
Damping caused by process

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°C/68°F	0dB
Low dust generation	5dB	Up to 40°C/104°F	5 to 10dB
Strong dust generation	5 to 20dB	Up to 80°C/176°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 +50dB
→ range approx. 5m/16ft from diagram

C

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

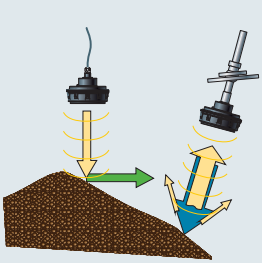
Remedial measures:

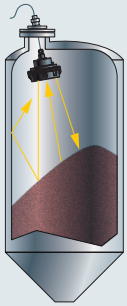
→ The sensors should be aligned as vertically as possible in relation to the product surface

→ This is facilitated by the FAU40 alignment device or the assembly bracket

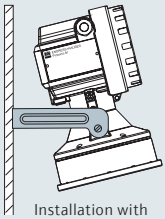
Advantages

- 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



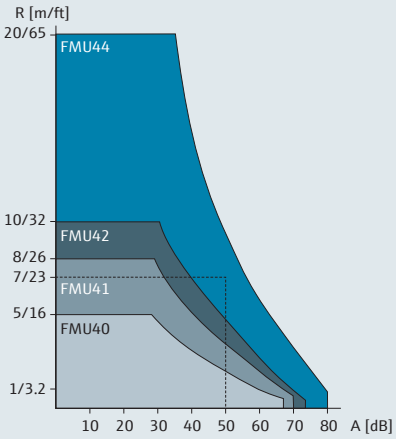


FAU40 for Prosonic



Installation with assembly bracket for Prosonic

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

C

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

Top-hat rail

FMU90/95

Field housing

FDU90

FDU91

FDU91F

FDU92

FDU93

FDU95

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"
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

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Prosonic M
FMU4x


FMU40


FMU41


FMU42


FMU44

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°

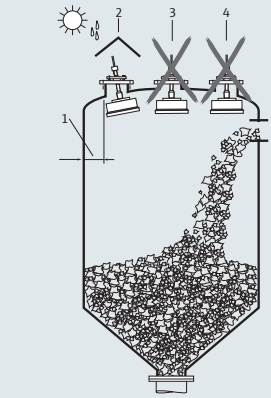
C

* At the process connection

*** The higher value is applicable

4. Instrument selection within the measuring principle

Installation instructions – ultrasonics

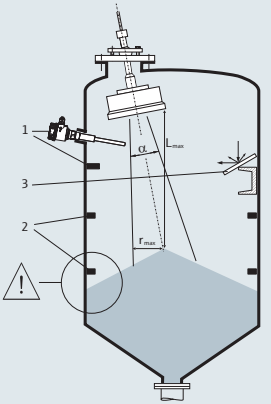


Installation
- Not centered [3]
- Not above filling curtain [4]
- Distance to wall: ~ 1/6 of the vessel diameter, at least however 20cm/7.9" [1]
- If 2 or several sensors are used in one vessel, please use separate instrumentation (FMU90/95 + FDU9x)

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)

C

	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

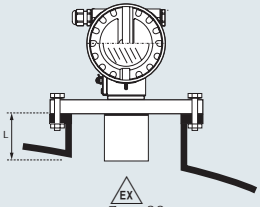
Nozzle ø	Max. nozzle length in mm/inch (L)										
	FMU 40	FMU 41	FMU 42	FMU 44	FDU 90	FDU 91	FDU 91F	FDU 92	FDU 93	FDU 95	FDU 96
DN50/ 2"	80/ 3.15				50[2]/ 1.97[2]						
DN80/ 3"	240/ 9.45	240/ 9.45	250/ 9.84		390[1], 250[2]/ 15.4[1], 9.84[2]	340/ 13.4	250/ 9.84*				
DN100/ 4"	300/ 11.8	300/ 11.8	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

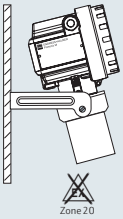
Options for installation

Prosonic M FMU4x

Universal flange installation

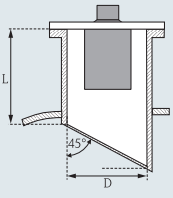


Assembly bracket installation

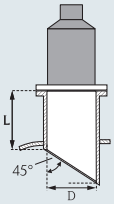


Prosonic S FDU9x

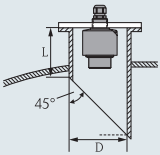
FDU9x



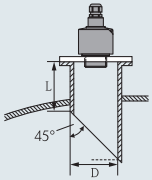
FDU91F



FDU90[1]



FDU90[2]



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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

Model	Sensing weight	Application	Temperature	Materials	
FMM50	Normal weight, cylindrical with removable spike	Coarse bulk solids, e. g. coal, ore or stones and granulates	Complete temperature range	Steel, stainless steel	
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	
FMM50	Bag weight	Bunkers with mills downstream	Max. 150°C/302°F	Bag made of Polyester, stainless steel	
FMM50	Cage weight	Fine-grained bulk solids	Complete temperature range	Steel, stainless steel	
FMM50	Oval float	Granulates	Max. 60°C/140°F	Rigid PVC	
FMM50	Bell weight	Light and loose bulk solids	Complete temperature range	Stainless steel	
FMM20	Normal weight, cylindrical with removable spike	Granulates and compacted bulk solids	Max. 150°C/302°F	Steel, stainless steel	
FMM20	Normal weight, cylindrical	Granulates and compacted bulk solids	Max. 70°C/158°F	Plastics	
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	
FMM20	Bag weight	Bunkers with mills downstream	Max. 150°C/302°F	Polyester, stainless steel	

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

	Weight	Ex	Special features
	3.5kg/8lbs	Yes	In case of downstream crusher or mill facility → use "tape breakage" signal function or cage weight
	3.8kg/8.3lbs, 3.9kg/8.6lbs	Yes	Large square surface → avoids deep immersion into the product
	0.25kg/0.5lbs (empty), 3.5kg/8lbs (full)	Yes	Tie the bag so that the content cannot escape
	3.5kg/8lbs	Yes	Avoids subsequent damage since the weight cannot enter the discharging facility
	3.5kg/8lbs (full)	Yes	
	4.3kg/9.5lbs	Yes	If the umbrella cannot be used any more in high temperatures or special product properties
	1.5kg/3.3lbs	Yes	In case of downstream crusher or mill facility → use "tape breakage" signal function
	1.5kg/3.3lbs	Dust-Ex not permitted	In case of downstream crusher or mill facility → use "tape breakage" signal function
	1.5kg/3.3lbs	Yes	Large square surface → avoids deep immersion into the product
	0.25kg/0.5lbs (empty), 1.5kg/3.3lbs (full)	Yes	Tie the bag so that the content cannot escape

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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	▪ Bunkers and silos with powdery, fine-grained or coarse-grained bulk solids	▪ Bunkers and silos for light bulk solids, e. g. cereals, plastics granulate, powder
Special features	▪ Easy commissioning	▪ Easy commissioning
Technical data		
▪ Process pressure	+0.8 to +3bar/+12 to +43.5psi	+0.8 to +1.1bar/+12 to +16psi
▪ Process temperature*	−20 to +230°C/−4 to +446°F	−20 to +150°C/−4 to +302°F
▪ Max. Measuring range	70m/230ft	32m/105ft
▪ Accuracy	±5cm/±2" or ±1 pulse	±2.5cm/±1" or. ±1 pulse
▪ Tensile force	Max. 500N	Max. 150N
▪ Process connection	On counterflange DN100 PN16	On counterflange DN100 PN16
▪ Process-contacting material	Alu, steel or stainless steel (301 modified, 304, 316, 316TI), Polyester, PVC	Alu, steel or stainless steel (301 modified, 304, 316, 316TI) plastic, polyester
▪ Ambient temperature	−40 to +70°C/−40 to +158°F	−40 to +60°C/−40 to +140°F
▪ Electronics	4 to 20mA / relay	0/4 to 20mA / relay
▪ Approvals	ATEX II 1/2D	ATEX II 1/2D
▪ Ingress protection	IP67	IP67

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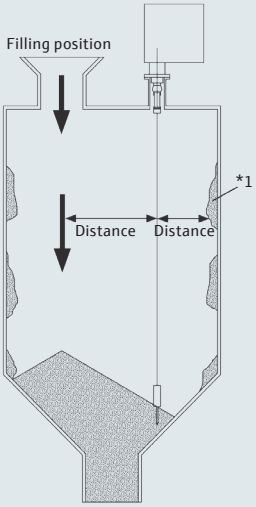
* At the process connection

Installation instructions – electromechanical level system

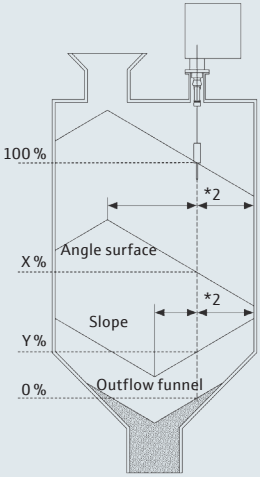


Installation
- Not in the filling curtain or in the area of collapsing product accumulation on walls
- Measuring point as close to the center of the slope as possible
- The sensing weight may neither sink into the product nor slide off the angled surface during the measuring operation
- Max. angle of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

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

www.addresses.endress.com

CP00023F/00/EN/20.25

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