Continuous level measurement in liquids and bulk solids

Selection and engineering guide for the process industry

Endress+Hauser

People for Process Automation

Legend

- Continuous level measurement in liquids
  starting page 3

- Continuous level measurement in solids
  starting page 73

Continuous level measurement in liquids

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/interface measurement in liquids as well as their application and installation.

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

The first section specifically covers continuous measurement in liquids.

A

Overview of measuring principles
The first section is 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
Refer to the selected measuring principle where you can choose the appropriate instrument from a product family.
Compare your application and process data with the instrument data.

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

Contents

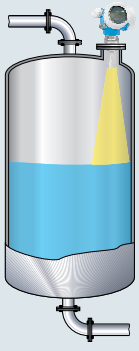
A

B

C

A

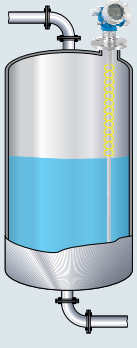
1. Overview of the measuring principles



Radar
Micropilot works with high-frequency radar pulses which are emitted by an antenna and reflected from the product surface. The Time-of-Flight of the reflected radar pulse is directly proportional to the distance traveled. If the tank geometry is known, the level can be calculated from this variable.

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 842°F/450°C
- Process pressures up to 2320psi/160bar



Guided radar
Levelflex works with high-frequency radar pulses which are guided along a rigid probe or cable. When the pulse contacts 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 842°F/450°C
- Process pressures up to 400bar/5800psi

Ultrasonic
Ultrasonic measurement is based on the Time-of-Flight principle. A sensor emits ultrasonic pulses, the surface of the media bounces the signal back 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 or volume 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 302°F/150°C
- Process pressures up to 44psi/3bar

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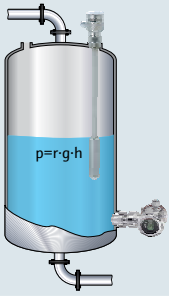
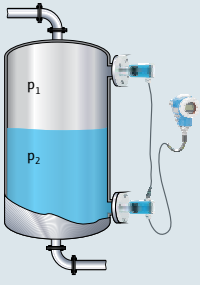


Hydrostatic (pressure)
Hydrostatic level measurement in open (vented) tanks is based on the determination of the hydrostatic pressure which is generated by the height of the liquid column. The obtained pressure is thus a direct measure for the level.

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 S).

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



Hydrostatic (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.

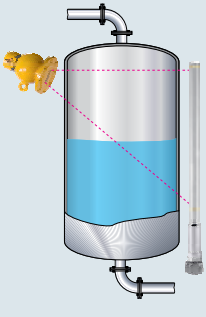
Deltabar
Unaffected by dielectric constant, foam, turbulence and obstacles. High overload resistance.

- Process temperatures up to 752°F/400°C
- Process pressures up to 6090psi/420bar
- Unaffected by ambient temperatures (Deltabar electronic dp)

Capacitance
The principle of capacitive level measurement is based on the capacitance change. 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 392°F/200°C
- Process pressures up to 1450psi/100bar



Gamma
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 M
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 external gammagraphy (radiography) (FHG65)

For more detailed information, please contact our sales team or use the Applicator® selection software.

A

1. Overview of the measuring principles

	Radar	Guided radar	Ultrasonic
			
Process temperature **Process pressure**	−196…+450°C/ −321…+842°F −1…+160bar/ −14.5…+2,320psi	−196…+450°C/ −321…+842°F −1…+400bar/ −14.5…+5,800psi	−40…+150°C/ −40…+302°F −0.3…+3bar/ −4.4…+44psi
Measuring range	0.3…70m/1…229ft	0.2…45m/0.7…148ft (longer upon request)	0.07…20m/0.2…65ft
Instrument accuracy	▪ C-band[2]: ±6mm ±0.24" ▪ K-band[2]: ±2mm ±0.08" ▪ Option: ±1mm/0.04"	▪ < 15m: ±2mm < 49ft: ±0.08" ▪ > 15m: ±10mm > 49ft: ±0.4" of distance	▪ < 1m: ±2mm < 3.2ft: ±0.08" ▪ > 1m: ±0.2% > 3.2ft: ±0.2% of distance
Function may be affected by	▪ Foam ▪ Extreme turbulent, boiling surfaces ▪ Conductive buildup on antenna connection ▪ Strong buildup formation	▪ Extreme buildup formation	▪ Foam ▪ Extreme turbulent, boiling surfaces ▪ Strong buildup or strong condensate at the sensor
Accuracy may be affected by	▪ Wall effects ▪ Interfering reflections/ signal strength (obstacles in the signal beam.) ▪ Extreme pressure changes e.g. 1.2% at Δ 50bar/725psi (+20°C/+68°F, air)	▪ Interfering reflections by obstacles near the probe (not for coaxial probe) ▪ Extreme pressure changes e.g. 1.2% at Δ 50bar/725psi (+20°C/+68°F, air)	▪ Higher vapor pressure may change the Time-of-Flight ▪ Temperature layers in the gas phase ▪ Interfering reflections ▪ Fast temperature change
Application limits	▪ Measurement up to abs. 0%[1] ▪ DK < 1.4	▪ Measurement up to abs. 0%[1] ▪ DK < 1.4 ▪ Strong mechanical stress in agitator applications	▪ Measurement up to abs. 0%[1] ▪ Vapor pressure > 50mbar/0.73psi (+20°C/+68°F) ▪ Blocking distance[3]

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

[2] Measurement only up to the probe end

A

	Capacitance	Gamma	Hydrostatic (pressure)	Hydrostatic (differential pressure)
				
	−80...+200°C/ −112...+392°F −1...+100bar/ −14.5...+1,450psi	Unaffected by temperature and pressure	−70...+400°C/ −94...+752°F Ambient pressure	−70...+400°C/ −94...+752°F/ 420bar/6,090psi
	0.1...10m/0.3...32ft	0.05...12m/0.16...39ft, cascadable	0.1...100m/0.3...328ft (1mbar...10bar/ 0.1psi...145psi)	from 0.1m/0.3ft (1mbar...40bar/ 0.1psi...580psi)
	▪ ±1% of measuring distance	▪ ±1% of measuring distance	▪ ±0.075% of the set span	▪ ±0.05% of the set span
	▪ Plastic tank ▪ Extreme conductive buildup	▪ External radiation (gammagraphy), solution with Gamma Modulator	▪ Dynamic pressure fluctuations by agitator or whirling	▪ Dynamic pressure fluctuations by agitator or whirling
	▪ Conductivity < 30µS/cm: changing dielectric constants ▪ Conductive buildup	▪ Extreme pressure fluctuations ▪ Extreme buildup	▪ Changing densities ▪ Very fast temperature change	▪ Changing densities ▪ Dynamic pressure, e.g. caused by agitator
	▪ Agitator blade ▪ Changing, non-conductive media or conductivity between 1...100µS/cm ▪ DK < 2.0 ▪ Media diffusing through PTPE, e.g. chlorine	▪ Non-contact measurement from outside and, therefore, no application limits ▪ License requirements	▪ Hard buildup ▪ Strong density fluctuations	▪ Hard buildup ▪ Vacuum and simultaneously temperatures > +200°C/+392°F (diaphragm seal) ▪ Strong density fluctuations

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

A

2. Checklist

You should be familiar with all of the requirements of your application for the selection of the right instrument. The checklist on page 11 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.

Gamma 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	Ultrasonic	Hydrostatic (pressure/dp)	Capaci-tance
Condensate	O	+	O	+	+
Foam formation	O	+	O	+	O
Conductivity 1...100µS/cm	+	+	+	+	O
Changing media (density)	+	+	+	–	+
Low DK	O	O	+	+	O
Viscosity	+	O	+	+	O
Buildup formation	+	O	+	O	O
Small tank (blocking distance)	O	O	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	O	O	+	+
Vapor pressure > 50mbar / +20°C, > 0.73psi / +68°F)	+	+	O	+	+
CIP/SIP temperature cycles	+	+	+	+	+

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

A

		Please complete		Notes
Details of medium	Medium			
	Density	g/cm³		
	Conductivity	µS/cm		
	Dielectric constant (DK)			
	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	
Electrical connection	2-wire	yes	no	
	4-wire	yes	no	
Digital communication	HART®, PROFIBUS®, FOUNDATION™ fieldbus, relay			
Approvals	Ex (Ex ia/Ex d), XP, IS, NI	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

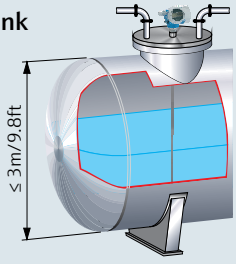
	Radar Micropilot®		Ultrasonic Prosonic S/M/T	
	 FMR5x		(Remote)  FMU90  FDU9x	(Compact)  FMU4x  FMU30
Advantages	▪ For highly viscous media ▪ High resistance to corrosion ▪ Universally usable (freely adjustable measuring range)		▪ High resistance to corrosion ▪ Self-cleaning effect of sensors ▪ Integrated alarm/point level relay ▪ Freely adjustable measuring range	
Technical data ▪ Connection ▪ Accuracy ▪ Process temperature ▪ Process pressure ▪ Process connection ▪ Maximum measuring range	2-wire (HART, PA, FF), 4-wire HART ±2mm/±0.08" −196...+450°C/−321...+842°F −1...+160bar/−14.5...+2,320psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 70m/229ft		2-/4-wire (HART, DP, PA, FF) ±2mm/±0.08", +0.17% of the distance −40...+105°C/−40...+221°F −0.3...+3bar/−4.4...+44psi Threads, Tri-Clamp, flanges (DIN, ANSI, JIS) 20m/65ft	
Application limits	▪ Strong formation of foam ▪ Many obstacles ▪ Low DK value (< 1.4)	→ guided radar, hydrostatic → guided radar, capacitance, hydrostatic → hydrostatic	▪ Strong formation of foam ▪ Vapor pressure ▪ Many obstacles ▪ Blocking distance	→ guided radar, hydrostatic → radar, guided radar, capacitance → guided radar, capacitance, hydrostatic

Please note:
Free Space Radar continued on Page 32

Please note:
Ultrasonic continued on Page 54

Horizontal cylindrical storage tank

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



Contact

First Choice

Guided radar Levelflex	Hydrostatic Deltapilot® M	Capacitance Liquicap® M
 FMP5x (coax)	 FMB5x	 FMI5x
▪ Not affected by changing media ▪ Coaxial probe	▪ Unaffected by foam ▪ Unaffected by installation situation ▪ Unaffected by DK 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...+450°C/−321...+842°F −1...+400bar/−14.5...+5,800psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 10m/33ft (rod), 45m/148ft (cable), 6m/20ft (coax), longer upon request	2-wire (HART, PA, FF) ±0.1%, (typ. 3...10mm/0.12"...0.4") −10...+80°C/+14...+176°F Ambient pressure Threads, flanges (DIN, ANSI, JIS), hygienic connections Typically up to 100m/328ft (10bar/145psi)	2-wire (HART) ±1.0% −80...+200°C/−112...+392°F −1...+100bar/−14.5...+1,450psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 4m/13ft (rod), 10m/32ft (cable)
▪ Strong buildup formation (e.g. high viscosity, crystallizing media, etc.) → radar, ultrasonic ▪ Low DK value (< 1.4) → hydrostatic	▪ Density change → guided radar, radar, ultrasonic ▪ Strong buildup formation → radar, ultrasonic ▪ Vented tank only → guided radar, radar	▪ Changing, non-conductive media or conductivity between 1...100µS/cm → guided radar, radar, ultrasonic ▪ Strong, conductive buildup formation → radar, ultrasonic

Please note:
Guided radar continued on Page 48

Please note:
Hydrostatic continued on Page 63

Please note:
Capacitance continued on Page 60

3. Selection of the measuring principle according to the application

B

Non-contact

First Choice

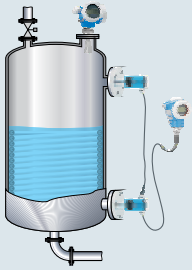
	Radar Micropilot		Ultrasonic Prosonic S/M/T	
	 FMR5x		(Remote)  FMU90  FDU9x (Compact)  FMU4x  FMU30	
Advantages	▪ Non-contact and unaffected by head pressures ▪ Universally usable due to ▪ Flexible measuring range ▪ Changing, highly viscous or aggressive media (100% PTFE)		▪ High resistance to corrosion ▪ Self-cleaning effect of sensors ▪ Integrated alarm/point level relay	
Technical data ▪ Connection ▪ Accuracy ▪ Process temperature ▪ Process pressure ▪ Process connection ▪ Maximum measuring range	2-wire (HART, PA, FF), 4-wire HART ±2mm/±0.08" −196...+450°C/−321...+842°F −1...+160bar/−14.5...+2,320psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 70m/229ft		2-/4-wire (HART, DP, PA, FF) ±2mm/±0.08", +0.17% of the distance −40...+105°C/−40...+221°F −0.3...+3bar/−4.4...+44psi Threads, Tri-Clamp, flanges (DIN, ANSI, JIS) 20m/65ft	
Application limits	▪ Strong formation of foam ▪ Many obstacles ▪ Low DK value (< 1.4)	→ guided radar, hydrostatic → guided radar, capacitance, hydrostatic → hydrostatic	▪ Strong formation of foam ▪ Vapor pressure > 50mbar/0.73psi (20°C/+68°F) ▪ Many obstacles	→ guided radar, hydrostatic → radar, guided radar, capacitance → guided radar, capacitance, hydrostatic

Please note:
Free Space Radar continued on Page 32

Please note:
Ultrasonic continued on Page 54

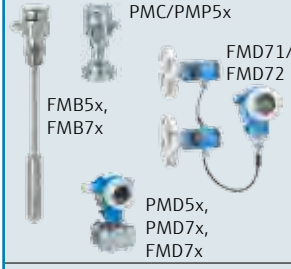
Vertical storage tank

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



Contact

First Choice

Hydrostatic Deltapilot, Cerabar®, Deltabar®	Guided radar Levelflex	Capacitance Liquicap M
		
▪ Unaffected by ▪ DK values ▪ Tank baffles ▪ Foam	▪ Unaffected by nozzle dimensions and tank obstacles	▪ Unaffected by nozzle dimensions and tank obstacles ▪ Calibration not required in conductive liquids ▪ No blocking distance
2-wire (HART, PA, FF) ±0.05% of the set span −70...+400°C/−94...+752°F up to +420bar/+6,092psi Threads, flanges (DIN, ANSI, JIS), hygienic connections Typically up to 100m/328ft	2-wire (HART, PA, FF), 4-wire HART ±2mm/±0.08" −196...+450°C/−321...+842°F −1...+400bar/−14.5...+5,800psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 10m/33ft (rod), 45m/148ft (cable), 6m/20ft (coax), longer upon request	2-wire (HART) ±1.0% −80...+200°C/−112...+392°F −1...+100bar/−14.5...+1,450psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 4m/13ft (rod), 10m/32ft (cable)
▪ Changing density → guided radar, radar, ultrasonic ▪ Strong buildup formation → radar, ultrasonic	▪ Strong buildup formation (e.g. high viscosity, crystallizing media, etc.) → radar, ultrasonic ▪ Low DK value (< 1.4) → hydrostatic	▪ Changing, non-conductive media or conductivity between 1...100µS/cm → guided radar, radar, ultrasonic ▪ Strong, conductive buildup formation → radar, ultrasonic

Please note:
Guided radar continued on Page 48

Please note:
Hydrostatic continued on Page 63

Please note:
Capacitance continued on Page 60

3. Selection of the measuring principle according to the application

B

Non-contact

First Choice

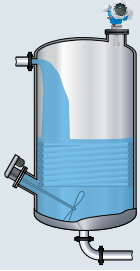
	Radar Micropilot	Ultrasonic Prosonic S/M
	 FMR5x	(Remote)  FMU90  FDU9x (Compact)  FMU4x
Advantages	▪ Non-contact and unaffected by head pressures ▪ Universally usable due to ▪ Flexible measuring range ▪ Changing, highly viscous or aggressive media (100% PTFE)	▪ High resistance to corrossion ▪ Self-cleaning effect of sensors ▪ Integrated alarm/point level relay ▪ Fast measuring frequency (4-wire)
Technical data ▪ Connection ▪ Accuracy ▪ Process temperature ▪ Process pressure ▪ Process connection ▪ Maximum measuring range	2-wire (HART, PA, FF), 4-wire HART ±2mm/±0.08" −196...+450°C/−321...+842°F −1...+160bar/−14.5...+2,320psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 70m/229ft	2-/4-wire (HART, DP, PA, FF) ±2mm/±0.08", +0.17% of the distance −40...+105°C/−40...+221°F −0.3...+3bar/−4.4...+44psi Threads, Tri-Clamp, flanges (DIN, ANSI, JIS) 20m/65ft
Application limits	▪ Strong formation of foam → guided radar, hydrostatic ▪ Many obstacles in the radar beam → guided radar, capacitance, hydrostatic ▪ Low DK value (< 1.4) → hydrostatic	▪ Strong formation of foam → guided radar, hydrostatic ▪ Vapor pressure outside published limits → radar, guided radar, capacitance ▪ Many obstacles → guided radar, capacitance, hydrostatic

Please note: Free Space Radar continued on Page 32

Please note: Ultrasonic continued on Page 54

Buffer tank

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



Contact

Hydrostatic Cerabar, Deltabar	Guided radar Levelflex	Capacitance Liquicap M
 FMD71/FMD72 (electronic dp) PMD5x, PMD7x, FMD7x	 FMP5x	 FMI5x
▪ Unaffected by foam ▪ Unaffected by installation situation ▪ Unaffected by DK value ▪ Electronic dp	▪ Unaffected by nozzle dimensions and tank obstacles ▪ Unaffected by agitated surfaces	▪ For small tanks with fast filling and discharging operations ▪ Unaffected by nozzle dimensions and tank obstacles ▪ No blocking distance
2-wire (HART, PA, FF) ±0.05% of the set span −70...+400°C/−94...+752°F up to +420bar/+6,092psi Threads, flanges (DIN, ANSI, JIS), hygienic connections Typically up to 100m/328ft	2-wire (HART, PA, FF), 4-wire HART ±2mm/±0.08" −196...+450°C/−321...+842°F −1...+400bar/−14.5...+5,800psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 10m/33ft (rod), 45m/148ft (cable), 6m/20ft (coax), longer upon request	2-wire (HART) ±1.0% −80...+200°C/−112...+392°F −1...+100bar/−14.5...+1,450psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 4m/13ft (rod), 10m/32ft (cable)
▪ Density change → guided radar, radar, ultrasonic ▪ Strong buildup formation → radar, ultrasonic, bubble system ▪ Ratio head-pressure to level max. 6:1 for electronic dp → radar, guided radar, dp	▪ Strong lateral load → radar, ultrasonic, hydrostatic ▪ Strong buildup formation (e.g. high viscosity, crystallizing media, etc.) → radar, ultrasonic ▪ DK starting at 1.4 → hydrostatic	▪ Changing, non-conductive media or conductivity between 1...100µS/cm → guided radar, radar, ultrasonic ▪ Strong, conductive buildup formation → radar, ultrasonic ▪ Strong lateral load → radar, ultrasonic, hydrostatic

Please note: Hydrostatic continued on Page 63

Please note: Guided radar continued on Page 48

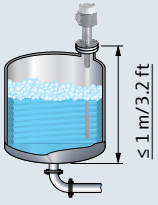
Please note: Capacitance continued on Page 60

3. Selection of the measuring principle according to the application

Notes

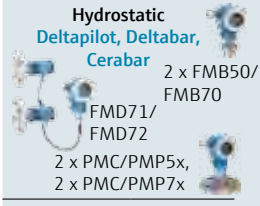
Surge tank (e.g. bottling facilities)

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



Contact

First Choice

	Capacitance Liquicap M	Guided radar Levelflex	Hydrostatic Deltapilot, Deltabar, Cerabar
	 FMI5x	 FMP5x	 2 x FMB50/ FMB70; FMD71/ FMD72; 2 x PMC/PMP5x, 2 x PMC/PMP7x
Advantages	▪ Fastest response times during filling and discharging operations ▪ No blocking distance ▪ Unaffected by nozzle dimensions and tank obstacles	▪ Unaffected by nozzle dimensions and tank obstacles ▪ Unaffected by product properties (conductivity, density)	▪ Electronic dp ▪ Unaffected by foam ▪ Unaffected by installation situation ▪ Unaffected by DK value ▪ Fast response times ▪ Unaffected by ambient temperatures
Technical data ▪ Connection ▪ Accuracy ▪ Process temperature ▪ Process pressure ▪ Process connection ▪ Maximum measuring range	2-wire (HART) ±1.0% −80...+200°C/−112...+392°F −1...+100bar/−14.5...+1,450psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 4m/13ft (rod), 10m/32ft (cable)	2-wire (HART, PA, FF), 4-wire HART ±2mm/±0.08" −196...+450°C/−321...+842°F −1...+400bar/−14.5...+5,800psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 10m/33ft (rod), 45m/148ft (cable), 6m/20ft (coax), longer upon request	2-wire (HART, PA, FF) ±0.05% of the set span −40...+150°C/−40...+302°F up to +40bar/+600psi Threads, flanges (DIN, ANSI, JIS), hygienic connections Typically up to 100m/328ft
Application limits	▪ Changing, non-conductive media or conductivity between 1...100µS/cm → hydrostatics	▪ Extremely fast filling and discharging operations (response times < 0.7sec) → capacitance ▪ Highly accurate measurements in the lower and upper area → capacitance ▪ DK starting at 1.4 → hydrostatics	▪ Density change → capacitance ▪ Electronic dp-ratio head pressure to level max. 6:1 → capacitance, guided radar

Please note: Capacitance continued on Page 60
Please note: Guided radar continued on Page 48
Please note: Hydrostatic continued on Page 63

3. Selection of the measuring principle according to the application

B

Non-contact

First Choice

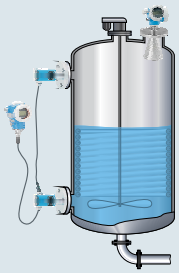
	Radar Micropilot	Ultrasonic Prosonic S/M	
	 FMR5x	(Remote)  FMU90  FDU9x	(Compact)  FMU4x
Advantages	▪ Non-contact and unaffected by head pressures ▪ Universally usable due to ▪ Flexible measuring range ▪ Changing, highly viscous or aggressive media (100% PTFE)	▪ High resistance to corrosion ▪ Self-cleaning effect of sensors ▪ Integrated alarm/point level relay ▪ Fast measuring frequency (4-wire)	
Technical data ▪ Connection ▪ Accuracy ▪ Process temperature ▪ Process pressure ▪ Process connection ▪ Maximum measuring range	2-wire (HART, PA, FF), 4-wire HART ±2mm/±0.08" −196...+450°C/−321...+842°F −1...+160bar/−14.5...+2,320psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 70m/229ft	2-/4-wire (HART, DP, PA, FF) ±2mm/±0.08", +0.17% of the distance −40...+105°C/−40...+221°F −0.3...+3bar/−4.4...+44psi Threads, Tri-Clamp, flanges (DIN, ANSI, JIS) 20m/65ft	
Application limits	▪ Strong formation of foam ▪ Many obstacles ▪ Low DK value (< 1.4) ▪ Strong turbulences → hydrostatic	▪ Strong formation of foam → hydrostatic ▪ Vapor pressure outside published limits → radar ▪ Many obstacles → hydrostatic ▪ Fast temperature changes → radar ▪ Strong turbulences → hydrostatic	

Please note:
Free Space Radar continued on Page 32

Please note:
Ultrasonic continued on Page 54

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

First Choice

Hydrostatic
Deltabar

FMD71/FMD72
(electronic dp)

PMD5x,
PMD7x,
FMD7x

- Unaffected by
  - DK values
  - Tank baffles
  - Foam
  - Strongly fluctuating ambient temperatures

2-wire (HART, PA, FF)
±0.05% of the set span
−70...+400°C/−94...+752°F
up to +420bar/+6,092psi
Threads, flanges (DIN, ANSI, JIS), hygienic connections
Typically up to 100m/328ft

▪ Density change ▪ Strong buildup formation	→ radar, ultrasonic → radar, ultrasonic, bubble system

Please note:
Hydrostatic continued on Page 63

3. Selection of the measuring principle according to the application

B

Non-contact

First Choice

	Radar Micropilot	Ultrasonic Prosonic S/M
	 FMR5x	(Remote)  FMU90  FDU9x (Compact)  FMU4x
Advantages	▪ Non-contact and unaffected by head pressures ▪ Universally usable due to flexible measuring range ▪ Installation for stilling wells > 4m /13' ▪ Can be used with a ball valve for isolation	▪ High resistance to corrosion ▪ Self-cleaning effect of sensors ▪ Integrated alarm/point level relay ▪ Unaffected by stilling well material
Technical data ▪ Connection ▪ Accuracy ▪ Process temperature ▪ Process pressure ▪ Process connection ▪ Maximum measuring range	2-wire (HART, PA, FF), 4-wire HART ±2mm/±0.08" −196...+450°C/−321...+842°F −1...+160bar/−14.5...+2,320psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 70m/229ft	2-/4-wire (HART, DP, PA, FF) ±2mm/±0.08", +0.17% of the distance −40...+105°C/−40...+221°F −0.3...+3bar/−4.4...+44psi Threads, Tri-Clamp, flanges (DIN, ANSI, JIS) 20m/65ft
Application limits	▪ Large changes in the stilling well cross section → guided radar, capacitance ▪ Arrangement, size of equalizing openings → guided radar, capacitance ▪ Plastic stilling wells → ultrasonic, guided radar ▪ DK starting at 1.4 → float	▪ Vapor pressure outside published limits → radar

Please note:
Free Space Radar continued on Page 32

Please note:
Ultrasonic continued on Page 54

Stilling well

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

B

Stilling well

Contact

First Choice

Guided radar Levelflex	Capacitance Liquicap M
 FMP5x	 FMI5x
▪ Unaffected by the stilling well geometry ▪ Detachable rod probe	▪ Unaffected by the stilling well geometry
2-wire (HART, PA, FF), 4-wire HART ±2mm/±0.08" −196...+450°C/−321...+842°F −1...+400bar/−14.5...+5,800psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 10m/33ft (rod), 45m/148ft (cable), longer upon request	2-wire (HART) ±1.0% −80...+200°C/−112...+392°F −1...+100bar/−14.5...+1,450psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 4m/13ft (rod), 10m/32ft (cable)
▪ Contact between probe and stilling well → radar, ultrasonic ▪ Highly viscous products (> 1000cst) → radar, ultrasonic ▪ Max. stilling well length 10m/33ft → float ▪ DK starting at 1.4	▪ Changing, non-conductive media or conductivity between 1...100µS/cm → guided radar, radar, ultrasonic

Please note:
Guided radar continued on Page 48

Please note:
Capacitance continued on Page 60

3. Selection of the measuring principle according to the application

B

Non-contact

	Radar Micropilot		
	 FMR5x		
Advantages	▪ Measurement with ball valve possible ▪ For highly viscous media (100% PTFE possible) ▪ Universally usable (freely adjustable measuring range)		
Technical data ▪ Connection ▪ Accuracy ▪ Process temperature ▪ Process pressure ▪ Process connection ▪ Maximum measuring range	2-wire (HART, PA, FF), 4-wire HART ±2mm/±0.08" −196...+450°C/−321...+842°F −1...+160bar/−14.5...+2,320psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 70m/229ft		
Application limits	▪ Strong formation of foam ▪ Many obstacles ▪ Low DK value (< 1.4)	→ guided radar, hydrostatic → guided radar, capacitance, hydrostatic → hydrostatic	

Please note:
Free Space Radar continued on Page 32

Bypass

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

Contact

First Choice

Guided radar Levelflex	Capacitance Liquicap M	Hydrostatic Deltabar
 FMP5x	 FMI5x	 PMD5x, PMD7x, FMD7x FMD71/FMD72 (electronic dp)
▪ No interference from bypass connections (coaxial probes) ▪ Unaffected by changing media ▪ Safe operation in case of filling via upper connection ("coaxial probe")	▪ For small tanks with fast filling and discharging operations ▪ Unaffected by nozzle dimensions and tank obstacles ▪ No blocking distance	▪ Unaffected by ▪ DK values ▪ Tank baffles ▪ Foam ▪ Strongly fluctuating ambient temperatures
2-wire (HART, PA, FF), 4-wire HART ±2mm/±0.08" −196...+450°C/−321...+842°F −1...+400bar/−14.5...+5,800psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 10m/33ft (rod), 45m/148ft (cable), longer upon request	2-wire (HART) ±1.0% −80...+200°C/−112...+392°F −1...+100bar/−14.5...+1,450psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 4m/13ft (rod), 10m/32ft (cable)	2-wire (HART, PA, FF) ±0.05% of the set span −70...+400°C/−94...+752°F up to +420bar/+6,092psi Threads, flanges (DIN, ANSI, JIS), hygienic connections Typically up to 100m/328ft
▪ Strong buildup formation (e.g. high viscosity, crystallizing media, etc.) → radar ▪ Low DK value (< 1.4) → hydrostatic	▪ Changing, non-conductive media or conductivity between 1...100µS/cm → guided radar, radar ▪ Strong, conductive buildup formation → radar, hydrostatic	▪ Changing density → radar, ultrasonic ▪ Strong buildup formation → radar, ultrasonic, bubble system

Please note: Guided radar continued on Page 48

Please note: Capacitance continued on Page 60

3. Selection of the measuring principle according to the application

B

Non-contact

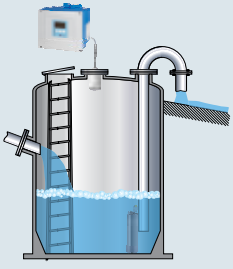
	First Choice	
	Ultrasonic Prosonic S/M	**Radar** Micropilot
	(Remote)  FMU90  FDU9x (Compact)  FMU4x	 FMR5x
Advantages	▪ Overspill-protected, heated sensors with self-cleaning effect ▪ Universal use due to flexible measuring range ▪ Operation and display at easily accessible mounting locations possible incl. integrated point level relay and integrated control functions	▪ Universally usable (freely adjustable measuring range) ▪ Unaffected by temperature layers ▪ Free of maintenance
Technical data ▪ Connection ▪ Accuracy ▪ Process temperature ▪ Process pressure ▪ Process connection ▪ Maximum measuring range	2-/4-wire (HART, DP, PA, FF) ±2mm/±0.08", +0.17% of the distance −40...+105°C/−40...+221°F −0.3...+3bar/−4.4...+44psi Threads, Tri-Clamp, flanges (DIN, ANSI, JIS) 20m/65ft	2-wire (HART, PA, FF), 4-wire HART ±2mm/±0.08" −196...+450°C/−321...+842°F −1...+160bar/−14.5...+2,320psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 70m/229ft
Application limits	▪ Strong formation of foam ▪ Many obstacles → hydrostatic	▪ Strong formation of foam ▪ Many obstacles → hydrostatic

Please note:
Ultrasonic continued on Page 54

Please note:
Free Space Radar continued on Page 32

Pumping station/sump/ rain water basin

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



B

Contact

First Choice

Hydrostatic Deltapilot M / Waterpilot	Capacitance Liquicap M
 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 (HART, PA, FF) ±0.1% −10...+80°C/+14...+176°F Ambient pressure Mounting clamp, cable mounting screw 200m/656ft (20bar/290psi)	2-wire (HART) ±1.0% −80...+200°C/−112...+392°F −1...+100bar/−14.5...+1,450psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 4m/13ft (rod), 10m/32ft (cable)
▪ Risk of sludge formation/pollution (buildup) → ultrasonic, radar	▪ Changing, non-conductive media or conductivity between 1...100µS/cm → guided radar, radar ▪ Strong, conductive buildup formation → radar, hydrostatic

Please note: Hydrostatic continued on Page 63

Please note: Capacitance continued on Page 60

3. Selection of the measuring principle according to the application

B

Non-contact

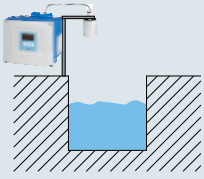
	First Choice	
	Ultrasonic Prosonic S/M	**Radar** Micropilot
	(Remote)  FMU90  FDU9x (Compact)  FMU4x	 FMR5x
Advantages	▪ No flow impairment ▪ Overspill-protected, heated sensors with self-cleaning effect ▪ Operation and display at easily accessible mounting locations possible incl. integrated point level relay and preprogrammed flow curves	▪ Universally usable (freely adjustable measuring range) ▪ Unaffected by temperature layers ▪ Maintenance free
Technical data ▪ Connection ▪ Accuracy ▪ Process temperature ▪ Process pressure ▪ Process connection ▪ Maximum measuring range	2-/4-wire (HART, DP, PA, FF) ±2mm/±0.08", +0.17% of the distance −40...+105°C/−40...+221°F −0.3...+3bar/−4.4...+44psi Threads, Tri-Clamp, flanges (DIN, ANSI, JIS) 20m/65ft	2-wire (HART, PA, FF), 4-wire HART ±2mm/±0.08" −196...+450°C/−321...+842°F −1...+160bar/−14.5...+2,320psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 70m/229ft
Application limits	▪ Strong formation of foam ▪ Many obstacles → hydrostatic	▪ Strong formation of foam ▪ Many obstacles → hydrostatic

Please note:
Ultrasonic continued on Page 54

Please note:
Free Space Radar continued on Page 32

Open channel flow measurement

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



B

Contact

Hydrostatic
Waterpilot / Deltapilot M

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

2-wire (HART, PA, FF)
±0.1%
–10...+80°C/+14...+176°F
Ambient pressure
Mounting clamp, cable mounting screw

200m/656ft (20bar/290psi)

▪ Risk of sludge accumulation / pollution (buildup formation)	→ ultrasonic, radar
▪ Installation not in flowing water	→ ultrasonic, radar

Please note:
Hydrostatic continued on Page 63

3. Selection of the measuring principle according to the application

B

Contact

	① Guided radar Levelflex  FMP51/52/54	① ② Multiparameter Levelflex  FMP55
Advantages	▪ Simultaneous acquisition of interface layer and total level ▪ Unaffected 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...+450°C/−321...+842°F −1...+400bar/−14.5...+5,800psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 6m/20ft (coax), 10m/33ft (cable/rod), longer upon request	 2-wire (HART/PA), 4-wire ±2mm/±0.08" (overall level); ±10mm/±0.39" (interface level) −50...+200°C/−58...+392°F −1...+40bar/−14.5...+580psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 6m/20ft (coax), 10m/33ft (cable), 4m/13ft (rod), longer upon request
Application limits	▪ Dielectric constant (DK value) of the upper medium must be determined ▪ DK value changes of the upper medium influence accuracy ▪ DK value of the upper medium may be max. 10 ▪ Difference of the DKs 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 (DK value) of the upper medium must be determined ▪ DK value changes of the upper medium affect the accuracy ▪ DK value of the upper medium may be max. 10 ▪ DK value difference between both media must be >10 ▪ For interface layer measurement, the thickness of the upper phase must be minimum 60mm/2.36"

Please note:
Guided radar continued on Page 48

Interface measurement

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

B

Non-contact

① ② Capacitance Liquicap	① ② ③ Gamma Gammapilot
 FMI51/52	  FMG60
▪ No wet calibration required (FieldCare software tool) ▪ Unaffected by the density of the medium ▪ Suitable for use in emulsion layers ▪ Ideal for very small measuring ranges ▪ Extremely fast response time	▪ Non-invasive and maintenance-free measuring method ▪ Unaffected by pressure and temperature ▪ Only slight influence by buildup ▪ Unproblematic use in emulsion layers ▪ Solutions for multiphase measurements using several detectors
2-wire (HART) ±1% –80...+200°C/–112...+392°F –1...+100bar/–14.5...+1,450psi Threads, flanges (DIN, ANSI, JIS), hygienic connections 4m/13ft (rod), 10m/32ft (cable)	4-wire (HART, PA, FF) ±1% of measuring distance Independent (non-invasive) Independent (non-invasive) Independent (non-invasive) Adaptable to application
▪ Difference of the dielectric constant (DK value) between the two media must be >10. The upper medium may not be conductive ▪ Nonconductive buildup on the probe will affect accuracy ▪ The smaller the vessel the higher the influence of DK changes in the upper medium ▪ The differential in DK (below) / DK(above) the better the accuracy ▪ The total level is not measured	▪ Density changes of the medium influence the accuracy ▪ The overall level is not measured (possible with a further source and detector) ▪ Wet calibration required ▪ Radiation Protection Laws must be observed

Please note:
Capacitance continued on Page 60

4. Instrument selection within the measuring principle

Free Space Radar

Required application data
- Pressure and temperature
- Dielectric constant of the medium (DK)/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
- T < −196°C/−321°F or T > +450°C/+842°F
- p > 160bar/2320psi
- Measuring range > 70m/229ft
- Dielectric constant < 1.4
- Process connection < 1½"

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

For reliable measurement

Use a horn antenna whenever possible. In addition, this should have the largest possible diameter.

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

Media group	DK value	Examples
A	1.4...1.9	non-conductive liquids, e.g. liquified gas[1)]
B	1.9...4	non-conductive liquids, e.g. benzene, oil, toluene, ...
C	4...10	e.g. concentrated acid, organic solvents, ester, analin, alcohol, acetone, ...
D	Larger than 10	conductive liquids, aqueous solutions, diluted acids and alkalis

- [1)]Treat ammonia (NH3) like a medium of group A, i.e. measurement in stilling wells always with FMR54. Alternatively, measurement with guided radar FMP54
- Measuring range: Larger than 40m/131ft → Micropilot with option "advanced dynamics" max. measuring range 70m/229ft
- Accuracy: More precise than 2mm/0.08" → Micropilot S (FMR5XX), or consult factory

4. Instrument selection within the measuring principle

Radar – process industry

	Micropilot FMR50 K-Band²	Micropilot FMR51 K-Band²	Micropilot FMR52 K-Band²
			
Technical data			
▪ Process pressure	−1…+3bar/ −14.5…+43.5psi	−1…+160bar/ −14.5…+2320psi	−1…+16bar/−14.5…+232psi
▪ Process temperature	−40…+130°C/ −40…+266°F	−196…+450°C/ −321…+842°F	−40…+200°C/−40…+392°F
▪ Accuracy	±2mm/±0.08"	±2mm/±0.08"	±2mm/±0.08"
▪ Process connection	G 1½", 1½" NPT, DN 80… DN 150/3"…6"	R 1½", DN 50… DN 150/2"…6", Tri-Clamp	DN 50…DN 150/2"…6", Tri-Clamp, hygienic connections
▪ Wetted parts	PTFE, PVDF, Viton, PP, sealings	316L/1.4435, Alloy C, PTFE, sealings	PTFE
▪ Measuring ranges	30m/98ft	40m/131ft	40m/131ft
▪ Gastight feedthrough	–	Optional	Optional
▪ Technical Information	TI 01039F	TI 01040F	TI 01040F
Applications			
Horizontal storage tank cyl.	O	+	+
Vertical storage tank	+	+	+
Buffer tank	+	+	+
Recipient tank	–	–	–
Process tank	O	+	+
Stilling well	–	+	+
Bypass	–	O	+
Pump station	+	+	+
Channel measurement	+	O	O
Application limits	▪ Ammoniacal gas phase → FMR54 in stilling well ▪ Strong buildup formation → FMR54 with air purge ▪ Low DK → FMR51 ▪ Only PTFE resistant → FMR52 ▪ Custody transfer measurement → FMR540	▪ Ammoniacal gas phase → FMR54 in stilling well ▪ Strong buildup formation → FMR54 with air purge ▪ 316L/1.4435 or Alloy C non-resistant → FMR50, 52, 52 ▪ Hygienic requirements → FMR52, 53 ▪ Custody transfer measurement → FMR5xx	▪ Ammoniacal gas phase → FMR54 in stilling well ▪ Strong build-up formation rate → FMR54 with air purge ▪ Small connections with low DK → FMR53 ▪ Low DK and high nozzle → FMR51 ▪ Custody transfer measurement → FMR5xx

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

	Micropilot FMR53 C-Band[1]	**Micropilot FMR54** C-Band[1]	**Micropilot S FMR53x** C-Band[1] / custody transfer	**Micropilot S FMR540** K-Band[2] / custody transfer
				
	−1...+40bar/ −14.5...+580psi −40...+150°C/ −40...+302°F ±6mm/0.24" R 1½", DN 50...DN 150/ 2"...6" 316L/1.4435, PTFE, PVDF, sealings 20m/65ft Optional TI 01041F	−1...+160bar/ −14.5...+2320psi −196...+400°C/ −321...+752°F ±6mm/0.24" DN 80...DN 250/3"...10" 316L/1.4435, Alloy C, PTFE, ceramics, graphite, sealings 20m/65ft Standard TI 01041F	−1...+40bar/ −14.5...+580psi −40...+200°C/ −40...+392°F ±1mm/±0.04" DN 80...DN 250/3"...10" 316Ti/1.4571, PTFE, 316L/ 1.4435, HNBR, sealings 25m/82ft Standard TI 00344F	−1...+16bar/ −14.5...+232psi −40...+200°C/ −40...+392°F ±1mm/±0.04" DN 80...DN 250/3"...10" 316L/1.4435, PTFE, PEEK, sealings 40m/131ft Standard TI 00412F
	–	–	–	–
	O	O	O	+
	O	O	–	–
	–	–	–	–
	+	+	–	–
	–	+	+*	–
	–	O	–	–
	–	–	–	–
	–	–	–	–
	▪ Nozzle height > 250 mm /9.8" ▪ Low DK → FMR51, 52, 54	▪ Free space with nozzle < DN 150/6" → FMR51, 52, 53 ▪ Stilling well with ball valve → FMR51, 52 ▪ Hygienic requirements ▪ 316L/ 1.4435 or Alloy C non-resistant → FMR 52, 53	▪ Free space and many baffles → FMR540	▪ Strong condensate or buildup formation → FMR53x ▪ Existing stilling wells with non-ideal measuring conditions → FMR532

[1] C-band: 6GHz

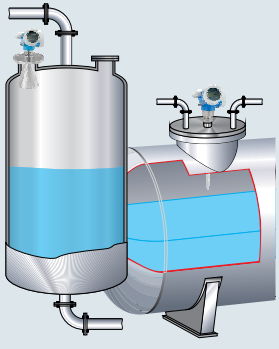
[2] K-band: 26GHz

4. Instrument selection within the measuring principle

Measuring range is based on the type of tank

Process conditions and medium for Micropilot FMR50/FMR51/FMR52

Storage tank / Channel measurement
Calm surface
(e. g. bottom filling, filling via immersion tube or rare free filling from above)



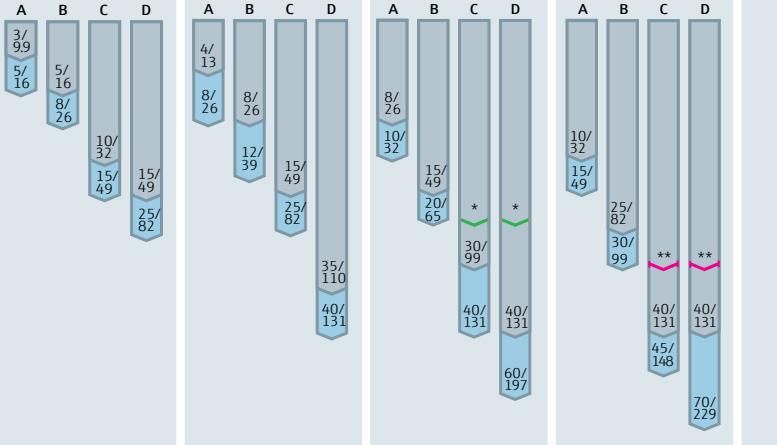
	Horn/antenna diameter			
FMR50	40mm/1.5"	–	* 80mm/3"	** 100mm/4"
FMR51	40mm/1.5"	50mm/2"	80mm/3"	100mm/4"
FMR52	–	50mm/2"	80mm/3"	–

Measuring range in m/ft

Media group
A: DK = 1.4...1.9
B: DK = 1.9...4
C: DK = 4...10
D: DK = > 10

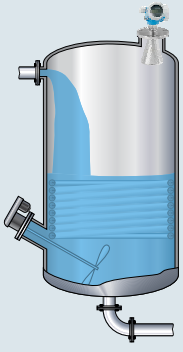
Standard: Max. measuring range = 40m/131ft

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



* Advised max. measuring range = 20m/65ft; with „advanced dynamics" = 30m/98ft
** Advised max. measuring range = 30m/98ft; with „advanced dynamics" = 40m/131ft

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



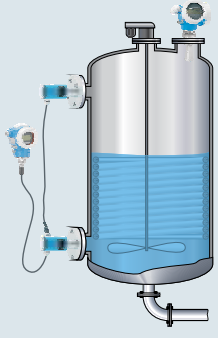
	40mm/1.5"	–	80mm/3"	100mm/4"
	40mm/1.5"	50mm/2"	80mm/3"	100mm/4"
	–	50mm/2"	80mm/3"	–
	B C D 2/ 6.6 4/ 13 5/ 16 7.5/ 25 10/ 32	B C D 3/ 9.9 5/ 16 7.5/ 25 10/ 33 10/ 32 15/ 49	A B C D 2,5 5/ 16 5/ 16 10/ 32 10/ 32 15/ 49 15/ 49 25/ 85	A B C D 5/ 16 7.5/ 25 10/ 32 15/ 49 15/ 49 25/ 82 25/ 82 35/ 110

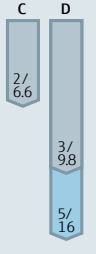
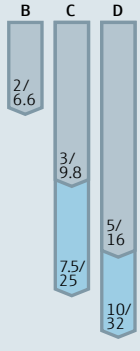
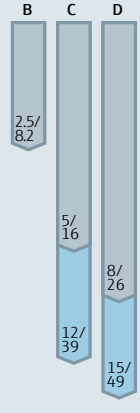
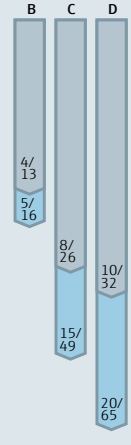
4. Instrument selection within the measuring principle

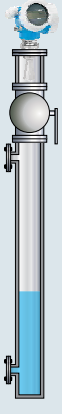
Measuring range is based on the type of tank

Process conditions and medium for Micropilot FMR50/FMR51/FMR52

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



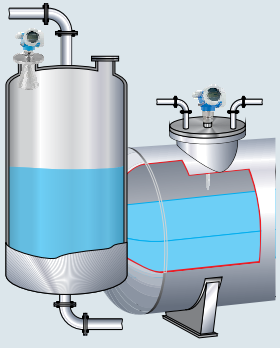
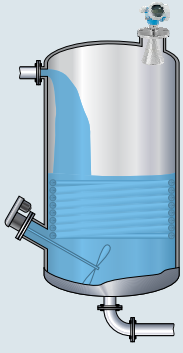
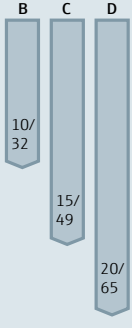
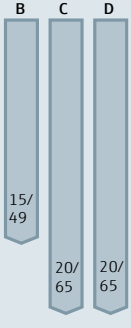
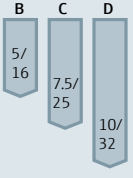
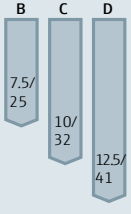
	Horn/antenna diameter			
FMR50	40mm/1.5"	–	80mm/3"	100mm/4"
FMR51	40mm/1.5"	50mm/2"	80mm/3"	100mm/4"
FMR52	–	50mm/2"	80mm/3"	–
	Measuring range in m/ft			
Media group **A:** DK = 1.4...1.9 **B:** DK = 1.9...4 **C:** DK = 4...10 **D:** DK = > 10 Standard: Max. measuring range = 40m/131ft With application package "Advanced dynamics": Max. measuring range = 70m/229ft Min. measuring range = 5m/16ft				

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

4. Instrument selection within the measuring principle

Radar – process industry

Measuring range is based on the type of tank, process conditions and medium for Micropilot FMR53/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			
FMR53	Rod antenna	–	Rod antenna	–
FMR54	150mm/6"	200mm/8" 250mm/10"	150mm/6"	200mm/8" 250mm/10"
	Measuring range in m/ft			
Media group **A:** DK = 1.4...1.9 **B:** DK = 1.9...4 **C:** DK = 4...10 **D:** DK = > 10				

[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.

	Tank with single-stage propeller agitator[1] Turbulent surface, single-stage agitator < 60 RPM		**Stilling well**		**Bypass**
					
	Rod antenna	–	–	–	–
	150mm/6"	200mm/8" 250mm/10"	80...250mm/ 3...10"	Planar antenna 150...300mm/6...12"	80...250mm/ 3...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

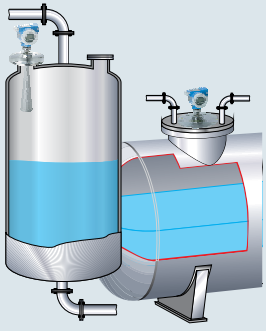
4. Instrument selection within the measuring principle

C

Measuring range is based on the type of tank

Process conditions and medium for Micropilot S FMR530/532/533/540

Storage tank
Highly accurate measurement, custody transfer



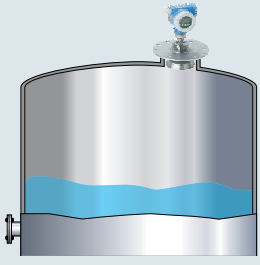
	Horn/antenna diameter		
FMR530		150mm/6"	200mm/250mm 8"/10"
FMR532			
FMR533			
FMR540	100mm/4"		
	Measuring range in m/ft		
Media group **A:** DK = 1.4...1.9 **B:** DK = 1.9...4 **C:** DK = 4...10 **D:** DK = > 10 Standard: Max. measuring range = 40m/131ft	B: 20/65 C, D: 23/75 *, 30/99	B: 10/32	B: 15/49 C: 20/65 D: 25/82

*Custody transfer NMi and PTB

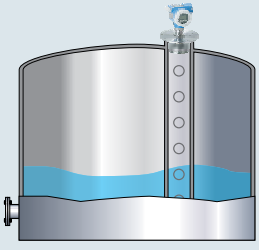
*Custody transfer NMi

*Custody transfer PTB

Storage tank
Highly accurate measurement, custody transfer



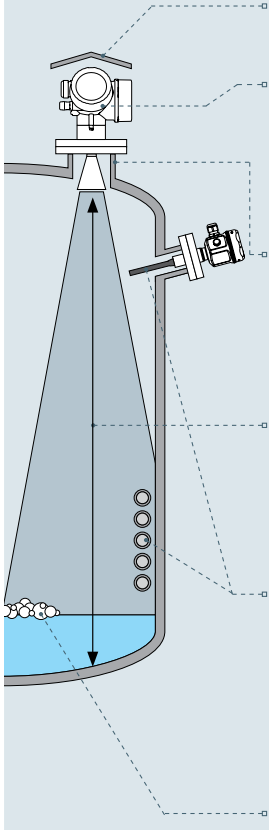
Stilling well
Highly accurate measurement, custody transfer



		150mm/200mm/250mm/300mm 6"/8"/10"/12"
	450mm/18"	
200mm/250mm 8"/10"		
B, C, D	B, C, D	A, B, C, D
26/ 85 * 40/ 131	25/ 82 * 30/ 98 * 40/ 131	25/ 82 * 30/ 98 * 38/ 125

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)

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

Nozzle
- FMR54 horn antenna should protrude from the nozzle. Please note the max. nozzle length, otherwise use antenna extension
- FMR50/52 note the max. nozzle length
- FMR53: 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 Documentation

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 buildup 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

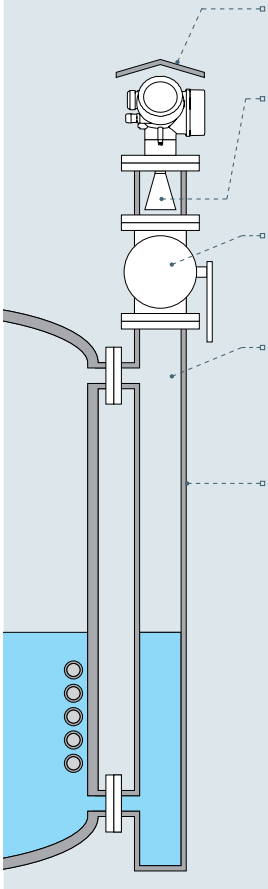
Optimization options
- Size of antenna: The larger the antenna diameter the smaller the beam angle (see table below, the less interference echoes)
- A stilling well or a Levelflex can always be used to avoid interference

Foam
- Radar pulses may be absorbed by foam
- The surface of foam can reflect. Solution: Trial measurement with 26GHz or e.g. Levelflex or hydrostatic measurement

Version FMR		**54**		**53 531**	**50 51**	**51 52**	**50 51 52**	**50 51**
Antenna	DN150	DN200	DN250	Rod	DN40	DN50	DN80	DN100
Beam angle	23°	19°	15°	30°	23°	18°	10°	8°
Max. nozzle length without extension **[mm/"]**	205/ 8.1	290/ 11.5	380/ 15	250/ 10	500/20			

measurements in mm/inch

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 inbetween sizes (e.g. 95mm/3.7") use the next largest antenna and adapt it mechanically

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

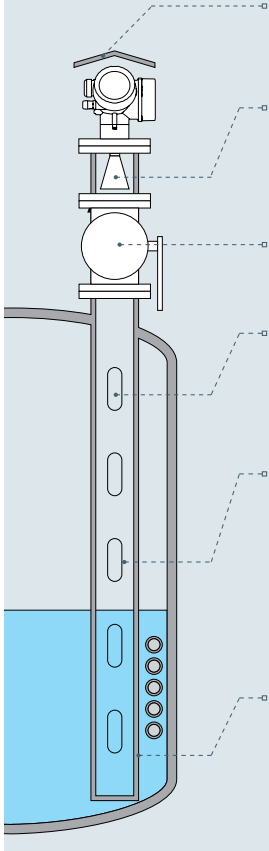
Measuring range
- Measurement is possible up to the tip of the antenna, on principle, however, the end of the measuring range should not be closer than 50mm/2" to the tip of the antenna because of corrosion and buildup formation

Recommendations for the bypass
- Metallic (without plastic or enamel coating)
- The bypass pipe must be smooth inside (averaged roughness Ra ≤ 6.3µm or 250µi)
- Constant diameter
- In transitions, caused for example by ball valves or joining of individual pipe pieces, gaps of max. 1mm/0.04" are permitted

	530		533	540	
DN150	DN200	DN250	Parabolic		DN100
23°	19°	15°	7°	4°	8°
180/ 7.1	260/ 10.2	350/ 13.8	200/ 7.9	50/ 2	430/ 17

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

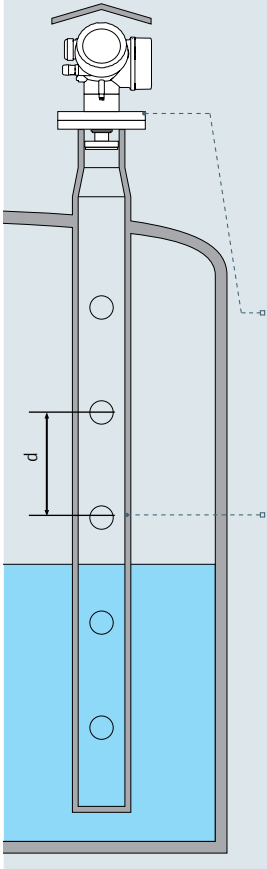
Optimum horn size
- Select horn antenna as large as possible. In case of inbetween sizes (e.g. 95mm/3.7") use the next larger antenna and adapt it mechanically (inner diameter of stilling well ≙ diameter of horn)

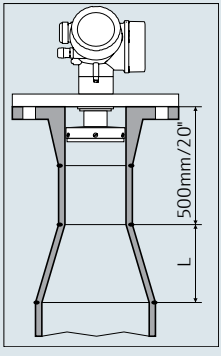
Ball valve (if available)
- Measurements through an open ball valve with full passage are possible

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 buildup 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
- Preferred on one side only
- 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/FMR532

- 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/FMR532 (planar antenna)** a gradual transition (DN 150/6" to DN 200/8", DN 200/8" to DN 250/10", DN 250/10" to DN 300/12") can be accepted. In such cases, the upper pipe end must have a minimum length of 500mm/20" prior to the transition. Length (L) of the transition must be an additional 300mm/12" or for DN 250/10" to DN 300/12" 450mm/18"
- Transitioning to a larger pipe (e.g. DN 150/6" to DN 300/12") is possible, if length (L) of the transition = 450mm/18"
- Ideally, a gauge nozzle is used as upper pipe end
- Rectangular pipe transition is not permitted

4. Instrument selection within the measuring principle

Guided radar

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

Additional for interface measurement
- Dielectric constant (DK) of both liquids

Application limits for guided level radar
- T < −196°C/−321°F and T > +450°C/+842°F
- p > 400bar/5,800psi
- Measuring range > 45m/148ft (longer upon request)
- Dielectric constant < 1.4
- Process connection < ¾"
- Measuring range > 10m/32ft for interface measurement (upon request)

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

C

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

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

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

4. Instrument selection within the measuring principle

Guided radar – process industry

	Levelflex FMP50	Levelflex FMP51	Levelflex FMP52
			
Technical data			
▪ Process pressure ▪ Process temperature ▪ Accuracy	−1…+6bar/−14.5…+87psi −20…+80°C/−4…+176°F < 15m/49ft: ±2mm/0.08"	−1…+40bar/−14.5…+580psi −40…+200°C/−40…+392°F < 15m/49ft: ±2mm/0.08"; > 15m/49ft: ±10mm/0.4"	−1…+40bar/−14.5…+580psi −50…+200°C/−58…+392°F < 15m/49ft: ±2mm/0.08"; > 15m/49ft: ±10mm/0.4"
▪ Process connection	G/NPT ¾"	G/NPT ¾" and 1½", DN 40…200/1.5"…8" flange	Tri-Clamp 1½" to 3", DIN 11851, DN 40…DN 150/1.5"…6" flange
▪ Wetted parts	Cable/rod: 316L, PPS	Cable: 316, rod and coax: 316L, Alloy C (C22/2.4602), ceramics	PTFE, PFA
▪ Measuring ranges	0.3…4m/1…13ft (rod), 0.3…12m/1…39ft (cable)	0.3…10m/1…33ft (rod), 1…45m/3.2…148ft (cable), 0.3…6m/1…20ft (coax)	0.3…4m/1…13ft (rod), 1…45m/3.2…148ft (cable)
▪ Gastight feedthrough ▪ Technical Information	– TI 01000F	Optional TI 01001F	Optional TI 01001F
Applications			
Horizontal storage tank cyl.	O	+*	–
Vertical storage tank	+	+	+
Buffer tank	O	+	+
Recipient tank	+	O	O
Process tank	–	–	–
Stilling well	+	+	O
Bypass	O	+	O
Pump station	–	–	–
Channel measurement	–	–	–
Interface measurement	–	+**	+**
Application limits	▪ Aggressive media → FMP52 ▪ High pressure/ temperatures >80°C/ 176°F; 6bar/87psi → FMP51, FMP54	▪ Aggressive media → FMP52 ▪ Interface with emulsion → FMP55	▪ High process temperatures (>302°F) → Possible diffusion through the probe coating → Limited lifetime → FMP54 ▪ Interface with emulsion → FMP55

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

	Levelflex FMP53	Levelflex FMP54	Levelflex FMP55
			
	−1...+16bar/−14.5...+232psi −20...+150°C/−4...+302°F < 15m/49ft: ±2mm/0.08"	−1...+400bar/−14.5...+5,800psi −196...+450°C/−321...+842°F < 15m/49ft: ±2mm/0.08"; > 15m/49ft: ±10mm/0.4", ±5mm/±0.02" (coax)	−1...+40bar/−14.5...+580psi −50...+200°C/−58...+392°F < 10m/33ft: ±2mm/0.08"; ±5mm/±0.02" (coax)
	Tri-Clamp, DIN 11851, SMS, DIN 11864, NEUMO	G/NPT 1½", DN 50...DN 100/2"...4" flange	DN 50...DN 150/2"...6" flange
	316L/1.4435, PEEK®	Cable: 316, rod and coax: 316L, ceramics, graphite, Alloy C (C22/2.4602)	PTFE, PFA
	0.3...6m/1...20ft (rod)	0.3...10m/1...33ft (rod), 1...45m/3.2...148ft (cable), 0.3...6m/1...20ft (coax)	0.3...4m/1...13ft (rod), 1...10m//3.2...33ft (cable), 0.3...6m/1...20ft (coax)
	– TI 01002F	Standard TI 01001F	Standard TI 01003F
	O	+*	–
	+	+	+
	+	+	–
	+	–	–
	–	–	–
	–	+	+
	–	+	+
	–	–	–
	–	–	–
	–	+**	+***
		▪ Interface with emulsion → FMP55	

* = consider coax probe

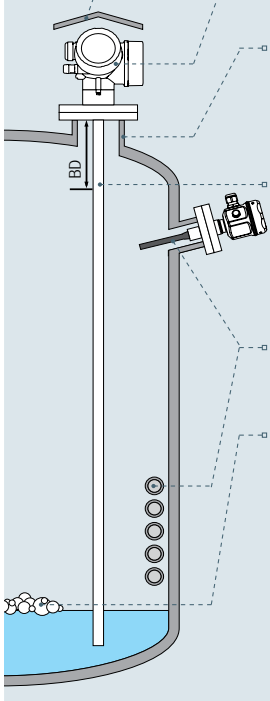
** = use of coax system recommended (coax probe, bypass, stilling well)

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

4. Instrument selection within the measuring principle

C

Installation instructions guided radar – direct insertion in vessel



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

Installation
- Not in the center
- Not above the fillstream
- Any wall distance, avoid wall contact

Nozzle
- Nozzle diameters of DN 40 to DN 150/1.5"...6" and nozzle heights up to 150mm/6" are preferred
- For cable probes in nozzles with > 150mm/6" in height, an HMP40 rod extension must be used

Measuring range
- Smallest measuring range: 300mm/12"
- Largest measuring range: 45m/148ft (longer upon request)
- For minimum distance probe end ↔ tank bottom see table below
- Measurement is possible up to the blocking distance (BD), based on application

Tank installations
- Distance to obstacles min. 300mm/12"
- During commissioning interference echos can be suppressed

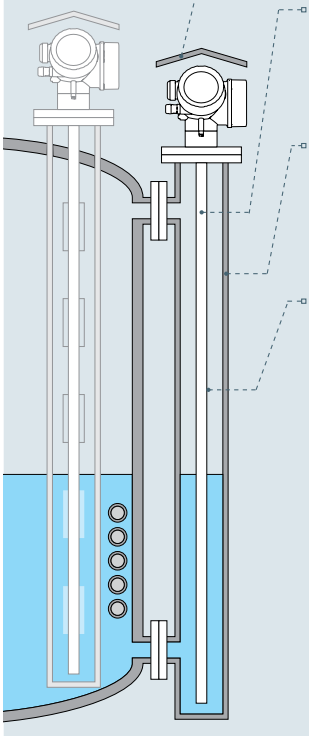
Turbulent surface/foam
- Turbulent surfaces do not affect measurement
- Foam layers of up to approx. 100mm/4" do not affect measurement. Higher foam thickness may result in too small readings

Blocking distance (BD) and minimal distance from the tank bottom
- Blocking distance top*:
  - Coax probe: 0mm/0"
  - Cable or rod probe ≤ 8m/26ft: 200mm/8"
    Cable or rod probe > 8m/26ft: 0.025 x probe length
- Minimal distance from tank bottom: > 10mm/0.4"

* The blocking distance (BD) is preset from the factory. Depending from the application these settings can be adjusted.

If the DK value in cable probes is < 7, measurement is not possible in the tensioning weight area (0...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 (larger upon request)

Pipe diameter
- Pipes of DN 40 ... DN 150/1.5"...6" are 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
- No special requirements of bypass pipe or stilling well
- Welding seams protruding internally up to approx. 5mm/0.2" do not impair measurement
- Wall contact by rod probes must be avoided. Use a centering disk at the end of the probe, if required

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 diameter must not change
- In case of interface layer measurement, the centering disk must be of plastic material

4. Instrument selection within the measuring principle

Ultrasonic

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
- T < –40°C/–40°F or T > 105°C/221°F
- p < –0.3bar/–4.4psi and p > 3bar/44psi
- Measuring range > 20m/65ft
- Vapor pressure > 50mbar/0.73psi (20°C/68°F)
- Process connection < 1½"
- Strong temperature fluctuations in the measuring range can affect the accuracy

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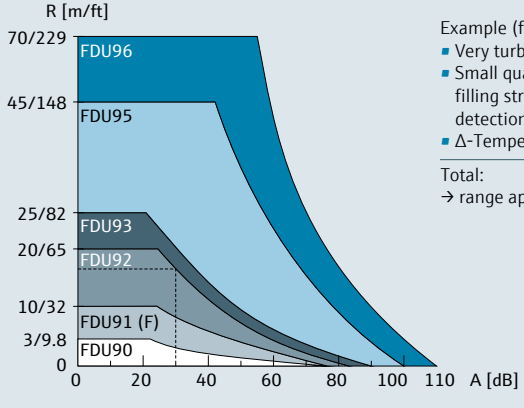
Damping caused by process

Surface of liquid		Filling stream in the detection range		Δ-Temp. sensor ↔ medium surface	
Calm	0dB	None	0dB	Up to 20°C/68°F	0dB
Waves	5...10dB	Small quantities	5...10dB	Up to 40°C/104°F	5...10dB
Strong turbulence	10...20dB	Large quantities	10...40dB	Up to 80°C/176°F	10...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 stream in the detection range: 10dB
- Δ-Temperature up to 40°C: 10dB

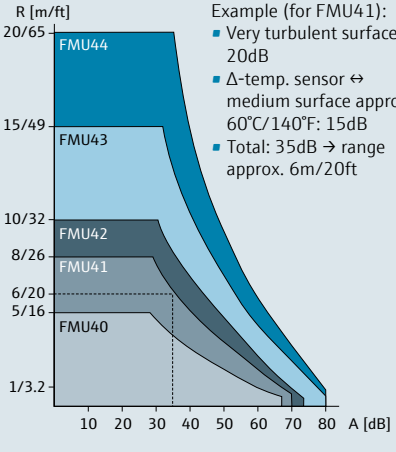
Total: 40dB
→ range approx. 15m/49ft from diagram

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.

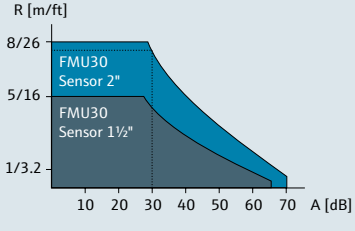
Advantages
- Non-contact, maintenance-free measurement
- Unaffected by product properties, e.g. DK, density, etc.
- Calibration without filling or discharging
- Self-cleaning effect of sensors due to the flexing of the transducer diaphragm

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 stream in detection range:	10dB
Total:	approx. 30dB

→ range approx. 7.8m/26ft from diagram

4. Instrument selection within the measuring principle

Ultrasonic – process industry

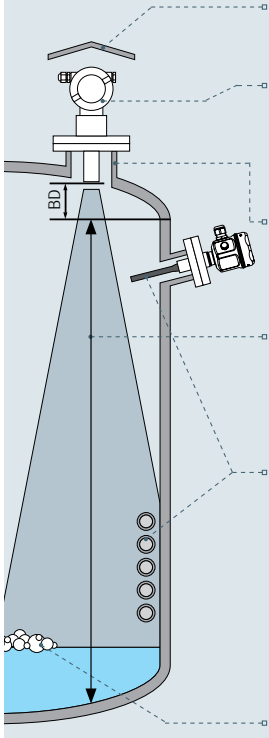
	Prosonic T FMU30		Prosonic M FMU40/41		Prosonic M FMU42/44	
						
Technical data						
▪ Process pressure	−0.3...+2bar/−4.4...+29psi		−0.3...+2bar/−4.4...+29psi		−0.3...+1.5bar/−4.4...+22psi	
▪ Process temperature	−20...+60°C/−4...+140°F		−40...+80°C/−40...+176°F		−40...+80°C/−40...+176°F	
▪ Accuracy	±3mm/±0.12" or 0.2% of distance		±2mm/±0.08" or 0.2% of distance		±4mm/±0.16" or 0.2% of distance	
▪ Process connection	G/NPT 1½" or 2"		G/NPT 1½" or 2" (accessory flange FAX50)		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...5m/0.8...16ft (1½") 0.35...8m/1.1...26ft (2")		0.25...5m/0.8...16ft (FMU40) 0.35...8m/1.1...26ft (FMU41)		0.4...10m/1.3...32ft (FMU42) 0.5...20m/1.6...65ft (FMU44)	
▪ Point level detection	–		–		–	
▪ Technical Information	TI 00440F		TI 00365F		TI 00365F	
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 station	O	O	O	O	O	O
Channel measurement	O	O	O	O	O	O
Application limits	▪ For higher resistance → FMU42, FDU9x ▪ Foam/high turbulence possible → FMU30 (2") FMU42, FDU91 ▪ Fast filling and discharging rate → FMU90 + FDU9x ▪ Point level detection → FMU90 + FDU9x		▪ For higher resistance → FMU42, FDU9x ▪ Foam/high turbulence possible → FMU41, FMU42/FDU91 ▪ Fast filling and discharging rate → FMU90 + FDU9x ▪ Point level detection → FMU90 + FDU9x		▪ Foam/high turbulence possible → FMU44/FDU92 ▪ Fast filling and discharging rate → FMU90 + FDU9x ▪ Point level detection → FMU90 + FDU9x	

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

Prosonic S FDU90	Prosonic S FMU90/95, FDU91	Prosonic S FMU90/95, FDU91F	Prosonic S FMU90/95, FDU92
			
−0.3...+3bar/−4.4...+44psi −40...+80°C/−40...+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...3m/0.2...9.6ft 1, 3 or 6 relays TI 00396 / TI 00397	−0.3...+3bar/−4.4...+44psi −40...+80°C/−40...+176°F ±2mm/±0.08" or +0.17% of distance G/NPT 1" (accessory flange FAX50) PVDF 0.3...10m/1...32ft 1, 3 or 6 relays TI 00396 / TI 00397	−0.3...+3bar/−4.4...+44psi −40...+105°C/−40...+221°F ±2mm/±0.08" or +0.17% of distance G/NPT 1" (accessory flange FAX50), Tri-Clamp DN 80 316L 0.3...10m/1...32ft 1, 3 or 6 relays TI 00396 / TI 00397	−0.3...+3bar/−4.4...+44psi −40...+95°C/−40...+203°F ±2mm/±0.08" or 0.2% of distance G/NPT 1" (accessory flange FAX50) PVDF 0.4...20m/1.3...65ft 1, 3 or 6 relays TI 00396 / TI 00397
+	+	+	O
+	+	+	+
+	+	+	–
–	–	–	–
+	+	+	+
+	+	+	+
–	–	–	–
+	+	O	+
+	+	O	+
▪ Foam/high turbulence possible → FDU91 ▪ For tank farm scanner FMU95	▪ Foam/high turbulence possible → FDU92 ▪ Flange-flush assembly → FDU91F ▪ For tank farm scanner FMU95	▪ If foam/high turbulence possible → FDU92 ▪ For tank farm scanner FMU95	▪ For tank farm scanner FMU95

4. Instrument selection within the measuring principle

Installation instructions ultrasonic – 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

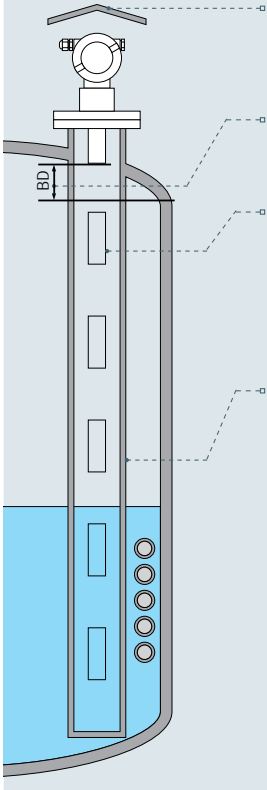
Tank installations
- Avoid any installations like limit switches, temperature sensors, etc. within the signal beam (see table)
- Symmetrical installations, i. e. heating coils, flow breakers, etc. can also interfere with the measurement

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 buildup tendency of the medium

Formation of foam
- Ultrasonic signals may be absorbed by foam
- The surface of foam can reflect. Solution: Trial measurement with ultrasonic 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"	3"				2"[2]			
DN 80 /3"	9.5"	9.5"	10"		13"[1]/10"[2]	13"	13"	
DN 100 /4"	12"	12"	12"		15"[1]/12"[2]	15"	15"	
DN 150 /6"	16"	16"	16"	16"	16"[1]/12"[2]	16"	16"	16"
Beam angle	11°	11°	11°	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



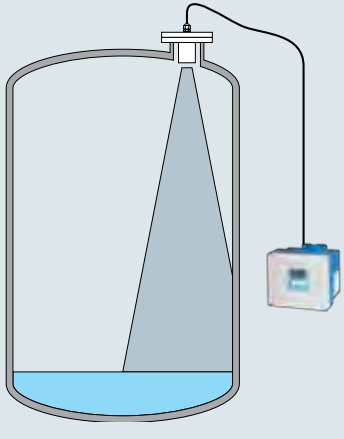
Weather protection cover
- Always recommended for outside installation to avoid strong temperature changes of electronics

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 transmitter with FMU9x



4. Instrument selection within the measuring principle

Capacitance

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

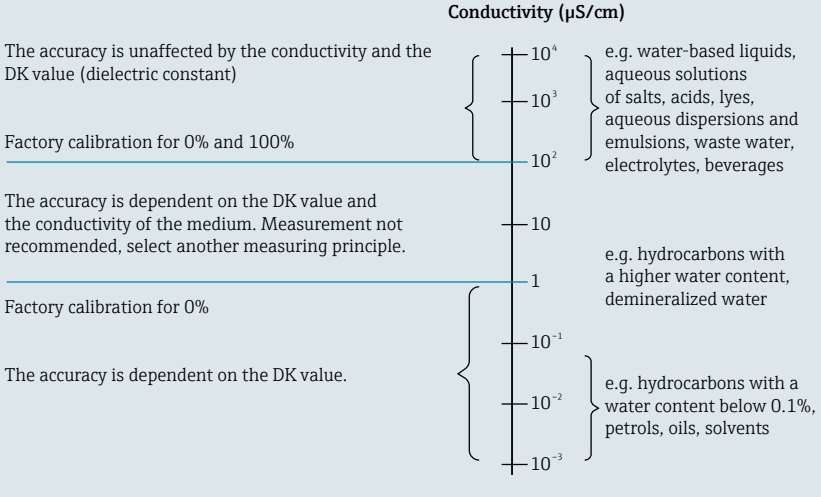
Starting from a conductivity of 100µS/cm the measured value is not affected by the dielectric constant and the conductivity of the medium.
The following table describes different media.

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.

C

Application limits for capacitance level measurement
- T < −80°C/−112°F or T > +200°C/+392°F
- p > 100bar/1,450psi
- Measuring range > 10m/3.2ft

Operating range of Liquicap



Capacitance – process industry

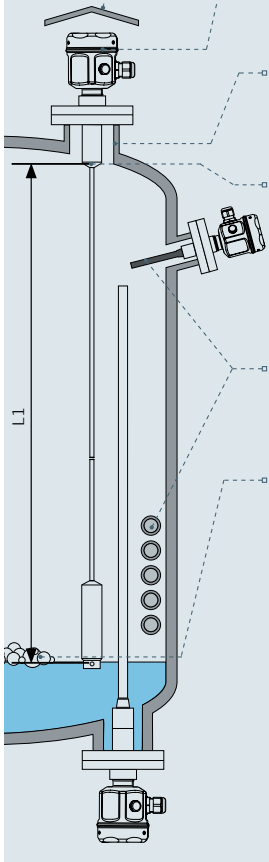
	Liquicap M FMI51	Liquicap M FMI52	Liquicap T FMI21
			
Technical data			
▪ Process pressure	–1…+100bar/ -14.5…+1,450psi	–1…+100bar/ -14.5…+1,450psi	–1…+10bar/ -14.5…+145psi
▪ Process temperature	–80…+200°C/ –112…+392°F	–80…+200°C/ –112…+392°F	–40…+100°C/ –40…+212°F
▪ Accuracy	±1%	±1%	±1%
▪ Process connection	Thread ½"…1½", flanges EN, ANSI, JIS, hygienic	Thread ½"…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	Cable probe up to 10m/32ft	up to 2.5m/8.2ft
▪ Gastight feedthrough	Optional	Optional	–
▪ Technical Information	TI 00401F	TI 00401F	TI 00393F
Applications			
Horizontal storage tank cyl.	+	O	+
Vertical storage tank	+	+	+
Buffer tank	+	–	–
Recipient tank	+	–	–
Process tank	+	–	–
Stilling well	+	O	–
Bypass	+	O	–
Pump station	O	O	O
Channel measurement	–	–	–
Interface measurement	+	+	–
Application limits	▪ Insufficient clearance towards ceiling ▪ Changing, non-conductive media or conductivity between 1…100µS/cm	▪ Changing, non-conductive media or conductivity between 1…100µS/cm	▪ Changing, non-conductive media or conductivity between 1…100µS/cm ▪ Highly viscous liquids > 2000cst

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

4. Instrument selection within the measuring principle

C

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
- In slight foam formation, the „Buildup compensation" mode may be selected

4. Instrument selection within the measuring principle

Hydrostatic (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
- T < −70°C/−94°F or
  T > +400°C/+752°F
- p > 420bar/6,090psi

Advantages
- Unaffected by surface foam
- Unaffected by tank obstacles/tank geometries
- Simple engineering
- Established technology

4. Instrument selection within the measuring principle

C

Hydrostatic – process industry

	Cerabar M PMC51	Cerabar M PMP55	Deltapilot M FMB50
			
Technical data			
▪ Process pressure	10mbar...40bar/ 0.15...580psi	50mbar...400bar/ 0.72...5,800psi	100mbar...10bar/ 1.5...145psi
▪ Process temperature	−40...+125°C/ −40...+257°F	−70...+400°C/ −94...+752°F	−10...+100°C/ +14...+212°F
▪ Accuracy	±0.2% (0.1% option)	±0.2%	±0.2% (0.1% option)
▪ 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, PTFE	316L, Alloy
▪ Gastight feedthrough	–	–	–
▪ Measuring cell	Ceramics	Metal welded	Contite, condensate-proof, water-tight, metal welded
▪ Technical Information	TI 00436P	TI 00436P	TI 00437P
Applications			
Horizontal storage tank cyl.	O	O	O
Vertical storage tank	+	+	+
Buffer tank	O	O	O
Recipient tank	O	–	O
Process tank	O	O	+
Stilling well	–	–	–
Bypass	–	–	–
Pump station	–	–	–
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

	Cerabar S PMC71	Cerabar S PMP75	Deltapilot S FMB70
			
	5mbar...40bar/ 0.07...580psi −40...+150°C/ −40...+302°F ±0.075% (0.05% option) Thread, flange, hygienic connections 316L, Al_2O_3, sealings, PVDF Standard Ceramics TI 00383P	50mbar...400bar/ 0.72...5,800psi −40...+400°C/ −40...+752°F ±0.075% (0.05% option) Thread, flange, hygienic connections 316L, Alloy, Tantal, PTFE Standard Metal welded TI 00383P	5mbar...10bar/ 0.07...145psi −10...+100°C/ +14...+212°F ±0.1% Thread, flange, hygienic connections 316L, Alloy Standard Contite®, condensate-proof, water-tight, metal welded TI 00416P
	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

4. Instrument selection within the measuring principle

C

Hydrostatic – process industry

	Waterpilot FMX21	Deltapilot M FMB51/52/53	Deltabar M PMD55
			
Technical data			
▪ Process pressure	100mbar...20bar 0.15...290psi	5mbar...10bar/ 0.07...145psi	1mbar...40bar/ 0.1...580psi
▪ Process temperature	–10...+70°C/ +14...+158°F	–10...+80°C/ +14...+176°F	–40...+85°C/ –40...+185°F
▪ Accuracy	±0.2%	±0.2% (0.1% option)	±0.1% (0.075% option)
▪ Process connection	Mounting clamp, cable mounting screw	Thread, flange	Oval flange (¼...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	TI 00351P/TI 00431P	TI 00437P	TI 00434P
Applications			
Horizontal storage tank cyl.	–	+	O
Vertical storage tank	–	+	O
Buffer tank	–	O	+
Recipient tank	–	O	–
Process tank	–	–	+
Stilling well	–	–	–
Bypass	–	–	O
Pump station	+	+*	–
Channel measurement	O	O	–
Application limits		▪ If pressurized, possibly use Deltabar FMD71/FMD72 electronic dp. Observe ratio head pressure to hydrostatic pressure ▪ FMB51: Cable version FMB52: Rod version	

*In case of an open tank or shaft use DB53 with mounting clamp.

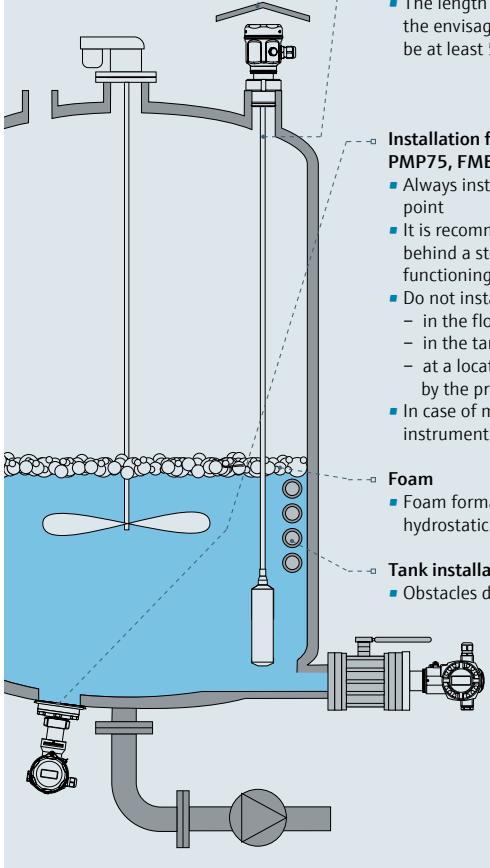
	Deltabar FMD71/FMD72	Deltabar S PMD75	Deltabar S FMD77	Deltabar S FMD78
				
	400mbar...40bar/ 0.15...580psi −40...+400°C/−40...+752°F with diaphragm seal Single sensor ±0.05% System ±0.07% Thread, flange, flush-mounted hygienic connections 316L, Alloy C276 Standard Metal welded, Ceraphire ceramics TI 01033P	1mbar...40bar/ 0.1...580psi −40...+125°C/ −40...+257°F ±0.075% (0.05% option) Oval flange (¼...18 NPT), IEC 61518 316L, Alloy, Monel, Tantal Standard Metal welded TI 00382P	10mbar...16bar/ 0.15...232psi −40...+400°C/ −40...+752°F ±0.075% Flanges 316L, Alloy, Monel, Tantal, PTFE Standard Metal welded TI 00382P	10mbar...16bar/ 0.15...232psi −70...+400°C/ −94...+752°F ±0.075% Thread, flange, hygienic connections 316L, Alloy, Monel, Tantal, PTFE Standard Metal welded TI 00382P
	O	O	O	O
	+	O	O	O
	O	+	+	O
	O	–	–	–
	+	+	+	+
	–	–	–	–
	–	O	–	O
	–	–	–	–
	–	–	–	–

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

4. Instrument selection within the measuring principle

Installation instructions hydrostatic (pressure)

Open tanks



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

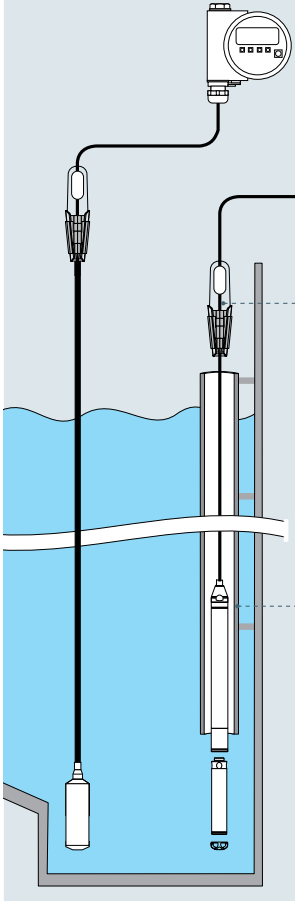
Installation from the top (FMB51/52)
- When installing rod and cable versions, please ensure that the head of the probe is at a location which is as free of flow as possible
- In order to protect the probe against contact by lateral movements, install probe in a guide tube (preferably of plastics) or 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 (PMC51, PMP55, FMB50, PMC71, PMP75, 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
- Foam 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

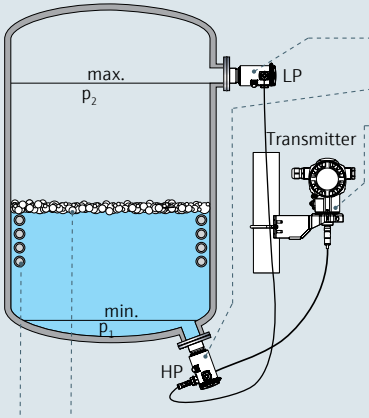
- The carrier cable is fastened by an mounting clamp/cable mounting screw above the well or basin

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

4. Instrument selection within the measuring principle

Installation instructions hydrostatic (differential pressure)



Closed tanks with Deltabar FMD71/FMD72 electronic dp

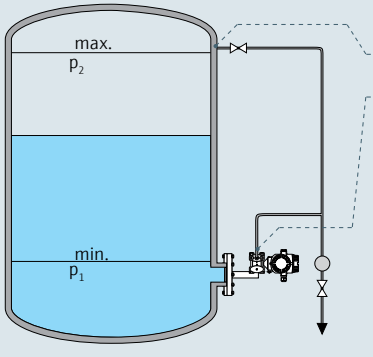
- LP (low pressure) install sensor above the maximum measuring point
- HP (high pressure) if possible, install sensor below the minimum measuring point
- In case of outdoor installation it is recommended to mount the transmitter at a position where it is protected against the environment
- It is recommended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

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

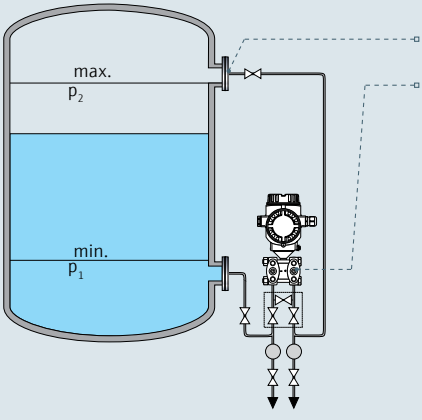
Tank installations

- Obstacles do not affect hydrostatic level measurement



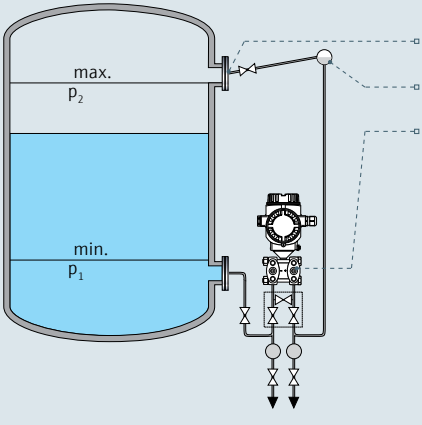
Closed tanks with FMD77 (diaphragm seal plus side)

- Always connect the minus side above the maximum level
- Install Deltabar S FMD77 directly at the tank below the lower measuring connection
- Generally speaking, the installation of separators and discharge valves makes sense to collect deposits, pollution or liquids in the upper pressure piping and to remove them
- Calibrate at operating temperature



Closed tanks with PMD75/PMD55 (pressure piping)

- Always connect the minus side above the maximum level
- Always install Deltabar S PMD75 / Deltabar M PMD55 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

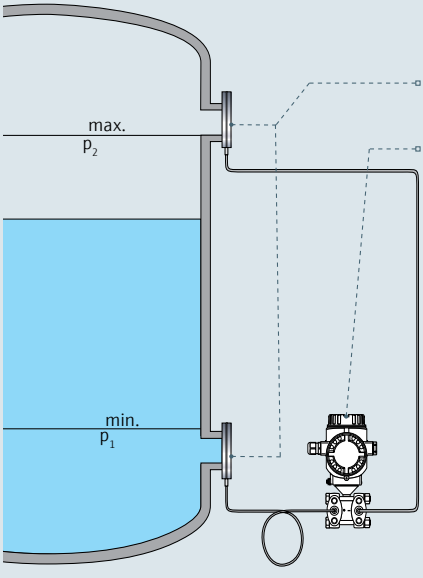


Closed vapor-pressurized tanks with PMD75/ PMD55 (pressure piping)

- Always connect the minus side above the maximum level
- The filled condensate vessel safeguards constant pressure on the minus side
- Always install Deltabar S PMD75 / Deltabar M PMD55 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 hydrostatic (differential pressure)

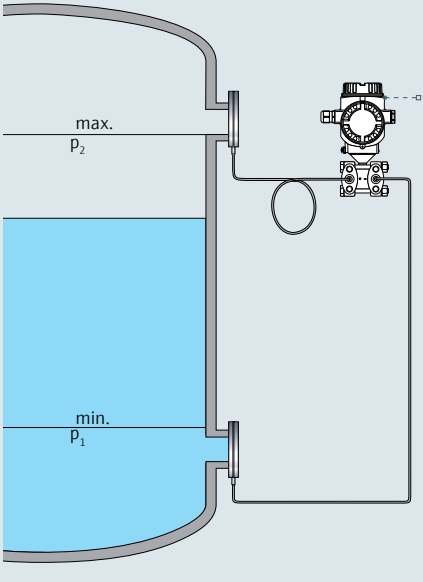


Closed tanks with FMD78 (capillary diaphragm seal)

- 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

Optimizing measures

- In order to avoid additional pressure fluctuations and a defective instrument, the capillaries should be installed free of vibrations
- The capillaries may not be installed in the vicinity of heating or cooling pipes which would impair exact measuring results
- It is recommended to insulate the capillaries in a colder or warmer environment, if appropriate apply Deltabar electronic dp (FMD71/FMD72)
- In case of two-sided diaphragm seal systems, the ambient temperature and the length of both capillaries should be identical
- Two identical diaphragm seals (e.g. diameter, material, etc.) should always be used for the minus and plus side

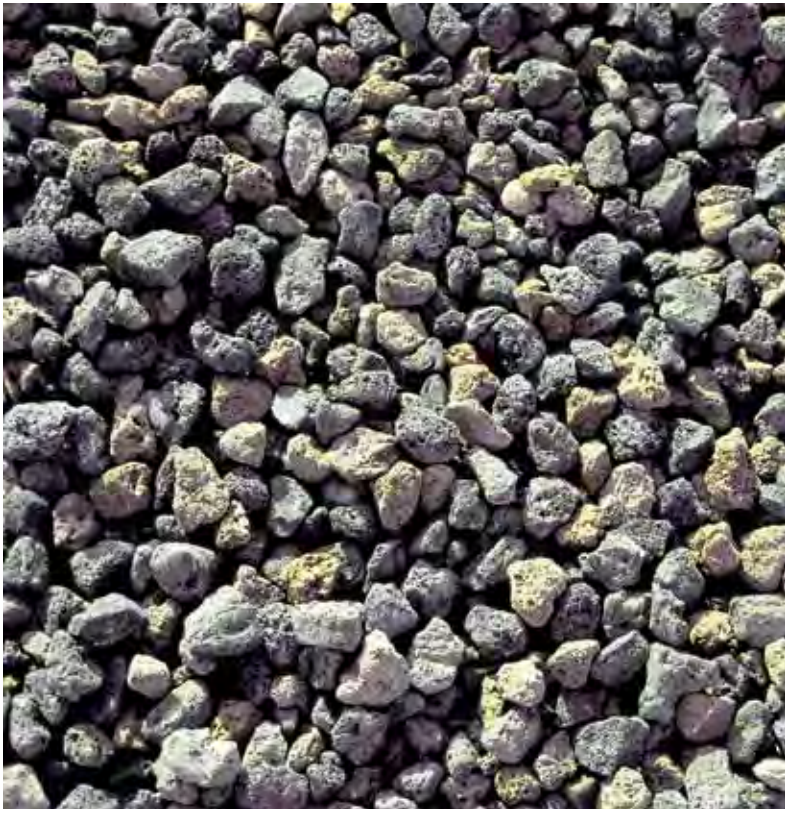


Installation of the pressure transmitter above the lower diaphragm seal

- If the pressure transmitter is installed above the lower diaphragm seal, the maximum height (see Technical Information) may not be exceeded
- The maximum difference in height depends on the density of the filling oil and the lowest pressure which may occur in the diaphragm seal of the plus side (empty tank) at any time

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.

This document contains two separate chapters: Level measurement in liquids and Level measurement in solids.

The second chapter specifically covers continuous measurement in bulk solids.

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.

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.

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

A

B

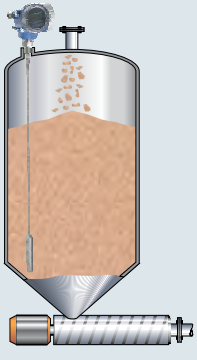
C

A

1. Overview of the measuring principles

Radar
Micropilot works with radar pulses which are reflected by the medium surface due to a change of the DK value (relative dielectric constant) between the air and the medium. The time between pulse launching and receiving is measured and analyzed by the instrument and constitutes a direct measurement for the distance between the antenna and the surface of the bulk solids.

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

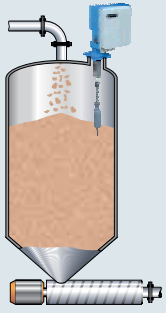


Guided radar
Levelflex works with radar pulses guided along a probe. As the pulses meet the medium surface, part of the emitted pulse is reflected due to a change of the DK value between the air and the medium. The time between pulse launching and receiving is measured and analyzed by the instrument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

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

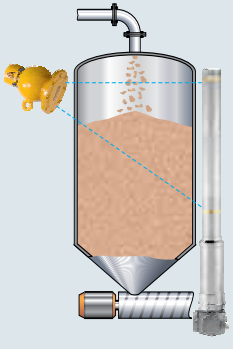
Ultrasonic
Prosonic works with ultrasonic pulses which are emitted by a sensor, reflected by the surface of the medium due to a change of the density between the air and the medium and again acquired by the sensor. The required Time-of-Flight is a measurement for the distance traveled in the empty part 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 buildup 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 pull force of the weight is reduced. This change is recognized, the instrument reverses the 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 M/T
Robust system for safe measurements also in extremely dusty environments and low density media. Unaffected by product properties and DK value.



Gamma
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 M
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:
Typical applications: Level measurement
in pulp digesters, wood chip silos and fluidized bed reactors or in density and mass flow measurement.

- Unaffected by media
- Any process temperature
- Any process pressure
- Unaffected by gammagraphy (FHG65)

For more detailed information, please contact our sales team or use the Applicator selection guide.

A

1. Overview of the measuring principles

	Radar	Guided radar	Ultrasonic
	 FMR56 FMR57	 FMP56 FMP57	 FMU90/95 FMU4x FDU9x
Process temperature* Process pressure	−40…+400°C/−40…+752°F −1…+16bar/−14.5…+232psi	−40…+150°C/−40…+302°F −1…+16bar/ −14.5…+232psi	−40…+150°C/−40…+302°F −0.3…+3bar/ −4.4…+44psi
Measuring range	0.3…70m/1…230ft	0.2…45m/0.7…148ft	0.07…70m/0.2…230ft
Instrument accuracy Surfaces of bulk solids affect accuracy	▪ Up to 2m/78": ±20mm/0.8" ▪ From 2m/78": ±3mm/0.12"	▪ < 15m/49ft: ±2mm/0.08" ▪ > 15m/49ft: ±10mm/0.4"	▪ ±2mm/0.08", +0.17% of measured distance
Function may be affected by	▪ Strong buildup formation ▪ Surface of bulk solids (grain size/angled surface) ▪ Conductive buildup on the antenna ▪ Strong fluidization ▪ Baffles causing interfering reflections	▪ Buildup formation ▪ Baffles in the immediate vicinity of the probe ▪ Strong fluidization	▪ Extreme dust formation ▪ Extreme filling noise ▪ Strong buildup formation ▪ Surface of bulk solids (grain size/angled surface) ▪ Fluidization ▪ Baffles causing interfering reflections
Application limits	▪ DK < 1.6 ▪ Baffles in the beam path ▪ Fill stream in the beam path ▪ Angled surface/funnel with a reflecting, smooth surface	▪ DK < 1.4 ▪ Coarse-grained (> 20mm/0.8") and abrasive media ▪ Extreme pull forces ▪ Measurement in the fill stream	▪ Blocking distance ▪ Baffles in the beam path ▪ Fill stream in the beam path ▪ Angled surface/funnel with a reflecting, smooth surface

*At the process connection

A

- Overview of application areas
- Limits of operating conditions

	Electromechanical level system	Radiometrics
	 FMM50 FMM20	 FMG60
	−20...+230°C/−4...+446°F −0.2...+2bar/ −3...+29psi	Unaffected by process temperature and pressure
	0.92...70m/3...230ft (special design up to 90m/295ft)	0.05...2m/0.16...6.5ft, cascadable as required
	▪ ±1% of the measuring range ▪ ±5cm/2" (FMM50) ▪ ±2.5cm/1" (FMM20)	▪ ±1% of measuring distance
	▪ Strong buildup formation ▪ Wear due to abrasion of mech. components ▪ Burying due to collapsing product accumulation	▪ Extreme buildup formation ▪ Pressure fluctuation ▪ External radiation (gammagraphy), solution with Gamma Modulator
	▪ Extreme pull 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 (NRC)

A

2. Checklist

You need to know your specific application requirements for a correct selection. The checklist on the next page 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

A

Name of medium		Please complete		Notes
Medium	Density	g/l (kg/m³)		
	Grain size (min/max)	mm/inch		
	Rel. dielectric constant (DK)			
	Tacky/buildup 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.	
	Hygienic 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...20mA	yes	no	
	4-wire DK, 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			
Other items				

3. Selection of the measuring principle according to the application

B

Non-contact

First Choice

	Radar Micropilot	Ultrasonic Prosonic S/M
	 FMR57  FMR56	(Remote)  FMU90/95  FDU93 FDU95 (Compact)  FMU4x
Advantages	▪ Unaffected by the density of bulk solids, temperature, humidity and filling noise ▪ For corrosive and abrasive media ▪ Easy installation for large measuring ranges	▪ Separate instrumentation ▪ Connection of up to 10 sensors ▪ Attractive price, e.g. silo farms ▪ Self-cleaning effect of sensors ▪ Corrosive and abrasive media ▪ Relay output for point levels ▪ Unaffected by the density of bulk solids, humidity and dielectric constant
Technical data ▪ Connection ▪ Accuracy ▪ Process temperature* ▪ Process pressure ▪ Min. DK value ▪ Process connection ▪ Maximum measuring range	2-wire (HART, PA, FF), 4-wire HART ±3mm/±0.12" −40...+400°C/−40...+752°F −1...+16bar/−14.5...+232psi 1.6 3" to 10" (DN80 to DN250), assembly bracket 70m/230ft	2-/4-wire (4-20mA HART, DP, PA, FF) ±2mm/±0.08", +0.17% of measured distance −40...+150°C/−40...+302°F −0.3...+3bar/−4.4...+44psi – Threads, flanges (DIN, ANSI, JIS), wall and assembly arm, assembly bracket 70m/230ft
Application limits	▪ DK value < 1.6 → ultrasonic, electromechanical level system ▪ Low density (< 10 g/l) → electromechanical level system ▪ Risk of strong buildup formation → use of purge air → ultrasonic ▪ Angled surface/ funnel with a reflecting, smooth surface → guided radar, electromechanical level system	▪ Temperatures > 150°C/302°F → radar, electromechanical level system ▪ Media with strong dust formation during filling → radar, guided radar ▪ Extreme filling noise → radar, guided radar ▪ Angled surface/ funnel with a reflecting, smooth surface → guided radar, electromechanical level system ▪ Measuring range > 35m/110ft in powdery products → radar, guided radar, electromechanical level system

* At the process connection

Please note: Free Space Radar continued on Page 90

Please note: Ultrasonic continued on Page 98

Silos/bunkers

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

Contact

First Choice

Guided radar Levelflex  FMP56  FMP57	Electromechanical level system Silopilot  FMM50  FMM20
▪ 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	▪ Unaffected by low density of bulk solids and DK value ▪ Easy installation
2-wire (HART, PA, FF), 4-wire HART < 15m/49ft: ±2mm/0.08"; > 15m/49ft: ±10mm/0.4" −40...+150°C/−40...+302°F −1...+16bar/−14.5...+232psi 1.4 ¾", 1½" NPT, (Flanges: 1½" - 6"/DN40...DN150) 45m/148ft	4-wire, 4-20mA, relay ±2.5cm/±1" (FMM20), ±5cm/±2" (FMM50) −20...+230°C/−4...+446°F −0.2...+2bar/−3...+29psi – flange 4"/DN100 PN16 (hole size) 70m/230ft (special design up to 90m/295ft)
▪ Abrasive, grained, lumpy products (> 20 mm/0.8"), probe damage → radar, ultrasonic ▪ Max. pull forces on the cable = 35kN (observe ceiling load) → radar, ultrasonic, electromechanical level system ▪ Extreme buildup formation on the probe → radar with purge air, ultrasonic ▪ High temperatures 150°C/302°F → radar, electromechanical level system ▪ DK < 1.4 → ultrasonic, electromechanical level system ▪ Measuring range > 45m/148ft in powdery products → radar, electromechanical level system ▪ Low density (< 10g/l) → electromechanical level system	▪ Risk of weight being buried → radar, ultrasonic ▪ Strong mechanical wear to be expected → radar, ultrasonic ▪ Measurement during filling → guided radar, radar, ultrasonic

Please note:
Guided radar continued on Page 94

Please note:
Electromechanical level system continued on Page 104

3. Selection of the measuring principle according to the application

B

Non-contact

	Radar Micropilot		Ultrasonic Prosonic S/M	
	 FMR57	 FMR56	(Remote)  FMU90/95  FDU93 FDU95	(Compact)  FMU4x
Advantages	▪ Unaffected by the density of bulk solids, temperature, humidity and filling noise ▪ For corrosive and abrasive media ▪ Easy installation for large measuring ranges		▪ Separate instrumentation ▪ Connection of up to 10 sensors ▪ Attractive price, e.g. silo farms ▪ Self-cleaning effect of sensors ▪ Corrosive and abrasive media ▪ Relay output for point levels ▪ Unaffected by the density of bulk solids, humidity and dielectric constant	
Technical data ▪ Connection ▪ Accuracy ▪ Process temperature* ▪ Process pressure ▪ Min. DK value ▪ Process connection ▪ Maximum measuring range	2-wire (HART, PA, FF), 4-wire HART ±3mm/±0.12" −40...+400°C/−40...+752°F −1...+16bar/−14.5...+232psi 1.6 3" to 10" (DN80 to DN250), assembly bracket 70m/230ft		2-/4-wire (4-20mA HART, DP, PA, FF) ±2mm/±0.08", +0.17% of measured distance −40...+150°C/−40...+302°F −0.3...+3bar/−4.4...+44psi – Threads, flanges (DIN, ANSI, JIS), wall and assembly arm, assembly bracket 70m/230ft	
Application limits	▪ DK value < 1.6 ▪ Low density (< 10 g/l) ▪ Risk of strong buildup formation ▪ Angled surface/ funnel with a reflecting, smooth surface	→ ultrasonic, electromechanical level system → electromechanical level system → use of purge air → ultrasonic → guided radar, electromechanical level system	▪ Temperatures > 150°C/302°F ▪ Media with strong dust formation during filling ▪ Extreme filling noise ▪ Angled surface/ funnel with a reflecting, smooth surface ▪ Measuring range > 35m/110ft in powdery products	→ radar, electromechanical level system → radar, guided radar → radar, guided radar → guided radar, electromechanical level system → radar, guided radar, electromechanical level system

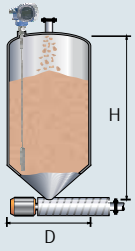
* At the process connection

Please note: Free Space Radar continued on Page 90

Please note: Ultrasonic continued on Page 98

Slim, narrow silos, vessels

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



Contact

First Choice

Guided radar Levelflex		Electromechanical level system Silopilot	
 FMP56	 FMP57	 FMM50	 FMM20
▪ 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		▪ Unaffected by low density of bulk solids and DK value ▪ Easy installation	
2-wire (HART, PA, FF), 4-wire HART < 15m/49ft: ±2mm/0.08"; > 15m/49ft: ±10mm/0.4" −40...+150°C/−40...+302°F −1...+16bar/−14.5...+232psi 1.4 ¾", 1½" NPT, (Flanges: 1½" - 6"/DN40...DN150) 45m/148ft		4-wire, 4-20mA, relay ±2.5cm/±1" (FMM20), ±5cm/±2" (FMM50) −20...+230°C/−4...+446°F −0.2...+2bar/−3...+29psi – flange 4"/DN100 PN16 (hole size) 70m/230ft (special design up to 90m/295ft)	
▪ Abrasive, grained, lumpy products (> 20 mm/0.8"), probe damage	→ radar, ultrasonic	▪ Risk of weight being buried	→ radar, ultrasonic
▪ Max. pull forces on the cable = 35kN (observe ceiling load)	→ radar, ultrasonic, electromechanical level system	▪ Strong mechanical wear to be expected	→ radar, ultrasonic
▪ Extreme buildup formation on the probe	→ radar with purge air, ultrasonic	▪ Measurement during filling	→ guided radar, radar, ultrasonic
▪ High temperatures 150°C/302°F	→ radar, electromechanical level system		
▪ DK < 1.4	→ ultrasonic, electromechanical level system		
▪ Measuring range > 45m/ 148ft powdery products	→ radar, electromechanical level system		
▪ Low density (< 10g/l)	→ electromechanical level system		

Please note:
Guided radar continued on Page 94

Please note:
Electrom. level system continued on Page 104

3. Selection of the measuring principle according to the application

B

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)

Non-contact

First Choice

	Radar Micropilot		Ultrasonic Prosonic S/M	
	 FMR57  FMR56		(Remote)  FMU90/95  FDU93  FDU95	(Compact)  FMU4x
Advantages	▪ Unaffected by the density of bulk solids, temperature, humidity, filling noise and weather impairment ▪ Purge air connection is standard (FMR57) ▪ Easy installation with alignment facility		▪ Separate instrumentation ▪ Connection of up to 10 sensors ▪ Self-cleaning effect of sensors ▪ Robust sensor (vibration) ▪ Relay output for point levels ▪ Unaffected by the density of bulk solids, humidity and dielectric constant ▪ Easy assembly/overall size (under conveyor belt derricks) ▪ Good price/performance ratio	
Technical data ▪ Connection ▪ Accuracy ▪ Process temperature* ▪ Process pressure ▪ Min. DK value ▪ Process connection ▪ Maximum measuring range	2-wire (HART, PA, FF), 4-wire HART ±3mm/±0.12" −40...+400°C/−40...+752°F −1...+16bar/−14.5...+232psi 1.6 3" to 10" (DN80 to DN250), assembly bracket 70m/230ft		2-/4-wire (4-20mA HART, DP, PA, FF) ±2mm/±0.08", +0.17% of measured distance −40...+150°C/−40...+302°F −0.3...+3bar/−4.4...+44psi – Threads, flanges (DIN, ANSI, JIS), wall and assembly arm, assembly bracket 70m/230ft	
Application limits	▪ DK value < 1,6 ▪ Risk of strong buildup formation ▪ Angled surface/ funnel with a reflecting, smooth surface ▪ Poor access to the instrument	→ ultrasonic → use of purge air → ultrasonic → ultrasonic with alignment facility, radar → ultrasonic, separated instrumentation	▪ Media with strong dust formation during filling ▪ Angled surface/ funnel with a eflecting, smooth surface ▪ Extreme filling noise	→ radar → ultrasonic with alignment facility, radar → radar

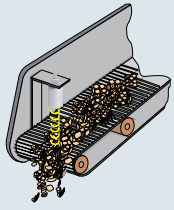
* At the process connection

Please note: Free Space Radar continued on Page 90

Please note: Ultrasonic continued on Page 98

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



B

Stockpiles, Mechanical conveyor systems

Non-contact

First Choice

	Radar Micropilot		Ultrasonic Prosonic S/M
	 FMR57  FMR56		(Remote)   FMU90/95 FDU93 FDU95 (Compact)  FMU4x
Advantages	▪ Unaffected by the density of bulk solids, temperature, humidity, filling noise and weather impairment ▪ Purge air connection is standard (FMR57) ▪ Easy installation with alignment facility		▪ Separate instrumentation ▪ Self-cleaning effect of sensors ▪ Robust sensor (vibration) ▪ Relay output for point levels ▪ Up to 3 measurements/sec ▪ Easy assemblyoverall size (under conveyor belt derricks) and above the conveyor belt/crusher
Technical data ▪ Connection ▪ Accuracy ▪ Process temperature* ▪ Process pressure ▪ Min. DK value ▪ Process connection ▪ Maximum measuring range	2-wire (HART, PA, FF), 4-wire HART ±3mm/±0.12" −40...+400°C/−40...+752°F −1...+16bar/−14.5...+232psi 1.6 3" to 10" (DN80 to DN250), assembly bracket 70m/230ft		2-/4-wire (4-20mA HART, DP, PA, FF) ±2mm/±0.08", +0.17% of measured distance −40...+150°C/−40...+302°F −0.3...+3bar/−4.4...+44psi – Threads, flanges (DIN, ANSI, JIS), wall and assembly arm, assembly bracket 70m/230ft
Application limits	▪ DK value < 1,6 ▪ Risk of buildup formation ▪ Strong vibration, poor access to the instrument ▪ Fast measurement > 1 measurement/s	→ ultrasonic → use of purge air → ultrasonic → ultrasonic, separated instrumentation → ultrasonic, separated instrumentation	▪ Observe blocking distance ▪ Strong vibration, please use remote instrumentation

* At the process connection

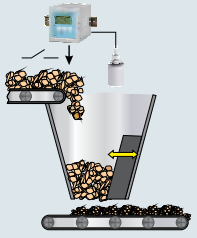
Please note: Free Space Radar continued on Page 90

Please note: Ultrasonic continued on Page 98

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

First Choice

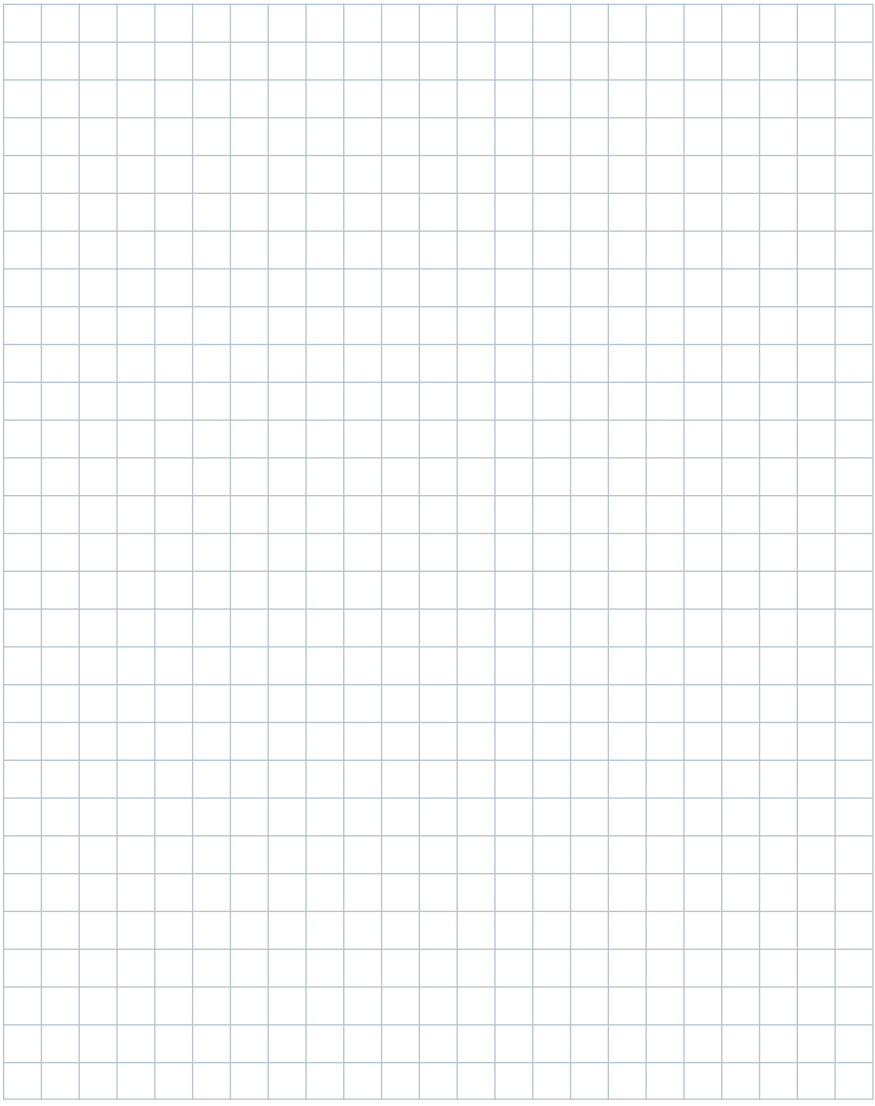
	Radar Micropilot	Ultrasonic Prosonic S
	 FMR57  FMR56	(Remote)  FMU90/95  FDU93  FDU92
Advantages	▪ Unaffected by the density of bulk solids, temperature, humidity, filling noise and adverse weather ▪ Purge air connection is standard (FMR57) ▪ Easy installation with alignment facility	▪ Separate instrumentation recommended ▪ Attractive measuring point price ▪ Self-cleaning effect of sensors, unaffected by buildup ▪ Additional point levels, programmable ▪ Robust sensor (vibration) ▪ Easy assemblyoverall size (under conveyor belt derricks) and above the conveyor belt/crusher
Technical data ▪ Connection ▪ Accuracy ▪ Process temperature* ▪ Process pressure ▪ Min. DK value ▪ Process connection ▪ Maximum measuring range	2-wire (HART, PA, FF), 4-wire HART ±3mm/±0.12" −40...+400°C/−40...+752°F −1...+16bar/−14.5...+232psi 1.6 3" to 10" (DN80 to DN250), assembly bracket 70m/230ft	2-/4-wire (4-20mA HART, DP, PA, FF) ±2mm/±0.08", +0.17% of measured distance −40...+150°C/−40...+302°F −0.3...+3bar/−4.4...+44psi – Threads, flanges (DIN, ANSI, JIS), wall and assembly arm, assembly bracket 70m/230ft
Application limits	▪ DK value < 1,6 → ultrasonic ▪ Risk of buildup formation → use of purge air → ultrasonic ▪ Strong vibration, poor access to the instrument → ultrasonic, remote instrumentation	▪ Possibly protection against mechanical damage (e.g. mount higher or protect by a grid)

* At the process connection

Please note: Free Space Radar continued on Page 90

Please note: Ultrasonic continued on Page 98

Notes



4. Instrument selection within the measuring principle

Free Space Radar

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

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

C

Application limits for level measurement by radar instruments in bulk solids
- T < −40°C/−40°F or T > 400°C/752°F
- p > 16bar/232psi
- Measuring range > 70m/230ft
- Dielectric constant < 1.6 e.g. PVC granules, Perlite
- Process connection < DN 80/3"

Media group	DK value	Examples
A	1.6...1.9	Plastic granulate, white lime, special cement, sugar
B	1.9...2.5	Cement, gypsum
C	2.5...4	Cereal, seeds, ground stones, sand
D	4...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 DK 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
- Buildup 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
- Unaffected by vessel materials
- Freely adjustable measuring range

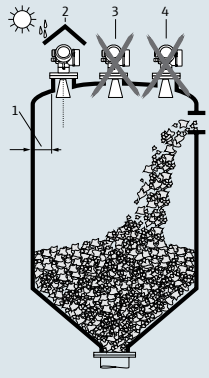
Non-contact

	Micropilot Horn / parabolic antenna	Micropilot Horn antenna
	 FMR57	 FMR56
Typical applications	▪ Silos, open stockpiles with highly dust-generating media ▪ Stockpiles, bunkers with measuring ranges > 30m/98ft ▪ High, narrow silos/cells ▪ High temperatures up to 400°C/752°F ▪ Very abrasive bulk solids	▪ Smaller silos, vessels, bunkers, stockpiles up to max. measuring range 30m/98ft ▪ Very abrasive bulk solids
Special features	▪ For small nozzle dimensions (horn) ▪ Precise beam focusing in high, narrow silos/cells (parabolic) ▪ Optional alignment feature ▪ Air purge connection is standard	▪ Plastic horn, metalized ▪ Optional alignment seal ▪ Optional assembly bracket
Technical data		
▪ Process pressure	−1...+16bar/−14.5...+232psi	−1...+3bar/−14.5...+232psi
▪ Process temperature*	−40...+400°C/−40...+752°F	−40...+80°C/−40...+176°F
▪ Antenna type	Horn: 3"/DN80, 4"/DN100 Parabolic: 8"/DN200, 10"/DN250	Horn, plated with PP
▪ Max. Measuring range	50m/164ft (horn) 70m/230ft (parabolic)	30m/98ft
▪ DK value	1.6	1.6
▪ Accuracy	±15mm/0.6"	±15mm/0.6"
▪ Process connection	Thread 1½ (G, NPT), DN80...DN250/3"...10", DN200...DN250/8"...10"	Mounting bracket, DN80...DN250/3"...10"
▪ Process-contacting materials	316L /1.4435/1.4404	PBT, PP

* At the process connection

4. Instrument selection within the measuring principle

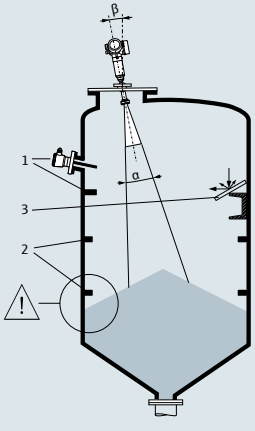
Installation instructions – radar



Installation
- Not centered [3]
- Not above filling stream [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]

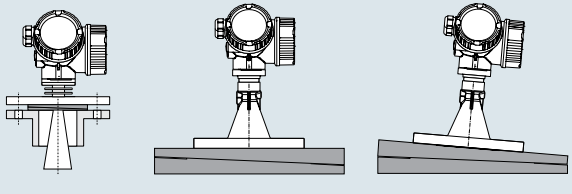
Connection for air purge or plating
- Connection for air purge:
  FMR57, standard option. In case of heavy dust, clogging of the antenna is avoided. Not available for FMR56
- Horn cover:
  FMR57, FMR51, see accessories
  FMR56, standard option PP cover on the horn, avoids clogging



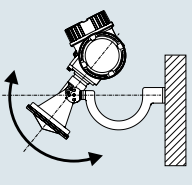
Baffles in vessels
- Make sure that baffles [1] like limit switches, struts, etc. are not within the beam path (see also the beam angle table in this respect (next page))
- Symmetrically arranged baffles [2], e.g. discharge aids etc., may impair measurements

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

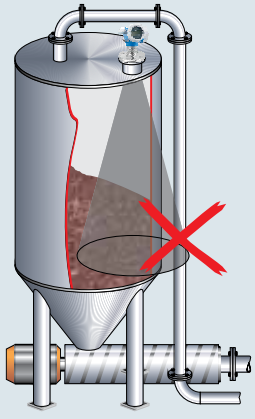
Alignment
- Aids in preventing interfering reflection and improved measurement since the measurement can be aligned to the angle of repose
- An alignment of the instrument is recommended
  FMR57, with optional alignment device
  FMR56, FMR51 with optional alignment seal or bracket assembly



Variable alignment with optional alignment seal



Mounting bracket



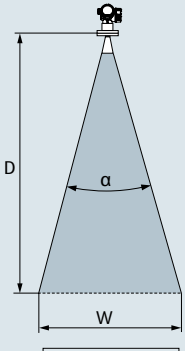
Measurement in plastic vessels
If the external wall of the vessel consists of a non-conductive material (e.g. FRP), microwaves may also be reflected by external interfering sources, e.g.

- Metal lines/pipes
- Conductors
- Grids

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

Beam angle
The beam angle is defined as the angle α at which the energy density of the radar waves assumes half the value of the max. energy density (3dB width).

Radar waves are also emitted outside of the beam path and may be reflected by interfering sources.
Beam path diameter (W) in dependence on the type of antenna, beam angle (α) and distance (D).



$$W = 2 \cdot D \cdot \tan\frac{\alpha}{2}$$

Size of antenna FMR56	Horn antenna	
	80mm/3"	100mm/4"
Beam angle α	10°	8°

Size of antenna FMR57	Horn antenna		Parabolic antenna	
	80mm/3"	100mm/4"	200mm/8"	250mm/10"
Beam angle α	10°	8°	4°	3.5°

Distance (D)	Cone diameter (W)			
	80mm/3"	100mm/4"	200mm/8"	250mm/10"
5m/16ft	0.87m/2.8ft	0.70m/2.24ft	0.35m/1.12ft	0.3m/0.98ft
10m/32ft	1.75m/5.6ft	1.40m/4.48ft	0.70m/2.23ft	0.61m/2ft
15m/49ft	2.62m/8.57ft	2.10m/6.85ft	1.05m/3.42ft	0.92m/3.01ft
20m/65ft	3.50m/11.37ft	2.80m/9.09ft	1.40m/4.54ft	1.22m/4ft
30m/98ft	5.25m/17.15ft	4.20m/13.71ft	2.10m/6.84ft	1.83m/6ft
40m/131ft	7.00m/22.92ft	5.59m/18.32ft	2.79m/9.15ft	2.44m/8ft
50m/164ft	8.75m/28.7ft	6.99m/22.94ft	3.50m/11.45ft	3.06m/10.04ft

4. Instrument selection within the measuring principle

Guided radar

Required application data
Level measurement
- Measuring range
- Consider ceiling load by max. pull force at the point of measurement
- Calculation of pull force by Endress+Hauser
- DK value (DK) of the product
- Pressure and temperature
- Resistance requirements
- Existing nozzle diameter and 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 (larger upon request)
- Dielectric constant < 1.4

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

C

Media group	DK	Typical bulk solids	Max. measuring range	
			Metallic uninsulated probes	PA-coated cable probes
1*	1.4...1.6	▪ Plastic powder	20...25m/66...82ft	–
2	1.6...1.9	▪ Plastic granulates ▪ White lime, special cement ▪ Sugar	25...30m/82...99ft	12...15m/ 39...49ft
3	1.9...2.5	▪ Cement, gypsum	30...45m/99...148ft	–
		▪ Flour	–	15...25m/49...82ft
4	2.5...4	▪ Cereal, seeds	–	25...30m/82...99ft
		▪ Ground stones ▪ Sand	45m/148ft	25...30m/82...99ft
5	4...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
- Buildup formation, particularly of humid products.

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

Guided radar

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

Contact

	Levelflex  FMP56	Levelflex  FMP57
Typical applications	▪ 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 (cable) ▪ Coated cable probes (for cereal, flour) ▪ Measurement during filling	▪ Exchangeable probes (cable) ▪ Coated cable probes (for cereal, flour) ▪ Measurement during filling
Technical data		
▪ Process pressure	−1...+16bar/−14.5...+232psi	−1...+16bar/−14.5...+232psi
▪ Process temperature*	−40...+120°C/−40...+248°F	−40...+150°C/−40...+302°F
▪ Max. Measuring range cable probe rod probe	 12m/39ft –	 45m/148ft 4m/13ft
▪ DK 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 1½ to 8"
▪ Process-contacting materials	304, 1.4301	304, 1.4301

* At the process connection

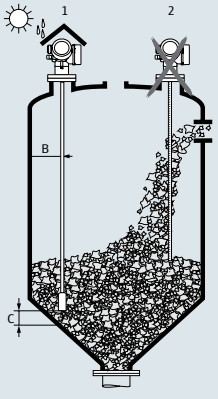
** The patented End-of-Probe (EoP) algorithm enables Levelflex to provide accurate and reliable level measurement in media with a low DK value (flour, cement, lime, PE granulates, PP granulates and various powders) also during pneumatic filling and fluidized discharge

4. Instrument selection within the measuring principle

Installation instructions – guided radar

Probe selection

- Use cable 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 cable may be so high that a cable with a plastic jacket must be used. We recommend a PA-coated cable for milled products like cereal, wheat and flour

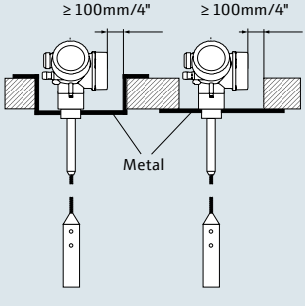


Installation

- Do not install rod and cable probes in the fill stream [2]
- Install rod and cable probes at a distance to the wall [B], so that in case of buildup on the wall a distance to the probe of at least 100mm/4" remains
- Install rod and cable 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 cable probes are installed in plastic vessels, the minimum distance of 300mm/12" is also applicable to metallic parts outside of the vessel
- Rod and cable 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 "Attachment of cable probes"
- Avoid bending the cable 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

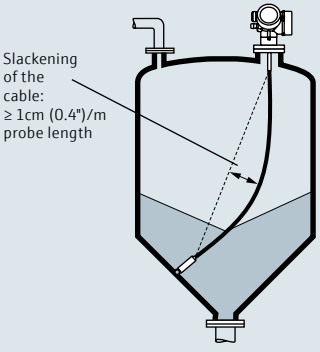
- In concrete silos, a minimum distance [B] of the probe to the concrete wall - of 0.5m/19.7" - is to be observed. Optimum ≥ 1m/39"
- The installation into a concrete ceiling must be flush with its bottom edge

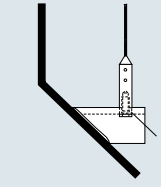
Expansion of cable probes by tension and temperature

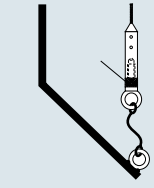
- 6mm/0.23" cable probe
  - Elongation by tension: At max. permissible tensile load (30kN) = 13mm (0.5")/m cable length
  - Elongation by temperature increase from 30°C/86°F to 150°C/302°F = 2mm (0.08")/m (ft) cable length
- 4mm/0.16" cable probe
  - Elongation by tension: At max. permissible tensile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

Attachment of cable 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 is closer than 0.5m/19.7" to a concrete wall. The probe weight provides an internal thread for this purpose:
  - 4mm/0.16" cable: M 14
  - 6mm/0.23" cable: M 20
- Please use the 6mm/0.23" cable probe because of its higher tensile-loaded capacity when fixing a cable probe
- The point of attachment must either be permanently grounded or reliably insulated. If attachment with permanent grounding is not possible, the insulated lug offered as an accessory may be used
- The cable must be loose to avoid extremely high tensile loads and the risk of breakage. Adjust the cable to a length which exceeds the required measuring range so that the cable slackens in the middle ≥ 1cm (0.4")/m cable length!







Tensile load

- Bulk solids exert pull forces on cable 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 cable
- The diagrams in the Technical Information TI 01004F 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 pull force values contain a safety factor of 2 (compensation of the fluctuation range in freely flowing bulk solids)
- Since the pull 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 instead a 6mm/0.23" cable than 4mm/0.16" in critical cases
- The same forces also act on the ceiling of silos. The pull forces are larger on fixed cables, 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

Ultrasonic

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

Application limits for ultrasonic level measurement in solids
- T < −40°C/−40°F and T > 150°C/302°F
- p < −0.3bar/−4.4psi and p > 3bar/44psi (relativ)
- Measuring range < 70m/230ft (ideal conditions)
- Process connection < 1½"
- Strong temperature fluctuations in the measuring range can affect the accuracy

C

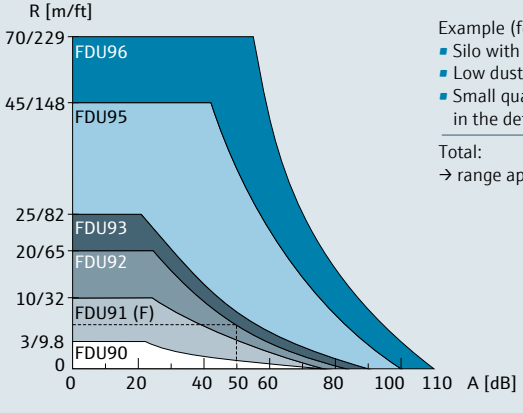
Damping caused by process

Product surface		Fill stream in the detection range	
Hard, rough (e.g. gravel)	40dB	None	0dB
Soft (e.g. peat, dust-covered clinker)	40...60dB	Small quantities	5dB
		Big quantities	5...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...10dB
Strong dust generation	5...20dB	Up to 80°C/176°F	10...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 fill stream in the detection range: +5dB

Total: +50dB
→ range approx. 5m/16ft from diagramm

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

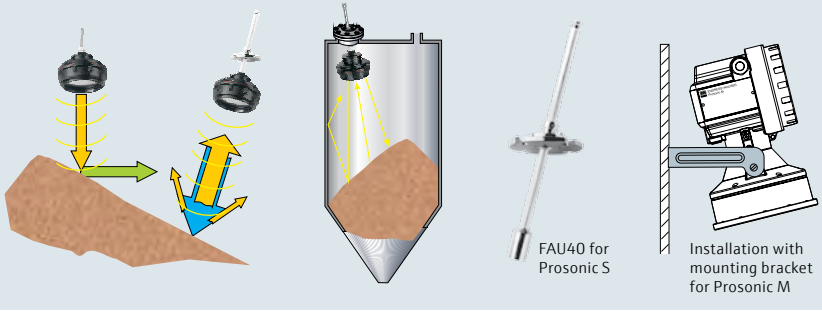
Remedial measures:

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

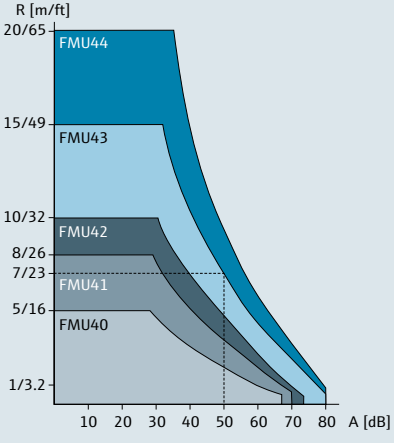
→ This is facilitated by the FAU40 alignment device or the mounting bracket

Advantages

- Non-contact, maintenance-free measurement
- Unaffected by product properties, e.g. DK 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



Range calculation and sensor selection Prosonic M FMU4x



Example (for FMU43):

▪ Product surface hard, rough:	+40dB
▪ Low dust generation:	+5dB
▪ Small quantities of fill stream in the detection range:	+5dB
Total:	+50dB

→ range approx. 7m/23ft from diagram

4. Instrument selection within the measuring principle

Ultrasonic

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

C

Prosonic S
FMU9x


DIN rail

FMU90/95


Field housing


FDU90


FDU91


FDU91F


FDU92


FDU93


FDU95

FDU96

Typical applications

- Measurement of coarse to fine-grained materials in silos, on belts, stockpiles and in crushers
- Measurement under rough process conditions (vibration, buildup, corrosion, abrasion)
- Measurement in 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...20mA HART or PROFIBUS DP

Technical data	FDU90	FDU91	FDU91F	FDU92	FDU93	FDU95	FDU96
Process pressure from -0.3/-4.4...	+3bar/ +44psi				+2bar/ +29psi	+0.5bar/ +7.2psi	+2bar/ +29psi
Process temperature* from -40...	+80°C/ +176°F	+80°C/ +176°F	+105°C/ +221°F	+95°C/ +203°F	+95°C/ +203°F	+80°C/ +176°F	+150°C/ +302°F
Max. Measuring range	1.2m/ 3.9ft	5m/ 16ft	5m/16ft	10m/ 32ft	15m/ 49ft	45m/ 150ft	70m/ 230ft
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**)	1.6m/ 5.2ft
Accuracy	±2mm/0.08", +0.17% of measuring distance						
Process connection	1", 1½"	1"	1", Tri-Clamp, collar flange	1"	1"	1"	1"
Process-contacting materials	PVDF	PVDF	316L	PVDF	UP, Alu, PTFE	UP, 316L**, PE	UP, Alu, PTFE
Beam angle α	12°	9°	12°	11°	4°	5°	6°

* At the process connection

** High temperature = 150°C/302°F

Prosonic M
FMU4x





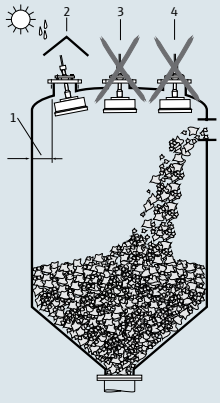
	FMU40	FMU41	FMU42	FMU43	FMU44
Typical applications	▪ Measurement from coarse to fine-grained materials in recipient tanks, on belts at feed points ▪ Measuring range up to 10m/32ft				
Special features	▪ Compact instrumentation (2 or 4-wire) ▪ Attractive price ▪ Robust aluminum housing ▪ 4...20mA HART, PROFIBUS PA or FF				
Technical data	**FMU40**	**FMU41**	**FMU42**	**FMU43**	**FMU44**
▪ Process pressure	−0.3...+2bar/−4.4...+29psi		−0.3...+1.5bar/−4.4...+22psi		
▪ Process temperature*	−40...+80°C/−40...+176°F				
▪ Max. Measuring range (solid)	2m/6ft	3.5m/11ft	5m/16ft	7m/22ft	10m/32ft
▪ Blocking distance	0.25m/ 0.8ft	0.35m/ 1.15ft	0.4m/1.3ft	0.6m/2ft	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"	DN80/3"; DN100/4"; DN150/6" mounting bracket	DN100/4"; DN150/6"; DN200/8" mounting bracket	DN100/4"; DN150/6"; DN200/8" mounting bracket
▪ Process-contacting materials	PVDF, EPDM	PVDF, EPDM	PVDF, EPDM or Viton, flange PP, PVDF, 316L	UP/316L, EPDM, flange PP, PVDF, 316L	PVDF, EPDM or Viton, flange PP, 316L
▪ Beam angle α	11°	11°	9°	6°	11°

* At the process connection

*** The higher value is applicable

4. Instrument selection within the measuring principle

Installation instructions – ultrasonic

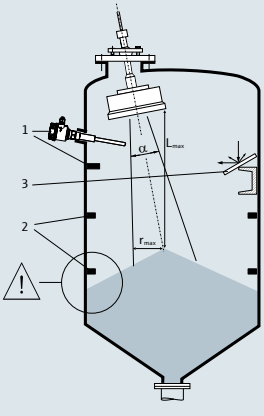


Installation
- Not centered [3]
- Not above fill stream [4]
- Distance to wall: ~ 1/6 of the vessel diameter, or 20cm/7.9", whichever is greater [1]
- If 2 or more sensors are used in one vessel, please use separate instrumentation (FMU90/95 + FDU9x)

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) based on model number
- 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 path (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 mounting bracket)

	FMU 40	FMU 41	FMU 42	FMU 43	FMU 44	FDU 90	FDU 91	FDU 91F	FDU 92	FDU 93	FDU 95	FDU 96
Beam angle α	11°	11°	9°	6°	11°	12°	9°	12°	11°	4°	5°	6°
L_{max} (m/ft)	2/ 6	3.5/ 11	5/ 16	7/ 22	10/ 32	1.2/ 3.9	5/ 16	5/ 16	10/ 32	15/ 49	45/ 150	70/ 230
r_{max} (m/ft)	0.19/ 0.6	0.34/ 1.1	0.39/ 1.3	0.37/ 1.2	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	3.6/ 11.8
Blocking distance (m/ft)	0.25/ 0.8	0.35/ 1.15	0.4/ 1.3	0.6/ 2	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*)	1.6/ 5.2

* High temperature = 150°C/302°F

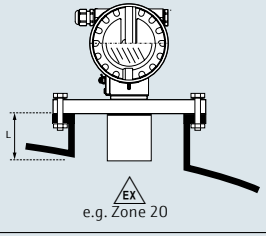
Nozzle ø	Max. nozzle length in mm/inch (L)											
	FMU 40	FMU 41	FMU 42	FMU 43	FMU 44	FDU 90	FDU 91	FDU 91F	FDU 92	FDU 93	FDU 95	FDU 96
DN50/ 2"	80/ 3.15					50[2]/ 1.97[2]						
DN80/ 3"	240/ 9.45	240/ 9.45	250/ 9.84			390[1], 250[2]/ 15.4[1], 9.84[2]	340/ 13.4	250/ 9.84*				
DN100/ 4"	300/ 11.8	300/ 11.8	300/ 11.8	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	300/ 11.8	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	300/ 11.8	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	300/ 11.8	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	300/ 11.8	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°	11°	6°	11°	12°	9°	12°	11°	4°	5°	6°
Blocking distance (m/ft)	0.25/ 0.8	0.35/ 1.15	0.4/ 1.3	0.6/ 2	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

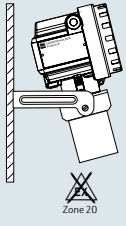
Options for installation

Prosonic M FMU4x

Universal flange installation

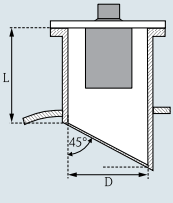


Mounting bracket installation

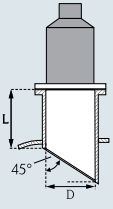


Prosonic S FDU9x

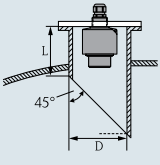
FDU9x



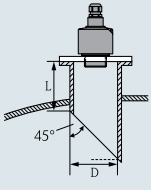
FDU91F



FDU90[1]



FDU90[2]



4. Instrument selection within the measuring principle

Electromechanical level system

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

Application limits for the electromechanical level system
- T < –20°C/–4°F or T > 230°C/446°F
- p > 2bar/29psi
- Measuring range > 70m/230ft
- Tensile force > 112 lbs (500N)

C

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. 70°C/158°F	Rigid PVC	
FMM50	Bell weight	Light and loose bulk solids	Complete temperature range	Steel, 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
	3.5kg/8lbs	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)	Dust-Ex not permitted	
	4.3kg/9.5lbs	Yes	The umbrella cannot be used 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

4. Instrument selection within the measuring principle

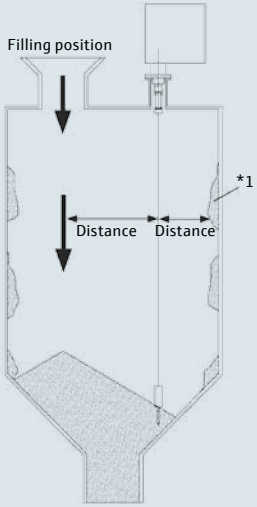
Electromechanical level system

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

	Silopilot M FMM50	Silopilot T 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	–0.2...+2bar/–3...+29psi	–0.2...+2bar/–3...+29psi
▪ Process temperature*	–20...+230°C/–4...+446°F	–20...+150°C/–4...+302°F
▪ Max. Measuring range	70m/230ft	32m/105ft
▪ Accuracy	±5cm/±2" or ±1 pulse	±2.5cm/±1" or. ±1 pulse
▪ Pull force	Max. 112 lbs (500N)	Max. 150N
▪ Process connection	On counterflange 4" (DN100) PN16	On counterflange 4" (DN100) PN16
▪ Process-contacting material	Alu, steel or stainless steel (301 modified, 304, 316, 316TI), Nomex, PVC	Alu, steel or stainless steel (301 modified, 304, 316, 316TI) plastic, polyester
▪ Ambient temperature	–40...+70°C/–40...+158°F	–40...+60°C/–40...+140°F
▪ Electronics	4...20mA / relay	0/4...20mA / relay
▪ Approvals	ATEX II 1/2D	ATEX II 1/2D
▪ Ingress protection	IP67	IP67

* At the process connection

Installation instructions – electromechanical level system

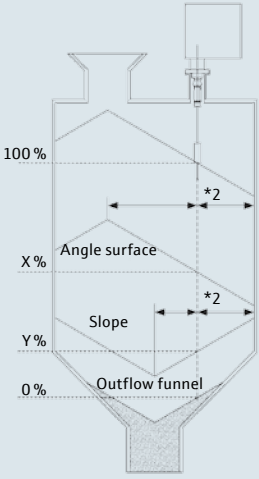


Installation
- Not in the fill stream or in the area of collapsing product accumulation on walls
- Measuring point as close to the center of the slope as possible
- The sensing weight may neither sink into the product nor slide off the angled surface during the measuring operation
- Max. angle of inclination 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 buildup on the wall of the vessel)
*2 Choose a measuring point located approximately in the middle of the slope

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

CP00023F/00/EN/15.14

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