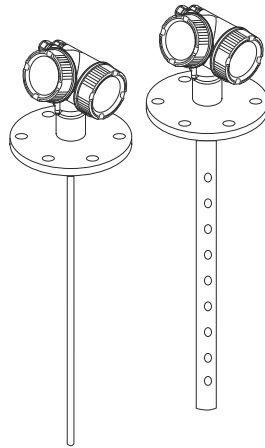


Application and Engineering Guide

Levelflex

FMP51, FMP52, FMP54, FMP55

Guided Level Radar



Level- and interface measurement for typical oil and gas applications

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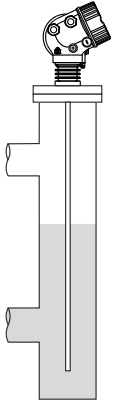

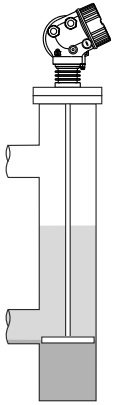

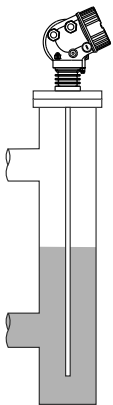

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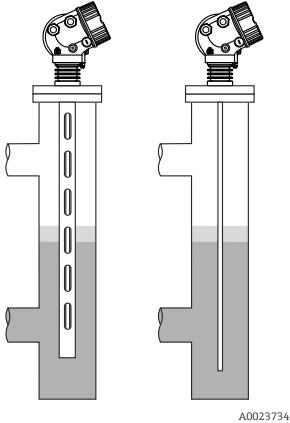
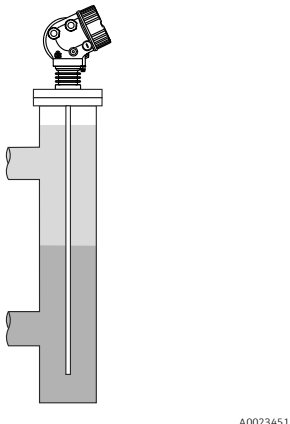
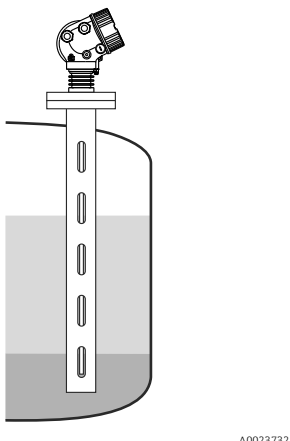
General information

Scope This document describes typical level- and interface applications in the oil- and gas industry. Based on the application, hints for the selection of the appropriate probe type, the installation and the commissioning are provided.

- Definitions**
- Water is used in the following text to represent all high DC value media (water based media)
 - Oil is used in the following text to represent all low DC value media (e.g. hydrocarbons)
 - Bypass is used in the following text to represent all bypass- and stilling well (tube-) installations
 - DC: Dielectric Constant

Overview about application scenarios

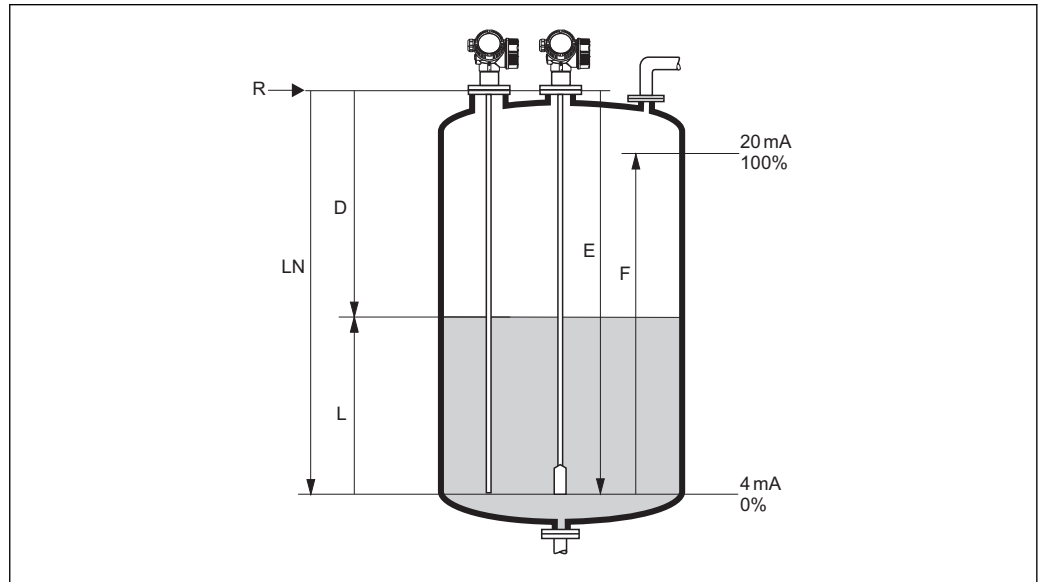
 <p style="text-align: right; font-size: small;">A0023733</p>	<p>1. Bypass chamber: Level measurement, oil, no water accumulation</p> <ul style="list-style-type: none"> ▪ Bypass chamber ▪ Level measurement ▪ If the probe may touch the inner pipe wall, install a centering element of the probe end. ▪ Optionally the sensor design of "Bypass chamber: Level measurement, oil with water below the lower connection" can be used. 	<p>(→  16)</p>
 <p style="text-align: right; font-size: small;">A0023452</p>	<p>2. Bypass chamber: Level measurement, oil, accumulation of water below the lower connection</p> <ul style="list-style-type: none"> ▪ Bypass chamber ▪ Level measurement ▪ Metallic centering disk located at the lower edge of the lower connection. ▪ Water accumulation below the lower connection possible (e.g. as a result of steam condensation). 	<p>(→  19)</p>
 <p style="text-align: right; font-size: small;">A0023454</p>	<p>3. Bypass chamber: Level measurement, water</p> <ul style="list-style-type: none"> ▪ Bypass chamber ▪ Level measurement ▪ If the probe may touch the inner pipe wall, install a centering element of the probe end. 	<p>(→  23)</p>

 <p>A0023734</p>	<p>4. Bypass chamber: Level measurement, water with the presence of small amount of oil on top</p> <ul style="list-style-type: none"> ▪ Bypass chamber ▪ Coax installation for bypasses > DN 50 (2") ▪ Level measurement ▪ Small oil layer may be present on top of the water-based medium. ▪ If the probe may touch the inner pipe wall, install a centering element of the probe end. 	<p>(→ 25)</p>
 <p>A0023451</p>	<p>5. Bypass chamber: Interface measurement, flooded</p> <ul style="list-style-type: none"> ▪ Bypass chamber ▪ Interface measurement ▪ Flooded bypass: <ul style="list-style-type: none"> - over all level is permanently inside the upper blocking distance - level indication always at 100% ▪ If the probe may touch the inner pipe wall, install a centering element at the probe end. 	<p>(→ 28)</p>
 <p>A0023732</p>	<p>6. Stilling well: Interface measurement, partially filled</p> <ul style="list-style-type: none"> ▪ Stilling well ▪ Interface measurement ▪ Partially filled tank ▪ If the probe may touch the inner pipe wall, install a centering element at the probe end. 	<p>(→ 32)</p>

Application description

Basic principles

The Levelflex is a "downward-looking" measuring system that functions according to the ToF method (ToF = Time of Flight). The distance from the reference point to the product surface is measured. High-frequency pulses are injected to a probe and led along the probe. The pulses are reflected by the product surface, received by the electronic evaluation unit and converted into level information. This method is also known as TDR (Time Domain Reflectometry).



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1 Parameters for level measurement with the guided radar

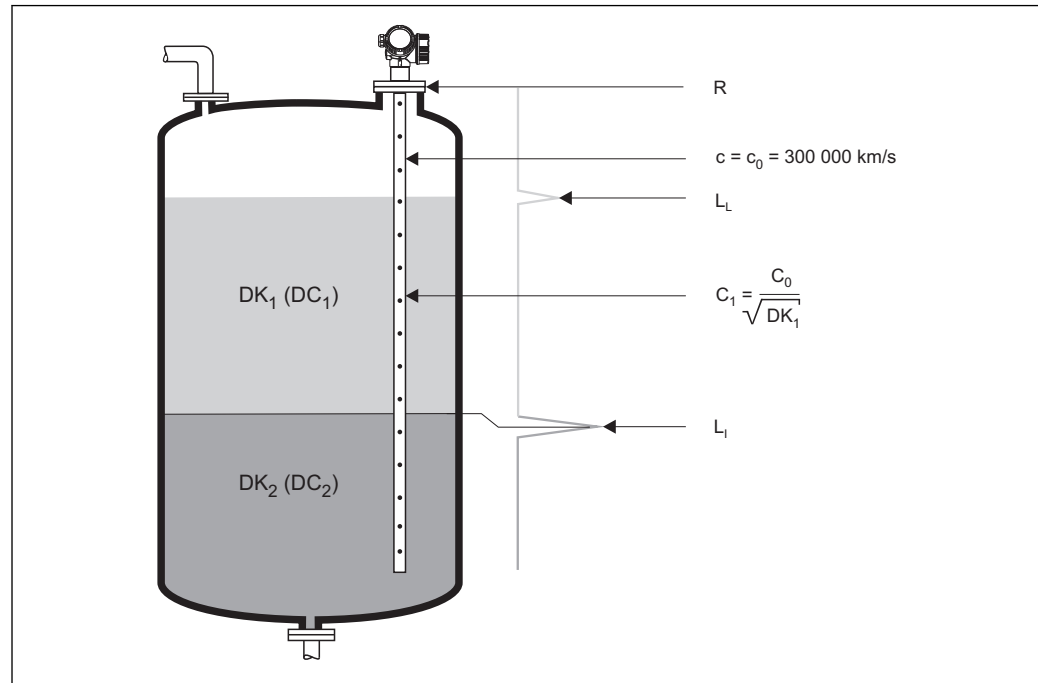
- LN Probe length
- D Distance
- L Level
- R Reference point of measurement
- E Empty calibration (= zero)
- F Full calibration (= span)

i If, for rope probes, the DC value is less than 7, then measurement is not possible in the area of the straining weight (0 to 250 mm (0 to 9.84 in) from end of probe; lower blocking distance).

Interface measurement

When the high-frequency pulses hit the surface of the medium, only a percentage of the transmission pulse is reflected. In the case of media with a low DC_1 , in particular, the other part penetrates the medium. The pulse is reflected once more at the interface point to a second medium with a higher DC_2 . The distance to the interface layer now can also be determined taking into account the delayed time-of-flight of the pulse through the upper medium.

In addition to this, FMP55 measures the capacitance of the probe. This enables interface measurements even if the second echo is missing due to an emulsion layer between the two phases.



2 Interface measurement with the guided radar

- LL Level complete
 LI Level interface
 R Reference point of measurement

In addition, the following general conditions must be observed for interface measurement:

- The DC of the upper medium must be known and constant ¹⁾. The DC can be determined with the aid of the DC manual CP00019F. In addition, if the interface thickness is existing and known, the DC can be calculated automatically via FieldCare.
- The DC of the upper medium may not be greater than 10.
- The DC difference between the upper medium and lower medium must be >10.
- The upper medium must have a minimum thickness of 80 mm.

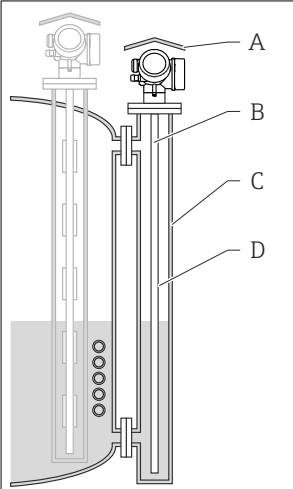
When using the capacitive measurement of FMP55:

- Conductivity of the upper medium: < 1 $\mu\text{S}/\text{cm}$
- Conductivity of the lower medium: > 100 $\mu\text{S}/\text{cm}$

1) For FMP55: Under certain conditions measurement is possible even with a changing DC. For details please contact your Endress+Hauser representative.

Installation guidelines

Installation instructions for guided radar - stilling well / bypass

	<p>A Weather protection cover Always recommended for outside installation to avoid strong temperature changes of electronics.</p>
	<p>B Measuring range</p> <ul style="list-style-type: none"> ■ Smallest measuring range: 300 mm (11.8 in) ■ Largest measuring range: 10 m (33 ft) (longer upon request)
	<p>C Pipe diameter Pipes of DN 50 to DN 100 (2" to 4") are to be preferred.</p>
	<p>D Bypass / measuring tube</p> <ul style="list-style-type: none"> ■ Metallic pipe ■ No special requirements of bypass pipe or stilling well. ■ Welding seams protruding internally up to approx. 5 mm (0.2 in) do not impair measurement. ■ Wall contact by rod probes must be excluded. Use a centering element at the end of the probe, if required.
<p>Additional instructions for interface measurement</p> <ul style="list-style-type: none"> ■ Rod probes can be installed up to a diameter of 100 mm (3.94 in). For larger diameters, a coax probe is recommended. ■ The pipe must not have any gradation. ■ In case of interface layer measurement, the centering element must be of plastic material. 	

Details of rod centering for bypass / stilling well installations

When to use a centering element (centering star/centering disk)?

Avoid contact between bypass/stilling well and probe

To ensure a stable and reliable measurement it must be guaranteed that rod probes do not come in contact with the inner wall of a bypass or a stilling well. Otherwise signal jumps may occur. To prevent this, the use of one of the following centering elements is recommended

- PEEK centering star
- PFA centering star
- Metallic centering disk

Typical applications which require centering elements are:

- Long bypasses (>2 m (6.6 ft))
- Rapidly changing levels (e.g. due to high process pressures)

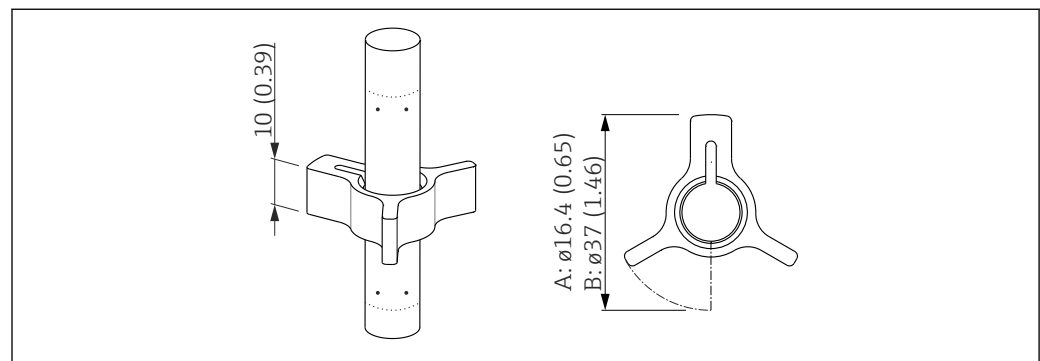
Defined positive end of probe (EOP) signals:

In case of water accumulation over time in an **oil level application** (e.g. due to steam condensation) the position and the polarity of the EOP signal may change. This may lead to instable measurements. To established predictable conditions, a metallic centering disk is recommended and has to be located at the end of the probe (→ 19).

How to order a standard centering element?

PFA centering star for level and interface measurement

Device		Centering star ordered with device: See feature 610 "Accessory Mounted" in product structure	Centering star ordered as accessory
FMP51	Rod 8 mm	-	71162453
	Rod 12 mm	OE: Rod centering star d=37mm / 1.45", PFA, interface measurement, pipe diameter DN40/1-1/2" + DN50/2"	71157270
	Rod 16 mm divisible	OE: Rod centering star d=37mm / 1.45", PFA, interface measurement, pipe diameter DN40/1-1/2" + DN50/2"	71069065
FMP52/ FMP55	Rod 16 mm	OE: Rod centering star d=37mm / 1.45", PFA, interface measurement, pipe diameter DN40/1-1/2" + DN50/2"	71069065
FMP54	Rod 16 mm	OE: Rod centering star d=37mm / 1.45", PFA, interface measurement, pipe diameter DN40/1-1/2" + DN50/2"	71069065
	Rod 16 mm divisible	OE: Rod centering star d=37mm / 1.45", PFA, interface measurement, pipe diameter DN40/1-1/2" + DN50/2"	71069065



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3 Dimensions: mm (in)

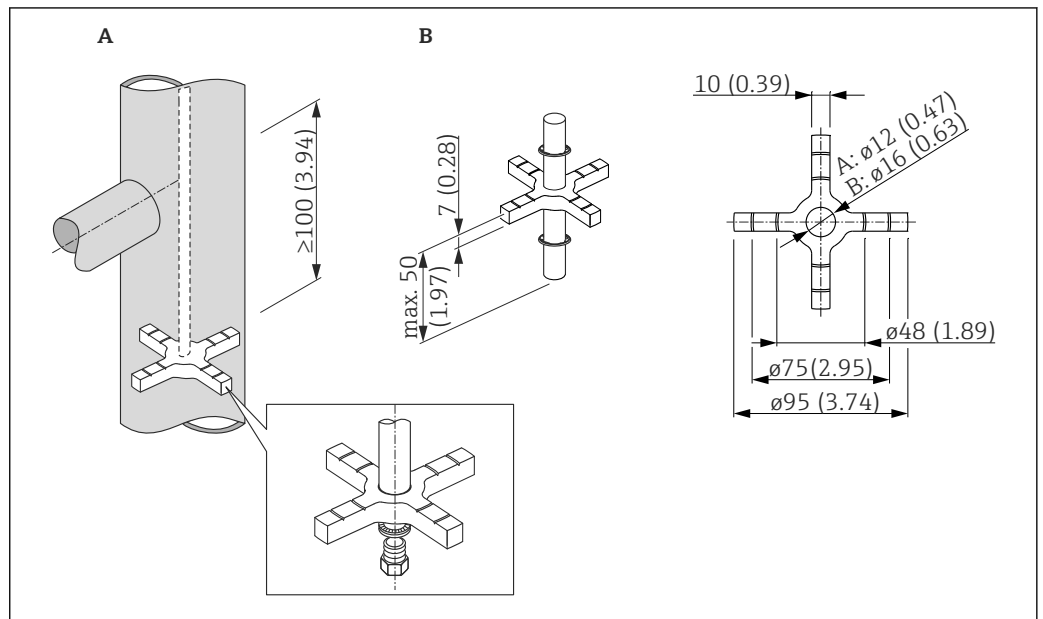
A For 8 mm (0.3 in) probes

B For 12 mm (0.47 in) and 16 mm (0.63 in) probes

PEEK centering star for level and interface measurement

Device		Centering star ordered with device: See feature 610 "Accessory Mounted" in product structure	Centering star ordered as accessory
FMP51	Rod 8 mm	-	-
	Rod 12 mm	OD: Rod centering star d=48-95mm / 1.88-3.74in, PEEK, interface measurement, pipe diameter DN50/2" + DN100/4" ¹⁾	-
	Rod 16 mm divisible	- ²⁾	71069064
FMP52/ FMP55	Rod 16 mm	-	-
FMP54	Rod 16 mm	OD: Rod centering star d=48-95mm / 1.88-3.74in, PEEK, interface measurement, pipe diameter DN50/2" + DN100/4"	71069064
	Rod 16 mm divisible	- ²⁾	71069064

- 1) Centering element is mounted at the end of the probe using a screw and a nordlock washer. If probe gets shortened, a new thread has to be cut into the rod. Alternatively for PEEK centering star (rod $\varnothing = 16$ mm (0.63 in) use spare part 71069064.
- 2) Only as separate accessory.



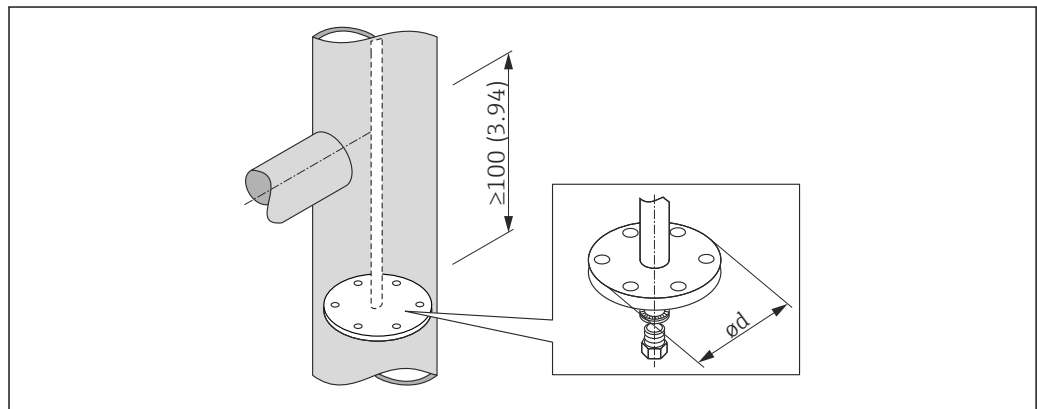
4 Dimensions: mm (in)

- A Mounting at a $\varnothing 12$ mm (0.47 in) rod
 B Mounting at a $\varnothing 16$ mm (0.63 in) rod

Metallic centering disk for level measurement

Device		Centering disk ordered with device: See feature 610 "Accessory Mounted" in product structure	Centering disk ordered as accessory
FMP51	Rod 8 mm	-	-
	Rod 12 mm	OA: ¹⁾ Rod center washer d=75mm / 2.95", 316L, pipe diameter DN80/3" + DN100/4"	-
		OB: Rod center washer d=45mm / 1.77", 316L, pipe diameter DN50/2" + DN65/2-1/2"	
Rod 16 mm divisible	-	-	
FMP52/ FMP55	Rod 16 mm	-	-
FMP54	Rod 16 mm	OA: Rod center washer d=75mm / 2.95", 316L, pipe diameter DN80/3" + DN100/4"	-
		OB: Rod center washer d=45mm / 1.77", 316L, pipe diameter DN50/2" + DN65/2-1/2"	
	Rod 16 mm divisible	-	-

- 1) Centering element is mounted at the end of the probe using a screw and a nordlock washer. If probe gets shortened, a new thread has to be cut into the rod. Alternatively for metallic centering disk use moveable metallic centering element (→ 10).



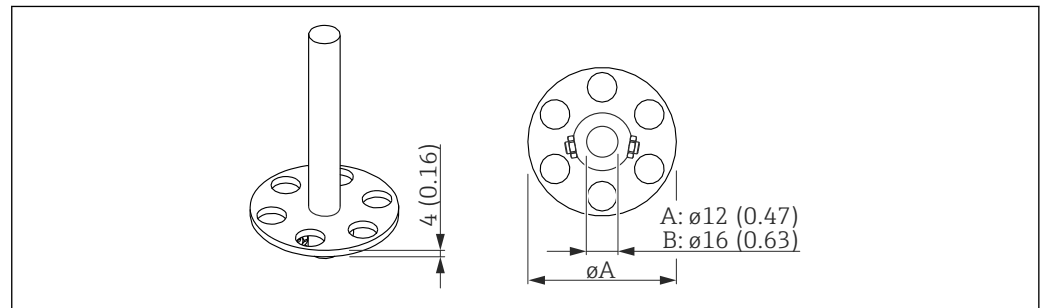
5 Dimensions: mm (in)

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How to order a metallic centering element for retrofitting?

Moveable metallic centering disk for level measurement (Moveable centering disk available via TSP)

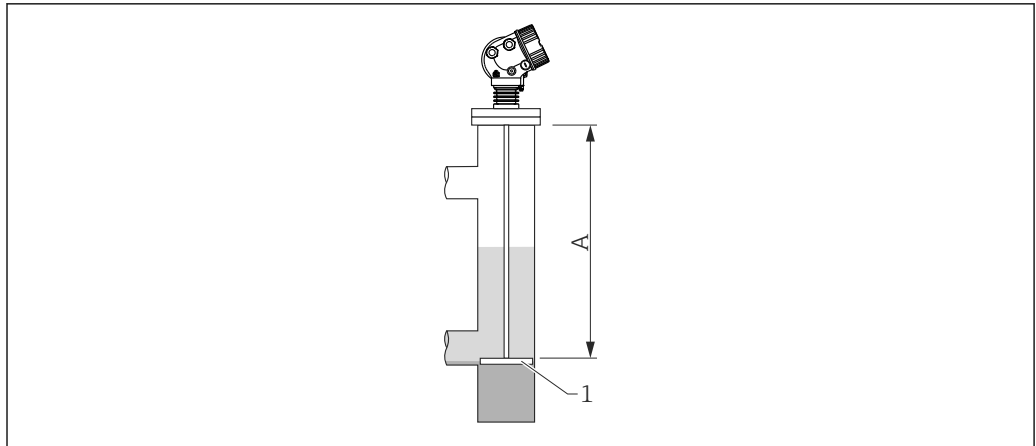
Device		Centering disk ordered as accessory	Comment	Diameter (A) of the centering disk
FMP51	Rod 8 mm	-	-	-
	Rod 12 mm	71213091	Suitable for DN 80 (3") and DN 100 (4") bypasses.	ø75 mm (2.95 in)
		71213093	Suitable for DN 50 (2") and DN 65 (2.5") bypasses	ø45 mm (1.77 in)
	Rod 16 mm divisible	71213092	Suitable for DN 80 (3") and DN 100 (4") bypasses.	ø75 mm (2.95 in)
		71213094	Suitable for DN 50 (2") and DN 65 (2.5") bypasses	ø45 mm (1.77 in)
FMP52/ FMP55	Rod 16 mm	-	-	-
FMP54	Rod 16 mm	71213092	Suitable for DN 80 (3") and DN 100 (4") bypasses.	ø75 mm (2.95 in)
		71213094	Suitable for DN 50 (2") and DN 65 (2.5") bypasses	ø45 mm (1.77 in)
	Rod 16 mm divisible	71213092	Suitable for DN 80 (3") and DN 100 (4") bypasses.	ø75 mm (2.95 in)
		71213094	Suitable for DN 50 (2") and DN 65 (2.5") bypasses	ø45 mm (1.77 in)



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6 Dimensions: mm (in)

- The moveable metallic centering disk must be placed at height of the lower edge of the lower connection (see the following figure).
- The moveable metallic centering causes a positive reflection which will be evaluated in case of an empty tank as the end of probe signal.



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 7 Positioning of the moveable metallic centering disk: to be located at the lower edge of the lower connection.

A New probe length

1 Moveable metallic centering disk

How to set up an FMP5x with a retrofitted metallic centering disk?

Step 1: Change the polarity of the end of probe signal. Polarity of end of probe signal (located in: expert > sensor > EOP evaluation):

Parameter	Default value	Value to be set	Comment
EOP search mode	Negative EOP	Positive EOP	Installed metallic moveable centering disk causes a positive EOP echo. Change to "positive EOP" required.

Step 2: Set the new probe length (→  13)

Step 3: Basic setup according to application scenario. Take into consideration to change the tank type accordingly. Basic setup (located in: setup):

Parameter	Default value	Value to be set	Comment
Tank type	Metallic	Bypass/pipe	

Shortening rod probes

- Rod probes must be shortened if the distance to the bypass bottom is less than 10 mm (0.39 in).
- The rods of a rod probe are shortened by sawing at the bottom end.
- Coated rod probes such as FMP52 and FMP55 can't be shortened.

Shortening coax probes

- Coax probes must be shortened if the distance to the container floor or outlet cone is less than 10 mm (0.39 in).
- Coax probes can be shortened max. 80 mm (3.15 in) from the end. They have centering units inside, which fix the rod centrally in the pipe. The centerings are held with borders on the rod. Shortening is possible up to approx. 10 mm (0.39 in) below the centering unit. The coax probe is shortened by sawing the pipe at the bottom end.

How to set up an FMP5x after shortening the probe?

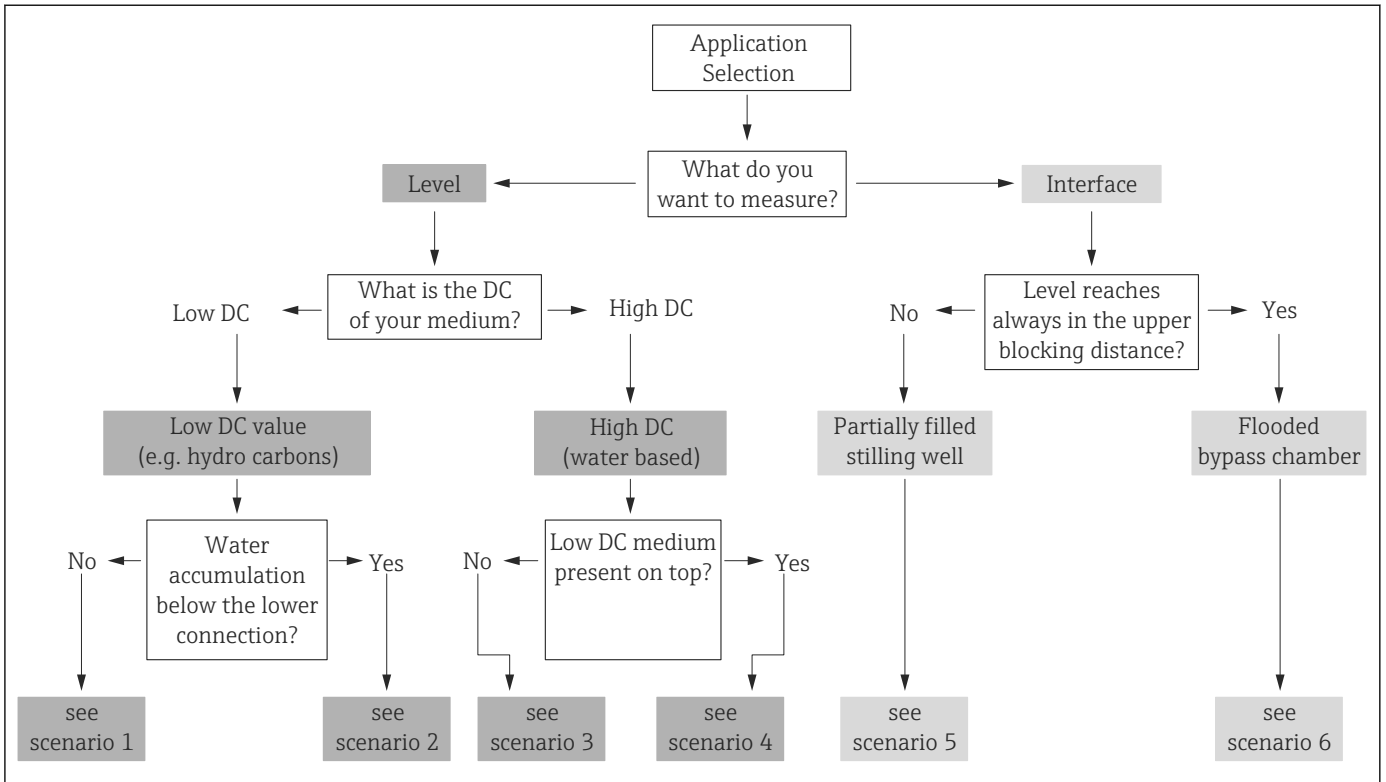
- A correct assignment of the probe length is mandatory for the measurement.
- The probe length, indicated by the device, has to match the actual length of the probe.
- For moveable metallic centering disks, the probe length is defined by distance from the process connection / reference point to the surface of metallic centering disk + 30 mm (1.18 in).
- The automatic probe length correction can only be performed if the probe is installed in the bypass and is completely uncovered (no medium).
- Additionally, the correct polarity of the end of probe signal has to be assigned:
(expert > sensor > EOP evaluation > EOP search mode)
 - Metallic centering disk: positive polarity
 - PEEK, PFA, no centering element: negative polarity
- Using the automatic probe length correction:
(located in: setup > advanced setup > probe settings)

Parameter	Default value	Value to be set	Comment
Present length	Probe length before shortening	Determination of the new probe length by parameter "Confirm length".	
Confirm length	Probe length ok	<ul style="list-style-type: none"> ■ Probe length ok ■ Probe length too small ■ Probe length too big 	The correct new probe length will be suggested by the device > confirmation with "probe length ok".

- For partially filled vessels and *if the length is known*, select "manual input" in order to enter the value manually.
- Entering the new probe length manually:
(located in: setup > advanced setup > probe settings)

Parameter	Default value	Value to be set	Comment
Confirm length	Probe length ok	Manual input	
Present length	Depending on the ordered probe length	<ul style="list-style-type: none"> ■ Enter the probe new length of the rod, or ■ Enter the distance to the moveable metallic centering disk + 30 mm (1.18 in). 	

Flow chart "application selection"



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- i The above mentioned application scenarios are also valid for all type of stilling well installations resp. coaxial probes.
- For horizontal, cylindrical tanks we always recommend the usage of a stilling well or a coaxial probe.

Level measurement

Scenario	DC	Description
1. No water accumulation below the lower connection		(→ 16)
2. Water accumulation below the lower connection	Low (e.g. hydro carbons)	(→ 19)
3. No low-DC medium present on top	High (water based)	(→ 23)
4. Low-DC medium present on top		(→ 25)

Interface measurement

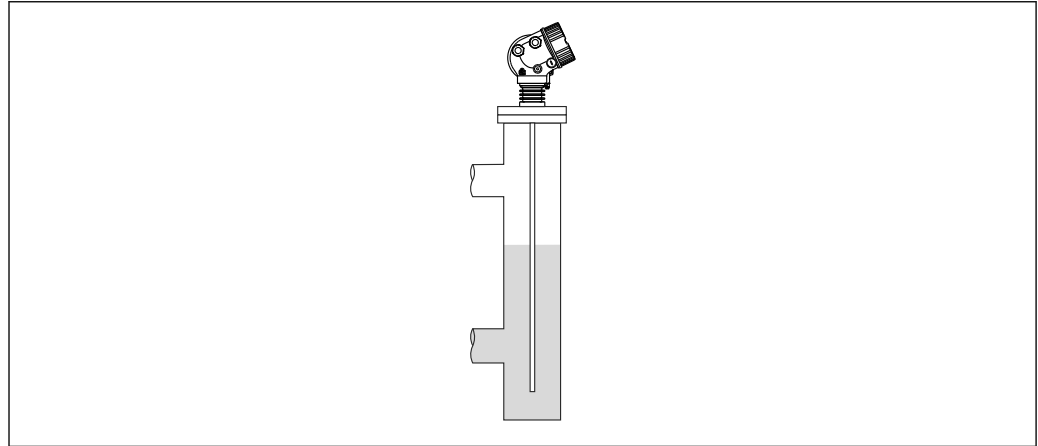
Scenario	Description
5. Flooded bypass chamber Level reaches always in the upper blocking distance.	(→ 28)
6. Partially filled stilling well Level does not always reach in the upper blocking distance.	(→ 32)

Detailed application description

1. Bypass chamber: Level measurement, oil, no water accumulation

Description of application

Measuring task is to measure the level of medium with a low DC value media such as oil in bypass chamber with Levelflex FMP51, FMP52 and FMP54. A water accumulation below the lower connection is not foreseen.



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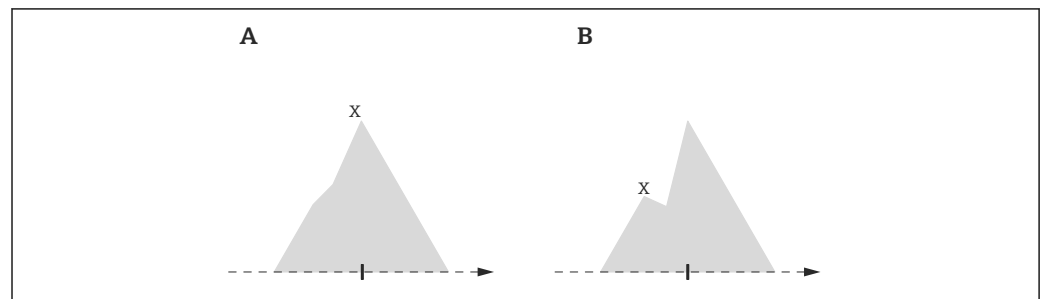
8 Bypass chamber: Level measurement, low dielectric constant medium, bypass dimensions unknown

Preconditions

- Installation inside a bypass chamber.
- It must be guaranteed that no water accumulates in the bypass / tank.

Limits

- In pure oil applications a PEEK / PFA centering disk is sufficient. As a result, the Levelflex evaluates a negative end of probe signal. If water accumulates below the lower connection, the resulting positive signal superimposes the negative end of probe signal. A reliable evaluation of the end of probe would therefore be no longer possible.
 - Overall level might be lost in case of filling into the blocking distance
 - Unstable empty detection in case of not having oil in the measuring range and water covering the end of probe (may result in an echo lost condition)
- Water results in a much stronger signal than oil. If only a small layer of oil is present (< 60 mm (2.36 in)), the water signal superimposes the oil reflection wherefore the oil signal can't be detected (see the following figure).



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- A Small DC value layer < 60 mm (2.36 in)
 B Small DC value layer > 60 mm (2.36 in)

Device selection - recommended device options


- FMP51:
Standard level applications up to +200 °C (+392 °F)
- FMP52:
Coated probe for standard level application up to +200 °C (+392 °F)
- FMP54:
Standard level applications for high temperatures up to +450 °C (+842 °F)

Feature	option		FMP51	FMP52	FMP54
060 "Probe"	Rod (up to 4 m (13 ft))		✓	✓	✓
	Divisible rod (up to 10 m (33 ft))		✓	x	✓
610 "Accessory mounted" ¹⁾	OD	Rod centering star d=48-95 mm / 1.88-3.74", PEEK, interface measurement, pipe diameter DN50/2" + DN100/4" ^{2) 3)}	✓	x	✓
	OE	Rod centering star d=37 mm / 1.45", PFA, interface measurement, pipe diameter DN40/1-1/2" + DN50/2" ⁴⁾	✓	✓	✓


- 1) Within the measuring range, the probe must not get into contact with the pipe wall. If necessary, use a centering star.
- 2) Suitable for DN 80 (3") and DN 100 (4") bypasses. Diameter can be adjusted in the field, according to the inner diameter of the available stilling well.
- 3) PEEK centering star for divisible rod probes only available as accessory (→ 8).
- 4) Suitable for DN 50 (2") and DN 65 (2.5") bypasses.

Installation guidelines

- The probe must be 60 mm (2.36 in) longer than the lower connection.
- Within the measuring range, the probe must not get into contact with the pipe wall. If necessary, use a centering element.
- Inner bypass diameter: DN 50 (2") to DN 100 (4")

 Recommendation DN 80 (3") to DN 100 (4") in case of clogging risk.

Commissioning

- The device is pre-configured according to the selected order code (→  17)
- Basic setup (see table below)
- Safety settings (see table below)

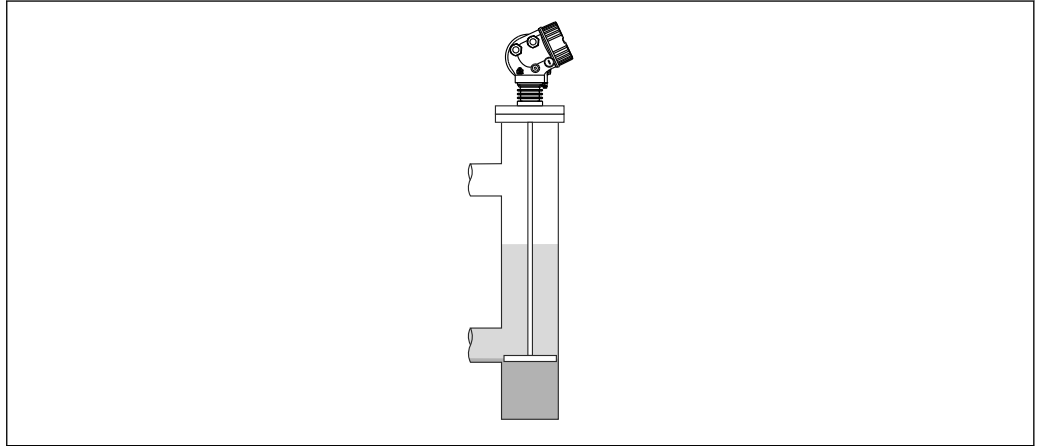
Setup > Basic setup			
Parameter	Default Value	Value to be set	Comment
Tank type	Metallic	Bypass / pipe	
Medium group	Others	Pre-configured default value - no change required	
Empty calibration	Depending of ordered probe length	Set zero (4 mA) according to your application	Empty e.g. at the lower edge of the lower connection.
Full calibration	Depending of ordered probe length	Set full (20 mA) according to your application	
Confirm distance	Distance ok	Tank empty	Make sure that the probe is uncovered!

Expert > Sensor > Safety settings			
Parameter	Default Value	Value to be set	Comment
Output echo lost	Last valid value	Other options: <ul style="list-style-type: none"> ■ Alarm ■ Ramp at echo lost ■ Value echo lost 	For safety critical applications the output echo lost value may be set to alarm.
Delay echo lost	60 s	For safety critical applications the delay time can be reduced to a smaller value e.g. 30 s	Time between echo lost and alarm output.

**2. Bypass chamber:
Level measurement, oil,
accumulation of water below
the lower connection**

Description of application

Measuring task is to measure the level of a medium with a low DC value media such as oil in a bypass chamber with Levelflex FMP51, FMP54. Water might accumulate below the lower connection (e.g. as result of steam condensation).



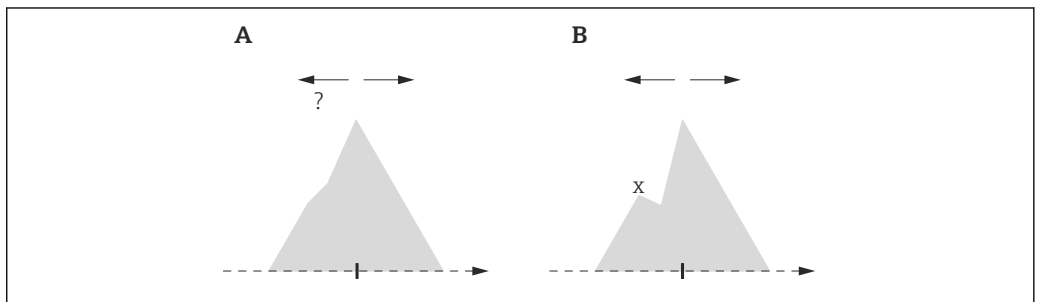
9 Bypass chamber: Level measurement, oil, accumulation of water below the lower connection

Preconditions

- Installation inside a bypass chamber.
- It must be guaranteed that the accumulated water continuously drains through the lower connection into the process tank. Water must not increase above the lower connection.


Limits

- Water results in a much stronger signal than oil. If only a small layer of oil is present (<60 mm (2.36 in)), the water signal superimposes the oil reflection wherefore the oil signal can't be detected (→ 10, 19).
- Depending on the amount of oil, both signals will be separated wherefore a reliable detection of the oil reflection is possible (layer > 60 mm (2.36 in)) (→ 10, 19).



10 Location of metallic centering disk

- A Small oil layer < 60 mm (2.36 in)
- B Oil layer > 60 mm (2.36 in)

- For a reliable measurement, the position of the eventually occurring water in the bypass has to be well-known. Therefore a metallic centering disk has to be placed at the highest possible water level to generate a well-defined end of probe signal.
- We do recommend to set the 0% position of the measuring range (= empty position) 60 mm (2.36 in) above the metallic centering disk to prevent measuring jumps.
- 
 - Without a metallic centering disk, varying water levels may lead to instable measurement results.
 - This may reduce the available measuring range in case of short bypass chambers.

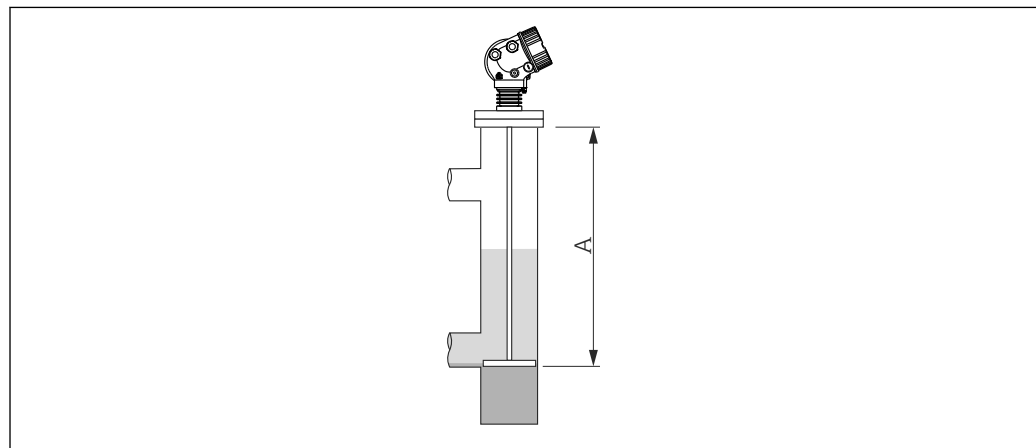
Device selections - recommended device options

- FMP51:
Standard level applications up to +200 °C (+392 °F)
- FMP54:
Standard level applications for high temperatures up to +450 °C (+842 °F)

Feature	option	FMP51	FMP54
060 "Probe"	Rod (up to 4 m (13 ft))	✓	✓
	Divisible rod (up to 10 m (33 ft)) ¹⁾	✓	✓
610 "Accessory Mounted"	OA Rod center washer d=75mm /2.95", 316L, pipe diameter DN80/3" + DN100/4"	✓	✓
	OB Rod center washer d=45mm / 1.77", 316L, pipe diameter DN50/2" + DN65/2-1/2"	✓	✓

1) Metallic centering disk for divisible rod probes only available via TSP: DN 80 (3"), DN 100 (4") (ø75 mm): FMP51 - 71170553; FMP54 - 71165932. Additional dimensions on request.

The Metallic centering disk must be located at the lower edge of the lower connection. Therefore the probe length has to be ordered according to the distance between the lower edge of the lower connection and the process connection (→ 20).




A Probe length




Installation guidelines

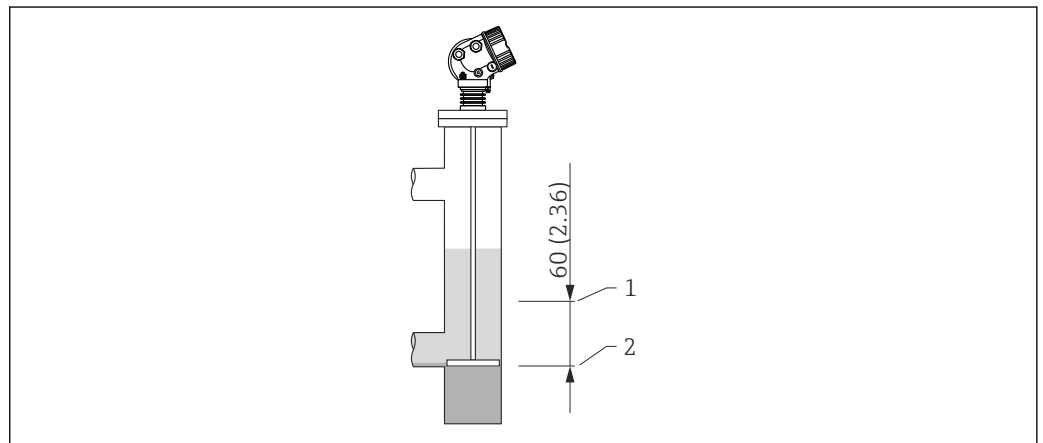
Inner bypass diameter: DN 50 (2") to DN 100 (4").

- i** ■ Recommendation DN 80 (3") to DN 100 (4") in case of clogging risk.
- A centering element is always necessary.


Commissioning

- The device is pre-configured according to the selected order code (→  20)
- Basic setup (see table below)
- Additional settings in case of the presence of a water layer covering the end of the probe (see table below)
- EOP evaluation (see table below)
- Safety settings (see table below)

Setup > Basic setup			
Parameter	Default Value	Value to be set	Comment
Tank type	Rod metal centering disk	Pre-configured default value - no change required	
Medium group	Others	Pre-configured default value - no change required	
Empty calibration	Depending of ordered probe length	Set zero (4 mA) according to your application Ordered probe length - 60 mm (2.36 in) (→  11,  21)	Prevent signal jumps due to merging echoes (→  19).
Full calibration	Depending of ordered probe length	Set full (20 mA) according to your application	
Confirm distance	Distance ok	Tank empty	Make sure that the probe is uncovered!



A0023466

 11 Location for 0% / empty / 4 mA allocation: 60 mm (2.36 in) above metallic centering disk. Dimensions: mm (in)

- 1 Empty
- 2 End of probe

Setup > Advanced Setup > Level			
Parameter	Default value	Value to be set	Comment
Advanced conditions	None	Oil / water condensate	Switches off the history mode and optimizes the evaluation of top level.

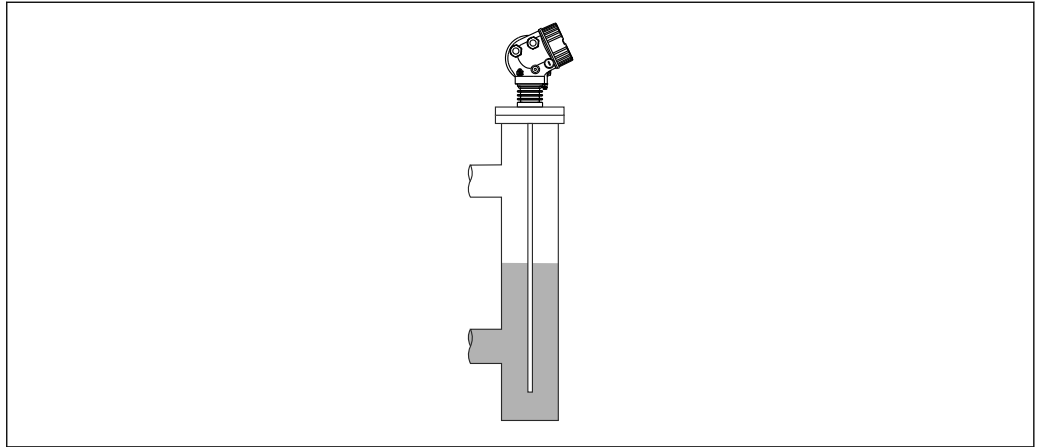
Expert > Sensor > EOP evaluation			
Parameter	Default value	Value to be set	Comment
EOP search mode	Automatic	Positive	Installed metallic moveable centering disk causes a positive EOP echo. Change to "positive EOP" required.

Expert > Sensor > Safety settings			
Parameter	Default values	Value to be set	Comment
Output echo lost	Last valid value	Other options: <ul style="list-style-type: none"> ▪ Alarm ▪ Ramp at echo lost ▪ Value echo lost 	For safety critical applications the output echo lost value may be set to alarm.
Delay echo lost	60 s	For safety critical applications the delay time can be reduced to a smaller value e.g. 30 s	Time between echo lost and alarm output.

**3. Bypass chamber:
Level measurement, water**

Description of application

Measuring task is to measure the overall level in a bypass chamber with Levelflex FMP51, FMP52 and FMP54. The bypass is filled with water.



A0023454

12 Bypass chamber: Level measurement of water

Preconditions

Installation inside a bypass chamber.

Limits

If a thin top layer of oil may be present:

- Top level evaluation always on water
- The oil layer may cause a measuring error of the water signal.

The real level might be higher as indicated.

Device selection - recommended device options

- FMP51:
Standard level applications up to +200 °C (+392 °F)
- FMP52:
Coated probe for standard level applications up to +200 °C (+392 °F)
- FMP54:
Standard level applications for high temperatures up to +450 °C (+842 °F)


Feature	option	FMP51	FMP52	FMP54
060 "Probe"	Rod (up to 4 m)	✓	✓	✓
	Divisible rod (up to 10 m)	✓	x	✓
610 "Accessory Mounted" ¹⁾	OD Rod centering washer d=48-95mm / 1.88-3.74", PEEK, interface measurement, pipe diameter DN50/2" + DN100/4" ²⁾	✓	x	✓
	OE Rod centering star d=37mm / 1.45", PFA, interface measurement, pipe diameter DN40/1-1/2" + DN50/2" ³⁾	✓	✓	✓

- 1) Within the measuring range, the probe must not get into contact with the pipe wall. If necessary, use a centering star.
- 2) Suitable for DN 80 (3") and DN 100 (4") bypasses. Diameter can be adjusted in the field, according to the inner diameter of the available stilling well.
- 3) Suitable for DN 50 (2") and DN 65 (2.5") bypasses.

Installation guidelines

- Inner bypass diameter: DN 50 (2") to DN 100 (4").
- The probe must be 60 mm (2.36 in) longer than the lower connection.
- Within the measuring range, the probe must not get into contact with the pipe wall. If necessary, use a centering element.

Commissioning

- The device is pre-configured according to the selected order code (→  23)
- Basic setup (see table below)
- Safety settings (see table below)

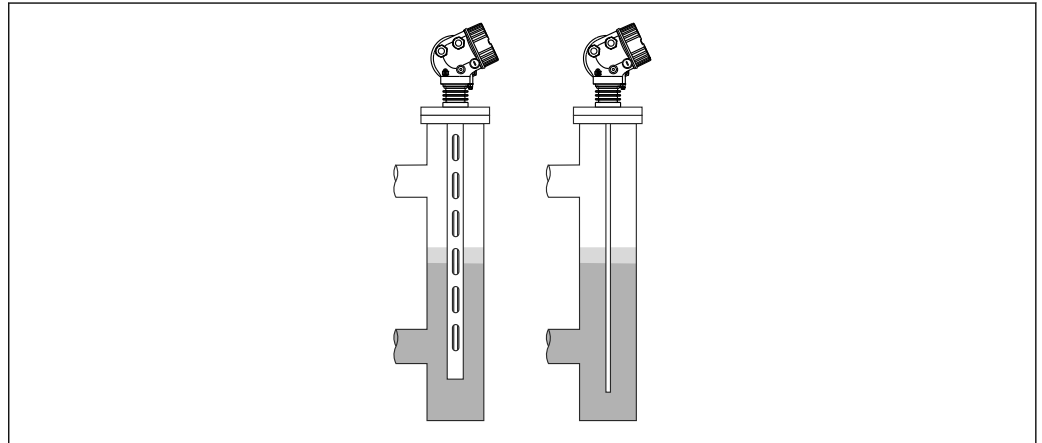
Setup > Basic setup			
Parameter	Default Value	Value to be set	Comment
Tank type	Metallic	Bypass / pipe	
Medium group	Others	Water based	
Empty calibration	Ordered probe length	Set zero (4 mA) according to your application	Empty e.g. at the lower edge of the lower connection.
Full calibration	Depending of ordered probe length	Set full (20 mA) according to your application	
Confirm distance	Distance ok	Tank empty	Make sure that the probe is uncovered!

Expert > Sensor > Safety settings			
Parameter	Default values	Value to be set	Comment
Output echo lost	Last valid value	Other options: <ul style="list-style-type: none"> ■ Alarm ■ Ramp at echo lost ■ Value echo lost 	For safety critical applications the output echo lost value may be set to alarm.
Delay echo lost	60 s	For safety critical applications the delay time can be reduced to a smaller value e.g. 30 s	Time between echo lost and alarm output.

4. Bypass chamber:
Level measurement, water
with the presence of small
amount of oil on top

Description of application

Measuring task is to measure the overall level in a bypass chamber with Levelflex FMP51, FMP52 and FMP54. Typically the bypass is filled with water. However, a smaller layer of oil may be present on top and should be evaluated as overall level.



13 Bypass chamber: level measurement of water with small layer of oil on top

Preconditions

- Installation inside a bypass chamber.
- Recommendation for bypasses > DN 50 (2"): Use coaxial probes.

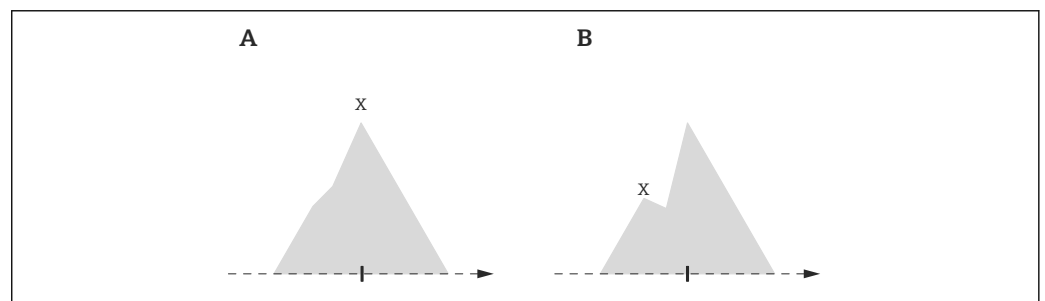
i Only for non-clogging media.

Limits

Two situations of oil as small layer on top may occur:

- Oil layer > 60 mm (2.36 in):
 Starting from 60 mm (2.36 in) the two reflections, caused by oil and water, will separate. Since the device is operating in level mode, the oil signal will be recognized as overall level.
- Oil layer < 60 mm (2.36 in):
 If only a small layer of oil is present (< 60 mm (2.36 in)), the water signal superimposes the oil reflection wherefore the oil signal can't be detected (→ 25).

- i** ■ The real level may be up to 60 mm (2.36 in) higher than the indicated level.
- If the oil layer accumulates to a thickness of more than 60 mm (2.36 in) a jump in the output signal may occur.



A Oil layer < 60 mm (2.36 in)
 B Oil layer > 60 mm (2.36 in)

For bypass installations > DN 50 (2") (w/o coaxial probe):

- i** In rare cases the bypass chamber may be completely flooded wherefore the overall level reaches into the upper blocking distance. As a consequence the overall level signal may be lost which could result in an "echo lost" alarm or in the evaluation of a false echo.

Device selection - recommended device options


- FMP51:
Standard level applications up to +200 °C (+392 °F)
- FMP52:
Coated probe for standard level applications up to +200 °C (+392 °F)
- FMP54:
Standard level applications for high temperatures up to +450 °C (+842 °F)

Feature	Option	FMP51	FMP52	FMP54
060 "Probe"	Rod (up to 4 m (13 ft))	✓	✓	✓
	Divisible rod (up to 10 m (33 ft))	✓	✗	✓
	Coax (up to 6 m (20 ft)) ¹⁾	✓	✗	✓
610 "Accessory Mounted" ²⁾	OD Rod centering star d=48-95mm / 1.88-3.74", PEEK, interface measurement, pipe diameter DN50/2" + DN100/4" ³⁾	✓	✗	✓
	OE Rod centering star d=37mm / 1.45", PFA, interface measurement, pipe diameter DN40/1-1/2" + DN50/2" ⁴⁾	✓	✓	✓

- 1) For bypasses > DN 50 (2"): Use coaxial probes.
- 2) Within the measuring range, the probe must not get into contact with the pipe wall. If necessary, use a centering star.
- 3) Suitable for DN 80 (3") and DN 100 (4") bypasses. Diameter can be adjusted in the field, according to the inner diameter of the available stilling well.
- 4) Suitable for DN 50 (2") and DN 65 (2.5") bypasses.

Installation guidelines

- The probe must be 60 mm (2.36 in) longer than the lower connection.
- Within the measuring range, the probe must not get into contact with the pipe wall. If necessary, use a centering element.
- Inner bypass diameter: DN 50 (2") to DN 100 (4")

 Recommendation DN 80 (3") to DN 100 (4") in case of clogging risk.

Commissioning

- The device is pre-configured according to the selected order code (→ 26)
- Basic setup (see table below)
- Additional settings (see table below)
- Safety settings (see table below)

Setup > Basic setup			
Parameter	Default Value	Value to be set	Comment
Tank type	<ul style="list-style-type: none"> ■ Metallic, or ■ Coax 	<ul style="list-style-type: none"> ■ Bypass/pipe, or ■ Pre-configured default value - no change possible 	
Medium group	Others	Pre-configured default value - no change required	The parameter medium group controls the echo detection threshold: To be able to detect the oil signal on top, the medium group must be others.
Empty calibration	Ordered probe length	Set zero (4 mA) according to your application	Empty e.g. at the lower edge of the lower connection.
Full calibration	Depending of ordered probe length	Set full (20 mA) according to your application	
Confirm distance	Distance ok	Tank empty	Make sure that the probe is uncovered!

Setup > Advanced Setup > Level			
Parameter	Default value	Value to be set	Comment
Advanced conditions	None	Oil / water condensate	Switches off the history mode and optimizes the evaluation of top level. Due to the deactivation of the history mode, the measurement inside the upper blocking distance is no longer possible (→ 25).

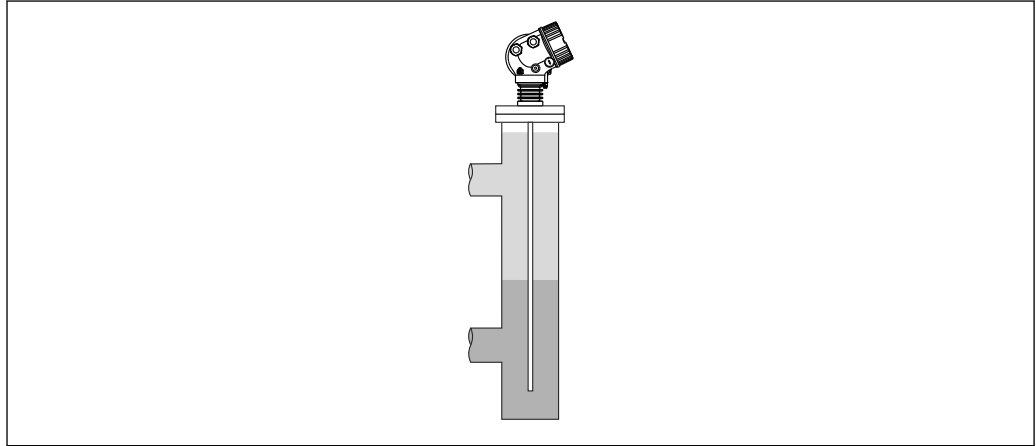
Setup > Advanced Setup > Safety settings			
Parameter	Default value	Value to be set	Comment
Upper blocking dist.	<ul style="list-style-type: none"> ■ Rod = 200 mm (7.87 in), or ■ Coax = 0 mm 	<ul style="list-style-type: none"> ■ Rod = 0 mm for bypasses ≤ DN 50 (2") ■ Rod = 200 mm (7.87 in) for bypasses > DN 50 (2"), or ■ Coax = no change required 	Blocking distance of 200 mm (7.87 in) for bypasses > DN 50 (2") minimizes the risk of "fluctuating output signals" at high levels.

Expert > Sensor > Safety settings			
Parameter	Default values	Value to be set	Comment
Output echo lost	Last valid value	Other options: <ul style="list-style-type: none"> ■ Alarm ■ Ramp at echo lost ■ Value echo lost 	For safety critical applications the output echo lost value may be set to alarm.
Delay echo lost	60 s	For safety critical applications the delay time can be reduced to a smaller value e.g. 30 s	Time between echo lost and alarm output.

5. Bypass chamber: Interface measurement, flooded

Description of application

Measuring task is to measure the interface between two media with different DC values in a flooded bypass chamber with Levelflex FMP51, FMP52, FMP54 or FMP55. The overall level is permanently inside the upper blocking distance and the level indication is always at 100%.



A0023450

 14 *Bypass chamber: Interface measurement, flooded*

Preconditions


- Installation inside a bypass chamber.
- Overall level must be permanently located inside the upper blocking distance.
- If the bypass chamber is completely filled with oil, the device will indicate 0 %.
- i**
 - If the overall level (oil level) may decrease out of the blocking distance, the device could accidentally interpret the oil level as interface level!
 - If the bypass chamber is completely filled with water, the device will show an echo lost (echo ignored by the blocking distance) or evaluate the position of a double echo!

Limits

- Medium which tends to clogging (e.g. paraffin).
- In case of the presence of emulsion layers (thickness > 60 mm (2.36 in) we recommend the usage of Levelflex FMP55.

Device selection - recommended device options

- FMP51:
Standard interface applications up to +200 °C (+392 °F)
- FMP52:
Coated probe for standard interface applications up to +200 °C (+392 °F)
- FMP54:
Standard interface applications for high temperatures up to +450 °C (+842 °F)
- FMP55:
Multiparameter device for interface applications with emulsion layers

 For temperatures > +200 °C (+392 °F) use coaxial probes only.

Feature	Option	FMP51	FMP52	FMP54	FMP55
060 "Probe"	Rod (up to 4 m (13 ft))	✓	✓	✓	✓
	Divisible rod (up to 10 m (33 ft))	✓	✗	✓	✗
	Coax ¹⁾ 6 m (20 ft)	✗	✗	✓	✗
540 "Application Package"	EB Interface measurement	✓	✓	✓	✗ ²⁾
610 "Accessory Mounted" ³⁾	OD Rod centering star d=48-95mm / 1.88-3.74", PEEK, interface measurement, pipe diameter DN50/2" + DN100/4" ⁴⁾	✓	✗	✓	✗
	OE Rod centering star d=37mm / 1.45", PFA, interface measurement, pipe diameter DN40/1-1/2" + DN50/2" ⁵⁾	✓	✓	✓	✓

- 1) Recommended for applications with temperatures >+200 °C (+392 °F).
- 2) Always equipped with interface capability.
- 3) Within the measuring range, the probe must not get into contact with the pipe wall. If necessary, use a centering star.
- 4) Suitable for DN 80 (3") and DN 100 (4") bypasses. Diameter can be adjusted in the field, according to the inner diameter of the available stilling well.
- 5) Suitable for DN 50 (2") and DN 65 (2.5") bypasses.

Our recommendation:

Use for HART devices a two channel 4 to 20 mA output electronics (feature 020 "Power Supply; Output": Option C "2-wire; 4-20 mA HART, 4-20 mA") to track both - the level- and the interface information separately - without any additional equipment (e.g. HART loop converter). Alternatively the level or interface information can be mapped to the four HART variables or to the Analog Input Blocks of FOUNDATION Fieldbus or PROFIBUS PA, respectively.


Installation guidelines

- The probe must be 60 mm (2.36 in) longer than the lower connection.
- Within the measuring range, the probe must not get into contact with the pipe wall. If necessary, use a centering element.
- Inner bypass diameter: DN 50 (2") to DN 100 (4")

 Recommendation DN 80 (3") to DN 100 (4") in case of clogging risk.

Commissioning

Levelflex FMP51, FMP52, FMP54

- The device is pre-configured according to the selected order code (→  29)
- Basic setup (see table below)
- Safety settings (see table below)

Setup > Basic setup			
Parameter	Default Value	Value to be set	Comment
Measurement mode	Interface	Pre-configured default value - no change required	
Tank type	Metallic	Bypass/pipe	
Tube diameter	0,0384 m (DN 40 (1½"))	Enter the inner tube diameter of the bypass	Only visible for FMP52 for tank type "bypass/pipe".
Tank level	Partially filled	Change into "flooded"	Level is forced to constantly 100%, first available echo outside the blocking distance is evaluated as interface.
Distance to upper connection	200 mm (7.87 in)	Change acc. to your bypass dimensions	Defines the upper blocking distance.
DC value	2.0	Enter the DC value of the upper medium	
Empty calibration	Depending of ordered probe length	Set zero (4 mA) according to your application	
Full calibration	Depending of ordered probe length	Set full (20 mA) according to your application	
Confirm distance	Distance ok	Tank empty	Make sure that the probe is uncovered!

Expert > Sensor > Safety settings			
Parameter	Default values	Value to be set	Comment
Output echo lost	Last valid value	Other options: <ul style="list-style-type: none"> ■ Alarm ■ Ramp at echo lost ■ Value echo lost 	For safety critical applications the output echo lost value may be set to alarm.
Delay echo lost	60 s	For safety critical applications the delay time can be reduced to a smaller value e.g. 30 s	Time between echo lost and alarm output.

Levelflex FMP55

- The device is pre-configured according to the selected order code (→ 29)
- Basic setup (see table below)
- Safety settings (see table below)

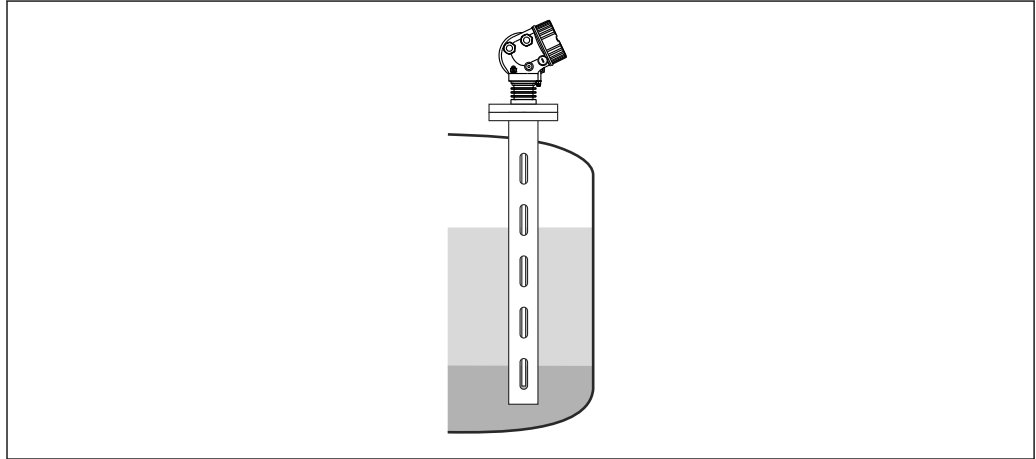
Setup > Basic setup			
Parameter	Default value	Value to be set	Comment
Measurement mode	Interface with Capacitance	Pre-configured default value - no change required	
Tank type	Bypass/pipe	Pre-configured default value - no change required	
Tube diameter	0,0384 m (DN 40 (1½"))	Enter the inner tube diameter of the bypass	
DC value	2.0	Enter the DC value of the upper medium	
Empty calibration	Depending of ordered probe length	Set zero (4 mA) according to your application	
Full calibration	Depending of ordered probe length	Set full (20 mA) according to your application	
Confirm distance	Distance ok	Tank empty	Make sure that the probe is uncovered!

Expert > Sensor > Safety settings			
Parameter	Default value	Value to be set	Comment
Output echo lost	Last valid value	Other options: <ul style="list-style-type: none"> ■ Alarm ■ Ramp at echo lost ■ Value echo lost 	For safety critical applications the output echo lost value may be set to alarm.
Delay echo lost	60 s	For safety critical applications the delay time can be reduced to a smaller value e.g. 30 s	Time between echo lost and alarm output.


6. Stilling well: Interface measurement, partially filled

Description of application

Measuring task is to measure the interface between two media with different DC values in a partially filled stilling well with Levelflex FMP51, FMP52, FMP54, FMP55. Typically partially filled applications are uncommon for bypass installation (→ [28](#)).



A0023732

 15 Stilling well: Interface measurement, partially filled

Preconditions


Installation inside a stilling well.

Limits

- Medium which tends to clogging (e.g. paraffin).
- In case of the presence of emulsion layers (thickness > 50 mm (1.97 in)) we recommend the usage of Levelflex FMP55.

Device selection - recommended device options

- FMP51:
Standard interface applications up to +200 °C (+392 °F)
- FMP52:
Coated probe for standard interface applications up to +200 °C (+392 °F)
- FMP54:
Standard interface applications for high temperatures up to +450 °C (+842 °F)
- FMP55:
Multiparameter device for interface applications with emulsion layers

 For temperatures > +200 °C (+392 °F) use coaxial probes only.

Feature	Option	FMP51	FMP52	FMP54	FMP55
060 "Probe"	Rod (up to 4 m (13 ft))	✓	✓	✓	✓
	Divisible rod (up to 10 m (33 ft))	✓	✗	✓	✗
	Coax (up to 6 m (20 ft)) ¹⁾	✗	✗	✓	✗
540 "Application Package"	EB Interface measurement	✓	✓	✓	✗ ²⁾
610 "Accessory Mounted" ³⁾	OD Rod centering star d=48-95mm / 1.88-3.74", PEEK, interface measurement, pipe diameter DN50/2" + DN100/4" ⁴⁾	✓	✗	✓	✗
	OE Rod centering star d=37mm / 1.45", PFA, interface measurement, pipe diameter DN40/1-1/2" + DN50/2" ⁵⁾	✓	✓	✓	✓

- 1) Recommended for applications with temperatures >+200 °C (+392 °F).
- 2) Always equipped with interface capability.
- 3) Within the measuring range, the probe must not get into contact with the pipe wall. If necessary, use a centering star.
- 4) Suitable for DN 80 (3") and DN 100 (4") bypasses. Diameter can be adjusted in the field, according to the inner diameter of the available stilling well.
- 5) Suitable for DN 50 (2") and DN 65 (2.5") bypasses.

Our recommendation:

Use for HART devices a two channel 4 to 20 mA output electronics (feature 020 "Power Supply; Output": Option C "2-wire; 4-20 mA HART, 4-20 mA") to track both - the level- and the interface information separately - without any additional equipment (e.g. HART loop converter). Alternatively the level or interface information can be mapped to the four HART variables or to the Analog Input Blocks of FOUNDATION Fieldbus or PROFIBUS PA, respectively.


Installation guidelines

- Within the measuring range, the probe must not get into contact with the pipe wall. If necessary, use a centering element.
- Inner stilling well diameter: DN 50 (2") to DN 100 (4")

 Recommendation DN 80 (3") to DN 100 (4") due to risk of clogging.

Commissioning

Levelflex FMP51, FMP52, FMP54

- The device is pre-configured according to the selected order code (→  33)
- Basic setup (see table below)
- Safety settings (see table below)

Setup > Basic setup			
Parameter	Default Value	Value to be set	Comment
Measurement mode	Interface	Pre-configured default value - no change required	
Tank type	Metallic	Bypass/pipe	
Tube diameter	0,0384 m (DN 40 (1½"))	Enter the inner tube diameter of the stilling well	Only visible for FMP52.
Tank level	Partially filled	Pre-configured default value - no change required	
DC value	2.0	Enter the DC value of the upper medium	
Empty calibration	Depending of ordered probe length	Set zero (4 mA) according to your application	
Full calibration	Depending of ordered probe length	Set full (20 mA) according to your application	
Confirm distance	Distance ok	Tank empty	Make sure that the probe is uncovered!

Expert > Sensor > Safety settings			
Parameter	Default values	Value to be set	Comment
Output echo lost	Last valid value	Other options: <ul style="list-style-type: none"> ■ Alarm ■ Ramp at echo lost ■ Value echo lost 	For safety critical applications the output echo lost value may be set to alarm.
Delay echo lost	60 s	For safety critical applications the delay time can be reduced to a smaller value e.g. 30 s	Time between echo lost and alarm output.

Levelflex FMP55

- The device is pre-configured to the selected order code (→ 33)
- Basic setup (see table below)
- Safety settings (see table below)

Setup > Basic setup			
Parameter	Default value	Value to be set	Comment
Measurement mode	Interface with Capacitance	Pre-configured default value - no change required	
Tank type	Bypass/pipe	Pre-configured default value - no change required	
Tube diameter	0,0384 m (DN 40 (1½"))	Enter the inner tube diameter of the bypass	
DC value	2.0	Enter the DC value of the upper medium	
Empty calibration	Depending of ordered probe length	Set zero (4 mA) according to your application	
Full calibration	Depending of ordered probe length	Set full (20 mA) according to your application	
Confirm distance	Distance ok	Tank empty	Make sure that the probe is uncovered!

Expert > Sensor > Safety settings			
Parameter	Default value	Value to be set	Comment
Output echo lost	Last valid value	Other options: <ul style="list-style-type: none"> ■ Alarm ■ Ramp at echo lost ■ Value echo lost 	For safety critical applications the output echo lost value may be set to alarm.
Delay echo lost	60 s	For safety critical applications the delay time can be reduced to a smaller value e.g. 30 s	Time between echo lost and alarm output.

Appendix

Standard documentation

Levelflex FMP51, FMP52, FMP54

Correlation of documentations to the device:

Device	Power supply, output	Communication	Document type	Document code
FMP51, FMP52, FMP54	A, B, C, K, L	HART	Technical Information	TI01001F
			Operating Instructions	BA01001F
			Brief Operating Instructions	KA01077F
			Description of Device Parameters	GP01000F
	G	PROFIBUS PA	Technical Information	TI01001F
			Operating Instructions	BA01006F
			Brief Operating Instructions	KA01079F
			Description of Device Parameters	GP01001F
	E	FOUNDATION Fieldbus	Technical Information	TI01001F
			Operating Instructions	BA01052F
			Brief Operating Instructions	KA01107F
			Description of Device Parameters	GP01015F

Levelflex FMP55

Correlation of documentations to the device:

Device	Power supply, output	Communication	Document type	Document code
FMP55	A, B, C, K, L	HART	Technical Information	TI01003F
			Operating Instructions	BA01003F
			Brief Operating Instructions	KA01060F
			Description of Device Parameters	GP01000F
	G	PROFIBUS PA	Technical Information	TI01003F
			Operating Instructions	BA01008F
			Brief Operating Instructions	KA01072F
			Description of Device Parameters	GP01001F
	E	FOUNDATION Fieldbus	Technical Information	TI01003F
			Operating Instructions	BA01054F
			Brief Operating Instructions	KA01109F
			Description of Device Parameters	GP01015F

"Applicator" selection and sizing tool

Applicator is a Software tool to conveniently select and size the correct measuring device for your application during planning. To ensure reliable selection, enter known parameters or choose your relevant industry application. Applicator is available:

- as Online too on the Endress+Hauser Homepage <http://www.endress.com>, see quick access: select and size product >>>
- or directly <https://portal.endress.com/webapp/applicator10/callapplicator.do?country=com&language=en>

Supplementary device documentation

General


Documentation	Contents	Comment
SD00326F	Levelflex FMP50, FMP51, FMP52, FMP53, FMP54, FMP55, FMP56, FMP57 Guided level radar for liquids and bulk solids with 4 to 20 mA output signal	Functional Safety Manual
CP00023F	Continuous level measurement in liquids and bulk solids	Selection and engineering guide for the process industry
CP01076F	Dielectric constant (DC value) Compendium	

FMP51, FMP52 and FMP54

Documentation	Contents	Comment
TI01001F	Levelflex FMP51, FMP52, FMP54 Guided level radar Level and interface measurement in liquids	Technical Information

FMP55

Documentation	Contents	Comment
TI01003F	Levelflex FMP55 Guided level radar Interface and level measurement	Technical Information

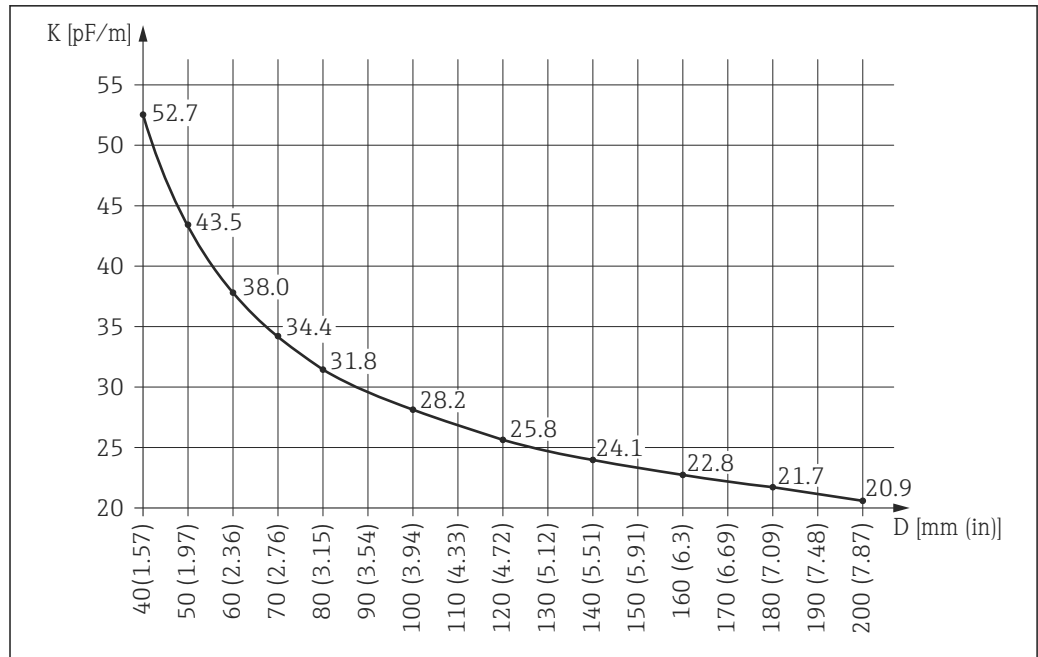
 FMP55 requires an empty bypass for setup. In cases where the bypass can't be emptied, the empty capacitance can be entered manually.

Normally, the device determines the empty capacitance automatically if during commissioning **Confirm distance = Tank empty** is selected. In exceptional cases - if emptying the tank during commissioning is impossible - a calculated value can be entered manually.

Calculation of the empty capacitance

1. Read the empty capacitance per meter from the diagram.
2. Multiply the read value by the length of the probe.
3. Add the result to the basic capacitance of the device according to the following table:

Device version	Basic capacitance
Compact device	29.5 pF
Feature 600 "Probe Design", option MB "Sensor remote, 3m/9ft cable, detachable+mounting bracket"	278.4 pF



A0023504

16 Empty capacitance per meter according to bypass or stilling well diameter

D Bypass or stilling well diameter
 K Capacitance per meter



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