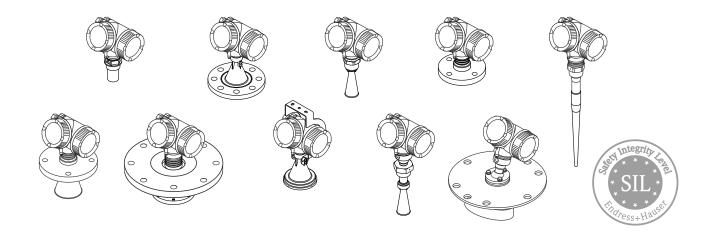
# Special Documentation Micropilot FMR50/51/52/53/54/56/57

Functional Safety Manual



Free space radar for Liquids and Bulk Solids with 4 to 20 mA Output Signal



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## **Declaration of Conformity**



The SIL Declaration of Conformity is specific to the device serial number. Therefore only a sample declaration is illustrated in this document!

SIL-12132b/00



### **Declaration of Conformity**

Functional Safety according to IEC 61508:2010 Supplement 1 / NE130 Form B.1

Endress+Hauser GmbH+Co. KG, Hauptstraße 1, 79689 Maulburg

declares as manufacturer, that the following level radar device

#### Micropilot FMR50/51/52/53/54/56/57

is suitable for the use in safety-instrumented systems up to SIL3 according to IEC 61508:2010.

In safety instrumented systems according IEC 61508 and IEC 61511, the instructions of the Safety Manual have to be followed.

Maulburg, 25-February-2016 Endress+Hauser GmbH+Co. KG

Dr. Arno Götz

Dept. Manager Product Safety Research & Development Thorsten Springmann
Dept. Manager Continuous

Level Measurement Research & Development

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A0029892

#### SIL-12132b/00



People for Process Automation

General						
Device designation	and permissible types	Leve	l radar, Micropilot FA	AR5x - **y**	*******+LA	
Order code selectio	in	x = 0,1,2,3,4,6,7; y = A,B,C,K				
Safety-related outp	out signal	420 mA				
Fault current		≤ 3.	5 mA; ≥ 21 mA			
Process variable/fu	nction	Level measurement				
Safety function(s)		MIN	, MAX, Range			
Device type acc. to	IEC 61508-2		ype A	☐ Type I	В	
Operating mode		_	ow Demand Mode	-	Demand Mode	☐ Continuous Mode
Valid hardware vers	sion	Aso	f manufacturing date			
Valid software versi	ion	-	f version 01.00.ZZ			
Safety manual	2 4 5 4	-	1087F			
			Complete HW/SW e FMEDA and change			
Type of evaluation				n-in-use" pe	rformance for HW	/SW incl. FMEDA and
(check only one box	×)		Evaluation of HW/SI IEC 61511	W field data	to verify "prior use	" acc. to
		Evaluation by FMEDA acc. to IEC 61508-2 for devices w/o software				
Evaluation through	/ certificate no.	TÜV	Rheinland Industry Se	rvice GmbH	- report no. 968/E	L 882.00/12
Test documents		Deve	elopment documents	Test repor	ts	Data sheets
SIL - Integrit	ty					
Systematic safety in	ntegrity				SIL 2 capabl	le SIL 3 capable
	100 Miles	Single channel use (HFT = 0)		0)	SIL 2 capabl	le SIL 3 capable
Hardware safety in	tegrity	Multi channel use (HFT ≥ 1) SIL 2 capable SIL 3			le SIL 3 capable	
FMEDA						
Safety function		MIN	, MAX, Range			
λ <sub>DU</sub> 1),2)		243				
λ <sub>DD</sub> <sup>1),2)</sup>		265	2652 FIT			
λ <sub>su</sub> 1),2)		713 FIT				
λ <sub>SD</sub> <sup>1),2)</sup>		55 F	IT			
A <sub>total</sub> 1),2)		366	B FIT			
SFF (Safe Failure Fr	raction)	93 9	6			
$PFD_{avg}$ ( $T_1 = 1$ year		1.09 · 10 <sup>-3</sup>				
PFD <sub>avg</sub> (T <sub>1</sub> = 2 year		2.15 · 10 · 3				
PFH			43 · 10 <sup>-7</sup> h <sup>-1</sup>			
PTC 3)		99 %				
MTBF <sup>4)</sup>		49 years				
Diagnostic test inte	erval 5)	30 min				
Fault reaction time 6)		30 s				
Declaration		1				
$\boxtimes$	Our internal company quality man	200000	at sustain answers lafa		*	and forth a late

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TFIT = Failure In Time, number of failures per 10° h

3º Valid for average ambient temperature up to +40°C (+104°F)

5º For continuous operation at ambient temperature close to +60°C (+104°F), a factor of 2.1 should be applied

5º PTC = Proof Test Coverage

6º MTBF (Mean Time Between Failures) is the predicted elapsed time between inherent failures of a system during operation in accordance to Siemens SN29500. Considered are failures of the electronics with functional relevance.

5º All diagnostic functions are performed at least once within the diagnostic test interval

6º Maximum time between error recognition and error response

# Other safety-related characteristic values

Characteristics as per IEC 61508	Value	
Safety function	MIN, MAX, Range	
SIL	SIL 2 (single-channel architecture 1001), SIL 3 (multi-channel architecture, also with homogeneous redundancy, e.g. 1002, 2003)	
HFT	0	
Device type	В	
Mode of operation	Low demand mode, High demand mode	
SFF	93 %	
MTTR	8 h	
Recommended time interval for proof-testing $T_1$	2 Jahre	
$\lambda_{sd}$	55 FIT	
$\lambda_{su}$	713 FIT	
$\lambda_{dd}$	2 652 FIT	
$\lambda_{du}$	243 FIT	
$\lambda_{tot}^{1)}$	3 663 FIT	
$PFD_{avg}$ for $T_1 = 1$ year $^{2)}$	1.09 x 10 <sup>-3</sup>	
$PFD_{avg}$ for $T_1 = 2$ years $^{2)}$	2.15 x 10 <sup>-3</sup>	
PFH	2.43 x 10 <sup>-7</sup> l/h	
MTBF 1)	49 Jahre	
Diagnostic test interval 3)	30 min	
Fault reaction time 4)	30 s	
System reaction time <sup>5)</sup>	<ul> <li>In "Increased safety mode":         <ul> <li>For "Medium type = Liquid":</li></ul></li></ul>	

- 1) According to Siemens SN29500. This value takes into account failure types relevant to the function of the electronic components.
- 2) Valid for ambient temperature up to +40 °C (+104 °F). Where the average temperature when in continuous use is in the region of +50 °C (+122 °F), a factor of 1.3 should be taken into account.
- 3) During this time, all diagnostic functions are executed at least once.
- 4) Time between error detection and error response.
- 5) Step response time as per DIN EN 61298-2. For changes greater than 175 mm (6.89 in) (FMR50/51/52/53/54) or 400 mm (15.7 in) (FMR56/57), the step response time can be greater than these values.

# Useful lifetime of electric components

The established failure rates of electrical components apply within the useful lifetime as per IEC 61508-2:2010, section 7.4.9.5, note 3. In accordance with DIN EN 61508-2:2011, section 7.4.9.5,

national footnote N3, appropriate measures taken by the manufacturer and operator can extend the useful lifetime.

#### Certificate



A0024245

## **Document information**

#### **Document function**

The document is part of the Operating Instructions and serves as a reference for application-specific parameters and notes.



- General information about functional safety: SILGeneral information about SIL is available: In the Download Area of the Endress+Hauser Internet site: www.de.endress.com/SIL

#### Using this document

#### Information on the document structure



For the arrangement of the parameters as per the **Operation** menu, **Setup** menu, **Diagnostics** menu, along a short description, see the Operating Instructions for the device.

#### Symbols used

#### Safety symbols

Symbol	Meaning
<b>▲</b> DANGER	DANGER! This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.
<b>▲</b> WARNING	<b>WARNING!</b> This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.
<b>▲</b> CAUTION	CAUTION! This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.
NOTICE	NOTE! This symbol contains information on procedures and other facts which do not result in personal injury.

#### Symbols for certain types of information

Symbol	Meaning
A0011193	Tip Indicates additional information.
A0011194	Reference to documentation Refers to the corresponding device documentation.
A0011195	Reference to page Refers to the corresponding page number.
A0011196	Reference to graphic Refers to the corresponding graphic number and page number.
1., 2., 3	Series of steps

#### Symbols in graphics

Symbol	Meaning
1, 2, 3,	Item numbers
1. , 2. , 3	Series of steps
A, B, C,	Views

# Supplementary device documentation

Micropilot FMR50, FMR51, FMR52, FMR53, FMR54, FMR56, FMR57

Documentation	Comment
Technical Information: TI01039F/00 (FMR50) TI01040F/00 (FMR51/52) TI01041F/00 (FMR53/54) TI01042F/00 (FMR56/57)	The documentation is available on the Internet:  → www.endress.com
Operating Instructions (HART):  BA01045F/00 (FMR50)  BA01049F/00 (FMR51/52)  BA01050F/00 (FMR53/54)  BA01048F/00 (FMR56/57)	The documentation is available on the Internet:  → www.endress.com
Brief Operating Instructions (HART):  KA01099F/00 (FMR50)  KA01100F/00 (FMR51/52)  KA01101F/00 (FMR53/54)  KA01102F/00 (FMR56/57)	<ul> <li>The document is provided with the device.</li> <li>The documentation is available on the Internet:</li></ul>
Description of Device Parameters: GP01014F/00	The documentation is available on the Internet:  → www.endress.com
Safety instructions depending on the selected option "Approval".	Additional safety instructions (XA, ZE) are supplied with certified device version. Please refer to the nameplate for the relevant safety instructions.

This supplementary Safety Manual applies in addition to the Operating Instructions, Technical Information and ATEX Safety Instructions. The supplementary device documentation must be observed during installation, commissioning and operation. The requirements specific for the protection function are described in this Safety Manual.

## Permitted devices types

The details pertaining to functional safety in this manual relate to the device versions listed below and are valid as of the specified soft- and hardware version. Unless otherwise specified, all subsequent versions can also be used for safety instrumented systems. A modification process according to IEC 61508 is applied for device changes.

Valid device versions for safety-related use:

Ordering feature	Designation	Option
010	Approval	all
020	Power Supply; Output	<ul> <li>A 2-wire; 4-20 mA HART</li> <li>B 1 2-wire; 4-20 mA HART, switch output</li> <li>C 2 2-wire; 4-20 mA HART, 4-20 mA</li> <li>K 4-wire 90-253 VAC; 4-20 mA HART</li> </ul>
030	Display; Operation	all
040	Housing	all
050	Electrical connection	all
070	Antenna	all
090	Seal (only FMR51/54/57)	all
100	Process connection	all
110	Purge air connection (FMR57 only)	all
500	Additional Operation Language	all
540	Application Package	all
550	Calibration	all
570	Service	all
580	Test; certificate (only FMR51/52/53/54/56)	all
590	Additional Approval	LA <sup>3)</sup> SIL
610	Accessory Mounted	all
620	Accessory Enclosed	all
850	Firmware version	If no version is selected here, the latest SIL-enabled SW is supplied. Alternatively, the following SW version may be selected:
		<ul> <li>78 01.00.zz, HART 6, DevRev01</li> <li>75 01.01.zz, HART 6, DevRev02</li> <li>72 01.02.zz, HART 7, DevRev03</li> </ul>

- For this version with one current output and one switching output, only the current output (terminals 1
  and 2) is suitable for safety functions. The switching output can, if necessary, be wired for non-safetyoriented purposes.
- 2) For this version with 2 current outputs, only the first output (terminals 1 and 2) is suitable for safety functions. The second output can, if necessary, be wired for non-safety-oriented purposes.
- 3) An additional selection of any further versions is possible.
- Valid firmware version: as of 01.00.zz (→ nameplate of the device)
- Valid hardware version (electronics): as of date of production 17.12.2012 (→ nameplate of the device)

SIL label on the nameplate

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SIL certified devices are marked with the following symbol on the nameplate: (91)

## Safety function

# Definition of the safety function

The device's safety functions are:

- Maximum level limit monitoring (overfill protection)
- Minimum level limit monitoring (dry run protection)
- Level range monitoring

The safety functions include level measurement of a liquid or bulk solid.

#### Safety-related signal

The safety-related signal is the analog output signal: 4 to 20 mA. All safety measures refer to this signal exclusively.

For devices with current output and switch output (ordering feature 020 "Power Supply; Output", option B "2-wire; 4-20 mA HART, switch output"), only the current output (terminals 1 and 2) is approved for safety functions. The switch output (terminals 3 and 4) can, if necessary, be wired for non-safety-oriented purposes.

For devices with two current outputs (ordering feature 020 "Power Supply; Output", option C "2-wire; 4-20 mA HART + 4-20 mA analog"), only the first current output (terminals 1 and 2) is approved for safety functions. The second output (terminals 3 and 4) can, if necessary, be wired for non-safety-oriented purposes.

The device additionally communicates for information only via HART and contains all HART features with additional device information.

The safety-related output signal is fed to a downstream logic unit, e.g. a programmable logic controller or a limit signal transmitter where it is monitored for the following:

- Exceed and/or undershoot a specific level limit.
- The occurrence of a fault, e.g. error current (≤3.6 mA, ≥21.0 mA, interruption or short-circuit of the signal line).
- i

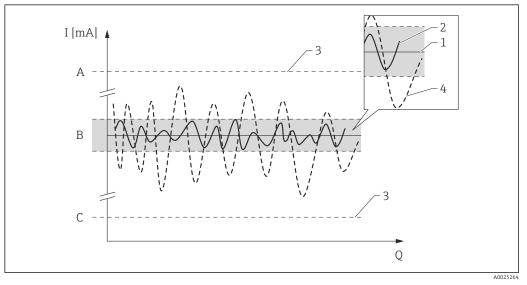
In case of fault it must be ensured that the equipment under control achieves or maintains a safe state.

#### Restrictions for use in safetyrelated applications

- The measuring system must be used correctly for the specific application, taken into account the medium properties and ambient conditions. Carefully follow instructions pertaining to critical process situations and installation conditions from the Operating Instructions. The applicationspecific limits must be observed.
- Information on the safety-related signal,  $( \Rightarrow \square 10)$ .
- The following restrictions also applies to safety-related use:
  - Strong, pulse-like EMC interference on the power supply line can cause transient (< 1 s) deviations  $\geq$  ±2% in the output signal. For this reason, filtering with a time constant of  $\geq$  1 s should be performed in the downstream logic unit.
  - The error range is device specific and is defined according to FMEDA (Failure Modes, Effects and Diagnostic Analysis) on delivery. It includes all influential factors described in the Technical Information (e.g. non-linearity, non-repeatability, hysteresis, zero drift, temperature drift, EMC influences).

According to IEC / EN 61508 the safety related failures are classified into different categories, see the following table. The table shows the implications for the safety related output signal and the measuring uncertainty.

Safety related error	Explanation	Implications for the safety related output signal	Implications for the measuring uncertainty (Position, see figure → 🖺 10)
No device error	Safe: No error	None	1 Is within the specification (see TI, BA,)
$\lambda_{\text{SD}}$	Safe detected: Safe failure which can be detected	The output signals an error (see, $\rightarrow \stackrel{ riangle}{=} 12$ )	3 No implications
y <sub>SU</sub>	Safe undetected: Safe failure which cannot be detected	Is within the defined error range	2 May be beyond the specification
$\lambda_{ m DD}$	Dangerous detected: Dangerous failure which can be detected (Diagnostic within the device)	The output signals an error (see, → 🖺 12)	3 No implications
$\lambda_{DU}$	Dangerous undetected: Dangerous failure which cannot be detected	May be outside the defined error range	4 May be outside the defined error range



- HI-Alarm ≥21 mA
- В
- Error range ±2 % LO-Alarm ≤3.6 mA

#### Dangerous undetected failures in this scenario

An incorrect output signal that deviates from the real value by more than 2 % but is still in the range of 4 to 20 mA is considered a dangerous, undetected failure.

## Use in protective systems

# Device behavior during operation

#### Device behavior during power-up

Once switched on, the device runs through a diagnostic phase of approx. 30 seconds. The current output is set to error current during this time. For approx. 5 seconds of this diagnostic phase, this current is  $\leq$  3.6 mA. After that, depending on the setting of the "Start-up mode" parameter, the current is:

at the MIN value: ≤3.6 mA
 at the MAX value: ≥21.0 mA

During the diagnostic phase, no communication is possible via the service interface (CDI) or via HART.

#### Device behavior in safety function demand mode

The device outputs a current value corresponding to the limit value to be monitored. This value must be monitored and processed further in an attached logic unit.

#### Device behavior in event of alarms and warnings

The output current on alarm can be set to a value  $\leq 3.6$  mA or  $\geq 21.0$  mA.

In some cases (e.g. failure of power supply, a cable open circuit and faults in the current output itself, where the error current  $\ge 21.0$  mA cannot be set), output currents  $\le 3.6$  mA irrespective of the configured fault current can occur.

In some other cases (e.g. short circuit of cabling), output currents  $\geq$ 21.0 mA can occur irrespective of the configured fault current.

For alarm monitoring, the logic unit must therefore be able to recognize failure currents of the upper level for signal on alarm ( $\geq$ 21.0 mA) and of the lower level for signal on alarm ( $\leq$ 3.6 mA).

#### Alarm and warning messages

Additional information is provided by the alarm and warning messages in the form of error codes and associated clear text messages.

The following table shows the correlation between the error code and the current output:

Error code 1)	Current output (message type)	Note
Fxxx	≥21.0 mA or ≤3.6 mA	xxx = three-digit number
Mxxx	corresponding to measuring mode	xxx = three-digit number
Cxxx	corresponding to measuring mode	xxx = three-digit number
Sxxx	corresponding to measuring mode	xxx = three-digit number

1) The error codes are listed in the Operating Instructions.

#### Exceptions:

Error code 1)	Current output (message type)	Note
M272	≥21.0 mA or ≤3.6 mA	Main electronic failure
C484	≥21.0 mA or ≤3.6 mA	Simulation failure mode
S942	≥21.0 mA or ≤3.6 mA	In safety distance

1) The error codes are listed in the Operating Instructions.

When SIL locking is active on the device, additional diagnostics are activated (e.g. a comparison between the readback-current with the nominal value). If one of these diagnostics results in an error message (e.g. F803 loop current) and the SIL locking is then deactivated, the error message remains while the error persists, even it the diagnostic is no longer active in the unlock state. In this case, the device must be disconnected briefly from the power supply (e.g. by unplugging the terminals). When the device is then restarted, a self-check is carried out, and the error message is reset where applicable.

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# Parameter configuration for safety-related applications

#### Calibration of the measuring point

Calibration of the measuring point is described in the Operating Instructions  $\rightarrow \blacksquare 8$ .

Check th initial factory setting of the E (zero point) and F (range) parameters in accordance with the desired measuring range and correct if necessary.

#### Methods of device configuration

When using the devices in process control safety systems, the device configuration must comply with two requirements:

- Confirmation concept:
  - Proven, independent testing of safety-related parameters entered.
- Locking concept:
   Locking of the device once configuration is complete (as required by IEC 61511-1 §11.6.4 and NE79 §3).

To activate SIL mode, the device must run through an operating sequence, during which the device can be operated by means of the device display or any Asset Management Tool (FieldCare, Pactware, AMS, PDM, Field Communicator 375/475, ...), for which integration is available.

Two methods of configuring the device are provided, which differ mainly with regard to the confirmation concept:

- "Increased safety mode"
  - While running through the commissioning sequence here, critical parameters which control functions in the safety path are either set automatically by the device to safe values or transferred to the display/operating tool via an alternative data format, to enable checking of the setting. This mode can be used for standard applications. As there are only a few safety-related parameters which can be freely configured, the risk of operating errors is greatly reduced, and the level in the tank does not need to be changed during commissioning in order to check the settings.
- "Expert mode"
  - A larger number of safety-related parameters can be freely configured here. This means that the device can be adapted to difficult applications. However, the settings must be checked by directly approaching the level in the tank or a similar method.
  - A mechanical swivel reflector can be used for example as a method for checking in the case of MAX monitoring. If a swivel reflector is used, the device must be operated with the "Very fast" setting in the operating menu under "Setup > Advanced setup > Level > Max. filling speed liquid".

A detailed description of both modes is provided in the following sections.



It is only in the case of SIL devices (ordering feature 590 "Additional Approval", option LA "SIL") that the SIL commissioning sequence is visible on the display and in external operating tools. For this reason, SIL locking can only be activated on these devices.

Locking in "Increased safety mode"

- 1. Reset device. This resets all parameters to defined values. To do this, select: "Diagnostics > Device reset > To factory defaults" or "Diagnostics > Device reset > To delivery settings"
- 3. Carry out "Device check". Activate the "Diagnostics > Device check > Start device check" parameter (more information available in the Operating Instructions → 🖺 8). The signal quality is tested here and possible installation errors are detected.
- 4. Start SIL/WHG confirmation sequence. To do this, enter the appropriate locking code (WHG: 7450; SIL: 7452; SIL and WHG: 7454) in the "Setup > Advanced setup > SIL/WHG confirmation > Set write prot." parameter.
  - In this way, forbidden parameter changes (e.g. via external operating tools if the confirmation sequence is performed at the device display) are prevented already during the SIL/WHG confirmation sequence.

- 5. For "Commissioning" select the "Increased safety" entry from the list. The device checks the parameter settings in accordance with the table and forces the switching of parameters if necessary. Once testing is complete, "SIL/WHG prepar.: Finished" is displayed, and the commissioning sequence can continue.
  - If configuration was not performed in accordance with the specifications in point 2, only "Expert mode" can be selected at this point.
- 6. Simulate the distance values using the "Value sim. dist." parameter checking that the current output responds as it should. For MIN monitoring and MAX monitoring, in each case simulate a distance directly above and below the switch point. For range monitoring, 5 distance values should be simulated which cover the entire measuring range.

#### **A** CAUTION

During distance simulation, the loop current does not correspond to the measured value.

- ▶ It must be ensured that there is no risk of danger arising from this.
- 7. Confirm that the distance simulation is correct. To do so, select the "Yes" value for the "Sim. correct" parameter.
- 8. Compare the character string which is now output ("0123456789+-,.") with the reference string printed here, and confirm if the output is correct.
- 9. The parameters previously configured and which require confirmation are transferred via an independent data format to the display/operating tool. Check the parameters one after the other and confirm if correct.
- Enter the locking code (WHG: 7450; SIL: 7452; SIL and WHG: 7454) once again under "Set write prot.". The locking status must be checked after SIL locking: The parameter "Setup > Advanced setup > Locking status > SIL locked" must be confirmed with an "X".
- 11. Optional, hardware locking may also be activated (via the dip switch marked "WP" on main electronics).

#### Locking in "Expert mode"

- Reset device. This resets all parameters to defined values. To do this, select:
  "Diagnostics > Device reset > To factory defaults" or
  "Diagnostics > Device reset > To delivery settings"
- 3. Carry out "Device check". Activate the "Diagnostics > Device check > Start device check" parameter (more information available in the Operating Instructions → 🖺 8). The signal quality is tested here and possible installation errors are detected.
- 4. Start SIL/WHG confirmation sequence. To do this, enter the appropriate locking code (WHG: 7450; SIL: 7452; SIL and WHG: 7454) in the "Setup > Advanced setup > SIL/WHG confirmation > Set write prot." parameter.
- 5. For "Commissioning" select the "Expert mode" entry from the list. The device checks the parameter settings in accordance with the table and forces the switching of parameters if necessary. Once testing is complete, "SIL/WHG prepar.: Finished" is displayed, and the commissioning sequence can continue.
- 6. Carry out function test. For MIN and MAX monitoring, at least one level below (MIN monitoring) or above (MAX monitoring) the switch point must be approached. For range monitoring, 5 distance values should be approached which cover the entire measuring range. Check that the current output responds as it should.
- 7. Confirm that the function test has been successful. To do so, select the "Yes" entry for "Conf. funct\_test"

- Enter the locking code (WHG: 7450; SIL: 7452; SIL and WHG: 7454) once again under "Set write prot.". The locking status must be checked after SIL locking: The parameter "Setup > Advanced setup > Locking status > SIL locked" must be confirmed with an "X".
- 9. Optional, hardware locking may also be activated (via the dip switch marked "WP" on main electronics).

#### Further parameter settings

Description	Parameter displayed		
These parameters affect the safety	Setup	> Tank type <sup>1)</sup>	
function. However, they may be freely configured in accordance		> Tube diameter <sup>1), 2)</sup>	
with the application. In increased safety mode, it is necessary to		> Bin type <sup>3)</sup>	
confirm the configured values during the remainder of the commissioning process. Confirmation is not required in expert mode. Recommendation: Note configured values!		> Max. filling speed solid <sup>3)</sup>	
	> Em	> Max. draining speed solid <sup>3)</sup>	
		> Empty calibration	
		> Full calibration	
		> Advanced setup > Level	> Advanced process conditions
			> Tank/silo height

- 1) 2) 3)
- Only for liquid measurement Only for pipe/bypass Only for bulk solids measurement

Description	Paramete	er displayed		
	Setup	> Advanced setup	> Level	> Level correction = 0
function and are not freely configurable in increased safety			> Linearization	> Linearization type = None
mode. Instead, they are automatically set by the device at the start of the SIL/WHG			> Current output 1	> Assign current output = Level linearized
confirmation to the safety-oriented				> Damping output = 0
values mentioned. If these parameters are to be set to other values, expert mode must be			> Display	> Backlight = Disable
selected.	Expert > Sensor	> Sensor	> Level	> Distance offset = 0
				> L max. drain speed = 0
				> L max. fill speed = 0
				> Level limit mode = Off
	> Output			> Output mode = Level linearized
			> Safety settings	> Jump delay echo lost = Off
				> Delay time echo lost = 3 s
		> Output	> Current output 1	> Assign current output
				> Turn down = Off
				> Measuring mode = Standard
		> Communication	> Configuration	> HART address = 0

Description	Paramete	er displayed		
These parameters affect the safety	Setup	> Advanced setup	> Level	> Max. draining speed liquid
function and are automatically set by the device when configuring				> Max. filling speed liquid
higher-ranking parameters (known				> Blocking distance
as application parameters). This indirect setting is permitted in	Expert	> Sensor	> Envelope curve	> Envelope curve statistic
increased safety mode. However, it is not permitted to change the				> Envelope Curve Statistic in window down
parameters directly.				> Envelope Curve Statistic in window up
If these parameters were changed directly, only expert mode is				> Envelope Curve Statistic out window down
available for selection in the SIL/WHG confirmation.				> Envelope Curve Statistic out window up
SIL/ WAG COMMINICUOM.				> Envelope Curve Statistic window size
				> Envelope smoothing mode
				> Asymmetric envelope smoothing near down
				> Asymmetric envelope smoothing near up
				> Asymmetric envelope smoothing far down
				> Asymmetric envelope smoothing far up
				> Envelope smoothing
			> Sensor properties	> HF module mode
			> Distance	> Dead time
				> Integration time
				> Max. integration time
			> Delta at integration time	
			> Safety settings  > Weighting curves	> Echo lost window right
				> Echo lost window left
				> Draining filter
				> Filling filter
				> Weighting curve selection
				> FAC window size
				> FAC offset
				> FMC window size
				> FMC offset
				> IEC offset
			> Mapping	> Map offset
				> Mapping window size
			> First echo factor	> First echo mode
				> First echo factor
			> Echo fine adjustment	> Fine adjustment mode
				> Parabolic fit window size
				> Merge echo distance
				> Merging echo window
				> Merging ratio
			> Tank bottom evaluation	> Tank bottom range
				> Min. amplitude TBD
				> Lower level area
			> Echo tracking	> Evaluation mode

Description	Parameter displayed	
		> Window size tracking
		> Maximal track counter

Description	Parameter	displayed		
These parameters affect the safety function and cannot be freely configured neither in increased	Setup	> Advanced setup	> Safety settings	> Output echo lost = Alarm
	Diagnostic	> Simulation	> Assign measurement variable = Off	
safety mode nor in expert mode. Instead they are automatically set	S		> Simulation current output 1 = Off	
at the start of the SIL/WHG	Expert >		> Simulation device alarm = Off	
confirmation to the safety-oriented values mentioned.			> Simulation diagnostic event = 65533	
		Expert > Sensor	> Distance	> Hysteresis = 0
				> Velocity filter = Off
		> Output	> Current output 1	> Trim

Description	Paramet	er displayed		
These parameters affect the safety	Setup	> Advanced setup	> Level	> Medium type
function. If the settings differ from the as-delivered state of the device.				> Blocking distance
only expert mode is available for			> Current output 1	> Current span
selection in the SIL/WHG confirmation.	Expert > Sensor	> Sensor	> Envelope curve	> Envelope curve statistic
				> Asymmetric envelope smoothing near dist.
			> Sensor properties	> Sensor type
				> Antenna ext.len.
				> Antenna ext. diameter
				> Microfactor
				> Antenna zero distance
				> Cable zero distance
				> Inactive length
			> Distance	> Blocking distance evaluation mode
			> Gas phase compensation	> GPC mode
				> Gas phase compensation factor
				> Reference distance
				> Reference echo window
				> Reference echo threshold
				> Const. GPC factor
			> Weighting curves	> Max Value EWC
			> Map gap	> Map gap
			> First echo factor	> First echo factor
				> Fix factor EWC
				> First echo factor threshold
			> Echo fine adjustment	> Merge echo distance
				> Merging echo window
				> Merging ratio
				> Edge correction

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Description	Parameter	displayed		
These parameters affect the safety	Setup	> Advanced setup	> Current output 1	> Assign current output
function. If the settings differ from the permitted values mentioned,				> Failure mode = "Min." or "Max."
the SIL/WHG confirmation is canceled automatically, and the	Expert	> Output	> Current output 1	> Assign current output
device cannot be locked neither in				> Start-up mode = "Min." or "Max."
increased safety mode nor in expert mode.		> Communication	> Output	> Assign PV



- Those parameters which are not mentioned do not affect the safety function and can be configured to any meaningful values. The visibility of the parameters mentioned in the operating menu depends in part on the user role, the SW options ordered and on the configuration of other parameters.
  - In SIL mode, the device must not be operated in HART multidrop mode, as otherwise the current output will have a fixed value. For this reason, only the setting "Expert > Communication > HART address = 0" is permitted in SIL mode and in the combined SIL/WHG mode when in increased safety mode. In pure WHG mode, HART multidrop is permitted in expert mode as long as the HART signal is evaluated in an external switching unit (e.g. Tank Side Monitor NRF590) which complies with the approval principles as per WHG.

#### Unlocking a SIL-device

When SIL locking is active on a device, the device is protected against unauthorized operation by means of a locking code and, as an additional option, by means of a hardware write protection switch. The device must be unlocked in order to change the configuration, for proof-tests as per test sequence B ( $\rightarrow \cong 22$ ), test sequence C ( $\rightarrow \cong 23$ ) or test sequence D ( $\rightarrow \cong 24$ ), as well as to reset self-holding diagnostic messages.

#### **A** CAUTION

Unlocking the device deactivates diagnostic functions, and the device may not be able to carry out its safety function when unlocked.

Therefore, independent measures must be taken to ensure that there is no risk of danger while the device is unlocked.

To unlock, proceed as follows:

- 1. Check the position of the hardware write protection switch (dip switch marked "WP" on main electronics), and set this switch to "Off".
- 2. Select "Setup > Advanced setup > Deactiv. SIL/WHG" and enter the appropriate unlocking code (WHG: 7450; SIL: 7452; SIL and WHG: 7454) for the "Res. write prot." parameter.
  - └─ The "End of sequence" message indicates that the device was successfully unlocked.

#### **Proof-testing**

Check the operativeness and safety of safety functions at appropriate intervals! The operator must determine the time intervals.

The values and graphics in the "Additional safety-related characteristics" section can be used for this purpose ( $\rightarrow \stackrel{\triangle}{=} 5$ ). The test must be carried out in such a way that it verifies the correct operation of the protective system in interaction with all of the components.

The values and graphics in the "Additional safety-related characteristics" section can be used for this purpose ( $\rightarrow \stackrel{\text{\tiny the}}{=} 5$ ). The test must be carried out in such a way that it verifies the correct operation of the protective system in interaction with all of the components.

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In a single-channel architecture, the  $PFD_{avg}$  value to be used depends on the diagnostic rate of coverage for the proof-test (PTC = Proof Test Coverage) and the intended lifetime (LT = Lifetime), as specified in the following formula:

$$PFD_{avg} = \frac{1}{2} \, \bullet PTC \, \bullet \, \lambda_{DU} \, \bullet \, T_1 + \, \lambda_{DD} \, \bullet \, MTTR \, + \, \frac{1}{2} \, \bullet \, (1 - PTC) \, \bullet \, \lambda_{DU} \, \bullet \, LT$$

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For the proof-tests described as follows, the respective proof test coverages are specified, which may be used for calculation.

Proof-testing of the device can be performed as follows:

- 1. Approaching the level in the original tank ( $\rightarrow$  test sequence A).
- 2. Removing the device and measuring the surface of a medium with comparable properties (→ test sequence B).
- 3. Device self-test and level simulation (→ test sequence C). No change of level in the tank is necessary for this sequence.
- 4. Device self-test and level simulation. No change of level in the tank is necessary for this sequence. Additional check of the measurement at an arbitrary level within the measuring range (→ test sequence D). This achieves a higher diagnostic rate of coverage than with test sequence C without changing the level.

You must also check that all cover seals and cable entries are sealing correctly.

#### **A** CAUTION

#### To ensure process safety.

- ▶ During the proof-test, alternative monitoring measures must be taken to ensure process safety.
- If one of the test criteria from the following test sequences is not fulfilled, the device may no longer be used as part of a protective system. The purpose of proof-testing is to detect random device failures ( $\lambda_{du}$ ). The impact of systematic faults on the safety function is not covered by this test and must be assessed separately. Systematic faults can be caused, for example, by process material properties, operating conditions, build-up or corrosion.

#### Test sequence A

#### Preparation

- 1. Connect suitable measuring device (recommended accuracy better than  $\pm 0.1$  mA) to the current output.
- 2. Determine the safety setting (level limit or range monitoring).

#### Procedure for level limit monitoring

- 1. Check safety function: Approach one level immediately above (MAX monitoring) or below (MIN monitoring) the limit to be monitored. A mechanical swivel reflector can be used for example as a method for checking in the case of MAX monitoring. If a swivel reflector is used, the device must be put into operation for the first time with the "Very fast > 2m (80in) /min" setting in the operating menu under "Setup > Advanced setup > Level > Max. filling speed liquid".
- 2. Check safety function: Read the output current, record it and assess for accuracy.
- 3. If (as an option) the function of the measuring point is to be checked immediately in front of the switch point: Checks the function in front of MIN or MAX switch point: Approach level immediately below (MAX monitoring) or above (MIN monitoring) the limit to be monitored. Read the output current, record it and assess for accuracy. This does not check the safety function of the device.
- 4. The test is to be considered successful if the current values trigger or ensure the required function.

#### Procedure for range monitoring

- 1. Approach five levels within the range to be monitored.
- 2. Read the output current at each level value, record it and assess for accuracy.
- 3. The test is to be considered successful if the current values in step 2 are within the required level of accuracy.
- The proof-test is to be considered to have failed if the expected current value deviates for a specific level by  $> \pm 2$  %. For troubleshooting, refer to the Operating Instructions ( $\rightarrow \triangleq 8$ ). 99 % of dangerous, undetected failures are detected using this test (Proof test coverage, PTC = 0.99).

#### Test sequence B

#### Preparation

- 1. Prepare a test tank with test medium (dielectric constant comparable to that of the medium to be measured). The tank can either be open or closed. For installation instructions, refer to the Operating Instructions (→ ≦8).
- 2. Deactivate SIL mode. To do so, enter the appropriate unlocking code (WHG: 7450; SIL: 7452; SIL and WHG: 7454) in the "Setup > Advanced setup > Deactiv. SIL/WHG" operating menu.
- 3. Remove the device and mount it in a closed test tank or above an open test tank.
- 4. Connect suitable measuring device (recommended accuracy better than  $\pm 0.1$  mA) to the current output.
- 5. Perform interference echo mapping if the shape and size of the test tank is different.
- 6. Determine the safety setting (level limit or range monitoring).

#### Procedure for level limit monitoring

- 1. Approach a level directly below (MAX monitoring) or directly above (MIN monitoring) the level limit to be monitored.
- 2. Read the output current, record it and assess for accuracy.
- 3. Approach a level directly above (MAX monitoring) or directly below (MIN monitoring) the level limit to be monitored.
- 4. Read the output current, record it and assess for accuracy.
- 5. The test is to be considered successful if the current in step 2 does not result in activation of the safety function but the current in step 4 does.

#### Procedure for range monitoring

- 1. Approach five levels within the range to be monitored.
- 2. Read the output current at each level value, record it and assess for accuracy.
- 3. The test is to be considered successful if the current values in step 2 are within the required level of accuracy.
- The proof-test is to be considered to have failed if the expected current value deviates for a specific level by  $> \pm 2$  %. For troubleshooting, refer to the Operating Instructions ( $\rightarrow \triangleq 8$ ). 99 % of dangerous, undetected failures are detected using this test (Proof test coverage, PTC = 0.99).

#### **A** CAUTION

#### Re-installation in the original tank

SIL mode is not activated.

- ▶ SIL mode must be reactivated  $\rightarrow$   $\stackrel{\triangle}{=}$  13.
- ▶ If an interference echo mapping was performed in the test tank, it is necessary following installation in the original tank to carry out another interference echo mapping that is valid for that tank.

#### Test sequence C

#### Preparation

- 1. Deactivate SIL mode. To do so, enter the appropriate unlocking code (WHG: 7450; SIL: 7452; SIL and WHG: 7454) in the "Setup > Advanced setup > Deactivate SIL/WHG" operating menu.
- 2. Connect suitable measuring device (recommended accuracy better than  $\pm 0.1$  mA) to the current output.
- 3. Determine the safety setting (level limit or range monitoring).

#### Procedure for level limit monitoring

- 1. Perform device self-check. To do so, select the value "Yes" in the "Expert > Sensor > Sensor diag. > Start self check" list. After performing the test, read the test results in the "Expert > Sensor > Sensor diag. > Result self check" parameter. This part of the test has been passed only when "OK" is displayed here.
- 2. Simulate a level directly below (MAX monitoring) or directly above (MIN monitoring) the level limit to be monitored. To do so, select the value "Level" in the operating menu in the "Diagnostics > Simulation > Assign meas. var." list and enter the value in the "Diagnostics > Simulation > Process variable value" parameter.
- 3. Read the output current, record it and assess for accuracy.
- 4. Simulate a level directly above (MAX monitoring) or directly below (MIN monitoring) the level limit to be monitored.
- 5. Read the output current, record it and assess for accuracy.
- 6. The test is to be considered successful if the current in step 2 does not result in activation of the safety function but the current in step 4 does.
- When selecting the "Expert" menu group, a prompt for the access code appears on the display. If an access code was defined under "Setup > Advanced setup > Def. access code" this must be entered here. If no access code was defined, the prompt can be acknowledged by pressing the "E" key.

#### Procedure for range monitoring

- 1. Perform device self-check. To do so, select the value "Yes" in the "Expert > Sensor > Sensor diag. > Start self check" list. After performing the test, read the test results in the "Expert > Sensor > Sensor diag. > Result self check" parameter. This part of the test has been passed only when "OK" is displayed here.
- 2. Simulate five levels within the range to be monitored. Procedure,  $\rightarrow$  Limit value monitoring, step 2.
- 3. Read the output current at each level value, record it and assess for accuracy.
- 4. The test is to be considered successful if the current values in step 2 are within the required level of accuracy.
- When selecting the "Expert" menu group, a prompt for the access code appears on the display. If an access code was defined under "Setup > Advanced setup > Def. access code" this must be entered here. If no access code was defined, the prompt can be acknowledged by pressing the "E" key.
  - The proof-test is to be considered to have failed if the expected current value deviates for a specific level by > ±2 %. For troubleshooting, refer to the Operating Instructions (→ ≅ 8). 56 % of dangerous, undetected failures are detected using this test (Proof test coverage, PTC = 0.56).

A number of sensor (antenna) faults and faults in the sensor electronics are not detected.

#### **▲** CAUTION

#### After the test sequence has been passed

▶ SIL mode must be reactivated  $\rightarrow$   $\triangleq$  13.

#### Test sequence D

#### Preparation

- 1. Deactivate SIL mode. To do so, enter the appropriate unlocking code (WHG: 7450; SIL: 7452; SIL and WHG: 7454) in the "Setup > Advanced setup > Deactivate SIL/WHG" operating menu.
- 2. Connect suitable measuring device (recommended accuracy better than  $\pm 0.1$  mA) to the current output.
- 3. Determine the safety setting (level limit or range monitoring).

#### Procedure for level limit monitoring

- 1. Perform device self-check. To do so, select the value "Yes" in the "Expert > Sensor > Sensor diag. > Start self check" list. After performing the test, read the test results in the "Expert > Sensor > Sensor diag. > Result self check" parameter. This part of the test has been passed only when "OK" is displayed here.
- 2. Read the actual measured value displayed by the device at an arbitrary level within the measuring range or determine the actual output current and compare it with the set point defined by the current level. This part of the test is deemed successful if the values are within the required level of accuracy.
- 3. Simulate a level directly below (MAX monitoring) or directly above (MIN monitoring) the level limit to be monitored. To do so, select the value "Level" in the operating menu in the "Diagnostics > Simulation > Assign meas. var." list and enter the value in the "Diagnostics > Simulation > Process variable value" parameter.
- 4. Read the output current, record it and assess for accuracy.
- 5. Simulate a level directly above (MAX monitoring) or directly below (MIN monitoring) the level limit to be monitored.
- 6. Read the output current, record it and assess for accuracy.
- 7. The test is to be considered successful if the current in step 2 does not result in activation of the safety function but the current in step 4 does.
- When selecting the "Expert" menu group, a prompt for the access code appears on the display. If an access code was defined under "Setup > Advanced setup > Def. access code" this must be entered here. If no access code was defined, the prompt can be acknowledged by pressing the "E" key.

#### Procedure for range monitoring

- 1. Perform device self-check. To do so, select the value "Yes" in the "Expert > Sensor > Sensor diag. > Start self check" list. After performing the test, read the test results in the "Expert > Sensor > Sensor diag. > Result self check" parameter. This part of the test has been passed only when "OK" is displayed here.
- 2. Read the actual measured value displayed by the device at an arbitrary level within the measuring range or determine the actual output current and compare it with the set point defined by the current level. This part of the test is deemed successful if the values are within the required level of accuracy.
- 3. Simulate five levels within the range to be monitored. Procedure,  $\rightarrow$  Limit value monitoring, step 2.
- 4. Read the output current at each level value, record it and assess for accuracy.
- 5. The test is to be considered successful if the current values in step 2 are within the required level of accuracy.
- When selecting the "Expert" menu group, a prompt for the access code appears on the display. If an access code was defined under "Setup > Advanced setup > Def. access code" this must be entered here. If no access code was defined, the prompt can be acknowledged by pressing the "E" key.
  - The proof-test is to be considered to have failed if the expected current value deviates for a specific level by > ±2 %. For troubleshooting, refer to the Operating Instructions (→ ≅ 8).
     93 % of dangerous, undetected failures are detected using this test (Proof test coverage, PTC = 0.93).

## **A** CAUTION

After test sequence D has been passed

► SIL mode must be reactivated → 🗎 13.

## Life cycle

#### Requirements for personnel

The personnel for installation, commissioning, diagnostics, repair and maintenance must meet the following requirements:

- Trained, qualified specialists must have a relevant qualification for this specific function and task
- Are authorized by the plant owner/operator
- Are familiar with federal/national regulations
- Before beginning work, the specialist staff must have read and understood the instructions in the manuals and supplementary documentation as well as in the certificates (depending on the application)
- Follow instructions and comply with basic conditions

The operating personnel must meet the following requirements:

- Are instructed and authorized according to the requirements of the task by the facility's owner-
- Follow the instructions in this manual

Installation	The installation of the device is described in the relevant Operating Instructions ( $\Rightarrow \triangleq 8$ ).
Commissioning	The commissioning of the device is described in the relevant Operating Instructions ( $\rightarrow \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \$
Operation	The operation of the device is described in the relevant Operating Instructions ( $\rightarrow \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \$
Maintenance	Please refer to the relevant Operating Instructions for information on maintenance and recalibration, $\rightarrow \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ $

Alternative monitoring measures must be taken to ensure process safety during configuration, proof-testing and maintenance work on the device.

#### Repairs



Repair means restoring functional integrity by replacing defective components. Components of the same type must be used for this purpose. We recommend documenting the repair. This includes specifying the device serial number, the repair date, the type of repair and the individual who performed the repair.

The following components may be replaced by the customer's technical staff if genuine spare parts are used and the appropriate installation instructions are followed:

Component	Installation Instructions	Checking the device after repair
Antennae	EA01069F/00 (FMR51) EA01071F/00 (FMR50, FMR52, FMR53, FMR56) EA01070F/00 (FMR54) EA01068F/00 (FMR57)	<ul> <li>Visual inspection to check whether all parts are present and properly mounted</li> <li>Interference echo mapping must be recorded again</li> <li>Proof check; test sequence A or B</li> </ul>
Antenna horns		<ul> <li>Visual inspection to check whether all parts are present and properly mounted</li> <li>Check the measurement at an arbitrary level</li> </ul>
Slip-on flange	EA01103F/00 (FMR50, FMR56)	<ul> <li>Visual inspection to check whether all parts are present and properly mounted</li> <li>Proof check; test sequence A or B</li> </ul>
HF cable	EA01067F/00	<ul> <li>Visual inspection to check whether all parts are present and properly mounted</li> <li>Interference echo mapping must be recorded again</li> <li>Proof check; test sequence A or B</li> </ul>
Seal between antenna and housing	EA00036F/00	<ul> <li>Visual inspection to check whether all parts are present and properly mounted</li> <li>Proof check; test sequence A or B</li> </ul>
Display SD02/SD03	EA00102D/06	Visual inspection to check whether all parts are present and properly mounted
Transmitter electronics of the remote display FHX50	EA01064F/00	Visual inspection to check whether all parts are present and properly mounted
Cable of the remote display FHX50	General safety data sheet: EA01062F/00	Visual inspection to check whether all parts are present and properly mounted
Main electronics	EA00041F/00	<ul> <li>Visual inspection to check whether all parts are present and properly mounted</li> <li>Interference echo mapping must be recorded again</li> <li>Proof check; test sequence A or B</li> </ul>
I/O-Module	EA00039F/00	<ul> <li>Visual inspection to check whether all parts are present and properly mounted</li> <li>Check the measurement at an arbitrary level</li> </ul>
Overvoltage protection OVP10/20	SD01090F/00	<ul> <li>Visual inspection to check whether all parts are present and properly mounted</li> <li>Check the measurement at an arbitrary level</li> </ul>
Terminals for I/O modules	EA00040F/00	<ul> <li>Visual inspection to check whether all parts are present and properly mounted</li> <li>Check the measurement at an arbitrary level</li> </ul>
Housing cover	EA00035F/00	Visual inspection to check whether all parts are present and properly mounted
Housing cover seals	EA00036F/00	Visual inspection to check whether all parts are present and properly mounted
Housing filters (vent plugs)	EA00037F/00	Visual inspection to check whether all parts are present and properly mounted
Safety clamps, housing	EA00038F/00	Visual inspection to check whether all parts are present and properly mounted

Installation Instructions, see the Download Area at www.endress.com

The replaced component must be sent to Endress+Hauser for the purpose of fault analysis if the device has been operated in a protective system and a device error cannot be ruled out. In this case, always enclose the "Declaration of Hazardous Material and Decontamination" with the note "Used as SIL device in protection system" when returning the defective device. Please refer to the "Return" section in the Operating Instructions ().

#### Modification



Modifications are changes to SIL capable devices already delivered or installed.

 $Modifications \ to \ SIL \ capable \ devices \ are \ usually \ performed \ in \ the \ Endress+Hauser \ manufacturing \ center.$ 

Modifications to SIL capable devices onsite at the user's plant are possible following approval by the Endress+Hauser manufacturing center. In this case, the modifications must be performed and documented by an Endress+Hauser service technician.

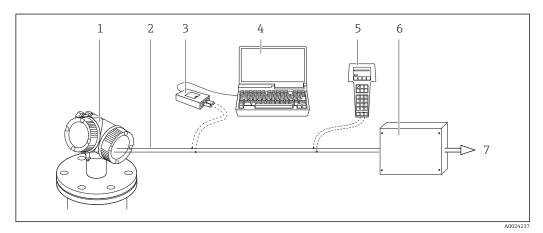
Modifications to SIL capable devices by the user are not permitted.

## **Appendix**

# Structure of the measuring system

#### System components

The measuring system's devices are displayed in the following diagram (example):



- Micropilot (optional with display module SD02/SD03)
- 2 4 to 20 mA line
- 3 Commubox FXA191/195
- 4 Computer with operating tool, e.g. FieldCare
- 5 Field Communicator 375/475
- 6 Logic Unit, e.g. PLC, limit signal transmitter
- 7 Actuator

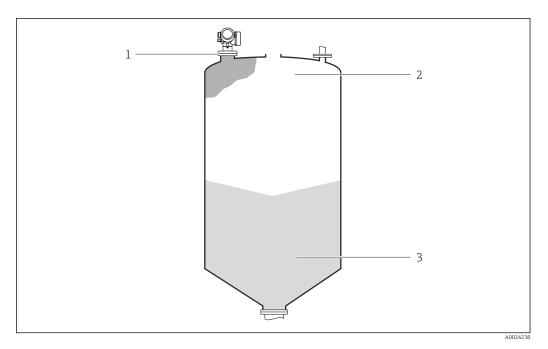
An analog signal (4 to 20 mA) in proportion to the level is generated in the transmitter. This is sent to a downstream logic unit (e.g. PLC, limit signal transmitter, ...)where it is monitored to determine whether it is below or above a specified limit value.

For fault monitoring, the logic unit must recognize both HI-alarms ( $\geq$ 21.0 mA) and LO-alarms ( $\leq$ 3.6 mA).

#### Description of use as a protective system

The Micropilot is a "downward-looking" measuring system, operating based on the time-of-flight method (ToF). The distance from the reference point (process connection of the measuring device) to the product surface is measured. High-frequency pulses are emitted via an antenna. 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 level-radar.

Typical measuring arrangement:



- Flange: Reference point of measurement 20 mA, 100% 4 mA, 0%
- 2

The device can be used in this arrangement in safety instrumented systems for MIN safety, MAX safety and range monitoring.

Correct installation is a prerequisite for safe operation of the device.

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#### **Proof-testing**

System-specific data		
Company		
Measuring point/TAG no.		
Facility		
Device type/Order code		
Serial number of device		
Name		
Date		
Access code (if individual to each device)		
Locking code used	WHG SIL SIL and WHG	□ 7450 □ 7452 □ 7454
Signature		

Device-specific commissioning parameters (only in "In	creased safety mode")
Tank type (liquid measurement)	
Tube diameter (liquid measurement; pipe/bypass)	
Bin type (bulk solids)	
Max. filling speed (bulk solids measurement)	
Max. draining speed solid (bulk solids measurement)	
Empty calib.	
Full calibration	
Advanced process conditions	
Tank/silo height	

Proof-test protocol		
Test step	Set point	Actual value
1. Current value 1		
2. Current value 2		
3. Current value 3 if applicable		
4. Current value 4 if applicable		
5. Current value 5 if applicable		

# Notes on the redundant use of multiple sensors

This section provides additional information regarding the use of homogeneous redundancy sensors e.g. 1002 or 2003 architectures.

The common cause factors  $\mathfrak B$  and  $\mathfrak B_D$  indicated in the table below are minimum values for the Micropilot. These must be used when designing the sensor subsystem.

Minimum value ß with homogeneous redundant use	2 %
Minimum value $\mathfrak{L}_{\mathbb{D}}$ with homogeneous redundant use	1 %

The device meets the requirements for SIL 3 in homogeneous redundancy.

The following must be taken into account in proof-testing:

If an error is detected in one of the redundantly operated devices, the other devices must be checked to see if there is the same error.

#### **Further information**

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General information on functional safety (SIL) is available at:

www.de.endress.com/SIL (Germany) or www.endress.com/SIL (English) and in the Competence Brochure CP01008Z/11 "Functional Safety in the Process Industry- Risk Reduction with Safety Instrumented Systems".



www.addresses.endress.com

