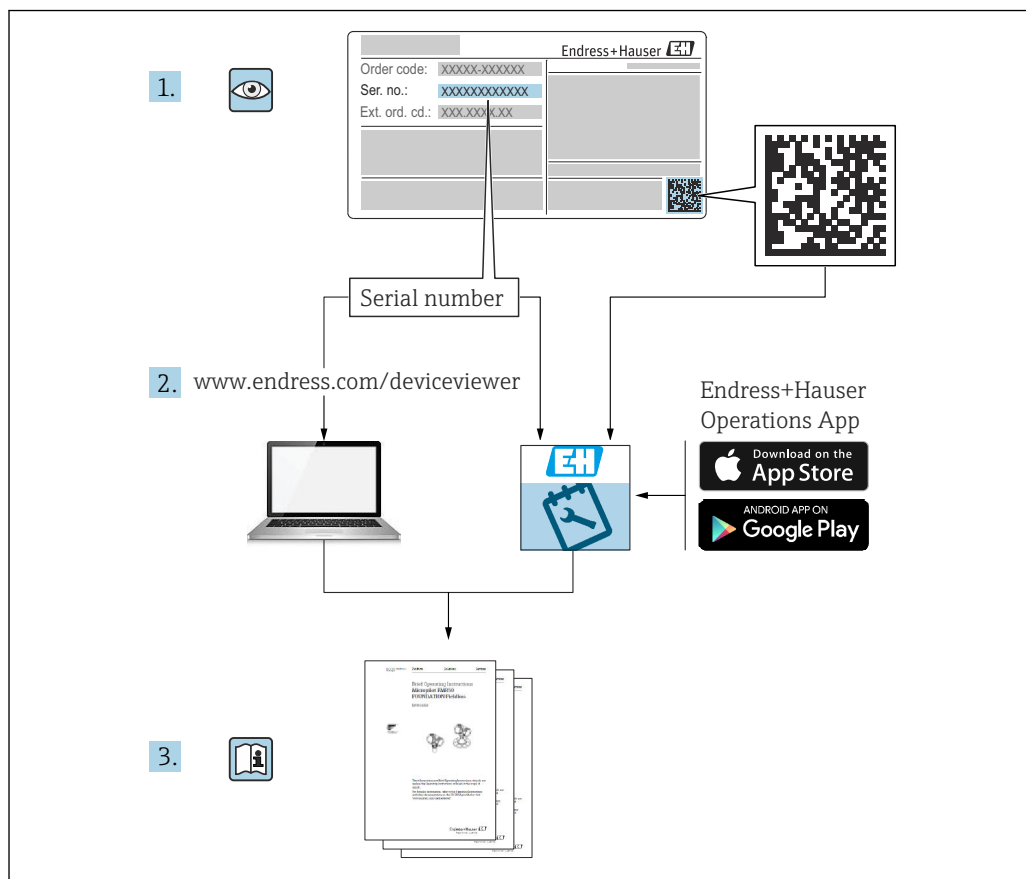


Functional Safety Manual

Gammapilot FMG50

Radiometric measuring technology





A0023555

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1 Declaration of Conformity

Declaration of Conformity

Functional Safety according to IEC 61508
Based on NE 130 Form B.1

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

being the manufacturer, declares that the product

Gammapilot FMG50

is suitable for the use in safety-instrumented systems according to IEC 61508. The instructions of the corresponding functional safety manual must be followed.

This declaration of conformity is exclusively valid for the listed products and accessories in delivery status.

Maulburg, May 6, 2024
Endress+Hauser SE+Co. KG

i. V.

i. V.

E-SIGNED by Thorsten Springmann
on 06 May 2024 08:48:48 CEST

Thorsten Springmann
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Research & Development

E-SIGNED by Manfred Hammer
on 06 May 2024 08:36:26 CEST

Manfred Hammer
Dept. Man. R&D Quality Management/FSM
Research & Development

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1.1 Safety-related characteristic values

General			
Device designation and permissible types ¹⁾	Gammapilot FMG50 ** BA * * * * * + [LA 78]		
Safety-related output signal	4 ... 20 mA		
Fault signal	≤ 3.6 mA / ≥ 21 mA		
Process variable/function	Level / Point Level / Interface / Density / Concentration Measurement		
Safety function(s)	MIN / MAX / RANGE		
Device type acc. to IEC 61508-2	☐ Type A		☒ Type B
Operating mode	☒ Low Demand Mode	☒ High Demand Mode	
Valid hardware version	01.00.ww (ww: any double number)		
Valid software version	01.00.zz (zz: any double number)		
Safety manual	FY01007F		
Type of evaluation (check only <u>one</u> box)	☒	Complete HW/SW evaluation parallel to development incl. FMEDA and change request acc. to IEC 61508-2, 3	
	☐	Evaluation of "proven in use" performance for HW/SW incl. FMEDA and change request acc. to IEC 61508-2, 3	
	☐	Evaluation of HW/SW field data to verify „prior use“ acc. to IEC 61511	
	☐	Evaluation by FMEDA acc. to IEC 61508-2 for devices w/o software	
Evaluation through – report/certificate no.	TÜV Rheinland 968/FSP 1924		
Test documents	Development documents	Test reports	Data sheets
SIL – Integrity			
Systematic safety integrity		☐ SC 2	☒ SC 3
Hardware safety integrity	Single channel use (HFT = 0)	☒ SIL 2 capable	☐ SIL 3 capable
	Multi channel use (HFT ≥ 1)	☐ SIL 2 capable	☒ SIL 3 capable
FMEDA			
Safety function	MIN	MAX	RANGE
$\lambda_{DU}^{2),3)}$	27 FIT	27 FIT	27 FIT
$\lambda_{DD}^{2),3)}$	1572 FIT	1572 FIT	1572 FIT
$\lambda_S^{2),3)}$	502 FIT	502 FIT	502 FIT
SFF	98%	98%	98%
PFD _{avg} (T ₁ = 1 year) ³⁾ (single channel architecture)	$1.24 \cdot 10^{-4}$	$1.24 \cdot 10^{-4}$	$1.24 \cdot 10^{-4}$
PFH	$2.75 \cdot 10^{-8}$ 1/h	$2.75 \cdot 10^{-8}$ 1/h	$2.75 \cdot 10^{-8}$ 1/h
PTC ⁴⁾ A / B / C	92% / 80% / 90%	92% / 80% / 90%	92% / 80% / 90%
Diagnostic test interval ⁵⁾	≤ 30 min	≤ 30 min	≤ 30 min
Fault reaction time ⁶⁾	≤ 5 s	≤ 5 s	≤ 5 s
Comments			
The limit values for MIN/MAX must be defined by the user on a downstream logic unit (e.g. PLC) for the safety-related output signal.			
Declaration			
☒	Our internal company quality management system ensures information on safety-related systematic faults which become evident in the future		

¹⁾ Valid order codes and order code exclusions are maintained in the E+H ordering system

²⁾ FIT = Failure In Time, number of failures per 10⁹ h

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

For continuous operation at ambient temperature close to +60 °C (+140 °F), a factor of 2.1 should be applied

⁴⁾ PTC = Proof Test Coverage

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

⁶⁾ Maximum time between error recognition and error response

2 About this document

2.1 Document function

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 to the protection function are described in this Safety Manual.



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

- www.endress.com/SIL
- CP01008Z, Brochure "Functional Safety – SIL, Safety Instrumented Systems in the Process Industry"

2.2 Symbols used

2.2.1 Safety symbols



This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.



This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.



This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.



This symbol contains information on procedures and other facts which do not result in personal injury.

2.2.2 Symbols for certain types of information and graphics



Tip

Indicates additional information



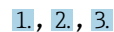
Reference to documentation



Reference to graphic



Notice or individual step to be observed



Series of steps



Result of a step

1, 2, 3, ...

Item numbers

A, B, C, ...

Views

**Hazardous area**

Indicates the hazardous area

**Safe area (non-hazardous area)**

Indicates the non-hazardous area

2.3 Supplementary device documentation



For an overview of the scope of the associated Technical Documentation, refer to the following:

- *W@M Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from nameplate
- *Endress+Hauser Operations App*: Enter the serial number from the nameplate or scan the 2D matrix code (QR code) on the nameplate

The following documentation types are available in the Downloads section of the Endress+Hauser website (www.endress.com/downloads):

2.3.1 Further applicable documents

- TI01462F
- BA01966F
- KA01427F
- GP01141F
- BA01170KEN, Loop-powered RIA15 process indicator with HART® communication
- SD02402F, Display with Bluetooth® module
- SD02414F, Heartbeat Verification

2.3.2 Technical Information (TI)

Planning aid

The document contains all the technical data on the device and provides an overview of the accessories and other products that can be ordered for the device.

2.3.3 Brief Operating Instructions (KA)

Guide that takes you quickly to the 1st measured value

The Brief Operating Instructions contain all the essential information from incoming acceptance to initial commissioning.

2.3.4 Operating Instructions (BA)

Your reference guide

These Operating Instructions contain all the information that is required in various phases of the life cycle of the device: from product identification, incoming acceptance and storage, to mounting, connection, operation and commissioning through to troubleshooting, maintenance and disposal.

2.3.5 Safety Instructions (XA)

Depending on the approval, the following Safety Instructions (XA) are supplied with the device. They are an integral part of the Operating Instructions.



The nameplate indicates the Safety Instructions (XA) that are relevant to the device.

3 Design

3.1 Permitted device types

The details pertaining to functional safety in this manual relate to the device versions listed below and are valid as of the specified firmware and hardware versions.

Unless otherwise specified, all subsequent versions can also be used for safety functions.

A modification process according to IEC 61508 is applied for device changes.

Valid device versions for safety-related use:

3.1.1 Ordering features

"FMG50"

Feature: 010 "Approval"

Version: all

Feature: 020 "Output"

Version: BA; 2-wire 4-20mA HART

Feature: 030 "Display, operation"

Version: all

Feature: 040 "Housing; Material"

Version: all

Feature: 050 "Electrical connection"

Version: all

Feature: 060 "Application"

Version: all

Feature: 090 "Sensor length, material"

Version: all

Feature: 540 "Application package"

Version: all

Feature: 570 "Service"

Version: all

Feature: 580 "Test, certificate, declaration"

Version: all

Feature: 590 "Additional approval"

Version: LA

This version must be selected for use in the safety function as per IEC 61508.

All other versions are permitted in addition to LA.

Feature: 610 "Accessory mounted"

Version: all

Feature: 620 "Accessory enclosed"

Version: all

If ordering an RIA15 unit separately, option 590 "LA" must be selected in the order code of the RIA15

Feature: 850 "Firmware version"

Version: 78

Feature: 895 "Marking"

Version: all

3.2 Identification marking

SIL-certified devices are marked with the SIL logo  on the nameplate.

3.3 Safety function

The safety function of the device depends on the measuring mode (see Section 8.1.2):

- Level measurement
- Point level measurement
- Interface measurement
- Density measurement
- Concentration measurement
- Concentration measurement with radiating media

For all safety functions, the limit values for maximum or minimum monitoring must be defined by the user at a downstream logic unit (e.g. PLC, limit signal transmitter) for the safety-related output signal.

The same safety-related characteristic values that apply for range also apply for maximum or minimum monitoring.

3.3.1 Safety-related output signal

The device's safety-related signal is the 4 to 20 mA analog output signal. All safety measures refer to this signal exclusively. In addition, the device also communicates via HART® for information purposes and comprises all the HART® features with additional device information. HART® communication is not part of the safety function. 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:

- To ascertain if it exceeds or drops below a predefined limit value
- The occurrence of a fault, e.g. failure current ($\leq 3.6 \text{ mA}$, $\geq 21 \text{ mA}$, interruption or short-circuit of the signal line)

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

3.3.2 Notes on the redundant use of multiple sensors

 This section provides additional information regarding the use of homogeneously redundant sensors e.g. in a 1oo2 or 2oo3 architecture.

The failure rates for HFT = 1 are based on an analysis in accordance with:

DIN EN 61508-6: 2011-02, Table D.4, "Using the β -factor to calculate the probability of failure in an E/E/PE safety-related system due to common cause failures."

The device meets the requirements for SIL 3 in homogeneously redundant applications. The following common cause factors β and β_D can be used for the design.

- β for homogeneously redundant use: 5 %
- β_D for homogeneously redundant use: 2 %

The system-specific analysis can produce other values depending on the specific installation and use of additional components.

 The following are possible measures to reduce the common cause factors:

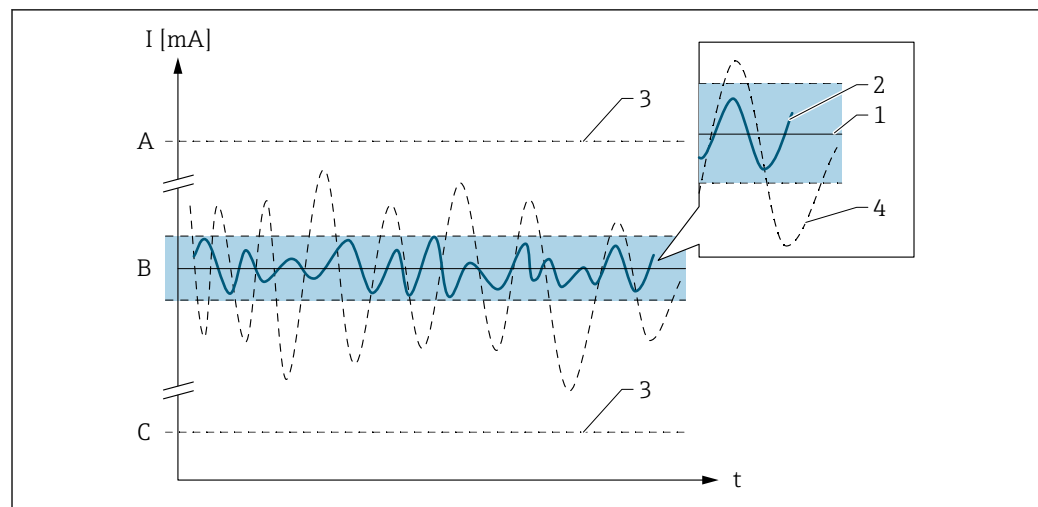
- Sensors installed in a physically separate location
- Cables routed separately
- Use of redundant radiation sources
- Separate protection from environmental influences, e.g.:
 - Impact
 - Sunshine
 - EMC protection and/or overvoltage

3.4 Basic conditions for use in safety-related applications

The measuring system must be used correctly for the specific application, taking into account the medium properties and ambient conditions. Carefully follow instructions pertaining to critical process situations and installation conditions from the Operating Instructions. The application-specific limits must be observed. The specifications in the Operating Instructions and the Technical Information must not be exceeded.

3.4.1 Additional restrictions for safety-related use

- Switching off the source container during live operation can cause an undetectable safety-critical error and must be prevented by taking suitable organizational measures to ensure safety.
- The FHG65 modulator is only suitable for maximum detection or range monitoring with the Max safe state. It may not be used for minimum detection or range monitoring with the Min safe state.
- Interconnecting for HART Multidrop operation is not permitted for reasons of freedom of interference.
- The Gammapilot FMG50 and the source container must be mechanically secured in such a way that permanently ensures that the devices cannot move or become displaced.
- The safety-related failures are classified into different categories according to IEC / EN 61508. The following list shows the implications for the safety-related output signal and the measuring uncertainty.



A0034924

- A HI alarm $\geq 21 \text{ mA}$
 B SIL error range $\pm 2\%$
 C LO alarm $\leq 3.6 \text{ mA}$

No device error

- No errors present
- Implications for the safety-related output signal: none
- Implications for measuring uncertainty: 1 - is within the specification (see TI, BA, etc.)

λ_{SD} (Safe detected)

- Safe failure which can be detected
- Implications for the safety-related output signal: results in a failure mode at the output signal
- Implications for the measuring uncertainty: 3 - has no effect

λ_{SU} (Safe undetected)

- Safe failure which cannot be detected
- Implications for the safety-related output signal: is within the defined error range
- Implications for the measuring uncertainty: 2 – can be outside the specifications

 λ_{DD} (Dangerous detected)

- Dangerous failure which can be detected
- Implications for the safety-related output signal: results in a failure mode at the output signal
- Implications for the measuring uncertainty: 3 – has no effect

 λ_{DU} (Dangerous undetected)

- Dangerous failure which cannot be detected
- Implications for the safety-related output signal: can be outside the defined error range
- Implications for the measuring uncertainty: 4 – can be outside the defined error range

3.5 Dangerous undetected failures in this scenario

An incorrect output signal that deviates from the value specified in this manual but is still in the range of 4 to 20 mA, is considered a "dangerous, undetected failure".

3.6 Safety measured error

The total deviations with regard to the safety-related current output are composed of:

- A) Measured errors under reference operating conditions: according to TI
- B) Measured errors due to process/installation/ambient conditions: according to TI
- C) Measured errors ¹⁾ due to ambient conditions (EMC)
- D) Measured errors ²⁾ due to random component failures (SIL error range)

3.7 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.

According to DIN EN 61508-2:2011 section 7.4.9.5 (national footnote N3) appropriate measures taken by the operator can extend the useful lifetime.

1) $\pm 0.5\%$ in relation to the span of the safety-related current output

2) $\pm 2.0\%$ in relation to the span of the safety-related current output

4 Commissioning (installation and configuration)

4.1 Requirements for personnel

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

- ▶ Trained, qualified specialists must have a relevant qualification for this specific function and task.
- ▶ Personnel must be authorized by the plant owner/operator.
- ▶ Be familiar with federal/national regulations.
- ▶ Before starting work: personnel must read and understand the instructions in the manual and supplementary documentation as well as the certificates (depending on the application).
- ▶ Personnel must follow instructions and comply with general policies.

The operating personnel must fulfill the following requirements:

- ▶ Personnel are instructed and authorized according to the requirements of the task by the facility's owner-operator.
- ▶ Personnel follow the instructions in this manual.

4.2 Installation

The mounting and wiring of the device and the permitted orientations are described in the Operating Instructions pertaining to the device.

4.3 Commissioning

The device is commissioned using the Commissioning Wizard. The commissioning procedure is described in the Operating Instructions pertaining to the device.

Prior to operating the device in a safety instrumented system, verification must be performed by carrying out a test sequence as described in **Section 6 Proof testing**.

4.4 Operation

The operation of the device is described in the Operating Instructions pertaining to the device.

4.5 Device configuration for safety-related applications

4.5.1 Adjustment of the measuring point

The adjustment of the measuring point is described in the Operating Instructions.

4.5.2 Device protection

The devices can be protected against external influences as follows:

- Software write protection: implemented with the "SIL Mode Activation/Deactivation Wizard".
- Hardware write protection: optionally via HW switch on the Main Unit.

4.5.3 Device configuration

The following operating methods are possible to configure the safety function:

- Field Care/Device Care
- SmartBlue (app)

The following steps must be performed to prepare SIL locking via the Wizard:

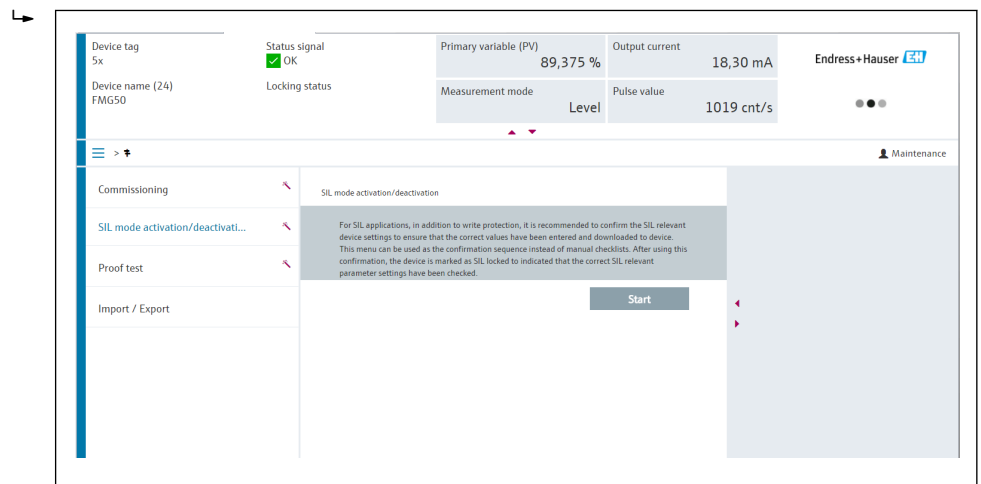
1. Recommended for initial commissioning: reset the device as specified in the Operating Instructions. This resets all parameters to defined values (factory settings or customized settings).
2. Carry out the configuration as described in the Operating Instructions

4.5.4 Locking a SIL device via the Wizard

A wizard is available in FieldCare, DeviceCare and SmartBlue (app) to guide you through the "activate" SIL mode.

 The following diagrams show the display in FieldCare or DeviceCare. The displays in other operating tools may differ, but the content is the same.

1. Click "User Navigation/SIL Mode Activation/Deactivation" to launch the Wizard



A0039772

2. On the "SIL Preparation" Wizard screen, enter the SIL locking code "7452"

Setting

Locking status = temporarily locked

1. Go through the SIL Mode Activation/Deactivation Wizard step by step
2. On the "SIL Locking" Wizard screen, enter the SIL locking code "7452" again
3. Once all the information has been entered on all the screens, click the "Finish" button on the "Finish" Wizard screen to close the Wizard

Setting: **Locking status = SIL-locked**

i At the end of the SIL activation sequence, the current CRC operator is saved and SIL locking is active on the device (device is SIL-locked). This checksum parameter is unique and is generated from the current safety-related parameter settings.

The CRC operator checksum (in the operating menu under System -> SW configuration) can be used to check undesired safety-related parameter changes.

If a device is unlocked and then locked again, the current CRC is compared against the saved CRC. If there is no difference in the values, the device is SIL-locked again immediately. If the values deviate from one another, the safety-related parameter settings must be confirmed once again.

- Optionally, the hardware write protection can also be activated via a switch.

CAUTION

- If you cancel the Wizard before going through all the necessary Wizard screens, the device returns to a state where SIL locking is not active (SIL-unlocked state).

4.5.5 Unlocking a SIL device via the Wizard

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.

To unlock, proceed as follows:

- Set the hardware write protection switch to "Off"
- On the "SIL Preparation" Wizard screen, enter the SIL unlocking code "7452"

A0039773

Successful unlocking is indicated by the "Locking status".

Setting

Locking status = SIL-unlocked

5 Operation

5.1 Device behavior when switched on

Once switched on, the device runs through a diagnostic phase of approx. 15 seconds.

The current output is set to failure current during this time.

For the first 5 seconds of the diagnostic phase, this current is ≤ 3.6 mA.

After that, depending on the setting of the "Current output failure mode" parameter, the current is:

- Min. value: ≤ 3.6 mA
- Max. value: ≥ 21 mA.

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

5.2 Device behavior in safety function demand mode

The device outputs a current value corresponding to the point level/level/interface/density/concentration value to be monitored. This value must be monitored and processed further in a connected logic unit.

5.3 Behavior of device in the event of an alarm and warnings

The output current on alarm can be set to a value of ≤ 3.6 mA or ≥ 21 mA. In some cases (e.g. failure of power supply, a cable open circuit and faults in the current output itself, where the failure current ≥ 21 mA cannot be set), output currents ≤ 3.6 mA can occur irrespective of the configured failure current.

In some other cases (e.g. short circuit of cabling), output currents ≥ 21 mA occur irrespective of the configured failure current.

For alarm monitoring, the downstream logic unit must therefore be able to detect HI alarms (≥ 21 mA) and LO alarms (≤ 3.6 mA).

5.4 Alarm and warning messages

The behavior of the device in the event of an alarm and warnings is described in the relevant Operating Instructions.

Correlation between the error code and the current that is output:

Error code "Fxxx"

Current output: ≥ 21 mA or ≤ 3.6 mA

Comment: xxx = three-digit number

Error code "Mxxx" / "Cxxx" / "Sxxx"

Current output: corresponding to measuring mode

- Comment: xxx = three-digit number
- Overview of output signals depending on the diagnostic state (warning and alarm).

Overview of output signals depending on the diagnostic state (warning and alarm).

⚠ CAUTION

- ▶ The "Gammagraphy detection" function can be triggered by interference radiation. Here, the output current is initially set to 3.8 mA (warning) and then set to alarm once the (gammagraphy) hold time has elapsed. The current output is held during the (gammagraphy) hold time. A change in the measuring signal cannot be detected during this time. If radiographic testing is performed in the system or in the immediate vicinity of the system, or if other sources of interference exist, alternative measures must be taken to guarantee safety during the (gammagraphy) hold time.

6 Proof-testing

- i** The functional integrity of the device in the SIL mode must be verified during commissioning, when changes are made to safety-related parameters, as well as at appropriate time intervals. The operator must determine the time intervals.

⚠ CAUTION

The safety function is not guaranteed during a proof test.

- ▶ Suitable measures must be taken to guarantee process safety during the test.

The individual proof test coverages (PTC) that can be used for calculation are specified in Section 1.1 "Safety-related characteristic values" for the proof tests described below.

Proof testing of the device can be performed as follows:

- **Test sequence A ³⁾: Approach the safety function via the wizard**
 - Approach or stimulate the lower and/or upper measured value and check.
Can contain limit values/switch points for maximum monitoring or minimum monitoring by a downstream logic unit (e.g. PLC, limit signal transmitter).
 - Simulate and check the min and max alarm current.
- **Test sequence B ⁴⁾: Check the current measured value via the wizard**
 - Perform a plausibility check to verify the current measured value.
Can contain limit values/switch points for maximum monitoring or minimum monitoring by a downstream logic unit (e.g. PLC, limit signal transmitter).
 - Simulate and check the min and max alarm current.
- **Test sequence C ³⁾: Manual test without Wizard**
Approach or stimulate the lower and/or upper measured value and check.
Can contain limit values/switch points for maximum monitoring or minimum monitoring by a downstream logic unit (e.g. PLC, limit signal transmitter).

Note the following for the test sequences:

- The individual proof test coverages (PTC) that can be used for calculation are specified in the Declaration of Conformity.
- The devices (e.g. ammeter) used for the verification should be sufficiently precise.
- Check that the Gammapilot FMG50 and source container are firmly secured:
 - It should not be possible to move the devices in any way.
 - Any components that are in a condition that can negatively affect the secure fastening and mounting of the devices must be replaced.
- Damaged or corroded source containers must be replaced immediately.
- Please refer to the Operating Instructions for additional information.
- Examples of measured value stimulation options:
 - Additional radiation source (test radiation source)
 - Introduce damping material into the beam path (calibration plates)
 - Switch the radiation source ON and OFF

3) Test with higher PTC (see Declaration of Conformity)

4) Test with lower PTC (see Declaration of Conformity)

6.1 Test sequence A

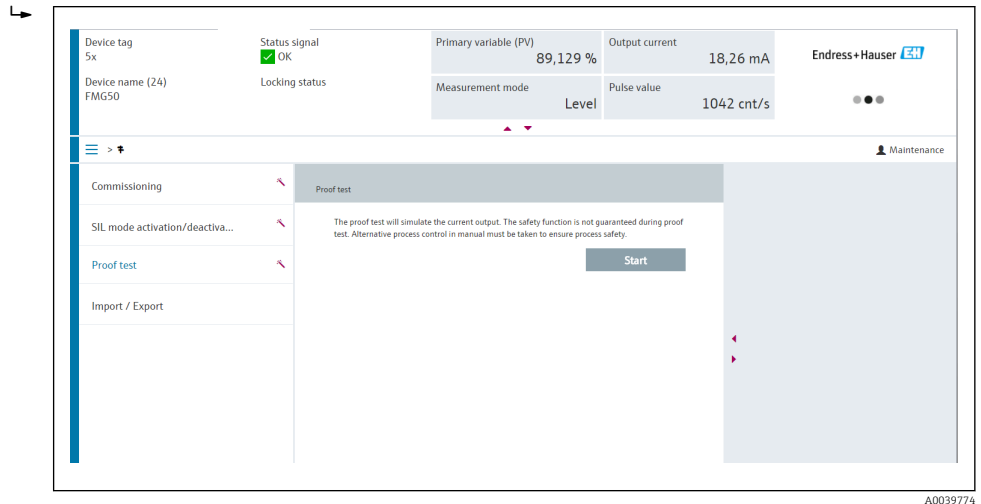
Preparation

A wizard is available in FieldCare, DeviceCare and SmartBlue (app) to guide you through the proof test.

 The following diagrams show the display in FieldCare or DeviceCare. The displays in other operating tools may differ, but the content is the same.

Proof-test procedure

1. Click "User navigation / Proof test" to launch the Wizard.



2. On the Wizard screen "Preparing for the proof test / select the test sequence", select the "Test sequence A" option.
3. Go through the Proof Test Wizard step by step.
4. Once all the information has been entered on all the screens, click the "Finish" button on the "Finish" Wizard screen to close the Wizard.

 The measured current value may deviate from the expected current value by a maximum of $\pm 2\%$. Otherwise the result of the proof test is "failed".

For troubleshooting measures, see the Operating Instructions.

6.2 Test sequence B

Preparation

- See test sequence A

Proof-test procedure

1. On the Wizard screen "Preparing for the proof test / select the test sequence", select the "Test sequence B" option.
2. Go through the Proof Test Wizard step by step.
3. Once all the information has been entered on all the screens, click the "Finish" button on the "Finish" Wizard screen to close the Wizard.

 The measured current value may deviate from the expected current value by a maximum of $\pm 2\%$. Otherwise the result of the proof test is "failed".

For troubleshooting measures, see the Operating Instructions.

6.3 Test sequence C

Preparation

1. Device identification (check tag name, device name, serial number, firmware version and hardware version)
2. Visual inspection:
 - ↳ - Cable gland
 - Wiring
 - Terminal block
 - Housing / housing cover
 - Mechanical and electrical installation

Proof test procedure for "MIN monitoring"

1. Approach or stimulate the measured value directly above the range to be monitored.
2. Check the safety-related output, record it and assess for accuracy. The result of this step is satisfactory if the safety-related output does not cause the safety function to be activated.
3. Approach or stimulate the measured value directly below the range to be monitored.
4. Check the safety-related output, record it and assess for accuracy. The result of this step is satisfactory if the safety-related output causes the safety function to be activated.

Proof test procedure for "MAX monitoring"

1. Approach or stimulate the measured value directly below the range to be monitored.
2. Check the safety-related output, record it and assess for accuracy. The result of this step is satisfactory if the safety-related output does not cause the safety function to be activated.
3. Approach or stimulate the measured value directly above the range to be monitored.
4. Check the safety-related output, record it and assess for accuracy. The result of this step is satisfactory if the safety-related output causes the safety function to be activated.

Proof test procedure for "RANGE monitoring"

1. Approach or stimulate the lower measured value (approx. 4 to 8 mA).
2. Check the safety-related output, record it and assess for accuracy. The result of this step is satisfactory if the output value is within the required accuracy range.
3. Approach or stimulate the upper measured value (approx. 16 to 20 mA)
4. Check the safety-related output, record it and assess for accuracy. The result of this step is satisfactory if the output value is within the required accuracy range.



Measured values can be stimulated by changing the radiation at the measuring point.

Stimulation options:

- Use of a radioactive test source
- Switching the radiation source ON and OFF
- Shielding with calibration plates

For troubleshooting measures, see the Operating Instructions

6.4 Verification criterion

If one of the test criteria from the test sequences described above is not fulfilled, the device may no longer be used as part of a safety instrumented system.

- The purpose of proof-testing is to detect dangerous undetected device failures (λ_{DU}).
- This test does not cover the impact of systematic faults on the safety function, which must be assessed separately.
- Systematic faults can be caused, for example, by process material properties, operating conditions, build-up or corrosion.
- As part of the visual inspection, for example, ensure that all of the seals and cable entries provide adequate sealing and that the device is not visibly damaged.

7 Repair and error handling

7.1 Maintenance

Maintenance instructions and instructions regarding recalibration may be found in the Operating Instructions pertaining to the device.

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

7.2 Repair

Repair means restoring functional integrity by replacing defective components.

Components may be repaired/replaced by the customer's technical staff if **genuine spare parts** from Endress+Hauser are used (they can be ordered by the end user) and the appropriate installation instructions are followed.

 A proof test must always be performed after every repair.

Spare parts are grouped into logical kits with the associated replacement instructions.

Document the repair with the following information:

- Serial number of the device
- Date of the repair
- Type of repair
- Person who performed the repair

 Installation Instructions are supplied with the original spare part and can also be accessed in the Download Area at www.endress.com

Return the replaced component to Endress+Hauser for fault analysis.

When returning the defective component, always enclose the "Declaration of Hazardous Material and Decontamination" with the note "Used as SIL device in a safety instrumented system."

For information on device returns, please see:

<http://www.endress.com/support/return-material>

7.3 Modification

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

- Modifications to SIL devices may compromise the functional safety of the device and must be carried out by personnel authorized by Endress+Hauser.
- Modifications to SIL 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 devices by the user are not permitted.

7.4 Decommissioning

When decommissioning, the requirements according to IEC 61508-1:2010 section 7.17 have to be observed.

7.5 Disposal



If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), our products are marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Such products may not be disposed of as unsorted municipal waste and can be returned to Endress+Hauser for disposal at conditions stipulated in our General Terms and Conditions or as individually agreed.

7.5.1 Battery disposal

- The end user is legally obliged to return used batteries.
- The end user can return old batteries or electronic assemblies containing these batteries free of charge to Endress+Hauser.

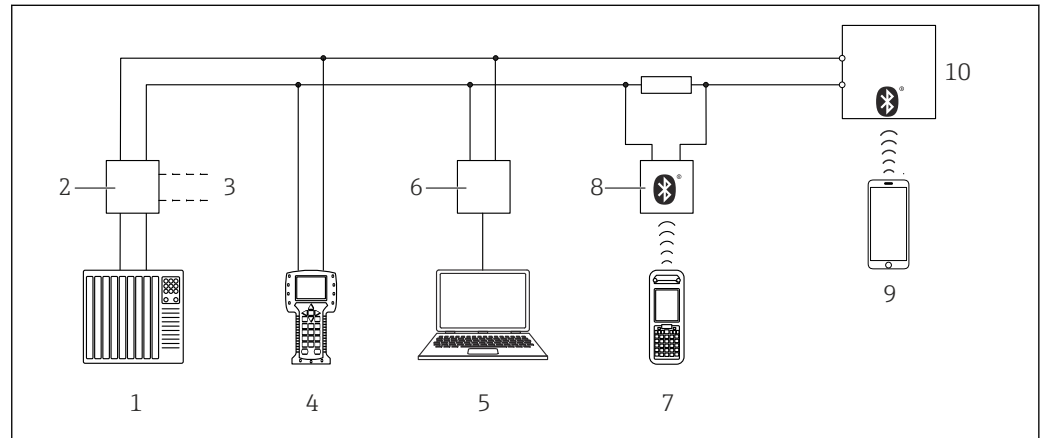


In accordance with German law regulating the use of batteries (BattG §28 Para 1 Number 3), this symbol is used to denote electronic assemblies that must not be disposed of as household waste.

8 Appendix

8.1 Structure of the measuring system

8.1.1 System components



1 Options for remote operation via HART protocol

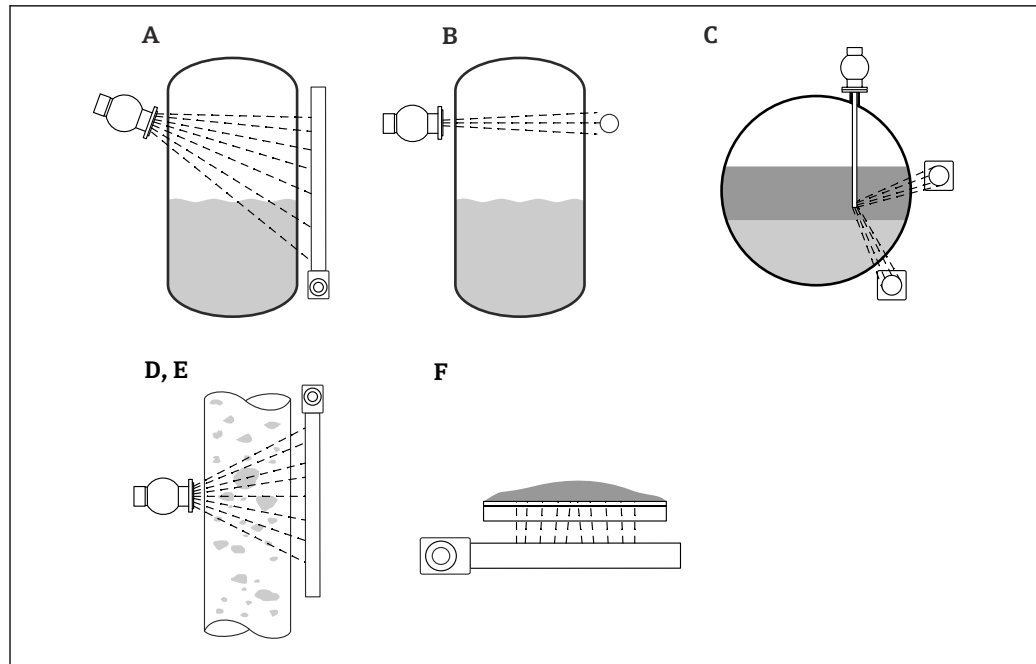
- 1 PLC (programmable logic control)
- 2 Transmitter power supply unit, e.g. RN221N (with communication resistor)
- 3 Connection for Commubox FXA191, FXA195 and Field Communicator 375, 475
- 4 Field Communicator 475
- 5 Computer with operating tool (e.g. DeviceCare/FieldCare, AMS Device Manager, SIMATIC PDM)
- 6 Commubox FXA191 (RS232) or FXA195 (USB)
- 7 Field Xpert SFX350/SFX370
- 8 VIATOR Bluetooth modem with connecting cable
- 9 Bluetooth-compatible device with SmartBlue (app)
- 10 Transmitter

An analog signal (4 to 20 mA) in proportion to the point level/level/density/concentration is generated in the transmitter. This is sent to a downstream logic unit (e.g. PLC, limit signal transmitter, etc.) 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 high alarms (≥ 21 mA) and low alarms (≤ 3.6 mA).

8.1.2 Description of application as a safety instrumented system

The radiometric measuring principle is based on the fact that gamma radiation is attenuated when it penetrates a material. Radiometric measurement can be used for a variety of measuring tasks.



A0018108

- A Continuous level measurement
- B Point level detection
- C Interface measurement
- D Density measurement
- E Concentration measurement (density measurement followed by linearization)
- F Concentration measurement with radiating media

Installation conditions

The installation conditions for various measurements are described in the Technical Information for the device.



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

Measurement function

The measuring principle and the measurement functions are described in the Technical Information for the device

8.2 Commissioning or proof test report

The following device-specific test report acts as a print/master template and can be replaced or supplemented any time by the customer's own SIL reporting and testing system.

8.2.1 Test Report - Page 1 of 2

Device information
System
Measuring points/TAG No.
Device type/order code
Serial number
Firmware version
Hardware version

Verification information
Company/contact person
Tester
Date/time
Validator

Verification result
Overall result
☐ Passed  ☐ Failed 

Comment

Date

Signature of tester

Signature of validator

8.2.2 Test Report - Page 2 of 2

Device information
Facility
Measuring points/TAG No.
Serial number
Date/time

Start		
I have read the warning information	☐	☐
Visual inspection: ■ Cable gland ■ Wiring ■ Terminal strip ■ Housing / housing cover ■ Mechanical and electrical installation	☐	☐

Proof-testing		
Measured value 1 approached?	☐	☐
Set point 1		
Read output current 1		
Max. permitted deviation 1 ($< \pm 2\%$)	☐ Passed	☐ Failed
Measured value 2 approached?	☐	☐
Set point 2		
Read output current 2		
Max. permitted deviation 2 ($< \pm 2\%$)	☐ Passed	☐ Failed

8.3 Version history

FY01007F; Version 01.19

- Firmware version: 01.00.zz (zz: any double number)
- Hardware version: 01.00.ww (ww: any double number) or from date of device delivery
- Reference to NE 53 customer information: MI01430F
- Changes:
First version

FY01007F/00/EN/02.20

- Firmware version: 01.00.zz (zz: any double number)
- Hardware version: 01.00.ww (ww: any double number) or from date of device delivery
- Reference to NE 53 customer information: MI01430F
- Changes:
 - Updated Declaration of Conformity (Section 1)
 - Safety-related characteristic values updated (Section 1.1)

FY01007F/00/EN/03.20

- Firmware version: 01.00.zz (zz: any double number)
- Hardware version: 01.00.ww (ww: any double number) or from date of device delivery
- Reference to NE 53 customer information: MI01430F
- Changes:
SD00025R removed from the list of further applicable documents

FY01007F/00/EN/04.21

- Firmware version: 01.00.zz (zz: any double number)
- Hardware version: 01.00.ww (ww: any double number) or from date of device delivery
- Valid as of SmartBlue (app) version: 1.8.1
- Reference to NE 53 customer information: MI01430F
- Changes:
 - Commissioning and proof test now also possible via Bluetooth.
 - SmartBlue (app) update required.

FY01007F/00/EN/05.21

- Firmware version: 01.00.zz (zz: any double number)
- Hardware version: 01.00.ww (ww: any double number) or from date of device delivery
- Reference to NE 53 customer information: MI01430F
- Changes:
 - Modification section adapted (Section 7.3)

FY01007F/00/EN/06.24

- Firmware version: 01.00.zz (zz: any double number)
- Hardware version: 01.00.ww (ww: any double number) or from date of device delivery
- Reference to NE 53 customer information: MI01431F
- Changes:
 - Declaration of Conformity



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