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2025-10-30

Operating Instructions
Gammapilot FMG50

Radiometric measuring technology

Endress+Hauser
People for Process Automation

- Make sure the document is stored in a safe place such that it is always available when working on or with the device.
- To avoid danger to individuals or the facility, read the "Basic safety instructions" section carefully, as well as all other safety instructions in the document that are specific to working procedures.
- The manufacturer reserves the right to modify technical data without prior notice. Your Endress+Hauser sales organization will supply you with current information and updates to this manual.

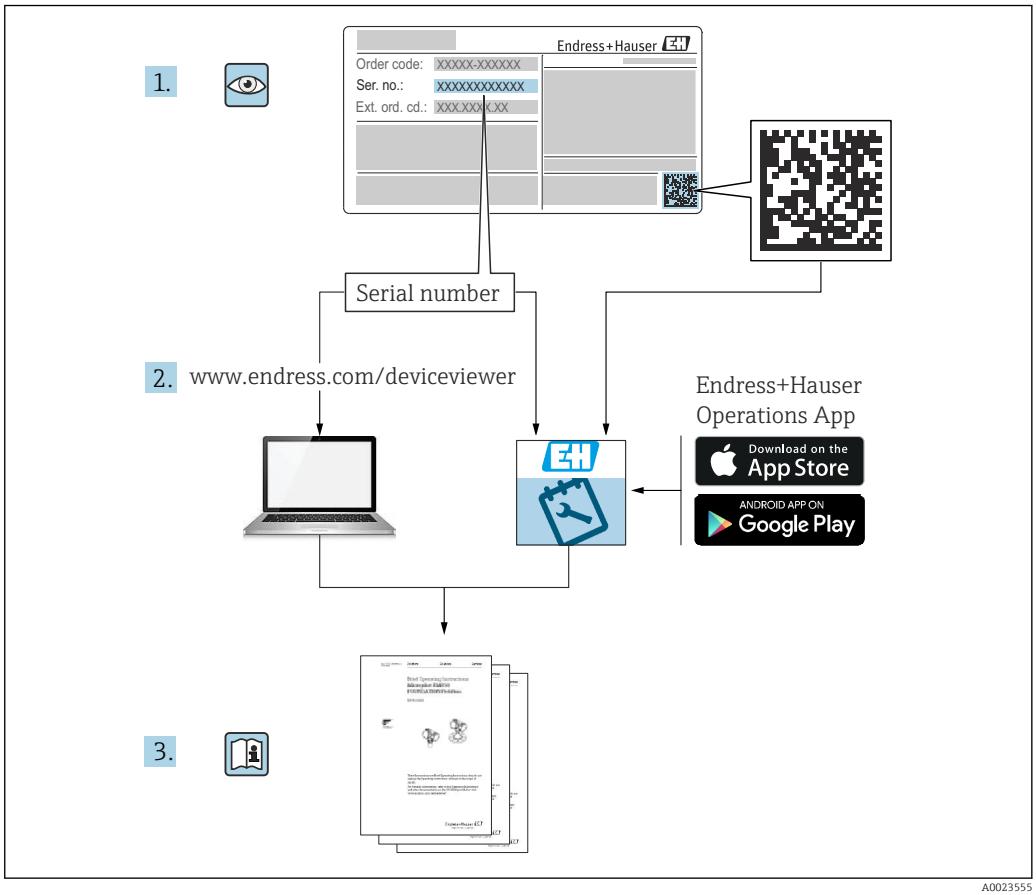
1.
Endress+Hauser
Order code: XXXXX-XXXXXX
Ser. no.: XXXXXXXXXXX
Ext. ord. cd.: XXX.XXXX.XX
Serial number
2. www.endress.com/deviceviewer
Endress+Hauser
Operations App
Download on the App Store
ANDROID APP ON Google Play
3.
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Table of contents

1 About this document

1.1 Purpose of this document

These Operating Instructions contain all the information that is required in the 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.

1.2 Symbols

1.2.1 Safety symbols

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

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

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

NOTICE
This symbol alerts you to a potentially harmful situation. Failure to avoid this situation can result in damage to the product or something in its vicinity.

1.2.2 Radiation warning sign

Warning symbol for radioactive source according to ISO 7010

Warning sign for ionizing radiation
Identification of places and objects in and around which the presence of ionizing radiation is to be expected.

Warning symbol for highly radioactive source according to ISO21482

High radiation warning sign
- Warns of highly radioactive substances or ionizing radiation.
- Highly radioactive sources are marked separately on the source containers with the wording "highly radioactive source" and the supplemental warning symbol according to ISO21482.

1.2.3 Symbols for certain types of information and graphics


Warning of radioactive substances or ionizing radiation sources

Permitted
Procedures, processes or actions that are permitted

Preferred
Procedures, processes or actions that are preferred

Forbidden
Procedures, processes or actions that are forbidden

Tip
Indicates additional information


Reference to documentation


Reference to page


Reference to graphic

▶
Notice or individual step to be observed

1., 2., 3.
Series of steps


Result of a step


Operation via local display


Operation via operating tool


Write-protected parameter

1, 2, 3, ...
Item numbers

A, B, C, ...
Views

→ Safety instructions
Observe the safety instructions contained in the associated Operating Instructions

Symbol for recycling electronic assemblies
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.

1.3 Documentation

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations app*: Enter serial number from nameplate or scan matrix code on nameplate.

1.4 Terms and abbreviations

FieldCare
Scalable software tool for device configuration and integrated plant asset management solutions

DeviceCare
Universal configuration software for Endress+Hauser HART, PROFIBUS, FOUNDATION Fieldbus and Ethernet field devices

DTM
Device Type Manager

Operating tool

The term "operating tool" is used in place of the following operating software:
- FieldCare / DeviceCare, for operation via HART communication and PC
- SmartBlue app, for operation using an Android or iOS smartphone or tablet

CDI
Common Data Interface

PLC
Programmable logic controller (PLC)

1.5 Registered trademarks

HART®
Registered trademark of the FieldComm Group, Austin, Texas, USA

Apple®
Apple, the Apple logo, iPhone, and iPod touch are trademarks of Apple Inc., registered in the U.S. and other countries. App Store is a service mark of Apple Inc.

Android®
Android, Google Play and the Google Play logo are trademarks of Google Inc.

Bluetooth®
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2 Basic safety instructions

⚠ WARNING

Risk of injury from ionizing radiation!
Ionizing radiation can increase the risk of cancer and genetic birth defects.
- ▶ Refer to the general instructions on radiation protection.
- ▶ Keep all unavoidable radiation exposure to a minimum.
- ▶ The Gammapilot FMG50 must only be installed if the source container is in the OFF position.
- ▶ All work with turned on radiation source (e.g. while adjusting the measuring point) should only be performed from a protected position.
- ▶ Please follow the instructions on radiation protection contained in the instructions for the source container.

⚠ WARNING

Risk of accident from heavy gross weight:
This could result in personal injury or even death or serious damage to objects as a consequence of impact.
- ▶ Wear personal protective equipment during installation.
- ▶ The area below and around the installation location must be kept clear during installation.
- ▶ Observe the installation instructions.
- ▶ Inspect the assembly diligently and check at regular intervals.

ℹ Follow the instructions for installing and operating the source container.

2.1 Requirements for the personnel

⚠ WARNING

Danger from inadequately qualified personnel.
Physical damage and personal injury. Particularly as a consequence of incorrect handling.
- ▶ The requirements for personnel described below are mandatory for the plant operator.

Operating personnel

The operating personnel are responsible for operation and monitoring. They switch the radiation on or off, for example. The operating personnel
- ▶ must be instructed and authorized by the plant operator according to the requirements of the task, and
- ▶ must have a relevant qualification for this specific function and task, in accordance with the relevant national requirements.

Installation and service personnel

The installation and service personnel are responsible for installation, commissioning, maintenance, monitoring, and removal. They must strictly meet the following requirements:
- ▶ They must be trained, qualified specialists, having a relevant qualification for this specific function and task, in accordance with the relevant national requirements.
- ▶ They must be authorized by the plant operator.
- ▶ They must be familiar with federal/national regulations.

Radiation safety officer

The radiation safety officer is responsible for compliance with all applicable laws and regulations. The company/plant operator must nominate a radiation safety officer in accordance with applicable national legislation. The radiation safety officer is, among other things, responsible for
- ▶ monitoring the source container at the respective point of use,

- the training of employees in the context of radiation protection and
- developing and implementing measures in an emergency. The radiation safety officer is therefore reachable at all times.

The radiation safety officer is
- qualified for the task,
- a nationally recognized person for the task and
- a specialist authorized by the plant operator.

2.2 Intended use

The Gammapilot FMG50 is a compact transmitter for non-contact level, point level, density and concentration measurement. The detector is up to 4.5 m (14.76 ft)in length. The Gammapilot FMG50 is certified according to IEC 61508 for safety-related operation up to SIL 2/3.

For intended use, the following conditions must be met:
- The instructions and handling guidelines in the Operating Instructions, particularly the radiation protection instructions, must be followed.
- Applications must be within the limits of the technical specifications.

2.2.1 Foreseeable incorrect use

The following is not permitted:
- Operation outside of the technical specification.
- Manipulation or modification of the sensor's Ex-D protective measures. In particular, machining the detector tube or modifying the detector tube screws is not permitted.
- Use of the device for radiation protection measurements, such as ambient dose measurements or clearance measurements.

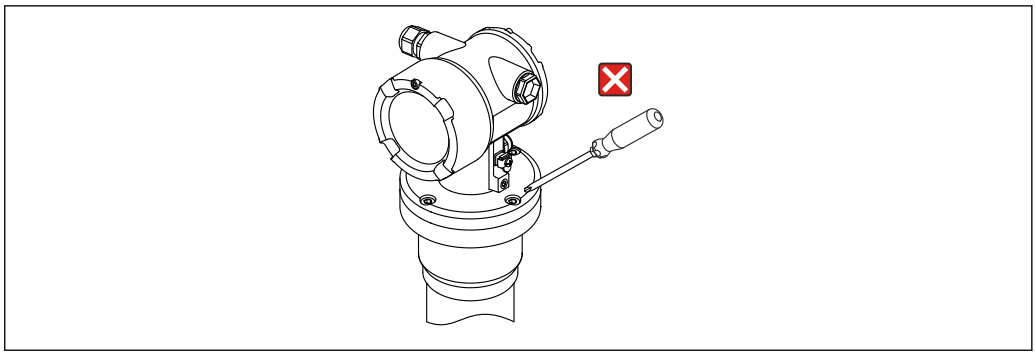
Endress+Hauser assumes no liability for damage resulting from improper use.

2.3 Installation, commissioning and operation

The Gammapilot FMG50 is designed to meet state-of-the-art safety requirements and complies with applicable standards and EC regulations. However, if it is used improperly or for applications for which it is not intended, application-related hazards may arise, such as product overflow due to incorrect installation or configuration. Installation, electrical connection, commissioning, operation and maintenance of the measuring system must therefore be carried out exclusively by trained specialists authorized to perform such work by the system operator. Technical personnel must have read and understood these Operating Instructions and must adhere to them. Modifications and repairs to the device may only be carried out if they are expressly permitted in the Operating Instructions.

⚠ WARNING

The detector tube is secured with four screws. The screws are part of the flameproof enclosure. Removing or manipulating these screws may compromise the flameproof enclosure and result in loss of explosion protection.
There is an acute risk of explosion! This can result in serious personal injury and material damage. In addition, the device's approval for use in hazardous areas will be void.
- These four screws may only be loosened or installed by authorized specialist personnel. This is permitted only during repair work and when the device is de-energized.
- Any manipulation must be documented and must comply with the applicable regulations.
- Observe the manufacturer's instructions.



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2.4 Hazardous area

If the measuring system is used in hazardous areas, the corresponding national standards and regulations must be observed. The device is accompanied by separate "Ex documentation", which is an integral part of these Operating Instructions. The installation specifications, connection data and safety instructions listed in this supplementary documentation must be observed.

- Technical personnel must be qualified and trained for the hazardous area.
- Comply with the metrological and safety-related requirements for the measuring point.

WARNING

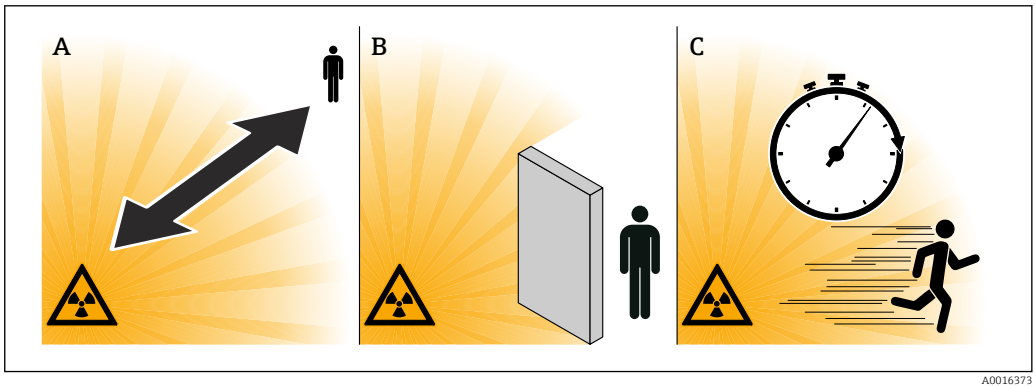
Safety instructions for the Ex certificate

The safety-relevant instructions associated with the ordered Ex certificate must be strictly observed. These instructions form part of the certification and serve to protect personnel, installations, and the environment in hazardous areas.

- ▶ Read and follow the safety instructions relating to the Ex certificate.
- ▶ Failure to comply with these instructions may result in serious safety risks and in loss of suitability for use in hazardous areas.

2.5 General instructions on radiation protection

When working with radioactive radiation sources, avoid any unnecessary exposure to radiation. All unavoidable radiation exposure must be kept to a minimum. Three basic concepts apply to achieve this:



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1 *Protective measures*

A Distance
B Shielding
C Time

Distance

Keep as far away from the radiation source as possible.

The local dose rate decreases in proportion to the square of the distance from the radiation source.

Shielding

Ensure the best possible shielding between the radiation source and personnel.

Effective shielding is provided by source containers and high-density materials (e.g. lead, iron, concrete).

Time

Keep the time spent in the area exposed to radiation as short as possible.

2.6 Legal regulations for radiation protection

The handling of radioactive radiation sources is regulated by law. The radiation protection regulations of the country in which the plant is operated are of overriding importance and must be strictly observed. In the Federal Republic of Germany, the current versions of the Radiation Protection Act and the Radiation Protection Directive apply. The following points derived from this Ordinance are particularly important for radiometric measurement:

Handling permit

A handling permit is required by the operator of a plant that uses gamma radiation. Permit applications are made to the local state government or the authority responsible (State Offices for Environmental Protection, Trade Inspection Offices, etc.). The Endress+Hauser sales organization will be happy to help you obtain the handling permit.

Radiation safety officer

The plant operator must appoint a radiation safety officer (RSO) who has the necessary specialist knowledge and who is responsible for observing the Radiation Protection Ordinance and all radiation protection procedures.

Endress+Hauser offers training courses in which individuals can acquire the necessary specialist knowledge.

Plant operator

The plant operator is responsible for ensuring compliance with all national radiation protection regulations. The operator must also ensure safe operation and adequate qualification of the personnel involved.

Controlled area

Only persons who are exposed to radiation during the course of their job and are subject to official personal dose monitoring procedures may work in controlled areas (i.e. areas where the local dose rate exceeds a specific value). The limit values for the controlled area are specified in the current Radiation Protection Ordinance applicable for your area.

For further information on radiation protection and regulations in other countries, please contact the relevant Endress+Hauser sales organization.

2.7 Supplementary safety instructions

Devices with a NaI (Tl) configuration contain more than 0.1% sodium iodide with CAS No. 7681-82-5 .

The sodium iodide is generally not accessible and fully encapsulated.

If the sodium iodide encapsulation inside the device is damaged, the safety instructions in the Safety Datasheet CAS No. 7681-82-5 must be strictly observed.

2.8 Workplace safety

For work on and with the device:
- ▶ Wear the required personal protective equipment according to federal/national regulations.
- ▶ Switch off the supply voltage before connecting the device.

2.9 Operational safety

Risk of injury!
- ▶ Operate the device only if it is in proper technical condition, free from errors and faults.
- ▶ The operator is responsible for interference-free operation of the device.

Modifications to the device

Unauthorized modifications to the device are not permitted and can lead to unforeseeable dangers:
- ▶ If modifications are nevertheless required, consult with the manufacturer.

Repair

To ensure continued operational safety and reliability:
- ▶ Carry out repairs on the device only if they are expressly permitted.
- ▶ Observe federal/national regulations pertaining to the repair of an electrical device.
- ▶ Use only original spare parts and accessories from the manufacturer.

Hazardous area

To eliminate danger to persons or the facility when the device is used in the hazardous area (e.g. explosion protection):
- ▶ Check the nameplate to verify if the device ordered can be put to its intended use in the hazardous area.
- ▶ Observe the specifications in the separate supplementary documentation that is an integral part of these instructions.

2.10 Product safety

This measuring instrument is designed in accordance with good engineering practice to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate. It meets general safety standards and legal requirements.

2.10.1 CE mark

The measuring system meets the legal requirements of the applicable EU directives. These are listed in the corresponding EU Declaration of Conformity together with the standards applied.

The manufacturer confirms successful testing of the device by affixing to it the CE mark.

2.10.2 EAC conformity

The measuring system meets the legal requirements of the applicable EAC guidelines. These are listed in the corresponding EAC Declaration of Conformity along with the standards applied.

The manufacturer confirms successful testing of the device by affixing to it the EAC mark.

2.11 Functional Safety SIL (optional)

The Functional Safety Manual must be strictly observed for devices that are used in functional safety applications.

2.12 IT security

The manufacturer warranty is valid only if the product is installed and used as described in the Operating Instructions. The product is equipped with security mechanisms to protect it against any inadvertent changes to the settings.

IT security measures, which provide additional protection for the product and associated data transfer, must be implemented by the operators themselves in line with their security standards.

2.13 Device-specific IT security

The device was developed in accordance with the requirements of the IEC 62443-4-1 "Secure product development lifecycle management" standard.

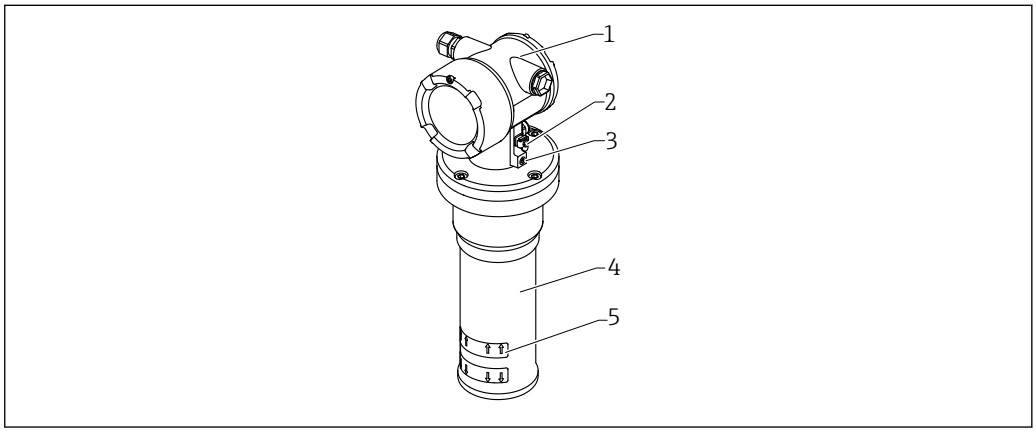
Link to the cybersecurity website: https://www.endress.com/cybersecurity

Further information on cybersecurity: see product-specific security manual (SD).

3 Product description

3.1 Product design

3.1.1 Components of the FMG50

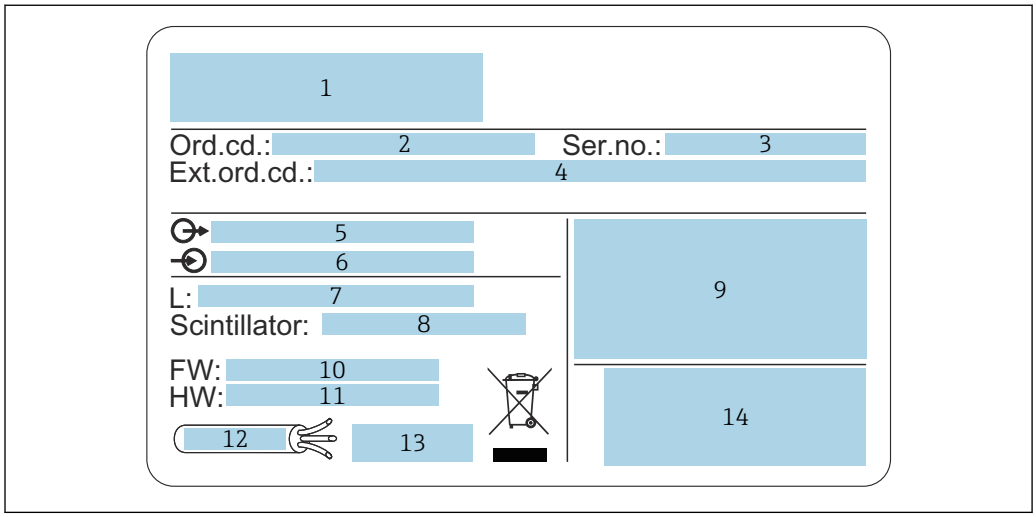


2 *A: Gammapilot FMG50*

1 Housing
2 Potential equalization terminal
3 Locking screw
4 Detector tube
5 Measuring range marking

3.2 Nameplates

3.2.1 Device nameplate



1 *Manufacturer's address and device name*
2 *Order code*
3 *Serial number*
4 *Extended order code*
5 *Signal outputs*
6 *Supply voltage*
7 *Length of measuring range*
8 *Scintillator type*
9 *Certificate- and approval-related data*
10 *Firmware version (FW)*
11 *Device revision (Dev.Rev.)*
12 *Temperature specifications for connecting cable*
13 *Permitted ambient temperature (T_a), reference to documentation*
14 *Date of manufacture: year-month and 2-D matrix code (QR code)*

3.3 Scope of delivery

- Ordered version of the device (including Brief Operating Instructions)
- Accessories as ordered

3.4 Accompanying documentation

3.4.1 Brief Operating Instructions

The Brief Operating Instructions describe how to install and commission the Gammapilot FMG50.

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Any additional functions are contained in the Operating Instructions and the "Description of Device Functions" document.

3.4.2 Description of Device Functions

The Description of Device Functions document contains a detailed description of all the functions of the Gammapilot FMG50 and applies for all communication versions. Available for download at "www.de.endress.com".

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3.4.3 Safety requirements

Additional safety instructions (XA, ZE, ZD) are supplied with certified device versions. Please refer to the nameplate for the safety instructions that apply to your device version.

An overview of the certificates and approvals can be found in the "Certificates and approvals" section.

4 Incoming acceptance and product identification

4.1 Incoming acceptance

Check the following during incoming acceptance:

❑ Are the order codes on the delivery note and the product sticker identical?

❑ Are the goods undamaged?

❑ Do the nameplate data match the ordering information on the delivery note?

❑ If required (see nameplate): Are the safety instructions (XA) provided?

If one of these conditions is not met, please contact the manufacturer's sales office.

4.2 Product identification

The following options are available for identification of the device:
- Nameplate specifications
- Extended order code with breakdown of the device features on the delivery note

- ▶ Enter serial number from nameplates in *W@M Device Viewer* (www.endress.com/deviceviewer)
  - ↳ All of the information on the measuring device and on the scope of the technical documentation pertaining to the device is displayed.

- ▶ Enter the serial number from the nameplate into the *Endress+Hauser Operations App* or scan the 2-D matrix code on the nameplate.
  - ↳ All of the information on the measuring device and on the scope of the technical documentation pertaining to the device is displayed.

4.3 Manufacturer address

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

Place of manufacture: See nameplate.

5 Transport and storage

5.1 Transportation to measuring point

⚠ CAUTION

Risk of injury due to heavy weight
This could result in personal injury in the form of bruising, crushed body parts, and back injuries.

- Follow the safety instructions and transport conditions for devices weighing more than 18 kg (39.69 lb).
- Wear protective equipment.
- Installation must be carried out by at least two persons when devices must be safely lifted and installed.

5.2 Storage

The measuring instrument must be packed for storage and transport so that it is protected against impact. The original packaging offers the best protection for this. The permitted storage temperature is:

NaI (Tl) crystal
−40 to +80 °C (−40 to +176 °F)

PVT scintillator (standard)
−40 to +60 °C (−40 to +140 °F)

PVT scintillator (high-temperature version)
−20 to +80 °C (−4 to +176 °F)

Since the device contains a battery, it is recommended to store it at room temperature, away from direct sunlight.

6 Installation

Mounting requires qualified installation and service personnel. See the "Requirements for personnel" section

6.1 Installation conditions

DANGER

When the shutter is switched to the EIN / ON position, the user will be exposed to unshielded ionizing radiation if they are located in the vicinity of the beam exit channel or look into it.

Ionizing radiation can increase the risk of cancer and genetic defects in offspring. Depending on the radiation dose, ionizing radiation can cause immediate physical harm such as nausea, vomiting, hair loss, changes in blood composition, and severe tissue damage that may lead to death.

- ▶ Never remain in the beam outlet area.
- ▶ Restrict access to the irradiated area.
- ▶ Restrict access to process tanks or pipelines that are exposed to radiation.

WARNING

Danger from inadequately qualified personnel.

Physical damage and personal injury. Particularly as a consequence of incorrect handling.

- ▶ The requirements for personnel described below are mandatory for the plant operator.

NOTICE

In cases of doubt during mounting, hazardous situations could arise.

- ▶ If there is any uncertainty, contact Endress+Hauser Service for support before work begins.

6.1.1 General

- The angle of emission of the source container must be aligned as precisely as possible to the measuring range of the Gammapilot FMG50. Observe the measuring range marks of the device.
- The source container and the Gammapilot FMG50 should be mounted as close to the vessel as possible. Any access to the useful beam must be restricted to prevent personnel from reaching into it.
- The Gammapilot FMG50 should be protected against direct sunlight or process heat in order to increase its service life.
  - Feature 620, option PA: "Weather protection cover 316L"
  - Feature 620, option PU: "Heat shield 3500-4000 mm, PVT"
  - Feature 620, option PV: "Heat shield 1200-3000 mm, PVT"
  - Feature 620, option PW: "Heat shield NaI, 200-800 mm, PVT"

- Collimators can optionally be ordered with the device for some sensor versions of the device.
  Feature 620, option P7: "Collimator on sensor side"
- Clamps can optionally be ordered with the device.
  - Feature 620, option Q1: "Mounting clamp 1x d=80 mm, 1x d=95 mm", up to 400 mm.
  - Feature 620, option Q2: "Mounting clamp 2x d=80 mm, 1x d=95 mm", 800 to 1600 mm.
  - Feature 620, option Q3: "Mounting clamp 3x d=80 mm, 1x d=95 mm", 2000 to 3000 mm.
  - Feature 620, option Q4: "Retaining bracket".
  - Feature 620, option Q5: "Mounting clamp 4x d=80 mm, 1x d=95 mm", 3500 to 4500 mm.
- The mounting device must be installed in such a way as to withstand the weight of the Gammapilot FMG50 and the mounted parts under all anticipated operating conditions (e.g. vibrations).

More information with regard to the safety-related use of the Gammapilot FMG50 can be found in the Functional Safety Manual.

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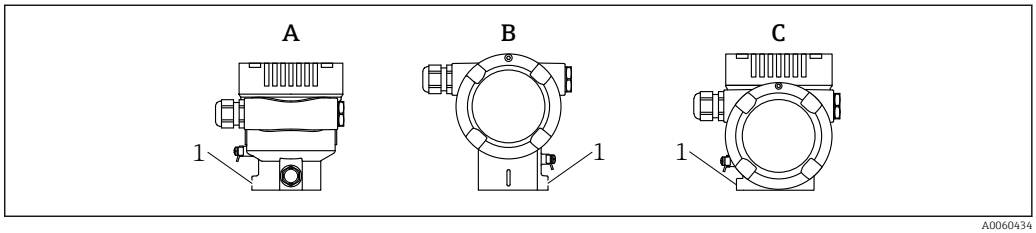
Rotating the housing

The housing can be rotated up to 380° by loosening the locking screw.

Your benefits

- Easy installation due to optimum alignment of housing
- Convenient access to the device's operating elements
- Optimum readability of the local display (optional)



A Single-compartment housing, aluminum, coated
B Dual-compartment housing, aluminum, coated
C Dual-compartment housing, L-shaped, aluminum, coated
1 Locking screw

NOTICE

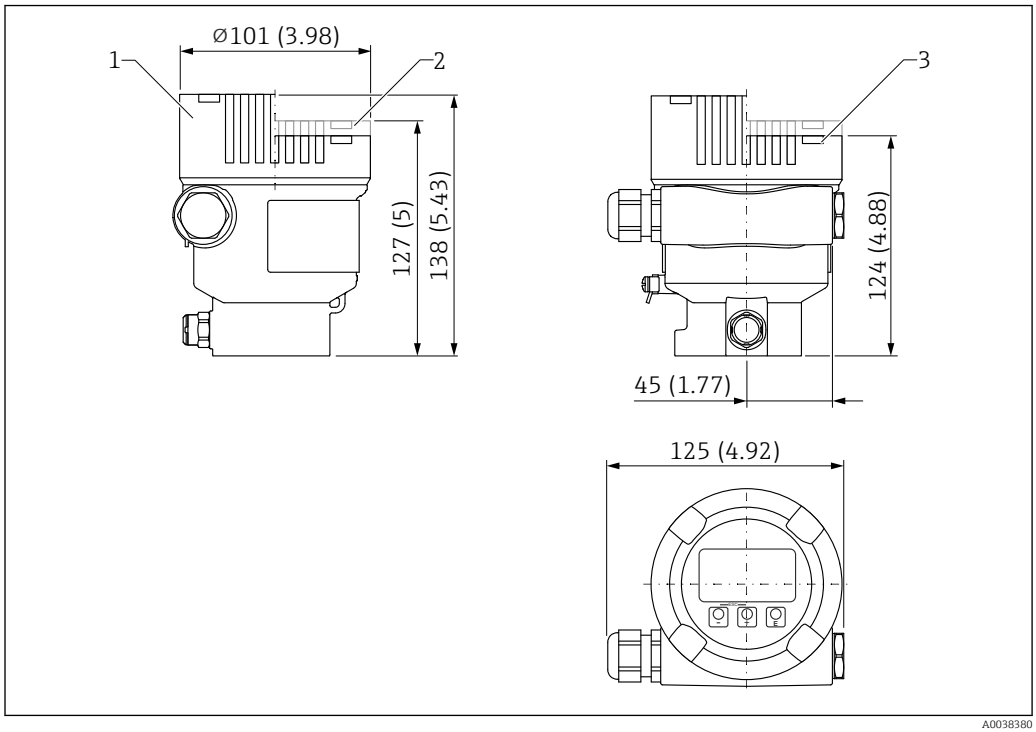
The housing cannot be completely unscrewed.

- ▶ Loosen the external locking screw by a maximum of 1.5 turns. If the screw is turned further or completely removed (beyond the screw lifting point), small parts (counter disk) may become loose and fall out.
- ▶ Tighten the securing screw (hexagon socket 4 mm (0.16 in)) with maximum 3.5 Nm (2.58 lbf ft) ± 0.3 Nm (0.22 lbf ft).

6.1.2 Dimensions

The dimensions of the individual components must be added together for the total dimensions.

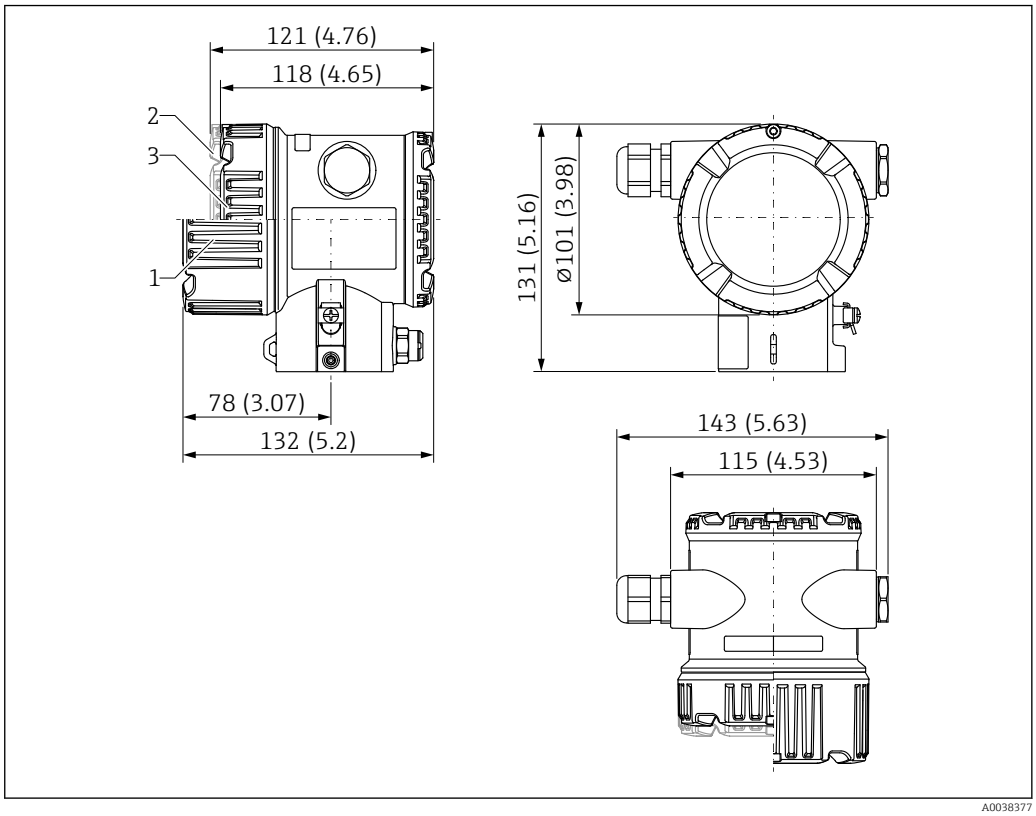
Single compartment housing, aluminum, coated



3 *Dimensions; single compartment housing, aluminum, coated; incl. M20 coupling and plug, plastic. Unit of measurement mm (in)*

1 *Height with cover comprising glass sight glass (devices for Ex d/XP, dust Ex)*
2 *Height with cover comprising plastic sight glass*
3 *Cover without sight glass*

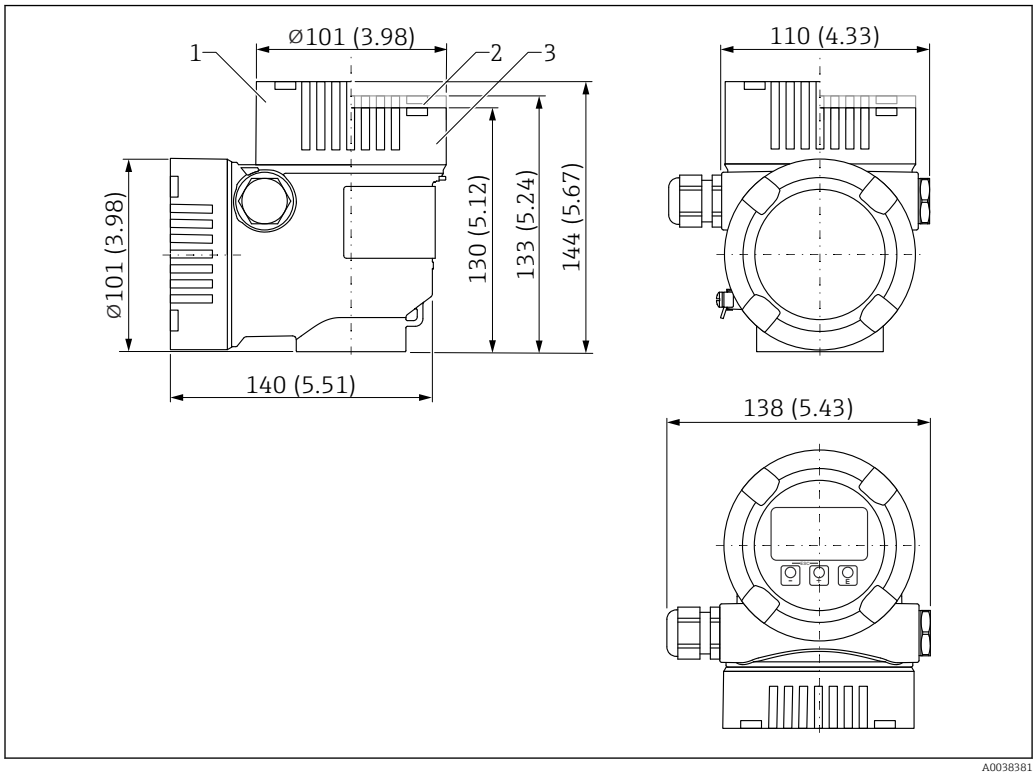
Dual compartment housing, aluminum, coated



4 *Dimensions; dual compartment housing, aluminum, coated; incl. M20 coupling and plug, plastic. Unit of measurement mm (in)*

1 Height with cover comprising glass sight glass (devices for Ex d/XP, dust Ex)
2 Height with cover comprising plastic sight glass
3 Cover without sight glass

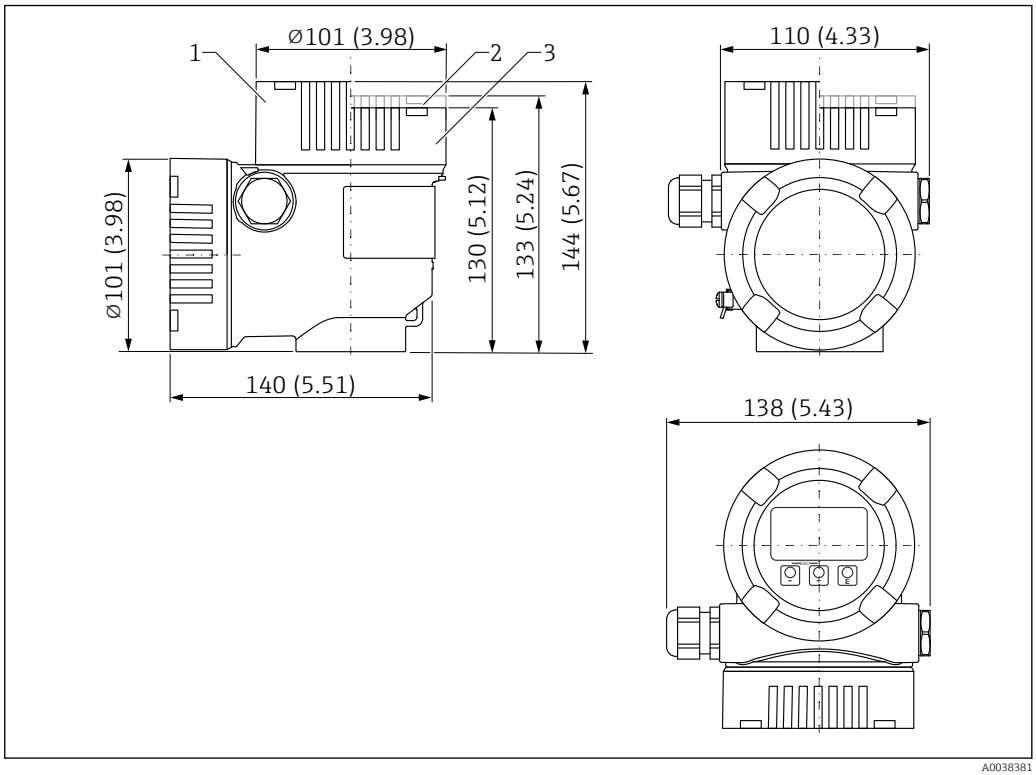
Dual compartment housing, L-shaped, aluminum, coated



5 Dimensions; dual compartment housing L-shaped, aluminum, coated; incl. M20 coupling and plug, plastic. Unit of measurement mm (in)

1 Height with cover comprising glass sight glass (devices for Ex d/XP, dust Ex)
2 Height with cover comprising plastic sight glass
3 Cover without sight glass

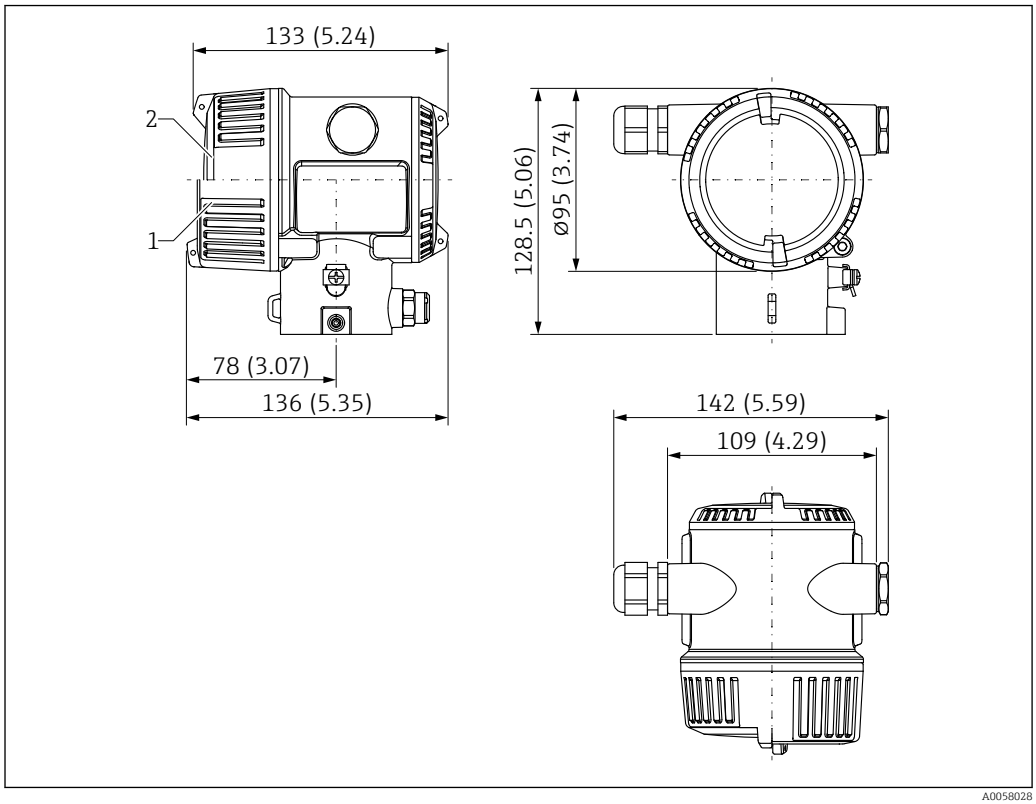
Dual compartment housing, L-shaped, 316L



6 *Dimensions; dual compartment housing L-shaped, 316L; incl. M20 coupling and plug, plastic. Unit of measurement mm (in)*

1 Height with cover comprising glass sight glass (devices for Ex d/XP, dust Ex)
2 Height with cover comprising plastic sight glass
3 Cover without sight glass

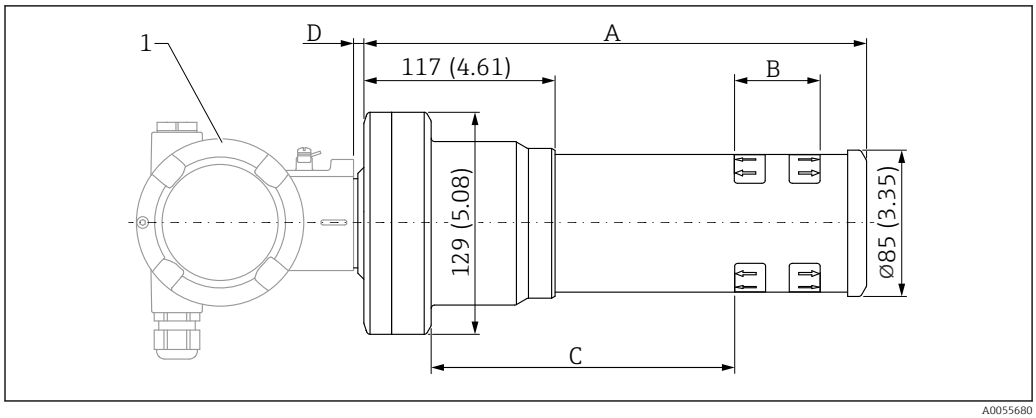
Stainless steel dual-compartment housing, precision cast



Unit of measurement mm (in)

1 Device with display, cover with sight glass made of glass (devices for Ex d/XP, dust Ex): 136 mm (5.35 in)
2 Device without display, cover without sight glass: 133 mm (5.24 in)

Detector tube

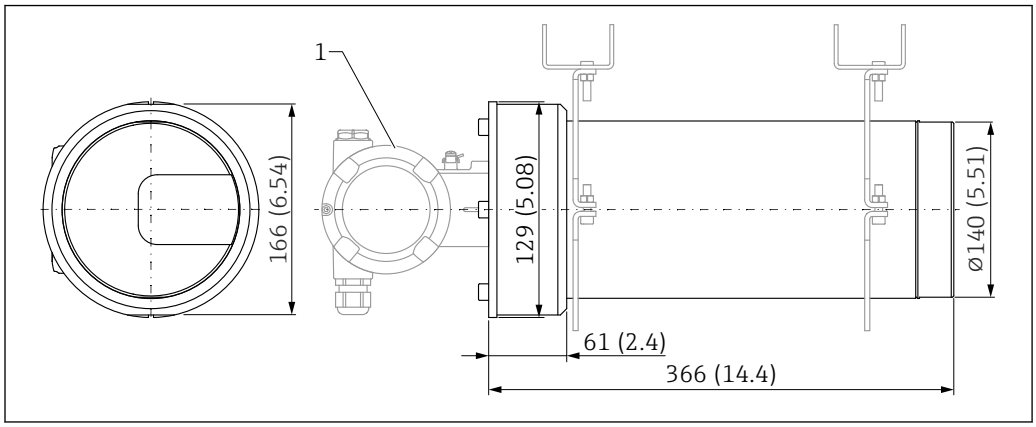


1 Housing
A Overall length of detector tube
B Position and length of the measuring range
C Distance between device flange and start of measuring range - PVT, distance: 171 mm (6.73 in)
C Distance between device flange and start of measuring range - NaI (Tl), distance: 178 mm (7.01 in)
D Distance between device flange and housing: 6 mm (0.24 in)

- **Version NaI (Tl) 2" :**
  - Total length A: 292 mm (11.5 in)
  - Measuring range length B: 51 mm (2 in)
- **Version NaI (Tl) 4" :**
  - Total length A: 341 mm (13.4 in)
  - Measuring range length B: 102 mm (4 in)
- **Version NaI (Tl) 8" :**
  - Total length A: 451 mm (17.8 in)
  - Measuring range length B: 204 mm (8 in)
- **Version PVT 50 :**
  - Total length A: 292 mm (11.5 in)
  - Measuring range length B: 50 mm (1.96 in)
- **Version PVT 100 :**
  - Total length A: 341 mm (13.4 in)
  - Measuring range length B: 100 mm (3.94 in)
- **Version PVT 200 :**
  - Total length A: 451 mm (17.8 in)
  - Measuring range length B: 200 mm (8 in)
- **Version PVT 400 :**
  - Total length A: 651 mm (25.6 in)
  - Measuring range length B: 400 mm (16 in)
- **Version PVT 800 :**
  - Total length A: 1 051 mm (41.4 in)
  - Measuring range length B: 800 mm (32 in)
- **Version PVT 1200 :**
  - Total length A: 1 451 mm (57.1 in)
  - Measuring range length B: 1 200 mm (47 in)
- **Version PVT 1600 :**
  - Total length A: 1 851 mm (72.9 in)
  - Measuring range length B: 1 600 mm (63 in)
- **Version PVT 2000 :**
  - Total length A: 2 251 mm (88.6 in)
  - Measuring range length B: 2 000 mm (79 in)
- **Version PVT 2400 :**
  - Total length A: 2 651 mm (104 in)
  - Measuring range length B: 2 400 mm (94 in)
- **Version PVT 3000 :**
  - Total length A: 3 251 mm (128 in)
  - Measuring range length B: 3 000 mm (118 in)
- **Version PVT 3500 :**
  - Total length A: 3 751 mm (148 in)
  - Measuring range length B: 3 500 mm (137.8 in)
- **Version PVT 4000 :**
  - Total length A: 4 251 mm (167 in)
  - Measuring range length B: 4 000 mm (157.48 in)
- **Version PVT 4500 :**
  - Total length A: 4 751 mm (187 in)
  - Measuring range length B: 4 500 mm (177 in)

If using a collimator, pay attention to the documentation SD02822F.

Gammapilot FMG50 with collimator



7 *Version NaI (Tl) 2" with collimator on sensor side*

1 Housing

Version NaI (Tl) 2" with collimator on sensor side:
Total length: 498 mm (19.6 in)

6.1.3 Weight

The weights of the individual components must be added together for the total weight.

Housing

Weight including electronics and display.

Single-compartment housing
Aluminum: 1.2 kg (2.65 lb)

Dual-compartment housing
- Aluminum: 1.4 kg (3.09 lb)
- Stainless steel: 3.2 kg (7.06 lb)

Dual-compartment housing, L-form
- Aluminum: 1.7 kg (3.75 lb)
- Stainless steel: 4.5 kg (9.9 lb)

Detector tube

- **Version NaI (Tl) 2" :**
  Total weight: 8.31 kg (18.32 lb)
- **Version NaI (Tl) 4" :**
  Total weight: 8.9 kg (19.62 lb)
- **Version NaI (Tl) 8" :**
  Total weight: 9.71 kg (21.41 lb)
- **Version PVT 50 :**
  Total weight: 7.91 kg (17.44 lb)
- **Version PVT 100 :**
  Total weight: 8.21 kg (18.1 lb)
- **Version PVT 200 :**
  Total weight: 8.81 kg (19.43 lb)
- **Version PVT 400 :**
  Total weight: 9.97 kg (21.98 lb)
- **Version PVT 800 :**
  Total weight: 12.25 kg (27.01 lb)

- **Version PVT 1200 :**
  Total weight: 14.65 kg (32.3 lb)
- **Version PVT 1600 :**
  Total weight: 16.85 kg (37.15 lb)
- **Version PVT 2000 :**
  Total weight: 19.15 kg (42.23 lb)
- **Version PVT 2400 :**
  Total weight: 21.45 kg (47.3 lb)
- **Version PVT 3000 :**
  Total weight: 24.85 kg (54.79 lb)
- **Version PVT 3500 :**
  Total weight: 27.62 kg (60.9 lb)
- **Version PVT 4000 :**
  Total weight: 30.47 kg (67.19 lb)
- **Version PVT 4500 :**
  Total weight: 33.32 kg (73.47 lb)

The additional weight for small parts is: 1 kg (2.20 lb)

If using a collimator, pay attention to the documentation SD02822F.

Gammapilot FMG50 with collimator

Version NaI (Tl) 2" with collimator on sensor side:
Weight of collimator (excluding FMG50 and excluding mounted parts): 25.5 kg (56.2 lb)

The additional weight for small parts is: 1 kg (2.20 lb)

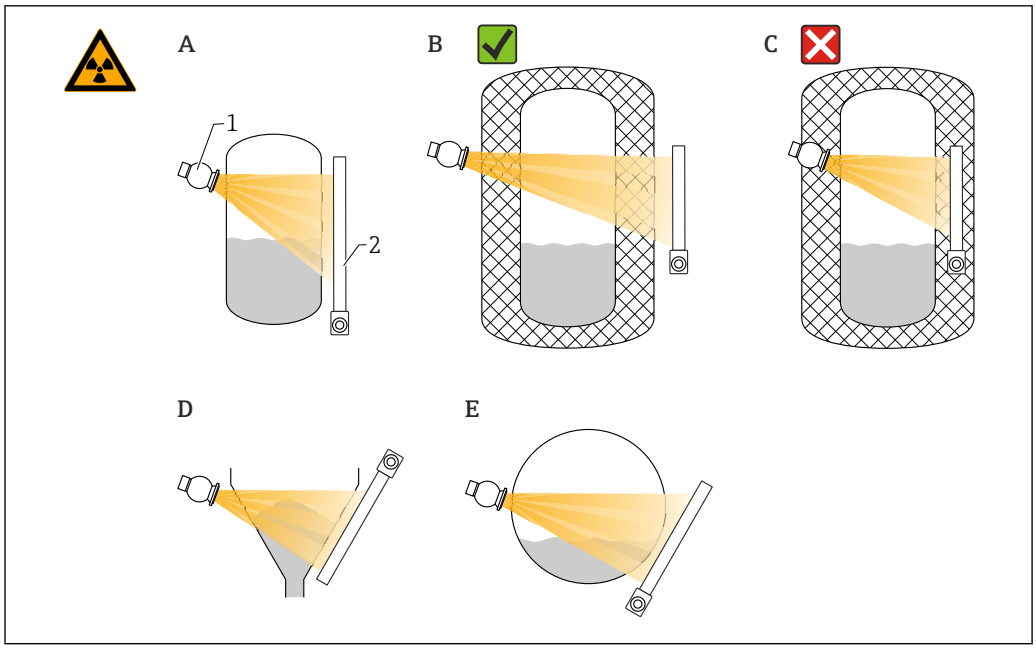
6.1.4 Mounting requirements for level measurements

Conditions

- The Gammapilot FMG50 is mounted vertically for level measurements.
- To facilitate installation and commissioning, the Gammapilot FMG50 can be configured and ordered with an additional support (order feature 620, option Q4: "Retaining bracket").

Examples

- ▶ ⚠ DANGER: IONIZING RADIATION WHEN OPENING THE SHUTTER! Follow the safety instructions at the start of this section.



A Vertical cylinder; the Gammapilot FMG50 is mounted vertically with the detector head pointing either downwards or upwards; the gamma radiation is aligned to the measuring range.
B Correct: Gammapilot FMG50 mounted outside the tank insulation
C Incorrect: Gammapilot FMG50 mounted inside the tank insulation
D Conical tank outlet
E Horizontal cylinder
1 Source container
2 Gammapilot FMG50

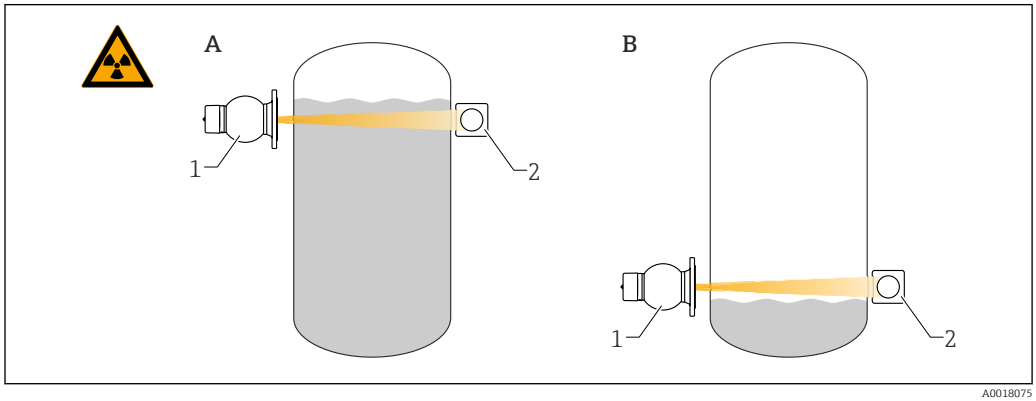
6.1.5 Mounting requirements for point level measurement

Conditions

For point level measurement, the Gammapilot FMG50 is generally mounted horizontally at the height of the desired level limit.

Measuring system arrangement

▶ ⚠ DANGER: IONIZING RADIATION WHEN OPENING THE SHUTTER! Follow the safety instructions at the start of this section.



A Maximum point level measurement
B Minimum point level measurement
1 Source container
2 Gammapilot FMG50

6.1.6 Mounting requirements for density measurement

Conditions

- If possible, density should be measured on vertical pipes with forward flow from bottom to top.
- If only horizontal pipes are accessible, the path of the beam should also be arranged horizontally to minimize the influence of air bubbles and deposits.
- The Endress+Hauser clamping device or an equivalent clamping device should be used to fasten the source container and the Gammapilot FMG50 to the measuring pipe.
  The clamping device itself must be installed in such a way as to withstand the weight of the source container and the Gammapilot FMG50 under all anticipated operating conditions.
- The sample point may not be further than 20 m (66 ft) from the measuring point.
- The distance of the density measurement to pipe bends is ≥3 x pipe diameter, and ≥10 x pipe diameter in the case of pumps.

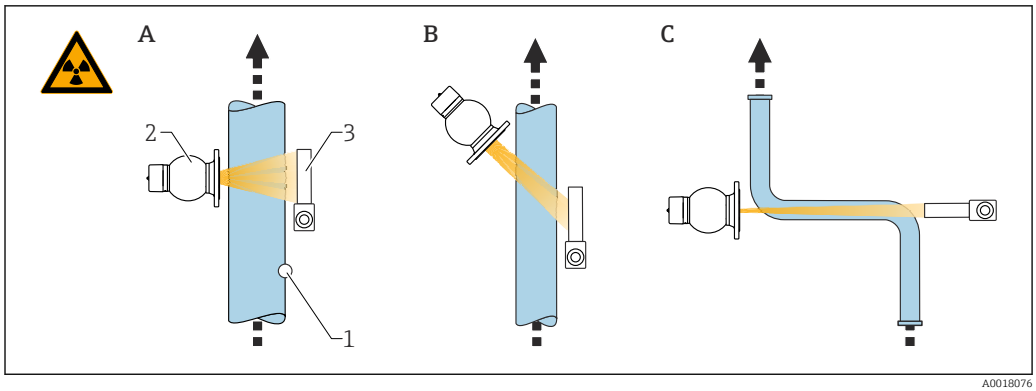
Measuring system arrangement

The arrangement of the source container and the Gammapilot FMG50 depends on the pipe diameter (or the radiated length) and the density measuring range. These two parameters determine the measuring effect (relative change in the pulse rate). The longer the radiated length, the greater the measuring effect. For small pipe diameters, diagonal irradiation or the use of a measuring path is therefore recommended.

To select the measuring system arrangement please contact the Endress+Hauser sales organization or use the Applicator™configuration software. [1)]

- ⚠ DANGER: IONIZING RADIATION WHEN OPENING THE SHUTTER! Follow the safety instructions at the start of this section.

1) The Applicator™ is available from your Endress+Hauser sales organization.



A0018076

A Vertical beam (90°)
B Diagonal beam (30°)
C Measuring path
1 Sample point
2 Source container
3 Gammapilot FMG50

- To increase the accuracy of density measurements, the use of a collimator is recommended. The collimator shields the detector against background radiation.
- When planning, the total weight of the measuring system must be taken into consideration.
- An FHG51 clamping device is available as an accessory
- A collimator is available for 2" NaI (Tl):
  Feature 620, option P7: "Collimator on sensor side". For details, see the documentation SD02822F.

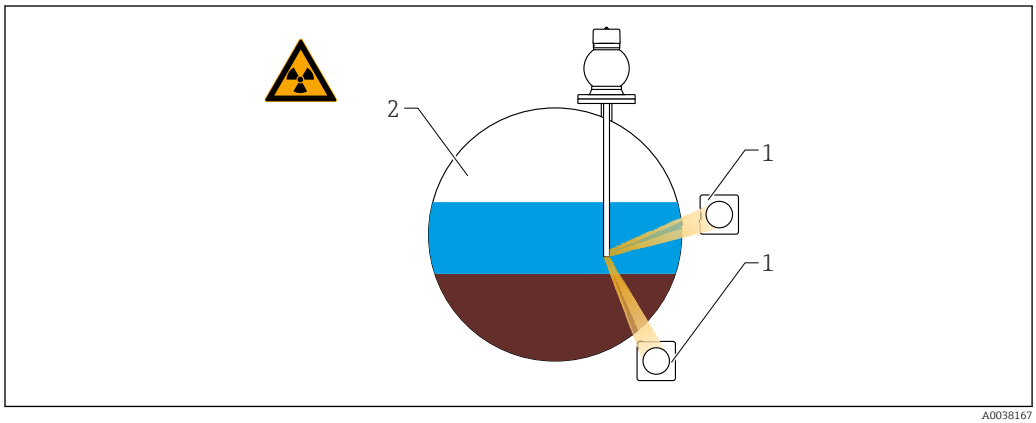
6.1.7 Mounting requirements for interface measurement

Conditions

For interface measurement, the Gammapilot FMG50 is typically mounted horizontally at the upper or lower limit of the interface range. When introducing a radiation source into a protection pipe, it is important to ensure that the measuring range is already filled with medium in order to keep the radiation in the vicinity of the source as low as possible. When using a gamma radiation source in a protection pipe, the radiation can be aligned with the measuring range of the Gammapilot using a collimator on the protection pipe.

Measuring system arrangement

▶ ⚠ DANGER: IONIZING RADIATION WHEN OPENING THE SHUTTER! Follow the safety instructions at the start of this section.



A0038167

1 Gammapilot (2 pcs)
2 Interface measurement

Description

The measuring principle is based on the fact that the gamma radiation source emits radiation which is attenuated when it penetrates a material and the medium to be measured. In radiometric interface measurement, the gamma radiation source is often lowered into a closed protection pipe with the help of a rope. This excludes the possibility of contact between the gamma radiation source and the medium.

Depending on the measuring range and the application, one or several detectors are mounted on the outside of the vessel. The average density of the medium between the radiation source and the detector is calculated from the radiation received. A direct correlation to the position of the interface can then be derived from this density value.

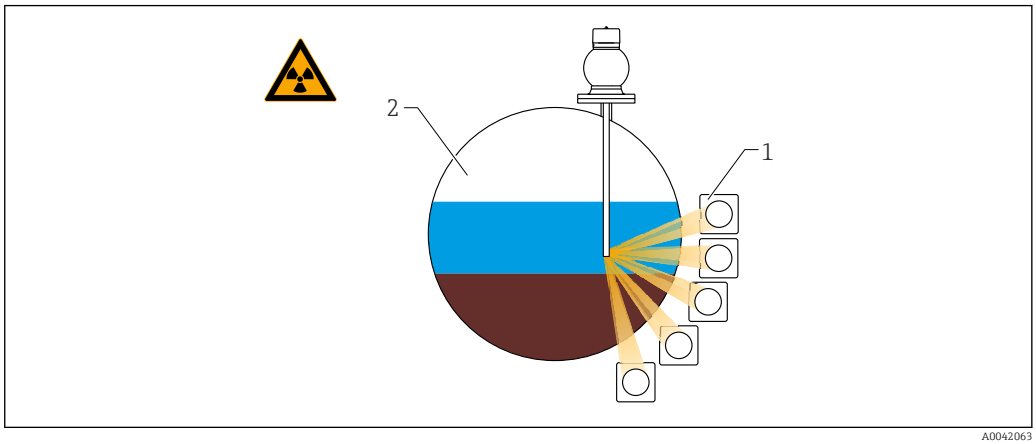
6.1.8 Mounting requirements for density profile measurement (DPS)

Conditions

For density profile measurement, Gammapilot FMG50 devices are installed horizontally at defined distances, depending on the size of the measuring range. In the case of density profile measurement, the gamma radiation source is normally inserted in a protection pipe, preferably one that is double-walled, and introduced into the vessel. When introducing a radiation source into a protection pipe, it is important to ensure that the measuring range is already filled with medium in order to keep the radiation in the vicinity of the source as low as possible.

Measuring system arrangement

▶ ⚠ DANGER: IONIZING RADIATION WHEN OPENING THE SHUTTER! Follow the safety instructions at the start of this section.



1 Arrangement of multiple FMG50 units
2 Density profile measurement

Description

To obtain detailed information on the distribution of layers of different densities in a vessel, a density profile is measured using a multi-detector solution. Several FMG50 units are installed next to one another on the outside of the vessel wall for this purpose. The measuring range is divided into zones and each compact transmitter measures the density value in its respective zone. A density profile is derived from these values.

This results in a high-resolution measurement of the distribution of medium layers (e.g. in separators)

6.1.9 Mounting requirements for concentration measurements

Conditions

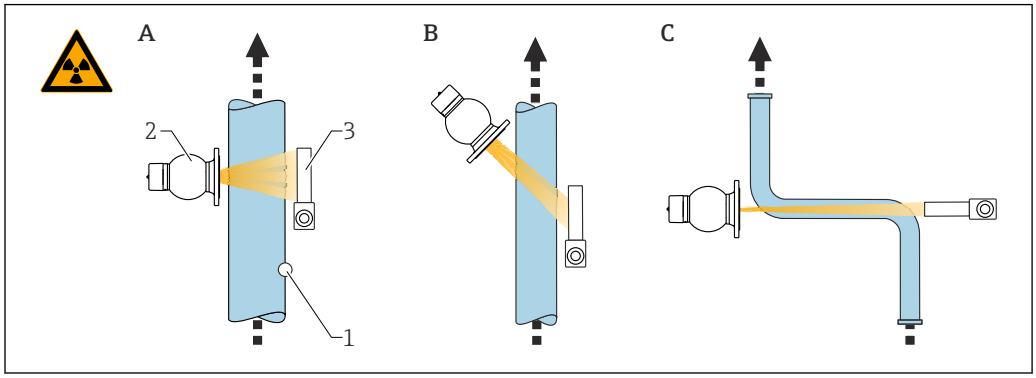
- If possible, the concentration should be measured on vertical pipes with forward flow from bottom to top.
- If only horizontal pipes are accessible, the path of the beam should also be arranged horizontally to minimize the influence of air bubbles and deposits.
- The Endress+Hauser FHG51 clamping device or an equivalent clamping device should be used to fasten the source container and the Gammapilot FMG50 to the measuring pipe. The clamping device itself must be installed in such a way as to withstand the weight of the source container and the Gammapilot FMG50 under all anticipated operating conditions.
- The sample point may not be further than 20 m (66 ft) from the measuring point.
- The distance of the density measurement to pipe bends is ≥3 x pipe diameter, and ≥10 x pipe diameter in the case of pumps.

Measuring system arrangement

The arrangement of the source container and the Gammapilot FMG50 depends on the pipe diameter (or the radiated length) and the density measuring range. These two parameters determine the measuring effect (relative change in the pulse rate). The longer the radiated length, the greater the measuring effect. For small pipe diameters, diagonal irradiation or the use of a measuring path is therefore recommended.

To select the measuring system arrangement please contact the Endress+Hauser sales organization or use the Applicator™configuration software. [2)]

▶ ⚠ DANGER: IONIZING RADIATION WHEN OPENING THE SHUTTER! Follow the safety instructions at the start of this section.



A Vertical beam (90°)
B Diagonal beam (30°)
C Measuring path
1 Sample point
2 Source container
3 Gammapilot FMG50

- When planning, the total weight of the measuring system must be taken into consideration.
- An FHG51 clamping device is available as an accessory

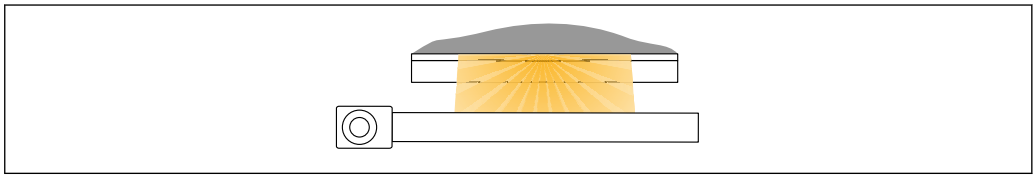
2) The Applicator™ is available from your Endress+Hauser sales organization.

6.1.10 Mounting requirements for concentration measurement with radiating media

Measuring the concentration of radiating media in vessels

The concentration of radiating media in vessels can be determined by taking a measurement at the vessel wall or in a protection pipe in the vessel. The intensity of the radiation received is proportional to the concentration of the radiating medium in the vessel. It is important to note that the medium in the vessel also absorbs its own radiation. The detected radiation will not increase further with larger diameters and the signal is saturated. This saturation length depends on the half-value layer of the material.

The level in the vessel must be constant in the vicinity of the detector to ensure the measurement is correct.



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Measurement of the mass flow of radiating media

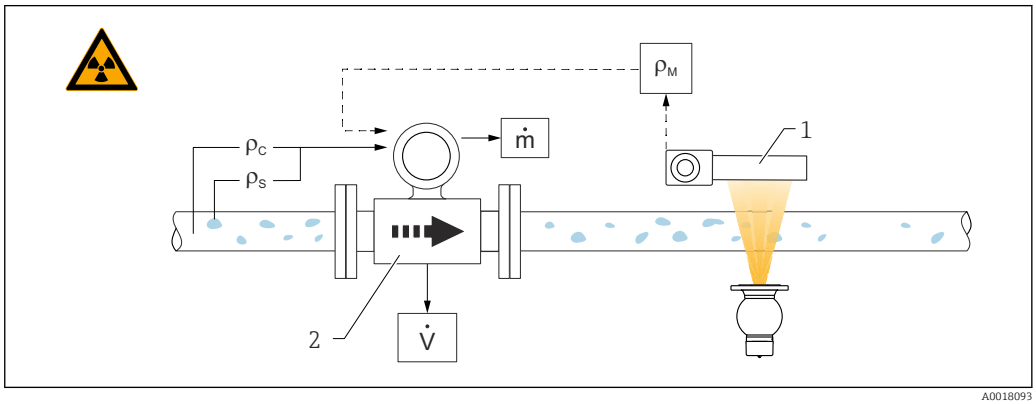
In the case of belt scales and pipes, the concentration of the radiating medium can be measured in the sample. Here, the device is mounted above or below the conveyor belt so that it is parallel to the belt direction, or is mounted on the pipe. The intensity of the radiation received is proportional to the concentration of the radiating medium in the conveyed material.

6.1.11 Mounting requirements for flow measurements

Measurement of mass flow (liquids)

The density signal determined by the Gammapilot FMG50 is transmitted to the Promag 55S. The Promag 55S measures the volume flow; the Promag can determine a mass flow in connection with the calculated density value.

▶ ⚠ DANGER: IONIZING RADIATION WHEN OPENING THE SHUTTER! Follow the safety instructions at the start of this section.



A0018093

8 *Mass flow measurement (m) using a density meter and a flowmeter. If the density of the solids (ρ_s) and the density of the carrier liquid (ρ_c) are also known, the solids flow rate can be calculated.*

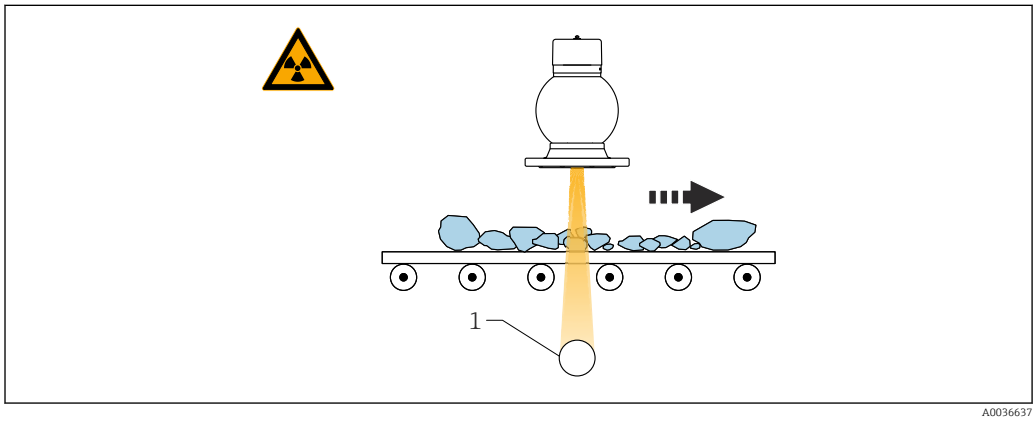
1 *Gammapilot FMG50 -> total density (ρ_m) consisting of the carrier liquid and solids*
2 *Flowmeter (Promag 55S) -> volume flow (V). The solids density (ρ_s) and the density of the carrier liquid (ρ_c) also have to be entered in the transmitter*

Measurement of mass flow (solids)

Bulk solids applications on conveyor belts and conveyor screws.

The source container is positioned above the conveyor belt and the Gammapilot FMG50 below the conveyor belt. The radiation is attenuated by the medium on the conveyor belt. The intensity of the radiation received is proportional to the density of the medium. The mass flow is calculated from the belt speed and the radiation intensity.

▶ ⚠ DANGER: IONIZING RADIATION WHEN OPENING THE SHUTTER! Follow the safety instructions at the start of this section.



1 Gammapilot FMG50

6.2 Post-installation check

After installing the measuring instrument, carry out the following checks:

❑ Is the device undamaged (visual inspection)?

❑ Does the device match the measuring point specifications (ambient temperature, measuring range etc.)?

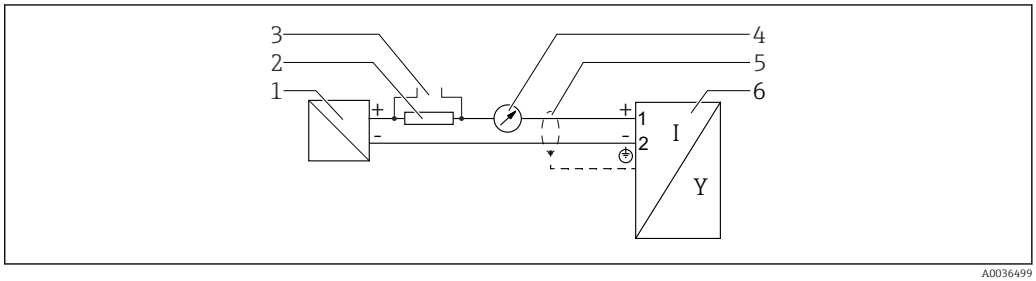
❑ If available: are the measuring point number and labeling correct (visual inspection)?

❑ Is the measuring instrument sufficiently protected against sunlight?

❑ Are the securing screws, cable glands and cover lock tightened correctly?

7 Electrical connection

7.1 Function diagram 4 to 20 mA HART



9 *Function diagram 4 to 20 mA HART*

1 *Active barrier for power supply; observe terminal voltage*
2 *Resistor for HART communication (≥ 250 Ω); observe maximum load*
3 *Connection for Commubox FXA195 or FieldXpert (via VIATOR Bluetooth modem)*
4 *Analog display unit; observe maximum load*
5 *Cable screen; observe cable specification*
6 *Measuring instrument*

7.2 Supply voltage

The supply voltage depends on the selected type of device approval

Non-hazardous, Ex d, Ex e	10.5 to 35 V_{DC}
Ex i	10.5 to 30 V_{DC}
Nominal current	4 to 20 mA
Power consumption	0.9 W max.

The power unit must be safety-approved (e.g. PELV, SELV, Class 2) and must comply with the relevant protocol specifications.

A suitable circuit breaker must be provided for the device in accordance with IEC/EN61010-1

7.2.1 Device display and Bluetooth

The display and the Bluetooth function (order option) are dependent on the supply voltage at the moment the device is switched on.

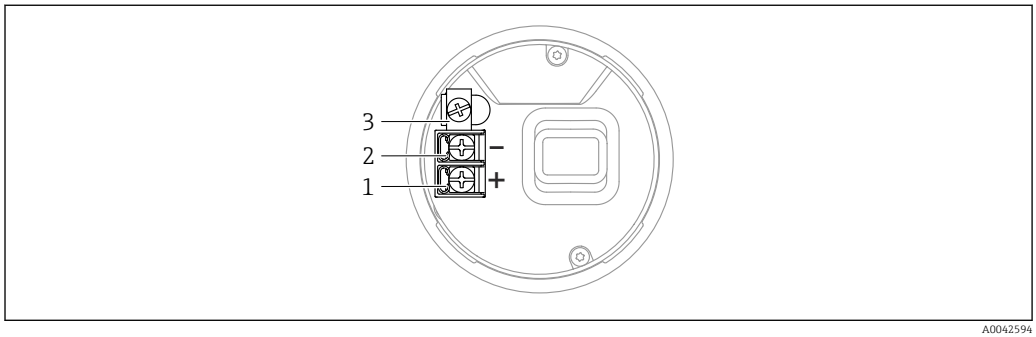
Supply voltage
- <15 V_{DC}; the background lighting is switched off
- <12 V_{DC}; the Bluetooth function is also switched off

If the remote display FHX50B is used (accessory)

Supply voltage
- <15 V_{DC}; the background lighting and the Bluetooth function are switched off
- 12.5 V_{DC} minimum

7.3 Terminal assignment

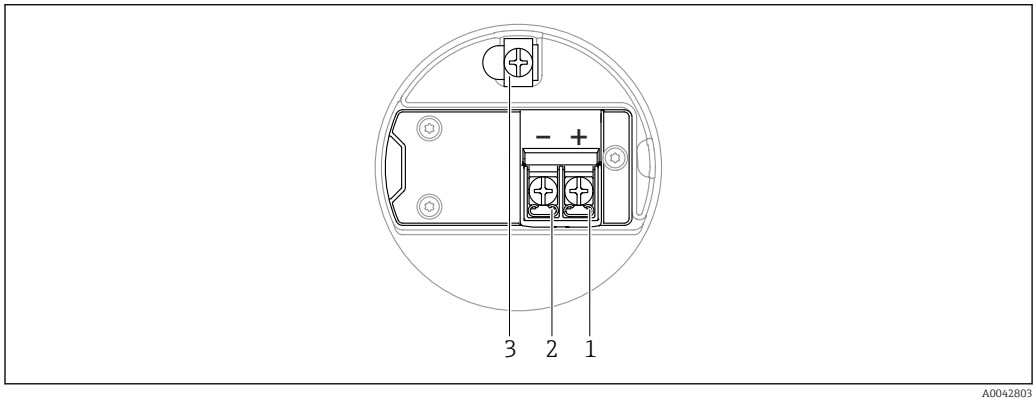
7.3.1 Single compartment housing



10 Connection terminals and ground terminal in the connection compartment, single compartment housing

1 Positive terminal
2 Negative terminal
3 Internal ground terminal

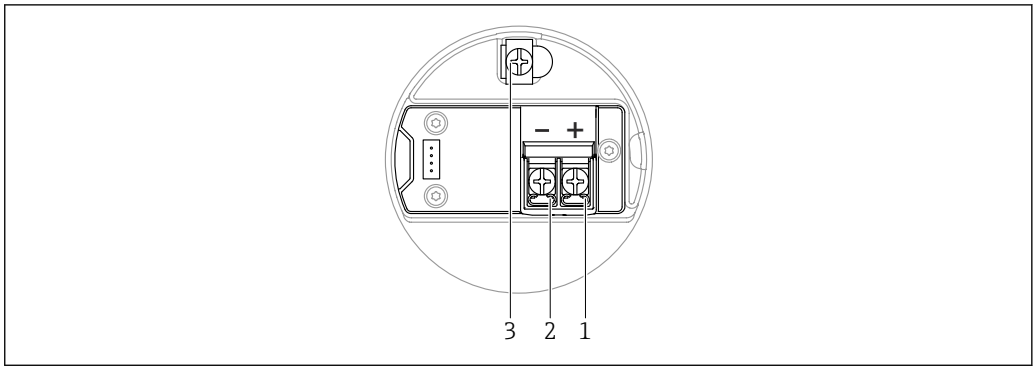
7.3.2 Dual compartment housing; 4 to 20 mA HART



11 Terminal assignment in connection compartment; 4 to 20 mA HART; dual compartment housing

1 Plus terminal 4 to 20 mA HART
2 Minus terminal 4 to 20 mA HART
3 Internal ground terminal

7.3.3 Dual compartment housing L-shaped; 4 to 20 mA HART



12 *Terminal assignment in connection compartment; 4 to 20 mA HART; dual compartment housing L-shaped*

1 *Plus terminal 4 to 20 mA HART*
2 *Minus terminal 4 to 20 mA HART*
3 *Internal ground terminal*

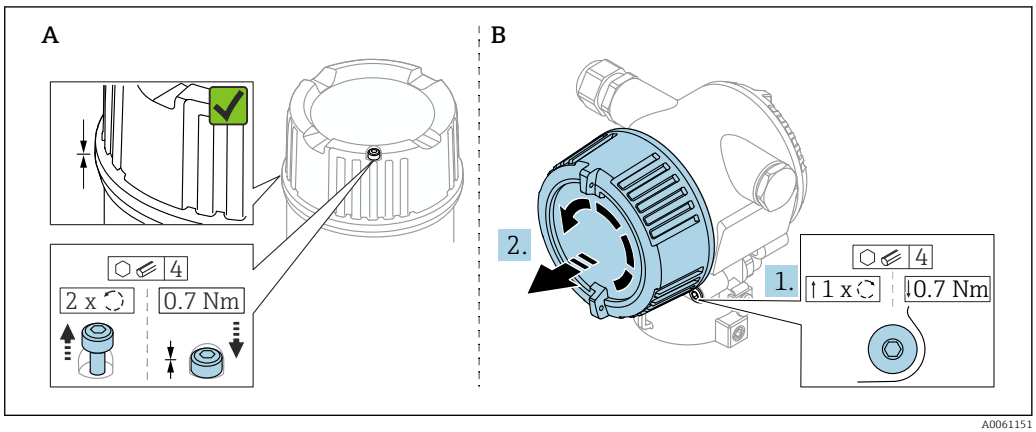
7.4 Cover with securing screw

For devices intended for use in hazardous areas with a certain type of explosion protection, the cover is secured by a securing screw.

NOTICE

If the securing screw is not positioned correctly, the cover cannot provide secure sealing.

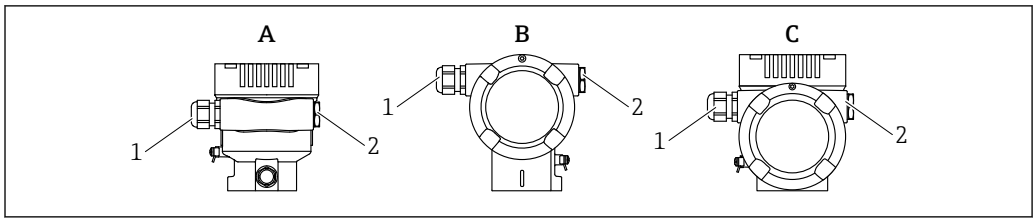
- Open the cover: slacken the screw of the cover lock with a maximum of 2 turns so that the screw does not fall out. Fit the cover and check the cover seal.
- Close the cover: screw the cover securely onto the housing, making sure that the securing screw is positioned correctly. There should not be any gap between the cover and housing.



13 *Cover with securing screw*

A *Single-compartment housing*
B *Dual-compartment housing*

7.5 Cable entries



A Single-compartment housing, aluminum, coated
B Dual-compartment housing, aluminum, coated
C Dual-compartment housing, L-shaped, aluminum, coated
1 Cable entry
2 Blind plug

The number and type of cable entries depend on the device version ordered.

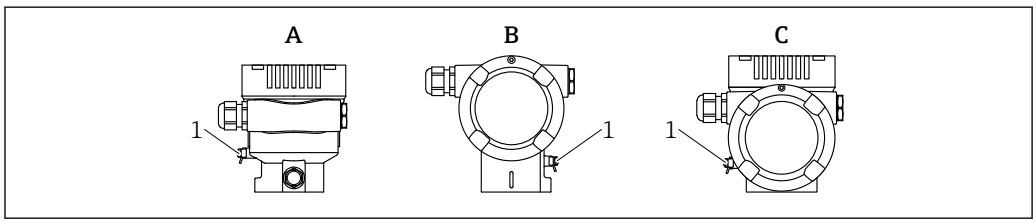
Always route connecting cables downwards so that moisture cannot penetrate the connection compartment.

If necessary, create a drip loop or use a weather protection cover.

7.6 Potential equalization

Before wiring, connect the potential matching line to the ground terminal.

The protective ground on the device must not be connected. If necessary, the potential matching line can be connected to the outer ground terminal of the housing before the device is connected.



A Single-compartment housing, aluminum, coated
B Dual-compartment housing, aluminum, coated
C Dual-compartment housing, L-shaped, aluminum, coated
1 Ground terminal for connecting the potential matching line

WARNING

Ignitable sparks or impermissibly high surface temperatures.
Explosion hazard!
▶ Please refer to the separate documentation on applications in hazardous areas for the safety instructions.

For optimum electromagnetic compatibility:
- Use the shortest possible potential matching line.
- Observe a conductor cross-section of at least 2.5 mm^2 (14 AWG)

7.7 Overvoltage protection

The overvoltage protection can optionally be ordered as a "Mounted accessory" via the product structure.

7.7.1 Devices without optional overvoltage protection

The devices satisfy the IEC/DIN EN IEC 61326-1 product standard (Table 2 Industrial environment).

Depending on the type of port (DC power supply, input/output port) different testing levels according to IEC/DIN EN 61326-1 against transient overvoltages are applied (IEC/DIN EN 61000-4-5 Surge):
Test level on DC power ports and input/output ports is 1 000 V line to earth

7.7.2 Devices with optional overvoltage protection

- Spark-over voltage: min. 400 V_{DC}
- Tested according to IEC/DIN EN 60079-14 sub chapter 12.3 (IEC/DIN EN 60060-1 chapter 7)
- Nominal discharge current: 10 kA

NOTICE

The device can be destroyed by excessively high electrical voltages.

▶ Always ground the device with integrated overvoltage protection.

7.7.3 Overvoltage category

Overvoltage category II

7.8 Cable specification

Rated cross-section

- Supply voltage: 0.5 to 2.5 mm^2 (20 to 13 AWG)
- Protective earth or grounding of the cable shield: > 1 mm^2 (17 AWG)
- External ground terminal: 0.5 to 4 mm^2 (20 to 12 AWG)

Cable outer diameter

The cable outer diameter depends on the cable gland used

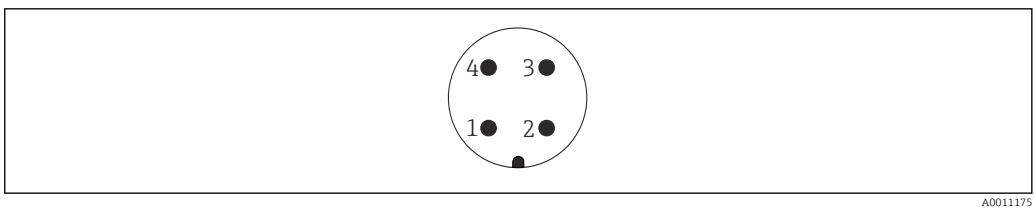
- Plastic gland: Ø5 to 10 mm (0.2 to 0.38 in)
- Nickel-plated brass gland: Ø7 to 10.5 mm (0.28 to 0.41 in)
- Stainless steel gland: Ø7 to 12 mm (0.28 to 0.47 in)

7.9 Available device plugs

In the case of devices with a plug, it is not necessary to open the housing for connection purposes.

Use the enclosed seals to prevent the penetration of moisture into the device.

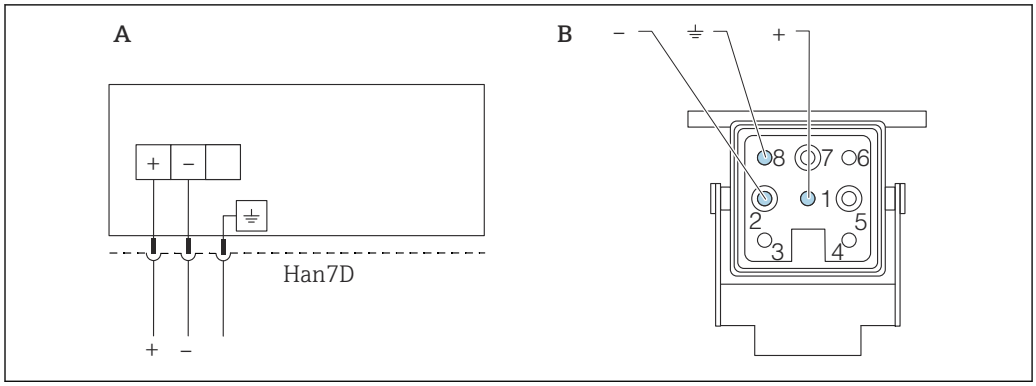
7.9.1 Devices with M12 plug



A0011175

1 Signal +
2 Not used
3 Signal –
4 Ground

7.9.2 Measuring instruments with Harting plug Han7D



A Electrical connection for devices with Harting plug Han7D
B View of the plug connection on the device
- Brown
⏚ Green-yellow
+ Blue

Material
- CuZn
- Gold-plated plug-in jack and plug contacts

7.10 Wiring

⚠ WARNING

Supply voltage might be connected!
Risk of electric shock and/or explosion!
- ▶ If the device is used in hazardous areas, make sure to comply with national standards and the specifications in the Safety Instructions (XAs). The specified cable gland must be used.
- ▶ The supply voltage must match the specifications on the nameplate.
- ▶ Switch off the supply voltage before connecting the device.
- ▶ If necessary, the potential matching line can be connected to the outer ground terminal of the device before the power supply lines are connected.
- ▶ A suitable circuit breaker should be provided for the device in accordance with IEC/EN 61010.
- ▶ The cables must be adequately insulated, with due consideration given to the supply voltage and the overvoltage category.
- ▶ The connecting cables must offer adequate temperature stability, with due consideration given to the ambient temperature.
- ▶ Only operate the measuring device with the covers closed.

Connect the device in the following order:

1. Release the cover lock (if provided).
2. Unscrew the cover.
3. Guide the cables into the cable glands or cable entries.
4. Connect the cables.
5. Tighten the cable glands or cable entries so that they are leak-tight. Counter-tighten the housing entry.
6. Screw the cover securely back onto the connection compartment.
7. If provided: tighten the screw of the cover lock using the Allen key 0.7 Nm (0.52 lbf ft) ±0.2 Nm (0.15 lbf ft).

7.11 Post-connection check

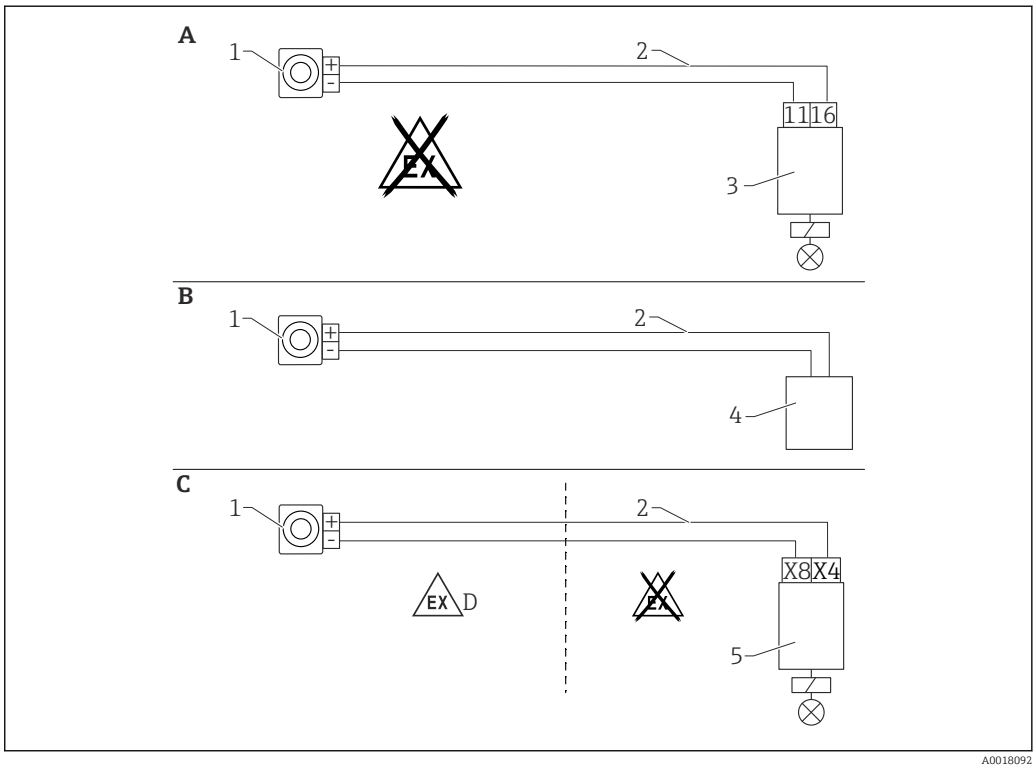
- ❑ Are the device or cables undamaged (visual inspection)?
- ❑ Do the cables used comply with the requirements?
- ❑ Do the mounted cables have strain relief?
- ❑ Cable glands mounted, securely tightened and leak-tight?
- ❑ Does the supply voltage correspond to the specifications on the nameplate?
- ❑ No reverse polarity, terminal assignment correct?
- ❑ Cover screwed down correctly?
- ❑ Cover lock tightened correctly?

7.12 Wiring examples

7.12.1 Point level measurement

The output signal is linear between free and covered adjustment (e.g. 4 to 20 mA) and can be evaluated in the control system. If a relay output is needed, the following Endress +Hauser process transmitters can be used:

- RTA421: for non-Ex applications, without WHG (German Water Resources Act), without SIL
- RMA42: for Ex-applications, with SIL certificate, with WHG



A Wiring with RTA421 switching unit
B Wiring with control system (pay attention to the explosion protection regulations)
C Wiring with RMA42 switching unit
D When installing in hazardous areas, please observe the corresponding Safety Instructions
1 Gammapilot FMG50
2 4 to 20 mA
3 RTA421
4 PLC (pay attention to the explosion protection regulations)
5 RMA42

7.12.2 Cascade mode with 2 FMG50 units

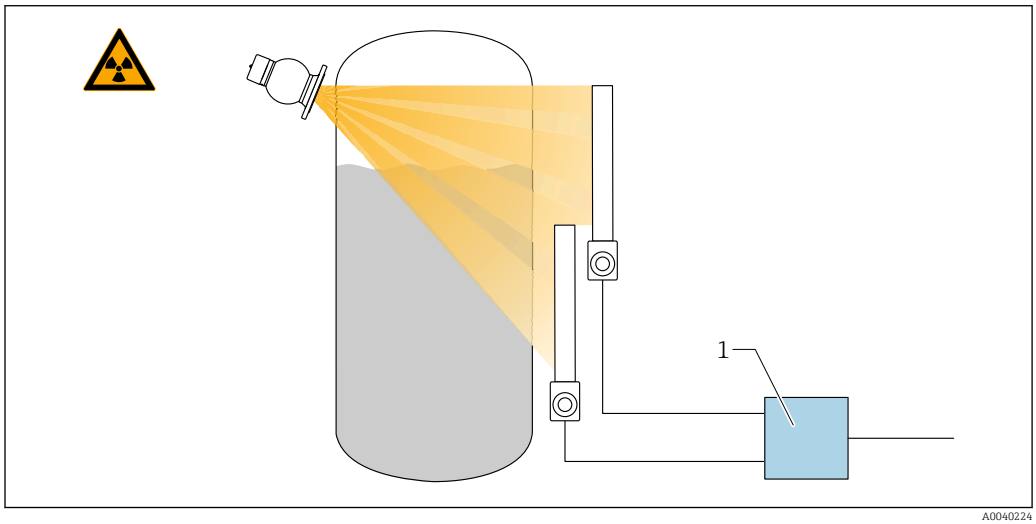
Level measurement: FMG50 with RMA42 process transmitter

Conditions requiring several FMG50 units:
- Large measuring ranges
- Special tank geometry

Two FMG50 units can be interconnected and powered via one RMA42 process transmitter. The individual output currents are added; this gives the total output current.

The internal HART resistor of the RMA42 is used for HART communication. HART communication with the FMG50 is possible via the front terminals of the RMA42.

Avoid overlap between the individual measuring ranges as this can result in an incorrect measured value. The devices can overlap provided this does not affect the measuring ranges.



14 Connection diagram: for two FMG50 units connected to one RMA42

1 RMA42

Sample settings for cascade mode

▶ FMG50 settings:
↳ All FMG50 units used in cascade must be adjusted individually. For example via the "Commissioning" Wizard in the "Level" operating mode.
The following example refers to a cascade measurement with 2 detectors:
Detector 1: 800 mm measuring range
Detector 2: 400 mm measuring range

1. Settings for RMA42 (analog input 1):
↳ Signal type: current
Range: 4 to 20 mA
Lower range value: 0 mm
Upper range value: 800 mm
Offset where applicable

2. Settings for RMA42 (analog input 2):
↳ Signal type: current
Range: 4 to 20 mA
Lower range value: 0 mm
Upper range value: 400 mm
Offset where applicable

3. Calculated value 1:
   ↳ Calculation: sum total
   Unit: mm
   Bar graph 0: 0 m
   Bar graph 100: 1.2 m
   Offset where applicable
4. Analog output:
   ↳ Assignment: calculated value 1
   Signal type: 4 to 20 mA
   Lower range value: 0 m
   Upper range value: 1.2 m

Only the current output of the RMA42 supplies the level measured value of the overall system. No HART values available for the entire cascade.

For more information, see:

BA00287R

7.12.3 Cascade mode with more than 2 FMG50 units

Level measurement: FMG50 with Memograph M RSG45

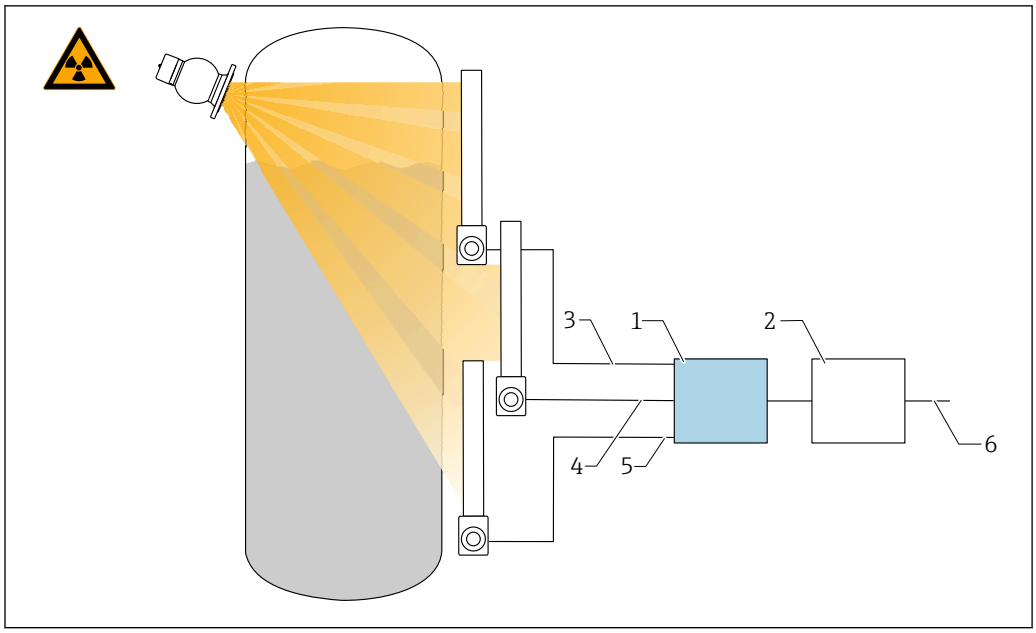
Conditions requiring several FMG50 units:
- Large measuring ranges
- Special tank geometry

More than two FMG50 units (maximum 20) can be interconnected and powered via one Memograph M RSG45. The pulse rates (cnt/s) of the individual FMG50 units are added together and linearized; this gives the total level.

To enable the application, the settings must be made on every FMG50. In this way, the actual level in the vessel can be determined over all the anticipated cascade areas. While the calculation is the same for all FMG50 devices in the cascade, the constants for every FMG50 unit vary and must remain editable.

The cascade mode requires at least 2 FMG50 units that communicate with the RSG45 via the HART channel.

Avoid overlap between the individual measuring ranges as this can result in an incorrect measured value. The devices can overlap provided this does not affect the measuring ranges.



15 *Connection diagram: for three FMG50 units (up to 20 FMG50s) connected to one RSG45*

1 *RSG45*
2 *Algorithm: addition of the individual pulse rates (SV_1 + SV_2 + SV_3) and subsequent linearization*
3 *HART signal FMG50 (1), PV_1: level, SV_1: pulse rate (cnt/s)*
4 *HART signal FMG50 (2), PV_2: level, SV_2: pulse rate (cnt/s)*
5 *HART signal FMG50 (3), PV_3: level, SV_3: pulse rate (cnt/s)*
6 *Overall output signal*

Settings

All FMG50 units used in cascade must be adjusted individually. This is possible via the "Commissioning" Wizard for example

1. Select the "Level" operating mode for all the FMG50 units
2. Configure the HART variable PV (Primary Value) as "Level"
   ↳ PV (level) is not relevant for the calculation
3. Configure the HART variable SV (Secondary Value) as "Pulse rate"
   ↳ SV (pulse rate) is relevant for the calculation
4. Connect HART channels with the RSG45
5. Edit the linearization table in the RSG45
   ↳ Value pairs (max. 32): pulse rate of cascade (total pulse rate) to cascaded level (total level)

The pulse rates (cnt/s) of all the FMG50 units in the cascade are added in the RSG45 and then linearized

Example of a linearization table

Linearization point	Total pulse rate cnt/s	Total level %
21	0	100
20	39	95
19	82	90
18	129	85
17	178	80
16	230	75

Linearization point	Total pulse rate cnt/s	Total level %
15	283	70
14	338	65
13	394	60
12	451	55
11	507	50
10	562	45
9	614	40
8	671	35
7	728	30
6	784	25
5	839	20
4	892	15
3	941	10
2	981	5
1	1013	0

Determine value pairs during commissioning

7.12.4 Ex applications in conjunction with RMA42

Observe the following Safety Instructions:
ATEX II (1) G [Ex ia] IIC, ATEX II (1) D [Ex ia] IIIC for RMA42

XA00095R

7.12.5 SIL applications for Gammapilot in connection with RMA42

The Gammapilot FMG50 meets the requirements of SIL2/3 as per IEC 61508, see:

FY01007F

The RMA42 meets SIL2 as per IEC 61508:2010 (Edition 2.0), see the Functional Safety Manual:

SD00025R

7.13 FMG50 with RIA15

The RIA15 remote display can be ordered together with the device.

Product structure, feature 620 "Accessory enclosed":
- Option PE "Remote indicator RIA15, non-hazardous area, aluminum field housing"
- Option PF "Remote indicator RIA15, hazardous, aluminum field housing"

Alternatively available as an accessory, for details see Technical Information TI01043K and Operating Instructions BA01170K

WARNING

Failure to observe the safety instructions (XAs) when using the Gammapilot FMG50 with the remote display RIA15 in hazardous areas.
Explosion hazard!
- ▶ Please refer to the separate documentation on applications in hazardous areas for the safety instructions (XAs).

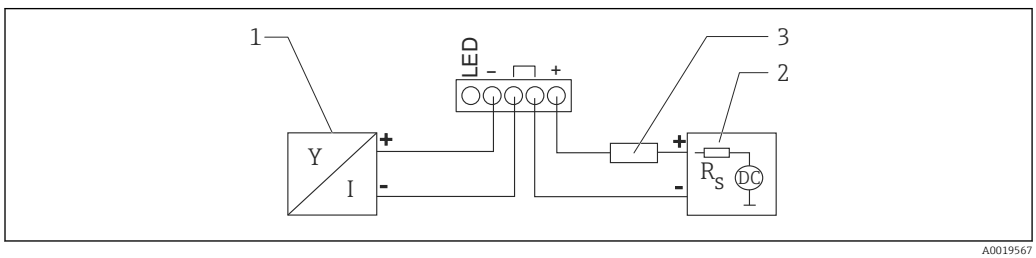
- XA01028R
- XA01464K
- XA01056K
- XA01368K
- XA01097K

Terminal assignment RIA15
- **+**
  Positive connection, current measurement
- **-**
  Negative connection, current measurement (without backlighting)
- **LED**
  Negative connection, current measurement (with backlighting)
- ⏚
  Functional grounding: Terminal in housing

The RIA15 process indicator is loop-powered and does not require any external power supply.

The voltage drop to be taken into account is:
- ≤1 V in the standard version with 4 to 20 mA communication
- ≤1.9 V with HART communication
- and an additional 2.9 V if display light is used

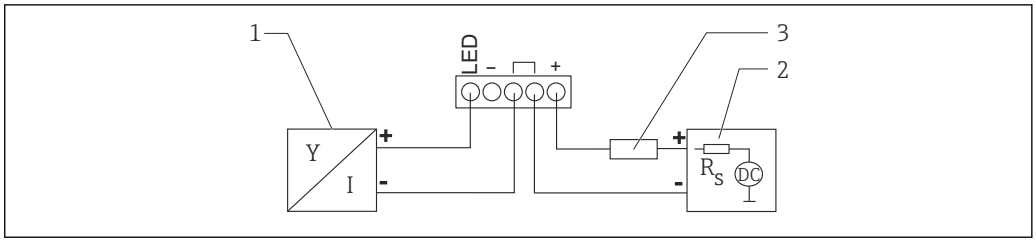
7.13.1 Connection of the HART device and RIA15 without backlighting



16 Block diagram of HART device with RIA15 process indicator without light

1 Device with HART communication
2 Power supply
3 HART resistor

7.13.2 Connection of the HART device and RIA15 with backlighting



17 *Block diagram of HART device with RIA15 process indicator with light*

1 *Device with HART communication*
2 *Power supply*
3 *HART resistor*

7.13.3 FMG50, RIA15 with installed HART communication resistor module

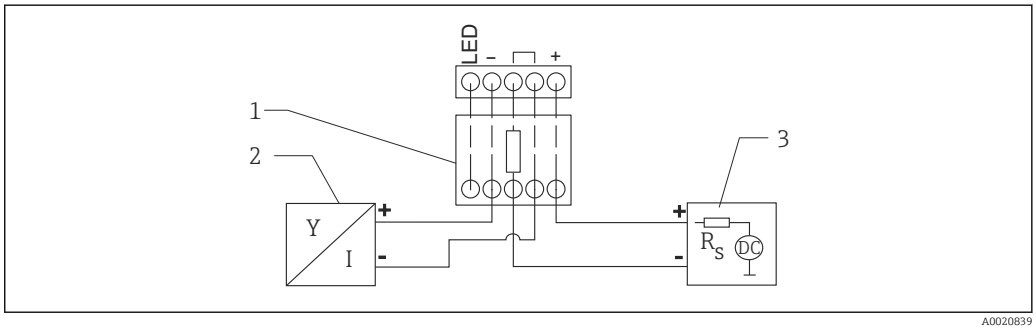
The HART communication module for installation in the RIA15 can be ordered together with the device.

Product structure, feature 620 "Accessory enclosed":
Option PI "HART communication resistor for RIA15"

The voltage drop to be taken into account is:
Max. 7 V

Alternatively available as an accessory, for details see Technical Information TI01043K and Operating Instructions BA01170K

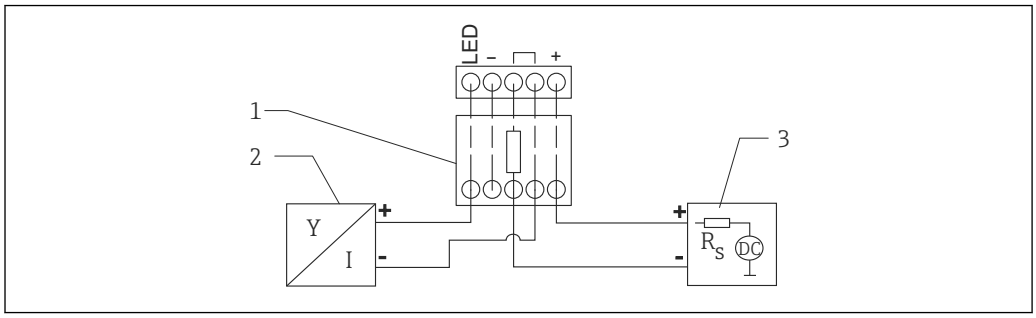
Connection of the HART communication resistor module, RIA15 without backlighting



18 *Block diagram of HART device, RIA15 without light, HART communication resistor module*

1 *HART communication resistor module*
2 *Device with HART communication*
3 *Power supply*

Connection of the HART communication resistor module, RIA15 with backlighting



19 *Block diagram of HART device, RIA15 with light, HART communication resistor module*

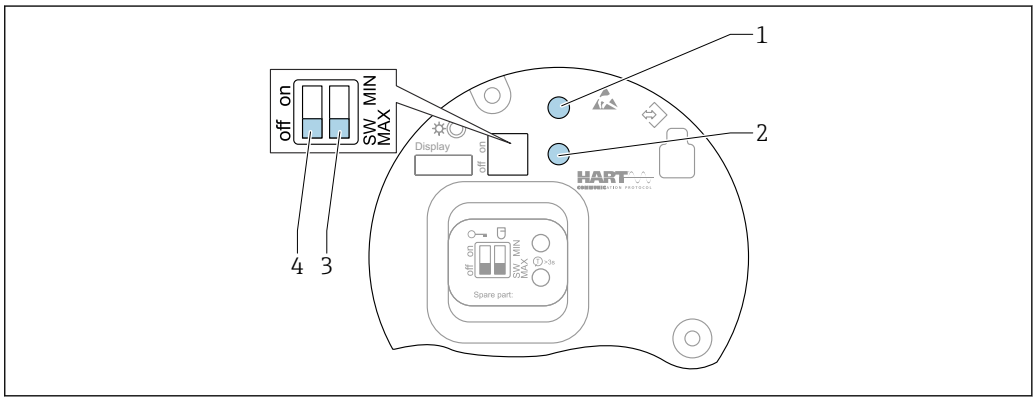
1 *HART communication resistor module*
2 *Device with HART communication*
3 *Power supply*

8 Operation options

8.1 Overview of operation options

- Operation via operating keys and DIP switches on the electronic insert
- Operation via optical operating keys on the device display (optional)
- Operation via Bluetooth® wireless technology (with optional device display, including Bluetooth® wireless technology) with SmartBlue app, Field Xpert or DeviceCare
- Operation via operating tool (Endress+Hauser FieldCare/DeviceCare, handheld terminal, AMS, PDM, ...)

8.2 Operating keys and DIP switches on the HART electronic insert



20 *Operating keys and DIP switches on the HART electronic insert*

1 Operating key for reset password (for Bluetooth login and Maintenanceuser role)
1+2 Operating keys for device reset (as-delivered state)
2 Operating key II (only for factory reset)
3 DIP switch for alarm current
4 DIP switch for locking and unlocking the device

The setting of the DIP switches on the electronic insert has priority over the settings made via other operation methods (e.g. FieldCare/DeviceCare).

8.3 Structure and function of the operating menu

The differences between the structure of the operating menus of the local display and the Endress+Hauser FieldCare or DeviceCare operating tools can be summarized as follows:

The local display is suitable for configuring simple applications.

The operating tools (FieldCare, DeviceCare, SmartBlue, AMS, PDM, ...) can be used to configure the parameters of wide-ranging applications.

Wizards help the user to commission the various applications. The user is guided through the individual configuration steps.

8.3.1 User roles and related access authorization

The two user roles **Operator** and **Maintenance** (as-delivered state) have different write access to the parameters if a device-specific access code has been defined. This access code protects the device configuration from unauthorized access.

If an incorrect access code is entered, the user obtains the access rights of the **Operator** role.

8.4 Access to operating menu via local display

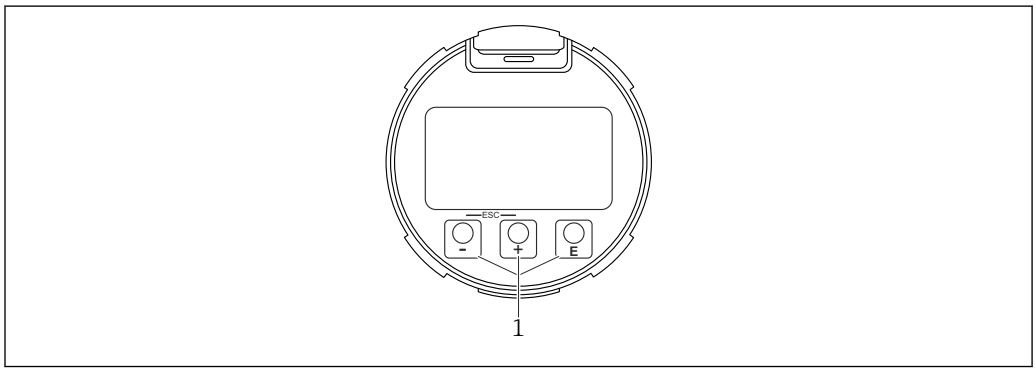
8.4.1 Device display (optional)

Possible to operate the optical operating keys through the cover. No need to open the device.

Functions:
- Display measured values and fault and notice messages
- Background lighting, which switches from green to red in the event of an error
- The device display can be removed for easier operation

Backlighting is switched on or off depending on the supply voltage and the current consumption.

The device display is optionally available with Bluetooth® wireless technology.



21 Graphic display with optical operating keys (1)

- ⊞ key
  - Navigate downwards in the selection list
  - Edit the numerical values and characters within a function
- ⊟ key
  - Navigate upwards in the selection list
  - Edit the numerical values and characters within a function
- Ⓔ key
  - Change from main display to main menu
  - Confirm entry
  - Jump to the next item
  - Selection of a menu item and activation of edit mode
  - Unlock/lock the display operation
  - Press and hold the Ⓔ key to display a short description of the selected parameter (if available)
- ⊞ key and ⊟ key (ESC function)
  - Exit edit mode for a parameter without saving the changed value
  - Menu at a selection level: pressing the keys simultaneously takes the user back up a level in the menu
  - Press and hold the keys simultaneously to return to the upper level

8.4.2 Operation via Bluetooth® wireless technology (optional)

Prerequisite
- Device with device display including Bluetooth® wireless technology
- Smartphone or tablet with Endress+Hauser SmartBlue app or PC with DeviceCare from version 1.07.05 or Field Xpert SMT70

The connection has a range of up to 25 m (82 ft). The range can vary depending on environmental conditions such as attachments, walls or ceilings.

The operating keys on the display are locked as soon as a Bluetooth® connection is established.

An available Bluetooth® connection is indicated by a flashing Bluetooth symbol.

If the Bluetooth® display is removed from one device and installed in another device.
- All login data are stored only in the Bluetooth® display and not in the device.
- The password changed by the user is also stored in the Bluetooth® display.

Special Documentation SD02530P

Operation via SmartBlue app

The device can be operated and configured with the SmartBlue App.

- The SmartBlue app must be downloaded onto a mobile device for this purpose
- For information on the compatibility of the SmartBlue app with mobile devices, see **Apple App Store (iOS devices)** or **Google Play Store (Android devices)**
- Incorrect operation by unauthorized persons is prevented by means of encrypted communication and password encryption.
- The Bluetooth® function can be deactivated after initial device setup.

22 *QR code for free Endress+Hauser SmartBlue App*

Download and installation:

1. Scan the QR code or enter **SmartBlue** in the search field of the Apple App Store (iOS) or Google Play Store (Android).
2. Install and start the SmartBlue app.
3. For Android devices: enable location tracking (GPS) (not required for iOS devices).
4. Select a device that is ready to receive from the device list displayed.

Login:

1. Enter the user name: admin
2. Enter the initial password: serial number of the device

3. Change the password after logging in for the first time

Information on password and reset code

For devices that meet the requirements of IEC 62443-4-1 "Secure product developement lifecycle management" ("ProtectBlue"):
- If the user-defined password is lost: refer to the user management instructions and the reset button in the operating manual.
- Refer to the associated Security Manual (SD).

For all other devices (without "ProtectBlue"):
- If the user-defined password is lost, access can be restored via a reset code. The reset code is the serial number of the device in reverse. The original password is once again valid after the reset code has been entered.
- The reset code can also be changed in addition to the password.
- If the user-defined reset code is lost, the password can no longer be reset via the SmartBlue app. Contact Endress+Hauser Service in this case.

8.5 DeviceCare

8.5.1 Function scope

Tool for connecting and configuring Endress+Hauser field devices.

The fastest way to configure Endress+Hauser field devices is with the dedicated "DeviceCare" tool. Together with the device type managers (DTMs), DeviceCare presents a convenient, comprehensive solution.

For details, see Innovation Brochure IN01047S

8.6 FieldCare

8.6.1 Function range

FDT-based plant asset management tool from Endress+Hauser. FieldCare can configure all smart field devices in a system and helps you manage them. By using the status information, FieldCare is also a simple but effective way of checking their status and condition.

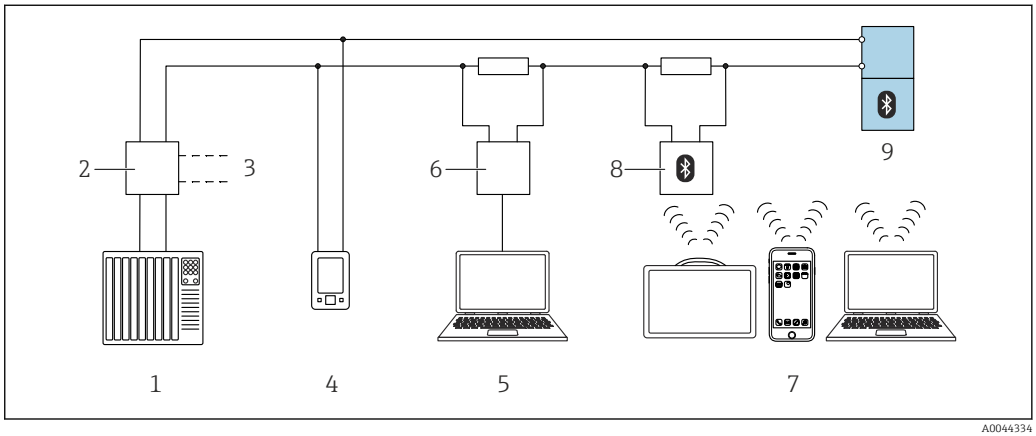
Access is via:
- CDI service interface
- PROFINET interface
- HART communication

Typical functions:
- Configuration of transmitter parameters
- Loading and saving of device data (upload/download)
- Documentation of the measuring point
- Visualization of the measured value memory (line recorder) and event logbook

For additional information about FieldCare, see Operating Instructions BA00027S and BA00059S

8.7 Overview of the HART operating options

8.7.1 Via HART protocol



23 *Options for remote operation via HART protocol*

1 *PLC (programmable logic controller)*
2 *Transmitter power supply unit, e. g. RN42 (with communication resistor)*
3 *Connection for Commubox FXA195 and AMS Trex Device Communicator*
4 *AMS Trex Device Communicator*
5 *Computer with operating tool e.g. DeviceCare, FieldCare, AMS Device View, SIMATIC PDM)*
6 *Commubox FXA195 (USB)*
7 *Field Xpert SMT70/SMT77, smartphone or computer with operating tool (e.g. DeviceCare, SmartBlue app)*
8 *Bluetooth modem with connecting cable (e.g. VIATOR)*
9 *Transmitter*

8.7.2 Operation via RIA 15 (remote display)

Loop-powered process indicator to display HART or 4 to 20 mA signals

8.7.3 Operation via WirelessHART

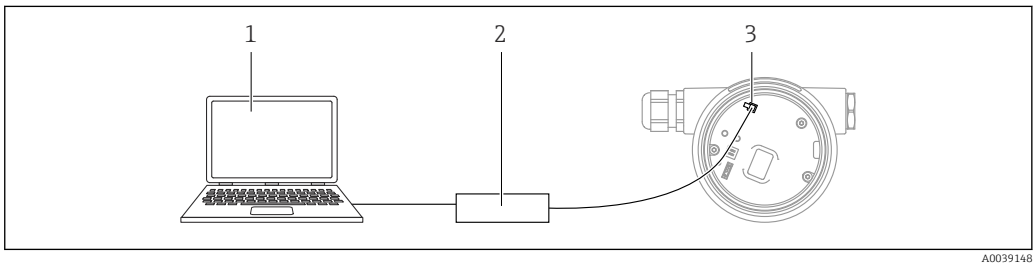
SWA70 WirelessHART adapter with the Commubox FXA195 and the "FieldCare/ DeviceCare" operating program

8.7.4 Alternative operation options

The measuring instrument can be configured and measured values can be retrieved in various ways.

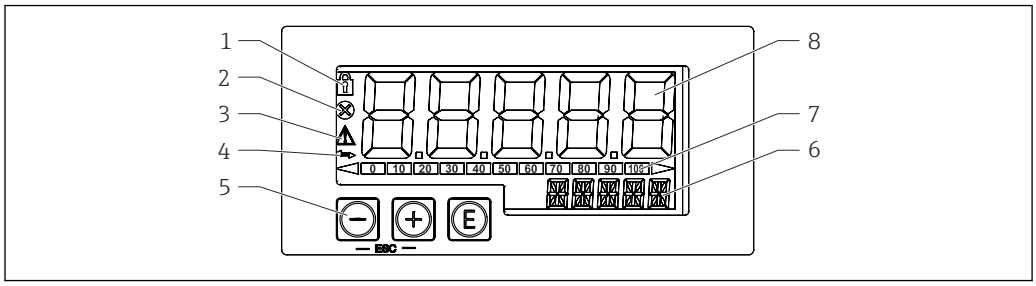
Operation via the service interface

Via service interface (CDI)



1 *Computer with FieldCare/DeviceCare operating tool*
2 *Commubox*
3 *Service interface (CDI) of the device (= Endress+Hauser Common Data Interface)*

Operation via RIA15



24 *Display and operating elements of the process indicator*

1 *Symbol: operating menu disabled*
2 *Symbol: error*
3 *Symbol: warning*
4 *Symbol: HART communication active*
5 *Operating keys*
6 *14-segment display for unit/TAG*
7 *Bar graph with indicators for under range and over range*
8 *5-digit 7-segment display for measured value, digit height 17 mm (0.67 in)*

The device is operated using three operating keys on the front of the housing.

Ⓔ
Enter key; for calling up the operating menu, confirming the selection/configuration of parameters in the operating menu

⊕ / ⊖
Selection and configuration/changing of values in the operating menu; pressing the '+' and '-' keys simultaneously takes the user back up a menu level. The configured value is not saved.

Additional information is available in the Operating Instructions for the RIA15

BA01170K

Heartbeat Verification/Monitoring

The **Heartbeat** submenu is only available during operation via **FieldCare**, **DeviceCare** or **SmartBlue app**. It contains the wizards that are available with the **Heartbeat Verification** and **Heartbeat Monitoring** application packages.

SD02414F

8.8 Locking/unlocking configuration

8.8.1 Software locking

Locking via password in FieldCare / DeviceCare / SmartBlue App

Access to the configuration of the FMG50 can be locked by assigning a password. The "User role" is set to "Maintainer" in the as-delivered state. The device can be fully configured in the "Maintainer" role. Afterwards, access to the configuration can be locked by assigning a password. The "User Role" is now set to "Operator". The configuration can be accessed by entering the password.

The password is defined under:

System -> User management -> Define password

You can switch from the "Maintainer" to "Operator" user role under:

System -> User management -> Logout

Deactivating the lock via FieldCare / DeviceCare / SmartBlue App

After entering the password, you can enable the configuration of the FMG50 as an "Operator" with the password. The "User role" then changes to "Maintainer"

Navigate to:

System -> User management -> Change user role

8.8.2 Hardware locking

Hardware locking can only be unlocked on the electronic insert (flip the switch). It is not possible to unlock the hardware by communication.

8.9 Resetting to the default configuration

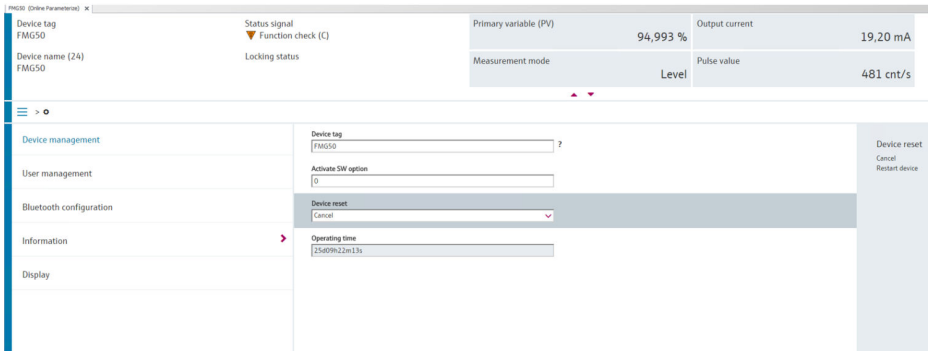
⚠ CAUTION

Resetting to the default configuration

When a reset is performed, all calibration data are deleted. This may affect the measurement.

- ▶ After a reset, a complete recalibration is required before the measurement can be put back into operation.

1. Connect the device with FieldCare or DeviceCare.
2. Open the device in FieldCare or DeviceCare.
   - ↳ The dashboard (homepage) of the device is displayed:
     Click "System -> Device management"



3. Reset the device in the "Device reset" parameter

The following types of reset can be selected:

- **Restart device**
  A soft reset is performed here. The device software performs all the diagnostics that would also be performed by a hard reset by switching the device on/off.
- **Reset to factory default**
  It is always advisable to reset the customer parameters if you want to use a device with an unknown history, or if the operating mode is changed. When a reset is performed, all customer parameters are reset to the factory default values
- **Optional: reset to customer settings**
  If the device was ordered with a customized configuration, a reset restores these customer settings configured at the factory.

A reset can also be performed on site via the operating keys (see the "Commissioning via onsite operation" section).

9 System integration

9.1 Overview of device description files

- Manufacturer ID: 17 (0x0011)
- Device type ID: 0x1130
- HART specification: 7.5
- DD files, information and files can be found at:
  - www.endress.com
  - www.fieldcommgroup.org

9.2 Measured variables via HART protocol

The following measured values are assigned to the device variables at the factory:

Device variable	Measured value
Primary variable (PV)	Process variable depends on the operating mode selected in %
Secondary variable (SV)	Measured current
Tertiary variable (TV)	Sensor temperature
Quaternary variable (QV)	Terminal voltage 1

The assignment of the measured values to the device variables can be changed in the following submenu:
Application → HART output → HART output

In a HART Multidrop loop, only one device may use the analog current value for signal transmission. For all other devices in **"Loop current mode" parameter**, select **Disable** option.

10 Commissioning

10.1 Post-installation and post-connection check

Perform the post-installation check and the post-connection check for the FMG50 prior to commissioning the measuring point.

Perform commissioning using the Commissioning Wizard!

If commissioning is performed via the menu, incorrect settings can result in device failure.

10.2 Commissioning using the wizard

10.2.1 General

When the device is switched on for the first time or following a reset to factory settings, see the section on "Reset to factory defaults", the device displays the error message **F440 "Device is not calibrated"**, the status signal indicates an alarm and the current output is set to failure current: MIN, -10 %, 3.6 mA (factory setting).

A Wizard is available in FieldCare, DeviceCare and the SmartBlue App to guide you through the initial commissioning process.

FieldCare and DeviceCare are available for download. You need to register in the Endress+Hauser software portal to download the application.

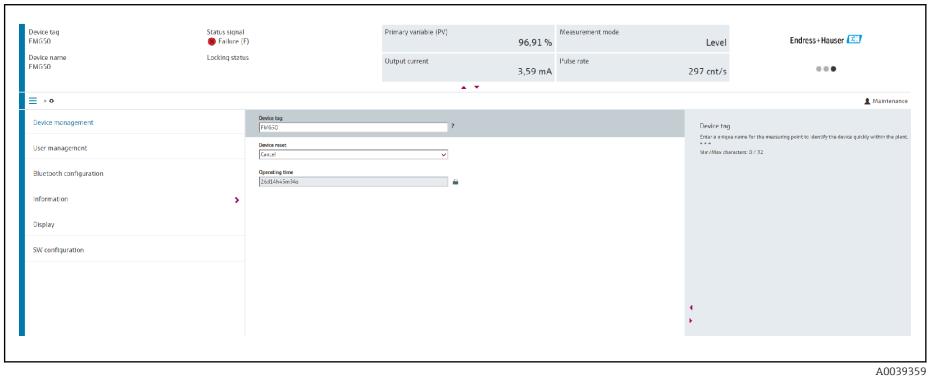
https://www.software-products.endress.com

SmartBlue enables operation via Bluetooth.

For details, see the "Commissioning via the SmartBlue App" section

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. Connect the device with FieldCare, DeviceCare or SmartBlue App (Bluetooth).
2. Open the device in FieldCare, DeviceCare or SmartBlue App.
   ↳ The dashboard (homepage) of the device is displayed:



A0039359

25 *Screenshot: Commissioning Wizard*

3. Click "Commissioning" to launch the Wizard.
4. Enter the appropriate value in each parameter or select the appropriate option. These values are written directly to the device.
5. Click "Next" to go to the next page.

6. Once all the pages have been completed, click "Finish" to close the Wizard.

If you cancel the Wizard before all the necessary parameters have been entered, the device may be in an undefined state. In such situations, it is advisable to reset the device to the factory default settings.

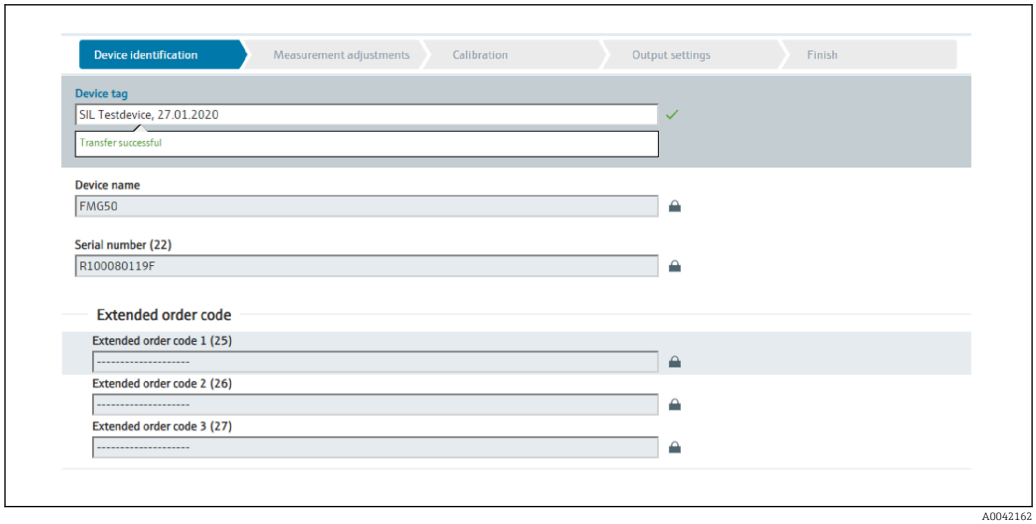
The following operating modes can be set via the Wizard:
- Level
- Min. or max. point level
- Density measurement
- Concentration measurement
- Concentration measurement of radiating media

Configuration of gammagraphy detection: see "Gammagraphy" section.

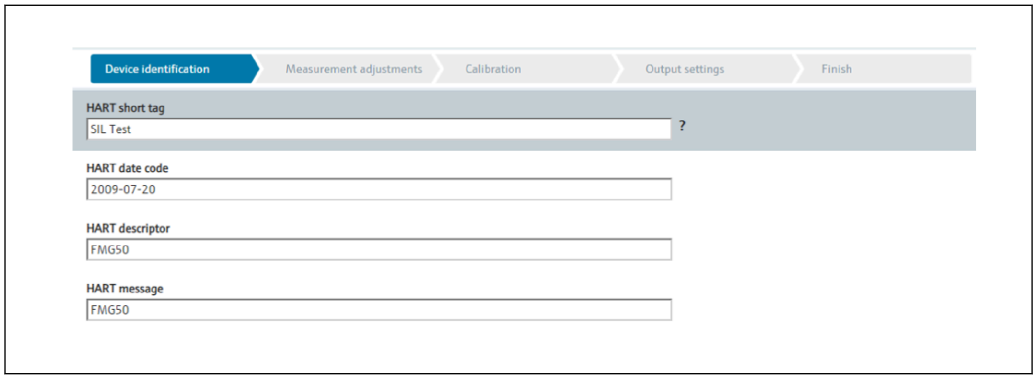
Recalibration of a density measurement: see the "Density recalibration for multiple-point calibration" section

10.2.2 Device identification

The user guidance starts with the general configuration of the tag name and some HART parameter settings.



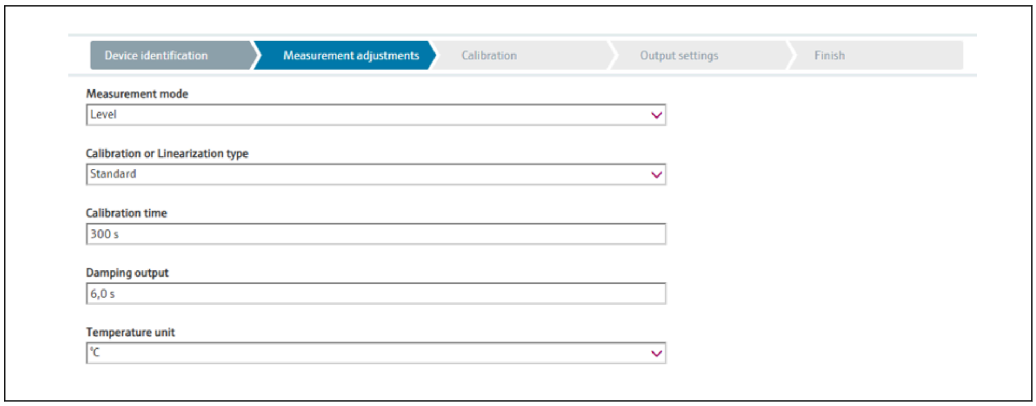
A0042162



A0042163

10.2.3 Measurement settings

After this, the general "measurement settings" of the Gammapilot FMG50 can then be made:



A0042164

The first settings page of the "measurement settings" is displayed for all operating modes.

The following configuration options are available:
- General settings
- Configuration of the reference time
- Selection of the isotope used (depends on the operating mode)
- Selection of the beam type (depends on the operating mode)

General settings

In the "slave mode" operating mode, no settings are made apart from the setting for the operating mode.

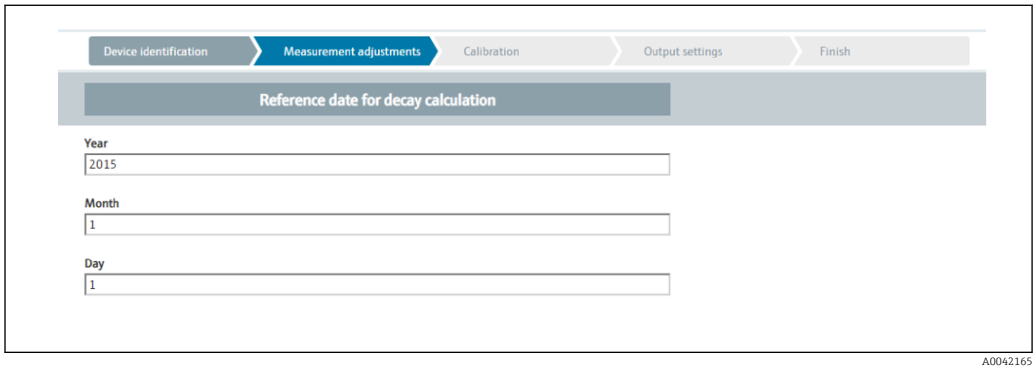
The pulse rate, measured value and current shown on the optional display are also filtered with the configured "Damping output".

1. Selection of the calibration or linearization type
   ↳ Depends on the operating mode
2. Configuration of the engineering unit for the level
   ↳ Depends on the "Level" operating mode with customer linearization
3. Configuration of the unit of length
   ↳ Depends on the operating mode
4. Configuration of the density unit
   ↳ Depends on the operating mode
5. Configuration of the calibration time
   ↳ The calibration time is the time to be measured for the calibration of the individual calibration points. This time should be changed depending on the measuring task.
6. Configuration of the output damping
   ↳ The output damping defines the time constant T_{63}. The setting depends on the process conditions. Increasing the damping value makes the measured value considerably steadier but also slower. In order to reduce the influence of stirrers or turbulent surfaces, it is advisable to increase the damping value. However, the value selected for damping should not be too large so that rapid changes in the measured value can also be detected quickly.
   Sample settings for the time constant T_{63}:
   Level: 6 s
   Density: 60 s
   For information about the effect on the current output, see the Technical Information:
   TI01462F

7. Setting of the temperature unit
   ↳ Selection of temperature unit

Configuration of the reference time

The first time you run the user guidance function, the reference date is entered for calculating the radioactive decay of the radiation source (this is normally the current date).



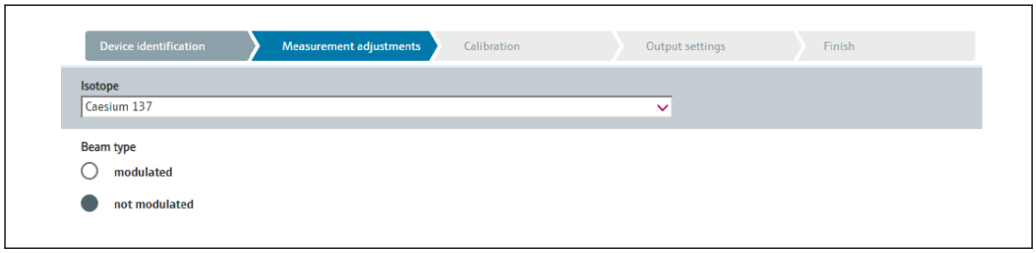
A0042165

The date of the operating tool is accepted by pressing the "Reference date for decay calculation" button.

The real-time clock is already set at the factory and backed by a battery. For more details, see the "Real-time clock and decay compensation" section.

Note: The reference date can only be set once. A change is only possible after resetting the device to the factory settings (reset); see the section on "Reset to factory defaults".

Selection of the isotope used and the beam type (depends on the operating mode)



A0042166

Once the reference date is set, the isotope used is then selected. The isotope must be selected to be able to compensate for isotope decay correctly

A ^{137}Cs or ^{60}Co source acts as the gamma radiation source. Alternatively, gamma radiation sources with other decay constants can also be used. The decay time can be defined as between 1 and 65536 days. Decay times for other isotopes can be found in the database of the "Decay Data Evaluation Project (DDEP)"; see:

http://www.lnhb.fr/home/nuclear-data/nuclear-data-table/

If no decay compensation is selected, the Gammapilot FMG50 determines the measured variable without any compensation.

If a gamma modulator FHG65 is used for interference radiation suppression, "modulated" must be selected for the beam type. If the Gammapilot FMG50 is used without the gamma modulator FHG65, the default option "not modulated" is left as is.

⚠ WARNING

Radiation type or isotope selected incorrectly

The Gammapilot FMG50 will output an incorrect measured value. This is a dangerous, non-detectable systematic error. Serious personal injury or material damage may result.

- ▶ Do not change the setting in the operating menu.

The type of isotope and beam can only be set once. A change is only possible after resetting the device to the factory settings (reset); see the section on "Reset to factory defaults".

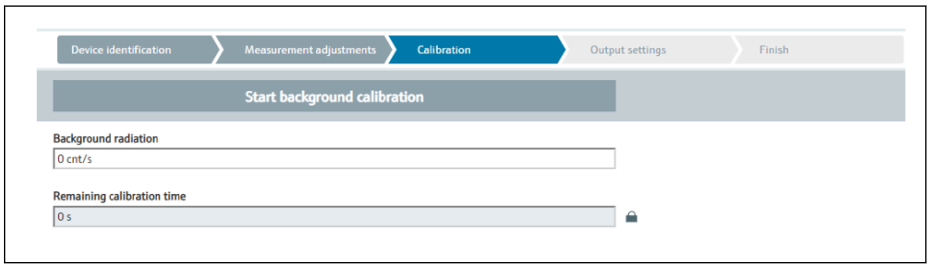
10.2.4 Calibration

Background calibration

The background calibration is necessary in order to record the natural background radiation at the mounting position of the Gammapilot FMG50. The pulse rate of this background radiation is automatically subtracted from all other measured pulse rates. Only the part of the pulse rate that originates from the radiation source used is taken into consideration.

In contrast to the radiation of the source used, the background radiation remains more or less constant for the entire duration of the measurement. For this reason, background calibration is not factored into the automatic decay compensation of the Gammapilot FMG50.

1. Select the isotope and the beam type
2. Switch off radiation (source container set to the "off" position) or fill vessel to the maximum level.
3. Press the "Start background calibration" button



A0042167

The measurement then starts automatically and continues, at the very maximum, for as long as has been configured for the calibration time. However, the process can also be stopped manually by pressing the "Stop calibration" button.
The calibration stops automatically as soon as a million pulses have been totalized.
Alternatively, the background value can also be entered directly.
For the "Next" button in the Wizard to be enabled, the value must, however, be changed from the start value, at least temporarily.

In the case of radiating media, the calibration of the background radiation must be performed at the lowest possible radiation (ideally: without a medium)

Point level calibration

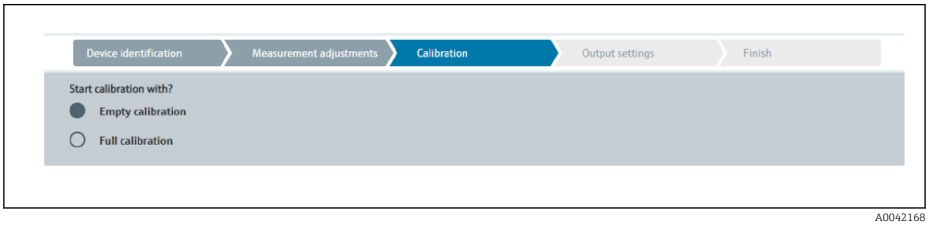
Depends on the operating mode selected.

For a point level measurement, the Gammapilot FMG50 requires two other calibration points in addition to the background calibration:

- Empty calibration
- Full calibration

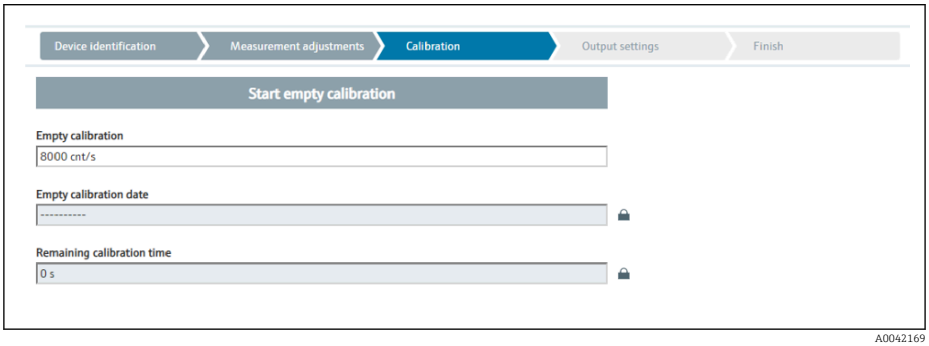
The correlation between the current output and the calibration values is always linear in the point level operating mode. In this sense, this operating mode is the same as the Level operating mode with the "linear" type of linearization.

1. **Selection:** start with full calibration or start with empty calibration
   ↳ Start calibration -> the calibration can be stopped once the pulse rate has stabilized.



A0042168

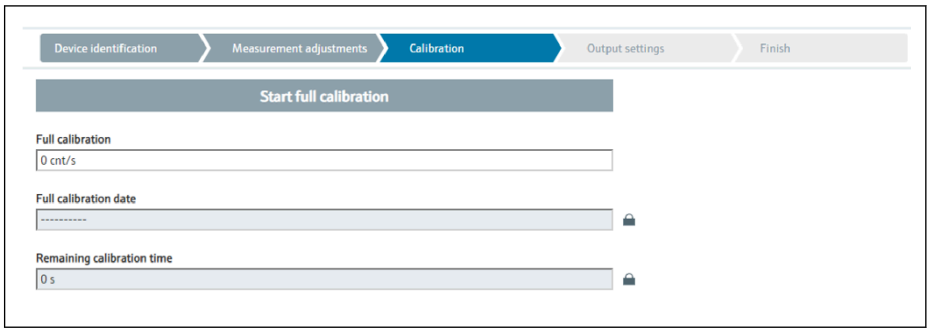
2. **Empty calibration point level:** the radiation is switched on and the beam path is completely free
   ↳ If these conditions are met, empty calibration can be started.



A0042169

The empty calibration can be performed by pressing the "Start empty calibration" button. The measurement then starts automatically and continues, at the very maximum, for as long as has been configured for the calibration time. However, the process can also be stopped manually by pressing the "Stop calibration" button.
The calibration stops automatically as soon as a million pulses have been totalized.
Alternatively, the empty calibration can also be entered directly.
For the "Next" button in the Wizard to be enabled, the value must, however, be changed from the start value, at least temporarily.

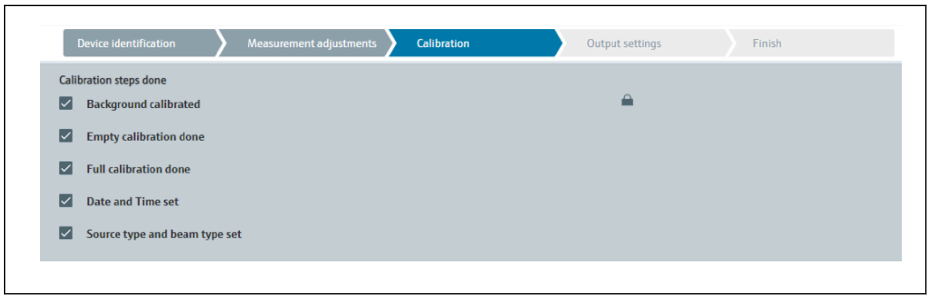
3. **Full calibration point level:** the radiation is switched on and the beam path is completely covered by medium.
   ↳ If these conditions are met, the calibration can be started.



A0042170

The full calibration can be performed by pressing the "Start full calibration" button. The measurement then starts automatically and continues, at the very maximum, for as long as has been configured for the calibration time. However, the process can also be stopped manually by pressing the "Stop calibration" button.
The calibration stops automatically as soon as a million pulses have been totalized.
Alternatively, the full calibration can also be entered directly.
For the "Next" button in the Wizard to be enabled, the value must, however, be changed from the start value, at least temporarily.
TIP: if the vessel cannot be filled appropriately, the full calibration can also be performed with the radiation switched off. This is a way of simulating a completely covered radiation path. In this case, full calibration is identical to background calibration and 0 cnt/s is typically displayed.

4. The calibration has been performed successfully.
   ↳



A0042171

5. The settings for the current output are then made in the "Output settings" step

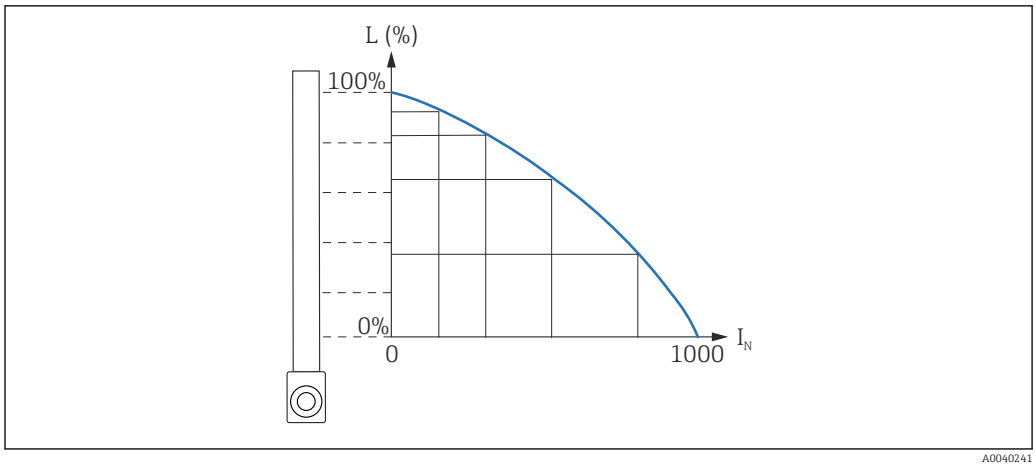
Level calibration

Depends on the operating mode selected.

For a level measurement, the Gammapilot FMG50 requires at least two other calibration points in addition to the background calibration:
- Empty calibration
- Full calibration

Linearization level measurement: the linearization defines the correlation between the pulse rate and the level (0 to 100%).

The Gammapilot FMG50 makes a variety of linearization modes available:
- Pre-programmed linearizations for frequent standard cases ("linear", "standard")
- Entry of any linearization table adapted to the specific application
  - The linearization table consists of up to 32 "normalized pulse rate : level" value pairs.
  - The linearization table must be monotonic decreasing, i.e. a higher pulse rate must always be paired with a lower level.



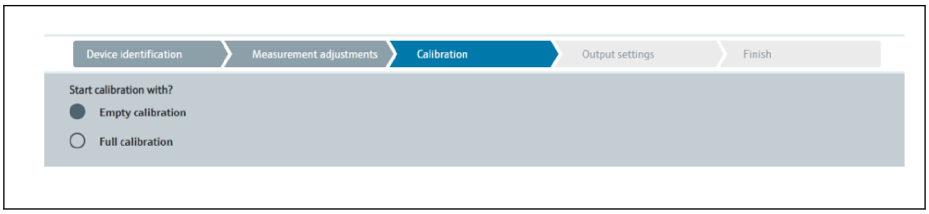
26 *Example of linearization curve for level measurements (consisting of 6 pairs of values)*

L *Level*
I_N *Normalized pulse rate*

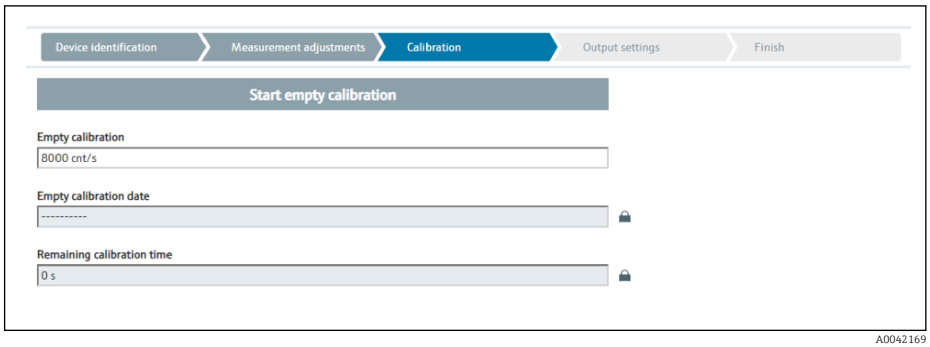
The type of linearization has already been selected in the "Measurement settings" section

The behavior of the "linear" type of linearization is identical to the "point level calibration" operating mode.

1. **Selection:** start with full calibration or start with empty calibration
   ↳ Start calibration -> the calibration can be stopped once the pulse rate has stabilized.



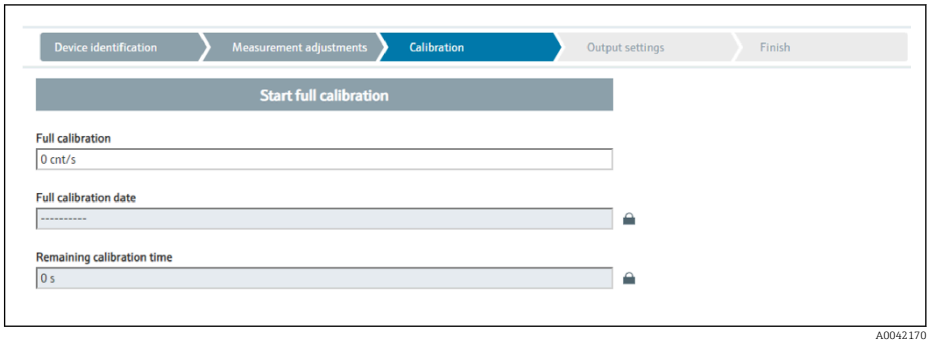
2. **Empty calibration level:** the radiation is switched on and the beam path is completely free.
   ↳ If these conditions are met, empty calibration can be started.



A0042169

The empty calibration can be performed by pressing the "Start empty calibration" button. The measurement then starts automatically and continues, at the very maximum, for as long as has been configured for the calibration time. However, the process can also be stopped manually by pressing the "Stop calibration" button.
The calibration stops automatically as soon as a million pulses have been totalized.
Alternatively, the empty calibration can also be entered directly.
For the "Next" button in the Wizard to be enabled, the value must, however, be changed from the start value, at least temporarily.

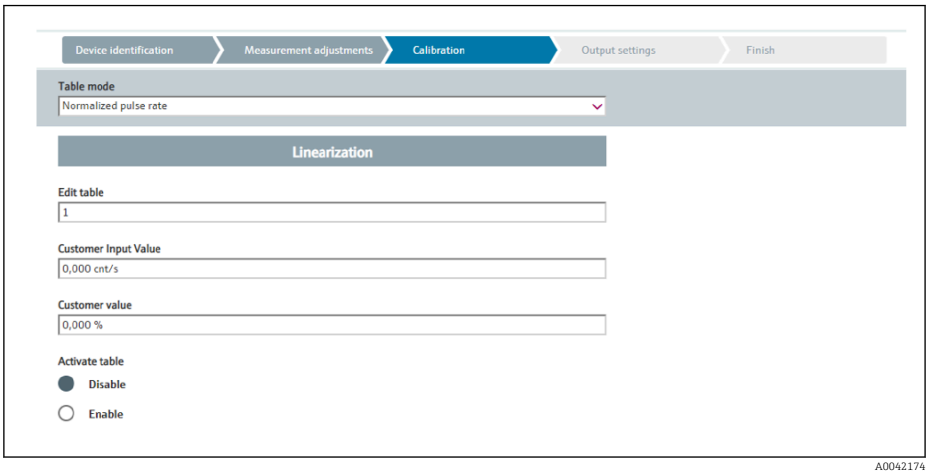
3. **Full calibration level:** the radiation is switched on and the beam path is completely covered by medium.
   ↳ If these conditions are met, the calibration can be started.



A0042170

The full calibration can be performed by pressing the "Start full calibration" button. The measurement then starts automatically and continues, at the very maximum, for as long as has been configured for the calibration time. However, the process can also be stopped manually by pressing the "Stop calibration" button.
The calibration stops automatically as soon as a million pulses have been totalized.
Alternatively, the full calibration can also be entered directly.
For the "Next" button in the Wizard to be enabled, the value must, however, be changed from the start value, at least temporarily.
TIP: if the vessel cannot be filled appropriately, the full calibration can also be performed with the radiation switched off. This is a way of simulating a completely covered radiation path. In this case, full calibration is identical to background calibration and 0 cnt/s is typically displayed.

4. If a customized table has been selected for the linearization, the following input screen appears:

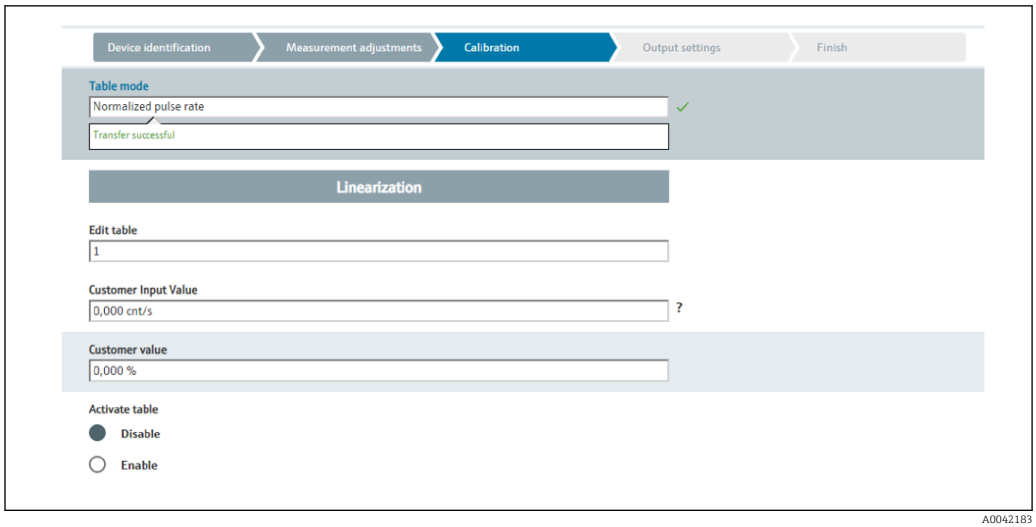


A0042174

The procedure varies depending on the type of table that is selected.
- For the "Normalized pulse rate" table type, see the description for "Normalized pulse rate"
- For the "Semi-automatic" table type, see the description for "Semi-automatic"

If the type of table is subsequently changed, please refer to the "Information on the use of the linearization module with linearization values recorded semi-automatically".

Normalized pulse rate



A0042183

N	L	I	I_N
1	0	2431	1000
2	35	1935	792
3	65	1283	519
4	83	642	250
5	92	231	77
6	100	46	0

Normalized pulse rate

Note that the normalized pulse rate is entered in the linearization table. The normalized pulse rate is not identical to the pulse rate actually measured. The correlation between these two variables is defined by:

$I_N = (I - I_0) / (I_{MAX} - I_0) \times 1000$

Where:
- I_0 is the minimum pulse rate (i.e. the pulse rate for full calibration)
- I_{MAX} is the maximum pulse rate (i.e. the pulse rate for empty calibration)
- I: the measured pulse rate
- I_N: the normalized pulse rate

The normalized pulse rate is used because it does not depend on the activity of the radiation source used:
- For L = 0 % (empty vessel), I_N always = 1000
- For L = 100 % (full vessel), I_N always = 0

The individual linearization values can be entered via the input screen or via a separate linearization module. The linearization table consists of up to 32 "normalized pulse rate : level" value pairs.

Linearization table conditions
- The table can consist of up to 32 "level - linearized value" pairs.
- The table must decrease monotonically
  - The first value in the table must correspond to the minimum level
  - The last value in the table must correspond to the maximum level

The table values can be sorted as monotonically decreasing using the "Table mode -> Sort table" function.

Edit table: the index of the linearization point is entered in this field (1-32 points)

Customer input value: enter the normalized pulse rate

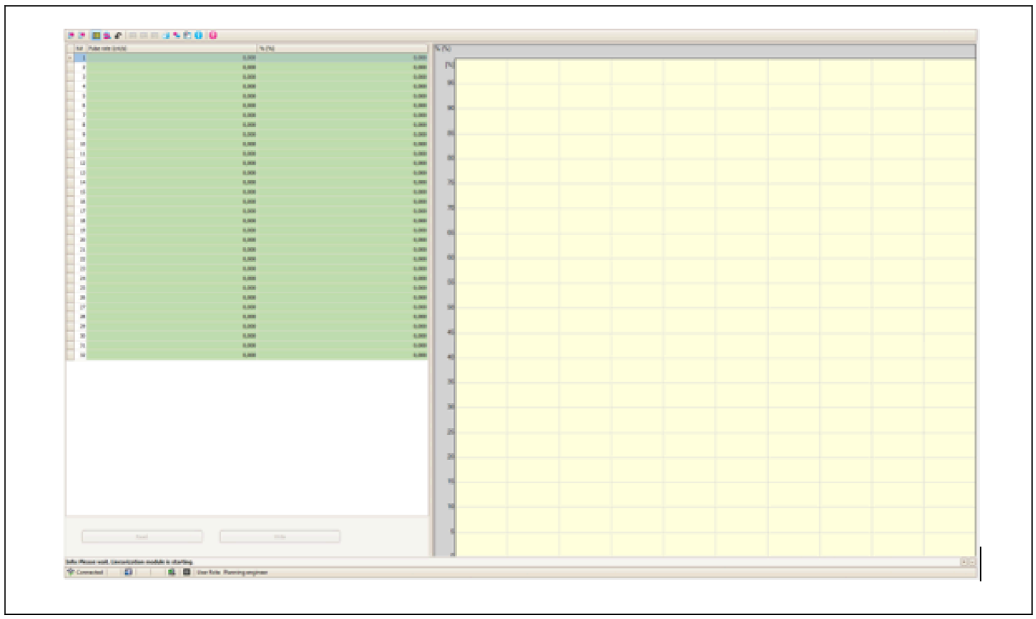
Customer value: level in unit of length, volume unit or %.

The customer input value in normalized pulse rates and the customer value as a percentage can be determined in the "Applicator" user software. [3)]

Activate table: the "Enable" option must first be selected before the linearization table is used. The linearization table is not used as long as "Disable" is selected.

The linearization table can also be entered manually in the linearization module. This is started by selecting the "Linearization" button:

3) The Endress+Hauser Applicator is available online at www.endress.com

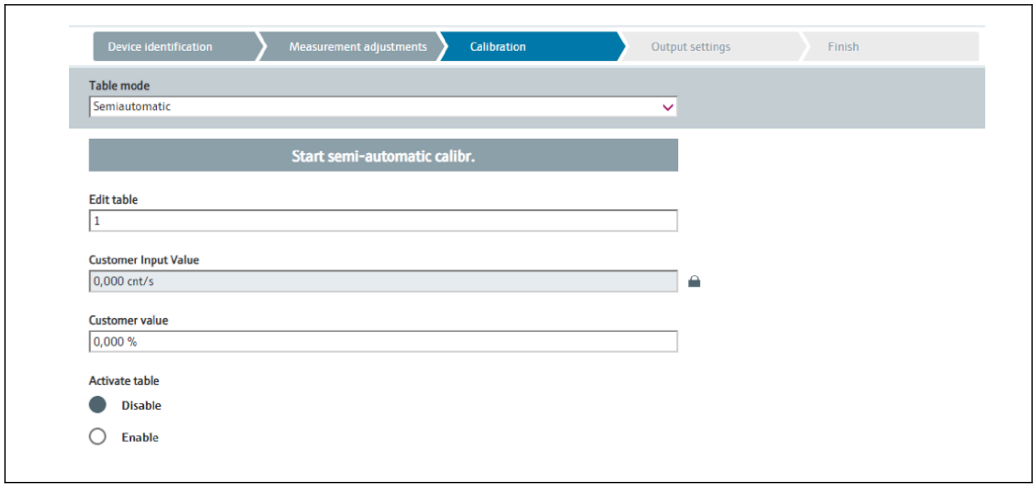


A0042194

The normalized pulse rate and the customer value can be entered directly in table form in this module.

The linearization table must be activated by selecting "Activate table" -> "Enable"

Semi-automatic



A0042195

During semi-automatic linearization, the device measures the pulse rate for every linearization point. The associated level value is entered manually. In contrast to the normalized pulse rate, the measured pulse rate is directly applied to the linearization table in the semi-automatic mode.

The linearization table consists of up to 32 "measured pulse rate : level" value pairs.

Linearization table conditions
- The table can consist of up to 32 "level - linearized value" pairs.
- The table must decrease monotonically
  - The first value in the table must correspond to the minimum level
  - The last value in the table must correspond to the maximum level

The table values can be sorted as monotonically decreasing using the "Table mode -> Sort table" function.

Edit table: the index of the linearization point is entered in this field (1-32 points)

Customer input value: measured pulse rate for the linearization point

Customer value: level in unit of length, volume unit or %.

Activate table: the "Enable" option must first be selected before the linearization table is used. The linearization table is not used as long as "Disable" is selected.

- ▶ To record a new input value, press the "Start semi-automatic calibration" button.
  - ↳ The measurement then starts automatically and continues, at the very maximum, for as long as has been configured for the calibration time. However, the process can also be stopped manually by pressing the "Stop calibration" button.
    The calibration stops automatically as soon as a million pulses have been totalized.

The remaining calibration time of the semi-automatic calibration is not displayed on the user interface.

The linearization table must be activated by selecting "Activate table" -> "Enable"

Use of the linearization module with linearization values recorded semi-automatically

Please note the following if using the linearization module with linearization tables recorded semi-automatically:

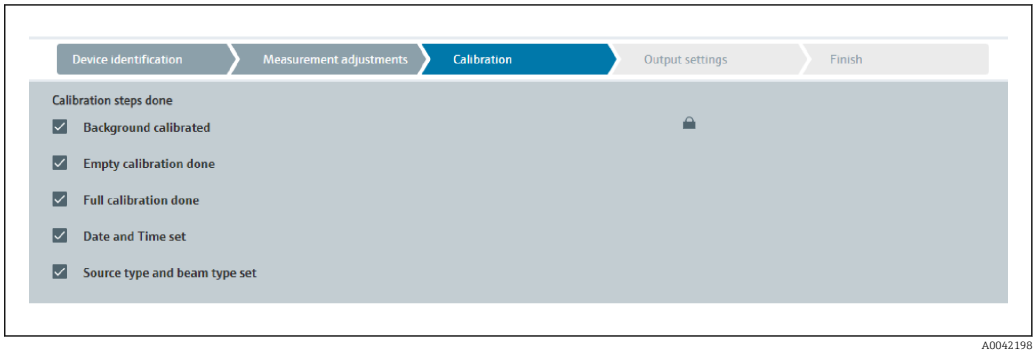
The module assumes pulse rates are normalized and automatically switches the internal measurement calculation to normalized values if the module is used. This falsifies the assignment between the output value and the measured value. If the linearization module has been opened with semi-automatic linearization curves, the table mode must be set to "semi-automatic" again.

If error F435 "Linearization incorrect" is displayed, the linearization table must be checked again according to the dependencies and conditions mentioned above.

⚠ WARNING

An incorrect table mode is being used.
Linearization may calculate an incorrect value; as a result, the current output will also output an incorrect measured value. Serious personal injury or material damage may result.
- ▶ Use the correct table mode.

The following message is displayed following a successful calibration:



A0042198

The settings for the current output are then made in the "Output settings" step

Density calibration

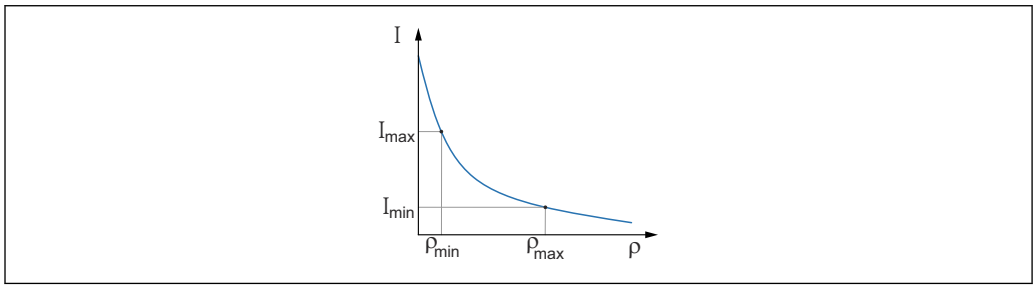
Depends on the operating mode selected.

The Gammapilot FMG50 requires the following parameters for density and concentration measurements:
- The length of the irradiated measuring path
- The absorption coefficient μ of the medium
- The reference pulse rate I_0

Two types of calibration are available to determine these parameters:
- Multi-point calibration
- One-point calibration

Multi-point calibration

Multi-point calibration is recommended particularly for measurements in a large density range or for particularly accurate measurements. Up to 4 calibration points can be used over the entire measuring range. The calibration points should be as far apart as possible and should be evenly distributed over the entire measuring range.

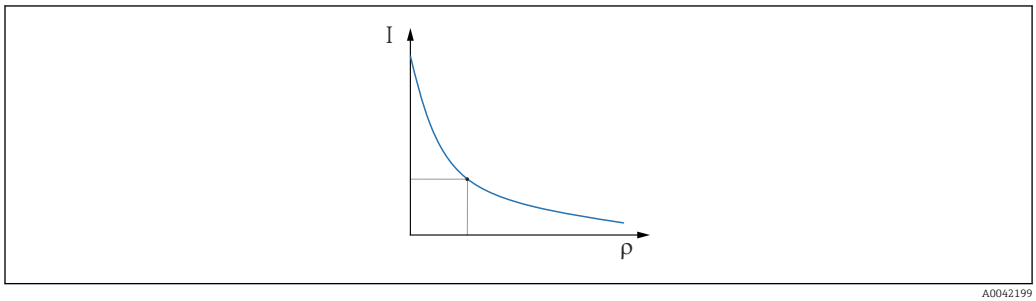


I *Pulse rate*
ρ *Density*

Once the calibration points have been entered, the Gammapilot FMG50 calculates the reference pulse rate I_0 and the absorption coefficient μ parameters on its own.

One-point calibration

A one-point calibration can be performed if a multi-point calibration is not possible. This means that apart from the background calibration only one additional calibration point is used. This calibration point should be as close as possible to the operating point. Density values near this calibration point are measured quite accurately, but the accuracy can decrease as the distance from the calibration point increases.



I *Pulse rate*
ρ *Density*

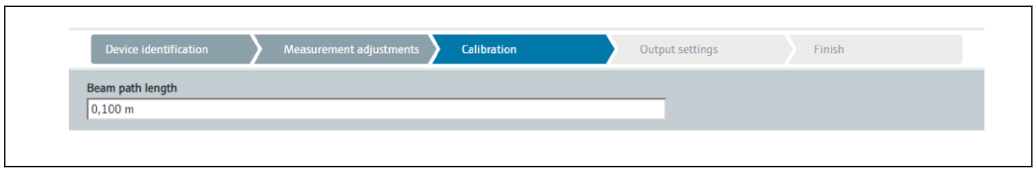
In one-point calibration, the Gammapilot FMG50 only calculates the reference pulse rate I_0. For the absorption coefficient μ, the device uses a predefined value. This predefined value can be edited directly or an absorption coefficient for the specific measuring point can be determined using the Applicator. The default value for the absorption coefficient is $\mu = 7.7\ mm^2/g$.

The type of calibration has already been selected in the "Measurement settings" section

The Gammapilot FMG50 does not have a Wizard for **recalibration**. Nevertheless, a recalibration can be performed easily. See the "Density recalibration for multiple-point calibration" section.

Beam path length

The length of the beam path in the medium to be measured is specified here.



A0042201

Examples:

If the beam passes through the pipe at an angle of 90°, this value corresponds to the internal pipe diameter. If the beam passes through the pipe at an angle of 30° in order to increase the sensitivity of the measurement, the length of the beam path corresponds to twice the internal pipe diameter.

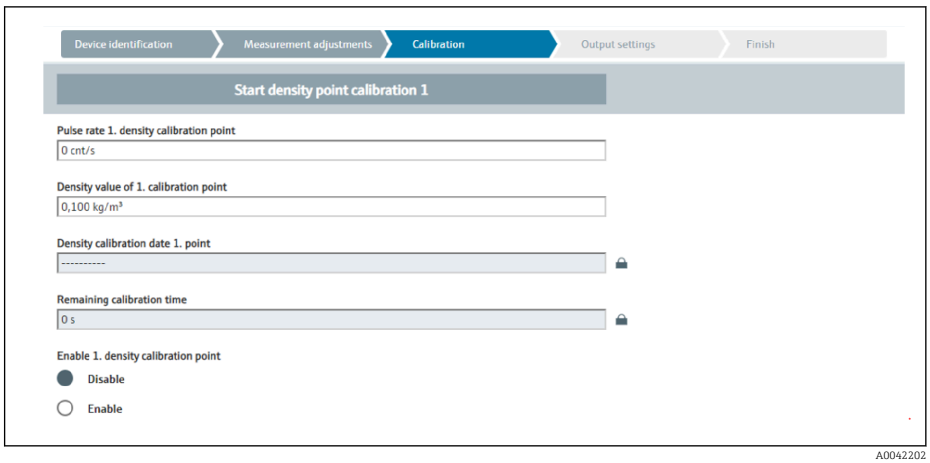
The unit of length can be defined in the "Measurement settings" section

Multi-point calibration

Up to four density calibration points can be recorded in a multiple-point calibration. The procedure is the same for all four calibration points. The first of the four possible calibration points is described below.

Calibration density point 1-4

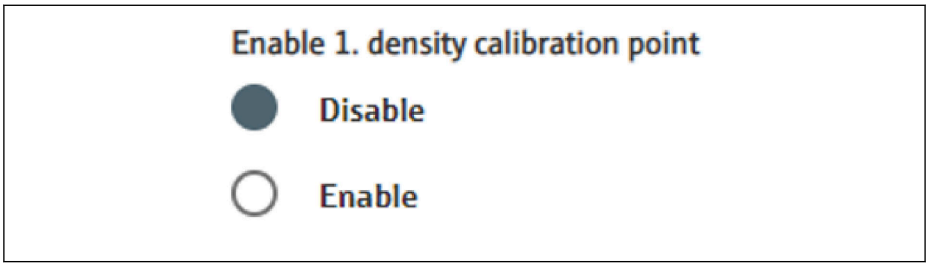
1. The radiation is switched on and the beam path is filled with medium of a known density.



A0042202

The calibration can be performed by pressing the "Start density point calibration" button. The measurement then starts automatically and continues, at the very maximum, for as long as has been configured for the calibration time. However, the process can also be stopped manually by pressing the "Stop calibration" button.
The calibration stops automatically as soon as a million pulses have been totalized.
Alternatively, the pulse rate can also be entered directly.
For the "Next" button in the Wizard to be enabled, the value must, however, be changed from the start value, at least temporarily.

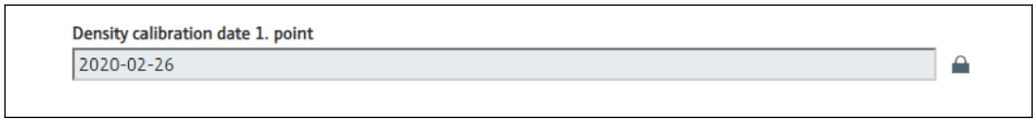
2. With this calibration point, the density of the product is entered in the "Density value of calibration point" field.
   ↳ This establishes the reference between the determined pulse rate and the density of the product.
   TIP: it is recommended to take a sample of the medium during the integration and determine its density subsequently (e.g. in the laboratory).
3. Activate the density calibration point
   ↳



A0042203

At least two of the four available density calibration points must be activated at the end. Three or four points can also be used, however. This increases the accuracy for determining the absorption coefficient μ and empty pulse rate I_0. If the calibration is to be ended after recording 2 density points, you can click the "Next" button to skip density points 3 and 4 without calibrating or activating them. The Gammapilot FMG50 then ignores these two density points.

The "Calibration date of density point" field provides the user with information on the time the specific calibration value was recorded.

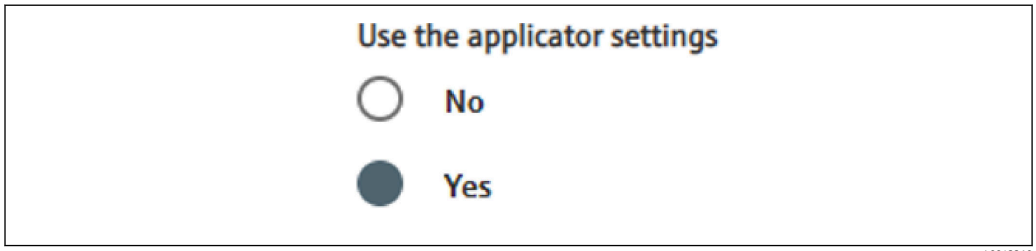


A0042209

In the event of the subsequent calibration of a new density calibration point, a free calibration point can be used and activated or an old measuring point can be overwritten.

One-point calibration

The user can choose from two different ways to perform the one-point density calibration. The choice is made when the user is asked to "Use the Applicator settings"



A0042210

"Use the Applicator settings" = No

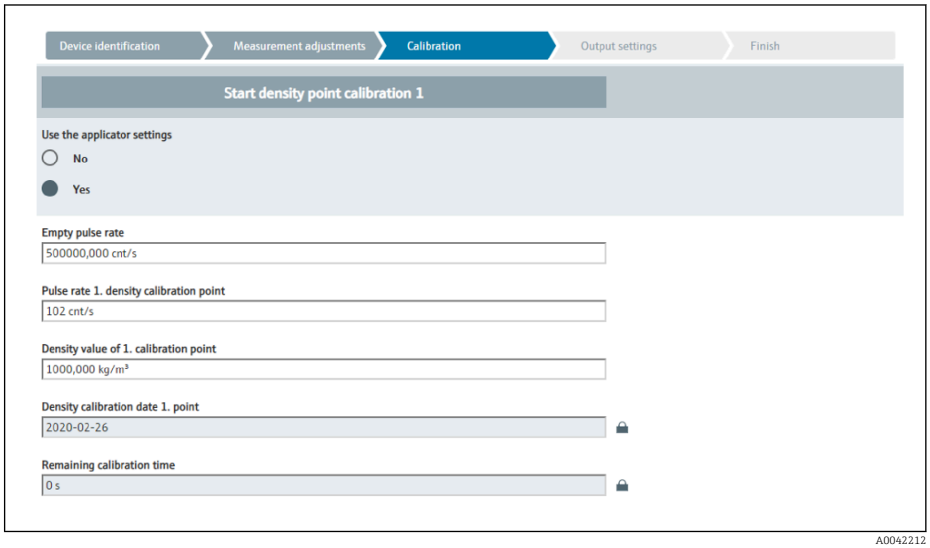
A density point is calibrated and the preset absorption coefficient of 7.7 mm^2/g is used to calculate the density values. Here, it is also possible to enter an absorption coefficient if this application-specific value is known for the measurement.

"Use the Applicator settings" = Yes

The value for the empty pulse rate of the measuring point is calculated in the Endress +Hauser Applicator [4] and entered here. With this patented process, the Gammapilot FMG50 can calculate an absorption coefficient on the basis of the specific geometry of the measuring point and therefore calibrate the density measurement.

Calibration density point 1:

1. The radiation is switched on and the beam path is filled with medium of a known density. The calibration point should be as close as possible to the operating point of the density measurement.
   ↳



A0042212

   The calibration can be performed by pressing the "Start calibration point 1" button. The measurement then starts automatically and continues, at the very maximum, for as long as has been configured for the calibration time. However, the process can also be stopped manually by pressing the "Stop calibration" button.
   The calibration stops automatically as soon as a million pulses have been totalized.
   Alternatively, the pulse rate can also be entered directly.
   For the "Next" button in the Wizard to be enabled, the value must, however, be changed from the start value, at least temporarily.
2. With this calibration point, the density of the medium is entered in the "Density value of calibration point" field.
   ↳ This establishes the reference between the determined pulse rate and the density of the product.
   TIP: it is recommended to take a sample of the medium during the integration and determine its density subsequently (e.g. in the laboratory).
   TIP: it is not necessary to activate the density point as the density point is activated automatically if only one point exists.
   CAUTION: in the "Density" operating mode, it is essential to assign the lower limit value (4 mA) and the upper limit value (20 mA) of the current output to the density.

The following message is displayed following a successful calibration:

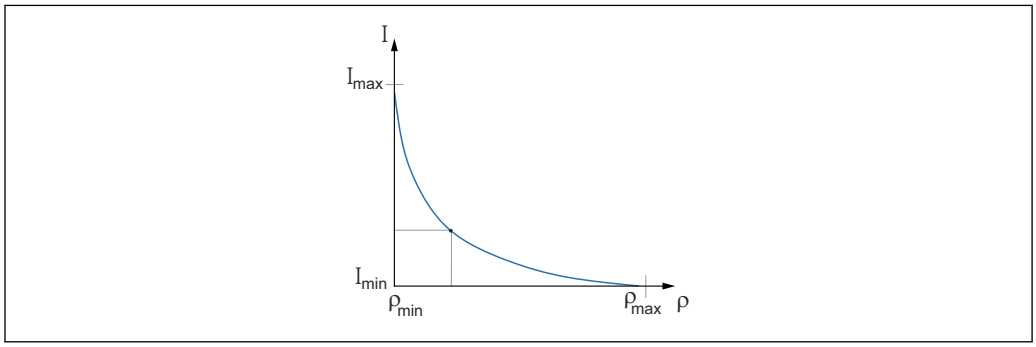
4) The Endress+Hauser Applicator is available online at www.endress.com

A0042213

The settings for the current output are then made in the "Output settings" step

Interface value

In the Gammapilot FMG50, interface measurement is performed by measuring the different densities of two media, such as oil and water. Interface measurement in a calibration is therefore very similar to a multi-point density measurement with two density calibration values.



A0042211

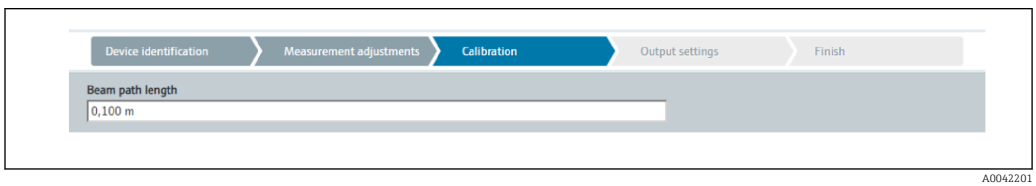
I *Pulse rate*
ρ *Density*
I_{min} *Minimum pulse rate*
$ρ_{min}$ *Minimum density, oil*
I_{max} *Maximum pulse rate*
$ρ_{max}$ *Maximum density, water*

Once the calibration points have been entered, the Gammapilot FMG50 calculates the interface layer in % on its own. Here, 0% corresponds to the minimum density and 100% to the maximum density.

The settings for the current output are then made in the "Output settings" step

Beam path length

The length of the beam path in the medium to be measured is specified here.



A0042201

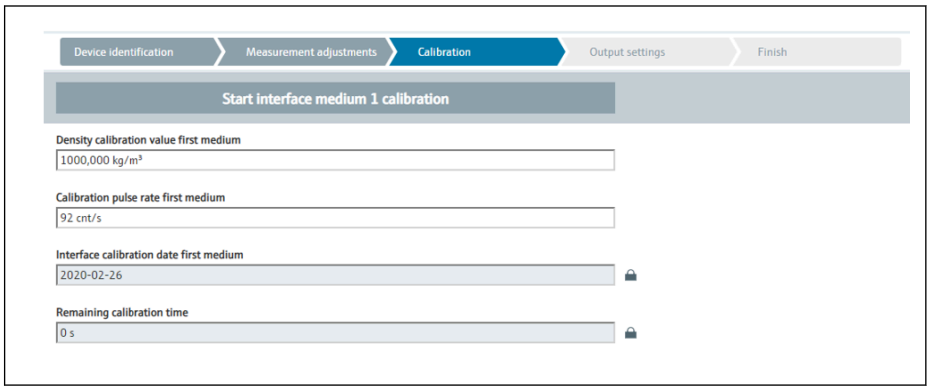
Examples:

If the beam passes through the pipe at an angle of 90°, this value corresponds to the internal pipe diameter. If the beam passes through the pipe at an angle of 30° in order to increase the sensitivity of the measurement, the length of the beam path corresponds to twice the internal pipe diameter.

The unit of length can be defined in the "Measurement settings" section

Calibration of interface medium 1 / 2

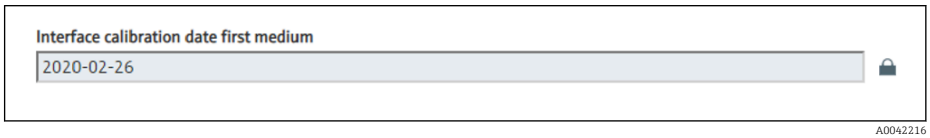
1. The radiation is switched on and the beam path is covered: only with **Medium 1** or only with **Medium 2**



A0042215

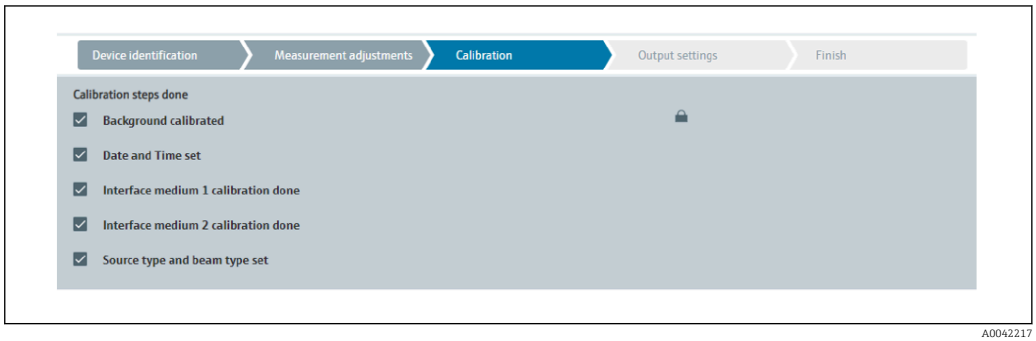
The calibration can be performed by pressing the "Start interface 1st/2nd medium calibration" button. The measurement then starts automatically and continues, at the very maximum, for as long as has been configured for the calibration time. However, the process can also be stopped manually by pressing the "Stop calibration" button.
The calibration stops automatically as soon as a million pulses have been totalized.
Alternatively, the pulse rate can also be entered directly.
For the "Next" button in the Wizard to be enabled, the value must, however, be changed from the start value, at least temporarily.

2. With this calibration point, the density of the medium is entered in the "Density calibration value of 1st/2nd medium" field.
   - This establishes the reference between the determined pulse rate and the density of the medium.
     The "Calibration date of 1st/2nd medium interface" field provides the user with information on the time the calibration value was recorded.



A0042216

The following message is displayed following a successful calibration:



A0042217

The settings for the current output are then made in the "Output settings" step

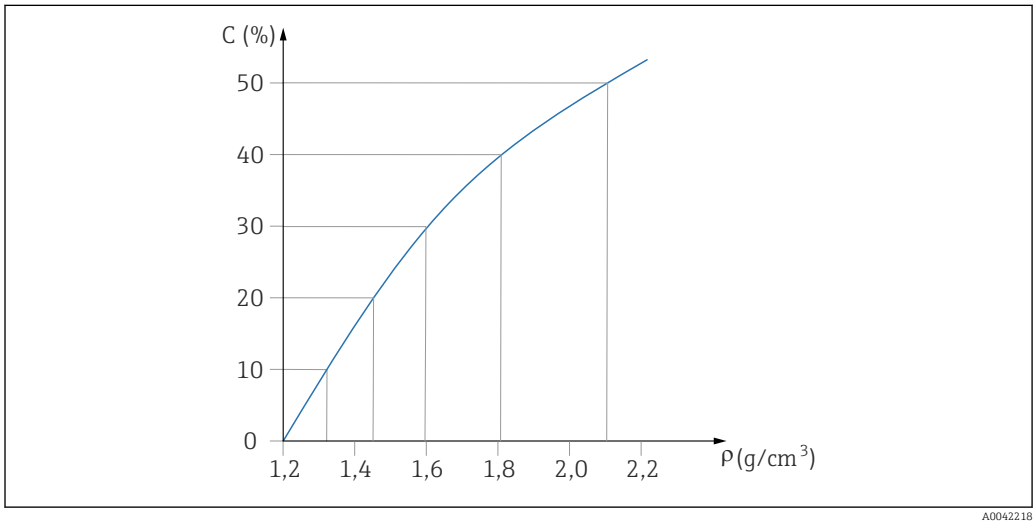
Concentration

In concentration measurements, linearization defines the correlation between the measured density and the concentration.

The concentration measurement is therefore a density measurement with subsequent linearization. The calibration process is identical to density measurement.

Linearization is performed on completion of the density calibration.

Example: take the necessary value pairs from the diagram.



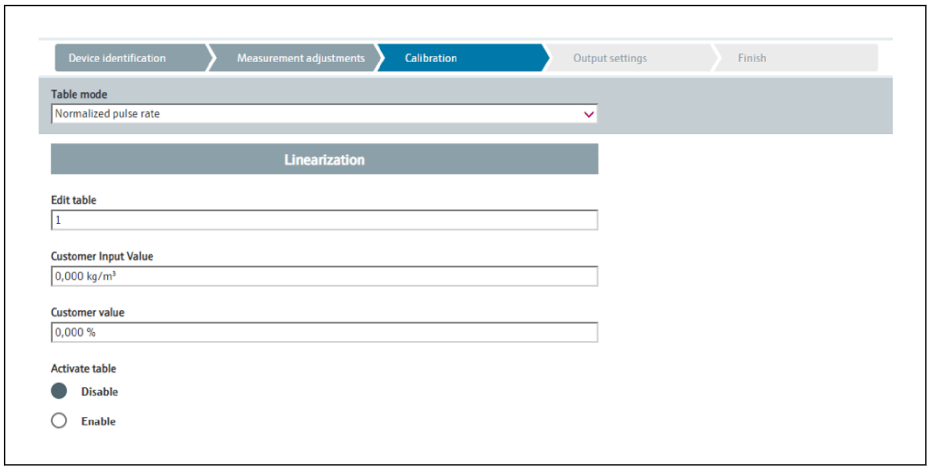
27 *Example of a linearization curve for concentration measurements*

Linearization

Linearization table conditions
- The table can consist of up to 32 "density value : concentration (%)" pairs
- The table must decrease monotonically
  - The first value in the table must correspond to the minimum density value
  - The last value in the table must correspond to the maximum density value

1. Perform density calibration

2. Perform linearization



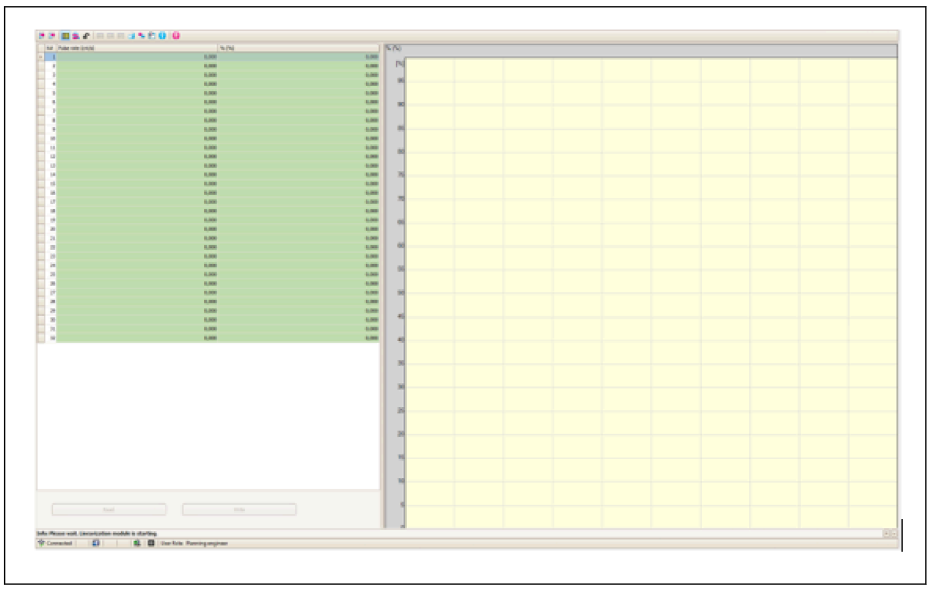
A0042219

The individual linearization values are entered via the input screen or via a separate linearization module.
The linearization table consists of up to 32 "density value : concentration (%)" value pairs.

3. The table values can be sorted as monotonically decreasing using the "Table mode -> Sort table" function.

Edit table: the index of the linearization point is entered in this field (1-32 points)
Customer input value: enter the customer density
Customer value: level in unit of length, volume unit or %.
Activate table: the "Enable" option must first be selected before the linearization table is used. The linearization table is not used as long as "Disable" is selected.

4. The linearization table can also be entered manually in the linearization module. This is started by selecting the "Linearization" button:



A0042194

The normalized pulse rate and the customer value can be entered directly in table form in this module.
The linearization table must be activated by selecting "Activate table" = Enable
TIP: if the density adjustment is already completed in the Wizard, it is no longer displayed. The operating mode must be temporarily set to "Density" in the Wizard to be able to perform the density adjustment again or to recalibrate.

5. The calibration has been performed successfully.

A0042220

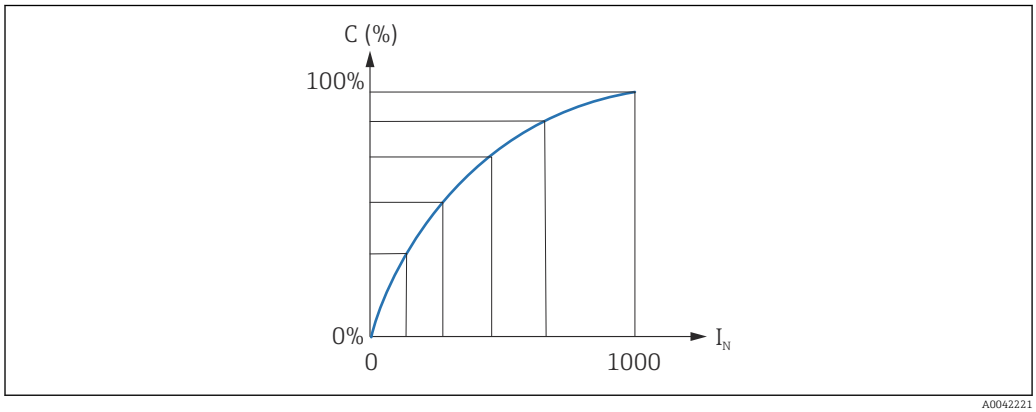
6. The settings for the current output are then made in the "Output settings" step

Concentration of radiating media

For concentration measurement in radiating media (e.g.: K40), the Gammapilot FMG50 requires at least two other calibration points in addition to the background calibration:
- Pulse rate at high concentration of radiating medium
- Pulse rate at low concentration of radiating medium

The linearization defines the correlation between the measured pulse rate and the concentration of the radiating medium (0 to 100%).

The Gammapilot FMG50 makes a variety of linearization modes available:
- Linear assignment of the pulse rate to the concentration
- Entry of any linearization table adapted to the specific application.
  - The linearization table consists of up to 32 "normalized pulse rate : concentration" value pairs
  - The linearization table must be monotonic increasing, i.e. a higher concentration must always be paired with a higher pulse rate.



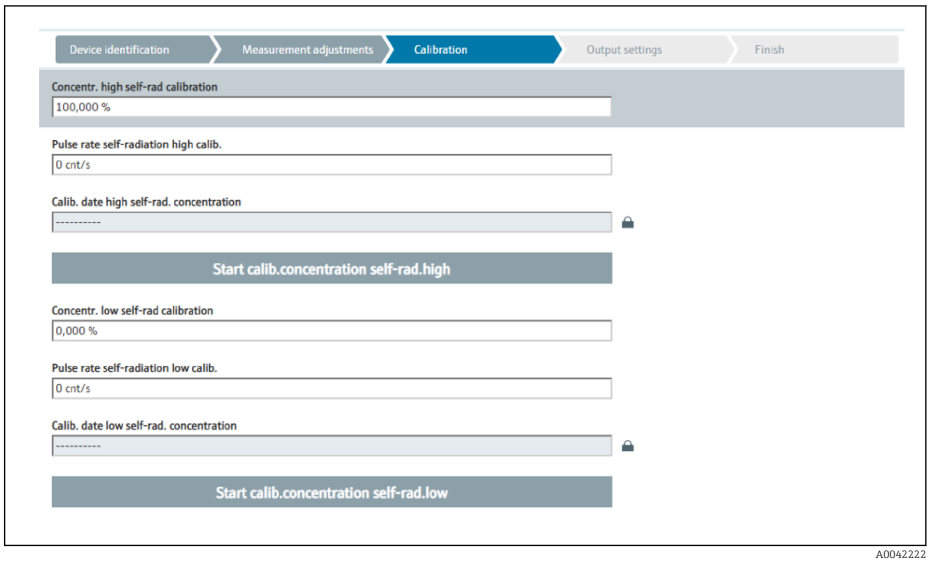
A0042221

28 Example of a linearization curve for measurements of the concentration of radiating media

C Concentration of radiating media
I_N Normalized pulse rate

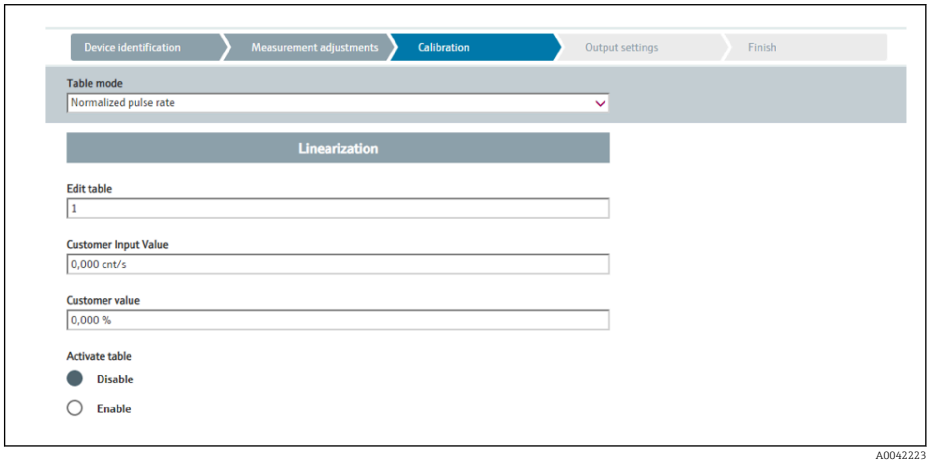
1. Selection of the type of linearization (already selected in the "Measurement settings" section)

2. **Selection:** start with a high concentration of the radiating medium or start with a low concentration of the radiating medium
   ↳ Start calibration -> the calibration can be stopped once the pulse rate has stabilized.



A0042222

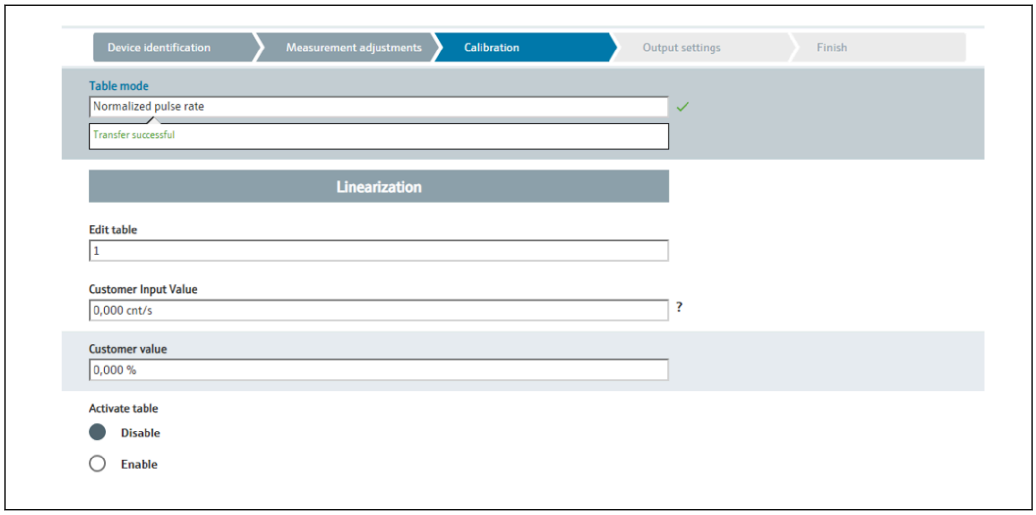
3. Calibration with high concentration
   ↳ Press the "Calibration conc. self-rad. high" button
4. Calibration with low concentration
   ↳ Press the "Calibration conc. self-rad. low" button
5. The measurement then starts automatically and continues, at the very maximum, for as long as has been configured for the calibration time.
   ↳ However, the process can also be stopped manually by pressing the "Stop calibration" button.
   The calibration stops automatically as soon as a million pulses have been totalized.
6. Entry for each calibration point: enter the concentration of the medium in the "Calibration conc. self-rad. high" and "Calibration conc. self-rad. low" field
   ↳ This establishes the reference between the determined pulse rate and the concentration of the radiating medium.
   TIP: take a sample of the medium during the integration and then determine the concentration (e.g. in the laboratory)
7. If a customized table has been selected for the linearization, the following input screen appears:
   ↳



A0042223

The procedure varies depending on the type of table that is selected.
- For the "Normalized pulse rate" type of table
- For the "Semi-automatic" type of table

Normalized pulse rate



A0042183

N	C	I	I_N
1	100	2431	1000
2	92	1935	792
3	83	1283	519
4	65	642	250
5	35	231	77
6	0	46	0

Normalized pulse rate

Note that the normalized pulse rate is entered in the linearization table. The normalized pulse rate is not identical to the pulse rate actually measured. The correlation between these two variables is defined by:

$I_N = (I - I_0) / (I_{MAX} - I_0) \times 1000$

Where:
- I_0 is the minimum pulse rate (i.e. the pulse rate for full calibration)
- I_{MAX} is the maximum pulse rate (i.e. the pulse rate for empty calibration)
- I: the measured pulse rate
- I_N: the normalized pulse rate

The normalized pulse rate is used because it does not depend on the activity of the radiation source used:
- For L = 0 % (empty vessel), I_N always = 1000
- For L = 100 % (full vessel), I_N always = 0

The individual linearization values can be entered via the input screen or via a separate linearization module. The linearization table consists of up to 32 "normalized pulse rate : concentration" value pairs.

Linearization table conditions
- The table can consist of up to 32 "concentration - linearized value" pairs.
- The table must decrease monotonically
  - The first value in the table must correspond to the minimum concentration
  - The last value in the table must correspond to the maximum concentration

The table values can be sorted as monotonically increasing using the "Table mode -> Sort table" function.

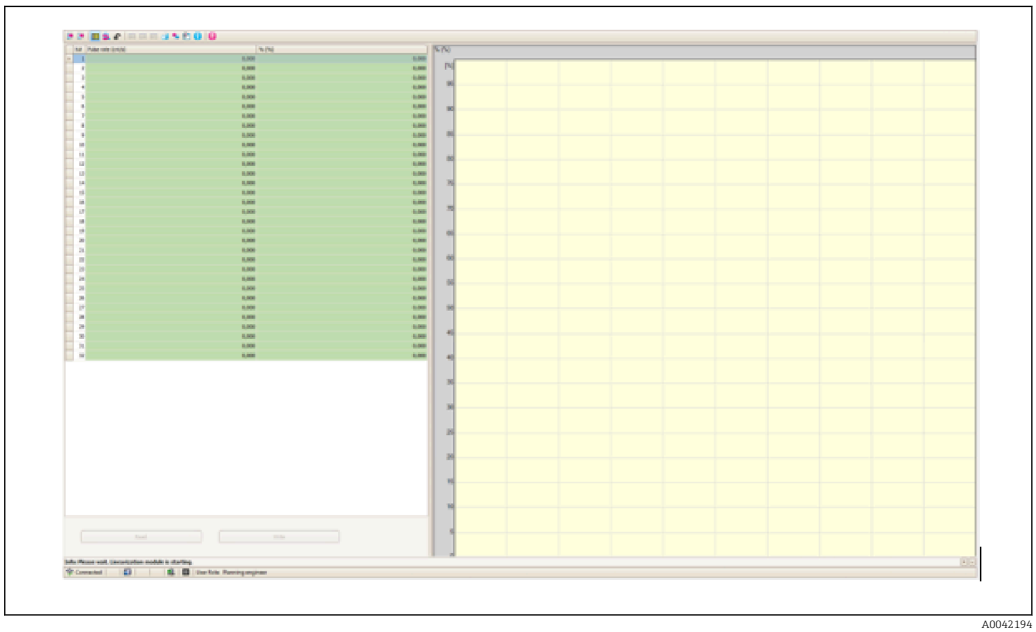
Edit table: the index of the linearization point is entered in this field (1-32 points)

Customer input value: enter the normalized pulse rate

Customer value: concentration in %.

Activate table: the "Enable" option must first be selected before the linearization table is used. The linearization table is not used as long as "Disable" is selected.

The linearization table can also be entered manually in the linearization module. This is started by selecting the "Linearization" button:

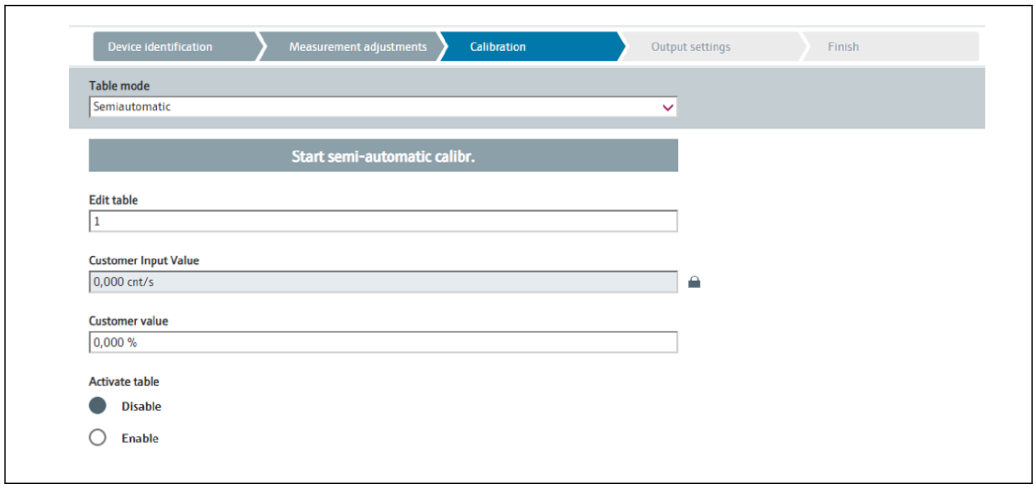


A0042194

The normalized pulse rate and the customer value can be entered directly in table form in this module.

The linearization table must be activated by selecting "Activate table" -> "Enable"

Semi-automatic



A0042195

During semi-automatic linearization, the device measures the concentration for every table point. The associated linearized value is entered manually. The individual linearization values are entered via the input screen. The linearization table consists of up to 32 "measured pulse rate : concentration" value pairs.

Linearization table conditions
- The table can consist of up to 32 "concentration - linearized value" pairs.
- The table must increase monotonically
  - The first value in the table must correspond to the minimum concentration
  - The last value in the table must correspond to the maximum concentration

The table values can be sorted as monotonically increasing using the "Table mode -> Sort table" function.

Edit table: the index of the linearization point is entered in this field (1-32 points)

Customer input value: measured pulse rate for the linearization point

Customer value: concentration in %.

Activate table: the "Enable" option must first be selected before the linearization table is used. The linearization table is not used as long as "Disable" is selected.

To record a new input value, press the "Start semi-automatic calibration" button. The measurement then starts automatically and continues, at the very maximum, for as long as has been configured for the calibration time. However, the process can also be stopped manually by pressing the "Stop calibration" button.

The calibration stops automatically as soon as a million pulses have been totalized.

The remaining calibration time of the semi-automatic calibration is not displayed on the user interface.

The linearization table must be activated by selecting "Activate table" -> "Enable"

Use of the linearization module with linearization values recorded semi-automatically

Please note the following if using the linearization module with linearization tables recorded semi-automatically:

The module assumes pulse rates are normalized and automatically switches the internal measurement calculation to normalized values if the module is used. This falsifies the assignment between the output value and the measured value. If the linearization module has been opened with semi-automatic linearization curves, the table mode must be set to "semi-automatic" again.

Note: the linearization can calculate an incorrect value if the wrong table mode is used. The current output will also output an incorrect measured value in this case.

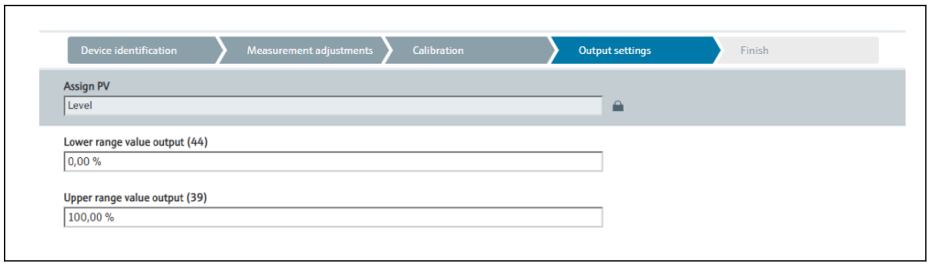
The following message is displayed following a successful calibration:

A0042225

The settings for the current output are made after the calibration of the operating mode in the "Output settings" step

Settings of the current output

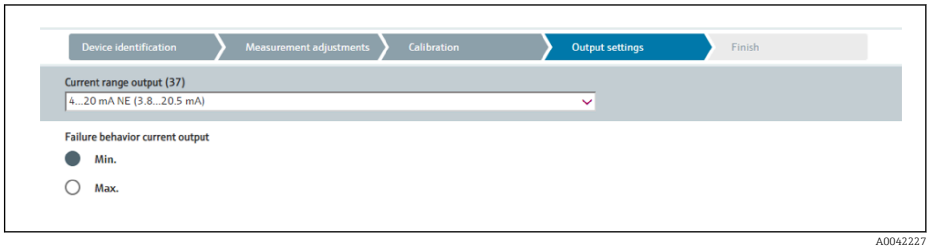
1. Set the lower limit value (4 mA) and the upper limit value (20 mA) of the current output to the desired values of the primary measured value



A0042226

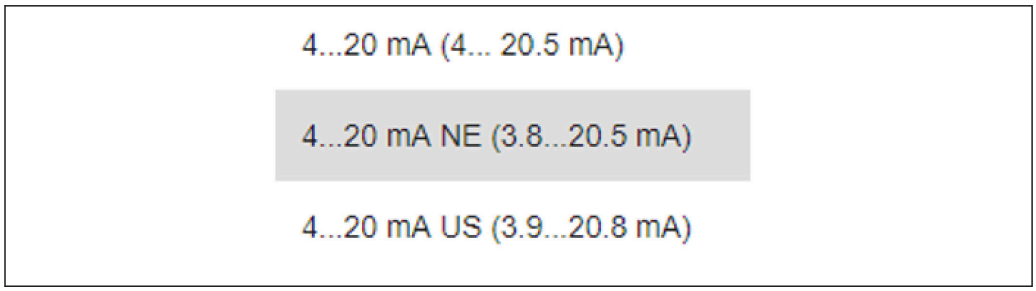
These values can be used for a zoom function or to invert the measured value to the current value.

2. The control range of the current output can be modified



A0042227

The measuring range of the current output can be defined as:



A0042228

The failure current behavior can be defined as a min or max alarm.
- Min alarm is defined with < 3.6 mA
- Max alarm is defined with > 21.5 mA

- Both alarm conditions are guaranteed over the entire temperature range and under the influence of EMC interferences
- If max alarm current has been selected as the failure current, the current value can be adjusted between 21.5 to 23 V
  The setting is made via the operating menu:
  Application -> Current output -> Failure current
- In the case of the min alarm settings, there may not be sufficient energy to power the display lighting and the Bluetooth function. To guarantee the measurement function, the display lighting/Bluetooth functions may be disabled and enabled again once sufficient power is available.

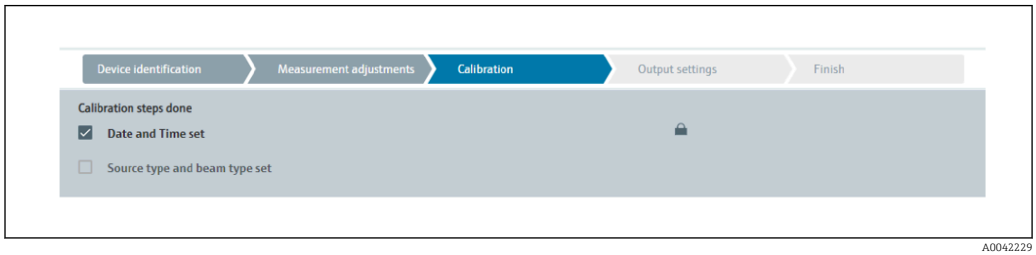
The calibration of the Gammapilot FMG50 is completed.

10.2.5 Slave mode

The slave mode can be used if the measured raw pulse rate is to be processed by a downstream evaluation unit (e.g. a controller) and not by the Gammapilot FMG50.

In this operating mode, the Gammapilot FMG50 transmits the raw pulse rate in cnt/125 ms as the primary value.

No other settings must be made once the "Slave mode" has been selected. Commissioning is concluded immediately.



A0042229

The current output is automatically assigned linearly:
- 4 mA = 0 cnt/125 ms
- 20 mA = 1000 cnt/125 ms

The use of a gamma modulator FHG65 cannot be configured in the "Slave" operating mode.

If the use of a gamma modulator FHG65 is required, please contact Endress+Hauser Service.

10.3 Commissioning via SmartBlue app

10.3.1 Prerequisites

Device requirements
Commissioning via SmartBlue is only possible if the device has a Bluetooth module.

SmartBlue system requirements
SmartBlue is available as a download from the Google Play Store for Android devices and from the iTunes Store for iOS devices.
- Devices with iOS:
  iPhone 4S or higher from iOS9.0; iPad2 or higher from iOS9.0; iPod Touch 5th generation or higher from iOS9.0
- Devices with Android:
  From Android 4.4 KitKat and *Bluetooth*® 4.0

Initial password
The serial number of the device is used as the initial password when establishing the connection for the first time. The serial number can be found on the nameplate.

10.3.2 SmartBlue app

1. Scan the QR code or enter "SmartBlue" in the search field of the App Store.
   ↳

29 Download link

2. Start SmartBlue.
3. Select device from livelist displayed.
4. Enter the login data:
   ↳ User name: admin
   Password: serial number of the device or ID number of the Bluetooth display
5. Tap the icons for more information.

For commissioning, see the "Commissioning Wizard" section

Change the password after logging in for the first time!

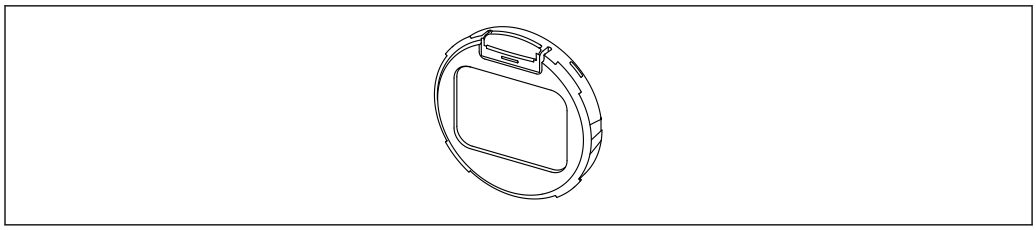
Bluetooth is not available in all markets.

Please pay attention to the radio approvals listed in document SD02402F or contact the Endress+Hauser sales organization.

10.3.3 Operation via Bluetooth® wireless technology

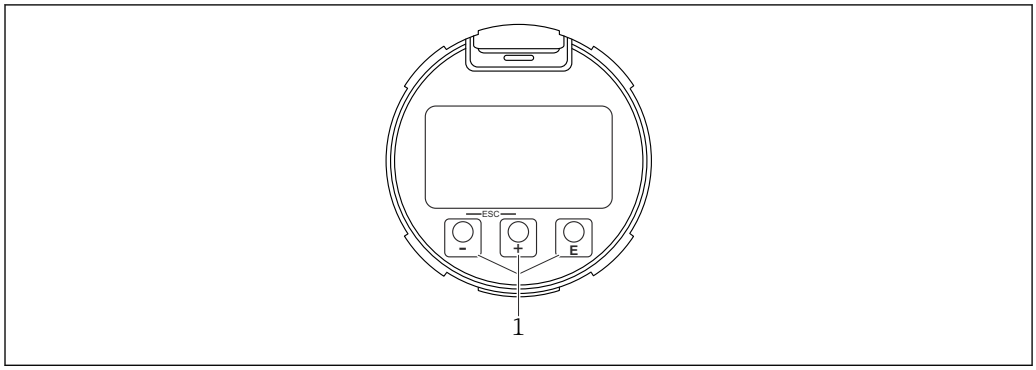
Prerequisites

Optional, only for devices with a Bluetooth-enabled display:
- **Feature 030 "Display, operation", option D "Segment display without keys + Bluetooth"**
- **Feature 030 "Display, operation", option F "Graphic display with keys + Bluetooth"**



A0039243

30 Display with Bluetooth module



A0039284

31 Graphic display with optical operating keys (1)

- ⊞ key
  - Navigate downwards in the selection list
  - Edit the numerical values and characters within a function
- ⊟ key
  - Navigate upwards in the selection list
  - Edit the numerical values and characters within a function
- Ⓔ key
  - Change from main display to main menu
  - Confirm entry
  - Jump to the next item
  - Selection of a menu item and activation of edit mode
  - Unlock/lock the display operation
  - Press and hold the Ⓔ key to display a short description of the selected parameter (if available)
- ⊞ key and ⊟ key (ESC function)
  - Exit edit mode for a parameter without saving the changed value
  - Menu at a selection level: pressing the keys simultaneously takes the user back up a level in the menu
  - Press and hold the keys simultaneously to return to the upper level

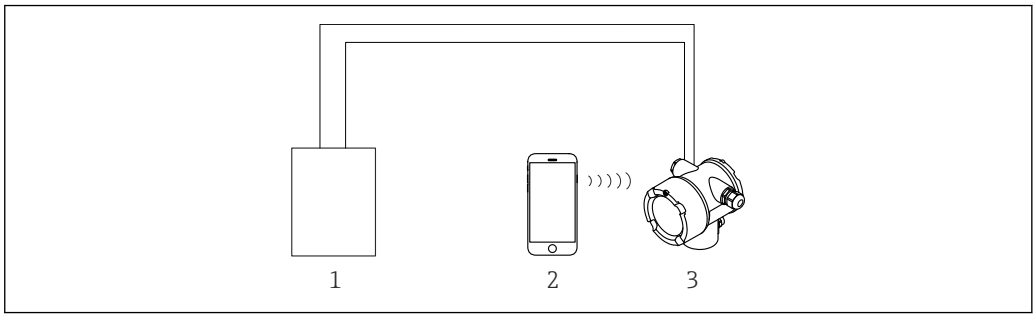
A flashing Bluetooth symbol indicates that a Bluetooth connection is available

Bluetooth communication with the device is possible with a supply voltage of 12 V or higher. The background lighting of the display is only guaranteed with a supply voltage ≥ 15 V. The measurement function is guaranteed as of a terminal voltage of 10.5 V; Bluetooth communication with the device is not possible with this voltage level, however.

If the available supply voltage drops below the aforementioned thresholds during operation, the background lighting switches off first before the Bluetooth function is switched off in order to guarantee the measurement function. A corresponding warning message is not displayed. These functions are reactivated when sufficient power is supplied.

If the available supply voltage was already too low when the device was started, these functions will not be activated later.

Operation via the SmartBlue app

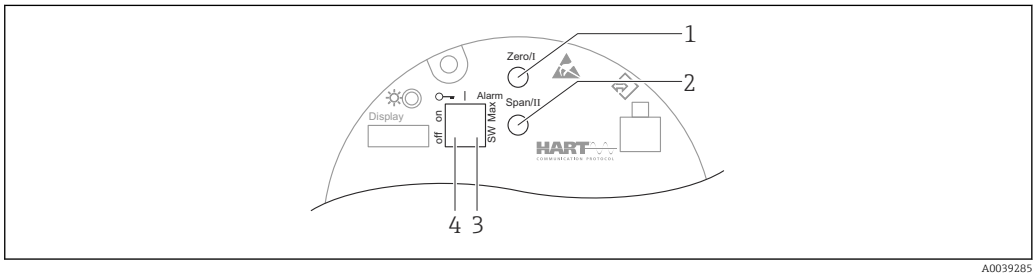


32 *Operation via the SmartBlue app*

1 *Transmitter power supply unit*
2 *Smartphone/tablet with SmartBlue App*
3 *Transmitter with Bluetooth module*

10.4 Commissioning via on-site operation

The device can also be operated on site using the keys. If operation is locked using the DIP switches on site, parameter entry via communication is not possible.



1 *Operating key for empty calibration (function I)*
2 *Operating key for full calibration (function II)*
3 *DIP switch for alarm current (SW-defined / Min alarm)*
4 *DIP switch for locking and unlocking the measuring device*

- **Empty calibration:** press and hold the operating key for empty calibration (I) > 3 s
- **Full calibration:** press and hold the operating key for full calibration (II) > 3 s
- **Background calibration:** simultaneously press and hold the operating key for empty calibration (I) and the operating key for full calibration (II) > 3 s
- **Reset to factory defaults:** simultaneously press and hold the operating key for empty calibration (I) and full calibration (II) > 12 s. The LED starts flashing. When the flashing stops, the device is reset to the factory default settings.

10.4.1 Level basic calibration

Calibration time per calibration: **5 min!**

1. Reset
   ↳ Press both keys > 12 s
2. Start background calibration
   ↳ Press both keys > 3 s
   The green LED is lit for one second and starts flashing at an interval of 2 s
3. Start empty calibration
   ↳ Press the "Zero / 1" key > 3 s
   The green LED is lit for one second and starts flashing at an interval of 2 s
   Wait 5 min until the green LED stops flashing

4. Start full calibration
   ↳ Press the "Span / 2" key > 3 s
   The green LED is lit for one second and starts flashing at an interval of 2 s
   Wait 5 min until the green LED stops flashing

A reset deletes all calibrations!

10.4.2 Status and power LED

A green LED that signals the status and button activation feedback is provided on the electronic insert.

Behavior of the LED
- The LED flashes once briefly when the measuring device is started
- When a key is pressed, the LED flashes to confirm the key activation
- When a reset is performed, the LED flashes as long as both keys are pressed and the reset is not yet active (countdown). The LED stops flashing once the reset is active.
- The LED flashes while calibration is being performed via onsite operation

10.5 Commissioning of density compensation with RSG45 (gamma computer)

Level measurement: FMG50 with Memograph M RSG45 and gas density information.

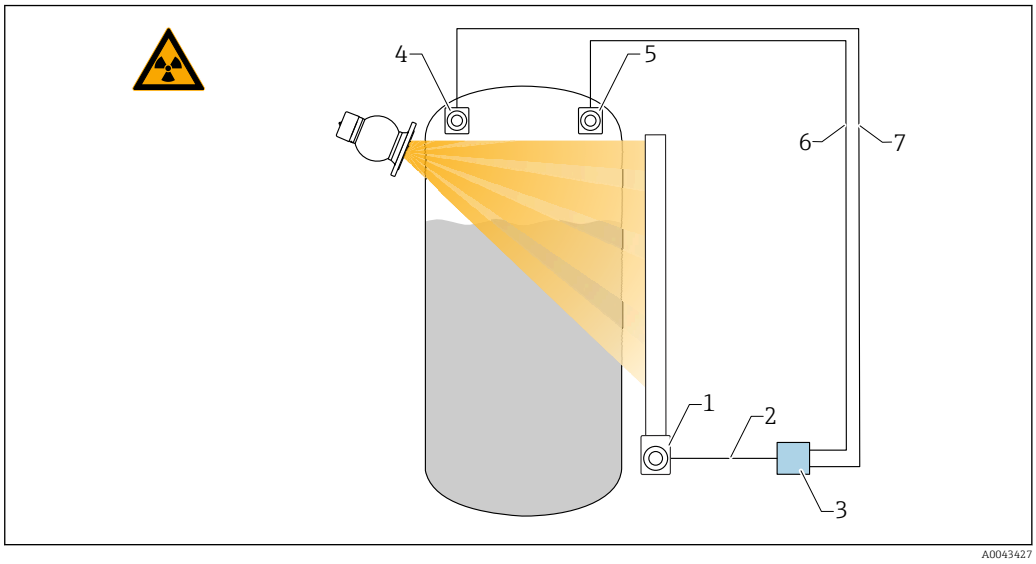
In the vessel containing the medium to be measured, the gas phase is above the medium. The gas phase also absorbs gamma radiation in the process, although to a significantly less extent than the medium. This absorption is factored into the calculations and offset during the calibration.

In processes with a fluctuating gas density however, compensation of the level measurement is recommended. Here, the level signal is calculated with the variable gas density value and compensated accordingly.

10.5.1 Scenario 1: density compensation via temperature and pressure measurement

The gas density is calculated depending on the pressure and temperature

Measuring system arrangement



33 *Connection example: RSG45 (scenario 1)*

1 *FMG50 (level)*
2 *HART channel 2 (level)*
3 *RSG45*
4 *Pressure measuring cell*
5 *Temperature sensor*
6 *HART channel 4 (temperature)*
7 *HART channel 3 (absolute pressure)*

Connection of HART channels of the RSG45

Channel 2: FMG50 level measurement

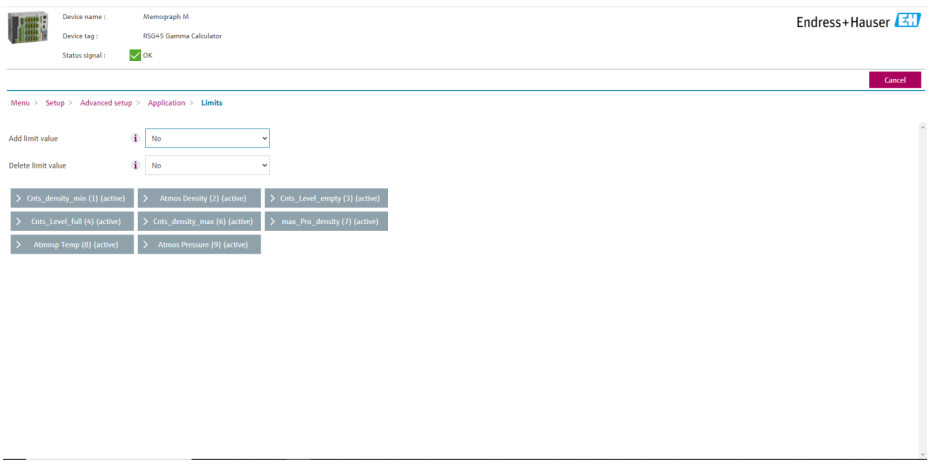
Channel 3: absolute pressure measurement

Channel 4: temperature measurement

Configuring RSG45

Setting or deleting the limit values

1. Navigate to limit values: "Setup -> Extended setup -> Application -> Limit values"



2. Enter the limit values

- FMG50 (density measurement), channel 1
  - **Cnts_density_min:** pulse rate (pulses per second, cnt/s) of the FMG50 (density) at atmospheric conditions (environment)
  - **Atmos Density:** atmospheric density (environment)
  - **Cnts_density_max:** pulse rate (pulses per second, cnt/s) of the FMG50 (density) at maximum process density
  - **max_Pro_density:** maximum process density
- FMG50 (level measurement), channel 2
  - **Cnts_Level_empty:** pulse rate (pulses per second, cnt/s) at 0 % level
  - **Cnts_Level_full:** pulse rate (pulses per second, cnt/s) at 100 % level
- Pressure measurement, channel 3
  Atmos Pressure: atmospheric pressure (reference)
- Temperature measurement, channel 4
  Atmos Temp: atmosphere temperature (reference)

Setting mathematical functions and linearization table

Display as percentage

1. In the Expert menu, navigate to the linearization table: Expert → Application → Mathematics → Level → Linearization

2. Enter value pairs in the linearization table. A value pair consists of a percentage value and the associated pulse rate (pulses per second, cnt/s).
   ↳ The linearized measured value is shown as a percentage.

The linearization table consists of up to 32 value pairs.

Enter as many value pairs as possible to maximize accuracy.

Setting sensors and channels

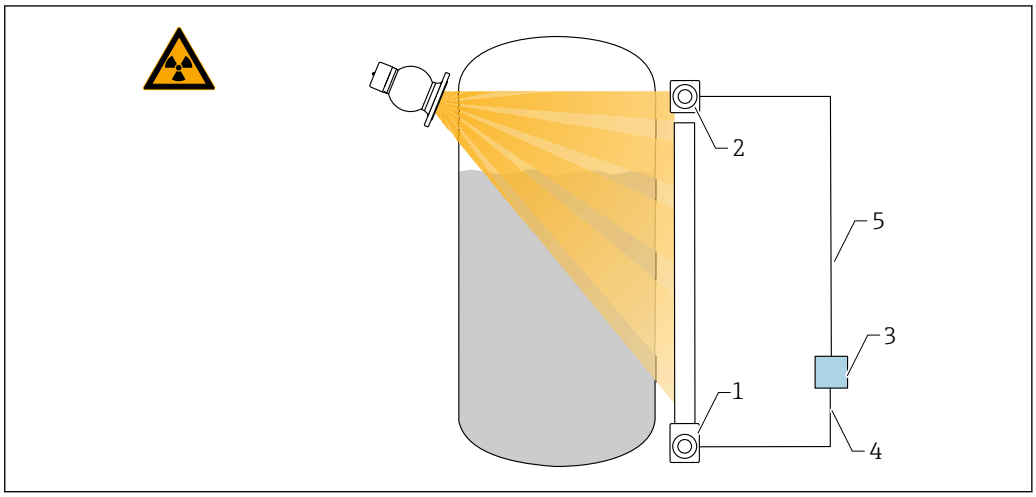
Channel 2:
FMG50 level measurement (HART output)
- PV: level (%)
- SV: pulse rate (pulses per second, cnt/s)

Channel 3:
Pressure measurement (HART output)
PV: absolute pressure (bar)

Channel 4:
Temperature measurement (HART output)
PV: temperature (K)

10.5.2 Scenario 2: density compensation via FMG50 gas density measurement

Measuring system arrangement



34 *Connection example: RSG45 (scenario 2)*

1 *FMG50 (level)*
2 *FMG50 (density)*
3 *RSG45*
4 *HART channel 2 (level)*
5 *HART channel 1 (density)*

Connection of HART channels of the RSG45

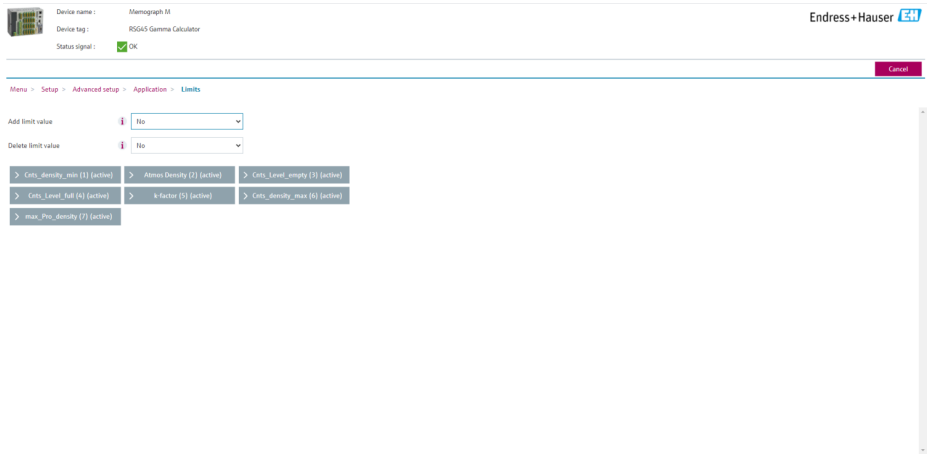
Channel 1: FMG50 density measurement

Channel 2: FMG50 level measurement

Configuring RSG45

Setting or deleting the limit values

1. Navigate to limit values: "Setup -> Extended setup -> Application -> Limit values"



2. Enter the limit values

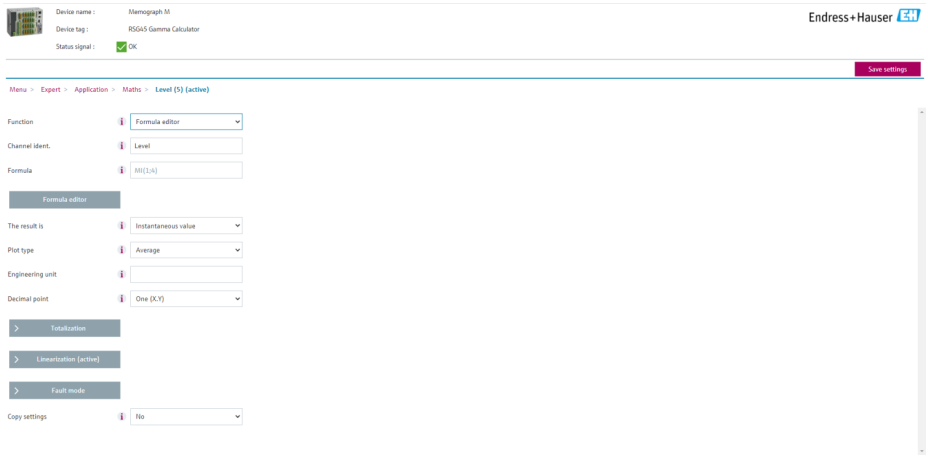
- FMG50 (density measurement), channel 1
  - **Cnts_density_min:** pulse rate (pulses per second, cnt/s) of the FMG50 (density) at atmospheric conditions (environment)
  - **Atmos Density:** atmospheric density (environment)
  - **Cnts_density_max:** pulse rate (pulses per second, cnt/s) of the FMG50 (density) at maximum process density
  - **max_Pro_density:** maximum process density
  - **K-factor =** ln (pulse rate$_{vapor}$ / pulse rate$_{atm}$) / (ρ_{vapor} - ρ_{atm})
- FMG50 (level measurement), channel 2
  - **Cnts_Level_empty:** pulse rate (pulses per second, cnt/s) at 0 % level
  - **Cnts_Level_full:** pulse rate (pulses per second, cnt/s) at 100 % level

Calculate the K-factor during commissioning and enter into the RSG45.

Setting mathematical functions and linearization table

Display as percentage

1. In the Expert menu, navigate to the linearization table: Expert → Application → Mathematics → Level → Linearization



2. Enter value pairs in the linearization table. A value pair consists of a percentage value and the associated pulse rate (pulses per second, cnt/s).
   → The linearized measured value is shown as a percentage.

The linearization table consists of up to 32 value pairs.

Enter as many value pairs as possible to maximize accuracy.

Setting sensors and channels

Channel 1:
FMG50 density measurement (HART output)
- PV: density (kg/m3)
- SV: pulse rate (pulses per second, cnt/s)

Channel 2:
FMG50 level measurement (HART output)
- PV: level (%)
- SV: pulse rate (pulses per second, cnt/s)

10.6 Operation and settings via RIA15

See the RIA15 Operating Instructions, BA01170K

10.7 Data access - Security

10.7.1 Locking via password in FieldCare / DeviceCare / SmartBlue

The Gammapilot FMG50 can be locked and unlocked via a password (see the "Software locking" section)

10.7.2 Hardware locking

The Gammapilot FMG50 can be locked and unlocked via a switch on the main unit. Hardware locking can only be unlocked via the main unit (flip the switch). It is not possible to unlock the hardware by communication.

10.7.3 Bluetooth® wireless technology (optional)

Signal transmission via Bluetooth® wireless technology uses a cryptographic technique tested by the Fraunhofer Institute

- The device is not visible via *Bluetooth*® wireless technology without the SmartBlue App.
- Only one point-to-point connection between **one** sensor and **one** smartphone or tablet is established.
- The *Bluetooth*® wireless technology interface can be deactivated via SmartBlue, FieldCare or DeviceCare.
- The *Bluetooth*® wireless technology interface can be reactivated via FieldCare or DeviceCare.
- It is not possible to reactivate the *Bluetooth*® wireless technology interface via the SmartBlue App.

10.7.4 RIA15 locking

The device setup can be locked with a 4-digit user code

Additional information is available in the Operating Instructions for the RIA15

10.8 Overview of the operating menu

A complete overview of the operating menu is provided in the "Description of Device Parameters" documentation.

GP01141F

11 Diagnostics and troubleshooting

11.1 System error messages

11.1.1 Error signal

Errors occurring during commissioning or operation are signaled in the following way:

- Error symbol, display color, error code and error description on the display and operating module.
- Current output, customizable:
  - MAX, 110 %, 22 mA
  - MIN, -10 %, 3.6 mA

Default setting: MIN, -10 %, 3.6 mA

The max. alarm current can be configured in the 21.5 to 23.0 mA range. The default value is 22.5 mA.

11.1.2 Types of error

- Error-free operation: display is lit green
- Alarm or warning: display is lit red
- Alarm: the output current adopts a value that has been defined beforehand. An error message is displayed
  - MAX, 110 %, 22 mA
  - MIN, -10 %, 3.8 mA
- Warning: the device continues to measure. An error message is displayed (alternating with the measured value).

Error indication via a display color change only works if the operating voltage is not below 15 V.

11.2 Possible calibration errors

Error	Possible causes	Remedial action
Pulse rate too low with empty vessel	Radiation source switched off	Switch on the radiation source at the source container
	Incorrect alignment of source container	Realign angle of emission
	Buildup in the vessel	Clean vessel or Recalibrate (if buildup is stable)
	Fittings in the vessel have not been considered in the activity calculation	Recalculate activity and change radiation source if required
	Pressure in the vessel has not been considered in the activity calculation	Recalculate activity and change radiation source if required
	No radiation source in the source container	Load radiation source
	Radiation source too weak	Use radiation source with higher activity
	If a modulator is used	Modulator is not mounted correctly
		Modulator is not in operation
		Radiation is not set to modulated

Error	Possible causes	Remedial action
	If a collimator is used	Incorrect alignment of radiation entry window
Pulse rate too high with empty vessel	Activity too high	Attenuate radiation, e.g. by mounting a steel plate in front of the source container; or replace radiation source.
	External radiation sources may be present (e.g. due to gammagraphy)	Shield them if possible and repeat the calibration without the external radiation source.
Pulse rate too high with full vessel	External radiation sources may be present (e.g. due to gammagraphy)	Shield them if possible and repeat the calibration without the external radiation source.

11.3 Diagnostic event

11.3.1 Diagnostic event in the operating tool

If a diagnostic event is present in the device, the status signal appears in the top left status area of the operating tool along with the corresponding symbol for the event level in accordance with NAMUR NE 107:

- Failure (F)
- Function check (C)
- Out of specification (S)
- Maintenance required (M)

- Error-free operation: display is lit green
- Alarm or warning: display is lit red

Calling up remedial measures

▶ Navigate to the **Diagnostics** menu
↳ In the **Actual diagnostics** parameter the diagnostic event is shown with event text

11.3.2 List of diagnostic events in the operating tool

Diagnostic number	Short text	Remedy instructions	Status signal [from the factory]	Diagnostic behavior [from the factory]
Diagnostic of sensor				
007	Sensor defective	Replace sensor electronics	F	Alarm
008	Sensor defective	1. Restart device 2. Contact service	F	Alarm
062	Sensor connection faulty	Check sensor connection	F	Alarm
064	Pulse rate out of range	1. Check process conditions 2. Check environmental conditions 3. Replace device	C	Warning
082	Data storage inconsistent	1. Check Data Unit 2. Contact service	F	Alarm
Diagnostic of electronic				
242	Firmware incompatible	1. Check software 2. Flash or change main electronic module	F	Alarm

Diagnostic number	Short text	Remedy instructions	Status signal [from the factory]	Diagnostic behavior [from the factory]
252	Module incompatible	1. Check if correct electronic modul is plugged 2. Replace electronic module	F	Alarm
270	Main electronics defective	Replace main electronics	F	Alarm
272	Main electronics faulty	1. Restart device 2. Contact service	F	Alarm
273	Main electronics defective	1. Emergency operation via display 2. Change main electronics	F	Alarm
282	Data storage inconsistent	1. Restart device 2. Contact service	F	Alarm
283	Memory content inconsistent	1. Transfer data or reset device 2. Contact service	F	Alarm
287	Memory content inconsistent	1. Restart device 2. Contact service	M	Warning
311	Electronic failure	Maintenance required! 1. Do not perform reset 2. Contact service	M	Warning
Diagnostic of configuration				
410	Data transfer failed	1. Check connection 2. Retry data transfer	F	Alarm
412	Processing download	Download active, please wait	C	Warning
431	Trim required	Carry out trim	C	Warning
434	Real time clock defective	Replace sensor electronics	C	Alarm
435	Linearization faulty	Check linearization table	F	Alarm
436	Date/time incorrect	Check date and time settings.	M	Alarm
437	Configuration incompatible	1. Restart device 2. Contact service	F	Alarm
438	Dataset different	1. Check data set file 2. Check device configuration 3. Up- and download new configuration	M	Warning
440	Device not calibrated	Calibrate device	F	Alarm
441	Current output out of range	1. Check process 2. Check current output settings	S	Warning
484	Failure mode simulation active	Deactivate simulation	C	Alarm
490	Output simulation	Deactivate simulation	C	Warning
491	Current output 1 simulation active	Deactivate simulation	C	Warning
495	Diagnostic event simulation active	Deactivate simulation	C	Warning
538	Configuration Sensor Unit invalid	1. Check sensor configuration 2. Check device configuration	M	Alarm
544	Background not calibrated	Background not calibrated	C	Warning
586	Calibration active	Recording pulse rate	M	Alarm
593	Simulation pulse rate active	Deactivate simulation	C	Warning

Diagnostic number	Short text	Remedy instructions	Status signal [from the factory]	Diagnostic behavior [from the factory]
Diagnostic of process				
801	Supply voltage too low	Increase supply voltage	F	Alarm
802	Supply voltage too high	Decrease supply voltage	S	Warning
803	Loop current faulty	1. Check wiring 2. Replace electronics	M	Warning
805	Loop current faulty	1. Check wiring 2. Replace electronics	F	Alarm
825	Operating temperature	1. Check ambient temperature 2. Check process temperature	S	Warning
826	Sensor temperature out of range	1. Check ambient temperature 2. Check process temperature	S	Warning
927	Overexposure detected	Please check source	C	Alarm
955	Gammagraphy detected	Gammagraphy detected	C	Warning [1]
956	Evaluation plateau curve	Evaluation plateau curve	M	Warning

1) Diagnostic behavior can be changed.

Diagnostic number C064:

The error can be triggered by either too much or too little radiation.

Contact the Endress+Hauser Service department before replacing the device.

Diagnostic number F825:

The diagnostic behavior can either be alarm or warning depending on the sensor version.

- In the case of NaI (Tl) scintillators, the diagnostic behavior is always warning:
  - if +80 °Cis exceeded
  - if −40 °Cis undershot
- In the case of PVT scintillators, the diagnostic behavior is:
  - **Alarm:** if +65 °Cis exceeded
  - **Warning:** if +60 °C is exceeded or −40 °Cis undershot
- In the case of PVT (HT) scintillators, the diagnostic behavior is:
  - **Alarm:** if −25 °Cis undershot
  - **Warning:** if +80 °C is exceeded or −20 °Cis undershot

Diagnostic number 955:

Diagnostic behavior can be changed. See the "Gammagraphy" section.

11.3.3 Displaying the diagnostic events

Actual diagnostics

The **Actual diagnostics** parameter is available in the menu with a time stamp.

Previous diagnostics

The **Previous diagnostics** parameter is available in the menu with a time stamp.

Event logbook

The events are saved in the event logbook.

Navigation
"Diagnostics" menu → Event logbook

11.4 Diagnostic event in RIA15

A diagnostic event is not directly shown on the RIA15. The fault F911 only appears directly on the RIA15 display in the event of an alarm.

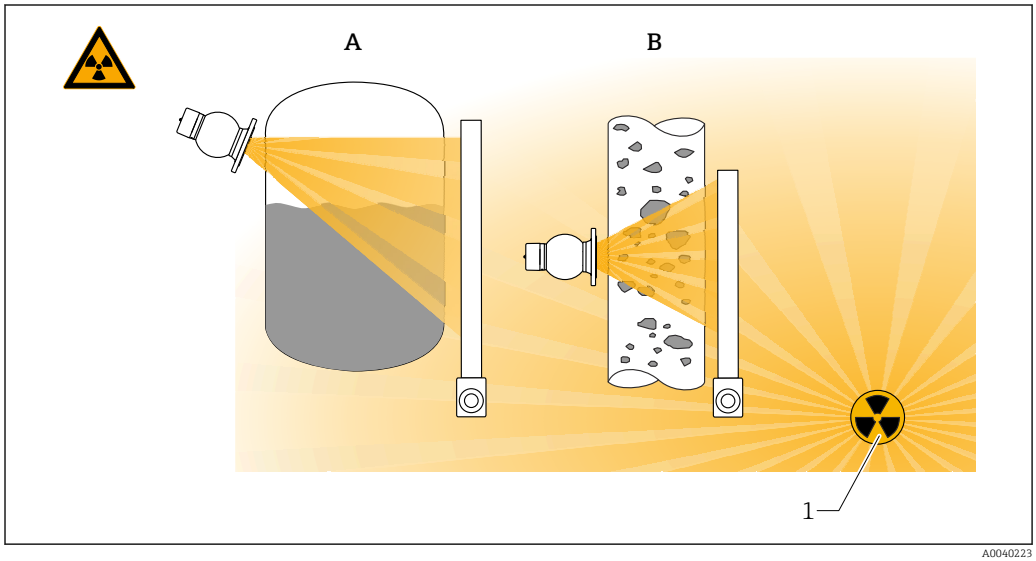
Displaying a diagnostic event on the RIA15

1. Navigate to: DIAG/TERR
2. Press E
3. Press +
4. Press E
5. Press + 3 times
6. Press E
   ↳ The diagnostic event of the field device is shown on the RIA15 display.
   Type of diagnostic event (F, M, C, S) + code of service ID is shown,
   e.g.: F124 - for F270 (main electronics defective) and service ID 124 (Rom Defect On MB).

11.5 Gammagraphy

11.5.1 General principles

This function involves the detection of interference radiation that interrupts the measurement. The aim of gammagraphy detection is to detect interference radiation that typically occurs during nondestructive material testing within the system. Without gammagraphy detection, this interference radiation would result in a low measured value (0% or ρmin). In contrast, when gammagraphy detection is used, the measured value adopts a defined value in this case (alarm current or hold last measured value).



35 *Influence of gammagraphy on radiometric measurements*

1 *Interference radiation*

11.5.2 Reaction to detected gammagraphy radiation

If the gammagraphy criterion "gammagraphy limit" is met, the device output adopts a value defined by the user (Gammagraphy detection parameter). Furthermore, a warning is also signaled. After a maximum time defined by the user (Hold time parameter), an alarm current is output and an event is displayed (can be selected via the Gammagraphy detection parameter).

Gammagraphy detection is also available with modulated radiation.

If the Heartbeat option is available, the number of detected gammagraphy events and the total duration of the detected gammagraphy events are available in the Heartbeat Verification Report.

11.5.3 Gammagraphy detection limits and behavior in event of excess radiation

Gammagraphy detection is active in the permitted radiation range of the device, i.e. up to ≤65000 cnt/s. The measurement accuracy of the device can be guaranteed within this range such that the device is ready to measure again immediately once the gammagraphy event no longer applies.

Above the permitted radiation range, an excess radiation alarm is signaled after 1 s (diagnostic number 927), irrespective of the settings for gammagraphy detection. The current output is always set to failure current during the excess radiation alarm.

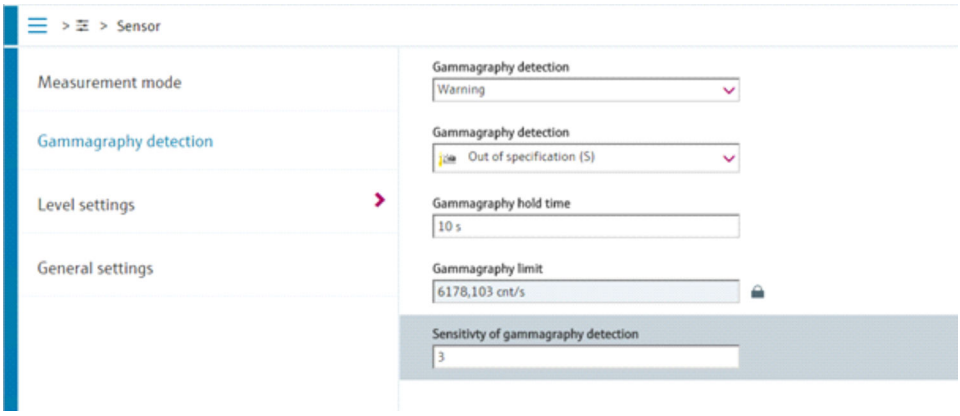
To protect the photomultiplier, the high-voltage supply for the tube is switched off while the excess radiation alarm is active and cyclically switched back on again in order to check the radiation intensity. The pause time during which the tube is switched off is 60 s. Therefore the end of a period of excess radiation can be detected after 60 s at the very earliest. When the excess radiation ends, the supply voltage is readjusted. As a result, in addition to the pause time approximately 30 s are also needed until the sensor signal leaves the alarm state.

By cyclically switching off the high-voltage, excess radiation can be present for arbitrarily long periods of time without this affecting the operating life of the photomultiplier or the device overall.

11.5.4 Gammagraphy settings

Gammagraphy detection can be configured under:

Application -> Sensor -> Gammagraphy detection



11.5.5 Gammagraphy detection parameter

Gammagraphy detection can be switched on and off with this parameter.

In addition, the event class can be defined according to NE107

Gammagraphy detection -> Off

Gammagraphy detection is switched off. In a gammagraphy event, the current output will display -10 % measured value (3.8 mA).

Gammagraphy detection -> Alarm

Gammagraphy detection is switched on. In a gammagraphy event, the current output will adopt the failure current (3.6 mA or ≥ 21.5 mA, depending on the configuration of the alarm current).

Gammagraphy detection -> Warning

Gammagraphy detection is switched on. The current output is held at the last valid measured value before gammagraphy detection.

11.5.6 Gammagraphy hold time parameter

This parameter defines how long the measured value is held if gammagraphy radiation has been detected. After this time, the current output adopts the value defined in the Gammagraphy detection parameter.

The hold time should be slightly longer than the maximum duration of a gammagraphy measurement. An alarm is signaled if the maximum pulse rate is still exceeded after the hold time.

An event is only written to the event list once the hold time has elapsed

WARNING

A change in the measured value is not detected during the hold time.
As a result, the current output may output an incorrect measured value. Serious personal injury or material damage may result.

- In a safety protection circuit, the selected hold time may not be greater than the permitted process safety time

11.5.7 Gammagraphy limit parameter

Gammagraphy radiation is detected if the pulse rate at the detector exceeds the maximum gammagraphy limit value. This value is determined using the maximum pulse rate from the calibration (generally "upper range value") and the configured gammagraphy sensitivity.

11.5.8 Gammagraphy sensitivity parameter

The suitable sensitivity value largely depends on the process and ambient conditions. Therefore no general rules apply for the choice of sensitivity value. However, the following principles can serve as a guide:

- A small value (between 1 and 3) should be entered for homogeneous products with an even, calm surface. Gammagraphy is then detected with a high degree of sensitivity.
- A large value (between 3 and 7) should be entered for non-homogeneous products and turbulent surfaces, as random variations in the pulse rate would otherwise be wrongly detected as a gammagraphy event.

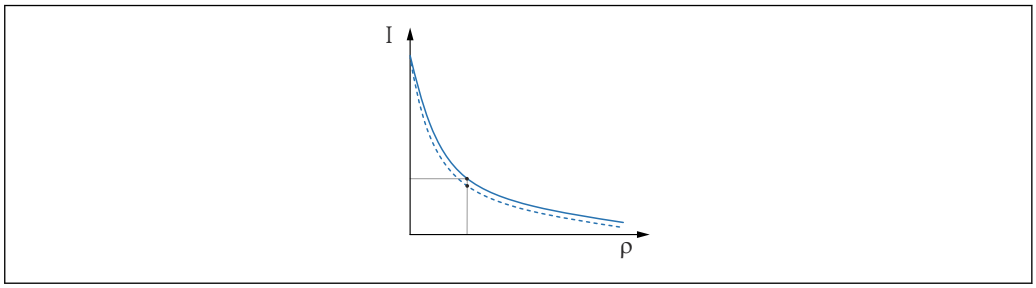
If the device occasionally reports gammagraphy even though no gammagraphy radiation is present, then it advisable to increase the value slightly. Conversely, the value should be reduced if gammagraphy radiation was not detected.

11.6 Density recalibration for multiple-point calibration

11.6.1 General principles

A recalibration of the measurement can be necessary if the measuring conditions have changed, e.g. in the event of deposit buildup on the pipe.

The absorption coefficient μ of the original calibration is maintained but the reference pulse rate I_0 is redetermined, which causes a shift in the overall linearization function.

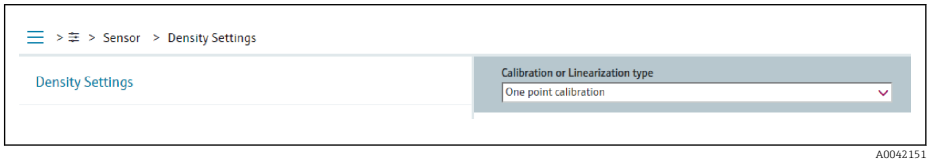


36 *Linearization shift*

I *Pulse rate (pulses per second, cnt/s)*
ρ *Density*

11.6.2 Performing density recalibration for multiple-point calibration

1. In the operating menu, change the type of calibration from **Multipoint calibration** option to **One point calibration** option
   ↳ Application → Sensor → Density Settings → Calibration or Linearization type



2. After changing the type of calibration to one-point calibration, perform the one-point calibration using the Commissioning Wizard.

Only change the type of calibration in the operating menu. If the type of calibration is changed in the Commissioning Wizard, the existing absorption coefficient of the current calibration is replaced by the default value 7.7 mm^2/g. This would require a complete recalibration of the measuring point. In this case, the μ-value can be taken manually from the commissioning documentation and entered instead of the default value.

11.7 Real-time clock and decay compensation

11.7.1 General principles

For decay compensation, the Gammapilot FMG50 contains a real-time clock, which is generally powered by the terminal voltage. This clock is backed up by a battery to bridge voltage interruptions.

The battery must have a sufficient remaining capacity to ensure the clock works correctly and continues to keep the correct date if power is interrupted.

The battery discharges during the operating life of the device. The process is temperature-dependent: self-discharging is faster at high ambient temperatures.

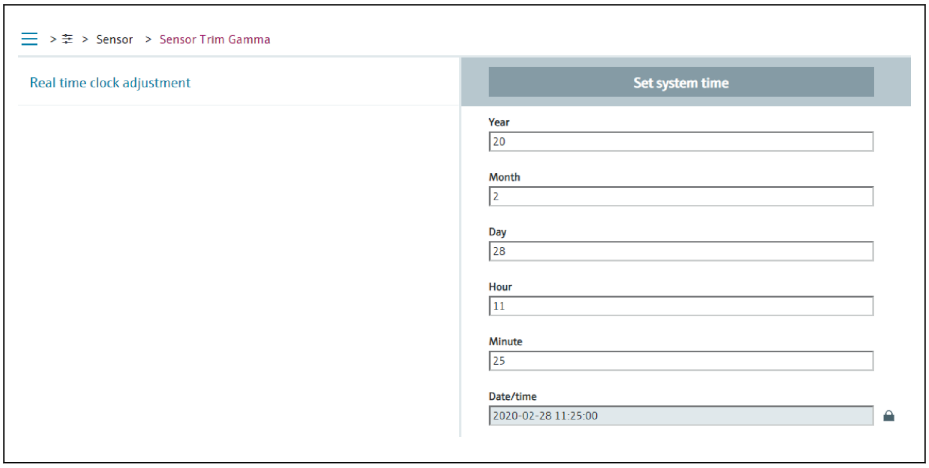
To keep self-discharging to a minimum, do not store the devices at high temperatures for a prolonged period

11.7.2 Setting the real-time clock

The battery can only be replaced by Endress+Hauser Service

Setting the time

1. ↳ Application → Sensor → Sensor Trim Gamma



A0042154

2. The time on the clock of the operating device (connected PC or Bluetooth device) is set by pressing the **"Set system time"** element.

Clock setting in as-delivered state: universal time coordinated (UTC).

⚠ WARNING

Incorrect real-time clock setting may result in an incorrect decay compensation result.
This can lead to a non-diagnosable, dangerous error. Serious personal injury or material damage may result.

► Set the real-time clock to the correct time.

11.8 Behavior in the event of low terminal voltage

11.8.1 General principles

If the terminal voltage is low, the available energy level may not suffice to make all functions of the device available. To ensure a reliable measurement function, the following measures are taken depending on the energy available:

- **For devices with a display (optional):** the background lighting of the display and the Bluetooth function are disabled
- **For devices without a display:** the total available energy is always available to the sensor

If the energy does not suffice to reliably guarantee the measurement function, an alarm **F801 "Increase supply voltage"** is output and the sensor function is switched off.

11.9 History

11.9.1 Firmware history

Firmware version

- 01.00.00
  - Initial software
  - Valid from: 31 August 2019
- 01.00.01
  - SIL functions certified
  - Display background lighting available
  - Valid from: 10 February 2020
- 01.00.02
  - Certified for overfill protection according to German Water Resources Act (WHG)
  - Behavior in event of excess radiation improved
  - Behavior of display in event of low power changed (display lighting and Bluetooth are reactivated when sufficient power supply is available)
  - Errors are now shown on the display weighted according to their relevance and no longer according to when they occur
  - The Wizards for Heartbeat Verification and SIL proof-testing are now also available via Bluetooth (SmartBlue App update required)
  - Bug fixes
  - Valid from: 1 March 2021
- 01.00.03
  Customer-specific OEM version, not publicly available
- 01.00.04
  - Behavior in the event of no terrestrial background radiation improved
  - Initial commissioning now possible via process indicator RIA15
  - Bug fixes
  - Valid from: 25 February 2022
- 01.00.05
  - Excess radiation alarm improved for empty pipe during density measurements
  - Restoration of the historome to factory settings possible for Endress+Hauser Service
  - Bug fixes
  - Valid from: 1 July 2022
- 01.00.06
  - Error correction in high voltage control
  - Valid from: 15 September 2023

- **01.00.07**
  Customer-specific OEM version, not publicly available
- **01.00.08**
  - Certified for overfill protection according to German Water Resources Act (WHG)
  - Minimum required firmware version for sensor hardware version 01.01.01 or newer
  - Valid from: 11 April 2024
- **01.00.09**
  - The HART-ID is no longer generated from the device serial number, but is predefined at the factory.
  - Minimum required firmware version for all devices with a production date as of 01.01.2026
  - Valid from: 16 September 2025

NOTICE

Use of a non-compliant firmware version under WHG.
Loss of validity of the WHG certificate.
▶ Devices with feature 590, option LD "WHG (German Federal Water Act) overfill protection system" may only be operated with firmware version **01.00.02**, **01.00.08** or **01.00.09**.

Firmware version **01.00.09** is recommended.

The firmware version can explicitly be ordered via the product structure. In this way it is possible to ensure compatibility of the firmware version with an existing or planned system integration.

12 Maintenance and repairs

12.1 Cleaning

When cleaning the exterior, always use cleaning agents that do not corrode the surface of the housing and the seals.

12.2 Repair

12.2.1 Repair concept

Under the Endress+Hauser repair concept, devices have a modular design and repairs can be carried out by Endress+Hauser Service or by properly trained customers.

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

For more information on service and spare parts, please contact Endress+Hauser Service.

12.2.2 Repairs to devices with an Ex-certificate

When repairing devices with an Ex-certificate, please also note the following:

- Only specialist personnel or Endress+Hauser Service may carry out repairs on Ex-certified devices.
- Comply with the prevailing standards, national Ex-area regulations, Safety Instructions (XA) and certificates.
- Only use original spare parts from Endress+Hauser.
- A certified device may only be converted into a different certified device version by Endress +Hauser Service in Endress+Hauser workshops.
- Document Ex-related repairs and Ex-related modifications.

Observe the information in the "Functional Safety Manual" for SIL devices

12.3 Replacement

⚠ CAUTION

Data upload/download is not permitted if the device is used for safety-related applications.

- ▶ After an entire device or an electronics module has been replaced, the parameters can be downloaded to the device again via the communication interface. For this, the data must have been uploaded to the PC beforehand using the "FieldCare/DeviceCare" software.

12.3.1 Level measurement and point level detection

You can continue measuring without performing a new calibration. However, the calibration values should be checked as soon as possible since the mounting position may have changed slightly.

12.3.2 Density and concentration measurement

A new calibration must be performed after the replacement.

12.3.3 HistoROM

It is not necessary to perform a new device calibration after replacing the display or transmitter electronics. The parameters are saved in the HistoROM.

After replacing the transmitter electronics, remove the HistoROM and insert it into the new replacement part.

Please contact the Endress+Hauser Service Department if the HistoROM is lost or defective.

12.4 Spare parts

Enter the serial number into *W@M Device Viewer* (www.endress.com/deviceviewer).

All the spare parts for the measuring device, along with the order code, are listed here and can be ordered. If available, users can also download the associated Installation Instructions.

Serial number:
- Located on the device and spare part nameplate.
- Can be read out via the "Serial number" parameter in the "Device information" submenu.

12.5 Return

The measuring device must be returned if it is in need of repair or a factory calibration, or if the wrong measuring device has been delivered or ordered. Legal specifications require Endress+Hauser, as an ISO-certified company, to follow certain procedures when handling products that are in contact with the medium.

To ensure safe, swift and professional device returns, please refer to the procedure and conditions for returning devices provided on the Endress+Hauser website at http://www.endress.com/support/return-material

12.6 Disposal

If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return them to the manufacturer for disposal under the applicable conditions.

12.6.1 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.

12.6.2 Disposing of devices with NaI (Tl) crystal

Devices with version NaI(Tl) contain more than 0.1% sodium iodide and are recorded in Safety Datasheet CAS No. 7681-82-5 and in small quantities of thallium iodide in Safety Datasheet CAS No. 7790-30-9 .

⚠ CAUTION

Health hazard if inhaled or swallowed!

The Gammapilot with NaI (Tl) crystal contains sodium iodide (thallium), which is harmful if inhaled or swallowed.

- Seek medical attention immediately after inhalation or swallowing.
- If the coating of the NaI (Tl) crystal is not present or is defective, wear personal protective equipment when handling the substance.

⚠ CAUTION

Substance hazardous to the aquatic environment!

The Gammapilot NaI (Tl) crystal contains sodium iodide (thallium), which is very toxic to aquatic organisms. The product must not be disposed of together with domestic waste or allowed to enter the waste water system.

- Dispose of the product only through an officially authorized waste disposal company.

12.7 Contact addresses at Endress+Hauser

Contact addresses are available at www.endress.com/worldwide or from your local Endress +Hauser branch office.

13 Accessories

13.1 Commubox FXA195 HART

For intrinsically safe HART communication with FieldCare/DeviceCare via the USB interface. For details refer to

TI00404F

13.2 Field Xpert SFX350, SFX370

Compact, flexible and robust industrial handheld terminal for remote operation and measured value interrogation of HART devices. For details refer to

- BA01202S
- TI01114S

13.3 Field Xpert SMT70

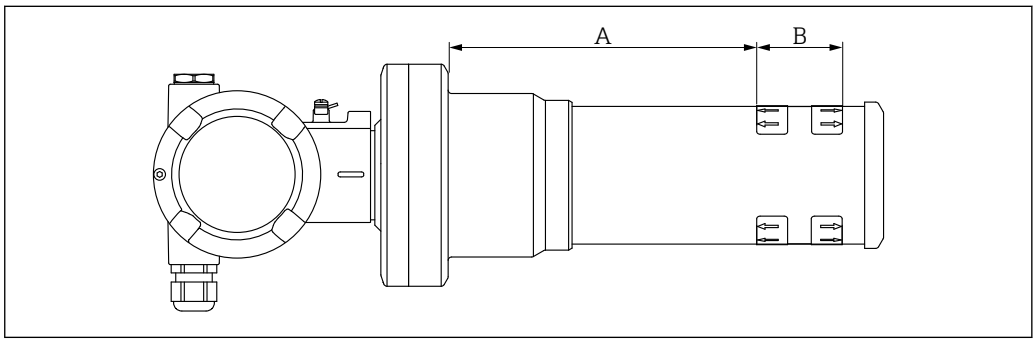
Universal, high-performance tablet PC for device configuration in Ex Zone 2 and non-Ex areas

Technical Information TI01342S

13.4 Mounting device (for level and point level measurement)

13.4.1 Installing the retaining bracket

Reference dimension A helps with positioning the retaining bracket depending on the measuring range. Dimensions can be adjusted as needed to make the installation easier.



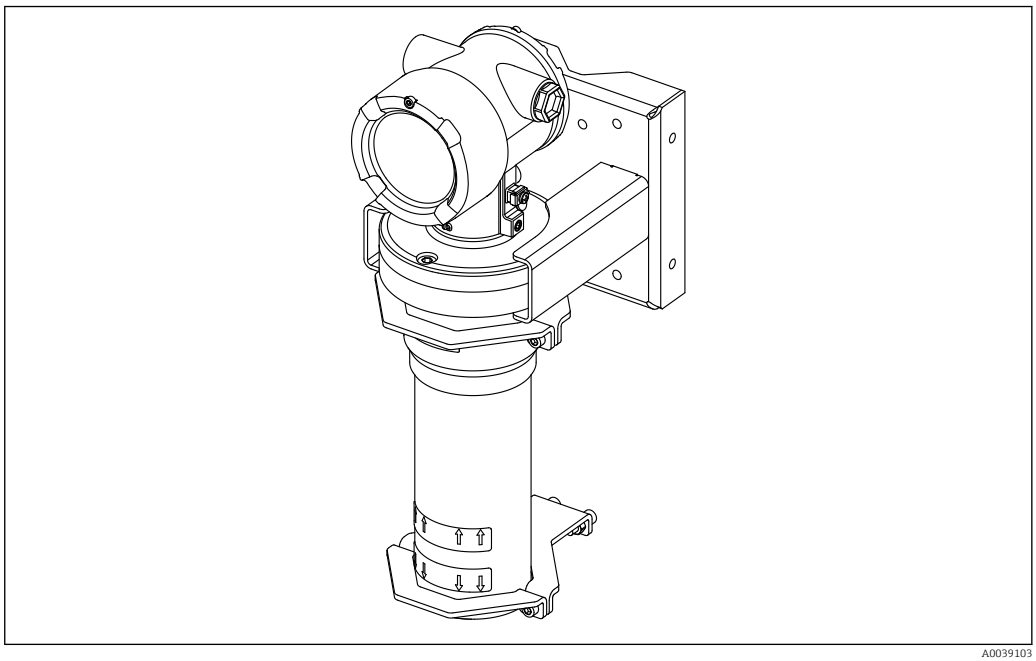
37 *A defines the distance between the device flange and the start of the measuring range. Distance A depends on the material of the scintillator (PVT or NaI).*

A: PVT, distance: 172 mm (6.77 in)
A: NaI, distance: 180 mm (7.09 in)
B: Position and length of the measuring range

13.4.2 Installation instructions

Keep the distance between the mounting clamps as large as possible.

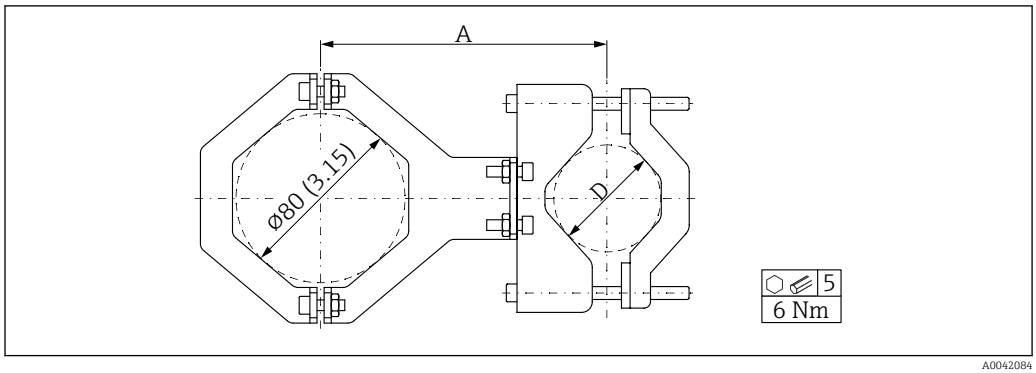
Do not install the lower mounting clamp in the area of the scintillator; see figure.



38 *Installation overview, with mounting clamps and retaining bracket*

Dimensions

Dimensions of mounting clamp

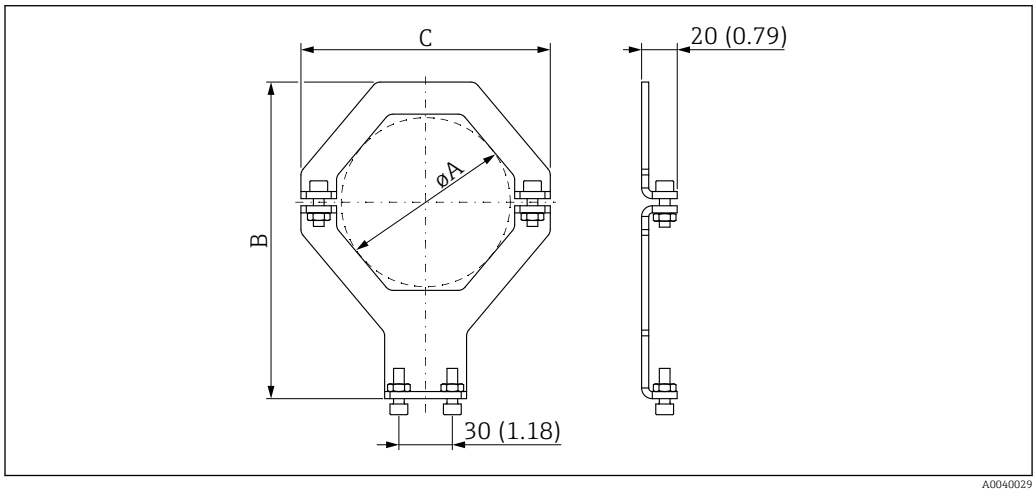


39 Dimensions of mounting clamp

A Distance between detector tube and mounting tube (center to center)
D Mounting tube diameter

A	D
146.6 mm (5.77 in)	42.2 mm (1.66 in), 1 1/4" NPS
148.2 mm (5.83 in)	44.5 mm (1.75 in)
150.7 mm (5.93 in)	48.3 mm (1.90 in), 1 1/2" NPS
152.6 mm (6.0 in)	51.0 mm (2.0 in)
154.6 mm (6.08 in)	54.0 mm (2.13 in)
156.6 mm (6.17 in)	57.0 mm (2.24 in)
158.8 mm (6.25 in)	60.3 mm (2.37 in), 2" NPS
161.0 mm (6.34 in)	63.5 mm (2.5 in)

Tighten the screws with the required torque.

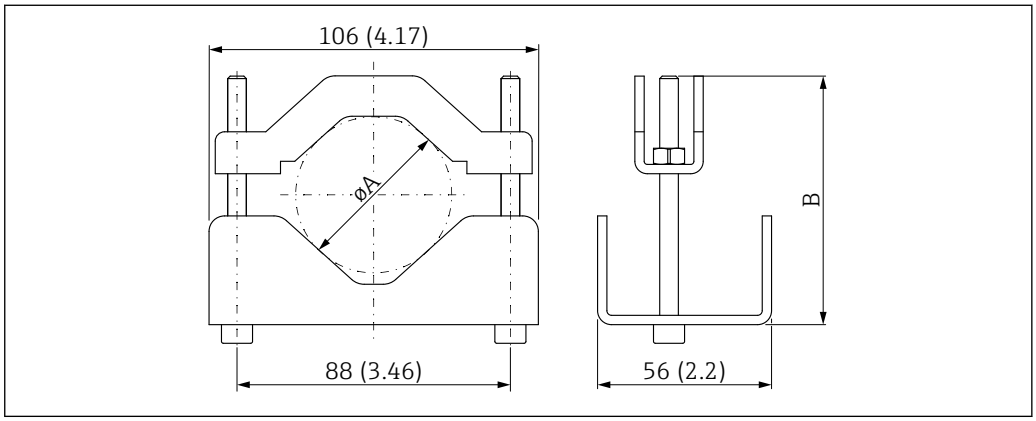


40 Dimensions of mounting clamp (at the device)

Electronics tube:
- **Diameter A:** 95 mm (3.74 in)
- **Distance B:** 178 mm (7.00 in)
- **Distance C:** 140 mm (5.51 in)

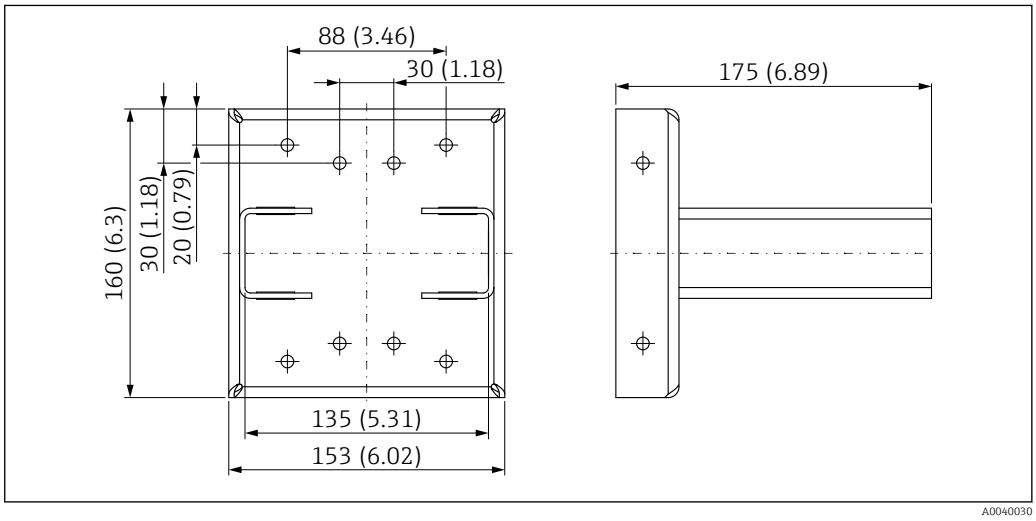
Detector tube:
- **Diameter A:** 80 mm (3.15 in)
- **Distance B:** 171 mm (6.73 in)
- **Distance C:** 126 mm (4.96 in)

Dimensions of mounting clamp (on pipe side)



øA 40 to 65 mm (1.57 to 2.56 in)
B 80 to 101 mm (3.15 to 3.98 in)

Dimensions of retaining bracket



41 Retaining bracket

13.4.3 Installation options

CAUTION

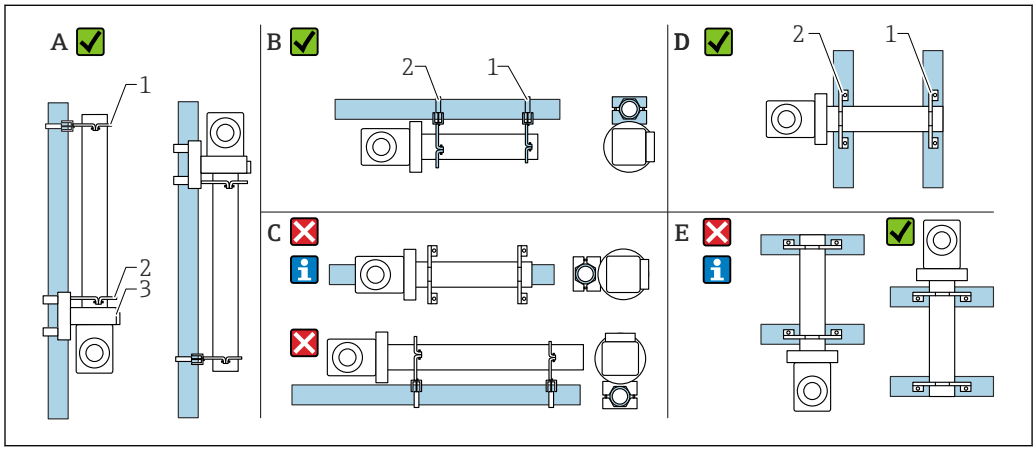
Risk of injury from heavy weight.

Personal injury and material damage may result.

- The mounting device must be installed in such a way as to withstand the weight of the Gammapilot FMG50 under all anticipated operating conditions.
- Four brackets must be used for measuring lengths of 1 600 mm (63 in) and more.
- Five brackets must be used for measuring lengths of 3 500 mm (137.8 in) and more.
- To facilitate installation and commissioning, the device can be configured and ordered with an additional support (order feature 620, option Q4: "Retaining bracket").
- Tighten the screws with the required torque. The detector tube of the device may be damaged if the torque is exceeded.
- At least two people are required to install the device.

permitted

not recommended, observe mounting instructions



A Vertical installation on vertical tubes (level measurement)
B Horizontal installation on horizontal tubes (point level measurement)
C Horizontal installation (see mounting instructions)
D Horizontal installation on vertical tubes
E Vertical installation on horizontal tubes (see mounting instructions)
1 Retainer for tube diameter 80 mm (3.15 in)
2 Retainer for tube diameter 95 mm (3.74 in)
3 Retaining bracket

Mounting instructions for horizontal installation (see Figure C): The tube must be mounted by the customer. It is important to ensure that the installation clamping force is sufficient to prevent the device from slipping. The dimensions are provided in the "Dimensions of mounting clamp" section.

Mounting instructions for vertical installation (see Figure E): Use of the retaining bracket is not possible in this orientation. If it is necessary to install the device with the connection compartment facing downwards, the customer must provide suitable design measures to secure the device from falling down.

13.5 Clamping device for density measurement FHG51

13.5.1 FHG51-A#1

For pipes with diameter 50 to 200 mm (2 to 8 in).

SD02543F

13.5.2 FHG51-A#1PA

For pipes with diameter 50 to 200 mm (2 to 8 in) with protective guard.

SD02533F

13.5.3 FHG51-B#1

For pipes with diameter 200 to 420 mm (8 to 16.5 in).

SD02544F

13.5.4 FHG51-B#1PB

For pipes with diameter 200 to 420 mm (8 to 16.5 in) with protective guard.

SD02534F

13.5.5 FHG51-E#1

For pipes with diameter 48 to 77 mm (1.89 to 3.03 in) and FQG60.

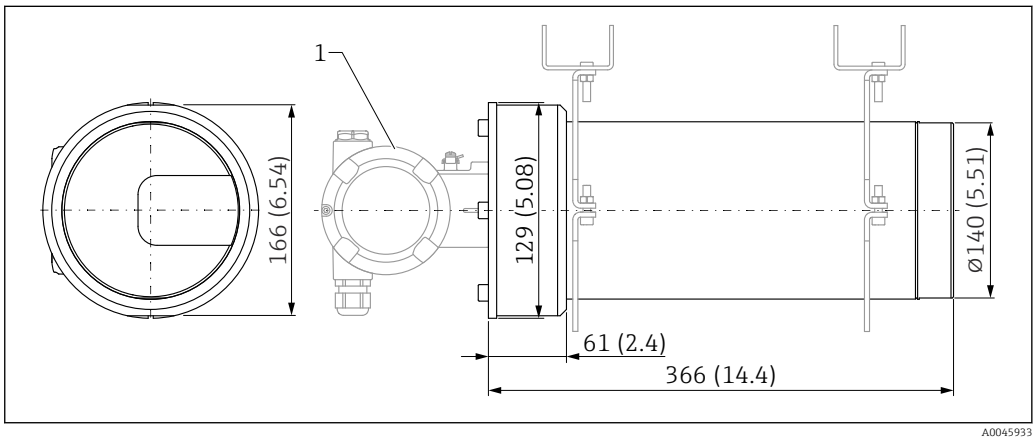
SD02557F

13.5.6 FHG51-F#1

For pipes with diameter 80 to 273 mm (3.15 to 10.75 in) and FQG60.

SD02558F

13.6 Collimator (sensor side) for Gammapilot FMG50



13.6.1 Intended use

The collimator can be used to increase measurement accuracy.

The collimator reduces interference radiation (e.g. from gammagraphy or scattered radiation) and background radiation at the detector. It allows gamma radiation to reach the Gammapilot FMG50 detector only from the direction of the useful radiation source, reliably shielding interfering radiation from the surroundings. The collimator consists of a lead jacket that effectively shields the radiation-sensitive measuring range of the

Gammapilot FMG50. The lead jacket has a side opening and is suitable for the lateral radiation of the Gammapilot FMG50 with the 2" NaI(Tl) scintillator.

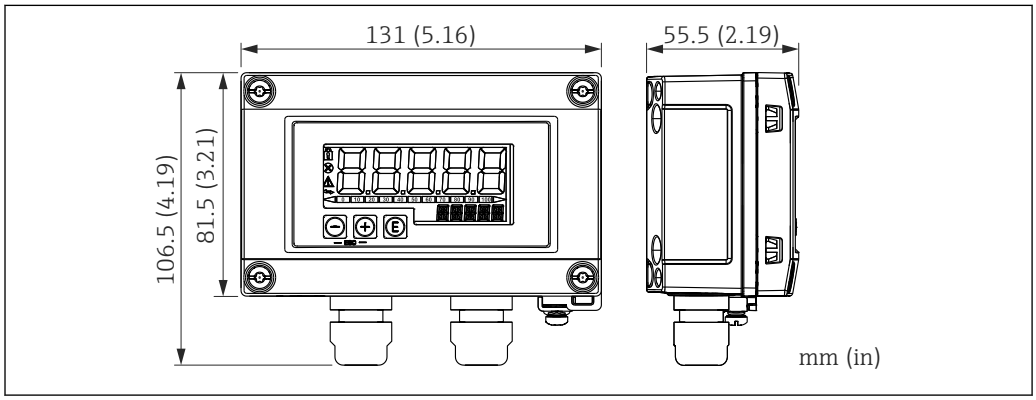
Please contact an Endress+Hauser sales organization for applications with frontal radiation or other scintillator versions

13.6.2 Additional information

Additional information is available in:

SD02822F

13.7 Process indicator RIA15



42 *Dimensions of RIA15 in field housing, engineering unit: mm (in)*

The RIA15 remote display can be ordered together with the device.

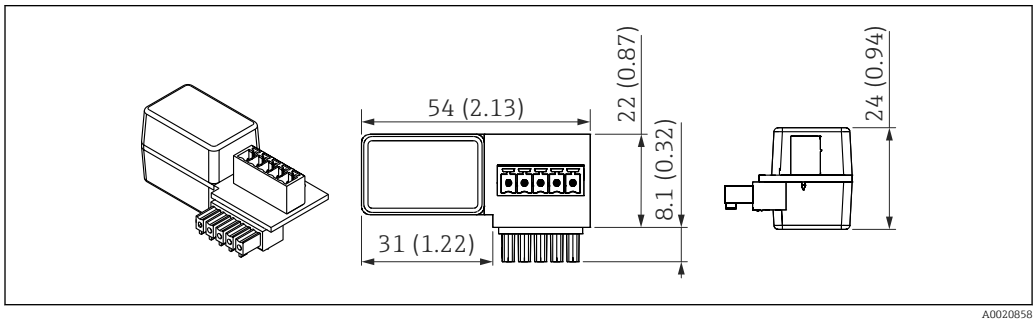
- Option PE "Remote indicator RIA15, non-hazardous area, aluminum field housing"
- Option PF "Remote indicator RIA15, hazardous, aluminum field housing"

Field housing material: aluminum

Other housing versions are available via the RIA15 product structure.

Alternatively available as an accessory, for details see Technical Information TI01043K and Operating Instructions BA01170K

13.7.1 HART communication resistor



43 *Dimensions of HART communication resistor, engineering unit: mm (in)*

A communication resistor is required for HART communication. If this is not already present (e.g. in the power supply RMA42, RN221N, RNS221, ...), it can be ordered with the device via the product structure, feature 620 "Accessory enclosed": option R6 "HART communication resistor hazardous / non-hazardous area".

13.8 Memograph M RSG45

13.8.1 Level measurement: FMG50 with Memograph M RSG45

Conditions requiring several FMG50 units:

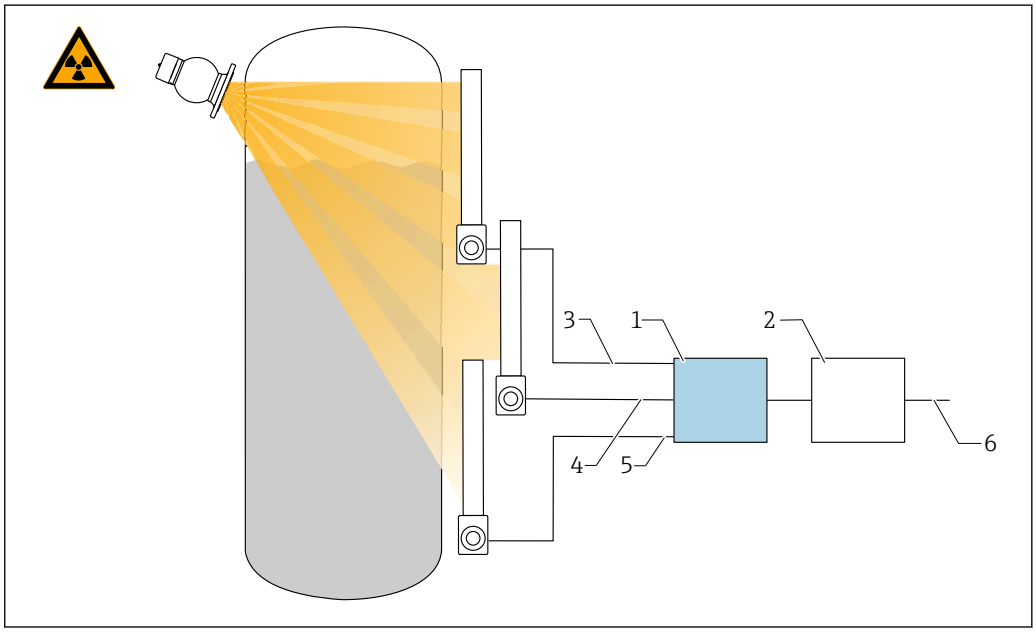
- Large measuring ranges
- Special tank geometry

More than two FMG50 units (maximum 20) can be interconnected and powered via one Memograph M RSG45. The pulse rates (cnt/s) of the individual FMG50 units are added together and linearized; this gives the total level.

To enable the application, the settings must be made on every FMG50. In this way, the actual level in the vessel can be determined over all the anticipated cascade areas. While the calculation is the same for all FMG50 devices in the cascade, the constants for every FMG50 unit vary and must remain editable.

The cascade mode requires at least 2 FMG50 units that communicate with the RSG45 via the HART channel.

Avoid overlap between the individual measuring ranges as this can result in an incorrect measured value. The devices may overlap physically, provided that their measuring ranges are not affected.



44 *Connection diagram: for three FMG50 units (up to 20 FMG50s) connected to one RSG45*

1 *RSG45*
2 *Algorithm: addition of the individual pulse rates (SV_1 + SV_2 + SV_3) and subsequent linearization*
3 *HART signal FMG50 (1), PV_1: level, SV_1: pulse rate (cnt/s)*
4 *HART signal FMG50 (2), PV_2: level, SV_2: pulse rate (cnt/s)*
5 *HART signal FMG50 (3), PV_3: level, SV_3: pulse rate (cnt/s)*
6 *Overall output signal*

13.8.2 Additional information

See Operating Instructions RSG45 :

BA01338R

See Operating Instructions FMG50:

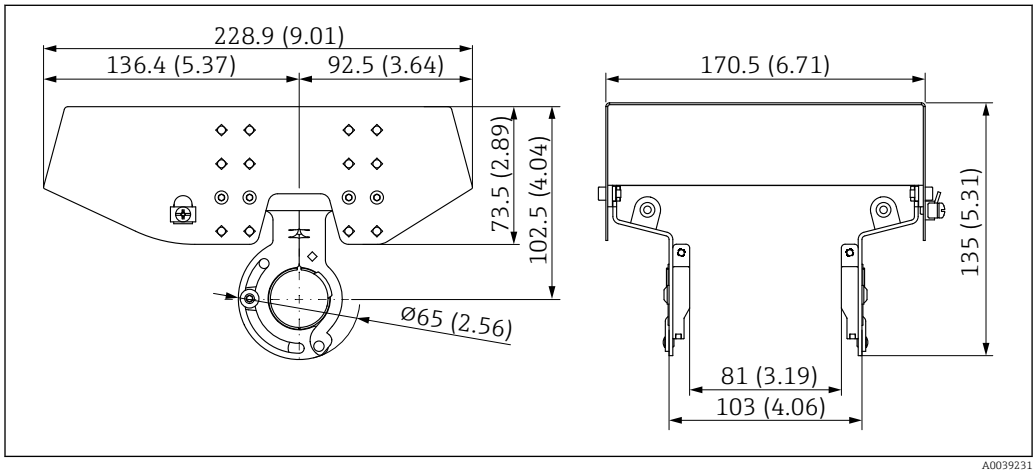
BA01966F

13.9 Weather protection cover: 316L, XW112

The weather protection cover can be ordered together with the device via the "Accessory enclosed" product structure.

It is used to protect against direct sunlight, precipitation and ice.

Weather protection cover 316L is suitable for the dual compartment housing made of aluminum or 316L. The delivery includes the holder for direct mounting on the housing.



45 *Dimensions of weather protection cover, 316 L, XW112. Unit of measurement mm (in)*

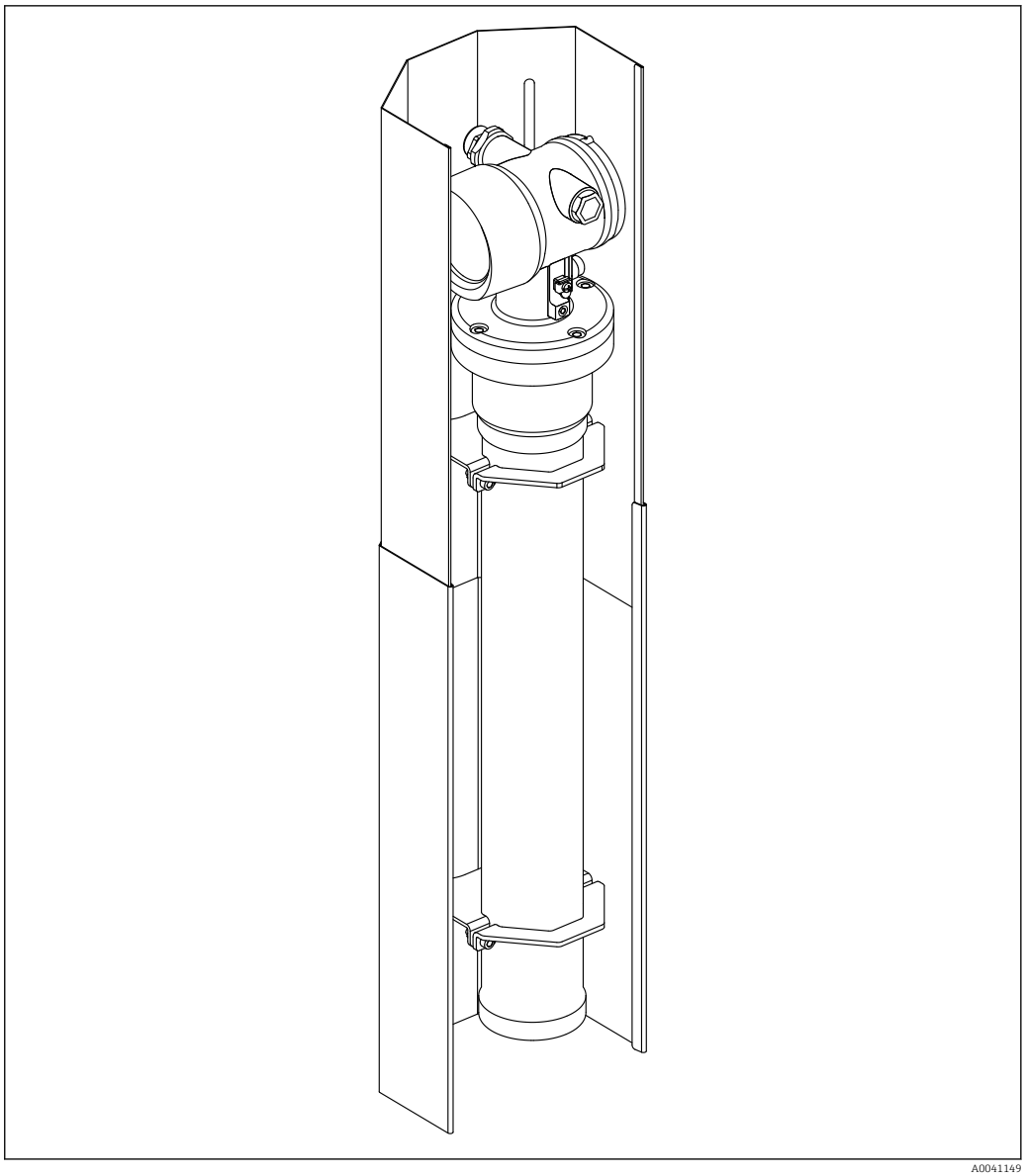
Material
- Weather protection cover: 316L
- Clamping screw: A4
- Bracket: 316L

Accessory order code:
71438303

Special Documentation SD02424F

13.10 Heat shield for Gammapilot FMG50

The heat shield protects against direct sunlight and is used for heat shielding in the process.



A0041149

46 Example of a heat shield for Gammapilot FMG50

For more information, see:

SD02472F

14 Technical data

14.1 Additional technical data

For additional technical data, see "Technical Information FMG50".

14.2 Supplementary documentation

Supplemental documentation is available on the individual product pages at www.endress.com.

- Technical Information
- "Description of Device Functions" manual
- Functional Safety Manual:
- Special Documentation "Heartbeat Verification + Monitoring"

14.2.1 Modulator FHG65

TI00423F

BA00373F

14.2.2 Source container FQG60

TI00445F

BA02521F

14.2.3 Source container FQG61, FQG62

TI00435F

BA02577F

14.2.4 Source container FQG63

TI00446F

BA02594F

14.2.5 Source container FQG66

TI01171F

BA01327F

14.2.6 Source container FQG74

TI01798F

BA02365F (source container with up to 12 radiation sources; detachable source magazine)

BA02361F (source container with up to 20 radiation sources)

14.2.7 Clamping device FHG51

SD02533F (clamping device for density measurement with protective guard)
SD02534F (clamping device for density measurement with protective guard)
SD02543F (clamping device for density measurement)
SD02544F (clamping device for density measurement)

14.2.8 Mounting device for Gammapilot FMG50

SD02454F

14.2.9 Heat shield for Gammapilot FMG50

SD02472F

14.2.10 Weather protection cover for dual-compartment housing

SD02424F

14.2.11 VU101 Bluetooth® display

SD02402F

14.2.12 Process indicator RIA15

TI01043K

14.2.13 Memograph M, RSG45

TI01180R

14.2.14 Collimator (sensor side) for Gammapilot FMG50

SD02822F

15 Certificates and approvals

Current certificates and approvals for the product are available at www.endress.com on the relevant product page:

1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Downloads**.

15.1 Functional safety

SIL 2/3 according to IEC 61508, see:
"Functional Safety Manual"

FY01007F

15.2 Heartbeat Monitoring + Verification

Heartbeat Technology offers diagnostic functionality through continuous self-monitoring, the transmission of additional measured variables to an external Condition Monitoring system and the in-situ verification of measuring devices in the application.
Special Documentation "Heartbeat Monitoring + Verification"

SD02414F

15.3 RoHS

The measuring system meets the substance restrictions of the Directive on the Restriction of the Use of Certain Hazardous Substances 2011/65/EU (RoHS 2) and the Delegated Directive (EU) 2015/863 (RoHS 3).

15.4 RCM marking

The supplied product or measuring system meets the ACMA (Australian Communications and Media Authority) requirements for network integrity, interoperability, performance characteristics as well as health and safety regulations. Here, especially the regulatory arrangements for electromagnetic compatibility are met. The products bear the RCM marking on the nameplate.

A0029561

15.5 Radio approval

Displays with Bluetooth LE have radio licenses according to CE and FCC. The relevant certification information and labels are provided on display.

15.6 Ex approval

The Ex certificates available are listed in the ordering information. Observe the related Safety Instructions (XA) and Control Drawings (ZD).

15.6.1 Explosion-protected smartphones and tablets

Only mobile end devices with Ex approval may be used in hazardous areas.

15.7 Other standards and guidelines

- **IEC 60529**
  Degrees of protection provided by enclosures (IP code)
- **IEC 61010**
  Safety requirements for electrical equipment for measurement, control and laboratory use
- **IEC 61326**
  Interference emission (Class B equipment), interference immunity (Annex A – Industrial area)
- **IEC 61508**
  Functional safety of safety-related electric/electronic/programmable electronic systems
- **NAMUR**
  Association for Standards for Control and Regulation in the Chemical Industry

15.8 Certificates

The certificates are available via the Product Configurator:
www.us.endress.com/en/field-instruments-overview/product-finder -> Select product -> Configure

15.9 CE mark

The measuring system meets the legal requirements of the EU Directives. Endress+Hauser confirms that the device has been successfully tested by applying the CE mark.

15.10 EAC

Approval for EAC

15.11 Overfill protection system

WHG for point level measurement: General type approval No. Z-65.15-603

www.addresses.endress.com

Endress+Hauser

People for Process Automation