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Technical Information
Gammapilot FMG50

Radiometric measuring technology

Compact transmitter for non-contact measurement through vessel walls

Application

- Level, interface, density, concentration and point level measurement
- Measurement in liquids, solids, suspensions or sludges
- Use under extreme process conditions
- All kinds of process vessels

Benefits

- Compact transmitter with loop-powered two-wire technology
- Multifunctional compact transmitter for all measuring tasks: level, interface, density, concentration and point level
- Safety compliance for all measurement tasks, with SIL2 approval according to IEC 61508 and SIL 3 with homogeneous or diverse redundancy
- Heartbeat Technology to verify the correct functioning of the measuring instrument within specifications without interrupting the process
- Optimum adjustment to the respective applications and measuring ranges via a variety of detector materials
- Bluetooth® wireless technology for easy commissioning, operation and maintenance via the free iOS / Android SmartBlue app
- Use of Gamma Modulator FHG65 for the reliable suppression of interference radiation irrespective of the isotope

Endress+Hauser
People for Process Automation

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About this document

Symbols

Safety symbols

⚠ CAUTION

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

⚠ DANGER

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

NOTICE

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

⚠ WARNING

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

Symbols for certain types of information

☢
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

Symbols in graphics

1, 2, 3, ...
Item numbers

A, B, C, ...
Views

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Function and system design

Application and advantages

Application

- Level, interface, density, concentration and point level measurement
- Measurement in liquids, solids, suspensions or sludges
- Use in extreme process conditions: high pressure, high temperature, corrosion, abrasion, viscosity, toxicity
- All kinds of process vessels, e.g. reactors, autoclaves, separators, acid tanks, cyclones

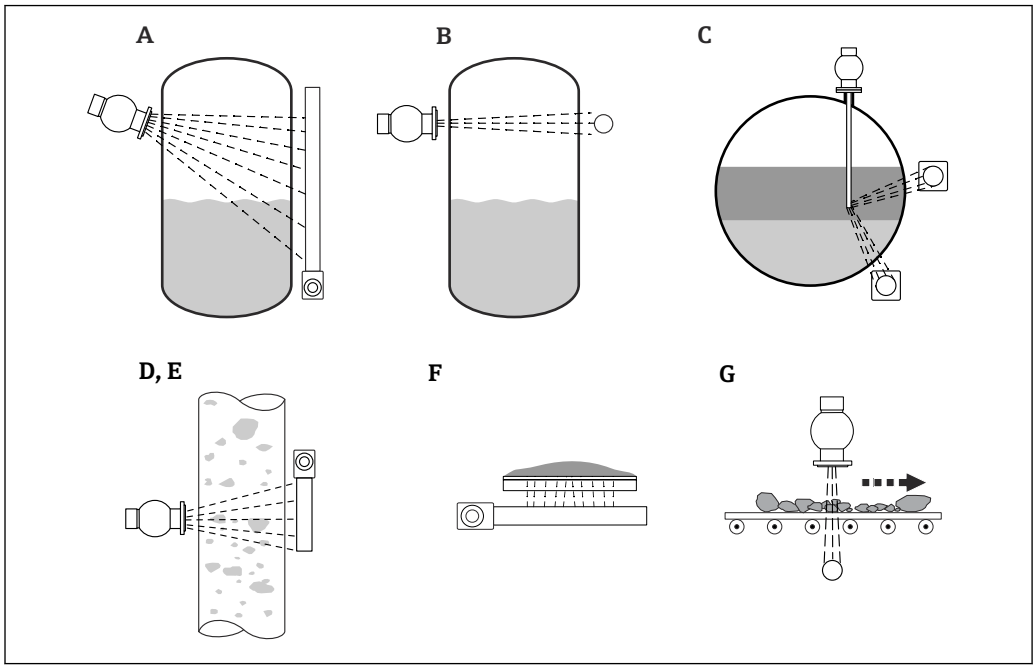
Benefits

- Compact transmitter with two-wire technology
  - Loop-powered: no separate evaluation unit necessary
  - Maximum safety thanks to intrinsically safe Ex-ia power supply
- Multifunctional compact transmitter for all measuring tasks: level, interface, density, concentration and point level
- Safety compliance for all measurement tasks, with SIL2 approval according to IEC 61508 and SIL 3 with homogeneous or diverse redundancy Permanent process and device diagnostics with high level of diagnostic coverage.
- Heartbeat Technology:
  - Verification of the correct functioning of the measuring instrument within specifications, with reporting, all without interrupting the process
  - Monitoring of internal device health parameters as part of "predictive maintenance" (in preparation)
- Variety of detectors ensure optimum adaptation to the individual applications and measuring ranges:
  - Thallium-doped sodium iodide (NaI (Tl)) crystal scintillator in 50 mm (2 in), 100 mm (4 in) and 200 mm (8 in) lengths
  - Standard and high-temperature PVT scintillators up to 3 m (118.1 ft) long
- Bluetooth® wireless technology for easy commissioning, operation and maintenance via the free iOS / Android SmartBlue app
- Easy, guided commissioning with intuitive user interface
- Easy proof testing for SIL and WHG
- 316L stainless steel housing for heavy-duty applications
- Use of Gamma Modulator FHG65 for the reliable suppression of interference radiation irrespective of the isotope

Highest availability, reliability and safety, even for extreme process and ambient conditions

Measuring principle

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



A Continuous level measurement
B Point level measurement
C Interface measurement
D Density measurement
E Concentration measurement (density measurement followed by linearization)
F Concentration measurement with radiating media
G Measurement of mass flow (solids)

Continuous level measurement

A source container with a radiation source and a Gammapilot FMG50 (to receive the gamma radiation) are mounted on opposite sides of a vessel. The radiation emitted by the radiation source is absorbed by the medium in the vessel. The higher the level rises, the more radiation is absorbed. Consequently, the Gammapilot FMG50 receives less radiation as the level of the medium increases. This effect is used to determine the current level of medium in the vessel. As the Gammapilot FMG50 is available in different lengths, the detector can be used for measuring ranges of different sizes.

Point level measurement

A source container with a radiation source and a Gammapilot FMG50 (to receive the gamma radiation) are mounted on opposite sides of a vessel. The radiation emitted by the radiation source is absorbed by the medium in the vessel. In the case of point level measurement, the radiation received by the Gammapilot FMG50 is typically absorbed completely if the radiation path between the radiation source and the detector is completely filled with medium. In this case, the level of the medium in the vessel is at the set limit. The Gammapilot FMG50 indicates the uncovered state (no medium in the radiation path) with 0 % and the covered state (medium in the radiation path) with 100 %.

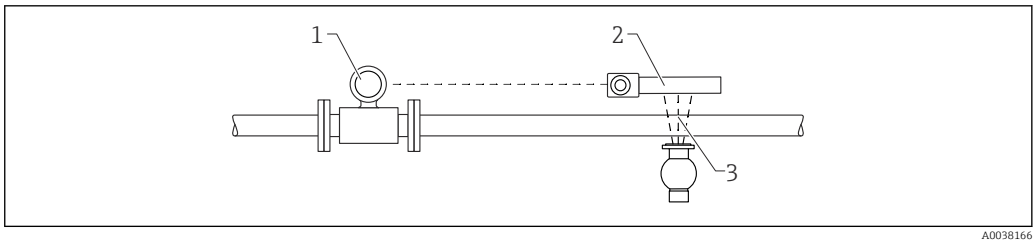
Density measurement

A source container with a radiation source and a Gammapilot FMG50 (to receive the gamma radiation) are mounted on opposite sides of a pipe. The radiation emitted by the radiation source is absorbed by the medium in the pipe. The denser the medium in the radiation path between the radiation source and the detector, the more radiation is absorbed. Consequently, the Gammapilot FMG50 receives less radiation as the density of the medium increases. This effect is used to determine the current density of the medium in the pipe. The density unit can be selected from a menu.

Density measurement to determine the mass flow

A source container with a radiation source and a Gammapilot FMG50 (to receive the gamma radiation) are mounted on opposite sides of a pipe. The radiation emitted by the radiation source is absorbed by the medium in the pipe. The denser the medium in the radiation path between the radiation source and the detector, the more radiation is absorbed. Consequently, the Gammapilot FMG50 receives less radiation as the density of the medium increases. This effect is used to determine the current density of the medium in the pipe. The density unit can be selected from a menu. The density signal of the Gammapilot FMG50 can be combined with the signal of a volume flowmeter, e.g. Promag 55S, and the mass flow can be calculated from these two signals.

Additional features are required when ordering a Promag 55S for mass flow measurement:
- **Order option:** "Solids stream" software function (F-CHIP)
- **Order option:** Current input



1 Volume flowmeter
2 Gammapilot
3 Density measurement

Concentration measurement

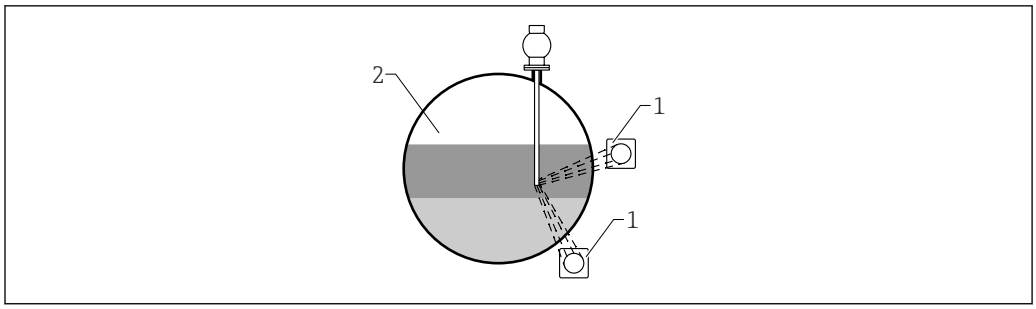
A source container with a radiation source and a Gammapilot FMG50 (to receive the gamma radiation) are mounted on opposite sides of a vessel. The radiation emitted by the radiation source is absorbed by the medium in the vessel. The denser the medium in the radiation path between the radiation source and the detector, the more radiation is absorbed. Consequently, the Gammapilot FMG50 receives less radiation as the density of the medium increases. This effect is used to determine the current density of the medium in the vessel. Using the linearization function, the corresponding concentration can be assigned to the medium density and the Gammapilot FMG50 displays concentration values.

Concentration measurement with radiating media

The Gammapilot FMG50 is mounted on the side of a measuring pipe or a conveyor belt. Radiating medium is conducted past the Gammapilot. The Gammapilot FMG50 can determine the concentration of the radiating content in the medium based on the intensity of the gamma radiation emitted by the radiating medium.

Interface measurement

A source container with a radiation source and a Gammapilot FMG50 (to receive the gamma radiation) are mounted on opposite sides of a vessel. If an FQG63 source container is used, the gamma radiation source can also be inserted into a vessel using a protection pipe. This excludes the possibility of contact between the radiation source and the medium. The radiation emitted by the radiation source is absorbed by the media in the vessel. The denser the medium in the radiation path between the radiation source and the detector, the more radiation is absorbed. Consequently, the Gammapilot FMG50 receives less radiation as the density of the medium increases. This effect is used to determine the current density of the medium in the vessel. The Gammapilot FMG50 calculates the position of the interface layer from the intensity of the radiation received. Its value is between 0 % (lowest possible position) and 100 % (highest possible position).



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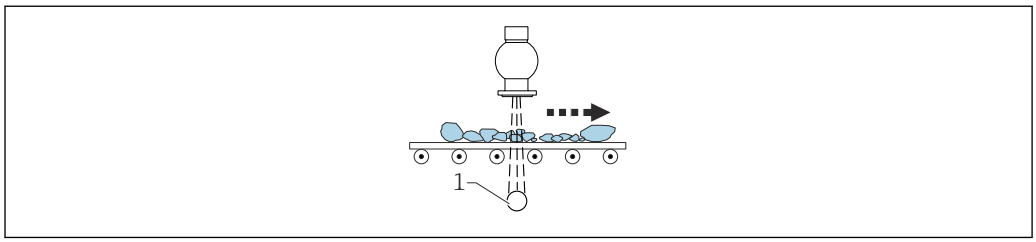
1 Gammapilot (2 pcs)
2 Interface measurement

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.



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1 Gammapilot FMG50

Measuring system

A radiometric measuring system typically consists of the following components:

Gamma radiation source

A ^{137}Cs or ^{60}Co source acts as the radiation source. Radiation sources with different activities are available to adapt the system to the specific application. The "Applicator" selection and configuration program can be used to calculate the required activity [1]. For additional information on the radiation source, refer to TI00439F.

Alternatively, 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/

Source container

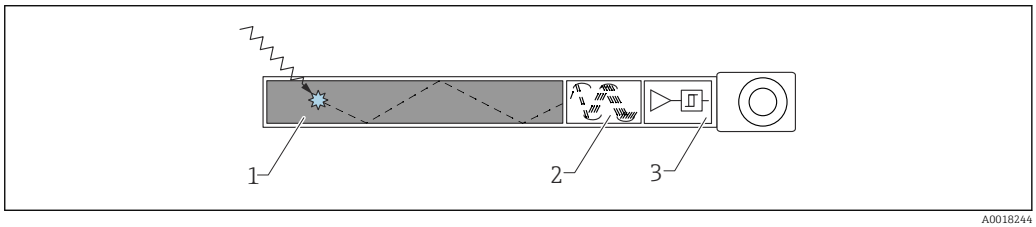
The radiation source is enclosed in a source container, which allows the radiation to be emitted only in one direction and screens it off in any other direction. The radiation is absorbed in all directions when the source container is closed. The source container is opened during commissioning and the radiation is emitted at a defined angle. This reduces the area of ionizing radiation to the minimum required to irradiate the active part of the Gammapilot FMG50. Source containers are available in different sizes and with different beam exit angles. The "Applicator" [1] program can be used to select the source container that suits your application. For additional information on the source container, refer to TI00445F (FQG60), TI00435F (FQG61, FQG62), TI00446F (FQG63), TI01171F (FQG66), TI01798F (FQG74) and SD02780F (FQG64).

Gammapilot FMG50

The Gammapilot FMG50 contains a scintillator, a photomultiplier and the electronic evaluation unit. Incident gamma radiation generates light flashes within the scintillator. These pass to the

1) The "Applicator" CD-ROM is available from your E+H sales organization

photomultiplier, where they are converted into electrical pulses and amplified. The pulse rate (number of pulses per second) is an indicator of the intensity of the radiation. Depending on the calibration, the pulse rate is converted to a level, limit switching, density or concentration signal by the electronic evaluation unit. The Gammapilot FMG50 is available with NaI (Tl) crystals or with PVT scintillators of different lengths, ensuring that it can be optimally adapted to each individual application.



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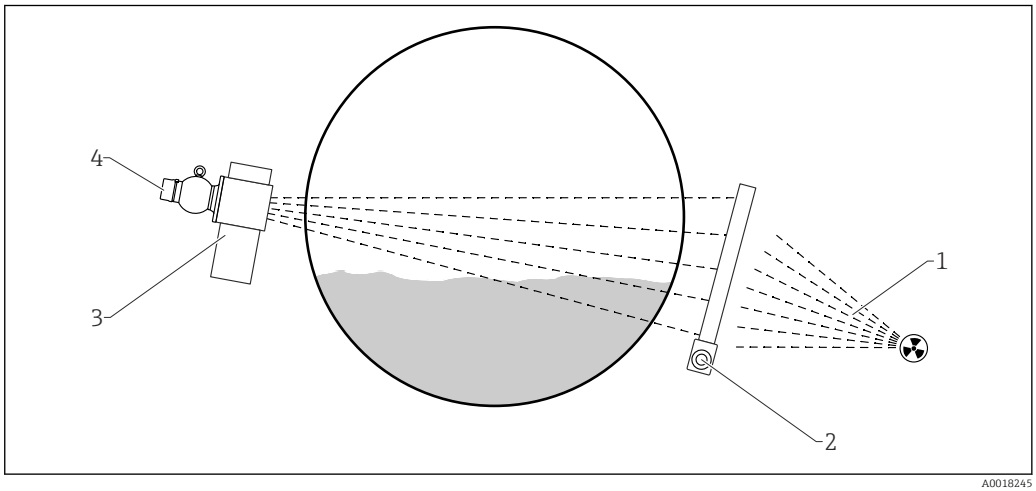
1 Gamma radiation generates light flashes (photons) in the scintillator
2 The photomultiplier converts the flashes into electrical pulses and amplifies them
3 The electronic evaluation unit calculates the measured value from the pulse rate

Gamma Modulator FHG65 (optional)

In a radiometric measuring point with a Gammapilot FMG50, the Gamma Modulator FHG65 is mounted in front of the beam exit channel of the source container. It contains a shaft slotted along the longitudinal axis. This shaft rotates continuously and alternately screens off the gamma beam at a frequency of 1 Hz or allows it through. Due to this frequency, the useful beam differs from fluctuating ambient interference radiation and from interference radiation occurring sporadically (e.g. from nondestructive material testing). Using a frequency filter, the Gammapilot FMG50 can separate the useful signal from interference radiation. In this way, it is possible to continue measuring even if interference radiation occurs. This significantly increases the measuring certainty and system availability. This is independent of the interference radiation isotope used.

For additional information, refer to TI00423F



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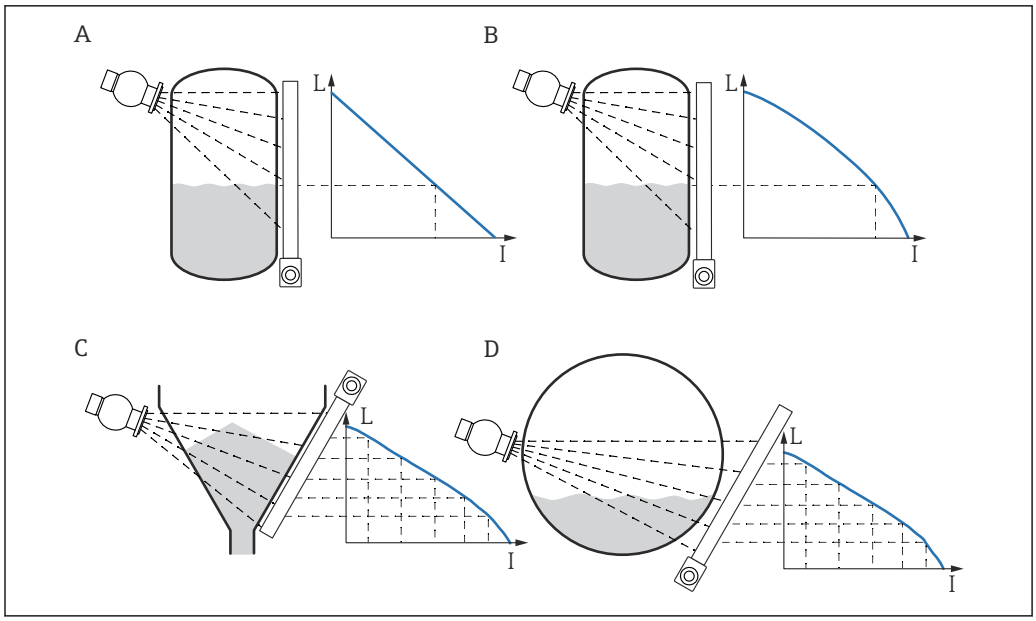
1 Interference radiation
2 Gammapilot FMG50
3 Gamma Modulator FHG65
4 Source container FQG61, FQG62

The Gamma Modulator FHG65 and the Gammapilot FMG50 are not interconnected electrically. When adjusting the Gammapilot , the "Beam type" parameter must be set to "Modulated".

Signal analysis

Level measurement

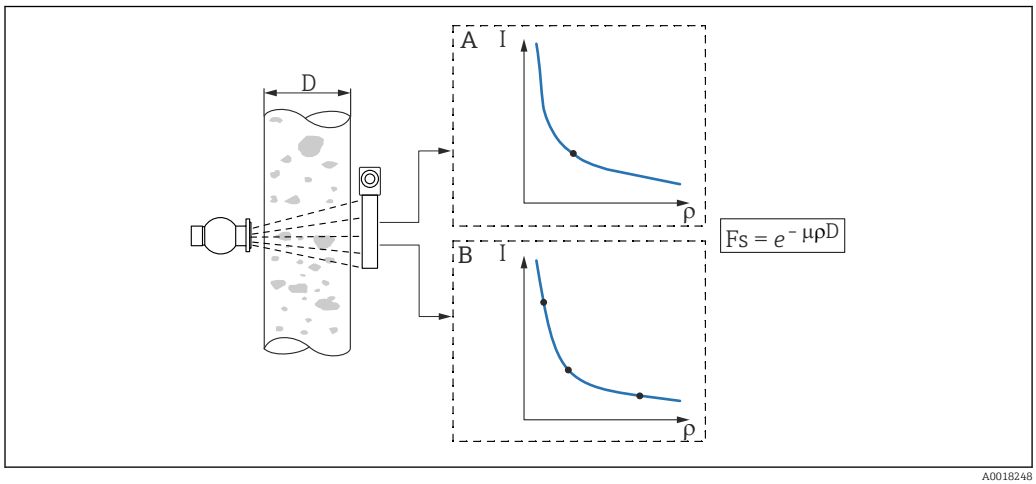
The device's linearization function allows the user to convert the measured value to length or volume units. A standard linearization curve for calculating the level in vertical cylinders is preprogrammed into the FMG50. Other linearization tables of up to 32 value pairs can be entered manually or semi-automatically. The linearization curve with its associated table can be calculated using the "Applicator" [1] selection and configuration software.



A Linear table
B Standard table
C, D User-specific table
I Pulse rate (pulses per second, cnt/s)
L Level (%)

Density measurement

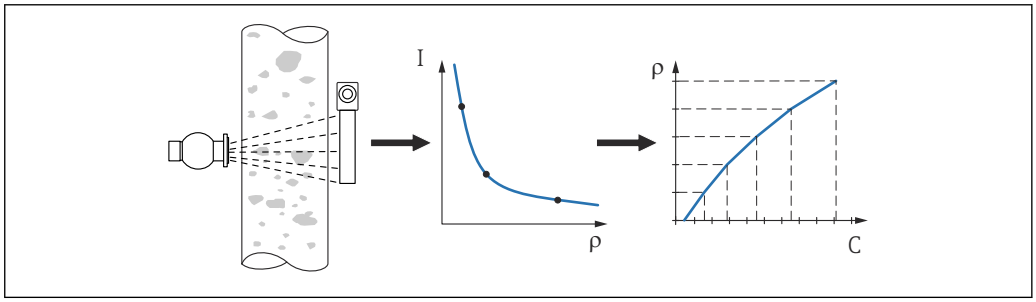
The measured values of up to four samples of known density can be stored in the FMG50 and used for the calibration of density measurements. The absorption coefficient μ and the linearization curve are automatically calculated from these values. The device then uses these parameters to calculate the density from the pulse rate. In the case of a one-point calibration, a default value is used for the absorption coefficient μ. This value can be changed manually. Alternatively, a second calibration point (the pulse rate in the empty pipe) can be calculated using the Applicator. The calculated empty calibration value of the Applicator is saved in the device with the measured one-point calibration value and the absorption coefficient μ is calculated from this.



A One-point calibration
B Multiple-point calibration
D Internal diameter of pipe or radiated length
I Pulse rate (pulses per second, cnt/s)
F_S Attenuation factor
ρ Density
μ Absorption coefficient

Concentration measurement

The FMG50 determines the concentration indirectly via a density measurement. A linearization table consisting of up to 32 "density - concentration" value pairs can be entered for this calculation. The solids content of liquids, for example, can be measured in this way (percentage of volume or weight).



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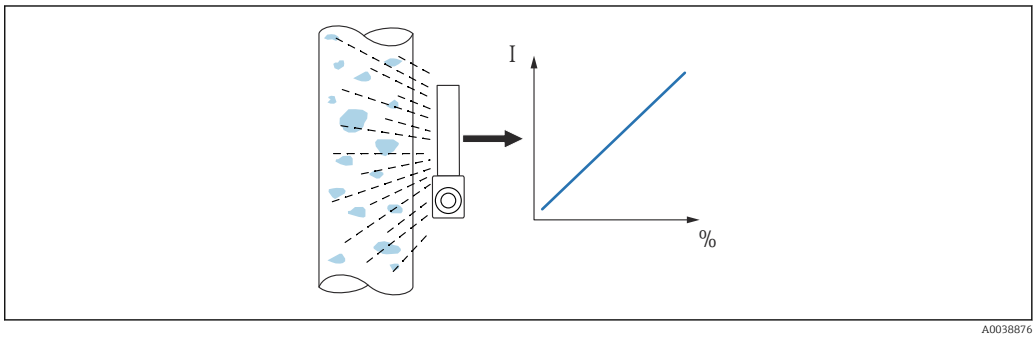
I *Pulse rate (pulses per second, cnt/s)*
ρ *Density*
C *Concentration*

Concentration measurement with radiating media

The FMG50 calculates the concentration of the medium from the intensity of the radiation that is emitted by the medium itself.

A source container and radiation source are not needed for the measurement



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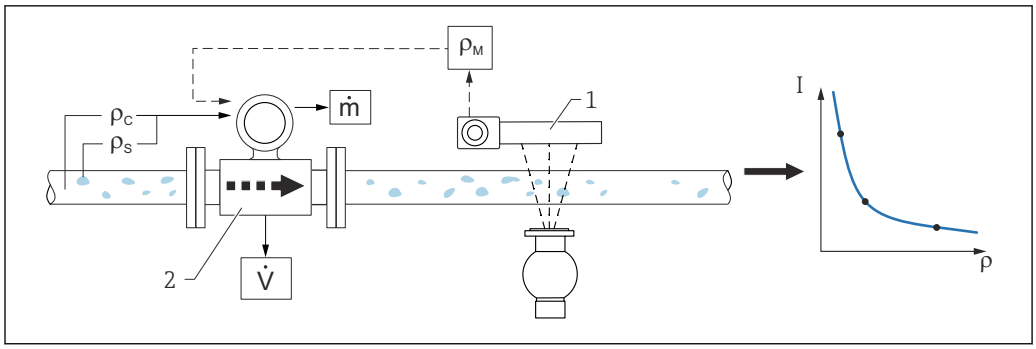
I *Pulse rate (pulses per second, cnt/s)*
% *Measured value*

Measurement of mass flow (liquids)

The density signal determined by the 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.



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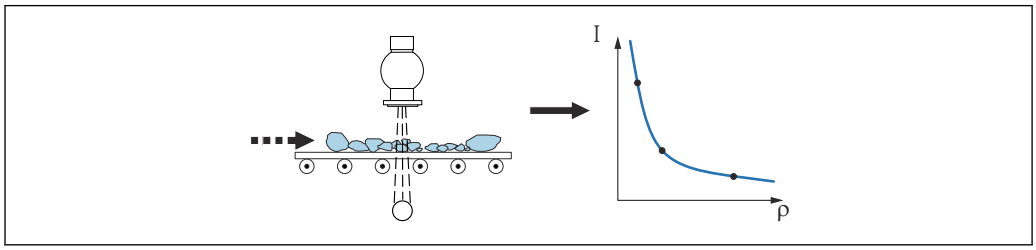
1 *Mass flow measurement (m) using a density meter and a flowmeter. If the density of the solids (ρ_s) and the density of the carrier liquid (ρ_c) are also known, the solids flow rate can be calculated.*

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

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 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.



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

General functions

Decay compensation

The automatic decay compensation function of the FMG50 compensates for the decrease in the activity of the radiation source as a result of radioactive decay. Accurate measurements are therefore possible over the entire operating time of the radiation source.

The following are possible:
- ^{60}Co
- ^{137}Cs
- No decay compensation
- Custom:
  Decay indicated in whole days

For other elements see:
http://www.lnhb.fr/home/nuclear-data/nuclear-data-table/

Gammagraphy detection

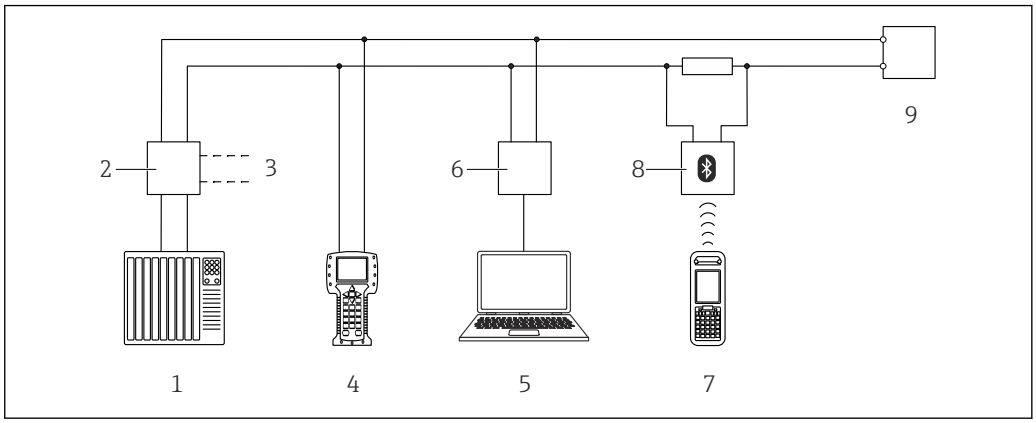
The FMG50 has a function to detect short-term interference radiation. This function displays a message if the measurement is affected by non-destructive gammagraphic material tests in the vicinity of the measuring point.

Excess radiation: In the event of excess radiation, the FMG50 switches off the evaluation of the radiation automatically. The device checks the radiation regularly. As soon as the FMG50 establishes that the radiation has normalized or no more radiation is detected, it resumes normal operation.

Empty pipe detection: see Operating Instructions

System integration

Via HART protocol



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2 *Options for remote operation via HART protocol*

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

Operation via the service interface

- Service interface (CDI) of the measuring device (= Endress+Hauser Common Data Interface)
- Commubox FXA291
- Computer with DeviceCare/FieldCare operating tool

Operation via HART

- With Field Xpert SFX350/SFX370
- With the Commubox FXA195 and the "FieldCare" operating program

Operation via WirelessHART

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

Operation via Bluetooth LE and "SmartBlue APP"

Local operation outside the radiation path

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Input variables

Measured variable

The Gammapilot FMG50 measures the pulse rate (number of pulses per second). This rate is proportional to the intensity of radiation at the detector. From this rate, the Gammapilot FMG50 calculates the measured value:
- Point level (0 % = "radiation path free"; 100 % = "radiation path covered")
- Level (in % or selectable units)
- Position of interface (in %)
- Density (selectable unit)
- Concentration (in %)

Pulse rate:
Max. 60000 cnt/s

Sensitivity

The sensitivity indicates which pulse rate occurs at a local dose rate of 1 µSv/h or 1 %K_2O. The sensitivity depends on the following parameters:
- Type of scintillator
- Measuring range
- Isotope used

The data represent typical values that may vary in specific installation situations due to scattering and partial irradiation of the scintillator.

NaI (Tl) scintillator
Typical sensitivity with lateral irradiation:
- **^{137}Cs:** 675 [(cnt/s)/(µSv/h)] per "inch" measuring range
- **^{60}Co:** 450 [(cnt/s)/(µSv/h)] per "inch" measuring range
- **K_2O:** 10 [(cnt/s)/%K_2O] per "inch" measuring range

PVT scintillator (standard)
Typical sensitivity with lateral irradiation
- **^{137}Cs:** 10 [(cnt/s)/(µSv/h)] per "mm" measuring range
- **^{60}Co:** 5 [(cnt/s)/(µSv/h)] per "mm" measuring range

PVT scintillator (high-temperature version)
Typical sensitivity with lateral irradiation
- **^{137}Cs:** 8 [(cnt/s)/(µSv/h)] per "mm" measuring range
- **^{60}Co:** 4 [(cnt/s)/(µSv/h)] per "mm" measuring range

Typical pulse rates

A radiometric measuring point should be designed in a way such that the following pulse rates, approximately, are obtained:

Level measurement (with empty vessel)
- 2500 cnt/s for ^{137}Cs
- 5000 cnt/s for ^{60}Co

Point level measurement (with free radiation path)
- 500 cnt/s for ^{137}Cs
- 1000 cnt/s for ^{60}Co

Density, concentration, interface and mass flow measurements
- 5000 cnt/s for ^{137}Cs
- 5000 cnt/s for ^{60}Co

Density and concentration measurements
- Depends on the application; information at Endress + Hauser Service or "Gamma Project Team" (gamma.ehlp@endress.com)
- Applicator https://www.endress.com/onlinetools

An application can deliver satisfactory measurement results even if the pulse rate is higher or lower than the values specified here. Information at Endress + Hauser Service or "Gamma Project Team" (gamma.ehlp@endress.com)

Measuring range

Level measurement

In the case of level measurement, the measuring range typically depends on the height of the vessel. To cover the entire measuring range, a scintillator is used that is longer than the measuring range.

Several Gammapilot FMG50 units can be used for measuring ranges >4.5 m (14.76 ft).

An RSG45 or an RMA42 can be used to totalize the individual measured values of all the Gammapilot FMG50 devices used.

For details, see:

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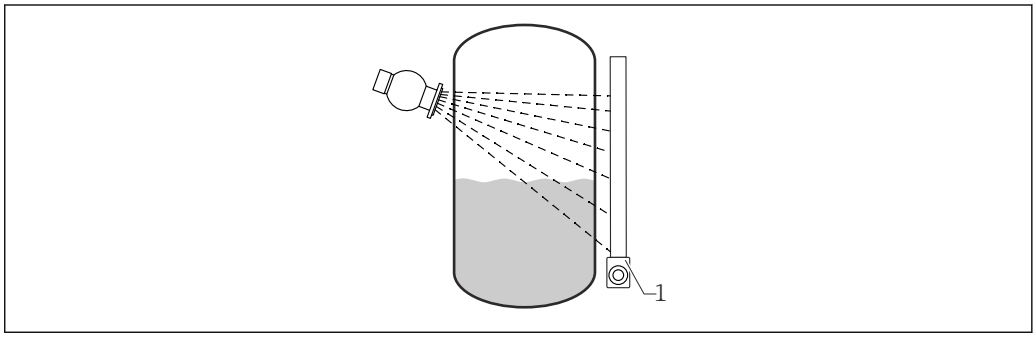

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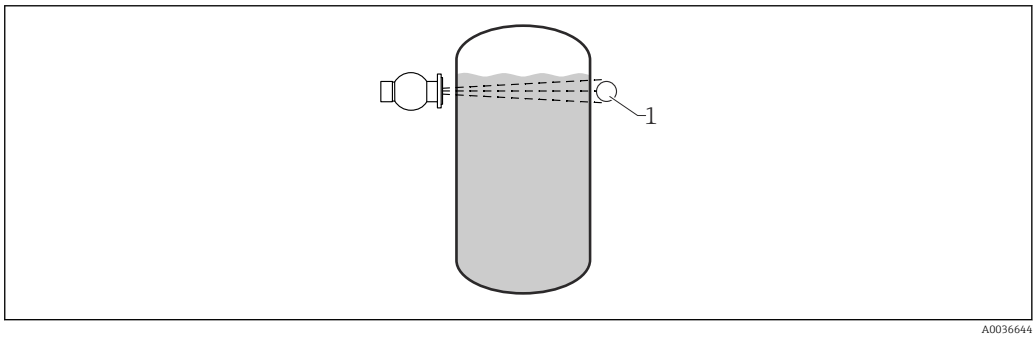
1 Gammapilot FMG50

Point level measurement

In the case of point level measurement, the measuring range is highly localized, almost to a single point.

The measuring range is smaller than the outer diameter of the FMG50 (< 85 mm (3.35 in))

Max. point level detection



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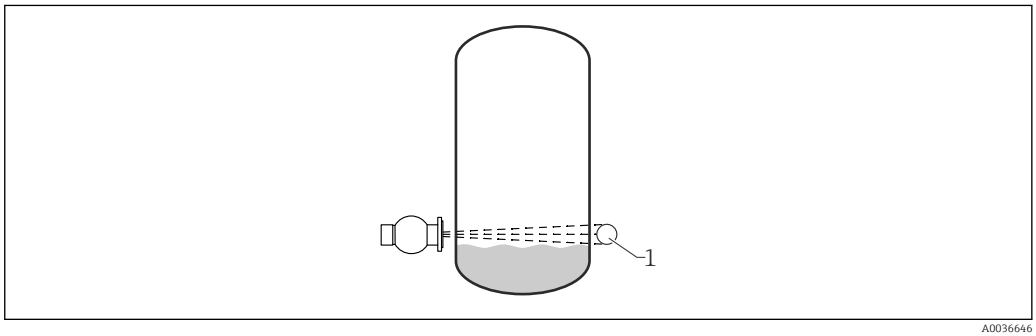
1 Gammapilot FMG50

Min. Point level measurement



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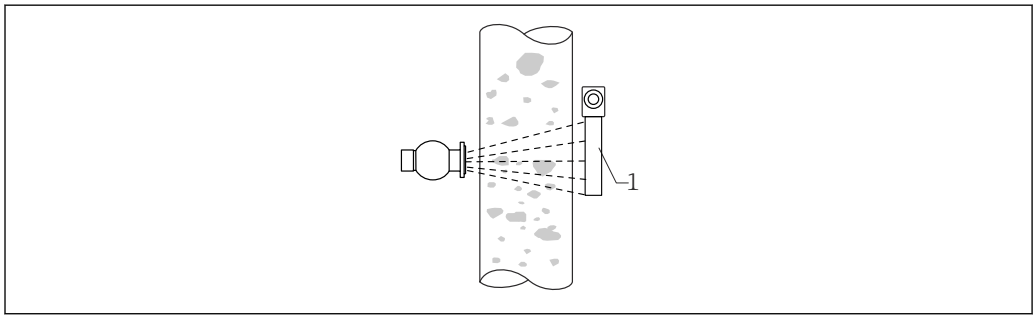
1 Gammapilot FMG50

Density measurement

In the case of density measurement, the density measuring range is defined by the minimum and maximum density of the measured medium.



1 Gammapilot FMG50

Interface measurement

In the case of interface measurement, the measuring range is determined by the possible position of an interface. Here, the 0% position is at the lowest possible point where the interface is to be monitored, while the 100% position is at the highest point.

Concentration measurement with source container and gamma radiation source

In the case of concentration measurement, the measuring range is defined by the minimum and maximum concentration of the measured medium.

Concentration measurement with radiating media

In the case of radiating media, the measuring range is defined by the minimum and maximum concentration of the medium.

Measurement of mass flow

For the FMG50, mass flow measurement constitutes a density measurement.

The density measuring range is defined by the minimum and maximum density of the measured medium.

Conditions/prerequisites for applications in safety-related operation

See the Functional Safety Manual

"Slave" operating mode: in this measuring mode, the measured pulse rate is output for further processing in a connected controller.

This mode is not permitted for "functional safety"

Output variables

Output signal

4 to 20 mA with HART protocol

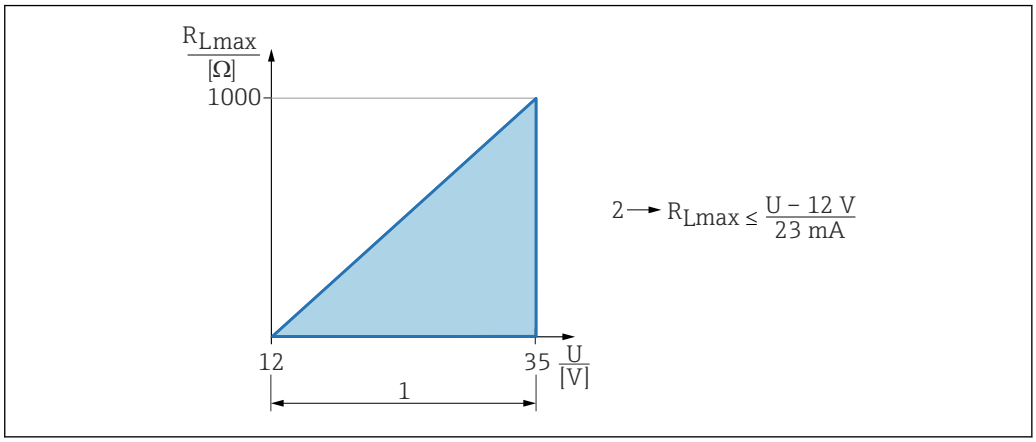
The current output offers a choice of three different operating modes:
- 4.0 to 20.5 mA
- NAMUR NE043: 3.8 to 20.5 mA
- US mode: 3.9 to 20.8 mA

Error signal

Errors occurring during commissioning or operation are signaled in the following way:
- Error symbol, error code and error description on the display module.
- Current output:
  - MAX, 110 %, 22 mA
  - MIN, -10 %, 3.6 mA

Load

- Max. load: 500 Ω
- Min. load for HART communication: 250 Ω



1 12 to 35 V power supply
2 R_{Lmax} Maximum load resistance
U Supply voltage

The diagram refers to the minimum possible terminal voltage of 12 V.

If Bluetooth is required, the terminal voltage should be at least 14 V. R_{Lmax} is therefore 910 Ω.

Output damping

The output damping is user-definable in the range from 0 to 999.9 s

Power supply

Supply voltage

Protected against reverse polarity
- Non-Ex: 14 to 35 V_{DC}
- Ex-i: 14 to 30 V_{DC}

Bluetooth communication with the device is possible with a supply voltage of 14 V or higher. The background lighting of the display is only guaranteed with a supply voltage ≥ 16 V. The measurement function is guaranteed as of a terminal voltage of 12 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 the device is restarted and sufficient power is supplied.

Power consumption

Power consumption: < 0.81 W

Overvoltage category

- Overvoltage category II
- Pollution degree II

Protection class

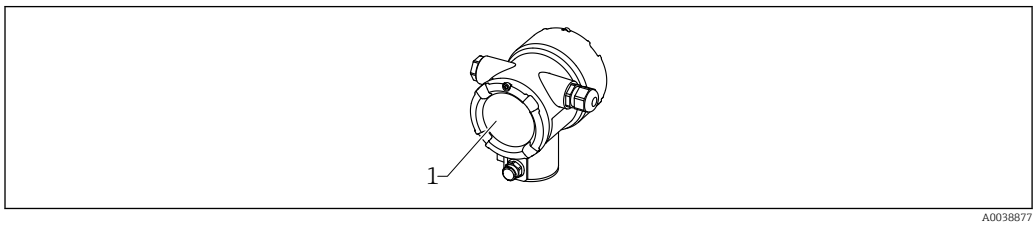
Class 1

Potential equalization

The device must be included in the local potential equalization system.

Electrical connection

Connection compartment



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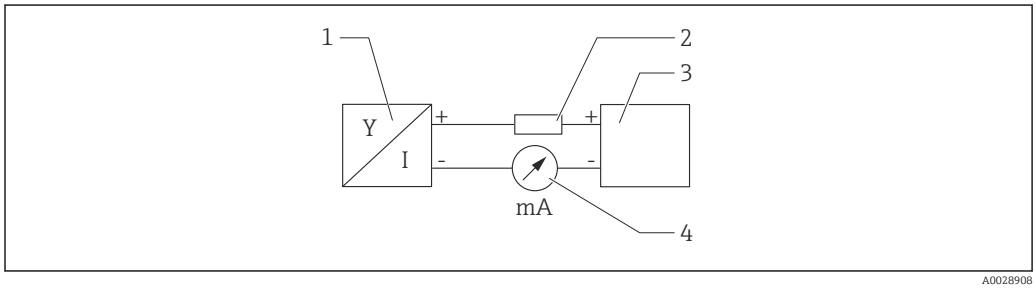
1 Connection compartment

4 to 20 mA HART connection

Connection of the device with HART communication, power source and 4 to 20 mA display



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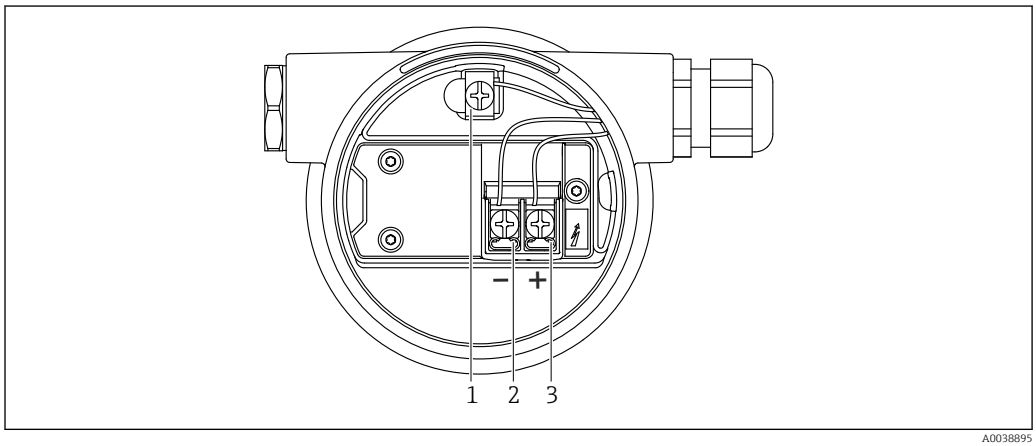
3 Block diagram of HART connection

1 Device with HART communication
2 HART resistor
3 Power supply
4 Multimeter or ammeter

The HART communication resistor of 250 Ω in the signal line is always necessary in the case of a low-impedance power supply.

The voltage drop to be taken into account is:
Max. 6 V for 250 Ω communication resistor

Terminal assignment



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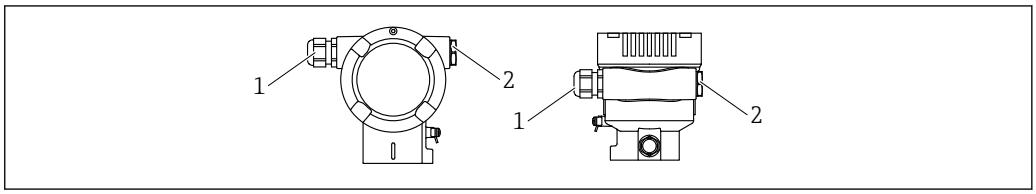
4 Connection terminals and ground terminal in the connection compartment

1 Internal ground terminal (to ground the cable shield)
2 Negative terminal
3 Positive terminal

- Non-Ex: supply voltage: 14 to 35 VDC
- Ex-i: supply voltage: 14 to 30 VDC

Cable entries



1 Cable entry
2 Dummy plugs

The number and type of cable entries depend on the device version ordered. The following are possible:

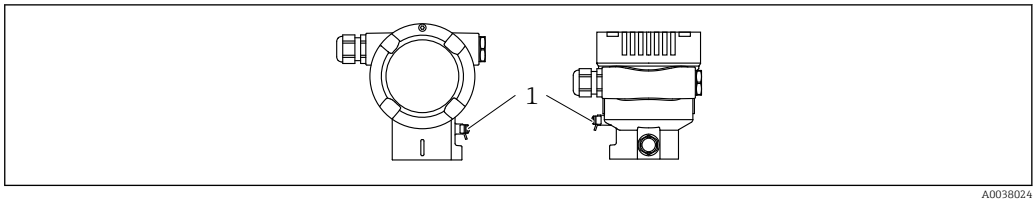
- M20 coupling, plastic, IP66/68 NEMA Type 4X/6P
- M20 coupling, nickel-plated brass, IP66/68 NEMA Type 4X/6P
- M20 coupling, 316L, IP66/68 NEMA Type 4X/6P
- M20 thread, IP66/68 NEMA Type 4X/6P
- G1/2 thread, IP66/68 NEMA Type 4X/6P, with enclosed M20 to G1/2 adapter
- NPT1/2 thread, IP66/68 NEMA Type 4X/6P
- M12 plug, IP66/68 NEMA Type 4X/6P
- HAN7D plug, 90 deg. IP65 NEMA Type 4x

Connecting cables should be routed away from the housing from below to prevent moisture from penetrating the connection compartment. Otherwise, a drip loop should be provided or a weather protection cover should be used.

Please follow the enclosed installation instructions if a G1/2 entry is used.

Potential equalization

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



1 Ground terminal for connecting the potential matching line

⚠ CAUTION

▶ Please refer to the separate documentation on applications in hazardous areas for the safety instructions

For optimum electromagnetic compatibility, the potential matching line should be as short as possible and at least 2.5 mm² (14 AWG) in cross-section.

Overvoltage protection (optional)

Product structure, feature 610 "Accessory mounted", option "NA"

- Overvoltage protection:
  - Nominal functioning DC voltage: 600 V
  - Nominal discharge current: 10 kA
- Surge current check î = 20 kA satisfied as per DIN EN 60079-14: 8/20 µs
- Arrester AC current check I = 10 A satisfied

NOTICE

Device could be destroyed!

▶ Devices with integrated overvoltage protection must be grounded.

Rated cross-section

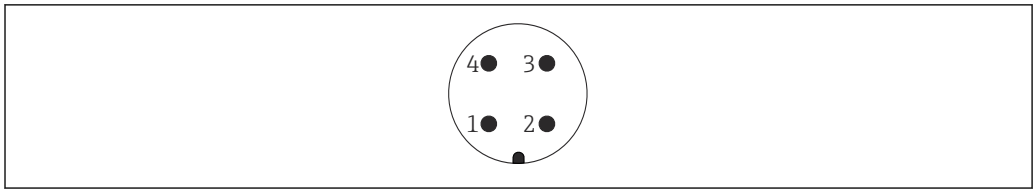
Protective ground or grounding of the cable shield: rated cross-section > 1 mm² (17 AWG)

Rated cross-section of 0.5 mm² (AWG20) to 2.5 mm² (AWG13)

Fieldbus connector

In the case of device versions with a fieldbus connector, the housing does not have to be opened to establish the connection.

Pin assignment for connector M12-A



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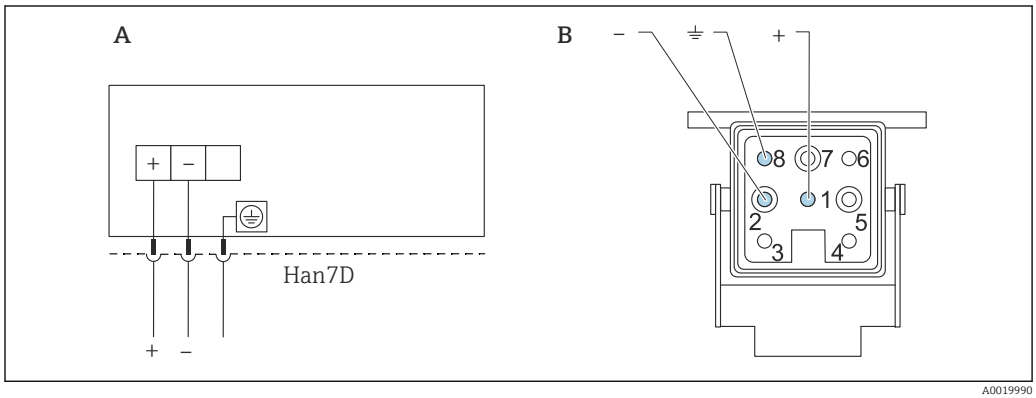
Pin 1: Signal +
Pin 2: Not used
Pin 3: Signal –
Pin 4: Ground

Material: CuZn, gold-plated contacts of the plug-in jack and plug

Connection for devices with Harting plug Han7D



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A Electrical connection for devices with Harting plug Han7D
B View of the connection on the device

Material: CuZn, gold-plated contacts of the plug-in jack and plug

FMG50 with RIA15

The RIA15 remote indicator 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

⚠ CAUTION

▶ Pay attention to the Safety Instructions (XAs) when using the Gammapilot FMG50 with the remote indicator RIA15 in hazardous environments:

- XA01028R
- XA01464K
- XA01056K
- XA01368K
- XA01097K

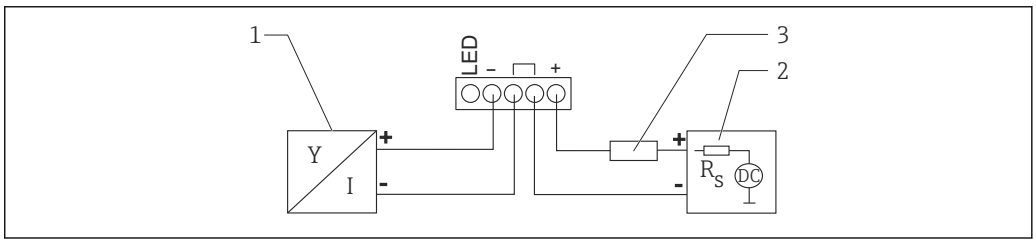
Terminal assignment RIA15

- **+**
  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

Connection of the HART device and RIA15 without backlighting



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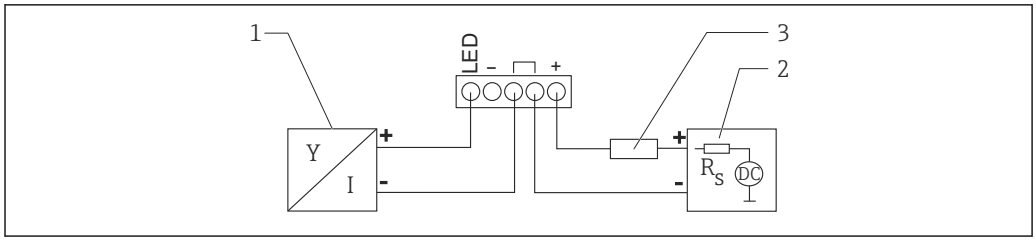
5 Block diagram of HART device with RIA15 process indicator without light

1 Device with HART communication
2 Power supply
3 HART resistor

Connection of the HART device and RIA15 with backlighting



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

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

FMG50, RIA15 with installed HART communication resistor module

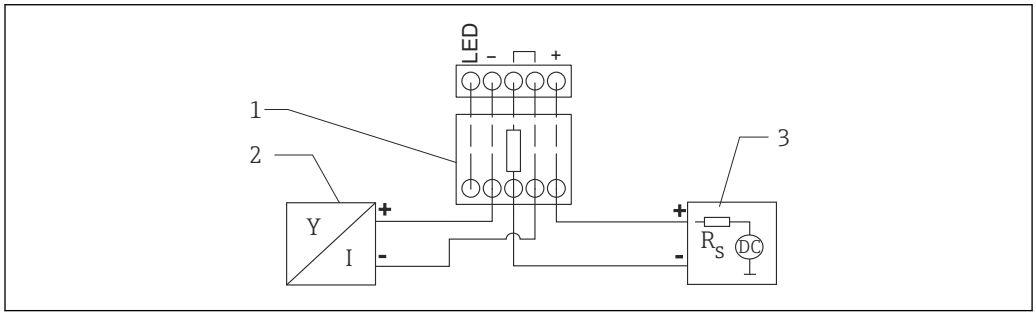
The HART communication module for installation in the RIA15 can be ordered together with the device.

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

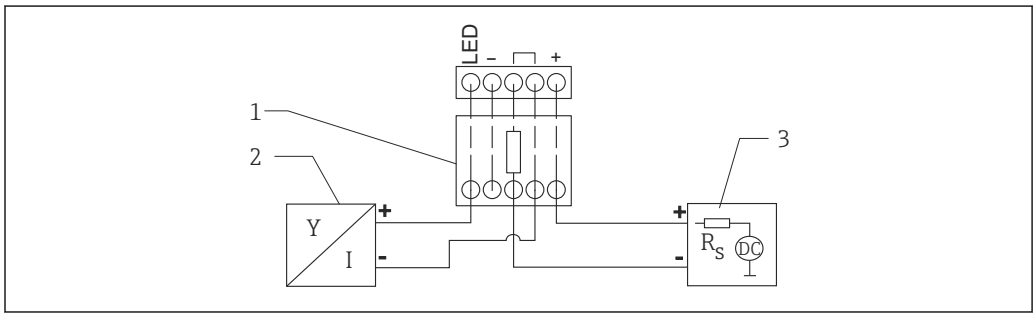
Connection of the HART communication resistor module, RIA15 without backlighting



7 *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



8 *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*

Wiring

⚠ CAUTION

Note the following before connecting:

- 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.
- Connect the potential matching line to the external ground terminal of the transmitter before connecting the device.
- Connect the protective ground to the protective ground terminal.
- 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.

1. Release the cover lock
2. Unscrew the cover
3. Guide the cables into the cable glands or cable entries
4. Connecting the cable
5. Tighten the cable glands or cable entries so that they are leak-tight
6. Screw the cover securely back onto the connection compartment
7. Tighten the cover lock

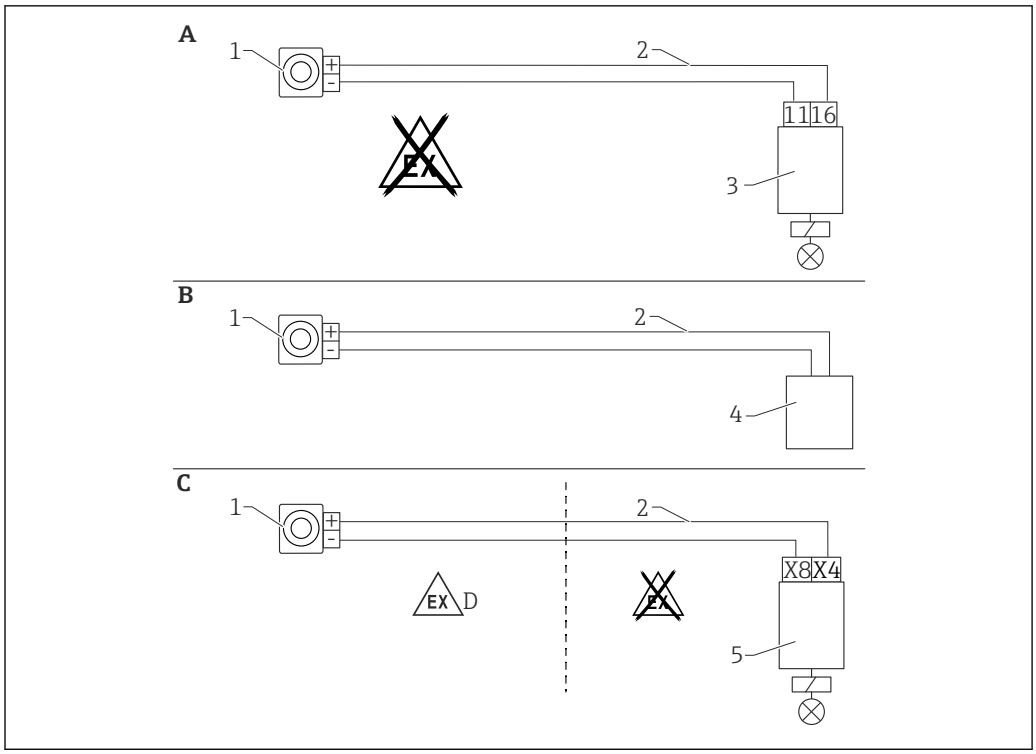
Housing thread
The threads of the electronics and connection compartment can be coated with an anti-friction coating.
The following applies for all housing materials:
☒ Do not lubricate the housing threads.

Wiring examples

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

Cascade mode with 2 FMG50 units

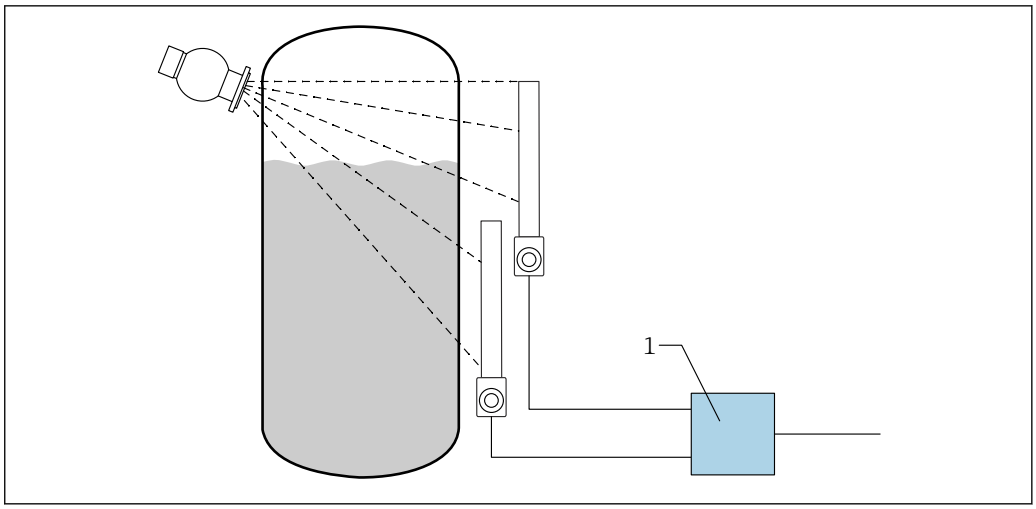
Level measurement: FMG50 with RMA42 process transmitter

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.



9 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

Cascade mode with more than 2 FMG50 units

Level measurement: FMG50 with Memograph M RSG45

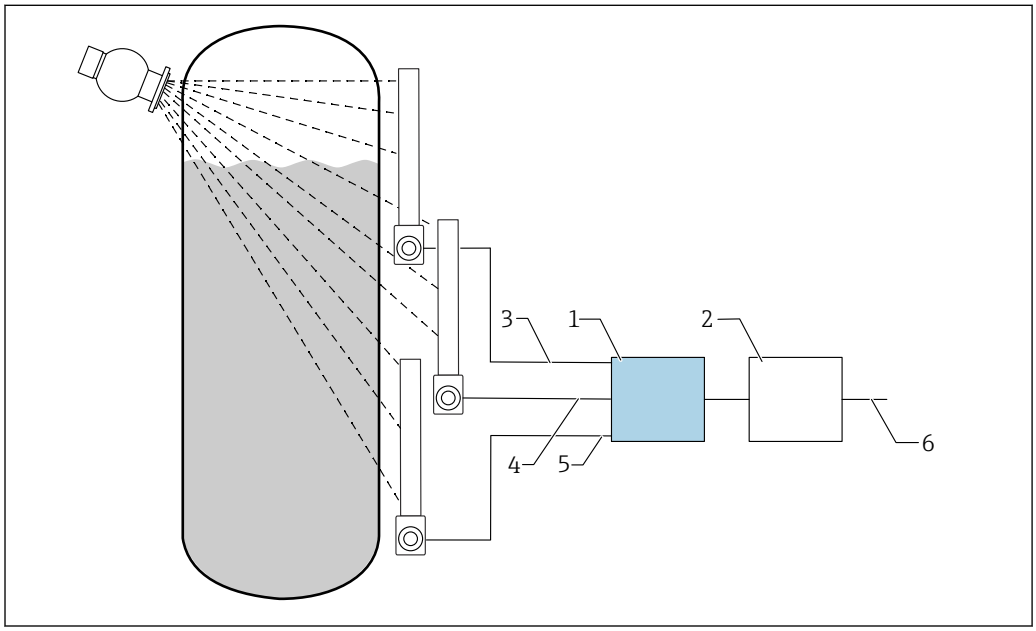
Conditions requiring several FMG50 units:
- Large measuring ranges
- Special tank geometry

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.



10 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
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

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

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

Post-connection check

WARNING

- Only operate the device with the covers closed

After wiring the device, carry out the following checks:

❑ Is the potential matching line connected?

❑ Is the terminal assignment correct?

❑ Are the cable glands and dummy plugs screwed tight?

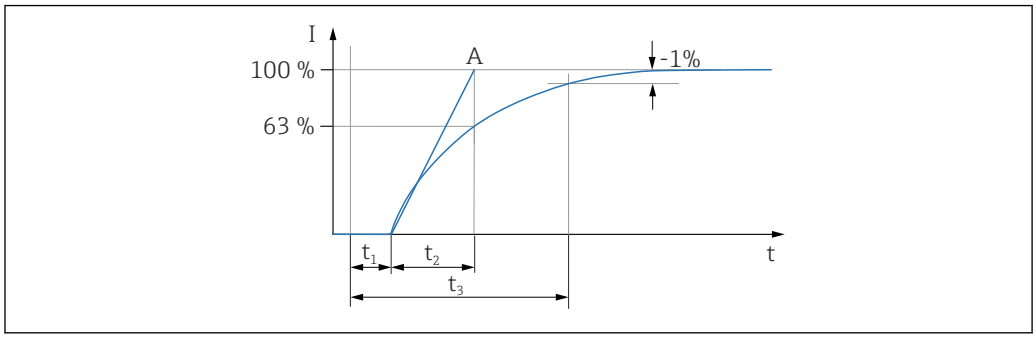
❑ Are the fieldbus connectors properly secured?

❑ Are the covers screwed down correctly?

Measurement accuracy/stability

Dead time, time constant, settling time

Presentation of the dead time, time constant and settling time as per DIN EN 61298-2



t_1 *Dead time*
t_2 *Time constant*
t_3 *Settling time*
A *Stable full scale value*

Dynamic behavior, current output (HART electronics)

- Dead time (t_1):
  - Unmodulated: 250 ms
  - Modulated: 400 ms
- Time constant T63 (t_2): adjustable 0.0 to 999.9 s
- Settling time (t_3):
  - Unmodulated: minimum 450 ms
  - Modulated: minimum 20 s

Dynamic behavior, digital output (HART electronics)

- Dead time (t_1):
  - **Unmodulated:**
    - Minimum: 400 ms
    - Maximum: 1 210 ms
  - **Modulated:**
    - Minimum: 4 150 ms
    - Maximum: 4 960 ms
- Time constant T63 (t_2):
  - Minimum: 310 ms + adjustable 0.0 to 999.9 s
  - Maximum: 1 100 ms + adjustable 0.0 to 999.9 s
- Settling time (t_3):
  - Unmodulated: minimum 600 ms
  - Modulated: minimum 21 s

Reading cycle

- Acyclic: max. 3/s, typical 1/s (depends on command # and number of preambles)
- Cyclic (burst): max. 3/s, typical 2/s

The device commands the BURST MODE function for cyclic value transmission via the HART communication protocol.

Cycle time (update time)

Cyclic (burst): min. 300 ms

Warm-up time (according to IEC62828-4)

≤10 s

Reference operating conditions

- Temperature: 20 °C (68 °F), ±10 °C (±50 °F)
- Pressure: 1013 mbar (15 psi), ±20 mbar (±0.29 psi)
- Humidity: not relevant
- Pulse rate: 4000 cnt/s

Measured value resolution

1 µA

Ambient temperature effect

NaI (Tl) crystal

- Temperature range: −40 to +50 °C (−40 to +122 °F)
  Influence of ambient temperature: ±0.1 %
- Temperature range: −40 to +80 °C (−40 to +176 °F)
  Influence of ambient temperature: −0.1 to +0.7 %

PVT scintillator (standard)

Temperature range: −40 to +60 °C (−40 to +140 °F)
Influence of ambient temperature: ±0.5 %

PVT scintillator (high-temperature version)

- Temperature range: +5 to +60 °C (41 to +140 °F)
  Influence of ambient temperature: ±0.5 %
- Temperature range: −20 to +80 °C (−4 to +176 °F)
  Influence of ambient temperature: ±1.5 %

Statistical fluctuation of the radioactive decay

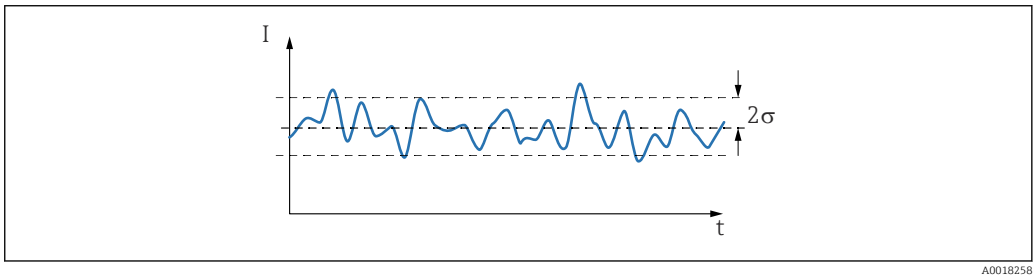
Radioactive decay of the radiation source is subject to statistical fluctuations. For this reason, the pulse rate displayed fluctuates around its mean value. The standard deviation σ is an indicator of the intensity of these fluctuations. It is calculated as follows:

$\sigma = \sqrt{I} / \sqrt{\tau}$

Where:

- I is the pulse rate
- τ is the output damping (can be selected by the user), (device parameter: damping output)

Various confidence intervals can be calculated from the standard deviation. The 2σ confidence interval is usually used for the planning of radiometric measuring systems. Approx. 95% of all pulse rates displayed deviate by less than 2σ from the mean value. The deviation is greater than 2σ in only about 5% of all cases.



11 95% of all measured values are within the 2σ confidence interval.

In order to calculate the relative (%) statistical measurement error, the standard deviation is divided by the pulse rate:

$2\sigma_{rel} = 2\sigma / I = 2 / \sqrt{(I\,\tau)}$

Example:

- I = 1000/s
- τ = 10 s

$2\sigma_{rel} = 0.02 = 2\ \%$

As a general rule, the statistical signal fluctuation can be reduced by increasing the output damping value (device parameter: damping output) or the radiation intensity.

Installation conditions

General

- The angle of emission of the source container must be exactly aligned 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 blocked to ensure that it is not possible to reach into this area.
- 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 PV: "Heat shield 1200-3000 mm, PVT"
  - Feature 620, option PW: "Heat shield NaI, 200-800 mm, PVT"
- Terminals can optionally be ordered with the device
- The mounting device must be installed in such a way as to withstand the weight of the Gammapilot FMG50 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.

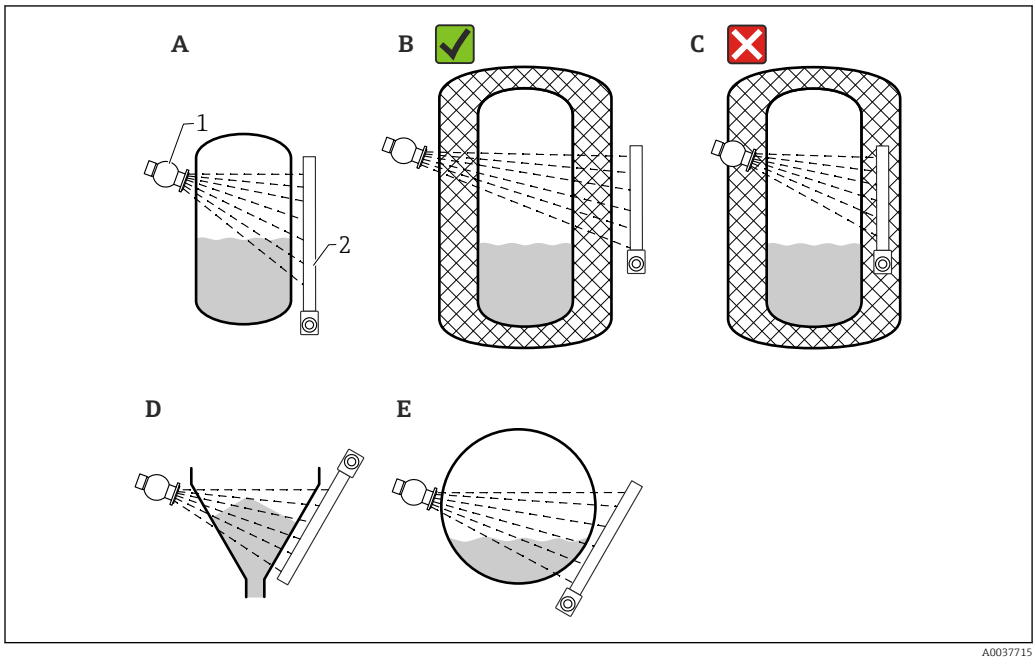
For heat shielding on devices > 3 000 mm, contact the Endress+Hauser sales organization.

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



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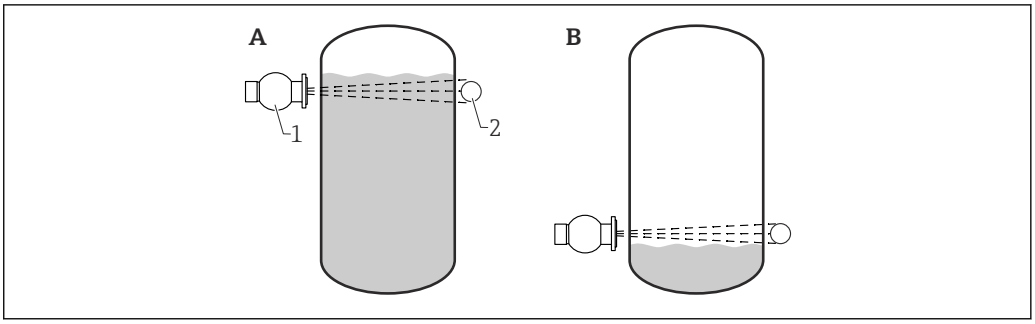
A Vertical cylinder; the Gammapilot FMG50 is mounted vertically with the detector head pointing either downwards or upwards, the gamma radiation is aligned to the measuring range.
B Correct: Gammapilot FMG50 mounted outside the tank insulation
C Incorrect: Gammapilot FMG50 mounted inside the tank insulation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

Mounting requirements for point level measurement

Conditions

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

Measuring system arrangement



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

Mounting requirements for density measurement

Conditions

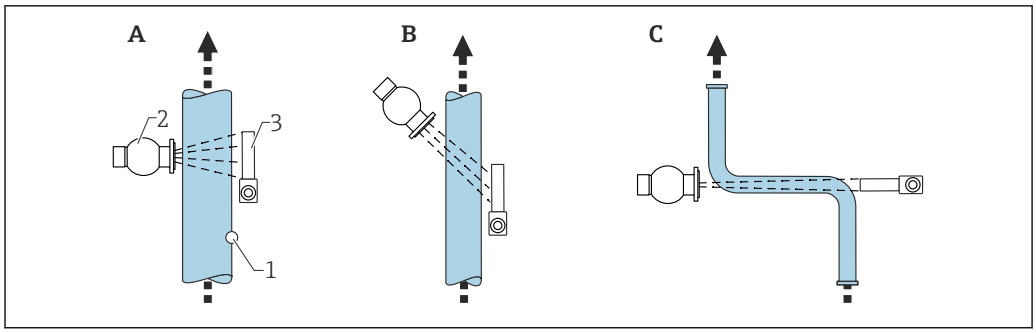
- If possible, density should be measured on vertical pipes with forward flow from bottom to top.
- If only horizontal pipes are accessible, the path of the beam should also be arranged horizontally to minimize the influence of air bubbles and deposits.
- The Endress+Hauser clamping device or an equivalent 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. Therefore, it is advisable to use diagonal irradiation or a measuring path for small pipe diameters.

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

2) 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

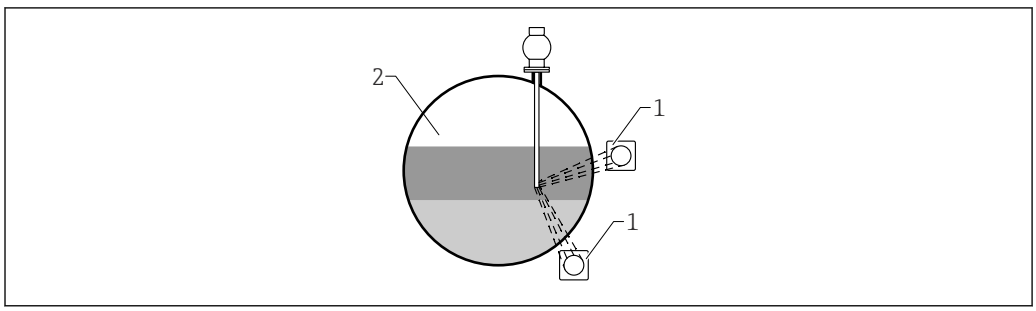
- To increase the accuracy of density measurements, the use of a collimator is recommended. The collimator screens the detector against background radiation.
- When planning, the total weight of the measuring system must be taken into consideration.
- An FHG51 clamping device is available as an accessory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

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 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



A0038167

1 Gammapilot (2 pcs)
2 Interface measurement

Description

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

For more information, see:

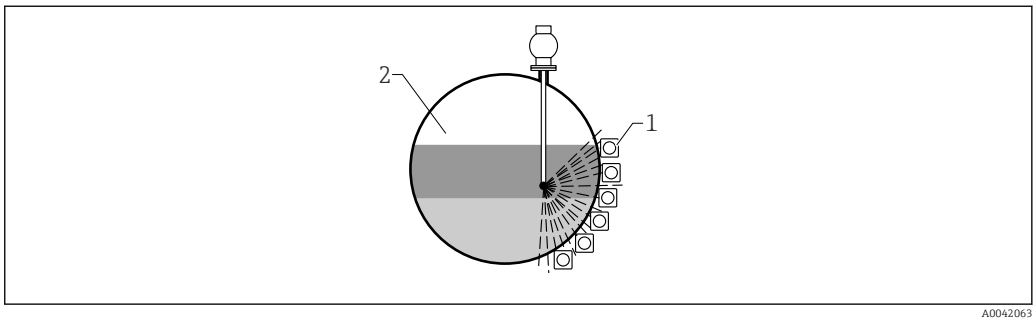
CP01205F

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



A0042063

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)

For more information, see:

CP01205F

Mounting requirements for concentration measurements

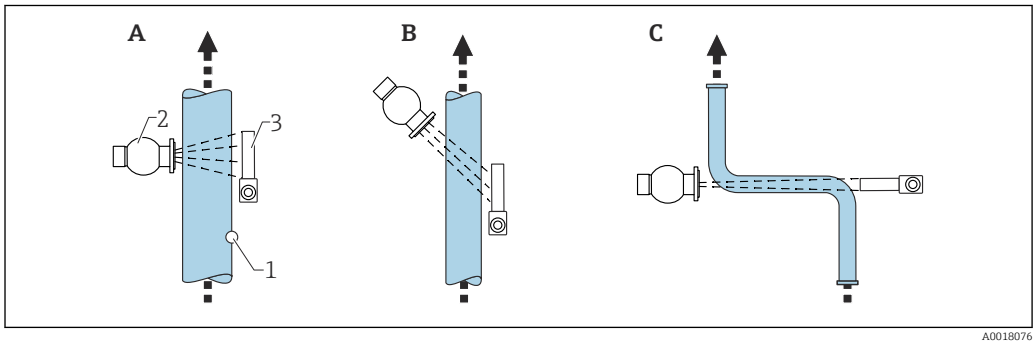
Conditions

- 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 must 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. Therefore, it is advisable to use diagonal irradiation or a measuring path for small pipe diameters.

To select the measuring system arrangement please contact the Endress+Hauser sales organization or use the Applicator™configuration software. [3)]



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

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.

Measurement of the mass flow of radiating media

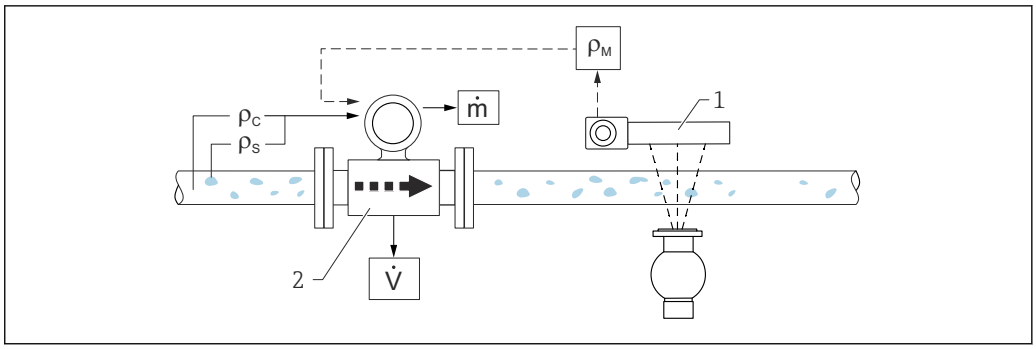
In the case of belt scales and pipes, the concentration of the radiating medium can be measured in the sample. Here, the device is mounted above or below the conveyor belt so that it is parallel to the belt direction, or is mounted on the pipe. The intensity of the radiation received is proportional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

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.

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



A0018093

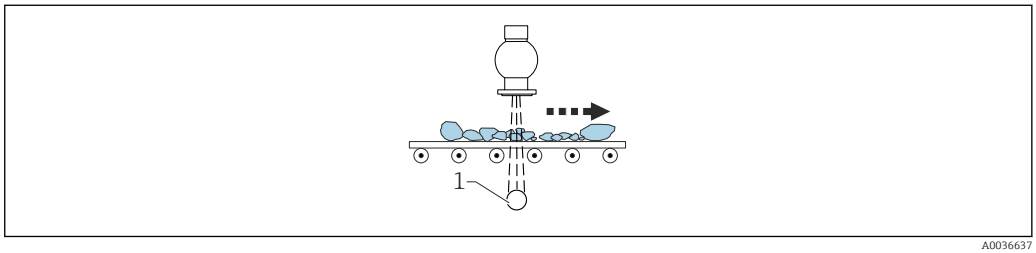
12 *Mass flow measurement (m) using a density meter and a flowmeter. If the density of the solids (ρ_s) and the density of the carrier liquid (ρ_c) are also known, the solids flow rate can be calculated.*

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.



A0036637

1 *Gammapilot FMG50*

Ambient conditions

Ambient temperature

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

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

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

The temperature range may be restricted for applications in hazardous areas. Observe the maximum ambient temperature indicated in the relevant approval. Avoid exposure to direct sunlight; Use a weather protection cover if necessary.

Storage temperature

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)
−40 to +80 °C (−40 to +176 °F)

- As the device contains a battery, it is recommended to store the device at room temperature in a location that does not receive direct sunlight
- The battery is needed to preserve date and time information if the device is not supplied with power

Climate class

IEC 60068-2-38 Test Z/AD

Operating height

Up to 5 000 m (16 404 ft) above sea level.

Degree of protection

- When housing is closed:
  - IP68 (at 1.83 m under water), NEMA Type 6P
  - IP66, NEMA Type 4X
- When housing is open: IP20, NEMA Type 1

The follows applies if an M12 plug is used:

- When housing is closed and connecting cable is plugged in: IP66/67, NEMA Type 4X
- When housing is open and/or connecting cable is not plugged in: IP20, NEMA type 1

In the case of the M12 plug, the degree of protection IP66/67, NEMA Type4X only applies under the following conditions:

- The connecting cable used is plugged in and screwed tight
- The connecting cable used is specified to at least IP67 NEMA Type 4X

The follows applies if an HAN7D plug is used:

- When housing is closed and connecting cable is plugged in: IP65, NEMA Type 2
- When housing is open or connecting cable is not plugged in: IP20, NEMA Type 1

Vibration resistance

DIN EN 60068-2-64; test Fh; 5 to 2000 Hz, $1(m/s^2)^2/Hz$

Shock resistance

IEC 60068-2-27; test Ea; 30 g, 18 ms, 3 shocks/direction/axis

Shock resistance of NaI (Tl) 8" version

IEC 60654-3; test: 40 m/s^2, 5 ms

Not to be used on rail or road vehicles

Avoid shocks and vibrations

Electromagnetic compatibility (EMC)

Electromagnetic compatibility in accordance with all of the relevant requirements of the EN 61326 series and NAMUR Recommendation EMC (NE 21). For details, please refer to the Declaration of Conformity [4)].

Maximum measurement error during EMC testing: < 0.5 % of the span.

Process conditions

General

- The measuring principle generally does not depend on the process conditions
- Take radiating media into consideration
  The FHG65 gamma modulator must be used for radiating media. This does not apply for concentration measurement with radiating media.

Process temperature

In the event of high process temperatures, ensure sufficient insulation between the process vessel and detector (see -> "Ambient temperature"). If necessary, use the heat shield that is optionally available.

Process pressure

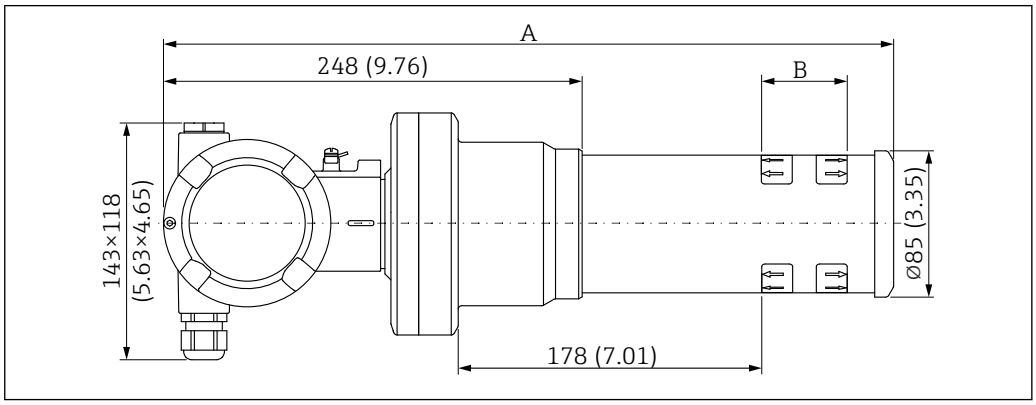
Consider the influence of the pressure on the gas phase when calculating the necessary activity and during adjustment.

4) Available for download at www.de.endress.com.

Mechanical construction

Dimensions, weights

Gammapilot FMG50



A0055680

- **Version NaI (Tl) 2" :**
  - Total length A: 430 mm (16.93 in)
  - Total weight: 11.60 kg (25.57 lb)
  - Measuring range length B: 51 mm (2 in)
- **Version NaI (Tl) 4" :**
  - Total length A: 480 mm (18.90 in)
  - Total weight: 12.19 kg (26.87 lb)
  - Measuring range length B: 102 mm (4 in)
- **Version NaI (Tl) 8" :**
  - Total length A: 590 mm (23.23 in)
  - Total weight: 13.00 kg (28.63 lb)
  - Measuring range length B: 204 mm (8 in)
- **Version PVT 50 :**
  - Total length A: 430 mm (16.93 in)
  - Total weight: 11.20 kg (24.69 lb)
  - Measuring range length B: 50 mm (1.96 in)
- **Version PVT 100 :**
  - Total length A: 480 mm (18.90 in)
  - Total weight: 11.50 kg (25.35 lb)
  - Measuring range length B: 100 mm (3.94 in)
- **Version PVT 200 :**
  - Total length A: 590 mm (23.23 in)
  - Total weight: 12.10 kg (26.68 lb)
  - Measuring range length B: 200 mm (8 in)
- **Version PVT 400 :**
  - Total length A: 790 mm (31.10 in)
  - Total weight: 13.26 kg (29.23 lb)
  - Measuring range length B: 400 mm (16 in)
- **Version PVT 800 :**
  - Total length A: 1 190 mm (46.85 in)
  - Total weight: 15.54 kg (34.26 lb)
  - Measuring range length B: 800 mm (32 in)
- **Version PVT 1200 :**
  - Total length A: 1 590 mm (62.60 in)
  - Total weight: 17.94 kg (39.55 lb)
  - Measuring range length B: 1 200 mm (47 in)
- **Version PVT 1600 :**
  - Total length A: 1 990 mm (78.35 in)
  - Total weight: 20.14 kg (44.40 lb)
  - Measuring range length B: 1 600 mm (63 in)
- **Version PVT 2000 :**
  - Total length A: 2 390 mm (94.09 in)
  - Total weight: 22.44 kg (49.47 lb)
  - Measuring range length B: 2 000 mm (79 in)

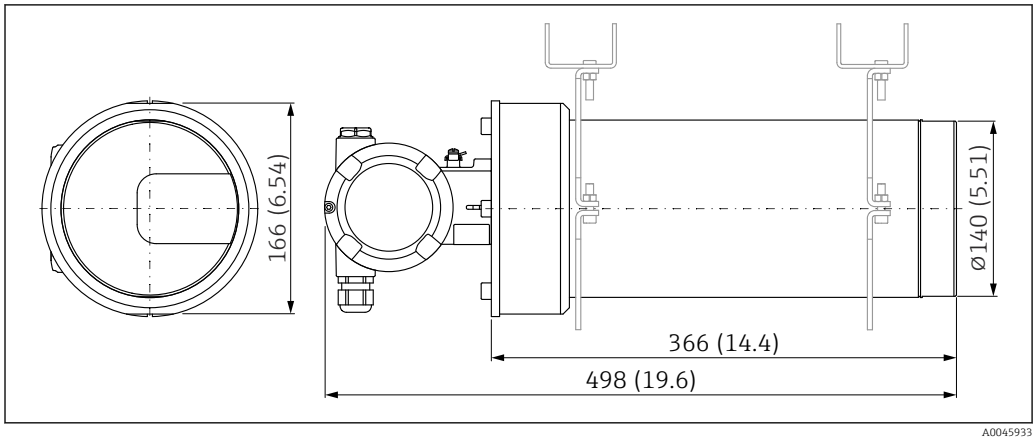
- **Version PVT 2400 :**
  - Total length A: 2 790 mm (109.84 in)
  - Total weight: 24.74 kg (54.54 lb)
  - Measuring range length B: 2 400 mm (94 in)
- **Version PVT 3000 :**
  - Total length A: 3 390 mm (133.46 in)
  - Total weight: 28.14 kg (62.04 lb)
  - Measuring range length B: 3 000 mm (118 in)
- **Version PVT 3500 :**
  - Total length A: 3 890 mm (153.15 in)
  - Total weight: 30.91 kg (68.14 lb)
  - Measuring range length B: 3 500 mm (137.8 in)
- **Version PVT 4000 :**
  - Total length A: 4 390 mm (172.83 in)
  - Total weight: 33.76 kg (74.42 lb)
  - Measuring range length B: 4 000 mm (157.48 in)
- **Version PVT 4500 :**
  - Total length A: 4 890 mm (192.52 in)
  - Total weight: 36.61 kg (80.71 lb)
  - Measuring range length B: 4 500 mm (177.17 in)

The weight data refer to the stainless steel housing versions. The aluminum housing versions are 2.5 kg (5.51 lb) lighter.

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



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

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

Materials

Two different housing versions are available for the Gammapilot FMG50.

FMG50 with stainless steel housing (HS27)

Product structure, feature 040 "Housing, material":
Option K: **316L**

FMG50 with aluminum housing (HA27)

Product structure, feature 040 "Housing, material":
Option J: **aluminum**

Sensor housing

- Sensor housing: 316L
- Sensor housing seal: EPDM

Devices with NaI (Tl) scintillator

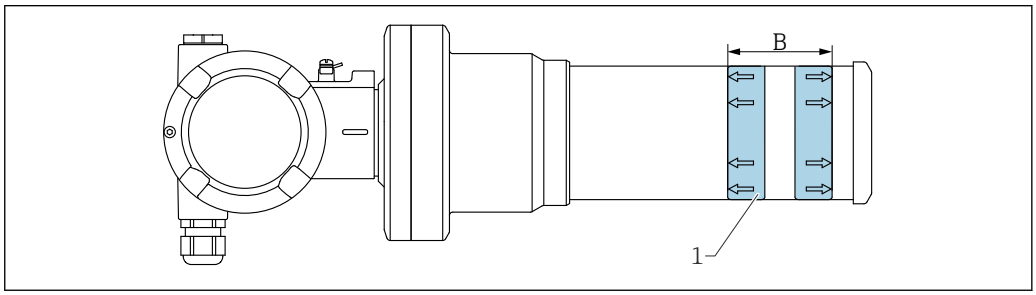
Product structure, feature 090 "Sensor length, material":
Option A, B, C

This device contains more than 0.1% sodium iodide with CAS no. 7681-82-5

Measuring range marks

The measuring range marks are located on the detector pipe.

They indicate the position and length of the measuring range (sensitive area).



1 Measuring range marks
B Measuring range

Operability

Electronic insert / display

The electronic insert has two pushbuttons. Simple calibration for the level and point level can be performed via the push buttons.

Remote operation

Operation with FieldCare, DeviceCare

FieldCare and DeviceCare are Endress+Hauser asset management tools based on FDT technology. With FieldCare, you can configure all Endress+Hauser devices as well as devices from other manufacturers that support the FDT standard. Hardware and software requirements can be found on the Internet at: www.de.endress.com -> Search: FieldCare -> FieldCare -> Technical data.

FieldCare and DeviceCare support the following functions:
- Configuration of transmitters in online mode
- Loading and saving device data (upload/download)
- Documentation of the measuring point

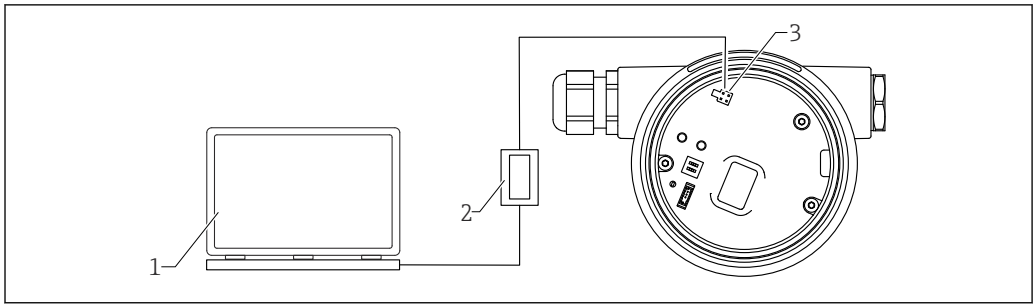
Connection options:
- HART via Commubox FXA195 and USB interface of a computer
- Commubox FXA291 via the service interface

Operation via CDI interface

Commubox FXA291
Order number: 51516983
Connects Endress+Hauser field devices with a CDI interface (Endress+Hauser Common Data Interface) and the USB port of a computer or laptop.

TI00405C

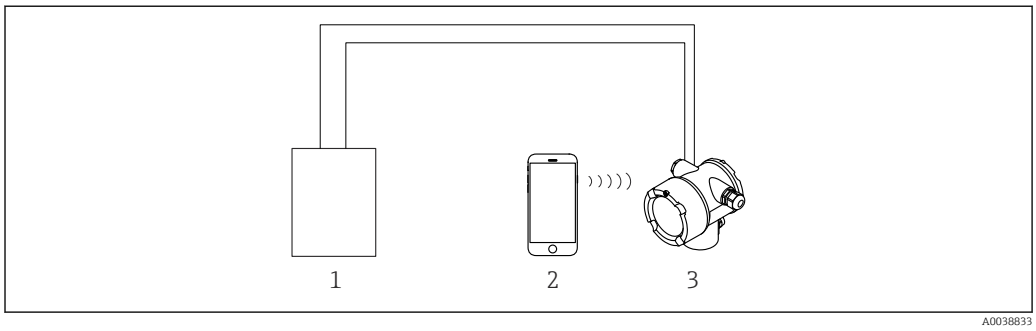
DeviceCare/FieldCare via service interface (CDI)



14 *DeviceCare/FieldCare via service interface (CDI)*

1 *Computer with DeviceCare/FieldCare operating tool*
2 *Commubox FXA291*
3 *Service interface (CDI) of the device (= Endress+Hauser Common Data Interface)*

Via Bluetooth® wireless technology (optional)



15 *Operation via SmartBlue (app)*

1 *Transmitter power supply unit*
2 *Smartphone / tablet with SmartBlue (app)*
3 *Transmitter with Bluetooth module*

SmartBlue app

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

16 *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.

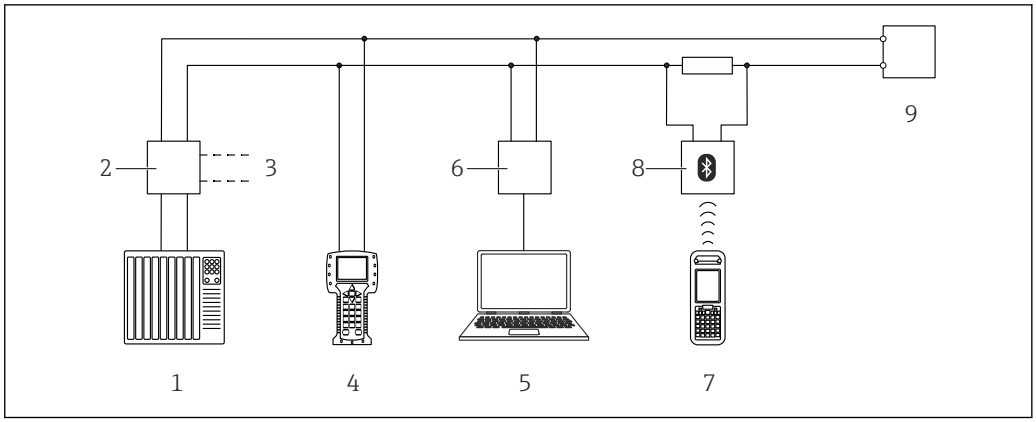
For commissioning, see the "Commissioning Wizard" section

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.

Via HART protocol

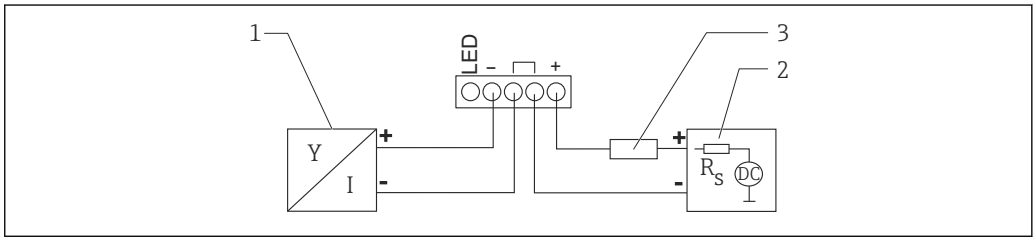


17 *Options for remote operation via HART protocol*

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

Local operation

Operation with RIA15



18 *Block diagram FMG50, with RIA15 process indicator*

1 *Gammapilot FMG50*
2 *Power supply*
3 *HART resistor*

The Gammapilot FMG50 can be configured for the basic setup using the RIA15 indicator

For details refer to

TI01043K

BA01170K

Certificates and approvals

The availability of approvals and certificates can be called up daily via the Product Configurator.

Functional safety	SIL 2/3 according to IEC 61508, see: "Functional Safety Manual" FY01007F
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
Ex approval	The Ex certificates available are listed in the ordering information. Observe the related Safety Instructions (XA) and Control Drawings (ZD). **Explosion-protected smartphones and tablets** Only mobile end devices with Ex approval may be used in hazardous areas.
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
Certificates	The certificates are available via the Product Configurator: www.us.endress.com/en/field-instruments-overview/product-finder -> Select product -> Configure
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.
EAC	Approval for EAC
Overfill prevention	WHG (German Water Resources Act) for point level detection

Ordering information

Ordering information	Detailed ordering information is available from the following sources: ▪ In the Product Configurator: www.us.endress.com/en/field-instruments-overview/product-finder -> Select product -> Configure ▪ From an Endress+Hauser Sales Center: www.endress.com/worldwide **Product Configurator - the tool for individual product configuration** ▪ Up-to-the-minute configuration data ▪ Depending on the device: Direct input of measuring point-specific information such as measuring range or operating language ▪ Automatic verification of exclusion criteria ▪ Automatic creation of the order code and its breakdown in PDF or Excel output format ▪ Ability to order directly in the Endress+Hauser Online Shop

Application packages

Detailed description

SD02414F

SIL wizard

Availability

Available for the following versions of feature 590 "Additional approval":
LA: SIL

Function

- Wizard for the proof test which must be performed at regular intervals in the following applications:
  SIL (IEC61508/IEC61511)
- To perform a proof test, the device must be locked (SIL locking).
- The wizard can be used via FieldCare, DeviceCare or a DTM-based process control system.

Heartbeat Diagnostics

Availability

Available in all device versions.

Function

- Continuous self-monitoring of the device.
- Diagnostic messages output to
  - the local display.
  - an asset management system (e.g. FieldCare/DeviceCare).
  - an automation system (e.g. PLC).

Advantages

- Device condition information is available immediately and processed in time.
- The status signals are classified in accordance with VDI/VDE 2650 and NAMUR recommendation NE 107 and contain information about the cause of the error and remedial action.

Heartbeat Verification

Availability

Available for the following versions of feature 540 "Application package":
EH: Heartbeat Verification + Monitoring

Device functionality checked on demand

- Verification of the correct functioning of the measuring device within specifications.
- The verification result provides information about the condition of the device: **Passed** or **Failed**.
- The results are documented in a verification report.
- The automatically generated report supports the obligation to demonstrate compliance with internal and external regulations, laws and standards.
- Verification is possible without interrupting the process.

Advantages

- No onsite presence is required to use the function.
- The DTM [5] triggers verification in the device and interprets the results. No specific knowledge is required on the part of the user.
- The verification report can be used to prove quality measures to a third party.
- **Heartbeat Verification** can replace other maintenance tasks (e.g. periodic check) or extend the test intervals.

5) DTM: Device Type Manager; controls device operation via DeviceCare, FieldCare or a DTM-based process control system.

Heartbeat Monitoring

Availability

Available for the following versions of feature 540 "Application package":
EH: Heartbeat Verification + Monitoring

Function

In addition to the verification parameters, the corresponding parameter values are also logged.

Advantages

- Supports the scheduling of maintenance work, and thereby helps ensure plant availability.
- Checks the percentage measured error (standard deviation and stability) during density measurements in order to adjust the accuracy.

Accessories

Commubox FXA195 HART

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

TI00404F

Field Xpert SFX350, SFX370, SMT70

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

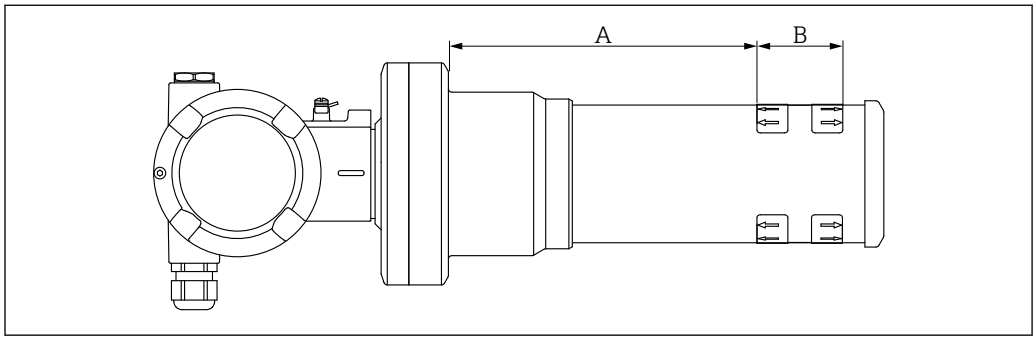
BA01202S

TI01114S

Mounting device (for level and point level measurement)

Mounting the retaining bracket

Reference dimension A is used to define the mounting location of the retaining bracket depending on the measuring range.

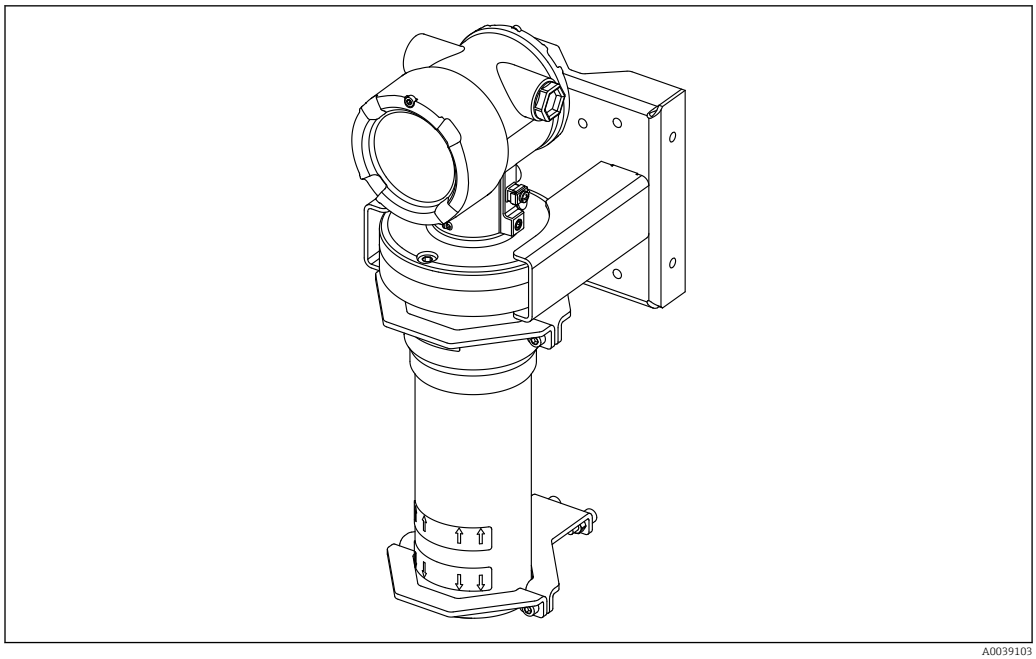


19 *A defines the distance between the device flange and the start of the measuring range. Distance A depends on the material of the scintillator (PVT or NaI).*

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

Installation instructions

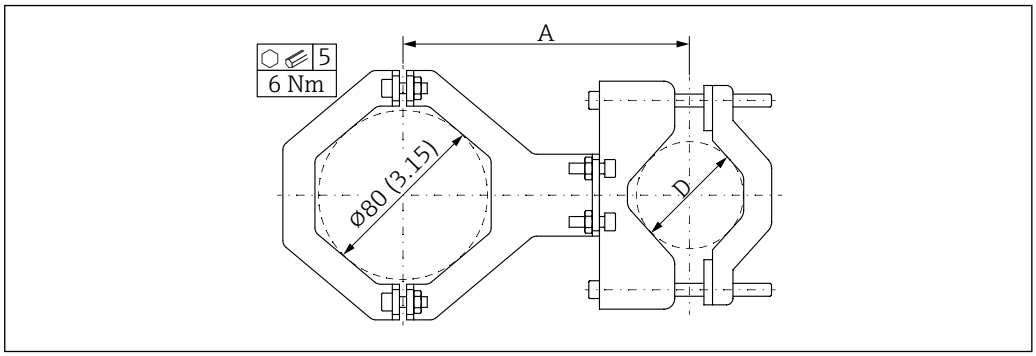
Keep the distance between the mounting clamps as large as possible



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

Dimensions

Dimensions of mounting clamp

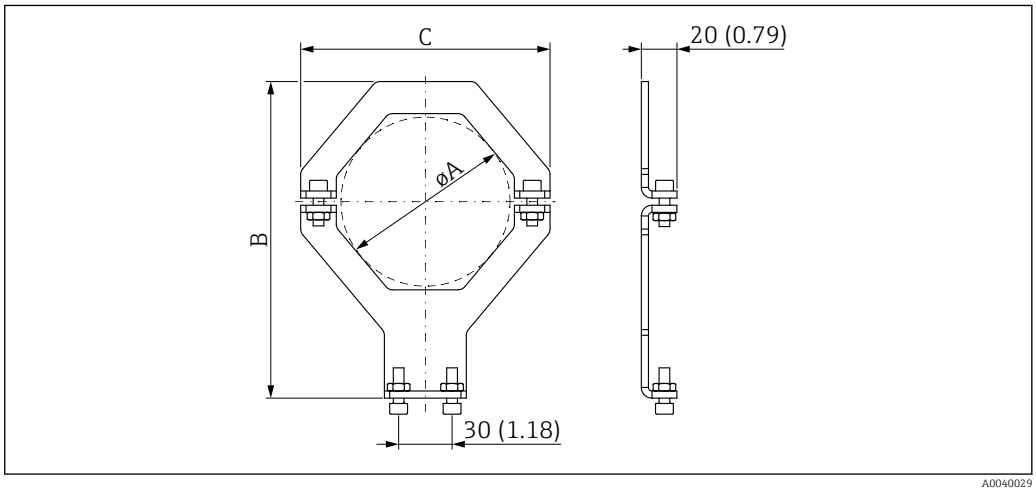


21 Overview of the mounting dimensions

A Distance between detector pipe and mounting pipe (center to center)
D Mounting pipe 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.

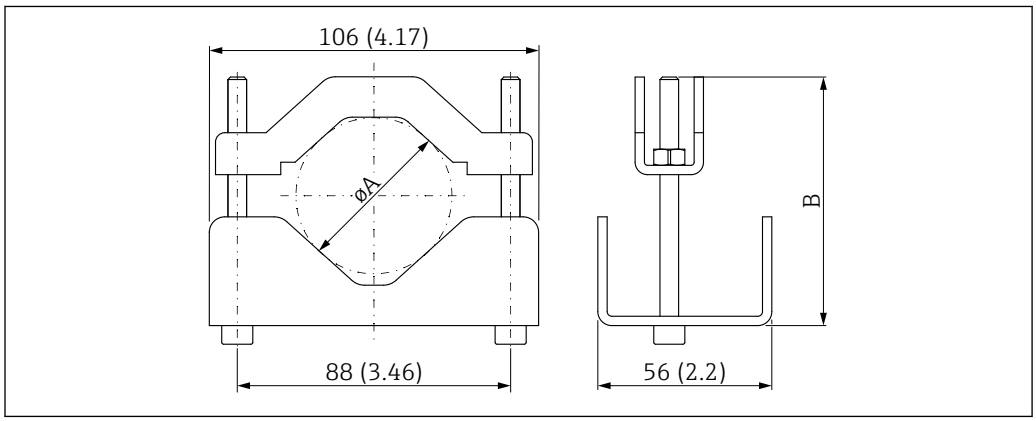


22 Dimensions of mounting clamp (at the device)

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

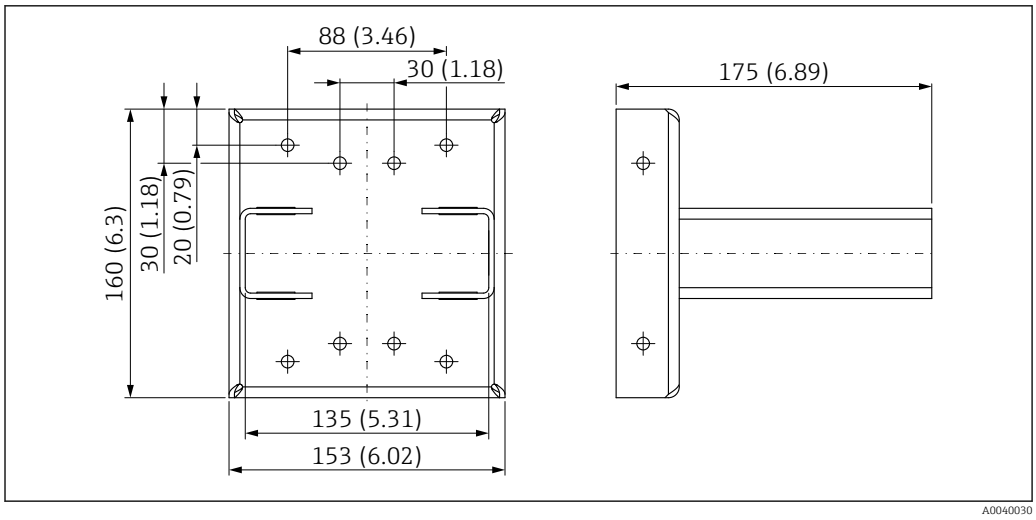
Detector tube:
- **Diameter A:** 80 mm (3.15 in)
- **Distance B:** 171 mm (6.73 in)
- **Distance C:** 126 mm (4.96 in)

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



23 Retaining bracket

Mounting options

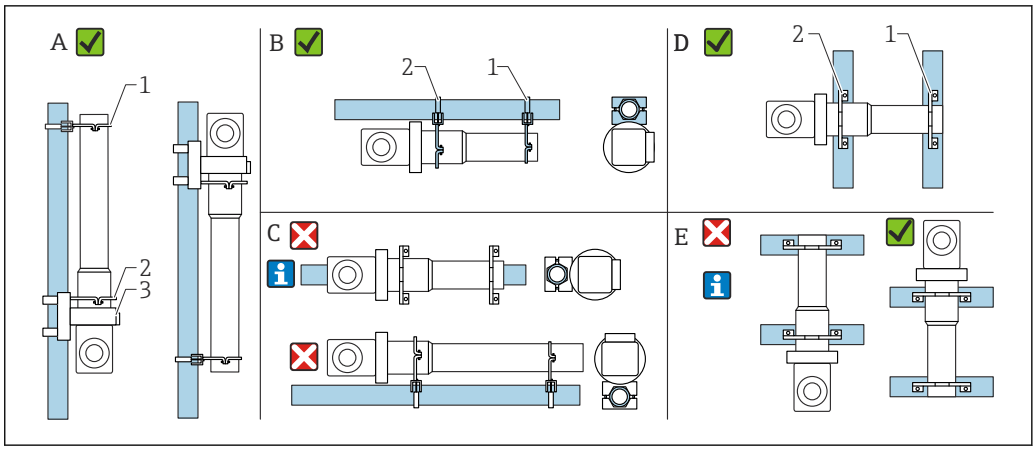
CAUTION

Note the following when mounting the device

- 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.
- 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.

✓ permitted

✗ not recommended, observe mounting instructions



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

Mounting instructions for horizontal installation (see Figure C): The pipe 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.

Clamping device for density measurement FHG51

FHG51-A#1

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

SD02543F

FHG51-A#1PA

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

SD02533F

FHG51-B#1

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

SD02544F

FHG51-B#1PB

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

SD02534F

FHG51-E#1

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

SD02557F

FHG51-F#1

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

SD02558F

Collimator (sensor side) for Gammapilot FMG50

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.

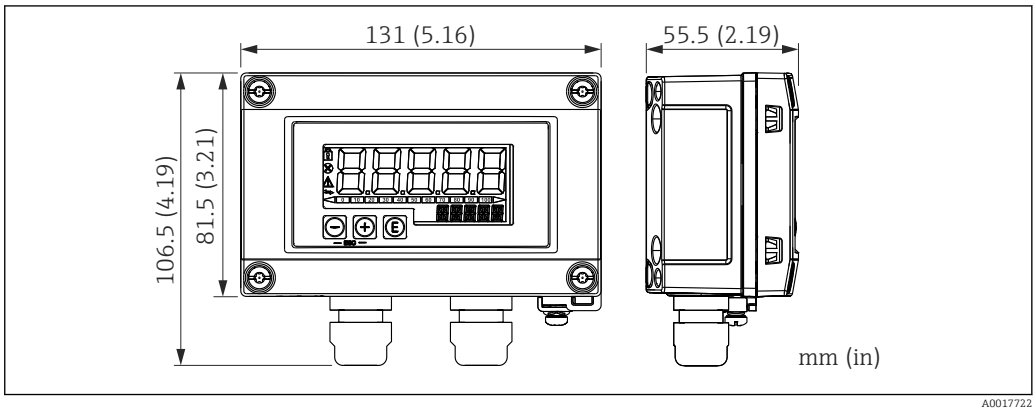
Please contact an Endress+Hauser sales organization for applications with frontal radiation or other scintillator versions

Additional information

Additional information is available in:

SD02822F

Process indicator RIA15



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

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

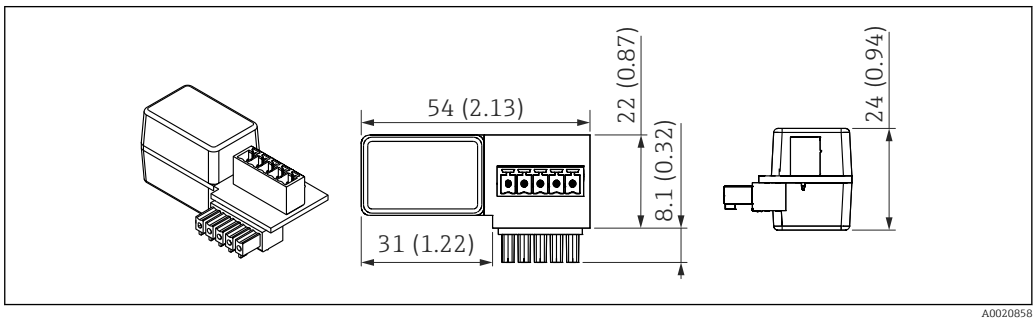
- Option PE "Remote indicator RIA15, non-hazardous area, aluminum field housing"
- Option PF "Remote indicator RIA15, hazardous, aluminum field housing"

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

HART communication resistor



25 *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".

Memograph M RSG45

Level measurement: FMG50 with Memograph M RSG45

Conditions requiring several FMG50 units:

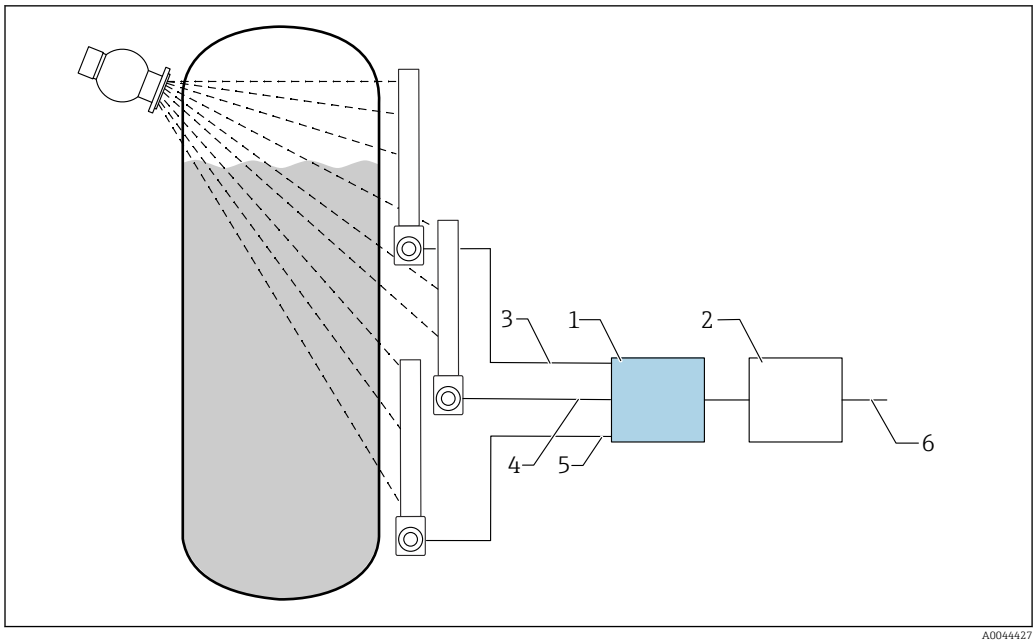
- Large measuring ranges
- Special tank geometry

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.



26 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

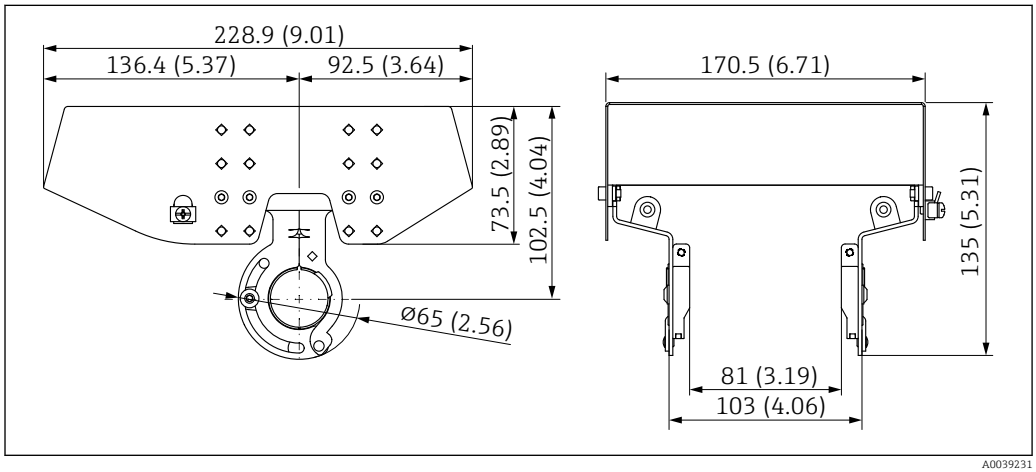
Additional information

See Operating Instructions RSG45 :
BA01338R

See Operating Instructions FMG50:
BA01966F

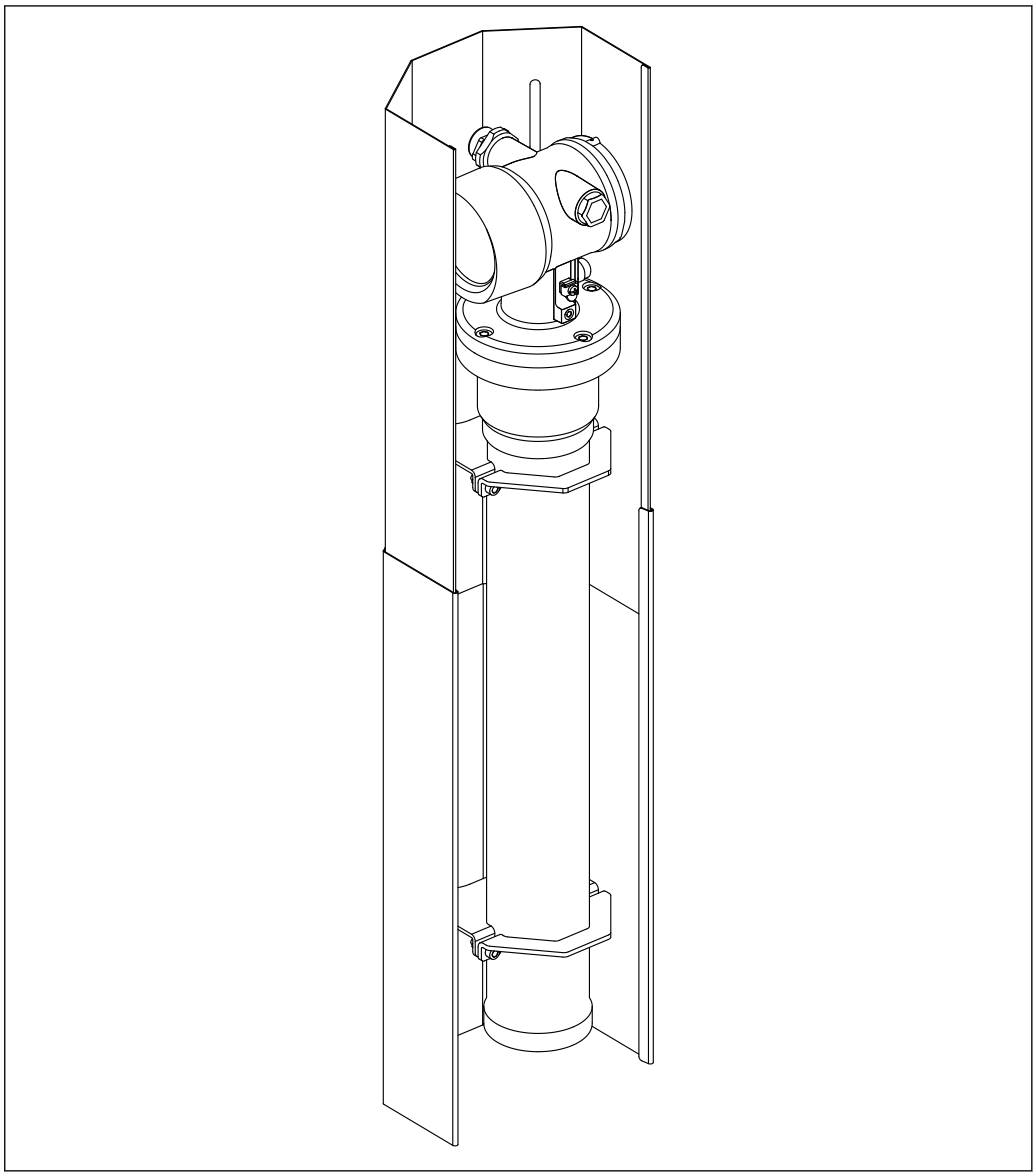
Weather protection cover for dual compartment housing, aluminum

- Material: stainless steel 316L
- Order number: 71438303



27 Weather protection cover for dual compartment housing, aluminum. Unit of measurement mm (in)

Heat shield for Gammapilot FMG50



A0041149

28 *Example of a heat shield for Gammapilot FMG50*

For more information, see:

SD02472F

Supplementary documentation for Gammapilot FMG50

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.

Fields of activity

Product overview for applications in liquids and bulk solids

FA00001F

Operating instructions	BA01966F
Technical information	TI01462F
Description of Device Functions	GP01141F
Functional safety	Functional Safety Manual for Gammapilot FMG50 FY01007F
Clamping device for density measurement	SD02543F Collimator (sensor side) for Gammapilot FMG50 SD02533F SD02544F SD02534F SD02557F SD02558F
Mounting device for Gammapilot FMG50	SD02454F
Collimator (sensor side) for Gammapilot FMG50	SD02822F
Weather protection cover for dual compartment housing	SD02424F
Heat shield for Gammapilot FMG50	SD02472F
Process transmitter RMA42	Technical Information for process transmitter RMA42 TI00150R Operating Instructions for process transmitter RMA42 BA00287R
Memograph M RSG45	Operating Instructions for Memograph M RSG45 BA01338R
VU101 Bluetooth® display	SD02402F
RIA15 process indicator	TI01043K

Supplementary documentation for radiation source, source container and modulator

Radiation source FSG60, FSG61

- Technical Information for radiation source FSG60/FSG61
- Returning source containers
- Type A packaging

TI00439F

Source container FQG60

Technical Information for source container FQG60

TI00445F

Source container FQG61, FQG62

Technical Information for source containers FQG61 and FQG62

TI00435F

Source container FQG63

Technical Information for source container FQG63

TI00446F

Source container FQG64

Documentation for source container FQG64

SD02780F

Source container FQG66

Technical Information for Source Container FQG66

TI01171F

Operating Instructions for Source Container FQG66

BA01327F

Gamma Modulator FHG65

Technical Information for Gamma Modulator FHG65 and Synchronizer FHG66

TI00423F

Operating Instructions for Gamma Modulator FHG65 and Synchronizer FHG66

BA00373F

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