

Technical Information

Gamma Modulator FHG65

Synchronizer FHG66

Radiometric measuring technology



Effective suppression of background radiation and extraneous radiation at the Gammapilot

Application

- **Gamma Modulator FHG65**
Improvement of the measurement results of radioactive measurement through the effective suppression of background radiation and extraneous radiation
- **Synchronizer FHG66**
Synchronization of an unlimited number of Gamma Modulators FHG65 and operating status display for easy diagnosis of the connected Modulators FHG65.

Advantages

- Disturbance-free measurement in the event of interference radiation and variable background radiation
- Easy mounting and integration into existing systems
- No maintenance required

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About this document

Symbols used

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



Warns against radioactive substances or ionizing radiation

**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

Function and system design

System design

A measuring point with the Gamma Modulator FHG65 consists of the following components:

- Gamma Modulator FHG65
- Gammapilot FMG50 or Gammapilot M FMG60
- Source container FQG61 or FQG62
- Radiation source ^{137}Cs or ^{60}Co (installed in the source container)
- If multiple Gamma Modulators are used or for diagnostic purposes: Synchronizer FHG66

System requirements

System requirements of FMG50

All versions of the Gammapilot FMG50 can evaluate the signal generated by the Gamma Modulator FHG65

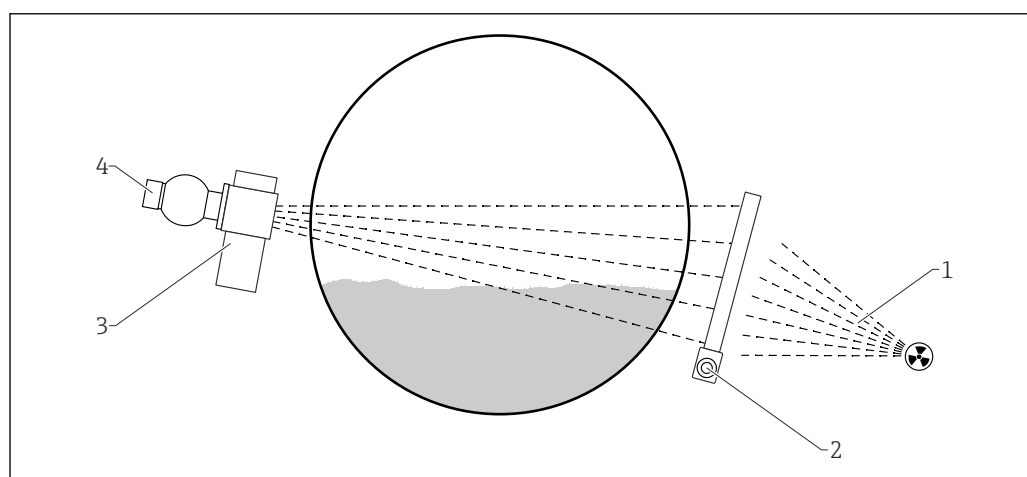
System requirements of FMG60

To be able to evaluate the signal generated by the Gamma Modulator FHG65, the Gammapiot M FMG60 must be equipped with the following software at least:

- HART electronics
 - For SIL devices with short point level detectors (200 mm and 400 mm): SW 01.02.02 or higher
 - For all other devices: SW 01.03.02 or higher
- PROFIBUS PA electronics
 - SW 01.03.02 or higher
- FOUNDATION Fieldbus electronics
 - SW 01.03.02 or higher

Gamma Modulator FHG65

In a radiometric measuring point, 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, or allows through, the useful beam at a frequency of 1 Hz. 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 FMG50 or FMG60 can thus 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.



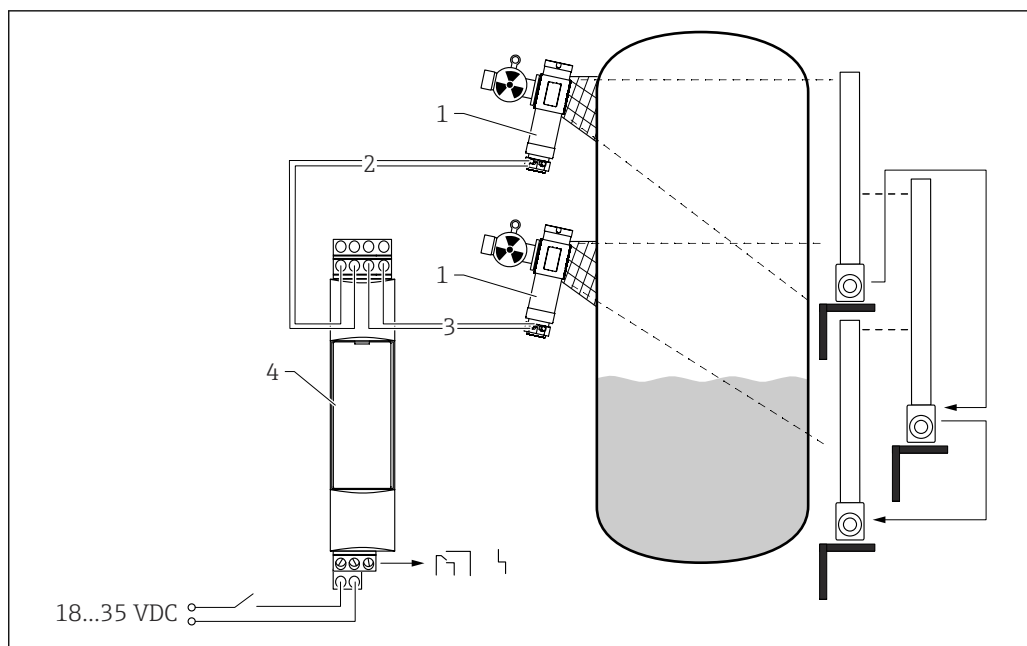
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- 1 Interference radiation
- 2 FMG50/FMG60
- 3 FHG65
- 4 FQG61/FQG62

i The Gamma Modulator FHG65 and the Gammapiot FMG50/FMG60 are not interconnected electrically. When adjusting the FMG50/FMG60, the "beam type" parameter must be set to "modulated".

Synchronizer FHG66

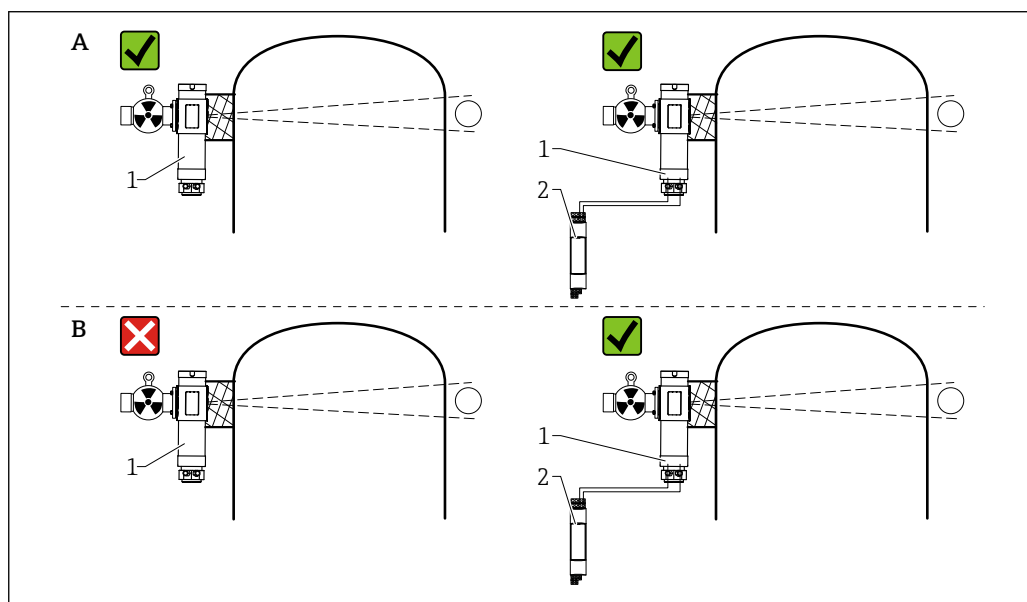
In a measuring point with multiple radiation sources, a Gamma Modulator FHG65 must be mounted on every source container. The Synchronizer FHG66 synchronizes the individual modulators to common mode. A Synchronizer FHG66 can synchronize up to three Gamma Modulators FHG65. (For more than three modulators, see the "Cascading multiple Synchronizers FHG66" section). In addition, the synchronizer offers a straightforward diagnostic solution for the connected Modulators FHG65, which is beneficial when only one Modulator FHG65 is in operation.



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- 1 FHG65
- 2 Electrical connection between FHG66 and FHG65 (1)
- 3 Electrical connection between FHG66 and FHG65 (2)
- 4 FHG66

-  It is recommended to install the switch for the supply voltage near the device and to mark it as a disconnector for the device.
-  Use of the Synchronizer FHG66, and particularly of its alarm output, is recommended for minimum point level detection, as an undetected failure of the Modulator FHG65 may result in faulty switching behavior



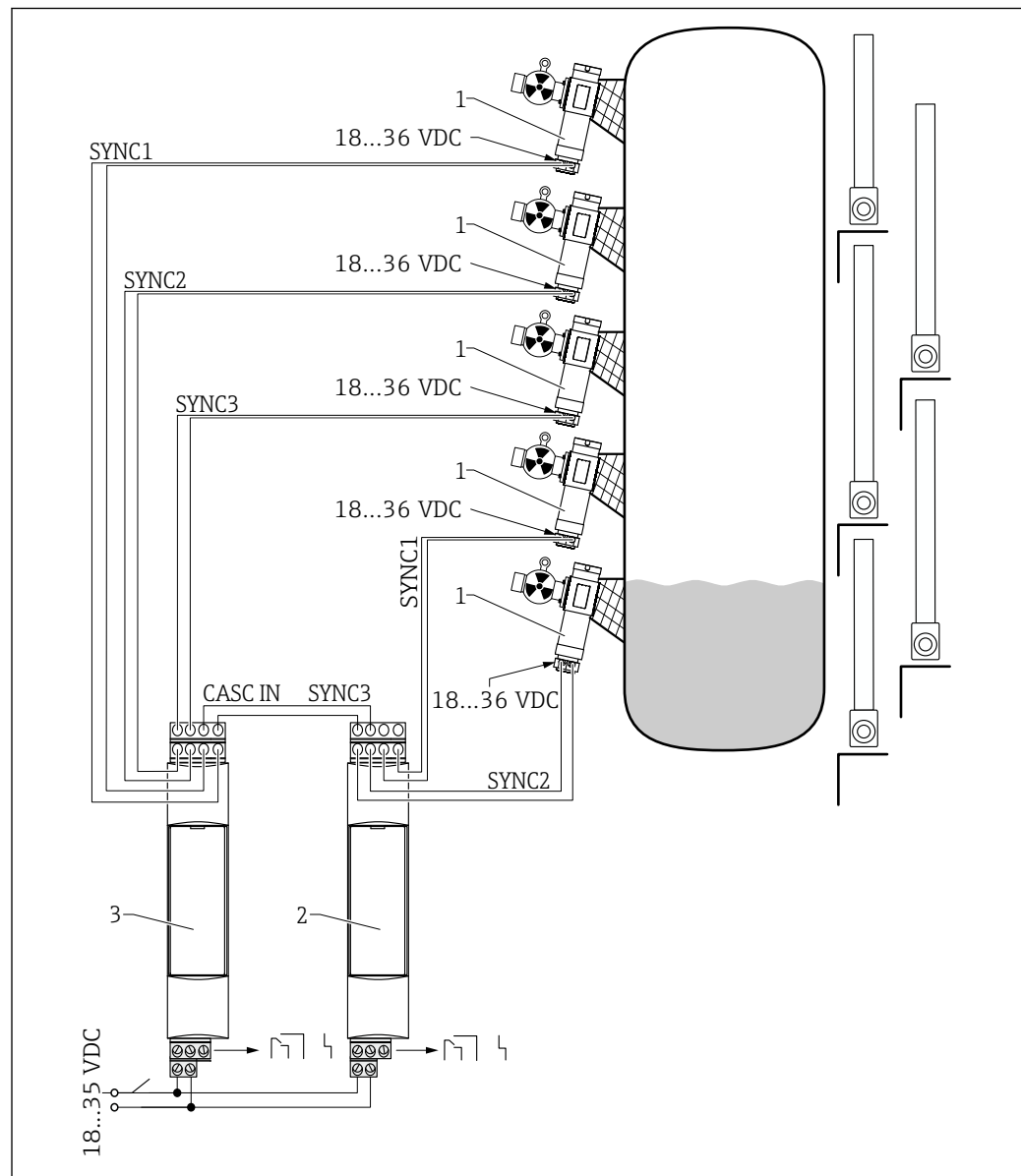
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- A Maximum point level detection
- B Minimum point level detection
- 1 FHG65
- 2 FHG66

Cascading multiple Synchronizers FHG66

If more than three radiation sources are used, the synchronization chain must be extended by cascading: here, an additional synchronizer (3) is connected to one of the outputs of the synchronizer (2) instead of a modulator. All connected Gamma Modulators then operate in common

mode. By interconnecting this cascading function, any number of modulators can be synchronized with one another.



- 1 FHG65
- 2 Primary synchronizer
- 3 Cascaded synchronizer

Gamma Modulator FHG65

Technical data

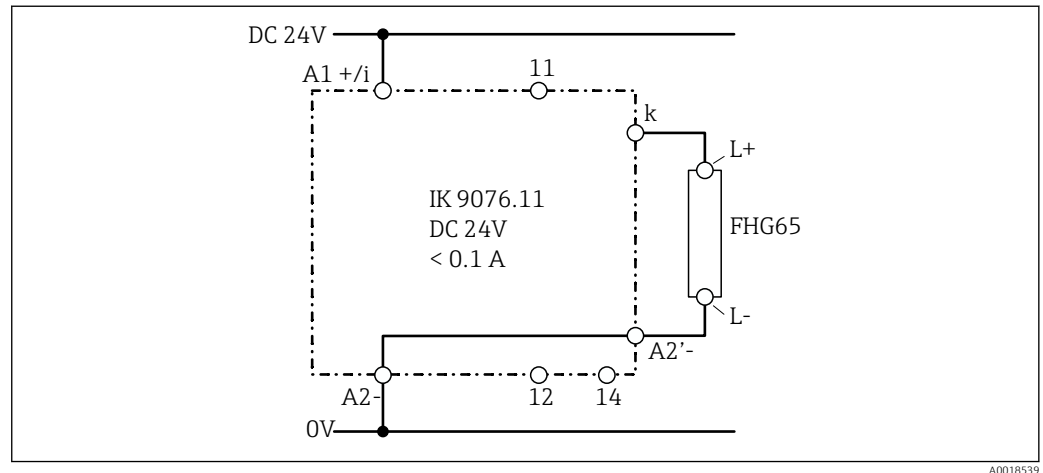
Power supply

- Supply voltage: 18 to 36 VDC
- Power consumption: 3.2 W
- Overvoltage category: II
- Protection class: 1
- Potential equalization: provided

Alarm output

The Gamma Modulator FHG65 does not have an alarm output of its own. Operating errors are reported as follows:

- **If a Synchronizer FHG66 is connected:** The FHG65 reports the error to the FHG66 via the synchronization input. The alarm relay of the FHG66 reports the error.
- **If a Synchronizer FHG66 is not connected:** The FHG65 switches off its motor completely in the event of an error. This reduces the current consumption to less than 30 mA. This can be detected by an external current monitor (e.g. Dold IK9076.11)



1 Connection diagram for external current monitor Dold IK9076.11

Environment

- **Ambient temperature:**
 - Without water cooling: -40 to +60 °C (-40 to +140 °F)
 - With water cooling at the water cooling jacket: 0 to +120 °C (32 to +248 °F)
 - With water cooling at the terminal head: max. +75 °C (+167 °F)
- **Storage temperature:** -40 to +75 °C (-40 to +167 °F)
- **Housing degree of protection:** IP66/67; TYPE 4X/6
- **Climate class:** DIN EN 60068-2-38 test Z/AD
- **Vibration resistance:** DIN EN 60068-2-64 test Fh; 10 to 2 000 Hz, 1 (m/s²)/Hz
- **Shock resistance:** DIN EN 60068-2-27; test Ea; 30 g, 18 ms, 3 shocks /direction/axis
- **Electromagnetic compatibility:** Interference emission according to EN 61326, Appendix A (Industrial) and NAMUR Recommendation NE21

Interference suppression

FMG50

Max 5 µSv/h per 1 000 mm (39.4 in) measuring length:

- Measuring range 200 mm (7.87 in): 25 µSv/h max. interference suppression
- Measuring range 800 mm (31.5 in): 6 µSv/h max. interference suppression
- Measuring range 2 000 mm (78.7 in): 2.5 µSv/h max. interference suppression
- Measuring range 10 000 mm (394 in)- cascading: 0.5 µSv/h max. interference suppression

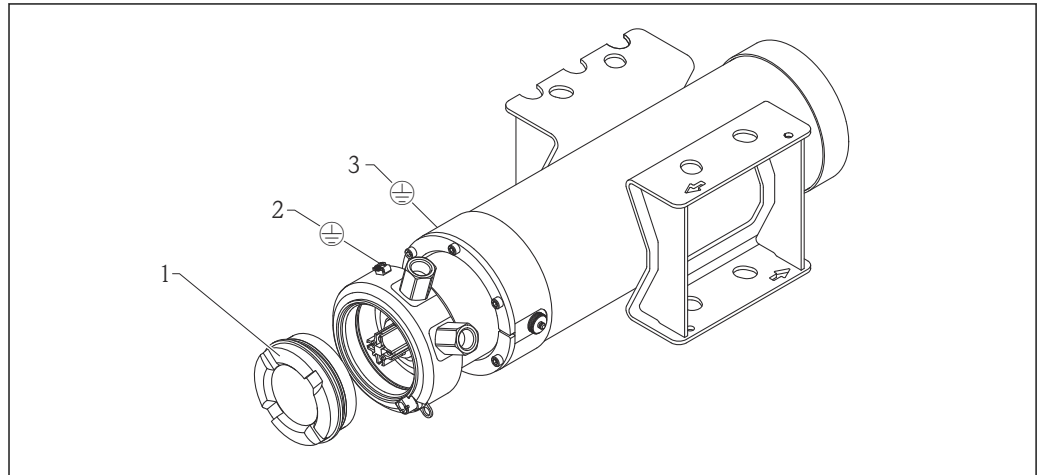
FMG60

Max 10 µSv/h per 1 000 mm (39.4 in) measuring length:

- Measuring range 200 mm (7.87 in): 50 µSv/h max. interference suppression
- Measuring range 800 mm (31.5 in): 12.5 µSv/h max. interference suppression
- Measuring range 2 000 mm (78.7 in): 5 µSv/h max. interference suppression
- Measuring range 10 000 mm (394 in)- cascading: 1 µSv/h max. interference suppression

Electrical connection

Connection compartment



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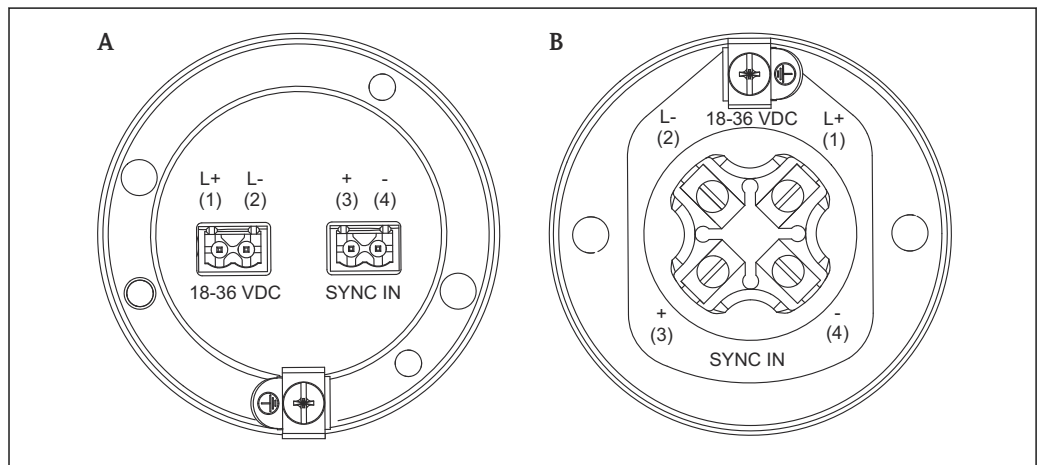
- 1 Cover of the connection compartment
 2 Ground terminal on modulator
 3 Ground terminal on water cooling jacket

Cable entries

Versions of the two cable entries (for supply voltage and synchronization connection)

- M20 gland
- M20 thread
- G ½ thread
- NPT ½ thread

Terminal assignment



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- A Ex d, Ex t, non-Ex - version
 B Ex de - version

- Terminal 1 (L+): supply voltage; 18 to 36 VDC
- Terminal 2 (L-): supply voltage; 18 to 36 VDC
- Terminal 3 (SYNC+): synchronization connection (to connect the Synchronizer FHG66); 12 VDC, 5 mA
- Terminal 4 (SYNC-): synchronization connection (to connect the Synchronizer FHG66); 12 VDC, 5 mA



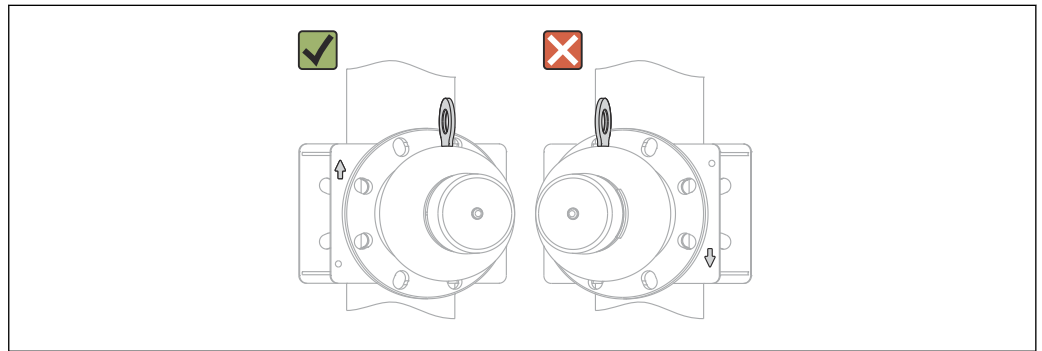
- Install a circuit breaker in the power supply line
- Use a cable with a minimum diameter of 0.5 mm² (20 AWG)
- Mount the earth tag of the ground connector in the position direction indicated in the graphic

Installation requirements**General installation conditions**

The Gamma Modulator FHG65 is mounted directly on the mounting flange of the source container FQG61 or FQG62. ¹⁾

⚠ CAUTION

- ▶ As the beam exit channel is not located in the middle of the source container, it is absolutely essential to ensure the device is oriented correctly when mounting. The arrow on the mounting plate of the Gamma Modulator must point in the direction of the transporting lug of the source container. Measurement is not possible otherwise.



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- The source container with the Gamma Modulator must be mounted as close as possible to the tank or measuring tube
- The unit must be mounted on a low-vibration construction
- Fasten with at least 4 M16 threaded bolts; torque:
 - Steel: 210 Nm (154.88 lbf ft)
 - Stainless steel: 144 Nm (106.20 lbf ft)
- When mounting, consider the total weight consisting of the source container and the Gamma Modulator FHG65. Ensure sufficient stability is guaranteed. Provide an additional support if necessary
- After mounting, measure the local dose rate in the vicinity of the source container and the Gamma Modulator. Cordon off any controlled areas, see also TI00435F (FQG61/FQG62)
- The use of the modulator reduces the effectively useful horizontal angle of the beam path from 6 ° to approx. 2 °. **Check that the detector is completely covered by the radiation beam!**

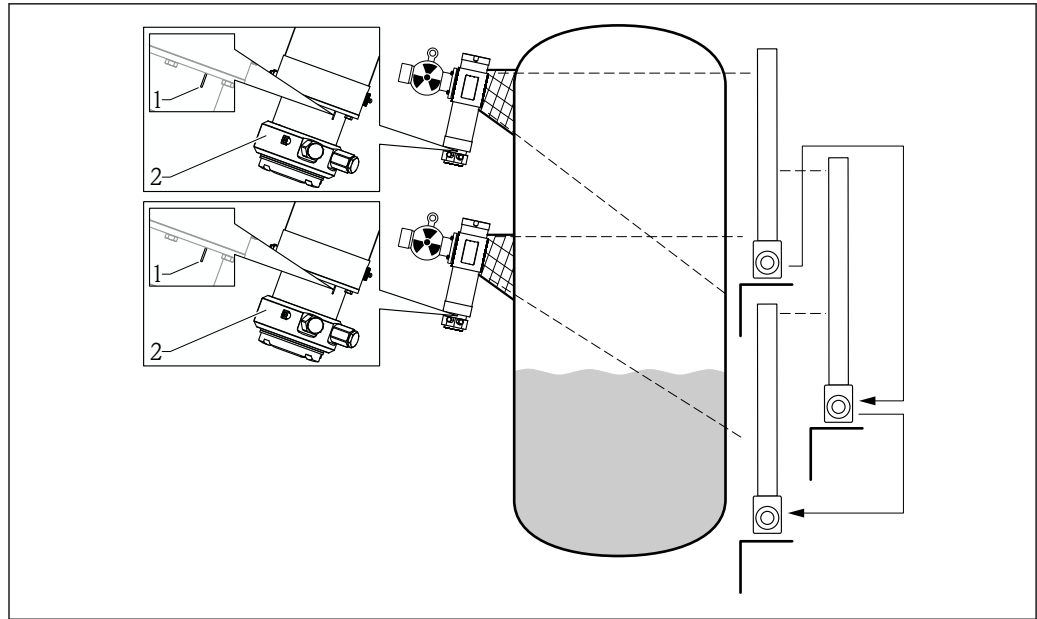
Mounting multiple Gamma Modulators FHG65

If multiple Gamma Modulators FHG65 are used in a measuring point, they must operate synchronously. The Synchronizer FHG66 is used for this purpose.



The synchronization requires that all the Gamma Modulators FHG65 be aligned in the same way. A mark is provided at the top of the Gamma Modulator FHG65 to align the units. This mark must be aligned in the same way relative to the source container on all the Gamma Modulators FHG65 used.

1) For applications with the source container FQG66: contact your local Endress+Hauser sales office



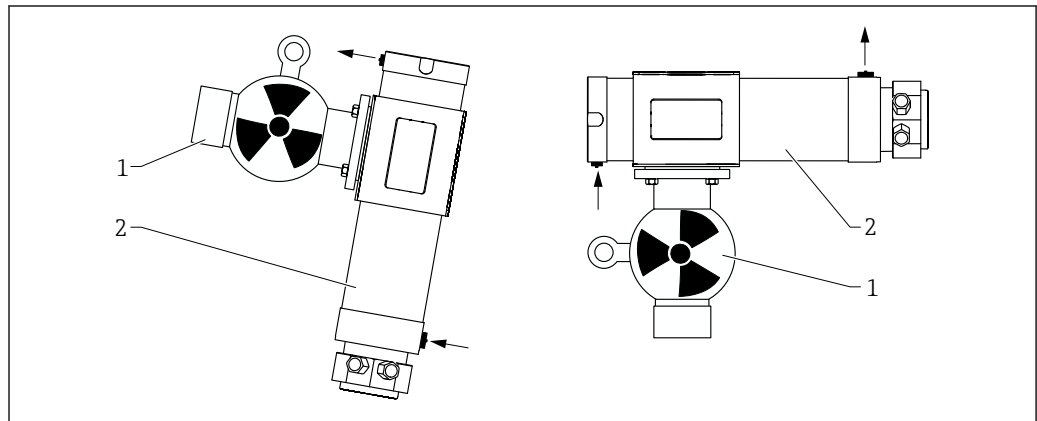
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- 1 Marking for aligning multiple Gamma Modulators
2 FHG65

Water cooling

The following applies to the Gamma Modulator FMG60 version with water cooling:

- Material: 316L and 304
- Water connection: 2 x G 1/4"A, DIN ISO 228
- Outlet temperature: max. +40 °C (104 °F); temperature monitoring is recommended
- Water pressure: 4 to 6 bar (58 to 87 psi)
- Water flow: min. 60 l/h
- Drain sensor with water cooling jacket in the event of frost or protect against freezing.



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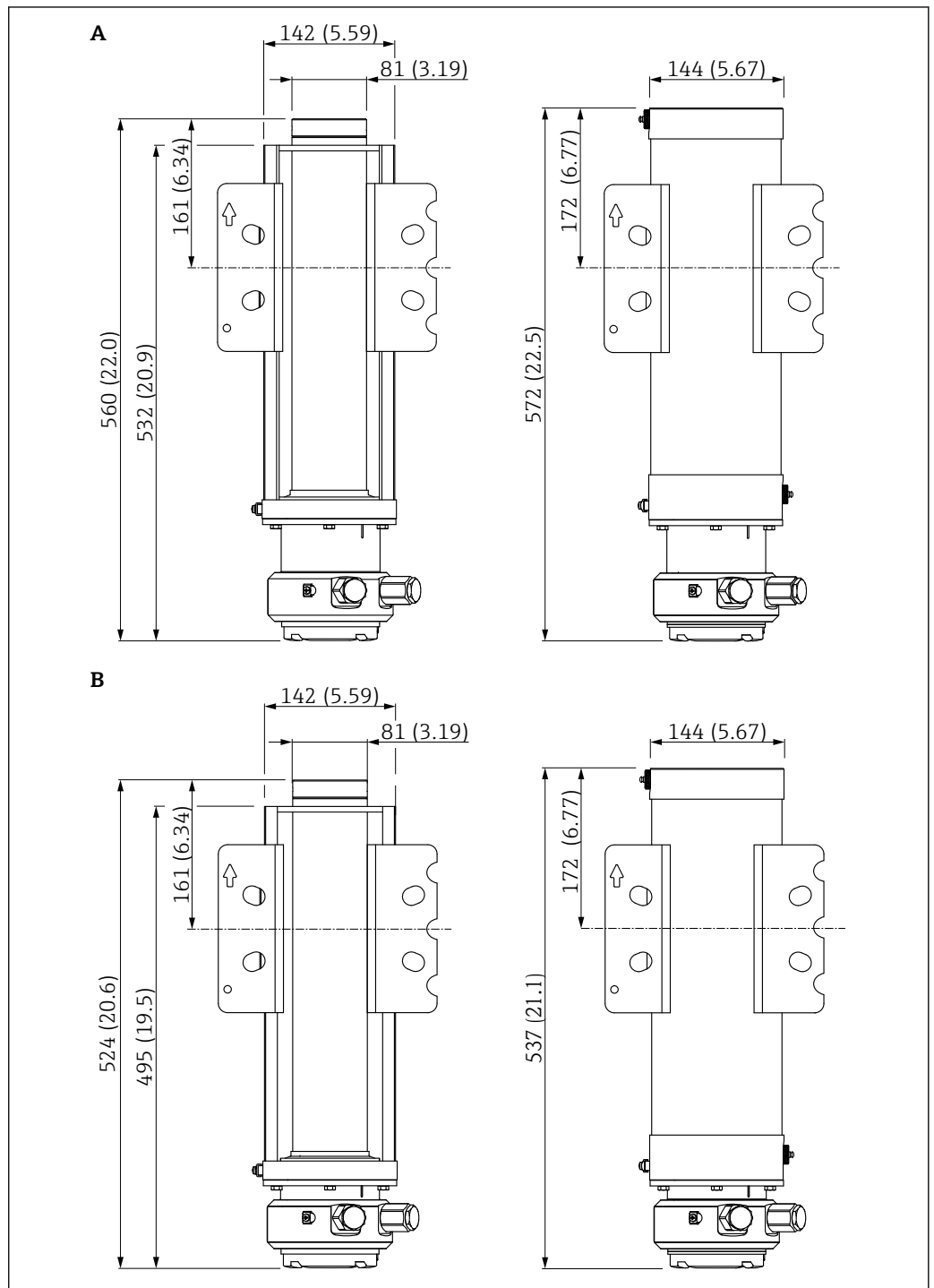
- 1 FQG61, FQG62
2 FHG65

⚠ CAUTION

- The water must always be introduced from the bottom to ensure that the water cooling jacket is completely filled.

Mechanical construction

Dimensions of the Gamma Modulator



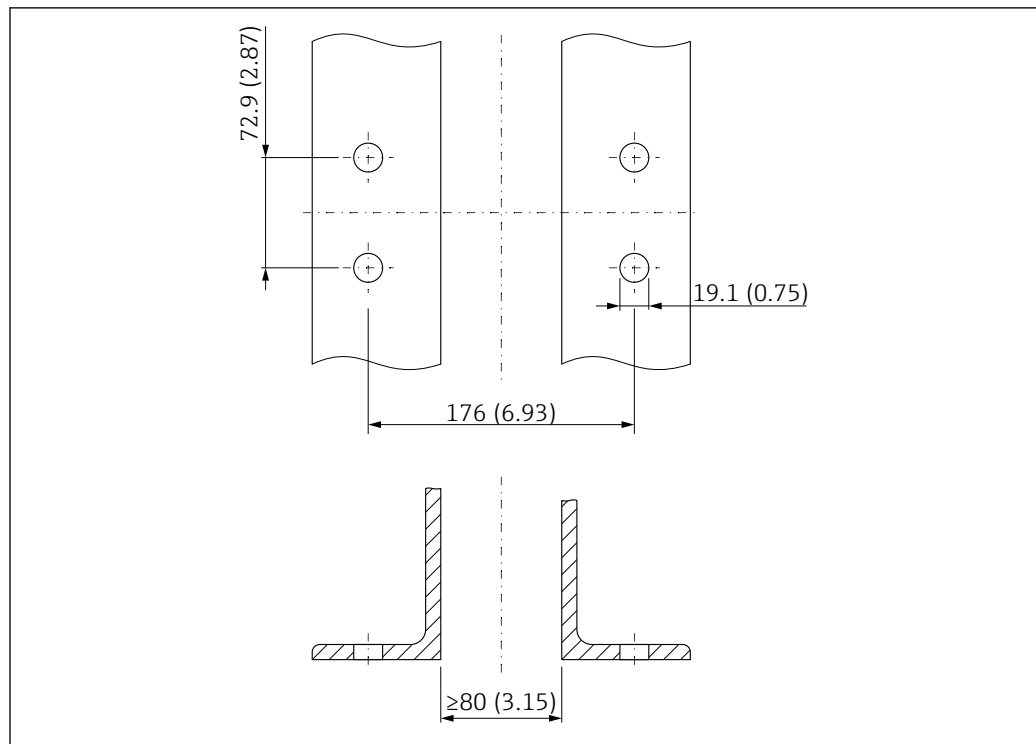
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2 Engineering unit: mm (in)

A Ex de - version (left: without water cooling jacket; right: with water cooling jacket)

B Ex d, Ex t, non-Ex - version (left: without water cooling jacket; right: with water cooling jacket)

Example of mounting with angle bracket (supplied by customer)



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3 L-angle bracket; engineering unit: mm (in)

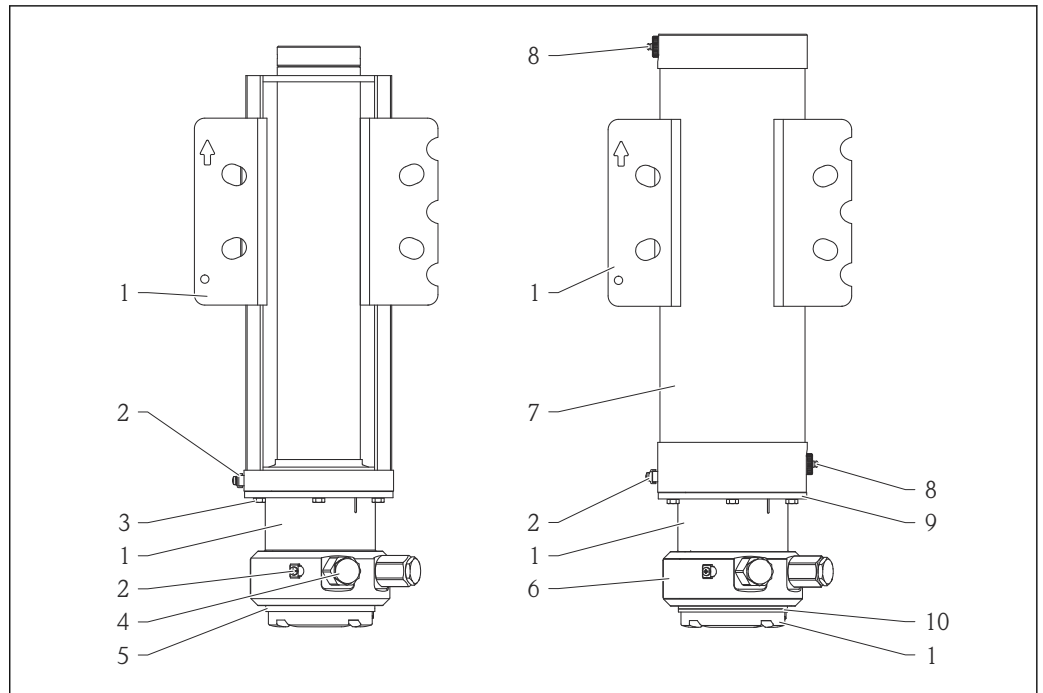
Weight

- Weight without water cooling jacket: max. 18 kg (39.69 lb)
- Weight with water cooling jacket (empty): max. 21 kg (46.31 lb)
- Weight with water cooling jacket (full): max. 25 kg (55.13 lb)

Operating life of the bearings

The operating life of the bearings is 36 years at maximum load in continuous operation

Materials



4 Materials of the FHG65

- **1; Housing:** 304 (1.4301)
- **2; Ground connection:** 316Ti (1.4571); 304 (1.4301); A2 ; A4
- **3; Screws:** A2-70
- **4; O-ring:** FKM 70
- **5; Cable entry with seal:** see next chapter
- **6; Nameplate and grooved pins:** 304 (1.4301); A2
- **7; Water cooling jacket:** 316L (1.4404)
- **8; Cooling water connection:** PA66
- **9; O-ring:** FKM 70
- **10; Cover clamp:** 304 (1.4301); 1.4581 ; A2

Materials of the cable entry with seal

Feature 040: "Cable entry, power supply"

- **Option A: M20 gland:**
 - 316L (1.4404/1.4435)
 - 12L13 (1.0718)
 - MS
 - EPDM70+PTFE
- **Option B: M20 thread:**
 - 316L (1.4404/1.4435)
 - 12L13 (1.0718)
 - EPDM70+PTFE
- **Option C: G 1/2 thread:**
 - 316L (1.4404/1.4435)
 - 12L13 (1.0718)
 - 304 (1.4301)
 - EPDM70+PTFE
- **Option D: NPT 1/2 thread:**
 - 12L13 (1.0718)
 - 304 (1.4301)
 - EPDM70+PTFE

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

Synchronizer FHG66

Technical data

Input

Cascading input

- For connection to a Synchronizer FHG66
- Galvanically isolated from additional power supply and output
- Connecting cable: twin-core; shielding not required (except in the event of strong electromagnetic interference)
- Cable requirements:
 - Max. capacitance: 120 nF
 - Max. resistance: 1 000 Ω
 - Max. inductance: 0.65 mH
 - Cable: not shielded/not twisted
- Signal transmission: closed current loop 0 to 5 mA, max. 12 V

Output

Alarm relay

- **Type:** Potential-free change-over contact
- **Switching delay:** 0 to 3 s
- **Switching capacity (DC voltage):**
 - U: maximum 40 V
 - I: maximum 2 A
 - P: maximum 80 W
- **Switching capacity (AC voltage):**
 - U: maximum 250 V
 - I: maximum 2 A
 - P: maximum 500 VA at $\cos \phi \geq 0.7$
- **Operating life:** Min. 10^5 switching cycles with maximum contact load
- **Function indicator:** Light emitting diodes for operation, faults and error assignment; device detects and reports errors in the configuration and in the connected devices
- **Overvoltage category:** II
- **Protection class:** 2 (double/reinforced isolation)

Signal on alarm

- Fault indicated by red LED
- Fault assignment by yellow LEDs
- Alarm relay deenergized

Power supply

- Supply voltage: 18 to 35 VDC (power supply with safe isolation required)
- Power consumption: max. 1 W
- Overvoltage category: II
- Protection class: 2
- Pollution degree: 2

Environment

- **Ambient temperature:**
 - Mounted individually: -20 to +60 °C (-4 to +140 °F)
 - Mounted in a row without lateral spacing: -20 to +50 °C (-4 to +122 °F)
 - When installed in protective housing: -20 to +40 °C (-4 to +104 °F)
- Storage temperature: -20 to +85 °C (-4 to +185 °F), preferably at 20 °C (68 °F)
- **Climate and mechanical application class:**
 - K3 according to DIN EN 60721-3-3
 - M2 according to DIN EN 60721-3-3
- **Degree of protection:**
 - IP20
 - Mechanical degree of protection IK06 (1J) according to IEC 62262
- **Electromagnetic compatibility:**
 - Interference emission according to EN 61326, Class B equipment
 - Interference immunity according to EN 61326, Appendix A (Industrial) and NAMUR Recommendation NE 21

Electrical connection

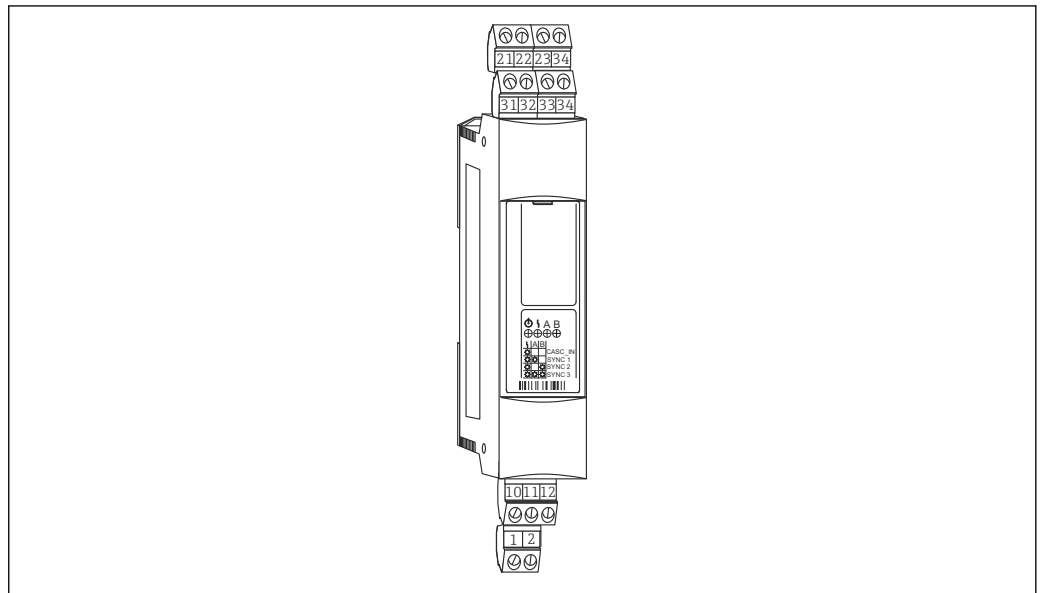
Terminals

Plug-in screw terminals. Wire cross-section:

- 1.0 to 2.5 mm² (17 to 13 AWG) for power supply and relay
- 0.5 to 2.5 mm² (20 to 13 AWG) for signal lines

⚠ CAUTION

- The terminals may only be replaced with terminals of the same type



5 Synchronizer FHG66 with terminals

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Terminal assignment

Power supply

- Terminal 1 (L+): supply voltage; 18 to 35 VDC power supply with safe isolation required
- Terminal 2 (L-): supply voltage; 18 to 36 VDC power supply with safe isolation required

Alarm relay

- Terminal 10 (changeover)
- Terminal 11 (NC contact): is connected to terminal 10 if an error occurs
- Terminal 12 (NO contact): is connected to terminal 10 during error-free operation

Outputs

- Terminal 33/34 (synchronization output 1)
- Terminal 31/32 (synchronization output 2)
- Terminal 21/22 (synchronization output 3)



- One Gamma Modulator FHG65 or an additional Synchronizer FHG66 (for cascading) can be connected to each output terminal.
- Synchronization signal: 12 V / 5 mA
- Any polarity is possible

Inputs

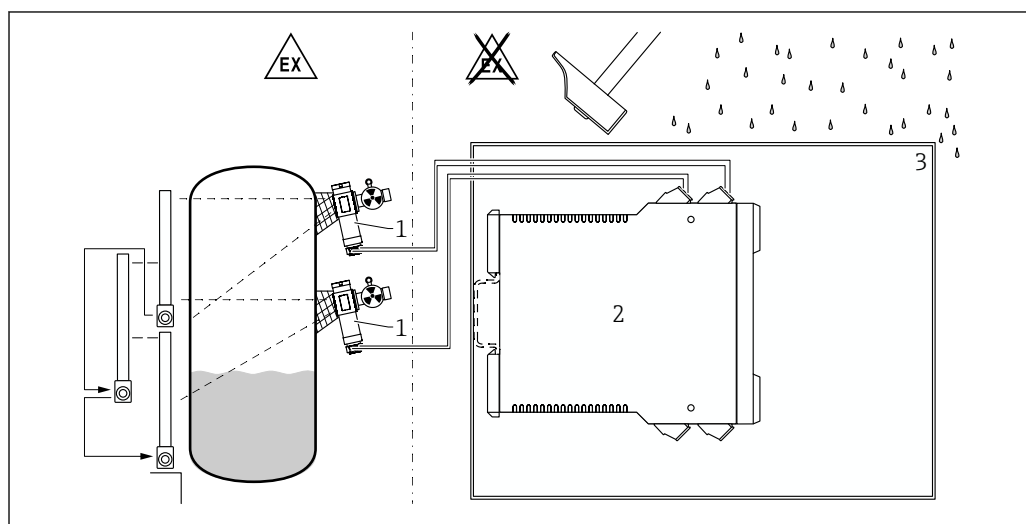
Terminal 23/24 (cascading input)



- For connecting an additional, upstream Synchronizer FHG66
- All the Gamma Modulators connected to the synchronizers then run in common mode.
- Cascading signal: 12 V / 5 mA

Installation requirements**Mounting location**

The Synchronizer FHG66 must be accommodated in a cabinet outside the hazardous area and protected against mechanical influences. If mounting outdoors, a protective housing (min. IP65) must be used.



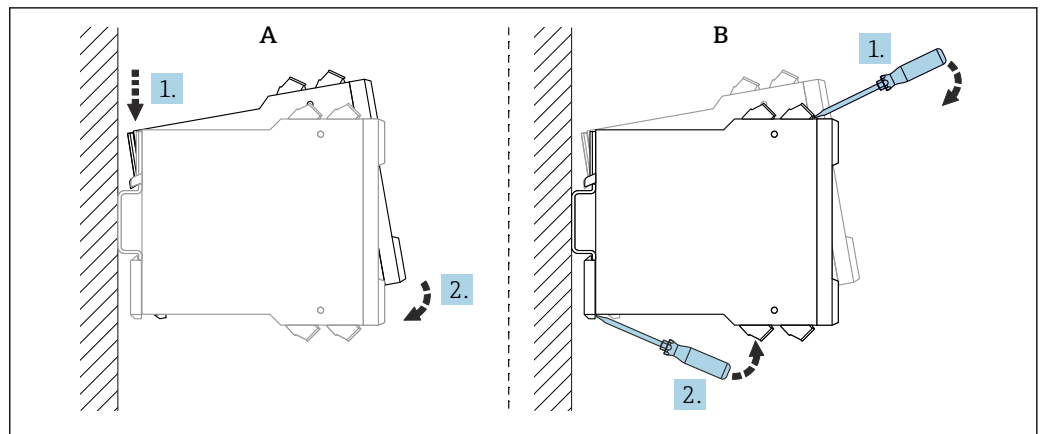
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- 1 FHG65
2 FHG66
3 Cabinet or protective housing (min. IP65)

⚠ CAUTION**Observe the following conditions:**

- ▶ Mechanical degree of protection for FHG66: see "Technical data" section
- ▶ The ventilation slots of the housing must not be blocked

Installation

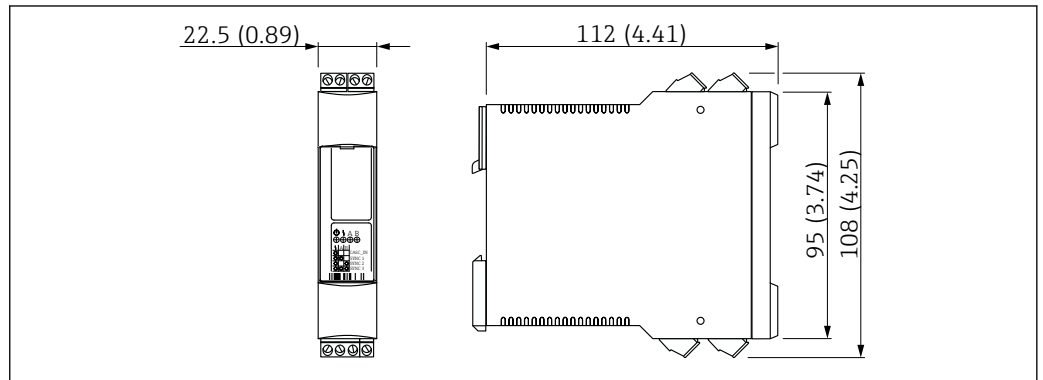


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- A Mounting on DIN rail (1. Hook into DIN rail; 2. Swivel until device clicks into place)
 B Disassembly (1. Remove terminal blocks; 2. Remove device)

Mechanical construction

Dimensions



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6 Engineering unit: mm (in)

Weight

Weight: approx. 150 g (5.29 oz)

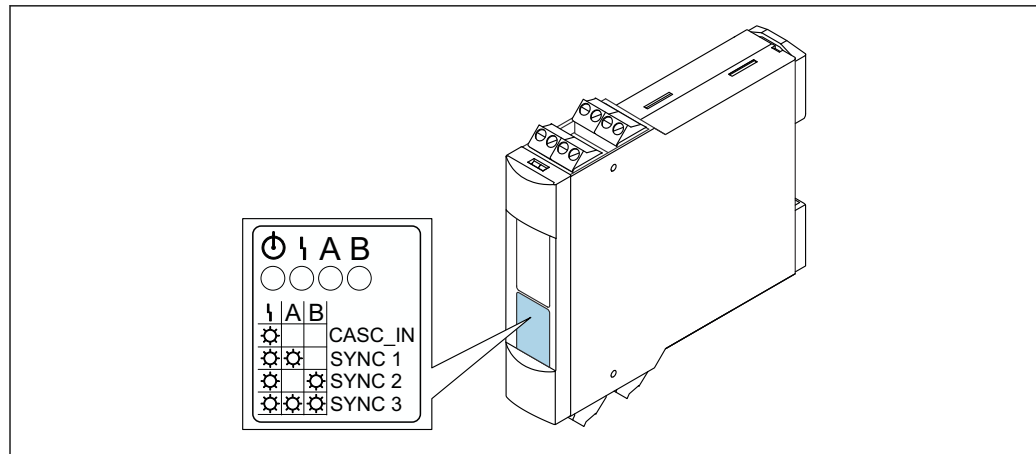
Materials

- **Housing:** polycarbonate
- **Front cover:** polyamide PA6
- **Fixing slide (to secure on DIN rail):** polyamide PA6

Human interface

Display elements

The LEDs are visible when the front panel is closed.



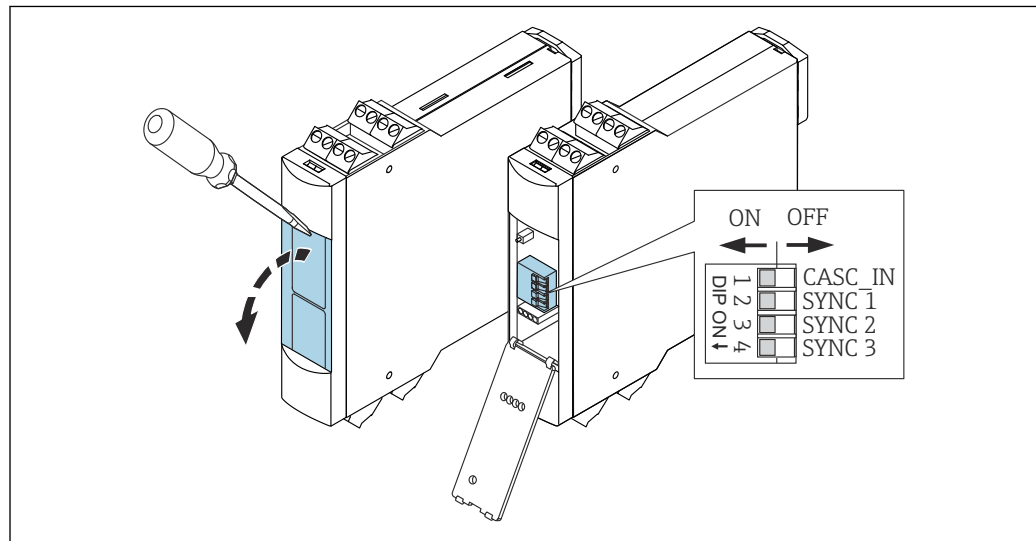
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7 Arrangement of the display LEDs

- **⏻**
Green LED; operational safety: Is lit as soon as the supply voltage is switched on
- **|**
Red LED; error: Is lit if an error is present at one of the synchronization outputs or the cascading input
- **A,B**
Yellow LEDs; error identification: Indicate the synchronization output where the error has occurred:
 - **A:** Error at SYNC 1
 - **B:** Error at SYNC 2
 - **A and B:** Error at SYNC 3
 - **A and B off, but red LED on:** Error at cascading input (CASC_IN)

Operating elements

The DIP switches are located behind the swing-down front panel.



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8 Visualization of the operating elements (DIP switches)

The DIP switches are used to switch the synchronization outputs and the cascading input on and off in accordance with the diagram above.

- **DIP switch 1:** Cascading input (terminals 23/24)
- **DIP switch 2:** Synchronization output 1 (terminals 33/34)
- **DIP switch 3:** Synchronization output 2 (terminals 31/32)
- **DIP switch 4:** Synchronization output 3 (terminals 21/22)

Ordering information

Order number: 71060806

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

Certificates and approvals

CE mark

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

Explosion protection

Gamma Modulator FHG65

Additional approvals

Synchronizer FHG66

CSA GP

Overfill protection

- May be used in max point level applications in connection with the Gammapilot M FMG60 (200/400 mm) in SIL 2/3 according to IEC 61508.
- Not tested for overfill protection according to WHG

Other standards and guidelines

- **IEC 60529:**
Degrees of protection provided by enclosures (IP code)
- **IEC 61326**
Electromagnetic compatibility (EMC requirements)
- **IEC 61010**
Safety requirements for electrical equipment for measurement, control and laboratory use
- **NAMUR:**
Association for Standards for Control and Regulation in the Chemical Industry

Supplementary documentation

**Gamma Modulator FHG65;
Synchronizer FHG66**

Technical Information for Gamma Modulator FHG65 and Synchronizer FHG66



TI00423F

Operating Instructions for Gamma Modulator FHG65 and Synchronizer FHG66



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**Source container FQG61,
FQG62**

Technical Information for source containers FQG61 and FQG62



TI00435F

**Radiation source FSG60,
FSG61**

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



TI00439F

Other documentation



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

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



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www.addresses.endress.com
