Level | Pressure | Flow | Temperature | Liquid Analysis | Registration | Systems Components | Services | Solutions

Technical Information

Gammapilot M FMG60

Radiometric Measurement
Compact transmitter for non-invasive limit detection, level, interface layer, and density measurement; suitable for hazardous locations

Application

- Continuous, non-contact measurement in liquids, solids, suspensions or sludges etc.
- Applications under extreme measuring conditions, e.g. high pressure, high temperature, corrosivity, toxicity, abrasion.
- All kinds of process vessels, e.g. reactors, autoclaves, separators, acid tanks, mixers, cyclones, cupola furnaces.
- Applications in food processing industry without additional requirements or approvals.
- System integration via
  - HART
  - PROFIBUS PA
  - Foundation Fieldbus

Features and benefits

- Compact transmitter: one instrument for all measuring tasks
- Highest availability, reliability and safety, even for extreme process and ambient conditions
- Highest sensitivity and accuracy at lowest dose rates (ALARA principle)
- Optimum adjustment to the respective application via a variety of detectors:
  - point detector
  - rod detectors of different lengths
- Ex d, Ex e or Ex i current output for simple plant integration
- Stainless steel hosuing 316L for rough applications
- SIL2 according to IEC/EN 61508 and WHG approval
- Temperature compensation for density measurements
- Gammagraphy detection
- Simple, menu guided on-site operation with four line plain text display or convenient operation, diagnosis and measuring point documentation with the supplied "ToF Tool - FieldTool Package" standard operating program

TI363F/00/en/11.04

Endress+Hauser

People for Process Automation

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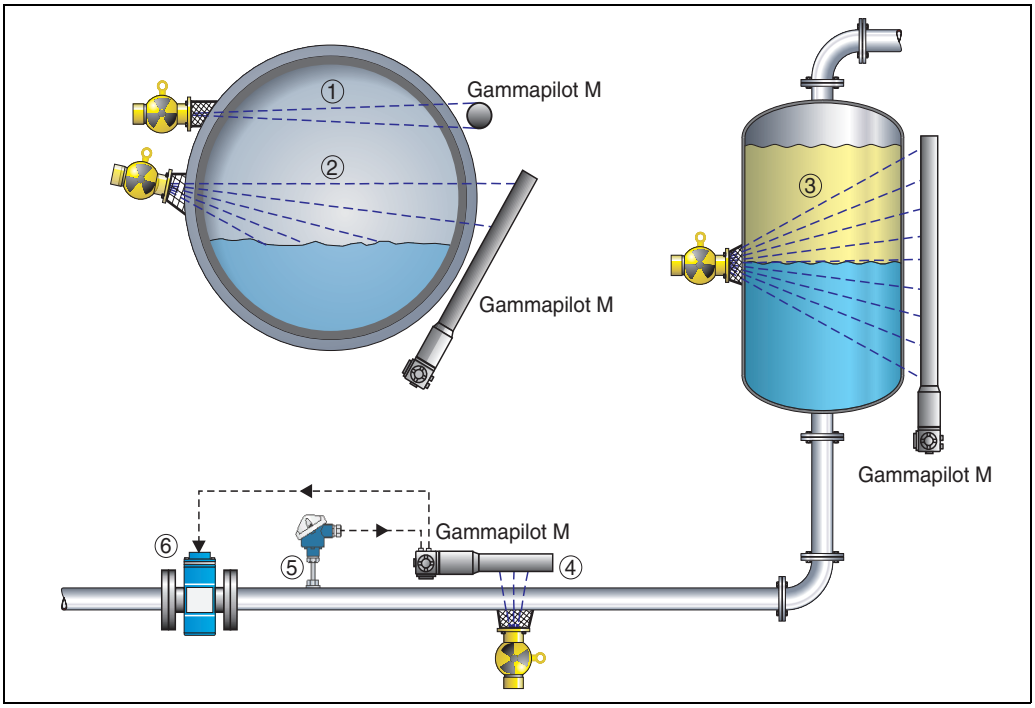
Function and system design

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 applied for different measuring tasks:



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Level limit detection (1)

A gamma radiation source and a Gammapilot M are mounted on opposite sides of the vessel at the height of the desired level limit. The Gammapilot M converts the received radiation intensity into a percentage. "0%" means that the radiation path is completely free, i.e. the level is below the limit. "100%" means that the radiation path is completely covered, i.e. the level is above the limit.

Continuous level measurement (2)

A gamma radiation source and a Gammapilot M are mounted on opposite sides of the vessel. The Gammapilot M calculates the level (percentage) from the radiation intensity. For adaption to the measuring range detectors of different lenghts are available. Also, multiple detectors can be interconnected (cascading).

Measurement of interface layers (3)

A gamma radiation source and a Gammapilot M are mounted on opposite sides of the vessel in a height such that both liquids are irradiated. The radiation source may also be mounted inside the vessel. The Gammapilot M calculates the position of the interface layer from the intensity of the received radiation. Its value is between 0% (lowest possible position) and 100% (highest possible position).

Density or concentration measurement (4)

A gamma radiation source and a Gammapilot M are mounted on opposite sides of a measuring tube. The Gammapilot M calculates the density or concentration of the medium from the intensity of the received radiation. The unit can be freely selected.
If an additional temperature sensor (5) is connected, the Gammapilot M accounts for the thermal expansion of the medium. That means, it does not output the measured density directly. Instead it calculates the density which the medium would have at a certain standard temperature defined by the user.
Furthermore, the density signal of the Gammapilot M can be combined with the signal of a volume flow meter (6), e.g. Promag 53. From these two signals it is possible to calculate the mass flow.

Equipment architecture

A radiometric measuring system typically consists of the following components:

Gamma Radiation Source

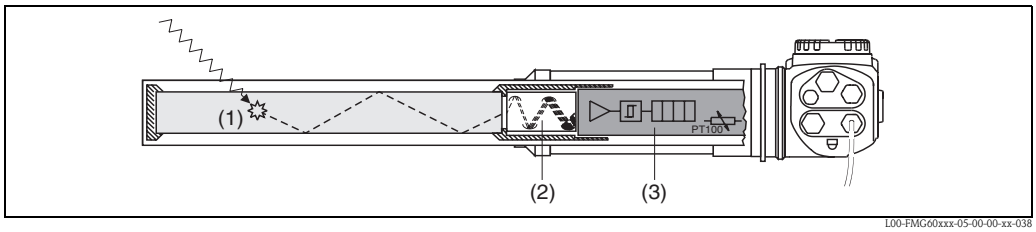
A ^{137}Cs or ^{60}Co isotope is used as gamma radiation source. Sources of different activities are available for optimum adjustment to the respecitve application. The "Applicator"[1] program can be used to calculate the required activity.
For further information on gamma radiation sources refer to Technical Information TI 213F.

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. Source containers of different sizes and with different radiation exit angles are available. The "Applicator"[1] program can be used to select the source container whicht fits your application.
For further information on source containers refer to Technical Informations TI 264F (QG 020 / QG 100) and TI 346F (QG 2000).

Compact transmitter Gammapilot M

The compact transmitter Gammapilot M contains a scintillator, a photomultiplier and the evaluation circuit. Incident radiation generates light flashes within the scintillator. The photomultiplier converts these flashes into electrical pulses and amplifies them. The pulse rate (number of pulses per second) is a measure of the radiation intensity. Depending on the calibration, the pulse rate is converted to a level, limit, density or concentration signal by the evaluation circuit.
The Gammapilot M is available with a NaI-crystal or with plastic scintillators of different lengths. Thus, optimum adaption to each individual application is ensured.



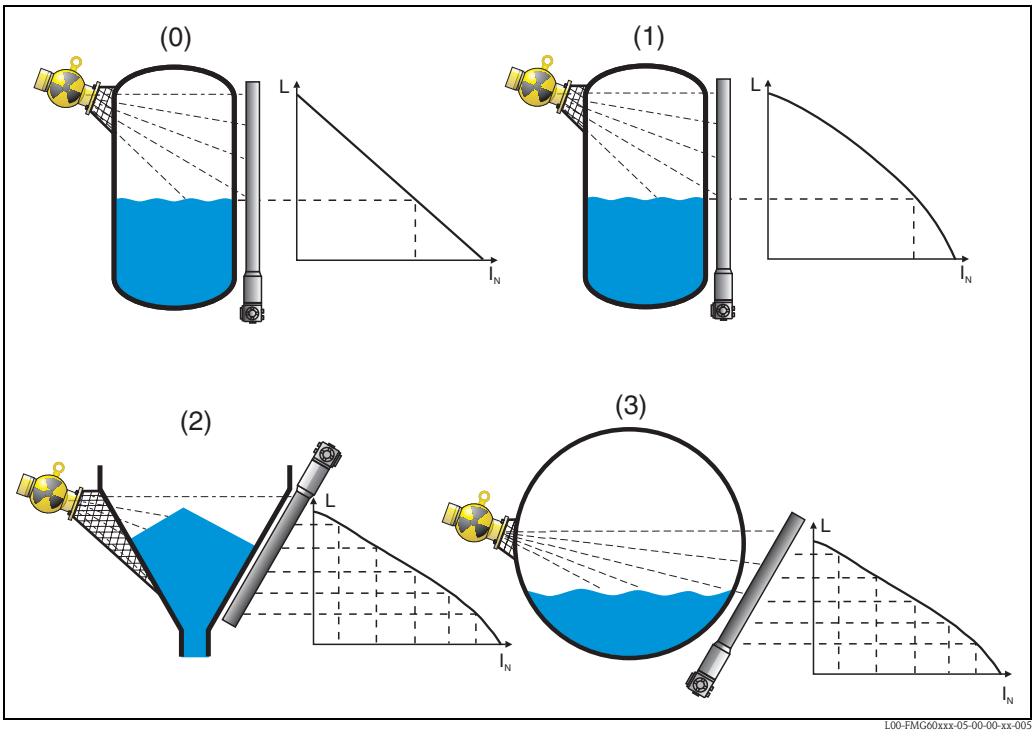
Operating principle of the Gammapilot M: **(1):** *Gamma radiation generates light flashes within the scintillator;* **(2):** *The photomultiplier converts the flashes into electrical pulses and amplifies them;* **(3):** *The evaluation circuit calculates the measured value from the pulse rate.*

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

Signal evaluation

Level measurement

A standard linearisation table for the calculation of the level in vertical cylinders is preprogrammed in the Gammapilot M. For other situations a linearisation table consisting of up to 32 points can be entered manually or half-automatically (by filling the vessel under controlled conditions). The linearisation curve with its associated table can be calculated by the selection and configuration software "Applicator"[1].



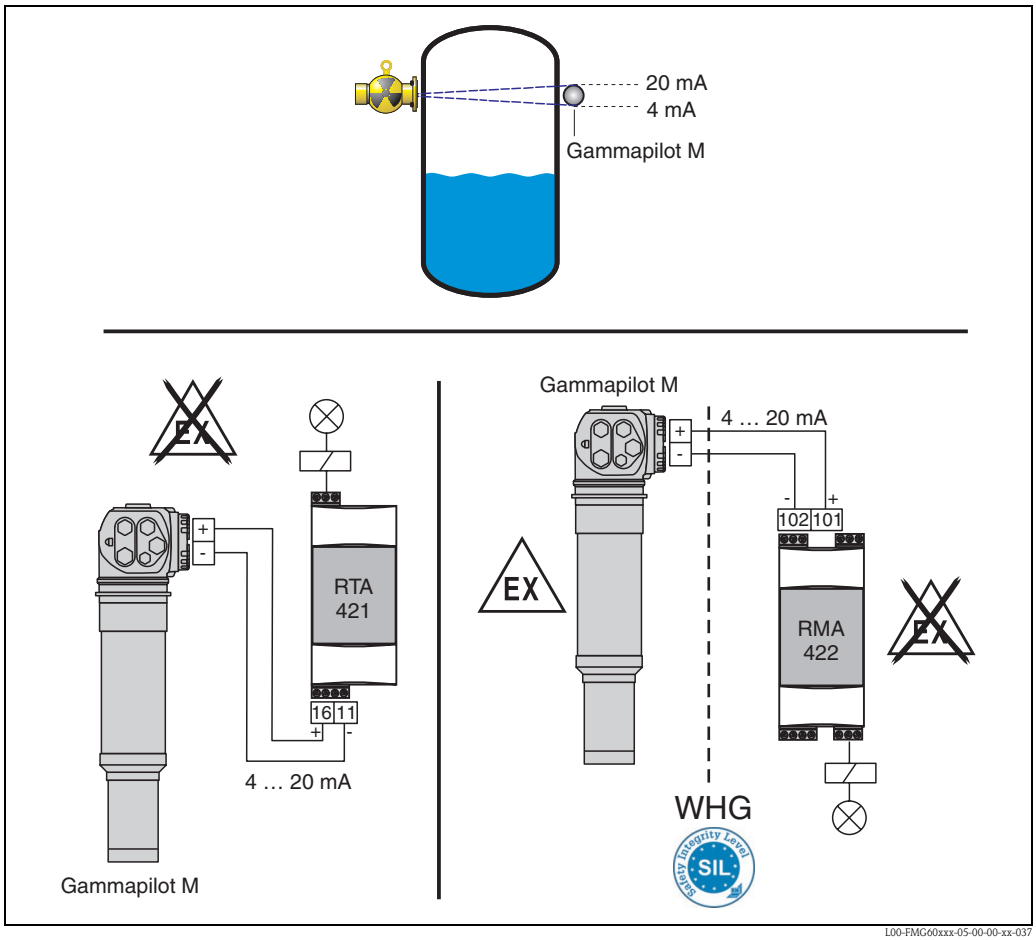
Linearisation modes for level measurements: **(0):** *Linear;* **(1):** *Standard;* **(2), (3):** *Linearisation table entered by the user;* **I_N:** *Pulse rate (counts per second, c/s);* **L:** *Level (%)*

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

Level limit detection

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

- RTA421: for non-Ex applications, without WHG, without SIL
- RMA421: for Ex-applications; with WHG and SIL certificates



Top: *For level limit detection the output signal is linear between the free and covered calibration.*
Left: *Wiring with process transmitter RTA421;*
Right: *Wiring with process transmitter RMA422*

Ex applications in connection with RMA422

Observe the following Safety Instructions:

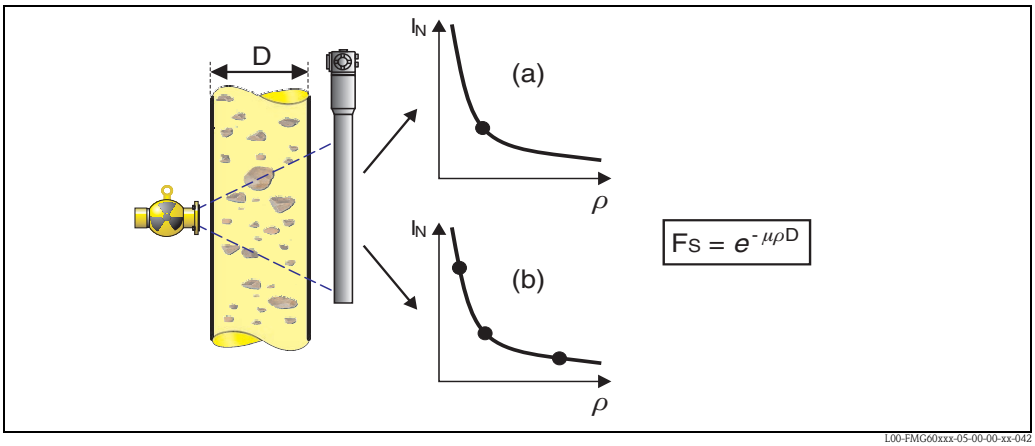
- XA 303F: ATEX II 2 (1) G for Gammapilot M
- XA 304F: ATEX II 2 (1) D for Gammapilot M
- XA 003R: ATEX II (1) GD for RMA422

SIL applications in connection with RMA422

- The Gammapilot M complies with SIL2 according to IEC 61508.
- The RMA 422 complies with SIL2 according to IEC 61511.

Density measurement

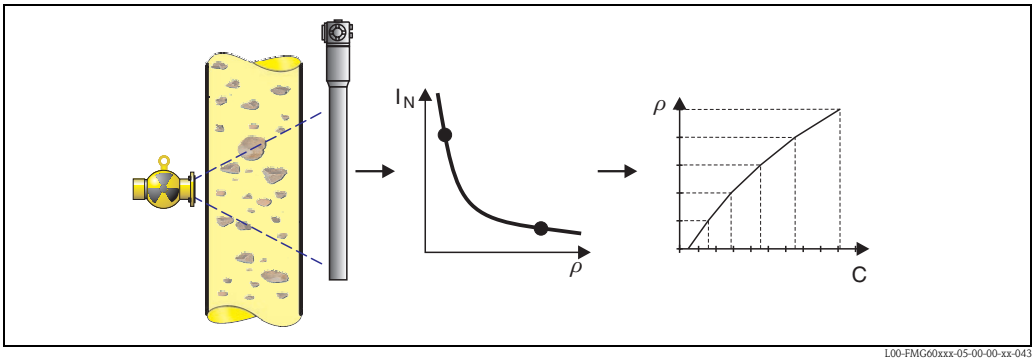
The measured values of up to nine samples of known density can be stored in the Gammapilot M and used for the calibration of density measurements.
From these calibration points, the Gammapilot M calculates the absorption coefficient μ and the linearisation curve automatically. These parameters are necessary 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 (which can be changed manually).



Modes of density calibration: **(a):** *One point calibration;* **(b):** *Multiple point calibration;*
I_N: *pulse rate (counts per second);* **F_S:** *damping factor;* **ρ:** *density;* **μ :** *absorption coefficient;* **D:** *pipe diameter or irradiated measuring path;*

Concentration measurement

The Gammapilot M determines the concentration indirectly via a density measurement. For this calculation a linearisation table consisting of up to 32 value pairs "density – concentration" can be entered.
In this way the solid content of a liquid can be measuered for example (percentage of volume or weight).



I_N: *Pulse rate (counts per second);* **ρ:** *Density;* **C:** *Concentration*

General functions

Decay compensation

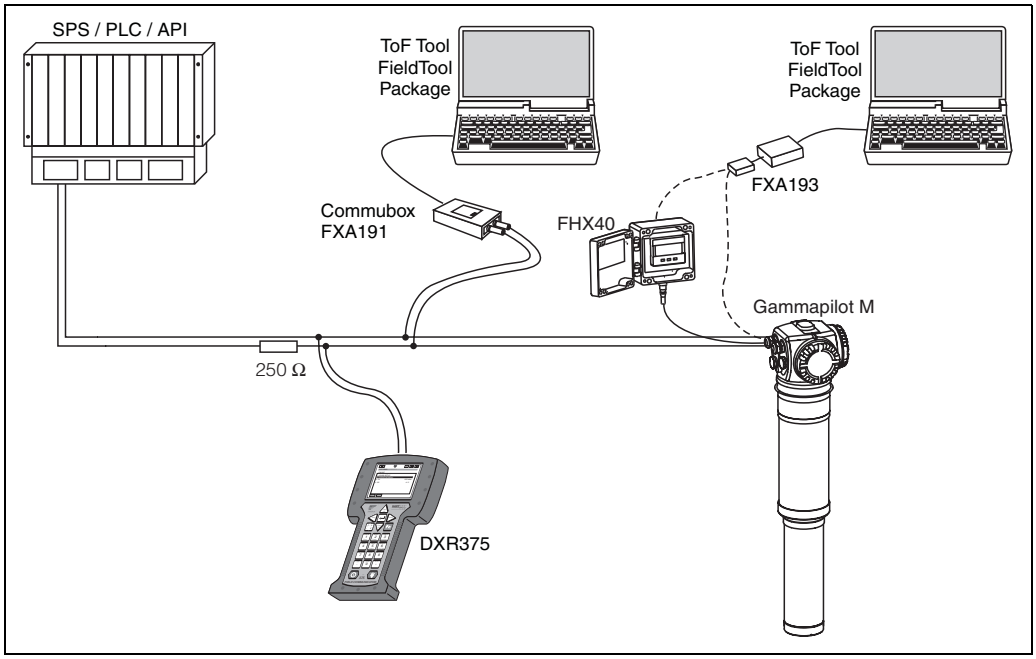
The automatic decay compensation of the Gammapilot M compensates the decrease of activity caused by the radiaoctive decay. Accurate measurement is thus possible over the entire application time of the gamma radiation source.

Gammagraphy detection

The Gammapilot M has got a function which detects short-term interference radiation. This function indicates, if the measurement is disturbed by non-destructive gammagraphic material-testings in the proximity of the measuring point.

System Integration

4 ... 20mA with HART protocol



If the HART communication resistor is not built into the supply unit, it is necessary to insert a communication resistor of 250 Ω into the 2-wire-line.

Operation via the service interface:

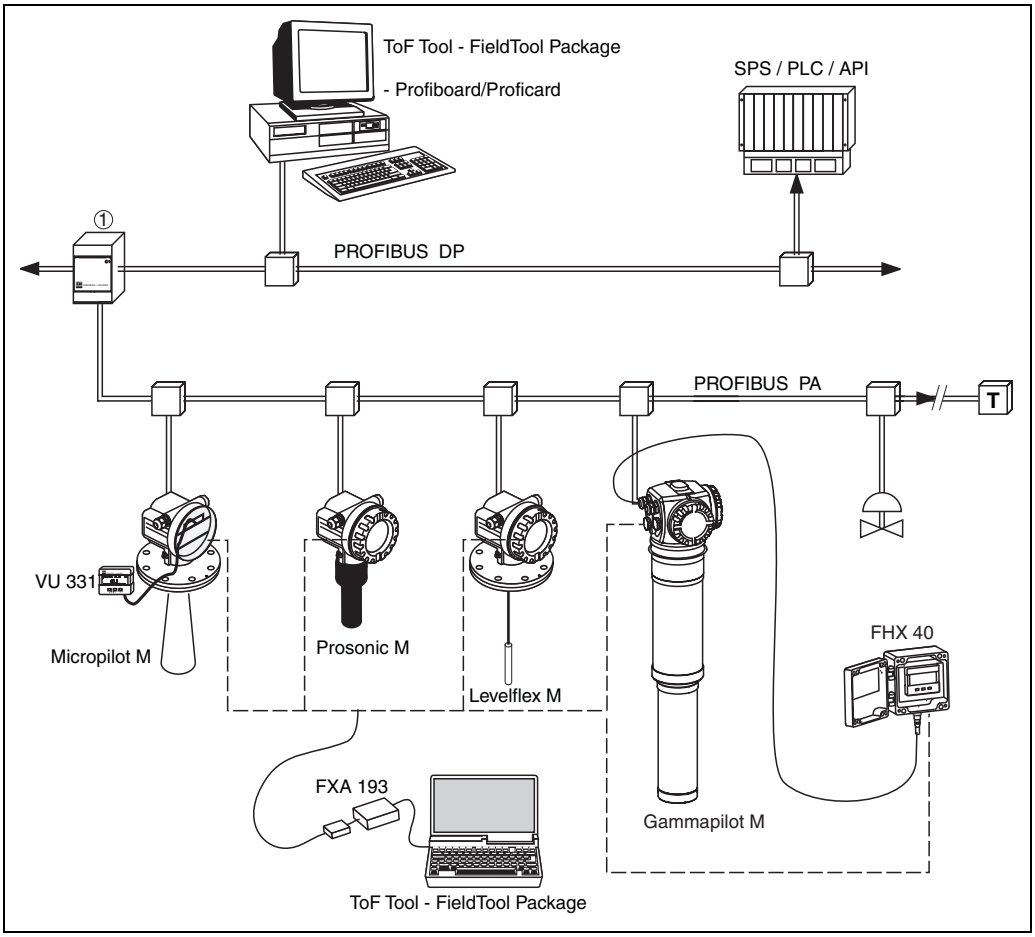
- with the display and operating unit FHX40
- with the Service Interface FXA193 and the operating program "ToF Tool – FieldTool Package"; The FXA193 can be connected to the display plug of the Gammapilot M or of the FHX40.

Operation via HART:

- with the HART handheld DXR375
- with the Commubox FXA191 and the operating program "ToF Tool – FieldTool Package"

PROFIBUS PA

A maximum of 32 transmitters (8 if mounted in an explosion hazardous location EEx ia IIC according to the FISCO model) can be connected to the bus. The segment coupler (①) provides the operating voltage to the bus. For further information on the PROFIBUS-PA standard refer to the Operating Manual BA 198F "PROFIBUS-DP/PA: Guidelines for planning and commissioning" or to the PROFIBUS-PA specification EN 50170 (DIN 19245).



Operation via the service interface:

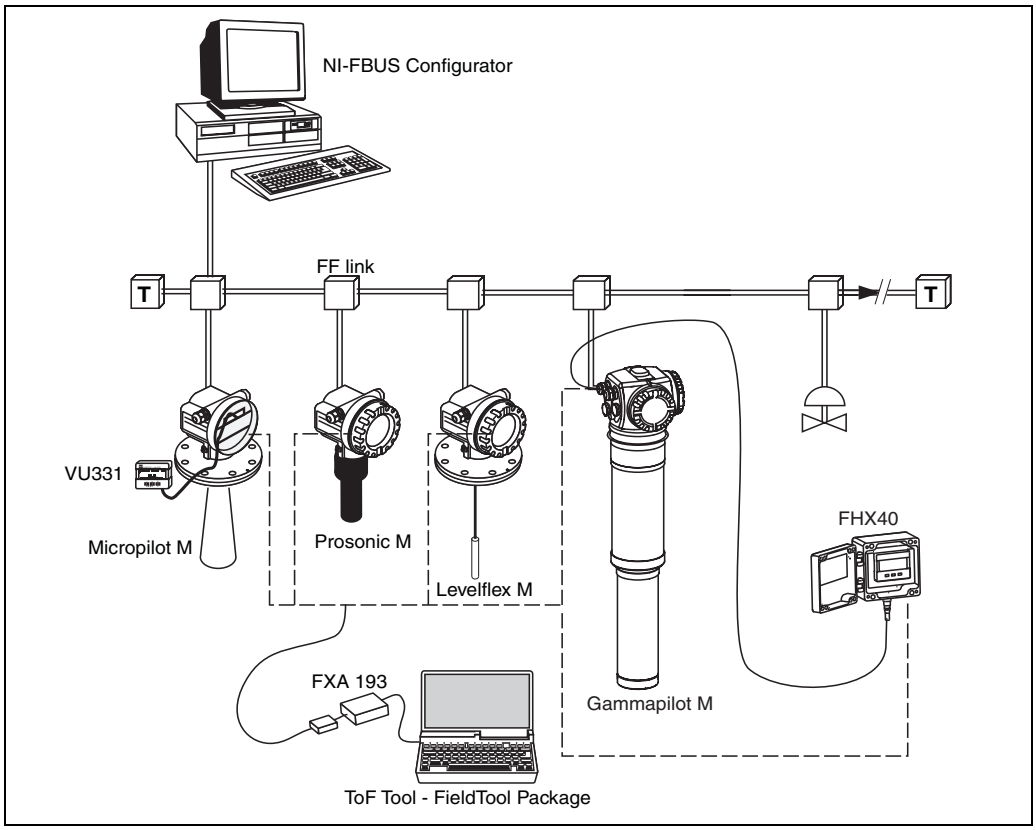
- with the display and operating unit FHX40
- with the Service Interface FXA193 and the operating program "ToF Tool – FieldTool Package"; The FXA193 can be connected to the display plug of the Gammapilot M or of the FHX40.

Operation via PROFIBUS:

- with Profiboard or Proficard and the operating program "ToF Tool – FieldTool Package"

Foundation Fieldbus (FF)

A maximum of 32 transmitters (standard or EEx d) can be connected to the bus. For protection class EEx ia: the maximum number of transmitters depends on the estabished rules and standards for intrinsically safe circuits (EN 60079-14) and proof on intrinsic safety.



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Operation via the service interface:

- with the display and operating unit FHX40
- with the Service Interface FXA193 and the operating program "ToF Tool - FieldTool Package"; The FXA193 can be connected to the display plug of the Gammapilot M or of the FHX40.

Operation via Foundation Fieldbus:

- with a configuration program, e.g. NI-FBUS Configurator

Input

Measured variable

The Gammapilot M measures the pulse rate (number of counts per second). This rate is proportional to the intensity of radiation at the detector. From this rate, the Gammapilot M calculates the desired measured value:

- Level limt (0% = "radiation path free"; 100% = "radiation path covered")
- Level (in %)
- Position of interface layer (in %)
- Density (unit selectable)
- Concentration (unit selectable)

Sensitivity

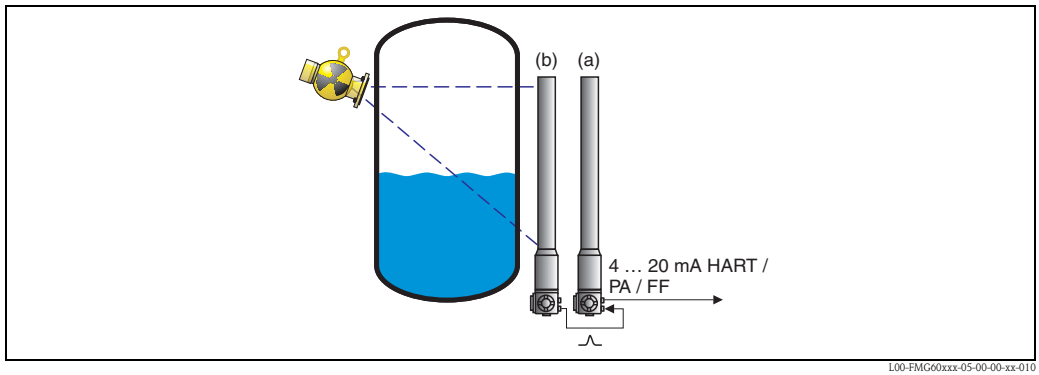
The sensitivity determines, which pulse rate arises from a local dose rate of 1 µSv/h. The sensitivity depends on the following parameters:

- type of scintillator
- measuring range
- applied isotope

Scintillator	Measuring range [mm]	Sensitivity for ^{137}Cs [(c/s)/(µSv/h)]	Sensitivity for ^{60}Co [(c/s)/(µSv/h)]
NaI	50	1250	350
PVT	200	2000	1000
	400	4000	2000
	800	8000	4000
	1200	12000	6000
	1600	16000	8000
	2000	20000	10000

Increasing the sensitivity by cascading

The sensitivity depends on the length of the detector. The sensitivity can be increased by connecting several sensors (cascading parallel mode). Only one transmitter - the "Master" - must be calibrated.



Double sensitivity achieved by cascading of two Gammapilot. They are assigned different roles: **(a):** *Master;* **(b):** *End-Slave*

Typical pulse rates

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

Level measurement (at empty vessel)

- 2500 c/s for ^{137}Cs
- 5000 c/s for ^{60}Co

Level limit detection (at free radiation path)

- 1000 c/s for ^{137}Cs
- 2000 c/s for ^{60}Co

Density and concentration measurements

depending on the application; contact the Endress+Hauser service or the "Gamma Project Team" (gamma@ii.endress.com).

Note!
Even if the pulse rate is higher or lower than the values specified, reliable measurement may be possible. In case of doubt contact the Endress+Hauser service or the "Gamma Project Team" (gamma@ii.endress.com).

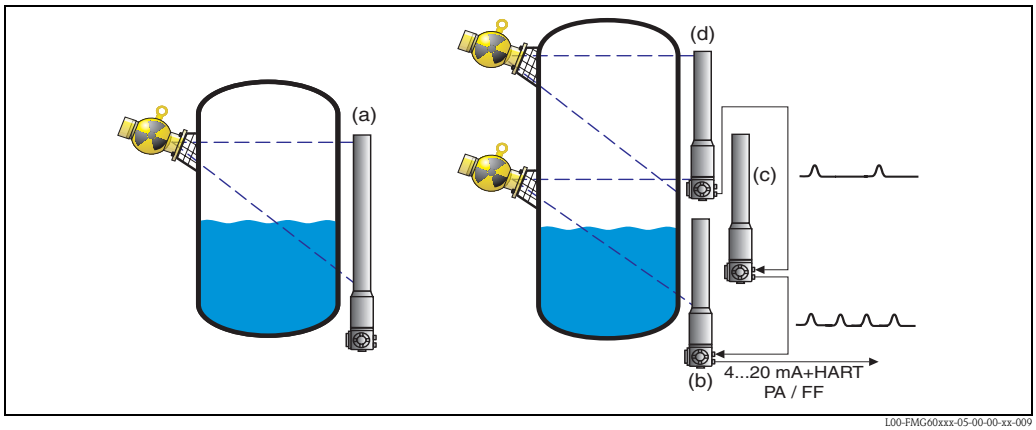
Maximum pulse rate

50,000 c/s
This limit should be taken into account especially when planning a plant with many cascaded transmitters.

Measuring range

Level measurement

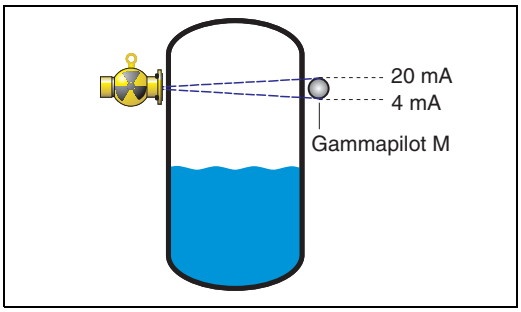
The transmitters are available with a measuring range up to 2 m.
In order to enlarge the measuring range, an arbitrary number of transmitters can be connected in series (cascading mode). The first transmitter of the series is defined to be the "Master", the further transmitters the "Slaves". The last transmitter of the series is defined to be the "End-Slave".
Only the "Master" must be calibrated.



(a): *One Gammapilot M is sufficient for measuring ranges up to 2 m;*
For larger measuring ranges as many Gammapilot M as required can be connected (cascading mode). By Software settings they are defined as **(b):** *Master,* **(c):** *Slave(s) or* **(d):** *End Slave.*

Level limit detection

For level limit detection the measuring range is nearly punctiform. It is determined by the thickness of the scintillator (approx. 40 mm).



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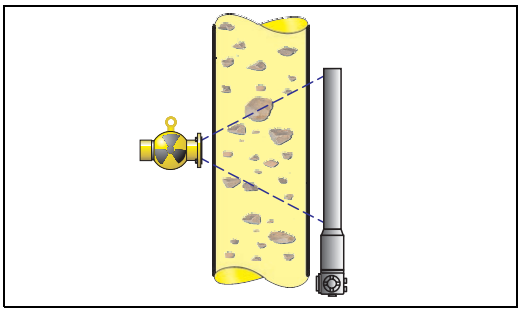
Density measurement

For density measurements, the measuring range is determined by the user.



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Temperature input (PT 100) for density measurements

In order to compensate temperature influences on the density measurements a temperature sensor PT 100 (4-wire connection) can be connected.

- Measuring range: -40 °C ... 200 °C
- Accuracy: ±1 K

Output

Output signal

- 4 ... 20 mA (active) with HART protocol
- PROFIBUS PA
- FOUNDATION Fieldbus (FF)
- Pulses for cascading mode

Error signal

Errors occuring during commissioning or operation are signalled in the following way:

- Error symbol, error code and error description on the display and operating module
- Current output, configurable (**"output on alarm" (*20)** function):
  - MAX, 110%, 22mA
  - MIN, -10%, 3,6 mA
  - HOLD (the last value is held)
  - user-specific value

Load HART

Minimum load for HART communication: 250 Ω

Output damping

Freely selectable, 1 ... 999 s

Power supply

Supply voltage

- 90 ... 253 V_{AC}; 50/60 Hz
- 18 ... 36 V_{DC}; protected against polarity reversion

Power consumption

- AC supply: approx. 8,5 VA
- DC supply: approx. 3,5 W

Overvoltage category

II

Protective class

1

Potential equalisation

The device must be included into the local potential equalisation system.

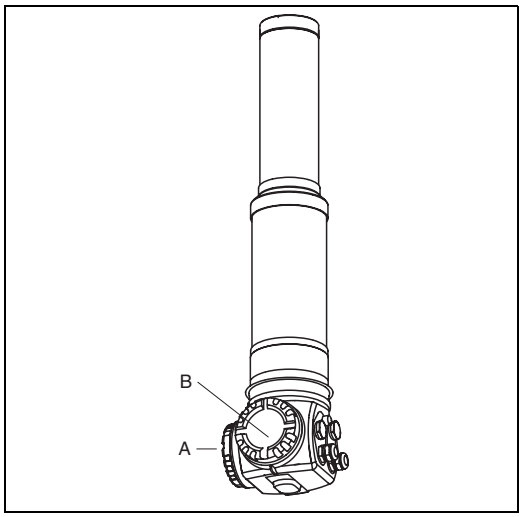
Electrical connection

Terminal compartments

The Gammapilot M has got two terminal compartments:

- terminal compartment A, for
  - Power supply
  - Signal output (depending on the instrument version)
- terminal compartment B, for
  - Signal output (depending on the instrument version)
  - PT-100 input (4-wire)
  - Pulse input for cascading mode
  - Pulse output for cascading mode
  - Display and operating module FHX40 (or VU331)

Note!
Depending on the instrument version, the signal output is located in the terminal compartment A or B.



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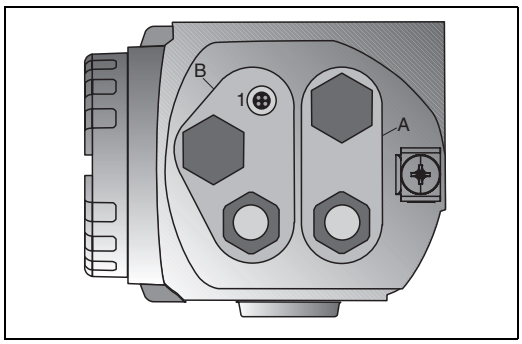
Cable entry

The number and type of calbe entries depend on the instrument version ordered. The following types may occur:

- Gland M20x1,5
  tightening diameter (clamping range):
  7.0 ... 10.5 mm
- Thread M20x1,5
- Thread G1/2
- Thread NPT1/2
- Plug M12 (s. below "Fieldbus plug connectors)
- Plug 7/8" (s. below "Fieldbus plug connectors)

Additionally, the Gammapilot M has a socket for connection of the separate display and operating module FHX 40. The FHX 40 can be connected without opening the hosuing of the Gammapilot M.



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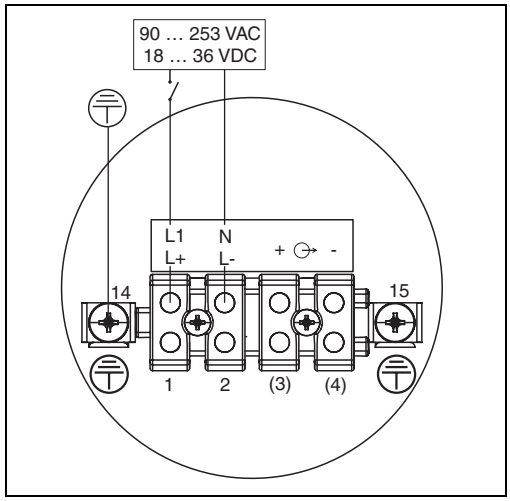
A: *Cable entries for terminal compartment A;*
B: *Cable entries for terminal compartment B;*
1: *Socket for FHX 40*

Note!
On delivery, not more than one cable gland is present for each of the terminal compartments. If further cable glands are required (e.g. for cascading mode), they must be supplied by the user.

Terminal assignment

Terminal compartment A



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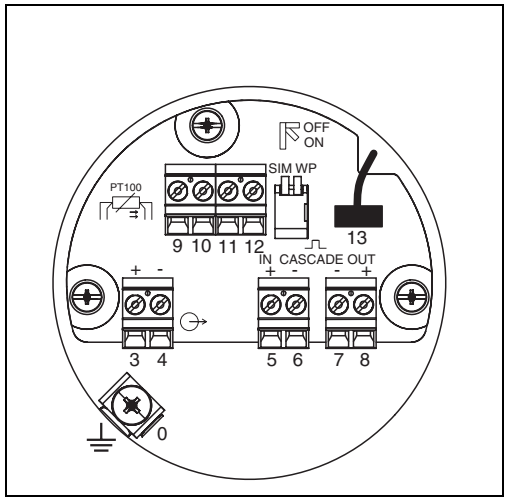
Terminal compartment B



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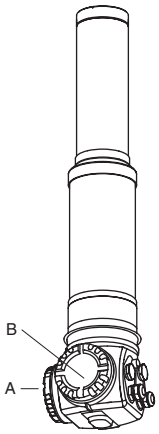
Terminal(s)	Meaning
0	Grounding of the cable screen
1, 2	Power supply[1]
Compartment B: 3, 4 **Compartment A:** (3)[1],(4)[1]	Signal output: 4...20 mA (active) with HART (The signal output is situated in the terminal compartment A or B depending on the instrument version, see below.) Note! For the versions of the Gammapilot M with fieldbus plug connectors (M12 or 7/8"), the signal output is wired in compartment B on delivery and connected to the fieldbus plug connector (see below, section "Fieldbus plug connectors"). In this case, the housing needs **not** to be opened for connecting the signal line.
5, 6	Pulse input (for cascading mode; is used for master and slave)
7, 8	Pulse output (for cascading mode; is used for slave and end slave)
9, 10, 11, 12	PT100 input (4-wire)
13	Plug for display and operating module VU331 (normally in FHX40); is wired on delivery and connected to the FHX40 plug
14	Protective earth
15	Protective earth or grounding of the cable screen

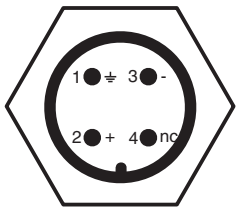
1) rated cross section max. 2,5 mm^2

Feature 30 of the product structure: Connection power supply / Connection output		Terminal compartment for		
		Power supply	Signal output	
A	Non-Ex; Non-Ex	A	B	
B	EEx e; EEx ia	A	B	
C	EEx e; EEx e	A	A	
D	Ex d (XP); Ex d (XP)	A	A	
E	Ex d (XP); Ex ia (IS)	A	B	
F	Dust-Ex; Dust-Ex	A	A	
G	EEx e, Dust-Ex; EEx e, Dust-Ex	A	A	
H	EEx d, Dust-Ex; EEx d, Dust-Ex	A	A	
J	EEx e, Dust-Ex; EEx ia, Dust-Ex	A	B	
K	EEx d, Dust-Ex; EEx ia, Dust-Ex	A	B	
L	Dust-Ex; Ex ia	A	B	

Fieldbus plug connectors

For the versions with fieldbus plug connector (M12 or 7/8"), the signal line can be connected without opening the housing.

Pin assignment of the M12 plug connector (PROFIBUS PA plug)



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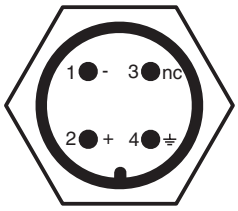
Pin	Meaning
1	Ground
2	Signal +
3	Signal –
4	not connected

Pin assignment of the 7/8" plug connector (FOUNDATION Fieldbus plug)



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Pin	Meaning
1	Signal –
2	Signal +
3	not connected
4	ground

Performance characteristics/Stability

Reaction time

dependent on the configuration; min. 2 s

Reference operating conditions

- Temperature: 20 °C ± 10 °C
- Pressure: 1013 mbar ± 20 mbar
- Humidity: not significant

Measured value resolution

depending on the measuring mode; up to 4 digits behind the decimal point

Influence of ambient temperature

Scintillator	Temperature range	Influence of ambient temperature
PVT	-40 ... +50 °C	± 1%
NaI crystal	-40 ... 60 °C	± 0,5%
	0 ... 50 °C	± 0,1%

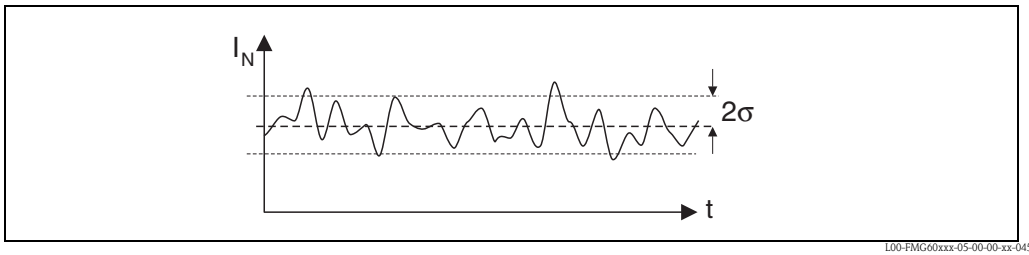
Statistical fluctuation of the radioactive decay

The radioactive decay is subject to statistical fluctuations. Therefore, the pulse rate fluctuates about its average value. The standard deviation σ is a measure for these fluctuations. It can be calculated in the following way:

$$\sigma = \frac{\sqrt{I_N}}{\sqrt{\tau}}$$

The required parameters are:
- I_N: the pulse rate
- τ: the output damping (integration time) as defined by the user

The standard deviation can be used to calculate various confidence limits. For the planning of radiometric measuring points, the 2σ confidence limit is generally used. Approx. 95% of the indicated pulse rates have got a deviation of less than 2σ from the average value. Only for approx. 5% is the deviation larger than 2σ.



95% of the displayed measuring values are within the 2σ confidence limit.

In order to calcutae the relative error (percentage), the standard deviation must be divided by the pulse rate:

$$2\sigma_{rel} = \frac{2\sigma}{I_N} = \frac{2}{\sqrt{I_N \tau}}$$

Example

- $I_N = 1000/s$
- $\tau = 10\ s$

$\Rightarrow 2\sigma_{rel} = 0{,}02 = 2\%$

Note!
As a general rule, the statistical fluctuations can be reduced by enlarging the output damping (integration time).

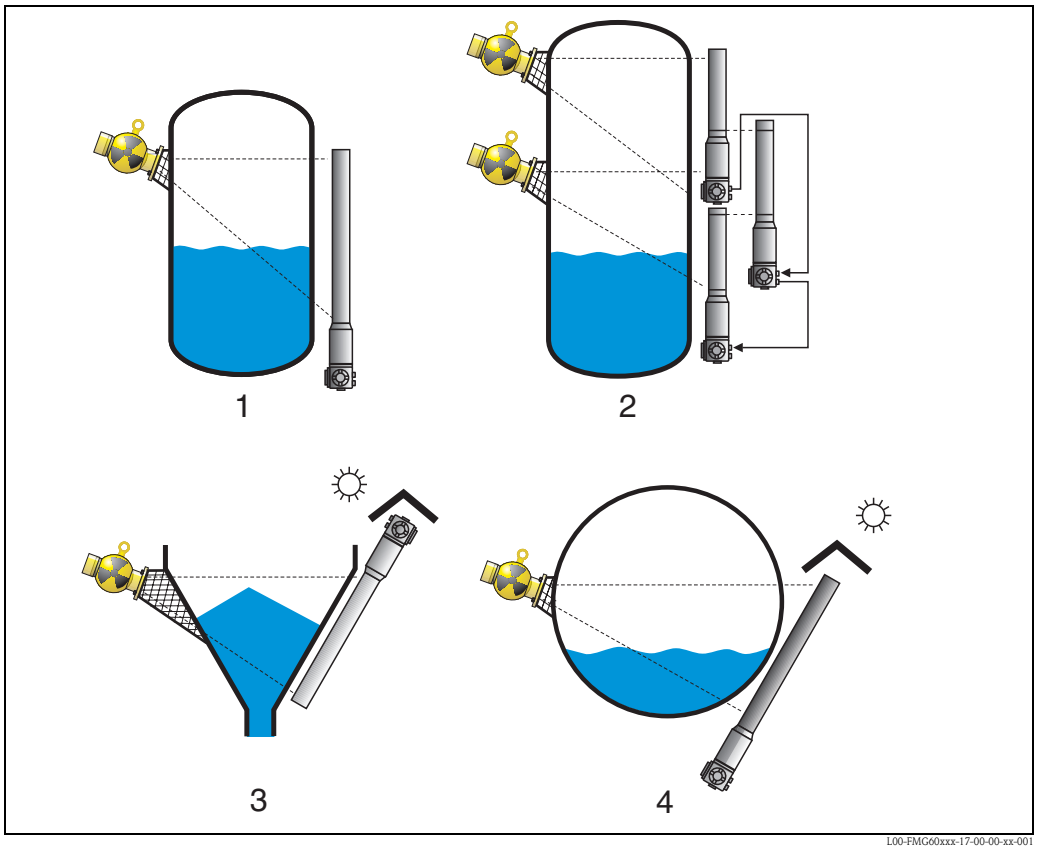
Installation conditions

Installation conditions for level measurement

Conditions

- For level measurements the Gammapilot M is mounted vertically; if possible the detector head should point downwards.
- The exit angle of the source container must be exactly aligned to the measuring range of the Gammapilot M. Observe the measuring range marks of the Gammapilot M.
- In cascading mode no gap should occur between the measuring ranges of the different Gammapilot M.
- The source container and the Gammapilot M must be mounted as close to the vessel as possible. Any access to the beam must be blocked so that no persons or part of their body (hand, arm, head) may come into the area of the beam.
- In order to enlarge the lifetime, the Gammapilot M should be protected against direct sun. If necessary, a protective cover should be applied.
- The mounting device FHG60 (see chapter "Accessories)or an equivalent mounting device should be used for fastening the Gammapilot M.
  The mounting device must be installed in a way such that it can withstand the weight of the Gammapilot M[1] under all operating conditions (e.g. vibrations).

Examples



1: *Vertical cylinder; the Gammapilot M is mounted vertically with the detector head pointing downwards; the gamma ray is aligned to the measuring range.* **2:** *Cascading of multiple Gammapilot M; there is no gap between the measuring ranges.* **3:** *conical outlet (with protective cover);* **4:** *horizontal cylinder (with protective cover).*

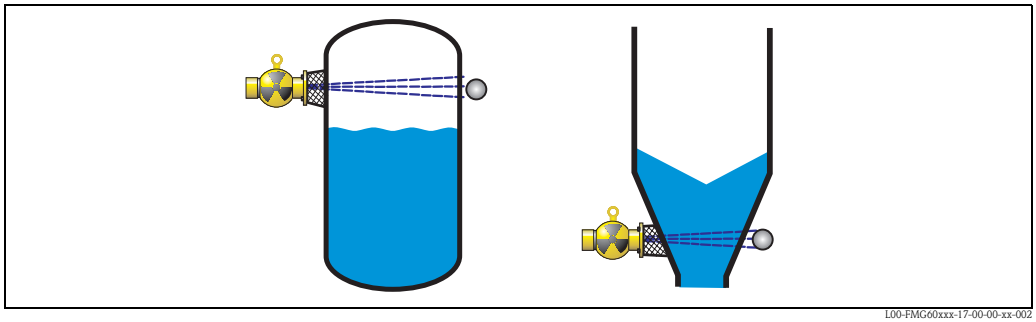
1) The weights of the various versions of the Gammapilot M are summarised in the section "Dimensions/Weight".

Installation conditions for limit detection

Conditions

- For level limit detection, the Gammapilot M should be mounted horizontally at the height of the desired level limit.
- The exit angle of the source container must be exactly aligned to the measuring range of the Gammapilot M. Observe the measuring range marks of the Gammapilot M.
- The source container and the Gammapilot M must be mounted as close to the vessel as possible. Any access to the beam must be blocked so that no persons or part of their body (hand, arm, head) may come into the area of the beam.
- In order to enlarge the lifetime, the Gammapilot M should be protected against direct sun. If necessary, a protective cover should be applied.
- The mounting device FHG60 (see chapter "Accessories)or an equivalent mounting device should be used for fastening the Gammapilot M.
  The mounting device must be installed in a way such that it can withstand the weight of the Gammapilot M[1] under all operating conditions (e.g. vibrations).

Examples



Left: *maximum fail-safe mode;* **right:** *minimum fail-safe mode*

1) The weights of the various versions of the Gammapilot M are summarised in the section "Dimensions/Weight".

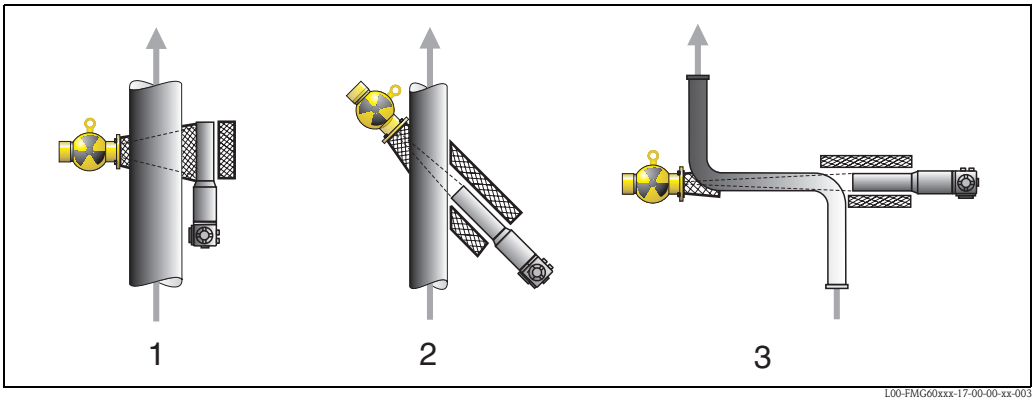
Installation conditions for density and concentration measurement

Conditions

- If possible, density and concentration should be measured at vertical pipes with a feed direction from bottom to top.
- If only horizontal pipes are accessible, the path of the ray should also be arranged horizontally to reduce the influence of air bubbles and sediments.
- The Endress+Hauser clamping device (see chapter "Accessories") or an equivalent clamping device should be used for fastening the radiation source container and the Gammapilot M to the measuring tube.
  The clamping device must be installed in a way such that it can withstand the weight of the radiation source container[1] and the Gammapilot M[2] under all operating conditions.

Configuration of the measuring system

The configuration of the source container and the Gammapilot M depends on the pipe diameter (or the length of the irradiated measuring path respectively) and the measuring range. These two parameters determine the measuring effect (relative change of the pulse rate). The measuring effect increases with the length of the radiation path through the medium. Therefore, diagonal irradiation or application of a measuring path is necessary for small pipe diameters.
For the configuration of the measuring system please contact your Endress+Hauser sales organisation or use the "Applicator"[3] configuration software



1: *Rectangular beam (90°);* **2:** *Diagonal beam (30° or 45°);* **3:** *Measuring path*

Note!
A clamping device and a measuring path are available as accessory (see chapter "Accessories").

1) The weights of the radiation source containers are summarised in Technical Information TI 264F (QG 020/100) or TI 346F (QG 2000).
2) The weights of the various versions of the Gammapilot M are summarised in the section "Dimensions/Weight".
3) The "Applicator" CD-ROM can be obtained from your Endress+Hauser sales organisation.

Ambient conditions

Ambient temperature

Instrument version	Ambient temperature		Storage temperature
	without water cooling	with water cooling	
PVT Scintillator	-40 °C ... +50 °C[1]	0 °C ... +120 °C[2]	-40 °C ... +50 °C
NaI crystal	-40 °C ... +60 °C[3]	0 °C ... +120 °C[2]	-40 °C ... +60 °C

1) If the ambient temperature permanently exceeds +40 °C, water cooling is recommended.

2) max. 75 °C at the compartment housing

3) If the ambient temperature permanently exceeds +50 °C, water cooling is recommended.

In explosion hazardous areas observe the instructions of the appropriate XA/ZD.
Avoid exposure to direct sunlight; if necessary use a protective cover.

Climate class

DIN EN 60068-2-38 examination Z/AD

Degree of protection

IP 65/67; NEMA 4/6; TYPE 4/6

Vibration resistance

DIN EN 60068-2-64; Examination Fh; 10 ... 2000 Hz, $1(m/s^2)^2/Hz$

Shock resistance

DIN EN 60068-2-27; Examination Ea; 30 g, 18 ms, 3 shocks/direction/axis

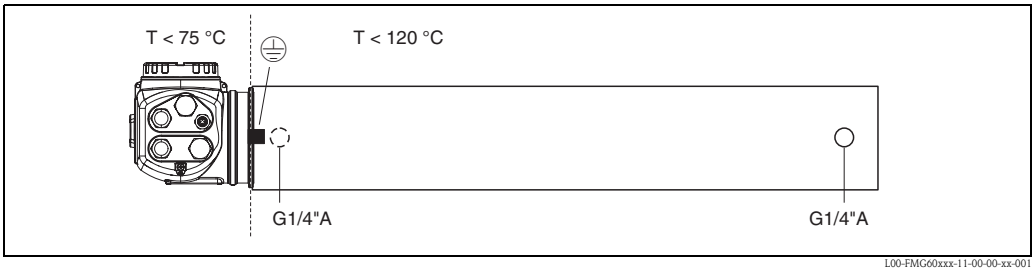
Electromagnetic compatibility

- Interference emmission to EN 61326, Equipment class B
- Interference immunity to EN 61326, Appendix A (Industrial) and NAMUR recommendation NE 21

Water cooling

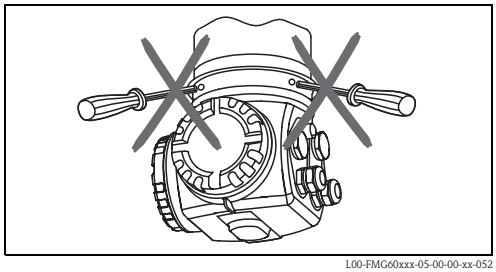
For the versions of the Gammapilot with water cooling jacket, the following applies:

- Material: 316L
- Water connection: 2 x G 1/4"A, DIN ISO 228
- Inlet temperature: max. 40 °C
- Outlet temperature: max. 50 °C (temperature monitoring recommended)
- Water pressure: 4 ... 6 bar

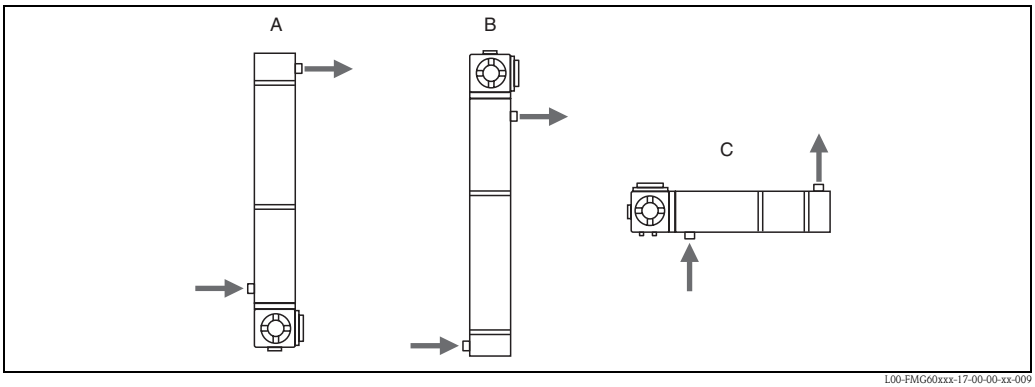


Connections of the water cooling jacket

Caution!
- It is recommended to ground the water cooling jacket separately at the provided earth terminal (see above picture)
- The ambient temperature of the compartment housing must not exceed 75 °C. This is also valid, if water cooling is applied.
- The three screws, connecting the pipe housing to the compartment housing, must **not** be opened.



Mounting versions



A: *Recommended mounting position for level measurement: compartment housing at the bottom;*
B: *In exceptional cases (e.g. shortage of space) the compartment housing may be located at the top.*
C: *Mounting position for limit detection and density measurement.*

Caution!
The water inlet must always be at the bottom to ensure that the water cooling jacket is completely filled.

Required flow rate

The required flow rate depends on
- the ambient temperature at the water cooling jacket
- the inlet temperature
- the measuring range of the Gammapilot M

Typical values are given in the following tables:

Ambient temperature T_A = 75 °C

inlet temperature	measuring range						
	50 mm	200 mm	400 mm	800 mm	1200 mm	1600 mm	2000 mm
20 °C	30 l/h	30 l/h	30 l/h	41 l/h	55 l/h	70 l/h	84 l/h
25 °C	30 l/h	30 l/h	30 l/h	45 l/h	61 l/h	77 l/h	93 l/h
30 °C	30 l/h	30 l/h	33 l/h	50 l/h	68 l/h	86 l/h	104 l/h
35 °C	30 l/h	30 l/h	38 l/h	59 l/h	80 l/h	101 l/h	122 l/h
40 °C	30 l/h	30 l/h	47 l/h	72 l/h	98 l/h	124 l/h	149 l/h

Ambient temperature T_A = 100 °C

inlet temperature	measuring range						
	50 mm	200 mm	400 mm	800 mm	1200 mm	1600 mm	2000 mm
20 °C	30 l/h	30 l/h	38 l/h	59 l/h	80 l/h	101 l/h	122 l/h
25 °C	30 l/h	30 l/h	42 l/h	64 l/h	87 l/h	110 l/h	133 l/h
30 °C	30 l/h	30 l/h	47 l/h	73 l/h	98 l/h	124 l/h	150 l/h
35 °C	30 l/h	30 l/h	54 l/h	84 l/h	113 l/h	143 l/h	173 l/h
40 °C	33 l/h	33 l/h	66 l/h	101 l/h	137 l/h	173 l/h	210 l/h

Ambient temperature T_A = 120 °C

inlet temperature	measuring range						
	50 mm	200 mm	400 mm	800 mm	1200 mm	1600 mm	2000 mm
20 °C	30 l/h	30 l/h	45 l/h	70 l/h	94 l/h	119 l/h	144 l/h
25 °C	30 l/h	30 l/h	50 l/h	77 l/h	104 l/h	131 l/h	158 l/h
30 °C	30 l/h	30 l/h	55 l/h	85 l/h	115 l/h	146 l/h	176 l/h
35 °C	32 l/h	32 l/h	64 l/h	98 l/h	133 l/h	168 l/h	203 l/h
40 °C	38 l/h	38 l/h	75 l/h	116 l/h	157 l/h	199 l/h	240 l/h

Process conditions

Process temperature

no limitations;
for high process temperatures sufficient isolation between process vessel and detector must be ensured (see table of ambient temperatures, page 22).

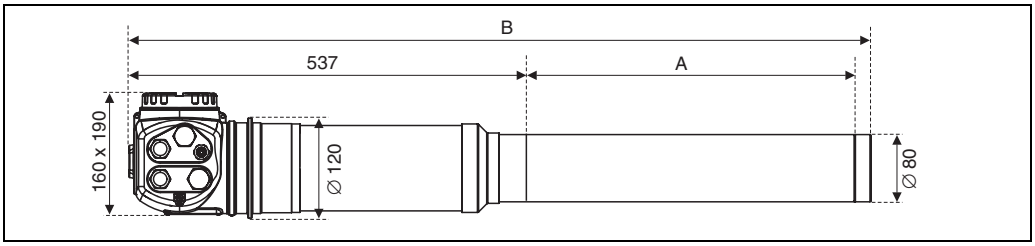
Process pressure

no limitations;
the influence of pressure must be taken into account when calculating the required activity and calibrating.

Mechanical construction

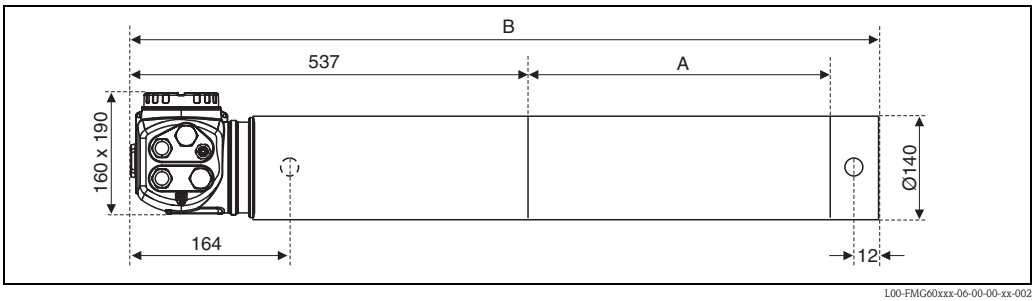
Dimensions, Weight

Gammapilot M without water cooling jacket



L00-FMG60xxx-06-00-00-xx-001

Gammapilot M with water cooling jacket



L00-FMG60xxx-06-00-00-xx-002

Type	measuring length A [mm]	without water cooling jacket		with water cooling jacket		
		total length B [mm]	weight [kg]	total length B [mm]	weight without water [kg]	weight including water [kg]
NaI	50	621	14	631	18	20
PVT	200	780	15	790	20	24
PVT	400	980	16	990	23	29
PVT	800	1380	20	1390	31	40
PVT	1200	1780	24	1790	37	50
PVT	1600	2180	28	2190	45	61
PVT	2000	2580	31	2590	51	72

Materials

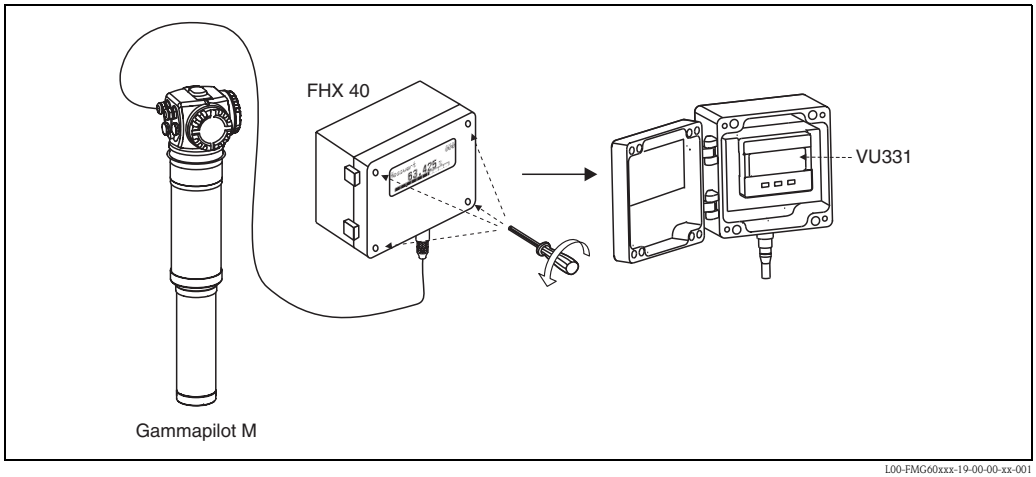
- Housing: SS316L
- Sealing materials:
  - housing: FKM
  - cable glands: EPDM; TPE-V

Human Interface

Display and operating unit FHX 40

Connection

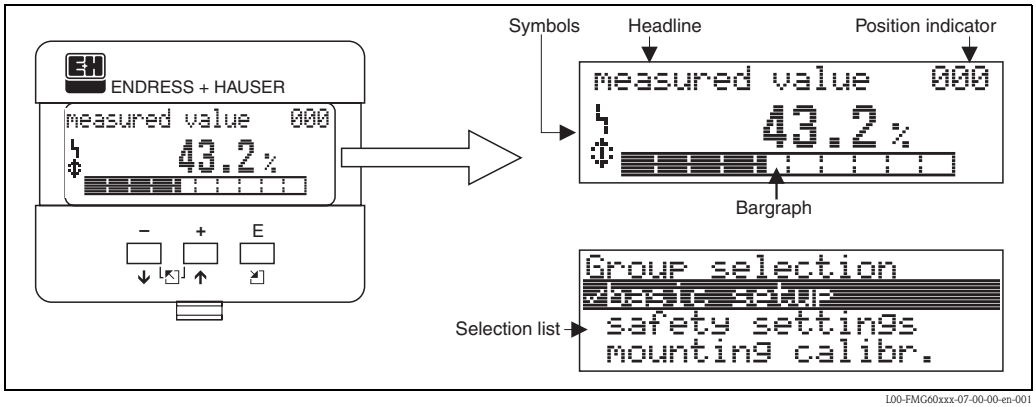
The separate display and operating unit FHX 40 is available as an accessory. It is connected via the supplied cable (20 m) and plug to the Gammapilot M. It contains the display and operating module VU 331.



L00-FMG60xxx-19-00-00-xx-001

Operation

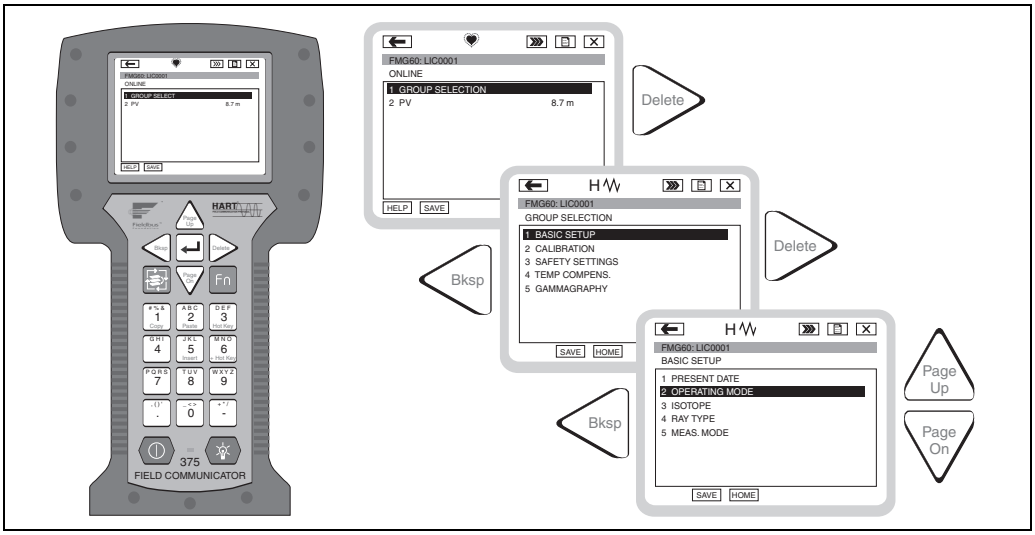
The display and operatin module VU 331 allows configuration via 3 keys. All device functions can be set through a menu system. The menu consists of function groups and functions. Within a function, application parameters can be read or adjusted. Via the plain text display, the user is guided through a complete configuration procedure.



L00-FMG60xxx-07-00-00-en-001

HART handheld terminal DXR 375

On devices with HART communication, you can also access the menu using the handheld terminal DXR 375.



L00-FMU4xxxx-07-00-00-de-005

Connect the handheld terminal directly to the HART communication line.

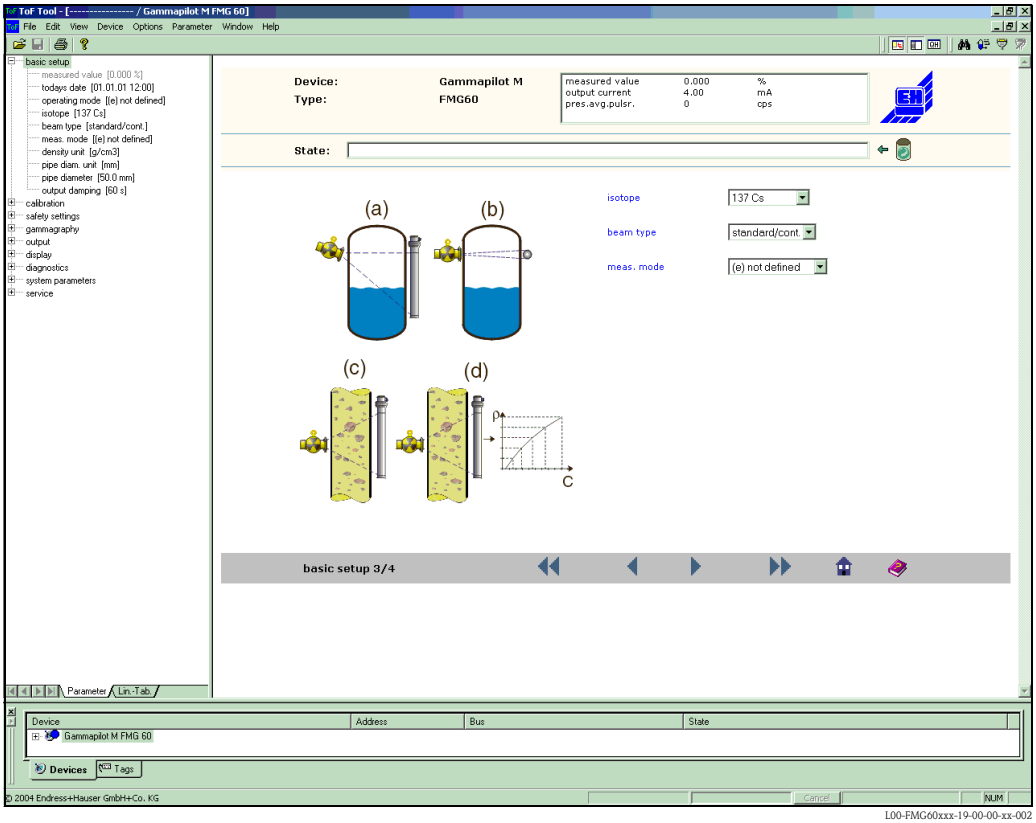
ToF Tool – FieldTool Package

The "ToF Tool – FieldTool Package" is a standardised graphical operating program for measuring instruments from Endress+Hauser. It is delivered together with the Gammapilot M. Observe the system requirements and installations hints on the cover of these CD-ROMs.

Connection options

- HART: Commubox FXA191 (s. chapter "Accessories")
- PROFIBUS PA: Profiboard or Proficard
- For all communication variants: Service Interface with Adapter FXA193 (s. chapter "Accessories")

Menu guided commissioning



L00-FMG60xxx-19-00-00-xx-002

- The function groups and functions of the instrument can be found in the **navigation bar**.
- Input fields for the parameters are situated in the **input window**.
- If you click on a parameter name, the **help pages** open with precise explanations of the required input.

NI-FBUS Configurator (only Foundation Fieldbus)

The NI-FBUS Configurator is an easy-to-use graphical environment for creating linkages, loops, and a schedule based on the fieldbus concepts.
You can use the NI-FBUS Configurator to configure a fieldbus network as follows:

- Set block and device tags
- Set device addresses
- Create and edit function block control strategies (function block applications)
- Configure vendor-defined function and transducer blocks
- Create and edit schedules
- Read and write to function block control strategies (function block applications)
- Invoke Device Description (DD) methods
- Display DD menus
- Download a configuration
- Verify a configuration and compare it to a saved configuration
- Monitor a downloaded configuration
- Replace devices
- Save and print a configuration

Certificates and Approvals

CE mark

The measuring system meets the legal requirements of the EC-guidelines. Endress+Hauser confirms the instrument passing the required tests by attaching the CE-mark.

Ex approval

The available certificates are listed in the ordering information.

ATEX (in preparation)

Observe the associated Safety Instructions (XA).

FM, CSA and TIIS (in preparation)

Observe the associated Control Drawings (ZD).

Overspill protection

- WHG (for level limit detection) (in preparation)
- SIL 2 according to IEC 61508 (for level limit detection) (in preparation)

External standards and guidelines

EN 60529

Protection class of housing (IP code)

EN 61326

Electromagnetic compatibility (EMC requirements)

EN 61010

Safety regulations for electrical devices for measurement, control, regulation and laboratory use.

NAMUR

Standards committee for meausrement and control in the chemical industry

Ordering Information

Product Structure Gammapilot M FMG60

	Approval
A	Non-hazardous area
F	Non-hazardous area, WHG (limit switch)
1	ATEX II 2 (1) G EEx de (ia) IIC T6
2	ATEX II 2 (1) G EEx de (ia) IIC T6, WHG (limit switch)
3	ATEX II 2 (1) G EEx d (ia) IIC T6
4	ATEX II 2 (1) G EEx d (ia) IIC T6, WHG (limit switch)
5	ATEX II 2 (1) D
6	ATEX II 2 (1) GD EEx de (ia) IIC T6
7	ATEX II 2 (1) GD EEx de (ia) IIC T6, WHG (limit switch)
8	ATEX II 2 (1) GD EEx d (ia) IIC T6
M	ATEX II 2 (1) GD EEx d (ia) IIC T6, WHG (limit switch)
S	FM Cl.I Gr.A-D/Cl.II Gr.E-G/Cl.III
P	CSA Cl.I Gr.A-D/Cl.II Gr.E-G/Cl.III
N	CSA General Purpose
K	TIIS Ex d (ia) IIC T6
Y	Special version, to be specified

	Power supply
1	90-253 VAC
2	18-36 VDC
9	Special version, to be specified

	Connection Power Supply / Connection Output
A	Non-Ex; Non-Ex
B	EEx e; EEx ia
C	EEx e; EEx e
D	Ex d (XP); Ex d (XP)
E	Ex d (XP); Ex ia (IS)
F	Dust-Ex; Dust-Ex
G	EEx e, Dust-Ex; EEx e, Dust-Ex
H	EEx d, Dust-Ex; EEx d, Dust-Ex
J	EEx e, Dust-Ex; EEx ia, Dust-Ex
K	EEx d, Dust-Ex; EEx ia, Dust-Ex
L	Dust-Ex; Ex ia
Y	Special version, to be specified

	Output
1	4-20 mA, HART
2	PROFIBUS PA
3	FOUNDATION Fieldbus
9	Special version, to be specified

	Scintillator measuring range
A	NaI-Crystal 50x50mm
C	NaI-Crystal 50x50mm + collimator radial
D	NaI-Crystal 50x50mm + water cooling
G	PVT 200mm
H	PVT 200mm + water cooling
J	PVT 400mm
K	PVT 400mm + water cooling
L	PVT 800mm
M	PVT 800mm + water cooling
N	PVT 1200mm
P	PVT 1200mm + water cooling
Q	PVT 1600mm
R	PVT 1600mm + water cooling
S	PVT 2000mm
T	PVT 2000mm + water cooling
Y	Special version, to be specified

FMG60 -	Product designation, first part

						Housing; Operation				
						1	316L; Prepared for FHX40, remopte display (Accessory)			
						9	Special version, to be specified			
							Cable entry power supply			
							A	Gland M20		
							B	Thread M20		
							C	Thread G1/2		
							D	Thread NPT1/2		
							Y	Special version, to be specified		
								Cable entry output		
								1	as for power supply (gland/thread)	
								2	Plug M12	
								3	Plug 7/8"	
								9	Special version, to be specified	
									Additional option	
									A	Basic version
									B	SIL2/IEC61508 Declaration of conformity, limit switch
									Y	Special version, to be specified
FMG 60 -										Product designation

Accessories

Commubox FXA191

For intrinsically safe communication between the HART protocol and the RS232 interface of a PC. Further Information can be found in Technical Information TI 237F.

Service Interface FXA193

The Service-Interface connects the Service plug of Proline and ToF instruments with the 9 pin RS 232C interface of a PC. (USB connectors must be equipped with a usual commercial USB/Serial adapter.)

Product structure

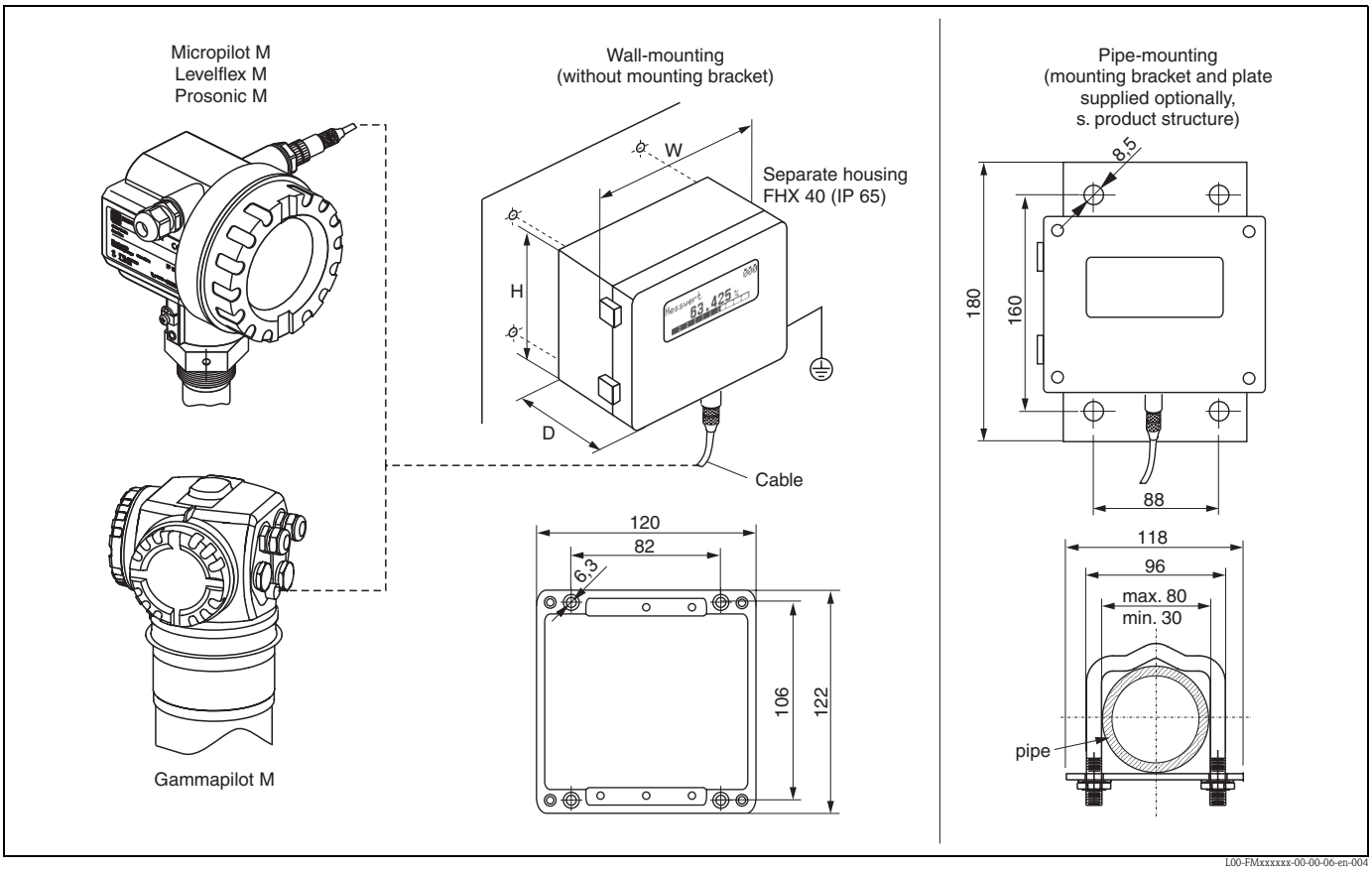
		Approvals	
	A	For use in non-hazardous areas	
	B	ATEX II (1) GD	
	C	CSA/FM Class I Div. 1	
	D	ATEX, CSA, FM	
	9	other	
		Connection cable	
	B	Connection cable for ToF devices	
	E	Connection cable for Proline and ToF devices	
	H	Connection cable for Proline and ToF devices and Connection cable for Ex two-wire devices	
	X	without connection cable	
	9	others	
FXA193-			Complete product designation

Associated documentation

- Technical Information: TI063D
- Safety Instructions for ATEX II (1) GD: XA077D
- Supplementary information for the cable adapters: SD092D

Note!
The Gammapilot M is a ToF device. Thus options "B", "E" or "H" of the connection cable can be used.

Remote display FHX40 **Dimensions**



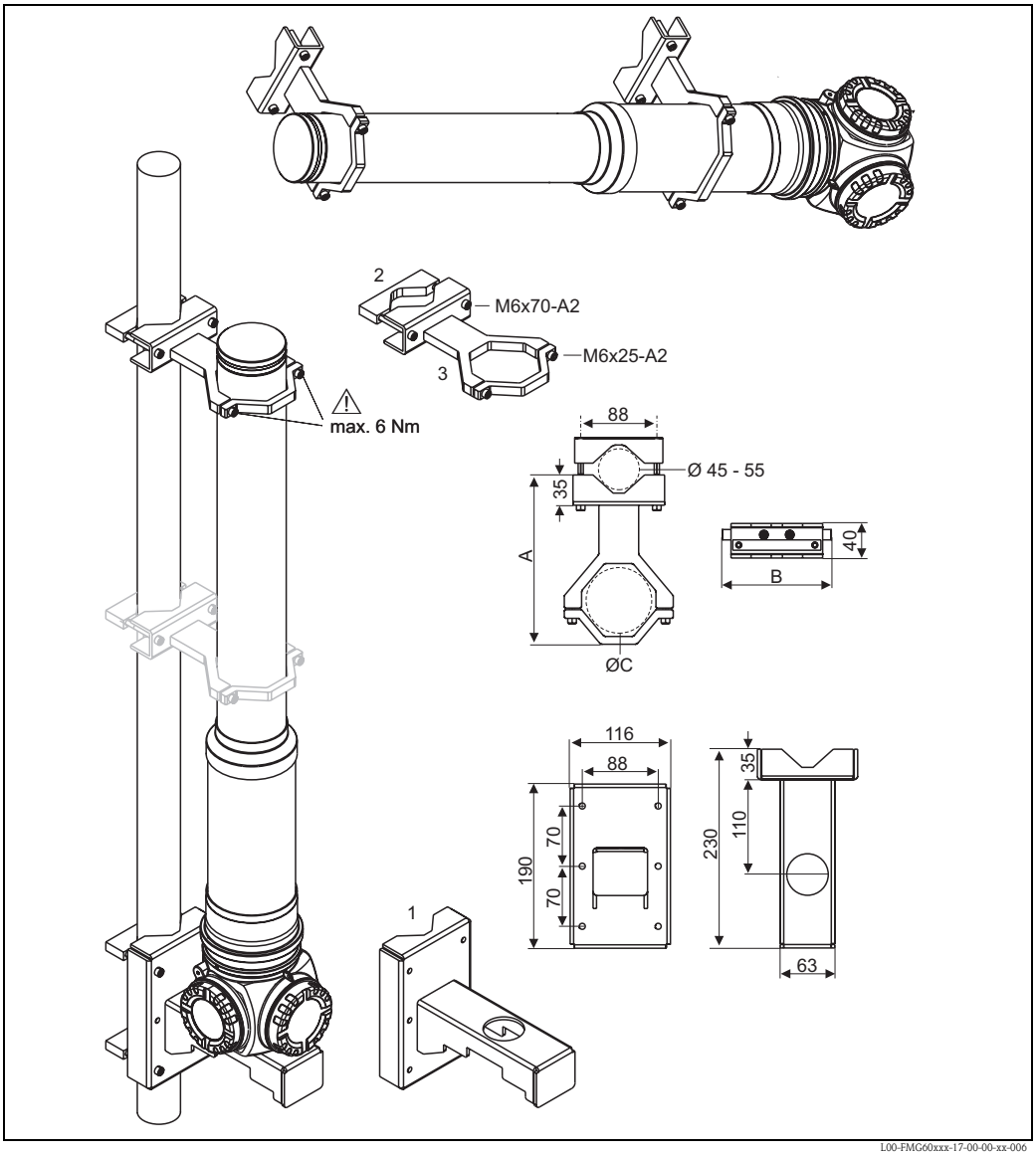
Technical data and product structure:

Max. cable length	20 m (65 ft)
Temperature range	-30 °C...+70 °C (-22 °F...158 °F)
Degree of protection	IP65 acc. to EN 60529 (NEMA 4)
Material for housing	Alloy of Aluminium AL Si 12
Dimensions [mm] / [inch]	122x150x80 (HxWxD) / 4.8x5.9x3.2

	Approval:				
	A				Nn-hazardous area
	1				ATEX II 2 G EEx ia IIC T6, ATEX II 3D
	S				FM IS Cl.I Div.1 Gr.A-D
	U				CSA IS Cl.I Div.1 Gr.A-D
	N				CSA General Purpose
		Cable length:			
		1			20m/65ft
			Additional option:		
			A		Basic version
			B		Mounting bracket, pipe 1"/ 2"
FHX40 -					Complete product designation

Mounting device FHG60 (for level measurement and limit detection)

Dimensions



L00-FMG60xxx-17-00-00-xx-000

1: *Bracket (for application "level" only[1]);* **2:** *mounting clamps (number according to selected application[1]);* **3:** *retainers (number and size according to selected application[1]; Allen screws according to ISO4762 are supplied)*

Size of the retainers (depending on the selected application)

mounting position at the FMG60	length A	width B	∅C
scintillator tube	196	126	80
electronics tube	210	150	102
water cooling jacket	230	200	140

Caution!
Max. torque for the screws of the retainers: 6 Nm.

1) see below: "Product structure for complete mounting set" and "Application hints"

Product structure for complete mounting set

	Application
1	Level, measuring range of FMG60: 400-1200 mm; (1 bracket, 1 retainer)
2	Level, measuring range of FMG60: 1600-2000 mm; (1 bracket, 2 retainers)
3	Limit switch, measuring range of FMG60: 200/400 mm; (2 retainers)
9	Special version, to be specified

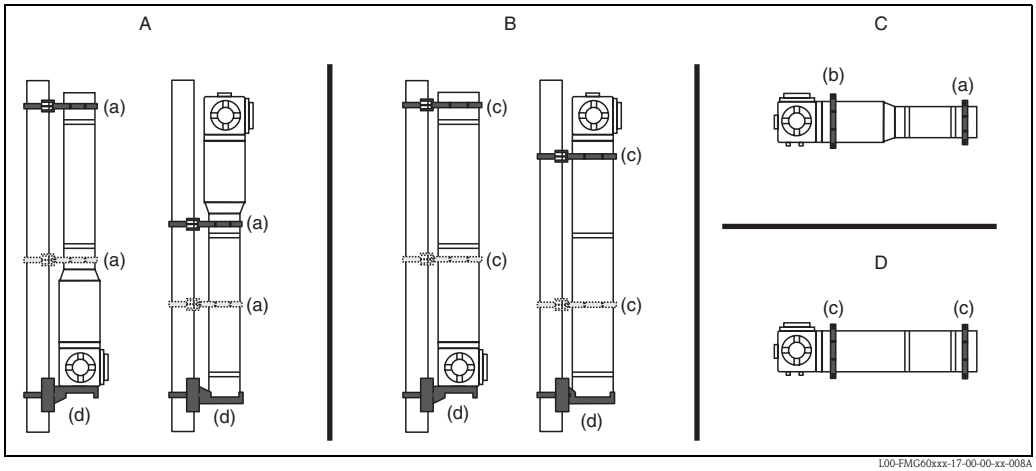
		Mounting clamp
A		FMG60 without water cooling
B		FMG60 with water cooling
Y		Special version, to be specified

		Material
1		316L
9		Special version, to be specified

FHG60 –					complete product designation

Application hints

The mounting device for level measurements and level limit detection consists of the bracket, mounting clamps, retainers and the associated screws. The Gammapilot M is fitted into the bracket by the centering knob and fixed to the tube by the mounting clamps and retainers. For a detector length of 1600 mm or more two retainers are to be used. For the limit switch version (horizontal mounting) the bracket is not needed.



A: level measurement, FMG60 without water cooling; B: level measurement, FMG60 with water cooling;
C: limit detection, FMG60 without water cooling; D: limit detection, FMG60 with water cooling
(a): *retainer for tube ∅ 80 mm;* **(b):** *retainer for tube ∅ 102 mm;* **(c):** *retainer for water cooling jacket;, ∅140 mm;*
(d): *bracket*

Caution!
- The mounting device must be installed in a way such that it can withstand the weight of the Gammapilot M[1] under all operating conditions (e.g. vibrations).
- For a measuring length of 1600 mm or more, two retainers must be used.
- For vertical mounting usage of the bracket is mandatory. Otherwise a sufficient stability and support of the Gammapilot M is not ensured.
- For stability reasons the mounting version with the compartment housing pointing upwards should only be used in exceptional cases(e.g. lack of space).
- To prevent damage of the detector tube, the maximum torque of the retainer screws is 6 Nm.

Clamping device for density measurements

on request

Measuring path for density measurements

on request

1) The weights of the various versions of the Gammapilot M are summarised in the section "Dimensions/Weight".

Supplementary documentation for Gammapilot M

Innovation	**IN 002F** Innovation brochure for Gammapilot M
Operating Instructions	**BA 236F** Operating Instructions for Gammapilot M **BA 287F** Description of Instrument Functions for Gammapilot M
Safety Instructions (ATEX)	**XA 303F** Safety Instructions for Gammapilot M with ATEX II 2 (1) G **XA 304F** Safety Instructions for Gammapilot M with ATEX II 2 (1) D

Supplementary documentation for Gamma Radiation Sources and Source Containers

Gamma Radiation Sources	**TI 213F** Technical Information for Gamma Radiation Sources
QG020/QG100	**TI 264F** Technical Information for Source Containers QG020/QG100
QG2000	**TI 346F** Technical Information for Source Container QG2000 **BA 223F** Operating Instructions for Source Container QG2000

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