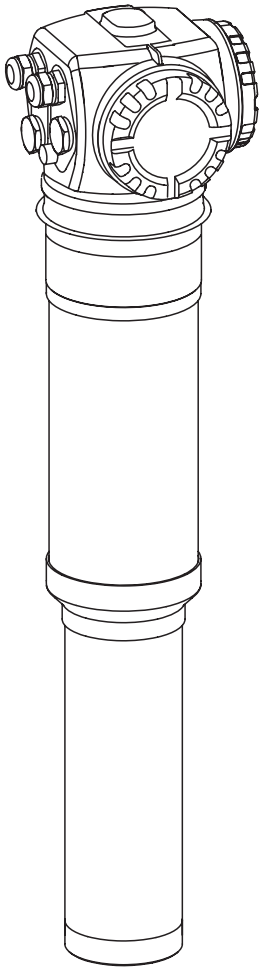
Füllstand | Druck | Durchfluss | Temperatur | Flüssigkeits-analyse | Registrierung | Systeme Komponenten | Services | Solutions

Operating Instructions

Gammapilot M FMG60

Radiometric Measurement



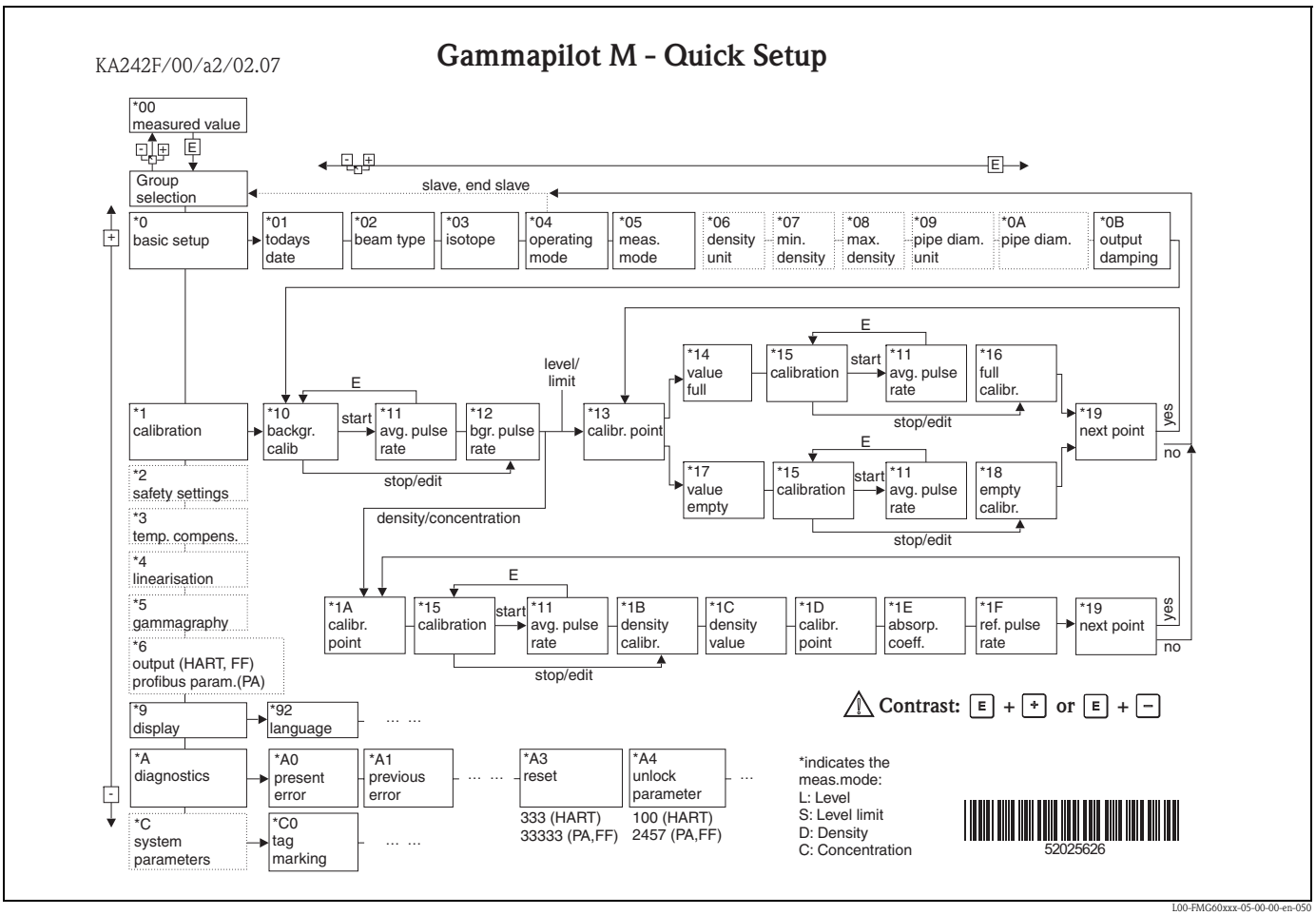
BA329F/00/en/10.09
71104600

Valid as of software version:
V01.03.02

Endress+Hauser

People for Process Automation

Brief operating instructions



Contents of the Operating Instructions

These Operating Instructions describe how to install and commission the radiometric compact transmitter Gammapilot M (communication version PROFIBUS PA). All the functions that are required for standard measuring tasks have been included. Also, the Gammapilot M provides additional functions for optimizing the measuring point and for converting the measured value. These functions are not included in these Operating Instructions.

You can find an **overview of all the device functions** in the Appendix.

A **detailed description of all the instrument functions** is given in Operating Instructions BA287F "Gammapilot M – Description of Device Functions" which can be found on the CD-ROM supplied.

Table of contents

1 Safety instructions

1.1 Designated use

The Gammapilot M is a compact transmitter for non-contact level, level limit, density and concentration measurement. The measuring range of a single Gammapilot M extends up to 2 m. Large measuring ranges of any size can be implemented, however, by cascading several Gammapilot M devices.

1.2 Installation, commissioning, operation

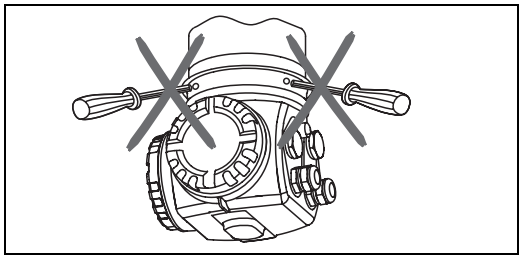
The Gammapilot M is fail-safe and is constructed to the state-of-the-art. It meets the appropriate standards and EC directives. However, if you use it improperly or other than for its designated use, it may pose application-specific hazards, e.g. product overflow due to incorrect installation or configuration. Installation, electrical connection, startup, operation and maintenance of the measuring device must therefore be carried out exclusively by trained specialists authorized by the system operator. Technical personnel must have read and understood these Operating Instructions and must adhere to them. You may only undertake modifications or repair work to the device when it is expressly permitted by the Operating Instructions.

1.3 Hazardous area

Measuring systems for use in hazardous environments are accompanied by separate "Ex documentation", which is an integral part of these Operating Instructions. Strict compliance with the installation instructions and ratings as stated in this supplementary documentation is mandatory.

- Ensure that all personnel are suitably qualified.
- Measuring point requirements with regard to measurement and safety must be observed.

⚠ Warning!
The three screws, connecting the pipe housing to the compartment housing, must **not** be opened.



L00-FMG60xxx-05-00-00-xx-052

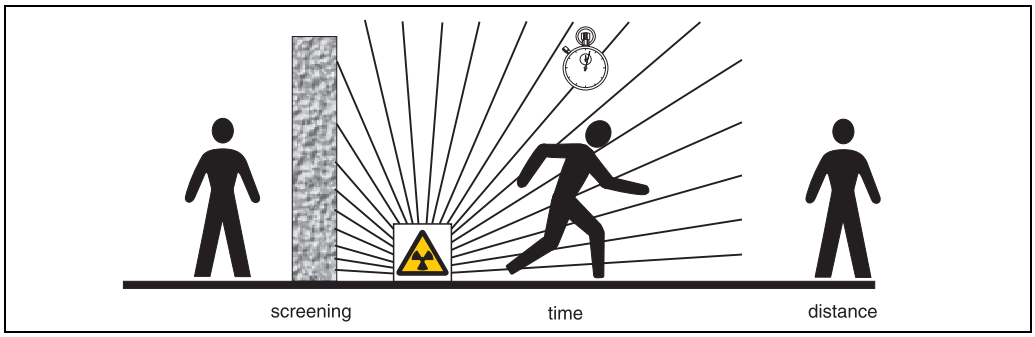
⚠ Warning!
Depending on the certificate version observe the associated Safety Instructions (→ 94).

1.4 Radiation protection

The Gammapilot M is used in conjunction with a radioactive source, contained in a source container. When handling radioactive sources, the following instructions have to be observed:

1.4.1 Basic regulations on radiation protection

Warning!
When handling radioactive sources, all unnecessary radiation exposure should be avoided. All unavoidable radiation exposure should be kept as low as possible. Three measures are used for this:



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Distance

Keep as far away as possible from the radiation source. The local radiation intensity decreases as the square-root of the distance from the radiation source.

Shielding

Ensure the best possible shielding between the radiation source and yourself as well as all other individuals. Effective shielding is provided by source containers (FQG61, FQG62, QG2000) and all high-density materials (lead, iron, concrete).

Caution!
When working with source containers, all the instructions for mounting and usage outlined in the following documents must be observed:

Source Container	Document
FQG61, FQG62	TI435F
QG2000	BA223F

Time

Stay as short as possible in the area exposed to radiation.

1.4.2 Legal requirements for radiation protection

Handling radioactive emitters is legally controlled. The radioactive protection regulations of the country in which the plant is to be operated are to be strictly observed. In the Federal Republic of Germany the current radiation protection requirements are applicable. The following points, in particular, are important for radioactive measurement:

Handling permit

A handling permit is required for operating a plant which uses gamma radiation. Application for the permit must be made to the state government (Land) or the authority responsible (State Offices for Environmental Protection, Trade Inspection Offices, etc.). The Endress+Hauser sales organization will be pleased to help you obtain the permit.

Radiation protection officer

The operator of the plant must nominate someone responsible for radiation protection who has the necessary specialist knowledge and who is responsible for observing all radiation protection regulations and procedures for radiation protection. Endress+Hauser offers training courses in which the necessary specialist knowledge can be acquired.

Control zone

Only persons exposed to radiation during the course of their job may sojourn in control zones (i.e. areas where the local dose rate exceeds a specific value) provided they are subjected to official personnel dose monitoring procedures. For the Federal Republic of Germany the limit values for the control zone are specified in the current radiation protection requirements.
The Endress+Hauser sales organization will be pleased to provide further information on radiation protection and regulations in other countries.

1.4.3 Behavior in the event of an incident

Emergency measures

If the source container or the radiation source is damaged by accident or another unforeseen event or if the radiation source is lost by other means, the following emergency measures shall be initiated immediately:

- Inform the radiation protection officer immediately.
- All employees must leave the danger area immediately. The area around the measuring point must be barred to access and labeled.
- Production must be halted immediately if there is a risk that the radioactive material has got into the material being measured. Possibly contaminated material must be secured and may not be further used before it has been tested.
- All persons involved in cleaning up (fire brigade, works security, etc.) must be informed of the hazards of radiation.

Report to the responsible authority

As soon as the emergency measures have been initiated, the authorities responsible for radiation must be informed by the radiation protection officer.

1.4.4 Procedures after termination of the application

Internal measures

As soon as a radiometric measuring device is no longer required, the radiation source on the source container must be switched off. The source container shall be removed in accordance with all relevant regulations and saved in a lockable room having no through traffic. The responsible authorities shall be informed of these measures. The access to the storage room shall be measured out and signed. The radiation protection officer is responsible for protecting against theft. The radiation source in the source container must not be scrapped with the other parts of the plant. It should be returned as quickly as possible.

Return

FR Germany

Contact your E+H sales center to organize the return of the radiation source for inspection with a view to reuse or recycling by Endress+Hauser.

Other countries

Contact your E+H sales center or the appropriate authorities (government ministry) or regulating authority to find a way of returning the radiation source nationally. If return is not possible domestically, the further procedure must be agreed with the sales center concerned. The destination airport for potential returns is Basle, Switzerland.

Conditions

The following conditions must be met before returning the material:

- An inspection certificate no more than three months old confirming the leak-tightness of the radiation source must be in the possession of E+H (wipe test certificate).
- The serial number, type of radiation source (^{60}Co or ^{137}Cs), activity and model of radiation source must be specified. This data may be found in the documents supplied with the radiation source.
- The material must be returned in an approved secondary containment suitable for simple handling and in type-tested type-A packaging (IATA rules).

1.4.5 Using source containers

Strict compliance with the safety instructions and instructions on installing, mounting and operating is mandatory.

For details, see
- TI264F/00 for FQG61 and FQG62
- TI346F/00 and BA223F/00 for QG2000

1.5 Notes on safety conventions and icons

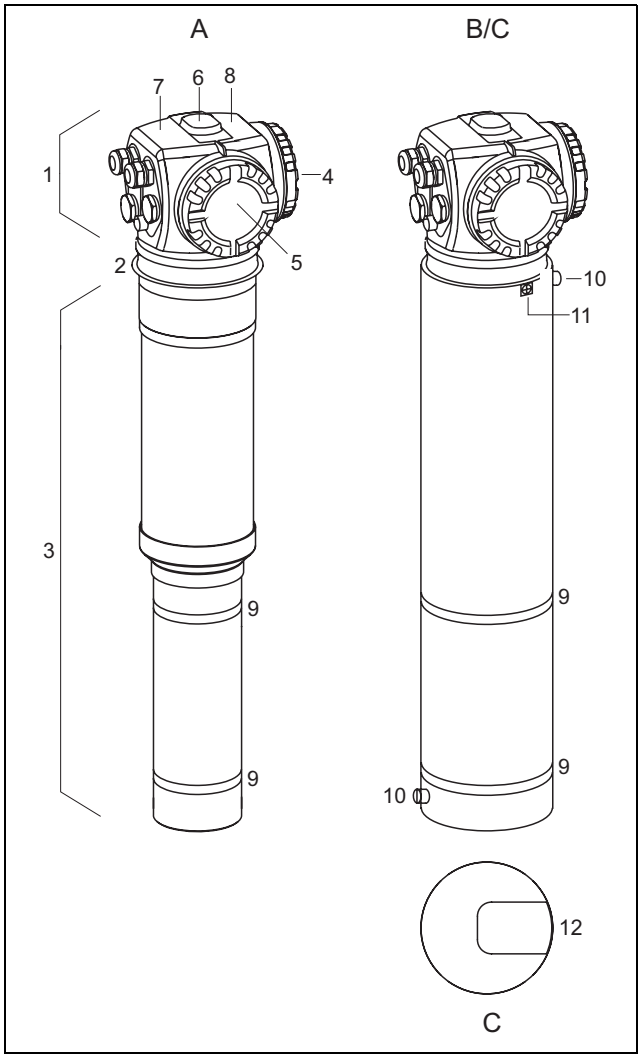
In order to highlight safety-relevant or alternative operating procedures in the manual, the following conventions have been used, each indicated by a corresponding symbol in the margin.

Safety instructions	
	**Warning!** Indicates an action or procedure which, if not performed correctly, can result in serious personal injury, a safety hazard or the destruction of the device.
	**Caution!** Indicates an action or procedure which, if not performed correctly, can result in personal injury or the incorrect operation of the device.
	**Note!** Indicates an action or procedure which, if not performed correctly, can have an indirect effect on operation or trigger an unexpected response on the part of the device.
Explosion protection	
	**Device certified for use in explosion hazardous area** If the device has this symbol embossed on its name plate it can be installed in an explosion hazardous area
	**Hazardous area** Symbol used in drawings to indicate explosion hazardous areas. Devices located in and wiring entering areas with the designation “explosion hazardous areas” must conform with the stated type of protection.
	**Safe area (non-explosion hazardous area)** Symbol used in drawings to indicate, if necessary, non-explosion hazardous areas. Devices located in safe areas still require a certificate if their outputs run into explosion hazardous areas
Electrical symbols	
	**Direct voltage** A terminal to which or from which a direct current or voltage may be applied or supplied
	Alternating voltage A terminal to which or from which an alternating (sine-wave) current or voltage may be applied or supplied
	**Ground connection** A grounded terminal, which as far as the operator is concerned, is already grounded by means of an earth grounding system
	**Protective ground connection** A terminal which must be connected to ground prior to making any other connection to the equipment.
	**Equipotential connection** A connection that has to be connected to the plant grounding system: This may be a potential equalization line or a star grounding system depending on national or company codes of practice.
	**Temperature resistance of the connecting cables** States that the connecting cables must be resistant to a temperature of at least 85 °C.

2 Identification

2.1 Parts of the Gammapilot M

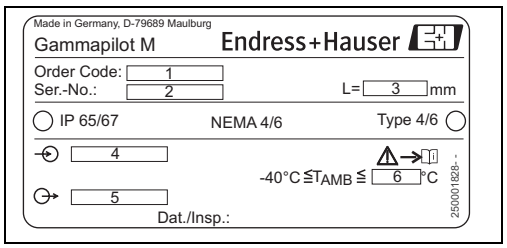
1. Terminal head
2. Mounting collar
3. Detector pipe
4. Terminal compartment A
5. Terminal compartment B
6. Centering knob
7. Instrument nameplate
8. Supplementary nameplate
9. Measuring range marks
10. Cooling water connections
11. PML connector of the water cooling jacket
12. Marking of the radiation window (only for versions with collimator)



A: *Gammapilot M without water cooling jacket*
B: *Gammapilot M with water cooling jacket*
C: *Gammapilot M with collimator*

2.2 Nameplates

Device nameplate



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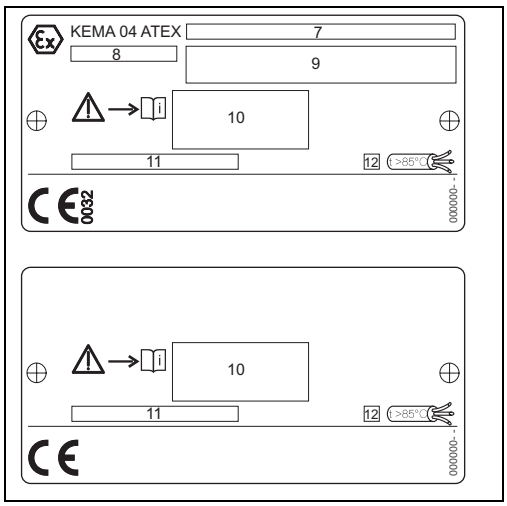
1: Order code (as defined by the ordering structure);
2: Serial number; 3: Measuring range; 4: Power supply;
5: Output signal; 6: Max. ambient temperature

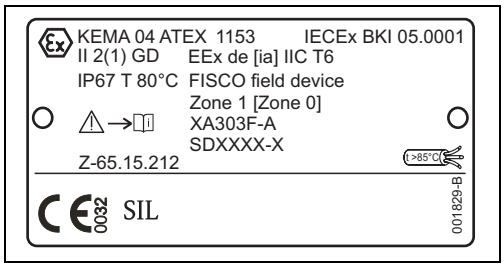
Supplementary nameplate (Examples)



L00-FMG60xxx-18-00-00-xx-002

7: No. of certificate; 8: Equipment group and category;
9: Type of protection; 10: Reference to additional safety-relevant information; 11: Reference to additional certificates (e.g. WHG); 12: Specification of required temperature resistance of the connected cables (only for device versions with water cooling jacket)

Example: approval nameplate for a FISCO field device



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2.3 Ordering structure

Versions that mutually exclude one another are not marked.

Ordering information Gammapilot M FMG60

Feature 10	Option Approval	
	A	Non-hazardous area
	C	NEPSI Ex de (ia) IIC T6
	D	NEPSI Ex d (ia) IIC T6
	F	Non-hazardous area, WHG (level limit)
	G	IECEx Zone 1 (Zone 0) Ex de (ia) IIC T6
	H	IECEx Zone 1 (Zone 0) Ex d (ia) IIC T6
	K	TIIS Ex d (ia) IIC T6
	M	ATEX II 2 (1) GD EEx d (ia) IIC T6, WHG (level limit)
	N	CSA General Purpose
	P	CSA Cl.I Gr.A-D/Cl.II Gr.E-G/Cl.III
	S	FM Cl.I Gr.A-D/Cl.II Gr.E-G/Cl.III
	1	ATEX II 2 (1) G EEx de (ia) IIC T6
	2	ATEX II 2 (1) G EEx de (ia) IIC T6, WHG (level limit)
	3	ATEX II 2 (1) G EEx d (ia) IIC T6
	4	ATEX II 2 (1) G EEx d (ia) IIC T6, WHG (level limit)
	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 (level limit)
	8	ATEX II 2 (1) GD EEx d (ia) IIC T6
	Y	Special version, to be specified

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

30			Power supply wiring/output wiring	
			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

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

FMG60 -						Product designation, first part

50						**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				
60							**Housing, Pipe; Operation**				
						1	316L, 316L; Prepared for FHX40, remote display (accessory)				
						3	Alu, 316L; prepared for FHX40, remote display (accessory)				
						9	Special version, to be specified				
70								**Cable entry power supply**			
								A	Gland M20		
								B	Thread M20		
								C	Thread G1/2		
								D	Thread NPT1/2		
								Y	Special version, to be specified		
80									**Cable entry output**		
									1	equal to supply (gland/thread)	
									2	Plug M12	
									3	Plug 7/8"	
									9	Special version, to be specified	
90										**Additional option**	
										A	Basic version
										B	SIL2 declaration of conformity (max limit switch)
										Y	Special version, to be specified
FMG60 -											Product designation

2.4 Scope of delivery

- Ordered version of the device (including Operating Instructions)
- Endress+Hauser operating program (on the CD-ROM supplied)
- Accessories as ordered

2.5 Supplied documentation

2.5.1 Operating Instructions (BA 329F, this manual)

Describe how to install and commission the Gammapilot M (communication version PROFIBUS PA). Those functions of the operating menu are included, which are required for standard measuring tasks. Any additional functions are contained in the "Description of Device Functions" (BA287F).

2.5.2 Description of Device Functions (BA287F, on CD-ROM)

Contains a detailed description of all the functions of the Gammapilot M and applies for all communication versions. This document can be found as a PDF file on the CD-ROM supplied and can be downloaded from the Internet under "www.de.endress.com" (→ download).

2.5.3 Safety instructions

Additional safety instructions (XA, ZE, ZD) are supplied with certified device versions. Refer to the nameplate for the names of the safety instructions that apply to your device variant.
An overview of the certificates and approvals can be found in the "Technical data" chapter, "Certificates and approvals" section.

2.6 Certificates and approvals

CE mark, declaration of conformity
The device is designed to meet state-of-the-art safety requirements, has been tested and left the factory in a condition in which it is safe to operate. The device takes into account applicable standards and regulations which are listed in the EC declaration of conformity and thus meets the legal requirements of the EC Directives. Endress+Hauser confirms the successful testing of the device by affixing to it the CE mark.

2.7 Registered trademarks

PROFIBUS®
Registered trademark of the PROFIBUS User Organization, Karlsruhe, Germany

ToF®
Registered trademark of Endress+Hauser GmbH+Co. KG, Maulburg, Germany

3 Installation

3.1 Incoming acceptance, transport, storage

3.1.1 Incoming acceptance

Check the packing and contents for any signs of damage.
Check the shipment, make sure nothing is missing and that the scope of supply matches your order.

3.1.2 Transport

Caution!
Follow the safety instructions and transport conditions for devices of more than 18 kg.

3.1.3 Storage

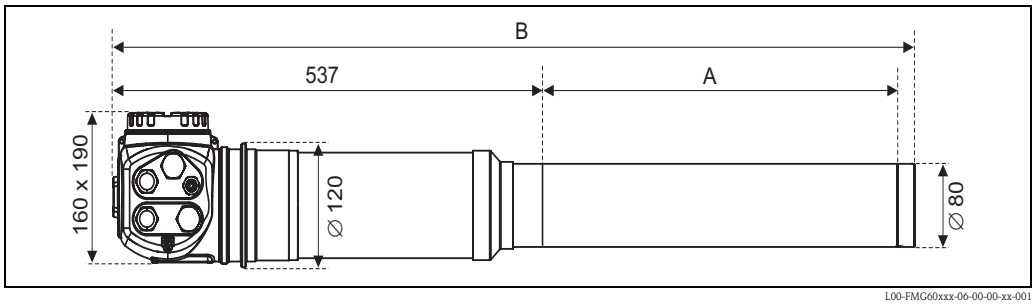
Pack the measuring device so that it is protected against impacts for storage and transport. The original packing material provides the optimum protection for this.
The permissible storage temperature is

- -40 °C to +50 °C for devices with PVT scintillator
- -40 °C to +60 °C for devices with NaI crystal

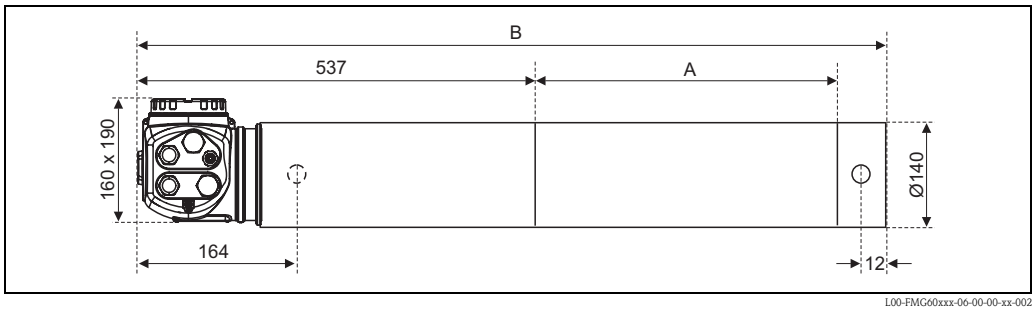
3.2 Installation conditions

3.2.1 Dimensions, weight

Gammapilot M (without water cooling jacket)



Gammapilot M with water cooling jacket or collimator



Type	Measuring length A [mm]	without water cooling jacket		with water cooling jacket		
		Overall length B [mm]	Weight [kg]	Overall length B [mm]	Weight without water [kg]	Weight including water [kg]
NaI	50	621	14	631	18	20
NaI with collimator	50	663	35	—	—	—
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

3.2.2 Installation conditions for level measurement

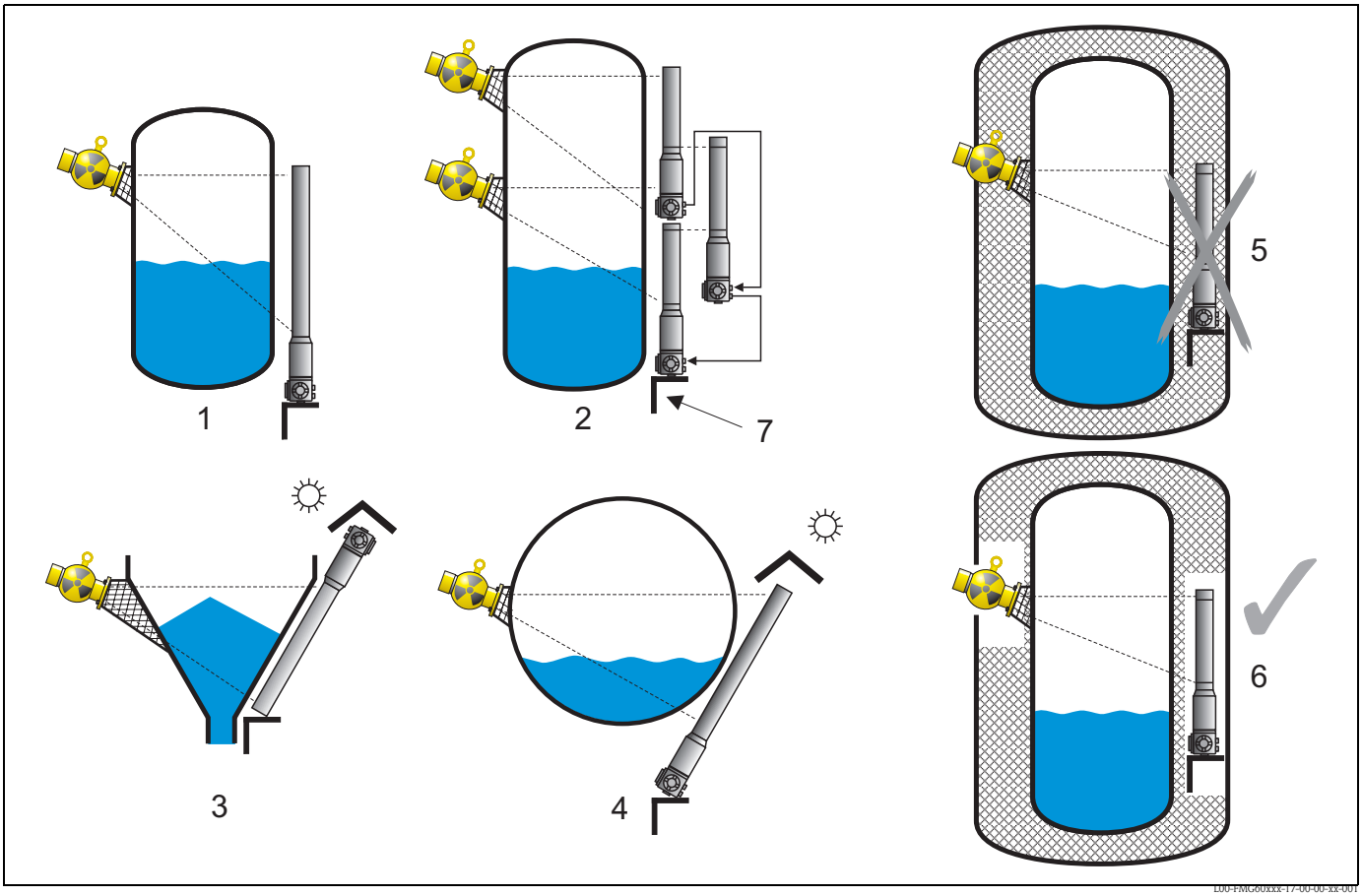
Conditions

- 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).

✎ Note!
The Gammapilot M should be given additional support to prevent damage to the connecting cable or to the unit if it falls off.

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 tank outlet (here with sun protection cover); 4: Horizontal cylinder (here with sun protection cover); 5: Wrong: Gammapilot M mounted inside the tank insulation; 6: Right: Tank insulation removed for Gammapilot M; 7: Support.

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

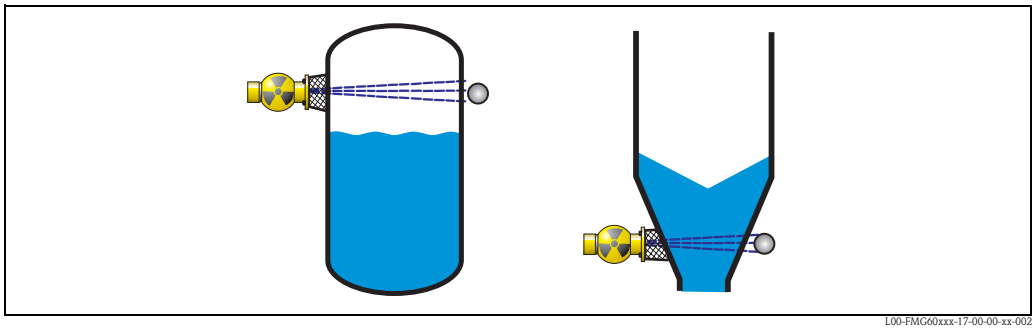
3.2.3 Installation conditions for level limit detection

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 itself must be fitted in a way such that it can withstand the weight of the Gammapilot M[2)] under all operating conditions to be expected.

More information with regard to the safety-related deployment of Gammapilot M can be found in Safety Manual SD230F/00.

Examples



Left: *maximum fail-safe mode;* ***right:*** *minimum level limit detection*

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

3.2.4 Installation conditions for density and concentration measurement

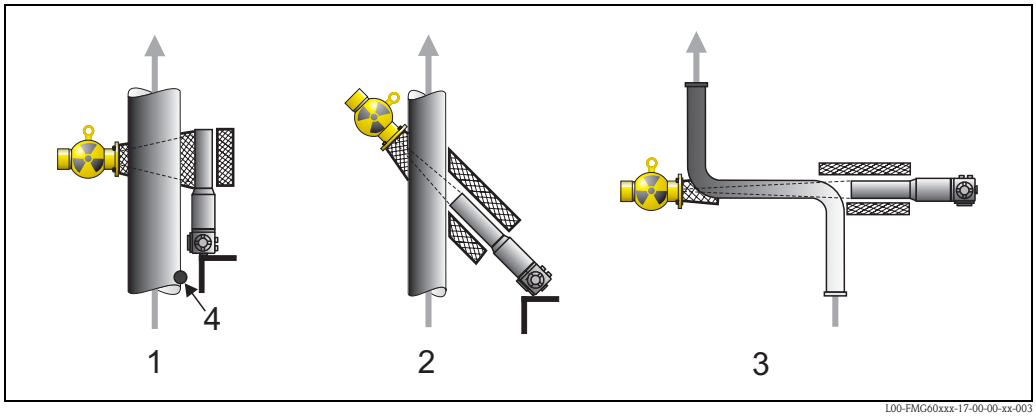
Conditions

- 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 itself must be installed in a way such that it can withstand the weight of the source container[3] and the Gammapilot M[4] under all operating conditions.
- The sample point may not be further than 20 m from the measuring point.
- The distance of the density measurement to pipe bends is ≥ 3 x pipe diameter and ≥ 10 x pipe diameter for pumps.

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 the use of a measurement section is necessary for small pipe diameters.

For the configuration of the measuring system please contact your Endress+Hauser sales organization or use the "Applicator" ™ [5]configuration software.



1: *Vertical beam (90°);* ***2:*** *Diagonal beam (30°);* ***3:*** *Measurement section;*
4: *Sample point*

Note!
To increase the accuracy for density measurements, the use of a collimator is recommended. The collimator screens the detector against environmental radiation.

Note!
- When planning, the total weight of the measuring system must be taken into consideration.
- The Gammapilot M should be given additional support to secure it against falling or prevent damage to the connecting cable.
- A clamping device and a measurement section are available as accessories (see chapter "Accessories").

3) The weights of the source containers are specified in Technical Information TI435F (FQG61, FQG62) and TI346F (QG2000).
4) The weights of the various versions of the Gammapilot M are summarized in the section "Dimensions/Weight".
5) The "Applicator"™ is available from your E+H sales organization.

3.2.5 Empty pipe detection

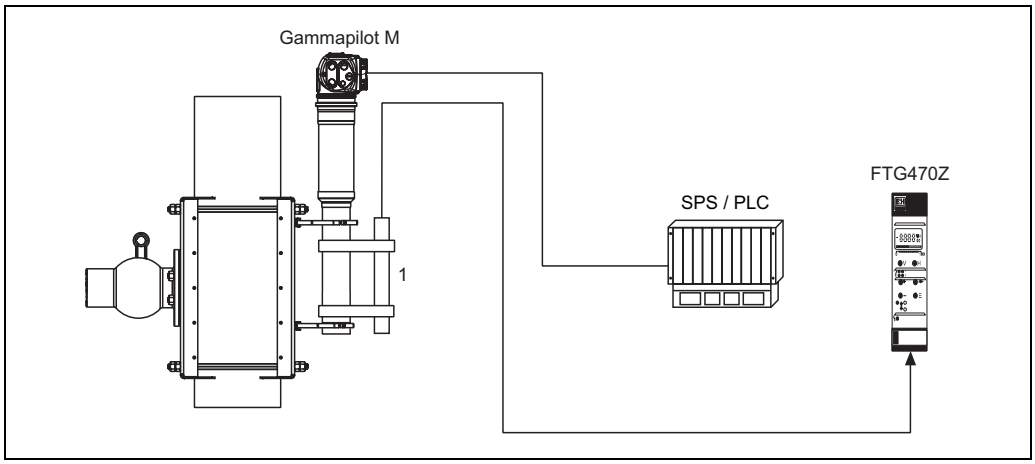


Fig. 1: 1: Monitoring detector DG17/27 or FMG60

Mounting the FMG60 or DG17/27 on the FMG60 for empty pipe detection

If the pipe becomes empty as a result of operational processes, the radiation on the detector side can hit dangerous levels.

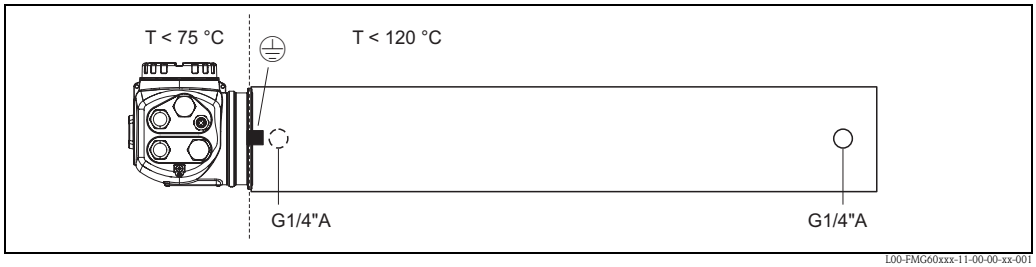
- In such instances, the irradiation channel must be closed immediately for reasons of radiation protection.
- A high local dose rate also causes the detector unit (scintillator and photomultiplier) to age quickly.

The best way of avoiding such a situation is to mount a second radiometric measuring system that monitors the radiation intensity. If high radiation levels occur, an alarm is output and/or the source container is automatically switched off through pneumatic action for example.

3.3 Water cooling

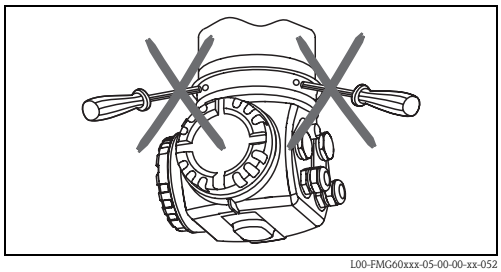
For the versions of the Gammapilot with water cooling jacket, the following applies:

- 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 to 6 bar

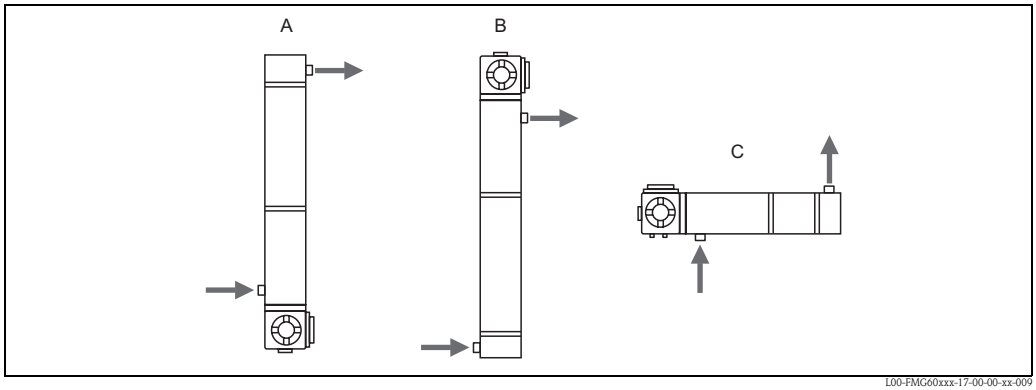


Connections of the water cooling jacket

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.



3.3.1 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 level 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.

3.3.2 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

3.4 Post-installation check

After installing the device, carry out the following checks:

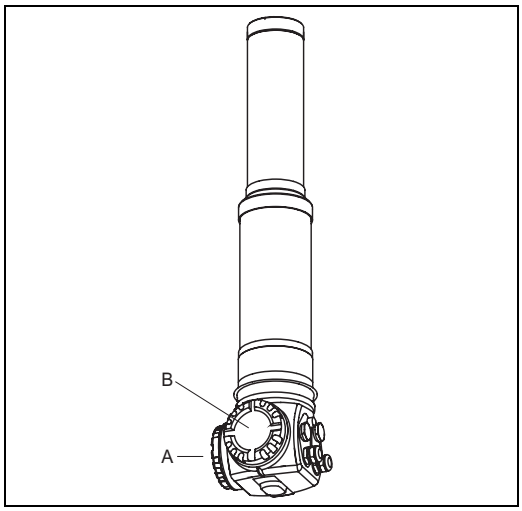
- Is the device damaged (visual inspection)?
- Does the device correspond to the measuring point specifications for ambient temperature, measuring range etc.?
- If available: Are the measuring point number and labeling correct (visual inspection)?
- Is the measuring device sufficiently protected against direct sunlight?
- Are the cable glands tightened correctly?

4 Wiring

4.1 Terminal compartments

The Gammapilot M has got two terminal compartments:

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



L00-FMG60xxx-05-00-00-xx-041

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

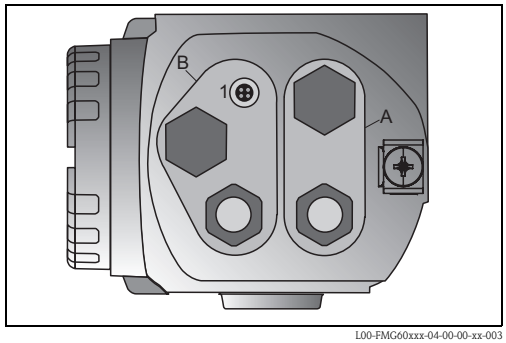
Maximum cable length:
- For cascade, 20 m each
- For PT-100 2 m (temperature should be measured as close as possible to density measurement)

4.2 Cable entries

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

- Gland M20x1.5
  tightening diameter (clamping range):
  7.0 to 10.5 mm
- Cable entry M20x1.5
- Cable entry G1/2
- Cable entry NPT1/2
- M12 connector (see "Fieldbus connectors")
- 7/8" connector (see "Fieldbus connector")

In addition, Gammapilot M has a socket to connect the separate display and operating unit FHX 40. The housing of the Gammapilot M does not have to be opened to connect the FHX 40.



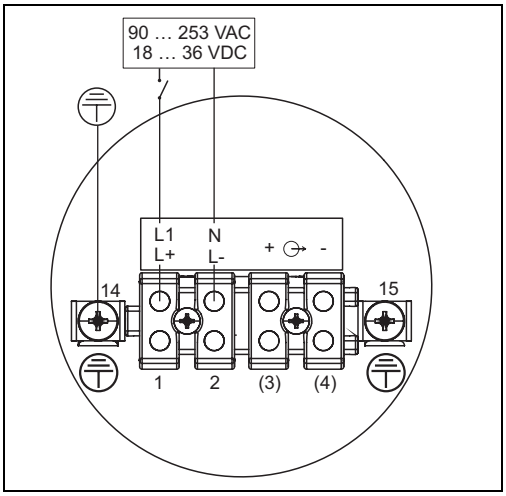
L00-FMG60xxx-04-00-00-xx-003

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.
- Connecting cables should be routed away from the housing from below to prevent moisture from penetrating the connection compartment. Otherwise, a drain loop should be provided or the Gammapilot M should be fitted with a weather protection cover.

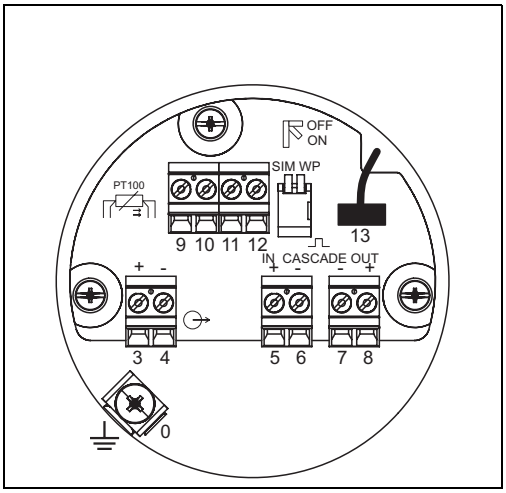
4.3 Terminal assignment

Terminal compartment A



L00-FMG60xxx-04-00-00-xx-002

Terminal compartment B

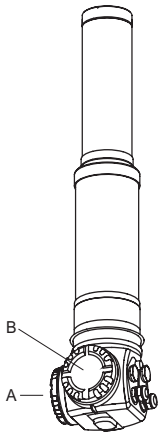


L00-FMG60xxx-04-00-00-xx-001

Terminal(s)	Meaning
0	Grounding of the cable screen[1)]
1, 2	Power supply[2)]
Compartment B: 3, 4 **Compartment A:** (3)[1],(4)[1]	Signal output, depending on communication version: ■ 4-20mA with HART ■ PROFIBUS PA ■ Foundation Fieldbus (Depending on the device version ordered, the signal output is in connection compartment A or B, 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	PT-100 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[1]
15	Protective earth or grounding of the cable screen[1]

1) rated cross section > 1 mm^2

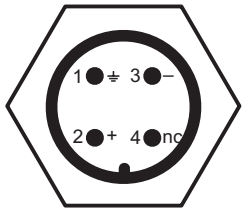
2) rated cross section max. 2.5 mm^2

Feature 30 of the ordering structure: Power supply wiring/output wiring		Terminal compartment for		
		Supply voltage	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	

4.4 Fieldbus connectors

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

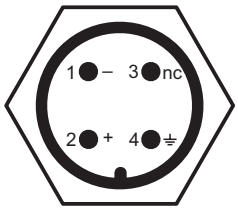
4.4.1 Pin assignment of the M12 connector (PROFIBUS PA connector)



L00-FMxxxxxx-04-00-00-yy-016

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

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



L00-FMxxxxxx-04-00-00-yy-017

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

4.5 PROFIBUS PA cable specifications

Twisted, shielded pairs must be used. The following specification must be met for explosion hazardous application (EN 50 020, FISCO model):

- Loop-resistance (DC): 15 to 150 Ω/km,
- Specific inductance: 0.4 to 1 mH/km,
- Specific capacitance: 80 to 200 nF/km

The following cable types can be used, for example

Non-Ex-area:
- Siemens 6XV1 830-5BH10 (black),
- Kerpen CEL-PE/OSCR/PVC/FRLA FB-02YS(ST)YFL (gray)
- Belden 3076F (orange)

Ex-area:
- Siemens 6XV1 830-5AH10 (blue),
- Belden 3076F
- Kerpen CEL-PE/OSCR/PVC/FRLA FB-02YS(ST+C)YFL (blue)

4.6 Supply voltage

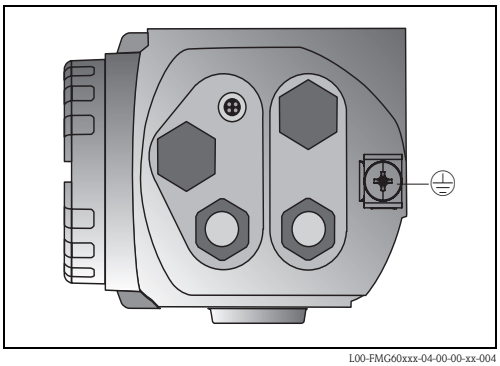
The following values are the voltages across the terminals directly at the device:

Type	Minimum terminal voltage	Maximum terminal voltage
standard	9 V	32 V
EEx ia (FISCO model)	9 V	17.5 V
EEx ia (Entity concept)	9 V	24 V

Approx. 11 mA for the range of voltages given above.

4.7 Potential equalization

For maximum EMC protection please observe the following points:
- The external ground terminal on the transmitter must be connected to ground. The cable should be kept as short as possible for optimum electromagnetic compatibility. The use of a grounding strip is ideal.
- The continuity of the cable shielding between tapping points must be ensured.
- If potential equalization is present between the individual grounding points, ground the shielding at each cable end or connect it to the device housing (as short as possible).
- If there are large differences in potential between grounding points, the grounding should run via a capacitor that is suitable for high frequency use (e.g. ceramic 10 nF/ 250 V~).



L00-FMG60xxx-04-00-00-xx-004

Caution!
Applications, which are subject to the explosion prevention, permit only under special conditions the repeated grounding of the protective screen , see to EN 60 079-14.

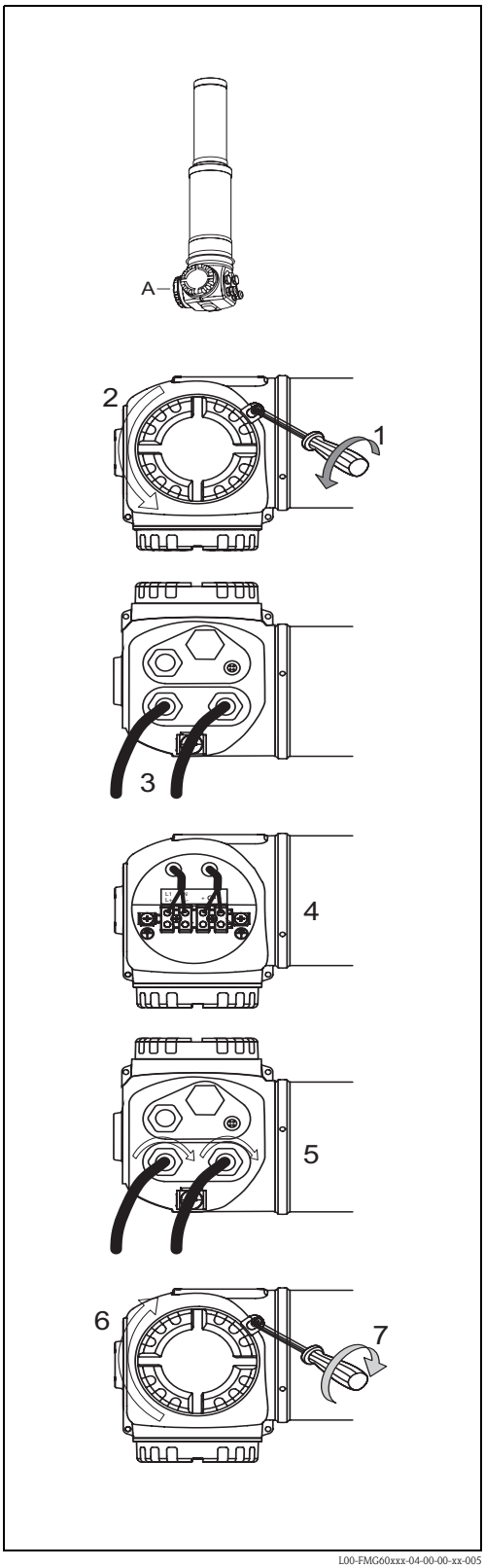
4.8 Wiring in terminal compartment A

Caution!
Before connection please note the following:

- When using the device in hazardous areas, make sure to comply with national standards and the specifications in the Safety Instructions (XAs). Make sure you use the specified cable gland.
- The supply voltage must comply to the data on the nameplate.
- Switch off power supply before connecting the device.
- Connect potential matching line to the outer transmitter ground terminal and to the ground terminal of the water cooling jacket (if present) before connecting up the device (section "Potential equalization").
- Connect protective earth to the protective earth terminal (section "Terminal assignment").
- According to IEC/EN 61010 a suitable power switch has to be provided for the device.
- The cable isolations must comply with the supply voltage and the overvoltage category.
- The temperature resistance of the connecting cable must comply with the ambient temperature.

The procedure

1. Using a 3 mm (7/64") Allen key, loosen the cover clamp for the connection compartment cover.
2. Unscrew the cover of the terminal compartment.
3. Push the power cable and (if required) the signal cable) through the appropriate cable glands or cable threads.
4. Wire up according to the terminal assignment diagram.
5. Tighten the cable glands or threads.
6. Screw the cover securely back onto the terminal compartment.
7. Adjust the cover clamp so it is set over the cover and tighten.



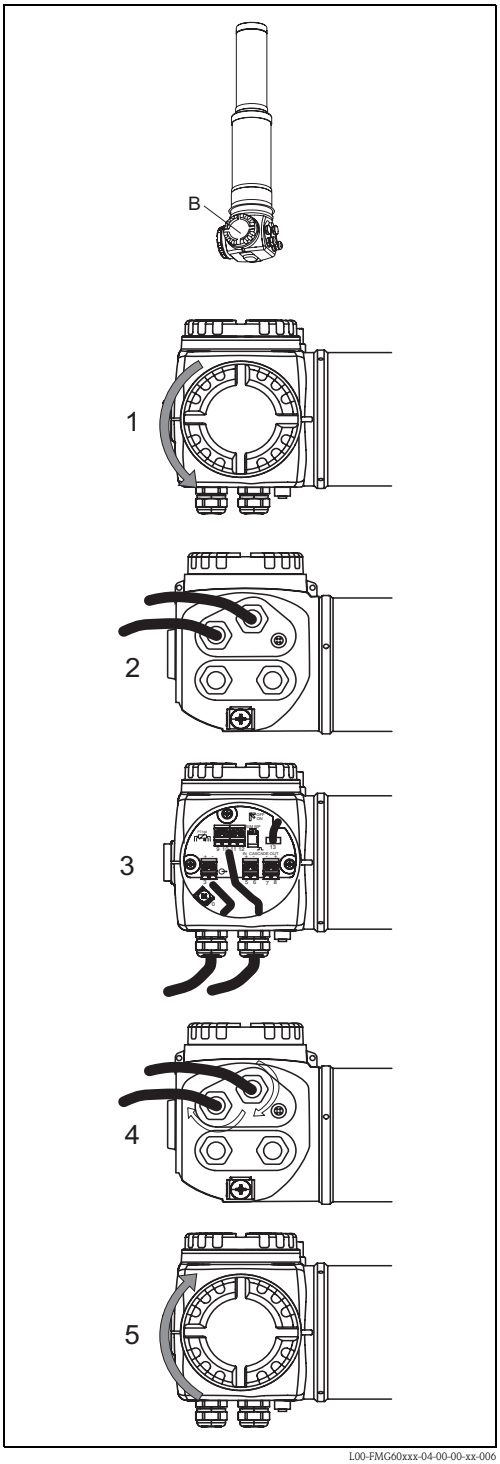
L00-FMG60xxx-04-00-00-xx-005

4.9 Wiring in terminal compartment B

Caution!
Before connection please note the following:
- Connect potential matching line to transmitter ground terminal and to the ground terminal of the water cooling jacket (if present) before connecting up the device (see above, section "Potential equalization").
- The cable isolations must comply with the supply voltage and the overvoltage category.
- The temperature resistance of the connecting cable must comply with the ambient temperature.

The procedure

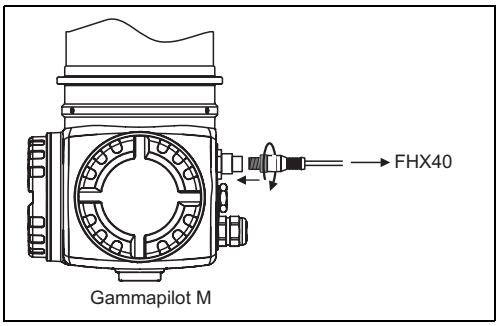
1. Unscrew the cover of the terminal compartment.
2. Push the following cables through the appropriate cable glands or threads:
   – signal cable (if the signal output is located in terminal compartment B)
   – PT-100 cable (if present)
   – cascading cables (input and/or output, if required)
3. Wire up according to the terminal assignment diagram.
4. Tighten the cable glands or threads.
5. Screw the cover securely back onto the terminal compartment.



L00-FMG60xxx-04-00-00-xx-006

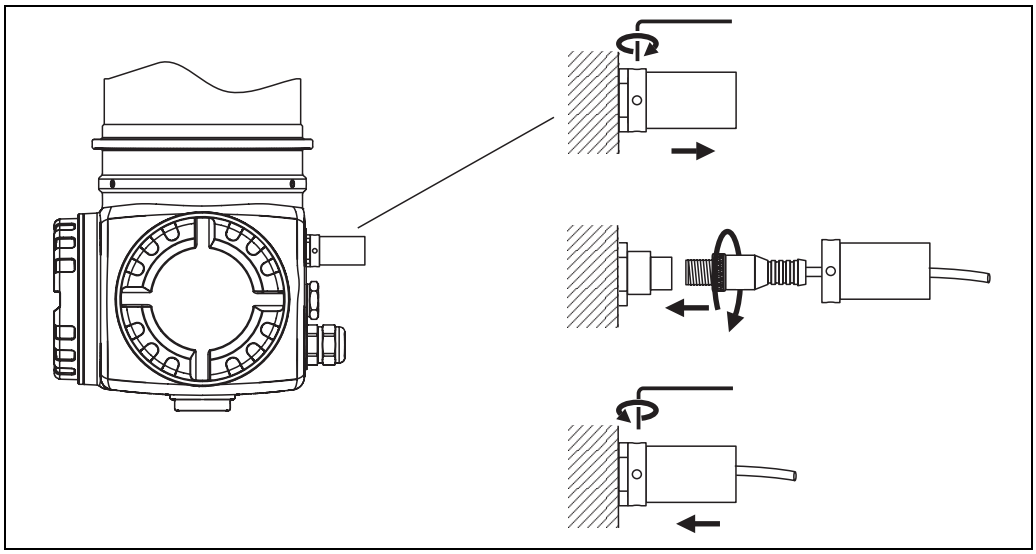
4.10 Connecting the remote display and operation FHX40

The remote display and operating unit FHX40 is available as accessory. It is connected to the FHX40-connector of the Gammapilot M via the supplied cable. To do this, the housing of the Gammapilot M needs not to be opened.



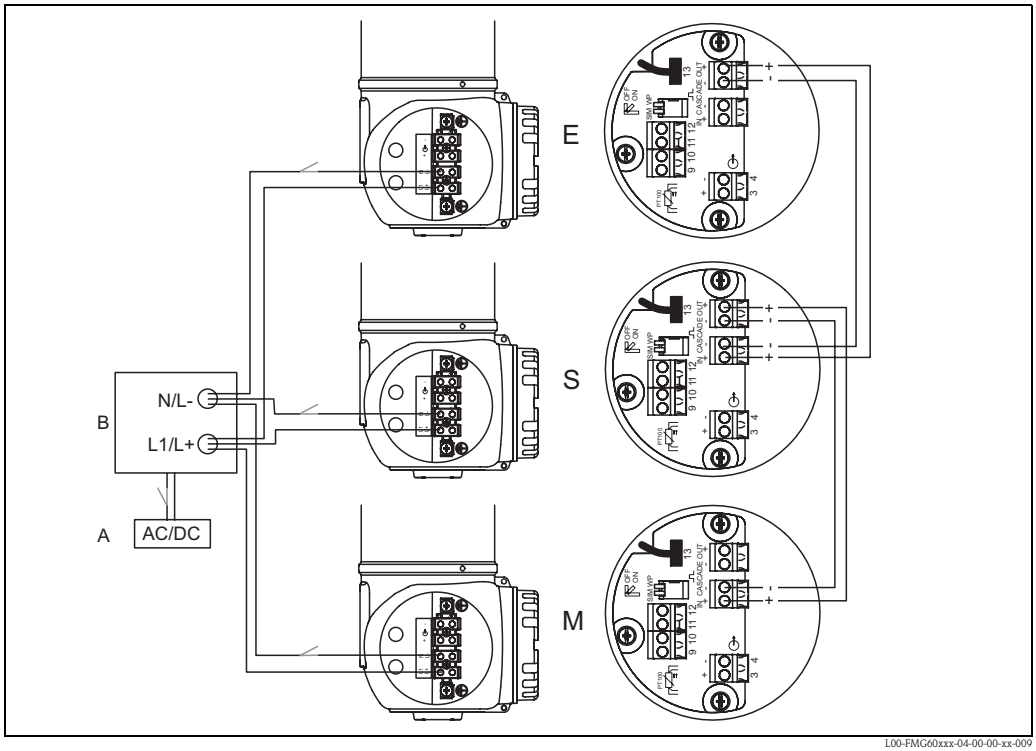
L00-FMG60xxx-04-00-00-xx-007

For some Dust-Ex versions of the Gammapilot M, the FHX40 connector is protected by a metal sleeve. This sleeve must be detached before connecting the FHX40 and reattached afterwards. Tighten all Allen screws securely.



L00-FMG60xxx-04-00-00-xx-008

4.11 Wiring in cascading mode



A: *power supply (90 to 253V_{AC} or 18 to 36V_{DC});* ***B:*** *junction box;* ***M:*** *Master;* ***S:*** *Slave;* ***E:*** *End-Slave*

Note!
For the positioning of the power switch according to IEC/EN 61010, there are two options:
- **at the side of the** power supply (one switch for all transmitters)
- **at the side of the** transmitters (an individual switch for every transmitter)

4.12 Measuring solids flow

In conjunction with a density measuring device, such as Endress+Hauser's "Gammapilot M", Promag 55S also determines the rate of solids with regard to the mass, volume or percentage content.
The following order information is required for this purpose for Promag 55S: Order option for software function "Solids flow" (F-CHIP) and order option for a current input.

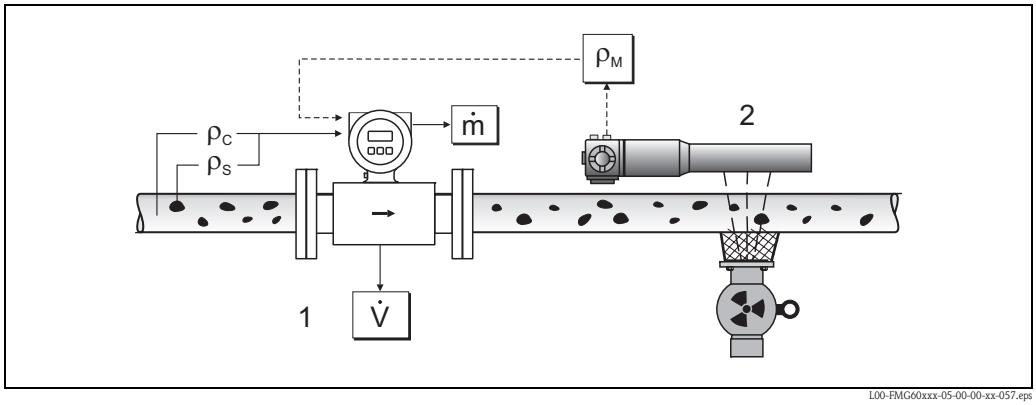


Fig. 2: Solids flow measurement (m) with the aid of a density and flow measuring device. If the density of the solids (ρ_S) and the density of the transporting liquid (ρ_C) are also known, the solids flow rate can be calculated.

1 Flow measuring device (Promag 55S) → Volume flow (V). The solids density (ρ_S) and the density of the transporting liquid (ρ_C) also have to be entered in the transmitter.

2 Density measuring device (e.g. "Gammapilot M") → Total density ρ_M (transporting liquid and solids)

4.13 Post-connection check

After wiring the device, carry out the following checks:

- Is the protective earth connected?
- Is the Potential Equalization Line (PEL) connected?
- Are the terminals correctly assigned?
- Are the cable glands and dummy plugs tight?
- Are the fieldbus connectors and the FHX40 connector fixed securely?
- Are the lids screwed tightly onto the terminal compartments?
- For dust ignition-proof devices: Is the protective sleeve for the FHX40 socket correctly attached?
- Is the cover of the terminal compartment A secured by the cover clamp?

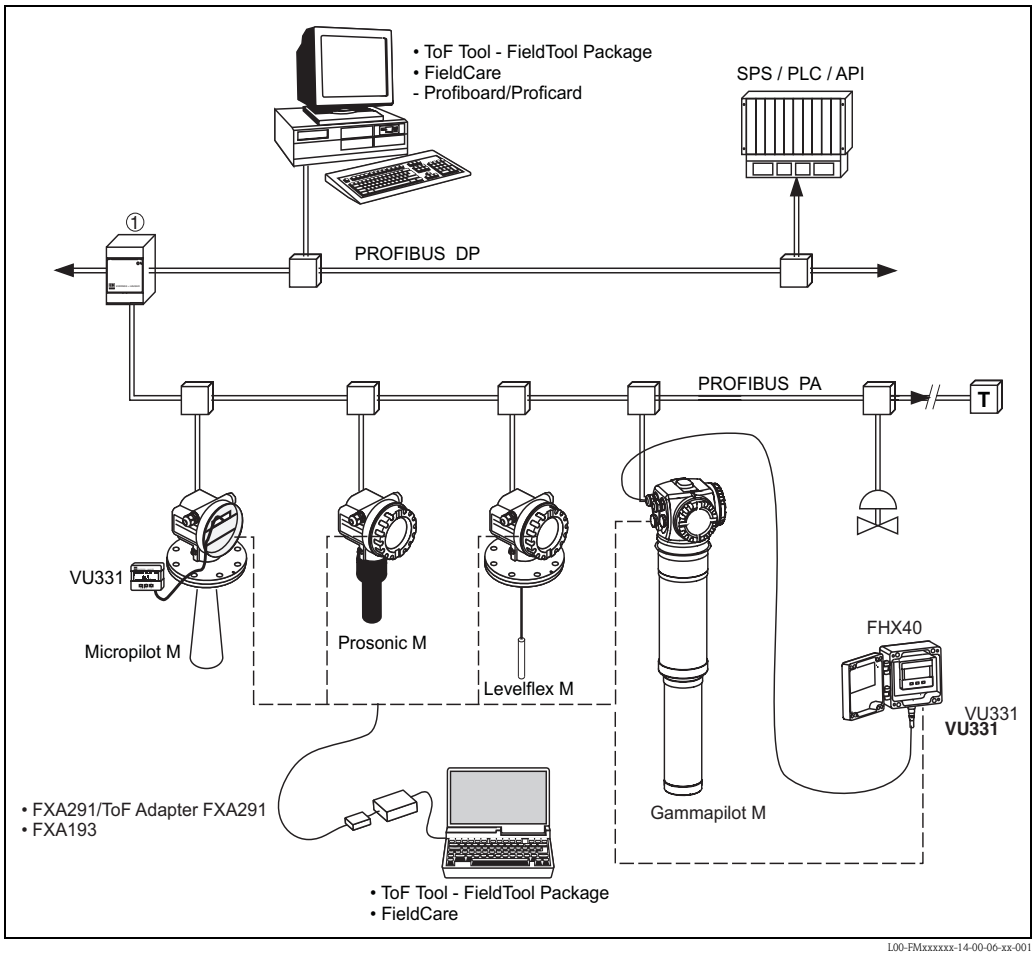
Warning!
The Gammapilot M may only be operated, if the cover of the terminal compartment is tightly closed.

5 Operation

5.1 Overview over the operating options

5.1.1 PROFIBUS PA

A maximum of 32 transmitters (8 if mounted in an explosion hazardous location EEx ia IICcording 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 Instructions BA198F/00 "PROFIBUS-DP/PA: Guidelines for planning and commissioning" or to the PROFIBUS-PA Specification EN 50170 (DIN 19245).



L00-FMxxxxxx-14-00-06-xx-001

Operation via the service interface:

- with the display and operating unit FHX40
- with a personal computer, FXA193 (RS232C) or FXA291 and ToF adapter FXA291 (USB) and the operating program "ToF Tool - FieldTool Package" or "FieldCare".
  The FXA193 (RS232C) or FXA291 and ToF adapter FXA291 (USB) can be connected to the display connector of Gammapilot M or FHX40.

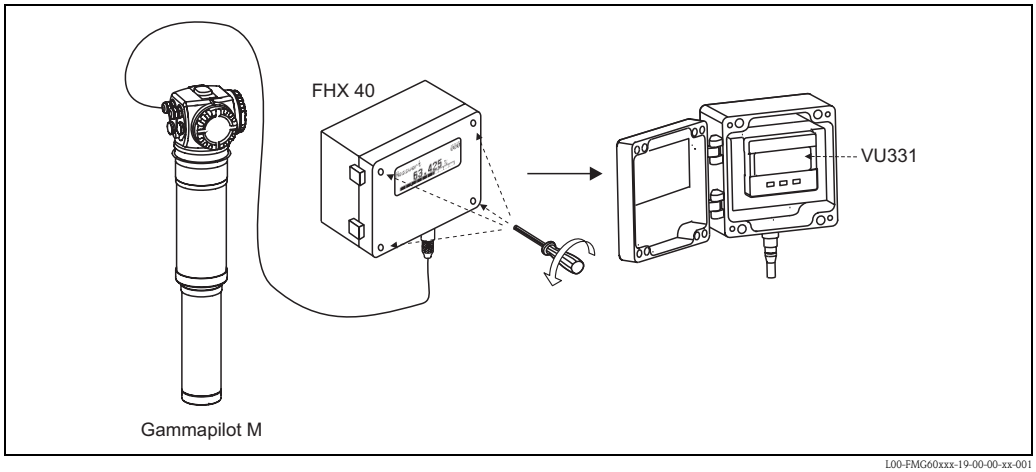
Operation via PROFIBUS:

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

5.2 Display operation

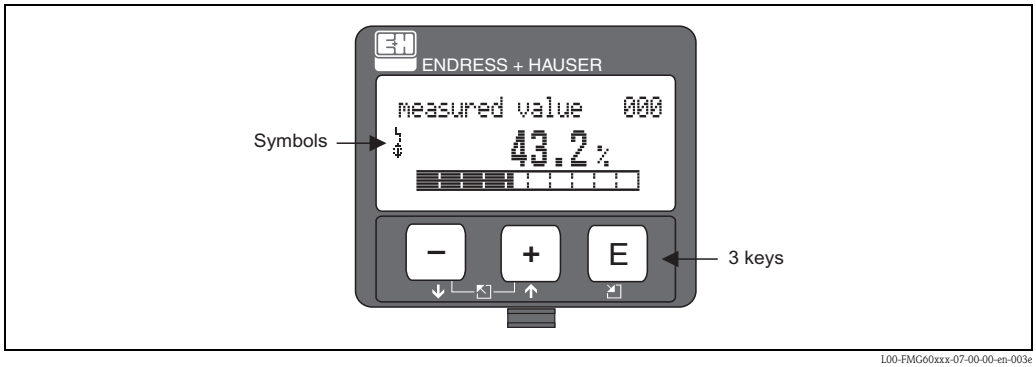
5.2.1 Display and operating elements

The LCD module VU331 for displaying and operating is inside the remote display and operating unit FHX 40. The measured value can be read off through the FHX 40 sight glass. In order to operate the device, the FHX40 must be opened by removing the four screws.



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

Display and operating module VU331



L00-FMG60xxx-07-00-00-en-003e

Display symbols

The following table describes the symbols that appear on the liquid crystal display:

Symbol	Meaning
	ALARM_SYMBOL This alarm symbol appears when the device is in an alarm state. If the symbol flashes, this indicates a warning.
	LOCK_SYMBOL This lock symbol appears when the device is locked, i.e. if no input is possible.
	COM_SYMBOL This communication symbol appears when data transmission via HART, PROFIBUS PA or FOUNDATION Fieldbus, for example, is in progress.
	SIMULATION_SWITCH_ENABLE This communication symbol appears when simulation in FOUNDATION Fieldbus is enabled via the DIP switch.

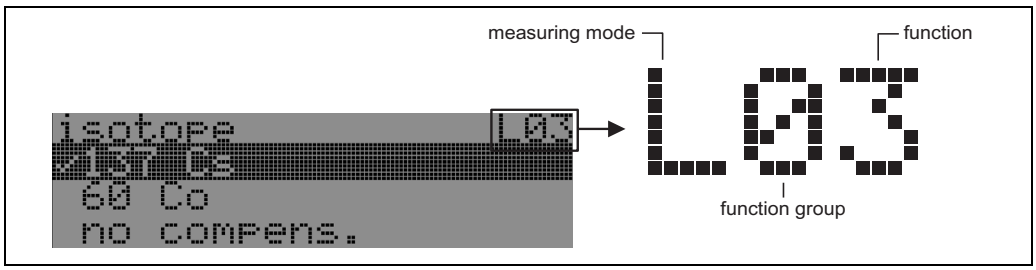
Function of the keys

Key(s)	Meaning
[+] or [↑]	Navigate upwards in the selection list Edit numeric value within a function
[−] or [↓]	Navigate downwards in the selection list Edit numeric value within a function
[Esc] [−] [+] or [←]	Navigate to the left within a function group
[E]	Navigate to the right within a function group, confirmation.
[+] and [E] or [−] and [E]	Contrast settings of the LCD
[+] and [−] and [E]	Hardware lock / unlock After a hardware lock, an operation of the device via display or communication is not possible! The hardware can only be unlocked via the display. An unlock parameter must be entered to do so.

5.2.2 The operating menu

Function code

The functions of the Gammapilot M are arranged in an operating menu. To ensure easy orientation within the menu, a unique position code is indicated on the display for each function. This code consists of one alphabetic and two numeric characters.



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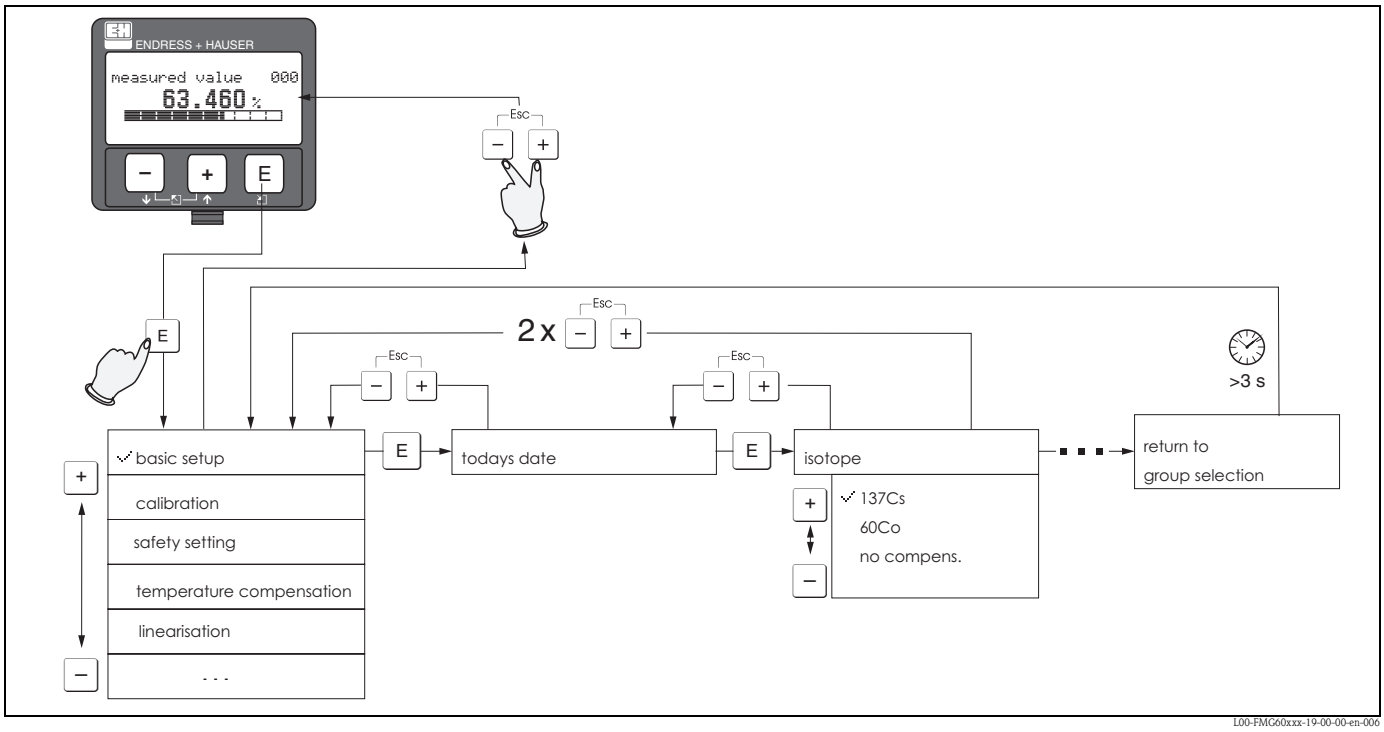
- The alphabetic character specifies the current measuring mode of the Gammapilot M:
  - **L**: level
  - **S**: limit (switch)
  - **D**: density
  - **C**: concentration
  - *****: no measuring mode selected yet

- The first numeric character identifies the function group:
  - **basic setup *0**
  - **calibration *1**
  - **safety settings *2**
  - **...**

- The second numeric character numbers the individual functions within the function group:
  basic setup *0
  - **today's date *01**
  - **beam type *02**
  - **isotope *03**
  - **operating mode *04**
  - **...**

Hereafter, the position is always given in brackets after the function name. "*****" (not yet selected) is always indicated as the measurement method, e.g. **"present date" (*01)**.

Operation using the onsite display VU 331



1. Change from Measured Value Display to **Group Selection** by pressing E.
2. Press − or + to select the required **Function Group** and confirm by pressing E.
   The active selection is marked by a ✓ in front of the menu text.
3. Activate Edit mode with + or −.

   Selection menus

   a. Select the required parameter in the **function** selected with − or +.

   b. E confirms selection; ✓appears in front of the selected parameter.

   c. E confirms the edited value; system quits edit mode.

   d. + and − (= ±) interrupts selection; system quits edit mode.

   Typing in numerals and text

   a. Press + or − to edit the first character of the numeral / text.

   b. E positions the cursor at the next character; continue with a. until you have completed your input.

   c. If a ↵ symbol appears at the cursor, press E to accept the value entered; system quits edit mode.

   d. If a ← symbol appears at the cursor, press E to return to the previous character (e.g. for correction of entries).

   e. + and − (= ±) interrupts selection; system quits edit mode.
4. Press E to select the next function.
5. Press + and − (= ±) once; return to previous **function**.
   Press + and − (= ±) twice; return to **Group Selection**.
6. Press + and − (= ±) to return to **Measured value display**.

5.3 Alternative operation options

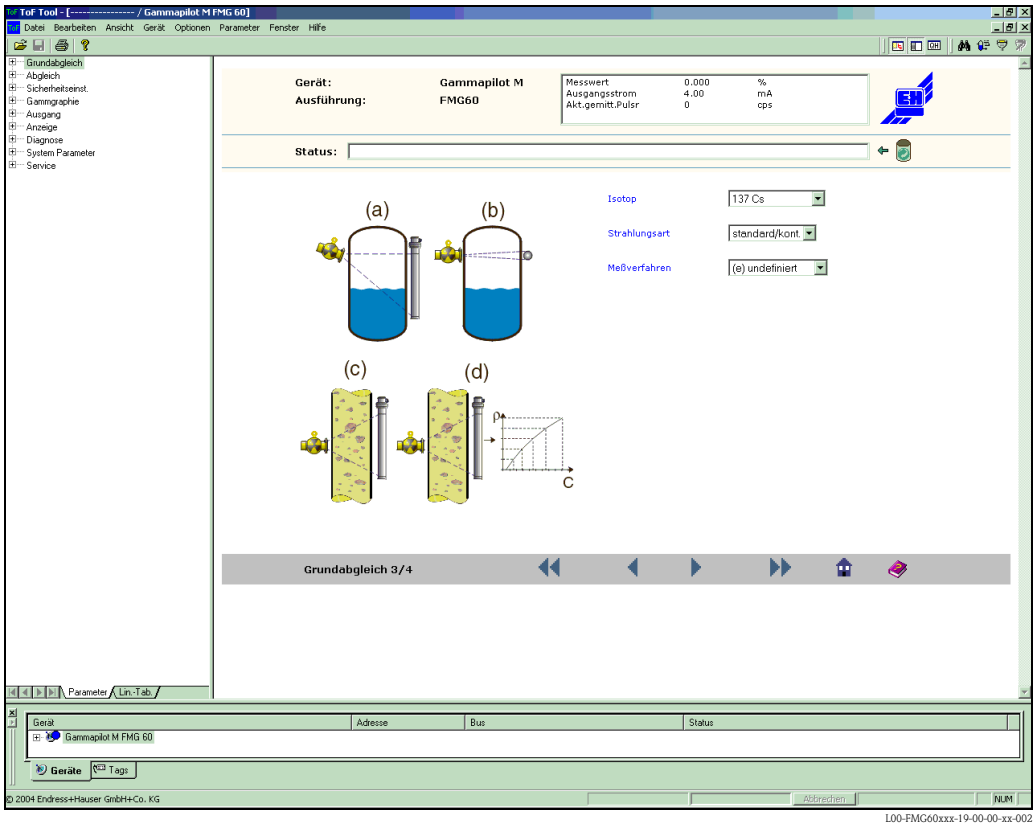
5.3.1 ToF Tool - FieldTool Package

The "ToF Tool - FieldTool Package" is a standardized graphical operating program for measuring devices 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 versions: service interface with adapter FXA193 (RS232C) or FXA291 and ToF adapter FXA291 (USB) (see Section "Accessories")

Menu guided commissioning



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

- The function groups and functions of the device 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.

5.3.2 FieldCare

FieldCare is Endress+Hauser's plant asset management tool based on FDT technology. FieldCare can be used to configure all Endress+Hauser devices and third-party devices which support the FDT standard. The following operating systems are supported: WinNT4.0, Win2000 and Windows XP.

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

Connection options:
- HART via Commubox FXA191 and the RS 232 C serial interface of a computer
- HART via Commubox FXA195 and the USB port of a computer
- PROFIBUS PA via segment coupler and PROFIBUS interface card

5.4 Lock/unlock configuration

5.4.1 Software security locking

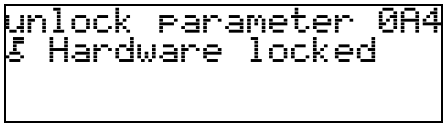
Enter a number ≠ 2457 into the **"unlock parameter" (*A4)** function in the **"diagnostics" (*A)** function group.
The symbol appears on the display. Changes are no longer possible.

If you try to change a parameter, the device jumps to the **"unlock parameter" (*A4)** function. Enter "2457".
Parameters can be changed again.

5.4.2 Hardware security locking

Press −, + and E simultaneously.
Changes are no longer possible.

If you try to change a parameter, the following appears:



L00-fmrxf0a4-20-00-00-en-001

Press −, + and E simultaneously. The **"unlock parameter" (*A4)** function appears. Enter "2457".
Parameters can be changed again.

Note!
A hardware locking can **only** be unlocked again via the display by pressing the +, − and E keys at the same time again. It is **not** possible to unlock the hardware by communication.

5.5 Reset to the default configuration

It is advisable to reset the customer parameters if you want to use a device with an unknown history.

Effects of resetting:
- All customer parameters are reset to their default values.
- Linearization is switched to **"linear"**, but the table values are kept. The table can be switched back on in the **"linearization" (*4)** function group in the **"linearization" (*40/*46)** function.

In order to carry out the reset, enter "33333" in the **"reset" (*A3)** function in the **"diagnostics" (*A)** function group.

Caution!
A reset impairs the measurement. You should perform a basic setup again following a reset.
All the calibration data are deleted after a reset. A complete calibration is needed to put the measurement back into operation.

Note!
The default values of each parameter are shown in bold in the menu overview in the appendix.

5.6 PROFIBUS PA interface

5.6.1 Device address

Selecting the device address

- Every PROFIBUS-PA device must be given an address. If the address is not set correctly, the device will not be recognized by the process control system.
- A device address may appear only once within a particular PROFIBUS-PA network.
- Valid device addresses are in the range 0 and 126. All devices are delivered from the factory with the software address 126.

Configuring the device address

The default address 126 can be used to check the function of the device and connect it to an operating PROFIBUS-PA system. After this, the address must be changed before further devices can be connected to the network.
The following options are available for setting the address:

1. The address can be set by means of the **display and operating module VU331 (in the FHX40)**.
   For this purpose, got to the "Profibus Param" function group and enter the desired address in the **"Instrument address" (*60) function**.
2. The address can be set by means of the **ToF Tool - Fieldtool Package**.
   For this purpose, got to the "Profibus Param" function group and enter the desired address in the **"Instrument address" (*) function**.

5.6.2 Device database and type files (GSD)

A device database file (GSD) contains a description of the properties of the PROFIBUS-PA device, e.g. the supported transmission rates and the type and format of the digital information output to the PLC.
In addition, bitmap files are also required when planning a PROFIBUS PA network in order to represent the device by an icon in the network design software.
Every device is allocated an identity code by the PROFIBUS User Organization (PNO). This appears in the device data base file name (.gsd).

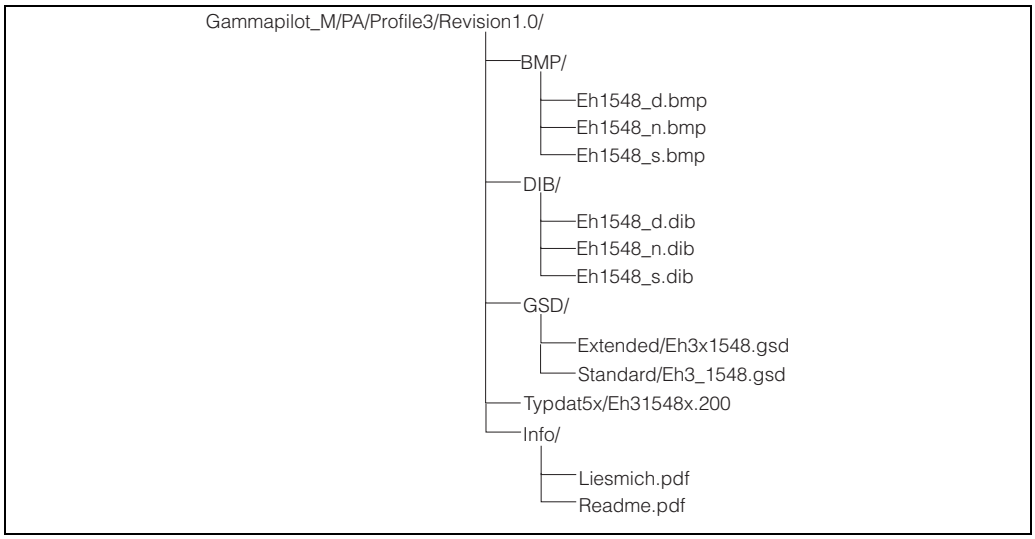
The Gammapilot M has the ID number 1548 (hex) = 5448 (dec).

Source of supply

- www.endress.de
  Click "Download" and enter "GSD" as the search string. A list with download links to all the GSD files available appears under "software".
- CD-ROM with all the GSD files for E+H devices; Order No.: 50097200
- GSD library of the PROFIBUS User Organization (PNO):http: //www.PROFIBUS.com

Directory structure

The files are organized in the following structure:



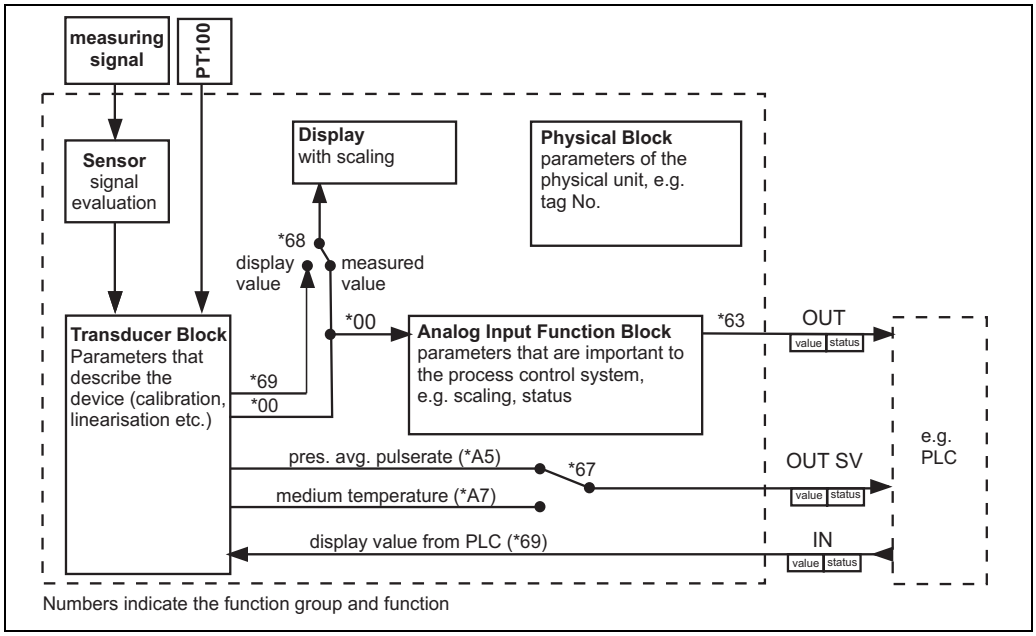
- The GSD files in the directory "Extended" are needed for the network design software STEP 7 of the S7-300/400 PLC family.
- The GSD files in the directory "Standard" are used for PLCs, which do not support an identifier format but only an identifier byte (e.g. PLC5 of Allen-Bradley)
- For the COM ET200 configuration software with Siemens S5, the "EH_1548x.200" type file is used instead of a GSD file and the DIB files are used instead of the BMP files.

Universal Database File

As an alternative to the device specific GSD file, the PNO provides a universal database file with the designation PA139700.gsd for devices with one analog input block. This file supports the transmission of the main value. Transmission of a second cyclic value or a display value is not supported.
When the universal database file is used, the "**profile**" **(*61)** option has to be selected in the "**Ident Number**" function.

5.6.3 Cyclic data exchange

Block model of the Gammapilot M



The block model shows which data are exchanged continuously (i.e. by cyclic data transfer) between the Gammapilot M and the PLC. The numbers refer to the function groups and functions:

- After linearization and integration in the Transducer block the "**measured value**" **(*00)** is transmitted to the Analog Input function block. There, it may be scaled and checked for limit transgression, and is output via "**OUT value**" **(*63)** to the PLC.
- The function "**select V0H0**" **(*68)** determines whether the "**measured value**" **(*00)** or the value from the PLC, "**display value**" **(*69)**, is displayed at the device display.
- The function "**2nd cycl. value**" **(*67)** specifies whether the "**present averaged pulse rate**" **(*A5)** or the "**medium temperature**" **(*A7)** (measured with an external PT-100 sensor) is output as the second cyclic value.

Modules for the cyclic data telegram

For the cyclic data telegram the Gammapilot M makes the following modules available:

1. **Main Process Value**
   This is the main measured value scaled by the Analog Input block (*63).
2. **2nd Cyclic Value**
   This is the present average pulse rate (*A5) or the medium temperature (*A7) measured by an external PT-100 temperature sensor.
3. **Display Value**
   This is a random value that is transmitted from the PLC to the Gammapilot M (*69). It can then be displayed on the device display.
4. **FREE PLACE**
   This module must be applied during configuration (see below), if the 2nd cyclic value or the display value are not to appear in the data telegram.

Configuration of the cyclic data telegram

Use the configuration software of your PLC in order to compose the data telegram from these modules in one of the following ways:

1. **Main value**
   In order to transmit the main measured value, select the module "**Main Process Value**".
2. **Main value and second cyclic value**
   Select the modules in the order "**Main Process Value**", "**2nd Cyclic Value**", "**FREE PLACE**" if you want to transmit the main measured value and the second cyclic value.
3. **Main value and display value**
   Select the modules in the order "**Main Process Value**", "**FREE PLACE**", "**Display Value**" if you want to transmit the main measured value and read out a display value from the PLC.
4. **Main value, second cyclic value and display value**
   Select the modules in the order "**Main Process Value**", "**2nd Cyclic Value", "Display Value**" if you want to transmit the main measured value and the second cyclic value and read out a display value from the PLC.

The exact way of performing the configuration depends on the configuration software of the PLC.

Structure of the input data (measuring device → PLC)

The input data are transmitted to the PLC with the following structure:

Index Input Data	**Data**	**Access**	**Format/Remarks**
0, 1, 2, 3	Main value (level, density)	read	32 bit floating point number (IEEE-754)
4	Status code for main value	read	see "Status codes"
5, 6, 7, 8 (option)	Secondary value (average pulse rate, temperature)	read	32 bit floating point number (IEEE-754)
9 (option)	Status code for secondary value	read	see "Status codes"

Structure of the output data (PLC → measuring device)

The output data from the PLC for display on the device have the following structure:

Index Input Data	**Data**	**Access**	**Format/Remarks**
0, 1, 2, 3	Display value	write	32 bit floating point number (IEEE-754)
4	Status code for Display value	write	see "Status codes"

IEEE-754 Floating Point Number

The measured value is transmitted as an IEEE 754 floating point number, whereby
Measured value = $(-1)^{VZ} \times 2^{(E-127)} \times (1+F)$

Byte 1								Byte 2							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
VZ	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}
	Exponent (E)							Mantissa (F)							

Byte 3								Byte 4							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
2^{-8}	2^{-9}	2^{-10}	2^{-11}	2^{-12}	2^{-13}	2^{-14}	2^{-15}	2^{-16}	2^{-17}	2^{-18}	2^{-19}	2^{-20}	2^{-21}	2^{-22}	2^{-23}
Mantissa (F)															

Example:

40 F0 00 00 (hex) = 0**100 0000 1**111 0000 0000 0000 0000 0000 (bin)
$= (-1)^0 \times 2^{(129-127)} \times (1 + 2^{-1} + 2^{-2} + 2^{-3})$
$= 1 \times 2^2 \times (1 + 0.5 + 0.25 + 0.125)$
$= 1 \times 4 \times 1.875$
$= 7.5$

Status codes

The status codes comprise one byte and have got the following meaning:

Status-Code	Device status	Meaning	Main value	Secondary value
0C Hex	BAD	device error		X
0F Hex	BAD	device error	X	
1F Hex	BAD	out-of-service (target mode)	X	
40 Hex	UNCERTAIN	non-specific (simulation)		X
47 Hex	UNCERTAIN	last usable value (Fail-safe-Mode active)	X	
4B Hex	UNCERTAIN	Substitute set (fail-safe mode active)	X	
4F Hex	UNCERTAIN	initial value (fail-safe mode active)	X	
5C Hex	UNCERTAIN	Configuration error (limits not set correctly)	X	
80 Hex	GOOD	OK	X	X
84 Hex	GOOD	Active block alarm (static revision counter incremented)	X	
89 Hex	GOOD	LOW_LIM (alarm active)	X	
8A Hex	GOOD	HI_LIM (alarm active)	X	
8D Hex	GOOD	LOW_LOW_LIM (alarm active)	X	
8E Hex	GOOD	HI_HI_LIM (alarm active)	X	

If a status other than "GOOD" is sent to the device, the display indicates an error.

5.6.4 Acyclic data exchange

Acyclic data exchange allows device parameters to be changed independently of the communication between the device and a PLC.
Acyclic data exchange is used
- to transmit device parameters during commissioning and maintenance;
- to display measured values that are not acquired in cyclic traffic.

There are two types of acyclic data exchange:

Acyclic communication with a Class 2 master (MS2AC)

In the case of MS2AC, a Class 2 master opens a communication channel via a so-called service access point (SAP) in order to access the device. Class 2 masters are for example:
- ToF Tool
- FieldCare
- PDM

Before data can be exchanged via PROFIBUS, however, the Class 2 master must be made aware of the parameters contained within the field device. This can be done by:
- a device description (DD)
- a device type manager (DTM)
- a software component within the master, which accesses the parameters via slot and index addresses.

Note!
- The DD or DTM is supplied by the device manufacturer.
- The number of Class 2 masters that can simultaneously access a device, is determined by the number of SAPs that the device can provide. The number of SAPs varies from device to device.
- The use of a Class 2 master increases the cycle time of the bus system. This must be taken into consideration when the control system or PLC is programmed.

Acyclic communication with a Class 1 master (MS1AC)

In the case of MS1AC, a Class 1 master that is already communicating cyclically with a device opens a communication channel via SAP 0x33, a special access point for MS1AC. As is the case for a Class 2 master, the parameter is read or written via the slot and index.

Note!
- Up to now, only a few PROFIBUS masters on the market support MS1AC.
- Not all PROFIBUS field devices support MS1AC.

Caution!
Permanent writing of parameters, e.g. with every cycle of the application program, must be avoided, since this can drastically reduce the life of the device.
Acyclic write parameters are stored electrically in the RAM (EEPROM, Flash...). The RAM modules are design for a limited number of write operations only. In standard operation without MS1AC, i.e. during configuration of the device, the number of write operations is negligible when compared to the limit. If the application program is badly designed, however, this limit can be reached quickly, This would dramatically reduce the lifetime of the device.

5.6.5 Slot/index tables

Device Management

Parameter	Menu position	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Dir. Object Header		1	0	12	STRING	X		constant
Comp. List Dir. Entry		1	1	24	STRING	X		constant

Analog-Input-Block

Parameter	Menu position	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Standard parameters								
Block Object		1	16	20	STRING	X		constant
Static revision		1	17	2	UINT16	X		static
Tag Description		1	18	32	STRING	X	X	static
Strategy		1	19	2	UINT16	X	X	static
Alert key		1	20	1	UINT8	X	X	static
Target Mode		1	21	1	ENUM8	X	X	static
Mode of Block		1	22	3	UINT8+ UINT8+ UINT8	X		dynamic
Alarm summary		1	23	8	UINT16+ UINT16+ UINT16+ UINT16	X		dynamic
Batch		1	24	10	UINT32+ UINT16+ UINT16+ UINT16	X		dynamic
Block parameters								
Out		1	26	5	FLOAT+ UINT8	X	X	static
PV Scale		1	27	8	FLOAT+ FLOAT	X	X	static
Out Scale		1	28	11	FLOAT+ FLOAT+ UINT16+ UINT8	X	X	static
Linearization type		1	29	1	UINT8	X	X	static
Channel		1	30	2	UINT16	X	X	static
PV filter time		1	32	4	FLOAT	X	X	static
Fail safe type		1	33	1	UINT8	X	X	static
Fail safe value		1	34	4	FLOAT	X	X	static
Alarm Hysteresis		1	35	4	FLOAT	X	X	static
HI HI Limit		1	37	4	FLOAT	X	X	static
HI Limit		1	39	4	FLOAT	X	X	static
LO Limit		1	41	4	FLOAT	X	X	static
LO LO Limit		1	43	4	FLOAT	X	X	static

Parameter	Menu position	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
HI HI Alarm		1	46		UINT8+ UINT8+ STRING+ UINT16+ FLOAT	X		dynamic
HI Alarm		1	47		UINT8+ UINT8+ STRING+ UINT16+ FLOAT	X		dynamic
LO Alarm		1	48		UINT8+ UINT8+ STRING+ UINT16+ FLOAT	X		dynamic
LO LO Alarm		1	49		UINT8+ UINT8+ STRING+ UINT16+ FLOAT	X		dynamic
Simulate		1	50	6	UINT8+ FLOAT+ UINT8	X	X	dynamic
Out unit text		1	51		STRING	X	X	static

Physical Block

Parameter	Menu position	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Standard parameters								
Block Object		0	16		STRING	X		constant
Static revision		0	17	2	UINT16	X		static
Tag description		0	18		STRING	X	X	static
Strategy		0	19	2	UINT16	X	X	static
Alert key		0	20	1	UINT8	X	X	static
Target mode		0	21	1	ENUM8	X	X	static
Mode		0	22	3	UINT8+UINT8 +UINT8	X		dynamic
Alarm summary		0	23	2	STRING	X		dynamic
Block parameters								
Software revision		0	24		STRING	X		constant
Hardware revision		0	25		STRING	X		constant
Device manufacturer ID		0	26	2	UINT16	X		constant
Device ID		0	27		STRING	X		constant
Device serial number		0	28		STRING	X		constant
Diagnosis		0	29		STRING	X		dynamic
Diagnosis extension		0	30		STRING	X		dynamic
Diagnosis mask		0	31		STRING	X		constant
Diagnosis mask ext.		0	32		STRING	X		constant
Device certification		0	33		STRING	X		constant

Parameter	Menu position	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Write locking		0	34	2	UINT16	X	X	static
Factory reset		0	35	2	UINT16	X	X	static
Descriptor		0	36	32	STRING	X	X	static
Device message		0	37	32	STRING	X	X	static
Device instal. date		0	38	16	STRING	X	X	static
Ident number select		0	40	1	UINT8	X	X	static
HW write protection		0	41	1	UINT8	X		dynamic
Endress+Hauser parameters								
error code		0	54	2	UINT16	X		dynamic
last error code		0	55	2	UINT16	X		static
Up Down features		0	56	1	STRING	X		constant
Up Down control		0	57	1	UINT8	X	X	dynamic
Up Down param		0	58	20	STRING	X	X	dynamic
Bus address		0	59	1	UINT8	X		dynamic
Device SW No.		0	60	2	UINT16	X		constant
set unit to bus		0	61	1	UINT8	X	X	dynamic
display value		0	62	6	FLOAT+UINT8 +UINT8 +STRING	X	X	
Select Main value		0	63	1	UINT8	X	X	static
PA profile revision		0	64	32	STRING	X		constant
Status		0	65	1	UINT8	X		static
Identification String		0	66	32	STRING	X		static
Identification Number		0	67	1	UINT8	X		dynamic
Dir. Object Header		1	0	12	STRING	X		constant
Comp. List Dir. Entry		1	1	24	STRING	X		constant

Endress+Hauser-specific Level Transducer block

Parameter	Menu position	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Standard parameters								
Block data		1	114	20	STRING	X	X	static
Static revision		1	115	2	UINT16	X		static
Tag description		1	116	32	STRING	X	X	static
Strategy		1	117	2	UINT16	X	X	static
Alert key		1	118	1	UINT8	X	X	static
Target mode		1	119	1	UINT8	X	X	static
Mode		1	120	3	UINT8+ UINT8 UINT8	X		dynamic
Alarm summary		1	121	8	STRING	X		dynamic
Status		1	122	1	UINT8	X	X	dynamic
Endress+Hauser parameters								
Measured value	(*00)	1	138	4	FLOAT	X		dynamic

Parameter	Menu position	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Present Date	(*01)	1	139	16	STRING	X		static
Present Date Day	(*01)	1	140	1	UINT8	X	X	dynamic
Present Date Month	(*01)	1	141	1	UINT8	X	X	dynamic
Present Date Year	(*01)	1	142	1	UINT8	X	X	dynamic
Present Date Hour	(*01)	1	143	1	UINT8	X	X	dynamic
Present Date Minute	(*01)	1	144	1	UINT8	X	X	dynamic
Ray type	(*02)	1	145	2	ENUM	X	X	static
Radiation Source	(*03)	1	146	2	ENUM	X	X	static
Master Slave Mode	(*04)	1	147	2	ENUM	X	X	static
Measurement Mode	(*05)	1	148	2	ENUM	X	X	static
Density Unit	(*06)	1	149	2	ENUM	X	X	static
Min. Density	(*07)	1	150	4	FLOAT	X	X	static
Max. Density	(*08)	1	151	4	FLOAT	X	X	static
Pipe Diam. Unit	(*09)	1	152	2	ENUM	X	X	static
Pipe Diameter	(*0A)	1	153	4	FLOAT	X	X	static
Output Damping	(*0B)	1	154	2	UINT16	X	X	static
Backgr. Calibr.	(*10)	1	160	2	ENUM	X	X	static
Average Pulse Rate	(*11)	1	161	4	INT32	X		dynamic
Backgr. Pulse Rate	(*12)	1	162	4	INT32	X	X	static
Calibr. Point Level	(*13)	1	163	2	ENUM	X	X	static
Value Full	(*14)	1	164	4	FLOAT	X	X	static
Calibration Start Stop	(*15)	1	165	2	ENUM	X	X	static
Full Calibr. Pulse Rate	(*16)	1	166	4	INT32	X	X	static
Value Empty	(*17)	1	167	4	FLOAT	X	X	static
Empty Calibr. Pulse Rate	(*18)	1	168	4	INT32	X	X	static
Calibration Next Point	(*19)	1	169	2	ENUM	X	X	static
Calibr. Point Density	(*1A)	1	170	1	UINT8	X	X	static
Density Calibr.	(*1B)	1	172	4	INT32	X	X	static
Density Value	(*1C)	1	173	4	FLOAT	X	X	static
Use of Cal. Point	(*1D)	1	174	2	ENUM	X	X	static
Absorp. Coeff.	(*1E)	1	175	4	FLOAT	X	X	static
Ref. Pulse Rate	(*1F)	1	176	4	UINT32	X		dynamic
Output On Alarm	(*20)	1	180	2	ENUM	X	X	static
Temp. Compens.	(*30)	1	190	2	ENUM	X	X	static
Select Temperature	(*31)	1	191	2	ENUM	X	X	static
Temp. Value	(*32)	1	192	4	FLOAT	X	X	static
Density Value	(*33)	1	193	4	FLOAT	X	X	static
Lin. Coeff.	(*34)	1	194	4	FLOAT	X		static
Square Coeff.	(*35)	1	195	4	FLOAT	X		static
Temp. Coeff. Next Point	(*36)	1	196	2	ENUM	X	X	static
Linearisation Level	(*40)	1	200	2	ENUM	X	X	static
Lin. Table Number	(*41)	1	201	1	UINT8	X	X	static
Input Level	(*42)	1	202	4	FLOAT	X	X	static

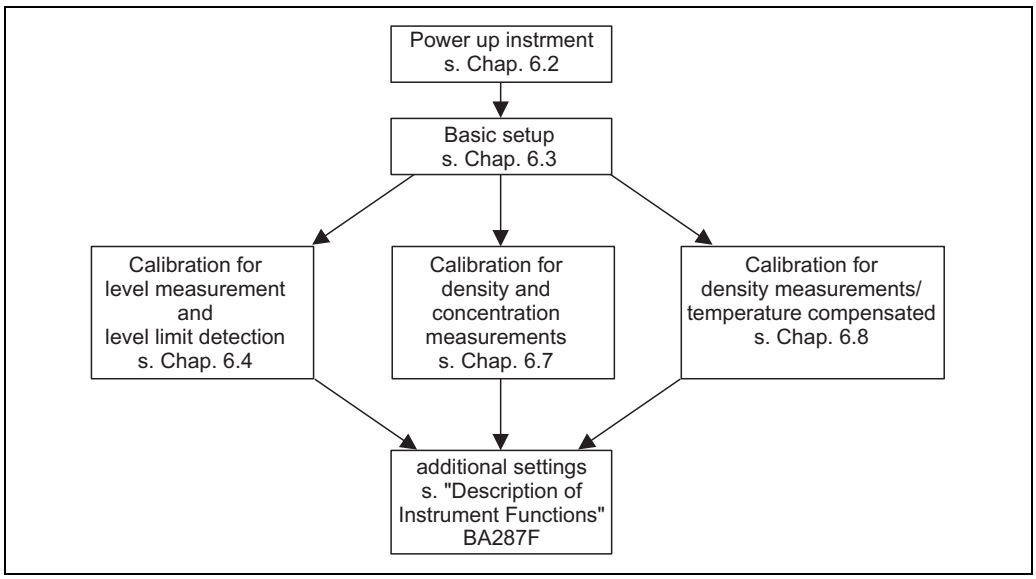
Parameter	Menu position	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Linearisation Start Stop	(*43)	1	203	2	ENUM	X	X	static
Normal. Pulse Rate	(*44)	1	204	4	INT32	X	X	static
Unit Selection	(*45)	1	205	2	ENUM	X	X	static
Customer Unit	(*46)	1	206	2	ENUM16	X	X	static
Linearisation Concentr.	(*47)	1	207	2	ENUM	X	X	static
Table Number Concentr.	(*48)	1	208	1	UINT8	X	X	static
Input Density	(*49)	1	209	4	FLOAT	X	X	static
Input Concentr.	(*4A)	1	210	4	FLOAT	X	X	static
Lin. Next Point	(*4B)	2	233	2	ENUM	X	X	static
Gammagr. Detect.	(*50)	1	220	2	ENUM	X	X	static
Span Time	(*51)	1	221	2	UINT16	X	X	static
Gammagr. Sensitivity	(*52)	1	222	1	UINT8	X	X	static
Gammagr. Output	(*53)	1	223	2	ENUM	X	X	static
Gammagr. Hold Time	(*54)	1	224	2	UINT16	X	X	static
Gammagr. Counter	(*55)	1	225	2	UINT16	X		dynamic
Gammagr. Counter Reset	(*56)	1	226	2	ENUM	X	X	static
PA Slave Address	(*60)	1	230	1	UINT8	X	X	static
PA Ident Number Sel.	(*61)	1	231	2	ENUM	X	X	static
Set Unit To Bus	(*62)	1	232	2	ENUM	X	X	static
AI Out Value	(*63)	1	233	4	FLOAT	X		dynamic
AI Out Status	(*64)	1	234	1	UINT8	X		dynamic
Sim. Level Mode	(*65)	1	235	2	ENUM	X	X	static
Sim. Density Mode	(*65)	1	236	2	ENUM	X	X	static
Sim. Concentr. Mode	(*65)	1	237	2	ENUM	X	X	static
Sim. Value Level	(*66)	1	238	4	FLOAT	X	X	static
Sim. Value Pulse Rate	(*66)	1	239	4	INT32	X	X	static
Sim. Value Density	(*66)	1	240	4	FLOAT	X	X	static
Sim. Value Concentr.	(*66)	1	241	4	FLOAT	X	X	static
2nd Cyclic Value	(*67)	1	242	2	ENUM	X	X	static
Select Main Value	(*68)	1	243	2	ENUM	X	X	static
Language	(*92)	1	245	2	ENUM	X	X	static
Back To Home	(*93)	1	246	2	INT16	X	X	static
No. of Decimals	(*95)	1	247	2	ENUM	X	X	static
Sep. Character	(*96)	1	248	2	ENUM	X	X	static
Display Test	(*97)	1	249	2	ENUM	X	X	static
Present Error	(*A0)	2	0	2	UINT16	X		dynamic
Last Error	(*A1)	2	1	2	UINT16	X		dynamic
Clear Last Error	(*A2)	2	2	2	ENUM	X	X	static
Reset	(*A3)	2	3	2	UINT16	X	X	static
Unlock Parameter	(*A4)	2	4	2	UINT16	X	X	static
Pres. Avg. Pulse Rate	(*A5)	2	5	4	INT32	X		dynamic
Avg. Raw Pulse Rate	(*A6)	2	6	4	INT32	X		dynamic
Medium Temp.	(*A7)	2	7	4	FLOAT	X		dynamic

Parameter	Menu position	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Density Value	(*A8)	2	8	4	FLOAT	X		dynamic
Tag Number	(*C0)	2	9	4	STRING	X	x	STATIC
Profile Version	(*C1)	2	10	16	STRING	X		static
Prot. Softw. Version	(*C2)	2	11	16	STRING	X		const.
Serial Number	(*C4)	2	12	16	STRING	X		static.
Temp. Unit	(*C6)	2	13	2	ENUM	X	X	static
Calibr. Date	(*C7)	2	14	16	STRING	X		static
Calibr. Date Day	(*C7)	2	15	1	UINT8	X	X	static
Calibr. Date Month	(*C7)	2	16	1	UINT8	X	X	static
Calibr. Date Year	(*C7)	2	17	1	UINT8	X	X	static
Calibr. Date Hour	(*C7)	2	18	1	UINT8	X	X	static
Calibr. Date Minute	(*C7)	2	19	1	UINT8	X	X	static
Recalibr. Date	(*C8)	2	20	16	STRING	X		static
Recalibr. Date Day	(*C8)	2	21	1	UINT8	X		static
Recalibr. Date Month	(*C8)	2	22	1	UINT8	X		static
Recalibr. Date Year	(*C8)	2	23	1	UINT8	X		static
Recalibr. Date Hour	(*C8)	2	24	1	UINT8	X		static
Recalibr. Date Minute	(*C8)	2	25	1	UINT8	X		static

6 Commissioning

Note!
This chapter describes the commissioning of the Gammapilot M using the operating module VU331 (which is located in the remote display and operating unit FHX40). Commissioning using the "ToF Tool – FieldTool Package", "FieldCare" or the HART handheld terminal DXR375 is similar. For further instructions refer to the Operating Instructions of the ToF Tool – FieldTool Package (BA224F), FieldCare or the Operating Instructions supplied together with the DXR375.

6.1 Calibration: overview



Note!
A detailed description of the functions used can be found in the following sections:
- 6.3: Basic setup
- 6.4: Calibration for level measurement and level limit detection
- 6.7: Calibration for density and concentration measurements
- 6.8: Calibration for density measurement/temperature-compensated

6.1.1 Basic setup

Step	Function	Entry or selection	Comments	See page
1	Present date (*01)	e.g. 12.11.04 10:30	Set day with ⊞ and ⊟ ; Confirm with ℇ; The same applies for month, year, hour and minute	56
2	Beam type (*02)	■ standard/cont. ■ modulated	Select with ⊞ and ⊟; Confirm with ℇ	56
3	Isotope (*03)	■ ^{137}Cs ■ ^{60}Co ■ no compensation	Select with ⊞ and ⊟; Confirm with ℇ	56
4	Operating mode(*04)	■ Stand alone ■ Master ■ Slave ■ End-slave ■ not defined	Select with ⊞ and ⊟; Confirm with ℇ	57
5	Measurement mode (*05)	■ level ■ limit ■ density ■ concentration	Select with ⊞ and ⊟; Confirm with ℇ	58
The following functions for density and concentration measurements only:				
6	Density unit (*06)	■ g/cm^3 ■ g/l ■ ...	Select with ⊞ and ⊟; Confirm with ℇ	59
7	Min. density (*07) (lower limit of the measuring range)	e.g. 0.9500 g/cm^3	Set each decimal place with ⊞ and ⊟ and confirm with ℇ; After the last place: confirm the whole value with ℇ.	59
8	Max. density (*08) (upper limit of the measuring range)	e.g. 1.2500 g/cm^3	Set each decimal place with ⊞ and ⊟ and confirm with ℇ; After the last place: confirm the whole value with ℇ.	59
9	Pipe diameter unit (*09)	■ mm ■ inch	Select with ⊞ and ⊟; Confirm with ℇ	60
10	Pipe diameter (*0A)	e.g. 200 mm	Set each decimal place with ⊞ and ⊟ and confirm with ℇ; After the last place: confirm the whole value with ℇ.	60
The following function for all measurement methods:				
11	Output damping (*0B)	e.g. 60 s	Set each decimal place with ⊞ and ⊟ and confirm with ℇ; After the last place: confirm the whole value with ℇ.	61

6.1.2 Calibration for level measurement and limit detection

Note!
The fundamentals for calibrating for level measurement and level limit detection are described in Section 6.4, P. 62.

Background calibration

(for details see Section 6.4.2, P. 65)

Step	Function	Action/comments
1		■ Switch off radiation ■ Fill tank for level: min. 60% for level limit: beam path covered
2	Background calibration (*10)	Select "start" with + or −; confirm with E
3	Avg. pulse rate (*11)	Wait until the value is stable, then confirm with E
4	Background calibration (*10)	Select "stop/edit" with + or −; confirm with E
5	Background pulse rate (*12)	Confirm value with E
Continue with full and empty calibration/covered and free calibration		

"Full" or "covered" calibration

(for details see Section 6.4.3, P. 67)

Step	Function	Action/comments
1		■ Switch on radiation ■ Tank remains filled.
2	Calibration point level (*13)	Select "full/covered" with + or −; confirm with E
The following function for level measurement only		
3	Value full (*14)	Enter the current level (60% - 100%)
The following functions for level and level limit measurement		
4	Calibration start stop (*15)	Select "start" with + or −; confirm with E
5	Avg. pulse rate (*11)	Wait until the value is stable, then confirm with E
6	Calibration start stop (*15)	Select "stop/edit" with + or −; confirm with E
7	Full calibration pulse rate (*16)	Confirm value with E
8	Calibration next point (*19)	Select "yes" with + or −; Confirm with E
Continue with "empty" or "free" calibration		

"Empty" or "free" calibration

(for details see Section 6.4.3, P. 67)

Step	Function	Action/comments
1		■ The radiation remains switched on ■ Empty tank Level: max. 40% Level limit: beam path free
2	Calibration point level (*13)	Select "empty/free" with + or −; confirm with E
The following function for level measurement only		
3	Value empty (*17)	Enter the current level (0% - 40%)
The following functions for level and level limit measurement		
4	Calibration start stop (*15)	Select "start" with + or −; confirm with E
5	Avg. pulse rate (*11)	Wait until the value is stable, then confirm with E
6	Calibration start stop (*15)	Select "stop/edit" with + or −; confirm with E
7	Empty calibration (*16)	Confirm value with E
8	Calibration next point (*19)	Select "no" with + or −; Confirm with E
This completes the calibration.		

6.1.3 Calibration for density and concentration measurements

Note!
The fundamentals for calibrating for density and concentration measurement are described in Section 6.5.1, P. 71.

Background calibration

(for details see Section 6.5.2, P. 73)

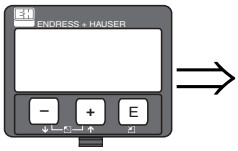
Step	Function	Action/comments
1		Switch off radiation
2	Background calibration (*10)	Select "start" with + or −; confirm with E
3	Avg. pulse rate (*11)	Wait until the value is stable, then confirm with E
4	Background calibration (*10)	Select "stop/edit" with + or −; confirm with E
5	Background pulse rate (*12)	Confirm value with E
Continue with entering the calibration points		

Calibration points (one-point calibration, multiple point calibration, recalibration)

(for details see Section 6.5.3, P. 75)

Step	Function	Action/comments
1		■ Switch on radiation ■ Fill the pipe with a medium whose density is known or take a sample of the medium during the calibration and determine its density in the laboratory (see Step 4).
2	Calibration point density (*1A)	Enter the number of the calibration point: ■ For one-point calibration: "1" ■ For multipoint calibration: "1" - "9" ■ For recalibration: "10"
3	Calibration start stop (*15)	Select "start" with + or −; confirm with E
4	Avg. pulse rate (*11)	Wait until the value is stable, then confirm with E; (during this time, take a sample of the medium and determine its density in the laboratory)
5	Calibration start stop (*15)	Select "stop/edit" with + or −; confirm with E
6	Density calibration (*1B)	Confirm value with E
7	Density value (*1C)	Enter the density of the medium (which was determined in the laboratory)
8	Use of cal. point (*1D)	Select "used" with + or −; confirm with E
9	Absorption coefficient (*1E)	Display value; confirm with E
10	Reference pulse rate (*1F)	Display value; confirm with E
11	Calibration next point (*19)	■ For one-point calibration: select "no"; this completes the calibration ■ For multiple point calibration: select "yes"; repeats steps 1 - 10 with a medium with a different density ■ For recalibration: select "no"; this completes the recalibration

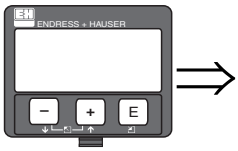
6.2 Switching on the device



FMG60
V01.01.06 PA

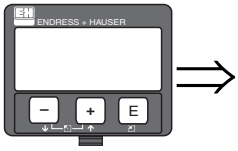
After switching on the supply voltage, the device is first initialized. Due to internal memory tests, this takes approx. 2 minutes. Then, the following appear for approximately five seconds:

- Device type: FMG60
- Software version: Vxx.yy.zz
  - xx: hardware version
  - yy: software version
  - zz: software revision
- Type of the communication signal:
  - HART
  - PA: PROFIBUS PA
  - FF: FOUNDATION Fieldbus



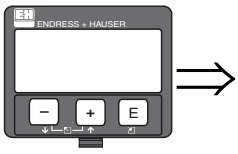
Language 092
✓English
Français
Español

On first power-up you are requested to select the language for the display texts.
Select the language with the + and − keys.
Confirm your choice by pressing E twice.



Measured
value 000
63.4 %
■■■■■■■■■■■

After that the measured value display appears.
Press E to switch to the group selection.

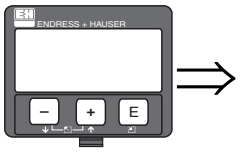


Group selection
✓basic setup
calibration
safety settings

The "basic setup" function group is already selected.
Press E to enter the first function of this function group.

6.3 Basic setup

6.3.1 "Present date" (*01)



present date *01
17.11.04 10:30
dd.mm.yy hh:mm

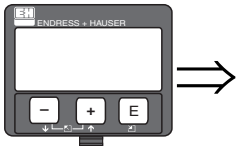
Date and time of the basic setup are specified in this function.

Format:
DD.MM.YY HH:MM

where:
– **DD:** the day ("01" to "31")
– **MM:** the month ("01"=January to "12"=December)
– **yy:** the year (e.g. "04" for 2004)
– **HH:** the hour ("00" to "23")
– **MM:** the minute ("00" to "59")

Each of these values must be confirmed by "E" after it has been entered.

6.3.2 "Beam type" (*02)

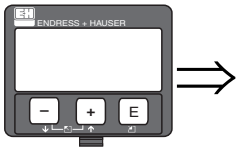


beam type *02
✓Standard/cont.
Modulated

This function is used to specify whether the radiation source used emits radiation continuously or whether it is modulated (for gammagraphy suppression).

Options:
- standard/continuous (permanent, continuous radiation)
- modulated (modulated radiation source) – under development

6.3.3 "Isotope" (*03)

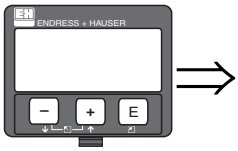


isotope *03
✓137Cs
60Co
no compens.

This function is used to specify which isotope is used for the measurement.
The Gammapilot M needs this information for the decay compensation.

Options:
- ^{137}Cs
- ^{60}Co
- no compensation

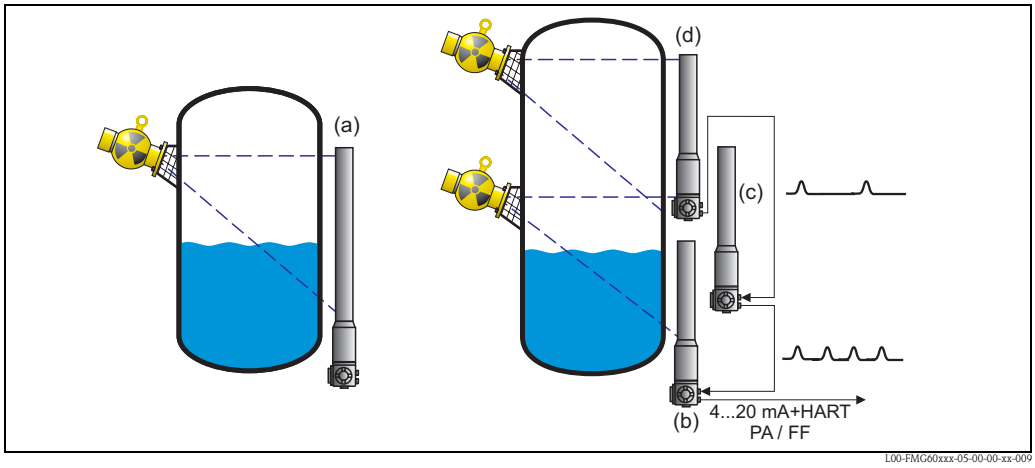
6.3.4 "Operating mode" (*04)



operating mode *04
✓stand alone
master
slave

This function is used to specify in which operating mode the Gammapilot M will be used.

Note!
The selection can be performed only once and the function is automatically locked after that. It can only be unlocked again by a reset of the Gammapilot M (**"Reset" (*A3)** function).



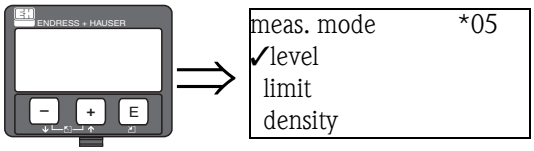
Possible operating modes of the Gammapilot M: ***a:*** *stand alone;* ***b:*** *master;* ***c:*** *slave(s);* ***d:*** *end-slave*

Options/display:

- **stand alone**
  This option is selected if the Gammapilot M is used as a single device.
- **master**
  This option is selected if the Gammapilot is located at the beginning of a cascading chain. It receives pulses from a connected slave, adds its own pulses and calculates the measuring value from this total.
- **slave**
  This option is selected if the Gammapilot M is located in the middle of a cascading chain. It receives the pulses from an additional connected slave or end-slave, adds its own pulses and transmits this total to the next device (master or slave).
  After selecting this option, the basic setup is finished. When cascading several transmitters the further calibration is performed on the master only.
- **end slave**
  This option is selected if the Gammapilot M is located at the end of a cascading chain. It does not receive pulses from another device but transmits its own pulses to the next device (master or slave).
  After selecting this option, the basic setup is finished. When cascading several transmitters the further calibration is performed on the master only.
- **not defined**
  is displayed if no operating mode has been selected yet. In order to continue the basic setup, a selection is necessary.

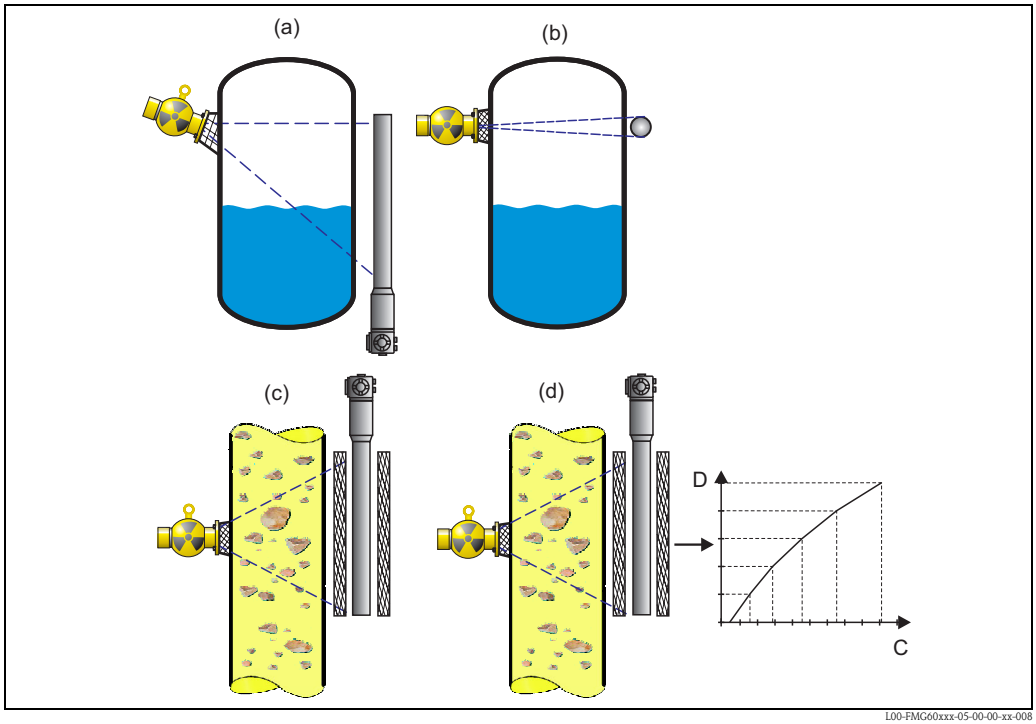
Note!
If a "slave" or an "end-slave" are connected to the "ToF Tool – FieldTool Package/FieldCare", the pulse rate of this device is displayed in the header instead of the measured value.

6.3.5 "Measurement mode" (*05)



This function is used to select the desired measuring mode.

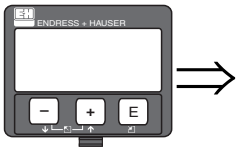
Note!
The selection can be performed only once and the function is automatically locked after that. It can only be unlocked again by a reset of the Gammapilot M (**"Reset" (*A3)** function).



*Possible measuring modes of the Gammapilot M: **a:** level measurement (continuous); **b:** level limit detection; **c:** density measurement (with temperature compensation if required); **d:** concentration measurement (density measurement followed by linearization)*

Options:
- level
- limit
- density (also with temperature compensation)
- concentration (density measurement followed by linearization)

6.3.6 "Density unit" (*06)



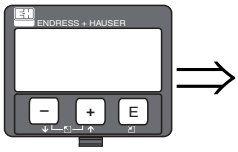

```
density unit        *06
✓g/cm3
 g/l
 lb/gal
```

This function is needed for density and concentration measurements only. It is used to select the density unit.

Options:
- g/cm^3
- g/l
- lb/gal; [1 g/cm^3 = 8,345 lb/gal]
- lb/ft^3; [1 g/cm^3 = 62,428 lb/ft^3]
- 1°Brix = [270 (1 - 1/x)]
- °Baumé; [1°Baumé = 144.3 (1 - 1/x)]
- °API; [1°API = 131.5 (1.076/x - 1)]
- °Twaddell; [1°Twaddell = 200 (x-1)]

"x" refers to the density in g/cm^3. The formula indicates how many degrees this density corresponds to.

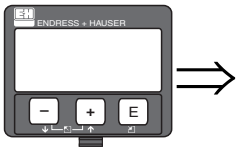
6.3.7 "Min. density" (*07)




```
min. density        *07
 0.9500 g/cm3
```

This function is needed for density and concentration measurements only. It is used to specify the lower limit of the density range.

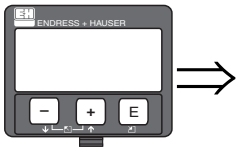
6.3.8 "Max. density" (*08)




```
max. density        *08
 1.2500 g/cm3
```

This function is needed for density and concentration measurements only. It is used to specify the upper limit of the density range.

6.3.9 "Pipe diameter unit" (*09)

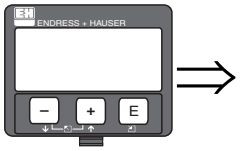


pipe diam. unit *09
✓mm
inch

This function is needed for density and concentration measurements only. It is used to select the unit for the pipe diameter.

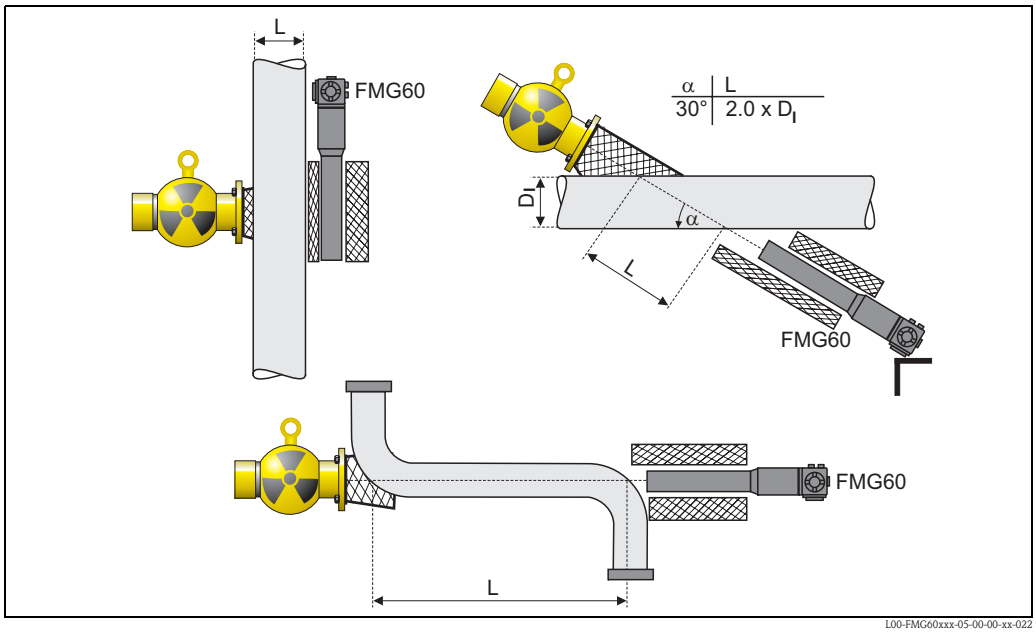
Options:
- mm
- inch [1 inch = 25.4 mm]

6.3.10 "Pipe diameter" (*0A)



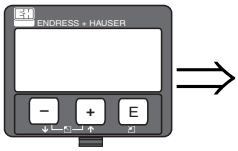
pipe diam. *0A
200 mm

This function is needed for density and concentration measurements only. It is used to specify the irradiated measuring path L. With standard installation, this value is identical to the inner pipe diameter D_I. For other installations (in order to enlarge the irradiated measuring path) it may be larger (s. sketch). The pipe walls are **not** to be considered a part of the measuring path.



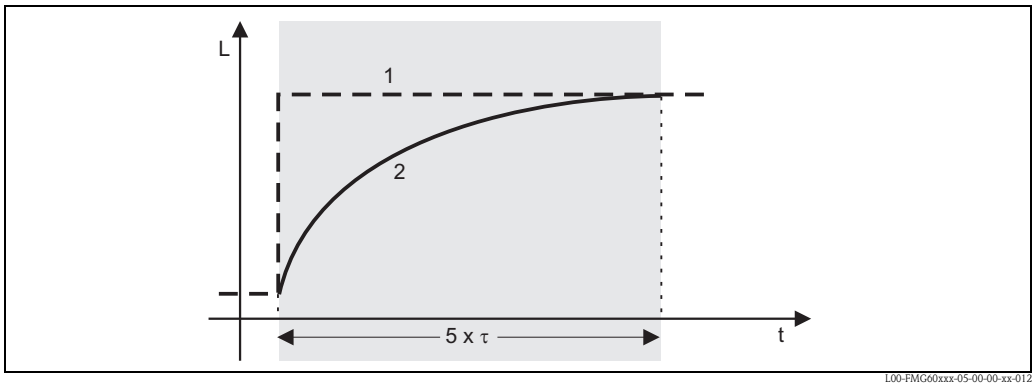
*Always specify the complete irradiated measuring path L in the "pipe diameter" (*0A) function. Depending on the installation, this value may be larger than the actual pipe diameter.*

6.3.11 "Output damping" (*0B)



output damping *0B
60 s

This function is used to specify the output damping τ (in seconds) by which changes of the measured value are attenuated.
After a surge in the level or density it takes 5 x τ until the new measured value is reached.



*Effect of the output damping; **1:** Level change (or density change); **2:** measured value*

Range of values
1 to 999 s

Default
The default depends on the selected **"measuring mode" (*05)**:
- level: 6 s
- limit: 6 s
- density: 60 s
- concentration: 60 s

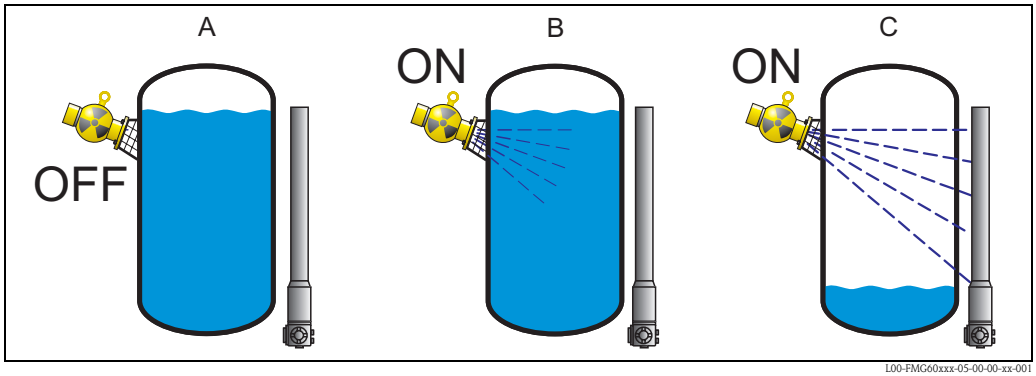
Selecting the output damping
The best value of the output damping depends on the process conditions. By enlarging the output damping, the measured value becomes considerably steadier but also slower.
In order to dampen the influence of strongly fluctuating surfaces or stirrers, it is advisable to enlarge the output damping.
On the other hand, if rapid changes of the measured value have to be detected accurately, the output damping may not be selected to large.

6.4 Calibration for level measurement and limit detection

6.4.1 Basic principles

The calibration points for the measurement are entered in the **"calibration" (*1)** function group. Each calibration point consists of a level and the associated pulse rate.

Calibration points for level measurement



*Calibration points for level measurement; **A**: Background calibration; **B**: Full calibration; **C**: Empty calibration*

Background calibration

refers to the following situation:
- The radiation is switched off.
- Within the measuring range, the vessel is filled as far as possible (ideally: 100%).

The background calibration is necessary, in order to register the natural background radiation at the mounting position of the Gammapilot M. The pulse rate of this background radiation is automatically subtracted from any other measured pulse rate. That means: only the part of the pulse rate which originates from the applied radiation source is taken into account and is displayed. As opposed to the radiation of the applied source, the background radiation remains nearly constant during the complete measurement. Therefore, it is not submitted to the automatic decay compensation of the Gammapilot M.

Full calibration

refers to the following situation:
- The radiation is switched on.
- Within the measuring range, the vessel is filled as far as possible (ideally: 100%, minimum 60%).

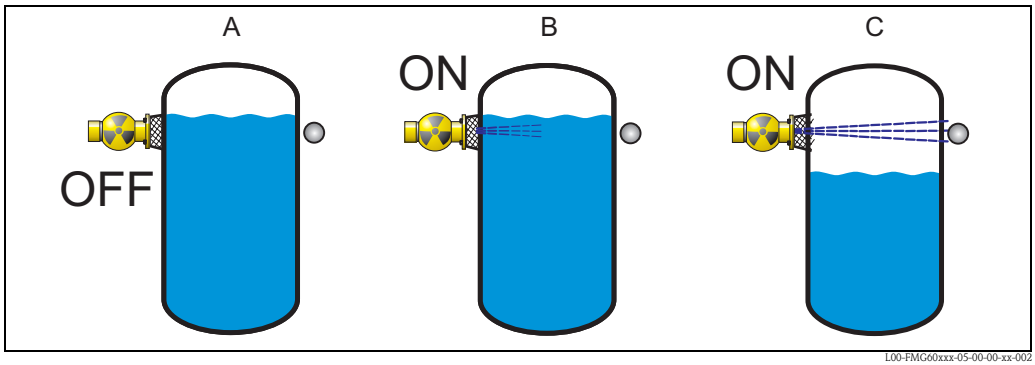
If the vessel cannot be filled to at least 60% during the calibration, the full calibration can alternatively be performed with the radiation switched off, which is a way of simulating a filling of 100%. In this case, the full calibration is identical to the background calibration. As the pulse rate of the background radiation is automatically subtracted, the displayed pulse rate is about 0 cps.

Note!
This type of simulated calibration is not possible with self-radiating media. In this case it is always necessary to perform the background and full calibration with the vessel filled to 100%.

Empty calibration

refers to the following situation:
- The radiation is switched on.
- Within the measuring range, the vessel is emptied as far as possible (ideally: 0%, maximum 40%).

Calibration points for limit detection



*Calibration points for limit detection; **A**: Background calibration; **B**: Covered calibration; **C**: Free calibration*

Background calibration

refers to the following situation:
- The radiation is switched off.
- If possible, the radiation path is completely covered.

The background calibration is necessary, in order to register the natural background radiation at the mounting position of the Gammapilot M. The pulse rate of this background radiation is automatically subtracted from any other measured pulse rate. That means: only the part of the pulse rate which originates from the applied radiation source is taken into account and is displayed. As opposed to the radiation of the applied source, the background radiation remains nearly constant during the complete measurement. Therefore, it is not submitted to the automatic decay compensation of the Gammapilot M.

Covered calibration

refers to the following situation:
- The radiation is switched on.
- If possible, the radiation path is completely covered.

If the radiation path cannot be completely covered during the calibration, the covered calibration can alternatively be performed with the radiation switched off, which is a way of simulating complete covering. In this case, the covered calibration is identical to the background calibration. As the pulse rate of the background radiation is automatically subtracted, the displayed pulse rate is about 0 c/s.

Note!
This type of simulated calibration is not possible with self-radiating media. In this case it is always necessary to perform the background calibration and the covered calibration with the radiation path completely covered.

Free calibration

refers to the following situation:
- The radiation is switched on.
- The radiation path is completely free.

Methods for entering the calibration points

Automatic calibration

For an automatic calibration, the vessel is filled to the required value. For the background calibration the radiation remains switched off, for the other calibration points the radiation is switched on. The Gammapilot M automatically records the pulse rate. The associated level is entered by the user.

Manual calibration

If during the commissioning of the Gammapilot M one or more calibration points cannot be realized (e.g. because the vessel cannot be sufficiently filled or emptied), the calibration point must be entered manually.
That is, not only the level but also the associated pulse rate must be entered by the user. For details concerning the calculation of the count rate please refer to your Endress+Hauser sales organization.

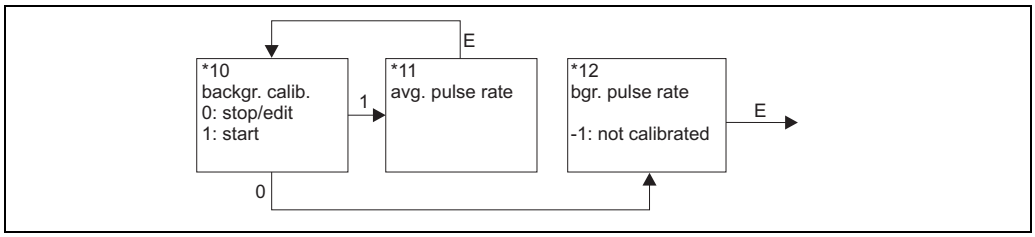
Note!
When calibrating manually, the calibration date is not set automatically. Instead, it must be entered manually into the **"calibration date" (*C7)** function.

Note!
A manually entered calibration point should be replaced by an automatic calibration as soon as the associated level occurs during the operation of the plant. This recalibration is advisable because calibration points entered automatically result in more precise measurement results than calculated ones.

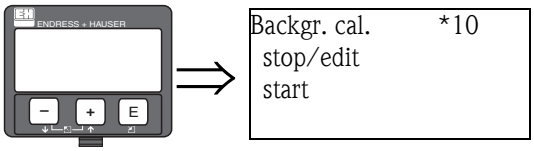
6.4.2 Background calibration

Excerpt from the operating menu

The following excerpt from the operating menu shows how the background calibration is entered. The individual functions are explained in the sections below.



"Background calibration" (*10)



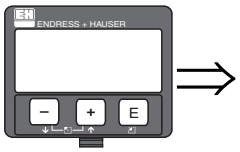
This function is used to start the background calibration

Options:

- **stop/edit** This option must be selected if
  - no background calibration is to be performed but the pulse rate of an existing background calibration is to be displayed instead.
  - a manual background calibration is to be performed.

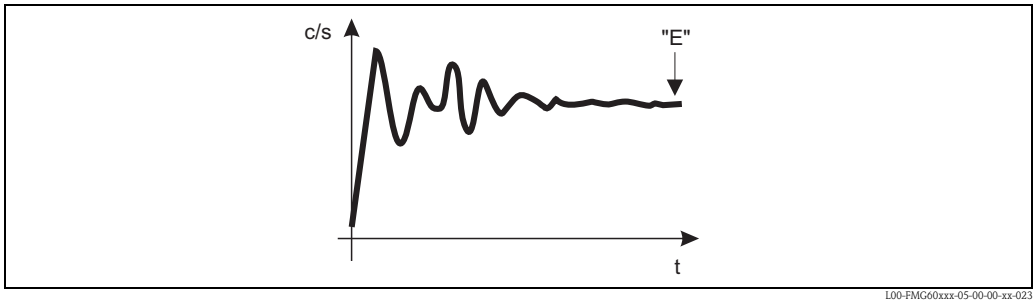
  After selecting this option, the Gammapilot M changes to the **"bgr. pulse rate" (*12)** function, where the existing pulse rate is displayed and can be changed if required.
- **start**
  This option is used to start an automatic background calibration. The Gammapilot M changes to the **"avg. pulse rate" (*11)** function.

"Avg. pulse rate" (*11)



avg. pulse rate *11
186 cps

The average pulse rate is displayed in this function (after selection of "start" in the previous function). Initially, this value fluctuates (because of the decay statistics), but due to the integration it reaches an average value in the course of time. The longer the averaging is performed the lower are the remaining fluctuations.



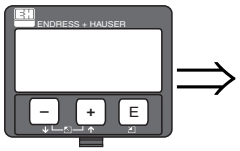
Initially, the pulse rate strongly fluctuates. In the course of time an average value is reached.

If the value is sufficiently stable, the function can be left by pressing "E".
Thereafter, the Gammapilot M changes to the **"backgr. calib." (*10)** function. Select **"stop/ edit"** to stop the averaging procedure. The value is then automatically transmitted to the **"bgr. pulse rate" (*12)** function.

Note!
The maximum integration time is 1000 s. After this time, the value is automatically transmitted to the **"bgr. pulse rate" (*1B)** function.

Note!
The integration is **not** terminated by pressing "E" in the **"avg. pulse rate" (*11)** function. It is continued until the selection of **"stop/edit"** in the **"backgr. calib." (*10)** function. This may result in a slight deviation between the last displayed average pulse rate and the final **"bgr. pulse rate" (*12)**.

"Background pulse rate" (*12)



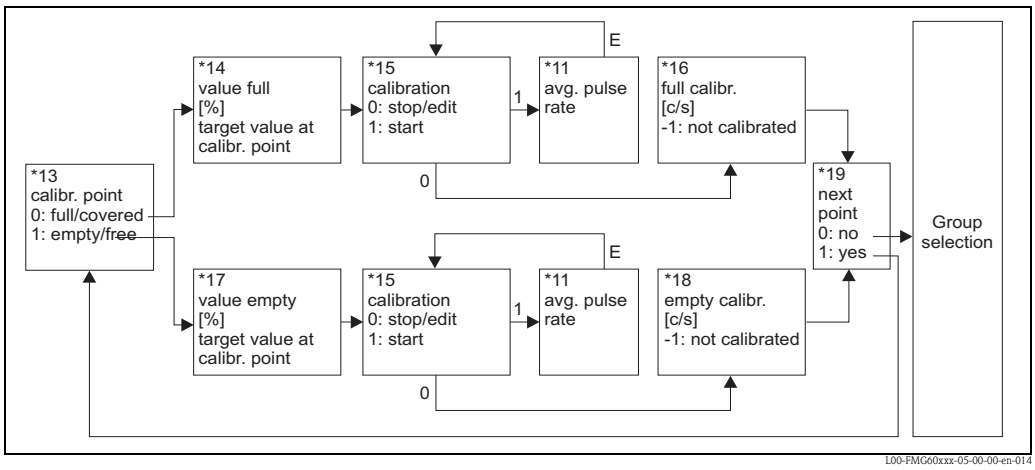
backgr. pul. rate *12
186 cps

The pulse rate of the background calibration is displayed in this function. By pressing "E" the displayed value can be confirmed and the background calibration completed.
"-1" indicates, that no background calibration is present yet. In this case, there are two options:
- either return to the **"background calibration" (*10)** function and restart the background calibration
- or enter a known or calculated pulse rate (manual calibration). Thereafter, the Gammapilot M changes to the **"calibr. point" (*13)**or **(*1A)** function.

6.4.3 Full and empty calibration or covered and free calibration

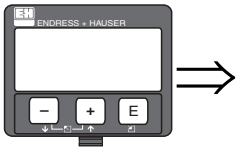
Excerpt from the operating menu

The following excerpt from the operating menu shows how the full and empty calibration (for level measurements) or the covered and free calibration (for level limit detection) are entered. The individual functions are explained in the sections below.
The functions are only accessible after the background calibration has been performed.



*Note: The "value full" (*14) and "value empty" (*17) functions only appear if the "level" option was selected in the "measurement method" function (*05).*

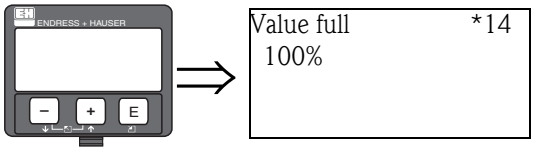
"Calibration point" (*13)

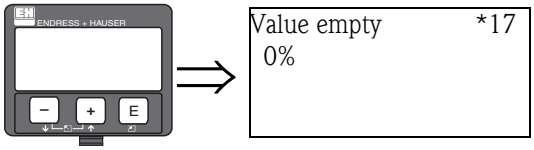


This function is used to select which calibration point ("full/covered" or "empty/free") will be entered.

Options:
- full/covered
- empty/free

"Value full" (*14)
"Value empty" (*17)



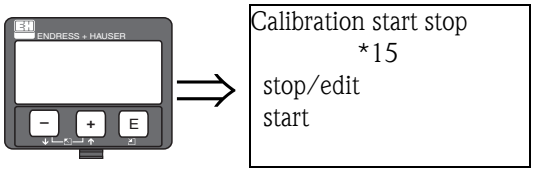


These functions are needed for level measurements only. They are used to specify the level at which the full or empty calibration are performed.

Range of values

	optimum value	minimum value	maximum value
Value full (*14)	100%	60%	100%
Value empty (*17)	0%	0%	40%

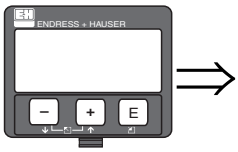
"Calibration start stop" (*15)



This function is used to start the automatic entering of the selected calibration point.

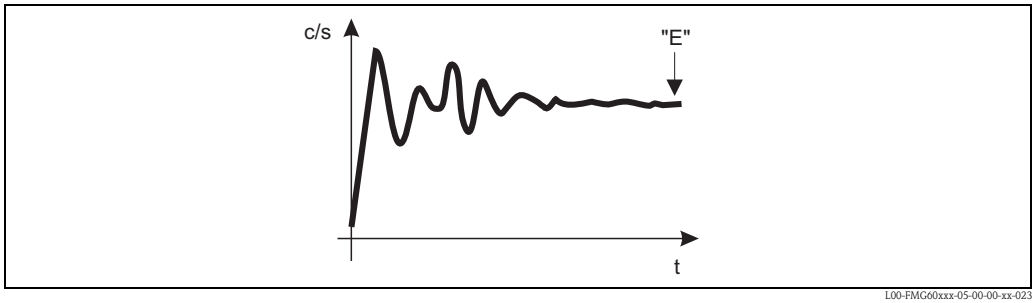
Options:
- **stop/edit** This option must be selected if
  - the calibration point is not to be entered (e.g. because it has already been entered). The pulse rate of the calibration point is then displayed in the following function, **"full calibr." (*16)** or **"empty calibr." (*18)**. If required, this value can be changed.
  - the calibration point is to be entered manually. This can be done in the following function, **"full calibr." (*16)** or **"empty calibr." (*18)**.
- **start**
  This option is used to start the automatic entering of the calibration point. The Gammapilot M then changes to the **"avg. pulse rate" (*11)** function.

"Avg. pulse rate" (*11)



avg. pulse rate *11
2548 cps

The average pulse rate is displayed in this function (after selection of "start" in the previous function). Initially, this value fluctuates (because of the decay statistics), but due to the integration it reaches an average value in the course of time. The longer the averaging is performed the lower are the remaining fluctuations.



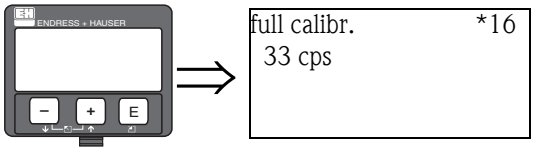
Initially, the pulse rate strongly fluctuates. In the course of time an average value is reached.

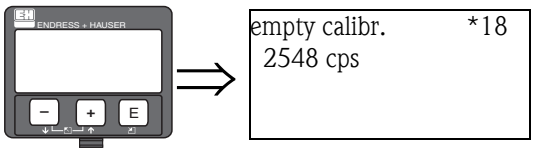
If the value is sufficiently stable, the function can be left by pressing "E".
Thereafter, the Gammapilot M changes to the **"calibration" (*15)** function. Select **"stop/edit"** to stop the averaging procedure. The value is then automatically transmitted to the **"full calibr." (*16)** or **"empty calibr." (*18)** function respectively.

Note!
The maximum integration time is 1000 s. The value is then transmitted automatically to the **"full calibr." (*16)** or **"empty calibr." (*18)** function.

Note!
The integration is **not** terminated by pressing "E" in the **"avg. pulse rate" (*11)** function. It is continued until the selection of **"stop/edit"** in the **"calibration" (*15)** function. This may result in a slight deviation between the last displayed average pulse rate and the final **"full calibr." (*16)** or **"empty calibr. (*18)**.

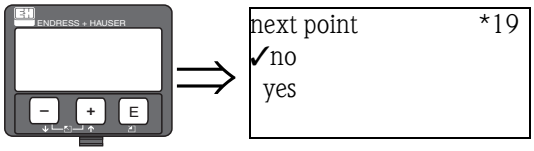
"Full calibration" (*16)
"Empty calibration" (*18)





The pulse rate of the respective calibration point is displayed in these functions. The displayed value must be confirmed by pressing "E".
"-1" indicates, that no background calibration is present yet. In this case, there are two options:
- either return to the "calibration" (*15) function and restart the calibration
- or enter a known or calculated pulse rate (manual calibration).

"Next point" (*19)



This function is used to specify, if a further calibration point is to be entered or not.

Options:
- **no**
  This option must be selected after both calibration points have been entered. After this selection the Gammapilot M returns to the group selection and the calibration is completed.
- **yes**
  This option must be selected if only one calibration point has yet been entered. After this selection the Gammapilot M returns to the **"calibr. point" (*13)** function and the next point can be entered.

6.4.4 Additional settings

After the calibration, the Gammapilot M outputs the measured value via the PROFIBUS PA interface.
Many additional functions are available for optimizing the measuring point. They can be configured as required. A detailed description of all instrument functions is given in Operating Instructions BA287F, "Gammapilot M – Description of Device Functions". This document can be found on the CD-ROM supplied for the "ToF Tool – FieldTool Package".

6.5 Calibration for density and concentration measurements

6.5.1 Basic principles

The calibration points for the measurement are entered in the **"calibration" (*1)** function group. Each calibration point consists of a density value and the associated pulse rate.

Calibration points for density and concentration measurements

Function of the calibration points

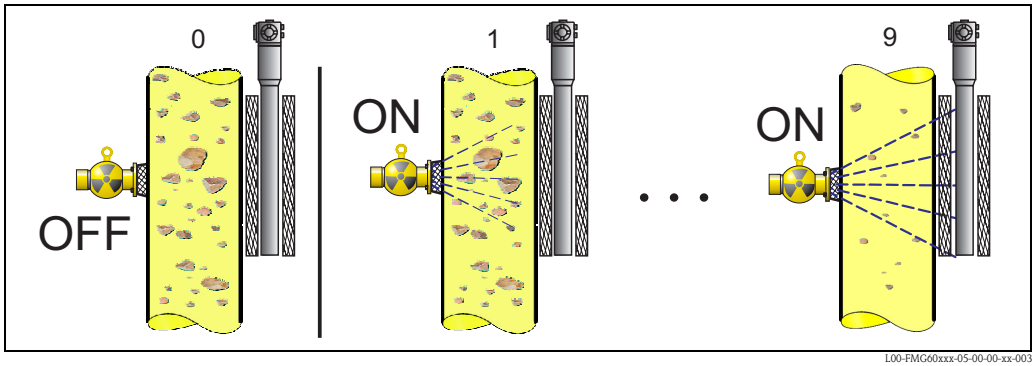
For density and concentration measurements the Gammapilot M needs (apart from the length of the irradiated measuring path) the following two parameters:

- The absorption coefficient μ of the material measured
- The reference pulse rate I_0[6].

It calculates these parameters automatically from the following calibration points:

- Background calibration (calibration with the radiation switched off)
- Up to nine calibration points for samples of various known densities.

Note!
With self-radiating media it is always necessary to perform the background calibration with a filled pipe. A simulated calibration with an empty pipe is not possible in this case.



*Calibration points for density and concentration measurements; **0**: background calibration; **1 to 9**: calibration points for various densities*

One-point calibration

For many applications a one-point calibration is sufficient. That means, that apart from the background calibration only one further calibration point is used. This calibration point should be located as near as possible to the operating point. Densities in the proximity of this operating point are measured fairly precisely, whereas the precision may decrease with increasing distance to the operating point.
In one-point calibration, the Gammapilot M only calculates the reference pulse rate I_0. For the absorption coefficient it uses the standard value $\mu = 7.7\ mm^2/g$ in this instance.

Multiple-point calibration

If high accuracy is required over the complete measuring range, two (or more - up to nine) calibration points should be applied. The calibration points should be located as far from each other as possible and should be uniformly distributed over the measuring range. After the calibration points have been entered, the Gammapilot M automatically calculates the parameters I_0 and μ.

6) I_0 is the pulse rate for the tube being empty. The value is significantly higher than any real pulse rate occurring during the measurement.

Multiple-point calibration is especially advisable for measurement in a wide range of densities or for especially precise measurements.

Recalibration

The Gammapilot M provides a further calibration point ("10") for recalibration. This point can be entered, if the measuring conditions have changed, e.g. by deposit in the measuring tube.
After entering of the recalibration point, I_0 is recalculated according to the current measuring conditions. The absorption coefficient μ is kept unchanged from the original calibration.

Methods for entering the calibration points

Automatic calibration

For an automatic calibration, the desired calibration point is realized at the measuring tube, i.e. the measuring tube is filled with a medium of the desired density. For the background calibration the radiation remains switched off, for the other calibration points the radiation is switched on.
The Gammapilot M automatically records the pulse rate. The associated density is determined in the laboratory and entered by the user.

Manual calibration

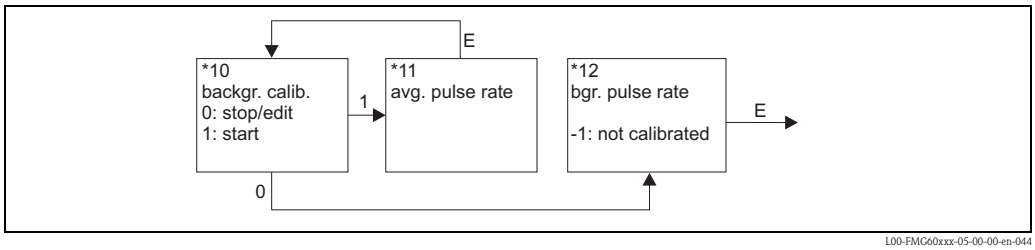
In order to achieve a high measuring accuracy, it is advisable to determine the pulse rates for a couple of samples of the same density and to calculate the average density and average pulse rate for these samples. These values can then be entered manually into the Gammapilot M.
If possible, this procedure should be repeated at a further density. The both density values should be as far from each other as possible.

Note!
When calibrating manually, the calibration date is not set automatically. Instead, it must be entered manually into the **"calibration date" (*C7)** function.

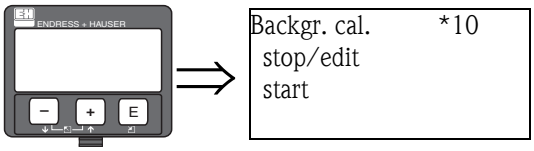
6.5.2 Background calibration

Excerpt from the operating menu

The following excerpt from the operating menu shows how the background calibration is entered. The individual functions are explained in the sections below.



"Background calibration" (*10)



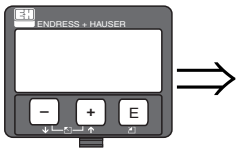
This function is used to start the background calibration

Options:

- **stop/edit** This option must be selected if
  - no background calibration is to be performed but the pulse rate of an existing background calibration is to be displayed instead.
  - a manual background calibration is to be performed.

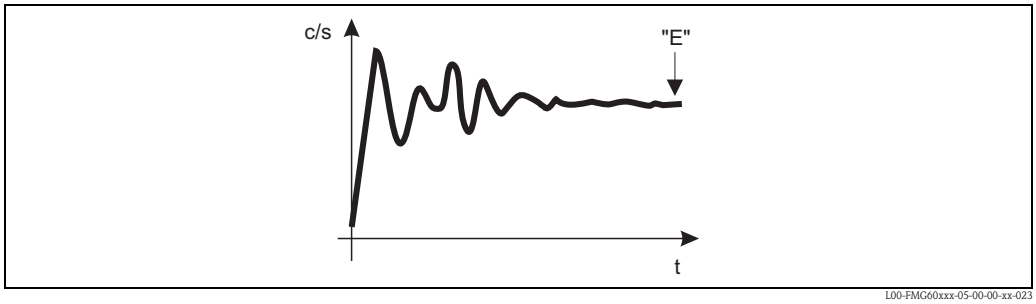
  After selecting this option, the Gammapilot M changes to the **"bgr. pulse rate" (*12)** function, where the existing pulse rate is displayed and can be changed if required.
- **start**
  This option is used to start an automatic background calibration. The Gammapilot M changes to the **"avg. pulse rate" (*11)** function.

"Avg. pulse rate" (*11)



avg. pulse rate *11
186 cps

The average pulse rate is displayed in this function (after selection of "start" in the previous function). Initially, this value fluctuates (because of the decay statistics), but due to the integration it reaches an average value in the course of time. The longer the averaging is performed the lower are the remaining fluctuations.



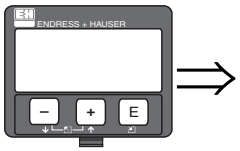
Initially, the pulse rate strongly fluctuates. In the course of time an average value is reached.

If the value is sufficiently stable, the function can be left by pressing "E".
Thereafter, the Gammapilot M changes to the **"backgr. calib." (*10)** function. Select **"stop/ edit"** to stop the averaging procedure. The value is then automatically transmitted to the **"bgr. pulse rate" (*12)** function.

Note!
The maximum integration time is 1000 s. After this time, the value is automatically transmitted to the **"bgr. pulse rate" (*1B)** function.

Note!
The integration is **not** terminated by pressing "E" in the **"avg. pulse rate" (*11)** function. It is continued until the selection of **"stop/edit"** in the **"backgr. calib." (*10)** function. This may result in a slight deviation between the last displayed average pulse rate and the final **"bgr. pulse rate" (*12)**.

"Background pulse rate" (*12)



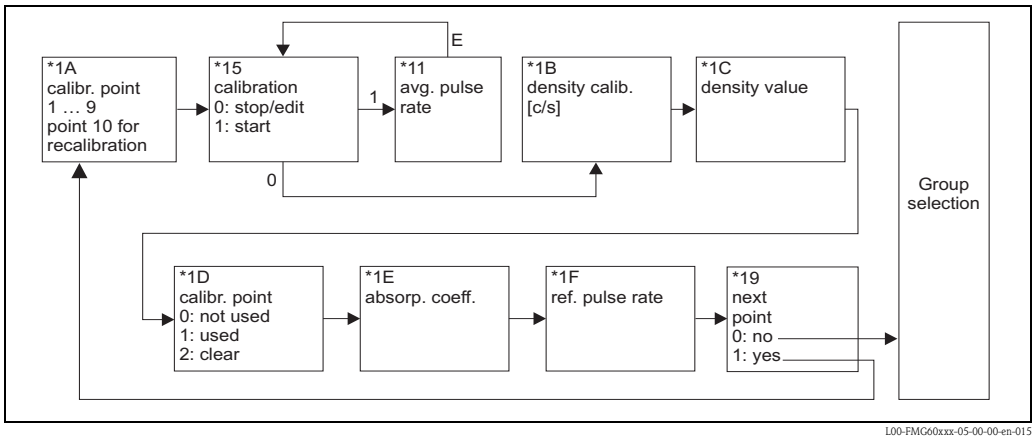
backgr. pul. rate *12
186 cps

The pulse rate of the background calibration is displayed in this function. By pressing "E" the displayed value can be confirmed and the background calibration completed.
"-1" indicates, that no background calibration is present yet. In this case, there are two options:
- either return to the **"background calibration" (*10)** function and restart the background calibration
- or enter a known or calculated pulse rate (manual calibration). Thereafter, the Gammapilot M changes to the **"calibr. point" (*13)**or **(*1A)** function.

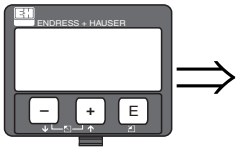
6.5.3 Calibration points

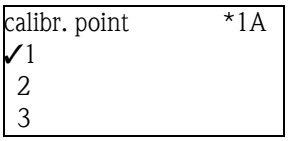
Excerpt from the operating menu

The following excerpt from the operating menu shows, how the density calibration points are entered. The individual functions are explained in the sections below.
The functions are only accessible after the background calibration has been performed.



"Calibration point" (*1A)

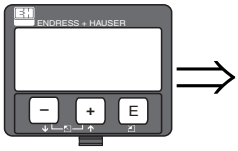


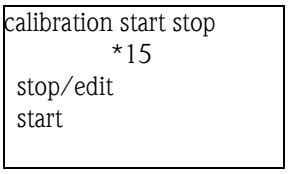


This function is used to select, which calibration point will be entered.

Options:
- "1" to "9" : Calibration points for various densities
- "10": recalibration point
  After entering of the recalibration point, I_0 is recalculated according to the current measuring conditions. The absorption coefficient μ is kept unchanged from the original calibration.
  The calibration point "10" can be entered if the measuring conditions have changed, e.g. due to buildup in the measuring tube.

"Calibration start stop" (*15)



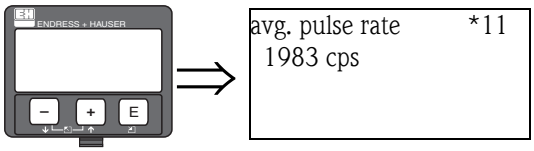


This function is used to start the automatic entering of the selected calibration point.

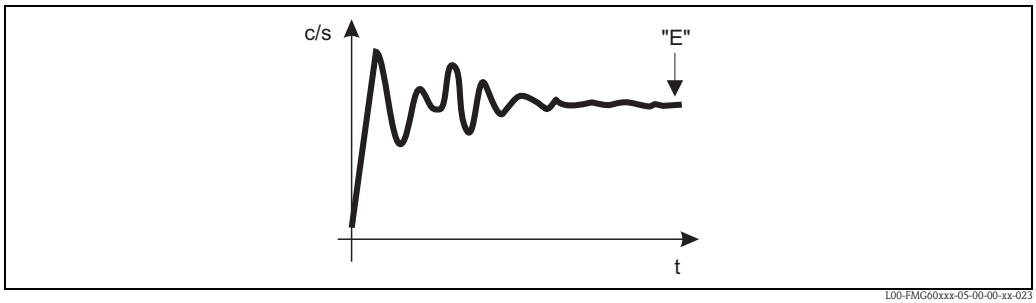
Options:
- **stop/edit** This option must be selected if
  – the calibration point is not to be entered (e.g. because it has already been entered). The pulse rate of the calibration point is then displayed in the following function **"density calib." (*1B)**. If required, this value can be changed.
  – the calibration point is to be entered manually. For this purpose, the Gammapilot M changes to the **"density calib." (*1B) function**.

- **start**
  This option is used to start the automatic entering of the calibration point. The Gammapilot M then changes to the **"avg. pulse rate" (*11)** function.

"Avg. pulse rate" (*11)



The average pulse rate is displayed in this function (after selection of "start" in the previous function). Initially, this value fluctuates (because of the decay statistics), but in the course of time it reaches an average value. The longer the averaging is performed the lower are the remaining fluctuations.



Initially, the pulse rate strongly fluctuates. In the course of time an average value is reached.

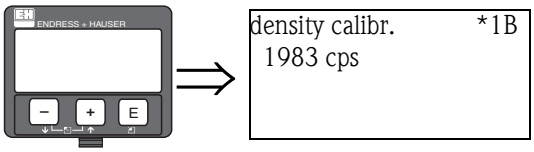
If the value is sufficiently stable, the function can be left by pressing "E".
Thereafter, the Gammapilot M changes to the **"calibration" (*15)** function. Select **"stop/edit"** to stop the averaging procedure. The value is then automatically transmitted to the **"density calibr." (*1B)** function.

Note!
The maximum integration time is 1000 s. After this time, the value is automatically transmitted to the **"density calibration" (*1B)** function.

Note!
During the integration a sample of the measured material must be taken. Its density must be determined in the laboratory.

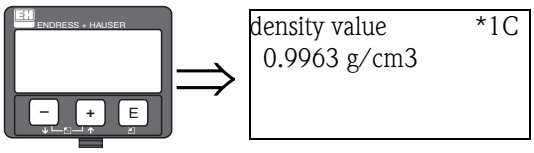
Note!
The integration is **not** terminated by pressing "E" in the **"avg. pulse rate" (*11)** function. It is continued until the selection of **"stop/edit"** in the **"calibration" (*15)** function. This may result in a slight deviation between the last displayed average pulse rate and the final **"density calibration" (*1B)**.

"Density calibration" (*1B)



The pulse rate of the respective calibration point is displayed in this function. The displayed value must be confirmed by pressing "E".
"-1" indicates, that no pulse rate is present yet. In this case, there are two options:
- either return to the "calibration" (*15) function and restart the calibration
- or enter a known or calculated pulse rate (manual calibration).

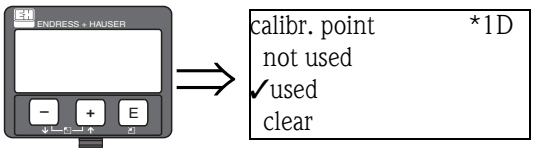
"Density value" (*1C)



This function is used to enter the density of the calibration point. The value must be determined from the sample in a laboratory measurement.

Note!
When entering the value, temperature influences have to be taken into account. The density entered must refer to the temperature at which the pulse rate has been determined. If the density and the pulse rate have been determined at different temperatures, the density value must be corrected accordingly.

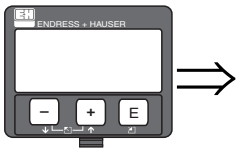
"Calibration point" (*1D)



This function is used to specify, if the current calibration point is to be used

Options:
- **not used**
  The calibration point is **not** used. However, it can be reactivated at a later point in time.
- **used**
  The calibration point is used.
- **clear**
  The calibration point is deleted. It cannot be reactivated at a later point in time.

"Absorption coefficient" (*1E)

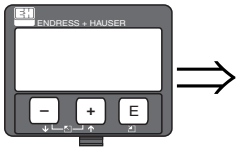


absorp. coeff. *1E
7.70 mm2/g

This function displays the absorption coefficient which results from the currently active calibration points. The displayed value should be used for plausibility checking.

Note!
If only one calibration point is currently active, the absorption coefficient is not calculated. The last valid value is used instead. At the first commissioning or after a reset, the default value, $\mu = 7.70\ mm^2/g$, is used. The value can be changed by the user.

"Reference pulse rate" (*1F)

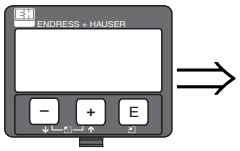


ref. pulse rate *1F
31687 cps

This function displays the reference pulse rate I_0, which results from the currently active calibration points. The value cannot be edited.

Note!
I_0 is the pulse rate for the tube being empty (theoretical reference value). Generally, the value is significantly higher than any real pulse rate occurring during the measurement.

"Next point" (*19)



next point *19
✓no
yes

This function is used to specify, if a further calibration point is to be entered or not.

Options:

- **no**
  This option must be selected if no further calibration point is to be entered or changed. After this selection the Gammapilot M returns to the group selection and the calibration is completed.
- **yes**
  This option must be selected if a further calibration point is to be entered or changed. The Gammapilot M returns to the **"calibr. point" (*1A)** function and the next point can be entered or changed.

6.5.4 Linearization (for concentration measurements)

If the concentration is to be measured in a unit other than the **"density unit" (*06)**, a linearization must be performed after the calibration. This can be done in the **"Linearization" (*4)** function group. The functions of this group and the linearization procedure are described in Operating Instructions BA 287F, "Gammapilot M – Description of Device Functions". This document can be found on the CD-ROM supplied for the "ToF Tool – FieldTool Package".

6.5.5 Additional settings

After the calibration, the Gammapilot M outputs the measured value via the PROFIBUS PA interface.
Many additional functions are available for optimizing the measuring point. They can be configured as required. A detailed description of all instrument functions is given in Operating Instructions BA287F, "Gammapilot M – Description of Device Functions". This document can be found on the CD-ROM supplied for the "ToF Tool – FieldTool Package/FieldCare".

6.6 Density measurement/temperature-compensated

Perform density measurement as described in the section "Calibration for density and concentration measurements" and then perform temperature calibration (see "Temperature compensation" section in function description "BA287F/00".

6.7 Gammagraphy detection

See "Gammagraphy" section in function description "BA287F/00".

7 Maintenance and repairs

7.1 Exterior cleaning

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

7.2 Repair

The Endress+Hauser repair concept assumes that repairs to the Gammapilot M are performed by the Endress+Hauser Service in Endress+Hauser workshops.
For more information contact the Service Department at Endress+Hauser.

7.3 Repairs to Ex-approved devices

When carrying out repairs to Ex-approved devices, please note the following:
- Repairs to Ex-approved devices may only be carried out by Endress+Hauser Service in Endress+Hauser workshops.
- Comply with the prevailing standards, national Ex-area regulations, safety instructions (XA) and certificates.
- Only use original spare parts from Endress+Hauser.
- A certified device may only be converted into a different certified device version by Endress+Hauser Service in Endress+Hauser workshops.
- Document all repair work and conversions.

7.4 Replacement

Caution!
An uploading/download procedure is not permitted for safety-related use of the device.

After a complete device or electronic module has been replaced, the parameters can be downloaded into the device again via the communication interface. As a prerequisite, the data have to have been uploaded to the PC beforehand using the "ToF Tool - FieldTool Package/FieldCare".

Level measurement and level limit detection
Measurement can continue without having to carry out a new setup. However, the calibration values should be checked as soon as possible, since the mounting position may have slightly changed.

Density and concentration measurement
After the replacement a new setup and calibration must be performed.

7.5 Return

The following procedures must be carried out before a transmitter is sent to Endress+Hauser e.g. for repair or calibration:

- Remove all residue which may be present. Pay special attention to the gasket grooves and crevices where fluid may be present. This is especially important if the fluid is dangerous to health, e.g. corrosive, poisonous, carcinogenic, radioactive, etc.
- Always enclose a duly completed "Declaration of contamination" form (a copy of the “Declaration of contamination” is included at the end of these Operating Instructions). Only then can Endress +Hauser transport, examine and repair a returned device.
- Enclose special handling instructions if necessary, for example a safety data sheet as per EN 91/155/EEC.

Additionally specify:

- The chemical and physical characteristics of the product.
- An exact description of the application.
- A short description of the error that occurred (specify error code if possible)
- Operating time of the device.

7.6 Disposal

When disposing, separate and recycle the device components based on the materials.

7.7 Contact addresses of Endress+Hauser

Contact addresses can be found on our homepage: www.endress.com/worldwide. If you have any questions, please contact your Endress+Hauser subsidiary.

8 Accessories

8.1 Commubox FXA291

The Commubox FXA291 connects Endress+Hauser field devices with a CDI interface (= Endress+Hauser Common Data Interface) and the USB port of a computer or laptop. For details, see TI405C/07/en.

Note!
For Gammapilot M, you also need the "ToF adapter FXA291" accessory.

8.2 ToF adapter FXA291

The ToF adapter FXA291 connects the Commubox FXA291 with the Gammapilot M by means of the USB port of a computer or laptop.
For details, see KA271F/00/a2.

8.3 Proficard

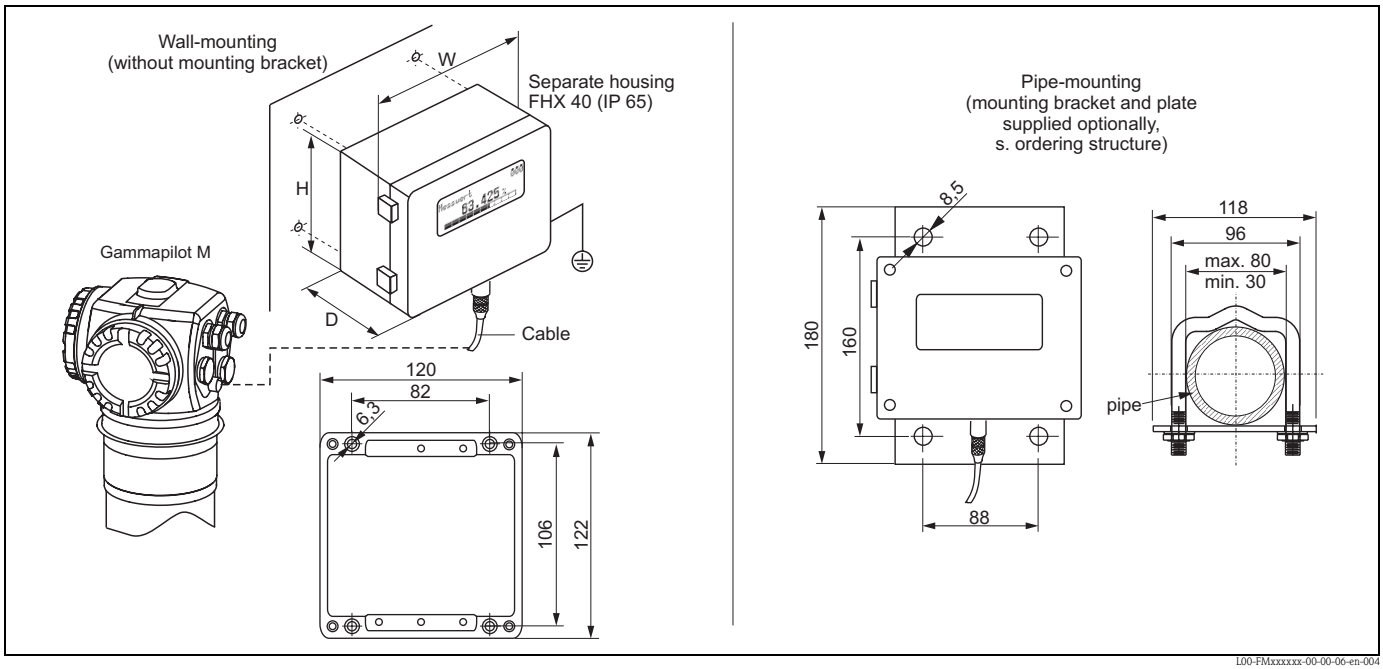
For the connection of a Laptop to PROFIBUS.

8.4 Profiboard

For the connection of a Personal Computer to PROFIBUS.

8.5 Remote display FHX40

8.5.1 Dimensions



8.5.2 Technical data and ordering information

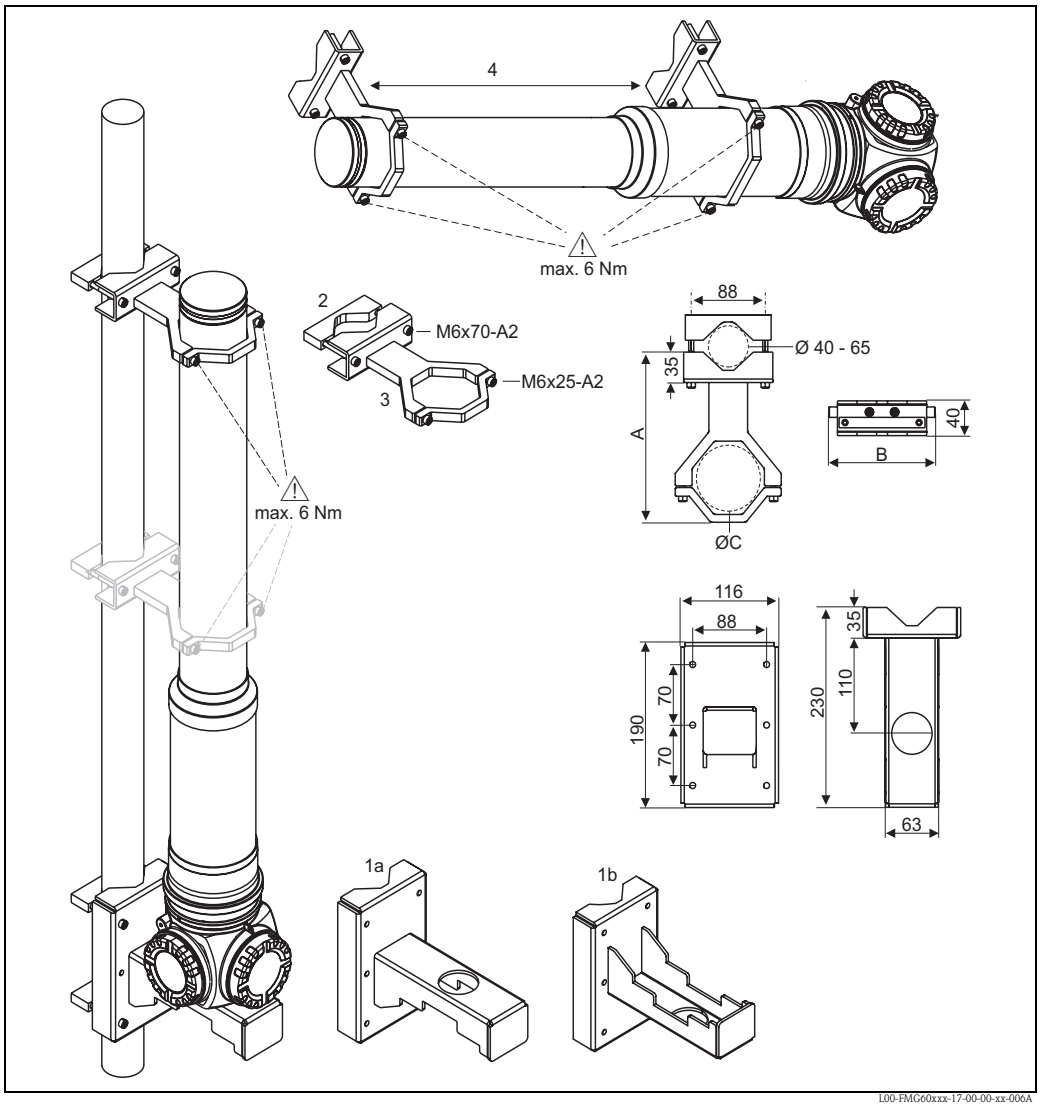
Max. cable length	20 m
Temperature range	-30 °C to +70 °C (-22 °F to 158 °F)
Degree of protection	IP65 acc. to EN 60529
Materials	Housing: AlSi12; cable gland: brass, nickel-plated
Dimensions [mm] / [inch]	122x150x80 (HxWxD) / 4.8x5.9x3.2

	Approval:				
	A				Non-hazardous area
	C				NEPSI Ex ia IIC T6/T5
	G				IECEx Zone1 Ex ia IIC T6/T5
	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
	K				TIIS ia IIC T6
		Cable:			
		1			20m; for HART
		5			20m; for PROFIBUS PA/FOUNDATION Fieldbus
			Additional option:		
			A		Basic version
			B		Mounting bracket, pipe 1"/ 2"
FHX40 -					Complete product designation

Use the cables provided for the corresponding communication version of the device to connect the remote display FHX40.

8.6 Mounting device FHG60 (for level measurement and level limit measurement)

8.6.1 Dimensions



1a: with preferred mounting method "housing head up" - bracket (for "level" application only [7]); 1b: with alternative mounting method "housing head down" - bracket (for "level" application only[1]); 2: Mounting clamps (number depending on selected application); 3: Retainers (number and size depending on selected application[7]; Allen screws to ISO4762 are supplied); 4: Spacing as large as possible

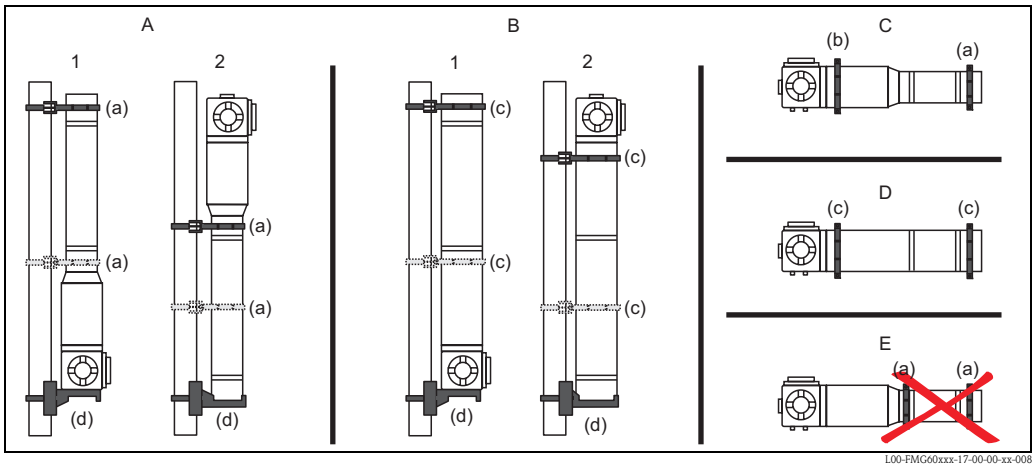
Size of the retainers (depending on the selected application):

Mounting position at the FMG60	Length A [mm]	Width B [mm]	ØC [mm]	Arrangement (see Fig. overleaf)
Scintillator pipe dimensions	196	126	80	(a)
Electronic pipe dimensions	210	150	102	(b)
Water cooling jacket dimensions	230	200	140	(c)

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

7) See "Use" and "Ordering information for complete mounting set".

8.6.2 Application hints



Mounting position: ① ***preferred;*** ② ***alternative***

A: Level measurement, FMG60 without water jacket; ***B:*** *Level measurement, FMG60 with water jacket;*
C: *Level limit measurement, FMG60 without water jacket;* ***D:*** *Level limit measurement, FMG60 with water jacket;*
E: *Such horizontal mounting not permitted*
(a): *Retainer for pipe ∅ 80 mm;* ***(b):*** *Retainer for pipe ∅ 102 mm;* ***(c):*** *Retainer for water cooling jacket, ∅140 mm;* ***(d):*** *Bracket*

Caution!
- The mounting device must be fitted in a way such that it can withstand the weight of the Gammapilot M under all operating conditions to be expected.
- For a measuring length of 1600 mm or more, two retainers (vertical) or three retainers (horizontal) must be used.
- For vertical mounting usage of the bracket or a support unit fitted by the customer 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.

8.6.3 Ordering information for complete mounting set FHG60

	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	Level limit, 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

8.7 Clamping device for density measurement FHG61

For details, see
- KA261F/00/a2 (clamping device supplementary set for pipes with diagonal irradiation, 50–20 mm in diameter)
- KA262F/00/a2 (clamping device for pipes with 50–220 mm diameter)
- KA263F/00/a2 (clamping device for pipes with 200–420 mm diameter)

8.8 Measurement section for density measurement FHG62

For drawings and description, see SD540F/00.

9 Troubleshooting

9.1 System error messages

9.1.1 Error signal

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

- Error symbol, error code and error description on the display and operating module
- PROFIBUS PA signal):
  – MAX: +99999

9.1.2 Last error

The last error is displayed in the **"diagnostics" (*A)** function group in the **"previous error" (*A1)** function. The displayed item can be deleted in the **"delete last error" function (*A2)**.

9.1.3 Types of error

Type of error	Symbol	Meaning
Alarm (A)	 continuous	The output signal assumes a defined value: ■ MAX: +99999 An error message is displayed.
Warning (W)	 flashing	The device continues measurement. An error message is displayed (alternating with the measured value).

9.1.4 Error codes

Code	Description	Remedy
A102	checksum error	call Endress+Hauser Service
W103	initializing	wait for completion of the initializing procedure
A106	downloading	wait for completion of the download
A110	checksum error	call Endress+Hauser Service
A111	electronics defect	switch device off/on; if error still is present: call Endress+Hauser service or exchange transmitter
A113	electronics defect	switch device off/on; if error still is present: call Endress+Hauser service or exchange transmitter
A114	electronics defect	switch device off/on; if error still is present: call Endress+Hauser service or exchange transmitter
A116	download error	repeat download
A121	electronics defect	switch device off/on; if error still is present: call Endress+Hauser service or exchange transmitter
W153	initializing	wait for completion of the initializing procedure
A160	checksum error	call Endress+Hauser Service
A165	electronics defect	switch device off/on; if error still is present: call Endress+Hauser service or exchange transmitter
A291	slave error	check basic setup and connection of the slave transmitter
A503	wrong sensor type	call Endress+Hauser Service
W513	calibration integration running	Wait, until a stable pulse rate has been reached; then, terminate integration (by pressing "E" in the **"average pulse rate" (*11)** function)
W514	PT-100 calibration	wait for the calibration to complete. if error still persists: call Endress+Hauser Service
A531	sensor electronics defect	switch device off/on; if error still is present: call Endress+Hauser service or exchange transmitter
A532	sensor voltage error	call Endress+Hauser Service
A533	wrong sensor software version	call Endress+Hauser Service
A535	sensor regulation error	call Endress+Hauser Service
W536	high voltage near limit	call Endress+Hauser Service
A538	sensor communication error	call Endress+Hauser Service
A602	linearization table not plausible	check monotony of the linearization table; if necessary, adjust table (**"linearization" (*4)** function group)
A612	linearization table not defined	enter or complete linearization table (**"linearization" (*4)** function group) The linearization table must contain the end points 0% = 1000 cps (standardized) and 100% = 0 cps (standardized). When entering via **ToF-Tool**: Select the right type of table (lin. tab. "level" or "concentration")
W621	simulation on	Switch off linearization (**"output" (*6)** function group **"simulation" (*65)** function)
W640	SIL lock device	SIL_locking not completed
W642	I_back calibration running	calibration of the current readback path active

Code	Description	Remedy
A631	background not calibrated	perform background calibration (**"calibration" (*1)** function group)
A632	full/covered not calibrated	perform full/covered calibration (**"calibration" (*1)** function group)
A633	empty/free not calibrated	perform empty/free calibration (**"calibration" (*1)** function group)
A634	density not calibrated	■ Check: Has at least one calibration point been entered and activated? If not: Enter and activate calibration point(s). (**"calibration" (*1)** function group) ■ Check: Is the "reference pulse rate" (*1F) larger than 2^{32}? If yes: re-perform density calibration (**"calibration" (*1)**) function group
A635	present date not defined	enter present date (**"basic setup" (*0)** function group **"today's date" (*01)** function)
A636	calibration date not plausible	check calibration date and enter it again (**"system parameters" (*C)** function group **"calibration date" (*C7)** function)
A637	operating mode not defined	Enter operating mode ("basic setup" (*0) function group **"operating mode" (*04)** function)
A638	measurement mode not defined	enter measurement mode ("basic setup" (*0) function group **"measurement mode" (*05)** function)
A639	temperature compensation not complete	enter at least two "temperature - density" value pairs (**"temperature compensation" (*3)** function group)
W662	high sensor temperature (warning)	install water cooling jacket or thermal shielding
A663	sensor temperature too high (alarm)	install water cooling jacket or thermal shielding
A664	temperature measurement error	check correct functioning and connection of the PT-100 sensor
W681	current out of range (3.8 to 20.5 mA)	check calibration and linearization
A692	gammagraphy detected (alarm)	■ Check, if interference radiation is present or the **"hold time" (*54)** is too short. ■ If no interference radiation is present: decrease gammagraphy sensitivity (**"gammagraphy" (*5)** function group **"sensitivity" (*52)**function)
W693	gammagraphy detected (warning)	wait for end of the gammagraphy measurement
W695	measurement counter overflow	the local dose rate is too high (where applicable, reduce with blind flange).

9.2 Possible calibration errors

Error	Possible cause and remedy
Pulse rate too low at empty vessel	■ Radiation source switched off → Switch on source at the source container ■ Incorrect alignment of radiation beam → realign beam ■ Buildup in the vessel → Clean vessel or → recalibrate (if buildup is stable) ■ Fittings in the vessel have not been considered in the activity calculation → recalculate activity and change source accordingly, if required ■ Pressure in the vessel has not been considered in the activity calculation → recalculate activity and change source accordingly, if required ■ No radiation source in the source container → load source capsule in the container ■ Source too weak → use source with higher activity
Pulse rate to high at empty vessel	■ Activity too high → attenuate radiation, e.g. by mounting a steel plate in front of the source container; or exchange source ■ External radiation source (e.g. by gammagraphy) → shield off if possible; repeat calibration without external radiation source
Pulse rate too high at full vessel	■ External radiation source (e.g. by gammagraphy) → shield off if possible; repeat calibration without external radiation source

9.3 Software history

Date	Software version	Software modifications	Documentation
11.2005	01.01.04	Original software.	BA329F/00/en/11.05 7100008 BA287F/00/en/08.04 52023818
08.2006	01.01.06	Bug fix. Corrections for high and low pulse rate.	
10.2007	01.02.02	Function "beam type (*02) added	BA329F/00/en/01.08 71041172 BA287F/00/en/06.07 71041170
02.2009	01.03.02	Automatic restart after error A165 caused by empty pipe at denmsit measurements (pulse rate > 160000 c/s) New filtering function for Gamma Modulator FHG65 implemented	BA329F/00/en/03.09 71091969 BA287F/00/en/06.07 71041170

10 Technical data

10.1 Technical data at a glance

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

Pulse rate:
- Max. 45000 c/s per individual unit
- Max. 65000 c/s cascade

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 to 200 °C
- Accuracy: ±1 K

10.1.2 Output

Output signal

- PROFIBUS PA
- Pulses for cascading mode

Output damping

Freely selectable, 1 to 999 s

10.1.3 Characteristic quantities of the PROFIBUS PA interface

Terminal voltage

The following values are the voltages across the terminals directly at the device:

Type	Minimum terminal voltage	Maximum terminal voltage
Standard	9 V	32 V
EEx ia (FISCO model)	9 V	17.5 V
EEx ia (Entity concept)	9 V	24 V

Current consumption

11 mA ± 1 mA

10.1.4 Power supply

Supply voltage

- 90 to 253 V_{AC}; 50/60 Hz
- 18 to 36 V_{DC}; protection again reversed polarity

The detector guarantees safe galvanic isolation up to max. 253 V_{AC} between the power supply circuit and all other detector circuits.

Power consumption	■ AC power supply: approx. 8.5 VA ■ DC power supply: approx. 3.5 W
Overvoltage category	II Power supply and signal output are galvanically isolated from one another.
Protective class	1

10.1.5 Performance characteristics/Stability

Response 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 to +60 °C	± 0.5%, typical long-term stability < 1%/a
NaI crystal	-40 to 60 °C	± 0.5%
	0 to 50 °C	± 0.1%

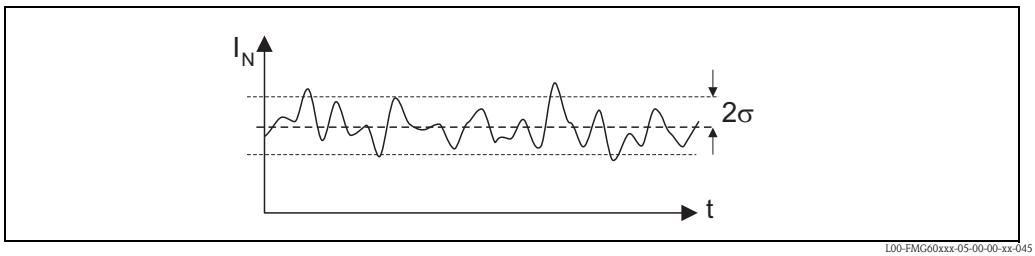
Statistical fluctuation of the radioactive decay

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:

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

where:
- 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 calculate 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).

10.1.6 Environment

Ambient temperature

Device version	Ambient temperature range		Storage temperature
	without water cooling	with water cooling	
PVT Scintillator	-40 °C to +60 °C[1)]	0 °C to +120 °C[2)]	-40 °C to +50 °C
NaI crystal	-40 °C to +60 °C	0 °C to +120 °C[2]	-40 °C to +60 °C

1) If the ambient temperature permanently exceeds +40 °C to 45 °C , water or air cooling is recommended.

2) Max. 75 °C at terminal head

The temperature range may be restricted for applications in hazardous areas. Observe the specifications of the respective approval.
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 to 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 emission to EN 61326, Equipment class B
- Interference immunity to EN 61326, Appendix A (Industrial) and NAMUR recommendation NE 21

10.1.7 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).
Process pressure	No limitations; the influence of pressure must be taken into account when calculating the required activity and calibrating.

10.1.8 Mechanical construction

Dimensions, weight	S. chapter "mounting conditions"
Materials	■ Terminal head: – Aluminum, powder-coated – 316L ■ Detector pipe: 316L ■ Sealing materials: – housing: FKM – cable glands: EPDM; TPE-V

10.1.9 Documentation

Note!
This supplementary documentation can be found on our product pages at www.endress.com.

- Technical Information (TI363F/00/en)
- Operating Instructions "Description of Device Functions" (BA287F/00/en)
- Safety Manual "Functional Safety Manual" (SD230F/00/en)

Clamping device for density measurement FHG61	For details, see ■ KA262F/00/a2 (clamping device for pipes with 50–220 mm diameter) ■ KA261F/00/a2 (clamping device for pipes with 200–420 mm diameter) ■ KA263F/00/a2 (clamping device supplementary set for pipes with diagonal irradiation, 50–220 mm in diameter)
Measurement section for density measurement FHG62	For drawings and description, see SD540F/00.
Certificates and approvals	*Ex approval* The available certificates are listed in the ordering information. Observe the related safety instructions (XA) and Control Drawings (ZD).

Certificates

Allocation of the Safety Information (XA) and Certificates (ZE) to the device:

Allocation to the option, see "Ordering information".						
Device type	Approval	Approval/Degree of protection	Power supply wiring/ Output wiring	Output (Communication)	Approval number	Safety Instructions
FMG60	A	Non-hazardous area	A	1, 2, 3	—	—
	F	Non-hazardous area, WHG	A	1	—	—
	C	NEPSI Ex de [ia] IIC T6	C	1	GYJ05399	XC001F
			C	2, 3		XC002F
			B	1		XC001F
			B	2, 3		XC002F
	D	NEPSI Ex d [ia] IIC T6	D	1		XC001F
			D	2, 3		XC002F
			E	1		XC001F
			E	2, 3		XC002F
	G	IECEx Zone 1 (Zone 0) Ex de (ia) IIC T6	B	1	IECEx BKI 05.0001	XA449F
			B	2, 3		XA450F
			C	1		XA449F
			C	2, 3		XA451F
	H	IECEx Zone 1 (Zone 0) Ex d (ia) IIC T6	E	1		XA449F
			E	2, 3		XA450F
			D	1		XA449F
			D	2, 3		XA451F
	1	ATEX II 2 (1) G EEx de [ia] IIC T6	B	1	KEMA 04 ATEX 1153	XA303F
			B	2, 3		XA332F
			C	1		XA303F
			C	2, 3		XA334F
	2	ATEX II 2 G EEx de [ia] IIC T6, WHG	B	1		XA303F
			C	1		XA303F
	3	ATEX II 2 G EEx d [ia] IIC T6	E	1		XA303F
			E	2, 3		XA332F
			D	1		XA303F
			D	2, 3		XA334F
	4	ATEX II 2 G EEx d [ia] IIC T6, WHG	E	1		XA303F
			D	1		XA303F
	5	ATEX II 2 D	F	1		XA304F
			F	2, 3		XA335F
			L	1		XA304F
			L	2, 3		XA333F
	6	ATEX II 2 GD EEx de [ia] IIC T6	J	1		XA303F+XA304F
			J	2, 3		XA332F+XA333F
			G	1		XA303F+XA304F
			G	2, 3		XA334F+XA335F
	7	ATEX II 2 GD EEx de [ia] IIC T6, WHG	J	1		XA303F+XA304F
			G	1		XA303F+XA304F
	8	ATEX II 2 GD EEx d [ia] IIC T6	K	1		XA303F+XA304F
			K	2, 3		XA332F+XA304F
			H	1		XA303F+XA304F
			H	2, 3		XA334F+XA335F
	M	ATEX II 2 GD EEx d [ia] IIC T6, WHG	K	1		XA303F+XA304F
			H	1		XA303F+XA304F

Allocation of the Control Drawings (ZD) to the device:

Allocation to the option, see "Ordering information".						
Device type	Certificate	Degree of protection	Power supply wiring/ Output wiring	Output (Communication)	Approval number	Safety instructions
FMG60	S	FM Cl. 1 Gp. A-D, Cl. II Gp. E-G, Cl. III, Cl. I Zone 1 Ex d [ia] IIC t6	D	1	ID 3022785	ZD202F
			D	2, 3		ZD203F
			E	1		ZD193F
			E	2, 3		ZD204F
	P	CSA Cl. I Gp. A-D, Cl. II Gp. E-G, Cl. III, Cl. I Zone 1 Ex d [ia] IIC T6	D	1	CSA 1653884	ZD207F
			D	2, 3		ZD205F
			E	1		ZD192F
			E	2, 3		ZD206F
	N	CSA General Purpose	A	1, 2, 3		—
	K	TIIS Ex d [ia] IIC T6	D	1	—	—

Approval for Gost available.

CE mark

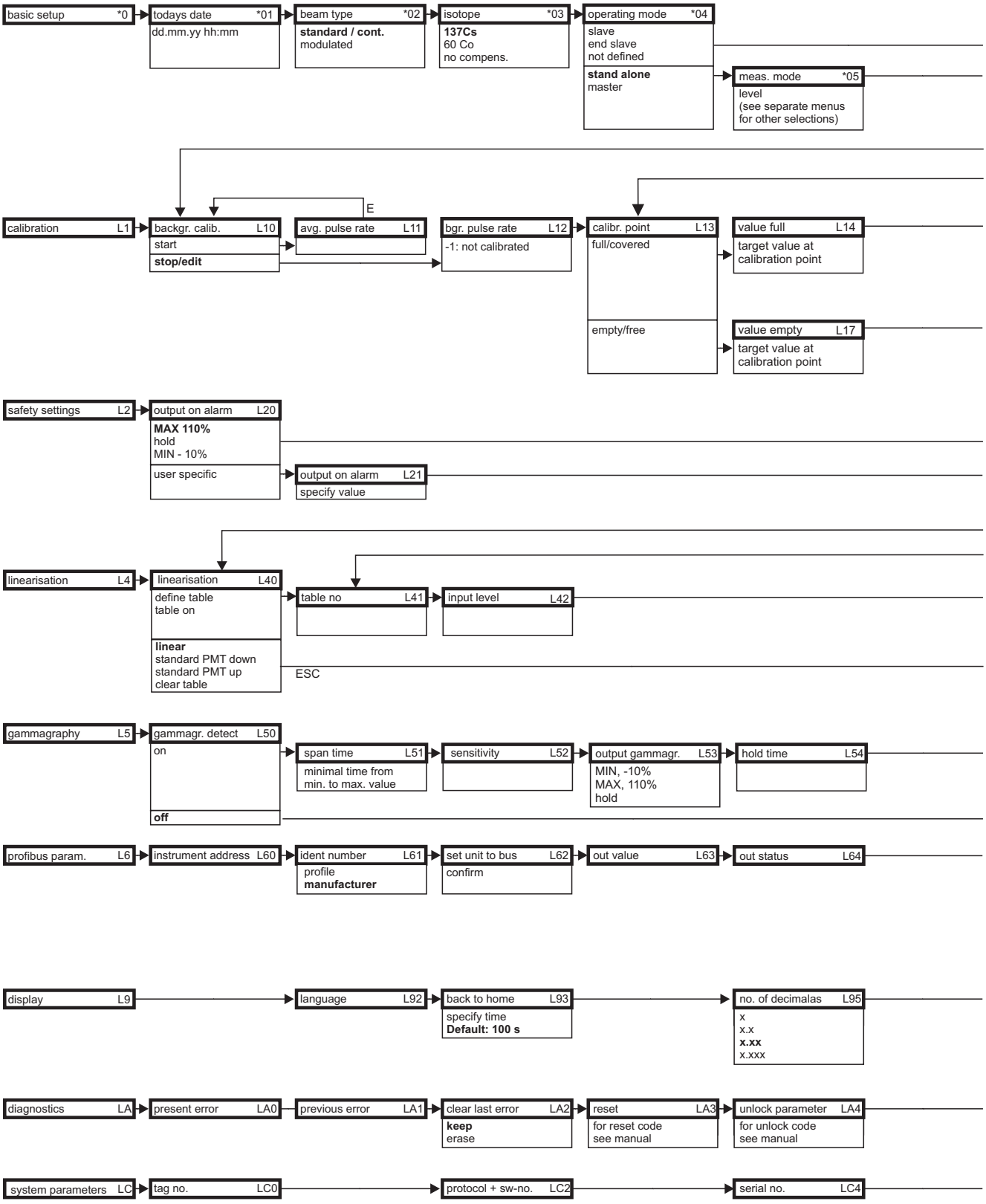
The measuring system meets the legal requirements of the EC-guidelines. Endress+Hauser confirms the device passing the required tests by attaching the CE-mark.

Overfill protection

- WHG for level limit detection

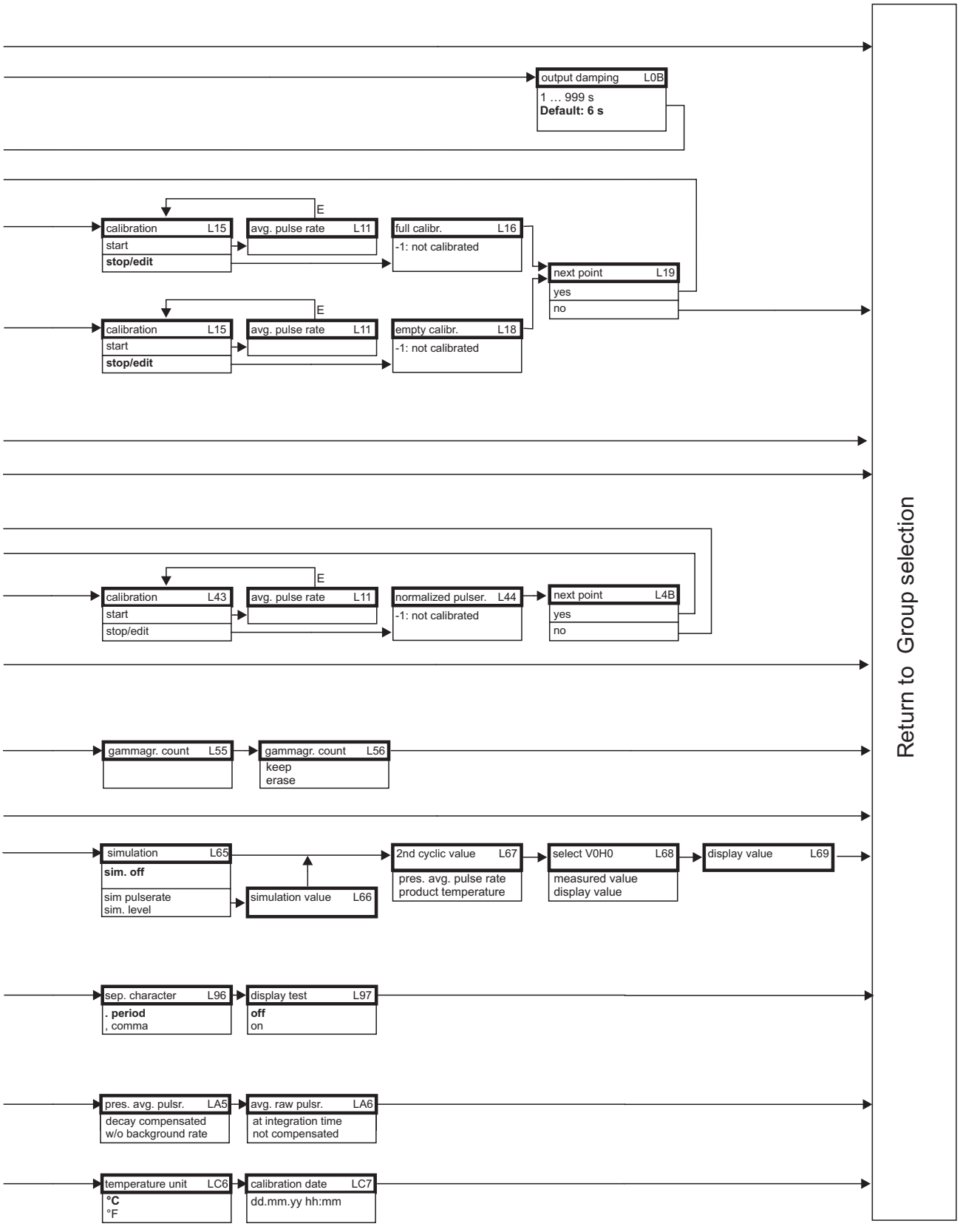
11 Appendix

11.1 Operating menu for level measurements



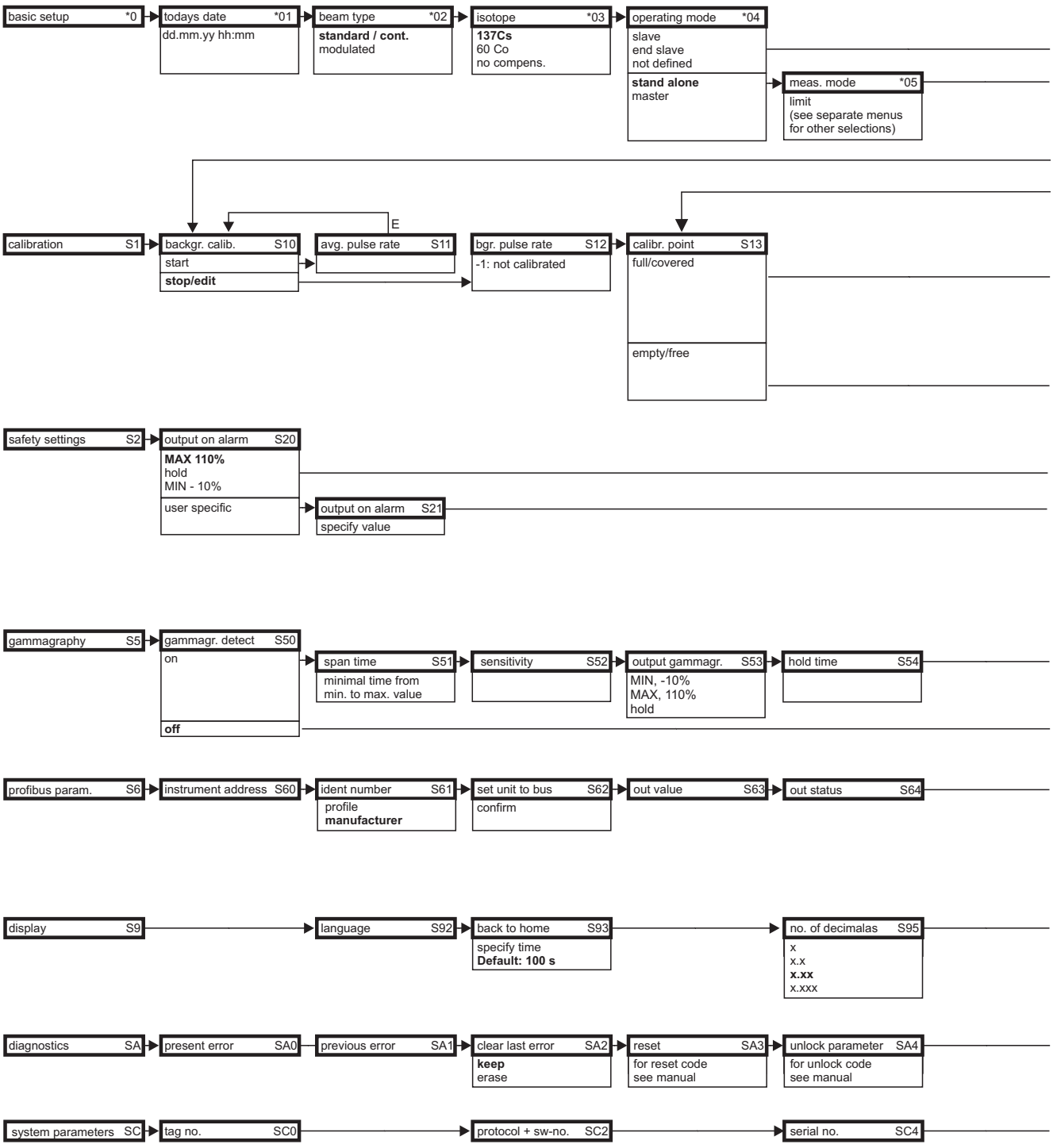
Note! The Default values of the parameters are typed in bold.

L00-FMG60xxx-19-00-01-en-011



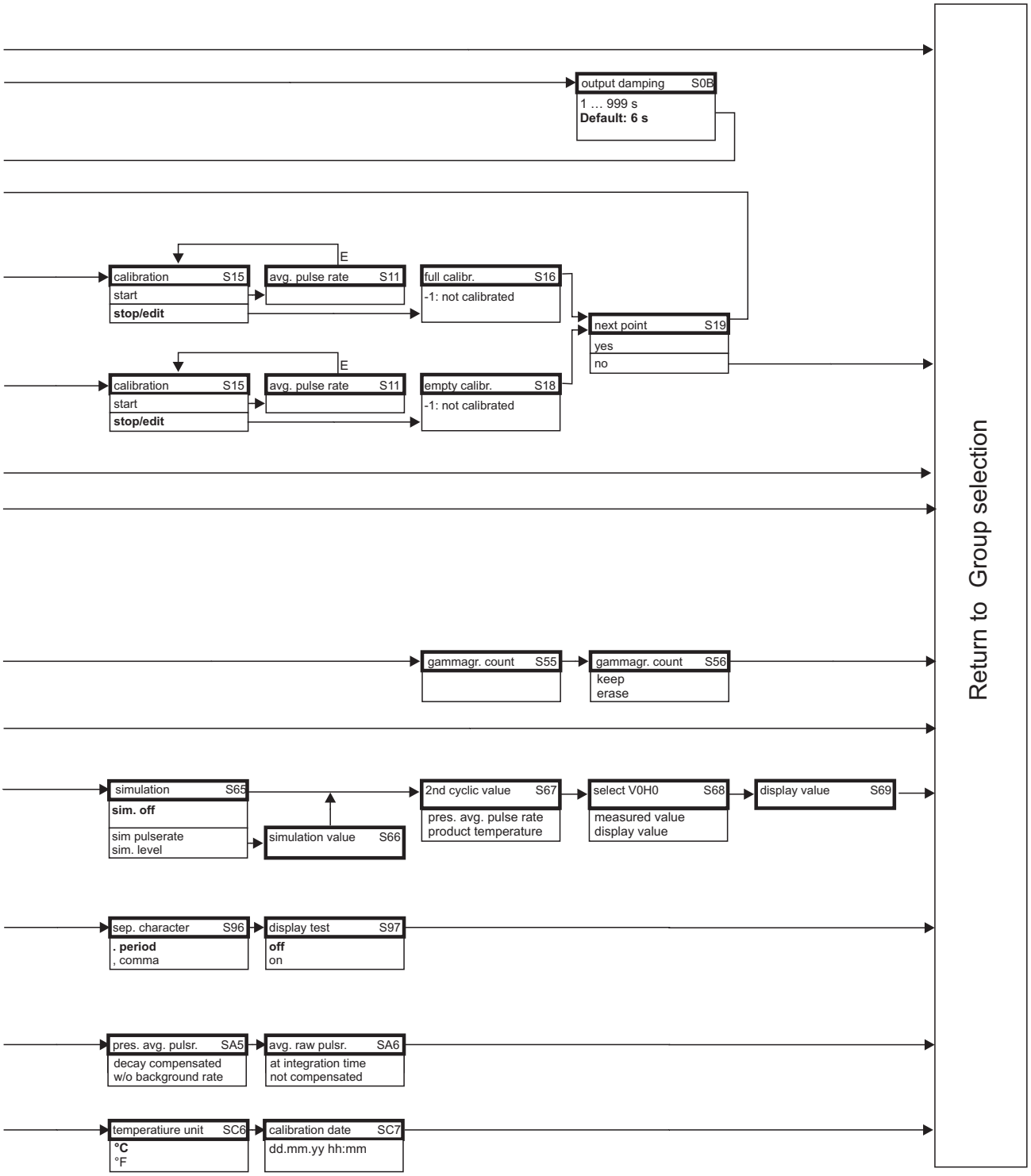
L00-FMG60xxx-19-00-02-en-011

11.2 Operating menu for level limit detection



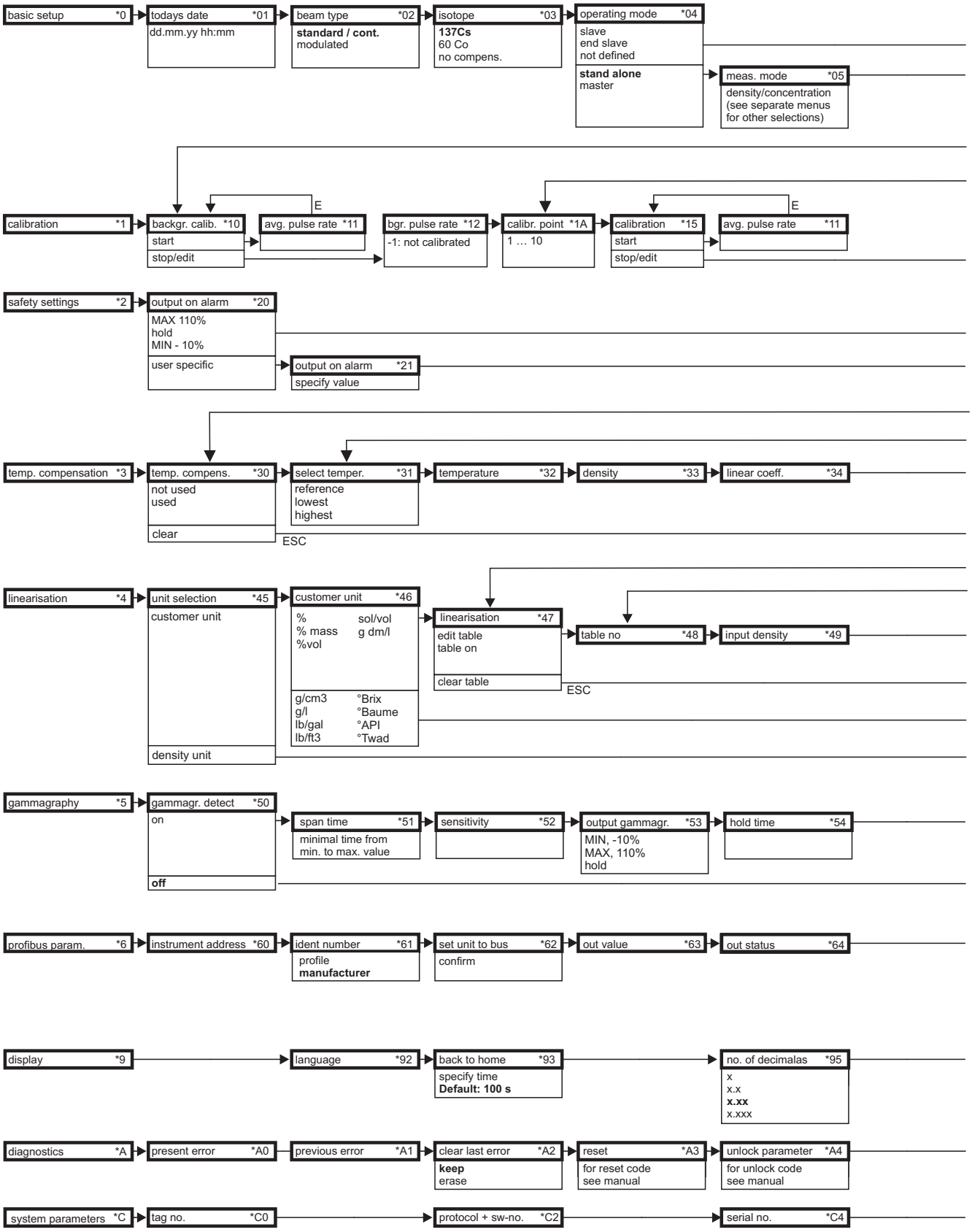
Note! The Default values of the parameters are typed in bold.

L00-FMG60xxx-19-00-01-en-012



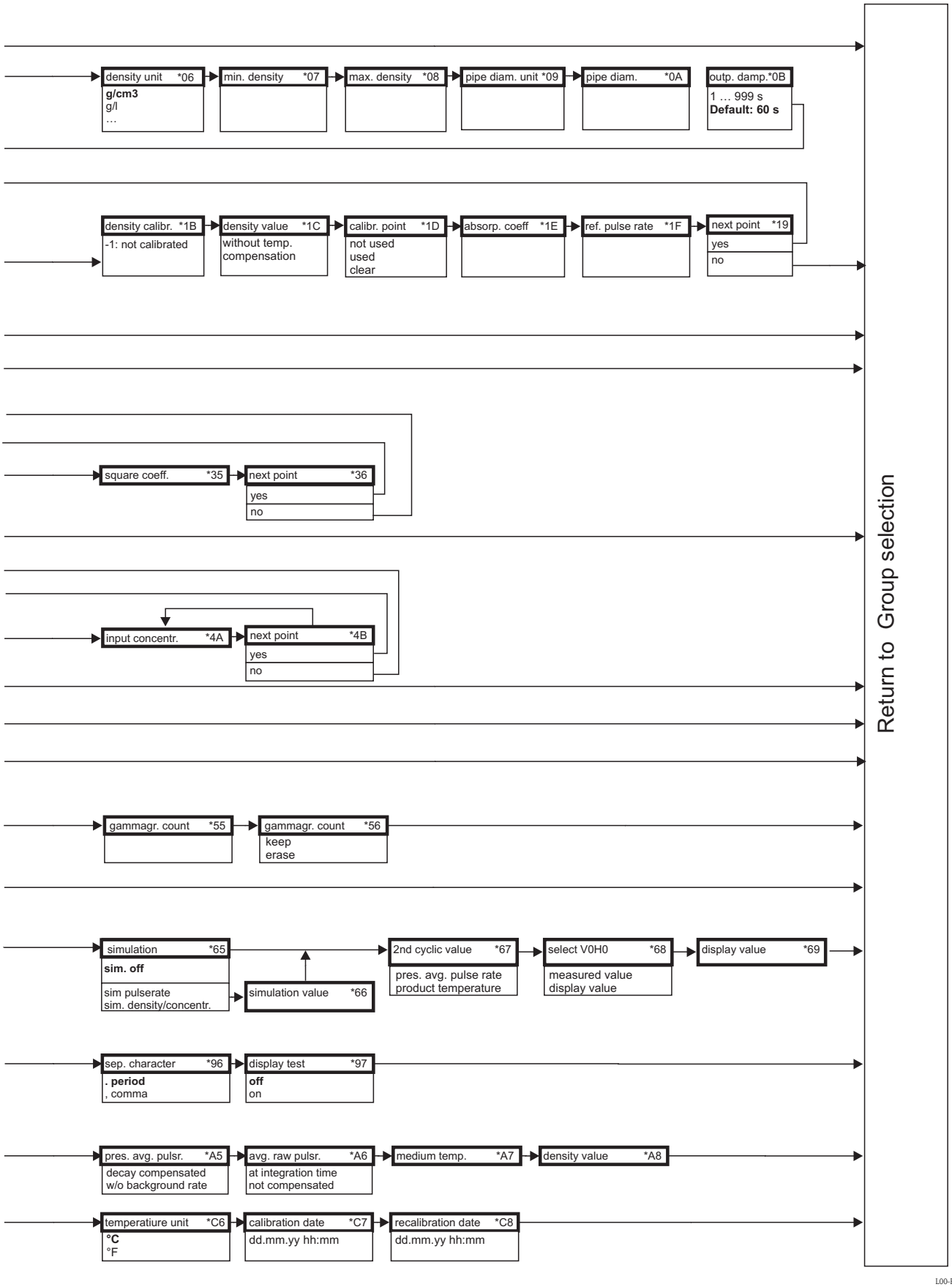
L00-FMG60xxx-19-00-02-en-012

11.3 Operating menu for density and concentration measurements



Note! The Default values of the parameters are typed in bold.

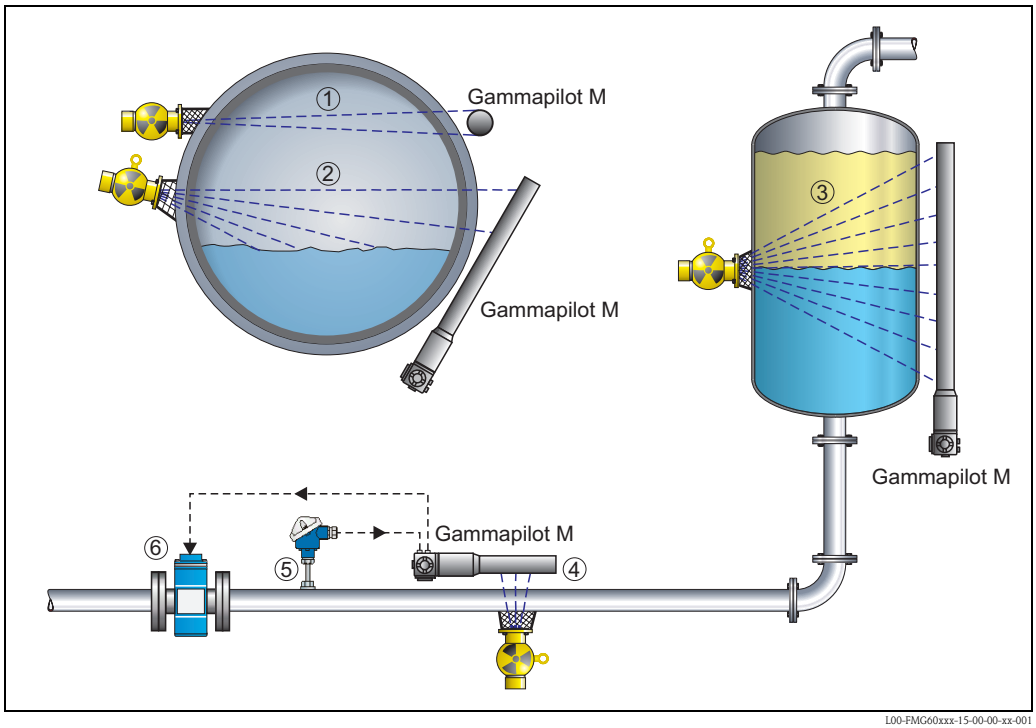
L00-FMG60xxx-19-00-01-en-013



L00-FMG60xxx-19-00-02-en-013

11.4 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:



11.4.1 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.

11.4.2 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. Detectors of different lengths are available to adapt the system to the measuring range. Also, multiple detectors can be interconnected (cascading).

11.4.3 Interface measurement (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).

11.4.4 Density or concentration measurement (4)

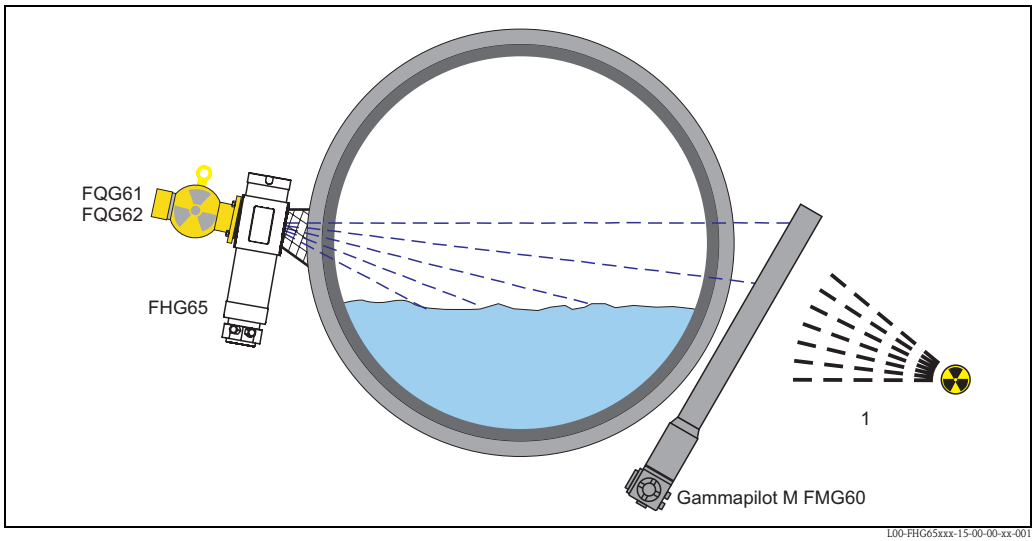
A gamma radiation source and a Gammapilot M are mounted on opposite sides of a measuring tube. The Gammapilot M calculates the density or concentration of the medium from the intensity of the received radiation. The unit can be freely selected.
If an additional temperature sensor (5) is connected, the 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 55S. From these two signals it is possible to calculate the mass flow.

11.4.5 Gamma Modulator FHG65 (option)

In a radiometric measuring point with Gammapilot FMG60, the Gamma Modulator FHG65 is mounted in front of the radiation 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 M FMG60 can thus separate the useful signal from interference radiation. In this way, it is possible to continue measuring even if interference radiation occurs, which, in turn, increases the measuring certainty and system availability.

For details please refer to Technical Information TI423F.



1: *Interference radiation*

Note!
The Gamma Modulator FHG65 and the Gammapilot M FMG60 are not interconnected electrically. When commissioning the Gammapilot FMG60, the **"beam type" (*02)** parameter must be set to "modulated".

Index

Symbols

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Endress+Hauser

People for Process Automation

Declaration of Hazardous Material and De-Contamination

Erklärung zur Kontamination und Reinigung

RA No. ☐☐☐☐☐☐☐☐

Please reference the Return Authorization Number (RA#), obtained from Endress+Hauser, on all paperwork and mark the RA# clearly on the outside of the box. If this procedure is not followed, it may result in the refusal of the package at our facility.

Bitte geben Sie die von E+H mitgeteilte Rücklieferungsnummer (RA#) auf allen Lieferpapieren an und vermerken Sie diese auch außen auf der Verpackung. Nichtbeachtung dieser Anweisung führt zur Ablehnung ihrer Lieferung.

Because of legal regulations and for the safety of our employees and operating equipment, we need the "Declaration of Hazardous Material and De-Contamination", with your signature, before your order can be handled. Please make absolutely sure to attach it to the outside of the packaging.

Aufgrund der gesetzlichen Vorschriften und zum Schutz unserer Mitarbeiter und Betriebseinrichtungen, benötigen wir die unterschriebene "Erklärung zur Kontamination und Reinigung", bevor Ihr Auftrag bearbeitet werden kann. Bringen Sie diese unbedingt außen an der Verpackung an.

Type of instrument / sensor
Geräte-/Sensortyp _____

Serial number
Seriennummer _____

☐ **Used as SIL device in a Safety Instrumented System /** *Einsatz als SIL Gerät in Schutzeinrichtungen*

Process data/ *Prozessdaten*

Temperature / *Temperatur* _____ [°F] _____ [°C]
Pressure / *Druck* _____ [psi] _____ [Pa]
Conductivity / *Leitfähigkeit* _____ [µS/cm]
Viscosity / *Viskosität* _____ [cp] _____ [mm^2/s]

Medium and warnings
Warnhinweise zum Medium

	Medium /concentration *Medium /Konzentration*	Identification CAS No.	 flammable *entzündlich*	 toxic *giftig*	 corrosive *ätzend*	 harmful/ irritant *gesundheits-schädlich/ reizend*	 other * *sonstiges**	 harmless *unbedenklich*
Process medium / *Medium im Prozess*								
Medium for process cleaning / *Medium zur Prozessreinigung*								
Returned part cleaned with / *Medium zur Endreinigung*								

* explosive; oxidising; dangerous for the environment; biological risk; radioactive
* *explosiv; brandfördernd; umweltgefährlich; biogefährlich; radioaktiv*

Please tick should one of the above be applicable, include safety data sheet and, if necessary, special handling instructions.
Zutreffendes ankreuzen; trifft einer der Warnhinweise zu, Sicherheitsdatenblatt und ggf. spezielle Handhabungsvorschriften beilegen.

Description of failure / *Fehlerbeschreibung* _____

_____

_____

Company data / *Angaben zum Absender*

Company / *Firma* _____

_____

Address / *Adresse*

_____

_____

Phone number of contact person / *Telefon-Nr. Ansprechpartner:*

_____

Fax / E-Mail _____

Your order No. / *Ihre Auftragsnr.* _____

"We hereby certify that this declaration is filled out truthfully and completely to the best of our knowledge.We further certify that the returned parts have been carefully cleaned. To the best of our knowledge they are free of any residues in dangerous quantities."

"Wir bestätigen, die vorliegende Erklärung nach unserem besten Wissen wahrheitsgetreu und vollständig ausgefüllt zu haben. Wir bestätigen weiter, dass die zurückgesandten Teile sorgfältig gereinigt wurden und nach unserem besten Wissen frei von Rückständen in gefahrbringender Menge sind."

_____ (place, date / *Ort, Datum*)

_____ Name, dept./ *Abt.* (please print / *bitte Druckschrift*)

_____ Signature / *Unterschrift*

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