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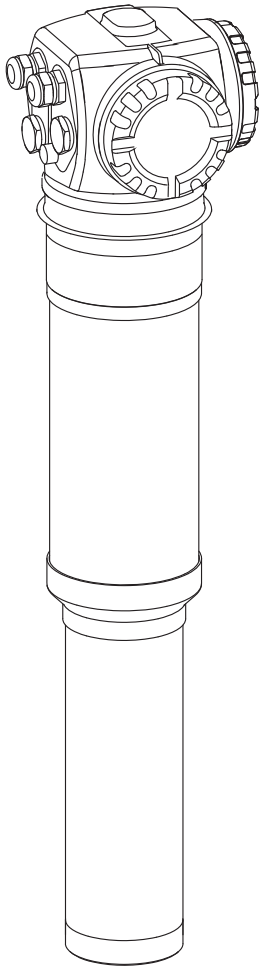
V01.02.00

Description of Device Functions

Gammapilot M FMG60

Radiometric Measurement



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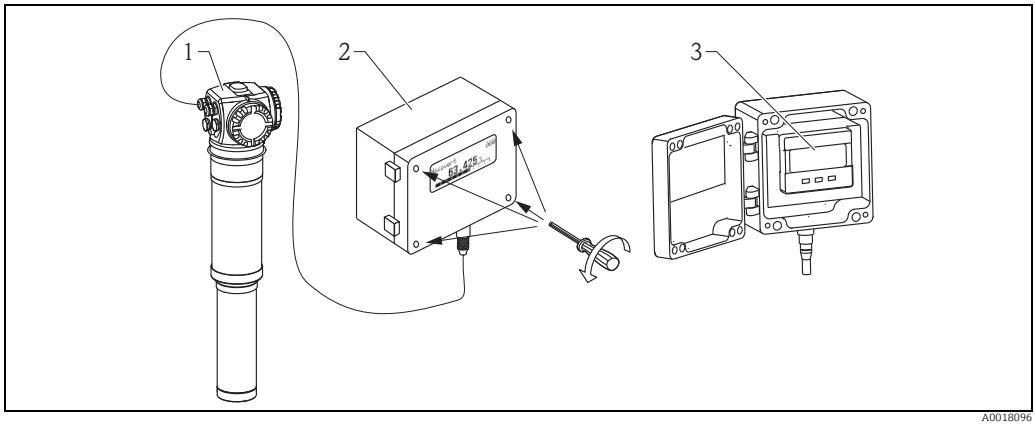
1 Operating concept

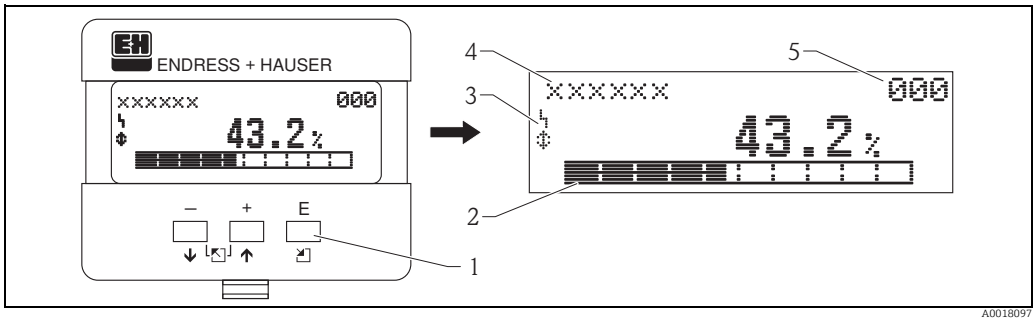
1.1 Display and operating elements

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



1 Gammapilot M
2 FHX40
3 Operating module VU331

1.1.1 Display and operating module VU331



1 Operating keys
2 Bargraph
3 Symbols
4 Function name
5 Parameter Identification number

1.1.2 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 instrument is in an alarm state. If the symbol flashes, this indicates a warning.
	LOCK_SYMBOL This lock symbol appears when the instrument 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.

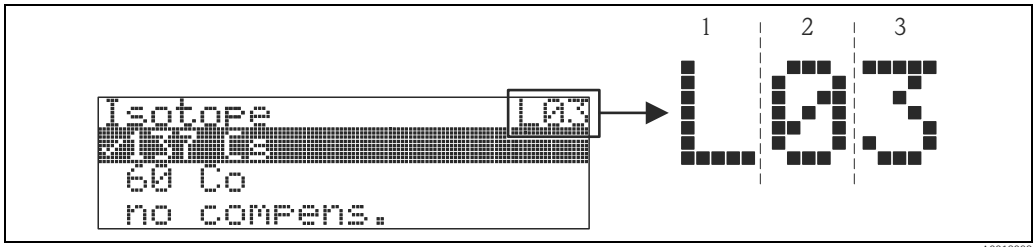
1.1.3 Function of the keys

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 instrument 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.

1.2 The operating menu

1.2.1 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.



1 Measuring mode
2 Function group
3 Function

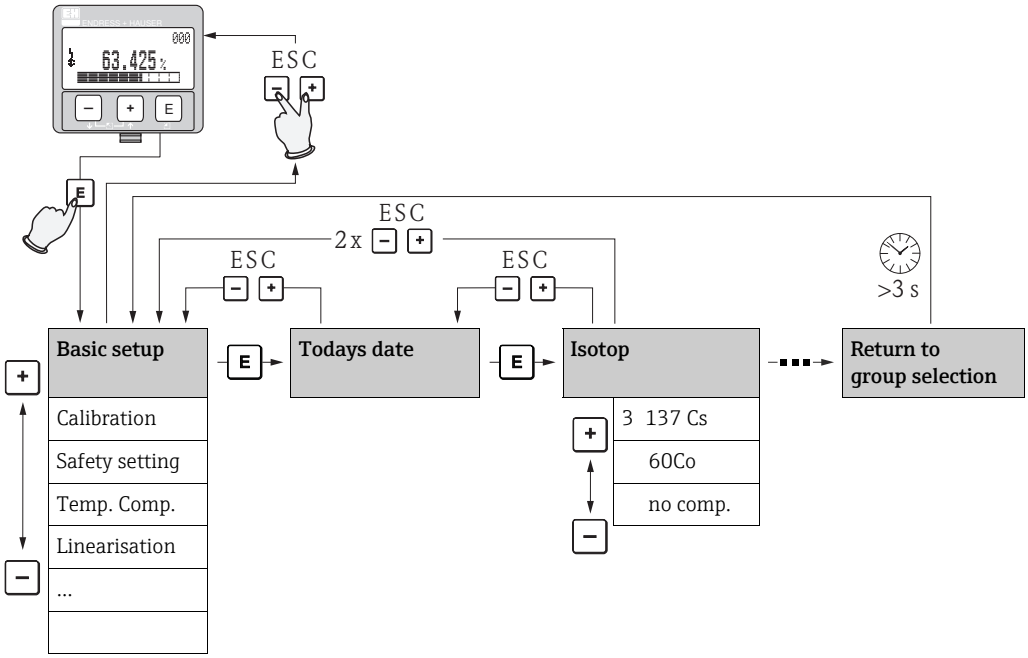
- The alphabetic character specifies the current measuring mode of the Gammapilot M:
  - **L**: level
  - **S**: limit (switch)
  - **D**: density
  - **C**: concentration
  - *****: no measuring mode selected yet

- 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)**.

1.2.2 Operation using the onsite display VU331



Selection and configuration in Operation menu:

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

2 Switching on the device

NOTICE

Error messages A165 "electronics defect" and A635 "present date not defined"

The Gammapilot M contains 2 real-time clocks for the decay compensation, which are permanently compared to each other for safety reasons. In order to bridge voltage interruptions, the clocks are buffered with a capacitor. To ensure that the clocks work correctly and retain the date in the event of a voltage interruption, this capacitor must have a minimum charge. If the A165 "Electronics defect" or A635 "Present date not defined" error message appears **after switching on** the Gammapilot M, then the capacitor may possibly not yet be charged sufficiently. In this case, the Gammapilot M must be operated at the operating voltage for at least 20 to 30 minutes, in order to charge the capacitor. After this, the date must be entered correctly. If the error message still persists subsequent to this, it can be deleted by switching the Gammapilot M off and on.

After switching on the supply voltage, the instrument is first initialized. Due to internal memory tests, this takes approx. 2 minutes.

On-site display	Meaning
FMG60 V01.03.06 HART	Then, the following appear for approximately five seconds: ▪ Device type ▪ Software version ▪ Type of the communication signal
	On first power up you are requested to select the language for the display texts.
Language 092 ✔ Englisch Français Español	Select the language with the + and − keys. Confirm your choice by pressing E twice.
	After that the measured value display appears. Now you can perform the basic setup and the calibration. Press E to switch to the group selection.
Group selection ✔ Basic setup Calibration Safety settings	Press E again to enter the first function of the "basic setup" function group.

3 "Basic setup" (*0) function group

On-site display	
Group selection	*0→
✔ basic setup	
calibrated	
safety settigs	

3.1 "Measured value" (*00)

On-site display	
Measured value	*00
85.00%	

Meaning

The current measured value is displayed in this function.

NOTICE

Display of measured value

- The number of decimals can be selected in the "No. of decimals" (*95) function.
- The decimal separator (point or comma) can be selected in the "Separation character" (*96) function.
- The bar graph in the bottom line gives a graphical representation of the measured value.
- If the Gammapilot M detects an error, the associated error message and the measured value are displayed alternately.

3.2 "Present date" (*01)

On-site display		
Present date		*01
17.11.04	10:30	
dd.mm.yy	hh:mm	

Meaning

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

3.3 "Beam type" (*02)

On-site display	
Beam type	*02
✔ Standard/cont.	
Modulated	

Meaning

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

- Standard/continuous (permanent, continuous radiation)
- Modulated (modulated radiation source)

3.4 "Isotope" (*03)

On-site display	
Isotop	*03
✔ 137 Cs	
60 Co	
no compens.	

Meaning

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

3.5 "Operating mode" (*04)

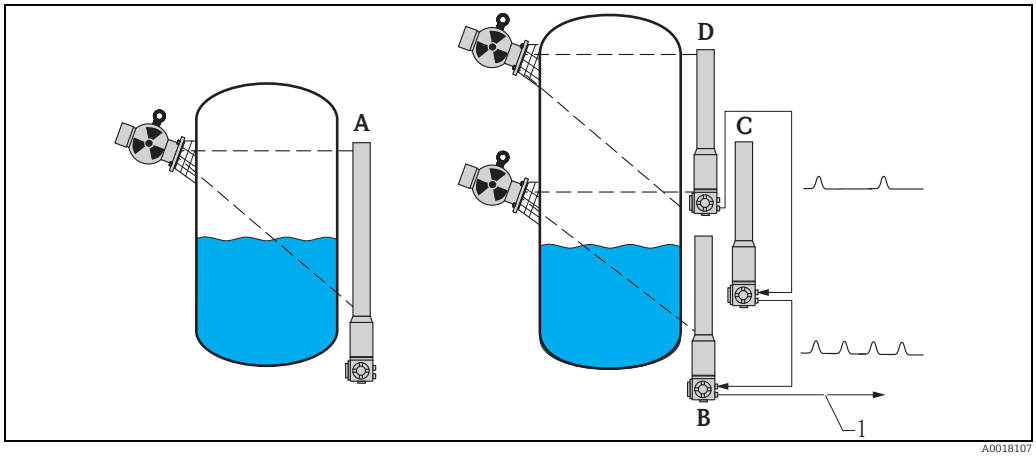
On-site display	
Operating mode	*04
✔ Stand alone	
Master	
Slave	

Meaning

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

NOTICE

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).



A One Gammapilot M is sufficient for measuring ranges up to 2 m (6.6 ft); For larger measuring ranges as many Gammapilot M as required can be connected (cascading mode). By Software settings they are defined as
B Master
C Slave(s) or
D End-Slave
1 4 to 20 mA HART; PROFIBUS PA; FOUNDATION Fieldbus

Options/display:

- **Stand alone**: This option is selected if the Gammapilot M is used as a single instrument.
- **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.

NOTICE

If a "Slave" or an "End-slave" are connected to the "FieldCare", the pulse rate of this device is displayed in the header instead of the measured value.

3.6 "Measuring mode" (*05)

On-site display	
Meas. mode	*05
✔ Level	
Limit	
Density	

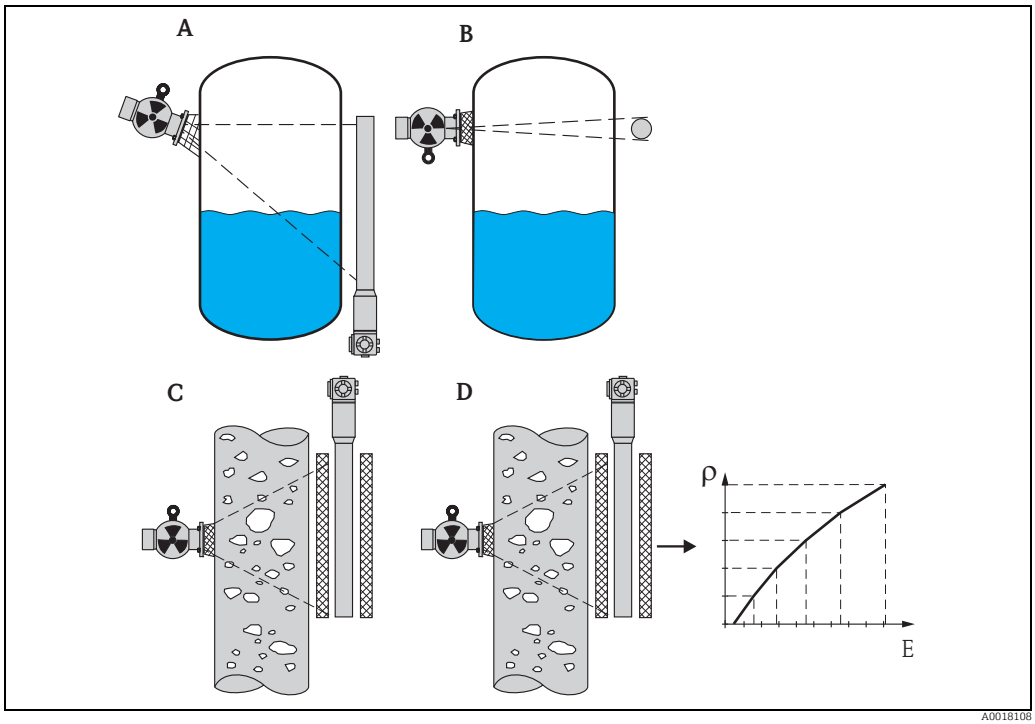
Meaning

This function is used to select the desired measuring mode.

Further options:
- Level measurement (continuous)
- Level limit detection
- Density measurement (with temperature compensation if required)
- Concentration measurement (density measurement followed by linearization)

NOTICE

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).



A Level measurement (continuous)
B Level limit detection
C Density measurement (with temperature compensation if required)
D Concentration measurement (density measurement followed by linearization)
ρ Density
E Concentration

3.7 "Density unit" (*06)

On-site display	
Density unit	*06
✔ g/cm3	
g/l	
lb/gal	

Meaning

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

Further 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.

3.8 "Min. density" (*07)

On-site display	
Min. density	*07
0,9500 g/cm^3	

Meaning

This function is needed for density and concentration measurements only. It is used to specify the lower limit of the density range.
The output current for this density is 4 mA.

3.9 "Max. density" (*08)

On-site display	
Max. density	*08
1,2500 g/cm^3	

Meaning

This function is needed for density and concentration measurements only. It is used to specify the upper limit of the density range.
The output current for this density is 20 mA.

3.10 "Pipe diameter unit" (*09)

On-site display	
Pipe diam. unit	*09
✔ mm	
inch	

Meaning

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

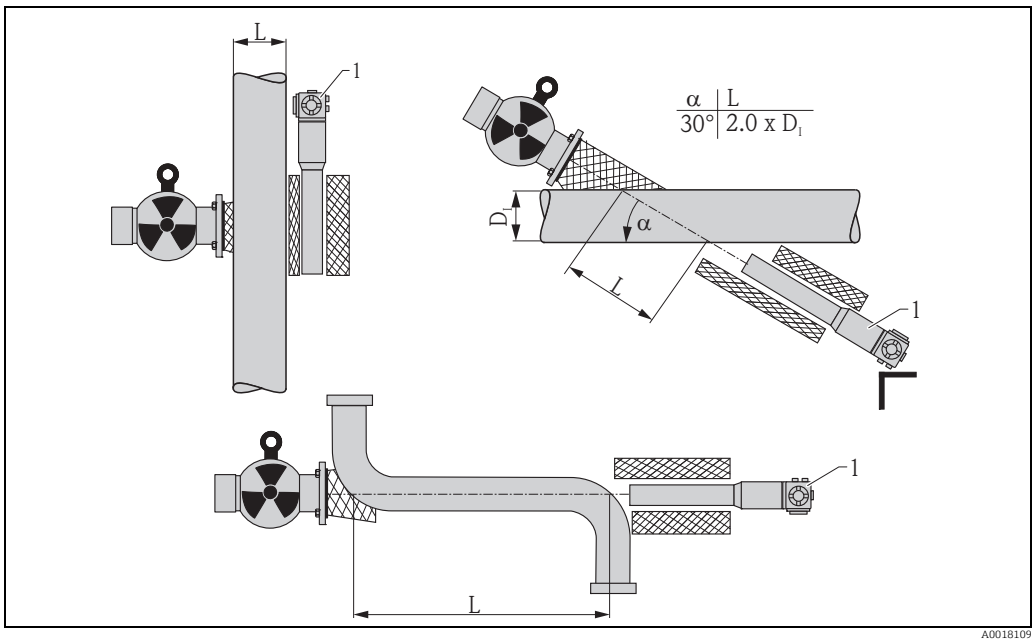
1 inch = 25,4 mm

3.11 "Pipe diameter" (*0A)

On-site display	
Pipe diam.	*0A
200 mm	

Meaning

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 (see figure). The pipe walls are **not** to be considered a part of the measuring path.



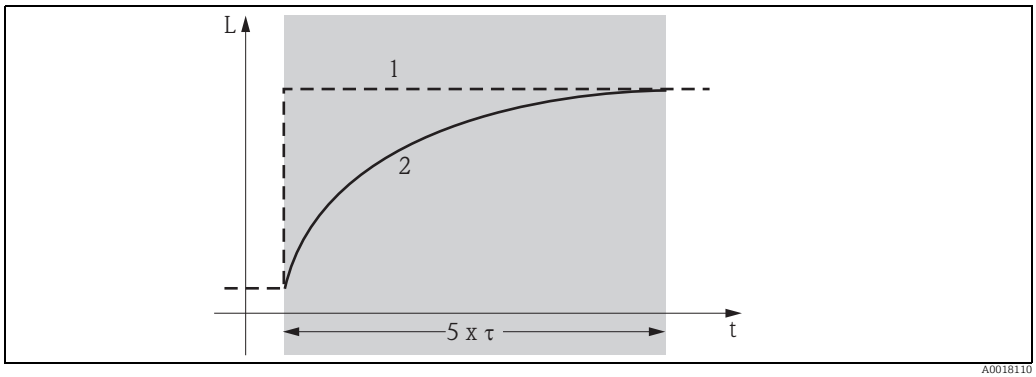
*Always specify the complete irradiated measuring path L in the "pipe diameter" (*0A) function. Depending on the installation, this value may be larger than the actual pipe diameter.*

3.12 "Output damping" (*0B)

On-site display	
Output damping	*0B
60 s	

Meaning

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.



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.

4 "Calibration" (*1) function group

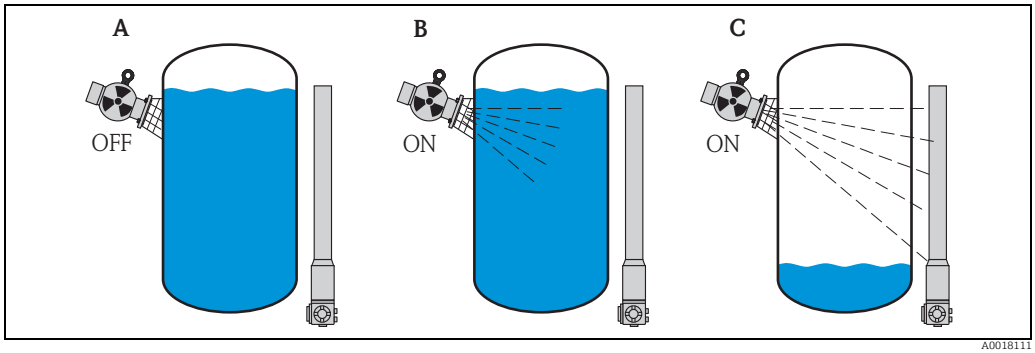
On-site display	
Group selection	*1→
✔ calibration	
safety settings	
Temp. compensation	

In this chapter the "calibration" (*1) function group is split according to the measuring mode:
→ 15, "Calibration for level measurement and limit detection"
→ 24, "Calibration for density and concentration measurements"

Some functions appear in both subchapters, which means that their description is adapted to the respective measuring mode.

4.1 Calibration for level measurement and limit detection

4.1.1 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 performed with the radiation being 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.

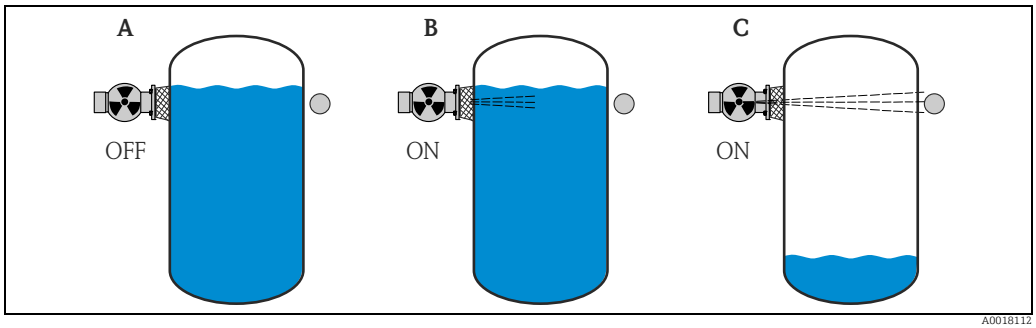
NOTICE

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%).

4.1.2 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 being 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.

NOTICE

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.

4.1.3 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.

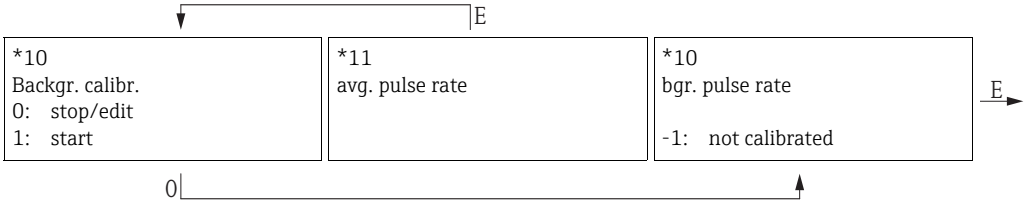
NOTICE

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

4.1.4 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)

On-site display	
Backgr. cal.	*10
stop/edit	
start	

Meaning

This function is used to start the background calibration.

Options:

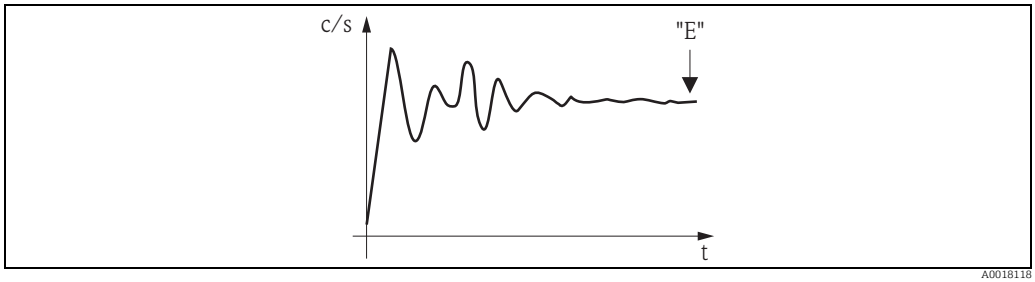
- **stop/edit**
  This option must be selected if
  – No background calibration is to be performed but the pulse rate of an existing background calibration is to be displayed instead.
  – A manual background calibration is to be performed.
  After selecting this option, the Gammapilot M changes to the **"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)

On-site display	
Avg. pulse rate	*11
186 cps	

Meaning

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.



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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.

NOTICE

Bgr. Pulse rate

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

On-site display	
Backgr. pulse rate	*12
186 cps	

Meaning

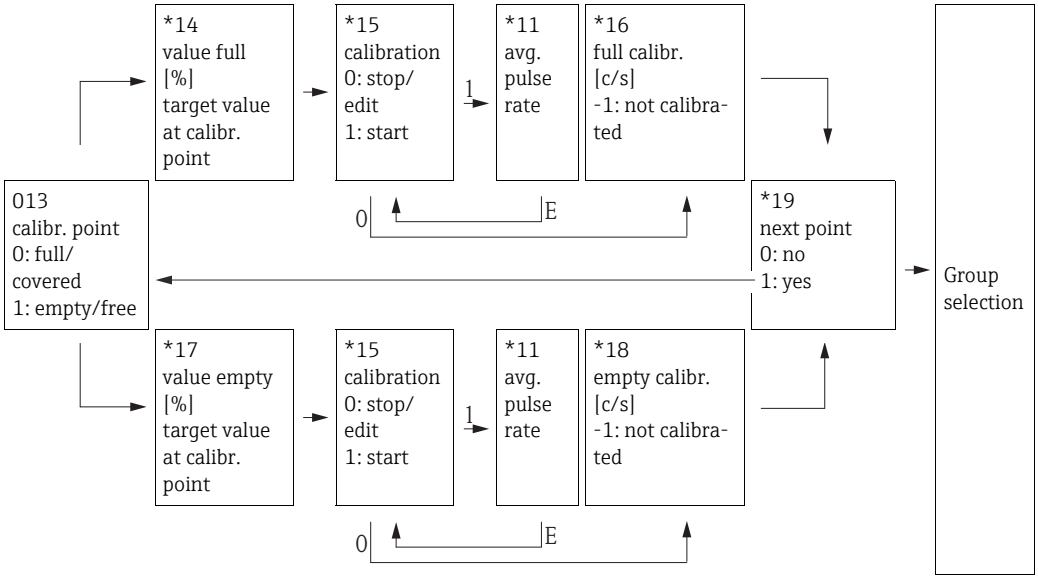
The pulse rate of the background calibration is displayed in this function. By pressing "E" the displayed value can be confirmed and the background calibration completed. **"-1"** indicates, that no background calibration is present yet. In this case there are two options:

- 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.

4.1.5 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.



NOTICE

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)

On-site display	
Calibr. point	*13
✔ full/covered	
empty/free	

Meaning

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

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

On-site display	
value full	*14
100%	

Meaning

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

value empty	*17
0%	

Range of values

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

"Calibration" (*15)

On-site display	
calibration	*15
stop/edit	
start	

Meaning

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

Options:

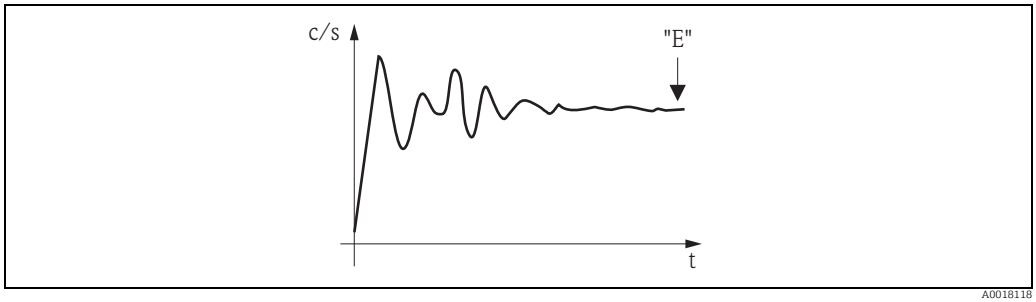
- **stop/edit**
  This option must be selected if
  - the calibration point is not to be entered (e.g. because it has already been entered). The pulse rate of the calibration point is then displayed in the following function, **"full calibr." (*16)** or **"empty calibr." (*18)**. If required, this value 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)

On-site display	
avg. pulse rate	*11
2548 cps	

Meaning

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.

NOTICE

Avg. Pulse rate

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

On-site display	
full calibr.	*16
33 cps	

empty calibr.	*18
2548 cps	

Meaning

The pulse rate of the respective calibration points 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 knwon or calculated pulse rate (manual calibration)

"Next point" (*19)

On-site display	
next point	*19
✔ no	
yes	

Meaning

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 been entered yet. After this selection the Gammapilot M returns to the **"calibr. point" (*13)** function and the next point can be entered.

4.2 Calibration for density and concentration measurements

4.2.1 Calibration points for density and concentration measurements

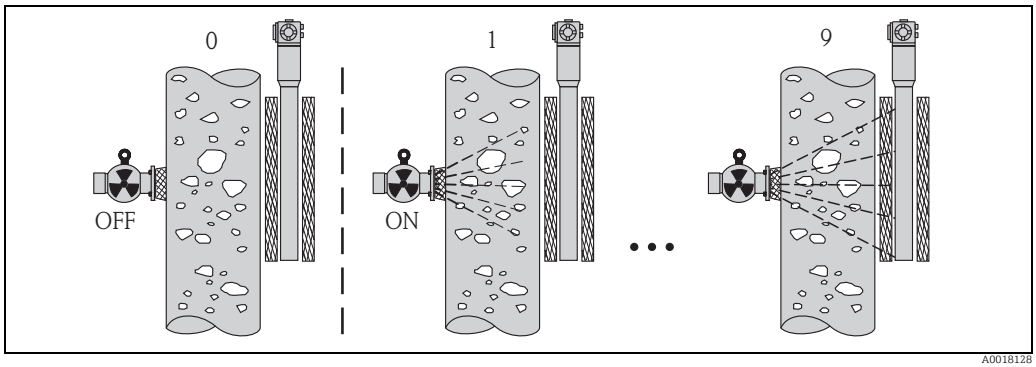
Function of the calibration points

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[1)].

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.

NOTICE

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.



0 Background calibration
1-9 Calibration points for various densities

Two-point calibration

The recommended comparisen procedure for high exactness standards about the whole measuring range is the two-point calibration. First the background calibration occurs. The two calibration points will be adapt. They should lie very far apart. After input of both calibration points, the Gammapilot M calculates the parameters I_0 und μ.

One-point calibration

If a two-point calibration is not possible, a one-point calibration can be carried out.
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.

1) 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

The multiple-point calibration is recommended particularly for measurements in a large density area or for especially exact measurements. Up to 9 calibration points can be used about the whole measuring range. 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. 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.

4.2.2 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.

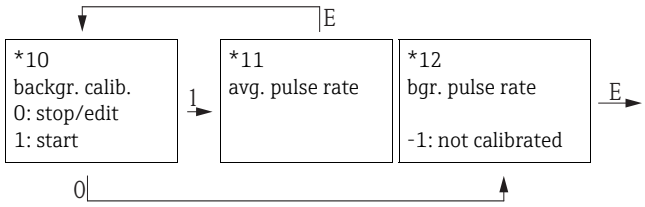
NOTICE

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

4.2.3 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)

On-site display		Meaning
backgr. cal.	*10	This function is used to start the background calibration.
stop/edit		
start		

Options:

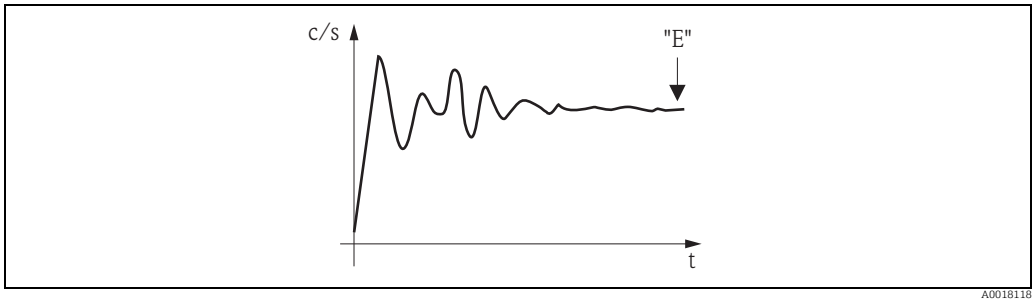
- **stop/edit**
  This option must be selected if
  – no background calibration is to be performed but the pulse rate of an existing background calibration is to be displayed instead.
  – a manual background calibration is to be performed.
  After selecting this option, the Gammapilot M changes to the **"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)

On-site display	
avg. pulse rate	*11
186 cps	

Meaning

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.



A0018118

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.

NOTICE

Bgr. Pulse rate

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

On-site display	
backgr. pul. rate	*12
186 cps	

Meaning

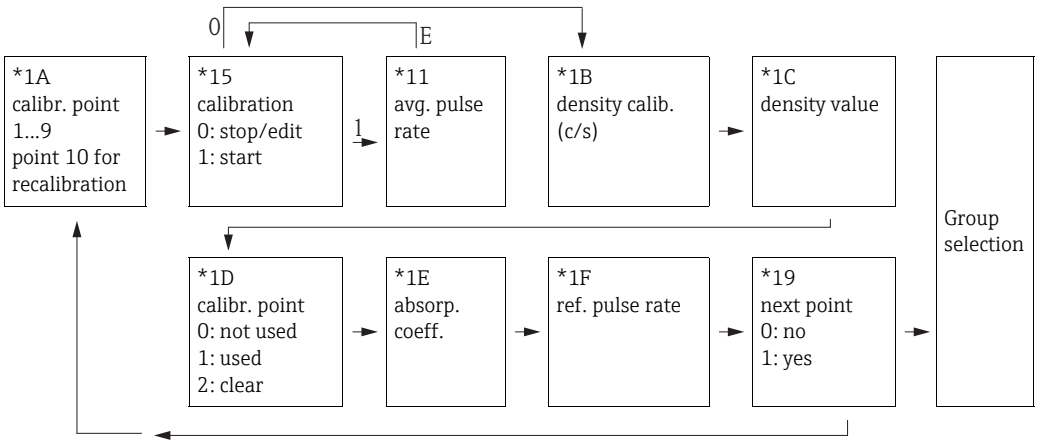
The pulse rate of the background calibration is displayed in this function. By pressing "E" the displayed value can be confirmed and the background calibration completed. "-1" indicates, that no background calibration is present yet. In this case there are two options:

- 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

4.2.4 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)

On-site display	
calibr. point	*1A
✔ 1	
2	
3	

Meaning

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

Further 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" (*15)

On-site display	
calibration	*15
stop/edit	
start	

Meaning

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

Options:

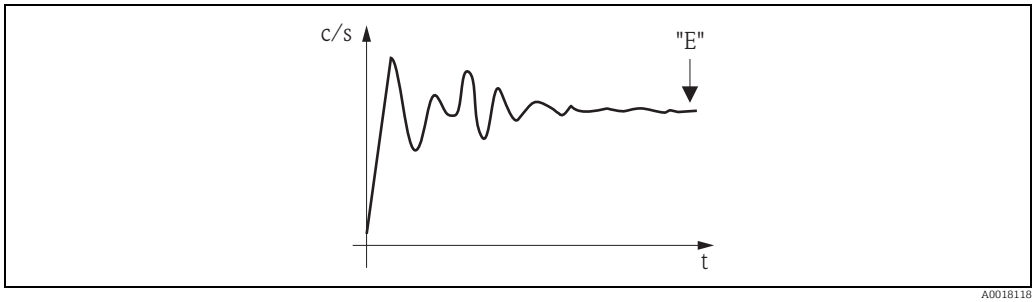
- **stop/edit**
  This option must be selected if
  - the calibration point is not to be entered (e.g. because it has already been entered). The pulse rate of the calibration point is then displayed in the following function **"density calib." (*1B)**. If required, this value can be changed.
  - the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

On-site display	
avg. pulse rate	*11
1983 cps	

Meaning

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 flucuations.



A0018118

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.

NOTICE

Density calibration

- The maximum integration time is 1000 s. After this time, the value is automatically transmitted to the **"density calibration" (*1B)** function.
- During the integration a sample of the measured material must be taken. Its density must be determined in the laboratory).
- 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)

On-site display	
density calibr.	*1B
1983 cps	

Meaning

The pulse rate of the respective calibration point is displayed in this function. The display 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)

On-site display	
density value	*1C
0.9963 g/cm3	

Meaning

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

NOTICE

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)

On-site display	
calibr. point	*1D
not used	
✔ used	
clear	

Meaning

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

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

"Absorption coefficient" (*1E)

On-site display	
absorp. coeff.	*1E
7.70 mm2/g	

Meaning

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

NOTICE

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)

On-site display	
ref. pulse rate	*1F
31687 cps	

Meaning

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

NOTICE

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)

On-site display	
next point	*19
✔ no	
yes	

Meaning

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.

5 "Safety settings" (*2) function group

On-site display	
Group selection	*2→
✔ Safety settings	
Temp. compensation.	
Linearization	

5.1 "Output on alarm" (*20)

On-site display	
outp. on alarm	*20
MIN -10% 3.6 mA	
MAX 110% 22 mA	
Hold	

Meaning

This function determines what value the output of the Gammapilot M assumes in the event of an alarm condition.

(*20)	Output on alarm	
	4 to 20 mA with HART	PROFIBUS PA FOUNDATION Fieldbus
MIN	3.6 mA	-99999
MAX	22 mA	+99999
Hold	The last measured value is held	
User-specific (can only be selected for HART devices)	As defined in "Output on alarm" (*21)	Not possible

5.2 "Output on alarm" (*21)

On-site display	
outp. on alarm	*21
22.00 mA	

Meaning

This function is used to specify what user-specific value the current output should assume in the event of an alarm condition. The value is entered in mA. This function is only available for HART devices.
It is only active if the **"user-specific"** option has been selected in the **"output on alarm" (*20)** function.
Range of values: 3.6 to 22 mA

5.3 SIL locking (for level limit detection 200/400 mm PVT scintillator (only for HART)

SIL locking ("Security locking" (022) function) is in the "**Safety settings function group**" **(S2)**. It can only be accessed in the "**stand alone**" operating mode in conjunction with the "**level limit**" measurement method (see also "Requirements for locking").
As soon as SIL locking or unlocking is started, communication via the display or via FieldCare is significantly slower. This is due to internal readback and parameter validation. However, this only applies during the locking or unlocking phase and does not affect the measurement itself.
In the event of locking, all the parameters are locked apart from the manufacturer reset code. The parameters can only be viewed. Only the manufacturer reset code can be modified. Locking starts by entering a four-digit password (1000 to 9999). Then there follows a sequence of prompts for the most important parameters which all have to be confirmed. The locking is concluded by confirming the password. The device is locked as soon as the password is confirmed. The password is no longer visible. If a parameter or the password is displayed incorrectly and thus the password or a parameter is not confirmed, the locking procedure is aborted. The FMG60 is then in an unlocked state, as it was before the locking procedure began.

Prerequisites for locking

The following parameters must be configured for locking to be possible:

1. Operatingmode = stand alone
2. Measurement mode = limit
3. Communication = HART Ex i or HART Ex e/d
4. Type of scintillator = PVT
5. Detector length = 200 or 400
6. SW version = 01.02.00 or 01.02.02
7. Radiation source = Cs or Co

Check whether the calibration values of the readback path are in the valid range.

5.3.1 List of the parameters to be confirmed

The following parameters can be modified by the user and thus they have to be confirmed. The detector length must be confirmed since it cannot be defined with regard to the safety function in the final check and is only in the service segment following any repair work.

1. Date
2. Beam type (standard or modulated[2)])
3. Source type (Cs or Co)
4. Output damping
5. Calibration date
6. Background pulse rate cps
7. Free calibration cps
8. Covered calibration cps
9. Gammagraphy hold time (can only be configured for standard beam type) or 10 for modulated source
10. Output current ≤ 3.0 mA
11. Detector length

2) Modulated just for max. level limit detection

5.3.2 Function "security locking" (*22) (SIL unlocking)

The FMG60 can be unlocked in SIL2/3 mode by entering the password. If the password is entered correctly, the FMG60 is unlocked. If an incorrect password is entered, the FGM60 goes back to the group selection. The device cannot be unlocked by switching the power ON and then OFF.

On-site display	
security locking	*22
✔ unlocked	
locked	
device locked	

Further options:
- unlocked
- locked
- device locked
- device unlocked

5.3.3 Forgotten your password?

The password cannot be viewed when the device is locked. For this reason, the password can only be deleted by a manufacturer reset. At the same time, all the parameters are set to default values and the calibration data are deleted. The device then has an error current.

5.3.4 Function "password" (*23) (security password)

The password is always a four-digit number in the range from 1000 to 9999. Other values are not valid. After locking, 0000 is displayed. The password itself is not.

On-site display	
password	*23
____	

5.3.5 Function "confirm Iout" (*24) (output current during locking)

The output current is shifted to <3.6, typically 2.4 mA, by means of the 2nd switch-off path by selecting "Device locked" so the user can clearly see that the FMG60 has actually been locked.
The user must explicitly confirm this current value. The FMG60 is only set to the "device locked" state and the current output is only released again once the system has successfully run through the entire locking sequence. If the FMG60 is switched off and then on again during the locking process, the FMG60 resumes normal, unlocked operation. If a parameter is not confirmed, the FMG60 remains in the "device locked" state. The device can be switched to "unlocked" during the locking process; it then operates in the normal measuring mode. The "device locked" state can also be disabled by means of a total reset (7864) which also deletes all the calibration parameters, however. The correct locking state can be determined using the "partial stroke test".

On-site display	
confirm Iout	*24
✔ not valid	
valid	

5.3.6 Function "confirm sequence" (*25) (display check)

To verify that numbers are shown properly on the display, the sequence of numbers > 0123456789 .- < is the first element to be confirmed on the display. The user must confirm the numbers are displayed correctly. If an error occurs in how the numbers are displayed, the user must abort the locking action.

On-site display	
confirm sequence	*24
>0123456789 .-<	
✔ not valid	
valid	

5.3.7 Function "confirm backgr." (*26)

On-site display	
confirm backgr.	*26
_ _ _ _ _ _ _ _	
✔ not valid	
valid	

Meaning

Select "valid" if the data displayed (see _ _ _ _ _ _) match the data you entered. Select "not valid" if you want to abort SIL locking.

5.3.8 Function "confirm cal." (*27)

On-site display	
confirm cal.	*27
✔ not valid	

Meaning

Select "valid" if the data displayed (see _ _ _ _ _ _) match the data you entered. Select "not valid" if you want to abort SIL locking.

Further options:
- Not valid
- Valid

5.3.9 Function "confirm source" (*28)

On-site display	
confirm source	*28
✔ not valid	

Meaning

Select "valid" if the data displayed (see _ _ _ _ _ _) match the data you entered. Select "not valid" if you want to abort SIL locking.

Further options:
- Not valid
- Valid

5.3.10 Function "confirm time" (*29) (output damping)

On-site display	
confirm time	*29
✔ not valid	

Meaning

Select "valid" if the data displayed (see _ _ _ _ _ _) match the data you entered. Select "not valid" if you want to abort SIL locking.

Further options:
- Not valid
- Valid

5.3.11 Function "confirm date" (*2A)

On-site display	
confirm date	*2A
✔ not valid	

Meaning

Select "valid" if the data displayed (see _ _ _ _ _ _) match the data you entered. Select "not valid" if you want to abort SIL locking.

Further options:
- Not valid
- Valid

5.3.12 Function "confirm length" (*2B)

On-site display	
confirm length	*2B
✔ not valid	
valid	

Meaning

Select "valid" if the data displayed (see _ _ _ _ _ _) match the data you entered. Select "not valid" if you want to abort SIL locking.

5.3.13 Function "confirm password" (*2C)

On-site display	
confirm password	*2C
✔ not valid	
valid	

Meaning

Select "valid" if the data displayed (see _ _ _ _ _ _) match the data you entered. Select "not valid" if you want to abort SIL locking.

5.3.14 Function "password" (*2D) (unlock password)

The password is always a four-digit number in the range from 1000 to 9999. Other values are not valid. To unlock the device, enter the the four-digit number password.

On-site display	
password	*2D

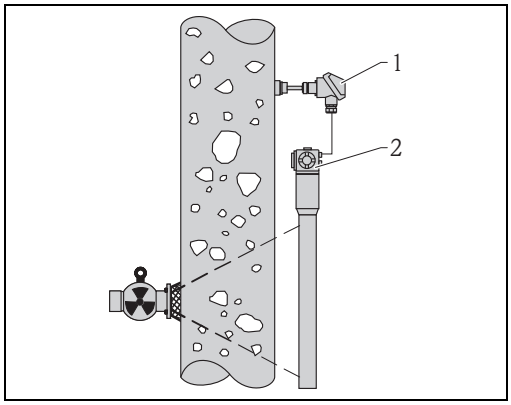
6 "Temperature compensation" (*3) function group

On-site display	
Group selection	*3→
✔ Temp. compensation	
Linearization	
Gammagraphy	

6.1 Basic principles

6.1.1 Function of the temperature compensation

The temperature compensation is designed to compensate for density changes caused by the influence of temperature.
The temperature compensation requires a PT-100 temperature sensor (4-wire version) to be connected to the Gammapilot M.



1 PT-100
2 Gammapilot M

6.1.2 Calculation of the compensated density

If the temperature compensation is activated, the measured density is converted to a reference temperature T_{ref}, which can be defined by the user.
The conversion is performed according to the following formula:

$$\rho_{ref} = \rho + (T_{ref} - T)\, t_{k1} + (T_{ref} - T)^2\, t_{k2}$$

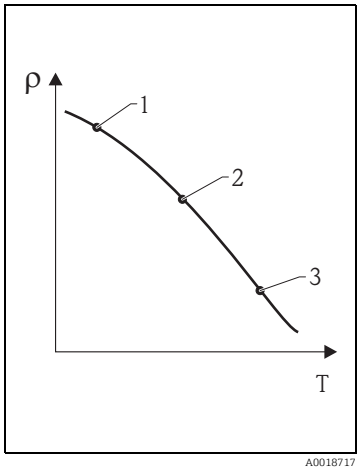
where:
- ρ_{ref} : the displayed density
- ρ : the measured density
- T_{ref} : the references temperature (as specified by the user)
- T : the current temperature of the measured medium as given by the PT-100 sensor
- t_{k1} : the linear temperature coefficient
- t_{k2} : the square temperature coefficient

6.1.3 Calculation of the temperature coefficients

The temperature coefficients t_{k1} and t_{k2} are not directly entered by the user. Instead, two or three pairs of values "temperature - density" are entered, from which the Gammapilot M calculates the coefficients automatically.

- If the reference temperature (1) and the lowest temperature (2) have been entered, the Gammapilot M calculates the linear temperature coefficient t_{k1}. In this case, the square temperature coefficient is t_{k2}=0.
- If additionally the highest temperature (3) is entered, the Gammapilot M calculates the square coefficient t_{k2} as well. Thus a square compensation will be performed, which is usually more precise than a linear compensation.

The density of the individual pairs of values can be taken from reference books or determined in the laboratory. The values for water are given in the following table.



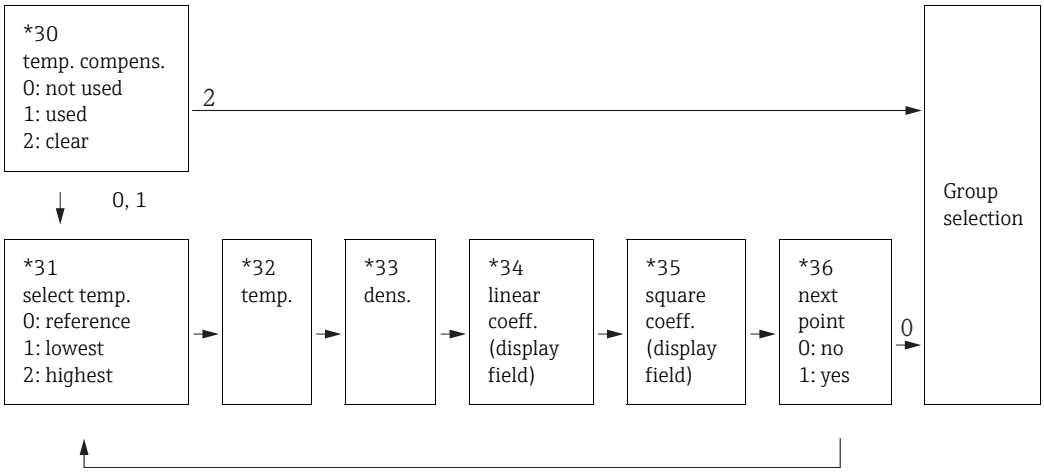
1 reference temperature Tref
2 lowest temperature
3 highest temperature (optional)

Example: Density of water

T [°C]	T [°F]	ρ [g/cm³]	T [°C]	T [°F]	ρ [g/cm³]
0	32.0	0.9998	34	93.2	0.9942
2	35.6	0.9999	36	96.8	0.9934
4	39.2	1.000	38	100.4	0.9928
6	42.8	0.9999	40	104.0	0.9922
8	46.4	0.9998	45	113.0	0.9902
10	50.0	0.9997	50	122.0	0.9880
12	53.6	0.9994	55	131.0	0.9857
14	57.2	0.9992	60	140.0	0.9832
16	60.8	0.9989	65	149.0	0.9806
18	64.4	0.9985	70	158.0	0.9778
20	68.0	0.9982	75	167.0	0.9748
22	71.6	0.9977	80	176.0	0.9718
24	75.2	0.9972	85	185.0	0968.6
26	78.8	0.9966	90	194.0	0.6953
28	82.4	0.9961	95	203.0	0.9618
30	86.0	0.9957	100	212.0	0.9584
32	89.6	0.9949			

6.2 Excerpt from the operating menu

The following excerpt from the operating menu explains how the temperature compensation is configured. The individual functions are explained in the sections below.



6.3 "Temperature compensation" (*30)

On-site display	
temp. compens.	*30
✔ not used	
used	
clear	

Meaning

The temperature compensation can be switched on and off in this function.

Options:

- **not used**
  The temperature compensation is **not** active in this mode. The measured density is displayed without correction. The entered pairs of values (temperature - density) can be displayed but not edited.
- **used**
  The temperature compensation is active in this mode. The corrected density is displayed. Pairs of values (temperature - density) can be entered, displayed and edited.
- **clear**
  The temperature compensation is deactivated by this selection. At the same time any pairs of values (temperature - density) are deleted.

6.4 "Select temperature" (*31)

On-site display	
select temp.	*31
✔ reference	
lowest	
highest	

Meaning

This function determines which temperature will be entered in the following functions (see diagram, → 38).

Options:
- **reference**
  the desired reference temperature
- **lowest**
  the lowest temperature
- **highest**
  the highest temperature

6.5 "Temperature" (*32)

On-site display	
Temperatur	*32
25 °C	

Meaning

The temperature of the selected pair of values is specified in this function. The unit for the temperature input can be set in the "temperature unit" (*C6) function.

6.6 "Density" (*33)

On-site display	
Density	*33
0,9670 g/cm3	

Meaning

The density of the selected pair of values is specified in this function.
The unit for the temperature input can be set in the "density unit" (*06) function.

6.7 "Linear coefficient" (*34)

On-site display	
linear coeff.	*34
0,0	

Meaning

The linear temperature coefficient t_{k1}, is displayed in this function.
"0.0" is displayed if fewer than two pairs of values have been entered. Temperature compensation is impossible in this case.
The unit is: $g/(cm^3K)$.
This function serves for plausibility checks only and cannot be edited.

6.8 "Square coefficient" (*35)

On-site display	
square coeff.	*35
0,0	

Meaning

The square temperature coefficient t_{k2} is displayed in this function.
"0.0" is displayed if not all three pairs of values have yet been entered. Only linear temperature compensation is possible in this case. The unit is: g/cm^3K^2).
This function serves for plausibility check only and cannot be edited.

6.9 "Next point" (*36)

On-site display	
next point	*36
✔ no	
yes	

Meaning

This functions is used to specify, if a further pair of values is to be entered or not.

Options:

- **no**
  No further pair of values will be entered. Instead, the Gammapilot M returns to the "**temperature compensation" (*30)** function, from where "ESC" leads back to the group selection.
- **yes**
  After selecting this option, the Gammapilot M returns to the **"select temperature" (*31)** function, where the next pair of values can be selected for entering.

7 "Linearization" (*4) function group

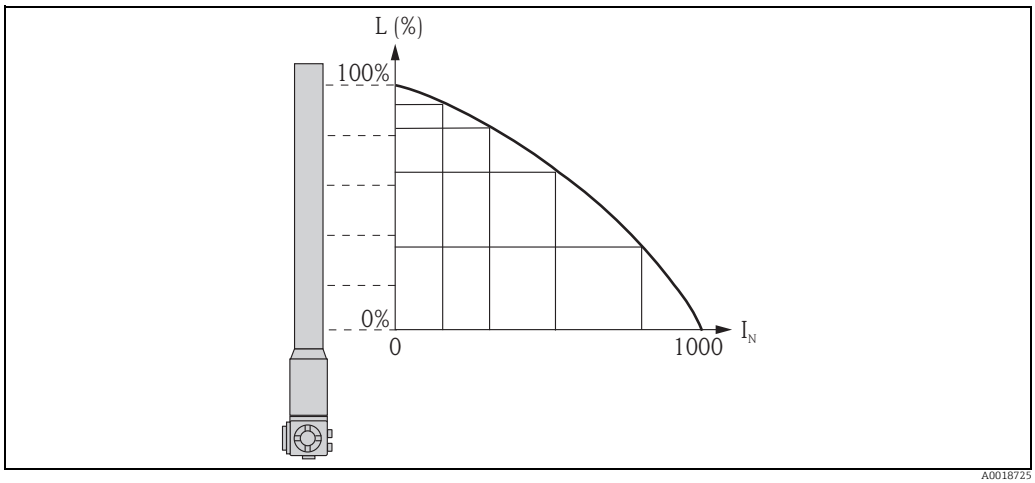
On-site display	
Group selection	*4→
✔ Linearization	
Gammagraphy	
Output	

7.1 Linearization for level measurements

7.1.1 Linearization modes, linearization table

For level measurements the linearization defines the relationship between the count rate and the level (0% to 100%). The Gammapilot M provides different linearization modes. On the one hand, there are preprogrammed linearization modes for frequently occurring standard applications ("linear", "standard"). On the other hand it is possible to enter a linearization table, which exactly suits the respective application. The linearization table consists of up to 32 pairs of values "normalized pulse rate : level). The linearization table must be monotonically decreasing, which means that a higher pulse rate always must be assigned a lower level.

Example



Example of a linearization table for level measurements (consisting of 6 pairs of values);
***N**: number of the pair of values; **L**: level; **I**: measured pulse rate; I_N : normalized pulse rate*

N (*41)	L (*42)	I	I_N (*43)
1	0	2431	1000
2	35	1935	792
3	65	1283	519
4	83	642	250
5	92	231	77
6	100	46	0

7.1.2 Normalized pulse rate

It is important to enter the normalized pulse rate into the linearization table, which is different from the actually measured pulse rate. The relationship between these two quantities is given by:

$$I_N = \frac{I - I_0}{I_{max} - I_0} \times 1000$$

where:
- I_0: the minimum pulse rate (i.e. the pulse rate of the full calibration)
- I_{max}: the maximum pulse rate (i.e. the pulse rate of the empty calibration)
- I: the measured pulse rate
- I_N: the normalized pulse rate

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

7.1.3 Methods of entering the linearization table

Automatic linearization

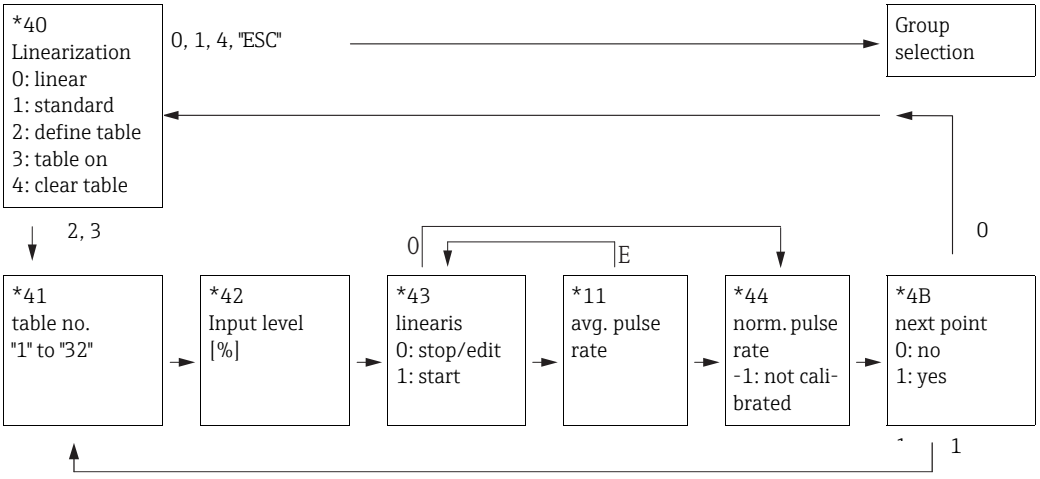
For automatic entering of the linearization point, the vessel must be filled to the required level. The radiation must be switched on. The Gammapilot M automatically records the pulse rate. The associated level is entered by the user.

Manual linearization

If during the commissioning of the Gammapilot M one or more points of the linearization table cannot be realized (e.g. because the vessel cannot be sufficiently filled or emptied), the table must be entered manually.
That means, 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.

7.1.4 Excerpt from the operating menu

The following excerpt from the operating menu gives an overview of the linearization for level measurements. The individual functions are explained in the following sections.

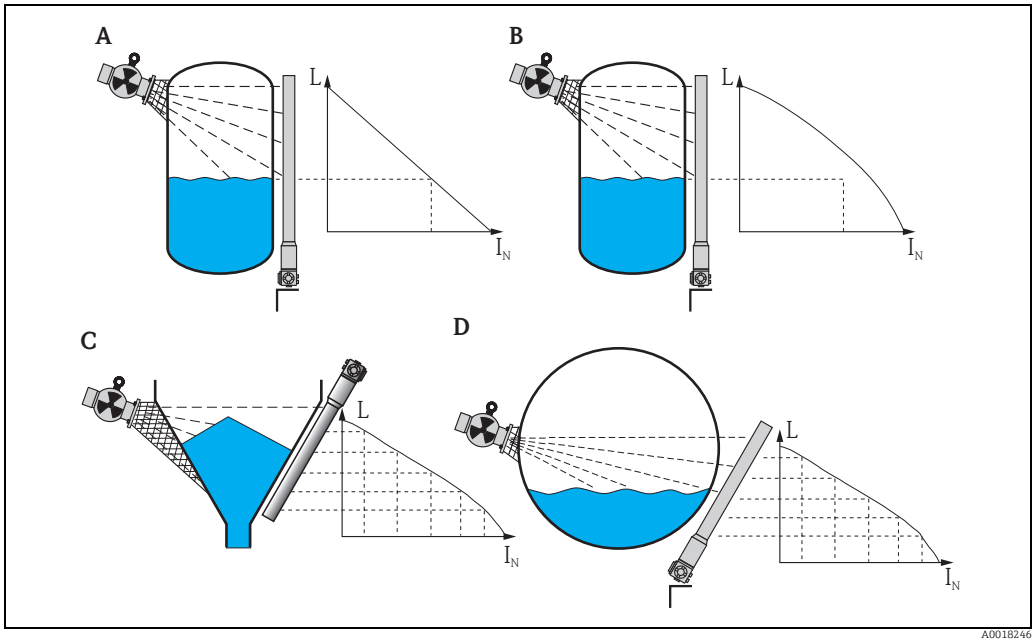


7.1.5 "Linearization (*40)

On-site display	
Linearisierung	*40
linear	
standard	
define table	

Meaning

This function is used to select the linearization mode for level measurements and to switch a linearization table on or off.



A *Linear*
B *Standard*
C, D *Linearization table entered by the user*
I_N *Pulse rate (counts per second, c/s)*
L *Level (%)*

Further options:

- **linear**
  In this mode the output depends linearly on the pulse rate. In the operating modes "slave" and "end slave" (see the **"operating mode" (*04)** function) this mode is the standard setting and cannot be edited.
- **standard**
  In this mode the level is calculated from a standard linearization curve. It is valid for the following situation:
  – The measurement is performed on a vertically cylindric vessel, the wall thickness of which is less than 30 mm (1.18 in) throughout.
  – Only one radiation source is used.
  – The radiation exit angle is less than 30°.
- **define table**
  Entering a new linearization table is started by this selection. The entering will then be performed by the following functions:
  – **"table no." (*41)**
  – **"input level" (*42)**
  – **"calibration" (*15)**
  – **"avg. pulse rate" (*11)**
  – **"linearization" (*43)**
  – **"next point" (*4A)**
- **table on**
  A table entered is switched on with this option. Otherwise it will not be used for the calculation of the desired value. After switching on the table, the Gammapilot M enters the **"table-no" (*41)** function. Return to the group selection by pressing "Esc" (O and S simultaneously) twice.
- **clear table**
  This selection deletes an existing linearization table. The linearization mode is set to "linear".

NOTICE

When selecting the options "linear" or "standard", an existing linearization table becomes deactivated but is not deleted. The table can be switched on again by selecting "table on". The table is not fully cleared until the "clear" option has been selected.

7.1.6 "Table no." (*41)

On-site display	
table no.	*41
1	

Meaning

This function is used to select a point of the linearization table for entering, viewing or editing. The following functions will refer to the selected point.

Range of values: 01...32

⚠ CAUTION

Table points must also be entered as a normalized pulse rate for the empty and full calibration. If these points are missing, the calibration cannot be performed for the entire measuring range.

7.1.7 "Input level" (*42)

On-site display	
input level	*42
10%	

Meaning

The level of the respective linearization point is entered or displayed in this function. Possible values range from 0% to 100%.

7.1.8 "Linearization" (*43)

On-site display	
calibration	*43
stop/edit	

Meaning

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

Options:

- **stop/edit**
  This option must be selected if
  - the linearization point is not to be entered (e.g. because it has already been entered). The pulse rate of the linearization point is then displayed in the following function, **"normalized pulse rate" (*44)**. If required, this value can be changed.
  - the calibration point is to entered manually. The Gammapilot M changes to the **"avg. pulse rate" (*44)** function.
- **start**
  This option is used to start automatic entering of the linearization point. The Gammapilot M then changes to the **"avg. pulse rate" (*11)** function.

NOTICE

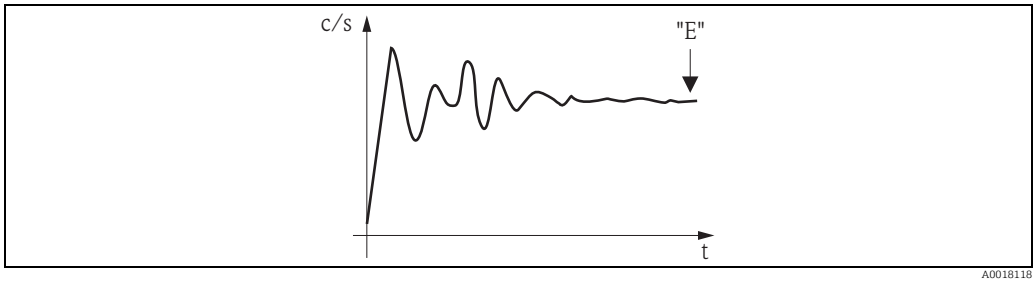
The "FieldCare" has a table editor which makes it easy to enter the linearization table. In this editor, linearization points which are not to be used must have a normalized pulse rate of "-1". An input field containing the value "-1" can only be left by "Esc".

7.1.9 "Avg. pulse rate" (*11)

On-site display	
Avg. pulse rate	*11
2548 cps	

Meaning

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.



If the value is sufficiently stable, the function can be left by pressing "E".
Thereafter, the Gammapilot M changes to the "calibration" (*43) function. Select "stop/edit" to stop the averaging procedure. The value is then automatically normalized and transmitted to the "normalized pulse rate" (*44) function.

NOTICE

Normalized Pulse rate

- ▶ The maximum integration time is 1000 s. After this time, the value is automatically transmitted to the "normalized pulse rate" (*44).
- ▶ 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" (*43) function. This may result in a slight deviation between the last displayed average pulse rate and the final "normalized pulse rate (*44).

7.1.10 "Normalized pulse rate" (*44)

On-site display	
norm. pulse rate	*44
876 cps	

Meaning

The pulse rate of the respective linearization point is displayed in this function. The displayed value must be confirmed by pressing "E". "-1" indicates, that no pulse rate is present yet for this point.
In this case, there are two options:

- either return to the "calibration" (*43) function and restart the integration
- or enter a known or calculated normalized pulse rate (manual linearization).

NOTICE

Due to the normalization, the "normalized pulse rate" does not match the "average pulse rate". The normalized pulse rate must always be between 0 and 1000 c/s.

7.1.11 "Next point" (*4B)

On-site display	
next point	*4B
no	
yes	

Meaning

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

Options:

- **no**
  This option must be selected if no further linearization point is to be entered. In this case, the Gammapilot M returns to the **"linearization" (*40)** function, where the table can be switched on.
- **yes**
  This option must be selected if a further linearization point is to be entered. In this case, the Gammapilot M returns to the **"table no." (*41)** function, where the next point can be selected.

7.2 Linearization for concentration measurements

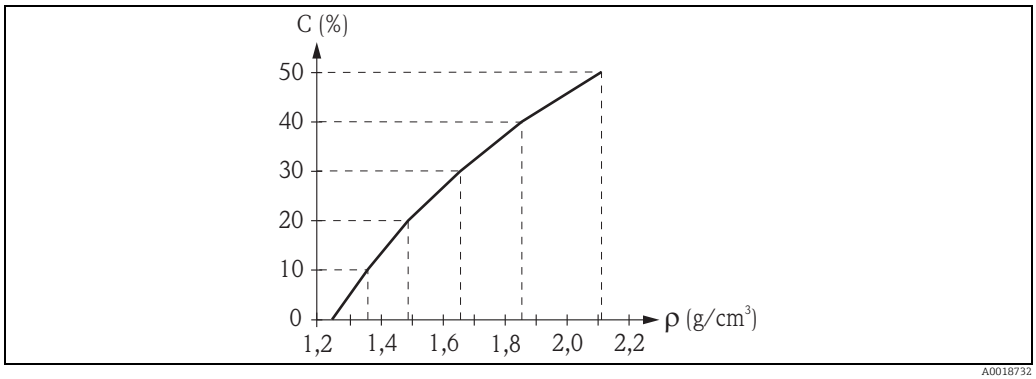
7.2.1 Units, linearization table

For concentrations measurements, the linearization defines the relationship between the measured density and the concentration.

The Gammapilot M provides different units for the concentration measurement.

- For some of these units (e.g. °Brix, °Baumé, °API), the relationship between density and concentration is predefined. If one of these units is used, nor further specifications and no linearization table are required.
- There are also units (e.g. % mass, % volume, mass per volume) **without** a predefined relationship between density and concentration. If using one of these units, a linearization table must be entered.
  The linearization table consists of up to 32 pairs of values "density : concentration".
  The linearization table must be monotonically increasing or monotonically decreasing, in such a way that a single-valued relationship between density and concentration is achieved.

Example



*Example of a linearization table for concentration measurements (consisting of 6 pairs of values); N: table no. (*48); ρ: density (*49); C: concentration (*4A)*

N	ρ	C
1	1,25	0
2	1,36	10
3	1,49	20
4	1,65	30
5	1,85	40
6	2,11	50

7.2.2 Determination of the pairs of values

The pairs of values can be:
- determined by sample measurements
- extracted from reference books
- or calculated from one of the following equations.

Solids content (% mass):

$$C = \frac{1 - (\rho_c/\rho)}{1 - (\rho_c/\rho_s)} \times 100\% \qquad \rho = \frac{\rho_c}{1 - \frac{C}{100\%}(1 - \rho_c/\rho_s)}$$

Solids content (% volume):

$$C = \frac{\rho - \rho_c}{\rho_s - \rho_c} \times 100\% \qquad \rho = \rho_c + \frac{C}{100\%}(\rho_s - \rho_c)$$

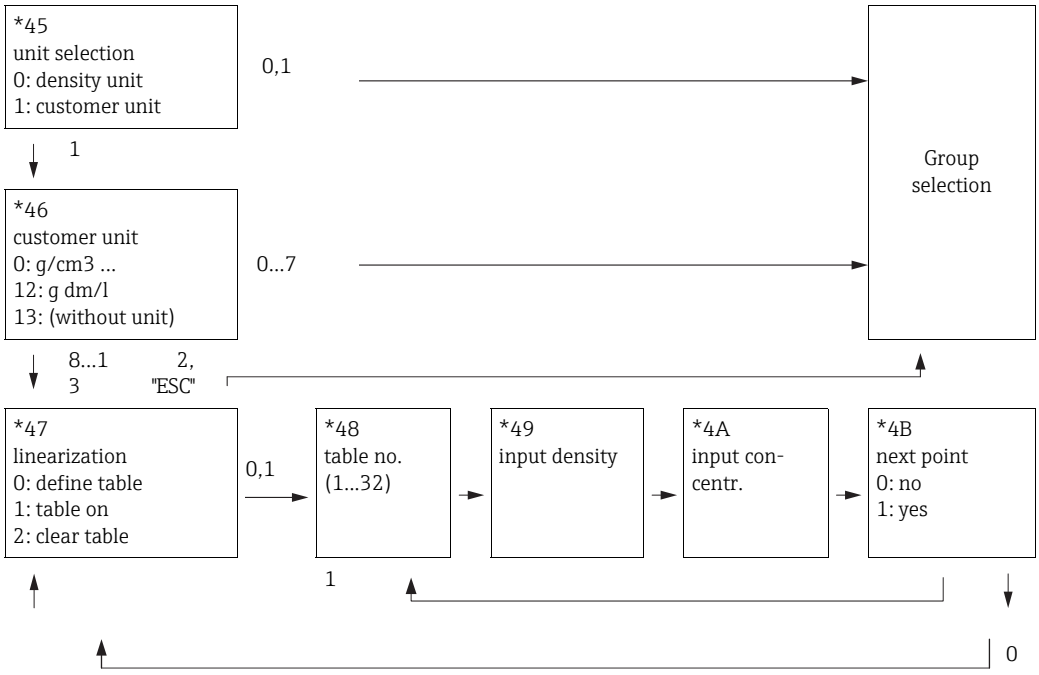
Solids content (mass per volume):

$$C = \frac{\rho - \rho_c}{1 - (\rho_s/\rho_c)} \qquad \rho = \rho_c + C \times (1 - \rho_s/\rho_c)$$

In these equations
- C: the concentration (to be entered into the linearization table)
- ρ: the measured density (to be entered into the linearization table)
- ρ_c: the density of the carrier liquid
- ρ_S: the density of the solid

7.2.3 Extract from the operating menu

The following extract from the operating menu shows how the linearization for concentration measurements is configured. The individual functions are explained in the following sections.



7.2.4 "Unit selection" (*45)

On-site display	
unit selection	*45
✔ density unit	
customer unit	

Meaning

This function defines, if the measured value is displayed in the density unit or if it is converted to a concentration (i.e. a customer unit).

Options:

- **density unit**
  If this option is selected, the measured value will be displayed in the **"density unit" (*06)** without conversion to a concentration.
- **customer unit**
  If this option is selected, the measured value will be converted before being displayed. The unit can be selected in the **"customer unit" (*46)** function.

7.2.5 "Customer unit" (*46)

On-site display	
customer unit	*46
✔ g/cm3	
g/l	
lb/gal	

Meaning

The desired concentration unit is selected in this function.

For the options 0 to 7 the relationship between density and concentration is predefined. Therefore no linearization table is required. For the options 8 to 13 a linearization table must be entered.

Further 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]
- °Brix; [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)]
- %
- % mass (for conversion see formula)
- % volume (for conversion see formula)
- solid/volume (for conversion see formula)
- g Trm./l
- (without unit)

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

7.2.6 "Linearization" (*47)

On-site display	
linearization	*47
✔ define table	
table on	
clear table	

Meaning

This function is used to start the entering of a linearization table. Also, an existing table can be switched on in this function or can be deleted if it is no longer needed.

Options:
- **define table**
  Entering a new linearization table is started by this selection. The entering will then be performed by the following functions:
  – **table no. (*48)**
  – **"input density" (*49)**
  – **"input concentration" (*4A)**
  – **"next point" (*4B)**
- **table on**
  A table entered is switched on with this option. Otherwise it will not be used for the calculation of the desired value. After switching on the table, the Gammapilot M enters the **"table-No" (*48)** function. Return to the group selection by pressing "Esc" (O and S simultaneously) twice.
- **clear table**
  This selection deletes an existing linearization table and a completely new table can be entered.

7.2.7 "Table no." (*48)

On-site display	
table no.	*48
1	

Meaning

This function is used to select a point of the linearization table for entering, viewing or editing. The following functions will refer to the selected point.

7.2.8 "Input density (*49)

On-site display	
input density	*49
0,987 g/cm3	

Meaning

The density of the respective linearization point is entered into this function. The unit is as specified in the "density unit" (*06) function.

7.2.9 "Input concentration" (*4A)

On-site display	
input concentr.	*4A
0,67%	

Meaning

The concentration of the respective linearization point is entered into this function. The unit is as specified in the "customer unit" (*46) function.

7.2.10 "Next point" (*4B)

On-site display	
next point	*4B
no	
yes	

Meaning

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

Options:

- **no**
  This option must be selected if no further linearization point is to be entered.
  Then, the Gammapilot M returns to the **"linearization" (*47)** function, where the table can be switched on.
- **yes**
  This option must be selected if a further linearization point is to be entered.
  Then, the Gammapilot M returns to the **"table no." (*48)** function, where the next point can be selected.

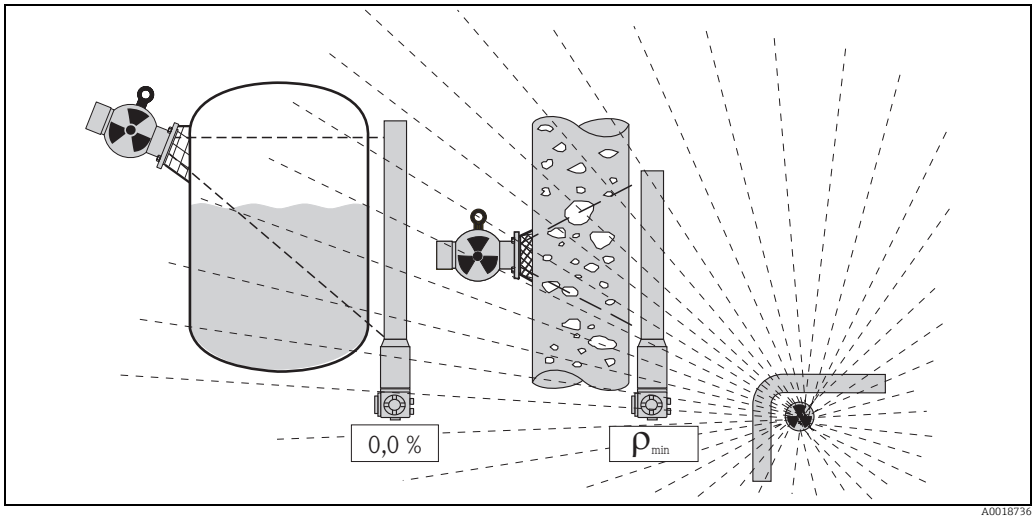
8 "Gammagraphy" (*5) function group

This function is for detecting interference radiation which interrupts the measurement.

On-site display	
Group selection	*5→
✔ gammagraphy	
output	
display	

8.1 Basic principles

The gammagraphy detection of the Gammapilot M is configured in this function group. It is the objective of the gammagraphy detection to detect interference radiation which typically occurs within the plant during material testing by gammagraphy.
Without gammagraphy detection, this interference radiation would result in too small a measured value (up to 0% or ρ_{min}). With gammagraphy detection on the other hand, the output assumes a definite value (e.g. -10%, 110% , hold last value) in this case.



Influence of gammagraphy on radiometric level measurements

8.1.1 Gammagraphy criteria

Normally, gammagraphy radiation occurs only during a short period. Therefore, the Gammapilot M uses the following two criteria to detect it:

1. The pulse rate at the detector rises or falls very abruptly ("span time" (*51) function).
2. The pulse rate at the detector exceeds the maximum or falls below the minimum value. These values are determined by the "measuring mode" (*05) function:

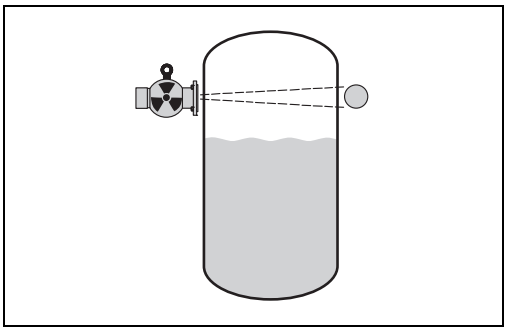
"measuring mode" (*05)	minimum pulse rate	maximum pulse rate
▪ level ▪ limit	"full calibration" (*16)	"empty calibration" (*18)
▪ density ▪ concentration	pulse rate associated with "maximum density" (*08)	pulse rate associated with "minimum density" (*07)

NOTICE

In general gammagraphy increases the pulse rate. But it might also decrease the pulse rate, if the detector "goes blind" due to excessive radiation. Therefore, too low pulse rates as well as too high ones are considered as gammagraphy criteria.

8.1.2 Gammagraphy detection for limit-detection applications

For horizontally mounted detectors, as they are usually applied for limit detection, the gammagraphy criteria do not work properly. In order to use the gammagraphy detection in limit-detection applications, it is advisable to use a short transmitter (200 mm) and to mount it vertically at the height of the desired limit.



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NOTICE

In the case of detectors mounted horizontally, as usually used for level limit applications, speed monitoring (1st gammagraphy criterion) cannot be used properly due to the narrow measuring range. In such instances the "span time" (*51) should be set to "0 s". This switches off the monitoring. Only the second gammagraphy criterion is then used.

8.1.3 Response to gammagraphy radiation being detected

If one of the gammagraphy criteria is fulfilled, the output of the Gammapilot M assumes the value which has been defined by the user in the "output gammagraphy" (*53) function and a warning message [3)] is produced. After the period defined by the "hold time" (*54) function, normal measuring operation is resumed.
If after the hold time the maximum (or minimum) pulse rate is still overshot (or undershot), an alarm message[3] is produced.

3) For the meaning of "warning" and "alarm" messages refer to Operating Instructions BA00236F/00/EN.

8.2 "Gammagraphy detection" (*50)

On-site display	
gammagr. det.	*50
✔ off	
on	

Meaning

The gammagraphy detection can be switched on and off in this function.

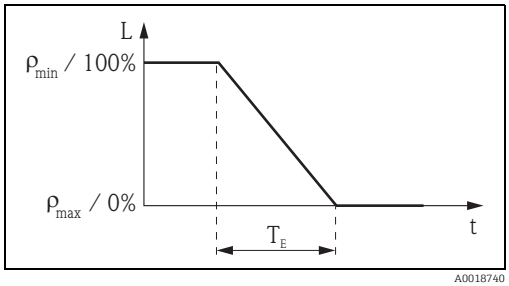
Options:

- **off**
  In this mode the gammagraphy detection is **not** active.
- **hold**
  In this mode the gammagraphy detection is active. The gammagraphy criteria must be configured.

8.3 "Span time" (*51)

On-site display	
span time	*51
999 s	

This function is used to specify the minimum time T_E, which is needed to completely empty the vessel from 100% of the measuring range to 0%. For density and concentration measurements the minimum time passing between maximum and minimum density must be entered. From this time the Gammapilot M calculates a maximum rate of change of the level. Whenever this rate is exceeded during the measurement, the Gammapilot M will indicate gammagraphy radiation.



NOTICE

The span time can be set between 0 and 999 s. 0 s means that the pulse rate change speed is not monitored. It can be useful to set the span time shorter than the actual span time for tanks with agitators so that the rapid changes in pulse rate caused by the stirring action do not result in an error message.

8.4 "Sensitivity " (*52)

On-site display	
sensitivity	*52
5	

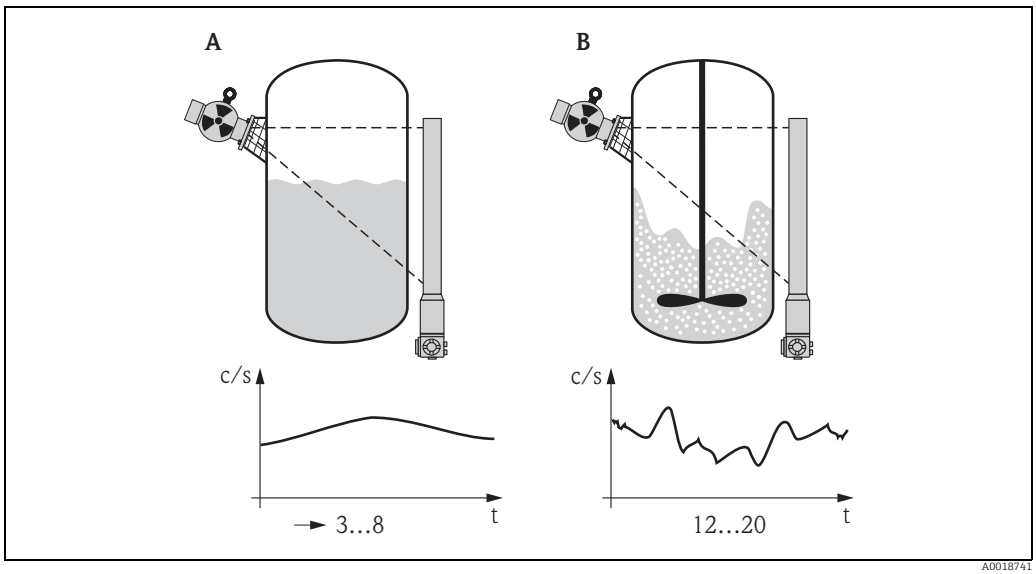
Meaning

This function determines, how sensitive the gammagraphy detection is concerning overshooting of the maximum and undershooting of the minimum pulse rate. Values between "3" (highest sensitivity) and "20" (lowest sensitivity) can be entered.

Selecting the sensitivity value

The suitable sensitivity value strongly depends on the process and ambient conditions. Therefore it is impossible to give a general rule for its selection. However, one can take the following principles as a guideline:

- For homogeneous materials with plain and calm surfaces a low value (3 to 8) should be chosen. Gammagraphy radiation will then be detected with high probability.
- For inhomogeneous materials and turbulent surfaces a high value (12 to 20) should be chosen, because otherwise random fluctuations of the pulse rate might be misleadingly interpreted as gammagraphy incidents.
- If the Gammapilot M occasionally reports gammagraphy, although no gammagraphy radiation is present, it is advisable to slightly increase the value.
- If the Gammapilot M does not recognize existent gammagraphy radiation, it is advisable to slightly decrease the value.



A Low values for plain, calm surfaces and homogeneous materials

B Large values for turbulent surfaces and in homogeneous materials

8.5 "Output gammagraphy" (*53)

On-site display	
outp. on gammagr.	*53
MIN -10% 3,8mA	
MAX 110% 20,5mA	
hold	

Meaning

This function defines, which value the output assumes, if gammagraphy radiation is detected.

In safety-related applications, the output current for gammagraphy is always 3.8 mA.

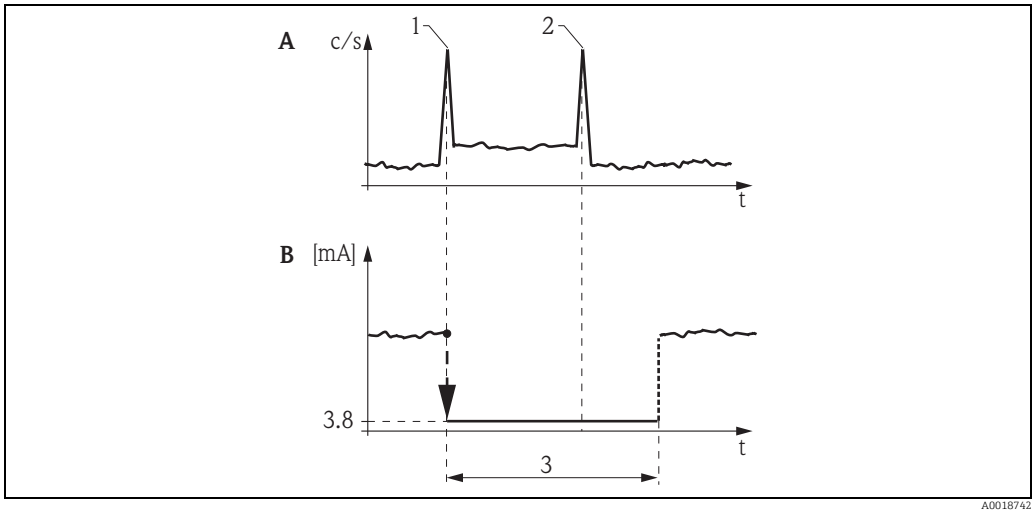
	Output at gammagraphy	
	4 to 20 mA with HART	**PROFIBUS PA Foundation Fieldbus**
MIN	3.8 mA	-10%
MAX	20.5 mA	+110%
hold	The last measured value is held.	

8.6 "Hold time" (*54)

On-site display	
hold time	*54
300 s	

Meaning

This function defines how long the measurement is interrupted in the case of a gammagraphy incident. During this time the output assumes the value defined in the "output gammagraphy" (*53) function. The hold time should be slightly longer than the maximum duration of a gammagraphy measurement.
If after the hold time the maximum (or minimum) pulse rate is still overshot (or undershot), an alarm message is produced.



A Typical curve of pulse rates
B Output signal
1 Start of the gammagraphy measurement
2 End of the gammagraphy measurement
*3 "hold time" (*54)*

8.7 "Gammagraphy count" (*55)

On-site display	
gammagr. count.	*55
11	

Meaning

This function displays the number of gammagraphy incidents which have occurred since the commissioning or since the last reset.

8.8 "Gammagraphy count" (*56)

On-site display	
gammagr. count.	*56
✔ keep	
clear	

Meaning

The gammagraphy counter can be reset by this function.

Options:
- **keep**
  The value of the gammagraphy counter is kept.
- **clear**
  The gammagraphy counter is reset to "0".

9 "Output" (*6) or "profibus param." (*6) function group

On-site display	
Group selection	*6→
✔ output	
display	
diagnostics	

On-site display	
Group selection	*6→
✔ profibus param.	
display	
diagnostics	

9.1 "Communication address" (*60) (only for HART)

On-site display	
commun. address	*60
0	

Meaning

Enter the communication address for the device with this function. Possible addresses
- for standard operation: 0
- for multidrop operation: 1 ... 15

The output current is constant at 4 mA in multidrop mode, but it can be changed to a different value by the "fixed current value" (*64) function. In safety-related applications, the HART communication address is always 0.

9.2 "Instrument address" (*60) (only for PROFIBUS PA)

On-site display	
instrument addr.	*60
126	

Meaning

Used to define the bus address of the device. Default:
- 126
  This address can be used to integrate the device into an existing PROFIBUS PA network. After this, the address must be changed before further devices can be connected to the network.

9.3 "No. of preambles" (*61) (only for HART)

On-site display	
no. of preambles	*61
5	

Meaning

Enter the number of preambles for the HART protocol with this function. An increase in the value is advisable for lines with communication problems

9.4 "Ident number" (*61) (only for PROFIBUS PA)

On-site display	
ident number	*61
✔ manufacturer	
profile	

Meaning

Use this function to select the ident number of the device.

Options:
- **manufacturer**
  The manufacturer-specific ident number is uses: 1548 hex (PNO-registered)
- **profile**
  The ident number of the profiles 3.0 is used: 9700 hex (device with one AI block)

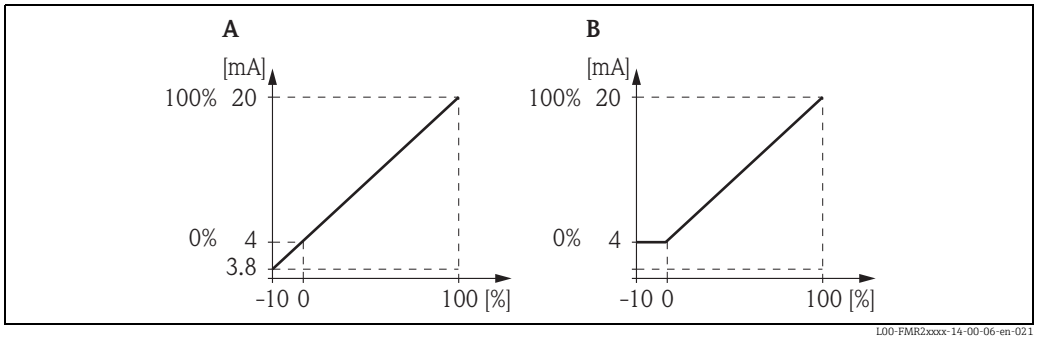
9.5 "Low output limit" (*62) (only for HART)

On-site display	
low output limit	*62
✔ off	
on	

Meaning

The output of negative measuring values can be suppressed with this function.
In safety-related applications, the "low output limit" is always "off"

Options:
- **off**
  minimum output: -10% (3.8 mA)
- **on**
  minimum output: 0% (4 mA)



A Low output limit: off
B Low output limit: on

9.6 "Set unit to bus" (*62) (only for PROFIBUS PA)

On-site display	
set unit to bus	*62
✔ confirm	

Meaning

After confirming this function, the unit of the measured variable is taken over in the AI block (PV scale -> Out scale). This function must always be confirmed after changing the unit.

9.7 "Current output mode" (*63) (only for HART only)

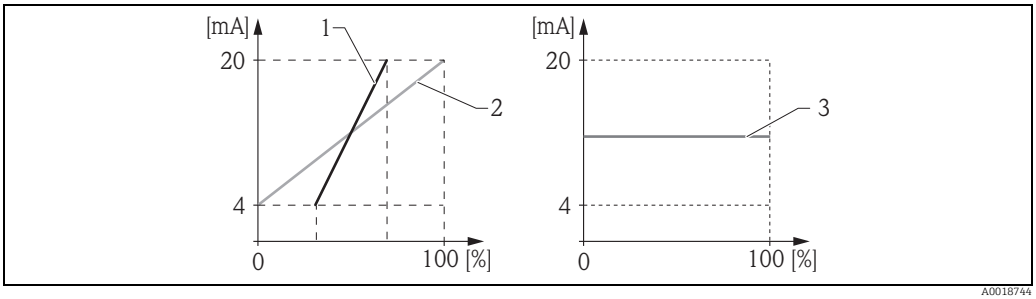
On-site display	
current outp. mode	*63
✔ standard	
current turn down	
fixend current	

Meaning

In this function you specify the mode of the current output.

Options:

- **standard**
  The total measuring range [0 ... 100%] of [ρ_{min}...ρ_{max}] will be mapped to the current interval [4...20 mA].
- **current turn down**
  Only a part of the measuring range will be mapped to the current interval [4...20 mA]. Use the functions **"4mA value" (*68)** and **"20mA value" (*69)** to define the concerning range.
- **fixed current**
  The current is fixed. The measured value is transmitted by the HART signal only. The value of the current is defined in the **"fixed current value" (*64)** function.



1 Current turn down
2 Standard
3 Fixed current

9.8 "Out value" (*63) (only for PROFIBUS PA)

On-site display	
out value	*63

Meaning

Displays the output of the AI block.

9.9 "Fixed current value" (*64) (only for HART)

On-site display	
fixed cur. value	*64
4.00 mA	

Meaning

Set the fixed current value with this function. This entry is necessary when you have selected the "fixed current" option in the "current output mode" (*63) function.

Range of values: 3.8 to 20.5 mA

9.10 "Out status" (*64) (only for PROFIBUS PA)

On-site display	
out status	*64

Meaning

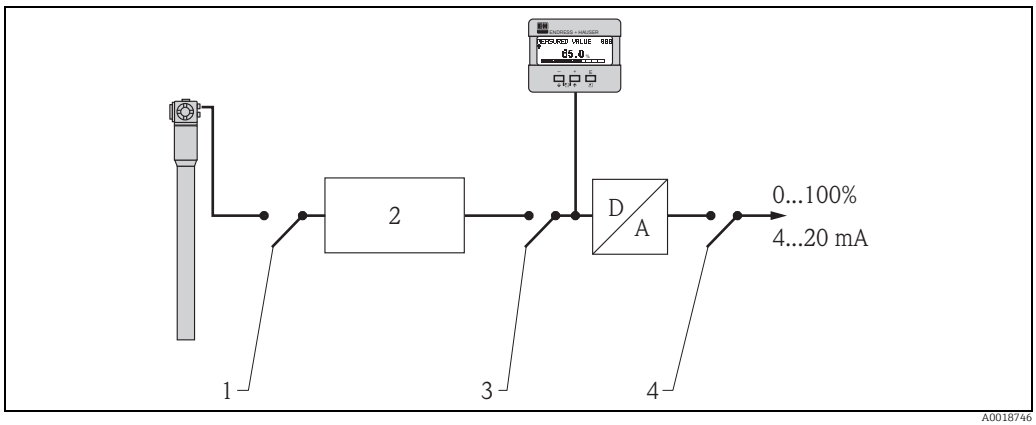
Displays the status of the output value (for the meaning of the status refer to Operating Instructions BA00329F/00/EN).

9.11 "Simulation" (*65)

On-site display	
simulation	*65
✔ Sim. off	
Sim. pulse rate	
Sim. level	

Meaning

The simulation function can be used to test if the linearization, the output signal and the current output are working properly. There are the following simulation possibilities (see figure below).



1 Simulation pulse rate
2 Signal evaluation
3 Simulation level, simulation density, simulation concentration
4 Simulation current (for HART only)

Further options:

- **sim. off**
  The simulation is switched off.
- **sim. pulse rate**
  A pulse rate (counts/second) can be entered into the **"simulation value" (*66)** function.
- **sim. level**
  This option is available for level measurements and limit detection only. If it has been selected, a level (percentage) can be entered into the **"simulation value" (*66)** function.
- **sim. density**
  This option is available for density measurements only. If it has been selected, a density can be entered into the **"simulation value" (*66)** function.
- **sim. concentration**
  This option is available for concentration measurements only. If it has been selected, a concentration can be entered into the **"simulation value" (*66)** function.
- **sim. current (for HART devices only)**
  A current value (mA) can be entered into the **"simulation value" (*66)** function.

9.12 "Simulation value" (*66)

On-site display	
simulation value	*66
2000 c/s	

Depending on the selected **"simulation" (*65)**, the following can be entered into this function:
- a pulse rate
- a level
- a density
- a concentration
- a current

During the simulation the following functions assume a value according to the entered value:
- the measured value (level, density or concentration)
- for HART devices: the **"output current" (*67)** function
- for HART devices: the actual current at the output

9.13 "Output current" (*67) (only for HART)

On-site display	
output current	*67
12,38 mA	

Meaning

This function displays the present output current.

9.14 "2nd cyclic value" (*67) (only for PROFIBUS PA)

On-site display	
2nd cyclic value	*67
✔ Avg. pulse rate	
medium temp.	

Meaning

Use this function to select the second cyclic value.

9.15 "4mA value" (*68) (only for HART)

On-site display	
4 mA value	*68
10%	

Meaning

In this function specify the measured value (level, density or concentration), at which the output current should be 4 mA. This value will be used if you choose the option "current turn down" in the "current output mode" (*63) function.

NOTICE

The unit for the "4mA value" (*68) and the "20mA value" (*69) depends on the measuring mode:

"Measuring mode" (*05)	unit for "4mA value" (*68) and "20mA value" (*69)
▪ level ▪ limit	%
density	"density unit" (*06)
concentration	"customer unit" (*46)

9.16 "select V0H0" (*68) (only for PROFIBUS PA)

On-site display	
select V0H0	*68
✔ measured value	
displayed value	

Meaning

Determines, which value is indicated on the display.

Options:

- **measured value (default)**
  Depending on the measuring mode (*05): level, density or concentration.
- **display value**
  (a value read from the PLC (*69))

9.17 "20 mA value" (*69) (only for HART)

On-site display	
20 mA value	*69
90%	

Meaning

In this function specify the measured value (level, density or concentration), at which the output current should be 20 mA. This value will be used if you choose the option "current turn down" in the "current output mode" (*63) function.

NOTICE

The unit for the "4mA value" (*68) and the "20mA value" (*69) depends on the measuring mode:

"Measuring mode" (*05)	unit for "4mA value" (*68) and "20mA value" (*69)
▪ level ▪ limit	%
density	"density unit" (*06)
concentration	"customer unit" (*46)

9.18 "Display value" (*69) (only for PROFIBUS PA)

On-site display	
display value	*69

Meaning

This field can be set externally, e.g. from a PLC. The value is then shown on the display as the primary value if "select V0H0" (068) = "display value".

10 "Display" (*9) function group

On-site display	
Group selection	*9→
✔ display	
diagnostics	
system	

10.1 "Language" (*92)

On-site display	
language	*92
✔ English	
Français	
Español	

Meaning

Selects the display language.

Further options:
- English
- Deutsch
- Français
- Español
- Italiano
- Nederlands
- Katakana (Japanese)

10.2 "Back to home" (*93)

On-site display	
back to home	*93
900 s	

Meaning

This function defines the time, after which the Gammapilot M automatically returns to the measured value display. The automatic return occurs if nothing is entered via the display during the specified time. "0s" means that there is no automatic return.
Range of values: 3 to 9999 s

NOTICE

This function is not active during the integration (which occurs during calibration or linearization).

10.3 "No. of decimals" (*95)

On-site display	
no. of decimals	*95
✔ x.xx	
x.xxx	
x	

Meaning

The number of decimals is specified in this function.

Further options:
- x
- x.x (default for level measurement and level limit detection)
- x.xx
- x.xxx
- x.xxxx (default for density and concentration measurement)

10.4 "Separation character" (*96)

On-site display	
sep. character	*96
✔ .	
,	

Meaning

The type of decimal separation character is selected in this function.

10.5 "Display test" (*97)

On-site display	
display test	*97
✔ off	
on	

Meaning

This function can be used to check the display.

Options:
- **off**
  No display test is performed.
- **on**
  All display pixels are switched on for a couple of seconds. If the whole display is dark, it is working correctly.

11 "Diagnostics" (*A) function group

On-site display	
Group selection	*A→
✔ diagnostics	
system	
basic setup	

11.1 "Present error" (*A0)

On-site display	
present error	*A0
background not calibrated	
	A631

Meaning

The present error is displayed in this function.
If several errors are present, use ⊞ and ⊟ to page through the error messages.

11.2 "Previous error" (*A1)

On-site display	
previous error	*A1
simulation switched on	
	A621

Meaning

The last error (previous to the current one) is displayed in this function.

11.3 "Clear last error" (*A2)

On-site display	
clear last error	*A2
✔ keep	
clear	

Meaning

The "previous error" (*A1) can be deleted by this function.

Options:
- **keep**
  The previous error is kept.
- **clear**
  The last error is deleted.

11.4 "Reset" (*A3)

Vor-Ort-Anzeige	
reset	*A3
0	
for reset code see manual	

Bedeutung

The device can be set back to factory settings by this function. A reset is recommended whenever a device with an unknown history is to be used.

Effects of the reset

- All parameters are reset to default values.
- The linearization table is deleted.
- The calibration data for the PT-100 sensor and for the current output (both within the service menu) are kept.
- The real-time clock is not reset.

Performing a reset
The reset is performed by entering "333" into the "reset" (*A3) function.

⚠ CAUTION

The reset affects the measurement. A completely new calibration is necessary after a reset.

11.5 "Unlock parameter" (*A4)

On-site display	
unlock parameter	*A4
0	

Meaning

The device can be locked against unauthorized or accidental changes by this function.

Locking the device
Enter a number ≠ 100 into the "unlock parameter" (*A4) function.
The symbol appears on the display. Changes are no longer possible.

Unlocking the device
When trying to change a parameter, the device changes to the "unlock parameter" (*A4) function. Enter "100". Parameters can be changed again.

NOTICE

If the device cannot be unlocked in this way, it has been locked by a hardware locking procedure. In this case it can only be unlocked by a hardware unlocking procedure. For details refer to Operating Instructions BA00236F/00/EN.

11.6 "Present average pulse rate" (*A5)

On-site display	
pres. avg. pulse rate	*A5
84 cps	
at integration time	
w/o background	

Meaning

This function displays the present average pulse rate.
The decay compensation is included. The pulse rate of the background calibration has already been subtracted.

11.7 "Average raw pulse rate" (*A6)

On-site display	
avg. raw pulse rate	*A6
182 cps	
at integration time	
not compensated	

Meaning

This function displays the present average pulse rate. The decay compensation is not included. The pulse rate of the background calibration is not yet subtracted.

11.8 "Medium temperature" (*A7)

On-site display	
medium temp.	*A7
26 °C	

Meaning

This function is required for density and concentration measurements only. It displays the temperature T, which the connected
PT-100 temperature sensor measures. This temperature is used for the temperature compensation.

11.9 "Density value" (*A8)

On-site display	
density value	*A8
0.9650 g/cm3	

Meaning

This function is required for density and concentration measurements only. It displays the measured density. The temperature compensation is not included in this value.

12 "System parameters" (*C) function group

On-site display	
Group selection	*C?
✔ system params	
basic setup	
calibration	

12.1 "Tag no." (*C0) (HART)

On-site display	
tag no.	*C0
_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _	

Meaning

The tag no. can be defined in this function.
The tag no. may consist of up to 16 alphanumeric values.

12.2 "Device tag" (*C0) (FOUNDATION Fieldbus)

On-site display	
device tag	*C0
_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _	

Meaning

The tag no. can be defined in this function.

12.3 "Profile version" (*C1) (PROFIBUS PA)

On-site display	
profile version	*C1
3,0	

Meaning

Displays the PROFIBUS PA profile version of the device.

12.4 "device id" (*C1) (FOUNDATION Fieldbus)

On-site display	
device id	*C1

Meaning

Displays the serial number (id) of the device.

12.5 "Protocol+SW-No." (*C2)

On-site display		Meaning
protocol+sw-no. V01.01.00 HART	*C2	This function displays the versions of protocol, hardware and software.

Format:
Vxx.yy.zz prot

where:
- **xx:** the hardware version
- **yy:** the software version
- **zz:** the software revision
- **prot:** the communication protocol (HART, PROFIBUS PA or FOUNDATION Fieldbus)

12.6 "device revision" (*C3) (FOUNDATION Fieldbus)

On-site display		Meaning
dev. rev.	*C3	Displays the revision of the device software.

12.7 "Serial no." (*C4) (HART)

On-site display		Meaning
serial no. YMLNR01ID	*C4	This function displays the serial number of the device.

12.8 "DD revision" (*C4) (FOUNDATION Fieldbus)

On-site display		Meaning
dd rev.	*C4	Displays the revision of the device's Device Description (DD).

12.9 "Temperature unit" (*C6)

On-site display	
temperature unit	*C6
✔ °F	
°C	

Meaning

This function is used to select the temperature unit.

12.10 "Calibration date" (*C7)

On-site display	
calibration date	*C7
17.11.04 10:30	
TT.MM.JJ HH:MM	

Meaning

This function is used to specify the calibration date.

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

NOTICE

In an automatic calibration, the Gammapilot automatically copies the date from its internal realtime clock. In this case, the "calibration date" (*C7) function is a display function only. In a manual calibration, the user must explicitly enter the date.

12.11 "Recalibration date" (*C8)

On-site display	
recal. date	*C8
25.03.05 17:50	
TT.MM.JJ HH:MM	

Meaning

This information field is active for density and concentration measurements only. The recalibration date is specified here.

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

NOTICE

In an automatic recalibration, the Gammapilot automatically copies the date from its internal clock. In this case, the "recalibration date" (*C8) function is a display function only. In a manual recalibration, the user can enter the date.

13 "Service" function group (0D)

A detailed description of the "Service" function group and a detailed overview of the function menu can be found in the Service Manual for Gammapilot M.

14 Troubleshooting

If you have followed the instructions in these Operating Instructions, the device should be successfully commissioned and ready for operation. If this is not the case, the device offers various ways of analyzing and correcting errors.

14.1 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 instrument off/on; If error still is present: call Endress+Hauser service or exchange transmitter
A113	electronics defect	Switch instrument off/on; If error still is present: call Endress+Hauser service or exchange transmitter
A114	electronics defect	Switch instrument off/on; If error still is present: call Endress+Hauser service or exchange transmitter
A116	download error	Repeat download
A121	electronics defect	Switch instrument 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 instrument off/on; If error still is present: call Endress+Hauser service or exchange transmitter ▪ See Note "**Error messages A165 "electronics defect" and A635 "present date not defined"** on → 🖹 8.
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 instrument 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)

Code	Description	Remedy
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 FieldCare: 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
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) ▪ See Note "**Error messages A165 "electronics defect" and A635 "present date not defined"** on → 8.
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).

14.2 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

14.3 Software history

HART

Date	Software version	Software modifications	Documentation
Since 09.2004	01.01.02	Original software.	BA236F/00/en/08.04 52023878 BA287F/00/en/08.04 52023818
Since 11.2005	01.01.04	Bug fix. Concentration mode corrected. Density measurement recalibration corrected.	
Since 08.2006	01.01.06	Bug fix. Corrections for high and low pulse rate.	
Since 04.2007	01.02.00 01.02.02	Software extended to include "SIL locking" function.	BA236F/00/en/03.07 71041168 BA287F/00/en/04.07 71041170
			BA236F/00/en/06.07 71041168 BA287F/00/en/06.07 71041170
Since 08.2008	01.03.00	Automatic restart after error A165 caused by empty pipe at density measurements (pulse rate > 160000 c/s) **NOTICE** **For instruments with SIL or WHG approvals, software version 01.02.02 remains valid.**	BA236F/00/en/09.08 71082936 BA287F/00/en/06.07 71041170
Since 02.2009	01.03.02	New filtering function for Gamma Modulator FHG65 implemented	BA236F/00/en/03.09 71091966 BA287F/00/en/06.07 71041170
Since 10.2010	01.03.06	Improved EMC stability for extreme interferences.	BA236F/00/en/10.09 71104595 BA287F/00/en/06.07 71041170

PROFIBUS PA

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
Since 10.2010	01.03.06	Improved EMC stability for extreme interferences.	BA00329F/00/en/10.09 71104600

FOUNDATION Fieldbus

Date	Software version	Software modifications	Documentation
Since 06.2005	01.01.00	Original software.	BA330F/00/en/06.05 71000010 BA287F/00/en/08.04 52023818
Since 07.2005	01.01.02		
Since 11.2005	01.01.04	Bug fix. Concentration mode corrected. Density measurement recalibration corrected.	
Since 08.2006	01.01.06	Bug fix. Corrections for high and low pulse rate.	
Since 03.2009	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	BA330F/00/en/03.09 71091971 BA287F/00/en/06.07 71041170
Since 10.2010	01.03.06	Improved EMC stability for extreme interferences.	BA00330F/00/en/10.09 71104603

List of functions

Symbols

Numerics

A

B

C

D

E

F

K

M

O

R

V

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