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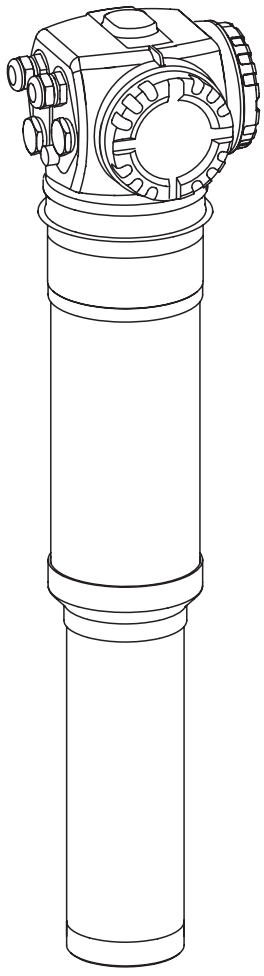
Description of Device Functions

Gammapilot M FMG60

Radiometric Measurement



BA287F/00/en/06.07
71041170

Valid as of software version:
V01.02.00

Endress+Hauser
People for Process Automation

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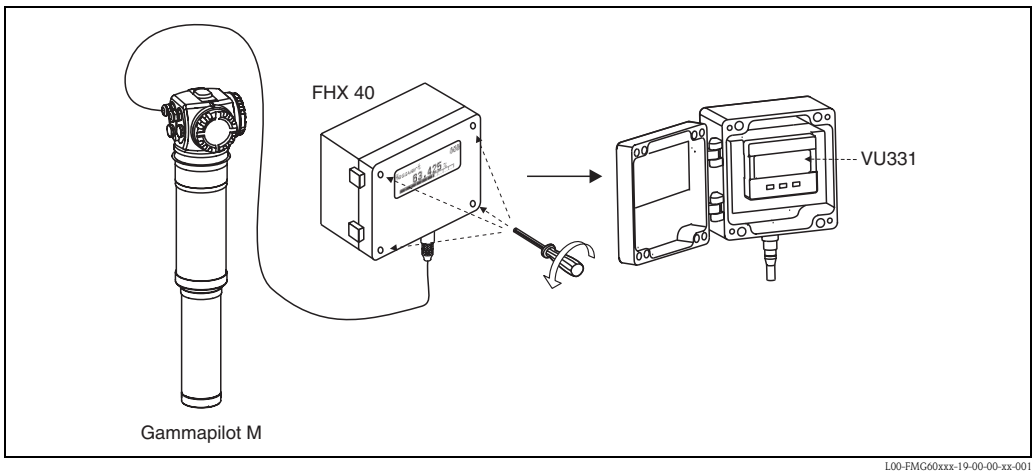
1 Operating concept

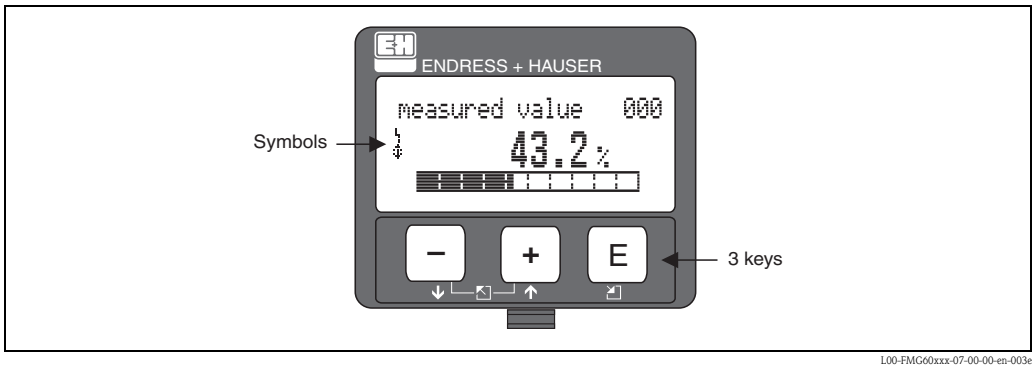
1.1 Display and operating elements

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



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

1.1.1 Display and operating module VU331



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

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

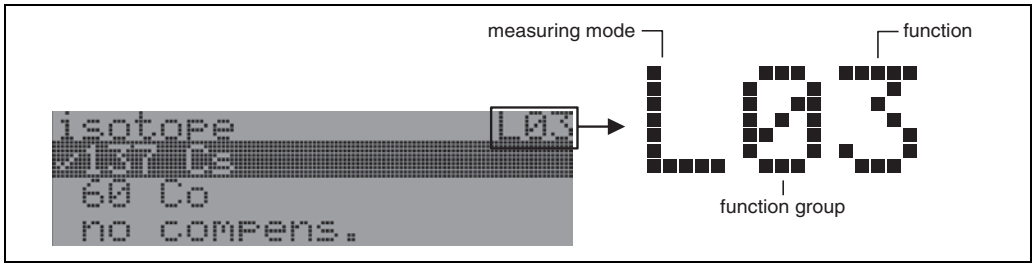
1.1.3 Function of the keys

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 device via display or communication is not possible! The hardware can only be unlocked via the display. An unlock parameter must be entered to do so.

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.



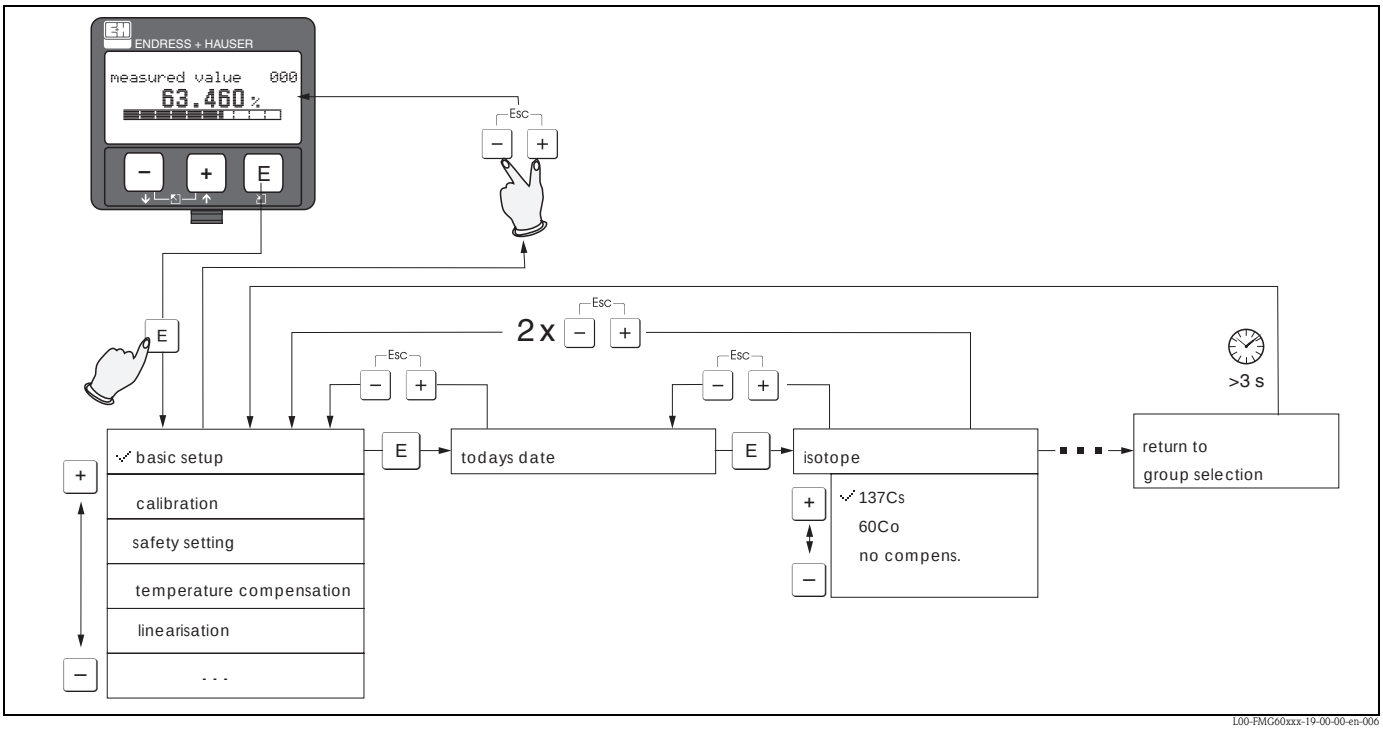
- The alphabetic character specifies the current measuring mode of the Gammapilot M:
  - **L**: level
  - **S**: limit (switch)
  - **D**: density
  - **C**: concentration
  - *****: no measuring mode selected yet

- 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 VU 331



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

   Selection menus

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

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

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

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

   Typing in numerals and text

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

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

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

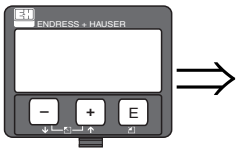
   d. If a ← symbol appears at the cursor, press E to return to the previous character (e.g. for correction of entries).

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

2 Switching on the device

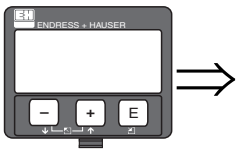
Note!
Error messages A165 "electronics defect" and A635 "present date not defined"
The Gammapilot M contains 2 real-time clocks for the decay compensation, which are permanently compared to each other for safety reasons. In order to bridge voltage interruptions, the clocks are buffered with a capacitor. 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. Then, the following appear for approximately five seconds:
- Device type: FMG60
- Software version: Vxx.yy.zz
  - xx: hardware version
  - yy: software version
  - zz: software revision
- Type of the communication signal:
  - HART
  - PA: PROFIBUS PA
  - FF: Foundation Fieldbus



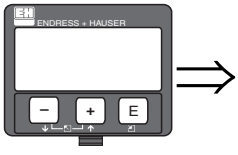

```
FMG60
V01.02.00 HART
```

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




```
language          092
✓English
 Français
 Español
```

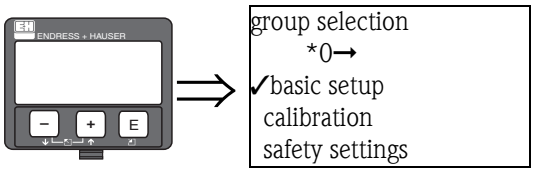
After that the measured value display appears. Now you can perform the basic setup and the calibration. Press E to switch to the group selection.



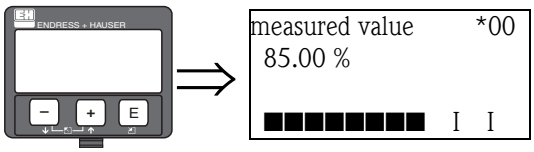

```
group selection
✓basic setup
 calibration
 safety settings
```

Press E again to enter the first function of the "basic setup" function group.

3 "Basic setup" (*0) function group



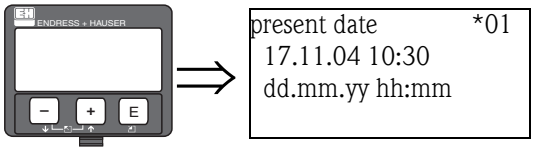
3.1 "Measured value" (*00)



The current measured value is displayed in this function.

Note!
- 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)



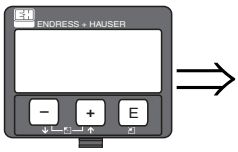
Date and time of the basic setup are specified in this function.

Format:
DD.MM.YY HH:MM

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

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

3.3 "Beam type" (*02)

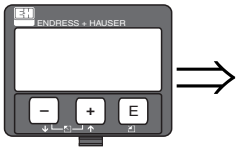


beam type *02
✓Standard/cont.
Modulated

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

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

3.4 "Isotope" (*03)

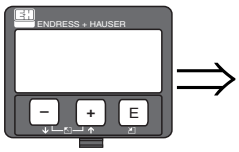


isotope *03
✓137Cs
60Co
no compens.

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

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

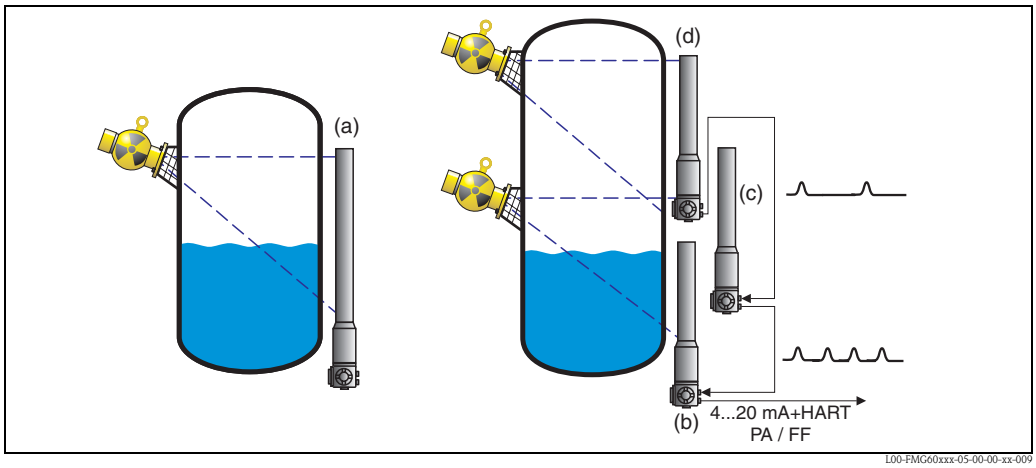
3.5 "Operating mode" (*04)



operating mode *04
✓stand alone
master
slave

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

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



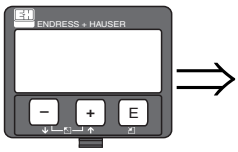
Possible operating modes of the Gammapilot M: ***a:*** *stand alone;* ***b:*** *master;* ***c:*** *slave(s);* ***d:*** *end-slave*

Options/display:

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

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

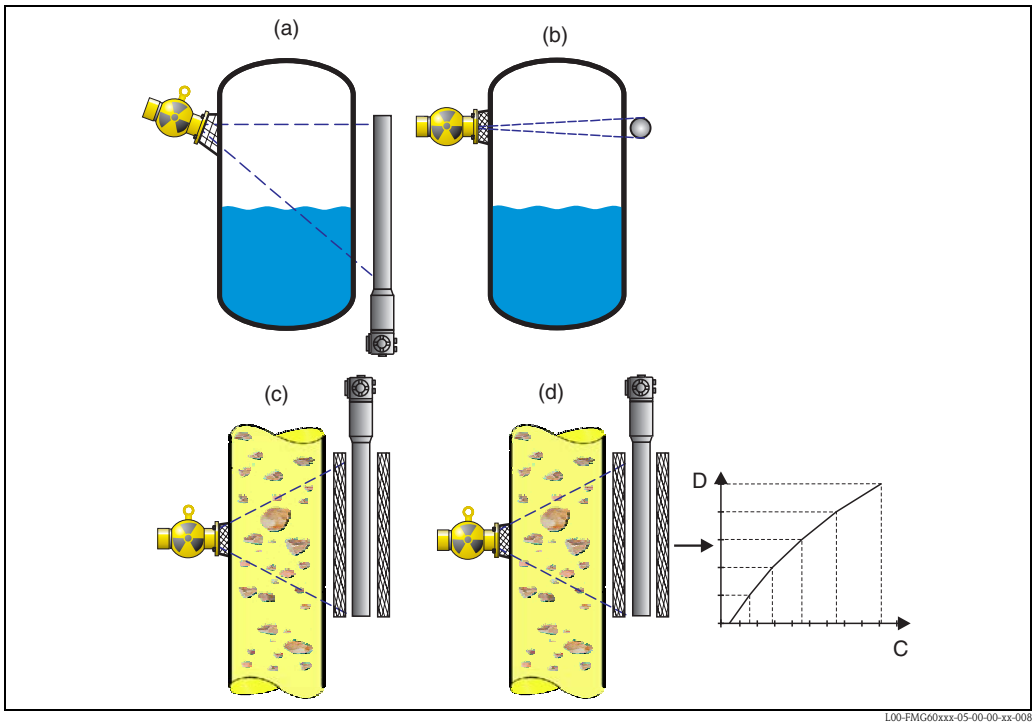
3.6 "Measuring mode" (*05)




```
meas. mode        *05
✓level
 limit
 density
```

This function is used to select the desired measuring mode.

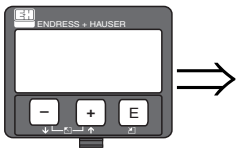
Note!
The selection can be performed only once and the function is automatically locked after that. It can only be unlocked again by a reset of the Gammapilot M (**"Reset" (*A3)** function).



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

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

3.7 "Density unit" (*06)



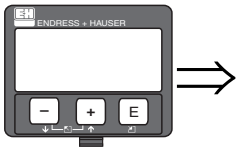
density unit *06
✓g/cm3
g/l
lb/gal

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

Options:
- g/cm^3
- g/l
- lb/gal; [1g/cm^3 = 8,345 lb/gal]
- lb/ft^3; [1g/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.

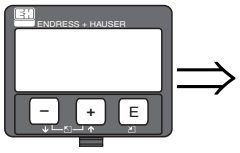
3.8 "Min. density" (*07)



min. density *07
0.9500 g/cm^3

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.

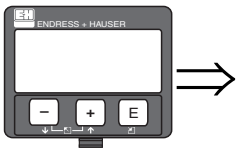
3.9 "Max. density" (*08)



max. density *08
1.2500 g/cm^3

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)

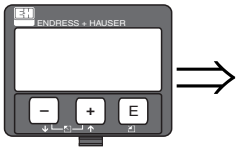


pipe diam. unit *09
✓mm
inch

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

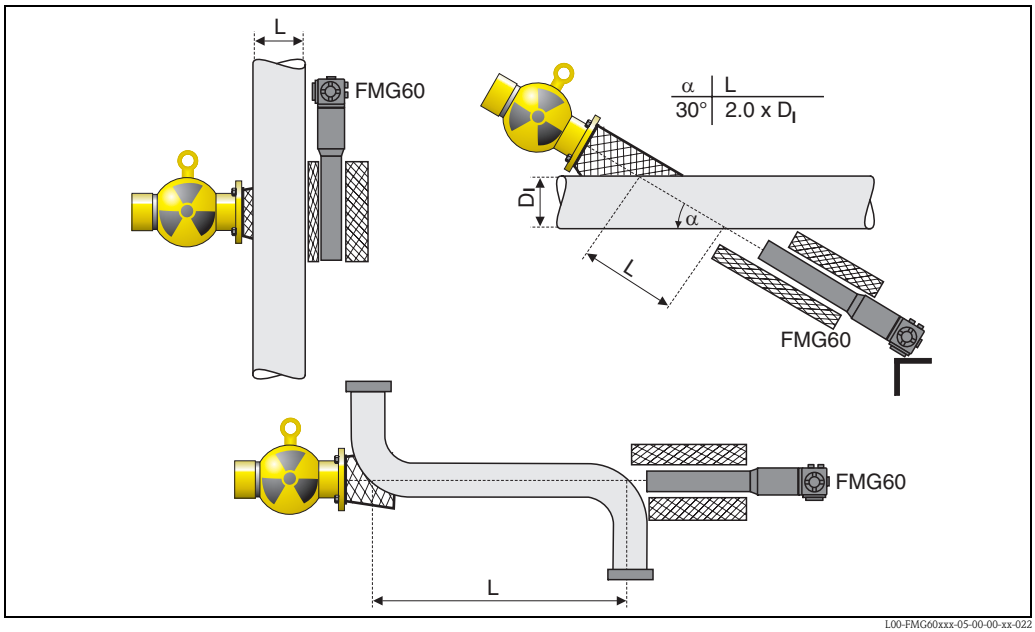
Options:
- mm
- inch [1 inch = 25.4 mm]

3.11 "Pipe diameter" (*0A)



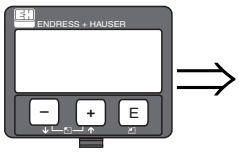
pipe diam. *0A
200 mm

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



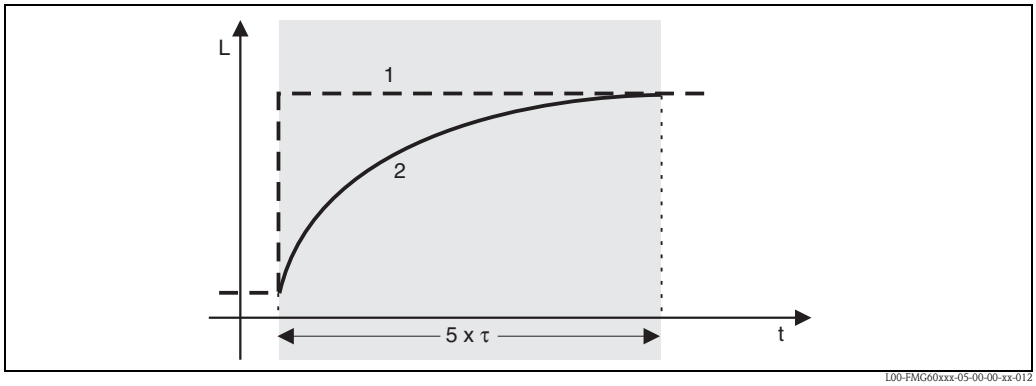
*Always specify the complete irradiated measuring path L in the "pipe diameter" (*0A) function. Depending on the installation, this value may be larger than the actual pipe diameter.*

3.12 "Output damping" (*0B)



output damping *0B
60 s

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



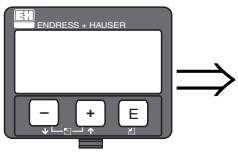
*Effect of the output damping; **1:** Level change (or density change); **2:** measured value*

Range of values
1 to 999 s

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

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

4 "Calibration" (*1) function group



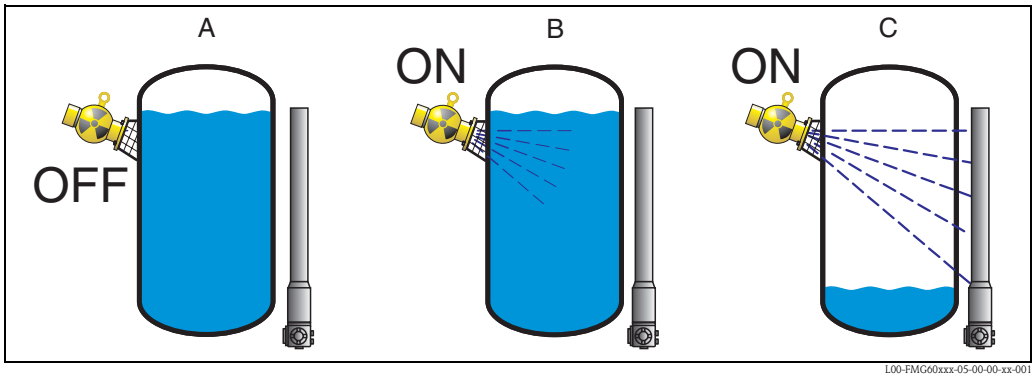
group selection *1→
✓calibration
safety settings
Temp. compensation

Note!
In this chapter the "calibration" (*1) function group is split according to the measuring mode:
- → Kap. 4.1: Calibration for level measurement and limit detection
- → Kap. 4.2: 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



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

Background calibration

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

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

Full calibration

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

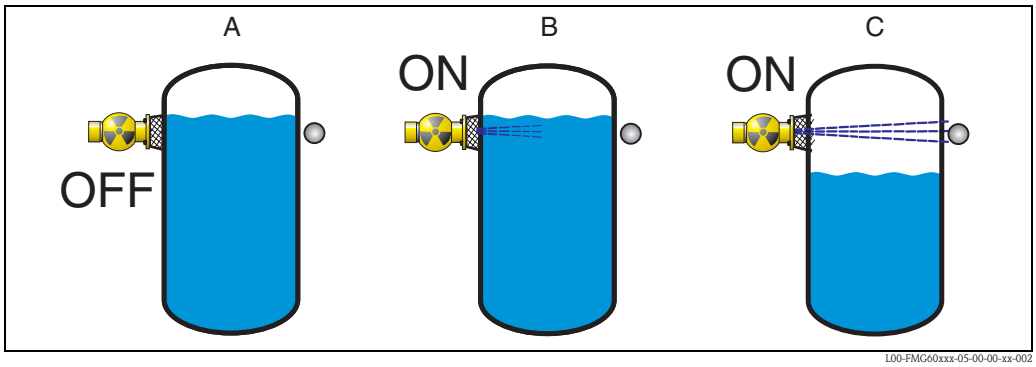
If the vessel cannot be filled to at least 60% during the calibration, the full calibration can alternatively be performed with the radiation switched off, which is a way of simulating a filling of

100%. In this case, the full calibration is identical to the background calibration. As the pulse rate of the background radiation is automatically subtracted, the displayed pulse rate is about 0 cps.

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



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

Background calibration

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

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

Covered calibration

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

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

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.

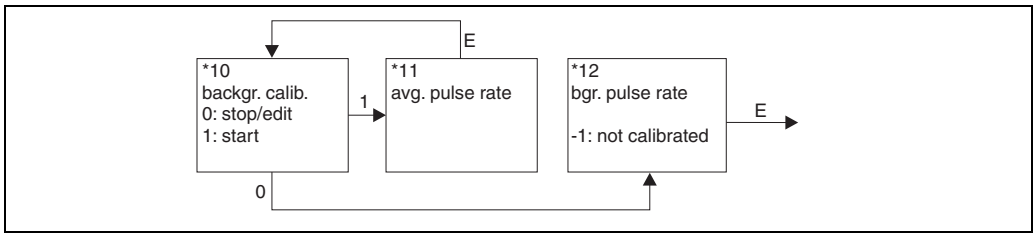
Note!
When calibrating manually, the calibration date is not set automatically. Instead, it must be entered manually into the **"calibration date" (*C7)** function.

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

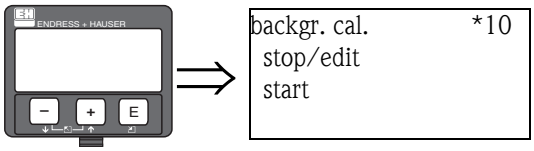
4.1.4 Background calibration

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)

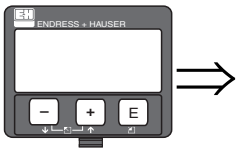


This function is used to start the background calibration

Options:

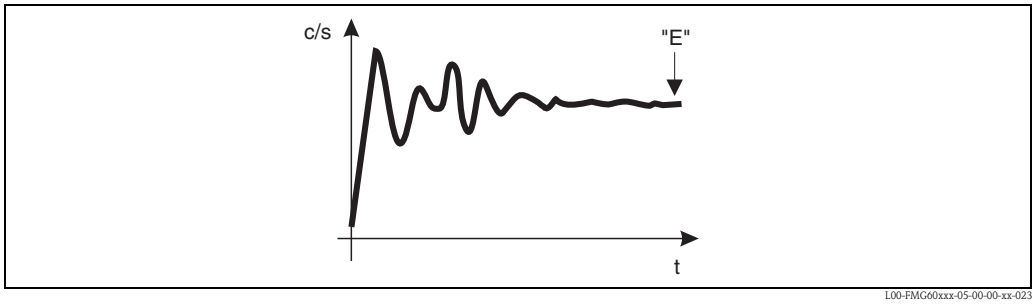
- **stop/edit** This option must be selected if
  – no background calibration is to be performed but the pulse rate of an existing background calibration is to be displayed instead.
  – a manual background calibration is to be performed.
  After selecting this option, the Gammapilot M changes to the **"bgr. pulse rate" (*12)** function, where the existing pulse rate is displayed and can be changed if required.
- **start**
  This option is used to start an automatic background calibration. The Gammapilot M changes to the **"avg. pulse rate" (*11)** function.

"Avg. pulse rate" (*11)



avg. pulse rate *11
186 cps

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



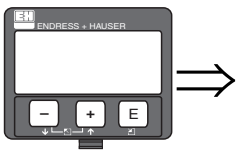
Initially, the pulse rate strongly fluctuates. In the course of time an average value is reached.

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

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

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

"Background pulse rate" (*12)



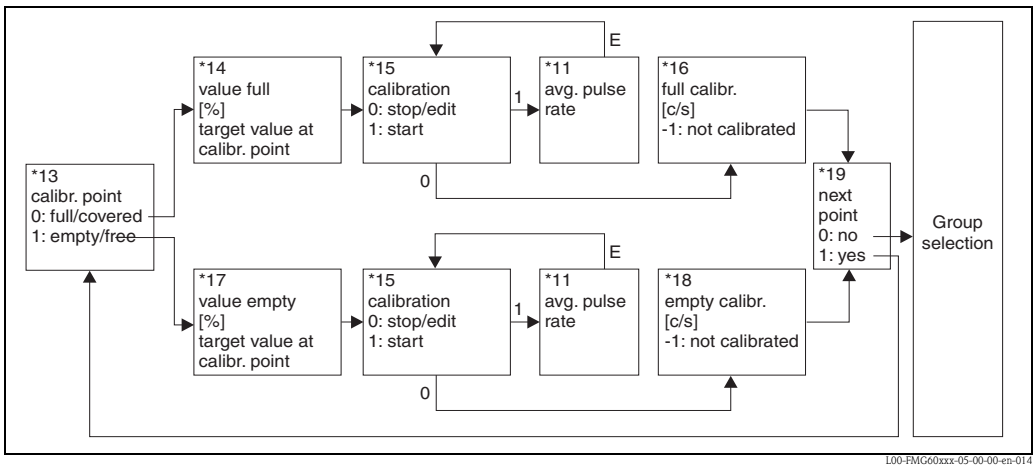
backgr. pul. rate *12
186 cps

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

4.1.5 Full and empty calibration or covered and free calibration

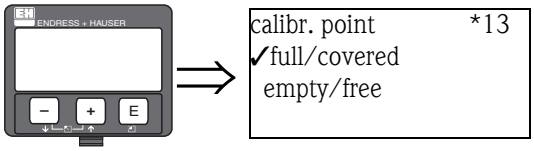
Excerpt from the operating menu

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.



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

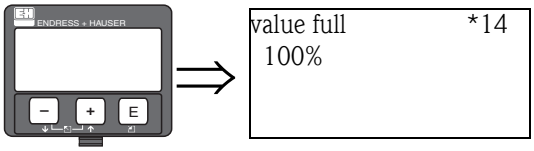
"Calibration point" (*13)

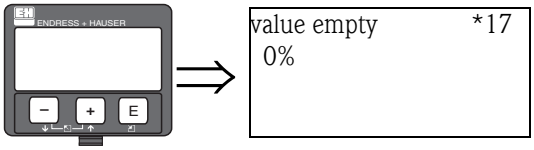


This function is used to select which calibration point ("full/covered" or "empty/free") will be entered.

Options:
- full/covered
- empty/free

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



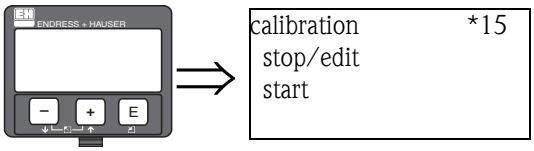


These functions are needed for level measurements only. They are used to specify the level at which the full or empty calibration are performed.

Range of values

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

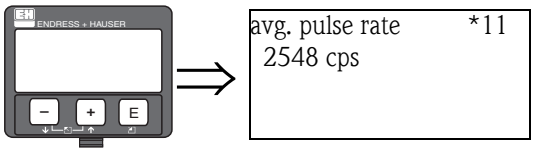
"Calibration" (*15)



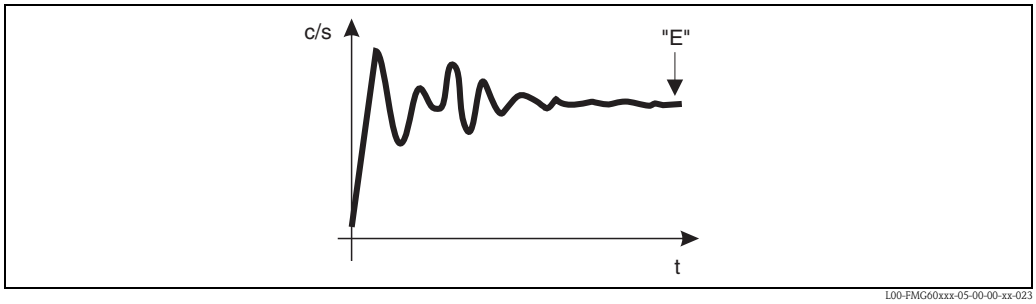
This function is used to start the automatic entering of the selected calibration point.

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

"Avg. pulse rate" (*11)



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



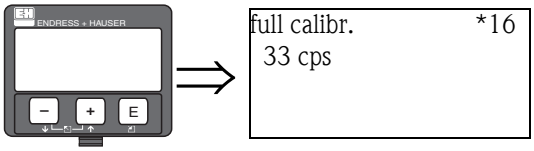
Initially, the pulse rate strongly fluctuates. In the course of time an average value is reached.

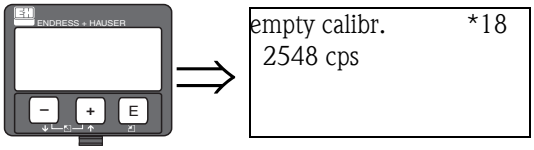
If the value is sufficiently stable, the function can be left by pressing "E".
Thereafter, the Gammapilot M changes to the **"calibration" (*15)** function. Select **"stop/edit"** to stop the averaging procedure. The value is then automatically transmitted to the **"full calibr." (*16)** or **"empty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

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

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

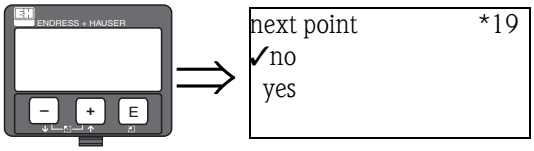
"Full calibration" (*16)
"Empty calibration" (*18)





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

"Next point" (*19)



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

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

4.2 Calibration for density and concentration measurements

4.2.1 Calibration points for density and concentration measurements

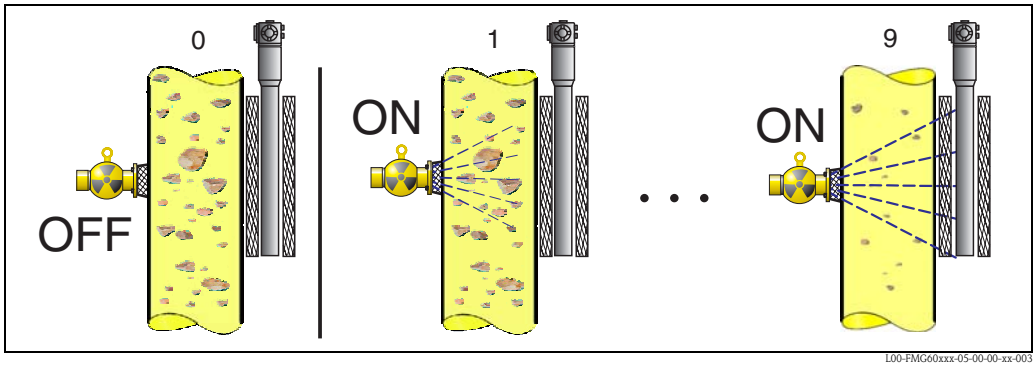
Function of the calibration points

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
- Up to nine calibration points for samples of various known densities.



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

One-point calibration

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

Multiple-point calibration

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

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.

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

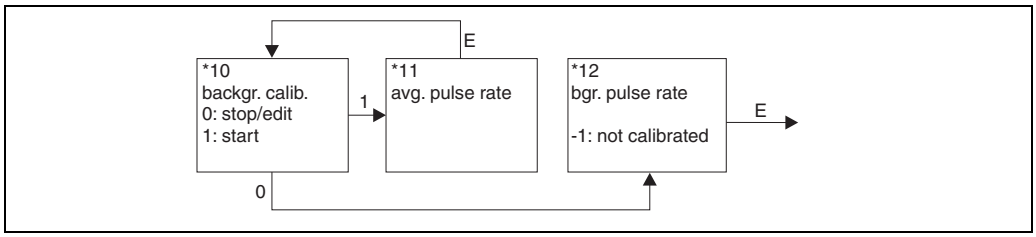
In order to achieve a high measuring accuracy, it is advisable to determine the pulse rates for a couple of samples of the same density and to calculate the average density and average pulse rate for these samples. These values can then be entered manually into the Gammapilot M.
If possible, this procedure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

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

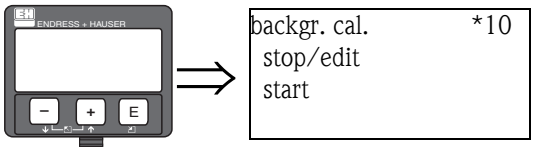
4.2.3 Background calibration

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)



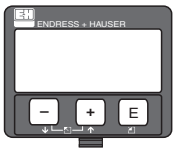
This function is used to start the background calibration

Options:

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

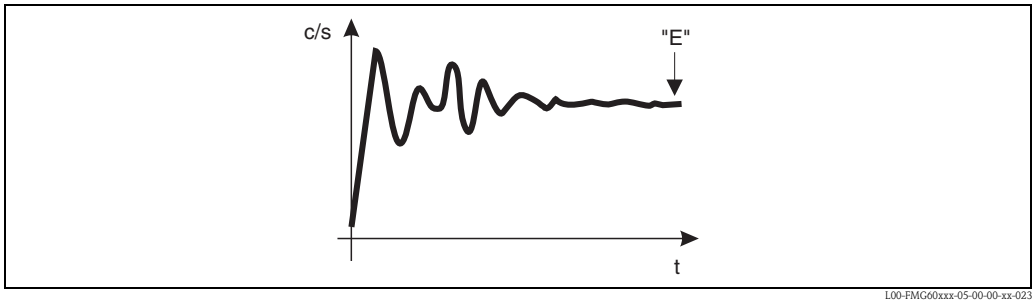
  After selecting this option, the Gammapilot M changes to the **"bgr. pulse rate" (*12)** function, where the existing pulse rate is displayed and can be changed if required.
- **start**
  This option is used to start an automatic background calibration. The Gammapilot M changes to the **"avg. pulse rate"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

"Avg. pulse rate" (*11)



avg. pulse rate *11
186 cps

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



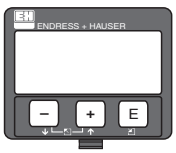
Initially, the pulse rate strongly fluctuates. In the course of time an average value is reached.

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

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

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

"Background pulse rate" (*12)



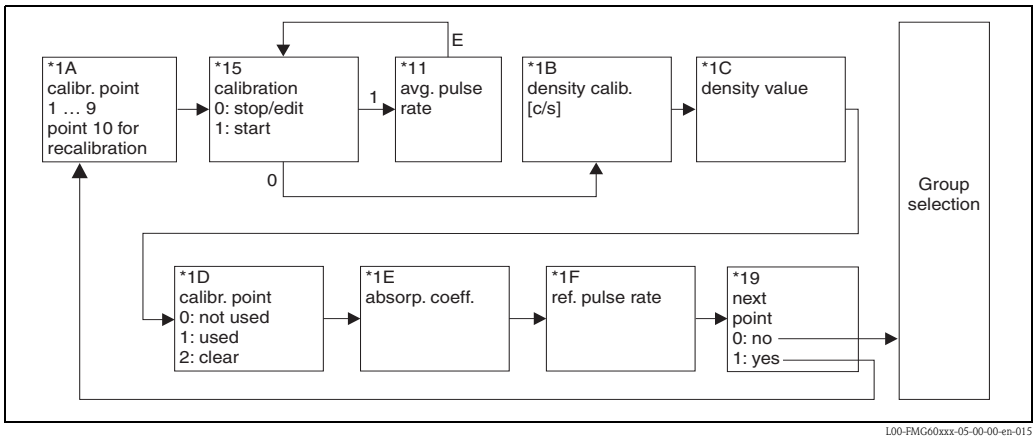
backgr. pul. rate *12
186 cps

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

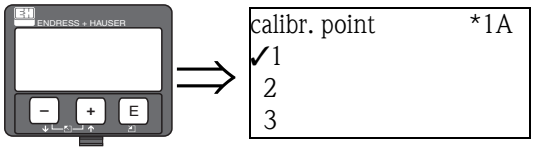
4.2.4 Calibration points

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.



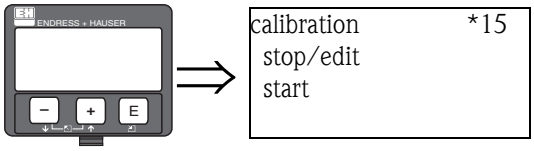
"Calibration point" (*1A)



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

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

"Calibration" (*15)

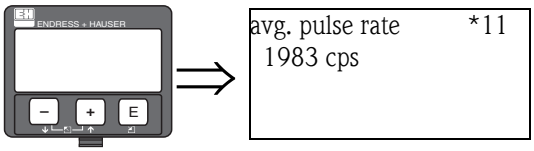


This function is used to start the automatic entering of the selected calibration point.

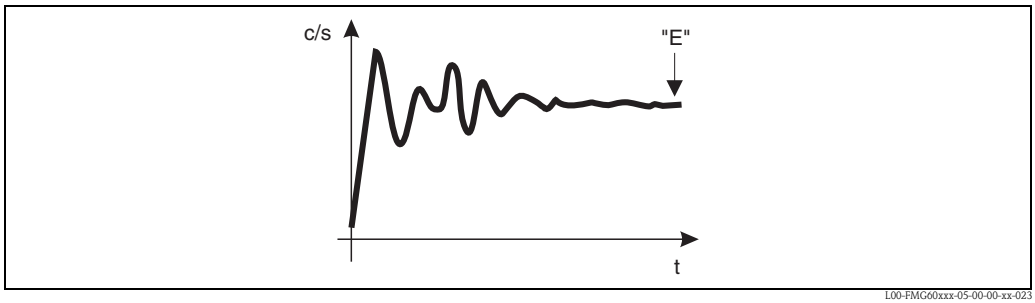
Options:
- **stop/edit** This option must be selected if
  – the calibration point is not to be entered (e.g. because it has already been entered). The pulse rate of the calibration point is then displayed in the following function **"density calib." (*1B)**. If required, this value can be changed.
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

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

"Avg. pulse rate" (*11)



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



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

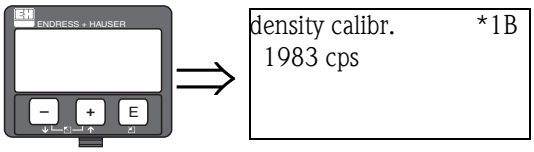
If the value is sufficiently stable, the function can be left by pressing "E".
Thereafter, the Gammapilot M changes to the **"calibration" (*15)** function. Select **"stop/edit"** to stop the averaging procedure. The value is then automatically transmitted to the **"density calibr." (*1B)** function.

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

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

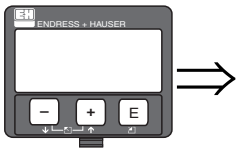
Note!
The integration is **not** terminated by pressing "E" in the **"avg. pulse rate" (*11)** function. It is continued until the selection of **"stop/edit"** in the **"calibration" (*15)** function. This may result in a slight deviation between the last displayed average pulse rate and the final **"density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

"Density calibration" (*1B)



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

"Density value" (*1C)

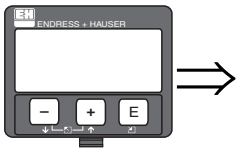


density value *1C
0.9963 g/cm3

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

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

"Calibration point" (*1D)

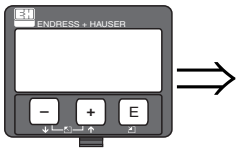


calibr. point *1D
not used
✓used
clear

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

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

"Absorption coefficient" (*1E)

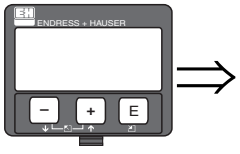


absorp. coeff. *1E
7.70 mm2/g

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

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

"Reference pulse rate" (*1F)

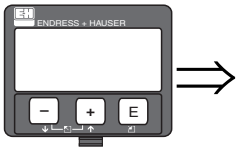


ref. pulse rate *1F
31687 cps

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

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

"Next point" (*19)



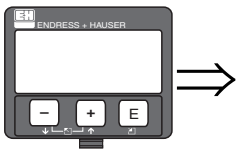
next point *19
✓no
yes

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

Options:

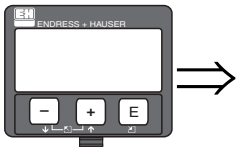
- **no**
  This option must be selected if no further calibration point is to be entered or changed. After this selection the Gammapilot M returns to the group selection and the calibration is completed.
- **yes**
  This option must be selected if a further calibration point is to be entered or changed.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

5 "Safety settings" (*2) function group



group selection *2→
✓Safety settings
Temp. compensation
Linearization

5.1 "Output on alarm" (*20)

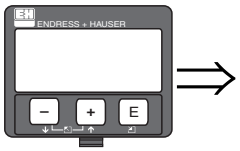


outp. on alarm *20
MIN -10% 3.6mA
MAX 110% 22mA
Hold

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)



outp. on alarm *21
22.00 mA

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 mA to 22 mA

5.3 SIL locking (for max. level limit detection 200/400 mm PVT scintillator)

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 or ToF Tool 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
7. Radiation source = Cs or Co

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

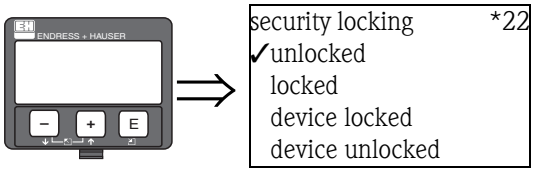
5.3.1 List of the parameters to be confirmed

The following list of 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)
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

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

The FMG60 can be unlocked in SIL2 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.



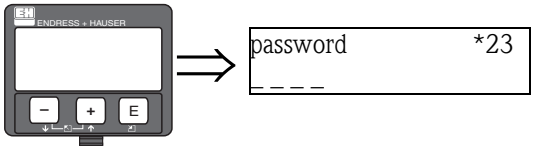
Options:
- unlocked
- locked
- device locked
- device unlocked

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 two real time clocks are synchronized in accordance with Section 13.1.2. The device then has an error current.

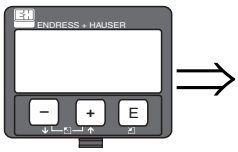
5.3.4 Function "password" (*23) (security password)

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.



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".

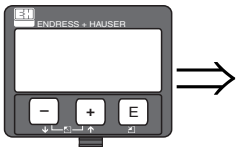


confirm Iout *24
✓not valid
valid

Options:
- not valid
- valid

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

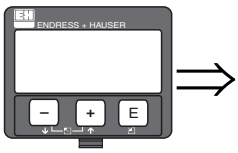
To verify that numbers are shown properly on the display, the sequence of numbers > 0123456789 .- < is the first element to be confirmed on the display. The user must confirm the numbers are displayed correctly. If an error occurs in how the numbers are displayed, the user must abort the locking action.



confirm sequence *25
>0123456789 .-<
✓not valid
valid

Options:
- not valid
- valid

5.3.7 Function "confirm backgr." (*26)

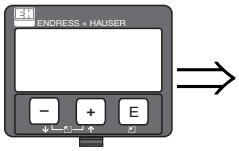


confirm backgr. *26
_ _ _ _ _ _
✓not valid
valid

Options:
- Not valid
- Valid

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)

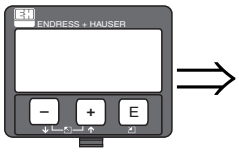


confirm cal. *27
_ _ _ _ _ _
_ _ _ _ _ _
✓not valid
valid

Options:
- Not valid
- Valid

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

5.3.9 Function "confirm source" (*28)

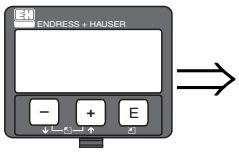


confirm source *28
_ _ _ _ _ _
_ _ _ _ _ _
✓not valid
valid

Options:
- Not valid
- Valid

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

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

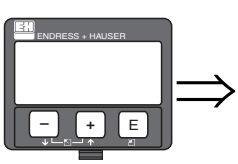


confirm time *29
_ _ _ _ _ _
_ _ _ _ _ _
✓not valid
valid

Options:
- Not valid
- Valid

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

5.3.11 Function "confirm date" (*2A)

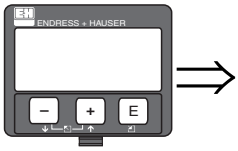


confirm date *2A
_ _ _ _ _ _
_ _ _ _ _ _
✓not valid
valid

Options:
- Not valid
- Valid

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

5.3.12 Function "confirm length" (*2B)

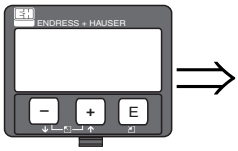


confirm length *2B
_ _ _ _ _ _
✓not valid
valid

Options:
- Not valid
- Valid

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)



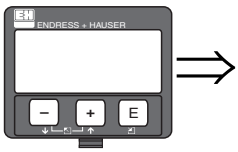
confirm password *2C
_ _ _ _ _ _
✓not valid
valid

Options:
- Not valid
- Valid

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

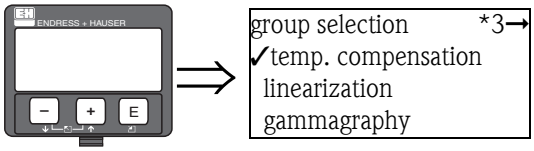
5.3.14 Function "password" (*2D) (unlock password)

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.



password *2D
_ _ _ _

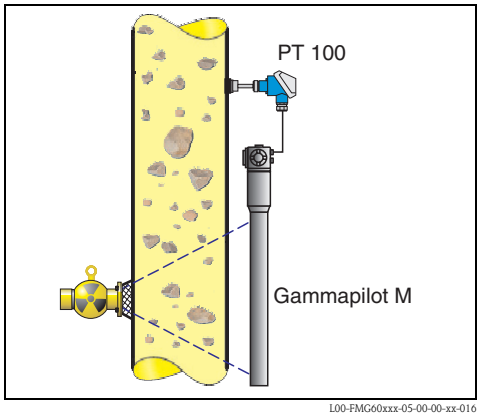
6 "Temperature compensation" (*3) function group



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.



L00-FMG60xxx-05-00-00-xx-016

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:

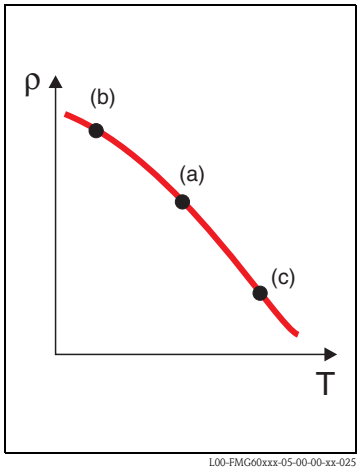
- ρ_{ref} : the displayed density
- ρ : the measured density
- T_{ref} : the references temperature (as specified by the user)
- T : the current temperature of the measured medium as given by the PT-100 sensor
- t_{k1} : the linear temperature coefficient
- t_{k2} : the square temperature coefficient

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 (a) and the lowest temperature (b) 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 (c) 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.



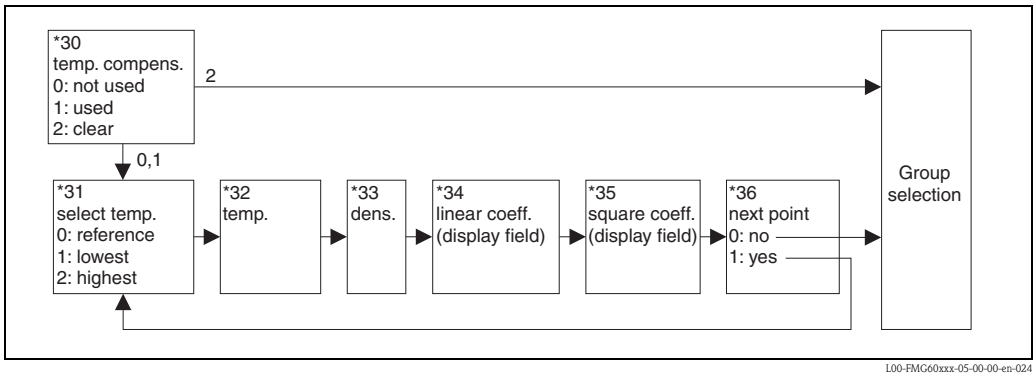
(a): reference temperature T_{ref}
(b): lowest temperature
(c): highest temperature (optional)

Example: Density of water

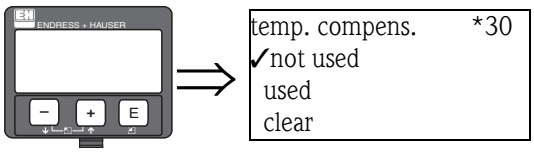
T [°C]	T [°F]	ρ [g/cm³]		T [°C]	T [°F]	ρ [g/cm³]
0	32.0	0.9998		34	93.2	0.9942
2	35.6	0.9999		36	96.8	0.9934
4	39.2	1.000		38	100.4	0.9928
6	42.8	0.9999		40	104.0	0.9922
8	46.4	0.9998		45	113.0	0.9902
10	50.0	0.9997		50	122.0	0.9880
12	53.6	0.9994		55	131.0	0.9857
14	57.2	0.9992		60	140.0	0.9832
16	60.8	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)

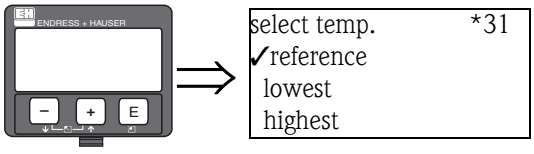


The temperature compensation can be switched on and off in this function.

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)

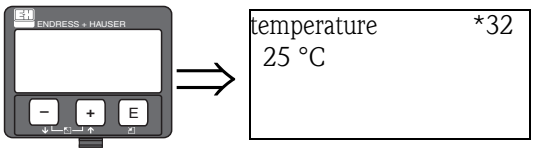


This function determines which temperature will be entered in the following functions (see diagram on 40).

Options:

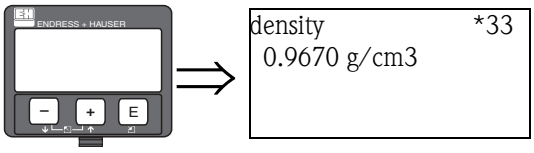
- **reference**
  the desired reference temperature
- **lowest**
  the lowest temperature
- **highest**
  the highest temperature

6.5 "Temperature" (*32)



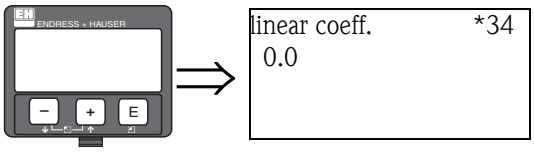
The temperature of the selected pair of values is specified in this function.
The unit for the temperature input can be set in the **"temperature unit" (*C6)** function.

6.6 "Density" (*33)



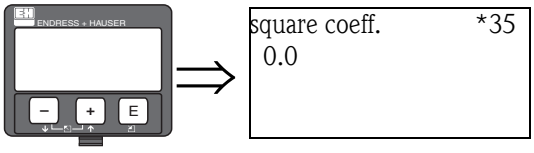
The density of the selected pair of values is specified in this function.
The unit for the temperature input can be set in the **"density unit" (*06)** function.

6.7 "Linear coefficient" (*34)



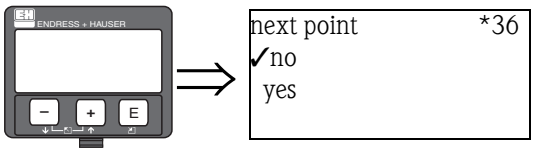
The linear temperature coefficient t_{k1}, is displayed in this function.
"0.0" is displayed if fewer than two pairs of values have been entered. Temperature compensation is impossible in this case.
The unit is: $g/(cm^3K)$.
This function serves for plausibility checks only and cannot be edited.

6.8 "Square coefficient" (*35)



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)

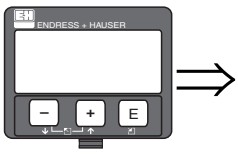


This functions is used to specify, if a further pair of values is to be entered or not.

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



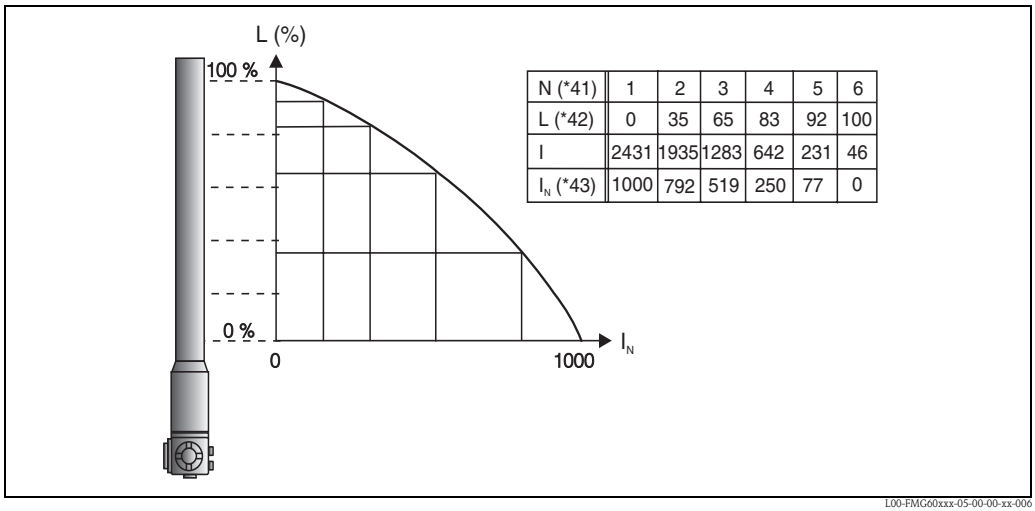
group selection *4→
✓linearization
gammagraphy
output

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



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

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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; **IN** : normalized pulse rate*

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

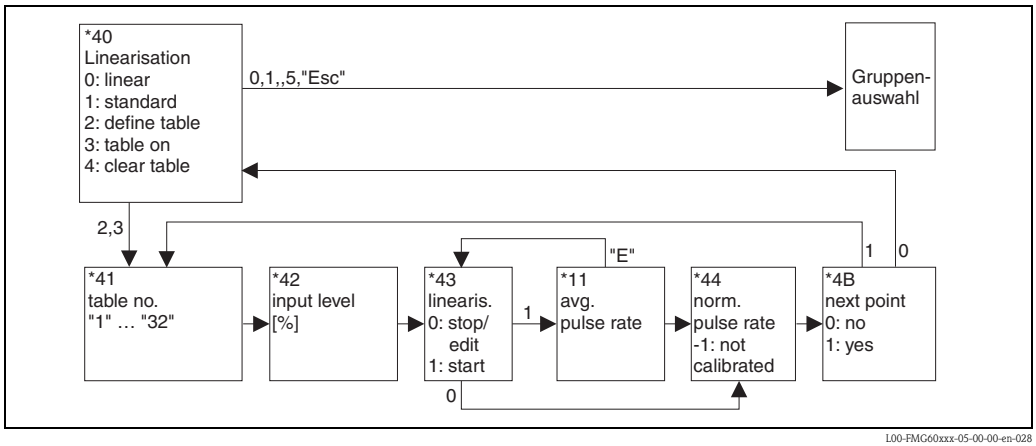
For automatic entering of the linearization point, the vessel must be filled to the required level. The radiation must be switched on. The Gammapilot M automatically records the pulse rate. The associated level is entered by the user.

Manual linearization

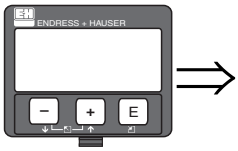
If during the commissioning of the Gammapilot M one or more points of the linearization table cannot be realized (e.g. because the vessel cannot be sufficiently filled or emptied), the table must be entered manually.
That means, not only the level but also the associated pulse rate must be entered by 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.

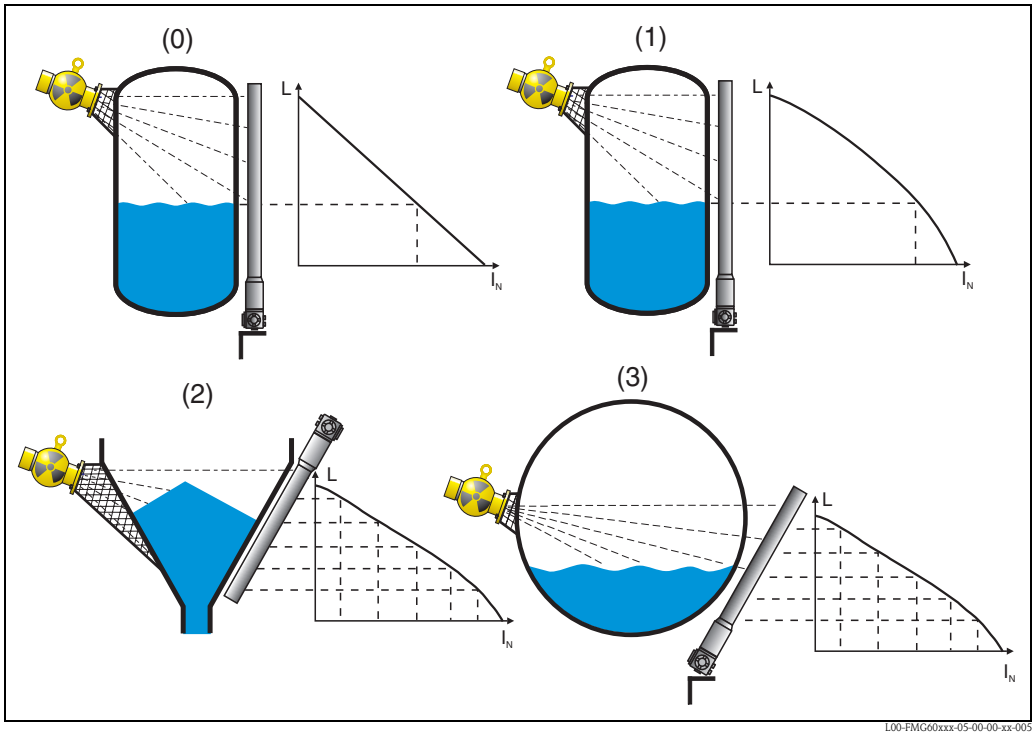


7.1.5 "Linearization (*40)



linearization	*40
linear	
standard	
define table	

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



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*Linearization modes for level measurements; **0:** linear; **1:** standard; **2/3:** linearization table (two examples); **L:** level; **IN:** normalized pulse rate*

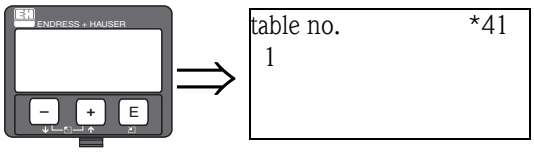
Options:

- **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 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" (+ and − simultaneously) twice.
- **clear table**
  This selection deletes an existing linearization table. The linearization mode is set to "linear".

Note!
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)

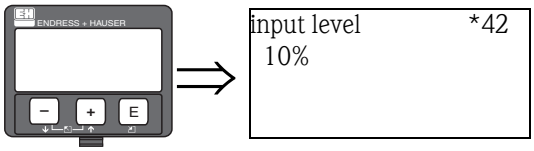


This function is used to select a point of the linearization table for entering, viewing or editing. The following functions will refer to the selected point.

Range of values
01 ... 32

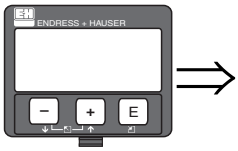
Caution!
Table points must also be entered as a normalized pulse rate for the empty and full calibration. If these points are missing, the calibration cannot be performed for the entire measuring range.

7.1.7 "Input level" (*42)



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)



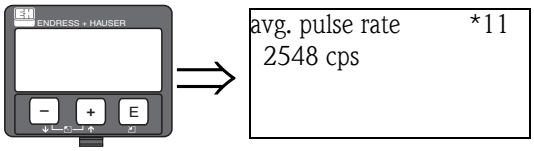
This function is used to start the automatic entering of the selected linearization point.

Options:

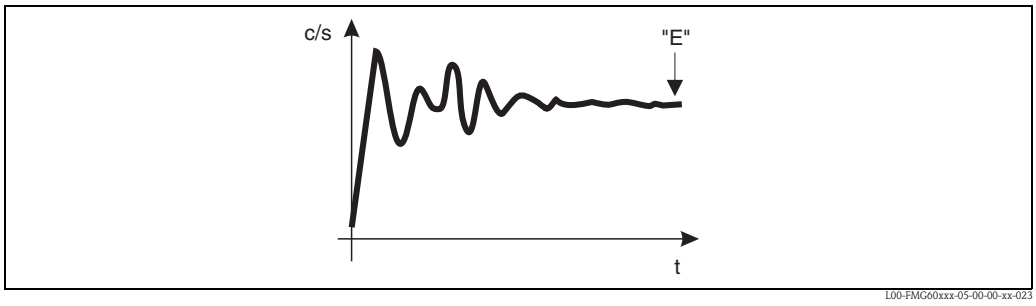
- **stop/edit** This option must be selected if
  - the linearization point is not to be entered (e.g. because it has already been entered). The pulse rate of the linearization point is then displayed in the following function, **"normalized pulse rate" (*44)**. If required, this value can be changed.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

Note!
The "ToF Tool - FieldTool Package/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)



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.



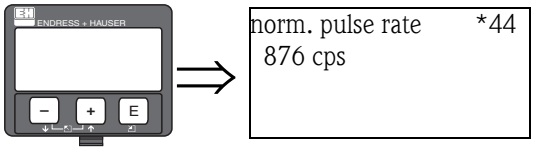
Initially, the pulse rate strongly fluctuates. In the course of time an average value is reached.

If the value is sufficiently stable, the function can be left by pressing "E".
Thereafter, the Gammapilot M changes to the **"calibration" (*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.

Note!
The maximum integration time is 1000 s. After this time, the value is automatically transmitted to the **"normalized pulse rate" (*44)**.

Note!
The integration is **not** terminated by pressing "E" in the **"avg. pulse rate" (*11)** function. It is continued until the selection of **"stop/edit"** in the **"calibration" (*43)** function. This may result in a slight deviation between the last displayed average pulse rate and the final **"normalized pulse rate (*44)**.

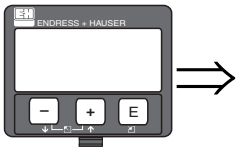
7.1.10 "Normalized pulse rate" (*44)



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).

Note!
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)



next point *4B
no
yes

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

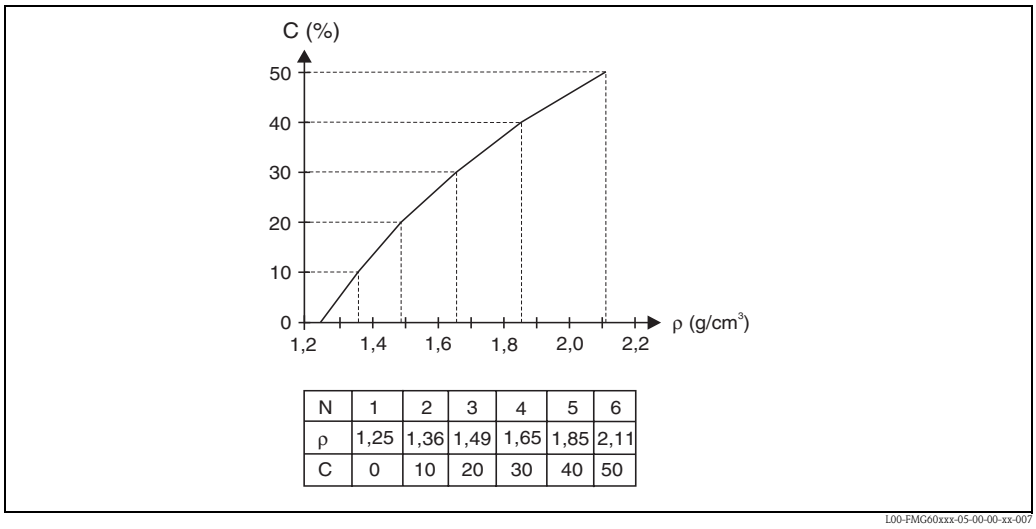
7.2.1 Units, linearization table

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



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

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

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):

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

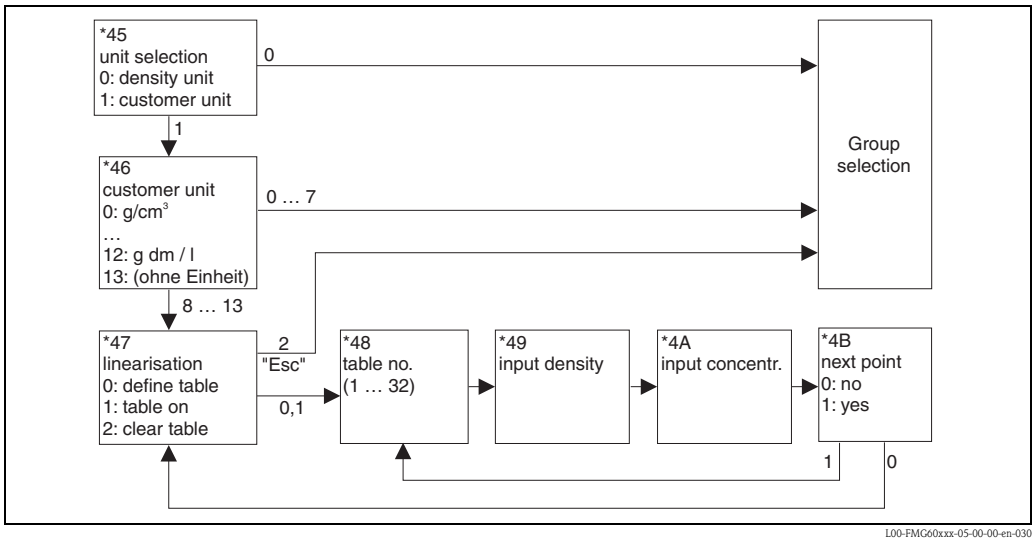
solids content (mass per volume):

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

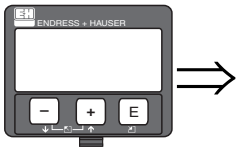
In these equations
- C: the concentration (to be entered into the linearization table)
- ρ: the measured density (to be entered into the linearization table)
- ρ_c: the density of the carrier liquid
- ρ_S: the density of the solid

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)

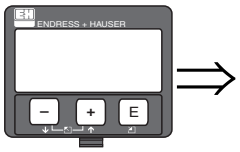


unit selection *45
✓density unit
customer unit

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)



customer unit *46
✓g/cm3
g/l
lb/gal

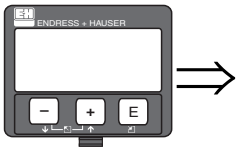
The desired concentration unit is selected in this function.

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.

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

7.2.6 "Linearization" (*47)



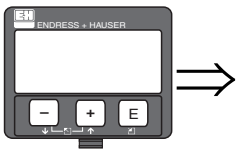

```
linearization          *47
✓define table
 table on
 clear table
```

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" (+ and – simultaneously) twice.
- **clear table**
  This selection deletes an existing linearization table and a completely new table can be entered.

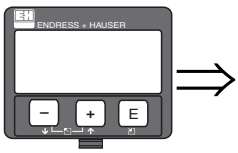
7.2.7 "Table no." (*48)




```
table no.              *48
 1
```

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.

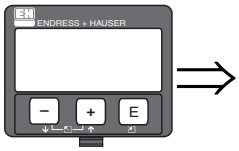
7.2.8 "Input density (*49)

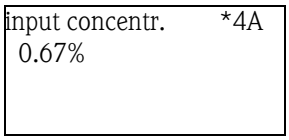



```
input density          *49
 0.987 g/cm3
```

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

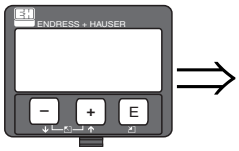
7.2.9 "Input concentration" (*4A)

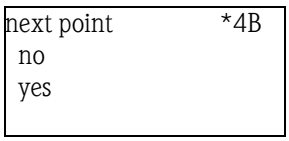




The concentration of the respective linearization point is entered into this function. The unit is as specified in the **"customer unit" (*46)** function.

7.2.10 "Next point" (*4B)





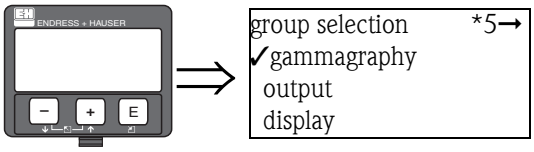
This function is used to specify, if a further linearization point is to be entered or not.

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.

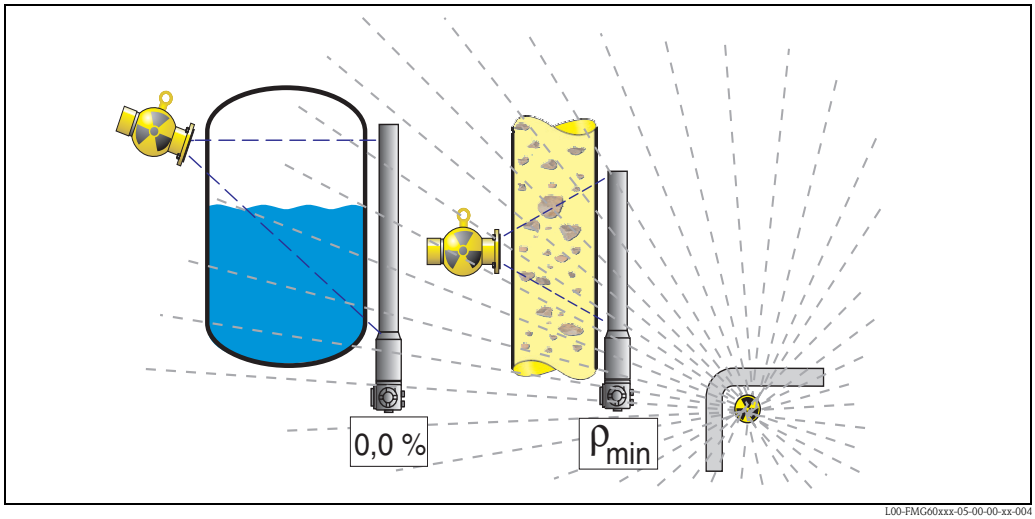
8 "Gammagraphy" (*5) function group

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



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:

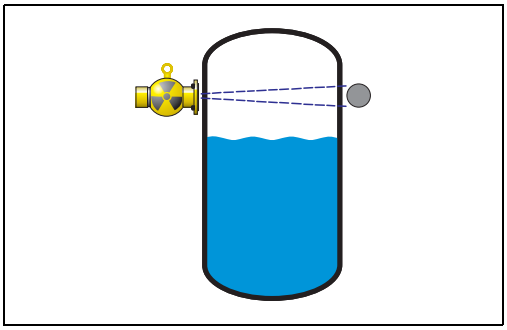
1. The pulse rate at the detector rises or falls very abruptly (**"span time" (*51)** function).
2. The pulse rate at the detector exceeds the maximum or falls below the minimum value. These values are determined by the **"measuring mode" (*05)** function:

"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)

Note!
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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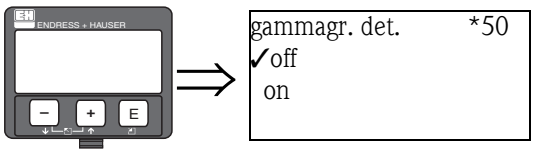
✎ Note!
In the case of detectors mounted horizontally, as usually used for level limit applications, speed monitoring (1st gammagraphy criterion) cannot be used properly due to the narrow measuring range. In such instances the "span time" (*51) should be set to "0 s". This switches off the monitoring. 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[2)] 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[2] is produced.

8.2 "Gammagraphy detection" (*50)

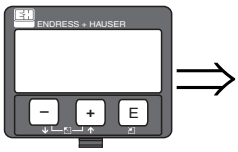


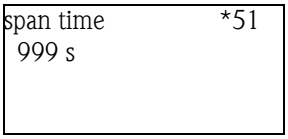
The gammagraphy detection can be switched on and off in this function.

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.

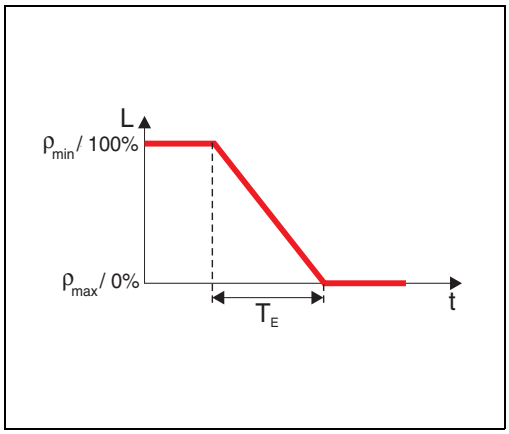
2) For the meaning of "warning" and "alarm" messages refer to Operating Instructions BA236F.

8.3 "Span time" (*51)





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.



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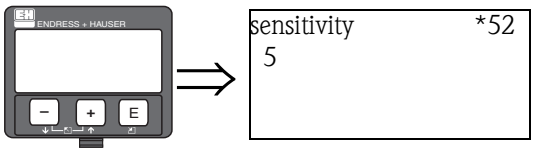
✎ Note!
The span time can be set between 0 and 999 seconds. 0 seconds means that the pulse rate change speed is not monitored. It can be useful to set the span time shorter than the actual span time for tanks with agitators so that the rapid changes in pulse rate caused by the stirring action do not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

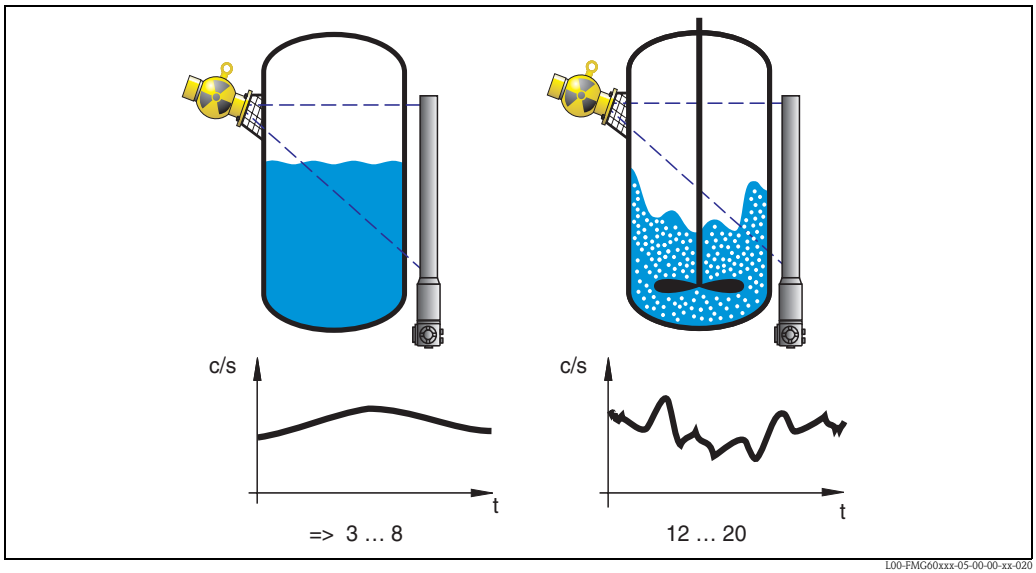
8.4 "Sensitivity " (*52)



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.

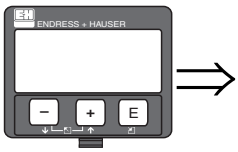
Selecting the sensitivity value
The suitable sensitivity value strongly depends on the process and ambient conditions. Therefore it is impossible to give a general rule for its selection. However, one can take the following principles as a guideline:

- For homogeneous materials with plain and calm surfaces a low value (3 ... 8) should be chosen. Gammagraphy radiation will then be detected with high probability.
- For inhomogeneous materials and turbulent surfaces a high value (12 ... 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.



*Criteria for selecting the sensitivity: **left**: ow values for plain, calm surfaces and homogeneous materials; **right**: large values for turbulent surfaces and inhomogeneous materials.*

8.5 "Output gammagraphy" (*53)



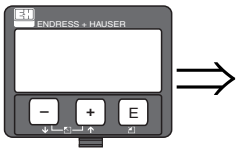
outp. on gammagr. *53
MIN -10% 3.8mA
MAX 110% 20.5mA
hold

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

	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.	

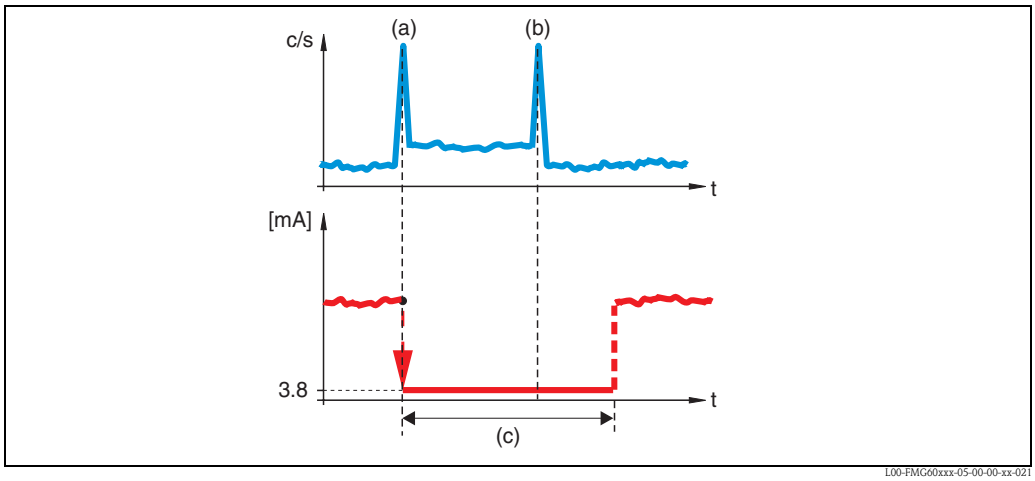
In safety-related applications, the output current for gammagraphy is always 3.8 mA.

8.6 "Hold time" (*54)



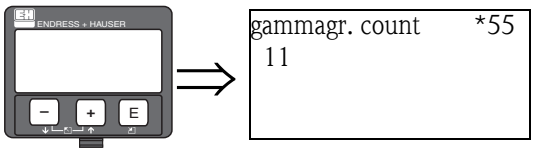
hold time *54
300 s

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.



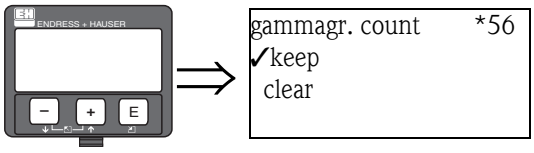
top: *typical curve of pulse rates;* ***(a):*** *start of the gammagraphy measurement;* ***(b):*** *end of the gammagraphy measurement*
bottom: *output signal;* ***(c):*** *"hold time" (*54)*

8.7 "Gammagraphy count" (*55)



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

8.8 "Gammagraphy count" (*56)

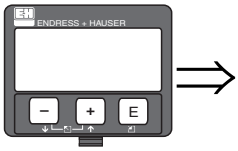


The gammagraphy counter can be reset by this function.

Options:

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

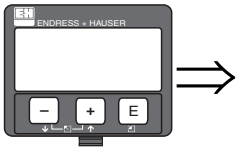
9 "Output" (*6) or "profibus param." (*6) function group



group selection *6→
✓output
display
diagnostics

group selection *6→
✓profibus param.
display
diagnostics

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



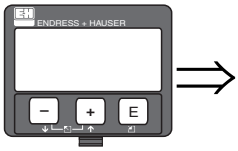
commun. address *60
0

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) (for PROFIBUS PA devices only)



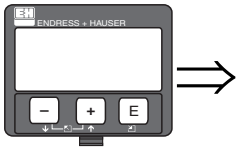
instrument addr. *60
126

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.

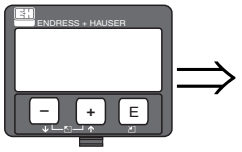
9.3 "No. of preambles" (*61) (for HART devices only)



no. of preambles *61
5

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) (for PROFIBUS PA devices only)

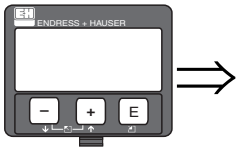


ident number *61
✓manufacturer
profile

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)

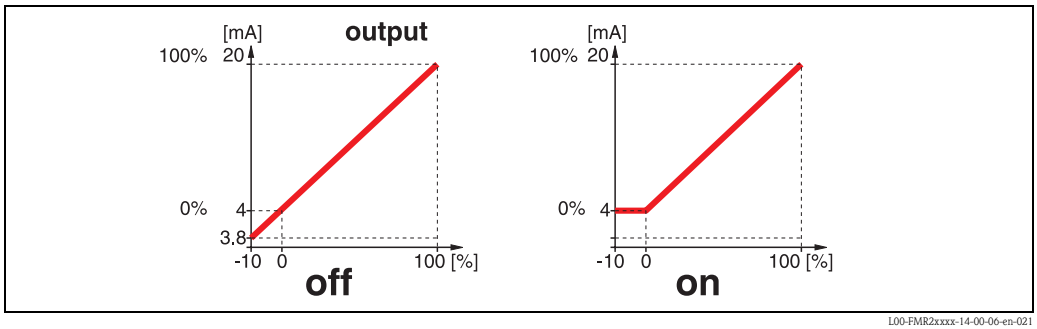
9.5 "Low output limit" (*62) (for HART devices only)



low output limit *62
✓off
on

The output of negative measuring values can be suppressed with this function.

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



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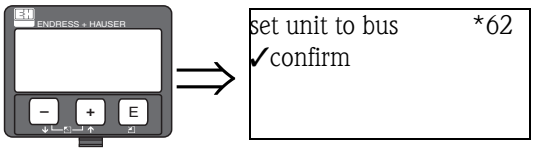
In safety-related applications, the "low output limit" is always "off".

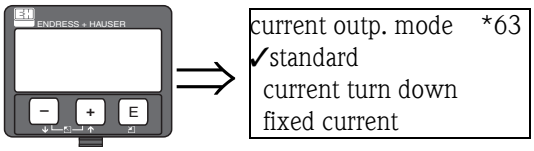
9.6 "Set unit to bus" (*62) (for PROFIBUS PA devices only)



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.

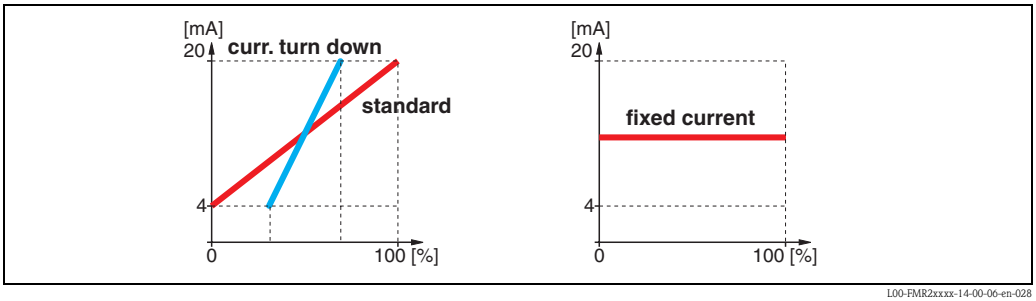
Options:
- confirm

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



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.



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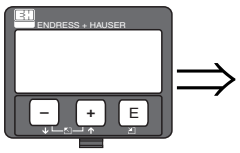
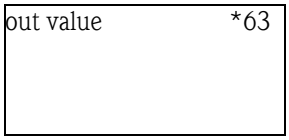
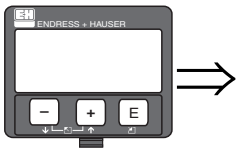
9.8 "Out value" (*63) (for PROFIBUS PA devices only)

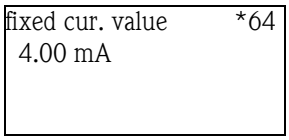




Displays the output of the AI block.

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

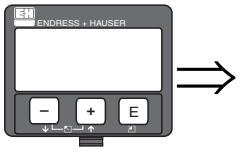


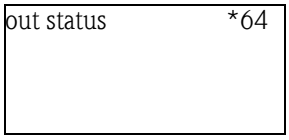


Set the fixed current value with this function. This entry is necessary when you have selected the **"fixed current"** option in the **"current output mode" (*63)** function.

Range of values:
- 3.8 ... 20.5 mA

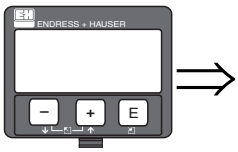
9.10 "Out status" (*64) (for PROFIBUS PA devices only)





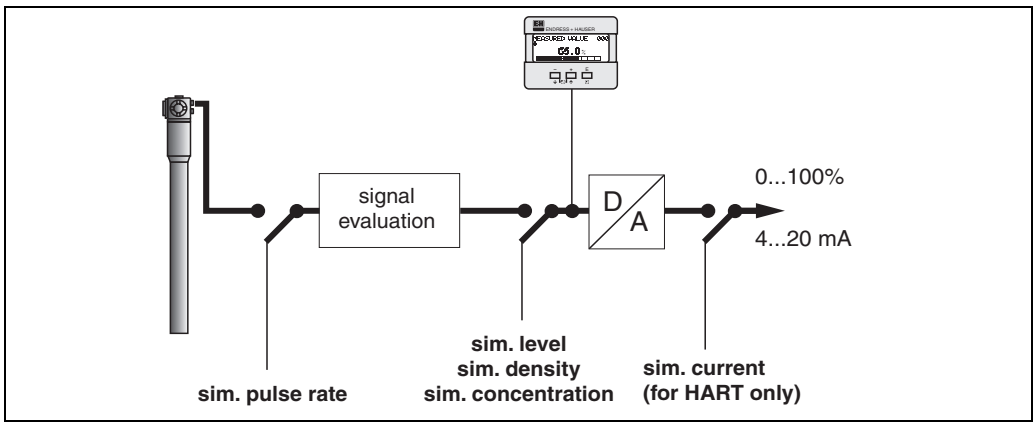
Displays the status of the output value (for the meaning of the status refer to Operating Instructions BA 329F).

9.11 "Simulation" (*65)



simulation *65
✓sim. off
Sim. pulse rate
Sim. level

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.



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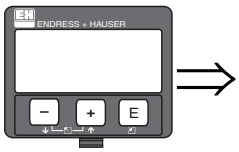
Options:

- **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)

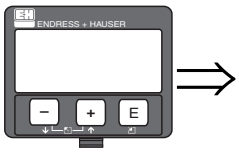


simulation value *66
2000 c/s

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

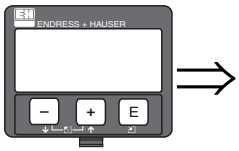
9.13 "Output current" (*67) (for HART devices only)



output current *67
12.38 mA

This function displays the present output current.

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

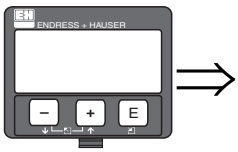


2nd cyclic value *67
✓Avg. pulse rate
medium temp.

Use this function to select the second cyclic value.

Options:
- pres. avg. pulse rate (default)
- medium temperature

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



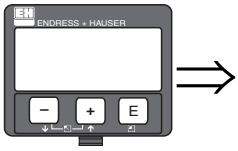

```
4mA value          *68
 10 %
```

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.

Note!
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) (for PROFIBUS PA devices only)

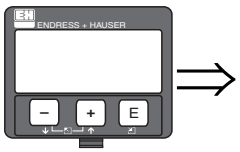



```
select V0H0        *68
✓measured value
 display value
```

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) (for HART devices only)



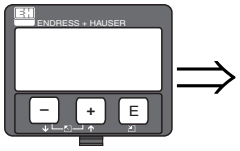
20mA value *69
90 %

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.

Note!
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)

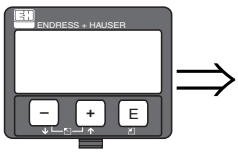
9.18 "Display value" (*69) (for PROFIBUS PA devices only)



display value *69

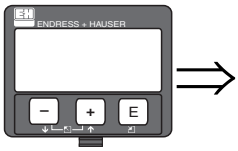
This field can be set externally, e.g. from a PLC. The value is then shown on the display as the primary value if **"select V0H0" (068) = "display value"**.

10 "Display" (*9) function group



group selection *9→
✓display
diagnostics
system

10.1 "Language" (*92)

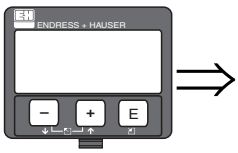


language *92
✓English
Français
Español

Selects the display language.

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

10.2 "Back to home" (*93)



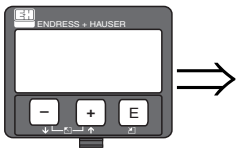
back to home *93
900 s

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

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

10.3 "No. of decimals" (*95)

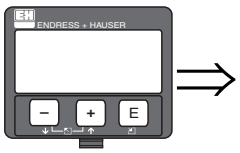



```
no. of decimals      *95
✓x.xx
 x.xxx
 x
```

The number of decimals is specified in this function.

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)

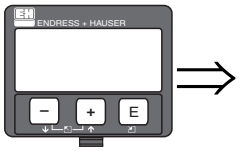



```
sep. character       *96
✓.
 ,
```

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

Options:
- point (.)
- comma (,)

10.5 "Display test" (*97)

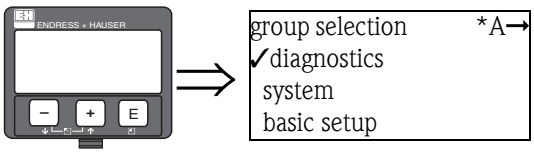



```
display test         *97
✓off
 on
```

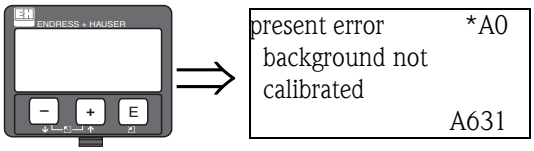
This function can be used to check the display.

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

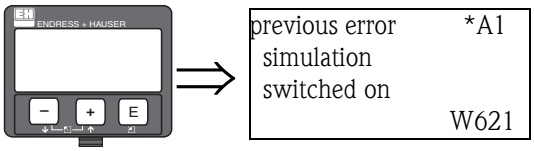


11.1 "Present error" (*A0)



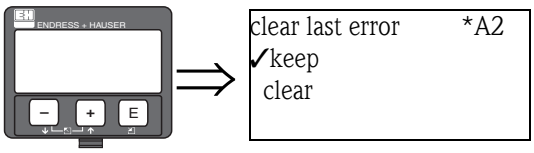
The present error is displayed in this function.
If several errors are present, use ⊞ and ⊟ to page through the error messages.

11.2 "Previous error" (*A1)



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

11.3 "Clear last error" (*A2)

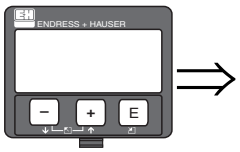


The "previous error" (*A1) can be deleted by this function.

Options:

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

11.4 "Reset" (*A3)



reset *A3
0
for reset code
see manual

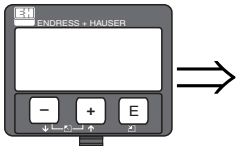
The device can be set back to factory settings by this function.
A reset is recommended whenever a device with an unknown history is to be used.

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)



unlock parameter *A4
0

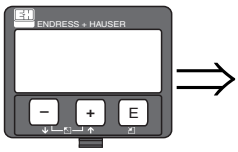
The device can be locked against unauthorized or accidental changes by this function.

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.

Note!
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 BA 236F.

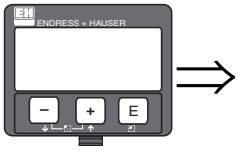
11.6 "Present average pulse rate" (*A5)



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

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

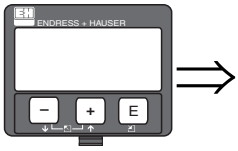
11.7 "Average raw pulse rate" (*A6)



avg. raw pulse rate *A6
182 cps
at integration time
not compensated

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.

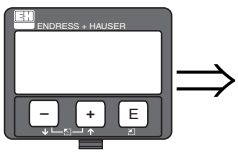
11.8 "Medium temperature" (*A7)



medium temp. *A7
26 °C

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.

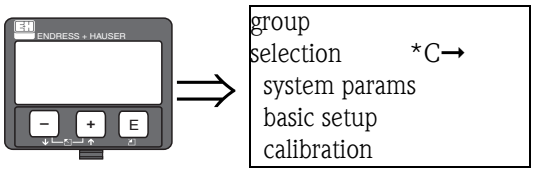
11.9 "Density value" (*A8)



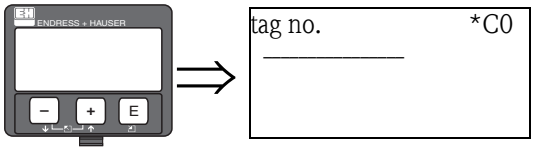
density value *A8
0.9650 g/cm3

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

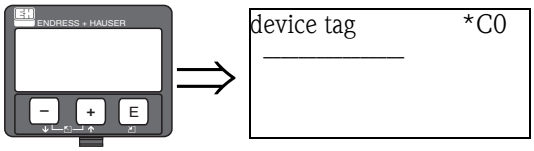


12.1 "Tag no." (*C0) (for HART devices only)



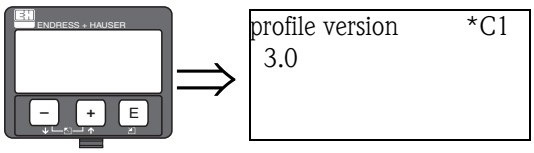
The tag no. can be defined in this function.
The tag no. may consist of up to 16 alphanumeric values.

12.2 "Device tag" (*C0) (for FF devices only)



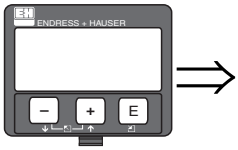
The tag no. can be defined in this function.

12.3 "Profile version" (*C1) (for PROFIBUS PA devices only)



Displays the PROFIBUS PA profile version of the device.

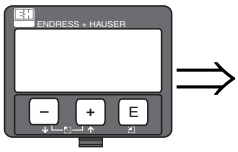
12.4 "Device id" (*C1) (for FF devices only)



device id *C1

Displays the serial number (id) of the device.

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



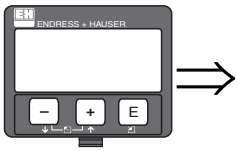
protocol+sw-no. *C2
V01.01.00 HART

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, PA or FF)

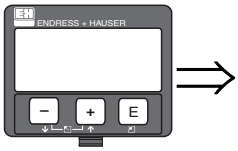
12.6 "Device revision" (*C3) (for FF devices only)



dev. rev. *C3

Displays the revision of the device software.

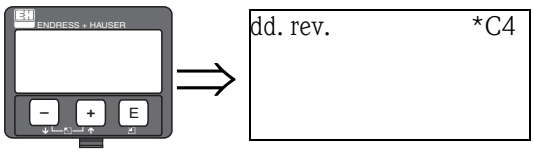
12.7 "Serial no." (*C4) (for HART devices only)



serial no. *C4
YMLNR 01ID

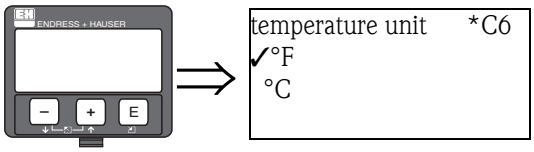
This function displays the serial number of the device.

12.8 "DD revision" (*C4) (for FF devices only)



Displays the revision of the device's Device Description (DD).

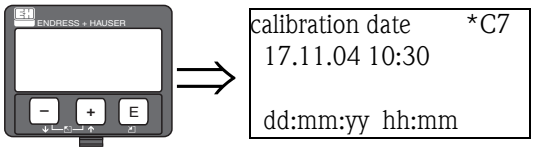
12.9 "Temperature unit" (*C6)



This function is used to select the temperature unit.

Options:
- °C
- °F

12.10 "Calibration date" (*C7)



This function is used to specify the calibration date.

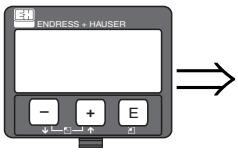
Note!
In an **automatic** calibration, the Gammapilot automatically copies the date from its internal realtime clock. In this case, the **"calibration date" (*C7)** function is a display function only. In a **manual** calibration, the user must explicitly enter the date.

Format:
DD.MM.YY HH:MM

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

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

12.11 "Recalibration date" (*C8)



recal. date *C8
25.03.05 17:50

dd:mm:yy hh:mm

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

Note!
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.

Format:
DD.MM.YY HH:MM

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

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

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 Levelflex should be successfully commissioned and ready for operation. If this is not the case, the Levelflex offers various ways of analyzing and correcting errors. A structured troubleshooting procedure is outlined in the Operating Instructions for the device in question or in Section 13.2.

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 device off/on; if error still is present: call Endress+Hauser service or exchange transmitter
A113	electronics defect	switch device off/on; if error still is present: call Endress+Hauser service or exchange transmitter
A114	electronics defect	switch device off/on; if error still is present: call Endress+Hauser service or exchange transmitter
A116	download error	repeat download
A121	electronics defect	switch device off/on; if error still is present: call Endress+Hauser service or exchange transmitter
W153	initializing	wait for completion of the initializing procedure
A160	checksum error	call Endress+Hauser Service
A165	electronics defect	■ switch 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 → 9.
A291	slave error	check basic setup and connection of the slave transmitter
A503	wrong sensor type	call Endress+Hauser Service
W513	calibration integration running	Wait, until a stable pulse rate has been reached; then, terminate integration (by pressing "E" in the **"average pulse rate" (*11)** function)
W514	PT-100 calibration	wait for the calibration to complete. if error still persists: call Endress+Hauser Service
A531	sensor electronics defect	switch device off/on; if error still is present: call Endress+Hauser service or exchange transmitter
A532	sensor voltage error	call Endress+Hauser Service
A533	wrong sensor software version	call Endress+Hauser Service
A535	sensor regulation error	call Endress+Hauser Service
W536	high voltage near limit	call Endress+Hauser Service
A538	sensor communication error	call Endress+Hauser Service
A602	linearization table not plausible	check monotony of the linearization table; if necessary, adjust table (**"linearization" (*4)** function group)

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 **ToF-Tool**: Select the right type of table (lin. tab. "level" or "concentration")
W621	simulation on	Switch off linearization (**"output" (*6)** function group **"simulation" (*65)** function)
W640	SIL lock device	SIL_locking not completed
W642	I_back calibration running	calibration of the current readback path active
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 → 📄 9.
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	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	Software extended to include "SIL locking" function.	BA236F/00/en/03.07 71041166 BA287F/00/en/04.07 71041169
			BA236F/00/en/06.07 71041166 BA287F/00/en/06.07 71041169

PROFIBUS PA

Date	Software version	Software modifications	documentation
Since 11.2005	01.01.04	Original software.	BA329F/00/en/11.05 7100008 BA287F/00/en/08.04 52023818
Since 08.2006	01.01.06	Bug fix. Corrections for high and low pulse rate.	

FOUNDATION Fieldbus

Date	Software version	Software modifications	documentation
Since 06.2005	01.01.00	Original software.	BA330F/00/en/06.05 71000010
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.	

List of functions

Symbols

Numerics

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C

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