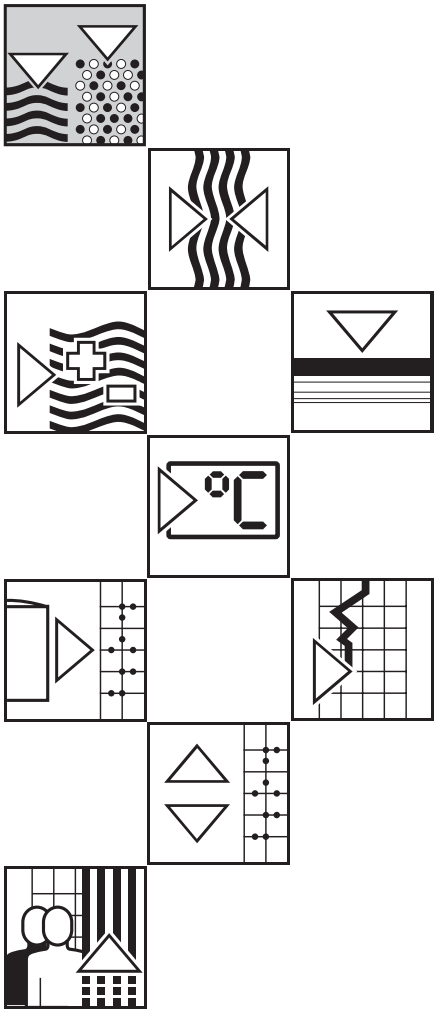
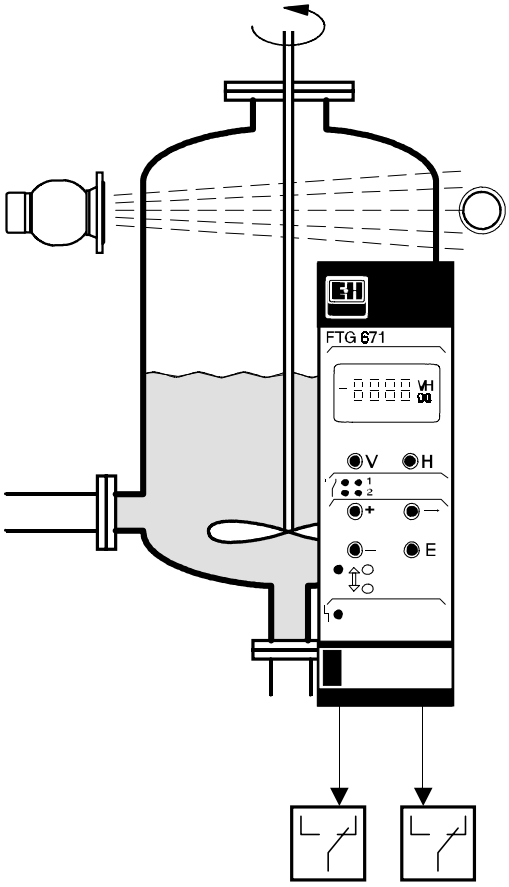
BA 082F/00/en/12.03
016309-1000
Software 1.3

gammapilot
FTG 671
Level Limit Detection

Operating Instructions



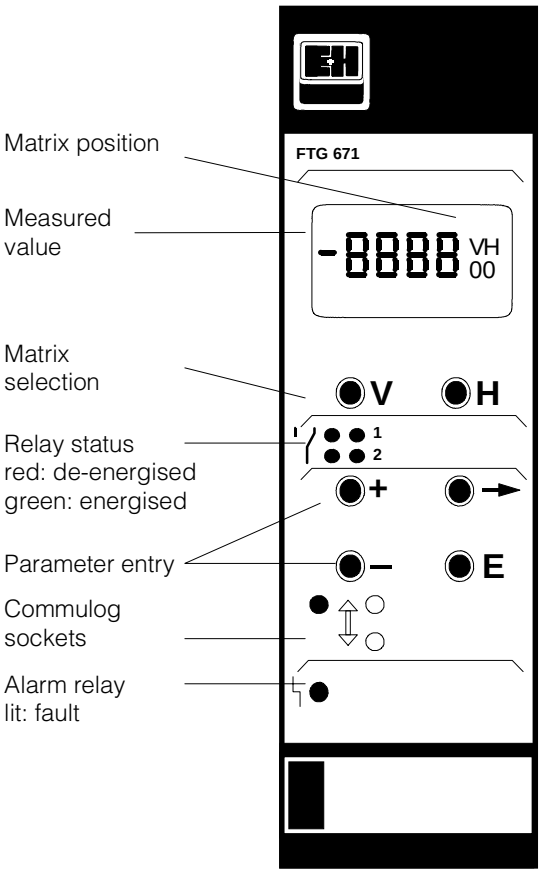


Endress+Hauser

The Power of Know How

Short Instructions

Operation



V Selects vertical matrix position

H Selects horizontal matrix position

V + H Select positon V0H0

→ Selects next digit

→ + + Move decimal point

\+ Increases value of digit

– Decreases value of digit

E Registers entry

See also »Controls«, Chapter 3

Quick Configuration (for Cs137, DG 57) with background calibration

The FTG 671 transmitter and DG 57 detector must be powered up for at least 6 hours before configuration

Function	Matrix	Action
Reset transmitter	**V9H5**	● Enter 671: see above for key functions Press »E« to register entry
Calibrate	**V3H0**	● Enter 5 to select standard calibration with background calibration Press »E« to register entry
	V3H4	● Enter calibration date: year (3 = 9**3**), week (01…53) weekday (1=Monday etc.) Press »E« to register entry
	V0H1	● With vessel empty (wait 100s) Press »E« to register entry
	V0H2	● With vessel full (wait 100s) Press »E« to register entry
	V0H9	● With radiation off and vessel full (wait 100s) Press »E« to register entry
Integration time	**V0H4**	● Enter max. permissible integration (relay switching) time in s Press »E« to register entry (default = 7 s)
Relays (default values)	…	● Relay 1 is set automatically to maximum fail-safe mode Switch-off point 38, switch-on point 72 ● Relay 2 to maximum fail-safe mode Switch-off point 72, switch-on point 38

Inhaltsverzeichnis

Notes on Safety

Radioactive sources

Radioactive isotopes are used as sources for level detection by gamma radiation. The source is encapsulated in a welded, double-walled container of special steel.

- In practically all countries, the handling and operation of radioactive sources is governed by strict regulations which are enforced by a national radiation protection board.
- Authorisation, which usually includes a requirement for personnel specially trained in radiation protection, must be obtained from this board before the equipment enters the factory.
- If you are in any doubt as to the regulations in your country, call your E+H sales office or representative - they will be glad to help you further!

Endress+Hauser radiometric systems are designed, manufactured and shipped with special regard to German and International radiation safety regulations. Original radiometric systems are normally delivered equipped with double-encapsulated sources of Cs 137 or exceptionally Co 60, both complying with DIN 24426/ISO 2919 classification 66646. This is acknowledged as the highest safety classification for industrial source containments.

Certificates

The Gammapilot FTG 671 is a transmitter for level limit detection which can be used with a variety of radioactive sources and detectors. It must be installed by qualified personnel according to the instructions in this manual.

The transmitter and ancillary equipment are available with certificates. The Table below indicates the combinations available and conditions for installation. Full details can be taken from the certificates. Please note that where quoted technical data differs from that listed in Section 2.6, that in the certificate applies.

Certificate	Instruments	Notes
PTB 99 ATEX 2089	Gammapilot FTG 671	II(2)G / [EEx ib] IIC, s. Safety instructions XA 054F-C
DIBt Check Report PA-VI 850.01	Gammapilot FTG 671	Overflow protection according to WHG
PTB Nr. Ex-94.C.1019 ATEX 1104	DG 57-A… DG 57-H… DG 57-M…	EEx d ib IIC T6 / ATEX II 2 G EEx d IIC T6 / ATEX II 2 G EEx de IIC T6 / ATEX II 2 G s. Safety instructions XA 057F-A
DMT 01 ATEX E 093	DG 57-D...	ATEX II 2 D IP 65 T 60°C s. Safety instructions XA 112F-A
PTB Report 6.62-1972/1 PTB Report 6.62-1972/2 PTB Report 6.32-2005	QG 020 QG 100 QG 2000	Report on local dosage measurement on source container

Safety conventions

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

Note!
- A note highlights actions or procedures which, if not performed correctly, may indirectly affect operation or may lead to an instrument response which is not planned.

Caution!
- Caution indicates actions or procedures which, if not performed correctly, may lead to personal injury or incorrect functioning of the instrument

Warning!
- A warning indicates actions or procedures which, if not performed correctly, will lead to personal injury, a safety hazard or destruction of the instrument

1 Introduction

Short instructions

The front cover contains short instructions for the standard set-up, level limit detection with two limit relays, using the FTG 671, DG 57 and Cs 137 source.

In this manual

Users unfamiliar with the Gammapilot FTG 671 must read the operating instructions which are structured as follows:

- Chapter 1: Introduction;
  contains general information including application, measurement principle and functional description.
- Chapter 2: Installation
  contains instructions on the installation of the radioactive source, Geiger-Müller and scintillation counters, Gammapilot FTG card, hardware configuration, connection diagrams and technical data for the plug-in card.
- Chapter 3: Controls;
  describes operation with the front panel keys, Commulog VU 260 Z and ZA 67… gateways.
- Chapter 4: Calibration and Operation;
  tells you how to commission and operate the Gammapilot for level limit detection.
- Chapter 5: Limit Switches;
  describes in detail the setting of the relays for fail-safe or acknowleged operation.
- Chapter 6: Trouble-Shooting;
  contains a description of the self-checking system with error messages, the simulation feature as well as instructions for configuration on replacement of the transmitter, source or detector.
- Index lists key words to help you find information quickly.

Further documentation

In addition to this manual, the following publications provide information on configuration of the Gammapilot FTG 671.

- BA 028 Commulog VU 260 Z handheld terminal
- BA 054 ZA 672 Modbus Gateway
- BA 073 ZA 673 Profibus Gateway
- BA 085 ZA 674 FIP Gateway

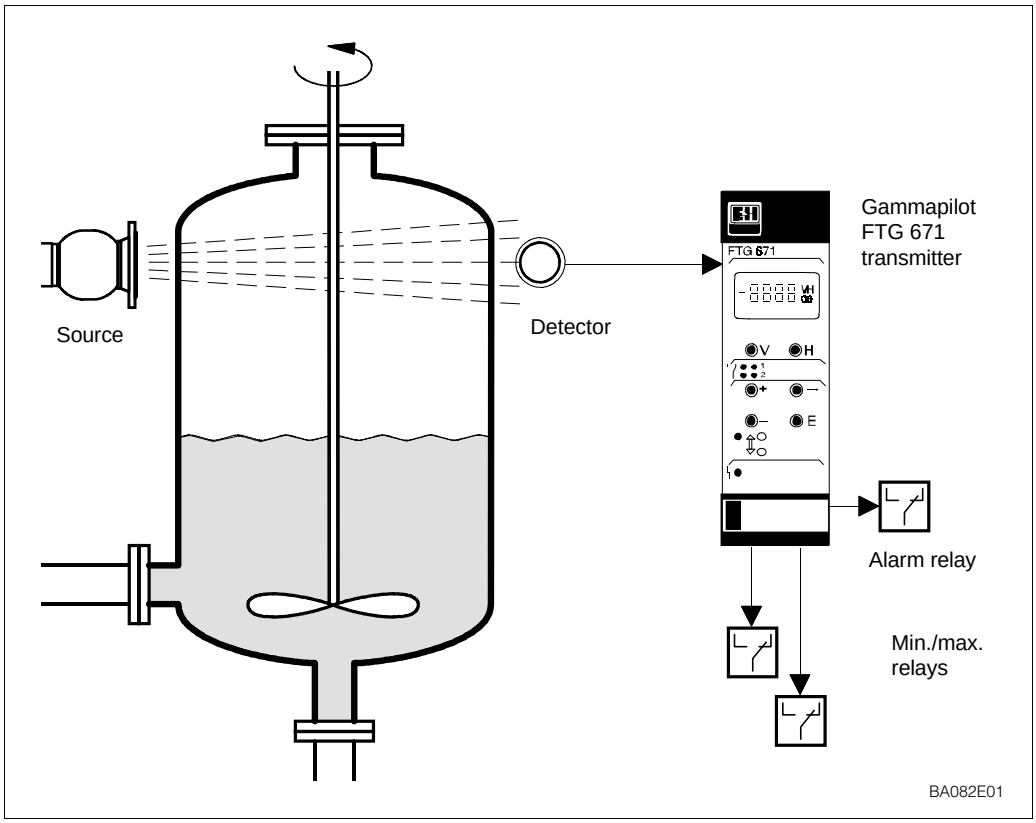
The installation of the radioactive source and detector is described in the documentation accompanying these articles as well as briefly in Chapter 2.

- TI 264F Source Container QG 020/100
- TI 346F Source Container QG 2000
- TI 180F Scintillation Detectors DG 57
- TI 197F Geiger-Müller counters DG 17 and DG 27

When installing detectors in explosion hazardous areas the instructions included in the accompanying certification must also be observed.

1.1 Application

Fig. 1.1: Standard application showing Gammapilot FTG 671, source and detector



The Gammapilot FTG 671 is designed as a

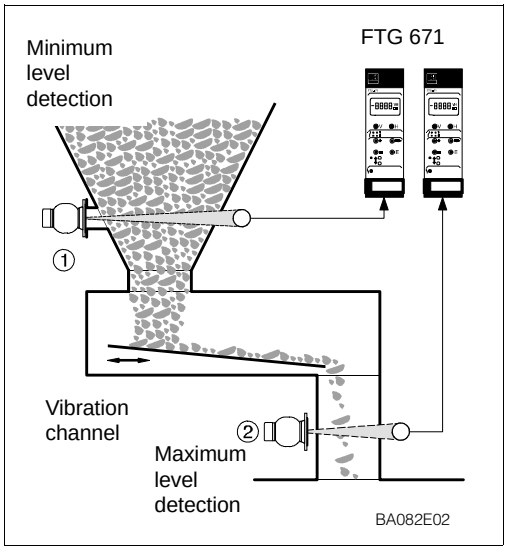
- non-contact, level limit switch

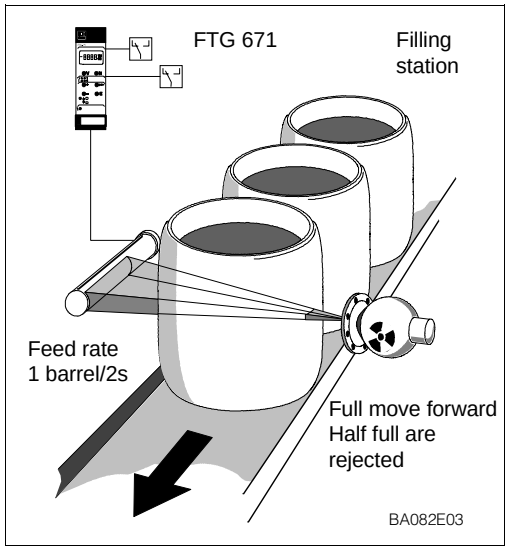
for containers (mixers, reactors, hoppers, silos, tanks) e.g. with inflammable, poisonous and aggressive bulk material and liquids. It is also suitable for applications in the food processing industry, e.g. on product filling lines.

Gammapilot transmitters may also be used for applications in explosion hazardous areas, e.g. in acid tanks, boilers, cement silos, etc., and possess intrinsically-safe sensor circuits conforming to EEx ib IIC. A list of certificated combinations is to be found in »Notes on Safety« preceding this chapter.

Fig. 1.2: Left: Conveying limestone Gamma radiation barriers control the drying process

Right: Automatic filling of beer barrels The level is checked as the barrels move past the barrier





1.2 Measuring system

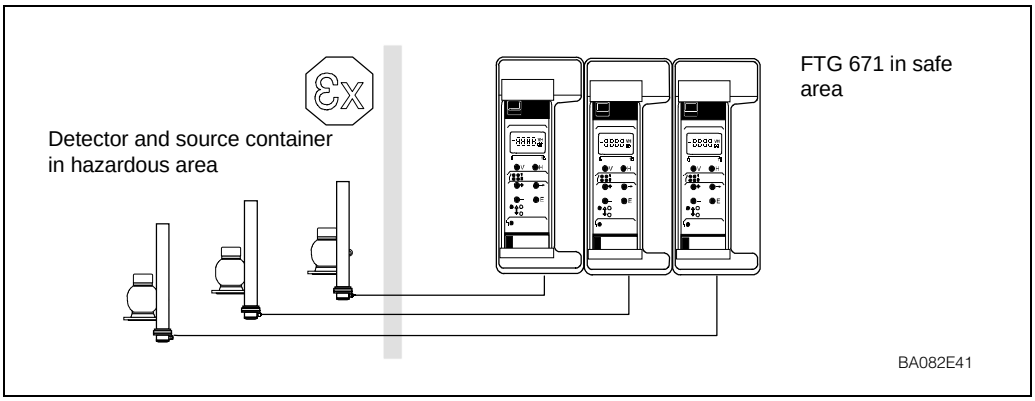


Fig. 1.3:
Gammapilots FTG 671 row mounted in Monorack II housings

A working system for limit level detection comprises:

- Gammapilot FTG 671 transmitter,
- QG 020 or QG 100 source container with Co 60 or Cs 137 gamma source
- DG 17 or DG 27 Geiger-Müller counter or DG 57 scintillation counter.

The Gammapilot may operate as a stand-alone or system unit. Two relays act as freely programmable limit switches which can be operated in fail-safe or acknowledgement mode. An alarm relay monitors the correct functioning of the measurement point and trips on fault condition.

If controlled remotely with other Commutec transmitters within a process control system, the Gammapilot is addressed via the Rackbus. In this case, communication is controlled by a ZA 67… Gateway which converts Rackbus data into the appropriate network protocol. The Gammapilot can be remotely configured, its measured data and status scanned and its settings up and downloaded through the Gateway.

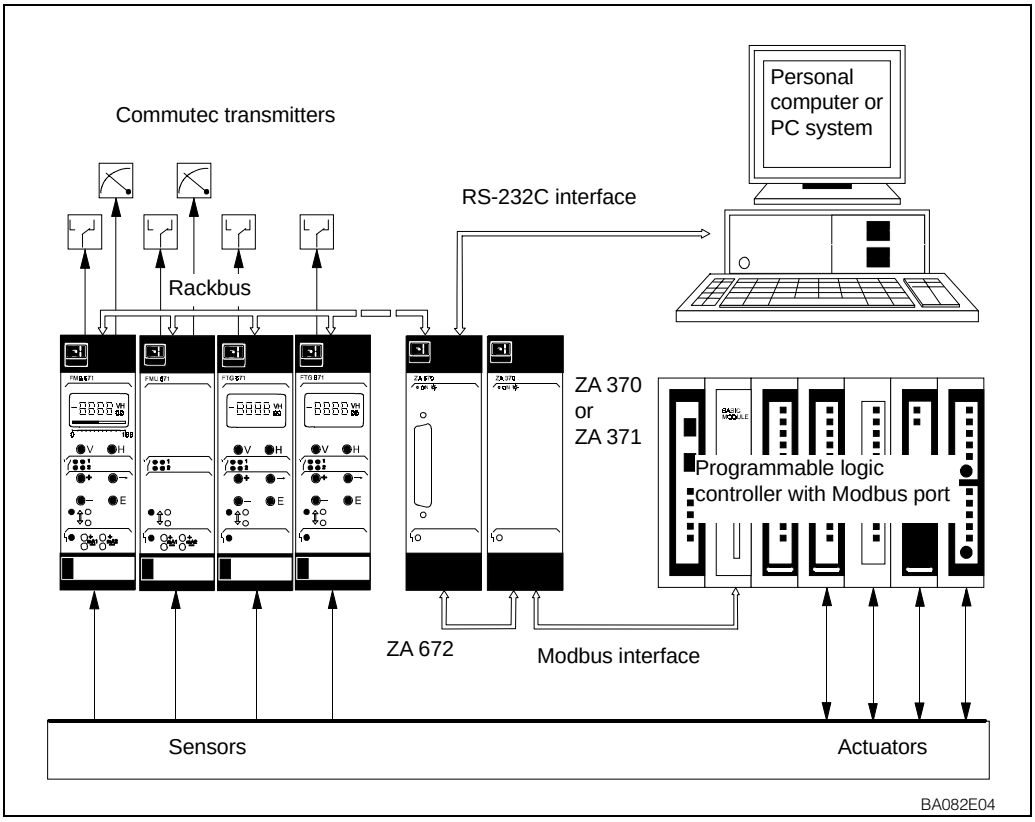
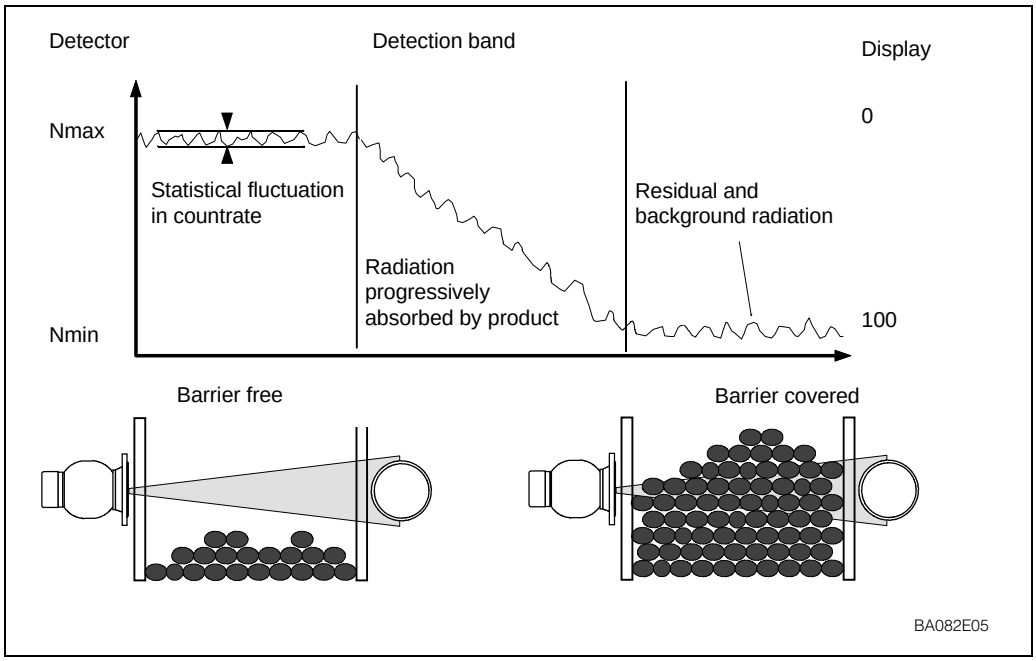


Fig. 1.4:
The Gammapilot FTG 671 can be used as part of a process control system.

Here it is shown with other Commutec transmitters and the ZA 672 Modbus Gateway

1.3 Measuring principle

Fig. 1.5: Operating principle of FTG 671 radiometric level limit switch



Gamma ray absorption

When Gamma radiation penetrates a material, it is absorbed to a degree dependent upon the density ρ, and thickness d of the material as well as the linear absorption factor μ, which is also dependent on the material and source. The attenuation F_s is given by:

$$F_s = e^{-\mu \bullet \rho \bullet d}$$

The radiation also decreases with the square of the distance between source and detector. For limit switching μ, ρ, and d are constants and the detected radiation level depends upon the presence or not of material in the beam. The countrate is at a maximum when the beam is completely free and at a minimum when the all radiation has to travel through the material. The maximum and minimum countrates N_{max} and N_{min} are obtained when the transmitter is calibrated. Their dependency is given by:

$$N_{min} = N_{max}/F_s = N_{max}e^{-\mu \bullet \rho \bullet d}$$

The FTG 671 output is normalised to produce the end values 0 and 100, relay 1 trips at 38 in minimum and relay 2 at 72 in maximum fail-safe mode (10 and 90 for DG 17/27 (Z) detectors). The detection band is dependent upon the orientation of the detector, which, however, is usually mounted horizontally on the vessel.

Statistical assessment

The precision of a gamma limit switch is dependent on the statistical variation in countrate. Since the emission of gamma rays from a radioactive source is a random phenomenom, several successive countrate measurements taken over a given period of time will be seen to vary randomly about a mean value. The degree of variation between measurements depends upon the time interval chosen. The measurement precision depends on the confidence level - 1σ, 2σ or 3σ - which is to be attained. For a countrate of N pulses per second:

$\pm 1\sigma = \pm 1\sqrt{N}$	68.28% confidence level
$\pm 2\sigma = \pm 2\sqrt{N}$	95.45% confidence level
$\pm 3\sigma = \pm 3\sqrt{N}$	99.74% confidence level

Normally a confidence level of 2σ is used. The statistical variation is reduced by increasing the sampling or integration time τ:

$$\text{Statistical variation} = \frac{\pm 2\sqrt{N}}{\sqrt{\tau}}$$

1.4 Functional description

The Gammapilot FTG 671 has been realised as a second generation 19" Racksyst card with Rackbus connection. It can be configured by the front panel keys, via a Commulog VU 260 Z handheld terminal, or remotely via a ZA 67… Gateway. The transmitter can be operated in the following modes:

- Limit switching with two relays using a DG 17/27 Geiger-Müller counter
- Limit switching with two relays using a DG 57 scintillation counter

Input circuit

The intrinsically safe input circuit of the Gammapilot FTG 671 is electrically isolated from the rest of the circuitry by a DC/DC converter. The Gammapilot supplies power to the detector and receives from it a frequency signal proportional to the countrate. Provision is made for the connection of either a Geiger-Müller or a scintillation counter: the detector type is set during configuration. For DG 57 detectors, sensor data is supplied in a separate EPROM (DAT) which must be installed in the FTG 671 during commissioning.

Relays

The transmitter evaluates the incoming signal and switches the level limit relays accordingly. The switching status of each is indicated on the front panel. The functioning of the relays depends upon the input signal and fail-safe mode configured in the operating matrix. Correct configuration ensures that the relays always operate in the desired fail-safe mode:

- Minimum fail-safe mode:
  The relay de-energises and the appropriate red LED lights when the switch-off point is dropped below, an alarm is detected or the power supply fails
- Maximum fail-safe mode:
  The relay de-energises and the appropriate red LED lights when the switch-off point is exceeded, an alarm is detected or the power supply fails.

A switching hysteresis is obtained by entering a second switch point. Alternatively the relays can be operated in acknowledgement mode, whereby they de- or re-energise only after confirmation in the appropriate matrix field.

Function monitoring

To increase operational safety, the Gammapilot monitors itself for correct function. If a fault is detected, the red alarm LED lights and the alarm and limit relays de-energise. An error code can be read from the operating matrix. A fault is detected e.g. when no input signal is present and when the detector or the input circuit is defective.

The transmitter is also equipped with several automatic protection mechanisms which ensure that the limits are plausible and do not drift. The reduction in countrate due to natural decay is corrected for daily, if limits are changed, the switch points are checked for plausibility and when the source is too weak for correct switching a corresponding warning is given when the DG 57 detector is in use. The user can now increase the intergration time, increase the distance between the relay switch points or a new source must be ordered. Despite the warning, the FTG 671 will continue to measure until the new source arrives.

Communication

Measured values, events and status as well as the complete transmitter configuration can be read from the communication sockets on the front panel by a Commulog VU 260 Z handheld terminal or over the Rackbus by a remote controller operating through a ZA 67… Gateway. The green communication LED lights when data are exchanged. The switch-over from local to remote configuration via Rackbus is made automatically by disconnecting the Commulog VU 260 Z from the communication sockets.

2 Installation

This Chapter describes the:

- Measurement system
- Installation hints for source container and detector
- Gammapilot installation in a rack or Monorack housing
- Transmitter and detector wiring
- Hardware configuration of the Gammapilot card
- Technical data of the Gammapilot FTG 671 card.

2.1 Measuring system

Table 2.1 lists the sources and detectors used with the Gammapilot FTG 671 transmitter together with the appropriate data sheets. In addition, each source container is supplied with an instruction sheet which describes:

- How to switch on the radiation
- How to switch off the radiation
- How to change the radiation source

These must be read before the measuring system is commissioned. Section 2.2 also includes a short description of the standard components with hints on correct installation.

Special versions of the source container are always accompanied by their own documentation.

Source container	**Technical Information, Operating manual**	**Detector**	**Technical Information, Operating manual**
QG 020/100	TI 264F/00/en	Scintillation counter DG 57	TI 180F/00/en
QG 2000	TI 346F/00/en BA 223F/00/en	Geiger-Müller counters DG 17 DG 27	TI 197F/00/en

Table 2.1: Source container and detectors for limit detection by gamma radiation

2.2 Installation hints for source container and detector

Warning!

Warning!

- All activities such as mounting, dismounting and exchange of the source or detector must be done by specially trained staff or radiation protection officials only, under strict observance of the governing rules and regulations.
- When equipment is being installed in explosion hazardous areas, observe the instructions on the certificates accompanying the equipment as well as your local rules and regulations.

Source

Radiometric systems are normally equipped with double-encapsulated ^{137}Cs or exceptionally ^{60}Co sources complying to DIN 24426/ISO 2919 classification 66646. This is acknowledged to be the highest safety classification governing industrial source containments.

Source Container

The gamma rays emitted by the radioactive source radiate equally in all directions. In level measurement, however, only that radiation which travels through the vessel is required. All radiation in other directions is unwanted and must be shielded off. For this reason, the capsule containing the source is located in the source container, ensuring that unattenuated radiation can be emitted in the required direction only.

Fig. 2.1: Source container QG 020/QG 100 Standard design

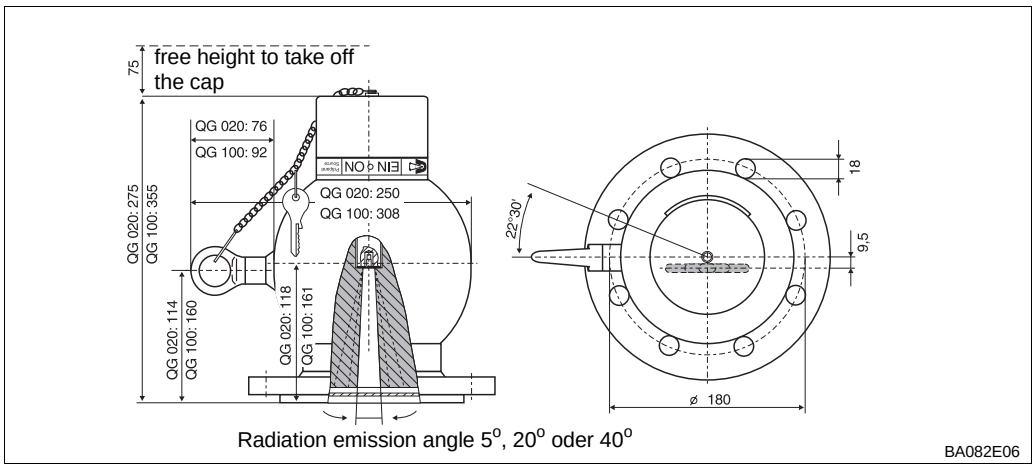
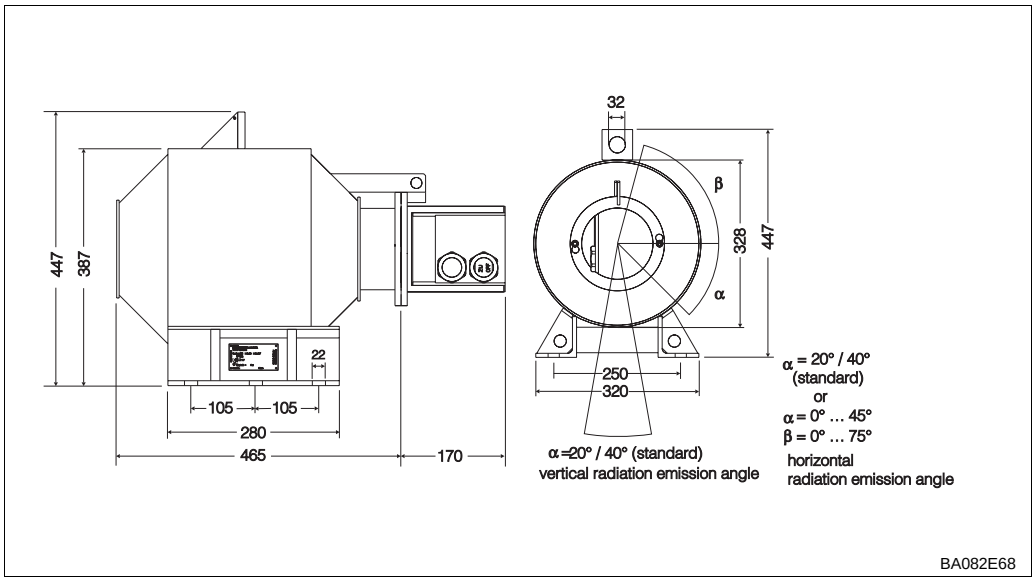


Fig. 2.2: Source container QG 2000 Standard design



The shielding material is lead in a welded steel housing. Fire proof source containers are available, which ensure that the radiation source and lead shielding cannot be lost when the housing is heated above the melting point of lead (327 °C/620 °F); e.g. in case of fire. The position of the radiation exit channel is marked in the dimensional drawing and on the container, and must be taken into account when planning and mounting.
The source containers are available with manual or pneumatic ON/OFF-switching. The QG 2000 can be obtained in a version with proximity switches for remote display of the switching status.
Additionally, QG 20 and QG 100 are available in Euro/Swedish and Chemical design for special safety requirements.

Attenuation factor

The attenuation factor F_S and the number of half-value layers for the different source containers with ^{60}Co and ^{137}Cs sources are summarized in the following table.

	F_S for ^{60}Co	F_S for ^{137}Cs
QG 020	37 (5,2 HWS)	194 (7,6 HWS)
QG 100	181 (7,5 HWS)	1448 (10,5 HWS)
QG 2000	4096 (12 HWS)	8.389.000 (23 HWS)

Table 2.2: Attenuation factors F_S and the number of half value layers (HWS)

From these values one may calculate:
- The *local dose rate D* at a given distance *r* from the source container (more precisely: from the source in the interior of the container).
- The radius *r* of the *control area*. At this radius the local dose rate is attenuated to a given value *D*.

$$D = K \frac{A}{r^2 F_S}$$

$$r = \sqrt{KA / DF_S}$$

D : Local dose rate [µSv/h]
r : Distance from source (control area) [m]
A : Activity of the source [GBq]
F_S : Attenuation factor (s. above table)

K = 357 µSv m^2 / h GBq (= 13.200 µSv m^2 / h Ci) for ^{60}Co
K = 96 µSv m^2 / h GBq (= 3.550 µSv m^2 / h Ci) for ^{137}Cs

Equation 2.1: Calculation of the local dose rate and the control area

The following table summarizes some typical examples:

Source container	Activity [GBq]	^{60}Co D = 7,5 µSv/h	^{60}Co D = 2,5 µSv/h	^{137}Cs D = 7,5 µSv/h	^{137}Cs D = 2,5 µSv/h
QG 020	0,74	0,98 m	1,69 m	0,22 m	0,31 m
QG 100	3,7	0,99 m	1,71 m	0,18 m	no control area
QG 2000	11	0,36 m	0,62 m	no control area	no control area

Table 2.3: Control area of the Source containers by different activitys from ^{60}Co and ^{137}Cs

For ^{137}Cs in the QG 2000 the local dose rate at the surface of the container is below the given value. Therefore, no control area is present in these cases.

Activity of the source

Endress+Hauser radiometric systems operating with the DG 57 rod scintillation counters utilize the lowest source strengths.
For limit switching, the source strength is calculated such that the dose rate arriving at the detector is:

- approx. 0.1…1 μSv/h (0.01…0.1 mR/h) for DG 57 detector
- approx. 1.2…8 μSv/h (0.12…0.8 mR/h) for DG 17 Z detector
- approx. 0.6…4 μSv/h (0.06…0.4 mR/h) for DG 27 Z detector.

In this case, the dose rate usually lies below that defining a control area, i.e. 7.5 μSv/h (0.75 mR/h) or 2.5 μSv/h (0.25 mR/h), which has to be sealed off.

Warning!

Warning!
- The actual extent of the control area depends on local regulations (other limits may apply) and must be determined on the basis of dose rate measurements made on site on both sides of the measuring system prior to the commissioning of the equipment.
- If the front of the source container can be accessed, shielding or other protective measures must be provided to prevent accidental exposure to the beam!

Detector DG 57

The use of a rod scintillator for detection of the gamma rays allows the lowest source strengths to be used for limit switching. The heart of the DG 57 is a cylindrical rod 48 mm in diameter made of transparent synthetic scintillation material. For limit detection a length of 100 mm or 400 m is used. For hot environments (> 40°C) it is recommended that the version with a water-jacket is used (flowrate 40-200 l/h; max. water temperature 40 °C; water pressure 4-6 bar).

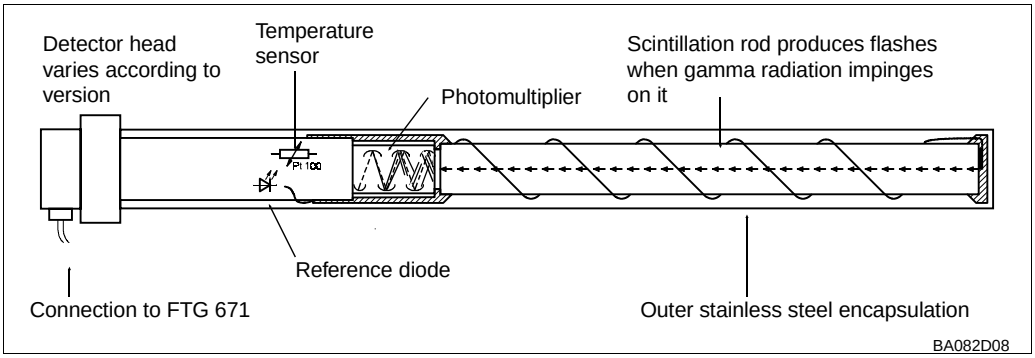
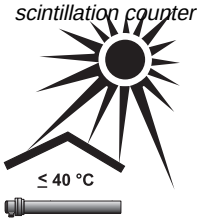


Fig. 2.3: Function of the DG 57 rod scintillation counter



The detector generates a pulse code modulation signal which is sampled by the FTG transmitter at intervals of 500ms. Prior to each sampling cycle a light pulse generated by a LED is sent through the scintillator to generate a reference value. The reference value, temperature and pulse rate are transmitted digitally via a two-wire connection to the transmitter FTG 671.

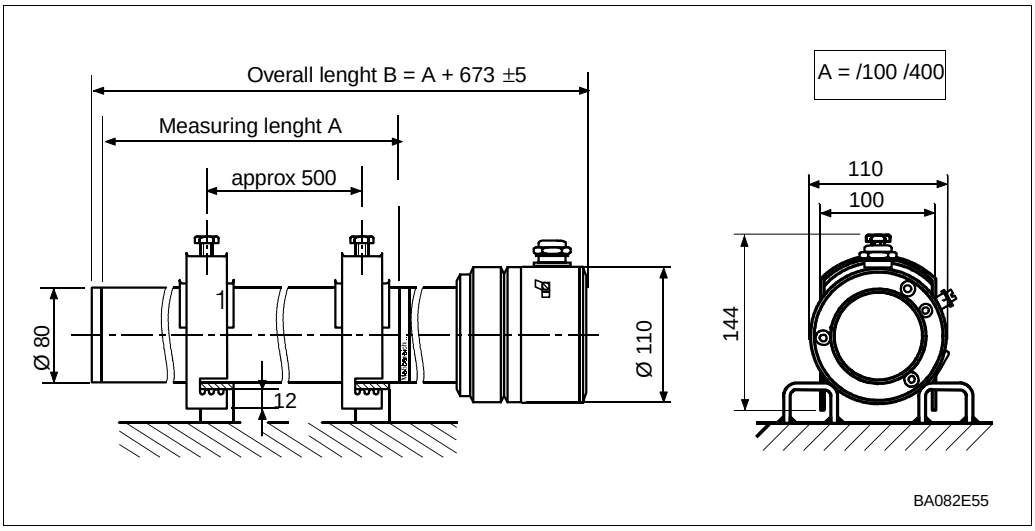


Fig. 2.4: Dimensions in mm Detector DG 57

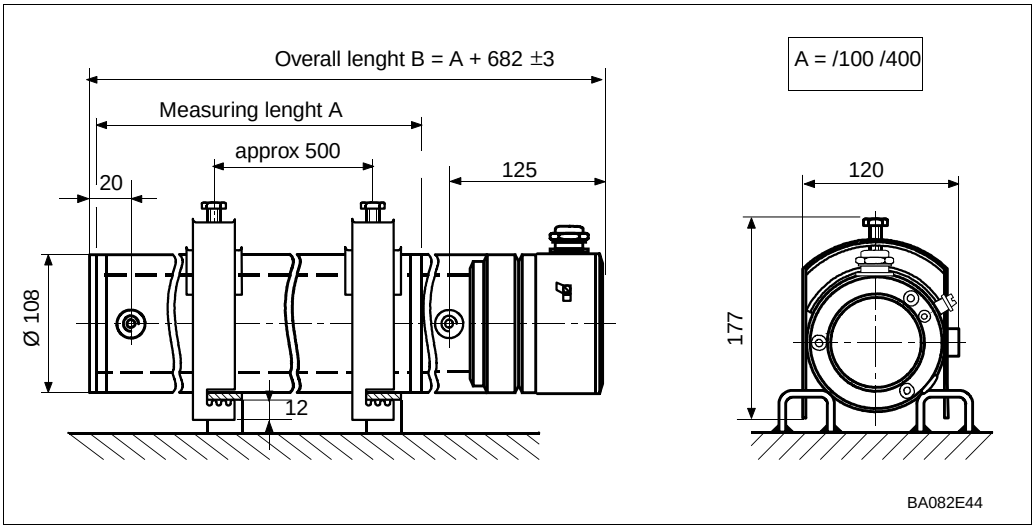


Fig. 2.5: Dimensions in mm Detector DG 57 with water jacket

Detector DG 17, DG 27

The Gammapilot FTG can also be connected to a DG 17/DG 27 Geiger-Müller counter. In this counter each gamma quantum causes a cascade of ions which are registered by the counter as a current pulse. The electronics process the pulses and pass a countrate-proportional frequency signal on to the FTG 671.

Four different Geiger-Müller counters are available, see Table 2.2. The detectors can be fitted with a water jacket for use in hot surroundings. Similarly a flange or clamps are available for mounting. The explosion protection is: DG 17, DG 27 - none

Fig. 2.6: Function of the DG 17/27 Geiger-Müller counter

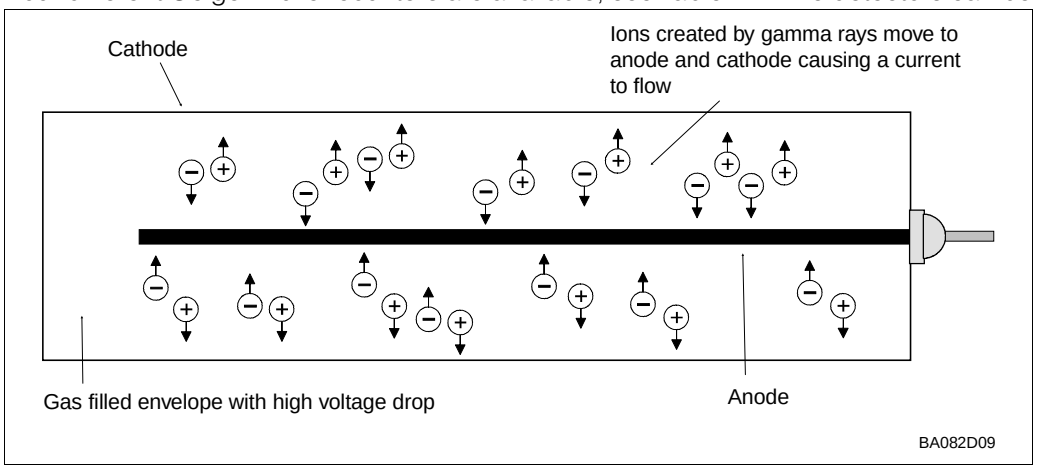
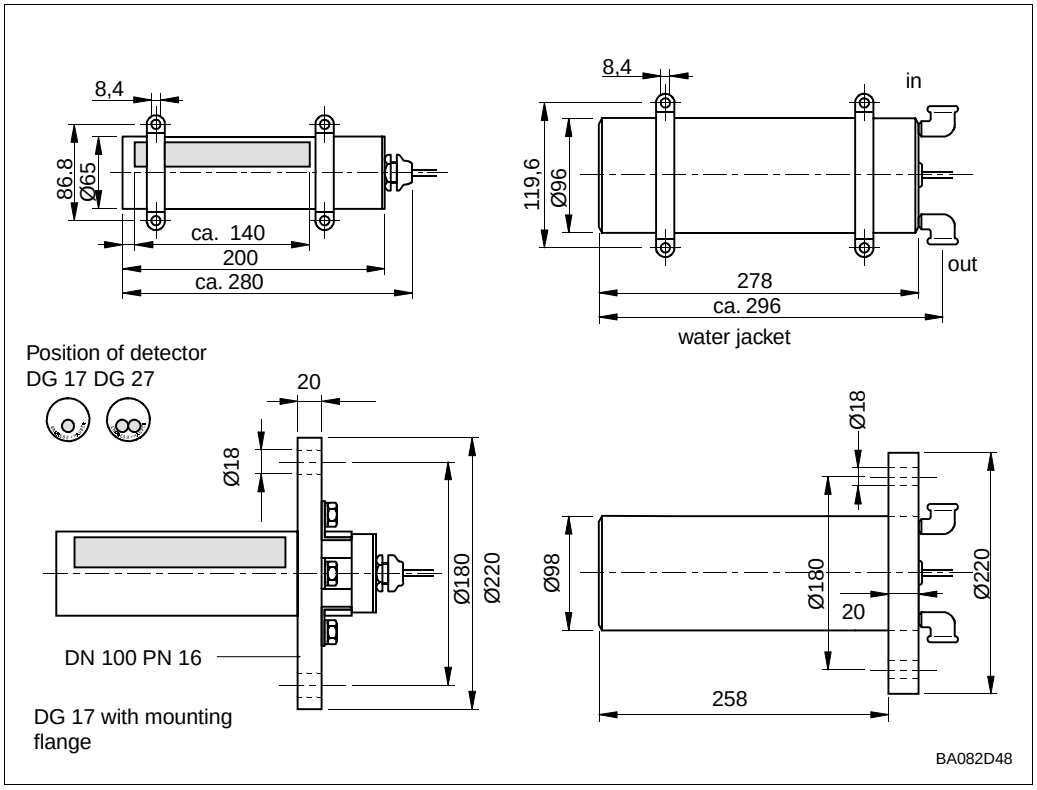


Table 2.4: Geiger-Müller counter versions

Detector types	DG 17	DG 27
Number of counter tubes	One	Two
Dose rate range (lateral mounting)	7…60 pA/kg = 1,2…8 µSv/h (0,12…0,8 mR/h)	3,5…30 pA/kg= 0,6…4 µSv/h (0,06…0,4 mR/h)
Dose rate range (frontal mounting)	14…120 pA/kg = 2,4…16 µSv/h (0,24…1,6 mR/h)	7…60 pA/kg 1,2…8 µSv/h (0,12…0,8 mR/h)

Fig. 2.7: Dimensions in mm Geiger-Müller counters DG 17/27



Mounting and installation

The QG … source container and DG…Z detector are mounted diametrically opposite each other at each side of the vessel.

- The detector is normally mounted horizontally
- The source and detector must be exactly aligned.
- For the DG 57, the beam must be aligned to fall into the area between the two gold strips on the detector which indicate the measuring zone (or length), for the DG 17/27 on the marking.

The QG… source container may be bolted onto a mounting pipe or the tank with an appropriate counterflange or onto e.g. a steel frame. Where the construction allows access to the front of the source container, appropriate protective measures must be taken to prevent accidental exposure.

Using the clamps supplied, the DG 57 detector must be clamped directly to the vessel or a steel frame. DG 17/DG 27 Geiger-Müller counters can in addition be bolted to a flange. Here it is also possible to mount the detector so that only the front face is irradiated. For limit value detection with the DG 57, the radiation levels at the detector side are usually so low that no control area exists. This must, however, be checked with a dosimeter during commissioning. Fig 2.8 shows mounting examples for common applications.

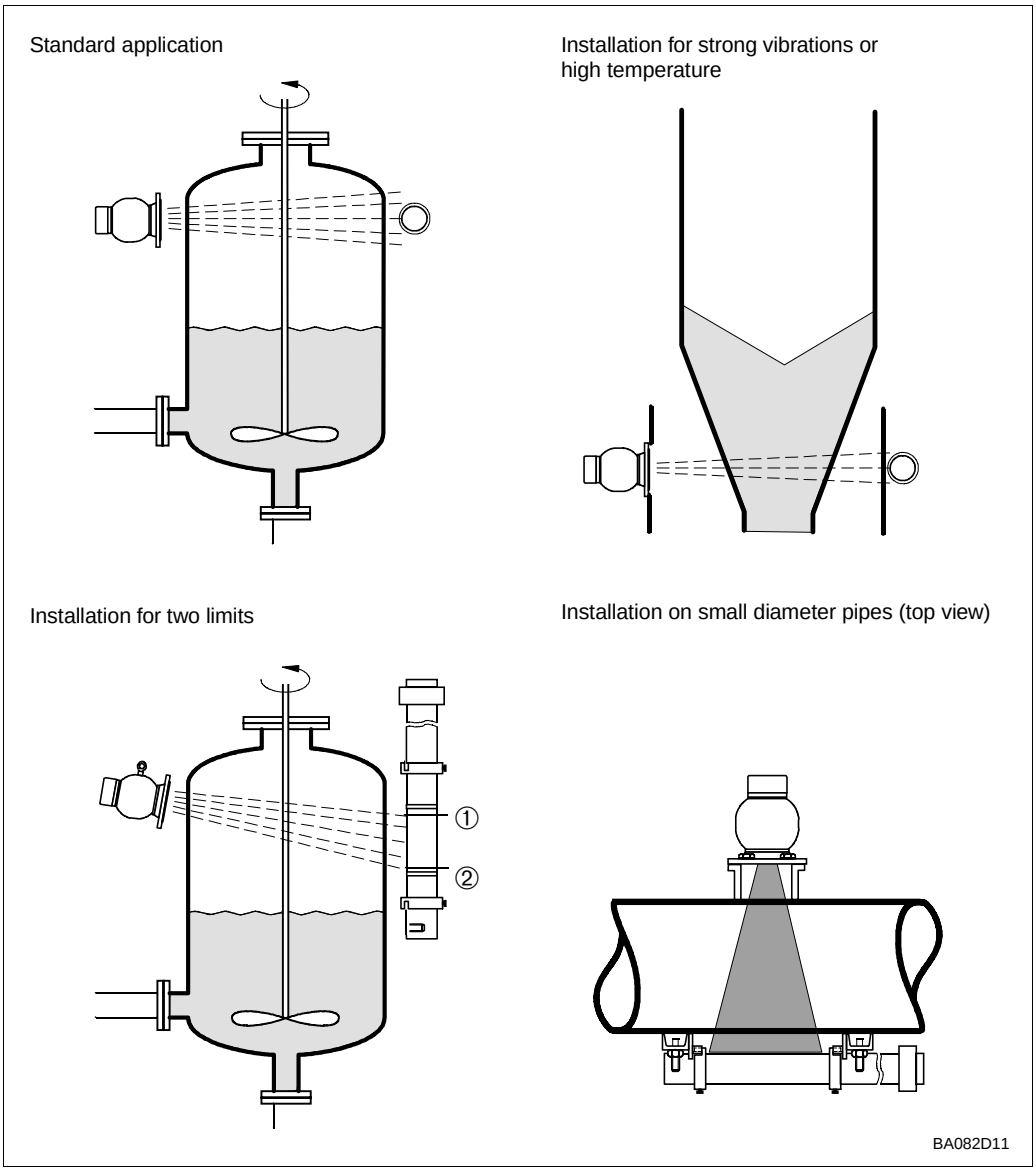


Fig. 2.8:
Mounting examples for common applications

2.3 Gammapilot installation

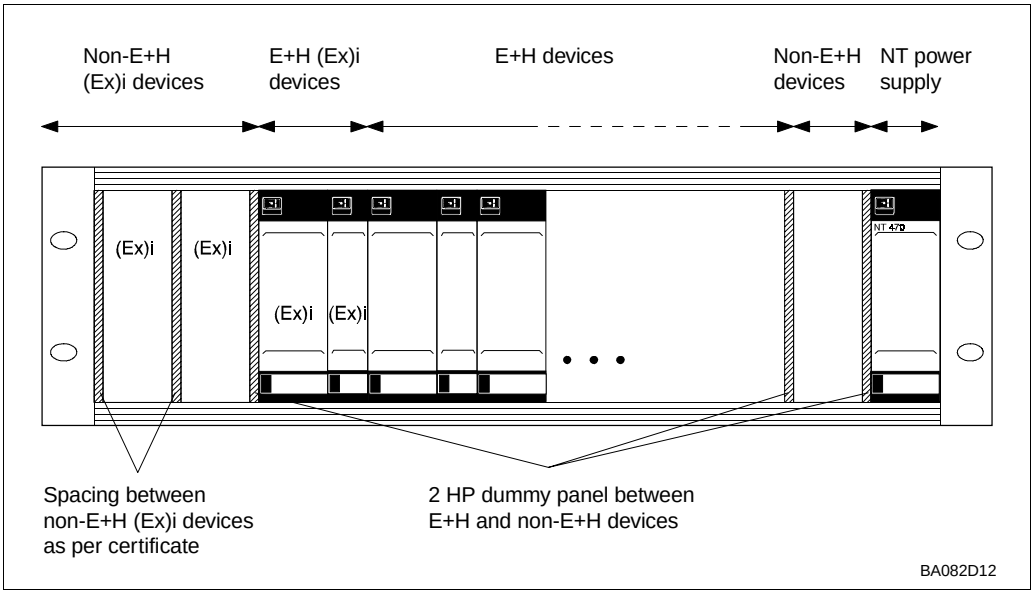
Gammapilot transmitters must be installed outside hazardous areas, whereby three possibilities for mounting exist:

- Standard 19" rack with space for 12 7HP cards,
- Field housing with space for up to 6 7HP cards,
- Monorack II housings for single transmitters.

Rack installation

A Racksyst system can be ordered fully wired, in which case the detectors and the external power supply only need to be connected. Planning hints can be found in Publication SD 041F, »Racksyst Assembly Racks«. For non-Racksyst installations and for installations including non-Racksyst cards, fill the rack as follows (see also Fig. 2.9):

Fig. 2.9: Recommended arrangement for Racksyst rack assemblies



Rack arrangement

Step	Procedure
1	Allocate the power supply (NT 470/471) at the rightmost position. - If two NT 470s are used, install a 2 HP dummy panel between them.
2	Install non-intrinsically safe transmitters next to the power supply. - Install a 2 HP dummy panel between all foreign transmitters and between Racksyst cards and foreign transmitters
3	Install intrinsically safe transmitters to the left of the rack. - Install foreign cards first. - Install dummy panels between all foreign transmitters and between Racksyst cards and foreign transmitters in accordance with the instructions on the Ex-Certificate. - No spacer is required between Racksyst cards.

Racksyst field housing

Instructions for installing Commutec transmitters in the Racksyst field housing with half 19" rack are to be found in Publication PI 003.

- Check that the field housing is not installed in direct sunlight.
  - If appropriate fit a protective sun cover.
- The maximum permissible ambient temperature for the field housing varies between +50…+60 °C according to the power consumption of the cards (0…20 W)

Note!

For EMC reasons we advise you to use special guide rails with metal clips when the plug-in card is installed in the field housing or subrack. This connents the instrument input filter to the subrack potential.

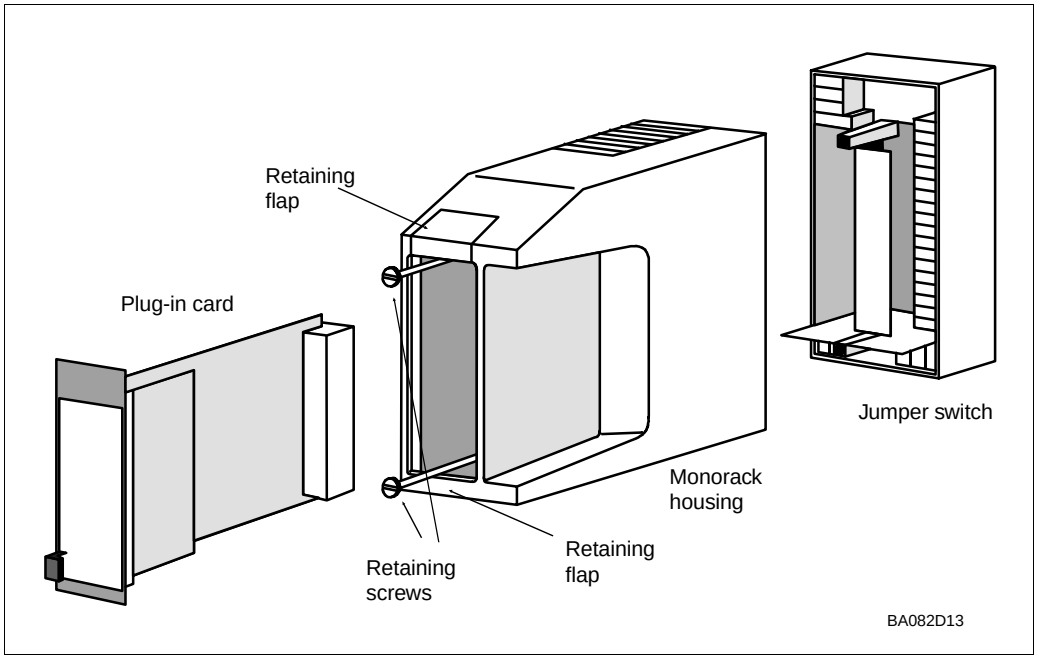


Fig. 2.10:
Assembly and disassembly of the Monorack II housing

Monorack II housing

The Gammapilot FTG 671 transmitter and Monorack II housing are supplied separately. Before use, the system must be assembled as shown in Fig. 2.10.

- The Monorack is prepared for wall-mounting, degree of protection IP 40.
- The site must be chosen such that the operating temperature of -20°C…+60°C for one Monorack and -20°C…+50°C for Monorack banks is not exceeded.

Full details of the Monorack installation procedure can be taken from the manual, BA 090F supplied with it.

Note!

- The Gammapilot FTG 671 cannot be installed in older versions of the Monorack housing. These can be identified by the lack of the jumper switch, see Fig. 2.10/2.17.

Note!

Monorack protective housing

If the Gammapilot FTG 671 transmitter and Monorack II housing are to be mounted at an exposed site, then it is recommended that they be installed in the protective housing, degree of protection IP 55, which is available as an accessory.

- The protective housing accomodates two Gammapilot FTG 671 transmitters.
- The permissible ambient temperature is -20°C…+50°C for one Monorack and -20°C…+40°C for two.

Dimensions and instructions for installation are to be found in the Technical Information sheet TI 099/00/e.

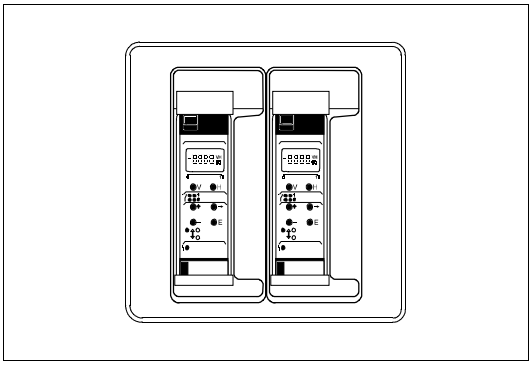


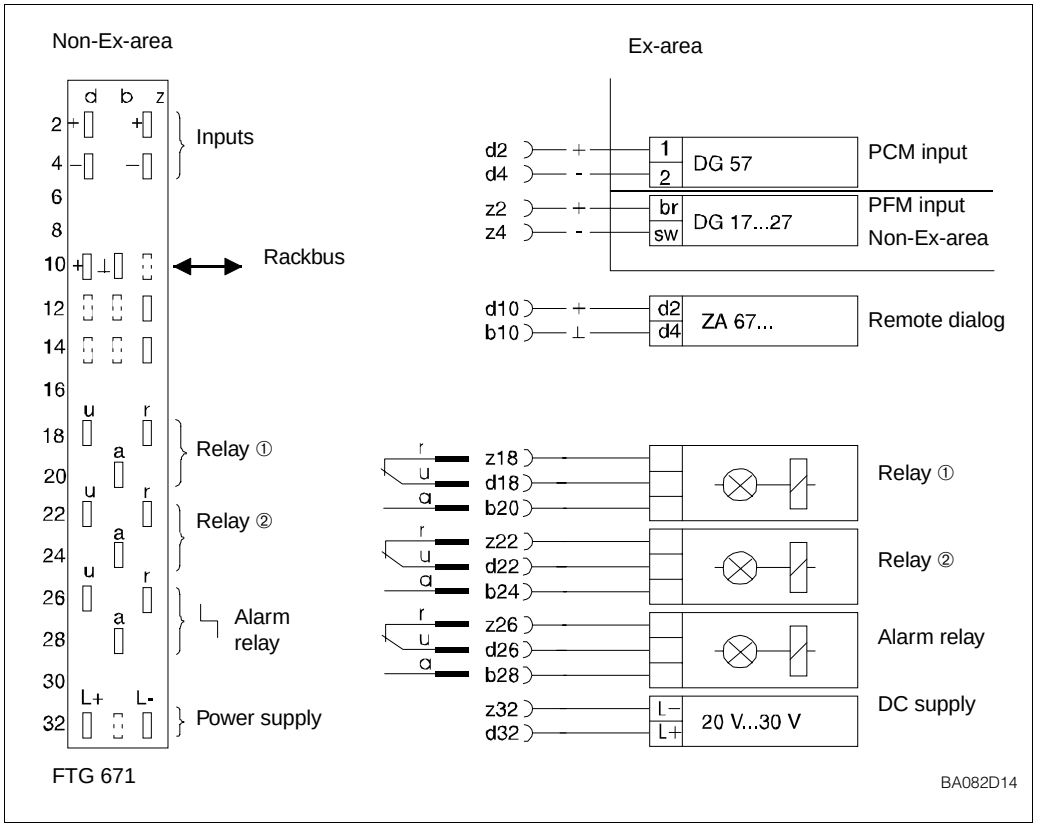
Fig. 2.11:
Monorack II protective housing

2.4 Transmitter wiring

Warning!

Warning!
- Switch off the power supply before making any electrical connections!
- When wiring up probes and sensors in explosion hazardous areas, observe the instructions on the certificate and other appropriate regulations.

Fig. 2.12: Pin assignment diagram for Gammapilot FTG 671



Rack wiring

Fig. 2.12 is a pin assignment diagram for the Gammapilot FTG 671.

- Inputs d2 and d4 are for DG 57 detector signals, z2 and z4 are for DG 17/27 counter signals. They are electrically isolated from all transmitter circuits and each other.
- The circuit zero of the unit (⊥) is connected to the negative terminal of the supply voltage.

Note!

Note!
- Two indexing pins, at positions 2 and 7 in the rack connector ensure that Gammapilot FTG 671 transmitters only can be inserted at these points. The pins must be inserted if the rack is not custom built by Endress+Hauser.

DG 57 detector wiring

The wiring for the standard version of the DG 57 detector [EEx ib] is shown in Fig. 2.13.

- We recommend the use of standard 2-core installation cable, max. 25 Ω per core.
- Use shielded cable where electromagnetic interference is to be expected.

The [EExd]/ATEX II 2 G, [EEx de]/ATEX II 2 G or ATEX II 2 D detector versions are connected in the same way - here the protective measures for the wiring, e.g. conduits, are to be observed. Observe the associated Safety Instructions (XA 057F-A for ATEX II 2 G; XA 112F-A for ATEX II 2 D).

Detector DG 57 Hxxxxx or Vxxxxx (EEx d version)

The EEx d version of the DG 57 detector is supplied with cable entries NPT $^1/_2$ ", M20x1.5 or G $^1/_2$ ". For Connection of the detector DG 57-H with connection housing of the type of protection "flameproof enclosure" the customer must supply suitable cable glands (ip65) or conduits and wire to explosion-proof standards in accordance with EN 50018, Section 12.1 and 12.2. Unused cable entries must be sealed to IP 65 in accordance with EN 50 018, Section 12.5. Type of protection IP65 must be obtained. For connection of the detector DG 57-V... with connection housing of the type of protection "flameproof enclosure" the supplied cable gland Shimada SCX-16B Exd IIC must be used.
After the cable has been connected, screw the compartment lid down as far as possible and lock with the safety claws.

Warning!

Do not unscrew the Allen screws which hold the protective steel tube and detector head together. Removing these screws will destroy the explosion protection of the detector electronics!

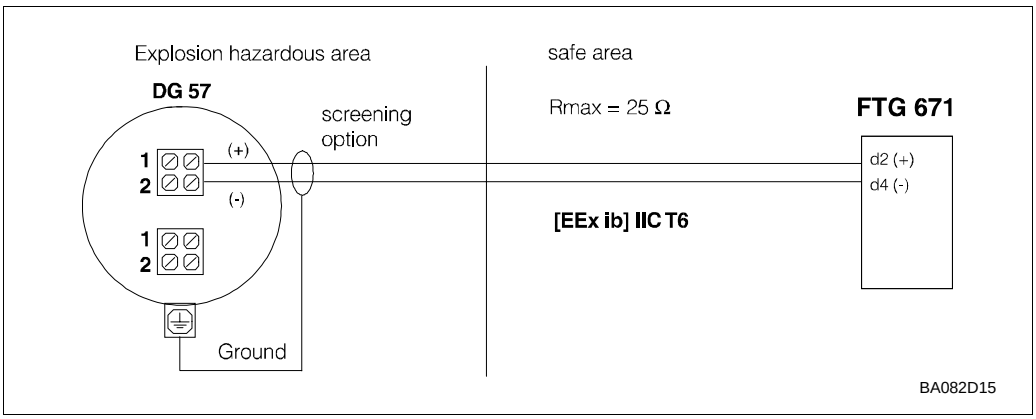


Fig. 2.13: Connecting diagram for DG 57 (PCM signal)

DG 17/DG 27 detector wiring

The DG 17/DG 27 Geiger-Müller counters are supplied ready wired (3m cable) at the detector end. They must be connected to the FTG 671 as shown in Fig. 2.14.

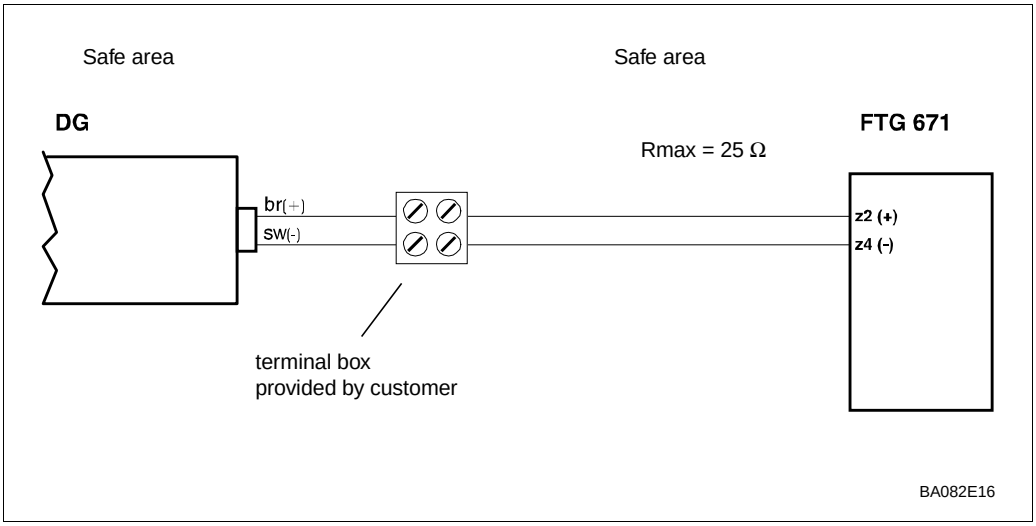
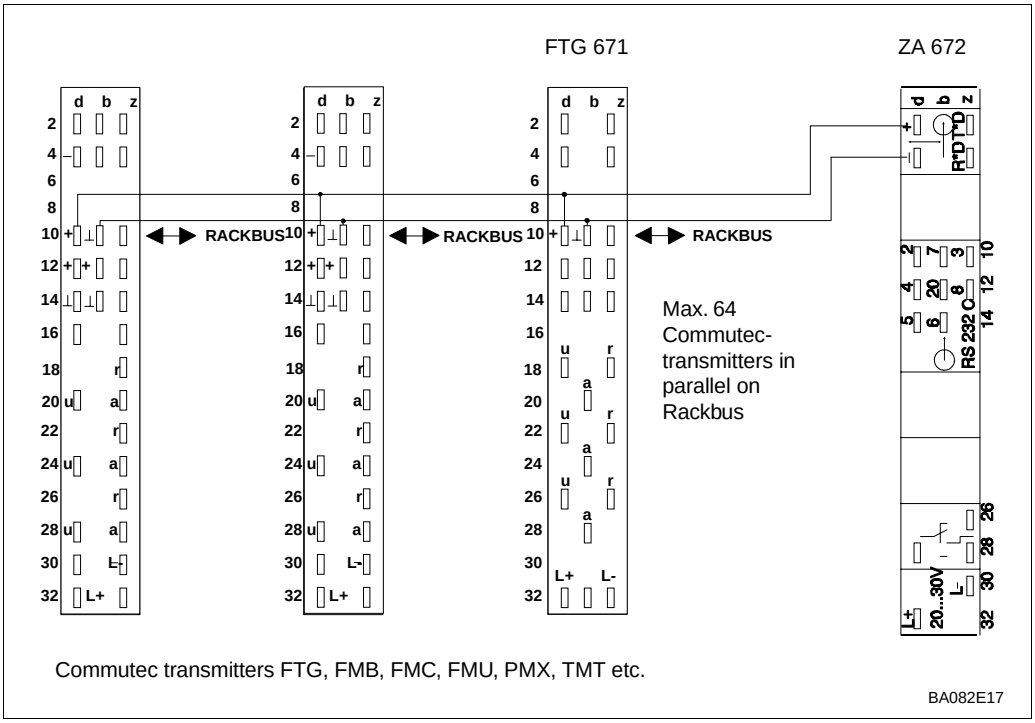


Fig. 2.14: Connecting diagram for DG 17/DG 27 (PFM signal)

Fig. 2.15:
Rackbus wiring diagram



Rackbus

For system use, wire the Rackbus as shown in Fig. 2.15.

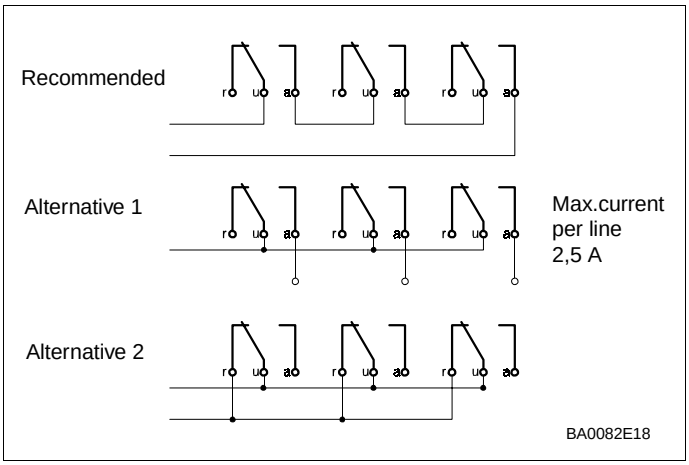
- For ZA 672 (Modbus) - Computer/PLC wiring see Operating Instructions BA 054E
  for ZA 673 (PROFIBUS) see Operating Instructions BA 073E
  for ZA 674 (FIP) see Operating Instructions BA 085E
- Be sure that the system is properly grounded. A difference in ground potential between the network device and Gateway can cause loss of data or transmission faults

Relays

Alarms and limit switch relays can be connected as shown in Fig. 2.16.

- Max. current per contact 2.5A : for switching capacity see Section 2.6.

Fig. 2.16:
Suggestions for wiring together relays and alarms



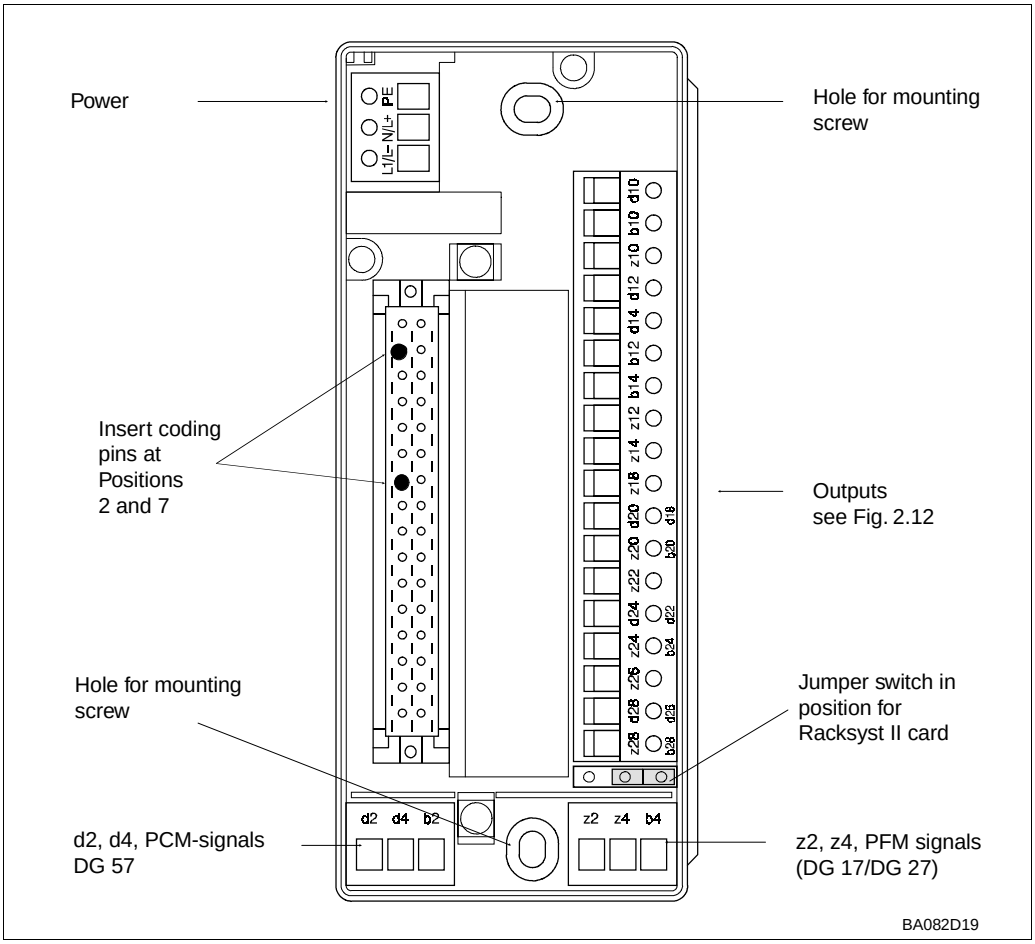


Fig. 2.17:
Layout of Monorack II terminal blocks

Monorack wiring

Fig. 2.17 shows the terminals in the base of the Monorack II housing, the pin assignments correspond to those in Fig. 2.12. When connecting together several Monoracks, follow the instructions BA 090F supplied with the housing.

- Check that the jumper switch in the base is set for a Racksyst II card.
- Where a terminal has two pin assignments, the one printed in green applies.
- Insert the coding pins supplied at positions 2 and 7 in the female connector at the base of the housing.

Note!

- The Gammapilot FTG 671 is a Racksyst II card. It cannot be installed in a Monorack I housing. These are easily identified by the lack of the jumper switch in the base, see above.
- Should the card accidently be installed in the wrong Monorack housing it will neither function nor be damaged.

Note!

2.5 Hardware configuration

Fig. 2.18: Position of configuration elements on Gammapilot FTG 671 card

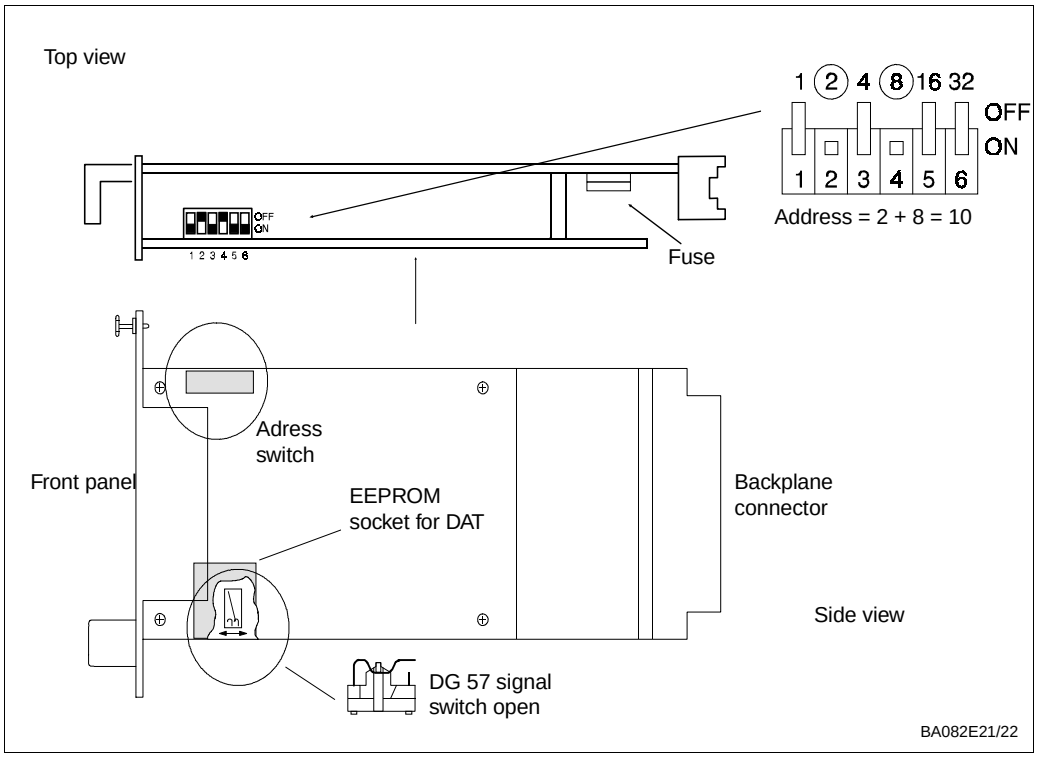


Fig. 2.18 shows the configuration elements on the Gammapilot FTG 671 plug-in card.

Caution!

Caution!
- Electrostatic discharge can degrade performance or damage electronic modules. Touch a grounded object to rid yourself of charge before handling the modules.

DG 57 detector data

An EEPROM containing the detector data (DAT) is supplied with each DG 57 detector . This must be plugged into the socket provided for it on the FTG board prior to commissioning.

DG 57 signal switch

This hook switch must always be open for operation with DG 57 and DG 17/27 detectors.

ZA 67… gateway

Configure the Gammapilot card for remote operation via the ZA 672 Modbus gateway, ZA 673 PROFIBUS gateway or ZA 674 FIP gateway as follows:

- Set a unique device address between 0 and 63 at the address switch.
  - When off, each switch has the value 0.
  - When on, each switch is assigned the value shown in Fig. 2.10, inset.
  - In the example the address is 2 + 8 = 10.

A full description of ZA 67… operation is to be found in the appropriate operating manual

Commulog VU 260 Z/ VU 160

Racksyst II cards automatically switch from remote operation via a ZA 67… gateway to local operation via Commulog handheld terminal when the latter is plugged into the communications sockets on the front panel. When the terminal is unplugged, the FTG 671 switches to remote operation again.

2.6 Technical data

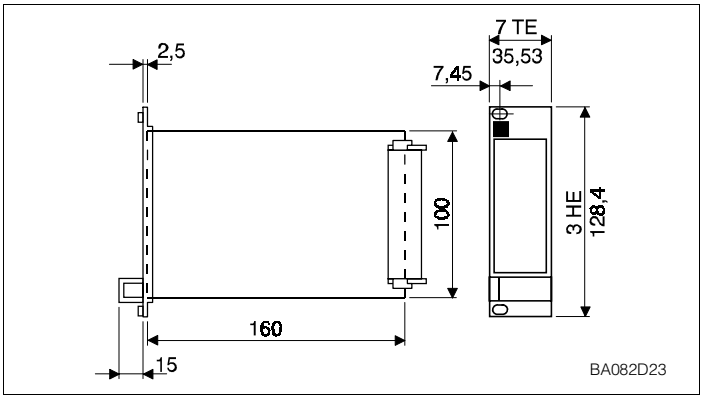


Fig. 2.19: Gammapilot FTG 671 plug-in card

Environment

- Operating temperature: 0°C...+70°C
  Storage temperature: -20°C...+85°C
- Climatic class to DIN 40 040: KSE
- Electromagnetic compatibility: Interference Emission to EN 61326, Electrical Equipment Class A
  Interference Immunity to EN 61326, Annex A (Industrial) and NAMUR Recommendation NE 21 (EMC)
  Use a screened cable between the sensor and transmitter. Refer to TI 241F for installation information pertaining to screened cables and general instructions on EMC test conditions for E+H equipment.

Construction

- Design: 19", 7 HP, plug-in card to DIN 41 494 (Europa card)
- Front panel: black synthetic with blue field inlay, grip and markings,
  Protection (DIN 40050): Front panel , IP 20
  Card, IP 00
- Dimensions: see diagram
- Weight: approx. 0.3 kg
- Multipoint plug: conforming to DIN 41 612, Part 3, Type F (25-pole)
  Coding pins in positions 2 and 7

Electrical connection

- Power supply: 24 V DC (+6V…-4V);
  residual ripple 2V, within tolerance
- Supply current: max. 135 mA
- Power consumption: max. 3.3 W at 24V, max. 4.0 W at 30 V
- Signal inputs: ATEX II (2) G, EEx ib IIC
- Detectors: DG 57 scintillation counter
  DG 17, DG 27 Geiger-Müller counters

Relays

- Relays: Two independent relays each with a potential-free change-over contact; freely selectable switching range and hysteresis; fail-safe mode, maximum or minimum selectable via switching points

  Third relay for fault indication

  Max. relay switching capacity:
  2.5 A, 250 VAC, 300 VA (cos φ= 0.7), 600 VA (cos φ= 1)
  or 100 VDC, 100 W

Certificates

- Intrinsic safety: ATEX II (2) G [EEx ib] IIC with DG 57,
  see ›Notes on Safety«, p.3.
  Non-Ex with DG 17/27

3 Controls

This Chapter describes how the Gammapilot transmitter is operated. It is divided into the following sections:

- Commutec operating matrix
- Configuration from the front panel
- Configuration with the Commulog VU 260 Z

3.1 Commutec operating matrix

All functions, including the relay switch points are configured via the operating matrix, see Figs 3.1 and 3.2:

- Each field in the matrix is accessed by a vertical (V) and horizontal (H) position which can be entered at the front panel of the FTG 671, by the Commulog VU 260 Z and via a ZA 67… computer gateway.
- For information on ZA 67… operation see the appropriate operating manual and Technical Information sheet »Commulog Operating Program« TI 113.

A matrix card, reproduced at the back of this manual, is delivered with the Gammapilot FTG 671 transmitter.

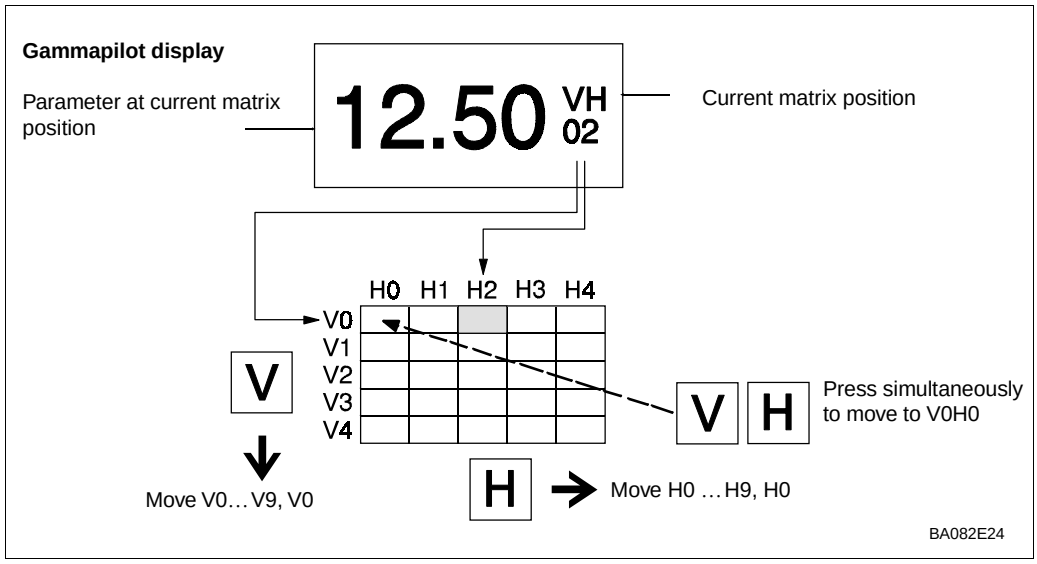


Fig. 3.20: Gammapilot FTG 671 Parameter matrix operation with function of V and H keys. The complete matrix has 10 x 10 fields, although not all are used

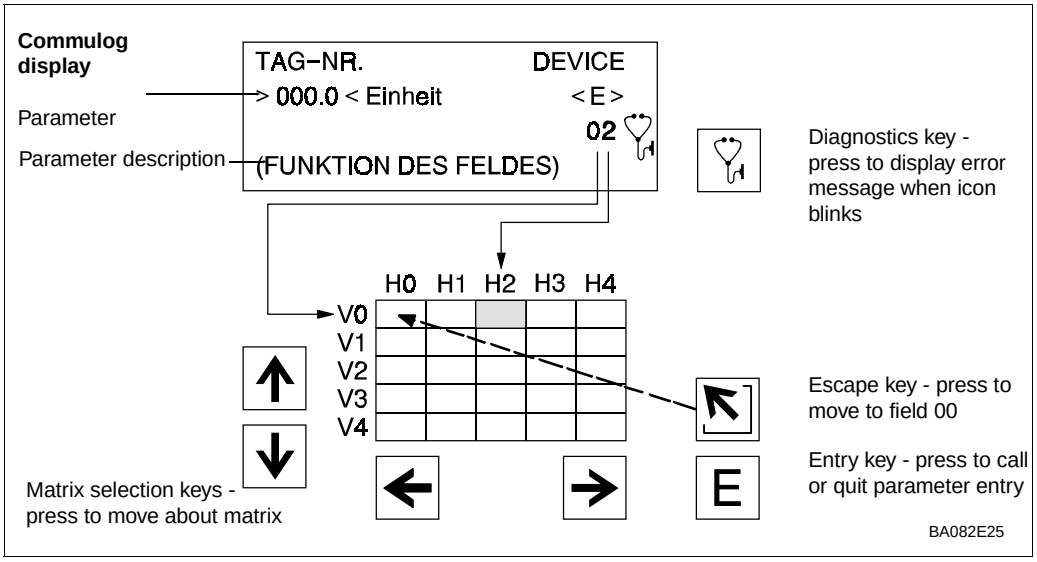


Fig. 3.21: Commulog display and key functions. The Tag No. is entered in the VA level which can be accessed by the Commulog or ZA 67… interface only

3.2 Configuration from front panel

Fig. 3.22:
Front panel of the
Gammapilot FTG 671

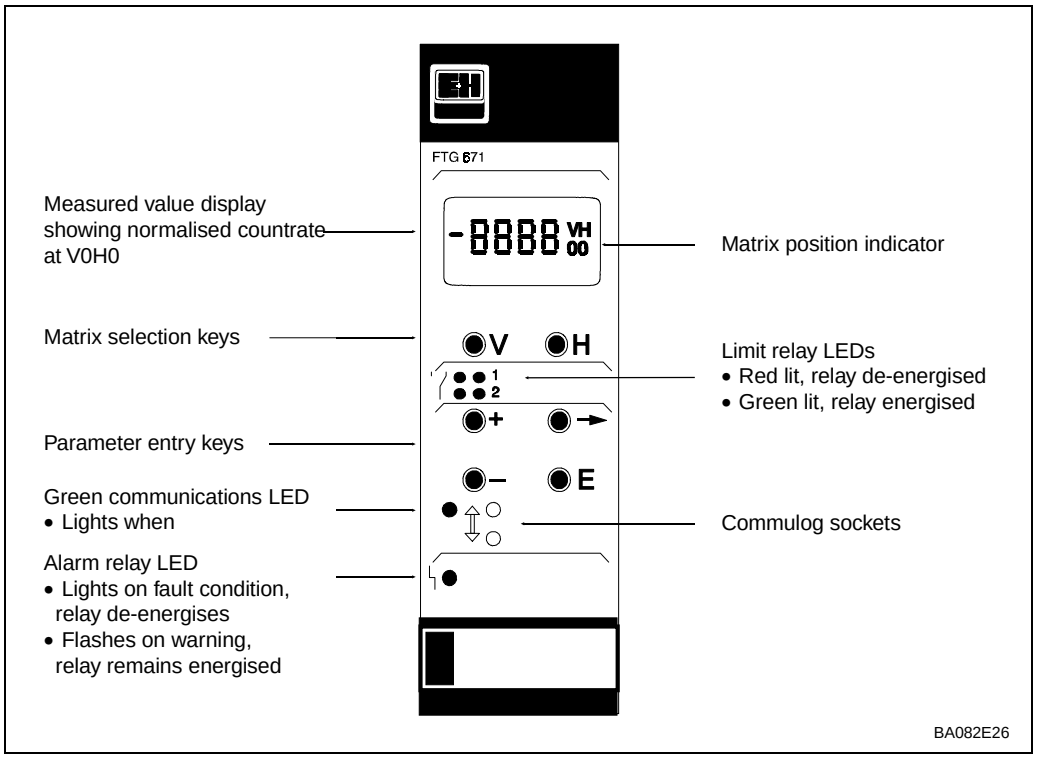


Fig. 3.1 shows the LC-display with matrix of the Gammapilot FTG 671, Fig. 3.3 its front panel. Table 3.1 below describes the function of the operating keys.

- Changes are not possible if the matrix has been locked (Section 4.6).
- Non-flashing parameters are either read-only indications or locked entry fields.

Table 3.5:
Gammapilot FTG 671
Parameter entry and display keys

Keys	Function
Matrix selection	
V	• Press V to select the vertical position.
H	• Press H to select the horizontal position
V + H	• Press simultaneously to select the measured value field, V0H0
Parameter entry	
→	• Select the digit to be changed. The digit at the extreme left is selected and flashes. • Move to the next digit by pressing »⇒« again. When the last digit is reached »⇒« selects the leftmost digit again.
+ + →	• To change the position of the *decimal point*, press down both »⇒« and »+«. The decimal point moves 1 space to the right.
+	• Increases the value of the flashing digit
–	• Decreases the value of the flashing digit • To enter a *negative number* decrease the leftmost digit until a minus sign appears in front of it
E	• Press »E« to register entry. • Unregistered entries remain ineffective and the instrument will operate with the old value.

3.3 Configuration with Commulog VU 260 Z

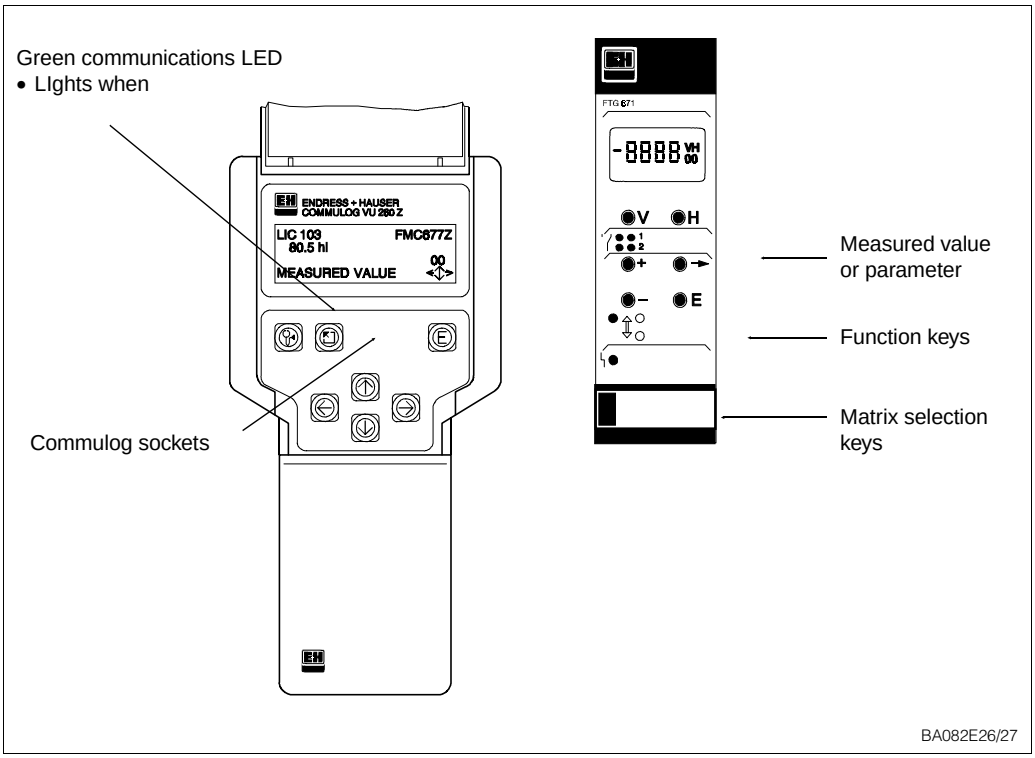


Fig. 3.23: Gammpilot FTG 671 Showing front panel and Commulog VU 260 Z key functions

The Gammapilot FTG 671 can also be configured with the Commulog VU 260 Z handheld terminal as shown in Figs 3.2, p. 24. A full description of Commulog operation is to be found in Operation Instructions BA 028, Table 3.2 summarizes the key functions.

- The tag numbers for the measuring point can be entered by calling up the VA fields in the operating matrix.

Table 3.6: Gammapilot FTG 671 Parameter entry and display keys for Commulog VU 260 Z

Keys	Function
Matrix selection	
← ↑ → ↓	• Select matrix position
↖	• »Escape key«, selects the position V0H0
	• Displays error message if diagnostics icon flashes • Press »Escape« to reset fault alarm and return to V0H0
Parameter entry	
E	• Calls the parameter entry mode • Quits parameter entry mode and registers the entered value
← →	• Select the digit to be changed: the selected digit flashes.
↑ ↓	• Enter the desired value: If the parameter is alphanumeric: - The ⇑ key scans through all characters starting from "-" through: 0,1,..,9,../,+, space, Z,Y,X,W,.. - The ⇓ key scans through all characters starting from "-" through: A,B,..,Y,Z, space,+,/,..,9,8,...
← + ↑ → + ↑	• Move the decimal point: - ⇐ and ⇑ together to move left or - ⇒ and ⇑ together to move right.
↖	• Restores original value and quits entry mode. The Commulog stays at the selected matrix field.

4 Calibration and Operation

This chapter is concerned with the basic settings of the Gammapilot, the principle sections describing the:

- Commissioning
- Standard calibration with background calibration
- Standard calibration without background calibration
- Provisional calibration
- Limit detection
- Additional functions
- Display of measured values
- Locking the parameter matrix.

The Gammapilot FTG 671 controls are described in Chapter 3, p. 23, and the setting of the relays in Chapter 5, p. 35.

Note your settings!

Note your parameters in the tables provided in the back cover. Should the transmitter be exchanged at a later date, simply re-enter all the parameters and the system is ready to run - see Chapter 6, p. 42.

4.1 Commissioning

Note!

- Make sure that the instrument has been switched on for at least six hours before it is commissioned or calibrated.

Note!

The commissioning comprises two steps:

- Transmitter reset
- Entry of detector information prior to calibration

Transmitter reset

A transmitter reset enters the factory based parameters into the operating matrix, see Table in back cover. It is made by entering a number between 670 and 679 at V9H5.

Step	Matrix	Entry	Significance
1	V9H5	e.g. 671	Enter any number 670…679 to reset transmitter
2	-	»E«	Registers entry

System information

The information in Table 4.1 must be entered into the Gammapilot in the commissioning phase of the calibration:

Table 4.7: System information required for commissioning

Parameter	Matrix	Significance
Source type	V3H1	0 = Cs137 1 = Co60
Detector type	V3H2	0 = DG 57 1 = DG 17 2 = DG 27
Detector orientation	V3H3	0 = Horizontal (or vertical) 1 = Head on
Calibration date	V3H4	Date on which calibration was made Y | WW | D Y = Last digit of year, e.g. 2 for 1992 WW = Calender week, e.g. 23 for week 23 D = Day, e.g. 1 = Monday, 2 = Tuesday

Example for commissioning

For a Gammapilot operating with a horizontally mounted DG 57 detector and Cs137 source, calibration date Friday, October 16th 1992, the following must be entered:

Step	Matrix	Entry	Significance
1	V3H0	5	Select standard calibration with background calibration (Section4.2) or
		2	for auxiliary calibration (Section 4.4) or
		1	without background calibration (Section 4.3)
2	-	»E«	Registers entry
3	V3H1	0	Cs137 source
4	-	»E«	Registers entry
5	V3H2	0	DG 57 detector
6	-	»E«	Registers entry
7	V3H3	0	Detector mounted horizontally
8	-	»E«	Registers entry
9	V3H4	2425	1992, week 42, Friday
10	-	»E«	Registers entry
11	…	…	Continue with calibration to Section 4.2, 4.3, or 4.4

During this procedure the alarm LED flashes and Warning 630 is generated to indicate that the calibration is incomplete.

4.2 Standard calibration with background calibration (for detector DG57)

The standard calibration requires the determination of three parameters, in any order:

- the countrate when the barrier is free at V0H1, s. Fig. 4.1
  the countrate when the barrier is covered at V0H2, s. Fig. 4.1(often simulated by switching off the radiation source)
- the countrate when radiation is switched off and barrier is covered, s. Fig. 4.2 (the background radiation from the source and environment is then measured.)

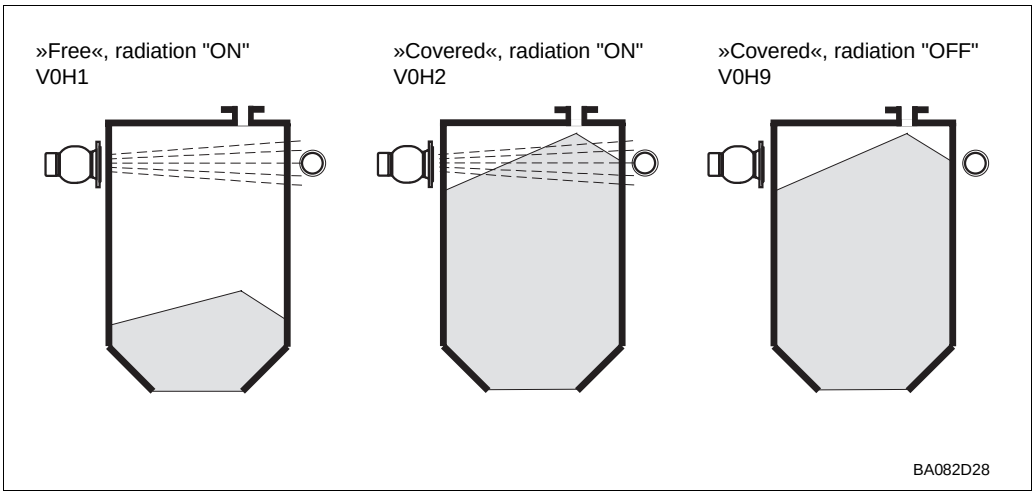


Fig. 4.1: Parameters of the standard calibration

The vessel should be completely free of build-up prior to calibration. If this cannot be guaranteed, a value of e.g. 20 can be entered in V0H1. This prevents the instrument from signalling an alarm due to too high a dose rate, if the build-up falls off after calibration.

As shown in Fig. 4.2, the Gammapilot FTG 671 comperates the calibration parameters for the decay of the source. The switching points are influenced by the compensation, too. The background calibration ensures, that the minimum countrate will not drop below the backraound rate.
Of course, when the minimum rate is hold while the maximum rate continues to fall, the distance between the two values decreases. The FTG 671 automatically perceives, when this distance becomes too small, and indicates an error (E635).

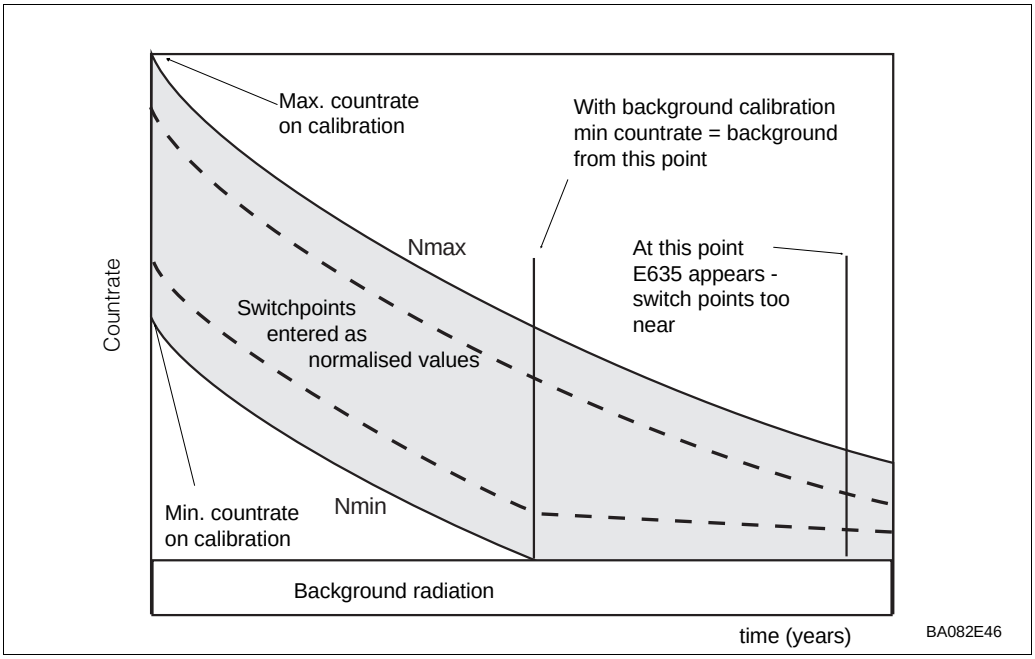


Fig. 4.2: Decay of countrate and compensation of switchpoints with background calibratrion

Pocedure for standard calibration with background calibration

Step	Matrix	Entry	Significance
1	V3H0	5	Commission as in Section 4.1, select background calibration
2	V0H1	»E«	With the barrier free, wait min. 100 seconds, press »E« to register countrate
3	V0H2	»E«	With the barrier covered (or with radiation turned off), wait min. 100 s, press »E« to register countrate
4	V0H9	»E«	With the barrier covered and the radiation source switched off wait min 100 s; press »E« to register countrate.
5	V0H4	e.g. 10 »E«	Enter integration time τ, see p. 37, register entry with »E«

After completion of the calibration:
- A normalised countrate (0…100) is displayed at V0H0
- The limit relays trip at the default values, see Section 4.5.
- When all parameters have been entered, the calibration fields V0H1 and V0H2 are automatically protected against accidental entries. Provided that no general parameter lock is in force, reselection of calibration mode enables them again.

Note!

Note!
- The alarm LED flashes (Warning E 630) until all parameters have been entered.
- The integration time τ is automatically set to 20 s during calibration (5xτ =100s) even if the value in V0H4 is less. If the time set τ >20s, the waiting time is 5xτ.
- For a repeat calibration, enter 1 at V3H0, then the new calibration date at V3H4.
- The background calibration can only be used with detector DG 57.

4.3 Standard calibration (normal) without background calibration (for DG 17 and DG 27)

For applications with the detectors DG 17 or DG 27 the local dose rates are that high, that the background radiation needs not to be taken into account. In these cases a shortened calibration procedure can be used:

Step	Matrix	Entry	Significance
1	V3H0…	1	Commission as in Section 4.1, select standard calibration (normal)
2	V0H1	»E«	With the barrier free, wait min. 100 s press »E« to register countrate
3	V0H2	»E«	With the barrier covered, wait min. 100 s press »E« to register countrate
4	V0H4	e.g. 10 »E«	Enter integration time τ, see p. 37, register entry with »E«

4.4 Auxiliary calibration

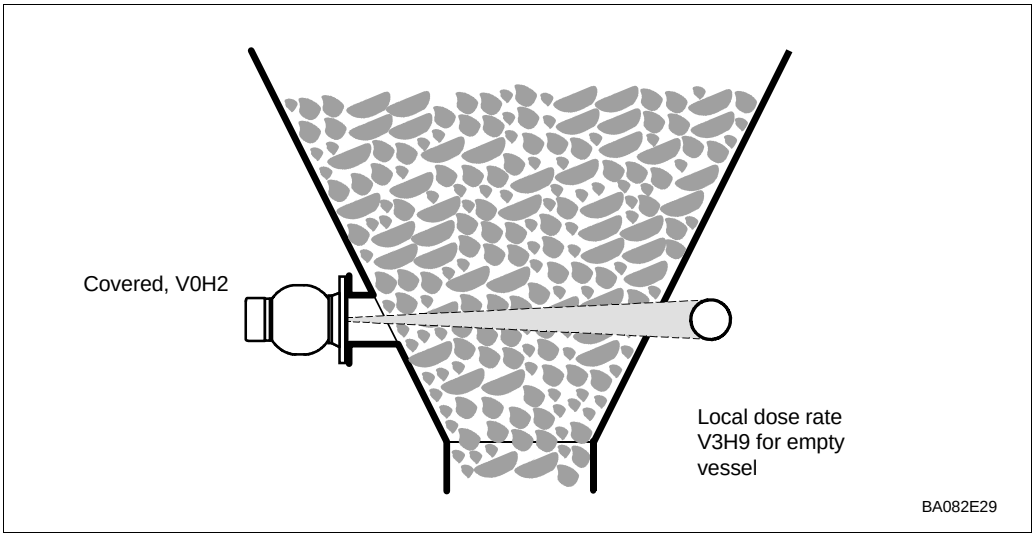


Fig. 4.3: Parameters required for provisional calibration

It is not always possible to calibrate as described in Section 4.2, e.g., it might not be possible to empty the vessel sufficiently to uncover the barrier. In this case an auxiliary calibration can be made, to be completed at a later date when the vessel is empty.

Procedure for auxiliary calibration

Step	Matrix	Entry	Significance
1	V3H0…	2	Commission as in Section 4.1, select auxiliary calibration
2	V3H9	...	Enter the local dose rate for empty at the detector (in µSv/h) (Check with Endress+Hauser)
3	-	»E«	Register entry
4	V0H2	»E«	With the barrier covered, wait min. 100 s, see note p 29. press »E« to register countrate
5	V0H4	e.g. 20 s	Enter integration time τ, see p. 37, register entry with »E«

The auxiliary calibration can be completed later by calling up the recalibration mode:

Recalibration

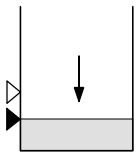
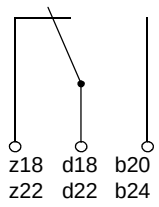
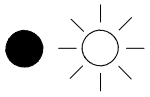
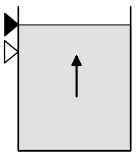
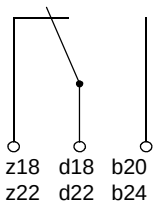
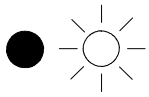
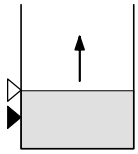
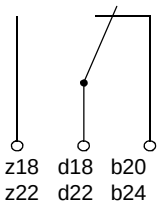
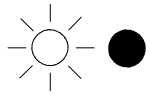
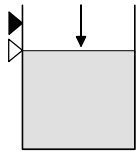
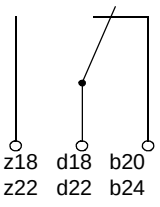
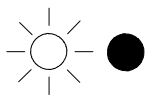
Step	Matrix	Entry	Significance
1	V3H0	4	Select recalibration mode
2	-		»E« Registers entry
3	V3H4	YWWD	Enter date of recalibration
4	-		»E« Registers entry
5	V0H1	»E«	With the vessel empty, wait 100 s, see note, press »E« to register countrate

Note!
- The alarm LED flashes (Warning E 630) until all parameters have been entered.
- For a repeat calibration, enter 2 at V3H0, then the new calibration date at V3H4.
- The field for today's date (V3H5) is enabled only in calibration mode 3!
- The recalibration can be called for any parameter V0H1, V0H2, V0H9

Note!

4.5 Limit switches

Table 4.8: Truth table for minimum and maximum fail-safe mode

Minimum fail-safe mode			Maximum fail-safe mode		
Level	**Relay status**	**LED**	**Level**	**Relay status**	**LED**
Drops below switch-off point 	De-energised 	Green off Red on 	Rises above switch-off point 	De-energised 	Green off Red on 
Rises above switch-on point 	Energised 	Green on Red off 	Drops below switch-on point 	Energised 	Green on Red off 

Default settings

On completion of the calibration, the (max.) countrate registered with the barrier free is assigned the normalised countrate 0 and the (min.) countrate registered with the barrier covered, the normalised countrate 100. The Gammapilot FTG 671 automatically sets the following switch points.

- Relay 1 is set to operate in minimum fail-safe mode with switch-off point at 38 and switch-on point at 72 normalised countrate (10/90 for DG 17/27).
- Relay 2 is set to operate in minimum fail-safe mode with switch-off point at 72 and switch-on point at 38 normalised countrate (90/10 for DG 17/27).
- On fault condition, both limit relays de-energise.

Table 4.2 indicates the Gammapilot relay responses. If other limits are required or the relays are to be operated in acknowledgement mode, the settings can be changed as described in Chapter 5, p. 35.

Switch point monitor

Once the relays are set, the Gammapilot monitors the switchpoints as follows:

- *Decay compensation*
  This function ensures that the maximum and minimum countrate are corrected for the natural decay in the activity of the radioactive source. It is run once every twenty four hours.
- *Minimum countrate check*
  The measured countrate is checked continuously against the corrected minimum countrate. If it is smaller, Alarm E 201 is set, the alarm relay trips and the alarm LED lights. In default mode, the limit relays de-energise.
- *Maximum countrate check*
  The measured countrate is checked continuously against the corrected maximum countrate. If it is greater, Alarm E 202 is set, the alarm relay trips and the alarm LED lights. This alarm usually indicates the presence of external gamma radiation. In default mode, the limit relays de-energise.
- *Plausibility test*
  The limits are checked with respect to their plausibility every four minutes. If the test is failed, Warnings E 631…635 may be set and the alarm LED flashes.

4.6 Additional functions

Detector monitor

The Gammapilot FTG 671 also checks whether the detector is operating correctly. Depending upon the type used, the following alarms and warnings may appear.

• E 201:	Pulserate too low	Alarm
• E 202:	Pulserate too high	Alarm
• E 204:	Temperature measurement faulty (DG 57 only)	Alarm
• E 206:	Reference measurement faultly (DG 57 only)	Alarm
• E 401:	No signal from detector	Alarm
• E 404:	Wrong detector connected	Alarm
• E 610:	Detector data chip changed (DG 57 only) - e.g. after exchange of detector	Warning
• E 660:	Detector temperature too high (DG 57 only)	Warning

The self-monitoring function is described in detail in Chapter 6, »Trouble-Shooting«

4.7 Measured value display

During normal operation the normalised countrate can be read at V0H0. In addition to this, several other fields contain system information which might be needed, e.g., for trouble-shooting etc.. Table 4.3 summarizes the measured value displays.

Table 4.9: Matrix positions of measured value displays

Matrix	Measured value	Remarks
V0H0	Normalised pulse rate or frequency	Display 0…100 of normalised countrate(PCM) or frequency (PFM) depending upon the detector mode used
V0H8	Current measuring frequency or pulse rate	Displays the frequency or pulse rate which is actually measured. The value is dispayed as frequency/10 or counts/100ms
V0H9	Background radiation DG 57 only	Pulse rate of the background radiation for calibration mode 5. For calibration modes 1…4 is always 0. Displayed as counts/100ms
V3H6	Free value	Original pulse rate or frequency used for calibration
V3H7	Covered value	Original pulse rate or frequency used for calibration
V3H8	Dose rate	Current mean dose rate measured at detector in µSv/h
V7H1… V7H9	Service parameters	Parameters which may be required for fault diagnosis during a service call
V9H0	Current error code	When red fault LED flashes, the error code can be read here
V9H1	Last error code	The previous error can be read and deleted here - press »E«
V9H3	Software version with instrument code	The first two figures indicate the instrument, the last, the software version; e.g. DDXX: Instrument code DD, Software version X.X
V9H4	Rackbus address	Indicates address set at DIP-switches on card

4.8 Locking the parameter matrix

When all parameter entries have been made (see also Chapters 5…7) the matrix can be locked by entering a code number.

Step	Matrix	Entry	Significance
1	V8H9	e.g. 888	Enter any code from 100 - 669 or from 680 - 999
2	-	"E"	Register entry

In this mode, all entries can be displayed but not changed.

- The lock is released when a number between 670 and 679, e.g. 672, is entered into the matrix at the same position.

5 Limit Switches - Relays

This Chapter describes the setting of the relay limit switches. It need only be read if the standard limit detection mode described in Section 4.5, which uses the default settings, does not satisfy your needs. This might be the case if the detector is mounted vertically (two widely spaced limits), if the relay acknowledgement mode is required, or if the switching is to be optimised by changing the integration time.

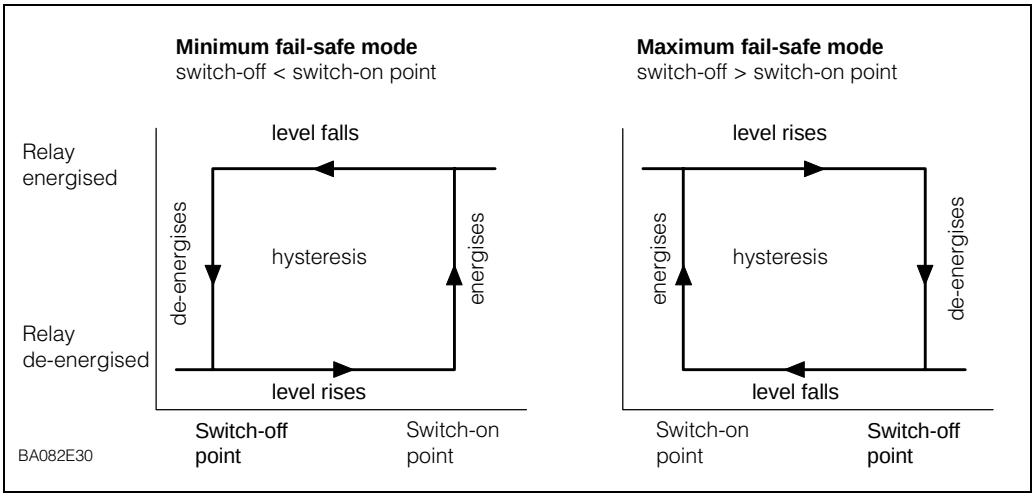


Fig. 5.4: Selection of minimum and maximum fail-safe mode by setting the switch points

Gammapilot FTG 671 transmitters have two independent relays, which switch according to the size of the measured value at V0H0.

- Each limit switch has a switch-on and switch-off point. The relative values of these two parameters determines the hysteresis and fail-safe mode, see Fig. 5.1.
- Both relays can be operated in acknowledgement mode.
- The switching precision of the relays can be adjusted by means of the integration time.
- The response time is determined by the local dose rate at the detector.

The relays are controlled by the matrix fields V1H0 to V1H4 for relay 1 and V1H6 to V1H9 for relay 2. Table 5.1 lists the configuration parameters. Table 4.2 in Section 4.5 summarizes the response of the relays in minimum and maximum fail-safe mode.

Table 5.10: Relay control parameters

Relay 1	Relay 2	Significance		Default
V1H0	V1H5	Relay switch-on point	DG 57 DG 17/27	72/38 90/10
V1H1	V1H6	Relay switch-off point	DG 57 DG 17/27	38/72 10/90
V1H2	V1H7	Relay operating mode 0 = standard operation 1 = acknowledgement mode		0
V1H3	V1H8	Relay at fault 0 = de-energises 1 = remains in status found at fault (hold)		0
V1H4	V1H9	Relay acknowledgement (V1H2/V1H7 = 1) Press »E« to acknowledge		
V0H4		Integration time - DG 57 Integration factor - DG 17/27 (Z)		7

5.1 Configuration

Switch point

If the default values are to be changed, two switch points can be set for each relay.

- The switch-on point, i.e. the value at which the relay energises, at V0H1 for relay 1 and V1H5 for relay 2
- The switch-off point, i.e. the value at which the relay de-energises, at V1H1 for relay 1 and V1H6 for relay 2.

The hysteresis is determined by the difference in the two switch points, the fail-safe mode by their relative size, see Fig. 5.1:

- in minimum fail-safe mode the relay de-energises if the level drops below the barrier (switch-off point < switch-on point)
- in maximum fail-safe mode the relay de-energises if the level rises above the barrier (switch-off point > switch-on point).

Table. 4.2 in Section 4.5 shows the function of the relays with rising and falling level. The example below illustrates the settings for minimum limit detection. The default values can be recalled by entering 0 at V1H2/V1H7.

Step	Matrix	Entry	Significance
1	V1H0	80	Normalised countrate at which relay 1 energises
2	-	»E«	Registers entry
3	V1H1	20	Normalised countrate at which relay 1 de-energises
4	-	»E«	Registers entry

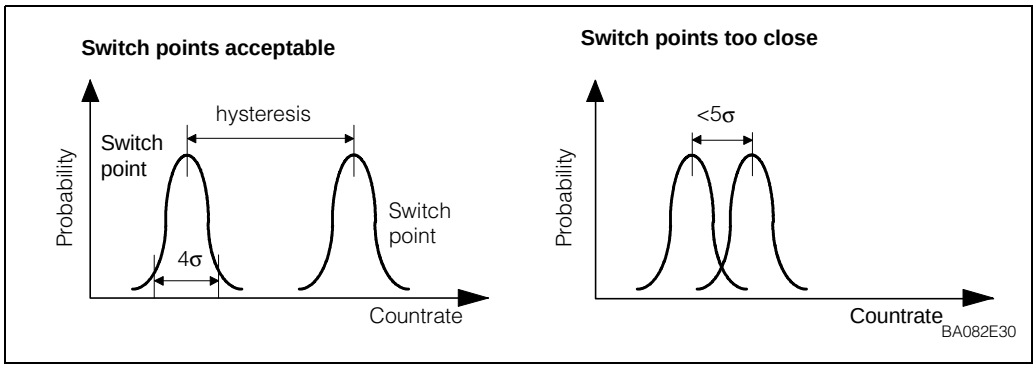
Plausibility test DG 57

The limits entered are subject to a plausibility test. Due to the statistical fluctuation in countrate, a (±2σ) band is defined which gives the probability of a measured value being at the limit, see Fig. 5.2. Warnings are given if the bands overlap or exceed the maximum or minimum countrate bands.

- E 631: Limit for relay 1 outside permissible range (DG 57 only)
- E 632: Limit for relay 2 outside permissible range (DG 57 only)
- E 633: Hysteresis for relay 1 too small
- E 634: Hysteresis for relay 2 too small

If a warning appears, either the limits must be changed or the width of the 4σ band reduced by increasing the integration time.

Fig. 5.5: Plausibility test for switch points. The resolution between switch points can be increased by increasing the integration time



Plausibility test DG 17/27

For the DG 17/27 detectors, the switchpoint hysteresis must be at least 45. If the hysteresis is less, warning E 633 or E634 appears.

Limit switch/ Acknowledgement mode

The choice between standard or acknowledged operation, see Section 5.2, is made at field V1H2 for relay 1 and V1H7 for relay 2:

- 0 = standard operation (default)
- 1 = acknowledgement mode

Step	Matrix	Entry	Significance
1	V1H2	e.g. 0	Selects standard mode (limit swich) for relay 1
2	-	»E«	Registers entry

Relay at fault

When the self-monitoring circuit triggers on a fault, the relay adopts the behaviour set at V1H3 for relay 1 and V1H8 for relay 2:

- Setting 0 = de-energised
- Setting 1 = remains in the status found when the alarm relay de-energised

Step	Matrix	Entry	Significance
1	V1H3	e.g. 0	The relay de-energises on alarm
2	-	»E«	Register entry

Integration time

The integration time is entered at V0H4 as follows:

Step	Matrix	Entry	Significance
1	V0H4	10	Integration time set to 10 seconds
2	-	»E«	Register entry

The determination of the integration time depends upon the detector connected:

- For the DG 57 detector, determine the maximum relay response time (0…300s) your process will tolerate. Enter this plus 2 s as the integration time.
  - Figs 5.3…5.6 can be used to check at which local dose rate the warning E635 (integration time too short) appears.
- For the DG 17/27 detector, the local dose rate determines the minimum response time of the relay, see Fig. 5.7…5.10. The integration time acts as a prolongation factor, which increases the response time 1…6 fold.
  Read the minimum response time τ from Fig. 5.7…5.10, then determine the maximum relay response time your process will tolerate τ_{max}.

  $$\text{Prolongation factor} = \tau_{max}/\tau$$

  Enter this factor rounded to next integer value in V0H4.

Half value layer (Figs 5.3…5.10)

Figs. 5.3…5.10 show the required local doserate at the detector as a function of relay response time, source type and detector type.

- The faster the response time, the higher the required local doserate
- If the HVLvalue is less than 4, the local doserate at the detector increases, see Fig. 5.11.

For the Cs 137 source, 4 HVL = $d_i \times \rho_{medium} \geq 450$, for Co 60, 4 HVL = $d_i \times \rho_{medium} \geq 620$, whereby d_i = path length through medium (mm) and ρ = density of medium (g/cm^3)

Fig. 5.6: Relay response time as a function of local dose rate for detector DG 57/400mm and source Co 60

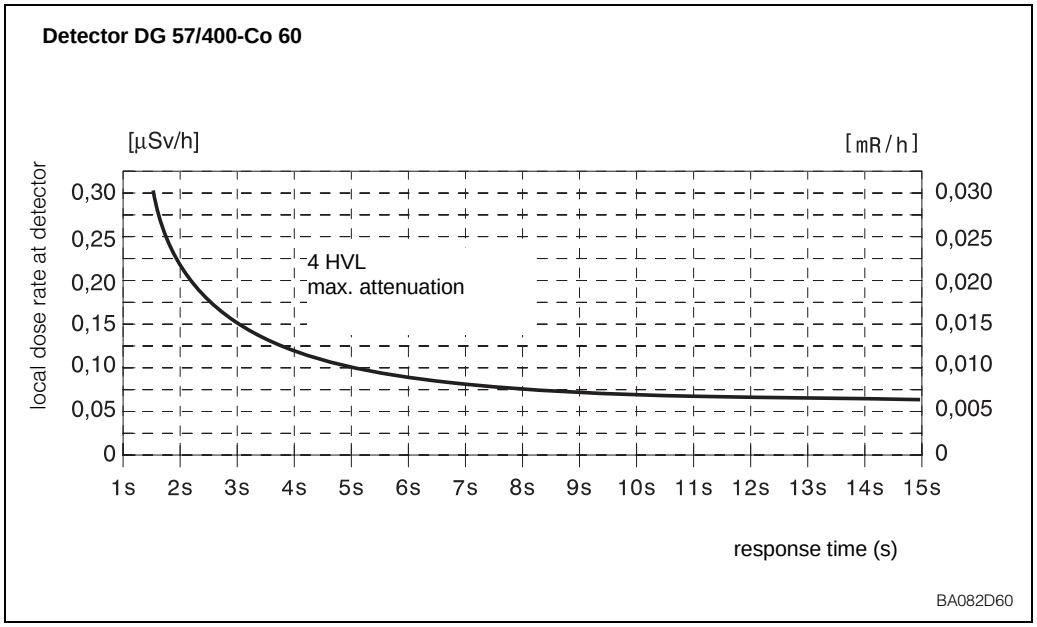


Fig. 5.7: Relay response time as a function of local dose rate for detector DG 57/400mm and source Cs 137

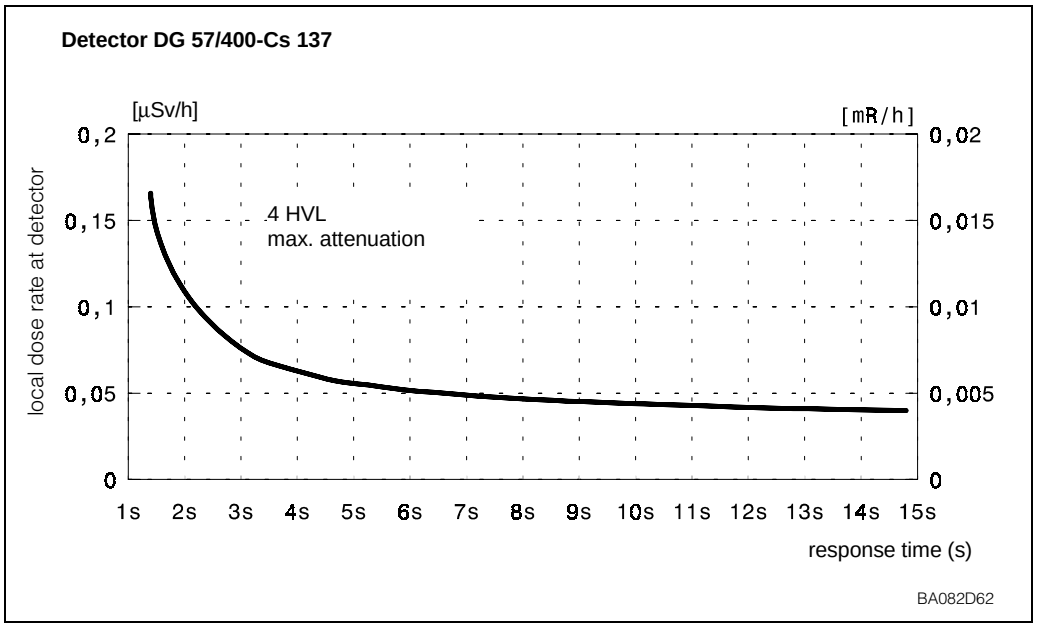
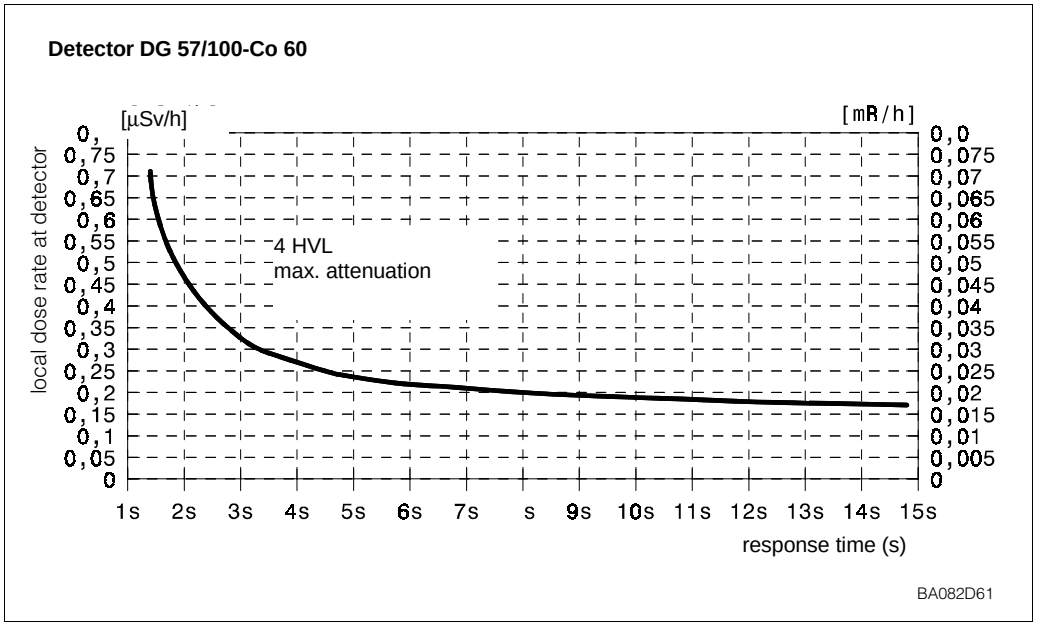


Fig. 5.8: Relay response time as a function of local dose rate for detector DG 57/100mm and source Co 60



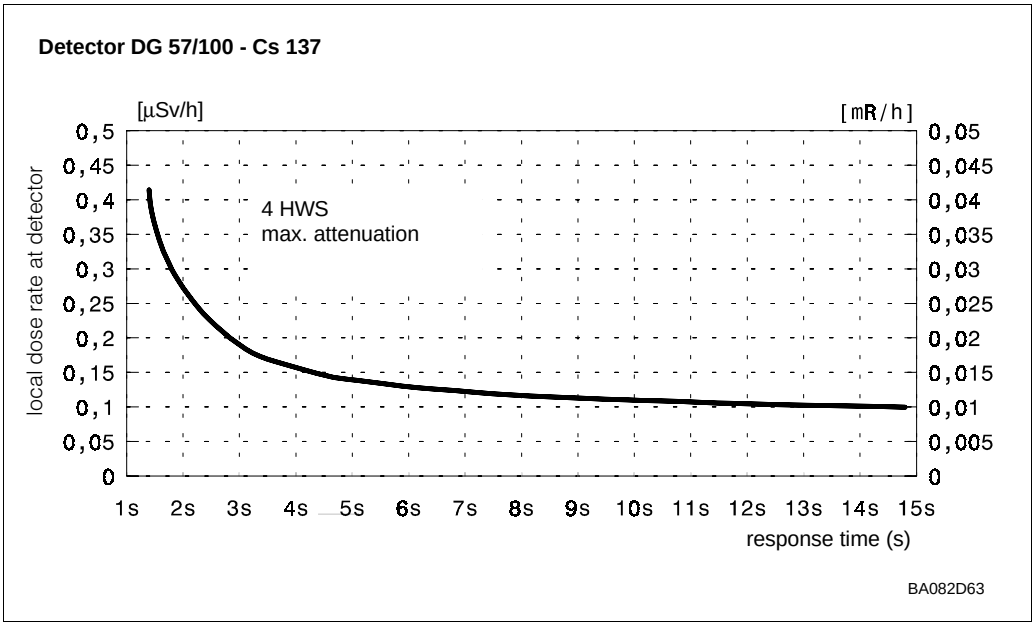


Fig. 5.9:
Relay response time as a function of local dose rate for detector DG 57/100mm and source Cs 137

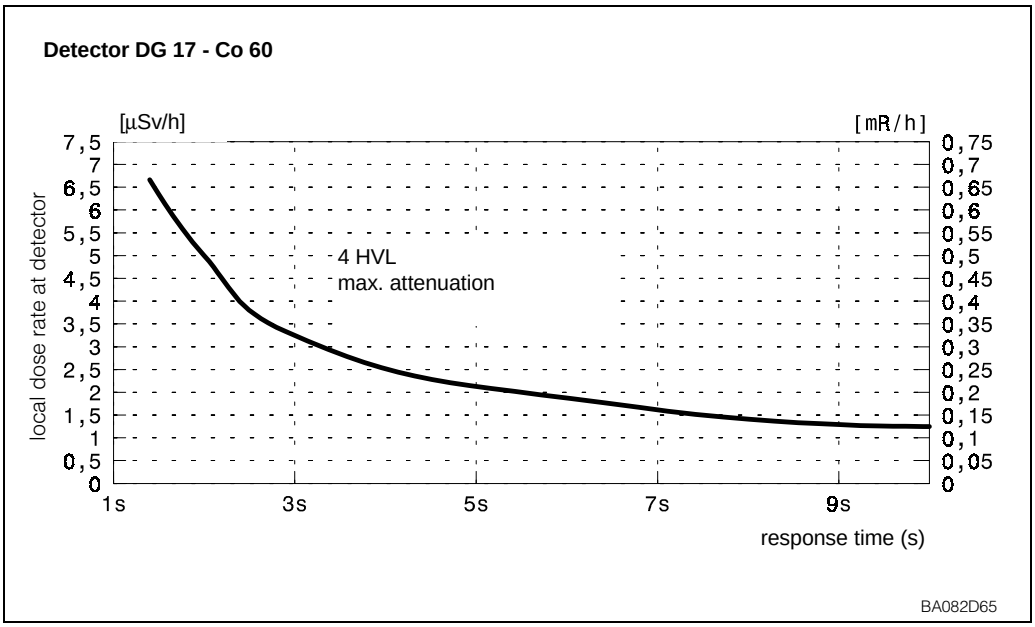


Fig. 5.10:
Relay response time as a function of local dose rate for detector DG 17 and source Co 60

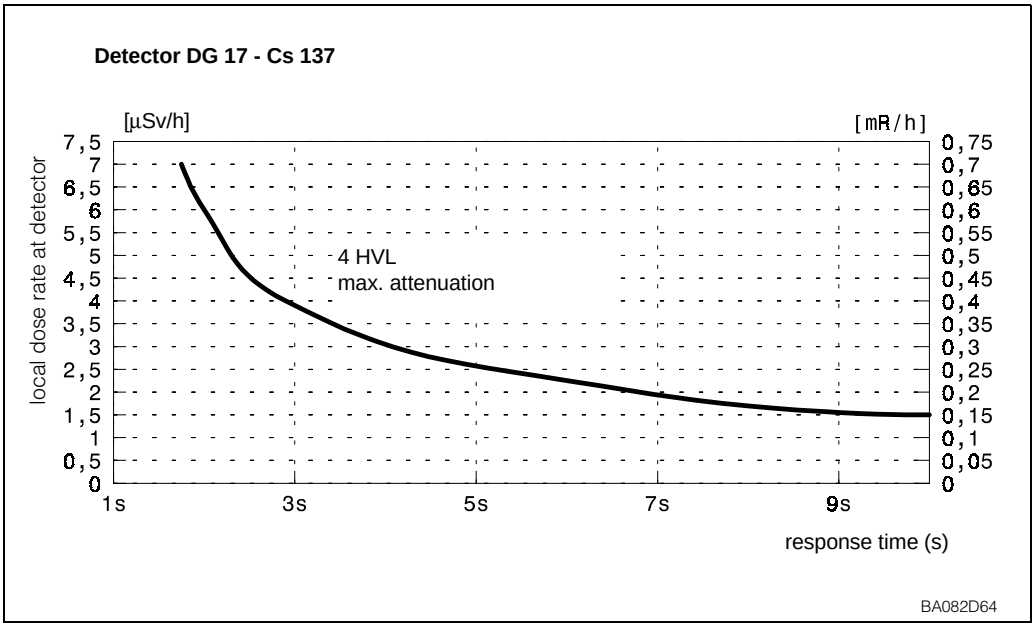


Fig. 5.11:
Relay response time as a function of local dose rate for detector DG 17 and source Cs 137

Fig. 5.12: Relay response time as a function of local dose rate for detector DG 27 and source Co 60

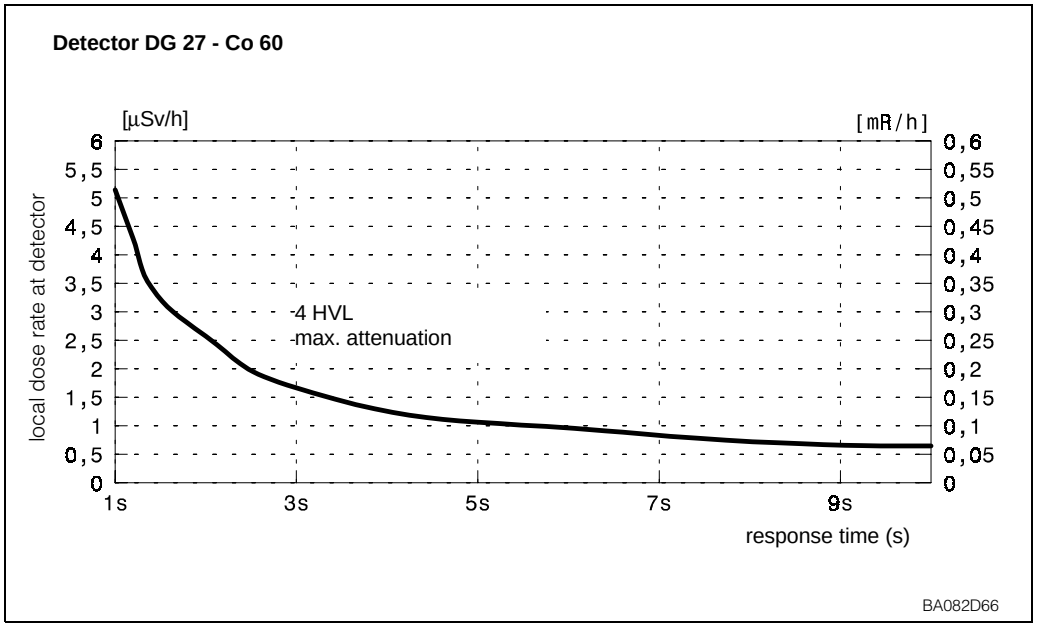


Fig. 5.13: Relay response time as a function of local dose rate for detector DG 27 and source Cs 137

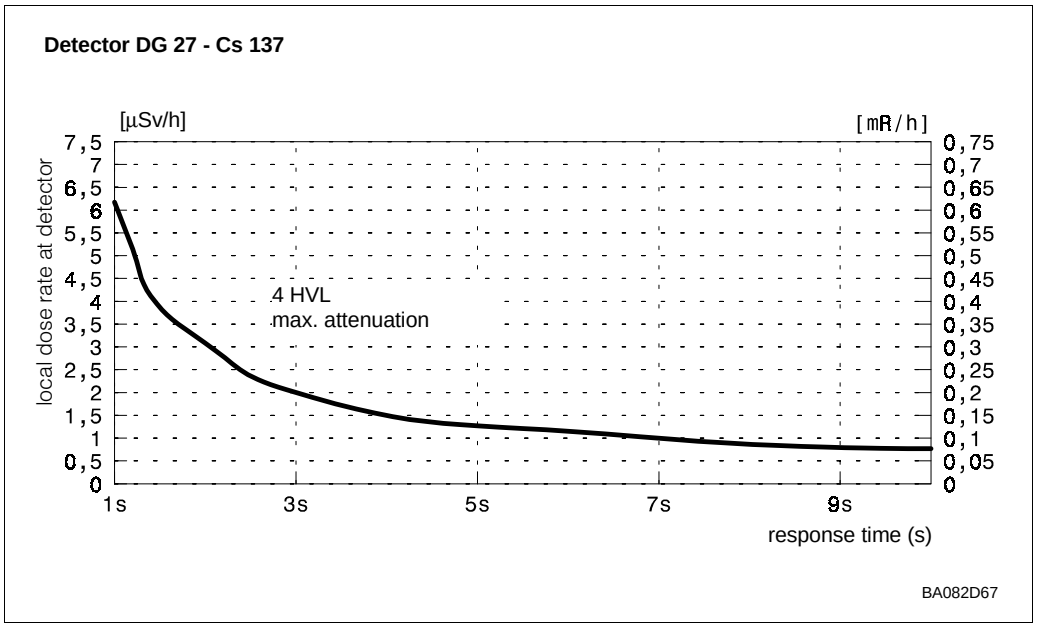
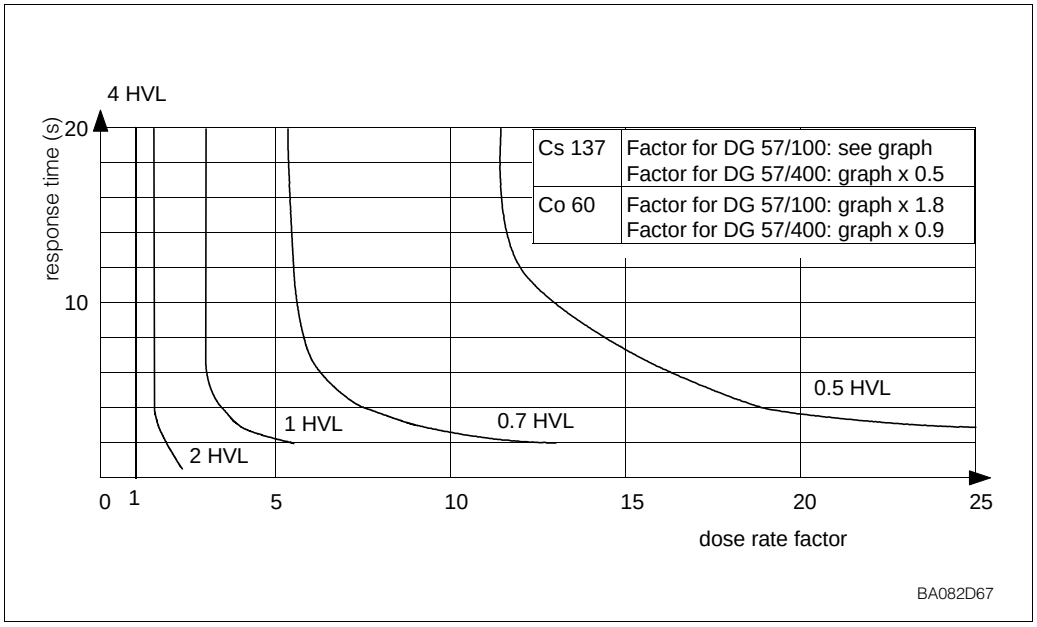


Fig. 5.14: Local dose rate as a function of relay response time for DG 57/100 and DG 57/400 detectors



5.2 Acknowledgement mode

By entering 1 at V1H2 or V1H7, each relay may be set to operate in acknowledgement mode. 0 reselects standard operation. Acknowledgement mode is suitable for applications which require a relay hold function. In this case, the relay is held in the attained switching status even when the operational conditions would normally dictate a return to the original status.

Step	Matrix	Entry	Significance
1	V1H2	e.g. 1	Selects acknowledgement mode for relay 1
2	-	»E«	Registers entry

Depending upon the switching direction chosen, the relay energises or de-energises when the switching condition is fulfilled. After switching, the relays return to initial status only after the operator presses »E« when the confirmation field V1H4 (relay 1) or V1H9 (relay 2) is selected and the switch-back condition is fulfilled. Figs. 5.11 and 5.12 illustrate the function.

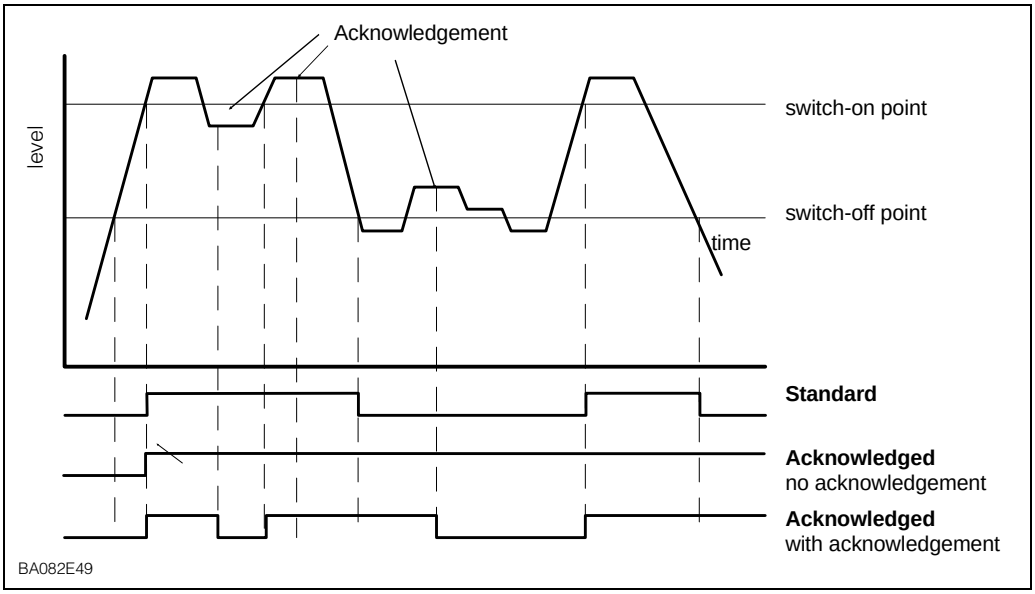


Fig. 5.15: Acknowledgement mode for switch-off point < switch-on point

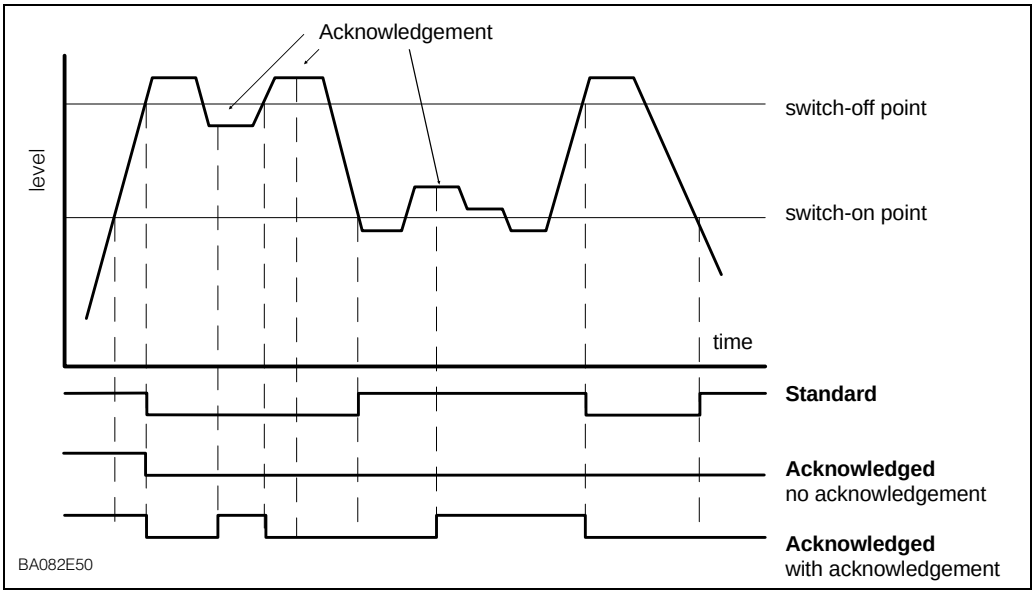


Fig. 5.16: Acknowledgement mode for switch-off point > switch-on point

6 Maintenance

When using the DG 57 detector, the following parameters should be checked in regular intervalls (approx. 6 month):

Sensor temperature °C (V7H3)
This field displays the highest temperature which has been present at the DG 57 during operation. If the limit of 50 °C is permanently exceeded, countermeasures have to be taken, e.g.
- usage of a detecteor with water cooling jacket
- thermal screening
- change of mounting position

Current reference % (V7H4)
This parameter is a measure for the relative sensitivity of the detector. It is used internally by the software in order to compensate for sensitivity changes which might occur in the course of time.
The value should be between 30% and 80%.
If the value is beyond this range, the inspection frequency should be increased (approx. every 3 months) and replacement of the detector should be scheduled.
If the value is below 5% or above 95%, the detector should be replaced.

7 Trouble-Shooting

When the instructions in the manual have been followed correctly, the system must now function. Should this not be the case, the Gammapilot FTG 671 transmitter provides a number of aids for setting up and operating the module correctly. This Chapter contains the following:

- Trouble-shooting tables, with error messages, meaning and response
- Description of simulated operating mode for service and commissioning purposes
- Instructions for commissioning replacement transmitters, sources and detectors.
- Repairs

7.1 Trouble-shooting tables

Alarms

If the Gammapilot FTG 671 transmitter recognizes a fault condition:

- the red fault LED lights and the alarm relay trips
- the limit value relays assume fail-safe mode as specified in fields V1H3 and V1H8 - see Chapter 5, p 35.
- the code for a diagnostic message is to be found in V9H0.

If several faults occur together, the code for the one with the highest priority is displayed. The others can be called up by pressing the »+« or »-« key when field V9H0 is selected.

If the cause of the fault is rectified, its code is no longer displayed:

- the code for the last fault rectified is retained in V9H1
- this message can be cleared by pressing the »E« key.

If the power fails, all relays de-energise.

Warnings

If the Gammapilot FTG 671 transmitter has detected a condition which requires a warning:

- the red fault LED flashes but the Gammapilot functions as normal
- the alarm relay remains energised
- the appropriate code is to be found in V9H0.

The codes and error messages are listed in Table 6.1 in the order of their priority. Table 6.2, trouble-shooting, indicates possible configuration errors for the Gammapilot.

Table 7.1
Error codes and error messages

Code	Type	Cause and Remedy
E101… E106	Alarm	Fault in instrument electronics - Check supply voltage - Call Endress+Hauser Service
E201	Alarm	Fault in detector, pulse rate too low (DG 17 = 0, DG 27 < 1 Hz, DG 57 < 2 Hz) - Check detector
E202	Alarm	Pulse rate > max. possible pulse rate (detector possibly defective) (DG 17/27 > 2 x empty calibration countrate; DG 57 ca. 110% of max. countrate - dependent on temperature and calibration value) - If calibration was made with build-up on the sides of the vessel, it is possible that this has fallen off and less radiation is being absorbed. In this case recalibrate and set V0H1 equal to e.g. 20. - Check detector - Check for external radiation source
E204	Alarm	No temperature measurement (DG 57 only)
E206	Alarm	LED reference measurement outside limits 30…95% (DG 57 only)
E401	Alarm	No signal from detector, - Check the wiring. Take into account the polarity. - If the wiring is correct, check the voltage at the terminals of the detector. The value should be 13.7 +/- 3V. If the voltage is correct, a mistake is present at the detector. Exchange detector. - If the voltage is not correct at the detector, check for the same voltage at the output of the transmitter FMG 671. If the output voltage is not correct, the transmitter is defective.
E404	Alarm	Wrong detector connected
E610	Warning	Detector data have been changed (DG 57 only) - Check whether detector data chip (DAT) is inserted in card or whether it corresponds to the detector connected -- Re-calibrate, if detector exchanged
E613	Warning	Instrument in simulation mode - Switch back when finished
E615	Alarm	Incorrect calibration points, e.g. through mix-up, repeat calibration
E630	Warning	Calibration incomplete
E631	Warning	Limit for switch point relay 1 exceeds maximum or drops below minimum countrate - re-enter
E632	Warning	Limit for switch point relay 2 exceeds maximum or drops below minimum countrate - re-enter
E633	Warning	Hysteresis relay 1 too small - re-enter, increase integration time
E634	Warning	Hysteresis relay 2 too small re-enter, increase integration time
E635	Warning	Difference between maximum and mimimum pulse rate too small - increase integration time - source too weak
E660	Warning	Detector temperature > 55°C (DG 57 only)

Trouble-shooting table

Use the following Table to check for faulty operation

Table 7.2 Trouble shooting table for incorrect function without error message

Fault	Cause and remedy
Dose rate for unhindered radiation too low	• Radiation switched off - switch on again • No radionuclide in source container - load source capsule in container • Detector incorrectly orientated with respect to detector - turn detector • Detector mounted end-on (DG 17, DG 27) - mount horizontally • Gamma beam not precisely aligned - re-align • Fittings in vessel not considered in activity calculation - recalculate activity and change source accordingly • Build up in vessel - Clean vessel • Source too weak - employ source with higher activity
Dose rate for unhindered radiation too high	• Detector has two counter tubes (DG 27) - Use detector with one tube only • External radiation - Shield off if possible • Activity too high - Exchange radionuclide or attenuate radiation, e.g. by mounting a steel plate in front of source container.
Dose rate for covered barrier too high	• External radiation source in use (gamma radiology) - Shield off if possible
Relays do not trip correctly	• Wrong fail-safe mode selected - re-enter switch points • Incorrect integration time settings - Increase time or hysteresis if relays »flutter« - Decrease time if delay too long • Wiring or load incorrect, see »Installation« - Use simulation mode to check correct switching
Alarm relay lights or blinks	• See Table 6.1
No communication with ZA 67…	• Check address switch • Check wiring

7.2 Fault by Gammagraphy

Gammagraphy is a destruction-free material test for piping, pressurised tanks, etc. and uses radioactive gamma sources. The high sensitivity of scintillation detectors to gamma radiation may mean that spurious radiation due to gammagraphy will cause the evaluation device to show the wrong display which suggests that the level is lower than it really is.
If the gammagraphy detection function is required, it is necessary to use the FMG 671 instead of the FTG 671. For more detailed information, please consult the Operating Instructions FMG 671, BA 133F/00/en.

7.3 Simulated operating mode

This function is intended primarily for checking the correct function of the system and is selected and terminated at V8H0:

- Enter 3 to simulate the input variable (pulse rate or frequency)
  - display 0…9999, actual 0…99990
- Enter 4 to simulate the normalised input variable (0…100)
- Enter 0 to terminate simulation and resume normal measurements.

Start and stop simulation

Step	Matrix	Entry	Significance
1	V8H0	e.g.3	Selects simulation of input variable
		or	
		e.g. 0	Selects standard operation mode and ends simulation
2	-	»E«	Registers entry

When a value is entered at matrix position V9H6 or V9H7, the relay response can be tested accordingly. Throughout the simulation the red alarm LED flashes to indicate that the instrument is no longer measuring, the alarm relay does not, however, trip.

Countrate/frequency

The countrate (or frequency) is entered in the same manner as it is displayed at V0H8, i.e. as value/10, e.g.

- 120.1 = 1201 pulses/s, 1234 = 12340 pulses/s for DG 57
- 2.5 = 25 Hz, 0.9 = 9 Hz for DG 17/DG 27

Step	Matrix	Entry	Significance
1	V9H6	e.g. 100	1000 pulse/sec for DG 57 or 1000 Hz for DG 17/27
2	-	»E«	Registers entry

Normalised countrate

Any value between 0…100 can be entered

Step	Matrix	Entry	Significance
1	V9H7	e.g. 10	Normalised countrate/frequency = 10
2	-	»E«	Registers entry

7.4 Exchanging transmitters and detectors

Transmitter

If the Gammapilot FTG 671 has to be exchanged, the replacement need not be recalibrated. Instead all the matrix values noted down at the time of the commissioning (Table in back cover) can be used to quickly commission the new transmitter.

Step	Matrix	Entry	Significance
1	V3H0	3	Select calibration on instrument exchange
2	-		»E« Registers entry
3	V3H4	YWWD	Enter the date of original calibration (see Section 4.1)*
4	-		»E« Registers entry
5	V3H5	YWWD	Enter today's date
6	-		»E« Registers entry
7	V3H6	...	Enter countrate/frequency of original free calibration
8	-		»E« Registers entry
9	V3H7	...	Enter countrate/frequency of original covered calibration
10	-		»E« Registers entry
11	V0H1	...	Enter normalised countrate of original free calibration
12	-		»E« Registers entry
13	V0H2	...	Enter normalised countrate of original covered calibration
14	-		»E« Registers entry
15	V0H9	...	If originally used, enter background radiation count - otherwise confirm "0" with »E«
16	-		»E« Registers entry
17	V0H4	... V1H0...V1H9	Enter integration time and relay parameters

*For Co-60 source and DG 17/27 detector, make additional entries at V3H1 (=1), V3H2 (=1/2)

On completion of the above procedure, the barrier now functions as before. If you did not note your parameters, a recalibration is necessary.

If your parameters have been downloaded from a computer, you need only enter the new date at V3H5; all other values are registered by pressing »E«.

Re-commissioning the transmitter

If the transmitter is switched off for some time, then the above procedure need not be run through on re-commissioning: after calling the re-calibration procedure with V3H0 = 3, only today's date at V3H5 has to be re-entered. This ensures that the source decay compensation values are brought up to date. This is particularly recommended for the Co 60 source which changes at ca. 1% per month. In comparison, Cs 137 changes at the rate of 0.2% per month.

Detectors

If the detector is exchanged or moved, a completely new calibration as per Chapter 4, Section 4.2, 4.3 or 4.4 is necessary.

Source

If the source is exchanged or the source container moved, a completely new calibration as per Chapter 4, Section 4.2, 4.3 or 4.4 is necessary.

7.5 Repairs

Should the Gammapilot FTG transmitter or its detector need to be repaired by Endress+Hauser, please send it to your nearest Service Centre with a note containing a short description of the fault.

Disposal of spent radioactive nuclides

In all countries, the disposal of radioactive material is strictly controlled by law. If you are uncertain of the procedures in force in your country, ask your radiation protection officer.

Operating Matrix

Operating and default parameters

Enter your operating parameters in the matrix below, a full matrix is to be found overleaf.
The parameters in brackets are default parameters.

	H0	H1	H2	H3	H4	H5	H6	H7	H8	H9
V0		[0.0]	[100.0]		[2]					
V1	[72]	[38]	[0]	[0]		[38]	[72]	[0]	[0]	
V2										
V3		[0]	[0]		[Y WW D]	[Y WW D]				
V4										
V5										
V6										
V7										
V8										[670]
V9				[39…]		[0]				

Display field

Parameter Matrix

	H0	H1	H2	H3	H4	H5	H6	H7	H8	H9
V0 Calibration	Normalised pulse rate or frequency	»Empty« calibration	»Full« calibration		Integration time (s)				Actual pulse rate or frequency per 100 ms [10/s]	Back ground countrate per 100 ms [10/s]
V1 Limit value	Relay 1 switch point »On« 0…100	Relay 1 switch point »Off« 0…100	Relay 1 0 = standard 1 = acknowledge	Relay 1 at fault 0 = de-energise 1 = unchanged	Relay 1 acknowledge E = confirm	Relay 2 switch point »On«	Relay 2 switch point »Off«	Relay 2 0 = standard 1 = acknowledge	Relay 2 at fault 0 = de-energise 1 = unchanged	Relay 2 acknowledge E = confirm
V2						.				
V3 Extended calibration	Mode 0=blocked 1= standard (normal) without background 2= auxiliary 3 = exchange 4 = recalibrate 5 = standard with background	Source 0 = Cs 1 = Co	Detector 0 = DG 57 1 = DG 17 2 = DG 27	Mounting 0 = horizontal 1 = face on	Date of calibration Y WW D	Today's date Y WW D	Pulse rate/ frequency for »empty« calibration per 100ms [10/s]	Pulse rate/ frequency for »full« calibration per 100 ms [10/s]	Current mean local dose rate µSv/h	Dose rate in µSv/h for partial calibration
V4										
V5										
V6										
V7 Service detector data*	Select service level	Sensor No.	Sensor length	Sensor temperature	Current reference	Δ reference	Mean reference at calibration	Max. registered pulserate/ frequency per 100 ms [10/s]	compenstd pulserate/ frequency uncovered per 100 ms [10/s]	compenstd pulserate/ frequency covered
V8 Operating mode	Operat. mode 0 = standard 3 = sim. pulse/f 4 = sim. norm									Security locking < 670 or > 679 Unlock 670…679
V9 Service and Simulation	Current error code	Last but one errorcode E=clear		Instrument and Software version	Rackbus address	Reset to default values 670…679	Simulation freq/pulse rate 0…9999	Simulation norm. freq/ pulse rate 0…100		
VA VU 260 Z ZA 672 only	Tag. No.									

Display field *not described in this manual

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