BA 133F/00/en/12.03
016433-1000
valid for Software 3.x

gammasilometer
FMG 671 (P)
Level Measurement

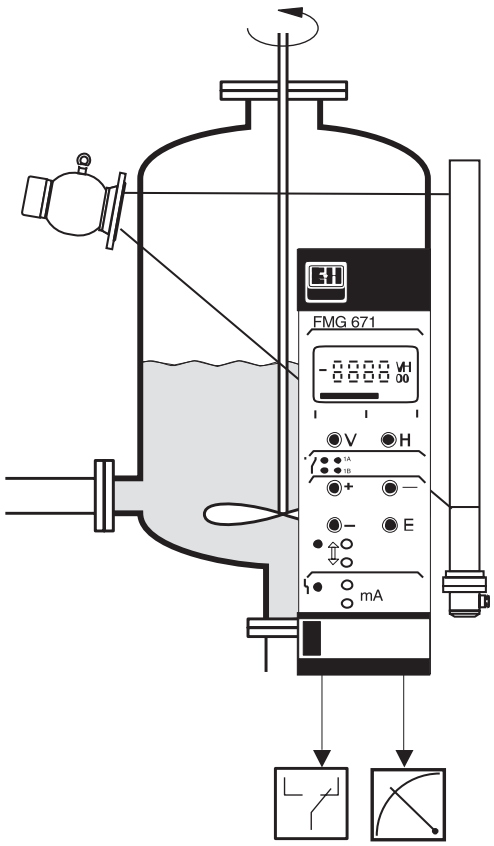






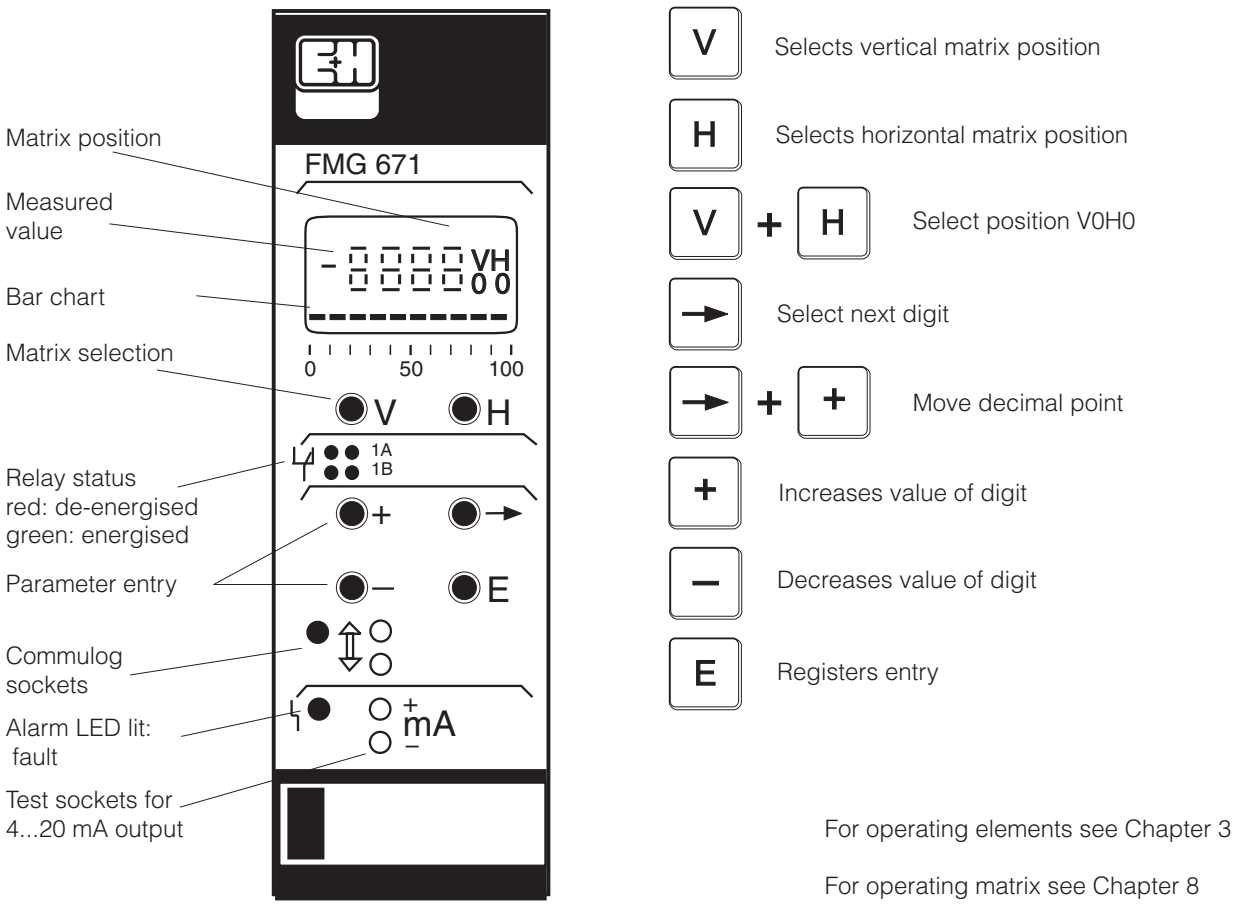


Installation and Operating Instructions



Endress + Hauser
The Power of Know How

Short Intructions for Use



Quick configuration for Cs137 source and DG 57 mounted with PMT at bottom*

Function	Matrix	Action
Check detector no. on label	V7H1	• Cs ☐☐☐☐
Reset transmitter	V9H5	• Enter 671: see above for key functions Press »E« to register entry
Calibrate	V3H0 V3H4 V0H1 V0H2 V3H9	• Enter 4 to select standard calibration with background calibration Press »E« to register entry • Enter calibration date: year (1 = 2001), week (01...53) weekday (1=Monday etc.) • Press »E« to register entry • With vessel empty (wait 100s) Press »E« to register entry • With vessel full (wait 100s) Press »E« to register entry • With radiation off and vessel full (wait 100s) Press »E« to register entry
Analogue output (default values) Relays (default values)	...	• 4 mA = 0%, 20 mA = 100% level • Relay 1 is set automatically to minimum fail-safe mode Switch-off point 10%, switch-on point 90% • Relay 2 to maximum fail-safe mode Switch-off point 90%, switch-on point 10%

*Measuring system must have been in operation (source switched on or off) for at least 6 hours before calibration

Table of Contents

Revision Index

Software	Issue	Changes
1.x	11.94	Original
2.x	06.95	Cascade operation, Chapter 5, corresponding revisions in Chapters 1...4 and 6. EMV requirements for CE mark Technical data moved to Section 1.5
3.x	02.96	Gammagraphy, Chapter 6, corresponding revisions in Chapters 1...5 and 7 Chapters renumbered As far as uploading and downloading from a computer is concerned, Software Version 3.x is not compatible with earlier versions.

Notes on Safety

Approved usage

The Gammasilometer FMG 671 is a transmitter for continuous level measurement in industrial environments which can be used with a variety of radioactive sources (in source containers) and detectors. It has been designed to operate safely in accordance with current technical and safety standards. It must be installed by qualified personnel according to the instructions in this manual and local radiation protection regulations.

The manufacturer accepts no responsibility for any damage arising from incorrect use, installation or operation of the equipment. Changes or modifications to the equipment not expressly approved in the operating manual or by the bodies responsible for compliance may void the user's authority to operate the equipment.

Radioactive sources

Radioactive isotopes are used as sources for level detection by gamma radiation.

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.
The source container must be switched off at all times during installation and maintenance of the measuring system as well as when maintenance work is required within the tank being measured.
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!

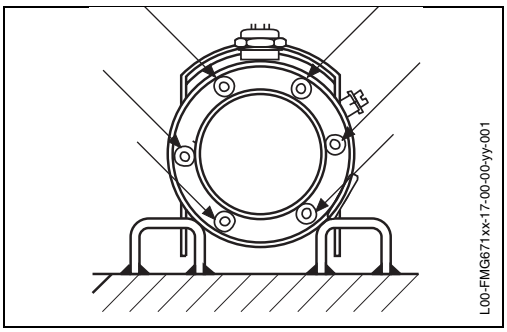
Endress+Hauser radiometric systems are designed, manufactured and shipped with special regard to German and International radiation safety regulations. Original radiometric systems are normally delivered equipped with double-encapsulated sources of ^{137}Cs or exceptionally ^{60}Co , both complying with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

Certificates

The transmitter and ancillary equipment are available with certificates of comformity for use in hazardous locations. 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 in Section 1.5, that in the certificate applies.

Certificate	Instruments	Notes
PTB 99 ATEX 2089	Gammasilometer FMG 671	ATEX II(2)GD / [EEx ib] IIC, s. Safety instructions XA 055F-C
PTB Nr. Ex-94.C.1019 ATEX 1104	DG 57-A... DG 57-H... DG 57-M...	ATEX II 2 G/EEx d ib IIC T6 ATEX II 2 G/EEx d IIC T6 ATEX II 2 G/EEx de IIC T6 s. Safety instructions XA 057F-A
DMT 01 ATEX E 093	DG 57-D...	ATEX II 2 D IP65 T 60 °C s.Safety instructions XA 112F-A
PTB Report 6.62-1972/1 (^{60}Co) PTB Report 6.22-1991 (^{137}Cs)	QG 020	Report on local dosage measurement on source container
PTB Report 6.62-1972/2 (^{60}Co) PTB Report 6.22-1993 (^{137}Cs)	QG 100	
PTB Report 6.32-2005 (^{60}Co)	QG 2000	

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!



Safety conventions

In order to highlight safety-relevant or alternate operational 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

Operating Manual

The operating manual must have been read and understood before the equipment is installed. The operating instructions are structured as follows:

- Chapter 1: Introduction;
  contains general information including application, measurement principle, functional description and technical data.
- Chapter 2: Installation;
  contains instructions on the installation of the radioactive source, DG 57 detector, Gammasilometer FMG card, hardware configuration and connection diagrams.
- 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 Gammasilometer for level measurement and set the analogue outputs and relays
- Chapter 5: Cascade Mode;
  describes the cascade mode which allows measurement with two DG 57 detectors,
- Chapter 6: Gammagraphy;
  describes the gammagraphy detection mode
- Chapter 7: 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.

Short instructions

The front cover contains short instructions for the standard set-up, level measurement, using the Gammasilometer FMG 671, DG 57 and Cs 137 source.

Further documentation

In addition to this manual, the following publications provide information on configuration of the Gammasilometer FMG 671:

Publication	Instrument
TI 264F	Source Container QG 020/100, Standard design
TI 194F	Source Container QG 020/100, Chemical, European and Swedish designs
TI 346F, BA 223F	Source Container QG 2000
TI 180F	Scintillation Detectors DG 57
TI 213F	Gamma sources
BA 028F	Commulog VU 260 Z handheld terminal
BA 054F	ZA 672 Modbus Gateway
BA 073F	ZA 673 Profibus Gateway
BA 085F	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.

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

1.1 Application

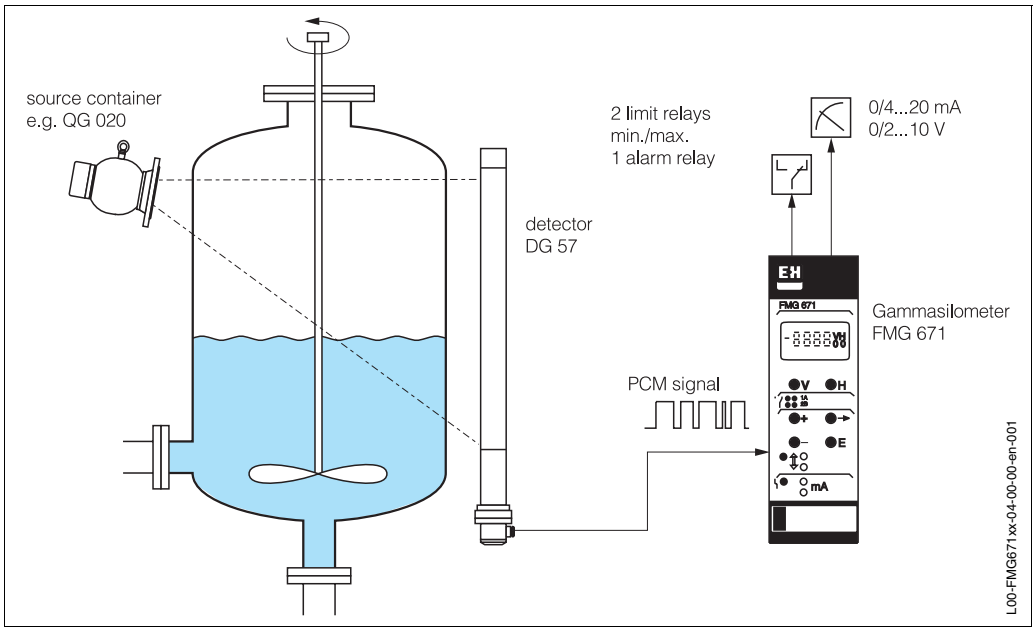


Fig. 1.1 Standard application showing Gammasilometer FMG 671, source and detector

The Gammasilometer FMG 671 is designed as a non-contact, level measurement transmitter 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.

Gammasilometer 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 / ATEX II (2) G. A list of certificated combinations is to be found in »Notes on Safety« preceding this chapter.

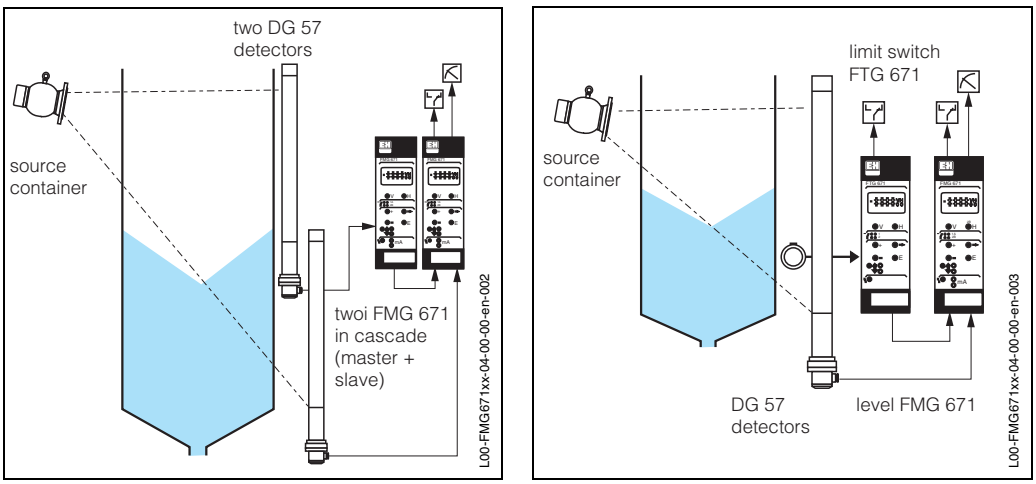


Fig. 1.2 left: Measurement with two detectors: both detectors are controlled by a Gammasilometer FMG 671 P transmitter (Chapter 5)
right: Measurement with automatic calibration correction. The external limit switch is e.g. a Gammapilot FTG 671 with a DG 57/100 detector or DG 17/27 GM-tube

1.2 Measuring system

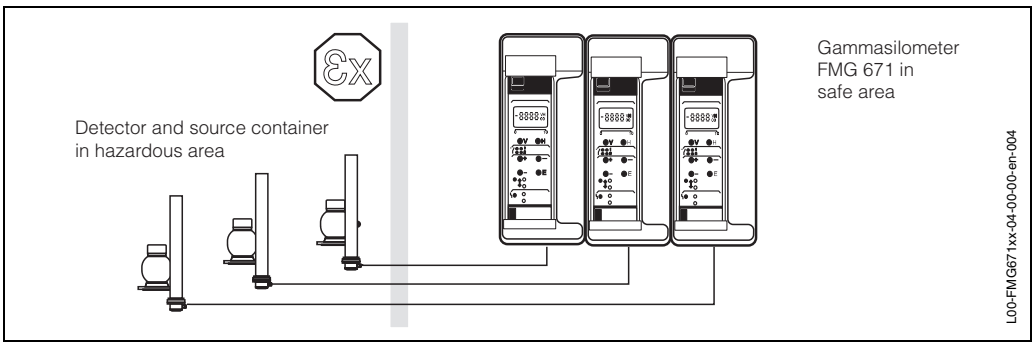


Fig. 1.3 Gammasilometer FMG 671 row mounted in Monorack II housing

A working system for level measurement comprises:

- Gammasilometer FMG 671 transmitter,
- QG 020, QG 100 or QG 2000 source container with ^{60}Co or ^{137}Cs gamma source
- DG 57 scintillation detector.

The Gammasilometer may operate as a stand-alone or system unit. In addition to the display on the front panel, the transmitter has two level proportional 0/4...20 mA and 0/2...10V analogue outputs as well as two limit relays which can be used to operate follow-up instrumentation. 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 Gammasilometer 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 Gammasilometer can be remotely configured, its measured data and status scanned and its settings up- and downloaded through the Gateway.

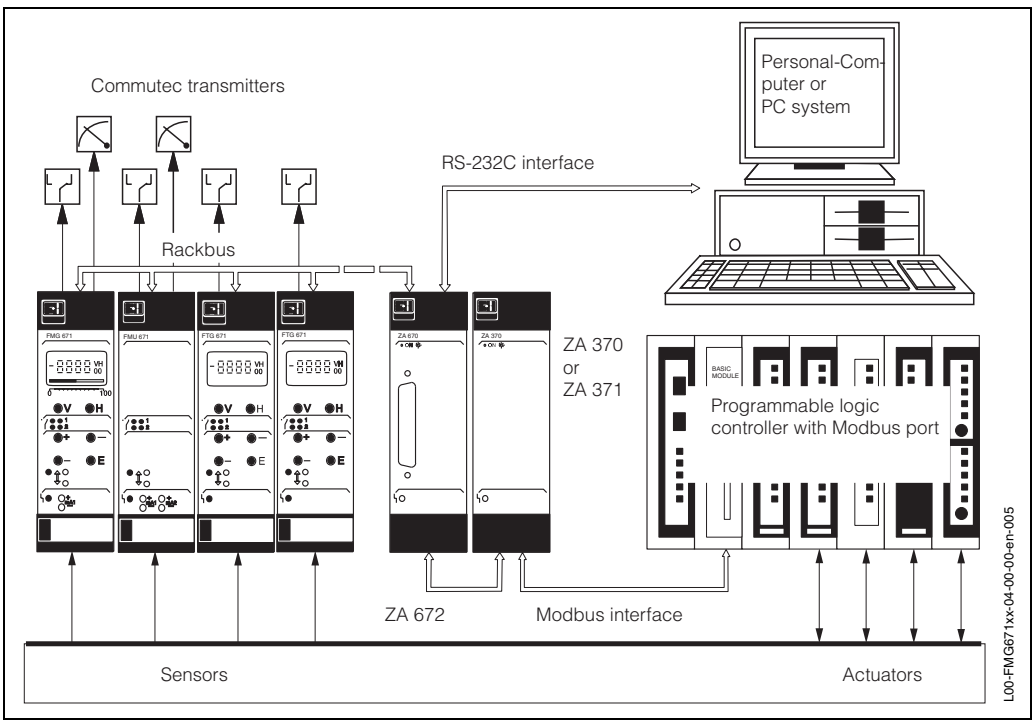


Fig. 1.4 The Gammasilometer FMG 671 can be used as part of a process control system. Here it is shown with other Commutec transmitters and the ZA 672 Modbus Gateway

1.3 Measuring principle

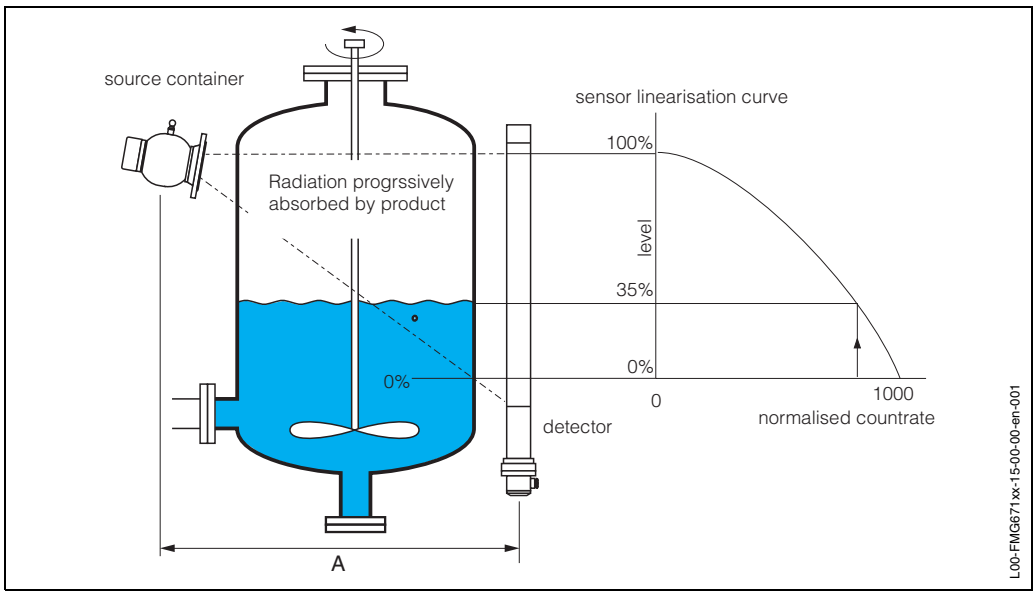


Fig. 1.5 Operating principle of radiometric level measurement

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:

$$F_S = e^{-\mu \rho d}$$

The radiation also decreases with the square of the distance *A* between source and detector.

Level measurement

For level measurement, μ, ρ, and *d* are constants (for usual tank diameters) 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 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; the measured countrate is normalised and lies between 0 and 1000.

Linearisation

The relationship between normalised countrate and level is non-linear and dependent upon the geometry of the vessel. A so-called sensor linearisation, which may be individually entered for maximum accuracy, ensures correct level measurement.

Influence of statistics on accuracy

The decay of a radioactive source is subject to statistical deviations.
During a fixed time period, decay is not always constant, but primarily deviates around its mean value N.
Accuracy depends on the relative statistical deviations:

$$\sigma_{rel} = \frac{1}{\sqrt{N}}$$

The larger the level of decay registered, the smaller the statistical measuring error becomes. To achieve the largest possible counting rates (and therefore optimum statistical accuracy), we advise you to increase the output damping as far as the process dynamics allow.
(see page 34).

1.4 Functional description

The Gammasilometer FMG 671 has been realised as a second generation 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:

- Level measurement with analogue output and limit relays
- Level measurement in cascade mode with two detectors and two tranmitters, one acting as master, one as slave (FMG 671 P)
- Level measurement as above, but with gammagraphy detection.

Input circuit

The intrinsically safe input circuit of the Gammasilometer FMG 671 is electrically isolated from the rest of the circuitry by a DC/DC converter. The Gammasilometer supplies power to the detector DG 57 and receives from it a signal proportional to the countrate. The sensor data is supplied in a separate EPROM (DAT) which is already installed or must be installed in the Gammasilometer FMG 671 during commissioning (can be found in the connection compartment of the DG 57 housing).

Analogue output

The Gammasilometer FMG 671 provides a level proportional, standardised 0/4...20 mA and 0/2...10V analogue signal with freely selectable range end values. Depending upon the configuration, the signals fall to -10%, rise to +110% or retain the last value on fault condition. In cascade mode, the analogue output of the slave is disabled.

Relays

The two relays switch according to the level and the relative values of the configured switch-on and switch-off points in minimum or maximum fail-safe mode. The switching hysteresis corresponds to the difference between the switch points. If gammagraphy detection is activated, the second relay acts as an alarm relay.

Function monitoring

To increase operational safety, the Gammasilometer 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 detector signal is plausible.

- The reduction in countrate due to natural decay is corrected for daily
- Successive countrates are checked for plausibility and if necessary the last countrate held until the change is confirmed by a second measurement
- When the gammagraphy detection mode is switched on, the last valid measured value is held when stray external radiation is detected.

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 ZA67... 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.

1.5 Technical data: Gammasilometer FMG 671

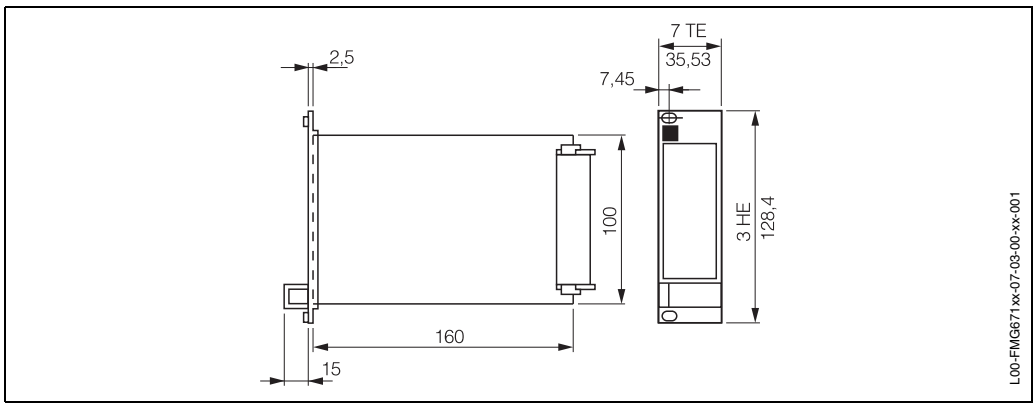


Fig. 1.6 Gammasilometer FMG 671plug-in card

Mechanical	*Design:*	7 HP, Racksyst plug-in card to DIN 41 494 (Europa card)
	Front panel:	Black synthetic with blue field inlay, grip and markings
	Dimensions:	see diagram
	Weight:	approx. 0.3 kg
	Multipoint connector:	conforming to DIN 41 612, Part 3, Type F (25-pole) coding pins in positions 2 and 8 plug-in point kit for assembly rack type 25/2
Power supply	*Direct voltage:*	24 V DC (+6 V...-4 V); residual ripple 2 V_{pp}, within tolerance
	Supply current:	ca. 135 mA
	Power consumption:	max. 3.8 W at 24 V, max. 4.0 W at 30 V
Environment	*Temperature:*	Operating temperature: 0°C...+70°C Storage temperature: -25°C...+85°C
	Climatic class:	to DIN 40 040: KSE
	Ingress protection:	to DIN 40 500: front panel IP 20, card IP 00
	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)
	Explosion protection:	[EEx ib] IIC / ATEX II (2) G a Zener barrier must be used on the switch input lines (channel 2)
Signal input	*Channel 1:*	PCM signal from DG 57 detector
	Channel 2:	Binary signal from neutral switch (e.g. relay 1 of FTG 671) output voltage (no-load): 10.5...12.5 V output voltage Uz at fault: max. 16.2 V short-circuit current Ik: max. 10 mA with neutral switch: 0...250Ω: closed, 450...∞Ω: open
Signal outputs	*Analogue output*	4...20 mA/0...20 mA selectable, R_L max. 500 Ω 2...10 V/0...10 V selectable, R_L min. 10 kΩ Not present in FMG 671 P slave
	Relays (in both master and slave of FMG 671 P)	Two independent relays each with a potential-free change-over contact; freely selectable switching points; fail-safe mode, maximum or minimum selectable via switching points One relay for fault indication (configurable as limit relay) 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
Communication	*Commulog 260 Z*	Connection via two sockets on front panel
	Rackbus	For connection to a personal computer or bus via ZA gateway Rackbus address set at 6 pole DIP switch on plug-in card
	Cascade circuit	Bidirectional INTENSOR signal between master/slave (FMG 671 P)

2 Installation

This Chapter describes the:

- Measurement system
- Installation hints for source container and detector
- Gammasilometer installation in a rack or Monorack housing
- Transmitter and detector wiring
- Hardware configuration of the Gammasilometer card

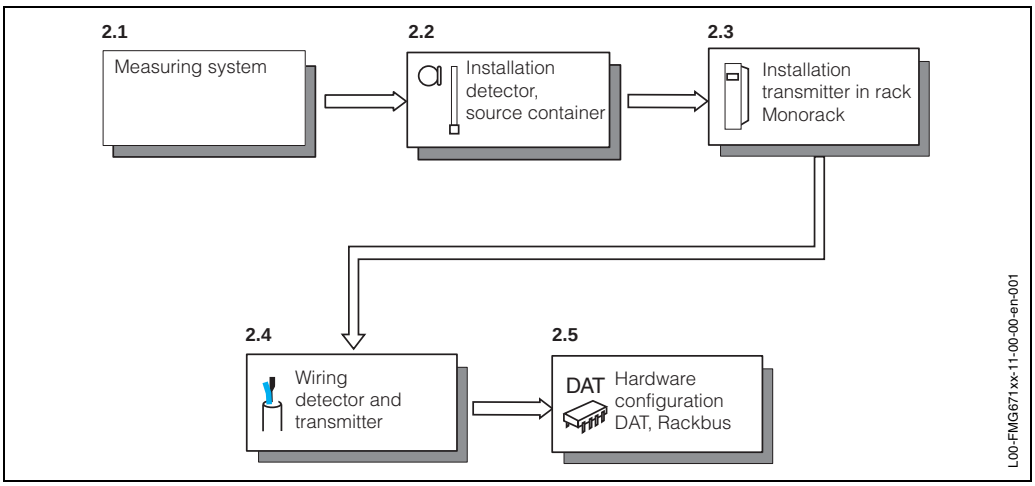


Fig. 2.1 Summary: installation of measuring system

2.1 Installation hints for source container and detector

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.

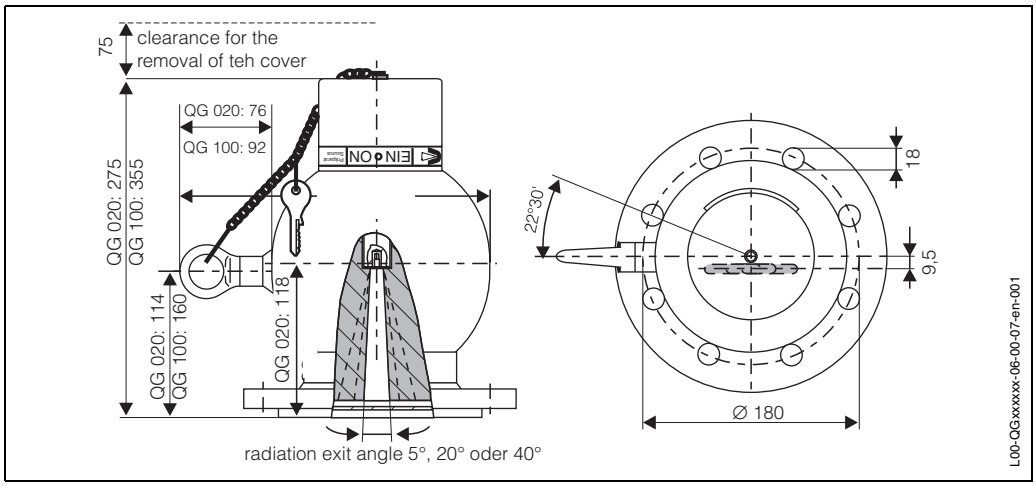


Fig. 2.2 Source container QG 020/QG 100 Standard design

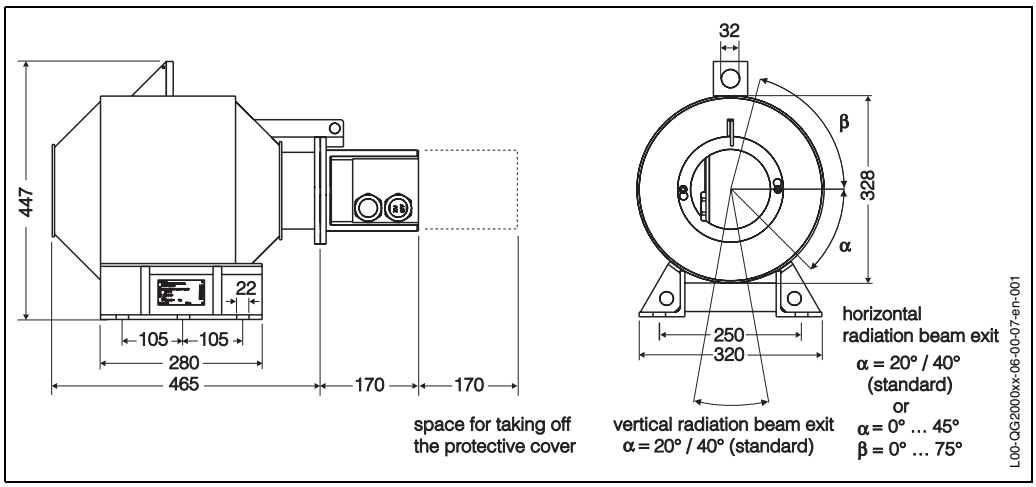


Fig. 2.3 Source container QG 2000 Standard design

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)

Tab. 2.1 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*.

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

$$r = \sqrt{\frac{(KA)}{(DF_S)}}$$

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

K = 357 µSv m² / h GBq (= 13.200 µSv m² / h Ci) for ^{60}Co
K = 96 µSv m² / h GBq (= 3.550 µSv m² / h Ci) for ^{137}Cs

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	^{60}Co D = 7,5 µSv/h	^{60}Co D = 7,5 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

Tab. 2.2 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.

An information sheet is supplied with every radiation protection container. This sheet describes the following:

- Switching on the gamma radiation
- Switching off the gamma radiation
- Replacing the sources

These information sheets must be read and understood before commissioning the measuring system. Chapter 2.1 contains a short description of the standard components with information on correct installation.

Special versions of the radiation protection container are always supplied with the appropriate documentation.

Activity of the source

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

- approx. 0.3...1.0 µSv/h (0.03...0.1 mR/h) for detector DG 57 with ^{60}Co
- approx. 0.3...1.0 µSv/h (0.03...0.1 mR/h) for detector DG 57 with ^{137}Cs

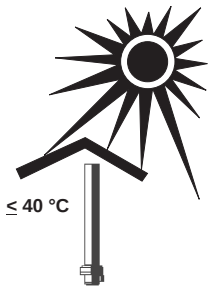
In this case, the dose rate usually lies below that defining a control area, i.e. 7.5 µSv/h (0.75 mR/h) or 2.5 µSv/h (0.25 mR/h), which has to be sealed off.

Warning!

- 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!

Detektor DG 57

The scintillator is a cylindrical rod 48 mm in diameter made of transparent synthetic scintillation material. For level measurement a length of 400 mm to 2 x 2000 mm is used. For hot environments (> 40°C) it is recommended that a version with a water-jacket is used (Flow rate 40...200 l/h; max. water temperature 40 °C; water pressure 4 - 6 bar).



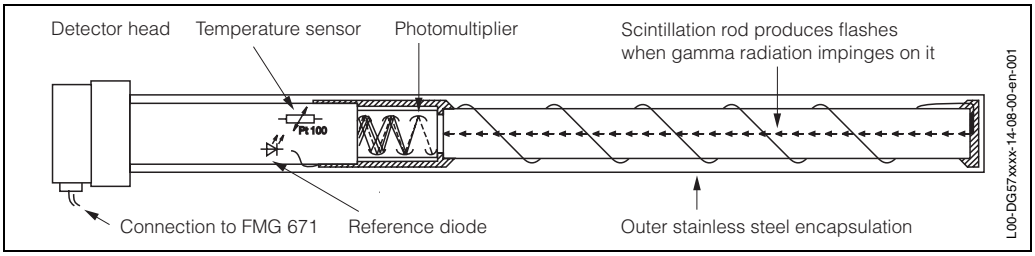


Fig. 2.4 Function of the DG 57 rod scintillation detector

The detector generates a pulse code signal which is transmitted to the FMG 671 at intervals of 250 ms. A reference value is generated in the scintillator at regular intervals (frequency 32 Hz) by a LED. The reference value, temperature and pulse rate are transmitted digitally via a two-wire connection to the transmitter FMG 671. The power supply (over the signal line) can be installed to EEx d ib, EEx d or EExde according to the detector version supplied.

Measuring length A	No. of clamps
100 mm	2
400 mm	2
600 mm	2
800 mm	2
1000 mm	3
1200 mm	3
1500 mm	3
2000 mm	4

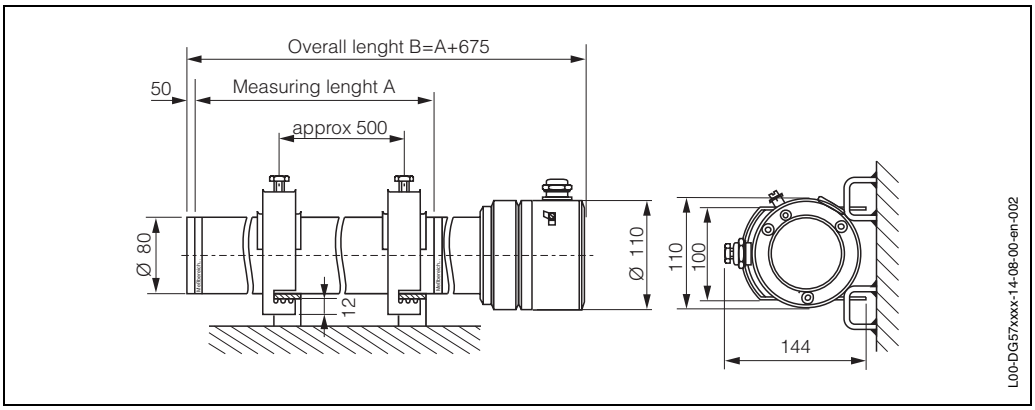


Fig. 2.5 Dimensions in mm Detector DG 57

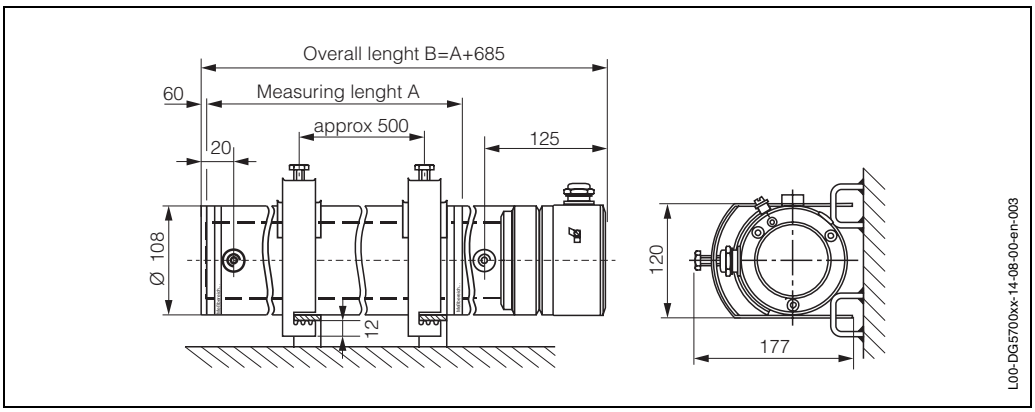


Fig. 2.6 Dimensions in mm Detector DG 57 with water jacket

Mounting and installation

The QG... source container and DG 57 detector are mounted diametrically opposite each other at each side of the vessel.

- The detector is mounted vertically along the vessel wall with the photomultiplier pointing downwards
- In cascade mode, the detector connected to the slave must be mounted above that connected to the master FMG 671... For double sensitivity, the detectors are mounted side-by-side
- 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).

The QG... source container may be bolted onto a mounting pipe, onto the tank with an appropriate counterflange, or onto a steel frame or box. 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. For level measurement, 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. 2.7 shows mounting examples for common applications - the preferred orientation is with the photomultiplier (head) pointing downwards.

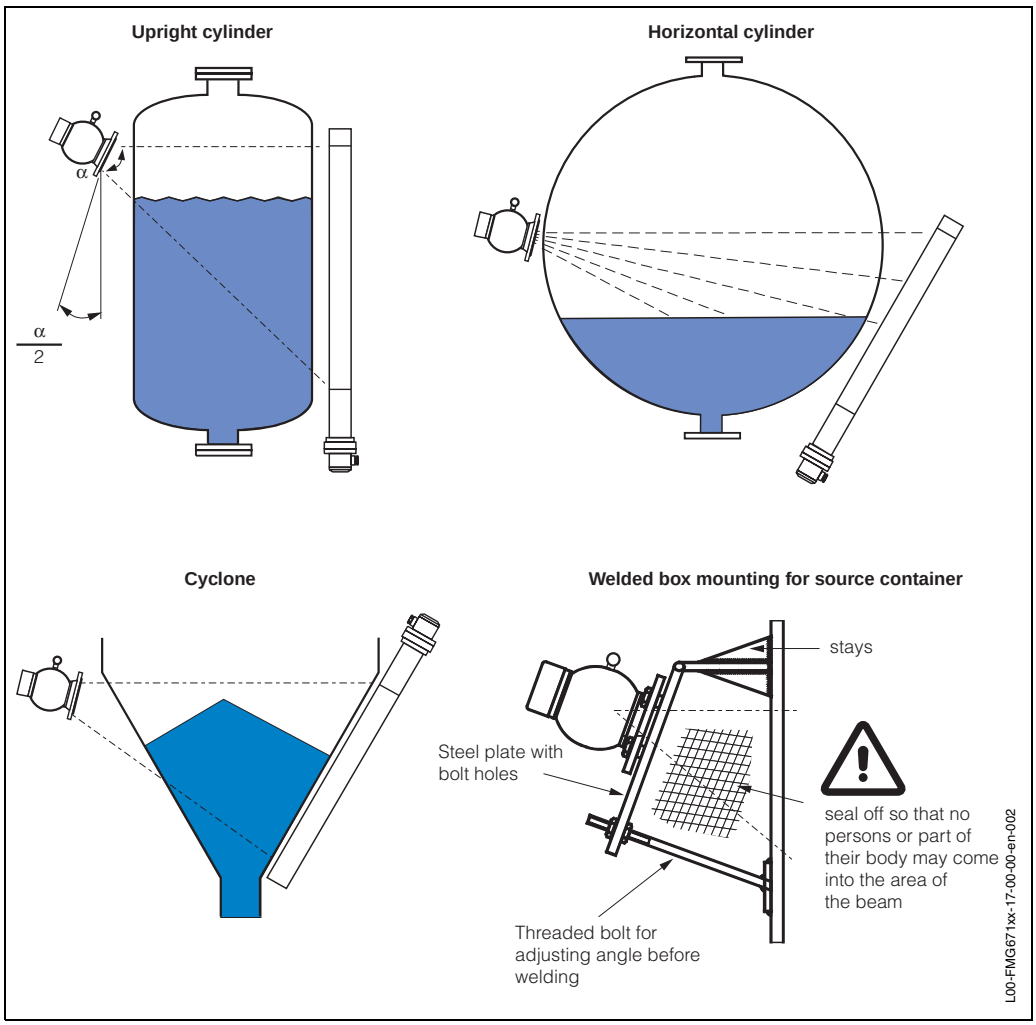


Fig. 2.7 Mounting examples for common applications

2.2 Gammasilometer installation

There are three possibilities for mounting a Gammasilometer:

- Standard 19" rack with space for 12 7HP cards,
- Field housing (IP 65) 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 TI 224fen, »Racksyst Assembly Racks«. For cascade mode, the master and slave should if possible occupy adjacent slots. For non-Racksyst installations and for installations including non-Racksyst cards, fill the rack as follows (see also Fig. 2.8):

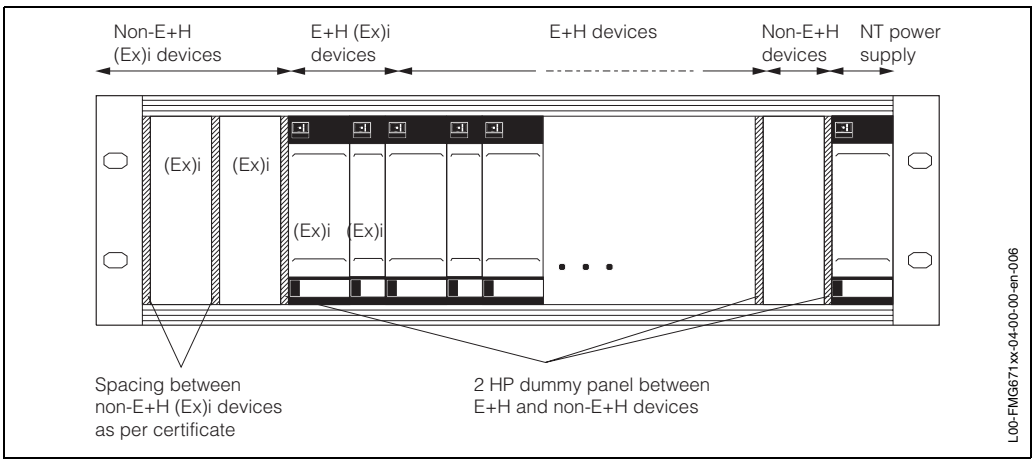


Fig. 2.8 Recommended arrangement for Racksyst rack assemblies

Rack arrangement

Step	Procedure
1	Allocate the power supply (NT 471) at the rightmost position.
-	If two NT 471s 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 TI 026F/00/en.

- 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.

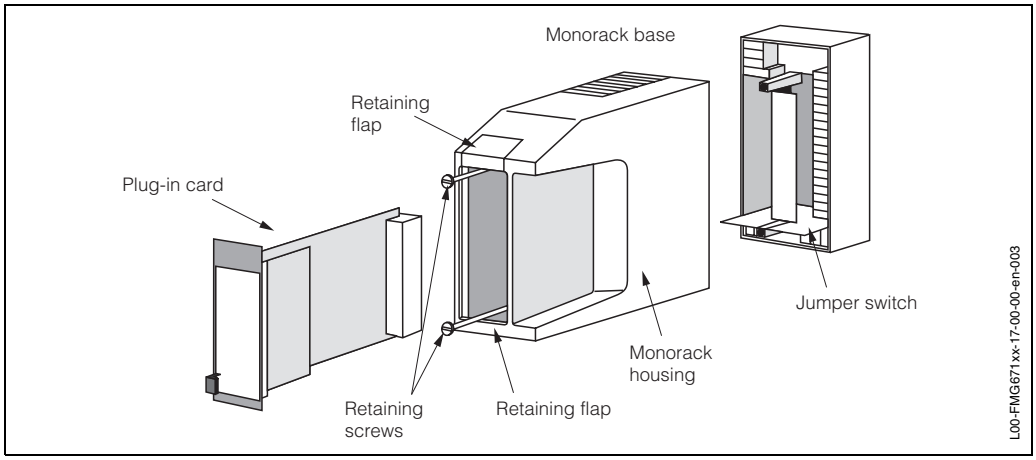


Fig. 2.9 Assembly and disassembly of the Monorack II housing

Monorack II housing

The Gammasilometer FMG 671 transmitter and Monorack II housing are supplied separately. Before use, the system must be assembled as shown in Fig. 2.9.

- The Monorack is prepared for wall-mounting, degree of protection IP40.
- 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, BA090F/00/en supplied with it.

Note!
The Gammasilometer FMG 671 cannot be installed in older versions of the Monorack housing. These can be identified by the lack of the jumper switch, see Fig. 2.9/Fig. 2.16 page 24.

Monorack II protective housing

If the Gammasilometer FMG 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 Gammasilometer FMG 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 090F/00/en.

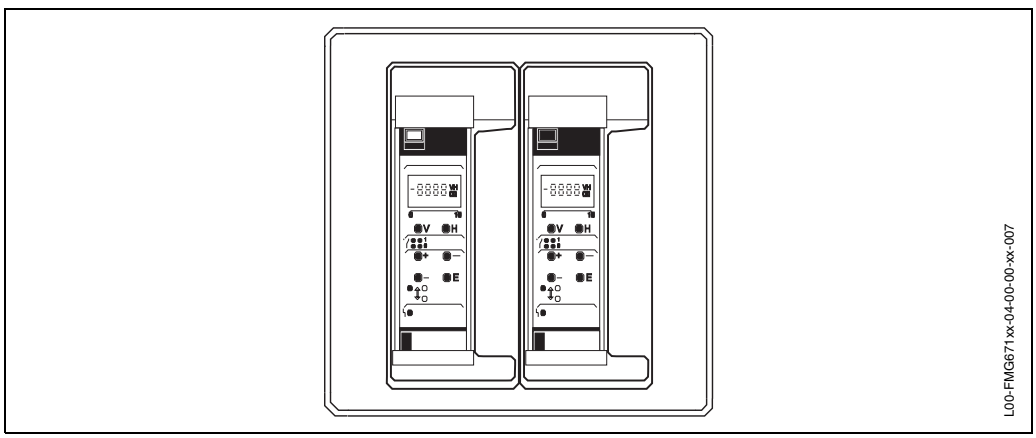


Fig. 2.10 Monorack II protective housing

2.3 Transmitter wiring

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.

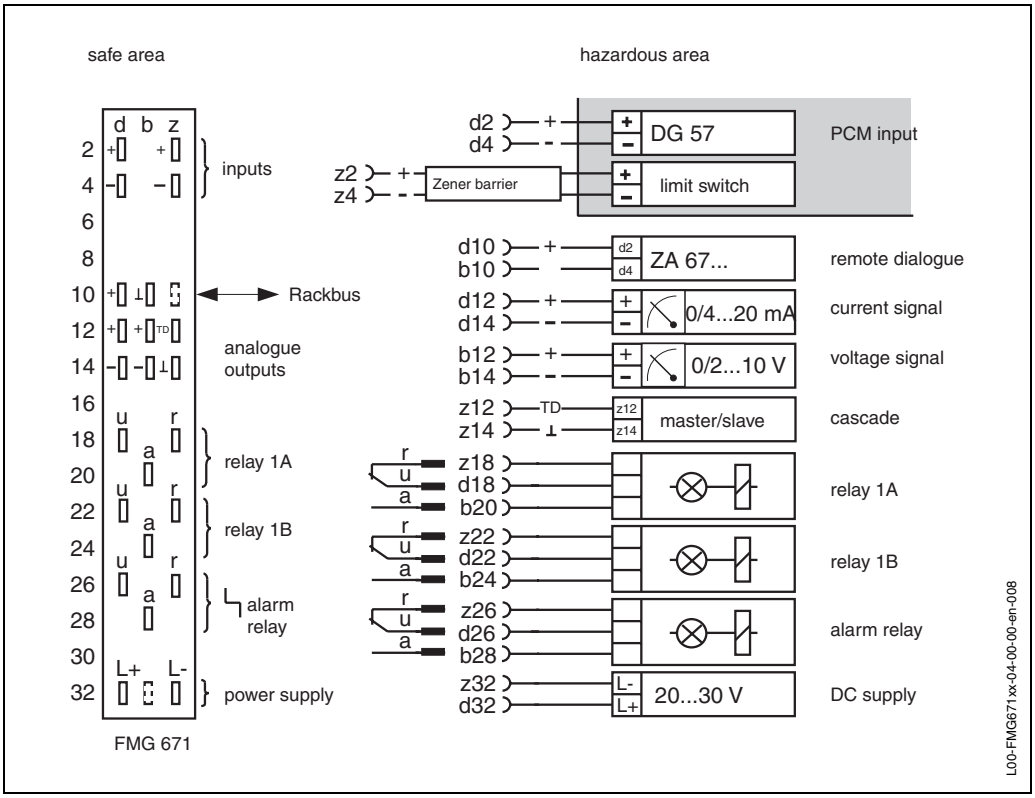


Fig. 2.11 Pin assignment diagram for Gammasilometer FMG 671

Rack wiring

Fig. 2.11 is a pin assignment diagram for the Gammasilometer FMG 671.

- Inputs d2 and d4 are for DG 57 detector signals
- Inputs z2 and z4 are for an external limit switch.
  - If the application is in an explosion hazardous area, a Zener barrier (Type GHG 1119430V1201 from ABB CEAG) must be installed between z2/z4 and the limit switch!
- Inputs z12 and z14 are used for communication between master and slave in cascade mode, they must be connected to inputs z12 and z14 respectively of the partner instrument.
- The signal inputs 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!
Two indexing pins, at positions 2 and 8 in the rack connector ensure that Gammasilometer FMG 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. 2.12. Screened, 2-core installation cable, max. 25 Ω per core, is recommended.

Ground the screen at both ends. If this is not possible, ground at one end only, preferably at the sensor end. For installation in hazardous areas, always observe local regulations and the specifications in the certificate!

The [EEx d] or [EEx e] detector versions are connected in the same way - here the protective measures for the wiring, e.g. conduits, are to be observed.

Detector DG 57 Hxxxxx or Vxxxxx (EEx d version)

The EEx d version of the DG 57 detector is supplied with cable entries NPT ½", M20x1.5 or G ½". The customer must provide suitable cable glands (IP 65) or conduits and wire to explosion-proof standards in accordance with EN 50 018, Sections 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!

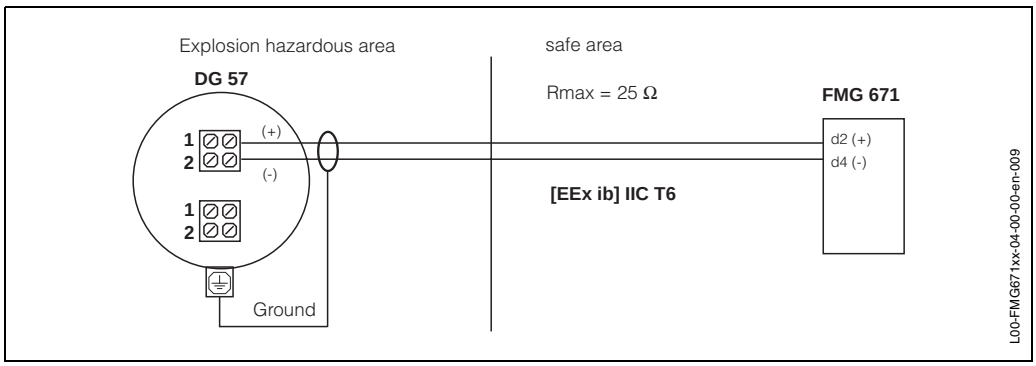


Fig. 2.12 Connection diagram for DG 57

Switch input

The wiring for an external limit switch is shown in Fig. 2.13:

If the Gammapilot FTG 671 limit switch is used, relay output 1 can be used as the switch - since the calibration correction is carried out everytime the switching status changes, the default settings of the FTG 671 can be used.

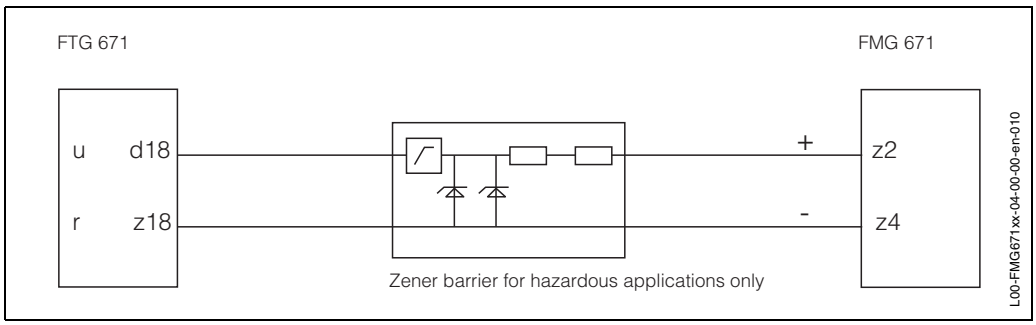


Fig. 2.13 Connection diagram for switch input using relay 1 of a Gammapilot FTG 671 limit switch

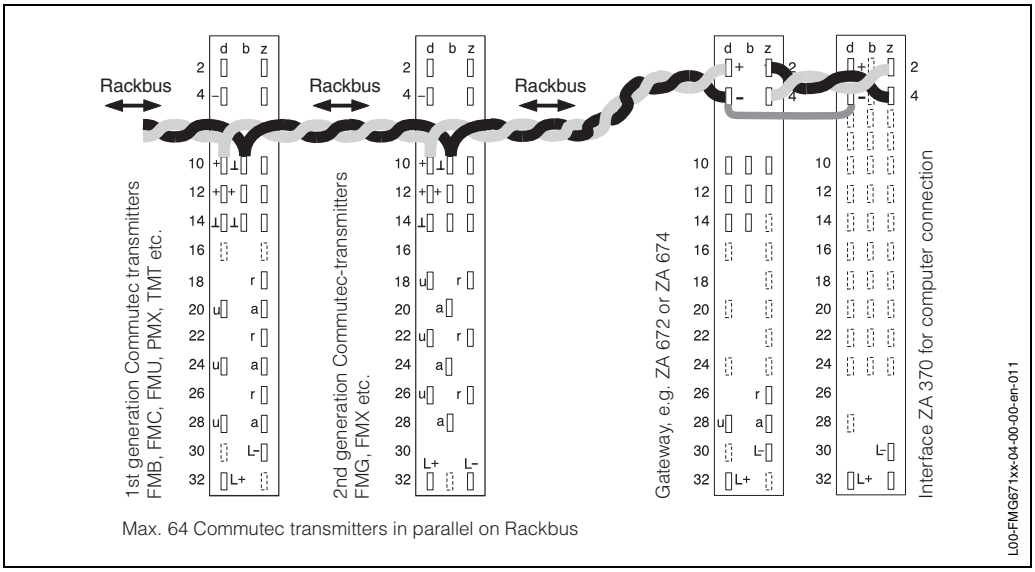


Fig. 2.14 Rackbus wiring diagram

Rackbus

For system use, wire the Rackbus as shown in Fig. 2.14.

- For ZA 672 (Modbus) - Computer/PLC wiring see Operating Instructions BA 054F/00/en
  for ZA 673 (PROFIBUS) see Operating Instructions BA 073F/00/en
  for ZA 674 (FIP) see Operating Instructions BA 085F/00/en
- 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.

Analogue output and relays

The negative terminal of the current output, of the voltage output and of the supply voltage are connected to the circuit zero of the transmitter.

- Voltage output 0/2...10 V
  Any number of instruments can be connected in parallel provided $R_L \geq 10\ k\Omega$
- Current output 0/4...20 mA
  Only one non-floating device can be directly connected.
  Any number of floating devices can be connected in series, $RL \leq 500\ \Omega$
- Alarms and limit switch relays can be connected as shown in Fig. 2.15
  Max. current per contact 2.5A : for switching capacity see Section 2.6.

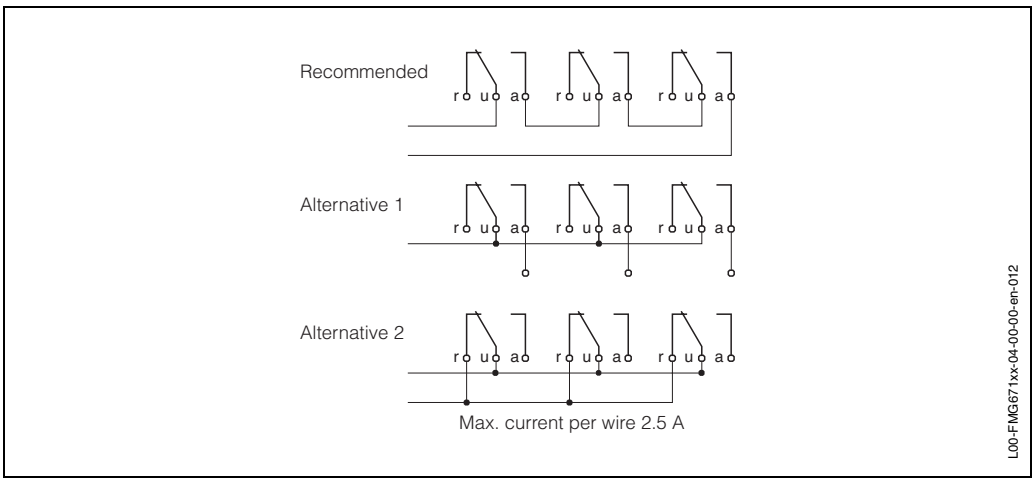


Fig. 2.15 Suggestions for wiring together relays and alarms

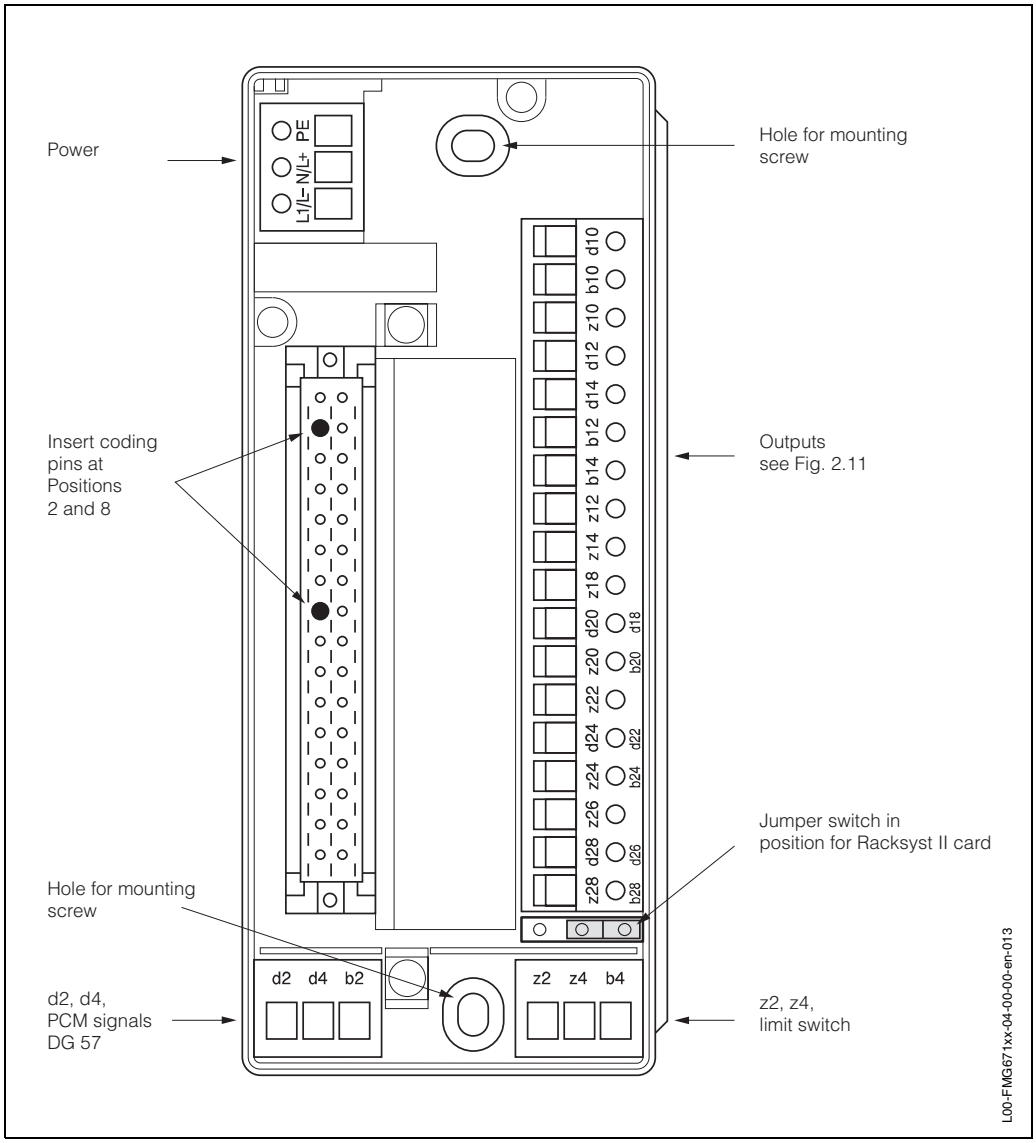


Fig. 2.16 Layout of Monorack II terminal blocks

Monorack wiring

Fig. 2.16 shows the terminals in the base of the Monorack II housing, the pin assignments correspond to those in Fig. 2.11. When connecting together several Monoracks, follow the instructions BA 090F/00/en 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 8 in the female connector at the base of the housing.

Note!
- The Gammasilometer FMG 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.

2.4 Hardware configuration

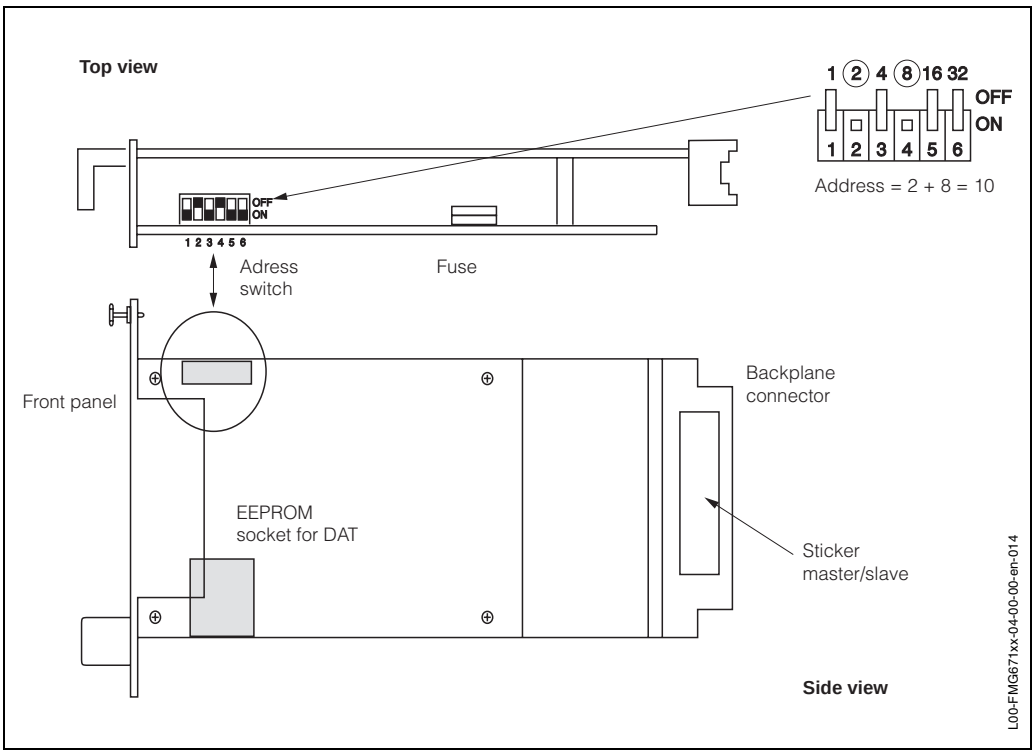


Fig. 2.17 Position of configuration elements on Gammasilometer FMG 671 card

Fig. 2.17 shows the configuration elements on the Gammasilometer FMG 671 plug-in card.

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 - either in the detector head or already plugged into the card. Check that this is plugged into the socket provided for it on the FMG board prior to commissioning and that its number is the same as that on the DG 57 nameplate.

ZA 67... gateway

Configure the Gammasilometer 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. 2.17, inset.
  - In the example the address is 2 + 8 = 10.
- For cascade mode, the master and slave each receive separate addresses.

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

Commulog VU 260 Z

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 FMG 671 switches to remote operation again.

3 Controls

This Chapter describes how the Gammasilometer 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 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 FMG 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 113F/00/en.

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

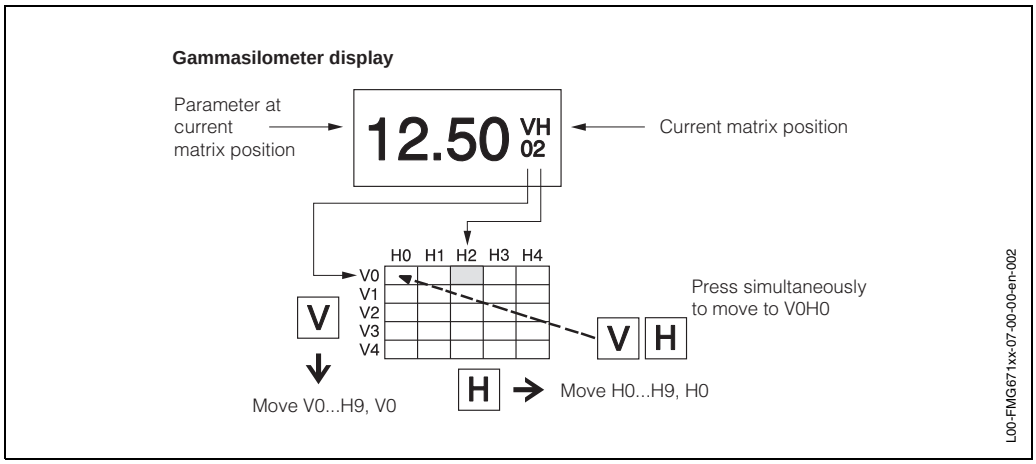


Fig. 3.1 Gammasilometer FMG 671 Parameter matrix operation with function of V and H keys. The complete matrix has 10 x 10 fields, although not all are used.

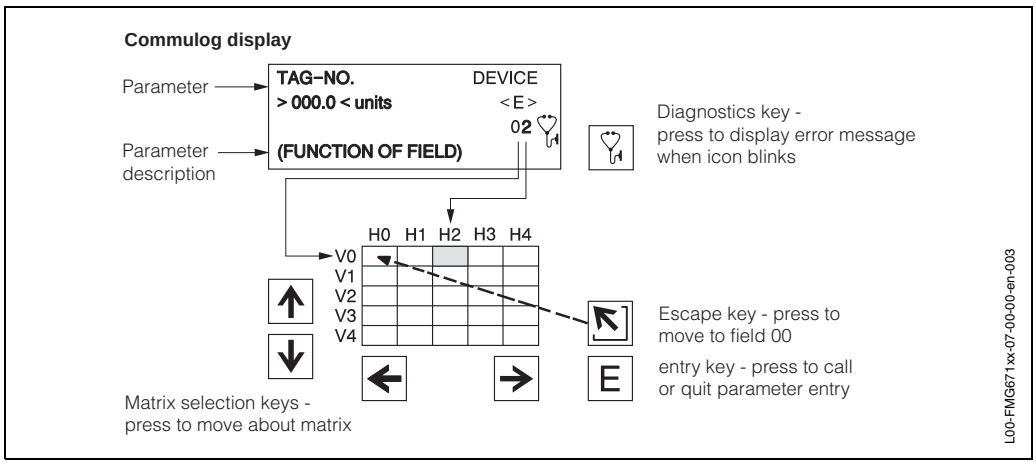


Fig. 3.2 Commulog display and key functions. The Tag No. is entered in the VA level which can be accessed by the Commulog or ZA 67... interface only.

3.2 Configuration from front panel

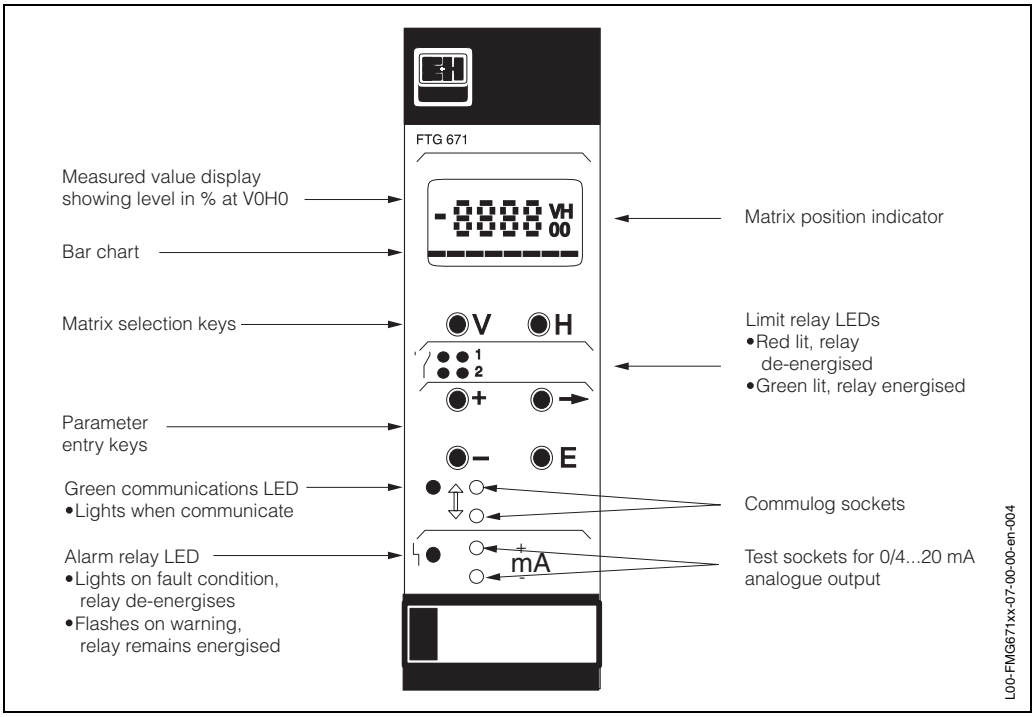


Fig. 3.3 Front panel of the Gammasilometer FMG 671

Fig. 3.1 shows the LC-display with matrix of the Gammasilometer FMG 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 4.8).
- Non-flashing parameters are either read-only indications or locked entry fields.

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.

Tab. 3.1 Gammasilometer FMG 671 Parameter entry and display keys

3.3 Configuration with Commulog VU 260 Z

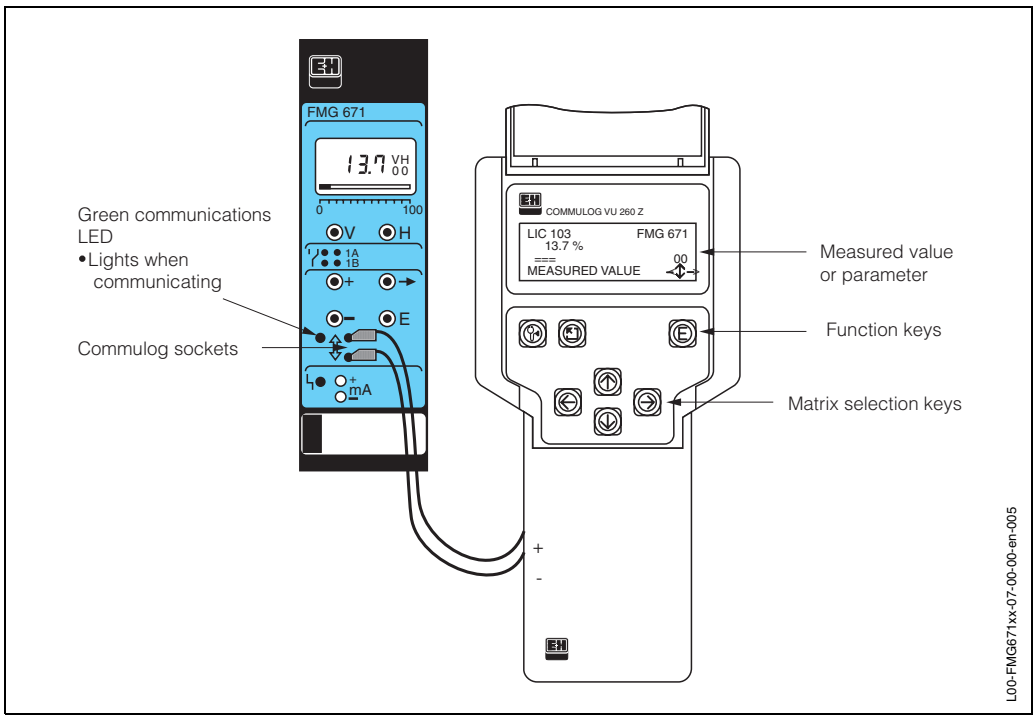


Fig. 3.4 Gammasilometer FMG 671. Showing front panel and Commulog VU 260 Z key functions.

The Gammasilometer FMG 671 can also be configured with the Commulog VU 260 Z handheld terminal as shown in Figs 3.2, p. 23. A full description of Commulog operation is to be found in Operation Instructions BA 028F/00/en, Table 3.2 summarizes the key functions.
The measuring point (Tag.No.) can be entered by calling up the VA fields in the matrix.

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.

Tab. 3.2 Gammasilometer FMG 671 Parameter entry and display keys for Commulog VU 260 Z

4 Calibration and Operation

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

- Commissioning and calibration
- Analogue outputs and relays
- Sensor linearisation
- Calibration correction (with external limit switch)
- Display of measured values
- Locking the parameter matrix.

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 page 55.

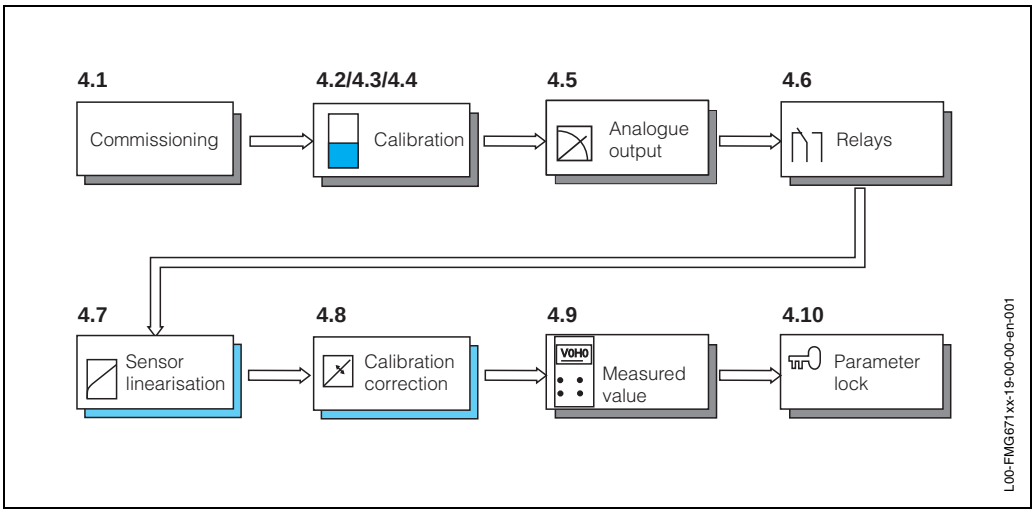


Fig. 4.1 Procedure: calibration and operation

4.1 Commissioning

Caution!
- Make sure that the measuring system has been switched on for at least six hours before it is commissioned or calibrated. The source container may be switched off during this period.

The commissioning comprises two steps:

- Transmitter reset
- Entry of detector information prior to calibration

Commssioning: 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«	Register entry

Commissioning: detector information

The detector information in Table 4.1 must be entered into the Gammasilometer during the commissioning phase of the calibration:

Parameter	Matrix	Significance
Calibration mode	V3H0	0 = disabled 1 = Standard calibration without background calibration, page 33 2 = exchange device, page 55 3 = recalibration, page 33 4 = standard calibration with background calibration, page 31
Source type	V3H1	0 = ^{137}Cs 1 = ^{60}Co 2 = none
Detector 1 orientation	V3H2	0 = PMT at bottom 1 = PMT at top
Detector 2 orientation (Cascade mode, Chapter 5)	V3H3	0 = PMT at bottom 1 = PMT at top
Calibration date	V3H4	Date on which calibration was made J KW T J = Last digit of year, e.g. 1 for 2001 KW = Calender week, e.g. 08 for week 08 T = Day, e.g. 1 = Monday, 2 = Tuesday

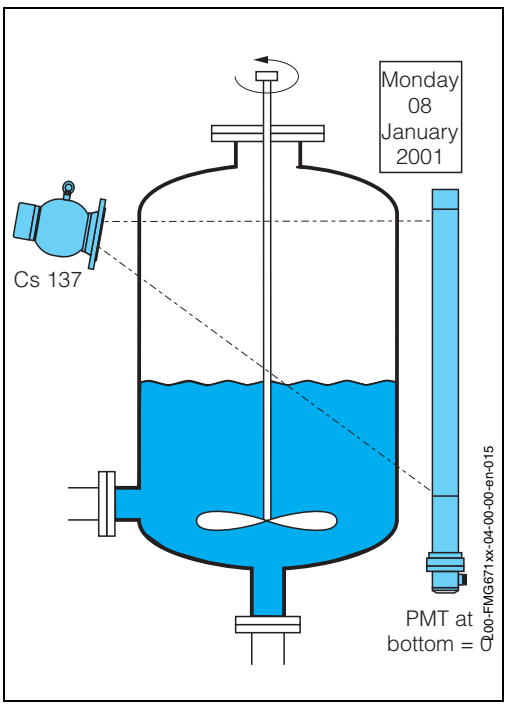
Tab. 4.1 System information required for commissioning

Example

For a Gammasilometer operating with a DG 57 detector with PMT at bottom and ^{137}Cs source, calibration date Monday, January 8th 2001, standard calibration, the following must be entered:

Example: Commissioning

#	Matrix	Entry	Significance
1	V3H0	1	Standard calibration
2	-	»E«	Register entry
3	V3H1	0	^{137}Cs source
4	-	»E«	Register entry
5	V3H2	0	PMT under
6	-	»E«	Register entry
7	V3H4	1021	2001, CW 02, Monday
8	-	»E«	Register entry
9	...	...	Continue with calibration, chap 4.2, or 4.3



Note!
During this procedure the alarm LED flashes and Warning 630 is generated to indicate that the calibration is incomplete. It disappears only when the calibration is complete.

4.2 Standard calibration with background calibration

The standard calibration requires the definition of three parameters which can be entered in any order:

- the count rate for 0% filling (V0H1)
- the count rate for 100% filling (V0H2)
- the count rate with switched-off radiation and 100% filling (V3H9)

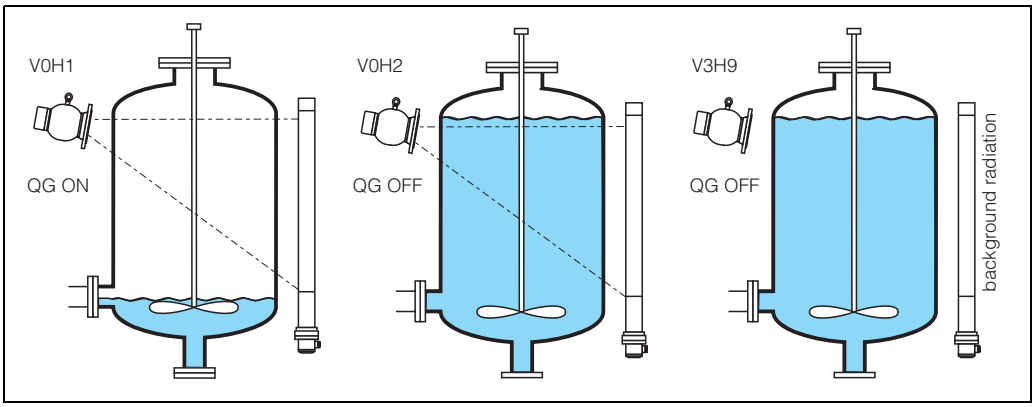


Fig. 4.2 Parameter for standard calibration

As can be seen in Fig. 4.3 the gamma silometer FMG 671 compensates all the calibration parameters for the decay of the source. The background calibration makes sure that the minimum pulse rate is not compensated at a level below the background radiation. By maintaining the minimum and further compensation of the maximum pulse rate, the distance between the minimum and maximum count rates is reduced.

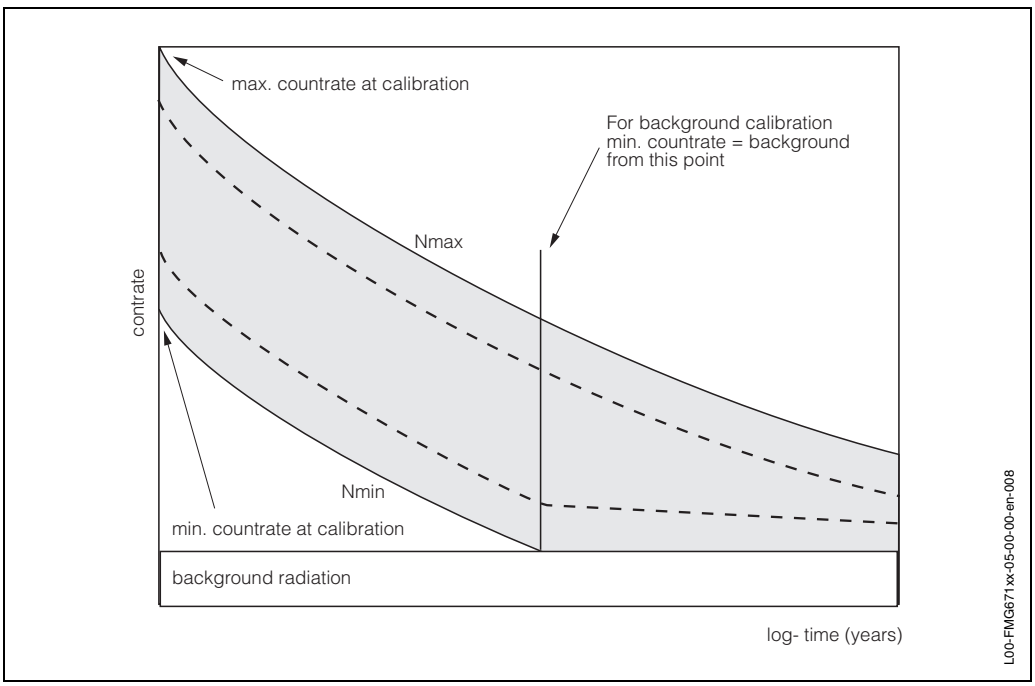


Fig. 4.3 Decey compensation of pulse rate and switching points

Procedure
Standard calibration with background calibration

Step	Matrix	Input	Meaning
1	V3H0	4	Preparation acc. to Chap. 4.1; select "Standard calibration with background Calibration"
...	...	...	...
9	V0H1	»E«	At 0% level, wait for stabilisation of the measured value (at least 100 s). Press "E" to accept the maximum pulse rate
10	V0H2	»E«	At 100% level, wait for stabilisation of the measured value (at least 100 s). Press "E" to accept the minimum pulse rate
11	V3H9	»E«	At 100% level and switched-off radiation, wait for stabilisation of the measured value (at least 100 s). Press "E" to accept the value
12	V0H4	e.g. 10 »E«	Enter integration time τ, see page 34 Confirm entry

After calibration

After complete calibration:
- The level L % is displayed in V0H0
- is set for the analogue output 4 mA = 0%, 20 mA = 100%
- the limit value relays respond to the default values (10% and 90%, minimum safety for relay 1, maximum safety for relay 2, see page 36)
- the calibration fields are automatically locked against unintentional entries. They are opened by reselecting a calibration mode if FMG 671 was not already interlocked in V8H9.

Note!
- During calibration, the fault warning LED flashes and the E 630 warning is displayed.
- During calibration, the output damping is at least 20 s, even if a shorter time was set in V0H4.
- The necessary time until equilibrium for empty, full and background calibrations should be five times longer than the output damping set in V0H4. The minimum waiting time is 100 s, even if the value in V0H4 is smaller than 20 s.
- When recalibrating, first enter V3H0 =4, and then enter the calibration date in V3H4.
- If the tank cannot be completely emptied, enter the actual level (in %) in V0H1 before confirmation with "E".
- If the tank cannot be completely filled, no background calibration is possible. Calibration in such cases is described in Kap. 4.3.
- If the 0% or 100% level can be achieved at a later point in time, it can be used for a post-calibration (see page 33)

4.3 Standard calibration without background calibration

If the tank cannot be filled, no background calibration is possible. In this case, select the calibration mode V3H0=1 ("without background calibration"). There are then two possibilities for full calibration (V0H2):

- when the radiation is **switched off** , wait at least 100 s, and then press "E" to confirm the entry (simulation of 100% filling).
- when the radiation is **switched on**, fill the vessel as high as possible (e.g. 90%) enter this level (90%) into V0H2, wait at least 100 s and then press "E" to confirm the entry.

Procedure Standard calibration without background calibration

Step	Matrix	Input	Meaning
1	V3H0	1	Preparation acc. to Chap. 4.1; select "Standard calibration without Background Calibration"
...	...	...	...
9	V0H1	»E«	At 0% level, wait for stabilisation of the measured value (at least 100 s). Press "E" to accept the maximum pulse rate
10	V0H2	»E«	With radiation switched off, wait for stabilisation of the measured value (at least 100 s). Press "E" to accept the minimum pulse rate
10* (alternative)	V0H2	e.g. 90 »E«	With highest possible filling (e.g. 90 %) and switched-off radiation, wait for stabilisation of the measured value (at least 100 s). Press "E" to accept the value
11	V0H4	e.g. 10 »E«	Enter integration time t, see page 34 Confirm entry

Note!
- During calibration, the fault warning LED flashes and the E 630 warning is displayed.
- During calibration, the output damping is at least 20 s, even if a shorter time was set in V0H4.
- The waiting time until equilibrium for empty, full and background calibrations should be five times longer as the output damping set in V0H4. The minimum waiting time is 100 s, even if the value in V0H4 is smaller than 20 s.

4.4 Post-calibration

Post-calibration allows entry of the following at later time:

- count rate for 0% in V0H1 or
- count rate for 100% in V0H2 or
- background count rate in V3H9.

Step	Matrix	Input	Meaning
1	V3H0	3	Postcalibration
2	-	»E«	Confirm entry
3	V3H4	JKWT	Current date
4	-	»E«	Confirm entry
5	V0H2	100 %	With full tank, wait at least 100 s.
		»E«	Accept count rate

4.5 Analogue Outputs

This section describes the setting of the analogue outputs. The following parameters can be entered or changed:

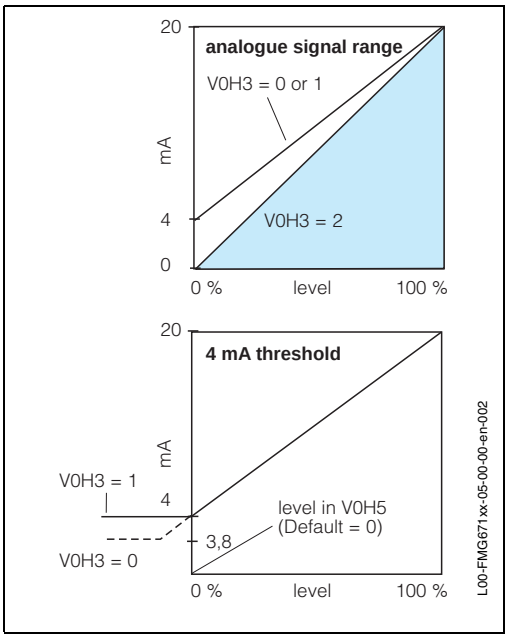
- Analogue signal range
- Output damping
- Value for 0/4 mA and 20 mA
- Output at fault

Analogue signal range (V0H3)

Three settings are possible:
- 0 = 4...20 mA (default)
- 1 = 4...20 mA with 4 mA threshold
- 2 = 0...20 mA

V0H3	4 mA-threshold	Current, mA	Voltage, V
0	aus	3,8...20,5	1,9...10,25
1	ein	4...20,5	2,0...10,25
2	0...20 mA	-0,5...20,5	-0,25...10,25

Depending on the values entered at V0H5 and V0H6 for the start and end of the range, it is possible that signals below 4 mA and above 20 mA can be generated in normal operation. If the instruments connected to the analogue outputs cannot process signals less than 4 mA, option 1 must be used.

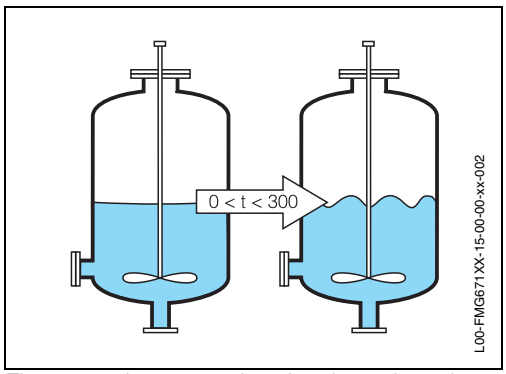


Note!
- On alarm, the output still falls to -10% of the signal range when this mode is selected at V0H7, page 35.

Output damping

This parameter sets the degree of damping of the analogue output: on a sudden change in level, 63% of the new value is attained in the set time (0...300 s).

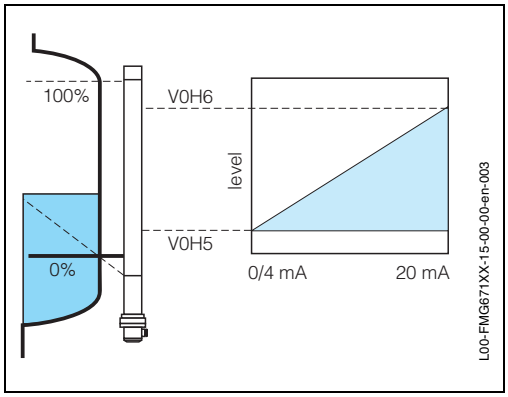
You can increase output damping to reduce the influence of statistical deviations on measurement accuracy. Take into account that level changes under the output damping can not be resolved.



The appropriate output damping depends on the product surface and on the process.

Value for 0/4 mA and 20 mA

The 0/4mA (V0H5) and 20 mA (V0H6) values, default values 0% and 100%, determine the levels at which the analogue signal range begins and ends.



Example

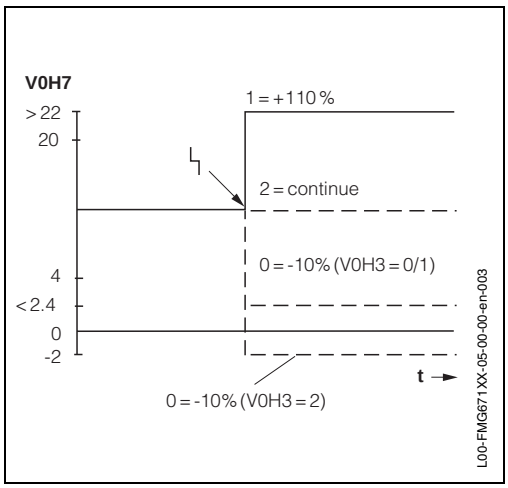
#	Matrix	Entry	Remarks
1	V0H5	20	4 mA at 20% level
2	-	»E«	Register entry
3	V0H6	80 %	20 mA at 80 % level
4	-	»E«	Register entry

Note!
- When V0H3 = 2, V0H5 = 0 mA value (not the 4 mA value)
- The voltage signal is set with the current
- If V0H5 is greater than V0H6, the signal is inverted.

Output on alarm (V0H7)

The analogue output can be set such that it takes on distinctive values when a fault with alarm is detected. The relays follow the analogue output. The entry is made in V0H7:

- 0 = -10% of analogue signal range
- 1 = +110% of analogue signal range (default)
- 2 = measurement continues



	Current on Alarm			Voltage on alarm		
V0H3	**V0H7=0 (-10%)**	**V0H7=1 (+110%)**	**V0H7=2**	**V0H7=0 (-10%)**	**V0H7=1 (+110%)**	**V0H7=2**
0 (4...20 mA)	≤ 2.4 mA	≥ 22.0 mA	continue	≤ 1.2 V	≥ 11 V	continue
1 (4...20 mA threshold))	≤ 2.4 mA	≥ 22.0 mA	continue	≤ 1.2 V	≥ 11 V	continue
2 (0...20 mA)	≤ -2 mA	≥ 22.0 mA	continue	≤ - 1 V	≥ 11 V	continue

Caution!
- If V0H7=2 is chosen, the fault recognition system on the 0/4...20 mA signal line is effectively deactivated. Although the transmitter recognises a fault, i.e. the alarm relay de-energises and the associated LED goes out, the signal output to any follow-up instrumentation appears to indicate a correct measured value.

4.6 Relays

The Gammasilometer FMG 671 has three independent relays with potential-free changeover contacts, the function of which is described in Fig. 4.9:

- Two limit relays, which can be set to operate in minimum or maximum fail-safe mode
- One alarm relay, which responds when the transmitter detects a fault with alarm, see Chapter 5.

If the gammagraphy detection mode is switched on, the second limit relay acts as alarm relay for the detection function, see chapter 6.

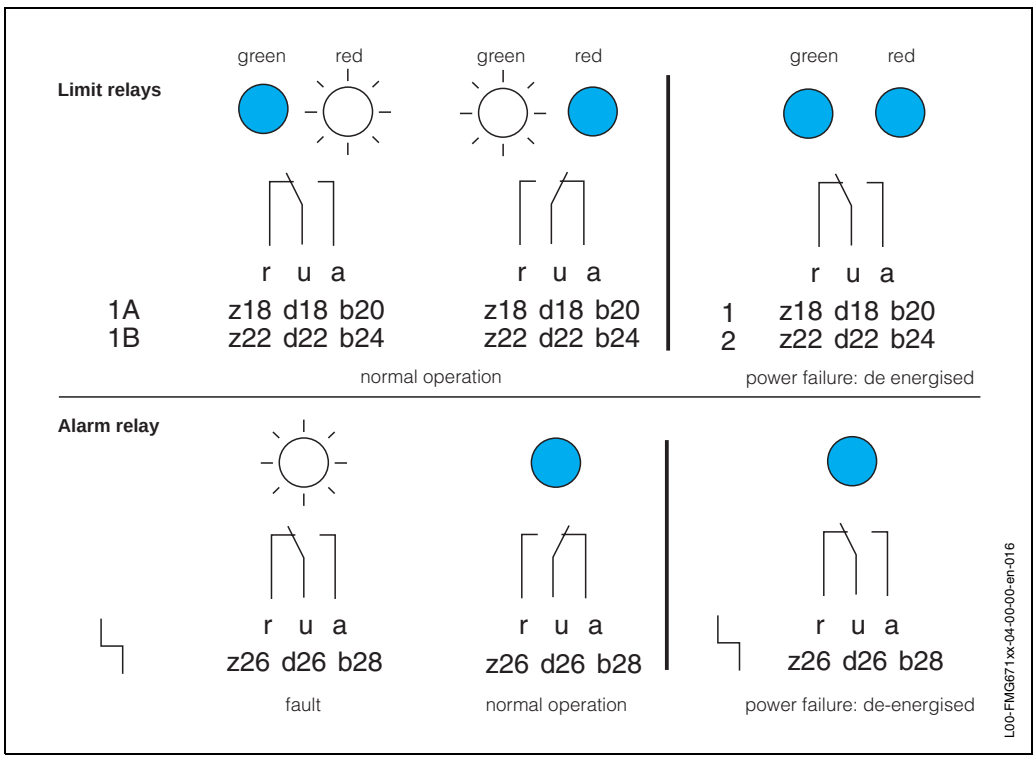


Fig. 4.4 Relay LEDs as a function of relay status:
limit relay: red lit, de-energised; green lit, energised
alarm relay: lit, de-energised; out, energised

Limit relays

Depending upon the switch-on and switch-off points, the limit relays can function in minimum or maximum fail-safe mode.

Minimum fail-safe mode:
The relay de-energises when the level displayed in V0H0 drops below the switch-off point; when the level rises above the switch-on point, it energises again, see Fig. 4.10.

Maximum fail-safe mode:
The relay de-energises when the level displayed in V0H0 rises above the switch-off point; when the level drops below the switch-on point, it energises again, see Fig 4.11.

The values of the switch-on and switch-off points are entered in % level, see examples.

Example:
Min. fail-safe mode, relay 1

#	Matrix	Entry	Remarks
1	V1H0	B %	Switch-on point
2	-	»E«	Register entry
3	V1H1	A %	Switch-off point
4	-	»E«	Register entry

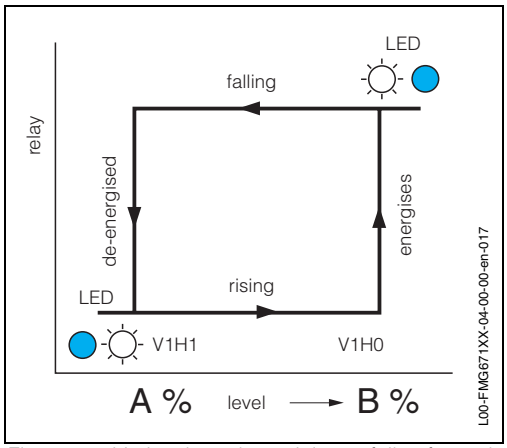


Fig. 4.5 Limit value relay: minimum fail-safe mode

Example:
Max. fail-safe mode, relay 2

#	Matrix	Entry	Remarks
1	V1H5	A %	Switch-on point
2	-	»E«	Register entry
3	V1H6	B %	Switch-off point
4	-	»E«	Register entry

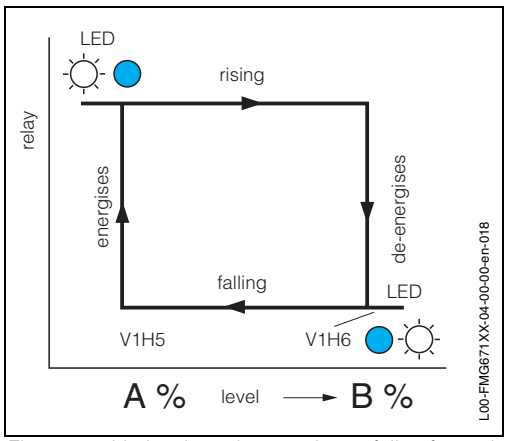


Fig. 4.6 Limit value relay: maximum fail-safe mode

Relay on alarm

When the self-monitoring circuit triggers on a fault with an alarm, relay 1 responds according to the entry at V1H3 and relay 2 to the entry at V1H8:

- 0 = de-energised
- 1 = as analogue output, see the following table

Setting at V0H7	Minimum fail-safe mode	Maximum fail-safe mode
0 = -10% (≤ -2 mA/2.4 mA)	Relay de-energises	Relay energises
1 = +110% (≥ 22mA)	Relay energises	Relay de-energises
2 = continue	dependent on value	dependent on value

4.7 Sensor linearisation

As mentioned in Section 1.3, the relationship between normalised countrate and level is non-linear. The sensor linearisation corrects for this effect: one of four modes can be selected in V2H0:

- 0: standard table for upright cylindrical vessels (default)
- 1: standard table for 2 detectors (cascade mode, Chapter 5)
- 2: manual entry of a linearisation table (Order No. 015147-0000)
- 3: automatic entry of a linearisation table
- 4: clear linerisation table 2 or 3

Standard table

Use the standard table when:

- wall thickness is uniform
- wall thickness < 30 mm
- one source only
- radiation beam angle used > 30°
- detector with PMT at bottom
- attenuation with product > 5 HVL (half-value layers)

The table is automatically activated on calibration of the system.

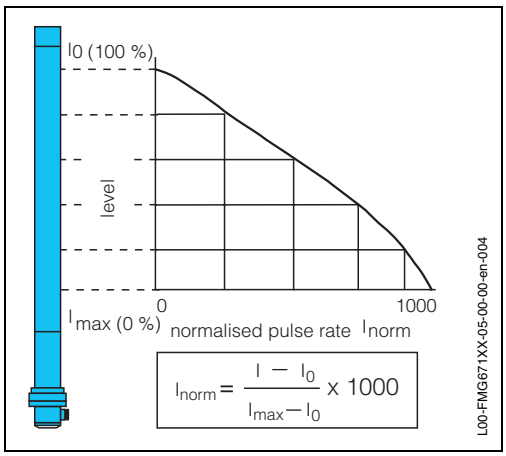


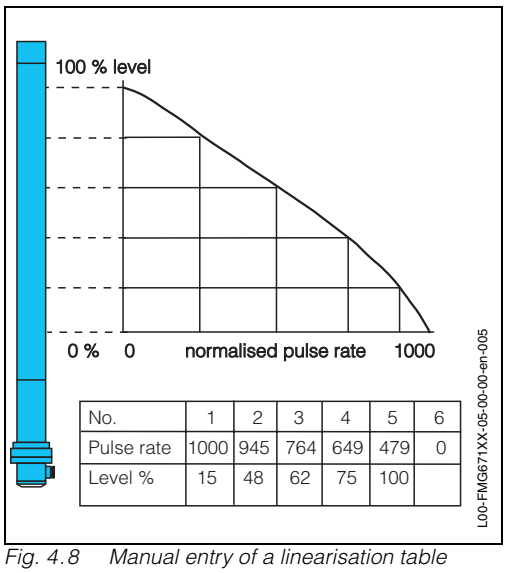
Fig. 4.7 Standard table for sensor linearisation

Manual entry

The table for manual entry is supplied with the system if ordered. It comprises up to 30 pairs of normalised countrate versus level values.

Example: Manual entry of table

#	Matrix	Entry	Remarks
1	V2H0	4	Clear previous table
2	-	»E«	Register entry
3	V2H1	$C_{1...30}$	Pulse rate
4	-	»E«	Register entry
5	V2H2	$L_{1...30}$	Level in %
6	-	»E«	Register entry
7	V2H3	**2** (...30)	Next pair of values
8	-	»E«	Register entry - springs to V2H1
	Repeat steps 3...8 for all values		
9	V2H0	2	Activate "manual"
10	-	»E«	Register entry



No.	1	2	3	4	5	6
Pulse rate	1000	945	764	649	479	0
Level %	15	48	62	75	100	

Fig. 4.8 Manual entry of a linearisation table

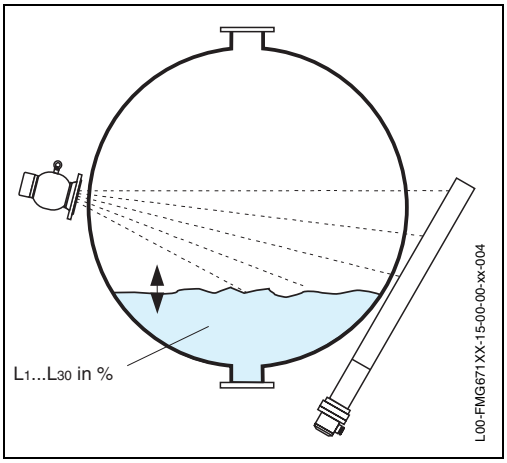
Note!

- The value pairs are automatically sorted in the FMG 671 after activation.
- On error E 603 after activation in V2H0, correct table.
- An entry of 9999 in V2H1 or V2H2 deletes the reference point
- Re-activate linearisation in V2H0

Automatic entry

For the automatic linearisation, the vessel is filled or emptied in steps and the count-rate automatically registered:

#	Matrix	Entry	Remarks
1	V2H0	4	Clear previous table
2	-	»E«	Register entry
3	V2H0	3	Automatic
4	-	»E«	Register entry
5	V2H1	****	Anzeige muß stabil sein
6	V2H2	$L_{1...30}$	Wait 100 s, level in %
7	-	»E«	Register entry
8	V2H3	**2** (...30)	Next pair of values
9	-	»E«	Register entry - springs to V2H1
Repeat steps 5...9 for all values			
10	V2H0	**2**	Activate linearisation
11	-	»E«	Register entry



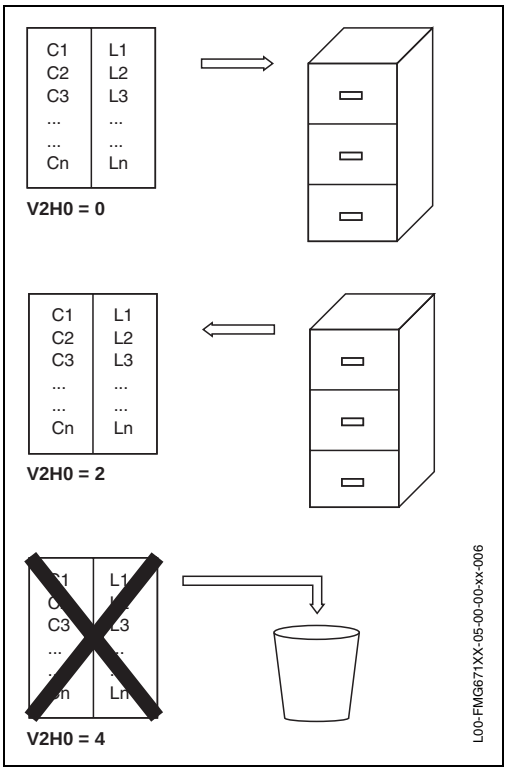
- If the display fluctuates, increase integrative time (page 30)
- The value pairs are automatically sorted in the FMG 671 after activation.
- On error E 603 after activation in V2H0, correct table
- An entry of 9999 in V2H1 or V2H2 deletes the reference point
- Re-activate linearisation in V2H0
- If you write down the value pairs during filling and later enter them as a manual table, the pulse rate must be converted into a standardized pulse rate (for equation, s. Fig. 4.7, page 38).

Deactivation or deletion of linearisation

There are two possibilities for deactivating or deleting a linearisation:

Deaktivation without deletion
- Enter "0" in V2H0: The linearisation is deactivated but the table remains stored. The standard table is used.
- Enter 2, to re-activate

Deaktivatin with deletion
- Enter "4" in V2H0: the manual or automatic linearisation is deleted
- The standard linearisation is used



4.8 Automatic calibration correction

The automatic calibration correction employs a limit switch, e.g. a Gammapilot FTG 671, at channel 2 to check the validity of the calibration at channel 1. If a descrepancy is found, the level display is corrected.

The level is checked and, if required, corrected every time the switching status of the switch changes, i.e. covered => uncovered or uncovered => covered.

- If the measured level is less than the installation height of the limit switch when this is covered, the value at V8H4 is displayed at V0H0 until the next automatic calibration
- If the measured level is greater than the installation height of the limit switch when this is uncovered, the value at V8H4 is displayed at V0H0 until the next automatic calibration.

Installation hints

Install the external limit switch where:

- it is frequently covered and uncovered - increases frequency of correction
- it is as near as possible to the 0% level - ensures greatest accuracywe recommend a height between 10 and 20%

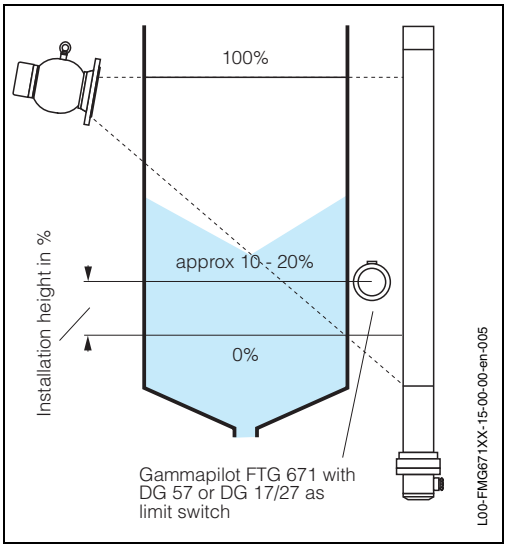
Procedure

Two parameters are required:

- the switching delay (0...20 s) determines the delay between response of the limit switch and the correction
- the installation height is the height of the limit switch above the 0% level expressed in % relative to the 100% level.

#	Matrix	Entry	Remarks
1	V8H2	1	Activate function
	-	»E«	Register entry
3	V8H3	z.B. 5 s	Switching delay
	-	»E«	Register entry
5	V8H4	z.B. 10 %	Installation height
6	-	»E«	Register entry

- The current correction factor can be read at V8H5, the switching status of the limit switch at V8H6
  - 0 = uncovered, 1 = covered.
- Product densities may not change during a filling operation, since there is no means of continuous operation.



4.9 Measured value display

During normal operation the level in % 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.. The following table summarizes the measured value displays.

Matrix	Measured value	Remarks
V0H0	Level	Level in percent, as defined in calibration
V0H1	Empty calibation	Level in % used for calibration (default = 0)
V0H2	Full calibration	Level in % used for calibration (default 100)
V0H8	Current pulse rate	Displays the pulse rate which is actually measured. The value is displayed as counts/100ms
V3H6	Range of pulse rates	Difference between unnormalised pulse rates for empty and full calibration
V3H7	Pulse rate covered	Pulse rate measured for full calibration
V3H8	Local dose rate	Display of average local dose rate - valid for empty vessel only
V3H9	Background radiation	Pulse rate of the background radiation for calibration mode 4. For calibration modes 1...3 is always 0. Displayed as counts/100ms
V7H1	Sensor number	Shows the 4 digit number on the DG 57 nameplate which indicates the source used, Cs or Co
V7H2... V7H9	Service parameters	Parameters which may be required for fault diagnosis during a service call
V8H5	Factor for automatic calibration correction	Current factor used for automatic calibration
V8H6	Switching status of limit switch	Indicates the current status of the limit switch when an automatic calibration correction is in use: 0 = uncovered/open, 1 = covered/closed
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

4.10 Locking the parameter matrix

When all parameter entries have been made the parameter 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.

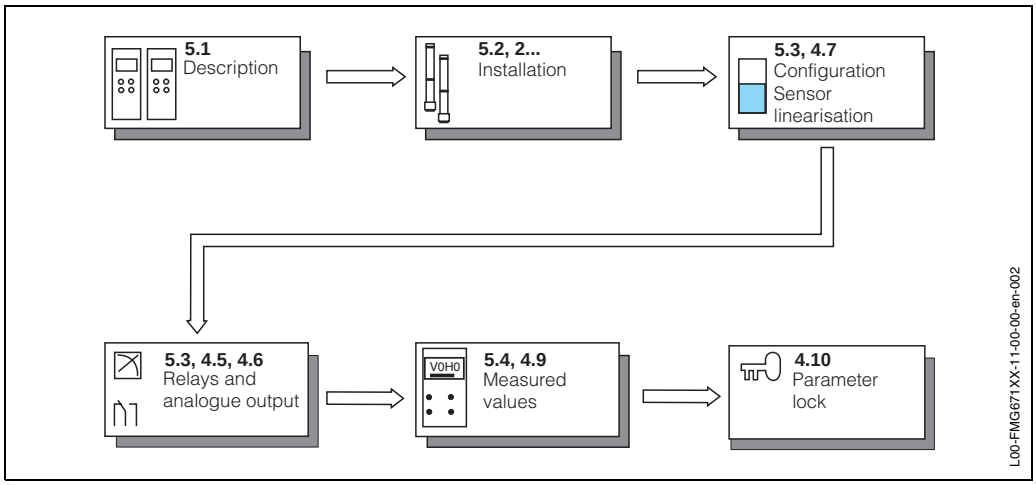
- The lock is released when a number between 670 and 679, e.g. 671, is entered into the matrix at the same position.

5 Cascade Mode with Two Detectors

The Gammasilometer FMG 671 P measurement system comprises two transmitters and two detectors which work in tandem. This Chapter contains the following:

- Functional description
- Installation hints
- Configuration
- Operation

Fig 5.1 gives an overview of the installation and configuration procedure.



Note!

- If the cascade mode is used, both transmittters must have the same software version - check in V9H3.

5.1 Functional description

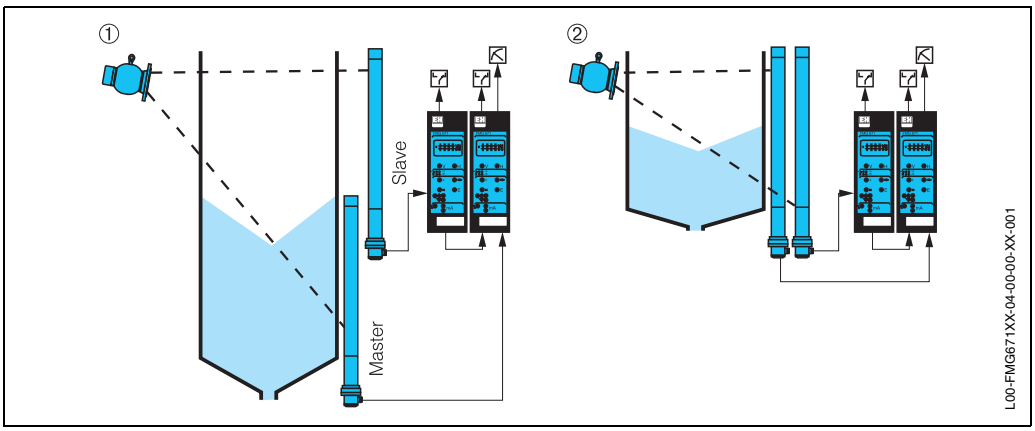


Fig. 5.1 Typical applicatrions for cascade mode:
① double range
② double sensitivity

Fig 5.2 shows the possible applications of the cascade mode:

- Measuring range can be extended by using two detectors of equal length mounted one above the other, max. range = 4 m.
- Sensitivity can be doubled by using two detectors of the same length mounted side by side.

Measuring system

The measuring system Gammasilometer FMG 671P comprises two transmitters and two detectors, one transmitter is marked as master, one as slave. The master is equipped with two limit relays, a voltage and a current output. The slave has two limit relays only. With the exception of the initial setting as slave and the slave relays, all parameters are programmed from the master transmitter.

Master and slave exchange data continuously over the cascade interface. A measured value, V0H0, is shown at the master only: the slave display shows matrix position. The bar graph display on the slave follows that of the master (with a slight delay). Similarly, alarms and warnings appear at both instruments.

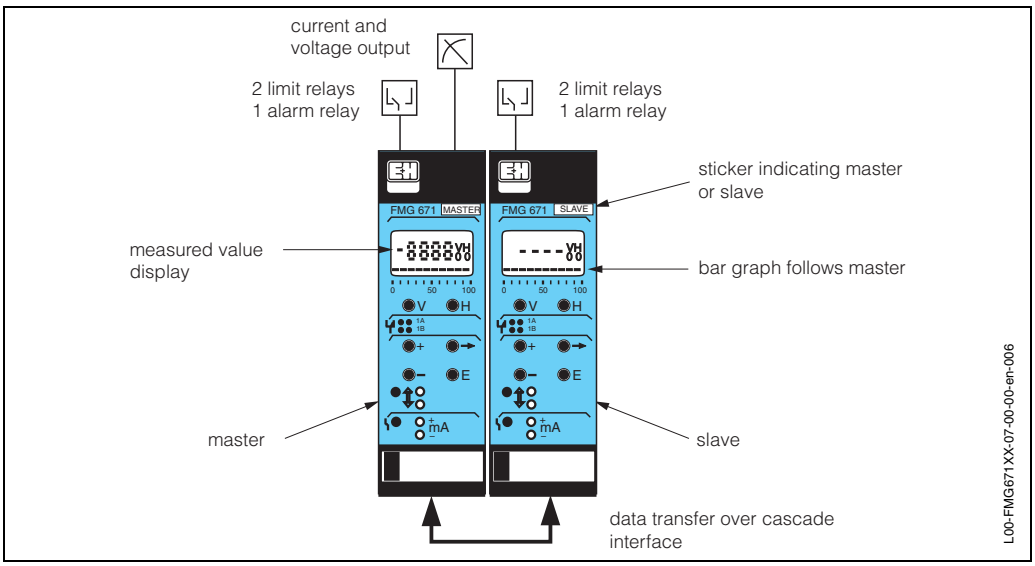


Fig. 5.2 FMG 671 P master and slave transmitters

5.2 Installation hints

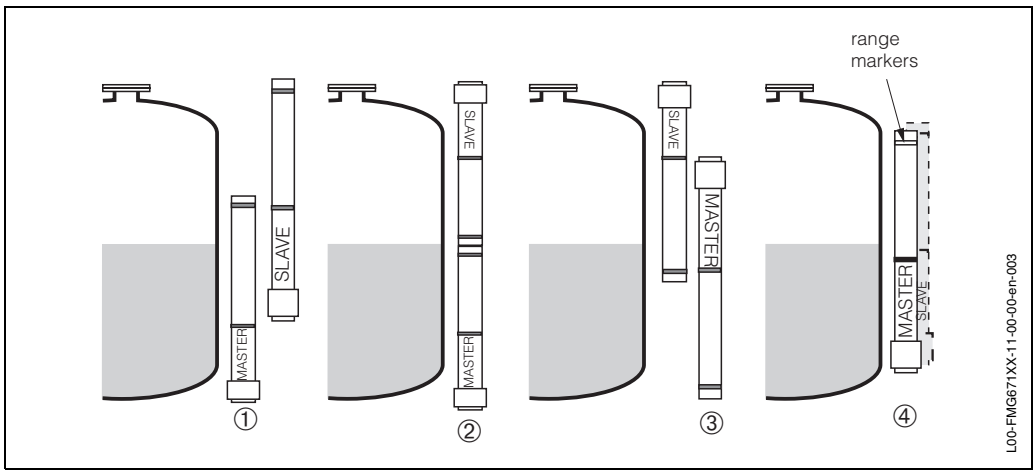


Fig. 5.3 Alignment of detectors for:
① extended range, detector heads at bottom recommended method
② extended range, detector face-to-face
③ extended range, detector heads at top
④ double sensitivity, detectors side-by-side, parallel to the tank wall

Detectors

The detectors must be installed in accordance with the instructions in Chapter 2. The arrangement depends upon the application:

- for extended range, the slave detector is above the master detector
  for mounting possibilities see Fig. 5.4.
- for double sensitivity, the slave detector is next to the master detector
  the measuring areas must lie exactly parallel both detectors must be in the beam.

Take care that the data module (DAT) delivered with each detector is plugged into the correct transmitter.

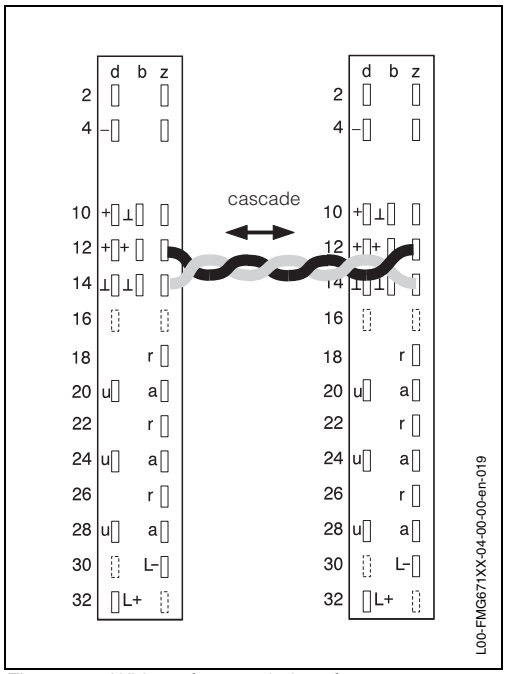


Fig. 5.4 Wiring of cascade interface z12, z14

Transmitters

Wire the transmitters as described in Chapter 2. In addition observe the following:

- Clearly label the master and slave using the adhesive tags which are stuck to the back of the card, see Fig. 2.17
- Check that the data module (DAT) from the upper detector is plugged into the slave module
- Position the two transmitters in adjacent slots (or as near as possible to each other)
- Wire up the cascade interface as shown in Fig. 5.5.
- If the transmitters are to be connected to the Rackbus, set different addresses at the master and slave. The slave delivers no measured value to the bus.

5.3 Configuration

The system is configured from the master transmitter according to the procedures described in Chapter 4. The additional steps for cascade mode (in bold type) are:

- the slave transmitter must be set to operating mode 1 (V8H0 = 1)
- the master transmitter must be set to operating mode 2 (V8H0 = 2)
  - the application at V8H1 (0 = extended range, 1 = double sensitivity)
  - the orientation of the slave detector must entered at V3H3
  - the sensor linearisation must be set to mode 1 at V2H0 (2 detectors).

Background calibration with extended range

Nr.	Matrix	Entry	Remarks
1	V9H5	671	Reset
2		»E«	Register entry
3	**V8H0**	**1**	**Slave (in slave)**
4		**»E«**	**Register entry**
5	V9H5	671	Reset
6		»E«	Eingabe bestätigen
7	**V8H0**	**2**	**Master (in master)**
8		**»E«**	**Register entry**
9	**V8H1**	**0**	**Extended range**
10		**»E«**	**Register entry**
11	**V2H0**	**1**	**Two detectors**
12		**»E«**	**Register entry**
13	V3H0	4	Background calibration
14		»E«	Register entry
15	V3H1	0	^{137}Cs source
16		»E«	Register entry
17	V3H2	0	PMT below (1)
18		»E«	Register entry
19	**V3H3**	**0**	**PMT below (2)**
20		**»E«**	**Register entry**
21	V3H4	5202	Date: 1995, Week 20, Tuesday
22		»E«	Register entry
23	V0H1	0 %	Tank empty wait 100 s
24		»E«	Register entry
25	V0H2	100 %	Tank full wait 100 s
26		»E«	Register entry
27	V3H9		Tank full, switch off radiation, wait 100 s
28		»E«	Register entry

- additional steps for cascading mode are typed in bold face

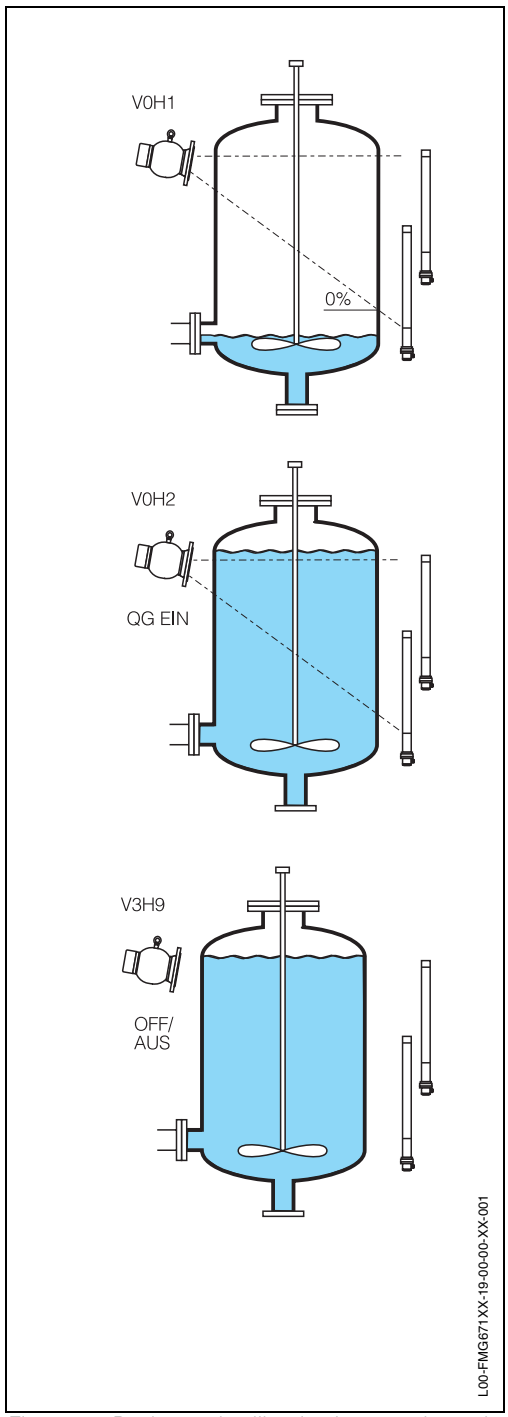


Fig. 5.5 Backgound calibration in cascade mode

Analogue output

The analogue output of the master transmitter is set as described in Section 4.5. The slave transmitter has no analogue output of its own and should be set as the master, however, an entry can be made at V0H7 for the function »relay on alarm«.
It is recommended that the value in V0H7 be the same for both, master and slave.

Relays

Each transmitter has two limit relays which can be set independently for master and slave as described in Section 4.6. Normally the slave relays respond according to the measured value at the master. On alarm, however, they act independently according to the value entered at V0H7 in the slave. Both transmitters have an alarm relay which responds as described in Chapter 6.

Parameter lock

When the configuration is complete, the matrix can be locked in both master and slave as described in Section 4.10.

5.4 Operation

During normal operation the measured value can be read from matrix position V0H0 at the master transmitter, the slave display is blank. The bar graph on the slave display follows that on the master. In Section 4.9 lists other display fields for both master and slave are listed.

The operating matrix of the master is to be found at the back of the manual. The slave matrix comprises the fields V0H7, V8H0, V8H9, V9H5,the relay fields and the display fields indicated in Section 4.9 only.

Alarms

The master and slave exchange data at regular intervals. If an alarm or warning is detected, both instruments display the appropriate error code at V9H0 as indicated on page 48 - there is a maximum delay of 0.5...0.75 s between registration by one transmitter and response at the other.

6 Gammagraphy Detection

6.1 Level measurement with gammagraphy

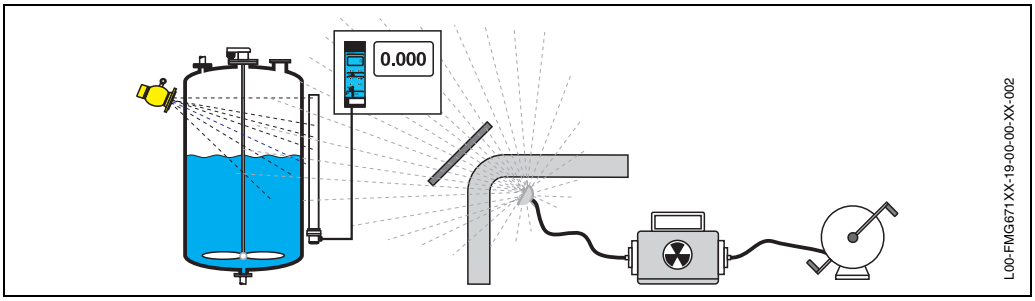


Fig. 6.1 Effect of gammagraphy

Gammagraphy is a non-destructive method of testing for cracks in e.g. pipelines or pressurised vessels, for which a gamma-ray emitting radioactive source is used. When testing is being carried out in the vicinity of the Gammasilometer measurement system, the high sensitivity of the DG 57 scintillation detectors to gamma rays can lead to incorrect measurements, and a level less than that actually in the vessel is displayed. Depending upon the application, the test has a duration of 3 to 5 minutes, typical effects are shown in Fig. 6.1. The actual effect on the countrate depends on the strength of the gammagraphy source, the material in the beam path and the distance.

The gammagraphy detection function of the Gammasilometer FMG 671 responds to the following criteria:

- rapid changes in pulse rate not attributable to level changes
- current pulse rate larger than maximum plausible pulse rate
- current pulse rate less than 2 pulses/s (detector in saturation mode).

If one of the criteria is fulfilled, the Gammasilometer holds the last displayed value and the presence of external radiation is indicated by the de-energising of the second limit relay (1B) as well as at field V5H4. Five parameters must be entered (in the case of cascading, at the master transmitter):

- The gammagraphy recognition function is switched on and off at V5H0.
- The maximum length of a test is entered as the time window in seconds in V5H1. During this time the transmitter holds the last value measured. Measurements begin again 20 s after the time window entered has elapsed.
- The time to empty the vessel in seconds, measured across the active detector length (measuring range), is entered in V5H2
- The responsiveness is entered in V5H3: normally this is set to 0. If, however, incorrect switching occurs due rapid changes in level, e.g. due to high waves, this parameter can be increased to a maximum of 10. As a rule a factor 10 x [wave height/measuring range] is ensures a correct response.
- The behaviour of the instrument on detection of gammagraphy is set in V5H6:
  0 = Warning: If a gammagraphy test is detected, relay 1B de-energises.
  1 = Alarm: If a gammagraphy test is detected, relay 1 B de-energises, the 4...20 mA signal reacts according to the setting in V0H7, and the alarm relay de-energises.

The gammagraphy detection status can be read from field V5H4: 0 = off, 1 = on: pressing the E key causes the current gammagraphy detection routine to be switched off. The number of tests detected can be read from the counter in V5H5: pressing the E key causes the counter to be reset to 0.

Switching on the gammagraphy detection

#	Matrix	Entry	Significance
1	V5H0	1	Switch on gamma-graphy detection 0 = Switch off
2	-	»E«	Register entry
3	V5H1	z.B. 360	Time window
4	-	»E«	Register entry
5	V5H2	z.B. 60	Emptying time of vessel (over measuring range)
6	-	»E«	Register entry
7	V5H3	z.B. 0)	Responsiveness
8	-	»E«	Register entry
9	V5H6	z.B. 0	Warning on detection
10	-	»E«	Register entry

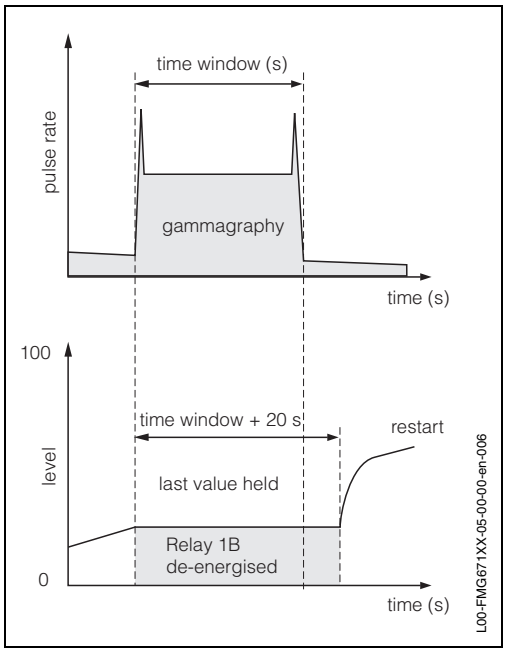


Fig. 6.2 Parameter for gammagraphy

Caution!
The following conditions may lead to incorrect function:
- Gammagraphy dose rate lies within the plausibility limits for level measurement: gammagraphy not detected, the indicated level is lower than it should be
- Extremely rapid emptying of the tank: gammagraphy detected although not present
- Switch on of gamma source: gammagraphy detected although not present.

Note!
- In cascade mode with two detectors (chap. 5) only relay 2 of the master and not that of the slave is active as a gammagraphy relay.

6.2 Limit detection with gammagraphy

Since it is not possible to integrate the gammagraphy detection function into the Gammapilot FTG 671 limit detector, applications where it is required must be solved with the Gammasilometer FMG 671 and detector DG 57.

- The measuring arrangement corresponds to that shown in Fig. 6.3. A 100 mm long scintillation detector is mounted vertically along the vessel wall.
- The Gammasilometer is calibrated in accordance with Chapter 4.2
- Relay 1A is set as a limit relay in maximum or minimum fail-safe in accordance with Chapter 4.6.

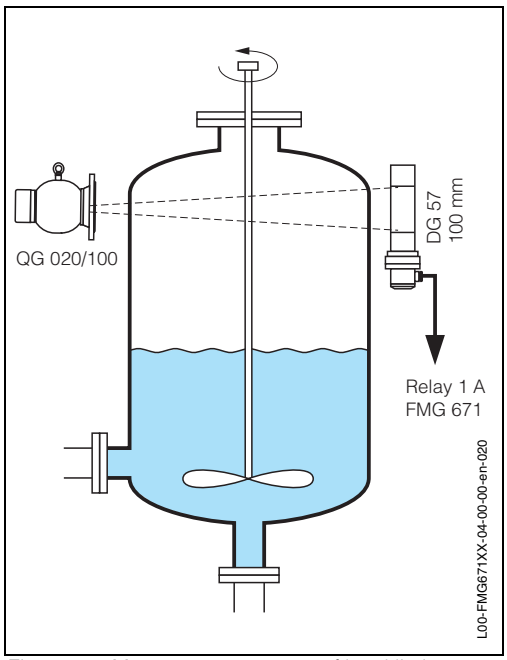


Fig. 6.3 Measurement system of level limit detection with gammagraphy (maximum)

7 Maintenance

In regular intervals (approx. 6 month), the following parameters should be checked:

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.

8 Trouble-Shooting

The Gammasilometer FMG 671 transmitter provides a number of aids for setting up and operating the module correctly. This Chapter contains the following:

- Fault recognition system
- Error message and trouble-shooting tables
- Simulated operating mode
- Commissioning replacement transmitters, sources and detectors.
- Repairs

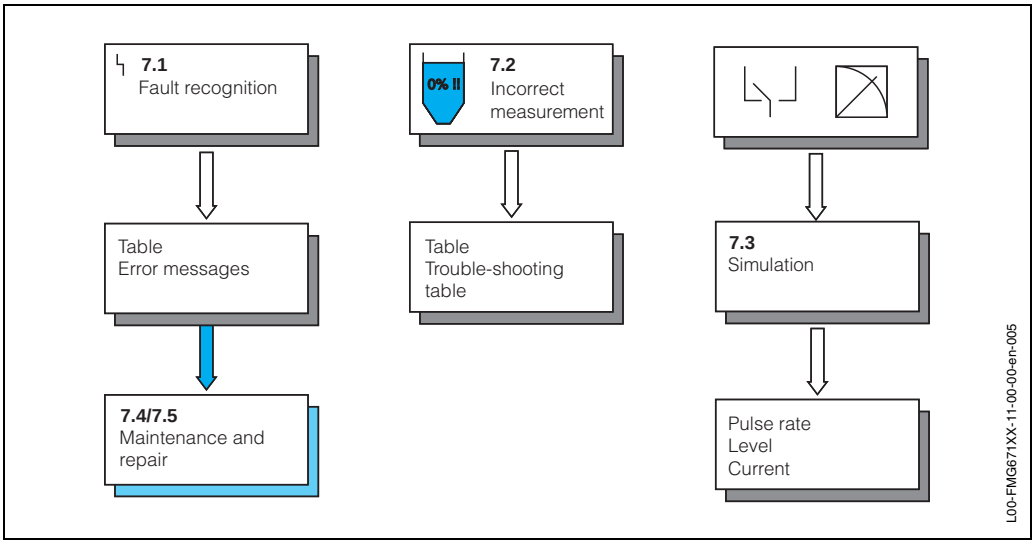


Fig. 8.1 Trouble-shooting and fault elimination for the Gammasilometer FMG 671

8.1 Fault recognition

Alarms

If the Gammasilometer FMG 671 transmitter recognizes a fault condition where further measurement is impossible, i.e. an alarm:

- the red alarm LED lights and the alarm relay trips
- the limit value relays assume respond according to the setting in V1H2/V1H7.
- 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 Gammasilometer FMG 671 transmitter has detected a fault condition where further measurement is possible, i.e. a warning:

- the red alarm LED flashes but the Gammasilometer functions as normal,however, depending on the fault the measured value may be incorrect
- the alarm relay remains energised
- the appropriate code is to be found in V9H0.

The codes and error messages are listed in the following table 7.1 in the order of their priority.

Code	Type	Cause and Remedy
E101... E106	Alarm	Fault in instrument electronics – For E102, check whether DAT is plugged into card – For E103 check supply voltage – Call Endress+Hauser Service
E201	Alarm	Fault in detector, pulse rate < 2 – Check whether dose rate too high: switch off source, if alarm disappears reduce dose rate, e.g. by bolting a blind flange on the QG source container – PMT or high voltage defective, call Endress+Hauser Service
E202	Warning	Fault in detector, pulse rate > max. possible pulse rate – Calibration made with build-up on wall which has since fallen off? Repeat calibration – Check for external radiation source – Detector defective, call Endress+Hauser Service
E204	Alarm	No temperature measurement (<-34 °C or >+80 °C) – May occur on connection of detector or when the transmitter is powered up - the alarm disappears after ca. 60 s – Call Endress+Hauser Service
E206	Alarm	LED reference measurement outside limits 5...95% – Check whether dose rate too high: switch off source, if alarm disappears reduce dose rate, e.g. by bolting a blind flange on the QG source container – Alarm remains: call Endress+Hauser Service
E210	Alarm	Gammagraphy conditions still exist after time window expires or time window to small
E211	Warning	Gammagraphy conditions detected (Fault mode = Warning) – Relay 1B de-energises
E212	Alarm	Gammagraphy conditions detected (Fault mode = Alarm)
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.
E603	Warning	Sensor linearisation does not fall monotonically – Check linearisation table and correct faulty entry
E605	Warning	Less than two reference points in the linearisation table – Enter more points or – Select standard table
E610	Warning	Detector data have been changed – No calibration? – Operating mode changed after calibration (reselect or recalibrate) – Cascade mode changed after calibration (reselect or recalibrate) – 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
E660	Warning	Detector temperature > 50°C – Use water jacket – Shield detector from heat source (if beam path interrupted, new calibration!)

Error codes for cascade mode

E110	Alarm	Fault in master
E111	Alarm	Fault in slave
E410	Alarm	Slave does not answer – Check wiring of cascade interface – Check whether 2nd device set as slave
E411	Alarm	Master does not answer – Check wiring of cascade interface – Check whether 2nd device set as master
E620	Warning	Warning in master
E621	Warning	Warning in slave

8.2 Incorrect measurements

Trouble-shooting table

The following Table summarises the most common operating errors which lead to incorrect measurement by the Gammasilometer transmitter.

Fault	Cause and remedy
Countrate for unhindered radiation (= empty tank) too low	• Radiation switched off – switch on again • Gamma beam not precisely aligned – re-align • Build up in vessel – Clean vessel • Fittings in vessel not considered in activity calculation – recalculate activity and change source accordingly • Pressure in vessel not considered in activity calculation – recalculate activity and change source accordingly • No radionuclide in source container – load source capsule in container • Source too weak – use source with higher activity
Countrate for unhindered radiation (= empty tank) too high	• 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 full vessel too high	• External radiation source in use (gamma radiography) – Shield off if possible
Measured value too high in empty tank	• Tank under pressure but empty calibration carried out without pressure – Calibrate at process pressure • Build-up in the tank – Clean tank or – Recalibrate (if build-up is stable)
Relays do not trip correctly	• Wrong switch points 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 page 52
No communication with ZA 67...	• Check address switch • Check wiring

8.3 Simulated operating mode

This function is intended primarily for checking the correct function of the system:

- Enter 6 at V8H0 to activate the simulation mode (for cascade mode, in master)
- On completion, enter last operating mode (0, 1 or 2) at V8H0 to terminate simulation and resume normal measurements.

When the simulation mode is activated, the alarm relay flashes (Warning E613). The following simulations are possible:

Matrix	Entry	Simulated value	Relays
V9H6	Pulse rate/10	Pulse rate, level, current	yes
V9H7	% Level	Level, current	yes
V9H9	Current (-2...+22 mA)	Current	no

Example:
Simulation of level and current by entry of pulse rate in V9H6

#	Matrix	Entry	Remarks
1	V8H0	6	Select simulation
2	-	»E«	Register entry
3	V9H6	e.g. 1324	Countrate 13240
4	-	»E«	Register entry
5	V9H7	****	Level % for count
6	V9H9	****	Current for count
7	V8H0	0	Measurement mode

Note!
Value in V9H6 must be in calibrated range (V3H6 - V3H7).

Example:
Simulation of current by entry of level in V9H7

#	Matrix	Entry	Remarks
1	V8H0	6	Select simulation
2	-	»E«	Register entry
3	V9H7	z.B. 60	Level = 60%
4	V9H9	****	Current for level
5	V8H0	0	Measurement mode

Example:
Simulation of current by entry of current in V9H8

#	Matrix	Entry	Remarks
1	V8H0	6	Select simulation
2	-	»E«	Register entry
3	V9H8	z.B. 10	Current = 10 mA
4	V8H0	z.B. 10	Measurement mode

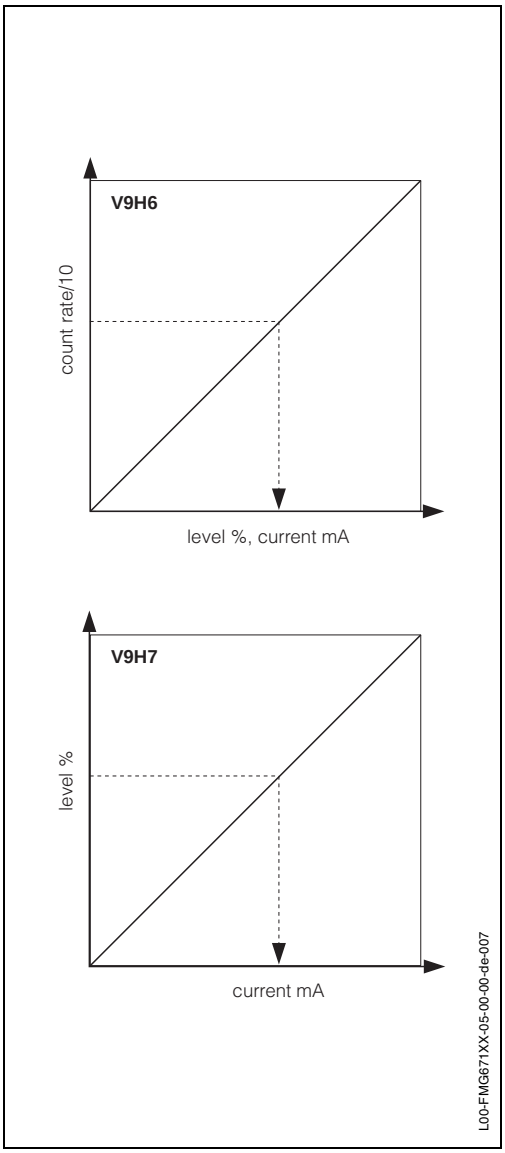


Abb. 8.2 Simulation mode

8.4 Exchanging transmitters and detectors

Transmitter

If the Gammasilometer FMG 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. The existing DAT module must be inserted in the new transmitter so that the detector data is correct. In the case of cascade mode the appropriate operating mode must first be set in V8H0, see Chapter 5.

In cascading mode: enter PMT position of slave detector in V2H3

Step	Matrix	Entry	Remarks
1	V3H0	2	Select calibration on instrument exchange
2	-	»E«	Register entry
3	V3H1	z.B. 0	^{137}Cs source
4	-	»E«	Register entry
5	V3H2	z.B. 0	PMT at bottom
6	-	»E«	Register entry
7	V3H4	YCWT	Enter the date of original calibration (see Section 4.1)
8	-	»E«	Register entry
9	V3H5	YCWT	Enter today's date
10	-	»E«	Register entry
11	V3H6	...	Enter noted countrate of measurement span for calibration
12	-	»E«	Register entry
13	V3H7	...	Enter noted countrate for full calibration
14	-	»E«	Register entry
15	V3H9	...	Enter background radiation count or confirm "0" with »E«
16	-	»E«	Register entry
17	V0H4...V2H3		Enter remaining parameters

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

Download

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 after stand-still

If the transmitter is switched off for some time, 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 ^{60}Co source which changes at ca. 1% per month. In comparison, ^{137}Cs changes at the rate of 0.2% per month.

Detector

If the detector is exchanged or moved, a completely new calibration as per Chapter 4, Section 4.2 or Chapter 5, Section 5.3 is necessary. Prior to this, the DAT module delivered with the detector must be plugged into the Gammasilometer card.

Source

If the source is exchanged or the source container moved, a completely new calibration as per Chapter4, Section 4.2 or Chapter 5, Section 5.3 is necessary.

8.5 Repairs

Should the Gammasilometer FMG 671 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.

9 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		[100]	[100.0]	[0]	[16]	[0.0]	[100]	[1]		
V1	[90]	[10]	[0]			[10]	[90]	[0]		
V2	[0]			[1]						
V3	[0]	[0]	[0]	[0]	[Y CW T]	[Y CW T]	[8000]	[2000]		
V4										
V5	[0]	[300]	[120]	[0]			[0]			
V6										
V7										
V8	[0]	[0]	[0]	[5]	[10]					[670]
V9				[38...]		[0]				

Display field

Parameter matrix

	H0	H1	H2	H3	H4	H5	H6	H7	H8	H9
V0 Calibration	Display measured value in %	»Empty« calibration	»Full« calibration	Output 0 = 4...20 mA 1 = 4...20 mA (threshold on) 2 = 0...20 mA	Output damping in (s) 0...300	Value for 0 bzw. 4 mA	Value for 20 mA	Output on alarm 0 = -10% 1 = +110% 2 = continue	Display current pulse rate per 100 ms [10/s]	
V1 Limit value	Relay 1 switch point »On« 0...100 %	Relay 1switch point »Off« 0...100 %	Relay 1 on alarm 0 = de-energise 1 = as V0H7			Relay 2 switch point »On« 0...100 %	Relay 2 switch point »Off« 0....100 %	Relay 2 on alarm 0 = de-energise 1 = as V0H7		
V2 Linearisation	Sensor linearisation 0 = Standard 1 = 2 detectors 2 = manual 3 =automatic 4 = clear	Norm. puls rate	Level	Table No. 1...30						
V3 Extended calibration	Mode 0=locked 1=standard calibration without background 2=exchange 3=recalibrate 4= standard calibration with background calibration	Source 0 = ^{137}Cs 1 = ^{60}Co 2 = none	Mounting 1 0 = PMT at bottom 1 = PMT at top	Mounting 2 0 = PMT at bottom 1 = PMT at top	Date of calibration Y CW D	Today's date Y CW D	Pulse rate measuring range per 100ms [10/s]	Pulse rate covered per 100ms [10/s]	Local dose rate (valid for empty vessel only)	Background pulse rate per 100ms [10/s]
V4										
V5 Gammagraphy	Gammagraphy mode 0 = off 1 = on	Time window in s	Discharge time in s	Responsiveness	Status Gammagraphy 0 = off 1 = on E = reset	Gammagraphy counter E = reset	Faultmode 0 = Warning 1 = Alarm			
V6										
V7 Servicedetector data	Select service level	Sensor No.	Sensor length	Sensor temperature °C	Current reference %	Δ reference %	Average reference at calibration	Max. registered pulserate/ frequency per 100ms [10/s]	Pulserate covered decay compensated per 100ms [10/s]	Range decay compensated per 100ms [10/s]
V8 Operating mode	Operating mode 0 = FMG only 1 = slave 2 = master 6 = simulation	Cascade mode 0 = extended range 1 = double sensitivityt	Limit switch input 0 = off 1 = automati-calibration correction	Switching delay in s	Installation height of limit switch in %	Factor for calibration correction	Staus of limit switch			Security locking <670> or 679 Unlock 670...679
V9 Service and Simulation	Current error code	Last error code E=clear	Rackbus address of partner	Instrument and Software version	Rackbus address	Reset to default values 670...679	Simulation pulse rate 0...9999	Simulation level 0...100%		Simulation Strom -2...+22mA
VA VU 260 Z+ ZA 672 only	Tag. No.									

Display field

slave

Cascade mode (master)

Index

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