Technical
Information
TI 219F/00/en

Radiometric Level Measurement
gammasilometer FMG 671

Non-invasive level measurement
Intrinsically safe signal circuit [EEx ib] IIC
For scintillation detector DG 57

The Gammasilometer FMG 671 transmitter is a 19" plug-in card, here installed in a Monorack housing

Application

The Gammasilometer FMG 671 transmitter is designed for

- non-invasive, radiometric level measurement with the DG 57 detector,

and measures independent of changing process conditions such as pressure, temperature, viscosity, corrosion or interference from fittings.

It is used with vessels containing inflammable, abrasive, poisonous and corrosive solids and liquids; acid tanks, boilers, cement silos, ballast hoppers, cyclones, cupolas, rotary furnaces etc.. Since the measuring system is fitted externally, it can also be applied in the food processing industry.

Gammasilometer transmitters possess intrinsically safe sensor circuits to EEx ib IIC, EEx d or EEx de, depending on the detector, and can be used for applications in hazardous areas.

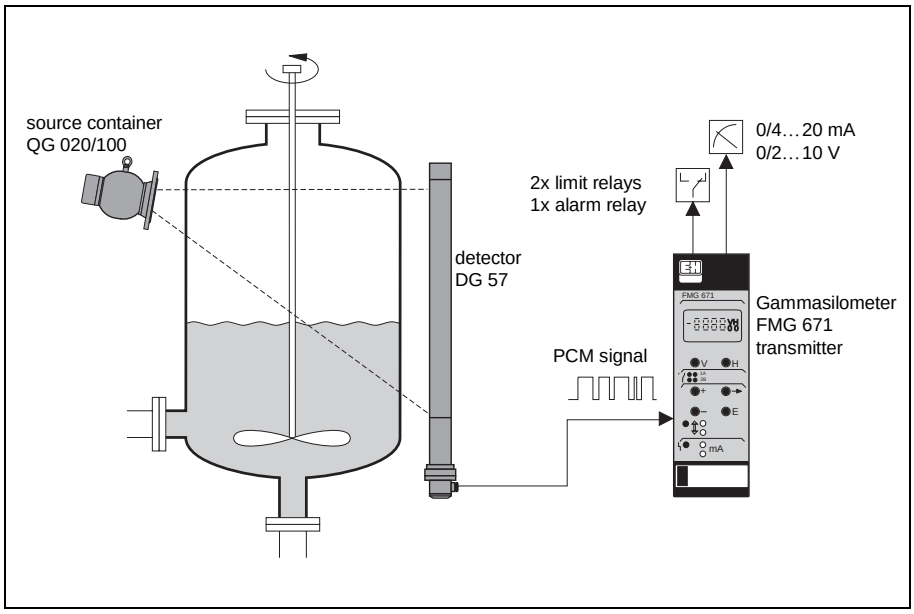
Features and Benefits

- For DG 57 scintillation detectors from 100mm to 2000 mm long
  – Ensures high sensitivity with low strength sources — the local dose rate is much less than that for point sources or ionisation chambers but still gives excellent statistical accuracy, even with low time constants
- Digital signal transmission
  – Interference-free function with two-core installation cable up to 1000 m
- Simple operation with parameter matrix
  – Uniform handling as for all Commutec transmitters
- Practical background functions
  – Automatic countrate compensation
  – Automatic correction of calibration
- Commutec transmitter
  – Simple connection to automatic systems via Rackbus
  – Up and download of data.

Endress+Hauser

Nothing beats know-how

Measuring System



Level measuring system comprising:
Gammasilometer FMG 671
Source container QG 020/100
Detector DG 57

Measuring System

A working system for level measurement comprises:

- Gammasilometer FMG 671 transmitter,
- QG 020 or QG 100 source container with Co 60 or Cs137 gamma source
- DG 57 scintillation counter.

Scintillation Counter DG 57

The DG 57 scintillation counter ensures:

- highest sensitivity
- with lowest source strength.

Endress+Hauser have many years of experience with rod scintillation counters — for level measurement, lengths of up to 2000 mm are available. For greater measuring ranges or higher sensitivity, two detectors can be connected in cascade by using a second Gammasilometer FMG 671 (in preparation).

Signal Input Circuit

The Gammasilometer FMG 671 supplies the power to the DG 57 detector which returns an interference-free pulse code modulated (PCM) countrate signal. The intrinsically safe signal input is electrically isolated from the transmitter supply and the outputs.

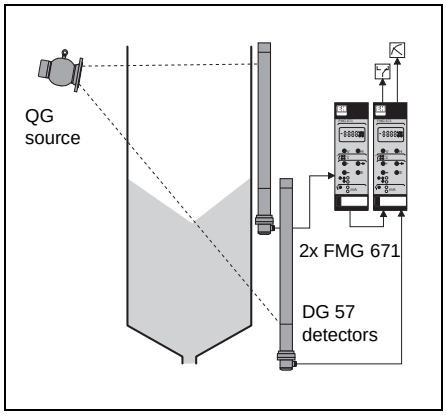
Output Signals

The Gammasilometer FMG 671 has a standard 4…20 mA and 0/2…10 V analogue output which is proportional to level, two independent, freely programmable limit relays which can be operated in minimum or maximum fail-safe mode, and an alarm relay.

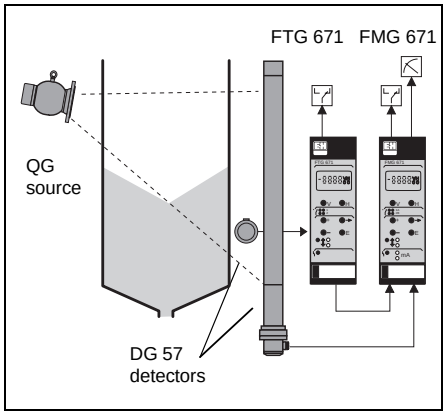
Self-Monitoring Function

The Gammasilometer FMG 671 continuously monitors all signal lines. On fault condition:

- The alarm relay de-energises
- The analogue output switches to -10% or +110% of the signal range or the transmitter continues measurement
- The limit relays de-energise or follow the analogue output.

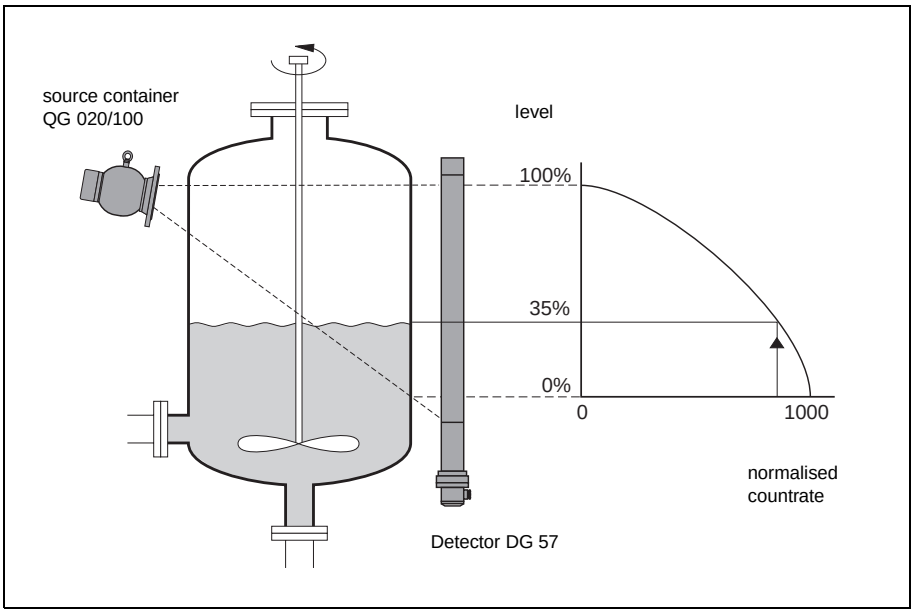


left
Measuring system for ranges from 2… 4 m. A second FMG 671 transmitter acting as slave powers the second detector



right
Measuring system for automatic calibration compensation – a Gammapilot FTG 671 with DG 57-100 or DG 17/27 acts as external limit switch

Measuring Principle



Due to the non-linear relationship between level and normalised countrate the signal must be linearised. A standard characteristic for upright cylindrical vessels is stored in the transmitter

Level Measurement

When gamma rays penetrate a material they are attenuated. The degree of attenuation is dependent upon the density, the absorption coefficient and the thickness of the material. For level measurement the absorption coefficient and density are normally constants and the detected radiation count depends on the extent to which the detector is covered, The countrate is:

- at a maximum when the path to the detector is completely free (tank empty) and
- at a minimum when all the radiation has to travel through the material (tank full).

The maximum and minimum countrates are obtained when the transmitter is calibrated. Between maximum and minimum the relationship between level and countrate is non-linear. The signal is linearised either by calling up a standard characteristic or determining one individually.

Individual Characteristics

If the standard characteristic cannot be used, the vessel characteristic can be calculated by Endress+Hauser on the basis of a drawing. The result is a table of normalised countrate versus level values which can then be programmed into the Gammasilometer. Alternatively the vessel can be filled under controlled conditions and the characteristic generated semi-automatically.

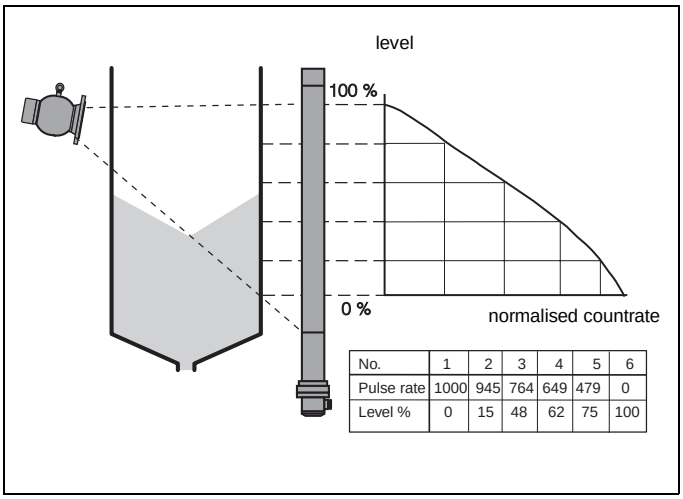
Radiation Statistics

The emission of gamma rays by a radioactive source is governed by the laws of statistics. For this reason the measurement precision of gamma systems is dependent on the statistical variation in countrate. Thanks to the sensitive DG 57 detector, the statistical variation is small, and can be further reduced by increasing the sampling or integration time τ or by using a stronger source.

Background Functions

The Gammasilometer FMG 671 is equipped with a number of background functions which ensure accurate and reliable level measurement:

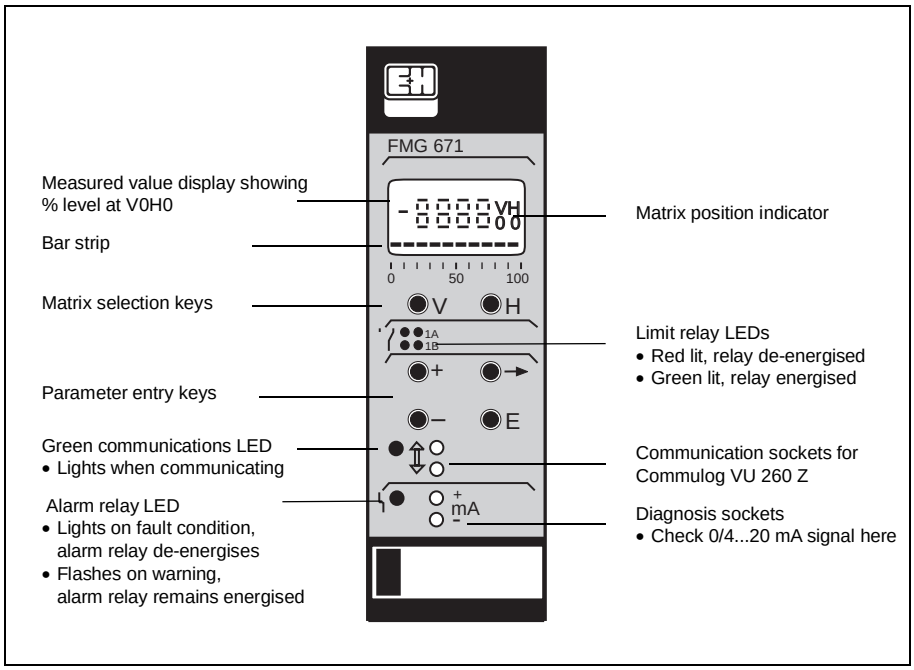
- The decay of the gamma source is accounted for without any action on the part of the operator.
- The plausibility of successive countrate measurements is checked and if necessary, the switching of the relays is delayed
- The operator is warned when the activity of the source is no longer sufficient for reliable measurement.



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

Individual linearisation using tabular values

Operation



Frontpanel of FMG 671 showing operating and display elements

Configuration at Front Panel
Gammasilometer FMG 671 transmitters can be configured at the front panel.

- Six keys access a parameter matrix, defined by a vertical (V) and horizontal (H) position, in which relevant data can be entered
- The selected matrix field and parameter are indicated in the LC-display
- A continuous display of level is available during operation
- A 10-step LCD bar strip indicates level as a fucntion of the analogue output.

Operational Status
The operational status of the transmitter is indicated by means of six LEDs which can be clearly seen from a distance.

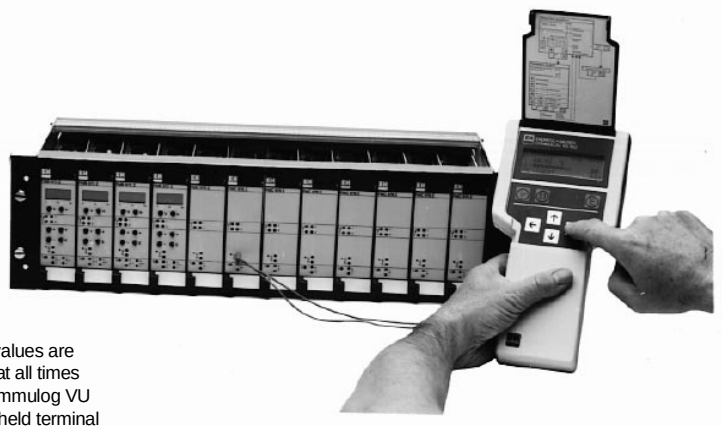
- The green and red LEDs in the central field indicate the limit relay status: red de-energised, green energised
- The green LED below lights when the Gammasilometer is communicating with the Commulog VU 260 Z handheld terminal or the ZA computer gateway
- The red LED in the diagnostics field flashes to indicate a warning or lights on fault condition.

Remote Configuration
The transmitter can also be configured by a Commulog handheld terminal or via the Rackbus.

- The Commulog is plugged into the front panel
- The data exchanged are displayed with supplementary information on the large LC-display.

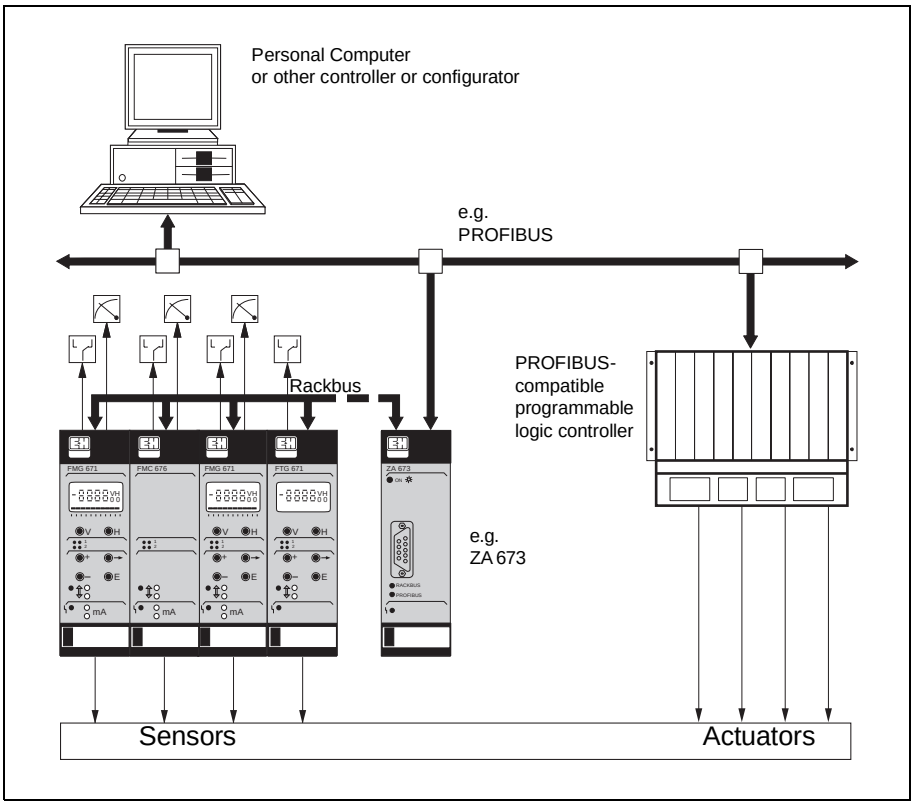
Diagnosis
The following possibilities exist for on-line diagnosis:

- an error code can be read from the matrix position V9H0: the associated text can be read with the Commulog VU 260 Z.
- the current output can be monitored at the sockets on the front panel — analogue signals can also be simulated to check connected instrumentation
- the transmitter can be connected to a personal computer via commissioning and service software, e.g., Commutool.



Measured values are accessible at all times with the Commulog VU 260 Z handheld terminal

Remote Control



The Gammasilometer FMG 671 is connected to the process control system via the Rackbus and a gateway ZA — gateways for Modbus, Profibus and FIP are available

Process Control Systems

Gammasilometer FMG 671 transmitters are easily integrated into supervisory control systems.

- Parameters are addressed over the Rackbus by the ZA gateway which presents them in appropriate format to the connected network
- Up to 64 Commutec transmitters (max. 128 measuring points) can be individually controlled and operated on-line from the control room. Each is accessed via a unique address
- Gateways and operating programs are available for
  - a variety of field buses,
  - programmable logic controllers (PLC),
  - process control systems (PCS) and
  - personal computers (PC).

The resulting dialogue between supervisory controller and subordinate transmitters makes for a safer and more flexible plant organisation.

Commutec operating programs provide an overview of the process variables for small and medium-sized plants

Installation

Mounting

Racksyst plug-in cards must be installed outside explosive hazardous areas in a rack or protective housing. Endress+Hauser can provide the following alternatives:

- 19" rack (84 HP wide) for mounting up to 12 transmitters in the control room
- Half 19" wide field housing with protection IP 65 for five 7 HP transmitters and a power supply unit
- Monorack II housing (7 HP) for single or multiple mounting on a local control panel.

Monorack II housing

Field housing

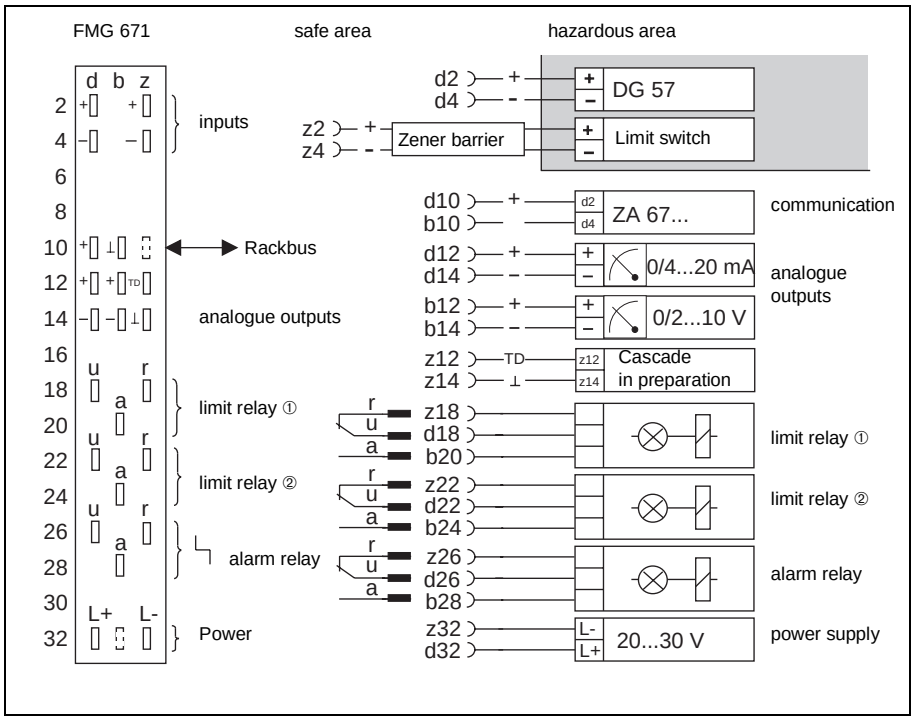
Detector Connection

- Use two-core installation cable, max. resistance 25 Ω per core
- If electromagnetic interference is to be expected: use screened cable, ground screen at the detector end.
- Note local regulations when laying cable in hazardous areas.

Connection of Instrumentation

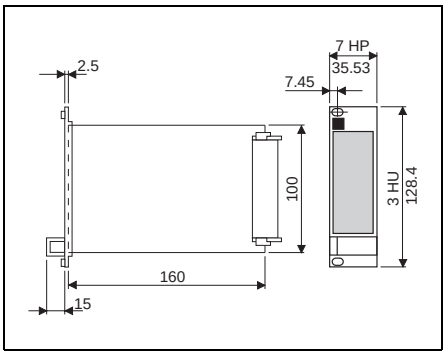
The negative terminals of the output signals and 24 V supply are connected to the circuit zero of the Gammasilometer.

- For instruments with a non-isolated input (eg. HTA 470 Z): only one instrument can be directly connected to the current output
- Several instruments can be connected to the voltage output in parallel, if their potentials are all related to the negative terminal of the 24 V supply
- There is no restriction on potential-free instruments, except for the minimum or maximum load.



Pin assignment diagram for female connector

Technical Data



Dimensions in mm of the Gammasilometer FMG 671 Racksyst card

1" = 25.4 mm

Construction
- Design: 19", 7 HP, Racksyst II* plug-in card to DIN 41 494 (Europa card)
- Front panel: black synthetic with blue field inlay, grip and markings
- Ingress protection (DIN 40 050):
  Front panel IP 20
  Card IP 00
- Dimensions: see diagram
- Weight: approx. 0.3 kg
- Multipoint plug: conforming to DIN 41 612, Part 3, Type F (25-pole)
  - Coding pins in positions 2 and 8
  - Rack installation kit 25/2

Environment
- Operating temperature: 0 °C...+70 °C
  Storage temperature: –25 °C...+85 °C
- Climatic class to DIN 40 040: KSE
- Vibration test, e.g. to GL, DNV, LR
  f = 2.0 Hz to 13.2 Hz; a = ± 1 mm
  f = 13.2 Hz to 100 Hz; 0.7 g
- Electromagnetic compatibility to
  EN 50 081-1 — radiation
  EN 50 082-2 — immunity
  and NAMUR recommendations

Electrical Connection
- Power supply: 24 V DC (20 V…30 V); residual ripple 2 V_{pp}, within tolerance
- Supply current: max. 160 mA
- Power consumption:
  max. 3.8 W at 24 V
- Protection against reverse polarity and overloading.

Signal Inputs
Electrically isolated from the rest of the circuitry.
Protection [EEx ib] IIC,
[EEx d], [EEx de] via detector
- Input 1 for detector DG 57
- Input 2 for external limit switch, e.g. Gammapilot FTG 671, for automatic calibration correction — a Zener barrier must be used for applications in hazardous areas
  output voltage U_z at fault: max. 16.2 V
  short-circuit current I_k: max. 8 mA
- Second detector DG 57 in cascade with second Gammasilomer FMG 671 (in preparation)

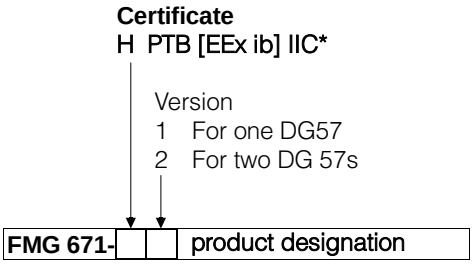
Signal Outputs
- Current output:
  0...20 mA/4...20 mA selectable,
  R_L max. 500 Ω
  - Test sockets on front panel for potential-free ammeter, $R_i \leq 10$ Ω
- Voltage output:
  0…10 V/2…10 V selectable,
  R_L min. 10 kΩ
- Limit switches
  Two independent relays each with a potential-free change-over contact.
  Switch-on and switch-off points fully adjustable
  Fail-safe mode selectable, minimum or maximum
- Fault alarm:
  relay with potential-free change-over contact
- Switching capacity:
  alternating current: max.2.5 A, max. 250 VAC, max. 600 VA at cos φ> 1, max. 300 VA at cos $\varphi \geq 0.7$
  direct current: max. 100 VDC, max. 100 W
- Rackbus: Baudrate 19 200 bits/s, 2-core cable, bidirectional

Certificates
- Intrinsic safety: [EEx ib] IIC
  PTB No. Ex-93.C.2145 X
- [EEx d ib], [EEx d], [EEx de]
  dependent upon detector DG 57
  PTB No. Ex-85/2051

*Type II Racksyst cards cannot be installed in Type I Monorack housings

Product Structure

Gammasilometer FMG 671



* [EEX d ib] IIC, [EEx de] IIC, [EEx d] IIC are determined by DG 57 detector

Supplementary Documentation

- ☐ Gammasilometer, Gammapilot System Information SI 016F/00/e
- ☐ QG 020/100 Source Containers Technical Information TI 194F/00/e
- ☐ DG 57 Scintillation Counters Technical Information TI 180F/00/e
- ☐ Gamma Radiation Sources Technical Information TI 213F/00/e
- ☐ Gammasilometer FMG 671 Operating Instructions BA 133F/00/e
- ☐ Racksyst planning hints for rack-mounting or Racksyst field housings and self-adhesive connection schematics
- ☐ Monorack II System Housing Technical Information TI 183F/00/e
- ☐ Commulog VU 260 Z Handheld Terminal Technical Information TI 140/00/e
- ☐ ZA 672 Modbus Gateway Technical Information TI 148/00/e
- ☐ ZA 673 PROFIBUS Gateway Technical Information TI 162F/00/e
- ☐ ZA 674 FIP Gateway Technical Information TI 167F/00/e
- ☐ Commutec Operating Program Technical Information TI 113/00/e

Endress+Hauser
GmbH+Co.
Instruments International
P.O. Box 2222
D-79574 Weil am Rhein
Germany

Tel. (0761) 975-02
Tx 773926
Fax (0761) 97534 5

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