Technical
Information
TI 177F/00/en

Radiometric Level Measurement *gammapilot FTG 671*

Non-invasive, radiometric limit detection
Intrinsically safe signal circuit [EEx ib] IIC / ATEX II (2) GD
For scintillation or Geiger-Müller detector

The Gammapilot FTG 671 transmitter is a 19" plug-in card, shown here in Monorack II housing

Application

The Gammapilot FTG 671 transmitter is designed for

- non-invasive, level limit detection

in containers - mixers, reactors, hoppers, silos, tanks - with inflammable, abrasive, poisonous and aggressive bulk material and liquids, e.g. in acid tanks, boilers, cement silos, ballast hoppers, cyclones, cupolas, rotary furnaces etc.. Thanks to the fact that the measuring system is fitted externally, it also finds application in the food processing industry.

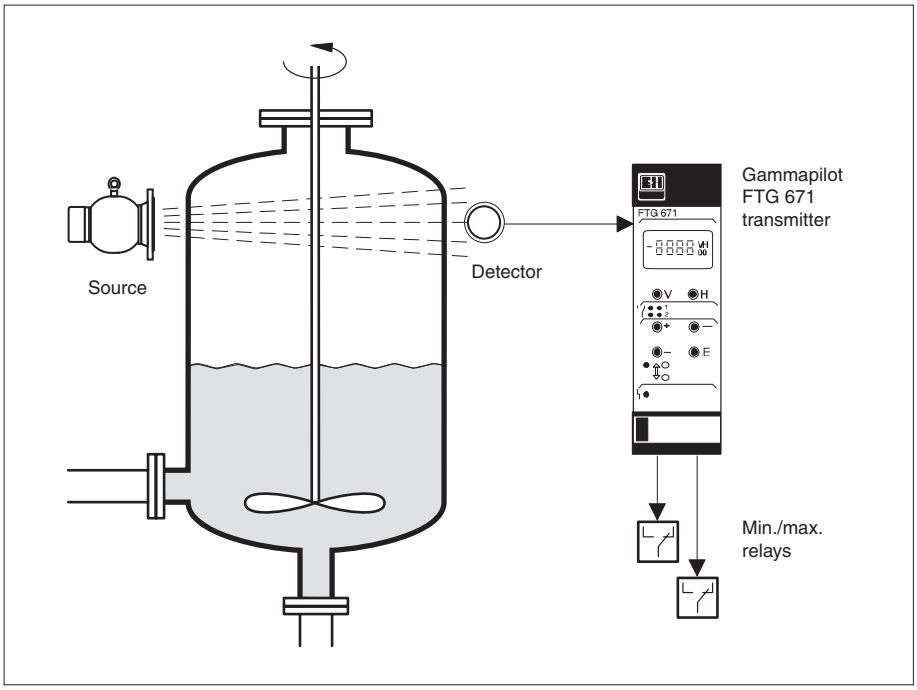
Gammapilot transmitters may also be used for applications in explosion hazardous areas, and possess intrinsically-safe sensor circuits conforming to EEx ib IIC, or EEx d IIC, EEx de IIC depending on the detector.

Features and Benefits

- Suitable for scintillation detector DG 57 or Geiger-Müller counters DG 17 or DG 27
- Uses lowest possible source activity with DG 57/100 mm or longer
- Digital signal transmission
  - Interference-free function with two-core installation cable up to 1000 m
- Intrinsically safe sensor circuits
  - Ex-protection withoutZener barriers approved as overspill protection (VBF, WHG Germany) and for use in explosion hazardous areas
- Simple operation with parameter matrix
  - Uniform handling as for all Commutec transmitters
- Practical background functions
  - Automatic compensation of source decay
  - Automatic adjustment of switch point
- Commutec transmitter
  - Simple connection to automatic systems via Rackbus
  - Up- and download of data

Endress+Hauser
The Power of Know How

Measuring System



Standard level detection application showing the arrangement of the system components source container, detector and transmitter

Measuring System
A working system for level limit detection comprises:

- Gammapilot FTG 671 transmitter,
- QG 020 or QG 100 source container with Co 60 or Cs137 gamma source
- DG 17, DG 27 Geiger-Müller counter or DG 57 scintillation counter.

Scintillation Counter DG 57
Most measurement systems use the DG 57 scintillation counter, thus ensuring:

- highest sensitivity
- with lowest source strength.

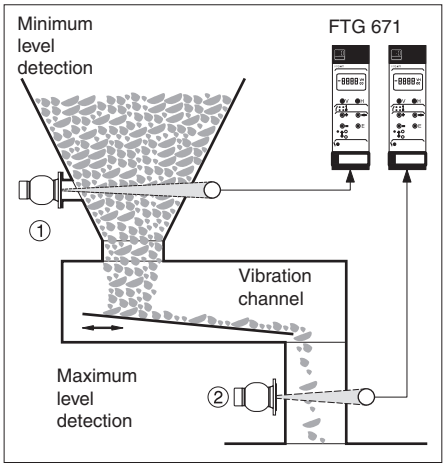
Endress+Hauser have many years of experience with rod scintillation counters and the new DG 57/100 mm counter has been specially developed for limit detection. Sensitivity can be further increased by using the DG 57/ 400 mm or longer.

Signal Input Circuit
The Gammapilot supplies the power to the DG… detector and, depending on type, the detector returns an interference-free pulse frequency or pulse code modulated countrate signal. The intrinsically safe signal input is electrically isolated from the transmitter supply and the outputs.

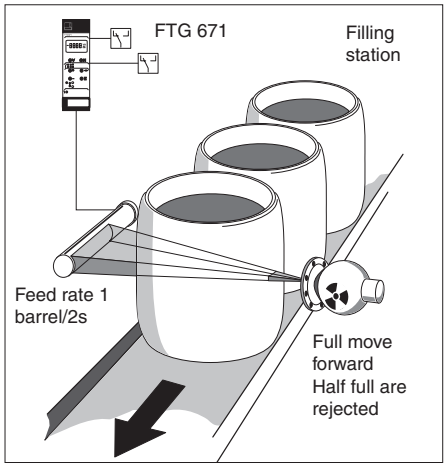
Output Signals
The Gammapilot FTG 671 has two limit relays which can be operated with freely adjustable hysteresis independently of each other in minimum or maximum fail-safe mode.

Self-Monitoring Function
The Gammapilot FTG 671 continuously monitors all signal lines. On fault condition:

- An alarm relay with potential-free changeover contact de-energises
- In default condition the limit relays also de-energise.

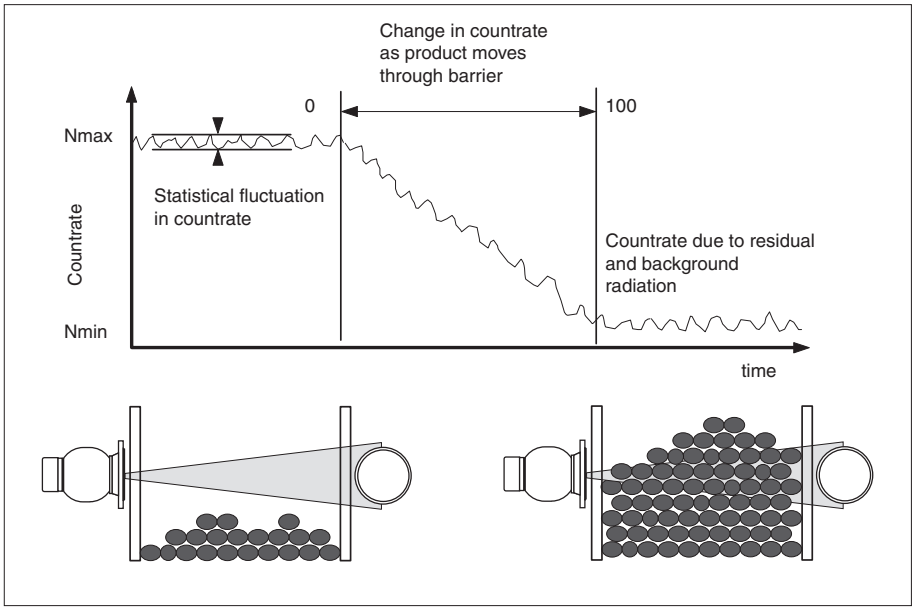


Conveying limestone
Gamma radiation barriers control the drying process



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

Measurement Principle



Principle limit detection by gamma radiography

Gamma-Ray Absorption

Radiometric level measurement relies on the fact that gamma rays are absorbed as they penetrate a material. The attenuation of the radiation is dependent upon the density ρ, the thickness d of the material as well as the linear absorption factor μ. This in turn is dependent on the material and gamma source. The attenuation is calculated from the formula

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

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

Limit Detection

For limit detection μ, and d are constants and the detected radiation level depends upon the presence or not of the penetrated material:

- The countrate is at a maximum when the path to the detector is completely free and
- at a minimum when all the radiation has to travel through the material and is attenuated.

The maximum and minimum countrates N_{max} and N_{min} are obtained when the transmitter is calibrated, whereby their dependency is given by:

$$N_{min} = N_{max}\, e^{-\mu \cdot \rho \cdot d}$$

The switch points can be set anywhere within these two countrates, which are normalised to produce the end values 0 and 100.

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. The variance, i.e. the degree of variation between measurements, depends upon the time interval chosen. The precision of the measurement depends on the chosen confidence level - 1σ, 2σ or 3σ. For a countrate of N pulses per second:

- $\sigma = \pm \sqrt{N}$; 68.28 % confidence level
- $2\sigma = \pm 2 \sqrt{N}$; 95.48 % confidence level
- $3\sigma = \pm 3 \sqrt{N}$; 99.74 % confidence level

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

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

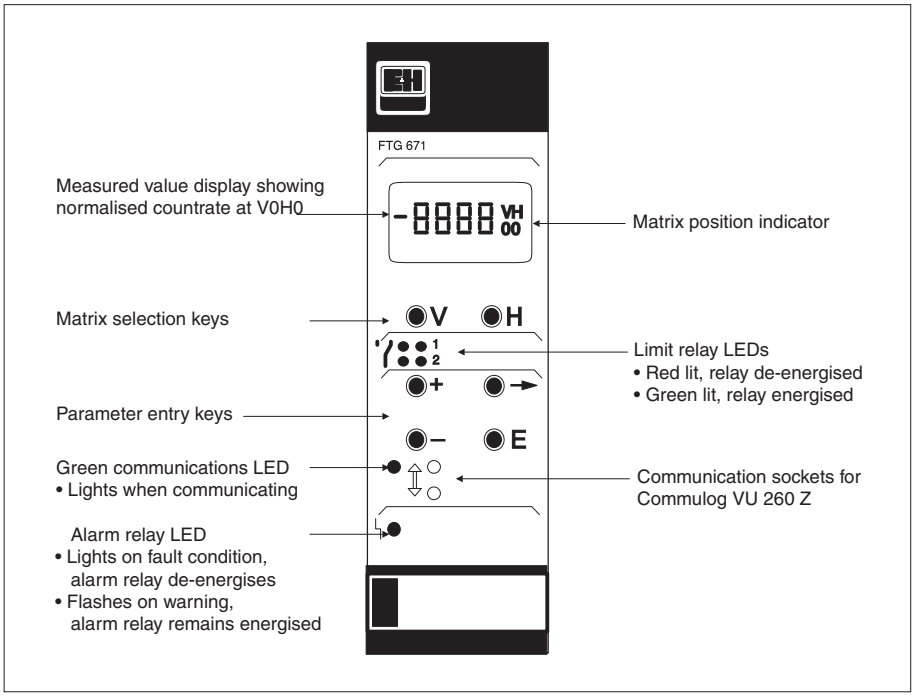
For limit switching the integration time corresponds to the response time of the relay.

Background Functions

The Gammapilot FTG 671 is equipped with a number of background functions which ensure accurate and reliable limit switching. Thus, for example, the statistical fluctuations in countrate and decay of the gamma source described above are accounted for without any action on the part of the operator.

After calibration, the FTG automatically sets the switch points to preset values. It warns the operator if incorrect limits are entered, and when the activity of the source is no longer sufficient for reliable switching.

Operation



Front panel of Gammapilot FTG 671 showing configuration and display elements

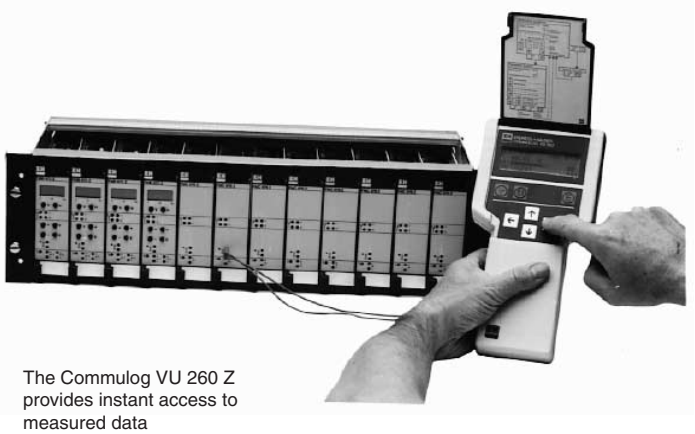
Configuration at Front Panel
Gammapilot FTG 671 transmitters can be configured at the front panel.

- 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 display of normalised countrate, 0-100, is available during operation

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 in plain language on the large LC-display.

When the Commulog is unplugged, Racksyst operation mode is selected automatically.



The Commulog VU 260 Z provides instant access to measured data

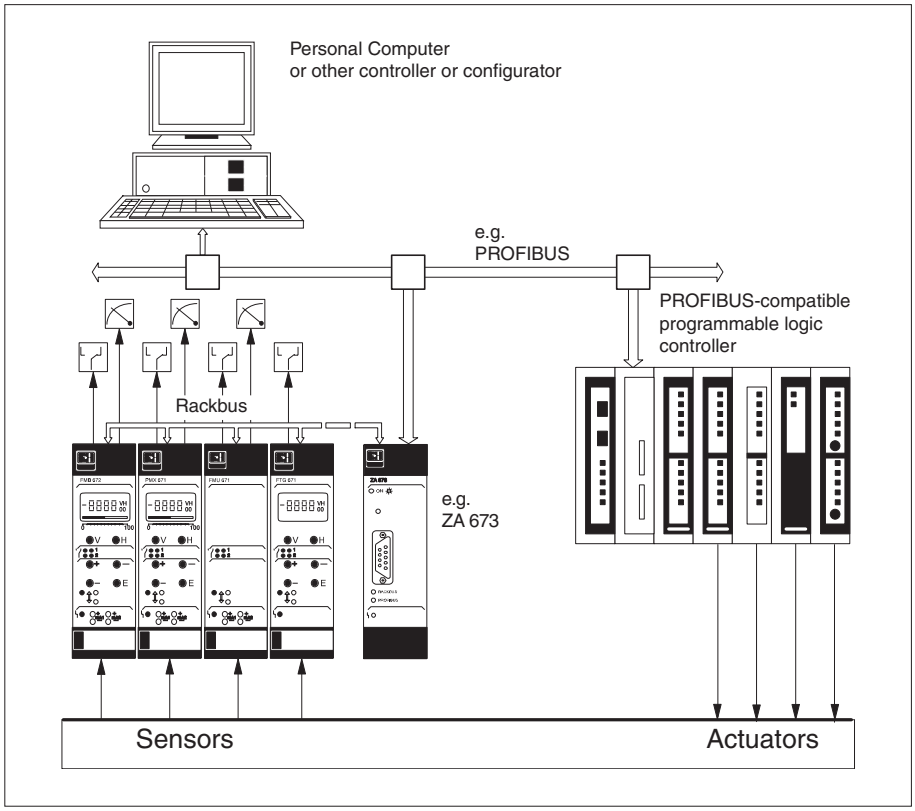
Operational Status
The operational status of the transmitter is indicated by means of six LEDs which can be clearly seen from a distance.

- 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 Gammapilot is communicating with the Commulog VU 260 Z handheld terminal or the ZA 67… computer gateway
- The red LED in the diagnostics field flashes to indicate a warning or lights on fault condition.

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 transmitter can be connected to a personal computer via commissioning and service software, e.g., Commutool.

Remote Control



The Gammapilot FTG 671 communicates with a supervisory controller via the two-core Rackbus and a ZA 67… computer gateway
Three possibilities exist: Modbus, Profibus or FIP.

Process Control Systems
Gammapilot FTG 671 transmitters are easily integrated into supervisory control systems.

- Parameters are addressed over the Rackbus by the ZA 67… 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 fieldbuses, 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 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.

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.

Field housing

Monorack II housing

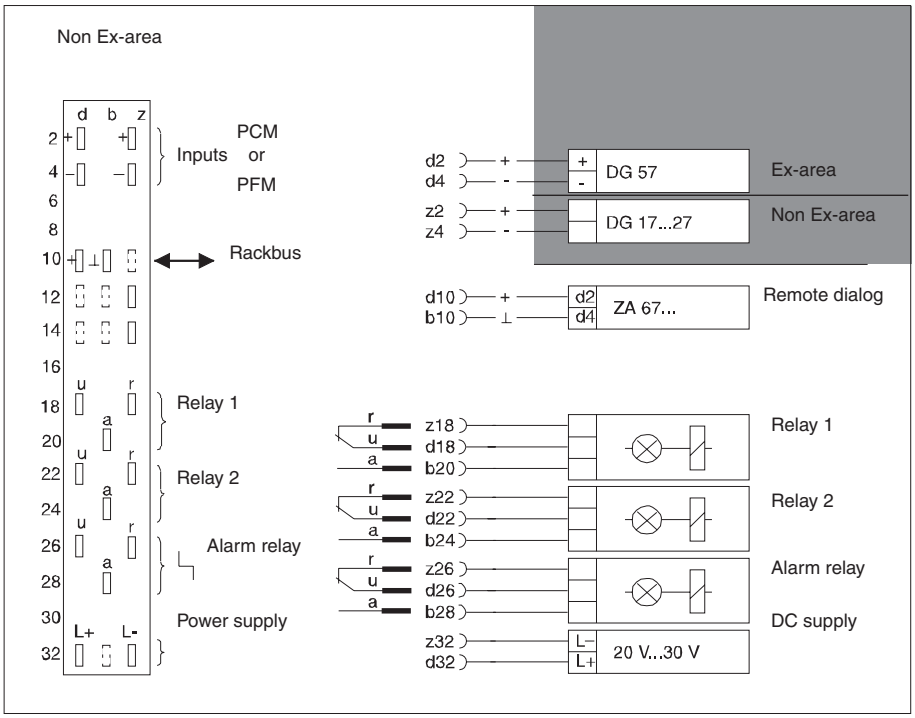
Detector Connection

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

Connection of Instrumentation

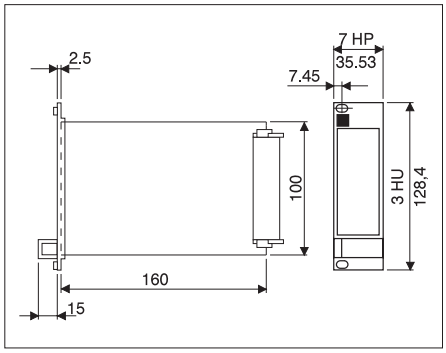
The circuit zero of the Gammapilot is connected to the negative terminal of the 24 V supply. One of two electrically isolated signal inputs can be used:

- Inputs d2 and d4 are for PCM signals from DG 57 scintillation counters
- Inputs z2 and z4 are for PFM signals from Geiger-Müller counters DG 17 resp. DG 27.



Connection diagram for Gammapilot FTG 671

Technical Data



Dimensions in mm of plug-in card
1" = 25.4 mm

Environment
- Operating temperature: 0 °C...+70 °C
- Storage temperature: -20 °C...+85 °C
- Climatic class to DIN 40 040: KSE
- Electromagnetic compatibility (EMC): Emitted interference to EN 61326; Class A equipment; Immunity to interference to EN 61326; Annex A (industry sector) and NAMUR EMC Recommendation (NE 21)

Construction
- Design: 19", 7 HP, Racksyst II* plug-in card to DIN 41 594 (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 41612, Part 3, Type F (25-pole) Coding pins in positions 2 and 7

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

Electrical Connection
- Power supply: 24 V DC (+6 V…-4 V);
  - residual ripple 2 V, within tolerance
- Supply current: max. 135 mA
- Power consumption: max. 3.3 W at 24 V, max. 4.0 W at 30 V
- Signal inputs: Electrically isolated from the rest of the circuitry.
  - Protection EEx ib IIC, EEx d IIC or EEx de IIC for DG 57. Non-Ex for DG17/27.

Relay Outputs
- Two independent limit relays each with a potential-free change-over contact
- Freely selectable switchpoint and hysteresis
- Fail-safe mode: maximum or minimum selectable
- Third alarm relay with potential-free change-over contact for fault indication
- Max. switching capacity:
  - 2.5 A, 250 VAC,
  - 300 VA (cos φ= 0.7),
  - 600 VA (cos φ= 1)
  - or 100 VDC, 100 W

Detectors
- DG 57 rod scintillation counter
- DG 17, DG 27 Geiger-Müller counters

Certificates
- Explosion protection: [EEx ib] IIC / ATEX II (2) GD
  PTB No. Ex-93.C.2145 X
- Explosion protection: EEx d ib IIC, EEx d IIC and EEx de IIC, dependent upon detector DG 57
  PTB No. Ex-85/2051
- Overspill protection (Germany)

Product Structure

Gammapilot FTG 671

Certificate
F [EEx ib] IIC*/ATEX II (2) G
Approval for use as overspill protection (Germany)

Version
A Single measurement point

FTG 671-			product designation

EEx d ib IIC, EEx de IIC, EEx d IIC are determined by the DG 57 detector
Non-Ex for DG 17/27

Supplementary Documentation

- ❑ Radiometric measurement
  Applications in all industries
  Practical know-how PK 001F/00/en
- ❑ Gammapilot, Gammasilometer
  System Information SI 014F/00/en
- ❑ Gammapilot FTG 671
  Operating instructions BA 082F/00/en
- ❑ Racksyst planning hints for rack-mounting or Racksyst field housings and self-adhesive connection schematics
- ❑ Monorack II System Housing
  Technical Information TI 183F/00/en
- ❑ QG 020/100 Source Containers
  Technical Information TI 264F/00/en
- ❑ QG 2000 Source Container
  Technical Information TI 346F/00/en
- ❑ DG 57 Scintillation Counters
  Technical Information TI 180F/00/en
- ❑ Gamma radiation source
  Technical information TI 213F/00/en
- ❑ Commulog VU 260 Z Handheld Terminal
  Technical Information TI 140/00/en
- ❑ ZA 672 Modbus Gateway
  Technical Information TI 148/00/en
- ❑ ZA 673 PROFIBUS Gateway
  Technical Information TI 162F/00/en
- ❑ ZA 674 FIP Gateway
  Technical Information TI 167F/00/en
- ❑ Commutec Operating Program
  Technical Information TI 113/00/en

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

Tel. (0 76 21) 9 75-02
Fax (0 76 21) 9 75-3 45
http://www.endress.com
info@ii.endress.com

Endress+Hauser
The Power of Know How

05.02/PT1

TI 177F/00/en/06.03
SL/CV8.0