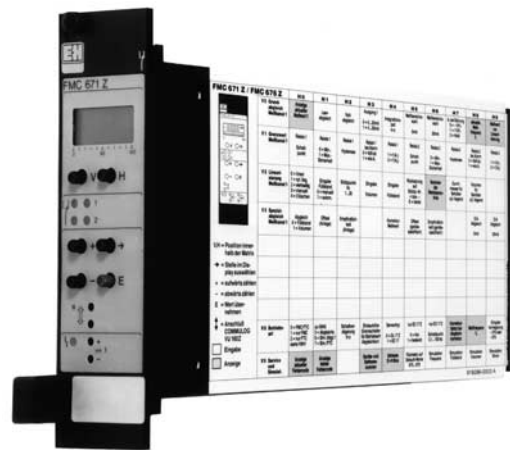# Level Measurement
silometer FMC 671 Z

**For liquids and bulk solids.
Operates in dialogue with a computer as well as
manual remote operation. Direct control and
two-point control by integral setpoint controllers.**

Silometer FMC 671 Z
Calibration elements for on-site dialogue,
LCD for measurements and parameters
entered, mode indication of setpoint
controllers and test sockets on front panel.

Application

- Continuous level measurement using
  capacitance sensors in tanks or silos
  containing liquids or bulk solids
- Continuous level measurement with
  hydrostatic sensors Deltapilot S in
  tanks containing liquids
- Limit detection using capacitance
  sensors in tanks or silos containing
  liquids or bulk solids
- Limit detection with vibrating probes
  Liquiphant FDL 30/31 in tanks
  containing liquids
- Combination of continuous
  measurement and limit detection
- Continuous level measurement in
  materials of changing characteristics
  providing an automatic correction of
  calibration to compensate for changes
  in dielectric constant (capacitance
  measurement) or density (hydrostatic
  measurement).

The two integral setpoint controllers are
fully programmable to provide direct
pump control (adjustable hysteresis)
and/or additional min./max. alarm.

Features and Benefits

- Intrinsically safe signal input
  [EEx ia] IIC or IIB allows use with
  sensors operating in
  explosion-hazardous area Zone 0
- A family of sensors allows level
  measurement in liquids and bulk
  solids under extreme conditions, e. g.:
  – high pressure
  – high temperature
  – condensation
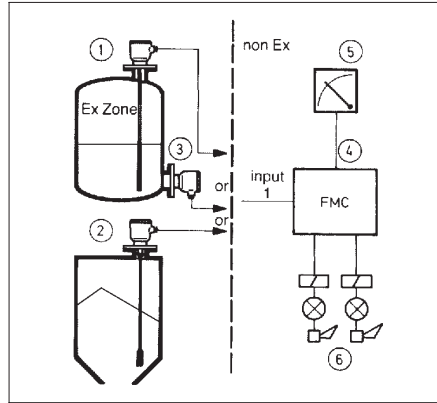 – aggressive material
  – heavy solids.

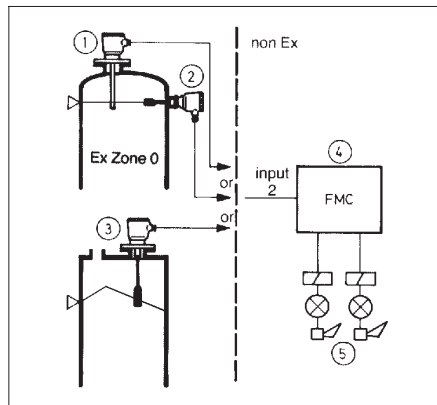# Endress+Hauser
The Power of Know How

Measuring System

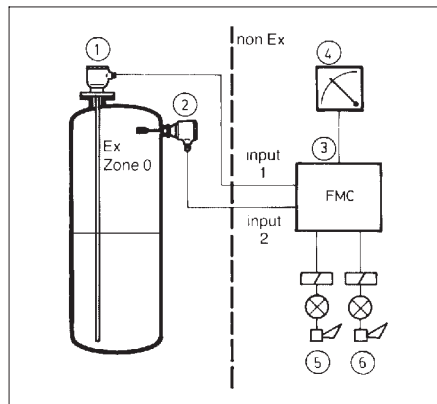The following figures show examples of complete measuring systems.

① Capacitance rod probe with electronic insert EC 37 Z or EC 47 Z
② Capacitance rope probe with electronic insert EC 37 Z or EC 47 Z
③ Hydrostatic sensor Deltapilot S with electronic insert FEB 17
④ Silometer FMC…
⑤ Analog output current and voltage signals
⑥ Two limit signals from the continuous measurement, with adjustable hysteresis.

Continuous level measurement in a liquids tank or bulk solids silo
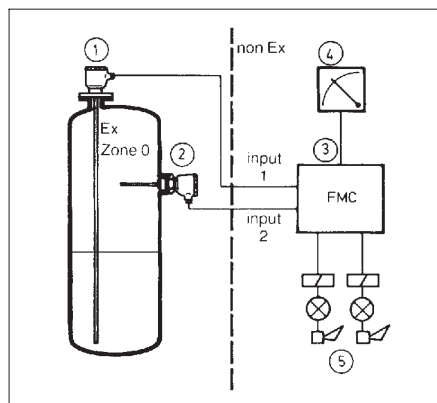

① Capacitance rod probe with electronic insert EC 17 Z
② Vibrating probe Liquiphant FDL 30/31
③ Capacitance rope probe with electronic insert EC 17 Z
④ Silometer FMC…
⑤ Two setpoint signals, same switchpoint, but min./max. mode for each relay independently selectable. One common adjustable switching delay.

Limit detection in a liquids tank or bulk solids silo

① Capacitance probe with electronic insert EC 37 Z or EC 47 Z for continuous level measurement
② Vibrating probe Liquiphant FDL 30/31 for maximum limit detection
③ Silometer FMC…
④ Analog output signals current and voltage, proportional to level or contents
⑤ Setpoint signal, fully adjustable for the continuous measurement, with adjustable hysteresis
⑥ Maximum limit detection.

Combination of continuous level measurement and limit detection

① Capacitance probe with electronic insert EC 37 Z or EC 47 Z for continuous level measurement
② Capacitance probe with electronic insert EC 17 Z for calibration correction, installed at a point that the product level passes most frequently
③ Silometer FMC…
④ Analog output signals current and voltage
⑤ Two setpoint signals from the continuous measurement, adjustable switch hysteresis.

Continuous level measurement with automatic calibration correction (example 1)

Measuring System (continued)

Continuous level measurement with automatic calibration correction (example 2)
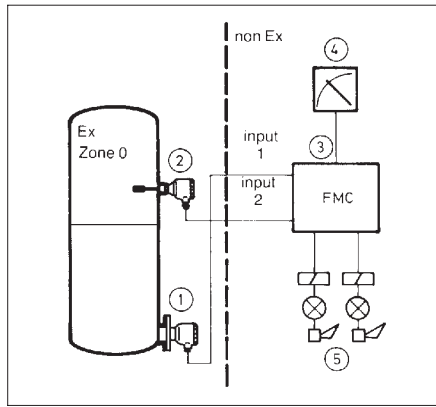
① Hydrostatic sensor Deltapilot S with electronic insert FEB 17 for continuous level measurement
② Vibrating probe Liquiphant FDL 30/31 for calibration correction, installed at a point that the product passes most frequently
③ Silometer FMC…
④ Analog output signals current and voltage
⑤ Two setpoint signals from the continuous measurement, adjustable switch hysteresis.

Measuring Principle

Inputs

The sensors for continuous measurement and the sensors for limit detection are each connected to the inputs by unscreened two-wire cable. The Silometer supplies the electronic inserts (transmitters) in the sensor. An interference-free PFM signal, proportional to level, is received. For limit detection with the Liquiphant vibrating fork probes, a frequency change indicates that the desired level has been reached.

Both intrinsically safe signal inputs (input 1 for continuous measurement, input 2 for limit detection) are galvanically isolated from the supply and outputs. By coupling both inputs, automatic compensation of the continuous measurement mode is possible. This means no re-calibration is required on changing material characteristics.
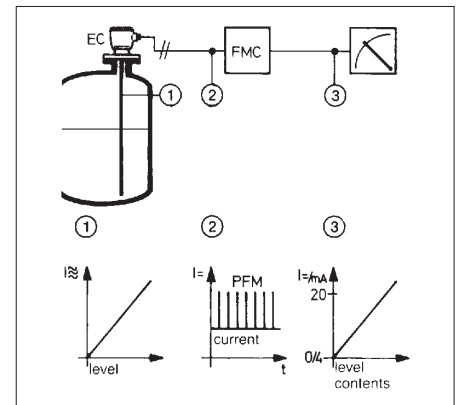
PFM signal between EC… and Silometer FMC…

Special Functions for Continuous Measurement

• *Linearisation of Vessel Shape*
The vessel curve describes the functional relationship between the height *h* and the vessel volume *V*. This is represented on the Silometer FMC… by 2…30 benchmarks. These points are determined either empirically or by the vessel manufacturer. A known curve can also be entered into the instrument. The most common curve (for a cylindrical, horizontal tank) is also programmed into the instrument.

Linearisation of vessel shape

3
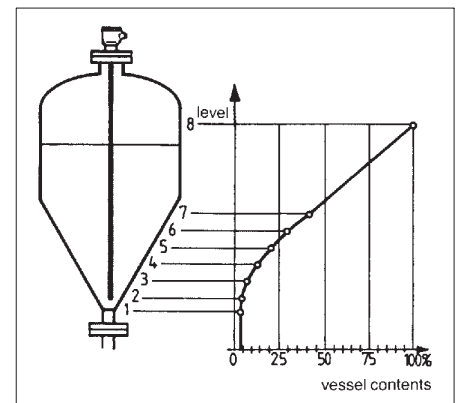
Measuring Principle (continued)

- *Automatic Calibration Correction for Changing Vessel Contents*
 The zero of the level curve is determined by empty calibration. When the level reaches the correction probe (at 60% in the diagram), the reference point K1 and therefore the gradient is determined.
  If the dielectric constant or the density of the material increases, then the slope becomes less pronounced. Thus, K1 is reached on filling the vessel, before the level has reached 60%. Indication remains constant on rising level until the level reaches the correction probe. Point K3 is then fixed, and the PFM signal is corrected accordingly.
  This correction takes place both on rising and on falling levels.

Calibration correction:
① Capacitance probe or Deltapilot S for level measurement
② Capacitance probe or Liquiphant for calibration correction
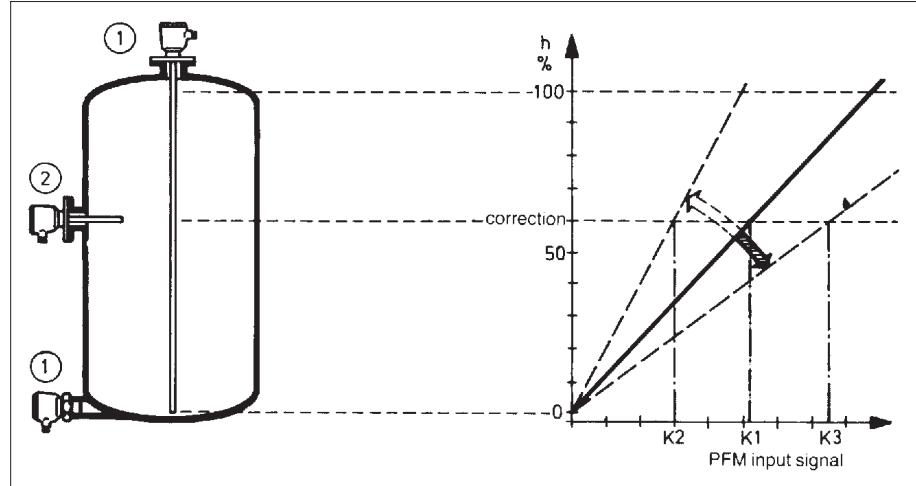
Output Signals

- The *analog output signals* are standardised 0…20 mA or 4…20 mA current and 0…10 V or 2…10 V voltage.
  Depending on calibration, output signals are proportional either to the level or to the contents of the vessel. The linearisation curve for contents indication on any vessel can be programmed easily.
  In the event of failure, the output signal may be programmed to drive −10% or +110%, or hold the last measurement .
- *Two setpoint controllers* each with a potential-free change-over contact are integral to the Silometer. Each can be operated in minimum or maximum fail-safe mode with adjustable hysteresis. This allows selection for full and empty alarm and also two-point control. The setpoint controllers are individually energised either by input 1 (continuous measurement) or by input 2 (limit detection).
- The *fault alarm* also has a potential-free change-over contact. Should a fault occur, then the relay de-energises.
- Sockets are located on the front panel to connect to the Commulog VU 260 Z for on-site programming and for direct access to the current outputs.

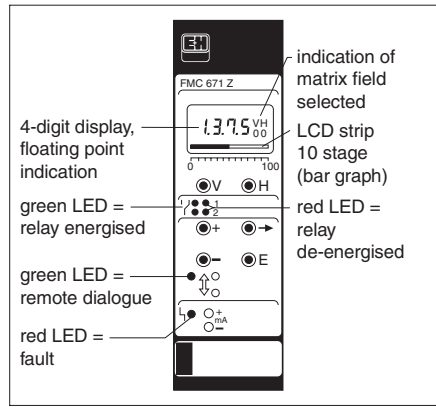## Measuring Signal and Function Indication on the Instrument

- The LCD indicates the level or contents of the tank or silo either in per cent or preset engineering units. By selecting the appropriate matrix field, other data may also be displayed, e. g. frequency of the PFM signal input and in the case of a fault, its code number.
  Similarly, the programmed data, such as the required level for an output signal 0 mA and 20 mA, processing time, switchpoints and hysteresis of setpoint controllers, linearisation values for contents measurement, offset and sensor sensitivity with electronic insert or the complete measuring system, is stored and may be called up.
- The bar display (10 part LCD) below the digital readout indicates actual percentage of full scale achieved.
- Clear display of the matrix field selected prevents error when reading the display or entering data.

Measuring Principle (continued)

Measuring signal and function indication on Silometer FMC 671 Z

- 4-digit display, floating point indication
- indication of matrix field selected
- LCD strip 10 stage (bar graph)
- green LED = relay energised
- red LED = relay de-energised
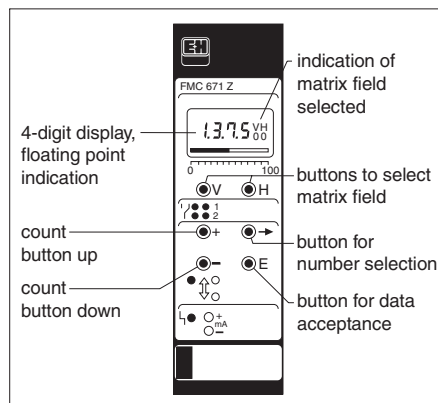- green LED = remote dialogue
- red LED = fault

- The green and red LEDs in the centre of the front panel indicate whether the setpoint controller relays are energised or de-energised. The operator can see at a glance whether a critical situation has occurred (too full or too empty).
- The green LED below indicates when the Silometer is operating in dialogue with the Modbus gateway ZA 672 or Commulog VU 260 Z.
- Fault or warning is indicated by the red LED ⌐. In fault conditions, the LED lights up, and it flashes to give a warning. Warning is given e. g. on false operation.

Operation

Parameters can be set on the Silometer FMC 671 Z from the front panel using only 6 pushbuttons and a table (operating matrix). The operating matrix is in two languages and is mounted within the instrument to one side. The matrix field required is selected using the V and H buttons whilst the other buttons allow data to be entered. (See operating instructions for further information.)

Operating elements on Silometer FMC 671 Z

- 4-digit display, floating point indication
- indication of matrix field selected
- buttons to select matrix field
- count button up
- button for number selection
- count button down
- button for data acceptance

- Calibration for *continuous measurement* can be carried out at any level and in any sequence: empty calibration at any level between 0% and 40%, full calibration between 60% and 100%. This eliminates the need to completely empty and fill the vessel for calibration purposes.
- Calibration for continuous measurement *with automatic calibration correction* is even simpler. Only empty calibration needs to be carried out. The Silometer calculates the full calibration automatically (gradient of curve) as soon as the level reaches the correction probe.
- Calibration for *limit detection* can be carried out easily by pushbutton with the probe covered or free.
- *On-site calibration* of the Silometer FMC 671 Z using the Commulog VU 260 Z is straigthforward, since data exchange takes place by dialogue with the FMC, giving additional information on the large annotated display of the VU 260 Z.
- The Silometer with its integrated microprocessor is *self-checking* from the PFM input signals to the output.

Installation

The Racksyst card must be installed outside the explosion-hazardous area in a rack or protective housing. E+H offers:
- a 19" rack for control panel mounting, housing up to 12 FMC cards
- a ½19" remote housing conforming to IP 65 protection
- the Monorack housing (7 HP) for individual card mounting in the control panel.

Planning directions, tables and self-adhesive connection schematics to simplify rack assembly and remote housing and also installation diagrams are available on request.

Electrical Connection

Connecting Instructions

If the sensors are to be mounted in an explosion-hazardous area, then an appropriate connection strip is available from E+H. This connection strip, to DIN 41612 format F, is only partly pinned (28 pole) and conforms to the explosion protection regulations relating to spacing and creepage. It is fitted with coding pins to ensure that only a Silometer FMC 671 Z can be connected. The device exhibits good electromagnetic compatibility.

For optimal use, however, it is recommended that two-core, screened cable is used to connect the sensor (resistance up to 25 Ω per core). If possible, ground the screen at both ends. Otherwise, preferably at the sensor end. Please note regulations when laying cable in an explosion-hazardous area.

General Notes for Connecting Controllers, Limit Switches, Recorders, Indicating Instruments

- For instruments with a *non-isolated* input (e. g. 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 pole of the 24 V supply.

- Except for the minimum or maximum load, there is no restriction on *potential-free* instruments.

Connecting Signal Instruments and Control Systems to the Relay Contacts of the Limit Switches

When connecting the signal systems, note the relay mode depending on level and safety mode required.
If an instrument with high inductance (e. g. solenoid valves etc.) is to be connected to the Silometer, then a spark arrester should be fitted to protect the relay contacts.

Safety Mode for Limit Switches

Both relays may be independently operated in minimum or maximum fail-safe mode.
- *Minimum Mode:* The relay de-energises when the level falls below the switchpoint or a fault occurs.
- *Maximum Mode:* The relay de-energises when the level rises above the switchpoint or a fault occurs.

By correctly selecting the safety mode, the operator ensures that the output relays always operate in a safety mode, i. e. alarm on de-energising.

Terminal connection on the Silometer FMC… The negative pole of the 24 V supply voltage and the negative poles of the output signals current and voltage are connected to the zero point of the FMC.

6
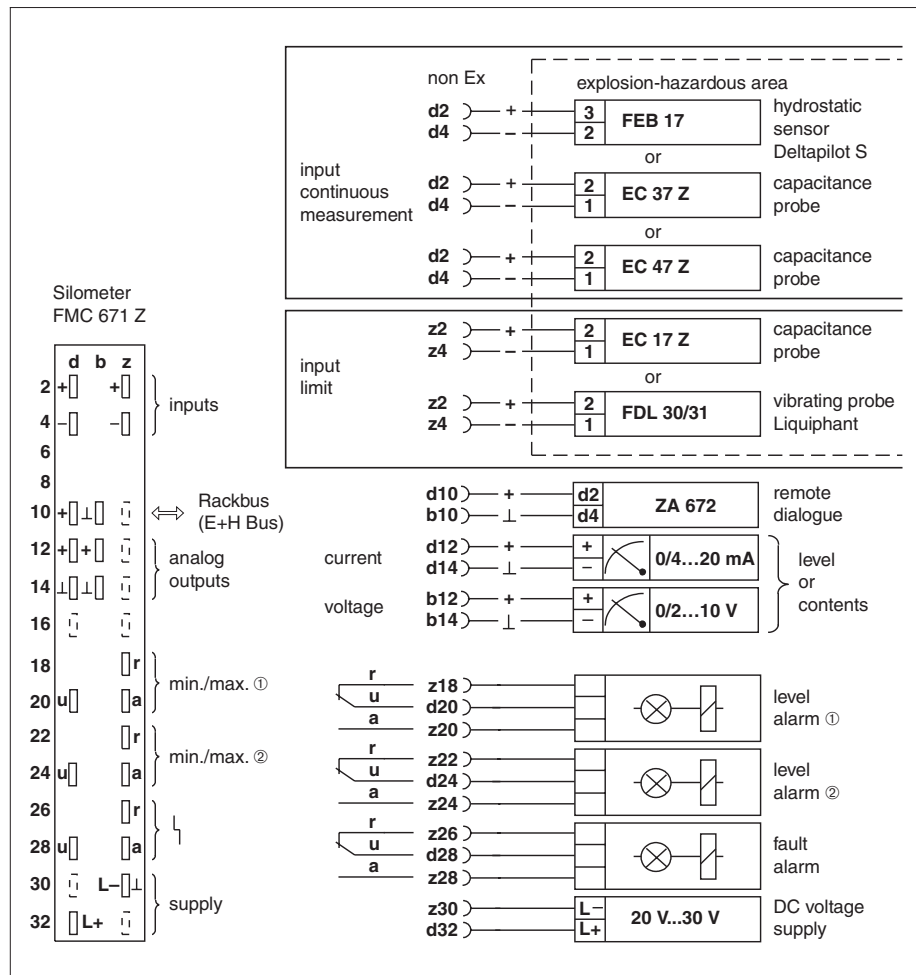
Technical Data

Mechanical construction

Design	Racksyst card to DIN 41494 (Eurocard)
Front panel	black plastic with inlaid blue area, with handle and label area
Weight	approx. 0.3 kg

Process conditions

Permissible ambient temperature	operating range 0…+70 °C, storage range –20…+85 °C
Protection type to DIN 40050	front panel IP 20, card IP 00

Electrical connection

Plug-in connection	strip to DIN 41612, part 3, format F (28 pole)
Coding pins in strip	at point 1 and 22
Supply voltage	24 V DC, tolerance +6 V, –4V
Permissible AC ripple $U_{\sim pp}$	2 V within tolerance
DC supply	approx. 90 mA, max. 125 mA, integral fine-blow fuse

Signal input: galvanically isolated from other circuits

| Explosion protection type FMC 671 Z, 676 Z	[EEx ia] IIC or IIB
Electromagnetic compatibility	Interference emission to EN 61326, Electrical Equipment Class A Interference immunity to EN 61326
Sensors for continuous measurement	capacitance probes with electronic insert EC 37 Z or EC 47 Z or Deltapilot S
Supply voltage for electronic insert	14.5…15.5 V
Supply current	max. 22 mA
Short-circuit current	max. 95 mA continuous
Connection cable	recommended: 2-core, screened, max. 25 Ω per core
Signal transmission	pulse-frequency-modulation
Pulse current	approx. 5 mA, superimposed on supply current
Pulse width	approx. 100 µs
Transmission frequency (EC 37 Z/EC 47 Z)	range I: 0.55…2.8 kHz, equivalent to 20…355 pF range II (standard): 0.06…2.8 kHz, equivalent to 20…4350 pF

Signal output

Current output	0…20 mA, selectable to 4…20 mA, R_L max. 500 Ω
Voltage output	0…10 V, selectable to 2…10 V, R_L min. 10 kΩ
Outputs from setpoint controllers	2 independent relays each with 1 change-over contact
Switchpoints and switching hysteresis	infinitely adjustable
Safety mode	minimum or maximum, switchable
Switching	max. 2.5 A, max. 250 V AC, max. 300 VA at cos φ > 0,7 max. 100 V DC, max. 90 W
Fault alarm	1 relay with potential-free change-over contact

Indication and calibration

FMC 671 Z	LCD and 6 buttons für on-site dialogue, 6 LEDs for function control

Dimensions
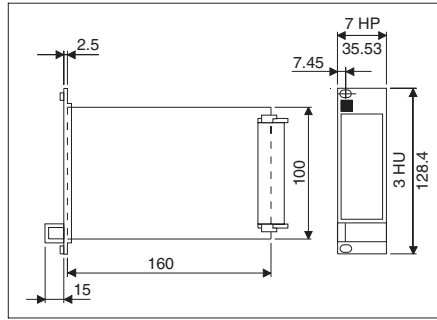
Dimensions of the
plug-in card [mm]

Accessories

❏ Commulog VU 260 Z

❏ Modbus gateway ZA 672

Supplementary Documentation

❏ Planning documentation for Racksyst racks or Racksyst remote housings and self-adhesive connection schematics (state instrument type)

❏ Monorack Protective Housing Technical Information TI 099F/00/en

❏ Electronic Inserts EC 37 Z, EC 47 Z Technical Information TI 271F/00/en

❏ Electronic Insert EC 17 Z Technical Information TI 268F/00/en

❏ Deltapilot S System Information SI 026F/00/en

❏ Deltapilot S DB 50, DB 51, DB 52 Deltapilot S DB 50 L Deltapilot S DB 53 Technical Information TI 257F/00/en

❏ EC-Type-examination certificate TÜV 00 ATEX 1640 CE ⟨Ex⟩ II (1) GD, [EEx ia] IIC/IIB XA 110F/00/a3

❏ Electronic Inserts FEB 11/FEB 17, FEB 11 P/FEB 17 P KA 048F/00/a3

❏ Liquiphant FDL 30/31 and FDL 35/36 Technical Information TI 185F/00/en

❏ Commulog VU 260 Z Technical Information TI 140F/00/en Operating Instructions BA 028F/00/a3

❏ Modbus Gateway ZA 672 Technical Information TI 148F/00/en Operating Instructions BA 054F/00/en

❏ General information on EMC (Testing method, installation recommendations) Technical Information TI 241F/00/en

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