

# TGM 5, TGM 5-Ex

Transmitter  
for angular position

Operating instruction

42/14-34 EN

Rev. 02



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Subject to technical changes.

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## **Important Instructions**

### **They must absolutely be read and obeyed!**

Proper and safe operation of the TGM 5 (-Ex) transmitter presupposes that it is correctly transported and stored, installed and commissioned by experts and carefully operated and maintained.

Only those persons conversant with the installation and commissioning of similar equipment and who possess the necessary qualifications may work on the apparatus. They must observe the contents of this Operating Manual and the relevant safety regulations for installation and operation of electrical apparatus.

This apparatus has been designed and tested in accordance with DIN VDE 0411, Part 1, „Safety Requirements for Electronic Measuring Equipment“ and has been supplied in a safe condition. To retain the apparatus in safe condition, the safety instructions with the title „Caution“ in this Operating Manual must be observed. Failure to comply with these safety instructions can result in death, severe bodily injuries and considerable damage to the apparatus itself or to other equipment.

Should the information given in the Operating Manual prove to be inadequate at any time please consult the Technical Branch Office, subsidiary, or representative of Hartmann & Braun in your area.

The industrial standards and regulations (e.g. DIN, VDI, VDE) as well as the directives, specifications and requirements governing explosion protection (e.g. ExeV, EX-RL, VDE, DIN EN) referred to in this Operating Manual are applicable in Germany. When using this device outside the German Federal jurisdiction, the relevant specifications, standards and regulations applicable in the country where the device is used must be observed.

# Applications and description

The TGM 5 (-Ex) transmitter is used for the analogue measurement of rotational angles. It transforms the angular position into a load-independent, direct current of either 0...20 mA or 4...20 mA.

## 1 Mounting and connection

### 1.1 Parts supplied with the unit

Depending on the order, the following accessories are supplied with the TGM 5 (-Ex) transmitter:

- Flange mounting (Catalogue No.14497-4-0381226)
- Foot mounting (Catalogue No.14497-4-0381225)

### 1.2 Mounting location

The TGM 5 (-Ex) transmitter may be installed in any chosen position fixed to the rotational angle sensor. The TGM 5 transmitter must be kept within the ambient temperature range - 25 ... + 80°C. To prevent humidity build-up the cable must be laid in a slope.

The **TGM 5-Ex** transmitter is approved for intrinsic safety classes EEx ib IIC T6 and EEx ib IIC T4. Mounting in hazardous areas of Zones 1 and 2 is possible with

- ambient temperatures up to 40°C for temperature class T6
- ambient temperatures up to 70°C for temperature class T4.

## 1.3 Mounting

(See Figs. 1, 2, and 3)

### Caution

**When mounting the TGM 5-Ex transmitter, the provisions of the regulation governing electrical apparatus in hazardous areas (ExV), the provisions of DIN VDE 0165 for the installation of electrical apparatus in hazardous workshops and the certificate of conformity must be observed.**

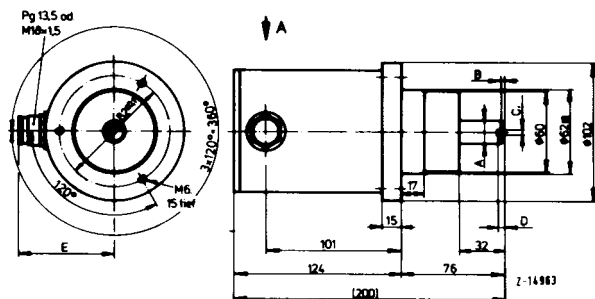
The red point at the shaft and case marks the position of the zero. For a coarse adjustment of the transmitter, case or coupling must be rotatable.

1. Fasten transmitter with three screws (M6 x 15).

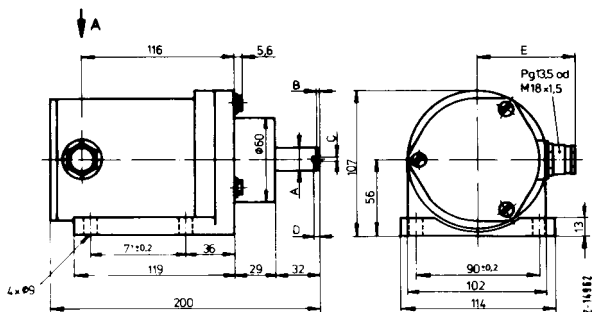
### Caution

**The shafts of both units may only be joined via a coupling which is free of both forces and play. This coupling must permit a certain degree of movement in a longitudinal direction and perpendicular to the axis as well as an angular offset.**

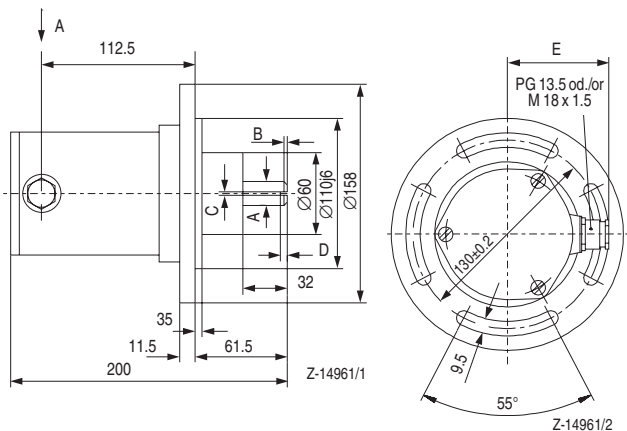
2. The TGM 5 (-Ex) transmitter is to be mounted onto the rotational angle sensor in such a way that the shafts of both units are aligned as exactly as possible.



**Fig. 1** Dimensional drawing of TGM 5 (-Ex) (dimensions in mm)



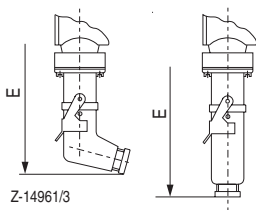
**Fig. 2** Dimensional drawing of TGM 5 (-Ex) (dimensions in mm) with foot mounting



**Fig. 3** Dimensional drawing of TGM 5 (-Ex) with flange mounting (dimensions in mm)



View A  
Version with plug  
connection



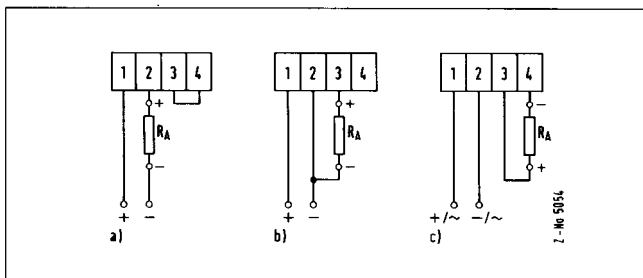
	TGM 5	
	friction bearing	ball bearing
A	$\varnothing 19_{f8}$	$\varnothing 10_{f8}$
B	$1 \times 45^\circ$	$0.5 \times 45^\circ$
C	$3 \pm 0.1$	—
D	$3.5 \pm 0.1$	—

	Cable entry		Plug connection	
	Pg13.5	M 18 x 1.5	angled	straight
E	71.5	90.5	$\approx 143$	$\approx 157$

to Fig. 3

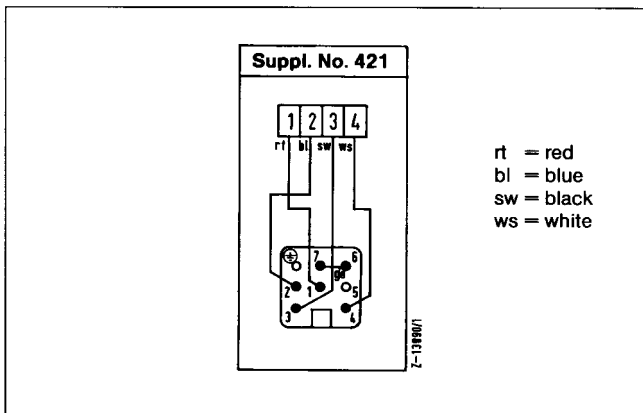
## 1.4 Connection

(See Figs. 4 and 5)



**Fig. 4** Connection diagrams

- a 2-wire circuit
- b 3-wire circuit
- c 4-wire circuit



**Fig. 5** Han 7D connector

## **Caution**

**The transmitter may only be operated at safety-low voltages with electrical isolation against higher mains voltage.**

**The transmitter will not deliver an output signal if the polarity of the supply voltage is incorrect.**

**In models without electrical isolation, the supply and output current circuits are provided with a common minus potential through internal connection (terminals 2 and 4).**

**The requirements of DIN VDE 0100 must be met when selecting line material and laying measuring and output signal lines. The provisions of DIN VDE 0165/2.91 must additionally be adhered to when connecting the TGM 5-Ex.**

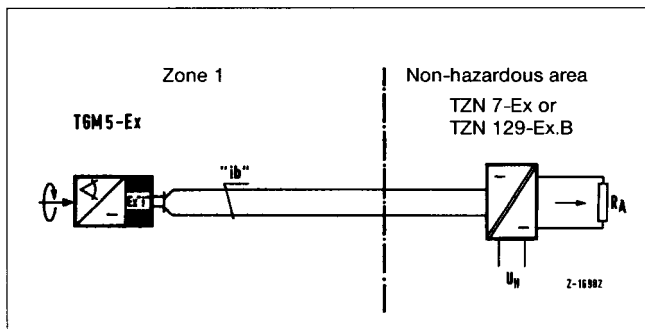
Connection:

- Screw terminals for 2.5 mm<sup>2</sup> wire
- Han 7D connector (not for TGM 5-Ex)

### ■ Connection of screw terminals

1. Determine the correct power supply for the unit from the rating plate.
2. Remove the screw using a screwdriver (blade width 5 mm) and take off the case cover.
3. Secure the wires (max. cross section 2.5 mm<sup>2</sup>) in the screw terminals with a screwdriver (blade width 3 mm).
4. Replace the case cover and fasten with screws.

The **TGM 5-Ex** transmitter must be supplied with power through a current circuit which is certified as intrinsically safe (Ex ib IIC). See Fig. 6.



**Fig. 6** An example of the use of the TGM 5-Ex

## 2 Commissioning

### Caution

Before switching on the power supply, the operating voltage of the unit (see rating plate) must be checked to ensure it conforms to the mains voltage.

For adjustment and calibration works on the TGM 5-Ex, please observe the chapter on explosion protection under „Technical data“.

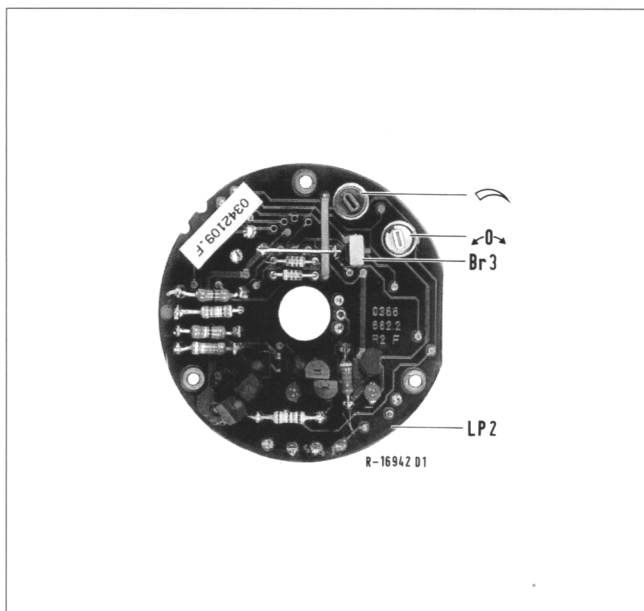
The TGM 5 transmitter is factory set to an output current of 0...20 mA and a 3-wire/4-wire circuit or as specified in the order. The output current may be switched to 4...20 mA by repositioning the jumper Br3 (see Fig. 7).

Jumper Br3 switchable

**Open**  4 ... 20 mA

**Closed**  0 ... 20 mA

The **TGM 5-Ex** transmitter is factory set to an output current of 4...20 mA and a 2-wire circuit.



**Fig. 7** Printed circuit board with LP2 electronics

- ↕ Potentiometer for setting the lower-range value
- ↪ Potentiometer for setting the upper-range value
- Br3 Jumper for adjusting the output current

## **2.1 Setting of lower-range and upper-range values**


The lower-range value of the transmitter is marked at the shaft and bearing cover. The coupling must be fixed in such a way that the two markings match when the case is in the desired position.

### **Caution**

**A screwdriver (blade width 3 mm) must be used to set the lower-range and upper-range values to avoid damaging the potentiometer.**


1. Set the rotational angle sensor to the lower-range value setting.
2. Remove the screw using a screwdriver (blade width 5 mm) and take the case cover off the transmitter.
3. Remove the fixing screws.
4. Twist the case of the transmitter until the output current rises to 0...0.3 mA or 4...4.3 mA.



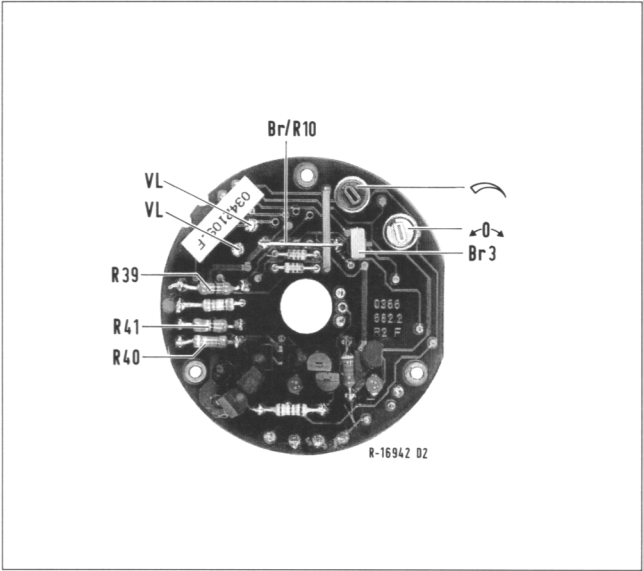
5. Fasten the fixing screws.
6. Set the lower-range value to 0 or 4 mA using the  potentiometer.
  - Turning the potentiometer anti-clockwise causes the current to drop
  - Turning the potentiometer clockwise causes the current to rise.

### **Note**



If the potentiometer has reached the limit position, return it to its central position and repeat the settings in Nos. 4 and 5.

7. Set the rotational angle sensor to the upper-range value setting.
8. Set the upper-range value to 20 mA with the  potentiometer.
9. Reset the lower-range and upper-range values and check them.
10. Close the case cover of the transmitter.

## 2.2 Changing the measuring range




**Fig. 8** Printed circuit board with LP2 electronics

-  Potentiometer for setting the lower-range value
-  Potentiometer for setting the upper-range value
- Br3 Jumper for adjusting the output current
- |     |   |   |
|-----|---|---|
| R39 | } | 3 resistors for matching the electronics to the chosen measuring range (capacitor type) |
| R40 |   |   |
| R41 |   |   |
- VL Connection lines between the differential capacitor and the soldering terminals
- Br/R10 Jumpers for adjusting the output current

## Caution


**A screwdriver (blade width 3 mm) must be used to set the measuring range to avoid damaging the potentiometer.**

1. Set the rotational angle sensor to the lower-range value setting.
2. Remove the screw using a screwdriver (blade width 5 mm) and take the case cover off the transmitter.
3. Remove the fixing screws.
4. Twist the case of the transmitter until the output current rises to 0...0.3 mA or 4...4.3 mA.
5. Fasten the fixing screws.

6. Set the lower-range value to 0 or 4 mA using the  potentiometer.
  - Turning the potentiometer anti-clockwise causes the current to drop.
  - Turning the potentiometer clockwise causes the current to rise.

**Note**

If the potentiometer has reached the limit position, return it to its central position and repeat the settings in Nos. 5 and 6.

7. Set the rotational angle sensor to the upper-range value setting.
8. Set the  potentiometer to the central position.
9. Unsolder the R40 resistor and replace it with a decade resistor.
10. Using the decade resistor, set the output signal to an upper range value of 20 mA.
11. Read the resistance value off the decade resistor and solder in position as a fixed resistance in place of the R40.
12. Check the lower-range and upper-range values several times.
13. Close the case cover of the transmitter.

## 2.3 Variation of the output current

The output current may be varied by means of the jumper Br3 and fixed-value resistor R10 (see Table below).

Output current	Type of connection	Jumper Br3	Resistor Br/R10
0 ... 20 mA	3/4-wire circuit	closed	jumper
4 ... 20 mA	2/4-wire circuit	open	jumper
0 ... 10 mA	3/4-wire circuit	closed	35.7 $\Omega$
0 ... 5 mA	3/4-wire	closed	110 $\Omega$

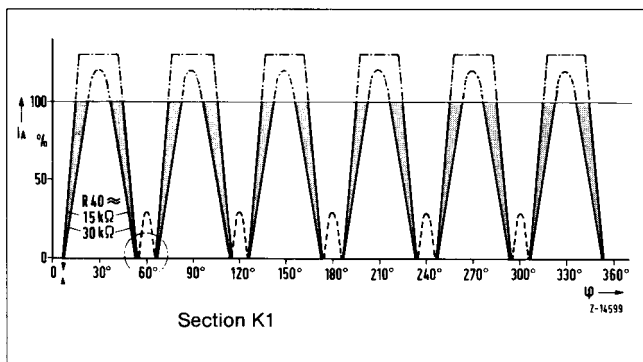
### Note

Output current 4 ... 20 mA, 4-wire circuit, can not be modified.

## 2.4 Changing the sense of rotation

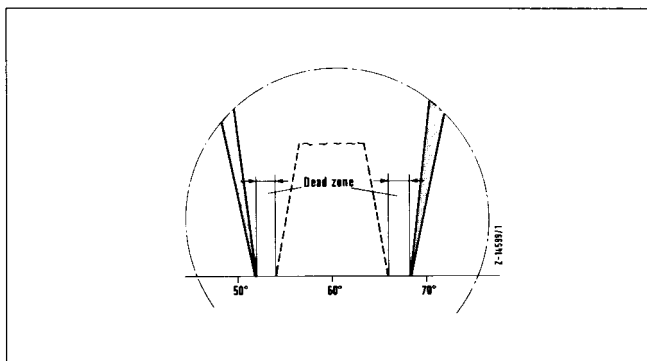
(See Figs. 9 to 14)

As can be seen from Figs. 9 to 14, the TGM 5 (-Ex) transmitters have up to 6 direct action and reverse action characteristics, depending on the measuring range of the capacitor which is fitted.



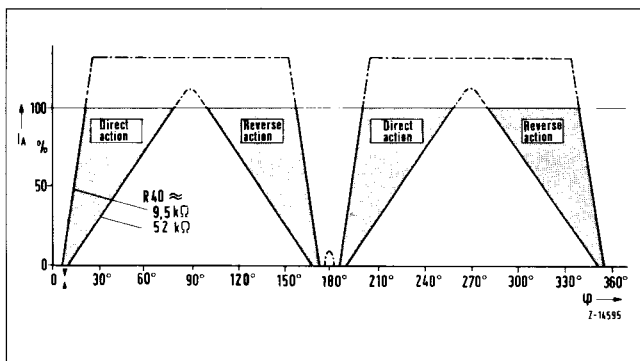
**Fig. 9** Capacitor type K1

Measuring range: min. 0...7.5°/max. 0...17°

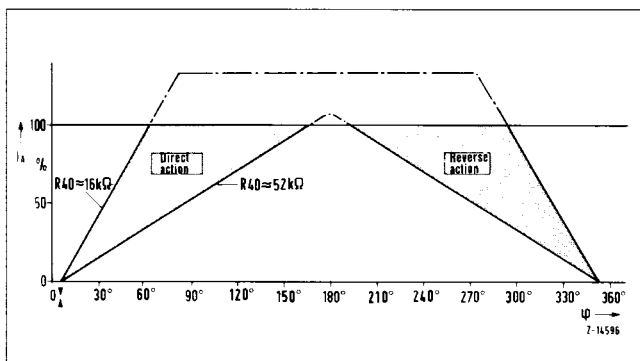


**Fig. 10** Section K1

- Usable characteristic
- - - Zone not usable
- · - Saturated output signal
- ▨ Setting ranges
- ▼ Lower-range value marker

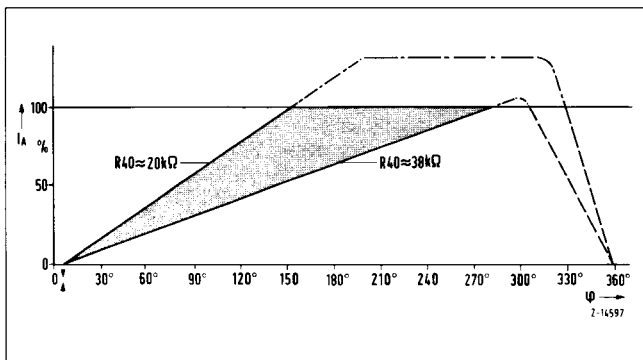


**Fig. 11** Capacitor type K2  
Measuring range: min. 0...15°/max. 0...75°

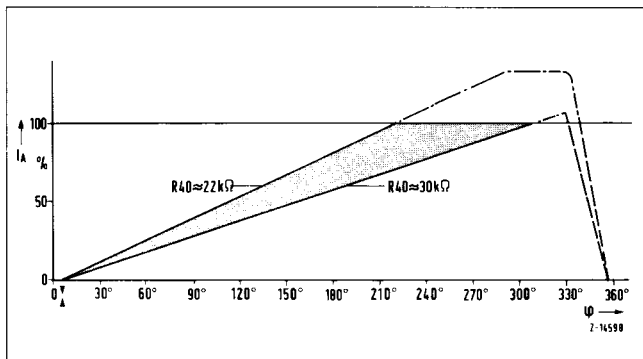


**Fig. 12** Capacitor type K3  
Measuring range: min. 0...60°/max. 0...165°





**Fig. 13** Capacitor type K4  
Measuring range: min. 0...150°/max. 0...280°



**Fig. 14** Capacitor type K5  
Measuring range: min. 0...220°/max. 0...310°

The measuring ranges

min. 0...7.5°/max. 0...17° (capacitor type K1)

min. 0...15°/max. 0...75° (capacitor type K2) and

min. 0...60°/max. 0...165° (capacitor type K3)

may be switched from clockwise to anti-clockwise and vice versa by rotating the case or the shaft in the opposite direction to that specified on the rating plate.

The following changes must additionally be carried out for the measuring ranges min. 0...150°/max. 0...280° (capacitor type K4) and

min. 0...220°/max. 0...310° (capacitor type K5)

- The connection lines between the differential capacitor and the soldering terminals on the LP2 have to be resoldered (see Fig. 8).

Straight connection lines = shaft rotates clockwise

Crossed connection lines = shaft rotates anti-clockwise

### **Note**

The sense of rotation specified on the rating plate relates to that of the shaft. The transmitter delivers a rising output signal whether rotation is in a clockwise or anti-clockwise direction.

- The R39, R40 and R41 resistors must be set as specified in the following tables.

Measuring range		Sense of rotation	
		clockwise	anti-clockwise
min. 0 ... 150° max. 0 ... 280°	R41 200 kΩ	R39 42.2 kΩ	R39 24.9 kΩ
min. 0 ... 220° max. 0 ... 310°	200 kΩ	45.3 kΩ	18.2 kΩ

Measuring range	Sense of rotation	
	clockwise	anti-clockwise
0 ... 180°	R40 25.5 kΩ	R40 20.5 kΩ
0 ... 270°	36.5 kΩ	30.1 kΩ
0 ... 310°	31.6 kΩ	23.2 kΩ

## **3 Repairs**

### **Caution**

**Working on an explosion-protected unit is only permitted after elimination of the explosion hazards.**

**Before recommissioning the device must be tested and approved by an expert.**

**This is not necessary if the work was executed by personnel authorized by the manufacturer. The fitter must carry respective identification. After the repair the fitter must attach a date and code (Hartmann & Braun certificate no.) to the repaired device.**

**These instructions do not apply to lower-range and upper-range value adjustments.**

**These works can also be executed by the user in a hazardous area if the required safety rules are observed.**

**The unit must be disconnected from all voltage sources before maintenance work is carried out or parts replaced which necessitate that the unit be opened.**

**Whenever it is likely that protection has been impaired, the unit must be rendered inoperative and secured against any unintended operation.**

**It must be assumed that the protection has been impaired when**

- the unit bears visible signs of damage**
- the unit no longer functions**
- the unit has been stored under unfavourable conditions for a long period of time**
- the unit has been subjected to adverse transport conditions.**

The TGM 5 transmitter is fitted with protective diodes to protect it and the peripheral units from damage. These are so-called TAZ suppressor diodes which are fitted to limit superimposed parasitic voltage peaks of the power supply. If the protective diodes are destroyed by overloading, a short-circuit in the input will result and the diodes need to be replaced.



The function of the TGM 5 (-Ex) transmitter relies on a capacitive process for the non-contact measurement of rotational angles which is virtually free of wear and tear and reaction. The shaft of the transmitter rotates freely.

The rotational angle to be measured is transferred to the rotor of the differential capacitor 1 via a mechanical coupling. The oscillator 2 feeds the differential capacitor with a constant alternating current. The alternating voltage, proportional to the angular position, is measured and fed to the pre-amplifier 4 via a coupling capacitor 3. This alternating voltage is rectified by the rectifier 5 and transformed into a load-independent, direct current  $I_A$  in the amplifier 6. The constant voltage source 7 is fed by an external power supply and provides the oscillator and amplifier with a stabilized voltage.

The TGM 5 (-Ex) transmitter comprises a case and a measuring insert.

The case of the TGM 5 (-Ex) transmitter consists of the casing and the shaft extension. There are two shaft extension versions:

- With 19 mm shaft  $\varnothing$  and a slide bearing of sintered bronze, optionally with or without rotary shaft seal.
- With 10 mm shaft  $\varnothing$  and ball bearing.

The measuring insert contains the following components:



- A differential capacitor
- A printed circuit board (LP2) with electronics
- A printed circuit board (LP1) with connections

The components are mounted on a flange through three set screws.

## Differential capacitor K

There are 5 standard capacitor types K1...K5 for the setting of a measuring range. A rotor revolves between the two stator plates of the capacitor. The angular position is picked up by the rotor in a non-contact manner and fed to the electronics section via the coupling capacitor.

### Printed circuit board LP2 with electronics

- Potentiometer for setting the lower range value 
- Potentiometer for setting the upper range value 
- Jumpers Br3 and Br/R10 for adjusting the output current 3 resistors, R39, R40 and R41 for matching the electronics to the chosen measuring range (capacitor type)

### Printed circuit board LP1 with connections

#### TGM 5 version

- UC power supply unit
- EMC protection circuit
- Electrical isolation (optional)

#### TGM 5-Ex version

- Power-limited components
- EMC protection circuit



# Technical data

## Input

### Standard measuring ranges

Min. 0...9°/ max. 0...11°, set to 0...10°

Min. 0...27°/max. 0...33°, set to 0...30°

Min. 0...54°/max. 0...66°, set to 0...60°

Min. 0...81°/max. 0...99°, set to 0...90°

Min. 0...162°/max. 0...198°, set to 0...180°<sup>1</sup>

Min. 0...224°/max. 0...280°, set to 0...270°<sup>1</sup>

### Special measuring ranges

Min. 0...7.5°/max. 0...17°

Min. 0...15° /max. 0...75°

Min. 0...60° /max. 0...165°

Min. 0...150°/max. 0...280°<sup>1</sup>

Min. 0...220°/max. 0...310°<sup>1</sup>

---

<sup>1</sup> Clockwise rotation, rising output current,  
Suppl. No. 310 necessary for anti-clockwise rotation

Permitted residual ripple of supply voltage  
< 1.5 V (peak-peak)

Residual ripple of the output signal  
< 1 % (peak-peak)

Output  
Short-circuit proof

## **Characteristics under nominal conditions (IEC 770)**

Nonlinearity  
<  $\pm 1$  % referred to the preset span  
<  $\pm 0.5$  % referred to the preset span  
(with measuring range <  $90^\circ$ )

Static error  
< 0.2 % referred to the preset span

## **Effects**

Ambient temperature  
< 0.4 % / 10 K for the range -10 °C...+80 °C  
< 0.8 % / 10 K for the range -25 °C...-10 °C

Power supply  
< 0.1 % / 10 V change in voltage

## Effects on output

Ambient temperature

< 0.1 % / 500  $\Omega$  change in load

Response time

< 50 ms (jump from 0 to 100 %)

## EMC

Immunity

- Meets the NAMUR recommendation for industrial standard apparatus (surge 1.2/50; 1.5 kV)
- TGM 5-Ex only with 2-wire circuit

Conforms to the general NAMUR recommendation in respect of immunity to

- mains supply tolerances
- inrush current limiting for alternating voltage power supply units
- transient overvoltages
- discharge of static electricity
- electromagnetic fields

## Output and power supply

Catalog No. optional model 4th position	Electrical isolation	Power supply $U_s$	Max. power supply con- sumption	Max. load
1	without	12...20 V DC	24 mA	$\frac{(U_S - 12V)}{I_A}$
	without	12...36 V DC	24 mA	$\frac{(U_S - 12V)}{I_A}$
2	without	13.2...36 V DC	24 mA	$\frac{U_S - (13, 2V)}{I_A}$
	without	13.2...26.4 V AC	24 mA	$\frac{U_S - (13, 2V)}{I_A} \times 1,4$
3	with	13.2...36 V DC	100 mA	600 $\Omega$
	with	13.2...26.4 V AC	100 mA	600 $\Omega$

Catalog No. optional model 4th position	2-wire circuit	3-wire circuit	4-wire circuit	Jumper Br3
<b>1</b>	4...20 mA			open
	—	0... 5 mA	0... 5 mA	closed
	—	0...10 mA	0...10 mA	closed
	—	0...20 mA	0...20 mA	closed
	4...20 mA	—	4...20 mA <sup>2)</sup>	open
<b>2</b>	—	0... 5 mA	0... 5 mA	closed
	—	0...10 mA	0...10 mA	closed
	—	0...20 mA	0...20 mA	closed
	4...20 mA	—	4...20 mA <sup>2)</sup>	open
			0... 5 mA	closed
			0...10 mA	closed
			0...20 mA	closed
			4...20 mA <sup>2)</sup>	open
<b>3</b>			0... 5 mA	closed
			0...10 mA	closed
			0...20 mA	closed
			4...20 mA <sup>2)</sup>	open
			0... 5 mA	closed
			0...10 mA	closed
			0...20 mA	closed
			4...20 mA <sup>2)</sup>	open

<sup>2)</sup> only with output 4...20 mA, 4-wire circuit (Catalog No. 14436-xx7xxx0)

# General and safety data

## Climatic capabilities

Application class acc. to DIN 40 040	Version
HQC	With plain bearings and rotary shaft seal
HQR	With plain bearings without rotary shaft seal
HQR	With ball bearings

Ambient temperature

-25...+80°C

Transport and storage temperature

-40...+80°C

Relative humidity

< 90 % annual average, condensation permitted

## **Mechanical stress**

Tested to

DIN IEC 68 Part 2-27 and

DIN IEC 68 Part 2-6

During transport

Shock 50g / 11 ms

During operation

Vibration 5g /  $\pm$  10 mm / 5...150 Hz

Seismic capabilities

Severe to extremely severe earthquakes as defined in the  
draft DIN IEC 50A(CO) 179

# Connection, case and mounting

## Electrical connections

Screw terminals for 2.5 mm<sup>2</sup> wire

Han 7D plug-in connection (not for TGM 5-Ex)

Degree of protect. of case acc. to DIN 40 050	Version
IP 66	With plain bearings and rotary shaft seal
IP 66 IP 50 At the shaft seal	With plain bearings without rotary shaft seal
IP 56 IP 50 At the shaft seal	With ball bearings

Torque	Version
approx. 8.6 Ncm	With plain bearings and rotary shaft seal
approx. 2 Ncm	With plain bearings without rotary shaft seal
approx. 0.6 Ncm	With ball bearings



Mounting position

Arbitrary

Case

Sea water resistant, cast aluminium

Surface anodic oxidized

Weight

TGM 5 (-Ex) Approx. 2.6 kg

## Explosion protection

Certificate of conformity

PTB 03 ATEX 2118

Designation

II 2 G EEx ib IIC T6 or

II 2 G EEx ib IIC T4

Temperature class

T6 for max. 40 °C ambient temperature

T4 for max. 70 °C ambient temperature

Mounting of the unit

Within hazardous areas of Zone 1 or Zone 2

Supply and signal current circuit

For connection to a certified intrinsically safe current circuit  
with the following maximum values

$U = 20 \text{ V}$ ,  $I = 35 \text{ mA}$ ,  $P = 700 \text{ mW}$

Effective internal inductance  $L_i$

Negligibly low

Effective internal capacitance  $C_i$  between the connections

Negligibly low

Effective internal capacitance  $C_i$  between the connections  
and case (ground)

$\leq 6 \text{ nF}$

## Packing instructions

If the original packing is no longer available, then the TGM 5 (-Ex) transmitter must be wrapped in an insulating air foil or corrugated board and packed in a sufficiently large crate lined with shock absorbing material (foamed material or similar). The thickness of cushioning should be in accordance with the weight of the unit and with the method of dispatch. Mark the crate „Fragile“.

For overseas shipping the instrument must additionally be sealed airtight in 0.2 mm thick polyethylene together with a dessicant (e.g. silica gel). The quantity of the dessicant should be in accordance with the packing volume and the envisaged transportation duration (at least 3 months). Furthermore, the crate should be lined with a double layer of kraft paper.

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Subject to technical changes  
Printed in the Fed. Rep. of Germany  
42/14-34 EN Rev. 02  
Edition 10.03