Turbine Meters TRZ 04 / TRZ 04-K

OPERATING INSTRUCTIONS

Reliable Measurement of Gas

RMG

STATUS February, 1st 2017 Version: 04

Manufacturer Our customer service is available for technical queries

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Note Unfortunately, paper is not updated automatically, whereas technical development continuously advances. Therefore, we reserve the right to make technical changes in regard to the representations and specifications of these operating instructions. The latest version of this manual (and other devices) can be downloaded at your convenience from our Internet home-page **www.rmg.com**.

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Contents

1 Introduction

1.1 Objective of the manual

The manual provides you with the information that is designed for trouble-free and safe operation.

The TRZ04 is state of the art and conceived and manufactured according to the recognized safety standards and guidelines. However, risks may arise during use that can be easily avoided by observing this manual. For this reason, you may only use the device as intended and in technically sound condition.

Warning

If the ultrasonic gas meter is not used for its intended purpose, warranty claims will be void.

1.1.1 Abbreviations

The following abbreviations are used:

ca.	circa, approximately
as app.	as applicable
max.	maximum
MC	Measurement Canada
MID	Measurement Instruments Directive
min.	minimum
e.g.	for example

1.1.2 Symbols

The following symbols are used:

1, 2, …	Marks steps within a work operation
..	

1.1.3 Layout of instructions

The following instructions are used:

Danger

This warning instruction informs you of potentially hazardous situations that can occur as a result of incorrect operation or human error. If these situations are not avoided, they can lead to fatal or severest injuries.

Warning

This warning instruction informs you of possible hazardous situations that can occur as a result of incorrect operation or human error. If these situations are not avoided, they can lead to fatal or severe injuries.

Caution

This warning instruction informs you of possible hazardous situations that can occur as a result of incorrect operation or human error. If these situations are not avoided, they can lead to slight or minor injuries.

Notice

This warning instruction informs you of potentially hazardous situations that can occur as a result of incorrect operation or human error. If these situations are not avoided, they can result in material damage to the device or the vicinity.

This notice may also give to you tips on how to simplify your work. With this screen, you additionally receive further information on the device or the work process.

1.1.4 Using the turbine meter TRZ04

1.1.4.1 Safety instructions

Danger

Observe the following safety instructions !!

Non-observance of these safety instructions can lead to a risk of life and limb and health of the person as well as damage to the environment or property damage.

Note that the safety instructions in this operating instruction and on the device cannot cover all possible hazardous situations as the combination of different circumstances is impossible to predict. To simply follow the instructions specified may not normally be sufficient enough to ensure for correct operation. Always be observant and also consider the following:

- Before working with the device for the first time, read through this operating instruction and, in particular, follow the safety instructions carefully.
- The operating instruction warns against the residual risks for users, third parties, devices or other material assets. The safety instructions used refer to residual risks that cannot be avoided due to the design.
- Operate the device only in a sound state and when observing the operating instruction.
- Also observe the local legal accident prevention, installation and assembly guidelines.

Notice

Always keep the operating instructions within reach for use at the place of installation.

For safe operation, the safety instructions must be observed and followed.

The manufacturer is not responsible for any damage that result as a consequence of not observing the operating instruction.

Danger

Service and maintenance work or repairs that are not described in the operating instruction must not be carried out without previous consultation with the manufacturer.

Changes to the device are forbidden.

For safe operation, the technical specifications must be observed and followed. Performance limits must not be exceeded (chapter 5 Specifications).

For a safe operation, the device must only be used in the scope of its intended use.

Only use the listed set screws, bolts, nuts and gaskets or parts with similar characteristics for the installation of the meter in the pipeline (chapter 1.14 Installing the device in the pipeline)

The device should only be used under the intended use for safe operation (Chapter 1.3 Overview, Function and Application)

1.1.4.2 Hazards during commissioning

Initial start up	Initial start-up must only be carried out by especially trained personal (training by RMG) or by service personal from RMG.

Notice

After the initial start-up an inspection report shall be drawn up. This, the operation manual and CE declaration of conformity must always be accessible.

As far as possible all the sharp edges have been eliminated on the device. Nevertheless, when working on the personal protective equipment must be used, which must provide the operator.

Danger

Install the device TRZ04 in accordance with operating instructions. If the TRZ04 is not installed according to the manual, there is possibly an insufficient explosion protection.

The explosion protection expires !!

Please take care during the installation to the flow direction marked on the housing by an arrow.

When staff carry out work without sufficient qualification, risks remain understated when working. Explosion or fire may happen. Perform the work only if you have the appropriate qualifications and you are an expert.

If you do not use the appropriate tools and materials, components may be damaged. Use tools that are recommended to you for the job in the operating instructions.

Mechanical installation	Mechanical installation must only be carried out by the respectively qualified specialist personnel.
Electrical installation	Installation on components must only be carried out by qualified electricians.
Mechanical and/or electrical installation	The specialist personnel require a training especially for working in potentially explosive environment. Specialist personnel are persons that can verify a training / further education according to **DIN VDE 0105**, **IEC 364** or a **similar national standards**.

Danger

The installation and removal of the TRZ04 or to the TRZ04 connected convertor may only be carried out in an explosion-free, de-pressurized atmosphere. It is important to pay attention to the descriptions of the operation manual during the installation process.

It is generally recommended to ask the RMG Service for any installation or removal.

After working on pressurized components, a control of leaks must be carried out.

All points above have to be considered for any repair and maintenance and in general, when an opening of the meter (convertor) is required.

Parts to lock the flanges, locking screws, fittings and check valves, oil supply and the pressure tap fittings, valves, HF pulse device, protecting pipe and rotating adapter may not be opened during operation.

1.1.4.3 Danger when using, servicing and maintaining the device TRZ04

Operating personnel	The operating personnel are to use and operate the device within the scope of the intended purpose.
Maintenance personnel	Work on the device must only be carried out by specialist personnel that can carry out the respective work assigned to them as a result of their training, knowledge and experience as well as the applicable regulations. These specialist personnel are familiar with the legal guidelines for accident prevention and can evaluate and avoid possible risks by themselves.
Maintaining and cleaning	Maintenance and cleaning must only be carried out by the respectively qualified specialist personnel.

Danger

If staff carry out work without sufficient qualification, risks may be underestimated when working. Explosion or fire may happen. If work is carried out in hazardous areas on voltage supporting equipment, resulting sparks may cause an explosion.

Danger

If the unit is not cleaned in accordance with the operating instructions, the device may be damaged. Clean the unit only in accordance with the operating instructions.

When not using appropriate tools, components can be damaged. The explosion protection expires.

- **Clean with a damp cloth!**

Danger

The TRZ04 may only be used as intended !!
(Chapter 1.3 Overview, Function and Application).

Avoid any use of the TRZ04 as possible climbing aid or attachments of TRZ04 as possible handholds !!

1.1.4.4 Specialized knowledge required

Notice

Persons working with or on the device must have the following knowledge:

- **Training / education for working in potentially explosive environments**
- **The ability to correctly assess dangers and risks when using the device. Possible dangers are, e.g., components under pressure or the result of incorrect installation.**
- **Recognize dangers that could be caused by the used flow medium.**
- **Training / education by RMG for working with gas measuring instruments.**
- **Education / instruction in all country-specific standards and directives to be observed for work that is to be carried out on the device.**

1.1.5 Risk assessment and mitigation

The TRZ04 subjects to risks in its use, which were judged by qualified staff of the company RMG. Risks may arise due to high pressures, more rarely by too low. Even work outside the permissible temperature range can lead to danger. Invalid current and voltage values can trigger explosions in hazardous areas.
The risk assessment assumes that when installing or removing a turbine a draining and venting of the pipeline takes place. Thus, and only then no explosive gas mixture is in the pipeline.
Of course (chapter 1.1.4.4 Specialized knowledge required) only work by trained personnel are permitted, which is also trained to know proper tools and use only this.
These risks have been considered during the development phase and action were taken to minimize these risks.

Risk mitigation measures:

- All pressurized parts are designed in accordance to AD 2000 regulations, PED Annex 1
- The complete design being pressurized is verified by the TÜV Hessen
- All pressurized parts are made with material certificate; there is a traceability to the batch tracking of all pressurized parts
- The mechanical properties of all relevant pressurized components are checked by tensile testing, impact testing and hardness testing
- In addition, non-destructive testing were applied: X-ray and ultrasonic testing of the meter housing for defects in material, surface crack detection by magnetic particle and dye-penetration
- With pressure tests 1.5 times of the intended operating pressure the strength of the components were verified; leak test were carried out at 1.1 times of the intended operating pressure. Successful tests were marked
- The maximum operating pressure is stated on the nameplate of the device, as well as the temperature range. Operation of the device is only permitted within the indicated ranges.

Danger

For any work in an explosive atmosphere (all areas):

- **The pulse output of the turbine meter has to be connected to intrinsically safe circuits, only.**
- **For maintenance and repair work only tool must be used, which is approved for Ex zone. 1**
- **Otherwise, work must be carried out only if there is no explosive atmosphere**
- **Danger of ignition caused by impact or friction must be avoided.**
- **In hazardous areas, the wiring / installation must be performed by trained personnel in accordance to EN 60079-14 and according to national regulations**
- **Skilled persons are in accordance to DIN VDE 0105 or IEC 364, or comparable standards**
- **Use only trained and qualified personnel. Work on the measuring system may only be carried out by qualified personnel and must be checked by a specialist supervisor.**
- **Qualified persons are able to carry out such work. Qualification is valid due to their training, experience or through instruction and their knowledge of relevant standards, regulations, accident prevention regulations and plant conditions for the safety of people. It is essential that these people are able to recognize and avoid possible dangers.**

1.1.6 Validity of the manual

This manual describes the turbine meter TRZ04. The TRZ04 is only a part of a complete on site system. Observe also the instructions of other components of the site system. If you find contradicting instructions, please contact RMG.

Notice

Make sure that the performance of the power connector corresponds to the data on the nameplate. Additionally observe any existing national regulations in the country. Use cable suitable for the cable glands.

Danger

Perform the work only if you have the appropriate qualifications and you are a trained specialist.

1.1.6.1 Hazards during Operation

Please take care of the information provided by the plant manufacturer and/or plant manager.

1.1.6.2 Danger during operation in hazardous areas

Operate the device in perfect and complete condition.
When you perform technical modifications to the instrument, a safe operation can no longer be guaranteed.

Danger

Use the device only in the original condition. The TRZ04 may be operated in explosion zone 1, but only within the permitted temperatures (Chapter 1.10 Temperature ranges)

1.1.6.3 Operator responsibility

Take care as plant manager that only sufficiently skilled personnel will work on the device. Ensure that all employees who handle the equipment have read and understood these instructions. Additionally, you are obliged to train staff on a regular basis and to inform them about any dangers. Ensure that any work carried out on the device is done by qualified personnel and checked by responsible specialists. You must establish clearly the responsibilities for installation, operation, troubleshooting, maintenance and cleaning. Point out to your staff any risks involved when using the device.

1.1.7 Transportation

The device is packaged customized according to the transport requirements.

Warning

Risk of injury during transport

Any foot screws must be fitted, if they are used as transit protection against rolling and tipping.

Take additional care that a rolling and tilting is safely prevented.

To lift the meter only the special lifting eyes / eye bolts may be used.

Pay attention to the maximal loads for the lifting devices (chapter 5 Specifications) – don't exceed those.

Make sure that the load is fastened securely before lifting.

Do not stand under lifted loads.

During lifting and/or depositing the device may slip, tip over or fall. Disregarding the maximum load capacity of the lifting device, the device may fall down. For any people standing nearby, there is a significant risk of serious injury.

If the unit is supplied on a Euro pallet, the unit can be transported using a lift truck or a forklift.

During the transport the meter has to be protected against shock or vibration.

The meter or its additionally mounted spool pieces are equipped with flanges that are protected with a sticker foil or blind plugs made of plastic. These must be removed completely before installation in the pipeline. Remaining rests of these protections may change the flow pattern and may result in a measurement error !!

For any transport e.g. for recalibration we ask you to use these protections.

1.1.8 Delivery

Supplied number of parts may differ depending on the optional customer order. "Usually" is following in the delivery:

Part	Quantity
Turbine meter TRZ04	1
1 small bottle of oil for lubrication	1
Manual	1
Test report	1
Calibration certificate	1
Material test report	1
Certificate strength 3.1 ..	optional
…	…

1.1.9 Dispose of packaging material

Dispose the packing material in an environmentally friendly way in accordance to the national standards.

1.1.10 Storage

Avoid long periods of storage. Check the device after any storage for damage and functionality. Ask for a check from the RMG service after a storage period for the device of over one year. In this case please send the device to RMG.

Notice
For storage, a dry and protected space has to be provided. **It is important to ensure that all open pipe pieces must be sealed.**

1.2 Structure of the manual

The introduction of this manual contains two parts. In the first part general guidelines are listed; the symbols used and structure of advices are given, but also issued is a risk assessment. In addition, it contains guidelines for the transport and storage of the TRZ04. The second part introduces the operation of TRZ04; there are basic standards listed; pressure and temperature ranges are given limiting the use of the TRZ04.

The second chapter describes the use of TRZ04. It explains how a high accuracy can be achieved, how data can be received by the encoder and tapped there. The third chapter provides recommendations on how the current operation can be ensured. These include the accuracy influencing flow disturbances as well as regular lubrication of the bearings of the turbine meter.

The fourth chapter describes the marking of the TRZ04 and in the fifth the technical data of TRZ04 are summarized. The appendix includes details to the previous chapters, a summary of certificates and approvals.

1.3 Overview, Function and Application

The TRZ 04 and TRZ 04-K are used to measure volume flow rates of non-aggressive gases and fuel gases, especially natural gas. Measurement of corrosive gases is only possible with special designs. The measurement of liquids is not possible and will destroy the device.

The TRZ 04 is a flow rate meter, which can be used for custody transfer flow rate measurement. The TRZ 04 K, however, can only be used for operational volume flow rate measurements. Both types measure the gas quantity, means the volume flowing through the unit at the actual pressure and temperature. Both determine the volume flow rate at the actual conditions. The volume flow rate of the gas flowing through the meter is indicated by a mechanical totalizer operating in m³.

In addition, the turbine can be equipped to supply high or low frequency pulses and reed contacts can be fitted, too. The measured number of pulses are proportional to the volume that has passed the meter. These pulses can be further processed by volume correctors or remote totalizers.

The most important differences between the versions TRZ 04 und TRZ 04-K are:

TRZ 04

- Approved for custody transfer metering
- Installation length: 3 x DN

- Accuracy ≤ ±0.5% (above 0.2 Q_{max})
- Blade monitoring system

TRZ 04-K

- For secondary metering.
- Installation length: ≤ 1.5 x DN (DN 50: 3 DN)
- Accuracy ≤ ±1% (above 0.2 Q_{max})

The following applies to all meter types:

- Maximum operating pressure: 100 bar (not for gas meters with a plastic turbine wheel)
- Meter sizes from G 65 to G 1600
- Measuring range 1:20 at operating pressure p_m = 1 barg;
- Measuring range up to 1:100 at p_m >= 3 barg (see table: Q_{min} depending on p_{min})
- Connections in compliance with DIN or ANSI are available
- Special designs for aggressive gases are available
- Available for low temperatures (< - 20°C)
- All gas meters can be operated in any position up to the nominal diameter of DN 200.

Notice

The meters with nominal diameters from DN 50 to DN 200 are approved for custody transfer metering (up to G 1600).

The nominal diameters from DN 250 are special versions without MID approval for which RMG does not guarantee the availability (only on request).

The TRZ 04 and TRZ 04-K are approved for the use in explosive areas; the indication is:

II 1G Ex ia IIC T4 (HF-Sensors)
II 2G Ex ib IIC T6 (Encoder)

The corresponding conformity certificates can be found in the appendix.

Danger

To operation the encoder you have to care of:

The encoder must be mounted and removed by a qualified electrician, as sensitive electronic circuits are part of the encoder.

Attention: Risk of destruction due to static electric discharge, for example caused by the friction of clothing.

Do not change anything at the encoder, otherwise the approvals and certificate lose their validity.

Information about temperature limits are given in chapter 1.10 Temperature ranges.

The TRZ04 meets the standards, guidelines and regulations:

⇨ Chapter 1.6 Standards / Guidelines and the appendix

These technical limitations you must comply with the TRZ04 for safe operation:

⇨ Chapter 5 Specifications

The device may only be operated with the following types of gases. Only with these stated gases a safe operation is ensured:

- Gases of class 1
- Gases of class 2
- Gases of class 3

The friction of the gas components must be within the limits in accordance with the EN 437: 2009 are for test gases.

The following instructions must be observed:

Notice

The RMG TRZ 04 and TRZ 04-K can be operated in any mounting orientation up to DN200, from the DN 250 is a horizontal orientation is required.

If a mounting orientation is specified when ordering, the meter has to be installed in this orientation.

It is also important to ensure that the filling port of the lubricator faces upwards.

1.4 Method of operation

The method of operation of the mechanical turbine meter is based on the measurement of the gas velocity. The velocity of the gas flowing through the gas meter is increased in the flow straightener and the gas strikes the turbine wheel in a defined flow cross section. In the flow straightener, unwanted vortices, turbulences and asymmetries are removed or reduced. The turbine wheel is mounted axially, while the blades of the turbine wheel are arranged at a certain angle to the gas flow. Within the measuring range (Q_{min} - Q_{max}), the rotational speed of the turbine wheel is almost proportional to the mean gas velocity and, therefore, to the rate of flow. The number of rotations is a measure of the volume that has flowed through. The rotary movement of the turbine wheel is transmitted by a magnetic coupling to the unpressurized meter head. Downstream of the coupling, there is a gearing which reduces the rotational speed of the turbine wheel to match the mechanical totalizer. Two LF pulse transmitters (reed contacts) and a tamper contact are located on the totalizer.

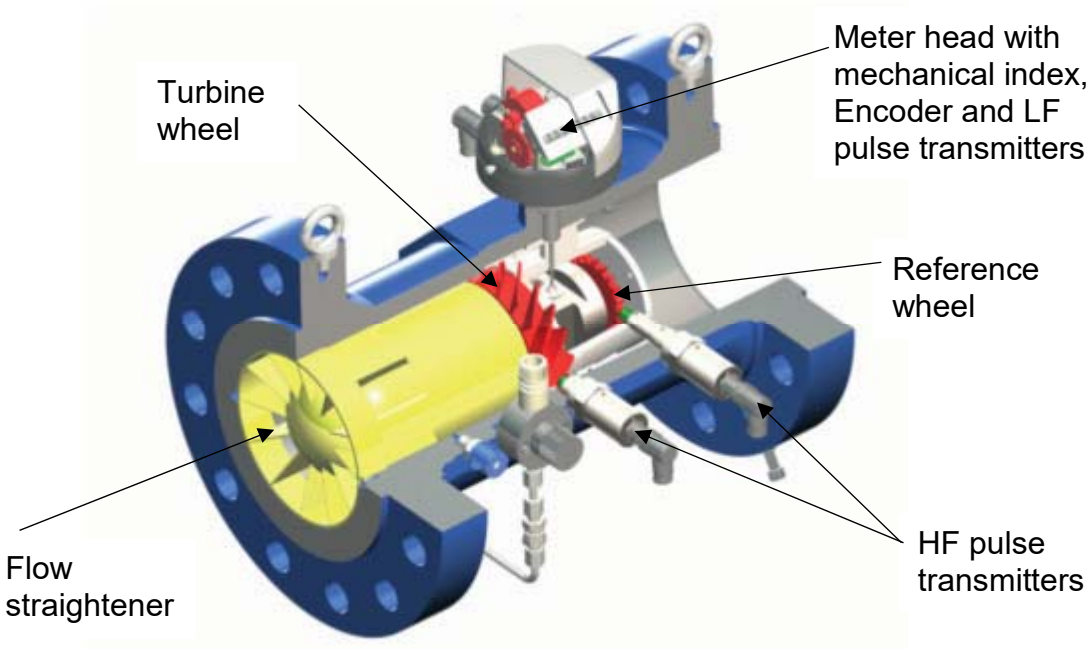


Figure 1: Sectional drawing of a turbine meter.

Downstream of the turbine wheel, a cam wheel (reference wheel) is located on the same shaft. Two HF sensors (proximity switches) generate a signal if a blade of the turbine wheel (HF 3-D) or a cam of the reference wheel (HF 2-D) passes them. In this way, two pulse sequences are generated which are out of phase. The generated pulses can be further processed for secondary volume measurements or flow measurements.

1.5 Approvals

Type **TRZ 04** has been approved for custody transfer metering.
The following approvals have been obtained:

MID approval	No. T10417
PED approval	No. CE 0091

Independent whether the turbine meter can be remotely read (via the encoder) it is fitted with a metrological controlled mechanical index. The reading of this index is the measurement result that serves as the basis for billing.

Type **TRZ 04-K** has not been approved for custody transfer metering. The following approvals have been obtained:

PED 2014/68/EU / DGRL2014/68/EU	ISG-22-12-1980	(TRZ04)
	ISG-22-12-1994	(TRZ04-K)

1.6 Standards / Guidelines

All RMG turbine meters have passed the disturbance measurements in compliance with OIML Recommendation IR-32/89, Annex A, with slight and heavy flow disturbances. Therefore, this meter design meets the requirements for installation in compliance with Technical Guideline G13, Sec. 1. Test specifications are as laid down in PTB Testing Instructions, Vol. 4, Volume gas meters, 2nd revised edition of 1992.

The RMG turbine meters of type TRZ 04 comply with EN 12261 and the European Measuring Instrument Directive 2004/22/EG (MID).

1.7 Validity of meter proving

The turbine meters of type TRZ 04 which are suitable for custody transfer metering must be subjected to subsequent meter proving at regular intervals. The validity of meter proving is determined in the German Metering and Calibration Rules (MessEV, Edition 11, December 2014) with the following periods:

Turbine meters without lubricator	8 years
Turbine meters with flow range 65 m3/h to ≤ 4.000 m3/h	12 years
Turbine meters with flow range > 4.000 m3/h to < 16.000 m3/h	16 years
Turbine meters with flow range ≥ 16.000 m3/h	unlimited

1.8 Measuring ranges

The measuring ranges are between 10 and 25.000 m^3/h (flowing conditions). A measuring range is specified for each meter size. It is limited by the minimum flow rate Q_{min} and the maximum flow rate Q_{max} (see table on page 35).

For types TRZ 04 this is the flow range where the gas meter must indicate correct values within the error limits specified by the German Metering and Calibration Rules.

Turbine meters of type TRZ 04 have measuring ranges up to 1:30 even under atmospheric pressure. If a high-pressure test is conducted in compliance with Technical Guideline G 7 (PTB), the measuring range can be extended to 1:100. Then the minimum flow rate Q_{min} HP is the lowest test point during high-pressure testing. Type TRZ 04 may then be used for billing purposes within the specified HP flow and density ranges.

The measuring range of type TRZ 04-K is 1:16.

1.8.1 Extension of the measuring range

In the range of 0.2 Q_{max} to Q_{max}, the measuring behavior of turbine meters is determined by the aerodynamic conditions in the flow channel and the measuring cross section. By means of many series of tests conducted both under atmospheric pressure and under higher pressures and with an appropriate rating for such ranges, it is possible to achieve a deviation of the calibration curve under atmospheric conditions and under high-pressure conditions of < 0.5% in the flow range of 0.2 Q_{max} to Q_{max}. In the lower flow range, the measuring behavior is determined by the relationship between the gas flow driving the measuring wheel and the slowing-down torques due to drags (bearings and totalizer). The driving torques increase linearly with the density and quadratic with the velocity of the gas to be measured. Due to the physical conditions, the measuring range is therefore enlarged in relation to the density. The lower flow limit shifts in the direction of smaller loads (see also the table in chapter 5.3 Qmin depending on the operating pressure in natural gas).

Use the formula below as approximate equation:

$$Q_{md} \approx Q_{min} \times \sqrt{\frac{1{,}2}{\rho}}\ (m^3/h)$$

The density ρ can be determined with the following approximate formula:

$$\rho \approx (p_m + 1)\ x\ \rho_n\ (kg/m^3)$$

The influence of the temperature is not taken into account in this formula.

With:

Q_{md}:	Minimum flow rate at flowing conditions
Q_{min}:	Minimum flow rate of the gas meter
p_m:	Operating pressure in bar
ρ:	Density in kg/m^3 (Density of air at 20°C and 1.01325 bar ≈ 1.2 kg/m^3)
ρ_n:	Standard density of the gas (standard density of natural gas ≈ 0,8 kg/m^3)

1.9 Accuracy of measurement

The following error limits apply within the permissible measuring range:

Measuring range:	Qmin to 0.2 Qmax	0.2 Qmax to Qmax
Calibration limit[1)]	± 2 %	± 1 %
TRZ 04	± 1 %	± 0.5 %
TRZ 04-K	± 2 % (DN 50, DN 80: ± 3 %)	± 1 % (DN 50: ± 1.5 %)

[1)] maximum error due to the German Metering and Calibration Rules

It will be checked whether these limits are observed. They also apply to the high-pressure range.

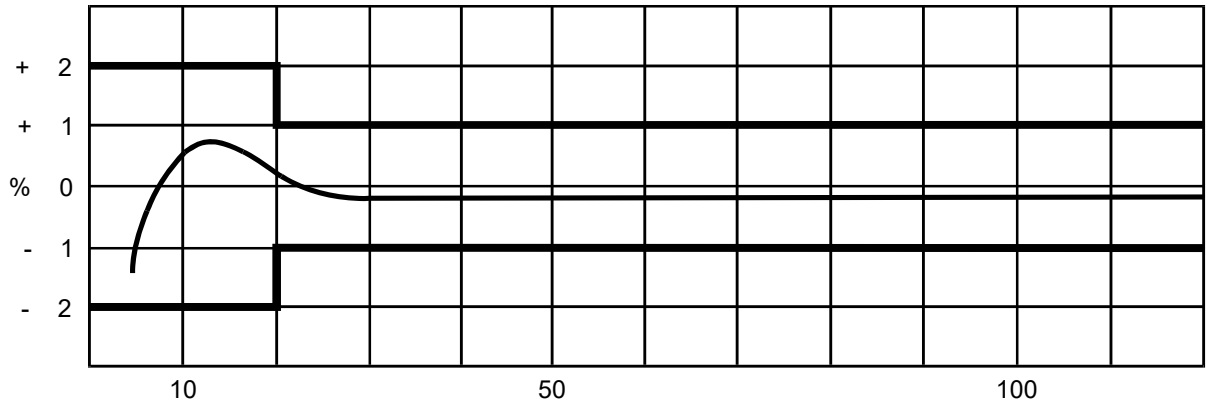


Figure 2: Calibration curve of a turbine meter

The reproducibility, i.e. the difference between the results of two measurements under identical conditions, is as follows:

TRZ 04, TRZ 04-K: ≤ ± 0.1%

1.10 Temperature ranges

For the standard designs of the turbine meters of types TRZ 04 and TRZ 04-K, the following temperature ranges are permitted:

MID:

-25°C to +55°C (TRZ 04 for custody transfer metering)

PED 2014/68/EU:

-20°C to +80°C (Spheroidal graphite iron)
-40°C to +80°C (cast steel)

ATEX:

-25°C to +70°C (T4)
-25°C to +55°C (T6)

1.11 Pressure loss

The pressure loss of RMG turbine meters has been reduced to a minimum thanks to modifications with regard to design. The measuring points for pressure loss are located 1 x DN upstream and downstream of the gas meter. The pressure loss is calculated using the following formula:

$$\Delta p = Z_p \cdot \rho \cdot \frac{Q_m^2}{DN^4}$$

where:

Δp	pressure loss	[mbar]
Z_p	pressure loss coefficient	
ρ	density	[kg/m^3]
Qm	volume flow rate at measurement conditions	[m^3/h]
DN	is the nominal diameter of the gas meter	[mm]

Gerätetyp Device type	Z_p
TRZ 04 / TRZ 04-K turbine meter	3000
L1 perforated-plate straightener as per ISO/DIN	3150
L2 perforated-plate straightener as per ISO/DIN	6300
L3 perforated-plate straightener as per ISO/DIN	9450
LP-35 perforated-plate straightener as per RMG standard	1260
RB 19 tube-bundle straightener as per ISO/DIN	1260

The values for Z_p are approximate mean values. The exact value is calculated from the pressure loss, which is determined during testing the turbine meter.

Example of calculation of the pressure loss for a turbine meter with upstream perforated-plate straightener:

TRZ 04, size DN 150

Q_m = 650 m^3/h
ρ = 1.3 kg/m^3 (natural gas)

From the table on the previous page you may find:

$Z_p(TRZ04)$ = 3000
$Z_p(LP\text{-}35)$ = 1260

Calculation:

$$Z_p(ges) = 3000 + 1260$$
$$= 4260$$
$$\Rightarrow \quad \Delta p = 4260 \cdot 1.3 \cdot \frac{650^2}{150^4}$$
$$= \underline{\underline{4.2 \text{ mbar}}}$$

1.12 Pressure tap

A pressure tap has been provided to connect the pressure transducer of a volume corrector or a pressure gauge to read the pressure at measurement conditions prevailing inside the gas meter. This pressure tap is identified by “p_m”.

1.13 Using gas meters with different types of gases

Gas type	Symbol	Density at 0°C 1.013 bar	Meter case	Comments
Acid gas			Special	Special measuring element
Air	Ar	1.29	Standard	
Ammonia	NH_3	0.77	Standard	O-rings/lubrication
Argon	AR	1.78	Standard	
Biogas			Special	Special measuring element
Butane	C4H10	2.70	Standard	
Carbon dioxide	CO_2	1.98	Standard	Exception: food industry
Carbon monoxide	CO	1.25	Standard	
Ethan	C_2H_6	1.36	Standard	
Ethylene (gaseous)	C_2H_4	1.26	Standard	Special design
Freon (gaseous)	CCl_2F_2	5.66	Standard	O-rings/lubrication
Helium	HE	0.18	Standard	Reduced measuring range
Hydrogen	H_2	0.09	Special	Reduced measuring range
Hydrogen sulphide (0.2 %)	H_2S	1.54	Standard	Special measuring element
Methane	CH_4	0.72	Standard	
Natural gas		0.8	Standard	
Nitrogen	N_2	1.25	Standard	
Oxygen (100%)	O_2	1.43	Standard	Special design
Pentane	C_5H_{12}	3.46	Standard	
Propane	C_3H_8	2.02	Standard	
Propylene (gaseous)	C_3H_6	1.92	Standard	Special measuring element
Sulphur dioxide	SO_2	2.93	Special	Special design
Town gas				

1.14 Installing the device in the pipeline

The units of RMG are equipped with flanges.

The flange connections for the connected pipes must comply with the connecting dimensions of the flanges of the unit:

- ANSI-pressure levels: Flange in accordance with ASME B 16.5.
- DIN-pressure levels: Flange in accordance with DIN EN 1092.

Danger

Gas leakage for the wrong gaskets

If wrong flange gaskets are used for connecting turbine gas meters, gas may flow through leaks resulting in an explosive gas mixture.

Poisoning and explosion hazard !!

In addition, the stress of the flange is increased inadmissible when tightening the bolts.

Make sure that no flange gaskets are protruding into the pipe.

Pay attention to a save mounting / hanging-up of the TRZ04 during assembly to avoid the risk of bruising. Avoid to have your fingers (or other body parts) between any openings and gaps that are moved together when tightening the flanges !!

Notice

Malfunction due to incorrect gaskets

When wrong flange gaskets are used for turbine meters, which protrude into the pipe, the measurement accuracy may be affected.

Make sure that the flange gaskets on the sealing surfaces are not protrude into the pipe.

The stability of the flange connection for gaskets and bolts with certain material properties (see chapter 2.2.3 Seals and chapter 2.2.4 Screws) was proved to AD2000 regulations. Other screw / flange - variants were not verified.

2 Installation and Commissioning

2.1 Installation

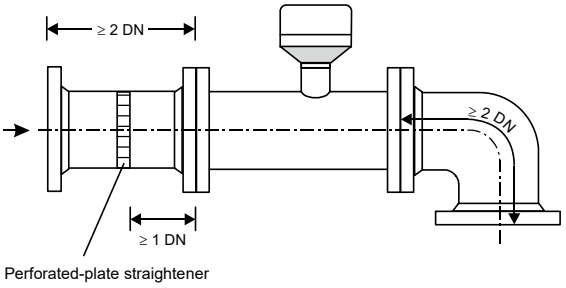
Notice

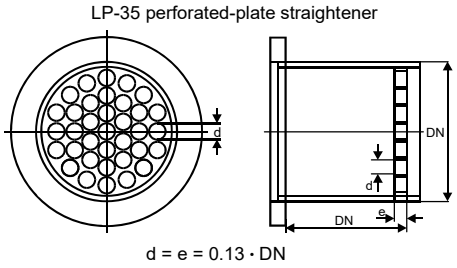
Any components affecting the gas flow must be avoided directly upstream of the turbine meter (see DVGW Guideline G 492 II [1] and PTB Guideline G 13 [2]).

An inlet pipe of a minimum of 2 x DN is required upstream of the RMG TRZ 04 turbine meter. The inlet pipe must be designed as a straight pipe section of the same nominal diameter as the gas meter. If there is a heavy flow disturbance, it is necessary to use flow straighteners (see table on next page). A pipe or fitting (bend) of the same nominal diameter as the gas meter and an overall length of 2 x DN must be installed downstream of the gas meter.

Temperature measuring instruments may only be installed at a distance of 1 x DN or in the case of nominal diameters of ≥ DN 300 at a minimum distance of 300 mm.

If there are flow disturbances (e.g. due to a gas pressure regulator) upstream of the inlet pipe, it is also necessary to use a perforated-plate straightener. You can use perforated-plate straighteners complying with ISO 5167-1 or of type RMG LP-35, the latter resulting in a pressure loss which is 2.5 times lower than that of the standardized flow straightener.





- The opening angle of reducers or expansion fittings installed upstream of a turbine meter of type TRZ 04 or TRZ 04-K must not exceed 30°.
- In order to obtain precise measurement results, the turbine meter must be installed in the gas line in such a way that no seals protrude from the flanges into the pipeline.

[1] can be ordered at DVGW, Josef-Wirmer-Str. 1-3, D-53123 Bonn (www.dvgw.de)
[2] can be ordered at PTB, Bundesallee 100, D-38116 Braunschweig (www.ptb.de)

Notice

A protective screen should be installed on the intake side of the gas meter to protect the turbine meter against any foreign particles possibly contained in the gas flow. The protective screen can be a perforated plate of sheet metal with a hole diameter of 3 mm which is available from RMG.

- The p_m tap which is located on the RMG turbine meter is the pressure-measuring point which was used for taking the relevant pressure at measurement conditions during meter proving. This pressure-measuring point is used for connecting pressure-measuring instruments such as flow computers or volume correctors. Other connection options (e.g. for temperature measurement) can be supplied on a pipe section on the output side of the gas meter.

⚠ Danger

Protect the turbine meter from damage caused by heavy flow variations, e.g. if the downstream pipeline system must be filled or blown off.

⚠ Danger

If it is necessary to do welding work on the gas line, such work can only be performed at a safe distance from the gas meter. Extreme temperatures prevailing in the gas line in the proximity of the gas meter can result in a permanent damage to the gas meter.

⚠ Danger

All electrical connections between the gas meter and the amplifiers or the flow computer must be carried out in compliance with the installation instructions. Make sure that these connections are intrinsically safe.

Danger

Any liquids remaining in the gas line after hydrostatic testing can damage the interior parts of the gas meter. If hydrostatic testing is necessary, the turbine meter must be replaced by a pipe section. Make sure that no liquid remains in the gas line upstream of the gas meter after hydrostatic testing.

2.2 Operating data

Recommended threshold values for maximum service life and maximum accuracy:

Notice

Maximum overload:	< 20% above Q_{max}, for a short time (< 30 sec)
Maximum flow or shock loads	< 0.01·Q_{max}/sec ≙ 1% of Q_{max}/sec e.g. starting up 0 - 100%: > 100 sec
Maximum pressure change:	< 0.1 bar/sec
Maximum flow pulsation:	< 5%
Particle size in the gas flow:	< 5 □m
Lubrication of bearings	See chapter on “Lubrication”. Lubrication intervals depend on the condition of the gas (condensate, rust or dust)
Vibration / mechanical shock:	< 1 mm/sec (vibration velocity)

These specified data must be determined and checked during commissioning, prior to filling and during the start-up and running-in phases of the gas meters. If more than one threshold value occurs at the same time, appropriate action must be taken in the station to improve the measuring conditions.

Notice

The operator must record all measuring data (gas meter and operating data) during the whole period of operation in order to detect the causes of a possible destruction of the gas meter at an early stage and take corrective action in good time.

Corrective action or reduction of the critical operating conditions can be achieved by the following measures for example:

- **Start-up screens (mesh width < 0.15 mm)**
- **Filters**
- **Perforated plates (Ø 3 - 4 mm) protecting the gas meter**
- **Valves with control drive mechanism (flow variation)**
- **Non-return valves (pulsation and return flow)**

2.2.1 Technical Guideline G 13

The installation conditions for new stations complying with TRG G 13 and the simpler installation conditions for RMG turbine meters are compared in the table below.

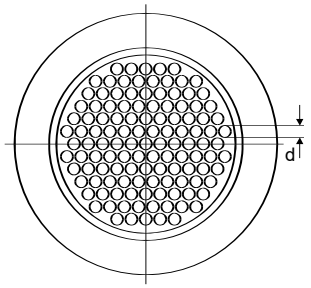
Type of flow disturbance	Installation cond. As per TR G13	Installation cond. for RMG gas meters Type TRZ 04	Comments
None	Inlet pipe ≥ 5 DN Outlet pipe ≥ 2 DN	Inlet pipe ≥ 2 DN Outlet pipe ≥ 2 DN	The outlet pipe can also be designed as a bend.
	Inlet pipe ≥ 10 DN		Flow disturbances upstream of this inlet pipe need not be considered, if the requirement for an alternating and pulsating flow is fulfilled
Bend	Inlet pipe ≥ 5 DN	Inlet pipe ≥ 2 DN	
Space bend	Inlet pipe ≥ 5 DN and **additionally 2** perforated-plate straighteners or one tube-bundle straightener	Inlet pipe ≥ 2 DN	

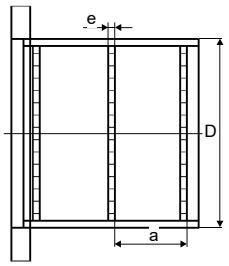
Gas pressure regulator with sound attenuator	Inlet pipe ≥ 5 DN	Inlet pipe ≥ 2 DN and **additionally** one perforated-plate straightener	
Gas pressure regulator without sound attenuator	Inlet pipe ≥ 5 DN and **additionally** two perforated-plate straighteners	Inlet pipe ≥ 2 DN and **additionally** one perforated-plate straightener	
Diffuser	Inlet pipe ≥ 5 DN and **additionally** one perforated-plate straighteners	Inlet pipe ≥ 2 DN	
Diffuser with swirling flow	Inlet pipe ≥ 5 DN and **additionally** two perforated-plate straighteners	Inlet pipe ≥ 2 DN	

2.2.2 Perforated-plate straighteners

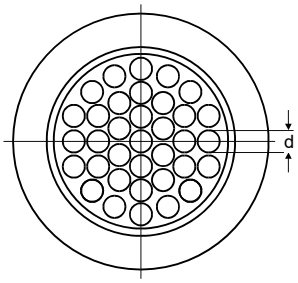
There are the following options for flow straighteners:

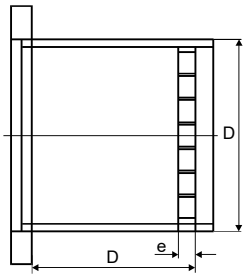
RMG L1 - L3 perforated-plate straighteners complying with ISO 5167-1 and DIN 1952





RMG LP-35 perforated-plate straightener





Features	ISO / DIN	L1 to L3	RMG LP-35
Hole diameter d	d ≤ 0.05 D	0.04 D	0.13 D
Plate thickness e	e ≥ d	e = d	0.13 D
Plate clearance a	0.5 D ≤ a ≤ 1 D	0.5 D	-
Opening ratio m	0.2 ≤ m ≤ 0.4	0.3	0.6
Pressure loss, dyn. Δp		5 - 15 (c^2 ρ / 2)	2 - 15 (c^2 ρ / 2)

In conjunction with RMG turbine meters, these flow straighteners fulfil the requirements of Technical Guideline G 13 and are approved under EU approval No. D 81 / 7.211.10 for turbine meters.

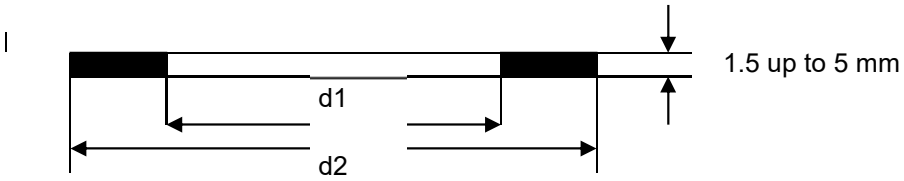
2.2.3 Seals

It must be guaranteed that flange seals of RMG turbine meters do not protrude from the flange into the gas line.

The stability of the flange connection has been verified for seals with the following maximum material properties of AD2000 guideline:

- gaskets: $k_0 \times K_D = 20 \times b_D \mid k_1 = 1.3 \times b_D$ [N/mm]
- grooved seals: $k_0 \times K_D = 15 \times b_D \mid k_1 = 1.1 \times b_D$ [N/mm]
- spiral seals: $k_0 \times K_D = 50 \times b_D \mid k_1 = 1.4 \times b_D$ [N/mm]
- octagonal ring joint seal: $K_D = 480$ N/mm²

For recommended dimensions, see the tables below.



Gaskets			PN 10	PN 16	ANSI 150	PN 25	PN 40
DN		d1	d2				
50	2"	77	107	107	105	107	107
80	3"	90	142	142	137	142	142
100	4"	115	162	162	175	168	168
150	6"	169	218	218	222	225	225
200	8"	220	273	273	279	285	292

Grooved seals		ANSI 300 / ANSI 600		PN 64	
DN		d1	d2	d1	d2
50	2"	69,8	88,9	65	87
80	3"	98,4	123,8	95	121
100	4"	123,8	154,0	118	144
150	6"	177,8	212,7	170	204
200	8"	228,6	266,7	220	258

Spiral seals		ANSI 300		PN 64		ANSI 600	
DN		d1	d2	D1	d2	d1	d2
50	2"	69,9	85,9	66	84	69,9	85,9
80	3"	101,6	120,7	95	119	101,6	120,7
100	4"	127,0	149,4	120	144	120,7	149,4
150	6"	182,6	209,6	174	200	174,8	209,6
200	8"	233,4	263,7	225	257	225,6	263,7

2.2.4 Screws

The stability of the flange connection was verified using the screws listed in this section in combination with the seals listed in the previous section. Other screw / flange variants were not verified.

	Temperature ranges for screws and nuts			
	-10°C to +80°C	-40°C to +80°C		
Pressure		**Variant 1**	**Variant 2**	**Variant 3**
up to and including 40 bar	Screws complying with DIN EN ISO 4014 made of material 5.6, Nuts complying with DIN EN ISO 4032 made of material 5-2	Screws complying with DIN EN ISO 4014 made of material 25CrMo4, Nuts complying with DIN EN ISO 4032 made of material 25CrMo4		
from 40 bar	Screw bolts complying with ANSI B1.1 made of material ASTM A193 Grade B7, Nuts complying with ANSI B1.1 made of material ASTM A194 Grade 2H	Screw bolts complying with ANSI B1.1 made of material ASTM A320 Grade L7, Nuts complying with ANSI B1.1 made of material ASTM A320 Grade L7	Screw bolts complying with ANSI B1.1 made of material 42CrMo4, Nuts complying with ANSI B1.1 made of material 42CrMo4	Anti-fatigue bolts complying with DIN 2510 made of material 25CrMo4, Nuts complying with DIN 2510 made of material 25CrMo4

2.3 Meter head

The RMG turbine meter TRZ 04 or TRZ 04-K is fitted with the meter head of type “G”.

Figure 3: Type “G” meter head

2.4 Standard version

The new standard design is type “G” meter head without mechanical drive shaft couplings. Therefore, this design provides no options for connecting additional mechanical equipment. The totalizer has the following features:

- 2 LF pulse transmitters (reed contacts)
- 1 tamper contact
- Encoder type ENCO 08 (option)
- Plastic case (optionally aluminum)
- IP 66 + IP 67 protection class
- Universally readable
- Rotatable by 355° without breaking a seal

Notice

The electrical connector must be covered by a cap closure or a connecting plug! Otherwise moisture may ingress into the meter head.

The tamper contact switches when a magnet is held outside the meter head close to the reed contacts.

2.5 Type “G-D” meter head

Figure 4: Type “G-D” meter head

Design and features like in the case of the type “G” meter head but additional with a mechanical drive shaft in compliance with EN 12261 on the top side of the case. This version is only possible with aluminum cap.

The direction of rotation of the drive shaft (with view on the drive shaft) is clockwise.

For dimensions and instructions for the connection see the description “Mechanical drive shaft coupling”. Especially note the maximum permissible torques!

2.5.1 Permissible torques (type “G-D”)

Nominal dia.	Sizes	Q_{max}	Q_{min} [m^3/h]	M_{max} [Nmm]

DN	G	m^3/h	1:20	1:10	1:5	1:20	1:10	1:5
50	65	100	-	10	20	-	-	-
80	100	160	8	16	32	-	1,0	2,0
80	160	250	13	25	50	1,4	2,4	3,9
80	250	400	20	40	80	1,4	2,3	3,9
100	160	250	13	25	50	0,14	0,6	1,3
100	250	400	20	40	80	0,5	1,1	2,1
100	400	650	32	65	130	0,8	1,6	3,3
150	400	650	32	65	130	0,5	1,5	2,4
150	650	1000	50	100	200	1,3	2	3,3
150	1000	1600	80	160	320	11,5	15,7	37,3
200	1000	1600	80	160	320	11	15	37
200	1600	2500	130	250	500	11	15	37

2.5.2 Mechanical drive shaft coupling

Type “G-D” meter head provides a mechanical drive shaft where additional equipment, e.g. slip-on pulse transmitters, volume correctors, etc., can be attached under official supervision.

Before you connect additional mechanically driven equipment, you must make sure that the direction of rotation and the rotation rate U_a (see chapter 5 Specifications) comply with the data on the gas meter. The torque required for driving the additional equipment must not exceed the value stated on the indicating plate of the drive shaft.

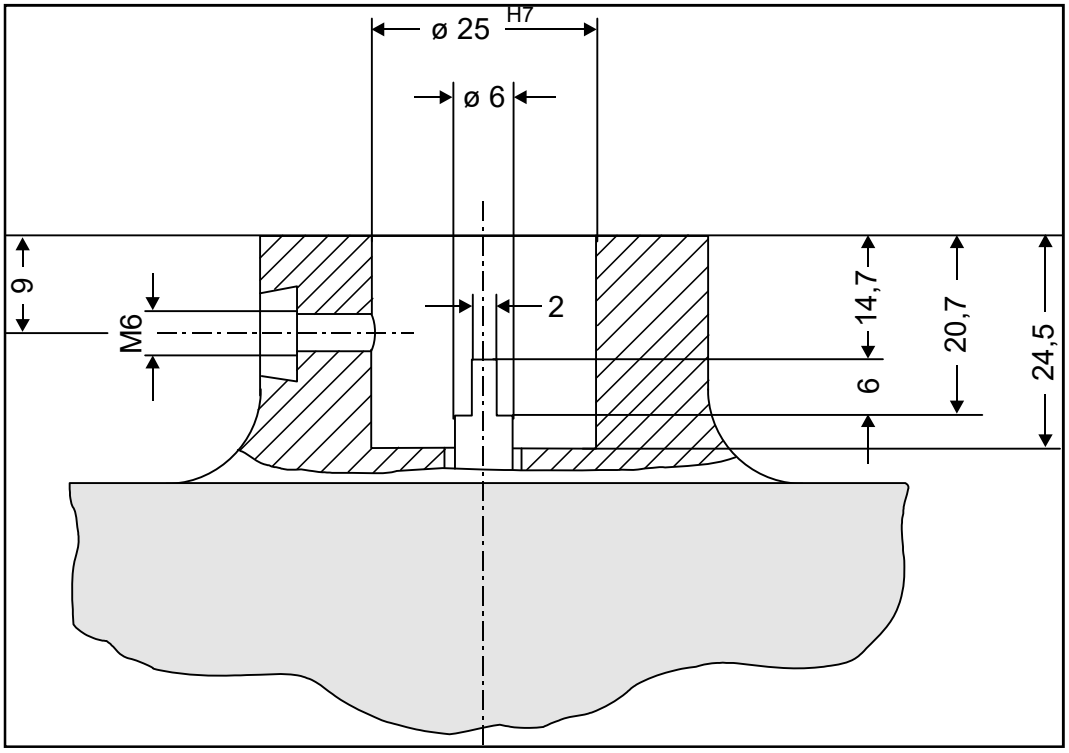


Figure 5: Dimensions of the drive shaft coupling

2.5.3 Connection of additional equipment

The drive shaft couplings of the meter head (type “G-D”) can be used for connecting additional mechanical or electronic measuring instruments. In this case, the total driving torque must not exceed the approved value. If no additional equipment is used, the drive shaft couplings are sealed.

The rotation rates of the drive shaft coupling depend on the meter size (see table).

Notice

Attention

Additional equipment or additional measuring instruments can only be attached or removed under official supervision. Before you connect additional equipment, make sure that the direction of rotation and the rotation rate of mechanical transmission coincide. Depending on the location for attaching additional equipment, you can turn the meter head into the most favorable position for installation without damaging the locking seals by loosening two hexagon socket screws.

General

You can turn the meter head through 355° without breaking a seal. It is not necessary to loosen a locking screw, the meter head is held in position because the rotary mechanism is stiff. The rotation thus requires a slight effort.

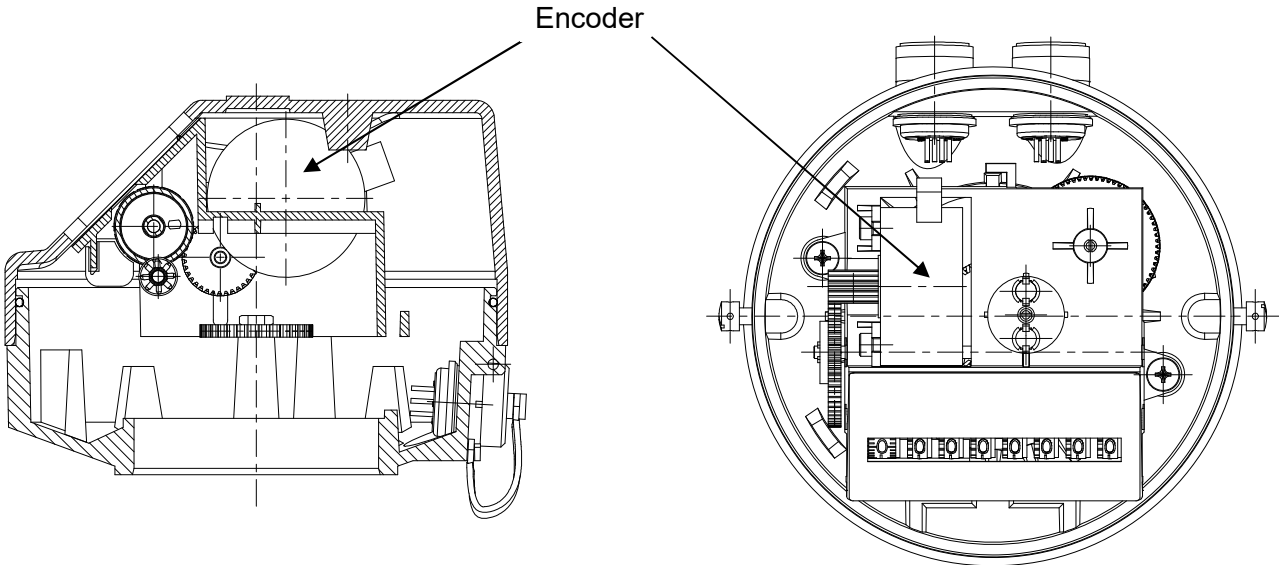


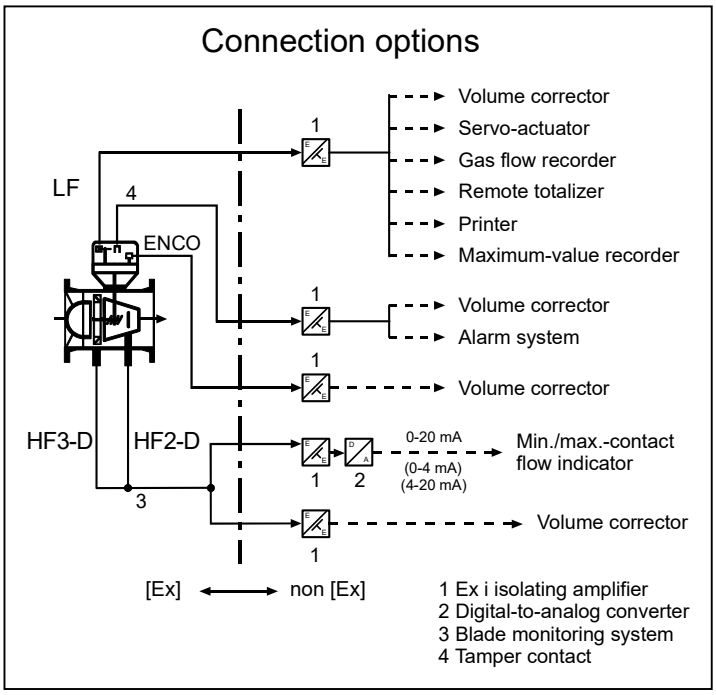
Figure 6: Type “G” meter head

Notice

If work has to be done on the meter head, please make sure that the official seals are not damaged.

2.5.4 Pulse transmitters

The TRZ 04 and TRZ 04-K turbine meters provide different sensors which supply volume pulses in a variety of frequency ranges. These pulses can be further processed by volume correctors or remote totalizers, for example. All pulse transmitters of the TRZ 04 have been approved for custody transfer metering. The connection options are shown in the following illustration.



Danger

All pulse transmitters are intrinsically safe and must be connected only to intrinsically safe circuits if they are used in areas subject to explosion hazards.

The safety barriers must meet the requirements of the

Ex ia IIC or Ex ib IIC type of protection.

For the NF and tamper contact the cable shield should only be connected on the supply side.

2.5.5 Pulse transmitters in the meter head (LF)

The meter heads of the RMG TRZ 04 and TRZ 04-K and turbine meters are fitted with two reed contacts as standard. The pulse value corresponds to the rotation rate U_a. See the indicating plate on the meter head for exact frequency data. The guide values are given in the tables on pages 33-34. The maximum pulse frequency is 0.3 Hz.

2.5.6 Pulse transmitters in the measuring element (HF 2-D and HF 3-D)

The higher-frequency flow signals from the HF 2-D and HF 3-D proximity sensors are used for control purposes and in conjunction with electronic flow computers suitable for custody transfer metering. In the case of the HF 3-D pulse transmitter, the pulses are picked off at the turbine wheel, while they are picked off at the reference wheel for the HF 2-D pulse transmitter. The two wheels are arranged in such a way that two pulse series of the same frequency are generated which are out of phase by 180°. The exact frequency is determined during meter proving and is stated on a supplementary data plate on the meter case. The guide values are listed in the tables on pages 33-34. The maximum pulse frequency is approx. 2100 Hz at Q_{max}, but depends on the meter size.

2.5.7 Tamper contact

A tamper contact is located directly next to the two reed contacts in the meter head. If the attempt is made to block the reed contacts with a magnet held on the meter head, this contact switches.

In passive state this contact is closed.

2.5.8 Encoder

With the rotary encoder type ENCO 08 the absolute totalizer reading of the mechanical index is acquired and transmitted as a data record to a volume corrector. The encoder is energy self-sufficient, which means, no battery or external power supply is necessary for the operation. The energy required for digital transmission of the totalizer reading is provided by the connected auxiliary device (volume corrector).

Danger

The encoder is approved for use in hazardous areas, the marking is as follows:

II 2 G Ex ib IIC T6

Warning

Attention must be paid to the selection of cables to guarantee that the permitted limits, in accordance with EC-type Examination Certificate of the explosion protected equipment, are not exceeded.

Danger

The Ex-signal circuit is to be laid in its own cable. For the installation of the encoder, a shielded cable may only be used (for example LIYCY 2 x 0.75 mm², coat color blue).

The cable shield has to be grounded at both sides. The earthing of the cable shield is on the non-explosion protected site. At the other cable end is the shield on the isolated mounted metallic ENCO 08 – housing.

Compliance with the regulations of DIN EN60079-14 the ENCO 08 housing can grounded also in explosive areas.

The meter body of turbine and rotary meter and the aluminum housing of ENCO 08-M have to be grounded.

The fixed installation of the intrinsically safe cables is absolutely required.

You may find the connector pin assignments in the appendix Connector pin assignments on page 57.

2.6 Specifications of the pulse transmitters

Electrical data:

<u>Reed-contact</u> – Contact as make-contact element

max. switching voltage	20 V/DC
max. switching current	40 mA
max. conduct load	200 mW
f_{max}	0,3 Hz

<u>HF 2/HF 3 – proximity switch</u>
Inductive proximity switch complying with DIN 19234 (NAMUR)

Supply voltage	7 to 15 V DC (with internal resistance R_i = 1 kΩ)
current if switch is not operated	≥ 3 mA
current if switch is operated	≤ 1 mA
f_{max}	2100 Hz
power	120 mW
explosion protection acc. to ATEX marking	II 1G Ex ia IIC T6

<u>ENCO 08</u> – Absolute Encoder

Supply voltage	7 – 13,5 V DC
Current	15 mA
Power	51 mW
Explosion protection acc. to ATEX marking	II 2G Ex ib IIC T6

Notice

The power rating in terms of the intrinsic safety, refer to the added certificates (s. Annex)

2.7 Temperature measurement

In order to measure the gas temperature, a resistance thermometer can be used in a thermowell in a fitting downstream of the gas meter. It is recommended that a second thermowell, e.g. for a monitoring thermometer, be used. If such thermowells are not provided for in the meter case, temperature measurement must be performed at a distance of up to 3 x DN or a maximum of 600 mm downstream of the turbine meter.

All turbine meters of types TRZ 04 from the nominal diameter of DN 80 (3") upwards can be fitted with a thermowell for a PT100 resistance thermometer.
Due to their short size, turbine meters of type TRZ 04-K cannot be fitted with a thermowell.

Operating temperatures prevailing at outdoor metering stations in winter or at natural gas metering stations downstream of regulating stations are usually in the range of -5°C to +10°C. By comparison, higher operating temperatures prevail at metering stations located downstream of compressor stations. For this reason, the measuring elements of the temperature sensors located outside the gas line must be appropriately insulated against the weather. In order to achieve optimum thermal conduction, oil as a heat transfer liquid should be filled in the thermowells in any case.

2.8 Commissioning

2.8.1 Filling with oil

Notice

When the turbine meters are delivered, the lubricators do not contain any oil. The oil pumps must not be filled with oil until they are at the installation site prior to commissioning! A small bottle of oil is supplied with each gas meter. Then you have to perform an initial lubrication.

For this see the detailed lubrication instructions in chapter 3.2 Lubrication.

2.8.2 Connecting the gas flow

⚠ Warning

Do not fill any downstream pipelines or station sections through the turbine meter. This may speed up the turbine wheel and lead to excessively high loads with resultant damage.

Notice

Short-time overload operation of 20% above the maximum flow rate Q_{max} is permissible. Such load conditions should be avoided, however, since in most cases they cannot be controlled and exceed the officially approved limits for custody transfer metering. Moreover, such overloads reduce the service life of the gas meter.

Warning

The gas flow must be free of foreign particles, dust or liquids. Otherwise it is recommended that filters or separators be installed.

Danger

With the start-up of this device it is to be observed that all cables were correctly laid and connected.

The housing must be completely closed.

With the connection and the start-up of the encoder, observe the guidelines of the appropriate norms

- **DIN EN 60079-0 and**
- **DIN EN 60079-14**

3 Operation

3.1 Influences on the error of measurement due to operation

3.1.1 Intermittent operation

Warning

Rapid changes of the gas flow should be avoided, since the turbine wheel can follow these changes only with a certain delay due to its inertia. In this way, errors of measurement occur, in particular, if the gas flow is shut off. Since in this case the turbine wheel slows down after the flow has stopped, a gas volume is measured which is always higher than that which has actually flowed through the gas meter.

3.1.2 Influence of pulsations

The gas flow must be free of shocks or pulsations. A gas metering station can be affected by flow pulsations, however, if the following equipment has been installed upstream or downstream in the system:

- reciprocating piston compressors,
- rotary displacement meters,
- gas pressure regulators lacking steadiness of operation,
- pipes where no gas flows (siphons).

Volume flow pulsation is the decisive quantity for evaluating the performance of gas meters under the influence of pulsations. Volume flow pulsation is physically always associated with **pressure variations**. The following relation is established in a first approximation:

$$\hat{Q}_{rel} \approx \hat{p}_{rel} \cdot \frac{DN^2}{\overline{Q}} \cdot K$$

With:

$\hat{Q}_{rel}$: is the relative volume flow pulsation (peak-to-peak)

$\overline{Q}$: is the mean volumetric flow

$\hat{p}_{rel}$: is the relative pressure pulsation (peak-to-peak)

DN: is the nominal diameter of the gas meter

K: is a constant depending on standard density, velocity of sound, compressibility, pressure at base conditions, temperature, and station-specific parameters.

With this relation, it is possible to estimate volume flow pulsation on the basis of pressure pulsation, which can be measured more easily.

Direct measurement of volume flow pulsation is preferable, however, since the results are more reliable. The crucial factor is the pulsation **at the location of measurement.**

3.1.3 Consequences

Notice

In the case of pulsating flow, the turbine meter shows a measured value which is too high.

Due to the pulse applied by the flow on the impeller which increases quadratically with the flow velocity, the resultant rotational speed is higher than the mean value of the flow velocity.

The influence with high gas density is less, but increases with a high mass moment of inertia (heavy impeller) or fast-running wheels.

Warning

Furthermore,
High pulsation amplitudes may result in premature wear of shaft bearings due to increased load.

3.1.4 Limiting values

Frequency ranges

- It is generally unlikely that measured values will be distorted in the frequency range above 100 Hz.
- In practice, it is hardly possible to initiate any significant flow variations at such frequencies.
- Disturbances are to be expected most frequently in the frequency range between 0.1 Hz and 100 Hz, since with typical station dimensions, the gas column can be expected to produce resonances. Flow variations with a high relative amplitude may occur.
- In the frequency range below 0.1 Hz, there is a quasi-steady flow which will not cause any distortion with the gas meters.

Pulsation amplitudes
Studies have shown that no disturbances are to be expected in the case of relative **flow pulsations below 5% (peak-to-peak)** and relative **pressure pulsations of less than 0.1% to 0.5% (peak-to-peak).**

These data should be regarded as approximate values depending on the flow rate and pulsation frequency involved.

3.2 Lubrication

3.2.1 Lubricator

For lubrication permanently fitted oil pressure pumps are used. The various designs are given in the tables below.

	Type of oil pump	Container volume	Delivered quantity
KO	Pushbutton pump	8 cm^3	0.114 cm^3/stroke
GO	Lever pump	150 cm^3	1.5 cm^3/stroke
DS	Permanent lubrication	--	--

	TRZ 04-K		TRZ 04	
	Pressure classes		Pressure classes	
DN	PN 10, 16 ANSI 150	PN 25, 40, 64, 100 ANSI 300, 600	PN 10, 16 ANSI 150	PN 25, 40, 64, 100 ANSI 300, 600
50	DS (KO)	KO	DS (KO)	KO
80	DS (KO)	KO	DS (KO)	KO
100	DS (KO)	KO	DS (KO)	KO
150	DS (KO)	KO	DS (KO)	KO
200	KO		KO	

Types in brackets are options

3.2.2 Specification for lubricating oils

Notice

For lubrication purposes, we recommend that you use only Shell Tellus S2 MA 10 or another lubricating oil with 2 to 4°E at 25°C in order to avoid damage to the shaft bearings. You can order your supply of lubricating oil from us in 1-liter containers under Ref. No. 82.11.148.00.

Shelf life of oil:

The shelf life depends on the operating conditions (e.g. UV light, humidity ..). In principle the oil suffers no quality loss during the first 3-4 years.

3.2.3 Initial lubrication

When the turbine meters are delivered, the lubricators do not contain any oil. The oil pumps must not be filled with oil until they are at the installation site prior to commissioning. A small bottle of oil is supplied with each gas meter.

For the initial lubrication more pump strokes are necessary than for the relubrications because first the oil pipes have to be filled with oil.

Pump	DN 50 – DN 200	DN 250 – DN 600
KO (pushbutton pump)	40 strokes	45 strokes
GO (lever pump)	-	10 strokes

3.2.4 Relubrication

Notice

The relubrication intervals are stated on an indicating plate on the meter case. See also “Lubrication procedure”.

Example:

Relubrication!
Every 3 months 2 strokes
Lubricating oil: 2-4°E at 25°C
see operating instructions

Notice

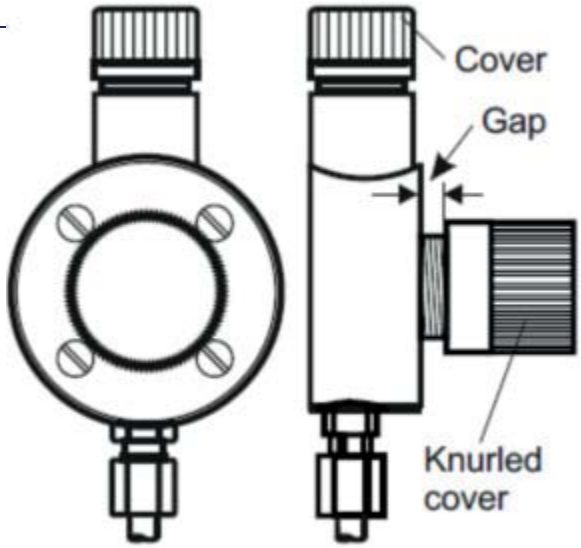
In the case of unfavorable operating conditions, such as condensate forming because of water or hydrocarbon, or dust-laden gas, or service temperatures above 50°C, we recommend that lubrication be performed at shorter intervals, even daily under extreme conditions (permanent formation of condensate).

If the gas meter is operated under the above-mentioned conditions, it is likely that its service life will be reduced. If you have questions to the relubrication in such cases please contact RMG.

3.2.5 Lubrication procedure

To fill the pumps and lubricate the turbine meters, proceed as follows:

Pushbutton pump (KO)



To fill with oil

- Unscrew cover.
- Fill with oil.
- Screw on cover again.

To lubricate up to 50 bar

- Unscrew knurled cover (screwed all the way to the pump casing when delivered)
- Press pushbutton, which is now visible, once for each stroke (delivered quantity: 0,114 cm3/stroke)
- Screw on knurled cover again. Make sure you stop screwing as soon as you can feel a resistance and leave a gap.

To lubricate over 50 bar

- Loosen the knurled cover (screwed all the way to the pump casing when delivered)
- Screw on the pushbutton tightly, once for each stroke (delivered quantity: 0,114 cm3/stroke)
- Screw on knurled cover again. Make sure you stop screwing as soon as you can feel a resistance and leave a gap.

Every 3 months 6 strokes

3.2.6 Maintenance

RMG turbine meters are maintenance-free except that they require lubrication at regular intervals. Since all gas meters fitted with oil pumps are shipped with an empty oil storage tank, it is absolutely essential to fill the storage tank of the oil pump with oil and perform the initial lubrication before the gas meter is put into service (see section “Lubrication”).

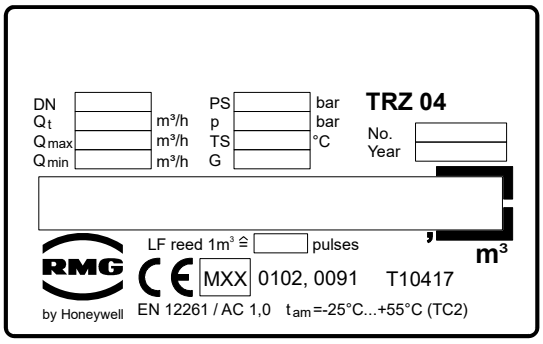
The operator should nevertheless check the turbine meter at regular intervals. In this connection, please refer also to DVGW code of practice G 495 (Gas pressure regulators for monitoring and servicing large-scale gas metering systems).

The gas meter should be checked for accuracy approximately every two years depending on whether it is possible or necessary to perform such checks. This can be done as follows:

- In the station itself by connecting two gas meters in series.
- In an officially acknowledged testing laboratory for gas measuring instruments.
- In the factory.

4 Labelling

All important data which are necessary for operating the gas meter are stated on the plates which are affixed to the meter case, totalizer or pulse transmitters.

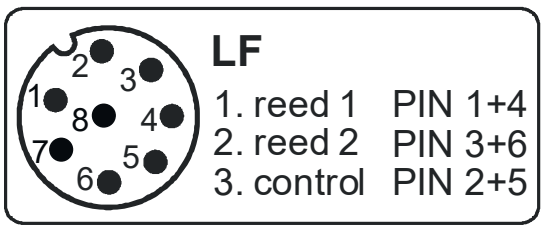


Main data plate of the TRZ 04 turbine meter with type “G” meter head

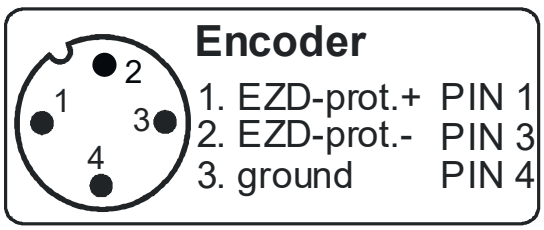
TS: Permissible temperature range for meter case (PED 2014/68/EU)

PS: Maximum permissible pressure for meter case (PED 2014/68/EU)

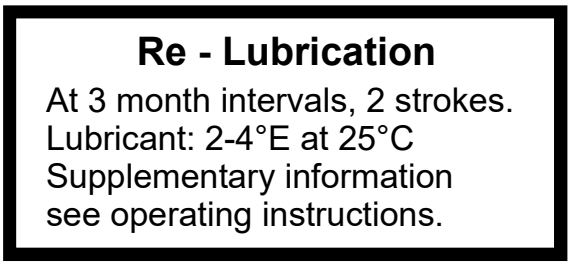
t_{am}: Permissible temperature range for custody transfer metering (MID)



Built-in pulse transmitters,
type “G” meter head
Pin 7 are 8 are not connected.



Built-in encoder
with type “G” meter head
Pin 2 is not connected.



Indicating plate for relubrication of the main bearings

Re- Lubrication

At 3 month intervals, 6 strokes.
Lubricant: 2 - 4°E at 25°C
The containervolume of 0,15 litre is sufficient for 3 months. Supplementary information see operating instructions.

Indicating plate for relubrication of the main bearings

Arrow indicating the direction of flow

p_m

Indication of the reference pressure tap

5 Specifications

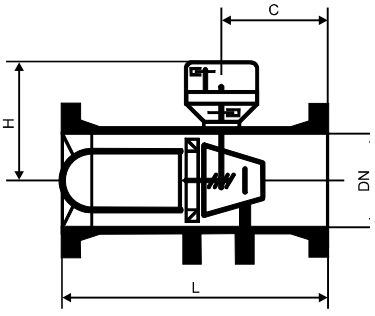
5.1 Meas. ranges/Dimensions/Pressure classes of the TRZ 04

DN	Size	Measuring range			U_a
mm		Q_{min}	Q_{max}	Q_t	
in		m^3/h	m^3/h	m^3/h	m^3
50 2"	G 65	5	100	20	0,1
80 3"	G 100	8	160	32	1
	G 160	13	250	50	1
	G 250	20	400	80	1
100 4"	G 160	13	250	50	1
	G 250	20	400	80	1
	G 400	32	650	130	1
150 6"	G 400	32	650	130	1
	G 650	50	1000	200	1
	G 1000	80	1600	320	10
200 8"	G 1000	80	1600	320	10
	G 1600	130	2500	500	10

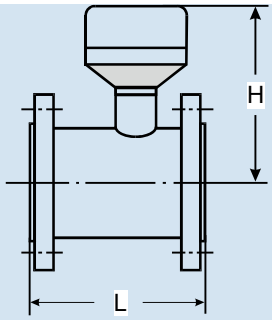
DN	Pressure classes/ Approx. weight.				Dimensions		
mm							
in	PN	kg	ANSI	kg	L	H	C
50 2"	10/16	13	150	13			
	25/40	21	300	13	150	210	60
			600	21			
80 3"	10/16	20	150	20			
	25/40	25	300	25	240	230	96
			600	36			
100 4"	10/16	25	150	30		240	
	25/40	32	300	35	300	260	120
			600	55		270	
150 6"	10/16	50	150	50		265	
	25/40	60	300	65	450	265	180
			600	100		285	
200 8"	10/16	75	150	100		300	
	25/40	95	300	120	600	320	240
	64	150	600	160		320	

PN pressure classes complying with DIN EN 1092, ANSI pressure classes complying with B16.5.

Turbine meters for all pressure ranges and pipe sizes can be equipped with a thermowell to accommodate a resistance thermometer.



5.2 Meas. ranges/Dimensions/Pressure classes of TRZ 04-K

Nominal dia / DN		Meas. range Qmin-Qmax	U_a	Pressure classes	L	H	Weight	Case design
mm	in	m^3/h	m^3		mm	mm	App. kg	
50	2“	6-100	0,1	PN 10, 16, 25, 40 ANSI 150, 300	150	212	10	Flanschausführung
80	3“	13-160 16-250 (25-400)	1	PN 10, 16, 25, 40 ANSI 150	120	245	14	
100	4“	25-400 (40-650)	1	PN 10, 16, 25, 40 ANSI 150	150	255	25	
150	6“	40-650 65-1000 (100-1600)	1	PN 10, 16, 25, 40 ANSI 150	175	285	40	
200	8“	100-1600 160-2500	10	PN 10, 16, 25, 40 ANSI 150	200	305	60	

On request you may get meters for other pressure ranges and other flange types as well.

5.3 Q_{min} depending on the operating pressure in natural gas

Values for custody transfer metering, according to MID approval

DN	G	Q_{max} [m^3/h]	$Q_{min,LP}$ [m^3/h]	Q_{min} [m^3/h] / p_{min} [bar_g]: Minimum flow rate for natural gas with corresponding minimum pressure											
				MB 1:30		MB 1:50		MB 1:80		MB 1:100		MB 1:120		MB 1:160	
				Q_{min}	p_{min}	Q_{min}	p_{min}	Q_{min}	p_{min}	Q_{min}	p_{min}	Q_{min}	p_{min}	Q_{min}	p_{min}
50	65	100	5	5*	4										
80	100	160	8	5	15	3,2	50								
	160	250	13	8	3	5	10	3,2	50						
	250	400	20	13	3	8	10	5	25						
100	160	250	13	8	3	5	25								
	250	400	20	13	3	8	10	5	25						
	400	650	32	20	3	13	4	8	10	6,5	15	5	25		
150	400	650	32	20	3	13	10	8	25	6,5	40				
	650	1000	50	32	3	20	4	13	10	10	15	8	25		
	1000	1600	80	50	3	32	4	20	10	16	15	13	25	10	40
200	1000	1600	80	50	3	32	4	20	10	16	15	13	25	10	40
	1600	2500	130	80	3	50	4	32	10	25	15	20	25	16	40

*: measuring range 1:20

To get the $Q_{min, HP}$ value for other gas types you can calculate it using the formula in chapter 1.8.1 Extension of the measuring range or you can contact RMG.

5.4 Values for 2nd metering or meters without MID approval

G	Q_{max} m³/h	$Q_{min,LP}$[1] m³/h	$Q_{min,HP}$ – natural gas **m³/h**								
			Operating pressure in bar_a								
			5	10	15	20	30	40	50	60	100
65	100	10[2]	5	4	3	3	2	2	2	2	1
100	160	16[2]	7	6	4	4	3	3	2	2	2
160	250	13	7	6	4	4	3	3	2	2	2
250	400	20	11	8	6	6	5	4	4	3	2
400	650	32	18	13	10	9	7	6	6	5	4
650	1000	50	28	20	16	14	11	10	9	8	6
1000	1600	80	44	31	26	22	18	16	14	13	10
1600	2500	130	72	51	42	36	29	26	23	21	16

[1] LP standard measuring ranges 1:20 and 1:30 (on request)
[2] Measuring range 1:10

It depends on national laws whether these measuring ranges are applicable for custody transfer metering.

To get the $Q_{min, HP}$ value for other gas types you can calculate it using the formula in chapter 1.8.1 Extension of the measuring range or you can contact RMG.

5.5 Overview of the materials used

Designation	Material
Meter case	Spheroidal graphite iron, cast steel or welded steel
Flow straightener	Delrin, aluminum or steel
Turbine wheel	Delrin or aluminum
Measuring element case	Aluminum
Measuring element bearings	Aluminum and/or stainless steel
Ball bearings	Stainless steel
Shafts	Stainless steel
Gearing	Stainless steel or plastic
Magnetic coupling	Stainless steel
Meter head cap	Plastic or aluminum
Totalizer	Plastic

Annex

Certificate for LF-, HF-sensors and Encoder

Table of used sensors

Pulse Generators	Type	EC-type examination certificate according to directive 94/9/EG	Producer	Annex
LF-sensor (LF)	Reed contakt: *PMC-1401*	Ex Schutz Gutachten vom 06. Juni 2013	PIC GmbH D-90530 Wendelstein Germany	**A** (1 page)
HF-sensor (HF2-D and HF3-D)	Inductive proximity switch:NF503A	PTB 01 ATEX 2192 IECEx PTB 08.0058 II 1 G Ex ia IIC T5	IFM electronic D-45127 Essen Germany	**B** (8 pages)
ENCO 08	Electronic encoder type ENCO 08	BVS 15 ATEX E 041 X II 2G Ex ib IIC T6	RMG Messtechnik D-35510 Butzbach Germany	**C** (2 pages)

Type approval to PED 2014/68/EU

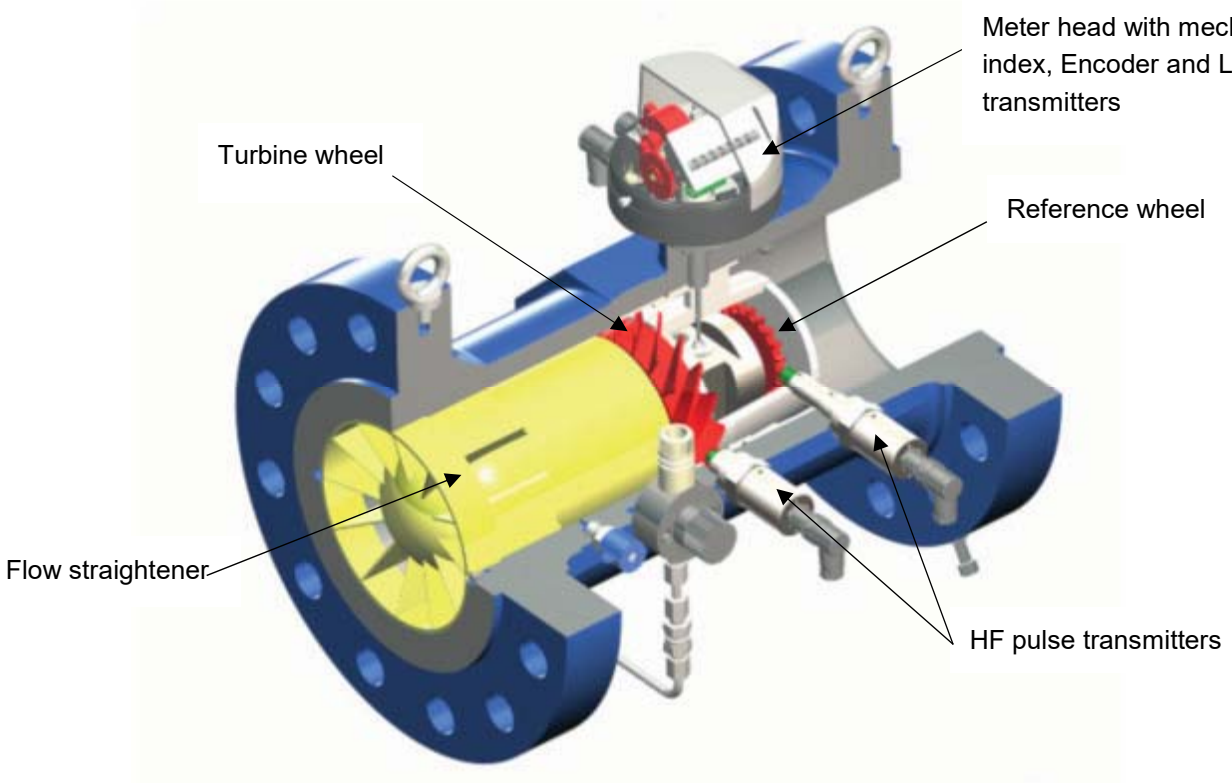
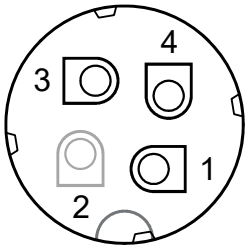
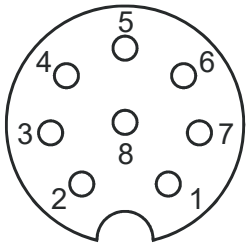
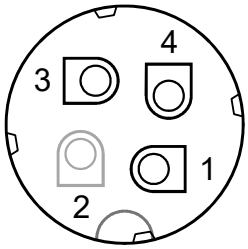


Figure 7: Sectional drawing of a turbine meter.

Connector pin assignments

On the rear side of the meter head there are two sockets for Binder plugs of series 713. The left one (optional) for connection of the encoder, the right one for the LF pulses. The figure shows the view on the plugging side of the sockets.

Contact	ENCO 08	LF / tamper	HF 2-D / HF 3-D
			
1	Vo **+**	LF 1	HF **+**
2	-	tamper contact	-
3	Vo **-**	LF 2	HF **-**
4	PE	LF 1	not connected
5		tamper contact	
6		LF 2	
7		not connected	
8		not connected	

Cable diameter for HF 2-D, HF 3-D and ENCO 08: 6-8 mm.

Annex: A

Ex-Schutz-Gutachten

Prüfgrundlage

EN 60079-0:2009
EN 60079-11:2012

Zündschutzart

Eigensicherheit

Auftraggeber

RMG Messtechnik

Prüfobjekt

Reedkontakteinheit Zählwerk G für TRZ 04 und DKZ 02
bestehend aus drei Reedschaltern im Träger und einem Steckverbinder
2 x Reedschalter Typ PMC 1401 (Schließer)
1 x Reedschalter Typ PMC 1496 (Öffner)
1 x Steckverbinder Typ 713, 8-polig (Fa. Binder)

Aufgabenstellung

Klärung der Frage, ob das Prüfobjekt als „Einfaches elektrische Betriebsmittel“ gelten kann. Die Prüfung erfolgt auf Basis der unten genannten Prüfungsunterlagen und eines Musters.

Prüfergebnis

Die Reedkontakteinheit ist ein „Einfaches elektrische Betriebsmittel“ und bedarf zu ihrem Einsatz in explosionsgefährdeten Bereichen der Zonen 1 und 2 keiner Zertifizierung.

Sie ist bestimmt zum Anschluss an 1 bis 3 eigensichere Stromkreise, die in der Reedkontakteinheit nur funktionell galvanisch getrennt, jedoch **nicht** sicher voneinander isoliert und **nicht** sicher isoliert zu anderen geerdeten oder ungeerdeten Teilen sind. Die Stromkreise sind folglich als untereinander und mit Erde verbunden zu betrachten und es ist zu prüfen, ob diese Zusammenschaltung sicher ist.

Höchstwerte (je Stromkreis): Ui = 20 V
Ii = 40 mA
Pi = 200 mW

Li, Ci und Eigenerwärmung sind vernachlässigbar

Ta = -25 … +60 °C, anwendbar für Temperaturklasse T6

Prüfungsunterlagen

Zeichnung Reedkontakteinheit 059951.3 von 2009-11-02
Datenblatt Gießharz DELO-DUOPOX AD 894 (Rev. 23)
Toleranzbetrachtung des Steckerherstellers
Datenblätter zu Reedröhren, Steckverbinder und Schaltlitzen

Verfasser

Dipl.-Ing. Werner Holtfreter, 68169 Mannheim, Am Sonnengarten 4 / 13,
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Subject to technical modification

For further information
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www.rmg.com

or contact your local sales support office
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