
Operating Manual

# Ultrasonic Flowmeter USM GT400

| | |
|---|---|
| Issued: | July 30th, 2024 |
| Version: | 11.1 |
| Firmware: | 1.5 |

**Manufacturer** Our customer service is available for technical queries:

| | |
|---|---|
| **Address** | RMG Messtechnik GmbH<br>Otto-Hahn-Straße 5<br>D-35510 Butzbach |
| **Telephone Switchboard** | +49 6033 897 – 0 |
| **Telephone Service** | +49 6033 897 – 0 |
| **Telephone Spare Parts** | +49 6033 897 – 173 |
| **Fax** | +49 6033 897 – 130 |
| **E-Mail** | service@rmg.com |

**Original Document** The Ultrasonic Flowmeter **USM GT400 OPERATING INSTRUCTION** July 30th, 2024 is the original document. This document may serve as a reference for translations into other languages. Please use in case of any uncertainties the German version as main reference.

You can register your product on our website at https://www.rmg.com/en/help/device-registration. By this you are helping us to improve our support

**Note** The latest version of this manual (and other devices) can be downloaded at your convenience from our Internet homepage:

**www.rmg.com**

| | |
|---|---|
| **Date created** | 1/31/2014 |
| **…** | |
| **8th revision date** | 02/19/2021 |
| **9th revision date** | 04/28/2021 |
| **10th revision date** | 12/07/2023 |
| **11th revision date** | 03/06/2023 |

**Document version and language**

| | |
|---|---|
| **Document version** | Ultrasonic Flowmeter USM GT400 manual en_11.1<br>July 30th, 2024 |
| **Language** | EN |

# Content

# 1 About this manual

**Content**



## 1.1 Objective of the manual

In this chapter you will be given information on this manual.

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

The ultrasonic gas meter 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.

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

## 1.2 Specialized knowledge required

This manual provides information that is necessary for fault-free and safe operation.

2

The Ultrasonic Flowmeter USM GT400 was designed and produced according to the state of the art and generally recognized safety standards and directives. However, its use can entail dangers that are avoidable by complying with this manual. The device must only be used as intended and in technically sound condition.

**⚠ Caution**

**Unintended use voids all warranty claims and the Ultrasonic Flowmeter USM GT400 can also lose its approvals.**

### 1.2.1 Specialized knowledge required

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.

Further information can be found under:

⇨ Chapter 5.3, „Qualification of the personnel“ on page 63

### 1.2.2 Abbreviations

The following abbreviations are used:

| | |
|---|---|
| AGC | Automatic Gain Control |
| ca. | circa, approximately |
| as app. | as applicable |
| max. | maximum |
| MC | Measurement Canada |
| MID | Measurement Instruments Directive |
| min. | minimum |
| SNR | Signal to Noise Ratio |
| SoS | Speed of Sound |
| TD | Transducer (ultrasonic transmitter and receiver) |
| TNG | Transducer of a certain production type. |
| USE | Ultrasonic electronics |
| USM | Ultrasonic gas meter |
| e.g. | For example |

### 1.2.3 Layout of instructions

The following notices are used:

4

**Danger**

**This warning notice informs you of imminently threatening dangers that can arise due to misuse/operator error. If these situations are not avoided, death or severe injuries can occur.**

**Warning**

**This warning notice informs you of potentially dangerous situations that can arise due to misuse/operator error. If these situations are not avoided, minor injuries can occur.**

**Caution**

**This notice informs you of potentially dangerous situations that can arise due to misuse/operator error. If these situations are not avoided, damage to the device or nearby property can occur.**

**Note**

**This notice provides you with helpful tips to make your work easier. This notice also provides you with further information about the device or the work process in order to prevent operator error.**

### 1.2.4 Working with the device

#### 1.2.4.1 Safety instructions Danger, Warning, Caution and Note

**Danger**

**All of the following safety notices must be observed!**

**Disregard of the safety notices can result in danger to the life and limb or environmental and property damage.**



Bear in mind that the safety warnings in this manual and on the device cannot cover all potentially dangerous situations, because the interaction of various conditions can be impossible to foresee. Merely following the instructions may not suffice for correct operation. Always remain attentive and consider potential consequences.

- Read this operating manual and especially the following safety notices carefully before working with the device for the first time.
- Warnings are provided in the operating manual for unavoidable residual risks for users, third parties, equipment, or other property. The safety instructions used in this manual do not refer to unavoidable residual risks.
- Only operate the device in fault-free condition and in observance of the operating manual.
- Compliance with local statutory accident prevention, installation and assembly regulations is also mandatory.

**Caution**

**All notices in the manual must be observed.**

**Use of the gas chromatograph PGC 9300 is only permitted in accordance with the specifications in the operating manual.**

**RMG assumes no liability for damages arising due to disregard of the operating manual.**

**Danger**

**Service and maintenance tasks or repairs that are not described in the operating manual must not be carried out without prior consultation with the manufacturer.**

**Changes to the device are not permitted.**

**The technical specifications must be observed and followed for safe operation (see chapter 13: Technical specifications).**

**Performance limits must not be exceeded.**

**Please only use the screws, bolts, nuts and seals listed in chapter 7 or parts with comparable characteristics to install the meter in the pipework.**

**For safe operation, the device must only be used in the scope of the intended use. (see chapter 5.1 Intended use).**

#### 1.2.4.2 Dangers during commissioning

| | |
|---|---|
| Initial commissioning | The initial commissioning must only be carried out by specially trained personnel (training by RMG) or RMG service personnel. |

**Note**

**An acceptance test certificate and corresponding test report must be created for the commissioning.**

**These, the operating manual and the CE Declaration of Conformity must be stored so that they are always readily available. In the process, the entire documentation, including the conformity declarations and certificates must be checked for completeness.**

**As far as possible, all sharp edges on the device have been removed. Nevertheless, personal protective equipment must be used for all work, which must be provided by the operator.**

**Danger**


**This symbol is used in the manual as a warning of the danger of explosion; observe the instructions following the symbol.**



With the danger of explosion, the following must be observed, in particular:

- Install the device as specified in the operating manual. If the device is not installed as specified in the operating manual, there may be a risk that other connected devices do not have adequate explosion protection.

  **The explosion protection is lost!**

- When installing, observe the flow direction marked with an arrow on the housing.
- Inadequately qualified persons working on the equipment are unable to correctly estimate dangers. Explosions can be triggered. Only work on the equipment if you have the appropriate qualifications.
- Components can be damaged if you do not use suitable tools and materials. Use tools that are recommended for the respective work in the operating manual.

| | |
|---|---|
| Mechanical installation | Mechanical installation must only be performed by appropriately qualified technicians. |
| Electrical installation | Installation on electrical components must only be carried out by qualified electricians. |
| Mechanical and/or electrical installation | These qualified personnel require training specifically for work in explosion-prone areas. Qualified personnel are persons who have training / education in accordance with **DIN VDE 0105, IEC 364** or **comparable standards**. |

**Danger**

**Connection of pressurized pipelines must only be carried out by trained qualified personnel.**

8

**Danger**

**The installation and removal of the USM GT400 may only take place in a depressurized state and in an explosion-free atmosphere. During the installation process, the descriptions in the operating instructions must be observed.**

**In general, it is recommended to carry out an exchange only in consultation with RMG Service.**

**After working on pressure-bearing components, the tightness must be checked.**

**All of the above points also apply to repair and maintenance work and generally when the meter has to be opened.**

**Flange fastening elements, screw plugs, screw connections and check valves as well as pressure extraction screw connections, valves and protective tubes must not be loosened during operation.**

### 1.2.4.3 Dangers during maintenance and repair

| | |
|---|---|
| Operating personnel | The operating personnel use and operate the device in the scope of the intended use. |
| Maintenance personnel | Work on the device must only be carried out by qualified personnel who can carry out the respective tasks on the basis of their technical training, experience and familiarity with the applicable standards and requirements. These qualified personnel are familiar with the applicable statutory regulations for accident prevention and can independently recognize and avoid potential dangers. |
| Maintenance and cleaning | Maintenance and cleaning must only be performed by appropriately qualified technicians. |

**⚠ Danger**

**Inadequately qualified persons working on the equipment are unable to correctly estimate dangers. Explosions can be triggered. If work on live equipment must be conducted in explosion-prone areas, sparks that are created can trigger an explosion.**

**Only work on the equipment if you have the appropriate training and qualifications.**

**⚠ Danger**

**The device can be damaged if it is not cleaned as specified in the operating manual. Only clean the device as specified in the operating manual.**

**If you do not use the appropriate tool, components may be damaged. The explosion protection becomes invalid.**

- **Only clean the device with a slightly damp cloth!**

**Danger**

**The USM GT400 must only be used as intended! (Chapter 5.1).**

**Danger**

**Prevent use of the USM GT400 as a potential climbing aid or use of attachments of the USM GT400 as potential handles.**

#### 1.2.4.4 Qualification of the user

**Note**

**In general, the following is recommended for all persons working with or on the USM GT400:**

- **Training / education for work in explosion-prone areas.**
- **The capacity to be able to correctly estimate dangers and risks when working with the gas USM GT400 and all connected devices. Possible dangers include components that are under pressure and consequences of incorrect installation.**
- **Recognition of dangers that can arise from the flow medium that is used.**
- **Training / education by RMG for work with gas measuring devices.**
- **Education / instruction in all national standards and directives to be complied with for the work to be carried out on the USM GT^^400 analytical computer.**

### 1.2.5 Risk assessment and minimization

According to assessment by qualified employees of RMG, the USM GT 400 is subject to risks during its use. Risks can also arise due to high pressures and occasionally due to pressures that are too low. Work outside of the permissible temperature range can also lead to dangers. Impermissible current and voltage values can trigger explosions in explosion-prone areas. The risk assessment requires an emptying and ventilation of the pipeline for connection of a USM GT 400. Then and only then it is assured that there is not an explosion-prone gas mixture in the pipeline. Naturally, work must only be carried out by trained personnel (see chapter 5.3 Qualification of the personnel) who are also trained to recognize suitable tools and use them exclusively. These risks were summarized alongside development and measures were taken to minimize these risks.



**Measures for risk minimization:**

- All pressurized parts are designed in accordance with AD 2000 rules and regulations, Pressure Equipment Directive, Annex 1
- The complete pressure design has been inspected by TÜV Hessen
- All pressurized parts have been manufactured with a material certificate; there is an uninterrupted change of batch tracing of pressurized components
- The mechanical properties of all relevant pressurized components have been subjected to tension tests, notch impact bending tests and hardness tests
- Non-destructive testing was also carried out: X-ray and ultrasonic inspection of the meter housing for defective points in material, surface crack testing with magnetic powder and a color penetration process
- Strength tests for components were conducted at 1.5 times the nominal pressure for the pressure testing; the leak testing for the assembly was conducted at 1.1. times the nominal pressure. Certificates were issued for successfully passed tests.
- The maximum operating pressure and the permissible temperature range are specified on the type plate of the device. Operation of the device is only permitted within these specified ranges.

**Danger**

**The following applies for work in explosion-prone areas (all zones):**

- **Only tools that are approved for Ex Zone 1 are permitted for maintenance and repair tasks. Components can be damaged if you do not use suitable tools.**
- **The explosion protection is lost.**
- **Otherwise, work must only be carried out when there is not an explosive atmosphere.**
- **The risk of ignition due to impact or friction must be avoided.**
- **The wiring from and installation of the gas chromatograph PGC 9300 in explosion-prone areas must only be carried out by trained personnel in accordance with EN60079-14 and in observance of national regulations.**
- **Qualified persons must satisfy the definitions in accordance with DIN EN 0105 or IEC 364 or directly comparable standards.**
- **Only trained and instructed personnel are permitted. Work on the measuring system must only be carried out by qualified persons and inspected by responsible qualified supervisors.**
- **Qualified persons have been authorized by the person responsible for safety of personnel to carrying out such work on the basis of their training, experience or instruction and familiarity with applicable standards, provisions, accident prevention regulations and system conditions. It is essential that these persons are able to recognize and avoid potential dangers in good time.**

### 1.2.6 Validity of the manual

This manual describes the Ultrasonic Flowmeter USM GT400. The Ultrasonic Flowmeter USM GT400 is only part of a complete system. The manuals of the other components of the system must be observed, too. If you find contradictory instructions, contact RMG and/or the manufacturers of the other components.



**⚠ Caution**

**Ensure that the power data of the current connection matches the specifications on the type plate. Observe any applicable national regulations in the country of use. Use cable that is appropriate for the cable fittings (see chapter 8.3 Connecting the device electrically).**

**⚠ Danger**

**Only work on the equipment if you have the appropriate training and qualifications.**

#### 1.2.6.1 Danger during operation

Observe the specifications of the system manufacturer and/or system operator.

#### 1.2.6.2 Dangers of operation in EX areas

**⚠ Danger**

**Only use the ultrasonic flowmeter USM GT 400 in its original condition.**

- Only operate the USM GT 400 in fault-free and complete condition. If you make technical changes to the device, safe operation can no longer be guaranteed.
- When connecting additional measuring components or additional equipment in explosion-prone areas, ensure that the appropriate explosion protection is provided for these components.
- They are intrinsically safe devices for which galvanic isolation must be provided with connection of these devices.

The USM GT 400 is permitted for operation in Ex Protection Zone 1, but only within the permissible temperature range (*Chapter 13: Technical specifications*).



#### 1.2.6.3 Responsibility of the operator

As the operator, you must ensure that only adequately qualified personnel work on the device. Ensure that all employees who work with the device have read and understood this manual. You are also obligated to train personnel regularly and inform them of the dangers. Ensure that all work on the device is carried out exclusively by qualified persons and inspected by responsible qualified supervisors. The responsibilities for installation, operation, fault rectification, maintenance and cleaning must be clearly regulated. Instruct your personnel with regard to the risks involved with working with the device.

Suitable personal protective equipment must be used for all work on the USM GT400, which you as the operator must provide. This also applies even though all sharp edges on the device have been removed as far as possible.

### 1.2.7 Transport

The device is packaged specific to the transport requirements for each customer. Ensure safe packaging that absorbs light impact and vibrations is used for any further transport. Nevertheless, inform the transport company that all types of impact and vibrations should be avoided during transport.

The following applies in particular to transport:

- Shocks and vibrations are to be avoided
- Protect the USM GT400 from moisture
- If you suspect improper transport or damage during transport, please contact RMG's service department immediately

**Warning**

**Risk of injury during transport**

Any foot screws must be mounted if they are provided as a transport safeguard to prevent rolling and tipping. Additional measures must be taken to ensure that impermissible rolling and tipping are prevented.

Only use the provided lifting eyes / ring screws to lift the meter. Please observe the relevant permissible loads for the lifting equipment. Prior to lifting, ensure that the load is securely fastened. Do not stand under suspended loads.

The device can slip, topple over or fall down when being lifted and set down. The device can fall over if the bearing capacity of the lifting equipment is disregarded. There is a risk of severe injury for nearby persons.

If the device is delivered on a Euro pallet, the device can be transported on the pallet using a pallet truck or forklift.

The gas meters and accessories must be protected from jarring and vibrations during transport.

The gas meters or any inlet/outlet pieces have a flange as an end piece. The flanges are sealed with a protective sticker or fitted with a plastic dummy plug. The protective stickers and/or dummy plugs must be removed without leaving any residue prior to installation in the pipeline. Residue from this film changes the flow and causes measuring errors!

This protection must be re-applied to the flanges for transport or storage of the device.

### 1.2.8 Scope of delivery

The scope of delivery can differ depending on the optional orders. The following is "normally" included in the scope of delivery:

| Part | Quantity |
|---|---|
| Ultrasonic Flowmeter USM GT400 | 1 |
| Manual | 1 |
| Test log | 1 |
| Calibration certificate | 1 |
| Material test certificate | 1 |
| Strength test certificate 3.1 | optional |

### 1.2.9 Disposal of packaging material

Dispose of the material in an environmentally friendly manner in accordance with national standards and directives.

### 1.2.10 Storage

Avoid extended periods of storage. After storage, inspect the device for damage and test for correct function. Contact the RMG service department to arrange for inspection of the device after a storage period of longer than one year. For this purpose, return the device to RMG.

If storage is nevertheless necessary, the following must be observed:

- Storage must take place in a dry and protected room.
- It must be ensured that all open pipes are sealed.

# 1.3 Explosion-proof design

## 1.3.1 General information



**Danger**

**The USM GT400 is permitted for installation in explosion-prone areas in Zone 1 that are endangered by gas and vapor assigned to explosion group IIB+$H_2$ and temperature class T6.**

**ATEX – Zulassungsnummer: BVS 14 ATEX E 034 X**

**Code:**  **II 2G Ex de IIB+$H_2$ T6 Gb**

The device conforms to the requirements of Directive 2014/34/EU.

The applicable regulations must always be observed during installation and operation. The device is approved for operation in hazardous areas. The permitted electrical data can be found in chapter 13.1 Performance data.

**Danger**

**Risk of destruction by body electricity, e.g. due to friction of clothing - appropriate protective clothing must be worn.**

**Note**

**During installation, it must be ensured that the enclosure protection class is observed. Direct sunlight must be avoided.**

The USM GT400 complies with protection class IP66 due to EN 60529.

**Temperature range**

**MID:**

-20 °C to +55 °C (Ambient temperature, for custody transfer measurement)

**ATEX:**

-40 °C to +80 °C

**Note**

**In case of doubt, the limited range of the MID applies: -25 °C to +55 °C (optional -40° to +55°C)**

# 1.4 Inspection and maintenance work

## 1.4.1 General information

Explosion-proof electrical control units must be regularly maintenanced. The time intervals of this maintenance depend on the operating and environmental conditions.

**Note**

**We recommend at least one check per year (e.g. in connection with the annual calibration).**

This chapter provides information on how you can extend the service life of the device through maintenance. You can only protect the device from premature wear if you adhere to the maintenance interval described here.

**Danger**

**Work on live electrical equipment is generally prohibited in hazardous areas (except for intrinsically safe circuits).**

In special cases, work can also be carried out on live electrical equipment in hazardous areas if it is ensured that no potentially explosive atmosphere is present. This may only be done with explosion-proof, approved measuring instruments.

**Danger**

**If access to electrical modules is necessary, the following precautions must be taken:**

- **The entire device must be disconnected from the power supply.**
- **When working with electronic assemblies, a connection must be established between an earthed object and the body.**

**Note**

**Pay attention to accumulation of water in the housing, because the explosion-proof housing is only conditionally protected from water by the gap protecting against ignition sparks (IP54).**

**Rusted or corroded gaps must not be cleaned with grinding materials or wire brushes; chemical means must be used, such as reducing oils. Then acid-free anti-corrosive agents, such as ESSO RUST BAN 397, Mobil Oil Tecrex 39 or equivalent products must be applied to the gaps for protection.**

**Danger**

**The seal for the Ex-e housing must be inspected for damage and replaced as necessary.**

**Check cable connections and sealing plugs for tight seating.**

**Damage to the housing can negate the Ex protection!**

If the device is repaired regarding a part which depends on explosion protection, it may only be put back into operation after it has been checked by a certified expert (*section 5.3 Qualification* ).

If repairs are carried out by RMG service, no acceptance by an expert is required.

### 1.4.2 Maintenance schedule

The maintenance schedule specifies the intervals at which maintenance work must be carried out to maintain the function of the device.

| Interval | Work |
|---|---|
| Weekly | Check seals for integrity. The time interval can be extended to a reasonable length of time. |
| As required | Clean the device. Check plug connections and screw connections for leaks and tightness, replace seals if necessary. |
| After 5 years | Check the device for leaks. Tightness should also be checked after any mechanical work on the USM or one of the connecting pipes. |
| After consultation with RMG | Check the device for leaks. The tightness of the device may be restricted if unauthorised types of gas are used. In this case, please contact RMG. |

### 1.4.3 Checking the device for leaks

To ensure safe operation, the device must be checked for leaks every 5 to 10 years.

**Note**

**During a recalibration at RMG, the device is also checked for leaks.**

If the device is used with the approved gases, the service life of the seals is unlimited (see also chapter 13.2, "Approved gas types")

**Note**

**If other gases are used, please consult RMG.**

**For the interaction with the ultrasonic gas meter and the type of gas used, RMG Service will recommend an interval for the leak test.**



### 1.4.4 Approved gas types

The device may only be operated with the following types of gas. Safe operation is only guaranteed with the specified gas types:

- Class 1 gases
- Class 2 gases
- Class 3 gases

The components of the gases must be within the concentration limits according to EN 437:2009 for test gases.

**⚠ Danger**

**Work on live electrical equipment is generally prohibited in potentially explosive atmospheres (except in the case of separate circuits).**

In special cases, work can also be carried out on energised electrical equipment in potentially explosive atmospheres if it has been ensured that no explosive atmosphere is present. This may only be done with explosion-protected, authorised measuring devices.

**⚠ Danger**

**If access to electrical assemblies is necessary, the following precautions must be observed:**

- **The entire device must be disconnected from the power supply.**
- **When working with electronic assemblies, establish a connection between an earthed object and the body.**

If the device is repaired with regard to a part on which the explosion protection depends, it may only be put back into operation after it has been checked by a recognised expert (chapter 5.3 Qualification of the personnel).



If repairs are carried out by the manufacturer, acceptance by an expert is not required.

# 2 Quick guide



This chapter does not replace the rest of the operating instructions. It shows only a brief section of the steps necessary in order to make the device ready for operation.

The chapter is only directed at experienced users.

- Observe the chapter safety.
  ⇨ *Section 5, “Safety” on page 60*

Detailed information for this content can be found under:

⇨ *Section 7, “Construction and Planning” on page 88*
⇨ *Section 8, “Installation” on page 104*
⇨ *Section 9, “Start Up” on page 141*
⇨ *Section 12.5, “Troubleshooting” 185*

**⚠ Danger**

**This chapter is only intended for experienced users!**

**It does <u>not</u> replace all safety instructions that are primarily listed in the first part of the manual but can also be found in the remaining chapters.**

**Moreover, use of this chapter “Quick guide” requires that the experienced user is familiar with all of these safety instructions and implements them when working with the device.**

**RMG rejects liability for any damage to the device or other connected devices if a user disregards even one of the safety notices in the overall manual because of this chapter “Quick guide”. This also applies to safety instructions to which reference was only made in this manual but were not explicitly listed.**

# 2.1 Mechanical connection

## 2.1.1 Connection flanges



**1** Make sure that the device and the connection flange have the same pressure rating / flange standards.

**2** Make sure that the device is sealed with the appropriate seals.

## 2.1.2 Inlet / outlet piping

| Operating mode | Inlet piping | Outlet piping | Temperature sensor position |
|---|---|---|---|
| Unidirectional operation | 10 D (no flow conditioner) | 3 D | 1,5 D to 5 D |
| Unidirectional operation | 3 / 5 D (with RMG or standardized flow conditioner)1 | 3 D | 1,5 D to 5 D |
| Bidirectional operation | 10 D (no flow conditioner) | 10 D (no flow conditioner) | 3 D to 5 D |
| Bidirectional operation | 3 / 5 D (with RMG or standardized flow conditioner)1 | 3 / 5 D (with RMG or standardized flow conditioner)1 | 2 D zo 5 D1 |

[1] Depending on the nominal width.

*See also “Inner diameter of connecting spool pieces” on page 199*

## 2.1.3 Joining pressure connections

■ **Establish connection with the clamping screw connection.**

**3** Unscrew the union nut of the clamping screw connection.

**4** Remove the blind plug.

**5** Push the union nut and clamping rings onto the pipe.

**6** Push the pipe into the clamping screw connection until the stop.

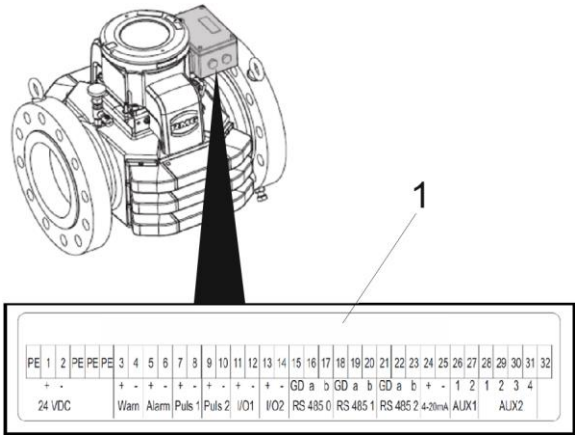
**7** Tighten the union nut to fix and seal the pipe.

■ **Establish connection with the female thread.**

**8** Unscrew the blind plug.

**9** Seal the connection in the thread.

## 2.2 Electrical connection




1 Terminal Connections

*Fig. 2.1: Connection assignment on the terminal strip*

**10** Connect the computer to the terminals **RS 485-0**.

**11** Allocate the terminal strips according to the applications.
Option: connect ERZ 2000 (-NG) to **RS 485-0**.

## 2.3 Start up

**12** Supply the device with power supply (24 V DC) via the system.

If the power LED illuminates green permanently, the device is ready for operation.

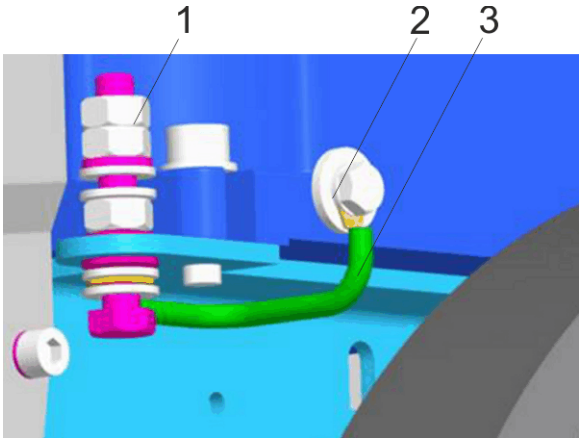
If the alarm and warning LED do not flash, the device operates trouble-free.

⇨ *Section 3.2, "Light emitting diodes" on page 33*

The USM-GT-400 is supplied without connection box to the North American region, the connection is made to cables that are led through a flame arrester. The marking of the cable (numbers) is (always) identical to the terminal assignment.

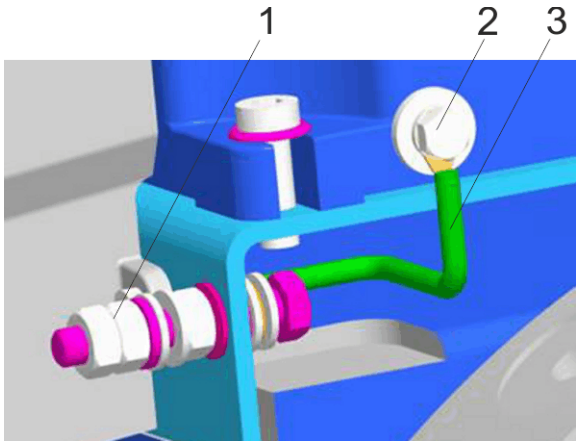
## 2.4 Earthing






1 Earthing screw M6
2 Earthing screw M6
3 Earthing cable

*Fig. 2.2: Earthing – Ultrasonic gas meters DN100 (4”) and DN150 (6”)*




1 Earthing screw M6
2 Earthing screw M6
3 Earthing cable

*Fig. 2.3: Earthing – Ultrasonic gas meters ≥ DN200 (8”)*

**13** Connect the earthing cable according to the ultrasonic gas meter version DN100 (4") to DN150 (6") or from DN200 (8").

## 2.5 Parameter setting

The device shall be supplied pre-assembled according to customer agreement. Changes to the pre-assembly are more extensive and are therefore not described in this brief instruction. If this should be necessary, you will then find the description:

⇨ *Section 10.1.3, “Calibration and Service Switch” on page 145*

# 3 Device overview

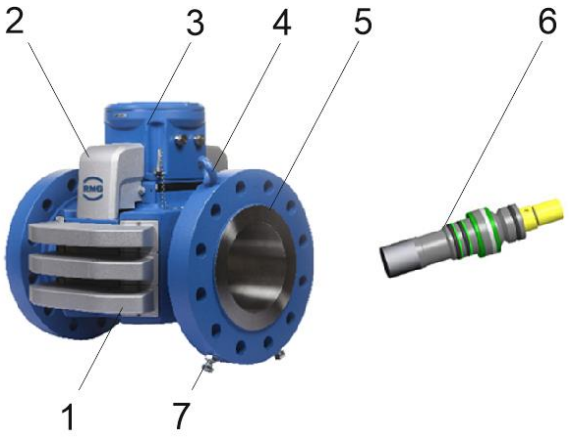


In this chapter you will receive information on the main components of the ultrasonic gas meter and the arrangement of the ultrasonic transducers in the housing of the ultrasonic gas meter.

**Content**



## 3.1 Main components




1 Covers of the transducer and transducer lines
2 Covers of the transducer
3 Ultrasonic electronics
4 Lifting eyes
5 Joining flanges
6 Transducer
7 Retaining bolts

*Fig. 3.1: Main components of the ultrasonic gas meter*

The ultrasonic gas meter consists of the following main components:

## Covers of the transducers (1 and 2)

The covers protect the connections and the lines of the transducer (TD) against contamination and mechanical damage.



## Ultrasonic electronics (3)

The ultrasonic electronics is in a pressure tight, encapsulated housing mounted on the ultrasonic gas meter. The ultrasonic electronics evaluates the data recorded by the transducers. In addition to the display, the parameters can be shown and evaluated on a computer using the RMGViewUSM software.

## Lifting eyes (4)

The lifting eyes can be used to safely transport the device using a suitable lifting gear.

## Connection flange (5)

The device is bolted onto the gas line using the connection flanges.

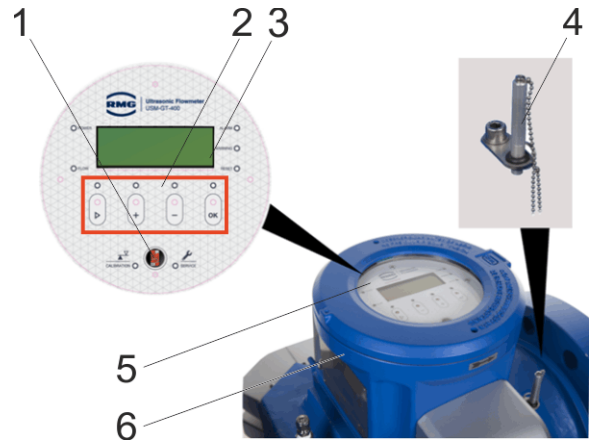
## Transducer (6)

The transducers are installed in the housing of the ultrasonic gas meter and are not visible once installed.

## Retaining bolts (7)

The retaining bolts are mounted when delivering the device. The retaining bolts secure the product from tipping over or rolling away. The bolts must be mounted to ensure for a safe installation or de-installation.

## 3.2 Ultrasonic electronics




1 Service- and calibration switch
2 Control panel
3 Display
4 Magnet for operation
5 Cover with viewing window
6 Pressure tight housing

*Fig. 3.2: Ultrasonic electronics and display*

Device data (readings and parameters) can be set and evaluated via the display and the operating elements.
Moreover, the device data (readings and parameters) can also be shown, evaluated and set using the RMGView$^{USM}$ software.

### Service and calibration switch (1)

The service switch (right switch) is only for RMG service. The service switch is, e.g., used to install new firmware.
The calibration switch (left switch) protects the parameters against unauthorized changes. The device can be configured by opening the calibration switch.

### Control panel (2)

The control field comprises buttons that are triggered by pressing a button or magnetically. Parameters, readings, warning, alarm and status messages are called up using the button.

### Display (3)

The display shows the readings, warning, alarm and status messages as well as the parameters.

### Magnet for operation (4)

The magnet is used to operate the control panel of the ultrasonic electronics when the housing is closed. If the magnet is placed above the symbol on the viewing window, this function is activated.

## Cover with viewing window and pressure tight housing (5 and 6)

The cover and the pressure tight housing encapsulate the ultrasonic electronics against the potentially explosive atmosphere.
During operation, information can be read through the viewing window from the display and status indicators of the LEDs.

## Electrical connection (Terminal strip)

More information on the electrical connection can be found here:

⇨ *Chapter 8.3, „Connecting the device electrically“ on page 112*

## Display screen

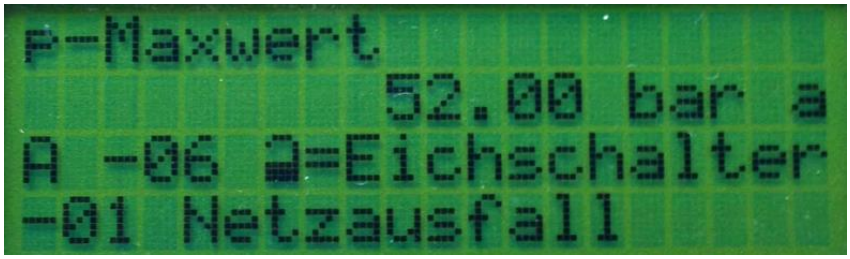



*Fig. 3.3: Ultrasonic electronics display*

### First line

Shows the name of the parameter (coordinates) called-up, e.g., p-maximum value (maximum pressure value).

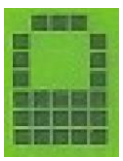
### Second line

Shows the value of the parameter (coordinates) called-up, e.g., 52.00 bar a.

### Third line

Shows the coordinate designation, e.g., A-06, thus column A, line 06.

The calibration switch is open. The value of the parameter can be changed.



The calibration switch is closed. The value of the parameter cannot be changed.

### Forth line

Shows the warning, alarm and status messages, e.g., -01 power failure.

## Buttons

When the cover is closed, the buttons can be operated through the glass using the magnet supplied. The cover must not be opened.

Switch in the columns. For example, jump from A to B and back.

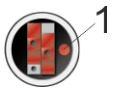
When holding for a longer time, you can change the columns by quickly scrolling back.

Move or scroll forwards in the lines step by step, e.g. from A-01 to A-02.
When holding for a longer time, you can change the lines quickly scrolling forward.

Move or scroll backwards in the lines step by step, e.g. from A-02 to A-01.
When holding for a longer time, you can change the lines quickly scrolling back.

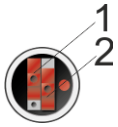

Enter values.

## Reset button



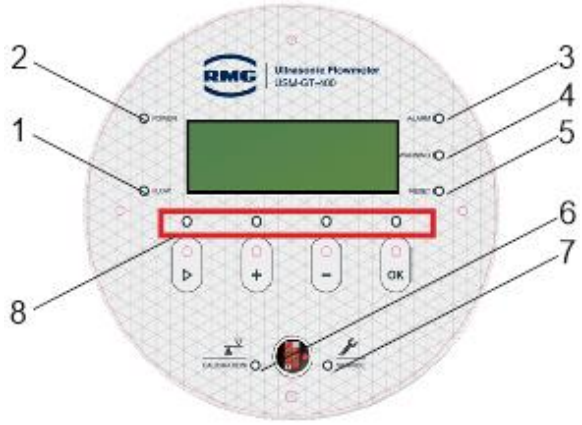

1 The reset button **(1)** is for RMG service only. If the reset button is pressed, the ultrasonic electronics is restarted.

## Switches




1 Calibration switch: Activate to change parameters.
2 Service switch: For RMG service only. For installing a new firmware.

## Light emitting diodes

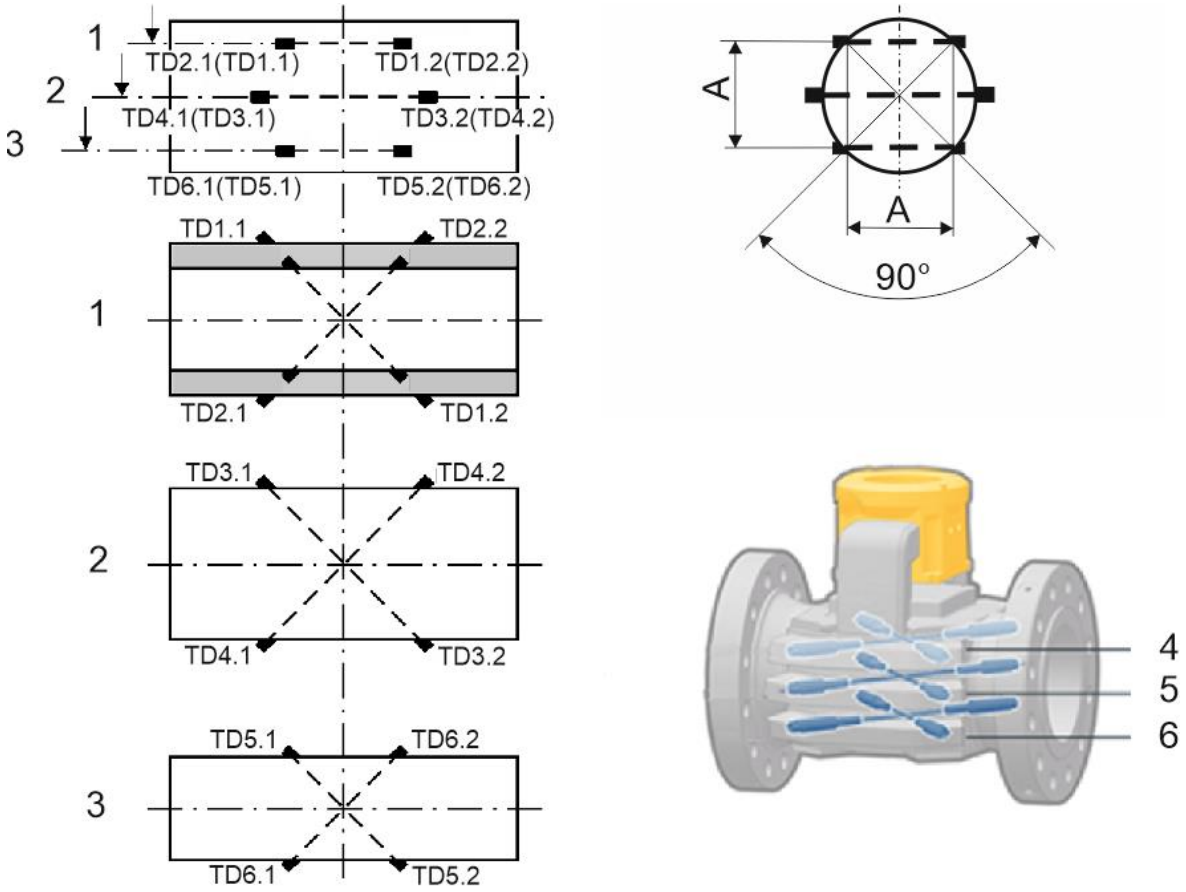



| | | | |
|---|---|---|---|
| 1 | Flow | 6 | Calibration (calibration switch state) |
| 2 | Power | 7 | Service (service switch state) |
| 3 | Alarm | 8 | Button states |
| 4 | Warning | | |
| 5 | Reset | | |

*Fig. 3.4: LEDs of the electronic ultrasonic electronics*

| LED | Illuminates continuously | flashing |
|---|---|---|
| Power | Voltage supply is switched on | --- |
| Flow | Gas flow present. | --- |
| Alarm | Alarm message is stored. | Alarm is active. |
| Warning | Warning message is stored. | Warning is active. |
| Reset | Reset is running. | --- |
| Calibration | Calibration switch is open. | --- |
| Service | Service switch is open. | --- |
| Control panel | Panel is being pressed. | --- |

## 3.3 Arrangement of the ultrasonic transducers




| | |
|---|---|
| 1 | Level 1 |
| 2 | Level 2 |
| 3 | Level 3 |
| 4 | Path 1 and 2 |
| 5 | Path 3 and 4 |
| 6 | Path 5 and 6 |

*Fig. 3.5: Transducer paths and levels of the ultrasconic gas meter*

The figure shows the arrangement of the transducers that are located in the ultrasonic gas meter. The arrangement of the transducers in the three levels is shown in three section representations.

Four transducers are installed per level. The transducers form two paths per level for the measurement.

# 4 Functional principle – Ultrasonic-flow measurement



**Content**

# 4.1 General description

In this chapter, you are provided with information as to how the ultrasonic gas meter records the data. The necessary formulas are listed for this purpose.



Figure 4.1 shows the general working principle. Transducer TD1 and TD2 are positioned opposite to each other for the measurement and form a measurement path with distance L. An ultrasonic pulse travels along the measuring path from sensor TD1 to transducer TD2 more quickly than the other way around. This is caused physically by vector addition of the flow velocity to the speed of sound, the arrow above the $\tilde{v}$ shows the direction of flow.

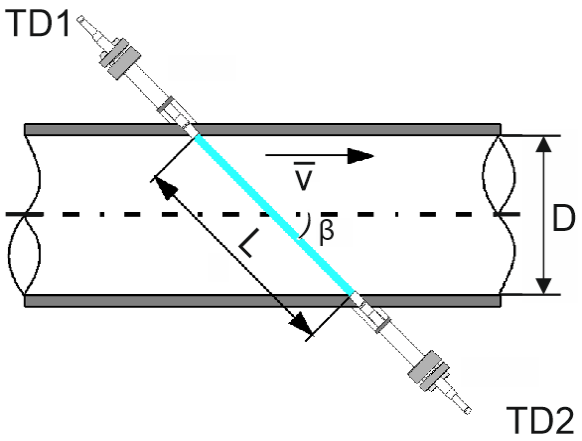



*Fig. 4.1: Two sensors form one path for the measurement*

The transit time from TD1 to TD2 (:= $t_{TD12}$ ) and from TD2 to TD1 (:= $t_{TD21}$ ) re calculated according to the following formula:

**Formulas**

$$t_{TD12} = \frac{L}{c_0 + \bar{v} \cdot cos\beta} \qquad t_{TD21} = \frac{L}{c_0 - \bar{v} \cdot cos\beta}$$

These transit times of the ultrasonic pulses are determined by the electronic ultrasonic system. These are used to determine the average velocity $\tilde{v}$ along the measuring path:

**Formula, average path velocity**

$$\bar{v} = \frac{L}{2 \cdot cos\beta} \cdot \left( \frac{1}{t_{TD12}} - \frac{1}{t_{TD21}} \right)$$

$$\bar{v} = \frac{L^2}{2 \cdot d} \cdot \frac{t_{TD21} - t_{TD12}}{t_{TD12} \cdot t_{TD21}} = \frac{L^2}{2 \cdot d} \cdot \frac{\Delta t}{t_{TD12} \cdot t_{TD21}}$$



**Legend**

| | |
|---|---|
| $\bar{v}$ | Average flow velocity |
| $c_0$ | Speed of sound |
| $\beta$ | Path angle to the pipe |
| $L$ | Path length |
| $d$ | Diameter D<br>(For a center path. Outer paths have a corresponding value.) |

For this calculation, it is important that only the transit times and the device parameters such as the transducer distance and the angle of the measuring path to the flow direction are required. All parameters that include a gas dependency are omitted.

In order to consider the average flow profile, in particular an asymmetrical or swirl-affected flow, a total of 6 paths is measured in 3 levels with the USM-GT-400 ultrasonic gas meter. The 3 levels can be derived mathematically via an integration procedure, the so-called Gauss integration.

⇨ *„Arrangement of the ultrasonic transducers" on page 33*

The respective average path velocities (designated with $v_i = \bar{v}_i$ for the respective measuring path i) along these measuring paths results analogically to the formula above.

Under certain conditions such as, e.g., smaller deviations from the tolerances during the production, it may be necessary to correct the path velocities with a common factor:

$$v_{ki} = k \cdot v_i$$

**Legend**

| | | | |
|---|---|---|---|
| $v_{ki}$ | = | Corrected path velocity | (m/s) |
| $k$ | = | Correction factor for the path velocities<br>(This factor is named vw factor d1 for the forward direction and vw factor d2 for back-flow; see parameter list) | |

Thus, one obtains for the average flow velocity:

$$v_w = \sum_{i=1}^{v} w_i \cdot v_{ki}$$

Flow velocity

**Legend**

| | | | |
|---|---|---|---|
| $v_w$ | = | Average flow velocity | (m/s) |
| $w_i$ | = | Weighting factor with regard to the flow profile | |

The summation and the weighting specified result from the mathematic Gaussian integration procedure.

**Quality of installation**

The USM-GT-400 provides parameters that allow a rating of the installation. If the values are within given ranges, then good measurement conditions can be assumed. If the values are outside the accuracy of the reading may be affected by disturbed flow conditions. Please contact in this case the RMG service.

⇨ *"Manufacturer" on page I*

**Turbulence**

Due to the actual flow, in particular the turbulence, there will be characteristic variations (variance $\sigma_i$ ) of the individual path velocities (i = 1..6; number of ultrasonic measuring paths), which allow an assessment of the installation. The ultrasonic path averaged turbulence ($Tu_i$ ) is calculated as follows:

$$\sigma_i = \sqrt{\frac{1}{N-1}\sum_{j=1}^{N}(v_{j,i} - \bar{v}_i)^2} \qquad \wedge\, i = 1..6; N = 20$$

Variance



$$Tu_i = \frac{\sigma_i}{\bar{v}_i}$$

Turbulence

**Legend**

| | | |
|---|---|---|
| $\bar{v}_i$ | = | Time averaged flow velocity along the ultrasonic path |
| $\bar{v}_{j,i}$ | = | Flow velocity along the ultrasonic path |
| $N$ | = | N = number of measured values according to parameter E-9 “moving average cnt”. For a significant determination of turbulence, the number should be at least 10. |

Typical values at very good flow conditions for middle paths are at 2 – 3%, for the outer paths, the turbulence increases to 4%. If these values are above 10%, then disturbed conditions can be assumed affecting the measurement accuracy. At lowest velocities the turbulence calculation is switched off.

**Profile and symmetry factor**

For a fully developed flow the middle path (3 + 4) have the highest velocity, the two outer paths (1 + 2; 5 + 6) are more or less equal. The profile factor ($PF$) is typically between 1.05 to 1.20; at values below 1.00 or above 1.50, the flow conditions should be checked.

$$PF = \frac{2(\bar{v}_3 + \bar{v}_4)}{(v_1 + \bar{v}_2) + (\bar{v}_5 + \bar{v}_6)}$$

Profile factor

The symmetry factor ($SY$) usually is between 0.9-1.10; at values below 0.75 or above 1.25 the flow conditions should be checked.

$$SY = \frac{(\bar{v}_5 + \bar{v}_6)}{(v_1 + \bar{v}_2)}$$

Symmetry factor

**Meter performance**

This value (*MP*) indicates whether the velocity of all ultrasonic paths could be measured and involved in the flow calculation. It is calculated on base of the last 20 measurements (same as turbulence).

$$MP = \frac{\sum_{1..100} \sum_{i=1..6} 1(\wedge v_{j,i} = ok) \vee 0(\wedge v_{j,i} \neq ok)}{600}$$

The highest value is 100%; under normal conditions it is above 95%. Since 2 measurement paths can fail before the USM-GT-400 loses its calibrated accuracy, the value may drop down to 66%; if the path failure is caused by a defect transducer an immediate repair of the failed transducers should be initiated.

All of these values are given at the display of the USM-GT-400; they are identical to the values in the RMGView[USM].

## 4.2 Correction of the base line

**Correction of the baseline for the velocity**
There are several influences (e.g. Reynolds number) resulting in a not exactly proportional relation between the measured and according to the formula in section 4.1 calculated mean velocity to the exact mean velocity. Here the following correction helps to compensate these variations:

**Formula, corrected average flow velocity**

$$v_{wk} = v_w \cdot K_v \cdot \left(1 + \frac{F}{100}\right)$$

**Legend**

| | | | |
|---|---|---|---|
| $v_{wk}$ | = | Corrected average flow velocity | (m/s) |
| $K_v$ | = | Meter factor | |
| $F$ | = | Error from the characteristic curve correction | |

These values can be used to calculate the process volume flow rate respectively the corrected process volume flow:

**Formula, process volume flow**

$$Q_m = v_w \cdot \pi \cdot \frac{D_i^2}{4} \cdot 3600 \cdot \frac{s}{h}$$

**Formula, corrected process volume flow**

$$Q_{mk} = k_k \cdot v_{wk} \cdot \pi \cdot \frac{D_i^2}{4} \cdot 3600 \cdot \frac{s}{h}$$

**Legend**

| | | | |
|---|---|---|---|
| $Q_{mk}$ | = | Corrected process volume flow | |
| $v_{wk}$ | = | Corrected weighted flow velocity | |
| $D_i$ | = | Inside pipe diameter | |
| $K_k$ | = | Characteristic curve correction | |

A 4th degree polynomial permits the so-called basic correction of the device:

## 4.2.1 Base line correction via polynomial

**Formula - Basic correction of the device, speed-based**

$$F_1 = \frac{Konst - G_{m2}}{v_w^2} + \frac{Konst - G_{m1}}{v_w^2} + Konst - G_0 + (Konst - G_1) \cdot v_w + (Konst - G_2) \cdot v_w^2$$

**Legend**

| | | | |
|---|---|---|---|
| $F_1$ | = | Deviation of the error curve | (%) |
| $v_w$ | = | Average flow velocity | (m/s) |
| $const\text{-}G_x$ | = | Constants of the basic correction (x=m2, m1, 0, 1, 2) | |

The constants const-Gx (x = m2, m1, 0, 1, 2) are calculated from the measured value pairs of the deviation with the respective flow velocity. The calculated correction F1 is used for the corrected average flow velocity for F in the formula above.

**Formula, corrected meter factor**

$$v_{wk} = v_w \cdot K_v \cdot \left(1 + \frac{F}{100}\right) \rightarrow v_w = v_w \cdot K_v \cdot \left(1 + \frac{F_1}{100}\right)$$

The process volume flow and the corrected process volume flow result, as listed above, from the multiplication of the corresponding velocities with the pipe cross-section. The correction formulas above are therefore accordingly easy to transfer to the volume flows.

**Alternative Reynolds correction**

The measuring accuracy as a result of a high-pressure calibration is sufficient for class 1.0 in the typical working pressure range of 0.5 Pa ... 2 Pa is sufficient for class 1.0 according to OIML R137. As an alternative to the above-mentioned velocity-based characteristic curve correction, the linearity of the "as-found" error curve can be further improved by an additional Reynolds correction, especially for small meter sizes and/or small flow velocities, so that the requirements of class 0.5 according to OIML are met.

The Reynolds correction is based on the following polynomial correction function:

$$k = f(\log(Re))$$

It can be activated by selecting "Polynomial (Re)" in coordinate F-1.
The coefficients of this fourth degree polynomial can be found in the coordinates F-2 to F-6 for flow direction 1 and F-10 to F-14 for flow direction 2.

Calculation of the Reynolds number:
If the dynamic viscosity $\eta$ is used instead of the kinematic viscosity $\nu$ to calculate the Reynolds number - as is usual in gas measurement technology - the result is:

$$Re = \frac{u \cdot d}{\nu} = \frac{u \cdot d \cdot \rho}{\eta}$$

**Legende**

| | | | |
|---|---|---|---|
| $Re$ | = | Reynolds number | |
| $u$ | = | Flow velocity | (m/s) |
| $d$ | = | Diameter (nominal width) | (m) |
| $\nu$ | = | Kinematic viscosity | (m²/s) |
| $\rho$ | = | Operating density | (kg/m³) |
| $\eta$ | = | Dynamic viscosity | (Pa·s) |

The diameter $d$ is determined by the nominal diameter and the velocity $u$ is determined by the ultrasonic measuring method.

The pressure- and temperature-dependent values of the density $\rho$ and the dynamic viscosity $\eta$ must be determined.
Since the Reynolds number does not have to be determined with high precision in this application, the operating density can only be determined as the product of standard density and pressure without taking the temperature into account.

To determine the Reynolds number, the standard density of the sample gas must therefore be specified in the coordinate F-21 and the dynamic viscosity in the coordinate F-22.
The pressure can either be available as a measured value from a connected pressure transducer or used as a default value from coordinate A-9.
To calculate the Reynolds number, the corresponding operating mode "4-20 mA_ERR" for the measured pressure value or "Default" for the use of the default value must be selected in coordinate A-17.
The calculated operating density and the Reynolds number are displayed in the coordinates F-26 and F-27.

**Polynomial, flow-based**
The characteristic curve correction is also carried out via a 4th degree polynomial that represents the error curve of the device.

**Formula error equation**

$$F_2 = \frac{const - m2}{Q_b^2} + \frac{const - m1}{Q_b} + const - 0 + (const - 1) \cdot Q_b + (const - 2) \cdot Q_b^2$$

**Legend**

| | | | |
|---|---|---|---|
| $F_2$ | = | Deviation from the error curve | (%) |
| $Q_b$ | = | Flow | (m/s) |
| *const-n* | = | Constants | |



The constants Konst-n (n = m2 bis n = 2) are calculated from the measured value pairs error $F_{2i}$ and flow $Q_{bi}$. The characteristic curve correction $K_k$ is used for further calculation of the corrected process volume flow.

**Formula characteristic curve correction**

$$K_k = \left(1 + \frac{1 + F_2}{100}\right)$$

### 4.2.2 Correction via a piecewise linearization

The correction of the base line with a polynomial described in section 4.2.1 takes into account the typical, characteristic curve of the USM-GT-400 in an ideal way. This correction is recommended for custody transfer metering in all countries where the MID is valid. Nevertheless, a comparable accuracy can be achieved with a piecewise linearization, if a sufficient number of interpolation points are used. Between the interpolation points, a simple linear interpolation is used. The correction of the base line with the piecewise linearization may also be used in all countries where the MID is valid if the error curve of the raw data meets the requirements of the ISO 17089.

In order to achieve a sufficient accuracy most of the measuring points should be placed in the relevant flow rate range. To take into account the higher gradient of the curve at lower flow rates the intervals should not be equidistant; recommended are more points in this lower flow rate range.

# 4.3 Diagnostic function Speed of Sound

The USM-GT-400 can calculate the SoS in 3 different ways.



## 4.3.1 Standard method of SoS calculation

The first calculation is realized with help of the transit time $t_{TD12}$ and $t_{TD12}$ of the ultrasonic pulses (see above) along the measuring path with the length $L$ . It is straight forward to result in the speed of sound $SoS$ or $c_0$ to:

**Calculation of SoS**

$$SoS = c_0 = \frac{L}{2} \cdot \frac{t_{TD12}+t_{TD21}}{t_{TD12} \cdot t_{TD21}}$$

This first option is pretty fast and is almost permanently "online" available.

## 4.3.2 SoS calculation via gas components

The second version of SoS calculation uses pressure, temperature and composition of the gas to determine the SoS according to the specifications of the AGA 10 standard (AGA Report No. 10, Speed of Sound in Natural Gas and Other Related Hydrocarbon Gases; January 2003; AGA - American Gas Association). The calculation is based on statistical considerations of thermodynamics; since it is very complex, it will not be presented here. Knowing the gas composition precisely values such as density, sound velocity and other gas properties can be calculated with very high accuracy.

Depending on the type of gas analyzer it may take 5-10 minutes to determine the volume fractions of the individual gas components accurately. Accordingly, the precise allocation of flow to the gas composition can be done in this time frame only.

**Diagnostic function SoS**

The USM-GT-400 determines with highest accuracy the flow rate of the gas flowing through it. For the payoff the gas quality, respectively the calorific value of the gas resulting from the gas composition is of course of big interest, too. The USM-GT-400 allows a second billing of the volume flow rate with the "right" gas composition, ie the "right" calorific value.

This temporal resolution can be achieved receiving permanently the gas composition data from a gas analyzer. A comparison of the two differently calculated SoS‘s in the USM-GT-400 allows the immediate detection of any deviation; in particular, another

gas composition results in a different SoS. A confirmation of another gas composition then provides the next comparison with the data of the gas analysis instrument.

The temporal correlation of the actual gas composition (using the SoS calculated via the gas composition) to the SoS using method 1 results in the higher temporal resolution for the gas composition, respectively the calorific value.



### 4.3.3 Extended SoS calculation

The third possibility SoS calculation is presented under the name "**Extended SoS measurement**". This new method is introduced as an additional determination.

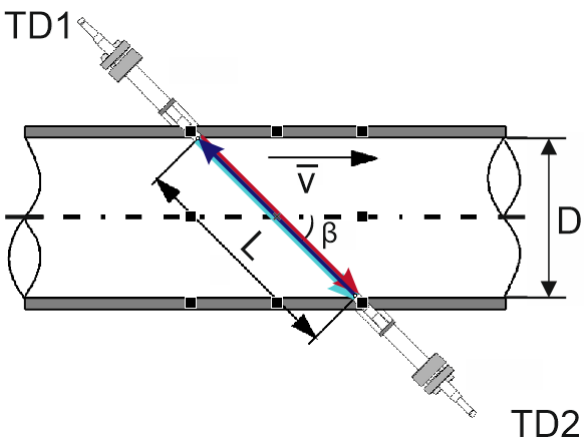



*Fig. 4.2: Extended SoS calculation*

Transducer TD2 receives at first the ultrasonic pulse (light blue) coming from TD1 at the time ($t_{TD12}$). This pulse is partially reflected and moves back to TD1 (dark blue). There this pulse is reflected, too and reaches TD2 (red) again after the time ($t_{TD12\ 21\ 12}$). The differences of $t_{TD12\ 21\ 12}$ and $t_{TD12}$ results in a new possibility to calculate SoS:

Calculation of extended SoS

$$SoS = c_0 = \frac{L}{2} \cdot \frac{t_{TD12}+t_{TD21}}{t_{TD12} \cdot t_{TD21}} = \frac{L}{2} \cdot \frac{(t_{TD12\ 21\ 12}-t_{TD12})}{t_{TD12} \cdot (t_{TD12\ 21\ 12}-2 \cdot t_{TD12})}$$

Due to a 10-times smaller variance of the SoS calculation this method offers significantly more accurate result compared to the standard method (version 1). There are 2 reasons for this result; first, the transmitter / receiver error is eliminated (especially $T_W$; the transit time of the pulse in electronic and transducer is different in the individual transducers) and secondly, any flow turbulence in medium has lowest influence to the transit time (the time interval between $t_{TD12}$ and $t_{TD21}$ is as short as possible). Having typical measuring conditions, this method can easily be applied, but there are conditions at which this method may fail.

The SoS calculation according to method 1 and 3 run simultaneously and controlled using the same criteria. If correct, the result of the extended measurement is preferred due to its higher accuracy. Otherwise, the standard method 1 is used; after any change the measurement conditions, both methods are revalued again. If correct the extended SoS calculation will be chosen again.

**$T_W$-setting**
Measurement tolerances and/or errors of the standard method are permanently controlled using the comparison with the expanded method. Having both values a correction for $T_W$ can be determined. When the calibration switch is open, the $T_W$-value of the standard measurement can be corrected to the value of the extended measurement. This is an important adjustment help in case of a transducer replaced, but also serves as an accurate path lengths determination between the transducers during the dry calibration.

## 4.4 Import of gas composition data

To use the diagnostic function SoS, respectively to calculate it from the gas composition the USM-GT-400 requires the volume fractions of the individual gas components in the gas (up to 21 components), the pressure and the temperature. From these data SoS is calculated using the guidelines of the AGA 10 standard. For the data transfer of the gas components four options are available:

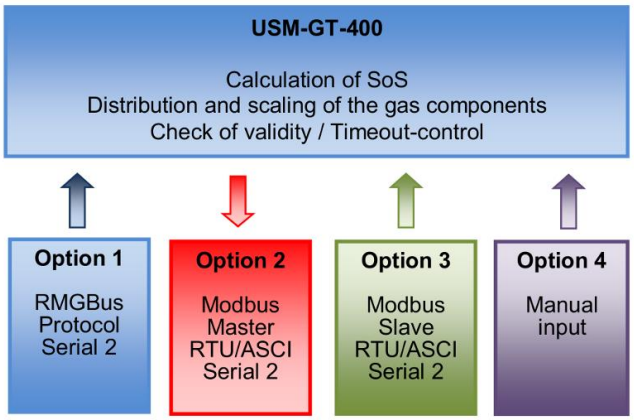



*Fig. 4.3: Import of gas composition data*

### 4.4.1 Option 4: Data input on fixed defaults

If there are no live data available for the gas analysis, then the gas data can be stored as fixed values in the USM-GT-400. For the AGA-10 calculation these default values are used as fixed gas shares (**AX-20 - AX-44**; in chapter 10 the matrix notation of parameters, measured values and variables will be explained). To change these values, they have to be confirmed by selecting “Accept new Comp.” in parameters **AX-11** and to be confirmed in “takeover gas components”. Only then they will be taken over as new values for the AGA-10 calculation.

1. Para0meter **AX-01** “AGA-10 Source”
   **Default data**
2. Setting of the default values of the individual gas components
   Parameter **AX-20** to **AX-44**
   Methane default value ....
   ....
   Propene default value
3. Takeover with parameter **AX-11** “AGA-10 Source”
   “**Taking over new components**”

### 4.4.2 Data input on fixed defaults for air

In mode “default air” fixed values of air composition for the gas analysis can be used. With the additional parameter "rel. humidity" in **AX-06** the water content and component is calculated in mol-% and the remaining components of the air are normalized to 100%. The unnormalized default values for air are:

Nitrogen: 78,105 mol-%

Oxygen: 20,946 mol-%

Argon: 0,916 mol-%

Carbon dioxide: 0,033 mol-%

Water: 0,0 .. mol-% (calculated)

The water content is calculated via the relative humidity.

1. Parameter **AX-01** “SoS source”:

   **“Default air”**

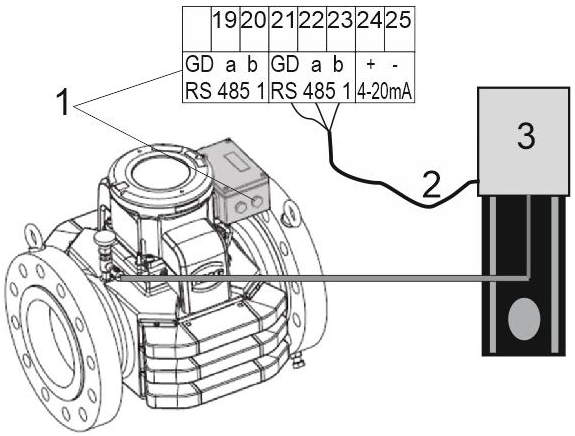
2. Setting of the default values relative humidity

   **Parameter AX-06 “relative humidity”**

All other possibilities to transmit the volume fractions of the individual gas components on the USM-GT-400, will use interface 2 of the USM-GT-400.

### Terminal connections

The following figure shows the terminal connections.




1 Terminal connections
2 COM
3 Gas-Chromatograph

*Fig. 4.4:* ***Terminal connections***

The SoS calculation depends in addition to the gas components also on the gas pressure and temperature. How to measure the pressure is described in chapter 8.4; temperature measurement is given in chapter 7.4. Setting of the parameters **AX-02** "SoS Source Temp." and **AX-03** "SoS Source Pressure" allows to select whether these measured values of temperature and pressure are used for AGA-10 calculation or default values **AX-04** and **AX-05**.



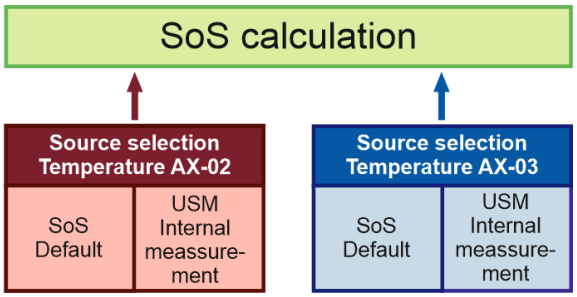



*Fig. 4.5: Pressure and Temperature input*

The electric connection of pressure (p) and temperature (T) has to be done a terminals 26 to 31; AUX1 = p; AUX2 = T.

### 4.4.3 Data input via RMGBus

The data of a gas chromatograph (eg. RMG GC9000 or GC9300) can be delivered as RMGBus telegram via the RMGBus protocol. Therefore, the coordinate AX-01 “SoS AGA-10 source data“ is set to "Serial port 2" and the serial interface in the mode "RMG- Bus". Additionally the parameters of the interfaces USM-GT-400 and the RMGBus master device have to be aligned to each other.

Because the content of the telegram may have data from different streams, the „right“ stream has to be set with the parameter AX-09 "Stream selection". Parameter AX-08 "RMGBus mode" fixes how many components are part of the telegram. When using a GC9000 this parameter has to be set to "RMGBus" to offer a correct evaluation for older versions of the software GC9000.

1. Parameter **J-25** "Opt. Ser2 mode":

   **"RMGBus"**

2. Schnittstellenparameter von Seriell 2 anpassen:

   **J-26 „baud“**

   **J-27 „bits“**

**J-28 „parity“**

Match RMGBus master:

„Serial port 2“

3. Parameter **AX-01** "AGA-10 source“:

   **"Serial port 2"**

4. Parameter **AX-07** "maximum timeout":

   Time in minutes, within which a new telegram has to come via RMGBus

5. Parameter **AX-08** "RMGBus mode":

   **GC9000: "RMGBus"**

   **GC9300: "RMGBus 24 Komp."**

6. Parameter **AX-09** "Stream selection":

   Allows the setting of the desired streams.

### 4.4.4 Data via Modbus (USM GT400 is SLAVE)

The gas data can be written to Modbus USM-GT-400 (USM-GT- 400 is Slave). Data source can be any field devices that operate as a Modbus master on the bus. The individual gas components will be written into the Modbus register of parameters **AY-20** to **AY-44**. To accept these values for the AGA-10 calculation parameters **AX-11** has to be set to "Set new comp.". The parameters will be set as:

1. Parameter **J-25** "Opt. Ser2 mode":

   **"Modbus"**

2. The parameters of serial port 2 have to be adapted to the setting of the Modbus master:

   **J-26** "baud"

   **J-27** "bits"

   **J-28** "parity"

3. The Modbus has to be set to "RTU" or "ASCII" according to the setting of the master. Due to the configuration of the hardware it has to be set to RS232 or RS485, too:

   **J-29** "Modbus-2 protocol"

   **J-30** Modbus-2 HW-mode

4. Parameter **AX-01** "AGA-10 source":

   **"Serial port 2"**

5. Parameter **J-25** "Opt. Ser2 mode":

   **"Modbus-Master"**



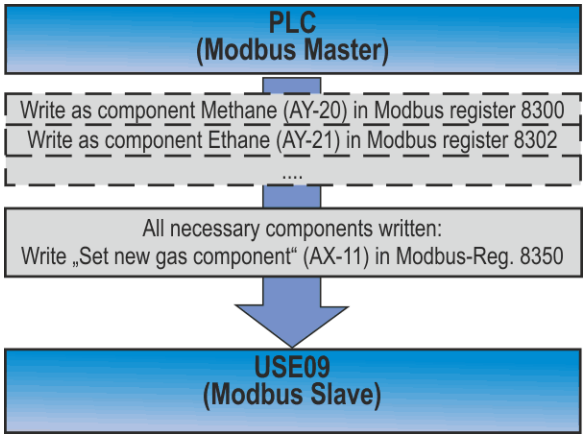



*Fig. 4.6: Import of data via Modbus*

### 4.4.5 Import of data via Modbus (USM GT400 is Master)

USM-GT-400 gets the gas data via Modbus. It is Modbus master and asks continuously if new data are available. In this case, all the components are re-read and fed to the AGA-10 calculation. Parameter **AX-10** "Modbus Master Target" sets which device the USM-GT-400 is addressing. If the GC9300 is chosen no Modbus register needs to be set at **AZ-01** to **AZ-54** for status and part of the gas component.

1. Parameter **AX-07** "maximum timeout":

   Time [minutes] in which a new telegram must have come via RMGBus.

2. Adjustment of the parameter of serial port 2

   **J-26** "baud"

   **J-27** "bits"

   **J-28** "parity"

3. Modbus configuration:

   **J-29** "Modbus-protocol 2"

   Master has to be set to "RTU" or "ASCII"

   **J-30** Modbus-2 HW-mode

   Hardware configuration can be selected as RS232 or RS485

   **J-31** "Modbus-address 2"

Slave-address of the device with the gas data

4. Parameter **AX-01** "AGA-10 source":

   **"Serial Port 2"**

5. Parameter **AX-07** "maximum timeout":

   Time [minutes] in which a new telegram must have come

Time [minutes] in which a new telegram must have come

**Timeout:** During the transfer of data, an adjustable time-out is available, generating a status signal if no new data arrived within the adjusted time.

6. Parameter **AX-10**

   "Modbus-Master Target": "GC9300"?

   If yes, continue after 8, otherwise at 7.

7. Parameter **AZ-01** - **AZ-54**

   Enter Modbus registers of the gas components and status of the slave device

## Treatment of the gas data

The gas data are validated after transmission and optionally normalized. The AGA-10 gas equation accepts up to 21 gas components; it might even accept up to 24 components adding some (surplus) gas components to other components.

**Neo-pentane:** added to n-pentane (see ISO 12213-2)

**Propene:** added to propane

**Ethen:** added to $CO_2$ (see ISO 12213-2).

**Hexane+:** sum of n-hexane, n-heptane, n-octane, n-nonane and n-decane. If there is only hexane+ in the samples and none of the above-mentioned components, then hexane+ is added to hexane. In case one of these components is > 0, then hexane is + ignored.

**Normalization to 100 mol-%:** If the sum of gas components isn‘t 100 mol-%, then the components are normalized to a total of > 100 mol-% (can only be applied if the sum is > 0 mol-% and < 110 mol-%). Otherwise, Bit 0 in **AW-01** "SOS calculation status" will be set and the calculation takes place with 100 mol-% methane instead.

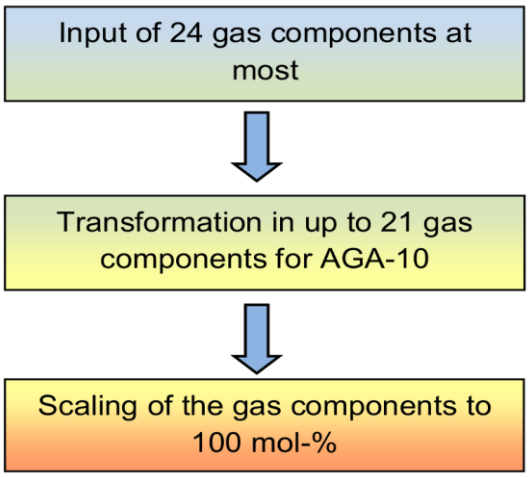



*Fig. 4.7: Sequence of gas components treatments*

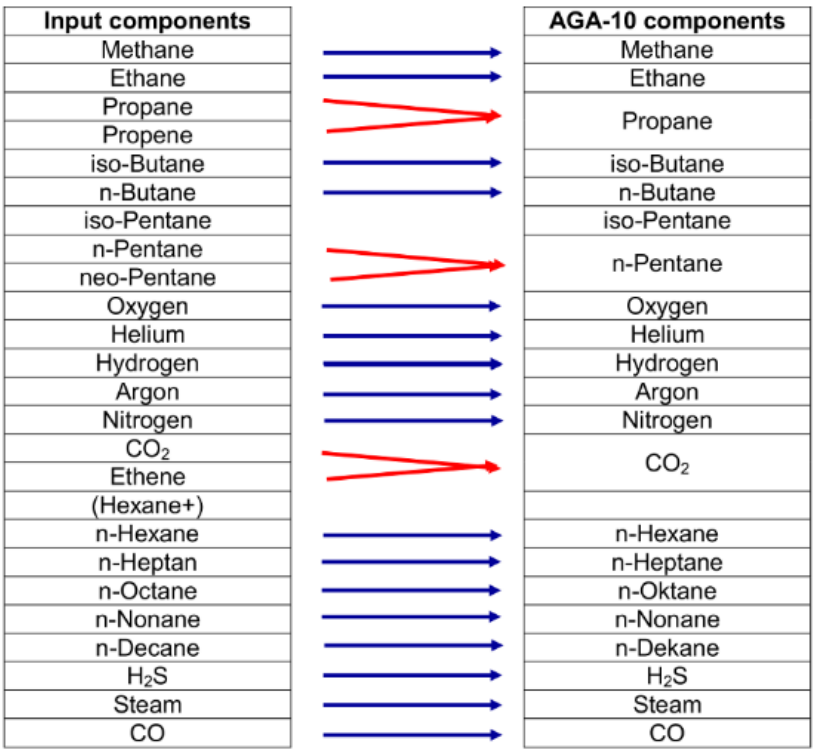



*Fig. 4.8: Classification of gas components*

The following examples demonstrate the classification of the gas components into the 21 AGA-10 components.

**Example 1:**

| Component | Input mol-% | AGA-10 unnormalized mol-% | AGA-10 normalized mol-% |
|---|---|---|---|
| Methane | 35.0 | 35.0 | 70.0 |
| Ethane | 5.0 | 5.0 | 10.0 |
| Propane | 1.0 | 2.0 | 4.0 |
| Propene | 1.0 | - | - |
| iso-Pentane | 1.0 | - | - |
| n-Pentane | 1.0 | 2.0 | 4.0 |
| $CO_2$ | 0.2 | 1.0 | 2.0 |
| Ethen | 0.8 | - | - |
| Hexane+ | (5.0) | - | - |
| Hexane | 3.0 | 3.0 | 6.0 |
| Nonane | 2.0 | 2.0 | 4.0 |
| Sum | 50.0 | 50.0 | 50.0 |

**Example 2:**

| Component | Input mol-% | AGA-10 unnormalized mol-% | AGA-10 normalized mol-% |
|---|---|---|---|
| Methane | 80.0 | 80.0 | 80.0 |
| Ethane | 5.0 | 5.0 | 5.0 |
| n-Butane | 1.0 | 1.0 | 1.0 |
| neo-Pentane | 1.0 | - | - |
| n-Pentan | 0.0 | 1.0 | 1.0 |
| $CO_2$ | 0.0 | 2.0 | 2.0 |
| Ethen | 2.0 | - | - |
| Hexane+ | 5.0 | - | - |
| Hexane | - | 5.0 | 5.0 |
| Nitrogen | 4.0 | 4.0 | 4.0 |
| Sum | 100.0 | 100.0 | 100.0 |

### Status code der AGA-10 calculation

Coordinate **AW-01** gives the status code of the AGA-10 calculation. This is a bit-coded value represented as a hexadecimal code. A value of **"0000h"** indicates a AGA-10 calculation with errors. The meaning of the individual bits are:

| Bit | Meaning |
|---|---|
| 0 | **Components invalid**<br><br>Sum of the un-normalized gas components<br>is <= 0 or > 110 mol-% |
| 1 | **Timeout of new gas data exceeded**<br>Within the defined time period in **AX-07,** no new data arrived. Possible reason:<br>• Time too short<br>• Communication interrupted<br>• transfer register has not been filled (for Modbus slave)<br>• Wrong RMGBus telegram or wrong stream selection<br>If there are new gas components latest within three times of the given timeout time, the error status will be reset. |
| 2 | **Temperature Error**<br>The temperature measurement is disturbed. Calculation will be done with the default value. |
| 3 | **Pressure errors**<br>The pressure measurement is disturbed. Calculation will<br>be done with the default value. |
| 4 | **Simulation active**<br>Parameter E-01 „USE09 mode“ is set to simulation no data (results) of the DSP will be accepted |
| 5 | no value |
| 6 | no value |
| 7 | no value |
| 8 | **Error AGA-10 calculation**<br>There is an error within the AGA-10 calculation. The calculation is on hold. Reason may be wrong pressure or temperature values, ... |
| 9-15 | no value |

The message "188: AGA-10" appears, if the status code is not 0. The Modbus master function is flexible in order to support PGC's other manufacturers, too; for example a Siemens PGC. Activating the RS 485 interface as Modbus master is described in ⇨ *chapter 10.3.3, “Interface 2” on page 160*.



## 4.5 Batch mode

In general, the USM-GT-400 is set for an optimal operation without disturbance. The setting / changing of the batch mode allows adaptation to disturbed conditions. The setting allows operation at "high-turbulent" flow conditions as well as at "strong background noise" conditions. High turbulent means highly distorted velocity profiles and rapidly changing asymmetries. A "smallest" batch mode should be chosen. At strong background noise, the signal detection can be disturbed, too. A "longer" batch mode increases the signal stability significantly. The number of batches permits a change of the signal duration.

- P1 Number of F-batches per measuring path 1
- ...
- P8 Number of F-batches per measuring path 8

The default values are 2. 0 and 1 are identical; there is no batch activated. All larger values are squared; F-Batch 2 means there are 4 signals superimposed. If the F-Batch is active the ring down time should be chosen as short as possible, preferably to 0 ms. The slow batch mode can be activated in coordinate AI-09; it is to be squared for all paths, too.

## 4.6 Signal damping

The output signal of the USM can be smoothed using the parameters E-9 (number of GDs) and AK-34 to AP-24 (F-Batch). The choice of the settings for these parameters is an optimization between interference immunity (high damping) and short response time to changes in flow rate (low damping). As standard, the USMs are delivered with GD=10 and F-Batch=2. This means:

a) The output signal is the moving average over the last 10 measurements. The number of measured values included in the moving average is entered directly in E-9.

b) The mean value of 4 raw signals is included in the measurements. The number of these measurements (F-batch) is path-specific and equal to the square of the input value in AK-34 to AP-34.

The shortest possible response time is therefore obtained with E-9 = 1 and AK-34 to AP-34 = 1. However, these settings should only be used with stable flow profiles and low noise levels. If necessary, these parameters must be optimized during commissioning.

# 5 Safety

60

In this chapter you will receive information on using the device in a safe manner.

**Content**

## 5.1 Intended use

The Ultrasonic Flowmeter USM GT400 device is used to measure the flow velocity of the gases in a pipeline and calculate the operating flow during running operation.



The Ultrasonic Flowmeter USM GT400 is hereafter designated as ultrasonic gas meter or device in the following.

When used for its intended purpose, the ultrasonic gas meter is suitable for use in potentially explosive areas classified as zone 1.

The device complies with ignition protection class

II 2 G Ex de IIB+H2 T6 Gb, ambient temperature between 40°C and +55°C

or

Class 1, Division 1 Group B, C and D, ambient temperature for code T5/T6 is -40°C to +40/+55°C.

The ultrasonic gas meter complies with the standards, directives and guidelines.

⇨ *Chapter 16.5, “Standards, directives and guidelines” on page 264*

These technical limits must be maintained for a safe use of the ultrasonic gas meter:

⇨ *Chapter 13, “Technical specifications” on page 187*

## 5.2 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.**

**Note**

**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 information gives you tips on how to simplify your work. With this screen, you additionally receive further information on the device or the work process.

## 5.3 Qualification of the personnel



**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.

- **Mechanical installation** must only be carried out by the respectively qualified specialist personnel.
- **Installation on electrical components** must only be carried out by qualified electricians.

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.

- **Initial start up** must only be carried out by especially trained personal (training by RMG) or by service personal from RMG.
- **Maintenance and cleaning** must only be carried out by the respectively qualified specialist personnel.

**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.

## 5.4 Safety instructions



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.
- Always keep the operating instructions within reach for use at the place of installation.
- 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.
- For safe operation, the safety instructions must be observed and followed.
- 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.
- The manufacturer is not responsible for any damage that result as a consequence of not observing the operating, instruction.
- 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.
- For a safe operation, the device must only be used in the scope of its intended use.

The device is exposed to different life phases, such as, e.g., installation, start upstart up, operation, maintenance and cleaning.

The following sections must be sorted thematically according to the life phases.

### 5.4.1 Hazards during transporting

The device may be damaged when lifting and putting down, tipping over or falling down. By disregarding the load bearing capacity of the lifting gear, the device may fall. There is a risk of severe injuries for persons in the vicinity.



- Lift the device only on the intended lifting eyes.
- Before lifting, make sure that the load is safely secured.
- Never stand under suspended loads.

Observe the weight specifications for the ultrasonic gas meter at hand.

### 5.4.2 Hazards during installation

When you carry out work on electric systems in potentially explosive environments, incorrect work may lead to explosions.

- Make sure that no potentially explosive atmosphere is at hand before starting work.

If personnel that have insufficient qualifications carry out work, they can incorrectly assess hazards. Explosions can occur.

- Carry out the work only if you have the respective qualification and are a trained specialist person.
- Carry out the installation according to the following standards:
  - CAN/CSA-C22.2 No. 0-1191
  - CSA C22.2 No. 30
  - CSA C22.2 No. 142
  - UL 916
  - UL 1203

or similar national standards.

In potentially explosive atmospheres, dangerous voltages can still remain as ignition sources for up to one minute after being switched off.

- Disconnect the device from the power supply before starting the maintenance work.
- Securing against reconnection.
- Cordon-off the work area of the device, e.g., using a barrier and signs.
- After switching off the device, wait at least one minute before starting work. Ensure that the device is voltage-free. Then connect to earth and short-circuit.

- Make sure that the insulation of the cables is intact.
- Make sure that no stripped cable is located outside the housing of the ultrasonic electronics and the connection box.

If the device is not installed according to the operating instruction, then there is not enough explosion protection.

- Install the device according to the operating instruction.

If you do not use the appropriate tool and material, component may be damaged. The explosion protection is void.

- Use tools that have been recommended for the respective work in the operating instruction.
- Make sure that the performance data of the power connection comply with the specifications of the type plate.
- Use only an Atex or IECEx certified EMC cable screw connection in the protection category increased safety with a metric thread (M20x1.5).
- Creepage distances and clearances must be maintained.
- Openings for line feeds not used must be sealed by impact resistant, anti-self-loosening and twisting safe blind plugs.
- The line insulation must reach to the terminals. When stripping, the conductor itself must not be damaged.
- When closing the housing, take care that the seals remain effective in order to ensure for the protection category IP 66 / NEMA 4X.
- Housing cover or housing with damaged thread must be replaced immediately.
- Observe the applicable national guidelines in the individual countries.
- Use cables that match the cable glands.

Gas may represent a risk to life and limb in different ways. Depending on the gas type, different hazards may have an effect on you with respective consequences. You may experience intoxication and injuries. There is also a risk of explosion.

- Before working, inform yourself about the media in the system.
- Install the device only when the system is switched off, depressurized and secured.
- Make sure that there is no potentially explosive gas mixture at the installation location.

The device is exposed to high pressures. If components under pressure are removed / assembled, the high pressure may escape suddenly causing the component to fly around. Mortal danger!

- Install the device only when the system is depressurized.
- With systems subjected to pressure:
  Have the assembly work (Hot-Tapping) only carried out by specially trained personnel.



If gas escapes at high temperature, there is a risk of life-threatening burns. You may suffer burn injuries in the event of contact with hot surfaces.

- Allow the components to cool down before working in the system.
- Wear personal protective equipment.

If connections not required during operation remain open, gas will escape. Risk of explosion and intoxication!

- Before start up, seal all open connections with certified blind plugs according to 2014/34/EU.
- Replace the blind plugs that have been installed for transportation with certified blind plugs according to 2014/34/EU or NEC500.

### 5.4.3 Hazards during start up

If personnel that have insufficient qualifications carry out work, they can incorrectly assess the hazards. Explosions can occur.

- Carry out the work only if you have the respective qualification and are a specialist person.

If the device is not sealed correctly during installation, then gas may escape. Explosions can occur. Danger of poisoning!

- Check the connections for leaks.
- Take the system immediately out of operation if you detect a leak.

### 5.4.4 Hazards during cleaning

If the device is not cleaned according to the operating instruction, then the device may be damaged.

- Clean the device only according to the operating instruction.

If you do not use the appropriate tool, components may be damaged. The explosion protection is void.

- Use tools that have been recommended for the respective work in the operating instruction.

Cleaning agents / corrosion protection used may be harmful to health.

- Always wear protective gloves and eye protection.
- Ensure for good ventilation and do not inhale vapours!
- Observe the safety data sheet!

### 5.4.5 Hazards during maintenance and repairs

If personnel that have insufficient qualifications carry out work, they can incorrectly assess hazards when working. Explosions can occur.

- Carry out the work only if you have the respective qualification and are a trained specialist person.

Flange joining elements, pressure tapping screw connections and valves must not be removed if the system is subject to pressure. Components may dangerously spray. Escaping gas may cause intoxication and burns. Risk of explosion!

- For the flange connection, use only the matching combination of screw bolts, nuts and seals. Select the appropriate tightening torque of the flange connection for this combination.
- In doing so, observe the specifications of the system manufacturer or system operator.
- Use only genuine spare parts from RMG.
  It is forbidden to install spare parts from third-party manufacturers. It voids all guarantees and claims for guarantee. The explosion protection is no longer ensured.

  When working on live devices in potentially explosive atmospheres, resulting sparks may lead to an explosion.

- Only work on de-energized devices when in potentially explosive atmospheres (except for intrinsically safe circuits).
- Make sure that there is no potentially explosive atmosphere before starting work.
- After working provide on pressurized components, leaks may occur. Escaping gas may lead to intoxication, Risk of explosion!
- Check all components for leaks!

  Special requirements for a safe operation in potentially explosive areas classified as zone 1:

  Under normal operating conditions, the transducer cannot be accessed from the outside, thus no sparks can result from impacts or friction of the transducer against hard materials.

- The transducers are made from titanium. If objects knock or rub against the transducers, this can generate a spark thus leading to an explosion!
- prevent hard objects from knocking or rubbing against the transducers.

Also observe these warning instructions:

⇨ “Hazards during installation” on page 65

### 5.4.6 Hazards during operation

If the device is loaded with a pressure that is too high, components may leak and burst.

- Never exceed the maximum operating pressure (see specifications on the type plate).

Flange joining elements, pressure tapping screw connections and valves must not be removed if the system is subject to pressure. Components may dangerously spray. Escaping gas may cause intoxication and burns. Risk of explosion!

- Observe the specifications of the system manufacturer or system operator.

The device can be heated or cooled by the temperature of the gas. You may be subject to burns when making skin contact with the device.

- Wear protective gloves that protect against heat and cold for this work.



Breakages or cracks may be caused to the device if the gas temperature or ambient temperature is outside the specified temperature ranges. Gas escaping may cause intoxication and burns. Risk of explosion!

- Never exceed the maximum gas temperature and / or ambient temperature of 80°C.

### 5.4.7 Hazards for operation in potentially explosive environments

If the device is operated with damaged or missing components, then gas may escape. In event of damaged threads, the ignition penetration safe gap is no longer guaranteed. Escaping gas may cause intoxication and burns. Risk of explosion!

- Operate the device only in a sound and complete state.

If you carry out technical changes to the device, safe operation can no longer be guaranteed.

- Use the device only in its original state.

## 5.5 Responsibilities of the operator



- You being the operator must ensure that only sufficiently qualified personnel work on the device.
  ⇨ *“Qualification of the personnel” on page 63*
- Make sure that all employees that are using the device have read and understood this operating instruction. Moreover, you are also obliged to train the personnel at regular intervals and inform them of the hazards.
- Make sure that all work on the device is only carried out by qualified persons and checked by responsible specialist personnel.
- The responsibilities for installation, operation troubleshooting, maintenance and cleaning must be clearly specified.
- Provide the personnel with the necessary protective equipment.

⇨ *“Qualification of the personnel” on page 63*

Using suitable measures, ensure that that constructive risks are ruled out when using the device. Inform your personnel about the risks when using the device.

# 6 Transport and storage



In this chapter you will receive information on the scope of supply, transport and storage of the device.

**Content**

# 6.1 Transport

The device will be packed to customer-specifics according to the transport requirements. In this chapter you will receive information on the standard packaging of the device.



## 6.1.1 Scope of supply

The scope of delivery may vary depending on the options of the orders.

The following are included in the scope of supply:

| Component | Quantity |
|---|---|
| Ultrasonic gas meter<br>USM GT400 (including US-Electronic) | 1 |
| Extension box<br>(In countries where ATEX / IECEx standards apply, connected at the ultrasonic electronic) | 1 |
| Special tools to open the US electronic | 2 |
| Inlet and outlet spool piece | 1 (optional) |
| Certificate of flow calibration | 1 |
| Certificate of material used | 1 |
| Certificate of stability | 1 |
| Certificate of density | 1 |
| Software RMGView$^{USM}$ | 1 |
| Operating instruction of the device | 1 |
| Screws and set of blank plugs | 1 |

### 6.1.2 Transporting the device


1 Euro pallet
2 Retaining bolts x 2
3 Ultrasonic gas meter
4 Retaining strap x 2
5 Timber wedge x 2

*Fig. 6.1: Device secured on a Euro pallet*

The device is as standard supplied on a Euro pallet **(1)**. The device can be protected by a customer-specific outer packaging. To secure the device against tipping-over and rolling away, the device **(3)** is supplied with retaining straps **(4)** and bolted to timber wedges **(5)**. The retaining bolts **(2)** of the device provide additional support.

The device can be transported on the pallet using a lifting cart or a fork lift.

### 6.1.3 Unpacking the device

**Remove the outer packaging**

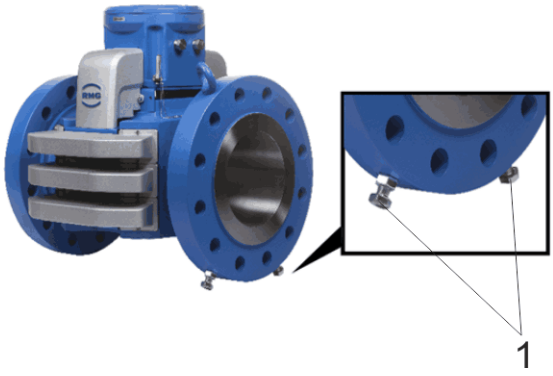
The outer packaging of the device is suited to customer specifics in order to protect the device against damage or influences from the environment during transport.

Options for the outer packaging can be, for example:

- sea-proof wooden crate
- cardboard packagings

**1** Remove the outer packing.

**2** Recommendation: store the outer packaging for the future or for returning to RMG for service work.




1 Retaining bolts

*Fig. 6.2: Retaining bolts of the device*

**3** Make sure that the retaining bolts (1) are screwed in, if necessary.

- **Removing the device from the pallet**


1 Lifting eyes
2 Lifting gear chains

*Fig. 6.3: Attaching the lifting gear*

**⚠ Warning**

**Risk of injury during transport**

The device may be damaged when lifting and putting down, tipping over or falling down. By disregarding the load bearing capacity of the lifting gear, the device may fall. There is a risk of severe injuries for persons in the vicinity.

- Lift the device only on the intended lifting eyes.
- Before lifting, make sure that the load is safely secured.
- Never stand under suspended loads.
- Observe the weight specifications for the ultrasonic gas meter at hand.

**1** Attach a suitable lifting gear **(2)** to the lifting eyes **(1)** of the device.
**2** Tension the chain of the lifting gear slightly to secure the device.


1 Timber wedge
2 Tension straps

*Fig. 6.4: Remove the timber wedges and retaining straps*

**3** Undo and remove the tension straps (2).

**4** Carefully lift the device with a lifting gear until the Euro pallet can be pulled from underneath the device.

**5** Pull the Euro pallet from under the device.

**6** Recommendation: store the Euro pallet for the future or for returning to RMG for service work.

### 6.1.4 Disposal of packaging material

If the packaging material and the Euro pallet are no longer required, dispose of the material in an environmentally responsible manner according to the country-specific standards and guidelines.



### 6.1.5 Prior to installation

The transport locks must only be removed once the device has been installed in the system and the device has been transported to the installation location.

**Note**

**Damage to the device from contamination and humidity**

If transport locks are removed too early, contamination and humidity may enter the device. The device could be damaged.

- Disassemble the transport locks immediately before installing the device.

The following belong to the transport locks:

- Blind plug
- Protective sticker
- Retaining bolts
- Recommendation: remove the retaining bolts only if it is absolutely necessary. This is the only way to ensure that the device does not tip over or roll away after being installed.
- Corrosion protection mat

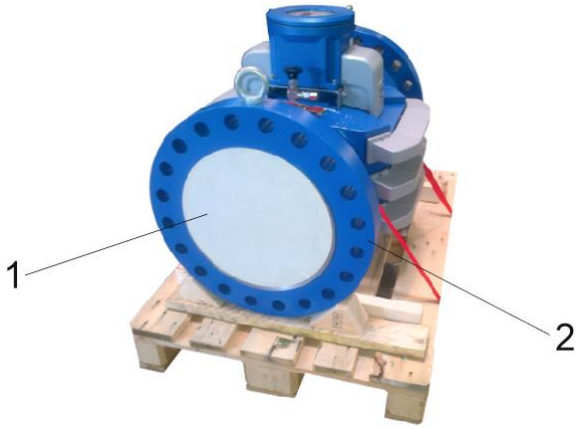
### 6.1.6 Removing the transporting locks

The removal of the transport locks is described here on the example of a connection or flange. The transport locks also have to be removed from all connections where the transport locks are located.



- **Removing the protective sticker / blind plugs from the flanges**

  The flanges are supplied sealed with a protective sticker or blind plug made of plastic.



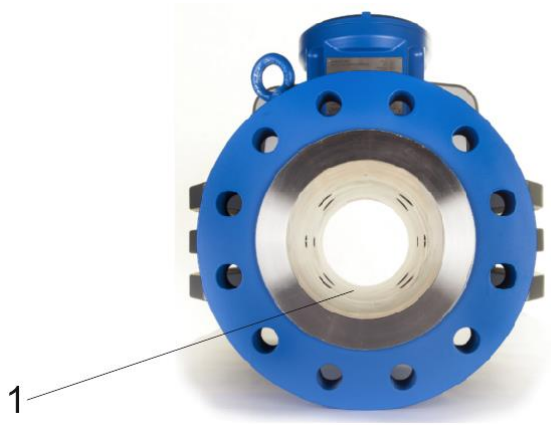

1 Protective sticker
2 Flange

*Fig. 6.5: Removing the protective sticker*

| | | |
|---|---|---|
| **Removing the protective sticker** | **1** | Release the protective sticker from the sealing surface of the flange. |
| | **2** | Remove any residual adhesives or other impurities from the sealing surfaces of the flange using a gentle cleaning agent. |
| **Remove the blind plugs** | **1** | Pull the blind plugs out of the openings. |

- **Remove the corrosion protection mat**

The inside of the device is protected using a corrosion protection mat. The corrosion protection mat must be removed before installation.




1 Corrosion protection mat

*Fig. 6.6: Position of the corrosion protection mat*

**1** Remove the corrosion protection mat **(1)** from the device.

## 6.2 Packing the device for transportation

The device must be packed to customer-specifics according to the transport requirements. In this chapter you will receive information as to how the device is as standard packed.

For packaging, use the original packaging material and sealing set that was supplied with the device.

If you no longer have the original packaging material and sealing set, you can order the packaging material and sealing set required from RMG.

RMG service would be pleased to consult you as to how the device should be packed.

You need the following for standard packaging:

- Euro pallet with timber wedges (with the original packaging, the timber wedges are already pre-mounted on the Euro pallet).
- Two tensioning straps
- Transport locks
- Sealing set (blind plugs)

- Acid-free corrosion protection agent, e.g., ESSO RUST BAN 397, Mobil Oil Tecrex 39

80

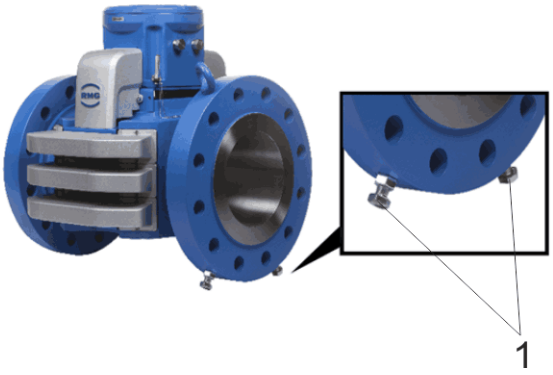
▪ **Ensure for a safe position of the device**

**⚠ Caution**

**Risk of injury from missing retaining bolts**

If the device is put down without the retaining bolts, it can tip over or roll away. Severe injuries may occur.

- Before starting work, make sure that the retaining bolts are screwed in.




1 Retaining bolts with counter-nuts

*Fig. 6.7: Check the retaining bolts*

The retaining bolts are screwed into the device ex-factory. These ensure for a safe position.

**1** Make sure that the retaining bolts are screwed in and that the counter-nuts are secured.

Recommendation: remove the retaining bolts only if it is absolutely necessary. This is the only way to ensure that the device does not tip over or roll away after being installed

- **Lifting the device onto the Euro pallet**


1 Lifting eyes
2 Lifting gear chains

*Fig. 6.8: Attaching the lifting gear*

**⚠ Warning**

**Risk of injury during transport**

The device may be damaged when lifting and putting down, tipping over or falling down. By disregarding the load bearing capacity of the lifting gear, the device may fall. There is a risk of severe injuries for persons in the vicinity.

- Lift the device only on the intended lifting eyes.
- Before lifting, make sure that the load is safely secured.
- Never stand under suspended loads.
- Observe the weight specifications for the ultrasonic gas meter at hand.

**1** Attach a suitable lifting gear (**2**) to the lifting eyes (**1**) of the device.

**2** Tension the chain of the lifting gear slightly.

**3** Undo the bolted connections from the system so that the device can be lifted out.


1 Retaining bolts
2 Tension straps
3 Timber wedge

*Fig. 6.9: Secure the device on the Euro pallet*

**4** Place the Euro pallet under the device.

Without the retaining bolts (1) the flange must be guided between the timber wedges (3).

**5** Carefully place the device on the Euro pallet with the lifting gear.

**6** Secure the device using the tensioning straps (2).

The tensioning straps must have a tight fit and must secure the device.

- **Place the corrosion protection mat inside the device**

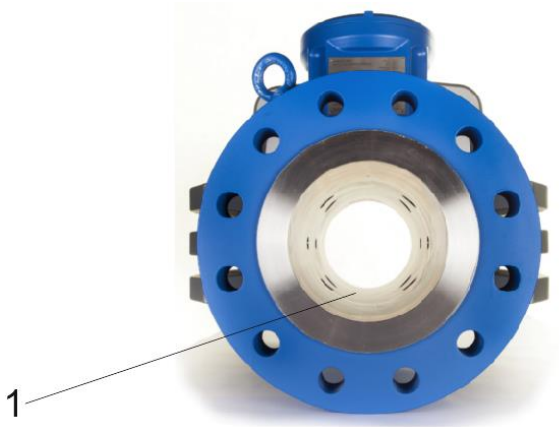
**Note**

**Damage to the device from corrosion**

If the device is not protected against corrosion, the function of the device may be affected.

- Place the corrosion protection mat inside the device.






1 Position of the corrosion protection mat

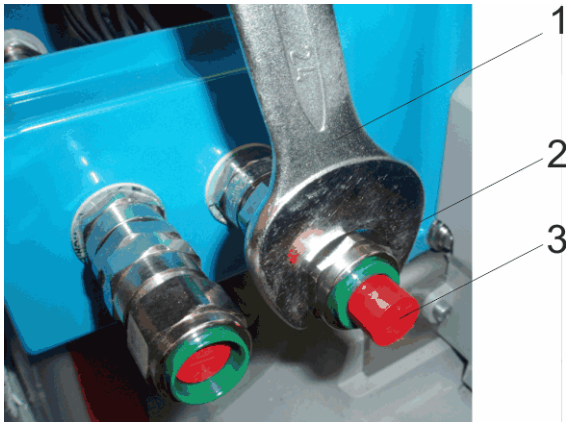
*Fig. 6.10: Corrosion protection mat in the device*

**1** Clean the device and protect all blank parts against corrosion with an acid-free corrosion protection agent, e.g., ESSO RUST BAN 397, Mobil Oil Tecrex 39.

⇨ Chapter 11.7, “Cleaning the device” on page 177

**2** Place the corrosion protection mat (1) inside the device.

- **Provide the connection box (ATEX / IECEx) with blind plugs**




1 Wrench
2 Screwed cable gland
3 Blind plug

*Fig. 6.11: Mount the blind plugs*

**1** Insert the blind plugs (3) into the connection.

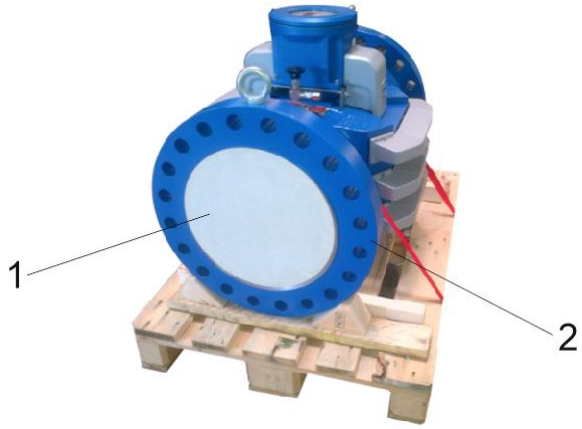
**2** Tighten the screw connection (2) with a suitable wrench (1).

The following sealing bolts supplied must be used in countries where CSA guidelines apply. If only transport is taking place, you can use 1/2" or 1" screws with appropriate length as an alternative.

- **Applying the protective sticker / blind plugs to the flanges**

  The flanges must be sealed with a protective sticker or blind plug made of plastic.

### Sealing the flange with protective stickers




1 Protective sticker
2 Flange

*Fig. 6.12: Applying the protective sticker*

**1 Clean the sealing area with grease remover.**

The sealing surface must be free of grease and contamination.

**2** Stick the protective sticker (A) onto the sealing surface of the flange (B).

### Sealing the flange with blind plugs

**1** Insert the blind plugs into the opening of the flange so that the blind plugs have a tight fit.

- **Applying the outer packaging to the device**

**Notice**

**Damage caused to the device from incorrect storage / transport**

If the device is not protected correctly by the packaging material, dirt or humidity may enter the device and damage it.

- Pack the device according to the instruction.
- Consider the special transport requirements on the packaging material, e.g., for transport overseas.
- Please contact RMG service in case of doubt.

Use the original packaging that was supplied along with the device. Please contact RMG service if you have any questions.

86

Options for the outer packaging can be, for example:

- sea-proof wooden crate
- cardboard packaging

**1** Protect the device in the outer packaging against environmental influences.

## 6.3 Storage

In this chapter you will receive information on the correct storage of the device. You are also provided with information that must be observed when storing for long periods.

**Danger**

**Mortal danger from damage in the warehouse**

If the device is stored for longer than one year, the device may be damaged from incorrect outer packaging or securing of the device. In potentially explosive environment, a defective device may lead to an explosion. Danger of poisoning!

- Avoid long storage times.
- Have the device checked by RMG service if the storage time is longer than one year. For this purpose, send the device to RMG.

### 6.3.1 Packing the device for storage

**Notice**

**Damage caused to the device from incorrect storage / transport**

If the device is not protected correctly by the packaging material, dirt or humidity may enter the device and damage it.

- Pack the device according to the instruction.
- Consider the special transport requirements on the packaging material, e.g., for transport overseas.
- Please contact RMG service in case of doubt.

1 Packing the device.

⇨ “Packing the device for transportation” on page 79

2 Observe the approved ambient temperature for storage.

⇨ Chapter 13.1, “Performance data” on page 188

### 6.3.2 Checking the device after storage

- **Checking the device for any signs of damage**

There is a high risk to life and limb if a damaged device is used.

The following damage can compromise safety and the function of the device:

- notches on the flange sealing surfaces
- corrosion in the device or on the sealing surfaces
- cracked glass of the viewing window
- clouded glass of the viewing window
- cracks, flaking on the housing or the covers
- flaking paint

1 Check that the device is intact by a visual inspection.

If you discover that there is, e.g., any damage or other damage to the device, the device may only be re-used after consulting RMG.

2 If damaged: please contact RMG services.

# 7 Construction and Planning



In this chapter you will receive information on how you can integrate the device into the system and what you have to observe during this process.

**Content**



## 7.1 Connection flanges

The devices from RMG are equipped with connection flanges.

The joining dimensions of the flanges for the pipelines to be connected must correspond to the connection dimensions of the device flanges.

- ANSI pressure stages: The flange joining dimensions comply with the standard ASME B 16.5.
- DIN pressure stages: The flange joining dimensions comply with the standard DIN EN 1092.

**Note**

**The USM GT400 with a nominal width of DN 80 (3“) uses different connection flanges. Instead of the screw lead-throughs - as in the flanges of all other nominal sizes - there are blind holes with internal threads. Corresponding screws are included in the scope of delivery, but can also be reordered if necessary.**



## 7.2 Seals

**Danger**

**Escaping gas from incorrect seals**

If incorrect flange seals are used for several ultrasonic gas meters, potentially explosive gas mixtures can escape due to leaks. Risk of intoxication and explosion! Moreover, the pressure of the flange increases with the improper tightening of the screw bolt.

- Make sure that the flat seal does *not* protrude over the sealing surface into the pipeline.

**Note**

**Malfunctions from incorrect seals**

If flange seals are used for ultrasonic gas meters that protrude into the pipeline, the measuring accuracy may be influenced.

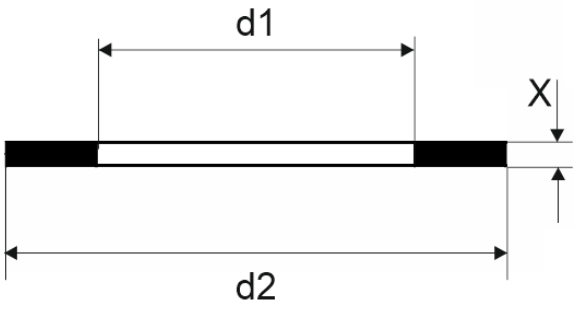
- Make sure that the flat seal does *not* protrude over the sealing surface into the pipeline.

| | |
|---|---|
| Flat seals: | k0 x KD = 20 x bD \| k1 = 1.3 x bD (N/mm) |
| Grooved gaskets: | k0 x KD = 15 x bD \| k1 = 1.1 x bD (N/mm) |
| Spiral seals: | k0 x KD = 50 x bD \| k1 = 1.4 x bD (N/mm) |
| Octagonal ring joint seal: | KD = 480 N/mm$^2$ |

The durability of the flange connections has been verified for seals with the following maximum material values according to the AD2000 regulations.

### 7.2.1 Flat seal

Flat seal according to DIN 2690 / EN 12560-1 Form IBC



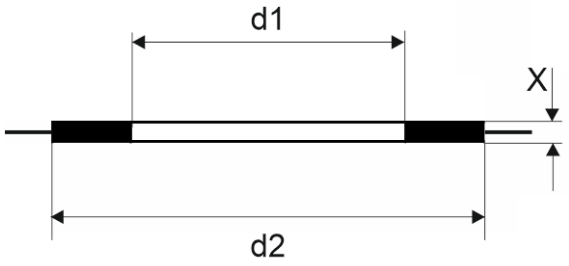

Dimensions of the seal:
d1 = Inside diameter
d2 = Outside diameter
X = Seal thickness 1.5 to 5 mm

*Fig. 7.1: Flat seal*

| | | PN10 | PN16 | ANSI150 | PN25 | PN40 |
|---|---|---|---|---|---|---|
| DN<br>in mm (inch) | d1<br>in mm (inch) | d2<br>in mm (inch) | | | | |
| 80 (3) | 90 (3.54)<br>89 (3.5)/ANSI150 | 142 (5.59) | 142 (5.59) | 136.5 (5.37) | 142 (5.59) | 142 (5.59) |
| 100 (4) | 115 (4.53) | 162 (6.38) | 162 (6.38) | 175 (6.89) | 168 (6.61) | 168 (6.61) |
| 150 (6) | 169 (6.65) | 218 (8.58) | 218 (8.58) | 222 (8.74) | 225 (8.86) | 225 (8.86) |
| 200 (8) | 220 (8.66) | 273 (10.75) | 273 (10.75) | 279 (10.98) | 285 (11.22) | 292 (11.52) |
| 250 (10) | 274 (10.79) | 328 (12.91) | 330 (12.99) | 340 (13.39) | 342 (13.46) | 353 (13.90) |
| 300 (12) | 325 (12.80) | 378 (14.88) | 385 (15.16) | 410 (16.14) | 402 (15.83) | 418 (16.46) |
| 400 (16) | 420 (16.54) | 490 (19.29) | 497 (19.57) | 514 (20.24) | 515 (20.28) | 547 (21.54) |
| 500 (20) | 520 (20.47) | 595 (23.43) | 618 (24.33) | 607 (23.90) | 625 (24.61) | 628 (24.72) |
| 600 (24) | 620 (24.41) | 695 (27.36) | 735 (28.94) | 718 (28.27) | 730 (28.74) | 745 (29.33) |

## 7.2.2 Grooved gaskets

Grooved gaskets according to EN 12560-6 with centering ring




Dimensions of the seal:
d1 = Inside diameter
d2 = Outside diameter
X = Seal thickness 1.5 to 5 mm

*Fig. 7.2: Grooved gaskets*

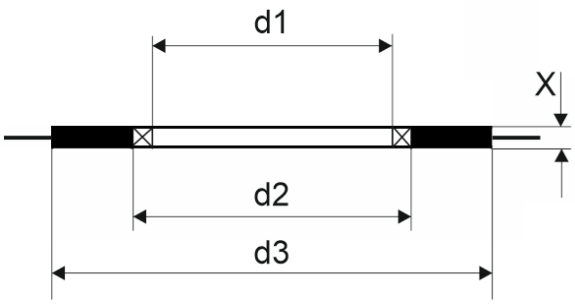
| | **ANSI 300 / ANSI 600** | | **PN64** | |
|---|---|---|---|---|
| DN<br>in mm (inch) | d1<br>in mm | d2<br>in mm | d1<br>in mm | d2<br>in mm |
| 80 (3) | 98.4 | 123.8 | 95 | 121 |
| 100 (4) | 123.8 | 154.0 | 118 | 144 |
| 150 (6) | 177.8 | 221.7 | 170 | 204 |
| 200 (8) | 228.6 | 266.7 | 220 | 258 |
| 250 (10) | 282.6 | 320.7 | 270 | 315 |
| 300 (12) | 339.7 | 377.8 | 320 | 365 |
| 350 (14)* | 371.5* | 409.6* | – | – |
| 400 (16) | 422.3 | 466.7 | 426 | 474 |
| 450 (18)* | 479.4* | 530.2* | – | – |
| 500 (20) | 530.2 | 581.0 | 530 | 578 |
| 600 (24) | 631.8 | 682.6 | 630 | 680 |

* Only available for Ansi 600!

### 7.2.3 Spiral seals

Spiral seals according to EN 12560-2 with centering ring






Dimensions of the seal:
d1 = Inside diameter of the centering ring
d2 = Inside diameter of the seal
d3 = Outside diameter
X = Seal thickness 1.5 to 5 mm

*Fig. 7.3: Spiral seals*

| | ANSI 300 | | | PN 64 | | | ANSI 600 | | |
|---|---|---|---|---|---|---|---|---|---|
| DN in mm (inch) | d1 in mm (inch) | d2 in mm (inch) | d3 in mm (inch) | d1 in mm (inch) | d2 in mm (inch) | d3 in mm (inch) | d1 in mm (inch) | d2 in mm (inch) | d3 in mm (inch) |
| 80 (3) | 81 (3.19) | 101.6 (3.98) | 120.7 (4.75) | 86 (3.39) | 95 (3.74) | 119 (4.69) | 81 (3.19) | 101.6 (3.98) | 120.7 (4.75) |
| 100 (4) | 106.4 (4.19) | 127.0 (5.00) | 149.4 (5.88) | 108 (4.25) | 120 (4.72) | 144 (5.67) | 106.4 (4.19) | 120.7 (4.75) | 149.4 (5.88) |
| 150 (6) | 157.2 (6.19) | 182.6 (7.19) | 209.6 (8.25) | 162 (6.38) | 174 (6.85) | 200 (7.87) | 157.2 (6.19) | 174.8 (6.88) | 209.6 (8.25) |
| 200 (8) | 215.9 (8.5) | 233.4 (9.19) | 263.7 (10.38) | 213 (8.39) | 225 (8.86) | 257 (10.12) | 215.9 (8.5) | 225.6 (8.88) | 263.7 (10.38) |
| 250 (10) | 268.3 (10.6) | 287.3 (11.31) | 317.5 (12.50) | 267 (10.5) | 279 (10.98) | 315 (12.40) | 268.3 (10.6) | 274.6 (10.81) | 317.5 (12.50) |
| 300 (12) | 317.5 (12.5) | 339.9 (13.38) | 374.7 (14.75) | 318 (12.5) | 330 (12.99) | 366 (14.41) | 317.5 (12.5) | 327.2 (12.88) | 374.7 (14.75) |
| 350 (14) | | | | | | | 349.3 (13.75) | 362.0 (14.25) | 406.4 (16) |
| 400 (16) | 400 (15.7) | 422.4 (16.63) | 463.6 (18.25) | 414 (16.3) | 426 (16.77) | 466 (18.35) | 400 (15.7) | 412.8 (16.25) | 463.6 (18.25) |
| 450 (18) | | | | | | | 449.3 (17.69) | 469.9 (18.5) | 527.1 (20.75) |
| 500 (20) | 500 (19.7) | 525.5 (20.69) | 577.9 (22.75) | 518 (20.4) | 530 (20.87) | 574 (22.60) | 500 (19.7) | 520.7 (20.50) | 577.9 (22.75) |
| 600 (24) | 603.3 (23.8) | 628.7 (24.75) | 685.8 (27.00) | 618 (24.3) | 630 (24.80) | 674 (26.54) | 603.3 (23.8) | 628.7 (24.75) | 685.8 (27.00) |

# 7.3 Screws



| | **Temperature range for bolts and nuts** | | |
|---|---|---|---|
| | **-40°C to +80°C** | | |
| **Pressure stages** | **Version 1** | **Version 2** | **Version 3** |
| Flange forms | | | USM DN80<br>Blind hole flange |
| PN10, PN16, PN25, PN40, | Screws according to DIN EN ISO 4014 of material **25CrMo4**, nuts according to DIN EN ISO 4032 of material **25CrMo4** | – | Screws<br>DIN EN ISO 4014<br>M16x48 -<br>material **25CrMo4** |
| PN64 | Bolts DIN 976-1 -<br>material **25CrMo4**<br>Nuts DIN EN ISO 4032 -<br>material **25CrMo4** | – | Bolts DIN 976-1 -<br>Material **25CrMo4**<br>Nuts DIN EN ISO 4032 -<br>material **25CrMo4** |
| ANSI150, | Bolts according to ANSI B16.5 of material **ASTM A 320 Grade L7 (42CrMo4),** nuts according to ANSI B18.2.2 of material **ASTM A 320 Grade L7 (42CrMo4)** | – | Screws<br>ANSI B18.2.1 5/8" -<br>11 UNC 2 x 2 1/8"<br>(L = 54 mm) -<br>material **ASTM A320 grade L7 (42CrMo4)** |
| ANSI300, ANSI600 | | Reduced shaft bolts DIN 2510 -<br>material **25CrMo4**<br>Nuts DIN 2510 form NF<br>material **25CrMo4** | Bolt ANSI B16.5 3/4" -<br>10 UNC 2A -<br>material **ASTM A320 Grade L7 (42CrMo4)**<br>Nuts ANSI B18.2.2 3/4" -<br>10 UNC 2B<br>material **ASTM A320 Grade L7 (42CrMo4)** |

The stability of the flange connection was verified using the screws listed above in conjunction with the seals listed in Chapter 7.2. Other screw / flange versions have not been inspected.

**Note**

Variant 3 bolts with reduced shank may only be used for devices within the area of PED (Pressure Equipment Directive) application.

**Note**

DN 80

Screws/threaded bolts are provided by RMG for the USM-GT400 for diameter DN80.

Depending on the flange type the following hexagonal bolts/threaded bolts with nuts are used for DN80:

| PN10/16 | PN25/40 | PN64 | ANSI150 | ANSI300 | ANSI600 |
|---|---|---|---|---|---|
| DIN EN 24014 (DIN931 ISO4014) M16 x 48 L=48 mm or material: 25CrMo4 galvanized | DIN EN 24014 (DIN931 ISO4014) M16 x 52 L=52 mm or material: 25CrMo4 galvanized | **Bolts** DIN 976-1 M20x85 Length 85 mm Material: 25CrMo4 **nuts** DIN EN ISO 4032 M20 Material: 25CrMo4 | 5/8“ - 11 UNC 2A x 2 1/8“ L=54mm (2 1/8“) UNC A320 Grad7 or material: 42CrMo4 galvanized | **Bolts** 3/4"-10 L=90 mm UNC 2A - Material: ASTM A320 Grade L7 (42CrMo4) **nuts** ANSI B18.2.2 3/4"-10 UNC 2B - Material: ASTM A320 Grade L7 (42CrMo4) | **Bolts** 3/4"-10 Length 100 mm UNC 2A - Material: ASTM A320 Grade L7 (42CrMo4) **nuts** ANSI B18.2.2 3/4"-10 UNC 2B - Material: ASTM A320 Grade L7 (42CrMo4) |

**These screws can be used down to -40°C. The threaded bolts must be screwed in up to the bottom of the blind hole thread.**

# 7.4 Installation possibilities



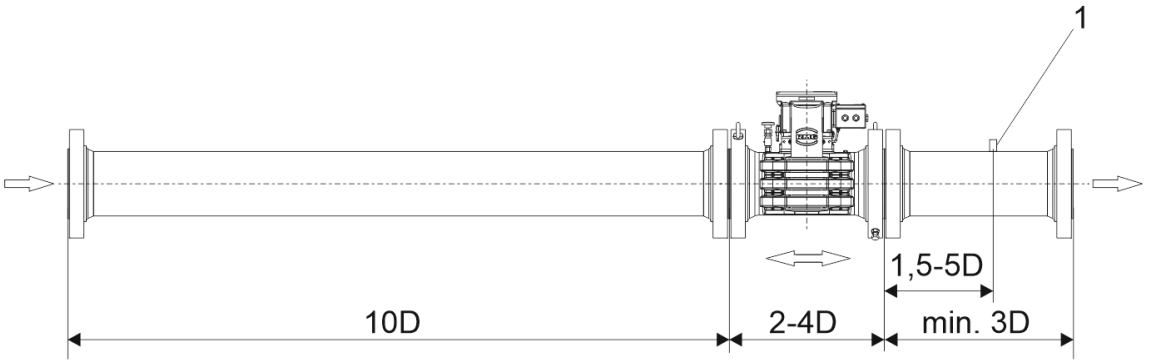
You have different possibilities when installing the device into your system. Please verify a proper inner diameter of any pipe that is connected to the meter.

⇨ See chapter 13.6 “Inner diameter of connecting spool pieces” on *page 199*

## 7.4.1 Dependency on the gas flow direction

In order for the installation to correspond to the requirements of the Measurement Instrument Directive 2004/22/EC (MID) or Measurement Canada (MC), the device must be installed with an inlet and outlet piping.

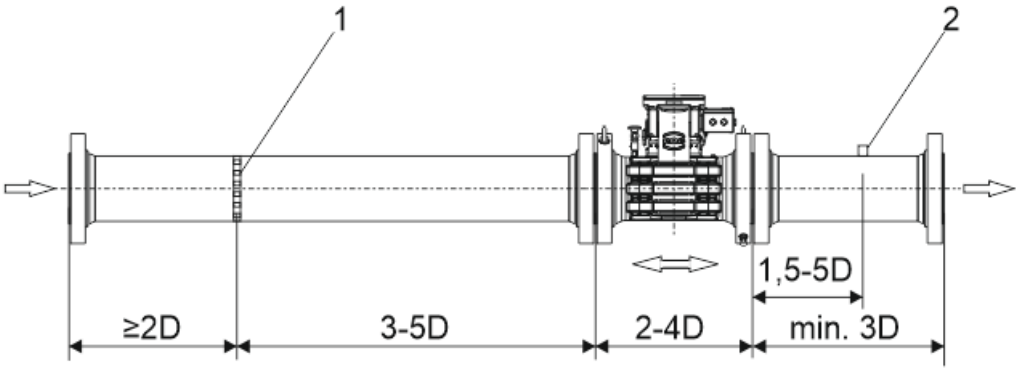
With this installation, the device can be used for calibrated measurements and for secondary measurements.




1 Temperature sensor

*Fig. 7.4: Unidirectional operation*

To meet the requirements of class 0.5 in accordance with OIML R137, a flow conditioner of type LP35 must be installed upstream of the inlet pipe with a length ≥ 10D, which also requires an inlet section of ≥ 5D. Alternatively, the compact installation with a flow straightener of type CPA55E can be selected as shown in fig. 7.6.




1 Flow conditioner LP35
2 Temperature sensor

*Fig. 7.5: Unidirectional operation – compact installation with flow conditioner LP 35*

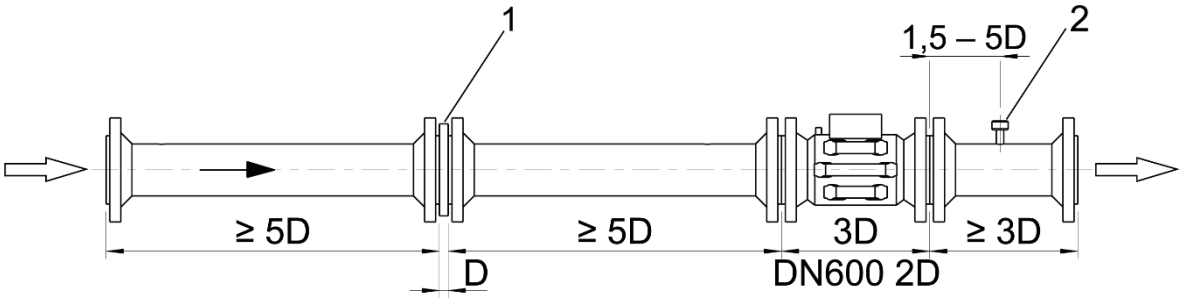
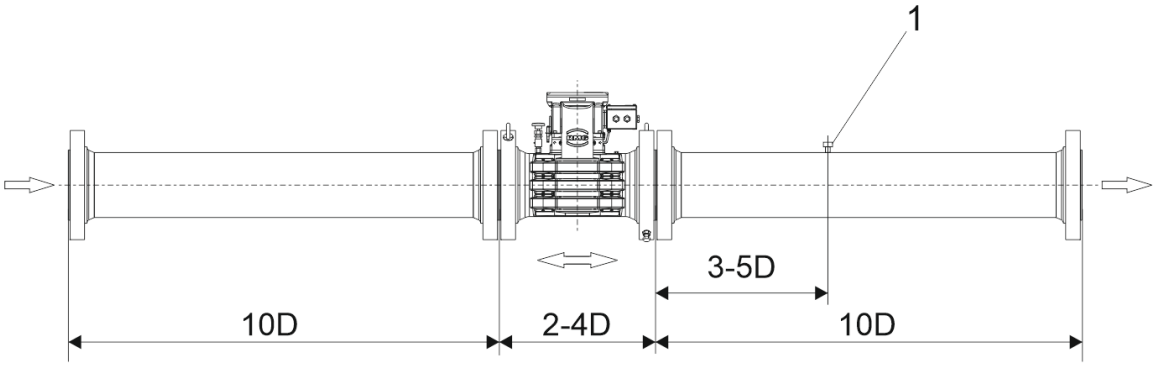


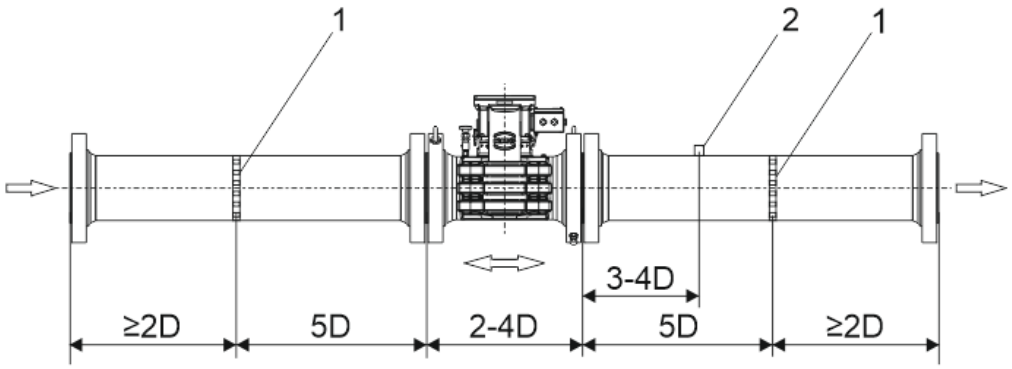

*Fig. 7.6: Unidirectional operation – compact installation with flow conditioner CPA55E*

**Bidirectional operation**



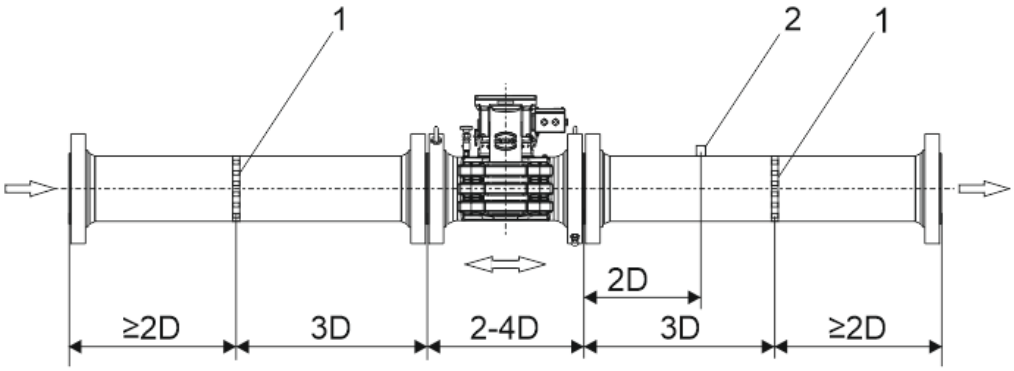

1 Temperature sensor

*Fig. 7.7: Bidirectional operation*




1 Flow conditioner
2 Temperature sensor

*Fig. 7.8: Bidirectional operation – compact installation < DN 300 (12")*




1 Flow conditioner
2 Temperature sensor

*Fig. 7.9: Bidirectional operation – compact installation ≥ DN 300 (12")*

## 7.4.2 Two devices series connected (Face to Face)

You can install one or several devices in series.

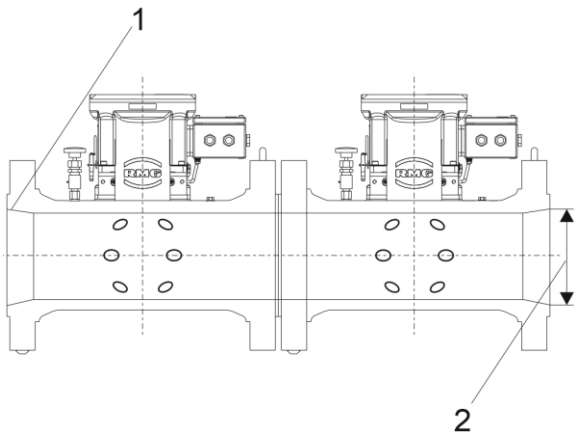
100

**Note**

**Malfunctions from pairing the devices incorrectly**

If the devices do not match one-another for these installation possibilities, incorrect measurements may occur.

- Please consult RMG if a Face-to-Face installation is possible with the desired devices and number of devices.




1 Tapered bore
2 Inner diameter

*Fig. 7.10: Face-to-Face Installation*

With this installation option, two or several devices are connected with one-another via the flanges. Third-party manufacturer devices can also be connected to RMG devices.

For this purpose, a tapered bore can be applied to the flanges on the inlet and outlet piping.

The flanges that are used to connect the devices with one-another do not require a tapering. For third-party manufacturer devices, you have to check if a tapering is required.

**Note**

For the device with the smaller inner diameter it is mandatory to use a tapering.



If two RMG devices are connected with one-another, the inner diameter must be continuously the same.
Different sized devices cannot be connected to one-another.

# 7.5 Flow computer



If required, you can connect one or two flow computers to the device.
Follow the installation guidelines of the flow computer:

⇨ *Observe the installation instructions for the flow computer*

The 2 interfaces RS485-1 and RS485-2 have the same features and you may change in the following1 to 2 (and 2 to 1) freely.

However, the RS 485-1 (in contrary to the RS 485-2) does not permit a parameterizable byte sequence for the data types Long and Float. We therefore recommend that you use the RS 485-1 for the DZU protocol and the RS 485-2 for instance F communication. You may find more information in chapter 8.3.

### Flow computer from RMG

The device is compatible with the following flow computer series from RMG:

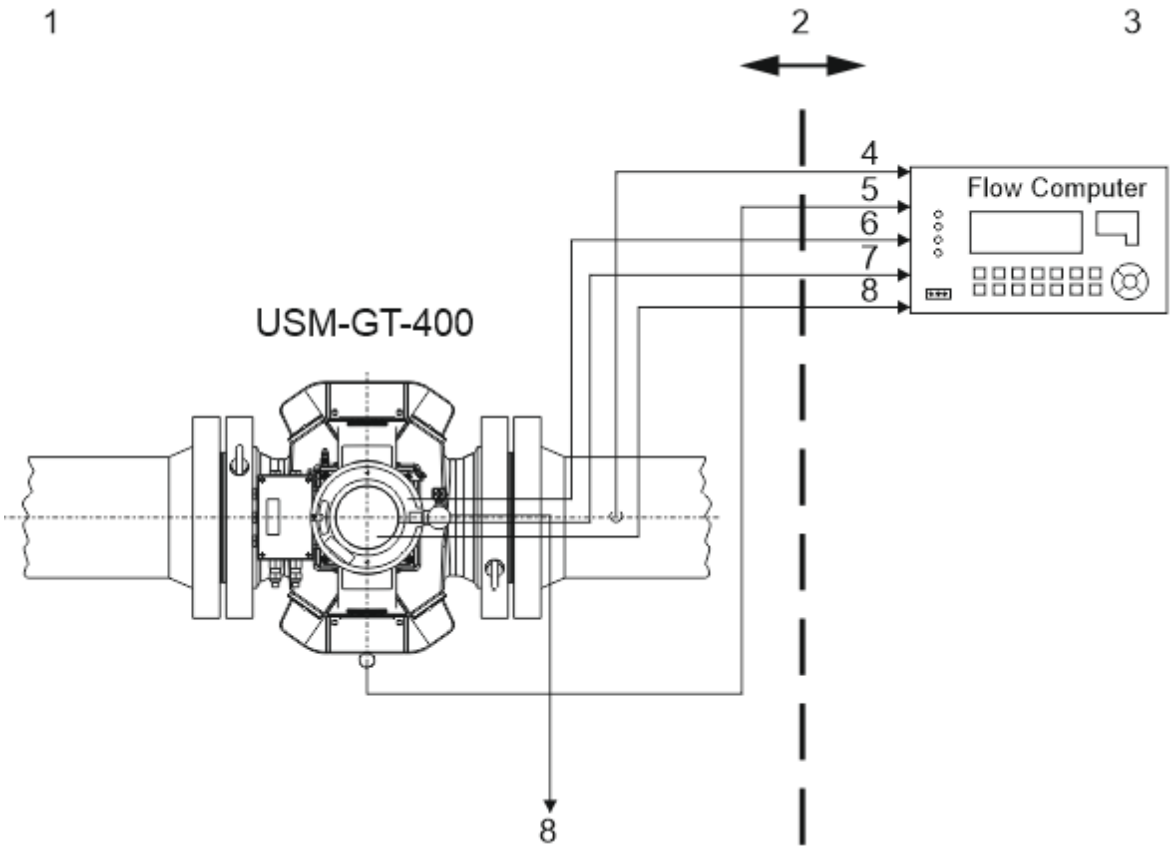
- ERZ 2000NG
- ERZ 2400

If you want to use the flow computer from RMG specified above, you do not have to carry out any configurations. The flow computers from RMG can directly process the protocol of the ultrasonic gas meter from RMG directly. For this purpose, the flow computer has to be connected to the digital interface RS485-1 in order to allow all diagnosis functions to be used. If you want to install an additional flow computer for reasons of security, this must be connected via the interface RS485-2.

### Flow computer from third party manufacturer

Flow computers from third-party manufacturers can be connected to the device. These can only be connected to the digital interface RS485-2. This interface communicates via a Modbus protocol. In order to be able to use all diagnosis functions, the Modbus must be configured. You can also use the high-frequency outputs pulse 1 and 2. When parameterizing, take care that the maximum possible gas flow rate correlates to a maximum frequency of 2 kHz. All diagnosis functions cannot be used via this interface. If you are using a third-party manufacturer device, you have to configure the flow computer.

**Connecting a flow computer for example an ERZ 2000 / ERZ 2400**




1 Explosive atmospheres Device group II zone I or Class 1, Division 1
2 Maximum distance 500m
3 Safe area
4 Temperature
5 Pressure
6 Pulse
7 Alarm
8 RS 486-2 (Modbus ASCII oder RTU)
9 Service-Interface RS 485-0 for RMG View

*Fig. 7.11: Connection diagram for connection of a flow computer for example ERZ 2000 / ERZ 2400*

The cable length must *not* exceed a length of 500 meters / 1640 feet.

More information on the installation of a flow computer can be found here:
⇨ *Operating instructions of the flow computer*

# 8 Installation



In this chapter you are provided with information on how you can correctly install the device and what you have to observe during the process.

The tasks of the chapter described must only be carried out by trained and certified personal.

**Content**

# 8.1 Assembly work preparations



**Danger**

**Mortal danger from electric current**

In potentially explosive environments, dangerous voltages can still remain as ignition sources for up to one minute after being switched off.

- Disconnect the device from the power supply before starting the maintenance work.
- Secure the device against being switched back on.
- Cordon-off the work area of the device, e.g., using a barrier and signs.
- After switching off the device, wait at least one minute before starting work. Ensure that the device is voltage-free. Then connect to earth and short-circuit.

**Mortal danger from components under pressure**

Flange joining elements, pressure tapping screw connections and valves must not be removed if pressure is applied to the device. Components may be flung around. Gas escaping may cause intoxication and burns. Risk of explosion!

- Carry out work on the device only when it is in a voltage-free state, is vented and without pressure.

**Mortal danger from incorrect work**

Hazards can only be recognized and avoided by specially trained personnel.

If work is carried out by persons who have not been trained for these special activities in potentially explosive areas, they may cause an explosion.

- Have installations only carried out by especially trained personnel, (expert according to DIN VDE 0105, IEC 364 or similar national, standards).

**Mortal danger from damaged sealing surfaces**

If sealing surfaces are damaged, e.g., from notches or scratches, leaks may occur. Risk of intoxication and explosion!

- Install only an undamaged device

**⚠ Warning**

**Risk of injury during transport**

The device may be damaged when lifting and putting down, tipping over or falling down. By disregarding the load bearing capacity of the lifting gear, the device may fall. There is a risk of severe injuries for persons in the vicinity.

- Lift the device only on the intended lifting eyes.
- Before lifting, make sure that the load is safely secured.
- Never stand under suspended loads.
- Observe the weight specifications for the ultrasonic gas meter at hand.

**⚠ Caution**

**Risk of injury from missing retaining bolts**

If the device is put down without the retaining bolts, it can tip over or roll away. Serious injuries may occur.

- Before starting work, make sure that the retaining bolts are screwed in.

**Note**

**Damage to the device when used as a climbing aid**

If the device is used as a climbing aid, components may be damaged.

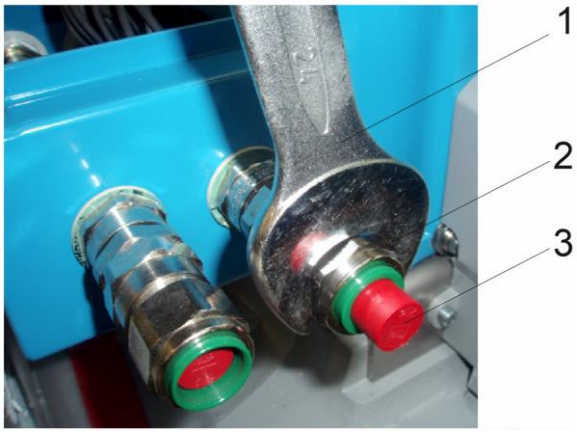
- Do *not* use the device as a climbing aid.
- Use a suitable non-slip step that allows you to reach the components easily and safely.

▪ **Carry out preparatory work**

**1** Unpack the device.
⇨ *Chapter 6.1.3, “Unpacking the device” on page 74*

**2** Remove the transporting locks.
⇨ *Chapter 6.1.6, “Removing the transporting locks” on page 78*

**For ATEX / IECEx**




1 Wrench
2 Screwed cable gland
3 Blind plug

*Fig. 8.1: Remove the blind plugs*

**3** Unscrew connection (2) with a suitable wrench (1).

**4** Pull the blind plugs (3) out of the connection.

**5** Screw glandes not required must be replaced by explosionproof screw connections.

Recommendation: store the blind plugs for the future or for returning to RMG for service work.

**For NEC 500**

In countries where CSA guidelines apply, the connections not required must be provided with gasket screws ex-factory. Please leave these in the screw connection and only connect the cable that leaves the conduit seal. When joining the conduits to the flame block, ensure for a slight gradient away from the flame block in order to avoid the accumulation of water on the conduit seal. Moreover, also ensure that you do not twist the conduit seal when securing the conduit as the cable in the electrics housing may tear-off as a result. If necessary, use a respective bolted connection (union).

**For all devices**

6 Secure the device with retaining bolts for the installation.
⇨ *Chapter 6.2, “Ensure for a safe position of the device” on page 80*

7 Check the device for any signs of damage.
⇨ *Chapter 6.3.2, “Checking the device after storage” on page 87*

8 Clean the sealing surface of the flange from contamination with a gentle cleaning agent.

# 8.2 Installation of the device

## 8.2.1 Mounting the inlet and outlet piping

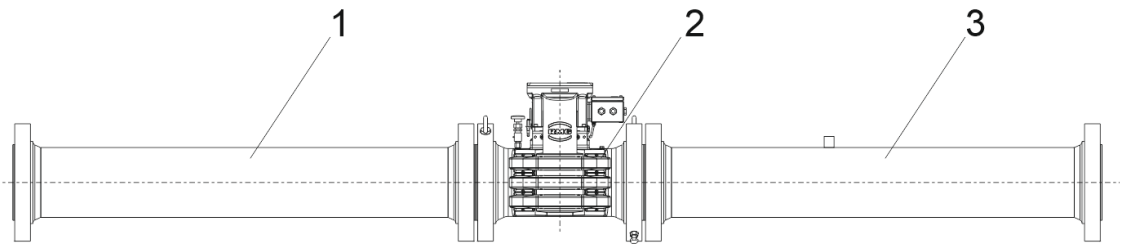
**Danger**

**Escaping gas from incorrect seals**

If flange seals are used for ultrasonic gas meters that protrude into the pipeline, potentially explosive gas mixtures may escape due to leaks. Risk of intoxication and explosion!

- Make sure that the flat seal does *not* protrude over the sealing surface into the pipeline.

Observe the instructions for the dimensions!
⇨ *Chapter 13.5, “Weights and dimensions” on page 194*




1 Inlet piping
2 Ultrasonic gas meter
3 Outlet piping

*Fig. 8.2: Installation of the Inlet and outlet piping*

The bolted connection of Inlet **(1)** and outlet piping **(3)** must be tightened according to the tightening torque of the plant manufacturer. The tightening torque must comply with the bolts and seals used.

**1** Clean the sealing surface of the flange from contamination with a gentle cleaning agent.
**2** Tighten the bolts crosswise in order to avoid tensioning.

**Note**

In general, only the horizontal installation of the USM GT400 is strongly recommended. Turning the meter by more than 2 flange holes should not be used to avoid the collection of condensates in the sensor pockets. Only in dry and clean gas, other installation positions might be possible also, but it is not recommendable.

## 8.2.2 Installation of the connection box

The device can be ordered in different versions. Depending on the version ordered, another procedure must be carried out for the installation.



These are the order versions:

- connection box according to ATEX / IECEx

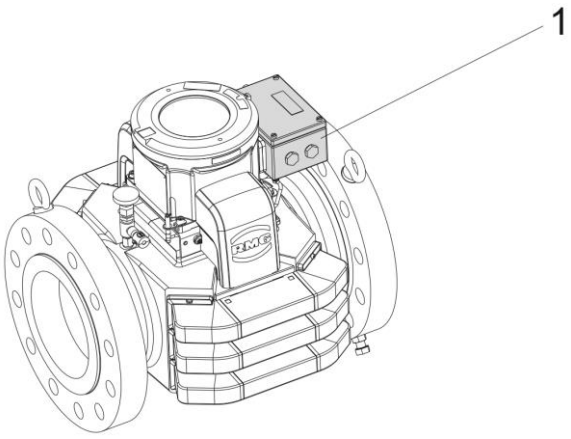
  ⇨ *“Installation of the connection box (ATEX / IECEx)” on page 110*

- connection according to NEC 50

  no box must be installed here, only connect the cable according to their designation.

  ⇨ *Cable connection “Connecting the device electrically” on page 112*

### Installation of the connection box (ATEX/IECEx)



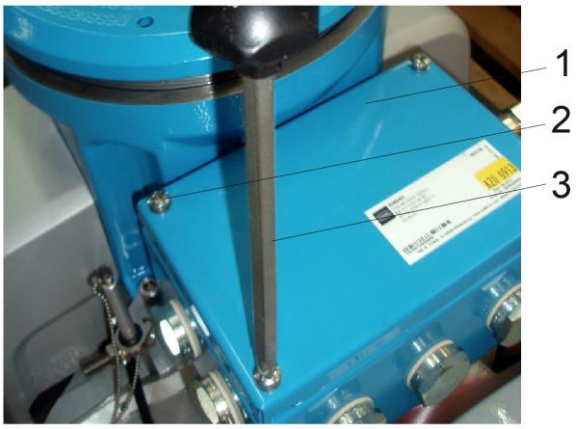

1 Connection box Ex-de

*Fig. 8.3: Connecting the connection box*

This version of the connection box is supplied in countries where the ATEX / IECEx standards apply.

The external connecting housing is pre-assembled and connected electrically to the ultrasonic electronics ex-factory.

### Open the connection box (Ex-de)




1 Cover
2 Screws
3 Screwdriver

*Fig. 8.4: Opening the connection box cover*

**1** Unscrew the screws (2) using a suitable screwdriver (3).

**2** Remove cover (1).

- **Closing the connection box (Ex-de)**

**1** Place cover (1) onto the connection box.

**2** Screw in the screws (2) using a suitable screwdriver (3).

### Joining the device to the customers flameproof connection box

With this order version, no connection box is mounted on the device.

The device offers the connection by cable that are routed through the flame block. The wiring in the ultrasonic electronics is carried out ex-factory. The cables are marked accordingly for connecting and can be connected in a customer's connection box.

Observe the following when installing:

- The cables must be connected according to the lettering.
- Select a maximum cable length of three meters. If you need to use longer cables, please contact RMG services.

# 8.3 Connecting the device electrically

In this chapter you will receive information on connecting the electrical connections.



The terminal strip for the electrical connection is located in the external connection box. The terminal assignment and the markings of the cable are always identical.

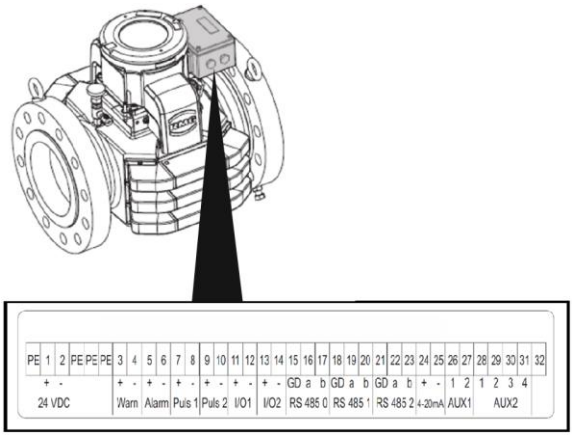



*Fig. 8.5: Connection assignment on the terminal strip*

**Maximum assignment**
The maximum assignment is always completely available for the connections of the Ex-de connection box.

- Current / voltage supply (24 VDC)
- Warning message (Warn)
- Alarm message (Alarm)
- Pulse output for "Forwards mode" (Pulse 1) and "Backwards mode" (Pulse 2)
- 2 x direction detectors for bi-directional operation (I/O1/2)
- Interface for RMGViewUSM (RS 485 0)
- Interface for an RMG flow computer (RS 485 1)
- Interface for any flow computer (RS 485 2)
- Analog output (4-20 mA)
- Connection for a pressure sensor as a 2-wire 4-20mA
  (AUX1; Terminal 26: [P +] Terminal 27: [P -])
- Connection for a temperature sensor (PT100; AUX2; Terminal28: [PT100 ++], Terminal 29: [PT100 +] Terminal 30: [PT100 -] Terminal 31: [PT100 -])

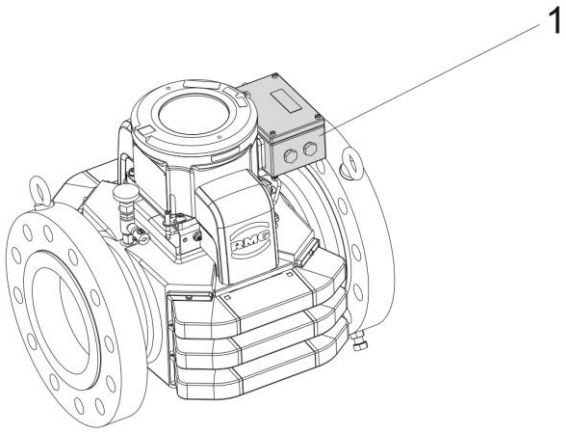
### Cable specification

The following cable specifications are according to a complete assignment of the USM-GT-400 ATEX / IECEx version. The cable types listed are recommendations that can be replaced by technically comparable cable types.

| | | |
|---|---|---|
| Power supply<br>24 VDC | ÖLFLEX® CLASSIC<br>3 x 1.5 mm² oder<br>3 x 2.5 mm² | Cable Ø<br>12.3 mm<br>13.5 mm |
| Interface:<br>RS 485-0,<br>RS 485-1, RS 485-2<br><br>(can be laid in one cable) | LIYCY (TP)<br><br>3 x 2 x 0.75 mm² | <br><br>9.4 mm |
| AUX1 | LIYCY<br>2 x 0.75 mm² | <br>6.0mm |
| AUX2 | LIYCY<br>2 x 2 x 0.75 mm² | <br>8.5 mm |
| Analog out<br>4-20 mA | LIYCY<br>2 x 0.75 mm² | <br>6.0 mm |
| Warning + alarm | LIYCY<br>2 x 2 x 0.75 mm² | <br>8.5 mm |
| Pulse 1 + pulse 2 +<br>I/O 1 + I/O 2 | LIYCY (TP)<br>4 x 2 x 0.75 mm² | <br>10.7 mm |

Twisted pair cable (TP) are only required in case of multiple circuits in one cable. Otherwise, LIYCY 2 x 0.75 mm² is sufficient for all signal outputs.

### Connection box according to ATEX / IECEx




**1 Ex-de connection box for Europe**

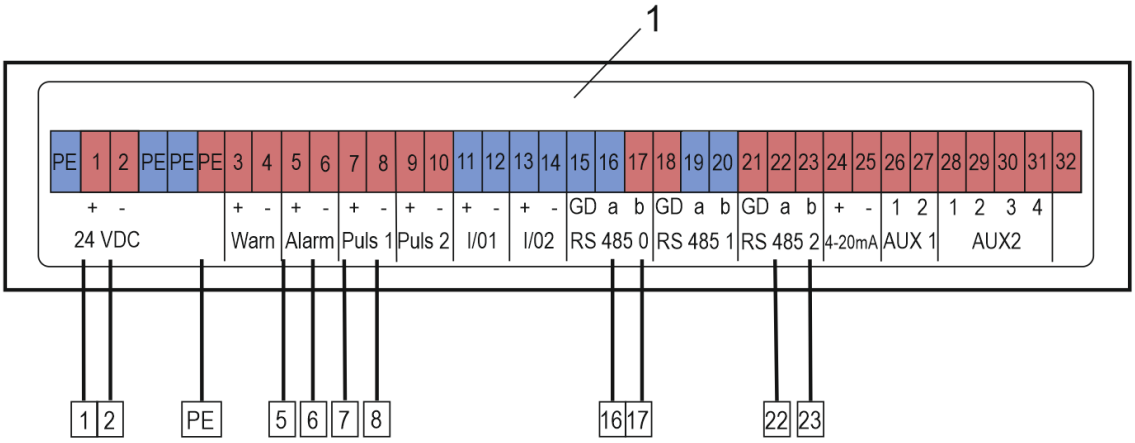
*Fig. 8.6:* Close the connection box

In those countries where the standards ATEX and IECEx are valid,
the device is supplied with the connection box Ex-de (1).
The external connection box is connected electrically to the ultrasonic electronics ex-factory and pre-assembled on the ultrasonic electronics. The external connection box does not have to be mounted.

**Connection according to NEC 500**
The number of lines that are permitted to be routed through the cable gland (½" and ¾") on the electrics housing and flame block is limited. Accordingly, this results in 4 different constellations that reflect the possibilities for connection.

The numbers given below at each figure only counts the limited number of cables; all cables are labeled due to the number of the basic upper terminal block

**Version 1: Minimum assignment-½" sealing fitting**



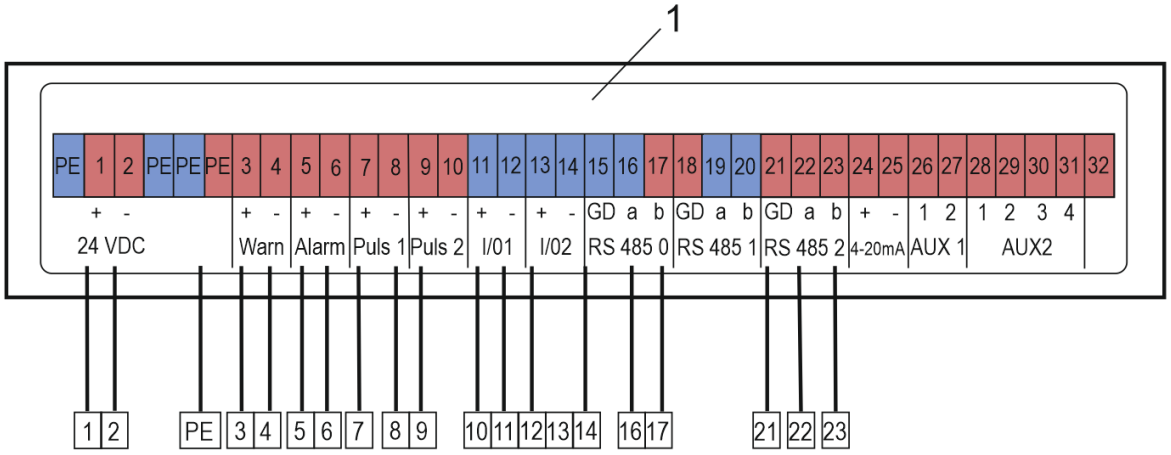

1 Terminal connections

*Fig. 8.7: ½" cable gland with 11 wires, size AWG 18*

**1** 1½" sealing fitting, connected with 11 wires, size AWG 18 (permitted, max. 11; Killark Type ENY-1TM).

For this version, the ERZ 2000 or ERZ 2000 NG cannot be connected via the DZU protocol (RS 485-1).

**Version 2: Minimum assignment for bi-directional operation - ¾" sealing fitting**



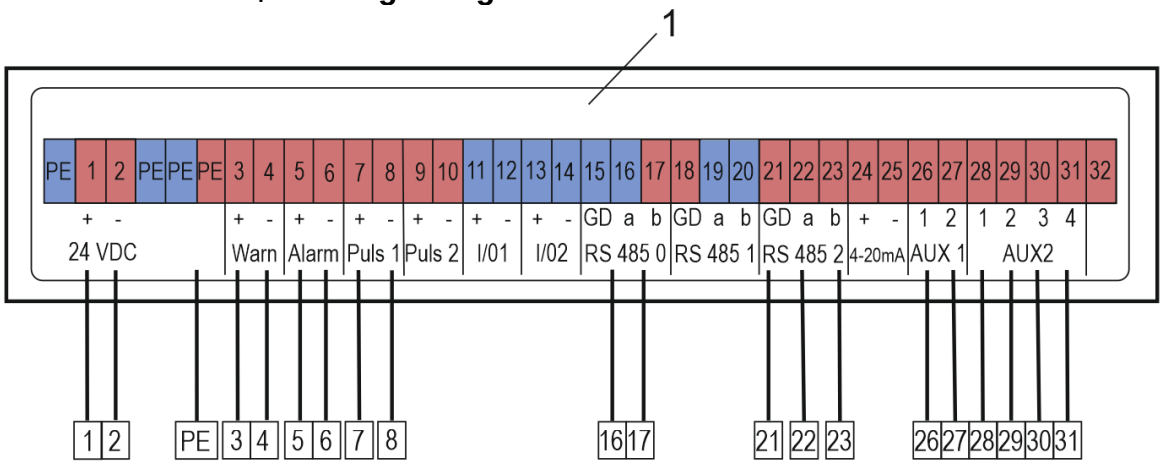

1 Terminal connections

*Fig. 8.8: ¾" cable gland with 20 wires, size AWG 18*

**2** ¾" sealing fitting, connected with 20 wires, size AWG 18 (permitted, max. 20; Killark Type ENY-2TM).

For bi-directional operation.
For this version, the ERZ 2000 or ERZ 2000 NG cannot be connected via the DZU protocol (RS 485-1).

**Version 3: Minimum assignment for operation with pressure and temperature measurement - ¾" sealing fitting**

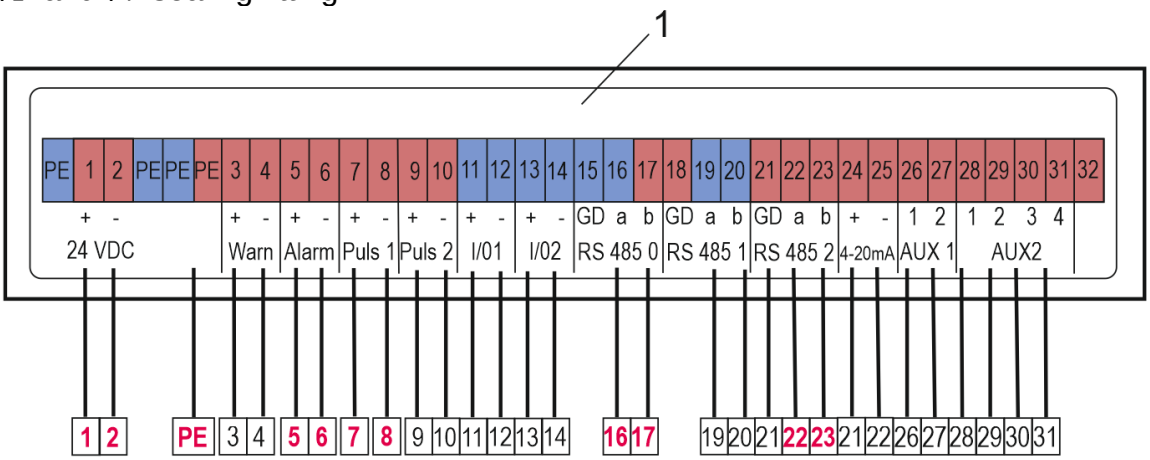



1 Terminal connections

*Fig. 8.9: Measuring with pressure and temperature*

For measuring with pressure and temperature:
For this version, the ERZ 2000 or ERZ 2000 NG cannot be connected via the DZU protocol (RS 485-1).

**Version 4: Maximum assignment**
½" and ¾" sealing fitting




1 Terminal connections

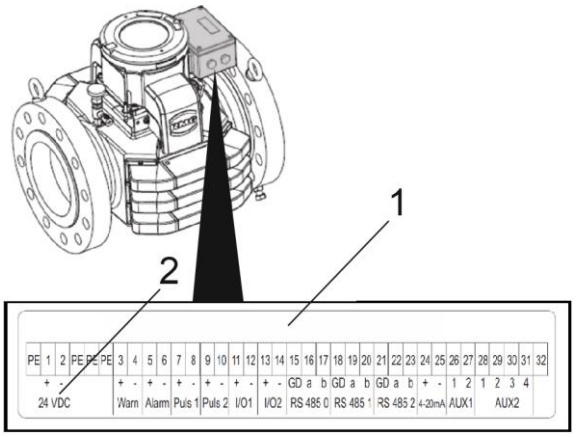
*Fig. 8.10: ½" and ¾" sealing fittings with up to 31 wires of size AWG 18*

***3*** Connect ¾" sealing fitting with 20 wires of size AWG 18 (permitted, max. 20; Killark type ENY-2TM) and ½" cable gland with 11 wires of size AWG 18 (permitted, max. 11; Killark type ENY-1TM).

All connections are routed to the outside and can be connected and used.

Not used cables need to be isolated or connected to any unused free terminals.

### 8.3.1 Connecting the power supply

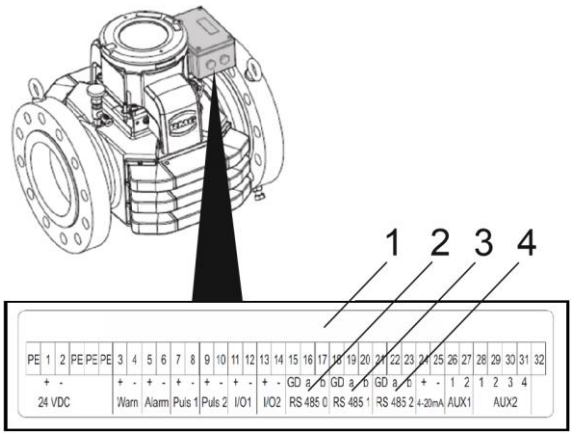



1 Terminal connections
2 Stromversorgung an den Klemmen 24 VDC

*Fig. 8.11: Connection assignment on the terminal strip*

**1** Connect the power supply to the terminals 24 VDC (2).
Figure 8-16 on page 94.

### 8.3.2 Digital interfaces of USM-GT400




1 Terminal connections
2 Digital interface RS485-0
3 Digital interface RS 485-1
4 Digital interface RS 485-2

*Fig. 8.12: Digital interfaces RS 485-0,1 und 2*

The interfaces **RS 485-0, RS 485-1** and **RS 485-2** are basically equal and can be set for all possible connections. However, there are minor differences. These are taken into account in the recommended connections and make it easier to connect the recommended devices or the PC if they are followed.

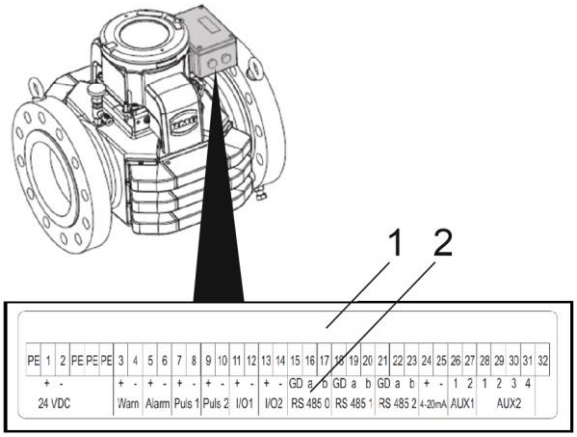
**Note**

**Please use the connections as recommended below. If connections are used differently additional, extensive settings may become necessary.**

### Recommended connections at the digital outputs.

| | RS 485-0 | RS 485-1 | RS 485-2 |
|---|---|---|---|
| **Protocol, device** | RMGView$^{USM}$ (service) | IGM-protocol<br>DZU-protocol<br><br>ERZ2000,<br>ERZ2400,<br>ERZ2000-NG,<br>ERZ2000-DI | Instanz-F<br><br>2$^{nd}$ ERZ ,<br>Flow computer<br>other suppliers |
| **features** | no parameterizable byte sequence for data types Long and Float | no parameterizable byte sequence for data types Long and Float | Modbus-Master, can handle IGM- and DZU-protocol, too, parameterizable byte sequence for data types Long and Float |

### 8.3.3 Connecting the computer for RMGView[USM]



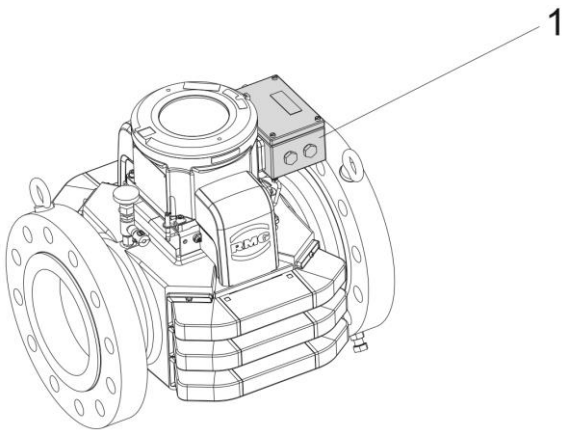

1 Terminal connections
2 Service connection

*Fig. 8.13: Connection assignment on the terminal strip*

**1** Connect the computer to the terminals RS 485-0 (1).

In order to connect, you need an interface converter from USB to RS 485. (please see recommendations in chapter 8.3.4).

### 8.3.4 Connecting the flow computer




1 Ex-de according to ATEX and IECEx

*Fig. 8.14: Connection box types*

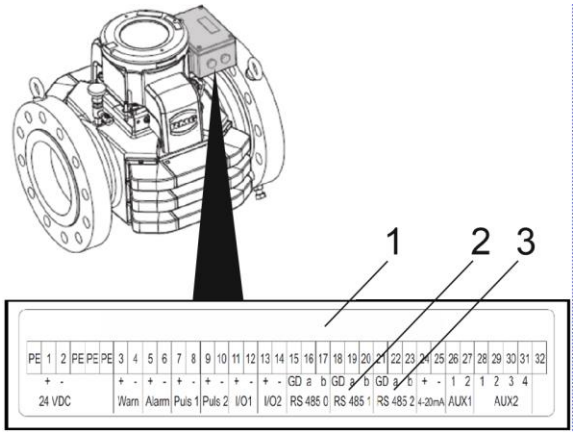
The flow computer is connected to the terminal strip of the external connection box (1).

120

**1.** Open the cover of the connection box.
⇨ “Open the connection box (Ex-de) ” on page 111

- **Connecting the flow computer from RMG**

**Connection via data cable for ERZ 2000**
Use the following cable:
- twisted pair and shielded cable
- maximum length 500 m / 1640 ft
- line cross-section min. 2 × 2 × 0.75 mm²




1 Terminal connections
2 Connection flow computer 1
3 Connection flow computer 2

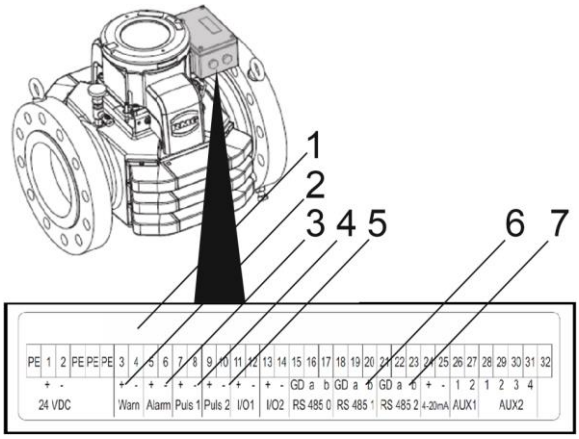
*Fig. 8.15: Connection assignment on the terminal strip*

The 2 interfaces **RS 485-1** and **RS485-2** are equivalent and you may change in the following 1 to 2 (and 2 to 1) freely.
The difference is that the RS 485-1 interface does not have a parameterizable byte sequence for the long and float data types. This interface is particularly suitable for communication using the DZU protocol. The RS 485-2 is intended for communication via the manufacturer-independent Instance-F protocol, as this interface offers a parameterizable byte sequence.

**1** Connect the first flow computer to the terminals **RS 485-1 (2)**.

**2** Connect the second flow computer to the terminals **RS 485-1 (3)**.

### Connecting a flow computer from third-party manufacturers




1 Terminal connections
2 Connection Warning messages
3 Connection Warning messages
4 Connection Pulse 1
5 Connection Pulse 2
6 Connection RS 485-1
7 Connection RS 485-2

*Fig. 8.16: Connection assignment on the terminal strip*

Flow computers from third-party manufacturers can be connected to **RS 485-1** or **RS 485-2** terminals. This interface communicates via a Modbus protocol.

All diagnosis functions can be made available via a configuration of the Modbus. Flow computers from third-party manufacturers can also be connected to the terminals **Pulse 1** and **Pulse 2**. When parameterizing, take care that the maximum possible gas flow rate is assigned to a maximum frequency of 2 kHz. All diagnosis functions are not available.

**1** Connect the flow computer to terminals **RS 485-1 (6)** or **RS 485-2 (7)** or **Pulse 1 (4)** and **2 (5)**.

Warning and alarm messages are also available. You also have to connect a direction contact for bi-directional operation.

**2** Connect the terminal **Warn (2)** for warning messages.

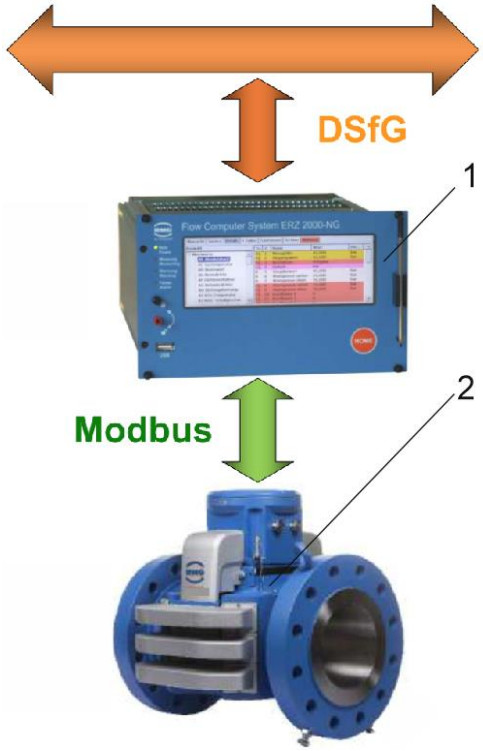
**3** Connect the terminal **Alarm (3)** for alarm messages.

### 8.3.5 Connection of external DSfG-Device-F via Modbus



The intension to connect Ultrasonic gas meters comparable to an electronic evaluations unit via the same protocol arises due to the wish to transfer "all" data determined by an ultrasonic gas meter, i. e. measured values as well as status information or diagnostic data. Therefore, the connection via DSfG-device-F has become the standard in Germany.

Since the USM GT400 does not have its own DSfG bus access, its DSfG-instance-F protocol is implemented externally via a flow computer, the ERZ 2000-NG, which has this access. To realize the access the necessary data are transferred between the ERZ 2000-NG and USM GT400 via Modbus, which is often
referred to as Instance-F, although it only provides the data required for DSfG Instance-F.




1 ERZ 2000NG with external DSfG device F
2 USM-GT-400 Ultrasonic flow rate meter for gas

*Fig. 8.17: Data exchange between ERZ 2000 NG and USM-GT-400*

The corresponding settings can be found in the VK Modbus Master USM menu in the ERZ2000-NG. The corresponding register expressions can be found in the VJ register expressions menu. In the USM GT400, the Modbus registers of instance F are listed in column BA.

### Electrical connection

The following figure shows the rear panel of the ERZ2000-NG.
The USM GT400 is connected to the serial interface COM6.


*Fig. 8.18: Connection of the USM‘s Modbus interface to COM 6*

### USM GT400 terminal compartment

Three serial interfaces for Modbus communication are available on the USM GT400.
For instance F Modbus communication, the **RS 485-2** is provided with terminal 21 (**GND**), terminal 22 (**Data +**) and terminal 23 (**Data -**).

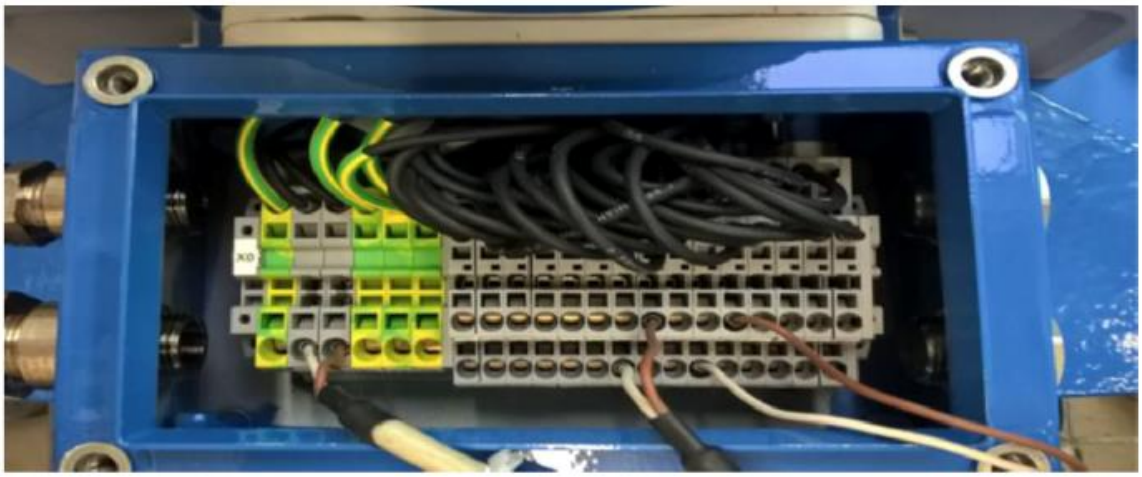
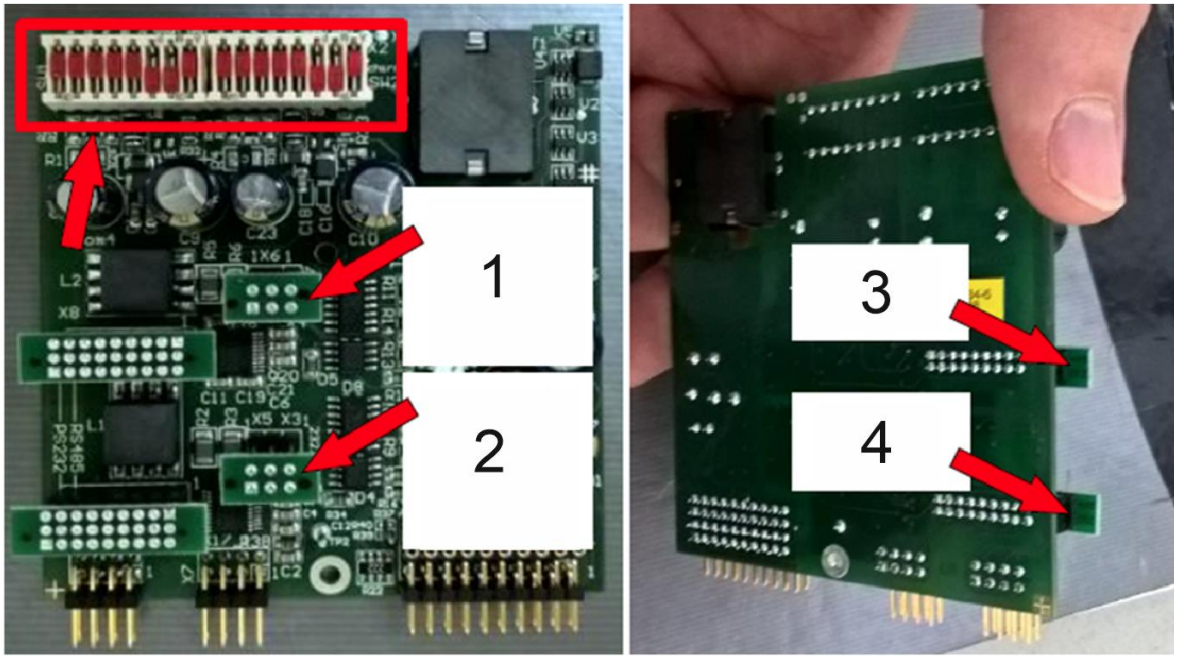


*Fig. 8.19: Connection of the RS 485-2 (22 +, 23 -) at the USM GT400*

### Configuration for COM6 and COM7



For communication with ultrasonic gas meters via instance F the optional interface COM 6 for the ERZ2000-NG is necessary. The DIL switches are located on the option card required for this purpose. The jumpers for the RS 485 require a setting that is shown in the following Figure. After that, the option card is to be placed into the COM6 and 7 slots, which is the first one from the right looking from the display




1 Square solder joint is to be aligned bottom left
2 Square solder joint is to be aligned bottom left
3 On top 485, below 232
4 On top 485, below 232

*Fig. 8.20: Configuration of the option card to be used as COM 6 and 7 of the ERZ 2000-NG*

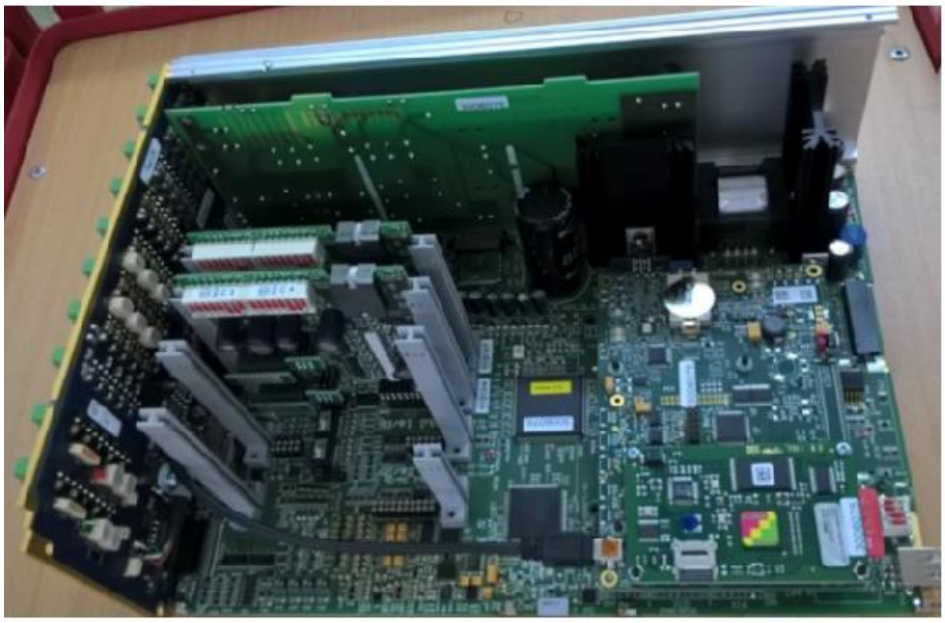


*Fig. 8.21: Slot for the option card with COM 6 and 7 of the ERZ 2000-NG*

**Operating mode of the ERZ 2000-NG**

If the button "DSfG: F-instance COM6/7" in the menu GB Flow rate parameter is activated, the further necessary settings are suggested in this menu (light yellow-green background):

- **GB16 Volume transducer mode** -> „DZU“ mode
- **GB51 Device type -> „USM GT400**“
- **GB53 Meter type** -> „USZ“ (or “USM”)

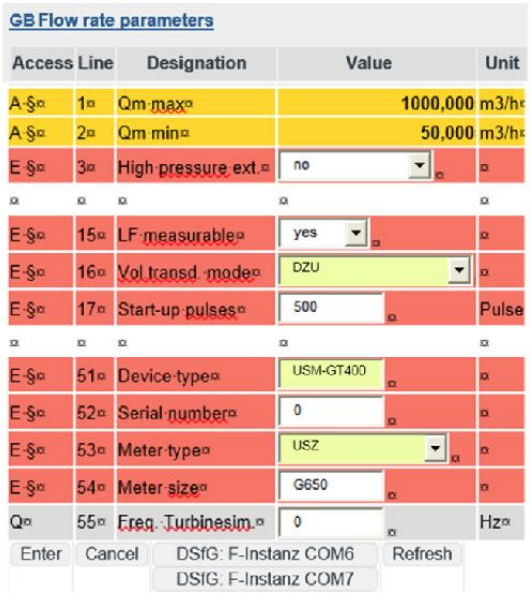



*Fig. 8.22: Selection of DZU in Vol.transd. mode GB16*

The proposal must then be "entered", i. e. accepted.

### Protocol type in menu VJ Register Expressions

After the selection of "DZU" in Volume transducer mode the protocol type "DSfG: F-instance" must be defined in the menu **VJ register expressions** by button selection. The corresponding registers for the Modbus communication are thus suggested.

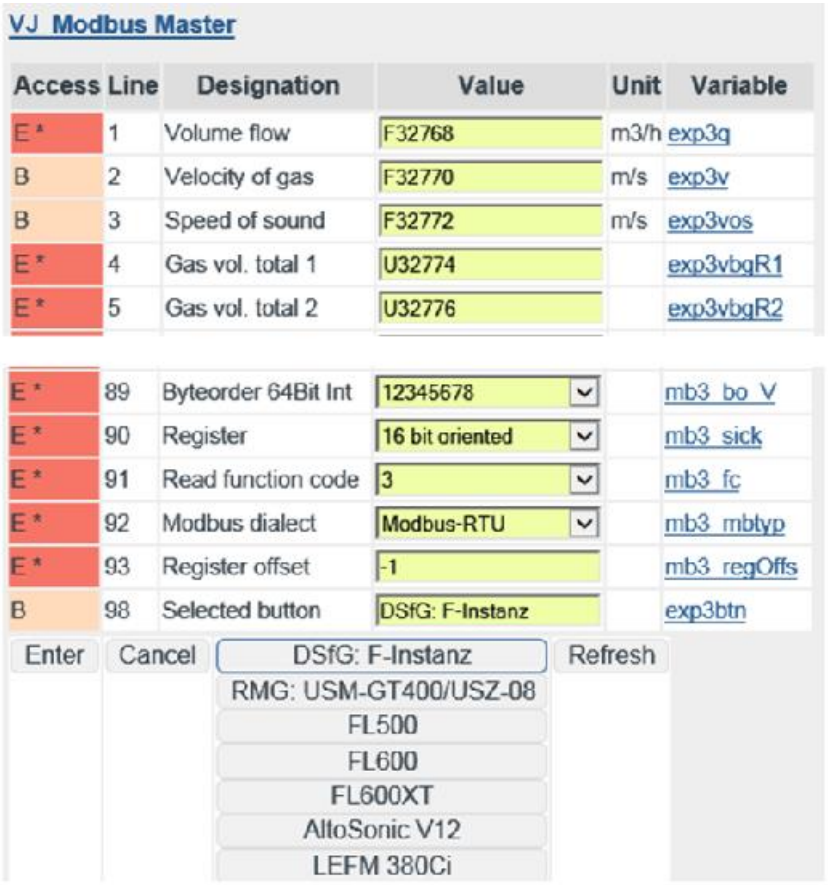



*Fig. 8.23: Selection of DSfG: F-Instanz in VJ98*

The proposal must then be "entered", i. e. adopted. In the complete menu you can see that many other parameters are transferred in addition to the flow rate.
The connection and selection of all other ultrasonic gas meters listed below are also possible due to legal metrology purposes.
Coordinate **VJ98 selected button** is used to enter which suggestion was entered.

## Note

**Attention:**

Even if in the same field with the same register, e. g. the information "swirl" is transmitted, the value is "swirl" is dependent form the device and path configuration used. It might be (significantly) different for the various devices.

The same applies to all device-specific parameters.

### Interface configuration COM6

For communication via Instance-F, the serial interface COM6 must be operated with parameters 38400 baud, 8 bits, parity None and 1 stop bit as well as the operating mode Universal Modbus master. These can be found in IB serial interfaces in coordinates IB31 to IB33.

IB Serial interfaces

| Access | Line | Designation | Value | Unit | Variable |
|---|---|---|---|---|---|
| B | 31 | COM6 Baudrate | 38400 | | baudC6 |
| B | 32 | COM6 B/P/S | 8N1 | | bpsC6 |
| B | 33 | COM6 operating mode | Univ.Modbus.Master | | modeC6 |

*Fig. 8.24: Interface configuration COM6*

**Note**

**COM6 is then no longer available for communication with a gas chromatograph. Therefore, the Modbus Master communication for GC1 and GC2 in the coordinates IL50 and IL51 must be realized via the serial interface COM7.**

**It has to be deactivated if no Modbus IP is used.**

IL Modbus Master GC1

| Access | Line | Designation | Value | Unit |
|---|---|---|---|---|
| E·§¤ | 50¤ | Operating·mode¤ | Modbus serial C7 | ¤ |
| E·§¤ | 51¤ | IP-Address¤ | 160.221.45.24 | ¤ |
| E·§¤ | 52¤ | Modbus·address¤ | 1 | ¤ |
| E·§¤ | 53¤ | ModbusIP·timeout¤ | 2000 | ms¤ |

*Fig. 8.25: Operating mode: Modbus serial C7*

IM Modbus Master GC2

| Access | Line | Designation | Value | Unit |
|---|---|---|---|---|
| E·§¤ | 50¤ | Operating·mode¤ | OFF | ¤ |
| E·§¤ | 51¤ | IP-Address¤ | 160.221.45.24 | ¤ |
| E·§¤ | 52¤ | Modbus·address¤ | 1 | ¤ |
| E·§¤ | 53¤ | ModbusIP·timeout¤ | 2000 | ms¤ |

*Fig. 8.26: Operating mode: OFF*

### Configuration VK Modbus according to instance F

For communication via DSfG Instance-F, **VK Modbus Master** USM must be parameterized according to the DSfG Instance-F specification as shown in the following figure.

VK Modbus Master USM

| Access | Line | Designation | Value | Unit |
|---|---|---|---|---|
| D | 32 | Communication | running | |
| D | 35 | Exception code | 0 | |
| D | 36 | Exception counter | 0 | |
| E S | 50 | Operating mode | Modbus serial C6 | |
| E S | 52 | Modbus address | 1 | |
| E S | 53 | Slave loves gaps | Yes | |
| E S | 54 | Gap size | 20 | |
| E S | 55 | Byteord 16-Bit-Int | 21 | |
| E S | 56 | Byteord 32-Bit-Int | 4321 | |
| E S | 57 | Byteorder float | 4321 | |
| E S | 58 | Byteorder double | 21436587 | |
| E S | 59 | Byte ord. 64-Bit-Int | 21436587 | |
| E S | 60 | Register | 16-Bit oriented | |
| E S | 61 | Read function code | 3 | |
| E S | 62 | Modbus dialect | Modbus-RTU | |
| E S | 63 | Register offset | -1 | |

Enter Cancel Load presets Refresh

*Fig. 8.27: Configuration of Modbus Master USM due to Instanz-F*

The Modbus address in **VK52** must be assigned with the address of the USM GT400 are the same. They can be found in J-31. Selection values in **VK58** and **VK59** are irrelevant because these data types are not included in the instance protocol.

## Configuration USM GT400 for Instance F

### Serial interface RS 485-2 (opt. Ser2)

If the ERZ2000-NG is configured according to the DSfG Instance-F specification as described in the previous chapter, the USM GT400 must be connected to the RS 485-2 serial interface. This is defined in the coordinates J-25 to J-37 under the indication "Opt. Ser2 ". Here these are to parameterize, too. The Modbus address in J-31 can be freely selected and must be set identically in **VK52** in the ERZ2000-NG.

| | | | | |
|---|---|---|---|---|
| J-25 | Opt. Ser2 Modus | Modbus | | 2112 |
| J-26 | Opt. Ser2 Baudrate | 38400 | baud | 2113 |
| J-27 | Opt. Ser2 Bits | 8 | | 2114 |
| J-28 | Opt. Ser2 Parität | KEINE | | 2115 |
| J-29 | Modbus-2 Protokoll | RTU | | 2178 |
| J-30 | Modbus-2 HW-Mode | RS485 | | 2179 |
| J-31 | Modbus-2 Adresse | 1 | | 2180 |
| J-32 | Modbus-2 Reg.Offset | 1 | | 2181 |
| J-33 | Modbus-2 Gap time | 45 | | 2182 |
| J-34 | Long Byte order | SWAPPED | | 2251 |
| J-35 | Float Byte order | SWAPPED | | 2252 |
| J-36 | Double Byte order | NORMAL | | 2253 |
| J-37 | DZU-2 Adresse | 3 | | 2285 |

*Fig. 8.28: Parameterization of RS 485-2 for Modbus according to instance F*

### Serial interface RS 485-1 (Serial-1)

The serial interface RS 485-1 may be used as well but requires a different setting due to fixed deviating Byte order. It will not be treated here, in case it is required you may have a look into the German manual of the USM GT400.

### Modbus Registers for Device-F

The Modbus registers for device-F can be found in chapter 18 the Appendix with the List of parameters. In the last part of this appendix, you may find the relevant Modbus registers 32768 to 33022 including the name, a short description a the type of the registers.

### Additional Registers

The following Modbus registers contain additional USM-GT-400 data which are not included in the tables above. A connected ERZ 2000-NG needs this information so that its DSfG Device-F can be used.

#### *9086 DSfG-Status*

Register 9086 is linked to USM coordinate *BA-1*.

| USM | Coordinate | Name | Value | Unit |
|---|---|---|---|---|
| USM_Ob | BA-1 | DSfG-Status | 0000 | |

*Fig. 8.29: Additional register*



This register contains 16 USM status bits.

- Bit-0 = 1: The unit “Volume” is set unequal „m3“.
- Bit-1 = 1: The unit “Flow” is set unequal „m3/h“.
- Bit-2 = 1: The unit “Speed” is set unequal „m/s“.

If one of these three bits equals 0 the requesting ERZ 2000-NG gets the message that the data of the registers 8000 to 80CE are invalid and may not be used for the external DSfG instance F. In this case the USM is mis-configured and the device-F will not work. Bits 3 to 15 are currently not in use.

### 9084 Qt

Register 9084 is linked to USM coordinate D-24.

| USM | Coordinate | Name | Value | Unit |
|---|---|---|---|---|
| USM_Ob | D-24 | Qt | 5000,00 | |

*Fig. 8.30: Additional register*

This register contains a characteristic value of the USM which is dependent from Qbmax and Qbmin.

- Qt = 0,20 x Qbmax If 00 <= (Qbmax / Qbmin) < 30
- Qt = 0,15 x Qbmax If 30 <= (Qbmax / Qbmin) < 50
- Qt = 0,10 x Qbmax If 50 <= (Qbmax / Qbmin)
- Qt = 0,10 x Qbmax If Qbmin = 0

### 32792 signal acceptance

Register 32792 is linked with USM coordinate C-6 Performance.

### Calculating the signal acceptance

The **signal acceptance** in BA-13 is equal to meter performance, which is given from coordinate C-6. This term is defined in chapter 4, Section 4.1 General description.

The value specifies how many values - of a maximum possible determinable quantity - could be taken into account. If one of ten measurements within a measurement cycle for a path is wrong (i.e. 9 valid measurements) the DSP provides 90% valid measurements, and the path performance is 90%.



The overall performance is the average of the performance of all individual paths (L-6 to Q-6, valid measurement G1 - G6) for the last n measurements (n = moving average in E-09; the default is 10 measurements).

**Note**

The USM-GT-400 **keeps its calibrated accuracy** even if up to 2 measurement paths fails! The value “signal acceptance“ falls down to **66**% then.

**Exceptions:**

- If | Vw | <VwUg (the speed is below the minimum speed), then the path performance and the overall performance goes to 100%.

## Additional documentation/literature Modbus

- *Modicon Modbus Protocol Reference Guide, PI-MBUS-300 Rev. J, June 1996*

**DSfG**

- *Gas Information Nr. 7 – 4. Überarbeitung 10 / 2009*
  *Technische Spezifikation für DSfG-Realisierungen*
  *Teil 1 Grundlegende Spezifikation*

- *Gas Information Nr. 7 – 4. Überarbeitung 10 / 2009*
  *Technische Spezifikation für DSfG-Realisierungen*
  *Teil 2 Abbildung der DSfG auf die IEC 60870-5-101 und -104*
- *DSfG-Datenelementeliste*
  *DSfG Dellist 23-10-09 Teil3*

**ERZ 2000-NG**

- *Bedienungsanleitung Flow Computer Serie ERZ 2000-NG*
- *Operating Instructions Flow Computer Series ERZ 2000-NG*

**Instance-F: measured values and register addresses in ERZ2000-NG**

In the ERZ2000-NG, with the calibration switch locked, the measured values and status information are displayed; if the calibration switch is open, the Modbus addresses can be seen (see below).
Detailed information including hourly averages and deviations of the individual values from the mean value can be found in the higher-level Instance-F menu V, whose subdirectories VA to VI are structured according to measured value categories.

VJ Modbus Master

| Access | Line | Designation | Value | Unit |
|---|---|---|---|---|
| E§ | 1 | Volume flow | 53.10 | m3/h |
| B | 2 | Velocity of gas | 3.048 | m/s |
| B | 3 | Speed of sound | 345.717 | m/s |
| E§ | 4 | Gas vol. total 1 | 152.000 | |
| E§ | 5 | Gas vol. total 2 | 0.000 | |

bus Master

| Line | Designation | Value | Unit |
|---|---|---|---|
| 1 | Volume flow | F32768 | m3/h |
| 2 | Velocity of gas | F32770 | m/s |
| 3 | Speed of sound | F32772 | m/s |
| 4 | Gas vol. total 1 | U32774 | |
| 5 | Gas vol. total 2 | U32776 | |

*Fig. 8.31: Modbus register list in ERZ2000-NG with locked (left) and open (right) calibration switch*

## 8.3.6 Interface converter

In this chapter you get some information about interface converters that have been tested and approved for operation with USM-GT-400.

**Interface converter from Ethernet (PC) to RS 485 (USM GT400)**

Here Phoenix module FL COMSERVER UNI 485-2313452 may be used. Link:

https://www.phoenixcontact.com/online/portal/de?uri=pxc-oc-itemdetail:pid=2313452&library=dede&pcck=P&tab=1

*Fig. 8.32: Interface converter from USB to RS485 (USM-GT-400)*

There are 3 recommendations:

**1** I-7561 U-G CR unter: http://www.icpdas-europe.com




*Fig. 8.33: Type ICP Con I-7561U-G CR*

**2** USB-RS485-WE-1800-BT (1,8 m cable length) and USB-RS485-WE-5000-BT (5,0 m cable length) at: http://rs-online.com

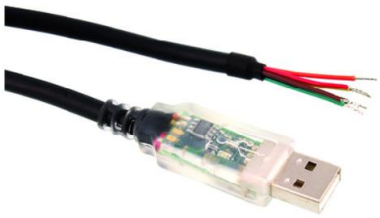


*Fig. 8.34: Type USB-RS485-WE-1800-BT 687-7834 (1,8 m) or Type USB-RS485-WE-5000-BT 730-0164 (5,0 m)*

**3** USB-RS485-Converter / part number: 0202047 at: http://www.ipcas.com


*Fig. 8.35: Type 0202047*

You may find more details of the interface converters and their product information at the given links**.**

### 8.3.7 Connecting the device to earth

In this chapter you will receive information on connecting the device to earth and the protection of the device.



The PA connection must be at least 4.0 $mm^2$

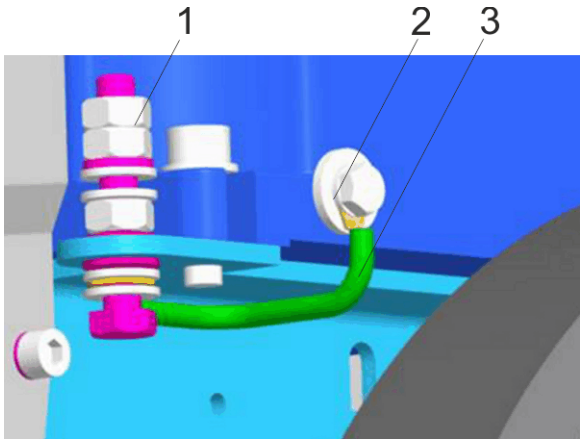
**Danger**

**Mortal danger from incorrect earthing**

When the device is not correctly connected to earth so that electrostatic discharge can lead to spark formation, there is a risk of an explosion.

- Connect the device to earth as described in the instructions.

**For ultrasonic gas meters DN150 (6") and DN100 (4")**

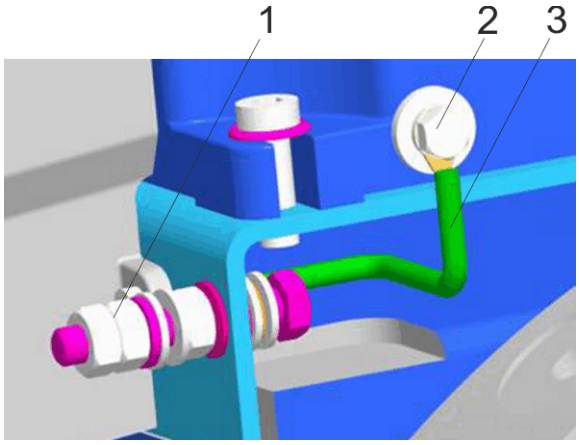



1 Earthing srew M6
2 Earthing srew M6
3 Earthing cable

*Fig. 8.36: Connect to earth – Ultrasonic meters DN150 (6") and DN100 (4")*

**1** Fasten the customers earthing to the earthing screw (1).

### For Ultrasonic meters DN200 (8")




1 Earthing screw M6
2 Earthing screw M6
3 Earthing cable

*Fig. 8.37: Connect to earth – Ultrasonic meters DN200 (8")*

**1** Fasten the customers earthing to the earthing screw (1).

### Cable specifications

From a cable length of 1 m, you must use a screened cable for the data and network cable. The screen must be applied on both sides or only on one side (meter or control room).

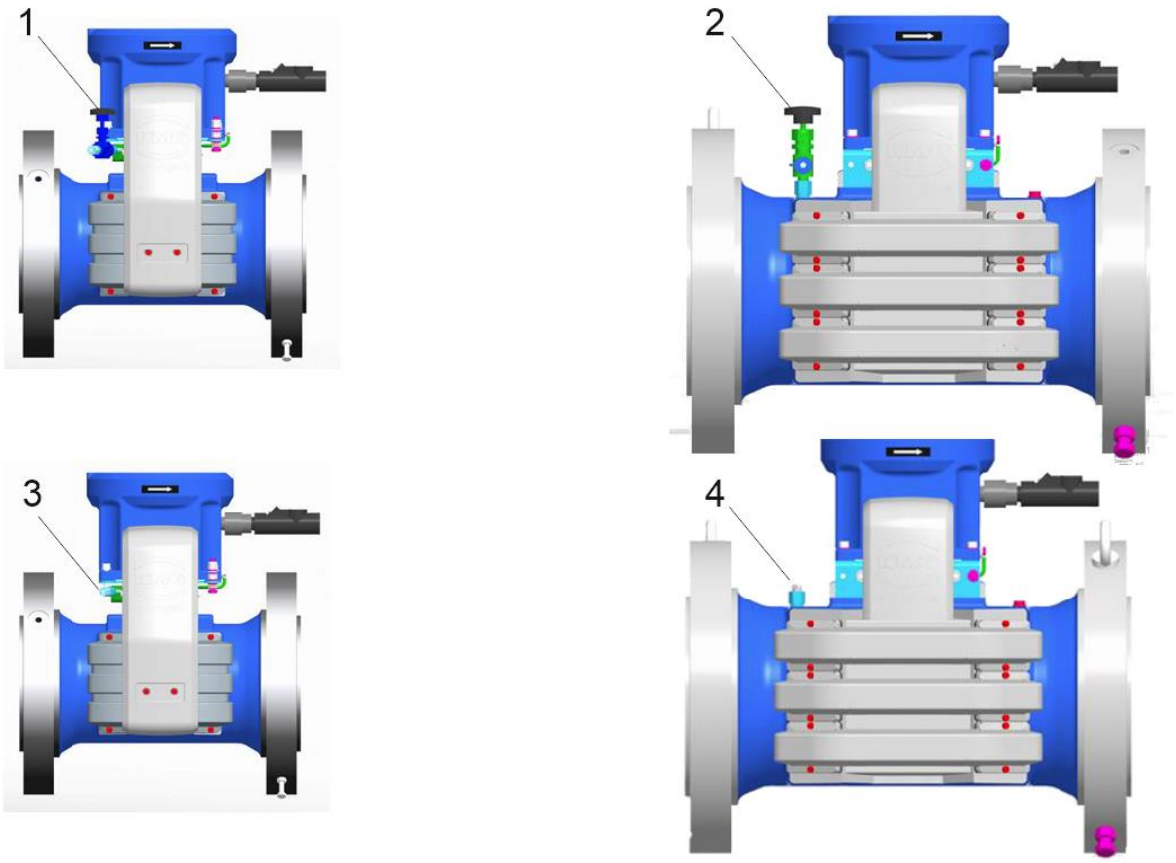
### Transducer

The transducers are metallic connected to the meter housing. You do not have to earth the transducer separately. You must ensure that the conductive connection with the pipeline of the measuring system is established.

# 8.4 Installing the pressure connection

**Malfunctions from too small pressure connections**
The cylindrical diameter of the pressure connection must be selected as ≥3 mm according to ISO 17089.



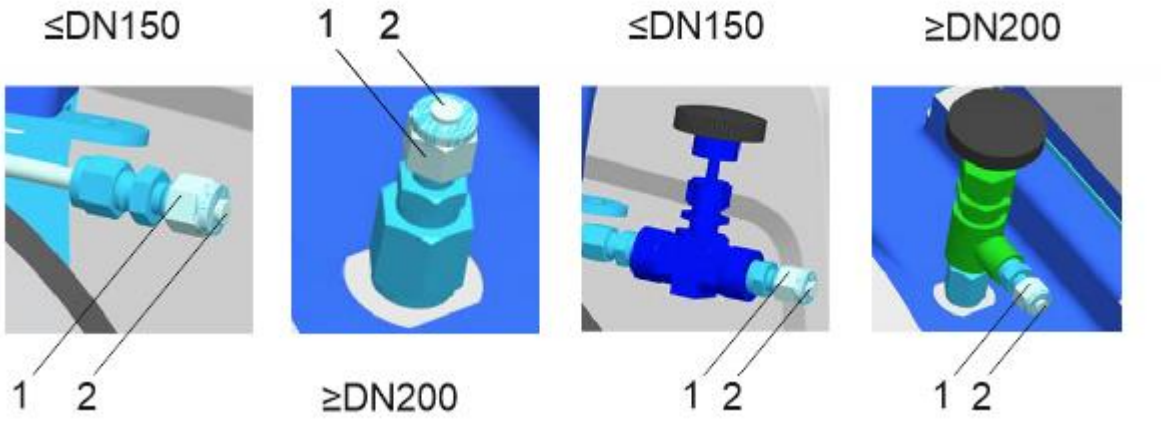



1 USM up to DN150 with shut-off valve
2 USM from DN200 with shut-off valve
3 USM up to DN150 without shut-off valve
4 USM from DN200 without shut-off valve

*Fig. 8.38: Device with and without a shut-off valve*

The pressure connection can be equipped with a shut-off valve (1 and 2) or without a shut-off valve (3 and 4). If the device is ordered without a shut-off valve, the connection is provided with a union nut (clamping screw connection) or a female thread.

- **Establish connection with the clamping screw connection**




1 Union nut with clamping screw connection Ø 6 mm
2 Blind plug (plugged)

*Fig. 8.39: Connection options of the pressure connection with clamping screw connection*

**1** Unscrew the union nut of the clamping screw connection (1).

**2** Remove the blind plug (2).

**3** Push the union nut and clamping rings onto the pipe.

**4** Push the pipe into the clamping screw connection until the stop.

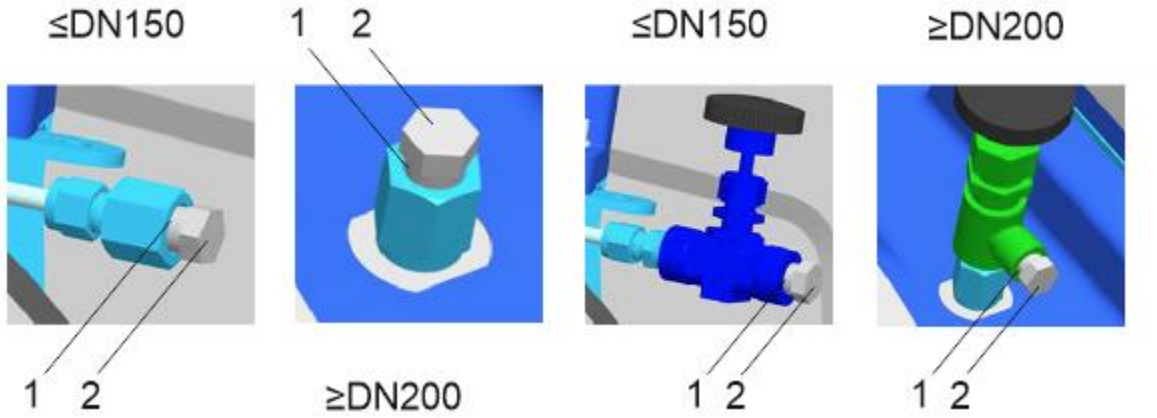
**5** Tighten the union nut in order to fix and seal the pipe.

Usually, Swagelok screw connections (or similar) are used here.

**6** Tighten the Swagelok screw connection hand tight.

**7** Tighten the Swagelok screw connection using a spanner (wide across flats 14) by a further ¼ turn.

- **Establish connection at the female thread**




1 Female thread ¼"
2 Blind plug (screwed)

*Fig. 8.40: Connection options of the pressure connection with female thread*

**1** Unscrew the blind plug (2).

**2** Seal the connection in the female thread (1).

## 8.5 Outdoor installation

The USM-GT-400 may also be installed outdoor, it corresponds to protection level IP66 / Type 4X according to CSA C22.2 NO 94 and UL 50E. Doing this requires some important considerations and advices:

1. Please pay attention to the ambient temperature, it must not exceed the range from -40°C to 55°C.
2. Please prevent any contact of the USM-GT-400 with chemically aggressive gases and vapors. These gases and vapors may not damage the protective coating nor the materials used. The materials used can be found below in the section "Technical data".
3. The USM-GT-400 may not be completely buried or submerged in water.
4. The display must not be exposed to direct sunlight for a longer period of time (> 5 minutes). In this case please use the recommended sun protection (see next picture), that can be supplied from RMG service.

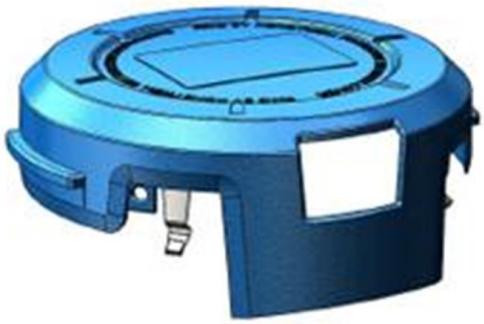


*Fig. 8.41: Sun protection for the US electronic*

5. If you expect higher temperatures than 55°C, then the USM-GT-400 has to be protected under a large sunshield (weather protection roof or similar).

# 9 Start Up

In this chapter you will receive information on start up after installation.



**Content**



## 9.1 Comparing meter parameters

After installing the meter and completing the electrical connections, the meter parameters must be compared with the values of the calibration certificate or test certificate. Example:

- Path lengths
- Axial distances
- Limit values

They are listed in an alphabetical order of their corresponding matrix coordinates and can be found using the operating display. As an alternative, they can be read out of the USE09 directly using the operating software RMGView$^{USM}$.

## 9.2 Checking functions of the USM

The functions can be checked as soon as the meter is exposed to pressure.

For this purpose, the content of the valid measurements (in %) are checked in the coordinates L-6 to Q-6. They should be 100% at zero flow and should also not fall below 70% under difficult flow conditions, for example, with high flow rates.

If the operating pressure is not reached, a functional check is only possible to a limited extent.

In this case, contact RMG services.

# 9.3 Reading out speed of sound



The slightly different speeds of sound are also readable (coordinate L-9 to Q-9).

The values of the individual paths should differ only by a little (< 0.5 m/s). An accurate comparison with the nominal speed of sound of the media is limited within the operating conditions.

**Temperature stratification within a pipeline**
If no flow is possible when start up, temperature stratification may occur within the pipeline so that speed of sound of paths with different measuring levels may deviate significantly from one another.
**Convenient function checks with ERZ 2000 (-NG)**
If an ERZ 2000 (-NG) is available, the content of valid measuring values (in %) and the measured speed of sound can also be checked in the column FH (ultrasonic diagnosis) for each path.

In case the speed of sound is not plausible, troubleshooting with RMGView$^{USM}$ is possible. If one individual path has failed, then there is probably an error in the wiring or with the transducers of this path.

Further information can be found at:

⇨ Chapter 12, „Alarm and warning messages“ on page 176

# 10 Operation

This chapter provides you with information for working with parameters, lists and measurement values.



**Content**

# 10.1 Measuring values and parameters



The measuring values and parameters are arranged in a matrix structure where the columns are designated with letters and the lines with figures.

Operation of the entire system is carried out via the display of the USE09 with magnetic pin operation or via the service and parameterization software "RMGView$^{USM}$".

## 10.1.1 Input protection for parameters

The following table describes the column designation.

| Terms | Input protection |
|---|---|
| A: | Display values that cannot be changed. |
| C: | User data that can be changed using the user password. |
| E: | Data subject to calibration that can only be changed with opened calibration switch. |
| F: | Free parameters without protection. |
| S: | Especially protected parameters that can only be changed via the user password and calibration switch. |

## 10.1.2 Parameter and measuring values with variable units

The units are variable with several parameters and measuring values. The units of the variable parameters and measuring values can be changed via a central entry under a coordinate. This change has an effect on all parameters and measuring values for which the variable units have been defined.

The variable units are marked with an **&**.

**Example:**
Several parameters and measuring values have the entry **&v**: for a variable unit. The unit **m/s** is currently set for this variable. All parameters and measuring values with this variable unit should be converted to **ft/s**.

Under coordinate **AG-32** the value for the unit **m/s** is converted to **ft/s**. All parameters and measuring values with this variable unit **&v**: are converted to **ft/s**.



**Possible variable units**

| Column | Coordinates | **Data type** |
|---|---|---|
| &v: | AG-32 | m/s or ft/s (flow velocity) |
| &Q: | AG-33 | m³/h or acfh (flow) |
| &Z: | AG-34 | m³ or acf (meter) |
| &P: | AG-35 | P/m³ or P/cf (puls factor) |

### 10.1.3 Calibration and Service Switch

There are several values / parameters which are protected against any change as long as the calibration switch is locked. The protection applies to the input from the keypad as well as to inputs via the Modbus - interface. The service switch extends the possibility of settings of the coordinate matrix for the service. The service switch prevents or allows to initialize the device parameters in case of failure with default values (CRC - error of Ferro - RAM see below).

**Note**

**Calibration and service switch must always be closed in custody transfer operation!**

### 10.1.4 Interfaces to converters and controllers

USM-GT-400 can be connected directly to a USZ 9000 or at an ERZ 2000 USC, the communication protocol used is IGM compatible. USZ 9000 or ERZ 2000 USC cannot transmit any data to USM-GT-400 via this interface.

**The USM-GT-400 - IGM - interface is non-reactive!**

For direct connection to a volume corrector either digital signals or serial protocols may be used.



Digital signals are:

- Two frequency outputs for the actual flow
- Two outputs for two flow directions
- Alarm and warning contacts

Serial protocols are:

- DZU
- DZU-DIAG
- DZU-X
- IGM und USE09
- VO
- DZU-SLAVE

### 10.1.5 Interface for service and parameterization

For parameterization of the USM-GT-400 different protections are available:

- sealable calibration switch
- individual user codeword
- sealable calibration switch and input of the individual user codeword
- freely programmable

For parameterization of the USM-GT-400 the interfaces "RS485-0", "RS485-1", "RS485-2" or keypad input and display are used. Protocol is Modbus - RTU or Modbus - ASCII. These protocols follow the protections noted above, means, if the calibration switch is closed, the corresponding parameters can not be changed. Also when using keyboard and display parameter can only be changed after the protections are unblocked. Display and keyboard do not effect the device further, i.e. it does not matter whether the display is available or not. Therefore it can be plugged or removed during operation. The Parameter setting can be changed to other protocols; but the parameters themselves can‘t be changed using them. Interface "RS485-0" can be used to update (to flash) the firmware. To flash a new firmware the software „HEXLoad“ is necessary at the PC. To initiate the update -function the calibration switch needs to be activated and the power needs to switched off / and on, too. An

eventually newly flashed firmware can be clearly identified via its firmware version and its checksum (CRC-16). Therefore, for matching checksum and version number is deposited at the PTB (registration authority). The checksum itself can be verified via the display or via Modbus.



### 10.1.6 Adaptation of the DZU protocol to ERZ 2400

DZU protocol (DZU slave) becomes bus-capable adjusting the coordinates of the bus address:

1. **J-01** mode serial 0 (extended menu: DZU-Slave)
2. **J-12** DZU-0 address
3. **J-14** mode serial 1 (extended menu: DZU slave)
4. **J-23** DZU-1 Address
5. **J-25** opt. ser2 mode (extended menu: DZU-Slave)
6. **J-37** DZU-2 address

**Note**

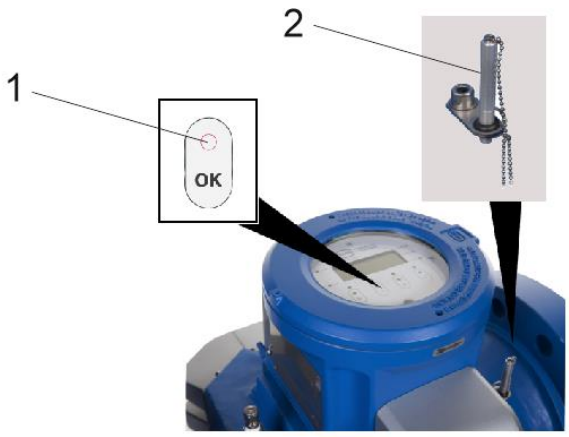
**This mode can be used only in areas where the MID is not applied!**

# 10.2 Calling up and changing the parameters via the ultrasonic electronics



This chapter provides you with information for operating the ultrasonic electronics via the display with a control panel.

The parameters can be called up and changed via the display with control panel or RMGView$^{USM}$.
⇨ *Software instructions RMGView$^{USM}$ (separate document)*




1 Switch point
2 Magnet

*Fig. 10.1: Magnet for operating the buttons*

When the cover of the ultrasonic electronics is closed, the buttons can be operated using the magnets supplied. In order to operate the buttons with the magnets (2), the magnet must be placed on the glass in the position with the switching point (1) of the button.

## 10.2.1 Calling up the value of a parameter



- **Select the column in the coordinate system**

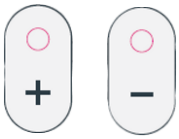
Select the column of the coordinate on the control panel of the ultrasonic electronics using the button.

The button has been allocated with the following functions for navigating:

- **Press the button briefly**: one column to the right, e.g., from A to B.
- **Press the button longer**: depending on the duration of pressing the button:
  - one column to the left, e.g., from B to A.
  - continuously column by column to the left, e.g., from U to F.

**1** Press the button to select the desired column.

- **Select the line in the coordinate system**



Select the line of the coordinate on the control panel of the ultrasonic electronics using the button.

The buttons have been allocated with the following functions for navigating:

- **Press the button briefly**: one column down, e.g., from E-01 to E-02.
- **Press the button longer**: continuously line by line downwards.

- **Press the button briefly**: one column up, e.g., from E-02 to E-01.
- **Press the button longer**: continuously line by line upwards.

**1** Press the buttons to select the desired line.

The coordinates (column and line) of the parameter are selected. The value of the parameter is shown on the display.

## 10.2.2 Entering data



Observe the designations of the columns and the rights assigned.

⇨ “Input protection for parameters” on page 144

A parameter that is entered in the protection **E** or **S** can only be changed when the calibration switch is open. For a value / parameter / measurement value **S**, the code word also has to be entered for the ultrasonic electronics.

If this parameter is changed then the device is no longer considered as calibrated.

- Only carry out these tasks if you are authorized.
  ⇨ “Changing the parameters of protection E and S” on page 153

Depending on the type of data, you are offered different selection options when making entries.

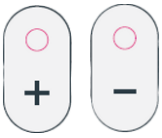
In order to change data, the coordinate of the parameter must be selected.

⇨ “Calling up the value of a parameter” on page 149

- **Example for data type Float (F)**

| Data type | Example |
|---|---|
| Float (F) | A-06 p-Max value |

1. Press the button until the next value is marked in the display.



2. Press the button to select a value from the list.
   Possible value of the list.: 0 /…/ 9 / - / + / . / E / _

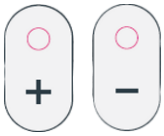

3. Press the button to confirm the value.

   The value is stored.

- **Example for data type Integer (I) and Long integer (L)**

| Data type | Example |
|---|---|
| Integer (I) | D-10 Qb-min time |
| Long integer (L) | AF-02 electronic no. |


1. Press the button until the next value is marked in the display.



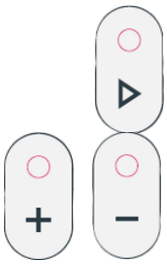

2. Press the button to select a value from the list.
   Possible value of the list: 0 /…/ 9 / - / _.


3. Press the button to confirm the value.
   The value is stored.

- **Example for data type Text (T)**

| Data type | Example |
|---|---|
| Text (T) | AU-01 User Test-1 |

1. Press the button until the next value is marked in the display.




2. Press the button to select a value from the list.
   Possible value of the list: 0 /…/ 9 / - / + / . / _ / A /…/ Z


3. Press the button to confirm the value.
   The value is stored.

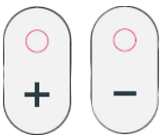
**Note**

**The data type text is not a text in the actual sense, but a bit combination.**

- **Example for data type Menu (M)**

| Data type | Example |
|---|---|
| Menu (M) | A-17 p-mode |

1. Press the button until the next value is marked in the display.



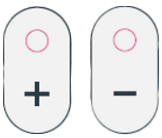
2. Press the button to select a value from the list.

3. Press the button to confirm the value.
   The value is stored.

- **Example for data type Time (U)**

| Data type | Example |
|---|---|
| Time (U) | D-23 Qb-S time 2 |

1. Press the button until the next value is marked in the display



2. Press the button to select a value from the list.

3. Press the button to confirm the value.
   The value is stored.

## 10.2.3 Changing the parameters of protection E and S

This chapter provides you with information for changing parameters that are protected by the calibration switch and also by the code word of the ultrasonic electronics. This affects all parameters that are stored in the coordinates for columns E and S. For a parameter in column **S**, the code word also has to be entered for the ultrasonic electronics.



**Danger**

**Danger to life from opening the device**

If the cover or the housing of the device is opened in an area with a potentially explosive environment, then the device is no longer suitable to be used in the area with a potentially explosive environment. Risk of explosion!

- Open the device only when the device is voltage free.

**Mortal danger from damaged components**

If threaded holes, bolts or the sealing surfaces of the housing are damaged, the spark protection gap can no longer be guaranteed. Sparks resulting may lead to an explosion.

- Proceed with care when working with the bolt connections.
- Replace damaged components with new ones.
- Make sure that no parts of the housing are damaged**.**

Please note that for this task the official seal must be broken. The device must not be used for calibrated operation if the official seal is broken.

If the task is carried out by RMG service, the device does not have to be calibrated by a testing institute. The device is provided with a new official seal by RMG service.

- Only carry out these tasks if you are authorized.

- **Opening the cover of the ultrasonic electronics**

**1** Switch off the system power supply.


1 Threaded pin
2 Boreholes for inserting the special tools
3 Special tool (2 pieces)

*Fig. 10.2: Opening the cover*

**2** Unscrew threaded pin (1) out of the housing.
**3** Insert the special tools into the boreholes.
**4** Release the cover with the special key.


1 Cover

*Fig. 10.3: Opening the cover*

**5** Screw the cover off with both hands.

- **Setting the ultrasonic electronics for configuration**


1 Calibration switch

*Fig. 10.4: Opening the calibration switch*

**1** Press calibration switch (1) upwards to open it.

- **Screw down the cover of the ultrasonic electronics**


1 Cover
2 Position O-ring

*Fig. 10.5:* Screw down the cover

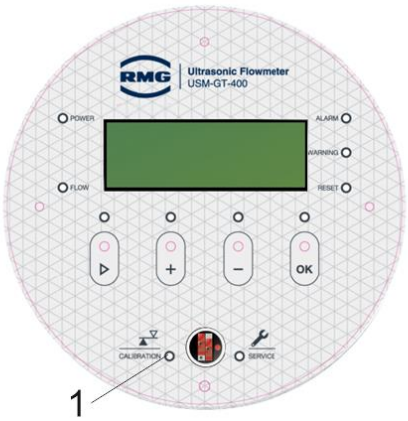
**1** Each time you open the ultrasonic electronic you have to expect that the O-ring is damaged. Therefore, this damaged O-ring has to be replaced with a new one in general. (RMG provides a replacement kit with O-ring, grease, ... sales number: 38.03.001.00)
**2** Screw the cover on with both hands.
**3** Insert the special tools into the boreholes.
**4** Tighten the cover with the special tools.
**5** Screw in threaded pin hand tight.
**6** Switch on the system.

- **Entering the code word of the ultrasonic electronics**

If you do not have the password for the ultrasonic electronics, request the code word from RMG Service.

**1** Enter the code word for the ultrasonic electronics under coordinate AG-4.

- **Changing the value of the protected parameters**




1 Calibration LED

*Fig. 10.6: Check LED*

AG-4 user code:
Standard setting: 9999 9999

- This value can be changed when the calibration switch is opened.

Note:

- During start up, this value can be set to customer requirements under the supervision of a calibration inspector.

**1** Check LED.
The **Calibration** lights up. The calibration switch has been opened correctly.

**2** Change the parameter values.

⇨ “Changing the parameters of protection E and S” on page 153

An open lock must be shown in the third line of the display to allow the value of the protected parameters to be changed.

If the lock is not shown as open, check the switch position of the calibration switch.


**3** Activate the button with the magnet.
The value of the parameter can be changed.
⇨ *Figure 10-1 on page 148*



**4** Activate the button with the magnet in order to position the cursor on the value of the parameters to be changed.

**5** Activate the button with the magnet in order to set the desired value.


**6** Activate the button with the magnet in order to confirm the desired value.

When the parameter is changed, you have to move the calibration switch back to the **closed** position.

- **Conclude work**

**1** Switch off the system power supply.

**2** Open the cover of the ultrasonic electronics.
⇨ *“Opening the cover of the ultrasonic electronics” on page 154*

**3** Press calibration switch (A) downwards to close it.

**4** Close the cover of the ultrasonic electronics.
⇨ *“Screw down the cover of the ultrasonic electronics” on page 155*


1 Calibration switch

*Fig. 10.7: Close the calibration switch*

# 10.3 Parameterize the USM interface



The ultrasonic gas meter has three serial interfaces that can be used for Modbus communication. The parameterization is carried out in column "J Serial Ports" of the coordinate matrix.

## 10.3.1 Interface 0

- Is reserved for service purposes or RMGView$^{USM}$.
- The parameterization is carried out using the coordinates J-1 to J-13.

| Coordinates | Name | Value | Unit | Modbus Address |
|---|---|---|---|---|
| J-01 | Serial 0 modus | Modbus | | 2099 |
| J-02 | Serial 0 baud rate | 38400 | baud | 2100 |
| J-03 | Seriell 0 bits | 8 | | 2101 |
| J-04 | Serial 0 parity | NONE | | 2102 |
| J-05 | Modbus 0 protocol | RTU | | 2103 |
| J-06 | Modbus 0 HW mode | RS485 | | 2104 |
| J-07 | Modbus 0 adresse | 1 | | 2105 |
| J-08 | Modbus 0 reg.offset | 0 | | 2106 |
| J-09 | Modbus 0 gap time | 45 | | 2118 |
| J-10 | Pressure application | OFF | | 2116 |
| J-11 | Lpt interval | 10 | | 2117 |
| J-12 | DZU-0 adress | 1 | | 2283 |
| J-13 | Serial 0 status | 10 | | 760 |

### 10.3.2 Interface 1

- Is intended for exchanging data with volume conversions.
- The parameterization is carried out using the coordinates J-14 to J-24.

| Coordinates | Name | Value | Unit | Modbus Address |
|---|---|---|---|---|
| J-14 | Serial 1 mode | DZU X-FRAME | | 2107 |
| J-15 | Serial 1 baud rate | 9600 | baud | 2108 |
| J-16 | Serial 1 bits | 8 | | 2109 |
| J-17 | Serial 1 parity | NONE | | 2110 |
| J-18 | Modbus-1 protocol | | | |
| J-19 | Not available | | | |
| J-20 | Modbus-1 address | | | |
| J-21 | Modbus-1 reg.offset | | | |
| J-22 | Modbus-1 gap time | | | |
| J-23 | DZU-1 address | 2 | | 2284 |
| J-24 | Serial 1 Status | 10 | | 770 |

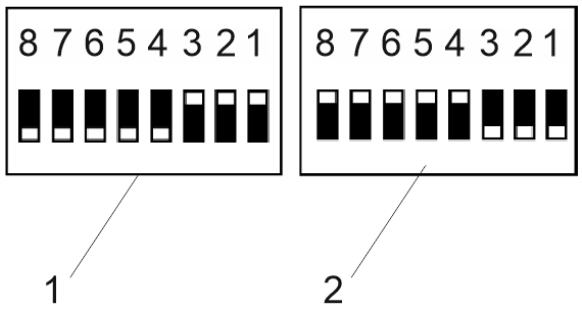
### 10.3.3 Interface 2



- Is intended for communication with a Modbus Master.
- The parameterization is carried out using the coordinates J-25 to J-40.

| Coordinates | Name | Value | Unit | Modbus Address |
|---|---|---|---|---|
| J-25 | Opt. Ser2 modus | Modbus | | 2112 |
| J-26 | Opt. Ser2 baud rate | 38400 | baud | 2113 |
| J-27 | Opt. Ser2 bits | 8 | | 2114 |
| J-28 | Opt. Ser2 parity | NONE | | 2115 |
| J-29 | Modbus-2 protocol | RTU | | 2178 |
| J-30 | Modbus-2 HW-mode | RS485 | | 2179 |
| J-31 | Modbus 2 address | 1 | | 2180 |
| J-32 | Modbus 2 reg. offset | 0 | | 2181 |
| J-33 | Modbus 2 gap time | 45 | | 2182 |
| J-34 | Long Byte order | NORMAL | | 2251 |
| J-35 | Float Byte order | NORMAL | | 2252 |
| J-36 | Double Byte order | NORMAL | | 2253 |
| J-37 | DZU-2 Address | 3 | | 2285 |
| J-38 | seriel 2 Status | | | |
| J-39 | DZU Interval | 100 | tics | 2111 |
| J-40 | DZU Checksum Preset | 0x00 | | 2255 |

- Interface 2 can be configured as RS232 or RS485.
- Factory setting or default is RS485.




1 DIP switch RS232 configuration
2 DIP switch RS485 configuration

*Fig. 10.8: Configuring interface with DIP switch*

- The configuration is carried out via software (coordinate J-30) and hardware (switch).
- The DIP switch is located on the optional card in the ultrasonic electronics housing.

**Communication as Modbus master**

J-25 Mode Opt. Serial 2

To activate the Modbus Master, the mode must be set to Modbus master.


*Fig. 10.9: Activation as Modbus master*

Coordinates AW-08 and AW-09 indicate the time since of the last AGA10 calculation respectively the time of last update of the gas components.

USM_Ob: AW: AGA-10 Values

| USM | Coordinate | Name | Value |
|---|---|---|---|
| USM_Ob | AW-8 | last calculation | 01.01.1970 01:00:00 |
| USM_Ob | AW-9 | last gas comp. | 01.01.1970 01:00:00 |

*Fig. 10.10: Status information of the AGA-10 calculation*

Using the coordinates AZ-01 Formula Methane to AZ-50 Formula Status the USM-input variables are linked to the PGC gas data.

| USM-GT-400 | Coordinates | Name | Value | Unit |
|---|---|---|---|---|
| USM_Ob | AZ-01 | Formula Methane | F8252 | |
| USM_Ob | AZ-02 | Formula Methane | | |
| USM_Ob | AZ-03 | Formula Ethane | F8256 | |
| USM_Ob | AZ-04 | Formula Ethane | | |
| USM_Ob | AZ-05 | Formula Propane | F8258 | |
| USM_Ob | AZ-06 | Formula Propane | | |
| USM_Ob | AZ-07 | Formula I-Butane | F8260 | |
| USM_Ob | AZ-08 | Formula I-Butane | | |
| USM_Ob | AZ-09 | Formula N-Butane | F8262 | |
| USM_Ob | AZ-10 | Formula N-Butane | | |
| USM_Ob | AZ-11 | Formula Neo-Pentane | 0 | |
| USM_Ob | AZ-12 | Formula Neo-Pentane | | |
| USM_Ob | AZ-13 | Formula I-Pentane | F8266 | |
| USM_Ob | AZ-14 | Formula I-Pentane | | |
| USM_Ob | AZ-15 | Formula l N-Pentane | F8268 | |
| USM_Ob | AZ-16 | Formula N-Pentane | | |
| USM_Ob | AZ-17 | Formula Hexane+ | 0 | |
| USM_Ob | AZ-18 | Formula Hexane+ | | |
| USM_Ob | AZ-19 | Formula Oxygen | F8280 | |
| USM_Ob | AZ-20 | Formula Oxygen | | |
| USM_Ob | AZ-21 | Formula Helium | F8282 | |
| USM_Ob | AZ-22 | Formula Helium | | |
| USM_Ob | AZ-23 | Formula Hydrogene | F8284 | |
| USM_Ob | AZ-24 | Formula Hydrogene | | |
| USM_Ob | AZ-25 | Formula Argon | 0 | |
| USM_Ob | AZ-26 | Formula Argon | | |
| USM_Ob | AZ-27 | Formula Nitrogen | F8250 | |
| USM_Ob | AZ-28 | Formula Nitrogen | | |
| USM_Ob | AZ-29 | Formula CO2 | F8254 | |
| USM_Ob | AZ-30 | Formula CO2 | | |
| USM_Ob | AZ-31 | Formula Hexane | 0 | |
| USM_Ob | AZ-32 | Formula Hexane | | |
| USM_Ob | AZ-33 | Formula Heptane | 0 | |
| USM_Ob | AZ-34 | Formula Heptane | | |
| USM_Ob | AZ-35 | Formula Octane | 0 | |
| USM_Ob | AZ-36 | Formula Octane | | |
| USM_Ob | AZ-37 | Formula Nonane | 0 | |
| USM_Ob | AZ-38 | Formula Nonane | | |
| USM_Ob | AZ-39 | Formula Decane | 0 | |
| USM_Ob | AZ-40 | Formula Decane | | |
| USM_Ob | AZ-41 | Formula H2S | 0 | |

| | | | | |
|---|---|---|---|---|
| USM_Ob | AZ-42 | Formula H2S | | |
| USM_Ob | AZ-43 | Formula H2O | 0 | |
| USM_Ob | AZ-44 | Formula H2O | | |
| USM_Ob | AZ-45 | Formula CO | 0 | |
| USM_Ob | AZ-46 | Formula CO | | |
| USM_Ob | AZ-47 | Formula Ethene | 0 | |
| USM_Ob | AZ-48 | Formula Ethene | | |
| USM_Ob | AZ-49 | Formula Propene | 0 | |
| USM_Ob | AZ-50 | Formula Propene | | |
| USM_Ob | AZ-51 | Formula Status | u1038==0 | |
| USM_Ob | AZ-52 | Formula Status | | |
| USM_Ob | AZ-53 | Formula Status | | |
| USM_Ob | AZ-54 | Formula Status | | |
| USM_Ob | AZ-55 | MB Pause | 20 | s |
| USM_Ob | AZ-56 | MB Timeout | 1000 | ms |
| USM_Ob | AZ-57 | MB Int16Order | 21 | |
| USM_Ob | AZ-58 | MB Int32Order | 4321 | |
| USM_Ob | AZ-59 | MB FloatOrder | 4321 | |
| USM_Ob | AZ-60 | MB DoubleOrder | 43218765 | |

The USM-GT-400 combines the information of the **PGC-register 8252** (= Register address component methane) with the coordinate **AZ-01**. Data type F8252 means that methane is delivered as a single-precision floating-point number (Float).

There are different data types: double-precision floating point = D (Double float), simple-precision floating point = F (Float), 32-bit unsigned integer = U (Long) and 16-bit unsigned integer = u (short).

| USM | Coordinate | Name | Value |
|---|---|---|---|
| 90156 | AZ-1 | Formula Methane | F8252 |
| 90156 | AZ-2 | Formula Methane | |

*Fig. 10.11: Gas component*

### Unit Conversion

An implemented formulary offers additional options for a conversion. Values from the PGC can be converted according to the requirements. For example to multiply the methane concentration (0.94) with 100 (94%) in coordinate AX-46 has to be selected F8252 * 100.

| USM | Coordinate | Name | Value |
|---|---|---|---|
| 90156 | AZ-1 | Formula Methane | F8252*100 |
| 90156 | AZ-2 | Formula Methane | |

*Fig. 10.12: Applying the unit conversion*

### Rules for distributing the gas components

Not all possible gas components can be filled. Then these gas components are to be distributed according to the distribution rules.

⇨ “Treatment of the gas data” on page 32

It might be possible that there is no input field in the USM-GT-400 for a measured gas component from the PGC, for example, Neo-pentane (register 8264). Neo -pentane will then be added to N-pentane (register 8268). Coordinate AZ-15 then has to be formulated as F8264 + F8268.

| USM | Coordinate | Name | Value |
|---|---|---|---|
| 90156 | AZ-15 | Formula N_Pentane | F8268+F8264 |
| 90156 | AZ-16 | Formula N_Pentane | |

*Fig. 10.13: Applied distribution rule*

### Rule for splitting gas components

If components as hexane, heptane, octane, nonane and decane are not given individually, but as a sum of hexane plus higher alkanes, eg Register in F8272, this sum can be split according to the rule of thirds to the components. Hexane, heptane, octane, nonane and decane are then distributed to 81: 27: 9: 3: 1. Normalized this results in 81/121: 27/121: 9/121: 3/121: 1/121. The coordinates AZ-31 to AZ-40 become to:

| | | | |
|---|---|---|---|
| 90156 | AZ-31 | Formula Hexane | (81/121)*F8272 |
| 90156 | AZ-32 | Formula Hexane | |
| 90156 | AZ-33 | Formula Heptane | (27/121)*F8272 |
| 90156 | AZ-34 | Formula Heptane | |
| 90156 | AZ-35 | Formula Octane | (9/121)*F8272 |
| 90156 | AZ-36 | Formula Octane | |
| 90156 | AZ-37 | Formula Nonane | (3/121)*F8272 |
| 90156 | AZ-38 | Formula Nonane | |
| 90156 | AZ-39 | Formula Decane | (1/121)*F8272 |
| 90156 | AZ-40 | Formula Decane | |

*Fig. 10.14: Applied splitting rule*

Beside addition and multiplication other mathematical rules such as division and bracket rules can be applied, too.

### Constants

It might be possible that components required from the USM-GT-400 are not given from the PGC, for example water and hydrogen sulfide. These can be set to 0:

| | | | |
|---|---|---|---|
| 90156 | AZ-41 | Formula H2S | 0 |
| 90156 | AZ-42 | Formula H2S | |
| 90156 | AZ-43 | Formula Water | 0 |
| 90156 | AZ-44 | Formula Water | |

*Fig. 10.15: Adjusting gas components*

**Remarks to the coordinates AZ-01 to AZ-50**

The input of a coordinate, for example, AZ-01 can have a maximum of 20 characters. To specify more complex expressions two coordinate per gas component may be used, for example methane

- AZ-01 Formula_Methane0 (less significant)
- AZ-02 Formula_Methane1 (highly significant)

An expression with more than 20 characters begins with the less significant coordinate AZ-01 and then continues with one with higher significant AZ-02. Unused high-order coordinates are filled with spaces.

The formulas combining the USM-GT-400 input variables with the PGC data may not exceed a maximum of 60 Modbus registers.

**AZ-51 Formula Status to AZ-54 Formula Status**

For the PGC status could be required for example:

- Value = 1 The PGC measures without error
- Value = 0 The PGC is in alarm
- Value = 0 The PGC is in revision

It is possible that a PGC is not providing its status in this form. Instead, there may be:

**Register 10**: It shows the number of pending alarms. When showing 0 the PGC is free of alarms. It is a 16-bit integer register.

**Register 2**: It is a bit coded information. In the measuring mode of the PGC the bit is set to 4. It is a 32-bit integer register.

The following considerations help to formulate the state-formation in coordinate AZ51:

- The first part of a 16-bit integer registers will be imported. The number of pending alarms shows the data type of an unsigned integer (unsigned short int). The prefix is a small u. The register address is 10, therefore, the value u10 should be requested.

- The value is checked to be 0. The first term is found to be u10 == 0. The result is true if u10 contains a 0.
- For the second part, a 32-bit integer registers is imported. This value has to be read bitwise. It is a 32-bit unsigned integer (unsigned long int). The prefix is a large U. Register address is 2; the value U2 must be requested.
- Now it is checked whether any bit is set to 4. As operator the bitwise "and" has to be used (&). The second part of the expression results to U2 & 4. The result is 0 when the bit with the value 4 is not set and a value other than 0 is set. Bits with other values then 4 do not affect the result.
- The two partial expressions are joined via a logical "and" (&&). Following the bracket rules both subexpressions have to be put in brackets. The complete expression for AZ-51 is found to be (u10== 0)&&(U2&4).

| Arithmetic Operators | Comparison Operators | Logical Operators | Bitwise Operators |
|---|---|---|---|
| Addition + | greater > | Logical And && | Bitwise And & |
| Subtraction - | smaller < | baud | Bitwise Or \| |
| Multiplication * | greater or equal >= | Logical Or \|\| | exclusive or ^ |
| Division / | less or equal <= | Not! | Bitwise negation |
| Modulo % | equal == | | |
| Sign - | not equal to =! | | |

### Terms may be

- a?b:c means: if a then b else c
- brackets: ()
- constants:
  Integers, for example, 42
  Floating point, for example, 1.234
  Exponential, for example, 1.2345E-3
  unsigned, the sign is realized by the operator sign

### Information to the status of the PGC

The input field of coordinate AZ-51 accommodates a maximum of 20 characters.
If this is insufficient for the formulation of a more complex expression, there are a total of four coordinates for the status.

**AX-51** Formula Status (lowest significance)

**AX-52** Formula Status (low significance)

**AX-53** Formula Status (high significance)

**AX-54** Formula Status (highest significance)

Entering a formula with more than 20 characters starts with the lowest order coordinate AZ-51 and then continues in the higher- AZ-52, AZ-53 and AZ-54. If the higher order coordinates are not needed, they are to be filled with spaces.

**AX-92 MB_Pause:** The requests of the USM-GT-400 to the PGC are summarized in a block. Between two blocks will be an interval. AX92 coordinate indicates the interval time.

**AX-93 MB_Timeout:** Maximum time between a PGC request and the associated response**.**

**AX-94 MB_Int16Order:** Adjustment of the byte order of 16-bit integers. A 16-bit value consists of two bytes, the least significant byte and the most significant byte. There are two settings: 12 and 21.

**AX-95 MB_Int32Order:** Adjustment of the byte order of 32-bit integers. A 32-bit value consists of four bytes. Common sequences are: 1234/2143/3412 / 4321. However, all other options can be set, too. For example, 4123.

**AX-96 MB_FloatOrder:** Adjustment of the byte order of single precision floating point numbers. A single-precision floating-point number consists of four bytes. Common sequences are: 1234/ 2143/3412 / 4321. However, all other options can be set, too. For example, 3124.

**AX-97 MB_DoubleOrder:** Adjustment of the byte order of double- precision floating point numbers. A double-precision floatingpoint number consists of eight bytes. Consistent Sequences are:
12345678/21436587/34127856/43218765/56781234/65872143/78563412 / 87654321. However, all other options can be set, too.For example, 81,726,354.

**Note to the coordinates AX94 to AX97:** The numbers represent the significance. It increases with the value of the byte. The sequence is read from left to right.

USM_Ob: AY: Gas Comp. MB-/RMGBus

| USM | Coordinate | Name | Value |
|---|---|---|---|
| USM_Ob | AY-90 | telegram counter | 0 |
| USM_Ob | AY-93 | MB timeouts | 19073 |
| USM_Ob | AY-94 | Modbus errors | 0 |
| USM_Ob | AY-95 | Modbus error reg. | 8252 |
| USM_Ob | AY-96 | Modbus error resp. | 0 |
| USM_Ob | AY-97 | MB_ErrorBits | 0 |
| USM_Ob | AY-98 | MB_InStatus | 1 |

*Fig. 10.16: Significance of the coordinates*

**AY-46 telegram counter:** Here all correct PGC answers are counted.

**AY-49 MB timeouts:** Here the timeouts detected on the Modbus are counted. The counter is incremented when no PGC-answer arrives within the time set in AX-93.

**AY-50 MB error-counter:** Here all incorrect PGC answers are counted.

**AY-51 MB error register:** If an unexpected answer from the PGC arrives, this coordinate indicates the related Modbus register.

**AY-52 MB error answer:** Here the PGC answers are counted with exception code.

**AY-55 MB_ErrorBits:** This coordinate informs about problems occurring during the link of the USM-input variables with the PGC data. However displayed is a three-digit hexadecimal number instead of any bit combination.

**Bit 0 - 7:** If a link was formulated incorrectly, a coded number here indicates the first failed formula. Examples:

0 = formula methane is faulty
1 = formula nitrogen is faulty
6 = formula H2S is faulty

**Bit 8:** Reserved

**Bit 9:** 0 = no error.
1 = Error for the formulation.

**Bit 10:** Reserved

**Bit 11:** Reserved

**Bit 12:** In the formulas for linking the USM input variables with the PGC data more than 60 Modbus registers were used in total.

**AY-56 MB_InStatus:** Here the evaluation result of the status formula (AZ-51 to AZ-54) is given.

# 10.4 Modbus communication in detail

## 10.4.1 Codes supported



The ultrasonic electronics supports the following codes:

**Function Code**

| Code | Description |
|---|---|
| 03 Hex | Read Holding Registers |
| 06 Hex | Preset Single Register |
| 10 Hex | Preset Multiple Registers |
| 08 Hex | Diagnostic |
| 00 Hex | Return Query Data |

**Exception Code**

| Code | Description |
|---|---|
| 03 | Illegal Function |
| 03 | Illegal Data Address (Register nicht vorhanden) |
| 03 | Illegal Data Value (Register nicht beschreibbar oder Wert falsch) |

## 10.4.2 Data types

| Data type | Register | Value | Byte 1 | Byte 2 | Byte 3 | Byte 4 | Byte 5 | Byte 6 | Byte 7 | Byte 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| float | 2 | 273,15 | 0x93 | 0x33 | 0x43 | 0x88 | | | | |
| text | 10 | USM GT400 | 0x53 | 0x55 | 0x30 | 0x5A | 0x2D | 0x38 | 0x50 | 0x36 |
| | | | 0x00 | 0x00 | 0x00 | 0x00 | 0x00 | 0x00 | 0x00 | 0x00 |
| | | | 0x00 | 0x00 | 0x00 | 0x00 | | | | |
| intd | 1 | 44067 | 0xAC | 0x23 | | | | | | |
| double | 4 | 14,2740 | 0x13 | 0x58 | 0x8A | 0xCF | 0x8C | 0x4C | 0x40 | 0x2C |
| long | 2 | 100000 | 0x86 | 0xA0 | 0x00 | 0x01 | | | | |

## Example (question / answer)

| Question | Modbus - ASCII | Modbus - RTU | |
|---|---|---|---|
| Start Char | : | | |
| Slave Address | 01 | 01 | |
| Function | 03 | 03 | |
| Starting Address Hi | 0F | 0F | |
| Starting Address Lo | A2 | A2 | Register = 4002 (0FA2) |
| No. of Points Hi | 00 | 00 | |
| No. of Points Lo | 01 | 01 | Amount = 0001 (0001) |
| LRC / CRC | 42 | 26 | |
| carriage return | CR | FC | |
| line feed | LF | | |
| | | | |
| Reply: | | | |
| Start Char | : | | |
| Slave Address | 01 | 01 | |
| Function | 03 | 03 | |
| Byte Count | 02 | 02 | |
| Data Hi (Reg 2000) | A8 | A8 | |
| Data Lo (Reg 2000) | 01 | 01 | Wert = A801 |
| LRC | 51 | 06 | |
| carriage return | CR | 44 | |
| line feed | LF | | |

## 10.5 Configuration of the current output



The connection of external devices to the current output of the meter is to be carried out as described in chapter 8.3 Connecting the device electrically.

The parameters are then set in column 'I Current Output' of the coordinate matrix as follows:

1. Enter the code number.
2. Look up the Modbus address of the physical quantity (measured or calculated value) to be output in the parameter list or with the RMGView$^{USM}$ operating software under "Values". Then enter this **Modbus address** in coordinate **I-06** (c-out select).
3. In coordinate **I-07** (c-out mode), select the **operating mode** of the current output (0-20mA or 4-20mA). With "SET VALUE" a constant current can be output, the value of which is set in coordinate I-05 (c-out set value).
4. In coordinate **I-03** (c-out min.), enter the **minimum value** for the physical quantity at which 0 or 4 mA should be output.
5. In coordinate **I-04** (c-out max.), enter the **maximum value** for the physical quantity at which 20 mA should be output.
6. In **I-08** (c-out err mode) it can then be determined whether the minimum value, the maximum value or 0 should be output in the event of an error.

The damping value in I-09 can be used to specify how quickly the output current reacts to a change in the physical quantity. The fastest possible reaction occurs with the value of 0.

## 10.6 List of the measurement values and parameters

The lists for parameter and measured values are in appendix 18.

# 11 Maintenance



In this chapter, you are provided with information as to how you can extend the service life of the device through maintenance. You can only protect the device against premature wear when observing the maintenance schedules described here.

**Content**

## 11.1 Maintenance schedule



The maintenance schedule specifies the intervals in which the maintenance work has to be carried out in order to maintain the function of the device.

| Interval | Activity |
|---|---|
| Weekly | • Check that the official seal has not been tampered with (this time interval can be extended to a meaningful length). |
| As required | • Clean the device.<br>• Check the plug connections and screw connections for leaks and tight fit, where necessary, replace the seals. |
| Every 5 to 10 Years | • Check the device for leaks. Please perform a leakage check each time the device has been physical touched. |
| On consultation with RMG. | • Check the device for leaks. The leak tightness of the device may be limited if non-approved gas types are used. In these cases, please contact RMG. |

## 11.2 Checking the device for leaks

For safe operation, the device must be sent back to RMG every 5 to 10 years to check for leaks.

In the course of a recalibration from RMG, the device will also be checked for leaks at the same time.

If the device is used with the permitted gases, the service life of the seals is unlimited.

⇨ *Chapter 13.2, "Approved gas types" on page 190*

If other gases are used, please contact RMG.
RMG service will provide you with an interval for the leak test for the interaction with the ultrasonic gas meter and the gas type used.

1 Pack the device for transport and shipping to RMG correctly.

⇨ Chapter 6.2, „Packing the device for transportation“ on page 79

## 11.3 Checking the device for any signs of damage

The device must only be used in a technically sound state.



- **Checking the device**

1. Perform a visual check of the ultrasonic electronics viewing window.

   The viewing window must be free of cracks and complete.

2. Perform a visual check of the transducer covers.

   The covers must be free of cracks and breaking points.

3. Perform a visual check of the ultrasonic gas meter housing.

   The housing must be free of damage resulting from mechanical influences.

## 11.4 Changing the battery

The ultrasonic electronics contains a battery which keeps date and time when no power is available. If the battery is empty, the setting for the time and date are lost.

1. Have the empty battery changed by the RMG service.

**Note**

**Recommendation: The battery should be changed on the regular base of re-calibration but latest each 10 years.**

## 11.5 Changing the transducer



**Danger**

**Mortal danger from incorrect replacement of the transducer**

If transducers of a system under pressure are not changed correctly, this may cause an explosion. Escaping gas may lead to intoxication.

- Change the transducer only if you have obtained a training from RMG for this activity.
- Observe the separate service instructions for changing the transducer.

The special tool from RMG must be used for changing the transducers.

You can find out more about changing the transducers with the tool here:

⇨ *Service manual for changing the transducers and ultrasonic electronics (separate document)*

## 11.6 Changing the ultrasonic electronics

**Danger**

**Mortal danger from incorrect replacement of the transducer**

If transducers of a system under pressure are not changed correctly, this may cause an explosion. Escaping gas may lead to intoxication.

- Change the transducer only if you have obtained a training from RMG for this activity.
- Observe the separate service instructions for changing the transducer.

You can find out more about changing the ultrasonic electronics here:

⇨ *Service manual for changing the transducers and ultrasonic electronics (separate document)*

## 11.7 Cleaning the device

**Note**

**Malfunction from soiling**

If the device is soiled on the inside, it cannot function correctly. This may lead to incorrect measuring values or a failure.

- Have a device that is contaminated on the inside only cleaned by RMG service or by personnel that have been especially trained by RMG.

**Damage to the device from incorrect cleaning agent**

If the device is cleaned with cleaning agent containing solvents or other unsuitable agents, the paint or plastic parts become brittle, for example.

- Use gentle cleaning agents that are suitable for glass surfaces, metal and plastic.

▪ **Performing cleaning**

1 Free the device from rough and lose dirt with a soft brush.

2 Clean the viewing window of the ultrasonic electronics with a moist cloth.

## 11.8 Check the official seal

The official seals must be available and must not be damaged for calibrated operation.

▪ **Perform a visual check of the official seals**

1 Check that the official seals are intact and complete in a visual inspection.

The positions of the official seals can be found here:

⇨ Chapter 13.7, “Official seal diagram” on page 204

# 11.9 Decommissioning and disposal



**Danger**

**Mortal danger from disassembly in potentially explosive environment.**

If the device is disassembled in a potentially explosive environment for disposal, resulting sparks may lead to an explosion.

- Disassemble the device only in an explosion-proof area.

**Warning**

**Risk of injury from work carried out incorrectly**

During decommissioning and removal work, there is a risk of severe injuries from components under pressure and highly explosive atmospheres if the system has not been correctly disconnected from the gas supply network and the power supply in advance.

- Before starting work, switch off the device and secure it against being switched back on.
- Depressurize the device.
- Only specialist personnel are allowed to undertake the decommissioning.

Observe the applicable national and local guidelines for disposal. Ask your local authorities about the legal guidelines at your company location as well as about the regional disposal companies or collecting points.

The device mainly comprises materials that can be disposed of as old metal. In the following we shall specify the components that may not be disposed of as old metal.

### Ultrasonic electronics

Electric components are contained in the housing of the ultrasonic electronics that must be disposed of as electric waste. In order to remove the ultrasonic electronics, you have to remove the cover of the ultrasonic electronics.

⇨ *Chapter 10.2.3, “Opening the cover of the ultrasonic electronics” on page 154*

### Battery

The battery is attached to the PCB of the ultrasonic electronics. In order to remove the battery, you have to remove the cover of the ultrasonic electronics.

⇨ *Chapter 10.2.3, “Opening the cover of the ultrasonic electronics” on page 154*

### Transducer

The transducer comprises titanium, plastic and heavy metals (e.g., lead in piezo crystal). The transducers must be disposed of according to the applicable national and local guidelines.
In order to remove the transducers, RMG service shall inform you of the procedure.

⇨ *„Manufacturer“ on the inside cover*

# 12 Alarm and warning messages



In this chapter, you will find out which information, alarm and warning messages can be displayed. In this chapter, you will also find out how to eliminate problems with the RMG components.

In general:

- Active alarm and warning messages are displayed with a + in front of the message number.
- Inactive or already acknowledged messages are displayed with a - in front of the message number and can be deleted manually from the message list.

**Content**



## 12.1 Alarm and warning outputs

The alarm and warning outputs of the USM GT400 are offered in two variants:

For the US market, the outputs are designed according to the closed-circuit current principle, i.e. a closed-circuit current flows in undisturbed operation and the current flow is interrupted in the event of a fault. The following faults can occur:

- Device in alarm state (alarm contact)
- Device in warning state (warning contact)
- Cable break
- Device is switched off.

For the European market, the alarm and warning outputs are designed as follows:

- Alarm or warning status, contact closed, conductive
- Fault-free operation, contact open, non-conductive
- Device switched off, contact closed, conductive

Technical data for the alarm and warning contact are as follows:

- Potential-free contact
- $U_{max}$ = 30 V DC
- $I_{max}$ = 100 mA



## 12.2 Alarm messages

| No. | Message | Explanation |
|---|---|---|
| 0 | No errors | Trouble-free operation |
| 1 | Power failure | Temporary power failure |
| 2 | FPGA Timeout | FPGA communication: FPGA does not answer |
| 3 | FPGA CRC | FPGA-communication: faulty checksum |
| 4 | DSP-SPI Timeout | DSP-communication: Serial Peripheral Interface (Databus) of the digital Signal processor does not respond. |
| 5 | DSP-SPI CRC | DSP-communication: faulty checksum at SPI |
| 6 | DSP no data | No DSP measuring data arrives |
| 7 | DSP R-length | DSP-communication: Telegram length invalid |
| 8 | DSP | Critical DSP fault. Faulty bits can be read-off separately with DSP faults |
| 9 | FPGA | Critical FPGA fault. Faulty bits can be read-off separately with FPGA faults |
| 10 | COM-0 | Fault with data transmission via interface COM-0 |
| 11 | COM-1 | Fault with data transmission via interface COM-1 |
| 12 | COM-2 | Fault with data transmission via interface COM-2 |
| 13 | COM-3 | Fault with data transmission via interface COM-3 |
| 14 | AD converter | Fault at analog digital converter of the option card 2 |
| 15 | Option card | Fault at the option card 1 |
| 16 | Meter invalid | Meter invalid |
| 17 | Replacement value invalid | Replacement value of the path reconstruction invalid |
| 18 | F-RAM invalid | Checksum of the F-RAM telegram invalid |
| 19 | F-RAM length | Length of the F-RAM telegram invalid |
| 20 | opt. Data crc | Checksum of the data from the option card invalid |
| 21 | ADCData crc | Checksum of the data from the AD converter invalid |
| 22 | Iout min/max | Min/Max limits of the power output violated |
| 23 | Send level min | Send level too low |
| 24 | DSP version | DSP SW version not compatible with M32 SW version |
| 25 | FPGA version | FPGA version not compatible with M32 SW version |
| 26 | LOGP invalid | Parameter in log memory invalid |
| 30 | Path 1 failure | Measuring path 1 failed |
| 31 | Path 2 failure | Measuring path 2 failed |
| 32 | Path 3 failure | Measuring path 3 failed |
| 33 | Path 4 failure | Measuring path 4 failed |
| 34 | Path 5 failure | Measuring path 5 failed |
| 35 | Path 6 failure | Measuring path 6 failed |
| 36 | Path 7 failure | Measuring path 7 failed (spare) |
| 37 | Path 8 failure | Measuring path 8 failed (spare) |
| 38 | max. path | Maximum permissible number of path failures exceeded |

| No. | Message | Explanation |
|---|---|---|
| 40 | Replacement value not cal. | Replacement value for failed path could not be calculated |
| 41 | USE09 Timeout | No valid measurement, all measuring paths have failed. |
| 42 | ADC temperature | ADCfault temperature input |
| 43 | ADC pressure | ADC fault pressure input |
| 45 | I1 Out min/max | Power outlet outside the min. / max. limits |
| 47 | Temp. min/max | Temperature outside the min. / max. limits |
| 48 | Pressure min/max | Pressure outside the min. / max. limits |
| 50 | DSP path 1 | Critical path error. Error bits can be read-off separately in Path 1 error |
| 51 | DSP path 2 | Critical path error. Error bits can be read-off separately in Path 2 error |
| 52 | DSP path 3 | Critical path error. Error bits can be read-off separately in Path 3 error |
| 53 | DSP path 4 | Critical path error. Error bits can be read-off separately in Path 4 error |
| 54 | DSP path 5 | Critical path error. Error bits can be read-off separately in Path 5error |
| 55 | DSP path 6 | Critical path error. Error bits can be read-off separately in Path 6 error |
| 56 | DSP path 7 | Critical path error. Error bits can be read-off separately in Path 7 error (spare) |
| 57 | DSP path 8 | Critical path error. Error bits can be read-off separately in Path 8 error (spare) |
| 60 | P1 AGC limit | Amplification factor for path 1 outside the permissible limits |
| 61 | P2 AGC limit | Amplification factor for path 2 outside the permissible limits |
| 62 | P3 AGC limit | Amplification factor for path 3 outside the permissible limits |
| 63 | P4 AGC limit | Amplification factor for path 4 outside the permissible limits |
| 64 | P5 AGC limit | Amplification factor for path 5 outside the permissible limits |
| 65 | P6 AGC limit | Amplification factor for path 6 outside the permissible limits |
| 66 | P7 AGC limit | Amplification factor for path 7 outside the permissible limits (spare) |
| 67 | P8 AGC limit | Amplification factor for path 8 outside the permissible limits (spare) |
| 77 | QVb min. Grenze | Operating volume flow below Qmin |
| 78 | QVb max. limit | Operating volume flow above Qmax |
| 99 | Wrong Parm. | Parameter entered is invalid |

## 12.3 Warning messages

| No. | Messages | Explanation |
|---|---|---|
| 100 | Path1 Warn. | Proportion invalid measurements for path 1 too high |
| 101 | Path2 Warn. | Proportion invalid measurements for path 2 too high |
| 102 | Path3 Warn. | Proportion invalid measurements for path 3 too high |
| 103 | Path4 Warn. | Proportion invalid measurements for path 4 too high |
| 104 | Path5 Warn. | Proportion invalid measurements for path 5 too high |
| 105 | Path6 Warn. | Proportion invalid measurements for path 6 too high |
| 106 | Path7 Warn. | Proportion invalid measurements for path 7 too high (spare) |
| 107 | Path8 Warn. | Proportion invalid measurements for path 8 too high (spare) |
| 108 | RTC Hardware | Hardware fault to the real time clock |
| 109 | Ext. Warning | External warning |
| 110 | P1 V min/max | Flow velocity from path 1 outside the min./max. limits |
| 111 | P2 V min/max | Flow velocity from path 2 outside the min./max. limits |
| 112 | P3 V min/max | Flow velocity from path 3 outside the min./max. limits |
| 113 | P4 V min/max | Flow velocity from path 4 outside the min./max. limits |

| No. | Messages | Explanation |
|---|---|---|
| 114 | P5 V min/max | Flow velocity from path 5 outside the min./max. limits |
| 115 | P6 V min/max | Flow velocity from path 6 outside the min./max. limits |
| 116 | P7 V min/max | Flow velocity from path 7 outside the min./max. limits (spare) |
| 117 | P8 V min/max | Flow velocity from path 8 outside the min./max. limits (spare) |
| 118 | work.mode test | Counter runs in test mode |
| 120 | P1 C min/max | Speed of sound from path 1 outside the min./max. limits |
| 121 | P2 C min/max | Speed of sound from path 2 outside the min./max. limits |
| 122 | P3 C min/max | Speed of sound from path 3 outside the min./max. limits |
| 123 | P4 C min/max | Speed of sound from path 4 outside the min./max. limits |
| 124 | P5 C min/max | Speed of sound from path 5 outside the min./max. limits |
| 125 | P6 C min/max | Speed of sound from path 6 outside the min./max. limits |
| 126 | P7 C min/max | Speed of sound from path 7 outside the min./max. limits (spare) |
| 127 | P8 C min/max | Speed of sound from path 8 outside the min./max. limits (spare) |
| 130 | P1.1 amplitude | Amplitude of the signal from sensor 1.1 too small |
| 131 | P2.1 amplitude | Amplitude of the signal from sensor 2.1 too small |
| 132 | P3.1 amplitude | Amplitude of the signal from sensor 3.1 too small |
| 133 | P4.1 amplitude | Amplitude of the signal from sensor 4.1 too small |
| 134 | P5.1 amplitude | Amplitude of the signal from sensor 5.1 too small |
| 135 | P6.1 amplitude | Amplitude of the signal from sensor 6.1 too small |
| 136 | P7.1 amplitude | Amplitude of the signal from sensor 7.1 too small (spare) |
| 137 | P8.1 amplitude | Amplitude of the signal from sensor 8.1 too small (spare) |
| 140 | P1.2 amplitude | Amplitude of the signal from sensor 1.1 too small |
| 141 | P2.2 amplitude | Amplitude of the signal from sensor 2.1 too small |
| 142 | P3.2 amplitude | Amplitude of the signal from sensor 3.1 too small |
| 143 | P4.2 amplitude | Amplitude of the signal from sensor 4.1 too small |
| 144 | P5.2 amplitude | Amplitude of the signal from sensor 5.1 too small |
| 145 | P6.2 amplitude | Amplitude of the signal from sensor 6.1 too small |
| 146 | P7.2 amplitude | Amplitude of the signal from sensor 7.1 too small (spare) |
| 147 | P8.2 amplitude | Amplitude of the signal from sensor 8.1 too small (spare) |
| 150 | Pfad1 delta c | Deviation from the speed of sound in path 1 from the average speed of sound too large |
| 151 | Pfad2 delta c | Deviation from the speed of sound in path 2 from the average speed of sound too large |
| 152 | Pfad3 delta c | Deviation from the speed of sound in path 3 from the average speed of sound too large |
| 153 | Pfad4 delta c | Deviation from the speed of sound in path 4 from the average speed of sound too large |
| 154 | Pfad5 delta c | Deviation from the speed of sound in path 5 from the average speed of sound too large |
| 155 | Pfad6 delta c | Deviation from the speed of sound in path 6 from the average speed of sound too large |
| 156 | Pfad7 delta c | Deviation from the speed of sound in path 7 from the average speed of sound too large (spare) |
| 157 | Pfad8 delta c | Deviation from the speed of sound in path 8 from the average speed of sound too large (spare) |
| 170 | P1 AGC delta | Deviation from the amplification factor in path 1 from the average amplification factor too large |
| 171 | P2 AGC delta | Deviation from the amplification factor in path 2 from the average amplification factor too large |
| 172 | P3 AGC delta | Deviation from the amplification factor in path 3 from the average amplification factor too large |
| 173 | P4 AGC delta | Deviation from the amplification factor in path 4 from the average amplification factor too large |
| 174 | P5 AGC delta | Deviation from the amplification factor in path 5 from the average |

| No. | Messages | Explanation |
|---|---|---|
| | | amplification factor too large |
| 175 | P6 AGC delta | Deviation from the amplification factor in path 6 from the average amplification factor too large |
| 176 | P7 AGC delta | Deviation from the amplification factor in path 7 from the average amplification factor too large (spare) |
| 177 | P8 AGC delta | Deviation from the amplification factor in path 8 from the average amplification factor too large (spare) |

## 12.4 Notes

| No. | Message | Explanation |
|---|---|---|
| 181 | Sys. Temp Min | System temperature to low |
| 182 | Sys. Temp Max | System temperature to high |
| 183 | Rawdata len | Length of the raw data telegram wrong |
| 184 | Rawdata crc | Checksum of the raw data telegram wrong |
| 185 | P-LOG full | Parameter log memory full |
| 186 | DSP-info len | Length of the DSP info telegram wrong |
| 187 | DSP-info crc | Checksum of the DSP info telegram wrong |
| 188 | SoS calc. status | Status of the SoS calculation |

## 12.5 Troubleshooting

If you cannot find a solution to your problem with the RMG component in the table below, then please contact the RMG service.
⇨ „Manufacturer“ on the inside cover



If problems cannot be eliminated, please contact RMG service.

- Note the active message (number and text) in order to be able to discuss the problem with RMG service.

| No. | Description |
|---|---|
| 45 | The current output is freely configurable (is only code word protected). Violating the limit value may occur in an otherwise trouble-free operation if the limits are selected too close together. In this case, the limits can simply be adjusted. The limits are set ex-factory in such a manner that they correspond with the limit values of the assigned measured values, e.g., flow. A limit value violation occurs at the current outlet only if the meter, for example, is run-over and thus also reports a QVb max error (No.78). |
| 60-65 | AGC limits can be violated if an actual fault is at hand on the sensors or it is simply caused by the operating conditions. In order to limit the cause, one should compare the values of all paths in L-16/17 to Q-16/17. If only the AGC value of a single path deviates then one has to expect a defect. If all paths are affected then the cause may be contamination or condensation deposits on the transducer heads or, also an operating pressure that is simply too low if, for example, the system has not been applied yet. If the actual operating pressure deviates significantly from that previously specified, the parameters must be adjusted by the service. For extremely fluctuating operating conditions, there is an option for switching the attenuator on and off automatically here, which does not always lead to an optimum setting of the gain as this is only a 2-point regulation |
| 78 | QVb max limit appears when the meter is actually run. Then all measuring paths in L-7 to Q-7 should supply respectively high flow velocities. If only one values stands significantly out here then it is probably a malfunction of the path affected. |
| 100-105 | Path errors occur if one or more of the criterion monitored are violated permanently so that the content of valid measurement falls below the permitted limit value. If all measuring paths are affected at the same time, the cause for this is usually due to unsuitable operating conditions. If, for example, high-pressure gas is not applied to the system, but it is filled with nitrogen at atmospheric pressure, path error messages are activated as the limit value for the gain (AGC limit) is exceeded as well as the speed of sound may fall short or the signal leaves the permissible range of the evaluation window. Change the operating conditions or have the parameters adapted to the desired mode of operation (service deployment)! Contamination or the accumulation of condensation may also be a possibility. Errors on an individual path typically indicate a malfunction or a defect of the affected transducer or the corresponding wiring. Check the wiring and plug connectors! Only qualified personnel must change the transducer! |
| 110-115 | The flow velocity of the single paths measured are monitored at the limit values ± 50 m/s. If this is a tangible exceeding of the limit value by the actual flow velocity or it is |

| No. | Description |
|---|---|
| | a malfunction of an individual path, can be determined by comparing the single measurements in L-7 to Q-7. A subsequent error is no. 78. |
| 120-125 | The speed of sound of the single paths measured are monitored at the limit values ± 500 m/s. When using a gas (e.g., hydrogen) that deviates strongly with regard to the speed of sound, a parameterization must be carried out (service). If strongly deviating speed of sound are to be expected, the function "Signal Tracking" can also be activated in AI-27 that then adjusts the respective speed of sound range of the evaluation window. In case of a path error 100-105, the speed of sound is set to 0 so that the path can also be clearly identified as faulty on the basis of the measuring value, even if the reconstructed path velocity with the aid of the replacement-value function appears plausible. |
| 130-135 und 140-145 | These additional messages are helpful in faulty path cases (100-105) in order to determine the defective transducer of the path affected. Naturally, these error messages are also triggered if the evaluation electronics were defective, but then, all at the same time. |
| 150-155 und 170-175 | The monitoring of individual paths with regard to their deviation from the average values with respect to measuring variable such as speed of sound and gain (AGC = automatic gain control) serves the premature recognition of possible irregularities. Thus, one has the option to already identify conspicuous paths when the limit values relevant for the calibration have not been violated for the validity of the measurement yet. Possible causes are identical with those described in 100 -125. |

# 13 Technical specifications

In this chapter you will receive information on the performance data of the device.



**Content**

# 13.1 Performance data

| | | |
|---|---|---|
| **Power supply** | Measuring element: | 24 VDC ±10% |
| **Power consumption** | Measuring element: | typical 7-9 W;<br>with heated display, typically 12 W;<br>max. 15 W |
| **Protection class** | IP 66 / Type 4X | |
| **Interfaces** | RS 485 0 (for RMGView$^{USM}$): | 9600 / 19200 / 38400 / 57600 Baud |
| | RS 485 1<br>(for Modbus ASCII, RTU or Flow Computer) | 9600 / 19200 / 38400 / 57600 Baud |
| | RS 485 2<br>(for Modbus ASCII, RTU or Flow Computer) | 9600 / 19200 / 38400 / 57600 Baud |
| **Current output** | $U_{max}$= 16 V | Load resistance: max. 400 Ω |
| **Pulse output** | $U_{max}$= 30 V | $f_{max}$= 5 kHz |
| **Sensor frequency** | 200 kHz (DN100 / 4“ and DN150 / 6“) or 120 kHz (DN200 / 8“ and larger) | |
| **Flow velocity** | -40 to + 40 m/s | |
| **Gas temperature range** | -40 C to +80 C<br>(-40 F to 176 F) | |
| **Maximum operating pressure** | observe the details on the type plate. | |
| **Ambient conditions** | -40 C to +55 C<br>(-40 F to 131 F) | |
| **Altitude** | ≤ 2000 m | |
| **Ambient humidity** | ≤ 95% relative humidity, non-condensing | |
| **MID Accuracy Class** | 1.0 | |

| | | |
|---|---|---|
| **OIML Accuracy Class** | 0.5 | |
| **Alarm, Warning:** | - Potential-free contact<br>- Max. 30 V DC<br>- Max. 100 mA | **Europe / RoW (Rest of World):**<br>- OK: Contact "Open" (no passage)<br>- Alarm, warning: Contact "Closed" (passage)<br>**America:**<br>- OK: Contact "Closed" (passage)<br>- Alarm, warning: "Open" contact (no passage) |

## 13.2 Approved gas types

The device must only be operated with the following gas types.



Safe operation is only guaranteed with the gas types specified:

- gases of class 1
- gases of class 2
- gases of class 3

The components of the gases must be within the concentration limits for test gases according to EN 437:2009 or similar national standards.

The national standards of other countries demand similar gas type specifications.

**Note**

In general, the gas to be measured must not build any condensates in the operating range of the USM (flow, pressure and temperature range) and must be free of corrosive and aggressive components, liquids and solids.

In case of deviating conditions a suitable operation has to be agreed with the RMG service.

### 13.2.1 Suitability and safety for natural gas containing H2

The USM GT400 can be used in hydrogen-containing natural gas. There are no safety-related concerns for this use.

**Note**

In accordance with the German TR-G19 – the USM GT400 is suitable and approved for use in custody transfer applications – in natural gases with a maximum hydrogen content of 10 mol-% without a loss of the accuracy.

Since there are currently no certified test rigs in Germany to calibrate meters with higher hydrogen-containing gases, an accuracy above 10 mol-% cannot be tested or certified.

Not custody transfer measurements are of course possible in natural gases with a hydrogen content above 10 mol%. However, a reduced measuring range must be taken into account if applicable. Please contact RMG for further information.

# 13.3 Approved measuring range according to MID

| Nominal diameter | | Measuring range (m³/h) / (acfh) | | Extended measuring range (m³/h) / (acfh) *1 | |
|---|---|---|---|---|---|
| mm | inches | $Q_{max}$ | $Q_{min}$ | $Q_{min}$ | |
| 80 | 3 | 650 / 23000 | 5 / 175 | (2,5 / 88) | in preparation |
| 100 | 4 | 1000 / 35320 | 8 / 208 | (4 / 140) | in preparation |
| 150 | 6 | 2400 / 84760 | 20 / 700 | (10 / 350) | in preparation |
| 200 | 8 | 4200 / 148350 | 32 / 1130 | 16 / 560 | |
| 250 | 10 | 6600 / 233100 | 50 / 1750 | 25 / 880 | |
| 300 | 12 | 9400 / 332000 | 70 / 2450 | 35 / 1240 | |
| 350 | 12 | 11400 / 403000 | 90 / 3180 | 45 / 1590 | |
| 400 | 16 | 15000 / 530000 | 120 / 4230 | 60 / 2120 | |
| 450 | 12 | 19000 / 670700 | 150 / 1750 | 75 / 2650 | |
| 500 | 20 | 23500 / 830000 | 180 / 6350 | 90 / 3180 | |
| 600 | 24 | 34000 / 1201000 | 260 / 9175 | 130 / 4590 | |
| 650 | 26 | 45000 / 1588000 | 340 / 12010 | 170 / 6000 | |
| 700 | 28 | 52000 / 1834800 | 420 / 14335 | 210 / 7400 | |
| 750 | 30 | 60000 / 2115000 | 460 / 16230 | 320 / 8100 | |
| 800 | 32 | 68000 / 2399000 | 550 / 19250 | 550 / 19250 | |
| 900 | 36 | 86000 / 3030000 | 700 / 24500 | 700 / 24500 | |
| 1000 | 40 | 108000 / 3800000 | 850 / 29750 | 850 / 29750 | |

*1 The extended measuring range only effects Qmin. It can be used at pressures above p ≥ 4 bar / p ≥ 60 psi.

For meters with a full bore inner diameter according to Di-2 in the table at the end of chapter 13.5, the table values for $Q_{min}$ and $Q_{max}$ are to be increased by a factor of 1.1.

The number of acoustic paths is 6 for all variants.

# 13.4 Type plate




1 Type plate

*Fig. 13.1: Position of the type plate*

The following details can be found on the type plate:

## 13.4.1 Type plate ATEX / IECEx

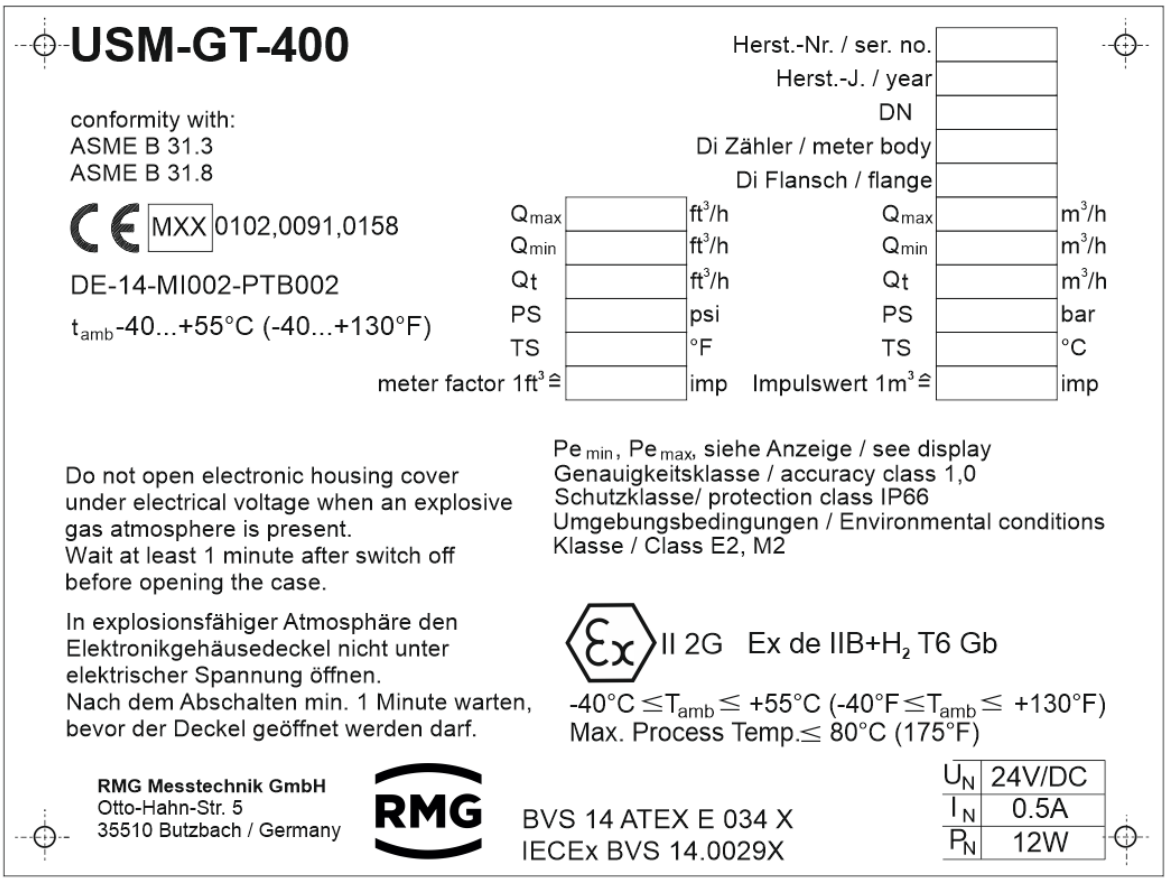



*Fig. 13.2: Type plate ATEX / IECEx*

### 13.4.2 Type plate NEC (CSA)

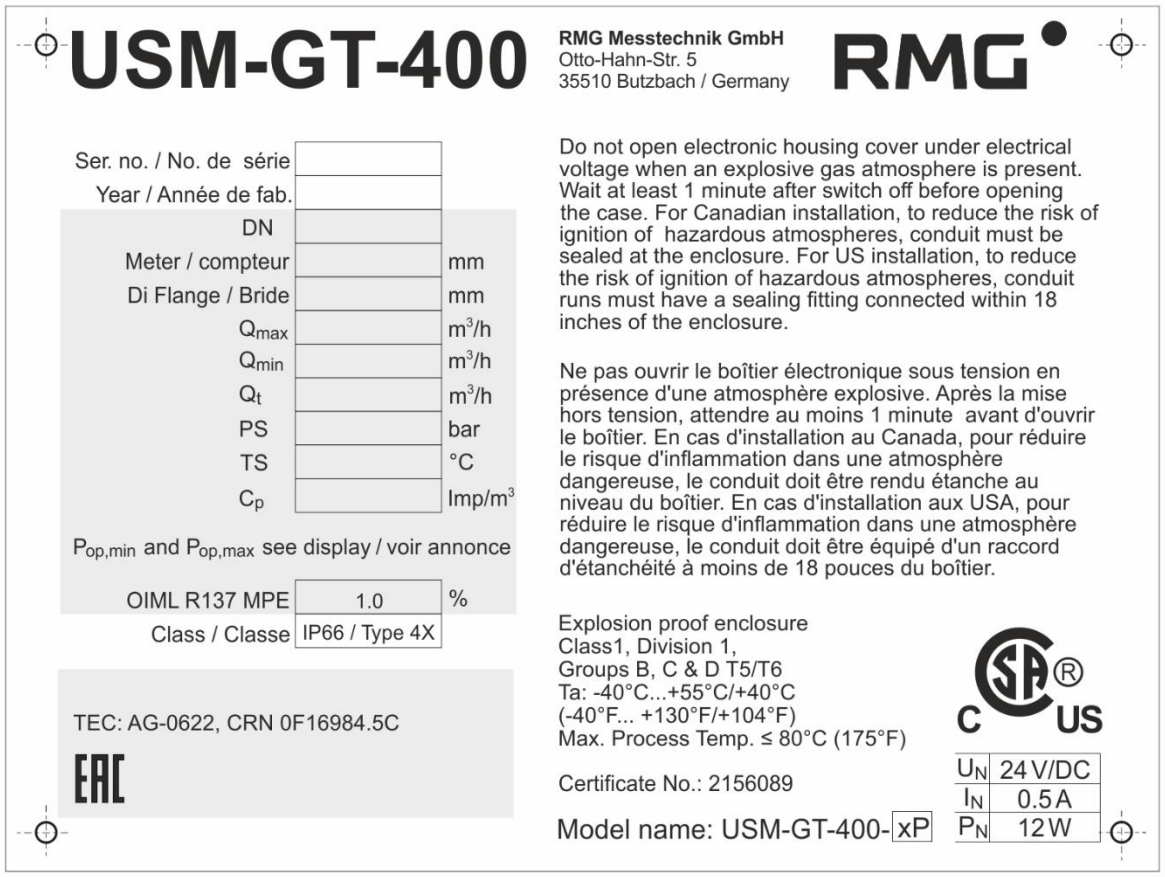


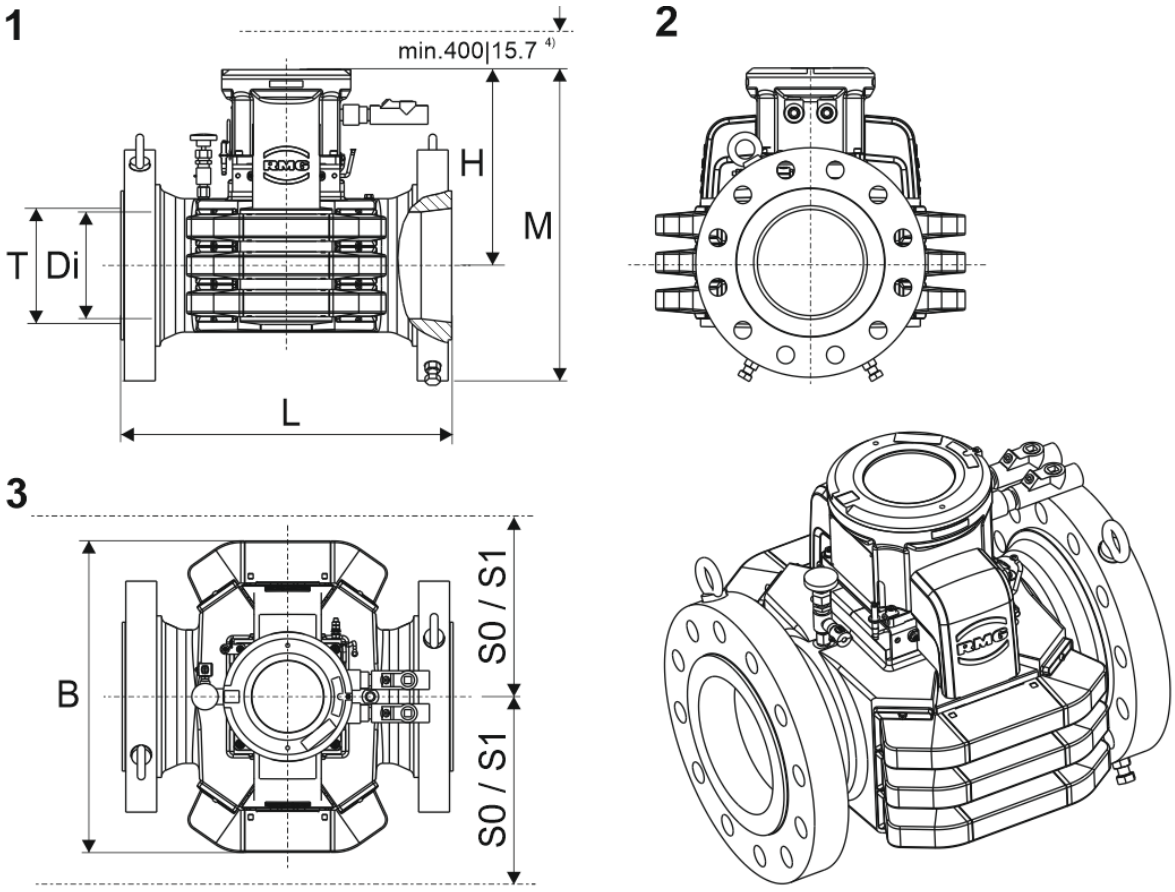

*Fig. 13.3: Type plate NEC (CSA / FM)*

## 13.5 Weights and dimensions

In this chapter you will receive information on the dimensions for the versions NEC and ATEX /IECEx.

**ANSI pressure stages:** The flange connecting dimensions comply with the standard ASME B 16.5.
**DIN pressure stages:** The flange connecting dimensions comply with the standard DIN EN 1092.

### 13.5.1 NEC (CSA)




1 Front view
2 Side view
3 Top view

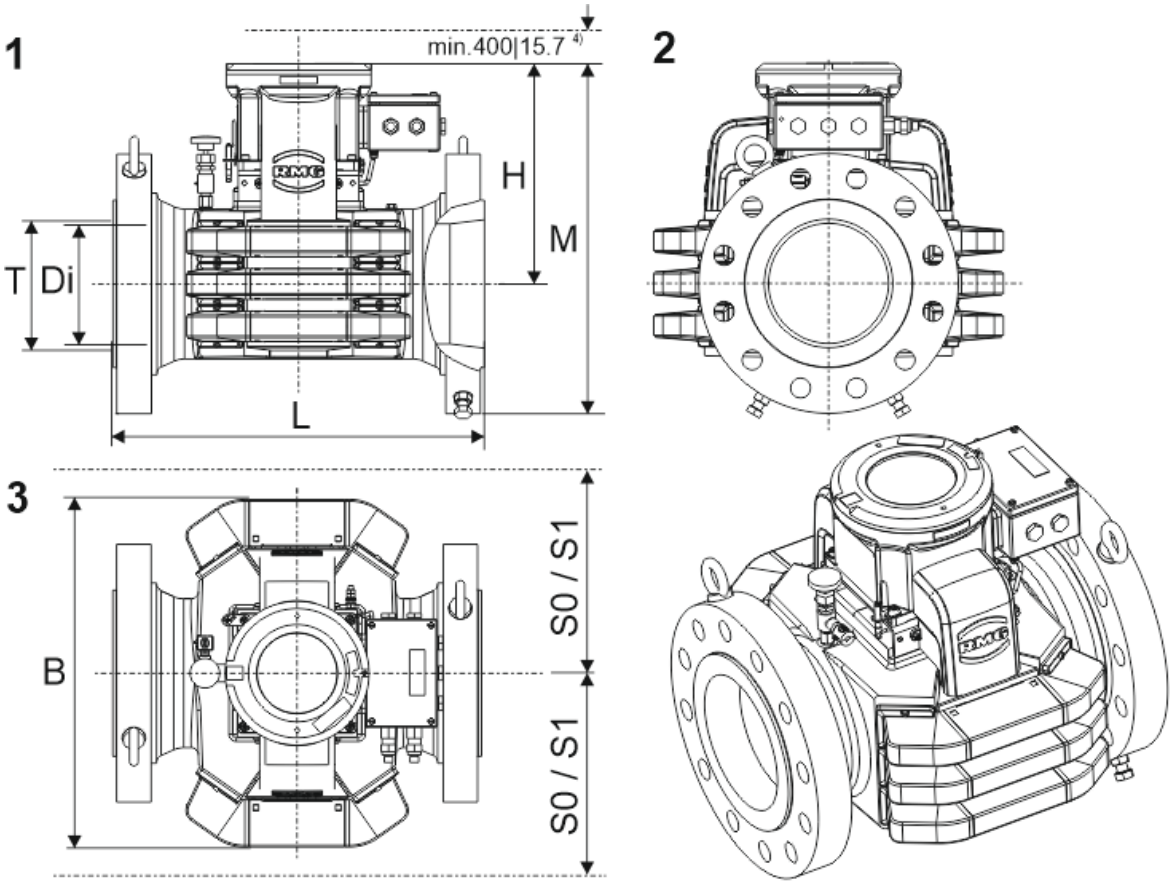
Space requirements for sensor exchange
S0: at non pressure flowmeter
S1: Flowmeter under pressure (with special tool)

*Fig. 13.4: Weights and dimensions NEC*

The version NEC and version ATEX / IECEx have identical dimensions. The table of the versions can be found on the following location:
“Dimensions - Version NEC and ATEX / IECEx” on page 198

## 13.5.2 ATEX / IECEx

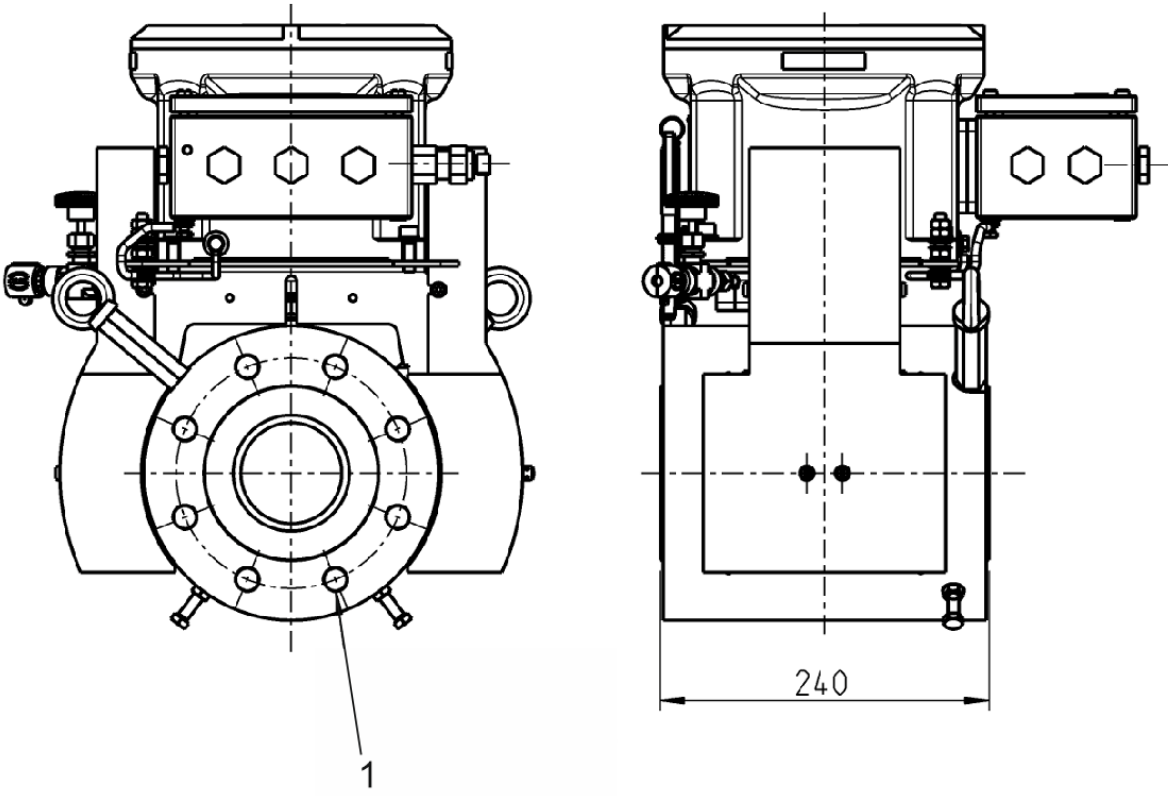





1 Front view
2 Side view
3 Top view

Space requirements for sensor exchange
S0: at non pressure flowmeter
S1: Flowmeter under pressure (with special tool)

*Fig. 13.5: Weights and dimensions NEC*




1 Threaded blind hole

*Fig. 13.6: Weights and dimensions DN80*

Due to the different sizes of the individual components, the device in DN80 is shown separately.

## Dimensions - Version NEC and ATEX / IECEx

| DN | L | L ANSI900 | Di-1 | Di-2 | T[1] | H[2] | B[2] | B[2] ANSI 900 | SO[2] | S1[2] | Weight[3] | Weight[3] ANSI 900 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 80 (3) | 240 (9.5) | - | 73.7 (2.9) | 77.9 (3.07) | 82.5 (3.25) | 450 (17.72) | 450 (17.72) | - | 225 (8.86) | - | 75 (165) | - |
| 100 (4) | 300 (11.81) | 400 (15.75) | 97.2 (3.83) | 102.3 (4.03) | 107.1 (4.22) | 330 (12.99) | 595 (23.43) | 415 (16.34) | 250 (9.84) | - | 100 (220) | 125 (276) |
| 150 (6) | 450 (17.72) | 450 (17.72) | 146.4 (5.76) | 154.1 (6.07) | 159.3 (6.27) | 340 (13.39) | 470 (18.5) | 470 (18.5) | 300 (11.81) | - | 160 (353) | 180 (397) |
| 200 (8) | 600 (23.62) | 800 (31.5) | 193.7 (7.63) | 202.7 (7.98) | 207.3 (8.16) | 360 (14.17) | 530 (20.87) | 565 (22.24) | 375 (14.76) | 1520 (59.84) | 300 (661) | 380 (838) |
| 250 (10) | 750 (29.53) | 1000 (39.37) | 242.8 (9.56) | 254.5 (10.02) | 260.4 (10.25) | 380 (14.96) | 650 (25.59) | 615 (24.21) | 400 (15.75) | 1550 (61.02) | 450 (992) | 560 (1235) |
| 300 (12) | 900 (35.43) | 900 (35.42) | 288.8 (11.37) | 303.2 (11.94) | 309.7 (12.19) | 395 (15.55) | 700 (27.56) | 660 (25.98) | 425 (16.73) | 1575 (62.01) | 550 (1213) | 670 (1477) |
| 350 (14) | 1050 (41.34) | 1050 (41.34) | 317,5 (12.5) | 333,3 (13.12) | 341,4 (13.44) | 407 (16.02) | 689 (27.13) | 689 (27.13) | 450 (17.72) | 1600 (62.99) | 710 (1565) | 800 (1764) |
| 400 (16) | 1200 (47.24) | 1200 (47.24) | 363.5 (14.31) | 381.0 (15.0) | 292.2 (11.50) | 500 (19.69) | 750 (29.53) | 750 (29.53) | 475 (18.70) | 1620 (63.78) | 950 (2094) | 1050 (2315) |
| 450 (16) | 1350 (53.15) | 1350 (53.15) | 409,3 (16.11) | 428,5 (16.87) | 448,8 (17.67) | 467 (18.39) | 790 (31.10) | 790 (31.10) | 500 (19.69) | 1650 (64.96) | 1232 (2716) | 1373 (3027) |
| 500 (20) | 1500 (59.06) | 1500 (59.06) | 455.6 (17.94) | 477.8 (18.81) | 493.8 (19.44) | 550 (21.65) | 900 (35.43) | 860 (31.5) | 525 (20.67) | 1670 (65.75) | 1500 (3307) | 1650 (3638) |
| 600 (24) | 1200 (47.24) | 1500 (59.06) | 547.7 (21.56) | 574.7 (22.63) | 595.8 (23.46) | 550 (21.65) | 1000 (39.37) | 1045 (41.14) | 600 (23.62) | 1725 (67.91) | 1550 (3417) | 2500 (5512) |
| 650 (26) | 1200 (47.24) | - | 632-648 (24.9-25-5) | | - | 680 (26.77) | 1040 (40.94) | - | 610 (24.02) | 1740 (68.5) | 1650 (3638) | - |
| 700 (28) | 1200 (47.24) | - | 679-699 (26.8-27.5) | | - | 700 (27.56) | 1050 (41.34) | - | 615 (24.21) | 1750 (68.9) | 1800 (3968) | - |
| 750 (30) | 1500 (59.06) | - | 730-749 (28.8-29.5) | | - | 800 (31.5) | 1100 (43.31) | - | 650 (25.59) | 1780 (70.08) | 1900 (4189) | - |
| 800 (32) | 1500 (59.06) | - | 778-800 (30.6-31.5) | | - | 850 (33.46) | 1150 (45.28) | - | 675 (26.57) | 1800 (70.87) | 2200 (4850) | - |
| 900 (36) | 1500 (59.06) | - | 876-902 (34.5-35.5) | | - | 1000 (39.37) | 1300 (51.18) | - | 750 (29.53) | 1875 (73.82) | 2600 (5732) | - |
| 1000 (40) | 1500 (59.06) | - | 978-1000 (38.5-39.4) | | - | 1200 (47.24) | 1400 (55.12) | - | 800 (31.5) | 1930 (75.98) | 3000 (6614) | - |

Dimensions are in mm (inch); weight in kg (lbs)

The given values are for pressure level ANSI 600, respectively ANSI900 (specified).

Di-1 = inner diameter (tapered, schedule 80)
Di-2 = inner diameter full bore (schedule 40)

[1] Maximum diameter at the flange, depending on tapering.
[2] Approximate dimension.
[3] Approximate values. Weights can vary due to casting tolerances.

An angle of 7° is used for tapering.



## 13.6 Inner diameter of connecting spool pieces

**Connection diameter at tapering of the USM GT400**
(= inner diameter for inlet and outlet spool pieces)

Maximum deviation from meter to piping:

**+/- 1% acc. MID**

For calibrated spool pieces belonging to the measuring instrument, the deviation may be up to +/- 3%. For the full-bore version, generally +5% / -2% are allowed regardless of the use during calibration.

The blue marked inner diameters for every ANSI pressure rating are to be understood as a recommendation if no inner diameter is specified by the customer.

| Meter size in DN / Inch | Pressure class | Inner Diameter [mm] | Min. ID of spools [mm] | Max. ID of spools [mm] | Schedule |
|---|---|---|---|---|---|
| 80 | PN10 | 82.5 | 81.7 | 83.3 | DIN |
| 80 | PN16 | 82.5 | 81.7 | 83.3 | DIN |
| 80 | PN25 | 82.5 | 81.7 | 83.3 | DIN |
| 80 | PN40 | 82.5 | 81.7 | 83.3 | DIN |
| 80 | PN64 | 81.7 | 80.9 | 82.5 | DIN |
| 80 | ANSI150 | 73.7 | 73 | 74.4 | 80 |
| 80 | ANSI150 | 77.9 | 77.2 | 78.7 | 40 |
| 80 | ANSI300 | 73.7 | 73 | 74.4 | 80 |
| 80 | ANSI300 | 77.9 | 77.2 | 78.7 | 40 |
| 80 | ANSI600 | 73.7 | 73 | 74.4 | 80 |
| 80 | ANSI600 | 77.9 | 77.2 | 78.7 | 40 |
| 100 | PN10 | 107.1 | 106.0 | 108.2 | DIN |
| 100 | PN16 | 107.1 | 106.0 | 108.2 | DIN |
| 100 | PN25 | 107.1 | 106.0 | 108.2 | DIN |
| 100 | PN40 | 107.1 | 106.0 | 108.2 | DIN |

200

| Meter size in DN / Inch | Pressure class | Inner Diameter [mm] | Min. ID of spools [mm] | Max. ID of spools [mm] | Schedule |
|---|---|---|---|---|---|
| 100 | PN64 | 106.3 | 105.2 | 107.4 | DIN |
| 100 | ANSI150RF | 97.2 | 96.2 | 98.2 | 80 |
| 100 | ANSI150RF | 102.3 | 101.3 | 103.3 | 40 |
| 100 | ANSI300RF | 97.2 | 96.2 | 98.2 | 80 |
| 100 | ANSI300RF | 102.3 | 101.3 | 103.3 | 40 |
| 100 | ANSI600RF | 97.2 | 96.2 | 98.2 | 80 |
| 100 | ANSI600RF | 102.3 | 101.3 | 103.3 | 40 |
| 100 | ANSI600RTJ | 97.2 | 96.2 | 98.2 | 80 |
| 100 | ANSI600RTJ | 102.3 | 101.3 | 103.3 | 40 |
| 150 | PN10 | 159.3 | 157.7 | 160.9 | DIN |
| 150 | PN16 | 159.3 | 157.7 | 160.9 | DIN |
| 150 | PN25 | 159.3 | 157.7 | 160.9 | DIN |
| 150 | PN40 | 159.3 | 157.7 | 160.9 | DIN |
| 150 | PN64 | 157.1 | 155.5 | 158.7 | DIN |
| 150 | ANSI150RF | 146.4 | 144.9 | 147.9 | 80 |
| 150 | ANSI150RF | 154.1 | 152.6 | 155.6 | 40 |
| 150 | ANSI300RF | 146.4 | 144.9 | 147.9 | 80 |
| 150 | ANSI300RF | 154.1 | 152.6 | 155.6 | 40 |
| 150 | ANSI600RF | 146.4 | 144.9 | 147.9 | 80 |
| 150 | ANSI600RF | 154.1 | 152.6 | 155.6 | 40 |
| 150 | ANSI600RTJ | 146.4 | 144.9 | 147.9 | 80 |
| 150 | ANSI600RTJ | 154.1 | 152.6 | 155.6 | 40 |
| 200 | PN10 | 206.5 | 204.4 | 208.6 | DIN |
| 200 | PN16 | 206.5 | 204.4 | 208.6 | DIN |
| 200 | PN25 | 206.5 | 204.4 | 208.6 | DIN |
| 200 | PN40 | 206.5 | 204.4 | 208.6 | DIN |
| 200 | PN64 | 204.9 | 202.9 | 206.9 | DIN |
| 200 | ANSI150RF | 193.7 | 191.8 | 195.6 | 80 |
| 200 | ANSI150RF | 198.5 | 196.5 | 200.5 | 60 |
| 200 | ANSI150RF | 202.7 | 200.7 | 204.7 | 40 |
| 200 | ANSI300RF | 193.7 | 191.8 | 195.6 | 80 |
| 200 | ANSI300RF | 198.5 | 196.5 | 200.5 | 60 |
| 200 | ANSI300RF | 202.7 | 200.7 | 204.7 | 40 |
| 200 | ANSI600RF | 193.7 | 191.8 | 195.6 | 80 |
| 200 | ANSI600RF | 198.5 | 196.5 | 200.5 | 60 |
| 200 | ANSI600RF | 202.7 | 200.7 | 204.7 | 40 |
| 200 | ANSI600RTJ | 193.7 | 191.8 | 195.6 | 80 |
| 200 | ANSI600RTJ | 198.5 | 196.5 | 200.5 | 60 |
| 200 | ANSI600RTJ | 202.7 | 200.7 | 204.7 | 40 |
| 250 | PN10 | 260.4 | 257.8 | 263.0 | DIN |

| Meter size in DN / Inch | Pressure class | Inner Diameter [mm] | Min. ID of spools [mm] | Max. ID of spools [mm] | Schedule |
|---|---|---|---|---|---|
| 250 | PN16 | 260.4 | 257.8 | 263.0 | DIN |
| 250 | PN25 | 258.8 | 256.2 | 261.4 | DIN |
| 250 | PN40 | 258.8 | 256.2 | 261.4 | DIN |
| 250 | PN64 | 255.4 | 252.8 | 258.0 | DIN |
| 250 | ANSI150RF | 242.8 | 240.4 | 245.2 | 80 |
| 250 | ANSI150RF | 247.6 | 245.1 | 250.1 | 60 |
| 250 | ANSI150RF | 254.4 | 251.9 | 256.9 | 40 |
| 250 | ANSI300RF | 242.8 | 240.4 | 245.2 | 80 |
| 250 | ANSI300RF | 247.6 | 245.1 | 250.1 | 60 |
| 250 | ANSI300RF | 254.4 | 251.9 | 256.9 | 40 |
| 250 | ANSI600RF | 242.8 | 240.4 | 245.2 | 80 |
| 250 | ANSI600RF | 247.6 | 245.1 | 250.1 | 60 |
| 250 | ANSI600RF | 254.4 | 251.9 | 256.9 | 40 |
| 250 | ANSI600RTJ | 242.8 | 240.4 | 245.2 | 80 |
| 250 | ANSI600RTJ | 247.6 | 245.1 | 250.1 | 60 |
| 250 | ANSI600RTJ | 254.4 | 251.9 | 256.9 | 40 |
| 300 | PN10 | 309.7 | 306.6 | 312.8 | DIN |
| 300 | PN16 | 309.7 | 306.6 | 312.8 | DIN |
| 300 | PN25 | 307.9 | 304.8 | 311.0 | DIN |
| 300 | PN40 | 307.9 | 304.8 | 311.0 | DIN |
| 300 | PN64 | 301.9 | 298.9 | 304.9 | DIN |
| 300 | ANSI150RF | 288.8 | 285.9 | 291.7 | 80 |
| 300 | ANSI150RF | 295.3 | 292.3 | 298.3 | 60 |
| 300 | ANSI150RF | 303.2 | 300.2 | 306.2 | 40 |
| 300 | ANSI300RF | 288.8 | 285.9 | 291.7 | 80 |
| 300 | ANSI300RF | 295.3 | 292.3 | 298.3 | 60 |
| 300 | ANSI300RF | 303.2 | 300.2 | 306.2 | 40 |
| 300 | ANSI600RF | 288.8 | 285.9 | 291.7 | 80 |
| 300 | ANSI600RF | 295.3 | 292.3 | 298.3 | 60 |
| 300 | ANSI600RF | 303.2 | 300.2 | 306.2 | 40 |
| 300 | ANSI600RTJ | 288.8 | 285.9 | 291.7 | 80 |
| 300 | ANSI600RTJ | 295.3 | 292.3 | 298.3 | 60 |
| 300 | ANSI600RTJ | 303.2 | 300.2 | 306.2 | 40 |
| 350 | ANSI600RF | 317.5 | 314.3 | 320.7 | 80 |
| 350 | ANSI600RF | 325.4 | 322.1 | 328.7 | 60 |
| 350 | ANSI600RF | 333.3 | 330.0 | 336.6 | 40 |
| 350 | ANSI600RTJ | 317.5 | 314.3 | 320.7 | 80 |
| 350 | ANSI600RTJ | 325.4 | 322.1 | 328.7 | 60 |
| 350 | ANSI600RTJ | 333.3 | 330.0 | 336.6 | 40 |
| 400 | PN10 | 392.2 | 388.3 | 396.1 | DIN |

| Meter size in DN / Inch | Pressure class | Inner Diameter [mm] | Min. ID of spools [mm] | Max. ID of spools [mm] | Schedule |
|---|---|---|---|---|---|
| 400 | PN16 | 390.4 | 386.5 | 394.3 | DIN |
| 400 | PN25 | 388.8 | 384.9 | 392.7 | DIN |
| 400 | PN40 | 384.4 | 380.6 | 388.2 | DIN |
| 400 | PN64 | 378 | 374.2 | 381.8 | DIN |
| 400 | ANSI150RF | 363.5 | 359.9 | 367.1 | 80 |
| 400 | ANSI150RF | 373.1 | 369.4 | 376.8 | 60 |
| 400 | ANSI150RF | 381 | 377.2 | 384.8 | 40 |
| 400 | ANSI300RF | 363.5 | 359.9 | 367.1 | 80 |
| 400 | ANSI300RF | 373.1 | 369.4 | 376.8 | 60 |
| 400 | ANSI300RF | 381 | 377.2 | 384.8 | 40 |
| 400 | ANSI600RF | 363.5 | 359.9 | 367.1 | 80 |
| 400 | ANSI600RF | 373.1 | 369.4 | 376.8 | 60 |
| 400 | ANSI600RF | 381 | 377.2 | 384.8 | 40 |
| 400 | ANSI600RTJ | 363.5 | 359.9 | 367.1 | 80 |
| 400 | ANSI600RTJ | 373.1 | 369.4 | 376.8 | 60 |
| 400 | ANSI600RTJ | 381 | 377.2 | 384.8 | 40 |
| 450 | ANSI600RF | 409.6 | 405.5 | 413.7 | 80 |
| 450 | ANSI600RF | 418.9 | 414.7 | 423.1 | 60 |
| 450 | ANSI600RF | 428.5 | 424.2 | 432.8 | 40 |
| 450 | ANSI600RTJ | 409.6 | 405.5 | 413.7 | 80 |
| 450 | ANSI600RTJ | 418.9 | 414.7 | 423.1 | 60 |
| 450 | ANSI600RTJ | 428.5 | 424.2 | 432.8 | 40 |
| 500 | PN10 | 493.8 | 488.9 | 498.7 | DIN |
| 500 | PN16 | 490.4 | 485.5 | 495.3 | DIN |
| 500 | PN25 | 488 | 483.1 | 492.9 | DIN |
| 500 | PN40 | 479.6 | 474.8 | 484.4 | DIN |
| 500 | ANSI150RF | 455.6 | 451.0 | 460.2 | 80 |
| 500 | ANSI150RF | 466.8 | 462.1 | 471.5 | 60 |
| 500 | ANSI150RF | 477.8 | 473.0 | 482.6 | 40 |
| 500 | ANSI300RF | 455.6 | 451.0 | 460.2 | 80 |
| 500 | ANSI300RF | 466.8 | 462.1 | 471.5 | 60 |
| 500 | ANSI300RF | 477.8 | 473.0 | 482.6 | 40 |
| 500 | ANSI600RF | 455.6 | 451.0 | 460.2 | 80 |
| 500 | ANSI600RF | 466.8 | 462.1 | 471.5 | 60 |
| 500 | ANSI600RF | 477.8 | 473.0 | 482.6 | 40 |
| 500 | ANSI600RTJ | 455.6 | 451.0 | 460.2 | 80 |
| 500 | ANSI600RTJ | 466.8 | 462.1 | 471.5 | 60 |
| 500 | ANSI600RTJ | 477.8 | 473.0 | 482.6 | 40 |
| 600 | PN10 | 594 | 588.1 | 599.9 | DIN |
| 600 | PN16 | 588 | 582.1 | 593.9 | DIN |

| Meter size in DN / Inch | Pressure class | Inner Diameter [mm] | Min. ID of spools [mm] | Max. ID of spools [mm] | Schedule |
|---|---|---|---|---|---|
| 600 | ANSI300RF | 547.7 | 542.2 | 553.2 | 80 |
| 600 | ANSI300RF | 560.4 | 554.8 | 566.0 | 60 |
| 600 | ANSI300RF | 574.6 | 568.9 | 580.3 | 40 |
| 600 | ANSI600RF | 547.7 | 542.2 | 553.2 | 80 |
| 600 | ANSI600RF | 560.4 | 554.8 | 566.0 | 60 |
| 600 | ANSI600RF | 574.6 | 568.9 | 580.3 | 40 |

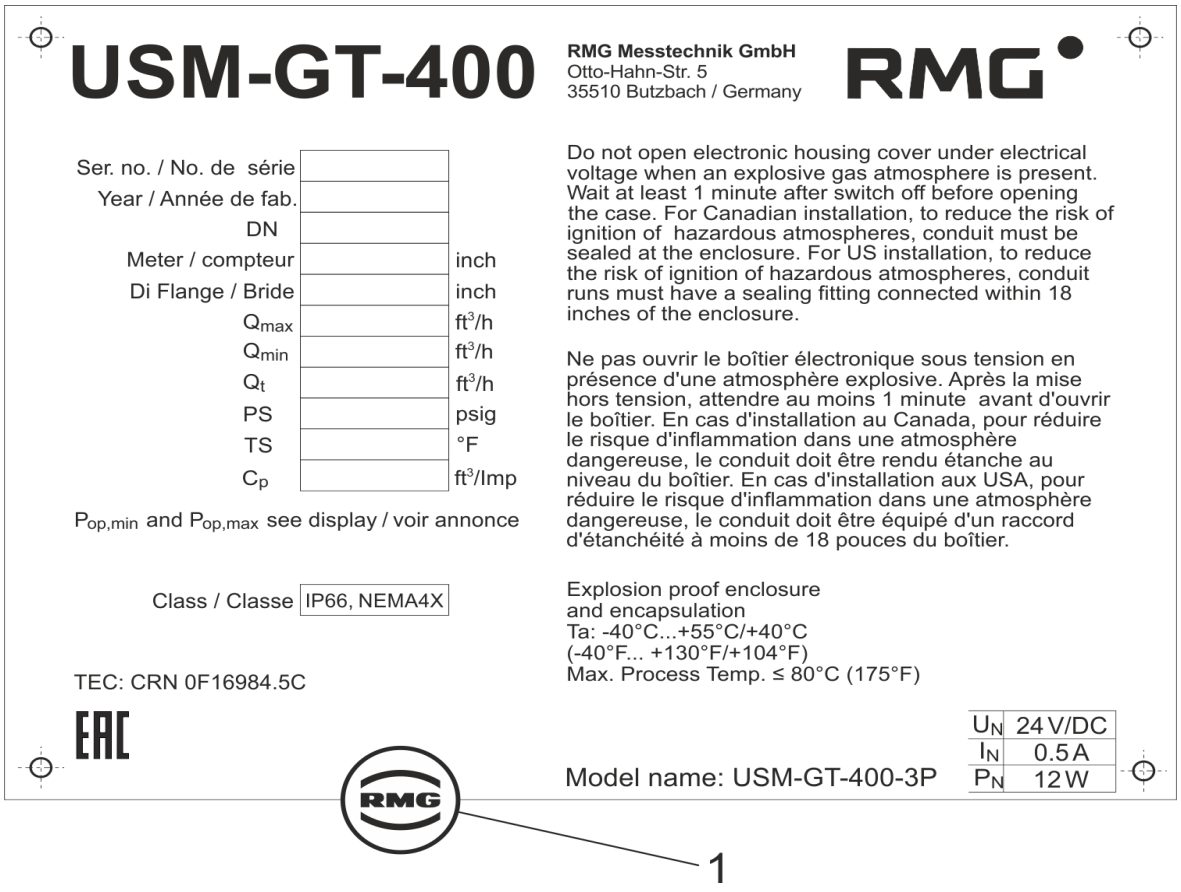
# 13.7 Official seal diagram

In this chapter you will receive information at which location the official seals are attached to the device.



The device must not be used for a calibrated operation if the official seal is broken.

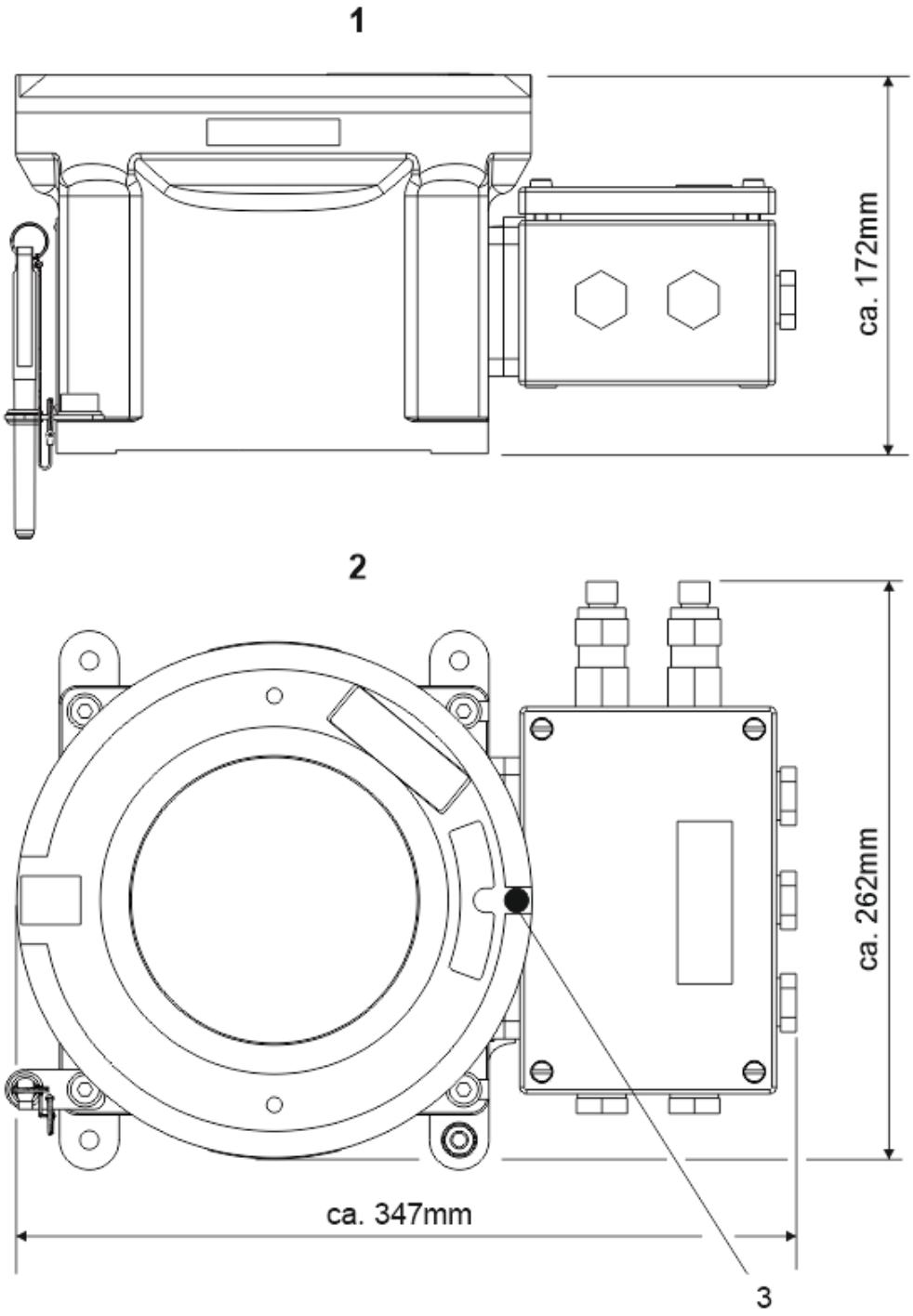
## 13.7.1 Type plate




1 Seal

*Fig. 13.7: Position of the official seal on the type plate*

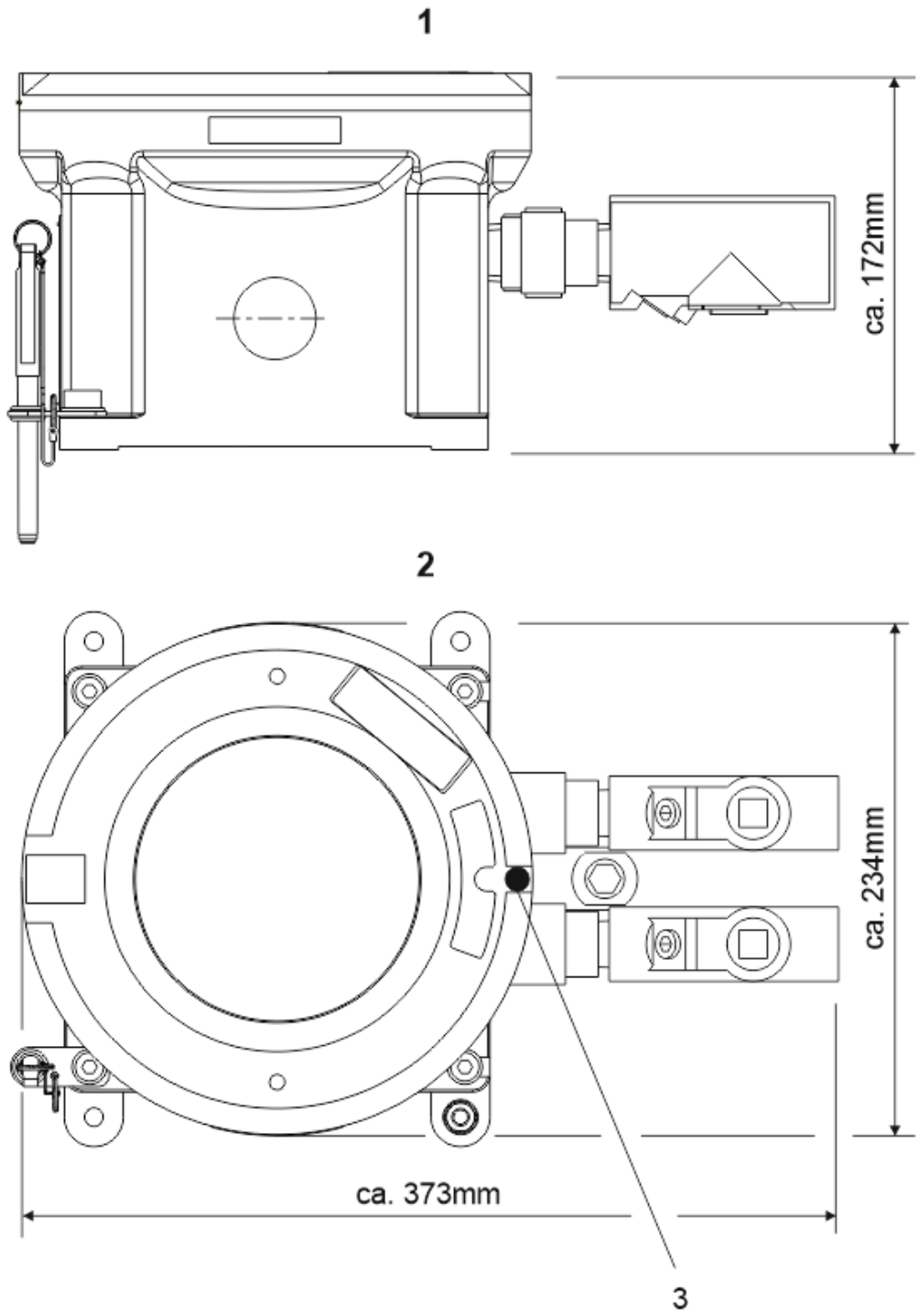
### 13.7.2 Ultrasonic electronics




Representation of the device with DN 150 (6“)

1 Side view
2 Top view
3 Seal

*Fig. 13.8: Official seal diagram according to AEX / IECEx*




Representation of the device with DN 150 (6“)

1 Side view
2 Top view
3 Seal

*Fig. 13.9: Official seal diagram according to NEC*

## 13.7.3 Ultrasonic gas meter

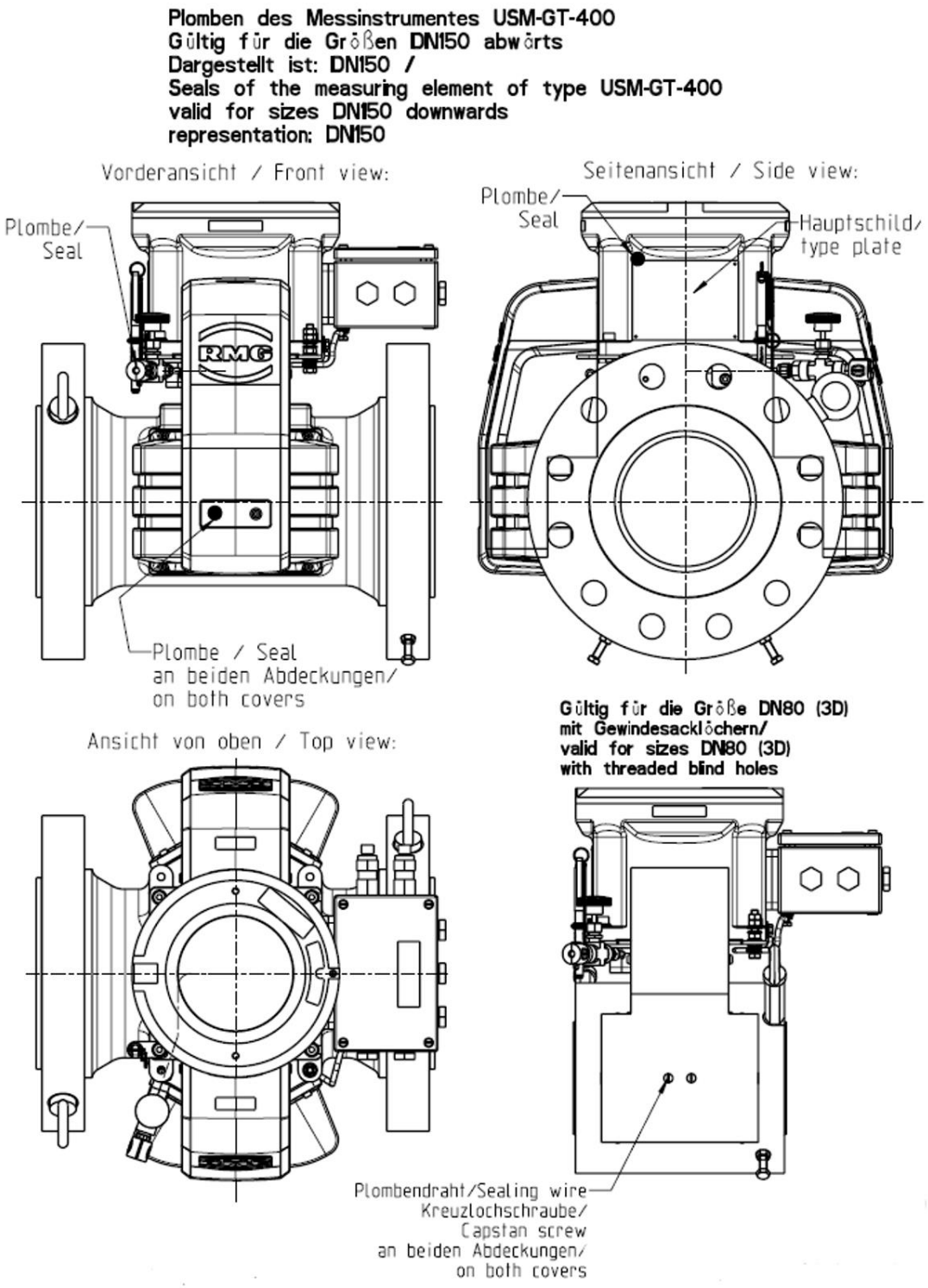
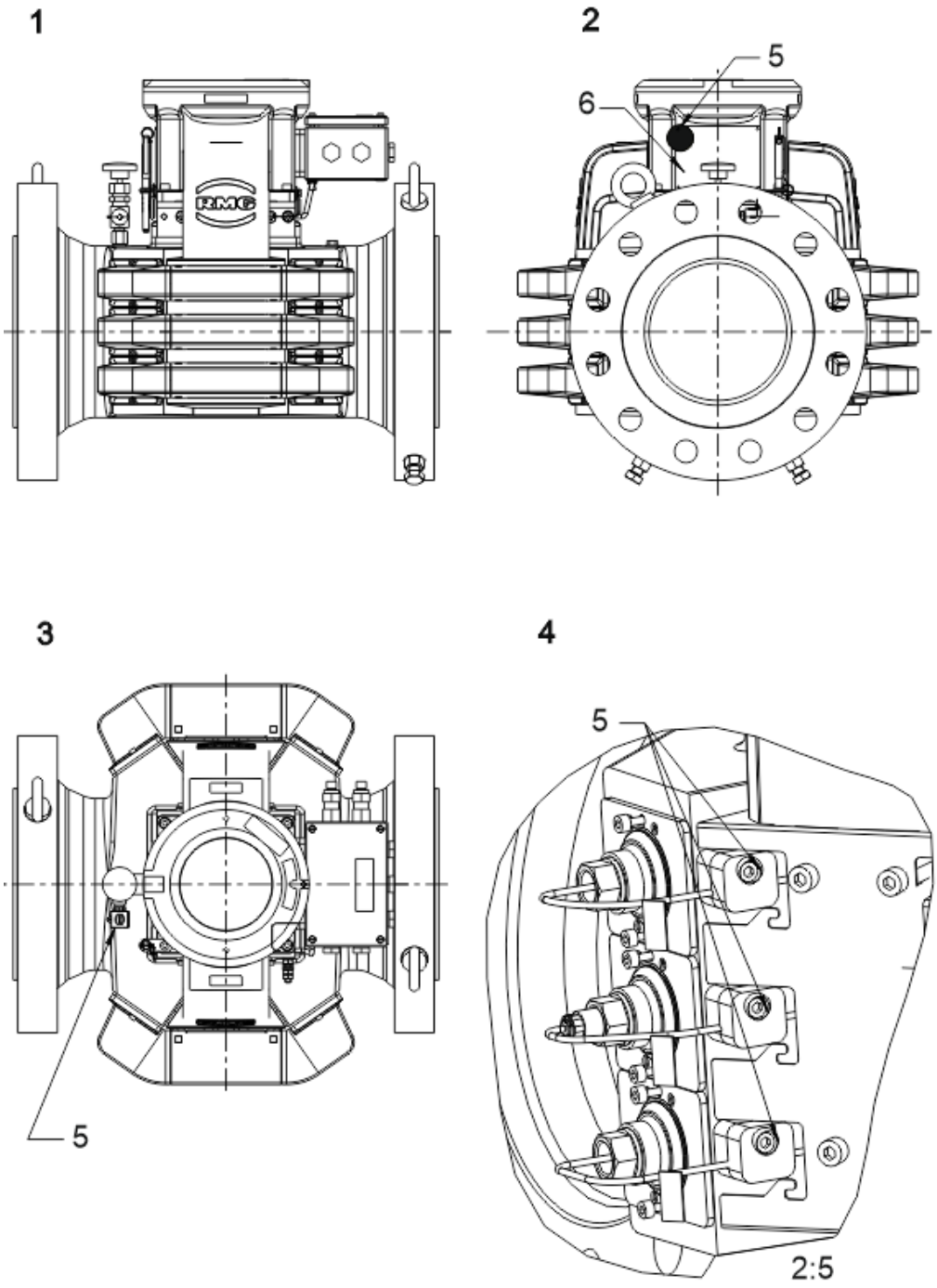



*Fig. 13.10: Devices DN 80 (3”), DN 100 (4“) and DN 150 (6“)*




| | | | |
|---|---|---|---|
| 1 | Front view | 2 | Side view |
| 3 | Top view | 4 | View without cover |
| 5 | Seal | 6 | Type plate |

*Fig. 13.11: Devices DN 200 (8 ") and larger*

Seals of the measuring element of type USM-GT-400
Valid for sizes DN 200 upwards

Representation: DN 200

# 13.8 Transducer types

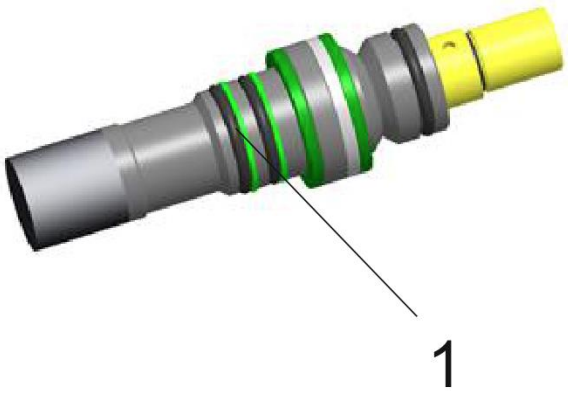
210

**Danger**

**Mortal danger from incorrect replacement of the transducer**

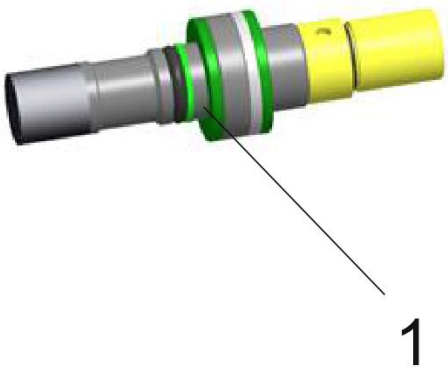
If transducers of a device under pressure are not changed correctly, this may cause an explosion. Escaping gas mixtures may lead to intoxication.

- Change the transducer only if you have obtained a training from RMG for this activity.
- Observe the separate service instruction for changing the transducer.




1 TNG 10-CP / -CHP

*Fig. 13.12: Trancducer type TNG 10-CP / -CHP*




1 TNG 20-SP / -SHP

*Fig. 13.13: Trancducer type TNG 20-SP / -SHP*

| Transducer type | Operating frequency (kHz) | Operating pressure range bar (psi) | Ambient temperature °C (°F) | Gas temperature °C (°F) |
|---|---|---|---|---|
| TNG 10-CP | 120 | 1–150<br>(14,5 to 2175.57) | -40 to +55 °C<br>(55 to 131 °F) | to +80 °C<br>(176 °F) |
| TNG 10-CHP | 120 | 1–300<br>(14,5 to 4351.13) | -40 to +55 °C<br>(55 to 131 °F) | to +80 °C<br>(176 °F) |
| TNG 20-SP | 200 | 1–150<br>(14,5 to 2175.57) | -40 to +55 °C<br>(55 to 131 °F) | to +80 °C<br>(176 °F) |
| TNG 20-SHP | 200 | 1–300<br>(14,5 to 4351.13) | -40 to +55 °C<br>(55 to 131 °F) | to +80 °C<br>(176 °F) |

# 14 Spare parts and accessories



| Order number | Description |
|---|---|
| **Electronics** | |
| 98800-14400 | USE 09, complete electronics |
| 98800-13352 | USE 09, display circuit board |
| 98800-13512 | USE 09, Options card 1 (RS485 and pulse outputs) |
| 98800-13762 | USE 09, Options card 2 (P&T inputs) |
| 98800-13020 | USE 09, Multiplexer (4 channels) |
| 00.66.197.00 | Magnetic pin, complete with holder |
| **External elements** | |
| 00.65.142.00 | Weather protection cover for electronics housing |
| 00.64.923.00 | Complete grill element DN 100 (4”) |
| 00.64.855.00 | Complete grill element DN 150 (6”) |
| 00.64.811.00 | Transducer cover for DN 80 (3”) to DN 150 (6”) |
| 00.64.798.00 | Grill element DN 200 (8”) |
| 00.64.860.00 | Grill element DN 250 (10”) |
| 00.64.862.00 | Grill element DN 300 (12”) |
| 00.64.864.00 | Grill element DN 400 (16”) |
| 00.64.866.00 | Grill element DN 500 (20”) |
| 00.64.868.00 | Grill element (middle level) DN 600 (24”) |
| 00.64.926.00 | Grill element (outer levels) DN 600 (24”) |
| 87.06.050.00 | Cable bushing M20x1.5 (Ø 3-9) |
| 87.06.051.00 | Cable bushing M20x1.5 (Ø 6-12) |
| 30.00.948.00 | Shut-off valve NV3F-4N-R-K 2x1/4NPT inn.H. |

## Pipe bundles

| | |
|---|---|
| 00.64.767.01 | Pipe bundle for DN 100 (4”) |
| 00.64.767.02 | Pipe bundle for DN 150 (6”) |
| 00.64.767.03 | Pipe bundle for DN 200 (8”) |
| 00.64.767.04 | Pipe bundle for DN 250 (10”) |
| 00.64.767.05 | Pipe bundle for DN 300 (12”) |
| 00.64.767.13 | Pipe bundle for DN 350 (14”) |
| 00.64.767.06 | Pipe bundle for DN 400 (16”) |
| 00.64.767.14 | Pipe bundle for DN 450 (18”) |
| 00.64.767.07 | Pipe bundle for DN 500 (20”) |
| 00.64.767.08 | Pipe bundle for DN 600 (24”) |
| 00.64.767.15 | Pipe bundle for DN 650 (26”) |
| 00.64.767.16 | Pipe bundle for DN 750 (30”) |

## Transducers

| | |
|---|---|
| 00.64.758.00 | USM-transducer type TNG 20-SP (3”-6”), 200 kHz, up to 150 bar(a) |
| 00.65.000.00 | USM-transducer type TNG20-SHP (3”-6”), 200 kHz, up to 300 bar(a) |
| 00.64.757.00 | USM-transducer type TNG 10-CP (8”-40”), 120 kHz, up to 150 bar(a) |
| 00.64.839.00 | USM-transducer type TNG10-CHP (8”-40”), 120 kHz, up to 300 bar(a) |

## Tools for transducer replacement

| | |
|---|---|
| 00.64.669.00 | Special tool for transducer replacement DN200 (8”) |
| 00.65.011.00 | Special tool for transducer replacement DN250 (10”) |
| 00.65.012.00 | Special tool for transducer replacement DN300 (12”) |
| 00.68.476.00 | Special tool for transducer replacement DN350 (14“) |
| 00.65.013.00 | Special tool for transducer replacement DN400 (16”) |
| 00.68.572.00 | Special tool for transducer replacement DN450 (18“) |
| 00.65.014.00 | Special tool for transducer replacement DN500 (20”) |
| 00.65.015.00 | Special tool for transducer replacement DN600 (24”) |
| 38.00.014.00 | Special tool pair d=7x10 for USE-09 |
| 00.61.128.00 | Special tool for transducer replacement under pressure (from DN 200) |

### Interface converter

| | |
|---|---|
| 30.00.212.00 | RS 485 to USB converter for top hat rail (I-7561U-G CR) |
| 35.00.023.00 | RS 485 to Ethernet converter (FL Comserver) |

# 15 Lists of parameters and measured values



The following tables show the parameters that can be shown and edited using the RMGView$^{USM}$ software or via the display with control panel.

With different versions of the device software, individual parameters may have different coordinates.

The abbreviations in the Type and Protection (Prot.) columns have the following meanings:

| **Type** | |
|---|---|
| F | Float |
| M | Menu |
| I | Integer |
| U | Unixtime |
| L | Long Int. |
| T | Text |
| D | Double |
| C | Code |

| **Protection** | |
|---|---|
| R | Reading Value |
| S | Official Key |
| F | free programmable |
| C | Codeword |
| CS | Code and Official Key |
| | |
| | |
| | |

(d) to the right of a menu option means “default value”.

## Pressure

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| A-01 | Pressure | 6252 | 2 | F | R | → Units: Pressure a | Shows the measured pressure | | |
| A-03 | Current Input | 6254 | 2 | F | R | mA | Shows the input value in mA | | |
| A-05 | p min value | 1392 | 2 | F | S | → Units: Pressure a | Measuring pressure min. value | | |
| A-06 | p max value | 1394 | 2 | F | S | → Units: Pressure a | Measuring pressure max. value | | |
| A-09 | p set value | 1396 | 2 | F | S | → Units: Pressure a | Measuring pressure default value | | |
| A-11 | p at base cond. | 1398 | 2 | F | S | → Units: Pressure a | base pressure | | |
| A-12 | curr. inp. gradient | 1400 | 2 | F | S | | Gradient (correction of the mA value) | | |
| A-13 | curr. inp. offset | 1402 | 2 | F | S | | Offset (correction of the mA value) | | |
| A-14 | p err. min | 1404 | 2 | F | S | → Units: Pressure a | Lower error limit of measuring pressure | | |
| A-15 | p err. max | 1406 | 2 | F | S | → Units: Pressure a | Upper error limit of measuring pressure | | |
| A-17 | p mode | 4078 | 1 | M | S | | Operating mode of measuring pressure | | |
| | | | | | | | 0x0000 | OFF | (d) |
| | | | | | | | 0x0001 | SET VALUE | |
| | | | | | | | 0x0002 | 4-20mA | |
| | | | | | | | 0x0003 | 4-20mA_ERR | |

## Temperature

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| B-01 | temperature | 6256 | 2 | F | R | → Units: Temp. | PT100-input | | |
| B-03 | PT100 resistance | 6258 | 2 | F | R | Ohm | PT100-input | | |
| B-09 | T set value | 1408 | 2 | F | S | → Units: Temp. | PT100-input | | |
| B-11 | T at base cond. | 1410 | 2 | F | S | → Units: Temp. | base temperature | | |
| B-12 | T gradient | 1412 | 2 | F | S | | Gradient (correction of the Ohm value) | | |
| B-13 | T offset | 1414 | 2 | F | S | | Offset (correction of the Ohm value) | | |
| B-14 | T err. min | 1416 | 2 | F | S | → Units: Temp. | Lower error limit of measuring temperature | | |
| B-15 | T err. max | 1418 | 2 | F | S | → Units: Temp. | Upper error limit of measuring temperature | | |
| B-17 | T mode | 4079 | 1 | M | S | | Operating mode of measuring temperature | | |
| | | | | | | | 0x0000 | OFF | (d) |
| | | | | | | | 0x0001 | SET VALUE | |
| | | | | | | | 0x0002 | PT100 | |
| | | | | | | | 0x0003 | PT100_ERR | |

## USE09-C Meas. Val.

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| C-01 | vw | 6220 | 2 | F | R | → velocity unit | weighted gas velocity |
| C-02 | vwc | 6222 | 2 | F | R | → velocity unit | corrected weighted gas velocity |
| C-03 | Qm | 6224 | 2 | F | R | → flow unit | Intermediate result for Qm (with preceding sign) |
| C-04 | Qmb | 6238 | 2 | F | R | → flow unit | Intermediate result for Qmb (with preceding sign) |
| C-05 | Qmc | 6226 | 2 | F | R | → flow unit | Intermediate result for Qmc (with preceding sign) |
| C-06 | performance | 6268 | 1 | I | R | % | Performance |

## USE09-C Qm

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| D-01 | vol. Flow rate Qm | 730 | 10 | T | R | → flow unit | Volumetric flow rate Qm after all corrections (as amount) with upstream/downstream identification | | |
| D-02 | vol. flow rate Qm | 6230 | 2 | F | R | → flow unit | Volumetric flow rate Qm after all corrections (Qm lower limit will be observed) | | |
| D-03 | Qm damped | 6264 | 2 | F | R | → flow unit | Volumetric flow rate Qm damped (Qm lower limit will be observed) | | |
| D-04 | Qm min. | 1320 | 2 | F | S | → flow unit | Qm min. limit | | |
| D-05 | Qm max. | 1322 | 2 | F | S | → flow unit | Qm max. limit | | |
| D-06 | vw factor d1 | 1324 | 2 | F | S | [1] | Constant Kv direction 1 | | |
| D-07 | vw factor d2 | 1436 | 2 | F | S | [1] | Constant Kv direction 2 | | |
| D-08 | vw lower limit | 1326 | 2 | F | S | → Calib. units: v | vw lower limit (creeping quantity before apply. polynomial) | | |
| D-09 | Qm lower limit | 1328 | 2 | F | S | → flow unit | Qm lower limit (creeping quantity) | | |
| D-10 | Qm-min time | 2120 | 1 | I | S | s | Time below Qm min | | |
| D-15 | Qm damping | 1446 | 2 | F | C | | Damping for Qmc-D (0.0=off, 1.0=max) | | |
| D-16 | pipe diameter | 1334 | 2 | F | S | → Calib. units: Length | Pipe diameter | | |
| D-17 | geometry correcting | 2258 | 1 | M | S | | Correction of the effects of press. and temp. | | |
| | | | | | | | 0x0000 | OFF | (d) |
| | | | | | | | 0x0001 | ON | |
| D-18 | temp. coefficient | 1450 | 2 | F | S | | Temperature coefficient | | |
| D-19 | pressure coeff. | 1452 | 2 | F | S | | Pressure coefficient | | |
| D-20 | Qm-max value 1 | 1330 | 2 | F | C | → flow unit | Qm max. value of direction 1 | | |
| D-21 | Qm-max time 1 | 2580 | 2 | U | C | | Time of Qm max. value 1 | | |
| D-22 | Qm-max value 2 | 1332 | 2 | F | C | → flow unit | Qm max. value of direction 2 | | |
| D-23 | Qm-max time 2 | 2582 | 2 | U | C | | Time of Qm max. value 2 | | |
| D-24 | Qt | 9084 | 2 | F | R | | Transition flow Qt | | |

## Parameters

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| E-01 | USE09 working mode | 2090 | 1 | M | S | | USE09 operating mode | | |
| | | | | | | | 0x0000 | IGM | (d) |
| | | | | | | | 0x0001 | USE09C | |
| | | | | | | | 0x0002 | SIMU | |
| | | | | | | | 0x0003 | SIMU_K | |
| | | | | | | | 0x0004 | SIMU_N | |
| | | | | | | | 0x0005 | SIMU_EW | |
| E-02 | path select | 690 | 10 | T | S | | Select activated paths (path 1.1, path 1.2 … path 4.2) | | |
| E-03 | max. path RV | 2121 | 1 | I | S | | Maximum number of used replacement values | | |
| E-04 | fault time | 2122 | 1 | I | S | s | Time limit for IGM timeout | | |
| E-05 | error per cent | 2123 | 1 | I | S | % | A measurement quality below this level will cause a path error | | |
| E-09 | moving average cnt | 2125 | 1 | I | C | | Number of measured values for the moving average, V, SoS | | |
| E-15 | SoS mode | 2240 | 1 | M | C | | Speed of Sound mode | | |
| | | | | | | | 0x0000 | STANDARD | (d) |
| | | | | | | | 0x0001 | EXTENDED | |
| | | | | | | | 0x0002 | CALIBRATION | |
| | | | | | | | 0x0003 | STATISTIC OFF | |
| E-16 | delta SoS mode | 2091 | 1 | M | C | | Delta SoS observing ON / OFF | | |
| | | | | | | | 0x0000 | OFF | |
| | | | | | | | 0x0001 | ON | (d) |
| E-17 | delta SoS limit | 1344 | 2 | F | C | % | Limit for Delta SoS | | |
| E-18 | std. SoS corr-factor | 1370 | 2 | F | S | [1] | Standard SoS correction-factor | | |
| E-19 | adv. SoS corr-factor | 9068 | 2 | F | S | [1] | Advanced SoS correction-factor | | |
| E-20 | std. SoS v factor | 1372 | 2 | F | S | [1] | Standard SoS v correction-factor | | |
| E-21 | adv. SoS v factor | 9070 | 2 | F | S | [1] | Advanced SoS v correction-factor | | |
| E-22 | delta AGC limits | 1438 | 2 | F | C | dB | Max. deviation between path-AGC and AGC-mean | | |
| E-23 | Tw correct | 2281 | 1 | M | S | | Correct TWs | | |
| | | | | | | | 0x0000 | OFF | (d) |
| | | | | | | | 0x0001 | SET | |
| E-24 | Tw damping | 1518 | 2 | F | C | | Damping for TW adjustment | | |

## USE09-C polynom-G

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|

### Basic corr. and Reynolds correction

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| F-01 | Basic correction | 2092 | 1 | M | S | | First error polynomial mode | | |
| | | | | | | | 0x0000 | OFF | (V) |
| | | | | | | | 0x0001 | POLYNOMIAL | |
| | | | | | | | 0x0002 | POLYNO-MIAL(Re) | |
| F-02 | const-Gm2 R.1 | 1266 | 2 | F | S | [1] | First error polynomial for the direction 1 | | |
| F-03 | const-Gm1 R.1 | 1268 | 2 | F | S | [1] | First error polynomial for the direction 1 | | |
| F-04 | const-G0 R.1 | 1270 | 2 | F | S | [1] | First error polynomial for the direction 1 | | |
| F-05 | const-G1 R.1 | 1272 | 2 | F | S | [1] | First error polynomial for the direction 1 | | |
| F-06 | const-G2 R.1 | 1274 | 2 | F | S | [1] | First error polynomial for the direction 1 | | |
| F-10 | const-Gm2 R.2 | 1296 | 2 | F | S | [1] | First error polynomial for the direction 2 | | |
| F-11 | const-Gm1 R.2 | 1298 | 2 | F | S | [1] | First error polynomial for the direction 2 | | |
| F-12 | const-G0 R.2 | 1300 | 2 | F | S | [1] | First error polynomial for the direction 2 | | |
| F-13 | const-G1 R.2 | 1302 | 2 | F | S | [1] | First error polynomial for the direction 2 | | |
| F-14 | const-G2 R.2 | 1304 | 2 | F | S | [1] | First error polynomial for the direction 2 | | |
| F-21 | Standard density | 1560 | 2 | F | S | kg/m³ | Standard density | | |
| F-22 | Dyn. viscosity | 1562 | 2 | F | S | kg/ms | Dynamic viscosity | | |
| F-26 | Operating density | 1570 | 2 | F | R | kg/m³ | Operating density | | |
| F-27 | Reynolds number | 1572 | 2 | F | R | | Reynolds number | | |

### Flow correction

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| G-01 | error curve lin. | 2093 | 1 | M | S | | Error curve linearization mode | | |
| | | | | | | | 0x0000 | OFF | (d) |
| | | | | | | | 0x0001 | POLYNOMIAL | |
| | | | | | | | 0x0002 | piecewise lin. | |
| G-02 | const m2 d.1 | 1276 | 2 | F | S | [1] | Error polynomial for direction 1 | | |
| G-03 | const m1 d.1 | 1278 | 2 | F | S | [1] | Error polynomial for direction 1 | | |
| G-04 | const 0 d.1 | 1280 | 2 | F | S | [1] | Error polynomial for direction 1 | | |
| G-05 | const 1 d.1 | 1282 | 2 | F | S | [1] | Error polynomial for direction 1 | | |
| G-06 | const 2 d.1 | 1284 | 2 | F | S | [1] | Error polynomial for direction 1 | | |
| G-10 | const m2 d.2 | 1306 | 2 | F | S | [1] | Error polynomial for direction 2 | | |
| G-11 | const m1 d.2 | 1308 | 2 | F | S | [1] | Error polynomial for direction 2 | | |
| G-12 | const 0 d.2 | 1310 | 2 | F | S | [1] | Error polynomial for direction 2 | | |
| G-13 | const 1 d.2 | 1312 | 2 | F | S | [1] | Error polynomial for direction 2 | | |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| G-14 | const 2 d.2 | 1314 | 2 | F | S | [1] | Error polynomial for direction 2 |
| G-20 | dir. 1: flowrate 1 | 1600 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 1: flow rate 1 |
| G-21 | dir. 1: error 1 | 1602 | 2 | F | S | % | Linear interpolation direction 1: error 1 |
| G-22 | dir. 1: flowrate 2 | 1604 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 1: flow rate 2 |
| G-23 | dir. 1: error 2 | 1606 | 2 | F | S | % | Linear interpolation direction 1: error 2 |
| G-24 | dir. 1: flowrate 3 | 1608 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 1: flow rate 3 |
| G-25 | dir. 1: error 3 | 1610 | 2 | F | S | % | Linear interpolation direction 1: error 3 |
| G-26 | dir. 1: flowrate 4 | 1612 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 1: flow rate 4 |
| G-27 | dir. 1: error 4 | 1614 | 2 | F | S | % | Linear interpolation direction 1: error 4 |
| G-28 | dir. 1: flowrate 5 | 1616 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 1: flow rate 5 |
| G-29 | dir. 1: error 5 | 1618 | 2 | F | S | % | Linear interpolation direction 1: error 5 |
| G-30 | dir. 1: flowrate 6 | 1620 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 1: flow rate 6 |
| G-31 | dir. 1: error 6 | 1622 | 2 | F | S | % | Linear interpolation direction 1: error 6 |
| G-32 | dir. 1: flowrate 7 | 1624 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 1: flow rate 7 |
| G-33 | dir. 1: error 7 | 1626 | 2 | F | S | % | Linear interpolation direction 1: error 7 |
| G-34 | dir. 1: flowrate 8 | 1628 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 1: flow rate 8 |
| G-35 | dir. 1: error 8 | 1630 | 2 | F | S | % | Linear interpolation direction 1: error 8 |
| G-36 | dir. 1: flowrate 9 | 1632 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 1: flow rate 9 |
| G-37 | dir. 1: error 9 | 1634 | 2 | F | S | % | Linear interpolation direction 1: error 9 |
| G-38 | dir. 1: flowrate 10 | 1636 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 1: flow rate 10 |
| G-39 | dir. 1: error 10 | 1638 | 2 | F | S | % | Linear interpolation direction 1: error 10 |
| G-40 | dir. 1: flowrate 11 | 1640 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 1: flow rate 11 |
| G-41 | dir. 1: error 11 | 1642 | 2 | F | S | % | Linear interpolation direction 1: error 11 |
| G-42 | dir. 1: flowrate 12 | 1644 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 1: flow rate 12 |
| G-43 | dir. 1: error 12 | 1648 | 2 | F | S | % | Linear interpolation direction 1: error 12 |
| G-44 | dir. 2: flowrate 1 | 1650 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 2: flow rate 1 |
| G-45 | dir. 2: error 1 | 1652 | 2 | F | S | % | Linear interpolation direction 2: error 1 |
| G-46 | dir. 2: flowrate 2 | 1654 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 2: flow rate 2 |
| G-47 | dir. 2: error 2 | 1656 | 2 | F | S | % | Linear interpolation direction 2: error 2 |
| G-48 | dir. 2: flowrate 3 | 1658 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 2: flow rate 3 |
| G-49 | dir. 2: error 3 | 1660 | 2 | F | S | % | Linear interpolation direction 2: error 3 |
| G-50 | dir. 2: flowrate 4 | 1662 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 2: flow rate 4 |
| G-51 | dir. 2: error 4 | 1664 | 2 | F | S | % | Linear interpolation direction 2: error 4 |
| G-52 | dir. 2: flowrate 5 | 1666 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 2: flow rate 5 |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| G-53 | dir. 2: error 5 | 1668 | 2 | F | S | % | Linear interpolation direction 2: error 5 |
| G-54 | dir. 2: flowrate 6 | 1670 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 2: flow rate 6 |
| G-55 | dir. 2: error 6 | 1672 | 2 | F | S | % | Linear interpolation direction 2: error 6 |
| G-56 | dir. 2: flowrate 7 | 1674 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 2: flow rate 7 |
| G-57 | dir. 2: error 7 | 1676 | 2 | F | S | % | Linear interpolation direction 2: error 7 |
| G-58 | dir. 2: flowrate 8 | 1678 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 2: flow rate 8 |
| G-59 | dir. 2: error 8 | 1680 | 2 | F | S | % | Linear interpolation direction 2: error 8 |
| G-60 | dir. 2: flowrate 9 | 1682 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 2: flow rate 9 |
| G-61 | dir. 2: error 9 | 1684 | 2 | F | S | % | Linear interpolation direction 2: error 9 |
| G-62 | dir. 2: flowrate 10 | 1686 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 2: flow rate 10 |
| G-63 | dir. 2: error 10 | 1688 | 2 | F | S | % | Linear interpolation direction 2: error 10 |
| G-64 | dir. 2: flowrate 11 | 1690 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 2: flow rate 11 |
| G-65 | dir. 2: error 11 | 1692 | 2 | F | S | % | Linear interpolation direction 2: error 11 |
| G-66 | dir. 2: flowrate 12 | 1694 | 2 | F | S | → Calib. units: Q | Linear interpolation direction 2: flow rate 12 |
| G-67 | dir. 2: error 12 | 1698 | 2 | F | S | % | Linear interpolation direction 2: error 12 |

## Freq., Pulse Outputs

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| H-01 | fo base value | 6248 | 2 | F | R | → flow unit | Measured value of the frequency output | | |
| H-02 | frequency value | 6250 | 2 | F | R | Hz | Frequency value of the frequency output (in Hz) | | |
| H-03 | fo corr. factor | 1386 | 2 | F | S | | Correction factor of the frequency output | | |
| H-04 | corr. frequency | 6266 | 2 | F | R | Hz | Correction of the frequency value of the frequency output (in Hz) | | |
| H-05 | fo base max. | 1388 | 2 | F | S | → Calib. units: Q | Upper range value of the frequency output (physical value) | | |
| H-06 | fo freq. max. | 1444 | 2 | F | S | Hz | Maximum value of the frequency output (in Hz) | | |
| H-07 | pulse value | 6262 | 2 | F | R | → pulse unit | Indication of the calculated pulse value of the frequency output | | |
| H-08 | fo set value | 1390 | 2 | F | S | Hz | Calibration frequency | | |
| H-09 | fo select | 2161 | 1 | M | C | | Selection of the measured value for the frequency output | | |
| | | | | | | | 0x0000 | QMC | (d) |
| | | | | | | | 0x0001 | QMC-D | |
| H-10 | fo mode | 2162 | 1 | M | S | | Operating mode of the frequency output | | |
| | | | | | | | 0x0000 | OFF | |
| | | | | | | | 0x0001 | SET VALUE | |
| | | | | | | | 0x0002 | ON | (d) |
| | | | | | | | 0x0003 | TEST | |
| H-11 | fo2 error mode | 2163 | 1 | M | S | | Frequency-2 mode if a fault occurs | | |
| | | | | | | | 0x0000 | F2 STOP | (d) |
| | | | | | | | 0x0001 | F2 ACTIVE | |
| | | | | | | | 0x0002 | CRYSTAL TEST | |
| H-12 | ferr waveform gen. | 6260 | 2 | F | R | Hz | Frequency delta | | |
| H-15 | IO-1 mode | 2165 | 1 | M | C | | Mode for IO-1 | | |
| | | | | | | | 0x0000 | OFF | |
| | | | | | | | 0x0001 | DIRECTION | (d) |
| | | | | | | | 0x0002 | DIRECTION INV. | |
| | | | | | | | 0x0003 | INPUT | |
| | | | | | | | 0x0004 | TEST | |
| | | | | | | | 0x0005 | WARN-INPUT HIGH | |
| | | | | | | | 0x0006 | WARN-INPUT LOW | |
| H-16 | IO-2 mode 2166 | | 1 | M | C | | Mode for IO-2 | | |
| | | | | | | | 0x0000 | OFF | |
| | | | | | | | 0x0001 | DIRECTION | (d) |
| | | | | | | | 0x0002 | DIRECTION INV. | |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 0x0003 | INPUT | |
| | | | | | | | 0x0004 | TEST | |
| | | | | | | | 0x0005 | CPU | |
| H-17 | mode ext. warning | 2186 | 1 | M | C | | Mode in the case of external warning | | |
| | | | | | | | 0x0000 | OFF | (d) |
| | | | | | | | 0x0001 | LOW_POWER | |
| H-20 | Test Alarm a. Warn 4081 | | 1 | M | C | | Tests the warning and alarm contacts | | |
| | | | | | | | 0x0000 | OFF | (d) |
| | | | | | | | 0x0001 | TEST | |

## Current Output

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| I-01 | c-out physical val. | 6244 | 2 | F | R | | Current output, physical value | | |
| I-02 | c-out value | 6246 | 2 | F | R | mA | Current output in mA | | |
| I-03 | c-out min. | 1374 | 2 | F | C | | Current output, physical minimum value | | |
| I-04 | c-out max. | 1376 | 2 | F | C | | Current output, physical maximum value | | |
| I-05 | c-out set value | 1378 | 2 | F | C | mA | Current output, set value | | |
| I-06 | c-out select | 2158 | 1 | I | C | | Current output, selection of the measured value (Modbus reg.) | | |
| I-07 | c-out mode | 2159 | 1 | M | C | | Current output, operating mode | | |
| | | | | | | | 0x0000 | OFF | (d) |
| | | | | | | | 0x0001 | SET VALUE | |
| | | | | | | | 0x0002 | 0-20mA | |
| | | | | | | | 0x0003 | 4-20mA | |
| I-08 | c-out err mode | 2160 | 1 | M | C | | Current output, operating mode if a fault occurs | | |
| | | | | | | | 0x0000 | OFF | (d) |
| | | | | | | | 0x0001 | MIN | |
| | | | | | | | 0x0002 | MAX | |
| I-09 | c-out damping | 1380 | 2 | F | C | | Current output, damping (0.0=OFF, 1.0=max) | | |
| I-10 | c-out gradient | 1382 | 2 | F | S | | Current output, gradient | | |
| I-11 | c-out offset | 1384 | 2 | F | S | | Current output, offset | | |

## Serial Ports

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| J-12 | DZU-0 address | 2283 | 1 | I | F | | Serial interface -1 DZU slave ID (ASCII: 00-99) | | |
| J-13 | serial-0 status | 760 | 10 | T | R | | Serial interface -1 status | | |
| J-14 | serial-1 mode | 2107 | 1 | M | F | | Serial interface -1 mode | | |
| | | | | | | | 0x0000 | OFF | (d) |
| | | | | | | | 0x0001 | IGM | |
| | | | | | | | 0x0002 | USE09 | |
| | | | | | | | 0x0003 | DZU | |
| | | | | | | | 0x0004 | DZU-DIAG | |
| | | | | | | | 0x0005 | DZU X-FRAME | |
| | | | | | | | 0x0006 | VO | |
| | | | | | | | 0x0007 | DZU-SLAVE | |
| | | | | | | | 0x0008 | Modbus | |
| J-15 | serial-1 baud rate | 2108 | 1 | M | F | baud | Serial interface -1 baud rate | | |
| | | | | | | | 0x0000 | 2400 | |
| | | | | | | | 0x0001 | 4800 | |
| | | | | | | | 0x0002 | 9600 | |
| | | | | | | | 0x0003 | 19200 | (d) |
| | | | | | | | 0x0004 | 38400 | |
| | | | | | | | 0x0005 | 57600 | |
| J-16 | serial-1 bits | 2109 | 1 | M | F | | Serial interface -1 number of bits | | |
| | | | | | | | 0x0000 | 7 | |
| | | | | | | | 0x0001 | 8 | (d) |
| J-17 | serial-1 parity | 2110 | 1 | M | F | | Serial interface -1 parity | | |
| | | | | | | | 0x0000 | NONE | (d) |
| | | | | | | | 0x0001 | EVEN | |
| | | | | | | | 0x0002 | ODD | |
| J-23 | DZU-1 address | 2284 | 1 | I | F | | Serial interface -1 DZU slave ID (ASCII: 00-99) | | |
| J-24 | serial-1 status | 770 | 10 | T | R | | Serial interface -1 status | | |
| J-25 | opt. ser2 mode | 2112 | 1 | M | F | | Optional serial interface -2 mode | | |
| | | | | | | | 0x0000 | OFF | |
| | | | | | | | 0x0001 | Modbus | (d) |
| | | | | | | | 0x0002 | IGM | |
| | | | | | | | 0x0003 | USE09 | |
| | | | | | | | 0x0004 | DZU-SLAVE | |
| | | | | | | | 0x0005 | RMGBus | |
| | | | | | | | 0x0006 | Modbus mas-ter | |
| J-26 | opt. ser2 baud rate | 2113 | 1 | M | F | baud | Optional serial interface -2 baud rate | | |
| | | | | | | | 0x0000 | 2400 | |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 0x0001 | 4800 | |
| | | | | | | | 0x0002 | 9600 | |
| | | | | | | | 0x0003 | 19200 | |
| | | | | | | | 0x0004 | 38400 | (d) |
| | | | | | | | 0x0005 | 57600 | |
| J-27 | opt. ser2 bits | 2114 | 1 | M | F | | Optional serial interface -2 number of bits | | |
| | | | | | | | 0x0000 | 7 | |
| | | | | | | | 0x0001 | 8 | (d) |
| J-28 | opt. ser2 parity | 2115 | 1 | M | F | | Optional serial interface -2 parity | | |
| | | | | | | | 0x0000 | NONE | (d) |
| | | | | | | | 0x0001 | EVEN | |
| | | | | | | | 0x0002 | ODD | |
| J-29 | Modbus-2 protocol | 2178 | 1 | M | F | | Optional serial interface -2 Modbus operating mode (Off, Ascii or RTU) | | |
| | | | | | | | 0x0000 | OFF | |
| | | | | | | | 0x0001 | RTU | (d) |
| | | | | | | | 0x0002 | ASCII | |
| J-30 | Modbus-2 hw-mode | 2179 | 1 | M | F | | Optional serial interface -2 Modbus hardware (RS232 or RS485) | | |
| | | | | | | | 0x0000 | RS232 | |
| | | | | | | | 0x0001 | RS485 | (d) |
| J-31 | Modbus-2 address | 2180 | 1 | I | F | | Optional serial interface -2 Modbus address (ID) | | |
| J-32 | Modbus-2 reg.offset | 2181 | 1 | I | F | | Optional serial interface -2 Modbus register offset | | |
| J-33 | Modbus-2 gap time | 2182 | 1 | I | F | | Optional serial interface -2 Modbus turn-off time | | |
| J-34 | Long Byte Order | 2251 | 1 | M | F | | Ser-2 Modbus byte order with long: (1,0)(3,2) or (3,2)(1,0) | | |
| | | | | | | | 0x0000 | NORMAL | |
| | | | | | | | 0x0001 | SWAPPED | (d) |
| J-35 | Float Byte Order | 2252 | 1 | M | F | | Ser-2 Modbus byte order with float: (1,0)(3,2) or (3,2)(1,0) | | |
| | | | | | | | 0x0000 | NORMAL | |
| | | | | | | | 0x0001 | SWAPPED | (d) |
| J-36 | Double Byte Order | 2253 | 1 | M | F | | Ser-2 Modbus byte order with double: (1,0)(3,2)(5,4)(7,6) or (7,6)(5,4)(3,2)(1,0) | | |
| | | | | | | | 0x0000 | NORMAL | (d) |
| | | | | | | | 0x0001 | SWAPPED | |
| J-37 | DZU-2 address | 2285 | 1 | I | F | | Serial interface -2 DZU slave ID (ASCII: 00-99) | | |
| J-38 | serial-2 status | 780 | 10 | T | R | | Optional serial interface -2 status | | |
| J-39 | DZU Interval | 2111 | 1 | I | S | tics | Optional serial interface -2 DZU-interval | | |
| J-40 | DZU Checksum Preset | 2255 | 1 | M | F | | Serial interface -1, initial DZU checksum value | | |
| | | | | | | | 0x0000 | 0x00 | (d) |
| | | | | | | | 0x0001 | 0x7F | |

## DSP, FPGA values

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| K-20 | DSP status | 4004 | 1 | I | R | hex | DSP status (bit encoded) |
| K-21 | DSP error | 4003 | 1 | I | R | hex | DSP error (bit encoded) |
| K-22 | DSP bytes received | 7034 | 1 | I | R | | Counts the receive telegrams from DSP |
| K-23 | FPGA status | 4006 | 1 | I | R | hex | FPGA status (bit encoded) |
| K-24 | FPGA error | 4005 | 1 | I | R | hex | FPGA error (bit encoded) |

## Path 1 Meas. Values

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| L-01 | p1.1 time of flight | 6100 | 2 | F | R | us | Path 1.1 time of flight |
| L-02 | p1.2 time of flight | 6120 | 2 | F | R | us | Path 1.2 time of flight |
| L-03 | path-1 delta-t | 6140 | 2 | F | R | us | Path 1 time difference |
| L-04 | p1 delta-t corr. | 6540 | 2 | F | R | us | Path 1 corrected time difference |
| L-06 | Valid samples G1 | 7000 | 1 | I | R | % | Path 1 valid measuring values in % |
| L-07 | path-1 velocity | 6000 | 2 | F | R | → velocity unit | Path 1 path velocity |
| L-08 | velocity vc1 | 6200 | 2 | F | R | → velocity unit | Path 1 corrected path velocity vc |
| L-09 | SoS1 | 6020 | 2 | F | R | → velocity unit | Path 1 Speed of Sound |
| L-10 | path-1 delta SoS | 6080 | 2 | F | R | % | Path 1 Path-SoS / Mean-SoS |
| L-12 | path-1 fault | 4030 | 1 | I | R | hex | Path 1 path error |
| L-13 | path-1 status | 4040 | 1 | I | R | hex | Path 1 path status |
| L-14 | p1.1 Amplitude | 7010 | 1 | I | R | % | Path 1.1 amplitude in per cent |
| L-15 | p1.2 Amplitude | 7020 | 1 | I | R | % | Path 1.2 amplitude in per cent |
| L-16 | p1.1 AGC-level | 6040 | 2 | F | R | dB | Path 1.1 Automated Gain Control |
| L-17 | p1.2 AGC-level | 6060 | 2 | F | R | dB | Path 1.2 Automated Gain Control |
| L-18 | p1.1 snr | 6640 | 2 | F | R | dB | Path 1.1 signal-to-noise ratio |
| L-19 | p1.2 snr | 6660 | 2 | F | R | dB | Path 1.2 signal-to-noise ratio |
| L-20 | path-1 fault (X) | 2270 | 1 | I | R | hex | Path 1 path error (3X-measurement) |
| L-21 | p1.1 AGC-level (X) | 6680 | 2 | F | R | dB | Path 1.1 Automated Gain Control (3X-measurement) |
| L-22 | p1.2 AGC-level (X) | 6700 | 2 | F | R | dB | Path 1.2 Automated Gain Control (3X-measurement) |
| L-23 | p1.1 snr (X) | 6720 | 2 | F | R | dB | Path 1.1 signal-to-noise ratio (3X-measurement) |
| L-24 | p1.2 snr (X) | 6740 | 2 | F | R | dB | Path 1.2 signal-to-noise ratio (3X-measurement) |
| L-26 | path-1 turbulence | 6776 | 2 | F | R | % | Path 1 turbulence |

## Path 2 Meas. Values

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| M-01 | p2.1 time of flight | 6102 | 2 | F | R | us | Path 2.1 time of flight |
| M-02 | p2.2 time of flight | 6122 | 2 | F | R | us | Path 2.2 time of flight |
| M-03 | path-2 delta-t | 6142 | 2 | F | R | us | Path 2 time difference |
| M-04 | p2 delta-t corr. | 6542 | 2 | F | R | us | Path 2 corrected time difference |
| M-06 | Valid samples G2 | 7001 | 1 | I | R | % | Path 2 valid measuring values in % |
| M-07 | path-2 velocity | 6002 | 2 | F | R | → velocity unit | Path 2 path velocity |
| M-08 | velocity vc2 | 6202 | 2 | F | R | → velocity unit | Path 2 corrected path velocity vc |
| M-09 | SoS2 | 6022 | 2 | F | R | → velocity unit | Path 2 Speed of Sound |
| M-10 | path-2 delta SoS | 6082 | 2 | F | R | % | Path 2 Path-SoS / Mean-SoS |
| M-12 | path-2 fault | 4031 | 1 | I | R | hex | Path 2 path error |
| M-13 | path-2 status | 4041 | 1 | I | R | hex | Path 2 path status |
| M-14 | p2.1 Amplitude | 7011 | 1 | I | R | % | Path 2.1 amplitude in per cent |
| M-15 | p2.2 Amplitude | 7021 | 1 | I | R | % | Path 2.2 amplitude in per cent |
| M-16 | p2.1 AGC-level | 6042 | 2 | F | R | dB | Path 2.1 Automated Gain Control |
| M-17 | p2.2 AGC-level | 6062 | 2 | F | R | dB | Path 2.2 Automated Gain Control |
| M-18 | p2.1 snr | 6642 | 2 | F | R | dB | Path 2.1 signal-to-noise ratio |
| M-19 | p2.2 snr | 6662 | 2 | F | R | dB | Path 2.2 signal-to-noise ratio |
| M-20 | path-2 fault (X) | 2271 | 1 | I | R | hex | Path 2 path error (3X-measurement) |
| M-21 | p2.1 AGC-level (X) | 6682 | 2 | F | R | dB | Path 2.1 Automated Gain Control (3X-measurement) |
| M-22 | p2.2 AGC-level (X) | 6702 | 2 | F | R | dB | Path 2.2 Automated Gain Control (3X-measurement) |
| M-23 | p2.1 snr (X) | 6722 | 2 | F | R | dB | Path 2.1 signal-to-noise ratio (3X-measurement) |
| M-24 | p2.2 snr (X) | 6742 | 2 | F | R | dB | Path 2.2 signal-to-noise ratio (3X-measurement) |
| M-26 | path-2 turbulence | 6778 | 2 | F | R | % | Path 2 turbulence |

## Path 3 Meas. Values

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| N-01 | p3.1 time of flight | 6104 | 2 | F | R | us | Path 3.1 time of flight |
| N-02 | p3.2 time of flight | 6124 | 2 | F | R | us | Path 3.2 time of flight |
| N-03 | path-3 delta-t | 6144 | 2 | F | R | us | Path 3 time difference |
| N-04 | p3 delta-t corr. | 6544 | 2 | F | R | us | Path 3 corrected time difference |
| N-06 | Valid samples G3 | 7002 | 1 | I | R | % | Path 3 valid measuring values in % |
| N-07 | path-3 velocity | 6004 | 2 | F | R | → velocity unit | Path 3 path velocity |
| N-08 | velocity vc3 | 6204 | 2 | F | R | → velocity unit | Path 3 corrected path velocity vc |
| N-09 | SoS3 | 6024 | 2 | F | R | → velocity unit | Path 3 Speed of Sound |
| N-10 | path-3 delta SoS | 6084 | 2 | F | R | % | Path 3 Path-SoS / Mean-SoS |
| N-12 | path-3 fault | 4032 | 1 | I | R | hex | Path 3 path error |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| N-13 | path-3 status | 4042 | 1 | I | R | hex | Path 3 path status |
| N-14 | p3.1 Amplitude | 7012 | 1 | I | R | % | Path 3.1 amplitude in per cent |
| N-15 | p3.2 Amplitude | 7022 | 1 | I | R | % | Path 3.2 amplitude in per cent |
| N-16 | p3.1 AGC-level | 6044 | 2 | F | R | dB | Path 3.1 Automated Gain Control |
| N-17 | p3.2 AGC-level | 6064 | 2 | F | R | dB | Path 3.2 Automated Gain Control |
| N-18 | p3.1 snr | 6644 | 2 | F | R | dB | Path 3.1 signal-to-noise ratio |
| N-19 | p3.2 snr | 6664 | 2 | F | R | dB | Path 3.2 signal-to-noise ratio |
| N-20 | path-3 fault (X) | 2272 | 1 | I | R | hex | Path 3 path error (3X-measurement) |
| N-21 | p3.1 AGC-level (X) | 6684 | 2 | F | R | dB | Path 3.1 Automated Gain Control (3X-measurement) |
| N-22 | p3.2 AGC-level (X) | 6704 | 2 | F | R | dB | Path 3.2 Automated Gain Control (3X-measurement) |
| N-23 | p3.1 snr (X) | 6724 | 2 | F | R | dB | Path 3.1 signal-to-noise ratio (3X-measurement) |
| N-24 | p3.2 snr (X) | 6744 | 2 | F | R | dB | Path 3.2 signal-to-noise ratio (3X-measurement) |
| N-26 | path-3 turbulence | 6780 | 2 | F | R | % | Path 3 turbulence |

## Path 4 Meas. Values

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| O-01 | p4.1 time of flight | 6106 | 2 | F | R | us | Path 4.1 time of flight |
| O-02 | p4.2 time of flight | 6126 | 2 | F | R | us | Path 4.2 time of flight |
| O-03 | path-4 delta-t | 6146 | 2 | F | R | us | Path 4 time difference |
| O-04 | p4 delta-t corr. | 6546 | 2 | F | R | us | Path 4 corrected time difference |
| O-06 | Valid samples G4 | 7003 | 1 | I | R | % | Path 4 valid measuring values in % |
| O-07 | path-4 velocity | 6006 | 2 | F | R | → velocity unit | Path 4 path velocity |
| O-08 | velocity vc4 | 6206 | 2 | F | R | → velocity unit | Path 4 corrected path velocity vc |
| O-09 | SoS4 | 6026 | 2 | F | R | → velocity unit | Path 4 Speed of Sound |
| O-10 | path-4 delta SoS | 6086 | 2 | F | R | % | Path 4 Path-SoS / Mean-SoS |
| O-12 | path-4 fault | 4033 | 1 | I | R | hex | Path 4 path error |
| O-13 | path-4 status | 4043 | 1 | I | R | hex | Path 4 path status |
| O-14 | p4.1 Amplitude | 7013 | 1 | I | R | % | Path 4.1 amplitude in per cent |
| O-15 | p4.2 Amplitude | 7023 | 1 | I | R | % | Path 4.2 amplitude in per cent |
| O-16 | p4.1 AGC-level | 6046 | 2 | F | R | dB | Path 4.1 Automated Gain Control |
| O-17 | p4.2 AGC-level | 6066 | 2 | F | R | dB | Path 4.2 Automated Gain Control |
| O-18 | p4.1 snr | 6646 | 2 | F | R | dB | Path 4.1 signal-to-noise ratio |
| O-19 | p4.2 snr | 6666 | 2 | F | R | dB | Path 4.2 signal-to-noise ratio |
| O-20 | path-4 fault (X) | 2273 | 1 | I | R | hex | Path 4 path error (3X-measurement) |
| O-21 | p4.1 AGC-level (X) | 6686 | 2 | F | R | dB | Path 4.1 Automated Gain Control (3X-measurement) |
| O-22 | p4.2 AGC-level (X) | 6706 | 2 | F | R | dB | Path 4.2 Automated Gain Control (3X-measurement) |
| O-23 | p4.1 snr (X) | 6726 | 2 | F | R | dB | Path 4.1 signal-to-noise ratio (3X-measurement) |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| O-24 | p4.2 snr (X) | 6746 | 2 | F | R | dB | Path 4.2 signal-to-noise ratio (3X-measurement) |
| O-26 | path-4 turbulence | 6782 | 2 | F | R | % | Path 4 turbulence |



## Path 5 Meas. Values

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| P-01 | p5.1 time of flight | 6108 | 2 | F | R | us | Path 5.1 time of flight |
| P-02 | p5.2 time of flight | 6128 | 2 | F | R | us | Path 5.2 time of flight |
| P-03 | path-5 delta-t | 6148 | 2 | F | R | us | Path 5 time difference |
| P-04 | p5 delta-t corr. | 6548 | 2 | F | R | us | Path 5 corrected time difference |
| P-06 | Valid samples G5 | 7004 | 1 | I | R | % | Path 5 valid measuring values in % |
| P-07 | path-5 velocity | 6008 | 2 | F | R | → velocity unit | Path 5 path velocity |
| P-08 | velocity vc5 | 6208 | 2 | F | R | → velocity unit | Path 5 corrected path velocity vc |
| P-09 | SoS5 | 6028 | 2 | F | R | → velocity unit | Path 5 Speed of Sound |
| P-10 | path-5 delta SoS | 6088 | 2 | F | R | % | Path 5 Path-SoS / Mean-SoS |
| P-12 | path-5 fault | 4034 | 1 | I | R | hex | Path 5 path error |
| P-13 | path-5 status | 4044 | 1 | I | R | hex | Path 5 path status |
| P-14 | p5.1 Amplitude | 7014 | 1 | I | R | % | Path 5.1 amplitude in per cent |
| P-15 | p5.2 Amplitude | 7024 | 1 | I | R | % | Path 5.2 amplitude in per cent |
| P-16 | p5.1 AGC-level | 6048 | 2 | F | R | dB | Path 5.1 Automated Gain Control |
| P-17 | p5.2 AGC-level | 6068 | 2 | F | R | dB | Path 5.2 Automated Gain Control |
| P-18 | p5.1 snr | 6648 | 2 | F | R | dB | Path 5.1 signal-to-noise ratio |
| P-19 | p5.2 snr | 6668 | 2 | F | R | dB | Path 5.2 signal-to-noise ratio |
| P-20 | path-5 fault (X) | 2274 | 1 | I | R | hex | Path 5 path error (3X-measurement) |
| P-21 | p5.1 AGC-level (X) | 6688 | 2 | F | R | dB | Path 5.1 Automated Gain Control (3X-measurement) |
| P-22 | p5.2 AGC-level (X) | 6708 | 2 | F | R | dB | Path 5.2 Automated Gain Control (3X-measurement) |
| P-23 | p5.1 snr (X) | 6728 | 2 | F | R | dB | Path 5.1 signal-to-noise ratio (3X-measurement) |
| P-24 | p5.2 snr (X) | 6748 | 2 | F | R | dB | Path 5.2 signal-to-noise ratio (3X-measurement) |
| P-26 | path-5 turbulence | 6784 | 2 | F | R | % | Path 5 turbulence |

## Path 6 Meas. Values

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| Q-01 | p6.1 time of flight | 6110 | 2 | F | R | us | Path 6.1 time of flight |
| Q-02 | p6.2 time of flight | 6130 | 2 | F | R | us | Path 6.2 time of flight |
| Q-03 | path-6 delta-t | 6150 | 2 | F | R | us | Path 6 time difference |
| Q-04 | p6 delta-t corr. | 6550 | 2 | F | R | us | Path 6 corrected time difference |
| Q-06 | Valid samples G6 | 7005 | 1 | I | R | % | Path 6 valid measuring values in % |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| Q-07 | path-6 velocity | 6010 | 2 | F | R | → velocity unit | Path 6 path velocity |
| Q-08 | velocity vc6 | 6210 | 2 | F | R | → velocity unit | Path 6 corrected path velocity vc |
| Q-09 | SoS6 | 6030 | 2 | F | R | → velocity unit | Path 6 Speed of Sound |
| Q-10 | path-6 delta SoS | 6090 | 2 | F | R | % | Path 6 Path-SoS / Mean-SoS |
| Q-12 | path-6 fault | 4035 | 1 | I | R | hex | Path 6 path error |
| Q-13 | path-6 status | 4045 | 1 | I | R | hex | Path 6 path status |
| Q-14 | p6.1 Amplitude | 7015 | 1 | I | R | % | Path 6.1 amplitude in per cent |
| Q-15 | p6.2 Amplitude | 7025 | 1 | I | R | % | Path 6.2 amplitude in per cent |
| Q-16 | p6.1 AGC-level | 6050 | 2 | F | R | dB | Path 6.1 Automated Gain Control |
| Q-17 | p6.2 AGC-level | 6070 | 2 | F | R | dB | Path 6.2 Automated Gain Control |
| Q-18 | p6.1 snr | 6650 | 2 | F | R | dB | Path 6.1 signal-to-noise ratio |
| Q-19 | p6.2 snr | 6670 | 2 | F | R | dB | Path 6.2 signal-to-noise ratio |
| Q-20 | path-6 fault (X) | 2275 | 1 | I | R | hex | Path 6 path error (3X-measurement) |
| Q-21 | p6.1 AGC-level (X) | 6690 | 2 | F | R | dB | Path 6.1 Automated Gain Control (3X-measurement) |
| Q-22 | p6.2 AGC-level (X) | 6710 | 2 | F | R | dB | Path 6.2 Automated Gain Control (3X-measurement) |
| Q-23 | p6.1 snr (X) | 6730 | 2 | F | R | dB | Path 6.1 signal-to-noise ratio (3X-measurement) |
| Q-24 | p6.2 snr (X) | 6750 | 2 | F | R | dB | Path 6.2 signal-to-noise ratio (3X-measurement) |
| Q-26 | path-6 turbulence | 6786 | 2 | F | R | % | Path 6 turbulence |

## Path 7 Meas. Values

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| R-01 | p7.1 time of flight | 6112 | 2 | F | R | us | Path 7.1 time of flight |
| R-02 | p7.2 time of flight | 6132 | 2 | F | R | us | Path 7.2 time of flight |
| R-03 | path-7 delta-t | 6152 | 2 | F | R | us | Path 7 time difference |
| R-04 | p7 delta-t corr. | 6552 | 2 | F | R | us | Path 7 corrected time difference |
| R-06 | Valid samples G7 | 7006 | 1 | I | R | % | Path 7 valid measuring values in % |
| R-07 | path-7 velocity | 6012 | 2 | F | R | → velocity unit | Path 7 path velocity |
| R-08 | velocity vc7 | 6212 | 2 | F | R | → velocity unit | Path 7 corrected path velocity vc |
| R-09 | SoS7 | 6032 | 2 | F | R | → velocity unit | Path 7 Speed of Sound |
| R-10 | path-7 delta SoS | 6092 | 2 | F | R | % | Path 7 Path-SoS / Mean-SoS |
| R-12 | path-7 fault | 4036 | 1 | I | R | hex | Path 7 path error |
| R-13 | path-7 status | 4046 | 1 | I | R | hex | Path 7 path status |
| R-14 | p7.1 Amplitude | 7016 | 1 | I | R | % | Path 7.1 amplitude in per cent |
| R-15 | p7.2 Amplitude | 7026 | 1 | I | R | % | Path 7.2 amplitude in per cent |
| R-16 | p7.1 AGC-level | 6052 | 2 | F | R | dB | Path 7.1 Automated Gain Control |
| R-17 | p7.2 AGC-level | 6072 | 2 | F | R | dB | Path 7.2 Automated Gain Control |
| R-18 | p7.1 snr | 6652 | 2 | F | R | dB | Path 7.1 signal-to-noise ratio |
| R-19 | p7.2 snr | 6672 | 2 | F | R | dB | Path 7.2 signal-to-noise ratio |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| R-20 | path-7 fault (X) | 2276 | 1 | I | R | hex | Path 7 path error (3X-measurement) |
| R-21 | p7.1 AGC-level (X) | 6692 | 2 | F | R | dB | Path 7.1 Automated Gain Control (3X-measurement) |
| R-22 | p7.2 AGC-level (X) | 6712 | 2 | F | R | dB | Path 7.2 Automated Gain Control (3X-measurement) |
| R-23 | p7.1 snr (X) | 6732 | 2 | F | R | dB | Path 7.1 signal-to-noise ratio (3X-measurement) |
| R-24 | p7.2 snr (X) | 6752 | 2 | F | R | dB | Path 7.2 signal-to-noise ratio (3X-measurement) |
| R-26 | path-7 turbulence | 6788 | 2 | F | R | % | Path 7 turbulence |

## Path 8 Meas. Values

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| S-01 | p8.1 time of flight | 6114 | 2 | F | R | us | Path 8.1 time of flight |
| S-02 | p8.2 time of flight | 6134 | 2 | F | R | us | Path 8.2 time of flight |
| S-03 | path-8 delta-t | 6154 | 2 | F | R | us | Path 8 time difference |
| S-04 | p8 delta-t corr. | 6554 | 2 | F | R | us | Path 8 corrected time difference |
| S-06 | Valid samples G8 | 7007 | 1 | I | R | % | Path 8 valid measuring values in % |
| S-07 | path-8 velocity | 6014 | 2 | F | R | → velocity unit | Path 8 path velocity |
| S-08 | velocity vc8 | 6214 | 2 | F | R | → velocity unit | Path 8 corrected path velocity vc |
| S-09 | SoS8 | 6034 | 2 | F | R | → velocity unit | Path 8 Speed of Sound |
| S-10 | path-8 delta SoS | 6094 | 2 | F | R | % | Path 8 Path-SoS / Mean-SoS |
| S-12 | path-8 fault | 4037 | 1 | I | R | hex | Path 8 path error |
| S-13 | path-8 status | 4047 | 1 | I | R | hex | Path 8 path status |
| S-14 | p8.1 Amplitude | 7017 | 1 | I | R | % | Path 8.1 amplitude in per cent |
| S-15 | p8.2 Amplitude | 7027 | 1 | I | R | % | Path 8.2 amplitude in per cent |
| S-16 | p8.1 AGC-level | 6054 | 2 | F | R | dB | Path 8.1 Automated Gain Control |
| S-17 | p8.2 AGC-level | 6074 | 2 | F | R | dB | Path 8.2 Automated Gain Control |
| S-18 | p8.1 snr | 6654 | 2 | F | R | dB | Path 8.1 signal-to-noise ratio |
| S-19 | p8.2 snr | 6674 | 2 | F | R | dB | Path 8.2 signal-to-noise ratio |
| S-20 | path-8 fault (X) | 2277 | 1 | I | R | hex | Path 8 path error (3X-measurement) |
| S-21 | p8.1 AGC-level (X) | 6694 | 2 | F | R | dB | Path 8.1 Automated Gain Control (3X-measurement) |
| S-22 | p8.2 AGC-level (X) | 6714 | 2 | F | R | dB | Path 8.2 Automated Gain Control (3X-measurement) |
| S-23 | p8.1 snr (X) | 6734 | 2 | F | R | dB | Path 8.1 signal-to-noise ratio (3X-measurement) |
| S-24 | p8.2 snr (X) | 6754 | 2 | F | R | dB | Path 8.2 signal-to-noise ratio (3X-measurement) |
| S-26 | path-8 turbulence | 6790 | 2 | F | R | % | Path 8 turbulence |

## Path 1 Sig. Analysis

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| T-01 | p1.1 tw offset | 6600 | 2 | F | R | us | Path 1.1 corrected delay time |
| T-02 | p1.2 tw offset | 6620 | 2 | F | R | us | Path 1.2 corrected delay time |
| T-03 | p1 Tw damped | 6830 | 2 | F | R | us | Path 1 delay time TwD |

## Path 2 Sig. Analysis

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| U-01 | p2.1 tw offset | 6602 | 2 | F | R | us | Path 2.1 corrected delay time |
| U-02 | p2.2 tw offset | 6622 | 2 | F | R | us | Path 2.2 corrected delay time |
| U-03 | p2 Tw damped | 6832 | 2 | F | R | us | Path 2 delay time TwD |

## Path 3 Sig. Analysis

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| V-01 | p3.1 tw offset | 6604 | 2 | F | R | us | Path 3.1 corrected delay time |
| V-02 | p3.2 tw offset | 6624 | 2 | F | R | us | Path 3.2 corrected delay time |
| V-03 | p3 Tw damped | 6834 | 2 | F | R | us | Path 3 delay time TwD |

## Path 4 Sig. Analysis

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| W-01 | p4.1 tw offset | 6606 | 2 | F | R | us | Path 4.1 corrected delay time |
| W-02 | p4.2 tw offset | 6626 | 2 | F | R | us | Path 4.2 corrected delay time |
| W-03 | p4 Tw damped | 6836 | 2 | F | R | us | Path 4 delay time TwD |

## Path 5 Sig. Analysis

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| X-01 | p5.1 tw offset | 6608 | 2 | F | R | us | Path 5.1 corrected delay time |
| X-02 | p5.2 tw offset | 6628 | 2 | F | R | us | Path 5.2 corrected delay time |
| X-03 | p5 Tw damped | 6838 | 2 | F | R | us | Path 5 delay time TwD |

## Path 6 Sig. Analysis

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| Y-01 | p6.1 tw offset | 6610 | 2 | F | R | us | Path 6.1 corrected delay time |
| Y-02 | p6.2 tw offset | 6630 | 2 | F | R | us | Path 6.2 corrected delay time |
| Y-03 | p6 Tw damped | 6840 | 2 | F | R | us | Path 6 delay time TwD |

## Path 7 Sig. Analysis

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| Z-01 | p7.1 tw offset | 6612 | 2 | F | R | us | Path 7.1 corrected delay time |
| Z-02 | p7.2 tw offset | 6632 | 2 | F | R | us | Path 7.2 corrected delay time |
| Z-03 | p7 Tw damped | 6842 | 2 | F | R | us | Path 7 delay time TwD |

## Path 8 Sig. Analysis

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AA-01 | p8.1 tw offset | 6614 | 2 | F | R | us | Path 8.1 corrected delay time |
| AA-02 | p8.2 tw offset | 6634 | 2 | F | R | us | Path 8.2 corrected delay time |
| AA-03 | p8 Tw damped | 6844 | 2 | F | R | us | Path 8 delay time TwD |

## USE09 meas. val.

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AB-01 | SoS average | 6228 | 2 | F | R | → velocity unit | Average Speed of Sound over all paths |
| AB-02 | p.1 AGC average | 6056 | 2 | F | R | dB | Path x.1 average AGC over all paths |
| AB-03 | p.2 AGC average | 6076 | 2 | F | R | dB | Path x.2 average AGC over all paths |

## USE09 Diagnosis

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AC-01 | Vz plane-1 | 6560 | 2 | F | R | → velocity unit | Velocity Vz of plane 1 |
| AC-02 | Vz plane-2 | 6562 | 2 | F | R | → velocity unit | Velocity Vz of plane 2 |
| AC-03 | Vz plane-3 | 6564 | 2 | F | R | → velocity unit | Velocity Vz of plane 3 |
| AC-04 | Vz plane-4 | 6566 | 2 | F | R | → velocity unit | Velocity Vz of plane 4 |
| AC-05 | Vx plane-1 | 6568 | 2 | F | R | → velocity unit | Velocity Vx of plane 1 |
| AC-06 | Vx plane-2 | 6570 | 2 | F | R | → velocity unit | Velocity Vx of plane 2 |
| AC-07 | Vx plane-3 | 6572 | 2 | F | R | → velocity unit | Velocity Vx of plane 3 |
| AC-08 | Vx plane-4 | 6574 | 2 | F | R | → velocity unit | Velocity Vx of plane 4 |
| AC-09 | Ve plane-1 | 6576 | 2 | F | R | → velocity unit | Velocity V of plane 1 |
| AC-10 | Ve plane-2 | 6578 | 2 | F | R | → velocity unit | Velocity V of plane 2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| AC-11 | Ve plane-3 | 6580 | 2 | F | R | → velocity unit | Velocity V of plane 3 |
| AC-12 | Ve plane-4 | 6582 | 2 | F | R | → velocity unit | Velocity V of plane 4 |
| AC-15 | Swirl Angle Plane-1 | 6584 | 2 | F | R | ° | Swirl angle of plane 1 |
| AC-16 | Swirl Angle Plane-2 | 6586 | 2 | F | R | ° | Swirl angle of plane 2 |
| AC-17 | Swirl Angle Plane-3 | 6588 | 2 | F | R | ° | Swirl angle of plane 3 |
| AC-18 | Swirl Angle Plane-4 | 6590 | 2 | F | R | ° | Swirl angle of plane 4 |
| AC-20 | Profile PFY1 | 6800 | 2 | F | R | | Profile factor PFY1 |
| AC-21 | Profile PFY2 | 6802 | 2 | F | R | | Profile factor PFY2 |
| AC-22 | Profile PFY | 6804 | 2 | F | R | | Profile factor PFY |
| AC-23 | Profile PFY31 | 6806 | 2 | F | R | | Profile factor PFY31 |
| AC-24 | Profile PFY35 | 6808 | 2 | F | R | | Profile factor PFY35 |
| AC-25 | Profile PFY42 | 6810 | 2 | F | R | | Profile factor PFY42 |
| AC-26 | Profile PFY46 | 6812 | 2 | F | R | | Profile factor PFY46 |
| AC-27 | Profile PFX | 6814 | 2 | F | R | | Profile factor PFX |
| AC-28 | Profile PFX12 | 6816 | 2 | F | R | | Profile factor PFX12 |
| AC-29 | Profile PFX56 | 6818 | 2 | F | R | | Profile factor PFX56 |
| AC-30 | Profile Factor | 6820 | 2 | F | R | | Diagnosis: Profile factor |
| AC-31 | Symmetry X | 6822 | 2 | F | R | | Symmetry X |
| AC-32 | Symmetry Y | 6824 | 2 | F | R | | Symmetry Y |
| AC-33 | Symmetry | 6826 | 2 | F | R | | Symmetry |

## Time and Date

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AD-01 | time | 2560 | 2 | U | F | | date and time |

## USE09-C Totalizers

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AE-01 | Tot. Volume d.1 | 3000 | 4 | D | CS | → volume unit | Actual volume counter for direction 1 |
| AE-02 | Tot. Volume d.2 | 3004 | 4 | D | CS | → volume unit | Actual volume counter for direction 2 |
| AE-04 | Tot. VolumeErr d.1 | 3008 | 4 | D | CS | → volume unit | Actual disturbed volume counter for direction 1 |
| AE-05 | Tot. VolumeErr d.2 | 3012 | 4 | D | CS | → volume unit | Actual disturbed volume counter for direction 2 |
| AE-07 | Tot. VolumeSum d.1 | 3016 | 4 | D | CS | → volume unit | Actual summarized volume counter for direction 1 |
| AE-08 | Tot. VolumeSum d.2 | 3020 | 4 | D | CS | → volume unit | Actual summarized volume counter for direction 2 |
| AE-09 | Total Volume | 3024 | 4 | D | CS | → volume unit | Total volume totalizer for volume at measurement conditions, both directions |
| AE-10 | tot. Error-mode | 2096 | 1 | M | S | | Error mode of Vm and test totalizers |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 0x0000 | STOP | (d) |
| | | | | | | | 0x0001 | RUN | |
| AE-11 | Total Volume mode | 2098 | 1 | M | S | | Mode of the total volume totalizer (VO) | | |
| | | | | | | | 0x0000 | D1 - D2 | (d) |
| | | | | | | | 0x0001 | DIRECTION_1 | |
| | | | | | | | 0x0002 | DIRECTION_2 | |
| AE-20 | test-tot. mode | 2097 | 1 | M | F | | Start/stop of the Vm test totalizers | | |
| | | | | | | | 0x0000 | STOP | (d) |
| | | | | | | | 0x0001 | RUN | |
| AE-21 | Vm-dir.1 test sum | 3040 | 4 | D | R | → volume unit | Actual volume test-counter for direction 1 | | |
| AE-22 | Vm-dir.2 test sum | 3044 | 4 | D | R | → volume unit | Actual volume test-counter for direction 2 | | |
| AE-23 | time for test sum | 6242 | 2 | F | R | s | Duration of on-the-fly calibration | | |
| AE-30 | Unit LF-Volumes | 2217 | 1 | M | F | | Unit (factor) for totalizers of type LONG | | |
| | | | | | | | 0x0000 | x 1 | (d) |
| | | | | | | | 0x0001 | x 0.1 | |
| | | | | | | | 0x0002 | x 0.01 | |
| AE-31 | L: Tot. Volume d.1 | 2600 | 2 | L | R | → Unit LF-Volumes | Copy of Vm totalizer, direction 1 (with factor in Long format) | | |
| AE-32 | L: Tot. Volume d.2 | 2602 | 2 | L | R | → Unit LF-Volumes | Copy of Vm totalizer, direction 2 (with factor in Long format) | | |
| AE-34 | L: Tot. Vol.Err d.1 | 2604 | 2 | L | R | → Unit LF-Volumes | Copy of disturbing Vm totalizer, direction 1 (with factor in Long format) | | |
| AE-35 | L: Tot. Vol.Err d.2 | 2606 | 2 | L | R | → Unit LF-Volumes | Copy of disturbing Vm totalizer, direction 2 (with factor in Long format) | | |
| AE-37 | L: Tot. Vol.Sum d.1 | 2608 | 2 | L | R | → Unit LF-Volumes | Copy of total volume totalizer (Vm+VmD), direction 1 (with factor in Long format) | | |
| AE-38 | L: Tot. Vol.Sum d.2 | 2610 | 2 | L | R | → Unit LF-Volumes | Copy of total volume totalizer (Vm+VmD), direction 2 (with factor in Long format) | | |
| AE-39 | L: Total Volume | 2612 | 2 | L | R | → Unit LF-Volumes | Copy of Vm total volume totalizer (with factor in Long format) | | |

## ID

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AF-01 | electronic type | 500 | 10 | T | S | | ID: Device type | | |
| AF-02 | electronic no | 2564 | 2 | L | S | | ID: Device No. | | |
| AF-03 | unit type | 510 | 10 | T | S | | ID: Type of measuring element | | |
| AF-04 | unit no | 2562 | 2 | L | S | | ID: Measuring element No. | | |
| AF-05 | manufacturer | 2151 | 1 | M | S | | ID: Manufacturer of the USE09 | | |
| | | | | | | | 0x0000 | RMG | (d) |
| AF-06 | model (year) | 2152 | 1 | I | S | | ID: Year of construction of the USE09 (DZU interface) | | |
| AF-07 | meter size | 520 | 10 | T | S | | ID: Meter size | | |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AF-08 | nominal diameter DN | 2210 | 1 | I | S | → Calib. units: Length | ID: Nominal diameter DN | | |
| AF-09 | pressure rating | 740 | 10 | T | S | | ID: Pressure rating | | |
| AF-10 | pipe flange type | 2211 | 1 | M | S | | ID: Flange standard | | |
| | | | | | | | 0x0000 | PN | (d) |
| | | | | | | | 0x0001 | ANSI | |
| AF-11 | pipe flange value | 2212 | 1 | I | S | | ID: Flange value | | |
| AF-12 | Qmin | 1346 | 2 | F | S | → flow unit | ID: q-min | | |
| AF-13 | Qmax | 1348 | 2 | F | S | → flow unit | ID: q-max | | |
| AF-14 | pmin | 1350 | 2 | F | S | → Units: Pressure g | ID: Calibration pressure min | | |
| AF-15 | pmax | 1352 | 2 | F | S | → Units: Pressure g | ID: Calibration pressure max | | |
| AF-16 | meas.press. min | 1520 | 2 | F | S | → Units: Pressure a | ID: Measuring pressure min | | |
| AF-17 | meas.press. max | 1522 | 2 | F | S | → Units: Pressure a | ID: Measuring pressure max | | |
| AF-18 | Tmin | 1354 | 2 | F | S | → Units: Temp. | ID: T-min | | |
| AF-21 | Tmax | 1356 | 2 | F | S | → Units: Temp. | ID: T-max | | |
| AF-23 | gas type | 2154 | 1 | M | S | | ID: Gas type | | |
| | | | | | | | 0x0000 | NATURAL GAS | (d) |
| AF-24 | p type | 2155 | 1 | M | S | | ID: P-type | | |
| | | | | | | | 0x0000 | 3051CA | (d) |
| | | | | | | | 0x0001 | G1151Ap | |
| | | | | | | | 0x0002 | G1151 | |
| | | | | | | | 0x0003 | 2088A | |
| AF-25 | p no. | 2566 | 2 | L | S | | ID: P-No. | | |
| AF-26 | T type | 2156 | 1 | M | S | | ID: T-type | | |
| | | | | | | | 0x0000 | AGG-EX | (d) |
| | | | | | | | 0x0001 | Q-4407 | |
| | | | | | | | 0x0002 | PT100 | |
| | | | | | | | 0x0003 | F-56 | |
| | | | | | | | 0x0004 | F-57 | |
| AF-27 | T no | 2568 | 2 | L | S | | ID: T-No. | | |
| AF-28 | Transducer type | 9072 | 10 | T | S | | ID: Transducer type | | |
| AF-29 | Transducer 1.1 no. | 530 | 10 | T | S | | ID: transducer 1/1 No. | | |
| AF-30 | Transducer 1.1 len. | 1524 | 2 | F | S | → Calib. units: Length | ID: transducer 1/1 length | | |
| AF-31 | Transducer 1.1 built | 2291 | 1 | I | S | | ID: transducer 1/1 year of manufacture | | |
| AF-32 | Transducer 1.2 no. | 540 | 10 | T | S | | ID: transducer 1/2 No. | | |
| AF-33 | Transducer 1.2 len. | 1526 | 2 | F | S | → Calib. units: Length | ID: transducer 1/2 length | | |
| AF-34 | Transducer 1.2 built | 2292 | 1 | I | S | | ID: transducer 1/2 year of manufacture | | |
| AF-35 | Transducer 2.1 no. | 550 | 10 | T | S | | ID: transducer 2/1 No. | | |
| AF-36 | Transducer 2.1 len. | 1528 | 2 | F | S | → Calib. units: Length | ID: transducer 2/1 length | | |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AF-37 | Transducer 2.1 built | 2293 | 1 | I | S | | ID: transducer 2/1 year of manufacture |
| AF-38 | Transducer 2.2 no. | 560 | 10 | T | S | | ID: transducer 2/2 No. |
| AF-39 | Transducer 2.2 len. | 1530 | 2 | F | S | → Calib. units: Length | ID: transducer 2/2 length |
| AF-40 | Transducer 2.2 built | 2294 | 1 | I | S | | ID: transducer 2/2 year of manufacture |
| AF-41 | Transducer 3.1 no. | 570 | 10 | T | S | | ID: transducer 3/1 No. |
| AF-42 | Transducer 3.1 len. | 1532 | 2 | F | S | → Calib. units: Length | ID: transducer 3/1 length |
| AF-43 | Transducer 3.1 built | 2295 | 1 | I | S | | ID: transducer 3/1 year of manufacture |
| AF-44 | Transducer 3.2 no. | 580 | 10 | T | S | | ID: transducer 3/2 No. |
| AF-45 | Transducer 3.2 len. | 1534 | 2 | F | S | → Calib. units: Length | ID: transducer 3/2 length |
| AF-46 | Transducer 3.2 built | 2296 | 1 | I | S | | ID: transducer 3/2 year of manufacture |
| AF-47 | Transducer 4.1 no. | 590 | 10 | T | S | | ID: transducer 4/1 No. |
| AF-48 | Transducer 4.1 len. | 1536 | 2 | F | S | → Calib. units: Length | ID: transducer 4/1 length |
| AF-49 | Transducer 4.1 built | 2297 | 1 | I | S | | ID: transducer 4/1 year of manufacture |
| AF-50 | Transducer 4.2 no. | 600 | 10 | T | S | | ID: transducer 4/2 No. |
| AF-51 | Transducer 4.2 len. | 1538 | 2 | F | S | → Calib. units: Length | ID: transducer 4/2 length |
| AF-52 | Transducer 4.2 built | 2298 | 1 | I | S | | ID: transducer 4/2 year of manufacture |
| AF-53 | Transducer 5.1 no. | 610 | 10 | T | S | | ID: transducer 5/1 No. |
| AF-54 | Transducer 5.1 len. | 1540 | 2 | F | S | → Calib. units: Length | ID: transducer 5/1 length |
| AF-55 | Transducer 5.1 built | 2299 | 1 | I | S | | ID: transducer 5/1 year of manufacture |
| AF-56 | Transducer 5.2 no. | 620 | 10 | T | S | | ID: transducer 5/2 No. |
| AF-57 | Transducer 5.2 len. | 1542 | 2 | F | S | → Calib. units: Length | ID: transducer 5/2 length |
| AF-58 | Transducer 5.2 built | 2300 | 1 | I | S | | ID: transducer 5/2 year of manufacture |
| AF-59 | Transducer 6.1 no. | 630 | 10 | T | S | | ID: transducer 6/1 No. |
| AF-60 | Transducer 6.1 len. | 1544 | 2 | F | S | → Calib. units: Length | ID: transducer 6/1 length |
| AF-61 | Transducer 6.1 built | 2301 | 1 | I | S | | ID: transducer 6/1 year of manufacture |
| AF-62 | Transducer 6.2 no. | 640 | 10 | T | S | | ID: transducer 6/2 No. |
| AF-63 | Transducer 6.2 len. | 1546 | 2 | F | S | → Calib. units: Length | ID: transducer 6/2 length |
| AF-64 | Transducer 6.2 built | 2302 | 1 | I | S | | ID: transducer 6/2 year of manufacture |
| AF-65 | Transducer 7.1 no. | 650 | 10 | T | S | | ID: transducer 7/1 No. |
| AF-66 | Transducer 7.1 len. | 1548 | 2 | F | S | → Calib. units: Length | ID: transducer 7/1 length |
| AF-67 | Transducer 7.1 built | 2303 | 1 | I | S | | ID: transducer 7/1 year of manufacture |
| AF-68 | Transducer 7.2 no. | 660 | 10 | T | S | | ID: transducer 7/2 No. |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AF-69 | Transducer 7.2 len. | 1550 | 2 | F | S | → Calib. units: Length | ID: transducer 7/2 length |
| AF-70 | Transducer 7.2 built | 2304 | 1 | I | S | | ID: transducer 7/2 year of manufacture |
| AF-71 | Transducer 8.1 no. | 670 | 10 | T | S | | ID: transducer 8/1 No. |
| AF-72 | Transducer 8.1 len. | 1552 | 2 | F | S | → Calib. units: Length | ID: transducer 8/1 length |
| AF-73 | Transducer 8.1 built | 2305 | 1 | I | S | | ID: transducer 8/1 year of manufacture |
| AF-74 | Transducer 8.2 no. | 680 | 10 | T | S | | ID: transducer 8/2 No. |
| AF-75 | Transducer 8.2 len. | 1554 | 2 | F | S | → Calib. units: Length | ID: transducer 8/2 length |
| AF-76 | Transducer 8.2 built | 2306 | 1 | I | S | | ID: transducer 8/2 year of manufacture |
| AF-77 | serial number USE09 | 790 | 10 | T | S | | ID: serial number USE09 |
| AF-78 | version | 100 | 2 | F | R | | ID: M32C software version |
| AF-79 | CPU CRC | 201 | 1 | I | R | hex | ID: M32C CRC-16 |
| AF-80 | Matrix version | 200 | 1 | I | R | | ID: M32C Matrix version |
| AF-81 | DSP version | 102 | 2 | F | R | | ID: DSP software version |
| AF-82 | DSP CRC | 202 | 1 | I | R | hex | ID: DSP CRC-16 |
| AF-83 | FPGA version | 104 | 2 | F | R | | ID: FPGA software version |
| AF-84 | FPGA CRC | 203 | 1 | I | R | hex | ID: FPGA CRC-16 |
| AF-85 | fiscal par. CRC | 204 | 1 | I | R | hex | ID: fiscally parameters crc-16 |
| AF-86 | piecewise lin. CRC | 205 | 1 | I | R | hex | ID: piecewise linearization parameters crc-16 |

## Mode

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AG-04 | codeword | 750 | 10 | C | F | | Entry of codeword | | |
| AG-26 | test working mode | 2185 | 1 | M | S | | Test mode for debugging the DSP | | |
| | | | | | | | 0x0000 | OFF | (d) |
| | | | | | | | 0x0001 | DEBUG | |
| | | | | | | | 0x0002 | WD | |
| AG-27 | Display, LED test | 65535 | 10 | T | R | | Display test, bottom | | |
| AG-28 | Test LEDs | 4080 | 1 | M | C | | Tests the LEDs on the front panel | | |
| | | | | | | | 0x0000 | OFF | (d) |
| | | | | | | | 0x0001 | TEST | |
| AG-30 | language | 2094 | 1 | M | C | | Selection of language | | |
| | | | | | | | 0x0000 | GERMAN | (d) |
| | | | | | | | 0x0001 | ENGLISH | |
| AG-31 | units | 2095 | 1 | M | CS | | Selection of units | | |
| | | | | | | | 0x0000 | METRICAL-UNITS | (d) |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 0x0001 | IMPERIAL-UNITS | |
| AG-32 | velocity unit | 7030 | 1 | M | R | | Unit: Velocities | | |
| | | | | | | | 0x0000 | m/s | |
| | | | | | | | 0x0001 | ft/s | |
| AG-33 | flow unit | 7031 | 1 | M | R | | Unit: Flow rate | | |
| | | | | | | | 0x0000 | m3/h | |
| | | | | | | | 0x0001 | acfh | |
| AG-34 | volume unit | 7032 | 1 | M | R | | Unit: Totalizers | | |
| | | | | | | | 0x0000 | m3 | |
| | | | | | | | 0x0001 | acf | |
| AG-35 | pulse unit | 7033 | 1 | M | R | | Unit: Pulse value | | |
| | | | | | | | 0x0000 | Imp/m3 | |
| | | | | | | | 0x0001 | Imp/cf | |
| AG-36 | Units: Temp. | 7035 | 1 | M | S | | Unit: temperature | | |
| | | | | | | | 0x0000 | °C | (d) |
| | | | | | | | 0x0001 | °F | |
| | | | | | | | 0x0002 | K | |
| | | | | | | | 0x0003 | °Ra | |
| AG-37 | Units: Pressure | 7036 | 1 | M | S | | Unit: pressure | | |
| | | | | | | | 0x0000 | bar | (d) |
| | | | | | | | 0x0001 | psi | |
| AG-38 | Units: Pressure a | 7037 | 1 | M | R | | Unit: absolute pressure | | |
| | | | | | | | 0x0000 | bar_a | |
| | | | | | | | 0x0001 | psi_a | |
| AG-39 | Units: Pressure g | 7038 | 1 | M | R | | Unit: relative pressure | | |
| | | | | | | | 0x0000 | bar_g | |
| | | | | | | | 0x0001 | psi_g | |
| AG-40 | Calib. units: Length | 7039 | 1 | M | S | | Calibration unit: length | | |
| | | | | | | | 0x0000 | mm | (d) |
| | | | | | | | 0x0001 | in | |
| AG-41 | Calib. units: v | 7040 | 1 | M | S | | Calibration unit: speed | | |
| | | | | | | | 0x0000 | m/s | (d) |
| | | | | | | | 0x0001 | ft/s | |
| AG-42 | Calib. units: Q | 7041 | 1 | M | S | | Calibration unit: flow | | |
| | | | | | | | 0x0000 | m3/h | (d) |
| | | | | | | | 0x0001 | acfh | |

## Faults

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AH-01 | fault message | 710 | 10 | T | R | | Fault message as rolling text | | |
| AH-02 | fault time | 7500 | 2 | U | R | | Date and time of the fault | | |
| AH-03 | clear fault | 2126 | 1 | M | F | | Clear fault | | |
| | | | | | | | 0x0000 | NO | (d) |
| | | | | | | | 0x0001 | YES | |
| AH-04 | fault mode | 2127 | 1 | M | S | | Fault mode below Qm-min | | |
| | | | | | | | 0x0000 | NORMAL | (d) |
| | | | | | | | 0x0001 | ALL | |
| AH-05 | fault display mode | 2128 | 1 | M | S | | Fault display mode active: Shows all currently active faults | | |
| | | | | | | | 0x0000 | NORMAL | (d) |
| | | | | | | | 0x0001 | ACTIVE | |
| AH-06 | path error mode | 2129 | 1 | M | S | | Error mode in the case of a path failure | | |
| | | | | | | | 0x0000 | WARNING | (d) |
| | | | | | | | 0x0001 | ALARM | |
| AH-07 | fault,warn contact | 2254 | 1 | M | F | | Mode for alarm and warning contact | | |
| | | | | | | | 0x0000 | NORMAL | (d) |
| | | | | | | | 0x0001 | 5_SECONDS | |
| | | | | | | | 0x0002 | HOLD | |
| AH-09 | path ok | 700 | 10 | T | R | | Indication of the path status (path monitoring is considered) | | |
| AH-10 | hint status | 4008 | 1 | M | R | | Current hint status | | |
| | | | | | | | 0x0000 | OFF | |
| | | | | | | | 0x0001 | ON | |
| | | | | | | | 0x0002 | QUIT | |
| AH-11 | warning status | 4001 | 1 | M | R | | Current warning status | | |
| | | | | | | | 0x0000 | OFF | |
| | | | | | | | 0x0001 | ON | |
| | | | | | | | 0x0002 | QUIT | |
| AH-12 | warn contact | 4120 | 1 | M | R | | Current warning contact | | |
| | | | | | | | 0x0000 | OFF | |
| | | | | | | | 0x0001 | ON | |
| AH-13 | fault status | 4000 | 1 | M | R | | Current alarm status | | |
| | | | | | | | 0x0000 | OFF | |
| | | | | | | | 0x0001 | ON | |
| | | | | | | | 0x0002 | QUIT | |
| AH-14 | fault contact | 4121 | 1 | M | R | | Current alarm contact | | |
| | | | | | | | 0x0000 | OFF | |
| | | | | | | | 0x0001 | ON | |
| AH-15 | USE09 device status | 4002 | 1 | I | R | hex | USE09 device status | | |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AH-16 | Fault bit 0-15 | 4010 | 1 | I | R | hex | Active faults (bit-coded) 0-15 |
| AH-17 | Fault bit 16-31 | 4011 | 1 | I | R | hex | Active faults (bit-coded) 16-31 |
| AH-18 | Fault bit 32-47 | 4012 | 1 | I | R | hex | Active faults (bit-coded) 32-47 |
| AH-19 | Fault bit 48-63 | 4013 | 1 | I | R | hex | Active faults (bit-coded) 48-63 |
| AH-20 | Fault bit 64-79 | 4014 | 1 | I | R | hex | Active faults (bit-coded) 64-79 |
| AH-21 | Fault bit 80-95 | 4015 | 1 | I | R | hex | Active faults (bit-coded) 80-95 |
| AH-22 | Fault bit 96-111 | 4016 | 1 | I | R | hex | Active faults (bit-coded) 96-111 |
| AH-23 | Fault bit 112-127 | 4017 | 1 | I | R | hex | Active faults (bit-coded) 112-127 |
| AH-24 | Fault bit 128-143 | 4018 | 1 | I | R | hex | Active faults (bit-coded) 128-143 |
| AH-25 | Fault bit 144-159 | 4019 | 1 | I | R | hex | Active faults (bit-coded) 144-159 |
| AH-26 | Fault bit 160-175 | 4020 | 1 | I | R | hex | Active faults (bit-coded) 160-175 |
| AH-27 | Fault bit 176-191 | 4021 | 1 | I | R | hex | Active faults (bit-coded) 176-191 |
| AH-28 | Fault bit 192-207 | 4022 | 1 | I | R | hex | Active faults (bit-coded) 192-207 |

## DSP Parameters

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AI-09 | number of batches | 2136 | 1 | I | C | | Number of batches | | |
| AI-10 | Relay delay time | 2137 | 1 | I | S | ms | Relay delay time (RDT) | | |
| AI-11 | sample frequency | 2138 | 1 | M | S | MHz | Sample frequency in MHz | | |
| | | | | | | | 0x0000 | 1 | |
| | | | | | | | 0x0001 | 1,25 | |
| | | | | | | | 0x0002 | 1,67 | |
| | | | | | | | 0x0003 | 2 | |
| | | | | | | | 0x0004 | 2,5 | |
| | | | | | | | 0x0005 | 3,33 | |
| | | | | | | | 0x0006 | 4 | |
| | | | | | | | 0x0007 | 5 | (d) |
| | | | | | | | 0x0008 | 6,67 | |
| | | | | | | | 0x0009 | 10 | |
| AI-12 | fifo size | 2139 | 1 | M | S | | Size of the receiving memory | | |
| | | | | | | | 0x0000 | 512 | |
| | | | | | | | 0x0001 | 1024 | |
| | | | | | | | 0x0002 | 2048 | (d) |
| AI-13 | FPGA testpin ctrl. | 2214 | 1 | I | F | hex | Hexadecimal control word for the FPGA test pins | | |
| AI-14 | transmission level | 2140 | 1 | I | S | % | Transmission level control in % | | |
| AI-15 | send mux time | 1364 | 2 | F | S | ms | Response time of transmit multiplexer in ms | | |
| AI-16 | receive mux time | 1366 | 2 | F | S | ms | Response time of receive multiplexer in ms | | |
| AI-17 | Attenuator mode | 2141 | 1 | M | S | | Operating mode of the attenuator | | |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 0x0000 | OFF | (d) |
| | | | | | | | 0x0001 | ON | |
| | | | | | | | 0x0002 | TEST | |
| | | | | | | | 0x0003 | AUTO_SEPA-RATE | |
| AI-18 | Attenuator on | 2142 | 1 | I | S | dB | Limit for the attenuator ON | | |
| AI-19 | Attenuator off | 2143 | 1 | I | S | dB | Limit for the attenuator OFF | | |
| AI-20 | Attenuator HV | 2144 | 1 | I | S | dB | Limit for the attenuator HV mode | | |
| AI-21 | amp. regulator mode | 2145 | 1 | M | C | | Operating mode of amplitude control | | |
| | | | | | | | 0x0000 | SET VALUE | |
| | | | | | | | 0x0001 | ON | (d) |
| | | | | | | | 0x0002 | HOLD | |
| AI-22 | amp. regulator min | 2146 | 1 | I | C | % | Min. range for amplitude control | | |
| AI-23 | amp. regulator max | 2147 | 1 | I | C | % | Max. range for amplitude control | | |
| AI-24 | amp. damping | 1448 | 2 | F | C | | Damping for amplitude control | | |
| AI-25 | theoretical SoS | 1368 | 2 | F | S | → velocity unit | Theoretical speed of sound of the fluid | | |
| AI-26 | ADC gain | 2164 | 1 | M | S | | FPGA AD gain 0 dB, +6 dB, -6 dB | | |
| | | | | | | | 0x0000 | 1 | (d) |
| | | | | | | | 0x0001 | 2 | |
| | | | | | | | 0x0002 | 0.5 | |
| AI-27 | signal tracking | 2169 | 1 | M | C | | Switches signal tracking on or off | | |
| | | | | | | | 0x0000 | ON | |
| | | | | | | | 0x0001 | OFF | (d) |
| AI-28 | max. track. Offset | 2187 | 1 | I | C | Tics | Max. size of the tracking window | | |
| AI-37 | corr. mode | 2256 | 1 | M | S | | Correlation mode | | |
| | | | | | | | 0x0000 | OFF | (d) |
| | | | | | | | 0x0001 | FADE_IN | |
| AI-38 | corr. length | 2189 | 1 | I | S | | Length of the correlation window | | |
| AI-39 | Batch: amp. min. | 2279 | 1 | I | S | % | Batch: Minimum amplitude | | |
| AI-47 | AmplitudeMin | 2000 | 1 | I | S | % | Limit for the input signal (Low) | | |
| AI-48 | AmplitudeMax | 2010 | 1 | I | S | % | Limit for the input signal (High) | | |
| AI-49 | Vmin | 1000 | 2 | F | S | → Calib. units: v | Lower limit for the flow velocity | | |
| AI-50 | Vmax | 1020 | 2 | F | S | → Calib. units: v | Upper limit for the flow velocity | | |
| AI-51 | Cmin | 1040 | 2 | F | S | → Calib. units: v | Lower limit for the speed of sound | | |
| AI-52 | Cmax | 1060 | 2 | F | S | → Calib. units: v | Upper limit for the speed of sound | | |

## DSP Parameters 3X

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AJ-07 | corr. mode (X) | 2257 | 1 | M | S | | Correlation mode (3X measurement) | | |
| | | | | | | | 0x0000 | OFF | (d) |
| | | | | | | | 0x0001 | FADE_IN | |
| AJ-09 | Batch: amp. min. | 2280 | 1 | I | S | % | Batch: Minimum amplitude (3X measurement) | | |

## Path 1 Parameters

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AK-09 | p1 f-trans set val | 2500 | 2 | L | S | Hz | Path 1 transmit frequency intended value in Hz | | |
| AK-10 | path-1 trans. freq. | 2520 | 2 | L | R | Hz | Path 1 transmit frequency actual value in Hz | | |
| AK-11 | path-1 band limits | 2190 | 1 | I | S | % | Path 1 limits to observe | | |
| AK-12 | path-1 trans.pulses | 2040 | 1 | I | S | | Path 1 number of transmit pulses | | |
| AK-13 | p1 filter selection | 2170 | 1 | M | S | kHz | Path 1 DSP filter selection | | |
| | | | | | | | 0x0000 | 50 | |
| | | | | | | | 0x0001 | 75 | |
| | | | | | | | 0x0002 | 100 | (d) |
| | | | | | | | 0x0003 | 125 | |
| | | | | | | | 0x0004 | 150 | |
| | | | | | | | 0x0005 | 175 | |
| | | | | | | | 0x0006 | 200 | |
| | | | | | | | 0x0007 | 225 | |
| | | | | | | | 0x0008 | 250 | |
| | | | | | | | 0x0009 | 275 | |
| | | | | | | | 0x000a | 300 | |
| | | | | | | | 0x000b | 325 | |
| AK-14 | path-1 tw | 1080 | 2 | F | S | us | Path 1 delay time | | |
| AK-16 | path-1 DAC-G1 cmd | 2050 | 1 | I | S | | Path 1 DAC-G1 command register | | |
| AK-17 | path-1 DAC-G1 val | 2060 | 1 | I | S | | Path 1 DAC-G1 data register | | |
| AK-18 | path-1 DAC-G2 cmd | 2070 | 1 | I | S | | Path 1 DAC-G2 command register | | |
| AK-19 | path-1 DAC-G2 val | 2080 | 1 | I | S | | Path 1 DAC-G2 data register | | |
| AK-20 | p1 blanking delay | 1100 | 2 | F | R | us | Path 1 blanking delay | | |
| AK-21 | p1 blanking count | 2540 | 2 | L | R | tic | Path 1 blanking count | | |
| AK-22 | path-1 decay time | 1120 | 2 | F | S | ms | Path 1 pulse decay time | | |
| AK-23 | path-1 path length | 1140 | 2 | F | S | → Calib. units: | Length Path 1 path length | | |
| AK-24 | path-1 axial dist. | 1160 | 2 | F | S | → Calib. units: | Length Path 1 smallest path distance | | |
| AK-25 | p1 assembly angle | 1500 | 2 | F | S | ° | Path 1 assembly angle | | |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AK-26 | p1 delta-t offset | 1420 | 2 | F | S | us | Path 1 time difference offset |
| AK-29 | const w1 | 1240 | 2 | F | S | [1] | Path 1 weigthing factor w1 |
| AK-30 | p1 tic offset | 2200 | 1 | I | S | tic | Path 1 tic offset |
| AK-31 | p1 tic offset (X) | 2260 | 1 | I | S | tic | Path 1 tic offset (3X-measurement) |
| AK-32 | p1 AGC-limit | 2220 | 1 | I | S | dB | Path 1 AGC limit |
| AK-34 | p1 no. of f-batches | 2312 | 1 | I | C | | Path 1 no. of measurement (FBatches) |

## Path 2 Parameters

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AL-09 | p2 f-trans set val | 2502 | 2 | L | S | Hz | Path 2 transmit frequency intended value in Hz | | |
| AL-10 | path-2 trans. freq. | 2522 | 2 | L | R | Hz | Path 2 transmit frequency actual value in Hz | | |
| AL-11 | path-2 band limits | 2191 | 1 | I | S | % | Path 2 limits to observe | | |
| AL-12 | path-2 trans.pulses | 2041 | 1 | I | S | | Path 2 number of transmit pulses | | |
| AL-13 | p2 filter selection | 2171 | 1 | M | S | kHz | Path 2 DSP filter selection | | |
| | | | | | | | 0x0000 | 50 | |
| | | | | | | | 0x0001 | 75 | |
| | | | | | | | 0x0002 | 100 | (d) |
| | | | | | | | 0x0003 | 125 | |
| | | | | | | | 0x0004 | 150 | |
| | | | | | | | 0x0005 | 175 | |
| | | | | | | | 0x0006 | 200 | |
| | | | | | | | 0x0007 | 225 | |
| | | | | | | | 0x0008 | 250 | |
| | | | | | | | 0x0009 | 275 | |
| | | | | | | | 0x000a | 300 | |
| | | | | | | | 0x000b | 325 | |
| AL-14 | path-2 tw | 1082 | 2 | F | S | us | Path 2 delay time | | |
| AL-16 | path-2 DAC-G1 cmd | 2051 | 1 | I | S | | Path 2 DAC-G1 command register | | |
| AL-17 | path-2 DAC-G1 val | 2061 | 1 | I | S | | Path 2 DAC-G1 data register | | |
| AL-18 | path-2 DAC-G2 cmd | 2071 | 1 | I | S | | Path 2 DAC-G2 command register | | |
| AL-19 | path-2 DAC-G2 val | 2081 | 1 | I | S | | Path 2 DAC-G2 data register | | |
| AL-20 | p2 blanking delay | 1102 | 2 | F | R | us | Path 2 blanking delay | | |
| AL-21 | p2 blanking count | 2542 | 2 | L | R | tic | Path 2 blanking count | | |
| AL-22 | path-2 decay time | 1122 | 2 | F | S | ms | Path 2 pulse decay time | | |
| AL-23 | path-2 path length | 1142 | 2 | F | S | → Calib. units: | Length Path 2 path length | | |
| AL-24 | path-2 axial dist. | 1162 | 2 | F | S | → Calib. units: | Length Path 2 smallest path distance | | |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AL-25 | p2 assembly angle | 1502 | 2 | F | S | ° | Path 2 assembly angle |
| AL-26 | p2 delta-t offset | 1422 | 2 | F | S | us | Path 2 time difference offset |
| AL-29 | const w2 | 1242 | 2 | F | S | [1] | Path 2 weigthing factor w2 |
| AL-30 | p2 tic offset | 2201 | 1 | I | S | tic | Path 2 tic offset |
| AL-31 | p2 tic offset (X) | 2261 | 1 | I | S | tic | Path 2 tic offset (3X-measurement) |
| AL-32 | p2 AGC-limit | 2221 | 1 | I | S | dB | Path 2 AGC limit |
| AL-34 | p2 no. of f-batches | 2313 | 1 | I | C | | Path 2 no. of measurement (FBatches) |

## Path 3 Parameters

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AM-09 | p3 f-trans set val | 2504 | 2 | L | S | Hz | Path 3 transmit frequency intended value in Hz | | |
| AM-10 | path-3 trans. freq. | 2524 | 2 | L | R | Hz | Path 3 transmit frequency actual value in Hz | | |
| AM-11 | path-3 band limits | 2192 | 1 | I | S | % | Path 3 limits to observe | | |
| AM-12 | path-3 trans.pulses | 2042 | 1 | I | S | | Path 3 number of transmit pulses | | |
| AM-13 | p3 filter selection | 2172 | 1 | M | S | kHz | Path 3 DSP filter selection | | |
| | | | | | | | 0x0000 | 50 | |
| | | | | | | | 0x0001 | 75 | |
| | | | | | | | 0x0002 | 100 | (d) |
| | | | | | | | 0x0003 | 125 | |
| | | | | | | | 0x0004 | 150 | |
| | | | | | | | 0x0005 | 175 | |
| | | | | | | | 0x0006 | 200 | |
| | | | | | | | 0x0007 | 225 | |
| | | | | | | | 0x0008 | 250 | |
| | | | | | | | 0x0009 | 275 | |
| | | | | | | | 0x000a | 300 | |
| | | | | | | | 0x000b | 325 | |
| AM-14 | path-3 tw | 1084 | 2 | F | S | us | Path 3 delay time | | |
| AM-16 | path-3 DAC-G1 cmd | 2052 | 1 | I | S | | Path 3 DAC-G1 command register | | |
| AM-17 | path-3 DAC-G1 val | 2062 | 1 | I | S | | Path 3 DAC-G1 data register | | |
| AM-18 | path-3 DAC-G2 cmd | 2072 | 1 | I | S | | Path 3 DAC-G2 command register | | |
| AM-19 | path-3 DAC-G2 val | 2082 | 1 | I | S | | Path 3 DAC-G2 data register | | |
| AM-20 | p3 blanking delay | 1104 | 2 | F | R | us | Path 3 blanking delay | | |
| AM-21 | p3 blanking count | 2544 | 2 | L | R | tic | Path 3 blanking count | | |
| AM-22 | path-3 decay time | 1124 | 2 | F | S | ms | Path 3 pulse decay time | | |
| AM-23 | path-3 path length | 1144 | 2 | F | S | → Calib. units: | Length Path 3 path length | | |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AM-24 | path-3 axial dist. | 1164 | 2 | F | S | → Calib. units: | Length Path 3 smallest path distance |
| AM-25 | p3 assembly angle | 1504 | 2 | F | S | ° | Path 3 assembly angle |
| AM-26 | p3 delta-t offset | 1424 | 2 | F | S | us | Path 3 time difference offset |
| AM-29 | const w3 | 1244 | 2 | F | S | [1] | Path 3 weigthing factor w3 |
| AM-30 | p3 tic offset | 2202 | 1 | I | S | tic | Path 3 tic offset |
| AM-31 | p3 tic offset (X) | 2262 | 1 | I | S | tic | Path 3 tic offset (3X-measurement) |
| AM-32 | p3 AGC-limit | 2222 | 1 | I | S | dB | Path 3 AGC limit |
| AM-34 | p3 no. of f-batches | 2314 | 1 | I | C | | Path 3 no. of measurement (FBatches) |

## Path 4 Parameters

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AN-09 | p4 f-trans set val | 2506 | 2 | L | S | Hz | Path 4 transmit frequency intended value in Hz | | |
| AN-10 | path-4 trans. freq. | 2526 | 2 | L | R | Hz | Path 4 transmit frequency actual value in Hz | | |
| AN-11 | path-4 band limits | 2193 | 1 | I | S | % | Path 4 limits to observe | | |
| AN-12 | path-4 trans.pulses | 2043 | 1 | I | S | | Path 4 number of transmit pulses | | |
| AN-13 | p4 filter selection | 2173 | 1 | M | S | kHz | Path 4 DSP filter selection | | |
| | | | | | | | 0x0000 | 50 | |
| | | | | | | | 0x0001 | 75 | |
| | | | | | | | 0x0002 | 100 | (d) |
| | | | | | | | 0x0003 | 125 | |
| | | | | | | | 0x0004 | 150 | |
| | | | | | | | 0x0005 | 175 | |
| | | | | | | | 0x0006 | 200 | |
| | | | | | | | 0x0007 | 225 | |
| | | | | | | | 0x0008 | 250 | |
| | | | | | | | 0x0009 | 275 | |
| | | | | | | | 0x000a | 300 | |
| | | | | | | | 0x000b | 325 | |
| AN-14 | path-4 tw | 1086 | 2 | F | S | us | Path 4 delay time | | |
| AN-16 | path-4 DAC-G1 cmd | 2053 | 1 | I | S | | Path 4 DAC-G1 command register | | |
| AN-17 | path-4 DAC-G1 val | 2063 | 1 | I | S | | Path 4 DAC-G1 data register | | |
| AN-18 | path-4 DAC-G2 cmd | 2073 | 1 | I | S | | Path 4 DAC-G2 command register | | |
| AN-19 | path-4 DAC-G2 val | 2083 | 1 | I | S | | Path 4 DAC-G2 data register | | |
| AN-20 | p4 blanking delay | 1106 | 2 | F | R | us | Path 4 blanking delay | | |
| AN-21 | p4 blanking count | 2546 | 2 | L | R | tic | Path 4 blanking count | | |
| AN-22 | path-4 decay time | 1126 | 2 | F | S | ms | Path 4 pulse decay time | | |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AN-23 | path-4 path length | 1146 | 2 | F | S | → Calib. units: | Length Path 4 path length |
| AN-24 | path-4 axial dist. | 1166 | 2 | F | S | → Calib. units: | Length Path 4 smallest path distance |
| AN-25 | p4 assembly angle | 1506 | 2 | F | S | ° | Path 4 assembly angle |
| AN-26 | p4 delta-t offset | 1426 | 2 | F | S | us | Path 4 time difference offset |
| AN-29 | const w4 | 1246 | 2 | F | S | [1] | Path 4 weigthing factor w4 |
| AN-30 | p4 tic offset | 2203 | 1 | I | S | tic | Path 4 tic offset |
| AN-31 | p4 tic offset (X) | 2263 | 1 | I | S | tic | Path 4 tic offset (3X-measurement) |
| AN-32 | p4 AGC-limit | 2223 | 1 | I | S | dB | Path 4 AGC limit |
| AN-34 | p4 no. of f-batches | 2315 | 1 | I | C | | Path 4 no. of measurement (FBatches) |

## Path 5 Parameters

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AO-09 | p5 f-trans set val | 2508 | 2 | L | S | Hz | Path 5 transmit frequency intended value in Hz | | |
| AO-10 | path-5 trans. freq. | 2528 | 2 | L | R | Hz | Path 5 transmit frequency actual value in Hz | | |
| AO-11 | path-5 band limits | 2194 | 1 | I | S | % | Path 5 limits to observe | | |
| AO-12 | path-5 trans.pulses | 2044 | 1 | I | S | | Path 5 number of transmit pulses | | |
| AO-13 | p5 filter selection | 2174 | 1 | M | S | kHz | Path 5 DSP filter selection | | |
| | | | | | | | 0x0000 | 50 | |
| | | | | | | | 0x0001 | 75 | |
| | | | | | | | 0x0002 | 100 | (d) |
| | | | | | | | 0x0003 | 125 | |
| | | | | | | | 0x0004 | 150 | |
| | | | | | | | 0x0005 | 175 | |
| | | | | | | | 0x0006 | 200 | |
| | | | | | | | 0x0007 | 225 | |
| | | | | | | | 0x0008 | 250 | |
| | | | | | | | 0x0009 | 275 | |
| | | | | | | | 0x000a | 300 | |
| | | | | | | | 0x000b | 325 | |
| AO-14 | path-5 tw | 1088 | 2 | F | S | us | Path 5 delay time | | |
| AO-16 | path-5 DAC-G1 cmd | 2054 | 1 | I | S | | Path 5 DAC-G1 command register | | |
| AO-17 | path-5 DAC-G1 val | 2064 | 1 | I | S | | Path 5 DAC-G1 data register | | |
| AO-18 | path-5 DAC-G2 cmd | 2074 | 1 | I | S | | Path 5 DAC-G2 command register | | |
| AO-19 | path-5 DAC-G2 val | 2084 | 1 | I | S | | Path 5 DAC-G2 data register | | |
| AO-20 | p5 blanking delay | 1108 | 2 | F | R | us | Path 5 blanking delay | | |
| AO-21 | p5 blanking count | 2548 | 2 | L | R | tic | Path 5 blanking count | | |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AO-22 | path-5 decay time | 1128 | 2 | F | S | ms | Path 5 pulse decay time |
| AO-23 | path-5 path length | 1148 | 2 | F | S | → Calib. units: | Length Path 5 path length |
| AO-24 | path-5 axial dist. | 1168 | 2 | F | S | → Calib. units: | Length Path 5 smallest path distance |
| AO-25 | p5 assembly angle | 1508 | 2 | F | S | ° | Path 5 assembly angle |
| AO-26 | p5 delta-t offset | 1428 | 2 | F | S | us | Path 5 time difference offset |
| AO-29 | const w5 | 1248 | 2 | F | S | [1] | Path 5 weigthing factor w5 |
| AO-30 | p5 tic offset | 2204 | 1 | I | S | tic | Path 5 tic offset |
| AO-31 | p5 tic offset (X) | 2264 | 1 | I | S | tic | Path 5 tic offset (3X-measurement) |
| AO-32 | p5 AGC-limit | 2224 | 1 | I | S | dB | Path 5 AGC limit |
| AO-34 | p5 no. of f-batches | 2316 | 1 | I | C | | Path 5 no. of measurement (FBatches) |

## Path 6 Parameters

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AP-09 | p6 f-trans set val | 2510 | 2 | L | S | Hz | Path 6 transmit frequency intended value in Hz | | |
| AP-10 | path-6 trans. freq. | 2530 | 2 | L | R | Hz | Path 6 transmit frequency actual value in Hz | | |
| AP-11 | path-6 band limits | 2195 | 1 | I | S | % | Path 6 limits to observe | | |
| AP-12 | path-6 trans.pulses | 2045 | 1 | I | S | | Path 6 number of transmit pulses | | |
| AP-13 | p6 filter selection | 2175 | 1 | M | S | kHz | Path 6 DSP filter selection | | |
| | | | | | | | 0x0000 | 50 | |
| | | | | | | | 0x0001 | 75 | |
| | | | | | | | 0x0002 | 100 | (d) |
| | | | | | | | 0x0003 | 125 | |
| | | | | | | | 0x0004 | 150 | |
| | | | | | | | 0x0005 | 175 | |
| | | | | | | | 0x0006 | 200 | |
| | | | | | | | 0x0007 | 225 | |
| | | | | | | | 0x0008 | 250 | |
| | | | | | | | 0x0009 | 275 | |
| | | | | | | | 0x000a | 300 | |
| | | | | | | | 0x000b | 325 | |
| AP-14 | path-6 tw | 1090 | 2 | F | S | us | Path 6 delay time | | |
| AP-16 | path-6 DAC-G1 cmd | 2055 | 1 | I | S | | Path 6 DAC-G1 command register | | |
| AP-17 | path-6 DAC-G1 val | 2065 | 1 | I | S | | Path 6 DAC-G1 data register | | |
| AP-18 | path-6 DAC-G2 cmd | 2075 | 1 | I | S | | Path 6 DAC-G2 command register | | |
| AP-19 | path-6 DAC-G2 val | 2085 | 1 | I | S | | Path 6 DAC-G2 data register | | |
| AP-20 | p6 blanking delay | 1110 | 2 | F | R | us | Path 6 blanking delay | | |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AP-21 | p6 blanking count | 2550 | 2 | L | R | tic | Path 6 blanking count |
| AP-22 | path-6 decay time | 1130 | 2 | F | S | ms | Path 6 pulse decay time |
| AP-23 | path-6 path length | 1150 | 2 | F | S | → Calib. units: | Length Path 6 path length |
| AP-24 | path-6 axial dist. | 1170 | 2 | F | S | → Calib. units: | Length Path 6 smallest path distance |
| AP-25 | p6 assembly angle | 1510 | 2 | F | S | ° | Path 6 assembly angle |
| AP-26 | p6 delta-t offset | 1430 | 2 | F | S | us | Path 6 time difference offset |
| AP-29 | const w6 | 1250 | 2 | F | S | [1] | Path 6 weigthing factor w6 |
| AP-30 | p6 tic offset | 2205 | 1 | I | S | tic | Path 6 tic offset |
| AP-31 | p6 tic offset (X) | 2265 | 1 | I | S | tic | Path 6 tic offset (3X-measurement) |
| AP-32 | p6 AGC-limit | 2225 | 1 | I | S | dB | Path 6 AGC limit |
| AP-34 | p6 no. of f-batches | 2317 | 1 | I | C | | Path 6 no. of measurement (FBatches) |

## Path 7 Parameters

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AQ-09 | p7 f-trans set val | 2512 | 2 | L | S | Hz | Path 7 transmit frequency intended value in Hz | | |
| AQ-10 | path-7 trans. freq. | 2532 | 2 | L | R | Hz | Path 7 transmit frequency actual value in Hz | | |
| AQ-11 | path-7 band limits | 2196 | 1 | I | S | % | Path 7 limits to observe | | |
| AQ-12 | path-7 trans.pulses | 2046 | 1 | I | S | | Path 7 number of transmit pulses | | |
| AQ-13 | p7 filter selection | 2176 | 1 | M | S | kHz | Path 7 DSP filter selection | | |
| | | | | | | | 0x0000 | 50 | |
| | | | | | | | 0x0001 | 75 | |
| | | | | | | | 0x0002 | 100 | (d) |
| | | | | | | | 0x0003 | 125 | |
| | | | | | | | 0x0004 | 150 | |
| | | | | | | | 0x0005 | 175 | |
| | | | | | | | 0x0006 | 200 | |
| | | | | | | | 0x0007 | 225 | |
| | | | | | | | 0x0008 | 250 | |
| | | | | | | | 0x0009 | 275 | |
| | | | | | | | 0x000a | 300 | |
| | | | | | | | 0x000b | 325 | |
| AQ-14 | path-7 tw | 1092 | 2 | F | S | us | Path 7 delay time | | |
| AQ-16 | path-7 DAC-G1 cmd | 2056 | 1 | I | S | | Path 7 DAC-G1 command register | | |
| AQ-17 | path-7 DAC-G1 val | 2066 | 1 | I | S | | Path 7 DAC-G1 data register | | |
| AQ-18 | path-7 DAC-G2 cmd | 2076 | 1 | I | S | | Path 7 DAC-G2 command register | | |
| AQ-19 | path-7 DAC-G2 val | 2086 | 1 | I | S | | Path 7 DAC-G2 data register | | |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AQ-20 | p7 blanking delay | 1112 | 2 | F | R | us | Path 7 blanking delay |
| AQ-21 | p7 blanking count | 2552 | 2 | L | R | tic | Path 7 blanking count |
| AQ-22 | path-7 decay time | 1132 | 2 | F | S | ms | Path 7 pulse decay time |
| AQ-23 | path-7 path length | 1152 | 2 | F | S | → Calib. units: | Length Path 7 path length |
| AQ-24 | path-7 axial dist. | 1172 | 2 | F | S | → Calib. units: | Length Path 7 smallest path distance |
| AQ-25 | p7 assembly angle | 1512 | 2 | F | S | ° | Path 7 assembly angle |
| AQ-26 | p7 delta-t offset | 1432 | 2 | F | S | us | Path 7 time difference offset |
| AQ-29 | const w7 | 1252 | 2 | F | S | [1] | Path 7 weigthing factor w7 |
| AQ-30 | p7 tic offset | 2206 | 1 | I | S | tic | Path 7 tic offset |
| AQ-31 | p7 tic offset (X) | 2266 | 1 | I | S | tic | Path 7 tic offset (3X-measurement) |
| AQ-32 | p7 AGC-limit | 2226 | 1 | I | S | dB | Path 7 AGC limit |
| AQ-34 | p7 no. of f-batches | 2318 | 1 | I | C | | Path 7 no. of measurement (FBatches) |

## Path 8 Parameters

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AR-09 | p8 f-trans set val | 2514 | 2 | L | S | Hz | Path 8 transmit frequency intended value in Hz | | |
| AR-10 | path-8 trans. freq. | 2534 | 2 | L | R | Hz | Path 8 transmit frequency actual value in Hz | | |
| AR-11 | path-8 band limits | 2197 | 1 | I | S | % | Path 8 limits to observe | | |
| AR-12 | path-8 trans.pulses | 2047 | 1 | I | S | | Path 8 number of transmit pulses | | |
| AR-13 | p8 filter selection | 2177 | 1 | M | S | kHz | Path 8 DSP filter selection | | |
| | | | | | | | 0x0000 | 50 | |
| | | | | | | | 0x0001 | 75 | |
| | | | | | | | 0x0002 | 100 | (d) |
| | | | | | | | 0x0003 | 125 | |
| | | | | | | | 0x0004 | 150 | |
| | | | | | | | 0x0005 | 175 | |
| | | | | | | | 0x0006 | 200 | |
| | | | | | | | 0x0007 | 225 | |
| | | | | | | | 0x0008 | 250 | |
| | | | | | | | 0x0009 | 275 | |
| | | | | | | | 0x000a | 300 | |
| | | | | | | | 0x000b | 325 | |
| AR-14 | path-8 tw | 1094 | 2 | F | S | us | Path 8 delay time | | |
| AR-16 | path-8 DAC-G1 cmd | 2057 | 1 | I | S | | Path 8 DAC-G1 command register | | |
| AR-17 | path-8 DAC-G1 val | 2067 | 1 | I | S | | Path 8 DAC-G1 data register | | |
| AR-18 | path-8 DAC-G2 cmd | 2077 | 1 | I | S | | Path 8 DAC-G2 command register | | |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AR-19 | path-8 DAC-G2 val | 2087 | 1 | I | S | | Path 8 DAC-G2 data register |
| AR-20 | p8 blanking delay | 1114 | 2 | F | R | us | Path 8 blanking delay |
| AR-21 | p8 blanking count | 2554 | 2 | L | R | tic | Path 8 blanking count |
| AR-22 | path-8 decay time | 1134 | 2 | F | S | ms | Path 8 pulse decay time |
| AR-23 | path-8 path length | 1154 | 2 | F | S | → Calib. units: | Length Path 8 path length |
| AR-24 | path-8 axial dist. | 1174 | 2 | F | S | → Calib. units: | Length Path 8 smallest path distance |
| AR-25 | p8 assembly angle | 1514 | 2 | F | S | ° | Path 8 assembly angle |
| AR-26 | p8 delta-t offset | 1434 | 2 | F | S | us | Path 8 time difference offset |
| AR-29 | const w8 | 1254 | 2 | F | S | [1] | Path 8 weigthing factor w8 |
| AR-30 | p8 tic offset | 2207 | 1 | I | S | tic | Path 8 tic offset |
| AR-31 | p8 tic offset (X) | 2267 | 1 | I | S | tic | Path 8 tic offset (3X-measurement) |
| AR-32 | p8 AGC-limit | 2227 | 1 | I | S | dB | Path 8 AGC limit |
| AR-34 | p8 no. of f-batches | 2319 | 1 | I | C | | Path 8 no. of measurement (FBatches) |

## Service

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AS-01 | CPU speed | 2574 | 2 | L | CS | Hz | Actual M32 clock speed | | |
| AS-02 | DSP speed | 2576 | 2 | L | S | Hz | Actual DSP clock speed | | |
| AS-04 | FPGA speed | 2578 | 2 | L | S | Hz | Actual FPGA clock speed | | |
| AS-05 | ext. card s.no. | 2584 | 2 | L | S | | IO card s. No. | | |
| AS-06 | ext. ADC s.no. | 2586 | 2 | L | S | | IO-ADC card s. No. | | |
| AS-07 | write opt.EEProm | 2167 | 1 | M | S | | (Service key!) Writes paramet. in the OPT-EEP | | |
| | | | | | | | 0x0000 | NO | (d) |
| | | | | | | | 0x0001 | YES | |
| AS-08 | write ADC EEProm | 2168 | 1 | M | S | | (Service key!) Writes paramet. in the OPT-ADC-EEP | | |
| | | | | | | | 0x0000 | NO | (d) |
| | | | | | | | 0x0001 | YES | |
| AS-09 | LCD lighting | 2183 | 1 | M | F | | Display lighting if key is pressed or steady light | | |
| | | | | | | | 0x0000 | KEY | (d) |
| | | | | | | | 0x0001 | always | |
| AS-10 | parameter reset | 2148 | 1 | M | CS | | Load new parameters | | |
| | | | | | | | 0x0000 | NO | (d) |
| | | | | | | | 0x0001 | YES | |
| AS-12 | RV reset | 2149 | 1 | M | C | | Clear replacement values | | |
| | | | | | | | 0x0000 | NO | (d) |
| | | | | | | | 0x0001 | YES | |
| AS-13 | RV: number | 2150 | 1 | I | C | | Number of average values for the calculation of replacement values | | |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AS-14 | RV status | 720 | 10 | T | R | | Status for the replacement value | | |
| AS-15 | RV mode | 2213 | 1 | M | S | | Mode of replacement values | | |
| | | | | | | | 0x0000 | OFF | |
| | | | | | | | 0x0001 | ON | (d) |
| AS-16 | Raw data path no. | 2124 | 1 | I | F | | Raw data: Path selection (0=OFF) | | |
| AS-17 | Raw data type | 2184 | 1 | M | F | | Raw data: Type selection | | |
| | | | | | | | 0x0000 | TEST | |
| | | | | | | | 0x0001 | RAW | (d) |
| | | | | | | | 0x0002 | FILTER | |
| | | | | | | | 0x0003 | RAW ERR | |
| | | | | | | | 0x0004 | FILTER ERR | |
| | | | | | | | 0x0005 | FFG | |
| | | | | | | | 0x0006 | RAW FFT | |
| | | | | | | | 0x0007 | FILTER FFT | |
| AS-18 | Raw data function | 2215 | 1 | I | F | | Raw data: Trigger function (subselection) | | |
| AS-20 | M32 Temperature | 5000 | 2 | F | R | → Units: Temp. | Temperature of the M32 board | | |
| AS-21 | Transmit Level | 5002 | 2 | F | R | % | Transmission level HV analog board | | |
| AS-22 | +-5V symmetry | 5004 | 2 | F | R | V | Symmetry +-5V, analog board | | |
| AS-23 | System Tempera-ture | 5006 | 2 | F | R | → Units: Temp. | Temperature, baseboard | | |
| AS-24 | +-12V symmetry | 5008 | 2 | F | R | V | Symmetry +-12V, analog board | | |
| AS-25 | 1V2 voltage | 5010 | 2 | F | R | V | Voltage 1V2 DSP board | | |
| AS-26 | 1V5 voltage | 5012 | 2 | F | R | V | Voltage 1V5 DSP board | | |
| AS-27 | 3V3 voltage | 5014 | 2 | F | R | V | Voltage 3V3 M32 board | | |
| AS-28 | adc-p binary val. | 7502 | 2 | L | R | | Pressure input, transmitter value | | |
| AS-29 | adc-t binary val. | 7504 | 2 | L | R | | PT100 input, transmitter value | | |
| AS-30 | max. sys. temp. | 1440 | 2 | F | C | → Units: Temp. | System temperature, max. value | | |
| AS-31 | time max. sys. temp | 2588 | 2 | U | C | | Time of max. system temperature | | |
| AS-32 | min. sys. temp. | 1442 | 2 | F | C | → Units: Temp. | System temperature, min. value | | |
| AS-33 | time min. sys. temp | 2590 | 2 | U | C | | Time of min. system temperature | | |

## Log Data

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AT-01 | Log-data date | 800 | 10 | T | R | | Data logger, date of last change |
| AT-02 | Log-data coordi-nate | 810 | 10 | T | R | | Data logger, coordinate of last change |
| AT-03 | Log-data old value | 820 | 10 | T | R | | Data logger (old value) |
| AT-04 | Log-data new value | 830 | 10 | T | R | | Data logger (new value) |
| AT-10 | Log-data fill level | 4007 | 1 | I | R | % | Data logger, fill level |
| AT-11 | clear par-log | 2157 | 1 | M | S | | Clear parameter logging list |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 0x0000 | NO | (d) |
| | | | | | | | 0x0001 | YES | |
| AT-12 | clear event-log | 2216 | 1 | M | F | | Clear event logging list | | |
| | | | | | | | 0x0000 | NO | (d) |
| | | | | | | | 0x0001 | YES | |



## Site Information

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AU-01 | User Text-1 | 840 | 10 | T | F | | User-programmable text line 1 |
| AU-02 | User Text-2 | 850 | 10 | T | F | | User-programmable text line 2 |
| AU-03 | User Text-3 | 860 | 10 | T | F | | User-programmable text line 3 |
| AU-04 | User Text-4 | 870 | 10 | T | F | | User-programmable text line 4 |
| AU-05 | User Text-5 | 880 | 10 | T | F | | User-programmable text line 5 |

## Remote Control

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AV-01 | remote access | 10000 | 1 | M | C | | Remote access | | |
| | | | | | | | 0x0000 | NO | (d) |
| | | | | | | | 0x0001 | YES | |
| AV-02 | remote keycode | 10001 | 1 | I | C | | Keyboard code | | |
| AV-03 | lcd row 1 | 10010 | 10 | T | R | | Actual line 1 LCD | | |
| AV-04 | lcd row 2 | 10020 | 10 | T | R | | Actual line 2 LCD | | |
| AV-05 | lcd row 3 | 10030 | 10 | T | R | | Actual line 3 LCD | | |
| AV-06 | lcd row 4 | 10040 | 10 | T | R | | Actual line 4 LCD | | |

## AGA-10 Values

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AW-01 | SoS calc. status | 8000 | 1 | I | R | hex | Status AGA-10 calculation |
| AW-02 | SoS | 8001 | 2 | F | R | → velocity unit | Measured average speed of sound |
| AW-03 | SoS calculated | 8003 | 2 | F | R | → velocity unit | Result speed of sound AGA-10 |
| AW-04 | rel. error SoS | 8005 | 2 | F | R | % | Relative error measured SoS to SoS calculated |
| AW-05 | abs. error SoS | 8007 | 2 | F | R | → velocity unit | SoS measured - SoS AGA-10 |
| AW-06 | temperature | 8009 | 2 | F | R | → Units: Temp. | Temperature: AGA-10 equation |
| AW-07 | pressure | 8011 | 2 | F | R | → Units: Pressure a | Pressure: AGA-10 equation |
| AW-08 | last calculation | 8013 | 2 | U | R | | Time of last AGA-10 calculation |
| AW-09 | last gas comp. | 8015 | 2 | U | R | | Time of last gas components input |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AW-20 | norm. methane | 8040 | 2 | F | R | mol-% | Methane: fraction in AGA-10 equation |
| AW-21 | norm. ethane | 8046 | 2 | F | R | mol-% | Ethane: fraction in AGA-10 equation |
| AW-22 | norm. propane | 8048 | 2 | F | R | mol-% | Propane: fraction in AGA-10 equation |
| AW-23 | norm. iso-butane | 8060 | 2 | F | R | mol-% | I-Butane: fraction in AGA-10 equation |
| AW-24 | norm. n-butane | 8062 | 2 | F | R | mol-% | N-Butane: fraction in AGA-10 equation |
| AW-26 | norm. iso-pen-tane | 8064 | 2 | F | R | mol-% | I-Pentane: fraction in AGA-10 equation |
| AW-27 | norm. n-pentane | 8066 | 2 | F | R | mol-% | N-Pentane: fraction in AGA-10 equation |
| AW-29 | norm. oxygen | 8058 | 2 | F | R | mol-% | Oxygen: fraction in AGA-10 equation |
| AW-30 | norm. helium | 8078 | 2 | F | R | mol-% | Helium: fraction in AGA-10 equation |
| AW-31 | norm. hydrogen | 8054 | 2 | F | R | mol-% | Hydrogen: fraction in AGA-10 equation |
| AW-32 | norm. argon | 8080 | 2 | F | R | mol-% | Argon: fraction in AGA-10 equation |
| AW-33 | norm. nitrogen | 8042 | 2 | F | R | mol-% | Nitrogen: fraction in AGA-10 equation |
| AW-34 | norm. CO2 | 8044 | 2 | F | R | mol-% | Carbon dioxide: fraction in AGA-10 equation |
| AW-35 | norm. n-hexane | 8068 | 2 | F | R | mol-% | N-Hexane: fraction in AGA-10 equation |
| AW-36 | norm. n-heptane | 8070 | 2 | F | R | mol-% | N-Heptane: fraction in AGA-10 equation |
| AW-37 | norm. n-octane | 8072 | 2 | F | R | mol-% | N-Octane: fraction in AGA-10 equation |
| AW-38 | norm. n-nonane | 8074 | 2 | F | R | mol-% | N-Nonane: fraction in AGA-10 equation |
| AW-39 | norm. n-decane | 8076 | 2 | F | R | mol-% | N-Decane: fraction in AGA-10 equation |
| AW-40 | norm. H2S | 8052 | 2 | F | R | mol-% | Hydrogen sulfide: fraction in AGA-10 equation |
| AW-41 | norm. water | 8050 | 2 | F | R | mol-% | Water: fraction in AGA-10 equation |
| AW-42 | norm. CO | 8056 | 2 | F | R | mol-% | Carbon monoxide: fraction in AGA-10 equation |

## AGA-10 Config

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AX-01 | SoS calc source | 8100 | 1 | M | F | | Source gas analysis for AGA-10 | | |
| | | | | | | | 0x0000 | OFF | (d) |
| | | | | | | | 0x0001 | SET VALUE | |
| | | | | | | | 0x0002 | default air | |
| | | | | | | | 0x0003 | serial port 2 | |
| AX-02 | SoS source temp. | 8101 | 1 | M | F | | Source temperature for AGA-10 | | |
| | | | | | | | 0x0000 | SoS default | (d) |
| | | | | | | | 0x0001 | USE09 | |
| AX-03 | SoS source press. | 8102 | 1 | M | F | | Source pressure for AGA-10 | | |
| | | | | | | | 0x0000 | SoS default | (d) |
| | | | | | | | 0x0001 | USE09 | |
| AX-04 | SoS temp. default | 8104 | 2 | F | F | → Units: Temp. | Default value temperature for AGA-10 | | |
| AX-05 | SoS press. default | 8106 | 2 | F | F | → Units: Pressure a | Default value pressure for AGA-10 | | |
| AX-06 | relative humidity | 8108 | 2 | F | F | % | Relative humidity | | |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AX-07 | timeout max. | 8110 | 1 | I | F | min | Timeout time for new analysis (except default) | | |
| AX-08 | RMGBus mode | 8111 | 1 | M | F | | Selection 24 or 9 gas components via RMGBus | | |
| | | | | | | | 0x0000 | RMGBus 24 comp. | (d) |
| | | | | | | | 0x0001 | RMGBus | |
| AX-09 | stream number | 8112 | 1 | M | F | | Selection of the stream with RMGBus | | |
| | | | | | | | 0x0000 | without indi-cation | (d) |
| | | | | | | | 0x0001 | stream 1 | |
| | | | | | | | 0x0002 | stream 2 | |
| | | | | | | | 0x0003 | stream 3 | |
| | | | | | | | 0x0004 | stream 4 | |
| AX-10 | Modbus master target | 8113 | 1 | M | F | | Target for Modbus master | | |
| | | | | | | | 0x0000 | RMG GC9300 | (d) |
| | | | | | | | 0x0001 | custom 1 | |
| AX-11 | set gas comp. | 8350 | 1 | M | F | | Set new components | | |
| | | | | | | | 0x0000 | gas comp. are set | (d) |
| | | | | | | | 0x0001 | set new comp. | |
| AX-20 | default methane | 8140 | 2 | F | F | mol-% | Methane: default value | | |
| AX-21 | default ethane | 8142 | 2 | F | F | mol-% | Ethane: default value | | |
| AX-22 | default propane | 8144 | 2 | F | F | mol-% | Propane: default value | | |
| AX-23 | default iso-bu-tane | 8146 | 2 | F | F | mol-% | iso-Butane: default value | | |
| AX-24 | default n-butane | 8148 | 2 | F | F | mol-% | n-Butane: default value | | |
| AX-25 | default neo-pen-tane | 8150 | 2 | F | F | mol-% | neo-Pentane: default value | | |
| AX-26 | default iso-pen-tane | 8152 | 2 | F | F | mol-% | iso-Pentane: default value | | |
| AX-27 | default n-pentane | 8154 | 2 | F | F | mol-% | n-Pentane: default value | | |
| AX-28 | default hexane+ | 8156 | 2 | F | F | mol-% | Hexane+: default value | | |
| AX-29 | default oxygen | 8158 | 2 | F | F | mol-% | Oxygen: default value | | |
| AX-30 | default helium | 8160 | 2 | F | F | mol-% | Helium: default value | | |
| AX-31 | default hydrogen | 8162 | 2 | F | F | mol-% | Hydrogen: default value | | |
| AX-32 | default argon | 8164 | 2 | F | F | mol-% | Argon: default value | | |
| AX-33 | default nitrogen | 8166 | 2 | F | F | mol-% | Nitrogen: default value | | |
| AX-34 | default CO2 | 8168 | 2 | F | F | mol-% | Carbon dioxide: default value | | |
| AX-35 | default n-hexane | 8170 | 2 | F | F | mol-% | n-Hexane: default value | | |
| AX-36 | default n-heptane | 8172 | 2 | F | F | mol-% | n-Heptane: default value | | |
| AX-37 | default n-octane | 8174 | 2 | F | F | mol-% | n-Octane: default value | | |
| AX-38 | default n-nonane | 8176 | 2 | F | F | mol-% | n-Nonane: default value | | |
| AX-39 | default n-decane | 8178 | 2 | F | F | mol-% | n-Decane: default value | | |
| AX-40 | default H2S | 8180 | 2 | F | F | mol-% | Hydrogen sulfide: default value | | |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AX-41 | default water | 8182 | 2 | F | F | mol-% | Water vapour: default value |
| AX-42 | default CO | 8184 | 2 | F | F | mol-% | Carbon monoxide: default value |
| AX-43 | default ethene | 8186 | 2 | F | F | mol-% | Ethene: default value |
| AX-44 | default propene | 8188 | 2 | F | F | mol-% | Propene: default value |
| AX-45 | sum of def. comp. | 8190 | 2 | F | R | mol-% | Sum of default values |
| AX-92 | MB_Pause | 8980 | 1 | I | F | s | Modbus-master pause |
| AX-93 | MB_Timeout | 8981 | 1 | I | F | ms | Modbus-master time outs |
| AX-94 | MB_Int16Order | 8982 | 10 | T | F | | Int16 order |
| AX-95 | MB_Int32Order | 8992 | 10 | T | F | | Int32 order |
| AX-96 | MB_FloatOrder | 9002 | 10 | T | F | | Float32 order |
| AX-97 | MB_DoubleOrder | 9012 | 10 | T | F | | Float64 order |

## Gas Comp. RMGBus

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AY-20 | methane | 8300 | 2 | F | F | mol-% | RMGBus/Modbus value methane |
| AY-21 | ethane | 8302 | 2 | F | F | mol-% | RMGBus/Modbus value ethane |
| AY-22 | propane | 8304 | 2 | F | F | mol-% | RMGBus/Modbus value propane |
| AY-23 | iso-butane | 8306 | 2 | F | F | mol-% | RMGBus/Modbus value iso-butane |
| AY-24 | n-butane | 8308 | 2 | F | F | mol-% | RMGBus/Modbus value n-butane |
| AY-25 | neo-pentane | 8310 | 2 | F | F | mol-% | RMGBus/Modbus value neo-pentane |
| AY-26 | iso-pentane | 8312 | 2 | F | F | mol-% | RMGBus/Modbus value iso-pentane |
| AY-27 | n-pentane | 8314 | 2 | F | F | mol-% | RMGBus/Modbus value n-pentane |
| AY-28 | hexane+ | 8316 | 2 | F | F | mol-% | RMGBus/Modbus value hexane+ |
| AY-29 | oxygen | 8318 | 2 | F | F | mol-% | RMGBus/Modbus value oxygen |
| AY-30 | helium | 8320 | 2 | F | F | mol-% | RMGBus/Modbus value helium |
| AY-31 | hydrogen | 8322 | 2 | F | F | mol-% | RMGBus/Modbus value hydrogen |
| AY-32 | argon | 8324 | 2 | F | F | mol-% | RMGBus/Modbus value argon |
| AY-33 | nitrogen | 8326 | 2 | F | F | mol-% | RMGBus/Modbus value nitrogen |
| AY-34 | CO2 | 8328 | 2 | F | F | mol-% | RMGBus/Modbus value carbon dioxide |
| AY-35 | n-hexane | 8330 | 2 | F | F | mol-% | RMGBus/Modbus value n-hexane |
| AY-36 | n-heptane | 8332 | 2 | F | F | mol-% | RMGBus/Modbus value n-heptane |
| AY-37 | n-octane | 8334 | 2 | F | F | mol-% | RMGBus/Modbus value n-octane |
| AY-38 | n-nonane | 8336 | 2 | F | F | mol-% | RMGBus/Modbus value n-nonane |
| AY-39 | n-decane | 8338 | 2 | F | F | mol-% | RMGBus/Modbus value n-decane |
| AY-40 | H2S | 8340 | 2 | F | F | mol-% | RMGBus/Modbus value hydrogen sulfide |
| AY-41 | Water | 8342 | 2 | F | F | mol-% | RMGBus/Modbus value water vapour |
| AY-42 | CO | 8344 | 2 | F | F | mol-% | RMGBus/Modbus value carbon monoxide |
| AY-43 | ethene | 8346 | 2 | F | F | mol-% | RMGBus/Modbus value ethene |
| AY-44 | propene | 8348 | 2 | F | F | mol-% | RMGBus/Modbus value propene |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description | | |
|---|---|---|---|---|---|---|---|---|---|
| AY-45 | sum of gas comp. | 8351 | 2 | F | R | mol-% | Sum of components via Modbus/RMG-Bus | | |
| AY-46 | telegram counter | 8126 | 1 | I | R | | Counter for new gas component transfers | | |
| AY-47 | RMGBus status | 8127 | 1 | M | R | | Last valid status | | |
| | | | | | | | 0x0000 | revision | |
| | | | | | | | 0x0001 | calibration | |
| | | | | | | | 0x0002 | analysis | |
| | | | | | | | 0x0003 | revision error | |
| | | | | | | | 0x0004 | calibration error | |
| | | | | | | | 0x0005 | analysis error | |
| | | | | | | | 0x0006 | invalid | |
| AY-48 | RMGBus stream | 8128 | 1 | I | R | | Stream number of the last telegram | | |
| AY-49 | MB timeouts | 8129 | 1 | I | R | | Number of modbus-master time outs | | |
| AY-50 | Modbus errors | 8130 | 1 | I | R | | Number of Modbus master telegram errors | | |
| AY-51 | Modbus error reg. | 8131 | 1 | I | R | | MB register of the last error | | |
| AY-52 | Modbus error resp. | 8132 | 1 | I | R | | MB register of the last error | | |
| AY-53 | MB_NAN_Counter | 9022 | 1 | I | R | | MB register of the last error | | |
| AY-54 | MB_SyntaxError | 9023 | 10 | T | R | | Modbus master syntax error coordinate | | |
| AY-55 | MB_ErrorBits | 9033 | 2 | L | R | hex Int. | Modbus master error bits | | |
| AY-56 | MB_InStatus | 9035 | 1 | I | F | | Modbus master status input | | |

## Gas Comp. Modbus

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AZ-01 | Formula methane | 8440 | 10 | T | S | | Formula methane |
| AZ-02 | Formula methane | 8450 | 10 | T | S | | Formula methane |
| AZ-03 | Formula ethane | 8460 | 10 | T | S | | Formula ethane |
| AZ-04 | Formula ethane | 8470 | 10 | T | S | | Formula ethane |
| AZ-05 | Formula propane | 8480 | 10 | T | S | | Formula propane |
| AZ-06 | Formula propane | 8490 | 10 | T | S | | Formula propane |
| AZ-07 | Formula i-butane | 8500 | 10 | T | S | | Formula i-butane |
| AZ-08 | Formula i-butane | 8510 | 10 | T | S | | Formula i-butane |
| AZ-09 | Formula n-butane | 8520 | 10 | T | S | | Formula n-butane |
| AZ-10 | Formula n-butane | 8530 | 10 | T | S | | Formula n-butane |
| AZ-11 | Formula neo-pentane | 8540 | 10 | T | S | | Formula neo-pentane |
| AZ-12 | Formula neo-pentane | 8550 | 10 | T | S | | Formula neo-pentane |
| AZ-13 | Formula i-pentane | 8560 | 10 | T | S | | Formula i-pentane |
| AZ-14 | Formula i-pentane | 8570 | 10 | T | S | | Formula i-pentane |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| AZ-15 | Formula n-pen-tane | 8580 | 10 | T | S | | Formula n-pentane |
| AZ-16 | Formula n-pen-tane | 8590 | 10 | T | S | | Formula n-pentane |
| AZ-17 | Formula hexane+ | 8600 | 10 | T | S | | Formula hexane |
| AZ-18 | Formula hexane+ | 8610 | 10 | T | S | | Formula hexane |
| AZ-19 | Formula oxygen | 8620 | 10 | T | S | | Formula oxygen |
| AZ-20 | Formula oxygen | 8630 | 10 | T | S | | Formula oxygen |
| AZ-21 | Formula helium | 8640 | 10 | T | S | | Formula helium |
| AZ-22 | Formula helium | 8650 | 10 | T | S | | Formula helium |
| AZ-23 | Formula hydrogen | 8660 | 10 | T | S | | Formula hydrogen |
| AZ-24 | Formula hydrogen | 8670 | 10 | T | S | | Formula hydrogen |
| AZ-25 | Formula argon | 8680 | 10 | T | S | | Formula argon |
| AZ-26 | Formula argon | 8690 | 10 | T | S | | Formula argon |
| AZ-27 | Formula nitrogen | 8700 | 10 | T | S | | Formula nitrogen |
| AZ-28 | Formula nitrogen | 8710 | 10 | T | S | | Formula nitrogen |
| AZ-29 | Formula CO2 | 8720 | 10 | T | S | | Formula CO2 |
| AZ-30 | Formula CO2 | 8730 | 10 | T | S | | Formula CO2 |
| AZ-31 | Formula hexane | 8740 | 10 | T | S | | Formula hexane |
| AZ-32 | Formula hexane | 8750 | 10 | T | S | | Formula hexane |
| AZ-33 | Formula heptane | 8760 | 10 | T | S | | Formula heptane |
| AZ-34 | Formula heptane | 8770 | 10 | T | S | | Formula heptane |
| AZ-35 | Formula octane | 8780 | 10 | T | S | | Formula octane |
| AZ-36 | Formula octane | 8790 | 10 | T | S | | Formula octane |
| AZ-37 | Formula nonane | 8800 | 10 | T | S | | Formula nonane |
| AZ-38 | Formula nonane | 8810 | 10 | T | S | | Formula nonane |
| AZ-39 | Formula decane | 8820 | 10 | T | S | | Formula decane |
| AZ-40 | Formula decane | 8830 | 10 | T | S | | Formula decane |
| AZ-41 | Formula H2S | 8840 | 10 | T | S | | Formula H2S |
| AZ-42 | Formula H2S | 8850 | 10 | T | S | | Formula H2S |
| AZ-43 | Formula water | 8860 | 10 | T | S | | Formula water |
| AZ-44 | Formula water | 8870 | 10 | T | S | | Formula water |
| AZ-45 | Formula CO | 8880 | 10 | T | S | | Formula CO |
| AZ-46 | Formula CO | 8890 | 10 | T | S | | Formula CO |
| AZ-47 | Formula ethene | 8900 | 10 | T | S | | Formula ethane |
| AZ-48 | Formula ethene | 8910 | 10 | T | S | | Formula ethane |
| AZ-49 | Formula propene | 8920 | 10 | T | S | | Formula propene |
| AZ-50 | Formula propene | 8930 | 10 | T | S | | Formula propene |
| AZ-51 | Formula status | 8940 | 10 | T | S | | Formula status |
| AZ-52 | Formula status | 8950 | 10 | T | S | | Formula status |
| AZ-53 | Formula status | 8960 | 10 | T | S | | Formula status |
| AZ-54 | Formula status | 8970 | 10 | T | S | | Formula status |

## DSfG Instance-F

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| BA-01 | DSfG error | 9086 | 1 | I | R | | DSfG Error (0000 if no error) |
| BA-02 | vol. flow rate Qm | 32768 | 2 | F | R | m3/h | Volume flow (pos. FD1, neg. FD2) |
| BA-03 | Gas velocity | 32770 | 2 | F | R | m/s | Velocity of Gas (pos. FD1, neg. FD2) |
| BA-04 | SoS | 32772 | 2 | F | R | m/s | Speed of Sound |
| BA-05 | Gas volume sum d.1 | 32774 | 2 | L | R | → Unit LF-Volumes | Volume of Gas total Flow direction 1 (V_tot_d1=Vm_d1+Vm_err_d1) |
| BA-06 | Gas volume sum d.2 | 32776 | 2 | L | R | → Unit LF-Volumes | Volume of Gas total Flow direction 2 (V_tot_d2=Vm_d2+Vm_err_d2) |
| BA-07 | Gas vol no err d.1 | 32778 | 2 | L | R | → Unit LF-Volumes | Volume of Gas undisturbed Flow direction 1 (Vm_d1) |
| BA-08 | Gas vol no err d.2 | 32780 | 2 | L | R | → Unit LF-Volumes | Volume of Gas undisturbed Flow direction 2 (Vm_d2) |
| BA-09 | Gas vol error d.1 | 32782 | 2 | L | R | → Unit LF-Volumes | Volume of Gas disturbed Flow direction 1 (Vm_err_d1) |
| BA-10 | Gas vol error d.2 | 32784 | 2 | L | R | → Unit LF-Volumes | Volume of Gas disturbed Flow direction 2 (Vm_err_d2) |
| BA-11 | Valence | 32786 | 2 | L | R | | Valency |
| BA-12 | Flow > Qt | 32788 | 2 | L | R | | Flow bigger Qt (0 = no, unequal 0 = yes) |
| BA-13 | Signal acceptance | 32790 | 2 | L | R | % | Signal acceptance |
| BA-14 | Meter error | 32792 | 2 | L | R | | Meter disturbed (0 = no, unequal 0 = yes) |
| BA-15 | Number of Paths | 32794 | 2 | L | R | | Number of Paths |
| BA-16 | SoS deviation P1 | 32796 | 2 | F | R | % | Speed of Sound deviation Path 1 (SoS_1_dev = (SoS_1-SoS)/SoS*100) |
| BA-17 | SoS deviation P2 | 32798 | 2 | F | R | % | Speed of Sound deviation Path 2 (SoS_2_dev = (SoS_2-SoS)/SoS*100) |
| BA-18 | SoS deviation P3 | 32800 | 2 | F | R | % | Speed of Sound deviation Path 3 (SoS_3_dev = (SoS_3-SoS)/SoS*100) |
| BA-19 | SoS deviation P4 | 32802 | 2 | F | R | % | Speed of Sound deviation Path 4 (SoS_4_dev = (SoS_4-SoS)/SoS*100) |
| BA-20 | SoS deviation P5 | 32804 | 2 | F | R | % | Speed of Sound deviation Path 5 (SoS_5_dev = (SoS_5-SoS)/SoS*100) |
| BA-21 | SoS deviation P6 | 32806 | 2 | F | R | % | Speed of Sound deviation Path 6 (SoS_6_dev = (SoS_6-SoS)/SoS*100) |
| BA-22 | SoS deviation P7 | 32808 | 2 | F | R | % | Speed of Sound deviation Path 7 (SoS_7_dev = (SoS_7-SoS)/SoS*100) |
| BA-23 | SoS deviation P8 | 32810 | 2 | F | R | % | Speed of Sound deviation Path 8 (SoS_8_dev = (SoS_8-SoS)/SoS*100) |
| BA-24 | Path velocity vc1 | 32896 | 2 | F | R | m/s | Velocity of Gas Path 1 |
| BA-25 | SoS P1 | 32898 | 2 | F | R | m/s | Speed of Sound Path 1 |
| BA-26 | Signal acceptance P1 | 32900 | 2 | F | R | % | Signal acceptance Path 1 |
| BA-27 | SNR P1 AB | 32902 | 2 | F | R | dB | Signal-Noise-Ratio AB Path 1 |
| BA-28 | SNR P1 BA | 32904 | 2 | F | R | dB | Signal-Noise-Ratio BA Path 1 |
| BA-29 | AGC-level P1 AB | 32906 | 2 | F | R | dB | Automatic gain AB Path 1 |
| BA-30 | AGC-level P1 BA | 32908 | 2 | F | R | dB | Automatic gain BA Path 1 |
| BA-31 | Path velocity vc2 | 32912 | 2 | F | R | m/s | Velocity of Gas path 2 |
| BA-32 | SoS P2 | 32914 | 2 | F | R | m/s | Speed of Sound Path 2 |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| BA-33 | Signal acceptance P2 | 32916 | 2 | F | R | % | Signal acceptance Path 2 |
| BA-34 | SNR P2 AB | 32918 | 2 | F | R | dB | Signal-Noise-Ratio AB Path 2 |
| BA-35 | SNR P2 BA | 32920 | 2 | F | R | dB | Signal-Noise-Ratio BA Path 2 |
| BA-36 | AGC-level P2 AB | 32922 | 2 | F | R | dB | Automatic gain AB Path 2 |
| BA-37 | AGC-level P2 BA | 32924 | 2 | F | R | dB | Automatic gain BA Path 2 |
| BA-38 | Path velocity vc3 | 32928 | 2 | F | R | m/s | Velocity of Gas path 3 |
| BA-39 | SoS P3 | 32930 | 2 | F | R | m/s | Speed of Sound Path 3 |
| BA-40 | Signal acceptance P3 | 32932 | 2 | F | R | % | Signal acceptance Path 3 |
| BA-41 | SNR P3 AB | 32934 | 2 | F | R | dB | Signal-Noise-Ratio AB Path 3 |
| BA-42 | SNR P3 BA | 32936 | 2 | F | R | dB | Signal-Noise-Ratio BA Path 3 |
| BA-43 | AGC-level P3 AB | 32938 | 2 | F | R | dB | Automatic gain AB Path 3 |
| BA-44 | AGC-level P3 BA | 32940 | 2 | F | R | dB | Automatic gain BA Path 3 |
| BA-45 | Path velocity vc4 | 32944 | 2 | F | R | m/s | Velocity of Gas path 4 |
| BA-46 | SoS P4 | 32946 | 2 | F | R | m/s | Speed of Sound Path 4 |
| BA-47 | Signal acceptance P4 | 32948 | 2 | F | R | % | Signal acceptance Path 4 |
| BA-48 | SNR P4 AB | 32950 | 2 | F | R | dB | Signal-Noise-Ratio AB Path 4 |
| BA-49 | SNR P4 BA | 32952 | 2 | F | R | dB | Signal-Noise-Ratio BA Path 4 |
| BA-50 | AGC-level P4 AB | 32954 | 2 | F | R | dB | Automatic gain AB Path 4 |
| BA-51 | AGC-level P4 BA | 32956 | 2 | F | R | dB | Automatic gain BA Path 4 |
| BA-52 | Path velocity vc5 | 32960 | 2 | F | R | m/s | Velocity of Gas path 5 |
| BA-53 | SoS P5 | 32962 | 2 | F | R | m/s | Speed of Sound Path 5 |
| BA-54 | Signal acceptance P5 | 32964 | 2 | F | R | % | Signal acceptance Path 5 |
| BA-55 | SNR P5 AB | 32966 | 2 | F | R | dB | Signal-Noise-Ratio AB Path 5 |
| BA-56 | SNR P5 BA | 32968 | 2 | F | R | dB | Signal-Noise-Ratio BA Path 5 |
| BA-57 | AGC-level P5 AB | 32970 | 2 | F | R | dB | Automatic gain AB Path 5 |
| BA-58 | AGC-level P5 BA | 32972 | 2 | F | R | dB | Automatic gain BA Path 5 |
| BA-59 | Path velocity vc6 | 32976 | 2 | F | R | m/s | Velocity of Gas path 6 |
| BA-60 | SoS P6 | 32978 | 2 | F | R | m/s | Speed of Sound Path 6 |
| BA-61 | Signal acceptance P6 | 32980 | 2 | F | R | % | Signal acceptance Path 6 |
| BA-62 | SNR P6 AB | 32982 | 2 | F | R | dB | Signal-Noise-Ratio AB Path 6 |
| BA-63 | SNR P6 BA | 32984 | 2 | F | R | dB | Signal-Noise-Ratio BA Path 6 |
| BA-64 | AGC-level P6 AB | 32986 | 2 | F | R | dB | Automatic gain AB Path 6 |
| BA-65 | AGC-level P6 BA | 32988 | 2 | F | R | dB | Automatic gain BA Path 6 |
| BA-66 | Path velocity vc7 | 32992 | 2 | F | R | m/s | Velocity of Gas path 7 |
| BA-67 | SoS P7 | 32994 | 2 | F | R | m/s | Speed of Sound Path 7 |
| BA-68 | Signal acceptance P7 | 32996 | 2 | F | R | % | Signal acceptance Path 7 |
| BA-69 | SNR P7 AB | 32998 | 2 | F | R | | Signal-Noise-Ratio AB Path 7 |
| BA-70 | SNR P7 BA | 33000 | 2 | F | R | dB | Signal-Noise-Ratio BA Path 7 |
| BA-71 | AGC-level P7 AB | 33002 | 2 | F | R | dB | Automatic gain AB Path 7 |

| Coord. | Value | Reg. | No. | Type | Prot. | Unit | Description |
|---|---|---|---|---|---|---|---|
| BA-72 | AGC-level P7 BA | 33004 | 2 | F | R | dB | Automatic gain BA Path 7 |
| BA-73 | Path velocity vc8 | 33008 | 2 | F | R | m/s | Velocity of Gas path 8 |
| BA-74 | SoS P8 | 33010 | 2 | F | R | m/s | Speed of Sound Path 8 |
| BA-75 | Signal acceptance P8 | 33012 | 2 | F | R | % | Signal acceptance Path 8 |
| BA-76 | SNR P8 AB | 33014 | 2 | F | R | dB | Signal-Noise-Ratio AB Path 8 |
| BA-77 | SNR P8 BA | 33016 | 2 | F | R | dB | Signal-Noise-Ratio BA Path 8 |
| BA-78 | AGC-level P8 AB | 33018 | 2 | F | R | dB | Automatic gain AB Path 8 |
| BA-79 | AGC-level P8 BA | 33020 | 2 | F | R | dB | Automatic gain BA Path 8 |

# 16 USM GT400 Approval



In this section, you will receive information in which fields of application the device is approved. The standards, guidelines and regulations are also listed which are applied for the development and manufacturing.

## 16.1 Metrological approvals

The device has the following approvals:

- MID approval (DE-14-MI002-PTB002)
- MC type approval (metrological approval of Measurement Canada, AG-0622)
- OIML Certificate, R 137-1:2012 „Gas meters“, Accuracy class 0,5 (R137/2012-A-NL1-23.04 revision 1, Project number 3711995)

## 16.2 Pressure devices approval

- PED 2014/68/EU /
  EU-type examination certificate (Module B)
  ISG-22-14-1630
- ASME B31.3 Ed.2012
- CRN

## 16.3 Electromagnetic compatibility

- FS-1312-249580-001
- FS-1312-249585

## 16.4 Explosion protection approval

- ATEX (BVS 14 ATEX E 034X)
- IECEx (BVS 14.0029X)

- CSA (NA) C22.2 No 0.-M91, 30-M1986, 142-M1987

## 16.5 Standards, directives and guidelines



We, RMG Messtechnik GmbH, herewith declare that due to its design and construction in the version brought onto the market the devices described in this operating instruction conforms to the relevant fundamental health and safety requirements of the applicable EC Directive.

In the event of a modification of the device is not authorized by us, this declaration shall be rendered void.

### EC guidelines

| | |
|---|---|
| **2014/68/EU** | EC Pressure Equipment Directive |
| **2014/30/EU** | Electromagnetic Compatibility |
| **2014/34/EU** | ATEX Operational Directive. |
| **2014/32/EU** | MID - Measuring Instrument Directive. |
| **2011/65/EU** | RoHS |

### Applied harmonized standards

| | |
|---|---|
| **DIN ISO 8434-1 (DIN 2353)** | Metallic tube connections. |
| **DIN ISO 17089** | Measurement of fluid flow in closed conduits. |
| **DIN EN 334:2009-07** | Gas pressure regulators for inlet pressures up to 100 bar |
| **DIN EN 14382** | Safety devices for gas pressure regulating stations and installations - Gas safety shut-off devices for inlet pressures up to 100 bar |
| **DIN IEC 60529:A1** | IP protection categories. |
| **OIML R137-1&2** | 1. Metrological and technical requirements.<br>2. Metrological controls and performance tests. |
| **OIML R137-3** | OIML Report format for type evaluation. |
| **DIN EN and IEC/EN 60079-0** | Explosive atmospheres |

| | |
|---|---|
| **DIN EN and IEC/EN 60079-1** | Explosive atmospheres - Part 1: Equipment protection by flame-proof enclosures "d" |
| **DIN EN and IEC/EN 60079-7** | Explosive atmospheres - Part 7: Equipment protection by flame-proof enclosures "e" |
| **CAN C22.2 No. 30** | Explosion-Proof Enclosures for Use in Class I Hazardous Locations |
| **UL 1203** | Explosion-Proof and Dust- Ignition-Proof Electrical Equipment for Use in Hazardous Locations |

## USA Directives

| | |
|---|---|
| **ASME B31.3 Ed. 2012** | Pressure safety |
| **AGA report No. 9** | Measurement of Gas by Multipath Ultrasonic Meters. |
| **AGA report No. 10** | Speed of Sound in Natural Gas and Other Related Hydrocarbon Gases. |

## Canada Directives

| | |
|---|---|
| **PS-G-06** | Provisional Specifications for the Approval, Verification, Reverification, Installation and Use of Ultrasonic Meters. |
| **G-16** | Recognition of Test Data From Gas Meter Test Facilities. |
| **S-EG-05** | Specifications for the Approval of Software Controlled Electricity and Gas Metering Devices. |
| **S-G-03** | Specifications for Approval of Type of Gas Meters and Auxiliary Devices - Amendments to Measurement Canada Specification LMB-EG-08. |
| **S-EG-06** | Specifications Relating to Event Loggers for Electricity and Gas Metering Devices. |
| **GEN-40** | Application and Implementation of Measurement Canada's Specifications for the Approval of both Software Controlled Electricity and Gas Meters and Event Loggers. |
| **CRN** | Canadian Registration Number |

# 17 USM GT400 Glossary



In this chapter you will be given information on terminology.

**Ultrasonic gas meter (USM)**

The flow of the gas is measured at different levels with ultrasonic transducers.

**Ultrasonic electronics (USE)**

The ultrasonic electronics are mounted on the ultrasonic gas meter. The ultrasonic electronics evaluate the data recorded by the sensors. The parameters can be displayed and evaluated on a computer with the USM software.

**Plot**

Graphic display of one or more measured values.

**Meter**

In der Software wird der Ultraschallzähler zum Teil als Messwerk bezeichnet.

**Device**

In the software the ultrasonic gas meter is sometimes called a meter.

**Transducer**

The transducer or sensor is built into the device. The transducer sends the opposing transducer an ultrasonic signal. Using the time measured for the ultrasonic signal to travel the distance between the two transducers, the ultrasonic electronics calculates the gas flow. 12 transducers are built into the device. They are distributed across three levels with four transducers on every level. Per level two paths measure the gas flow. A path comprises two opposing transducers.

In the manual the transducer is called a sensor.

**Sensor**

⇨ Transducer

**Meter**

⇨ Ultrasonic gas meter (USM)

# 18 USM GT400 Attachment

You will find the declaration of conformity and approvals of the device in this section.



**Note**

**EU Declaration of Conformity**

The declaration of conformity listed reflects the status on the date of issue of the operating instructions. The latest version of the EU declaration of conformity can be found on our website www.rmg.com.

## EU-Declaration of Conformity
***EU-Konformitätserklärung***

CE

We **RMG Messtechnik GmbH**
*Wir* Otto – Hahn – Straße 5
35510 Butzbach
Germany

Declare under our sole responsibility that the product is in conformity with the directives. Product is labeled according to the listed directives and standards and in accordance with the Type-Examination.
*Erklären in alleiniger Verantwortung, dass das Produkt konform ist mit den Anforderungen der Richtlinien. Das entsprechend gekennzeichnete Produkt ist nach den aufgeführten Richtlinien und Normen hergestellt und stimmt mit dem Baumuster überein.*

Product **Ultrasonic Gas Flowmeter type USM-GT-400**
*Produkt* ***Ultraschallgaszähler Typ USM-GT-400***

| **Harmonisation Legislations** *Harmonisierungs-rechtsvorschriften* | **EMV** | **ATEX** | **PED** | **MID** |
|---|---|---|---|---|
| **EU- Directives** *EU-Richtlinie* | 2014/30/EU | 2014/34/EU | 2014/68/EU | 2014/32/EU |
| **Marking** *Kennzeichen* | --- | Ex II 2G Ex db eb IIB+$H_2$ T6 Gb | --- | --- |
| **Normative Documents** *Normative Dokumente* | EN 61000-6-3:2007 +A1: 2011 EN 61000-6-2:2005 | EN 60079-0: 2018 EN 60079-1: 2014 EN IEC 60079-7: 2015 + A1: 2018 | AD 2000 – Merkblätter | OIML R 137-1&2/2012 OIML D 11 / 2013 Welmec-Guide: 7.2 / 11.1 / 11.3 |
| **EU Type-Examination issued by** *EU-Baumusterprüfung ausgestellt durch* | Prüfbericht/ Test Report: FS-1312-249580-001 und FS-1312-249585 (Fa. Nemko GmbH) | Modul B BVS 14 ATEX E 034 X DEKRA Testing and Certification GmbH Germany | Modul B ISG-22-19-1497 Rev. F TÜV Hessen Germany | Modul B DE-14-MI002-PTB002 PTB Germany |
| **Approval of a Quality System by** *Anerkennung eines Qualitätssicherungs-systems durch* | --- | Modul D BVS 17 ATEX ZQS/E139 Notified Body: 0158 DEKRA Testing and Certification GmbH Germany | Modul D 73 202 2839 Notified Body: 0091 TÜV Hessen Germany | Modul D DE-M-AQ-PTB023 Notified Body: 0102 PTB Germany |

RoHS 2011/65/EU

The object of the declaration described above is in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
*Der oben beschriebene Gegenstand der Erklärung erfüllt die Vorschriften der Richtlinie 2011/65/EU des Europäischen Parlaments und des Rates vom 8. Juni 2011 zur Beschränkung der Verwendung bestimmter gefährlicher Stoffe in Elektro- und Elektronikgeräten.*

**RMG Messtechnik GmbH**
Butzbach, den 16.11.2023

Thorsten Dietz
(CEO)

i.A.
Sascha Körner
(Technical Manager)

**Sitz der Gesellschaft** Butzbach • **Registergericht Friedberg** HRB 2535
**Geschäftsführung** Barbara Baumann, Thorsten Dietz
**Qualitätsmanagement** DIN EN ISO 9001:2015

Seite 1 von 1

**Nemko GmbH & Co. KG**
**Prüf- und Zertifizierungsstelle**
***Test and Certification Institute***
Reetzstraße 58
D-76327 Pfinztal
Tel.: +49 (0) 72 40 / 63 -0
Fax: +49 (0) 72 40 / 63 -11

ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-18175-01-01 Nemko EMV Testzentrum

# PRÜFBERICHT - *TEST REPORT*

**Elektromagnetische Verträglichkeit (EMV)** - *Electromagnetic Compatibility (EMC)*

## ANTRAGSTELLER - *APPLICANT*

| | |
|---|---|
| Firma - *Company:* | **RMG Messtechnik GmbH** |
| Anschrift - *Address:* | **Otto-Hahn-Str. 5**<br>**D - 35510 Butzbach** |
| Anwesende - *Witness(es):* | **Hr. Schmitt, Hr. Henning** |

## PRÜFLING (EUT) - *EQUIPMENT UNDER TEST*

| | |
|---|---|
| Gerätebez. - *Equipment:* | **Ultraschallgaszähler** - ***Ultrasonic Flowmeter*** |
| Modell/Typ - *Model/Type:* | **USM-GT-400** |
| Fertigungs Nr. - *Serial No.:* | **Zähler: # 13, (Bj. 2013, DN 150, Q: 20 - 2400 $m^3/h$)** |

## PRÜFUNG - *TEST*

| | | |
|---|---|---|
| Anlieferung<br>*Arrival of EUT:* | **03.01.2014** | |
| Meßtermin(e)<br>*Date of measurement:* | **07. - 09.01.2014** | |
| Prüfungsgrundlage<br>*Standards:* | ***Störaussendung - Emission:***<br>**EN 61000-6-3:2007+A1:2011**<br>**Klasse B** - ***class B*** | ***Störfestigkeit - Immunity:***<br>**EN 61000-6-2:2005** |
| Ergebnisse - *Results:* | **Anforderungen erfüllt** - ***Passed***<br>**Details siehe Zusammenfassung** - ***Details see test result summary*** | |
| Bemerkungen - *Remarks:* | **Höherer Prüfschärfegrad gem. OIML R 137-1&2: 2012 berücksichtigt**<br>***Higher perfomance criteria OIML R 137-1&2: Ed. 2012 was considered.*** | |
| Bemerkungen - *Remarks:* | **Ein Prüfplan wurde vorgelegt.**<br>***The test plan was presented.*** | |
| Durchführung - *Performed by:* | **Dipl.-Ing. Th. W. Stein, Dipl.-Ing. M. Korny** | |

## PRÜFBERICHT - *TEST REPORT*

| | | |
|---|---|---|
| Identifikationsnummer<br>*Identification No.:* | **FS-1312-249585** | |
| Datum des Prüfberichts<br>*Date of Report:* | **20.01.2014** | |
| bearbeitet von - *Provided by:* | **Dipl.-Ing. Th. W. Stein** | |
| | **Prüfer** - *Person responsible* | **Unterschrift** - *Signature* |
| überprüft von - *Approved by:* | **Dipl.-Ing. P. Lukas** | |
| | **Prüfer** - *Person responsible* | **Unterschrift** - *Signature* |

QMV-5.10-2 d-e / Rev 6.03

Dieser Prüfbericht besteht inkl. diesem Deckblatt aus 58 numerierten Seiten und darf ohne schriftliche Genehmigung des Prüflabors nicht auszugsweise vervielfältigt werden. Die Prüfergebnisse beziehen sich ausschließlich auf den oben aufgeführten Prüfling (Typ-Prüfung). Rechtsgültigkeit besitzt nur das handschriftlich unterschriebene Original.

*This report consists of 58 numbered pages including this page and shall not be reproduced except in full, without the written approval of the testing laboratory. The results are related to the equipment under test only (type-test) The English version is a translation. In case of doubt you should follow the original German text. Legal validity is given by the handwritten signed document only.*

**Nemko GmbH & Co. KG**
**Prüf- und Zertifizierungsstelle**
***Test and Certification Institute***
Reetzstraße 58
D-76327 Pfinztal
Tel.: +49 (0) 72 40 / 63 -0
Fax: +49 (0) 72 40 / 63 -11

ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-18175-01-01 Nemko EMV Testzentrum

# PRÜFBERICHT - *TEST REPORT*

**Elektromagnetische Verträglichkeit (EMV) - *Electromagnetic Compatibility (EMC)***

## ANTRAGSTELLER - *APPLICANT*

| | |
|---|---|
| Firma - *Company:* | **RMG Messtechnik GmbH** |
| Anschrift - *Address:* | **Otto-Hahn-Str. 5**<br>**D - 35510 Butzbach** |
| Anwesende - *Witness(es):* | **Hr. Schmitt, Hr. Henning** |

## PRÜFLING (EUT) - *EQUIPMENT UNDER TEST*

| | |
|---|---|
| Gerätebez. - *Equipment:* | **Ultraschallgaszähler - *Ultrasonic Flowmeter*** |
| Modell/Typ - *Model/Type:* | **USM-GT-400** |
| Fertigungs Nr. - *Serial No.:* | **Zähler: # 15, (Bj. 2013, DN 200, Q: 32 - 4200 $m^3/h$)** |

## PRÜFUNG - *TEST*

| | | |
|---|---|---|
| Anlieferung - *Arrival of EUT:* | **03.01.2014** | |
| Meßtermin(e)<br>*Date of measurement:* | **09.; 10.; 13.01.2014** | |
| Prüfungsgrundlage<br>*Standards:* | ***Störaussendung - Emission:***<br>**EN 61000-6-3:2007+A1:2011**<br>**Klasse B - *class B*** | ***Störfestigkeit - Immunity:***<br>**EN 61000-6-2:2005** |
| Ergebnisse - *Results:* | **Anforderungen erfüllt - *Passed***<br>**Details siehe Zusammenfassung - *Details see test result summary*** | |
| Bemerkungen - *Remarks:* | **Höherer Prüfschärfegrad gem. OIML R 137-1&2: 2012 berücksichtigt**<br>***Higher perfomance criteria OIML R 137-1&2: Ed. 2012 was considered.*** | |
| Bemerkungen - *Remarks:* | **Ein Prüfplan wurde vorgelegt.**<br>***The test plan was presented.*** | |
| Bemerkungen - *Remarks:* | **Ersatz für Prüfbericht FS-1312-249580 vom 16.01.2014.**<br>***Replacement for test report FS-1312-249580 dated 2014-01-16.*** | |
| Durchführung - *Performed by:* | **Dipl.-Ing. J. Szipanski** | |

## PRÜFBERICHT - *TEST REPORT*

| | | |
|---|---|---|
| Identifikationsnummer<br>*Identification No.:* | **FS-1312-249580-001** | |
| Datum des Prüfberichts<br>*Date of Report:* | **24.02.2014** | |
| bearbeitet von - *Provided by:* | **Dipl.-Ing. J. Szipanski**<br>**Prüfer - *Person responsible*** | **Unterschrift - *Signature*** |
| überprüft von - *Approved by:* | **Dipl.-Ing. P. Lukas**<br>**Prüfer - *Person responsible*** | **Unterschrift - *Signature*** |

QMV-5.10-2 d-e / Rev 6.03

Translation

# (1) EC-Type Examination Certificate

(2) Equipment and protective systems intended for use in potentially explosive atmospheres - Directive 94/9/EC

(3) No. of EC-Type Examination Certificate: **BVS 14 ATEX E 034 X**

(4) Equipment: **Ultrasonic meter type USM-GT-400**

(5) Manufacturer: **RMG Messtechnik GmbH**

(6) Address: **Otto-Hahn-Straße 5, 35510 Butzbach, Germany**

(7) The design and construction of this equipment and any acceptable variation thereto are specified in the appendix to this type examination certificate.

(8) The certification body of DEKRA EXAM GmbH, notified body no. 0158 in accordance with Article 9 of the Directive 94/9/EC of the European Parliament and the Council of 23 March 1994, certifies that this equipment has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment and protective systems intended for use in potentially explosive atmospheres, given in Annex II to the Directive. The examination and test results are recorded in the test and assessment report BVS PP 14.2061 EG.

(9) The Essential Health and Safety Requirements are assured by compliance with:

**EN 60079-0:2012 General requirements**
**EN 60079-1:2007 Flameproof enclosure "d"**
**EN 60079-7:2007 Increased Safety "e"**

(10) If the sign "X" is placed after the certificate number, it indicates that the equipment is subject to special conditions for safe use specified in the appendix to this certificate.

(11) This EC-Type Examination Certificate relates only to the design, examination and tests of the specified equipment in accordance to Directive 94/9/EC.
Further requirements of the Directive apply to the manufacturing process and supply of this equipment. These are not covered by this certificate.

(12) The marking of the equipment shall include the following:

**Ex II 2G Ex de IIB+$H_2$ T6 Gb**

DEKRA EXAM GmbH
Bochum, dated 2014-03-17

Signed: Simanski
Certification body

Signed: Leiendecker
Special services unit



DEKRA EXAM GmbH Dinnendahlstrasse 9 44809 Bochum Germany Phone +49.234.3696-105 Fax +49.234.3696-110 zs-exam@dekra.com

(13) Appendix to

(14) **EC-Type Examination Certificate**
**BVS 14 ATEX E 034 X**

(15) 15.1 Subject and type
Ultra sonic meter type USM-GT-400

15.2 Description
The Ultrasonic gas flow meter type USM-GT-400 serves to measure the quantity of gas.It consists of a metallic meter body with an electronics unit installed on the top. A number of ultrasonic transducers (max. 16) is installed inside the meter body. Each pair of ultrasonic transducers build an acoustic path. The electronic unit is used to generate, detect and analyze ultrasonic pulses.

The enclosure type 8265/53-... (size 3) in type of protection Flameproof Enclosure "d" is used to house the electronics. It is a product of company R.STAHL Schaltgeräte GmbH and is separately certified (PTB 06 ATEX 1023 U resp. IECEx PTB 07.0027 U). The connection between the ultrasonic transducers and the electronics are realized with coaxial cables which are individually laid in stainless steel tubes leading into the electronics enclosure via a multiple-tubule feed through. The electronics enclosure together with the pipes and the transducer form one flameproof unit.
The control and distribution box type 8125/5...-..., product of company R.STAHL Schaltgeräte GmbH, which is separately certified in type of protection Increased Safety "e", is used as junction box (PTB 01 ATEX 1001 resp. IECEx PTB 06.0079).
The control and distribution box is equipped with separately certified terminal blocks.
A separately certified conductor bushing is used between the enclosure in type of protection "d" and control and distribution box in type of protection "e".

15.3 Parameters

| | | | |
|---|---|---|---|
| 15.3.1 | Electrical data | | |
| 15.3.1.1 | Electronics in the „d"-enclosure | | |
| | supply voltage | DC 24 | V |
| | power dissipation | max. 12 | W |
| 15.3.1.2 | Transducer | | |
| 15.3.1.2.1 | Types TNG 10-CP, TNG 10-CHP | | |
| | max. pulse input voltage | ± 200 | V |
| | pulse length | 10 | µs |
| | ultrasonic frequency | 100 | kHz |
| 15.3.1.2.2 | Types TNG 20-SP, TNG 20-LP, TNG 20-LHP and TNG 20-SHP | | |
| | Max. pulse input voltage | ± 200 | V |
| | pulse length | 5 | µs |
| | ultrasonic frequency | 200 | kHz |
| 15.3.2 | Thermal data | | |
| | temperature class T6 at | | |
| | permitted ambient temperature range of -40 °C ≤ $T_{amb}$ ≤ +55 °C | | |

(16) Test and assessment report
BVS PP 14.2061 EG as of 2014-03-17

(17) Special conditions for safe use

17.1 Since the transducers are made of titanium, suitable measures must be taken to prevent impact or friction sparcs.

17.2 Some of the dimensions of the flameproof joints of this equipment exceed the permissible minimum values or go below the permissible maximum values which are given by EN 60079-1:2007. For information concerning these dimensions contact the manufacturer.

---

We confirm the correctness of the translation from the German original.
In the case of arbitration only the German wording shall be valid and binding.

DEKRA EXAM GmbH
44809 Bochum, 2014-03-17
BVS-Hk/Sch A 20130972

Certification body

Special services unit



DEKRA EXAM GmbH Dinnendahlstrasse 9 44809 Bochum Germany Phone +49.234.3696-105 Fax +49.234.3696-110 zs-exam@dekra.com

# IECEx Certificate of Conformity

## INTERNATIONAL ELECTROTECHNICAL COMMISSION
## IEC Certification Scheme for Explosive Atmospheres

for rules and details of the IECEx Scheme visit www.iecex.com

| | | |
|---|---|---|
| Certificate No.: | IECEx BVS 14.0029X issue No.:0 | Certificate history: |
| Status: | Current | |
| Date of Issue: | 2014-03-25 Page 1 of 4 | |
| Applicant: | **RMG Messtechnik GmbH**<br>Otto-Hahn-Straße 5<br>35510 Butzbach<br>**Germany** | |
| Electrical Apparatus:<br>*Optional accessory:* | **Ultrasonic meter type USM-GT-400** | |
| Type of Protection: | **Equipment protection by flameproof enclosures "d", Equipment protection by increased safety "e"** | |
| Marking: | Ex de IIB+$H_2$ T6 Gb | |
| *Approved for issue on behalf of the IECEx Certification Body:* | H.-Ch. Simanski | |
| *Position:* | Head of Certifcation Body | |
| *Signature:*<br>*(for printed version)* | H. Ch. Simanski | |
| *Date:* | 25.3.2014 | |

1. This certificate and schedule may only be reproduced in full.
2. This certificate is not transferable and remains the property of the issuing body.
3. The Status and authenticity of this certificate may be verified by visiting the Official IECEx Website.

Certificate issued by:

**DEKRA EXAM GmbH**
**Dinnendahlstrasse 9**
**44809 Bochum**
**Germany**

DEKRA EXAM GmbH

**TÜV Technische Überwachung Hessen GmbH**
Industrie Service
Hans – Böckler – Straße 4
Telefon: 06403 / 9008 – 0

35440 Linden
Fax: 06403 / 9008 - 20

# ZERTIFIKAT

**(EU–BAUMUSTERPRÜFBESCHEINIGUNG FÜR BAUMUSTER)**
**(EU-type examination certificate – production type)**

**EU-Baumusterprüfung (Modul B für Baumuster) nach Richtlinie 2014/68/EU**
**EU-type examination (Module B - production type) according to directive 2014/68/EU**

**Zertifikat – Nr.: ISG-22-19-1497_Rev. D**

| | |
|---|---|
| **Name und Anschrift** des Herstellers: Name and postal address of the manufacturer: | **RMG Messtechnik GmbH**<br>**Otto-Hahn-Strasse 5**<br>**D-35510 Butzbach** |

**Hiermit wird bestätigt, dass das unten genannte Baumuster die Anforderungen der Richtlinie 2014/68/EU erfüllt.**
We herewith certify that the type mentioned below meets the requirements of the directive 2014/68/EU.

| | |
|---|---|
| Prüfbericht – Nr.: Test report No.: | siehe Beiblätter zu/ *see attached sheet:* ISG-22-19-1497_Rev. D |
| Bezeichnung: Designation: | Ultraschallgaszähler USZ08 / USM-GT-400<br>DN80, DN100, DN150, DN200, DN250, DN300, DN350, DN400, DN500, DN600, DN800, DN900 |
| Geltungsbereich: Scope of examination: | **Ultraschallgaszähler Typ: USZ08-6P / USM-GT-400**<br>siehe Beiblätter zu/ *see attached sheet to:* ISG-22-19-1497_Rev. D |
| Prüfobjekt: Inspection item: | druckhalt. Ausrüstungsteil (pressure accessory) |
| Kategorie: Category: | I - IV |
| Fertigungsstätte: Manufacturing plant: | Otto-Hahn-Str. 5, D-35510 Butzbach |
| Gültig bis: Valid: | **siehe Beiblätter zu/ see attached sheets to: ISG-22-19-1497_Rev. D** |
| Bemerkungen / Hinweise: Remarks / hints: | **Das Zertifikat ISG-22-19-1497_Rev. C vom 14.10.2020 ist hiermit ersetzt und verliert seine Gültigkeit!** |

Anlagen: siehe Beiblatt zu/ *see attached sheet to:* documents: ISG-22-19-1497_Rev. D

TÜV Technische Überwachung Hessen GmbH
Notified body, No.: 0091

Linden, 11.04.2022
place, date

Zertifizierer:

☐ Budesheim ☒ Dietrich ☐ S. Droß

Umseitige Hinweise beachten / see hints overleaf

ISG_22_19_1497_REV-D_RMG_B+D_USZ +USM GT-400_DN100-DN900.Docx

CSA GROUP

# Certificate of Compliance

**Certificate:** 2156089 **Master Contract:** 261288

**Project:** 70191602 **Date Issued:** January 9, 2019

**Issued to:** **RMG Messtechnik Gmbh**
**Otto-Hahn-Straße 5**
**Butzbach, 35510**
**Germany**

**Attention:** **Andreas Weigand**

***The products listed below are eligible to bear the CSA Mark shown with adjacent indicators 'C' and 'US' for Canada and US or with adjacent indicator 'US' for US only or without either indicator for Canada only***

C US

**Issued by:** Rob Oldfield

**PRODUCTS**

**CLASS 2258 02** – PROCESS CONTROL EQUIPMENT – For Hazardous Locations
**CLASS 2258 82** – PROCESS CONTROL EQUIPMENT – For Hazardous Locations – Certified to US Standards

**Class I, Division 1, Groups B, C and D:**

Ultrasonic Flowmeter Model USM-GT-400 with transducers TNG 10-CP, 20-SP and 20-LP (Operating pressure ≤ 150 bar / 2175 psi) or 10-CHP, 20-SHP and 20-LHP (Operating pressure ≤ 300 bar / 4351 psi). Sizes DN80 (3") to DN1000 (40"). Input rated 24Vdc max, 0.5A, 12.0W, Class-2 circuits only; -40°C to +40/55 ambient, temperature code rating T6/T5. Process temperature ≤ 80°C.

**Conditions of Acceptability**

i. For Canadian installation, to reduce the risk of ignition of hazardous atmospheres, conduit must be sealed at the enclosure.
ii. For US installation, to reduce the risk of ignition of hazardous atmospheres, conduit runs must have a sealing fitting connected within 18 inches of the enclosure.

DQD 507 Rev 2018-11-12  Page 1

**Certificate:** 2156089 **Master Contract:** 261288

**Project:** 70191602 **Date Issued:** January 9, 2019

## APPLICABLE REQUIREMENTS

| | | |
|---|---|---|
| CAN/CSA-C22.2 No. 0-M91 | - | General Requirements – Canadian Electrical Code, Part II |
| CSA C22.2 No. 30-M1986 | - | Explosion-Proof Enclosures for Use in Class I Hazardous Locations |
| CSA C22.2 No. 142-M1987 | - | Process Control Equipment |
| UL 916 (4th Ed.) December 2007 | - | Energy Management Equipment |
| UL 1203 (4th Ed.) September 2006 | - | Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations |

## MARKINGS

The manufacturer is required to apply the following markings:

- Products shall be marked with the markings specified by the particular product standard.
- Products certified for Canada shall have all Caution and Warning markings in both English and French.

Additional bilingual markings not covered by the product standard(s) may be required by the Authorities Having Jurisdiction. It is the responsibility of the manufacturer to provide and apply these additional markings, where applicable, in accordance with the requirements of those authorities.

The products listed are eligible to bear the CSA Mark shown with adjacent indicators 'C' and 'US' for Canada and US (indicating that products have been manufactured to the requirements of both Canadian and U.S. Standards) or with adjacent indicator 'US' for US only or without either indicator for Canada only.

Enclosure (main nameplate) - required marking information is as shown below and are laser etched onto a metallic plate having a minimum thickness of 0.02 in, which is secured to the enclosure by screws or rivets:

- CSA Monogram with adjacent indicators C and US;
- Company name (RMG Messtechnik GmbH);
- Model number;
- Serial number or date code;
- Electrical rating;
- Hazardous location designation;
- Temperature code rating;
- Minimum and maximum ambient;
- Maximum working Pressure (MWP);
- Conditions of Acceptability in accordance with the product section of this report.
- Caution: "Do not opening the electronic housing cover under electrical voltage when and explosive gas atmosphere is present. Wait at least 1 minute after switch off before opening the case."

Note: Nameplate drawing 064892.4 is for company RMG Messtechnik GmbH, of which Mercury Instruments are a subsidiary, and includes a CSA MC/File number.

Transducer housings are to be marked with a serial number allowing them to be linked with the transducer housing type.

Physikalisch-Technische Bundesanstalt
Nationales Metrologieinstitut

KBS
Konformitätsbewertungsstelle

# EU-Baumusterprüfbescheinigung

*EU Type-examination Certificate*

| | |
|---|---|
| Ausgestellt für:<br>*Issued to:* | RMG Messtechnik GmbH<br>Otto-Hahn-Str. 5<br>35510 Butzbach |
| gemäß:<br>*In accordance with:* | Anhang II Modul B der Richtlinie 2014/32/EU des Europäischen Parlaments und des Rates vom 26. Februar 2014 zur Harmonisierung der Rechtsvorschriften der Mitgliedstaaten über die Bereitstellung von Messgeräten auf dem Markt.<br>*Annex II Module B of the Directive 2014/32/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of measuring instruments.* |
| Geräteart:<br>*Type of instrument:* | Gaszähler<br>*Gas meter* |
| Typbezeichnung:<br>*Type designation:* | USM-GT-400 |
| Nr. der Bescheinigung:<br>*Certificate No.:* | DE-14-MI002-PTB002, Revision 7 |
| Gültig bis:<br>*Valid until:* | 11.02.2028 |
| Anzahl der Seiten:<br>*Number of pages:* | 30 |
| Geschäftszeichen:<br>*Reference No.:* | PTB-1.42-4118457 |
| Notifizierte Stelle:<br>*Notified Body:* | 0102 |

Zertifizierung:
*Certification:*
Braunschweig, 06.03.2024

Im Auftrag
*On behalf of PTB*
*Dr. Bodo Mickan*

Siegel
*Seal*

Bewertung:
*Evaluation:*
Im Auftrag
*On behalf of PTB*
*Dr. Roland Schmidt*

R3-072097

TÜV PROFI CERT

TÜV HESSEN

# CERTIFICATE

for a management system as per

**Pressure Equipment Directive 2014/68/EU Module D**

Evidence of conformity has been furnished.

RMG

ONE STEP AHEAD

RMG Messtechnik GmbH
Otto-Hahn-Straße 5
35510 Butzbach
Germany

scope:

Production of gas meters and
associated items of equipment

Certificate registration No. **73 202 2839** Certificate valid from 2021-07-26 to **2024-07-15**

Audit report No. 4383 6173

ZLS
ZLS-NB-0223

Darmstadt, 2021-07-26
Certification body of TÜV Hessen
– Head of Certification body –

PAGE 1 OF 1.
*previous certificate was valid until 2021-07-15
This certification confirms the introduction and maintenance of the Management system specified above and is monitored regularly. The manufacturer is entitled to provide in the context of the scope of pressure equipment devices with CE-marking with the identification number 0091 of the notified body of TÜV Hessen.
The current validity is verifiable at www.proficert.com. Original certificates contain a glued hologram.
TÜV Technische Überwachung Hessen GmbH, Robert-Bosch-Strasse 16, D-64293 Darmstadt, Germany, Phone +49 6151/600331 Rev-GB-2007

Physikalisch-Technische Bundesanstalt
Nationales Metrologieinstitut

KBS
Konformitätsbewertungsstelle

# Zertifikat
*Certificate*

**über die Anerkennung eines Qualitätssicherungssystems**
*on the approval of a quality system*

| | |
|---|---|
| Ausgestellt für:<br>*Issued to:* | RMG Messtechnik GmbH<br>Otto-Hahn-Str. 5<br>35510 Butzbach |
| gemäß:<br>*In accordance with:* | Mess- und Eichverordnung vom 11. Dezember 2014 (MessEV)<br>*Measures and Verification Ordinance dated 11 December 2014 (MessEV)*<br>in Verbindung mit<br>*in connection with*<br><br>- Richtlinie **2014/32/EU** vom 26. Februar 2014 (MID)<br>*- Directive **2014/32/EU** of 26 February 2014 (MID)* |
| Messgröße lt. MessEV § 1:<br>*Measurand acc. to Measures and Verification Ordinance, section 1:* | Volumen<br>*Volume*<br>Sonstige Messgrößen bei der Lieferung von strömenden Flüssigkeiten oder strömenden Gasen<br>*Other measurands in the supply of flowing liquids or flowing gases* |
| Nr. des Zertifikats:<br>*Certificate No.:* | DE-M-AQ-PTB023, Revision 5 |
| Gültig bis:<br>*Valid until:* | 08.02.2027 |
| Anzahl der Seiten:<br>*Number of pages:* | 6 |
| Geschäftszeichen:<br>*Reference No.:* | PTB-9.22-4116650 |
| Nr. der Stelle:<br>*Body No.:* | 0102 |

Im Auftrag
*On behalf of PTB*

*Markus Ulmer*

Braunschweig, 09.02.2024

Siegel
*Seal*

PHYSIKALISCH-TECHNISCHE BUNDESANSTALT

R3-027579

Physikalisch-Technische Bundesanstalt
Nationales Metrologieinstitut

KBS
Konformitätsbewertungsstelle

Seite 2 des QS-Anerkennungszertifikats Nr. DE-M-AQ-PTB023, Revision 5 vom 09.02.2024
*Page 2 of the QS Approval Certificate No. DE-M-AQ-PTB023, Revision 5 dated 09.02.2024*

## Zertifikatsgeschichte

*History of the Certificate*

| **Zertifikats-Ausgabe** *Issue of the Certificate* | **Datum** *Date* | **Änderungen** *Modifications* |
|---|---|---|
| DE-09-AQ-PTB023MID | 09.02.2009 | Erstbescheinigung *Initial certificate* |
| DE-09-AQ-PTB023, Revision 01 | 01.10.2009 | 1. Revision, Erweiterung des Geltungsbereichs um Gaszähler *Extension of the scope to Gas Meter* |
| DE-12-AQ-PTB023 | 09.02.2012 | 1. Reanerkennung, Verlängerung der Gültigkeit um 3 Jahre *1st reapproval, prolongation for another 3 years* |
| DE-M-AQ-PTB023 | 09.02.2015 | 2. Reanerkennung nach MID und Erweiterung des Geltungsbereichs nach Anhang 4 Modul D der Mess- und Eichverordnung *2nd reapproval according to MID and extension of the scope according to Annex 4 Module D of the Measures and Verification Ordinance* |
| DE-M-AQ-PTB023, Revision 1 | 12.06.2017 | 1. Revision, Erweiterung mit dem Standort-Aldingen *Extension of the scope to location Aldingen* |
| DE-M-AQ-PTB023, Revision 2 | 09.02.2018 | 3. Reanerkennung, Verlängerung der Gültigkeit um 3 Jahre *3rd reapproval, prolongation for another 3 years* |
| DE-M-AQ-PTB023, Revision 3 | 23.11.2020 | Erweiterung mit dem Standort Pardubice/CZ *Extension of the scope to location Pardubice/CZ* |
| DE-M-AQ-PTB023, Revision 4 | 09.02.2021 | 4. Reanerkennung, Verlängerung der Gültigkeit um 3 Jahre *4th reapproval, prolongation for another 3 years* |
| DE-M-AQ-PTB023, Revision 5 | 09.02.2024 | 5. Reanerkennung, Verlängerung der Gültigkeit um 3 Jahre *5th reapproval, prolongation for another 3 years* |

Diese Revision 5 ersetzt die Revision 4 des Zertifikats Nr. DE-M-AQ-PTB023 vom 09.02.2021, Geschäftszeichen PTB-9.22-4103484.
*This Revision 5 replaces Revision 4 to Certificate No. DE-M-AQ-PTB023 dated 09.02.2021, Reference No. PTB-9.22-4103484*

Physikalisch-Technische Bundesanstalt
Nationales Metrologieinstitut

KBS
Konformitätsbewertungsstelle

Seite 3 des QS-Anerkennungszertifikats Nr. DE-M-AQ-PTB023, Revision 5 vom 09.02.2024
*Page 3 of the QS Approval Certificate No. DE-M-AQ-PTB023, Revision 5 dated 09.02.2024*

## Vorbemerkungen

*Preliminary remarks*

Die Konformitätsbewertungsstelle der Physikalisch-Technischen Bundesanstalt (PTB) bescheinigt mit diesem Zertifikat, dass das Qualitätssicherungssystem in dem in diesem Zertifikat genannten Geltungsbereich den folgenden Anforderungen entspricht:

*By means of this certificate, the Conformity Assessment Body of the Physikalisch-Technische Bundesanstalt (PTB) certifies that the Quality System complies - within the scope of validity specified in this Certificate - with the following requirements:*

- Anlage 4 **Modul D der Mess- und Eichverordnung** vom 11.12.2014 (BGBl. I S. 2010) in der derzeit geltenden Fassung, Absätze 3.2 und 3.3
  *Annex 4 **Module D of the Measures and Verification Ordinance** dated 11.12.2014 (Federal Law Gazette – BGBl. I p. 2010) in the currently valid version, sections 3.2 and 3.3*
- Anhang II **Modul D der Richtlinie 2014/32/EU** des Europäischen Parlaments und des Rates vom 26. Februar 2014 zur Harmonisierung der Rechtsvorschriften der Mitgliedstaaten über die Bereitstellung von Messgeräten auf dem Markt (ABl L 96 S. 149) in der derzeit geltenden Fassung, Abs. 3.2.
  *Annex II **Module D of Directive 2014/32/EU** of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of measuring instruments (OJ L 96 p. 149), ) in the currently valid version, para. 3.2.*

Der Zertifikatsinhaber ist berechtigt, die Kennzeichnung für die im Geltungsbereich dieses anerkannten Qualitätssicherungssystems gefertigten Messgeräte mit der PTB-Kennnummer 0102 zu versehen. Die Bewertung basiert auf einer Begutachtung der eingereichten Dokumente und einem Audit im Unternehmen. Das Qualitätssicherungssystem unterliegt der laufenden Überwachung der Konformitätsbewertungsstelle.

*The owner of this certificate is entitled to provide the marking of the measuring instruments which have been produced within the scope of validity of this approved Quality System with the PTB identification number 0102. The assessment is based on an evaluation of the submitted documents and on an audit on site. The quality system is subject to permanent surveillance by the Conformity Assessment Body.*

Physikalisch-Technische Bundesanstalt
Nationales Metrologieinstitut

KBS
Konformitätsbewertungsstelle

Seite 4 des QS-Anerkennungszertifikats Nr. DE-M-AQ-PTB023, Revision 5 vom 09.02.2024
*Page 4 of the QS Approval Certificate No. DE-M-AQ-PTB023, Revision 5 dated 09.02.2024*

## Standorte und Gerätearten

*Sites and kinds of instruments*

Standort 1:
*Site 1:*

RMG Messtechnik GmbH
Otto-Hahn-Str. 5
35510 Butzbach
DEUTSCHLAND

Messgerätearten:
*Kinds of measuring instruments:*

EU-Gaszähler
*EU gas meters*

EU-Gasmengenumwerter (TG)
*EU volume conversion devices for gas (sub-assembly)*

ZE: getrennt und integriert angeordnete Zusatzeinrichtungen für Gaszähler oder Mengenumwerter
*Additional device: Additional devices for gas meters or volume conversion devices arranged separately and in an integrated way*

ZE: Gebergeräte für Zählwerkstände
*Additional device: Transmitter units for meter reading*

Brennwertmessgeräte
*Calorific value determination devices*

Gasbeschaffenheitsmessgeräte
*Devices to determine the gas quality*

ZE: Schnittstellenwandler
*Additional device: Interface converter*

Physikalisch-Technische Bundesanstalt
Nationales Metrologieinstitut

KBS
Konformitätsbewertungsstelle

Seite 5 des QS-Anerkennungszertifikats Nr. DE-M-AQ-PTB023, Revision 5 vom 09.02.2024
*Page 5 of the QS Approval Certificate No. DE-M-AQ-PTB023, Revision 5 dated 09.02.2024*

| | |
|---|---|
| Standort 2:<br>*Site 2:* | RMG Messtechnik GmbH<br>Heinrich-Lanz-Str. 9<br>67259 Beindersheim<br>DEUTSCHLAND |
| Messgerätearten:<br>*Kinds of measuring instruments:* | EU-Gasmengenumwerter (TG)<br>*EU volume conversion devices for gas (sub-assembly)*<br><br>ZE: Dichte-Mengenumwerter<br>*Additional device: Density conversion device*<br><br>ZE: getrennt und integriert angeordnete Zusatzeinrichtungen für Gaszähler oder Mengenumwerter<br>*Additional device: Additional devices for gas meters or volume conversion devices arranged separately and in an integrated way*<br><br>ZE: Brennwert-Mengenumwerter<br>*Additional device: Energy conversion device*<br><br>ZE: Langzeitspeicher<br>*Additional device: Long-term storage*<br><br>EU-Gaszähler<br>*EU gas meters*<br><br>Gasbeschaffenheitsmessgeräte<br>*Devices to determine the gas quality* |
| Standort 3:<br>*Site 3:* | ELGAS, s.r.o.<br>Semitínská 211<br>CZ-53353 Pardubice |
| Messgerätearten:<br>*Kinds of measuring instruments:* | EU-Gasmengenumwerter (TG)<br>*EU volume conversion devices for gas (sub-assembly)*<br><br>ZE: getrennt und integriert angeordnete Zusatzeinrichtungen für Gaszähler oder Mengenumwerter<br>*Additional device: Additional devices for gas meters or volume conversion devices arranged separately and in an integrated way* |

Physikalisch-Technische Bundesanstalt
Nationales Metrologieinstitut

KBS
Konformitätsbewertungsstelle

Seite 6 des QS-Anerkennungszertifikats Nr. DE-M-AQ-PTB023, Revision 5 vom 09.02.2024
*Page 6 of the QS Approval Certificate No. DE-M-AQ-PTB023, Revision 5 dated 09.02.2024*

| | |
|---|---|
| Standort 4:<br>*Site 4:* | Vier Gas Services GmbH & Co.KG, pigsar™<br>Haltener Str. 125<br>46284 Dorsten<br>DEUTSCHLAND |
| Messgerätearten:<br>*Kinds of measuring instruments:* | EU-Gaszähler<br>*EU gas meters* |
| Standort 5:<br>*Site 5:* | qbig GmbH<br>Brenzstraße. 3<br>26789 Leer<br>DEUTSCHLAND |
| Messgerätearten:<br>*Kinds of measuring instruments:* | EU-Gaszähler<br>*EU gas meters* |

Die Konformitätsbewertungsstelle führt eine Liste der von diesem Zertifikat abgedeckten Messgerätetypen. Die Liste wird laufend aktualisiert und dem Inhaber des Zertifikats zugeschickt.
*The Conformity Assessment Body maintains a list of the measuring instrument types covered by this Certificate. This list will be kept up to date and sent to the owner of the Certificate.*

DEKRA

1

# Production Quality Assurance Notification

2 Equipment and Protective Systems intended for use in potentially explosive atmospheres
Directive 2014/34/EU
Annex IV - Module D: Conformity to type based on quality assurance of the production process
Annex VII - Module E: Conformity to type based on product quality assurance

3 Notification number: **BVS 20 ATEX ZQS/E139**

4 Product category: **Equipment and components**
**equipment-group II, category 2G: Manufacturing and sale of Volume Meters, Electronic Correctors and Gas Analysers, Electrical equipment and devices**

RMG
ONE STEP AHEAD

5 Manufacturer: **RMG Messtechnik GmbH**

6 Address: **Otto-Hahn-Strasse 5, 35510 Butzbach, Germany**

Site(s) of manufacture: **RMG Messtechnik GmbH, Otto-Hahn-Strasse 5, 35510 Butzbach, Germany**
**RMG Messtechnik GmbH, Heinrich-Lanz-Strasse 9, 67259 Beindersheim, Germany**

7 The certification body of DEKRA Testing and Certification GmbH, Notified Body No 0158 in accordance with Article 17 of the Council Directive 2014/34/EU of 26 February 2014 notifies that the manufacturer has a production quality system, which complies with Annex IV of the Directive.
This quality system in compliance with Annex IV of the Directive also meets the requirements of Annex VII.
In the updated annex all products covered by this notification and their type examination certificate numbers are listed.

8 This notification is based on audit report ZQS/E139/20 issued 2020-11-20.
Results of periodical re-assessments of the quality system are a part of this notification.

9 This notification is valid from 2020-10-28 until 2023-10-28 and can be withdrawn if the manufacturer does not satisfy the production quality assurance surveillance according to Annex IV and VII.

10 According to Article 16 (3) of the Directive 2014/34/EU the CE marking shall be followed by the identification number 0158 of DEKRA Testing and Certification GmbH as notified body involved in the production control phase.

DEKRA Testing and Certification GmbH
Bochum, 2020-11-20

Managing Director

This is a translation from the German original.
In the case of arbitration only the German wording shall be valid and binding.

# OIML Certificate

**OIML Member State**
The Netherlands

Number R137/2012-A-NL1-23.04 revision 1
Project number 3711995
Page 1 of 5

| | |
|---|---|
| Issuing authority | NMi Certin B.V.<br>Person responsible: M.Ph.D. Schmidt |
| Applicant and Manufacturer | RMG Messtechnik GmbH<br>Otto-Hahn-Strasse 5<br>35510 Butzbach<br>Germany |
| Identification of the certified type | An **ultrasonic gas meter**<br>Manufacturers mark: RMG Messtechnik GmbH<br>Type: USM-GT400 |
| Characteristics | See following page(s) |

This OIML Certificate is issued under scheme A.

This Certificate attests the conformity of the above identified type (represented by the samples identified in the OIML Type Evaluation Report) with the requirements of the following Recommendation of the International Organization of Legal Metrology (OIML):

**R 137-1:2012** "Gas meters"

Accuracy class 0,5

This Certificate relates only to the metrological and technical characteristics of the type of measuring instrument covered by the relevant OIML International Recommendation identified above.
This Certificate does not bestow any form of legal international approval.

Important note: Apart from the mention of the Certificate's reference number and the name of the OIML Member State in which the Certificate was issued, partial quotation of the Certificate and of the associated OIML Type Evaluation Report(s) is not permitted, although either may be reproduced in full.

Issuing Authority **NMi Certin B.V., OIML Issuing Authority NL1**
5 January 2024

Certification Board

NMi Certin B.V.
Thijsseweg 11
2629 JA Delft
the Netherlands
T +31 88 636 2332
certin@nmi.nl
www.nmi.nl

*Subject to technical modification.*

**For further information**

If you would like to learn more about
The products and solutions from RMG,
visit our website:

www.rmg.com

or contact your local sales representative.

**RMG Messtechnik GmbH**
Otto-Hahn-Straße 5
35510 Butzbach, Germany
Tel: +49 6033 897 – 0
Fax: +49 6033 897 – 130
Email: service@rmg.com

ONE STEP AHEAD