Ultrasonic Flowmeter USM GT400

OPERATING INSTRUCTION

Reliable Measurement of Gas

Read the instructions before starting work!

Version: 08
Firmware: 1.5

Manufacturer

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Original Document

The Ultrasonic Flowmeter USM GT400 OPERATING INSTRUCTION 14/10/2019 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.

Note

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

www.rmg.com

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1 About this manual

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

Contents

1.1 Objective of the 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

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 39*

1.3 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

1.4 Symbols

The following symbols are used:

1, 2, ...	Marks steps within a work operation.
1	Marks steps in an illustration that are described in the text.
(A)	Reference to a component (element) marked with a letter in an illustration.
A	Marks elements in an illustration. The arrow points to the element being described.
⇨	Marks a cross-reference that refers to another part in this manual or in another document.
Print Screen	Marks switches, regulators, slides, buttons and other terms from the software are marked by bold text.

1.5 Validity of the manual

This manual describes the Ultrasonic Flowmeter USM GT400.

The Ultrasonic Flowmeter USM GT400 device is only a part of a complete on site system. Observe also the instructions of other components of the site system.

If you find contradicting instructions, please contact RMG.

2 Brief instructions

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 37*

Detailed information for this content can be found under:

⇨ *Section 7, "Construction and Planning" on page 65*
⇨ *Section 8, "Installation" on page 77*
⇨ *Section 9, "Start Up" on page 115*
⇨ *Section 12.4, "Troubleshooting" on page 157*

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 to 5 D[1]

1 Depending on the nominal width.

– *See also "Inner diameter of connecting spool pieces" on page 168*

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 in order 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

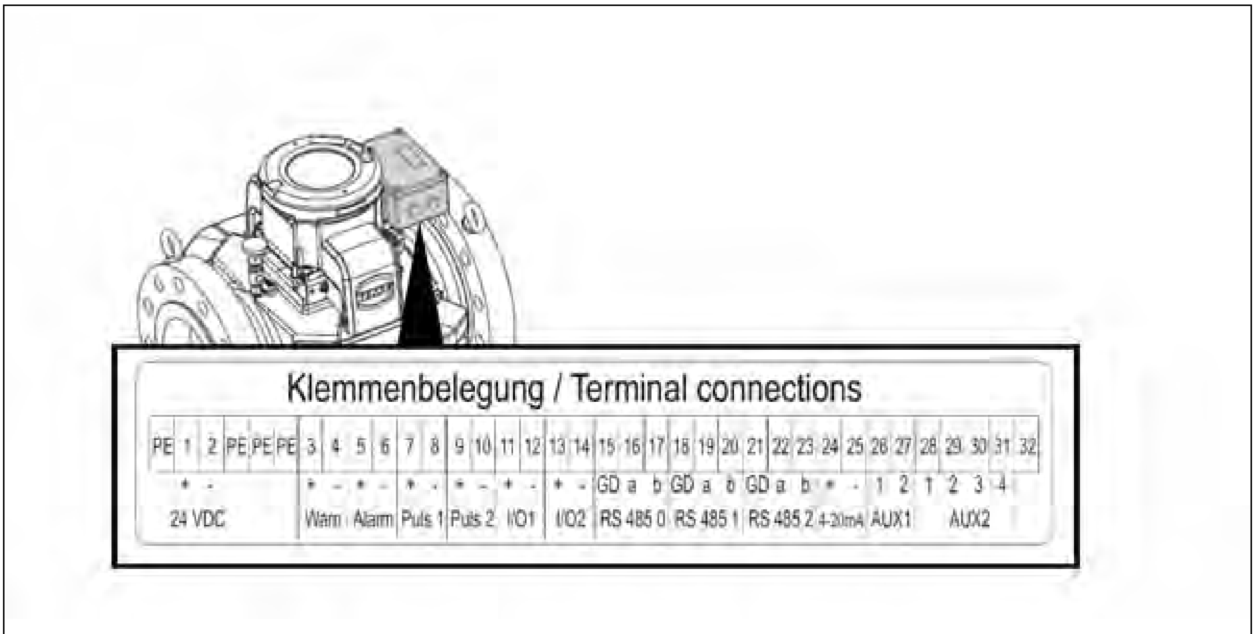


Fig. 2-1: Connection assignment on the terminal strip

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 485-1**.

2.3 Start Up

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

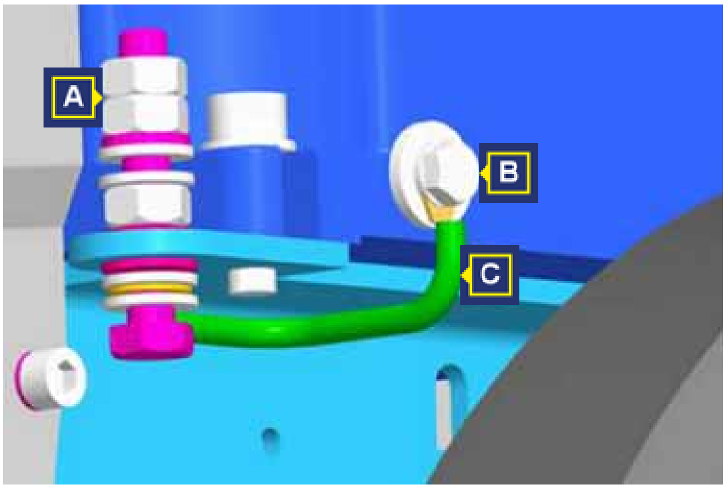
If the power LED illuminates green permanently, the device is ready for operation.

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

⇨ *Section 3.1, "Light emitting diodes" on page 14*

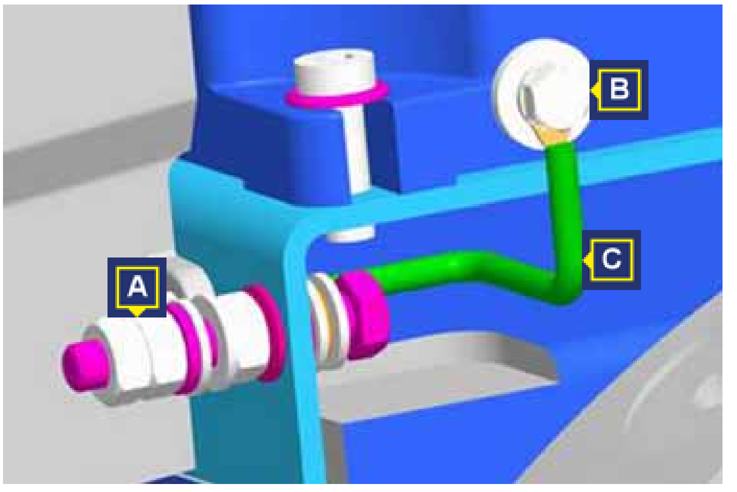
The USM-GT-400 is supplied without connection box to the North American region, the connection is made to cables that are led through a flame arrester. The marking of the cable (numbers) is (always) identical to the terminal assignment.

2.4 Earthing



A Earthing screw M6
B Earthing screw M6
C Earthing cable

Fig. 2-2: Connect to earth - Ultrasonic gas meters DN150 (6") and DN100 (4")



A Earthing screw M6 B Earthing screw M6
C Earthing cable

Fig. 2-3: Connect to earth - Ultrasonic gas meter ≥ 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:

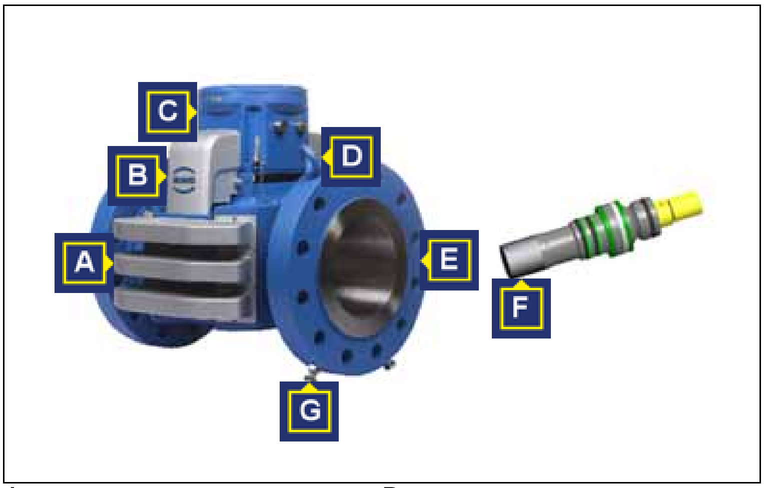
⇨ *Section 10.1.3, "Calibration and Service Switch" on page 119*

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.

Contents

3.1 Main components



A Covers of the transducer and transducer lines
B Covers of the transducer lines
C Ultrasonic electronics
D Lifting eyes
E Joining flanges
F Transducer
G 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 (A and B) The covers protect the connections and the lines of the transducer (TD) against contamination and mechanical damage.

Ultrasonic electronics (C) 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 RMGView^{USM} software.

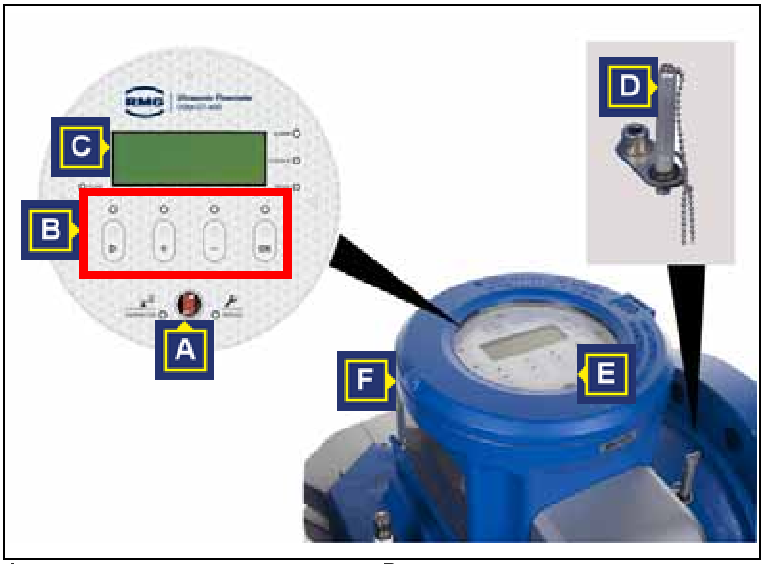
Lifting eyes (D) The lifting eyes can be used to safely transport the device using a suitable lifting gear.

Connection flange (E) The device is bolted onto the gas line using the connection flanges.

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

Retaining bolts (G) 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



A Service and calibration switch
B Control panel
C Display
D Magnet for operation
E Cover with viewing window
F 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 (A)

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 (B)

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 (C)

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

Magnet for operation (D)

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 (E and F)

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 84*

Display screen

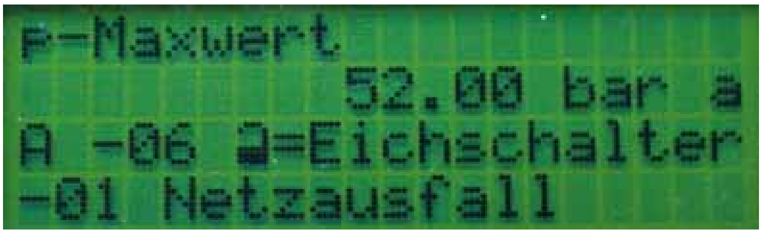


Fig. 3-3: Example for a possible display

First line

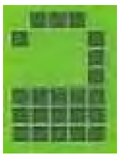
Shows the name of the parameter (coordinates) called-up, e.g., p-maximum value (maximum pressure value).

Second line

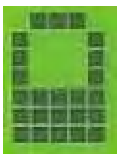
Shows the value of the parameter (coordinates) called-up, e.g., 52.00 bar a.

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 magnets supplied. The cover must not be opened.

Change to the columns. Jump, e.g., from A to B and back again.

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

Change 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.

Change or scroll back 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 with quick return.

Enter values.

Reset button

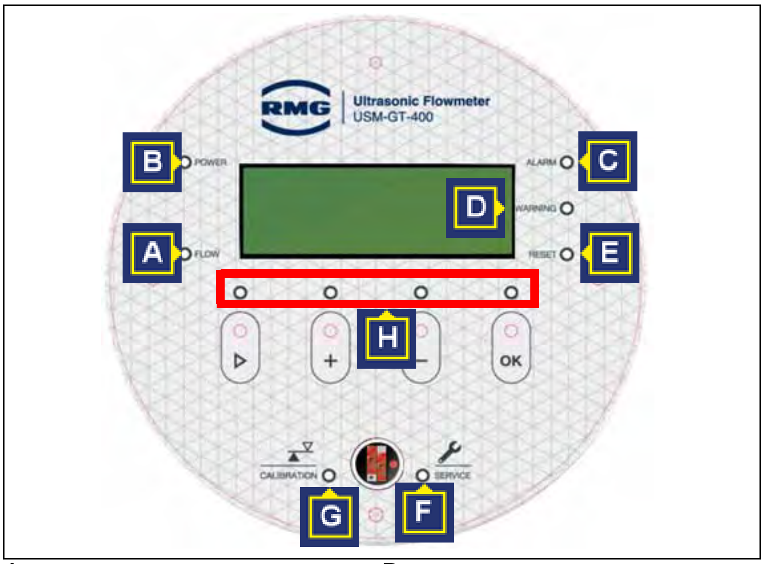
The reset button **(A)** is for RMG service only. If the reset button is pressed, the ultrasonic electronics is restarted.

Switches

Calibration switch (A): Activate to change parameters.

Service switch (B): For RMG service only. For installing a new firmware.

Light emitting diodes



A	Flow	B	Power (supply voltage)
C	Alarm	D	Warning
E	Reset	F	Service (service switch state)
G	Calibration (calibration switch state)	H	Button states

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

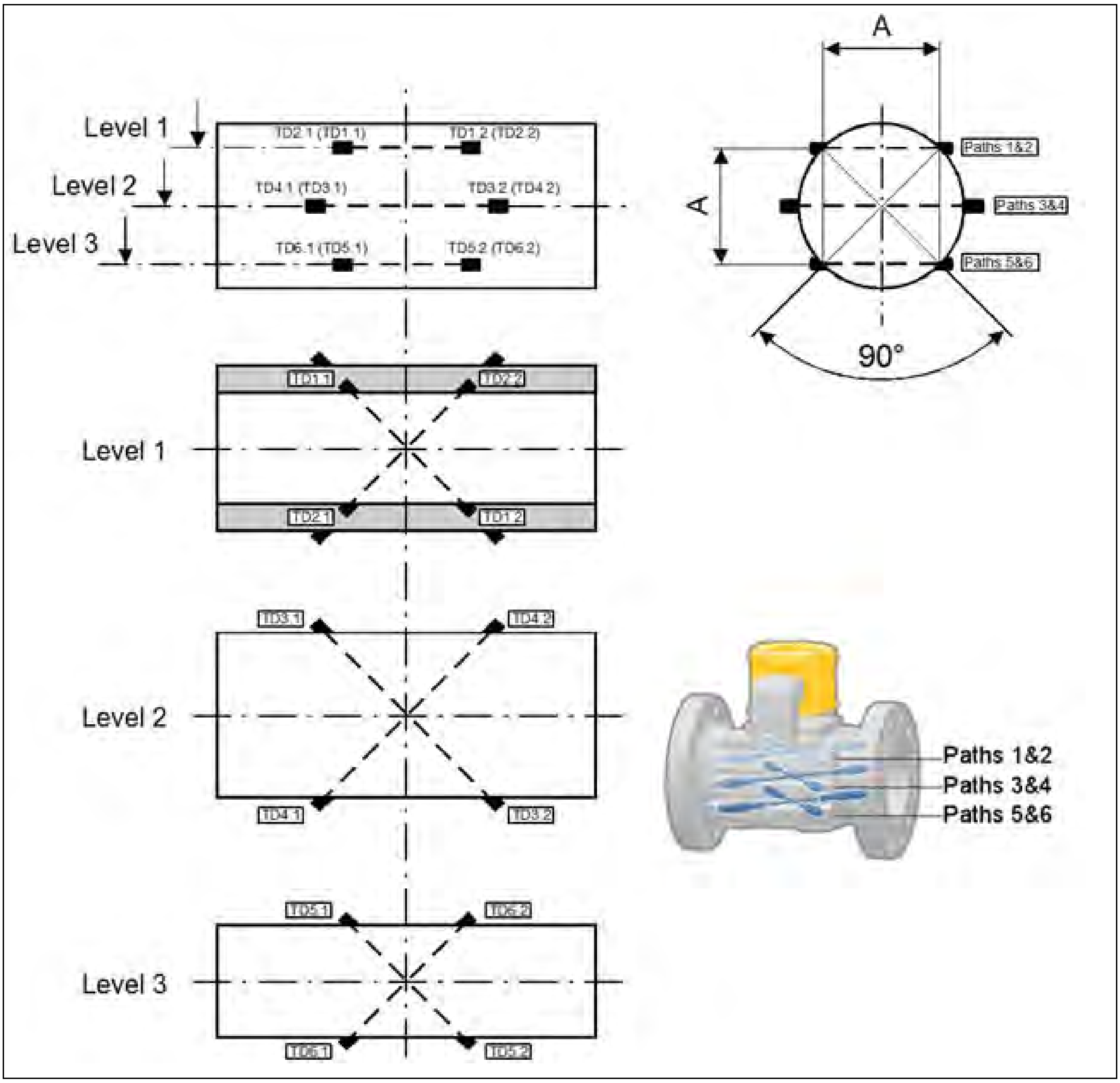


Fig. 3-5: Transducer paths and levels of the ultrasonic gas meter

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 $\bar{v}$ shows the direction of flow.

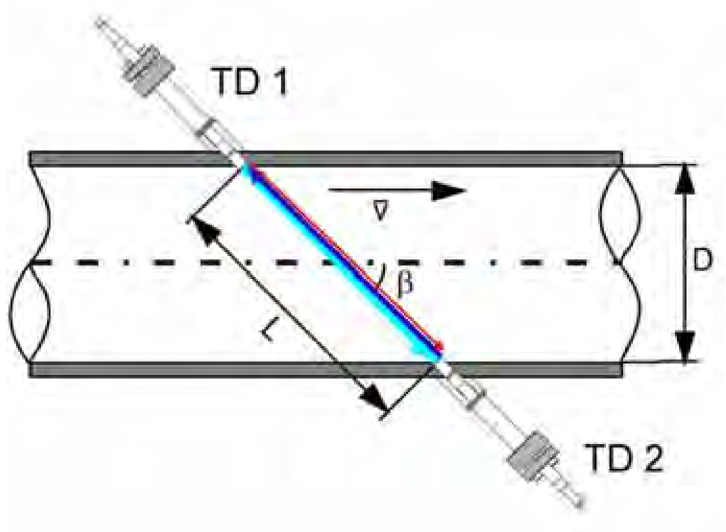


Fig. 4-1: Two sensors form one path for the measurement

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

Formulas

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

Fig. 4-2: Formula, transit time

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

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

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

Fig. 4-3: Formula, average path velocity

Legend

$\bar{v}$:	Average flow velocity
c_0:	Speed of sound
β:	Path angle to the pipe
L:	Path length

d:	Diameter D (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 15*

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:

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

Fig. 4-4: Formula, corrected path velocity

Legend

$\mathbf{v_{ki}}$	=	Corrected path velocity	(m/s)
k	=	Correction factor for the path velocities (This factor is named vw factor d1for the forward direction and vw factor d2 for back-flow; see chapter parameter setting 10.5.4)	

Thus, one obtains for the average flow velocity:

$$v_w = \sum_{i=1}^{6} w_i \cdot v_{ki}$$

Fig. 4-5: Formula, flow velocity

Legend

$\mathbf{v_w}$	=	Average flow velocity	(m/s)
$\mathbf{w_i}$	=	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 σ_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:

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

Fig. 4-6: Variance

$$Tu_i = \frac{\sigma_i}{\left|\bar{v}_i\right|}$$

Fig. 4-7: Turbulence

Legend

$\bar{v}_i$	=	Time averaged flow velocity along the ultrasonic path
$v_{j,i}$	=	Flow velocity along the ultrasonic path
N	=	20; number of values for turbulence calculation (named Turb./Perf. count; see chapter parameter)

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.

$$PF = \frac{2(\bar{v}_3 + \bar{v}_4)}{(\bar{v}_1 + \bar{v}_2) + (\bar{v}_5 + \bar{v}_6)}$$

Fig. 4-8: 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.

$$SY = \frac{(\bar{v}_1 + \bar{v}_2)}{(\bar{v}_5 + \bar{v}_6)}$$

Fig. 4-9: 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).

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

Fig. 4-10: Meter performance

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 fall down to 66%; if the path failure is caused by a defect transducer an immediate repair of the failed transducers should to 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 (eg. Reynolds number) resulting in a not exactly proportional relation between the measured and according to the formula 4.5 calculated mean velocity to the exact mean velocity. Here the following correction helps to compensate these variations:

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

Bild 4-11: Formula, corrected average flow velocity

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:

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

Fig. 4-12: Formula, process volume flow

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

Fig. 4-13: Formula, corrected process volume flow

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

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

Fig. 4-14: Formula - Basic correction of the device

Legend

F_1	=	Deviation of the error curve	(%)

v_w	=	Average flow velocity	(m/s)
const-Gx	=	Constants of the basic correction (x = m2, m1, 0, 1, 2)	

The constants const-G_x (x = m2, m1, 0, 1, 2) are calculated from the measured value pairs of the deviation with the respective flow velocity.

The calculated correction F_1 is used for the corrected average flow velocity for F in the formula above.

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

Fig. 4-15: Formula, corrected meter factor

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.

Polynomial

The characteristic curve correction is also carried out via a 4th degree polynomial that represents the error curve of the device.

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

Fig. 4-16: Formula, error equation

F_2	=	Deviation from the error curve	(%)
Q_m	=	Flow	(m3/h)
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.

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

Fig. 4-17: Formula, characteristic curve correction

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 mets 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:

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

Fig. 4-18: Calculation of SoS

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.

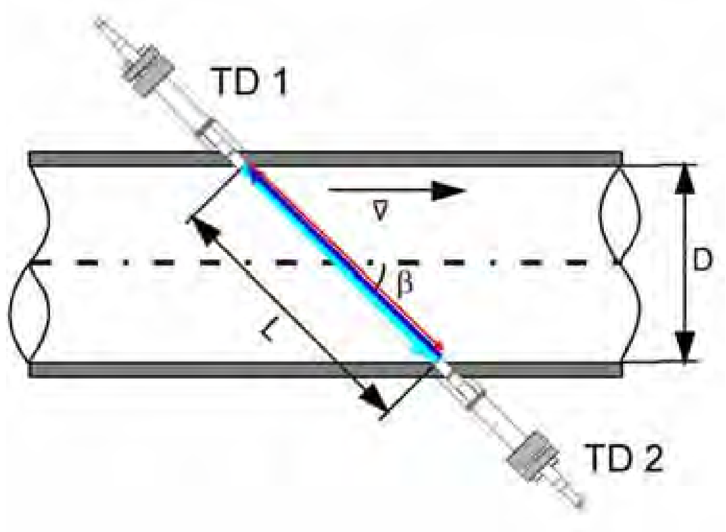


Fig. 4-19: Extended SoS calculation

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 :

$$
\begin{aligned}
SoS &= c_0 \\
&= \frac{L}{2} \cdot \frac{t_{TD12} + t_{TD21}}{t_{TD12} \cdot t_{TD21}} \\
&= \frac{L}{2} \cdot \frac{t_{TD12\ \ 21\ \ 12} - t_{TD12}}{t_{TD12} \cdot \left(t_{TD12\ \ 21\ \ 12} - 2 \cdot t_{TD12}\right)}
\end{aligned}
$$

Fig. 4-20: Calculation of extended SoS

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 12TDt and 21TDt 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:

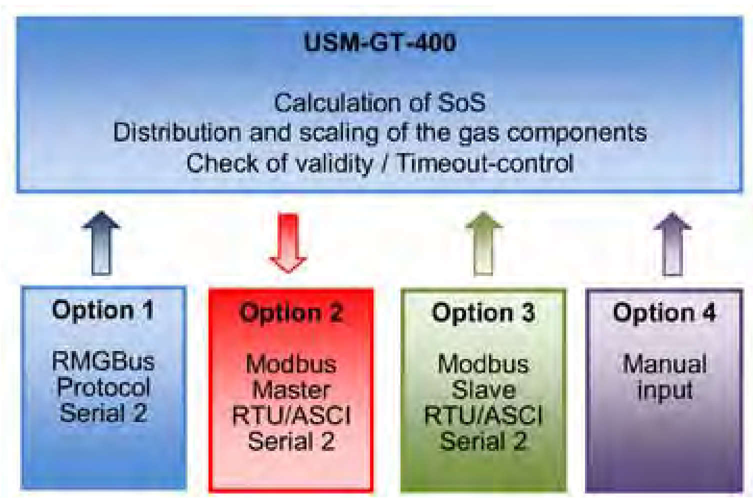


Fig. 4-21: Import of gas composition data

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-11and to be confirmed in "takeover gas components". Only then they will be taken over as new values for the AGA-10 calculation.

1. Parameter AX-01 „AGA-10 Sourse“

   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 Option 4: 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** "AGA-10 source":

   "Default air"

2. Setting of the default values relative humidity

   Paramater **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.

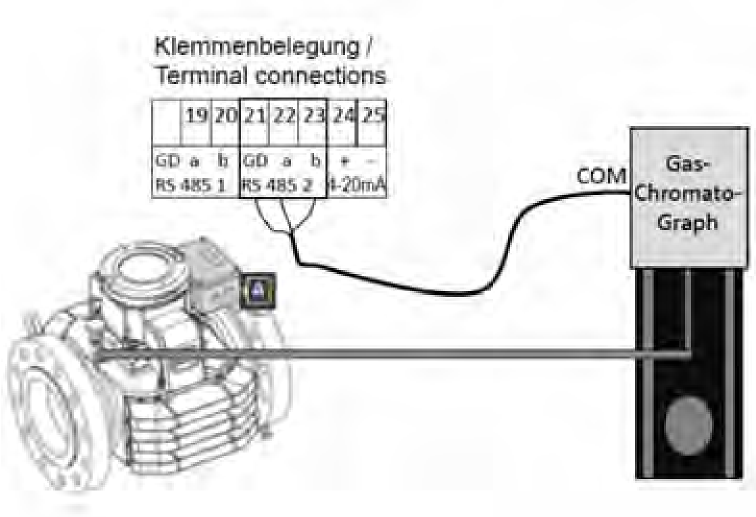


Fig. 4-22: Terminal connections

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**.

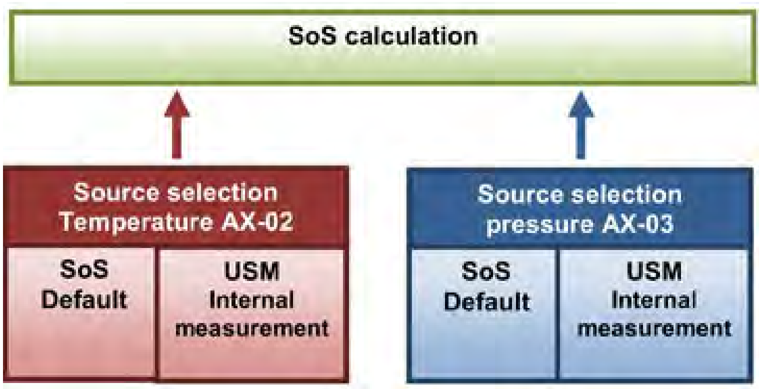


Fig. 4-23: Pressure and Temperature input

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. Setting the parameters of serial 2:

   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-GT-400 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 protocol 2"

   J-30 Modbus2 HW Fashion
4. Parameter **AX-01** "AGA-10 source":

   "Serial port 2"
5. Parameter **J-25** "Opt. Ser2 mode"

   "Modbus Master"

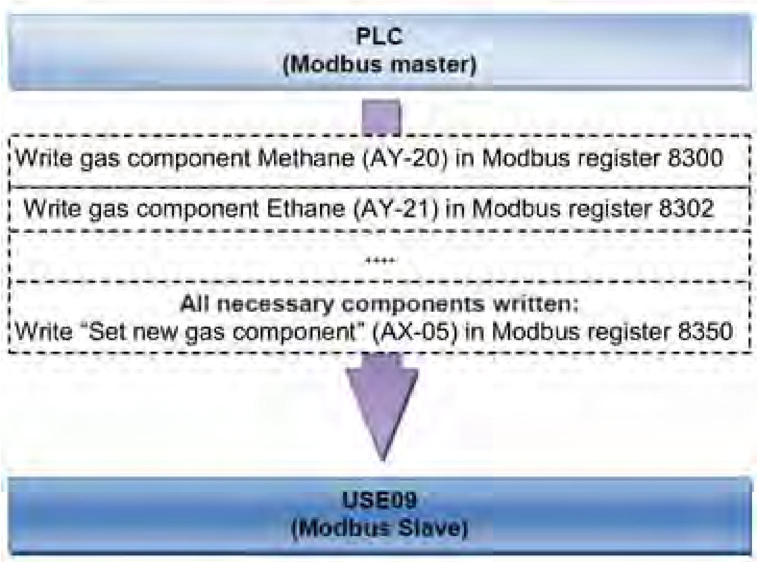


Fig. 4-24: Import of data via Modbus

4.4.5 Import of data via Modbus (USM-GT-400 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 Modbus2 HW Fashion

   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

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

Ethene: 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.

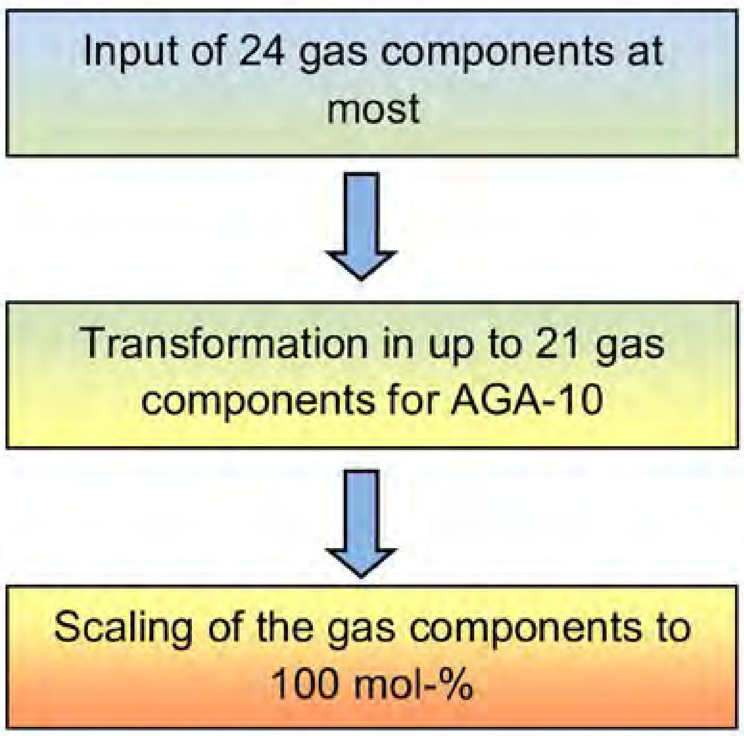


Fig. 4-25: Sequence of gas components treatment

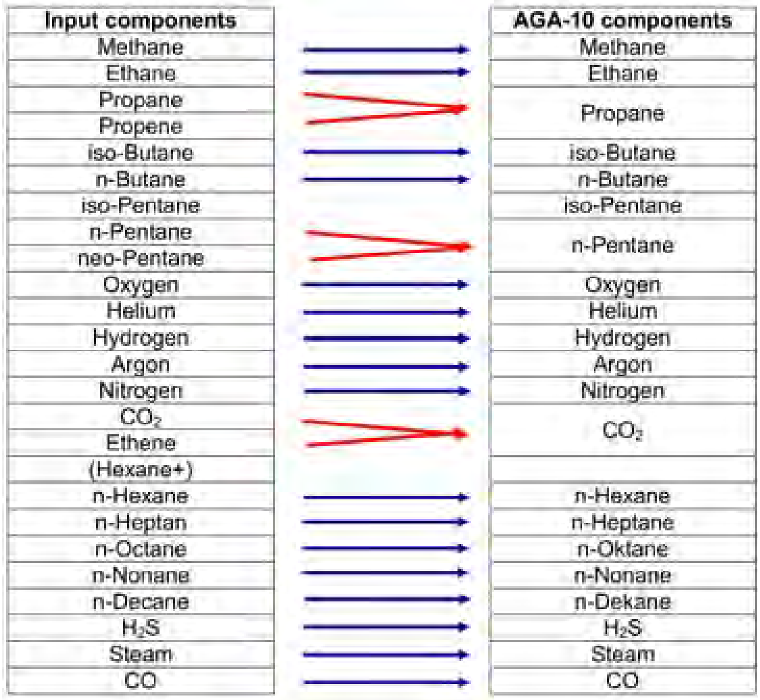


Fig. 4-26: Classification of gas components

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**	**100.0**

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
Propane	2.0	2.0	2.0
n-Butane	1.0	1.0	1.0
neo-Pentane	1.0	-	-
n-Pentane	-	1.0	1.0
CO_2	-	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 of 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** Sum of the un-normalized gas components is <= 0 or > 110 mol-%
1	**Timeout of new gas data exceeded** Within the defined time period in **AX-07**, no new gas data arrived. Possible reason: • Time too short • Communication interrupted • transfer register has not been filled (for Modbus slave) • Wrong RMGBus telegram or wrong stream selection If there are new gas components latest within three times of the given timeout time, the error status will be reset.
2	**Temperature Error** The temperature measurement is disturbed. Calculation will be done with the default value.

3	**Pressure errors** The pressure measurement is disturbed. Calculation will be done with the default value.
4	**Simulation active** Parameters 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** 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.

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.

5 Safety

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

Contents

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 14.5, „Standards, directives and guidelines“ on page 176*

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

⇨ *Chapter 13, „Technical specifications“ on page 159*

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.

Notice

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

This 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.

5.4 Safety instructions

⚠ Danger

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

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

- Before working with the device for the first time, read through this operating instruction and, in particular, follow the safety instructions carefully.
- 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 are 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, components 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 94/9/EC.
- Replace the blind plugs that have been installed for transportation with certified blind plugs according to 94/9/EC or NEC 500.

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 vapors!
- 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 41*

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 39*
- 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 39*
- 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.

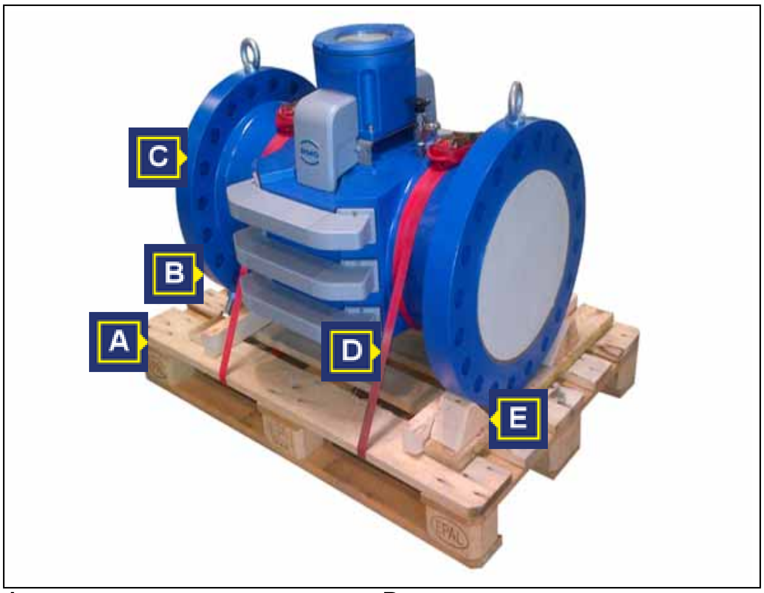
6.1.1 Scope of supply

The scope of supply may deviate depending on the options of the orders.

The following are included in the scope of supply:

Component	Quantity
Ultrasonic gas meter USM GT400 (including US-Electronic)	1
Extension box (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



A	Euro pallet	B	Retaining bolts x 2
C	Ultrasonic gas meter	D	Retaining strap x 2
E	Timber wedge x 2		

Fig. 6-1: Device secured on a Euro pallet

The device is as standard supplied on a Euro pallet **(A)**. The device can be protected by a customer-specific outer packaging. To secure the device against tipping-over and rolling away, the device **(C)** is supplied with retaining straps **(D)** and bolted to timber wedges **(E)**. The retaining bolts **(B)** 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**

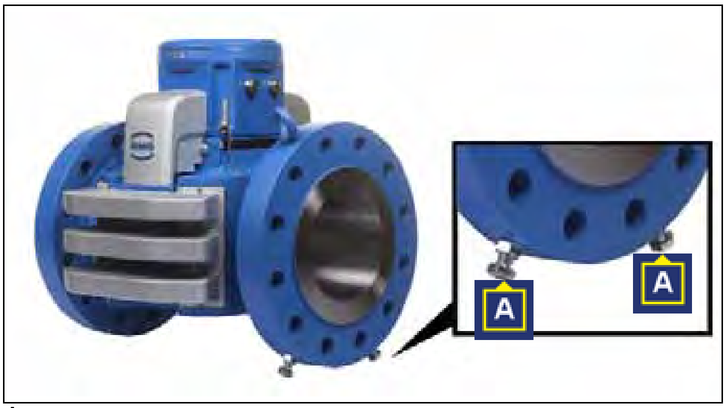
The outer packaging of the device is suited to customer specifics in order to protect the device against damage or influences from the environment during transport.

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.



A Retaining bolts

Fig. 6-2: Retaining bolts of the device

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

■ **Removing the device from the Euro pallet**

A Lifting eyes B Lifting gear chains

Fig. 6-3: Attaching the lifting gear

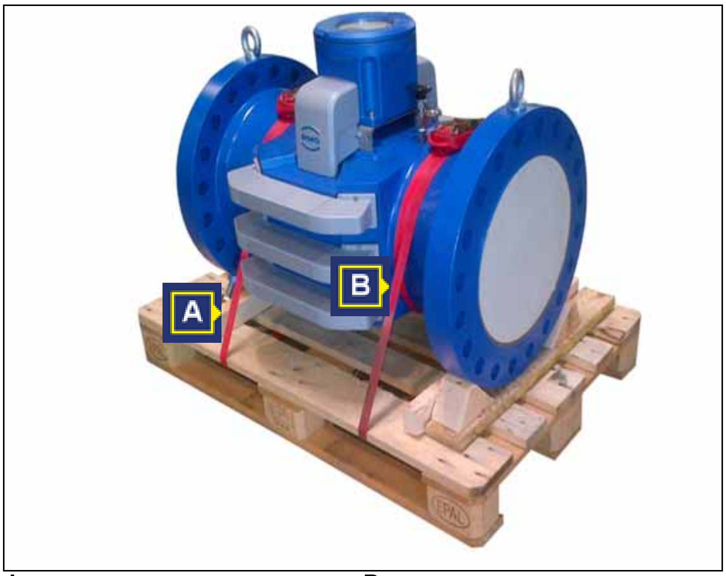
⚠ Warning

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 **(B)** to the lifting eyes **(A)** of the device.

2 Tension the chain of the lifting gear slightly to secure the device.



A Timber wedge B Tension straps

Fig. 6-4: Remove the timber wedges and retaining straps

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

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.

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.

Notice

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

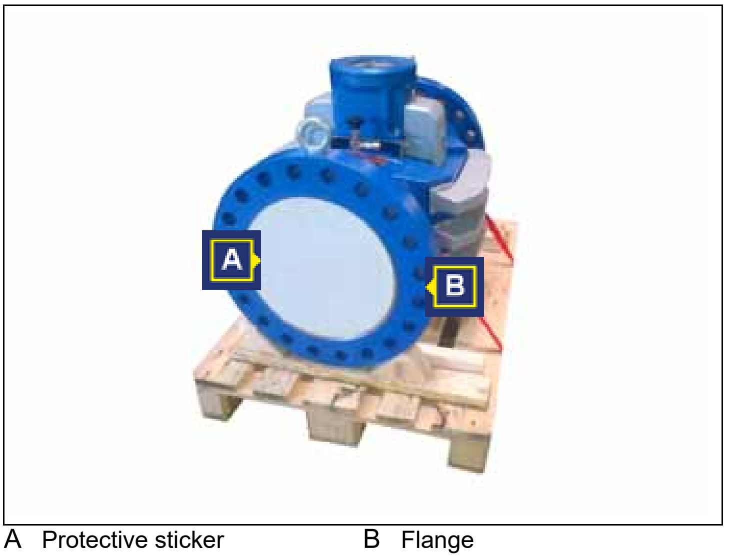
6.1.6 Removing the transporting locks

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.

Removing the protective sticker



A Protective sticker B Flange

Fig. 6-5: 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.

A Position of the corrosion protection mat

Fig. 6-6: Corrosion protection mat in the device

1 Remove the corrosion protection mat **(A)** 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:

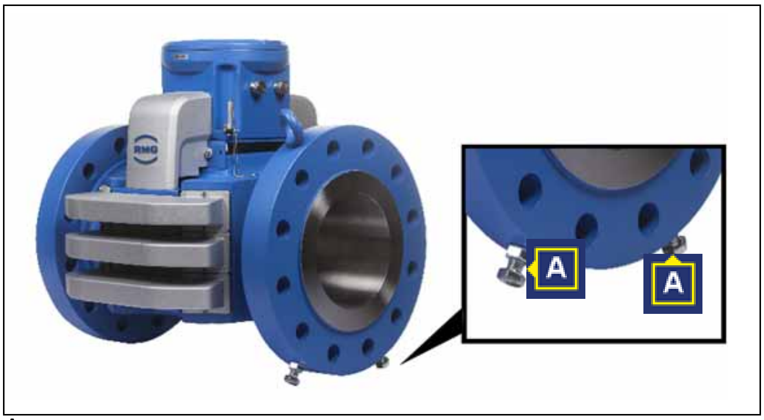
- Euro pallet with timber wedges (with the original packaging, the timber wedges are already pre-mounted on the Euro pallet).
- Two tensioning straps
- Transport locks
- Sealing set (blind plugs)

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

■ 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. Servere injuries may occur.
- Before starting work, make sure that the retaining bolts are screwed in.



A 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

A Lifting eyes B Lifting gear chains

Fig. 6-8: Attaching the lifting gear

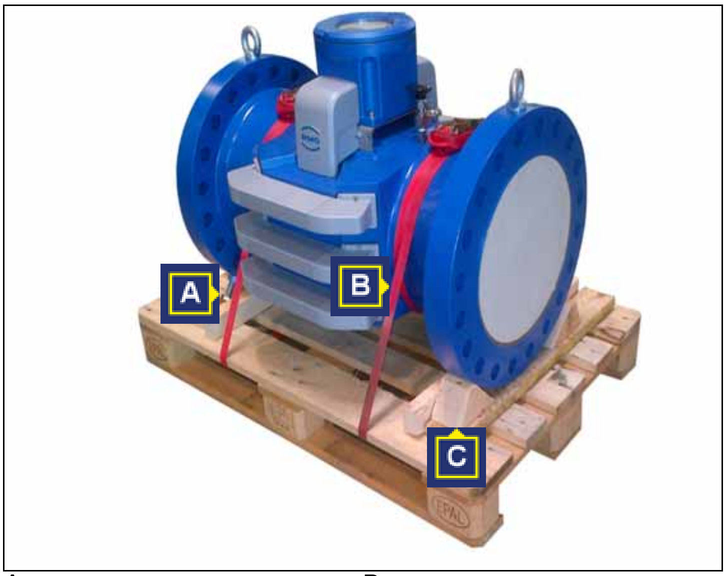
⚠ Warning

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 **(B)** to the lifting eyes **(A)** 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.



A Retaining bolts
B Tension straps
C Timber wedge

Fig. 6-9: Secure the device on the Euro pallet

4 Place the Euro pallet under the device.

Without the retaining bolts **(A)** the flange must be guided between the timber wedges **(C)**.

⚠ 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.

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

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

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

■ Place the corrosion protection mat inside the device

Notice

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.

A Position of the corrosion protection mat

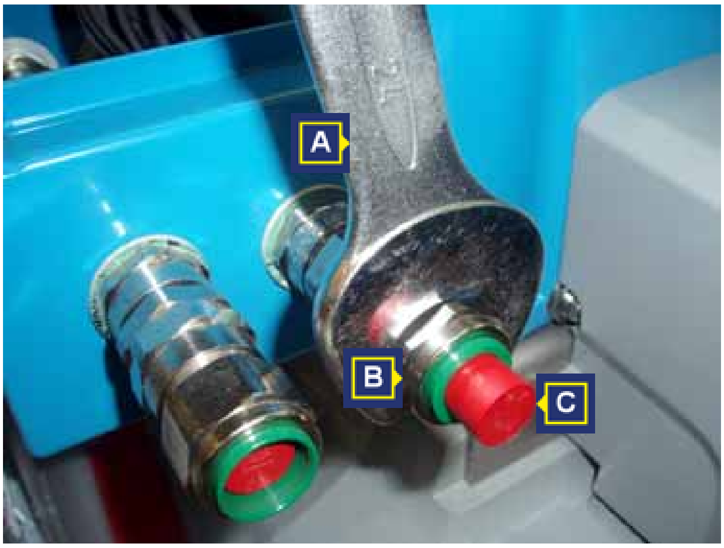
Fig. 6-10: Corrosion protection mat in the device.

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 148*

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

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



A Wrench
B Screwed cable gland
C Blind plug

Fig. 6-11: Mount the blind plugs

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

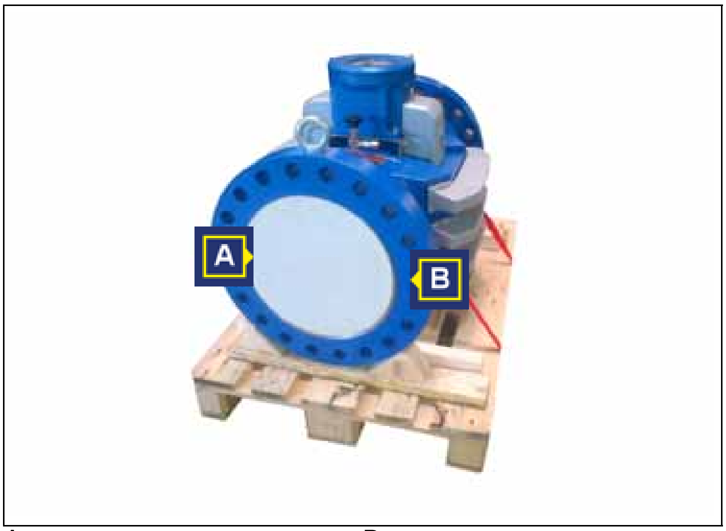
2 Tighten the screw connection **(B)** with a suitable wrench **(A)**.

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



A Protective sticker B 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.

Options for the outer packaging can be, for example:

- sea-proof wooden crate
- cardboard packagings

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 55*

2 Observe the approved ambient temperature for storage.

⇨ *Chapter 13.1, „Performance data“ on page 160*

6.3.2 Checking the device after storage

⚠ 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 longer 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.

■ **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.

Contents

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.

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.

Notice

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.

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

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

7.2.1 Flat seal

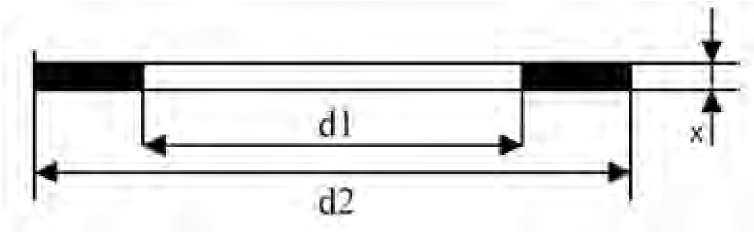


Fig. 7-1: Dimensions of the seal

d1 = Inside diameter
d2 = Outside diameter
x = Seal thickness 1.5 to 5 mm

		PN 10	PN 16	ANSI 150	PN 25	PN 40
DN in mm (inch)	**d1 in mm (inch)**	**d2 in mm (inch)**				
80 (3)	90 (3.54) 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

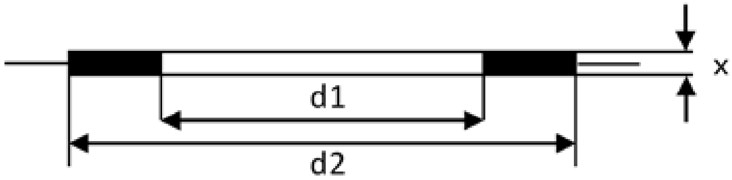


Fig. 7-2: Dimensions of the seal

d1 = Inside diameter
d2 = Outside diameter
x = Seal thickness 1.5 to 5 mm

	ANSI 300 / ANSI 600		**PN 64**	
DN in mm (inch)	**d1 in mm**	**d2 in mm**	**d1 in mm**	**d2 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
400 (16)	422.3	466.7	426	474
500 (20)	530.2	581.0	530	578
600 (24)	631.8	682.6	630	680

7.2.3 Spiral seals

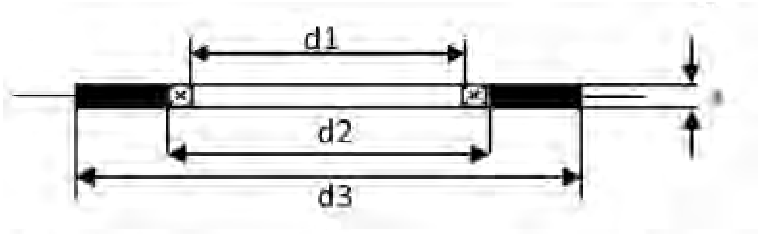


Fig. 7-3: Dimensions of the seal

d1 = Inside diameter of the centering ring
d2 =Inside diameter of the seal
d2 = Outside diameter
x = Seal thickness 1.5 to 5 mm

	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)	120.7 (4.75)	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)	174.8 (6.88)	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)	225.6 (8.88)	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)	274.6 (10.81)	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)	327.2 (12.88)	327.2 (12.88)	374.7 (14.75)
400 (16)	400 (15.7)	422.4 (16.63)	463.6 (18.25)	414 (16.3)	426 (16.77)	466 (18.35)	412.8 (16.25)	412.8 (16.25)	463.6 (18.25)
500 (20)	500 (19.7)	525.5 (20.69)	577.9 (22.75)	518 (20.4)	530 (20.87)	574 (22.60)	520.7 (20.50)	520.7 (20.5)	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)	628.7 (24.75)	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**
PN10, PN16, PN25, PN40, PN64	Bolts according to DIN EN ISO 4014 of material 25CrMo4, nuts according to DIN EN ISO 4032 of material 25CrMo4	–	–
ANSI150, ANSI300, ANSI600	Bolts according to ANSI B1.1 of material ASTM A 320 Grade L7, nuts according to ANSI B1.1 of material ASTM A 320 Grade L7	Bolts according to ANSI B1.1 of material 42CrMo4, nuts according to ANSI B1.1 of material 42CrMo4	Bolts with reduced shank according to DIN 2510 of material 25CrMo4, nuts according to DIN 2510 of material 25CrMo4

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.

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

Notice

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

Depending on the flange type the following hexagonal bolts are used for DN80:

PN16/10	PN40/25	PN64	ANSI150	ANSI300	ANSI600
DIN EN 24014 (DIN931 ISO4014) M16 x 48 – 8.8 *1 L=48 mm or material: 25CrMo4 galvanized *2	DIN EN 24014 (DIN931 ISO4014) M16 x 52 – 8.8 *1 L=52 mm or material: 25CrMo4 galvanized *2	DIN EN 24014 (DIN931 ISO4014) M16 x 56 – 8.8 *1 L=56 mm or material: 25CrMo4 galvanized *2	5/8“ - 11 UNC 2A x 2 1/8“ L=54mm (2 1/8“) UNC A320 Grade7 or material: 42CrMo4 galvanized *2	3/4“ - 10 UNC 2A x 2 1/4“ L=54mm (2 1/4“) UNC A320 Grade7 or material: 42CrMo4 galvanized *2	3/4“ - 10 UNC 2A x 2 5/8“ L=54mm (2 5/8“) UNC A320 Grade7 or material: 42CrMo4 galvanized *2

*1 These screws can only be used down to -10°C.

*2 These screws can be used down to -46°C.

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.

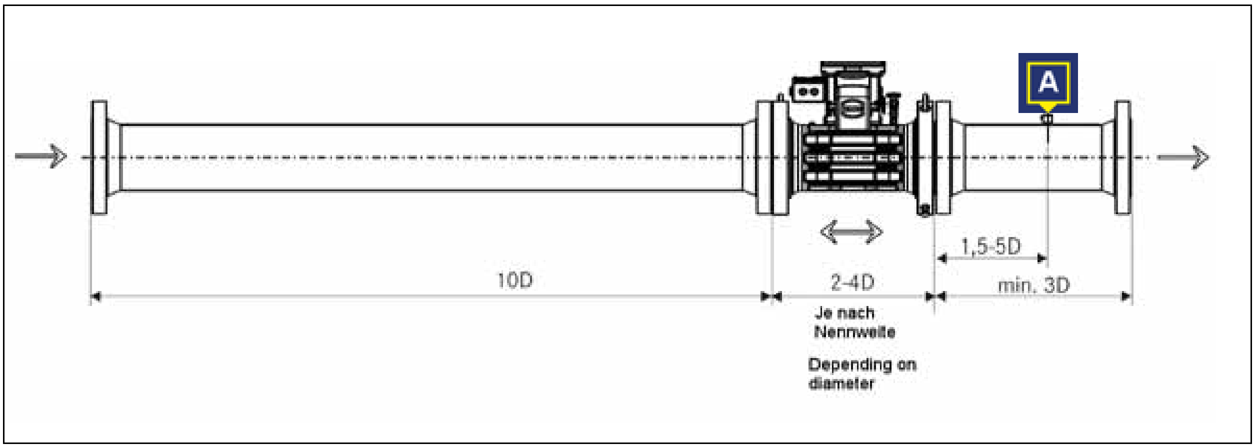
– See „Inner diameter of connecting spool pieces“ on page 168

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.

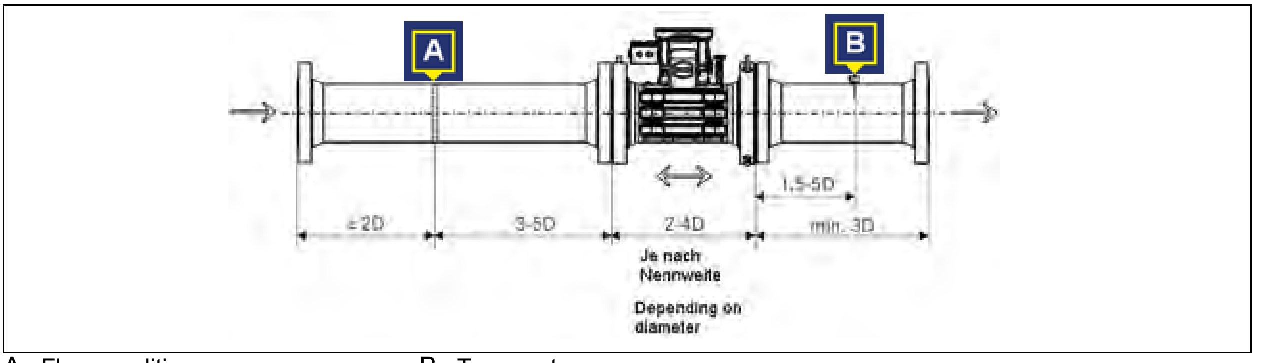
With this installation, the device can be used for calibrated measurements and for secondary measurements.

Unidirectional operation



A Temperature sensor

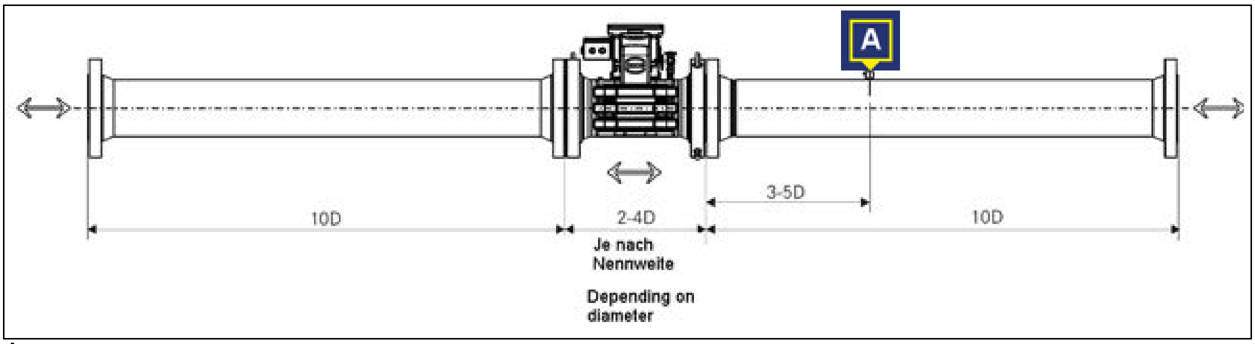
Fig. 7-4: Unidirectional operation



A Flow conditioner B Temperature sensor

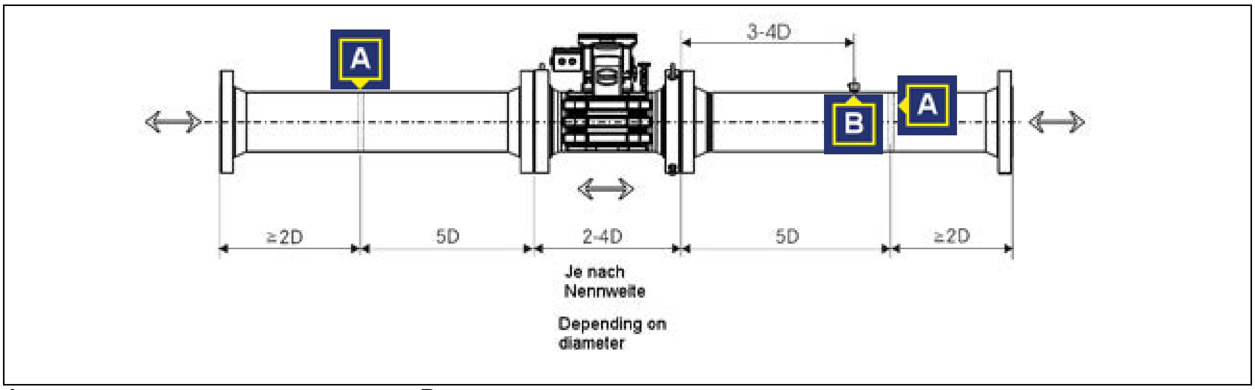
Fig. 7-5: Unidirectional operation - compact installation

Bidirectional operation



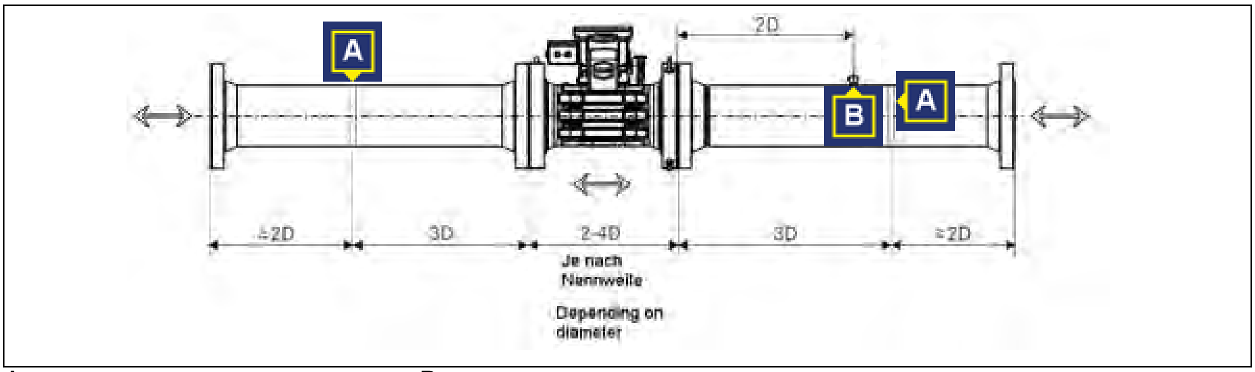
A Temperature sensor

Fig. 7-6: Bidirectional operation



A Flow conditioner B Temperature sensor

Fig. 7-7: Bidirectional operation - compact installation < DN 300 (12")



A Flow conditioner B Temperature sensor

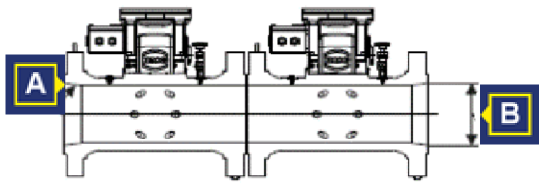
Fig. 7-8: Bidirectional operation - compact installation ≥ DN 300 (12")

7.4.2 Two devices series connected (Face to Face)

You can install one or several devices in series.

Notice

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.



A Tapered bore
B Inner diameter

Fig. 7-9: 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.

Notice

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:

⇨ *Operating instructions of 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 2000 NG
- 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 ERZ2000 / ERZ2400

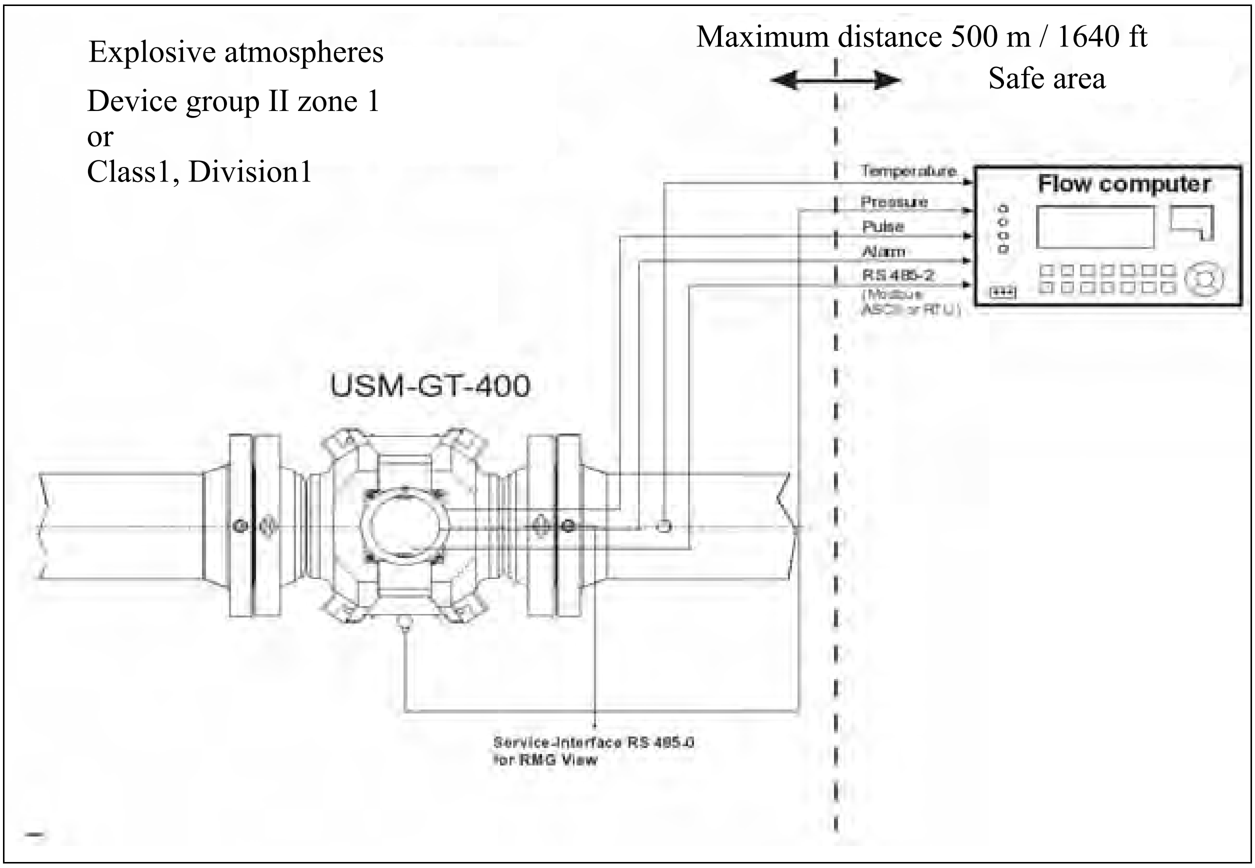


Fig. 7-10: Connection diagram for connection of a flow computer for example an ERZ2000 / ERZ2400

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.

Notice

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 easily and safely reach the components.

■ **Carry out preparatory work**

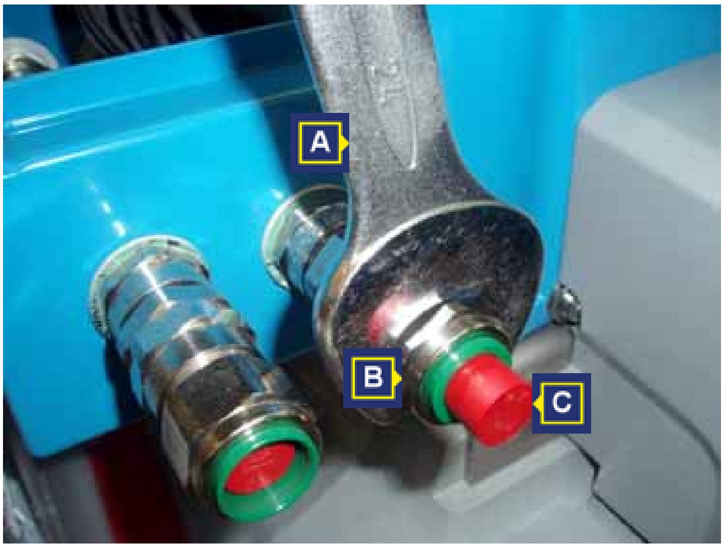
1 Unpack the device.

⇨ *Chapter 6.1.3, „Unpacking the device“ on page 49*

2 Remove the transporting locks.

⇨ *Chapter 6.1.6, „Removing the transporting locks“ on page 53*

For ATEX / IECEx



A Wrench
B Screwed cable gland
C Blind plug

Fig. 8-1: Remove the blind plugs

3 Unscrew connection **(B)** with a suitable wrench **(A)**.

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

5 Screw glandes not required must be replaced by explosion-proof 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 connec-tions 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 56*

7 Check the device for any signs of damage.

⇨ *Chapter 6.3.2, „Checking the device for any signs of damage“ on page 63*

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

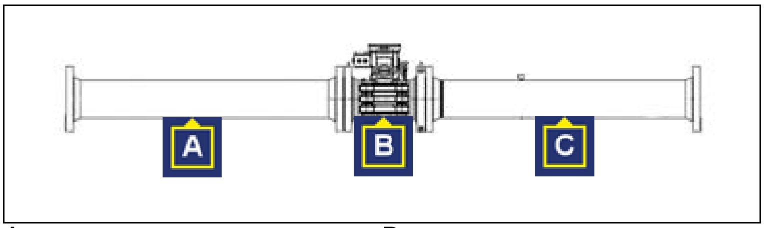
Escaping gas from incorrect seals

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 164*



A Inlet piping B Ultrasonic gas meter
C Outlet piping

Fig. 8-2: Installation of the Inlet and outlet piping

The bolted connection of Inlet **(A)** and outlet piping **(C)** 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 cross-wise in order to avoid tensioning.

Notice

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 condensate 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

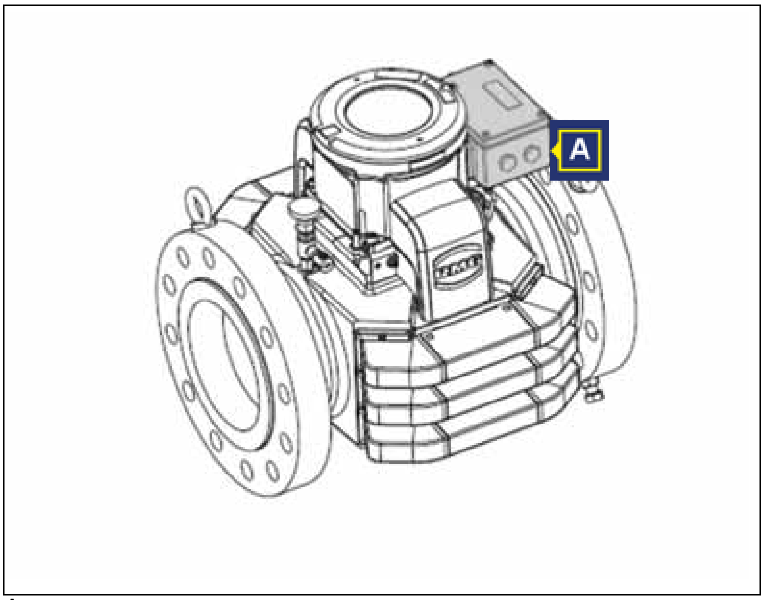
  ⇨ *„Installation of the connection box (ATEX / IECEx)“ on page 82*

- connection according to NEC 500

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

  ⇨ *Cable connection „Connecting the device electrically“ on page 84*

Installation of the connection box (ATEX / IECEx)



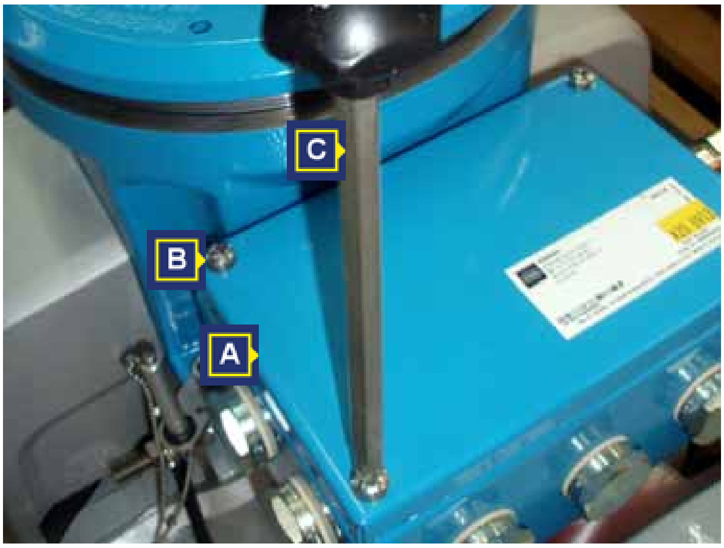
A Connection box Ex-de

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)**



A Cover
B Screws
C Screwdriver

Fig. 8-4: Opening the connection box cover

1 Unscrew the screws **(B)** using a suitable screwdriver **(C)**.

2 Remove cover **(A)**.

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

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

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

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.

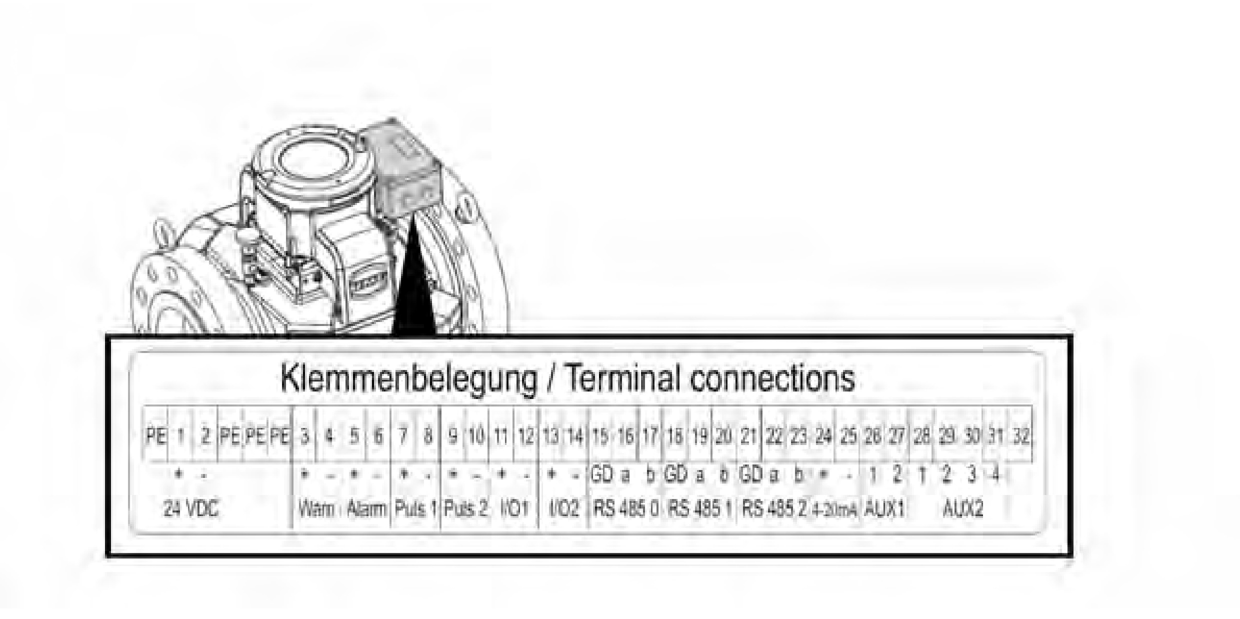


Fig. 8-5: Connection assignment on the terminal strip

Maximum assignment

The maximum assignment are 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 RMGView^{USM} (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; Terminal 28: [PT100 ++], Terminal 29: [PT100 +] Terminal 30: [PT100 -] Terminal 31: [PT100 -])

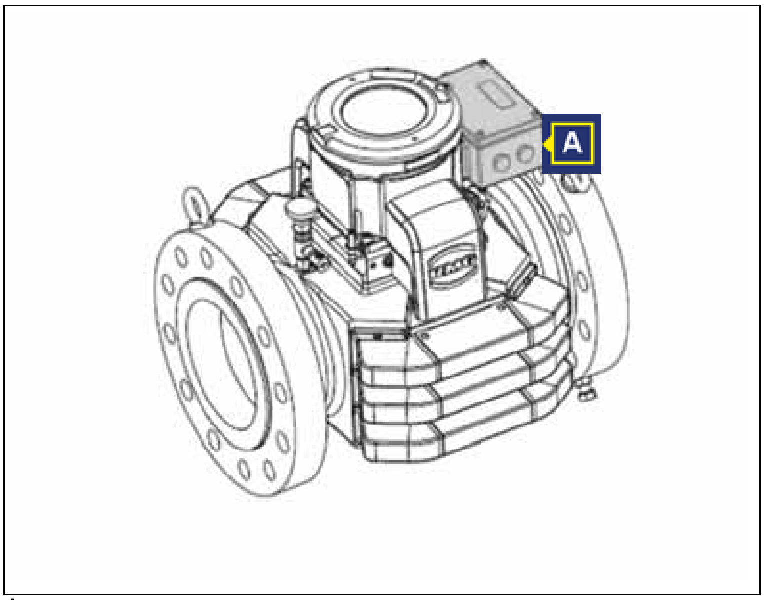
Cable specification

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 24 VDC	ÖLFLEX® CLASSIC 3 x 1.5 mm² 3 x 2.5 mm	Cable ∅ 12.3 mm 13.5 mm
Interface: RS485-0, RS485-1, RS485-2 (can be layed in one cable)	LIYCY (TP) 3 x 2 x 0.75 mm²	9,4 mm
AUX1	LIYCY 2 x 0.75 mm²	6.0 mm
AUX2	LIYCY 2 x 2 x 0.75 mm²	8.5 mm
Analog out: 4..20 mA	LIYCY 2 x 0.75 mm²	6.0 mm
Warning + alarm	LIYCY 2 x 2 x 0.75 mm²	8.5 mm
Pulse1 + pulse2 + I/O1+ I/O2	LIYCY (TP) 4 x 2 x 0.75 mm²	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



A Ex-de 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 **(A)**.

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

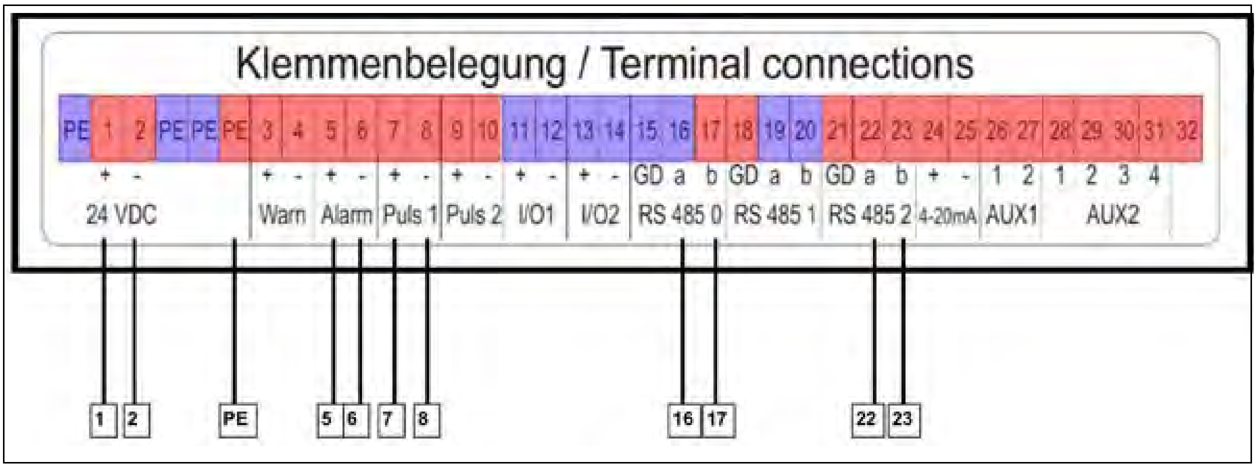


Fig. 8-7: ½" cable gland with 11 wires, size AWG 18

1 ½" 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

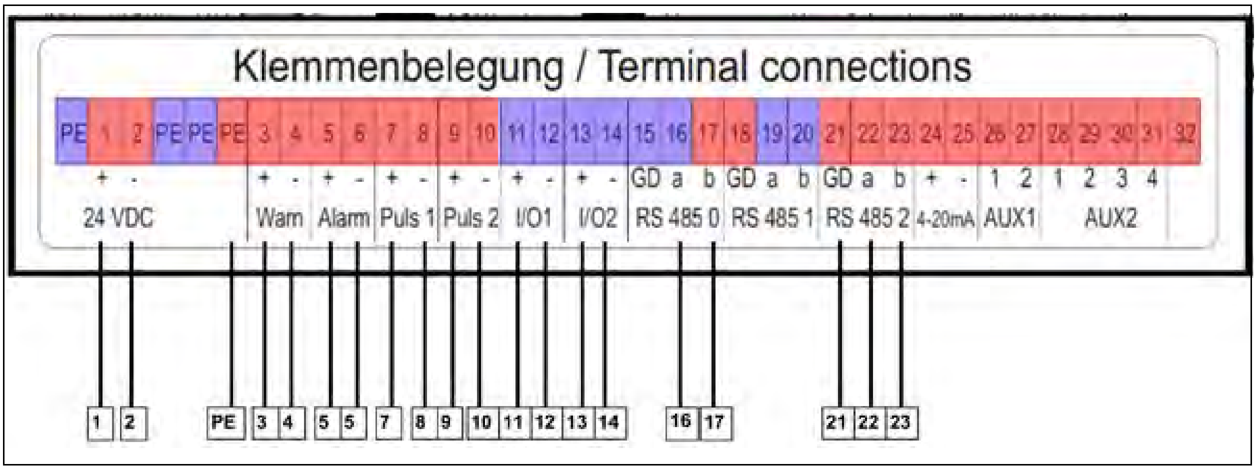


Fig. 8-8: ¾" cable gland with 20 wires, size AWG 18

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

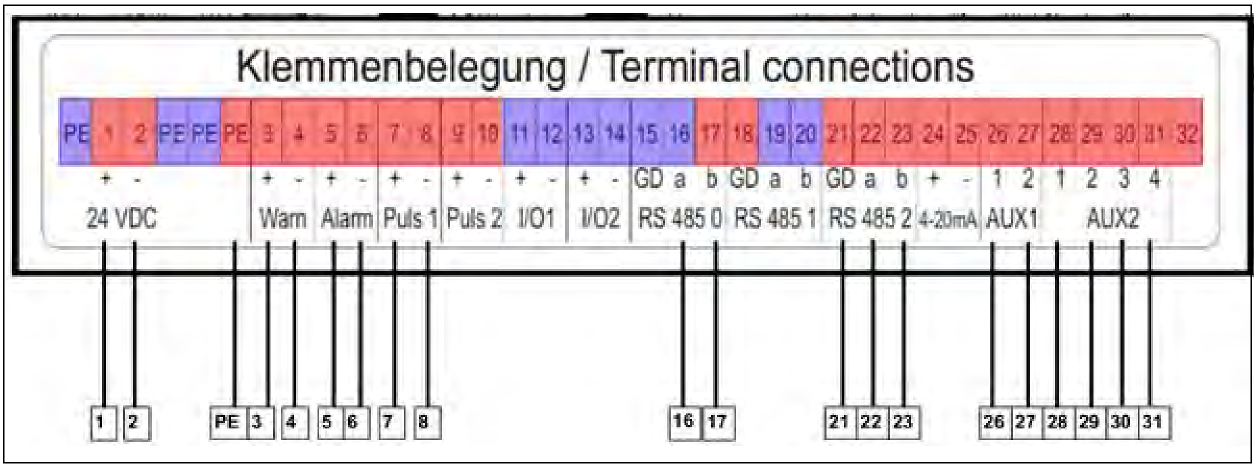


Fig. 8-9: Measuring with pressure and temperature

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

1/2" and 3/4" sealing fitting

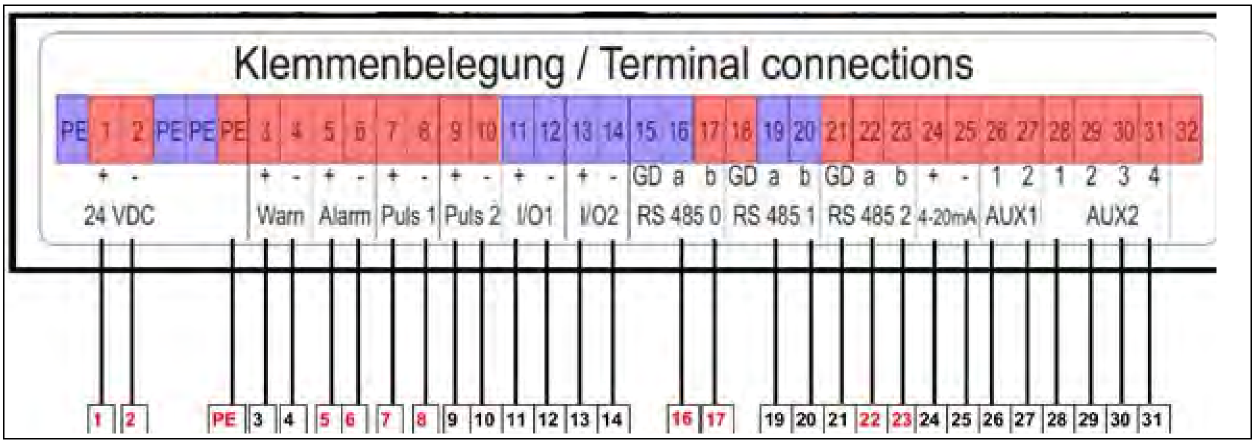
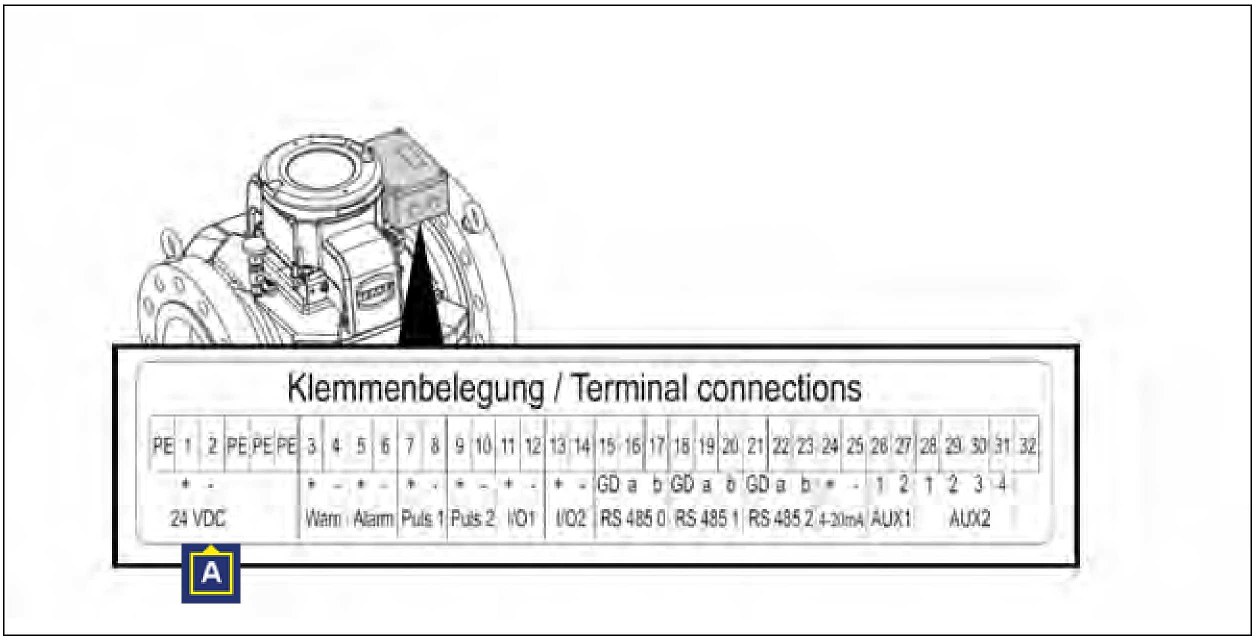


Fig. 8-10: ½" and ¾" sealing fittings with up to 31 wires of size AWG 18

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



A Power supply

Fig. 8-11: Connection assignment on the terminal strip

1 Connect the power supply to the terminals 24 VDC **(A)**.

⇨ *Figure 8-16 on page 94*

8.3.2 Digital interfaces of USM-GT400

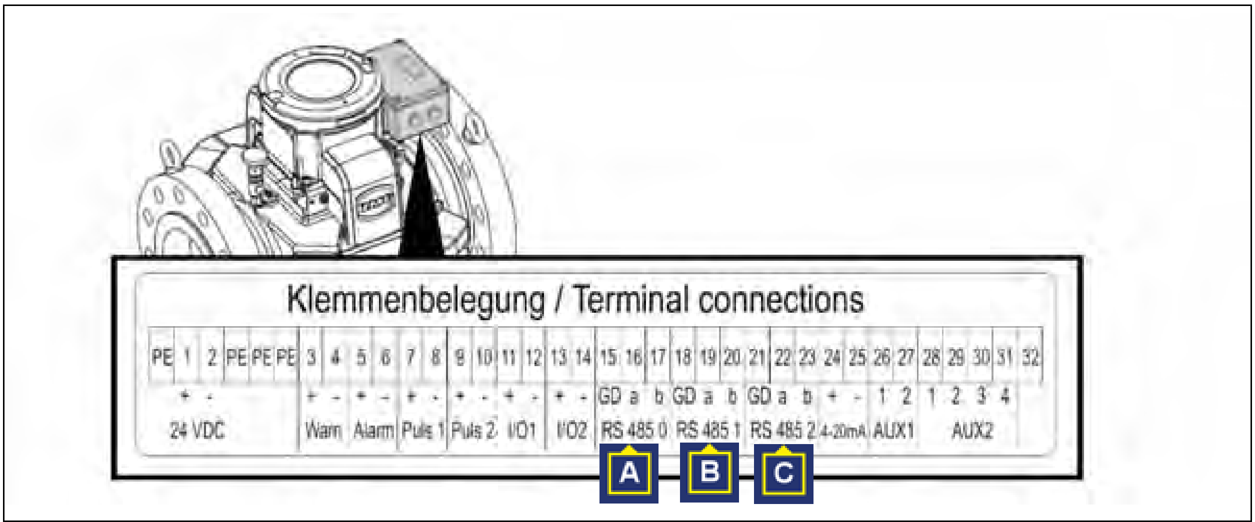


*Fig. 8-12: Dgital interfaces RS485-0 (**A**), RS 485-1 (**B**) and RS 485 -2 (**C**)*

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.

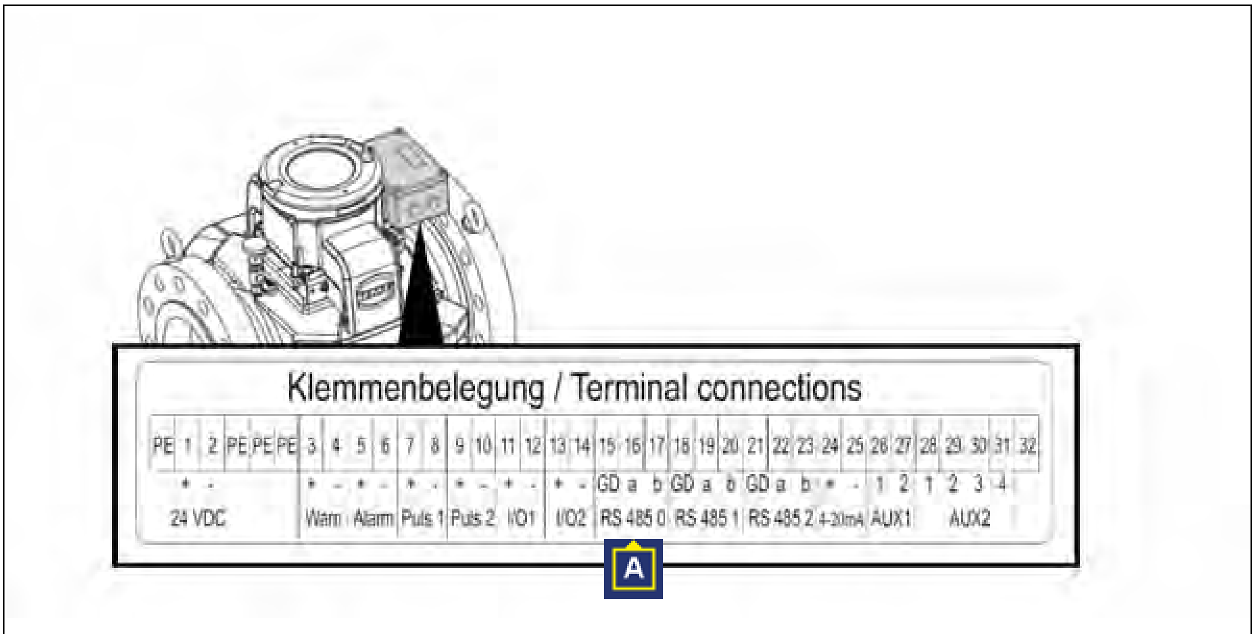
Notice

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**
proto-col, device	RMGView^{USM} (service)	IGM-protocol, DZU-protocol ERZ2000, ERZ2400, ERZ2000-NG, ERZ2000-DI	Instanz-F, 2nd ERZ ..., Flowcomputer other suppliers
fea-tures	no parameteriz-able byte sequence for data types Long and Float	no parameteriz-able 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}



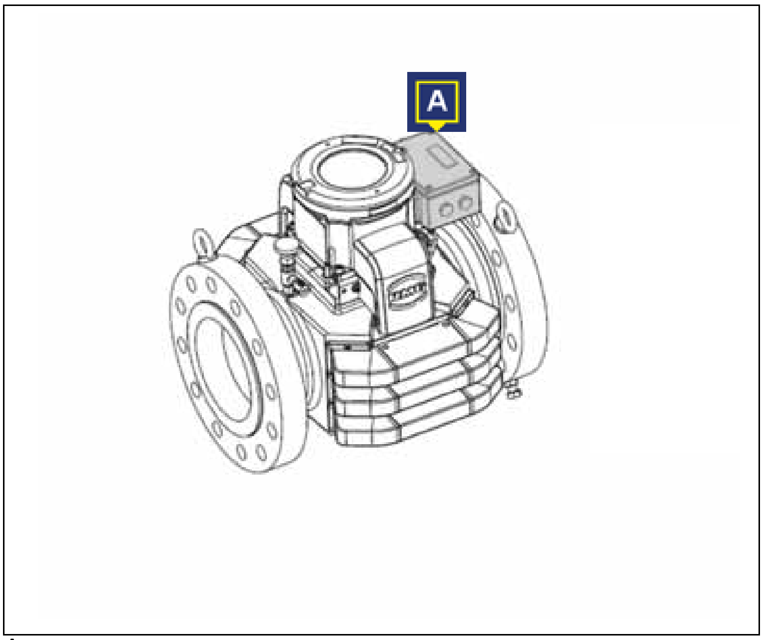
A Service connection

Fig. 8-13: Connection assignment on the terminal strip

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

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



A Ex-de according to ATEX und IECEx

Fig. 8-14: Connection box types

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

1 Open the cover of the connection box.

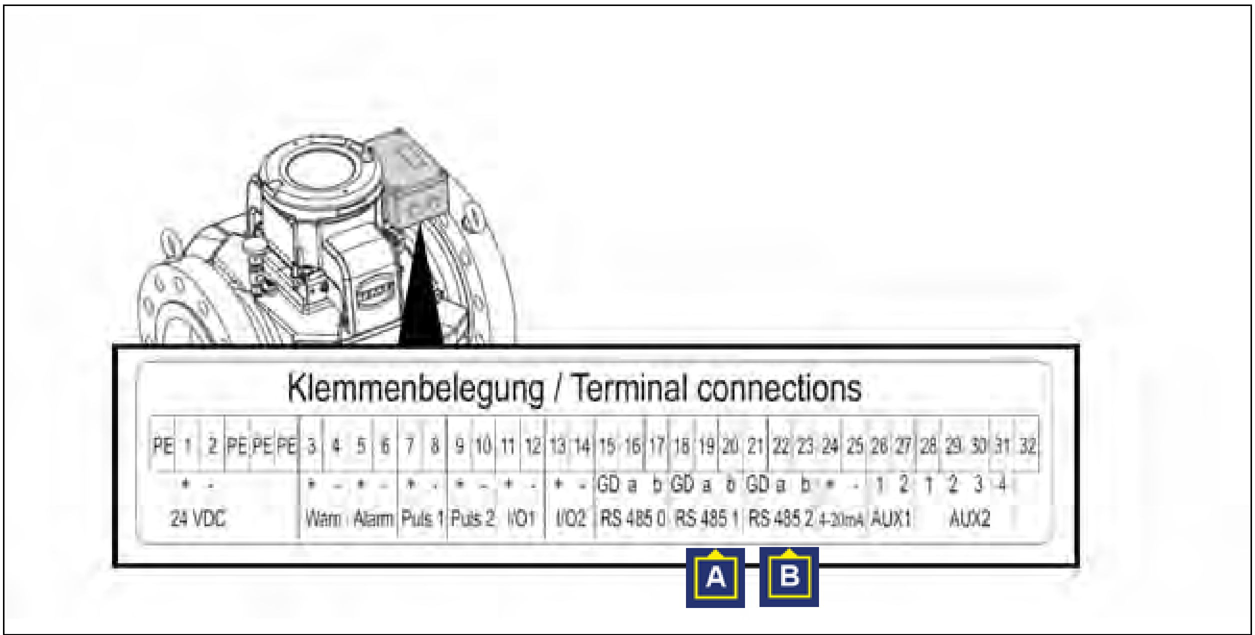
⇨ *„Open the connection box (Ex-de)“ on page 83*

■ **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 mm^2



A Connection Flow computer 1 B Connection Flow computer 1

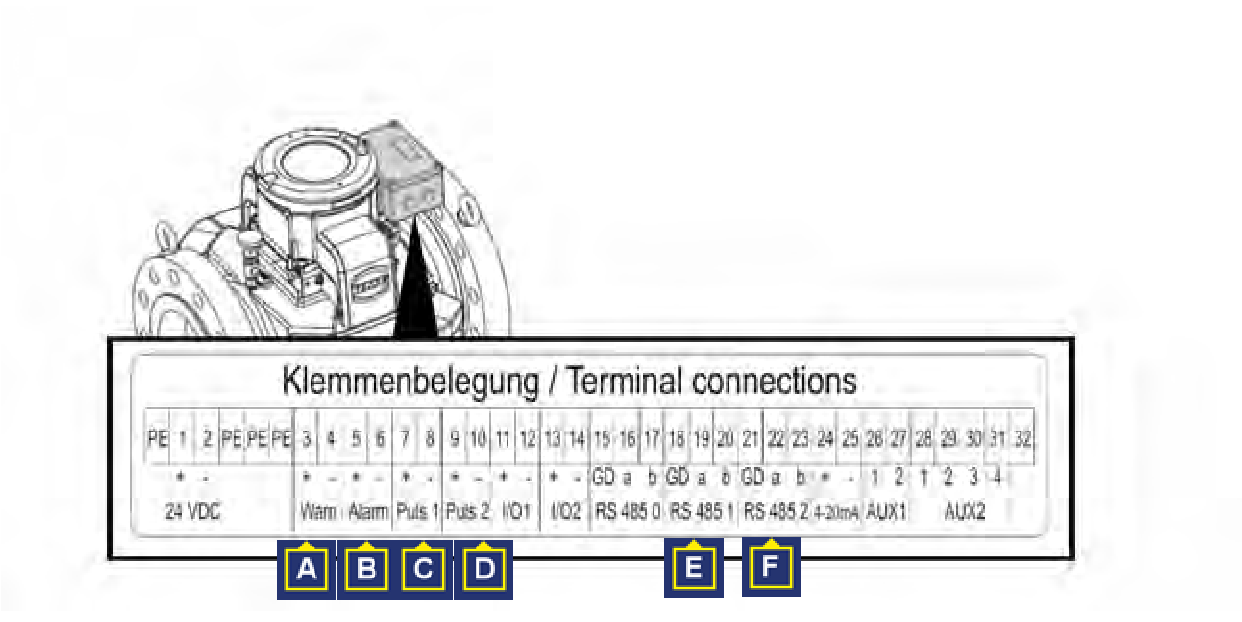
Fig. 8-15: Connection assignment on the terminal strip

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.

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

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

■ Connecting a flow computer from third-party manufacturers



A	Connection Warning messages	B	Connection Warning messages	C	Connection Pulse 1
D	Connection Pulse 2	E	Connection RS 485-1	F	Connection of S 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 (E), RS 485-2 (F)** or **Pulse 1 (C)** and **2 (D)**.

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

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

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

8.3.5 Connection of external DSfG-Device-F via Modbus

Notice

Even though DSfG Device-F (DSfG Instanz-F) is a German standard the wish for a common connection for different ultrasonic gas flow rate meters may arise in other countries as well. Therefore this connection and its treatment is mentioned here, too.

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.

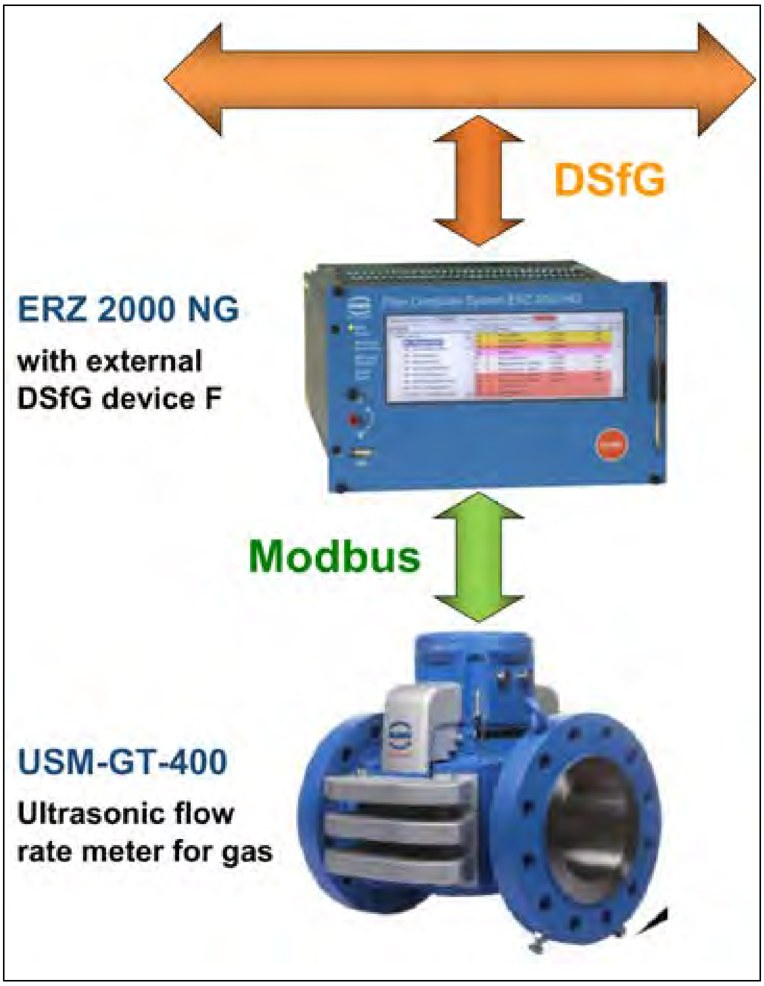


Fig. 8-17: Data exchange between ERZ 2000 NG and USM-GT-400

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.

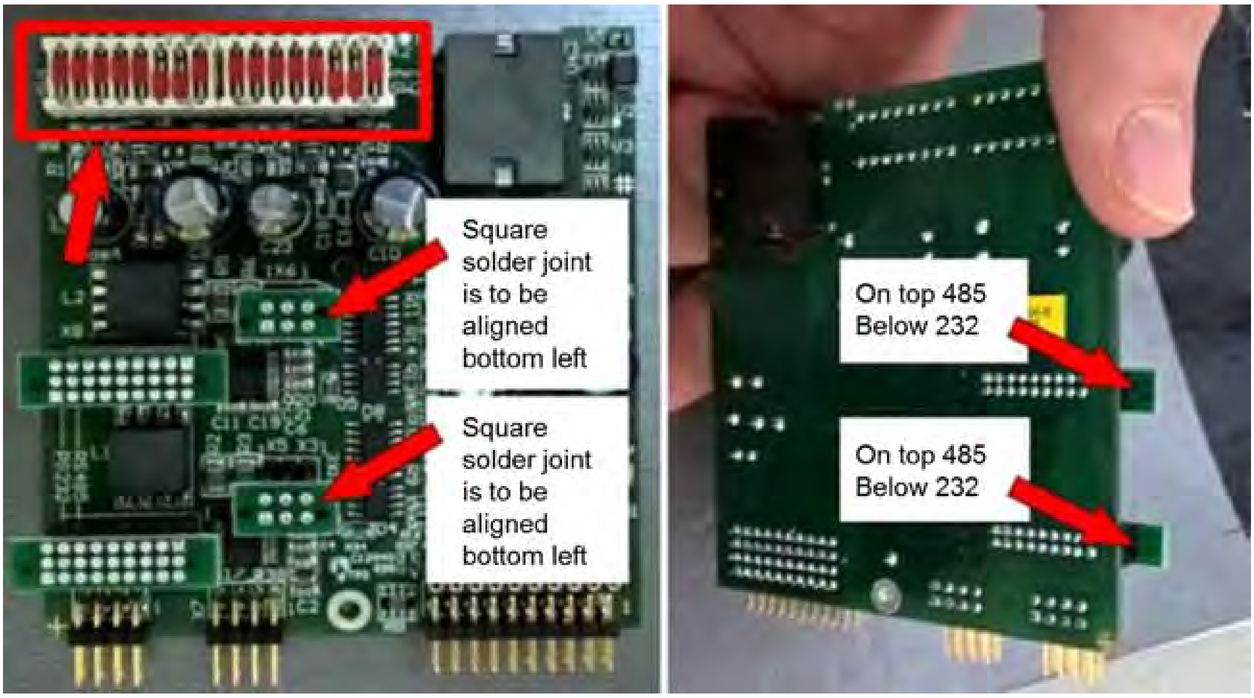


Fig. 8-20: Configuration of the option card to be used as COM 6 and 7 of the ERZ 2000-NG

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")

GB Flow rate parameters

Access	Line	Designation	Value	Unit
A §	1	Qm max	1000,000	m3/h
A §	2	Qm min	50,000	m3/h
E §	3	High pressure ext.	no	
E §	15	LF measurable	yes	
E §	16	Vol.transd. mode	DZU	
E §	17	Start-up pulses	500	Pulse
E §	51	Device type	USM-GT400	
E §	52	Serial number	0	
E §	53	Meter type	USZ	
E §	54	Meter size	G650	
Q	55	Freq. Turbinesim.	0	Hz

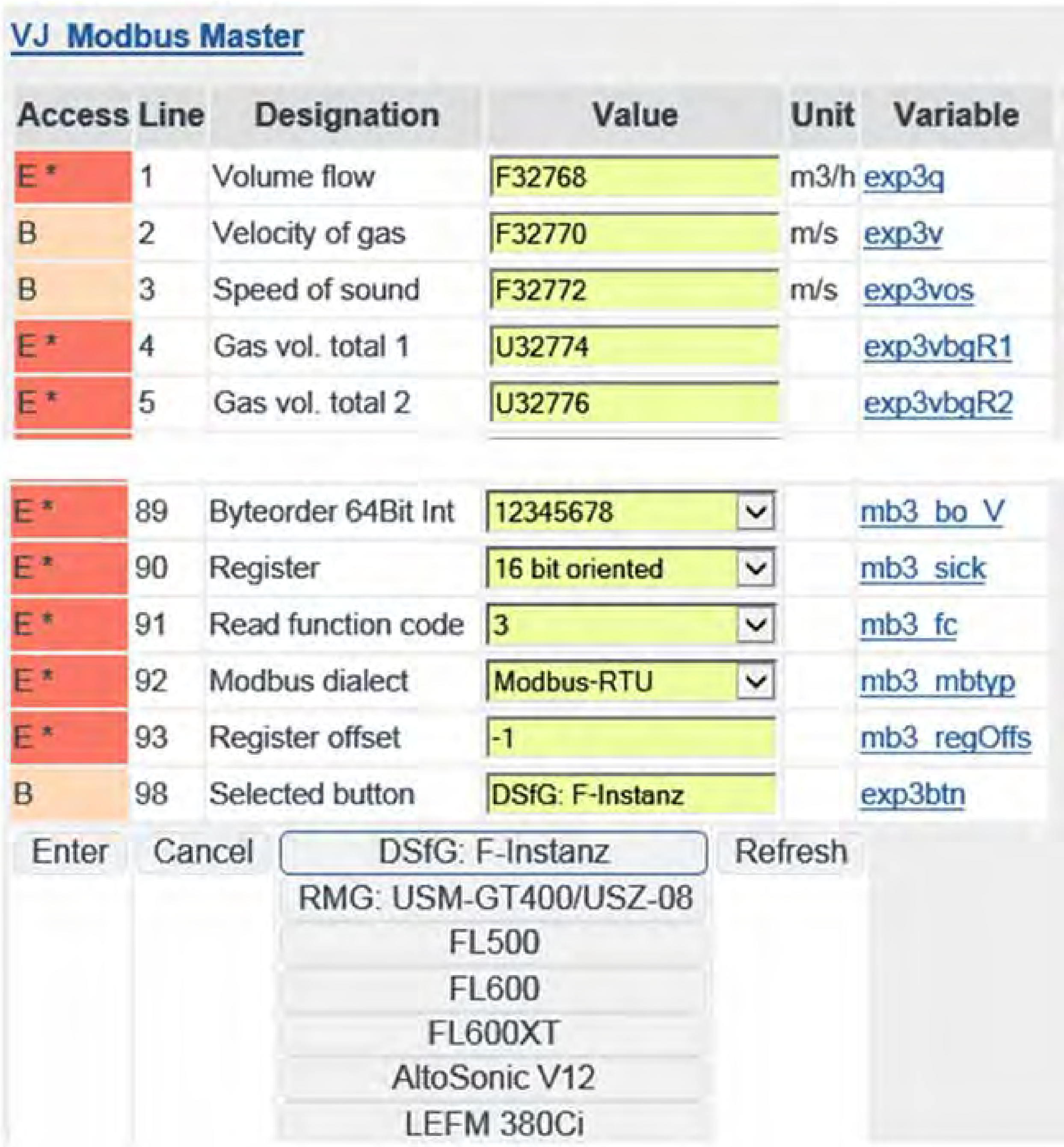
Enter | Cancel | DSfG: F-Instanz COM6 | DSfG: F-Instanz COM7 | Refresh

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.



VJ Modbus Master

Access	Line	Designation	Value	Unit	Variable
E *	1	Volume flow	F32768	m3/h	exp3q
B	2	Velocity of gas	F32770	m/s	exp3v
B	3	Speed of sound	F32772	m/s	exp3vos
E *	4	Gas vol. total 1	U32774		exp3vbqR1
E *	5	Gas vol. total 2	U32776		exp3vbqR2
E *	89	Byteorder 64Bit Int	12345678		mb3_bo_V
E *	90	Register	16 bit oriented		mb3_sick
E *	91	Read function code	3		mb3_fc
E *	92	Modbus dialect	Modbus-RTU		mb3_mbtyp
E *	93	Register offset	-1		mb3_regOffs
B	98	Selected button	DSfG: F-Instanz		exp3btn

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.

> **Notice**
>
> **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

> **Notice**
>
> COM6 is then not 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 §	50	Operating mode	Modbus serial C6	
E §	52	Modbus address	1	
E §	53	Slave loves gaps	Yes	
E §	54	Gap size	20	
E §	55	Byteord 16-Bit-Int	21	
E §	56	Byteord 32-Bit-Int	4321	
E §	57	Byteorder float	4321	
E §	58	Byteorder double	21436587	
E §	59	Byte ord. 64-Bit-Int	21436587	
E §	60	Register	16-Bit oriented	
E §	61	Read function code	3	
E §	62	Modbus dialect	Modbus-RTU	
E §	63	Register offset	-1	

Enter Cancel Load presets Refresh

Fig. 8-27: Configuration oof Mobus 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 parameterise, 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 0 <= (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).

Notice
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.

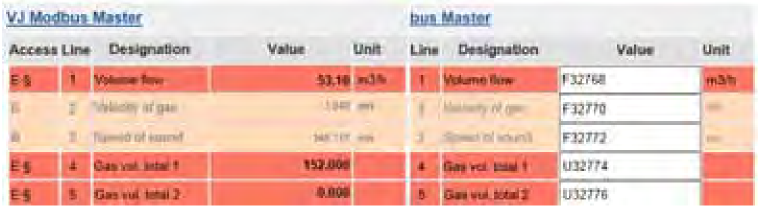


Fig. 8-31: Modbus register list in ERZ2000-NG with locked (left) and open (right) calibration switch

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-GT-400)

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 Ethernet to RS 485

Interface converter from USB to RS 485 (USM-GT-400)

There are 3 recommendations:

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

Fig. 8-33: Type ICP Con I)-7561 U-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) s

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

Fig. 8-35: Type 0202047s

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

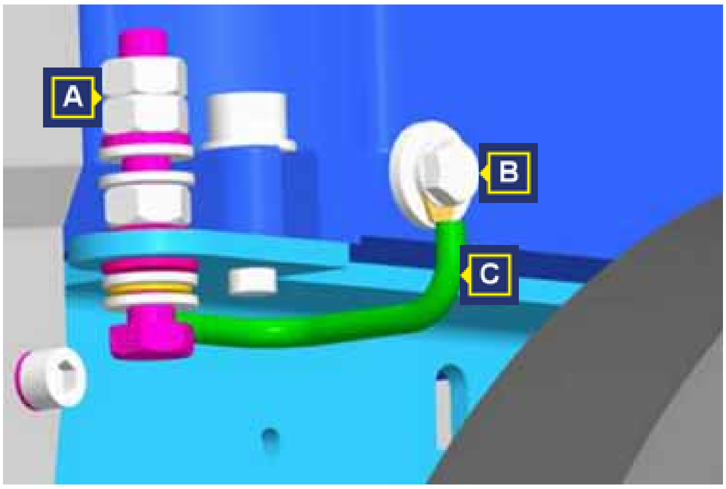
In this chapter you will receive information on connecting the device to earth and the protection of the device.

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")

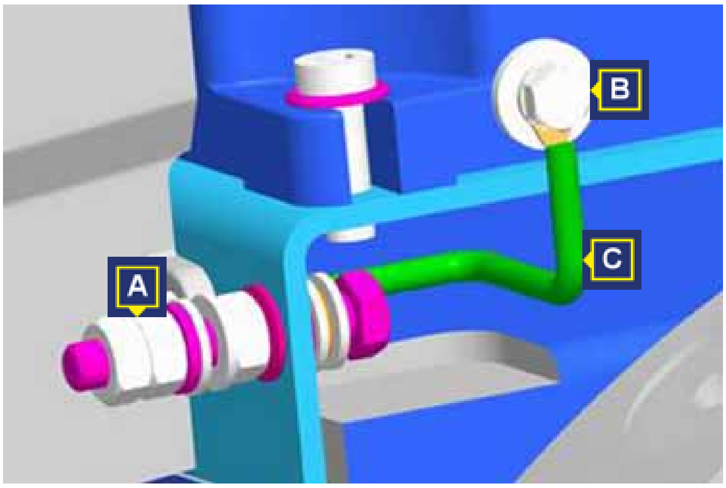


A Earthing screw M6 B Earthing screw M6
C Earthing cable

Fig. 8-36: Connect to earth - Ultrasonic gas meters DN150 (6") and DN100 (4")

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

For ultrasonic gas meters DN200 (8")



A Earthing screw M6 B Earthing screw M6
C Earthing cable

Fig. 8-37: Connect to earth - Ultrasonic gas meter ≥ DN200 (8")

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

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).

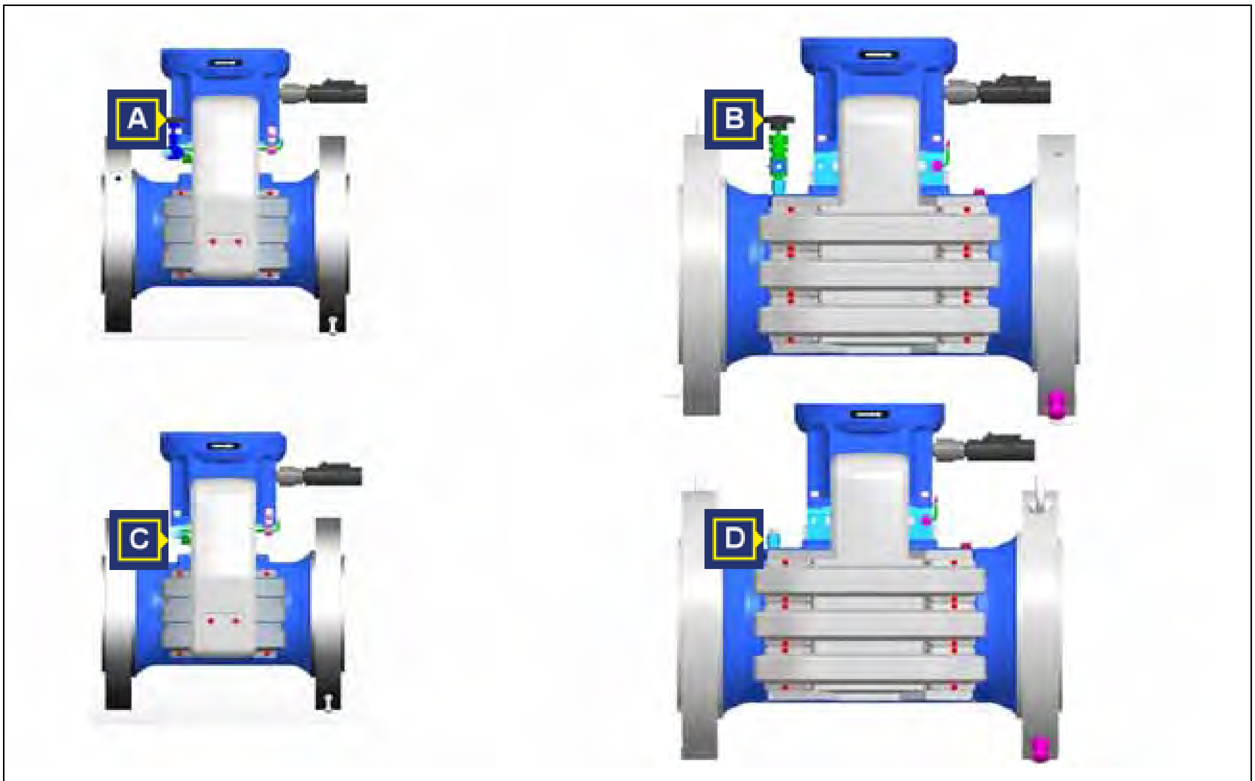
Transducer

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.



A USM up to DN150 with shut-off valve

B USM from DN200 with shut-off valve

C USM up to DN150 without shut-off valve

D 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 (**A** and **B**) or without a shut-off valve (**C** and **D**). 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**

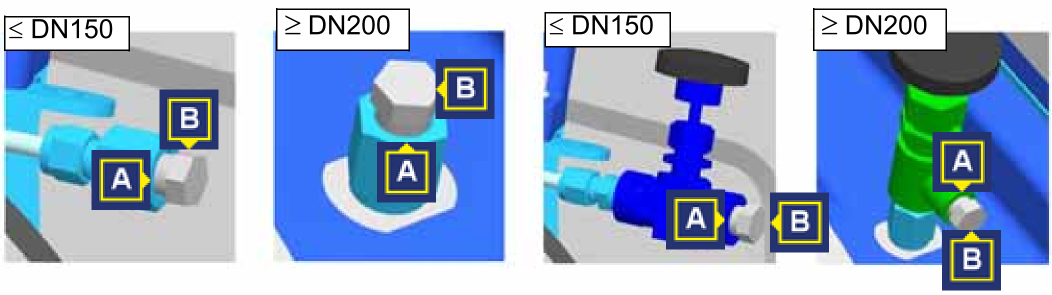
A Union nut with clamping screw connection ∅ 6 mm
B Blind plug (plugged)

Fig. 8-39: Connection options of the pressure connection with clamping screw connection

1. Unscrew the union nut of the clamping screw connection (**A**).
2. Remove the blind plug (**B**).
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**



A Female thread ¼"
B Blind plug (screwed)

Fig. 8-40: Connection options of the pressure connection with female thread

1. Unscrew the blind plug (**B**).
2. Seal the connection in the female thread (**A**).

8.5 Outdoor installation

The USM-GT-400 may be installed outdoor, too. 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 demage 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.

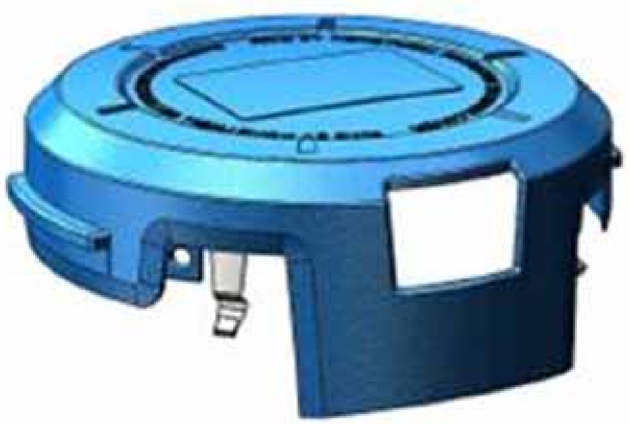


Fig. 8-41: sun protection for the US electronic

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

9 Start Up

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

Contents

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 oneanother.

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 151*

10 Operation

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

Contents

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**	m^3/h or acfh (flow)
&Z:	**AG-34**	m^3 or acf (meter)
&P:	**AG-35**	Imp/m^3 or Imp/cf (pulse 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).

Notice

- 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 and 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 ERZ2400

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

Notice

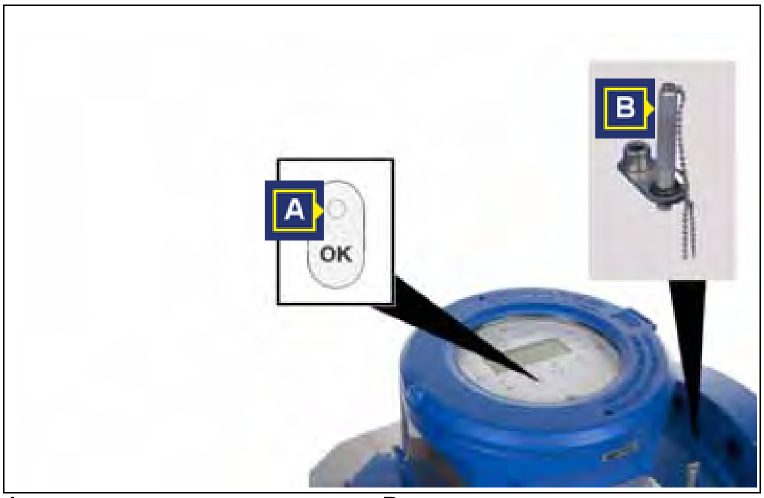
- This mode can be used only in areas where the MID is applied.

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)*



A Switch point B 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 **(B)**, the magnet must be placed on the glass in the position with the switching point **(A)** 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 118*

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 126*

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 122*

■ 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.

■ 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.

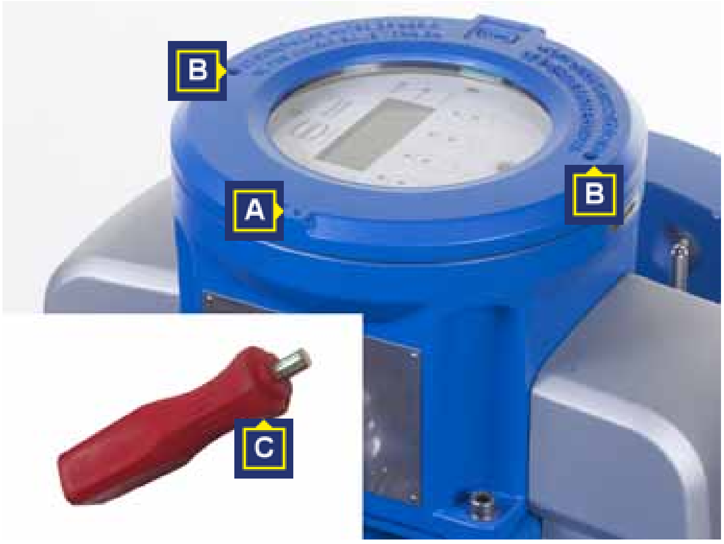
Please note that for this task the official seal must be broken. The device must not be used for calibrated operation if the official seal is broken.

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.



A Threaded pin

B Boreholes for inserting the special tools

C Special tool (2 pieces)

Fig. 10-2: Opening the cover

2 Unscrew threaded pin **(A)** out of the housing.

3 Insert the special tools into the boreholes.

4 Release the cover with the special key.

A Cover

Fig. 10-3: Open the cover

5 Screw the cover off with both hands.

■ **Setting the ultrasonic electronics for configuration**

A Calibration switch

Fig. 10-4: Opening the calibration switch

1 Press calibration switch **(A)** upwards to open it.

■ **Screw down the cover of the ultrasonic electronics**

A Cover B 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 handtight.

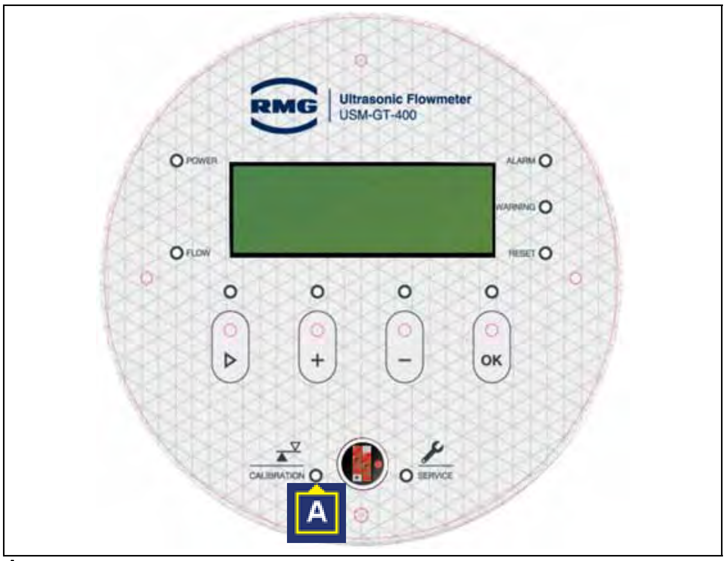
6 Switch on the system.

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



A 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:

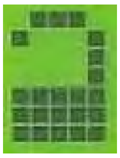
- During start up, this value can be set to customer requirements under the supervision of a calibration inspector.

1 Check LED.

The **Calibration** LED lights up. The calibration switch has been opened correctly.

2 Change the parameter values.

⇨ *„Calling up the value of a parameter“ on page 122*



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 121*

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.

A Calibration switch

Fig. 10-7: Close the calibration switch

■ **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 127*

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 128*

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 mode	Modbus		2099
J-02	Serial 0 baud rate	38400	baud	2100
J-03	Serial 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 address	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 address	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

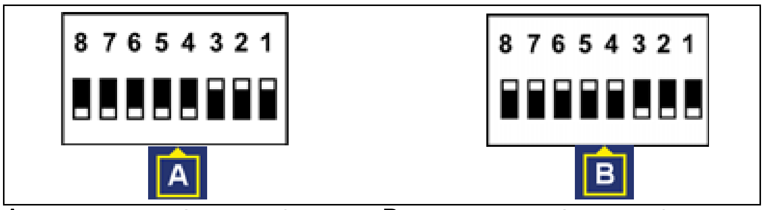
10.3.3 Interface 2

- 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 mode	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

Coordinates	Name	Value	Unit	Modbus Address
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.



A DIP switch RS232 configuration B 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.

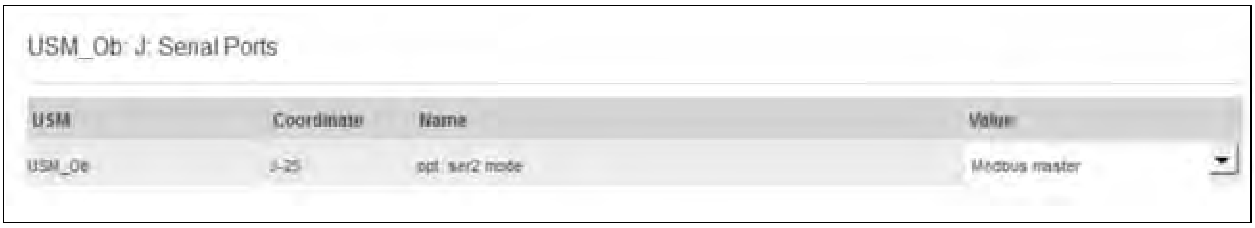
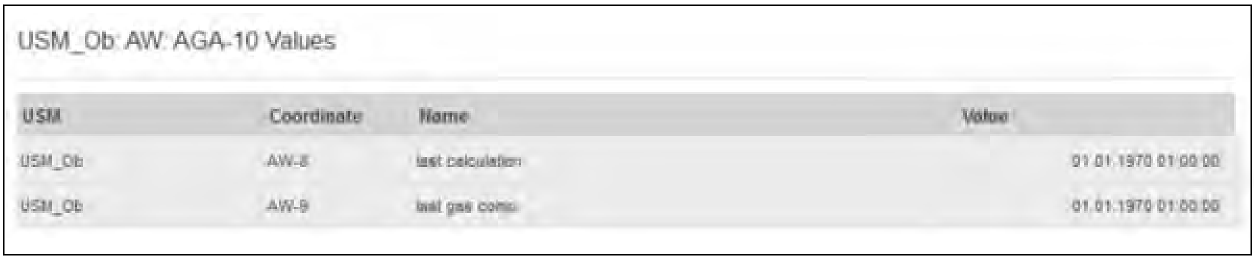


Fig. 10-9: Activation as Modbus master

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.

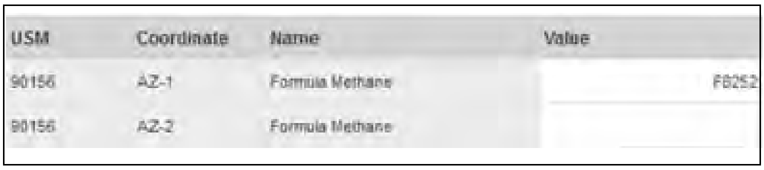
USM-GT-400	Coordinate	Name	Value	Unit
USM_Ob	AZ-01	Formula Methane	F8252	
USM_Ob	AZ-02	Formula Methane		
USM_Ob	AZ-03	Formula Ethane	F8256	
USM_Ob	AZ-04	Formula Ethane		
USM_Ob	AZ-05	Formula Propane	F8258	
USM_Ob	AZ-06	Formula Propane		
USM_Ob	AZ-07	Formula I-Butane	F8260	
USM_Ob	AZ-08	Formula I-Butane		
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 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-GT-400	Coordinate	Name	Value	Unit
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-GT-400	Coordinate	Name	Value	Unit
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	432	
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).

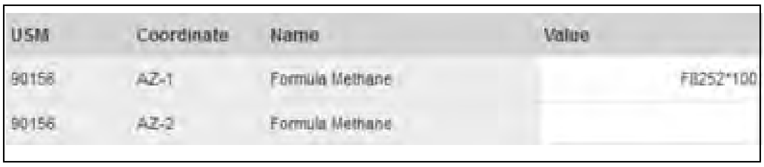


USM	Coordinate	Name	Value
90156	AZ-1	Formula Methane	F8252
90156	AZ-2	Formula Methane	

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 Methane (less significant)
• AZ-02 Formula Methane (highly significant)

An expression with more than 20 characters begins with the less significant coordinate AZ-01 and then continues with one with higher significants 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).

Terms may be

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 =!		

- 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 floating-point 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.

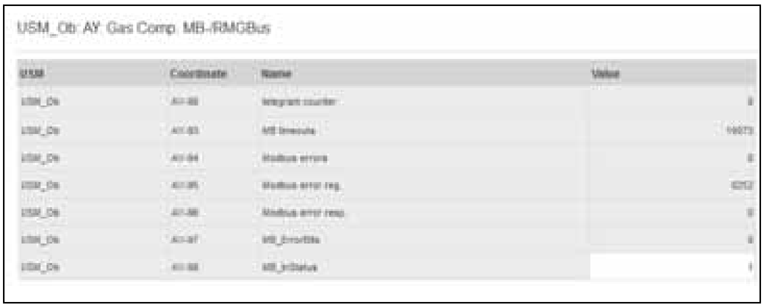


Fig. 10-16: Significance of the coordinates

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 codes

Code	Description
03 Hex	Read Holding Registers
06 Hex	Preset Single Register
10 Hex	Preset Multiple Registers
08 Hex	Diagnostic

Code	Description
00 Hex	Return Query Data

Exception codes

Code	Description
03	Illegal Function
03	Illegal Data Address (Register not available)
03	Illegal Data Value (Register can-not be described or incorrect value)

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-GT-400	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		

Question	Modbus - ASCII	Modbus - RTU	
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	Value = A801
LRC	51	06	
carriage return	CR	44	
line feed	LF		
	Value in ASCII	Value in HEX	

10.5 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. • 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 160*

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 55*

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.

Notice

Recommendation: The battery should be changed on the regular base of recalibration 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:

⇨ *Operating instructions service manual for changing the transducer (separate document)*

11.6 Changing the ultrasonic electronics

⚠ Danger

Mortal danger from incorrect replacement of the ultrasonic electronics

If the ultrasonic electronics is not changed correctly, this may result in explosions.

- Change the ultrasonic electronics only if you have obtained a training from RMG for this activity.
- Observe the separate service instructions for changing the ultrasonic electronics.

You can find out more about changing the ultrasonic electronics here:

⇨ *Service instructions for changing the ultrasonic electronics (separate document)*

11.7 Cleaning the device

Notice

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 169*

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 127*

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 127*

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 page I*

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.

Active warning messages are displayed with a **+** in front of the message number.

Warning messages that can be acknowledged are displayed with a **-** in front of the message number.

12.1 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: **S**erial **P**eripheral **I**nterface (Databus) of the **d**igital **S**ignal **p**rocessor 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

No.	Message	Explanation
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
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	ADC fault 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

No.	Message	Explanation
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 5 error
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. limit	Operating volume flow below Qmin
78	QVb max. limit	Operating volume flow above Qmax
99	Wrong param.	Parameter entered is invalid

12.2 Warning messages

No.	Message	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
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

No.	Message	Explanation
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 1.2 too small
141	p2.2 amplitude	Amplitude of the signal from sensor 2.2 too small
142	p3.2 amplitude	Amplitude of the signal from sensor 3.2 too small
143	p4.2 amplitude	Amplitude of the signal from sensor 4.2 too small
144	p5.2 amplitude	Amplitude of the signal from sensor 5.2 too small
145	p6.2 amplitude	Amplitude of the signal from sensor 6.2 too small
146	p7.2 amplitude	Amplitude of the signal from sensor 7.2 too small (spare)
147	p8.2 amplitude	Amplitude of the signal from sensor 8.2 too small (spare)
150	Path1 delta c	Deviation from the speed of sound in path 1 from the average speed of sound too large
151	Path2 delta c	Deviation from the speed of sound in path 2 from the average speed of sound too large
152	Path3 delta c	Deviation from the speed of sound in path 3 from the average speed of sound too large
153	Path4 delta c	Deviation from the speed of sound in path 4 from the average speed of sound too large
154	Path5 delta c	Deviation from the speed of sound in path 5 from the average speed of sound too large
155	Path6 delta c	Deviation from the speed of sound in path 6 from the average speed of sound too large
156	Path7 delta c	Deviation from the speed of sound in path 7 from the average speed of sound too large (spare)
157	Path8 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

No.	Message	Explanation
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 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)

12.3 Notes

No.	Message	Explanation
181	Sys. Temp Min	System temperature too low
182	Sys. Temp Max	System temperature too 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

12.4 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 page I*

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 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 and 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 and 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
Power consumption:	Measuring element:	typical 7-9 W; with heated display, typically 12 W max. 15 W
Protection class:	IP 66 / NEMA 4X	
Interfaces:	RS 485 0 (for RMGView^{USM}):	9600 / 19200 / 38400 / 57600 Baud
	RS 485 1 (for Modbus ASCII, RTU or Flow Computer)	9600 / 19200 / 38400 / 57600 Baud
	RS 485 2 (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 / -131 to + 131 ft/s	
Gas temperature range:	-40 °C to +80 °C (-40 °F to 176 °F)	
Maximum operating pressure	observe the details on the type plate.	
Ambient conditions	-40 °C to +55 °C (-40 °F to 131 °F)	

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.

Notice

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.

Notice

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 / 280	(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	14	11400 / 403000	90 / 3180	45 / 1590	
400	16	15000 / 530000	120 / 4230	60 / 2120	

Nominal diameter		Measuring range (m³/h) / (acfh)		Extended measuring range (m³/h) / (acfh) *1
mm	inches	Q_{max}	Q_{min}	Q_{min}
450	18	19000 / 670700	150 / 5300	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 Q_{min}. It can be used at pressures above p ≥ 4 bar / p ≥ 60 psi.

The number of acoustic paths is 6 for all variants.

13.4 Type plate

A Type plate

Fig. 13-1: Position of type plate

The following details can be found on the type plate:

13.4.1 Type plate ATEX / IECEx

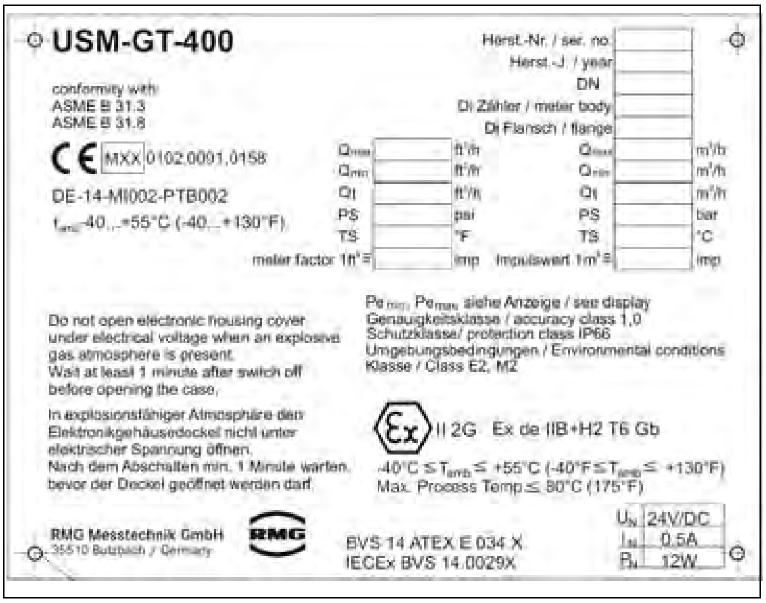


Fig. 13-2: Type plate ATEX / IECEx

13.4.2 Type plate NEC (CSA)

Fig. 13-3: Type plate NEC (CSA)

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)

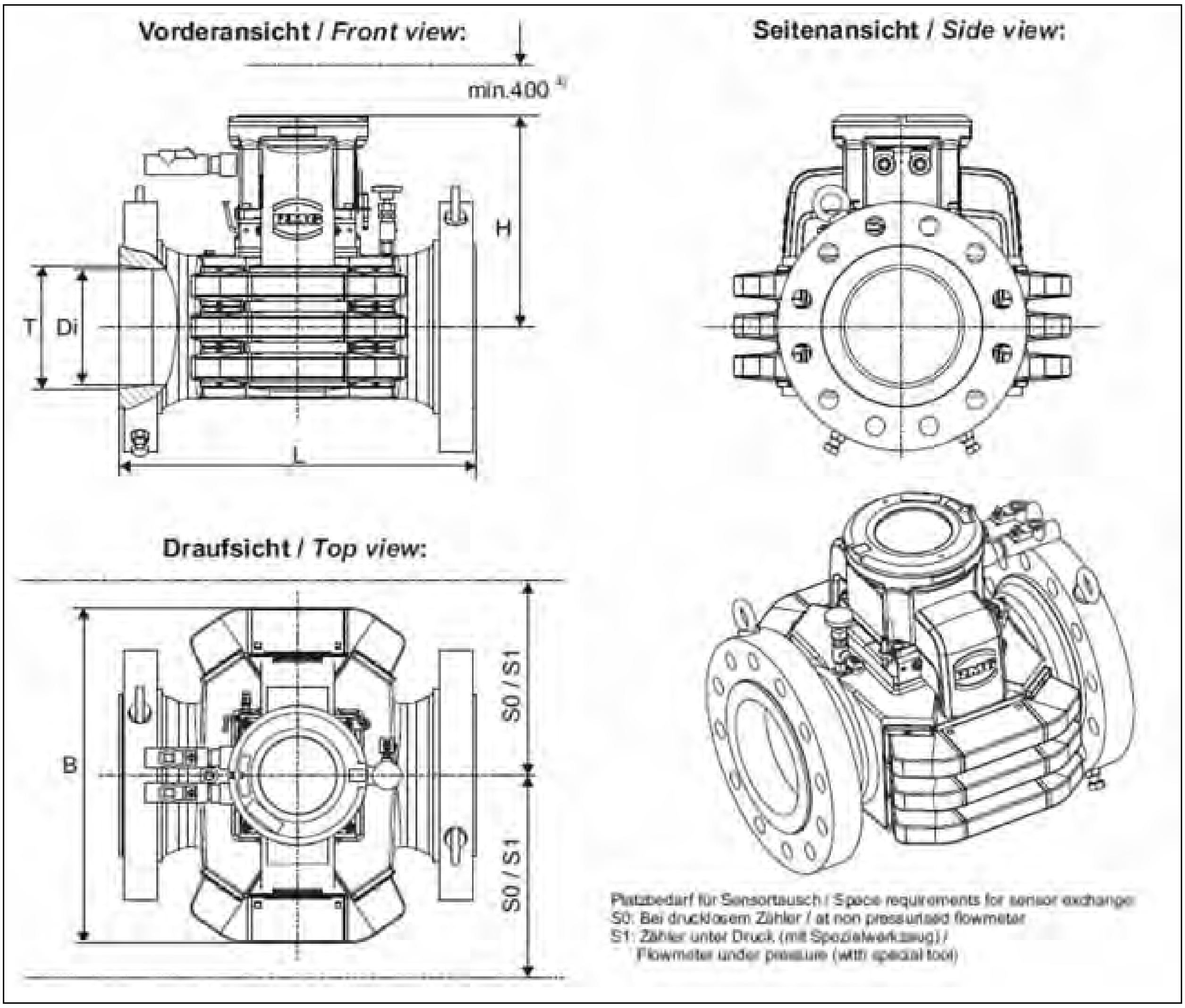


Fig. 13-4: NEC

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 167

13.5.2 ATEX / IECEx

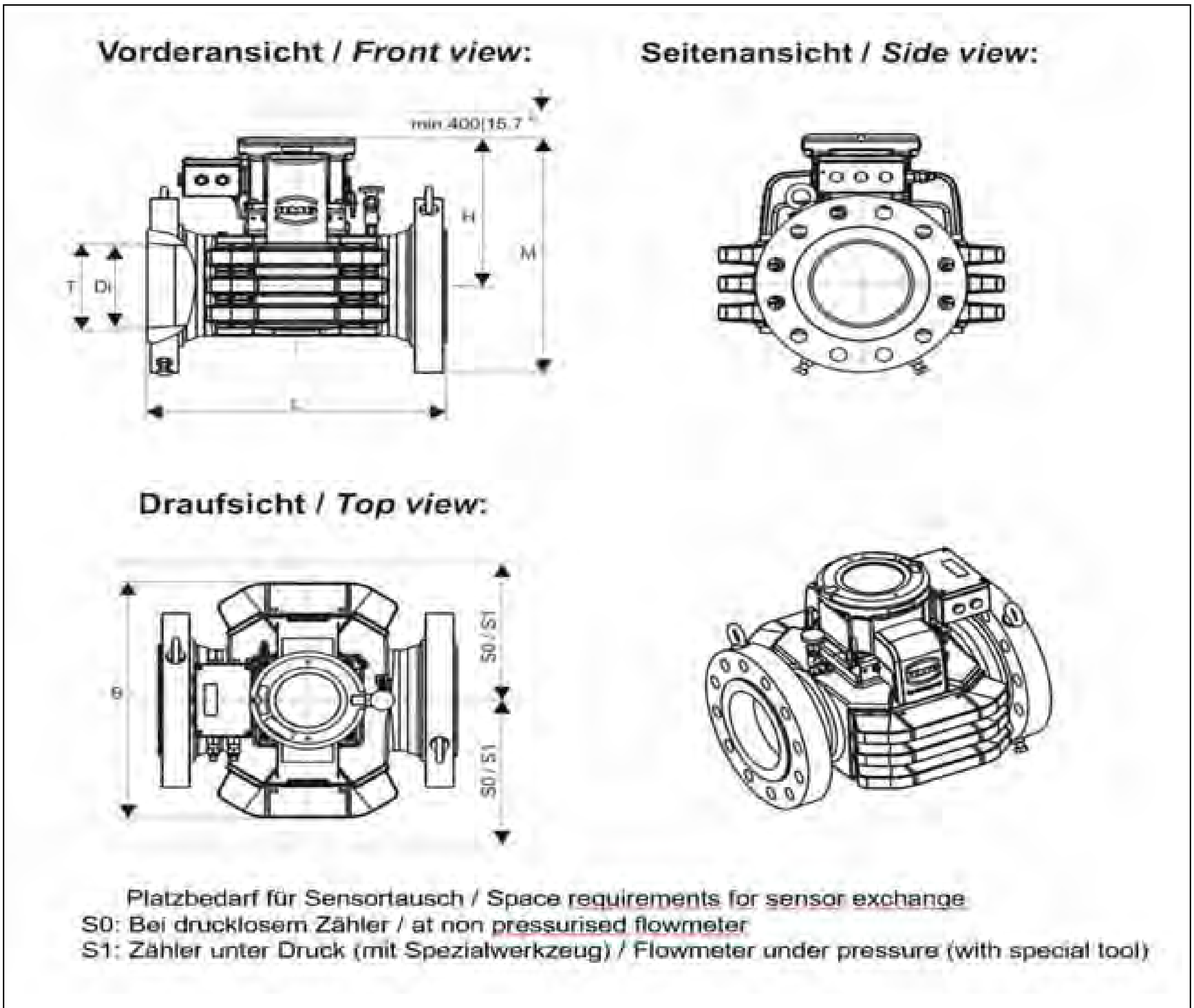


Fig. 13-5: ATEX / IECEx

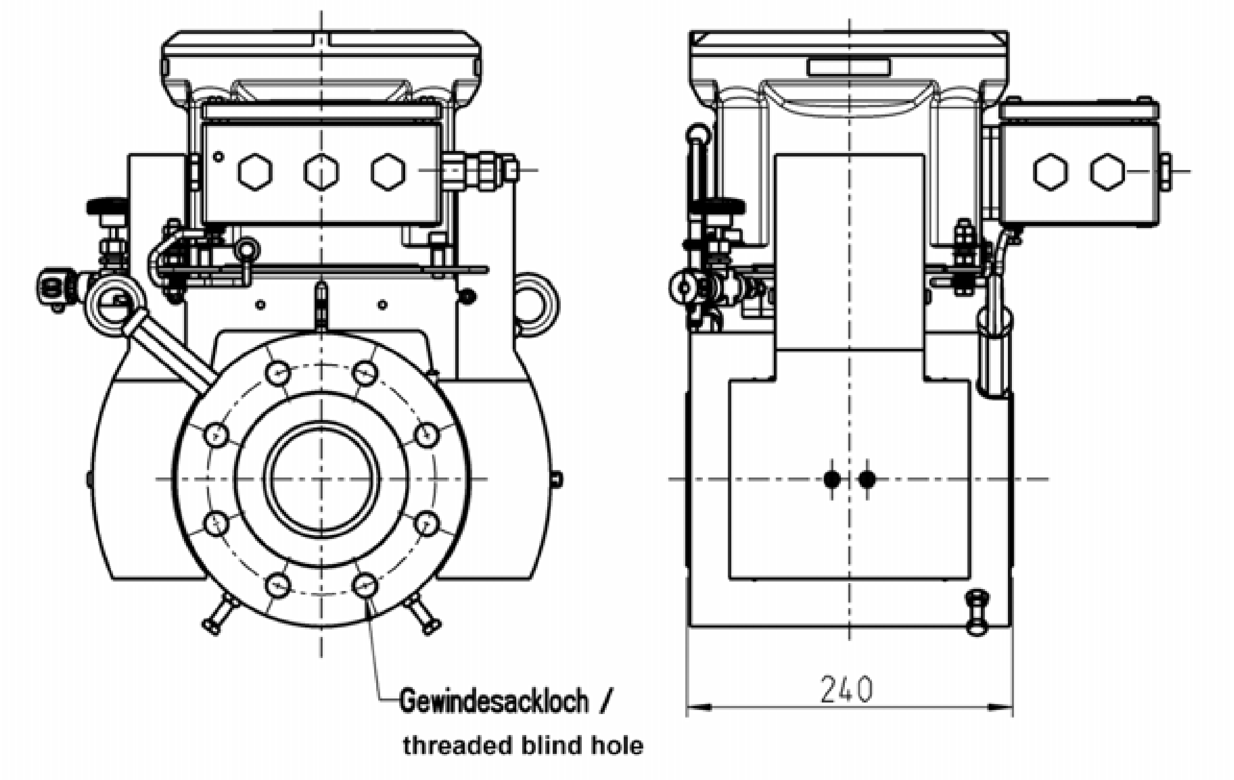


Fig. 13-6: *DN80*

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	T[1]	H[2]	B[2]	B[2] ANSI900	SO[2]	S1[2]	Weight[3]	Weight[3] ANSI900
80 (3)	240 (9.5)	-	73.7 (2.9)	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)	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)	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)	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)	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)	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)	-	284-348 (11.2-13.7)	-	420 (16.54)	730 (28.74)	-	450 (17.72)	1600 (62.99)	700 (1543)	-
400 (16)	1200 (47.24)	1200 (47.24)	363.5 (14.31)	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)	-	367-449 (14.4-17.7)	-	530 (20.87)	820 (32.28)	-	500 (19.69)	1650 (64.96)	1000 (2205)	-
500 (20)	1500 (59.06)	1500 (59.06)	455.6 (17.94)	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)	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).

[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 / AGA 9

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 GT400		Diameter Flange GT400		Min. ID of spools		Max. ID of spools		Schedule
80 / 3“	ANSI150RF	73.7	2.90			73.0	2.87	74.4	2.93	80
80 / 3“	ANSI150RF	77.9	3.07			77.2	3.04	78.7	3.10	40
80 / 3“	ANSI300RF	73.7	2.90			73.0	2.87	74.4	2.93	80
80 / 3“	ANSI300RF	77.9	3.07			77.2	3.04	78.7	3.10	40
80 / 3“	ANSI600RF	73.7	2.90			73.0	2.87	74.4	2.93	80
80 / 3“	ANSI600RF	77.9	3.07			77.2	3.04	78.7	3.10	40
100 / 4"	ANSI300RF	97.2	3.83	102.3	4.03	101.3	3.99	103.3	4.07	40
100 / 4"	ANSI600RF	97.2	3.83	97.2	3.83	96.2	3.79	98.2	3.87	80
100 / 4"	ANSI600RF	97.2	3.83	102.3	4.03	101.3	3.99	103.3	4.07	40
150 / 6"	ANSI600RF	146.4	5.76	146.4	5.76	144.9	5.71	147.9	5.82	80
150 / 6"	ANSI600RF	146.4	5.76	154.1	6.07	152.6	6.01	155.6	6.13	40
200 / 8"	ANSI600RF	193.7	7.63	193.7	7.63	191.8	7.55	195.6	7.70	80
200 / 8"	ANSI600RF	193.7	7.63	198.5	7.81	196.5	7.74	200.5	7.89	60
200 / 8"	ANSI600RF	193.7	7.63	202.7	7.98	200.7	7.90	204.7	8.06	40
250 / 10"	ANSI600RF	242.8	9.56	242.8	9.56	240.4	9.46	245.2	9.65	80
250 / 10"	ANSI600RF	242.8	9.56	247.6	9.75	245.1	9.65	250.1	9.85	60
250 / 10"	ANSI600RF	242.8	9.56	254.4	10.02	251.9	9.92	256.9	10.12	40
300 / 12"	ANSI600RF	288.8	11.37	288.8	11.37	285.9	11.26	291.7	11.48	80
300 / 12"	ANSI600RF	288.8	11.37	295.3	11.63	292.3	11.51	298.3	11.74	60
300 / 12"	ANSI600RF	288.8	11.37	303.2	11.94	300.2	11.82	306.2	12.06	40
400 / 16"	ANSI600RF	363.5	14.30	363.5	14.31	359.9	14.17	367.1	14.45	80
400 / 16"	ANSI600RF	363.5	14.30	373.1	14.69	369.4	14.54	376.8	14.84	60
400 / 16"	ANSI600RF	363.5	14.30	381	15.00	377.2	14.85	384.8	15.15	40

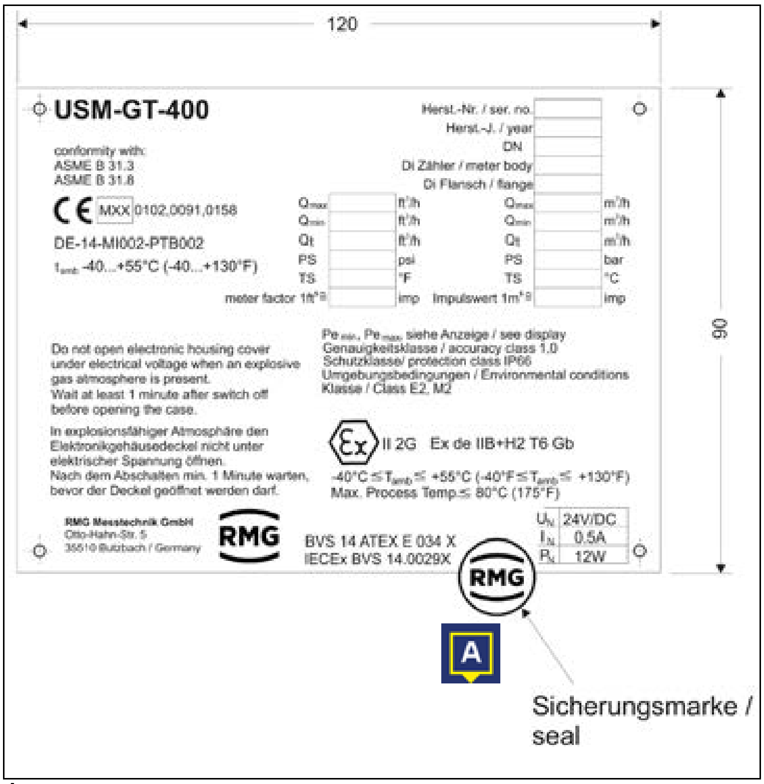
500 / 20"	ANSI600RF	455.6	17.94	455.6	17.94	451.0	17.76	460.2	18.12	80
500 / 20"	ANSI600RF	455.6	17.94	466.8	18.38	462.1	18.19	471.5	18.56	60
500 / 20"	ANSI600RF	455.6	17.94	477.8	18.81	473.0	18.62	482.6	19.00	40
600 / 24"	ANSI600RF	547.7	21.56	547.7	21.56	542.2	21.35	553.2	21.78	80
600 / 24"	ANSI600RF	547.7	21.56	560.4	22.06	554.8	21.84	566.0	22.28	60
600 / 24"	ANSI600RF	547.7	21.56	574.6	22.62	568.9	22.40	580.3	22.85	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



A Official seal

Fig. 13-7: Position of the official seal on the type plate

13.7.2 Ultrasonic electronics

Official seal diagram according to ATEX / IECEx

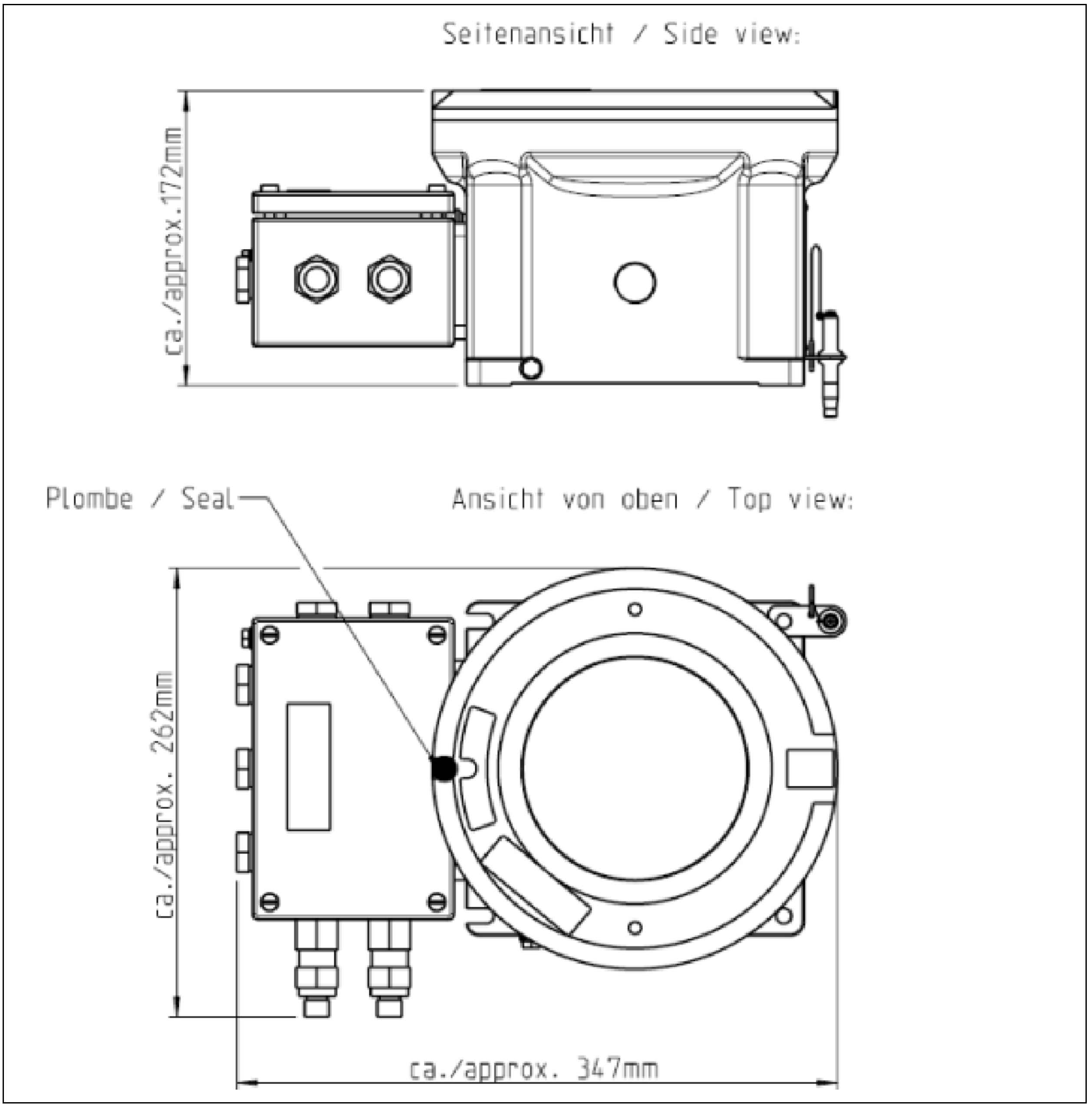


Fig. 13-8: Representation of the device with DN 150 (6")

Official seal diagram according to NEC

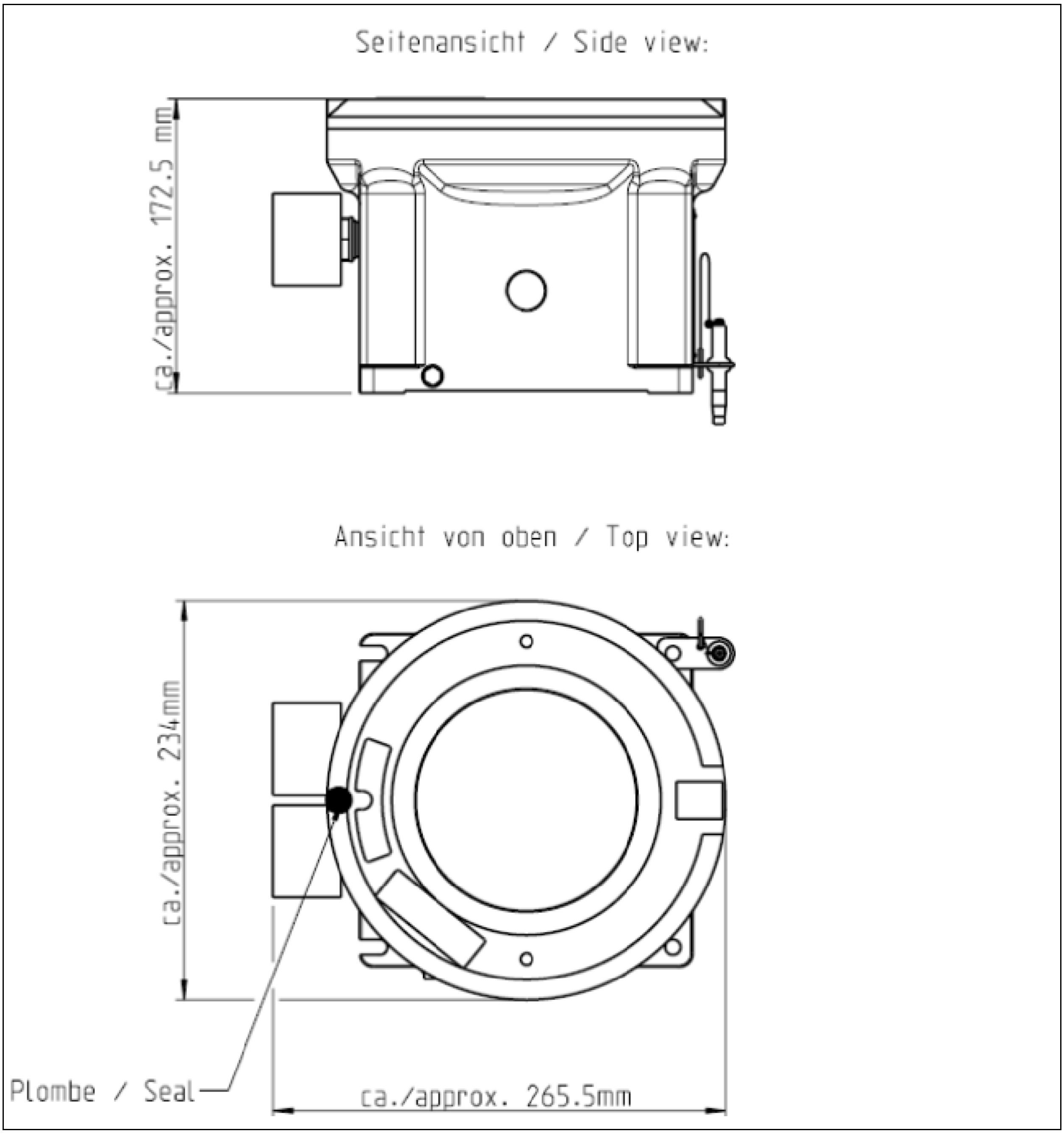


Fig. 13-9: Representation of the device with DN 150 (6")

13.7.3 Ultrasonic gas meter

Devices DN 100 (4") and DN 150 (6")

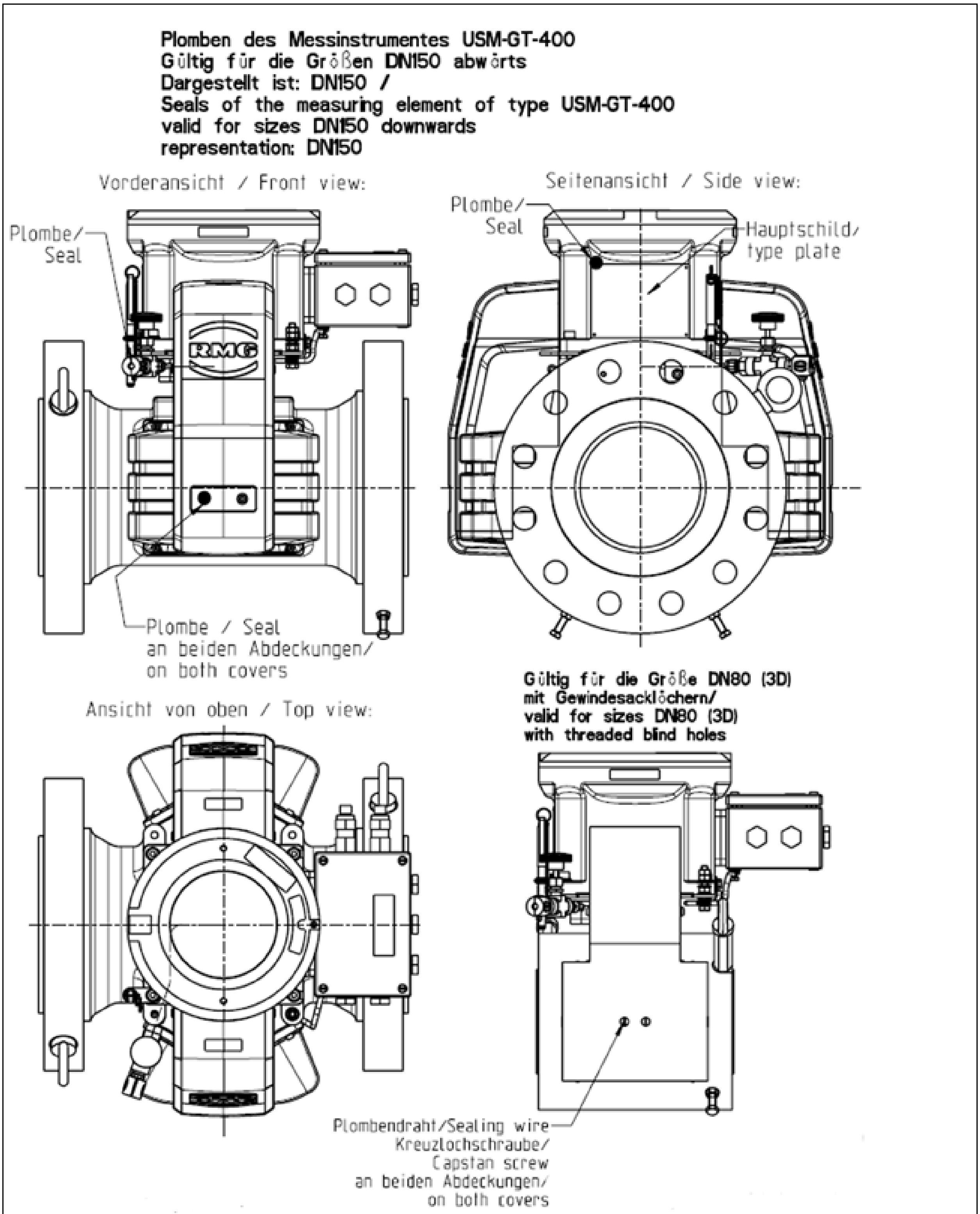


Fig. 13-10: Representation of the device with DN 150 (6")

Devices DN 200 (8") and larger

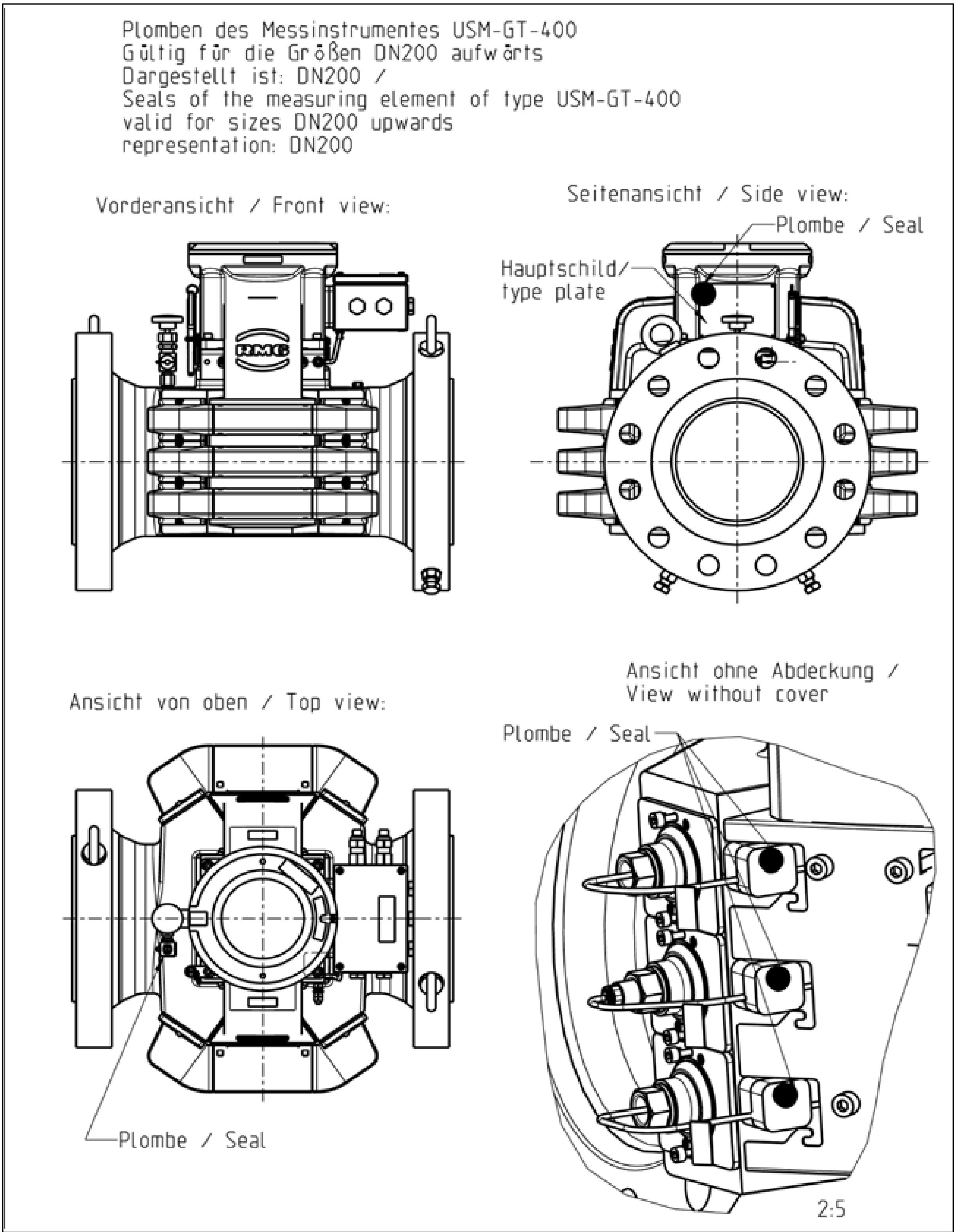


Fig. 13-11: Representation of the device with DN 200 (8")

13.8 Transducer types

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.

A TNG 10-CP / -CHP B TNG 20-SP / -SHP

Fig. 13-12: Transducer types

Transducer type	Operating frequency (kHz)	Operating pressure range bar (psi)	Ambient temperature °C (°F)	Gas temperature °C (°F)
TNG 10-CP	120	1–150 (14.5 to 2175.57)	-40 to +55 °C (55 to 131 °F)	up to +80 °C (176 °F)
TNG 10-CHP	120	1-300 (14.5 to 4351.13)	-40 to +55 °C (55 to 131 °F)	up to +80 °C (176 °F)
TNG 20-SP	200	1–150 (14.5 to 2175.57)	-40 to +55 °C (55 to 131 °F)	up to +80 °C (176 °F)
TNG 20-SHP	200	1-300 (14.5 to 4351.13)	-40 to +55 °C (55 to 131 °F)	up to +80 °C (176 °F)

14 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.

14.1 Metrological approvals

The device has the following approvals:

- MID approval (DE-14-MI002-PTB002)
- MC type approval (metrological approval of Measurement Canada, AG-0622)

14.2 Pressure devices approval

- PED 2014/68/EU /
  EU-type examination certificate(Module B)
  ISG-22-14-1630
- ASME B31.3 Ed.2012
- CRN

14.3 Electromagnetic compatibility

- FS-1312-249580-001
- FS-1312-249585

14.4 Explosion protection approval

- ATEX (BVS 14 ATEX E 034X)
- IECEx (BVS 14.0029X)
- CSA (NA) C22.2 No 0.-M91, 30-M1986, 142-M1987

14.5 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. 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 flameproof enclosures "d"
DIN EN and IEC/ EN 60079-7	Explosive atmospheres - Part 7: Equipment protection by flameproof 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-Guideline

PS-G-06	Provisional Specifications for the Approval, Verification, Re-verification, 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

15 Index

16 USM GT400 Glossary

In this chapter you will be given information on terminology.

Ultrasonic gas meter (USM)

The gas flows through the ultrasonic gas meter. 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 the software the ultrasonic gas meter is sometimes called a meter.

Device

In the manual, the ultrasonic gas meter and the ultrasonic electronics are called devices.

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)*

17 USM GT400 Attachment

You will find the declaration of conformity and approvals of the device in this section.

Reliable Measurement of Gas

EU-Declaration of Conformity

EU-Konformitätserklärung

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 de IIB+H_2 T6 Gb	—	—
Normative Documents *Normative Dokumente*	EN 61000-6-3:2007 +A1:2011 EN 61000-6-2:2005	EN 60079-0: 2012 EN 60079-1: 2007 EN 60079-7: 2007	AD 2000 – Merkblätter	OIML R 137-1&2 / 2012 OIML D 11 / 2013 Welmec-Guide: 7.2 / 11.1 / 11.3
EC Type-Examination issued by *EG-Baumusterprüfung ausgestellt durch*	Prüfbericht/ Test Report: FS-1312-249580-001 und FS-1312-249585 (Fa. Nemko GmbH)	BVS 14 ATEX E 034 X DEKRA EXAM Germany	ISG-22-19-1497_Rev. - TÜV Hessen Germany	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 EXAM 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 05.11.2019

Thorsten Dietz, Managing Director

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

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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** **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 *Arrival of EUT:*	**03.01.2014**	
Meßtermin(e) *Date of measurement:*	**07. - 09.01.2014**	
Prüfungsgrundlage *Standards:*	***Störaussendung*** *- Emission:* **EN 61000-6-3:2007+A1:2011** **Klasse B** - *class B*	***Störfestigkeit*** *- Immunity:* **EN 61000-6-2:2005**
Ergebnisse - *Results:*	**Anforderungen erfüllt** - *Passed* **Details siehe Zusammenfassung** - *Details see test result summary*	
Bemerkungen - *Remarks:*	**Höherer Prüfschärfegrad gem. OIML R 137-1&2: 2012 berücksichtigt** *Higher perfomance criteria OIML R 137-1&2: Ed. 2012 was considered*	
Bemerkungen - *Remarks:*	**Ein Prüfplan wurde vorgelegt.** *The test plan was presented.*	
Durchführung - *Performed by:*	**Dipl.-Ing. Th. W. Stein, Dipl.-Ing. M. Korny**	

PRÜFBERICHT - *TEST REPORT*

Identifikationsnummer *Identification No.:*	**FS-1312-249585**	
Datum des Prüfberichts *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

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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.

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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** **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) *Date of measurement*	**09.; 10.; 13.01.2014**	
Prüfungsgrundlage *Standards*	***Störaussendung - Emission:*** **EN 61000-6-3:2007+A1:2011** **Klasse B** - *class B*	***Störfestigkeit - Immunity:*** **EN 61000-6-2:2005**
Ergebnisse - *Results*	**Anforderungen erfüllt** - *Passed* **Details siehe Zusammenfassung** - *Details see test result summary*	
Bemerkungen - *Remarks*	**Höherer Prüfschärfegrad gem. OIML R 137-1&2: 2012 berücksichtigt** *Higher perfomance criteria OIML R 137-1&2: Ed. 2012 was considered.*	
Bemerkungen - *Remarks*	**Ein Prüfplan wurde vorgelegt.** *The test plan was presented.*	
Bemerkungen - *Remarks*	**Ersatz für Prüfbericht FS-1312-249580 vom 16.01.2014.** *Replacement for test report FS-1312-249580 dated 2014-01-16.*	
Durchführung - *Performed by*	**Dipl.-Ing. J. Szipanski**	

PRÜFBERICHT - *TEST REPORT*

Identifikationsnummer *Identification No.*	**FS-1312-249580-001**	
Datum des Prüfberichts *Date of Report*	**24.02.2014**	
bearbeitet von - *Provided by*	**Dipl.-Ing. J. Szipanski** 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

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DEKRA

(1) EG-Baumusterprüfbescheinigung

(2) Geräte und Schutzsysteme zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen - Richtlinie 94/9/EG

(3) Nr. der EG-Baumusterprüfbescheinigung: **BVS 14 ATEX E 034 X**

(4) Gerät: **Ultraschallgaszähler Typ USM-GT-400**

(5) Hersteller: **RMG Messtechnik GmbH**

(6) Anschrift: **Otto-Hahn-Straße 5, 35510 Butzbach**

(7) Die Bauart dieses Gerätes sowie die verschiedenen zulässigen Ausführungen sind in der Anlage zu dieser Baumusterprüfbescheinigung festgelegt.

(8) Die Zertifizierungsstelle der DEKRA EXAM GmbH, benannte Stelle Nr. 0158 gemäß Artikel 9 der Richtlinie 94/9/EG des Europäischen Parlaments und des Rates vom 23. März 1994, bescheinigt, dass das Gerät die grundlegenden Sicherheits- und Gesundheitsanforderungen für die Konzeption und den Bau von Geräten und Schutzsystemen zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen gemäß Anhang II der Richtlinie erfüllt. Die Ergebnisse der Prüfung sind in dem Prüfprotokoll BVS PP 14.2061 EG niedergelegt.

(9) Die grundlegenden Sicherheits- und Gesundheitsanforderungen werden erfüllt durch Übereinstimmung mit

EN 60079-0:2012	**Allgemeine Anforderungen**
EN 60079-1:2007	**Druckfeste Kapselung „d"**
EN 60079-7:2007	**Erhöhte Sicherheit „e"**

(10) Falls das Zeichen „X" hinter der Bescheinigungsnummer steht, wird in der Anlage zu dieser Bescheinigung auf besondere Bedingungen für die sichere Anwendung des Gerätes hingewiesen.

(11) Diese EG-Baumusterprüfbescheinigung bezieht sich nur auf die Konzeption und die Baumusterprüfung des beschriebenen Gerätes in Übereinstimmung mit der Richtlinie 94/9/EG.
Für Herstellung und Inverkehrbringen des Gerätes sind weitere Anforderungen der Richtlinie zu erfüllen, die nicht durch diese Bescheinigung abgedeckt sind.

(12) Die Kennzeichnung des Gerätes muss die folgenden Angaben enthalten:

Ex II 2G Ex de IIB+H_2 T6 Gb

DEKRA EXAM GmbH
Bochum, den 17.03.2014

Zertifizierungsstelle	Fachbereich

Seite 1 von 2 zu BVS 14 ATEX E 034 X
Dieses Zertifikat darf nur vollständig und unverändert weiterverbreitet werden.
DEKRA EXAM GmbH, Dinnendahlstraße 9, 44809 Bochum, Telefon +49.234.3696-105, Telefax +49.234.3696-110, zs-exam@dekra.com

(1) # EG-Baumusterprüfbescheinigung

(2) Geräte und Schutzsysteme zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen - Richtlinie 94/9/EG

(3) Nr. der EG-Baumusterprüfbescheinigung: **BVS 14 ATEX E 034 X**

(4) Gerät: **Ultraschallgaszähler Typ USM-GT-400**

(5) Hersteller: **RMG Messtechnik GmbH**

(6) Anschrift: **Otto-Hahn-Straße 5, 35510 Butzbach**

(7) Die Bauart dieses Gerätes sowie die verschiedenen zulässigen Ausführungen sind in der Anlage zu dieser Baumusterprüfbescheinigung festgelegt.

(8) Die Zertifizierungsstelle der DEKRA EXAM GmbH, benannte Stelle Nr. 0158 gemäß Artikel 9 der Richtlinie 94/9/EG des Europäischen Parlaments und des Rates vom 23. März 1994, bescheinigt, dass das Gerät die grundlegenden Sicherheits- und Gesundheitsanforderungen für die Konzeption und den Bau von Geräten und Schutzsystemen zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen gemäß Anhang II der Richtlinie erfüllt. Die Ergebnisse der Prüfung sind in dem Prüfprotokoll BVS PP 14.2061 EG niedergelegt.

(9) Die grundlegenden Sicherheits- und Gesundheitsanforderungen werden erfüllt durch Übereinstimmung mit

EN 60079-0:2012 **Allgemeine Anforderungen**
EN 60079-1:2007 **Druckfeste Kapselung „d"**
EN 60079-7:2007 **Erhöhte Sicherheit „e"**

(10) Falls das Zeichen „X" hinter der Bescheinigungsnummer steht, wird in der Anlage zu dieser Bescheinigung auf besondere Bedingungen für die sichere Anwendung des Gerätes hingewiesen.

(11) Diese EG-Baumusterprüfbescheinigung bezieht sich nur auf die Konzeption und die Baumusterprüfung des beschriebenen Gerätes in Übereinstimmung mit der Richtlinie 94/9/EG. Für Herstellung und Inverkehrbringen des Gerätes sind weitere Anforderungen der Richtlinie zu erfüllen, die nicht durch diese Bescheinigung abgedeckt sind.

(12) Die Kennzeichnung des Gerätes muss die folgenden Angaben enthalten:

Ex **II 2G Ex de IIB+H_2 T6 Gb**

DEKRA EXAM GmbH
Bochum, den 17.03.2014

Zertifizierungsstelle

Fachbereich

Seite 1 von 2 zu BVS 14 ATEX E 034 X
Dieses Zertifikat darf nur vollständig und unverändert weiterverbreitet werden.
DEKRA EXAM GmbH, Dinnendahlstraße 9, 44809 Bochum, Telefon +49.234.3696-105, Telefax +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** Otto-Hahn-Straße 5 35510 Butzbach **Germany**		
Electrical Apparatus: *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: (for printed version)

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
DEKRA EXAM GmbH

TÜV Technische Überwachung Hessen GmbH
Industrie Service
Hans – Böckler – Straße 4 35440 Linden
Telefon: 06403 / 9008 – 0 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. -

Name und Anschrift des Herstellers: Name and postal address of the manufacturer:	**RMG Messtechnik GmbH** **Otto-Hahn-Strasse 5** **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. -
Bezeichnung: Designation:	Ultraschallgaszähler USZ08 / USM-GT-400 DN80, DN100, DN200, DN250, DN300, DN350, DN400, DN500, DN600, DN800, DN900
Geltungsbereich: Scope of examination:	**Ultraschallgaszähler Typ: USZ08-6P / USM-GT-400** siehe Beiblätter zu/ *see attached sheet to:* ISG-22-19-1497_Rev. -
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. -**
Bemerkungen / Hinweise: Remarks / hints:	**Das Zertifikat ISG-22-14-1630_Rev. I vom 05.07.2019 ist hiermit ersetzt und verliert seine Gültigkeit!**

Anlagen: siehe Beiblatt zu/ *see attached sheet to*
documents: ISG-22-19-1497_Rev. -

TÜV Technische Überwachung Hessen GmbH
Notified body, No.: 0091

Linden, 31.10.2019
place, date

Zertifizierer:
☐ T. Budesheim ☒ H. Dietrich ☐ S. Droß

Umseitige Hinweise beachten / see hints overleaf

CSA Group

Certificate of Compliance

Certificate: 2156089 **Master Contract:** 261288

Project: 70019644 **Date Issued:** February 24, 2015

Issued to: **RMG Messtechnik Gmbh**
Otto-Hahn-Straße 5
Butzbach, 35510
Germany
Attention: Ralf Both

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: James May
James May

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. 2012-05-22 Page 1

CSA Group

Certificate: 2156089 **Master Contract:** 261288
Project: 70019644 **Date Issued:** February 24, 2015

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

DQD 507 Rev. 2012-05-22 Page 2

PTB
Physikalisch-Technische Bundesanstalt
Nationales Metrologieinstitut

KBS
Konformitätsbewertungsstelle

EU-Baumusterprüfbescheinigung

EU Type-examination Certificate

Ausgestellt für: *Issued to:*	RMG Messtechnik GmbH Otto-Hahn-Str. 5 35510 Butzbach
gemäß: *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. *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: *Type of instrument:*	Gaszähler *Gas meter*
Typbezeichnung: *Type designation:*	USM GT400
Nr. der Bescheinigung: *Certificate No.:*	DE-14-MI002-PTB002, Revision 5
Gültig bis: *Valid until:*	11.02.2028
Anzahl der Seiten: *Number of pages:*	29
Geschäftszeichen: *Reference No.:*	PTB-1.42-4092296
Notifizierte Stelle: *Notified Body:*	0102

Zertifizierung:
Certification:

Im Auftrag
On behalf of PTB

Dr. Rainer Kramer

Braunschweig, 04.09.2018

Siegel
Seal

Bewertung:
Evaluation:

Im Auftrag
On behalf of PTB

Dr. Roland Schmidt

R3-072097

TÜV PROFI CERT

CERTIFICATE

Management system as per

Pressure Equipment Directive 2014/68/EU Module D

Evidence of conformity with the above standard(s) has been furnished
and is certified in accordance with TÜV PROFICERT procedures for

RMG

RMG Messtechnik GmbH
Otto-Hahn-Straße 5
D-35510 Butzbach
GERMANY

scope:

Production of gas meters and
associated items of equipment

Certificate registration No. **73 202 2839**

Certificate valid from 2018-07-16 to **2021-07-15**

Audit report No. 4331 6307

ZLS

ZLS-NB-0223

TÜV HESSEN

PTB
Physikalisch-Technische Bundesanstalt
Nationales Metrologieinstitut

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Konformitätsbewertungsstelle

Zertifikat
Certificate

über die Anerkennung eines Qualitätssicherungssystems
on the approval of a quality system

Ausgestellt für: *Issued to:*	RMG MESSTECHNIK GmbH Otto-Hahn-Str. 5 35510 Butzbach
gemäß: *In accordance with:*	Mess- und Eichverordnung vom 11. Dezember 2014 (MessEV) *Measures and Verification Ordinance dated 11 December 2014 (MessEV)* in Verbindung mit *in connection with* - Richtlinie **2014/32/EU** vom 26. Februar 2014 (MID) *- Directive **2014/32/EU** of 26 February 2014 (MID)*
Messgröße lt. MessEV § 1: *Measurand acc. to Measures and Verification Ordinance, section 1:*	Volumen *Volume* Sonstige Messgrößen bei der Lieferung von strömenden Flüssigkeiten oder strömenden Gasen *Other measurands in the supply of flowing liquids or flowing gases*
Nr. des Zertifikats: *Certificate No.:*	DE-M-AQ-PTB023, Revision 2
Gültig bis: *Valid until:*	08.02.2021
Anzahl der Seiten: *Number of pages:*	5
Geschäftszeichen: *Reference No.:*	PTB-9.22-4089350
Nr. der Stelle: *Body No.:*	0102

Im Auftrag
On behalf of PTB

Markus Umer

Braunschweig, 09.02.2018

Siegel
Seal

PHYSIKALISCH-TECHNISCHE BUNDESANSTALT 72

R3-027579

PTB

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Nationales Metrologieinstitut

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Seite 2 des QS-Anerkennungszertifikats Nr. DE-M-AQ-PTB023, Revision 2 vom 09.02.2018
Page 2 of the QS Approval Certificate No. DE-M-AQ-PTB023, Revision 2 dated 09.02.2018

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*

Diese Revision 2 ersetzt Zertifikat Nr. DE-M-AQ-PTB023 vom 12.06.2017, Geschäftszeichen PTB-Q.32-4085287.
This Revision 2 replaces Certificate No. DE-M-AQ-PTB023 dated 12.06.2017, Reference No. PTB-Q.32-4085287

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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), zuletzt geändert durch Artikel 1 der Verordnung vom 10.08.2017 (BGBl. I S. 3098), Absätze 3.2 und 3.3
  Annex 4 ***Module D of the Measures and Verification Ordinance*** *dated 11.12.2014 (Federal Law Gazette I, p. 2010), last amended by article 1 of the Ordinance of 10.08.2017 (BGBl. I p. 3098), 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), zuletzt geändert durch Berichtigung vom 20.01.2016 (ABl L 13 S. 57), 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),), last amended by Corrigendum of 20.01.2016 (OJ L 13 p. 57) 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.

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Seite 4 des QS-Anerkennungszertifikats Nr. DE-M-AQ-PTB023, Revision 2 vom 09.02.2018
Page 4 of the QS Approval Certificate No. DE-M-AQ-PTB023, Revision 2 dated 09.02.2018

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

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Seite 5 des QS-Anerkennungszertifikats Nr. DE-M-AQ-PTB023, Revision 2 vom 09.02.2018
Page 5 of the QS Approval Certificate No. DE-M-AQ-PTB023, Revision 2 dated 09.02.2018

Standort 2: *Site 2:*	RMG Messtechnik GmbH Heinrich-Lanz-Str. 9 67259 Beindersheim DEUTSCHLAND
Messgerätearten: *Kinds of measuring instruments:*	EU-Gasmengenumwerter (TG) *EU volume conversion devices for gas (sub-assembly)*
	ZE: Dichte-Mengenumwerter *Additional device: Density conversion device*
	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: Brennwert-Mengenumwerter *Additional device: Energy conversion device*
	ZE: Langzeitspeicher *Additional device: Long-term storage*

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.

PTB | Physikalisch-Technische Bundesanstalt | Nationales Metrologieinstitut
PTB | Physikalisch-Technische Bundesanstalt | National Metrology Institute

Konformitätsbewertungsstelle
Conformity Assessment Body

Bundesallee 100 • 38116 Braunschweig • DEUTSCHLAND
Abbestraße 2-12 • 10587 Berlin • DEUTSCHLAND

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 17 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

5 Manufacturer: **RMG Messtechnik GmbH**

6 Address: **Otto-Hahn-Straße 5, 35510 Butzbach, Germany**

Site(s) of manufacture: **Otto-Hahn-Straße 5, 35510 Butzbach, Germany**

RMG Messtechnik GmbH, Heinrich-Lanz-Straße 9, 67259 Beindersheim, Germany

7 The certification body of DEKRA EXAM 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/E139/17 issued 2017-10-24.
Results of periodical re-assessments of the quality system are a part of this notification.

9 This notification is valid from 2017-10-28 until 2020-10-28 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 EXAM GmbH as notified body involved in the production control phase.

DEKRA EXAM GmbH
Bochum, 2017-10-24

Certifier | Approver

This is a translation from the German original.
In the case of arbitration only the German wording shall be valid and binding.

Page 1 of 1
This notification may only be reproduced in its entirety and without any change.
DEKRA EXAM GmbH Dinnendahlstrasse 9 44809 Bochum Germany Phone +49.234.3696-105 Fax +49.234.3696-110
e-mail zs-exam@dekra.com

18 Lists of parameters and measured values

The following tables show the parameters that can be shown and edited using the RMGView^{USM} software 5.0 or via the display with control panel.

With different versions of the device software, individual parameters may have different coordinates.

1. Pressure
2. Temperature
3. USE09-C measuring value
4. USE09-C flow
5. Parameter
6. USE09-C flow correction
7. USE09-C polynomial
8. Freq., Pulse outputs
9. Current output
10. Serial Ports
11. DSP, FPGA values
12. Path 1 measurement values
13. Path 2 measuring values
14. Path 3 measuring values
15. Path 4 measuring values
16. Path 5 measuring values
17. Path 6 measuring values
18. Path 7 measuring values
19. Path 8 measuring values
20. Path 1 signal analysis
21. Path 2 signal analysis
22. Path 3 signal analysis
23. Path 4 signal analysis
24. Path 5 signal analysis
25. Path 6 signal analysis
26. Path 7 signal analysis
27. Path 8 signal analysis
28. USE09 measuring values
29. USE09 diagnosis
30. Times

31. USE09-C meter
32. Type plate
33. Mode
34. Error
35. DSP Parameter
36. DSP parameters 3X
37. Path 1 Parameter
38. Path 2 Parameter
39. Path 3 Parameter
40. Path 4 Parameter
41. Path 5 Parameter
42. Path 6 Parameter
43. Path 7 Parameter
44. Path 8 Parameter
45. Service
46. Log memory
47. User info
48. Remote control
49. AGA-10 values
50. AGA-10 Configuration
51. Gas comp. RMGBus
52. Gas comp. Modbus

Pressure

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
A-01	Pressure	6252	2	Float	Reading Value	→ Units: Pressure a	Shows the measured pressure
A-03	Current Input	6254	2	Float	Reading Value	mA	Shows the input value in mA
A-05	p min value	1392	2	Float	Official Key	→ Units: Pressure a	Measuring pressure min. value
A-06	p max value	1394	2	Float	Official Key	→ Units: Pressure a	Measuring pressure max. value
A-09	p set value	1396	2	Float	Official Key	→ Units: Pressure a	Measuring pressure default value
A-11	p at base cond.	1398	2	Float	Official Key	→ Units: Pressure a	base pressure
A-12	curr. inp. gradient	1400	2	Float	Official Key		Gradient (correction of the mA value)
A-13	curr. inp. offset	1402	2	Float	Official Key		Offset (correction of the mA value)
A-14	p err. min	1404	2	Float	Official Key	→ Units: Pressure a	Lower error limit of measuring pressure
A-15	p err. max	1406	2	Float	Official Key	→ Units: Pressure a	Upper error limit of measuring pressure
A-17	p mode	4078	1	Menu	Official Key		Operating mode of measuring pressure
							0x0000 OFF (default value)
							0x0001 SET VALUE
							0x0002 4-20mA
							0x0003 4-20mA_ERR

Temperature

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
B-01	temperature	6256	2	Float	Reading Value	→ Units: Temp.	PT100-input
B-03	PT100 resistance	6258	2	Float	Reading Value	Ohm	PT100-input
B-09	T set value	1408	2	Float	Official Key	→ Units: Temp.	PT100-input
B-11	T at base cond.	1410	2	Float	Official Key	→ Units: Temp.	base temperature
B-12	T gradient	1412	2	Float	Official Key		Gradient (correction of the Ohm value)
B-13	T offset	1414	2	Float	Official Key		Offset (correction of the Ohm value)
B-14	T err. min	1416	2	Float	Official Key	→ Units: Temp.	--
B-15	T err. max	1418	2	Float	Official Key	→ Units: Temp.	--
B-17	T mode	4079	1	Menu	Official Key		--
							0x0000 OFF (default value)
							0x0001 SET VALUE
							0x0002 PT100
							0x0003 PT100_ERR

USE09-C Meas. Val.

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
C-01	vw	6220	2	Float	Reading Value	→ velocity unit	weighted gas velocity
C-02	vwc	6222	2	Float	Reading Value	→ velocity unit	corrected weighted gas velocity
C-03	Qm	6224	2	Float	Reading Value	→ flow unit	--
C-04	Qmb	6238	2	Float	Reading Value	→ flow unit	--
C-05	Qmc	6226	2	Float	Reading Value	→ flow unit	--
C-06	performance	6268	1	Integer	Reading Value	%	Performance

USE09-C Qm

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
D-01	vol. Flow rate Qm	730	10	Text	Reading Value	→ flow unit	--
D-02	vol. flow rate Qm	6230	2	Float	Reading Value	→ flow unit	--
D-03	Qm damped	6264	2	Float	Reading Value	→ flow unit	--
D-04	Qm min.	1320	2	Float	Official Key	→ flow unit	--
D-05	Qm max.	1322	2	Float	Official Key	→ flow unit	--
D-06	vw factor d1	1324	2	Float	Official Key	[1]	Constant Kv direction 1
D-07	vw factor d2	1436	2	Float	Official Key	[1]	Constant Kv direction 2
D-08	vw lower limit	1326	2	Float	Official Key	→ Calib. units: v	--
D-09	Qm lower limit	1328	2	Float	Official Key	→ flow unit	--
D-10	Qm-min time	2120	1	Integer	Official Key	s	--
D-15	Qm damping	1446	2	Float	Codeword		--
D-16	pipe diameter	1334	2	Float	Official Key	→ Calib. units: Length	Pipe diameter
D-17	geometry correcting	2258	1	Menu	Official Key		--
							0x0000 OFF (default value)
							0x0001 ON
D-18	temp. coefficient	1450	2	Float	Official Key		Temperature coefficient
D-19	pressure coeff.	1452	2	Float	Official Key		Pressure coefficient
D-20	Qm-max value 1	1330	2	Float	Codeword	→ flow unit	--
D-21	Qm-max time 1	2580	2	Unixtime	Codeword		--
D-22	Qm-max value 2	1332	2	Float	Codeword	→ flow unit	--
D-23	Qm-max time 2	2582	2	Unixtime	Codeword		--

D-24	Qt	9084	2	Float	Reading Value		Transition flow Qt

Parameters

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
E-01	USE09 working mode	2090	1	Menu	Official Key		--
							0x0000 IGM (default value)
							0x0001 USE09C
							0x0002 SIMU
							0x0003 SIMU_K
							0x0004 SIMU_N
							0x0005 SIMU_EW
E-02	path select	690	10	Text	Official Key		--
E-03	max. path RV	2121	1	Integer	Official Key		Maximum number of used replacement values
E-04	fault time	2122	1	Integer	Official Key	s	--
E-05	error per cent	2123	1	Integer	Official Key	%	--
E-09	moving average cnt	2125	1	Integer	Codeword		--
E-15	SoS mode	2240	1	Menu	Codeword		Speed of Sound mode
							0x0000 STANDARD (default value)
							0x0001 EXTENDED
							0x0002 CALIBRATION

							0x0003 STATISTIC OFF
E-16	delta SoS mode	2091	1	Menu	Codeword		Delta SoS observing ON / OFF
							0x0000 OFF
							0x0001 ON (default value)
E-17	delta SoS limit	1344	2	Float	Codeword	%	Limit for Delta SoS
E-18	std. SoS corr-factor	1370	2	Float	Official Key	[1]	Standard SoS correction-factor
E-19	adv. SoS corr-factor	9068	2	Float	Official Key	[1]	Advanced SoS correction-factor
E-20	std. SoS v factor	1372	2	Float	Official Key	[1]	Standard SoS v correction-factor
E-21	adv. SoS v factor	9070	2	Float	Official Key	[1]	Advanced SoS v correction-factor
E-22	delta AGC limits	1438	2	Float	Codeword	dB	--
E-23	Tw correct	2281	1	Menu	Official Key		--
							0x0000 OFF (default value)
							0x0001 SET
E-24	Tw damping	1518	2	Float	Codeword		--

USE09-C polynom-B

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description

Flow correction

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
G-01	error curve lin.	2093	1	Menu	Official Key		--
							0x0000 OFF (default value)
							0x0001 POLYNOMIAL
							0x0002 piecewise lin.
G-02	const m2 d.1	1276	2	Float	Official Key	[1]	--
G-03	const m1 d.1	1278	2	Float	Official Key	[1]	--
G-04	const 0 d.1	1280	2	Float	Official Key	[1]	--
G-05	const 1 d.1	1282	2	Float	Official Key	[1]	--
G-06	const 2 d.1	1284	2	Float	Official Key	[1]	--
G-10	const m2 d.2	1306	2	Float	Official Key	[1]	--
G-11	const m1 d.2	1308	2	Float	Official Key	[1]	--
G-12	const 0 d.2	1310	2	Float	Official Key	[1]	--
G-13	const 1 d.2	1312	2	Float	Official Key	[1]	--

G-14	const 2 d.2	1314	2	Float	Official Key	[1]	--
G-20	dir. 1: flowrate 1	1600	2	Float	Official Key	→ Calib. units: Q	--
G-21	dir. 1: error 1	1602	2	Float	Official Key	%	--
G-22	dir. 1: flowrate 2	1604	2	Float	Official Key	→ Calib. units: Q	--
G-23	dir. 1: error 2	1606	2	Float	Official Key	%	--
G-24	dir. 1: flowrate 3	1608	2	Float	Official Key	→ Calib. units: Q	--
G-25	dir. 1: error 3	1610	2	Float	Official Key	%	--
G-26	dir. 1: flowrate 4	1612	2	Float	Official Key	→ Calib. units: Q	--
G-27	dir. 1: error 4	1614	2	Float	Official Key	%	--
G-28	dir. 1: flowrate 5	1616	2	Float	Official Key	→ Calib. units: Q	--
G-29	dir. 1: error 5	1618	2	Float	Official Key	%	--
G-30	dir. 1: flowrate 6	1620	2	Float	Official Key	→ Calib. units: Q	--
G-31	dir. 1: error 6	1622	2	Float	Official Key	%	--
G-32	dir. 1: flowrate 7	1624	2	Float	Official Key	→ Calib. units: Q	--
G-33	dir. 1: error 7	1626	2	Float	Official Key	%	--

G-34	dir. 1: flowrate 8	1628	2	Float	Official Key	→ Calib. units: Q	--
G-35	dir. 1: error 8	1630	2	Float	Official Key	%	--
G-36	dir. 1: flowrate 9	1632	2	Float	Official Key	→ Calib. units: Q	--
G-37	dir. 1: error 9	1634	2	Float	Official Key	%	--
G-38	dir. 1: flowrate 10	1636	2	Float	Official Key	→ Calib. units: Q	--
G-39	dir. 1: error 10	1638	2	Float	Official Key	%	--
G-40	dir. 1: flowrate 11	1640	2	Float	Official Key	→ Calib. units: Q	--
G-41	dir. 1: error 11	1642	2	Float	Official Key	%	--
G-42	dir. 1: flowrate 12	1644	2	Float	Official Key	→ Calib. units: Q	--
G-43	dir. 1: error 12	1648	2	Float	Official Key	%	--
G-44	dir. 2: flowrate 1	1650	2	Float	Official Key	→ Calib. units: Q	--
G-45	dir. 2: error 1	1652	2	Float	Official Key	%	--
G-46	dir. 2: flowrate 2	1654	2	Float	Official Key	→ Calib. units: Q	--
G-47	dir. 2: error 2	1656	2	Float	Official Key	%	--
G-48	dir. 2: flowrate 3	1658	2	Float	Official Key	→ Calib. units: Q	--

G-49	dir. 2: error 3	1660	2	Float	Official Key	%	--
G-50	dir. 2: flowrate 4	1662	2	Float	Official Key	→ Calib. units: Q	--
G-51	dir. 2: error 4	1664	2	Float	Official Key	%	--
G-52	dir. 2: flowrate 5	1666	2	Float	Official Key	→ Calib. units: Q	--
G-53	dir. 2: error 5	1668	2	Float	Official Key	%	--
G-54	dir. 2: flowrate 6	1670	2	Float	Official Key	→ Calib. units: Q	--
G-55	dir. 2: error 6	1672	2	Float	Official Key	%	--
G-56	dir. 2: flowrate 7	1674	2	Float	Official Key	→ Calib. units: Q	--
G-57	dir. 2: error 7	1676	2	Float	Official Key	%	--
G-58	dir. 2: flowrate 8	1678	2	Float	Official Key	→ Calib. units: Q	--
G-59	dir. 2: error 8	1680	2	Float	Official Key	%	--
G-60	dir. 2: flowrate 9	1682	2	Float	Official Key	→ Calib. units: Q	--
G-61	dir. 2: error 9	1684	2	Float	Official Key	%	--
G-62	dir. 2: flowrate 10	1686	2	Float	Official Key	→ Calib. units: Q	--
G-63	dir. 2: error 10	1688	2	Float	Official Key	%	--

G-64	dir. 2: flowrate 11	1690	2	Float	Official Key	→ Calib. units: Q	--
G-65	dir. 2: error 11	1692	2	Float	Official Key	%	--
G-66	dir. 2: flowrate 12	1694	2	Float	Official Key	→ Calib. units: Q	--
G-67	dir. 2: error 12	1698	2	Float	Official Key	%	--

Freq.,Pulse Outputs

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
H-01	fo base value	6248	2	Float	Reading Value	→ flow unit	--
H-02	frequency value	6250	2	Float	Reading Value	Hz	--
H-03	fo corr. factor	1386	2	Float	Official Key		--
H-04	corr. frequency	6266	2	Float	Reading Value	Hz	--
H-05	fo base max.	1388	2	Float	Official Key	→ Calib. units: Q	--
H-06	fo freq. max.	1444	2	Float	Official Key	Hz	--
H-07	pulse value	6262	2	Float	Reading Value	→ pulse unit	--
H-08	fo set value	1390	2	Float	Official Key	Hz	--
H-09	fo select	2161	1	Menu	Codeword		--
							0x0000 QMC (default value)
							0x0001 QMC-D
H-10	fo mode	2162	1	Menu	Official Key		--
							0x0000 OFF
							0x0001 SET VALUE
							0x0002 ON (default value)
							0x0003 TEST
H-11	fo2 error mode	2163	1	Menu	Official Key		--
							0x0000 F2 STOP (default value)
							0x0001 F2 ACTIVE

								0x0002	CRYSTAL TEST	
H-12	ferr waveform gen.	6260	2	Float	Reading Value	Hz	--			
H-15	IO-1 mode	2165	1	Menu	Codeword		--			
								0x0000	OFF	
								0x0001	DIRECTION	(default value)
								0x0002	DIRECTION INV.	
								0x0003	INPUT	
								0x0004	TEST	
								0x0005	WARN-INPUT HIGH	
								0x0006	WARN-INPUT LOW	
H-16	IO-2 mode	2166	1	Menu	Codeword		--			
								0x0000	OFF	
								0x0001	DIRECTION	(default value)
								0x0002	DIRECTION INV.	
								0x0003	INPUT	
								0x0004	TEST	
								0x0005	CPU	
H-17	mode ext. warning	2186	1	Menu	Codeword		--			
								0x0000	OFF	(default value)
								0x0001	LOW_POWER	
H-20	Test Alarm a. Warn	4081	1	Menu	Codeword		--			
								0x0000	OFF	(default value)
								0x0001	TEST	

Current Output

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
I-01	c-out physical val.	6244	2	Float	Reading Value		--
I-02	c-out value	6246	2	Float	Reading Value	mA	--
I-03	c-out min.	1374	2	Float	Codeword		--
I-04	c-out max.	1376	2	Float	Codeword		--
I-05	c-out set value	1378	2	Float	Codeword	mA	--
I-06	c-out select	2158	1	Integer	Codeword		--
I-07	c-out mode	2159	1	Menu	Codeword		--
							0x0000 OFF (default value)
							0x0001 SET VALUE
							0x0002 0-20mA
							0x0003 4-20mA
I-08	c-out err mode	2160	1	Menu	Codeword		--
							0x0000 OFF (default value)
							0x0001 MIN
							0x0002 MAX
I-09	c-out damping	1380	2	Float	Codeword		--
I-10	c-out gradient	1382	2	Float	Official Key		--
I-11	c-out offset	1384	2	Float	Official Key		--

Serial Ports

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
J-12	DZU-0 address	2283	1	Integer	free programmable		Serial interface -1 DZU slave ID (ASCII: 00-99)
J-13	serial-0 status	760	10	Text	Reading Value		Serial interface -1 status
J-14	serial-1 mode	2107	1	Menu	free programmable		Serial interface -1 mode
							0x0000 OFF (default value)
							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	Menu	free programmable	baud	Serial interface -1 baud rate
							0x0000 2400
							0x0001 4800
							0x0002 9600
							0x0003 19200 (default value)
							0x0004 38400
							0x0005 57600
J-16	serial-1 bits	2109	1	Menu	free programmable		Serial interface -1 number of bits

							0x0000 7
							0x0001 8 (default value)
J-17	serial-1 parity	2110	1	Menu	free programmable		Serial interface -1 parity
							0x0000 NONE (default value)
							0x0001 EVEN
							0x0002 ODD
J-23	DZU-1 address	2284	1	Integer	free programmable		Serial interface -1 DZU slave ID (ASCII: 00-99)
J-24	serial-1 status	770	10	Text	Reading Value		Serial interface -1 status
J-25	opt. ser2 mode	2112	1	Menu	free programmable		Optional serial interface -2 mode
							0x0000 OFF
							0x0001 Modbus (default value)
							0x0002 IGM
							0x0003 USE09
							0x0004 DZU-SLAVE
							0x0005 RMGBus
							0x0006 Modbus master
J-26	opt. ser2 baud rate	2113	1	Menu	free programmable	baud	Optional serial interface -2 baud rate
							0x0000 2400
							0x0001 4800
							0x0002 9600
							0x0003 19200
							0x0004 38400 (default value)
							0x0005 57600

J-27	opt. ser2 bits	2114	1	Menu	free programmable		Optional serial interface -2 number of bits
							0x0000 7 0x0001 8 (default value)
J-28	opt. ser2 parity	2115	1	Menu	free programmable		Optional serial interface -2 parity
							0x0000 NONE (default value) 0x0001 EVEN 0x0002 ODD
J-29	Modbus-2 protocol	2178	1	Menu	free programmable		Optional serial interface -2 Modbus operating mode (Off, Ascii or RTU)
							0x0000 OFF 0x0001 RTU (default value) 0x0002 ASCII
J-30	Modbus-2 hw-mode	2179	1	Menu	free programmable		Optional serial interface -2 Modbus hardware (RS232 or RS485)
							0x0000 RS232 0x0001 RS485 (default value)
J-31	Modbus-2 address	2180	1	Integer	free programmable		Optional serial interface -2 Modbus address (ID)
J-32	Modbus-2 reg.offset	2181	1	Integer	free programmable		Optional serial interface -2 Modbus register offset
J-33	Modbus-2 gap time	2182	1	Integer	free programmable		Optional serial interface -2 Modbus turn-off time
J-34	Long Byte Order	2251	1	Menu	free programmable		--
							0x0000 NORMAL 0x0001 SWAPPED (default value)
J-35	Float Byte Order	2252	1	Menu	free programmable		--

							0x0000 NORMAL 0x0001 SWAPPED (default value)
J-36	Double Byte Order	2253	1	Menu	free programmable		--
							0x0000 NORMAL (default value) 0x0001 SWAPPED
J-37	DZU-2 address	2285	1	Integer	free programmable		--
J-38	serial-2 status	780	10	Text	Reading Value		Optional serial interface -2 status
J-39	DZU Interval	2111	1	Integer	Official Key	tics	Optional serial interface -2 DZU-interval
J-40	DZU Checksum Preset	2255	1	Menu	free programmable		--
							0x0000 0x00 (default value) 0x0001 0x7F

DSP,FPGA values

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
K-20	DSP status	4004	1	Integer	Reading Value	hex	DSP status (bit encoded)
K-21	DSP error	4003	1	Integer	Reading Value	hex	DSP error (bit encoded)
K-22	DSP bytes received	7034	1	Integer	Reading Value		Counts the receive telegrams from DSP
K-23	FPGA status	4006	1	Integer	Reading Value	hex	FPGA status (bit encoded)
K-24	FPGA error	4005	1	Integer	Reading Value	hex	FPGA error (bit encoded)

Path1 Meas. Values

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
L-01	p1.1 time of flight	6100	2	Float	Reading Value	us	Path 1.1 time of flight
L-02	p1.2 time of flight	6120	2	Float	Reading Value	us	Path 1.2 time of flight
L-03	path-1 delta-t	6140	2	Float	Reading Value	us	Path 1 time difference
L-04	p1 delta-t corr.	6540	2	Float	Reading Value	us	Path 1 corrected time difference
L-06	Valid samples G1	7000	1	Integer	Reading Value	%	Path 1 valid measuring values in %
L-07	path-1 velocity	6000	2	Float	Reading Value	→ velocity unit	Path 1 path velocity
L-08	velocity vc1	6200	2	Float	Reading Value	→ velocity unit	Path 1 corrected path velocity vc
L-09	SoS1	6020	2	Float	Reading Value	→ velocity unit	Path 1 Speed of Sound
L-10	path-1 delta SoS	6080	2	Float	Reading Value	%	Path 1 Path-SoS / Mean-SoS
L-12	path-1 fault	4030	1	Integer	Reading Value	hex	Path 1 path error
L-13	path-1 status	4040	1	Integer	Reading Value	hex	Path 1 path status
L-14	p1.1 Amplitude	7010	1	Integer	Reading Value	%	Path 1.1 amplitude in per cent
L-15	p1.2 Amplitude	7020	1	Integer	Reading Value	%	Path 1.2 amplitude in per cent
L-16	p1.1 AGC-level	6040	2	Float	Reading Value	dB	Path 1.1 Automated Gain Control
L-17	p1.2 AGC-level	6060	2	Float	Reading Value	dB	Path 1.2 Automated Gain Control
L-18	p1.1 snr	6640	2	Float	Reading Value	dB	Path 1.1 signal-to-noise ratio
L-19	p1.2 snr	6660	2	Float	Reading Value	dB	Path 1.2 signal-to-noise ratio
L-20	path-1 fault (X)	2270	1	Integer	Reading Value	hex	Path 1 path error (3X-measurement)
L-21	p1.1 AGC-level (X)	6680	2	Float	Reading Value	dB	Path 1.1 Automated Gain Control (3X-measurement)
L-22	p1.2 AGC-level (X)	6700	2	Float	Reading Value	dB	Path 1.2 Automated Gain Control (3X-measurement)
L-23	p1.1 snr (X)	6720	2	Float	Reading Value	dB	Path 1.1 signal-to-noise ratio (3X-measurement)
L-24	p1.2 snr (X)	6740	2	Float	Reading Value	dB	Path 1.2 signal-to-noise ratio (3X-measurement)

L-26	path-1 turbulence	6776	2	Float	Reading Value	%	Path 1 turbulence

Path2 Meas. Values

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
M-01	p2.1 time of flight	6102	2	Float	Reading Value	us	Path 2.1 time of flight
M-02	p2.2 time of flight	6122	2	Float	Reading Value	us	Path 2.2 time of flight
M-03	path-2 delta-t	6142	2	Float	Reading Value	us	Path 2 time difference
M-04	p2 delta-t corr.	6542	2	Float	Reading Value	us	Path 2 corrected time difference
M-06	Valid samples G2	7001	1	Integer	Reading Value	%	Path 2 valid measuring values in %
M-07	path-2 velocity	6002	2	Float	Reading Value	→ velocity unit	Path 2 path velocity
M-08	velocity vc2	6202	2	Float	Reading Value	→ velocity unit	Path 2 corrected path velocity vc
M-09	SoS2	6022	2	Float	Reading Value	→ velocity unit	Path 2 Speed of Sound
M-10	path-2 delta SoS	6082	2	Float	Reading Value	%	Path 2 Path-SoS / Mean-SoS
M-12	path-2 fault	4031	1	Integer	Reading Value	hex	Path 2 path error
M-13	path-2 status	4041	1	Integer	Reading Value	hex	Path 2 path status
M-14	p2.1 Amplitude	7011	1	Integer	Reading Value	%	Path 2.1 amplitude in per cent
M-15	p2.2 Amplitude	7021	1	Integer	Reading Value	%	Path 2.2 amplitude in per cent
M-16	p2.1 AGC-level	6042	2	Float	Reading Value	dB	Path 2.1 Automated Gain Control
M-17	p2.2 AGC-level	6062	2	Float	Reading Value	dB	Path 2.2 Automated Gain Control
M-18	p2.1 snr	6642	2	Float	Reading Value	dB	Path 2.1 signal-to-noise ratio
M-19	p2.2 snr	6662	2	Float	Reading Value	dB	Path 2.2 signal-to-noise ratio
M-20	path-2 fault (X)	2271	1	Integer	Reading Value	hex	Path 2 path error (3X-measurement)
M-21	p2.1 AGC-level (X)	6682	2	Float	Reading Value	dB	Path 2.1 Automated Gain Control (3X-measurement)
M-22	p2.2 AGC-level (X)	6702	2	Float	Reading Value	dB	Path 2.2 Automated Gain Control (3X-measurement)
M-23	p2.1 snr (X)	6722	2	Float	Reading Value	dB	Path 2.1 signal-to-noise ratio (3X-measurement)
M-24	p2.2 snr (X)	6742	2	Float	Reading Value	dB	Path 2.2 signal-to-noise ratio (3X-measurement)

M-26	path-2 turbulence	6778	2	Float	Reading Value %	Path 2 turbulence

Path3 Meas. Values

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
N-01	p3.1 time of flight	6104	2	Float	Reading Value	us	Path 3.1 time of flight
N-02	p3.2 time of flight	6124	2	Float	Reading Value	us	Path 3.2 time of flight
N-03	path-3 delta-t	6144	2	Float	Reading Value	us	Path 3 time difference
N-04	p3 delta-t corr.	6544	2	Float	Reading Value	us	Path 3 corrected time difference
N-06	Valid samples G3	7002	1	Integer	Reading Value	%	Path 3 valid measuring values in %
N-07	path-3 velocity	6004	2	Float	Reading Value	→ velocity unit	Path 3 path velocity
N-08	velocity vc3	6204	2	Float	Reading Value	→ velocity unit	Path 3 corrected path velocity vc
N-09	SoS3	6024	2	Float	Reading Value	→ velocity unit	Path 3 Speed of Sound
N-10	path-3 delta SoS	6084	2	Float	Reading Value	%	Path 3 Path-SoS / Mean-SoS
N-12	path-3 fault	4032	1	Integer	Reading Value	hex	Path 3 path error
N-13	path-3 status	4042	1	Integer	Reading Value	hex	Path 3 path status
N-14	p3.1 Amplitude	7012	1	Integer	Reading Value	%	Path 3.1 amplitude in per cent
N-15	p3.2 Amplitude	7022	1	Integer	Reading Value	%	Path 3.2 amplitude in per cent
N-16	p3.1 AGC-level	6044	2	Float	Reading Value	dB	Path 3.1 Automated Gain Control
N-17	p3.2 AGC-level	6064	2	Float	Reading Value	dB	Path 3.2 Automated Gain Control
N-18	p3.1 snr	6644	2	Float	Reading Value	dB	Path 3.1 signal-to-noise ratio
N-19	p3.2 snr	6664	2	Float	Reading Value	dB	Path 3.2 signal-to-noise ratio
N-20	path-3 fault (X)	2272	1	Integer	Reading Value	hex	Path 3 path error (3X-measurement)
N-21	p3.1 AGC-level (X)	6684	2	Float	Reading Value	dB	Path 3.1 Automated Gain Control (3X-measurement)
N-22	p3.2 AGC-level (X)	6704	2	Float	Reading Value	dB	Path 3.2 Automated Gain Control (3X-measurement)
N-23	p3.1 snr (X)	6724	2	Float	Reading Value	dB	Path 3.1 signal-to-noise ratio (3X-measurement)
N-24	p3.2 snr (X)	6744	2	Float	Reading Value	dB	Path 3.2 signal-to-noise ratio (3X-measurement)

N-26	path-3 turbulence	6780	2	Float	Reading Value	%	Path 3 turbulence

Path4 Meas. Values

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
O-01	p4.1 time of flight	6106	2	Float	Reading Value	us	Path 4.1 time of flight
O-02	p4.2 time of flight	6126	2	Float	Reading Value	us	Path 4.2 time of flight
O-03	path-4 delta-t	6146	2	Float	Reading Value	us	Path 4 time difference
O-04	p4 delta-t corr.	6546	2	Float	Reading Value	us	Path 4 corrected time difference
O-06	Valid samples G4	7003	1	Integer	Reading Value	%	Path 4 valid measuring values in %
O-07	path-4 velocity	6006	2	Float	Reading Value	→ velocity unit	Path 4 path velocity
O-08	velocity vc4	6206	2	Float	Reading Value	→ velocity unit	Path 4 corrected path velocity vc
O-09	SoS4	6026	2	Float	Reading Value	→ velocity unit	Path 4 Speed of Sound
O-10	path-4 delta SoS	6086	2	Float	Reading Value	%	Path 4 Path-SoS / Mean-SoS
O-12	path-4 fault	4033	1	Integer	Reading Value	hex	Path 4 path error
O-13	path-4 status	4043	1	Integer	Reading Value	hex	Path 4 path status
O-14	p4.1 Amplitude	7013	1	Integer	Reading Value	%	Path 4.1 amplitude in per cent
O-15	p4.2 Amplitude	7023	1	Integer	Reading Value	%	Path 4.2 amplitude in per cent
O-16	p4.1 AGC-level	6046	2	Float	Reading Value	dB	Path 4.1 Automated Gain Control
O-17	p4.2 AGC-level	6066	2	Float	Reading Value	dB	Path 4.2 Automated Gain Control
O-18	p4.1 snr	6646	2	Float	Reading Value	dB	Path 4.1 signal-to-noise ratio
O-19	p4.2 snr	6666	2	Float	Reading Value	dB	Path 4.2 signal-to-noise ratio
O-20	path-4 fault (X)	2273	1	Integer	Reading Value	hex	Path 4 path error (3X-measurement)
O-21	p4.1 AGC-level (X)	6686	2	Float	Reading Value	dB	Path 4.1 Automated Gain Control (3X-measurement)
O-22	p4.2 AGC-level (X)	6706	2	Float	Reading Value	dB	Path 4.2 Automated Gain Control (3X-measurement)
O-23	p4.1 snr (X)	6726	2	Float	Reading Value	dB	Path 4.1 signal-to-noise ratio (3X-measurement)
O-24	p4.2 snr (X)	6746	2	Float	Reading Value	dB	Path 4.2 signal-to-noise ratio (3X-measurement)

O-26	path-4 turbulence	6782	2	Float	Reading Value	%	Path 4 turbulence

Path5 Meas. Values

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
P-01	p5.1 time of flight	6108	2	Float	Reading Value	us	Path 5.1 time of flight
P-02	p5.2 time of flight	6128	2	Float	Reading Value	us	Path 5.2 time of flight
P-03	path-5 delta-t	6148	2	Float	Reading Value	us	Path 5 time difference
P-04	p5 delta-t corr.	6548	2	Float	Reading Value	us	Path 5 corrected time difference
P-06	Valid samples G5	7004	1	Integer	Reading Value	%	Path 5 valid measuring values in %
P-07	path-5 velocity	6008	2	Float	Reading Value	→ velocity unit	Path 5 path velocity
P-08	velocity vc5	6208	2	Float	Reading Value	→ velocity unit	Path 5 corrected path velocity vc
P-09	SoS5	6028	2	Float	Reading Value	→ velocity unit	Path 5 Speed of Sound
P-10	path-5 delta SoS	6088	2	Float	Reading Value	%	Path 5 Path-SoS / Mean-SoS
P-12	path-5 fault	4034	1	Integer	Reading Value	hex	Path 5 path error
P-13	path-5 status	4044	1	Integer	Reading Value	hex	Path 5 path status
P-14	p5.1 Amplitude	7014	1	Integer	Reading Value	%	Path 5.1 amplitude in per cent
P-15	p5.2 Amplitude	7024	1	Integer	Reading Value	%	Path 5.2 amplitude in per cent
P-16	p5.1 AGC-level	6048	2	Float	Reading Value	dB	Path 5.1 Automated Gain Control
P-17	p5.2 AGC-level	6068	2	Float	Reading Value	dB	Path 5.2 Automated Gain Control
P-18	p5.1 snr	6648	2	Float	Reading Value	dB	Path 5.1 signal-to-noise ratio
P-19	p5.2 snr	6668	2	Float	Reading Value	dB	Path 5.2 signal-to-noise ratio
P-20	path-5 fault (X)	2274	1	Integer	Reading Value	hex	Path 5 path error (3X-measurement)
P-21	p5.1 AGC-level (X)	6688	2	Float	Reading Value	dB	Path 5.1 Automated Gain Control (3X-measurement)
P-22	p5.2 AGC-level (X)	6708	2	Float	Reading Value	dB	Path 5.2 Automated Gain Control (3X-measurement)
P-23	p5.1 snr (X)	6728	2	Float	Reading Value	dB	Path 5.1 signal-to-noise ratio (3X-measurement)
P-24	p5.2 snr (X)	6748	2	Float	Reading Value	dB	Path 5.2 signal-to-noise ratio (3X-measurement)

P-26	path-5 turbulence	6784	2	Float	Reading Value	%	Path 5 turbulence

Path6 Meas. Values

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
Q-01	p6.1 time of flight	6110	2	Float	Reading Value	us	Path 6.1 time of flight
Q-02	p6.2 time of flight	6130	2	Float	Reading Value	us	Path 6.2 time of flight
Q-03	path-6 delta-t	6150	2	Float	Reading Value	us	Path 6 time difference
Q-04	p6 delta-t corr.	6550	2	Float	Reading Value	us	Path 6 corrected time difference
Q-06	Valid samples G6	7005	1	Integer	Reading Value	%	Path 6 valid measuring values in %
Q-07	path-6 velocity	6010	2	Float	Reading Value	→ velocity unit	Path 6 path velocity
Q-08	velocity vc6	6210	2	Float	Reading Value	→ velocity unit	Path 6 corrected path velocity vc
Q-09	SoS6	6030	2	Float	Reading Value	→ velocity unit	Path 6 Speed of Sound
Q-10	path-6 delta SoS	6090	2	Float	Reading Value	%	Path 6 Path-SoS / Mean-SoS
Q-12	path-6 fault	4035	1	Integer	Reading Value	hex	Path 6 path error
Q-13	path-6 status	4045	1	Integer	Reading Value	hex	Path 6 path status
Q-14	p6.1 Amplitude	7015	1	Integer	Reading Value	%	Path 6.1 amplitude in per cent
Q-15	p6.2 Amplitude	7025	1	Integer	Reading Value	%	Path 6.2 amplitude in per cent
Q-16	p6.1 AGC-level	6050	2	Float	Reading Value	dB	Path 6.1 Automated Gain Control
Q-17	p6.2 AGC-level	6070	2	Float	Reading Value	dB	Path 6.2 Automated Gain Control
Q-18	p6.1 snr	6650	2	Float	Reading Value	dB	Path 6.1 signal-to-noise ratio
Q-19	p6.2 snr	6670	2	Float	Reading Value	dB	Path 6.2 signal-to-noise ratio
Q-20	path-6 fault (X)	2275	1	Integer	Reading Value	hex	Path 6 path error (3X-measurement)
Q-21	p6.1 AGC-level (X)	6690	2	Float	Reading Value	dB	Path 6.1 Automated Gain Control (3X-measurement)
Q-22	p6.2 AGC-level (X)	6710	2	Float	Reading Value	dB	Path 6.2 Automated Gain Control (3X-measurement)
Q-23	p6.1 snr (X)	6730	2	Float	Reading Value	dB	Path 6.1 signal-to-noise ratio (3X-measurement)
Q-24	p6.2 snr (X)	6750	2	Float	Reading Value	dB	Path 6.2 signal-to-noise ratio (3X-measurement)

Q-26	path-6 turbulence	6786	2	Float	Reading Value	%		Path 6 turbulence

Path7 Meas. Values

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
R-01	p7.1 time of flight	6112	2	Float	Reading Value	us	Path 7.1 time of flight
R-02	p7.2 time of flight	6132	2	Float	Reading Value	us	Path 7.2 time of flight
R-03	path-7 delta-t	6152	2	Float	Reading Value	us	Path 7 time difference
R-04	p7 delta-t corr.	6552	2	Float	Reading Value	us	Path 7 corrected time difference
R-06	Valid samples G7	7006	1	Integer	Reading Value	%	Path 7 valid measuring values in %
R-07	path-7 velocity	6012	2	Float	Reading Value	→ velocity unit	Path 7 path velocity
R-08	velocity vc7	6212	2	Float	Reading Value	→ velocity unit	Path 7 corrected path velocity vc
R-09	SoS7	6032	2	Float	Reading Value	→ velocity unit	Path 7 Speed of Sound
R-10	path-7 delta SoS	6092	2	Float	Reading Value	%	Path 7 Path-SoS / Mean-SoS
R-12	path-7 fault	4036	1	Integer	Reading Value	hex	Path 7 path error
R-13	path-7 status	4046	1	Integer	Reading Value	hex	Path 7 path status
R-14	p7.1 Amplitude	7016	1	Integer	Reading Value	%	Path 7.1 amplitude in per cent
R-15	p7.2 Amplitude	7026	1	Integer	Reading Value	%	Path 7.2 amplitude in per cent
R-16	p7.1 AGC-level	6052	2	Float	Reading Value	dB	Path 7.1 Automated Gain Control
R-17	p7.2 AGC-level	6072	2	Float	Reading Value	dB	Path 7.2 Automated Gain Control
R-18	p7.1 snr	6652	2	Float	Reading Value	dB	Path 7.1 signal-to-noise ratio
R-19	p7.2 snr	6672	2	Float	Reading Value	dB	Path 7.2 signal-to-noise ratio
R-20	path-7 fault (X)	2276	1	Integer	Reading Value	hex	Path 7 path error (3X-measurement)
R-21	p7.1 AGC-level (X)	6692	2	Float	Reading Value	dB	Path 7.1 Automated Gain Control (3X-measurement)
R-22	p7.2 AGC-level (X)	6712	2	Float	Reading Value	dB	Path 7.2 Automated Gain Control (3X-measurement)
R-23	p7.1 snr (X)	6732	2	Float	Reading Value	dB	Path 7.1 signal-to-noise ratio (3X-measurement)
R-24	p7.2 snr (X)	6752	2	Float	Reading Value	dB	Path 7.2 signal-to-noise ratio (3X-measurement)

R-26	path-7 turbulence	6788	2	Float	Reading Value	%	Path 7 turbulence

Path8 Meas. Values

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
S-01	p8.1 time of flight	6114	2	Float	Reading Value	us	Path 8.1 time of flight
S-02	p8.2 time of flight	6134	2	Float	Reading Value	us	Path 8.2 time of flight
S-03	path-8 delta-t	6154	2	Float	Reading Value	us	Path 8 time difference
S-04	p8 delta-t corr.	6554	2	Float	Reading Value	us	Path 8 corrected time difference
S-06	Valid samples G8	7007	1	Integer	Reading Value	%	Path 8 valid measuring values in %
S-07	path-8 velocity	6014	2	Float	Reading Value	→ velocity unit	Path 8 path velocity
S-08	velocity vc8	6214	2	Float	Reading Value	→ velocity unit	Path 8 corrected path velocity vc
S-09	SoS8	6034	2	Float	Reading Value	→ velocity unit	Path 8 Speed of Sound
S-10	path-8 delta SoS	6094	2	Float	Reading Value	%	Path 8 Path-SoS / Mean-SoS
S-12	path-8 fault	4037	1	Integer	Reading Value	hex	Path 8 path error
S-13	path-8 status	4047	1	Integer	Reading Value	hex	Path 8 path status
S-14	p8.1 Amplitude	7017	1	Integer	Reading Value	%	Path 8.1 amplitude in per cent
S-15	p8.2 Amplitude	7027	1	Integer	Reading Value	%	Path 8.2 amplitude in per cent
S-16	p8.1 AGC-level	6054	2	Float	Reading Value	dB	Path 8.1 Automated Gain Control
S-17	p8.2 AGC-level	6074	2	Float	Reading Value	dB	Path 8.2 Automated Gain Control
S-18	p8.1 snr	6654	2	Float	Reading Value	dB	Path 8.1 signal-to-noise ratio
S-19	p8.2 snr	6674	2	Float	Reading Value	dB	Path 8.2 signal-to-noise ratio
S-20	path-8 fault (X)	2277	1	Integer	Reading Value	hex	Path 8 path error (3X-measurement)
S-21	p8.1 AGC-level (X)	6694	2	Float	Reading Value	dB	Path 8.1 Automated Gain Control (3X-measurement)
S-22	p8.2 AGC-level (X)	6714	2	Float	Reading Value	dB	Path 8.2 Automated Gain Control (3X-measurement)
S-23	p8.1 snr (X)	6734	2	Float	Reading Value	dB	Path 8.1 signal-to-noise ratio (3X-measurement)
S-24	p8.2 snr (X)	6754	2	Float	Reading Value	dB	Path 8.2 signal-to-noise ratio (3X-measurement)

S-26	path-8 turbulence	6790	2	Float	Reading Value	%	Path 8 turbulence

Path1 Sig. Analysis

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
T-01	p1.1 tw offset	6600	2	Float	Reading Value	us	Path 1.1 corrected delay time
T-02	p1.2 tw offset	6620	2	Float	Reading Value	us	Path 1.2 corrected delay time
T-03	p1 Tw damped	6830	2	Float	Reading Value	us	Path 1 delay time TwD

Path2 Sig. Analysis

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
U-01	p2.1 tw offset	6602	2	Float	Reading Value	us	Path 2.1 corrected delay time
U-02	p2.2 tw offset	6622	2	Float	Reading Value	us	Path 2.2 corrected delay time
U-03	p2 Tw damped	6832	2	Float	Reading Value	us	Path 2 delay time TwD

Path3 Sig. Analysis

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
V-01	p3.1 tw offset	6604	2	Float	Reading Value	us	Path 3.1 corrected delay time
V-02	p3.2 tw offset	6624	2	Float	Reading Value	us	Path 3.2 corrected delay time
V-03	p3 Tw damped	6834	2	Float	Reading Value	us	Path 3 delay time TwD

Path4 Sig. Analysis

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
W-01	p4.1 tw offset	6606	2	Float	Reading Value	us	Path 4.1 corrected delay time
W-02	p4.2 tw offset	6626	2	Float	Reading Value	us	Path 4.2 corrected delay time
W-03	p4 Tw damped	6836	2	Float	Reading Value	us	Path 4 delay time TwD

Path5 Sig. Analysis

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
X-01	p5.1 tw offset	6608	2	Float	Reading Value	us	Path 5.1 corrected delay time
X-02	p5.2 tw offset	6628	2	Float	Reading Value	us	Path 5.2 corrected delay time
X-03	p5 Tw damped	6838	2	Float	Reading Value	us	Path 5 delay time TwD

Path6 Sig. Analysis

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
Y-01	p6.1 tw offset	6610	2	Float	Reading Value	us	Path 6.1 corrected delay time
Y-02	p6.2 tw offset	6630	2	Float	Reading Value	us	Path 6.2 corrected delay time
Y-03	p6 Tw damped	6840	2	Float	Reading Value	us	Path 6 delay time TwD

Path7 Sig. Analysis

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
Z-01	p7.1 tw offset	6612	2	Float	Reading Value	us	Path 7.1 corrected delay time
Z-02	p7.2 tw offset	6632	2	Float	Reading Value	us	Path 7.2 corrected delay time
Z-03	p7 Tw damped	6842	2	Float	Reading Value	us	Path 7 delay time TwD

Path8 Sig. Analysis

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AA-01	p8.1 tw offset	6614	2	Float	Reading Value	us	Path 8.1 corrected delay time
AA-02	p8.2 tw offset	6634	2	Float	Reading Value	us	Path 8.2 corrected delay time
AA-03	p8 Tw damped	6844	2	Float	Reading Value	us	Path 8 delay time TwD

USE09 meas. val.

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AB-01	SoS average	6228	2	Float	Reading Value	→ velocity unit	Average Speed of Sound over all paths
AB-02	p .1 AGC average	6056	2	Float	Reading Value	dB	Path x.1 average AGC over all paths
AB-03	p .2 AGC average	6076	2	Float	Reading Value	dB	Path x.2 average AGC over all paths

USE09 Diagnosis

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AC-01	Vz plane-1	6560	2	Float	Reading Value	→ velocity unit	Velocity Vz of plane 1
AC-02	Vz plane-2	6562	2	Float	Reading Value	→ velocity unit	Velocity Vz of plane 2
AC-03	Vz plane-3	6564	2	Float	Reading Value	→ velocity unit	Velocity Vz of plane 3
AC-04	Vz plane-4	6566	2	Float	Reading Value	→ velocity unit	Velocity Vz of plane 4
AC-05	Vx plane-1	6568	2	Float	Reading Value	→ velocity unit	Velocity Vx of plane 1
AC-06	Vx plane-2	6570	2	Float	Reading Value	→ velocity unit	Velocity Vx of plane 2
AC-07	Vx plane-3	6572	2	Float	Reading Value	→ velocity unit	Velocity Vx of plane 3
AC-08	Vx plane-4	6574	2	Float	Reading Value	→ velocity unit	Velocity Vx of plane 4
AC-09	Ve plane-1	6576	2	Float	Reading Value	→ velocity unit	Velocity V of plane 1
AC-10	Ve plane-2	6578	2	Float	Reading Value	→ velocity unit	Velocity V of plane 2
AC-11	Ve plane-3	6580	2	Float	Reading Value	→ velocity unit	Velocity V of plane 3
AC-12	Ve plane-4	6582	2	Float	Reading Value	→ velocity unit	Velocity V of plane 4
AC-15	Swirl Angle Plane-1	6584	2	Float	Reading Value	°	Swirl angle of plane 1
AC-16	Swirl Angle Plane-2	6586	2	Float	Reading Value	°	Swirl angle of plane 2
AC-17	Swirl Angle Plane-3	6588	2	Float	Reading Value	°	Swirl angle of plane 3
AC-18	Swirl Angle Plane-4	6590	2	Float	Reading Value	°	Swirl angle of plane 4
AC-20	Profile PFY1	6800	2	Float	Reading Value		Profile factor PFY1
AC-21	Profile PFY2	6802	2	Float	Reading Value		Profile factor PFY2
AC-22	Profile PFY	6804	2	Float	Reading Value		Profile factor PFY
AC-23	Profile PFY31	6806	2	Float	Reading Value		Profile factor PFY31
AC-24	Profile PFY35	6808	2	Float	Reading Value		Profile factor PFY35
AC-25	Profile PFY42	6810	2	Float	Reading Value		Profile factor PFY42

AC-26	Profile PFY46	6812	2	Float	Reading Value		Profile factor PFY46
AC-27	Profile PFX	6814	2	Float	Reading Value		Profile factor PFX
AC-28	Profile PFX12	6816	2	Float	Reading Value		Profile factor PFX12
AC-29	Profile PFX56	6818	2	Float	Reading Value		Profile factor PFX56
AC-30	Profile Factor	6820	2	Float	Reading Value		Diagnosis: Profile factor
AC-31	Symmetry X	6822	2	Float	Reading Value		Symmetry X
AC-32	Symmetry Y	6824	2	Float	Reading Value		Symmetry Y
AC-33	Symmetry	6826	2	Float	Reading Value		Symmetry

Time and Date

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AD-01	time	2560	2	Unixtime	free programmable		date and time

USE09-C Totalizers

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AE-01	Tot. Volume d.1	3000	4	Double	Code and Official Key	→ volume unit	Actual volume counter for direction 1
AE-02	Tot. Volume d.2	3004	4	Double	Code and Official Key	→ volume unit	Actual volume counter for direction 2
AE-04	Tot. VolumeErr d.1	3008	4	Double	Code and Official Key	→ volume unit	Actual disturbed volume counter for direction 1
AE-05	Tot. VolumeErr d.2	3012	4	Double	Code and Official Key	→ volume unit	Actual disturbed volume counter for direction 2
AE-07	Tot. VolumeSum d.1	3016	4	Double	Code and Official Key	→ volume unit	Actual summarized volume counter for direction 1
AE-08	Tot. VolumeSum d.2	3020	4	Double	Code and Official Key	→ volume unit	Actual summarized volume counter for direction 2
AE-09	Total Volume	3024	4	Double	Code and Official Key	→ volume unit	--
AE-10	tot. Error-mode	2096	1	Menu	Official Key		--
							0x0000 STOP (default value)
							0x0001 RUN
AE-11	Total Volume mode	2098	1	Menu	Official Key		--
							0x0000 D1 - D2 (default value)
							0x0001 DIRECTION_1
							0x0002 DIRECTION_2
AE-20	test-tot. mode	2097	1	Menu	free programmable		--
							0x0000 STOP (default value)
							0x0001 RUN
AE-21	Vm-dir.1 test sum	3040	4	Double	Reading Value	→ volume unit	Actual volume test-counter for direction 1
AE-22	Vm-dir.2 test sum	3044	4	Double	Reading Value	→ volume unit	Actual volume test-counter for direction 2

AE-23	time for test sum	6242	2	Float	Reading Value	s	--
AE-30	Unit LF-Volumes	2217	1	Menu	free programmable		--
							0x0000 x 1 (default value)
							0x0001 x 0.1
							0x0002 x 0.01
AE-31	L: Tot. Volume d.1	2600	2	Long Int.	Reading Value	→ Unit LF-Volumes	--
AE-32	L: Tot. Volume d.2	2602	2	Long Int.	Reading Value	→ Unit LF-Volumes	--
AE-34	L: Tot. Vol.Err d.1	2604	2	Long Int.	Reading Value	→ Unit LF-Volumes	--
AE-35	L: Tot. Vol.Err d.2	2606	2	Long Int.	Reading Value	→ Unit LF-Volumes	--
AE-37	L: Tot. Vol.Sum d.1	2608	2	Long Int.	Reading Value	→ Unit LF-Volumes	--
AE-38	L: Tot. Vol.Sum d.2	2610	2	Long Int.	Reading Value	→ Unit LF-Volumes	--
AE-39	L: Total Volume	2612	2	Long Int.	Reading Value	→ Unit LF-Volumes	--

ID

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AF-01	electronic type	500	10	Text	Official Key		--
AF-02	electronic no	2564	2	Long Int.	Official Key		--
AF-03	unit type	510	10	Text	Official Key		--
AF-04	unit no	2562	2	Long Int.	Official Key		--
AF-05	manufacturer	2151	1	Menu	Official Key		--
							0x0000 RMG (default value)
AF-06	model (year)	2152	1	Integer	Official Key		--
AF-07	meter size	520	10	Text	Official Key		--
AF-08	nominal diameter DN	2210	1	Integer	Official Key	→ Calib. units: Length	--
AF-09	pressure rating	740	10	Text	Official Key		--
AF-10	pipe flange type	2211	1	Menu	Official Key		--
							0x0000 PN (default value) 0x0001 ANSI
AF-11	pipe flange value	2212	1	Integer	Official Key		--
AF-12	Qmin	1346	2	Float	Official Key	→ flow unit	ID: q-min
AF-13	Qmax	1348	2	Float	Official Key	→ flow unit	ID: q-max
AF-14	pmin	1350	2	Float	Official Key	→ Units: Pressure g	--
AF-15	pmax	1352	2	Float	Official Key	→ Units: Pressure g	--
AF-16	meas.press. min	1520	2	Float	Official Key	→ Units: Pressure a	--

AF-17	meas.press. max	1522	2	Float	Official Key	→ Units: Pressure a	--
AF-18	Tmin	1354	2	Float	Official Key	→ Units: Temp.	ID: T-min
AF-21	Tmax	1356	2	Float	Official Key	→ Units: Temp.	ID: T-max
AF-23	gas type	2154	1	Menu	Official Key		--
							0x0000 NATURAL GAS (default value)
AF-24	p type	2155	1	Menu	Official Key		ID: P-type
							0x0000 3051CA (default value)
							0x0001 G1151Ap
							0x0002 G1151
							0x0003 2088A
AF-25	p no.	2566	2	Long Int.	Official Key		ID: P-No.
AF-26	T type	2156	1	Menu	Official Key		ID: T-type
							0x0000 AGG-EX (default value)
							0x0001 Q-4407
							0x0002 PT100
							0x0003 F-56
							0x0004 F-57
AF-27	T no	2568	2	Long Int.	Official Key		ID: T-No.
AF-28	Transducer type	9072	10	Text	Official Key		ID: Transducer type
AF-29	Transducer 1.1 no.	530	10	Text	Official Key		ID: transducer 1/1 No.
AF-30	Transducer 1.1 len.	1524	2	Float	Official Key	→ Calib. units: Length	ID: transducer 1/1 length
AF-31	Transducer 1.1 built	2291	1	Integer	Official Key		ID: transducer 1/1 year of manufacture

AF-32	Transducer 1.2 no.	540	10	Text	Official Key		ID: transducer 1/2 No.
AF-33	Transducer 1.2 len.	1526	2	Float	Official Key	→ Calib. units: Length	ID: transducer 1/2 length
AF-34	Transducer 1.2 built	2292	1	Integer	Official Key		ID: transducer 1/2 year of manufacture
AF-35	Transducer 2.1 no.	550	10	Text	Official Key		ID: transducer 2/1 No.
AF-36	Transducer 2.1 len.	1528	2	Float	Official Key	→ Calib. units: Length	ID: transducer 2/1 length
AF-37	Transducer 2.1 built	2293	1	Integer	Official Key		ID: transducer 2/1 year of manufacture
AF-38	Transducer 2.2 no.	560	10	Text	Official Key		ID: transducer 2/2 No.
AF-39	Transducer 2.2 len.	1530	2	Float	Official Key	→ Calib. units: Length	ID: transducer 2/2 length
AF-40	Transducer 2.2 built	2294	1	Integer	Official Key		ID: transducer 2/2 year of manufacture
AF-41	Transducer 3.1 no.	570	10	Text	Official Key		ID: transducer 3/1 No.
AF-42	Transducer 3.1 len.	1532	2	Float	Official Key	→ Calib. units: Length	ID: transducer 3/1 length
AF-43	Transducer 3.1 built	2295	1	Integer	Official Key		ID: transducer 3/1 year of manufacture
AF-44	Transducer 3.2 no.	580	10	Text	Official Key		ID: transducer 3/2 No.
AF-45	Transducer 3.2 len.	1534	2	Float	Official Key	→ Calib. units: Length	ID: transducer 3/2 length
AF-46	Transducer 3.2 built	2296	1	Integer	Official Key		ID: transducer 3/2 year of manufacture
AF-47	Transducer 4.1 no.	590	10	Text	Official Key		ID: transducer 4/1 No.
AF-48	Transducer 4.1 len.	1536	2	Float	Official Key	→ Calib. units: Length	ID: transducer 4/1 length
AF-49	Transducer 4.1 built	2297	1	Integer	Official Key		ID: transducer 4/1 year of manufacture
AF-50	Transducer 4.2 no.	600	10	Text	Official Key		ID: transducer 4/2 No.
AF-51	Transducer 4.2 len.	1538	2	Float	Official Key	→ Calib. units: Length	ID: transducer 4/2 length
AF-52	Transducer 4.2 built	2298	1	Integer	Official Key		ID: transducer 4/2 year of manufacture
AF-53	Transducer 5.1 no.	610	10	Text	Official Key		ID: transducer 5/1 No.
AF-54	Transducer 5.1 len.	1540	2	Float	Official Key	→ Calib. units: Length	ID: transducer 5/1 length
AF-55	Transducer 5.1 built	2299	1	Integer	Official Key		ID: transducer 5/1 year of manufacture
AF-56	Transducer 5.2 no.	620	10	Text	Official Key		ID: transducer 5/2 No.
AF-57	Transducer 5.2 len.	1542	2	Float	Official Key	→ Calib. units: Length	ID: transducer 5/2 length
AF-58	Transducer 5.2 built	2300	1	Integer	Official Key		ID: transducer 5/2 year of manufacture

AF-59	Transducer 6.1 no.	630	10	Text	Official Key		ID: transducer 6/1 No.
AF-60	Transducer 6.1 len.	1544	2	Float	Official Key	→ Calib. units: Length	ID: transducer 6/1 length
AF-61	Transducer 6.1 built	2301	1	Integer	Official Key		ID: transducer 6/1 year of manufacture
AF-62	Transducer 6.2 no.	640	10	Text	Official Key		ID: transducer 6/2 No.
AF-63	Transducer 6.2 len.	1546	2	Float	Official Key	→ Calib. units: Length	ID: transducer 6/2 length
AF-64	Transducer 6.2 built	2302	1	Integer	Official Key		ID: transducer 6/2 year of manufacture
AF-65	Transducer 7.1 no.	650	10	Text	Official Key		ID: transducer 7/1 No.
AF-66	Transducer 7.1 len.	1548	2	Float	Official Key	→ Calib. units: Length	ID: transducer 7/1 length
AF-67	Transducer 7.1 built	2303	1	Integer	Official Key		ID: transducer 7/1 year of manufacture
AF-68	Transducer 7.2 no.	660	10	Text	Official Key		ID: transducer 7/2 No.
AF-69	Transducer 7.2 len.	1550	2	Float	Official Key	→ Calib. units: Length	ID: transducer 7/2 length
AF-70	Transducer 7.2 built	2304	1	Integer	Official Key		ID: transducer 7/2 year of manufacture
AF-71	Transducer 8.1 no.	670	10	Text	Official Key		ID: transducer 8/1 No.
AF-72	Transducer 8.1 len.	1552	2	Float	Official Key	→ Calib. units: Length	ID: transducer 8/1 length
AF-73	Transducer 8.1 built	2305	1	Integer	Official Key		ID: transducer 8/1 year of manufacture
AF-74	Transducer 8.2 no.	680	10	Text	Official Key		ID: transducer 8/2 No.
AF-75	Transducer 8.2 len.	1554	2	Float	Official Key	→ Calib. units: Length	ID: transducer 8/2 length
AF-76	Transducer 8.2 built	2306	1	Integer	Official Key		ID: transducer 8/2 year of manufacture
AF-77	serial number USE09	790	10	Text	Official Key		ID: serial number USE09
AF-78	version	100	2	Float	Reading Value		ID: M32C software version
AF-79	CPU CRC	201	1	Integer	Reading Value	hex	ID: M32C CRC-16
AF-80	Matrix version	200	1	Integer	Reading Value		ID: M32C Matrix version
AF-81	DSP version	102	2	Float	Reading Value		ID: DSP software version
AF-82	DSP CRC	202	1	Integer	Reading Value	hex	ID: DSP CRC-16
AF-83	FPGA version	104	2	Float	Reading Value		ID: FPGA software version
AF-84	FPGA CRC	203	1	Integer	Reading Value	hex	ID: FPGA CRC-16
AF-85	fiscal par. CRC	204	1	Integer	Reading Value	hex	ID: fiscally parameters crc-16

AF-86	piecewise lin. CRC	205	1	Integer	Reading Value	hex	ID: piecewise linearization parameters crc-16

Mode

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AG-04	codeword	750	10	Code	free programmable		--
AG-26	test working mode	2185	1	Menu	Official Key		--
							0x0000 OFF (default value)
							0x0001 DEBUG
							0x0002 WD
AG-27	Display, LED test	65535	10	Text	Reading Value		--
AG-28	Test LEDs	4080	1	Menu	Codeword		--
							0x0000 OFF (default value)
							0x0001 TEST
AG-30	language	2094	1	Menu	Codeword		--
							0x0000 GERMAN (default value)
							0x0001 ENGLISH
AG-31	units	2095	1	Menu	Code and Official Key		--
							0x0000 METRICAL-UNITS (default value)
							0x0001 IMPERIAL-UNITS
AG-32	velocity unit	7030	1	Menu	Reading Value		--
							0x0000 m/s
							0x0001 ft/s

AG-33	flow unit	7031	1	Menu	Reading Value		--		
							0x0000	m3/h	
							0x0001	acfh	
AG-34	volume unit	7032	1	Menu	Reading Value		--		
							0x0000	m3	
							0x0001	acf	
AG-35	pulse unit	7033	1	Menu	Reading Value		--		
							0x0000	Imp/m3	
							0x0001	Imp/cf	
AG-36	Units: Temp.	7035	1	Menu	Official Key		Unit: temperature		
							0x0000	°C	(default value)
							0x0001	°F	
							0x0002	K	
							0x0003	°Ra	
AG-37	Units: Pressure	7036	1	Menu	Official Key		Unit: pressure		
							0x0000	bar	(default value)
							0x0001	psi	
AG-38	Units: Pressure a	7037	1	Menu	Reading Value		Unit: absolute pressure		
							0x0000	bar_a	
							0x0001	psi_a	
AG-39	Units: Pressure g	7038	1	Menu	Reading Value		Unit: relative pressure		
							0x0000	bar_g	
							0x0001	psi_g	

AG-40	Calib. units: Length	7039	1	Menu	Official Key		Calibration unit: length		
							0x0000	mm	(default value)
							0x0001	in	
AG-41	Calib. units: v	7040	1	Menu	Official Key		Calibration unit: speed		
							0x0000	m/s	(default value)
							0x0001	ft/s	
AG-42	Calib. units: Q	7041	1	Menu	Official Key		Calibration unit: flow		
							0x0000	m3/h	(default value)
							0x0001	acfh	

Faults

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description		
AH-01	fault message	710	10	Text	Reading Value		--		
AH-02	fault time	7500	2	Unixtime	Reading Value		--		
AH-03	clear fault	2126	1	Menu	free programmable		--		
							0x0000	NO	(default value)
							0x0001	YES	
AH-04	fault mode	2127	1	Menu	Official Key		--		
							0x0000	NORMAL	(default value)
							0x0001	ALL	
AH-05	fault display mode	2128	1	Menu	Official Key		--		
							0x0000	NORMAL	(default value)
							0x0001	ACTIVE	
AH-06	path error mode	2129	1	Menu	Official Key		--		
							0x0000	WARNING	(default value)
							0x0001	ALARM	
AH-07	fault,warn contact	2254	1	Menu	free programmable		--		
							0x0000	NORMAL	(default value)
							0x0001	5_SECONDS	

							0x0002	HOLD
AH-09	path ok	700	10	Text	Reading Value		--	
AH-10	hint status	4008	1	Menu	Reading Value		--	
							0x0000	OFF
							0x0001	ON
							0x0002	QUIT
AH-11	warning status	4001	1	Menu	Reading Value		--	
							0x0000	OFF
							0x0001	ON
							0x0002	QUIT
AH-12	warn contact	4120	1	Menu	Reading Value		--	
							0x0000	OFF
							0x0001	ON
AH-13	fault status	4000	1	Menu	Reading Value		--	
							0x0000	OFF
							0x0001	ON
							0x0002	QUIT
AH-14	fault contact	4121	1	Menu	Reading Value		--	
							0x0000	OFF
							0x0001	ON
AH-15	USE09 device status	4002	1	Integer	Reading Value	hex	--	
AH-16	Fault bit 0-15	4010	1	Integer	Reading Value	hex	--	
AH-17	Fault bit 16-31	4011	1	Integer	Reading Value	hex	--	
AH-18	Fault bit 32-47	4012	1	Integer	Reading Value	hex	--	
AH-19	Fault bit 48-63	4013	1	Integer	Reading Value	hex	--	

AH-20	Fault bit 64-79	4014	1	Integer	Reading Value	hex	--
AH-21	Fault bit 80-95	4015	1	Integer	Reading Value	hex	--
AH-22	Fault bit 96-111	4016	1	Integer	Reading Value	hex	--
AH-23	Fault bit 112-127	4017	1	Integer	Reading Value	hex	--
AH-24	Fault bit 128-143	4018	1	Integer	Reading Value	hex	--
AH-25	Fault bit 144-159	4019	1	Integer	Reading Value	hex	--
AH-26	Fault bit 160-175	4020	1	Integer	Reading Value	hex	--
AH-27	Fault bit 176-191	4021	1	Integer	Reading Value	hex	--
AH-28	Fault bit 192-207	4022	1	Integer	Reading Value	hex	--

DSP Parameters

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AI-09	number of batches	2136	1	Integer	Codeword		--
AI-10	Relay delay time	2137	1	Integer	Official Key	ms	--
AI-11	sample frequency	2138	1	Menu	Official Key	MHz	--
							0x0000 1.00
							0x0001 1.25
							0x0002 1.67
							0x0003 2.0
							0x0004 2.5
							0x0005 3.33
							0x0006 4.0
							0x0007 5.0 (default value)
							0x0008 6.67
							0x0009 10.0
AI-12	fifo size	2139	1	Menu	Official Key		--
							0x0000 512
							0x0001 1024
							0x0002 2048 (default value)
AI-13	FPGA testpin ctrl.	2214	1	Integer	free programmable	hex	--
AI-14	transmission level	2140	1	Integer	Official Key	%	--
AI-15	send mux time	1364	2	Float	Official Key	ms	--

AI-16	receive mux time	1366	2	Float	Official Key	ms	--
AI-17	Attenuator mode	2141	1	Menu	Official Key		--
							0x0000 OFF (default value)
							0x0001 ON
							0x0002 TEST
							0x0003 AUTO_SEPARATE
AI-18	Attenuator on	2142	1	Integer	Official Key	dB	--
AI-19	Attenuator off	2143	1	Integer	Official Key	dB	--
AI-20	Attenuator HV	2144	1	Integer	Official Key	dB	--
AI-21	amp. regulator mode	2145	1	Menu	Codeword		--
							0x0000 SET VALUE
							0x0001 ON (default value)
							0x0002 HOLD
AI-22	amp. regulator min	2146	1	Integer	Codeword	%	--
AI-23	amp. regulator max	2147	1	Integer	Codeword	%	--
AI-24	amp. damping	1448	2	Float	Codeword		--
AI-25	theoretical SoS	1368	2	Float	Official Key	→ velocity unit	--
AI-26	ADC gain	2164	1	Menu	Official Key		--
							0x0000 1 (default value)
							0x0001 2
							0x0002 0.5
AI-27	signal tracking	2169	1	Menu	Codeword		--
							0x0000 ON
							0x0001 OFF (default

									value)
AI-28	max. track. offset	2187	1	Integer	Codeword	Tics	--		
AI-37	corr. mode	2256	1	Menu	Official Key		--		
							0x0000	OFF	(default value)
							0x0001	FADE_IN	
AI-38	corr. length	2189	1	Integer	Official Key		--		
AI-39	Batch: amp. min.	2279	1	Integer	Official Key	%	--		
AI-47	AmplitudeMin	2000	1	Integer	Official Key	%	--		
AI-48	AmplitudeMax	2010	1	Integer	Official Key	%	--		
AI-49	Vmin	1000	2	Float	Official Key	→ Calib. units: v	--		
AI-50	Vmax	1020	2	Float	Official Key	→ Calib. units: v	--		
AI-51	Cmin	1040	2	Float	Official Key	→ Calib. units: v	--		
AI-52	Cmax	1060	2	Float	Official Key	→ Calib. units: v	--		

DSP Parameters 3X

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AJ-07	corr. mode (X)	2257	1	Menu	Official Key		--
							0x0000 OFF (default value) 0x0001 FADE_IN
AJ-09	Batch: amp. min.	2280	1	Integer	Official Key	%	--

Path1 Parameters

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AK-09	p1 f-trans set val	2500	2	Long Int.	Official Key	Hz	Path 1 transmit frequency intended value in Hz
AK-10	path-1 trans. freq.	2520	2	Long Int.	Reading Value	Hz	Path 1 transmit frequency actual value in Hz
AK-11	path-1 band limits	2190	1	Integer	Official Key	%	Path 1 limits to observe
AK-12	path-1 trans.pulses	2040	1	Integer	Official Key		Path 1 number of transmit pulses
AK-13	p1 filter selection	2170	1	Menu	Official Key	kHz	Path 1 DSP filter selection
							0x0000 50
							0x0001 75
							0x0002 100 (default value)
							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	Float	Official Key	us	Path 1 delay time
AK-16	path-1 DAC-G1 cmd	2050	1	Integer	Official Key		Path 1 DAC-G1 command register
AK-17	path-1 DAC-G1 val	2060	1	Integer	Official Key		Path 1 DAC-G1 data register

AK-18	path-1 DAC-G2 cmd	2070	1	Integer	Official Key		Path 1 DAC-G2 command register
AK-19	path-1 DAC-G2 val	2080	1	Integer	Official Key		Path 1 DAC-G2 data register
AK-20	p1 blanking delay	1100	2	Float	Reading Value	us	Path 1 blanking delay
AK-21	p1 blanking count	2540	2	Long Int.	Reading Value	tic	Path 1 blanking count
AK-22	path-1 decay time	1120	2	Float	Official Key	ms	Path 1 pulse decay time
AK-23	path-1 path length	1140	2	Float	Official Key	→ Calib. units: Length	Path 1 path length
AK-24	path-1 axial dist.	1160	2	Float	Official Key	→ Calib. units: Length	Path 1 smallest path distance
AK-25	p1 assembly angle	1500	2	Float	Official Key	°	Path 1 assembly angle
AK-26	p1 delta-t offset	1420	2	Float	Official Key	us	Path 1 time difference offset
AK-29	const w1	1240	2	Float	Official Key	[1]	Path 1 weigthing factor w1
AK-30	p1 tic offset	2200	1	Integer	Official Key	tic	Path 1 tic offset
AK-31	p1 tic offset (X)	2260	1	Integer	Official Key	tic	Path 1 tic offset (3X-measurement)
AK-32	p1 AGC-limit	2220	1	Integer	Official Key	dB	Path 1 AGC limit
AK-34	p1 no. of f-batches	2312	1	Integer	Codeword		Path 1 no. of measurement (FBatches)

Path2 Parameters

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AL-09	p2 f-trans set val	2502	2	Long Int.	Official Key	Hz	Path 2 transmit frequency intended value in Hz
AL-10	path-2 trans. freq.	2522	2	Long Int.	Reading Value	Hz	Path 2 transmit frequency actual value in Hz
AL-11	path-2 band limits	2191	1	Integer	Official Key	%	Path 2 limits to observe
AL-12	path-2 trans.pulses	2041	1	Integer	Official Key		Path 2 number of transmit pulses
AL-13	p2 filter selection	2171	1	Menu	Official Key	kHz	Path 2 DSP filter selection
							0x0000 50
							0x0001 75
							0x0002 100 (default value)
							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	Float	Official Key	us	Path 2 delay time
AL-16	path-2 DAC-G1 cmd	2051	1	Integer	Official Key		Path 2 DAC-G1 command register
AL-17	path-2 DAC-G1 val	2061	1	Integer	Official Key		Path 2 DAC-G1 data register

AL-18	path-2 DAC-G2 cmd	2071	1	Integer	Official Key		Path 2 DAC-G2 command register
AL-19	path-2 DAC-G2 val	2081	1	Integer	Official Key		Path 2 DAC-G2 data register
AL-20	p2 blanking delay	1102	2	Float	Reading Value	us	Path 2 blanking delay
AL-21	p2 blanking count	2542	2	Long Int.	Reading Value	tic	Path 2 blanking count
AL-22	path-2 decay time	1122	2	Float	Official Key	ms	Path 2 pulse decay time
AL-23	path-2 path length	1142	2	Float	Official Key	→ Calib. units: Length	Path 2 path length
AL-24	path-2 axial dist.	1162	2	Float	Official Key	→ Calib. units: Length	Path 2 smallest path distance
AL-25	p2 assembly angle	1502	2	Float	Official Key	°	Path 2 assembly angle
AL-26	p2 delta-t offset	1422	2	Float	Official Key	us	Path 2 time difference offset
AL-29	const w2	1242	2	Float	Official Key	[1]	Path 2 weigthing factor w2
AL-30	p2 tic offset	2201	1	Integer	Official Key	tic	Path 2 tic offset
AL-31	p2 tic offset (X)	2261	1	Integer	Official Key	tic	Path 2 tic offset (3X-measurement)
AL-32	p2 AGC-limit	2221	1	Integer	Official Key	dB	Path 2 AGC limit
AL-34	p2 no. of f-batches	2313	1	Integer	Codeword		Path 2 no. of measurement (FBatches)

Path3 Parameters

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AM-09	p3 f-trans set val	2504	2	Long Int.	Official Key	Hz	Path 3 transmit frequency intended value in Hz
AM-10	path-3 trans. freq.	2524	2	Long Int.	Reading Value	Hz	Path 3 transmit frequency actual value in Hz
AM-11	path-3 band limits	2192	1	Integer	Official Key	%	Path 3 limits to observe
AM-12	path-3 trans.pulses	2042	1	Integer	Official Key		Path 3 number of transmit pulses
AM-13	p3 filter selection	2172	1	Menu	Official Key	kHz	Path 3 DSP filter selection
							0x0000 50
							0x0001 75
							0x0002 100 (default value)
							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	Float	Official Key	us	Path 3 delay time
AM-16	path-3 DAC-G1 cmd	2052	1	Integer	Official Key		Path 3 DAC-G1 command register
AM-17	path-3 DAC-G1 val	2062	1	Integer	Official Key		Path 3 DAC-G1 data register

AM-18	path-3 DAC-G2 cmd	2072	1	Integer	Official Key		Path 3 DAC-G2 command register
AM-19	path-3 DAC-G2 val	2082	1	Integer	Official Key		Path 3 DAC-G2 data register
AM-20	p3 blanking delay	1104	2	Float	Reading Value	us	Path 3 blanking delay
AM-21	p3 blanking count	2544	2	Long Int.	Reading Value	tic	Path 3 blanking count
AM-22	path-3 decay time	1124	2	Float	Official Key	ms	Path 3 pulse decay time
AM-23	path-3 path length	1144	2	Float	Official Key	→ Calib. units: Length	Path 3 path length
AM-24	path-3 axial dist.	1164	2	Float	Official Key	→ Calib. units: Length	Path 3 smallest path distance
AM-25	p3 assembly angle	1504	2	Float	Official Key	°	Path 3 assembly angle
AM-26	p3 delta-t offset	1424	2	Float	Official Key	us	Path 3 time difference offset
AM-29	const w3	1244	2	Float	Official Key	[1]	Path 3 weigthing factor w3
AM-30	p3 tic offset	2202	1	Integer	Official Key	tic	Path 3 tic offset
AM-31	p3 tic offset (X)	2262	1	Integer	Official Key	tic	Path 3 tic offset (3X-measurement)
AM-32	p3 AGC-limit	2222	1	Integer	Official Key	dB	Path 3 AGC limit
AM-34	p3 no. of f-batches	2314	1	Integer	Codeword		Path 3 no. of measurement (FBatches)

Path4 Parameters

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AN-09	p4 f-trans set val	2506	2	Long Int.	Official Key	Hz	Path 4 transmit frequency intended value in Hz
AN-10	path-4 trans. freq.	2526	2	Long Int.	Reading Value	Hz	Path 4 transmit frequency actual value in Hz
AN-11	path-4 band limits	2193	1	Integer	Official Key	%	Path 4 limits to observe
AN-12	path-4 trans.pulses	2043	1	Integer	Official Key		Path 4 number of transmit pulses
AN-13	p4 filter selection	2173	1	Menu	Official Key	kHz	Path 4 DSP filter selection
							0x0000 50
							0x0001 75
							0x0002 100 (default value)
							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	Float	Official Key	us	Path 4 delay time
AN-16	path-4 DAC-G1 cmd	2053	1	Integer	Official Key		Path 4 DAC-G1 command register
AN-17	path-4 DAC-G1 val	2063	1	Integer	Official Key		Path 4 DAC-G1 data register

AN-18	path-4 DAC-G2 cmd	2073	1	Integer	Official Key		Path 4 DAC-G2 command register
AN-19	path-4 DAC-G2 val	2083	1	Integer	Official Key		Path 4 DAC-G2 data register
AN-20	p4 blanking delay	1106	2	Float	Reading Value	us	Path 4 blanking delay
AN-21	p4 blanking count	2546	2	Long Int.	Reading Value	tic	Path 4 blanking count
AN-22	path-4 decay time	1126	2	Float	Official Key	ms	Path 4 pulse decay time
AN-23	path-4 path length	1146	2	Float	Official Key	→ Calib. units: Length	Path 4 path length
AN-24	path-4 axial dist.	1166	2	Float	Official Key	→ Calib. units: Length	Path 4 smallest path distance
AN-25	p4 assembly angle	1506	2	Float	Official Key	°	Path 4 assembly angle
AN-26	p4 delta-t offset	1426	2	Float	Official Key	us	Path 4 time difference offset
AN-29	const w4	1246	2	Float	Official Key	[1]	Path 4 weigthing factor w4
AN-30	p4 tic offset	2203	1	Integer	Official Key	tic	Path 4 tic offset
AN-31	p4 tic offset (X)	2263	1	Integer	Official Key	tic	Path 4 tic offset (3X-measurement)
AN-32	p4 AGC-limit	2223	1	Integer	Official Key	dB	Path 4 AGC limit
AN-34	p4 no. of f-batches	2315	1	Integer	Codeword		Path 4 no. of measurement (FBatches)

Path5 Parameters

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AO-09	p5 f-trans set val	2508	2	Long Int.	Official Key	Hz	Path 5 transmit frequency intended value in Hz
AO-10	path-5 trans. freq.	2528	2	Long Int.	Reading Value	Hz	Path 5 transmit frequency actual value in Hz
AO-11	path-5 band limits	2194	1	Integer	Official Key	%	Path 5 limits to observe
AO-12	path-5 trans.pulses	2044	1	Integer	Official Key		Path 5 number of transmit pulses
AO-13	p5 filter selection	2174	1	Menu	Official Key	kHz	Path 5 DSP filter selection
							0x0000 50
							0x0001 75
							0x0002 100 (default value)
							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	Float	Official Key	us	Path 5 delay time
AO-16	path-5 DAC-G1 cmd	2054	1	Integer	Official Key		Path 5 DAC-G1 command register
AO-17	path-5 DAC-G1 val	2064	1	Integer	Official Key		Path 5 DAC-G1 data register

AO-18	path-5 DAC-G2 cmd	2074	1	Integer	Official Key		Path 5 DAC-G2 command register
AO-19	path-5 DAC-G2 val	2084	1	Integer	Official Key		Path 5 DAC-G2 data register
AO-20	p5 blanking delay	1108	2	Float	Reading Value	us	Path 5 blanking delay
AO-21	p5 blanking count	2548	2	Long Int.	Reading Value	tic	Path 5 blanking count
AO-22	path-5 decay time	1128	2	Float	Official Key	ms	Path 5 pulse decay time
AO-23	path-5 path length	1148	2	Float	Official Key	→ Calib. units: Length	Path 5 path length
AO-24	path-5 axial dist.	1168	2	Float	Official Key	→ Calib. units: Length	Path 5 smallest path distance
AO-25	p5 assembly angle	1508	2	Float	Official Key	°	Path 5 assembly angle
AO-26	p5 delta-t offset	1428	2	Float	Official Key	us	Path 5 time difference offset
AO-29	const w5	1248	2	Float	Official Key	[1]	Path 5 weigthing factor w5
AO-30	p5 tic offset	2204	1	Integer	Official Key	tic	Path 5 tic offset
AO-31	p5 tic offset (X)	2264	1	Integer	Official Key	tic	Path 5 tic offset (3X-measurement)
AO-32	p5 AGC-limit	2224	1	Integer	Official Key	dB	Path 5 AGC limit
AO-34	p5 no. of f-batches	2316	1	Integer	Codeword		Path 5 no. of measurement (FBatches)

Path6 Parameters

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AP-09	p6 f-trans set val	2510	2	Long Int.	Official Key	Hz	Path 6 transmit frequency intended value in Hz
AP-10	path-6 trans. freq.	2530	2	Long Int.	Reading Value	Hz	Path 6 transmit frequency actual value in Hz
AP-11	path-6 band limits	2195	1	Integer	Official Key	%	Path 6 limits to observe
AP-12	path-6 trans.pulses	2045	1	Integer	Official Key		Path 6 number of transmit pulses
AP-13	p6 filter selection	2175	1	Menu	Official Key	kHz	Path 6 DSP filter selection
							0x0000 50
							0x0001 75
							0x0002 100 (default value)
							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	Float	Official Key	us	Path 6 delay time
AP-16	path-6 DAC-G1 cmd	2055	1	Integer	Official Key		Path 6 DAC-G1 command register
AP-17	path-6 DAC-G1 val	2065	1	Integer	Official Key		Path 6 DAC-G1 data register

AP-18	path-6 DAC-G2 cmd	2075	1	Integer	Official Key		Path 6 DAC-G2 command register
AP-19	path-6 DAC-G2 val	2085	1	Integer	Official Key		Path 6 DAC-G2 data register
AP-20	p6 blanking delay	1110	2	Float	Reading Value	us	Path 6 blanking delay
AP-21	p6 blanking count	2550	2	Long Int.	Reading Value	tic	Path 6 blanking count
AP-22	path-6 decay time	1130	2	Float	Official Key	ms	Path 6 pulse decay time
AP-23	path-6 path length	1150	2	Float	Official Key	→ Calib. units: Length	Path 6 path length
AP-24	path-6 axial dist.	1170	2	Float	Official Key	→ Calib. units: Length	Path 6 smallest path distance
AP-25	p6 assembly angle	1510	2	Float	Official Key	°	Path 6 assembly angle
AP-26	p6 delta-t offset	1430	2	Float	Official Key	us	Path 6 time difference offset
AP-29	const w6	1250	2	Float	Official Key	[1]	Path 6 weigthing factor w6
AP-30	p6 tic offset	2205	1	Integer	Official Key	tic	Path 6 tic offset
AP-31	p6 tic offset (X)	2265	1	Integer	Official Key	tic	Path 6 tic offset (3X-measurement)
AP-32	p6 AGC-limit	2225	1	Integer	Official Key	dB	Path 6 AGC limit
AP-34	p6 no. of f-batches	2317	1	Integer	Codeword		Path 6 no. of measurement (FBatches)

Path7 Parameters

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AQ-09	p7 f-trans set val	2512	2	Long Int.	Official Key	Hz	Path 7 transmit frequency intended value in Hz
AQ-10	path-7 trans. freq.	2532	2	Long Int.	Reading Value	Hz	Path 7 transmit frequency actual value in Hz
AQ-11	path-7 band limits	2196	1	Integer	Official Key	%	Path 7 limits to observe
AQ-12	path-7 trans.pulses	2046	1	Integer	Official Key		Path 7 number of transmit pulses
AQ-13	p7 filter selection	2176	1	Menu	Official Key	kHz	Path 7 DSP filter selection
							0x0000 50
							0x0001 75
							0x0002 100 (default value)
							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	Float	Official Key	us	Path 7 delay time
AQ-16	path-7 DAC-G1 cmd	2056	1	Integer	Official Key		Path 7 DAC-G1 command register
AQ-17	path-7 DAC-G1 val	2066	1	Integer	Official Key		Path 7 DAC-G1 data register

AQ-18	path-7 DAC-G2 cmd	2076	1	Integer	Official Key		Path 7 DAC-G2 command register
AQ-19	path-7 DAC-G2 val	2086	1	Integer	Official Key		Path 7 DAC-G2 data register
AQ-20	p7 blanking delay	1112	2	Float	Reading Value	us	Path 7 blanking delay
AQ-21	p7 blanking count	2552	2	Long Int.	Reading Value	tic	Path 7 blanking count
AQ-22	path-7 decay time	1132	2	Float	Official Key	ms	Path 7 pulse decay time
AQ-23	path-7 path length	1152	2	Float	Official Key	→ Calib. units: Length	Path 7 path length
AQ-24	path-7 axial dist.	1172	2	Float	Official Key	→ Calib. units: Length	Path 7 smallest path distance
AQ-25	p7 assembly angle	1512	2	Float	Official Key	°	Path 7 assembly angle
AQ-26	p7 delta-t offset	1432	2	Float	Official Key	us	Path 7 time difference offset
AQ-29	const w7	1252	2	Float	Official Key	[1]	Path 7 weigthing factor w7
AQ-30	p7 tic offset	2206	1	Integer	Official Key	tic	Path 7 tic offset
AQ-31	p7 tic offset (X)	2266	1	Integer	Official Key	tic	Path 7 tic offset (3X-measurement)
AQ-32	p7 AGC-limit	2226	1	Integer	Official Key	dB	Path 7 AGC limit
AQ-34	p7 no. of f-batches	2318	1	Integer	Codeword		Path 7 no. of measurement (FBatches)

Path8 Parameters

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AR-09	p8 f-trans set val	2514	2	Long Int.	Official Key	Hz	Path 8 transmit frequency intended value in Hz
AR-10	path-8 trans. freq.	2534	2	Long Int.	Reading Value	Hz	Path 8 transmit frequency actual value in Hz
AR-11	path-8 band limits	2197	1	Integer	Official Key	%	Path 8 limits to observe
AR-12	path-8 trans.pulses	2047	1	Integer	Official Key		Path 8 number of transmit pulses
AR-13	p8 filter selection	2177	1	Menu	Official Key	kHz	Path 8 DSP filter selection
							0x0000 50
							0x0001 75
							0x0002 100 (default value)
							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	Float	Official Key	us	Path 8 delay time
AR-16	path-8 DAC-G1 cmd	2057	1	Integer	Official Key		Path 8 DAC-G1 command register
AR-17	path-8 DAC-G1 val	2067	1	Integer	Official Key		Path 8 DAC-G1 data register

AR-18	path-8 DAC-G2 cmd	2077	1	Integer	Official Key		Path 8 DAC-G2 command register
AR-19	path-8 DAC-G2 val	2087	1	Integer	Official Key		Path 8 DAC-G2 data register
AR-20	p8 blanking delay	1114	2	Float	Reading Value	us	Path 8 blanking delay
AR-21	p8 blanking count	2554	2	Long Int.	Reading Value	tic	Path 8 blanking count
AR-22	path-8 decay time	1134	2	Float	Official Key	ms	Path 8 pulse decay time
AR-23	path-8 path length	1154	2	Float	Official Key	→ Calib. units: Length	Path 8 path length
AR-24	path-8 axial dist.	1174	2	Float	Official Key	→ Calib. units: Length	Path 8 smallest path distance
AR-25	p8 assembly angle	1514	2	Float	Official Key	°	Path 8 assembly angle
AR-26	p8 delta-t offset	1434	2	Float	Official Key	us	Path 8 time difference offset
AR-29	const w8	1254	2	Float	Official Key	[1]	Path 8 weigthing factor w8
AR-30	p8 tic offset	2207	1	Integer	Official Key	tic	Path 8 tic offset
AR-31	p8 tic offset (X)	2267	1	Integer	Official Key	tic	Path 8 tic offset (3X-measurement)
AR-32	p8 AGC-limit	2227	1	Integer	Official Key	dB	Path 8 AGC limit
AR-34	p8 no. of f-batches	2319	1	Integer	Codeword		Path 8 no. of measurement (FBatches)

Service

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AS-01	CPU speed	2574	2	Long Int.	Code and Official Key	Hz	--
AS-02	DSP speed	2576	2	Long Int.	Official Key	Hz	--
AS-04	FPGA speed	2578	2	Long Int.	Official Key	Hz	--
AS-05	ext. card s.no.	2584	2	Long Int.	Official Key		--
AS-06	ext. ADC s.no.	2586	2	Long Int.	Official Key		--
AS-07	write opt.EEProm	2167	1	Menu	Official Key		--
							0x0000 NO (default value)
							0x0001 YES
AS-08	write ADC EEProm	2168	1	Menu	Official Key		--
							0x0000 NO (default value)
							0x0001 YES
AS-09	LCD lighting	2183	1	Menu	free programmable		--
							0x0000 KEY (default value)
							0x0001 always
AS-10	parameter reset	2148	1	Menu	Code and Official Key		--
							0x0000 NO (default value)
							0x0001 YES
AS-12	RV reset	2149	1	Menu	Codeword		Clear replacement values

							0x0000 NO (default value)
							0x0001 YES
AS-13	RV: number	2150	1	Integer	Codeword		Number of average values for the calculation of replacement values
AS-14	RV status	720	10	Text	Reading Value		Status for the replacement value
AS-15	RV mode	2213	1	Menu	Official Key		Mode of replacement values
							0x0000 OFF
							0x0001 ON (default value)
AS-16	Raw data path no.	2124	1	Integer	free programmable		--
AS-17	Raw data type	2184	1	Menu	free programmable		--
							0x0000 TEST
							0x0001 RAW (default value)
							0x0002 FILTER
							0x0003 RAW ERR
							0x0004 FILTER ERR
							0x0005 FFG
							0x0006 RAW FFT
							0x0007 FILTER FFT
AS-18	Raw data function	2215	1	Integer	free programmable		--
AS-20	M32 Temperature	5000	2	Float	Reading Value	→ Units: Temp.	--
AS-21	Transmit Level	5002	2	Float	Reading Value	%	--
AS-22	+-5V symmetry	5004	2	Float	Reading Value	V	--
AS-23	System Temperature	5006	2	Float	Reading Value	→ Units: Temp.	--
AS-24	+-12V symmetry	5008	2	Float	Reading Value	V	--

AS-25	1V2 voltage	5010	2	Float	Reading Value	V	--
AS-26	1V5 voltage	5012	2	Float	Reading Value	V	--
AS-27	3V3 voltage	5014	2	Float	Reading Value	V	--
AS-28	adc-p binary val.	7502	2	Long Int.	Reading Value		--
AS-29	adc-t binary val.	7504	2	Long Int.	Reading Value		--
AS-30	max. sys. temp.	1440	2	Float	Codeword	→ Units: Temp.	--
AS-31	time max. sys. temp	2588	2	Unixtime	Codeword		--
AS-32	min. sys. temp.	1442	2	Float	Codeword	→ Units: Temp.	--
AS-33	time min. sys. temp	2590	2	Unixtime	Codeword		--

Log Data

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AT-01	Log-data date	800	10	Text	Reading Value		--
AT-02	Log-data coordinate	810	10	Text	Reading Value		--
AT-03	Log-data old value	820	10	Text	Reading Value		--
AT-04	Log-data new value	830	10	Text	Reading Value		--
AT-10	Log-data fill level	4007	1	Integer	Reading Value	%	--
AT-11	clear par-log	2157	1	Menu	Official Key		--
							0x0000 NO (default value)
							0x0001 YES
AT-12	clear event-log	2216	1	Menu	free programmable		--
							0x0000 NO (default value)
							0x0001 YES

Site Information

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AU-01	User Text-1	840	10	Text	free programmable		--
AU-02	User Text-2	850	10	Text	free programmable		--
AU-03	User Text-3	860	10	Text	free programmable		--
AU-04	User Text-4	870	10	Text	free programmable		--
AU-05	User Text-5	880	10	Text	free programmable		--

Remote Control

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AV-01	remote access	10000	1	Menu	Codeword		--
							0x0000 NO (default value)
							0x0001 YES
AV-02	remote keycode	10001	1	Integer	Codeword		--
AV-03	lcd row 1	10010	10	Text	Reading Value		--
AV-04	lcd row 2	10020	10	Text	Reading Value		--
AV-05	lcd row 3	10030	10	Text	Reading Value		--
AV-06	lcd row 4	10040	10	Text	Reading Value		--

AGA-10 Values

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AW-01	SoS calc. status	8000	1	Integer	Reading Value	hex	--
AW-02	SoS	8001	2	Float	Reading Value	→ velocity unit	--
AW-03	SoS calculated	8003	2	Float	Reading Value	→ velocity unit	--
AW-04	rel. error SoS	8005	2	Float	Reading Value	%	--
AW-05	abs. error SoS	8007	2	Float	Reading Value	→ velocity unit	--
AW-06	temperature	8009	2	Float	Reading Value	→ Units: Temp.	--
AW-07	pressure	8011	2	Float	Reading Value	→ Units: Pressure a	--
AW-08	last calculation	8013	2	Unixtime	Reading Value		--
AW-09	last gas comp.	8015	2	Unixtime	Reading Value		--
AW-20	norm. methane	8040	2	Float	Reading Value	mol-%	--
AW-21	norm. ethane	8046	2	Float	Reading Value	mol-%	--
AW-22	norm. propane	8048	2	Float	Reading Value	mol-%	--
AW-23	norm. iso-butane	8060	2	Float	Reading Value	mol-%	--
AW-24	norm. n-butane	8062	2	Float	Reading Value	mol-%	--
AW-26	norm. iso-pentane	8064	2	Float	Reading Value	mol-%	--
AW-27	norm. n-pentane	8066	2	Float	Reading Value	mol-%	--
AW-29	norm. oxygen	8058	2	Float	Reading Value	mol-%	--
AW-30	norm. helium	8078	2	Float	Reading Value	mol-%	--
AW-31	norm. hydrogen	8054	2	Float	Reading Value	mol-%	--
AW-32	norm. argon	8080	2	Float	Reading Value	mol-%	--
AW-33	norm. nitrogen	8042	2	Float	Reading Value	mol-%	--
AW-34	norm. CO2	8044	2	Float	Reading Value	mol-%	--

AW-35	norm. n-hexane	8068	2	Float	Reading Value	mol-%	--
AW-36	norm. n-heptane	8070	2	Float	Reading Value	mol-%	--
AW-37	norm. n-octane	8072	2	Float	Reading Value	mol-%	--
AW-38	norm. n-nonane	8074	2	Float	Reading Value	mol-%	--
AW-39	norm. n-decane	8076	2	Float	Reading Value	mol-%	--
AW-40	norm. H2S	8052	2	Float	Reading Value	mol-%	--
AW-41	norm. water	8050	2	Float	Reading Value	mol-%	--
AW-42	norm. CO	8056	2	Float	Reading Value	mol-%	--

AGA-10 Config

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AX-01	SoS calc source	8100	1	Menu	free programmable		--
							0x0000 OFF (default value)
							0x0001 SET VALUE
							0x0002 default air
							0x0003 serial port 2
AX-02	SoS source temp.	8101	1	Menu	free programmable		--
							0x0000 SoS default (default value)
							0x0001 USE09
AX-03	SoS source press.	8102	1	Menu	free programmable		--
							0x0000 SoS default (default value)
							0x0001 USE09
AX-04	SoS temp. default	8104	2	Float	free programmable	→ Units: Temp.	--
AX-05	SoS press. default	8106	2	Float	free programmable	→ Units: Pressure a	--
AX-06	relative humidity	8108	2	Float	free programmable	%	--
AX-07	timeout max.	8110	1	Integer	free programmable	min	--
AX-08	RMGBus mode	8111	1	Menu	free programmable		--
							0x0000 RMGBus 24 comp. (default value)
							0x0001 RMGBus

AX-09	stream number	8112	1	Menu	free programmable		--		
							0x0000	without indication	(default value)
							0x0001	stream 1	
							0x0002	stream 2	
							0x0003	stream 3	
							0x0004	stream 4	
AX-10	Modbus master target	8113	1	Menu	free programmable		--		
							0x0000	RMG GC9300	(default value)
							0x0001	custom 1	
AX-11	set gas comp.	8350	1	Menu	free programmable		--		
							0x0000	gas comp. are set	(default value)
							0x0001	set new comp.	
AX-20	default methane	8140	2	Float	free programmable	mol-%	--		
AX-21	default ethane	8142	2	Float	free programmable	mol-%	--		
AX-22	default propane	8144	2	Float	free programmable	mol-%	--		
AX-23	default iso-butane	8146	2	Float	free programmable	mol-%	--		
AX-24	default n-butane	8148	2	Float	free programmable	mol-%	--		
AX-25	default neo-pentane	8150	2	Float	free programmable	mol-%	--		
AX-26	default iso-pentane	8152	2	Float	free programmable	mol-%	--		
AX-27	default n-pentane	8154	2	Float	free programmable	mol-%	--		
AX-28	default hexane+	8156	2	Float	free programmable	mol-%	--		
AX-29	default oxygen	8158	2	Float	free programmable	mol-%	--		
AX-30	default helium	8160	2	Float	free programmable	mol-%	--		
AX-31	default hydrogen	8162	2	Float	free programmable	mol-%	--		

AX-32	default argon	8164	2	Float	free programmable	mol-%	--
AX-33	default nitrogen	8166	2	Float	free programmable	mol-%	--
AX-34	default CO2	8168	2	Float	free programmable	mol-%	--
AX-35	default n-hexane	8170	2	Float	free programmable	mol-%	--
AX-36	default n-heptane	8172	2	Float	free programmable	mol-%	--
AX-37	default n-octane	8174	2	Float	free programmable	mol-%	--
AX-38	default n-nonane	8176	2	Float	free programmable	mol-%	--
AX-39	default n-decane	8178	2	Float	free programmable	mol-%	--
AX-40	default H2S	8180	2	Float	free programmable	mol-%	--
AX-41	default water	8182	2	Float	free programmable	mol-%	--
AX-42	default CO	8184	2	Float	free programmable	mol-%	--
AX-43	default ethene	8186	2	Float	free programmable	mol-%	--
AX-44	default propene	8188	2	Float	free programmable	mol-%	--
AX-45	sum of def. comp.	8190	2	Float	Reading Value	mol-%	--
AX-92	MB_Pause	8980	1	Integer	free programmable	s	Modbus-master pause
AX-93	MB_Timeout	8981	1	Integer	free programmable	ms	Modbus-master time outs
AX-94	MB_Int16Order	8982	10	Text	free programmable		--
AX-95	MB_Int32Order	8992	10	Text	free programmable		--
AX-96	MB_FloatOrder	9002	10	Text	free programmable		--
AX-97	MB_DoubleOrder	9012	10	Text	free programmable		--

Gas Comp. RMGBus

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AY-20	methane	8300	2	Float	free programmable	mol-%	--
AY-21	ethane	8302	2	Float	free programmable	mol-%	--
AY-22	propane	8304	2	Float	free programmable	mol-%	--
AY-23	iso-butane	8306	2	Float	free programmable	mol-%	--
AY-24	n-butane	8308	2	Float	free programmable	mol-%	--
AY-25	neo-pentane	8310	2	Float	free programmable	mol-%	--
AY-26	iso-pentane	8312	2	Float	free programmable	mol-%	--
AY-27	n-pentane	8314	2	Float	free programmable	mol-%	--
AY-28	hexane+	8316	2	Float	free programmable	mol-%	--
AY-29	oxygen	8318	2	Float	free programmable	mol-%	--
AY-30	helium	8320	2	Float	free programmable	mol-%	--
AY-31	hydrogen	8322	2	Float	free programmable	mol-%	--
AY-32	argon	8324	2	Float	free programmable	mol-%	--
AY-33	nitrogen	8326	2	Float	free programmable	mol-%	--
AY-34	CO2	8328	2	Float	free programmable	mol-%	--
AY-35	n-hexane	8330	2	Float	free programmable	mol-%	--
AY-36	n-heptane	8332	2	Float	free programmable	mol-%	--
AY-37	n-octane	8334	2	Float	free programmable	mol-%	--
AY-38	n-nonane	8336	2	Float	free programmable	mol-%	--
AY-39	n-decane	8338	2	Float	free programmable	mol-%	--
AY-40	H2S	8340	2	Float	free programmable	mol-%	--
AY-41	water	8342	2	Float	free programmable	mol-%	--

AY-42	CO	8344	2	Float	free programmable	mol-%	--
AY-43	ethene	8346	2	Float	free programmable	mol-%	--
AY-44	propene	8348	2	Float	free programmable	mol-%	--
AY-45	sum of gas comp.	8351	2	Float	Reading Value	mol-%	--
AY-46	telegram counter	8126	1	Integer	Reading Value		--
AY-47	RMGBus status	8127	1	Menu	Reading Value		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	Integer	Reading Value		--
AY-49	MB timeouts	8129	1	Integer	Reading Value		Number of modbus-master time outs
AY-50	Modbus errors	8130	1	Integer	Reading Value		--
AY-51	Modbus error reg.	8131	1	Integer	Reading Value		--
AY-52	Modbus error resp.	8132	1	Integer	Reading Value		--
AY-53	MB_NAN_Counter	9022	1	Integer	Reading Value		--
AY-54	MB_SyntaxError	9023	10	Text	Reading Value		--
AY-55	MB_ErrorBits	9033	2	Long Int.	Reading Value	hex	--
AY-56	MB_InStatus	9035	1	Integer	free programmable		--

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
AZ-01	Formula Methane	8440	10	Text	Official Key		Formula methane
AZ-02	Formula Methane	8450	10	Text	Official Key		Formula methane
AZ-03	Formula Ethane	8460	10	Text	Official Key		Formula ethane
AZ-04	Formula Ethane	8470	10	Text	Official Key		Formula ethane
AZ-05	Formula Propane	8480	10	Text	Official Key		Formula propane
AZ-06	Formula Propane	8490	10	Text	Official Key		Formula propane
AZ-07	Formula I_Butane	8500	10	Text	Official Key		--
AZ-08	Formula I_Butane	8510	10	Text	Official Key		--
AZ-09	Formula N_Butane	8520	10	Text	Official Key		--
AZ-10	Formula N_Butane	8530	10	Text	Official Key		--
AZ-11	Formula Neo_Pentane	8540	10	Text	Official Key		--
AZ-12	Formula Neo_Pentane	8550	10	Text	Official Key		--
AZ-13	Formula I_Pentane	8560	10	Text	Official		--

					Key		
AZ-14	Formula I_Pentane	8570	10	Text	Official Key		--
AZ-15	Formula N_Pentane	8580	10	Text	Official Key		--
AZ-16	Formula N_Pentane	8590	10	Text	Official Key		--
AZ-17	Formula Hexane+	8600	10	Text	Official Key		Formula hexane
AZ-18	Formula Hexane+	8610	10	Text	Official Key		Formula hexane
AZ-19	Formula Oxygen	8620	10	Text	Official Key		Formula oxygen
AZ-20	Formula Oxygen	8630	10	Text	Official Key		Formula oxygen
AZ-21	Formula Helium	8640	10	Text	Official Key		Formula helium
AZ-22	Formula Helium	8650	10	Text	Official Key		Formula helium
AZ-23	Formula Hydrogene	8660	10	Text	Official Key		Formula hydrogen
AZ-24	Formula Hydrogene	8670	10	Text	Official Key		Formula hydrogen
AZ-25	Formula Argon	8680	10	Text	Official Key		Formula argon
AZ-26	Formula Argon	8690	10	Text	Official Key		Formula argon
AZ-27	Formula Nitrogen	8700	10	Text	Official Key		Formula nitrogen
AZ-28	Formula Nitrogen	8710	10	Text	Official		Formula nitrogen

					Key		
AZ-29	Formula CO2	8720	10	Text	Official Key		Formula CO2
AZ-30	Formula CO2	8730	10	Text	Official Key		Formula CO2
AZ-31	Formula Hexane	8740	10	Text	Official Key		Formula hexane
AZ-32	Formula Hexane	8750	10	Text	Official Key		Formula hexane
AZ-33	Formula Heptane	8760	10	Text	Official Key		Formula heptane
AZ-34	Formula Heptane	8770	10	Text	Official Key		Formula heptane
AZ-35	Formula Octane	8780	10	Text	Official Key		Formula octane
AZ-36	Formula Octane	8790	10	Text	Official Key		Formula octane
AZ-37	Formula Nonane	8800	10	Text	Official Key		Formula nonane
AZ-38	Formula Nonane	8810	10	Text	Official Key		Formula nonane
AZ-39	Formula Decane	8820	10	Text	Official Key		Formula decane
AZ-40	Formula Decane	8830	10	Text	Official Key		Formula decane
AZ-41	Formula H2S	8840	10	Text	Official Key		Formula H2S
AZ-42	Formula H2S	8850	10	Text	Official Key		Formula H2S
AZ-43	Formula Water	8860	10	Text	Official		Formula water

					Key		
AZ-44	Formula Water	8870	10	Text	Official Key		Formula water
AZ-45	Formula CO	8880	10	Text	Official Key		Formula CO
AZ-46	Formula CO	8890	10	Text	Official Key		Formula CO
AZ-47	Formula Ethene	8900	10	Text	Official Key		Formula ethane
AZ-48	Formula Ethene	8910	10	Text	Official Key		Formula ethane
AZ-49	Formula Propene	8920	10	Text	Official Key		Formula propene
AZ-50	Formula Propene	8930	10	Text	Official Key		Formula propene
AZ-51	Formula Status	8940	10	Text	Official Key		Formula status
AZ-52	Formula Status	8950	10	Text	Official Key		Formula status
AZ-53	Formula Status	8960	10	Text	Official Key		Formula status
AZ-54	Formula Status	8970	10	Text	Official Key		Formula status

DSfG Instance-F

Coordinate	Value	Register	Reg. quantity	Typ	Protect	Unit	Description
BA-01	DSfG error	9086	1	Integer	Reading Value		DSfG Error (0000 if no error)
BA-02	vol. flow rate Qm	32768	2	Float	Reading Value	m3/h	Volume flow (pos. FD1, neg. FD2)
BA-03	Gas velocity	32770	2	Float	Reading Value	m/s	Velocity of Gas (pos. FD1, neg. FD2)
BA-04	SoS	32772	2	Float	Reading Value	m/s	Speed of Sound
BA-05	Gas volume sum d.1	32774	2	Long Int.	Reading Value	→ 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	Long Int.	Reading Value	→ 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	Long Int.	Reading Value	→ Unit LF-Volumes	Volume of Gas undisturbed Flow direction 1 (Vm_d1)
BA-08	Gas vol no err d.2	32780	2	Long Int.	Reading Value	→ Unit LF-Volumes	Volume of Gas undisturbed Flow direction 2 (Vm_d2)
BA-09	Gas vol error d.1	32782	2	Long Int.	Reading Value	→ Unit LF-Volumes	Volume of Gas disturbed Flow direction 1 (Vm_err_d1)
BA-10	Gas vol error d.2	32784	2	Long Int.	Reading Value	→ Unit LF-Volumes	Volume of Gas disturbed Flow direction 2 (Vm_err_d2)
BA-11	Valence	32786	2	Long Int.	Reading Value		Valency
BA-12	Flow > Qt	32788	2	Long Int.	Reading Value		Flow bigger Qt (0 = no, unequal 0 = yes)
BA-13	Signal acceptance	32790	2	Long Int.	Reading Value	%	Signal acceptance
BA-14	Meter error	32792	2	Long Int.	Reading Value		Meter disturbed (0 = no, unequal 0 = yes)
BA-15	Number of Paths	32794	2	Long	Reading Value		Number of Paths

				Int.			
BA-16	SoS deviation P1	32796	2	Float	Reading Value	%	Speed of Sound deviation Path 1 (SoS_1_dev = (SoS_1-SoS)/SoS*100)
BA-17	SoS deviation P2	32798	2	Float	Reading Value	%	Speed of Sound deviation Path 2 (SoS_2_dev = (SoS_2-SoS)/SoS*100)
BA-18	SoS deviation P3	32800	2	Float	Reading Value	%	Speed of Sound deviation Path 3 (SoS_3_dev = (SoS_3-SoS)/SoS*100)
BA-19	SoS deviation P4	32802	2	Float	Reading Value	%	Speed of Sound deviation Path 4 (SoS_4_dev = (SoS_4-SoS)/SoS*100)
BA-20	SoS deviation P5	32804	2	Float	Reading Value	%	Speed of Sound deviation Path 5 (SoS_5_dev = (SoS_5-SoS)/SoS*100)
BA-21	SoS deviation P6	32806	2	Float	Reading Value	%	Speed of Sound deviation Path 6 (SoS_6_dev = (SoS_6-SoS)/SoS*100)
BA-22	SoS deviation P7	32808	2	Float	Reading Value	%	Speed of Sound deviation Path 7 (SoS_7_dev = (SoS_7-SoS)/SoS*100)
BA-23	SoS deviation P8	32810	2	Float	Reading Value	%	Speed of Sound deviation Path 8 (SoS_8_dev = (SoS_8-SoS)/SoS*100)
BA-24	Path velocity vc1	32896	2	Float	Reading Value	m/s	Velocity of Gas Path 1
BA-25	SoS P1	32898	2	Float	Reading Value	m/s	Speed of Sound Path 1
BA-26	Signal acceptance P1	32900	2	Float	Reading Value	%	Signal acceptance Path 1
BA-27	SNR P1 AB	32902	2	Float	Reading Value	dB	Signal-Noise-Ratio AB Path 1
BA-28	SNR P1 BA	32904	2	Float	Reading Value	dB	Signal-Noise-Ratio BA Path 1
BA-29	AGC-level P1 AB	32906	2	Float	Reading Value	dB	Automatic gain AB Path 1
BA-30	AGC-level P1 BA	32908	2	Float	Reading Value	dB	Automatic gain BA Path 1
BA-31	Path velocity vc2	32912	2	Float	Reading Value	m/s	Velocity of Gas path 2
BA-32	SoS P2	32914	2	Float	Reading Value	m/s	Speed of Sound Path 2
BA-33	Signal acceptance P2	32916	2	Float	Reading Value	%	Signal acceptance Path 2
BA-34	SNR P2 AB	32918	2	Float	Reading Value	dB	Signal-Noise-Ratio AB Path 2
BA-35	SNR P2 BA	32920	2	Float	Reading Value	dB	Signal-Noise-Ratio BA Path 2
BA-36	AGC-level P2 AB	32922	2	Float	Reading Value	dB	Automatic gain AB Path 2
BA-37	AGC-level P2 BA	32924	2	Float	Reading Value	dB	Automatic gain BA Path 2
BA-38	Path velocity vc3	32928	2	Float	Reading Value	m/s	Velocity of Gas path 3
BA-39	SoS P3	32930	2	Float	Reading Value	m/s	Speed of Sound Path 3
BA-40	Signal acceptance P3	32932	2	Float	Reading Value	%	Signal acceptance Path 3
BA-41	SNR P3 AB	32934	2	Float	Reading Value	dB	Signal-Noise-Ratio AB Path 3

BA-42	SNR P3 BA	32936	2	Float	Reading Value	dB	Signal-Noise-Ratio BA Path 3
BA-43	AGC-level P3 AB	32938	2	Float	Reading Value	dB	Automatic gain AB Path 3
BA-44	AGC-level P3 BA	32940	2	Float	Reading Value	dB	Automatic gain BA Path 3
BA-45	Path velocity vc4	32944	2	Float	Reading Value	m/s	Velocity of Gas path 4
BA-46	SoS P4	32946	2	Float	Reading Value	m/s	Speed of Sound Path 4
BA-47	Signal acceptance P4	32948	2	Float	Reading Value	%	Signal acceptance Path 4
BA-48	SNR P4 AB	32950	2	Float	Reading Value	dB	Signal-Noise-Ratio AB Path 4
BA-49	SNR P4 BA	32952	2	Float	Reading Value	dB	Signal-Noise-Ratio BA Path 4
BA-50	AGC-level P4 AB	32954	2	Float	Reading Value	dB	Automatic gain AB Path 4
BA-51	AGC-level P4 BA	32956	2	Float	Reading Value	dB	Automatic gain BA Path 4
BA-52	Path velocity vc5	32960	2	Float	Reading Value	m/s	Velocity of Gas path 5
BA-53	SoS P5	32962	2	Float	Reading Value	m/s	Speed of Sound Path 5
BA-54	Signal acceptance P5	32964	2	Float	Reading Value	%	Signal acceptance Path 5
BA-55	SNR P5 AB	32966	2	Float	Reading Value	dB	Signal-Noise-Ratio AB Path 5
BA-56	SNR P5 BA	32968	2	Float	Reading Value	dB	Signal-Noise-Ratio BA Path 5
BA-57	AGC-level P5 AB	32970	2	Float	Reading Value	dB	Automatic gain AB Path 5
BA-58	AGC-level P5 BA	32972	2	Float	Reading Value	dB	Automatic gain BA Path 5
BA-59	Path velocity vc6	32976	2	Float	Reading Value	m/s	Velocity of Gas path 6
BA-60	SoS P6	32978	2	Float	Reading Value	m/s	Speed of Sound Path 6
BA-61	Signal acceptance P6	32980	2	Float	Reading Value	%	Signal acceptance Path 6
BA-62	SNR P6 AB	32982	2	Float	Reading Value	dB	Signal-Noise-Ratio AB Path 6
BA-63	SNR P6 BA	32984	2	Float	Reading Value	dB	Signal-Noise-Ratio BA Path 6
BA-64	AGC-level P6 AB	32986	2	Float	Reading Value	dB	Automatic gain AB Path 6
BA-65	AGC-level P6 BA	32988	2	Float	Reading Value	dB	Automatic gain BA Path 6
BA-66	Path velocity vc7	32992	2	Float	Reading Value	m/s	Velocity of Gas path 7
BA-67	SoS P7	32994	2	Float	Reading Value	m/s	Speed of Sound Path 7
BA-68	Signal acceptance P7	32996	2	Float	Reading Value	%	Signal acceptance Path 7

BA-69	SNR P7 AB	32998	2	Float	Reading Value	dB	Signal-Noise-Ratio AB Path 7
BA-70	SNR P7 BA	33000	2	Float	Reading Value	dB	Signal-Noise-Ratio BA Path 7
BA-71	AGC-level P7 AB	33002	2	Float	Reading Value	dB	Automatic gain AB Path 7
BA-72	AGC-level P7 BA	33004	2	Float	Reading Value	dB	Automatic gain BA Path 7
BA-73	Path velocity vc8	33008	2	Float	Reading Value	m/s	Velocity of Gas path 8
BA-74	SoS P8	33010	2	Float	Reading Value	m/s	Speed of Sound Path 8
BA-75	Signal acceptance P8	33012	2	Float	Reading Value	%	Signal acceptance Path 8
BA-76	SNR P8 AB	33014	2	Float	Reading Value	dB	Signal-Noise-Ratio AB Path 8
BA-77	SNR P8 BA	33016	2	Float	Reading Value	dB	Signal-Noise-Ratio BA Path 8
BA-78	AGC-level P8 AB	33018	2	Float	Reading Value	dB	Automatic gain AB Path 8
BA-79	AGC-level P8 BA	33020	2	Float	Reading Value	dB	Automatic gain BA Path 8

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