



# **GFA414**

## **ULTRASONIC GAS FLOW METER**

### **DATA SHEET**



**2026**

## 1 DESCRIPTION AND OPERATION

### 1.1 Application

1.1.1 GFA414 gas meters are designed to measure the flow rate and volume of natural gas and other gaseous media having a density not less than  $0.4 \text{ kg/m}^3$  in the forward and reverse directions; the meter can be used to measure the flow rate and volume of natural gas of wells at gas condensate fields with water factor of  $0 \text{ ml/m}^3$  to  $200 \text{ ml/m}^3$  and condensate content from  $0 \text{ g/m}^3$  to  $140 \text{ g/m}^3$  and to convert the volume of gas measured at process conditions to base conditions (with the integrated flow corrector). The meters comply with the requirements of OIML R137:2012 (w/ amend. 2014), EN 12405-1:2021, EN 12405-2:2012 and the EU directive 2014/32/EU (MID). For bidirectional meters for measurement of instantaneous flow rate and volume of natural gas, settings for forward and reverse flow are done by the Manufacturer.

The version with built-in corrector is equipped with pressure and temperature transducers.

The GFA414 version has 4 measurement channels.

The description, characteristics, and features related to gas volume conversion to standard conditions, energy calculation, corrector operation, pressure and temperature transducers apply only to meters with a built-in corrector.

1.1.2 The field of application of the meter is gas measurement, including custody transfer applications in the gas production industry, at gas distribution points, utilities and industrial enterprises.

1.1.3 The meter operating conditions: ambient temperature - from minus  $25^\circ\text{C}$  to  $55^\circ\text{C}$ , humidity up to 100%.

Meters can be supplied for operation at high ambient temperature from minus  $25^\circ\text{C}$  to  $70^\circ\text{C}$  under order. Also on order, the meter can be produced for an extended temperature range from minus  $40^\circ\text{C}$  to  $70^\circ\text{C}$  (meters in these temperature versions are not included in EU Directive 2014/32/EU (MID)).

1.1.4 The GFA414 gas meter is designed with types of protection "explosion-proof enclosure "d" according to EN 60079-1:2014/AC:2018-09, "intrinsically safe electrical circuit "i" according to EN 60079-11:2012 and meets the requirements of EN IEC 60079-0:2018/AC:2020-02.

The meters comply with the requirements of the EU directive 2014/34/EU (ATEX).

The explosion protection marking of the meter depending on the type of built-in modem is shown in Table 1.

Table 1 - Explosion protection marking of the meter depending on the type of built-in modem

| Version                                            | Built-in modem type | Explosion protection marking         |
|----------------------------------------------------|---------------------|--------------------------------------|
| GFA414-*-*-*-*-*X-*-*-*<br>GFA414-*-*-*-*-*D-*-*-* | Without modem       | II 2(1) G Ex db ib [ia Ga] IIC T4 Gb |
| GFA414-*-*-*-*-*N-*-*-*                            | Nb-IoT              |                                      |
| GFA414-*-*-*-*-*G-*-*-*                            | GSM/GPRS            | II 2(1) G Ex db ib [ia Ga] IIA T4 Gb |

***Warning!***

- 1) Do not use batteries other than the ones supplied / approved by Energoflow AG.***
- 2) It is forbidden to open the battery covers in a hazardous area.***

1.1.5 An example of how to specify the meter model when ordering and in the technical documentation is shown in Annex A.

## **1.2 Technical Specifications**

1.2.1 The meters are available in the following standard sizes depending on gas flow rate: G65, G100, G160, G250, G400; G650; G1000, G1600, G2500; G4000; G6500; G10000, G16000, G25000.

1.2.2 The meters are produced for maximum operating pressure 1.6; 2.5; 4.0; 6.3; 10; 16; 25 MPa.

1.2.3 The meter provides measurement of volumetric flow rate and gas flow rate with designated accuracy in the ranges of volume flow rates stated in Table 2, which correspond to gas flow velocities in the range 0.15 to 40.0 m/s.

1.2.4 The meter calculates the current volumetric flow rate as a product of the measured flow velocity and the internal cross-sectional area of the pipeline according to the formula:

$$Q = \frac{\pi D^2}{4} \cdot V \cdot 3600 \cdot Sg;$$

Q – volumetric flow rate, m<sup>3</sup>/h;

*Sg* — hydrodynamic coefficient;

V — flow velocity, m/s;

D — inner diameter of pipeline, m.

Table 2 - Normalised meter flow rates

| DN  | Meter<br>standard size | Volumetric flow rate, m <sup>3</sup> /h |                       |                       |                       | Measuring<br>ranges<br>$Q_{\min}:Q_{\max}$ |
|-----|------------------------|-----------------------------------------|-----------------------|-----------------------|-----------------------|--------------------------------------------|
|     |                        | threshold*<br>$Q_{\text{thr}}$          | minimal<br>$Q_{\min}$ | transitional<br>$Q_t$ | maximum<br>$Q_{\max}$ |                                            |
| 50  | G65                    | 0,5                                     | 1                     | 12,5                  | 100                   | 1:100                                      |
|     | G100                   |                                         |                       |                       | 160                   | 1:160                                      |
|     | G160                   |                                         |                       |                       | 250                   | 1:250                                      |
| 80  | G160                   | 1,25                                    | 2.5                   | 32,5                  | 250                   | 1:100                                      |
|     | G250                   |                                         |                       |                       | 400                   | 1:160                                      |
|     | G400                   |                                         |                       |                       | 650                   | 1:250                                      |
| 100 | G250                   | 2,0                                     | 4,0                   | 50,0                  | 400                   | 1:100                                      |
|     | G400                   |                                         |                       |                       | 650                   | 1:160                                      |
|     | G650                   |                                         |                       |                       | 1000                  | 1:250                                      |
| 150 | G400                   | 4,0                                     | 10,0                  | 125,0                 | 650                   | 1:65                                       |
|     | G650                   |                                         |                       |                       | 1000                  | 1:100                                      |
|     | G1000                  |                                         |                       |                       | 1600                  | 1:160                                      |
|     | G1600                  |                                         |                       |                       | 2500                  | 1:250                                      |
| 200 | G650                   | 5,0                                     | 16,0                  | 200,0                 | 1000                  | 1:65                                       |
|     | G1000                  |                                         |                       |                       | 1600                  | 1:100                                      |
|     | G1600                  |                                         |                       |                       | 2500                  | 1:160                                      |
|     | G2500                  |                                         |                       |                       | 4000                  | 1:250                                      |
| 250 | G1000                  | 6,25                                    | 25,0                  | 325,0                 | 1600                  | 1:65                                       |
|     | G1600                  |                                         |                       |                       | 2500                  | 1:100                                      |
|     | G2500                  |                                         |                       |                       | 4000                  | 1:160                                      |
|     | G4000                  |                                         |                       |                       | 6500                  | 1:250                                      |
| 300 | G1600                  | 10,0                                    | 40,0                  | 500,0                 | 2500                  | 1:65                                       |
|     | G2500                  |                                         |                       |                       | 4000                  | 1:100                                      |
|     | G4000                  |                                         |                       |                       | 6500                  | 1:160                                      |
|     | G6500                  |                                         |                       |                       | 10000                 | 1:250                                      |
| 400 | G2500                  | 16,0                                    | 64,0                  | 800,0                 | 4000                  | 1:65                                       |
|     | G4000                  |                                         |                       |                       | 6500                  | 1:100                                      |
|     | G6500                  |                                         |                       |                       | 10000                 | 1:160                                      |
|     | G10000                 |                                         |                       |                       | 16000                 | 1:250                                      |
| 500 | G4000                  | 25,0                                    | 100,0                 | 1250,0                | 6500                  | 1:65                                       |
|     | G6500                  |                                         |                       |                       | 10000                 | 1:100                                      |
|     | G10000                 |                                         |                       |                       | 16000                 | 1:160                                      |
|     | G16000                 |                                         |                       |                       | 25000                 | 1:250                                      |
| 600 | G6500                  | 40,0                                    | 160,0                 | 2000,0                | 10000                 | 1:65                                       |
|     | G10000                 |                                         |                       |                       | 16000                 | 1:100                                      |
|     | G16000                 |                                         |                       |                       | 25000                 | 1:160                                      |
|     | G25000                 |                                         |                       |                       | 40000                 | 1:250                                      |

*Note:* \* - factory setting of the programmable meter function that determines the lower limit of the volume flow rate at which its value is automatically set to zero, while the volume measured by the meter remains unchanged.

1.2.5 The relative accuracy of the meters is normalized in two flow ranges: from minimum  $Q_{\min}$  to transitional  $Q_t$  (inclusive) and from transitional  $Q_t$  to maximal  $Q_{\max}$ .

In the range from the threshold  $Q_{\text{thr}}$  to the minimum  $Q_{\min}$  the meter operates with an unrated accuracy.

In the range from 0 to  $Q_{\text{thr}}$ , the value of accumulated volume remains unchanged.

1.2.6 The limits of the relative accuracy of the meter when measuring the flow rate and gas volume are given in Table 3.

Table 3

| Flow rate                                | Relative accuracy of the meter, %, not more than |         |
|------------------------------------------|--------------------------------------------------|---------|
|                                          | Class 0,5*                                       | Class 1 |
| from $Q_{\min}$ (incl.) to $Q_t$         | $\pm 1$                                          | $\pm 2$ |
| from $Q_t$ (incl.) to $Q_{\max}$ (incl.) | $\pm 0,5$                                        | $\pm 1$ |

*Note: \*) Class 0.5 only for DN not less than 100 mm;*

*Failure of one or more flow channels leads to partial inoperability and in this case the meter keeps metering with an abnormal error.*

Compensation of inoperable channels in the partial inoperability mode is based on the calculation of the flow rate in the pipeline based on the measured gas velocity of the operable channels, taking into account the actual flow profile.

The flow profile is determined continuously in the meter's full-operating mode by the ratio of the average flow velocity in the pipeline to the velocity in the individual channels. In this case, the average velocity is calculated as the sum of the velocities in individual channels, taking into account their weighting coefficients.

To reduce the compensation error, the flow profile is determined by averaging the values of the last 1000 measurements separately in two speed ranges: from 0.5 m/s to 5 m/s and from 5 m/s to 32 m/s. Immediately after switching on the meter, when there are no measured values, compensation of inoperable channels is performed based on the default values determined experimentally.

Taking into account the measurement period of 1 second, compensation of inoperable channels based on the actual flow profile is possible after the meter has been in operation for at least 1000 seconds in a fully operational state at a flow rate of 0.5 m/s to 5 m/s and at least 1000 seconds in a fully operational state at a flow rate of 5 m/s to 32 m/s.

At a flow rate below 0.5 m/s, compensation is carried out according to a flow profile determined in the range of speeds from 0.5 m/s to 5 m/s, and at a flow rate above 32 m/s, according to a flow profile determined in the range of speeds from 5 m/s to 32 m/s.

*For class 0,5: limits of permissible relative accuracy in the pressure range from  $0,2P_{max}$  to  $P_{max}$  when measuring the gas volume reduced to standard conditions do not exceed:*

- in the range from  $Q_{min}$  (inclusive) to  $Q_t$   $\pm 1,25\%$ ;
- in the range from  $Q_t$  (inclusive) to  $Q_{max}$  (inclusive)  $\pm 0,75\%$ .

*For class 1: limits of permissible relative accuracy in the pressure range from  $0,2P_{max}$  to  $P_{max}$  when measuring the gas volume reduced to standard conditions do not exceed:*

- in the range from  $Q_{min}$  (inclusive) to  $Q_t$   $\pm 2,25\%$ ;
- in the range from  $Q_t$  (inclusive) to  $Q_{max}$  (inclusive)  $\pm 1,25\%$ .

*Note: Failure of one of the flow channels will result in partial inoperability and the meter will operate with an unspecified accuracy.*

Measurement repeatability is not more than  $\pm 0.1\%$ .

1.2.7 The minimum overpressure in the pipeline at which the meter achieves the required accuracy is 0 MPa.

The gas pressure drop across the meter does not exceed 200 Pa.

1.2.8 The meter has two pulse outputs, which, depending on the meter configuration, can be either one or two low frequency pulse (LF) outputs or one LF pulse, or one high frequency pulse (HF) outputs and one LF output. Output type: "dry contact".

Closed circuit resistance does not exceed 60 Ohm; open circuit resistance is at least 1 MOhm.

In the autonomous operation mode, when the meter is powered by battery only, the meter generates one LF signal proportional to the volume of gas flowing through the meter in forward and reverse directions. The low-frequency pulse output can be used to connect the meter to an external volume corrector.

When operating from an external power supply, the meter can generate up to two LF pulse signals or one LF pulse signal and one HF pulse signal with a frequency of up to 600 Hz, proportional to the volume of gas passing through the meter. The HF outputs are designed to connect the meter to an automated verification system during its verification (calibration).

Permissible configurations of frequency outputs are shown in Table 4.

Table 4 - Allowed configurations of frequency outputs

| Type of frequency-pulse signal                             | Power supply from built-in battery |                   | Power supply from external source |                   |
|------------------------------------------------------------|------------------------------------|-------------------|-----------------------------------|-------------------|
|                                                            | 1-st pulse output                  | 2-nd pulse output | 1-st pulse output                 | 2-nd pulse output |
| LF forward direction                                       | +                                  | +                 | +                                 | +                 |
| LF reverse direction                                       | -                                  | +                 | +                                 | +                 |
| LF forward direction (volume converted to base conditions) | -                                  | +                 | -                                 | +                 |
| LF reverse direction (volume converted to base conditions) | -                                  | +                 | -                                 | +                 |
| HF forward direction                                       | -                                  | -                 | +                                 | -                 |
| HF reverse direction                                       | -                                  | -                 | +                                 | -                 |

The LF and HF dry contact outputs of the meter accept a supply voltage of 5 V to 28 V and a current of up to 20 mA. The HF outputs only work when there is an external power supply to the meter.

Each pulse of the pulse output signal represents an increase of the gas volume by a fixed amount. The "Pulse Rate" values depending on the internal diameter and meter size are shown in Table 5 and 6.

Table 5 - value of "Pulse Rate" depending on internal diameter and meter size

| DN  | Pulse rate, imp./m3 |           |
|-----|---------------------|-----------|
|     | HF output           | LF output |
| 50  | 5000                | 5         |
| 80  | 2000                | 2         |
| 100 | 1000                | 1         |
| 150 | 500                 | 0,5       |
| 200 | 500                 | 0,2       |
| 250 | 200                 | 0,2       |
| 300 | 200                 | 0,1       |
| 400 | 100                 | 0,1       |
| 500 | 50                  | 0,05      |
| 600 | 50                  | 0,02      |

Table 6 - "Pulse price" values of the low-frequency output depending on the meter size and maximum pressure for standard conditions

| DN, mm/<br>P, MPa | 0,1  | 0,6   | 1     | 1,6   | 2     | 2,5   | 4      | 5      | 6,3    | 10     | 16     | 25     |
|-------------------|------|-------|-------|-------|-------|-------|--------|--------|--------|--------|--------|--------|
| 50                | 5    | 0,5   | 0,5   | 0,2   | 0,2   | 0,2   | 0,1    | 0,1    | 0,05   | 0,05   | 0,02   | 0,02   |
| 80                | 2    | 0,2   | 0,2   | 0,1   | 0,1   | 0,05  | 0,05   | 0,05   | 0,02   | 0,02   | 0,01   | 0,01   |
| 100               | 1    | 0,2   | 0,1   | 0,05  | 0,05  | 0,05  | 0,02   | 0,02   | 0,02   | 0,01   | 0,005  | 0,005  |
| 150               | 0,5  | 0,05  | 0,05  | 0,02  | 0,02  | 0,02  | 0,01   | 0,01   | 0,01   | 0,005  | 0,002  | 0,002  |
| 200               | 0,2  | 0,05  | 0,02  | 0,02  | 0,01  | 0,01  | 0,005  | 0,005  | 0,005  | 0,002  | 0,002  | 0,002  |
| 250               | 0,2  | 0,02  | 0,02  | 0,01  | 0,01  | 0,005 | 0,005  | 0,005  | 0,002  | 0,002  | 0,001  | 0,001  |
| 300               | 0,1  | 0,02  | 0,01  | 0,005 | 0,005 | 0,005 | 0,002  | 0,002  | 0,002  | 0,001  | 0,0005 | 0,0005 |
| 400               | 0,1  | 0,01  | 0,005 | 0,005 | 0,002 | 0,002 | 0,001  | 0,001  | 0,001  | 0,001  | 0,0005 | 0,0005 |
| 500               | 0,05 | 0,005 | 0,005 | 0,002 | 0,002 | 0,002 | 0,001  | 0,001  | 0,001  | 0,0005 | 0,0002 | 0,0002 |
| 600               | 0,02 | 0,005 | 0,002 | 0,002 | 0,001 | 0,001 | 0,0005 | 0,0005 | 0,0005 | 0,0002 | 0,0002 | 0,0001 |

1.2.9 The integrated volume corrector can calculate the gas compression factor using one of the following methods: NX19 mod., GERG-91 mod. or SGERG88.

1.2.10 Relative error of calculation of volume flow, volume of gas converted to base conditions and energy is within  $\pm 0,02\%$ .

1.2.11 Meter has a built-in temperature sensor with nominal static characteristic Pt100, which corresponds to class A according to IEC 60751:2022. Temperature sensor meet the requirements of clause 5.7 «Simple apparatus» («Simple devices») of EN 60079-11:2017. Absolute error of the thermal channel does not exceed  $\pm 0,1\text{ }^{\circ}\text{C}$ .

Absolute error of temperature measurement in the range from minus  $55\text{ }^{\circ}\text{C}$  to plus  $70\text{ }^{\circ}\text{C}$  does not exceed  $\pm 0,3\text{ }^{\circ}\text{C}$ .

1.2.12 The meter has a built-in pressure transducer (PT) for measuring gas pressure with intrinsic safety explosion protection type, approved in the established manner for use in hazardous areas, in accordance with the explosion protection marking and requirements of EN IEC 60079-0:2018/AC:2020-02, EN 60079-11:2012. Limiting parameters of intrinsically safe electrical circuits for connecting the pressure transducer (connector XS10 of the Insert Section harness) are given in Table 7.

Table 7 — Limiting parameters of intrinsically safe circuits for pressure transducer connection

| Parameter                   | Value (not more than) |
|-----------------------------|-----------------------|
| Output voltage, $U_0$       | 6.0 V                 |
| Output current, $I_0$       | 300 mA                |
| Output power, $P_0$         | 0.44 W                |
| External capacitance, $C_0$ | 25 $\mu\text{F}$      |
| External inductance, $L_0$  | 0.3 mH                |

The total error of pressure measurement in the range from  $0,2 P_{\max}$  to  $P_{\max}$  does not exceed  $\pm 0,1 \%$ .

1.2.13 The meter automatically creates and stores in its non-volatile memory archives showing the values of measured parameters

- hourly - for each previous hour. Depth of the archive is 1080 records (45 days);
- daily - for each preceding day. Depth of the archive is 365 records (12 months);
- periodic values of all parameters to be measured, with a configurable period of 60s (default setting is 1800s (30 min). Depth of the archive is 4320 records;
- instantaneous values of all measured parameters, with a configurable period in steps of 1s. Depth of the archive is 3000 records.

1.2.14 The meter logs all alarms.

The list of alarms is shown in Table D.7 in Annex D.

The meter logs in separate archives:

- emergencies & alarms - The depth of archive is 1000 records;
- interferences - message about changes of settings (depth of archive - 1000 records). List of meter settings is shown in table D.8 of annex D;
- security archive - a message about user authorization and logout time, change of username and password, adding and deleting users (see Table E.9 of Annex E). Depth of the archive is 600 records.

When the archive is full, the old entries are overwritten with the new ones.

1.2.15 Information exchange between meter and PC is performed via RS-485 interface.

The communication protocol is ModBus RTU.

Baud rate can be selected from 1200; 2400; 4800; 9600; 19200; 38400; 57600; 115 200 bps.

Length of communication line: for RS-485 up to 1200 m. These ports function only when external power supply is available.

1.2.16 The meter can be equipped with a GSM/GPRS modem or an LTE Nb-IoT modem to transmit data to a remote server.

GSM/GPRS modem has the following features:

- frequency range of the modem is GSM 900/1800 MHz;
- emitting power: Class 4 at 900 MHz and Class 1 at 1800 MHz;
- GPRS - class 10; SMS.

The LTE Nb-IoT modem has the following characteristics:

- modem frequency range - B1/B3/B5/B8;
- transmitting power - up to 23 dBm;

By default, the meter is configured to communicate with the server once a day.

1.2.17 Under order, the meters can be configured with additional outputs - current (4...20) mA or RS-485 - according to the meter ordering code (see Annex A).

Similarly, if ordered, meters without modems can be supplied with 2 discrete outputs NO (max. 50 mA, 24 V) according to the meter code of Annex A.

1.2.18 The meter is powered by two built-in lithium batteries. The capacity of one battery is at least 14 A\*h at 7.2 V, which provides meter's operation without battery replacement for at least 5 years (without using a modem).

The meter can be powered from an external power supply with a voltage of  $(12 \pm 3)$  V DC.

1.2.19 The degree of protection of the meter against penetration of foreign particles and water is IP 67 (according to EN/IEC 60529).

1.2.20 The meters are resistant against vibration with frequency from 10 Hz to 150 Hz and amplitude of acceleration up to 7 m/s<sup>2</sup>.

1.2.21 Level of radio emissions from the meter complies with applicable requirements of EU directive 2014/30/EU (EMC) , as well as EN IEC 61000-6-4:2019 "Electromagnetic compatibility. Part 6-4. Basic standards. Emission of interference in industrial environments".

1.2.22 Overall dimensions of EU, mm, max - 216×140×145.

Weight ( EU), kg, max - 2,0.

ISs for various nominal meter sizes are similar in design but have different dimensions (see Annex B).

1.2.23 Reliability indicators:

The average lifetime is 20 years.

Average MTBF - at least 50,000 hours.

### 1.3 Meter Components

1.3.1 Meter Components are shown in the table 8 below.

Table 8 – Meter Components

| Label                                                                                        | Name                                                                 | Q-ty.  | Note                                |
|----------------------------------------------------------------------------------------------|----------------------------------------------------------------------|--------|-------------------------------------|
| 636128.314EU-414                                                                             | <b>Gas Meter GFA414-**-**-**-**-**-**-**-**-**-**</b><br>components: | 1      | Meter selection code as per Annex A |
| B1.801.00.00.000-__                                                                          | Electronics unit                                                     | 1      | according to order specification    |
|                                                                                              | <u>In-line section</u>                                               | 1      | according to order specification    |
| B1.XXX.00.00.000                                                                             | Mounting kit                                                         | 1      | according to order specification    |
| B1.XXX.XX.00.000                                                                             | Pressure transducer                                                  | 1      | according to order specification    |
|                                                                                              | Resistive temperature transducer                                     | 1      | sleeve diameter                     |
|                                                                                              | TCPI 101 Pt100 A4                                                    |        | according to order specification    |
|                                                                                              |                                                                      |        |                                     |
|                                                                                              |                                                                      |        |                                     |
|                                                                                              |                                                                      |        |                                     |
|                                                                                              | <u>Kits</u>                                                          |        |                                     |
|                                                                                              | <u>Maintenance documentation set</u>                                 |        |                                     |
| 636128.314EU PS                                                                              | Passport                                                             | 1 pcs. |                                     |
| 636128.314EU-414 OM                                                                          | Operation manual                                                     | 1 pcs. | *                                   |
|                                                                                              |                                                                      |        |                                     |
|                                                                                              | Software                                                             |        |                                     |
|                                                                                              | software for configuration and data management                       | 1      | **for single installation only      |
|                                                                                              |                                                                      |        |                                     |
| XXX – serial number assigned to the manufacturer's classification.                           |                                                                      |        |                                     |
| * When a batch of meters is delivered to a single address, 1 copy may be enclosed per batch. |                                                                      |        |                                     |
| ** Supplied on a separate order                                                              |                                                                      |        |                                     |

## **1.4 Description and operation**

1.4.1 The meter includes the following integral units: an in-line section (IS), an electronic unit (EU) and electro-acoustic transducers (EAT).

The IS is a straight section with installed EAT, temperature transducer, pressure transducer and two batteries. The IS is manufactured with flanges at both ends or without flanges. The IS can be made of carbon steel, low-temperature carbon steel, stainless steel, aluminum alloy, etc. Standard dimensions and mounting dimensions of the IS are given in tables of Annex B.

EU is designed in a separate explosion-proof enclosure. There is a flange socket in the bottom part of the enclosure, which is fixed to the similar flange on the IS. The electrical circuits from the EAT, temperature transducer, pressure transducer and batteries are connected to the EU by means of a connector installed hermetically in the cavity of the flange spigot. The EU has internal and external earthing terminals. The flange on which the EU is mounted is equipped with a turning mechanism to allow 180° rotation of the EU. In order to simplify the operation of the display as much as possible, follow the installation procedure shown in figure C.2 of Annex C.

Four pairs of EAT s are installed in the meter. Each pair of EAT s forms a separate measuring channel, for which each EAT acts as a receiver and transmitter.

1.4.2 The installation locations of the EAT, temperature and pressure transducers, as well as battery compartments are closed with hermetic covers that protect the transducers and signal cables from environmental influences when installing the meter outdoors and from unauthorised interference with the meter operation. The appearance of meters of different modifications is shown in Figure B.1 of Appendix B.

The meter assembly diagrams are shown in Figures B.3 - B.7 of Annex B.

1.4.3 The ER34615M type batteries with current limiting module are installed inside the battery compartments, which are structurally designed as a cylindrical explosion-proof shell (sleeve), closed on both sides with blind threaded covers. The battery has intrinsically safe "ib" level output circuits, which are connected to the power supply circuits of the electronic unit by means of a connector.

1.4.4 External circuits are connected to the contacts of the terminals of the EU via certified Ex cable glands. To access the terminals it is necessary to remove the rear cover of the EU enclosure (see Figure C.3 of Annex C). The connectors have a screw arrangement for holding the conductor wire in place. Diagrams of connection of the meter to external electric circuits are shown in Annex D. It is recommended to connect external circuits with a low capacitance twisted pair type cable suitable for data transmission.

When connecting the external circuits, pin assignments marking shown on the back of the EU should be followed. The pin assignments of the external connection terminals are shown in Table 9.

Table 9 - Terminal pin assignment and their correspondence to circuit terminals

| Contact #                                                                                                                                                   | Circuit | Application                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-------------------------------------------------------------------------------------|
| X1:1                                                                                                                                                        | +U      | External power supply                                                               |
| X1:2                                                                                                                                                        | -U      |                                                                                     |
| X2:1                                                                                                                                                        | A1      | RS-485 interface                                                                    |
| X2:2                                                                                                                                                        | B1      |                                                                                     |
| X4:1                                                                                                                                                        | A2 (I+) | RS-485 interface / Current output 4-20mA**                                          |
| X4:2                                                                                                                                                        | B2 (I-) |                                                                                     |
| X5:1                                                                                                                                                        | +Fout1* | First pulse output<br>(volume of gas passed through the meter in forward direction) |
| X5:2                                                                                                                                                        | -Fout1* |                                                                                     |
| X6:1                                                                                                                                                        | +Fout2* | Second pulse output<br>(gas volume flowing through the meter in reverse direction)  |
| X6:2                                                                                                                                                        | -Fout2* |                                                                                     |
| X7                                                                                                                                                          | Dout1   | Discrete output 1                                                                   |
| X8                                                                                                                                                          | Dout2   | Discrete output 2                                                                   |
| * – by default, the pulse outputs provide low-frequency signals; depending on the configuration, the meter can generate signals, see clause 1.2.8, Table 4. |         |                                                                                     |
| ** - the type of signal is determined by the meter version                                                                                                  |         |                                                                                     |

1.4.6 The EU of the meter is based on a single-chip microcontroller (SMC), which controls the operation of the meter according to the algorithm of the operating program and values of adjustable parameters recorded in the EU when configuring the meter.

SMC generates probing pulses which are transmitted and received as acoustic beams by pairs of EATs, with each EAT of the pair, positioned at a certain angle to the gas flow direction, alternately acting as the transmitter or the receiver. SMC processes the measured signals and calculates the operation and idle times with the built-in real time clock.

When operating in the flow correction mode, the meter measures the volume of gas at standard conditions. The meter has three independent measurement channels - for measuring flow rate and volume at measurement conditions, for pressure measurement and for temperature measurement. The measured volume of the gas over a given time period is converted to volume at base conditions based on these three measured parameters.

The meter operating in corrector mode has a natural gas energy calculation function based on the gas volume during the calculation period and the higher calorific value. The higher calorific value is input manually using the provided software and is

considered as a conditionally constant parameter. The energy of natural gas is calculated by multiplying the measured gas volume converted to base conditions by the value of higher calorific value of gas.

The meter has a function to provide correction of the body geometry and Reynolds number by pressure and temperature.

SMC performs generation of archives of received information in internal independent memory, as well as provides the possibility of displaying it on LCD and transferring to external devices via serial interfaces.

1.4.7 The meter counts the time interval during which there was no acoustic signal between both EAT measuring channels ("full inoperability" state).

In case of absence of acoustic signal between at least one of the EAT measuring channels, the meter counts the time interval during which it was in the "partial inoperability" condition. In this case, the volume flow rate is determined based on the measured flow rate in the working channel.

1.4.8 A graphical LCD indicator is installed under the glass cover of the EU body, which displays current values of measured parameters, data of archives and configuration, service symbols (see section 3.5).

A control and display system, consisting of menus and different levels of screens, is used to select the information to be displayed. The screens are operated by means of a magnetic stylus that is brought close to the required magnetic sensor. See paragraph 3.5.2 for details about the magnetic sensors.

The LCD backlight is only switched on permanently when the meter is powered from an external source.

When the meter is operating on internal battery power, the display backlight is in standby (switched off mode) in order to reduce power consumption. The display is switched on when one of the magnetic sensors is activated with the magnetic stylus and will stay on for about 60 s, after which it will go out if no action is taken on the magnetic sensors during this time.

1.4.9 The processed and accumulated information can be transmitted to a PC via standard RS-485 serial interfaces or via radio, depending on the meter version.

The manufacturer provides a convenient interface PC software "GFA4x4" for communication with the meter via PC, for reading and viewing the meter's archive information on the monitor, as well as for storing it in a file on the hard drive of the PC.

1.4.10 The meter is powered by two batteries, one of which is active (main) and the other is a stand-by battery. The active and standby batteries are connected to a controller which is designed to monitor the voltage output of the batteries and, if the main battery is discharged, switches the meter's power supply to the standby battery. The date and time when the meter switches from one battery to the other is recorded in the alarm archive.

Battery discharge status is indicated by a symbol on the meter's display (see 3.5.2). Batteries can be replaced without affecting meter operation and there is no need to unseal the meter completely.

1.4.11 The meter has the following protection measures against unauthorized interference:

- control of changes in meter settings and configuration by the password system (the password system has three access levels);
- use of configuration protection switch against overwriting; setting the switch to the extreme right position blocks access to changing meter's setup and configuration parameters;
- calculation of checksum of meter firmware and the checksum of metrologically significant parameters recorded in meter memory during its configuration.

## **1.5 Explosion protection**

1.5.1 Explosion protection of meters is ensured by design and construction solutions in accordance with the type of protection "flameproof enclosure" according to EN IEC 60079-0:2018/AC:2020-02 and EN 60079-1:2014/AC:2018-09 and "intrinsically safe electrical circuit" according to EN 60079-11:2012.

1.5.2 Explosion protection of meters is ensured by the design which meets the requirements of EN IEC 60079-0:2018/AC:2020-02 "Explosion proof enclosure".

1.5.3 The intrinsic safety of electrical circuits is ensured by limiting the voltage and current in electrical circuits to intrinsically safe values, by selecting the parameters of electrical circuit diagram elements, and by design of electrical circuits in accordance with EN 60079-11:2012 and EN IEC 60079-0:2018/AC:2020-02. Values of permissible voltages and currents of input/output circuits of meters are given in tables H.1 and H.2 of annex H.

## **1.6 Marking and sealing**

1.6.1 The marking on the front panel of the meter mounted under the sight-glass contains:

- name and product identification code;
- name and trade mark of manufacturer;
- factory number and date of manufacture (year);
- temperature range of ambient air at operating conditions;
- explosion protection marking - «II 2(1)G Ex db ib [ia Ga] IIC T4 Gb» or «II 2(1)G Ex db ib [ia Ga] IIA T4 Gb»;
- enclosure protection degree according to IEC 60529 - "IP67";

1.6.2 The marking plate mounted on the battery contains:

- name and trademark of the manufacturer;
- the name of the product;
- designation "B1.801.13.00.000-01";
- output voltage " $U_o = 7.8 \text{ V}$ ";
- output current " $I_o = 311 \text{ mA}$ ";
- warning inscription "Do not charge";
- serial number and date of manufacture (year).

1.6.3 The marking plate, mounted on the IS depicts:

- product designation - "GFA";
- name and trademark of the manufacturer;
- explosion protection marking – «II 2(1)G Ex db ib [ia Ga] IIC T4 Gb» or «II 2(1)G Ex db ib [ia Ga] IIA T4 Gb»;
- Factory number and date of manufacture (year);
- enclosure protection degree according to IEC 60529 - "IP67";
- meter parameters.

1.6.4 Additionally the meter has the following markings:

- label with warning "WARNING – DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE IS PRESENT" on EU enclosure;
- the inner cover of the connection compartment bears the parameters of external circuits;
- on the cover of the IS there is an arrow of gas flow direction, which is used to orient the IS during installation;
- the covers covering the battery compartments are marked with inscriptions: "battery 1" and "battery 2".

1.6.5 The following marks and inscriptions are on the marking plate mounted on the straight runs:

- trademark and name of the manufacturer;
- product name;
- serial number and date of manufacture (year);
- the place of installation of the run: "DS" - downstream in the flow direction; "US" - after the IS;
- abbreviation "DS" (for downstream section) or "US" (for upstream section) followed by marking "x/y"m where numerator x indicates the number of section, denominator indicates the total number of sections in the straight run;
- gas flow direction arrow, showing the correct orientation of the straight section during installation.

1.6.6 Pressure transducers are marked with serial numbers according to the manufacturer's numbering system.

1.6.7 The transport marking contains:

- full or conventional name of consignee;
- name of destination;
- the full or conventional name of the consignor;

- the name of the point of departure;
- the handling marks "Fragile - Careful" and "Top";
- gross weight, kg.

#### 1.6.8 Meter sealing

The components of the meter to be sealed, and the persons performing the sealing, are shown in Table 10. The scheme of sealing against unauthorized access and the places for imprinting seals are shown in the Figures F.1 - F.4 of Annex F.

Table 10 - Meter components to be sealed and persons to performing sealing

| Item          | Sealing location                                                                                 | Person performing the sealing                                                                                                                 | Note                              |
|---------------|--------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| EU            | Special screw securing the protective bracket to the body and front cover (figure F.1)           | Authorized representative of the state metrological service or an accredited specialized laboratory (hereinafter referred to as the verifier) | After verification                |
|               |                                                                                                  | Manufacturer                                                                                                                                  | At release and after repair       |
|               | Special screw securing the protective bracket to the body and rear cover (figure F.1)            | Representative of the gas supply company                                                                                                      | After completion of commissioning |
|               | Bolts securing the rotating unit (figure F.1)                                                    | Manufacturer                                                                                                                                  | At release and after repair       |
|               | Terminal cover plate (figure F.2)                                                                | Manufacturer                                                                                                                                  | At release and after repair       |
|               |                                                                                                  | Verification company (additional seal)                                                                                                        | After verification                |
| IS            | Screws for fastening the covers of battery compartments (Figure F.1)                             | Manufacturer                                                                                                                                  | At release and after repair       |
|               |                                                                                                  | Representative of the gas supply company                                                                                                      | After battery replacement on site |
|               | Screws for fastening the covers of EAT compartments (Figure F.1)                                 | Manufacturer                                                                                                                                  | At release and after repair       |
|               | Screws for fastening protective covers (Figure F.1)                                              | Manufacturer                                                                                                                                  | At release and after repair       |
|               |                                                                                                  | Verification body                                                                                                                             | After verification                |
|               | Pressure tap point (Figure F.1)                                                                  | Representative of the gas supply company                                                                                                      | At installation site              |
|               | Screws for mounting the BE stand to the VS (for a meter without a protective cover) (Figure F.1) | Manufacturer                                                                                                                                  | At release and after repair       |
| Straight Runs | Screws securing the rotator to the IS (figure F.1)                                               | Manufacturer                                                                                                                                  | At release and after repair       |
|               | One of the rivets securing the marking plate to a special bracket                                | Manufacturer                                                                                                                                  | At release and after repair       |
|               | Bolts or studs connecting the straight pipe line to the IS (Figure F.3)                          | Representative of the gas supply company                                                                                                      | After completion of commissioning |

## 2. OPERATING LIMITATIONS

2.1.1 The meters should be operated at the conditions of environmental factors and parameters not exceeding the allowable values stated in section 1.2.

2.1.2 Ultrasonic gas meters are not susceptible to contamination because there are no moving parts.

2.1.3 In order to ensure the design metrological characteristics, straight runs in accordance with values given in Table 11 must be provided at the meter inlet. Length of straight pipeline section at the meter's outlet must not be less than 3DN.

2.1.4 In order to reduce the length of the straight pipe section in front of the meter, the latter can be supplied with a straight pipe section with an integrated flow conditioner.

2.1.5 The meter may be installed on welded pipes only if the weld seam is not spiral.

2.1.6 The pipeline shall be straight at the point where the meter is installed and the cross section of the pipeline shall not be distinctly elliptical. The pipeline shall be considered straight if its curvature does not exceed 5 degrees. The curvature of the pipeline is considered satisfactory if no deviation from straightness can be detected visually.

Table 11 - Required lengths of straight pipeline sections at the inlet of the meter to ensure its design metrological characteristics

| Name of local resistance (LR)                                                                               | The length of the straight section of the pipeline in front of the meter, not less than |                          |                           |                          |
|-------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|--------------------------|---------------------------|--------------------------|
|                                                                                                             | Class 1                                                                                 |                          | Class 0,5                 |                          |
|                                                                                                             | Without flow straightener                                                               | With flow straightener * | Without flow straightener | With flow straightener * |
| Constrictor, fully open full bore ball valve                                                                | 15 DN                                                                                   | 3 DN                     | 20 DN                     | 5 DN                     |
| Diffuser, elbow                                                                                             | 20 DN                                                                                   | 5 DN                     | 25 DN                     | 10 DN                    |
| Two or more elbows in the same plane, not fully open snap-in, filter, tee                                   | 30 DN                                                                                   | 10 DN                    | 35 DN                     | 15 DN                    |
| Two or more elbows in different planes, compressor, regulator                                               | 50 DN                                                                                   | 15 DN                    | 50 DN                     | 20 DN                    |
| * distance from the local resistance to the flange of the straight section with integrated flow conditioner |                                                                                         |                          |                           |                          |

2.1.7 The deviation of the internal diameters of the IS and adjoining pipeline sections must meet the following requirements:

- the difference of average internal diameters of cross-sections of the pipeline and IS or the straight run with built-in flow straightener shall not exceed 3% at the distance of 2DN from the flange of IS or straight run , at the same time the difference in radii at the joint of piping and IS shall not exceed 3% of the internal diameter of IS.

If the pipeline diameter does not meet this requirement, a part of the pipeline must be replaced with a pipe of appropriate diameter or a meter with a tapered transition with a taper angle not exceeding  $10^{\circ}$  (see Figure B.2 of Annex B) must be used.

2.1.8 For transition from pipeline to IS of smaller diameter it is necessary to use a constrictor and a diffuser with an expansion angle of  $5\div 20$  degrees.

2.1.9 At the place of the meter installation it shall be possible to connect the case of EU to the protective earthing line.

## Typical Ordering Code for the GFA Meters

| <b>GFA</b>                                                                                                                                                                                             | <b>4</b> | <b>1</b> | <b>4-</b> | <b>__-</b> | <b>___-</b> | <b>DN_-</b> | <b>G_-</b> | <b>_-</b> | <b>_-</b> | <b>_-</b> | <b>_-</b> | <b>_-</b> | <b>_-</b> | <b>_-</b> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|----------|-----------|------------|-------------|-------------|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Meter type                                                                                                                                                                                             |          |          |           |            |             |             |            |           |           |           |           |           |           |           |
| Channel number: <b>2</b> or <b>4</b>                                                                                                                                                                   |          |          |           |            |             |             |            |           |           |           |           |           |           |           |
| In-line section:<br><b>0, 1</b> - need for straight lines<br><b>2</b> - no need for straight lines                                                                                                     |          |          |           |            |             |             |            |           |           |           |           |           |           |           |
| Number of EAT pairs: <b>2</b> or <b>4</b>                                                                                                                                                              |          |          |           |            |             |             |            |           |           |           |           |           |           |           |
| Maximum operating pressure, MPa                                                                                                                                                                        |          |          |           |            |             |             |            |           |           |           |           |           |           |           |
| Type of calibration: <b>A</b> – air;<br><b>G</b> – natural gas;<br><b>W</b> – without calibration;                                                                                                     |          |          |           |            |             |             |            |           |           |           |           |           |           |           |
| IS nominal diameter, mm                                                                                                                                                                                |          |          |           |            |             |             |            |           |           |           |           |           |           |           |
| Meter standard size G according to Table 2                                                                                                                                                             |          |          |           |            |             |             |            |           |           |           |           |           |           |           |
| Flange type: <b>D</b> –DIN; xxxx – PN, bar;<br><b>A</b> –ANSI; xxxx – pressure;<br><b>O</b> – on order;                                                                                                |          |          |           |            |             |             |            |           |           |           |           |           |           |           |
| Ambient temperature:<br><b>S</b> – Standard (-25.. +55 °C);<br><b>H</b> – High temperature (-25 .. +70 °C);<br><b>L</b> – Низькотемпературний (-40.. +55 °C);<br><b>LH</b> – Розширений (-40.. +70 °C) |          |          |           |            |             |             |            |           |           |           |           |           |           |           |
| Availability of a modem or discrete outputs:<br><b>G</b> – GSM/GPRS<br><b>N</b> – Nb-Iot;<br><b>D</b> – two discrete outputs;<br><b>X</b> – not available;                                             |          |          |           |            |             |             |            |           |           |           |           |           |           |           |
| Additional outputs:<br><b>C</b> - current;<br><b>R</b> - RS-485;                                                                                                                                       |          |          |           |            |             |             |            |           |           |           |           |           |           |           |
| Power supply:<br><b>B</b> – autonomous power with the possibility of connecting external power source;<br><b>D</b> – external;                                                                         |          |          |           |            |             |             |            |           |           |           |           |           |           |           |
| Flow correction features:<br><b>C</b> – with integrated flow corrector (PTZ);<br><b>W</b> – without volume correction feature (without integrated pressure and temperature measurement)                |          |          |           |            |             |             |            |           |           |           |           |           |           |           |
| Flow configuration:<br><b>1</b> – only in the forward direction;<br><b>2</b> – in the forward and reverse directions;                                                                                  |          |          |           |            |             |             |            |           |           |           |           |           |           |           |