

Translated English of Chinese Standard: GB/T18604-2023

www.ChineseStandard.net → Buy True-PDF → Auto-delivery.

Sales@ChineseStandard.net

GB

NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA

ICS 75.180.30

CCS E 98

GB/T 18604-2023

Replacing GB/T 18604-2014

**Measurement of natural gas flow by gas ultrasonic flow
meters**

用气体超声流量计测量天然气流量

Issued on: May 23, 2023

Implemented on: December 01, 2023

**Issued by: State Administration for Market Regulation;
Standardization Administration of the People's Republic of China.**

Table of Contents

Foreword	4
1 Scope	7
2 Normative references	7
3 Terms and definitions	8
4 Measurement principle	12
4.1 Basic principle	12
4.2 Factors affecting measurement accuracy	12
5 Working conditions	13
5.1 Natural gas quality	13
5.2 Pressure	13
5.3 Temperature	13
5.4 Flow range and flow direction	13
5.5 Velocity distribution	14
6 Measurement performance requirements	14
6.1 General requirements	14
6.2 Measurement performance requirements for multi-acoustic-path gas ultrasonic flow meters	14
6.3 Measurement performance requirements for single-acoustic-path gas ultrasonic flow meters	16
6.4 Effect of working conditions on measurement performance	16
7 Flow meters	16
7.1 Composition and basic regulations	16
7.2 Meter body	17
7.3 Ultrasonic transducer	19
7.4 Electronic components	20
7.5 Flow computer	22
8 Installation and maintenance requirements	24
8.1 Installation influencing factors	24
8.2 Pipeline configuration	25

Measurement of natural gas flow by gas ultrasonic flow meters

1 Scope

This document specifies the measurement performance, flow meter body, installation and maintenance, field verification test requirements, as well as flow calculation method and measurement uncertainty estimation of insertion-type gas ultrasonic flow meters using transit-time difference method (hereinafter referred to as “flow meters”).

This document applies to measurement of natural gas flow in gathering and transmission equipment, gas transmission pipelines, storage facilities, gas distribution systems, user metering systems, measuring standard devices and other application places.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 2624.2 Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 2: Orifice plates

GB/T 3836.1 Explosive atmospheres - Part 1: Equipment - General requirements

GB/T 3836.2 Explosive atmospheres - Part 2: Equipment protection by flameproof enclosures “d”

GB/T 3836.4 Explosive atmospheres - Part 4: Equipment protection by intrinsic safety “i”

GB/T 4208 Degrees of protection provide by enclosure (IP code)

GB/T 11062 Natural gas - Calculation of calorific values, density, relative density and Wobbe indices from composition

GB/T 13610 Analysis of natural gas composition - Gas chromatography

GB/T 17747 (all parts) Natural gas - Calculation of compression factor

GB/T 21446 Measurement of natural gas flow by means of standard orifice meter

- f) changes in geometric dimensions over time;
- g) natural gas composition.

5 Working conditions

5.1 Natural gas quality

The natural gas composition measured by the flow meter shall be within the range specified in GB/T 17747 (all parts), and the relative density of natural gas is 0.55 ~ 0.80.

When any of the following situations occurs, the manufacturer shall be consulted on the material of the flow meter, the selection of ultrasonic transducers, and whether the flow meter measurement accuracy meets the requirements:

- a) CO₂ content exceeds 10 %;
- b) working under conditions close to the critical density of natural gas mixture;
- c) total sulfur content exceeds 460 mg/m³.

NOTE: Total sulfur content refers to the total content of all sulfur compounds including mercaptans, hydrogen sulfide, and sulfides.

5.2 Pressure

The minimum working pressure of ultrasonic transducers shall ensure that the sound pulse can propagate normally in natural gas.

5.3 Temperature

The manufacturer shall provide flow meters that meet the temperature range requirements according to the actual working conditions of the user, including specified working and ambient temperature range of flow meter body, field-installed electronic devices, and its related external equipment, cable connections and ultrasonic transducers. The working medium temperature of flow meters should be (-20 ~ 60) °C, and the working environment temperature range should be (-40 ~ 60) °C.

5.4 Flow range and flow direction

The flow measurement range of flow meters is determined by the actual flow velocity of the gas. The typical flow velocity range of the measured natural gas should be (0.3 ~ 30) m/s. The user shall verify that the measured gas flow velocity is within the flow range declared by the manufacturer, and the flow meter performance shall comply with the provisions of Clause 6.

Due to the existence of temperature gradients and non-ideal velocity distribution, ultrasonic flow meters working below the transition flow rate q_t may produce large measurement uncertainties.

Flow meters have the ability to measure in both directions, and the accuracy of the bidirectional measurement is the same. Users shall indicate whether bidirectional measurement is required so that the manufacturer can configure the signal processing unit parameters appropriately.

5.5 Velocity distribution

Under ideal conditions, the natural gas flow entering the flow meter shall be a symmetrical and fully developed turbulent velocity distribution. The upstream pipeline configuration (i.e., various upstream pipeline accessories, pressure regulating valves, and the length of the straight pipe section, etc.) will affect the gas velocity profile entering the flow meter, thereby affecting the measurement accuracy. The magnitude and positive or negative of the impact are to a certain extent related to the compensation capability of the flow meter.

6 Measurement performance requirements

6.1 General requirements

This Clause specifies a set of minimum measurement performance requirements that flow meters shall meet. Before adjusting the real flow calibration coefficient, the flow meter shall meet these performance requirements to ensure that the flow meter's own problems and defects are not covered up by the calibration coefficient adjustment.

NOTE: See Annex B for real flow calibration.

Users shall inspect the flow meter in accordance with the provisions of Clause 7 and install it in accordance with the provisions of Clause 8 to ensure that the flow meter improves the measurement accuracy on the basis of meeting the minimum performance requirements.

For each structural size of the flow meter, the manufacturer shall declare the flow limit values, namely the minimum flow $q_{\min}$, the transition flow rate q_t and the maximum flow $q_{\max}$. Regardless of whether it has been calibrated for real flow, the flow meter shall meet the measurement performance requirements of this Clause within the flow range declared by the manufacturer.

6.2 Measurement performance requirements for multi-acoustic-path gas ultrasonic flow meters

6.2.1 General

- a) a flow meter body, ultrasonic transducers and their mounting parts.
- b) a signal processing unit (SPU) that composed of electronic components and microprocessor system.

7.1.2 Basic regulations

The materials of flow meter body and all other parts, including pressure-bearing components and external electronic components, shall meet the working conditions of the flow meter and the process requirements of the metering system. If the user has special requirements, the specified installation conditions shall be met.

Before a flow meter leaves the factory, the manufacturer shall conduct factory-exit tests on it and provide the user with a factory-exit test report. The factory-exit test shall comply with the provisions of Annex C, and the documents required are shown in Annex D.

7.2 Meter body

7.2.1 Maximum working pressure

The maximum design working pressure of a flow meter shall be the minimum value of the maximum working pressure of the flow meter body, flange, ultrasonic transducer components and their mounting parts.

7.2.2 Corrosion resistance requirements

The materials of flow meters used for corrosive media such as H₂S and CO₂ shall comply with the provisions of SY/T 0599.

The external parts of flow meters shall be made of corrosion-resistant materials or protected with corrosion-resistant coatings in typical atmospheric environments of the natural gas industry.

7.2.3 Ability to adapt to the environment

The enclosure and various components of flow meters shall comply with the provisions of GB/T 4208 and shall at least meet the IP65 grade requirements.

7.2.4 Length and diameter

The manufacturer shall provide the standard length of the flow meter body under various pressure levels and diameters. In order to match the existing pipeline, the user can specify different lengths and flow meter diameters. For equal-diameter flow meters, the deviation between the inner diameter measured at any position and the average inner diameter shall be within 0.5 %. For reduced-diameter flow meters, the deviation between the inner diameter obtained in the measurement area and the average inner diameter shall be within 0.5 %.

NOTE: Ultrasonic flow meters with an inner diameter equal to the inner diameter of the flange are called “equal-diameter” flow meters, and those with an inner diameter smaller than the inner diameter of the flange are called “reduced-diameter” flow meters.

7.2.5 Ultrasonic transducer port

Natural gas may contain impurities (such as condensate or dust), so the designed ultrasonic transducer port shall reduce the possibility of liquid or solid staying on it. A valve for disassembling and assembling the ultrasonic transducer under pressure can be set according to user requirements.

7.2.6 Pressure tapping port

There shall be a pressure tapping port on the flow meter body to measure static pressure. The nominal diameter of each pressure tapping port shall be between 4 mm ~ 10 mm. When the wall thickness of the flow meter body is less than 20 mm, the nominal diameter of the pressure tapping port shall be 4 mm, and it shall be cylindrical within 2.5 times the length of the nominal diameter of the pressure tapping port from the inner wall of the flow meter body, and the axis of the pressure tapping port shall be perpendicular to the axis of the measuring pipe. The edge of the pressure tapping port on the inner wall of the flow meter body shall be right angles and free of burrs and curling.

Each pressure tapping port shall have an internal thread and a rotation space for installing an isolation valve. The specification of the internal thread should be 1/4"FNPT (FNPT is a 60° cone pipe internal thread) or 1/2"FNPT. The pressure tapping port shall be located on the top, left or right side of the flow meter body. The pressure tapping port of reduced-diameter flow meters shall be located at the reduced diameter part, and the connecting pipe of the pressure tapping port shall be marked with “ P_m ”.

If necessary, additional pressure tapping ports can be added to provide users with flexibility in installing pressure transmitters, and facilitate maintenance and discharge of condensate in the pressure transmitter pressure pipe back into the flow meter body. When there are multiple “ P_m ” pressure tapping ports, the difference in pressure readings at each pressure tapping port shall not exceed 100 Pa at the maximum flow.

7.2.7 Flow meter marking

The flow meter nameplate shall contain the following:

- a) manufacturer name, model, serial number and year of manufacture of the flow meter;
- b) nominal pressure and total mass;
- c) nominal diameter and inner diameter;
- d) maximum and minimum storage temperature;

The manufacturer shall specify the pressure drop and pressure increase rate of flow meters during installation, startup, maintenance and operation. The pressure drop rate of flow meters shall not exceed 0.5 MPa/min.

7.3.3 Replacement, removal and reinstallation

When replacing, removing or reinstalling an ultrasonic transducer, the performance of the flow meter shall not be changed. That is, after replacing the ultrasonic transducer and adjusting the signal processing unit software constants accordingly, the measurement performance of the flow meter shall still meet the requirements of Clause 6. The manufacturer shall specify the working procedures for replacing the ultrasonic transducer and the mechanical, electrical and other tests and adjustments required.

7.3.4 Testing

The manufacturer shall test each or each pair of ultrasonic transducers, and the test results shall be recorded and preserved in the form of documents as part of the ultrasonic flow meter quality assurance system. Each ultrasonic transducer shall be marked with a permanent serial number and the manufacturer shall provide the technical parameters required by 7.3.1. When the signal processing unit requires special ultrasonic transducer characteristic parameters, the test documents of each or each pair of ultrasonic transducers shall be provided, including special calibration test data, calibration methods used and characteristic parameters.

7.4 Electronic components

7.4.1 General

The manufacturer shall provide a unique identification for signal processing units (SPU). The test of electronic components shall comply with the provisions of JJG 1030.

Remote units such as power supply parts and working interfaces installed in non-explosion hazardous areas shall be connected to the signal processing unit with shielded cables.

The signal processing unit shall operate within the range of flow meter measurement performance requirements specified in Clause 6 and under the environmental conditions specified in Clause 5, and when the entire signal processing unit or part of the module is replaced, it will not cause a significant change in the flow meter measurement performance (see 7.3.3).

The signal processing unit shall have a monitoring timing function to ensure that the signal processing unit is restarted in the event of a program failure lock.

The power supply of flow meters should be 50 Hz, 220 V AC power supply or (12 ~ 24) V DC power supply or battery.

7.4.2 Technical requirements for output signals

The signal processing unit shall have at least the following output signals:

- a) frequency signal representing the volume flow under working conditions;
- b) serial communication data interface, such as RS-232, RS-485 or equivalent interface.

The flow meter shall also have a (4 ~ 20) mA analog signal for the volume flow under working conditions. The flow signal shall be adjustable to 120 % of the maximum flow.

The flow meter shall also have a small flow cut-off function, that is, when the flow is lower than a certain minimum value, its output is set to 0 (but not applicable to serial communication data output).

When the maximum flow of the flow meter is exceeded, the manufacturer shall provide the user with selectable flow outputs, which can be zero, maximum flow or the flow determined by the user.

For bidirectional flow applications, it shall provide two independent flow outputs and one flow direction status output and serial communication data value, and the corresponding flow computer and flow direction status output signal will perform cumulative calculation of flow, respectively.

All output signals shall be isolated from the ground and have overvoltage protection.

7.4.3 Electrical safety requirements

All electronic components of flow meters shall be analyzed, tested and verified by a competent laboratory, and then labeled on each flow meter. The explosion-proof level of electrical equipment and instruments of flow meters shall comply with the provisions of GB/T 3836.1, the flameproof electrical equipment and instruments shall comply with the provisions of GB/T 3836.2, the intrinsically safe circuits and electrical equipment shall comply with the provisions of GB/T 3836.4, and other explosion-proof electrical equipment shall also comply with the provisions of the corresponding standards. Users can specify the explosion-proof level that the flow meter shall meet to meet safer installation requirements.

Cable sheaths, rubber, plastics and other exposed parts shall be flame retardant and resistant to ultraviolet light, water and oil.

7.4.4 Component replacement

After replacing or reinstalling the ultrasonic transducer, cable, electronic components and software, the manufacturer shall provide the user with a set of working procedures and data to ensure that after any component is replaced or reinstalled, the measurement performance of the flow meter can still meet the requirements of Clause 6, and the function after replacement is not less than the function before replacement.

- i) signal quality.

The manufacturer may use part of embedded software of flow meters to achieve the above functions.

7.5.3 Inspection and verification functions

For inspection and verification purposes, all flow calculation constants and parameters shall be checked and confirmed on the flow computer when the flow meter is operating.

The inspection or verification personnel can view and print the flow measurement configuration parameters of the signal processing unit.

Parameters that affect the performance of flow meters shall be protected, including lead-sealed switches or jumpers, hardened programmable read-only memory chips, or passwords set in the signal processing unit. The verification personnel shall be able to verify all algorithms, constants, and configuration parameters used by any specific flow meter to ensure that the flow meter meets or exceeds the performance of the original flow meter during the actual flow test, or meets or exceeds the performance of the specific flow meter after the most recent flow calibration and changes its calibration coefficient.

The user shall establish basic information for the flow meter and save the relationship between the acoustic path propagation time, acoustic path automatic gain control, speed of sound along each acoustic path, average speed of sound, mean axial fluid velocity, and uncorrected volume during the process of factory-exit test, actual flow calibration, and initial installation of the flow meter to determine whether the flow meter is working properly under different conditions and whether the flow meter needs to be calibrated after replacing electronic components or hardware.

7.5.4 Alarms

The flow meter shall provide the following alarm status outputs in the form of fail-safe relay contacts or passive contacts isolated from ground:

- a) output failure: when the indicated flow is invalid under pipeline transportation conditions;
- b) fault state: when any of several monitoring parameters exceeds the normal operating range within a set time period;
- c) partial failure: when one or more of the multiple acoustic paths cannot be used.

7.5.5 Diagnostic measurements

The manufacturer shall provide at least the following diagnostic measurement data through RS-232, RS-485 or equivalent serial communication ports:

The inner surface roughness (R_a) of the upstream and downstream straight pipe sections adjacent to the flow meter should not be greater than $3.2\ \mu\text{m}$.

8.2.5 Temperature measuring hole and sampling hole

When the flow meter is only used for unidirectional flow measurement, the temperature measuring hole and sampling hole shall be set between $(2 \sim 5)D$ from the flange end face of the flow meter downstream; when the flow meter is used for bidirectional flow measurement, the temperature measuring hole and sampling hole shall be set between $(3 \sim 5)D$ from the flange end face of the flow meter. Multiple temperature measuring holes shall not be arranged in a straight line. The manufacturer or supplier shall provide the user with the best temperature measuring hole position related to the flow meter acoustic path layout.

The manufacturer shall provide the installation orientation of the temperature measuring hole relative to the acoustic path. The axis of the temperature measuring hole should be perpendicular to the axis of the pipeline. The installation of the temperature measuring hole shall ensure that the heat transfer of the pipeline, the auxiliary components of the temperature measuring sleeve and the solar heat radiation do not affect the measurement of gas temperature. The insertion depth of the thermometer sleeve and the sampling probe should be $1/3D$. For large-diameter flow meters of DN 300 (DN is the nominal diameter of the pipeline) and above, the insertion depth shall not exceed 125 mm. When the insertion depth is greater than $1/3D$, the thermometer sleeve needs special design, and the resonance of the temperature measuring sleeve caused by high-speed airflow shall be avoided.

When the difference between the ambient temperature and the gas temperature is large, an insulation layer should be installed $1D$ downstream of the farthest temperature measuring hole on the upstream pipeline of the flow meter to the downstream pipeline, and a sunshade shall be installed on the flow meter or other measures shall be taken to prevent the ambient temperature from affecting the metering performance of the flow meter.

8.2.6 Flow conditioner

Ultrasonic flow meters should be installed with plate-type flow conditioners, which shall comply with the provisions of flow conditioners in GB/T 2624.2. The performance verification test is shown in Annex F.

NOTE: Whether to install a flow conditioner and what type of flow conditioner to install mainly depends on two factors: the type of flow meter selected (mono-acoustic-path or multi-acoustic-path) and the severity of the interference to the upstream velocity profile of the flow meter.

8.2.7 Flow meter installation orientation

Flow meters shall be installed horizontally, and other installation methods shall be consulted with the manufacturer. During design and installation, maintenance space shall be left.

8.2.8 Series metering

When series metering is used, the flow meters shall come from different manufacturers or have different acoustic path configurations. The distance between the two flow meters should not be less than $15D$, and ensure that the transducer port and transducer acoustic wave excitation of each flow meter will not interfere with the flow stability and signal detection of the adjacent flow meter. Each flow meter shall be equipped with pressure, temperature measurement equipment and data acquisition channels, and the measurement performance shall meet the requirements of Clause 6. Metering package for serial metering should be verified or calibrated together.

8.2.9 Gas filtration

In situations where the gas is dirty, a gas filter with good effect can be installed upstream of the flow meter. The structure and size of the filter shall ensure the smallest possible pressure loss and flow state change at the maximum flow. During use, the differential pressure of the filter shall be monitored, and the dirt shall be discharged and cleaned regularly to ensure that the filter works in good condition.

8.3 Maintenance

8.3.1 Daily maintenance

The manufacturer shall be responsible for training the on-site staff on basic operation and maintenance skills. Daily maintenance mainly involves targeted inspection and maintenance based on the information fed back by the ultrasonic flow meter's self-diagnosis system to ensure the on-site measurement performance of the flow meter. For relevant technical requirements, see Annex G.

8.3.2 Regular inspection

The inspection frequency shall be determined according to the manufacturer's recommended cycle or at least once a year. The inspection content includes whether the signal processing unit and timing system are working properly, whether the acoustic path has any faults, whether the zero-flow measurement is accurate, whether there is any sediment on the surface of the ultrasonic transducer, and whether the signal gain has a significant change. And according to the actual situation, check whether there is any sediment in the adjacent pipeline, and drain or clean it according to the inspection situation.

NOTE: Under normal gas transmission working conditions, the attachments in the flow meter body (such as condensate or oil residues with processing impurities, dust and sand, etc.) will reduce the

This is an excerpt of the PDF (Some pages are marked off intentionally)

Full-copy PDF can be purchased from 1 of 2 websites:

1. <https://www.ChineseStandard.us>

- SEARCH the standard ID, such as GB 4943.1-2022.
- Select your country (currency), for example: USA (USD); Germany (Euro).
- Full-copy of PDF (text-editable, true-PDF) can be downloaded in 9 seconds.
- Tax invoice can be downloaded in 9 seconds.
- Receiving emails in 9 seconds (with download links).

2. <https://www.ChineseStandard.net>

- SEARCH the standard ID, such as GB 4943.1-2022.
- Add to cart. Only accept USD (other currencies - <https://www.ChineseStandard.us>).
- Full-copy of PDF (text-editable, true-PDF) can be downloaded in 9 seconds.
- Receiving emails in 9 seconds (with PDFs attached, invoice and download links).

Translated by: Field Test Asia Pte. Ltd. (Incorporated & taxed in Singapore. Tax ID: 201302277C)

About Us (Goodwill, Policies, Fair Trading...): <https://www.chinesestandard.net/AboutUs.aspx>

Contact: Wayne Zheng, Sales@ChineseStandard.net

Linkin: <https://www.linkedin.com/in/waynezhengwenrui/>

----- The End -----