FEDERAL AGENCY ON TECHNICAL REGULATION AND METROLOGY

CERTIFICATE

for pattern approval

RU.C.29.592.A No. 56845/1

Validity term to September 25, 2019

TYPE OF MEASURING INSTRUMENT
ULTRAMAG gas metering systems

MANUFACTURED BY
Engels Instrument Manufacturing Association Signal Limited Liability Company (Signal LLC); Engels-19, Saratov Region

SERIAL NUMBER **58524-14**

DOCUMENT FOR VERIFICATION
СЯМИ.407229 - 671 МП with amendment No. 1

VERIFICATION TESTING INTERVAL **4 years**

Certificate for pattern approval has been redrafted by order **No. 963** of the Federal Agency on Technical Regulation and Metrology dd. **May 10, 2017**

Description of the measuring instrument type is a normative annex hereto.

Deputy Head
of the Federal Agency S.S.Golubev

"19" 05 2017.

Official seal: FEDERAL AGENCY ON TECHNICAL REGULATION AND METROLOGY* OGRN 1047706034232

Series СИ **No. 029356**

DESCRIPTION OF THE MEASURING INSTRUMENT TYPE
(revised and approved by order No. 963 of the Federal Agency on Technical Regulation and Metrology dd. May 10, 2017)

ULTRAMAG gas metering system

Application

ULTRAMAG gas metering systems are designed to measure the operating volume of natural gas according to GOST 5542-2014, free oil gas according to GOST P 8.615-2000, other gases and to convert the measured volume automatically to standard conditions, depending on the pressure, temperature and gas compressibility factor.

Description of the measuring instrument

The principle of functioning of the system is based on measurement of the gas operating volume by ultrasonic flow transducer, operating gas pressure and temperature by pressure and temperature transducers and calculation made upon measured gas volume converted to standard conditions.

The system provides for calculation methods for compressibility factor of:

- natural gas according to GOST 30319.2-2015, GOST 30319.3-2015, AGA-8 (international standard ISO 20765-1:2005);
- free oil gas, nitrogen, air, carbonic acid gas, inert gases using the national standard reference data service.

The system includes the following:

- measuring and computing complex (MCC) with a casing, microprocessor, communication module, optical port, screen, keyboard and independent power supply;
- ultrasound transducer of operating flow rate (USTF);
- integrated transducer of the absolute (negative) pressure (TP);
- integrated transducer for gas temperature (TT).

Measuring and computing unit is a microcomputer constructed on the basis of modern microprocessor technology enabling performing of high-precision measurement of the required parameters, compute, store and output information to the external devices. The MCU case has inside a board of the standard flow computer, RPMU board and independent power source.

An indicator is used as a screen providing a possibility for a user to display information in the form which is available to him/her. T

The keyboard controls indicator functioning, monitor information and program a system.

Communication with the system and its programming can be provided using «ULTRAMAG.exe» service software included in the supplied package of system

The system is powered by:

- independent built-in battery-type power supply of max. 3,9 V voltage. Open-circuit voltage and short-circuit current shall no exceed 3,9 V and 0,18 A;
- external power supply (input ~ 220 V; 50 Hz, output = 6 B ±2 %, 220 mA).

The ultrasonic pulse method of gas flow measuring is integrated in the system. A principle of functioning of the USTF is based on measuring time difference of ultrasonic vibrations transfer towards and back (against gas flow). The ultrasonic vibrations are generated and received by the electroacoustic transducer (EAT). Time of spreading ultrasonic vibrations depends on the velocity of ultrasound in gas and gas flow rate. The electric signals received from EAT are processed by microprocessor and operating volume is calculated. The standard volume is determined upon the calculated operating volume and measured values of pressure and temperature.

A number of the absolute (gage) pressure transducers is used in the system ranging from 0,08 to 1,6 (from 0 to 1,6) MPa. Maximum pressure working range is 1:11. The transducers are integrated into the general electric circuit, powered from the general diagram. They may be built-in the MCC casing or remote-mount. Circuital current of pressure transducers is 300-320 μA, voltage - 1,2-1,5 V, output - 10 mV.

Resistance temperature detectors are used as gas temperature transducers according to GOST 6651-2009. The temperature transducers may be built-in the MCC casing or remote-mount. Circuital current of temperature transducers is 300-345 μA, voltage 0,04 V, output - 10 mV.

Exchange of system with the peripherals is made via RS-232 and RS-485 interfaces and optical interface. The rate of information transfer via interface RS-232 and optical interface 2400 baud (by default) and 19200 baud (by command). MODBUS-RTU protocol is used for exchange. A peripheral exchange (PC, printer, modem, monitoring system) is carried out without connectors switching.

A low-frequency output terminal (max. 100 Hz frequency) is provided for the system to connect the frequency-meter during verification of operating volume measuring channel.

The system creates the archives of the hour, daily, monthly settings for gas metering, as well as the archives of abnormal situations, modifications, etc. The depth of the hour archive is 20 months max., the depth of the daily archive is 60 months max., the depth of the monthly archive is 2000 months max., the depth of the archives of abnormal situations and changes is 4000 and 2000 records accordingly.

The systems are coupled and flanged.

Reverse design (according to the gas flow direction) of the system is provided.

The systems have 3 options of design based on measurement accuracy of the operating flow rate and the following modifications based on the upper range limit of the operating flow rate measurement: G10, G16, G25, G40, G65, G100, G 160, G250.

Figure 1 – ULTRAMAG general drawing

The system design restricts an access to some of its parts to avoid unauthorized settings and tempering of the instrument which can result in measurements distortion.

At the pup joints of the System casing (in case of the threaded connection of the System with the pipeline) 2 seals are installed in order to prevent the access to the fluid passage of the System. MCC cover (2 seals and 2 seal screws for sealing of system under operation) is sealed, 2 seals are installed to block the access to the computer boards and USTF. The seals are installed on the programming switch (1 seal) and programming adapter (1 seal).

All interferences of the unit and modifications made are recorded in the archives of abnormal situations and modifications indicating time and date. Control sum of the verification factors of pressure - and temperature – sensing passages is recorded in the system datasheet when the primary verification has been conducted.

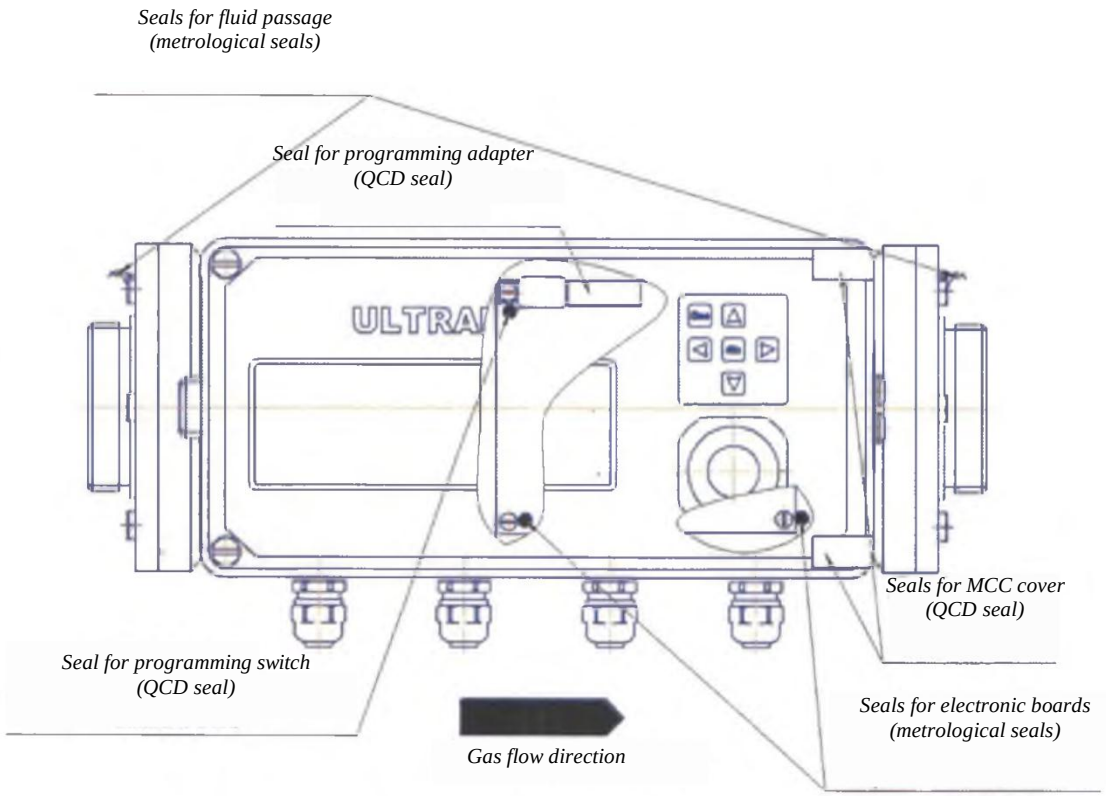

Figure 2 – System sealing circuit

Software

A software is embedded. Conversion of the measured values and processing of measurements is carried out using internal hardware and software. ULTRAMAG software is stored in the volatile memory.

The software of the ULTRAMAG systems is divided into the following parts:

- of metrological significance;
- of metrological non-significance;

The software is divided inside a software code at the programming language. The part of metrological significance includes the following:

- software modules involved in processing (estimation) of measurement results or effecting them;
- software modules displaying the measurement data, their storage, software and data security;
- software settings involved in calculation and affecting measurement results;
- components of the secured interface for data exchange between ULTRAMAG and peripherals

The identification data of the part of metrological significance of the system software are specified in the Table 1

Table 1

Identification data (characteristics)	Value
Identification software name	СЯМИ.00047-01 12 01
Software version number (ID)	B.0.0.2.5
Software digital certificate (DC)	2CC4
Algorithm for DC calculation	CRC-16

Protection level of the part of metrological significance of software for ULTRAMAG gas metering systems from the intended changes is "high" according to P 50.2.077-2014.

Metrological and technical specifications are listed in the Tables 2 and 3

Table 2 – Metrological characteristics

Parameter	Value
The relative accuracy limits of operating volume sensing passage at the ambient temperature ranging from minus 40°C to plus 60°C, % - option 1	
within flow range from $Q_{min.}$ to 0,05$Q_{max.}$	±1,7
within flow range from 0,05$Q_{max.}$ to $Q_{max.}$	±0,75
- option 2	
within flow range from $Q_{min.}$ to 0,05 $Q_{max.}$	±2
within flow range from 0,05$Q_{max.}$ to $Q_{max.}$	±1
- option 3	
within flow range from $Q_{min.}$ to 0,05 $Q_{max.}$	±1,2
within flow range from 0,05$Q_{max.}$ to $Q_{max.}$	±0,75
The relative accuracy limits of the pressure sensing passage in the operational range of pressure measurement and at the ambient temperature ranging from minus 40°C to plus 60°C. %	±0,4
The relative accuracy limits of gas temperature sensing passage at ambient temperature ranging from minus 40°C to plus 60°C, %	±0,1
The relative accuracy limits of the correction factor, %	±0,5
The relative accuracy limits for gas volume calculations converted to the standard conditions, %	±0,05
The relative accuracy limits of gas operating volume standardization according to GOST 2939 within pressure and ambient temperature operating range from minus 40°C to plus 60°C, % - option 1	
within flow range from $Q_{min.}$ to 0,05$Q_{max.}$	±2
within flow range from 0,05$Q_{max.}$ до $Q_{max.}$	±1
- option 2	
within flow range from $Q_{min.}$ to 0,05$Q_{max.}$	±2,3
within flow range from 0,05$Q_{max.}$ to $Q_{max.}$	±1,3
- option 3	
within flow range from $Q_{min.}$ to 0,05$Q_{max.}$	±1,5
within flow range from 0,05$Q_{max.}$ to $Q_{max.}$	±1

Table 3 – Basic technical specifications

Parameter	Value for standard size							
Modification	G10	G16	G25	G40	G65	G100	G160	G250
Measured medium	Natural gas according to GOST 5542-2014 free oil gas according to GOST P 8.615-2005, nitrogen, air and other gases							
Nominal diameter, DN, mm	32 40	40 50	50	50	50	80	80	100	100	100
Maximum flow rate, Q_{max}, m^3/hr	16	25	40	65	100		160		250	400
Measuring range $Q_{max.}$:$Q_{min.}$	1:100 / 1:160 / 1:200							
Process temperature, °C	from -20 to +60							
Threshold, m^3/hr, max.	0,33 $Q_{min.}$							
Operating gage pressure, MPa, max.	1,6							
Pressure losses, Pa,, max.: measuring range 1:160/1:200 measuring 1:100(1:20)	720 320							
Overall dimensions, mm, max.: length, width, height	320 150 225					380 195 255	380 215 275	
Weight, kg, max.	17					21	25	
The values of the pulse of the output signal of operating volume sensing passage:, m^3	0,01				0,1			
Display unit capacity: a) by operating volume measuring, m^3 b) by standard volume measuring, m^3	999999999.99 999999999.99							
Pipe straight length, DN - at system input - at system output	5DN 3DN							
Environmental protection according to GOST 14254-96	IP 66							
Average life, years, at least	12							
MTBF, hr, at least	60000							
Operating conditions. - ambient temperature, °C - relative air humidity, % at 35 °C, max. - air pressure, kPa	from -40 to +60 95 from 84 to 106,7							

Pattern approval mark is placed on the control panel by flat photoprinting and on the front pages of the Operational Manual and certificate

Completeness of measuring instrument

Delivery in complete sets is shown in the Table 4.

Table 4

Item	Marking	Quantity	Note
ULTRAMAG gas metering system	СЯМИ.407229- 671 СП	1	
Operational Manual	СЯМИ.407229- 671 РЭ	1	
Datasheet	СЯМИ.407229- 671 ПС	1	
Verification methods	СЯМИ.407229- 671 МП	1	
"ULTRAMAG.exe" service software (CD-R disc) Operator Manual	СЯМИ. 00048-01 12 01 СЯМИ. 00049-01 34 01	1 1	
RS-232 wire harness for exchange with PC	623-СБ15 СП	1	
Optical head	623-СБ7 СП	1	on order
Wire harness for modem connection	623-СБ11 СП	1	on order
Wire harness for printer connection	623-СБ16 СП	1	on order
Straight piping set	СЯМИ.407229-671 Д1 СП	1	on order

Verification

is carried out according to СЯМИ.407229-671 МП "Instruction. National Measurement Assurance System. ULTRAMAG gas metering systems" with amendment 1 , approved by State Center for Testing Measuring Instruments of Federal State Unitary Enterprise VNIIR dated 09.12.2016.

Basic verification instruments:

- verification unit for gas meters – industrial standard, I class according to GOST P 8.618-2014, flow range from 0,01 to 2500 m^3/hr, relative accuracy limits ±0,25%; ±0,33%;
- pressure gauge PMG (registration No. 1844-15), measuring range from 0 to 2,5 MPa, accuracy class 1,5;
- psychometric hygrometer, ВИТ-1, ВИТ-2 (registration No. 42453-09), measuring range of relative humidity from 20 to 90 %, temperature measuring range from 15 to 40 °C, temperature error ±2 °C, humidity error ±5 %;
- aneroid barometer M 67 (registration No. 3744-73), measuring range from 81130 to 105320 Pa, error ±106 Pa;
- stop clock СОС пр-2б-2 (registration No. 11519-11), measuring range from 0 to 3600 s, accuracy class 2;
- frequency counter Ч3-64 (registration No. 9135-83), relative accuracy limits as per reference-frequency generator $\pm 1{,}5 \cdot 10^{-7}$;
- digital pressure gauge DPI 145 (registration No. 16348-05), measuring range from 0 to 3,5 MPa, relative accuracy limits ±0,025%;
- "Термотест-100" liquid thermostat (registration No. 25777-03), temperature control range from minus 30 to plus 100 °C, set temperature non-uniformity ±0,01 °C, temperature field nonuniformity in thermostat working volume ±0,01 °C.

Similar verification instruments enabling determination of metrological characteristics of the measuring instruments to be calibrated with the required accuracy are acceptable.

Verification mark is placed in the certificate of verification and/or datasheet

Measurement methods

GOST 8.611-2013 National Measurement Assurance System. Gas flow rate and volume. Method of measuring with ultrasonic flow transducers.

Regulatory and technical documents specifying the requirements to the ULTRAMAG gas metering systems

GOST P 8.618-2014 National Measurement Assurance System. State verification schedule for volume and mass flow rate of the measuring instruments

СЯМИ. 407229 - 671 ТУ. ULTRAMAG gas metering systems. Specifications.

TP CU 012/2011 On Safety of Equipment Intended for Use in Explosive Atmospheres

GOST 30319.2-2015 Natural gas. Methods of physical properties calculation. Calculation of physical properties based upon density, nitrogen and carbon dioxide content

GOST 30319.3-2015 Natural gas. Methods of physical properties calculation. Calculation of physical properties based upon composition.

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Accreditation certificate FSUI VNIIR for testing of measurement instruments for Pattern Approval No. RA.RU. 310592 dated 24.02.2015.

Deputy Head of
the Federal Agency
on Technical Regulation
and Metrology

S.S.Golubev

«19» 05 2017

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