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Operation Manual

Ultrasonic gas meter

EcoSonic X12

Document	Changes	Approved	Date
UZ_01_00_BA002_28_01	Information regarding electronics without integrated NAMUR and Ex-i support also listed. (Editorial changes screendump updated for English GUI UZ_01_00_BA002_28_01 en) 01/2021		02/2020
UZ_01_00_BA002_27_01	Electronics: NAMUR E x-i/Ex-e digital outputs; metering unit size DN 600; bidirectional sampling; OIML 0.5		09/2019
UZ_01_00_BA002_26_04	Minor corrections to tables in Sections 16/17		11/2018
UZ_01_00_BA002_26_03	Corrections of descriptions for encoder		11/2018
UZ_01_00_BA002_26_02	Correction: ATEX labelling;		09/2018
UZ_01_00_BA002_26_01	Metering unit size DN 500, connector box for detached Eco-Touch in accordance with MID; EVC switchable.		08/2018
UZ_01_00_BA002_25_01	New layout, expanded ATEX temperature range of -40 °C to +65 °C, connector box, EcoTouch heating		08/2017
UZ_01_00_BA002_24_02	Internal document references updated		05/2017
UZ_01_00_BA002_24_01	0.8 to 101 bar sensor for USM (submitted to PTB)		03/2017
… …			

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1. General information

This operating manual describes the EcoSonic X12, a range of ultrasonic gas meters for the sampling of gas flowing through pipelines. The EcoSonic X12 features metering units of varying pipe diameters and varying pressure stages.

The EcoSonic X12 has a modular design. This document describes the use of the device as a gas meter. (Depending on the specific customer requirements, additional functions can be activated: volume corrector, measured data archive, adapted Modbus configuration etc.)

The EcoSonic X12 is put on the market in a calibrated state and complies with the Measuring Instruments Directive, and makes it possible to use the progress of the operating volume meter V_m for the further determination and calculation[1] *of the gas volume.*

The measured values, the current settings and the status of the device can be read off directly from the integrated EcoTouch operating and display unit. The interfaces and protocols that are customary within this sector have been implemented for the further processing of this data.

1.1 Risk of explosion — fuel gases under pressure

The metering unit is typically used for the metering of natural gas in pipelines. It is therefore essential that all persons who work with the unit or who are in the vicinity of a metering system are aware of the risks and comply with the applicable safety regulations.

1.1.1 ATEX classification and protection class

The EcoSonic X12 ultrasonic gas meter can be used in potentially explosive areas in zone 1 in accordance with ATEX

⟨Ex⟩ II 2 (2) G Ex db eb ib[ib] mb II B T4 Gb.

The registration number is TÜV 09 ATEX 554348 X. EcoSonic X12 is in the protection class IP 65.

[1] Sampling in accordance with the EU Measuring Instruments Directive (MID) for the calculation of gas volumes is regulated by law. National regulations and legislation may also apply – in particular in relation to the period after the metering unit is brought onto the market.

1.2 Documentation relating to the EcoSonic X12 ultrasonic gas meter

The operating manual contains information on:

- Safety
- Technical specifications
- Structure and function of the metering system
- Installation and initial operation
- Measurement method
- Maintenance
- Certification for custody transfer measurements, re-certification for custody transfer measurements, functional testing

If you have any questions or if anything is unclear, the responsible RMA representative will be able to provide you with additional information and support.

1.3 Data plate

The data plates provide up-to-date data for the individual metering unit. In the event of any deviations from the information in the documentation, the information on the affixed data plates takes priority.

The various data plates on the EcoSonic X12 are detailed below.

1.3.1 Main data plate

The main data plate is affixed to the housing of the USM electronics. It contains technical information and safety instructions relating to the specific unit. Some of this information can only be reliably obtained from on the main data plate. On delivery of the EcoSonic X12, particular attention should be paid to

- The ATEX classification
- The weight of the gas meter

The ATEX classification indicates the areas where the metering unit can be used. The weight specification means that suitable lifting equipment and a suitable installation site can be selected from the outset, before the metering unit is installed or connected. The additional safety instructions in this operating manual and the safety instructions for the metering point must be observed without fail when installing and connecting the EcoSonic X12.

The EcoSonic X12 for the metering of natural gas is designed and produced in compliance with the pressure equipment regulations and ATEX requirements. Different versions that comply with ATEX requirements and the Pressure Equipment Directive are available for ambient temperatures of −25 °C to 55 °C and for −40 °C to +60 °C.

For units that are also produced and calibrated in compliance with the EU Measuring Instruments Directive (MID), the permissible ambient temperature is −25 ° to 55 °C.

Serial numbers, the year of construction, the pressure and temperature information and the flow volume information are indicated by the placeholder “x” on the following data plates.

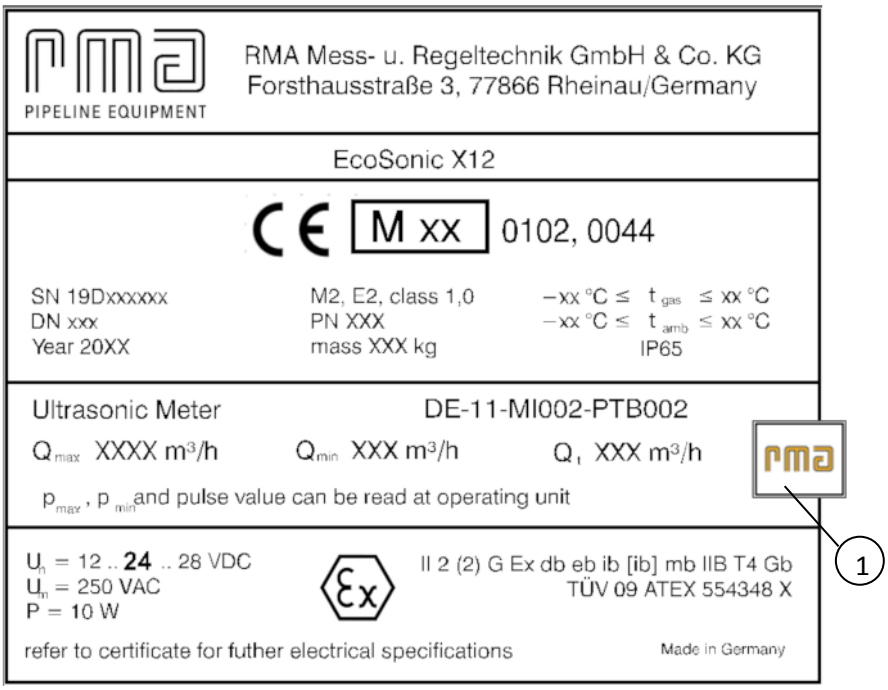


Fig. 1 Main data plate with adhesive label of the manufacturer (1)

Fig. 2 Additional plate: Metering unit in accuracy class 0.5 in accordance with OIML R137

The additional plate is attached if calibration at the manufacturer’s premises and the intended installation meet the prerequisite conditions for sampling in accuracy class 0.5 in accordance with OIML R 137.

There are also additional data plates and metrological protections for custody transfer measurements (e.g. seals, adhesive labels (1), see Fig. 1 on the data plate and housing of the EcoSonic X12).
Additional data plates and calibration safeguards are affixed to the EcoTouch operating unit. In the metering unit version with a detached operating unit, the unique serial number for the overall unit is also noted on the EcoTouch operating unit. This means that the EcoTouch display can be unequivocally assigned to the relevant gas meter.

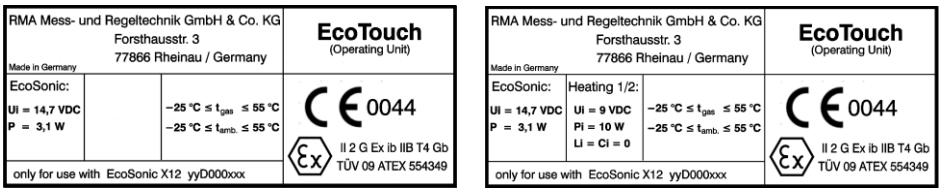


Fig. 3 Data plate on the EcoTouch

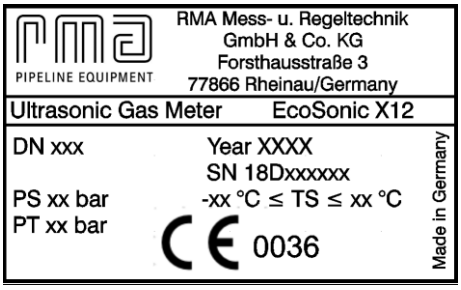


Fig. 4 Pressure Equipment Directive data plate - on the meter housing

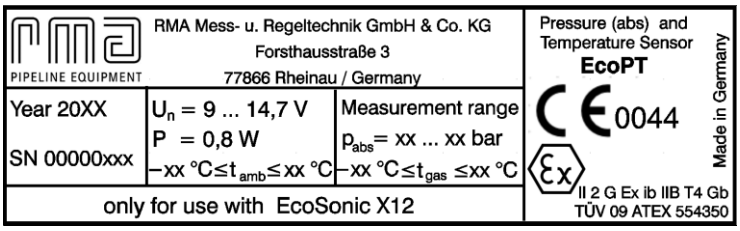


Fig. 5 Data plate on the EcoPT pressure and temperature sensor

Units brought into circulation under the Measuring Instruments Directive (MID) have calibration safeguards, seals and protective seals, which must not be damaged.

1.4 Storing the documentation – operating company obligation

The directives stipulate that the unit documents for the metering unit must be available at the metering system. These include

- The operating manual
- Supplied test certificates
- Documents relating to functional testing and re-certification for custody transfer measurements

If the metering unit is dismantled at a metering point, always store all of the documentation together with the unit.

1.5 Symbols used

The following symbols are used to indicate the risks associated with the EcoSonic X12 ultrasonic gas meter:

DANGER

Death, serious injury or significant material damage
will occur if the corresponding precautions are not taken.

WARNING

Death, serious injury or significant material damage
may occur if the corresponding precautions are not taken.

CAUTION

Minor injury may occur if the corresponding precautions are not taken.

Note

The signal word “note” is used to draw attention to a situation that could cause the unit or metering system to become damaged or inoperable, or that could severely impair its functioning.

2. Safety – responsibility of the operator

EcoSonic X12 is typically used for the metering of fuel gases. The pipelines are under pressure. The installation engineer and system operator are responsible for the dimensioning, installation and safe operation of the system, and in particular for the protection of persons, the surrounding area and the environment.

The EcoSonic X12 metering system must only be used in the manner specified by the manufacturer. The operator must therefore ensure that the following points are complied with:

2.1 Qualified and authorised personnel

Persons who handle, work with, have access to or are located in the vicinity of the metering unit and the metering system may be put at risk or may contribute to a risk. Understanding and awareness of the risks is an important prerequisite for preventing and dealing with hazardous situations.

DANGER

Risk of explosion, risk of death, risk of injuries

The metering system with the EcoSonic X12 can be used with gases that are detrimental to health and that are under high pressure at high temperatures.

Work on the metering system or the gas-carrying system must only be performed by qualified persons.

- Work on the metering system or the gas-carrying system must only be performed by qualified persons. It is the obligation of the operator and the safety officers to guarantee and check that this is the case.
- The appointed persons must have precise knowledge of the operating risks, e.g. those caused by hot or toxic gases or gases under pressure or other media, and they must also be able to demonstrate adequate knowledge of the metering system by means of completed training sessions.
- In potentially explosive areas, cabling and installation must only be carried out in accordance with EN 60079-14 and taking into account the national regulations.

2.2 Intended use

The EcoSonic X12 ultrasonic gas meter is designed for measuring the flow Q_m, the pressure p_m and the temperature t_m of dry natural gas and air. It has been tested and approved for gases in gas group IIB (ATEX) and for 2nd family gases in accordance with EN 437 (MID) in pipelines within the specified temperature and gas pressure limits. EcoSonic X12 also measures the speed of sound c in the gas and calculates the operating volume V_m.
The optional volume corrector can determine the base volume V_b. The correction method for determining the base volume V_b can be selected based on the particular conditions, such as the composition of the gas, the gas pressure and the gas temperature.

The metering system must only be used in the manner specified by the manufacturer and described below. Particular care must be taken to ensure that:

- The system is used in compliance with the specifications, the information regarding permissible use and the assembly, connection, environmental and operating conditions. All of the necessary data and information in this regard can be found in the order documentation, the data plate, the approval documents and this operating manual.
- All of the necessary measures for maintenance, inspection, transport and storage are complied with.

2.2.1 Improper use

The following points must be observed:

- Not suitable for the metering of aggressive gases, oxygen, acetylene and hydrogen.
- EcoSonic X12 must not be exposed to any impermissible mechanical stresses, e.g. those caused by pigging of pipelines.
- The metering unit must only be repaired by RMA service personnel or by persons who have been trained in the EcoSonic X12 by RMA.

The warranty will cease to apply in the event of improper use or if impermissible parts and pipelines are used.

2.3 Safety instructions and protective measures

The following points must be observed:

- When preparing for and performing work, the statutory provisions that apply to the system in question must be complied with, in addition to the technical rules and directives.
- The operator must ensure that the applicable national and regional provisions, rules and directives are complied with.
- Special care should be taken with systems with increased risk potential (pressure lines, explosion protection zones).
- The operating manuals for the metering system and the system documentation must all be available on site. Information contained within these manuals and documentation regarding the prevention of risks and damage must be observed without fail.

2.3.1 Risks due to gases or high pressure

EcoSonic X12 is usually installed directly inside gas-filled pipelines, so the following must be observed:

WARNING

Risk of explosion

The system with the EcoSonic X12 can be used with gases that are detrimental to health and that are under high pressure at high temperatures.

The selected ignition protection class must be considered before the system is used in potentially explosive areas.

EcoSonic X12 is always operating within the specified pressure and temperature limits.

2.3.2 Risks during transport, storage and installation

The weight of the EcoSonic X12 must be taken into account during transport, storage and installation.

WARNING

Risk of injury, risk of crushing

Injuries and/or crushing may occur when lifting and installing the EcoSonic X12.

Suitable lifting equipment must be used when lifting and installing the EcoSonic X12. The weight of the EcoSonic X12 is specified on the main data plate.
Lifting eyes are attached to the flanges on EcoSonic X12 products with nominal widths of DN 150 and over. Check the lifting eyes for secure fit, and use them to lift the EcoSonic X12.

The EcoSonic X12 must always be securely fixed in position, even during storage and transport.

3. Product features

The EcoSonic X12 metering system is an ultrasonic gas meter. It does not contain any mechanically moving parts. As a result, it offers a range of benefits compared to other metering systems:

- There is no need for the regular maintenance and inspection of moving parts
- It is suitable for harsh environments
- It has long-time stability due to the lack of wear parts
- It is resistant to interference
- There is no pressure loss

The EcoSonic X12 is supplied with the EcoPT pressure and temperature sensor already connected to the unit, as well as the EcoTouch operating and display unit. The EcoView configuration and diagnostics program is also included with the delivery.

3.1 EUconformity

EcoSonic X12 is subject to the following EU Directives:

- Pressure Equipment Directive 2014/68/EU
- ATEX Directive 2014/34/EU
- EMC Directive 2014/13/EU
- Measuring Instruments Directive MID 2014/32/EU

Development and production are monitored and maintained as part of the RMA quality assurance system. The unit features a corresponding CE mark.
With the EcoSonic X12, the following standards are considered in particular:

Area	European standard
ATEX	EN 60079-0, EN 60079-1, EN 60079-7, EN 60079-11, EN 60079-18
Climate	EN 60068-2-1, EN 60068-2-2, EN 60068-2-30, EN 60068-2-78
Shock	EN 60068-2-31
Vibration	EN 60068-2-47, EN 60068-2-64
EMC	EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6, EN 61000-4-29, EN 61000-6-4, EN 60654-2
Pressure Equipment Directive	AD 2000 data sheets

3.1.1 Metrological standards and rules

- OIML R 32:1989, “Rotary piston gas meters and turbine gas meters”, Annex A
- OIML R 137-1&2:2012, “Gas Meter Requirements”
- Welmec Guide -11.1:2015, “Common application for utility meters”
- Welmec Guide -11.3:2015, “Guide for information in the type examination certificate, to be borne by and to be accompanied (or provided) by the markings on the gas meters”
- A.G.A Report No. 9:1998, “Measurement of Gas by Multipath Ultrasonic Meters”

The aforementioned standards are taken into account. The requirements of the OIML and EN standards in particular were stipulated for the PTB type-examination certificate, and are also listed in this certificate.

3.2 Versions, measuring ranges of the EcoSonic X12

Nominal width DN [mm]	Qmin [m³/h]	Qmax [m³/h]	Load range	[pulse/m3]
DN 80 (3")	8	650	1:80	11100
DN 100 (4")	10	1,000	1:100	11000
DN 150 (6")	25	2,500	1:100	2880
DN 200 (8")	40	4,000	1:100	2880
DN 250 (10")	65	6,500	1:100	1440
DN 300 (12")	100	10,000	1:100	1440
DN 400 (16")	160	16,000	1:100	720
DN 500 (20")	180	22000	1:120	300
DN 600 (24")	240	30000	1:125	300

The specified pulse values are usually factory settings. The pulse output can be operated at frequencies up to a maximum of 6 kHz.

3.3 EcoSonic X12 specifications

3.3.1 Ultrasonic gas meter

Gas	Natural gas, air ATEX: Gases in gas group IIB, Metrology (MID): Gases in the 2nd gas family in accordance with EN 437
Number of measuring paths	6 independent measuring paths on 3 levels
Sampling rate	10 measurements per second
Load range	Qmin / Qmax 1:80 up to 1:100

3.3.2 Ambient conditions

Temperature range	−25 °C … +55 °C (Measuring Instruments Directive - MID) −25 °C … +60 °C (non-MID, optional) −40 °C … +60 °C (non-MID, optional)
Storage temperature	−40 °C …+65 °C
Protection class	IP65
Weather/sun protection	Weather-protected during storage and operation, no constant direct sunlight on the EcoTouch display
Mechanical ambient conditions	Class M2
Electromagnetic ambient conditions	Class E2

3.3.3 Measuring range for pressure, temperature

Pressure range	0.8 bar .. 101 bar absolute
Temperature range (ambient temperature or gas temperature)	−25 °C … +55 °C (MID) −25 °C … +60°C (non-MID, optional) -40 °C … +60 °C (non-MID, optional)

3.3.4 Measurement accuracy

Accuracy class	1.0 (MID) 0.5 (OIML R 137-1:2012) optional (→ Section 5.2.6)
Repeatability (USM)	< 0.1% of the measured value
Measurement inaccuracy (USM)	± 0.2% of the measured value

3.3.5 Displays

Measured variables	Counters for operating volume V_m Disturbance volume counters VmD Measured operating flow Qm Gas velocity v Speed of sound c in the gas Gas pressure p_m Gas temperature t_m
Status	Three different-coloured LEDs

3.3.6 Interfaces

3.3.6.1 Interfaces for electronics with integrated NAMUR and Ex-i capability

<table>
<tr><td>DO…</td><td>The digital outputs DO1…DO6 can be connected as a group using either intrinsically safe or non-intrinsically-safe wiring systems – no mixed operation!

Individual characteristic values with connection to intrinsically safe wiring systems:
<table><tr><td>U_i</td><td>15 V</td></tr><tr><td>I_i</td><td>0.1 A</td></tr><tr><td>P_i</td><td>1.5 W</td></tr><tr><td>C_i</td><td>12 nF</td></tr><tr><td>L_i</td><td>negligible</td></tr></table>
Characteristic values with connection to non-intrinsically-safe SELV/PELV wiring systems:
<table><tr><td>U_b</td><td>≤ 30V</td></tr><tr><td>I_{max}</td><td>0.1 A</td></tr></table>
In switched-on condition, the current that flows into the digital outputs is limited to approx. 20 mA by these outputs for reasons of self-protection.
Output type: open collector or NAMUR (set at the factory)

fmax = 6 kHz

Function assignment
DO1…DO3 configurable status outputs, see 5.5.3

DO4 permanently as encoder output, see 5.5.4
(encoder: DSfG association protocol for connection to an external volume corrector — transmitter unit for the counter readings of the USM)

DO5, DO6 pulse outputs, see 5.5.5</td></tr>
<tr><td>RS485 RS1</td><td>RS485 level, various Modbus protocols can be configured, see 5.5.1</td></tr>
<tr><td>RS485 RS2</td><td>RS485 level, encoder output, see 5.5.5</td></tr>
<tr><td>RS485 RS3</td><td>RS485 level, diagnostic and parameterisation interface, see 5.5.6</td></tr>
</table>

3.3.6.2 Interfaces for electronics without integrated NAMUR and Ex-i capability

EcoSonic X12 is also produced in a version without integrated NAMUR and Ex-i capability. In this case, the connection area is designed with protection class Ex-e. The above characteristics apply for non-intrinsically-safe wiring systems.

In this version, it is only possible to connect to Ex-i wiring systems and NAMUR-compliant interfaces using external tools such as safety barriers or resistors.

The encoder is not implemented as a digital output, but rather as an RS485 interface.
Digital outputs are open collector outputs.

3.4 Explosion protection

	In accordance with Directive 2014/34/EU (ATEX) ⟨Ex⟩ II 2 (2) G Ex db eb ib [ib] mb IIB T4 Gb

3.5 Power supply

Operating voltage	Ub = 24 V DC (SELV/PELV) The power supply must comply with DIN EN 60950-1 and/or DIN 62368-1
Power consumption	≤ 10 W Approx. 0.4 A at a nominal voltage of 24V Umin: Ub > 12 V DC, approx. 0.8 A (minimum input voltage at the EcoSonic terminals) Umax: Ub < 28 V DC, approx. 0.4 A
Heating option (−40 °C product version; non-MID)	The heating consists of two electrically identical Ex-i circuits. Connection only to associated equipment (e.g. EcoHT) Ui = 9 V (2x), Pi = 10 W (2x)

During operation, the supply input can be considered as electrically isolated from all other circuits in the device. If voltages exceeding 350V are present during insulation testing, there may be a flow of current to the housing due to protective components inside the device.

In order to ensure continual sampling even during a temporary power supply failure, the EcoSonic X12 must be connected to an uninterruptible power supply (UPS), especially for samples being taken in accordance with the Measuring Instruments Directive. The minimum requirements for the UPS are as follows:

Voltage/current	Approx. 0.4 A at a nominal voltage of 24 V (Deviations +30% to -25% correspond to Class d. c. 4 in accordance with EN 60654-2/IEC 60654-2)
Power output	> 11 W, pay attention to power loss in the line
Response time	< 5 ms (Classification in accordance with EN 60654-2/ IEC 60654-2)
Capacity	The capacity of the UPS must be defined by the system operator. In doing so, the particular on-site conditions of the metering point must be taken into account.

4. Structure and system components

The EcoSonic X12 metering system consists of the following components

- EcoTouch operating unit (1)
- USM electronics (2)
- Ultrasonic transducer (3)
- Metering unit (4)
- T-bore ball valve (5)
- EcoPT pressure and temperature sensor (fitted behind the T-bore ball valve)
- Side panels (6) – hinged, removable

optional:

- Volume corrector in accordance with the Measuring Instruments Directive (MID)
- Heated display for use at temperatures below –25 °C (non-MID)

Parameterisation and detailed system diagnostics are performed using the EcoView PC program

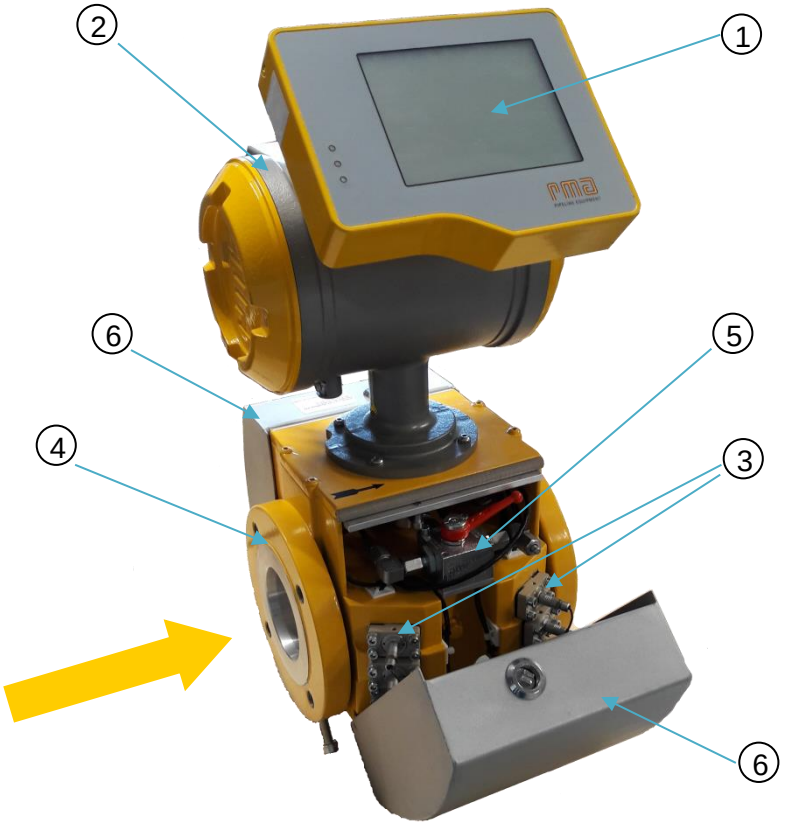


Fig. 6 Structure of the EcoSonic X12 metering system

Components	**RMA no.**	**ATEX RL 2014/34/EU**
Metering unit with sheathing	3.93xx.xxxx	Part of the overall unit
USM electronics, complete	3.9306.0000	Part of the overall unit
EcoTouch operating unit	3.9306.0100	Ⓔx II 2 G Ex ib IIB T4 Gb
EcoPT pressure and temperature sensor	3.9306.03xx	Ⓔx II 2 G Ex ib IIB T4 Gb
Ultrasonic transducer	3.9306.0201	“mb”, part of the overall unit
EcoSonic X12	**USMxxxx**	Ⓔx **II 2 (2) G Ex db eb ib[ib] mb IIB T4 Gb**

4.1 Metering unit

The metering unit block is produced using precision machinery. The inner diameter of the metering unit is used directly in the calculation of the gas flow, and is therefore an integral part of the measurement accuracy. The machining quality and the quality of the surface inside the metering unit are extremely important factors in ensuring the long-time stability of the metering accuracy.

In order to ensure that your EcoSonic X12 maintains its long-lasting high level of metering accuracy, the following points should be taken into account without fail when working with the gas meter:

Transport, lift and store the EcoSonic X12 so as to prevent corrosion or damage to the metering unit or the flange sealing faces.
A filter and separator may need to be fitted upstream from the metering unit in order to remove any condensing moisture and contamination in the flow of gas.

WARNING

Risk of explosion

The ultrasonic transducer and the thermowell, which extends into the flow of gas inside the metering unit, both have a safe design for the intended use. Serious damage caused by objects in the flow of gas could impair the pressure-resistance of the EcoSonic X12.

The EcoSonic X12 must not be damaged as a result of pigs or objects in the flow of gas. Damaged ultrasonic transducers or thermowells must not be used.

The EcoSonic X12 is tested for pressure-resistance and leak-tightness during production. The certificates from the resistance and leak-tightness tests are part of the product documentation.

4.1.1 Ultrasonic transducer

The EcoSonic X12 ultrasonic gas meter is fitted with six pairs of ultrasonic transducers that face each other from opposite sides. Each pair of transducers constitutes an independent measuring path, and measures transit times of ultrasonic pulses. This information is then used to calculate the flow rate of the gas inside the metering unit. The two transducers that make up a measuring path are operated alternately as transmitters and receivers.

The design, material selection and dimensioning of the EcoSonic X12 ultrasonic transducer are tailored to the conditions inside the metering unit. When combined with a carefully tailored control system, this means that transit time differences can be accurately measured to within a few nanoseconds.

The dimensioning and configuration of the transducers and in particular the emission characteristics of the ultrasonic transducers have been optimised in order to ensure reliable coverage of a large measuring range.

4.1.2 EcoPT pressure and temperature sensor

The EcoSonic includes an EcoPT pressure and temperature sensor fitted on the metering unit. The electrical connection and the pressure-measurement connection are already installed. Depending on the metering unit design, the temperature measuring point may be either inside or outside the EcoSonic housing. If it is outside the housing, the temperature sensor will need to be correctly fitted into the designated thermowell during installation → 5.2.8.1.

The pressure and temperature values are used to improve the measurement accuracy of the flow measurement by:

- Taking into account the expansion of the metering unit as a result of pressure and temperature changes
- Performing temperature compensation for the transit time measurement
- Adapting the flow profile

The metering unit can determine the operating volume in a manner that is valid for custody transfers even with an invalid pressure and/or temperature measurement, as substitute values will be used in this case. To this end, the substitute pressure value in the UPS parameters must ideally be selected such that it corresponds to the high-pressure test pressure value p_HP (over-pressure). As a minimum, however, the relative pressure must be between 0.5 * p_HP and 2 * p_HP.

4.1.2.1 Temperature measurement

The EcoPT temperature sensor is installed in a thermowell. The actual Pt500 sensor is attached onto a 3-wire cable in the tip of a metal sleeve. The sensor sleeve with cable is fitted in a thermowell in the flow of gas.

- The temperature sensor is fitted in the tip of the thermowell, i.e. centrally in the flow of gas.
- In order to ensure good thermal contact with the thermowell and therefore the gas temperature, the metal sensor sleeve is immersed in a small volume of clean machine oil, or a heat-transfer compound is used.

4.1.2.2 Pressure measurement

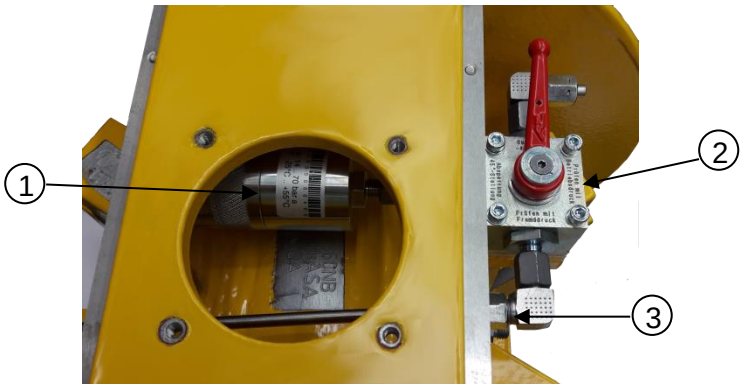


Fig. 7 EcoPT pressure and temperature sensor

The pressure connection for the EcoPT (1) is fitted to the 3-way ball valve (2). In measuring mode the 3-way ball valve is open

- to the pressure line (3) from inside the metering unit and
- to the EcoPT (1).

The third inlet used for verification purposes is shut off in measuring mode and is blocked with a blank plug (4).

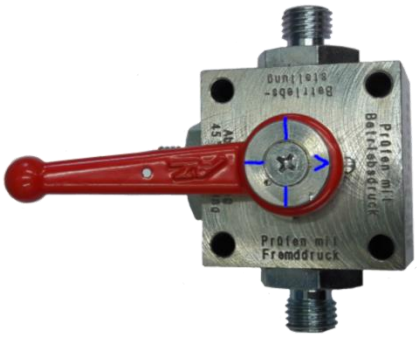


Fig. 8 T-bore ball valve – open at all 3 points.

The marking “—” or “|” means continuity. The blocked path “>” is facing the side without connection in the illustration. (The third pressure connection is covered by the control lever in the illustration.)

The 3-way ball valve is in the “operating position” on delivery and in measuring mode. The pressure and temperature values are read by the control electronics twice per second. The EcoPT pressure sensor measures the absolute pressure of the gas.

The pressure sensor is available with various different pressure measuring ranges. The EcoSonic X12 can therefore be adapted to the design of the metering point.

EcoPT sensors for the EcoSonic X12 ultrasonic gas meters are available in the following versions:

Pressure measuring range	Max. permissible overload
0.8 bar to 4 bar absolute	25 bar absolute
0.8 bar to 10 bar absolute	40 bar absolute
0.8 bar to 20 bar absolute	40 bar absolute
0.8 bar to 30 bar absolute	60 bar absolute
0.8 bar to 70 bar absolute	105 bar absolute
20 bar to 101 bar absolute (only for USM)	600 bar absolute

The calibrated measuring range of the pressure sensor [pmin cal, pmax cal] is configured in the EcoPT sensor. pmin cal and pmax cal are displayed on the EcoTouch.

(The EcoSonic units that are also operated with the volume corrector option use the aforementioned EcoPT version of pmax = 4 bar to pmax = 70 bar. In this case, the calibrated permissible pressure is limited to a smaller pressure range with more complex calibration, e.g. pmin = 14 bar, pmax = 70 bar.)

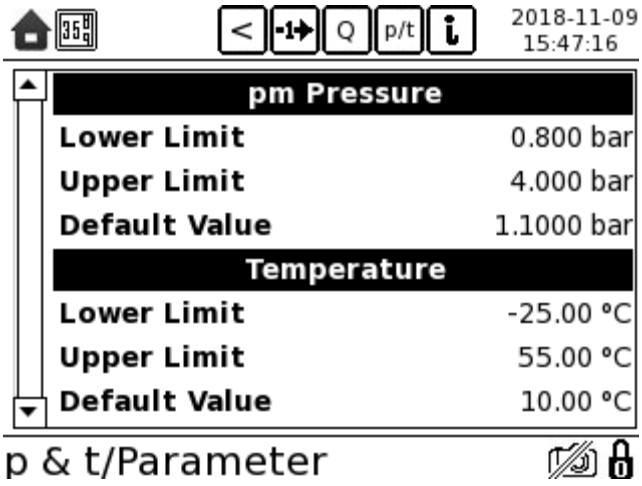


Fig. 9 pmin, pmax, Tmin, Tmax for the pressure and temperature sensor

4.1.3 Additional pressure information

4.1.3.1 Pressure unit:

The PS information on the data plate on the meter housing (Fig. 4, page 13) indicates the maximum pressure that can be exerted on the meter housing.

4.1.3.2 Pressure range for the flow calibration

The flow calibration is only valid for a limited pressure range, depending on the particular rules and accuracy requirements. When the unit is being used in accordance with the Measuring Instruments Directive, high-pressure calibration is required for an operating pressure of over 5 bar (absolute).

The calibrated [pmin, pmax] range of the ultrasonic gas meter can be read off from the EcoTouch and the EcoView software:

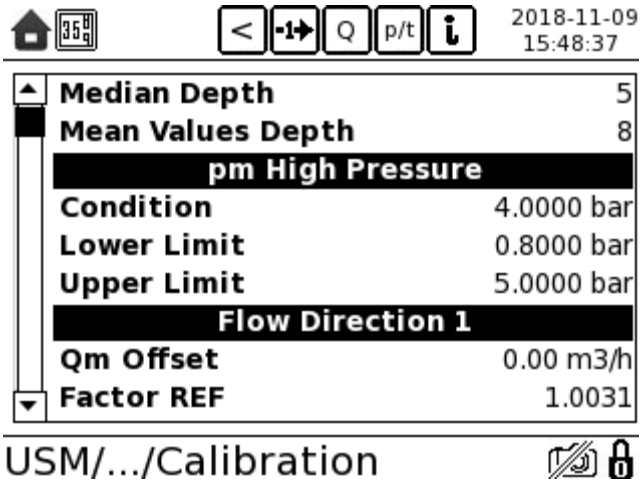


Fig. 10 pmin, pmax – calibrated pressure range

Example shown: High-pressure calibration at 33 bar absolute → pmin high pressure = 17 bar, pmax high pressure = 3 bar (both absolute))

Metering units that are operated at pressures of below 5 bar absolute are calibrated at ambient pressure. In this case, the minimum limit is 0.8 bar (pmin) or 5 bar (pmax). The test pressure (condition) is then set to a pressure value in between these two limit values, e.g. 1 bar or 2 bar.

4.2 No excess pressure

The following upper pressure limits must not be, and should not need to be, exceeded during regular operation:

- Maximum permissible operating pressure of the meter housing PS (see data plate, Fig. 4 Pressure Equipment Directive data plate - on the meter housing, page 13)
- Upper calibration value pmax for the EcoPT, or even the
- maximum permissible overload of the EcoPT, or the
- upper pressure (pmax) of the flow calibration

The pressure measuring range of the pT sensor may under some circumstances be temporarily exceeded during pressure or leak tests, but the maximum permissible overload will not be.

The maximum permissible overload must not be exceeded.

WARNING

Risk of explosion

If the max. pressure loads are exceeded, this may cause permanent impairments to the resistance and leak-tightness of the EcoSonic X12 as well as damage to the metering point.

The operator of the metering system must ensure that the specified pressure limits are complied with.

Note

The operator of the metering system must ensure that the specified pressure measuring ranges are not exceeded.

Once the max. overload of the EcoPT sensor has been exceeded, it will no longer be possible to guarantee metering accuracy within the pressure measuring range.

4.3 USM electronics

The USM electronics contain the essential electrical and electronic components of the gas meter, such as the core components for activating the ultrasonic transducers.
The electronics

- Periodically generate ultrasonic transmission signals
- Evaluate the received signals
- Determine the transit time
- Calculate the operating flow Qm of the gas
  (The index “m” in operating volume Vm stands for “measured”).

The USM electronics transmit the measured data to the EcoTouch operating unit. The current measured data can be reliably read off from the display of the operating unit.

The USM electronics meet the typical requirements for metering units certified by the Metrological Authority for custody transfer measurements or metering units that comply with the Measuring Instruments Directive.
The non-volatile data memories retain the data and settings even in the event of power failures lasting more than 1 year. Events and data with a relevance for custody transfer purposes are transmitted to the EcoTouch display unit where they are permanently stored in the log for custody transfer measurements.

The date and time, which are always specified with the measured data and entries in the log, are provided by the USM electronics. A long-life battery (10 years) is used in the USM electronics in order to ensure reliable and uninterrupted operation of the system clock. The EcoSonic X12 system clock will therefore continue running even if the EcoSonic X12 is not connected to the power supply. This means that the correct time will be entered with a log entry if the metering unit is restarted.

The current configuration data, calibration parameters and measured values are stored in the non-volatile data memories. The measured data can be read off at the EcoTouch operating unit. The USM electronics provide interfaces for communication with the EcoView program as well as typical standardised interfaces for process control systems.

4.4 EcoTouch operating unit

The EcoTouch operating unit is used to display the measured data, the operating state and the operation and calibration parameters in a manner that is suitable for custody transfer measurements.

EcoTouch is the display and operating unit of the EcoSonic.
Important functions and features of the EcoTouch operating unit are as follows:

- User guidance based on clear text
- Display of measured data
- EcoSonic X12 status display via LEDs
- Detailed status display on the screen
- Display of set parameters
- Display of the non-volatile data memories (log, log for custody transfer measurements)
- Display of the parameters with a relevance for custody transfer purposes, in order that these can be verified
- Secured calibration switch for calibration and configuration by authorised parties
- Display of the entries in the log for custody transfer measurements

When used in conjunction with the EcoSonic X12, the operating unit is approved for use in Ex zone 1. The EcoTouch is labelled Ⓔx II 2 G Ex ib II B T4.Gb, and the certificate number is TÜV 09 ATEX 554349.

4.4.1 Connector box – optional temperature range (non-MID)

Note

If the EcoSonic X12 is designed for use in the extended temperature range of -40 °C … 60 °C, then the EcoTouch is fitted with a heater. This heater is connected to separate related power supply equipment in the connector box.

The heater circuit is powered by the related EcoHT equipment. EcoHT is permanently installed in a switch cabinet outside of the Ex zone. It feeds the intrinsically safe heater circuit for the EcoTouch. The EcoHT connecting cable is connected to the heater circuit in the connector box.

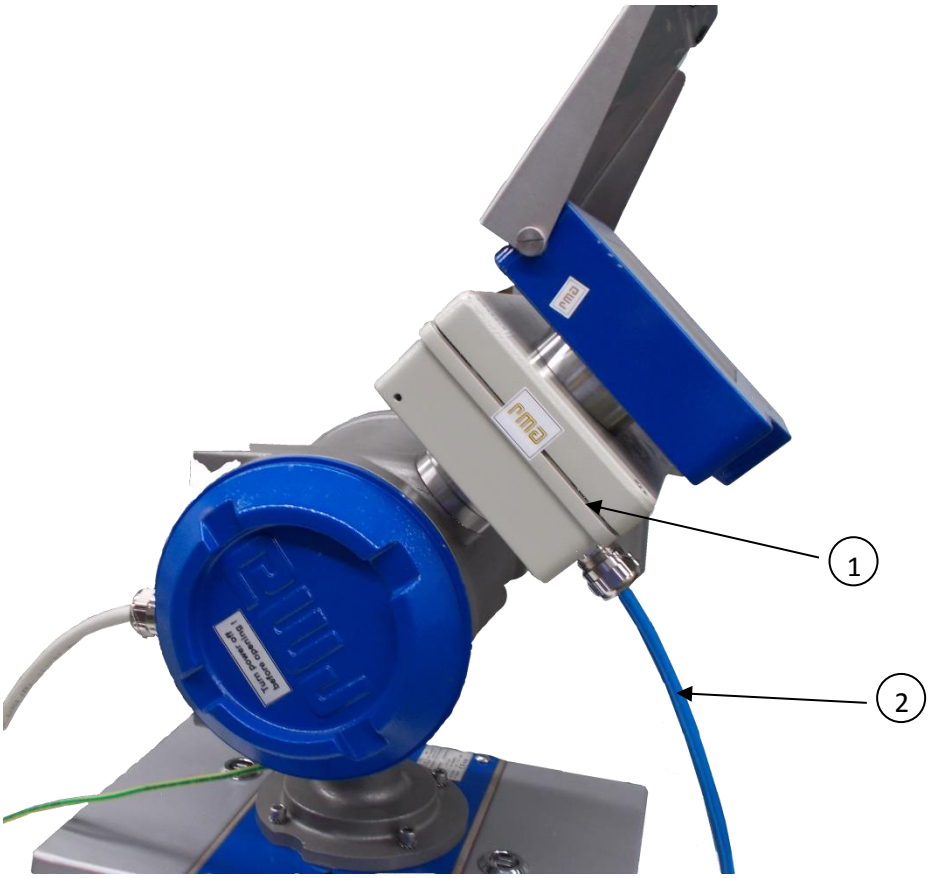


Fig. 11 EcoSonic with connector box (1) for the extended temperature range

The connector box is a housing with protection class IP 65. The housing contains the terminal strips for the cables from the EcoHT power supply (2) and for the cables between the EcoTouch and the measurement electronics of the EcoSonic X12 ultrasonic gas meter.

4.5 Detached EcoTouch

The EcoTouch operating unit is typically mounted directly onto the device. In difficult-to-access meter unit installations, this product version means that a detached EcoTouch unit can be fitted where it is easy to read, easy to access and easy to operate at eye level.

The cable length between the detached EcoTouch and the EcoSonic X12 must not exceed 20 m. A connector box version is used as a wall holder. The cable from the EcoSonic X12 (max. 20 m in length) is connected in the connector box.

For EcoSonic units that are put on the market in accordance with the Measuring Instruments Directive (MID), only

- the connection between the EcoTouch and the EcoSonic electronics is established

in the connector box.

Fig. 12 Detached EcoTouch

Only with the (non-MID) version with extended temperature range (-40 °C … +55 °C/+60 °C) the EcoHT power supply

- for the heater circuit is also connected

in the connector box.

WARNING

Safety in potentially explosive areas

In order to ensure optimal protection and safe operating behaviour of the EcoSonic X12, please observe the following restrictions.

The maximum cable length of 20 m between the EcoTouch and the EcoSonic X12 must not be exceeded. There must be equipotential bonding over the entirety of the intrinsically safe wiring system.

Note

Verifiability, maintainability

It may be necessary to make changes to operating parameters on site in the event of a functional test carried out by the Metrological Authority or during re-certification for custody transfer measurements. In this case, the calibration switch will need to be opened.

During planning and installation, it must be ensured that the calibration switch on the left-hand side of the EcoTouch operating unit is always easily accessible.

4.5.1 Calibration switch

Access to the calibration switch in the EcoTouch operating unit is guaranteed by means of a screw and an affixed security label in units for custody transfer measurements. When the calibration switch is closed, this protects against changes being made to important parameters and calibration data that is required for correction purposes and for the display of measurement results.

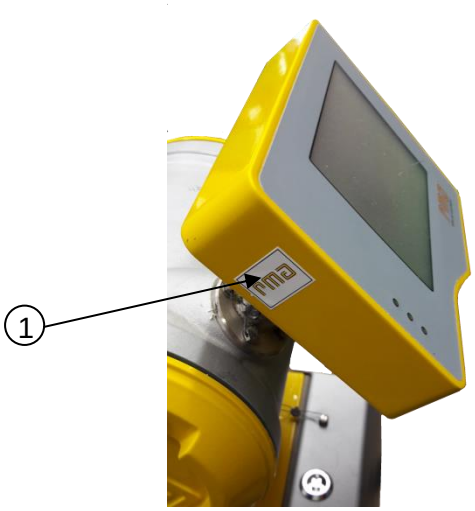


Fig. 13 Calibration switch, secured by an adhesive label (1)

The user administration system for the EcoSonic X12 firmware provides different access levels and access rights. An opened calibration switch corresponds to the top access level with the most access rights.

The system can only reach this user level if the calibration switch is actually physically opened on the device. It is only possible to make changes to settings with a relevance for custody transfer purposes via the EcoTouch operating unit and the EcoView program when the calibration switch is open.
Once open, the calibration switch will close automatically approximately 15 minutes after the last change is made. The calibration switch will be closed immediately if the unit is changed to a lower user level.

4.5.2 Status LEDs

The three LEDs on the EcoTouch show the general unit status at all times. In normal operation without any malfunctions, the green LED is permanently illuminated.

With an EcoSonic X12 that is already installed and connected, precisely one of the three LEDs on the EcoTouch operating unit will always be illuminated.

LED		System status	Description
Green	●	Normal operation	Normal metering operation The EcoSonic X12 is metering the flow of gas.
Yellow flashing	●	Warning	A malfunction has occurred The log provides information on the type and origin of the malfunction
			Once there is no longer a malfunction, the green LED ● will illuminate →Check and acknowledge the message to stop the yellow LED flashing.
Red flashing	●	Error	An error has occurred. An error usually requires an intervention. The internal log provides information on the type and origin of the error.
			Once there is no longer an error, the green LED ● will also illuminate. → Check and acknowledge the message to stop the red LED flashing.
Red (permanently illuminated)	●	Serious fault	The log provides information on the type and origin of the fault. Contact your RMA representative.

The EcoSonic X12 ultrasonic gas meter will automatically switch to operating state as soon as it is connected to the power supply. Continual sampling can only be interrupted either briefly as a result of changes to parameters with a relevance for custody transfer purposes, or for a longer period in the event of interventions being performed when the custody transfer settings lock has been opened.

A temporary interruption could be due to the adaptation of interface parameters, for example. This type of interruption, i.e. every single intervention, is only possible at password-protected user levels or user levels protected by a calibration switch.

The EcoSonic X12 starts up immediately after it is connected to the power supply: Self-tests are carried out, processes are started and the configuration parameters are read and checked. All 3 LEDs will illuminate simultaneously for a short period before the EcoSonic X12 moves to normal permanent metering operation after approximately two minutes.

4.5.3 Touch screen

The illuminated monochrome display has a resolution of 320 x 240 pixels. If no entries are made on the EcoTouch for an extended period, the display will shut down automatically.
The display shuts down in stages and then switches to sleep mode.

After 5 minutes of inactivity	The counter unit value page is displayed
Further 3 minutes of inactivity	The background lighting is switched off
Further 2 minutes of inactivity	The display is shut down

Once shut down, the display will be re-activated when touched.

The touch screen shows measured values such as pressure, temperature, total measured operating volume V_m, current flow Qm [m3/h], disturbance volume, …, current parameter values.
The most important measured values for flow direction 1 are displayed after tapping the quick-selection key .

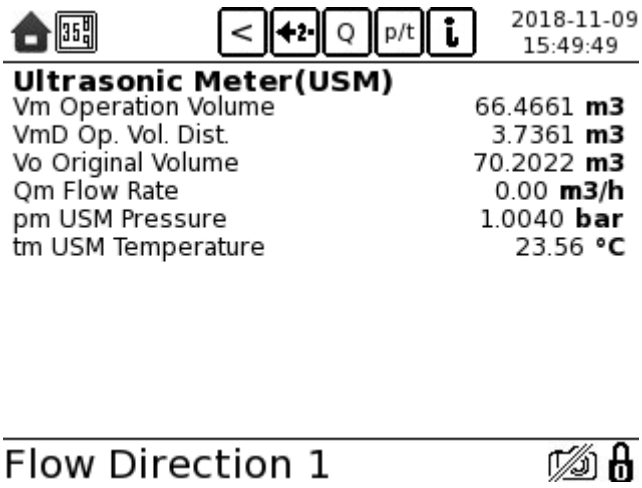


Fig. 14 Touch screen – meter readings and flow

This page is continually updated automatically. For further information on the operation of the EcoTouch, see Section 9.

There is a stylus attached to the right-hand side of the unit for tapping the various menu items.

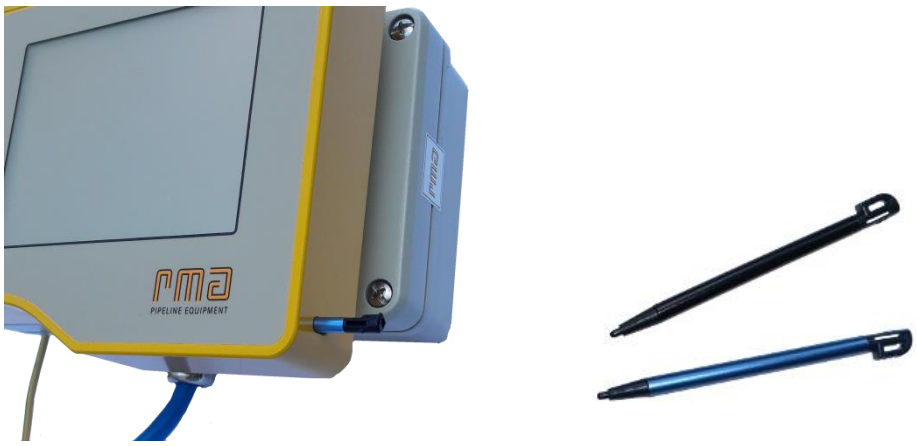


Fig. 15 Storing the stylus

WARNING

Risk of explosion, loss of function

The touch-sensitive touch screen is designed for use in harsh environments. Nevertheless, it may be damaged by very sharp, hard objects. The display film prevents the ingress of dirt and moisture.

Use the supplied stylus or tap the touch screen lightly with your finger. Put the stylus back into its casing after use!

If the display film is damaged, meaning that dirt and moisture could get into the housing, the metering unit is no longer approved for use in an ATEX zone.

The metering unit must be switched off.

4.6 EcoView operating and diagnostics program

The EcoView operating and diagnostics program is supplied together with the EcoSonic X12. It displays all of the data and information that is also shown by the EcoTouch operating unit. In addition to providing a clear and comprehensive display on a PC screen, the EcoView program also gives the user the option to save measured data, log entries and settings to a file, or to further process or archive this information.

The EcoView program can only change parameters relating to custody transfer measurements if the calibration switch on the operating unit is open. EcoView is typically used to display measured data and settings, and to save and load parameter sets. EcoView is used during initial calibration and certification for custody transfer measurements, during re-calibration and functional tests, and during analyses and tests by the manufacturer's service personnel.

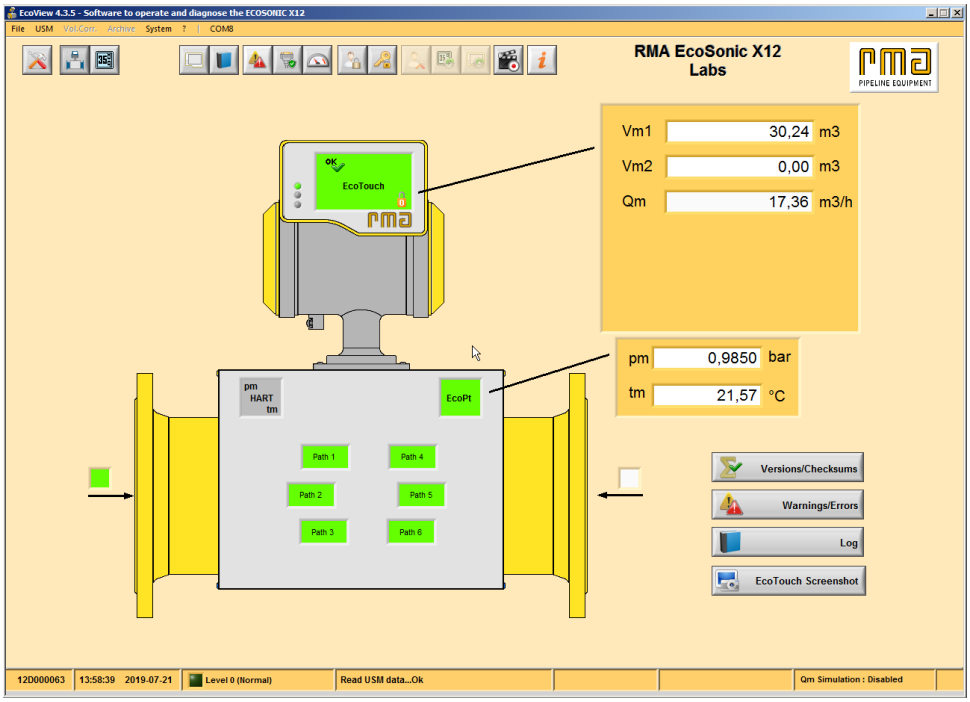


Fig. 16 EcoView

The EcoView program is an add-on program that is not subject to compulsory certification for custody transfer measurements. With regard to custody transfer measurements, the program works with copies of the data and parameters, which can only be reliably read off from the EcoTouch operating unit.

5. Assembly and installation

5.1 Points to be observed prior to assembly

5.1.1 Delivery

The EcoSonic X12 is delivered in a calibrated state, pre-configured as per the customer's specifications.

Depending on the on-site conditions, the EcoSonic X12 is stored for a short period of time after delivery rather than being installed immediately. Always observe the following information for transport, storage and installation:

WARNING

Risk of injury, risk of crushing

Injuries and/or crushing may occur when lifting and installing the EcoSonic X12.

Suitable lifting equipment must be used when lifting and installing the EcoSonic X12. The weight of the EcoSonic X12 is specified on the main data plate.

Lifting eyes are attached to the flanges on EcoSonic X12 products with nominal widths of DN 150 and over. Check the lifting eyes for secure fit, and use them to lift the EcoSonic X12.

The EcoSonic X12 must always be securely fixed in position even during storage, as well as whenever it is being transported.

Carry out the following checks when the unit is delivered:

- Check the packaging and the EcoSonic X12 for visible damage
- Check that the delivery is complete
- Check that there are end caps on the metering unit flanges to protect against contamination and check that there is no contamination or damage in the metering unit.

Record any damage to the packaging or the unit, and contact the responsible RMA representative immediately.

5.2 Conditions of installation

During the planning stage, and then again prior to installation, check that the following requirements have been met regarding the metering point:

- In the simplest case, there must be a straight and unobstructed inlet pipe of 10 DN in length upstream from the metering unit of the EcoSonic X12. (More detailed information regarding the inlet and outlet pipe and other configurations can be found in the following section).
- Due to the measuring principle and the lack of moving parts, ultrasonic gas meters can be installed at the metering point without having to consider orientation. This also applies to EcoSonic X12 ultrasonic gas meters, which can be fitted in either horizontal or vertical installations, for example.
  In order to guarantee reliable metering, it must be ensured that the pressure line from the metering unit to the pressure sensor always has an ascending gradient wherever possible. It is important that it does not have a descending gradient at any point. When planning the gas temperature measurement in thermowells, it is important to consider a rising or falling vertical flow of gas.
- In order to carry out a functional test or re-certification for custody transfer measurements, the front panel on the metering unit will need to be opened in order to connect reference pressure at the T-bore ball valve.
- The T-bore ball valve is attached to the same side as the EcoTouch operating unit (except in a few special cases). When standing in front of the operating unit, the directional arrow on the metering unit (i.e. the main flow direction) will usually point from left to right.
- The metering system around the EcoSonic X12 is weather-protected, ventilated and dry. The EcoSonic X12 is protected against water, rain, snow, snow drifts and direct sunlight.
- There must be sufficient space on the left-hand side of the EcoTouch operating unit for the operation of the calibration switch, which is particularly important to bear in mind when using a detached operating unit.
- A suitable uninterruptible power supply (UPS) is provided and used for the EcoSonic X12.

DANGER

Check that the on-site installation and usage conditions correspond to the labels and the information on the EcoSonic X12 data plates.

5.2.1 Inlet pipe

When installing ultrasonic gas meters, a straight inlet pipe is usually required upstream from the metering unit in order to limit disruptions to the flow as a result of elbow joints or sliders.

The precise design of the inlet pipe is checked against the currently permissible configurations prior to installation. The EcoSonic X12 requires a straight, unobstructed inlet pipe of 10 DN or above, and an outlet pipe of 3 DN or above.

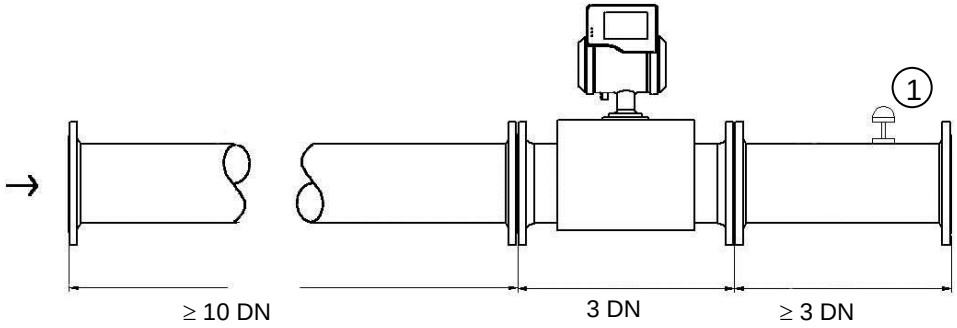


Fig. 17 Inlet pipe – with temperature measuring point (1) in the outlet

The following applies for the gas meters with DN 200, DN 250, DN 300, DN 400, DN 500 and DN 600 during use with p> 4 bar: If there is a serious flow disturbance in the area of 20 DN upstream from the metering unit (caused by a pressure regulator, slider that can be completely open or completely closed in other positions, or any other components that restrict the circular cross-section), the inlet pipe will need to be constructed of two pieces that are both at least 5 DN in length, with a flow conditioner in between them.

Important:

Valves or sliders in the metering system that are installed upstream from the gas meter must always be completely open or completely closed. If the unit is to be operated with partially open valves or sliders in an area of 20 DN upstream from the ultrasonic gas meter, a flow conditioner will also need to be used.

5.2.2 Activating path failure compensation

The flow measurement of the EcoSonic X12 with 6 measuring paths is redundant in standard installations. The EcoSonic ultrasonic gas meter is therefore able to compensate for a path failure and to continue performing custody transfer measurements under certain conditions.

For this purpose, the EcoSonic X12 continually learns characteristic values for different flows. If measuring paths fail, the currently learned characteristic values will be used to reconstruct the missing information from the failed path.

The path failure is entered in the log as a warning. With a corresponding configuration, the USM issues a warning via the status outputs, allowing the operator to implement measures to rectify the path failure.

5.2.2.1 Compensation of a path failure that is valid for custody transfer measurements

If a path fails and learned values are available, the path failure can be compensated for and the measured flow added to the volume valid for custody transfer measurements.

The path failure compensation must be deactivated if there are any variable, flow-restricting components or varying partial flows (e.g. due to T-pieces) up to 20 DN upstream from the USM.

The compensation can be activated/deactivated individually for flow direction 1 and flow direction 2. This setting is performed in EcoView (USM – Parameters – Acoustic transducer):

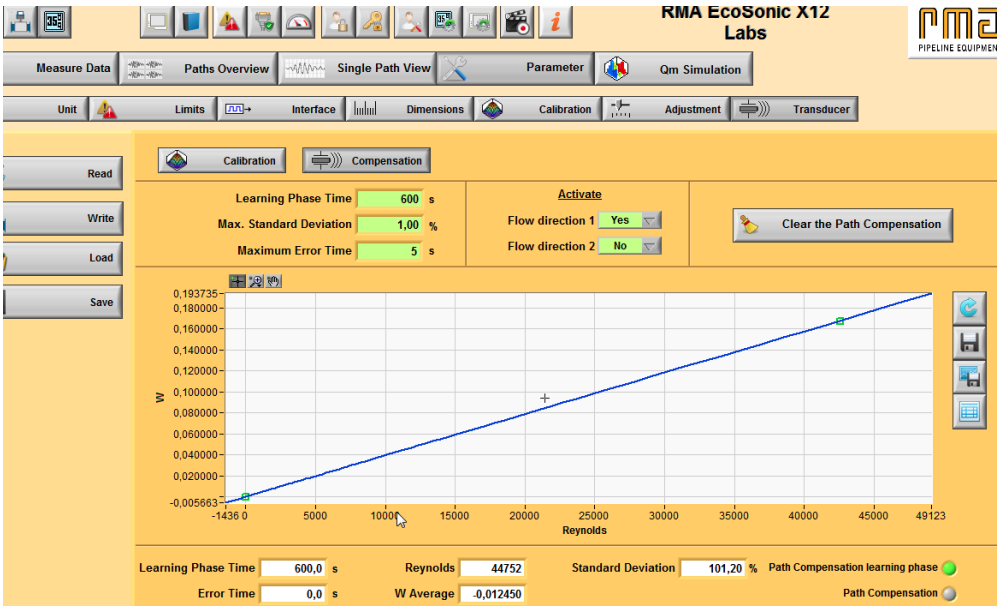


Fig. 18 Switch path compensation on/off

The change can be made when the calibration switch is open or at user level 6. An entry is made in the EcoSonic's metrological log.

The current setting can be read off directly from the EcoTouch display at any time.

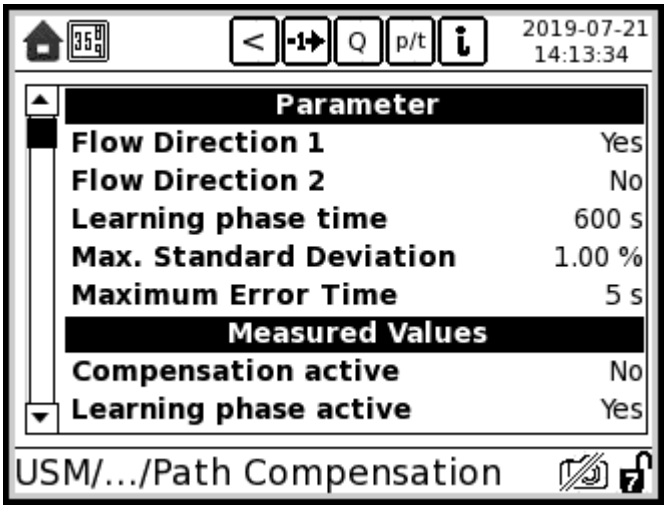


Fig. 19 Current path compensation setting

5.2.2.2 Compensation (not valid for custody transfer measurements) of one or more path failures

If multiple paths fail or if it is not possible to carry out compensation of a path failure that is valid for custody transfer measurements for any other reason, the ultrasonic gas meter will continue to determine the flow and will add this to the disturbance volume.

The number of path failures for compensation that is not valid for custody transfer measurements can be configured to between n = 1 and n = 5. To do so, the calibration switch will need to be actuated and the unit switched to manufacturer level by entering a password.

5.2.2.3 Learning phase

The parameters for the learning phase of the characteristic flow values must be set as follows for operation valid for custody transfer measurements:

- Duration of learning phase 600s
- Max. permissible standard deviation 1%
- Max. permissible error rate 5%

The flow situation must stay as stable as possible during the learning phase. This essentially relates to the relationships between the individual path velocities and not to the flow rate itself. The average flow rate itself may therefore vary more than the standard deviation value specified above.

If the criteria specified above are met, then learned values will be available that are suitable to compensate for a path failure in a flow rate range of vavg /2 < vavg < 2 vavg, without losing the valid custody transfer measurement.

5.2.2.4 Resetting the learned values

The learned values are reset if:

- The power supply was switched off
- A manual reset was performed

5.2.3 Reduced inlet pipe with flow conditioner

If there is no serious disruption in the area of 20 DN upstream from the metering unit (e.g. caused by pressure regulator, slider that can be completely open or completely closed in other positions, or any other components that restrict the circular cross-section), the following configuration is permissible:

Straight inlet pipe of ≥ 3DN in length followed by an RMA flow conditioner and an additional inlet pipe of ≥ 2DN in length.

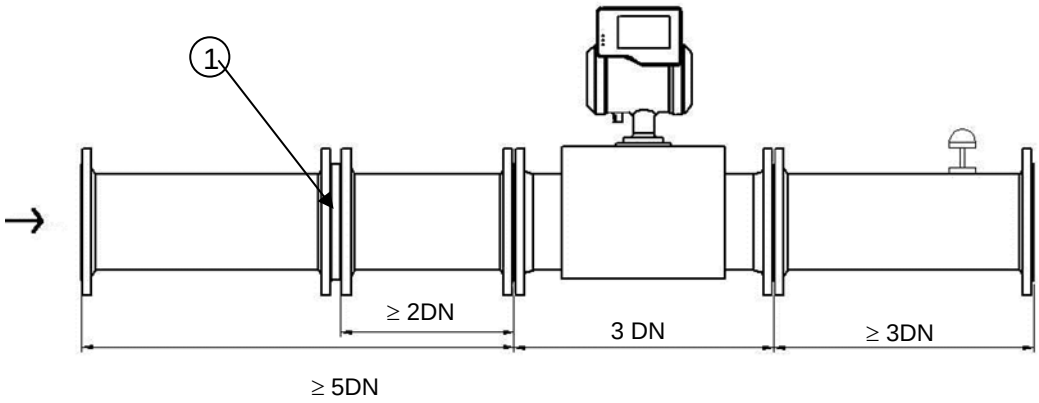


Fig. 20 Reduced inlet pipe with flow conditioner (1)

5.2.4 Inner diameter of the inlet and outlet pipes

The inner diameter of the inlet and outlet pipes must correspond to the inner diameter of the EcoSonic X12. If the metering unit is calibrated without the inlet pipe, a check must be performed to see whether there is any deviation between the EcoSonic X12 pipe diameter and the diameter of the inlet pipe. The deviation must not exceed 1% of the inner diameter. Larger deviations of 2% to 3% may lead to a shift in the error curve of the metering unit. These deviations are permissible. Precise up-do-date information regarding this can be found in the current type-approval certification.

5.2.4.1 Inner diameter at the flanges

Pipes with a nominal width are offered with a variety of different wall thicknesses. The following table lists the dimensions and the maximum deviation for pipes used by RMA.

	Inner diameter at the flange	**Inlet and outlet pipe**	
	di/mm	di (min)/mm	di (max)/mm
DN 80	82.5	79.9	84.9
DN 100	107.1	104.3	110.3
DN 150	155.7	154.1	159.3
DN 200	206.5	201.5	210.1
DN 250	260.4	253.0	264.0
DN 300	309.7	303.9	314.9
DN 400	389.0	380.1	397.1
DN 500	483.0	479.4	495.3

DN 600	570.0	560.7	584.6

The precise determination of dimensions and pipe diameters usually takes place in advance in collaboration with the metering unit manufacturer during the planning of the metering point. As part of this process, the current status of the type-approval certifications is also checked.

The metering units are typically fitted with a cone of up to 7° at the flanges. This reduces the flange opening to the size of the inner diameter in the meter housing.

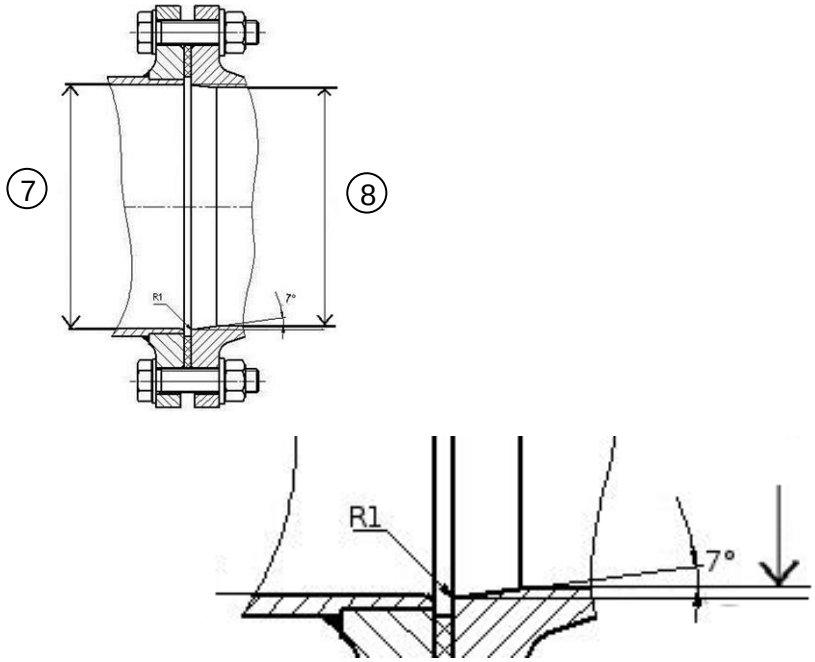


Fig. 21 Inlet pipe inner diameter (7)

5.2.4.2 Full-bore version

Inlet and outlet pipes and meter inner diameters can be optimally coordinated with one another:

- At the metering unit flanges, there is no reduction to a smaller inner diameter in the metering unit
- Full-bore: the metering unit has the same flow cross-section throughout
- The inner diameters of the metering unit and the inlet and outlet pipes are the same. Potential production-related deviations to the inner diameters are < 1%

If different pipes are used when inspecting the gas meter, these pipes are permitted to deviate from the inner diameter of the gas meter in the full-bore version by between 97% and 104%.

5.2.5 Bidirectional **sampling**

5.2.5.1 Standard – unidirectional calibration

The EcoSonic X12 ultrasonic gas meter is calibrated in the main flow direction DIR1, and is brought to the market in accordance with the MID. The flow measurement in flow direction 2 is not calibrated. Flow in direction of travel 2 always counts into disturbance volume VmD2. The status of the operating volume meter Vm2 always remains at 0 m^3.

5.2.5.2 Version – bidirectional calibration

Bidirectional sampling requires unobstructed inlet pipes in both flow directions. Flow in flow direction 1: DIR1 counts into counter V_m1. Flow in the opposite direction DIR2 counts into counter V_m2.
MID-compliant calibration in both flow directions DIR1 and DIR2 can be performed with firmware version 02.04.10, Revision 8 of the type-examination certificate or any newer version.

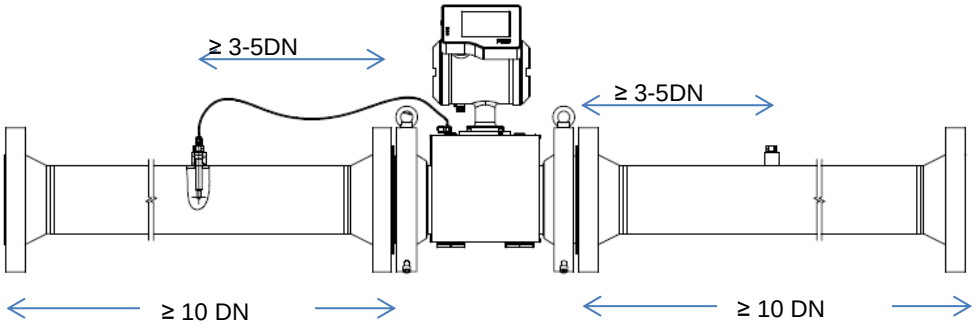


Fig. 22 Bidirectional sampling with 10 DN inlet pipes

There are inlet pipes ≥ 10 DN with a suitable inner diameter on both sides. On one side there is a thermowell for the EcoSonic's EcoPT temperature sensor. On the other side is one or typically two thermowells for performing temperature measurements on a volume corrector. The thermowells are located between 3 DN and 5 DN away from the EcoSonic flange.

Instead of 10 DN, the EcoSonic can also be calibrated bidirectionally using flow conditioners and shortened inlet pipes: the basic arrangement is outlined below:

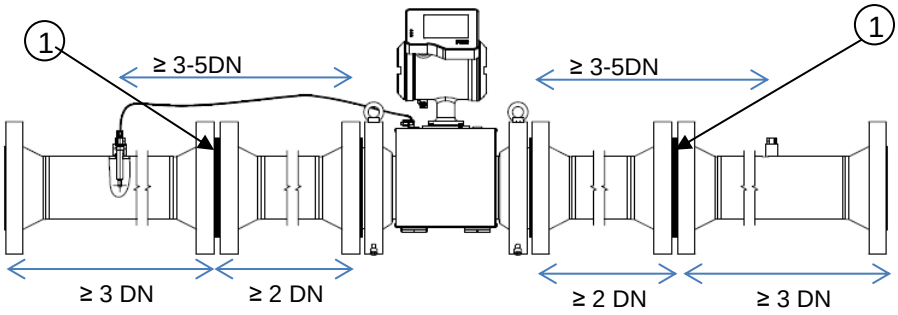


Fig. 23 Bidirectional sampling with two flow conditioners (1)

In bidirectional mode with short inlet pipes, two RMA flow conditioners are fitted at a distance of at least 2 DN. The flow conditioners are positioned between the EcoSonic X12 and the thermowells for the EcoSonic and the volume corrector. The thermowells are fitted at a distance of 3-5 DN from the EcoSonic X12 flanges.

Please contact RMA Mess- und Regeltechnik GmbH & Co. KG in good time in the event of specific requirements such as

- Bidirectional: one side 10DN — USM — metering unit — second side short inlet pipe with flow conditioner (requires more complex calibration and parameter determination)
- Permanent series connection with other metering units (turbines)
- Permanent series connection of two ultrasonic gas meters in accordance with PTB TR-G18
- Permanent series connection of two ultrasonic gas meters back-to-back in accordance with the type-examination certificate.

5.2.6 Installation for OIML class 0.5

EcoSonic X12 can be used for measurement accuracy class 1.0 in accordance with the Measuring Instruments Directive. For sampling in accordance with OIML R137 class 0.5, the following conditions must be met in addition to the requirements of the type-examination certificate:

- Calibration of the EcoSonic with at least 11 flows (Q = 0.01 / 0.02 / 0.03 / 0.05 / 0.07 / 0.1 / 0.16 / 0.2 / 0.4 / 0.7 / 1.0 * Omax)
- A polynomial correction with 5 coefficients was used for error compensation.
- The metering unit's inlet pipe consists of
  5 DN – "RMA - Nova flow conditioner" – 10DN – EcoSonic X12 USM – outlet pipe.

5.2.7 Pressure connection for external volume corrector

An external volume corrector can be connected to the EcoSonic X12 gas meter. Information regarding the flow and the operating volume is transmitted to the volume corrector via the pulse interface or the EcoSonic X12 encoder interface or via Modbus (DSfG instance F).
In order to perform a correction that is valid for custody transfer measurements, this transmission line must be secured at the volume corrector and the EcoSonic X12. With the EcoSonic X12, this is achieved by securing the terminal compartment, the screw cap and the screwed cable glands.

The pressure transducer of an external volume corrector is connected to the pressure measuring point “pm”.
The gas pressure is measured directly at the metering point and is guided to the pressure measuring point “pm” through a pressure line inside the USM housing. The following applies both for the pressure line in the USM housing and for the line from the pressure measuring point to the pressure transducer of the volume corrector:

In order to guarantee reliable metering, it must be ensured that the pressure line from the metering unit to the pressure sensor always has an ascending gradient wherever possible. It is important that it does not have a descending gradient at any point.

For a correction that is valid for custody transfer measurements, the line to the pressure transducer must also be secured at the pressure connection p_m.

WARNING

Risk of explosion

The system with the EcoSonic X12 can be used with gases that are detrimental to health and that are under high pressure at high temperatures.

Activities such as installing or dismantling the EcoSonic X12, or repair or maintenance work for which the metering unit or gas-carrying parts need to be opened, must only be performed with a vented and de-pressurised line and when the system is shut down.

Fig. 24 Pressure connection for external volume corrector (sealed)

- The applicable safety guidelines must be observed during the connection process.
- Once connection is complete, check for gas leaks in accordance with the applicable rules and guidelines.

5.2.8 Temperature metering points

The thermometer in the EcoPT measures the gas temperature on a continual ongoing basis. It is installed in a protective thermowell within the flow of gas, and can be secured such that it is valid for use with custody transfer measurements.

There must be an additional temperature measuring point in order to carry out a functional test relating to custody transfer measurements or on-site certification for custody transfer measurements. In this case, the gas temperature is checked using a second independent thermometer, and the results compared with the values from the EcoSonic X12 sensor. If possible, the two thermowells are arranged close to one another and close to the flow measurement.

5.2.8.1 Temperature measuring points in the outlet pipe

There are installations where the thermowells are fitted not in the metering unit housing but in the outlet pipe. This must be determined when planning the measurement section. Possible examples for the installation of a thermowell in the outlet pipe are as follows:

- DN 80 and DN 100 metering units (up to PN 25). A thermowell can be integrated into the metering unit housing. A second thermowell is fitted in the outlet pipe.
- Metering units with ANSI flanges. Both thermowells can be fitted in the outlet pipe.
- Bidirectional sampling: With this installation, the flow is also measured in the opposite flow direction 2 (DIR2). Thermowells in the metering unit housing would disrupt this measurement. In this case, thermowells on the EcoSonic or the volume correctors can be fitted at a distance of 3 DN to 5 DN from the flanges on the EcoSonic X12.
- The temperature measuring points of external volume correctors are fitted in the outlet pipe. The temperature measuring point for functional testing and re-certification for custody transfer measurements can be used to check both the external volume corrector and the EcoSonic X12 volume corrector.
- In the event of permanent series connection with a second ultrasonic gas meter fitted directly downstream, the temperature transducers must be fitted downstream from the second ultrasonic gas meter.

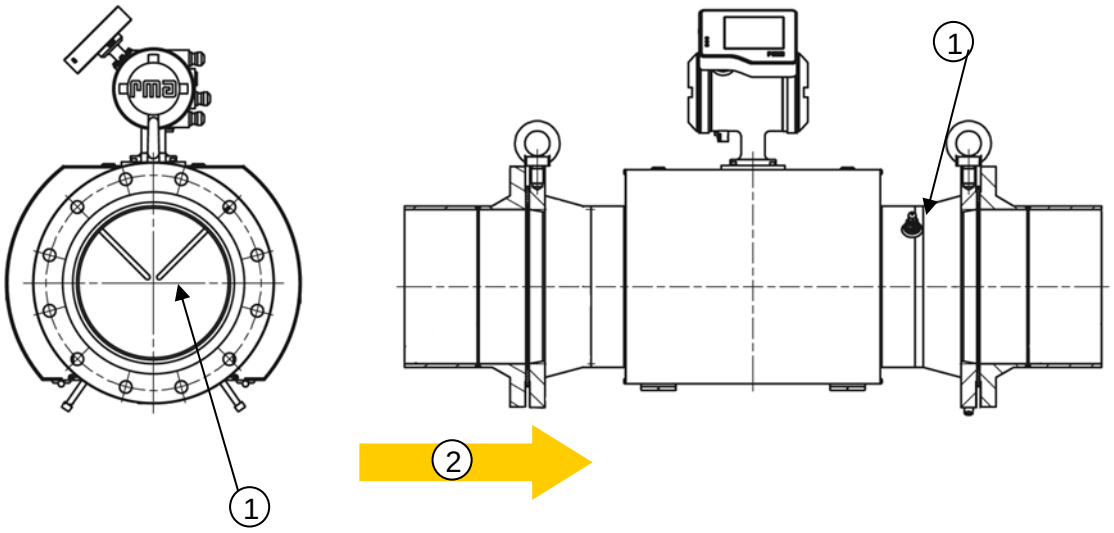


Fig. 25 USM with integrated thermowells (1) – flow direction (2)

Depending on the design, the temperature measuring points can also be integrated into the metering unit – underneath the side panel or on the outside. With low nominal widths in particular, temperature measuring points are fitted in the outlet pipe:

Important

The following applies for temperature measuring points in the outlet pipe with flow only in the main flow direction:

The distance to the EcoSonic X12 must be at least 1.5 DN. The distance must also not exceed 3 DN and must also not exceed 600 mm. (unidirectional installation)

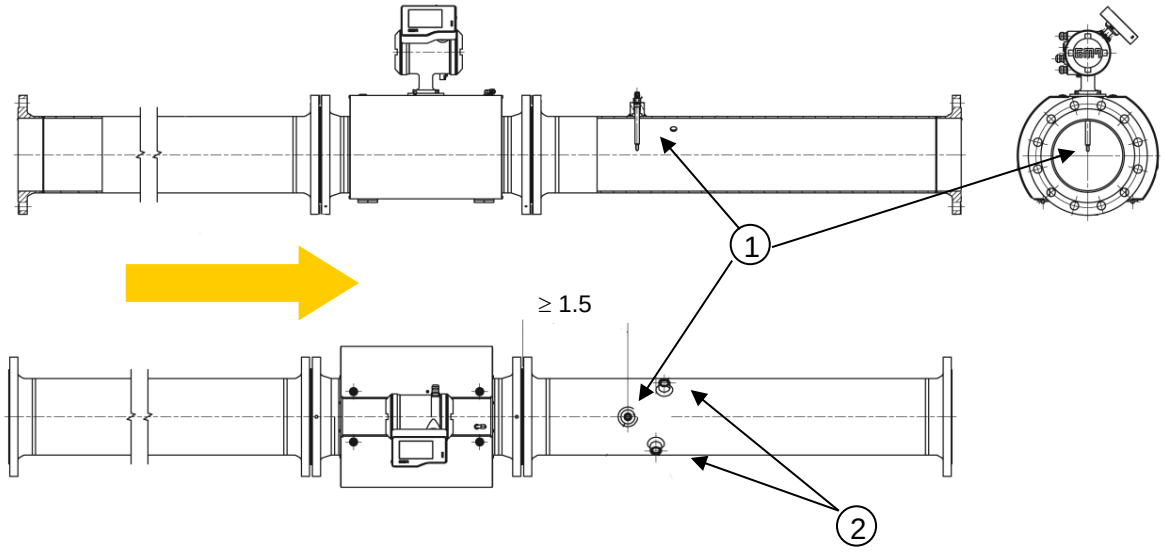


Fig. 26 Example of an external RMA thermowell (1)

The example in Fig. 26 shows an RMA thermowell (1) 1.5 DN in the outlet pipe for the temperature sensor and two additional sleeves (2) for the thermowells for an external volume corrector (2).

5.2.8.2 RMA thermowells

Depending on the metering point or the EcoSonic X12 version, there is an empty thermowell in the metering unit or in the outlet pipe. The thermometer that is used to carry out the check must be no greater than di ≤ 6.5 mm in diameter. The sensor itself must have a sufficient length L_{min} so that it can be inserted right down to the tip of the thermowell.
The exact requirements for the length L_{min} depend on the particular installation.
Approximate reference values are as follows:

Nominal width	Inner diameter of the thermowell [mm]	Min. length [mm]
DN 80	6.5	90
DN100	6.5	120
DN 150	6.5	120
DN 200	6.5	145
DN 250	6.5	170
DN 300	6.5	200
DN 400	6.5	200
DN 500	6.5	200
DN 600	6.5	200

5.3 Installation direction - access for testing and maintenance

There is a directional arrow (1) affixed to the EcoSonic X12 metering unit, indicating the main flow direction. The EcoSonic X12 must be fitted such that the directional arrow is facing in the direction of the gas flow (main flow direction).

The EcoSonic X12 gas meters are produced as standard such that the T-bore ball valve and the EcoTouch operating unit are fitted on the same side.

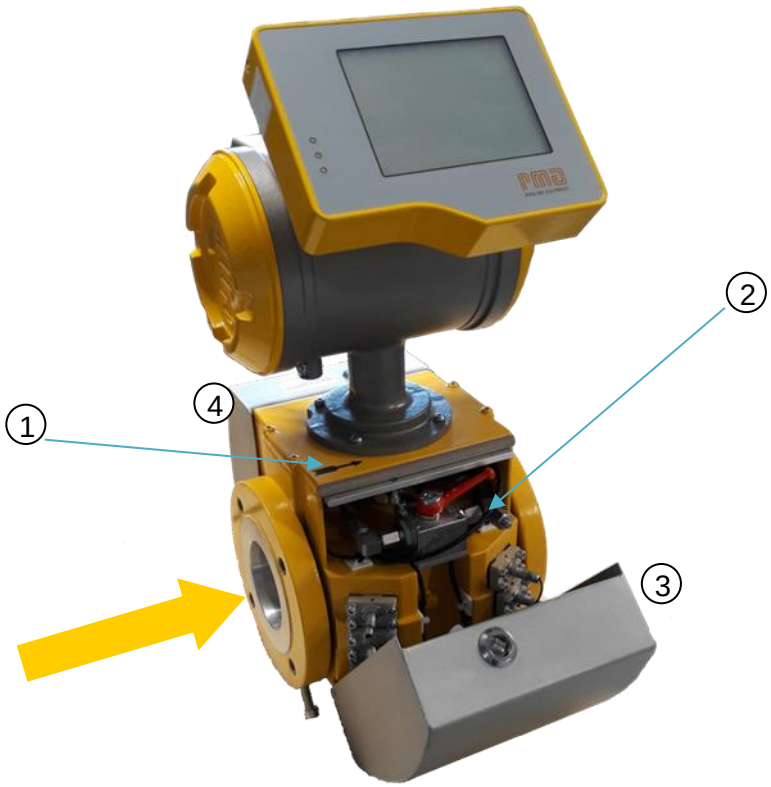


Fig. 27 Installation direction (1)

During servicing work and when performing on-site certification for custody transfer measurements (volume corrector), the panels at the front (3) and rear (4) must be opened and removed in order to provide access to the ultrasonic transducer, the temperature sensor and the T-bore ball valve.

The panels are sealed in units for custody transfer measurements. They will need to be opened at the T-bore ball valve in the event of an EVC functional test for custody transfer measurements. If there are integrated thermowells, both covers will need to be opened.

Metering units with large nominal widths are also produced in the EcoSonic version with external T-ball valve. Covers are not opened, but are detached at the top and bottom and can then be removed. (Service and maintenance work by RMA).
The T-bore ball valve and the connection for the test pressures are fitted outside of the covers. If the temperature measuring points are also located outside of the covers, e.g. in the outlet pipe, then certification for custody transfer measurements or an audit check of an integrated volume corrector can be performed without removing the covers.

5.3.1 Installation of the EcoSonic X12 in the pipeline

The applicable safety regulations must be observed when working on the EcoSonic X12 or the metering point. The following points must be observed in particular in relation to the EcoSonic X12 ultrasonic gas meter:

DANGER

Risk of explosion, risk of death, risk of injuries

The metering system with the EcoSonic X12 can be used with gases that are detrimental to health and that are under high pressure at high temperatures.

Work on the metering system or the gas-carrying system must only be performed by qualified persons.
Also observe the national and regional safety regulations and the provisions regarding safety, protective clothing and behaviour that apply at the metering point.

WARNING

Risk of explosion

The EcoSonic X12 is approved for use in ATEX zone 1, i.e. in temporarily explosive atmospheres.

The specified ignition protection class must be considered before the system is used in potentially explosive areas.

WARNING

Risk of explosion

The system with the EcoSonic X12 can be used with gases that are detrimental to health and that are under high pressure at high temperatures.

Activities such as installing or dismantling the EcoSonic X12, or repair or maintenance work for which the metering unit or gas-carrying parts need to be opened, must only be performed with a vented and de-pressurised line and when the system is shut down.

WARNING

Risk of injury, risk of crushing

Injuries and/or crushing may occur when lifting and installing the EcoSonic X12.

Suitable lifting equipment must be used when lifting and installing/dismantling the EcoSonic X12. The weight of the EcoSonic X12 is specified on the main data plate. Lifting eyes are attached to the flanges on EcoSonic X12 products with nominal widths of DN 150 and over. Check the lifting eyes for secure fit, and use them to lift the EcoSonic X12.

The EcoSonic X12 must always be securely fixed in position, even during storage and transport.

Observe the following points when installing the EcoSonic X12 in the metering point pipeline:

- Do not remove the sealing caps on the flanges until shortly before installation.
- The sealing faces of the flanges must be clean and undamaged.
- The EcoSonic X12, the inlet pipe and the outlet pipe must be aligned precisely so as to prevent any offset at the joints.
- The flange seals must fit correctly. They must not protrude into the pipeline.
- During installation, the regional and local regulations must be observed in addition to the regulations of the metering point operator. (e.g. provisions regarding the tightening torques)
- After installation, check for gas leaks in accordance with the applicable regulations and guidelines.

5.4 Electrical installation in an Ex zone

The following basic rules apply for carrying out electrical work on the EcoSonic X12:

DANGER

Risk of explosion, risk of death, risk of injuries

The metering system with the EcoSonic X12 can be used with gases that are detrimental to health and that are under high pressure at high temperatures.

Work on the metering system or the gas-carrying system must only be performed by qualified persons.
Also observe the national and regional safety regulations and the provisions regarding safety, protective clothing and behaviour that apply at the metering point.

The applicable rules and standards must be strictly adhered to for the connection and operation of the EcoSonic X12. The following must be observed in particular:

- The standards for the installation, testing and servicing of electrical systems in potentially explosive atmospheres must be complied with; in particular EN 60079-14 (in conjunction with IEC 79-0), EN 60079-17 and EN 60079-19.
- The equipotential bonding must be configured in accordance with EN 60079-14.
- The USM electronics housing must be connected to the equipotential bonding.
- When using a detached EcoTouch operating unit, the EcoTouch must be connected to the equipotential bonding.
- Equipotential bonding is required as set out in Item 5.4.1.
- The cables must meet the prerequisites stipulated in EN 60079-14.
- In order to protect against mechanical damage, the cables must be fitted in cable ducts or pipes. All connections to cable armour or cable shielding should be kept as short as possible. When laying cables, the minimum permissible bend radii must be observed. The conductor ends must be fitted with wire-end ferrules to protect against splaying.
- The intrinsically safe wiring system between the EcoSonic X12 and the EcoTouch and the EcoPT must only be connected to the EcoTouch (TÜV 09 ATEX 554349) or the EcoPT (TÜV 09 ATEX 554350).

DANGER

Risk of explosion, risk of death, risk of injuries

The metering system with the EcoSonic X12 can be used with gases that are detrimental to health and that are under high pressure at high temperatures.

The housing of the USM electronics must only be opened when the power supply is switched off and only if it has been ensured that there is no potentially explosive atmosphere at the EcoSonic X12. (This also applies to screwed cable glands and Ex-blank plugs)

5.4.1 Equipotential bonding

When installing the EcoSonic in a potentially explosive area, the EcoSonic X12's connection to earth must always be connected to the local equipotential bonding using as short a cable as possible (cable cross-section ≥4 mm²). The connection screw is located underneath the USM housing (see illustration).
The brass screw next to the equipotential bonding is a vent screw and must not be opened!

In the version with detached EcoTouch, the connector box's connection to earth (underneath the EcoTouch) must be connected to the local equipotential bonding of the EcoSonic.

Fig. 28 Connection of the equipotential bonding (1) to the EcoSonic

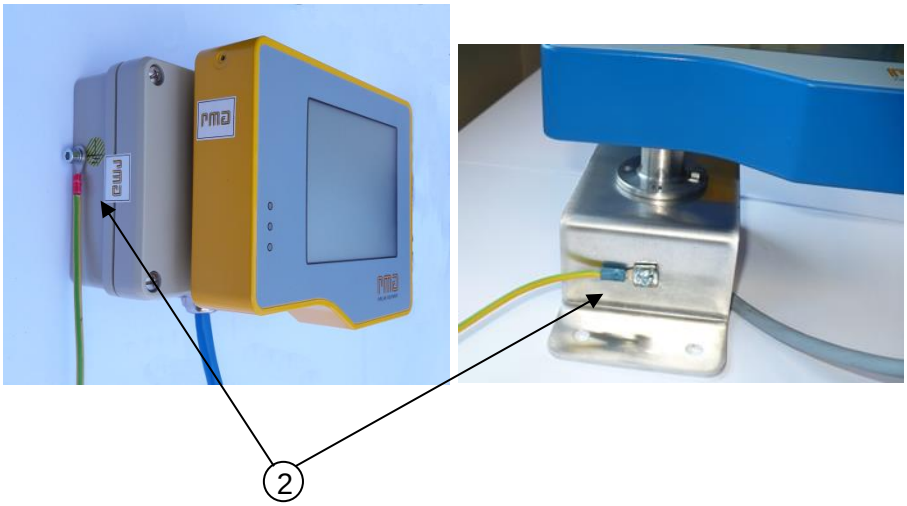


Fig. 29 Connection of the equipotential bonding (2) with detached EcoTouch

5.4.2 Electrical connections – power supply, data cables

The supply and data cables are connected in the terminal compartment of the EcoSonic X12 (exception: heating lines of product version described in 5.4.7). The terminal compartment is located on the side of the EcoSonic electronics housing, behind the screw cap near the screwed cable gland.
The connections to the EcoTouch are connected underneath the black cover. The area is sealed and must not be opened.
In the lower area, there is a terminal block with digital outputs DO1 … DO6 and a terminal block with RS485 connections and the power supply. The labels “DO1”… “DO6” and “RS485” are permanently affixed to the circuit board. The functional use of the connections by the firmware can also be specified on adhesive labels.

Fig. 30 EcoSonic terminal compartment (NAMUR-compatible versions + integrated Ex-i capability)

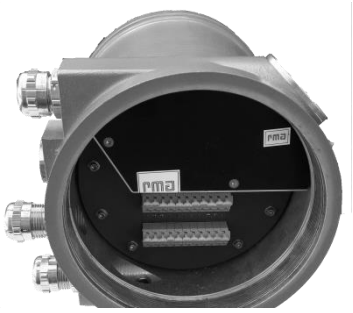


Fig. 31 EcoSonic terminal compartment (Ex-e terminal compartment version)

EcoSonic X12 gas meter with electronics as described in Fig. 31 are designed for the connection of Ex-e wiring systems. NAMUR connections and Ex-i wiring systems require additional external measures (safety barriers or resistors).

WARNING

The screw cap on the opposite side is secured by an adhesive label and a screw on delivery. For installation in potentially explosive areas, these security devices must not be damaged as the screw cap must not be opened.

It serves as an access point for the electronics, and must not be opened during normal operation or during testing or re-certification for custody transfer measurements. Access is only required when replacing electronics modules or batteries, which may only be carried out by qualified personnel trained by RMA.

Any conductors that are not required should be left open and isolated (e.g. with suitable terminal connections). Standard 60079-14 must be observed (Section 9.6 as well as Section 16.2.2.5.3 in the case of intrinsically safe wiring systems).

Terminal zones:	Stripping length:
rigid conductors: 0.2 mm^2 … 4 mm^2	10 mm

For the data cable:	twisted in pairs, shielded; cable impedance approx. 120 Ω, e.g. LiYCY (TP), PUR CP (TP), max. cable length 500 m. (The length may be limited if necessary for connecting to intrinsically safe wiring systems).

Standard cable type for the supply cable: 1.5 mm^2, unshielded.

All RS485 connections are not electrically isolated from the equipotential bonding.
The RS485 outputs must only be connected to SELV/PELV wiring systems.

5.4.3 Digital outputs DO1 … DO6

All digital outputs are electrically isolated from one another.

Digital outputs DO1…DO6 must only ever be connected either to voltage SELV/PELV or alternatively to suitable intrinsically safe wiring systems in accordance with the specifications in 3.1.4.6 (see 3.1.4.6).

Mixed operation is not permitted.

Operation in ignition protection class Ex-i (EN 60097-11) can be carried out again with a modified installation following operation in an installation in line with ignition protection class Ex-e (EN 60097-7).

5.4.4 Cable and line entries

EcoSonic X12 is delivered with screwed cable glands.

Special conditions apply for use in ATEX zones:

- Only fixed lines and cables may be fed in. The operator must guarantee appropriate strain relief.
- The sealing rings on the screwed cable glands must not be cut with a knife.
- Unused screwed cable glands on the USM housing must be replaced with the supplied EX-e sealing plugs.
- The tightening torques of the screwed cable gland and the blank plugs must be observed.

If required, other suitable screwed cable glands can also be used following consultation with RMA Mess- und Regeltechnik GmbH & Co. KG.

Standard M20 screwed cable glands on the EcoSonic X12:

Execution	Sealing area max-min Ø	max. tightening torque
Pflitsch blueglobe bg 220msHTex	14-5 mm	10 Nm
Pflitsch blueglobe EMC bg 220ms tri HTex (with shield contacting)	14-9 mm	10 Nm
Pflitsch 7220 / DRex. Ex blank plug Nickel-plated brass	—	10 Nm

5.4.5 Wiring diagrams

5.4.5.1 Version with integrated NAMUR and Ex-i capability

To help with system planning, wiring diagrams (RMA no. 3.9306.9000) are available for the following eight versions:

- DO1 … DO6 connected to the intrinsically safe inputs of a volume corrector
  or to non-intrinsically-safe inputs
- EcoTouch directly attached to the USM electronics (not detached)
  or detached (fitted a maximum of 20 m cable length away)
- Temperature range −25 °C … 55 °C
  or extended temperature range −40 °C … 60 °C (not for applications in line with the Measuring Instruments Directive - MID)

5.4.5.2 Version without integrated NAMUR or Ex-i capability

For the version without integrated NAMUR or Ex-i capability, wiring diagrams (RMA no. 3.9306.9001) are supplied for the various versions:

- EcoTouch directly attached to the USM electronics or detached
- Temperature range −25 °C … 55 °C or for use with the heated display for temperatures from −40 °C … 60 °C.

The terminal designations J0, …, J22 are used with this version.

5.4.6 Connection to the detached EcoTouch (operating unit)

The USM electronics and the detached EcoTouch must only ever be connected using the cable supplied by the manufacturer (maximum length 20 m). The maximum connection length is 20 m (ATEX type-examination certificate). The connection is subject to specific ATEX requirements. For more detailed information on this, please contact RMA Mess- und Regeltechnik.
In the USM electronics, the connection is already attached and is sealed with an adhesive manufacturer label. Once the cable has been laid on site, the free end is connected to terminal block J1. The shielding remains free here and must be isolated. The connector box must also be secured in a way that ensures validity for custody transfer measurements following installation where applicable.

The pin assignment can be found in the current wiring diagram.

5.4.7 Connecting the heater circuit to the connector box (non-MID)

With the EcoSonic X12 version for operating temperatures −40 °C … +55/60 °C, the EcoTouch display needs to be heated up (Ex-i). To this end, the outputs for the related EcoHT equipment must be connected to terminal strip J3 in the connector box via an unshielded cable.
The length is limited to around 100 m by the ATEX limiting values for the related equipment and the inductance of the cable (suitability must be verified during installation). Depending on the length, either 2.5 mm² or 4 mm² should be selected in order to ensure effective power transmission. The screwed cable gland of the connector box is suitable for cable diameters of between 5.0 mm and 14.0 mm.

Further details can be found in the wiring diagrams (RMA no. 3.9306.900x) for versions with the extended temperature range.

5.5 Interface properties and configuration

The functions of some interfaces can be specifically configured as restricted by the software, whereas others have functions that are permanently assigned.
Assignment on delivery of the EcoSonic (see also the adhesive labels in the terminal compartment):

5.5.1 Version with integrated NAMUR and Ex-i capability

Terminals D01 … DO6	DO1… DO3	Status signals/digital outputs 1-3 (configurable)
	DO4	Encoder
	DO5	Counter progress (configurable metering unit)
	DO6	Counter progress (configurable metering unit)
Terminals RS485 …,	RS485 RS1	Diagnostics (EcoView software/Windows PC via RS485 converter)
	RS485 RS2	Only following consultation (encoder - for compatibility with existing installations)
	RS485 RS3	Modbus

5.5.2 Version without integrated NAMUR or Ex-i capability

	Terminal designation	Use	
		Short	Long
①	J01 J02	UDC+ UDC−	Input 24VDC supply
②	J03 J04 J05 J06	DSfG RS485 V_{CC} DSfG RS485 GND DSfG RS485 B DSfG RS485 A	RS485 DSfG Bus/Modbus. Connection to conductors twisted in pairs.
③	J07 J08	Diag RS485 A Diag RS485 B	RS485, diagnostic interface. Connection to conductors twisted in pairs.
④	J09 J10	Enc RS485 A Enc RS485 B	RS485, encoder interface. Connection to conductors twisted in pairs.
⑤	J11 J12	Status 4 − Status 4 +	Status signal 4, freely assignable
⑥	J13 J14	Status 2 + Status 2 −	Status signal 2, freely assignable
⑦	J15 J16	Pulse 2 − Pulse 2 +	Pulse signal 2, volume-proportional pulse signal, suitable for parameterisation
⑧	J17 J18	Pulse 1 − Pulse 1 +	Pulse signal 1, volume-proportional pulse signal, suitable for parameterisation
⑨	J19 J20	Status 3 − Status 3 +	Status signal 3, freely assignable
⑨	J21 J22	Status 1 − Status 1 +	Status signal 1, freely assignable

Unlike the product version with integrated NAMUR or Ex-i capability the encoder is only implemented as an RS485 interface. A fourth status output is available.

5.5.3 Status outputs

These digital outputs can be assigned with status and warning messages with definable polarity using EcoView, e.g.:

- All alarms
- All warnings
- USM warnings
- …
- System alarms
- Pressure outside of range
- Operating disturbance volume
- …

5.5.4 Encoder output

This output interface gives out permanently set, non-reactive and unidirectional volume meter readings of the EcoSonic X12. There is the option to select either operating volume (V_m) or original volume (Vo) in the main flow direction. For transmission of data for custody transfer measurements, the transmission line must be secured accordingly on both sides.

The counter reading transmission is performed 1x per second at a rate of 2400 bit/s.
The transmission is performed character by character. Each character is made up of 1 start bit, 7 data bits, even parity and 1 stop bit. The data frame here follows the EAZ guideline of the DVGW.

5.5.4.1 Parameters

The encoder interface can be parameterised, as connected volume correctors expect different data formats:

- Encoder digit numbers: 8 to 14
- Encoder value: 0.01 to 100
- Volume meter type: Operating volume (V_m) or original volume (Vo)

The settings are compared with the receiver settings in advance. The transmission of data is checked during initial operation at the latest.

5.5.4.2 Digital output encoder – RS485 encoder

The EcoSonic version with integrated NAMUR and Ex-i capability is the right option for reading out the encoder using a volume corrector. The counter reading can be retrieved at the terminal connections for digital output DO4.

In both EcoSonic versions, the encoder information can be retrieved at an RS485 interface. Additional external safety barriers or resistors are usually required in this case. Get in touch with RMA Mess- und Regeltechnik GmbH & Co. KG for more information.

5.5.4.3 Data transmission

The encoder transmission is performed 1x per second at a rate of 2400 bit/s.
The transmission is performed character by character. Each character is made up of 1 start bit, 7 data bits, even parity and 1 stop bit. The data frame here follows the EAZ guideline of the DVGW.

5.5.5 Pulse outputs

The two independent, configurable interfaces transmit the counter increases as a pulse. This could be the increase in the measured operating volume at an externally independent volume corrector, for example. Parameterisation and adjustment of the pulse outputs

5.5.6 Diagnostic interface

The diagnostic interface works via a protocol that is similar to Modbus, with CRC-secured data packets. The data is transmitted in RTU mode. The settings are as follows:

- 115200 baud, 8 data bits, no parity, 1 stop bit (8N1)

The interface is usually connected via an RS485 <-> USB converter to a PC on which the EcoView program is running.

The diagnostic interface can be used to display data and to read out and set parameters. Access management for writing parameters is controlled by the EcoTouch firmware. The EcoTouch display reliably shows parameters, altered parameters and measured values that are valid for custody transfer measurements. From a custody-transfer-measurement perspective, the EcoView program only shows copies of the data and the parameters.

5.5.7 Modbus interface (with instance F protocol)

Measured values from the EcoSonic X12 can be accessed via this interface.

The interface parameters can be configured on the EcoTouch operating unit or using the EcoView program (user level 3 or above):

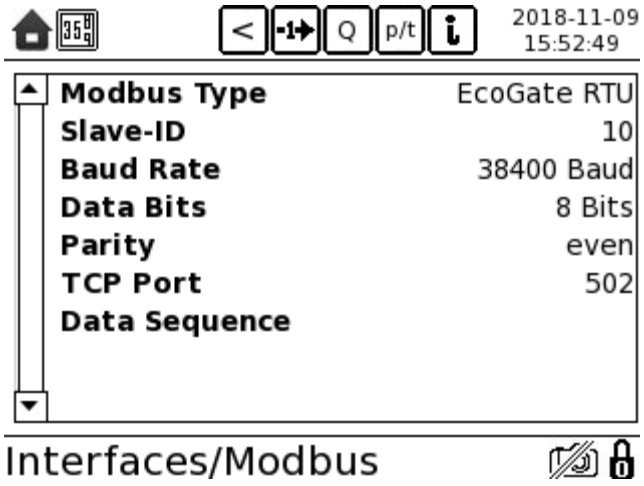


Fig. 32 Overview of interface parameters

Modbus Slave ID	1 – 247
Transmission rate	0 = 9600 1= 19200 2 = 38400 3 = 57600 4 = 115200
Parity	0 = no parity 1 = even parity 2 = odd parity

The Modbus interface is usually operated in RTU mode. Measured flows and volumes can be read off via the interface, as can the pressure and temperature values, the average flow velocity and the speed of sound. The Modbus interface is not subject to compulsory certification for custody transfer measurements, and is non-reactive.

5.5.7.1 Modbus – instance F protocol

In the EcoSonic X12, the DSfG protocol for meters (instance F) is integrated based on the Modbus register. Access is non-reactive. Only data retrieval is implemented via the protocol. The requesting receiver receives data regarding the flow, counter readings, status etc. as agreed in the protocol.

The following illustration shows the interface selection menu with the selections required for setting the protocol.

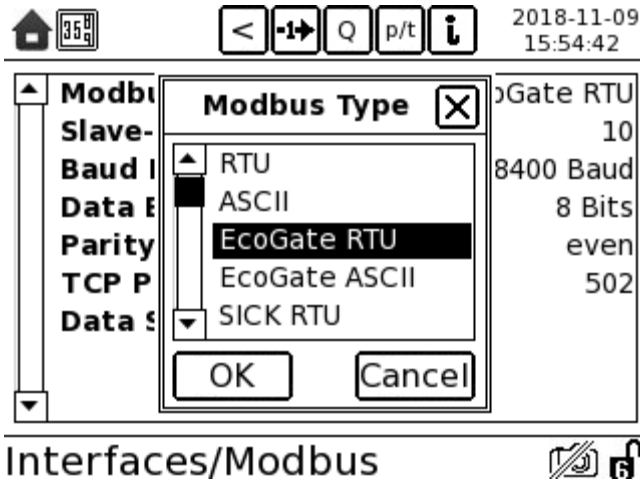


Fig. 33 Modbus type EcoGate RTU for instance F

Selecting the EcoGate RTU transmits meter data to an external volume corrector or flow computer in accordance with the DSfG transmission protocol, instance F. The protocol makes it possible to connect each instance-F-compatible volume corrector and flow computer.

The connection of the ultrasonic gas meter to an instance-F-compatible volume corrector or flow computer is listed in the type-examination certificate for the EcoSonic and is a simple procedure. The following components are connected in the EcoSonic terminal compartment:

- Power supply
- Modbus with instance F (EcoGate RTU selection)
- Diagnostics

6. Initial operation

Once it has been installed and connected to the power supply, the EcoSonic X12 starts up and starts the metering operation. The metering unit is calibrated in the factory, has been configured based on customer requirements as applicable, and is ready for metering operation following installation and connection.

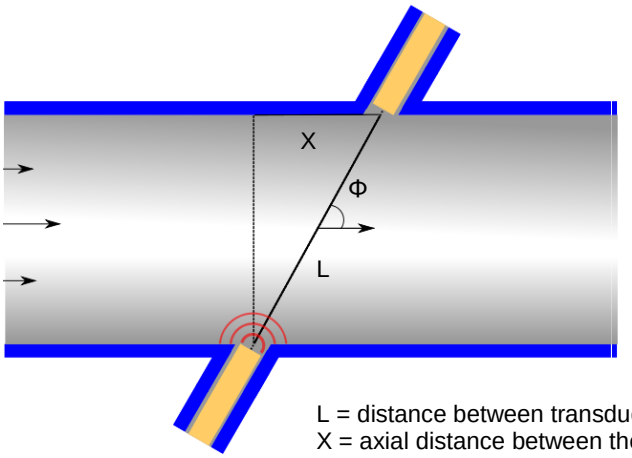
In order to operate the EcoSonic X12 in a manner subject to compulsory certification for custody transfer measurements, the installation, the metering unit settings and other points must be checked by an officer of the Metrological Authority before starting up operation and before the measurement results can be used for billing purposes.

7. Measurement principle

The EcoSonic X12 works based on the transit time difference principle. The flow rate of the gas is determined based on the different transit times of ultrasonic signals through the flowing gas. Ultimately, it is the transit time of the ultrasonic signals, the dimensions in the metering unit and the gas pressure and gas temperature that are used to calculate all other values such as the flow rate, the operating volume V_m and the base volume V_b.

7.1 Determination of the flow rate

An ultrasonic signal is sent from transducer A to the opposing transducer B via the metering unit, at an angle of 60° to the direction of the flow. The transit time is measured.



L = distance between transducers
X = axial distance between the opposing transducer openings
Φ = angle between the flow and the sound path

Fig. 34 Determination of the flow rate

Transducer B then sends an ultrasonic signal to transducer A.

If there is no flow of gas, i.e. in the event of stationary gas, then the transit time between the transducers will be the same, regardless of whether transducer A sends a signal to transducer B or vice versa.
If there is a flow of gas and the signal is sent in the direction of the flow of gas, the transit time t_d will be shorter. In the opposite direction (from B to A), the signal is sent against the flow of gas. The transit time t_u will be longer. The higher the flow rate, the larger the difference between the measured transit times $t_u - t_d$. (The index “u” in t_u stands for upstream, and the index “d” for downstream)

The transit time of the ultrasonic signal from one transducer to the other depends on the length of the sound path L_{path}, the speed of sound in the gas c_{gas}, the angle to the direction of the flow cos Φ and the flow rate via the measuring path v_{path}. The transit time in the flow direction t_d (d for downstream) is calculated as follows:

(1) $$t_d = \frac{L_{path}}{c_{gas} + v_{path} * \cos\phi}$$

For transit time against the flow direction t_u (u for upstream), the following equation applies:

(2) $$t_u = \frac{L_{path}}{c_{gas} - v_{path} * \cos\phi}$$

The flow rate v_{path} of the gas is calculated based on the difference between the two equations. The sum of the equations provides the speed of sound in the gas.

7.1.1 Zero offset adjustment – offsets – path adjustment

When calibrating the EcoSonic X12, the influences of the measurement set-up and the electronics on the transit time measurement are determined by carrying out a zero offset adjustment. The “cumulative transit time offset” is determined by taking a measurement with gas, with a known speed of sound and a known temperature.

The transit time difference offset is temperature-dependent and has an influence on the measurement of the gas flow rates for each measuring path, in particular in the case of low flow rates. Therefore, the transit time difference offset is determined for each path by carrying out a factory calibration at 5 different temperatures.

These calibration parameters are used in order to achieve a very high level of accuracy when calculating the speed of sound in the gas and the flow rate.

In addition to the calibration steps specified above, there is also the option of carrying out a fine adjustment of the transit time difference under high-pressure conditions and with zero flow. This adjustment is only possible when the calibration switch is open, and is performed automatically using the EcoView program. This helps to ensure path velocities of < 6mm/s at zero flow and room temperature under high-pressure conditions, and an average USM flow rate of ≤ 1mm/s. The calibration values for 1 bar air are not affected by this adjustment.

In addition to these calibrations, the expansion of the metering unit as a result of pressure and temperature changes is also taken account when determining the flow (Section 7.1.7 Correction of pressure and temperature influences).

7.1.1.1 Path adjustment:

With flowing gas, the sound path does not travel in a perfect straight line, but is curved. Depending on the gas flow rate and the profile of the flow of gas, the sound path may be fractionally longer. The following correction factor takes into account the actual length of the path taken by the ultrasonic waves through the flowing gas.

(3)
$$L_{path} = L_{path} * \left(1 + \frac{1}{2} * \frac{X^2}{L^2} * \frac{\bar{v}^2}{\bar{c}^2_{path}} * \tan^2 \varphi \right)$$

(The correction uses the average flow rates $\bar{v}$ and speeds of sound $\bar{c}$ from the immediately preceding measurements).

7.1.2 Determination of the gas velocity

The difference between the transit times $t_u - t_d$ provides the flow rate v_{path} measured on a measuring path.

(4)
$$v_{path} = \frac{L^2_{path}}{2 * X_{path}} * \left(\frac{t_u - t_d - dt\_corr}{t_u * t_d} \right)$$

The correction factor dt_corr takes into account the aforementioned effects of the zero adjustment and temperature compensation. The length-corrected signal path is used for L_{path}.

7.1.3 Measuring interval and path velocity

An ultrasonic signal, such as the one measured during the zero adjustment, typically has the following structure:

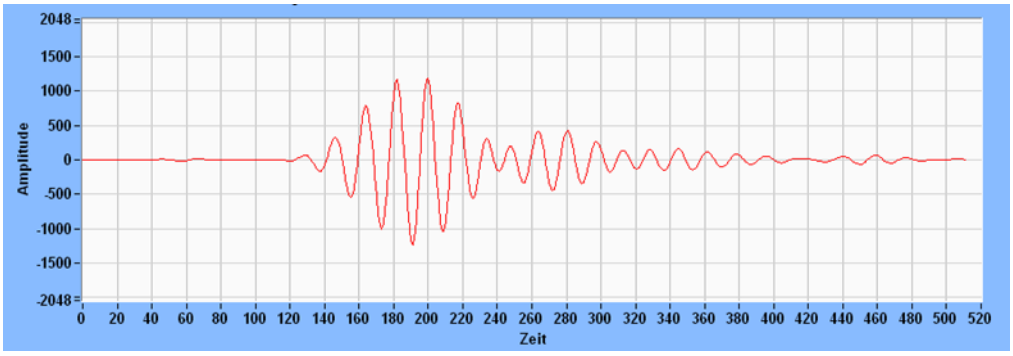


Fig. 35 Ultrasonic signal during zero adjustment

In order to accurately determine the transit times t_u and t_d from the measured analogue signals, a cross-correlation analysis is performed. The measured analogue signals are amplified, sampled, evaluated and are then used in the analysis. During this process, there are substantial demands placed on the quality of the measured signal. Measured signals that do not meet these criteria are rejected prior to the cross-correlation analysis.

To this end, an envelope is formed over the measured and amplified signals. One criterion for the validity of the measurement is a sufficient rise in the envelope. The intersection between the envelope tangent and the time axis is useful for the subsequent cross-correlation analysis. The results of the cross-correlation analysis are also checked for plausibility.

The measurement is performed 10-times per second on each measuring path.

7.1.3.1 Error rate

The proportion of rejected measurements is determined as a percentage-based error rate for each measuring path over 50 measurements, i.e. every 5 seconds. The current error rate of each path is displayed on the EcoTouch operating unit and in the EcoView operating and diagnostics program.

In normal operation, the error rate may well be 50% or even higher. However, even with an error rate of 50%, the measured values are still based on 5 measurements per second.

This “error rate” is heavily dependent upon the flow rate. If there is no flow or if the flow is very slow, there will usually be an error rate of zero in the range of Q_{min}. Nevertheless, the measured high flow rates are also correct at high error rates. Due to the configuration of the system and the restriction to the maximum volume rate Q_{max}, a maximum flow rate is implicitly specified for the operating range and of custody-transfer-measurement range of the metering unit.

A fixed internal limiting value is defined for the error rate. If the measured error rate exceeds this limiting value, the measurement is invalid. The flow is assigned to the disturbance volume.

An authorised user has the option of specifying individual user-defined threshold values for the error rate. This makes it possible to issue a warning in good time, which will be recorded in the log.

The option of specifying a user-defined error rate has been provided in order to give the user access to the parameters for the measurement process. Users can measure the error rate at their metering point. They can reduce the threshold value of the user-defined error rate in line with the conditions prevalent at the metering point, meaning that they will be alerted in good time to any changes at the metering point.
The user-defined error rate limit has no impact on the measurement or metering accuracy.

7.1.3.2 Formation of average values

The measurement process is continually repeated. 10 measurements per second are performed on each of the six independent measuring paths. The measured values for the flow rates and flows pass through a median and average value filter.

(5)
$$\bar{v}_{path} = \frac{\sum_{i=1}^{n} v_{path,i}}{n}$$

The depth N of the average value filter and the depth M of the median filter are adjustable.
The pre-set values are suitable for standard applications as well as for the majority of applications with controllers.

- N = 8
- M = 5

In applications that require quicker measuring, these values can be reduced even further. The measurement result for Q will then fluctuate a little more:

- N=2
- M=3

In applications where rapid fluctuation of Q would be disruptive, the depth of the average value filter and the median filter can be increased:

- N=40
- M=9

Changes to M and N have virtually no impact on the integral determination of the flowed-through volume (Δ << measurement inaccuracy).

7.1.4 Arrangement of the measuring paths

The EcoSonic X12 measures the flow rate using six independent measuring paths.
The multiple measurement procedure leads to increased accuracy and redundancy.

There are always two independent measuring paths fixed crosswise on the same level. Two transducers on opposite sides and the associated transformer board with calibration data constitute a metering unit.

The designation A, B relates to the main flow direction from left to right: A is the ultrasonic transducer fitted upstream and B is the opposite transducer fitted downstream.
Path 2 and path 5 are in the middle measuring level.

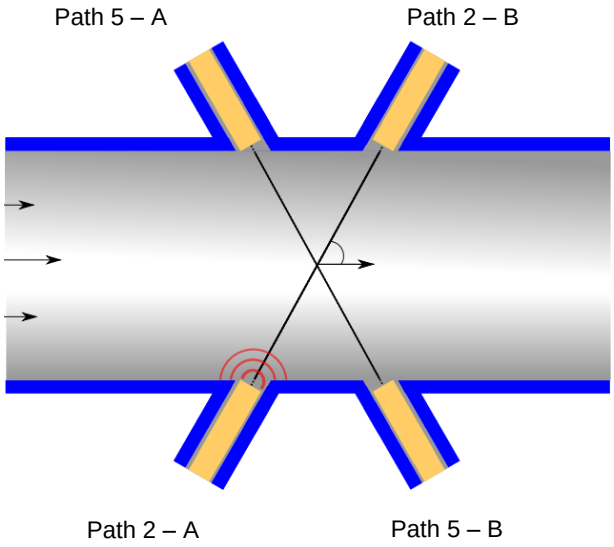


Fig. 36 Arrangement of the measuring paths

The arrangement and designation of the measuring paths is shown in diagram form in the EcoView program.

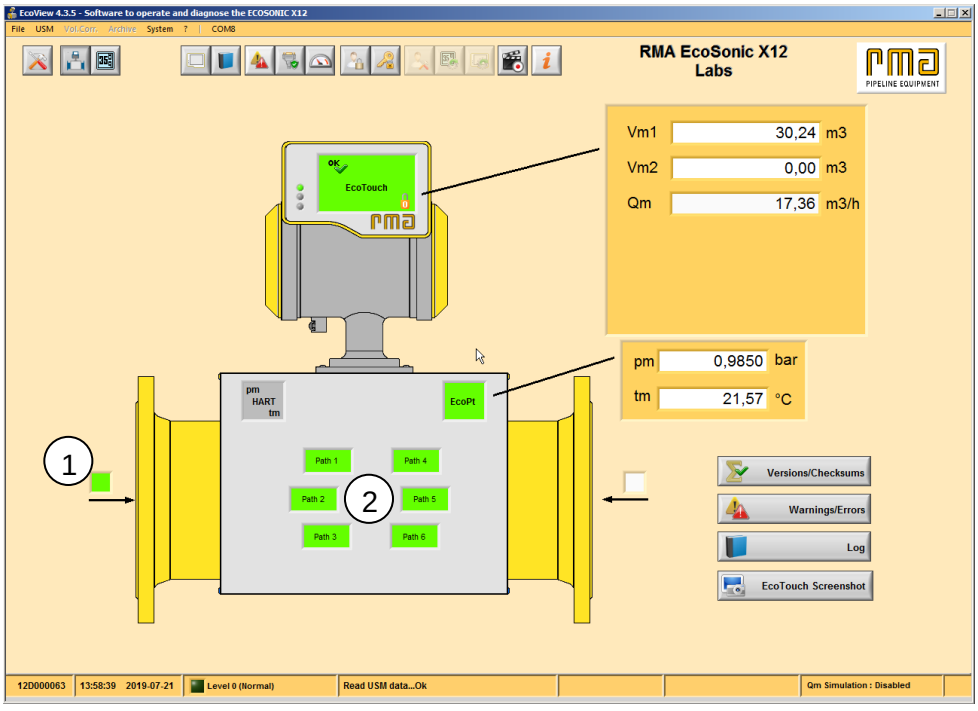


Fig. 37 Arrangement of the measuring paths - EcoView view

In the event of a failure, the individual paths, EcoPT or the EcoTouch display unit is shown in orange or red.

The arrangement of the measuring paths (2) is optimised so as to allow for the recording and consideration of information regarding the flow profile. The gas flow becomes more or less inhomogeneous depending on the cable conditions upstream from the metering unit. Despite the plans and specifications stipulating a straight inlet pipe, the metering unit measures these characteristics in the flow of gas and compensates for them when calculating the flow using the flow rates.

Flow disturbances are usually indicated by swirl, asymmetry and transverse flow. These indicators are also calculated and displayed in the EcoView program. They can be stored to a file with the other measured values for the USM.
They are non-dimensional variables that are calculated as follows using the measured velocities of the individual measuring paths:

(6) $$asymmetry = \frac{v_1 + v_4}{v_3 + v_6}$$

(7) $$crossflow = \frac{v_1 + v_2 + v_3}{v_4 + v_5 + v_6}$$

(8) $$swirl = \frac{(v_1 - v_3) + (v_6 - v_4)}{2 * \bar{v}}$$;

$\bar{v}$ = mean value of the path velocities

7.1.5 Gas flow rate

The flow rate of the gas is calculated using a weighted mean of the determined flow rates of the individual paths.

(9) $$\bar{v}_{gas} = \frac{\sum w_i * v_i}{\sum w_i}$$

The weight values of a path w_i were determined during calibration. The values can be read off at the EcoTouch operating unit or using the diagnostics software.
Typical values take into account different path geometries and are 0.25 for paths 2 and 5, i.e. in the middle measuring level, and 0.125 for the other paths.

7.1.6 Calculation of the operating flow

The operating flow of the gas is calculated using the weighted flow rate and geometry and the inner diameter of metering unit D:

(10)

$$Q_b = \bar{v}_{gas} * \frac{(D)^2 * \pi}{4}$$

7.1.6.1 Creepage volumes Q_l

The EcoSonic X12 is calibrated for flow values of Q_{min} to Q_{max}. The ratio of Q_{min} **:** Q_{max} is referred to as the measuring range or the load range of a metering unit. The EcoSonic X12 ultrasonic gas meter has a load range of 1**:**100.
Only the versions with a small pipe diameter (≤ DN 80) have a load range of 1:80.

$Q_m > Q_{max}$

If the measured flow is larger than Q_{max}, i.e. outside of the calibrated range, the gas volume will be assigned to the disturbance volume. The flow Q_m is displayed in brackets on the EcoTouch.

$Q_m < Q_{min}$

Parameters:

- Q_{max} Maximum flow rate
- Q_{min} Minimum flow rate
- Q_l Creepage limit, default = 0.25 * Q_{min}
- tQ_l Maximum dwell time for $Q_{min} > Q_m \geq Q_l$

When a metering unit starts up or stops, the metering unit flow Q_m always passes the two limiting values Q_l and Qmin. The flow direction is of no relevance here.

- If a metering unit is in operation, the flow Q_m is in the range $Q_{min} > Q_m > Q_{max}$ under operating conditions. If the pipeline is then closed, the flow Q_m will initially reach the minimum flow volume Q_{min}. If the Q_{min} value is not met, a stopwatch is started that measures the time t. As long as $t < tQ_S$, the measured flow will continue to be counted on the operating volume metering unit.
  After a period of time t, the flow will reach the creepage limit Q_l. The stopwatch will pause. If the flow does not meet the creepage limit Q_l, the flow display will be set to zero and the time t will be reset.

If the time t exceeds the limiting value tQ_l, the flow display will also be set to zero.

- If the pipeline is opened, the process will run in reverse. Q_m is set to zero until Q_m exceeds the creepage limit Q_l. If $Q_m < Q_l$, the stopwatch will start counting. If Q_m increases further and exceeds Qmin, the stopwatch will reset.
  At a flow of $Q_l > Q_m \geq$ Qmin, checks will be performed on a continual basis to establish whether the measured time t has exceeded the tQ_l limit.
  If this is the case, an alarm notification will be triggered. If Q_l is not met or if Qmin is exceeded, the alarm will automatically be acknowledged.

The configurable creepage limit Q_l serves to ensure that gas respiration or pressure surges, e.g. due to closing of the pipeline, lead to undesirable incrementing of the metering unit. Q_l is usually set to 0.25 times the value of Qmin. However, the value must always be adapted to the on-site conditions.

These parameters can be changed at the log level.

Below Q_l, the flow is set to zero. Alarm notifications and warning notifications with $Q < Q_{min}$ are reset.

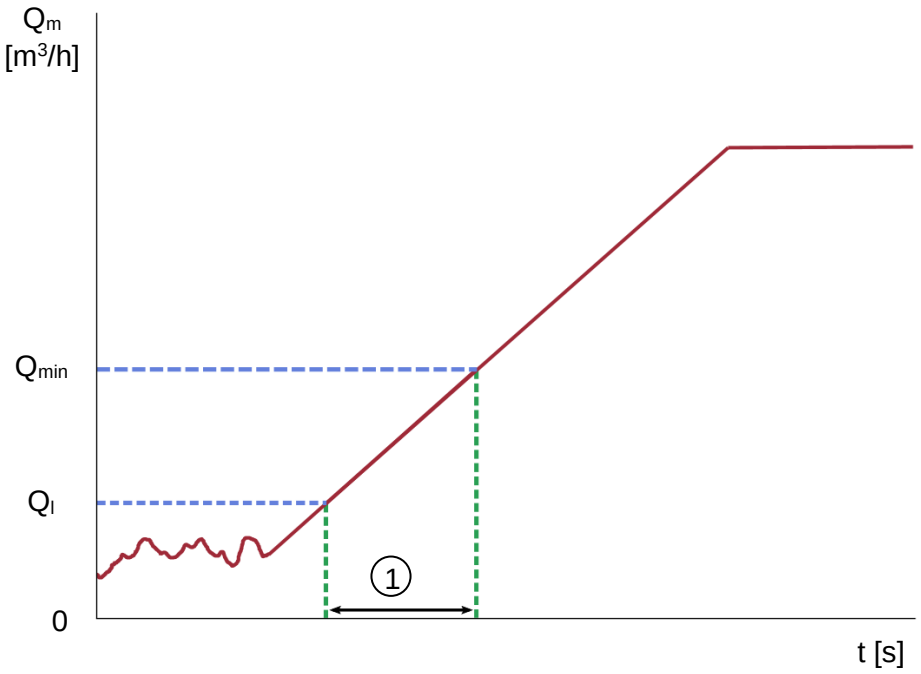


Fig. 38 (1) Creepage volume time = time for $Q_l > Q_m \geq Q_{min}$

This function can also be used to monitor the correct closing or opening of a valve.

The creepage volume limit Q_l and the time tQ_l are set separately for the main flow direction DIR1 and the opposite direction DIR2 using the EcoView program.

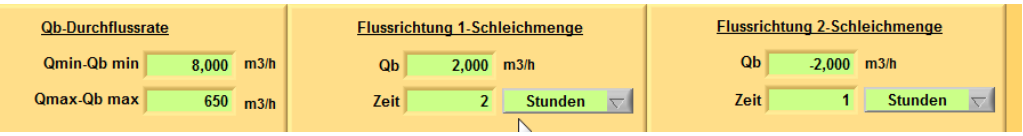


Fig. 39 Separate creepage volume settings for each flow direction

7.1.7 Correction of pressure and temperature influences

The EcoSonic X12 performs sampling over a certain temperature and pressure range. The expansion of the metering unit as a result of temperature changes is minor, but is still taken into account during the correction. The influence of gas pressure within the metering unit is negligible within the permitted pressure range. The correction is based on metering unit dimensions at an ambient temperature of 20 °C and a pressure of 1 bar.

(11)
$$Q_m = Q_m * (1 + (293 - T_m) * \alpha_m)$$

For the EcoSonic X12, α 3.9 $\cdot 10^{-5}$ K^{-1} is assumed.

7.1.8 Characteristic line adjustment

When calibrating the metering unit, a characteristic line is established for each gas meter, and this line indicates the deviation between the measured values and the target value in dependence of the flow.

The EcoSonic X12 has two ways of applying these deviations in order to improve the metering accuracy:

- Constant factor
- Correction polynomial

7.1.8.1 Constant factor

There is an established procedure that is used to correct the metering accuracy using a constant factor. This procedure involves the establishment of a weighted mean error WME[2], which essentially represents the measured characteristic line.

[2] The illustration of the WME is based on the PTB testing instructions Band 30 Measuring instruments for gas: high-pressure testing of gas meters". The formula provided in OIML recommendation R32 gives the same results when the test points recommended there are used.

(12) $$WME = \frac{\sum_{i=1}^{n} k_i * E_i}{\sum_{i=1}^{n} k_i}$$

(13) $$k_i = (Q_i / Q_{max}) \; if \;\; Q_i \leq 0.7\, Q_{max}$$

(14) $$k_i = 1{,}4 - (Q_i / Q_{max}) \; if \; 0{,}7\, Q_{max} < Q_i \leq Q_{max}$$

The Q_i values are the flows at which the calibration was performed. The E_i values are the percentage deviations at calibration points Q_i. n indicates the number of calibration points in the range [Q_{min}, Q_{max}].

The weighted mean error established using the characteristic line can be used to correct the flow.

(15) $$Factor = 100.0/(100.0 + WME)$$

(16) $$Q_{corr} = Q_m * Factor + Q_{Offset}$$

The “factor” correction factor established using the WME can be used in this way as a calibration parameter in the EcoView program. The parameters are reliably displayed on the EcoTouch operating unit as “Factor DIR1” and “Qoffset DIR1” and are valid for custody transfer measurements.

With the EcoSonic X12, the “Factor DIR1” correction factor can be used for the characteristic line adjustment in the main flow direction. A “Factor DIR2” correction factor is also provided for the opposite direction. To this end, a characteristic line must be measured for the opposite direction during calibration, and the WME must be established as described above. Factor_DIR1 can be determined and calibrated separately as Factor_DIR1_Ref (under reference conditions) by carrying out a test on the air test bench, and as Factor_DIR1_HP (HP for high pressure) by carrying out a test on the high-pressure test bench. The EcoSonic X12 is only calibrated and certified by the Metrological Authority for custody transfer measurements in the main flow direction DIR1. Calibration without certification for custody transfer measurements in flow direction 2 can be performed on customer request.

The calibration factors for the EcoSonic X12 are defined during calibration. They can only be modified when the calibration switch is open. If the factor is set to 1000 and Qoffset to 0.000, the correction using a constant factor will not be effective.

7.1.8.2 Correction polynomial

This characteristic line adjustment method describes the characteristic lines using one polynomial for the main flow direction and one polynomial for flows against the main flow direction:

(17) $$F_{Dir1}(Q) = a_{-2} * Q_{Dir1}^{-2} + a_{-1} * Q_{Dir1}^{-1} + a_0 * Q_{Dir1} + a_1 * Q_{Dir1}^{-1} + a_2 * Q_{Dir1}^{2}$$

(18) $$F_{Dir2}(Q) = b_{-2} * Q_{Dir2}^{-2} + b_{-1} * Q_{Dir2}^{-1} + B_{m0} * Q_{Dir2} + b_1 * Q_{Dir2}^{-1} + b_2 * Q_{Dir2}^{2}$$

The coefficients a_i for the main flow direction and b_i for the characteristic line for the opposite direction are determined based on the calibration. They are then stored in the EcoSonic X12 as coefficient set “Polynomial DIR1” for the characteristic line for the main flow direction and as “Polynomial DIR2” for the characteristic line for the opposite direction.

The correction polynomial is used to determine the corrected flow:

(19) $$Q_{corr} = Q_m * \frac{1}{1 + F(Q)/100}$$

(With the EcoSonic X12, “Polynomial DIR1” can be used for the characteristic line adjustment in the main flow direction. A “Polynomial DIR2” correction polynomial is also provided for the opposite direction. To this end, a characteristic line must be measured for the opposite direction during calibration, and the polynomial must be established for the opposite direction.
The EcoSonic X12 is only calibrated and certified by the Metrological Authority for custody transfer measurements in the main flow direction DIR1. Calibration without certification for custody transfer measurements in flow direction 2 can be performed on customer request.

The calibration factors for the EcoSonic X12 are defined during calibration. They can only be modified when the calibration switch is open.
If all coefficients are set to 0.000, a polynomial correction will not be effective.

7.1.9 Calculation of the operating volume V_b

The measured flow is determined every quarter of a second and is assigned to the operating volume V_m. The operating volume is reliably displayed on the flow direction screen of the EcoTouch operating unit (see Fig. 63), together with the other most important measured values. The EcoView program can provide a graphical depiction of the current time progression of the measured operating volume. During the measurement process, EcoView can also save the measured data to a file for further analysis on the PC.

7.1.10 Determination of the speed of sound

The speed of sound in the gas is determined for each path using the measured transit times.

(20)
$$c_{path} = \frac{L_{path}}{2} * \left(\frac{t_u + t_d - dt\_sum}{t_u * t_d} \right)$$

The correction value dt_sum takes into account effects on the measuring path such as the duration of signal processing by the electronics, which was measured during calibration with speed of sound adjustment. The path-length-corrected path is used for L_{path}.

The measured speed of sound is determined for each path, and is shown in the EcoView program for example.

7.1.11 Integrated operating range monitoring

The EcoSonic X12 is tested and approved for a defined temperature and pressure range, which is defined by $t_{min,}$, $t_{max,}$ $p_{min,}$ p_{max} , Q_{max}. (If 0.25 *Q_{min} (creepage volume) is not met, the flow will be set to 0. The creepage volume is configurable). The maximum values for the operation of the EcoSonic X12 are specified on the main data plate.
The EcoPT pressure and temperature sensor also measures the following: If the measured pressure and temperature values are outside of the permissible operating values, a warning will be displayed. This event will be recorded in the log.
Once the values are back within the operating range, the measurement will automatically be valid again. This event will also be recorded in the log.

8. Logs

8.1 General information

The entries and the logs form the basis for billing-relevant information or for the evaluation of error statuses. The EcoSonic X12 provides the user with a number of different logs. The EcoView software can be used to save these to a PC.

A log for values relating to custody transfer measurements is integrated into the EcoSonic X12, as well as a parameter log and an event log.

Archives and logs can be retrieved via the display of the EcoSonic X12 as well as via the serial interfaces using a MODBUS or DSfG protocol. The information can be retrieved based on a time stamp or reference number assigned to each archive entry.

8.2 Logs

Logs are used to record messages or changes to parameters.
The following logs are available in the EcoSonic X12:

- Ultrasonic gas meter version log
- Volume corrector version log

The version logs are further sub-divided as follows:

- Event log
- Parameter log
- Custody transfer (metrological) log

The following can also be performed in the log display:

- Display of pending errors
- Acknowledgement of warnings and alarms

Example parameter log entry:

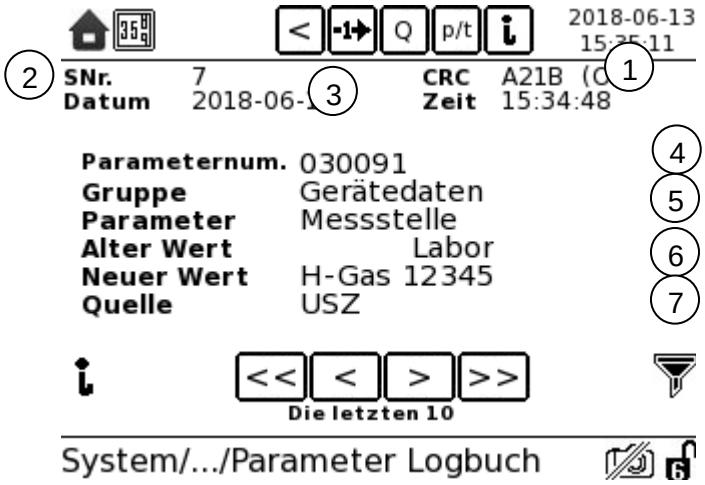


Fig. 40 Example parameter log

1. CRC – log entry checksum
2. Consecutive number
3. Time stamp
4. Parameter no. (index)
5. Group
6. Old and new value
7. Source of the entry

Key assignment:			
<<	Back to the start of the log overview	<	Previous log entry
>>	Forwards to the end of the log overview	>	Next log entry
			Search filter

For more information on the messages, see table “Displays and parameters” in the appendix on p. 149)

8.2.1.1 Consecutive number and time stamp

Each log entry is given a unique number and is also labelled with the date and time.

8.2.1.2 Source of the entry

The source of the entry is the area or the software module that generated the entry. Possible log entry sources are as follows:

SYS	EcoTouch control, control software, system software
uTo	EcoTouch –control software – software application for controlling the EcoTouch display and the operating unit
USM	Ultrasonic gas meter
TD	Archive for measured values
MOD	External Modbus connection

8.2.1.3 Levels of access

The table “Displays and parameters” in the appendix on p. 149 contains a column labelled “Access level”.
An entry’s level of access indicates which authorisation of access is required in order to remove the entry using the diagnostics program. An entry with access level L3 corresponds to user level 3 **User.** Log entries can only be deleted by a logged-in user from the corresponding user level or higher.

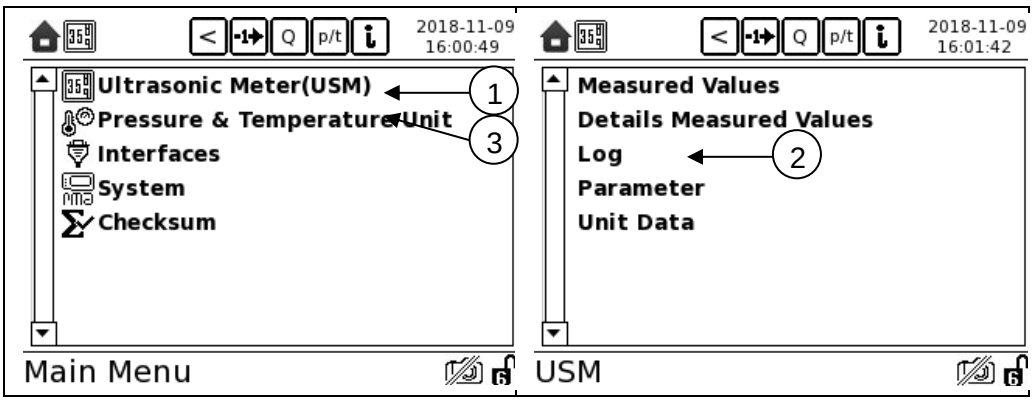
8.2.1.4 Type of message

The EcoSonic X12 offers the following types of log entries:

Parameters	Parameter change
	Info, event
	Warning
	Error
	Alarm incoming
	Alarm outgoing
	Critical error

8.2.2 Ultrasonic gas meter log

- Tap on “Ultrasonic meter” in the main menu (1).
- Tap on “Log” on the following screen (2)



1. Ultrasonic gas meter (USM)
2. Log
3. Volume corrector (EVC)

Fig. 41 USM log selection

- Tap on the required log in the following log overview (Fig. 43)

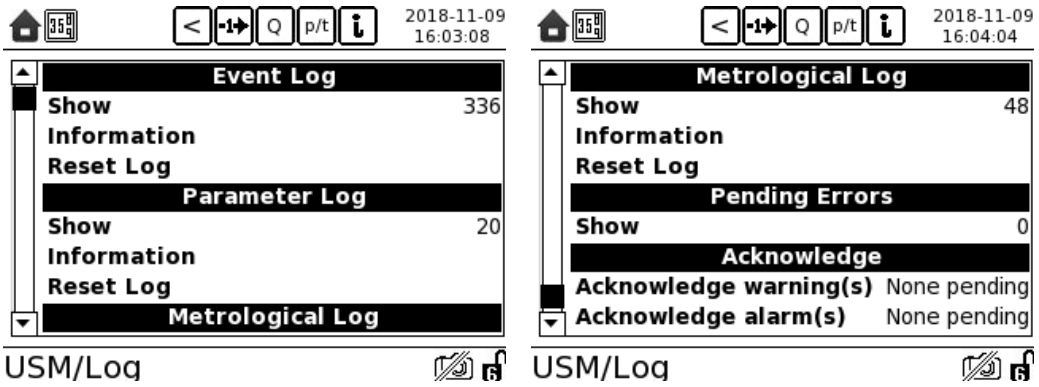


Fig. 42 USM logs

8.2.2.1 Event log

The event log has the following structure:

Explanation	Example	Comment
Reference no. (SNo.):	593785291	Range from 1 to 2E64
Time stamp	21/10/2014 09:37:07	Time of the event
CRC	2374	Checksum
Status	Incoming/out-going/symbol	Occurrence or rectification of the event
Event no.	482	Number of the event
Status	Status text	Event status
Short event text	Upper pressure limit	Explanation of the event

The event log records all events in the ultrasonic gas meter (USM) and in the EcoSonic X12 volume corrector (EVC). In addition to error and warning messages, events can also include the opening and closing of the calibration lock or changes to a password.
The event log has a maximum of 3000 entries.

The log has a rotational storage system, meaning that when the maximum number of entries is reached, the next entry will be stored as the first entry and the previous first entry deleted.

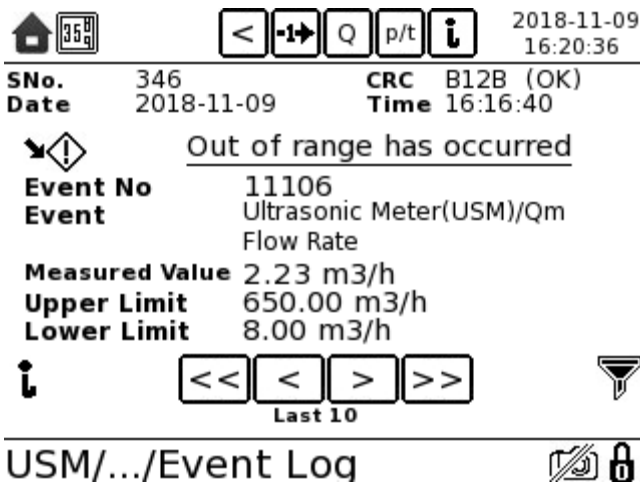


Fig. 43 USM event log

In the example shown in Fig. 43, an event is logged due to the operating flow at the USM being beyond the displayed limits at the displayed time.

Symbol	Description	Symbol	Description
↘⚠	Incoming event	⚠↗	Outgoing event

8.2.2.2 Parameter log

The parameter log has the following structure:

Explanation	Example	Comment
Reference no. (SNo.):	593785291	Range from 1 to
CRC	2374	Checksum
Time stamp	21/10/2014 09:37:07	Time of change
Old value	abcdefghijklmnopqrst	Value before the change
New value	bcdefghijklmnopqrstu	Value after the change
Parameter no.	2246/name	Number/name of the parameter

All parameters of the EcoSonic X12 that are not categorised as custody transfer parameters are entered in this archive as soon as a parameter value is changed.
The parameter log has a maximum of 1000 entries.

The log has a rotational storage system, meaning that when the maximum number of entries is reached, the next entry will be stored as the first entry and the previous first entry deleted.

8.2.2.3 Metrological log

The metrological log has the following structure:

Explanation	Example	Comment
Reference no. (SNo.):	593785291	Range from 1 to 2E64
Time stamp	21/10/2014 09:37:07	Time of change
CRC	2374	Checksum
Old value	abcdefghijklmnopqrst	Value before the change
New value	bcdefghijklmnopqrstu	Value after the change
Parameter no.	2246	Number of the parameter

All parameters of the EcoSonic X12 that are categorised as custody transfer parameters are entered in this archive as soon as a parameter value is changed. The metrological log has a maximum of 1000 entries.

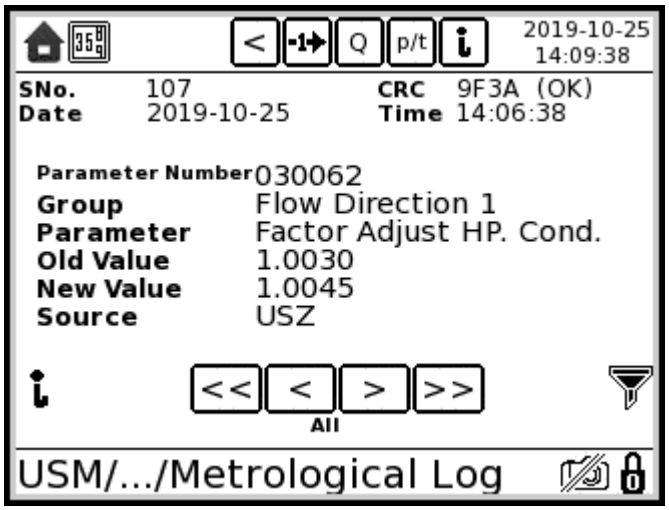


Fig. 44 Metrological log

8.2.2.4 Resetting a log

Logs can only be reset in authorisation level 6 (“log”)
(see Fig. 45). For the procedure for changing the user level, see Section 9.4.5.

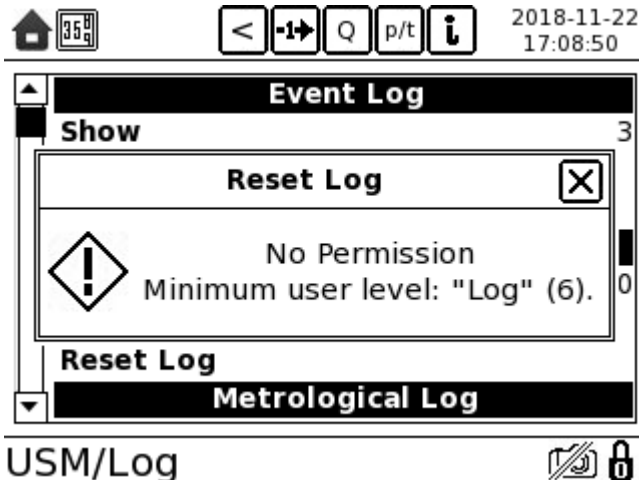


Fig. 45 Resetting a log

Following the password prompt for changing the user level, the user will need to once again confirm their intention to perform a reset.

Note

Resetting/deleting the metrological log

The log is **not** rotational. This means that when the maximum number of entries is reached, it will no longer be possible to change any more custody transfer parameters.
The log can only be deleted by opening the calibration lock.
The first entry is always generated automatically and reports that the log has been deleted

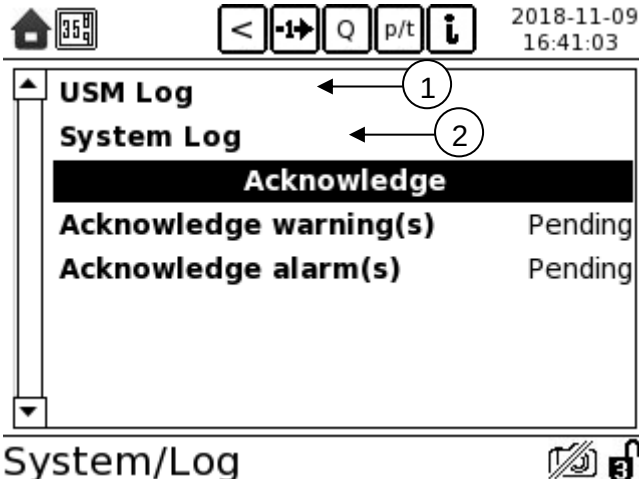
8.2.3 Log overview

An overview of the various logs is shown under System/log, with access to all logs.

Internally, the log is created as a database in a non-volatile memory. The log entries for the gas metering unit are shown as “USM log”.
The entries relating to the system (3) can also be retrieved from the database in a separate log (3) (Fig. 46).

If the maximum number of custody transfer parameters is exceeded, it will no longer be possible to make any changes to custody transfer parameters. The log will firstly need to be deleted so that further entries can be made.

If the maximum number of entries is exceeded for changes recorded in the parameter log or event log, the oldest entries will be overwritten (FIFO).



1. USM log
2. System log

Fig. 46 System log

Example of an event recorded in the system log:

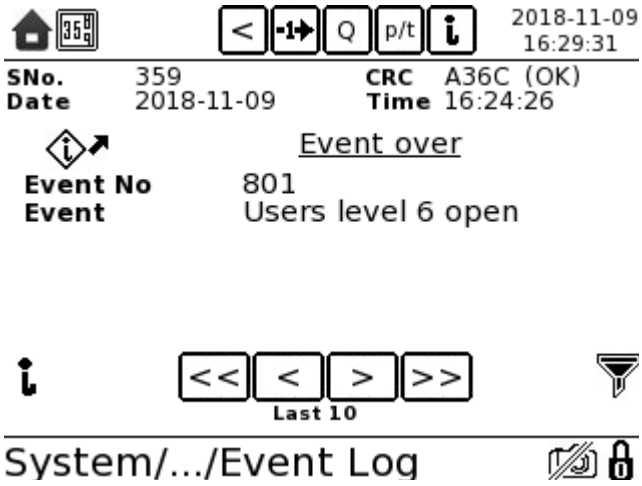


Fig. 47 System event log

8.2.4 Pending errors

Errors are generally logged with a time stamp. There are some errors that disappear again by themselves. In this case, the error will be acknowledged automatically.

Serious errors (e.g. checksum errors) must be acknowledged manually

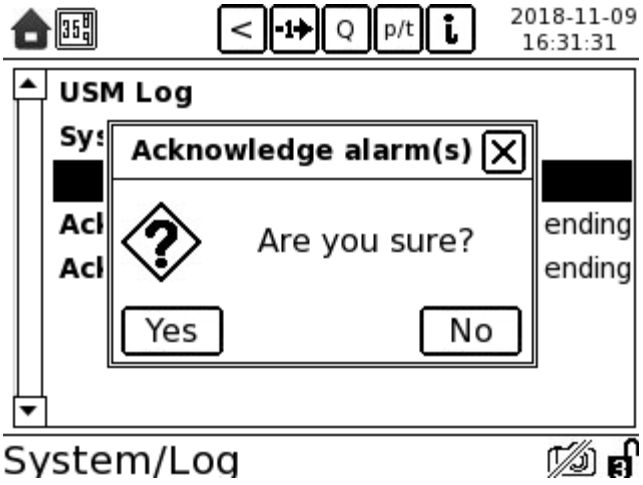
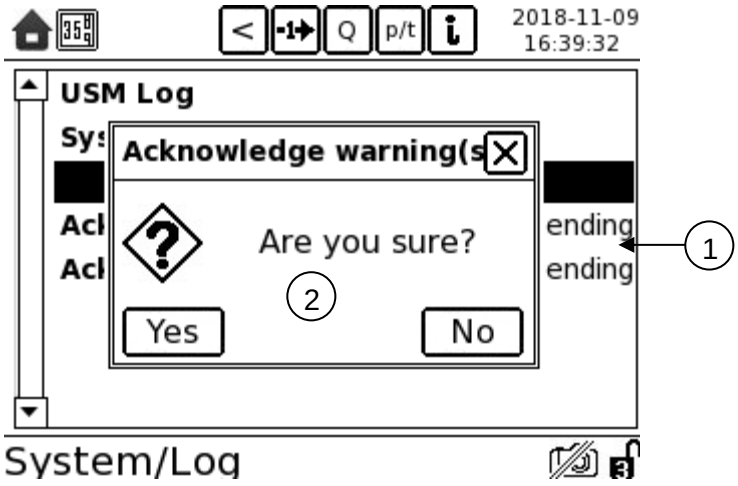


Fig. 48 Pending errors

8.2.5 Acknowledging warnings and alarms

In order that pending warnings and alarms (1) can be taken note of and that any serious errors can be rectified, these will need to be acknowledged.

To acknowledge warnings and alarms, a user will need to be in **user level 3** or above.



1. Pending warnings and alarms

2. Acknowledge warnings/alarms (yes/no)

Fig. 49 Acknowledgement prompt

- Confirm the prompt (2) (Fig. 50)

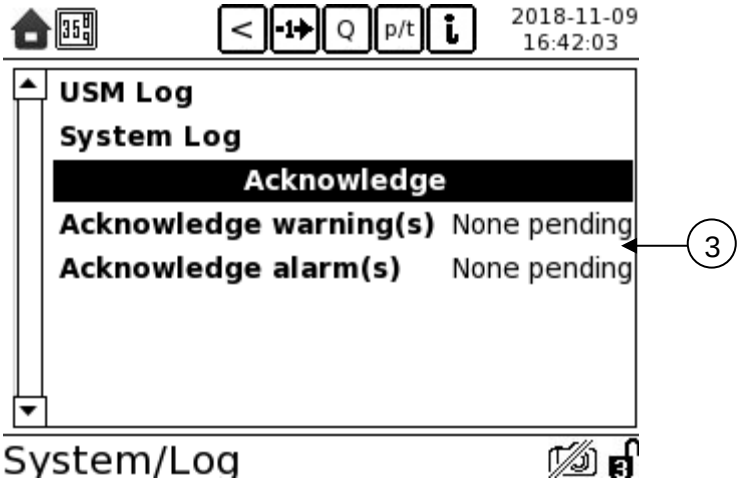


Fig. 50 Acknowledgement prompt

A message will appear (3) explaining that the warning or alarm is no longer pending.

9. Operation with EcoTouch

9.1 General information

The EcoSonic X12 has an operating console with touch screen, which can be used to access the different functional components of the EcoSonic X12. The functional components are as follows:

- Ultrasonic gas meter
- Pressure/temperature sensor
- Interfaces
- System.

These functions are integrated into a single unit.

9.2 EcoTouch – main menu

Once the EcoSonic X12 has been started up, EcoTouch automatically starts up too. Once it has started up, the EcoTouch main menu will always appear first.

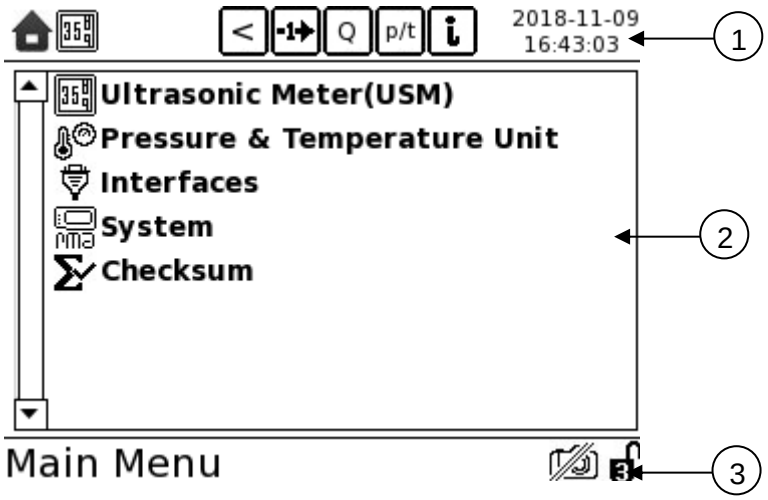


Fig. 51 EcoTouch main menu

The operating elements on the start screen are arranged according to the functions of the EcoSonic X12:

The screen is split up into three sections:

Position	Function	Position	Function
1	Header line:	3	Footer line:
2	Detail section:		

The **header line** contains graphical navigation elements and control keys. These can be used for quick access to the main functions of the EcoSonic X12.
The header line also contains **status displays** such as:

- **Time:** The time of the metering unit is used as a time stamp for all entries in a log. The time can only be changed via the EcoView program when the calibration switch is opened, and only at **user level 6 "Log"**.
- Users in **user level 3 "User"** can carry out readjustments in the seconds range.
- Tap on the time to switch to the date display.

- **Date:** The date of the metering unit is used as a time stamp for all entries in a log. The date can only be changed via the EcoView program when the calibration switch is opened, and only at **user level 6 "Log"**.

The header line with the quick-selection keys is available on every screen.

The **detail section** contains selection fields and displays relating to each module and each function.
There are sub-menus here for each module and each function, allowing for the following information to be retrieved:

- Measured values
- Function log
- Parameters for this function
- Unit data relating specifically to this function (e.g. version statuses, serial numbers).

If this screen has more lines than can be displayed on a single screen, a scroll bar will be shown on the left-hand side that can be used to access the additional data.

The **footer line** indicates where the user currently is within the program as well as the current user level. There is also a "screen-shot function" here that can be used to take an image of the current screen.

Key assignment:

Header line key assignment:			
	Back to main menu		Selection of flow direction 1 for USM[1] Switch display for flow direction 2
	Ultrasonic gas meter (USM) module		Selection of flow direction 2 for USM Switch display for flow direction 1
	Volume corrector (EVC) module (optional)		Flow display Display of the operating flow and the base volume flow
	Tariff device module (TD)		Pressure/temperature display
	Back to the previous screen		Current pressure display
			Current temperature display
			Unit system information EcoSonic X12

[1]Note on selecting the flow direction:
The flow and meter readings will be shown in the relevant flow direction if the metering unit is designed for two flow directions (DIR1 and DIR2). Otherwise, no measured values will be shown in flow direction 2.

Footer line key assignment:			
	Delete the image		Display the active user level When the padlock is open, it will show the user level. When closed, it is not possible to make any changes to parameters.
	Take a screen shot		

The detail section contains a list of the keys for the USM module. The link takes the user to the same sub-menu.

The detail section for the main menu also contains additional keys:

Detail section switching symbols:			
	Pressure and temperature sensor (EcoPT)		System, Information and settings relating to the EcoTouch
	Control interfaces		

9.3 Navigation to other EcoTouch menus

9.3.1 System information on the EcoSonic X12

Tapping on the  field (“System information”) in the header line takes the user to the screen containing system information on the EcoSonic X12.

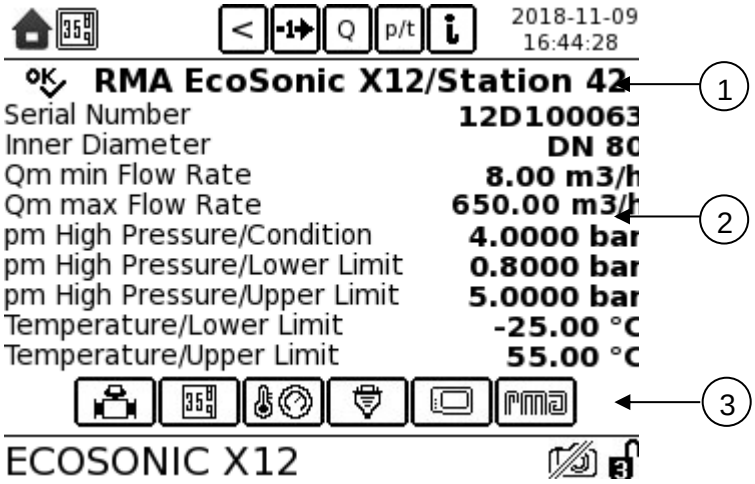


Fig. 52 System information on the EcoSonic X12 USM

The current operating data and metering unit variables are clearly summarised here. All further information and parameters in relation to the EcoSonic X12 can be retrieved by navigating using the touch screen.

Position	Function	Position	Function
1	Status display: Unit designation, location Message about incoming/outgoing events, warnings	3	Keys for accessing additional system data relating to individual functions
2	Detail section: Serial number, limiting values		

Key assignment:

Key assignment, panel 2:			
	System information on the EcoSonic X12 (or back to Fig. 52)		Version and status displays relating to interfaces
	System information on the USM		EcoTouch SW versions
	Pressure/temperature limiting values		Manufacturer information

9.3.2 Log displays

For information on log displays see Section 8.2

9.4 User administration

The EcoSonic X12 hardware and software distinguishes between multiple user levels with various rights.

Level no.	EcoTouch user levels	Password-protected
7	**Calibration switch**	Physical, only via opening of the calibration switch
6	**Log**	Yes
3	**Authorised user**	Yes
0	**Normal**	No

The user level is displayed on the EcoTouch with a padlock symbol

	Level 0 is the normal operating state during metering. This access level is assigned to the "**Normal** user". The EcoSonic X12 works and measures on a continual basis. Passwords cannot be assigned to level 0. No menus for changing parameters are shown on the EcoTouch display. All settings and data can be read. The **Normal** general user does not require a password. All higher levels are password-protected.
	The padlock is opened. An authorised user has logged in using a password. The displayed number indicates the user level (0, 1 to 7). Used user levels are: Level 3 = authorised **User** Level 6 = **Log** (log for custody transfer measurements) At each level, the password for the level in question and the passwords for the lower levels can be changed
	User level 7 (Calibration switch) can only be reached by opening the calibration switch. (This is also the level where all passwords can be changed for lower levels). The certification of the EcoSonic X12 for custody transfer measurements is indicated by the undamaged metal calibration seals and additional seal on the unit. Access to the calibration switch is also secured in a way that makes the unit valid for custody transfer measurements. The important parameters that can have an impact on the measurement results can only be changed at this user level. Log entries with a relevance for custody transfer purposes can only be removed when the calibration switch is open.

9.4.1 “Calibration switch” user level

The user level with the most rights is the **Calibration switch** level.
This user level **7** can only be accessed by opening the calibration switch on the EcoTouch operating unit, or by breaking the calibration seal on units in official metering operation.
The calibration seal protects against changes to the most important parameters – in particular those parameters that could have an impact on the calculation of the measurement results.

Levels 1-6 below the **Calibration switch** level are password-protected.

9.4.2 “Log” user level

A user in the **Log** user level can change some parameters such as the assignment of the pulse outputs. These changes are entered in the metrological log at the **calibration switch** level, and can therefore only be deleted by a user in the **Calibration switch** user level.

9.4.3 “User” user level

A user in the **User** user level can set threshold values for warnings in the USM in order to adapt the EcoSonic X12 to the conditions at the metering point. If the threshold value is exceeded, a warning will be displayed via LEDs. A log entry will be made in this case.
This enables the **User** to adapt wide-ranging threshold values to the conditions at the metering point, including those serving as indicators for the particular measuring process. As a result, messages can be issued and entries made in the log as a result of minor deviations in otherwise stable and characteristic behaviour.

At the **User** user level, it is also possible to change the assignment of status signals and their polarity.

9.4.4 Normal

User level 0, the **Normal** user, is the level used for the standard user who only has read-only access to all data and settings.

The **Normal** user does not require a password. This user can therefore access an overview of the EcoSonic X12 status at any time. Once it has been connected to the power supply and once the initialisation processes are complete, the system starts up in the **Normal** user level.
The **Normal** user has comprehensive reading rights. This user can view or collate measured data in the EcoView program and write this data to a file on the PC. He or she can also save settings such as the correction parameters for the volume corrector to a file.

9.4.5 Changing user level

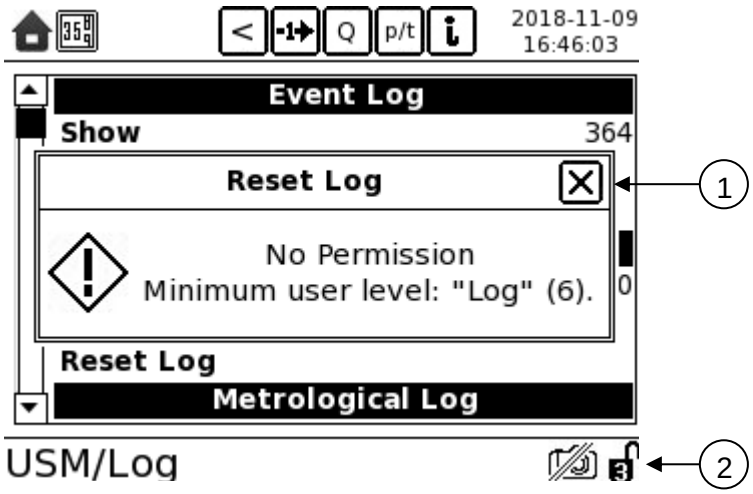
The EcoTouch operating unit is primarily intended for the display of measured data and calibration and system parameters. In normal operation, the **Normal** user (user level 0) is logged in.

The following passwords are pre-set on delivery:

- The number 3 for user level 3 **User**
- The number 6 for user level 6 **Log**

User level 0 **Normal** does not have a password.

If a user currently in user level 0 wishes to reset a message in the event log, for example (see Fig. 54), the user level will need to be changed from 0 to 6.

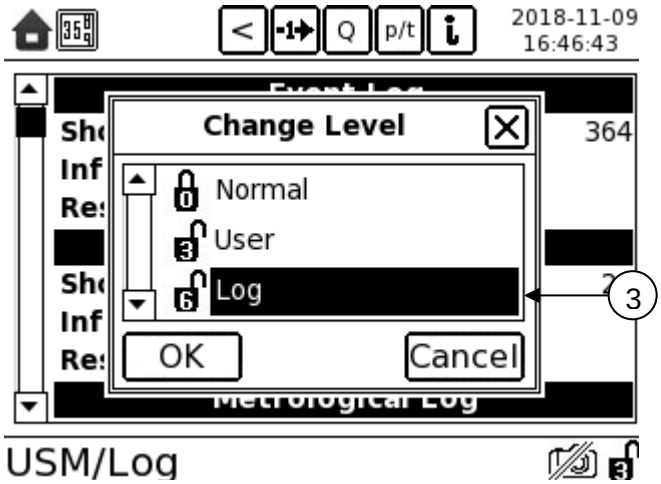


1. Close window
2. Padlock symbol

Fig. 53 Change of user level required

In this example, the request to change user level must firstly be closed.

- Close window. To do so, tap on (1) (Fig. 54).
- Tap on the padlock symbol (2) in the footer line



3. Select the level Log

Fig. 54 Changing the user level

The “Change level” window opens (Fig. 55)

- Select the required user level (3) and tap on “OK” to confirm

To change between level 0 (Normal) and level 6 (Log), a password will need to be entered.
A password input window opens (Fig. 55)

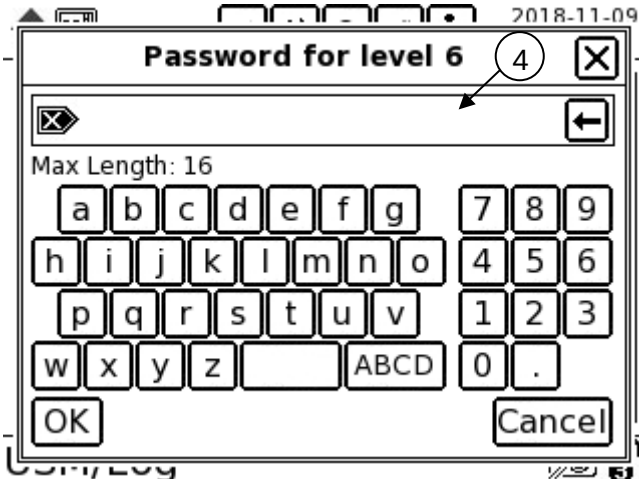


Fig. 55 Password entry

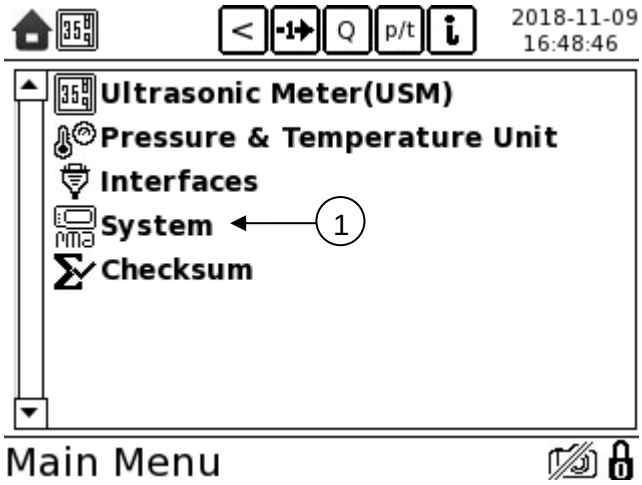
- Enter the password in the corresponding input field (4).

The password consists of the digits 0 and 1 to 9. It can be entered and changed both on the EcoTouch operating unit and in the EcoView program.

- To confirm the password, tap on “OK” (or discard by tapping on “Cancel” and then enter the password again).

The user level display in the footer line changes to 6

The user level can be changed in the following way:



1. System

Fig. 56 EcoTouch main menu

- Tap on “System” (1) from within the EcoTouch main menu.
- Tap on “Access management” in the window with the system menu (Fig. 58).

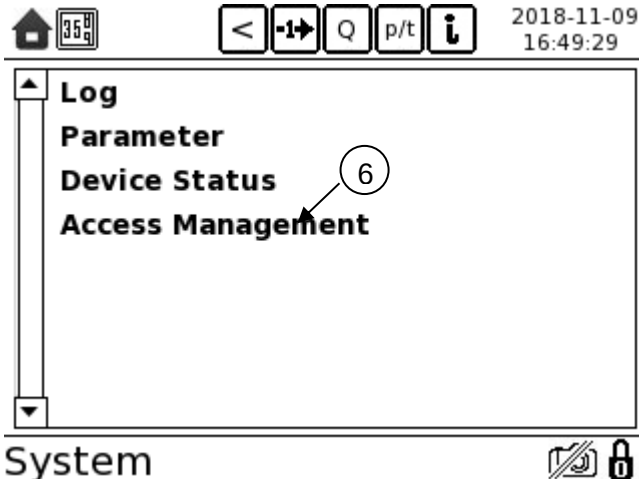
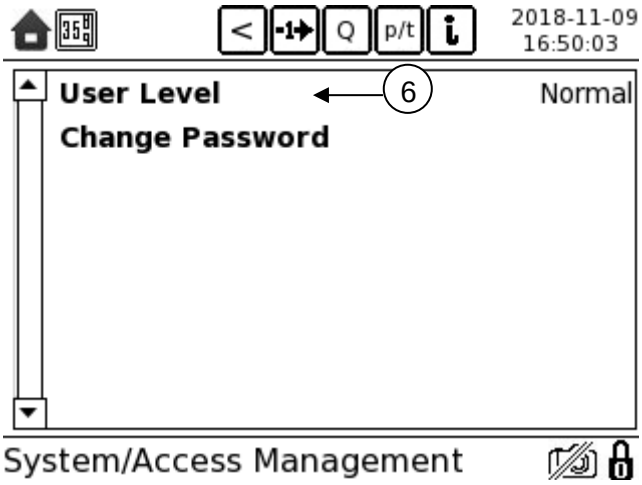


Fig. 57 System menu

The “Access management” window opens (Fig. 59)



6. Access management

Fig. 58 System access management

- Tap on “User level” (6)

The “Change level” window opens. The procedure from this point is the same as that described above.

9.5 Changing the password

Condition: A user is logged in at user level 6 (**Log**) and can therefore change his or her own password or the password for any lower user level.

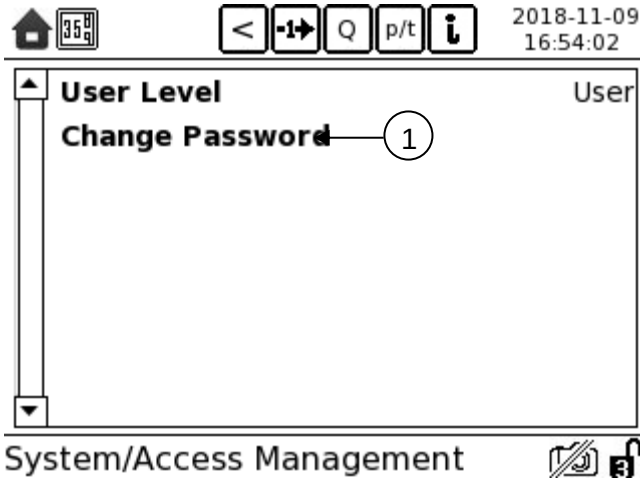


Fig. 59 System menu Change password

- Tap on “Change password” (1) in the system menu.

The “Change password” window opens (Fig. 61).

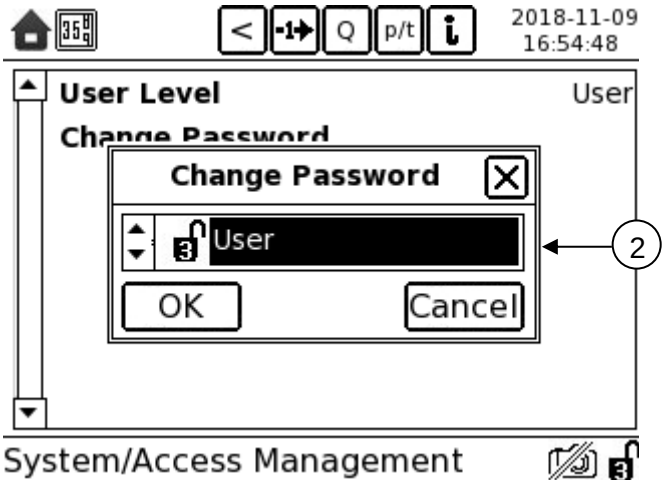


Fig. 60 Changing the password

Select the user whose password you wish to change (2):

- 3 Authorised user
- 6 Log user

(The user level 0 Normal is not protected by password)

- Tap on “OK” to confirm the user

A password input window opens (Fig. 62)

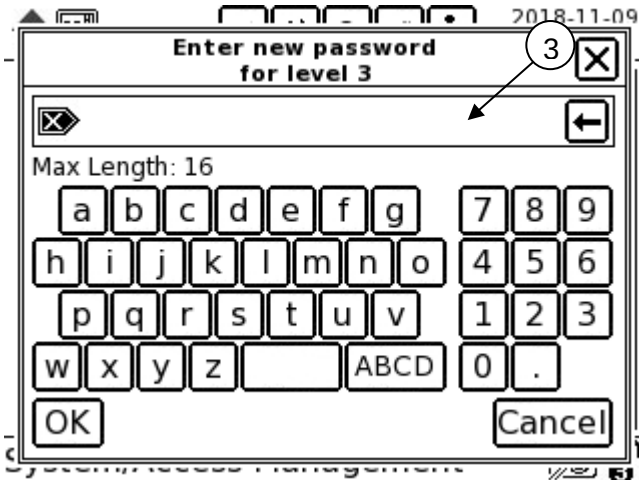


Fig. 61 Enter a new password

- Enter the password in the corresponding input field (3).

The password must not be longer than 16 characters.

To confirm the new password, tap on “OK” (or discard by tapping on “Cancel” and then enter the password again). The user now has a new password.

10. Metering operation and settings

Once it has been connected to the power supply, the EcoSonic X12 starts by carrying out a self-test of the components and then initialises the software and processes, which can take a few minutes. The EcoSonic X12 then automatically starts metering operation. Metering operation is only briefly interrupted if parameters are changed, and is then restarted automatically.

Saving or transmitting data and checking the software uses the free computing capacity of the EcoSonic X12. The metering process has the highest priority. It cannot be shut down.

10.1 Current measured values

The current measured values can be reliably read off from the EcoTouch operating unit at any time and are valid for custody transfer measurements.

The current operating data is clearly summarised in the flow direction display .

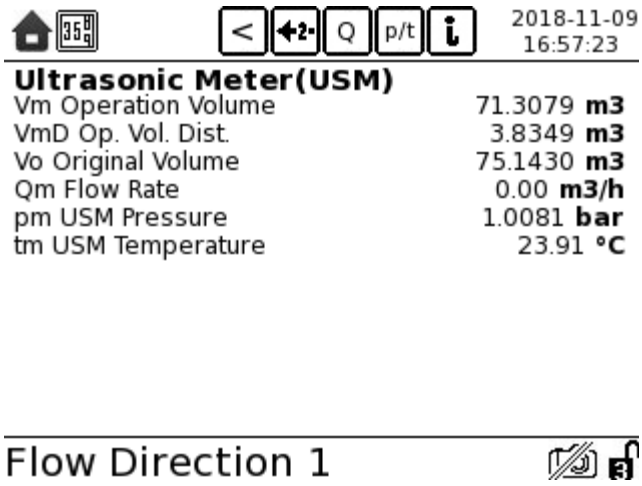


Fig. 62 Flow direction display

All further information and parameters in relation to the EcoSonic X12 can be retrieved by navigating using the touch screen (see Fig. 64 for an example).

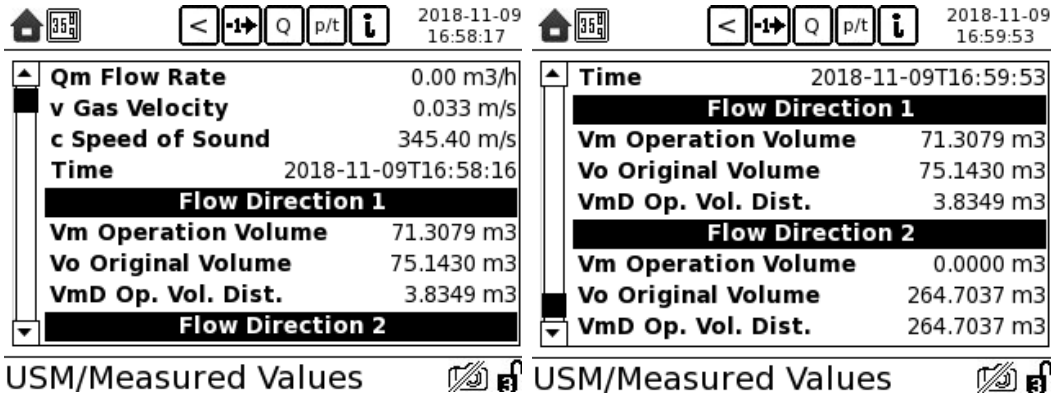


Fig. 63 USM measured values

The measured values can also be displayed using the EcoView program (not subject to compulsory certification for custody transfer measurements)[3] and then read out via Modbus interface.

The EcoView program provides the option of retrieving measured values and saving them to a file. The measured gas volumes are continually stored in the measured value database regardless of whether this option is used.

[3] From a custody transfer perspective, this portrayal is a copy of the data for display on a non-custody transfer unit.

10.1.1 Substitute values – identification

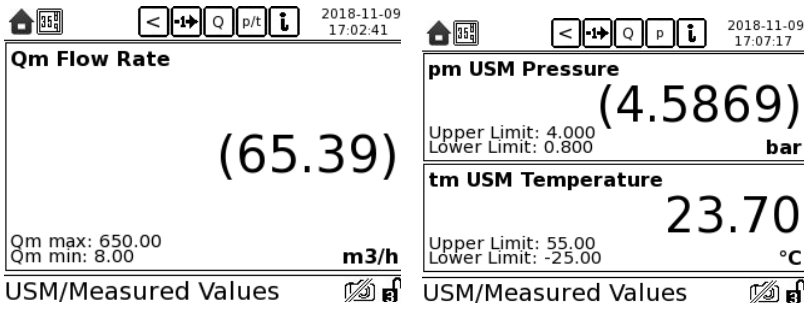


Fig. 64 Measured variables relevant for custody transfers are shown in brackets

If the flow is disrupted or if measured values are outside of the permissible limiting values for gas pressure [p_{min}, p_{max}] or gas temperature [T_{min}, T_{max}] for example, then the value is shown in brackets (1). If the pressure or temperature measurement is above the maximum value by several percent or if the measurement fails altogether, the parameterised substitute value will be displayed instead of a measured value. The substitute values for measured variables relevant for custody transfers are shown in brackets.

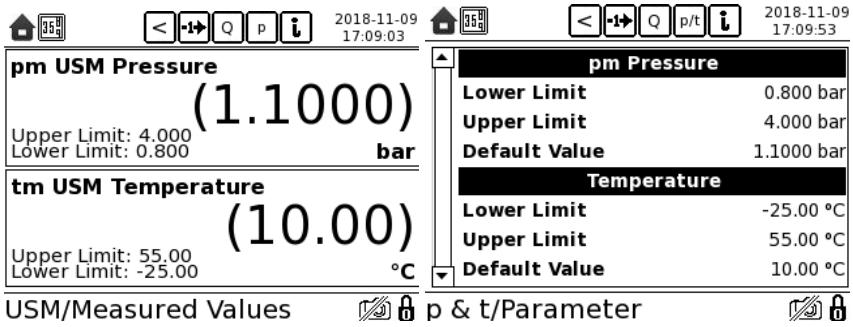


Fig. 65 Substitute value

10.1.2 Resetting log entries

Users in the **Calibration switch** user level and authorised users with a password, i.e. users in the **Log** and **User** levels, can remove log entries at their user level (i.e. access level) or lower.

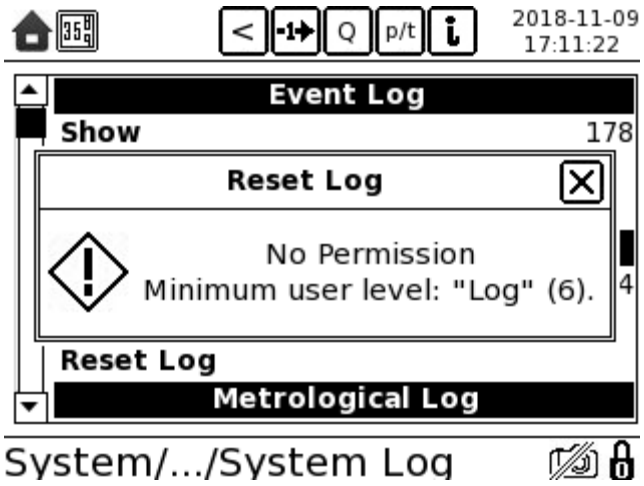


Fig. 66 Resetting a log

Entries in the parameter log can only be reset at level 7 **"Calibration switch"**.

The EcoSonic X12 user level is crucial with regard to the access rights to unit parameters and settings and the associated available options, regardless of the interface via which the unit is accessed.

10.2 Configuration

10.2.1 Display of variables relevant for custody transfer measurements

The binding read-out device for measured values such as base volume or calibration parameters is the EcoTouch operating unit. Copies of the measured values are provided via the additional interfaces such as the EcoView program or the Modbus interface. These copies can be read and further processed.
All data, including the settings with a relevance for custody transfer purposes, can be read without any special authorisation.

10.2.2 User settings - limiting values and warnings - normal operation

Once logged in, users can make changes to some settings of the EcoSonic X12 using the EcoView program. As with users in the **Normal** user level, they can also read all data, calibration and configuration parameters.

Authorised users with passwords can make changes to the settings listed below. These are generally threshold values. If these values are not met or if they are exceeded, an entry is made in the log and the orange LED lights up for as long as the threshold value is exceeded.

Warning, speed of sound min.	[m/s]
Warning, speed of sound max.	[m/s]
Warning, speed of sound deviation	[m/s]
Warning, error rate	[%]
Warning, amplification	[dB]
Warning, amplification deviation	[dB]
Warning, SNR	[dB]

Unit name	
Location	
Time update	[s]

An authorised **User** can adjust the time by ±20 s. This procedure is recorded in the log at the Calibration switch access level. This entry can only be deleted at this access level.
It is only possible to set the EcoSonic X12 clock to any date or any time with an open calibration switch and at **Log** level. This procedure is recorded in the log at the **Calibration switch** access level.

The described changes can only be performed using the EcoView program. Each change is recorded in a log.

10.2.2.1 Configuration of the status outputs

The four status outputs of the EcoSonic X12 are part of the pulse interface. They can also be configured.

The allocation of the outputs can be changed from the **User** user level and higher. Each change is recorded in the log. The entries can be removed from the log at the **Log** user level. Each status output can be assigned a signal from the following list. The signal level is freely selectable for each status output: low signal or high signal.

- All warnings (H/L)
- All alarms (H/L)
- USM warning (H/L)
- USM alarm (H/L)
- System warning (H/L)
- System alarm (H/L)
- System or USM warnings (H/L)
- System or USM alarms (H/L)
- Qmax (H/L)
- pm outside range (H/L)
- tm outside range (H/L)
- USM disturbance volume (H/L)
- Flow direction (H/L)

10.2.3 User settings for custody transfer measurements:

Some parameters for custody transfer measurements can be changed at the **Log** user level. These relate to the impulse interface of the gas metering unit. Changes to these parameters are saved in the log at the **Calibration switch** level. Therefore, only users in the **Calibration switch** user level can delete these entries from the log if necessary.

The pulse interface of the EcoSonic X12 comprises two configurable pulse outputs and four configurable status outputs. The status outputs are not relevant for custody transfer measurements and can be configured by any authorised user.

10.2.3.1 Configuration of the pulse outputs

A component such as a second independent external volume corrector can be connected to the pulse interface of the EcoSonic X12 gas meter.

The pulse interface is an output interface of the EcoSonic X12.

The pulse interface transmits the change in operating volume to an external volume corrector by means of electrical pulses.

The increase in the measured volumes can be individually set with an adjustable pulse rate/pulse value for each pulse output:

	Assignment/increase in volume	Pulse rate/pulse value
Pulse output 1	Deactivated Flow direction 1. V_m operating volume Flow direction 2. V_m operating volume Flow direction 1. Vo original volume Flow direction 2. Vo original volume Flow direction 1. V_mD operating volume, disturbance Flow direction 2. V_mD operating volume, disturbance Q simulation	Freely adjustable from 1 pulse/m^3 to… (Default values are pre-configured. The maximum frequency that is output must not exceed 6 kHz.)
Pulse output 2	Deactivated Flow direction 1. V_m operating volume… … … Flow direction 2. V_mS operating volume, disturbance Q simulation	Freely adjustable from 1 pulse/m^3 to… (Default values are pre-configured. The maximum frequency that is output must not exceed 6 kHz.)

The “Off” setting switches the pulse output off. DIR1 indicates the main flow direction. (DIR2 is the opposite direction in bidirectional mode).

The raw volume indicates the sum of the metered volume valid for custody transfer measurements and the disturbance volume. E.g. raw operating volume DIR1= operating volume DIR1 + operating disturbance volume DIR1.

The Q simulation output outputs the values of a simulated constant flow to the pulse output. This means that pulse outputs and connected units can be supplied with a constant pulse frequency. The Q simulation operating state can only be activated when the calibration switch is open.

The assignment and pulse value of the pulse outputs are protected against modification. The configuration can be changed from the **Log** user level and higher. Each change is recorded in the metrological log. The log entry can only be deleted when the calibration switch is open, i.e. at the **Calibration switch** user level.

The set assignment and pulse value for each output can be reliably read out on the EcoTouch operating unit.

The status signals of the pulse interface can be changed by any authorised user. Unlike other mechanical metering units, these signals are not essential in indicating the validity of the measurement in the EcoSonic X12. If the flow measurement is not valid, no pulse signal will be output.

10.2.3.2 Deviating settings in the first software versions

In the first versions of the EcoSonic X12 software, it was not possible to deactivate the pulse outputs. There was no special setting for Q simulation. The pulse of a Q simulation was always output at pulse output 1.

10.3 Self-diagnosis, status

10.3.1 Switch-on sequence

Once it has been connected to the power supply, the EcoSonic X12 carries out a self-test. The firmware then starts up. Checksums are formed for programs and parameters, and are then compared with the stored target values.
The LEDs on the EcoTouch briefly all light up at the same time. After a few minutes, all components have initialised and the firmware and measuring processes start up.
The green LED on the EcoTouch operating unit lights up permanently. EcoSonic X12 is in metering operation.

10.3.2 Self-test during ongoing operation

In addition to the continual ongoing metering, the EcoSonic X12 also carries out other processes on a continual basis with the aim of guaranteeing the correct functioning of the unit. Alongside the hardware-related function monitoring (watchdog), the integrity of programs and parameters is also continually monitored by the software.

10.3.2.1 CRC-secured communication

Communication between the various EcoSonic X12 processors and between the software applications is secured by a checksum.

The internal data paths via serial RS485 and RS422 protocols are secured against transmission errors by a CRC16 checksum. When an entry is made in a log and when saving measured data, CRC16 checksums are also saved, and these are verified when the entry is read.

10.3.2.2 MD5-secured software applications

The processes in the EcoTouch operating unit that are relevant for custody transfer purposes are permanently monitored. The software is checked for correct functioning on a cyclical basis. Any detected malfunctions are documented in the log and the system restored to an operative condition as necessary. The checksum for the application is re-calculated every 10 minutes and compared with the saved value. Deviations are classed as errors and are documented in the log.
The recorded checksum of log entries is therefore checked multiple times when reading the log.

10.3.2.3 Checksums for programs and parameters

Checksums are stored for the various programs that run within the various EcoSonic X12 processors, as well as for the parameters with a relevance for custody transfer purposes. The checksums relating to parameters and programs are checked using low-priority processes.

10.4 Saving settings and parameters

All current parameters and settings of the EcoSonic X12 can be saved to files using the EcoView program. The EcoView program makes a distinction between three different parameter sets based on the three functions of the EcoSonic X12:

Ultrasonic gas meter USM

The ultrasonic gas meter is the base unit that is built on by the volume corrector and measured value database.
The USM parameters include:

Status information such as serial numbers and software versions

- Threshold values for warnings
- Measuring range limits[4] such as p_{min}, p_{max}, t_{min}, t_{max}, Q_{max}
- Geometric data such as dimensions, weight value of a path
- Offsets and calibration parameters

10.4.1 Measured data

The EcoView program offers the option of displaying the measured data from the USM continually and in detail, and of exporting this data to a file.

[4] p_{min}, p_{max}, T_{min} and T_{max} are standard parameters for a volume corrector and not a gas meter. They are defined in the pressure and temperature sensor EcoPT and are also used in the gas meter with the EcoSonic X12 in order to monitor the measuring range and for corrections in order to increase the measurement accuracy.

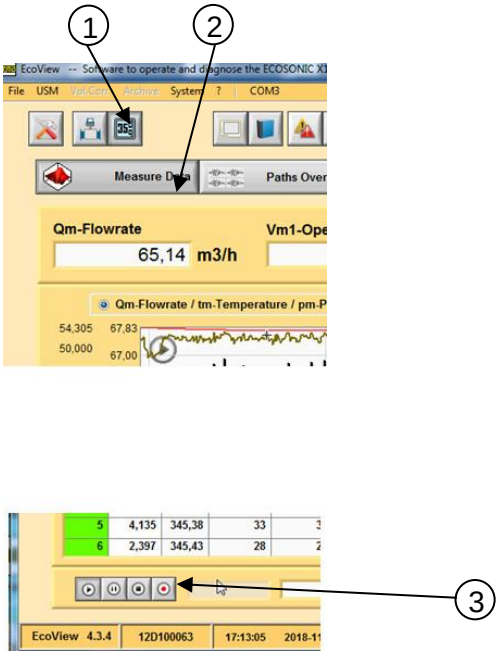


Fig. 67 Start/stop measured data recording

10.4.1.1 Saving USM measured data

To save the USM measured data to a file, measured data records can be copied from the EcoView program at the following intervals: 3
A data record can be added to a text file every ¼ second, ½ second, 1 second, 2 seconds, 5 seconds or every 10 seconds.

The data structure is largely self-explanatory: The data takes the form of tab-separated ASCII characters. The column headers are in the first row.

EcoView 3.4.3 writes the following data to a text file:

Column header	Note
(0) Date	
(1) Time	
(2) Qm flow rate [m³/h]	
(3) vavg - average gas velocity [m/s]	Average flow rate of the gas
(4) cavg - average speed of sound [m/s]	Average speed of sound of the gas
(5) V_m1-operating volume DIR1 [m³]	Operating volume counter in main flow direction DIR1

(6) Vm2 operating volume FD2 [m³]	Operating volume counter against the main flow direction
(7) VmD1 - operating disturbance volume FD1 [m³]	Disturbance volume counter in main flow direction
(8) VmD2 - operating disturbance volume FD2 [m³]	Disturbance volume against the main flow direction
(9) pm pressure [bar]	Pressure measured by the EcoPT
(10) tm temperature [°C]	Temperature measured by the EcoPT
(11) Reynolds number	
(12) Asymmetry	
(13) Transverse flow	
(14) Swirl [m/s]	
(15) Path 1/DIR1/transit time [ns]	Transit time on path 1 in main flow direction (transducer A → transducer B)
(16) Path 1/DIR2/transit time [ns]	Transit time on path 1 against main flow direction (transducer B → transducer A)
(17) Path 1/gas velocity [m/s]	Flow rate on path 1
(18) Path 1/speed of sound	Speed of sound on path 1
(19) Path 1/error [%]	Error rate on path 1
(20) Path 1/DIR1/amplification [dB]	Automatic signal amplification of transducer A on path 1
(21) Path 1/DIR2/amplification [dB]	Automatic signal amplification of transducer B on path 1
(22) Path 1/DIR1/signal-to-noise ratio	Signal-to-noise ratio with transducer A on path 1
(23) Path 1/DIR2/signal-to-noise ratio	Signal-to-noise ratio with transducer B on path 1
(24) Path 1/DIR1/RMS [dB] [dB]	Ratio: Root mean square (signal strength)/root mean square (noise)
(25) Path 1/DIR2/RMS [dB] [dB]	
(26) Path 2/DIR1/transit time [ns]	
(27) Path 2/DIR2/transit time [ns]	
… … …	
… … …	
(80) Path 6/DIR2/RMS [dB] [dB]	
(81) Pulse rate pulse output 1 [Hz]	
(82) Pulse rate pulse output 2 [Hz]	
(83) Vo1 - original volume FD1 [m³]	Original volume = operating volume + disturbance volume
(84) Vo2 - original volume FD2 [m³]	

10.4.2 Saving a log

The EcoView program can save the log to a file and make it available for further analysis.

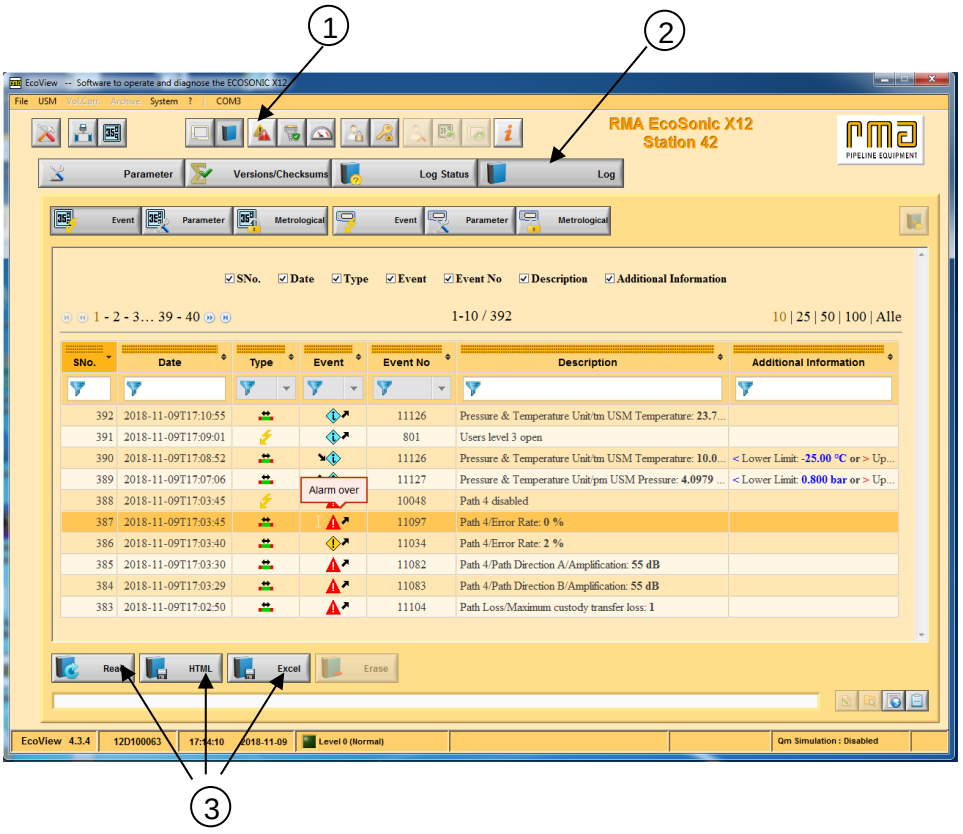


Fig. 68 Saving a log with EcoView

11. Maintenance

As with other ultrasonic gas meters, the EcoSonic X12 does not have any moving parts. Additional complex maintenance work and therefore maintenance intervals are not required, as the necessary and recommended tests and measures can be carried out as part of re-certifications for custody transfer measurements and functional tests carried out by the Metrological Authority.

11.1 Status monitoring

Regular status monitoring is included as part of normal metering unit operation. If the gas flow conditions change, this could lead to warnings and to entries being made in the log.

- Check the status of the metering unit on a regular basis (LED)
- Pay attention to new log entries

11.2 Data and parameter backup

The non-volatile memories of the EcoSonic X12 are very large. Nevertheless, the following backup measure is recommended:

- Back up the measured value archive, the log and the parameter sets twice a year using the EcoView program.
- Delete any log entries that are no longer needed

11.3 Battery

In order to ensure the continual and correct dating of events and log entries, the metrological standards stipulate a battery for the timer of the EcoSonic X12 and for the continual storage of volume meter readings in the event of a power failure.

The timer in the EcoSonic X12 continues to run even after the unit it disconnected from the power supply or in the event of a power failure. As soon as the timer is reconnected, metering operation will be started up again with the valid time and the last meter reading.

The EcoSonic X12 is fitted with a long-lasting 3 V lithium battery that supplies the timer in the EcoSonic X12 with operating voltage in the event of a power failure. The service life of the battery is 10 years if it is not overloaded.

The remaining battery life is determined based on the service life of the internal timer in the event of a power failure and the self-discharge of the battery. If the battery's remaining capacity falls below 7%, a warning will be issued. Another warning will be output once the computed remaining battery life has expired.

The battery must always be replaced once the duration of validity for custody transfer measurements (5 or 8 years) has elapsed.

Note

Replacing the battery

When the EcoSonic X12 is switched off, the internal clock is powered by the built-in battery.

The battery must be replaced during each re-certification for custody transfer measurements.

If the battery voltage falls below the set threshold value, this will cause an entry to be made in the log. In this case, the battery must also be replaced.

In the EcoTouch, the user can check when the battery was last replaced and the remaining capacity of the battery under System – Parameters – Real-time clock – Battery real-time clock.

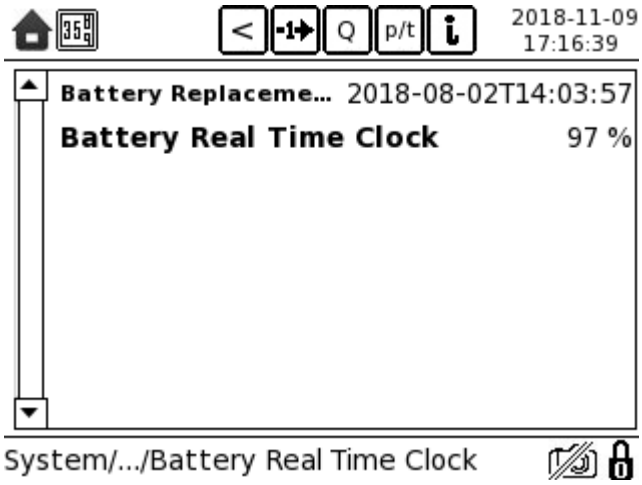


Fig. 69 Battery real-time clock

See the service manual for information on how to perform a battery replacement.

12. Tests relating to custody transfer measurements

This section contains descriptions of the necessary parameters and unit-specific procedures for functional tests relating to custody transfer measurements, re-certifications for custody transfer measurements and the adaptation of parameters to current conditions.

The EcoSonic X12 provides the option of combining the three functions of ultrasonic gas meter, volume corrector and measured value database (tariff device) into a single unit.

The benefits of this compact design are put to good use by the EcoSonic X12. The three functions are treated as independent modules in the software structure and user guidance. In the user guidance of the EcoTouch, information on the software versions, checksums, calibration parameters and correction factors with a relevance for custody transfer purposes is stored under the item “Unit data” for the relevant function.

12.1 Checking the status – condition control

In order to assess the condition of the metering unit, the metrological protections for custody transfer measurements such as the main seal, safety seal and other seals are checked, along with the information regarding the software and parameters relating to custody transfer measurements.
(Section 18 Metrological protection for custody transfer measurements – seal plan)

12.1.1 Calibration switch

The calibration switch is located on the left-hand side of the EcoTouch housing. The calibration switch is an electrical pressure switch protected by a screw with a seal and a security label.

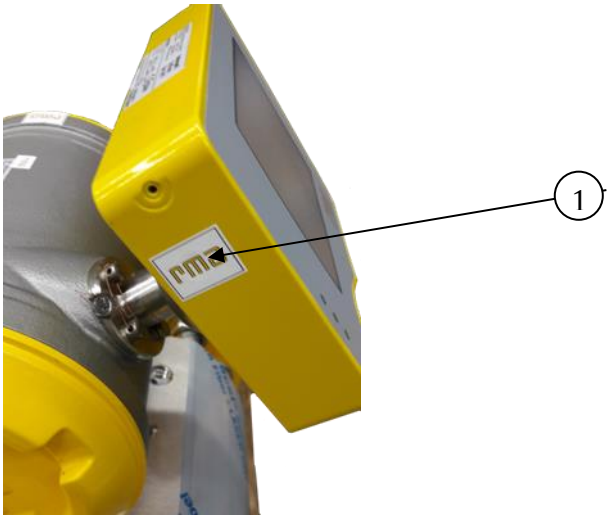


Fig. 70 Calibration switch protected by an adhesive label

To open the calibration switch:

1. Remove or destroy the security label (1)
2. Unscrew the safety screw with seal (4-mm Allen wrench)
3. Insert a long, solid object, ideally a plastic stylus or a thin screwdriver, through the screw opening to push the electric push-button.

This will open the calibration switch. The symbol, i.e. the **Calibration switch** user level, will be displayed in the footer line of the EcoTouch operating unit.

If no further setting adjustments or parameterisations are carried out on the unit, the EcoSonic X12 will automatically return to the **Normal** level after 15 minutes. The calibration switch will be closed.
The calibration switch can also be actively closed by selecting a different user level with the EcoTouch or the EcoView program.

Any changes made to custody transfer parameters will be entered in the log at the **Calibration switch** user level. Users in the **Calibration switch** user level can delete all entries from the log.

4. Re-insert the safety screw with seal
5. Affix a new security label

12.1.2 Checking the parameters relating to custody transfer measurements

The display on the EcoTouch operating unit is the binding reliable display. The currently set parameters, the status information and the software version numbers and checksums can be read off from this display.

12.1.2.1 Software versions, checksums

The parameters with a relevance for custody transfer purposes are specified in the following section. They are also listed in the unit ID card/data book.

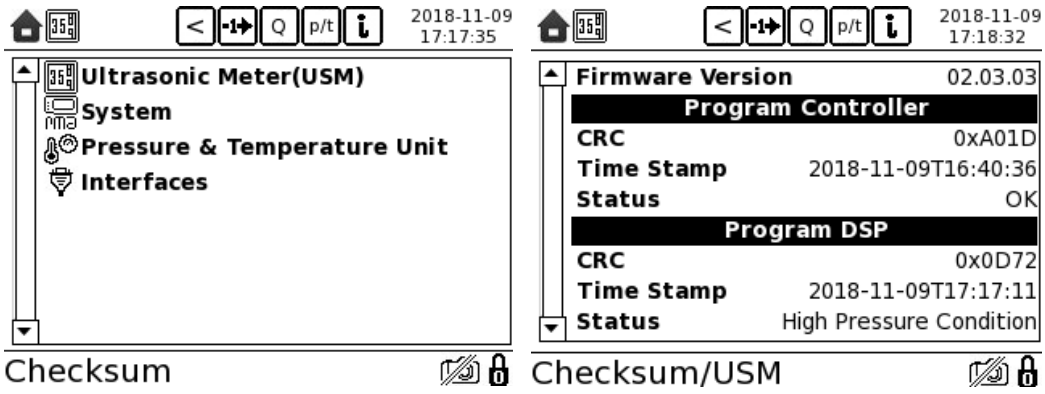


Fig. 71 Checksum menu

USM – ultrasonic gas meter

S/N unit	Serial number of the EcoSonic X12	Identical to the serial number on the main data plate of the EcoSonic X12
FW version	Firmware version	
S/N acoustic transducer DIR1 + CRC	Serial numbers of the ultrasonic transducers that send the signal in the main flow direction, arranged by measuring path	The two acoustic transducer serial numbers, the serial number of the transformer module and temperature sampling points with differential transit time offsets and cumulative transit time offset (zero adjustment) form a parameter set that is secured by means of a CRC.
S/N acoustic transducer DIR2 + CRC	Serial numbers of the ultrasonic transducers that send the signal against the main flow direction, arranged by measuring path	

System	
ETControl	The control application of the EcoTouch operating unit. The display provides the following information: Main version, Minor release version MD5 hash Time stamp of last test Status

uTouch	The uTouch application controls the data display and the operation via the EcoTouch display. The display provides the following information: Main version, Minor release version MD5 hash Time stamp of last test Status
comUSM	The comUSZ application controls the communication between the EcoTouch and the EcoView program The display provides the following information: Main version, Minor release version MD5 hash Time stamp of last test Status
Modbus	The Modbus application makes it possible to read out meter readings, pressure and temperature values, statuses etc. The use of the interface is regulated via the “Modbus type” setting. The Modbus type EcoGate RTU transmits the data in accordance with the DSfG meter protocol (instance F) The display provides the following information: Main version Minor release version MD5 hash Time stamp of last test Status The Modbus interface is intended for the use of data relevant for custody transfers (DSfG meter instance F). It can also output measured values and status information for non-custody-transfer purposes. The interface with program version 2.0 is non-reactive.

Interfaces

Modbus	The Modbus application makes it possible to read out meter readings, pressure and temperature values, statuses etc. The use of the interface is regulated via the “Modbus type” setting.

The Modbus type EcoGate RTU transmits the data in accordance with the DSfG meter protocol (instance F)

The display provides the following information:
Main version
Minor release version
MD5 hash
Time stamp of last test
Status
The Modbus interface is intended for the use of data relevant for custody transfers (DSfG meter instance F). It can also output measured values and status information for non-custody-transfer purposes.
The interface with program version 2.0 is non-reactive.

12.1.2.2 Calibration and measurement parameters for the flow measurement

D	Inner diameter	[mm]
L	Transducer - transducer distance	[mm]
X	Axial centre-to-centre distance between the opposing boreholes in the metering unit	[mm]
W	Weighting factor for the path velocity	
Q_{min}	Flows below Q_{min} are counted within the operating disturbance volume. Flows below 0.25 * Q_{min} are considered creepage volumes and are not displayed.	[m^3/h]
Q_{max}	Flows above $Q_{max.}$ are counted within the operating volume.	[m^3/h]
t_{min}		[°C]
t_{max}		[°C]
p_{min}		[bar]
p_{max}		[bar]
Offset zero flow DIR1		
Offset zero flow DIR2		
Factor DIR1	Correction determined from the meter characteristic line (WME)	Factor 1.0 indicates no correction
Factor DIR2	Correction determined from the meter characteristic line (WME)	
Polynomial direction of travel 1	Coefficients of the correction polynomial	All coefficients = 0

Polynomial direction of travel 2	Coefficients of the correction polynomial	indicates no correction
Speed of sound range during zero adjustment		[m/s]
Temperature substitute value	Used if the temperature is outside of the specified limiting values	°C
Pressure substitute value	Used if the pressure is outside of the specified limiting values	bar

12.1.3 Pulse output, pulse value

The EcoSonic X12 can transmit the measured operating volume V_m, the base volume V_b or associated disturbance volume to a component such as an external volume corrector or recording instrument via the pulse output. More precisely:

The pulse output always transmits a counter increase in pulses/m^3.

The increases in the following counters can be output at the pulse outputs:

Deactivated	Pulse output is inactive
Flow direction 1. V_m operating volume	Increase in the operating volume meter in the main flow direction
Flow direction 2. V_m operating volume	Increase in the operating volume meter against the main flow direction
Flow direction 1. Vo original volume	Increase (operating volume DIR1 + operating disturbance volume DIR1)
Flow direction 2. Vo original volume	Increase (operating volume DIR2 + operating disturbance volume DIR2)
Flow direction 1. VmD operating volume, disturbance	Increase in the operating disturbance volume meter in the main flow direction
Flow direction 2. VmD operating volume, disturbance	Increase in the operating disturbance volume meter against the main flow direction
Q simulation	Flow simulation (only possible with an open calibration switch) outputs pulses at the pulse output with a fixed frequency.

Of the specified settings, only the operating volume DIR1 in the main flow direction as denoted above will be measured with validity for custody transfer measurements when carrying out measurements for custody transfer purposes.
All other settings output disturbance volumes or contain proportions of disturbance volumes. These counters are not measured with validity for custody transfer measurements

The number of pulses/m^3 can be freely configured for each pulse output. The EcoSonic X12 can output pulses at a maximum frequency of 6 kHz.
If there are greater meter increases for a very short period, the EcoSonic X12 can compensate for the excess pulses. If the pulse output is transmitting pulses at the maximum frequency and the excess pulses cannot be sent within 30 seconds, then an “alarm incoming” message will be entered in the metrological log (pulse output <x> warning). If the excess pulses cannot be sent within 60 seconds, an additional “alarm incoming” message will be entered in the metrological log. (pulse output <x> error).

The pulse output settings and the set pulse value can be reliably and bindingly read off at the EcoTouch display under the menu item

Interfaces → Pulse outputs

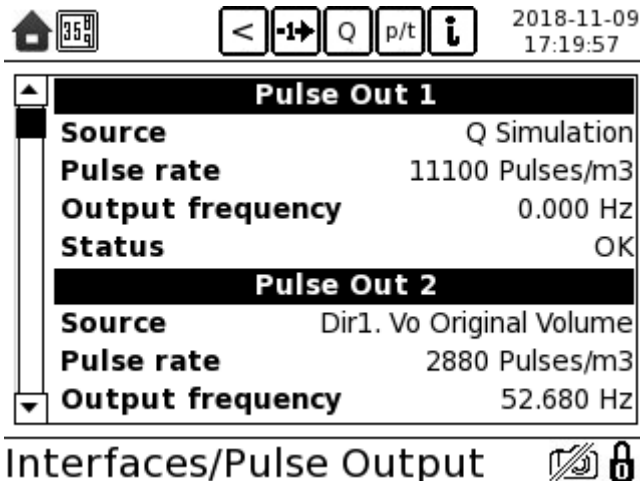


Fig. 72 Pulse outputs

Note

Pulse value

If the pulse value settings are not carefully coordinated, the transmission of the counter increases via the pulse outputs may be incorrect.

When determining the pulse value, both the maximum pulse frequency of the EcoSonic X12 and the maximum input frequency of the connected device must be taken into consideration. These two maximum values must not be exceeded.

Therefore, the maximum flow Q_{max} must be taken into account when determining the pulse value of operating volume meters. The influence of the state factor must also be considered for the pulse output from base volume meters, i.e. primarily the maximum pressure and minimum gas temperature.
When connecting measured data recording devices for custody transfer measurements, it is important to note that a meter increment at 30% Q_{max} will be transmitted with a minimum of 100 pulses/increments.

The pulse values of the EcoSonic X12 and the receiving device must match.

(With the Q simulation, a constant flow and therefore a constant frequency can be simulated at the pulse output.)

12.1.4 Characteristic line adjustment

With the characteristic line adjustment, low metering deviations of a metering unit are corrected and the metering accuracy of the unit is improved.

12.1.4.1 Polynomial correction

When performing the initial calibration of the EcoSonic X12, the measured residual deviations from the flow of the measurement standard is described using a polynomial with a maximum of 5 coefficients.
(-> Section characteristic line adjustment on page 84)
During re-certification for custody transfer measurements, the characteristic line can be re-determined and the results used to determine a new correction polynomial with different parameters. At least 7 sampling points on the characteristic line must be used to determine the correction polynomial.

The coefficients of flow direction 2, i.e. against the main flow direction, are only valid in bidirectional metering operation. Metering in flow direction 2 is still not valid for custody transfer measurements.

The determined coefficients a_i for the main flow direction and b_i for the characteristic line for the opposite direction are determined based on the calibration. They are then stored in the EcoSonic X12 as coefficient set “Polynomial DIR1” for the characteristic line for the main flow direction and as “Polynomial DIR2” for the characteristic line for the opposite direction.
Determined coefficients are entered as parameters using the EcoView program, and are transmitted to the EcoSonic X12.

Prerequisite: open calibration switch

The correction polynomial is used to determine the corrected flow:

(21) $$Q_{korr} = Q_b * \frac{1}{1 + F(Q)/100}$$

(With the EcoSonic X12, “Polynomial DIR1” can be used for the characteristic line adjustment in the main flow direction. A “Polynomial DIR2” correction polynomial is also provided for the opposite direction. To this end, a characteristic line must be measured for the opposite direction during calibration, and a separate polynomial must be established for the opposite direction where applicable.
The EcoSonic X12 is only calibrated and certified by the Metrological Authority for custody transfer measurements in the main flow direction DIR1. Calibration without certification for custody transfer measurements in flow direction 2 can be performed on customer request.

The calibration factors for the EcoSonic X12 are defined during calibration. They can only be modified when the calibration switch is open.
If all coefficients are set to 0.000, a polynomial correction will not be effective.

12.1.4.2 Constant factor and offset

When performing a correction with a constant factor, a weighted mean error (WME) is determined based on the measured characteristic line data (see “Characteristic line adjustment” section on page 84). The WME is usually used to calculate a correction factor:

(22) $$Faktor = 100.0/(100.0 + WME)$$

An offset can also be parameterised. The factor and offset correct the measured flow in a linear manner.

(23) $$Q_{korr} = Q_b * Faktor + Q_{Offset}$$

The “factor” correction factor established using the WME can be used in this way as a calibration parameter in the EcoView program. The parameters are reliably displayed on the EcoTouch operating unit as “Factor DIR1” and “Qoffset DIR1” and are valid for custody transfer measurements.
(With the EcoSonic X12, the “factor DIR1” correction factor for the characteristic line adjustment affects the sampling in the main flow direction. A correction factor for the opposite direction (“factor DIR2”) can be applied to sampling in flow direction 2).

Factor_DIR1 can be determined and calibrated separately as Factor_DIR1_Ref (under reference conditions) by carrying out a test on the air test bench, and as Factor_DIR1_HP (HP for high pressure) by carrying out a test on the high-pressure test bench. The EcoSonic X12 is only calibrated and certified by the Metrological Authority for custody transfer measurements in the main flow direction DIR1. Calibration without certification for custody transfer measurements in flow direction 2 can be performed on customer request.

The calibration factors for the EcoSonic X12 are defined during calibration. They can only be modified when the calibration switch is open. If the factor is set to 1000 and Qoffset to 0.000, the correction using a constant factor will not be effective.

For reference conditions (i.e. during calibration on the air test bench at air pressure) and for high-pressure conditions, another factor DIR1 can be specified in each case. These factors will be shown as “Factor_DIR1_Ref” and “Factor_DIR1_HP” on the EcoTouch display.

If the parameter “Factor_DIR1_Ref” is set to a value other than 1 during calibration on the air test bench at air pressure, the following point must be noted:

- The “Factor_DIR1_Ref” correction factor is determined and recorded.
- The same value is also recorded as “Factor_DIR1_HP” and the associated pressure parameter is set to p_{max}.

This helps to ensure that the same correction factor is used for all pressures that occur.

If necessary, a “Factor_DIR1_HP” factor can be determined using the meter characteristic line during a high-pressure calibration. The determined “Factor_DIR1_HP” is recorded as a parameter. The pressure at which the calibration was performed is recorded as an associated pressure parameter.

The correction factors are used to optimise the metering accuracy, and correct deviations of 1% and under from an ideal meter characteristic line.

12.1.4.3 Manufacturer parameters of the USM

The USM parameters a_corr, b_corr, f2 and fcw, as well as asym and cross, are manufacturer parameters that must not be changed during re-certification for custody transfer measurements.

The calibration data for the two acoustic transducers are also manufacturer parameters. For each measuring path, there is exactly one pair of acoustic transducers and one transformer board. The temperature dependency is characterised by 5 data pairs (temperature, temperature-dependent transit time offset). These parameter pairs must also not be changed during re-certification for custody transfer measurements.
The only exception to this rule is in the event of the replacement of a transducer pair. In this case, the parameters of the replacement pair will need to be entered.

(Temperature-independent sum and differential transit time offsets are saved together with the acoustic transducer parameters. These offsets are not manufacturer's parameters and can be optimised during production or subsequent calibration when the calibration lock is open).

12.1.5 Flow simulation - Q simulation

The flow simulation, or Q simulation for short, is a tool that can only be started up via the EcoView program when the calibration switch is open.
Its intention and purpose is to simulate a constant flow. The pressure and temperature can also be fixed. It is therefore suitable for

- Carrying out corrections with fixed input variables for testing purposes
- Temporary operation of a pulse output with a fixed frequency

Normal metering operation is interrupted during the flow simulation. An entry is made in the metrological log. The simulated flow is added to the DIR1 operating-disturbance volume (main flow direction).
The used pulse output must be switched to Q simulation at user level 7 in EcoView (position 1, Fig. 73).

12.1.5.1 Input values for the Q simulation in the EcoView program

dV	Target value counted on the disturbance volume counter as a simulated constant flow. dV is a target value that may be marginally exceeded by the simulation.
dt	Indicates how long the simulation is to last, expressed as hh:mm:ss. The change in time is linked with the other input parameters Q, f pulse output 1, pulse output 2 If dt is changed then the other input values will also change and vice versa.
Q	Flow - indicates what the flow through the metering unit should be during the simulation. The flow setting is linked with the other input parameters, e.g. the frequency f at the pulse output. If the frequency is changed then the flow will also change and vice versa.
(f pulse output 1)	Frequency to be output at pulse output 1. A prerequisite here is that the pulse output 1 has been set to “Q simulation”. The frequency is calculated based on the set flow Q and the set pulse value of pulse output 1. The setting for frequency f at pulse output 1 is linked with the other input parameters and vice versa. If the simulated flow is changed, for example, then the frequency will also change and vice versa.
(f pulse output 2)	Frequency to be output at pulse output 2. A prerequisite here is that the pulse output 2 has been set to “Q simulation”. The frequency is calculated based on the set flow Q and the set pulse value of pulse output 2. The setting for frequency f at pulse output 2 is linked with the other input parameters. If these parameters are changed, the frequency of pulse output 2 can also change and vice versa.

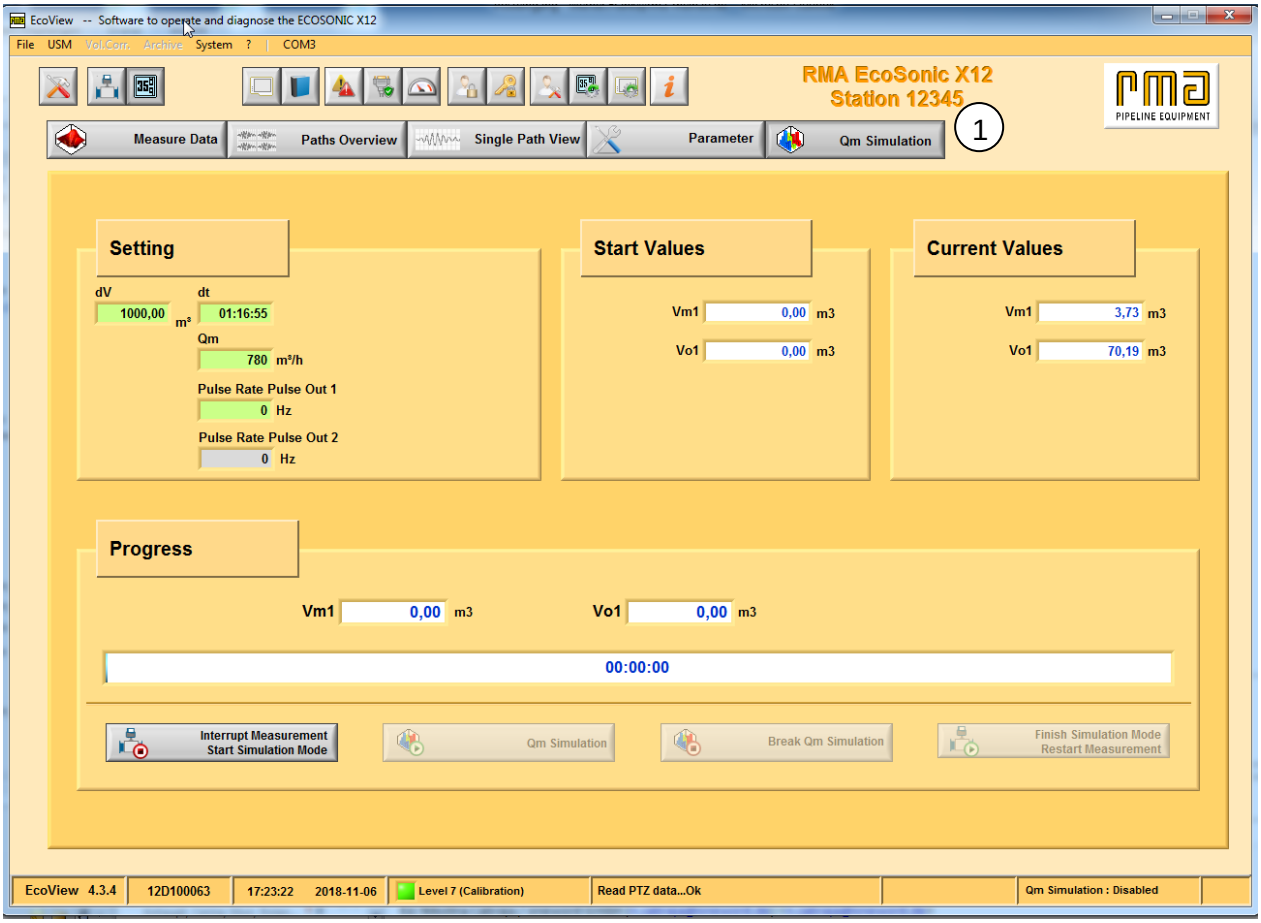


Fig. 73 Q simulation, EcoView

12.1.5.2 Deviating settings in the first software versions

In the first versions of the EcoSonic X12 software, which work in conjunction with EcoView version 3.x, pulse output 2 is not taken into account. This field is not shown in the Q simulation. In these versions, the Q simulation always outputs the simulated pulses at pulse output 1.

12.1.5.3 Q simulation output values

Progress	Indicates the progress of the continual simulated flow: The disturbance volume Vm1D in the main flow direction increases.
Starting values	The meter readings at the start of each individual simulation are specified here.
Current measured values	Indicates the current meter readings and the current compressibility as well as the state factor.
Pulses at pulse output 1, pulse output 2	Only when the pulse output is switched to “Q simulation” for testing purposes will the simulated flow also be output at pulse output 1 or pulse output 2 with the appropriate set pulse value.

Note

Exiting the Q simulation

After a Q simulation, it is possible to adjust any modified parameters, in particular the assignment of the pulse outputs and the pulse rates.

The Q simulation is a tool that can only be used when the calibration switch is open.

After exiting the Q simulation, any modified parameters will need to be reset.

After using the Q simulation function, the parameters of the EcoSonic X12 must be checked.

13. List of parts

13.1 Accessories

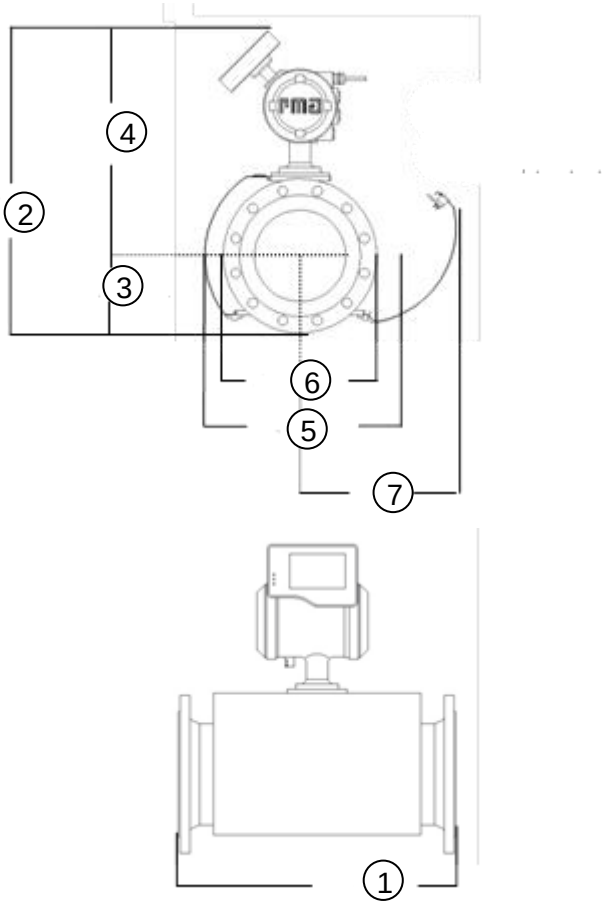
Designation	RMA part no.
Ex blank plug	0.3001.5002
Screwed cable gland, USM electronics (without shield)	0.3002.5417
Screwed cable gland, USM electronics (with shield)	0.3002.5418
Screwed cable gland, connector box (without shield)	0.3002.5417
Ex blank plug (closure instead of screwed cable gland)	0.3002.5002
Ex-i power supply EcoHT (related equipment)	4.9306.0100
EcoSonic X12 24V power supply on request	
RS485 PC adapter on request	0.3002.5086

13.2 Spare parts

Designation	RMA part no.
Ultrasonic metering unit (2 transducers, transformer board, calibration data)	3.9306.0220
Lifting eyes	0.0118.5010
T-bore ball valve	1.9306.0305
EcoPT sensor	3.9306.03xx
EcoTouch operating unit	3.9306.0100
Additional parts on request	

14. Dimensions

14.1 Parameters and dimensions of the metering element



(The old/new values in the following table refer to different versions. Metering units with the “new design” usually have a T-bore ball valve with test connection located on the outside of the side covers).

Nominal width	Pressure stages	Weight	Length (1)	Height (2)	Height (3)	Height (4)	Width (5)	Flange diameter (6)	Inner flange diameter	Inlet pipe inner diameter	Wall clearance (7)
		[kg]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
DN 80 3”	PN16/25	60	240	560	105	455	325	210	80	82.5	300
	ANSI 150										
	ANSI 300										
	ANSI 600										
DN 100 4”	PN16	85	300	605	140	465	335	275	100	107.1	320
	PN25										
	ANSI 150										
	ANSI 300										
	ANSI 600										
DN 150 6”	PN16	70	450	630	145	485	285	285	154	155.7	315
	PN25	76		635	150		300	300			
	ANSI 150	76		625	140		280	280			
	ANSI 300	90		645	160		320	320			
	ANSI 600	120		665	180		355	355			
DN 200 8”	PN16/25	90	600	680	180	500	340	340	202	206.5	400
	PN25	105		680	180		340	340			
	ANSI 150	105		680	180		345	345			
	ANSI 300	125		690	190		380	380			
	ANSI 600	170		710	210		420	420			
DN 250 10”	PN16	135	750	725	205	525	405	405	250	260.4	400
	PN25	155		735	215		425	425			
	ANSI 150	155		725	205		405	405			
	ANSI 300	185		745	220		440	440			
	ANSI 600	245		780	225		510	510			
DN 300 12”	PN16	185	900	780	230	550	460	460	300	309.7	400
	PN25	210		795	245		485	485			
	ANSI 150	210		795	245		485	485			
	ANSI 300	250		820	260		520	520			

Nominal width	Pressure stages	Weight	Length (1)	Height (2)	Height (3)	Height (4)	Width (5)	Flange diameter (6)	Inner flange diameter	Inlet pipe inner diameter	Wall clearance (7)
		[kg]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
	ANSI 600	330		830	280		560	560			
DN 400 16”	PN16	350	1200	860	290	590	560	560	380	389	420
	PN25	385		900	310		620	620			
	ANSI 150	385		890	300		595	595			
	ANSI 300	470		915	325		650	650			
	ANSI 600	605		935	345		685	685			
DN 500 20”	PN16	620	1500	995	360	635	715	715	483	483	900
	PN25	625		1000	365		730	730			
	ANSI 150	625		990	355		700	700			
	ANSI 300	775		1025	390		775	775			
	ANSI 600	965		1045	410		815	815			
DN 600 24”	ANSI 6005	1350	1800	1200	470	725	950	940	570	570	1000

The values specified above are standard dimensions. The precise determination of dimensions and pipe diameters takes place in advance in collaboration with the metering unit manufacturer during the planning of the metering point. Further diameters/pressure stages on request.

5 Metering units with DN 600 are only used from an operating pressure of pm > 10 bar. With pressures higher than 10 bar, the increased gas density makes it easier to perform reliable metering over the length of the measuring path.

15. Appendix 2

15.1 Abbreviations

ASCII	American Standard Code for Information Interchange
AGA	American Gas Association
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
CSA	Canadian Standards Association
DC	Direct Current
DIN	German Institute for Standardization
DN	Nominal width (Diameter Nominal) - indicates the inner diameter
DSfG	Digital interface for gas metering device (-> DVGW)
DSP	Digital Signal Processor
DVGW	German Technical and Scientific Association for Gas and Water
EN	European standard
EX	Potentially explosive (ATEX = ATmosphères EXplosibles)
IEC	International Electrotechnical Commission
LED	Light Emitting Diodes
NAMUR	User Association of Automation Technology in Process Industries
OIML	International Organization of Legal Metrology
PTB	National Metrology Institute of Germany
VDE	Association for Electrical, Electronic & Information Technologies
WELMEC	European Cooperation in Legal Metrology

15.2 Measured variables

German	international	
t_u	t_u	Transit time, upstream
t_d	t_d	Transit time, downstream
p	p	Operating/measurement pressure in bar absolute
t	t	Operating/measurement temperature in °C
p_n	p_b	Standard/base pressure ($_n$ = standard or $_b$ = base)
T_n	T_b	Standard/base temperature ($_n$ = standard or $_b$ = base)
v, v_m	v, v_m	Mean flow rate
$v_{path, i}$	$v_{path, i}$	Gas velocity measured over the measuring path i (i = 1 to 6)
c, c_m	c, c_m	Mean speed of sound in the gas
$c_{path, i}$	$c_{path, i}$	Speed of sound measured over the measuring path i (i = 1 to 6)
V_n	V_b	Base volume at p_b, T_b ($_{\text{under standard conditions}}$)
V_b	V_m	Operating volume at p, t
Q_n	Q_b	Standard flow ($_{\text{under standard conditions}}$)
Q_b	Q_m	Operating flow at p, t
Q_s	Q_l	Creepage volume limit

15.3 Descriptions used in relation to the EcoSonic X12

USM	Ultrasonic gas meter
EVC	Volume corrector
TD	Tariff device
ETC	EcoTouch Control (program module controlling the EcoTouch processes)
US transducer	Ultrasonic transducer
DN	Nominal width (Diameter Nominal) – indicates the pipe diameter
PN	Nominal pressure (Pressure Nominal) – parameter for the design pressure, determines the flanges and wall thicknesses
SN	Serial number
U_n	Nominal voltage – operating voltage
U_m	Safety system: maximum voltage

16. Displays and parameters

16.1 USM displays and parameters

Param. Index	Description	Unit	Read / Write (R/W)	Access level
	Amplification. Error limit	dB	L	
	c speed of sound. Error limit (min)	m/s	L	
	c speed of sound. Error limit (max)	m/s	L	
	Signal-to-noise ratio. Error limit		L	
	Error rate. Error limit	%	L	
	Ultrasonic gas meter (USM). Firmware version		L	
030090	Unit data. Unit name		R / W	3
030091	Unit data. Metering point		R / W	3
030092	Signal output 1. Source		R / W	3
030093	Signal output 2. Source		R / W	3
030094	Signal output 3. Source		R / W	3
030095	Signal output 4. Source		R / W	3
030096	Amplification. Warning limit	dB	R / W	3
030097	Amplification. Warning. (Deviation)	dB	R / W	3
030098	c speed of sound. Warning limit (min)	m/s	R / W	3
030099	c speed of sound. Warning limit (max)	m/s	R / W	3
030100	c speed of sound. Warning. (Deviation)	m/s	R / W	3
030101	Signal-to-noise ratio. Warning limit		R / W	3
030102	Error rate. Warning limit	%	R / W	3
030026	Dimensions. Inner diameter	mm	R / W	7
030027	Path 1. L path length	mm	R / W	7
030028	Path 2. L path length	mm	R / W	7
030029	Path 3. L path length	mm	R / W	7
030030	Path 4. L path length	mm	R / W	7
030031	Path 5. L path length	mm	R / W	7
030032	Path 6. L path length	mm	R / W	7
030033	Path 1. X path offset	mm	R / W	7
030034	Path 2. X path offset	mm	R / W	7
030035	Path 3. X path offset	mm	R / W	7
030036	Path 4. X path offset	mm	R / W	7
030037	Path 5. X path offset	mm	R / W	7
030038	Path 6. X path offset	mm	R / W	7

Param. Index	Description	Unit	Read / Write (R/W)	Access level
030039	Path 1. W path weight value		R / W	7
030040	Path 2. W path weight value		R / W	7
030041	Path 3. W path weight value		R / W	7
030042	Path 4. W path weight value		R / W	7
030043	Path 5. W path weight value		R / W	7
030044	Path 6. W path weight value		R / W	7
030045	Flow direction 1. Polynomial correction. 1/Q²		R / W	7
030046	Flow direction 1. Polynomial correction. 1/Q		R / W	7
030047	Flow direction 1. Polynomial correction. 1		R / W	7
030048	Flow direction 1. Polynomial correction. Q		R / W	7
030049	Flow direction 1. Polynomial correction. Q²		R / W	7
030050	Flow direction 2. Polynomial correction. 1/Q²		R / W	7
030051	Flow direction 2. Polynomial correction. 1/Q		R / W	7
030052	Flow direction 2. Polynomial correction. 1		R / W	7
030053	Flow direction 2. Polynomial correction. Q		R / W	7
030054	Flow direction 2. Polynomial correction. Q²		R / W	7
030068	Limits & warnings. Qm min flow rate	m3/h	R / W	7
030071	Limits & warnings. Qm max flow rate	m3/h	R / W	7
030057	Flow direction 1. Qm offset zero flow	m3/h	R / W	7
030058	Flow direction 2. Qm offset zero flow	m3/h	R / W	7
030059	Manufacturer parameter. Correction a_corr reference condition		R / W	7
030060	Manufacturer parameter. Correction a_corr HP condition		R / W	7
030061	Manufacturer parameter. Correction b_corr		R / W	7
030055	Flow direction 1. Factor, reference condition		R / W	7
030062	Flow direction 1. Factor, high-pressure condition		R / W	7
030056	Flow direction 2. Factor, reference condition		R / W	7
030063	Flow direction 2. Factor, high-pressure condition		R / W	7
030064	Manufacturer parameter. Correction f2 reference condition		R / W	7
030065	Manufacturer parameter. Correction f2 HP condition		R / W	7
030066	Manufacturer parameter. Correction fcw reference condition		R / W	7
030067	Manufacturer parameter. Correction fcw HP condition		R / W	7
030074	pm high pressure. Condition	bar	R / W	7
030078	Path failures. Maximum		R / W	7
030079	Path failures. Maximum custody-transfer-related		R / W	7
030080	Path compensation. Activated		R / W	6

Param. Index	Description	Unit	Read / Write (R/W)	Access level
030084	Manufacturer parameter. Reference signal		R / W	7
030089	Manufacturer parameter. Prescaler signal		R / W	7
030081	Path compensation. Learn phase time	s	R / W	7
030082	Path compensation. Maximum standard deviation	%	R / W	7
030083	Path compensation. Maximum error time	s	R / W	7
030085	Calibration. Median depth		R / W	6
030086	Calibration. Mean depth		R / W	6
030087	Manufacturer parameter. Envelope curve deviation limit	mV	R / W	7
030088	Manufacturer parameter. Envelope curve increase limit		R / W	7
030073	Manufacturer parameter. Condition	bar	R / W	7
030069	Creepage volume. Q_l minimum flow	m3/h	R / W	7
030070	Creepage volume. Time		R / W	7
030075	pm high pressure. Minimum limit	bar	R / W	7
030076	pm high pressure. Maximum limit	bar	R / W	7
030105	Interfering noise limiting value. Test range time	µs	R / W	7
030106	Interfering noise limiting value. RMS	%	R / W	7
030001	Unit data. Serial number		R / W	7
030002	Unit data. Serial number electronics		R / W	7
030110	Manufacturer parameter. Correction asym HP condition		R / W	7
030111	Manufacturer parameter. Correction cross reference condition		R / W	7
030112	Manufacturer parameter. Correction cross HP condition		R / W	7
030077	tm temperature. Specified substitute value	°C	R / W	6
030072	pm pressure. Specified substitute value	bar	R / W	6
030003	Pulse output 1. Pulse rate	Pulse per m3	R / W	6
030004	Pulse output 2. Pulse rate	Pulse per m3	R / W	6
030005	Pulse output 1. Source		R / W	6
030006	Pulse output 2. Source		R / W	6
030007	Encoder. Source		R / W	6
030008	Encoder. Encoder number of digits		R / W	6
030009	Encoder. Value		R / W	6
030010	Real-time clock. Changing the time		R / W	6
030011	Real-time clock. UTC		R / W	6
030103	HART. Mode		R / W	7
030104	HART. EcoPT redundancy		R / W	7

Param. Index	Description	Unit	Read / Write (R/W)	Access level
	EcoPT temperature. Minimum limit	°C	L	
	EcoPT temperature. Maximum limit	°C	L	
	EcoPT pressure. Minimum limit	bar	L	
	EcoPT pressure. Maximum limit	bar	L	
	EcoPT. Serial number		L	

16.2 Ultrasonic sensors

Param. Index	Description	Unit	Read / Write R / W	Access level
	Path 1. Serial number sensor A		R / W	7
	Path 1. Serial number sensor B		R / W	7
	Path 1. Serial number transformer		R / W	7
	Data archive. Path 1 T1	°C	R / W	7
	Data archive. Path 1 T2	°C	R / W	7
	Data archive. Path 1 T3	°C	R / W	7
	Data archive. Path 1 T4	°C	R / W	7
	Data archive. Path 1 T5	°C	R / W	7
	Data archive. Path 1 LZD1	ns	R / W	7
	Data archive. Path 1 LZD2	ns	R / W	7
	Data archive. Path 1 LZD3	ns	R / W	7
	Data archive. Path 1 LZD4	ns	R / W	7
	Data archive. Path 1 LZD5	ns	R / W	7
	Cumulative transit time offset. Base	ns	R / W	7
	Cumulative transit time offset. Adapted	ns	R / W	7
	Air pressure offset. Base	ns	R / W	7
	High-pressure offset. Base	ns	R / W	7
	Air pressure offset. Adapted	ns	R / W	7
	High-pressure offset. Adapted	ns	R / W	7
030020	CRC ultrasonic transducer. Path 1		L	
	Path 2. Serial number sensor A		R / W	7
	Path 2. Serial number sensor B		R / W	7
	Path 2. Serial number transformer		R / W	7
	… … … … …		…	
	Data archive. Path 2 T1	°C	R / W	7
	High-pressure offset. Adapted	ns	R / W	7
030021	CRC ultrasonic transducer. Path 2		L	
	Path 3. Serial number sensor A		R / W	7
	… … … … …		…	
	High-pressure offset. Adapted	ns	R / W	7
030022	CRC ultrasonic transducer. Path 3		L	
	… … … … …		…	
030023	CRC ultrasonic transducer. Path 4		L	
	… … … … …		…	

Param. Index	Description	Unit	Read / Write R / W	Access level
030024	CRC ultrasonic transducer. Path 5		L	
	… … … … …		…	
	High-pressure offset. Adapted	ns	R / W	7
030025	CRC ultrasonic transducer. Path 6		L	

16.3 EcoTouch

Param. Index	Description	Unit	Read / Write R/W	Access level
010001	System. Language		R / W	0
010002	System. Units		R / W	0
000001	Interfaces. Serial interface mode		R / W	6
000002	Network. IP EcoTouch		R / W	6
000003	Network. Screen		R / W	6
050001	Modbus. Slave ID		R / W	3
050002	Modbus. Baud rate		R / W	3
050003	Modbus. Data bits		R / W	3
050004	Modbus. Parity		R / W	3
050005	Modbus. Modbus type		R / W	6
050006	Modbus. TCP port		R / W	3
050007	Data sequence. 16-bit integer		R / W	3
050008	Data sequence. 32-bit integer		R / W	3
050009	Data sequence. 64-bit integer		R / W	3
050010	Data sequence. Float		R / W	3
050011	Data sequence. Double		R / W	3
050012	Data sequence. String (2 per register)		R / W	3
060001	Serial interface. Baud rate		R / W	3
060002	Serial interface. Data bits		R / W	3
060003	Serial interface. Parity		R / W	3
060004	Serial interface. Stop bits		R / W	3
060005	Volume corrector (EVC). Converter address		R / W	3
060010	Volume corrector (EVC). CRC12 start value		R / W	3
060006	Registration. Registration address		R / W	3
060011	Registration. CRC12 start value		R / W	3
060007	Dial-up. Dial-up address		R / W	3
060008	Dial-up. Bus ID		R / W	3
060009	Dial-up. Dial-up ID		R / W	6
060012	Dial-up. CRC12 start value		R / W	3

17. Alarms and warnings

17.1 Ultrasonic gas meter

Event No.	Event	Type A = Alarm W = Warning	Auto acknowledgement Yes/no	Acknowledgement via level
010000	CRC checksum error, USM firmware	A	No	7
010001	CRC error, USM RAM custody transfer parameter	A	Yes	
010002	CRC error, USM EEPROM custody transfer parameter	A	Yes	
010005	CRC checksum error, DSP firmware	W	Yes	
010006	CRC error, DSP custody transfer parameter	A	No	
010007	CRC checksum error, DSP firmware	A	No	7
010010	CRC error, sensor parameter path 1	A	No	7
010011	CRC error, sensor parameter path 2	A	No	7
010012	CRC error, sensor parameter path 3	A	No	7
010013	CRC error, sensor parameter path 4	A	No	7
010014	CRC error, sensor parameter path 5	A	No	7
010015	CRC error, sensor parameter path 6	A	No	7
010016	CRC checksum error, Eco-Pt firmware	A	No	7
010017	Parameters were changed at USM	I	Yes	
010018	Restart performed	I	Yes	
010108	CRC error, DSP custody transfer parameter	A	No	7
010109	CRC error, DSP parameter (non-custody-transfer)	W	No	
000407	Restart performed	A	Yes	
010019	Watchdog reset	A	Yes	
010020	DSP communication error	A	No	
010021	EcoTouch communication error	A	No	
010022	EcoPT communication error	A	No	
010023	EcoPT status	A	No	7
000421	Real-time clock defective	A	No	7
010024	Invalid measurement	A	No	
010025	Internal log full	A	No	
010032	Qm simulation	W	No	
010039	Path 1 compensation	W	No	
010040	Path 2 compensation	W	No	

Event No.	Event	Type A = Alarm W = Warning	Auto acknowledgement Yes/no	Acknowledgement via level
010041	Path 3 compensation	W	No	
010042	Path 4 compensation	W	No	
010043	Path 5 compensation	W	No	
010044	Path 6 compensation	W	No	
010045	Path 1 deactivated	A	No	
010046	Path 2 deactivated	A	No	
010047	Path 3 deactivated	A	No	
010048	Path 4 deactivated	A	No	
010049	Path 5 deactivated	A	No	
010050	Path 6 deactivated	A	No	
012000	Pending alerts acknowledged	W	No	
012001	Pending fault messages acknowledged	A	No	
012002	Pending computer errors acknowledged	A	No	
012003	Pending computer error %u was acknowledged	A	No	
010060	EcoPT communication error	W	No	
010061	CRC checksum error, Eco-Pt firmware	W	No	
010062	EcoPT status	W	No	
010070	HART temperature gateway communication error	W	No	
010071	HART temperature gateway error	W	No	
010072	HART temperature sensor error	W	No	
010073	HART temperature sensor UOM error	W	No	
010074	HART pressure gateway communication error	W	No	
010075	HART pressure gateway error	W	No	
010076	HART pressure sensor error	W	No	
010077	HART pressure sensor UOM error	W	No	
010080	HART temperature gateway communication error	A	No	
010081	HART temperature gateway error	A	No	
010082	HART temperature sensor error	A	No	
010083	HART temperature sensor UOM error	A	No	
010084	HART pressure gateway communication error	A	No	
010085	HART pressure gateway error	A	No	
010086	HART pressure sensor error	A	No	
010087	HART pressure sensor UOM error	A	No	

Event No.	Event	Type A = Alarm W = Warning	Auto acknowledgement Yes/no	Acknowledgement via level
010108	CRC error, DSP RAM custody transfer parameter	A	No	
010109	CRC error, DSP RAM parameter (non-custody-transfer)	W	No	
010208	CRC error, USM RAM parameter (non-custody-transfer)	A	No	
010209	CRC error, USM EEPROM parameter (non-custody-transfer)	W	No	

Event No.	Event	Type A = Alarm W = Warning	Auto acknowledgement Yes/no	Acknowledgement via level
11001 / 11002 to 11011 / 11012	Path 1 / path direction A / SNR < limiting values Path 1 / path direction B / SNR < limiting values Path 6 / path direction A / SNR < limiting values Path 6 / path direction B / SNR < limiting values	W	Yes	
11013 / 11014 to 11023 / 11024	Path 1 / path direction A / SNR > limiting values Path 1 / path direction B / SNR > limiting values Path 6 / path direction A / SNR > limiting values Path 6 / path direction B / SNR > limiting values	W	Yes	
11025 to 11030	Path 1 / speed of sound C < limiting values Path 6 / speed of sound C < limiting values	W	Yes	
11031 to 11036	Path 1 / error rate > limiting values Path 6 / error rate > limiting values	W	Yes	
11037	Pulse outputs/pulse output 1 / output frequency" is higher than 6003.950 Hz	W	Yes	
11038	Pulse outputs/pulse output 2 / output frequency" is higher than 6003.950 Hz	W	Yes	
11039	Battery real-time clock/battery real-time clock" is lower than 7%	Info	Yes	
11040	Battery real-time clock/battery real-time clock" is lower than 0%	W	Yes	
11041	Ultrasonic gas meter (USM)/operating flow Q_m is lower than the minimum limiting value or higher than the maximum limiting value	W	Yes	

Event No.	Event	Type A = Alarm W = Warning	Auto acknowledgement Yes/no	Acknowledgement via level
11064 / 11065 to 11074 / 11075	Path 1 / path direction A / SNR ratio < 60 Path 1 / path direction B / SNR ratio < 60 Path 6 / path direction A / SNR ratio < 60 Path 6 / path direction B / SNR ratio < 60	A	Yes	
11076 / 11077 to 11086 / 11087	Path 1 / path direction A / amplification > 56dB Path 1 / path direction B / amplification > 56dB Path 6 / path direction A / amplification > 56dB Path 6 / path direction B / amplification > 56dB	A	Yes	
11088 to 11093	Path 1 / speed of sound C < 200 m/s or > 600 m/s Path 6 / speed of sound C < 200 m/s or > 600 m/s	A	Yes	
11094 to 11099	Path 1 / error rate > 80% Path 6 / error rate > 80%	A	Yes	
11100	Pressure, temp. sensor tm < min.- or > max. limit	A	Yes	
11101	Pressure, temp. sensor pm < min.- or > max. limit	A	Yes	
11103	Path failures > 2	A	Yes	
11104	Path failures for custody transfer measurements > 0	A	Yes	
11105	Speed of sound C < 200 m/s or > 600 m/s	A	Yes	
11106	Ultrasonic gas meter (USM)/operating flow Qm is lower than the minimum limiting value or higher than the maximum limiting value	A	Yes	
11107	Power supply DSP VDDINT < 1.0V or > 1.4V	Info	Yes	
11108	Power supply +12V < 11.0V or > 14.1V	Info	Yes	
11109	Power supply +5V < 4.5V or > 5.5V	Info	Yes	
11110	Power supply +3.3V < 3.0V or > 3.6V	Info	Yes	
11111	Power supply -5V < -5.5V or > 4.5V	Info	Yes	
11112	Pulse outputs/pulse output 1 / output frequency" is higher than 6003.950 Hz	A	Yes	
11113	Pulse outputs/pulse output 2 / output frequency" is higher than 6003.950 Hz	A	Yes	
11114 / 11115 to 11124/11125	Path 1 interfering noise < min. limit Path 1 interfering noise > max. limit Path 6 interfering noise < min. limit Path 6 interfering noise > max. limit	A		

17.2 EcoTouch

Event No.	Event	Type A = Alarm W = Warning	Auto acknowledgement Yes/no	Acknowledgement via level
013001	ETControl firmware was updated	Info	Yes	
013002	uTouch firmware was updated	Info	Yes	
013003	Volume corrector firmware was updated	Info	Yes	
013004	comUSZ firmware was updated	Info	Yes	
013005	ETUpdate firmware was updated	Info	Yes	
013006	Modbus firmware was updated	Info	Yes	
013007	DSfG firmware was updated	Info	Yes	
013008	ETControl application not present	Info	No	
013009	uTouch application not present	Info	No	
013010	Volume corrector application not present	Info	No	
013011	comUSZ application not present	Info	No	
013012	ETUpdate application not present	Info	No	
013013	Modbus application not present	Info	No	
013014	DSfG application not present	Info	No	
013015	ETControl application not present	A	No	7
013016	uTouch application not present	A	No	7
013017	Volume corrector application not present	A	No	7
013018	comUSZ application not present	A	No	7
013019	ETUpdate application not present	A	No	7
013020	Modbus application not present	A	No	7
013021	DSfG application not present	A	No	7
013022	ETControl application checksum error	Info	No	
013023	uTouch application checksum error	Info	No	
013024	Volume corrector application checksum error	Info	No	
013025	comUSZ application checksum error	Info	No	
013026	ETUpdate application checksum error	Info	No	
013027	Modbus application checksum error	Info	No	
013028	DSfG application checksum error	Info	No	
013029	ETControl application checksum error	A	No	7
013030	uTouch application checksum error	A	No	7
013031	Volume corrector application checksum error	A	No	7
013032	comUSZ application checksum error	A	No	7
013033	ETUpdate application checksum error	A	No	7

Event No.	Event	Type A = Alarm W = Warning	Auto acknowledgement Yes/no	Acknowledgement via level
013034	Modbus application checksum error	A	No	7
013035	DSfG application checksum error	A	No	7
013036	ETControl application not running	Info	No	
013037	uTouch application not started	Info	No	
013038	Volume corrector application not started	Info	No	
013039	comUSZ application not started	Info	No	
013040	ETUpdate application not started	Info	No	
013041	Modbus application not started	Info	No	
013042	DSfG application not started	Info	No	
013043	ETControl application not running	A	No	7
013044	uTouch application not started	A	No	7
013045	Volume corrector application not started	A	No	7
013046	comUSZ application not started	A	No	7
013047	ETUpdate application not started	A	No	7
013048	Modbus application not started	A	No	7
013049	DSfG application not started	A	No	7
013050	ETControl application running with unknown process ID	Info	No	
013051	uTouch application running with unknown process ID	Info	No	
013052	Volume corrector application running with unknown process ID	Info	No	
013053	comUSZ application running with unknown process ID	Info	No	
013054	ETUpdate application running with unknown process ID	Info	No	
013055	Modbus application running with unknown process ID	Info	No	
013056	DSfG application running with unknown process ID	Info	No	
013057	ETControl application running with unknown process ID	A	No	7
013058	uTouch application running with unknown process ID	A	No	7
013059	Volume corrector application running with unknown process ID	A	No	7
013060	comUSZ application running with unknown process ID	A	No	7
013061	ETUpdate application running with unknown process ID	A	No	7
013062	Modbus application running with unknown process ID	A	No	7
013063	DSfG application running with unknown process ID	A	No	7
013064	ETControl application restarted	Info	Yes	
013065	uTouch application restarted	Info	Yes	
013066	Volume corrector application restarted	Info	Yes	
013067	comUSZ application restarted	Info	Yes	

Event No.	Event	Type A = Alarm W = Warning	Auto acknowledgement Yes/no	Acknowledgement via level
013068	ETUpdate application restarted	Info	Yes	
013069	Modbus application restarted	Info	Yes	
013070	DSfG application restarted	Info	Yes	
013071	ETControl application restarted	A	Yes	
013072	uTouch application restarted	A	Yes	
013073	Volume corrector application restarted	A	Yes	
013074	comUSZ application restarted	A	Yes	
013075	ETUpdate application restarted	A	Yes	
013076	Modbus application restarted	A	Yes	
013077	DSfG application restarted	A	Yes	
013078	ETControl could not be started	A	Yes	
013079	uTouch could not be started	A	Yes	
013080	Volume corrector could not be started	A	Yes	
013081	comUSZ could not be started	A	Yes	
013082	ETUpdate could not be started	A	Yes	
013083	Modbus could not be started	A	Yes	
013084	DSfG could not be started	A	Yes	
013085	Error in required system memory	A	Yes	
010017	Parameters were changed in ETControl	Info	Yes	
013000	Log created	Info	Yes	
000421	Real-time clock defective	A	No	7
010051	Log full	A	No	
000407	Restart performed	A	Yes	
000801	User lock (level 0) open	Info	No	
000801	User lock (level 1) open	Info	No	
000801	User lock (level 2) open	Info	No	
000801	User lock (level 3) open	Info	No	
000801	User lock (level 4) open	Info	No	
000801	User lock (level 5) open	Info	No	
000801	User lock (level 6) open	Info	No	
000800	Calibration lock open	Info	No	
012000	Pending warning messages were acknowledged	Info	No	
012001	Pending fault messages were acknowledged	Info	No	
012002	Pending computer errors were acknowledged	Info	No	
012003	Pending computer error %u was acknowledged	Info	No	

Event No.	Event	Type A = Alarm W = Warning	Auto acknowledgement Yes/no	Acknowledgement via level
012004	Event log deleted	Info	Yes	
012005	Parameter log deleted	Info	Yes	
012006	Certified parameter log deleted	Info	Yes	
013086	ETControl application restarted	A	No	
013087	uTouch application restarted	A	No	
013088	Volume corrector application restarted	A	No	
013089	comUSZ application restarted	A	No	
013090	ETUpdate application restarted	A	No	
013091	Modbus application restarted	A	No	
013092	DSfG application restarted	A	No	

18. Metrological protections for custody transfer measurements – seal plan

The type and position of the metrological protections for custody transfer measurements can be found in the following drawings:
The connections to the EcoTouch in the terminal compartment are separately protected by means of a cover with a metrological protection for custody transfer measurements.

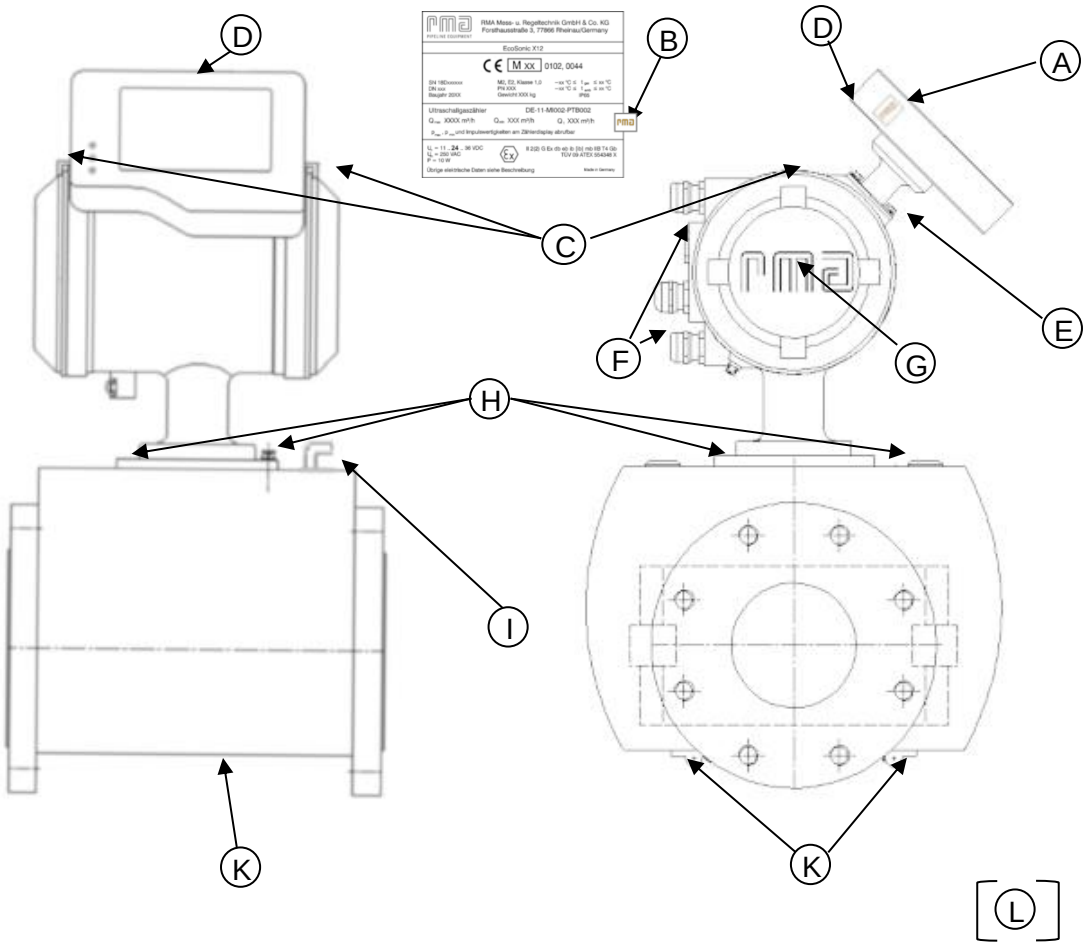


Fig. 74 Metrological protections for custody transfer measurements (seals, adhesive labels)

(A) Adhesive label on the calibration switch (Fig. 13, p. 39)

(B) Adhesive label on the metrological main data plate

(C) An adhesive label on each of the side screw caps prevents them from being opened

(D) An adhesive label secures at least one screw on the EcoTouch housing

(E) EcoTouch on the USM electronics – detached EcoTouch

(F) Seals secure the screwed cable glands

(G) Adhesive labels in the terminal compartment secure the Ex-i connection of the EcoTouch

(H) A seal secures each side cover of the ultrasonic sensors

(I) A seal secures the external pressure connection

(K) Underside of each side cover

- DN 80, DN 100 adhesive labels on the hinge screw
- All EcoSonic X12 units with external T-bore ball valve are screwed on from the outside at the top and bottom. On each of the two covers and on the metering unit, there are screws that secure the cover using seal wire.
  (Having one protection device on the top of the cover is only sufficient for covers of metering units with a diameter of DN 150 and above and with hinges that are screwed onto the bottom of the cover on the inside).

(L) Where applicable, temperature sensor of the EcoPT in the outlet pipe/not underneath the covers

18.1 Manufacturer's security labels

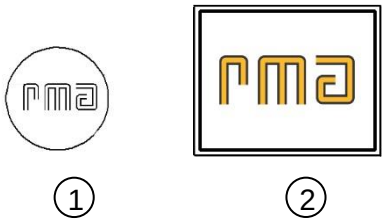


Fig. 75 Manufacturer's security labels

Two types of manufacturer's security labels are used:

- Seal wire and a seal with embossed RMA logo (1)
- Adhesive label with yellow RMA logo (2) (two different sizes)

18.2 Safety information

Security device (E) – mounting the EcoTouch

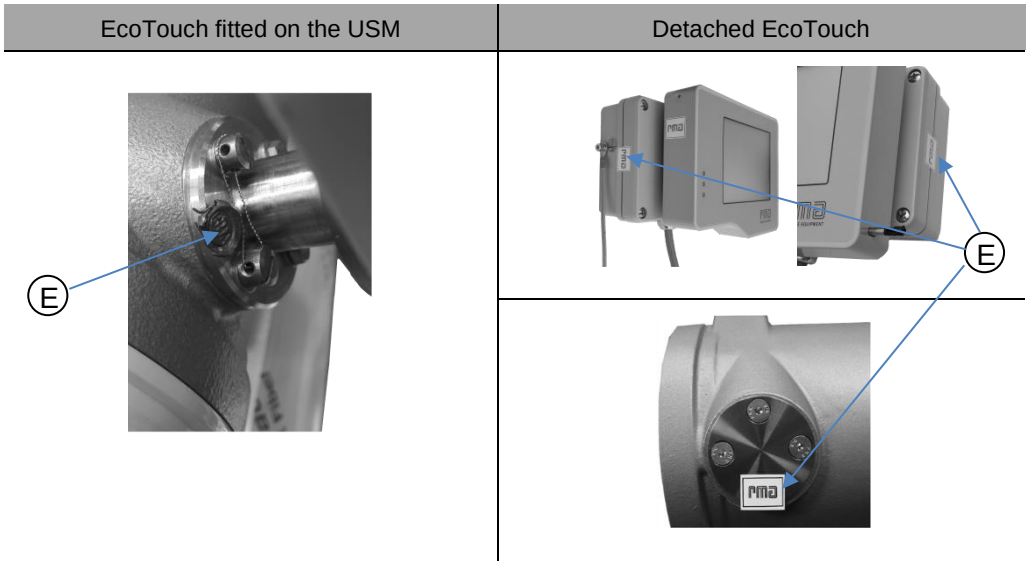


Fig. 76 Security device (E) – mounting the EcoTouch

- The mounting of the EcoTouch onto the housing of the USM electronics is secure.
- A detached EcoTouch is mounted in the connector box, which is secure.
  The USM electronics housing is sealed by a secure cover in this case.
  (There must be sufficient space on the left-hand side of the detached EcoTouch operating unit for the operation of the calibration switch).

18.2.1 Security device (F) for the screwed cable glands

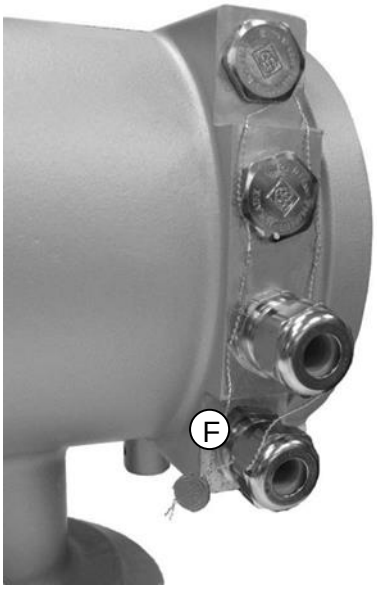


Fig. 77 Security device (F) for the screwed cable glands and blank plugs (embossed) (F)

18.2.2 Security device (G) in the terminal compartment

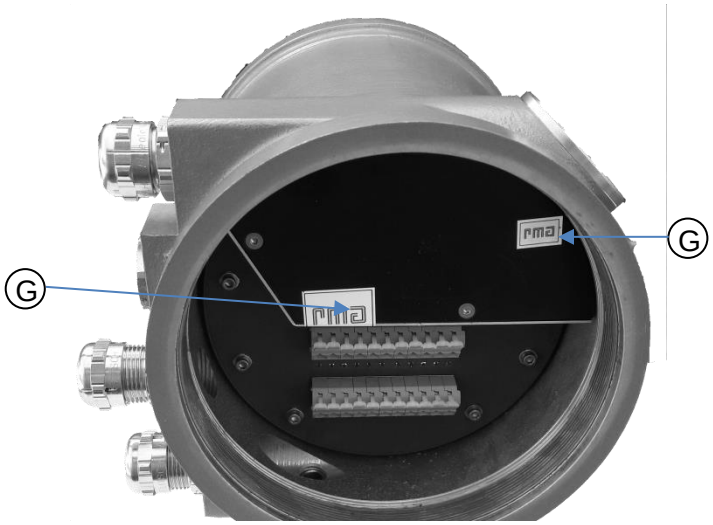


Fig. 78 Manufacturer's security device in the terminal compartment (G)

The electrical connection of the EcoTouch to the USM electronics is secured by a cover and manufacturer’s adhesive labels (G) on the fixing screws on the cover.

18.2.3 Security devices (H) – side cover

18.2.3.1 EcoSonic X12 – T-bore ball valve underneath the cover

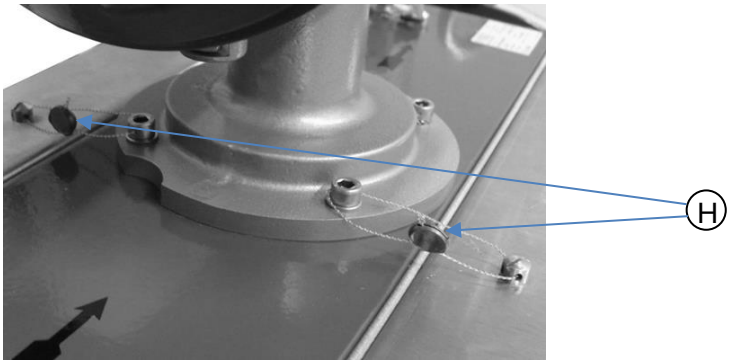


Fig. 79 Security device (H) on the side cover of the EcoSonic X12

18.2.3.2 EcoSonic X12 – external T-bore ball valve

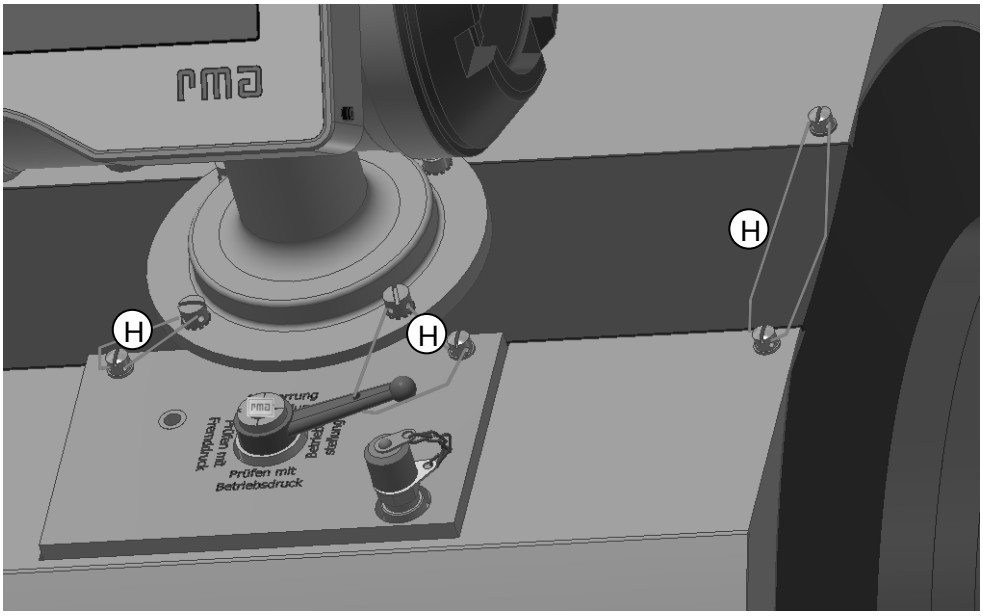


Fig. 80 Security device (H) with external T-bore ball valve

- The covers are secured by seals on the fixing screws.
- There is a borehole in the lever of the T-bore ball valve. The lever is secured and sealed by seal wire on the screw. An adhesive label on the T-bore ball valve means that the lever cannot be removed undetected.

The external T-bore ball valve with test connection can be used as an access point for audits on an EcoSonic with EVC.

18.2.4 Security device for the external pressure connection (I)

An optional pressure connection p_m for an external volume corrector is secured by means of an embossed security label:

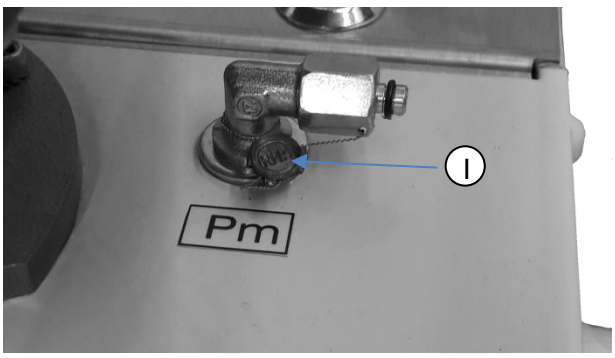


Fig. 81 Security device (I) for the pressure connection p_m for external volume corrector

18.2.5 Security device for the RMA thermowell (L)

For metering units with ANSI flanges or for installations with bidirectional sampling where the flow in the opposite direction DIR2 is measured (without validity for custody transfer measurements), the thermowell of the EcoSonic X12 temperature sensor can be fitted in the outlet pipe.

Temperature sensors with a relevance for custody transfer purposes that are not fitted underneath the side covers must be secured with metrological protections for custody transfer measurements.

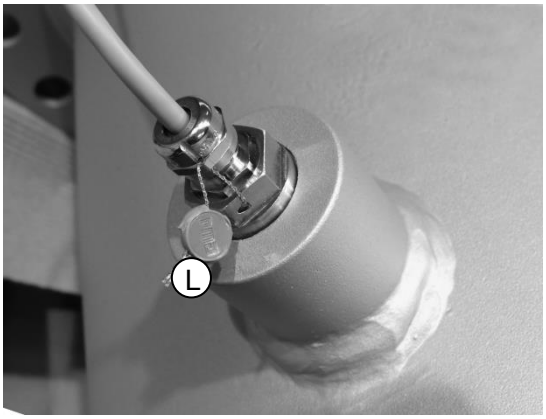


Fig. 82 Security device (L) for the temperature sensor in the thermowell

19. List of illustrations

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