



ALTOSONIC V12 Handbook

Ultrasonic gas flowmeter for custody transfer

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1.1 Intended use



CAUTION!

Responsibility for the use of the measuring devices with regard to suitability, intended use and corrosion resistance of the used materials against the measured fluid lies solely with the operator.



INFORMATION!

The manufacturer is not liable for any damage resulting from improper use or use for other than the intended purpose.

The ALTOSONIC V12 is an ultrasonic gas flowmeter for high accurate and custody transfer applications.



CAUTION!

High levels of CO₂ can inhibit the operation of an ultrasonic flowmeter due to its acoustic absorption properties. It is recommended to submit a specification of the process medium to be measured at the manufacturer for advice.

1.2 Certifications



LEGAL NOTICE!

The ALTOSONIC V12 custody transfer gas flowmeter meets the technical requirements and standards applicable to equipment designed for use in different countries world wide.

European Union (EU):

- Pressure Equipment Directive 2014/68/EC
- EMC directive 2014/30/EU, according to:
 - EN 61326-1
 - EN 61326-2
 - EN 61326-3
- ATEX directive 2014/34/EU according to:
 - EN 60079-0
 - EN 60079-1 (Ex 'd')
 - EN 60079-7 (Ex 'e')
 - EN 60079-18 (Ex 'ma')
- Custody transfer approvals according to:
 - MID directive 2014/32/EU (MID = Measurement Instrument Directive)
 - OIML R137-1 (International Organization for Legal Metrology)
 - OIML D11
- Fully compliant to AGA 9
- Fully compliant to ISO 17089

USA:

- Certified for use in potentially explosive atmospheres according to FM:
 - FM3615
 - ANSI/UL 50E
 - UL 61010-1

Canada:

- CAN
- CSA C22.2 No. 30
- CSA C22.2 No. 25
- CSA C22.2 No. 94.2
- CSA C22.2 No. 61010-1

**INFORMATION!**

Not all country specific approvals are listed here. Please consult KROHNE in case of a specific approval that is not listed here.

1.3 Safety instructions from the manufacturer

1.3.1 Copyright and data protection

The contents of this document have been created with great care. Nevertheless, we provide no guarantee that the contents are correct, complete or up-to-date.

The contents and works in this document are subject to copyright. Contributions from third parties are identified as such. Reproduction, processing, dissemination and any type of use beyond what is permitted under copyright requires written authorisation from the respective author and/or the manufacturer.

The manufacturer tries always to observe the copyrights of others, and to draw on works created in-house or works in the public domain.

The collection of personal data (such as names, street addresses or e-mail addresses) in the manufacturer's documents is always on a voluntary basis whenever possible. Whenever feasible, it is always possible to make use of the offerings and services without providing any personal data.

We draw your attention to the fact that data transmission over the Internet (e.g. when communicating by e-mail) may involve gaps in security. It is not possible to protect such data completely against access by third parties.

We hereby expressly prohibit the use of the contact data published as part of our duty to publish an imprint for the purpose of sending us any advertising or informational materials that we have not expressly requested.

1.3.2 Disclaimer

The manufacturer will not be liable for any damage of any kind by using its product, including, but not limited to direct, indirect or incidental and consequential damages.

This disclaimer does not apply in case the manufacturer has acted on purpose or with gross negligence. In the event any applicable law does not allow such limitations on implied warranties or the exclusion of limitation of certain damages, you may, if such law applies to you, not be subject to some or all of the above disclaimer, exclusions or limitations.

Any product purchased from the manufacturer is warranted in accordance with the relevant product documentation and our Terms and Conditions of Sale.

The manufacturer reserves the right to alter the content of its documents, including this disclaimer in any way, at any time, for any reason, without prior notification, and will not be liable in any way for possible consequences of such changes.

1.3.3 Product liability and warranty

The operator shall bear responsibility for the suitability of the device for the specific purpose. The manufacturer accepts no liability for the consequences of misuse by the operator. Improper installation or operation of the devices (systems) will cause the warranty to be void. The respective "Standard Terms and Conditions" which form the basis for the sales contract shall also apply.

1.3.4 Information concerning the documentation

To prevent any injury to the user or damage to the device it is essential that you read the information in this document and observe applicable national standards, safety requirements and accident prevention regulations.

If this document is not in your native language and if you have any problems understanding the text, we advise you to contact your local office for assistance. The manufacturer can not accept responsibility for any damage or injury caused by misunderstanding of the information in this document.

This document is provided to help you establish operating conditions, which will permit safe and efficient use of this device. Special considerations and precautions are also described in the document, which appear in the form of icons as shown below.

1.3.5 Warnings and symbols used

Safety warnings are indicated by the following symbols.



DANGER!

This warning refers to the immediate danger when working with electricity.



DANGER!

This warning refers to the immediate danger of burns caused by heat or hot surfaces.



DANGER!

This warning refers to the immediate danger when using this device in a hazardous atmosphere.



DANGER!

These warnings must be observed without fail. Even partial disregard of this warning can lead to serious health problems and even death. There is also the risk of seriously damaging the device or parts of the operator's plant.



WARNING!

Disregarding this safety warning, even if only in part, poses the risk of serious health problems. There is also the risk of damaging the device or parts of the operator's plant.



CAUTION!

Disregarding these instructions can result in damage to the device or to parts of the operator's plant.



INFORMATION!

These instructions contain important information for the handling of the device.



LEGAL NOTICE!

This note contains information on statutory directives and standards.



• **HANDLING**

This symbol designates all instructions for actions to be carried out by the operator in the specified sequence.

➔ **RESULT**

This symbol refers to all important consequences of the previous actions.

1.4 Safety instructions for the operator



WARNING!

In general, devices from the manufacturer may only be installed, commissioned, operated and maintained by properly trained and authorized personnel.

This document is provided to help you establish operating conditions, which will permit safe and efficient use of this device.

2.1 Scope of delivery



INFORMATION!

Do a check of the packing list to make sure that you have all the elements given in the order.



INFORMATION!

The instrument is delivered in a seaworthy, reinforced wooden crate. Inspect the packing carefully for damages or signs of improper handling. Report damage to the carrier and to the local office of the manufacturer.

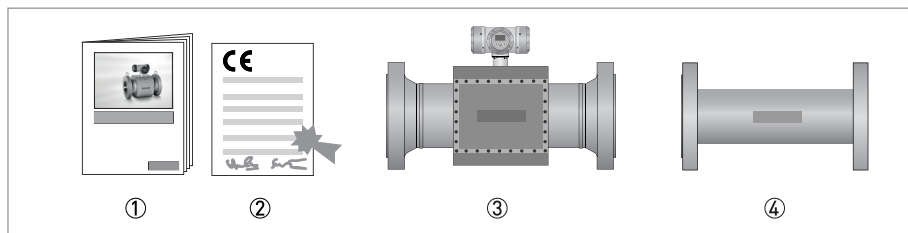


Figure 2-1: Scope of delivery

- ① Product documentation
- ② CE Declaration
- ③ Flowmeter in ordered version
- ④ Optional: flow conditioner, spare parts and / or installed impact indicators



INFORMATION!

Calibration reports and project specific documents are in the meter's databook that is sent separately.

2.2 Hardware description

The flowmeter is designed to meet explosion safety requirements:

- the application of an explosion proof (Ex d) electronics enclosure according to IEC 60079-1
- using Ex certified transducers according to IEC 60079-18
- using cables with an Ex d certified connector according to IEC 60079-1 to connect to the transducers

The flowmeter consists of a meter body with one or two (twin meter) electronic units installed on top of it.

For smaller diameters the meter body is fully machined hence no welding is done.

For larger diameters the meter body is a welded construction.

A series of acoustic transducer are installed on the inside of the meter body. Each pair of ultrasonic transducers forms an acoustic measurement path. The acoustic measurement path consists of one (direct) chord or two (reflective) chords.

The chords in the horizontal plane are used for flow measurement, the chords in the vertical plane are used for diagnostics only. The reflective chords that are offset from the meter's centre line use acoustic mirrors to reflect the ultrasonic signal. The reflective chords that are in the centre line of the meter reflect directly on the pipe wall. Direct chords do not reflect and therefore do not require acoustic mirrors.

The transducers are electrically connected to the electronic unit on top of the meter by means of coaxial cables. The cabling is protected against mechanical damage and moisture by means of covers. The coaxial cables enter the electronics enclosure through its “foot” (or support). In this foot an Ex d approved cable feed through is installed that closes this entry to the electronics enclosure.

On the other side the coax cables are connected to the transducers, this connection is also done by an Ex d approved connector.

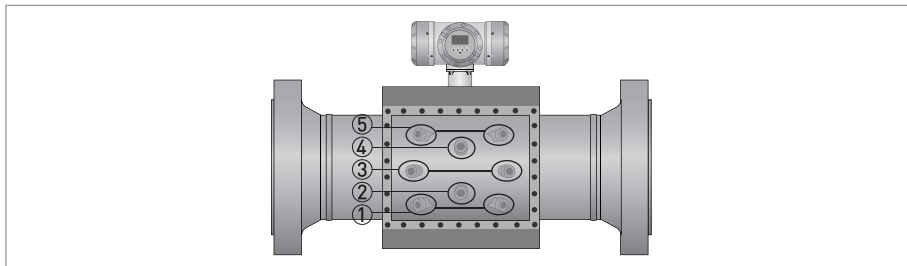


Figure 2-2: Location of sensors and electronic unit

2.2.1 Transducers

Acoustic signals are transmitted and received by means of ultrasonic transducers. The active part of an ultrasonic transducer is a small disk of piëzo electric ceramic in the front of the transducer. It is packaged (sealed) in a construction of metal parts and high grade epoxy or inside a titanium housing. The front side of the transducer is exposed to the gas to be measured, this results in the best efficiency for transmitting and receiving ultrasound.

Overview installation of epoxy transducer type (standard)

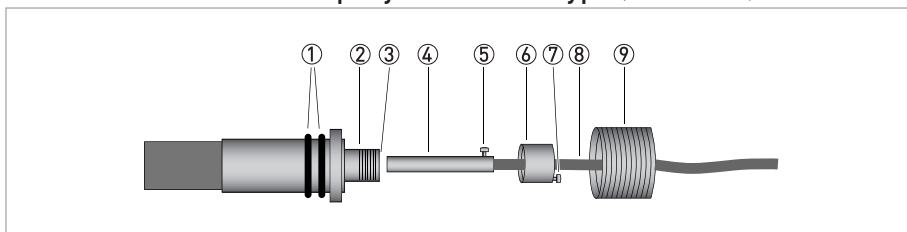


Figure 2-3: Sensor assembly

- ① Double O-ring
- ② Slot in the socket
- ③ Ex-d socket
- ④ Ex-d plug
- ⑤ Alignment pin
- ⑥ Cap
- ⑦ Securing screw M2
- ⑧ Coaxial wire
- ⑨ Transducer nut

**DANGER!**

The transducers have an Ex-d socket (socket, ③) that connects to an Ex-d plug ④ which terminates a coaxial wire ⑤.

An alignment pin ⑤ on the connector engages with a slot in the Ex-d socket ②, this ensures that the transducer is connected with the correct polarity. The cap ⑥, screwed on the Ex-d socket, fastens the connector, a small securing screw (M2) ⑦ secures this cap. The transducers are fastened in the meter body using a transducer nut with a hole in the centre ⑧. A double O-ring ① seals the pressure inside the piping effectively from the outside world.

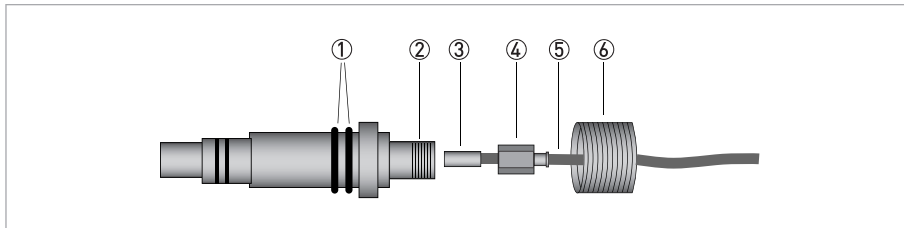
Overview installation of titanium transducer type (optional)

Figure 2-4: Sensor assembly

- ① Double O-ring
- ② Ex-d socket
- ③ Connector
- ④ Hexagonal cap
- ⑤ Coaxial wire
- ⑥ Transducer nut

2.2.2 The electronic unit

The housing consists of three compartments. Each compartment has a removable cover that gives access to the inside, in order to connect external wiring or to install or to replace components.

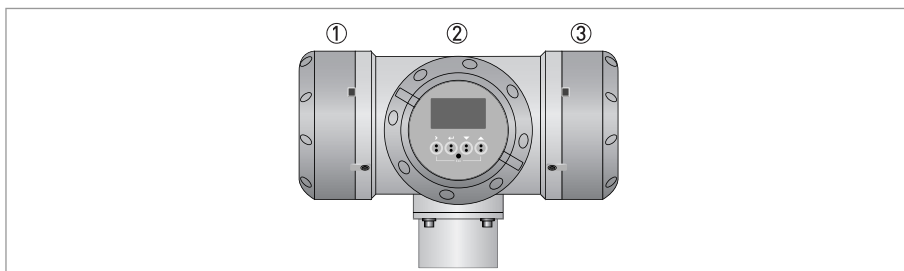


Figure 2-5: Converter housing

- ① Power supply / RS485 compartment / Optional KROHNE Care board
- ② Electronics compartment
- ③ Connection compartment

**INFORMATION!**

If needed, ask your supplier for the optional KROHNE Care manual.

Connection compartment

The compartment on the right side is the connection compartment, which contains only a block with screw terminals. Signal wires from and to the electronics compartment are connected to this terminal block. Wiring to other (external/auxiliary) equipment can be connected to the screw terminals in this compartment.

Cables can enter this compartment through cable glands installed in either one of four threaded holes M20x1.5.



DANGER!

Unused holes must be closed with Ex d approved blind plugs.

Power supply / RS485 compartment

The compartment on the left side is used to install the power converter. This board also includes two serial data ports (RS485). As an option an additional diagnostics processor board can be installed. Wiring to external equipment or to a power source is attached to connectors with screw terminals. These connectors engage directly with matching parts on the printed circuit boards.

Cables can enter this compartment through cable glands installed in either one of four threaded holes M20x1.5.

Electronics compartment

The compartment on the front has a cover with a glass window. It contains a frame with a number of printed circuit boards. The boards have the following functions:

- Frequency and status output board
- Processor boards
- Sensor driver board
- Display module (connected to the front side of the frame, can be seen through the cover with the glass window)

2.3 Software description

The ALTOSONIC V12 contains a powerful microprocessor that controls the functions and calculations it performs. The microprocessor executes program code consisting of several modules, according to the functions it has to perform. By means of a set of parameters the software can be configured to various sizes and models of flowmeters and according to specific requirements depending of applications or customers.



LEGAL NOTICE!

The parameters are stored in a configuration file. Configuration parameters are password protected in order to prevent unauthorized modification. Access in order to read, view and inspect parameter values is unrestricted.

Individual parameters are classified according to “roles” in order to define differentiated access rights. Each “role” is associated with a “typical” user or operator having specific responsibilities or duties. Users have to be registered with a user name and a password, when registered the role of the user is also defined, and by consequence also the access rights of that user.

The following roles have been defined, listed in according to the rank in the hierarchy.

Roles and authorisation

Factory	restricted to KROHNE factory employees, to implement factory settings in the meter.
Service	restricted to authorized service personnel, to the discretion of KROHNE.
Calibrator	restricted to personnel acting on behalf of a legal calibration station.
Supervisor	restricted to personnel acting on behalf of the owner/operator of the meter (administrator function), to the discretion of the owner/operator of the meter.
Operator	restricted to personnel acting on behalf of the owner/ operator of the meter (for day to day operation), to the discretion of the owner/operator of the meter.

Only a higher rank user can register a lower rank user. Users can have the same rank.

In addition to restrictions depending of the defined role of a user, a physical “overwrite disable” contact / jumper protects the configuration parameters. This disables any user from making modifications to parameters that would influence the measured flow or volume value. This prevents unintentional or unauthorized changes to the parameters and possibly invalidation of the calibration.

Normally the meter is delivered with a set of parameters suitable for the application. In case a modification of the configuration file is made, this is stored in the data logging memory. This information can be retrieved afterwards for auditing and verification purposes.

2.4 Nameplates



INFORMATION!

Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

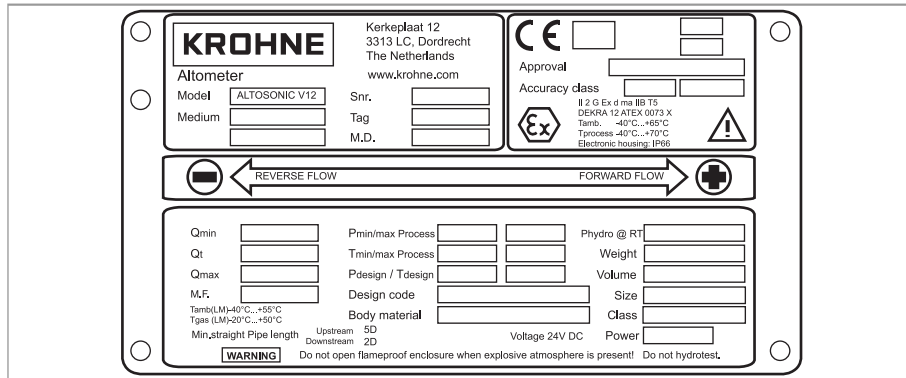


Figure 2-6: Example of a ATEX nameplate

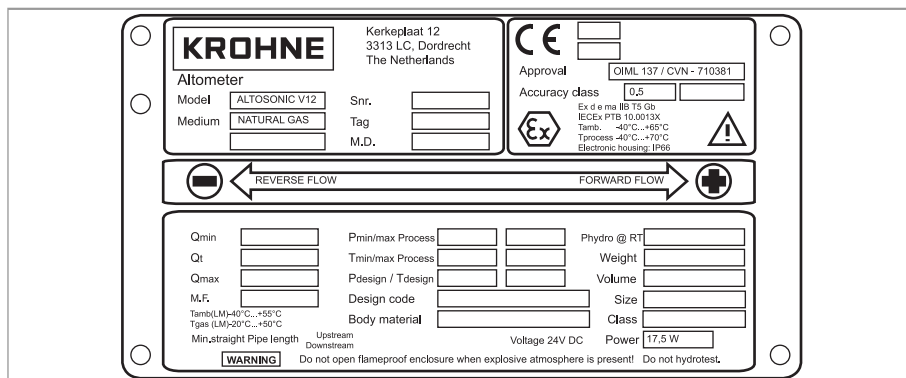


Figure 2-7: Example of a IECEx nameplate

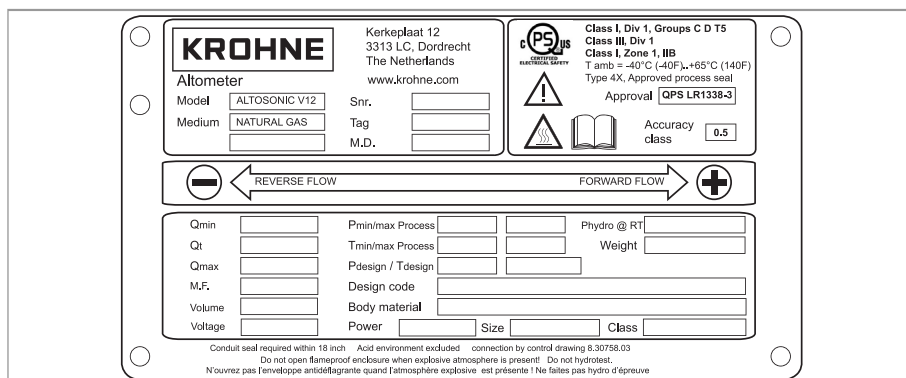


Figure 2-8: Example of a CLASS I, DIV I nameplate

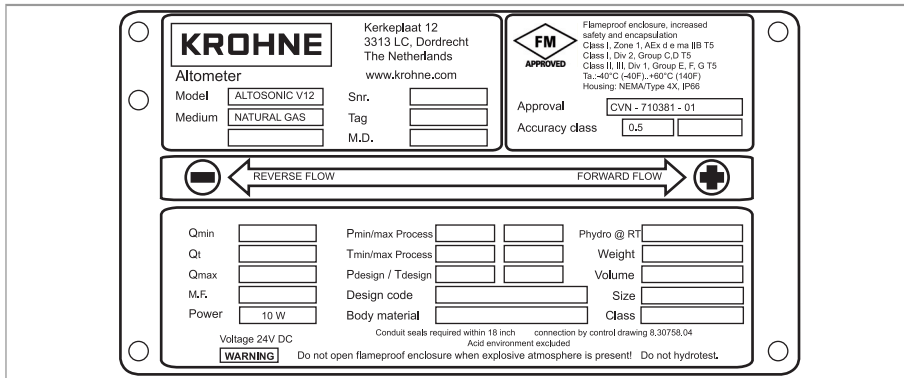


Figure 2-9: Example of an FM Class I Division 2 nameplate

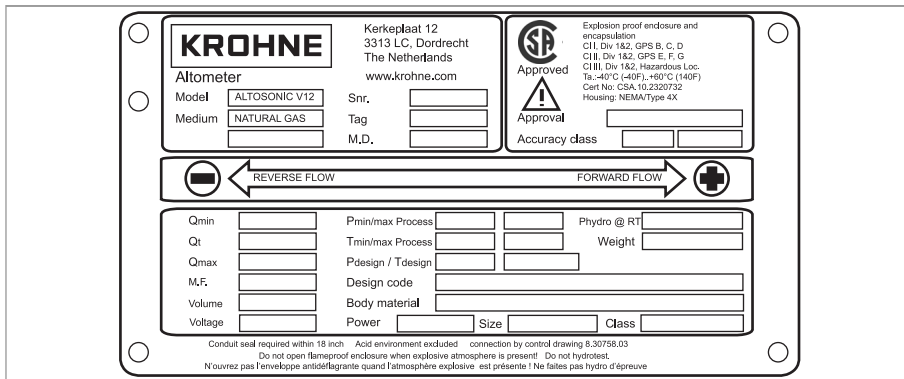


Figure 2-10: Example of a CSA nameplate

3.1 Notes on installation



CAUTION!

Inspect the packaging carefully for damages or signs of rough handling. Report damage to the carrier and to the local office of the manufacturer.



INFORMATION!

Do a check of the packing list to make sure that you have all the elements given in the order.



INFORMATION!

Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

3.2 Storage

Correct storage position

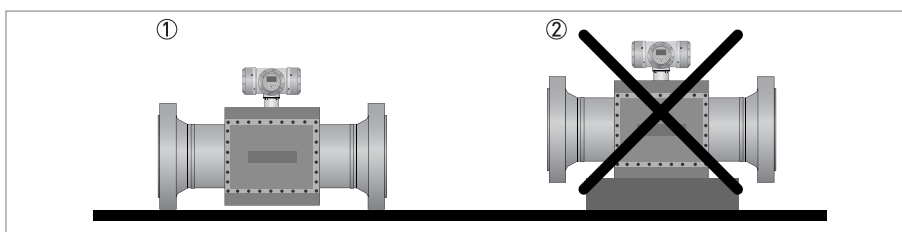


Figure 3-1: Storage

- ① Correct position for all sizes
- ② Position not allowed for flowmeters > 12"



WARNING!

Make sure that the extensions on the bottom of the flanges are in good order to prevent the meter from rolling over. Otherwise take appropriate measures to prevent the meter from rolling over.

Storage conditions

Maintain the following storage conditions to prevent the equipment from corrosion or early failure:

- Humidity: <95 % RH (closed and heated storage area)
- Storage temperature: -40...+70° C / -40...+158° F
- Avoid direct solar radiation during long storage periods, store under a sunshade

How to prevent corrosion

Pay attention to the conservation of the inner pipe wall, especially for carbon steel meters. Typical applications such as measuring dry natural gas (sales quality) or natural gas with a corrosion inhibitor do not require an anti corrosion coating inside the meter tube. A coating can even be regarded as unwanted because it may wear off, which will have an impact (although minor) on the accuracy.

However for storage and/or transportation additional protective measures are recommended. Depending on how long the protection should last one of several methods can be considered:

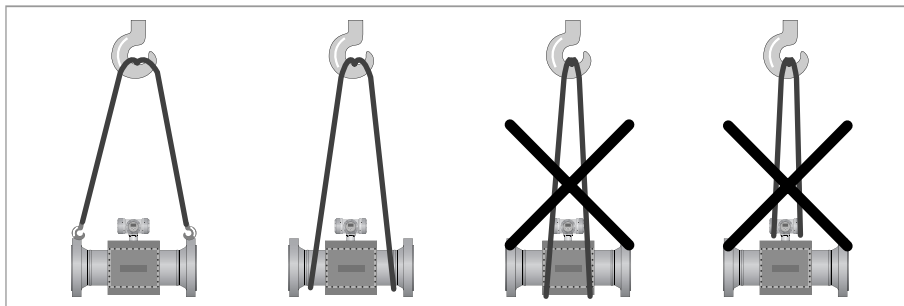
1. For a storage period of less than one year, the inner pipewall should be protected by a corrosion inhibitor such as Shell Ensys.
Do not apply the corrosion inhibitor on the acoustic transducers.
2. For a period of a year or longer, the pipewall should be protected by Tectyl or a similar product.
Do not apply Tectyl on the acoustic transducers.
3. Independent of the storage period, the inner pipewall can be protected by an oxygen free environment. This can be created by mounting blind flanges, using a vacuum pump to remove the air and subsequently filling the meter with nitrogen. It is recommended to place some bags of silica gel inside the flowmeter. To protect against corrosion, the humidity should be less than 38% and/or oxygen should not be present. Special regulations may be applicable for transportation and storage of a pressurised flowmeter.

3.3 Transport



WARNING!

- *Even smaller size flowmeters have a considerable weight. Check the weight of your flowmeter in order to select suitable means for transportation and lifting.*
- *Use appropriate materials such as chains or hoisting straps that are in good condition.*
- *Use the eye bolts on the meter body to attach chains or straps to lift the meter (if not present: check condition of the threaded holes on the flanges and if okay screw eye bolts in the threaded holes).*
- *The supplied lifting lugs are for one time use only.*
- *Never lift the meter using the converter housing to attach straps.*
- *In case a fork lift will be used make sure that the flowmeter is secured against rolling off the forks, or against straps sliding off the forks.*
- *Verify local safety regulations, directives and company procedures with respect to hoisting, rigging and transportation of (heavy) equipment.*



3.4 Pre-installation requirements

**INFORMATION!**

The equipment is designed for safe operation under conditions according to the following classifications:

- *Pollution degree 2: this means that normally only nonconductive (dry) pollution will occur. Temporary conductivity caused by condensation can occur.*
- *Protection class I: this means the equipment must be earthed.*
- *Humidity: <95% RH*
- *Ambient temperature: -40...+60° C / -40...+140° F
(ATEX / DIV1 / IECEx versions: -40...+65° C / -40...+149° F)*
- *Suitable for indoor and outdoor use.*
- *IP66 / NEMA 4X classification.*

**CAUTION!**

The flowmeter should be protected from corrosive chemicals or gases and dust or particles accumulation.

**CAUTION!**

Do not intend to perform a hydrostatic test of the installed flowmeter.

The flowmeter has been hydrostatically tested during manufacturing (see reports) and must not be retested with the ultrasonic sensors installed. Water will protude in the sensor pockets and remain. This will create acoustic shortcuts and possibly cause the flowmeter to start operating in failure.

**DANGER!**

To avoid the risk of ignition as a result of electrostatic charging, the equipment cannot be used in locations where:

- *high charge generating processes occur*
- *mechanical friction and/or separation can occur*
- *electron emission (e.g. near electrostatic equipment) can occur*

3.5 Installation

3.5.1 Mounting position

Install the ultrasonic gas flowmeter in horizontal position with the flow arrow indicator on the nameplate or on the meter body in the direction of the positive (forward) gas flow.

Make sure that the converter is on top of the flowmeter after the installation.

Check the weight of the meter. Typically the weight of the meter will be considerably more than the same length of pipe line.

To support the meter additional supports might be needed, preferably two, one on either side of the meter.

Always support the meter at its flanges, the weight of the meter shall never rest on the case around the transducers and the cabling.

If supports can not be placed under the meter flanges, supports may be placed under the mating flanges of the pipeline. If supports can only be placed under the pipeline sections upstream or downstream of the meter, these supports shall be as close as possible to the meter. In this case a calculation must be made to verify that the load on the pipeline will not exceed acceptable values.

The meter should be installed in the pipe line with gaskets, nuts and bolts according to the type and size of the flanges of the gas flowmeter. The flanges of the meter should match with the flanges of the pipeline where the meter should be installed.

Make sure that the gaskets do not protrude into the flow as this can reduce the accuracy of the flowmeter.

In order to install the gas flowmeter, the pipeline must have a slot of such length that the meter including the gaskets fits nicely in the slot. It should not be necessary to use excessive force to tighten the bolts in order to close the gaps on either side of the meter.

Nor should the slot be too small, implying the slot has to be widened by applying brute force to fit the meter and gaskets in the slot.

For tightening the bolts of the flanges, apply a lubricant as required, in accordance with the materials as used and applicable standards.

Tighten the bolts of the flanges with a torque according to the standards applicable to the flanges and materials used.

3.5.2 Pipe diameters and lengths

Make sure that the inner diameter of upstream and downstream pipes matches the specified connection diameter of the ultrasonic flowmeter within 1%. Contact the manufacturer if the inner diameter deviates more than 1%.

3.5.3 Flow conditioners

Although the flowmeter is a highly accurate device, an additional flow conditioner can be installed upstream of the flowmeter in order to minimize measuring uncertainty, in particular when a strongly distorted flow velocity profile is expected, or when the available space for a metering run is critical. If a flow conditioner is used the total inlet length may be reduced to only 5 DN: having 2 DN upstream of the flow conditioner and 3 DN in between the flow conditioner and the flowmeter.



INFORMATION!

- Preferred model is the “perforated plate” type. A “pipe bundle” type of flow conditioner is not recommended.
- When a flow conditioner is included in the metering run, it is strongly advised to use the same flow conditioner and inlet pipe configuration during a flow (wet) calibration (see e.g. ISO 17089 or AGA-9 for detailed requirements).

3.5.4 Inlet and outlet for uni-directional use

Without flow conditioner (OIML R137 class 0.5)

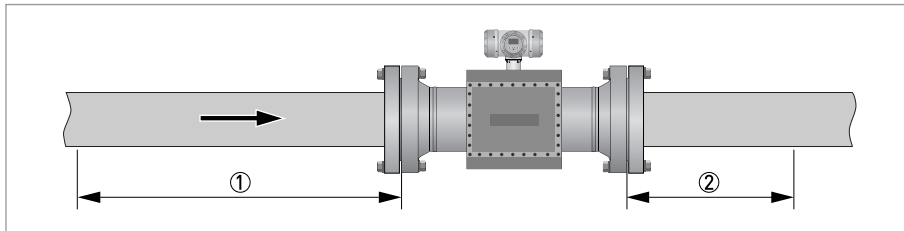


Figure 3-2: Required straight lengths for inlet and outlet

- ① Inlet section: 10 DN
- ② Outlet section: 3 DN

Without flow conditioner (AGA9, ISO 17089 and OIML R137 class 1)

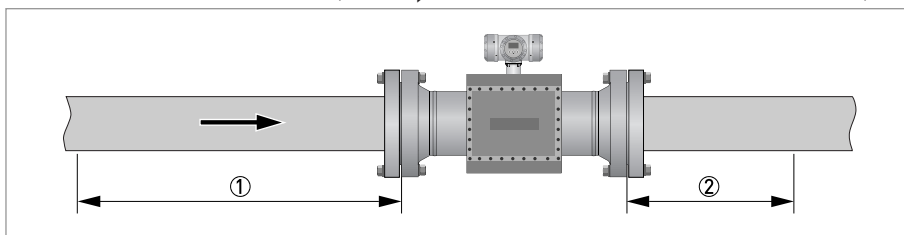


Figure 3-3: Required straight lengths for inlet and outlet

- ① Inlet section: 5 DN
- ② Outlet section: 3 DN

With flow conditioner

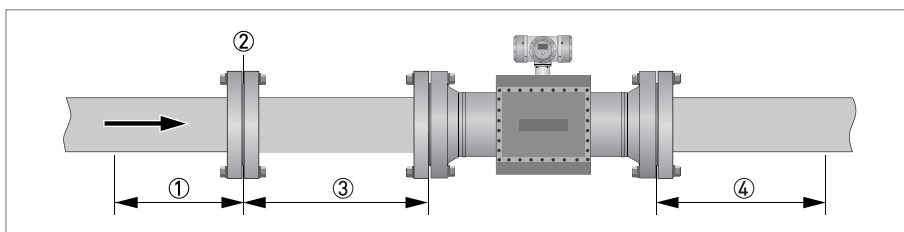


Figure 3-4: Required straight lengths for inlet and outlet

- ① Inlet section before flow conditioner: 2 DN
- ② Flow conditioner (perforated plate)
- ③ Inlet section after flow conditioner: 3 DN
- ④ Outlet section: 3 DN



INFORMATION!

Contact the manufacturer for recommendations on bi-directional use.

3.5.5 Control valves



CAUTION!

Under adverse circumstances ultrasonic gas flowmeters can suffer from interference from noise generated by pressure control valves (PCV). In case the frequency spectrum of the PCV-noise extends in the range of the operation frequency of the ultrasonic transducers and the strength of the noise results in a signal to noise ratio smaller than the critical value, the ultrasonic flowmeter will not be able to operate. Consult the manufacturer for advice in case a PCV with high pressure cut will be operated close to the ultrasonic flowmeter.

3.5.6 P and T sensors

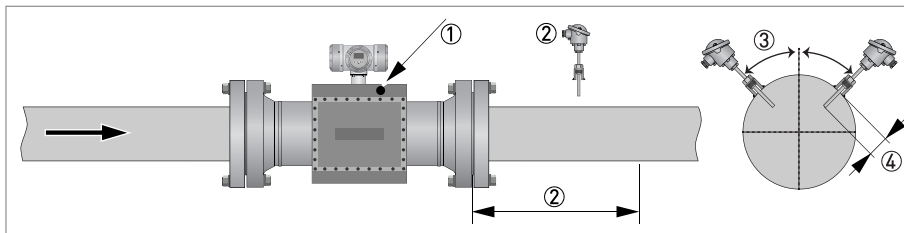


Figure 3-5: Location of pressure and temperature sensors

- ① Install pressure sensor on body of flowmeter at Pr point
- ② Install temperature sensor at 2...5 DN downstream of flowmeter
- ③ Install temperature sensor at an angle of no more than 45 degrees from the vertical
- ④ Install temperature sensor with an insertion depth between 0.1 and 0.33 of nominal pipe diameter



INFORMATION!

- See ISO 17089 for further details.
- Use a Pt100 element with thermowell and transmitter as temperature sensor. Preferably use tapered thermowells to avoid vibrations.
- Connect the pressure sensor to the Pr-point in the meter body using an intermediate isolation valve and/or valve manifold.



CAUTION!

Either use a suitable blind plug or blind flange (and sealing as required) to blind the pressure port, or a pressure sensing line should be connected in an appropriate way. A pressure sensing line should be properly supported to avoid vibrations and to prevent the weight of the sensing line from applying a strain on the pressure port connection.

3.6 Temperatures

The device must not be heated by radiated heat (e.g. exposure to the sun) to a converter surface temperature above the maximum permissible ambient temperature.

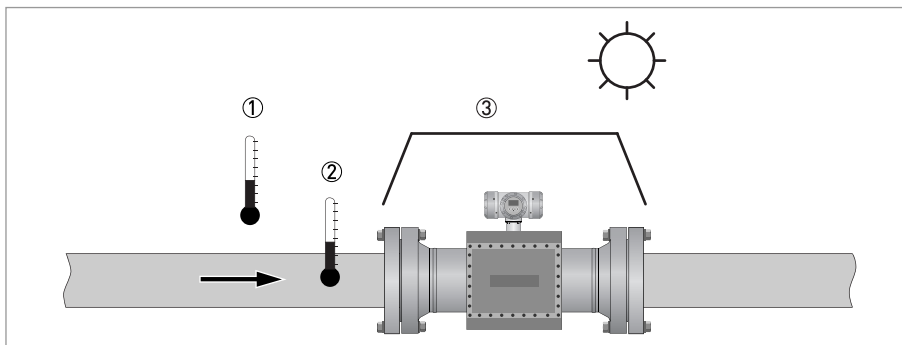


Figure 3-6: Temperatures

- ① Ambient temperature
- ② Process gas temperature
- ③ Use a sun shade to protect the flowmeter against direct solar radiation.



CAUTION!
SUNSHADE

Direct solar radiation introduces temperature gradients in the metering section and must be avoided as much as possible. Use a sunshade or canopy over the flow, pressure and temperature sensors to protect against direct exposure to sunshine. Another option is to thermally insulate the complete metering section including the sensors.

For more detailed information about temperatures, refer to *Technical data table* on page 107.

4.1 Safety instructions



DANGER!

All work on the electrical connections may only be carried out with the power disconnected. Take note of the voltage data on the nameplate!



DANGER!

Observe the national regulations for electrical installations!



WARNING!

Observe without fail the local occupational health and safety regulations. Any work done on the electrical components of the measuring device may only be carried out by properly trained specialists.



INFORMATION!

Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.



DANGER!

For FM installations, cables must be used that are resistant to high temperatures. For all other applications, cable must be used that are resistant to high temperatures if the process temperature is 65°C / 149°F or higher.

4.2 Opening and closing covers

All covers are equipped with an interlocking device to prevent unauthorized or inadvertent opening and removal of the covers. Before a cover can be turned counter clockwise, the interlocking device has to be released as shown in the figure below.

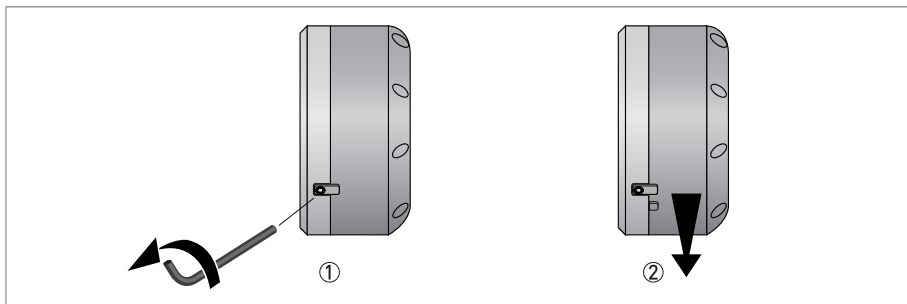


Figure 4-1: Opening cover with interlocking device

- ① Loosen the hex screw with a 2.5 mm Allen key.
- ② Turn the cover counter clockwise to open the cover.

Closing the covers is done in the reverse order. Turn the cover until the little knob on the cover is located under the interlocking device, then fasten the interlocking device.

4.3 Digital I/O connections

**WARNING!**

1. In order to prevent unauthorized or inadvertent opening and removal of the covers, an interlocking device is provided for each cover. Before a cover can be rotated (counter clockwise) for opening, release this interlocking device with a 2.5 mm Allen key.
2. The foot of the converter housing provide an earthing point, this must be connected to the nearest safety earth conductor.

3. Only open the converter housing one minute after the power has been switched off and after it has been verified that there is no risk due to the presence of potentially explosive gas.

- The digital outputs are passive open collector outputs, galvanically isolated from each other and from the main circuit. To use these outputs an external voltage source and current limiting resistors must be used. (NEC class 2 power supply (max. 100 VA, 24 VDC, IEC 61010-1, clause 6.3.1 and 6.3.2)
- For frequencies above 100 Hz, use shielded cables in order to reduce radiation from electrical interferences (EMC).
- Terminal A+ is not used.

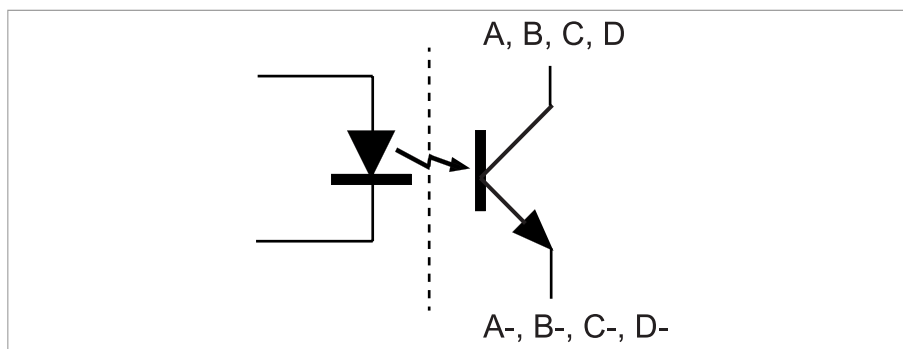


Figure 4-2: Digital I/O as NPN transistor

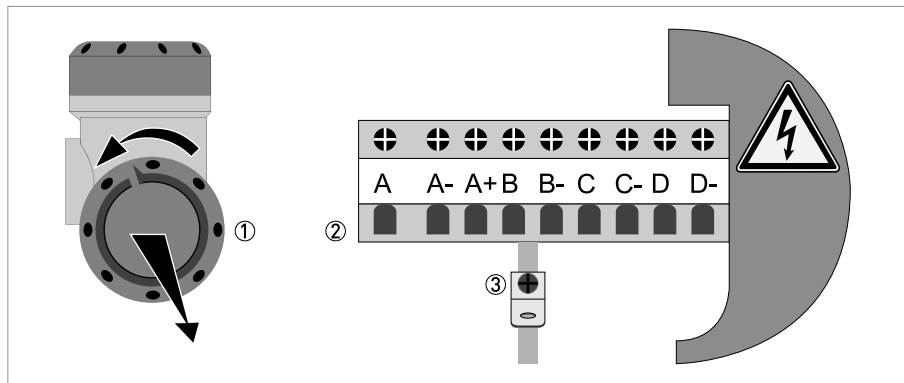


Figure 4-3: Terminal compartment for inputs and outputs in field housing



- ① Open the housing cover.
- ② Push the prepared cable through the cable entry and connect the necessary conductors.
- ③ Connect the shield if necessary.



- Close the cover of the terminal compartment.
- Close the housing cover.



INFORMATION!

Each time a housing cover is opened, the thread should be cleaned and greased. Use only resin-free and acid-free grease.

Ensure that the housing gasket is properly fitted, clean and undamaged.

4.3.1 Pulse and frequency output

By default the first 2 digital I/O connections are set as a pulse/frequency output (B 90° shifted to A), having a frequency proportional to the volume flow rate (actual volume: under process conditions). It is possible to assign another variable to control this output (defined by means of parameter settings).

4.3.2 Status outputs

By default the next two digital I/O connections are defined as status outputs (Alarm / Error and Reverse flow). However the function of these outputs can be programmed to various alarms or status signals. One of the status outputs may be programmed to a second pulse output, having the same frequency as the first pulse output, however the phase difference can be set to either 0, 90, 180 or 270 degrees.

4.3.3 Emulation of a turbine meter

To emulate a turbine meter, use the following setup and settings:

- A/A-: Frequency output related to the line flow
- B/B-: Frequency output inverted related to the line flow whereby this frequency output will stop operating if data valid alarm on status bit C/C- will occur.

Place the frequency output B/B- in series with status bit C/C- as presented in the figure shown below.

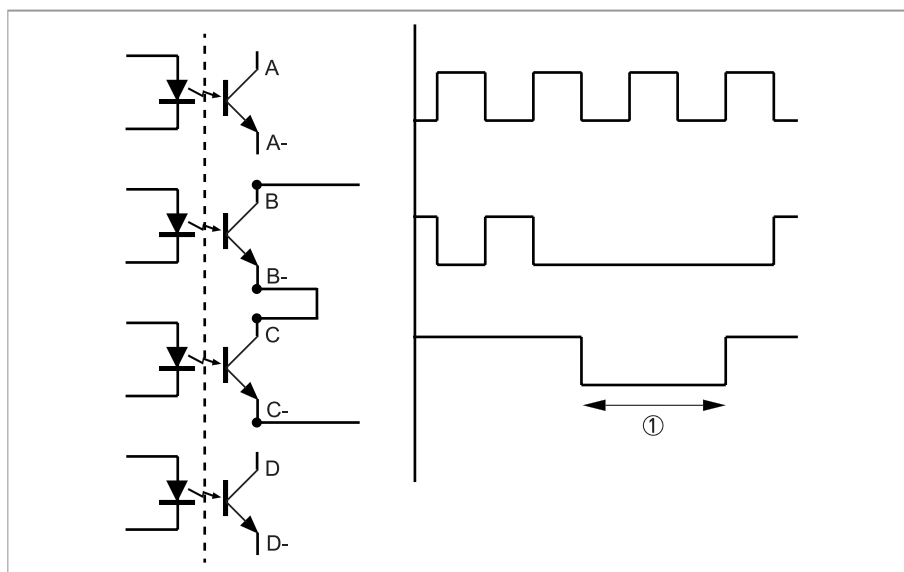


Figure 4-4: Connection diagram for turbine emulation

① Alarm

4.4 Serial data communication (RS 485)

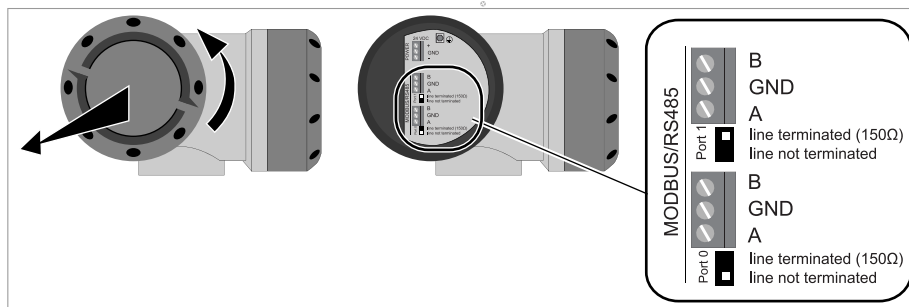


Figure 4-5: Connection of serial data communication



INFORMATION!

For more information about Modbus, refer to Modbus protocol description and set-up on page 119.

4.5 KROHNE Care board

If the ALTOSONIC V12 is provided with the optional KROHNE Care diagnostics board, then one Custody Transfer Modbus connection is used for the communication with this board.

With this KROHNE Care board, there are some new I/O connections:

- 1x extra digital output
- 1x current output
- 1x multidrop (dual) HART
- 2x ethernet
- 2x (non-Custody Transfer) Modbus (master and/or slave)

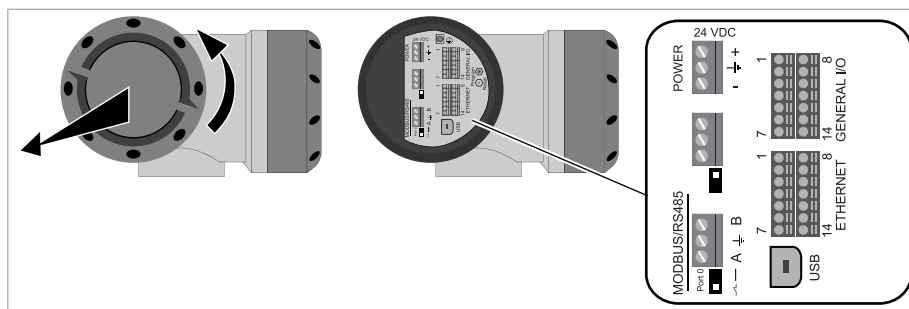


Figure 4-6: KROHNE Care board

Please contact your supplier for more details about the KROHNE Care board.

4.6 Power connection



WARNING!

- Use a 24 VDC power supply to power the flowmeter, which complies to NEC class 2 (max. 100 VA, 24 VDC \pm 10%, see also IEC 61010-1, clause 6.3.1 and 6.3.2). The maximum power consumption is 17 W. The power supply must be able to supply 3 A (needed during start-up).
- The protective earth conductor (1...4 mm², AWG 17...AWG 11) of the power supply must be connected to the protective conductor clamp terminal size M5, which is press-fitted in the terminal compartment.
- Use a cable entry to lead the power supply cable to the electronics. The power delivered from the power converter inside the unit is limited to a maximum of 15 W according to the “fold-back” principle (when the admissible internal power consumption is exceeded the delivered power is reduced to zero). Separately the current consumption is limited to appr. 1A. Requires typically 3 x 1.5 mm² (AWG 15) conductors.
- Connection to a flow computer, a data acquisition system or process control system by means of digital output signals; requires as a maximum 4 pairs of wires of 0.75 mm² (AWG 18) copper each.
- Connection by means of a RS 485 data line to a device for logging or monitoring data or running a software service tool for performing a function check or a service jobs; requires a shielded pair of two twisted conductors of 0.75 mm² (AWG 18) copper each.
- Connection to a data acquisition system by means of digital signals; requires a shielded pair of two twisted conductors of 0.75 mm² (AWG 18) copper each.
- Connection to safety / protective ground (earthing); requires insulated wire, minimum copper cross section area 4 mm² (AWG 11).



INFORMATION!

- The protective conductor clamp or GND of the connector can be used for the shielding of the cable.
- The electronics is protected against connecting a power supply with the wrong polarity.

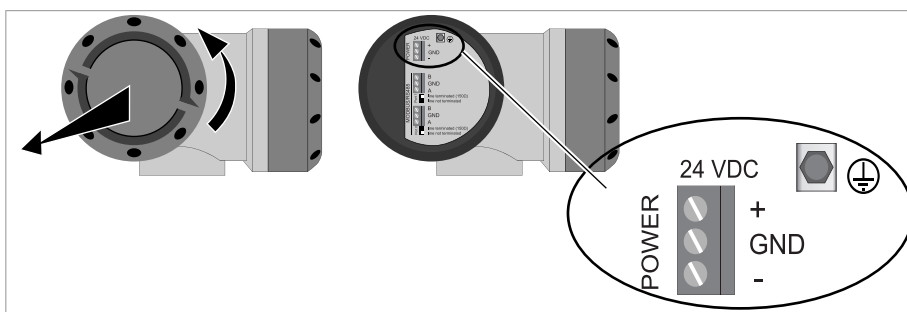


Figure 4-7: Location of power connector

4.7 Cabling

Use the correct cable gland for each cable, refer to the figure below.

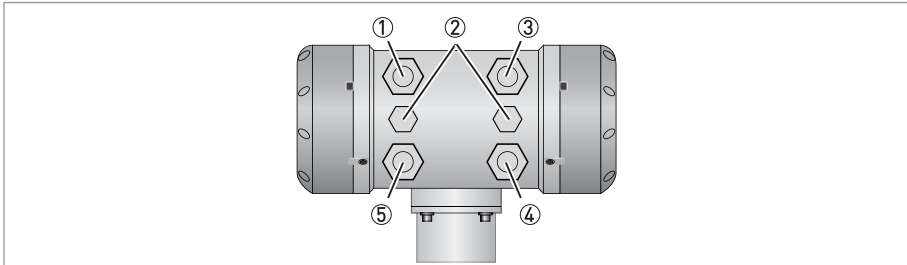


Figure 4-8: Location of cable glands

- ① Signal output (frequency / pulse)
- ② Ex d approved blind plug
- ③ Power supply 24 VDC
- ④ RS485 Modbus (optional UTP cable for KROHNE Care Expert system)
- ⑤ Signal output (frequency / pulse)



WARNING!

- Replace any unused cable gland by an Ex-d blind plug!
- The temperature rating of all cables must have a temperature rating of at least 65°C / 149°F. In case the process design temperature exceeds 65°C, the cables must have a temperature rating as high as the maximum process design temperature.



DANGER!

Only use Ex d approved cable glands. The enclosure entries that are not used must be closed with Ex d approved blind plugs.

We recommend to use screened cable with twisted pairs for connecting power, serial outputs and the status signals. The screen can be used to connect the ground terminal.

Length of power supply cable versus diameter

Length of cable between power supply and flowmeter		Required minimum copper cross section
[m]	[ft]	
70	230	2 x 0.5 mm ² (AWG 20)
100	328	2 x 0.75 mm ² (AWG 18)
200	656	2 x 1.5 mm ² (AWG 15)
400	1312	2 x 4 mm ² (AWG 11)

4.8 Grounding

There are two screw connection points (one M5 thread and one M4 thread) to attach a ground conductor. They can be used to connect the upstream and downstream piping to the flowmeter (Equipotential).

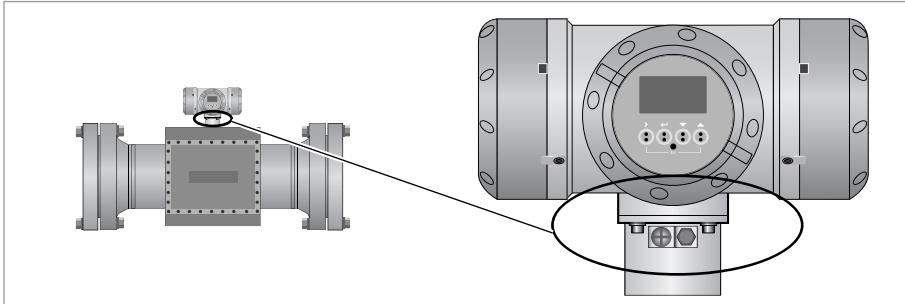


Figure 4-9: Location of grounding connectors

5.1 Starting the signal converter

The measuring device, consisting of the measuring sensor and the signal converter, is supplied ready for operation. All operating data have been set at the factory in accordance with your order specifications.



CAUTION!

The used power supply must be able to supply at least 3 A during the start-up of the converter.

When the power is switched on, a self test is carried out (KROHNE logo is visible during the test). After that the device immediately begins measuring, and the current values are displayed.

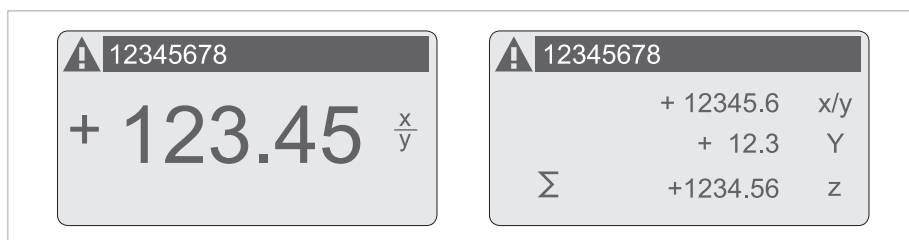


Figure 5-1: Displays in measuring mode (examples for 2 or 3 measured values)
x, y and z denote the units of the measured values displayed

It is possible to change between the two measured value windows, the trend display and the list with the status messages by pressing the keys \uparrow and \downarrow .

6.1 Display and operating elements

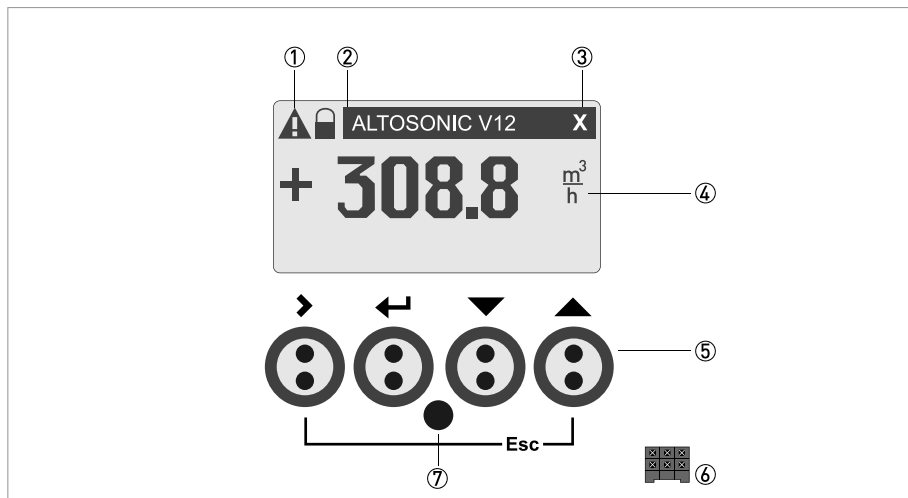


Figure 6-1: Display and operating elements (Example: flow indication with 2 measuring values)

- ① Indicates a possible status message in the status list
- ② Field with product name, indication whether CT parameters have been locked (closed lock symbol) and the page number that is shown on the display
- ③ Indicates when a key has been pressed
- ④ 1st measured variable in large representation
- ⑤ Keys (see table below for function and representation in text)
- ⑥ Interface to the GDC bus (not present in all signal converter versions)
- ⑦ Infrared sensor (not present in all signal converter versions)



INFORMATION!

- *The switching point for the 4 optical keys is located directly in front of the glass. It is recommended to activate the keys at right angles to the front. Touching them from the side can cause incorrect operation.*
- *After 5 minutes of inactivity, there is an automatic return to measuring mode. Previously changed data is not saved.*

Key	Measuring mode	Menu mode	Submenu or function mode	Parameter and data mode
>	Switch from measuring mode to menu mode; press key for 2.5 s	Access to displayed menu, then 1st submenu is displayed	Access to displayed submenu or function	For numerical values, move cursor (highlighted in blue) one position to the right
←	Reset of display	Return to measuring mode but prompt whether the data should be saved	Press 1 to 3 times, return to menu mode, data saved	Return to submenu or function, data saved
▼ or ▲	Switch between the five screens: M1, M2, G1, S0, Version and modbus settings.	Select menu	Select submenu or function	Use cursor highlighted in blue to change number, unit, setting and to move the decimal point
Esc (> + ↑)	-	-	Return to menu mode without acceptance of data	Return to submenu or function without acceptance of data

Table 6-1: Description of key functionality

6.1.1 Display in measuring mode with 1 or 3 measured values

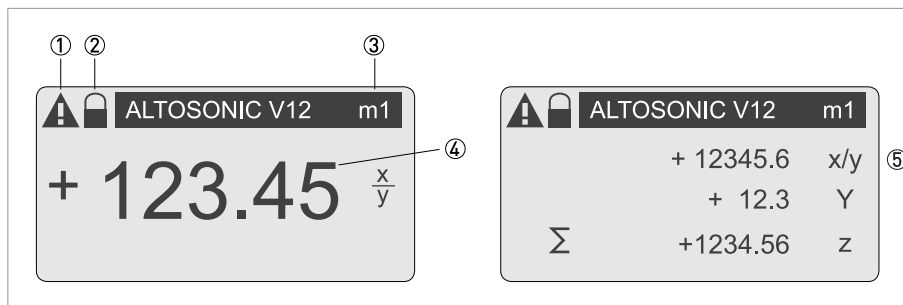


Figure 6-2: Example for display in measuring mode with 1 or 3 measured values

- ① Indicates a possible status message in the status list
- ② Lock, indicating that programming is not possible
- ③ Actual screen
- ④ First measured variable in large depiction
- ⑤ Description with 3 measured values

6.2 Menu overview

Menu number		Description
4.1.2		Settings
	4.1.2.1	Language
	4.1.2.2	Default Page
	4.1.2.3	Bargraph Labrl
4.1.3		Measurement Page 1
	4.1.3.1	Number of lines
	4.1.3.2	Line Settings 1
	4.1.3.3	Line Settings 2
	4.1.3.4	Line Settings 3
4.1.4		Measurement Page 2
	4.1.4.1	Number of lines
	4.1.4.2	Line Settings 1
	4.1.4.3	Line Settings 2
	4.1.4.4	Line Settings 3
4.1.5		Graphical Page
	4.1.5.1	Show Value
	4.1.5.2	Graph type
	4.1.5.3	Minimum
	4.1.5.4	Maximum
	4.1.5.5	Time
4.1.6		Status Page
	4.1.6.1	Reset Errors

6.3 Access control and seals

All acoustic transducers and the electronics unit of ALTOSONIC V12 can be exchanged without the need for recalibration. The only exception is the board that holds all Custody Transfer (CT) settings. After initial calibration of the ALTOSONIC V12 all CT settings are stored inside the meter and a dipswitch no 4 is put in the locked position. The dipswitches are subsequently sealed by the calibration facility, guaranteeing no un-authorized changes can be made to the meter. Contact KROHNE in case the board with the sealed dipswitches needs to be replaced.

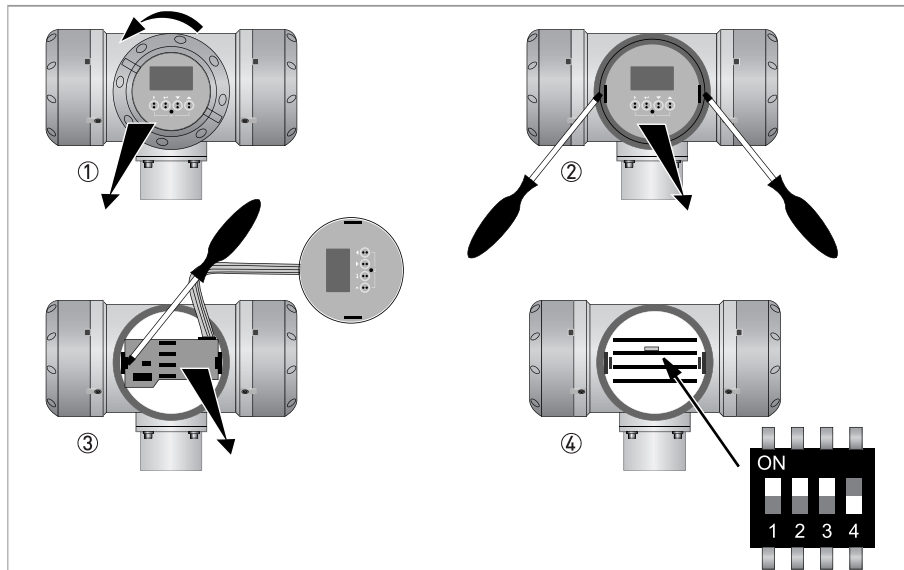


Figure 6-3: Location of DIP switch for sealing



- ① Turn cover counter clockwise and remove the cover.
- ② Pull the metal grips to remove the display.
- ③ Remove the plastic cover with a screwdriver.
- ④ Locate the DIP switch number 4:
ON = free
OFF = locked.



CAUTION!

The CT approval is no longer valid if the dipswitch number 4 is switched to ON!

The cover of the electronics can be sealed too (optionally).

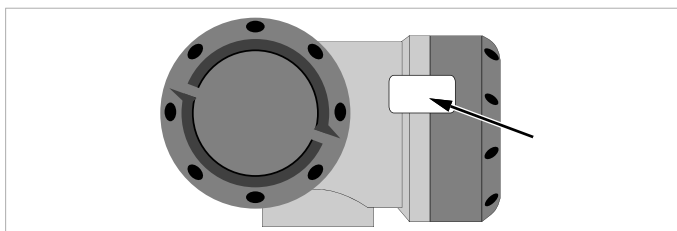


Figure 6-4: Optional sealing of cover



INFORMATION!

The sealing of the cover is not required and can be broken without affecting the CT approval.

The nameplate must be sealed to the flowmeter, as shown in the figure below. Alternatively the nameplate can be welded on the flowmeter or be mounted with rivets, so that removal without destroying the name plate is not possible.

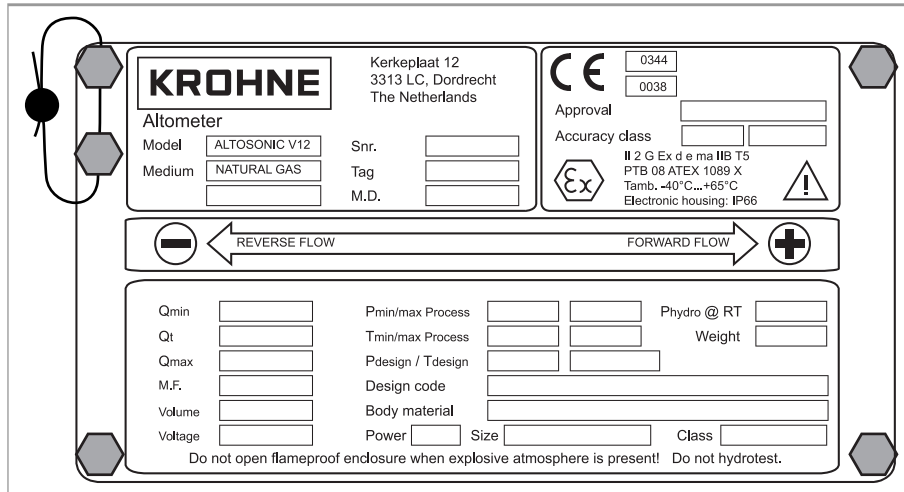


Figure 6-5: Sealing of nameplate

7.1 Introduction

The KROHNE Flowmeter Configuration and Monitoring Tool is a software package to support the application of the ALTOSONIC 5 Reference flowmeters. It is designed to be used with a PC with a Windows operating system and can be downloaded from www.krohne.com.

It can:

- collect data from a flowmeter
- present data from a flowmeter
- verify / set / adjust parameters used by the software inside the flowmeter.

The software can be operated using different communication methods such as:

- TCP/IP
- Modbus
- USB

7.2 Installation of the software

After the software has been installed, the Windows Program menu will have an item KROHNE Custody Transfer Products with sub item KROHNE Flow Meter Configuration & Monitoring Tool.

7.3 Starting a session



CAUTION!

To secure reliable operation of the meter, access is limited by means of passwords. Different levels of passwords are available for staff with the proper skills and authorization to allow them to perform the jobs they are entitled to.



INFORMATION!

A session is the activity starting with establishing communication (connecting) with a meter. A session ends when the communication process with a meter is terminated (disconnecting). During a session data can be collected from a meter in order to monitor and evaluate the performance, the collected data may be stored as a log file and parameters can be adjusted.

After the program is launched a blank screen will appear with only a number of menu pull down buttons on the menu bar on the upper left side of the computer screen.

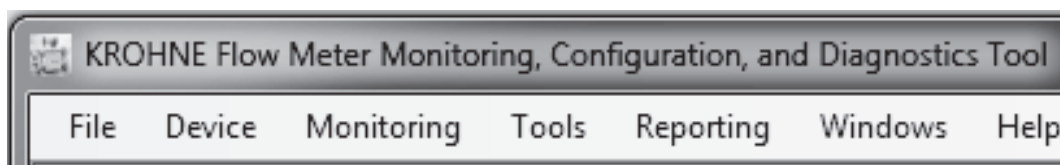


Figure 7-1: Start-up screen, upper part

The lower left corner of the screen shows a status bar with some information fields and status fields or status indicators.



Figure 7-2: Start-up screen, lower part

The first field is an information field, reserved to show the communication method in operation. Without an active communication the first and the second fields will show a dash.

When communication with a flowmeter has been established, the second field will show the address of this flowmeter, valid for the communication method in operation.

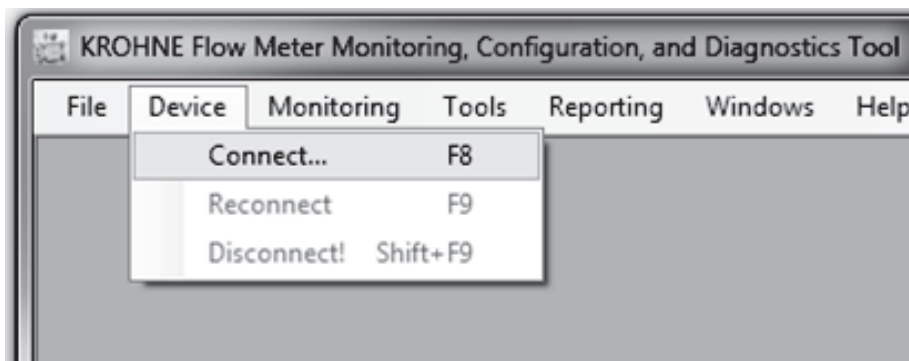


Figure 7-3: Connect the device

1. Choose and click the menu pull down button Device.
A menu will open with the options Connect, Reconnect and Disconnect.
2. Click Connect (at this time the only valid option).
This will open a dialog box asking to select or confirm the communication method you intend to use.

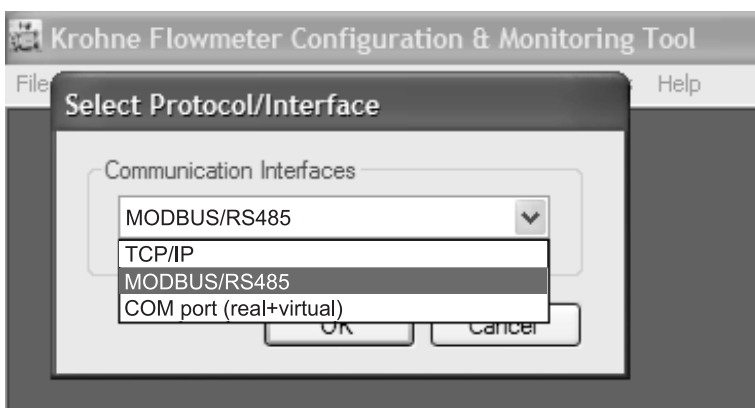


Figure 7-4: Communication interfaces

1. Click OK to confirm if you want to select the option as displayed or - if not -
2. Click the down button to have the other options displayed.

3. Select and click the option you need.
4. Click OK to confirm.

KROHNE Flowmeter Configuration and Monitoring Tool will now send a message, asking for a response from any meter that is able to communicate using the selected communication method.

MODBUS/RS485 Settings

Port Settings

COM Port: COM1

Baud Rate: 38400

Data Bits: 8 Stop Bits: One

Parity: Even Handshake: None

Modbus Settings

PC Address: 0 Meter Address: 237

Mode: MODE_RTU

Compatibility: MODICON_COMPATIBLE

Time-out: 1000 ms

Own Data Readback

Computer does receive own transmitted data

Computer does NOT receive own transmitted data

OK Cancel

Figure 7-5: Settings for Modbus port 0

MODBUS/RS485 Settings

Port Settings

COM Port: COM1

Baud Rate: 115200

Data Bits: 8

Parity: Even

Stop Bits: One

Handshake: None

Modbus Settings

PC Address: 0

Meter Address: 237

Mode: MODE_RTU

Compatibility: MODICON_COMPATIBLE

Time-out: 1000 ms

Own Data Readback

Computer does receive own transmitted data

Computer does NOT receive own transmitted data

OK Cancel

Figure 7-6: Settings for Modbus port1

When using TCP/IP (network environment) a dialog box will appear listing the responding meters. If multiple instruments are present in the same network a list will be presented. The other communication options are peer-to-peer and will request for setting up the communication link.

An arrow in the most left column in the dialog box marks the meter selected to start a communication session.

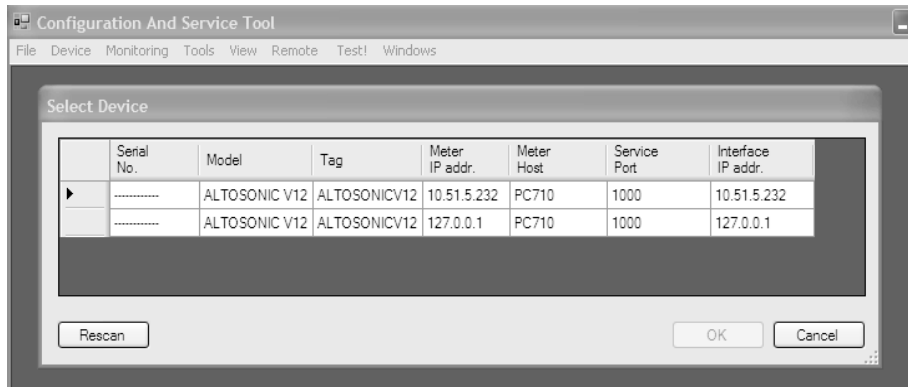


Figure 7-7: Select the device

1. To confirm the selection, click on the arrow in the most left field of the row with the meter selected by default.
2. To select another meter: move the arrow to the row with the meter you want to communicate with, click in the most left field of the row showing the meter.
3. Confirm your choice by clicking OK.

In case that you do not get a response from any meter or you don't get a response from the meter you want to communicate with. Reasons can be:

- there is no ultrasonic flowmeter operational, or
- the meter you want to communicate with is not connected to a power source, or
- the communication line is not properly connected.

If this happens you can press the button "Rescan" after the problem is solved. MCST will now resend the message, asking for a response from any meter that is able to communicate using the selected communication method. If the problem has been solved properly, the meter that you are looking for will be listed in the dialog box.

Type your name and password in the dialog box and click OK.

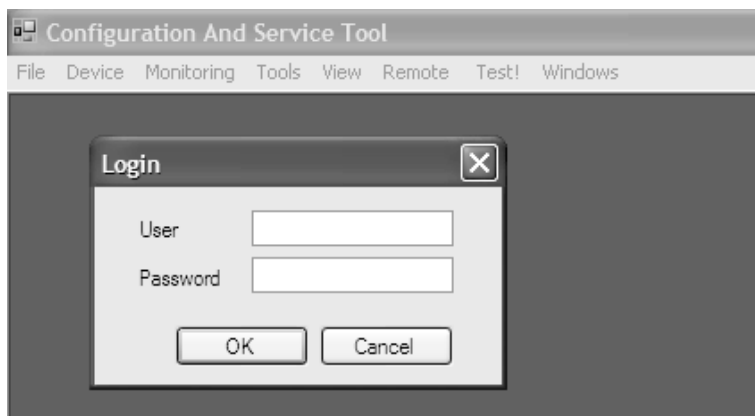


Figure 7-8: Login dialog box

Standard: User: operator / Password: operator
or User: supervisor / Password: supervisor

The selected communication method and flowmeter address will appear in the respective information fields in the status bar at the bottom of the screen.



Figure 7-9: Status bar information

7.4 Loading a monitoring configuration



INFORMATION!

There are two different methods to obtain data from a flowmeter.

- *Request information on a specific data item: if it is a parameter the current value will be reported, this is a static value. If it is a variable, the value will be reported and updated every 2 seconds.*
- *Define a selection of data that the flowmeter will send as a package and update at specific rate. This way the data collecting process is customized to collect only those variables or data elements that one really needs or wants to be monitored and / or logged (as the meter produces a large amount of data it will not be possible to collect and update all the variables in a short time interval).*

The option "Configure" is available to customize the selection of data to be sent from the flowmeter at a specific update rate. This option is used to define the set of data that will be collected from the flowmeter: this set of data will be available to be displayed simultaneously. The specification of such a set of data is stored in a monitoring configuration file, a file with an extension ".mon". A default monitoring configuration file can be found in the software installation package. Once a monitoring configuration is loaded, the monitoring process can be started and stopped.

To load a monitoring configuration:

Step 1: Click the button “File” to open the File menu.

Step 2: Select the option “Open Monitoring Configuration”.

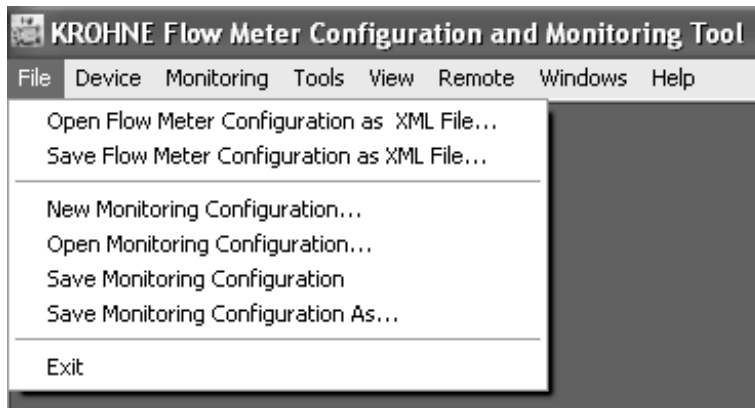


Figure 7-10: File menu

A browser window will open.



Figure 7-11: Open monitoring configuration

Step 3: Select a monitoring configuration file and click “Open”.



INFORMATION!

You can create and save one or more monitoring configurations of your own, according to your own preferences. Later it will be explained how you can do this.

As a start you can select the default monitoring configuration file.

A dialog box will appear, asking whether you want to start the monitoring function now:

Step 4: Click “Yes” to start the monitoring function.

The monitoring status field updates from “Mon.OFF” to “Mon.ON”, and turns from yellow into green.

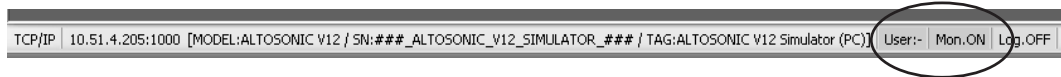


Figure 7-12: Green status field

Alternatively you can configure the software to automatically find a monitoring configuration file and start monitoring immediately after the program is launched.

Step 5: Click the “Tools” button to open the tools menu.

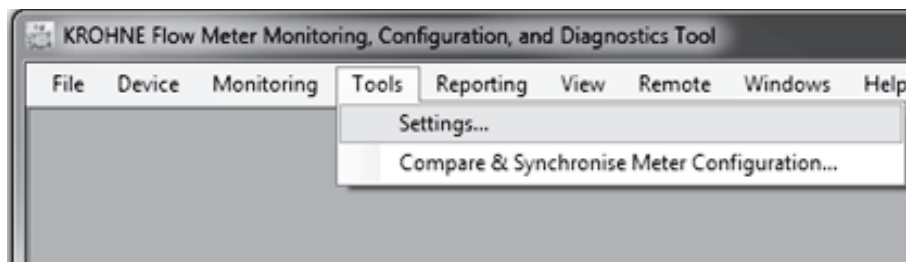


Figure 7-13: Tools menu

Step 6: Click “Settings”. A window “Settings” with tabbed sheets will open.

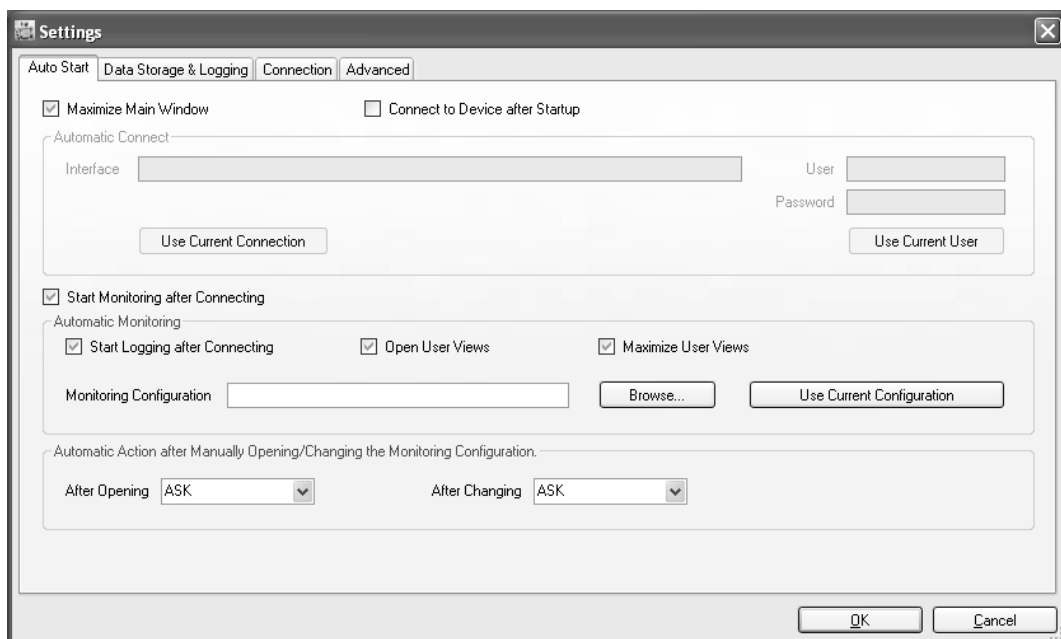


Figure 7-14: Settings

Step 7: On the sheet "Auto start" select the box "Start monitoring after connecting".

Step 8: You can:

- click the button "Use current configuration", or
- click "Browse" to open another window This is an identical browse window as used before to find a monitoring configuration file.
Select the file you want to use to start monitoring the next time you connect to a meter.

Step 9: Click "OK" to confirm the settings.

The next time you launch the program the steps 1...4 will be skipped.

7.5 Changing and saving a monitoring configuration

7.5.1 Creating a monitoring configuration

When opening the KROHNE Flowmeter Configuration and Monitoring Tool the default settings are such that a default monitoring file is loaded and that a default user view is activated. Also the KROHNE Flowmeter Configuration and Monitoring Tool will start logging directly. All these features will be discussed in the next paragraphs. If due to unforeseen reasons the default start up settings does not start up in the paragraphs below the different steps are discussed to activate monitoring, user view and logging.

In order to modify the selection of data available for monitoring, change the monitoring configuration.

Step 1: Click the button "Monitoring" to open the monitoring menu.

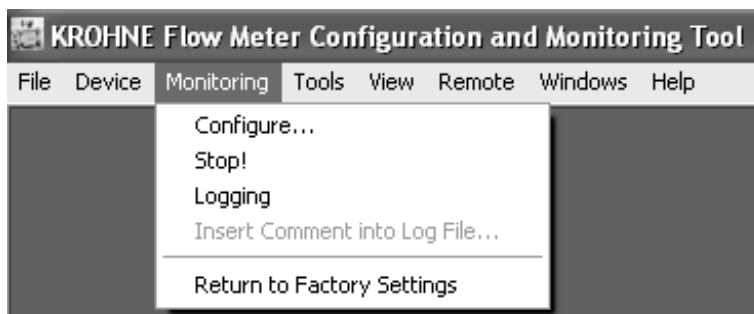


Figure 7-15: Monitoring menu

Step 2: Click the option "Configure...".

In case a monitoring session is active the message box as below will appear.

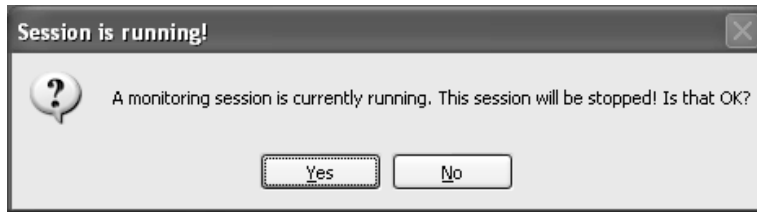


Figure 7-16: Warning for running session

Step 3: Click “Yes” to stop the monitoring activity.



INFORMATION!

Note that the instrument itself will not stop measuring! Only the presentation of measuring results will be interrupted.

The Monitoring Configuration dialog appears:

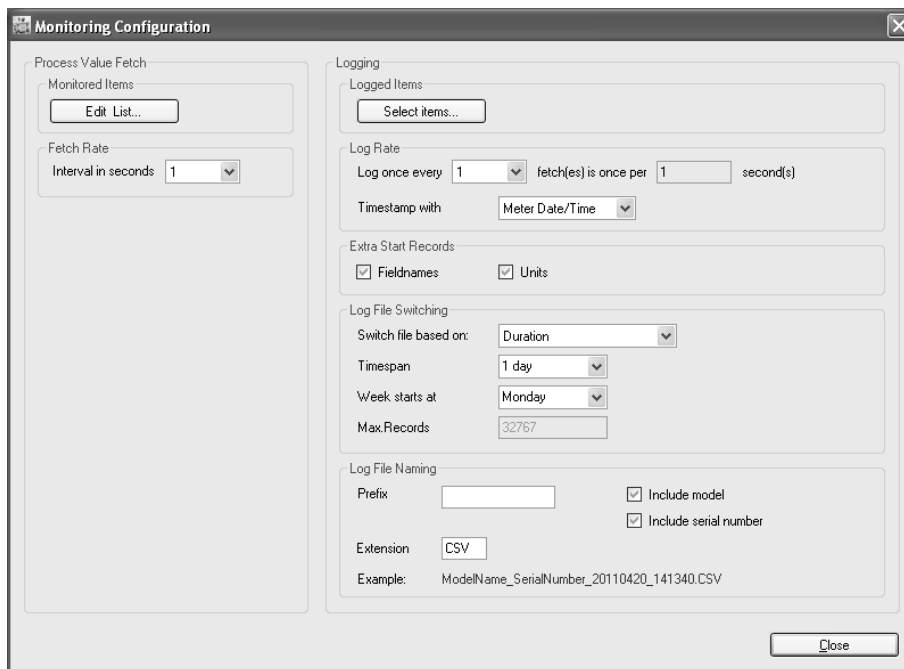


Figure 7-17: Monitoring configuration

Step 4: Click “Edit List” . The Monitoring List editor dialog appears:

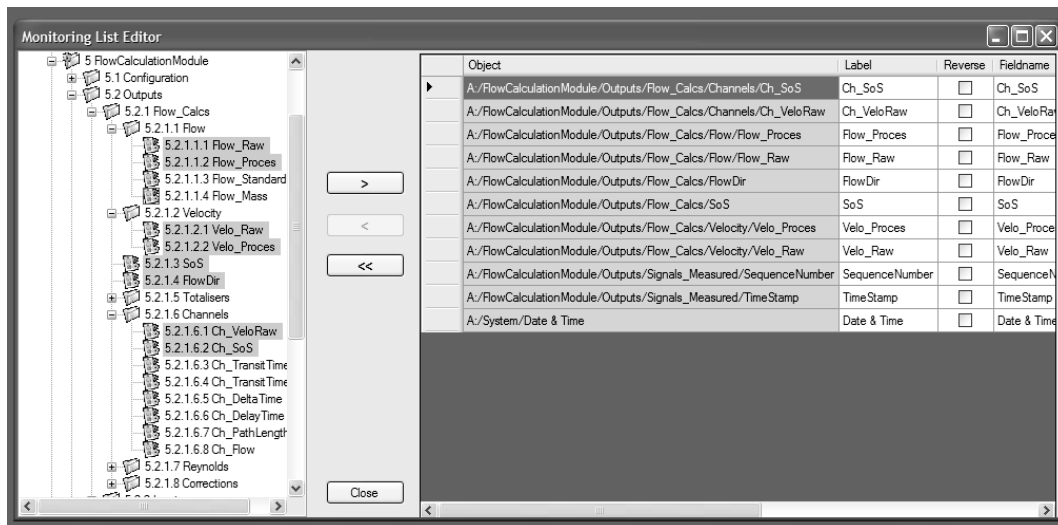


Figure 7-18: Monitoring list

Variables can be added to the list of values to be collected from the meter and become available for presentation:

Step 5: Open the tree structure in the left panel, and select the variable name to be added to the list.

Step 6: Click the button pointing to the right in the center panel. The item will now appear in the list in the right panel.

Similarly variables can be deleted from the list of values to be collected from the meter, these values will no longer be available for monitoring / logging.

Step 7: In the right panel, click in the box to the left of the name/description of the variable to be deleted, the pointer will not move to this line. This will also enable the button in the center panel with the arrow pointing to the left.

Step 8: Click on this button to remove the selected item from the list.

Step 9: Click the button in the centre panel with the double arrow to the left to clear the list completely.

Step 10: Click the button “Close” in the centre panel to finish this part: Monitoring List editor screen will disappear, Returning to the “Monitoring Configuration Window”.

You can adjust the rate at which the selected data will be sent and updated:

Step 11: Click the “down”- arrow left of “Interval in sec.”

Step 12: Click on the rate according to your preference.

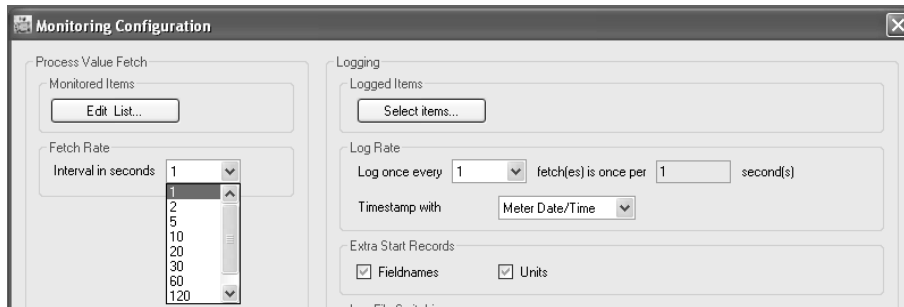


Figure 7-19: Monitoring configuration

Step 13: Click the “Close” button in the lower right corner of this window to finish this part. A dialog box will ask if you want to (re)start the monitoring process.

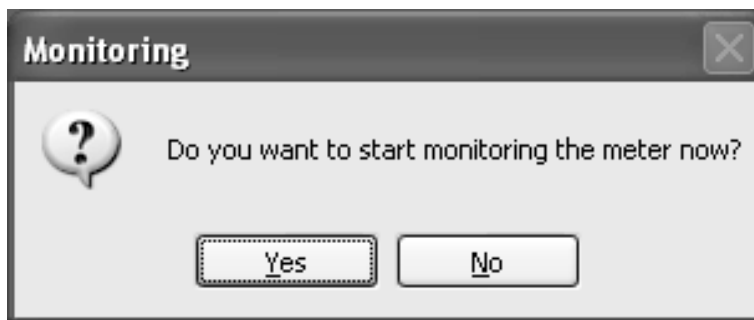


Figure 7-20: Restart of monitoring

Step 14: Click “Yes” to resume the monitoring process.

7.5.2 Saving a monitoring configuration with a new name



INFORMATION!

- If you want to save both the modified monitoring configuration as well as the monitoring configuration you used as a starting point, you will need to save now the modified configuration (with a new unique name).
- If you do not save the modified configuration now, the program will prompt you at the time you close the program, however at that time you have only two options: you can save the configuration used as a starting point (losing your modifications) or you can save the modified configuration, this will overwrite the starting configuration (and the starting configuration will be lost).

Step 1: Click the button “File” to open the file menu.

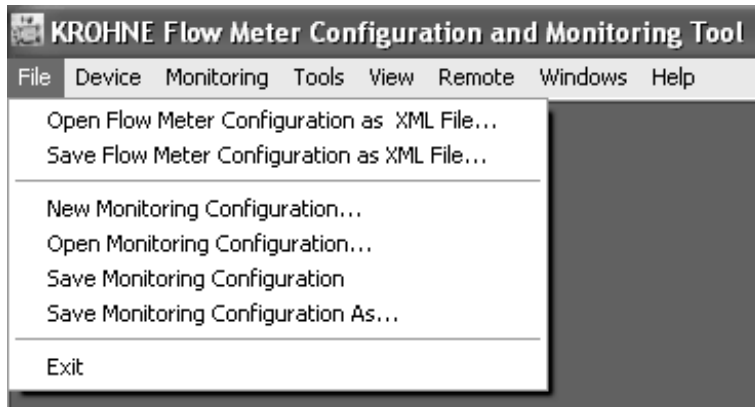


Figure 7-21: File menu

Step 2: Click the menu item "Save Monitoring Configuration As..".



Figure 7-22: Save monitoring configuration

Step 3: Type a new name in the box "Filename".

Step 4: Click "Save".

Your new monitoring configuration is now saved with its new name.

7.5.3 Saving a monitoring configuration with its current name

You can save an updated version of your monitoring configuration at any time:

Step 1: Click the "File" button to open the file menu.

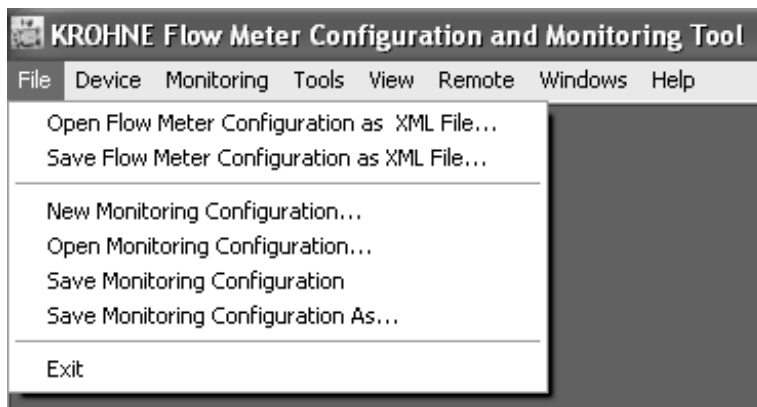


Figure 7-23: File menu

Step 2: Click "Save Monitoring Configuration".

The monitoring configuration file used as starting point will now be replaced by the modified monitoring configuration.

7.6 Creating a monitoring configuration

**CAUTION!**

If you have no monitoring configuration file available to start with, or when you have not yet opened a monitoring configuration file, the option “Configure...” in the “Monitoring” menu is not available.

You have to use the option “New Monitoring Configuration...” in the File menu to create a monitoring configuration file.

Step 1: Click the “File” menu button.

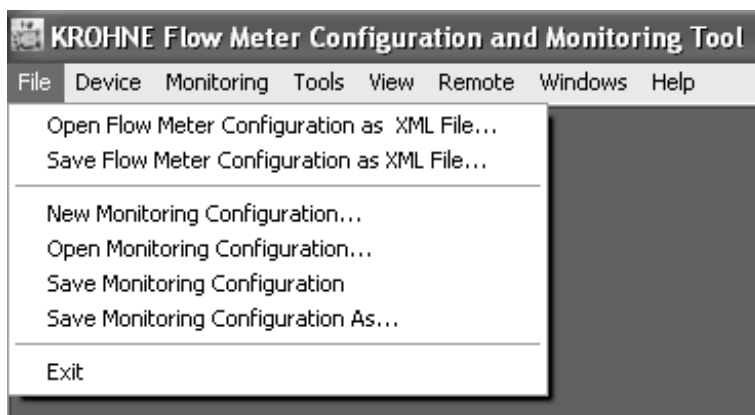


Figure 7-24: File menu

Step 2: Click the option “New Monitoring Configuration...”.

You can use this even if you already have a monitoring configuration opened and running. In that case you are asked to stop the running monitoring session.

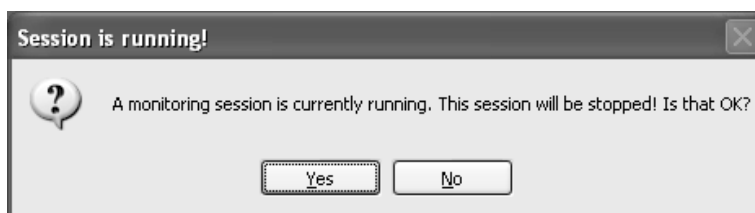


Figure 7-25: Warning for running session

Click “Yes”.

Now the Monitoring Configuration screen appears:

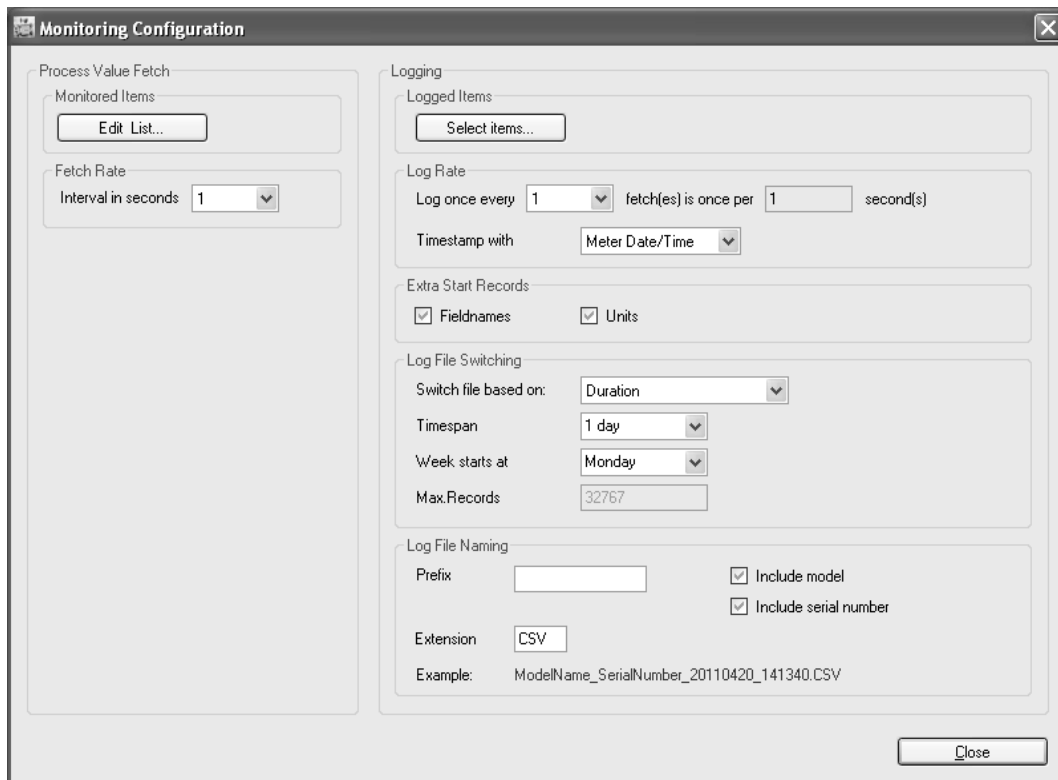


Figure 7-26: Monitoring configuration

Step 3: Click “Edit List”.

The empty Monitoring List Editor window will appear.

Step 4: Open the tree in the panel to the left of the window, select the data items you want to monitor and add these to the list in the panel to the right of the window, by pressing the “>” button.

Step 5: When finished, click “Close” in the “Monitoring List Editor” window.

Step 6: Set or adjust the “Fetch Rate” to the value as required.

Step 7: Click “Close” in the “Monitoring Configuration” window.

The “Monitoring” window reappears:

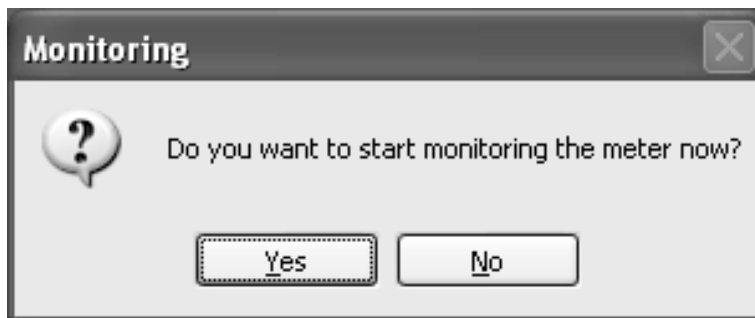


Figure 7-27: Start monitoring?

Step 8: Click “Yes” to start the monitoring process.

Store the new monitoring configuration using the “Save...” option in the File menu as described before. Assign a name to the new monitoring configuration: the “Save Monitoring Configuration” screen will appear.

If you create a new monitoring configuration while an existing monitoring configuration is open: at the time you exit the program, you are asked to replace the starting configuration, or you may decide not (if you want to keep both you have to use the “Save as...” option before you exit the program).

7.7 Viewing data

The easiest way to view data is to open a predefined User Views menu.

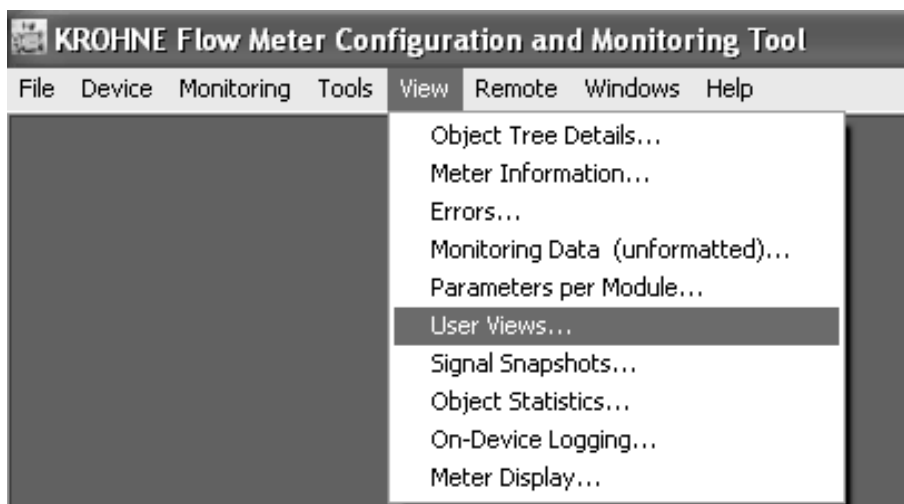


Figure 7-28: View menu

1. Click the button View on the menu bar to open the View menu.
2. Click the option User Views to open the User Views window.

This window may contain multiple sheets or tabs. Each tab represents a sheet displaying a selection of data, in numerical or graphical format (or both).

More sheets may be present allowing to present different sets of data or to present data in different formats. A particular sheet is identified by means of its name as is shown on its Tab.

3. In the window User Views, any sheet may be selected by clicking on its associated Tab.
4. Other windows may be selected to be viewed using the View menu.

7.7.1 Unformatted data

Step 1: Click the button “View” on the menu bar to open the “View menu”.

Step 2: Click “Monitoring Data (unformatted)...”.

An information window as below will appear as a scroll list.

The shown data is the data as currently being collected from the meter: only the values of the variables as defined in the monitoring configuration file.

7.8 Customizing the way data is presented

The data presented in “User Views” can be configured according to your specific needs or preferences. This applies to the selection of the data and to the way the data is presented: in numerical format or as a graph.



INFORMATION!

Only data that is actually gathered from the flowmeter (as set up in the Monitoring Configuration), is available to be displayed. A data item not included in the “Fetch list” will not be available to be displayed. You have to use the option “Configure” in the “Monitoring” menu to add to the “Fetch list” any data item you want to see in order to make it available for presentation.

7.8.1 Setting up tabs in the user view window

The window “User Views” has two buttons in its lower right corner: “Add Tab” and “Remove Tab”.

Removing a tab

Use the button “Remove Tab” to remove an existing sheet in the window “User Views”. In case the “User Views” window has multiple sheets, the currently opened sheet will be deleted.



INFORMATION!

in case you made a change, you will be reminded that you changed the monitoring configuration file when you close MCST. If you accept the modified configuration file to be saved, you will not be able to recover the deleted sheet the next time you start MCST.

If you want to keep both the set up you started with and the modified version, save the new version with a new name before closing the program. Use the command “Save Monitoring Configuration As..” (in File Menu) . This command stores the set up of the information sheets contained in “User Views” as well.

Adding / creating a tab

Using the button “Add Tab” you can add a new (empty) sheet in the window “User Views” and create a sheet to your own preferences.

A sheet can be set up as one single panel, or split in two sections, arranged as an upper panel and a lower panel. Each panel can be used to display data either as a graph or as numerical values displayed in cells arranged in a grid.



INFORMATION!

The format of the way data is presented in a panel is stored in a file with an extension “.grdx” (for presenting data as numerical values), “.trdx” (for presenting data as a graph, showing values as a trend on a time axis) or “.xygx” (for presenting data as a graph of one variable as a function of another variable).

The name of the file defining the format of the presentation in a specific panel can be read in its upper left corner.

**CAUTION!**

The files used for the preset “User Views” tabs can be reused. This is the easiest way to create your own “sheets” or “tabs” : making combinations of the predefined grids and/or graphs according to your preference.

In case you use an existing – predefined- format (even if it appeared before as a format filling only a half sized upper or lower panel) to fill a sheet or tab with only one panel, it will automatically expand to fill the whole of the panel.

To add/create a new tab:

Step 1: Click the “Add Tab” button.

Step 2: The “Add Tab” dialogue appears prompting you to enter a name for the sheet and to define the data format (graph or numerical) to be used in the upper panel and the lower panel (in case only one panel is defined the sheet will have just one panel).

The screenshot shows a dialog box titled "Add Tab". It has a close button (X) in the top right corner. The dialog contains the following fields and controls:

- Tab Name:** A text input field.
- Upper Panel:** A section containing:
 - Type:** A dropdown menu with "Empty" selected.
 - Configuration File:** A dropdown menu.
- Lower Panel:** A section containing:
 - Type:** A dropdown menu with "Empty" selected.
 - Configuration File:** A dropdown menu.
- Buttons:** "OK" and "Cancel" buttons at the bottom.

Figure 7-29: Add tab

Step 3: Type a name for the new sheet in the box “Tab Name”.

Step 4: Open the selection list for the type of panel you want to use: click the down arrow to the right of the box “Type” in the section “Upper Panel”.

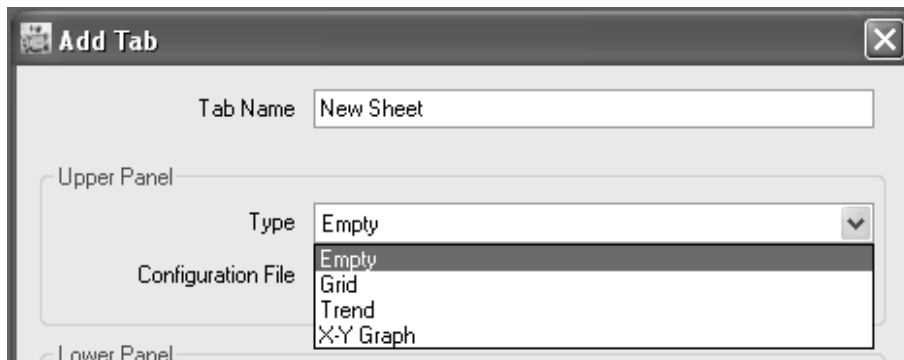


Figure 7-30: Add tab

Step 5: Click “Grid”, “Trend” or “X-Y Graph” according to your choice and then click “OK”.

Step 6: Click the “down” arrow to the right of the box configuration file.

Step 7: A list of available presentation formats will become visible. Click the file of your choice.

Step 8: If desired, select a format and a definition file for the second panel.

Step 9: Click the “OK” button.

Now the new sheet will appear with one or two panels as you have chosen.



INFORMATION!

As you have added a new tab, you will be reminded you have changed the monitoring configuration file when MCST is closed (shut down). If you accept the modified configuration file to be saved, you will not be able to recover the monitoring configuration you started with. If you want to keep both the set up you started with and the modified version, you have to save the new version with a new name before closing the program. Use the command “Save Monitoring Configuration As..” (in the File Menu). This command stores the set up of the information sheets contained in “User Views” as well.

7.8.2 Creating a new grid definition

In order to define a “grid” for presentation of data in numerical format according to your own preferences:

Step 1: Click “Add Tab”.

Step 2: Type a name for the new tab.

Step 3: Select “Grid”.

Note: Leave the “Configuration File” field empty.

Step 4: Click “OK”.

A new tab defined as a grid will appear initially as a grey area.

Step 5: In order to have a visible grid displayed, the size of the grid (number of cells) has to be defined. With a right mouse click a menu will open, click the option “Add Column(s)”:

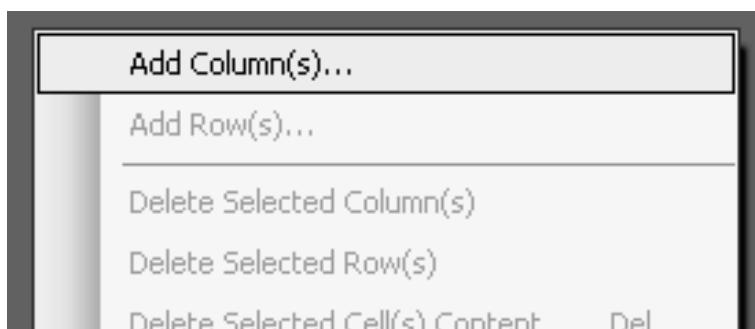


Figure 7-31: Add columns

Step 6: Enter the number of columns in the dialogue box that appears and click OK.

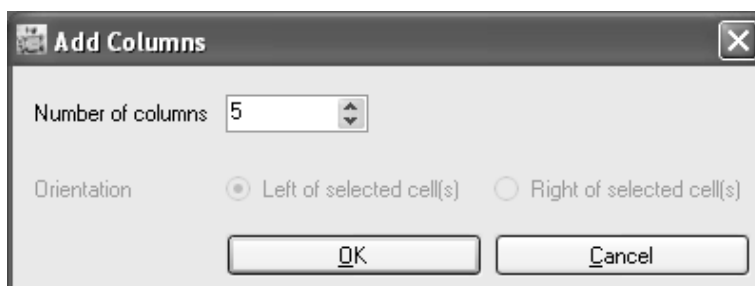


Figure 7-32: Add columns

Step 7: Click again in the gray area with the right mouse button to open the context menu, and click the option “Add Row(s)”.

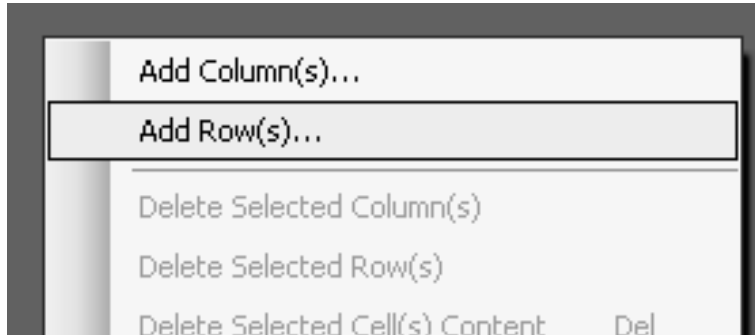


Figure 7-33: Add Rows

Step 8: Type the number of rows in the dialogue box that appears and click OK.

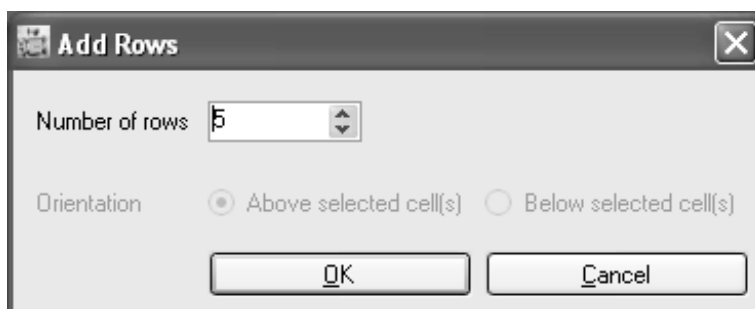


Figure 7-34: Add rows

The size of the grid is now defined, however it can be adjusted at any time adding columns or rows.

To define the information to be displayed by a specific cell:

Step 1: Position the cursor on the cell to be defined.



INFORMATION!

Do not forget the next step! If you skip the cell selection and continue with the following steps you might edit the content or format a cell you don't want to change.

Step 2: Select the desired cell with a click of the left mouse button.

Step 3: Open a menu with a right mouse click.

Step 4: Click “Cell Content...”.

In the dialogue box that appears, for the field “Cell Content Type”.

Step 5: Click “down” to open the value list to display the options: “Empty” / “User Text” / “Process Value Property”.



INFORMATION!

Steps 6...8 can be done in two ways. After “Step 13” you find an alternative way.

Step 6: Click “Process Value Property” .

Step 7: For the field “Process Variable” open the variable list .

Step 8: Click the variable to be displayed.

Step 9: For the field “Subitem” open the variable list.
Subitem is the array index for a variable defined as an array.

Step 10: Click the index of the array element to be displayed.

Step 11: For the box referenced as “Property”, open the list to show the properties that can be selected:
Label / Fieldname / Name / Full path / Parent name / Full parent path / Actual value / Average value / Minimum value / Maximum value / Unit / Status.

Step 12: Click the property to be displayed.

Step 13: Click “OK”.

Alternative way for steps 6...8:

Step 6: Click “User text”.

Step 7: Type the text “String” to be displayed in the cell in the field “User text”.

Step 8: Click “OK”.

To adjust the appearance of a cell and its content:

Step 1: Position the cursor on the cell to be defined.

Step 2: Click this cell with a click of the left mouse button.

Step 3: Open a menu with a right mouse click.

Step 4: Click “Cell Properties...”.

Continue to specify the content of any cell as you like.

Right click with your mouse in the area of the panel with the new grid to open the menu.
 Click “Save...” or “Save as...” to open a dialog box to enter a name for the grid definition you just created.
 Click the “Save” button to finish.



INFORMATION!

As you have added a tab with a new grid definition, you will be reminded you have changed the monitoring configuration file when MCST is being closed (shut down). If you accept the modified configuration file to be saved, you will not be able to recover the monitoring configuration you started with.

If you want to keep both the set up you started with and the modified version, you have to save the new version with a new name before closing the program. Use the command “Save Monitoring Configuration As..” (in File Menu). This command stores the set up of the information sheets contained in “User Views” as well.

7.8.3 Creating a new graphical presentation

Step 1: Click “Add Tab”.

Step 2: Type a name for the new tab.

Step 3: In the box “Type” click on the option “Trend”.

Note: Leave the “Configuration File” field empty.

Step 4: Click “OK”.

An empty graphic screen appears.

Step 5: Click the button “Configure”.

A window will open for defining the settings of the graphical presentation.



INFORMATION!

It is beyond the scope of this manual to give detailed instructions about how to define the graphical presentation. However you will be able to find your own way using the brief description of the next steps:

Step 1: Set the number of variables you want to be displayed (each variable selected for being displayed is called a “profile”).

Step 2: Set the number of Y-axis’s you will need to represent the values of the variables (profiles) you want to be displayed. This number can not be larger than the number of profiles.

Step 3: Set how many stacks you need. A stack is a chart area with its own X and Y axis’s. The height of area in the graphical window will be split in sections, each section will accommodate one “Stack”. The number of stacks can not be larger than the number of Y-Axis’.

Step 4: Set the number of Y-scales you will need on the first (upper) stack.

Step 5: Enter this number in the tab Y-Stacks/Y-Stack0.

Do the same for any subsequent “stack”.

Step 6: In the tab “Profile – Process Value Mapping” specify the process value to be represented by each profile.

Step 7: In the tab “Profiles” set the axis to be used for displaying the value of each profile.

Step 8: Adjust colours and line/marker styles according to your taste.

Step 9: Click “OK” .

Step 10: Click “Save As”.

Enter a name for the graphical presentation you just have created.

Step 11: Click “Save”.

7.9 Creating reports

The service tool has been developed to also enable you to create records regarding the state of the ultrasonic flowmeter and the way the meter performs. Records can be printed reports or records can be exported and saved as data files on a storage medium.

Records can be created regarding:

- the actual parameter values as present in the meter, governing the performance and functionality of the meter.
- process values as observed at a specific instant.
- the Modbus address mapping regarding the parameters and process values that can be retrieved from the meter using Modbus register addressing.
- rights and/or restrictions regarding access to the ultrasonic meter and the functionality of this service tool, as is available for a user of a specific category (such as operator, supervisor, calibrator, service technician or factory authorized support engineer).

To obtain a report:

Click “Tools” to open the Tools menu.

Click “Reporting” to open the Reporting submenu.

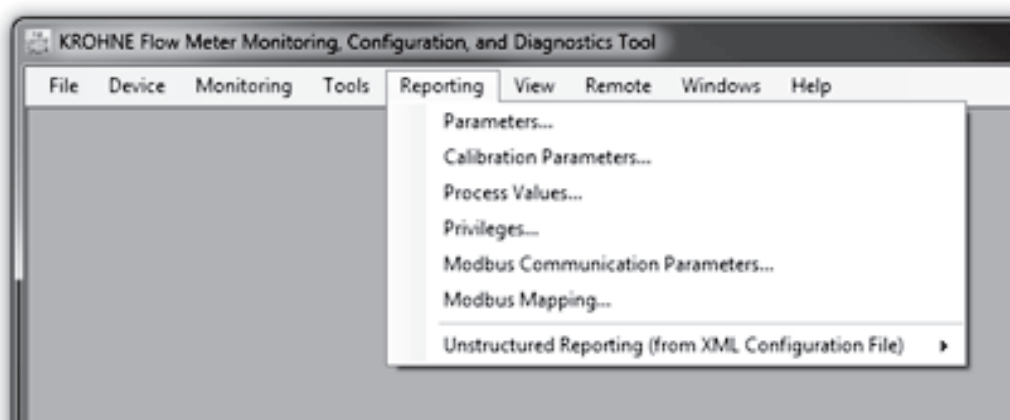


Figure 7-35: Tools > Reporting menu

7.9.1 Reporting related to parameter settings

Click “Parameters” to open a window in which all parameters are listed.

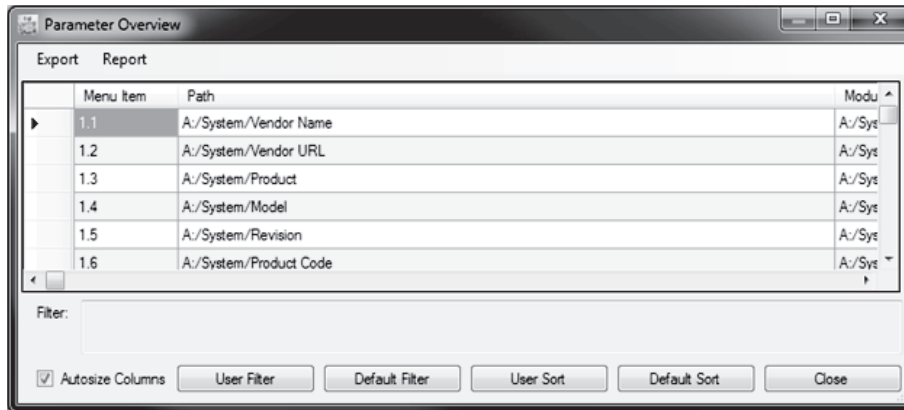


Figure 7-36: Parameters

Use the scroll bar at the right side of the window to scroll through the list and the scroll bar at the bottom to display the columns you are interested in.

Creating a formatted report

Go to "Reports & Exports > Reports > Standard parameter report".

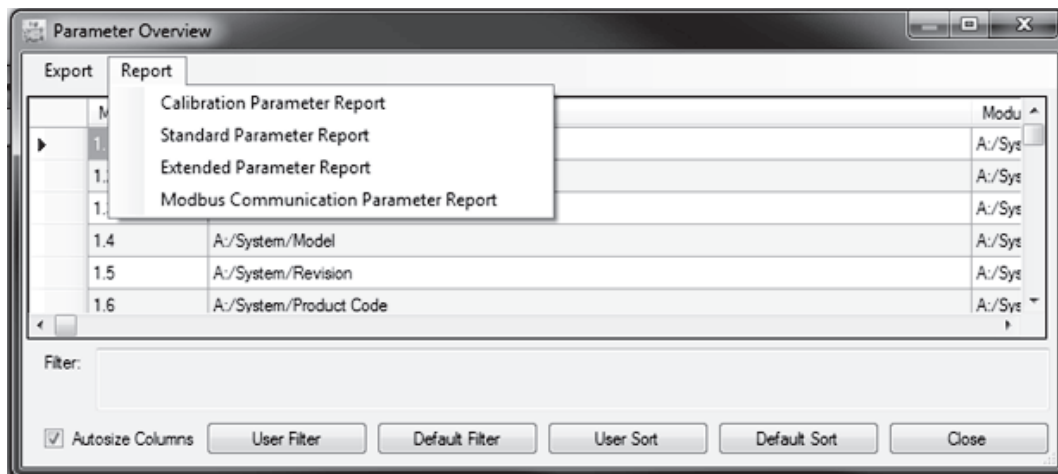


Figure 7-37: Parameter report

A formatted preview of the Standard Parameter Report will be displayed:

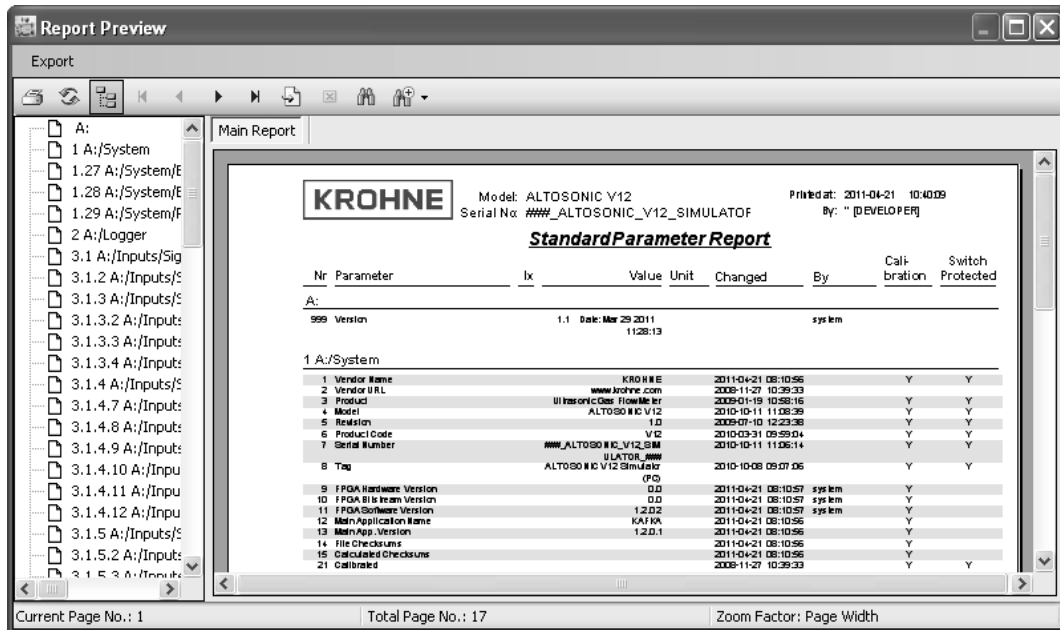


Figure 7-38: Preview of report

As this report will occupy several pages you can use the buttons on top of the screen to select a particular page.

The small panel at the left side lists – as a tree structure - all the items included in the report. You can use the scroll bar in the right of the small panel to position immediately the report page where this parameter is printed in front in the right panel. You can click the highlighted “tree” icon to remove this “tree” panel, click again to let it reappear.

Printing a formatted report

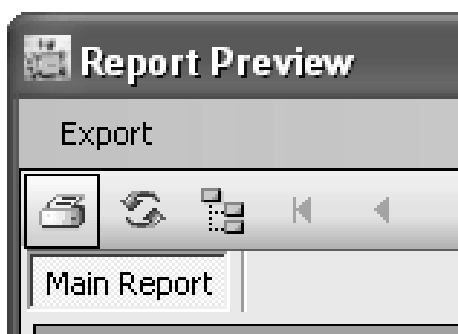


Figure 7-39: Report preview

Click the button with the printer icon in the upper left of the window to get a printed copy of the report.

Exporting a formatted report

Open the Report Preview's Export menu:

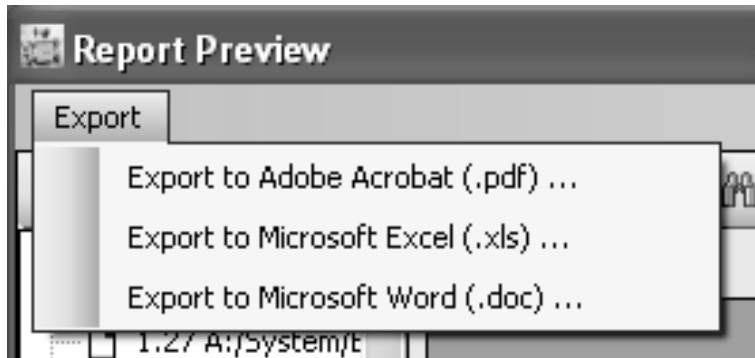


Figure 7-40: Report preview

Select the application format of the exported report: Adobe Acrobat (.pdf), Microsoft Excel (.xls), or Microsoft Word (.doc). Use the file selector dialogue to select the location and the filename for the export.

Create a file listing the parameters in CSV format

Click "Tools" to open the Tools menu.

Click "Reporting" to open the Reporting submenu.

Click "Parameters" to open a window in which all parameters are listed.

Click "Reports and Exports", then "Export to CSV...".

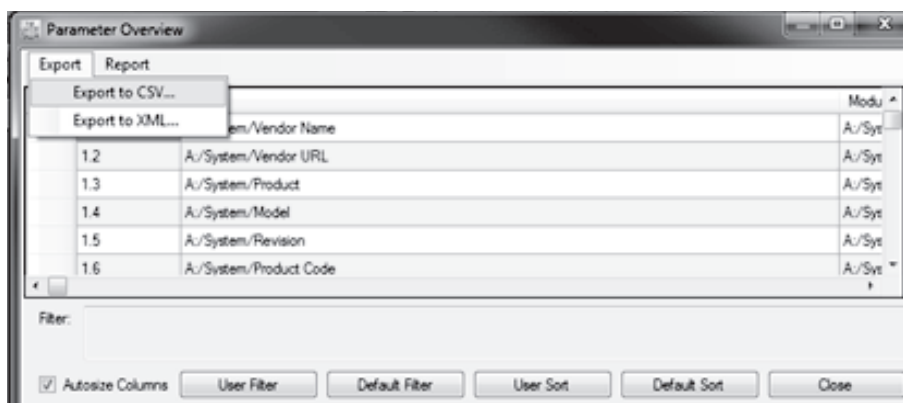


Figure 7-41: Parameter overview

A window opens that allows you to make a selection of the attributes to be listed for each parameter.

Select the items you want to include in the exported file.

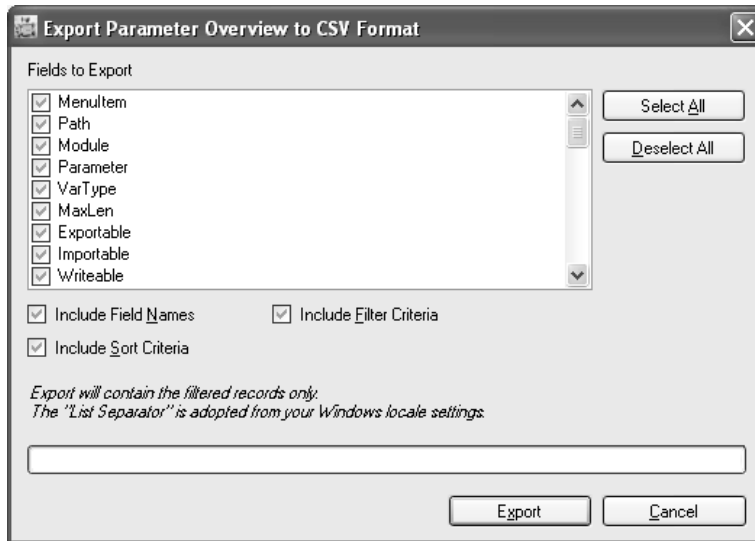


Figure 7-42: Export parameter overview

Click the button “Export”.

In the output dialog box that appears:

Specify the location where you want to store the file.

Type a unique file name for the document.

Click the button “Save”.

To save the parameter list in an XML format file:

- Click Tools to open the Tools menu.
- Click Reporting to open the Reporting submenu.
- Click Parameters to open a window in which all parameters are listed.
- Click Reports and Exports.
- Click Export to XML.
- In the window that appears click Export to confirm.
- In the output dialog box that appears: specify the location where you want to store the file.
- Type a unique file name for the document.
- Click the button Save.

7.9.2 Reporting related to process values

For the reporting functions related to actual process values the same features and procedures are applicable as valid for the parameters.

7.9.3 Reporting related to calibration parameters

The calibration parameters is a subset of the whole collection of parameters. The calibration parameters are those parameters that will effect the value of the measuring results. Do not modify these parameters after the meter has been calibrated.

For the reporting functions related to calibration parameters the same features and procedures are applicable as valid for the parameters.

7.9.4 Reporting related to privileges

For the reporting functions related to privileges the same features and procedures are applicable as valid for the parameters.

7.10 Logging data from a flowmeter

After connecting with a flowmeter, the default monitoring configuration file included in the “Quick Start” software package will start the logging process automatically. A predefined set of data will be collected from the meter and stored as a file on disk.

A field in the status bar at the bottom of the screen will show a field displaying “Log.ON” with a green background colour.

In the same field the name of the disk file where the data is stored is displayed between square brackets.

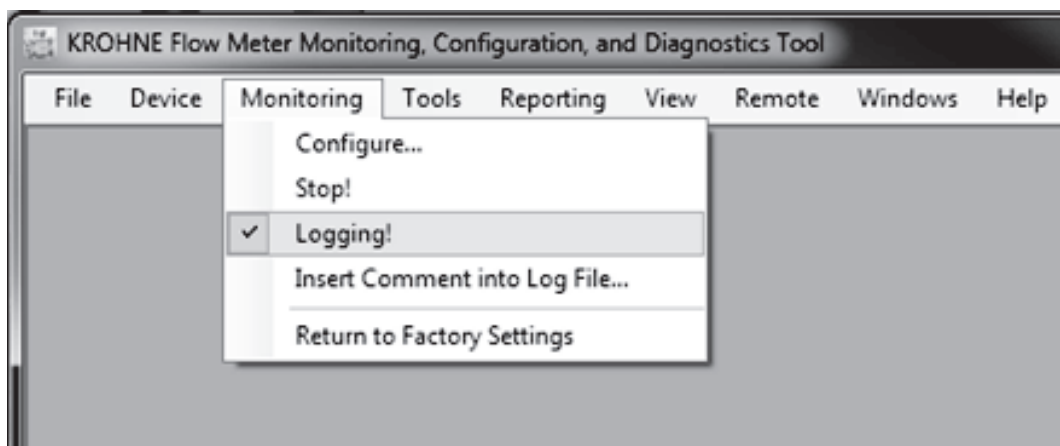


Figure 7-43: Monitoring menu

When you open the “Monitoring” menu you will observe also a check mark to the left of the option “Logging” when data is actually being logged.

To stop or interrupt the logging process:

Click the option “Logging”.

The check mark will now disappear, the field in the status bar at the bottom of the screen will become yellow and display “Log.OFF”:

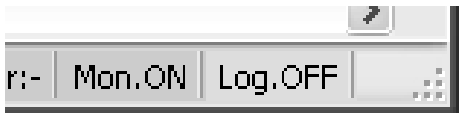


Figure 7-44: Yellow color of Log.OFF

To restart the logging process:

Open the “Monitoring” menu.

Click “Logging”.

The check mark will reappear and the status field will display “Log.ON” and turn to green again. Logged data will be stored in a file for each day (provided it is the same meter).

The software will automatically assign a name to file where the logged data will be stored, the date will be part of the file name.

When the logging process is restarted - after it has been interrupted – the new data will be appended to the same file as used before (assuming this will happen on the same day).

When a new day breaks a new log file will be created even while a logging process is running.

Logged data will be stored in a file with “.CSV” format.

By default, the file will be stored in the folder:

C:\KrohneData\Logging\MeterModel\Meters\MeterSerialNumber

Some of the actions above or the way the service tool performs depend on specific settings. How settings can influence the way the service tool works is explained in the next chapter.

7.11 Customizing the data logging process

As the meter produces a large amount of data, it is not possible to collect all data at a high rate. Storing this amount of data would create log files of unpractical sizes.

Decide which data elements have to be collected and stored.

A first selection is already made when defining the set of data selected for the monitoring process. The set of data to be saved in a log file on disk must be the same as selected for monitoring or a subset thereof.

Another way to reduce the amount is implemented by means of a setting “Log Rate”. This is either the same as the “Fetch Rate” (parameter value equal to 1) or it is a fraction of the “Fetch rate” (integer parameter value 2..10).

Set “Log Rate”

Click “Monitoring” to open the “Monitoring” menu.

Click “Configure...” to open the Monitoring Configuration window.

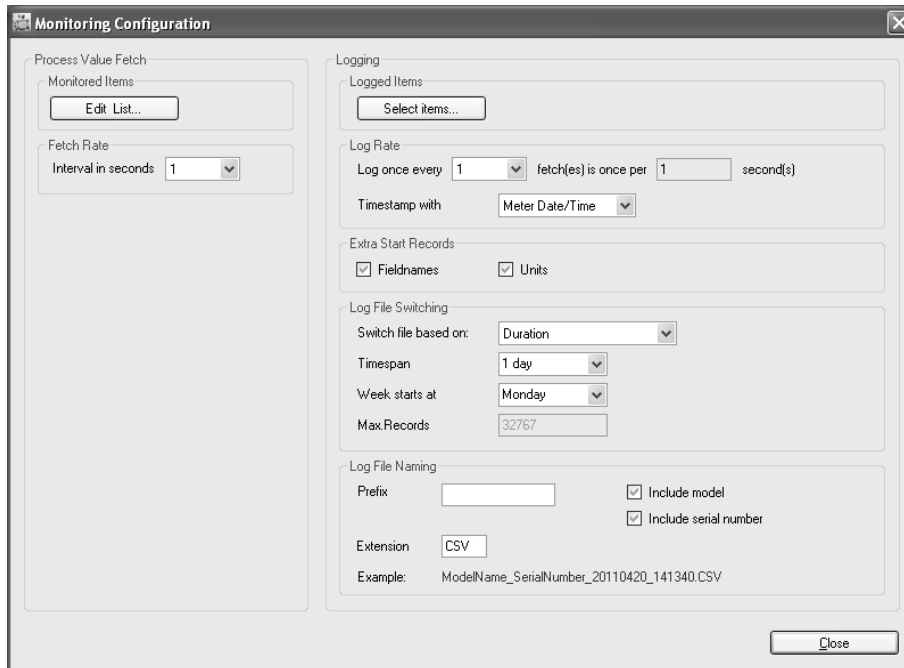


Figure 7-45: Monitoring configuration

Click the down arrow to the right of the box log rate.
Select a value.

Example (as displayed above): When the “Fetch Rate” equals 2, the set of data collected from the flowmeter is refreshed every 2 seconds. When the “Log Rate” is set to 5, the fifth of each set of data collected from the flowmeter will be stored in the log file. Effectively this means a set of data is stored in the log file every 10 seconds.

Select the data items to be stored in the log file.



INFORMATION!

It is recommended not to decide lightly to make changes to the set of data being stored in a log file. The result might be in the .CSV file, and consequently in a related Excel file, specific data items will appear in another sequence or in other columns as before. Tools developed for processing and analyzing the data in the .CSV file or in the Excel file may no longer work properly and as expected.

In case you want to make changes to the data stored in the log file:

To define or select the data items to be stored in the log file:

Click “Monitoring” to open the “Monitoring” menu.

Click “Configure...” to open the Monitoring Configuration window.

In the Monitoring Configuration window as above:

Click “Select Items”.

The window “Monitoring List Editor” will open:

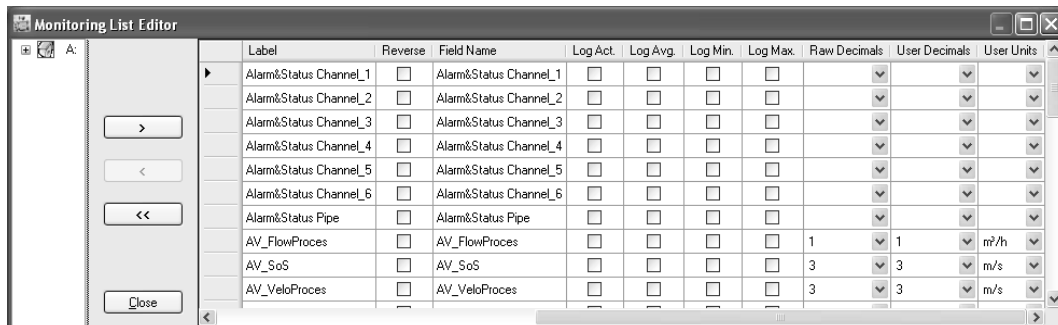


Figure 7-46: Monitoring List Editor

The variables listed in the window are the variables selected for being collected for monitoring purposes.



INFORMATION!

- It is possible to store different representations of any variable: the actual value, the average value, the minimum value or the maximum value.
- Here the average, the minimum and the maximum relate to the number of “Fetches” represented by the set of data that is being stored. (A “Fetch” can be regarded as a sample including the actual values of all the selected variables at a specific instant.)
- As an example, this means: in case one set of data is logged every time 5 “Fetches” are completed, the “Actual” is one value of that particular variable (the most recent value from the values as present in the 5 most recent “Fetches” or samples).
- “Average” is the average of the values of a particular variable as present in the most recent 5 samples or “Fetches”. The same applies to “Minimum” and “Maximum”.

Use the horizontal scroll bar to make the logging-specific columns visible in the window. The headers of these columns reads:

- Log Act.
- Log Avg.
- Log Min.
- Log Max.

Select a check mark in any of these columns to indicate which representations of a specific variable are included in the logged data.

Missing items in the list of monitored variables can be added here as well:

Step 1: Open the tree structure in the small panel in the left side of the window.

Step 2: Open the folders to the level where individual variable names become visible.

Step 3: (Variables already included in the monitoring list will have a green background colour).

Step 4: Find the variable you want to add in order to be included in the logging.

Step 5: Click on the variable to select it.

Step 6: Click on the button pointing to the right in the panel in the middle.

Step 7: Put check marks in the columns for the representations you want to be logged.

Step 8: Click the Monitoring List Editor's "Close" button.

Step 9: Click the Monitoring Configuration dialogue's "Close" button to accept the configuration. A confirmation dialogue appears:

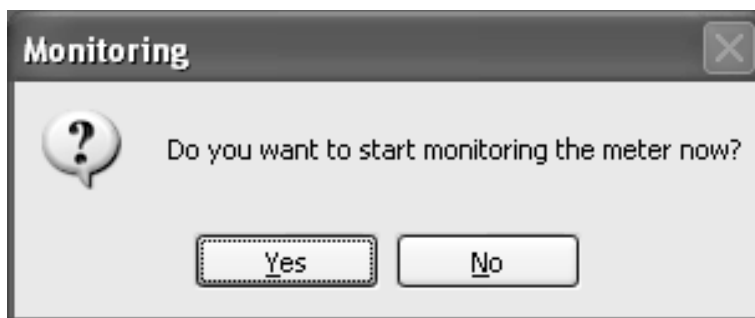


Figure 7-47: Monitoring

Step 10: Click "Yes" to confirm that you want to resume monitoring the flowmeter.

Some more features to customize the logged data file

(In the window "Monitoring configuration")

Time stamp

The time stamp associated with each data record can be the date and time from the meter itself or from your computer system. Select what you want from the value list associated with the box "Timestamp with".

Start Records

When starting or restarting your logging you can include a record with the names of the fields and/or the units used. In the Excel file these will appear as column headers (one row with field names and one row with the units used).

Log file size limitation

The size of a log file can be limited either to a maximum number of records or to a maximum time span.

In the value list of the box "Switch file based on;" click either

- Duration, or
- Number of records

For Duration, select a time span of:

- 1 hour
- 4 hours
- 12 hours
- 1 day
- 1 week

Click on your choice in the value list associated with the box "Timespan". New intervals start at multiples of the selected "Timespan". In case of week the start of a new interval (and the end of the previous interval) occurs on the day specified by "Week starts at".

When using "Number of records", specify any number of records in the box "Max.Records". However it is not recommended to choose a value over 32767 (which is the maximum number of rows that older versions of Microsoft Excel can handle).

Log file name

Date and time are automatically included in the log file name.

Add a prefix of your own choice: for example the name of your company, the name of a site/plant or the name of a person.

You can also include the meter model number in the log file name and or include the meter serial number. Select or disable the associated boxes.

It is not recommended to change the extension of the log file name, however if you have good reasons to do so it is possible. Just fill three characters according to your choice in the box "Extension".

Storage location

By default the location for storing log files on the hard disk of your computer is:
"C:\KrohneData\Logging".

Dependant of meter model and serial number, subfolders will automatically be created for well organized archiving of log files.

You can store you files in another location. For example this can be a drive for centralized storage of meter data in a network.

To set the location where you want your data to be stored:

Step 1: Click the menu button "Tools" to open the Tools menu.

Step 2: Click "Settings..." to open the "Settings" window below:

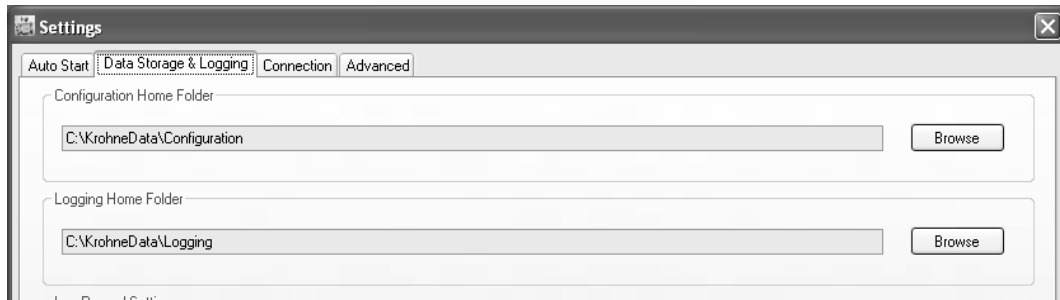


Figure 7-48: Settings

Step 3:Type in the box “Logging Home Folder” the name (and path) of the directory where you want your data to be stored.

7.12 Adjusting parameter settings

A typical adjustment of the parameter setting is the adjustment of the meter factor. The meter factor is determined during the calibration and is programmed before the ultrasonic flowmeter is sealed.

Adjustment of the meter factor for Custody Transfer (CT) applications can only be done under the supervision of a calibration officer. A dedicated procedure for calibration adjustment and programming the meter is available from KROHNE on request.

7.13 Save flowmeter configuration file

Step 1: Click the button “File” to open the file menu.

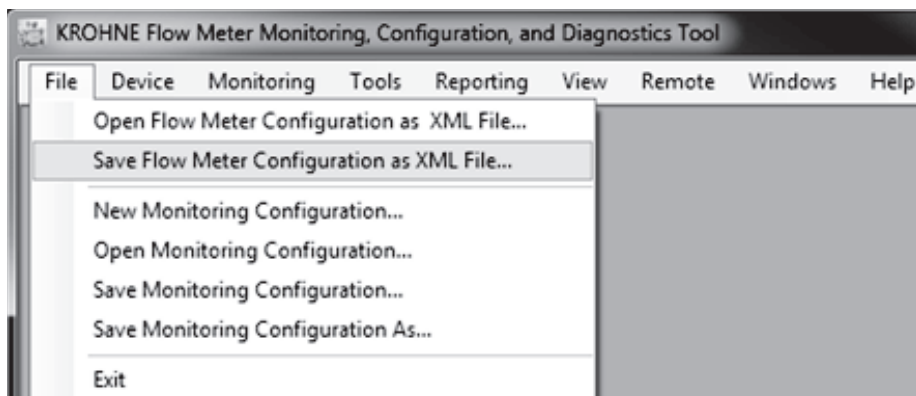


Figure 7-49: File menu

Step 2: Click the menu item “Save Flow Meter Configuration as XML file...”.

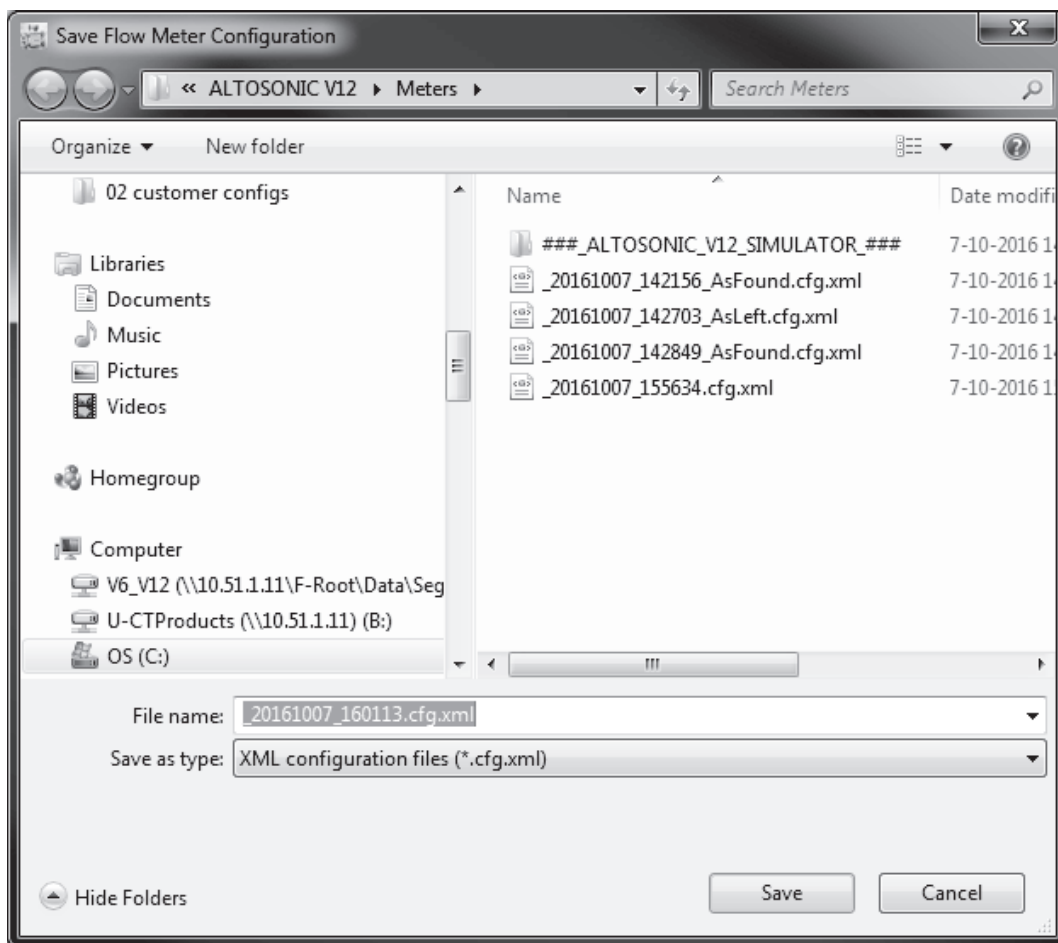


Figure 7-50: Save flowmeter configuration XML file

Step 3: Type a new name in the box “Filename”.

Step 4: Click “Save”.

Your new Flow Meter Configuration is now saved.

8.1 Periodic maintenance

The ultrasonic gas flowmeter does not contain any moving parts. During operation no maintenance will be required such as lubrication or replacing parts that wear out. Therefore during normal operation there will be no need to disassemble the meter in order to gain access to the inner parts of the meter.

It is however good practice to make a log file on regular basis, refer to *Logging data from a flowmeter* on page 69. It is not to be expected that wear or tear takes place but external influences such as an overflow in a separator or a process failure in a gas treatment plant, may cause a fouling of the meter which may result in deviations. By making a log file on regular basis such a failure can be pinpointed in time, and as such the financial consequences can be correctly adjusted. The ALTOSONIC V12 also has on board diagnostic features that will alert the operator in case of malfunctioning. In a log file information will be stored with much more detail.



DANGER!

In case of malfunction, it is recommended to call for support of the manufacturer or assistance of a trained and qualified service technician, in order to address the problem and to identify the parts that may need to be replaced, in case the meter itself causes the problem.

As a general rule, in order to maintain the explosion safety, removing the covers from the electronics enclosure or from the meter body shall only be performed after the power supply has been switched off or disconnected. In addition to that it shall be verified that no explosive gas is present at the time the covers are opened or removed.

Before the meter is powered up again it shall be verified that the covers (and gaskets if applicable) are reinstalled properly. The nuts that fasten the covers on the meter body shall be tightened well enough to make sure that the gaskets provide a protection degree of at least IP 54, keeping moisture out of the space behind the covers. (The rubber gasket shall be slightly but noticeable compressed, the torque applied on the nuts will then be approximately 5 Nm.)

The screw thread of the reinstalled covers of the electronics enclosure shall be completely engaged. The cover shall be closed by clockwise rotation until resistance will be sensed, to a level that the cover effects a gentle pressure on the o-ring sealing, in order to prevent penetration of moisture (according to a protection degree of IP66/67). Finally the interlocking device shall be reinstalled.

*For more information about the interlocking device, refer to *Opening and closing covers* on page 25.*

8.2 Cleaning

In case of exceptional growth of contamination inside the meter body, the ultrasonic gas flowmeter may need dismantling and cleaning.

8.3 Exchange of transducers

Transducers are not likely to break down. For cleaning, inspection or, in the unlikely situation that a transducer fails, the transducer has to be retracted.

If the transducer has to be replaced, it is not strictly required but common practice to replace the other transducer on the same acoustic path too.

If possible, depressurise the flowmeter. If this is not possible, use the extraction tool to remove the transducer under pressure (maximum 150 bar(g)).

8.4 Exchange of transducers - Depressurised condition



DANGER!

Always read instructions for safe handling of the equipment and installations first.



CAUTION!

Make sure that you have the following tools available before you start.

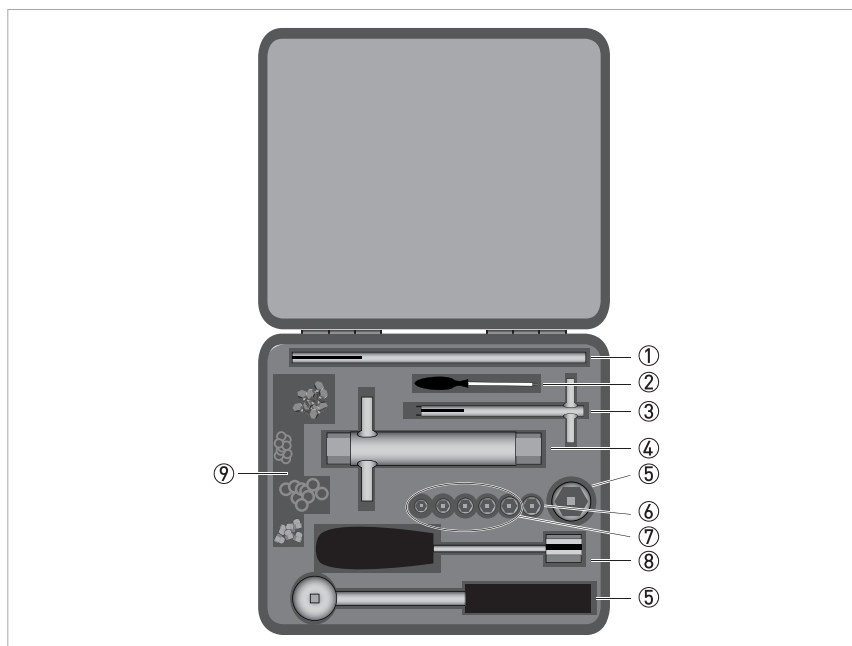


Figure 8-1: Toolbox

- ① Cable guide
- ② Allen key screw driver
- ③ Special tool with two pins
(for epoxy transducers)
- ④ Transducer nut tool
- ⑤ Hexagonal bolt and wrench
(can be used together with tool number ④)
- ⑥ Insertion for tool number ④
- ⑦ Bits in different sizes
(to open the housing)
- ⑧ Slotted hexagonal wrench
(for titanium transducers)
- ⑨ O-rings, nuts and capbolts

Switch off the power supply to the meter and wait at least 1 minute before opening the Ex-d enclosure. It is advised to use a gas detector to detect possible hazardous environmental conditions. Also make sure no water/rain/dust can penetrate in the electronic housing. It is preferred to disconnect the power supply from the equipment. Loosen the cover on the right-hand side of the electronic housing. Disconnect the power connector and close the cover fully. Attach labels to switching gear to prevent unwanted switching on. The transducers are installed and fixed mechanically at a very precise manufactured position inside the meter body. To access the transducer position that needs to be replaced use the following instructions.

**WARNING!**

The ALTOSONIC V12 is a pressurised UFM. Do not remove transducer, bolts or other pressurised parts without the guarantee that the meter is fully depressurised.

**INFORMATION!**

Different types of transducers can be used!

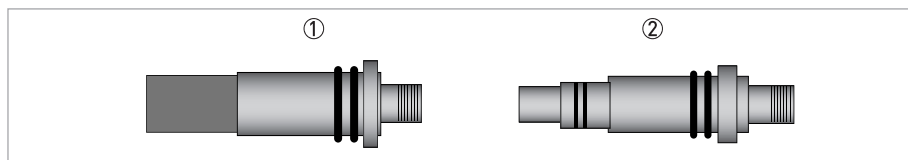


Figure 8-2: Transducer types

- ① Epoxy type
- ② Titanium type

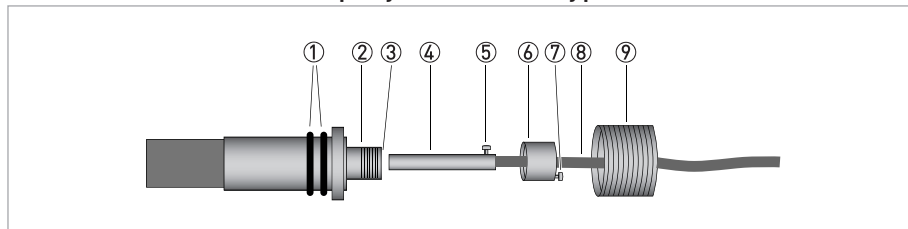
Overview installation of epoxy transducer type (standard)

Figure 8-3: Sensor assembly

- ① Double O-ring
- ② Slot in the socket
- ③ Ex-d socket
- ④ Ex-d plug
- ⑤ Alignment pin
- ⑥ Cap
- ⑦ Securing screw M2
- ⑧ Coaxial wire
- ⑨ Transducer nut

Overview installation of titanium transducer type (optional)

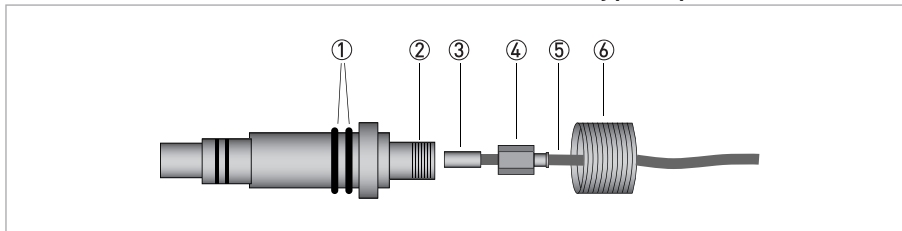


Figure 8-4: Sensor assembly

- ① Double O-ring
- ② Ex-d socket
- ③ Connector
- ④ Hexagonal cap
- ⑤ Coaxial wire
- ⑥ Transducer nut

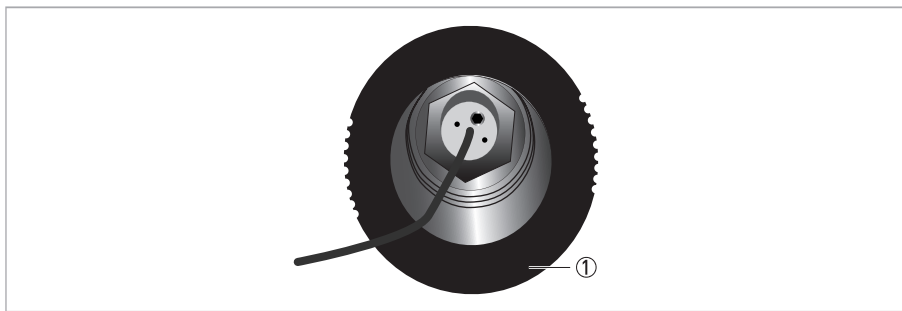


Figure 8-5: Delrin protection cap

- ① Delrin protection cap (only at welded meter bodies)

Steps to remove a transducer:



- Remove the Delrin protection cap (only for welded meter bodies).
- Untighten and release the small M2 screw (number 1 in picture below).

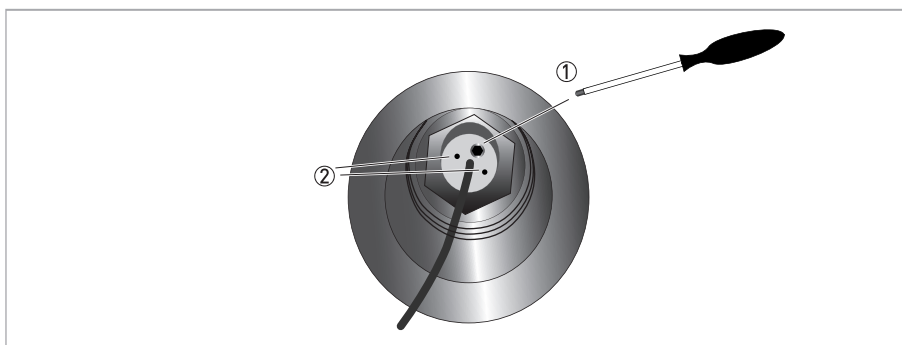


Figure 8-6: View at installed transducer

- ① Hexagonal securing screw M2
- ② Holes for removal of cap (epoxy transducer)



INFORMATION!

To remove the cap, a different tool is used for each type of transducer.

Epoxy transducer

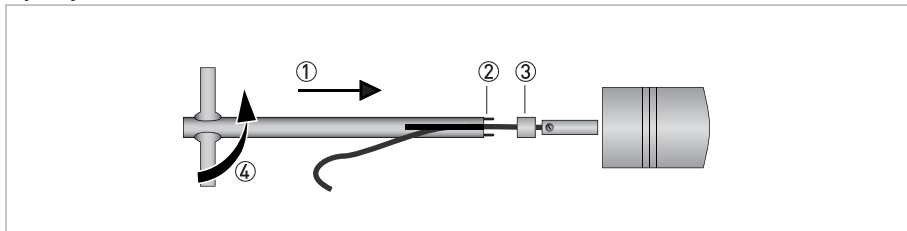


Figure 8-7: Remove cap



- Install the special tool ① with the two pins ② in the cap ③.
- Carefully turn the special tool counter clockwise ④ in steps to loosen the cap from the transducer. Make sure that the cable is not twisted.

Titanium transducer

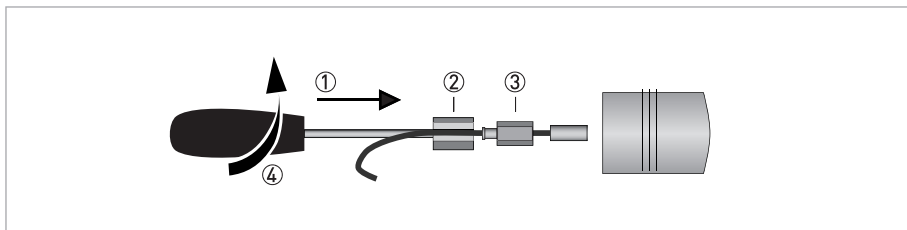


Figure 8-8: Remove cap



- Move the special tool ① with the slotted hexagonal head ② over the cap ③.
- Carefully turn the special tool counter clockwise ④ in steps to loosen the cap from the transducer. Make sure that the cable is not twisted.



- Pull the coax cable with the Ex-d plug out of the transducer.

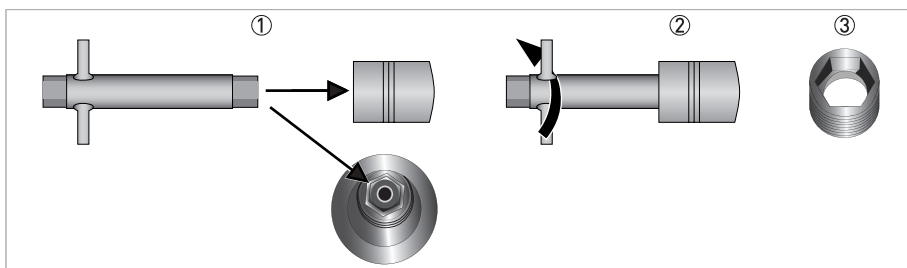


Figure 8-9: Removal of transducer nut

- ① Insert the tool in the transducer nut
- ② Turn tool counter clockwise to loosen the transducer nut
- ③ Transducer nut

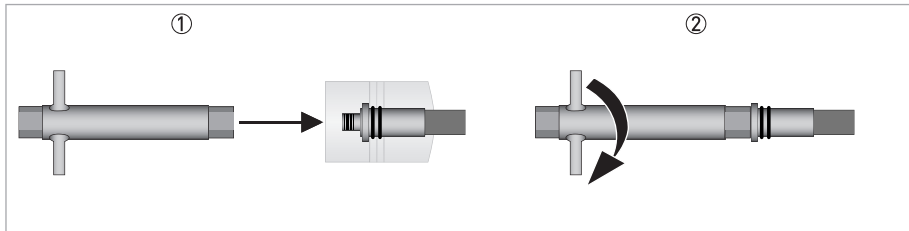


Figure 8-10: Installing transducer in tool

- ① Put the tool on the transducer.
- ② Turn the tool clockwise to attach it to the transducer.

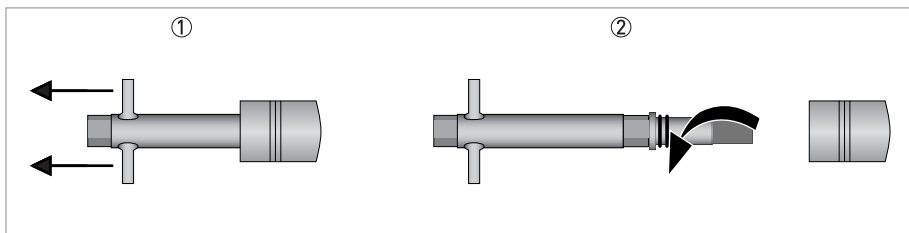


Figure 8-11: Pulling out the transducer

- ① Pull to remove the transducer
- ② Turn the transducer to loosen the transducer from the tool

Steps to install a transducer:



CAUTION!

- Make sure that the inside of the transducer nozzle is completely clean.
- Make sure that the two O-rings of the new transducer are a little greasy.
- When the same transducer is reused, make sure that two new O-rings are used to prevent leakage.

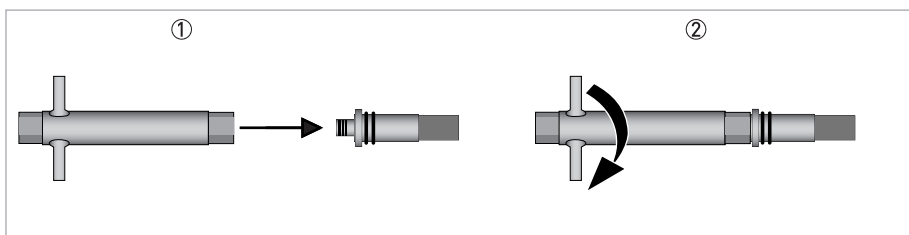


Figure 8-12: Installing transducer in tool

- ① Put the tool on the transducer.
- ② Turn the tool clockwise to attach it to the transducer.

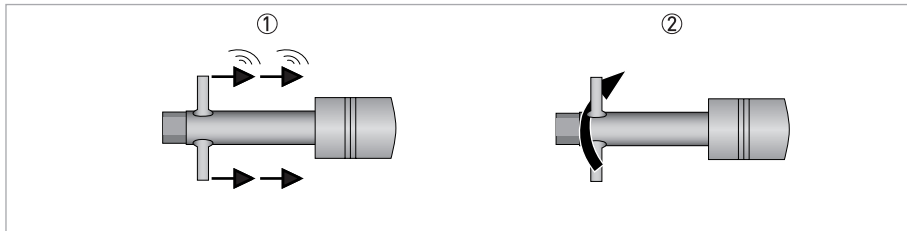


Figure 8-13: Replacing the transducer

- ① Firmly push the wrench. Two O-rings snap in place.
- ② Turn the wrench counter clockwise to loosen it.



CAUTION!

Make sure that the transducer does not come loose when you remove the wrench.



INFORMATION!

Put a little grease on the screw thread of the transducer nut to make it easier to install.



- Plug the coax cable connector back into the transducer.

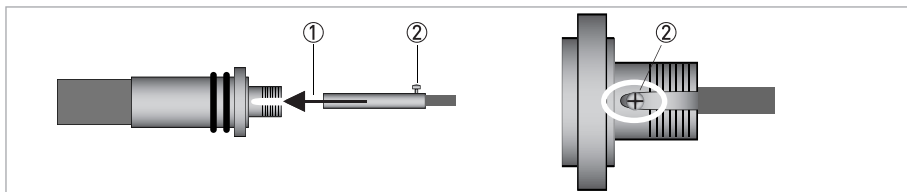


Figure 8-14: Connecting cable to transducer

- ① Insert the coax cable connector into the transducer
- ② Make sure that the screw slides in the slot of the transducer

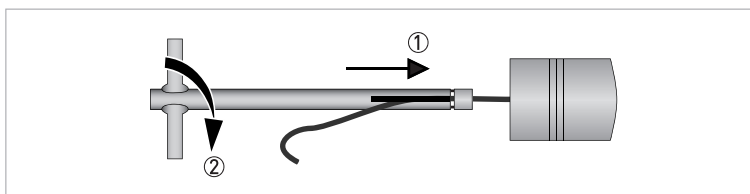


Figure 8-15: Installing of Ex-d plug and cap

- ① Put cap on tool and insert it onto the transducer
- ② Carefully turn tool clockwise in small steps to tighten the cap



INFORMATION!

For a titanium transducer, you will need the tool with the slotted hexagonal head.

**CAUTION!**

Make sure that the hole for the screw is aligned with the hole in the body.

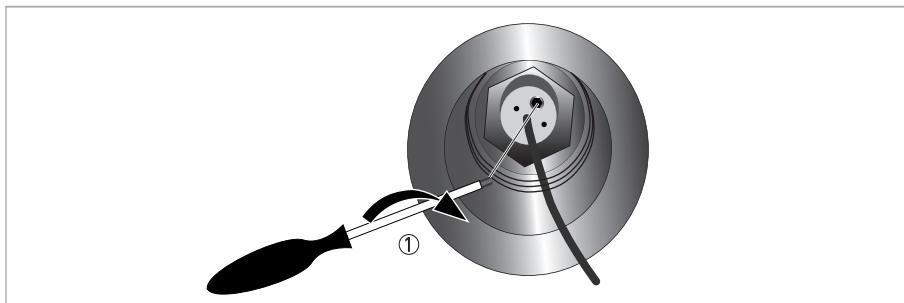


Figure 8-16: Tightening securing screw M2

① Turn Allen key clockwise to tighten the securing screw M2



- Put back the Delrin protection ring (only for welded meter bodies).
- Put back all covers of the flowmeter.

**CAUTION!**

After the maintenance work, make sure that no error messages are displayed on the display and /or check the correct operation with the Flow Meter Configuration and Monitoring Tool.

8.5 Exchange of transducers - Pressurised condition



WARNING!

The tool is designed to be able to replace a transducer of a ultrasonic gas flowmeter - while it is pressurized - in a safe way. Nevertheless, working with equipment with high gas pressure requires utmost care. Observe the following precautions:

- *Make sure that staff working with this tool are familiar with and act accordingly with laws and regulations - especially regarding safety - applicable to the site or location where the job will be performed.*
- *Make sure that staff supposed to work with this tool are adequately trained and educated and have sufficient knowledge of the tool and the way to use it. It is recommended to attend a training session that can be offered by the manufacturer.*
- *Check the availability of all materials that may be needed; make sure that, once started, the operation can be finished with the proper installation of a new transducer; the procedure should not be interrupted because of any kind of interference or put on hold for reason of lacking parts or materials.*
- *Before starting the operation check if the equipment (retraction tool, bolts, tools) is complete and in good working order. In case one or more bolts are missing, make sure replacement bolts are conform to grade (strength) 12.9 (according to DIN ISO 898/1).*
- *During the procedure a small amount of gas will escape. Check if this may lead to any health risk due to hazardous substances.*
- *Provide means to detect potentially dangerous concentrations of hazardous gases. Take measures to avoid breathing escaping gas anyhow.*
- *Make sure that there is enough free room for a fully extracted retraction tool around the flowmeter.*
- *Take precautions to prevent vehicles (fork lift, crane etc.) to come close to the retraction tool while it is installed on a meter; the risk that the tool accidentally will be hit (and damaged) by such transportation means must be eliminated.*
- *Check if the electric power supply of the meter can be switched off (necessary for reasons of explosion safety). If the electric power supply can not or should not be switched off: make sure a gas detector is available, to verify the absence of hazardous atmosphere when performing the retraction and replacement of a transducer.*
- *Do not use the tool to sit on, to lean on or step on it when installed on the ultrasonic gas flowmeter.*
- *Do not leave the retraction tool unattended while it is installed on a meter and the operation is in progress until the operation is finished.*



CAUTION!

- *Make sure it has been properly diagnosed and identified which transducer(s) is (are) suspect and may need to be replaced.*
- *Make sure an electronic instrument for measuring resistance and capacitance is available, check that it is recently calibrated and fitted with fresh batteries (or spare batteries are available).*

**INFORMATION!**

- *Whenever it is possible to isolate and depressurize an ultrasonic gas flowmeter in case it would be necessary to replace one or more transducers, that should be the preferred way to proceed instead of using the retraction tool.*
- *Decide which persons need to be involved in the operation, especially the ones that have to perform the job at the location of the meter, empower procedures to limit access to the area where the operation takes place only to them.*

8.5.1 Transducer retraction tool

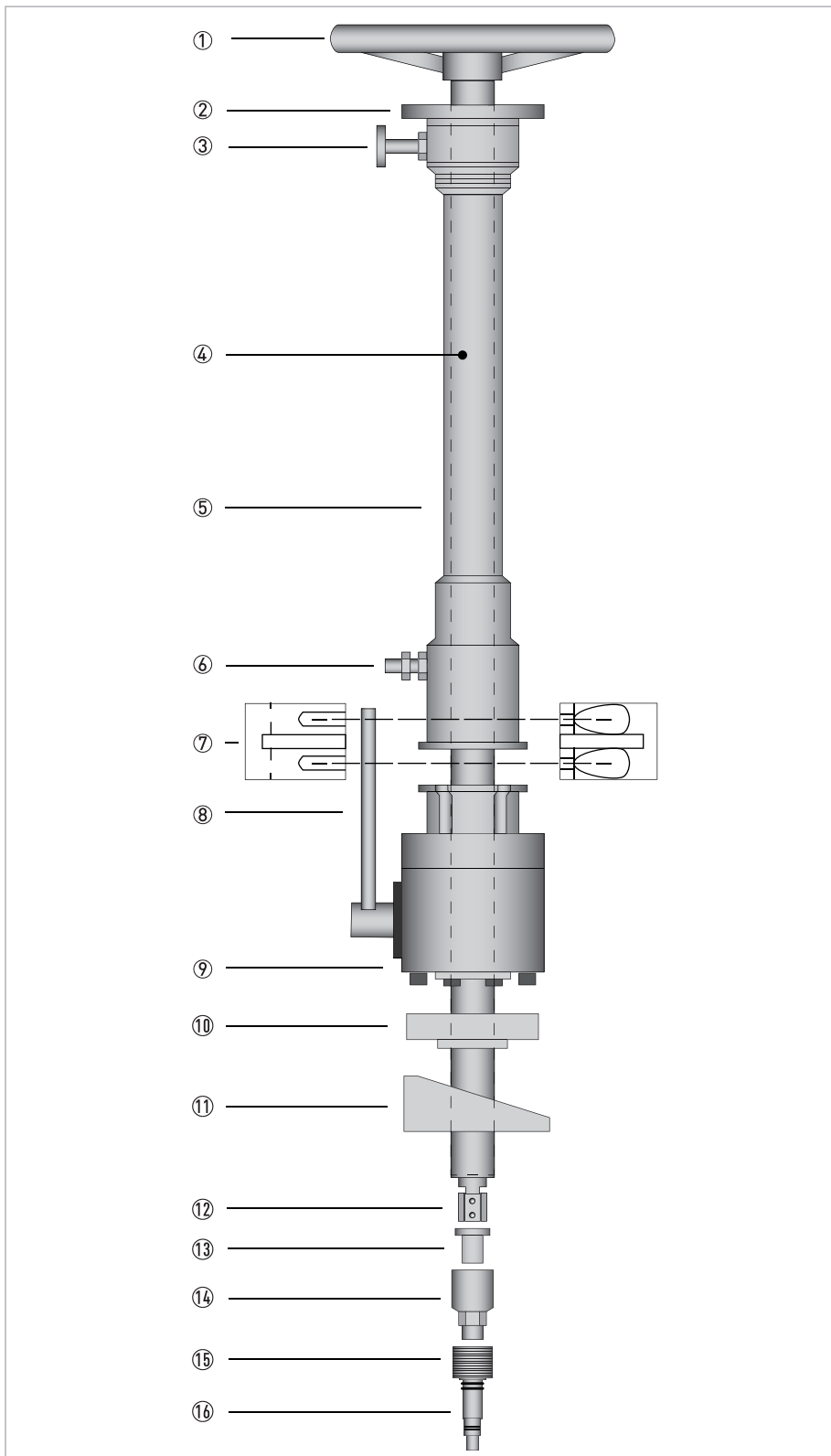


Figure 8-17: Retraction tool

Number in picture	Description
1	Hand wheel at upper end of the main shaft
2	Adjusting disk to position the shaft
3	Locking device
4	Main shaft
5	Tube
6	Pressure relief valve
7	Clamping device
8	Handle to operate the ball valve
9	Ball valve
10	Intermediate flange Only to be used for flowmeters with welded transducers
11	Wedge shape adapter Only to be used for flowmeters machined out of one piece
12	Spring loaded hexagon at lower end of main shaft
13	Nut to fasten the transducer adapter
14	Transducer adapter
15	Nut to fasten the transducer in the transducer port
16	Transducer

8.5.2 Procedure to remove a transducer

Step 1: Locate the suspect transducer



- Locate the position of the suspect transducer on the meter body.
- Switch off the electric power supply to the gas flowmeter.
- Remove the cover as necessary to gain access to the suspect transducer and the signal cable that connect to the transducer.

In case of a warning, a problem or a failure, a technician using the diagnostic tool that is available for the ultrasonic gas flowmeter, will be able to identify the number of the acoustic path that most likely causes the problem.

The transducers are identified with codes as: 1U, 1D, 2U ... 6D. The number refers to the acoustic path number. A "U" refers to the upstream transducer and a "D" refers to the downstream transducer of an acoustic path.

For an ALTOSONIC V12 six transducers (belonging to three acoustic paths) are located on one side (front) of the flowmeter. The codes and locations of these transducers are indicated in the figure below.

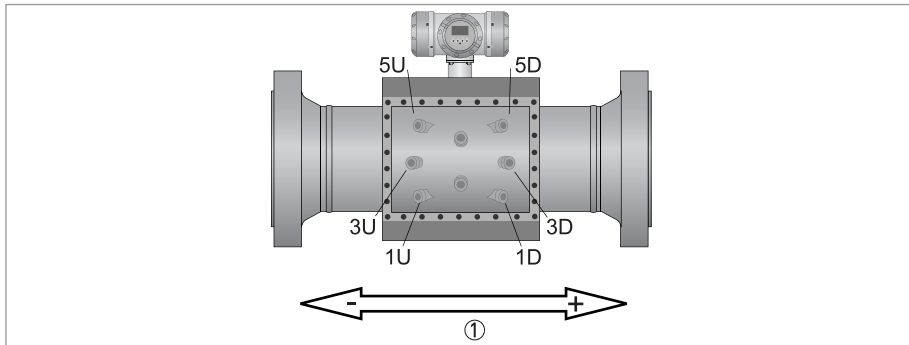


Figure 8-18: Transducers on front side of the flowmeter

Four transducers (belonging to two acoustic paths) are located on the back side of the flowmeter. The codes and locations of these transducers are indicated in the figure below.

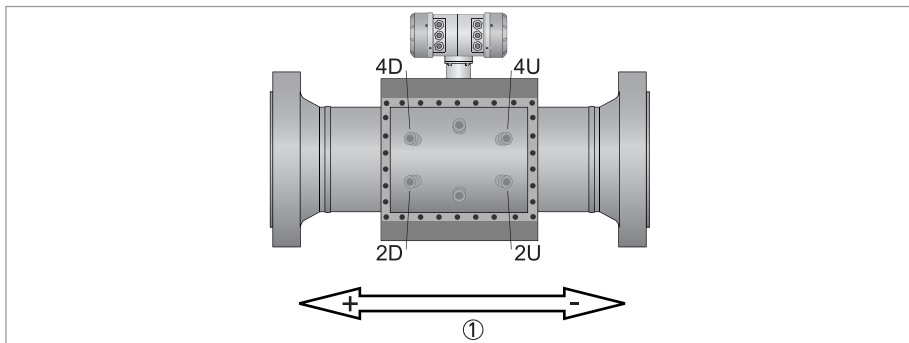


Figure 8-19: Transducers on back side of the flowmeter

Two transducers are located on the top of the ultrasonic flowmeter. The codes and locations of these transducers are indicated in the figure below.

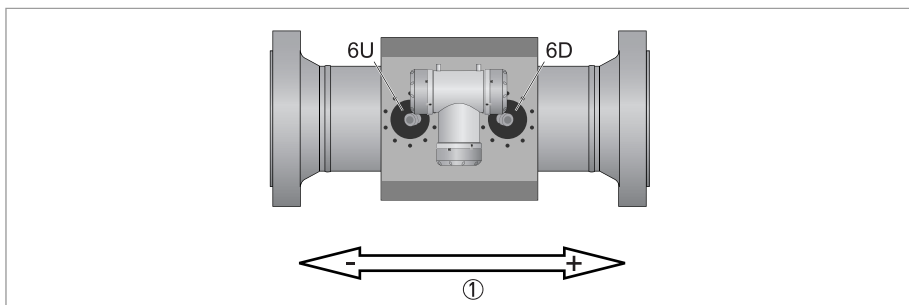


Figure 8-20: Transducers on top side of the flowmeter

Step 2: Disconnect the transducer cable



INFORMATION!

The transducer cable must be disconnected before the retraction tool can be used.

Disconnect the transducer connection cable in the following steps.



- Untighten and release the small M2 screw (number 7 in picture below) on top of the cap fastened to the extension with M10 screw thread on top of the transducer.

Overview installation of epoxy transducer type (standard)

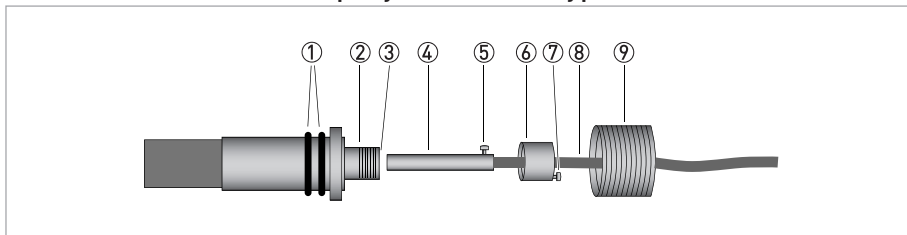


Figure 8-21: Sensor assembly

- ① Double O-ring
- ② Slot in the socket
- ③ Ex-d socket
- ④ Ex-d plug
- ⑤ Alignment pin
- ⑥ Cap
- ⑦ Securing screw M2
- ⑧ Coaxial wire
- ⑨ Transducer nut



- Install the special tool ① with the two pins ② in the cap ③.
- Turn the special tool counter clockwise ④ to loosen the cap from the transducer. Make sure that the cable is not twisted.

Epoxy transducer

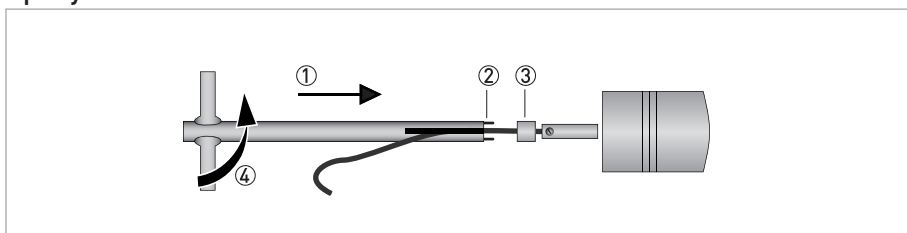


Figure 8-22: Remove cap



- Pull the coax cable with the connector out of the transducer.

Step 3: Test the suspected transducer



INFORMATION!

Before starting the operation to replace a transducer care must be taken to make sure which transducer is suspect to be failing. As a start the diagnostic tool to check the performance of the ultrasonic gas flowmeter shall be used for this purpose. In case of doubt consult the local support organisation of the manufacturer. Be aware transducers always operate as pairs (belonging to the same acoustic path). Therefore, using this diagnostic tool it may not be certain which one of a pair needs to be replaced.

Secondly the electrical capacitance and resistance of the suspect transducer can be measured to identify which transducer of an acoustic path is suspect. An observation of a low resistance value or a capacitance value deviating from specification can be a helpful confirmation for identifying a transducer that may be failing.

The electronic measuring instrument is not supplied as part of the kit. It can be any instrument suitable to measure a capacitance in the range of 0.1 ...1.0 nF and an electric resistance in the range of 1 M Ω ... 20G Ω . This is a fairly common device and supposed to be available.



- Position the connector of the coax adapter cable in the connector in the transducer.
- Measure the electrical capacitance of the transducer. The value must be 0.32...0.34 nF.
- Measure the electrical resistance of the transducer. The value must be > 10 M Ω (typical value = 1 G Ω).
- Release the adapter cable.

Step 4: Put the transducer adapter in position

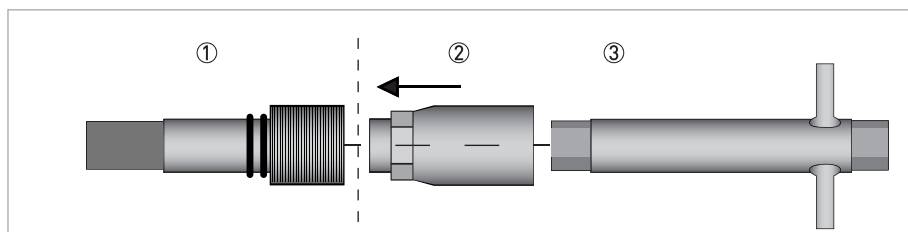


Figure 8-23: Mount transducer adapter

- ① Transducer and fastening nut inside the flowmeter.
- ② Transducer adapter.
- ③ Wrench



- Position the transducer adapter in such a way that it will (partly) engage with the transducer fastening nut.
- Turn the transducer adapter - together with the transducer fastening nut - counter clockwise (not more than one turn) to allow the pin inside the transducer adapter to slide into the slot in the extension with M10 screw thread on top of the transducer.

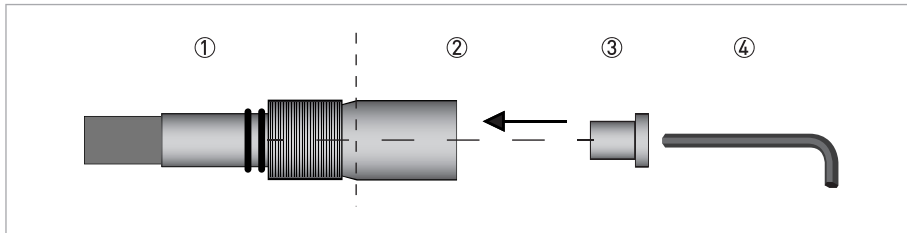


Figure 8-24: Mount bronze fixation nut

- ① Transducer and fastening nut inside the flowmeter
- ② Mounted transducer adapter.
- ③ Bronze nut
- ④ Use a 5 mm hexagon key.



- Fasten the transducer adapter by means of the bronze nut using a 5mm hexagon key.

Step 5: Mount the adapter plate



INFORMATION!

To be able to install the retraction tool on the transducer port, a transducer adapter plate must be used. Two different models are available. It depends from the construction of the flowmeter which adapter must be installed.

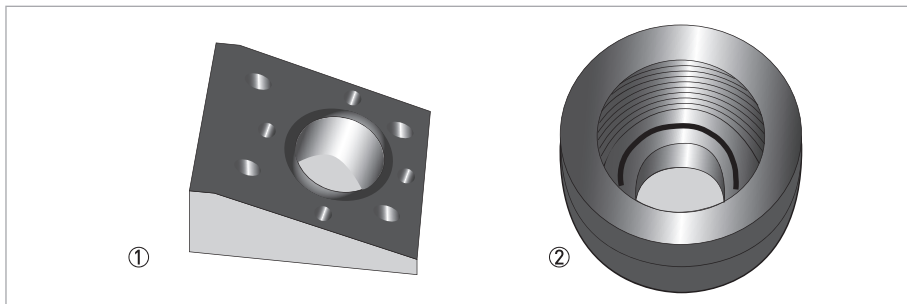


Figure 8-25: Two models of transducer adapter plates

- ① Square wedge shaped transducer adapter plate
- ② Round shaped transducer adapter plate



INFORMATION!

The square wedge model is used for flowmeters that are machined out of one piece of metal. The round model is used for flowmeters with welded transducer ports.

Square wedge model



WARNING!

Make sure that the pressure sealing (O-ring) between the adapter plate and the meter body is in good shape and fitted properly, if damaged replace (size 43.0 x 3.5 mm).

**CAUTION!**

The square wedge adapter plate is available with two offset angles. For flowmeters with a nominal size of 6", the adapter must have an offset angle of 18 degrees. For flowmeters with a nominal size of 8" and larger, the adapter must have an offset angle of 20 degrees.



- Fasten the square wedge shaped adapter by means of 4 bolts M8 x 25 (grade 12.9) with a 6 mm hexagon key. Mind the proper angle of the adapter.
- Proceed with **Step 6: Mount the retraction tool.**

Round model

- Turn the Delrin protection cap counter clockwise and remove it from the transducer port.

**CAUTION!**

Check the front face of the transducer port is free of damages or scratches. It should be smooth and clean, otherwise there might be a risk of gas leakage when continuing with the procedure.

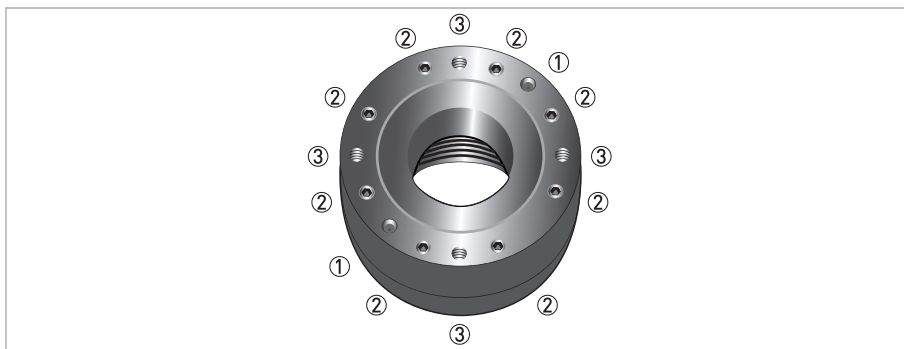


Figure 8-26: Round model of transducer adapter

- ① Two M5 bolts (not to be used by customer)
- ② Eight M6 bolts to pull both plates to each other.
- ③ Four threaded holes M8 to mount the retraction tool.



- Prepare the round adapter unit: untighten the bolts (8 pieces) with the 5 mm hexagon key (each 2 turns counter clockwise).
- Position the adapter to allow the screw thread to engage with the screw thread on the transducer port. It may be beneficial to use some lubricant (should be suitable for stainless steel). Turn the adapter clockwise as much as possible.

**INFORMATION!**

This should force the clearance between both plates to open to about 1 mm.



- Tighten the bolts (8 pieces) with the 5 mm hexagon key.

**INFORMATION!**

When properly tightened there should still be some clearance between both plates of the adapter.

Step 6: Mount the retraction tool

- Fasten the lower part of the retraction tool (the ball valve) on the transducer adapter by means of 4 bolts M 8 x 130 (grade 12.9) using the 6 mm hexagon screw driver. Check the O-ring sealing, if damaged replace (size 40.87 x 3.53 mm).
- Tighten the M8 bolts with appropriate force using the 6 mm hexagon angled key.
- Make sure that the ball valve is in fully open position.

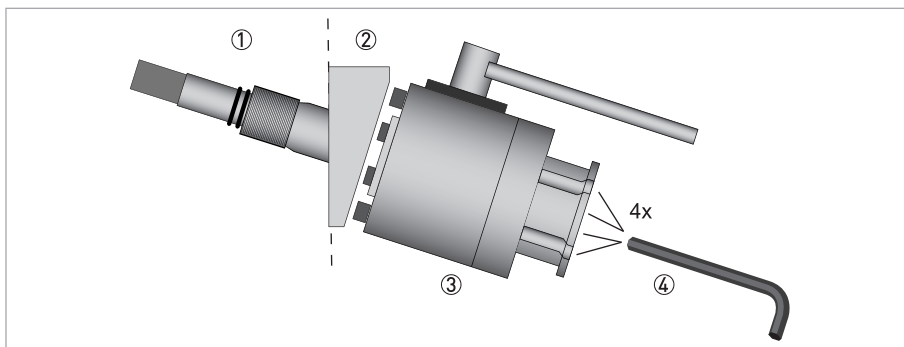


Figure 8-27: Mount the ball valve of the retraction tool to the flowmeter

- ① Transducer, fastening nut and transducer adapter inside the flowmeter.
- ② Wedge shaped adapter plate.
- ③ Ball valve of the retraction tool
- ④ Use a 6 mm hexagon key to tighten the four M8 x 130 bolts.

**INFORMATION!**

In the figure above the square wedge shaped adapter plate is shown. This can also be the round adapter plate, dependent from the type of flowmeter.



- Measure the position of the transducer adapter inside the transducer port (depth in the center, touching the bronze nut) with the ruler.
- Memorize and note this value as "Depth".

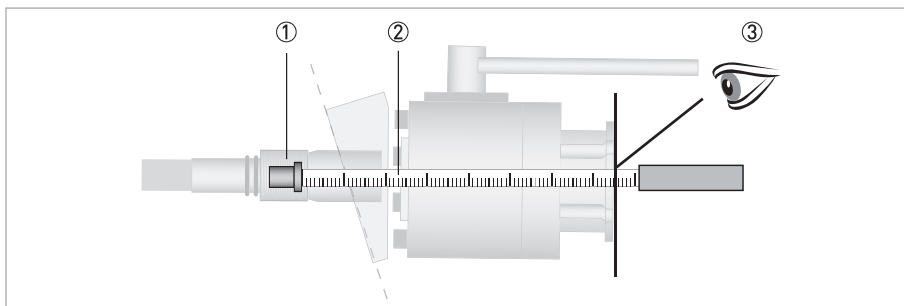


Figure 8-28: Measure depth

- ① Bronze fixation nut.
- ② Insert ruler up to bronze fixation nut.
- ③ Read the depth.



- Measure the position of the end of the hexagon on the main shaft relative to the flange of the tube.
- Memorize and note this value as "Length".
- Make sure that the knob of the locking device is lowered to disable rotation of the adjusting disk.
- Turn the handwheel to adjust this "Length" to a value of "Depth" minus 35 mm.

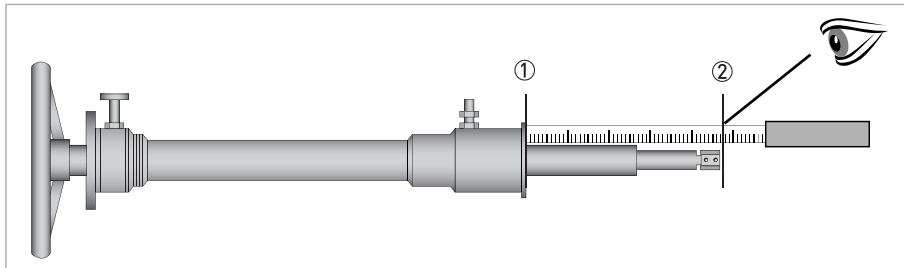


Figure 8-29: Measure length

- ① Put the ruler to the flange of the tube.
- ② Read the length at the end of the hexagon.



- Position the tube on top of the ball valve, the extension of the tube (40 mm diameter) has to slide into the ball valve. Mind the O-ring sealing in the flange of the ball valve, if damaged: replace (size 55.56 x 3.53 mm).

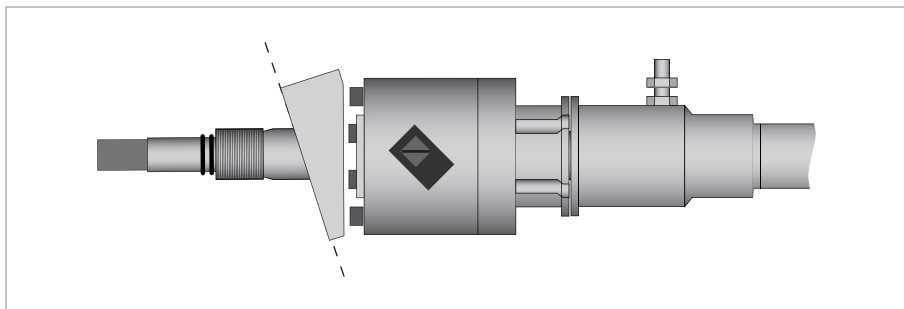


Figure 8-30: Put the tube in position into the ball valve



- Fasten the tube to the ball valve using the clamping device. This device consists of two halves, bolted together with 4 bolts M8 x 20 mm (only use grade 12.9). When properly positioned and tightened: on opposite sides, where the ends of two halves meet, the clearance should be equal, on each side approximately 3 mm.

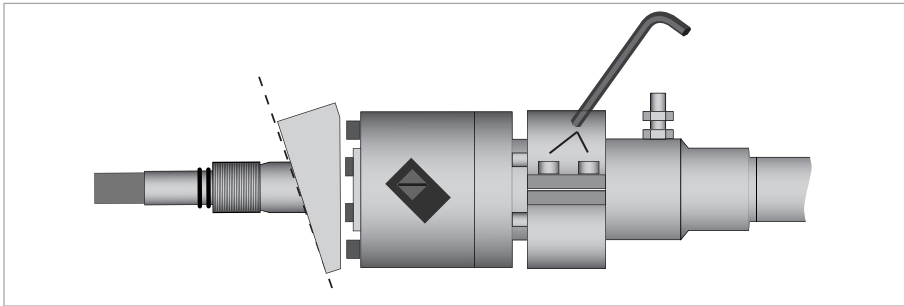


Figure 8-31: Clamping device

Step 7: Extracting the transducer



- Turn the hand wheel a few (one or two) turns clockwise until resistance is ensed as a result of the hexagon at the end of the shaft becoming engaged with the adapter.
- Use the ruler to measure the position of the shaft relative to the tube (the distance between the inner side of the hand wheel and the adjusting disk).
- Memorize and note this value as "Reference".
- Pull the knob of the locking device to unlock it and rotate it 90 degrees to fix it in that position.

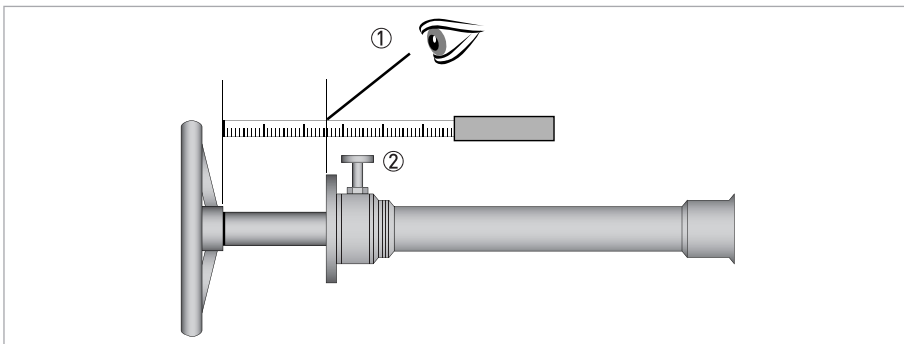


Figure 8-32: Measure shaft length

- ① Read the distance.
- ② Knob of the locking device.



INFORMATION!

The adjusting disk is now free to rotate.



- Turn the adjusting disk counter clockwise to move the main axis further into the retraction tool.
- Continue turning until steeply increasing resistance is sensed, preventing it to move any further.



INFORMATION!

This should happen after approximately 18 turns. The hexagon at the end of the main shaft is completely inserted in the transducer adapter and pushed back against the end of the shaft (against the spring load).



- Measure the position of the shaft relative to the tube.
- Check that the shaft has moved at least 33 mm further compared to the measurement at the previous item ("Reference").

- Memorize and note the value : "Lowest shaft position" (when a transducer is placed back again this value will be needed to check that the transducer has arrived at the correct position).
- Turn the knob of the locking device to allow it to return to its locked position.
- Turn the adjusting disk back (clockwise) to find the position where the locking device will lock.

**INFORMATION!**

This should take one turn or less, at the same time it should allow some play for the hexagon at the end of the main shaft.



- Close the pressure relief valve.

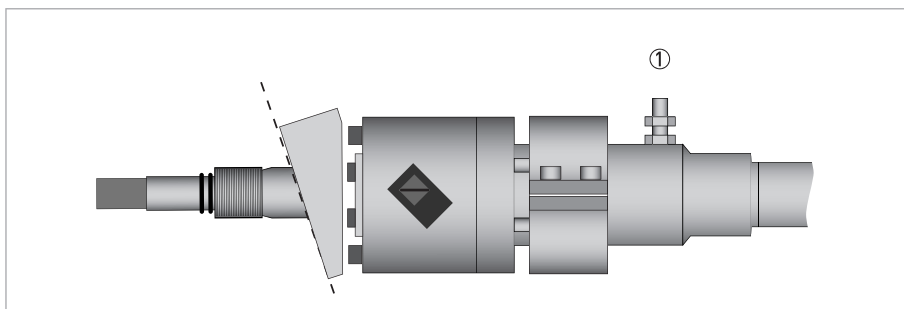


Figure 8-33: Close pressure relief valve

- ① Pressure relief valve



- Turn the hand wheel counter clockwise to untighten and release the transducer fastening nut; at the same time the transducer with the nut will travel outward from the meter body or transducer port.
- Continue turning until the mail shaft has moved to its end: as far as possible out from the tube.
- Measure the position of the shaft relative to the tube, the distance as read on the ruler should be approximately 300 mm (actually 300 plus 9 mm: 9 mm is the length of the piece of the ruler before the beginning of the scale, that is not accounted for in the numbers engraved along the scale at the ruler).

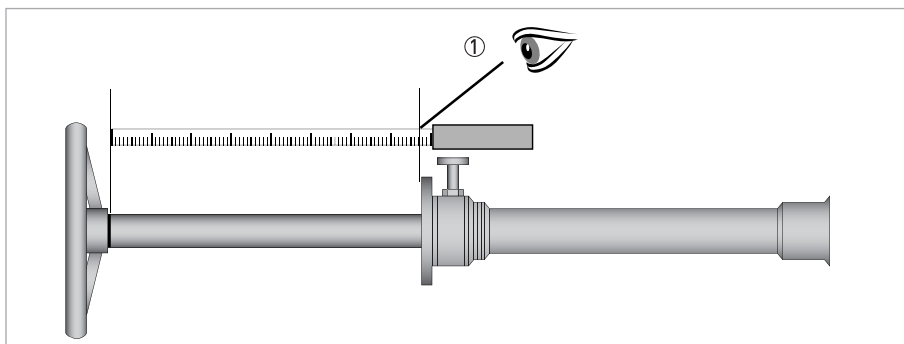


Figure 8-34: Measure position shaft

- ① Read the distance.



- Close the ball valve.
- Open the pressure relief valve to allow the gas in the cavity between the ball valve and the tube to escape.

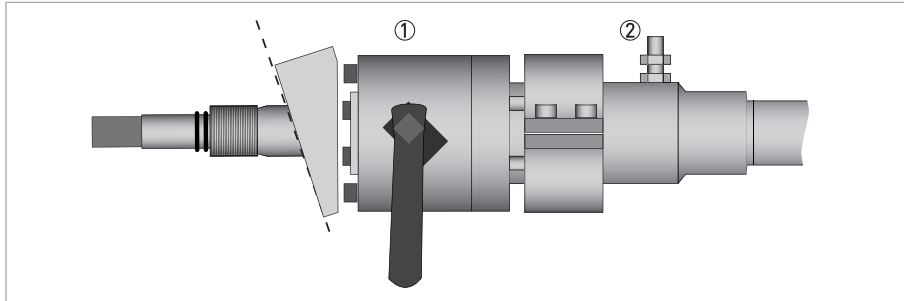


Figure 8-35: Close ball valve

- ① Close ball valve
- ② Open pressure relief valve



- Untighten and remove the bolts of the clamping device.
- Remove both halves of the clamping device from the combination of the tube and the ball valve.



INFORMATION!

Due to friction this may require some force. Use a large size screw driver: insert the blade into the slot between both halves; use it as a lever to separate both halves. This way at least one of the halves will be released. If necessary use a light hammer (preferable with a plastic head) for gently applying a light impact to release the second halve.



- Remove the tube with the main shaft from the ball valve. The front (green colour) of the removed transducer should be visible in the part of the tube that was inserted into the ball valve before.

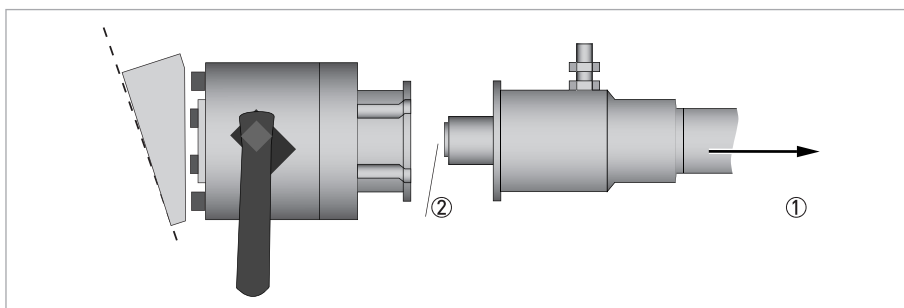


Figure 8-36: Remove tube

- ① Pull tube out of ball valve.
- ② Locate the front of the transducer.



- Turn the hand wheel clockwise to move the end of the main shaft with the transducer outward. The assembly of the transducer and the adapter is now accessible to be removed from the shaft.

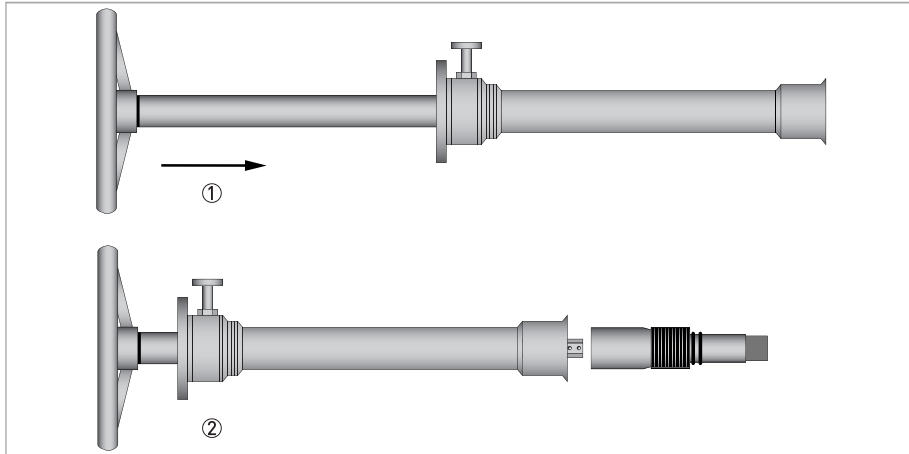


Figure 8-37: Extracted transducer

- ① Turn wheel clockwise
- ② Extracted transducer, fastening nut and transducer adapter

The removed transducer can now be detached from the transducer adapter. The adapter, the transducer fastening nut and the bronze adapter fastening nut are available to be used to continue the operation to re-install a new transducer.

8.6 Exchange of electronics unit

Before opening the converter housing:



DANGER!

All work on the electrical connections may only be carried out with the power disconnected. Take note of the voltage data on the nameplate!



WARNING!

Observe without fail the local occupational health and safety regulations. Any work done on the electrical components of the measuring device may only be carried out by properly trained specialists.



INFORMATION!

Make notes of important specific data, before exchanging the electronics.

8.6.1 Field version



DANGER!

All work on the electrical connections may only be carried out with the power disconnected. Take note of the voltage data on the nameplate!

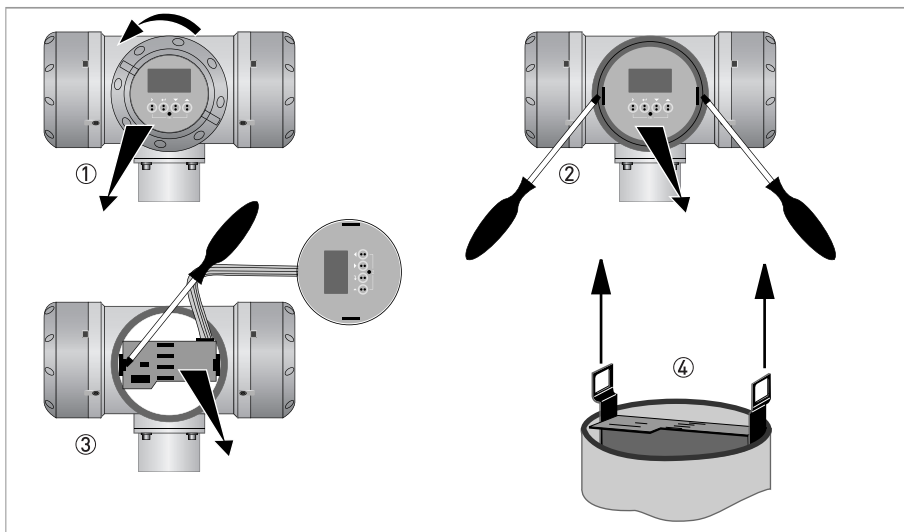


Figure 8-38: Remove electronic unit



- First release the fasteners that prevent thoughtless or imprudent opening of the Ex d enclosure, this requires a 2.5 mm Allen key.
- Loosen the display cover of the electronics compartment by hand, by turning it counter clockwise ①.
- Pull the metal pullers to remove the display.
- Pull the pullers a bit out.
- Remove the plastic covers and loosen the two M4 screws ③ at the electronics unit.
- Loosen all connectors.
- Pull the two metal pullers ④ at the left and right of the display and partially pull out the electronics unit.

- Loosen all coax cables on the bottom of the electronic unit (the number of cables depend on the version of the flowmeter).

**CAUTION!**

Please pay attention that the same amount of force is applied on both pullers, otherwise the connector at the backside can be damaged.

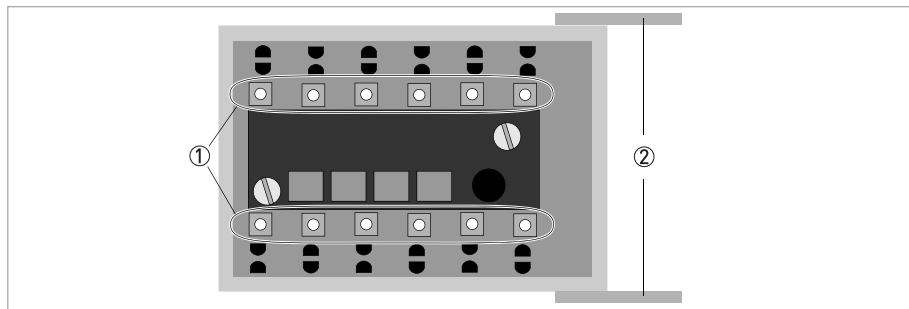


Figure 8-39: Location of connectors

- ① Position of connectors for transducer cables
- ② Metal pullers

**DANGER!**

Electrostatic discharge (ESD) can damage electronic parts. Make sure to discharge yourself by wearing a wrist strap. If no wrist strap is available, ground yourself by touching a metal surface that is grounded.



- Slide the new electronics unit partially back into the housing.
- Push the metal pullers back to their original position. Don't use excessive force, otherwise the connector at the backside can be damaged!
- Screw the electronics unit back to the housing.
- Re-install the display and make sure not to kink the display's flat ribbon cable.
- Replace cover and tighten by hand.
- Connect power.

8.7 Battery maintenance

Within the electronics a battery is present. This battery is used only for the internal clock. If a meter is installed and operating from an external power supply the battery will not be used. If a meter is shut down or on stock than the battery will power the internal clock. The following maintenance actions with respect to the battery should be taken:

- Replace the battery after 10 years of service.
- Replace the battery after 1 year on stock (or powered down).



CAUTION!

Only use type CR2032 batteries for replacement.

In case of problems with the battery the metrological performance aspects of the flowmeter is not at risk as critical data is stored in flash memory. However, in this case the internal clock will be reset with each power up. A reset of the internal clock indicates that the battery is out of order and replacement of the battery is required.

8.8 Availability of services

The manufacturer offers a range of services to support the customer after expiration of the warranty. These include repair, maintenance, technical support and training.



INFORMATION!

For more precise information, please contact your local sales office.

8.9 Returning the device to the manufacturer

8.9.1 General information

This device has been carefully manufactured and tested. If installed and operated in accordance with these operating instructions, it will rarely present any problems.



WARNING!

Should you nevertheless need to return a device for inspection or repair, please pay strict attention to the following points:

- *Due to statutory regulations on environmental protection and safeguarding the health and safety of the personnel, the manufacturer may only handle, test and repair returned devices that have been in contact with products without risk to personnel and environment.*
- *This means that the manufacturer can only service this device if it is accompanied by the following certificate (see next section) confirming that the device is safe to handle.*



WARNING!

If the device has been operated with toxic, caustic, radioactive, flammable or water-endangering products, you are kindly requested:

- *to check and ensure, if necessary by rinsing or neutralising, that all cavities are free from such dangerous substances,*
- *to enclose a certificate with the device confirming that it is safe to handle and stating the product used.*

8.9.2 Form (for copying) to accompany a returned device



CAUTION!

To avoid any risk for our service personnel, this form has to be accessible from outside of the packaging with the returned device.

Company:		Address:	
Department:		Name:	
Tel. no.:		Fax no. and/or Email address:	
Manufacturer's order no. or serial no.:			
The device has been operated with the following medium:			
This medium is:	<input type="checkbox"/>	radioactive	
	<input type="checkbox"/>	water-hazardous	
	<input type="checkbox"/>	toxic	
	<input type="checkbox"/>	caustic	
	<input type="checkbox"/>	flammable	
	<input type="checkbox"/>	We checked that all cavities in the device are free from such substances.	
	<input type="checkbox"/>	We have flushed out and neutralized all cavities in the device.	
We hereby confirm that there is no risk to persons or the environment through any residual media contained in the device when it is returned.			
Date:		Signature:	
Stamp:			

8.10 Disposal



LEGAL NOTICE!

Disposal must be carried out in accordance with legislation applicable in your country.

Separate collection of WEEE (Waste Electrical and Electronic Equipment) in the European Union:



According to the directive 2012/19/EU, the monitoring and control instruments marked with the WEEE symbol and reaching their end-of-life **must not be disposed of with other waste**.

The user must dispose of the WEEE to a designated collection point for the recycling of WEEE or send them back to our local organisation or authorised representative.

9.1 Measuring principle

The ultrasonic gas flowmeter operates according to the principle of measuring the transit time of an ultrasonic sound wave. A gas velocity is derived from the difference in transit time of a sound wave travelling in a direction with the flow direction and the sound wave travelling in the opposite direction.

The trajectory of the sound wave is called the acoustic path. A chord is the direct path crossing the pipe from one side to the opposite side. Using reflection, an acoustic path can consist of two or more chords. The name ALTOSONIC V12 is related to its design where 12 chords build 6 acoustic paths.

9.2 Transit time measuring principle

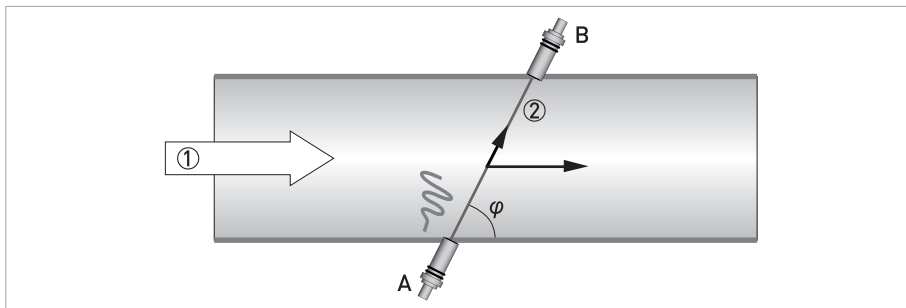


Figure 9-1: Transit time measuring principle

- ① Direction of the gas flow
- ② Component of velocity in the direction of the chord

In a pipe section two transducers A and B create an acoustic path, which in the above figure, is a single chord. This chord is the distance between transducer A and B and has a length L . The chord intersects with the centre line of the pipe at an angle φ .

Both transducers are capable to transmit and receive an ultrasonic signal. First, one transducer acts as a transmitter and the other as receiver, then the other way around. The transit time of an ultrasonic signal along a measuring chord is influenced by the velocity of the gas flow (v). If the gas flow is zero the transit time from transducer A to B is exactly the same as the transit time from transducer B to A (determined by the speed of sound in the gas).

When the gas flows with a velocity v and with c being the speed of sound in the gas: $v \cdot \cos(\varphi)$ is the component of velocity in the direction of the measurement chord.

This component increases or decreases the travel time (time of flight of an acoustic waveform) as it moves from one transducer to the other transducer. The transit time from transducer A to B (t_{AB}) is:

$$t_{AB} = \frac{L}{c + v \cos \varphi} \quad (1)$$

In opposite direction from transducer B to A the transit time (t_{BA}) is:

$$t_{BA} = \frac{L}{c - v \cos \varphi} \quad (2)$$

The velocity of the gas is derived from formula (1) and (2) as:

$$v = \frac{L}{2 \cos \varphi} \cdot \left(\frac{1}{t_{AB}} - \frac{1}{t_{BA}} \right) \quad (3)$$

An important feature of this method is that the calculated gas velocity does not depend on the speed of sound in the gas or gas properties in general. The gas velocity as calculated is only a function of the measured transit times t_{AB} and t_{BA} ; the length of the chord and the angle of intersection of the measuring chord are supposed to be known from the design of the flowmeter.

As a “bonus” the speed of sound in the gas can be derived from formula (1) and (2) as :

$$c = \frac{L}{2} \cdot \left(\frac{1}{t_{AB}} + \frac{1}{t_{BA}} \right) \quad (4)$$

This gives a measured speed of sound value, a valuable tool for diagnostic purposes, as it can be compared with data from other sources.

9.3 Swirl compensation

At specific spots in the pipe, the local gas velocity vector may not be exactly parallel to the pipe axis. This effect can be the result of a flow velocity pattern called swirl. This is a frequently occurring velocity pattern where the gas mass in the pipe rotates as it flows. As an example, the flow velocity pattern after a double out-of-plane bend is shown below.

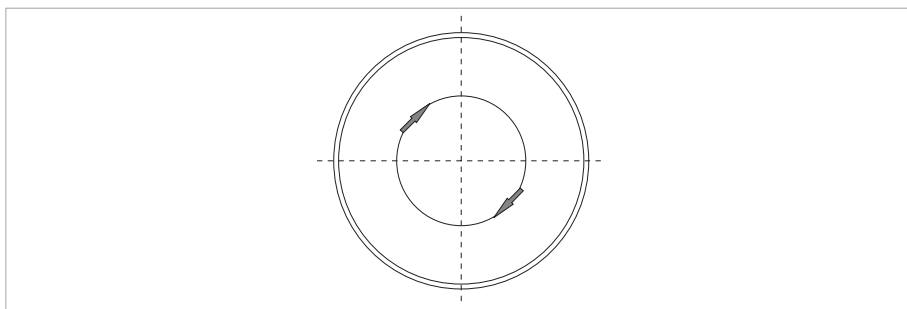


Figure 9-2: Swirl pattern after a double out-of-plane bend

Another velocity pattern that frequently occurs, especially downstream of a single elbow or bend in the pipeline, is shown in the picture below. There, just after the bend, the gas mass splits in two contra rotating vortices.

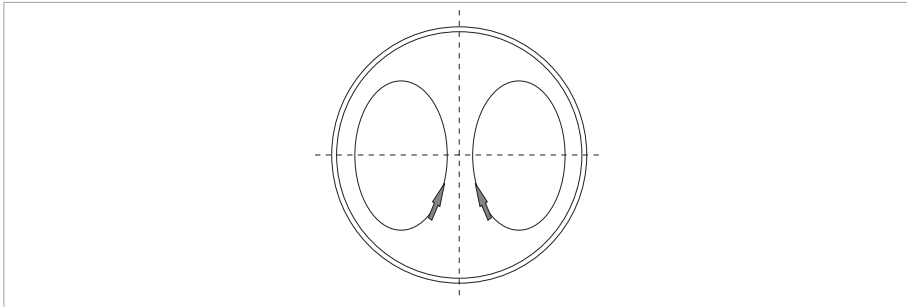


Figure 9-3: Swirl pattern after a single bend

Swirl can disturb the gas velocity measurement as the tangential velocity component adds up with the gas velocity measured along one chord. However chords can be arranged in a way to compensate for swirl effects. Two chords arranged in the same plane intersect the flow at opposite angles (cross configuration). These chords respond to the tangential velocity component with the same magnitude but with the opposite sign.

This allows cancellation of the swirl effect by adding or averaging the measured velocity value of both chords. An acoustic path with two chords in a V-shape, with a reflecting signal, has the same effect. The measured flow velocity is increased by the tangential component on one chord and decreased by the same value on the other chord.

9.4 Multipath ultrasonic flowmeters

With an ultrasonic measuring system the measured gas velocity value is the average velocity sampled across the length of the acoustic path. Due to distortion of the gas velocity profile in the pipe this value may not be representative for the average gas velocity across the whole of the pipe cross section. In order to obtain a high accuracy the flow is sampled using a number of measuring chords intersecting the flow in different planes, as shown in the figure below.

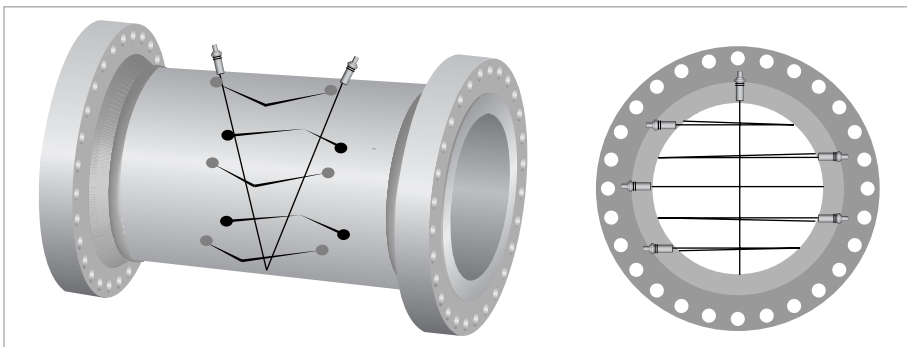


Figure 9-4: Path configuration with multiple acoustic paths

The total volume flow is calculated by means of an integration algorithm using the results from the individual paths.

As swirl components are already compensated for in each individual measuring plane, the integration method using data from multiple paths makes the flowmeter highly insensitive for any kind of distortion of the flow profile.

The average speed of sound is the average of the speed of sound values measured on each of the chords. Normally these values are very close to each other.

9.5 Technical data table



INFORMATION!

- The following data is provided for general applications. If you require data that is more relevant to your specific application, please contact us or your local sales office.
- Additional information (certificates, special tools, software,...) and complete product documentation can be downloaded free of charge from the website (Downloadcenter).

Measuring system

Measuring principle	Ultrasonic transit time
Application range	Flow measurement of natural gases with a minimum of 75% methane.
	Other applications on request.
Measured value	
Primary measured value	Transit time
Secondary measured values	Actual volume flow and totalised flow rate

Design

Construction	The ALTOSONIC V12 measurement system consists of a meter body with ultrasonic transducers and a signal converter for signal processing and counter display on top of the meter body.
Nominal diameter	DN100...350 / 4" ...14": machined out of one piece of metal
	DN400...1600 / 16" ...64": welded design
	Other diameters on request.
Flow range	For more detailed information, refer to <i>Flow tables</i> on page 117.
Signal converter	
Inputs / outputs	Without integrated KROHNE Care:
	Digital output: 4x
	Serial: 1x Modbus over RS 485 (individually configurable)
	With integrated KROHNE Care:
	Signals from the KROHNE Care board are categorised non-Custody transfer. Only signals coming directly from the base electronic unit are certified for Custody transfer purpose.
	Digital output: 4x
	Serial: 2x Modbus over RS 485 (individually configurable)
	Ethernet: 2x
	Current output: 1x 4...20 mA
	Current input: 1x Multidrop (dual) HART®

Display and user interface	
Graphic display	LC display, backlit white
	Size: 128x64 pixels, corresponds to 59x31 mm = 2.32"x1.22".
	Display turnable in 90° steps.
	The readability of the display could be reduced at ambient temperatures below -25°C / -13°F.
Operator input elements	4 optical keys for operator control of the signal converter without opening the housing.
Display functions	
Language of display texts	English, French, German, Dutch, Russian
Units	Metric and imperial units selectable from list / free unit.

Measuring accuracy

Accuracy	$\leq \pm 0.1\%$ of measured flow rate, for high pressure flow calibrated and linearised.
	$\leq \pm 0.2\%$ of measured flow rate, for high pressure flow calibrated.
	$\leq \pm 0.5\%$ of measured flow rate, SOS calibrated.
Repeatability	$< \pm 0.05\%$

Operating conditions

Temperature	
Process temperature	-40...+100°C / -40...+212°F
Ambient temperature	FM, DIV2, CSA: -40...+60°C / -40...+140°F
	ATEX, DIV1, IECEx: -40...+65°C / -40...+149°F
Storage temperature	-40...+70°C / -40...+158°F
Pressure	
Pressure range	1...450 bar / 0.1...45MPa / 15...6525 psi (ASME 150...2500)
	All sensor designs at full rating acc. to below flange standards for standard materials.
Properties of medium (other properties on request)	
Physical condition	Natural gas with a minimum of 75% methane.
	Other applications on request.
Wet gas content	Typically $\leq 1\%$ LVF, contact manufacturer for detailed sizing.
CO ₂ content	Depends on diameter and pressure, contact manufacturer for detailed sizing.
Minimum pressure requirement	Depends on diameter and CO ₂ concentration, contact manufacturer for detailed sizing.

Installation conditions

Installation	For detailed information, refer to <i>Installation</i> on page 18.
Dimensions and weights	For detailed information, refer to <i>Dimensions and weights</i> on page 112.

Materials

Flanges	Standard: low temperature carbon steel A350 LF2
	Option: stainless steel, Duplex
Measuring tube	≤ 14": low temperature carbon steel A350 LF2
	≥ 16": low temperature carbon steel A333 GR6
	Option: stainless steel, Duplex
Converter housing	Stainless steel 316 (1.4408)
Coating	Inside: corrosion preservative oil film
	Outside: 3 layer epoxy coating RAL 9006 (silver)
	Other outside coatings available on request.

Electrical connections

Power supply	24 VDC (-25% / +30%) / 3 A
Power consumption	Without integrated KROHNE Care: ≤ 10 W
	With integrated KROHNE Care: ≤ 17 W
Cable entries	Standard: M20 x 1.5
	Option: ½" NPT, PF ½

Inputs and outputs

MODBUS	
Description	Modbus RTU or Modbus ASCII, Slave, RS485 (galvanically isolated)
Transmission procedure	Half duplex, asynchronous
Address range	1...247
Supported function codes	03, 04, 06, 08, 16
Supported Baudrate	50, 75, 110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 56000, 64000, 115200, 128000 Baud

Approvals and certificates

CE	
This device fulfills the statutory requirements of the EC directives. The manufacturer certifies successful testing of the product by applying the CE mark.	
	For full information of the EU directive & standards and the approved certifications; please refer to the CE declaration or the website of the manufacturer.
Electromagnetic compatibility	Directive: 2014/30/EU, NAMUR NE21/04
	Harmonized standard: EN 61326-1
Pressure Equipment Directive (PED)	Directive: 2004/68/EU
	Category I, II, III
	Gas group 1
	Production module H
Equipment used in explosive atmosphere (ATEX)	Directive: 2014/34/EU
	Zone 1
	Harmonized standard: EN 60079-0, EN 60079-1, EN 60079-7, EN 60079-18 Certificate number: DEKRA 12 ATEX 0073X
Measuring Instrument Directive (MID)	Directive: 2014/32/EU
	EC type examination certificate number T10170
Other approvals, standards and certificates	
IECEX	Standards: IEC 60079-0, IEC 60079-1, IEC 60079-7, IEC 60079-18
	Certificate number: IECEX PTB 10.013X
Canada CSA	Standards: C22.2 No.30, C22.2 No.25, C22.2 No.94, C22.2 No. 610101-1
	DIV 1
	Certificate numbers: QPS LR1338-3; CSA 2320732
US America FM & UL	Standards: FM 3615, ANSI/UL 50E, UL 61010-1
	DIV 1
	Certificate number: QPS LR1338-3
	DIV 2
	Certificate number: FM 30400520
China	Ex. safety:
	Standards: GB 3836-1, GB 3836-2, GB 3823-3, GB3836-9
	Certificate number: NEPSI GYJ16.1212X
	Metrology:
	Certificate number: PAC 2009-F265
Russia	Ex. safety:
	Standards: CU TR 012
	Certificate number: EAC RU C-NL..??04.B.00228
	Metrology:
	Pattern certificate number: NL.C.29.004.A No 43620
Custody transfer	OIML R137 class 0.5
	Certificate NMI CVN-710381-02
	Fully compliant with AGA 9 and ISO 17089.

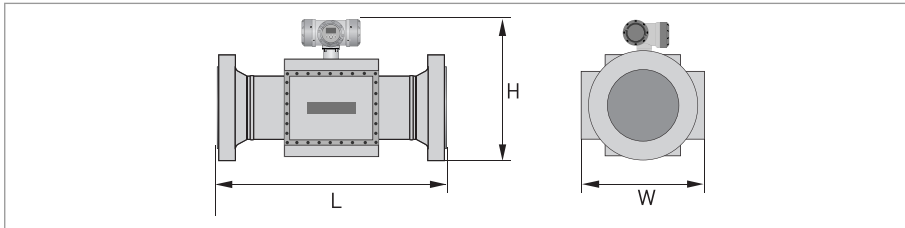
Ingress protection code	Standards: IEC/EN 60529
	IP 66/67
	Standard: NEMA 250
	NEMA 4X
Verifications	<p>Standard: High pressure hydrostatic pressure test on meter body Factory Acceptance Test (FAT) Low pressure leakage test on nitrogen on complete meter High pressure helium test on transducers</p> <p>Option: High pressure leakage test on nitrogen on complete meter High pressure flow calibration</p>
Other worldwide approvals and certificates also available on request.	
Equipment marking	
Standard	Product marking
ATEX (zone 1)	II 2G Ex d e ma IIB (or IIC) T4 (or T5) Gb or
	II 2G Ex d e IIB (or IIC) T4 (or T5) Gb
IECEx (zone 1)	Ex d e ma IIB (or IIC) T4 (or T5) Gb or
	Ex d e IIB (or IIC) T4 (or T5) Gb
US America (DIV1)	Class I, Division 1, Groups C and D Temperature Class T5 or T4, Type 4x; approved process seal
US America (DIV2)	NI, Class I, Division 2, Groups C and D, Temperature Class T5, Class II/III, Division 1, Groups E, F and G, Temperature Class T5, IP Type 4X/IP66
US America (zone 1)	Class I, Zone 1, AEx d e ma IIB, Temperature Class T5, IP Type 4X
CANADA (DIV1)	Class I, Division 1, Groups C and D Temperature class T5 or T4 Class II/III, DIVISION 1, Group E, F and G, Type 4x; approved process seal

9.6 Dimensions and weights



INFORMATION!

- Flowmeters with diameters $\geq 6''$ and ASME ≤ 900 lb are standard equipped with transducers that are retractable under pressure.
- All measures are provided as indication. They can vary slightly with different schedule sizes.
- Values for larger diameters are available on request.
- Values for meters with marking US America (DIV 1) Class I, Division I are available on request



ASME 150 lb

Nominal size [mm]	H [mm]	L [mm]	Weight [kg]
100	520	400 ①	151
150	570	450	238
200	620	600	351
250	660	750	498
300	740	900	719
350	780	1050	911
400	840	1200	420
450	890	1350	529
500	940	1500	709
600	1050	1800	1113

① 300 mm available on request.

ASME 150 lb

Nominal size [inch]	H [inch]	L [inch]	Weight [lbs]
4	20.47	15.75 ①	333
6	22.44	17.72	525
8	24.41	23.62	774
10	25.98	29.53	1098
12	29.13	35.43	1585
14	30.71	41.34	2009
16	33.07	47.24	926
18	35.04	53.15	1166
20	37.01	59.06	1563
24	41.34	70.87	2454

① 11.81" available on request.

ASME 300 lb

Nominal size [mm]	H [mm]	L [mm]	Weight [kg]
100	520	400 ①	158
150	570	450	248
200	620	600	371
250	680	750	533
300	760	900	755
350	810	1050	1008
400	870	1200	520
450	920	1350	659
500	980	1500	862
600	1100	1800	1354

① 300 mm available on request.

ASME 300 lb

Nominal size [inch]	H [inch]	L [inch]	Weight [lbs]
4	20.47	15.75 ①	348
6	22.44	17.72	547
8	24.41	23.62	818
10	26.77	29.53	1175
12	29.92	35.43	1665
14	31.89	41.34	2223
16	34.25	47.24	1147
18	36.22	53.15	1453
20	38.58	59.06	1901
24	43.31	70.87	2986

① 11.81" available on request.

ASME 600 lb

Nominal size [mm]	H [mm]	L [mm]	Weight [kg]
100	520	400 ①	168
150	575	450	271
200	630	600	411
250	710	750	618
300	780	900	850
350	815	1050	1070
400	880	1200	640
450	930	1350	805
500	1000	1500	1055
600	1100	1800	1621

① 300 mm available on request.

ASME 600 lb

Nominal size [inch]	H [inch]	L [inch]	Weight [lbs]
4	20.47	15.75 ①	370
6	22.64	17.72	598
8	24.8	23.62	906
10	27.95	29.53	1363
12	30.71	35.43	1874
14	32.09	41.34	2359
16	34.65	47.24	1411
18	36.61	53.15	1775
20	39.37	59.06	2326
24	43.31	70.87	3574

① 11.81" available on request.

ASME 900 lb

Nominal size [mm]	H [mm]	L [mm]	Weight [kg]
100 ①	520	400	176
150	590	600	324
200	660	600	464
250	730	750	684
300	810	900	957
350	840	1050	1190
400	890	1200	720
450	960	1350	964
500	1020	1500	1254
600	1160	1800	2200

① Minimum Inner diameter: 80 mm [≤ sch 80].

ASME 900 lb

Nominal size [inch]	H [inch]	L [inch]	Weight [lbs]
4 ①	20.47	15.75	388
6	23.23	23.62	714
8	25.98	23.62	1023
10	28.74	29.53	1508
12	31.89	35.43	2110
14	33.07	41.34	2624
16	35.04	47.24	1588
18	37.8	53.15	2126
20	40.16	59.06	2765
24	45.67	70.87	4851

① Minimum Inner diameter: 3.15" [≤ sch 80].

ASME 1500 lb

Nominal size [mm]	H [mm]	L [mm]	Weight [kg]
100 ①	530	500	221
150	600	600	434
200	660	800	652
250	760	750	1030
300	860	900	1507

① Minimum Inner diameter: 80 mm (≤ sch 80).

ASME 1500 lb

Nominal size [inch]	H [inch]	L [inch]	Weight [lbs]
4 ①	20.87	19.69	487
6	23.62	23.62	957
8	25.98	31.5	1438
10	29.92	29.53	2271
12	33.86	35.43	3323

① Minimum Inner diameter: 3.15" (≤ sch 80).

ASME 2500 lb

Nominal size [mm]	H [mm]	L [mm]	Weight [kg]
100 ①	574	500	298
150	681	750	658
200	729	800	946
250	844	1000	1664
300	947	1200	2359

① Minimum Inner diameter: 80 mm (≤ sch 80).

ASME 2500 lb

Nominal size [inch]	H [inch]	L [inch]	Weight [lbs]
4 ①	22.6	19.69	657
6	26.81	29.53	1451
8	28.7	31.5	2086
10	33.23	39.37	3669
12	37.28	47.24	5205

① Minimum Inner diameter: 3.15" (≤ sch 80).

9.7 Flow tables

Nominal range

Nominal size [inch]	Q _{min}		Q _{max}	
	[m ³ /h]	[cf/h]	[m ³ /h]	[cf/h]
4	25	900	1000	35300
6	45	1600	2300	81200
8	55	1900	4100	144800
10	85	3000	6200	219000
12	115	4100	8500	300200
14	140	4900	9900	349600
16	185	6500	12300	434400
18	230	8100	15000	529700
20	260	9200	17600	621500
24	290	10200	23000	812200
26	360	12700	25000	882900
28	410	14500	28500	1006500
30	470	16600	32000	1130100
36	620	21900	41000	1447900
40	765	27000	51000	1801000
42	845	29800	56000	1977600
48	1100	38800	73000	2578000
56	1500	53000	95000	3354900
64	1910	67500	120000	4237800
Qt as per ISO 17089 (Vt = 3 m/s for <12" and Vt=1.5 m/s for ≥ 12"				
For piping > Sch 80 values can vary slightly.				
Technical data is provided as indication, please ask KROHNE for detailed sizing.				

Extended range

Nominal size [inch]	Q _{min}		Q _{max}	
	[m ³ /h]	[cf/h]	[m ³ /h]	[cf/h]
4	10	400	1150	40600
6	16	600	2600	91800
8	20	700	4500	158900
10	25	900	7000	247200
12	35	1200	9000	317800
14	45	1600	10500	370800
16	60	2100	13000	459100
18	75	2600	16000	565000
20	90	3200	19000	671000
24	130	4600	25000	882900
26	180	6400	30000	1059400
28	210	7400	33800	1193600
30	230	8100	38900	1373700
36	300	10600	51400	1815200
40	380	13400	61000	2154200
42	420	14800	64500	2277800
48	550	19400	80600	2846400
56	750	26500	105000	3708000
64	950	33500	127250	4493800
Flow rates can have certain restrictions, therefore an application check is always required.				
Qt as per ISO 17089 [Vt = 3 m/s for <12" and Vt=1.5 m/s for ≥ 12"]				
For piping > Sch 80 values can vary slightly.				
Technical data is provided as indication, please ask KROHNE for detailed sizing.				

10.1 Introduction

Modbus communication is based on the master-slave principle. Only the master can initiate transactions (requests), and only the addressed device (slave) responds. The master can also send a broadcast message ("message to all"); none of the slaves will respond to such a message.

The flowmeter always acts as a Modbus compatible slave when communicating with host systems. Slaves are identified by means of a "device address". Check the documentation to find the preset device address of the flowmeter. In case necessary, the address can be reprogrammed.

Contact the manufacturer for information about the procedures and tools that are needed for reprogramming the device address.

The Modbus protocol defines a message structure that Modbus enabled controllers will recognise and use, regardless of the type of network over which they communicate.

It describes:

- the process that a controller uses to request access to other devices.
- how to respond to requests from the other devices.
- how errors will be detected and reported.

The Modbus request consists of:

- an address
- a function code defining the requested action.
- data (if necessary for the requested function).
- an error check for testing the integrity of the message.

The response of the slave contains:

- the slave address.
- data conform the request type.
- an error check.

If the data integrity test fails, no response is sent back.

If a request can not be processed an exception message is returned.

10.2 Physical Communication Layer

The Modbus over serial line protocol is a master-slave protocol. The physical layer can be half-duplex or full-duplex. In case of the ALTOSONIC V12 the physical layer is a half-duplex (two-wire) connection according to RS 485 specifications.

The end of a RS 485 line has to be terminated by means of a resistor. This terminating resistor is included in the line driving circuit in the flowmeter.

Multiple flowmeters may be connected to the same RS 485 line. In this case only the terminating resistor in the flowmeter at the end of the line should be connected. The terminating resistors in the other flowmeters on the line should be disconnected by means of the switch on the RS 485 driver printed circuit board. Default this switch is set to connect the line terminating resistor.

Because of the half-duplex operation, the RS 485 communication circuit in the flowmeter is normally always in data receiving mode. Only in case it is requested to send it will automatically switch to data transmit mode for the time needed.

10.3 Serial transmission format

Two transmission modes are defined for a Modbus data communication link:

- Modbus ASCII
- Modbus RTU

Both transmission modes are supported, the user can select the desired mode along with the serial communication parameters (baud rate, parity).

The default configuration of the flowmeter is Modbus RTU communication mode with “standard” Modbus settings.

For a list of programmable parameters and the default settings of these parameters, refer to *Default settings* on page 135. Except for the device addresses all these parameters must be the same for all controllers in the network.

10.3.1 ASCII mode

In the Modbus message each byte of data is coded as 2 ASCII characters; one to represent the upper 4 bits and another to represent the lower 4 bits. Each group of 4 bits is represented by a hexadecimal number, transmitted as an ASCII character from the range 0...9, A...F.

Standard serial communication parameters

Start bits	1
Data bits	7
Parity	odd/even/none
Stop bits	1 stop bit if parity is used
	2 stop bits if no parity is used
Error check field	Longitudinal Redundancy Check (LRC)

An advantage of ASCII mode is that it allows for a time interval up to 1 second between characters without causing a timeout.

A disadvantage of ASCII mode is the larger message length.

10.3.2 RTU mode

Each byte of data is represented in the message by an equivalent number of bits (8). The number of bits transmitted in the process of communicating one byte of information is sometimes also referred to as a “character”.

Note that this is not the same as an ASCII character.

Standard serial communication parameters

Start bits	1
Data bits	8
Parity	even
Stop bits	1
Error check field	Cyclic Redundancy Check (CRC)

10.4 Modbus message framing

ASCII mode

In ASCII mode a message starts with a colon character (:) and ends with a carriage return-linefeed. Intervals up to one second can elapse between characters within the message. If the interval is longer, a timeout error occurs and the message is rejected.

RTU mode

In RTU mode a message starts with a silent time interval equivalent to at least 3.5 characters. The entire message frame must be transmitted as a continuous stream. If a silent interval of more than 3.5 character times occurs before completion of the frame, the receiving device flushes the incoming message and assumes that the next byte will be the address field for the new message.

Mode	Start	Address	Function	Data	Checksum	End
ASCII-mode	:	2 hex characters	2 hex characters	N*2 hex characters	LRC 2 hex characters	CR-LF
RTU-mode	3.5 characters silent interval	8 bits	8 bits	N*8 bits	CRC 16 bits	3.5 character silent interval

Table 10-1: Example of a typical message frame

10.4.1 Address Field (Device Address)

The address field of a message frame contains:

ASCII mode	2 characters
RTU mode	8 bits

Valid slave addresses are 1...247.

Address 0 is used for a broadcast to address all slaves.

10.4.2 Function Field

The function field of a message frame contains:

ASCII mode	2 characters
RTU mode	8 bits

Valid function codes are 1...127.

The function code tells the slave which kind of action to perform.

For information on the supported functions, refer to *Supported functions* on page 124.

A slave response always contains the function code of the request. If a function is not applicable, the slave sends an exception response. An exception is indicated by a returned function code with bit 8 (most significant bit) set.

10.4.3 Data Field

The data field contains 8 bit values (bytes) in the range of 0 to FF hexadecimal.

In ASCII mode each 8 bit value is represented by 2 ASCII characters.

The data field of messages contains information which both master and slave use to perform an action. This includes the register address, quantity of registers, and the necessary data.

10.4.4 Error checking methods

Two error checking methods are defined for the Modbus protocol:

- Optional: an additional bit (parity bit) is appended to each character (or byte) for detecting errors during the transmission of individual characters (or bytes).
- Obligatory: two bytes (or characters) are appended to the message for detecting errors during the transmission of the message.

As an even number of bit errors in one character (or byte) will not be detected using a parity bit, the second method is used to check the contents of the entire message.

Both character check and message check are generated in the transmitting device and appended to the message before transmission. The slave checks each character and the entire message frame during receipt.

The contents of the error checking field for the entire message depend on the transmission mode.

Error check in ASCII mode transmission

For detecting errors in the entire message the error-checking field contains two ASCII characters. The error check characters are the result of a Longitudinal Redundancy Check (LRC) calculation. This is performed on the message contents with exception of the beginning colon, the carriage return and line feed characters. The LRC characters are appended to the message as the last field preceding the CR-LF characters.

Error check in RTU mode transmission

For detecting errors in the entire message the error-checking field contains a 16-bit value implemented as two bytes. The error check value is the result of a Cyclic Redundancy Check (CRC) calculation performed on the message contents. The CRC field is appended to the message as the last field.

10.4.5 Transmission gaps

Gaps that exceed a specific value during the transmission of a message will be qualified as a transmission error.

ASCII mode

In ASCII mode the maximum time between 2 characters is one second. If a longer interval occurs, the message will be ignored and the search for a starting character (colon) is resumed.

RTU mode

In RTU mode the entire message frame must be transmitted as a continuous stream. If a silent interval of more than 3.5 character times occurs before completion of the frame, the receiving device ignores the message and assumes the next byte will be the device-address field of a new message.

10.4.6 Time out

The master device has a predetermined time out interval before aborting a transaction.

This interval shall be set long enough for any slave to respond normally.

The time out interval is set by a parameter in the master system: **request_to_response_timeout**.

10.5 Supported functions

A number of functions is available to perform operations on variables in the slave.

An operation can be a “read” operation to obtain the value of a variable or a “write” operation to assign a value to a variable. Variables are identified by means of their register number (address).

Typically in a Modbus slave, data can be stored in multiple areas that can be seen as different memories:

- Discrete Inputs: data from logical (also called binary, Boolean, or ON/OFF) inputs. By nature the data in this area is “read-only”: the master has only access to read this data.
- Coils: logical (also called binary, Boolean, or ON/OFF) outputs. The master device may read the current state of an output, but may also set or change the state of an output.
- Input Registers: data, for example originating from electrical inputs of the slave or results from calculations in the slave, can be stored in “input registers”. By nature the data in this area is “readonly”: the master has only access to read this data.
- Holding Registers: the master has access to this area to read the data but as well to set or change the value of data (write).

As these register groups are located in apparently different memories, the addresses may overlap: for example, an input register having address 100 can exist and at the same time a holding register having address 100. These are not the same: which one will be selected for an operation is implied from the function code, referring to an input register or to a holding register, for example.

The device does not use Discrete Inputs or Coils, but only Input Registers and Holding Registers.

Variables are grouped according to data type and dependant of being input registers (read-only data) or being holding registers (read/write data). An address range is assigned to each variable type, subdivided in input registers (read-only) and holding registers (read/write).

The device’s address ranges of Input Registers and Holding Registers do not overlap. Accessing a specific register address is therefore unambiguous. The functions “read register” and “read input” could both be used to effectively access the same register/address. However, in this application, functions shall still be used consistent with the type of memory they are intended to be used for.

In the master and the slave register addresses are referenced (counted) starting from 1. However, the address range used in the message during in the transmission starts from 0. As an example, when referencing address 4001, the address actually present in the message will be 4000.

On an application level the user will not notice this, as during the coding and decoding of the message this offset of 1 will be taken into account. However, when the message – as it is transmitted – is analyzed and checked one has to be aware of this offset.

When functions which do not support broadcast requests, are accessed with a broadcast address, the request will be ignored.

10.5.1 Function 01: READ COILS

Function 01 reads the status of 1 to 2000 contiguous logical (Boolean or ON/OFF) variables.

This function is not used, as in this application Boolean (or logical) variables are not used as individual entities. Boolean variables are represented by means of specific bits packed in 32 bit data word (type "Long").

10.5.2 Function 02: READ DISCRETE INPUTS

Function 02 reads the status of 1 to 2000 contiguous logical (Boolean or ON/OFF) variables.

This function is not used, as in this application Boolean (or logical) variables are not used as individual entities. Boolean or logical variables are represented by means of specific bits packed in 32 bit data word (type "Long").

10.5.3 Function 03: READ HOLDING REGISTERS

Function 03 reads the contents of 1 to 125 contiguous holding registers in the slave. The maximum number of registers at each request is limited to 125 16-bit registers: 125 integers, 62 long integers, 62 floats, 31 doubles or 31 long longs.

Request

The request message specifies the starting register and the quantity of registers to be read. Registers are addressed starting from zero. Registers 1...16 are addressed as 0...15.

Example

A request to read from slave device 17, registers 40108...40110 (decimal), or starting from 9CAC (hex):

Header	Slave address	Function	Starting address		Number of data items		Error check	Trailer
--	11(h)	03(h)	Hi 9C(h)	Low AB(h)	Hi 00(h)	Low 03(h)	--	--

Table 10-2: Example read holding registers

Response

Header	Slave addr.	Funct.	Byte count	Data						Error check	Trailer
--	11(h)	03(h)	06(h)	(Reg. 40108 Hi) 02(h)	(Reg. 40108 Low) 2B(h)	(Reg. 40109 Hi) 00(h)	(Reg. 40109 Low) 00(h)	(Reg. 40110 Hi) 00(h)	(Reg. 40110 Low) 64(h)	--	--

Table 10-3: Response read holding registers

For each register the first byte contains the high order byte, the second the low order byte.

The contents of register 40108 are shown as the two byte values of 02 2B hex (555 decimal). The contents of register 40109 is 00 00 hex (0 decimal) and of register 40110 is 00 64 hex (100 decimal).

If the request is not applicable, an exception response will be sent. For more information, refer to *Exception responses* on page 128.

10.5.4 Function 04: READ INPUT REGISTERS

Function 04 performs a “read” operation, similar to function 03. The difference is that function 04 addresses input registers (which are “read-only”), whereas function 03 addresses holding registers (which are “read/write”).

10.5.5 Function 05: WRITE SINGLE COIL

Function 05 writes the status of a logical (Boolean or ON/OFF) variable.

This function is not used, as in this application Boolean variables are not used as individual entities. Boolean variables are represented by means of specific bits packed in 32 bit data word (type “Long”).

10.5.6 Function 06: WRITE SINGLE HOLDING REGISTER

Function 06 presets a value into a single holding register.

When the address is a broadcast, all slaves will process the request.

Request

The request specifies the register reference to be written. Registers are addressed starting from zero. Registers 1-16 are addressed as 0-15. The value to be written is specified in the data field, which is a 16-bit value.

Example

Request for slave 17 to preset register 40002 (decimal), 9C42 (hex) to 00 03 (hex).

Header	Slave address	Function	Register address		Data		Error check	Trailer
--	11(h)	06(h)	Hi 9C(h)	Low 42(h)	Hi 00(h)	Low 03(h)	--	--

Table 10-4: Example write single holding register

Response

The response message is an echo of the request, returned after the register contents has been written.

Header	Slave address	Function	Register address		Data		Error check	Trailer
--	11(h)	06(h)	Hi 9C(h)	Low 42(h)	Hi 00(h)	Low 03(h)	--	--

Table 10-5: Response write single holding register

If the request is not applicable, an exception response will be sent.
For more information, refer to *Exception responses* on page 128.

10.5.7 Function 08: DIAGNOSTICS

Function 8 provides a test for checking the communication system between the master and the slave.

Request

The function uses a two-byte sub-function field in the request to define the test to be performed:

Header	Slave address	Function	Sub-function	Data Hi+Lo	Error check	Trailer
--	11(h)	08(h)	00 00(h)	A1B8(h)	--	--

Table 10-6: Diagnostics

All sub-functions are supported.

10.5.8 Function 15: WRITE MULTIPLE COILS

Function 15 writes the status of 1...2000 contiguous logical (Boolean or ON/OFF) variables.

This function is not used, as in this application Boolean variables are not used as individual entities. Boolean variables are represented by means of specific bits packed in 32 bit data word (type "Long").

10.5.9 Function 16: WRITE MULTIPLE HOLDING REGISTERS

Function 16 writes the contents of 1 to 123 contiguous holding registers in the slave.

When the address is a broadcast, the function pre-sets the same register references in all attached slaves.

Request

The request message specifies the register references to be pre-set. Registers are addressed starting at zero (register 1 is addressed as 0).

Example

An example of a request for slave device 17 to pre-set two registers starting at 40002 (decimal), 9C42 (hexadecimal) to 00 0A and 01 02 hex:

Header	Slave addr.	Funct.	Starting address		Quantity		Byte counts	Data				Error check / Trailer
			Hi 9C(h)	Low 41(h)	Hi 00(h)	Low 02(h)		Hi 00(h)	Low 0A(h)	Hi 01(h)	Low 02(h)	
-	11(h)	10(h)					04(h)					- / -

Table 10-7: Example multiple holding registers

Response

The normal response returns the slave address, the function code, starting address, and quantity of registers pre-set:

Header	Slave address	Function	Starting address		Quantity of points		Error check	Trailer
--	11(h)	10(h)	Hi 9C(h)	Low 41(h)	Hi 00(h)	Low 02(h)	--	--

Table 10-8: Response multiple holding registers

If the request is not applicable, an exception response will be sent. For more information, refer to *Exception responses* on page 128.

10.5.10 Exception responses

Except for broadcast messages, a master device expects a normal response, when it sends a request to a slave device. One of the four possible events can occur upon the master device's request:

- If the slave device receives the request without a communication error and can handle the request normally, it returns a normal response.
- If the slave does not receive the request due to a communication error, no response is returned. The master program will eventually process a timeout condition for the request.
- If the slave receives the request, but detects a communication error (parity, CRC, LRC), no response is returned. The master program will eventually process a timeout condition for the request.
- If the slave receives the request without a communication error, but cannot handle it, the slave will return an exception response informing the master of the nature of the error.

The exception response message has two fields that differentiate it from a normal response.

Function Code Field

In a normal response the slave echoes the function code of the original request in the function code field of the response. In an exception response the slave sets the most significant bit of the function code to 1.

The master recognises the exception response by means of this bit and can examine the data field for the exception code.

Data Field

In an exception response the slave returns an exception code in the data field. By means of this exception code the slave reports a reason for not being able to respond normally.

The exception response message:

Header	Slave address	Function	Exception code	Error check	Trailer
--------	---------------	----------	----------------	-------------	---------

Table 10-9: Exception response message

Exception codes (for example)

Code	Name	Meaning
01	Illegal function	The function code in the request is not an allowable action for the slave.
02	Illegal data address	The data address received in the request is not an allowable address for the slave.

Table 10-10: Exception codes

10.6 Handling of large data types

The standard Modbus specification does not explain how data types larger than 16 bits should be handled. The standard Modbus functions to modify holding registers are used for handling larger data types.

Function 03 (read multiple holding registers), function 06 (write single holding register), and function 16 (write multiple holding registers) are used to read or modify these data types. Each register area contains a datatype.

To be compatible with older systems, a parameter 8.1.1.6 COMPATIBILITY MODE controls how the registers are counted.

- In the "Modicon compatible mode", each address refers to a 16 bit register. Large data types will occupy multiple addresses.
- In the "not-Modicon compatible mode", each address refers to one data item, independent of its type (length). Note that function 6 in not-Modicon compatible mode will also write one type of the accompanying data type!

The supported data types are:

- Boolean
- Integer (16 bit)
- Long integer (32 bit)
- Long long integer (64 bit)
- Float (32 bit)
- Double (64 bit)
- ASCII 8 Characters (64 bit)
- ASCII 16 Characters (128 bit)

The register ranges for each data type:

Function	Address range	Data Type	Numbers of registers to request for each data type	
			Modicon compatible	Not Modicon compatible
1, 2, 5, 15	1000...2999	Boolean	1	1
3, 4, 6, 16	3000...3999	Integer (16 bit)	1	1
	4000...4999	Long integer (32 bit)	2	1
	5000...5999	Long long integer (64 bit)	4	1
	7000...8999	Float (32 bit)	2	1
	9000...9999	Double (64 bit)	4	1
3, 16	13000...13999	ASCII (8 char.)	4	1
	14000...14999	ASCII (16 char.)	8	1

Note that in **Modicon compatible mode** each data type larger than 16 bits should be addressed as 16-bit registers. For instance the first float is located at address 7000/7001; the next float is located at address 7002/7003.

A double would be accessed by four 16-bit registers, so the first double 6000/6001/6002/6003 and the next double 6004/6005/6006/6007.

The data in the chapter 8.4 MODBUS MAPPING ASSIGNMENTS is printed as it should be addressed in **not-Modicon compatible mode**.

10.6.1 Integer (16 bit), Transmit sequence

Integers are transmitted and stored with the most significant part first.

Example

Integer value 1790 decimal (6FE hexadecimal) is transmitted as:

First transmitted byte in data field	Second transmitted byte in data field
06	FE

Table 10-11: Example integer (16 bit)

10.6.2 Long integer (32 bit), Transmit Sequence

Example

Long integer value 305419896 (12345678 hexadecimal).

Long integers could be transmitted in two possible ways. The transmit order in both modes:

Example long integers

Normal mode	(1) 12 _h	(2) 34 _h	(3) 56 _h	(4) 78 _h
Reversed mode	(3) 56 _h	(4) 78 _h	(1) 12 _h	(2) 34 _h

10.6.3 Single precision floating point (32 bit), transmit sequence

Single precision floating-point numbers are stored in 32-bit registers, represented using the IEEE 754 encoding. In IEEE 754-2008 the 32-bit base 2 format is officially referred to as **binary32**. It was called single in IEEE 754-1985.

The IEEE 754 standard specifies a binary32 as having:

- Sign bit: 1 bit
- Exponent width: 8 bits
- Significant (also known as mantissa) precision: 24 (23 explicitly stored)

The true significant (mantissa) includes an implicit leading bit with value 1 unless the exponent is stored with all zeros. Thus only 23 bits of the significant (mantissa) appear in the memory format but the total precision is 24 bits (equivalent to $\log_{10}(2^{24}) \approx 7.225$ decimal digits). The bits are laid out as follow:

Sign + (Biased) Exponent	Exponent + Mantissa 3 (high)	Mantissa 2	Mantissa 1 (low)
SEEE EEEE	E MMM MMMM	MMMM MMMM	MMMM MMMM

The single precision binary floating-point exponent is encoded using an offset binary representation, with the zero offset being 127; also known as exponent bias in the IEEE 754 standard.

Example

The float number 4.125977 will give the IEEE 754 representation.

Example IEEE

Sign	Exponent	Mantissa
0	1000 0001	(1) 000 0100 0000 1000 0000 0000

A positive sign.

A biased exponent of 129 (81 hexadecimal) is exponent 2.

Mantissa = 4 + 1/8 + 1/1024. Note that the first bit is not stored!

Floats could be transmitted in two ways. The transmit order in both modes:

IEEE 754	(1) 40 _h	(2) 84 _h	(3) 08 _h	(4) 00 _h
Normal mode	(1) 40 _h	(2) 84 _h	(3) 08 _h	(4) 00 _h
Reversed mode	(3) 08 _h	(4) 00 _h	(1) 40 _h	(2) 84 _h

10.6.4 Double precision floating point (64 bit), transmit sequence

Double precision floating-point numbers are stored in 64-bit registers, represented using the IEEE 754 encoding. In IEEE 754-2008 the 64-bit base 2 format is officially referred to as binary64. It was called double in IEEE 754-1985.

The IEEE 754 standard specifies a binary64 as having:

- Sign bit: 1 bit
- Exponent width: 11 bits
- Significant (also known as mantissa) precision: 53 (52 explicitly stored)

The true significant (mantissa) includes an implicit leading bit with value 1 unless the exponent is stored with all zeros. Thus only 52 bits of the significand (mantissa) appear in the memory format but the total precision is 53 bits (equivalent to $\log_{10}(2^{53}) \approx 16$ decimal digits). The bits are laid out as follows:

Double precision bits

Sign + (Biased) Exponent	Exponent + Mantissa	Mantissa 6	Mantissa 5
SEEE EEEE	EEEE MMMM	MMMM MMMM	MMMM MMMM

Double precision bits 2

Mantissa 4	Mantissa 3	Mantissa 2	Mantissa 1
MMMM MMMM	MMMM MMMM	MMMM MMMM	MMMM MMMM

Example

The double number 4.125000001862645 will give the IEEE representation:

double number example

Sign	Exponent	Mantissa
0	100 0000 0001	(1)0000 1000 0000 0000 0000 0000 0000 0010 0000 0000 0000 0000 0000

A positive sign

A biased exponent of 1025 (401 hexadecimal) is exp. 2

Mantissa = $4 + 1/8 + 1/536870912$. Note that the first bit is not stored!

Doubles could be transmitted in two ways. The transmit order in both modes:

Doubles transmit order

IEEE 754	(1) 40 _h	(2) 10 _h	(3) 80 _h	(4) 00 _h	(5) 00 _h	(6) 20 _h	(7) 00 _h	(8) 00 _h
Normal mode	(1) 40 _h	(2) 10 _h	(3) 80 _h	(4) 00 _h	(5) 00 _h	(6) 20 _h	(7) 00 _h	(8) 00 _h
Reversed mode	(3) 80 _h	(4) 00 _h	(1) 40 _h	(2) 10 _h	(7) 00 _h	(8) 00 _h	(5) 00 _h	(6) 20 _h

10.6.5 Long long (64 bit integer), transmit sequence

Example

64 bit integer value 4.616.330.355.545.210.880 (= 4010 8000 0020 0000 hexadecimal).

64 bit integers could be transmitted in two ways. The transmit order in both modes:

Transmit order 64 bit integer

Normal mode	(1) 40 _h	(2) 10 _h	(3) 80 _h	(4) 00 _h	(5) 00 _h	(6) 20 _h	(7) 00 _h	(8) 00 _h
Reversed mode	(3) 80 _h	(4) 00 _h	(1) 40 _h	(2) 10 _h	(7) 00 _h	(8) 00 _h	(5) 00 _h	(6) 20 _h

10.6.6 Maximum number requested items

The maximum amount of data that can be sent in a single response limits the amount of items that can be requested in a single query.

The table below shows the maximum number of items per data type:

Data type	Number of items
Boolean	2000
Integer (16 bit)	125
Long integer (32 bit)	62
Float (32 bit floating point)	62
Double (64 bit floating point)	31
Long long (64 bit integer)	31

10.7 Default settings

By means of a number of parameters the Modbus communication link can be adjusted to one's needs or preferences. When the flowmeter is delivered these parameters are set to default values as listed below:

Port 0

Baud rate:	38400
Data bits:	8
Stop bits:	1
Parity:	Even
Modbus Mode:	RTU
Modbus End Code:	2
Addressing Mode:	Modicon compatible
Representation Mode:	Normal
Modbus Address:	237
Modbus Start Gap:	40 (bits)
Modbus End Gap:	20 (bits)
Modbus Start Code:	":" (colon character)
Modbus End Code1:	ASCII 13 (carriage return, CR)
Modbus End Code2:	ASCII 10 (line feed, LF)
Modbus Time Out:	1 second

Port 1

Baud rate:	115200
Data bits:	8
Stop bits:	1
Parity:	Even
Modbus Mode:	RTU
Modbus End Code:	2
Addressing Mode:	Modicon compatible
Representation Mode:	Normal
Modbus Address:	237
Modbus Start Gap:	40 (bits)
Modbus End Gap:	20 (bits)
Modbus Start Code:	":" (colon character)
Modbus End Code1:	ASCII 13 (carriage return, CR)
Modbus End Code2:	ASCII 10 (line feed, LF)
Modbus Time Out:	1 second

10.8 Modbus register mapping

Registers are mapped to specific address ranges according to both data and register type:

Data type	Register type	Read command(s)	Write command(s)	Address range
Integer (16 bit)	Input register	4	n.a.	3000..3499
	Holding register	3	6, 16	3500..3999
Long integer (32 bit)	Input register	4	n.a.	5000..5499
	Holding register	3	6, 16	5500..5999
Double (64 bit)	Input register	4	n.a.	6000..6499
	Holding register	3	6, 16	6500..6999
Float (32 bit)	Input register	4	n.a.	7000..7499
	Holding register	3	6, 16	7500..7999
Long long (64 bit)	Input register	4	n.a.	8000..8499
	Holding register	3	6, 16	8500..8999



INFORMATION!

The relative addresses listed in the tables below are addresses relative to the starting address of the designated register group.

10.8.1 Input Registers (read-only): Integer (16-bit); address range 3000-3499

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
0	3000	3000-3001 (2 regs)	TestRegister uint 16	Test Register



INFORMATION!

Register reserved for testing communications and protocol handling with this type of register, without affecting the operation of the flowmeter.

10.8.2 Holding Registers (read/write): Integer (16-bit); address range 3500-3999

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
0	3500	3500-3501 (2 regs)	TestRegister uint 16	Test Register



INFORMATION!

Register reserved for testing communications and protocol handling with this type of register, without affecting the operation of the flowmeter.

10.8.3 Input Registers (read-only): Long integer (32-bit); address range 5000-5499

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
0	5000	5000-5001 (2 regs)	TestRegister uint 32	Test Register



INFORMATION!

Register reserved for testing communications and protocol handling with this type of register, without affecting the operation of the flowmeter.

Alarm / status events

Relative address	Absolute address		Name		Parameter / Variable (short description)
	non-Modicon	Modicon-comp.	Register	Bit	
1	5001	5002-5003 (2 regs)	Alarm& Status Pipe	A FailAll (bit 0)	Down all channels, no custody transfer standard (FAILED)
			Alarm flag indicating none of the acoustic paths is operational.		
1	5001	5002-5003 (2 regs)	Alarm& Status Pipe	A Fail Unreliable (bit 1)	Down Channels, Custody Transfer unreliable (FAILED)
			Alarm flag indicating some paths out of operation, reading NOT valid for custody transfer measurement.		
1	5001	5002-5003 (2 regs)	Alarm& Status Pipe	A Fail Reliable (bit 2)	Down Channels, but Custody Transfer reliable
			Alarm flag indicating some paths out of operation, reading valid for custody transfer measurement.		
1	5001	5002-5003 (2 regs)	Alarm& Status Pipe	A OOR_Flow (bit 4)	Out of range FLOW
			Status signal flow rate is out of range, activated at overspeeding by 25%.		
1	5001	5002-5003 (2 regs)	Alarm& Status Pipe	A OOR_Reynolds (bit 5)	Correction out of range REYNOLDS
			Alarm flag indicating Reynolds number out of range.		
1	5001	5002-5003 (2 regs)	Alarm& Status Pipe	A OOR_Substit (bit 6)	Correction out of range PATH SUBSTITUTION
			Alarm flag indicating gas velocity is out of range where path substitution can be applied. This signal only appears in case of active path substitution (at least one path failing) and gas velocity is out min/max limits OR Reynolds number is out of min/max limits OR no valid velocity profile is available.		
1	5001	5002-5003 (2 regs)	Alarm& Status Pipe	S Flow_Direction (bit 16)	Flow direction
			Status signal indicating flow direction: 0 = Forward flow 1 = Reverse flow		
1	5001	5002-5003 (2 regs)	Alarm& Status Pipe	S LowFlow CutOff	Low flow cut-off
			Status signal indicating low flow cut-off: 0 = Flow velocity above threshold. 1 = Flow velocity below threshold.		

Relative address	Absolute address		Name		Parameter / Variable (short description)
	non-Modicon	Modicon-comp.	Register	Bit	
1	5001	5002-5003 (2 regs)	Alarm& Status Pipe	S Reset Totals (bit 18)	Reset occurred: All Totalisers
			Status signal indicating totalisers have been reset. Note: this operation is only allowed for specially authorized personnel.		
2	5002	5004-5005 (2 regs)	Alarm& Status Channel_1	A Ch_Unreliable (bit 0)	Channel 1 Unreliable
			Alarm flag indicating path error (channel 1): channel unreliable.		
2	5002	5004-5005 (2 regs)	Alarm& Status Channel_1	A Ch_Down (bit 1)	Channel 1 Down
			Alarm flag indicating path error (channel 1): channel down.		
2	5002	5004-5005 (2 regs)	Alarm& Status Channel_1	A Ch_Deviation_SOS (bit 2)	Channel 1 Down: Deviation SoS too large
			Alarm flag indicating path error (channel 1): SOS deviation too large.		
2	5002	5004-5005 (2 regs)	Alarm& Status Channel_1	A Ch_Signal_Lost (bit 3)	Channel 1 Down: Signal lost
			Alarm flag indicating path failure (channel 1): signal lost.		
3	5003	5006-5007 (2 regs)	Alarm& Status Channel_2	A Ch_Unreliable (bit 0)	Channel 2 Unreliable
			Alarm flag indicating path error (channel 2): channel unreliable.		
3	5003	5006-5007 (2 regs)	Alarm& Status Channel_2	A Ch_Down (bit 1)	Channel 2 Down
			Alarm flag indicating path error (channel 2): channel down.		
3	5003	5006-5007 (2 regs)	Alarm& Status Channel_2	A Ch_Deviation_SOS (bit 2)	Channel 2 Down: Deviation SoS too large
			Alarm flag indicating path error (channel 2): SOS deviation too large.		
3	5003	5006-5007 (2 regs)	Alarm& Status Channel_2	A Ch_Signal_Lost (bit 3)	Channel 2 Down: Signal lost
			Alarm flag indicating path failure (channel 2): signal lost.		
4	5004	5008-5009 (2 regs)	Alarm& Status Channel_3	A Ch_Unreliable (bit 0)	Channel 3 Unreliable
			Alarm flag indicating path error (channel 3): channel unreliable.		
4	5004	5008-5009 (2 regs)	Alarm& Status Channel_3	A Ch_Down (bit 1)	Channel 3 Down
			Alarm flag indicating path error (channel 3): channel down.		
4	5004	5008-5009 (2 regs)	Alarm& Status Channel_3	A Ch_Deviation_SOS (bit 2)	Channel 3 Down: Deviation SoS too large
			Alarm flag indicating path error (channel 3): SOS deviation too large.		

Relative address	Absolute address		Name		Parameter / Variable (short description)
	non-Modicon	Modicon-comp.	Register	Bit	
4	5004	5008-5009 (2 regs)	Alarm& Status Channel_3	A Ch_Signal_Lost (bit 3)	Channel 3 Down: Signal lost
			Alarm flag indicating path failure (channel 3): signal lost.		
5	5005	5010-5011 (2 regs)	Alarm& Status Channel_4	A Ch_Unreliable (bit 0)	Channel 4 Unreliable
			Alarm flag indicating path error (channel 4): channel unreliable.		
5	5005	5010-5011 (2 regs)	Alarm& Status Channel_4	A Ch_Down (bit 1)	Channel 4 Down
			Alarm flag indicating path error (channel 4): channel down.		
5	5005	5010-5011 (2 regs)	Alarm& Status Channel_4	A Ch_Deviation_SOS (bit 2)	Channel 4 Down: Deviation SoS too large
			Alarm flag indicating path error (channel 4): SOS deviation too large.		
5	5005	5010-5011 (2 regs)	Alarm& Status Channel_4	A Ch_Signal_Lost (bit 3)	Channel 4 Down: Signal lost
			Alarm flag indicating path failure (channel 4): signal lost.		
6	5006	5012-5013 (2 regs)	Alarm& Status Channel_5	A Ch_Unreliable (bit 0)	Channel 5 Unreliable
			Alarm flag indicating path error (channel 5): channel unreliable.		
6	5006	5012-5013 (2 regs)	Alarm& Status Channel_5	A Ch_Down (bit 1)	Channel 5 Down
			Alarm flag indicating path error (channel 5): channel down.		
6	5006	5012-5013 (2 regs)	Alarm& Status Channel_5	A Ch_Deviation_SOS (bit 2)	Channel 5 Down: Deviation SoS too large
			Alarm flag indicating path error (channel 5): SOS deviation too large.		
6	5006	5012-5013 (2 regs)	Alarm& Status Channel_5	A Ch_Signal_Lost (bit 3)	Channel 5 Down: Signal lost
			Alarm flag indicating path failure (channel 5): signal lost.		
7	5007	5014-5015 (2 regs)	Alarm& Status Channel_6	A Ch_Unreliable (bit 0)	Channel 6 Unreliable
			Alarm flag indicating path error (channel 6): channel unreliable.		
7	5007	5014-5015 (2 regs)	Alarm& Status Channel_6	A Ch_Down (bit 1)	Channel 6 Down
			Alarm flag indicating path error (channel 6): channel down.		
7	5007	5014-5015 (2 regs)	Alarm& Status Channel_6	A Ch_Deviation_SOS (bit 2)	Channel 6 Down: Deviation SoS too large
			Alarm flag indicating path error (channel 6): SOS deviation too large.		

Relative address	Absolute address		Name		Parameter / Variable (short description)
	non-Modicon	Modicon-comp.	Register	Bit	
7	5007	5014-5015 (2 regs)	Alarm& Status Channel_6	A_Ch_Signal_Lost (bit 3)	Channel 6 Down: Signal lost. Alarm flag indicating path failure (channel 6): signal lost.
8	5008	5016-5017 (2 regs)	Alarm inputs	A_Temperature_OOR (bit 0)	Process Temperature: Out of range. Alarm flag, measured body temperature is out of range.
8	5008	5016-5017 (2 regs)	Alarm inputs	A_Temperature_OVR (bit 1)	Process Temperature: Override value used. Status/alarm flag indicating manual input of temperature value overrides measured temperature (process temperature input); will appear in case alarm parameter nr 6 set to enabled and Override Mode (User Control) set to enabled (mode 1 or 2); Mode 3 will not generate an alarm.
9	5009	5018-5019 (2 regs)	Status Totalisers	S_Fwd_Process_Roll (bit 1)	Rollover Totaliser Process Forward. Status signal, totaliser has reached maximum value that can be represented and displayed, totalising is continued starting from zero.
9	5009	5018-5019 (2 regs)	Status Totalisers	S_Rev_Process_Roll (bit 5)	Rollover Totaliser Process Reverse. Status signal, totaliser has reached maximum value that can be represented and displayed, totalising is continued starting from zero.
9	5009	5018-5019 (2 regs)	Status Totalisers	S_FwdFail_Process_Roll (bit 9)	Rollover Totaliser FAIL Process Forward. Status signal, totaliser has reached maximum value that can be represented and displayed, totalising is continued starting from zero.
9	5009	5018-5019 (2 regs)	Status Totalisers	S_RevFail_Process_Roll (bit 13)	Rollover Totaliser FAIL Process Reverse. Status signal, totaliser has reached maximum value that can be represented and displayed, totalising is continued starting from zero.

10.8.4 Holding Registers (read/write): Long integer (32-bit), address range 5500-5999

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
0	5500	5500-5501 (2 regs)	TestRegister uint 32	Test Register

**INFORMATION!**

Register reserved for testing communications and protocol handling with this type of register, without affecting the operation of the flowmeter.

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
1	5501	5502-5503 (2 regs)	ANSI time	Date and time

**INFORMATION!**

Built-in real time clock: date and time according to ANSI standard: number of seconds elapsed since January 1st, 1970, 00:00:00 hours.

Although this is a Holding Register, this register is readonly.

Use the KROHNE Flowmeter Configuration and Monitoring software to set or adjust the real-time clock.

10.8.5 Input Registers (read-only): Double (64-bit floating point), address range 6000-6499

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
0	6000	6000-6003 (4 regs)	TestRegister double64	Test Register

**INFORMATION!**

Register reserved for testing communications and protocol handling with this type of register, without affecting the operation of the flowmeter.

10.8.6 Holding Registers (read/write): Double (64-bit floating-point), address range 6500-6999

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
0	6500	6500-6503 (4 regs)	TestRegister double64	Test Register

**INFORMATION!**

Register reserved for testing communications and protocol handling with this type of register, without affecting the operation of the flowmeter.

10.8.7 Input Registers (read-only): Float (32-bit floating-point), address range 7000-7499

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
0	7000	7000-7001 (2 regs)	TestRegister float32	Test Register

**INFORMATION!**

Register reserved for testing communications and protocol handling with this type of register, without affecting the operation of the flowmeter.

Transit Time Measuring Process Values

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
1-6	7001-7006 (6 regs)	7002-7013 (12 regs)	Ch_GainAB	Gain "downstream" (= gain for transducer B), Channel 1-6
				Gain for transmission of signal from transducer A towards transducer B, array with values for channel 1 through 6 (in dB).
7-12	7007-7012 (6 regs)	7014-7025 (12 regs)	Ch_GainBA	Gain "upstream" (= gain for transducer A), Channel 1-6
				Gain for transmission of signal from transducer B towards transducer A, array with values for channel 1 through 6 (in dB).
13-18	7013-7018 (6 regs)	7026-7037 (12 regs)	CH_SNRratioAB	SNR "downstream" (= received at trd. B), Channel 1-6
				Signal-to-noise ratio for transmission of signal from transducer A towards transducer B, array with values for channel 1 through 6 (in dB).
19-24	7019-7024 (6 regs)	7038-7049 (12 regs)	CH_SNRratioBA	SNR "upstream" (= received at trd. A), Channel 1-6
				Signal-to-noise ratio for transmission of signal from transducer B towards transducer A, array with values for channel 1 through 6 (in dB).

Measured / entered process parameters

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
25	7025	7050-7051 (2 regs)	TemperatureProces	Temperature process value
			Value used for calculations, can either be the measured process value, a calculated (indirectly determined) value or a manual setting (fixed value) (in °C)	
26	7026	7052-7053 (2 regs)	ViscosityDynamic-Proces	Dynamic Viscosity at process conditions
			Value used for calculations, can either be the measured process value, a calculated (indirectly determined) value or a manual setting (fixed value) (in cP)	
27	7027	7054-7055 (2 regs)	DensityProces	Density Process
			Value used for calculations, can either be the measured process value, a calculated (indirectly determined) value or a manual setting (fixed value) (in kg/m ³)	

Calculated flow variables

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
28	7028	7056-7057 (2 regs)	Flow_Proces	Flow process
			Measured volume flow rate at process conditions (in m ³ /s).	
29	7029	7058-7059 (2 regs)	Velo_Proces	Velocity Process
			Measured gas velocity (in m/s) (integrated value from all paths) at process conditions.	
30	7030	7060-7061 (2 regs)	SoS	Speed of Sound
			Measured speed of sound (in m/s), average of all acoustic paths, corrected for mach effect.	
31-36	7031-7036 (6 regs)	7062-7073 (12 regs)	Ch_VeloRaw	Channel Velocity Channel 1-6
			"Raw" gas velocity as observed on each channel; array with values for channel 1 through 6 (in m/s).	
37-42	7037-7042 (6 regs)	7074-7085 (12 regs)	Ch_SoS	Channel SoS Channel 1-6
			Speed of sound as observed on each channel; array with values for channel 1 through 6 (in m/s).	

Statistics / diagnostics variables

Averages and standard deviations are calculated for a number of flow variables. The number of measurement values that are included in this calculation are specified by means of a preset parameter. Averages and standard deviations are evaluated and updated each time a number of measurements equal to this parameter has been collected. Collecting data for a new block of data to be evaluated then starts again from there.

As an exception to the rule above, for the flow standard deviation tau, the preset number of measurement values is evaluated every time a new measurement value becomes available. The series of measurements values then contains the most recent values and shifts with each acquired sample (measurement data), like a running average.

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
43-48	7043-7048 (6 regs)	7086-7097 (12 regs)	Ch_Reliab	Channel reliability, channel 1-6
			Reliability per channel (in %); array with values for channel 1 through 6.	
49-54	7049-7054 (6 regs)	7098-7109 (12 regs)	Ch_AV_Velocity	Channel velocity, average, channel 1-6
			Average gas velocity (in m/s), as observed on each channel; array with values for channel 1 through 6.	
55-60	7055-7060 (3 regs)	7110-7121 (12 regs)	Ch_AV_SoS	Channel SoS, average, channel 1-6
			Average speed-of-sound (in m/s), as observed on each channel; array with values for channel 1 through 6.	
61	7061	7122-7123 (2 regs)	AV_SoS	SoS Average
			Speed of Sound value, average (in m/s).	
62	7062	7124-7125 (2 regs)	AV_FlowProces	Flow Average
			Volume flow rate value, average (in m ³ /s).	
63	7063	7126-7127 (2 regs)	SD_FlowProces	Flow standard deviation
			Standard deviation of volume flow rate ("batchwise calculation") (in %).	
64	7064	7128-7129 (2 regs)	SD_FlowProces Tau	Flow standard deviation Tau
			Standard deviation of volume flow rate ("batchwise calculation") (in %).	
65	7065	7130-7131 (2 regs)	SD_SoS	SoS standard deviation
			Speed of Sound standard deviation (in %).	
66-71	7066-7071 (6 regs)	7132-7143 (12 regs)	Ch_SD_Velocity	Channel velocity standard deviation channel 1-6
			Gas velocity (in %), standard deviation, as observed on each channel; array with values for channel 1 through 6.	
72-77	7072-7077 (6 regs)	7144-7155 (12 regs)	Ch_SD_SoS	Channel SoS, standard deviation channel 1-6
			Speed of Sound (in %), standard deviation, as observed on each channel; array with values for channel 1 through 6.	
78	7078	7156-7157 (2 regs)	Weighted_Reliability	Overall weighted reliability
			The reliabilities of the individual paths are combined in an overall figure using the weighing factors of the paths (in %).	

10.8.8 Holding Registers (read/write): Float (32-bit) floating-point, address range 7500-7999

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
0	7500	7500-7501 (2 regs)	TestRegister float32	Test Register
			Register reserved for testing communications and protocol handling with this type of register, without affecting the operation of the flowmeter.	

Flowmeter configuration

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
1	7501	7502-7503 (2 regs)	Diameter	Internal diameter
			Internal diameter of meter body at the measuring section (in m).	
2	7502	7504-7505 (2 regs)	MeterConstat_Fwd	Meter constant forward
			Meter constant, forward flow direction.	
3	7503	7506-7507 (2 regs)	MeterConstant_Rev	Meter constant reverse
			Meter constant, reverse flow direction.	
4	7504	7508-7509 (2 regs)	ThermExp_Alpha_Pipe	Thermal expansion factor pipe material Alpha
			Property of the material of the meter body, used to calculate the effect of thermal expansion (in 1/° C)	
5	7505	7510-7511 (2 regs)	ThermExp_Reference_Temp	Reference temperature Body expansion
			Temperature (in ° C) at which the internal diameter of meter body at the measuring section is specified.	
6-11	7506-7511 (6 regs)	7512-7523 (12 regs)	Ch_PathLength_Cal	Channel Calibrated Path Length L, channel 1-6
			Length (in m) of acoustic path between two transducers of a measuring path; array with values for channel 1 through 6.	
12-17	7512-7517 (6 regs)	7524-7532 (12 regs)	Ch_Angle_Measuring	Channel Measuring Angle channel 1-6
			Angle at which the ultrasonic beam intersects with the meter body (in Deg); array with values for channel 1 through 6.	
18	7518	7536-7537 (2 regs)	Fwd_MaxFlowRate	Flow Full Scale Forward
			Indicated value (in m ³ /s) (full scale) at flow of 100 % of rated volume flow in forward flow direction.	
19	7519	7538-7539 (2 regs)	Rev_MaxFlowRate	Flow Full Scale Reverse
			Indicated value (in m ³ /s) (full scale) at flow of 100 % of rated volume flow in reverse flow direction.	
20	7520	7540-7541 (2 regs)	Fwd_LowFlowCutoff	Low Flow cutoff Forward
			For forward flow rates with smaller magnitude than this cutoff value, totalisers stop counting and outputs (such as the frequency output) will be disabled; flow rate indication will still be available (in m/s).	

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
21	7521	7542-7543 (2 regs)	Rev_LowFlowCutoff	Low Flow cutoff reverse
			For reverse flow rates with smaller magnitude than this cutoff value, totalisers stop counting and outputs (such as the frequency output) will be disabled; flow rate indication will still be available (in m/s).	
22	7522	7544-7545 (2 regs)	Low_Flowcut_Threshold	Low Flow cutoff Threshold
			Hysteresis preventing frequent on/off switching of low flow cut-off (in %).	

Alarm configuration

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
23	7523	7546-7547 (2 regs)	SOSDev	Allowed Deviation SOS per channel on SOS average pipe
			Defines alarm limit for deviation or measured SOS of any acoustic path from average value of all paths (in m/s) (all SoS values calculate with mach-correction).	
24	7524	7548-7549 (2 regs)	T_LimitHigh	Input Temperature Proces: LimitHigh
			Upper limit for process temperature measurement (in °C).	
25	7525	7550-7551 (2 regs)	T_LimitLow	Input Temperature Proces: LimitLow
			Lower limit for process temperature measurement (in °C).	

Viscosity configuration

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
26	7526	7552-7553 (2 regs)	VD_Reference_Visc	Dynamic Viscosity at Reference Temperature
			Input value of dynamic viscosity (in cP), used as base value to correct reference viscosity to actual viscosity at process temperature and pressure.	
27	7527	7554-7555 (2 regs)	D_Reference_Dens	Reference Density
			Input value of density (in kg/m ³), used as base value to correct reference density to actual density at process temperature and pressure.	

Override control

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
28	7528	7556-7557 (2 regs)	Ovr_Value_T	Temperature Process Manual override value
			Manually set temperature value (in °C), to be taken into effect in case of failing temperature measurement.	

10.8.9 Input Registers (read-only): Long long (64-bit integer), address range 8000-8499

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
0	8000	8000-8003 (4 regs)	TestRegister uint64	Test Register



INFORMATION!

Register reserved for testing communications and protocol handling with this type of register, without affecting the operation of the flowmeter.

Totalisers

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
1	8001	8004-8007 (4 regs)	Fwd_Proces	Totaliser PROCESS Forward
			Accumulated volume (with normal working meter) in forward flow direction, at line conditions (in ml (=10 ⁻⁶ m ³)).	
2	8002	8008-8011 (4 regs)	Rev_Proces	Totaliser PROCESS Reverse
			Accumulated volume (with normal working meter) in reverse flow direction, at line conditions (in ml (=10 ⁻⁶ m ³)).	
3	8003	8012-8015 (4 regs)	FwdFail_Proces	Totaliser FAIL PROCESS Forward
			Accumulated volume (with meter in error state) in forward flow direction, at line condition (in ml (=10 ⁻⁶ m ³)).	
4	8004	8016-8019 (4 regs)	RevFail_Proces	Totaliser FAIL PROCESS Reverse
			Accumulated volume (with meter in error state) in reverse flow direction, at line condition (in ml (=10 ⁻⁶ m ³)).	

10.8.10 Holding Registers (read/write): Long long (64-bit integer), address range 8500-8999

Relative address	Absolute address		Name	Parameter / Variable (short description)
	non-Modicon	Modicon-comp.		
0	8500	8500-8503 (4 regs)	TestRegister uint64	Test Register

**INFORMATION!**

Register reserved for testing communications and protocol handling with this type of register, without affecting the operation of the flowmeter.



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