elster
Instromet

Ultrasonic Flow Meter
Series 6

Q.Sonic^{max}

Manual
Operation and Maintenance

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Contents

1 General Information

1.1 About these Instructions

This manual is a complete guide to the operation and maintenance of an Ultrasonic Flow Meter (UFM) Series 6 **Q.Sonic^{max}** meter. This manual together with the UFM Series 6 Safety Instructions and UFM Series 6 Wiring Instructions provide essential information for safe use in compliance with and insofar applicable:

- European Directives (e.g. ATEX, PED, EMC, MID).
- International IECEx standards.
- North American FM Approvals standards.
- Canadian CSA standards.

This manual explains how to verify which certifications your flow meter complies with, based on the labelling from the ultrasonic flow meter. The manual also contains important instructions to prevent accidents and serious damage before start-up, during operation, and to maintain trouble-free operation in the safest possible way throughout the entire lifespan of the device. Before using the product read this manual carefully, familiarise yourself with the operation of the product, and strictly follow the instructions.

If you have any questions, or need further details on specific matters concerning this product, please do not hesitate to contact one of our staff members by email at **gas-mainz-quotations@honeywell.com** (or see more contact information on page 2).

Important!

It is required to read and understand all other documentation of your meter.

⇨ **Please see Appendix II – References on page 81 for a complete list of resources.** Additionally, you may look online at **http://www.docuthek.com/**.

1.2 Limitation of Liability

This manual is based on the latest information available. It is provided subject to alterations. We reserve the right to change the construction and/or configuration of our products at any time without obligation to update previously shipped equipment.

The warranty provisions stipulated in the manufacturer's *Terms of Delivery* are applicable to the product. The manufacturer shall have no obligation in the event that:

- Repair or replacement of equipment or parts is required through normal wear and tear, or by necessity in whole or part by catastrophe, or the fault or negligence of the purchaser;
- The equipment, or parts, have been maintained or repaired by someone other than an authorized representative of the manufacturer, or have been modified in any manner without prior express written permission of the manufacturer;
- Non-original parts are used;
- Equipment is used improperly, incorrectly, carelessly or not in line with its nature and/or purpose;
- Use of this product with unauthorized equipment or peripherals, including, but not necessarily limited to, cables, testing equipment, computers, voltage, etc.

The manufacturer is not responsible for the incidental or consequential damages resulting from the breach of any express or implied warranties, including damage to property, and to the extent permitted by law, damage for personal injury.

Read through this Operation and Maintenance manual carefully before beginning any work.

The manufacturer assumes no liability for loss and malfunctions that result from non-compliance with these instructions.

We reserve the right to make technical changes within the scope of improving performance characteristics and continuous development of the device.

Current warranty conditions in the General Terms and Conditions are available on our website:

http://www.elster-instromet.com/en/general-terms-of-business

2 Text Labelling

This manual employs consistent visual cues and standard text formats to help you easily locate and interpret information. This information will help you quickly identify relevant content.

2.1 Presentation of Safety and Risk Instructions

Hazard Warnings

Hazard warnings indicate hazardous situations which may result in material damage and bodily harm or even death if disregarded. Hazard warnings are described below:

DANGER WORD!

Type of danger / consequences in case of non-compliance

Avoiding danger

Safety Instructions

Safety instructions include notes and information which if disregarded may lead to functions not working correctly or not working at all. Safety instructions are described below:

Safety instruction (optional)

Safety instruction text

Tips and Recommendations

Tips include notes and information that make it easier for the user. Tips are described below:

Heading (optional)

Hint text

2.1.1 Paragraph Formats

► This triangle prompts you for an action.
✓ This character will show you the immediate result of your action.

Example

Multi-row examples are marked by two continuous blue lines and the keyword “Example”.

2.1.2 Character Formats

Example	Use
⇨ See Chapter 5 System Description (p.19)	References to additional information are marked with an arrow. If the arrow refers to information within the document, these references are formatted as hyperlinks in blue font. You can go directly to the corresponding section by clicking on the blue text.
www.docuthek.com	Links (Hyperlink). Click to open in a browser.
Info	Seen on the meter screen itself; this shows a hyperlink within the meter software. You must highlight the hyperlink before it will open the next screen.
Info	The hyperlink (shown above) has been **highlighted**. Press the ↵ button on the touch screen (or PC) to open the new window. Ex: Open the **Info** section.

Table 1: Character formats

2.1.3 Abbreviations

The following abbreviations may appear in this document:

AFB	**A**pplication **F**unction **B**lock
ATEX	**At**mosphères **Ex**plosibles; European Directive 94/9/EC on equipment and protective systems intended for use in potentially explosive atmospheres New Directive (valid 20.04.2016): 2014/34/EU
CSA	**C**anadian **S**tandards **A**ssociation
DC	**D**irect **C**urrent
EC	**E**uropean **C**ommunity
EMC	**E**lectro**M**agnetic **C**ompatibility; European EMC Directive 2004/108/EC New directive (valid 20.04.2016): 2014/30/EU
HART	**H**ighway **A**ddressable **R**emote **T**ransducer
IECEx	**I**nternational **E**lectrotechnical **C**ommission System for Certification to Standards Relating to Equipment for use in **Ex**plosive Atmospheres
FM	**F**actory **M**utual Approvals
NMi	**N**ederlands **M**eet**i**nstituut
PED	**P**ressure **E**quipment **D**irective; European Directive 97/23/EC concerning pressure equipment New Directive (valid 19.07.2016): 2014/68/EU
PC	**P**ersonal **C**omputer
PCB	**P**rinted **C**ircuit **B**oard
SPU	**S**ignal **P**rocessing **U**nit
UFM	**U**ltrasonic **F**low **M**eter

3 Ultrasonic Flow Meter Series 6

3.1 General

The UFM Series 6 Q.Sonic^{max} is a sophisticated, multi-path ultrasonic gas flow meter manufactured by Elster. It has been specifically designed for custody transfer measuring applications that demand a high degree of accuracy and reliability. It can be extended with an extra functionality whereby the flow meter has the possibility to convert the measured line volume to standardised volume, mass or energy.

WARNING!

Improper use of an UFM Series 6 may not only result in unreliable performance, but may lead to hazardous situations.

Please refer to the type plates, located on the meter for the correct operating conditions. Never use the meter outside these limitations!

The Ultrasonic Flowmeter Series 6 contains 2 type plates:

- **Main plate**: Provides information on mechanical design conditions as well as flow related information such as meter factor and range
- **SPU type plate**: Provides information on applicable hazardous area approval.

Ensure the meter never operates outside the limits stated on the type plates. Any discrepancy between the type plates should be reported to Elster or your local agent immediately. ⇨ Please refer to Chapter 5.6 Labels and Nameplates (p.23) for more information.

3.2 Applicable Standards

The Ultrasonic Flow Meter Series 6 is manufactured to be in accordance with European Directives: ATEX, PED, EMC and optionally MID.

If the meter is ordered for use at a location where European Directives are NOT mandatory, the meter can alternatively be manufactured in compliance with IECEx, FM Approval or CSA certificate for use in hazardous areas.

Applicable standards for the optional integrated flow computer functionality are: AGA8-92 DC, SGERG-88, AGA-NX19 and ISO 6976.

3.3 Configuration

Several pairs of transducers are mounted in pairs on the flow cell of the UFM. Each pair of transducers represents one individual measuring path. There are three different measuring path types on the Q.Sonic^{max}. These are shown in Figure 3-1.

- Direct Bottom/Top: no bounce, at 0.707 radius
- Direct Mid: no bounce, straight through the middle
- Swirl: double bounce

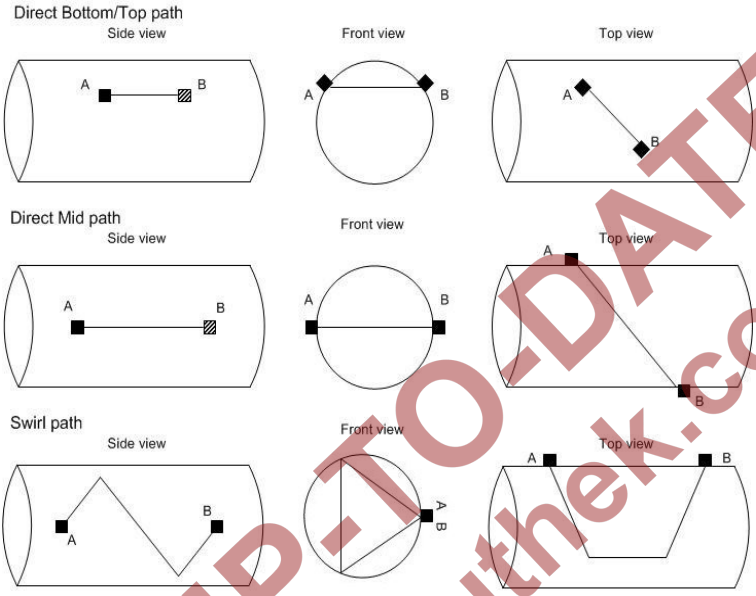


Figure 3-1: Path Types

The Q.Sonic^{max} path layout consists of 6 direct and 2 swirl paths. This combination ensures the most optimal measurement accuracy combined with a highly robust nature. It provides measurements of the highest standards even in difficult applications (e.g. high CO2, low pressure, high ultrasonic noise…).

Figure 3-2 shows the path layout of the Q.Sonic^{max}.

Q.Sonic^{max} Path Configuration

Front view: Side view:

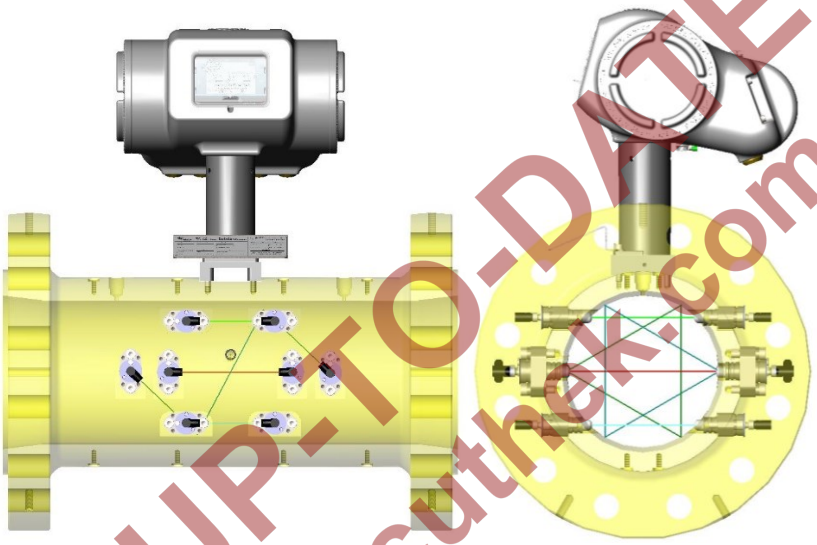


Figure 3-2: Path Layout Q.Sonic^{max}

When using the UFM Series 6 Q.Sonic^{max} in custody transfer applications, most countries demand (by law) a calibration from a certified calibration institute supervised by an inspector of weights and measures. Examples of facilities generally used for calibrations are Euroloop in Rotterdam (NL), TransCanada Calibrations in Canada and PIGSAR GH45 or Open Grid European Dorsten (D).

If the Q.Sonic^{max} meter has to be in accordance with MID, extra restrictions should be taken into account. ⇨ Please see Chapter 12.4 Calibration (p.64).

4 Theory of Operation

An ultrasonic flow meter is an inferential measurement device that consists of ultrasonic transducers that are typically located along a pipe's wall. The transducers are inserted into the piping using a gas tight mechanism. Ultrasonic pulses are alternately transmitted by one transducer and received by the other one.

Figure 4-1 shows a simple geometry of two transducers, 'A' and 'B', at a sharp angle "φ" with respect to the axis of a straight cylindrical pipe with diameter "D". Please note: the Q.Sonic^{max} flow meter employs reflection paths, where the acoustic pulses reflect one or more times off the pipe wall.

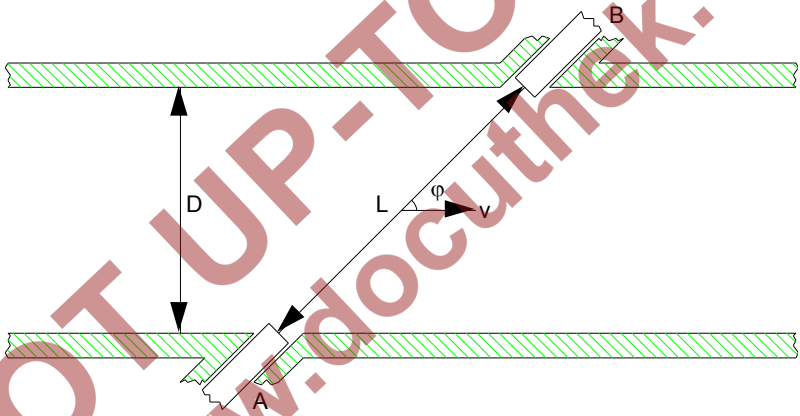


Figure 4-1: Ultrasonic Measuring Line

4.1 Flow Velocity Measurement

The acoustic pulses are crossing the pipe like a ferryman crossing a river. Without flow, they propagate with the same speed in both directions. If the gas in the pipe has a flow velocity different from zero, pulses travelling downstream with the flow will move faster, while those travelling upstream against the flow will move slower. Thus, the downstream travel times "t_{ab}" will

be shorter, while the upstream ones "t_{ba}" will be longer as compared when the gas is not moving. The equation below illustrates the computation:

$$VoG_{raw_n} = \frac{L_n}{2 \cdot \cos(\varphi_n)} \cdot \left(\frac{1}{tab_n} - \frac{1}{tba_n} \right)$$

where:

t_{abn} the downstream travel time of path n.

t_{ban} the upstream travel time of path n.

L_n the straight line length of the acoustic path between the two transducers.

$VoGraw$ is the average uncorrected (raw) gas velocity.

φ_n the angle between the gas flow and ultrasonic signal.

The raw gas velocity is corrected by a Reynolds flow profile correction. This correction is depending on the path type. Also the contribution of the gas velocity of each path to the combined gas velocity is depending on the path type.

4.2 Correction after Calibration

After flow calibration the meter can be adjusted either through an adjust factor or through linearization. How the meter is adjusted can be visualized at the display. ⇨ Please see Chapter 7.1 LED at Display (p.34).

4.3 Volume Flow at Line Conditions

The volume flow at line conditions Q_{Line} is the (adjusted) profile-corrected gas velocity V_{line} multiplied by the internal cross section A of the flow cell:

$$Q_{line} = V_{line} \cdot A \cdot t$$
$$= V_{line} \cdot \frac{\pi \cdot D^2}{4} \cdot 3600 \left[m^3/h \right]$$

where:

Q_{Line} the volume flow at line conditions
V_{line} the adjusted profile-corrected gas velocity
D the internal diameter of the meter
A the internal cross-section of the flow cell
t time coefficient to go from seconds to hours.

5 System Description

5.1 Flow Cell

The flow cell is the part of the UFM Series 6 that is mounted in the piping system. All components making the UFM Series 6 (SPU, transducers, type plates, temperature sensor, and optional pressure sensor) are mounted on the flow cell. Please see Figure 5-1 below.

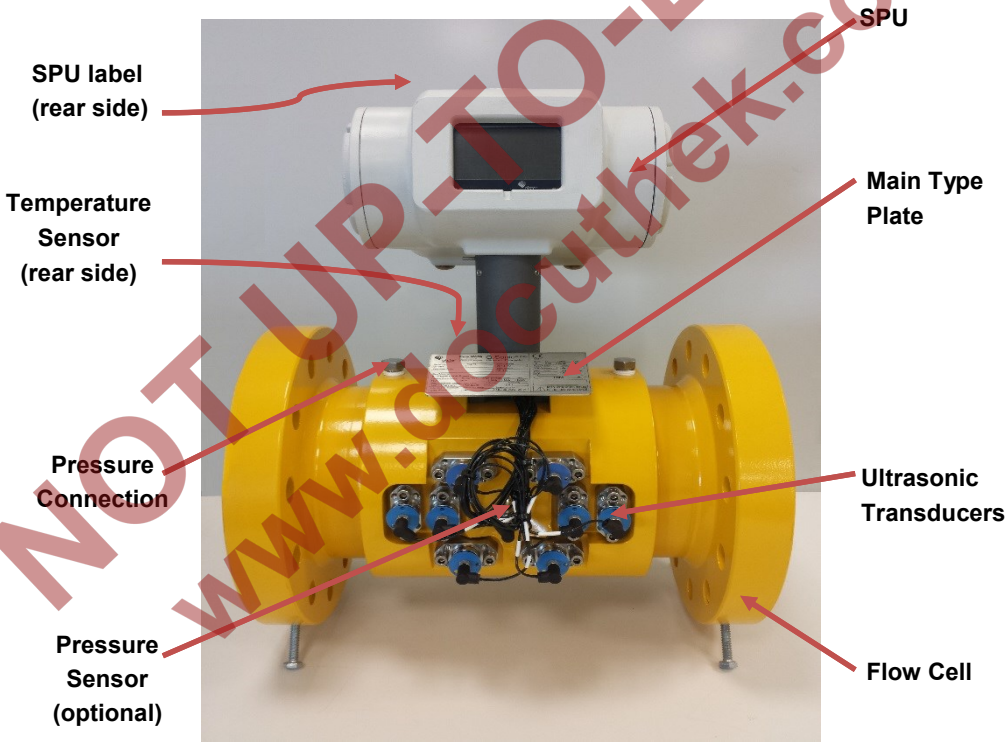


Figure 5-1: Example of an Elster Ultrasonic Gas Flow Meter

5.2 Signal Processing Unit

The SPU is mounted in an explosion proof housing. The box consists of two separate compartments; a main and a rear compartment (see Figure 5-2).

The main compartment can be opened from the side of the SPU and contains the main circuit boards. The main compartment also comprises intrinsically safe connections for the ultrasonic transducers and temperature and optional pressure sensors. All data processing from excitation of the transducers to calculating the flow rate is handled by the electronics in this compartment.

To prevent the box from opening by vibration, the covers on the side need to be firmly tightened and secured with the lock screw in the cover, as seen in Figure 5-2. When closing the back compartment, ensure all screws are used.

A grounding point can be seen at the bottom of the SPU. As the meter is already internally grounded, it is not necessary to use this grounding for normal operation.

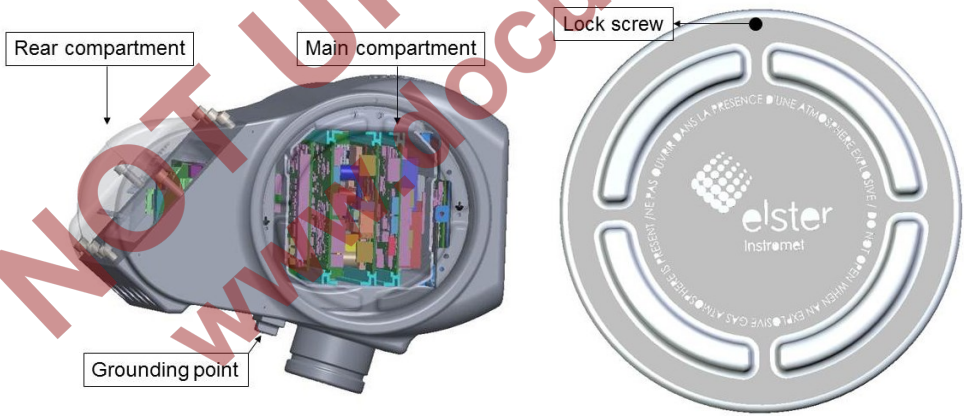


Figure 5-2: SPU Compartments and SPU Cover

The rear compartment comprises of a field terminal board used for connecting the Ultrasonic Flow Meter Series 6 to the end user's applications. For detailed information about this see ⇨ Chapter 6.3 Wiring Instructions (p.32).

5.3 Transducers

The ultrasonic signals required for the flow measurement are generated and received by ultrasonic transducers.

Piezoelectric transducers employ crystals or ceramics that are set into vibration when an alternating voltage is applied to the piezoelectric element. The vibrating element generates sound waves in the gas. Since the piezoelectric effect is reversible, the element will become electrically polarised and produce voltages related to the mechanical strain, when the crystal is distorted by the action of incident sound waves. Because the acoustic impedance of the gas is much smaller compared to the acoustic impedance of the piezoelectric element, and to maximise the acoustic efficiency, a matching layer is employed between the gas and the piezoelectric element.

The transducers used in the Ultrasonic Flow Meter Series 6 are type ‘NG’, see Figure 5-3. Figure 5-4 visualises the NG transducer with the mounting bracket.

Figure 5-3: NG Transducer

Figure 5-4: NG Transducer with Mounting Bracket

5.4 Flow Cell Pressure Sensor (Optional)

As an optional feature the UFM can be equipped with a pressure sensor. This pressure sensor is used for:

- Reynolds flow profile correction
- Compensation of the flow cell expansion due to gas pressure.

CAUTION!

The pressure sensor is not used for volume conversion.

5.5 Flow Cell Temperature Sensor

The UFM is equipped with a temperature sensor. The temperature sensor is used for:

- The Reynolds flow profile correction
- Compensation of the flow cell expansion due to flow cell temperature

5.6 Labels and Nameplates

Nameplates and labels are used to identify the product and to provide details on the specific product. Together with the product manual it specifies how the product is certified and designed.

- The main (type) plate (see Figure 5-5, for an example of a Q.Sonic^{max} main plate) provides information on mechanical design conditions as well as flow related information such as meter factor and range. If the UFM has been manufactured in accordance with the Measuring Instruments Directive (MID) the related certificate reference T10586 is mentioned in the top right corner of the main plate. ⇨ Refer to Chapter 12 MID Requirements (p.63) for more information about MID.

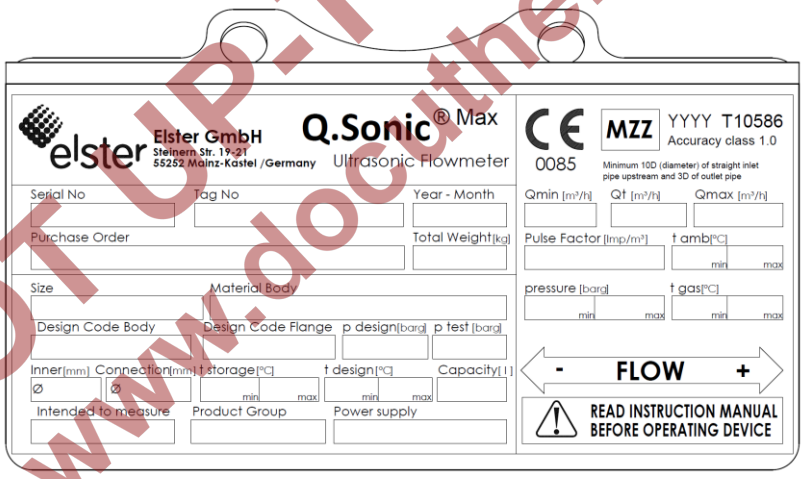


Figure 5-5: Example of a Q.Sonic^{max} Main Plate

- Refer to the type plate on the SPU for the applicable hazardous area approval. This could be according to ATEX, IECEx, FM or CSA. ⇨ Please refer to Figure 5-6 to Figure 5-9 for type plate examples for a Q.Sonic^{max} meter.

5.6.1 ATEX Certified

The explosion proof housing has the following ATEX certification information:

- Classification: Ex II 2 G Ex d ia [ia] IIB+H2 T6 Gb IP66
- -50 °C ≤ Tamb ≤ +60 °C
- ATEX markings: Ⓔ II 2 G Ⓧ 0044
    - 0044 is the notified body number of TÜV NORD CERT GmbH
- ATEX certificate reference: DEKRA 11ATEX0170 X
- Warning: Read instruction manual before operating device.

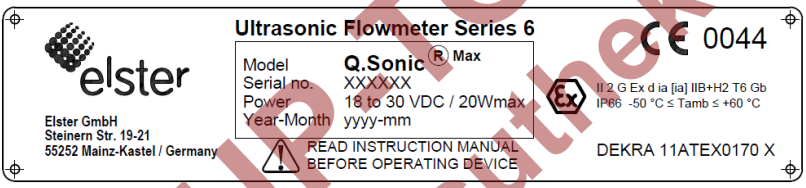


Figure 5-6: Example of an ATEX Label

5.6.2 IECEx Certified

The explosion proof housing has the following IECEx certification information:

- Classification: Ex d ia [ia] IIB+H2 T6 Gb IP66
- -40 °C ≤ Tamb ≤ +60 °C
- IECEx certificate reference: IECEx DEK11.0062 X
- Warning: Read instruction manual before operating device

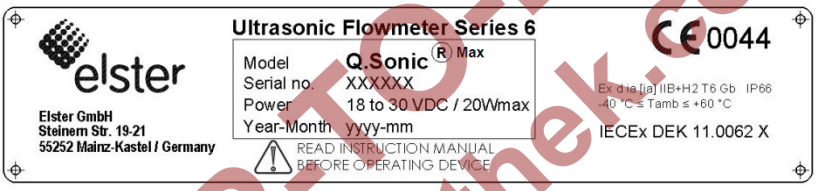


Figure 5-7: Example of an IECEx Label

5.6.3 FM Certified

The explosion proof housing has the following FM certification information:

- Explosion proof for Class I, Division 1, Group A, B, C and D
- Intrinsically safe for Class I, Division 1, Group A, B, C and D
- Ta = -40 °F to 140 °F (-40 °C to +60 °C), T6
- Type 4X
- “FM approved” mark
- Installation requirement: Seal fitting required within 1.5 inches of enclosure
- Warning: Read Instruction Manual (Control Drawing: 03.304.001.003.05/2) before operating device. See UFM Series 6 Safety Instructions (⇨ listed in Appendix II – References) for the control drawing.

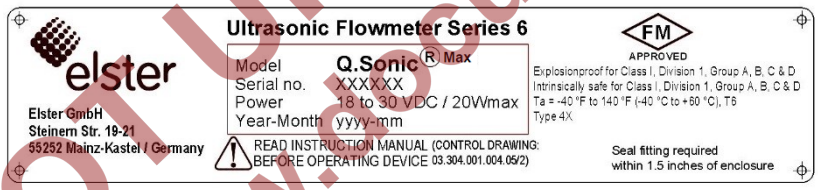


Figure 5-8: Example of an FM Label

5.6.4 CSA Certified

The explosion proof housing has the following CSA certification information:

- Explosion proof for Class I, Division 1, Group B, C and D T6
- Ex d ia [ia] IIB + H2 T6
- -50 °C ≤ Tamb ≤ +60 °C
- Type 4X
- IP66
- CSA 13.70001043
- Installation requirement: Seal all conduit within 1.50 inches in group B & C
- Warnings:
    - Substitution of components may impair intrinsic safety.
    - Read Instruction Manual (Control Drawing: 03.304.001.004.05/2) before operating device. See UFM Series 6 Safety Instructions (listed in ⇨ Appendix II – References) for the control drawing.

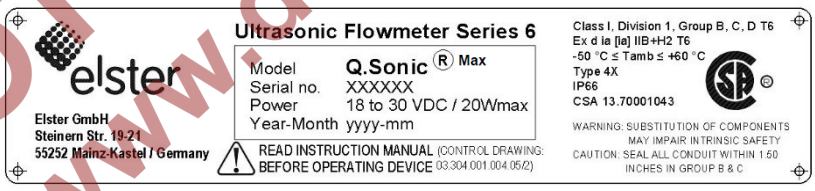


Figure 5-9: Example of a CSA Label

5.7 Sealing

This chapter describes the important sealing locations and sealing process as required by MID certificate T10586 (⇨ see also Chapter 12 MID Requirements [p.63]). Even if MID is not required it is advised to seal the UFM.

5.7.1 Main Plate

Figure 5-10 displays how the main plate is sealed to the flow cell:

Figure 5-10: Seal on the main plate to the flow cell

5.7.2 SPU

The SPU in the main compartment of the flameproof certified box is sealed in 2 locations.

- By means of the PCB sealing bracket the SPU electronics is sealed to the flameproof certified box. Please see Figure 5-11 below.

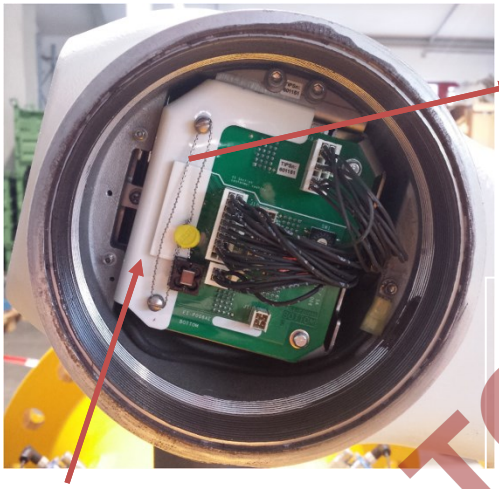
Figure 5-11: Example of a PCB sealing bracket

- The meter should be protected from undesired changes in the software.

1. Therefore a hardware switch is placed on the main board. This hardware switch can be reached through an opening in the back panel. The hole in the back panel is protected with a plastic cap (see Figure 5-12).

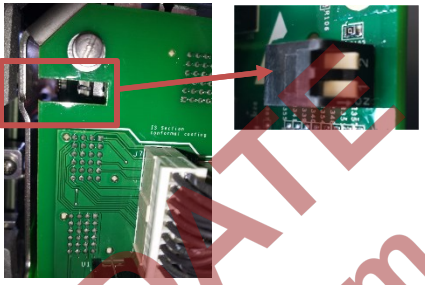
   If both pins on the switch are **up**, the meter is sealed and the parameter settings of the meter are locked from editing.

   If both pins on the switch are **down**, the meter is unsealed and parameter settings can be altered using the software program SonicExplorer. Sealing of the switch itself should be done with the screw socket on the protective cap.



Backpanel with **Protective Cap**

(Screw sockets are used for sealing)



Sealing switch on the mainboard is accessible after removing the protective cap.

- Meter **unsealed**: both pins **down** (Towards the print board)
- Meter **sealed**: both pins **up** (Away from the print board)

Figure 5-12: Hardware protection on the main board

2. In addition to the hardware protection, access to the meter software is secured by different user access levels and password protection. ⇨ See Chapter 9.5 PC Software Package (p.61).

6 Installation and Commissioning

6.1 Introduction

It is very important to check the shipment of your ultrasonic flow meter equipment. A visual inspection of surfaces and flanges should be performed. In case of damage, contact Elster immediately.

As well, please verify if all the necessary documentation is available. In addition to this Operation and Maintenance manual, you also require (at bare minimum) the UFM Series 6 Safety Instructions.

Please refer to ⇨ Appendix II – References for a complete list of related documentation.

Also look at your project data to see if extra documentation is required and delivered. If documentation is missing, contact Elster or your local agent immediately.

6.2 Flow Cell Installation Requirements

6.2.1 Installing a Meter in the Pipeline

The Ultrasonic Flow Meter Series 6 (including flow cell, transducers and SPU) is shipped in a suitable box (e.g. wooden box, cardboard box …). Carefully disassemble the box. Remove the transport straps from the flow cell, and then move the ultrasonic flow meter (using the lifting lugs provided on the flow cell) to the installation site. Install the meter according to the end-user's company regulations and applicable local and national requirements. To ensure optimal performance of the UFM, comply with the up- and downstream spool requirements specified for your particular UFM (see your order documentation).

WARNING!

To avoid possible injury, make sure the lifting equipment is suitable for the weight of the Ultrasonic Flow Meter Series 6. Always use the lifting lugs and make sure lifting equipment is certified and shows no damage or wear.

Eyebolts must be inspected before each use and used according to the manufacturer's specification.

Be Aware!

Special attention needs to be taken when the UFM Series 6 Q.Sonic^{max} has to be installed in accordance with MID. ⇨ See Chapter 12.5 Installation Requirements (p.64).

For FM Approved and CSA Certified UFMs also see their respective Control Drawings and particular installation remarks in the UFM Series 6 Safety Instructions (⇨ listed in Appendix II – References).

6.2.2 Testing Installation

The flow cell is always hydrotested in-house at the correct hydrotest pressure before the transducers are installed on the ultrasonic flow meter. Herewith all welding of the flow cell is checked. When a Series 6 UFM is installed in a pipe line, it is no longer possible to hydrotest the pipeline. Water can be trapped between the housing and the transducers, causing the meter to have difficulties measuring.

Before pressurizing, check all pressure points on the meter. If necessary remove the cover caps to have a clear view of the entire pressure point, particularly when an adapter is fitted on the meter body.

6.3 Wiring Instructions

All detailed information about wiring is stated in the UFM Series 6 Wiring Instructions, as well as UFM Series 6 Safety Instructions (⇨ see Appendix II – References). Please refer to these documents for correct wiring.

6.4 SPU Configuration

When the meter is installed and correctly wired, it is advisable to read out the parameter settings of the meter. If the meter has been calibrated before, the parameter set-up should be compared to the one of the calibration.

The parameter set-up can be read with the software package SonicExplorer. Connection should be made through the Ethernet or VDSL communication, more detailed information about this matter can be found in the manual of the software packages. When discrepancies are detected; contact Elster or your local representative immediately.

WARNING!

When opening the SPU (either main or rear compartment), obey the rules and regulations that apply to hazardous area operations.

6.5 Cold Commissioning

During cold commissioning the meter is pressurized with a known gas composition at a known temperature and pressure, because in the case of atmospheric (low pressure) conditions, the UFM is not able to measure correctly.

A thorough functional test is performed by means of a PC and diagnostic software package (SonicExplorer). Diagnostics and status per measuring path and the zero flow can be checked, assuming there is sufficient pressure in the meter. A technician of Elster will, if this has been agreed, verify measurements and check the system performance.

6.6 Hot Commissioning

The hot commissioning is in most cases the last test of the UFM and can be witnessed by a representative of the client and, if required, by an inspector of weights and measures for the official sealing. Under this condition there is process gas in the pipe and a flow test is being performed. The performance, AGC Levels/Limits and zero flow are checked again. If possible, the gas flow running through the UFM will be compared to another flow meter in the line. Most UFMs are calibrated gas flow meters, so the

measured value is reliable without exception. Furthermore, the interaction with the flow computer can be tested.

7 Operation

This chapter describes how the UFM Series 6 can be operated through the interactive touch screen display on the meter.

7.1 LED at Display

2 LEDs provide an overall status indication of the meter.

Figure 7-1: LED at Display

Power LED - **LED 1** at Figure 7-1	
LED Status	**Description**
Off	Power is off
Green	Power is on

Table 2: Power LED

Status LED - **LED 2** at Figure 7-1	
LED Status	**Description**
Off	Power is off or; the device is running warning and error free.
Yellow, flashing	A warning is pending that does not affect the metrology relevant functionalities. *
Yellow, permanently illuminated	At least one warning that does not affect the metrology relevant functionalities was pending but has already ended. *
Red, flashing	An error is pending that affects the metrology relevant functionalities. *
Red, permanently illuminated	At least one error that affects the metrology relevant functionalities was pending but has already ended. *)

* The user has to accept such warnings at the operation panel before the colour of the status LED turns back to off (see Chapter 9.4)

Table 3: Status LED

7.2 Front Panel and Touch Display

The SPU contains an interactive touch screen display, showing the most important measurements and diagnostics (line flow, gas velocity, speed of sound, totalizers …). It contains a touch screen with 7 touch areas (see Figure 7-2) These touch areas will disappear when not in use and reappear with a touch of the screen in one of the 7 touch areas.

Figure 7-2: Front Panel Basic Display with 7 touch areas

Press the bent arrow ↵ in the middle of the screen to select and open a highlighted menu.

View Front Panel on your PC

It's also possible to mimic the interactive touch screen display on your PC. To do this, connect the Ethernet cable at the field terminal board (⇨ for help, refer to document: UFM Series 6 Wiring Instructions, listed in Appendix II – References.
Next, go to the internet browser of the PC and type the following address: **http://xxx.xxx.xxx.xxx/frontpanel.html** (where xxx.xxx.xxx.xxx represents the IP-address of the meter).

7.3 Basic Display

The basic display is shown below in Figure 7-3 and displays the following values:

- **Qline** - Gas line flow running through the meter in m^3/h.
- **Vm FWD (Volume Forward)** - Total amount of gas volume passed through the meter in the positive direction.
- **Vm REV (Volume Reverse)** - Total amount of gas volume passed through the meter in the negative direction.
- **Vline** - Speed of the gas running through the meter. (Scroll down on the meter display to view)

Touch one of the 7 touch areas (as seen above in Figure 7-2) and use the arrow buttons on the right to navigate up and down.

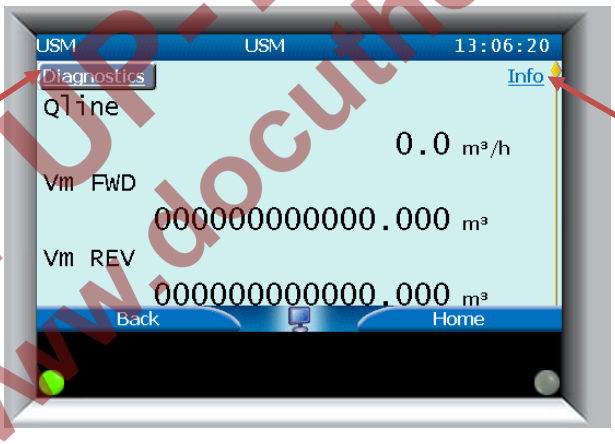


Figure 7-3: Basic Display/USM

Along the top of the basic display page you will see the sub-menus **Diagnostics** and **Info** marked with red arrows in Figure 7-3. You have to scroll to the top of the page to view or select these sub-menus. For more information on Diagnostics, as well as the two submenus from this screen, please see ⇨ Chapters 7.5 Diagnostics (p.43) and 7.6 Info (p.50), respectively.

7.4 Home Screen

Pressing the **Home** button from the **Basic Display** (as seen in Figure 7-3) will bring you to a screen as depicted below in Figure 7-4.

Figure 7-4: Home Screen and Menu

Touch the screen in one of the 7 touch areas to activate the arrows. Use the arrow buttons on the left and right to navigate and highlight a particular option on the screen. Press the bent arrow ↵ in the middle of the screen to select and open a menu. When connected with the front panel through Ethernet, you can click in one of the 7 touch areas, navigate by clicking on the arrows, and click the bent arrow to select the option you desire.

Below is an overview of the available options:

❶ Language Selection

Standard language setting is English. Select **Deutsch** for German language setting.

❷ Info (Basic Information)

In this menu some general important information about the meter can be found, regarding: **Device Monitor** information, **Software status**, **License information**, and the **IP address**. Through this menu it is also possible to perform a display test. Please see Figure 7-5. After selecting **Display test**, the screen will alternate between black and white. Pressing **Back** or **Home** will stop the test.

Figure 7-5: Info Screen

❸ Error List

Here you can see a list of the most recent meter errors, filtered by error type if desired. If the errors are no longer relevant, you can select **Accept all** and the errors will be accepted and removed from the list. To use the filter, scroll

up and select your desired filter, as seen in Figure 7-6. A logbook of errors is available on the right hand side.

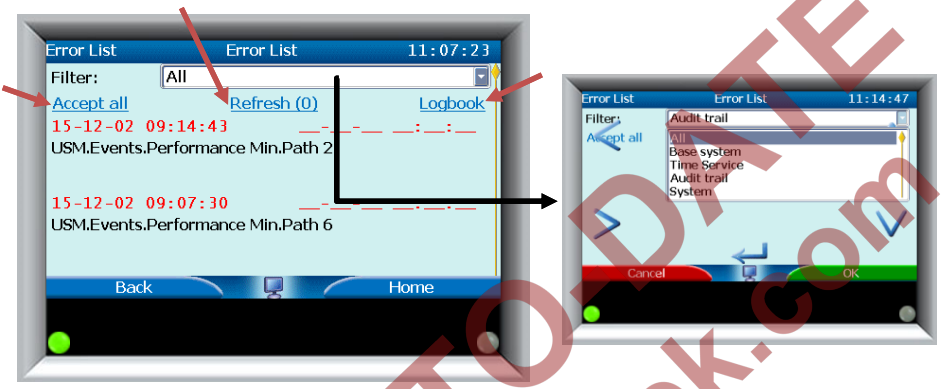


Figure 7-6: Error List and Filter

❹ System

The System screen contains general system information including **Time Service** (setting the date and time), **Users** (logging in with appropriate user rights), an **Error List**, an **Audit trail**, **Intelligent measurement devices**, and **Measurement tools**. A brief description of each submenu is described below.

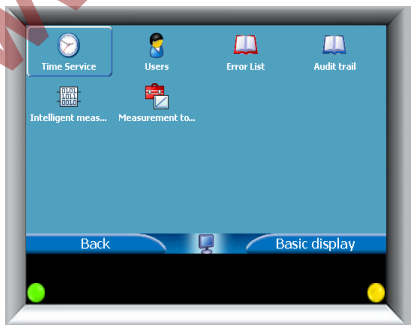


Figure 7-7: System Screen

Time Service – To program the date and time of the meter:

- ► Highlight **Date & Time** (from **Basic Display** -> **Time Service**)
- ► Press the select arrow ↵.
- ► Highlight and select **Update date and time** when you have entered the correct information.
- ✓ Date and time will be updated.

Please note: you have the possibility to activate daylight savings time. See Figure 7-8.

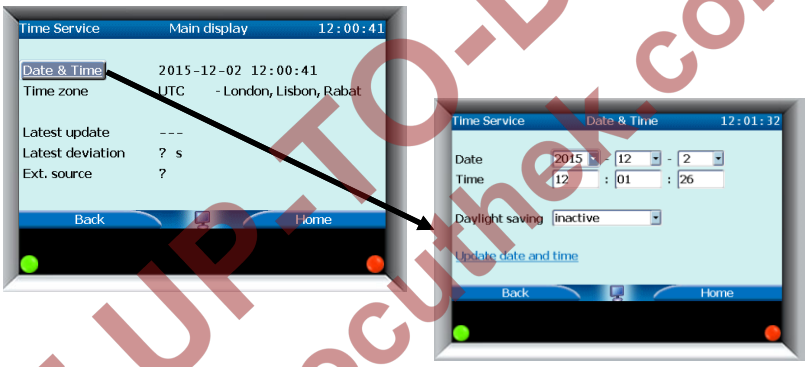


Figure 7-8: Update Date & Time

❺ USM

This button will also bring you back to the **Basic Display**.
⇨ Please see Chapter 7.3 Basic Display (p.37) for more information.

❻ Archive

With the software package SonicExplorer it is possible to set up an archive in the Series 6 Ultrasonic Flowmeters. For detailed information about the nature of the archive and its possibilities, please refer to the SonicExplorer

user manual, available at http://www.docuthek.com/. By choosing the right **Group** and **Channel** and selecting **Show values** it is possible to see all important data of the selected archive (see Figure 7-9).

Figure 7-9: Archives Screen

❼ Modbus

This menu will bring you to the Modbus protocol screen. Modbus Registers are listed on the left hand side, with corresponding values on the right. (For example in Figure 7-10 the Modbus Register 00000 relates to the Flow Meter Identification Code. E.g. the output of 66 equates to the UFM model Q.Sonic^{plus}.

For the descriptions of each value output and other information regarding Modbus Protocol, please see the document UFM Series 6 Modbus Protocol - listed in ⇨ Appendix II – References, or available online at http://www.docuthek.com/.

Figure 7-10: Modbus Screen

7.5 Diagnostics

- ► From the **Basic Display** screen, scroll to the top of the page and highlight the **Diagnostics** field in the top left hand corner. (See Figure 7-3)
- ► Press the select arrow to open the diagnostics screen.
- ✓ From this window it is possible to perform some easy firsthand diagnostics of the ultrasonic flow meter and its individual paths.

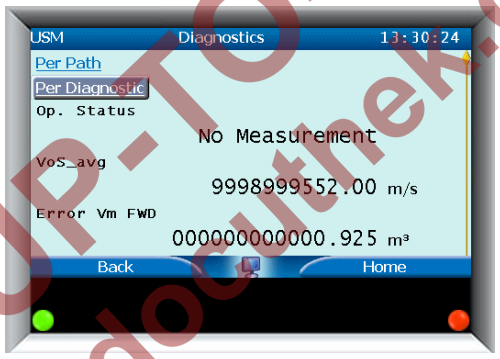


Figure 7-11: General Diagnostics Screen

The main diagnostics display shows general meter diagnostics, all of which is detailed in Table 4 (you must scroll down). You may view diagnostics in two ways:

Per Path (Path 1, Path 2, etc.) or

Per Diagnostic (VoG Raw, VoS Raw, Profile Diagnostics, Performance, and Correction Factors). This will be discussed further.

On the **Diagnostics** screen the following general items are shown:

Diagnostics	
Op. Status (Operational Status)	**OK**: Everything is working properly **Reduced Acc**.: There are some paths which are failing, nevertheless the measurement is still suitable for custody transfer. Contact Elster or your local representative. **Non fiscal:** There are some paths which are failing; measurement is no longer suitable for custody transfer. Contact Elster or your local representative. **No Measurement**: all paths are failing. Contact Elster or your local representative.
VoS_avg	Average measured Velocity of Sound of the gas.
Error Volume FWD	Total volume measured in forward direction, while the meter was in error mode.
Error Volume REV	Total volume measured in reverse direction, while the meter was in error mode.
Pressure	With our optional pressure sensor the live pressure can be given. If the meter is not equipped with the pressure sensor or it is not working, a pre-set value will be shown in red.
Temperature	With the optional temperature sensor the live temperature can be given. If the meter is not equipped with the temperature sensor or it is not working, a pre-set value will be shown in red.
Density	This value is calculated from the option temperature and pressure sensor. If the meter is not equipped with the pressure and/or pressure sensor or they are not working, a pre-set value will be shown in red.
Viscosity	This value is calculated from the optional temperature and pressure sensor. If the meter is not equipped with the pressure and/or pressure sensor or they are not working, a pre-set value will be shown in red. *…Continued on next page*

Diagnostics	
Internal Temperature	This is the temperature measured in the SPU box on the mainboard. When the electronics are not equipped with the temperature sensor or it is not working, a pre-set value will be shown in red.

Table 4: Meter Diagnostics

As seen in Figure 7-12, on the diagnostics page you may also choose from two sub-menus:

- **Per Path**
- **Per Diagnostic**

These sub-menus are shown on the top of the display, and will disappear if you scroll down. Use the “up” arrow ^ to make them reappear.

Figure 7-12: Diagnostics sub-menus

Per Path

Per Path provides an overview of all paths and the current performance of each individual path can be checked. By choosing an individual path (for example in Figure 7-13; **Path 1**) you can then view the performance %, diagnostic details (by selecting the hyperlink), VoG and VoS of that path.

By further selecting the highlighted **Diagnostic** result box 131072, you can see a detailed breakdown of the path diagnostics.

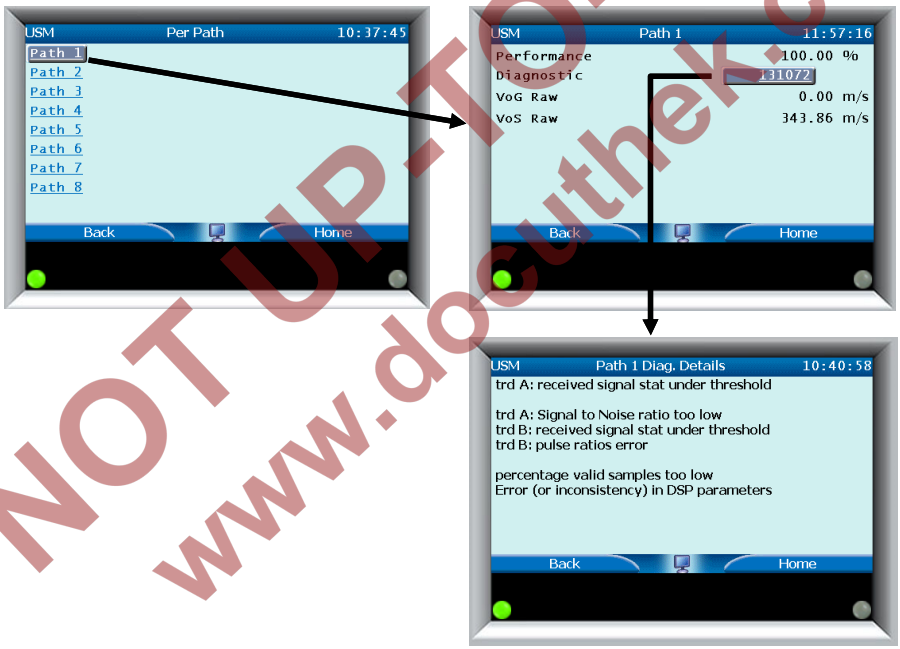


Figure 7-13: Diagnostic view: Per Path

Per Diagnostic

Per Diagnostic is broken down into 5 subsections:

- **VoG Raw** (Velocity of Gas Raw)
- **VoS Raw** (Velocity of Sound Raw)
- **Profile Diagnostics**,
- **Performance**
- **Correction Factors**

A description of each diagnostic follows:

a) VoG Raw and VoS Raw

These subsections display the raw Velocity of Gas and Velocity of Sound results.

b) Profile Diagnostics

Profile Diagnostics displays an array of useful calculations including: Profile Factor Axial/Swirl, Swirl Angle, Axial Asymmetry, Horizontal Asymmetry, Reynolds PathType A and Reynolds PathType B. Please see Figure 7-14 below.

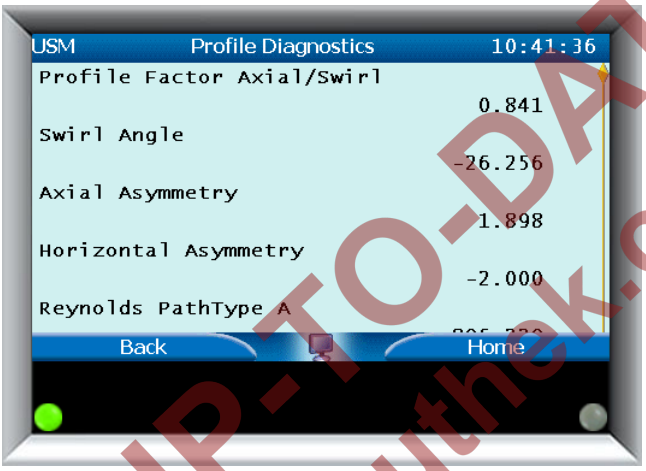


Figure 7-14: Profile Diagnostics

c) Performance

The performance screen displays the performance of each individual path, as seen in Figure 7-15. For further explanation, please see ⇨ Chapter 8.2.2 Performance (p.53).

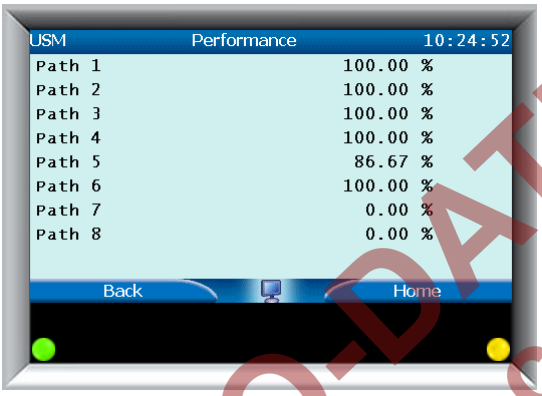


Figure 7-15: Performance display

d) Correction Factors

This section provides an overview of all correction factors of the meter.

- **k – factor Geometry Corr. –** This correction factor corrects the size of the flow cell's body, based upon the measurements of the internal pressure and temperature sensors. The factor will only be taken into account if the meter is equipped with the pressure and temperature sensor and when this function is enabled. Enabling should be done with the software package SonicExplorer (by pressing Configure -> Correction -> Geometry).

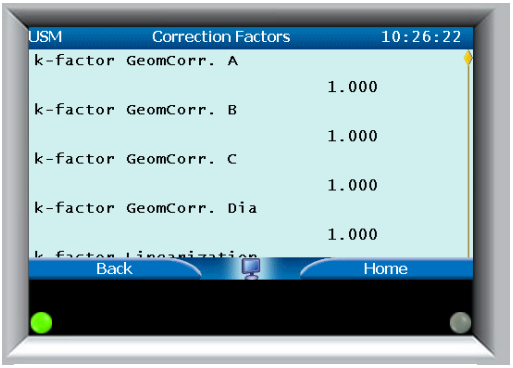


Figure 7-16: k-factor Geometry Correction

This is useful if the process conditions differ significantly from the conditions during the calibration process since both high pressure and high temperature results in an increase in the tube cross-section and a change in path lengths and angles.

Please Note:
k-factor GeomCorr. **A** is for the **Axial Path** (if applicable)
k-factor GeomCorr. **B** is for the **Swirl Path**
k-factor GeomCorr. **C** is for the **Half Square Path** (if applicable)
k-factor GeomCorr. **D** is for the **Direct Path** (if applicable)
k-factor GeomCorr. **Dia** is the correction factor for the inner **diameter** for the meter body at operation conditions

- **k – factor Linearization** - When a meter is corrected after calibration through linearization, the adjust factor will be flow depending (interpolated between the calibration points). The meter can have a linearization for each flow direction. This factor shows the adjust factor calculated for the current operating flow (and direction).

- **k – factor Adjustment** - This is the factor when a meter is corrected after calibration with one single adjust factor. There can be a different adjust factor for both flow directions.
  When operating around zero flow, it possible that this factor is constantly switching from positive adjust factor to negative adjust factor.

- **Voffset Correction** - It is possible to put a fixed velocity offset in the meter. This will normally only be used on special projects. The standard for this factor is 0 m/s.

7.6 Info

With the **Info** tab on top of the **Basic Display** screen some general information about the electronics and its software can be checked.

Please see Figure 7-17. There are 3 submenus: **Analog Outputs**, **Selftests**, and **SW Versions (Internal).**

- **Analog Outputs –** displays the results of the current and frequency outputs based on the user's defined values.
- **Selftests –** Some important parts of the electronics will perform self-tests. Outcome can be **OK** or **FAIL**. If a **FAIL** is encountered, the selftest should be done again. If it continues to fail, contact Elster or your local agent.
- **SW versions (internal) –** Herewith all software versions and their matching checksum in the electronics can be read.

Figure 7-17: Info Screen

8 Maintenance

The UFM contains no moving parts. The transducers are the only components that are in contact with the gas medium. The materials used for the transducers are resistant to the conditions that were clearly specified for the measuring instrument. As a result the transducers and the electronics are virtually maintenance free.

However, Elster recommends inspection of the UFM at regular intervals, for example weekly or monthly evaluations. In case of deterioration of the meter, appropriate measures should be taken before a serious failure occurs.

8.1 Collecting Data

A quick health check of the meter can be done through the **Basic display** screen on the front panel. This is described in ⇨ Chapter 7.3 Basic Display (p.37). However this will only provide you with meter information in its current status. For a more detailed indication of the meter's condition, Elster recommends performing a trend analysis on the meter's measured data (comparison of recent measured data with results from a past period of time). The software package SonicExplorer is specially designed for this purpose. More information about this software package can be obtained at Elster, your local agent, or online at **http://www.elster-instromet.com/en/sonicexplorer**. It is a recommended engineering practice to record the measured data at regular intervals.

8.2 Inspection of Measured Data

The following general rules provide a good basis for analysing the measured data:

8.2.1 Sample Rate

The process of travel time measurement for all paths is repeated a number of times per second. This number is called Sample Rate. Typically this is a stable value of about 20 with a variation of -1.

The sample rate is programmable to be anything between 1 and 100Hz. However, the actual sample rate may be lower than the programmed value since, particularly with large size meters, the travel times of the ultrasonic pulses in the gas do not allow for the programmed sample rate. The UFM will then adjust the sample rate to the highest possible value. The highest possible sample rate is not necessarily the best setting for optimum performance. Although the sample rate is not critical, a value between 8 and 25 samples/second is recommended.

8.2.2 Performance

Performance is the pulse acceptance rate, expressed as a percentage for the pulses transmitted each second. Each transducer transmits a number of pulses each second. To be accepted as a valid received pulse by the signal processing system, each pulse must arrive within a small time window, be of sufficient strength, and match a unique waveform signature. The percentage of accepted pulses is shown as an average value of all measuring paths, and for each individual path.

8.2.3 Velocity of Sound

The UFM calculates the speed of sound in the gas, based on the measured travel times and the programmed spool piece geometry. This value may be compared to the (theoretically) expected value, for example as calculated using the AGA-10 equations of state. The difference between measured and expected values can be as little as 0.25%, provided that gas composition, temperature, and pressure are precisely known.

8.2.4 Gas Velocity (Zero Flow Measurement)

When there is no flow through the meter, i.e. the block valve(s) are closed, the corrected gas velocity should randomly fluctuate between ±0.025 m/s and average very close to zero. During a sunny day the warm walls of the meter will cause small thermal convection currents to circulate inside the meter. The ultrasonic meter may actually measure these very slow currents as an increase in the random fluctuations.

8.2.5 Presentation of AGC-Levels and AGC-Limits

AGC limits and levels are presented in decibels (dB).

The AGC ratio (AGC-limit / AGC-level) largely depends on the meter size and application (operating pressure, amount of CO2, control valve nearby, etc.). It is preferred to have a high AGC ratio.

The change of the AGC ratio over time is a very useful parameter to predict the performance of the meter in the future.

8.2.6 Swirl Angle

If your meter is equipped with a swirl path, this value indicates the amount of swirl measured by an ultrasonic flow meter, expressed in degrees. A positive swirl angle indicates clockwise swirl, whilst a negative swirl angle indicates counter-clockwise swirl. The meter operates reliably if the angle is between -20° and +20°. If the indicated swirl angle exceeds these values please consult Elster for support.

8.3 Exchanging Components

Different parts of the Ultrasonic Flow Meter Series 6 metering system such as transducers, electronic boards, etc. can easily be exchanged. The digital programmed pulse shape and pulse identification of the meter is always identical. Therefore the electronic and transducer products need no adjustment. This means that re-programming or re-calibration of the meter after exchanging any identical part of the Ultrasonic Flow Meter Series 6 metering system is not necessary.

Spare parts of the Ultrasonic Flow Meter Series 6 metering system must be supplied by Elster. After exchanging parts of the Q.Sonic Series 6 metering system the present “calibration” sealing must be renewed. ⇨ Please see Chapter 5.7 Sealing (p.28).

Caution!

Before exchanging any components verify with your local metrology authority on proper procedures. It may be required that the operation needs to be witnessed by a representative of the local authority.

WARNING!

Exchanging of components should only be done with the same type and model; unless otherwise specified by Elster.

8.3.1 Pressure Sensors Exchange

The meter may be equipped with an optional pressure sensor for internal use (⇨ see chapter 5.4 Flow Cell Pressure Sensor [p.22]). As the pressure sensors are specially designed for the Ultrasonic Flow Meter Series 6, they may only be exchanged with sensors from Elster.

WARNING!

For the pressure sensor it is absolutely necessary to **depressurize** the line before exchanging.

8.3.2 Temperature Sensors Exchange

The meter is equipped with a temperature sensor for internal use (for more information ⇨ see Chapter 5.5 Flow Cell Temperature Sensor [p.22]). As the temperature sensors are specially designed for the Ultrasonic Flow Meter Series 6, they may only be exchanged with sensors from Elster.

As the temperature sensor only measures the flow cell temperature and is not in contact with the gas in the pipe, exchanging can be done under pressure.

8.3.3 Transducer Exchange

Each transducer is a separate component of the Ultrasonic Flow Meter Series 6 that can be exchanged independently. This can be done without degradation of the measuring properties and accuracy (thus the calibration) of the Ultrasonic Gas Flow Meter.

However, as the transducers are paired up during production, Elster always recommends changing both transducers of an acoustic path, if possible.

WARNING!

Obey the rules and regulations that apply to hazardous area operations and those with respect to custody transfer regulations (sealing).

WARNING!

Exchanging a transducer can take place when the line with the Ultrasonic Flow Meter Series 6 is **depressurized:**

- Refer to specific installation instructions delivered with the transducers: Transducer Exchange at Atmospheric Conditions (⇨ listed in Appendix II – References)

Optionally, exchanging a transducer can be done when the Ultrasonic Flow Meter Series 6 is **pressurized:**

- A special tool is required for this: the 'Retraction tool NG Transducers'. Please familiarise yourself with the documentation regarding this special tool: Retraction tool NG transducers (⇨ listed in Appendix II – References).
- Before beginning this procedure please verify if this is allowed by the safety standards set by your company and local safety regulations. If in doubt, DO NOT remove the transducers under pressure.

8.3.4 SPU Exchange

Some parts of the SPU can be exchanged without issue, provided that the appropriate hardware and software versions are used. The product numbers can be found on the PCB and have the following structure xxx-xxx-xxx-xxx. The software version and its checksums can be checked through the front panel. For more information ⇨ see Chapter 7.1 LED at Display (p.34).

An SPU exchange will not affect the measuring characteristics and accuracy (and as a consequence the calibration) of the UFM. However if the board is sealed after calibration, please contact Elster or your local representative before proceeding with the exchange.

When exchanging the SPU (or parts of the SPU), refer to the specific manual delivered with the component. Depending on the board, it could be one of the following documents:

- Ultrasonic Flow Meter Series 6 Exchanging PCB boards in TIP

- Ultrasonic Flow Meter Series 6 Exchanging Boards at the Rear Compartment of the SPU

Both documents are listed in ⇨ Appendix II – References.

9 Verifying Software Versions

It's possible to verify the software version with checksum for all components. This should be done with two different methods. Figure 9-1 and Figure 9-2 show the steps to complete this process.

9.1 Verifying the Components with their Checksums

► Start from the Front Panel (main display)
► Highlight and select **Info** (you may need to scroll to the top of the page using the up arrow in order to highlight the button)
► Go to **SW Versions (Internal)**
✓ A list of all components is displayed. Choose the one which needs to be verified. (Bootstrap, Bootleader, DSP, etc.)

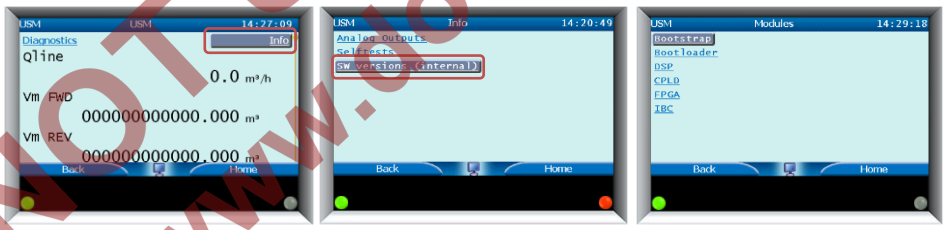


Figure 9-1: Checking Software Versions

9.2 Verifying the Software Status of the Parameter Build Up

- ► If you are at the front panel, go to the **Home** page
- ► Select **Info**
- ► Go to **Software Status**
- ✓ A list is presented with the status of the software modules.

Figure 9-2: Checking software versions and checksum through the front panel

9.3 Display Test

Display test of the screen can be carried out as follows:

- ► If you are at the front panel, go to the **Home** page
- ► Choose **Info**
- ► Go to **Display Test**
- ✓ The display will alternate between black and white. Press any button to stop the test.

Figure 9-3: Display Test

9.4 Checking Errors and Warnings

The status LED on the display shows when a warning or error has taken place (⇨ see Chapter 7.1 LED at Display [p.34]). Through the front panel it is possible to get more information on the errors/warnings (see Figure 9-4). It is also possible to 'accept' the errors/warnings. Hereby it will be written in the Logbook of the meter and will no longer influence the status LED on the meter.

- ► Go to the **Home** page
- ► Choose **Error List**
- ✓ A list of the errors is displayed

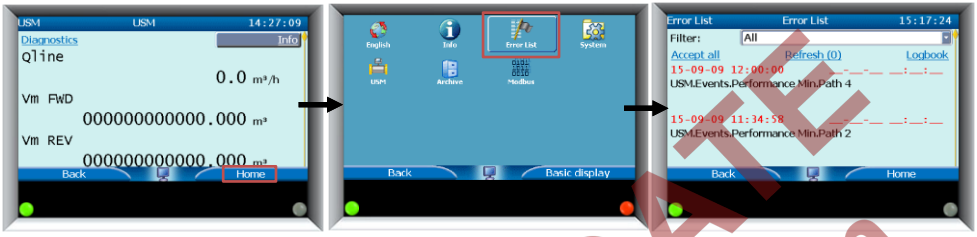


Figure 9-4: Errors/Warnings List

9.5 PC Software Package

For configuration and monitoring of the Ultrasonic Flow Meter Series 6 Elster has developed a software package called SonicExplorer. This program is specially designed to perform advanced monitoring of the Ultrasonic Flow Meter Series 6.

For more information about SonicExplorer, please check the Elster website. You can download the SonicExplorer Software and Manual here:

http://www.elster-instromet.com/en/sonicexplorer

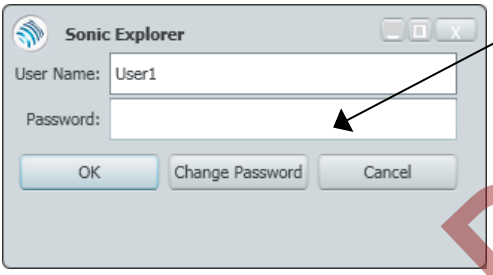
10 User Rights / Login

From software version 2.8 onwards user rights are implemented in the Ultrasonic Flow Meter Series 6. Access to the device with the software package SonicExplorer is only granted after login with a password.

By default there are three user profiles available:

- Admin can modify all parameters
- User1 can modify non-fiscal parameters
- User2 cannot modify parameters – read access only

User1 and User2 do not have a default password set. Just leave “Password” blank and click “OK”.



To request an administrator password please contact Elster at:
aftersales@honeywell.com

11 Shipping and Storage

As the Ultrasonic Flow Meter Series 6 is a delicate instrument, care should be taken to carefully handle and store the flow meter in a proper way. Improper handling, shipping, or storing may void its warranty.

The Ultrasonic Flow Meter Series 6 should be stored in indoor conditions, with a low humidity (5% - 95% non-condensing); storage temperature should remain between -20 °C and +60 °C (long term storage temperature: between 0 °C - +60 °C). Please refer to our UFM Series 6 Shipping and Storage Manual (⇨ listed in Appendix II – References) for more detailed information.

12 MID Requirements

12.1 General

This chapter is only applicable when the Ultrasonic Flow Meter Series 6 Q.Sonic^{max} needs to be in accordance with European Directive 2004/22/EC *) on measuring instruments (MID) as stated in EC-type Examination Certificate T10586.

The Ultrasonic Flow Meter Series 6 can be used legally for fiscal metering based on European Directive 2004/22/EC *), Annex MI-002.

*) New European Directive valid from 20.04.2016: 2014/32/EU

12.2 EC Declaration of Conformity

Elster ultrasonic gas flow meters are manufactured in accordance with applicable directives, e.g.:

- Pressure Equipment Directive (PED)
- Equipment and Protective systems intended for use in potential Explosive Atmospheres (ATEX) Directive
- Electro Magnetic Compatibility (EMC) Directive
- Measuring Instruments Directive (MID)

In compliance with the applicable directives the meters are supplied with the CE mark and the EC Declaration of Conformity. This declaration is part of your flow meter documentation since it also contains important details of your particular flow meter (e.g. PED category, ATEX markings).

12.3 Sealing

An MID compliant meter shall be sealed. ⇨ See Chapter 5.7 Sealing (p.28) for more information.

12.4 Calibration

An MID compliant meter is accompanied by a copy of the EC Declaration of Conformity stating compliance with Measuring Instruments Directive 2004/22/EC *) Annex MI-002, based on:

- EC-Type examination certificate T10586 according MID Annex B and
- A certificate of conformity from a Notified Body according to MID Annex F.

*) New European Directive valid from 20.04.2016: 2014/32/EU

12.5 Installation Requirements

Special attention needs to be taken so that the UFM Series 6 meter and its in- and outlet spools are mounted according to EC examination Certificate T10586 (last valid version).

Note that parameters stated in certificate T10586 may indicate a limit or limits of a range. The values and ranges applicable to your flow meter may be different.

The UFM needs to be powered by an Uninterruptible Power Supply (UPS).

⇨ Please also refer to Chapter 6 Installation and Commissioning (p.30).

13 Index

Appendix I – Integrated Volume Conversion and Gas Quality Functionality

The Ultrasonic Flow Meter Series 6 contains an integrated flow computer for measuring and calculating the normalized or mass flow of natural gas. Additional transmitters are to be connected via the optional input card (pressure transmitters, temperature transmitters and, optionally, gas quality measurement devices).

Device type	Connection options
Pressure transmitters	• 4… 20 mA input (Not for fiscal use) • HART protocol interface*
Temperature transmitters	• Resistance input • HART protocol interface*
Gas quality measurement devices	• Serial interface • TCP/IP interface

* In total 4 devices can be connected through HART protocol (typical is 2 pressure and 2 temperature devices)

Table 5: Connection of Measurement Devices

Within the software of the Ultrasonic Flow Meter Series 6 two additional AFB's (Application Function Blocks) are handling the conversion:

- The Gas Quality AFB calculates the conversion factor C, density and heating values by using pressure, temperature and gas quality measurement data, taking the selected calculation standards and the base conditions to be applied into consideration.
- The Flow Conversion AFB generates counters for volumes at base and measurement conditions as well as mass and energy by using the Qline data from the ultrasonic measurement AFB and the results of the Gas Quality AFB. Optionally it may perform additional meter correction and additional counter administration due to error handling.

The device software of a Series 6 Ultrasonic Flow Meter is equipped with integrated flow computer functions consisting of the Basic System, an Ultrasonic measurement AFB, two Flow Conversion AFB's and one Gas Quality AFB. This configuration implements a typical "one stream, two flow directions" application, where each flow conversion AFB represents a flow direction. Please see Figure 1. With forward flow only the 'Flow Conversion FWD' AFB will be addressed and with reverse flow only the 'Flow Conversion REV' AFB will be addressed.

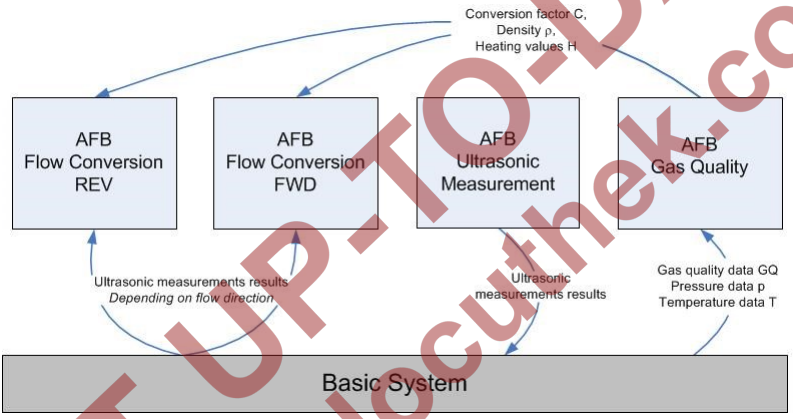


Figure 1: Data flow for a basic "one stream, two flow direction" application

Remarks:

- One Flow Conversion AFB is necessary for each flow direction. For the ultrasonic meter standard the two flow directions with their flow conversion AFBs are available.
- One Gas Quality AFB is necessary for each C calculation working with different measurement data (pressure / temperature and/or gas quality) or based on different calculation rules (as to calculation standards and/or base conditions).
- The Flow Conversion and Gas Quality AFBs working with the same measurement data are linked via parameterization. The parameterization supports the grouping of AFBs in user-defined

structures. This way, it is easy to identify which AFBs belong together in both the parameterization user interface and the device screen.

Appendix I.I – Flow Conversion AFB

The Flow Conversion AFB generates counters for volume at base and measurement conditions as well as mass and energy by using the gas meter measurement data and the results of the Gas Quality AFB. It performs the meter correction and the counter administration due to error handling and – if applicable – takes the counter activation message (e.g. for flow direction switching) into consideration. Please see Figure 2.

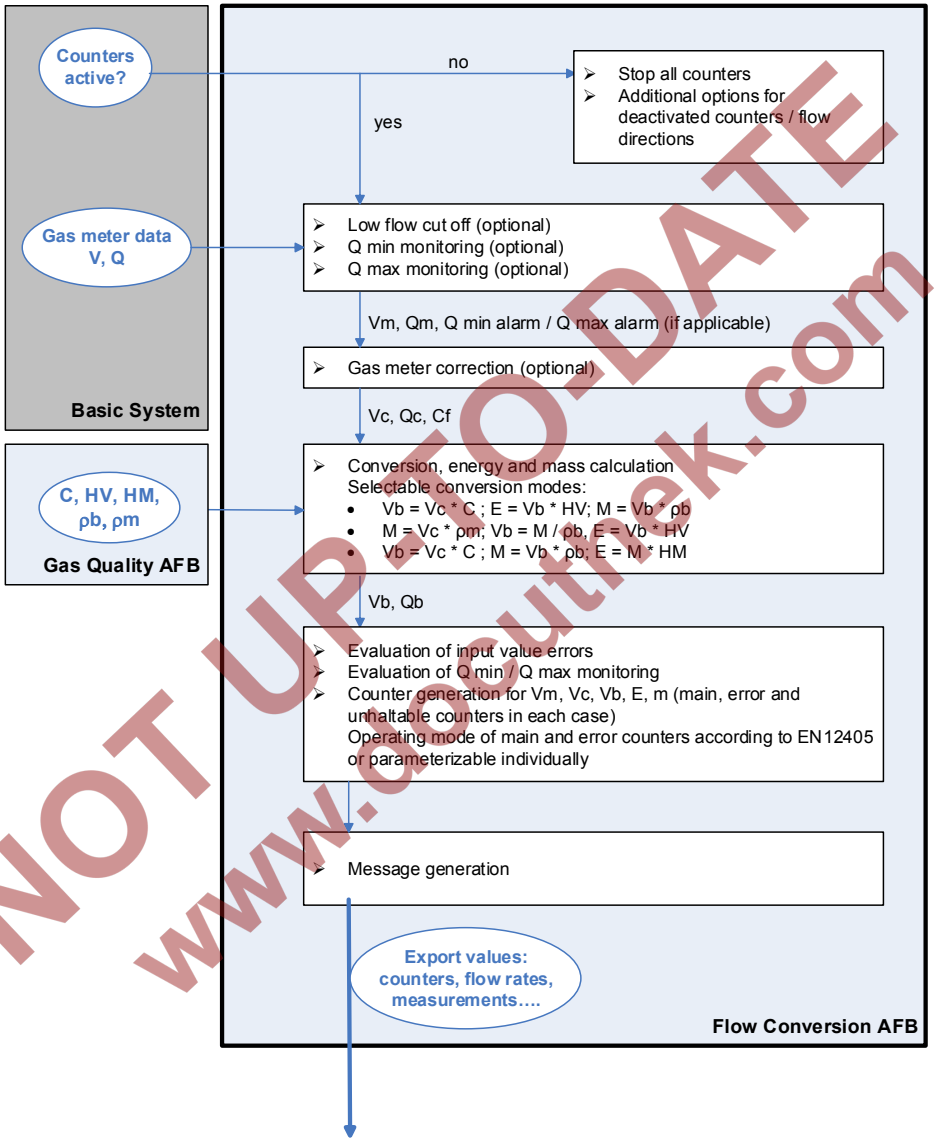


Figure 2: Data flow for Flow Conversion AFB

The Flow Conversion AFBs are responsible for generating the fiscal counters. Each single Flow Conversion AFB administers the counters of a distinct flow direction.

Each Flow Conversion AFB provides a so-called fiscal display wherein the main counter for volume at base conditions is preferentially indicated.

That means that the Vb counter is highlighted, marked with a preceding special icon and displayed using a larger font size. See Figure 3 below:

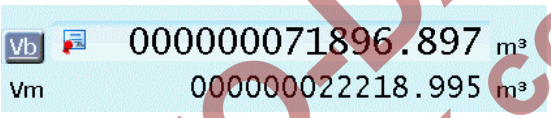


Figure 3: Display indication of Vb (Fiscal Display)

When the ultrasonic meter is powered on, the front screen is displayed (see Figure 5 on the next page). By pressing the **Home** button a list of AFBs are shown. By using the 7 touch areas you can navigate to one of the 'Flow Conversion AFBs' (see Figure 4). For switching back to the basic display, you may either activate the corresponding AFB button or the button labeled **Basic display**.

Figure 4: Display with AFB Menus

In most ultrasonic flow meter displays, there are labels that are designed as hyperlinks. Hyperlinks are underlined and displayed in blue color. Using these hyperlinks is the most intuitive way for switching to subordinate displays showing further values and results.

Figure 5 shows an example of a Flow Conversion fiscal display; Table 6 lists the target displays of the available hyperlinks as well as the values and results included.

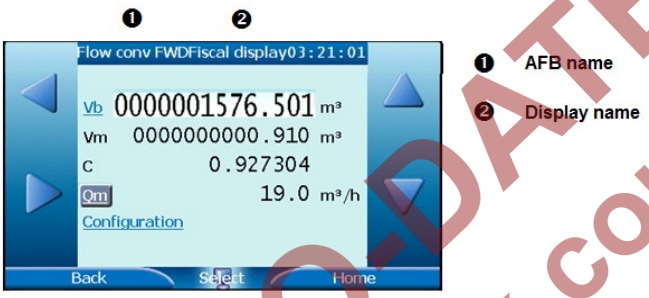


Figure 5: Example of the Flow Conversion: Display Screen

Hyperlink / value	Target Display	Values shown in target display
Vb	Flow Conversion AFB (main display)	See Table 7
Vc[1]	-	-
Vm	-	-
C	Gas quality AFB (main display)	See Table 8
Qc[2]	Flow rates	QE Energy flow rate QM Mass flow rate Qc Corrected volume flow rate Qm Flow rate for volume at measurement conditions Cf Correction factor

1) The line for the corrected Volume Vc is omitted in case that no gas meter correction is parameterized.

2) If no gas meter correction is parameterized, the flow rate Qm (uncorrected flow rate at measurement conditions) is displayed instead of Qc. Within the target display, the lines for Qc and the correction factor are omitted in that case

Table 6: Contents of the Flow Conversion's Fiscal Display

The labels for all counters and additional measurements that are shown in the Flow Conversion's main display are hyperlinks.

Figure 6 shows a typical example of a Flow Conversion main display; Table 7 on the next page lists the target displays of the hyperlinks as well as the values and measurements included.

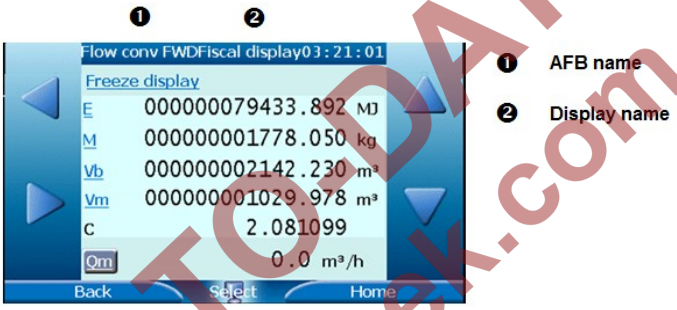


Figure 6: Example of the Flow Conversion: Main Display

Hyperlink	Target Display	Values shown in target display
Freeze display	Main display	Stops the display with all its information (counters, measurements, time). All calculations and processing routines continue in the background. The "frozen" display allows a visual of all actual values comfortably at the same point of time. Activate Unfreeze display to return to the normal display mode.
E	Energy	E Energy main counter Ee Energy error counter Eu Energy unhaltable counter HVol Volume-based heating value HMass Mass-based heating value
M	Mass	M Mass main counter Me Mass error counter Mu Mass unhaltable counter ρb Base density ρm Density at measurement conditions
Vb	Base volume	Vb Base volume main counter Vbe Base volume error counter Vbu Base volume unhaltable counter
Vc[1]	Corrected volume	Vc Corrected volume main counter Vce Corrected volume error counter Vcu Base volume unhaltable counter Cf Correction factor
Vm	Measured volume	Vm Volume at measurement conditions, main counter Vme Volume at measurement conditions, error counter Vmu Volume at measurement conditions, unhaltable counter

Hyperlink	Target Display	Values shown in target display
C	Gas quality AFB (main display)	See Table 8
Qc[2]	Flow rates	QE Energy flow rate QM Mass flow rate Qb Base volume flow rate Qc Corrected volume flow rate Qm Flow rate for volume at measurement conditions Cf Correction factor

1) The line for the corrected volume Vc is omitted in case that no gas meter correction is parameterized.

2) Qc is replaced by Qm if no gas meter correction is parameterized.

Table 7: Hyperlinks in Flow Conversion's Main Display

Gas Meter Correction (Optional)

The optional gas meter correction of the Flow Conversion AFB uses up to 10 calibration points, each of them consisting of the flow rate in m^3/h and the related error in %.

The correction factor Cf is calculated for any measured flow rate Q by linear interpolation between the parameterized calibration points. If Q falls below the lowest flow of all calibration points, the correction factor obtained for that flow is retained (no extrapolation). The behavior regarding high flow rates is similar: above the highest flow rate of all calibration points, the correction factor remains at the value obtained for that flow rate. As the EN12405 standard prescribes in Chapter 4.4, with special behavior of the gas meter correction below Qmin and above Qmax, the following additional rules are applied:

- no gas meter correction is performed below Qmin (Cf := 1).
- above Qmax, the correction factor remains at the value obtained at Qmax.

The calibration points are specified in the gas meter's calibration certificate and have to be parameterized in the related Flow Conversion AFB, as well as the minimum and maximum flow rates Qmin and Qmax. During operation, for each operating point the gas meter correction is carried out by applying the calculated correction factor Cf as follows:

$$Vc = Vm * Cf$$

$$Qc = Qm * Cf$$

Where:

Vm = volume at measurement conditions

Vc = volume at measurement conditions, gas meter correction applied

Qm = flow rate at measurement conditions

Qc = flow rate at measurement conditions, gas meter correction applied

Cf = correction factor

Appendix I.II – Gas Quality AFB

The Gas Quality AFB calculates special characteristics of the gas, using gas quality data, pressure and temperature measurements and taking the base conditions to be applied into consideration.

The gas quality data are either provided by the Basic System or parameterized as constant values.

In detail, the Gas Quality AFB performs the following tasks (also see Figure 7):

- Normalization of the gas component vector, if required.
- Calculation of Compression factor C (and the interim results Compressibility factors Zm and Zb, K factor) according to either:
  - AGA8 92 DC (ISO 12213-2).
  - SGERG-88 (ISO 12213-3).
  - AGA NX19 mod.
  - AGA-NX19 mod BR.KOR.3H.
  - AGA NX19 GOST.
- Calculation of density at base / measurement conditions and relative density, according to either:
  - AGA8-92DC.
  - ISO 6976.
- Calculation of heating values and Wobbe Indices according to
  - ISO 6976.

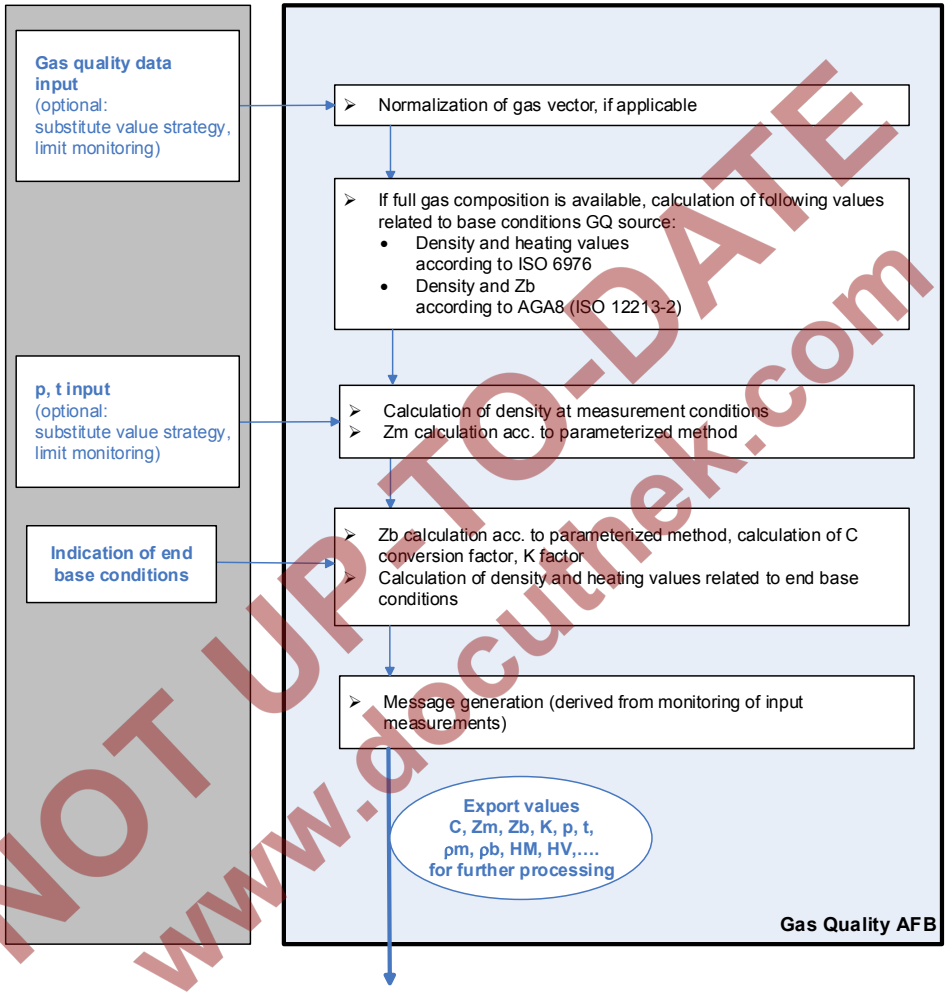


Figure 7: Data Flow for Gas Quality AFB

As the calculation of the compression factor is performed by the Gas Quality AFB, the measurements used for this calculation are indicated in the main display of the responsible Gas Quality AFB. As shown in Table 6 and Table 7 this display can be activated by using the C Conversion factor hyperlink in

the Flow Conversion AFB (fiscal and main display). Alternatively, the main display of the Gas Quality AFB can be invoked by using the corresponding button in the home display as usual.

The labels of some of the measurements that are shown in the Gas Quality's main display are designed as hyperlinks.

Figure 8 shows a typical example of a Gas Quality main display; Table 8 lists the target displays of the hyperlinks as well as the values and measurements included.

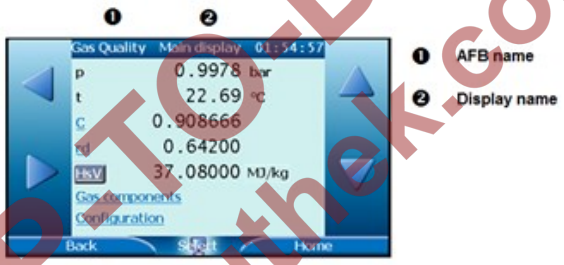


Figure 8: Gas Quality: Main Display

Hyperlink / value	**Target Display**	**Values shown in target display**
Pressure p	-	-
Temperature t	-	-
C	Compressibility	p Pressure t Temperature C Conversion factor Zm Compressibility factor at measurement conditions Zb Compressibility factor at base conditions K K factor Zb air Compressibility factor of air at base conditions (acc. to ISO 6976)
rd	Density	Measurements and calculated values for density and relative density
HsV	Heating values	Heating values and Wobbe Indices
Gas components	Gas components	Gas components (as far as available)

Table 8: Contents of the Gas Quality's Main Display

Appendix II – References

All references listed below can be obtained from Elster. Additionally, most references are available online at: http://www.docuthek.com/ .

[1] MID Certificate T10586 (last valid version)
Doc. No.: T10586_certificate

[2] UFM Series 6 Q.Sonic^{plus} Operation and Maintenance Manual
SAP Ref.: 73023467
Doc. No.: 10000050188 (last valid revision)

[3] UFM Series 6 CheckSonic Operation and Maintenance Manual
SAP Ref.: 73023471
Doc. No.: 10000050192 (last valid revision)

[4] UFM Series 6 Q.Sonic^{max} Operation and Maintenance Manual
SAP Ref.: 73023477
Doc. No.: 10000051506 (last valid revision)

[5] UFM Series 6 Wiring Instructions
SAP Ref.: 73023470
Doc. No.: 10000050191 (last valid revision)

[6] UFM Series 6 Shipping and Storage Manual
SAP Ref.: 73023469
Doc. No.: 10000050190 (last valid revision)

[7] UFM Series 6 Safety Instructions
SAP Ref.: 73023465
Doc. No.: 10000050186 (last valid revision)

[8] UFM Series 6 Modbus Protocol
SAP Ref.: 73023466
Doc. No.: 10000050187 (last valid revision)

[9] MID Certificate T10335 (last valid version)
Doc. No.: T10335_certificate

[10] UFM Series 6 Transducer Exchange at Atmospheric Conditions
SAP Ref.: 73023472
Doc. No.: 03.200.001.001/02/2 (last valid revision)

[11] Retraction Tool NG Transducers
SAP Ref.: 73023473
Doc. No.: 03.203.101.001.02/2 (last valid revision)

[12] UFM Series 6 Exchanging PCB boards in TIP
SAP Ref.: 73023474
Doc. No.: 03.303.101.000.02/2 (last valid revision)

[13] UFM Series 6 Exchanging Boards at the Rear Compartment of the SPU
SAP Ref.: 73023475
Doc. No.: 03.302.101.000.02/2 (last valid revision)

[14] External VDSL Range Extender User Manual
SAP Ref.: 73023483
Doc. No.: 10000050357 (last valid revision)

[15] UFM Series 6 SonicExplorer Software Application Manual
SAP Ref.: 73023308
Doc. No.: 10000050563 (last valid revision)