Honeywell

Ultrasonic Flow Meter Series 6
Q.Sonic®

Commissioning & Verification Procedure

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Disclaimer

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Contents

1 General information

1.1 About these instructions

This document provides information on procedures and criteria for verification and validation, maintenance, and commissioning of a Honeywell Elster Ultrasonic Flow Meter (UFM) series 6. Also, some background information relating to the usage and interpretation of the relevant data is presented.

The different tests described in ⇨ section 4 will be checked during verification activities.

All information required (measured data, test results) shall be written in the Q.Sonic Ultrasonic Flow Meter Checklist (Document number: U92.4 latest version).

enSuite is a software tool which is specially designed for configuring and verifying the UFM series 6. It plays a key role in the verification and validation procedure. Please also familiarize yourself with the manual "Configuration and analysis with enSuite" (order no. 73025730, latest valid version).

1.2 Relevant user documentation

Elster Gas Metering business provides the user documentations such as manuals, certificates, technical information for your UFM Series 6 meter in a ZIP file. The download information for this ZIP file is supplied with your device. Manuals referenced by this manual are included in this ZIP, such as UFM Series 6 "Safety Instructions".

We especially recommend the following manuals for commissioning and verification:

- UFM Series 6 „Wiring Instructions" (order no. 73023470)

Depending on meter firmware version (⇨ 1.4 Required tools and materials, p. 5):

- UFM Series 6 "Configuration and analysis with enSuite" (order no. 73025730)
- UFM Series 6 "Software Application Manual" – SonicExplorer (order no. 73023308, deprecated)

Single documents are published in the Docuthek. The documents are updated regularly.

www.docuthek.com/
Use the device series or the device type as search term:
UFM Series 6 or **Q.Sonic-max**

1.3 General

The ultrasonic gas flow meter contains no moving parts. 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.

Honeywell recommends inspection of the ultrasonic gas flow meter at regular intervals, at least once a month. It is ultimately up to the operator to decide at what intervals to check. A permanent check via a tool, such as Honeywell's MIQ, has proven to be effective. In case of degradation of the meter, appropriate measures can be taken before a serious failure occurs.

Inspection of the ultrasonic gas flow meter comprises:

- visual inspection of the ultrasonic gas flow meter (UFM) (no damage, proper wiring incl. grounding of the meter etc.)

  For wiring details including grounding information, refer to the ⇨ "Wiring Instructions".
- inspection of the UFM based on a diagnostics report (health support package) containing signal captures, electrical and diagnostics data over time collecting electrical data, using the enSuite on a service PC.

Everything starts with the initial commissioning of the meter. Proper commissioning of the meter is the basis for obtaining reliable and accurate measurements. The data recorded during flow calibration and commissioning of the ultrasonic gas meter are necessary as a reference and comparison for data recorded later.

1.4 Required tools and materials

The following tools and materials are required to perform the verification and validation, service and commissioning of an UFM:

Hardware tools

- Gas detector
- Endoscope for the inner wall inspection (when required)
- Transducer tool for removal
- Interface between the EEx d enclosure and the service PC:

  Ethernet cable or through the optional VDSL/Ethernet-Range-Extender connection.
  For detailed information ⇨ Ultrasonic Flowmeter Series 6, Wiring instructions (doc. code: 73023470 latest valid version)

Service PC with the following software

- Configuration and analysis software depending on the meter firmware version:

Firmware version	PC software
V3-40	enSuite
V2.11 and V3.2	enSuite or SonicExplorer
V2.10 and older	SonicExplorer

Latest product releases on Honeywell website

The Honeywell website provides the most up-to-date product releases for Elster Gas device series. You can download the latest enSuite and SonicExplorer versions in the download section.

process.honeywell.com/us/en/site/elster-instromet/support#software-downloads

- Microsoft Office (Excel and Word)

2 Principle of operation

The basis of the ultrasonic gas flow measurement is the measurement of the travel times of ultrasonic sound signals. The ultrasonic sound signals travel along an acoustic path between two transducers, in two directions, downstream with the gas flow and upstream against the gas flow. The travel time of the ultrasonic sound signal is measured for both directions of transmission.

This process is performed for each path and repeated a number of times per second. An UFM series 6 has several acoustic paths (for example: a Q.Sonic-plus has 6 paths), each path being measured for example 15 times per second. From each measurement a number of variables are determined and each second this data is processed to averages that are representative for the one second time interval.

Every second all the data generated by the ultrasonic flow meter is transmitted through the ethernet connection. This data can be monitored using enSuite.

The generated data can be evaluated based on actual values and general criteria. The general criteria are not specific to a particular application but are generally applicable.

3 Operational status data: Explained

In this section the background of several variables that together reflect the operational status of an ultrasonic gas flow meter, will be explained.

The data that is available for diagnostic purposes is listed as below:

- Acceptance range value (performance) – general and per path
- Automatic gain control (AGC) levels – per transducer
- Velocity of sound (VOS) – general and per path
- Raw gas velocity – general and per path
- Signal to noise ratio (SNR) – per transducer

The actual values of these variables can be monitored using enSuite by reading the data directly from the computer screen shown in the "Dashboard" and specifically in the health care monitoring graph. Since the actual values may exhibit some variability due to dynamic flow phenomena, average values over a longer period of time, such as 60 seconds, are more useful, assuming conditions have remained constant over this time interval.

Average values can be obtained using enSuite by recording a logfile. The data from each one second transmission is stored in this logfile as one record. The logfile data can be processed using general purpose software, for example it may be imported in MS Excel and processed using Excel functionality. Use export to “CSV – Compatible Format (*.csv)” in enSuite.

The data recorded in the log file is date and time stamped, so it is important that the computer's date and time are set correctly.

For reason of documentation, it is useful to record a logfile of a few minutes, anytime a meter is inspected. (Use a clear and unique name or identification for future reference to this logfile.) It is recommended to read the programmable parameters from the electronics on the meter spool piece before making the log file. These parameters are stored in the parameter file and the most important parameters are summarized in the configuration report. This ensures that the parameter settings related to the reported log file are known. This way it is always traceable that the parameters are correct and identical to the initial settings or identical to the settings specified on a certificate.

Calculating a reference value for the velocity of sound for a specific gas composition at specific temperature and pressure conditions is also possible with enSuite.

3.1 Acceptance rate value (performance)

The process of “interrogating” or “sampling” the gas velocity on each acoustic path by measuring the travel times in both directions, is repeated a number of times per second. Each ultrasonic signal pulse (sample) is inspected according to certain quality criteria. The percentage of accepted pulses is calculated and presented as "performance". Also known as signal acceptance rate.

The performance is presented as an average for all acoustical paths present on the UFM series 6. This number indicates the general or overall acceptance range of qualified pulses, this value is useful for an inspection at first glance.

For a more detailed inspection the performance of each individual path is available. Under normal circumstances and with low flow the performance of individual paths should be almost 100 %. At higher flow rates the performance of individual paths (and the general performance) may decrease due to the acoustic signals being affected by turbulent fluctuations in the gas flow.

It should be noted that even with a performance on an individual path as low as 20 % the accuracy of the gas flow measurement will be maintained as only accepted signal pulses are used in the evaluation of the result.

3.2 Automatic gain control (AGC) level

The strength of the received signal may vary with meter size and process conditions, i.e., gas composition, pressure.

The efficiency of the transducers and consequently the signal strength is proportional to the gas pressure (more fundamentally: density). The signal attenuation is proportional to the length of the acoustic path. Some gas components are known for high absorption of acoustic energy, for example CO2.

An automatic gain control circuit automatically adjusts the strength of the received signal. This results in an “AGC level”. These AGC levels are presented in decibel (dB). An AGC level is available for each path in both directions, the AGC level values are labelled according to the receiving transducer.

3.3 Velocity of sound (VOS)

Based on the measured signal travel times and the programmed path length, the ultrasonic flow meter calculates the velocity of sound (VOS) in the gas under the actual operating conditions (also known as SOS (Speed of Sound)). The VOS is theoretically not affected by the gas velocity since it is derived only from the averaged travel times (upstream and downstream) and the acoustic path length. The VOS derived in this way, shows excellent reproducibility and stability. In addition to this the VOS values observed on individual acoustic paths have excellent tracking properties. This makes the VOS a very powerful diagnostic tool.

VOS is available as a measured value for each individual acoustic path, and as well as a general “total” value, calculated from the values of individual paths.

It should be noted that the measured VOS (as available for the individual paths) will be slightly affected at high gas velocity due to diffraction of the acoustic path. This should be considered when comparing the VOS of individual paths to a theoretically calculated expected value. For doing such a comparison most accurately, a gas velocity below 6 m/s is recommended (not below 2 m/s as well for reasons of thermal stability).

The UFM calculates the general “total” VOS value as well. This is not a simple arithmetic mean value but a more complicated calculation to compensate for the effect that will occur at high gas velocities. The "total" VOS value can be accurately compared to a theoretically calculated expected value regardless of gas velocity.

The expected value can be calculated using, for example, the AGA-10 equations of state. Be aware that precise knowledge of the gas composition, accurate temperature, and pressure measurement are critical. Otherwise, a disagreement of several percent is easily found. Also, wet gas can cause deviations between calculation and measurement VOS.

Comparing the VOS values of individual paths amongst each other is highly insensitive to gas composition or pressure and temperature effects (as long as thermal stratification is avoided, flow should therefore not be below 2 m/s).

3.4 Raw gas velocity

This applies to the gas velocities observed on individual acoustic paths, without any correction or compensation, so called “raw gas velocities”.

Due to the laws of physics governing the dynamics of a moving fluid in a conduit, a velocity profile will exist. The axial (single reflection) acoustic paths sample the velocity profile along a line through the center of the pipe. This results in an over-reading in comparison to the average gas velocity (relating to the whole of the cross section). This over-reading is dependent of the flow profile, characterized by the Reynolds number and is also dependent of the degree of disturbance.

The double reflecting swirl paths are less sensitive to the degree of distortion in the flow profile but are sensitive to swirl. The degree of swirl reflects in the difference in reading between both swirl paths, but the average of both swirl paths is highly insensitive to swirl.

The calculation method programmed in the meter will take care of “integrating” the values of individual paths to an overall result. The method of integration should ensure that deviations of individual paths are compensated resulting in a minimum overall error.

The top and bottom direct paths (non-reflection) sample the velocity profile at 0.707 radius. They show a lower velocity compared to the axial and swirl paths.

The mid direct paths (non-reflection) sample the velocity profile along a line through the center of the pipe. These paths show similar gas velocity values as the axial (single reflection) paths.

In a practical installation/application it can be useful to observe the average of the axial paths and compare this to the average of the swirl paths. The ratio as such may vary in a relatively wide range; the ratio as a function of the flow rate should be a relative constant number.

3.5 Signal to noise ratio (SNR)

A pulse picked-up by a transducer is always too small to analyze. The electronics will increase this pulse to a more suitable larger value. This increase/amplification of the pulse by the electronics is called the gain.

Through the transducer the electronics also detect the ‘background noise’ in front of the pulse. The signal to noise ratio is the comparison of the strength of the signal relative to the background noise.

3.6 Pulse check

Checking the transducer pulses can be done using enSuite. In the manual of the enSuite it is explained how to gather these pulses. Validation of these pulses should be done by an experienced Ultrasonic Engineer. In case of doubt, please contact Honeywell.

4 Commissioning and validation criteria

Document all relevant information with regards to the UFM (type, serial number, etc.) in the Q.Sonic Ultrasonic Flow Meter Checklist.

Connect with enSuite to the meter and all further analysis of the meter will take place using enSuite.

Once enSuite is connected to the meter it will automatically start a logfile. This logfile captures all relevant data during the time enSuite is connected. It is good practice to save this logfile so it can always be verified in the future.

4.1 Visual inspection

It is important to do a visual inspection of the UFM.

- Check if there are no visual damages
- Ensure all sealings are still in order
- Check display

4.2 Health care procedure

When connected to the meter with enSuite, run a health care procedure (press button “Create Support Package, ⇨ manual “Configuration and analysis with enSuite”).

Analysis in the enSuite will perform a health check on the meter.

For decent health care, a minimum amount of flow is necessary. If the flow is too small, health care will continue, but certain checks are ignored and not taken into account, and the corresponding diagrams are grayed out.

After the health care enSuite will provide a report. There might be some check ‘failed’, but this does not necessarily mean the meter does not work. Some criteria need to be fine-tuned on location. For example, if there is swirl in the flow profile, some fine-tuning of the parameters will be necessary. This should be done by a commissioning engineer. A piping configuration with information about pipe lengths, valves, can be useful to make the right decision.

4.3 Detection settings

The functionality of the ultrasonic meter must be checked carefully, especially during initial commissioning. Influences due to the respective station setup may also require an optimization of the signal detection parameter. In case health care check fails due to path performance and (large) VOS and VOG path ratio variations, it could indicate an issue with the meter health itself, then some pulse shape signal detection setting may need optimization. Or it could indicate transducer replacement is required.

For optimization we recommend contacting an experienced Ultrasonic Engineer from Honeywell.

4.4 Parameter set-up

Use enSuite to save the parameter file and take a configuration report of the ultrasonic flowmeter. This should be compared to the calibration certificate (if applicable).

4.5 Multiple pulse collection

Through enSuite pulses should be captured (preferably at zero flow and several flow rates). This is for internal use stored as history or used for signal detection optimization. In case the customer wants this data for their meter, a copy can be handed over.

4.6 Exchanging parts of the UFM

If exchanging parts of the UFM can be necessary, please contact Honeywell to make an appointment for a service engineer.