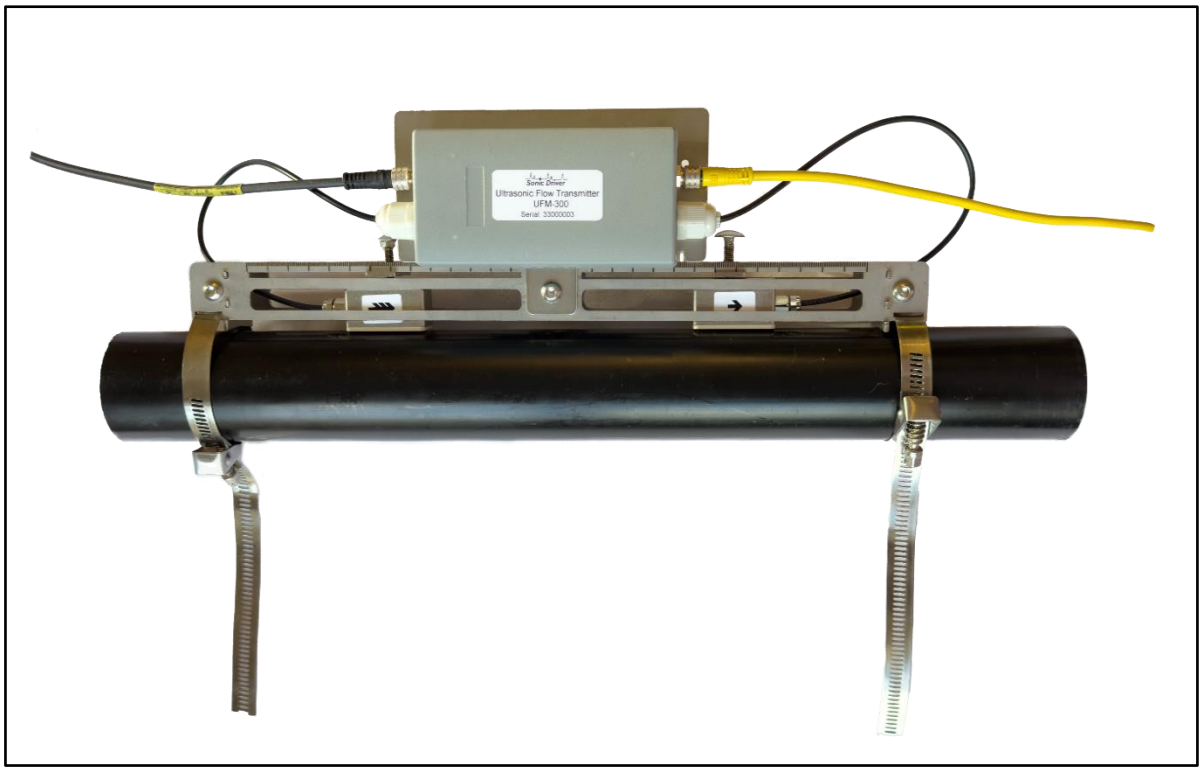
Sonic Driver

Made in Britain

Ultrasonic Clamp-on Flowmeter UFM-300

Laptop Operating Instructions

Version 1.0



1st July 2024

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1.0 Introduction

Congratulations on choosing the Sonic Driver^{TM} Ultrasonic Flowmeter UFM-300, guide-rail, pipe, wall or panel mounted clamp-on ultrasonic flowmeter, figure (1).

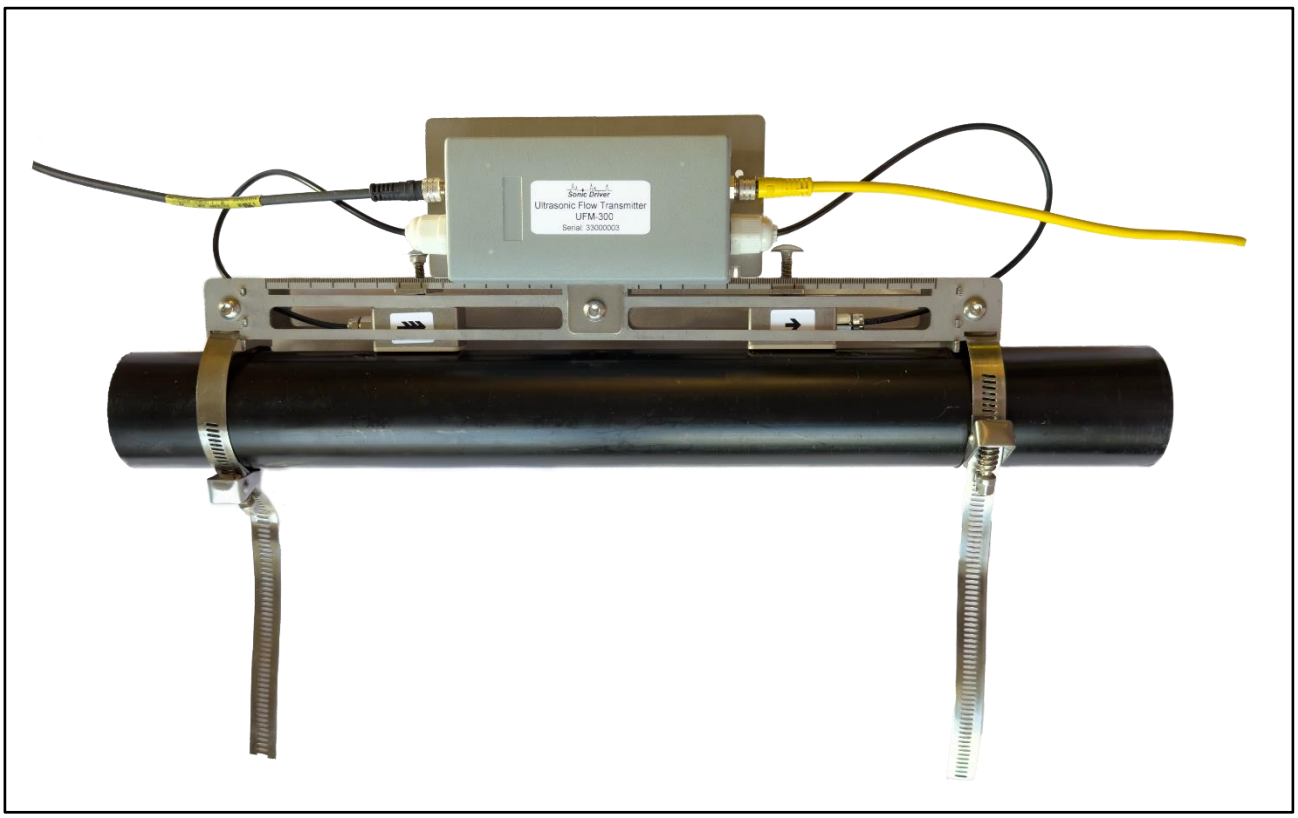

Figure (1) The Sonic Driver UFM-300.

The UFM uses advanced Digital Signal Processing (DSP) and transit time measurement techniques (Sonic Driver^{TM}) to make accurate and reliable clamp-on ultrasonic flow velocity measurements on liquids flowing in closed pipes.

Using information about the installation, entered by the user, via the meter's laptop based configuration program (Windows) or Smart phone App the UFM can calculate;

- Flow velocity (m/s)
- Volumetric flow rate (l/min)
- Mass flow rate (kg/min)
- Flow positive total (l)
- Flow negative total (l)
- Flow net total (l)

When using the Smart phone App, the meter will additionally display flow velocity in ft/s and volumetric flow rate in m3/hr, GPM, GPH and ft3/min

All of the above flow measurements and a complete set of diagnostics are available over Modbus RTU RS485.

For installation a laptop is connected to the UFM via a bidirectional USB to RS485 converter. All installation parameters are available for editing locally via the laptop or remotely over Modbus RTU.

The UFM comes in 2 different versions;

- Standard - outer pipe diameter ranged 10.0 to 115.0 mm
- Medium - outer pipe diameter ranged 115.0 to 225.0 mm

Once installed the laptop and converter can be disconnected and the UFM connected to a Modbus RTU RS485 network for remote interrogation or configuration via a control room, Cloud based monitoring applications or 3rd party datalogger where a Modbus Master polls the UFM Slave. However, local interrogation continues to be available by simply unplugging the network and plugging in the laptop.

This manual details operation using the laptop Windows configuration program route.

A separate manual details operation using the Smart phone configuration App route.

1.1 General Precautions

The content of this manual has been carefully checked and is believed to be accurate.

Sonic Driver Ltd assumes no responsibility for any inaccuracies that may be contained in this manual.

In no event will Sonic Driver be liable for direct, indirect, special, incidental or consequential damages resulting from any defect or omission in this manual, even if we are advised of the possibility of such damages.

Sonic Driver Ltd reserves the right to make improvements to its manuals, instructions and products at any time, without notice or obligation. The latest revisions may be found on the company web site, see appendix A.

The UFM is a precision measuring instrument and should be handled and operated with care;

- Before operating the UFM for the first time read the installation manual and operating instruction fully.
- Further detail on connecting and using the UFM on a Modus RTU network are available in Sonic Driver Ultrasonic Clamp-on Flowmeter UFM-300 Modbus RTU Protocol, including a full register map.
- Only use the UFM in the way and for the purpose that it is intended.
- Do not subject the UFM to bumps and shocks such as caused by dropping the UFM.
- Keep the UFM and its transducers clean.
- Only use the UFM within its ambient temperature and stated level of Ingress Protection.
- Avoid excessive stress and bending of transducer cables and connectors.

2.0 Configuration Program Functionality

The UFM is installed and commissioned using the Configuration Program installed and running on a laptop (Windows).

Read the Installation manual for instructions on installing the Configuration program.

The Configuration program is basically a dashboard, see figure (2) which includes sections for;

- Quick Start
- Display of Ultrasonic Signal, Transducer Positioning
- Display of Measurements
- Display of Diagnostics
- Display of Internal Values

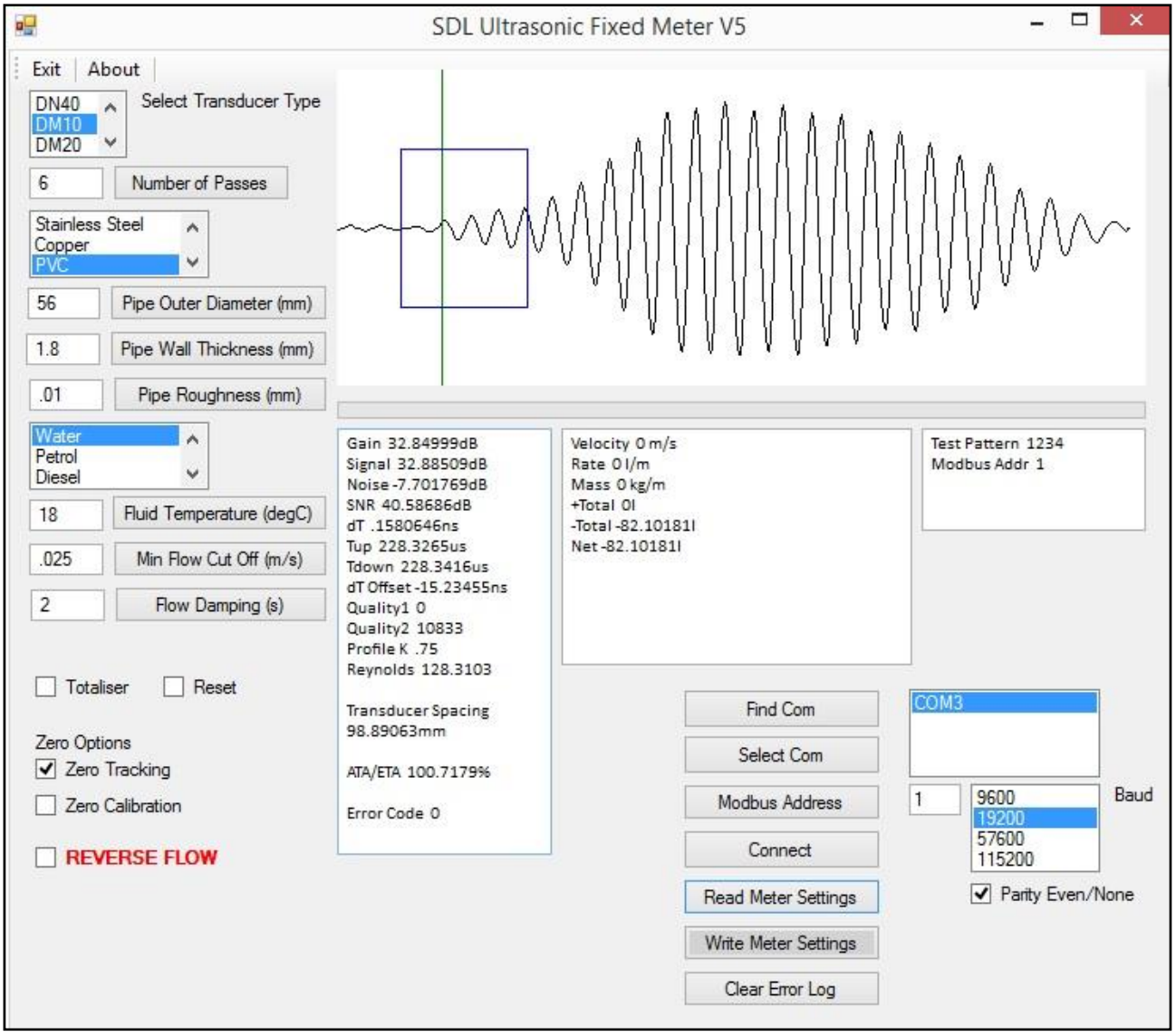

Figure (2) Configuration Program Dashboard.

2.1 Quick Start

This section, on the left-hand side of the dashboard, takes the user through a sequence of configuring the basic parameters necessary to get the UFM measuring reliably and accurately, see figure (3).

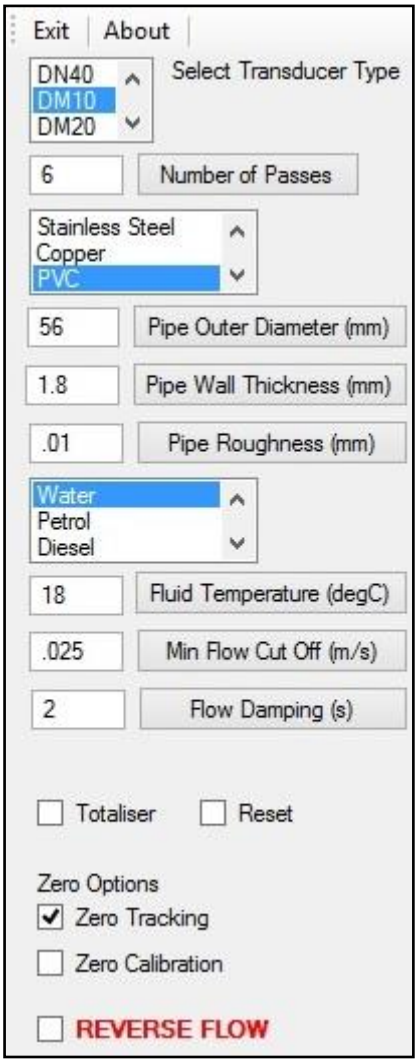

Figure (3) Quick Start Section.

Parameters and settings in the UFM can be edited by;

- Selecting an item using a scrolling list
- Ticking a Tick Box
- Direct numerical entry

It is important to note that after direct numerical entry of a parameter value it is important to press the named button next to the entry for it to be checked against limits, entered and saved.

If the value entered it not within limits, then the entry is rejected.

After entering the required Quick Start parameters, the spacing between the transducers is calculated and displayed. Check the value displayed in the diagnostics section and space the transducers, accordingly, read the Installation manual for instructions on mounting the transducers.

2.1.1 Transducer Type

The user is prompted to select the type of sensors mounted on the pipe from a list;

- DN40
- DM10 **(Default)**
- DM20
- DS10

DM sensors are Sonic Driver standard PEEK/stainless steel design. DN sensors are Sonic Driver small pipe design. DS sensors are for large diameter pipes.

2.1.2 Number of Passes (Transducer Mounting)

The user is prompted to enter the number of times the sound path crosses the pipe. Allowed values are 1 to 16.

Ideally choose a number of passes that results in a path length in the fluid of 100 mm or greater.

- 1 pass, most common on large diameter pipes.
- 2 passes, the most used method, simplest to install as both sensors are on the same side of the pipe.
- 3 passes, used on small diameter pipes.
- 4 passes, used on the lowest diameter pipes.
- 5 to 15 and 16, etc.

It may be that on small diameter pipes then the recommended transducer spacing at 16 passes is not sufficient to allow the transducers to be coupled on the same side of the pipe, an even number of passes as they touch. In this case it is unavoidable to couple the transducers on opposite sides of the pipe using an odd number of passes, for example 13 or 15 passes.

2.1.3 Pipe Material

The user can select the pipe material from a list;

- Carbon Steel
- Stainless Steel
- Copper
- PVC **(Default)**
- Cast Iron
- Ductile Iron
- HDPE

The transverse speed of sound in the pipe material is read from a database held in the UFM.

2.1.4 Pipe Outer Diameter

The user is prompted to enter a value for the pipe outer diameter. Allowed values are ranged 10.0 to 115.0 mm or 115.0 to 225.0 mm, default 56.0 mm.

2.1.5 Pipe Wall Thickness

The user is prompted to enter a value for the pipe wall thickness. Allowed values are ranged 0.5 to 100.0 mm, default 1.8 mm.

2.1.6 Pipe Roughness

The user is prompted to enter a value for the peak/trough height of the roughness on the inside surface of the pipe. Allowed values are ranged 0.001 to 10.000 mm, default 0.010 mm.

This value is used in flow profile correction calculations.

2.1.7 Fluid Type

The user can select the fluid in the pipe from a list;

- Water **(Default)**
- Petrol
- Diesel
- Glycol/Water

2.1.8 Fluid Temperature

The user is prompted to enter the temperature of the fluid in the pipe. Allowed values are ranged -20 to +150 deg C, default 18 deg C.

Changing Fluid Temperature causes Fluid Sound Velocity, Fluid Kinematic Viscosity and Fluid Density to be recalculated.

2.1.9 Min Flow Cutoff

If the flow velocity falls below the low flow cutoff value, the measured flow velocity and calculated flow rate indication is driven to zero. This function can prevent the flow meter from reading flow after a pump is shut down but there is still circulating liquid creating movement in the pipe.

Generally, 0.025 m/s is recommended as the low flow cutoff point. The low flow cutoff value has no relation to the measurement results once the velocity increases over the low flow cutoff value.

The user is prompted to enter a value in m/s below which the meter reports flow as zero. Allowed values are ranged 0.000 to 1.000 m/s, default 0.025 m/s.

Note. This absolute value is applied to both positive and negative flow as a +/- band either side of zero.

2.1.10 Flow Damping

The user is prompted to enter a display damping or averaging time.

Allowed values are ranged 1 to 255 seconds, the default is 2 seconds.

The damping time can be adjusted to stabilise the flow value being displayed. Essentially, it is a

type of signal filter applying an RC time constant.

Increasing the damping increases the stability. However, the measurement displayed can be slightly delayed due to over damping. Too much damping may also result in no response to real time fluctuations, especially when flow rate fluctuates wildly.

Therefore, damping should be kept at a minimum and increased just enough to reduce the fluctuation to an acceptable degree.

Once the installation configuration has been set press the Write Meter Settings button, see figure (4).

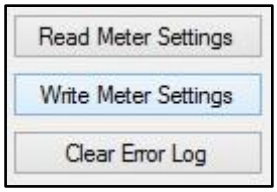

Figure (4) Write Meter Settings

To read a previously configured UFM configuration press the Read Meter Settings button.

2.2 Display of Ultrasonic Signal, Transducer Positioning

This section displays the received ultrasonic signal to aid transducer mounting and allows coupling optimization, see figure (5).

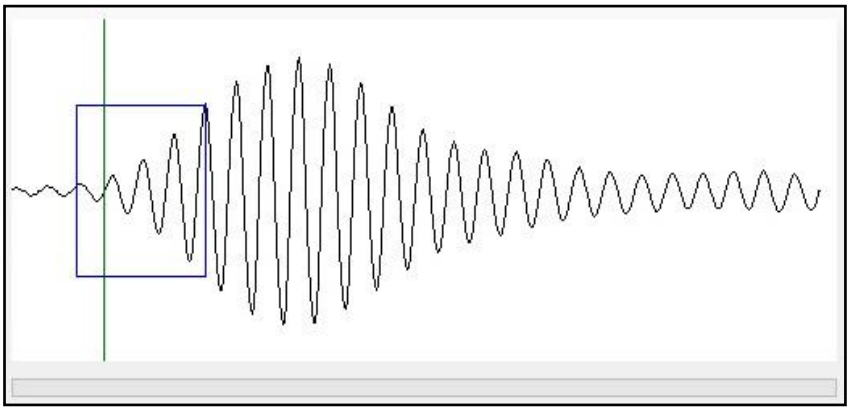

Figure (5) Ultrasonic Signal, Transducer Positioning.

To make a flow measurement and update this display press Read Meter Settings.

The configuration program reads and displays the ultrasonic signal being measured. The first arrival of the signal should appear in the blue square, the green line indicates where the UFM has determined the first arrival to be. If the UFM is not confident then this line will be red.

Flow measurement and diagnostics are shown in the relevant sections on the dashboard.

Given the parameter values entered the UFM displays the required spacing for the transducers clamped on the pipe in the diagnostics listing.

Below the scope trace is a progress bar which shows the progress of data and parameter value download.

2.3 Display of Measurements

This section, see figure (6) below, displays;

- Flow velocity (m/s)
- Flow rate (l/min)
- Mass flow rate (kg/min)
- Flow positive total (l)
- Flow negative total (l)
- Flow net total (l)

These values are averaged and have flow profile compensation and minimum flow cut off applied.

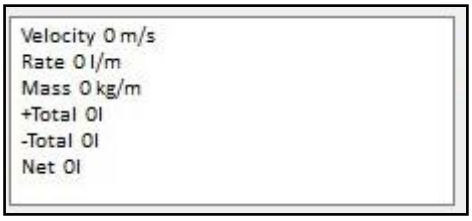

Figure (6) Display of Measurements.

To just make flow measurements press the Read Meter Settings button.

Flow velocity is a rolling average value (see flow damping), which is flow profile compensated, with zero flow cut off applied (see minimum flow cut-off). The other measured values are derived from this velocity.

The fluid temperature is used for compensation of; speed of sound, density and viscosity.

2.4 Display of Diagnostics

This section, see figure (7) displays diagnostics to aid transducer mounting and allows coupling optimization.

Figure (7) Diagnostics Values.

To just make diagnostic measurements press the Read Meter Settings button.

2.4.1 Signal Based Diagnostics

This section displays diagnostics related to the signal strength and SNR of the received sonic signal;

- Gain
- Signal
- Noise
- SNR

Gain indicates the amount of electronic gain being used by the UFM receiver amplifier. Gain is indicated by numbers from typically 0.0 to 81.0, in decibels (dB).

0.0 represents the minimum gain whilst 81.0 represents the maximum.

Old pipes, attenuating pipes, corrosion, attenuating fluids, etc. can require the UFM to automatically turn up its gain.

The UFM normally operates with a gain typically around 30.0 to 60.0 dB.

Signal strength indicates the detected strength of the sonic signal in dB. Signal strength is indicated by numbers from typically -25.0 to +55.0.

Normally, the stronger the signal strength detected the better and more reliable the flow measurement is, as well as the more stable the measurement value obtained.

Adjust the transducer positioning to the best position, within limits and check to ensure that enough sonic coupling compound is applied during installation to obtain the maximum signal strength.

The UFM normally requires signal strength over 0.0 dB to measure reliably. If the signal strength detected is too low (is zero or negative), the transducer installation position and the transducer mounting spacing should be adjusted and the pipe should be inspected. If necessary, change the mounting position and/or method.

Noise indicates the level of extraneous sonic and electrical noise being detected in dB. Noise is indicated by numbers from typically -25.0 to +55.0.

The UFM normally requires noise strength below +10.0 dB to measure reliably.

SNR indicates the quality of the sonic signal detected. SNR is indicated by numbers from typically 1.0 to 99.0, in dB.

1.0 represents the minimum SNR whilst 99.0 represents the maximum.

Normally, the transducer position should be adjusted and coupling compound application should be checked until the SNR detected is as large as possible.

The UFM normally requires SNR over 12.0 dB to measure reliably.

2.4.2 Time Based Diagnostics

This section shows diagnostics relating to the timing measurements being made by the UFM.

- Delta Time
- Transit Time Up
- Transit Time Down
- dT Offset

Delta Time is the difference in time between the two absolute transit times through the fluid. Delta Time is of the order of tens of nanoseconds because the absolute upstream and downstream times are so close together in value.

The absolute upstream transit time through the fluid in the pipe and the absolute downstream transit time through the fluid in the pipe are usually of the order of hundreds of microseconds. They are very nearly identical.

These values can help indicate the accuracy and condition of the installation. The measurement calculations in the UFM are based upon these values.

Therefore, when transit time difference fluctuates widely, the flow and velocities fluctuate accordingly. This is usually accompanied by a signal strength and/or signal to noise ratio (SNR) that is too low and varying. This may be the result of poor pipe installation conditions, inadequate transducer installation, or incorrect parameter input. Generally, fluctuations should be less than ± 20 %.

dT Offset is the offset value currently being used by the zero-tracking function. This is usually in the range ± 2.5 ns.

Quality1 and Quality2 are diagnostic values intended for service personnel.

2.4.3 Profile K

Flow profile compensation factor based on Reynolds number.

2.4.4 Reynolds

The Reynolds number for the flow in the pipe.

2.4.5 Transducer Spacing

Given the values entered during Quick Start then this value is the UFM required transducer spacing, mount the transducers on the pipe at this spacing.

The Installation Manual that accompanies these Operating Instructions gives more details regarding mounting, coupling and spacing the transducers correctly.

2.4.6 ATA/ETA

This key gives access to a display of transit time ratio shown as a percentage value. This is a measure of the ratio of the measured transit time to that which is expected given the parameters

entered by the user during Quick Start. It indicates if the transducer mounting and spacing is accurate. The normal transit time ratio should be 100 ± 3 % if the installation is correct.

It is acceptable to have to move one of the transducers up to ± 5 mm to achieve a figure of 100 %. If more movement is necessary, then one of the pipe parameters is probably incorrect. This is most likely to be the value entered for pipe wall thickness as this is often taken from tables or it is an estimated value.

2.4.7 Error Code

The Error Code should always be zero, see Appendix A. It can be zeroed using the Clear Error Log button, see figure (4).

2.5 Display of Internal Values

This section displays a Test Pattern and the Modbus address of the UFM, see figure (8).

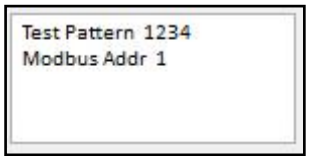

Figure (8) Internal Values.

If the UFM is communicating correctly then the Test Pattern should always appear as **1234**.

3.0 Flow Totalisers

The UFM has positive, negative and net flow totalisers. These are activated by ticking the Totaliser tick box, see figure (9)

Figure (9) Totaliser tick box.

When the totalisers are running the UFM puts itself into an un-polled mode of measurement so that measurements are taken automatically against an internal clock. The latest totalised values are stored in non-volatile memory so are retained if the power to the UFM is removed.

When totalising the user can read the UFM setup, measurement values and totalisers but cannot write to it, see figure (10).

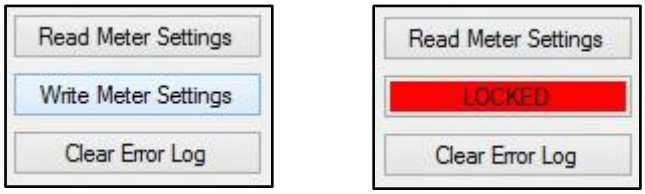

Figure (10) Write meter locked when totaliser is running.

To stop totalising untick the Totaliser box. To restart totalising tick the Totaliser box again.

To reset totals to zero tick the Reset box.

4.0 Zero Tracking and Calibration

Tick boxes exist to allow the user to set zero tracking and zero calibration functions On/Off, see figure (11).

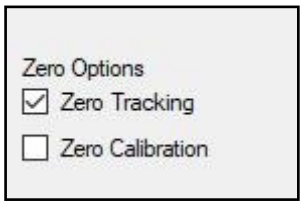

Figure (11) Turn Zero Tracking and Calibration On/Off.

4.1 Zero Tracking

When the measured delta time falls below a lower limit then the flow being measured is assumed by the UFM to be zero.

The user can turn a tracking algorithm On/Off so that such a small offset value is tracked/trended to zero.

By default, zero tracking is always turned On.

At extremely low flows the meter can mistakenly identify a flow from for example a real leak as an erroneous offset. To avoid the leak being tracked off turn zero tracking Off.

4.2 Set Zero Calibration

The user is prompted to turn zero calibration On/Off. A zero calibration can be made before the meter proceeds to measurement mode by using this option.

By default, Set Zero calibration is turned Off.

If Set Zero calibration is turned on then a zero flow calibration is made.

It is important that the SNR and other signal diagnostics are within tolerance during this process. Until the meter is satisfied the display does not update. Only when happy will it start to average up.

NOTE. PIPE MUST BE FULL AND FLOW MUST BE ZERO.

The meter will make averaged measurements and determine any offset values. When the displayed value stabilises then turn the calibration function off.

If a zero-flow delta time difference of greater then +/- 2.5 ns is measured then the user should check that there is zero flow in the pipe.

5.0 Reverse Flow

Depending upon site specific installation considerations, such as confined space, when using the UFM with its guide-rail then the rail may be installed with the transducers aligned against the flow in the pipe. In this case tick the Reverse Flow tick box, see figure (12) and measurements will be indicated with the correct positive/negative value.

Figure (12) Reverse Flow.

6.0 Powering On

To power on the UFM simply apply DC power, see the installation manual for details of mounting and wiring the UFM and important safety information.

As soon as the UFM is switched on a self-diagnostic program will start.

If an error is detected an error message will be logged in the diagnostics section prompting user action. If the error persists contact customer support. Error codes and their meanings can be found in Appendix A. Error codes can be cleared using the Clear Error button, see figure (13).

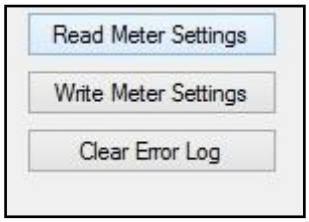

Figure (13) Clear Error Log

See relevant sections on Input/Output below for more detail of what tests are carried out.

During connection the dashboard will display;

- **Company Name -** Sonic Driver.
- **Model Code -** Show model code of the UFM.
- **Serial No. -** Show the unique serial number assigned to the UFM during manufacture.

- **HW Issue -** Show the HW version for the UFM.
- **SW Issue -** Show the SW version for the UFM.

7.0 Communications Software

There are several communications programs available for download online.

The UFM has been tested using Modbus Poll (for Windows platform) and Modbus Monitor (for Android and Windows platforms).

Appendix A Error codes

Error codes are a 16-bit value, where each bit represents an error flag with value 0 when there is no error and 1 when an error condition is present;

- 0 Processor internal address error
- 1 Processor internal math error
- 2 Processor internal oscillator error
- 3 Processor internal stack error
- 4 External FRAM memory error
- 5 SPI1 bus error
- 6 SPI2 bus error
- 7 TOFM communications error
- 8 UART error
- 9 Spare
- 10 Spare
- 11 Spare
- 12 Spare
- 13 Spare
- 14 Spare
- 15 Spare

Spare bits are always 0.