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Sonic Driver 30000001 Ultrasonic Flow Transmitter Instruction Manual

Contents

Sonic Driver

Sonic Driver 30000001 Ultrasonic Flow Transmitter

Ultrasonic Flow Transmitter Operating Instructions

- **Version:** 1.1
- Made in Britain
- 13th March 2023
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Contents

Introduction

Congratulations on choosing the Sonic DriverTM Ultrasonic Flow Transmitter (UFT), a pipe, wall, or panel-mounted clamp-on ultrasonic flowmeter.

The UFT 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 using the meter's PC-based Configuration program (Windows), the UFT can calculate various flow parameters.

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.

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The UFT is a precision measuring instrument and should be handled and operated with care.

Configuration Program Functionality

The UFT is installed and commissioned using the Configuration Program installed and running on a PC (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 various settings and parameters.

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 UFT measuring reliably and accurately, see Figure(3).

Transducer Type

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

- **DM sensors:** Sonic Driver standard PEEK stainless steel design.
- **DN sensors:** Sonic Driver small pipe design.
- **DS sensors:** For large diameter pipes.

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 100mm or greater.

On small-diameter pipes, the recommended transducer spacing at 16 passes may not be sufficient to allow the transducers to be coupled on the same side of the pipe. In this case, it is necessary to couple the transducers on opposite sides of the pipe using an odd number of passes, for example, 13 or 15 passes.

Introduction

Congratulations on choosing the Sonic DriverTM Ultrasonic Flow Transmitter(UFT), pipe, wall or panel-mounted clamp-on ultrasonic flowmeter, figure(1).

Figure(1) The Sonic Driver UFT.
The UFT 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, using the meter's PC-based Configuration program (Windows) the UFT 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)

All of the above flow measurements and a complete set of diagnostics are available over Modbus RTU RS485. For installation, a PC is connected to the UFT via a bidirectional USB/RS485 converter. All installation parameters are available for editing over Modbus RTU. Once installed the PC and converter can be disconnected and the UFT connected to a Modbus RTU RS485 network and back to a control room, Cloud-based monitoring applications or 3rd party data logger where a Modbus Master polls the UFT Slave.

General Precautions

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

Configuration Program Functionality

The UFT is installed and commissioned using the Configuration Program installed and running on a PC (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

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 UFT measuring reliably and accurately, see

Figure(3) Quick Start Section.

parameters and settings in the UFT 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 the 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.

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.

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 100mm or greater.

- 1 pass, most common on large-diameter pipes.
- 2 passes, the most commonly used method, simplest to install as both sensors are on the same side of the pipe.
- 3 passes are 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.

Pipe Material
The user can select the pipe material from a list;

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

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

Pipe Outer Diameter

The user is prompted to enter a value for the pipe outer diameter. Allowed values range 10.0 to 750.0mm, with a default of 60.6mm.

Pipe Wall Thickness

The user is prompted to enter a value for the pipe wall thickness. Allowed values are ranged 0.5 to 100.0mm, default 3.2mm.

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 10.000mm, default of 0.010mm.

This value is used in flow profile correction calculations.

Fluid Type

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

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

Fluid Temperature

The user is prompted to enter the temperature of the fluid in the pipe. Allowed values range from -20 to +150 degC, with a default 18 degrees. Changing Fluid Temperature causes Fluid Sound Velocity, Fluid Kinematic Viscosity, and Fluid Density to be recalculated.

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, 0.025m/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 from 0.000 to 1.000m/s, default 0.025m/s. Note. This absolute value is applied to both positive and negative flow as a +/- band on either side of zero.

Flow Damping

The user is prompted to enter a display damping or averaging time. Allowed values range 1 to 255 seconds, the default is 10 seconds. The damping time can be adjusted to stabilize 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 the 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).
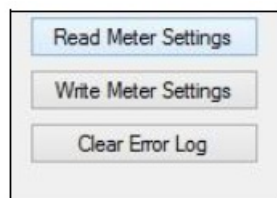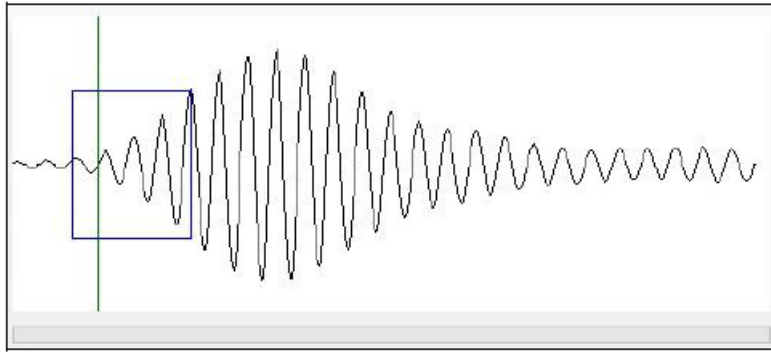

To read a previously configured UFT configuration press the Read Meter Settings button.

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 UFT has determined the #firstarrival to be. If the UFT 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 UFT displays the required spacing for the transducers clamped on the pipe in the diagnostics listing. Below the scope trace is a progress bar that shows the progress of data and parameter value download.
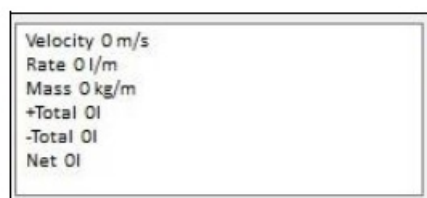
Display of Measurements

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; the speed of sound, density, and viscosity.

Display of Diagnostics

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

```
Gain 14.85dB
Signal 50.61065dB
Noise 5.018271dB
SNR 45.59238dB
dT -.03327453ns
Tup 230.2659us
Tdown 230.2679us
dT Offset -1.862314ns
Quality1 0
Quality2 6898
Profile K .75
Reynolds 40.75824

Transducer Spacing
98.89063mm

ATA/ETA 99.86965%

Error Code 0
```

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

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 UFT receiver amplifier. Gain is indicated by numbers from typically 0.0 to 81.0, in dB. 0.0 represents the minimum gain whilst 81.0 represents the maximum. Old pipes, attenuating pipes, corrosion, attenuating fluids, etc. can require the UFT to automatically turn up its gain. The UFT normally operates with a gain typically around 30.0 to 60.0 dB.Signal strength indicates the detected strength of the sonic signal in decibels (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 in order to obtain the maximum signal strength.

The UFT normally requires signal strength over 0.0dB 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 UFT normally requires noise strength below +10.0dB 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. represents the minimum SNR whilst 99.0 represents the maximum. Normally, the transducer position should be adjusted and the coupling compound application should be checked until the SNR detected is as large as possible. The UFT normally requires SNR over 12.0dB to measure reliably.

Time-Based Diagnostics

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

- 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 UFT 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 ± 2.5ns. Quality1 and Quality2 are diagnostic values intended for service personnel.

Profile K
Flow profile compensation factor based on Reynolds number.
Reynolds
The Reynolds number for the flow in the pipe.
Transducer Spacing
Given the values entered during Quick Start then this value is the UFT 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.
ATA/ETA
This key gives access to a display of the 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 ± 5mm 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.
Error Code
The Error Code should always be zero, see Appendix B. It can be zeroed using the Clear Error Log button, see figure (4).
Display of Internal Values
This section displays a Test Pattern and the Modbus address of the UFT, see Figure (8).

Test Pattern 1234
Modbus Addr 1

Figure(8) Internal Values.

If the UFT is communicating correctly then the Test Pattern should always appear as 1234.
Flow Totalisers
The UFT has positive, negative and net flow totalisers. These are activated by ticking the Totaliser tick box, see Figure (9)

☐ Totaliser

Zero Options
☐ Zero Tracking
☐ Zero Calibration
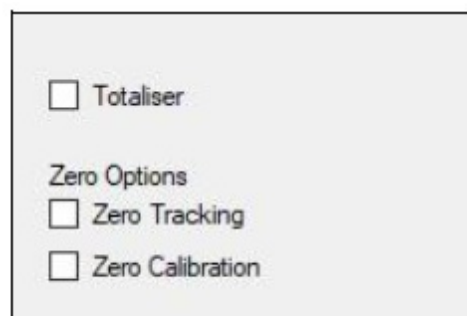
Figure(9) Totaliser tick box.

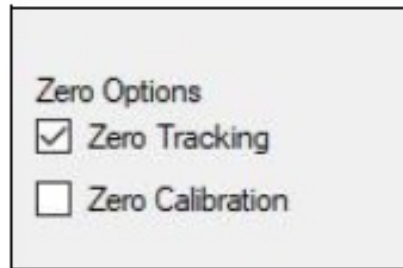When the totalisers are running the UFT puts itself into an un-polled mode of measurement so that measurements are taken automatically against an internal clock. The latest totalized values are stored in nonvolatile memory so are retained if the power to the UFT is removed. When totalizing the user can read the UFT setup, measurement

values, and totalizers but cannot write to it. To stop totalising untick the Totaliser box. Re-ticking the box to restart totalizing resets the totals to zero.

Zero Tracking and Calibration
Tick boxes exist to allow the user to set zero tracking and zero calibration functions On/Off, see figure(10).

Figure(10) Turn Zero Tracking and Calibration On/Off.

Zero Tracking
When the measured delta time falls below a lower limit then the flow being measured is assumed by the UFT 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.
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.
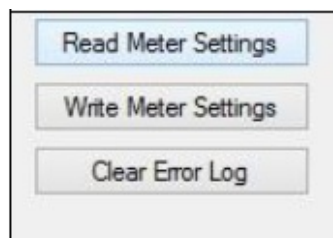**NOTE.** THE PIPE MUST BE FULL AND THE FLOW MUST BE ZERO.
The meter will make averaged measurements and determine any offset values. When the displayed value stabilises then turn the calibration function off. If a zero-flow delta time difference of greater than +/-2.5ns is measured then the user is should check that there is zero flow in the pipe.
Powering On
To power on the UFT simply apply DC power, see the installation manual for details of mounting and wiring the UFT and important safety information.

As soon as the UFT 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 (11).

Figure(11) 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 UFT.
- **Serial No**. – Show the unique serial number assigned to the UFT during manufacture.

- **HW Issue** – Show the HW version for the UFT.
- **SW Issue** – Show the SW version for the UFT.

Communications Software

There are several communications programs available for download online. The UFT has been tested using Modbus Poll (for Windows platforms) 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 Meter 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.

Documents / Resources

Ultrasonic Flow Transmitter Operating Instructions Version 1.1	**Sonic Driver 30000001 Ultrasonic Flow Transmitter** [pdf] Instruction Manual 30000001, Ultrasonic Flow Transmitter, 30000001 Ultrasonic Flow Transmitter, Flow Transmitter, Transmitter

References

- **Home - Clamp-on flow solutions ®**