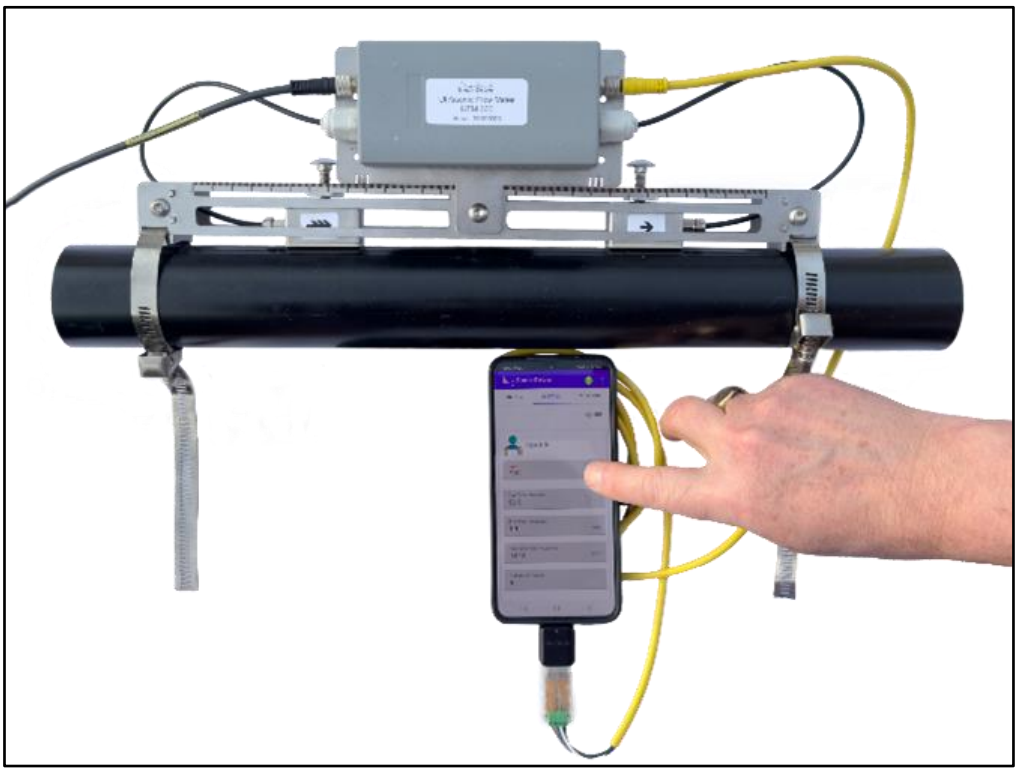
Sonic Driver

Made in Britain

Ultrasonic Clamp-on Flowmeter UFM-300

Smart Phone Installation Manual

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).

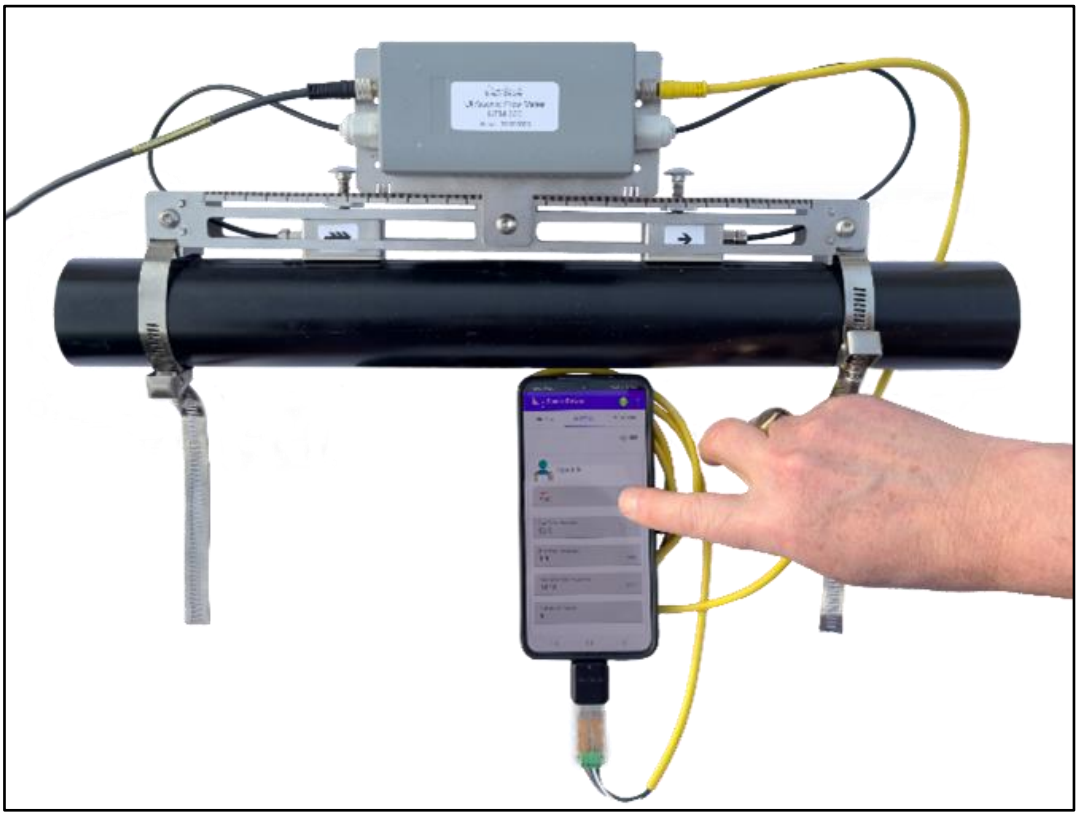

Figure (1) The Sonic Driver UFM-300.

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 Smart phone App or laptop-based configuration program (Windows) 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 the above flow measurements and a complete set of diagnostics are available over Modbus RTU RS485.

For installation a Smart phone is connected to the UFM via a bidirectional USB to RS485 converter. All installation parameters are available for editing locally via the Smart phone App 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 Smart phone 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 Smart phone.

This manual details installation using the Smart phone configuration App route.

A separate manual details installation using the laptop Windows configuration program route

1.1 Transit Time Measurement

The principle of flow measurement using ultrasonic clamp-on transit time measurement is simple, see figure (2).

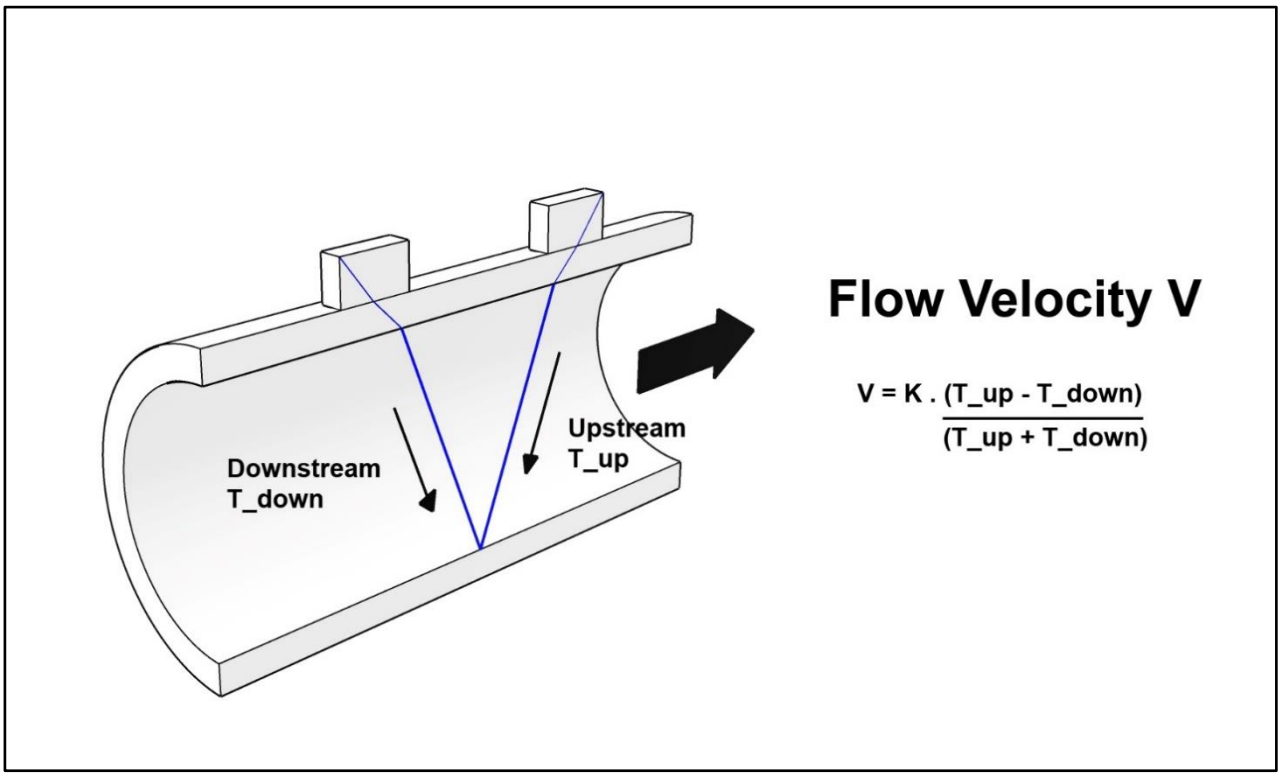

Figure (2) The principle of transit time flow measurement.

Two ultrasonic transducers are coupled or clamped to the outside of the pipe at a predetermined distance apart.

Ultrasonic pulses travel between the transducers through the pipe wall and the fluid within the pipe.

If the fluid is flowing then it takes slightly longer for the ultrasound to travel against the flow (upstream time T_up) than with the flow (downstream time T_down), see figure (2).

In a typical installation the individual times measured upstream and downstream are just a few hundred microseconds, the difference between them is typically measured in tens of nanoseconds.

This very small-time difference (T_up - T_down) is measured by the UFM and is directly proportional to the flow velocity (V) of the fluid.

Knowing the pipe internal cross-sectional area the UFM can calculate volumetric flow rate in many common engineering units. A further knowledge of the density of the fluid allows the UFM to calculate mass flow rate.

1.2 Packing List

Within the UFM packaging you should find;

Item	Quantity
UFM with selected mounting bracket	1
PEEK/Stainless Steel Flow Transducer	2
Coupling Gel	1

Table (1) Packing List.

If any item on the packing list is missing or has been damaged in transit contact Service, see Appendix A.

1.3 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.

1.4 Cleaning

Wipe the UFM and transducers with tissue or soft cloth after use, remove excess coupling gel.

2.0 Mounting the UFM and its Flow Transducers

The UFM and its transducers can be physically installed in 4 different configurations:

2.1 Guide-rail mounting

Mount the guide-rail on the pipe using cable ties (small pipes) or metal banding (large pipes), see figure (3). Fit the transducers in the guide-rail and space them appropriately.

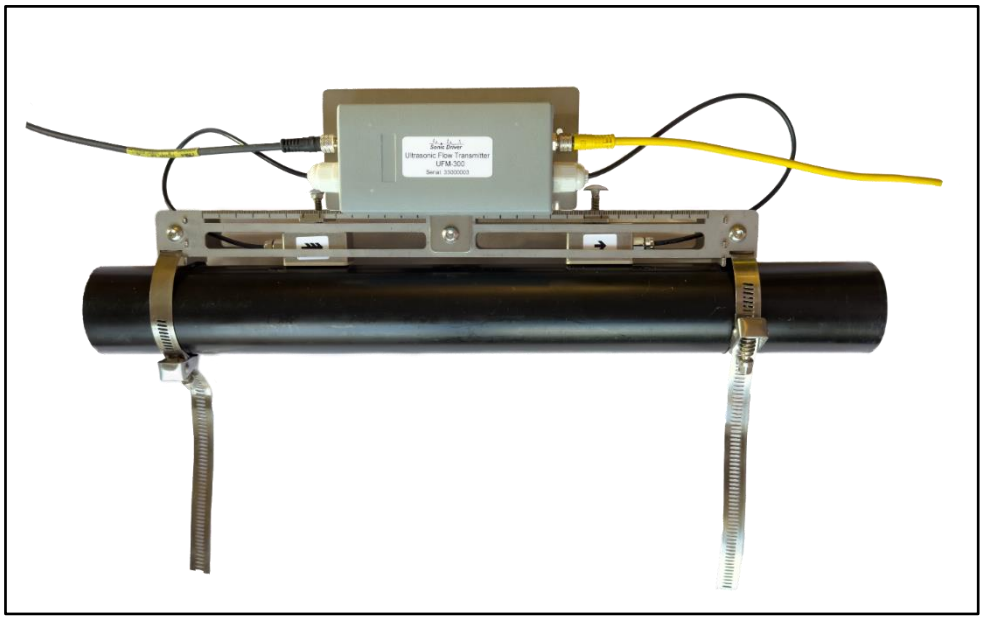

Figure (3) Guide-rail mounting.

Use the mounting screws to firmly position the transducers on the pipe, figure (4).

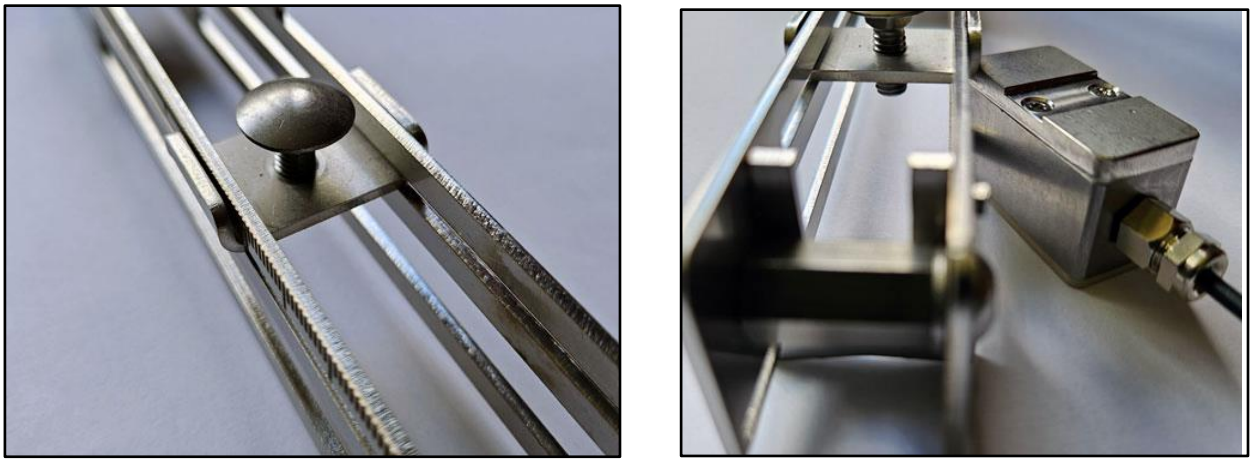

Figure (4) Guide-rail mounting screws.

The screws can be tightened finger tight into the slot in the sensor lid.

2.2 Pipe mounting

Mount the flow transducers and the UFM mounting plate on the pipe using cable ties (small pipes) or metal banding (large pipes), see figures (5, 6, 7).

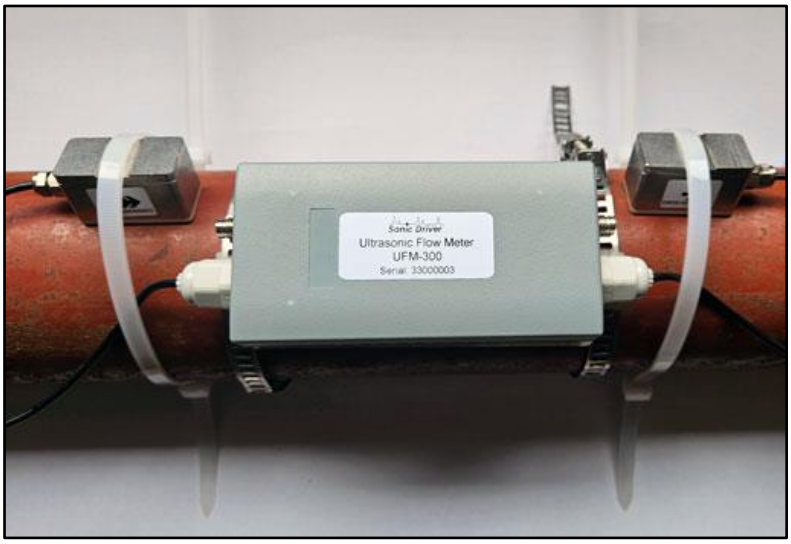

Figure (5) Pipe mounting bracket attached with metal banding, transducers attached with cable ties.

When making the installation select banding or cable ties as appropriate.

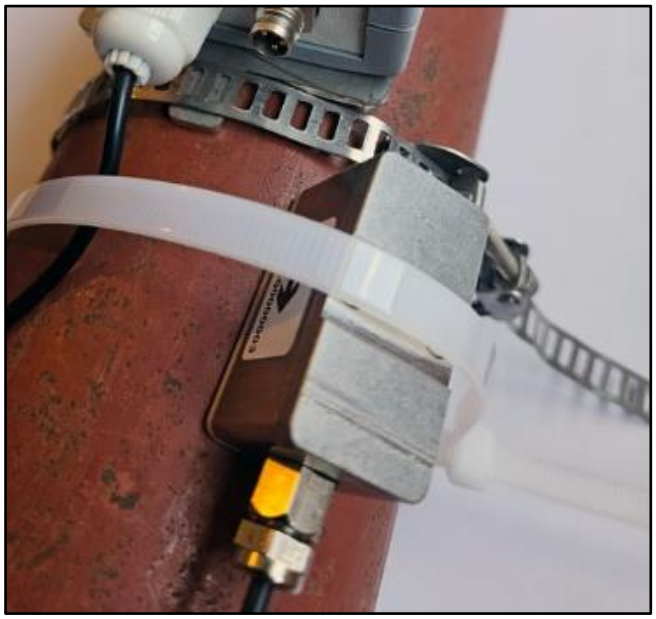

Figure (6) Detail showing position of banding and cable ties.

Note the position of the tab on the mounting plate, over which the banding passes.

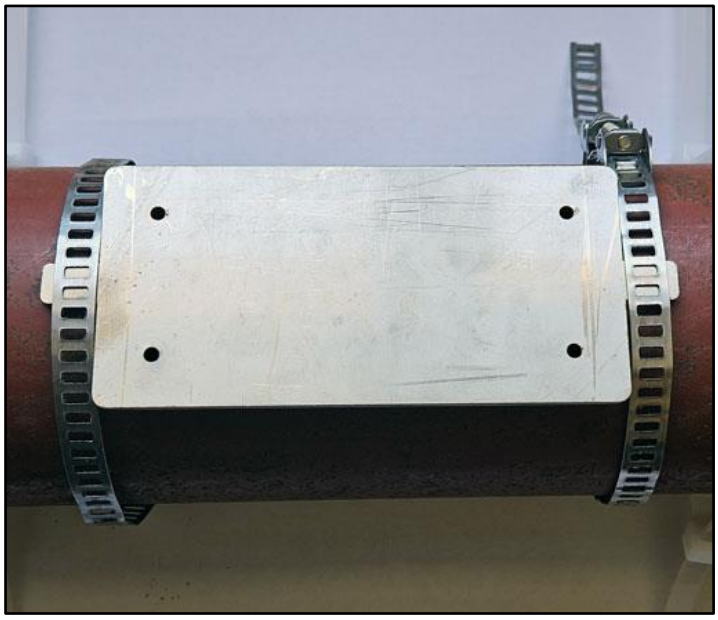

Figure (7) Pipe mounting with UFM removed for clarity of mounting tabs.

Figure (7) is for clarity only; it is not recommended to remove the UFM.

2.3 Wall mounting

Mount the flow transducers on the pipe using cable ties (small pipes) or metal banding (large pipes), see figure (8, 9). Screw the UFM mounting plate to the wall using the 2 holes provided.

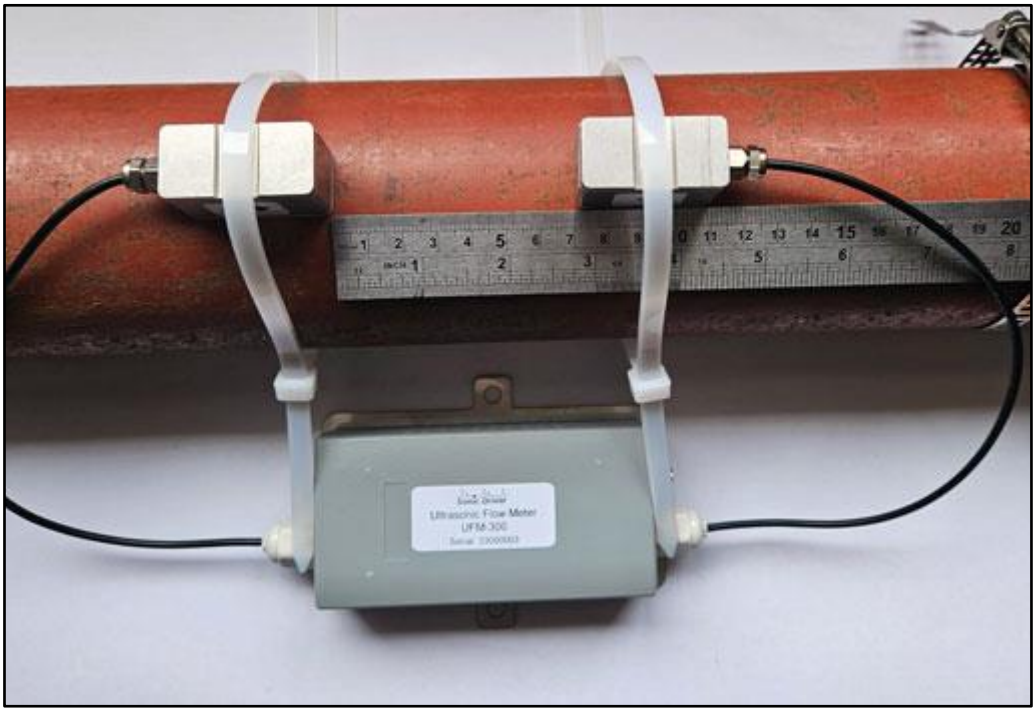

Figure (8) Wall mounting.

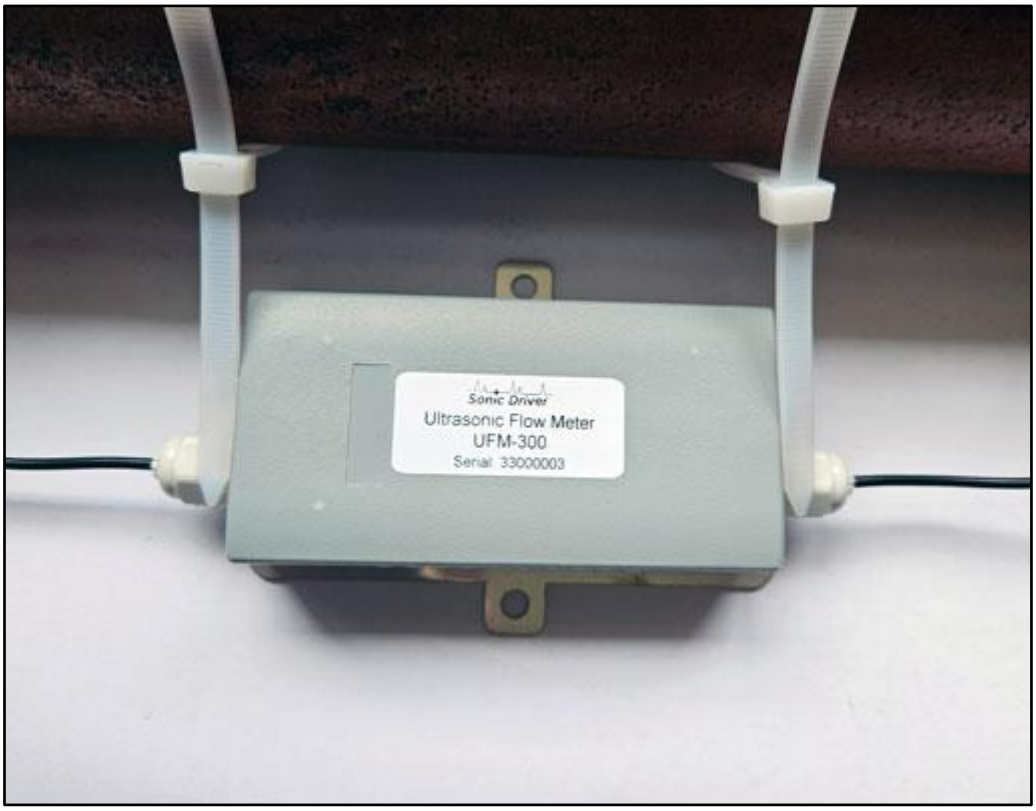

Figure (9) Wall mounting tabs.

2.4 Panel mounting

Mount the flow transducers on the pipe using cable ties (small pipes) or metal banding (large pipes) as in section 2.3, figure (8). Screw or bolt the UFM mounting plate inside the panel.

When measuring the spacing of the transducers, note that spacing is measured between the front faces of the transducers, see figure (10).

Figure (10) Flow transducer mounting, spacing is 70 mm between front faces.

Ensure the transducers are facing each other and aligned axially along the pipe.

In figure (11) and figure (12) the transducers are misaligned and twisted, as a result the UFM will make poor flow measurements.

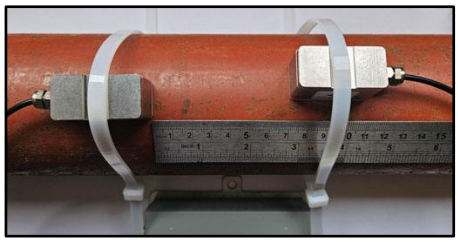

Figure (11) Misaligned transducers.

Figure (12) Twisted transducers.

Ensure that the arrow on the labels (arrowhead and flights) on the flow transducers is pointing in the direction of flow.

Use coupling gel between the transducers and the pipe to give good ultrasonic contact.

3.0 Using the App and the UFM

Before connecting the UFM to your Smart phone or tablet ensure that the device is turned on and its screen lock is off.

Connect the UFM to your phone or tablet via a USB to RS485 converter.

The device will automatically identify the UFM and request that you allow permissions. You may tick the Always Allow box.

The Smart device App will now automatically run and attempt to connect to the UFM.

Once connected the UFM is controlled via the user interface (UI) of the App running on the Smart device.

The UI is detailed in the UFM-300 Smart Operating Instructions.

The basic sequence is to work through the tabs;

- Connect
- Install
- Measure

These tabs take the user through the minimum sequence of parameters needed to get the UFM measuring reliably;

- Pipe Diameter
- Pipe Wall Thickness
- Pipe Material
- Fluid
- Fluid Temperature
- Transducer Type
- Transducer Mounting

Each parameter is described in the relevant section of the Operating Instructions.

3.1 Transducer Menu

This menu allows the user to change transducer settings.

3.1.1 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 larger diameter pipes.

3.1.2 Number of Passes

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, typically 100 mm or more in diameter. If the UFM suggests a negative spacing, then this is measured as in figure (13).

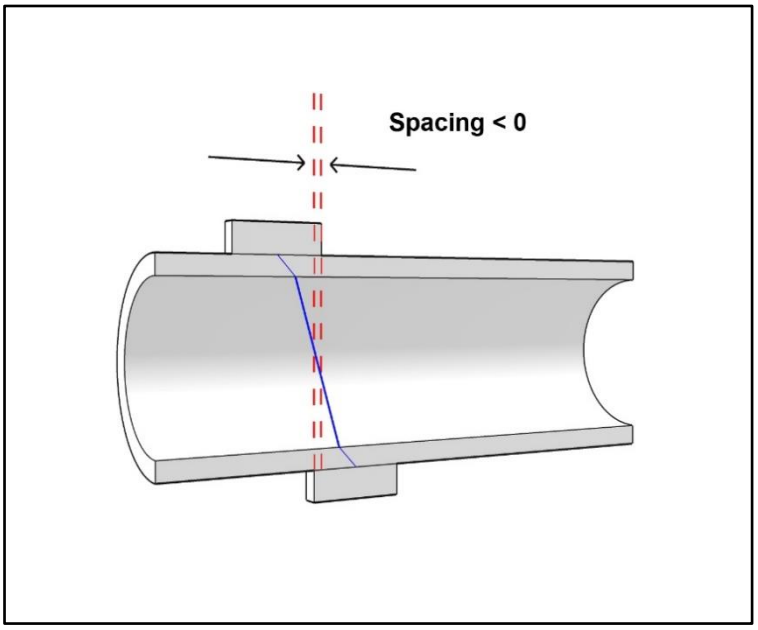

Figure (13) 1 pass, demonstrating a negative transducer spacing.

- 2 passes, the most used method, this is the simplest to install as both sensors are on the same side of the pipe, see figure (14).

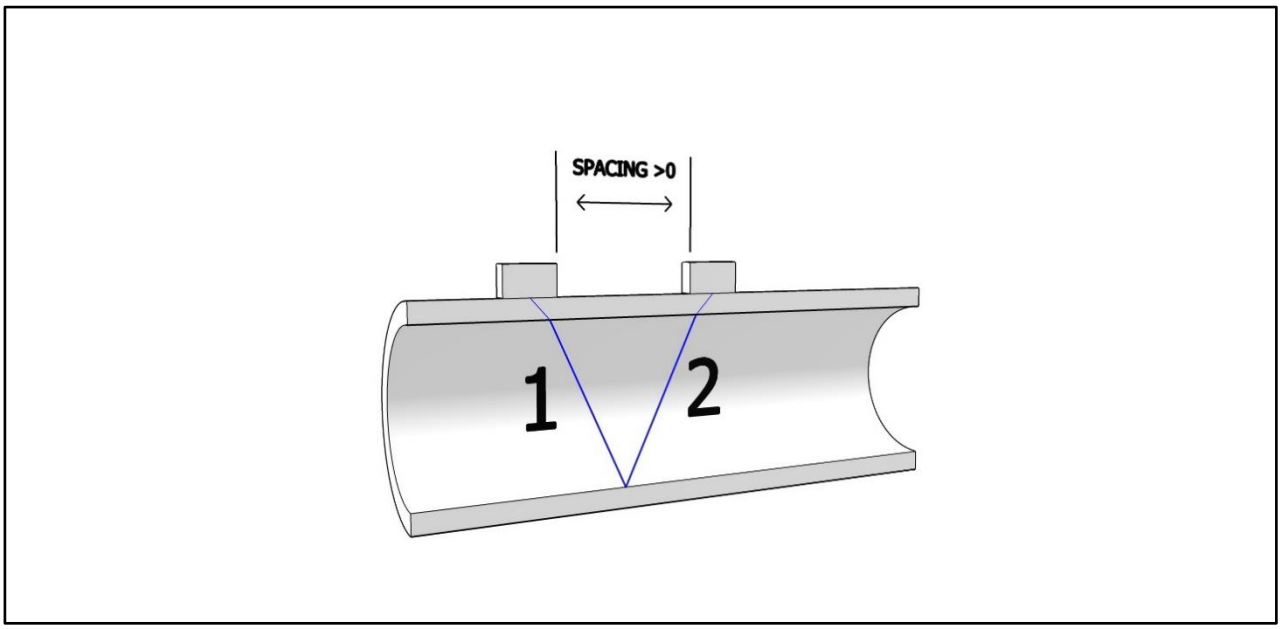

Figure (14) 2 passes.

- 3 passes, used on small diameter pipes.
- 4 passes, used on the smallest diameter pipes, see figure (15).

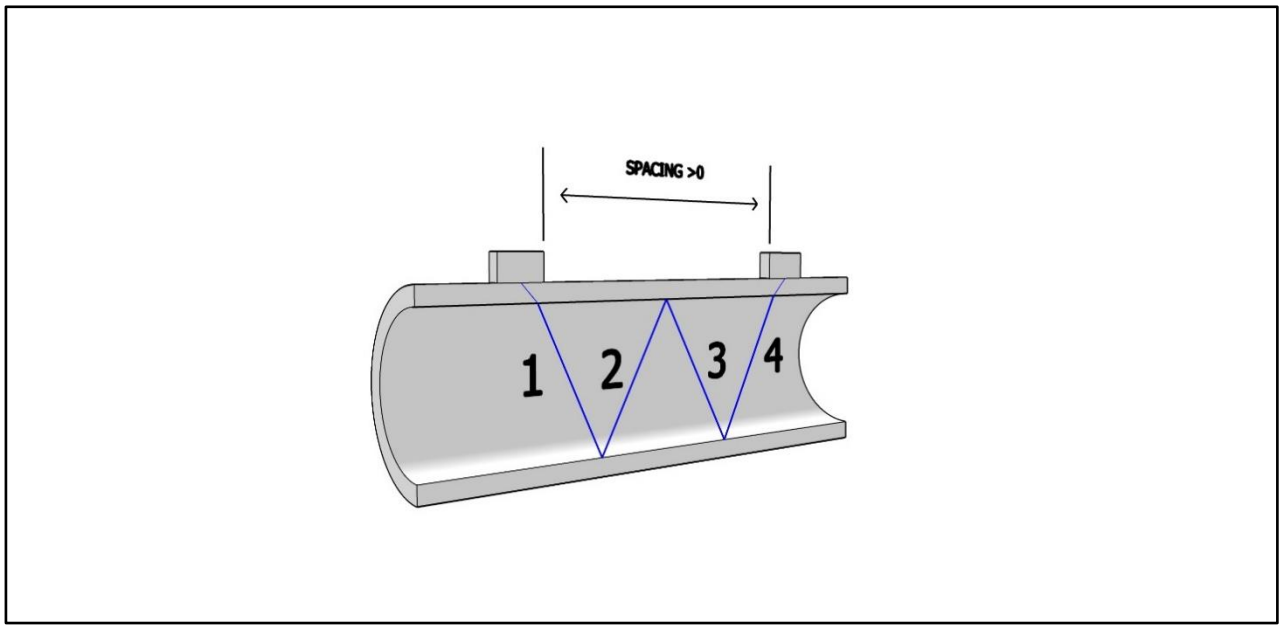

Figure (15) 4 passes.

- 5 to 15 and 16, etc.

It may be that on the smallest 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, using an even number of passes as they still 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.

3.2 Pipe Menu

The following parameters allow the user to specify the pipe.

3.2.1 Material

The user can select the pipe material from a list;

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

3.2.2 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 mm, default 56.0 mm.

3.2.3 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.

3.2.4 Pipe Wall 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. See Appendix B for a list of typical values.

3.3 Fluid Menu

This menu allows the user to change fluid settings.

3.3.1 Type

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

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

Sound Velocity, Kinematic Viscosity and Density for the selected fluid are stored in an internal database withing the UFM. These values are automatically temperature compensated.

3.3.2 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.

4.0 Sensor Positioning

Using the entered parameters, the UFM calculates and gives the required transducer spacing on the pipe under diagnostics.

The user is then presented with a sensor positioning screen and diagnostics showing,

- Graph of received ultrasonic signal
- Calculated sensor spacing
- Number of sound passes in the pipe
- Signal to Noise Ratio
- ATA/ETA

If the parameters entered are all correct, then the graph should appear as in figure (16).

Figure (16) Ideal Sensor Positioning.

Note how the first arrival in the received signal appears at the first vertical line in the grid.

However, if the user has an incomplete knowledge of the pipe, then the screen may look like figure (17) or figure (18).

Figure (17) Non-ideal Sensor Positioning, transducers too far apart.

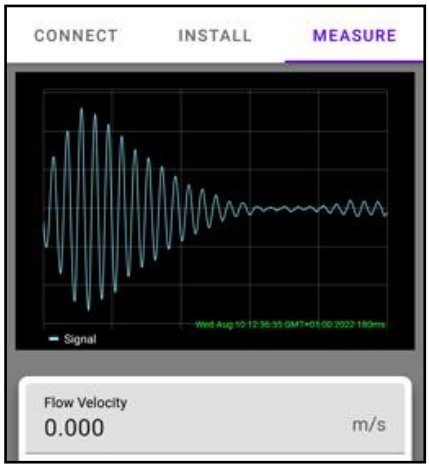

Figure (18) Non-ideal Sensor Positioning, transducers too close together.

In figure (17) the received signal is too far to the right; the user should slide the transducers closer together.

In figure (18) the received signal is too far to the left; the user should slide the transducers further apart.

The most common cause of an incomplete or incorrect spacing is a lack of knowledge about the pipe wall thickness.

As long as the signal is located as figure (9) resulting in an ATE/ETA value between 97 and 103 % then the UFM will measure accurately. It is acceptable to reposition the transducers to adjust their spacing by +/- 5 mm to optimise the positioning screen, the arrival marker will move on the screen accordingly.

SNR should peak and be above 24 dB.

4.1 Optimising Transducer Mounting Location

For the best results ensure that,

- Ideally the transducers are mounted on bare pipe material, for metal pipes this should be metal free from dust, rust and paint.
- Consider a location away from internal corrosion, sediment and streams of entrained air, do not mount the transducers top to bottom on the pipe, mount at 2 or 10 o'clock.
- Avoid mounting the transducers either on or opposite axial welds along the pipe.
- Ensure the transducers are aligned axially along the pipe.
- Mount the transducers away from bends, valves and other inserted instrumentation.
- Observe were practical the advised upstream and downstream straight sections, see below, figure (19).
- Ensure the pipe will always be full at the point of installation, ideally mount the transducers at a low point in the system.
- If mounting the transducers on a vertical pipe section, ensure the flow direction is upwards in the section.
- Composite pipes can have de-laminations in their wall thickness, this type of pipe is notoriously bad when installing a UFM.
- Ensure the temperature at the transducer location is within the transducers rated range.

- Ideally the fluid should be free of particulates and bubbles, in the limit then an alternative method such as Doppler flow measurement may be required.
- Porous pipes, such as concrete can cause measurement problems.
- Using information from Standard Pipe Tables can be inaccurate, it is always best to measure the pipe outer diameter and wall thickness.
- No matter how accurate the meter is at making a velocity measurement, an inaccurate knowledge of the internal cross-sectional area of the pipe will lead to inaccuracy in the conversion to volumetric flow rate.

4.2 Upstream and Downstream Pipe Runs

Ideally the UFM transducers should be installed on as long a section of straight pipe as is possible, see figure (19).

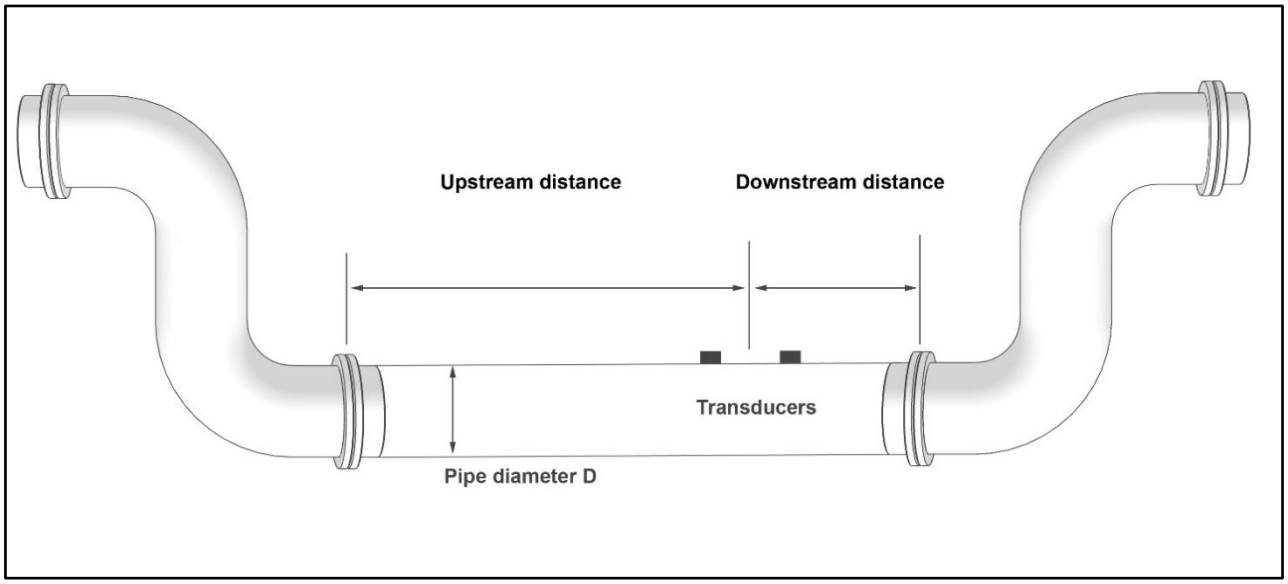

Figure (19) Upstream and downstream pipe lengths.

Considering a pipe with an outer diameter of D then, if possible, ensure at least 10D upstream distance between the transducers and a bend in the pipework.

In the case of an upstream Valve then if possible, ensure at least 20D upstream.

In the case of an upstream Pump then, if possible, ensure at least 30D upstream.

In all cases ideally ensure 5D downstream exists before a bend or obstruction in the pipework.

4.3 Transducer Mounting

Locate an optimum position on the pipe following the advice above.

Use Coupling gel. Apply adequate couplant and ensure no gap exists between the transducer and the pipe surfaces.

Banding or clamping is required to keep the transducers in place. It is recommended to use 10 mm wide jubilee clips. Plastic cable ties are also an option if transducer alignment can be maintained.

4.4 Transducer Spacing

Given that all information regarding the installation has been entered accurately and the advice above has been followed then the UFM will measure reliably and accurately.

This is confirmed by,

- A strong received signal strength
- A high SNR value
- Value of ATA/ETA close to 100 %

If is acceptable to make small adjustments to the transducer spacing to optimise the received signal strength and ATA//ETA.

However, if large adjustments are necessary then the importance of wall thickness should be considered. Wall thickness is typically the parameter about which the user has the least knowledge.

If all other avenues have been explored, including recoupling the transducers at several different locations on the pipework then adjusting the wall thickness parameter may help.

5.0 Battery Life

The UFM can be powered by the Smart device.

Under normal operating conditions the battery life of the UFM is more than 6 hours continuous measurement (Smart device dependent).

6.0 Specification

The UFM specification, features and performance are listed below;

- Available in 2 competitively priced pipe outer diameter ranges:
    - 10 to 115 mm.
    - 115 to 225 mm.
- Temperature range for control unit -10 to +65 deg C.
- Weight 300g including sensors but excluding mounting.
- Dimensions 120 x 60 x 30 mm.
- IP54 enclosure.
- 5 or 12 to 24 Vdc PSU options at 10 W.

Features

- Intuitive installation and commissioning using configuration program running on a laptop (Windows) or Smart phone App (Android only).
- Full set of measured values and instrument and measurement diagnostics available over Modbus RTU RS485.
- Signal oscilloscope for sensor positioning and diagnostics.
- Internal database of pipe and fluid materials.
- Fluid database of sound speed, density and viscosity compensated for fluid temperature.
- Instantaneous flow velocity, volumetric and mass flow rate measurement.
- Flow positive, negative and net totalisers.

Performance

- Measurement principle ultrasonic transit time difference.
- Flow velocity range 0.01 to 25 m/s.
- Resolution 0.25 mm/s.
- Repeatability 0.15 % of measured value.
- Accuracy +/- 0.5 to +/- 3.0 % of measured value for velocity greater than 0.2 m/s, depending on application.
- Turn down ratio 1/100.
- Measurement rate 1 Hz as standard.
- Gas/solids < 10 % of volume.

Quantity and units of measurement

- 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

Internal database

- Pipe materials
    - Carbon steel
    - Stainless steel
    - Copper
    - PVC
    - Cast Iron
    - Ductile Iron
    - HDPE
- Fluids
    - Water
    - Petrol
    - Diesel
    - Glycol-Water

Call to discuss other options.

Transducers

Figure (20) PEEK/stainless steel transducers.

- DM10 sensors cover the range of pipe outer diameter 10 to 225 mm.
- Material stainless steel and PEEK.
- Temperature range -10 to +80 deg C.
- Ingress Protection rated IP54, with IP68 option.
- Cable length as standard:
    - 1.5 m pipe mount.
    - 3.0 m wall and panel mount.
- Matched pairs for accurate zero flow measurement.

7.0 Product Identification

Each UFM and pair of flow transducers comes with a unique Identification code.

In the case of the UFM this is written into the software and can be read using the HMI.

In the event of a need to contact Sonic Driver please have these codes available to quote.

8.0 Service

The UFM is a sophisticated measuring instrument and contains no user serviceable parts.

For all operational problems please contact our service department by telephone or email, see Appendix A.

Sonic Driver do offer a software upgrade service. Please contact the factory for information about the latest software.

9.0 Limited Warranty and Disclaimer

Sonic Driver Ltd warrants to the end purchaser, for a period of one year from the date of shipment from our factory, that all new products manufactured by it are free from defects in materials and workmanship.

This warranty does not cover products that have been damaged due to normal use, misapplication, abuse, lack of maintenance, or improper installation.

Sonic Driver obligation under this warranty is limited to the repair or replacement of a defective product, if the product is inspected by Sonic Driver Ltd and found to be defective. Repair or replacement is at the discretion of Sonic Driver Ltd.

If the product is outside of the warranty period, a purchase order must be received from the end purchaser before repair work will start.

The product must be thoroughly cleaned, and any contamination removed before it will be accepted for return.

The purchaser must determine the applicability of the product for its desired use and assumes all risks in connection therewith. Sonic Driver Ltd assumes no responsibility or liability for any omissions or errors in connection with the use of its products.

Sonic Driver Ltd will under no circumstances be liable for any incidental, consequential, contingent or special damages or loss to any person or property arising out of the failure of any product, component or accessory.

All expressed or implied warranties, including the implied warranty of merchantability and the implied warranty of fitness for a particular purpose or application are expressly disclaimed and shall not apply to any products sold or services rendered by Sonic Driver Ltd.

The above warranty supersedes and is in lieu of all other warranties, either expressed or implied and all other obligations or liabilities.

No agent or representative of Sonic Driver Ltd has any authority to alter the terms of this warranty in any way.

Appendix A Contact Details

Telephone: +44(0)7971 273000

Postal Address: Sonic Driver Ltd, Lochiel, Llaneilian Road, Amlwch, Gwynedd, LL68 9HU, UK.

Email: service@sonic-driver.com

Website: www.sonic-driver.com

Appendix B Table of typical pipe roughness values

When a fluid flows through a pipe then the pipes own internal roughness is important when considering friction losses.

Pipe manufacturers often quote a pipe roughness value for their products.

Some typical figures are given below, see table (2).

Pipe Material	Peak to Trough Roughness (mm)
Concrete	0.3 to 3.0
Cast Iron	0.26
Galvanized Iron	0.15
Asphalted Cast Iron	0.12
Commercial or Welded Steel	0.045
PVC, Glass and other drawn tubing	0.0015

Table (2) Pipe roughness.

By default, the Sonic Driver flowmeter uses a figure of 0.01 mm as a good compromise for most common pipes.

Sonic Driver