Made in Britain

POCKET PLUS-UFM Ultrasonic Flowmeter

Operating Instructions

Version 4.0

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Contents

1.0 Introduction

Congratulations on choosing the Sonic Driver ^{TM} POCKET PLUS-UFM ^{TM} clamp-on ultrasonic flowmeter, figure (1).

Figure (1) The Sonic Driver POCKET PLUS-UFM.

The ultrasonic flowmeter (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.

Using information about the installation, entered by the user, using the meters intuitive and easy to us menu driven User Interface (UI) the UFM can display;

- Flow velocity
- Volumetric flow rate
- Mass flow rate
- Heat quantity flow rate

With the addition of a wall thickness measuring probe the UFM can also function as a pipe wall thickness gauge (WTG).

The POCKET PLUS-UFM includes a date and time stamped 4MB datalogger and USB serial communications functionality as standard.

When connected to a computer USB port or USB charger the UFM is powered over the USB. This allows for extended datalogging sessions.

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, www.sonic-driver.com

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.
- 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 and probes 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.
- Avoid striking the clear display window and keypad with sharp objects.

2.0 Keypad Functionality

The UFM keypad offers several dual operation FUNCTION KEYS for quick setup and display. Press any of the FUNCTION KEYS to go to the desired menu or display instantly. Note however that depending on what the user is attempting to do the focus of certain keys will change.

On	This key turns the flowmeter on.

When the user is navigating the UI and selecting a Menu screen;

1	Jump to MAIN MENU, the Quick Start option will be highlighted.
2	Jump to show Sensor Positioning screen, the user is prompted to select a Transducer Type.
3	Jump to show ATA/ETA % diagnostic.
Run/Stop	Jump to Measurement screen.
4	Jump to show Flow Rate and Net Total.
5	Jump to show flow velocity, flow rate, net, positive and negative flow totaliser.
6	Jump to show Reynolds Number, flow profile correction K Factor, Raw Flow velocity and Corrected flow velocity.
^/+	Scroll up through Menu items.
7	Jump to show Energy Rate and Net Total.
8	Jump to show energy rate, net, positive and negative energy totaliser.
9	Jump to show Compensation, Inlet and Outlet temperature.
ENTER	Step forward to selected Menu.
.	Jump to show time based diagnostics.
0	Jump to show signal based diagnostics.
</Off	Step back to previous Menu (When at Main Menu press and hold whilst progress bar decrements to turn meter off).
V/-	Scroll down through Menu items.

When the meter is in measurement mode and measuring the keypad keys have the following functions;

1	Jump to MAIN MENU, the Quick Start option will be highlighted.
2	Jump to show Sensor Positioning screen, the user is prompted to select a Transducer Type.
3	Jump to show ATA/ETA % diagnostic.
Run/Stop	Jump to UI, show last menu accessed.
4	Jump to show Flow Rate and Net Total.
5	Jump to show flow velocity, flow rate, net, positive and negative flow totaliser.
6	Jump to show Reynolds Number, flow profile correction K Factor, Raw Flow velocity and Corrected flow velocity.
^/+	Display contrast up.
7	Jump to show Energy Rate and Net Total.
8	Jump to show energy rate, net, positive and negative energy totaliser.
9	Jump to show Compensation, Inlet and Outlet temperature.
ENTER	Step through all available display screens.
.	Jump to show time based diagnostics.
0	Jump to show signal based diagnostics.
</Off	No action.
V/-	Display contrast down.

When the user is editing a parameter and the parameter editing cursor starts to flash the keypad keys change function to become alphanumeric inputs;

1	Enter "1".
2	Enter "2".
3	Enter "3".
Run/Stop	No action.
4	Enter "4".
5	Enter "5".
6	Enter "6".
^/+	Enter "+" symbol or scroll up though available parameter options in a list.
7	Enter "7".
8	Enter "8".
9	Enter "9".
ENTER	Accept and Save changes and return to last Menu screen.
.	Enter ".".
0	Enter "0".
</Off	Return to last Menu screen, discard any changes.
V/-	Enter "–" symbol or scroll down though available parameter options in a list**.**

3.0 FUNCTION KEY Functions

The keypad has a number of FUNCTION KEYS, which allow the user to instantly access functions;

<1> Quick Start

This key jumps to the Main Menu with the Quick Start option highlighted.

Press ENTER to start the Quick Start sequence or navigate the UI in the usual way.

<2> Transducer Positioning

This key gives access to a function which calculates the recommended transducer spacing and displays diagnostics to aid transducer mounting and allows coupling optimization.

After entering the required Quick Start parameters, the spacing between the ends of the 2 transducers is calculated and displayed. Check the value displayed and space the transducers accordingly.

If the Set Zero calibration function is enabled a zero flow calibration will also be made. It is vitally important to ensure that there is zero flow during this procedure. If the UFM suspects that there is flow in the pipe then a visual warning is given.

When the process is complete the user is returned to the UI.

<3> 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.

<4> Flow Rate and Net Total

This key gives access to a display showing;

- Flow rate
- Net flow totaliser

<5> Flow Velocity, Rate and Totals

This key gives access to a display showing;

- Flow velocity
- Flow rate
- Net flow totaliser
- Positive flow totaliser

- Negative flow totaliser

Net total is simply the sum of the positive and negative flow totals.

<6> Flow Profile

This key gives access to a display showing;

- Reynolds Number
- Flow profile correction K factor
- Raw flow velocity
- Rolling average flow velocity
- Corrected flow velocity

The raw flow velocity is displayed without averaging and uncompensated for flow profile.

Rolling average flow velocity is raw flow velocity with average and flow profile compensation applied.

Corrected flow velocity is rolling average flow velocity with zero flow cut off applied.

<7> Energy Rate and Net Total

This key gives access to a display showing;

- Energy rate
- Net energy totaliser

<8> Energy Rate and Totals

This key gives access to a display showing;

- Energy rate
- Net energy totaliser
- Positive energy totaliser
- Negative energy totaliser

<9> Temperature

This key gives access to a display showing;

- Fluid temperature
- Pipe inlet temperature
- Pipe outlet temperature

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

<.> Time Based Diagnostics

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

- Delta Time
- Transit Time
- Path Time
- dT Offset
- SOS

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. For this reason Transit Time is simply displaying the absolute upstream transit time through the fluid in the pipe.

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.

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

Path Time is the absolute upstream transit time through the entire ultrasonic path. This is different to the absolute upstream transit time in the fluid as it includes time spent traversing the transducer wedges, pipe and lining (if applicable). It is useful for fault finding with an oscilloscope as it is referenced to a trigger signal available at a test point on the UFM PCB.

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

SOS displays the expected and measured speed of sound in the fluid. It is used to calculate the value of ATA/ETA %. A large difference (typically greater than ± 3 %) can indicate something wrong in the installation.

<0> Signal Based Diagnostics

This key gives access to a display showing diagnostics related to the signal strength and SNR of the received sonic signal;

- Signal
- SNR
- Noise
- ATA/ETA
- Gain

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 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 re-inspected. If necessary, change the mounting method.

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.

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.

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 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.

ATA/ETA % or transit time ratio indicates if the transducer mounting spacing is accurate. The normal transit time ratio should be 100 ± 3 % if the installation is correct.

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

4.0 Powering On

To power on a POCKET-UFM press and hold the On key.

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

If an error is detected an error message will be displayed prompting user action. If the error persists contact customer support.

Error codes and their meanings can be found in the Diagnostics Menu.

Alternatively, when connected to a computer USB port or USB charger the UFM is powered over the USB and will power on automatically. This allows for extended datalogging sessions.

4.1 Power Off

From the Main Menu press and hold the “</Off” key.

A progress bar decrements to turn the meter off.

If the “</Off” key is released before the progress bar fully decrements the meter returns to the Measurement screen.

The “</Off” key has no function when in Measurement Mode.

If there is no keypad activity in UI mode for 60 seconds then the UFM will automatically power off. Automatic power off does not apply in Measure mode.

To fully power down the UFM it is also necessary to disconnect the USB if it is connected.

The LCD backlight will flash when the battery is low and needs to be changed.

5.0 User Interface (UI)

The Main Menu allows the user to select a group of parameters to edit or a meter function;

- Quick Start
- Installation
- System
- Diagnostics
- Serial
- Logger
- Load/Save

5.1 Quick Start Function

The Quick Start function takes the user through the minimum sequence of parameters needed to get the UFM measuring reliably and accurately;

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

Each parameter is described below in the relevant section.

After selecting Transducer Type and Transducer Mounting it is also possible to jump to the end of the sequence by pressing the Run/Stop key.

If Transducer Type WTG (Wall Thickness Gauge) is selected then the sequence of parameters changes to;

- Transducer Type
- Pipe Material

and the UFM enters a wall thickness measuring mode. To make use of this feature the user must purchase an additional WTG probe as well as a pair of flow measurement transducers. Contact Sales for details.

When operating as a wall thickness gauge the user can scroll between 3 display modes by repeatedly pressing the “Enter” key, the modes are;

- Full display of wall thickness measurement and all measurement diagnostics.
- A-Scan showing the raw received ultrasonic signal.
- Processed signal showing the measured signal corresponding to the wall thickness.

5.2 Installation Menu

The Installation Menu allows the user to edit parameters specific to the physical installation of the UFM on a pipe;

- Pipe
- Liner
- Fluid
- Transducer
- Calibration
- Display Units
- Totaliser
- Load Defaults

These parameters represent an extended set of parameters needed to get the UFM measuring and displaying values, above and beyond the very basic parameter set used by the Quick Start sequence**.**

5.2.1 Pipe Menu

This menu allows the user to change pipe settings. A test is made to check that the parameters that are entered do not result in a Closed Pipe.

5.2.1.1 Outer Diameter

The user is prompted to enter a value for the pipe outer diameter. Allowed values are ranged 10.0 to 6500.0 mm, default 56.0 mm.

5.2.1.2 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.

5.2.1.3 Material

The user can select the pipe material from a list;

- Carbon Steel
- Stainless 304
- Stainless 316
- Cast Iron
- Ductile Iron
- Copper
- PVC **(Default)**
- Lead
- Nylon
- PE
- Aluminium
- Asbestos
- Fibre Glass
- Other

If Other is selected then the user is prompted to enter the transverse (shear) speed of sound in the pipe material, see below. Otherwise the transverse speed of sound in the pipe material is read from a database held in the UFM.

5.2.1.4 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.

If a liner material is selected then this roughness is automatically transposed and applied to the inner surface of the lining.

This value is used in flow profile correction calculations.

5.2.1.5 Sound Velocity

Appearance of this parameter is context driven. If the Pipe Material is entered as Other then the user

is prompted to enter a pipe transverse sound velocity.

The user is prompted to enter the transverse speed of sound in the pipe. Allowed values are ranged 500 to 7000 m/s, default 1060 m/s (PVC default).

5.2.1.6 WTG SOS

This value is used to make wall thickness measurements using the UFM when fitted with a wall thickness probe rather than flow transducers, see the Transducer Type parameter below.

Appearance of this parameter is context driven. If the Material is entered as Other then the user is prompted to enter a pipe longitudinal sound velocity.

The user is prompted to enter the longitudinal speed of sound in the pipe. Allowed values are ranged 500 to 7000 m/s, default 2460 m/s (PVC default).

5.2.2 Liner Menu

This menu allows the user to change pipe lining settings.

5.2.2.1 Material

The user can select a pipe liner material from a list;

- None **(Default)**
- Cement
- Epoxy
- Glass
- PP
- Teflon
- Rubber
- Other

The list allows no liner (None) to be selected.

5.2.2.2 Sound Velocity

Appearance of this parameter is context driven. If the user selected Other from the list of liner materials then the user is prompted to enter the transverse speed of sound in the liner material. Otherwise the speed of sound in the liner material is read from a database held in the UFM.

Allowed values are ranged 500 to 7000 m/s, default 0 m/s (None).

5.2.2.3 Thickness

Appearance of this parameter is context driven. If the user selected a liner then the user is prompted for the thickness of the liner. Allowed values are ranged 0.5 to 100.0 mm, default 0.0 mm (None).

5.2.3 Fluid Menu

This menu allows the user to change fluid settings.

5.2.3.1 Type

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

- Water **(Default)**
- Sea Water
- Kerosene
- Petrol
- Fuel Oil
- Crude Oil
- Freon R134a
- Freon R22
- Diesel Oil
- Castor Oil
- F-76 Fuel Oil
- Novec 1230
- Glycol/Water
- Alcohol
- Other

If the user selected Other from the list of fluid types then the user is prompted to enter various context driven parameters, see below.

5.2.3.2 Temperature

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

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

5.2.3.3 Sound Velocity

Appearance of this parameter is context driven. If the user selected Other from the list of fluid types then the user is prompted to enter the longitudinal speed of sound in the fluid (NOTE not transverse as this type of wave is not supported in fluids). Otherwise the longitudinal speed of sound in the fluid is read from a database held in the UFM.

The user is prompted to enter the longitudinal speed of sound in the fluid. Allowed values are ranged 50 to 4000 m/s, default 1475 m/s (Water at 18 degC).

5.2.3.4 Viscosity

Appearance of this parameter is context driven. If the user selected Other from the list of fluid types then the user is prompted to enter the kinematic viscosity of the fluid. Otherwise the kinematic

viscosity of the fluid is read from a database held in the UFM.

The user is prompted to enter the kinematic viscosity of the fluid. Allowed values are ranged 0.001 to 40000 cST, default 1.08 cST (Water at 18 degC).

5.2.3.5 Density

Appearance of this parameter is context driven. If the user selected Other from the list of fluid types then the user is prompted to enter the density of the fluid. Otherwise the density of the fluid is read from a database held in the UFM.

The user is prompted to enter the density of the fluid. Allowed values are ranged 50 to 3000 kg/m3, default 998.52 kg/m3 (Water at 18 degC).

5.2.3.6 SHC

The UFM can make energy calculations using the Specific Heat Capacity (SHC) method, where the user must manually enter values for pipe inlet and outlet temperature.

The user can enter a value for the Specific Heat capacity of the fluid flowing in the pipe. Allowed values are ranged 0.0 to 10.0 J/(g.K), default 4185.6 J/(g.K) (Water at 18 degC).

5.2.3.7 Inlet Temp

The user can enter a fixed value here.

The user can enter a value for the temperature of the fluid flowing in the pipe at the pipe inlet. Allowed values are ranged -20.0 to 150.0 degC, default 18 degC (Water at 18 degC).

5.2.3.8 Outlet Temp

The user can enter a fixed value here.

The user can enter a value for the temperature of the fluid flowing in the pipe at the pipe outlet. Allowed values are ranged -20.0 to 150.0 degC, default 18 degC (Water at 18 degC).

5.2.4 Transducer Menu

This menu allows the user to change transducer settings.

5.2.4.1 Type

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

- DS05
- DS10
- DS20
- DS40
- DM10 **(Default)**
- DM20
- DN40
- Flow Other
- WTG

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

If Flow Other is selected then the user will be prompted to enter detailed transducer specific information, see Appendix A.

The ability to select Flow Other is intended for use when using the UFM with special sensors supplied by Sonic Driver.

WTG is for use with 5MHz dual element wall thickness probes.

5.2.4.2 Mounting

The user is prompted to select the sound path in the pipe from a list;

- Auto
- Z
- V
- N
- W
- 5
- 6 **(Default)**
- 7
- 8
- 9
- 10
- 11
- 12

Selecting Auto means that the UFM determines for itself which sound path to use.

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

- Z is 1 pass, most common on large diameter pipes.
- V is 2 passes, the most commonly used method, simplest to install as both sensors are on the same side of the pipe.
- N is 3 passes, used on small diameter pipes.
- W is 4 passes, used on the lowest diameter pipes.
- 5 to 11 and 12, etc.

It may be that on small diameter pipes then the recommended transducer spacing at 12 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 9 or 11 passes.

5.2.4.3 WTG Standoff

This parameter allows the user to enter the correct stand off time in microseconds for the type of thickness probe being used to make wall thickness measurements.

The user is prompted to enter the stand off time for the probe being used. Allowed values are ranged 7 to 100 us, default 7 us (WTG).

5.2.4 Calibration Settings Menu

This menu allows the user to change calibration and calculation settings.

5.2.4.1 Low Flow Cut

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, which will result in a totaling error.

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.

5.2.4.2 Corrected Flow

The user is prompted to turn flow profile correction On/Off. By default flow profile correction is always turned on.

When turned On the meter measurements are corrected for flow profile using Reynolds Number and pipe wall internal roughness values.

The ability to turn flow profile correction Off is useful for benchmarking different types and makes of flowmeter where the sophistication of the manufacturers correction algorithms can lead to different results.

5.2.4.3 User Offset

This user zero offset method is not commonly used. It is only suitable for experienced operators to set zero flow velocity in m/s under conditions when it is not preferable to use other methods. Enter the flow velocity value manually to add to the measured value to obtain the actual value.

The user is prompted to enter a measurement offset value in m/s. Allowed values are ranged -30.0 to +30.0 m/s, default 0.0 m/s.

5.2.4.4 User Scaling

The user scaling factor is used to modify the measurement results. The user can enter a numerical value other than 1.0 according to calibration results.

The user is prompted to enter a measurement scaling value. Allowed values are ranged 0.001 to 10.000, default 1.000.

5.2.4.5 Set Zero

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 the transducer positioning FUNCTION KEY <2>. The user is prompted to couple and space the transducers in the normal way, but after this an additional optional automatic zero calibration is made.

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 will show a "Waiting" warning message. Only when happy will it start to average up.

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

The meter will make 19 averaged measurements and determine any offset values. Allow the zero calibration process to finish or press [ENTER] to finish early.

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

5.2.4.6 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.

5.2.4.7 Tup Method

Only intended for expert users. The user can change the method used to calculate the upstream and downstream transit times.

5.2.4.8 Calculation Method

Only intended for expert users. The user can change the method used to calculate flow velocity.

5.2.6 Display Units Menu

This menu allows the user to change display unit settings.

5.2.6.1 Flow Rate Units

The user can select the units to be used for display of flow rate from a list;

- Cubic Meters (m3)
- Litres (1) **(Default)**
- USA Gallons (GAL)
- Imperial Gallons (Imp gal)
- Million Gallons (mg)
- Cubic Feet (cf)
- USA Barrels (US bbl)
- Imperial Barrels (Imp bbl)
- Oil Barrels (Oil bbl)
- Kilograms (kg)

Cubic Meters, Litres, USA Gallons, Imperial Gallons, Million Gallons, Cubic Feet, USA Barrels, Imperial Barrels and Oil Barrels are examples of volumetric flow rates.

Kilograms is a mass flow rate.

5.2.6.2 Flow Rate Time Units

The user can select the time units to be used for display of flow rate from a list;

- \second
- \minute **(Default)**
- \hour
- \day

5.2.6.3 Totaliser Units

The user can select the units to be used for display of flow totaliser (net, positive and negative) from a list;

- Cubic Meters (m3)
- Litres (1) **(Default)**
- USA Gallons (GAL)
- Imperial Gallons (Imp gal)
- Million Gallons (mg)
- Cubic Feet (cf)
- USA Barrels (US bbl)
- Imperial Barrels (Imp bbl)
- Oil Barrels (Oil bbl)
- Kilograms (kg)

The flow rate and flow totaliser units do not have to be the same.

5.2.6.4 Energy Units

The user can select the units to be used for display of both energy flow rate and energy totaliser (net, positive and negative) from a list;

- Giga Joule (GJ) **(Default)**
- Mega Joule (MJ)
- Kilo Joule (kJ)
- Kilo Calorie (kcal)
- Million BTU (MMBtu)
- BTU (BTU)
- American Tons (Tons)
- Metric Tonnes (Tonnes)
- Kilo Watt Hour (kWh)

The energy flow rate and energy totaliser units are the same.

5.2.6.5 Energy Time Units

The user can select the time units to be used for display of energy flow rate from a list;

- \second **(Default)**
- \minute
- \hour
- \day

5.2.6.6 Measurement Units

The user can select the units to be used for entry and display of certain values from a list;

- Metric **(Default)**
- Imperial

5.2.6.7 Damping

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

Allowed values are ranged 1 to 255 seconds, the default is 10 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.

5.2.7 Totalisers Menu

This menu allows the user to change totaliser settings.

5.2.7.1 Net Flow Total

The user can turn a net flow totaliser On/Off so that net flow total is accumulated and displayed.

By default the net flow totaliser is turned Off.

5.2.7.2 Pos Flow Total

The user can turn a positive flow totaliser On/Off so that positive flow total is accumulated and displayed.

By default the positive flow totaliser is turned Off.

5.2.7.3 Neg Flow Total

The user can turn a negative flow totaliser On/Off so that negative flow total is accumulated and displayed.

By default the negative flow totaliser is turned Off.

5.2.7.4 Flow Total Reset

The user can reset (zero) the flow totalisers.

Selecting YES will zero Net, Pos and Neg totalisers.

5.2.7.5 Energy Total

The user can turn a net energy totaliser On/Off so that net energy total is accumulated and displayed.

By default the net energy totaliser is turned Off.

5.2.7.6 Energy Total Reset

The user can decide to reset (zero) the energy totaliser by selecting On/Off.

By default the net energy totaliser is not reset.

5.2.8 Load Defaults

The user is prompted to reload factory defaults and return the meter to its factory configuration.

All parameters are reset to factory defaults.

Display contrast is reset to the factory default.

Tag and Identifier strings are reset to factory values.

All Totalisers are reset to zero.

Saved Setups are not affected.

By default the factory reset is not active.

5.3 System Settings Menu

5.3.1 LCD Backlight

The user is prompted to turn the UFM LCD backlight on/off. By default the backlight is On.

5.3.2 Audio

The user is prompted to turn the UFM keypad audio on/off. By default the buzzer is On.

5.3.3 Tag

The user can enter a site Tag for the meter, this is an 8 character alpha numeric.

5.3.4 Identifier

The user can enter a site Identifier for the meter, this is an 8 character alpha numeric.

5.3.5 Test

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

The Test Menu allows the user to repeat the power on tests and also to further test the other major functions of the meter;

5.3.5.1 Display

The user is taken through a factory series of tests which fully exercise the meter LCD, its backlight and icons. The user can also adjust the contrast of the display

5.3.5.2 Keypad

The user is taken through a factory series of tests which fully exercise the meter keypad and its audio indicator (Buzzer).

5.3.5.3 Memory

The user is taken through a factory series of tests which fully exercise the meter system FRAM memory.

5.3.5.4 Clock

This option allows the user to test the function of the UFM real-time clock for date and time stamping of logged data.

5.3.5.5 TOFM Scope

This option allows the user to test the function of the UFM time of flight module using a calibrated test block.

5.3.5.6 TOFM Values

This option allows the user to test the function of the UFM time of flight module using a calibrated test block.

5.3.5.7 Serial

This option allows the user to test the function of the UFM serial communication by streaming a test message.

5.3.5.8 Logger

This option allows the user to test the function of the UFM datalogger and its memory. In order to carry out the test the logger memory needs to be erased blank.

5.3.6 System Info Menu

This menu allows the user to view key meter values.

5.3.6.1 Model Code

Show model code of the meter.

5.3.6.2 Serial No.

Show the unique serial number assigned to the meter during manufacture.

5.3.6.3 HW Issue

Show the HW version for the meter.

5.3.6.4 SW Issue

Show the SW version for the meter.

5.4 Diagnostics Menu

This menu allows the user to see a display of error reports.

Each item is given a simple Pass/Fail indication. Error codes and their meanings can be found in the Main Menu under the Diagnostics Menu;

- ADDR, there is a memory addressing problem.
- MATH, there is a problem with the UFM central maths processor.
- OSC, the UFM core oscillator is suffering a problem.
- STACK, there is a stack overflow problem.
- FRAM, there is a problem with the UFM external FRAM memory.
- I2C, there is a problem with the internal I2C data bus.
- LOGGER, there is problem with the internal logger memory.
- SPI, there is a problem with the internal SPI data bus.
- SYSTEM, a general system wide fault has occurred.
- RTC, there is a problem with the UFM internal real-time clock.

The UFM has a series of icons along the top of the LCD.

The meanings of these icons are from left to right as they appear;

- Maple leaf, unreliable measurement, check installation.
- Page, Datalogger on/off.
- Battery, on means UFM is powered from internal battery (not a battery level indicator). Off when UFM is powered over USB. When on USB the battery back up for the RTC is charged.
- Display, LCD backlight on/off.
- Loudspeaker, Audio buzzer on/off.
- Bell, I2C1, SPI2, external FRAM or datalogger error.
- Clock, SYSTEM RTC, or timing error.
- Warning Triangle, ADDR, MATH, OSC or STACK error.
- Spinner, USB serial communications on/off.

In addition to showing icons, depending on the flow regime the UFM displays;

- Zero, no flow
- L, laminar
- Tr, transition
- T, turbulent

in the top-left when in measurement mode.

Laminar flow is generally regarded to exist for Reynolds Number less than 2300, transition is in the range 2300 to 4000 and turbulent flow typically has a Reynolds Number greater than 4000.

5.5 Serial Menu

This menu allows the user to change serial communication settings for the USB port.

The USB serial communication connector is next to the flow transducer LEMO connectors at the top of the UFM.

5.5.1 Mode

The user is prompted to select the mode for the USB from a list;

- Off **(Default)**
- LPT
- Diagnostics

Selecting mode Off turns the USB transmit off. USB port can still receive.

Line Printer (LPT) streams measurement values out on the USB;

- Flow velocity
- Flow rate
- Flow positive totaliser
- Flow negative totaliser
- Flow net totaliser
- Energy
- Energy rate
- Energy positive totaliser
- Energy negative totaliser
- Energy net totaliser
- Pipe internal cross-sectional area
- Fluid density
- Fluid Specific Heat Capacity
- Inlet temperature
- Outlet temperature

Diagnostics streams key diagnostic values on the USB;

- Flow velocity
- Flow rate
- Energy
- Energy rate
- Delta time
- Upstream transit time
- Signal amplitude
- Signal noise
- Signal gain
- Signal SNR
- Dropped communications counter
- Signal quality 1
- Signal quality 2

- Signal quality 3
- Inlet temperature
- Outlet temperature
- Fluid temperature
- Error code 1
- Error code 2

5.5.2 Baud

The user is prompted to select the communication baud rate from a list;

- 9600
- 19200
- 115200 **(Default)**

5.5.3 Parity

The user is prompted to select the communication parity from a list;

- Even **(Default)**
- None
- Odd

5.6 Logger Menu

This menu allows the user to edit parameters specific to the meters internal datalogger.

The meter has a date and time stamped 4MB internal flash datalogger memory.

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

As part of this diagnostic the UFM checks the function of the flash data memory hardware, successful test indicated by a Pass for each) and reads any logged data to check its integrity (Progress shown by incrementing address). If no logged data is found then no progress will show.

A percentage figure of free logger memory remaining can also be found in the Diagnostics Menu.

5.6.1 Interval

The user is prompted to enter a datalogger interval.

Entering a value for Interval starts datalogging. An Interval of zero turns the data logger off.

All meter measurement values are logged with a date and time stamp.

Allowed values are ranged 0 to 255 s, default 0 s meaning off.

5.6.2 Date

Set the RTC date. The UI checks for illegal entry and leap years. The date format is dd/mm/yy.

5.6.3 Time

Set the RTC time, uses 24-hour format. Only enter hours and minutes. The time format is hh:mm.

5.6.4 Download

The user is prompted to download the datalogger memory over USB by selecting On/Off. By default memory is not downloaded.

5.6.5 Erase

The user is prompted to erase the datalogger memory by selecting On/Off. By default memory is not erased

5.7 Load/Save Setups Menu

This menu allows the user to Save, Load and Delete up to 10 meter configurations for different applications.

5.7.1 Save Option

Select Save from the list and press ENTER.

A list of 10 available configuration spaces is displayed by name. Empty spaces are shown as -BLANK-.

Use ^ and V to scroll through the list of names.

Use ENTER to select a configuration space to write to or < to quit.

The user is prompted to enter a unique Tag and then Identifier, press ENTER.

A complete mirror image copy of all meter parameters is saved to memory.

5.7.2 Load Option

Select Load and press ENTER.

A list of 10 available configuration spaces is displayed by name. Empty spaces are shown as -BLANK-.

Use ^ and V to scroll through the list.

Use ENTER to select a configuration space to load or < to quit.

All meter parameters are overwritten with the stored configuration read from memory.

5.7.3 Delete Option

Select Delete and press ENTER.

A list of 10 available configuration spaces is displayed by name. Empty spaces are already shown as -BLANK-.

Use ^ and V to scroll through the list.

Use ENTER to select a configuration space to delete or < to quit.

The configuration is deleted and the displayed configuration name (Tag) is changed to -BLANK-.

Appendix A Transducer parameters

These parameters are only intended for trained service personnel.

Wedge Angle

The user is prompted to enter a value for the transducer wedge angle.

Allowed values are ranged 0.0 to 90.0 deg, default 40.0 deg.

Wedge SOS 20

The user is prompted to enter a value for the speed of sound in the wedge at 20 degC.

Allowed values are ranged 500.0 to 7000.0 m/s, default 2522.0 m/s.

Wedge SOS 60

The user is prompted to enter a value for the speed of sound in the wedge at 60 degC.

Allowed values are ranged 500.0 to 7000.0 m/s, default 2522.0 m/s.

Crystal Offset

The user is prompted to enter a value for the offset position of the piezo crystal on the wedge.

Allowed values are ranged 0.0 to 100.0 mm, default 11.6 mm.

Spacing Offset

The user is prompted to enter a value for the transducer offset position.

Allowed values are ranged 0.0 to 100.0 mm, default 30.0 mm.

Code

The user is prompted to select the transducer frequency in kHz from a list;

- 500
- 952
- 1000 **(Default)**
- 1052
- 1100
- 1818
- 2000
- 2222
- 4000
- 4500

The default value is 1000 kHz, DM10 sensor.

Zero Flow Offset

The user can view/edit inherent offsets in the transducers.

Allowed values are ranged -20.0 to +20.0 ns, default 0.0 ns.

Zero Calibration and Zero Tracking adjust this value in real time when measuring when they are enabled.

K factor

Allows the entry of a factory calibrated meter factor.