Series UFC Ultrasonic Flowmeter Kit

Installation and Operating Instructions

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1: General Description

1.1 Introduction

This manual describes the operation of the Dwyer UFC flowmeter. The flowmeter is designed to work with clamp-on transducers to enable the flow of a liquid within a closed pipe to be measured accurately without needing to insert any mechanical parts through the pipe wall, or protrude into the flow system.

Using ultrasonic *transit time* techniques, the UFC is controlled by a micro-processor system which contains a wide range of data that enables it to be used with pipes having an outside diameter ranging from 0.5 to 79 inches (13 to 2000 mm) and constructed of almost any material. This can be extended to pipes of up to 197 inches (5000 mm) using the optional type D sensors. The instrument will also operate over a wide range of fluid temperatures.

UFC standard features:

- Large, easy to read graphic display with backlight.
- Simple to follow, dual function keypad.
- Simple 'Quick Start' set up procedure.
- Continuous signal monitoring.
- Isolated pulse output (volumetric or frequency).
- Isolated current output (4 to 20 mA, 0 to 20 mA, or 0 to 16 mA).
- 2x Isolated programmable alarm outputs.
- Password-protected menu operation for secure use.
- Signal diagnostics.
- Multi-function alarm outputs.
- Operates from Mains, 24 Vac, or 24 Vdc.
- Logging of Flows and Volume total.
- Output to USB pen

Volumetric flow rates are displayed in L/h, L/min, L/sec, gal/min, gal/h, USgals/min, USgals/h, Barrel/h, Barrel/day, m³/s, m³/min, m³/h. Linear velocity is displayed in meters or feet per second. When operating in the 'Flow Reading' mode the total volumes, both positive and negative, are displayed up to a maximum 12-digit number.

The flowmeter can be used to measure clean liquids or oils that have less than 3% by volume of particulate content. Cloudy liquids such as river water and effluent can be measured along with cleaner liquids such as demineralized water. In addition, the UFC can function as a data logger. When operating in this mode the logged data, which includes the flow rates and totalizers, is stored in memory and can then be transferred to a USB memory stick.

Typical UFC applications include:

- Sea or River water.
- Potable water.
- Demineralized water.
- Treated water.

The UFC is available in two model options. Model UFC-A is supplied with type 'A' transducers which are designed to work with pipe diameters between 0.5 to 4.5 inches (13 to 115 mm). Model UFC-B is supplied with type 'B' transducers which are designed to work with pipe diameters between 2 to 79 inches (50 to 2000 mm). Both sets of transducers use a common mounting system for pipe attachment, and throughout this manual any reference to 'UFC' applies to both 'A' and 'B' model variants unless otherwise stated.

1.2   Principles of Operation

Reflex mode
This is the mode most commonly used. The two transducers (U & D) are attached to the pipe in line with each other and the signals passing between them are reflected by the opposite pipe wall.
The separation distance is calculated by the instrument in response to entered data concerning the pipe and fluid characteristics.

Reflex mode (double bounce)
In this mode the separation distance is calculated to give a double bounce. This is most likely to occur if the pipe diameter is so small that the calculated reflex mode separation distance would be impractical for the transducers in use.

Reflex mode (triple bounce)
This illustration goes one step further to show a triple bounce situation. This would normally apply when working with very small pipes relative to the transducer range in use.

Diagonal mode
This mode might be selected by the instrument where relatively large pipes are concerned. In this mode the transducers are located on opposite sides of the pipe but the separation distance is still critical in order for the signals to be received correctly.

This mode can be used with the standard 'A' & 'B' transducer sets but for really large pipe installations the optional transducer set 'D' might be recommended.

Figure 1.1   Operating modes

When ultrasound is transmitted through a liquid, the speed at which the sound travels through the liquid is accelerated slightly if it is transmitted in the same direction as the liquid flow, and decelerated slightly if transmitted against it. The difference in time taken by the sound to travel the same distance but in opposite directions is therefore directly proportional to the flow velocity of the liquid.

The UFC system employs two ultrasonic transducers attached to the pipe carrying the liquid and compares the time taken to transmit an ultrasound signal in each direction. If the sound characteristics of the fluid are known,

the instrument's microprocessor can use the results of the transit time calculations to compute the fluid flow velocity. Once the flow velocity is known the volumetric flow can be easily calculated for a given pipe diameter.

The system can be set up to operate in one of four modes, determined mainly by the pipe diameter and the type of transducer set in use. The diagram in Figure 1.1 illustrates the importance of applying the correct separation distance between the transducers to obtain the strongest, and therefore most reliable, signal.

1.3   Supplied Hardware

The supplied UFC components are shown in Figure 1.2.

Figure 1.2   Standard UFC equipment

UFC Standard equipment
- Instrument with backlit graphic display.
- Transducer cables (x2) 16.5 feet (5.0m) in length.
- Transducers 'A-ST' x2 (UFC-A) for use with pipes ranging 0.5 to 4.5 inches (13 to 115 mm).
- Transducers 'B-ST' x2 (UFC-B) for use with pipes ranging 2 to 79 Inches (50 to 2000 mm).
- Transducer holder for use with 'A' or 'B' transducers.
- Steel bands used to secure the transducer holder to the pipe.
- Acoustic couplant applicator.
- USB Memory stick.
- User documentation.

UFC Optional equipment
- Transducer set 'D' can be used for monitoring pipes of 59 inches to 197 inches (1500 to 5000 mm) outside diameter, over a temperature range -4°F to +176°F (-20°C to +80°C). This optional kit is supplied in a

separate case and includes the type 'D' transducers together with ratchet straps and holders for attaching the transducers to the pipe.

1.4   UFC Instrument

The UFC is a microprocessor controlled instrument operated through a menu system using an inbuilt LCD display and keypad. It can be used to display the instantaneous fluid flow rate or velocity, together with totalized volumes. The instrument also provides an isolated current output, or variable pulse output, that is proportional to the measured flow rate and can be scaled to suit a particular flow range. Two isolated alarm outputs are provided which can be configured in a number of ways. For example, to operate when the flow rate exceeds a specified maximum or minimum value.
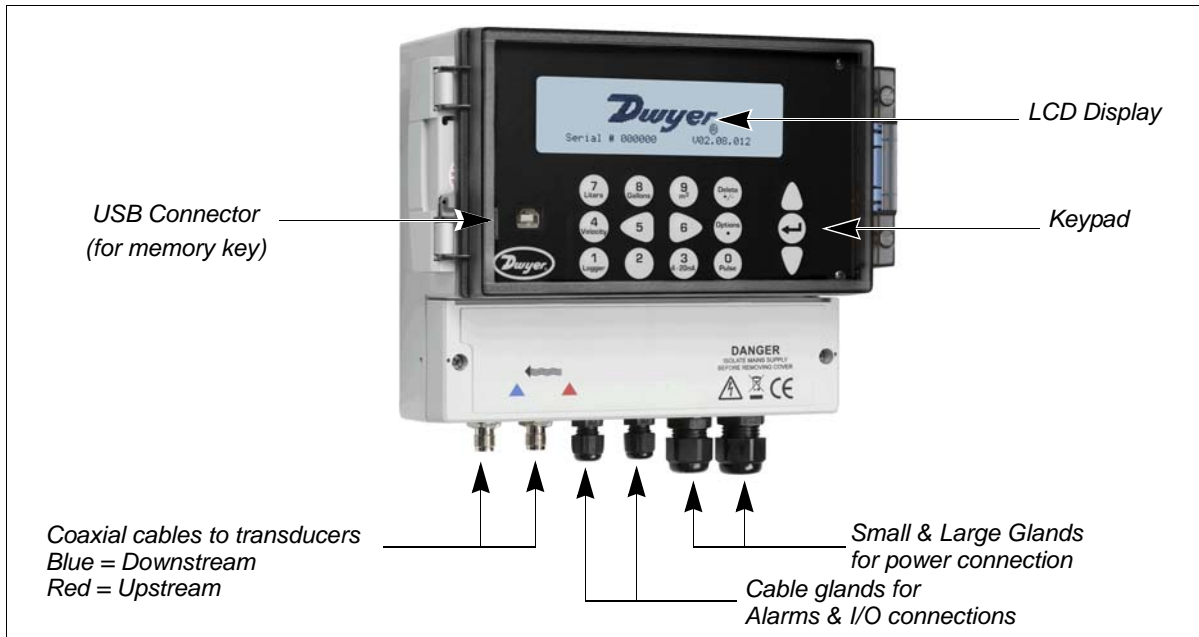
Figure 1.3   **Instrument details**

1.4.1   Connections

Transducer connections

The transducers are connected to two coaxial sockets located on the bottom left-hand of the instrument. The silk-screen above these connectors show a red and blue triangle and a direction of flow symbol. For a positive flow reading, it is important that the upstream transducer is connected to the RED socket and the downstream transducer to the BLUE one. It is safe to connect or disconnect these cables while the instrument is switched on.

4 to 20 mA, 'Pulse', and Alarm I/O connections

The 4 to 20 mA, 'pulse', and alarm I/O cables, enter the bottom of the instrument via two cable glands and connected internally to a terminal block. Full details of the terminal connections are provided in Chapter 2 (Installation).

Power supply

Two cable glands located on the bottom right-hand side of the instrument are available for the power supply cable. Two sizes of glands are provided to accept cables of different diameters.

1.4.2   Keypad

The instrument is configured and controlled via a 15-key tactile membrane keypad, as shown in Figure 1.4.

Figure 1.4   UFC Keypad

Menus and the menu selection keys

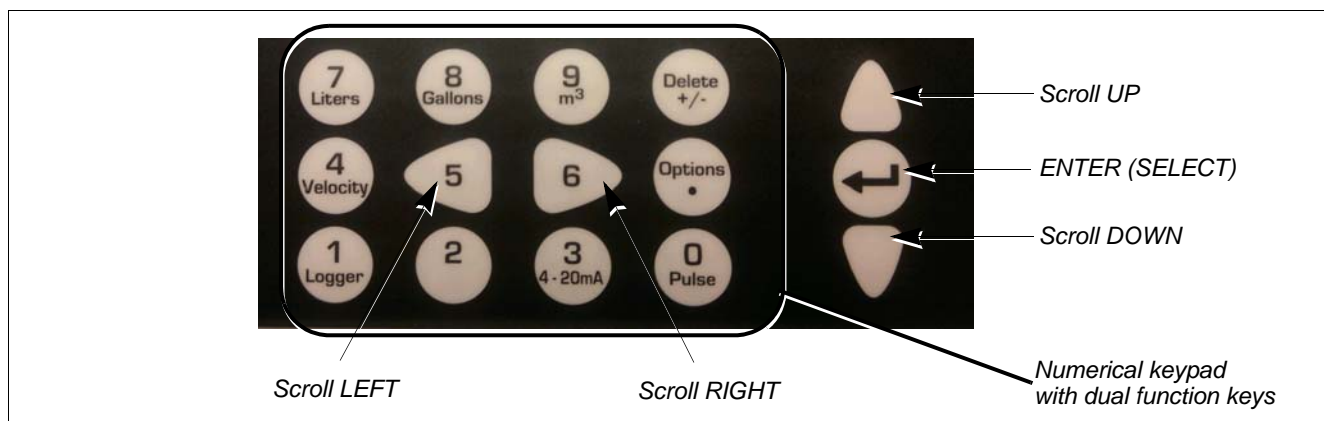***Note:*** *As a security measure, once the instrument has been set-up for the first time, a password is required to gain subsequent access to the operating menus (see page 22).*

The UFC menus are arranged hierarchally with the MAIN MENU being at the top level. Menu navigation is achieved by three keys located on the right hand side of the keypad which are used to scroll UP and DOWN a menu list and SELECT a menu item. When scrolling through a menu, an arrow-shaped cursor moves up and down the left hand side of the screen to indicate the active menu choice, which can then be selected by pressing the ENTER (SELECT) key.

Some menus have more options than can be shown on the screen at the same time, in which case the overflowed choices can be brought into view by continuing to scroll DOWN past the bottom visible item. Menus generally 'loop around' if you scroll beyond the first or last items.

If you select Exit on any menu it usually takes you back one level in the menu hierarchy, but in some cases it may go directly to the 'Flow Reading' screen.

Some screens require you to move the cursor left and right along the display as well as up and down. This is achieved using keys 5 (scroll LEFT) and 6 (scroll RIGHT).

Dual function numerical keypad

The block of keys shown in the center of the keypad in Figure 1.4 are dual function keys. They can be used to enter straight-forward numerical data, select the displayed flow units, or provide quick access to frequently required control menus.

1.4.3 Power supply

Mains supply

As standard, the UFC instrument is designed to work with a mains supply of 86 to 236 Vac and 50/60 Hz. A mains supply fuse is located adjacent to the mains power connection (see Figure 2.2).

24V Supply

An alternative 24 V (ac/dc) power supply module is available as a factory fitted option.

Power failure

The instrument will automatically power-up and become operational when the input power is applied. In the event of a power failure, the instrument's configuration parameters are stored in non-volatile memory which then allows the instrument to return to normal operation immediately power is restored. A real time clock (RTC) records the date and time of any power disruptions, and time-stamps any such occurrence in the output log. All data logging ceases while power is unavailable.

2: Installation

2.1 Safety Precautions and Warnings

<table>
<tr>
<td>⚠️
WARNING</td>
<td>**LETHAL VOLTAGES**

You may be exposed to potentially lethal (mains) voltages when the terminal cover of this instrument is removed. Always isolate the supply to this instrument before removing the terminal cover.</td>
</tr>
</table>

<table>
<tr>
<td>⚠️
WARNING</td>
<td>**LETHAL VOLTAGES**

This instrument must be installed by an electrically qualified technician aware of the potential shock hazards presented when working with mains powered equipment.</td>
</tr>
</table>

<table>
<tr>
<td>⚠️
WARNING</td>
<td>**SUPPLY EARTHING**

If the equipment is powered from a 24 Vac supply then the supply must be isolated from earth.</td>
</tr>
</table>

<table>
<tr>
<td>⚠️
Caution</td>
<td>*IP65 Enclosure Protection*

Blanking plugs are fitted to the cable glands on leaving the manufacturer. In order to preserve the enclosure's IP65 rating, ensure that the blanking plugs remain fitted in any unused cable gland.</td>
</tr>
</table>

2.2 Installing the UFC Instrument

2.2.1 Positioning the instrument

The UFC instrument should be installed as close as conveniently possible to the pipe-mounted ultrasonic sensors. Standard transducer cables are 16.5 ft (5 m) in length with 33 ft (10 m) cables being optionally available. Where, for operational reasons, it is not possible to mount the instrument this close to the sensors, bespoke cables of up to 328 ft (1000 m) can be provided. Consult Dwyer for further information and availability.

A suitable mains supply must be available to power the instrument (an optional 24V (ac/dc) supply module is available). The external supply must be suitably protected and connected via an identifiable isolator. A 500 mA fuse is fitted internally in the instrument's input supply line.

2.2.2 Mounting the instrument

Ideally, the UFC enclosure should be fixed to a wall using three screws – see Figure 2.2.

1. Remove the UFC terminal cover.

2. Fix a screw into the wall at the required point to align with the mounting keyhole on the back of the enclosure.

3. Attach the enclosure to the wall using the keyhole screw mounting.

4. Align the enclosure then mark out the positions for the two remaining screw fixings through the slots near the bottom corners of the enclosure. Then remove the enclosure, and drill (and plug) the two fixing points.

5. Clear the site of any dust/debris, then mount the enclosure on the wall.

Mounting Details
The instrument should be securely wall-mounted using the three fixing points shown.

Keyhole

4.5in

7.8in

Screw Slot

Cable connections
All power and control cables enter through cable glands located on the bottom of the instrument and connect to terminal blocks as shown.

GND TxD RxD mA+ mA- PULSE+ PULSE- AL1+ AL1- AL2+ AL2- IO1 IO2 IO3 IO4 IO5 IO6 IO7 IO8 IO9 IO10 IO11 IO12 + - 24V L N E 230V AC F1

Figure 2.1 **UFC Mounting and connection details**

2.2.3   Connecting the instrument

All cables enter the instrument through the (4) cable glands located at the bottom of the instrument and are connected by means of screwed terminals to a number of plug-in connectors – see Figure 2.1.

Control & monitoring cables

Depending on the fitted options, any of the following control and monitoring cables may be required:

- *Current output* – a 4 to 20 mA, 0 to 16 mA, or 0 to 20 mA monitoring signal is output at terminal `mA+` and `mA-`. (`mA+` is the current output terminal and `mA-` is the return terminal).
- *Pulse output* – an opto-isolated pulse output is available at terminals `PULSE+` and `PULSE-` (`PULSE+` is the pulse output terminal and `PULSE-` is the return terminal).
- *Alarm Outputs* – two programmable, multifunction alarm outputs are available using MOSFET, SPNO relays. The relays, which are rated at 48 V/500 mA continuous load, are connected to terminals ALARM1+, ALARM1-, ALARM2+ and ALARM2- respectively.
- *Expansion ports* – terminals IO1 to IO12 are used for I/O connections to a number of optional expansion boards that may be fitted to the UFC expansion slot.

1. Remove the terminal block cover.

2. Route the control and monitoring cables through the two smaller cable glands.

3. Cut the wires to length, strip back the insulation by approximately 0.4in (10 mm) and connect them to the required terminals identified in Figure 2.1.

4. On completion, tighten the cable glands to ensure the cables are held securely.

Power connections

<table>
<tr><td>⚠️
WARNING</td><td>**LETHAL VOLTAGES**

Ensure the power cable is isolated from the mains supply. Do not apply mains voltage with the terminal cover removed.</td></tr>
</table>

<table>
<tr><td>⚠️
WARNING</td><td>**SUPPLY EARTHING**

If the equipment is powered from a 24V AC supply then the supply must be isolated from earth.</td></tr>
</table>

The UFC instrument can be powered from a mains supply (86 to 264 Vac, 47 to 63 Hz) or from a 24 V(ac/dc) supply if it is fitted with a 24 V supply module.

1. Route the power cable through one of the two cable glands located below the power connection terminals, using the gland most suitable for the power cable diameter.

2. Cut the wires to length, strip back the insulation by approximately 0.4 inches (10mm), and connected to them to the correct power supply terminals identified in Figure 2.1.

3. On completion, tighten the cable glands to ensure the cables are held securely.

4. Refit the terminal block cover.

2.3 Installing the Ultrasonic Transducers

2.3.1 Transducer positioning

The UFC equipment expects a uniform flow profile as a distorted flow will produce unpredictable measurement errors. Flow profile distortions can result from upstream disturbances such as bends, tees, valves, pumps and other similar obstructions.

To ensure a uniform profile, the transducers must be mounted a sufficient distance away from any cause of distortion.

Figure 2.2   Locating the transducers

In many applications an even flow velocity profile over a full 360° is unattainable due to, for example, air turbulence at the top of the flow and possibly sludge in the bottom of the pipe. Experience has shown that the most consistently accurate results are achieved when the transducer holders are mounted at 45° with respect to the top of the pipe.
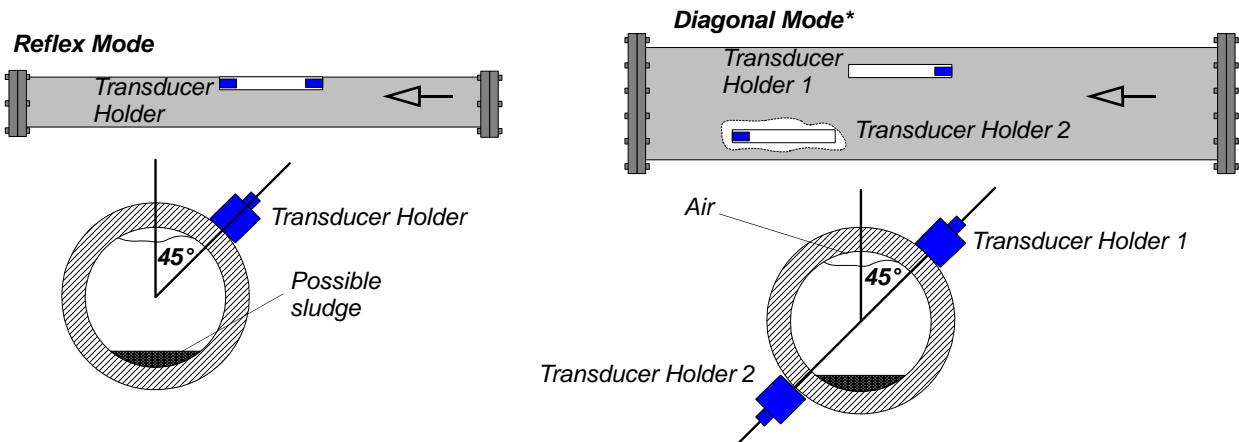
***Note:** when using the UFC in the 'diagonal' mode an additional transducer holder and fixing kit is required.*

Figure 2.3   Transducer holder attachment (reflex vs. diagonal mode)

To obtain the most accurate results, the condition of both the liquid and the pipe wall must be suitable to allow the ultrasound transmission along its predetermined path. It is important also that the liquid flows uniformly within the length of pipe being monitored and that the flow profile is not distorted by any upstream or downstream obstructions. This is best achieved by ensuring there is a straight length of pipe upstream of the transducers of at least 20 times the pipe diameter and 10 times the pipe diameter on the downstream side, as shown in Figure 2.2. Flow measurements can be made on shorter lengths of straight pipe, down to 10 diameters upstream and 5 diameters downstream, but when the transducers are positioned this close to any obstruction the resulting errors can be unpredictable.

> *Key Point:* Do not expect to obtain accurate results if the transducers are positioned close to any obstructions that distort the uniformity of the flow profile.

Preparation

Before you attach the transducers you should first ensure that the proposed location satisfies the distance requirements shown in Figure 2.2, otherwise the resulting accuracy of the flow readings may be affected.

Prepare the pipe by degreasing it and removing any loose material or flaking paint in order to obtain the best possible surface. A smooth contact between the pipe surface and the face of the transducers is an important factor in achieving a good ultrasound signal strength, and therefore maximum accuracy.

2.3.2   Transducer attachment
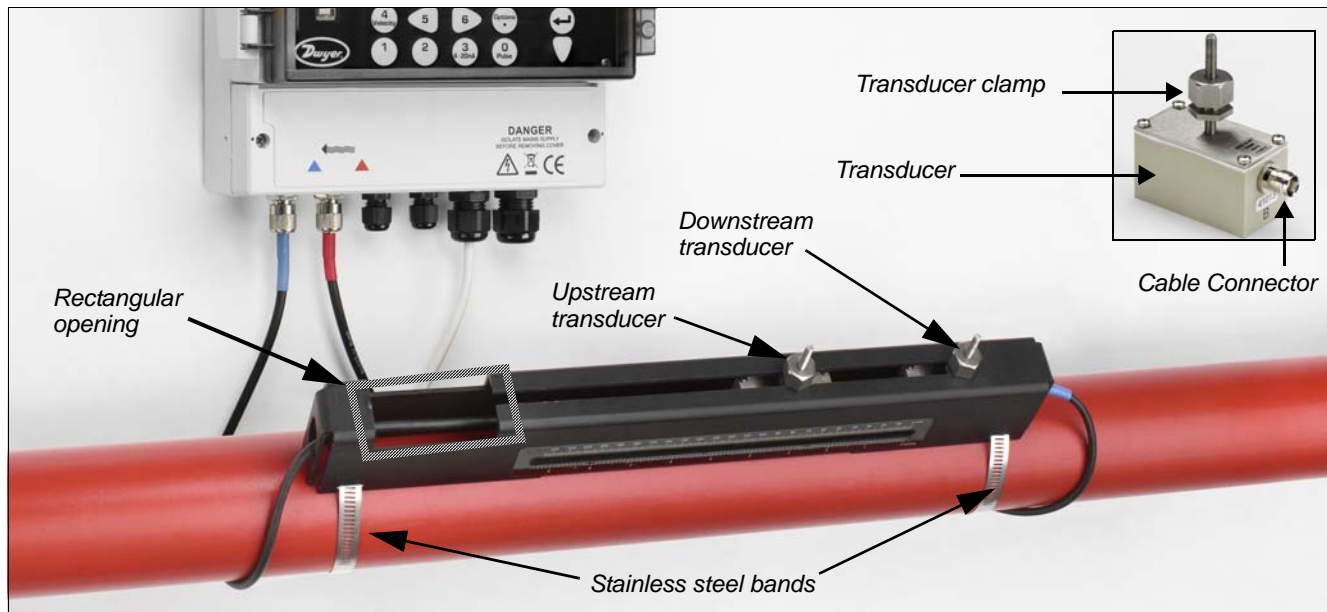
Figure 2.4 **Transducer attachment (completed assembly)**

Type 'A' or 'B' transducers are attached to the pipe using the adjustable guide rail assembly shown in Figure 2.4. The guide rail itself is secured to the pipe using two wrap-around steel bands. For user convenience, an imperial (inches) and metric (millimetres) ruler is attached to the side plate of the guide rail – as shown in Figure 2.4. Once the guide rail assembly is fully assembled the transducers are locked into position by tightening the transducer clamp.

Note: When using the UFC in the 'diagonal' mode, or in 'reflex' mode on pipes over 13.75 inches diameter, two guide rails are required with a transducer mounted in each one – see Paragraph 2.3.5 for diagonal mode details.

2.3.3 Attaching the guide rail to the pipe

1. Position the guide rail horizontally on the pipe at 45° with respect to the top of the pipe and secure it in position using the supplied stainless steel banding, as shown in Figure 2.5.

Note: In the following procedure the guide rail is installed with the rectangular opening facing towards the upstream end of the pipe.

Figure 2.5

2.3.4 Fitting the transducers

1. Tighten each transducer clamp clockwise until it is close to the top of the transducer Figure 2.6. This is necessary in order to prevent the acoustic couplant touching the pipe when the transducer is initially inserted into the guide rail – as described below.

2. Using the suppled syringe applicator, apply a 0.1 inch bead of acoustic couplant to the base of both transducers (Figure 2.7).

Figure 2.6

Figure 2.7

3. Thread the downstream transducer cable (blue) through the right-hand end of the guide rail and up through the rectangular opening at the top left-hand end of the guide rail, as shown in Figure 2.8.

4. Connect the downstream cable (blue) to one of the transducers.
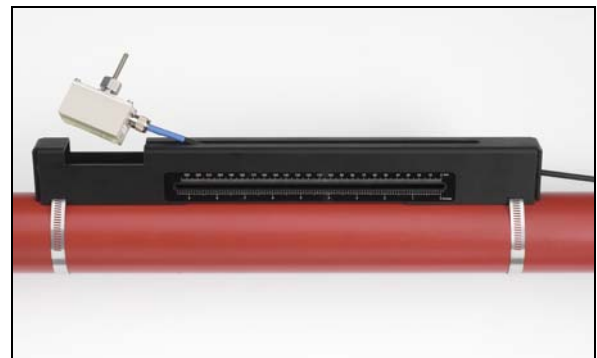
Figure 2.8

Note: When carrying out the following steps handle the transducer assembly with care to avoid smearing the acoustic couplant on the pipe whilst attaching the transducer to the guide rail.

5. Carefully lower the transducer and cable through the rectangular opening until the slots in the side of the transducer clamp align with the edges on the top of the guide rail.
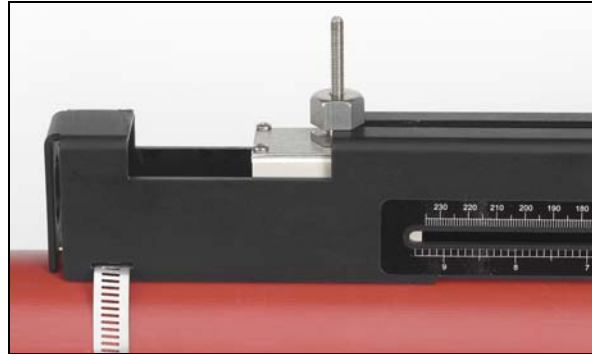
Figure 2.9

6. Carefully slide the downstream transducer assembly along the guide rail until the inner face of the transducer is aligned with the '0' mark on the ruler scale (Figure 2.10).

7. Lower the transducer onto the pipe by turning the transducer clamp anti-clockwise until it is 'finger tight' (do not use a spanner).
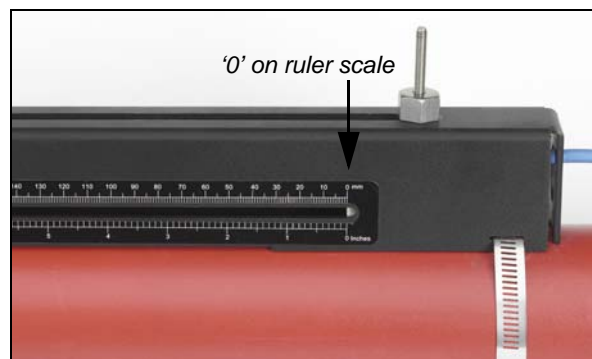
Figure 2.10

8. Thread the upstream signal cable (red) through the left-hand end of the mounting rail and connect it to the second transducer (Figure 2.11).

9. Following the method used to insert the downstream transducer, carefully lower the transducer assembly through the rectangular opening until the slots in the side of the transducer clamp align with the edges on the top of the guide rail (Figure 2.9).

Figure 2.11

13

10. Position the upstream transducer so that the inner face of the transducer is set to the required separation distance on the ruler, as shown in Figure 2.12 (2 inches in this example).

Note: The separation distance for a particular application can be found using the 'Quickstart' menu as described in Paragraph 3.2.

Calculated separation distance
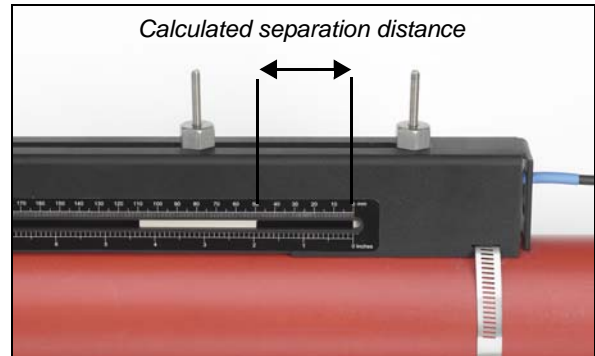
Figure 2.12

11. Lower the transducer onto the pipe by turning the transducer clamp anti-clockwise until it is 'finger tight' (do not use a spanner).

    Figure 2.13 shows the final position of the transducers when the transducer clamps are fully tightened.

12. Ensure the transducer signal cables are correctly connected to the UFC instrument – i.e. with the RED cable connected to the upstream transducer connector and the BLUE cable to the downstream transducer connector.
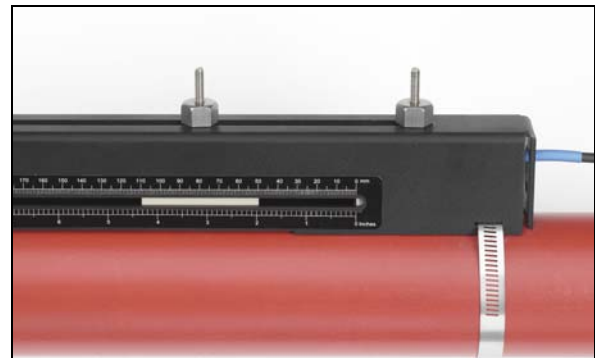
Figure 2.13

13. In some cases, particularly on large pipes using diagonal mode, or pipes with a poor internal condition, the signal from the sensors can be very noisy.
    In order to improve sensor performance and noise immunity, we recommend that the transducers are earthed, using the supplied cables and attachment hardware, in all installations – as shown in Figure 2.14.

Note: Remove any paint on the pipe in the area of the clamp to achieve a good electrical connection.
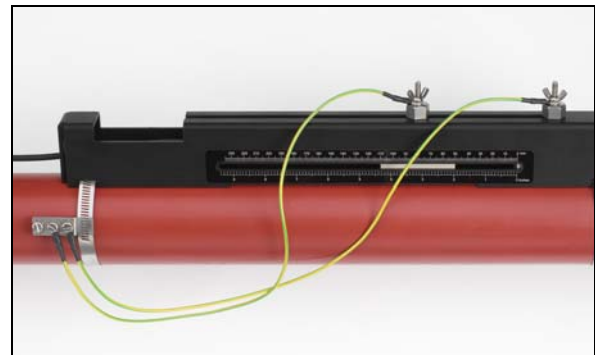
Figure 2.14

2.3.5 Transducer attachment (diagonal mode)

This mode of operation requires two transducer holders fitted on opposite sides of the pipe, as shown in Figure 2.15 – notice that the transducer holders are still fitted on a 45° axis with respect to the top of the pipe. When used with type 'A' or 'B' transducers, the transducer holders used are identical to that shown above, and the second transducer holder and fixings must be purchased as an option kit.

> ***Key Point:*** For installations on larger pipes (in the range 79 inches to 197 inches O.D.) it is necessary to use the type 'D' transducer kit which contains the transducers together with their particular mounting rails and fitting instructions. This will have been supplied with the electronics assembly that is configured to work with these larger pipes.

When installing the equipment to operate in the diagonal mode, the method of securing the transducers to the transducer holders and connecting them to the UFC instrument is identical to that described above for the reflex mode. The major difference is that you have to physically mark out the required position of the transducers on the pipe in order to determine where to attach the transducer holders.

1. Obtain and note the required separation distance between the transducers using the 'Quickstart' menu, as described in Paragraph 3.2.

2. Using whatever means available, mark a reference line around the circumference of the pipe approximately where the upstream transducer is to be fitted – line 'A' in Figure 2.15.

3. On line 'A', mark a position (point 'X') on an axis of approximately 45° from the top of the pipe, then draw a three foot line ('B') perpendicular to 'A' and parallel to the pipe axis.

4. On line A, mark a position (point 'Y') 180° opposite point 'X'.

5. From point 'Y', draw a three foot long line ('C') perpendicular to 'A' and parallel to the pipe axis. This is shown as a dashed line in Figure 2.15 as it is on the rear of the pipe.

6. Mark a position (point 'Z') on line 'C' which is equal to the transducer separation distance noted in step 1 from point 'Y'.

7. Position and attach the upstream transducer holder to the pipe such that line 'B' runs centrally along the length of the transducer holder and point 'X' is within the transducer attachment part of the transducer holder.

8. Fit the upstream transducer (red cable) to the transducer holder as described in Paragraph 2.3.4 such that the leading face of the transducer aligns with line 'A'.

9. Position and attach the downstream transducer holder to the pipe such that line 'C' runs centrally along the length of the transducer holder and point 'Z' is within the transducer attachment part of the holder.

10. Fit the downstream transducer (blue cable) to the transducer holder as described in Paragraph 2.3.4 such that the leading face of the transducer aligns with point 'Z'.

11. Connect the transducer cables to the UFC instrument.

Figure 2.15 **Transducer mounting for diagonal mode of operation**
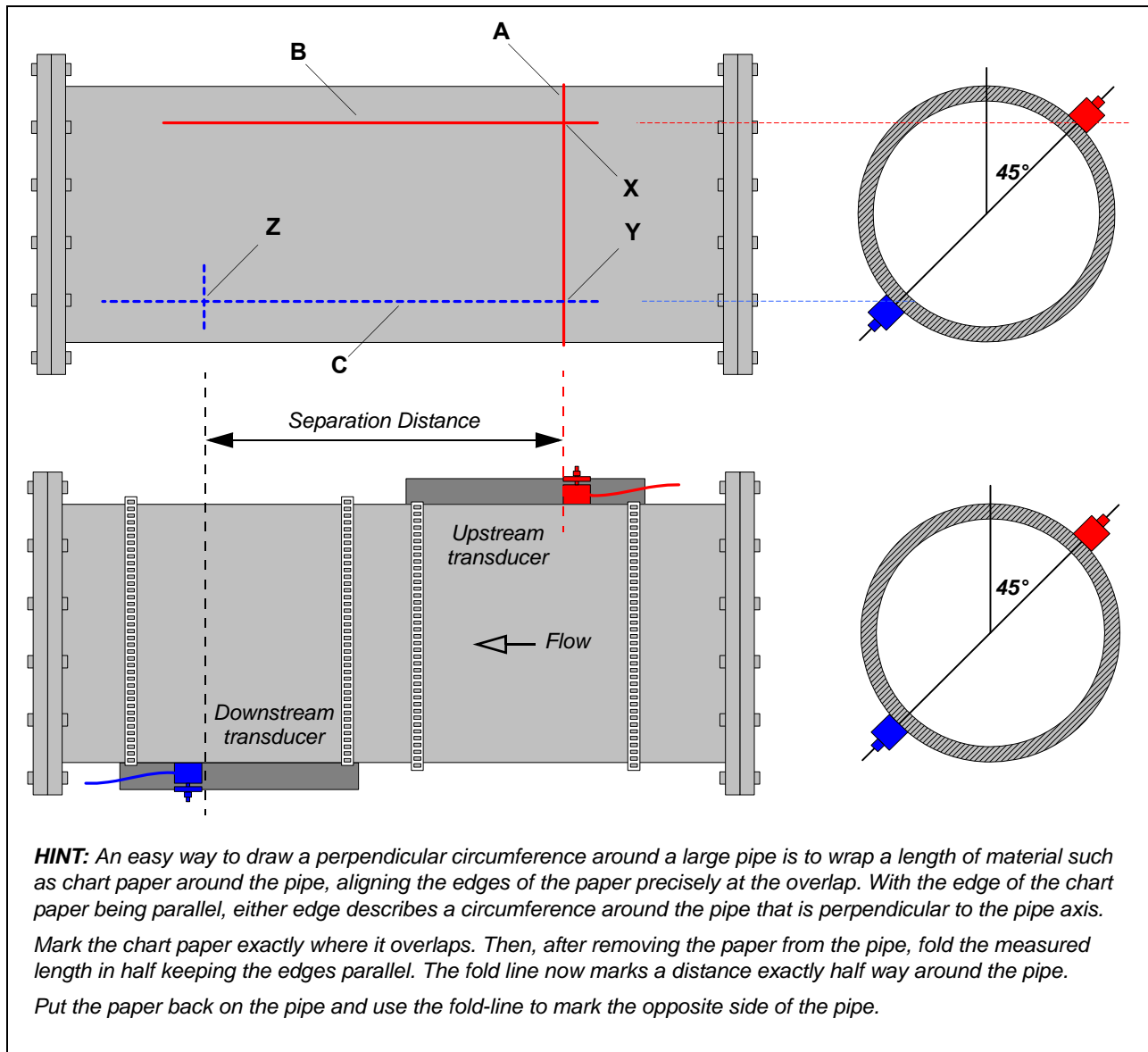
HINT: An easy way to draw a perpendicular circumference around a large pipe is to wrap a length of material such as chart paper around the pipe, aligning the edges of the paper precisely at the overlap. With the edge of the chart paper being parallel, either edge describes a circumference around the pipe that is perpendicular to the pipe axis.

Mark the chart paper exactly where it overlaps. Then, after removing the paper from the pipe, fold the measured length in half keeping the edges parallel. The fold line now marks a distance exactly half way around the pipe.

Put the paper back on the pipe and use the fold-line to mark the opposite side of the pipe.

3: *Operating Procedures*

Initial instrument setup *(Paragraph 3.1)*

Set date/time, Language

Connect and take basic flow readings *(Paragraph 3.2)*

QUICK START

Enter data

Attach sensors

FLOW READING

Carry out any necessary calibration *(Paragraph 3.3)*

How to adjust the Zero Flow Offset – Paragraph 3.3.2
How to adjust the Calibration Factor – Paragraph 3.3.3
How to adjust the Roughness Factor – Paragraph 3.3.4
How to adjust the Damping Factor – Paragraph 3.3.5

Set-up a monitoring *(Paragraph 3.4)*

How to measure totalized flows – Paragraph 3.5
Operation with an Energy Meter – Paragraph 3.7

Configure the interfaces

(Paragraph 3.4)

4-20mA ON/OFF – Paragraph 3.4.1
4-20mA Calibration – Paragraph 3.4.1
Pulse ON/OFF – Paragraph 3.4.2
Pulse calibration – Paragraph 3.4.2
Alarm outputs – Paragraph 3.4.3

Data Logging *(Chapter 4)*

How to set up basic (manual) logging – Paragraph 4.1
How to set up auto-timed logging – Paragraph 4.2
How to download logged data – Paragraph 4.3

3.1 Setting-up the Instrument

Key Point: When the instrument used for the first time the operator has free access to all the set-up and operating menus until the instrument is put into FLOW READING operation, where-upon all the menus become password protected (see page 22).

3.1.1 Using the instrument for the first time

Initial user language selection

The first time you power-up the instrument you will be asked to select a user language, which will then be the default language when the instrument is next used. If you want to change the language when the instrument is in use, see below.

1. On initial power-up, the start-up screen will be displayed for 5 seconds, showing the instrument's serial number and software revision.

2. After 5 seconds, the available language list will be displayed.

3. Select the required language and press `ENTER`.

4. The instrument will display the `MAIN MENU`.

```
              Dwyer®

Serial# 0012345        V 00.00.000
         Please wait.........
```

The MAIN MENU screen

The `MAIN MENU` screen is at the top of the menu hierarchy and is the starting point for all the operations described in this chapter. This screen is normally accessed from the `FLOW READING` screen by pressing the `ENTER` key.

```
MAIN MENU              DD-MM-YY  HH:MM:SS

 Quick start
 View/Edit Site Data
 Setup Instrument
 Read flow
```
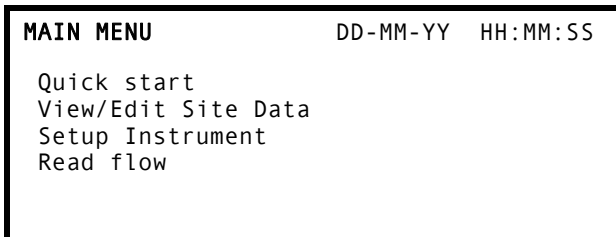
Setting the date & time

5. Select `Setup Instrument` from the `MAIN MENU` and press `ENTER`. The `SETUP INSTRUMENT` screen should now be displayed.

6. Select `Set Date & Time` then press `ENTER`.

7. A flashing cursor should appear under the first date number. Enter the date sequence in `dd-mm-yy` order then press `ENTER`.

8. Repeat this action to set the time.

9. Select `Exit` then press `ENTER` to return to the `MAIN MENU`.

```
SETUP INSTRUMENT        DD-MM-YY   HH:MM:SS

 *Set Date & Time  : dd-mm-yy hh:mm:ss
 Calibrate 4-20mA
 Factory settings
 Change Language
 Exit
```
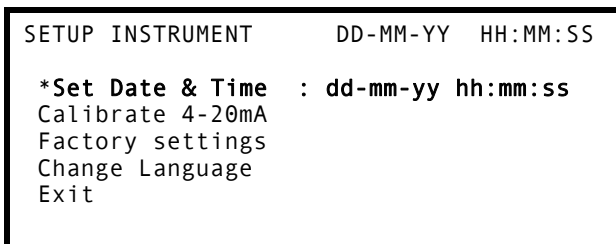
Note: If you make a mistake when entering the data press the `Delete` key to move the cursor back to the number you wish to change, then continue. If you enter an invalid number an '`ERR:Invalid Date or Time!`' error message is displayed on the second line of the screen. If this occurs repeat the set date/time procedure.

3.1.2 Changing the user language

If you want to change the user language at any time after the instrument has been put into operation:

1. Select `Setup Instrument` from the `MAIN MENU` then press ENTER.

2. Select `Change Language` from the `SETUP INSTRUMENT` screen then press `ENTER`.

3. Select the required language from the list provided and press ENTER.

4. The instrument returns to the `MAIN MENU`.

```
SETUP INSTRUMENT        DD-MM-YY  HH:MM:SS

 Set Date & Time  : dd-mm-yy hh:mm:ss
 Calibrate 4-20mA
 Factory settings
 Change Language
 Exit
```

3.1.3 Changing the date and time

The correct date and time should have been set when the instrument was initially put into service. To update the date/time parameters:

1. Set the required Date & Time as described in Paragraph 3.1.1.

```
SETUP INSTRUMENT        DD-MM-YY  HH:MM:SS

 Set Date & Time  : dd-mm-yy hh:mm:ss
 Calibrate 4-20mA
 Factory settings
 Change Language
 Exit
```

3.2 Using the Quick Start Menu

The Quick Start menu gathers various data for the site to be monitored and returns details of the transducer configuration that must be applied when mounting the transducers on the pipe.

Before you can use the UFC system you need to obtain the following details (this information is required when setting up the `Quick Start` menu):

- The pipe outside diameter.
- The pipe wall thickness and material.
- The pipe lining thickness and material (if any).
- The type of fluid contained in the pipe being monitored.
- The fluid temperature.

Entering the site data

1. Select `Quick Start` from the `MAIN MENU` and press `ENTER`. You will then be presented with a series of screens in which to enter the data mentioned above.

2. Select the dimension units (millimeters or inches) used to measure the pipe, then press ENTER.

```
DIMENSION UNIT          DD-MM-YY  HH:MM:SS

Select the dimension units:

  mm
➥Inches
```

3. Enter the pipe outside diameter dimension, then press ENTER.

```
OUTSIDE DIAMETER        DD-MM-YY   HH:MM:SS


Dimensions:                     Inches

Pipe outside diameter:      6.50

```

4. Enter the pipe wall thickness dimension, then press ENTER.

```
PIPE WALL THICKNESS DD-MM-YY   HH:MM:SS


Dimensions:                     Inches

Pipe outside diameter:      6.50
Pipe wall thickness:        0.50
```

5. If the pipe has a lining, enter the lining thickness.
    If nothing is entered the instrument automatically assumes there is no lining.

6. Press ENTER to continue.

```
PIPE LINING THICKNESS DD-MM-YY   HH:MM:SS


Dimensions:                     Inches

Pipe outside diameter:      6.50
Pipe wall thickness:        0.50
Pipe lining thickness:      0.12
```

7. Select the pipe wall material from the list provided, then press ENTER.

    If the material is not listed select Other and enter the propagation rate of the pipe wall material in meters/sec. Contact Dwyer if this is not known.

```
PIPE WALL MATERIAL     DD-MM-YY   HH:MM:SS

Select pipe wall material

Mild Steel
S' less Steel 316
S' less Steel 303
Plastic

Cast Iron
Ductile Iron
Copper
Brass
Concrete
Glass
Other  (m/s)
```

8. If a lining thickness value was entered earlier, this screen is displayed to request that you enter the lining material type. If no lining thickness was entered this screen will be bypassed.

9. Select the lining material from the list provided then press `ENTER`.

    If the material is not listed select `Other` and enter the propagation rate of the lining material in meters/sec. Contact Dwyer if this is not known

```
PIPE LINING MATERIAL  DD-MM-YY  HH:MM:SS

Select pipe lining material

Steel
Rubber
Glass
Epoxy
```
```
Concrete
Other  (m/s)
```

10. Select the fluid type from the list provided and press `ENTER`.

    If the liquid is not listed select `Other` and enter a propagation rate in meters/second.Contact Dwyer if this is not known

```
FLUID TYPE              DD-MM-YY  HH:MM:SS

Select fluid type

Water
Glycol/water 50%
Glycol/water 30%
Lubricating oil
```
```
Diesel
Freon
Other  (m/s) --
```

11. If you need to alter the fluid temperature from that shown select either °C or °F with the cursor and press the `ENTER` key.

12. Enter the new temperature value and press the `ENTER` key.

13. The new temperature should now be indicated in both °C and °F.

14. Select `Continue..` and press `ENTER`.

```
FLUID TEMPERATURE       DD-MM-YY  HH:MM:SS

Enter Fluid Temperature

   °C: 5.00
   °F: 41.00
 Continue..
```

15. The `SENSOR SEPARATION` screen now displays a summary of the entered parameters and informs you of the type of sensor to be used, the mode of operation, and the distance to set up between the sensors.
    In this example, it recommends type `A-ST` (A standard) sensors operating in the 'Reflex' mode spaced at `3.62 Inches` apart.
    Take a note of these details.

```
SENSOR SEPARATION       DD-MM-YY  HH:MM:SS
Site        : Quickstart
Pipe        : 6.50 Inches
Wall        : 0.50 Inches
Sensors     : A-ST      Reflex
Temperature : 5.00°C 41.00°F
Set sensor separation to   3.62 Inches
Press ↵ to continue,△▽ to select sens.
```

Key Point: The above example shows the spacing required using a standard type 'A' probe set (A-ST), as supplied with the model UFC-A.

Selecting the operating mode

On large pipes using either type 'B' or 'D' sensors it may be necessary to use the 'Diagonal' mode of operation rather than the 'Reflex' mode. The system will automatically select 'Reflex' mode if it is valid, but the mode can be changed using the following steps.

16. When in the SENSOR SEPARATION screen, press either the Up or Down arrow keys. This will display the SENSOR SELECTION menu.

17. Scroll down to Sensor mode and press ENTER.

18. Scroll to the required mode and press ENTER.

19. Select Exit and press ENTER, to return to the SENSOR SEPARATION screen.

20. The correct sensor separation distance for the selected mode will now be displayed.

Note: Do not press ENTER (to continue with the operating procedure) until the transducers are fitted and connected to the instrument.

Password Control

After data has been entered for the first time, the UFC password control feature is 'enabled' when you exit from Quick start to the FLOW READING screen. This prevents unauthorized tampering of the set-up data. Once 'enabled', a password control box is displayed if any key is pressed and you must then enter 71360 to 'disable' the password control and gain access to any of the menus.

Note: Once disabled, the password control feature is re-enabled if no keys are pressed for five minutes.

Attaching and connecting the transducers

21. Fit the designated sensors to the pipe using the transducer holder as described in Paragraph 2.3.2. The separation distance must be set to within ±0.02 inches.

Taking a flow reading

22. Once the transducers have been fitted and connected, press the ENTER key twice.

23. This will take you from the SENSOR SEPARATION screen to the FLOW READING screen via the signal-checking screen (shown here).

```
Please wait..
Checking signals

*****************************************
*                                       *
*****************************************
```

24. Check that the indicated signal strength on the left of the screen shows at least 2 bars (ideally 3 or 4). If less than 2 bars are shown it indicates there could be a problem with the transducer spacing, alignment or connections; or an application problem.

25. Qxx.xx% indicates the signal quality and should have a value of 60% or greater.

```
FLOW READING          DD-MM-YY  HH:MM:SS
                                  Qxx.xx%
Signal
  ▄▄█   0.000  gal/min

   +Total: 0.00        gallons
   -Total: 0.00        gallons
```
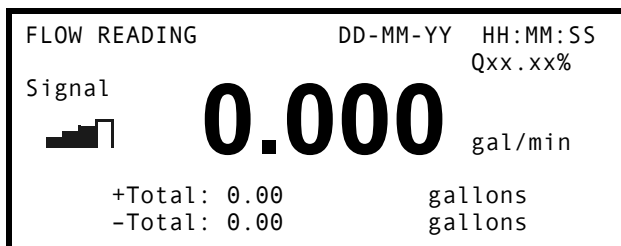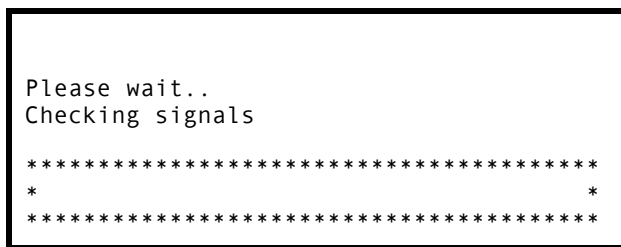
Flow monitoring

The FLOW READING screen is the one most used during normal monitoring operation. It shows the instantaneous fluid flow together with totalized values (when enabled). In this mode you can select the flow rate measurement

units by pressing keys 7 (liters), 8 (Gallons, Barrels) or 9 (m³), or change the display to show velocity by pressing key 4.

If the flow reading exceeds a value of +/-9999 in the current units, then a *10 multiplier will be displayed above the units and the value displayed will be a tenth of the actual value. Similarly a * 100 and *1000 may be displayed on very large flow rates.

Once a valid flow reading is obtained, if the pipe conditions change (such that the flow reading is lost) then the system will automatically rescan to re-establish a stable flow reading. It is important that the instrument is left with the `FLOW READING` screen on the display because the automatic rescan is disabled if any of the other screens that can be reached from the `FLOW READING` screen are being displayed.

Note: There will be a delay in the keyboard response if a rescan is in progress when a key is pressed.

3.3   Instrument Calibration

The instrument is fully calibrated before it leaves the factory; however the following adjustments are provided to allow you to further 'fine tune' your instrument to suit local conditions and applications where necessary. Apart from the 'zero flow offset', these adjustments are normally carried out only where the instrument is to be used at a permanent, or semi-permanent, location.

3.3.1 Adjusting the zero cut-off

This adjustment allows you to set a minimum flow rate (m/s) below which the instrument will indicate '0'. The default setting is 0.1 m/s but you may adjust this value if required.

1. With the instrument operating in `FLOW READING` mode, press the `Options` key to access the `FLOW READING OPTIONS` menu shown (password required).

2. Select `Zero Cutoff (m/s)` and press `ENTER`.

3. Enter the value for the `Zero Cutoff` (e.g. 0.06 m/s) then press `ENTER`.

```
FLOW READING OPTION    DD-MM-YY  HH:MM:SS

 Data review
 Zero Cutoff (m/s)     :        0.100
 Set zero flow (m/s)   :        0.000
 Damping (secs)        :          10
 Totalizer             :        Run
 Reset +Total
```

4. Scroll down to select `Exit` and press `ENTER` to return to the `FLOW READING` screen.

3.3.2 Adjusting the set zero flow offset

The UFC instrument operates by comparing the time taken to send an ultrasonic signal between two transducers in either direction. A `Set zero flow` offset adjustment is provided to compensate for any inherent differences between the two sensors, noise pick-up, internal pipe conditions etc. It can be used to 'zero' the flow indication under no-flow conditions.

Key Point: If you have adjusted the `Zero Cutoff` point to anywhere above '0' you must reset it to '0' before you can observe and adjust the `Set zero flow` offset, as its value is very small. Once the `Set zero flow` offset has been cancelled you can then reapply the `Zero Cutoff` if required.

1. Stop the liquid flow.

2. With the instrument in `FLOW READING` mode, press the `Velocity` function key and observe the reading (m/s). Any reading other than 0.000 indicates an offset error and in practice this will typically be in the range

±0.005m/s (possibly higher on smaller diameter pipes). If a greater figure is shown, it is worth cancelling the offset to obtain a more accurate result. Continue as follows:

3. Press the `Options` key to access the `FLOW READING OPTION` screen shown.

4. Select `Set zero flow (m/s)` and press `ENTER`.

5. Press `ENTER` on the subsequent screen to accept the change, which will return you to the screen shown.

6. Scroll down to select `Exit` and press `ENTER` to return to the `FLOW READING` screen.

```
FLOW READING OPTION    DD-MM-YY  HH:MM:SS

 Data review
 Zero Cutoff (m/s)     :        0.010
 Set zero flow (m/s)   :        0.000
 Damping (secs)        :        10
 Totalizer             :        Run
 Reset +Total
```

Key Point: In order to cancel any applied offset, you must read the flow via `Quick Start`. Any value that you trim-out using the offset adjustment will be added/subtracted from the flow reading across the whole range.

3.3.3 Adjusting the calibration factor

Key Point: USE THIS FACILITY WITH CARE & ONLY WHERE NECESSARY

The instrument is fully calibrated before leaving the factory and under normal circumstances does not require further calibration when used on site.

This facility can be used to correct the flow indication where unavoidable errors occur due to the lack of a straight pipe or where the sensors are forced to be fitted close to the pipe-end, valve, junction etc.

Any adjustment must be made using a reference flowmeter fitted in the system.

With the system running:

1. Stop (`Stall`) the totalizer facility and zero it (Paragraph 3.5).

2. `Run` the totalizer to measure the total flow over a 30-60 minute period, and note the total flow indicated by the reference flow meter over the same period.

3. Calculate the % error between the UFC instrument and reference meters. If the error is greater than ±1% calibrate the UFC as detailed below.

4. Press the `Options` key to access the `FLOW READING OPTION` screen shown.

5. Scroll down and select `Calibration factor` then press `ENTER`.

6. Change the calibration factor according to the error calculated in step 3. For example, if the instrument was reading 1% high then increase the `Calibration factor` value by 0.010. Conversely, if the reading is 1% low then decrease the calibration factor to 0.990.

7. Press `ENTER` to apply the change.

8. Select `Roughness factor` or `Exit` as required and press `ENTER`.

```
FLOW READING OPTION   DD-MM-YY  HH:MM:SS

Data review
Zero Cutoff (m/s)     :        0.010
Set zero flow (m/s)   :        0.000
Damping (secs)        :        10
Totalizer             :        Run
Reset +Total
```

```
Reset -Total
Calibration factor    :        1.000
Roughness factor      :        0.010
Alarm Settings        :
Max Pulse Freq (Hz)   :        10.00
Flow at Max Frequency :        200.00
Calculated Pulse Value:        2.00
Diagnostics
Select Totals         :         +Total
Exit
```

3.3.4 Adjusting the roughness factor

The roughness factor compensates for the condition of the internal pipe wall, as a rough surface will cause turbulence and affects the flow profile of the liquid. In most situations it is not possible to inspect the pipe internally and the true condition is not known. In these circumstances experience has shown that the following values can be used:

Pipe Material	Roughness Factor	Pipe Material	Roughness Factor

Non ferrous metal
  • Glass
  • Plastics
  • Light metal
	0.01	Welded steel pipes, new:
		  • Long usage, cleaned
		  • Lightly and evenly rusted
		  • Heavily encrusted
			0.1

Drawn steel pipes:
  • Fine planed, polished surface.
  • Plane surface
  • Rough planed surface
	0.01	Cast iron pipes:
		  • Bitumen lining
		  • New, without lining
		  • Rusted / Encrusted
			1.0

The increase in the roughness factor has the effect of reducing the measured flow rate, compensating for the drag caused by the rougher internal surface.

With the system running in FLOW READING mode:

1. Press the Options key to access the FLOW READING OPTION screen shown.

2. Scroll down and select Roughness factor then press ENTER.

3. Change the roughness factor according to the pipe material and condition as described above.

4. Press ENTER to apply the change.

```
FLOW READING OPTION    DD-MM-YY   HH:MM:SS

Data review
Zero Cutoff (m/s)     :        0.010
Set zero flow (m/s)   :        0.000
Damping (secs)        :        10
Totalizer             :        Run
Reset +Total
```

```
Reset -Total
Calibration factor    :        1.000
Roughness factor      :        0.010
Alarm Settings        :
Max Pulse Freq (Hz)   :        10.00
Flow at Max Frequency :        200.00
Calculated Pulse Value:        2.00
Diagnostics
Select Totals         :        +Total
Exit
```

3.3.5 Adjusting the damping factor

By averaging-out the flow rate over several seconds, the Damping factor can be used to smooth out rapid changes in flow rate to prevent wild fluctuations in the displayed flow value. It has a range of 1 to 50 seconds, with a default setting of 10. With the system running in FLOW READING mode:

1. Press the `Options` key to access the `FLOW READING OPTION` screen shown.

2. Scroll down and select `Damping (secs)` and press `ENTER`. This will open the `DAMPING OPTION` screen.

```
FLOW READING OPTION    DD-MM-YY  HH:MM:SS

 Data review
 Zero Cutoff (m/s)     :        0.010
 Set zero flow (m/s)   :        0.000
 Damping (secs)        :        10
 Totalizer             :        Run
 Reset +Total
```

```
 Reset -Total
 Calibration factor    :        1.000
 Roughness factor      :        0.010
 Alarm Settings        :
 Max Pulse Freq (Hz)   :        10.00
 Flow at Max Frequency :        200.00
 Calculated Pulse Value:        2.00
 Diagnostics
 Select Totals         :         +Total
 Exit
```

3. Select the value of the `Damping factor` as required to remove any unwanted display fluctuations. Increasing the value applies a greater smoothing affect.

4. Press `ENTER` to apply the change.

```
DAMPING OPTION          DD-MM-YY  HH:MM:SS

 1 second
 10 seconds
 15 seconds
 20 seconds
 30 seconds
 50 seconds
```

Key Point: If the damping factor is set too high, the value displayed may appear stable but might exhibit large step changes when the value is updated.

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3.4   Outputs

The UFC has configurable Current, Pulse, and Alarm outputs.

3.4.1 Current output

Note: Where long cable runs are necessary, or noise pickup is causing unstable flow readings, the use of two core screened cable such as BELDEN 9501 060U500, or similar, is recommended for use with the 4 to 20 mA current output. The cable screen should be connected to the GND terminal located on the left hand end of the instrument's connector block.

How to turn the 4 to 20 mA output OFF/ON

1. With the instrument operating in the `FLOW READING` mode, press the `4-20mA` function key. This will access the `4-20mA OUTPUT` screen.

2. The ON/OFF status of the 4-20mA output is shown on line 2 of the display.

3. To change the ON/OFF status select `Output Range` and press `ENTER`

4. Select `Off`, to turn OFF the 4-20mA Output or select one of the output ranges to turn it ON.

5. Press `ENTER` to return to the `4-20mA OUTPUT` screen

```
4-20 mA OUTPUT        DD-MM-YY  HH:MM:SS
4-20 mA O/P is ON
 mA Output Reading   :        0.00
 Output Range        :        4-20
 Units               :        gal/min
 Flow at max. output :        0.00
 Flow at min. output :        0.00
 Output mA for error :        22.00

 Exit
```

```
4-20 mA OUTPUT        DD-MM-YY  HH:MM:SS

 Off
 4-20mA
 0-20mA
 0-16mA


```

4 to 20 mA Signal calibration and ranging

Key Point: The 4 to 20 mA output has been calibrated in the factory and should not require further adjustment. In the rare event that re-calibration is necessary, this procedure should be carried out only by a trained engineer.

This procedure describes how to calibrate the 4 to 20 mA output and 'scale' it to cover a defined flow-rate range.

Signal calibration

6. Select `Setup Instrument` from the `MAIN MENU` then press `ENTER` to access the `SETUP INSTRUMENT` screen.

7. Select `Calibrate 4-20mA.` and press `ENTER`

```
SETUP INSTRUMENT        DD-MM-YY  HH:MM:SS

 Set Date & Time  : dd-mm-yy hh:mm:ss
 Calibrate 4-20mA
 Factory settings
 Change Language
 Exit

```

8. Connect a calibrated ammeter to the 4 to 20 mA output and adjust the `UP/DOWN` Scroll keys (Coarse) and `LEFT/RIGHT` Scroll keys 5 & 6 (fine) until the output is exactly 4.00 mA. The DAC should indicate approximately 8000.

9. Press `ENTER` when done.

```
┌─────────────────────────────────────────┐
│ CALIBRATE 4mA          DD-MM-YY  HH:MM:SS │
│                                           │
│     Adjust the output current to 4mA      │
│        Use △▽ to set, 5/6 to trim         │
│                                           │
│     DAC Value:          8000              │
│                                           │
│             Press  ↵   when done          │
└─────────────────────────────────────────┘
```

10. With the meter still connected to the 4 to 20 mA output adjust the Scroll keys to obtain an output of exactly 20.00 mA. The DAC should indicate approximately 40000.

11. Press `ENTER` when done.

```
┌─────────────────────────────────────────┐
│ CALIBRATE 20mA         DD-MM-YY  HH:MM:SS │
│                                           │
│     Adjust the output current to 20mA     │
│        Use △▽ to set, 5/6 to trim         │
│                                           │
│     DAC Value:          40000             │
│                                           │
│             Press  ↵   when done          │
└─────────────────────────────────────────┘
```

4-20mA Signal scaling

Note: The 4 to 20 mA can be set to represent a particular flow range. It is also possible to enter a negative figure for the minimum output and this would enable a reverse flow to be monitored.

12. With the instrument operating in the `FLOW READING` mode, press the `4-20mA` function key. This will access the `4-20mA OUTPUT` screen.

13. Select `Flow at max. output` and press `ENTER, then` enter a value of the flow rate that you want to associate with a 20.00 mA output.

14. Select `Flow at min. output` and press `ENTER` then enter a value of the flow rate that you want to associate with a 4.00 mA output. This could be '0'.

```
┌─────────────────────────────────────────┐
│ 4-20 mA OUTPUT         DD-MM-YY  HH:MM:SS │
│ 4-20 mA O/P is ON                         │
│  mA Output  Reading   :         0.00      │
│  Output Range         :         4-20      │
│  Units                :         gal/min   │
│  Flow at max. output  :         0.00      │
│  Flow at min. output  :         0.00      │
│  Output mA for error  :         22.00     │
├─────────────────────────────────────────┤
│  Exit                                     │
└─────────────────────────────────────────┘
```

15. Select `Output mA for error` and enter a value (max of about 26 mA) that you want the 4 to 20 mA output to produce in the event of an error (e.g. if the flow-rate is outside the set range).

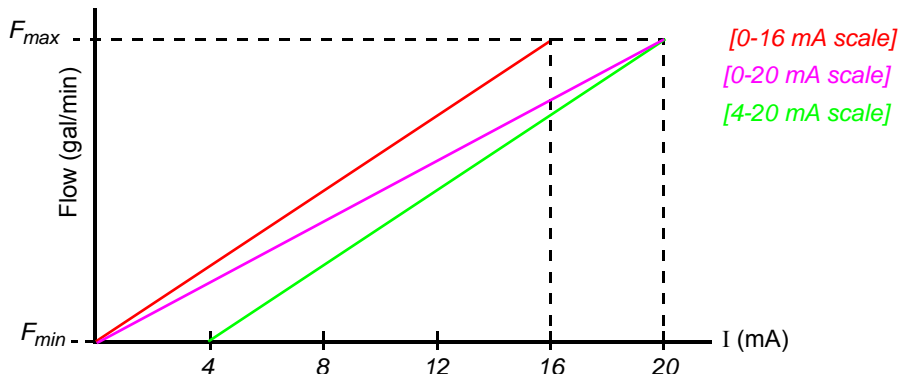16. Upon completion press `ENTER` to return to the `FLOW READING` screen.

How to convert the measured current to flow rate

Assume the maximum flow rate is F_{max} (gal/min) and the minimum flow rate F_{min} is '0' (gal/min), as shown.

To calculate the flow rate (gal/min) for a measured current I(mA) then:

0-20 mA	0-16 mA	4-20 mA
Flow rate $= \dfrac{I \times (F_{max} - F_{min})}{20} + F_{min}$	Flow rate $= \dfrac{I \times (F_{max} - F_{min})}{16} + F_{min}$	Flow rate $= \dfrac{(I-4) \times (F_{max} - F_{min})}{(16)} + F_{min}$

3.4.2 Pulse output

Pulse output configuration

Two parameters can be configured from the `PULSE OUTPUT` menu:

- Volume of fluid per pulse.
- Pulse width.

1. With the instrument operating in the `FLOW READING` mode, press the `Pulse` function key to access the `PULSE OUTPUT` screen.

2. Ensure that the `Output` is `Off`.

3. Select `Vol per pulse` and press `ENTER`.

4. Enter the required value. (In the example shown, a pulse is produced for every 10 gallons of flow).

```
PULSE OUTPUT          DD-MM-YY  HH:MM:SS
Pulse output is ON
Flow units           :          gallons
Output               :          Off
Vol per pulse        :          10.00
Pulse width (ms)     :          10
Exit
```

Note: The `Vol per pulse` can only be changed if the `Pulse Output` is `Off`.

5. Select a `Pulse width` (in ms) to suit the particular application – e.g. electro-mechanical counter. Refer to the manufacturer's data sheet for the minimum pulse width.

6. Select `Exit` and press `ENTER` to return to the `FLOW READING` screen.

How to turn the pulse output OFF/ON

7. With the instrument operating in the `FLOW READING` mode, press the `Pulse` function key to access the `PULSE OUTPUT` menu.

8. Select `Output` and press `ENTER`.

9. Select `On` and press `ENTER`.

10. A *Pulse output is ON* message will appear in the second line of the display.

11. Select `Exit` and press `ENTER` to return to the `FLOW READING` screen.

```
PULSE OUTPUT          DD-MM-YY  HH:MM:SS
Pulse output is ON
Flow units        :        gallons
Output            :        Off
Vol per pulse     :        10.00
Pulse width (ms)  :        10
Exit
```

3.4.3 Alarm outputs

The UFC provides two programmable alarm outputs that are interfaced by opto-isolated relays. The relay contacts are rated at a 48 V (maximum voltage across the open contacts) and 500 mA (maximum continuous current through the closed contacts).

The two alarm outputs can be individually configured to operate in one of five modes:

- Activate at a predefined Low or High flow rate.
- Activate when a specified Volume is measured.
- Activate if a signal error is detected – either due to poor signal strength or complete signal loss.
- Alarm Test mode.
- Pulse Frequency output.

Alarm settings selection

1. To access the The `ALARM SETTINGS` menu select `Alarm Settings` from the `FLOW READING OPTION` menu and press `ENTER`.

2. The `ALARM SETTINGS` screen should be displayed, as shown below.
This screen shows two parameters (`Mode` and `Limit`) that can be individually set for Alarm 1 and Alarm 2.

```
FLOW READING OPTION   DD-MM-YY  HH:MM:SS

Data review
Zero Cutoff (m/s)    :        0.010
Set zero flow (m/s)  :        0.000
Damping (secs)       :        10
Totalizer            :        Run
Reset +Total
```

```
Reset -Total
Calibration factor   :        1.000
Roughness factor     :        0.010
Alarm Settings       :
Max Pulse Freq (Hz)  :        10.00
Flow at Max Frequency :       200.00
Calculated Pulse Value:       2.00
Diagnostics
Select Totals        :         +Total
Exit
```

Alarm configuration

1. To setup Alarm 1, select `Alarm1 Mode` and press `ENTER`. This will access the `ALARM1 MODE` menu screen (shown below).

```
ALARM SETTINGS          DD-MM-YY   HH:MM:SS

Alarm1 Mode
Alarm1 Level        :           <value>
Alarm2 Mode
Alarm2 Level        :           <value>
Exit
Alarm1 ON       Alarm2 ON
```

2. Scroll down the menu to the required alarm operating mode and press `ENTER`.

```
ALARM1 MODE             DD-MM-YY   HH:MM:SS

Off
Low
High
Volume
On Flow Error
Alarm Test

Frequency
```

3. This will return you to the `ALARM SETTINGS` menu.

4. If the selected mode is `Low`, `High` or `Volume`, select `Alarm1 Level`, enter an appropriate value then press `ENTER` to set the alarm operating point (see below).

```
ALARM SETTINGS          DD-MM-YY   HH:MM:SS

Alarm1 Mode
Alarm1 Level        :           <value>
Alarm2 Mode
Alarm2 Level        :           <value>
Exit
Alarm1 ON       Alarm2 ON
```

High or Low limit values

If High or `Low` limits are selected, the value entered in the `ALARM SETTINGS` menu must be in the range -9999 to +9999. This value is in the units previously selected (e.g. `gal/min`). The default value is +9999.

Volume limit values

If VOL limit is selected, the value entered in the `ALARM SETTINGS` menu must be in the range -3,999,999,999.99 to +3,999,999,999.99. This value will be in the units previous selected (e.g. `liters`, `m3`, `gals`) The default value should be +3,999,999,999.99.

Alarm Test

1. Select `Alarm Test` and press `ENTER` in the `Alarm1 MODE` menu to test that Alarm1 can be activated.

2. Select `Alarm Test` and press `ENTER` in the `Alarm2 MODE` menu to test that `Alarm2` can be activated.

Pulse Frequency

When `Frequency` is selected, a variable frequency pulse proportional to the flow rate can be output at the `ALARM 1` or `ALARM 2` outputs. When this feature is used, the `Max Pulse freq (Hz)` and `Flow at Max Frequency` must be set in the `FLOW READING OPTION` menu.

Resetting an alarm

When either Alarm1 or Alarm2 is activated, the appropriate relay will be held in the closed position until:

- The activation condition is removed, *or*
- The Alarm is reset.

Both Alarm1 and Alarm2 can be reset by using one of the following procedure:

1. Access the The ALARM SETTINGS menu by selecting Alarm Settings from the FLOW READING OPTION menu, and press ENTER.

2. The ALARM SETTINGS screen should be displayed, as shown below.

```
FLOW READING OPTION    DD-MM-YY   HH:MM:SS

 Data review
 Zero Cutoff (m/s)    :         0.010
 Set zero flow (m/s)  :         0.000
 Damping (secs)       :         10
 Totalizer            :         Run
 Reset +Total
```

```
 Reset -Total
 Calibration factor   :         1.000
 Roughness factor     :         0.010
 Alarm Settings       :
 Max Pulse Freq (Hz)  :         10.00
 Flow at Max Frequency :        200.00
 Calculated Pulse Value:        2.00
 Diagnostics
 Select Totals        :           +Total
 Exit
```

Alarm configuration

1. To reset Alarm 1, select Alarm1 Mode and press ENTER. This will access the ALARM1 MODE menu screen (shown below).

```
ALARM SETTINGS         DD-MM-YY   HH:MM:SS

Alarm1 Mode
Alarm1 Limit         :           <value>
Alarm2 Mode
Alarm2 Limit         :           <value>
Exit
Alarm1 ON        Alarm2 ON
```

2. Select Off from the menu and press ENTER.

3. This should de-activate the alarm.

   To re-arm the alarm you must ensure that the activation condition is removed and then reconfigure the Alarm Mode as described above on page 32.

```
ALARM1 MODE            DD-MM-YY   HH:MM:SS

Off
Low
High
Volume
On Flow Error
Alarm Test
```

```
Frequency
```

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3.5 How to Measure Totalized Flows (manually)

The basic measurement indicated on the FLOW READING screen is the instantaneous flow rate, which in some applications may vary over a period of time. Average flow rates are therefore often required in order to get a better understanding of an application's true performance. This is simply achieved by noting the total flow over a specific period (for example 30-60 minutes) and then calculating the average flow rate over that period of time.

1. Press the Options key to access the FLOW READING OPTION screen shown.

2. If the Totalizer is indicating Run, select it and change it to Stall. Press ENTER.

3. Select Reset +Total and press ENTER.

4. Press ENTER on the subsequent screen to accept the reset.

5. Press ENTER again to return to the FLOW READING OPTIONS menu.

6. Select Reset -Total and press ENTER.

7. Press ENTER on the subsequent screen to accept the reset.

8. Press ENTER again to return to the FLOW READING OPTIONS menu.

9. Note and record the current time.

10. Select Totalizer and change it to Run. Press ENTER.

```
FLOW READING OPTION    DD-MM-YY  HH:MM:SS

 Data review
 Zero Cutoff (m/s)     :         0.010
 Set zero flow (m/s)   :         0.000
 Damping (secs)        :         10
 Totalizer             :         Stall
 Reset +Total
```

```
FLOW READING OPTION    DD-MM-YY  HH:MM:SS

 Zero Cutoff (m/s)     :         0.00
 Set zero flow (m/s)   :         0.00
 Damping (secs)        :         10
 Totalizer             :         Run
 Reset +Total
 Reset -Total
```

Note: the totalizers begin to count up as soon as Totalizer *is set to* Run*.*

11. Scroll down and select Exit to return to the FLOW READING screen which will now indicate the instantaneous flow together with the totalized flow.

   Note that in some installations the measured flow can be in either direction. When this is the case, the upstream flow is shown separately in the -Total field.

```
FLOW READING           DD-MM-YY  HH:MM:SS
                                    Qxx.xx%
 Signal
 ◼◻        12.34           gal/min
   +Total: 300.0           gallons
   -Total: 0.00            gallons
```

Calculating the average flow

To calculate the average flow, wait for the allotted monitoring period to expire then divide the indicated total flow by the time taken. This will give you the average flow in m/s, galls/hour or whatever units you select.

Note that in a bi-directional flow situation you must calculate the difference between the indicated positive and negative flow totals before carrying out the average flow rate calculation.

How to stop the totalizer temporarily

If you want to stop the totalizer temporarily for operational reasons, set the Totalizer option to Stall in the FLOW READING OPTIONS screen as described above. This will stop the totalizer operation without affecting its current values.

3.6 Display of totalizers

1. To change the display of the totalizers, select the `Select Totals` menu item from the `FLOW READING OPTION` menu.

2. The display of the totals on the `FLOW READING` screen is controlled by this menu.

3. Select one, both or no totals to be displayed. The default is the display of `the +Total`.

4. Press the ENTER key.

```
FLOW READING OPTION    DD-MM-YY  HH:MM:SS

 Off
 Both
 +Total
 -Total

```

Note: This menu selection only affects the Display of the totalizer. Unless the totalizers are stalled, the recorded volume will still be incremented and the totals will be logged irrespective of the display setting.

3.7 Operation with an Energy Meter

The UFC can be operated with an energy meter which allows accumulated energy measurements to be made. In this configuration, one temperature sensor is fitted to the output pipe (hot side) and another to the return pipe (cold side). The temperature difference ($\Delta T = Thot - Tcold)$, measured by the energy meter, together with the pulse input from the UFC, allows the energy meter to calculate and display the accumulated energy absorbed by the heating system.

3.7.1 Pulse output

When working with an energy meter, the UFC normal pulse output is not used. Instead, a pulse whose frequency is proportional to the flow rate is independently generated and output on ALARM1 or ALARM2 outputs. This gives a more stable reading than the pulse 'packets' that would normally be produced.

3.7.2 Configuring the UFC

Configure the UFC frequency pulse output using the following procedure:

1. From the `FLOW READING` screen, press the `Options` key to select the `FLOW READING OPTIONS` menu, shown here.

   Note: You may need to enter the password first.

2. Scroll down to `Alarm Settings` and press `ENTER` to select the `ALARM SETTINGS` menu.

```
FLOW READING OPTION    DD-MM-YY  HH:MM:SS

 Data review
 Zero Cutoff (m/s)    :        0.010
 Set zero flow (m/s)  :        0.000
 Damping (secs)       :        10
 Totalizer            :        Run
 Reset +Total
```

```
 Reset -Total
 Calibration factor   :        1.000
 Roughness factor     :        0.010
 Alarm Settings       :
 Max Pulse Freq (Hz)  :        10.00
 Flow at Max Frequency :       200.00
 Calculated Pulse Value:       2.00
 Diagnostics
 Exit
```

3. Select `Alarm 1 Mode` and press `ENTER` to select the ALARM1 MODE menu shown below:

```
ALARM SETTINGS          DD-MM-YY  HH:MM:SS

Alarm1 Mode              Off
Alarm1 Level        :
Alarm2 Mode              Off
Alarm2 Level        :
Exit
```

4. Scroll down to `Frequency` and press `ENTER`.

5. This returns to the `ALARM SETTINGS` menu which will indicate `Frequency` on the `Alarm 1 Mode` field as shown below.

```
ALARM1 MODE             DD-MM-YY  HH:MM:SS

Off
Low
High
Volume
On Flow Error
Alarm Test

Frequency
```

6. Select `Exit` to return to the `FLOW READING OPTIONS` menu.

```
ALARM SETTINGS          DD-MM-YY  HH:MM:SS

Alarm1 Mode              Frequency
Alarm1 Level        :
Alarm2 Mode              Off
Alarm2 Level        :
Exit
```

7. Scroll down to select `Max Pulse Freq. (Hz)` and press `ENTER`.

8. Enter the required maximum pulse frequency, e.g. `10Hz` or `200Hz` and press `ENTER`.

9. Select `Flow at Max Frequency` and press `ENTER`.

10. Enter the maximum flow rate (in liters per second) corresponding to 10Hz (or 200Hz) and press `ENTER`.

11. The `Calculated Pulse Value` indicates the relationship between the frequency and the flow rate. This is a non-editable value.

12. Select `Exit` and press `ENTER` to return to the `FLOW READING` screen.
The message 'Frequency Pulse is ON' should now be displayed on the status line of the display (line 2).

```
FLOW READING OPTION   DD-MM-YY  HH:MM:SS

 Data review
 Zero Cutoff (m/s)     :        0.010
 Set zero flow (m/s)   :        0.000
 Damping (secs)        :        10
 Totalizer             :        Run
 Reset +Total

 Reset -Total
 Calibration factor    :        1.000
 Roughness factor      :        0.010
 Alarm Settings        :
 Max Pulse Freq (Hz)   :        10.00
 Flow at Max Frequency :        200.00
 Calculated Pulse Value:        20.0
 Diagnostics
 Exit
```

Note: ALARM 2 can be used instead of ALARM 1. The procedure is identical except that `Alarm 2 Mode` *is selected and the frequency pulse output is connected to ALARM2+ and ALARM2-.*

4: Data Logging

4.1 How to Set Up the Basic Logging Application to Memory

This procedure shows you how to set up a basic logging session under manual start/stop control.

Logged data is saved to the instrument's memory and can be down loaded to a PC at a later time. Both the flow rate and totals will be logged

Setting up and starting the logging

1. With the UFC operating in `FLOW READING` mode, check that the indicated flow units are the same as those you want to appear on the logger output (e.g. `l/min`).

2. Press the `Logger` function key to access the `REAL TIME LOGGER` screen.

3. Select `Logging interval` and enter the required period (e.g. `10 seconds`).

4. Select `Clear log` if you want to discard any existing logging data.

5. Select `START NOW`.

```
REAL TIME LOGGER
Logging to SD card
 Unit               : l/min
 Log name           : Quickstart
 Log data to        : USB
 Logging interval   : 10 seconds
 Start date & time  : dd-mm-yy hh:mm:ss
 Stop date & time   : dd-mm-yy hh:mm:ss

                      MM DD HH MM SS
 View log as text
 START NOW
 Set Auto start
 Clear log
 Exit
```

Monitoring the last four log events as a table

1. The `VIEW LOG AS TEXT` screen displays the log events in date-stamped chronological order.

2. Press the `ENTER` key to return to the `REAL TIME LOGGER` screen. Then select `Exit` to return to the `FLOW READING` screen. Logging will continue to take place in the background.

```
VIEW LOG AS TEXT
Logging to SD card
   Log:Quickstart         l/min
   Date       Time        Flow
   DD-MM-YY   hh:mm:ss    xxx.xx
   DD-MM-YY   hh:mm:ss    xxx.xx
   DD-MM-YY   hh:mm:ss    xxx.xx
   DD-MM-YY   hh:mm:ss    xxx.xx
```

Monitoring the logged events at a later time

If you wish to monitor the logging progress at any time while you are operating in `FLOW READING` mode, without interfering with the logging operation:

1. Press the `Logger` function key as described above to switch to the `REAL TIME LOGGER` screen.

2. Select `View log as text.`

```
REAL TIME LOGGER
Logging to SD card
 Unit                : l/min
 Log name            : Quickstart
 Log data to         : USB
 Logging interval    : 10 seconds
 Start date & time   : dd-mm-yy hh:mm:ss
 Stop date & time    : dd-mm-yy hh:mm:ss

 View log as text
 START NOW
 Set Auto start
 Clear log
 Exit
```

Key Point: To ensure that logging and flow readings continue under all circumstances, the display must be returned to the `FLOW READING` screen.

Stop logging

1. From the `FLOW READING` screen, press the `Logger` function key to access the `REAL TIME LOGGER` screen.

2. Select `STOP NOW` to cease logging. Note that the `START NOW` and `STOP NOW` options toggle depending on which was last selected.

3. Select `Exit` to return to the `FLOW READING` screen.

4. Note that the logged data will remain stored in the instrument's memory and can be accessed at a later time.

```
REAL TIME LOGGER
Logging to SD card
 Unit                : l/min
 Log name            : Quickstart
 Log data to         : USB
 Logging interval    : 10 seconds
 Start date & time   : dd-mm-yy hh:mm:ss
 Stop date & time    : dd-mm-yy hh:mm:ss

 View log as text
 STOP NOW
 Set Auto start
 Clear log
 Exit
```

4.2   How to Set Up Automatic (Timed) Logging Mode

This procedure shows you how to set up an auto logging session under timed start/stop control. The logged data is saved to the instrument's memory and can be downloaded at a later time.

Starting point

This procedure assumes that the instrument has been correctly installed and is operating in the `FLOW READING` mode. Also, that the instrument's date and time are set correctly.

Setting up, starting and cancelling auto logging

Key Point: When entering the Start and Stop times in this procedure, you must enter '00' in the seconds field rather than leave it blank, otherwise an error message is displayed.

1. With the UFC instrument operating in `FLOW READING` mode, check that the indicated flow units are the same as those you want to appear on the logger output (e.g. `l/min`).

2. Press the `Logger` function key to access the `REAL TIME LOGGER` screen.

3. Select `Logging interval` and enter the required period (e.g. `10 seconds`).

4. Select `Start date & time` and enter the date and time you wish logging to commence. Note this must be in the future.

5. Select `Stop date & time` and enter the date and time you wish logging to cease. Note this must be later than the start time.

```
REAL TIME LOGGER
Logging to SD card
 Unit               : l/min
 Log name           : Quickstart
 Log data to        : USB
 Logging interval   : 10 seconds
 Start date & time  : dd-mm-yy hh:mm:ss
 Stop date & time   : dd-mm-yy hh:mm:ss

 View log as text
 START NOW
 Set Auto start
 Clear log
 Exit
```

6. Select `Set Auto start`. This enables the auto logging application.

    If `Set Auto start` is enabled with valid start and stop times, this entry will change to `Cancel Auto start`.

7. To cancel the automatic logging session before it commences, click `Cancel Auto Start`.

8. Select `Exit` to return to the `FLOW READING` screen.

```
REAL TIME LOGGER
Logging to SD card
 Unit               : l/min
 Log name           : Quickstart
 Log data to        : USB
 Logging interval   : 10 seconds
 Start date & time  : dd-mm-yy hh:mm:ss
 Stop date & time   : dd-mm-yy hh:mm:ss

 View log as text
 START NOW
 Set Auto start
 Clear log
 Exit
```

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Monitoring the logged events

This is described in detail in Paragraph 4.1. If, while operating in `FLOW READING` mode, you wish to view the logging progress at any time without interfering with the logging operation:

1. Press the `Logger` function key as described above to access the `REAL TIME LOGGER` screen.

2. Select `View log as text` to display the last four entries in the log files.

Manually stopping an auto logging session

1. The logging session will stop automatically at the programmed `Stop date & time`.

2. If you wish to manually stop logging earlier than programmed, press the `Logger` function key to access the `REAL TIME LOGGER` screen then select `STOP NOW` to cease logging.

3. Select `Exit` to return to the `FLOW READING` screen.

   The logged data will remain stored in the instrument's memory and can be viewed at any time as described above.

```
REAL TIME LOGGER
Logging to SD card
 Unit              : l/min
 Log name          : Quickstart
 Log data to       : USB
 Logging interval  : 10 seconds
 Start date & time : dd-mm-yy hh:mm:ss
 Stop date & time  : dd-mm-yy hh:mm:ss

 View log as text
 STOP NOW
 Cancel Auto start
 Clear log
 Exit
```

4.3   How to Download Logged Data

All the logged data stored in the UFC instrument can be transferred to a USB memory stick. When a data transfer is performed, all the data files contained in the instrument will be transferred to the memory stick and then erased from the UFC internal memory.

The files created on the USB key have a file name that is the serial number of the instrument followed by a two digit file number. If the USB key has a file with the same name as the file on the SD card, then the data will be appended to the existing file, with a repeat of the header data.

This procedure describes how to download stored data.

Note: The USB key must be formatted as FAT32.

1. Insert the USB memory stick into the USB socket mounted on the lower left region of the UFC keypad.

   a) The message `Transferring to USB key` will be displayed on the UFC screen.
   b) The led on the USB key will flash as the data is transferred.

2. When the data transfer is completed the LED on the USB will extinguish and the message `Safe to remove USB key` will be displayed on the UFC screen.
   The logged data can be retrieved while data logging is active, but any samples that should have been taken, between inserting the USB key and the display of the "safe to remove USB key" message, will be lost. A new internal log file is started when transfer of data to the USB key is complete. A first sample is taken as soon as the file is created, and the time interval starts from this logged time.

   Key Point: If the USB memory stick has insufficient capacity to download all the files, the UFC will display an error message and no file transfer will take place.

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The downloaded CSV file format

The data download file is in a Comma Separated File (CSV) format that can be imported directly into a spreadsheet such as Microsoft® Excel®. Any loss of signal that is logged will be indicated in a status column and the flow value during the signal loss will be set to zero.

CSV File format

Product, Serial number, Control software revision, Flow code revision, FPGA code revision

Site name, Dimensions, Pipe OD, Pipe wall, Pipe lining, Pipe material, Lining material, Sensor type, Sensor mode, Fluid, Temperature °C, Temperature °F, Separation distance

Date, Time, Flow value, Units, +Total, -Total, Status

(The Status column is used to indicate if the flow meter cannot measure a valid flow reading).

Importing the log into Microsoft® Excel®

The .CSV file on the memory stick can be opened automatically in Microsoft® Excel® by double-clicking on the filename. If Excel® is not available, the file can be opened with a text file reader, or imported as a comma separated variable file into a spreadsheet program.

Microsoft® and Excel® is a registered trademark of Microsoft Corporation.

5: Maintenance & Repair

5.1   Introduction

This instrument does not contain any user-serviceable parts. The following notes are provided as a guide to general equipment

<table>
<tr>
<td>⚠️
WARNING</td>
<td>**Do not disassemble this unit.**
Return the unit to an approved service agent or place of purchase for further advice.</td>
</tr>
</table>

5.2   General care

The following notes are provided as a guide to general equipment care.

1. Ensure the unit is disconnected from the mains, then wipe the exterior of the instrument with a clean, damp cloth or paper towel. Do not use a solvent-based cleaning fluid on the instrument as it could damage the instrument surface.

2. Ensure all cables and connectors are kept clean and free from grease or contaminants. Connectors may be cleaned with a general purpose cleaner if necessary.

3. Avoid the use of excessive grease/ultrasonic couplant on the sensors as this may impair the performance of the equipment. Excessive grease/couplant can be removed from the sensors and transducer holders using an absorbent paper towel and a general purpose solvent cleaner.

4. We recommend that the ultrasonic couplant is replaced on the sensors every 6 months, especially on pipes where the application is too hot to touch. If the signal level drops below 30% this is also an indication that the sensors need re-greasing.

5. Regularly check all cables/parts for damage. Replacement parts are available from Dwyer.

6. Ensure the person who services your instrument is qualified to do so. If in doubt, return the instrument to Dwyer with a detailed report on the nature of any problem.

7. Ensure that suitable precautions are taken when using any materials to clean the instrument/sensors.

8. If the instrument was supplied with dust or dirt caps make sure they are re-fitted when the instrument is not in use.

5.3   Warranty / Return

Refer to "Terms and Condition of Sales" in our catalog and on our website. Contact Customer Service to receive a Return Goods Authorization number before shipping the product back for repair. Be sure to include a brief description of the problem plus any additional application notes,

6: Troubleshooting

6.1 Overview

If you have a problem with your flow monitoring system it can be due to any of the following:

Faulty instrument

Blank instrument display:

- Loss of power supply to the instrument.
- Internal power supply fuse ruptured.

Scrambled instrument display:

- Reboot the instrument by temporarily disconnecting its power supply.

Incorrect setup

A low, or zero, signal could be caused by incorrect set-up such as:

- Incorrect site data entered into the instrument.
- Incorrect or non-matching ultrasonic transducers selected for use.
- Incorrectly fitted transducers – lack of couplant applied, incorrect spacing, insecure attachment.
- Poor connections between the probes and the instrument.

Application problem

If you are certain that the instrument is healthy and suitably set-up for the current site; and the probes are properly assembled and fitted correctly, there could be an application problem concerned with the site.

Check such conditions such as:

Poor pipe outer surface quality
- Uneven surface preventing good surface contact with the transducer.
- Flaking paint (should be removed).
- Variable air gap in concrete-covered pipes affecting the ultrasonic signal quality.

Poor internal pipe construction
- Rough internal pipe walls affecting fluid flow (see roughness factor).
- Internal welds positioned in the transducer signal path affecting the signal quality.
- The 'drippings' in galvanized-dipped pipes or other irregularities interfering with the signal path.

Incorrect probe location
- Transducers located too close to bends or valves, disturbing the flow profile.
- Transducers located too close to insertion probes, disturbing the flow profile.
- For horizontal pipework, transducers should not be positioned on the top of the pipe.

Poor fluid conditions within the pipe
- Fluid contains bubbles, high particle density or sludge.
- Air in the top of the pipe.

Low fluid flow within the pipe
- Pipe obstructions.
- Malfunctioning valve not opening fully (or closed inadvertently).

Liquid content problems
- Multiple liquid contents do not comply accurately to expected sound speed criteria.

- Very hot pipe almost turns water to steam and therefore exhibits the wrong speed characteristics –could be due to reduced pipe pressure.
- Flashover – liquid turns into a gas because of lower than required pressure.
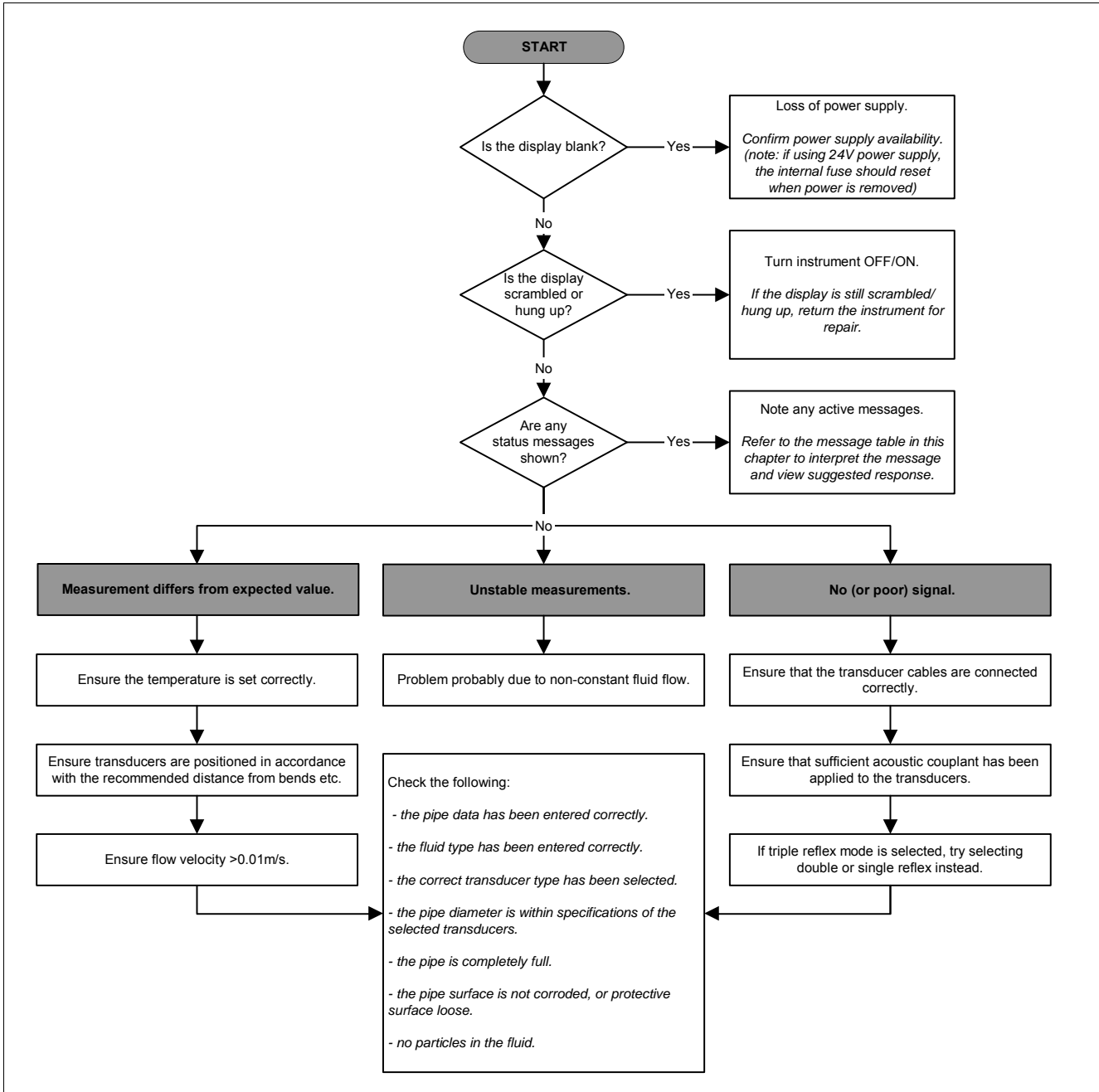
6.2 General Troubleshooting Procedure

Figure 6.1 **Troubleshooting chart**

6.3   Warning and Status Messages

FLOW RATE ERRORS	
ERR:No flow signal	**Interpretation:** This message appears when the transducers cannot send or receive signals to each other. **Response:** Check that all cables are connected, transducers are on the pipe correctly with sufficient couplant on the face. This condition could also be due to a partially empty pipe, aerated liquid, particulate content too high or when the condition of the pipe being measured is poor.
Flow signal is poor	**Interpretation:** This warning appears when the signal is lower than 25%. **Response:** This could be due to an application problem, a poor quality pipe – see also the conditions for No flow signal (above). Check for sufficient couplant.
ERR:Zero cut-off!	**Interpretation:** You have entered an out-of-range value in the Zero cutoff field in the Options menu. **Response:** Enter a valid number.
Totalizer beyond maximum!	**Interpretation:** The totalizer has overflowed its maximum count. The counter will roll-over and restart from zero but this message alerts you to the fact. **Response:** Reset the totalizer as described in Paragraph 3.5.
PULSE ERRORS	
ERR:Pulse output!	**Interpretation:** The flow rate exceeds the capability of the pulse output – i.e. too many pulses per second are required than can be achieved. **Response:** Narrow the pulse width time or increase the volume per pulse, as described in Paragraph 3.4.2.
ERR:Pulse volume!	**Interpretation:** You have entered an out-of-range value in the Pulse volume error field in the PULSE OUTPUT menu – see Paragraph 3.4.2. **Response:** Enter a valid number.
ERR:Pulse width!	**Interpretation:** You have entered an out-of-range value in the Pulse width error field in the PULSE OUTPUT menu – see Paragraph 3.4.2. **Response:** Enter a valid number.

4-20mA ERRORS	
`Calibration 20mA Error!`	NOTE: The 4 to 20 mA output is calibrated before the instrument leaves the factory and should not require further adjustment. *Interpretation:* You have adjusted the DAC outside its accepted range when calibrating the 20 mA signal output. *Response:* Re-calibrate the 4 to 20 mA output – see Paragraph 3.4.1.
`Calibration 4mA Error!`	NOTE: The 4 to 20 mA output is calibrated before the instrument leaves the factory and should not require further adjustment. *Interpretation:* You have adjusted the DAC outside its accepted range when calibrating the 4 mA signal output. *Response:* Re-calibrate the 4 to 20 mA output – see Paragraph 3.4.1.
SET-UP ERRORS	
`ERR:Pipe OD range!`	*Interpretation:* You have entered an out-of-range value for the pipe outside diameter dimension – i.e. larger or smaller than the unit or sensor can be used on. *Response:* Enter a valid number.
`ERR:Wall thk. range!`	*Interpretation:* You have entered an out-of-range value for the pipe wall thickness dimension – accepted range is 0.04 to 3 inches (1 to 75 mm). *Response:* Enter a valid number.
`ERR:Lining thick. range!`	*Interpretation:* You have entered an out-of-range value for the lining thickness dimension – acceptable range is 0 to 1 inch (0 to 25 mm). *Response:* Enter a valid number.
`ERR:Temperature range!`	*Interpretation:* You have entered an out-of-range value for the fluid temperature. Accepted temperature range -4°F to +392°F (-20°C to +200°C). *Response:* Enter a valid number.
`ERR:Invalid Date or Time!`	*Interpretation:* The entered Date or Time is invalid, or when setting up 'timed' data logging the Stop time is set earlier than the Start time. *Response:* Enter a valid Date and Time.
`ERR:Invalid Sensor or Mode`	*Interpretation:* The selected temperature is higher than the maximum allowed for the sensor type. *Response:* Change the temperature.
`Mode: Err Type`	*Interpretation:* The selected sensors are invalid and the mode cannot be verified. *Response:* Choose a mode that gives a non-zero separation distance.

DATA LOGGING ERRORS	
`Low Memory on USB key`	***Interpretation:*** There may not be room on the USB key for the logged data. ***Response:*** Remove the USB key and replace with one that has sufficient free capacity.
`Low Memory on SD Card`	***Interpretation:*** The internal SD memory card is 80% full – note that this represents at least 4 years of data collected. ***Response:*** Download the data.
`Approaching File Limit`	***Interpretation:*** There are more than 80 files on the internal SD memory card that are waiting to be downloaded. ***Response:*** Download the data files to free-up the file space.

6.4   Diagnostics Display

This feature is designed for advanced users and is intended to provide information that will aid the user to diagnose problems – e.g. no signal strength.

When operating in the `FLOW READING` mode you can access a diagnostics screen by pressing the `Options` function key and then selecting `Diagnostics` from the `FLOW READING OPTIONS` screen. This will display the operating values for the following parameters.

Calculated time (µs)

This is a value the instrument predicts will be the time in µsecs that it should take for the acoustic wave to propagate across a particular pipe size. This value is ascertained from the data entered by the user. i.e. Pipe size, material, sensor set etc.

Actual time (µs)

This is the value the instrument measures as the time taken for the acoustic wave to propagate across the pipe. It is used to see if the signal is being taken from the burst, at the correct time to get the strongest signal. This value is normally a few µs below the calculated µs value. If, however, this value is much greater than the calculated time, there is a problem with the set-up.

Flow (m/s)

This displays flow velocity in m/s to 3 decimal places.

Signal strength

This is the averaged value of Signal and should be a value between 800 and 1600 – where 800 is approximately 50%, and 1600 is approximately 100%.

Gain

Gain values are typically in the range 600 to 850.

Switches

Typical Switches values are `None` and `*10`. On small pipes (and when using the test block) the value should be `None`. A Switch value of *100 indicates poor sensor set-up or poor connections.

UP/DN time difference

The difference in transit times between the upstream and downstream signals due to the fluid flow.

Fluid propagation rate

This is the sound speed of the fluid calculated using the data entered by the user.

Sensor separation

The same value as displayed in the setup screen.

7: Options

7.1   Large Pipe Diameter Transducers

Type 'D' transducers are available for use with pipe diameters in the range 59 to 197 inches (1500 to 5000 mm), operating over the temperature range -4°F to +176°F (-20°C to +80°C). The type 'D' transducer kit is supplied in a separate case and includes the sensors together with ratchet straps and transducer holders for attaching to the pipe.

7.2   Transducer Holder Options

The standard method of securing the transducer holder to the pipe is by stainless steel banding. However, optional end plates are available to allow fixing by chain.

7.3   Extended Signal Cable Options

Standard transducer cables are 16.5 ft. (5 m) in length with 33 ft. (10 m) cables being optionally available. Where, for operational reasons, it is not possible to mount the instrument this close to the sensors, bespoke cables of up to 328 ft. (100 m) can be provided. Consult Dwyer for further information and availability.

8: Specification

GENERAL	
DSP Measurement Technique:	Transit time.
Timing Resolution:	50 pico-second, continuous signal level indication on display.
Flow Velocity Range:	Minimum Velocity 0.33 ft/s; Max Velocity 33 ft/s: Bi-directional.
Turn Down Ratio:	200:1
Accuracy:	±0.5% to ±2% of flow reading for flow rates >0.66 ft/s and Pipe OD >3.0 in (75 mm). ±3% of flow reading for flow rates >0.66 ft/s and Pipe OD in range 0.5 to 3.0 in (13 to 75 mm). ±6% of flow reading for flow rates <0.66 ft/s.
Repeatability:	±0.5% of measured value or ±0.66 ft/s whichever is the greater.
Reynolds Number Correction:	Flow velocity corrected for Reynolds number over entire velocity range.
Response Time:	< 500 ms depending on pipe diameter.
Selectable Flow Units:	VELOCITY: m/sec, ft/sec. VOLUME: L/s, L/min, L/h, gal/s gal/min, gal/h, USgals/s, USgals/min, USgals/h, Barrel/h, Barrel/day, m³/s, m³/min, m³/h.
Selectable Volume Units:	US gallons, gallons, barrels (oil), liters, m³.
Total Volume:	12 Digits - forward and reverse.
APPLICABLE FLUID TYPES	
Fluid Condition:	Clean liquids or oils that have less than 3% by volume of particulate content. Applications include river water, sea water, potable water, demineralized water, glycol/water mix, hydraulic systems and diesel oil.
APPLICABLE PIPE TYPES	
Pipe Materials:	Any sonic conducting medium such as Carbon Steel, Stainless Steel, Copper, UPVC, PVDF, Concrete, Galvanized Steel, Mild Steel, Glass, Brass. Including Lined Pipes - Epoxy, Rubber, Steel, Plastic.
Pipe Dimension (outside diameter):	Min 0.5 inch (13 mm); Max 197 inches (5000 mm) with D sensor set.
Pipe Wall Thickness:	0.04 to 3.0 inches (1 to 75 mm).
Pipe Lining:	Applicable pipe linings include Rubber, Glass, Concrete, Epoxy, Steel.
Pipe Lining Thickness:	0.0 to 1.0 inches (0 to 25 mm).
Pipe Wall Temperature Range:	Standard sensor operating temperature is -4°F to +275°F (-20°C to +135°C).

TRANSDUCER SETS	
Standard:	Temperature Range -4°F to +275°F (-20°C to +135°C). 'A-ST' (standard) 0.5 to 4.5 inches (13 to 115 mm) pipe OD (2 MHz). 'B-ST' (standard) 2 to 79 inches (50 to 2000 mm) pipe OD (1 MHz). Protection: IP54.
Optional:	'D' 59 to 197 inch (1500 to 5000 mm) pipe OD (0.5 MHz), with an operating temperature range of -4°F to +176°F (-20°C to +80°C).
LANGUAGES	
Standard Supported Languages:	English, French, German, Italian, Spanish, Portuguese, Russian, Norwegian, Dutch, Swedish.
DATA LOGGER	
Data Logged:	All measurement parameters and flow readings, and both Totalized values.
Log Capacity:	The internal SD card can store more than 4 years of data at the fastest logging rate.
Time Stamping:	All data points are date and time stamped.
Number of Sites:	1 non-editable site plus 1 editable site.
Logging Interval:	User programmable, 5 seconds to 1 hour.
Logged Data Transfer:	Logged data can be transferred to a USB memory stick.
OUTPUTS	

Current Output:
    No. Channels
    Format:
    Resolution:
    Error Currents:
    Isolation:
    Maximum Load:
	
	1
	4 to 20 mA, 0 to 20 mA, 0 to 16 mA.
	0.1% of full scale.
	Any between 0 to 26 mA.
	1000 V Opto-isolated from unit.
	620 Ohms.

Pulse Output TTL:
    Number Available:
    Isolation:
    Pulse Repetition Rate:
    Pulse Width:
    Max Current:
    Max Voltage:
	
	1 – Opto-isolated MOSFET relay.
	1500 V opto isolated from unit.
	User programmable from 1 to 250 pps.
	User programmable from 2 ms to 500 ms.
	500 mA.
	48V.

Alarms:
    Number of Channels Available:
    Isolation:
    Relay Contact Mode:
 	
    Alarm Functions:
 	
    Frequency output:
    Max Current:
    Max Voltage:
	
	2 off opto-isolated MOSFET relay.
	1500 V opto isolated from unit.
	N/O when switching condition is False.
	Closed when switching condition is True.
	The two relays can be configured to operate when:
	• a predefined MINimum or MAXimum flow rate is exceeded.
	• a specified VOLume is measured.
	• a signal Error condition occurs.
	• manual alarm test.
	• pulse frequency.
	Maximum 200 Hz.
	500 mA.
	48V.

ELECTRICAL	
Supply Voltage:	
Mains Input Voltage:	86 to 264 Vac.
Mains Input Frequency:	47 to 63 Hz.
Power Consumption:	10.5 W.
Alternative Input Supply:	24 V(ac/dc), 1 A max. (The 24 Vac supply must be isolated from earth.)

MECHANICAL	
Enclosure:	
Material:	ABS and aluminium.
Dimensions:	9 x 7 x 4.7 inches.
Weight:	2.65 lb.
Protection:	IP65.
Fixing:	Wall mountable.
Keypad:	
No. Keys:	15 key tactile feedback membrane keypad.
Display:	
Format:	240 x 64 pixel graphic display, high contrast black-on-white, with backlight.
Viewing Angle:	Min 30°, typically 40°.
Active Area:	5.0 in (W) x 1.3 in (H).
Overlay:	Standard English, Optional overlays available.
ENVIRONMENTAL	
Operating Temperature:	-4°F to +122°F (-20°C to +50°C).
Storage Temperature:	-13°F to +167°F (-25° to +75°C).
Operating Humidity:	90% RH MAX at +122°F.
APPROVALS	
Safety:	BS EN 61010-1:2001.
EMC:	BS EN 61326 - 1:2006, BS EN 61326-2-3:2006.
Environmental:	BS EN 60068-1:1995, BS EN 60068-2-1:2007, BS EN 60068-2-2:2007.

SHIPPING INFORMATION	
Box Dimensions:	18.9 in x 12.6 in x 6in.
Weight:	9.9 lb.
Volumetric Weight:	8.4 lb.

Dwyer reserve the right to alter any specification without notification.