



Series PUF Portable 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 PUF portable 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 PUF is controlled by a micro-processor system which contains a wide range of data that enables it to be used with pipes with an outside diameter ranging from 0.5 to 197 inches (13 to 5000 mm) and constructed of almost any material. The instrument will also operate over a wide range of fluid temperatures.

Easy to operate, the PUF standard features are:

- Large, easy to read graphic display with backlighting.
- Simple to follow dual function keypad.
- Simple 'Quick Start' set up procedure.
- 98k stored data points.
- Continuous signal monitoring.
- RS232 output.
- USB output.
- Pulse output (volumetric or frequency).
- 4 to 20 mA, 0 to 20 mA, or 0 to 16 mA output.
- Rechargeable battery.
- Battery management.
- Diagnostics.

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.

Typical PUF applications include:

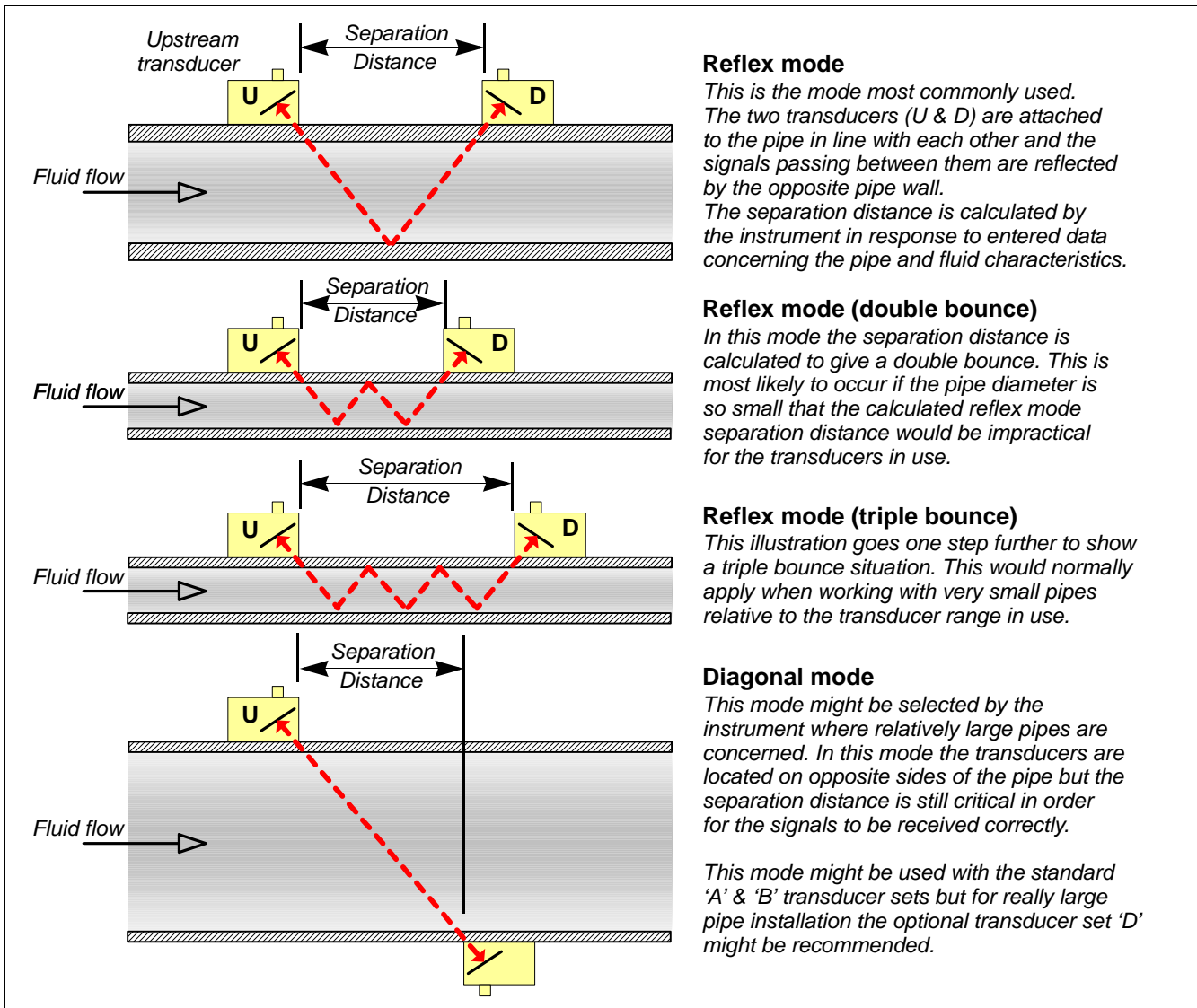
- River water.
- Seawater.
- Potable water.
- Demineralized water.
- Treated water.



1.2 Principles of Operation

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 PUF 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 PUF 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 PUF 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 below illustrates the importance of applying the correct separation distance between the transducers to obtain the strongest signal.



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

Figure 1.1 Operating modes

1.3 Supplied Hardware

The PUF equipment is supplied in a rugged IP67 carrying case fitted with a foam insert to give added protection for transportation. The supplied components are shown in Figure 1.2.



Figure 1.2 Standard PUF equipment

Standard equipment

- PUF instrument with backlit graphic display.
- Power supply - with UK, US, European adaptors. 110/240VAC.
- 4 to 20 mA/Pulse Output cable, USB cable and RS232-C cable.
- 2 lengths of chain each at 130 inches (3.3 m) long.
- Test block.
- Transducer cables (x2) 79 inches (2 m) long.
- Transducer set 'A' (Transducers x2).
- Transducer set 'B' (Transducers x2).
- Set of transducer holders for use with 'A' or 'B' transducers.
- Ruled separation bar (2-piece).
- Ultrasonic couplant.
- Manual.

Optional equipment

- Transducer set 'D' – used for monitoring pipes of 50 to 197 inches (1.27 to 5 m) diameter, over a temperature range of -4°F to +176°F (-20°C to +80°C). Kit is supplied in a separate case and includes the sensors together with ratchet straps and transducer holders for attaching to the pipe.



1: General Description

1.4 PUF Instrument

The PUF 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 values, or act as a data logger. When operating in the data logger mode, the logged data can be output directly to a PC or printer using the RS232/USB interface or stored in the instrument's non-volatile memory for downloading at a later time. Up to 98k logging events can be stored internally.

The instrument can also provide a variable current or 'pulse' (volumetric or frequency) output that is proportional to the detected flow rate. These outputs, which can be used with a range of external interface devices such as those found in building management or site monitoring systems, can be calibrated to suit a particular flow range.

1.4.1 Connectors



Figure 1.3 Instrument details

Transducer connections

The transducers are connected to two color-coded miniature coaxial sockets located on the top of the instrument. Using the red/blue connector cables provided, the upstream transducer should always be connected to the RED socket and the downstream transducer to the BLUE one for a positive flow reading. It is safe to connect or disconnect the cable while the instrument is switched on.

RS232 and USB connections

RS232 and USB cables are included as part of the PUF kit. These can be connected to the yellow 8-pin connector on the top of the flowmeter as shown in Figure 1.3. The RS232 cable is terminated with a 9-pin 'D-type' connector.

4 to 20 mA and Pulse output connection

The 4 to 20 mA / 'pulse' output cable should be connected to the green 7-pin connector on the top of the flowmeter, as shown in Figure 1.3. A single cable that can be adapted for use for either of these output functions is included in the PUF kit. The 'tails' on the free end of the cable must be terminated to suit the intended application.

- Red – 4 to 20 mA positive
- White – Pulse output
- Thick Black – Cable screen

- Black – 4 to 20 mA negative
- Green – Pulse return



Battery charger connection

The supplied battery charger is connected to the instrument by means of the gray 2-pin connector on the bottom of the unit, as shown in Figure 1.3.

Note: The above connectors have different key-ways to prevent incorrect cable connection.

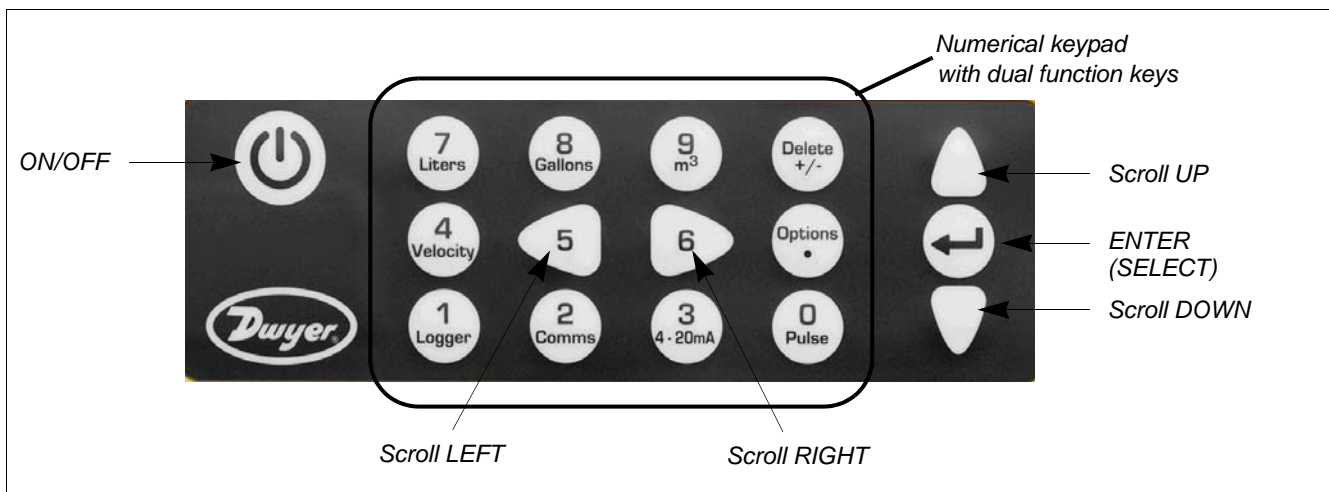


Figure 1.4 Keypad

1.4.2 Keypad

The instrument is configured and controlled via a 16-key tactile membrane keypad, as shown in Figure 1.4.

ON/OFF Key

The ON/OFF key is shown on the top left of the keypad. When turned ON an initialization screen is displayed on the LCD showing the instrument's serial number and software revision. Once this appears, the instrument can be started by pressing the ENTER key once – the initialization screen is then replaced by a MAIN MENU which provides access to the remaining functions.

Menus and the menu selection keys

The PUF menus are arranged hierarchally with the MAIN MENU being at the top level. Menu navigation is achieved by three keys 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 it usually results in taking 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 and battery charging

Operating power is provided by an internal battery that can be charged from the utility supply using the supplied external charger. When you first receive the unit you must put the battery on charge for a minimum of 6.5hrs before use. A fully charged battery will power the instrument for up to 20hrs depending on the output utilization and backlight usage.

The backlight can be selected to be either permanently OFF, illuminated for 10 seconds, 30 seconds or 1 minute every time a key is pressed, or permanently ON – as configured in the *Setup Instrument* menu. If the backlight is active continuously it will reduce the available battery operating time to 8hrs. Similarly, if the 4 to 20 mA output is used constantly at 20 mA, the battery life would reduce by 50%. It is therefore beneficial to turn off the backlight and 4 to 20 mA output facilities when they are not required.

When the instrument is operating in the 'Flow Reading' mode, the percentage battery charge level is displayed symbolically on the LCD screen. A warning message is triggered if the charge falls to approximately 30%, at which point there is up to four hours of battery operation remaining, depending on usage. The battery can be charged both while the instrument is in use or when switched off. The instrument's internal data is stored in non-volatile memory and will not be lost even if the battery discharges completely.



Key Point: The battery is not a user-changeable item. The instrument must be returned to your distributor if the battery needs replacing.



Key Point: Only use the supplied charger, or special adaptor lead. Failure to comply with this will invalidate your warranty.

1.5 Transducers

Two sets of ultrasonic transducers are provided as standard. When setting up the instrument it will indicate the appropriate transducer set to use for a particular application, depending on data entered by the user. Default pipe ranges are programmed into the instrument and most of the time there will be no need to use an alternative transducer set to the one suggested by the instrument. However, if circumstances dictate that a different set must be used, it is possible to manually program the instrument to accept the alternative set.



Key Point: Each transducer set has its designed working parameters and there are limitations as to how far these can be extended in the field without degrading the instrument's sensitivity and accuracy. Contact Dwyer for advice if needed.

Transducer set 'A'

Supplied as standard for use on pipes of 0.5 to 4.5 inches (2 to 115 mm) outside diameter.

Transducer set 'B'

Supplied as standard for use on pipes 2 to 79 inches (50 to 2000 mm) outside diameter.

Transducer set 'D'

Type 'D' transducers are optional equipment that can be used by the PUF on pipes from 59 to 197 inches (1500 to 5000 mm). They are supplied complete with ratchet straps for 'diagonal mode' attachment.

2: Installation

2.1 Transducer Positioning

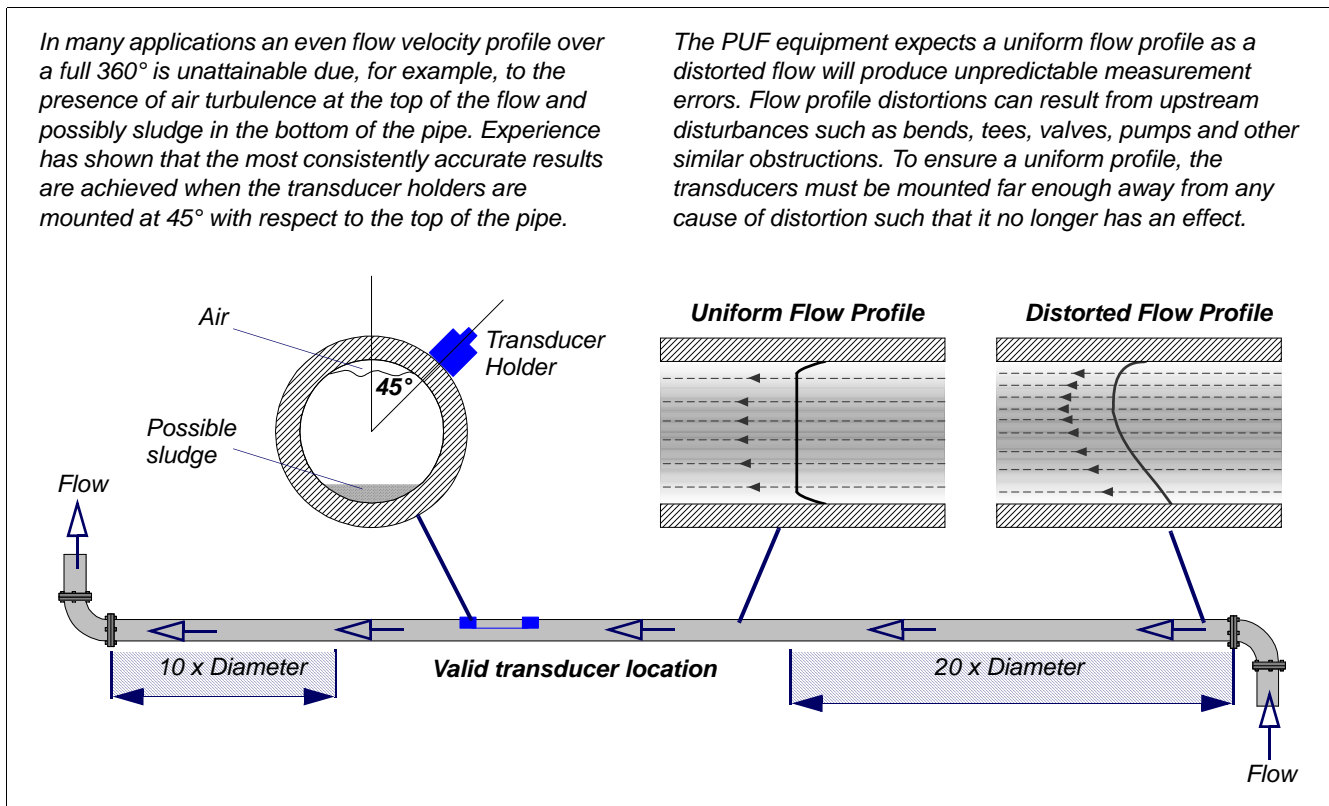


Figure 2.1 Locating the transducers

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 2.1. 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.

2.2 Transducer Attachment (Type 'A' & 'B')

Type 'A' & 'B' transducers are fitted to adjustable holders which are secured to the pipe using wrap-around chains and mechanically connected together by a steel separation bar. The separation bar also acts as a ruler to allow the distance between the transducers to be accurately set to the value determined by the PUF instrument.

When fitting the transducer holders it is easiest to assemble them onto the separation bar and adjust to the required separation distance before attaching them to the pipe.

2.2.1 Preparation

1. Before you attach the transducers you should first ensure that the proposed location satisfies the distance requirements shown in Figure 2.1, otherwise the resulting accuracy of the flow readings may be affected.
2. 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 pipe surface and the face of the transducers is an important factor in achieving a good ultrasound signal strength and therefore maximum accuracy.

2.2.2 Attaching the transducer holders

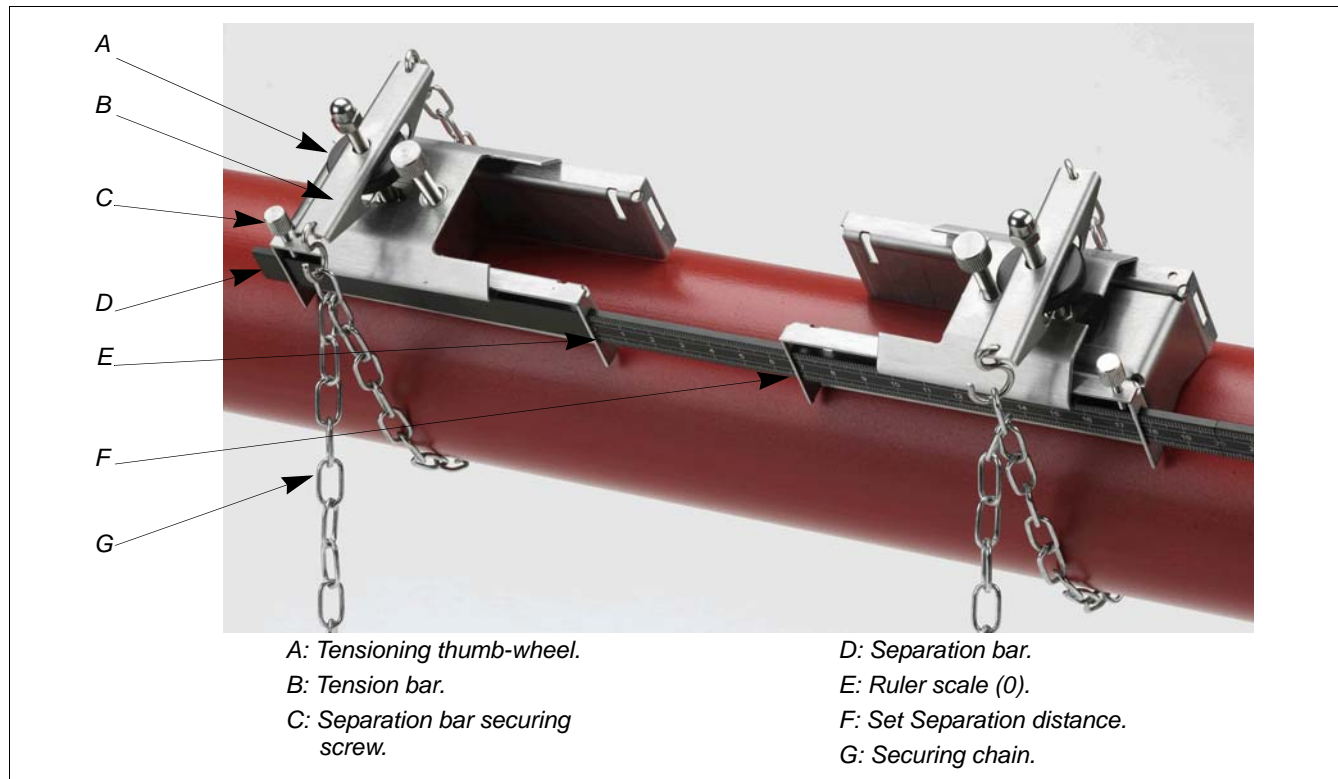


Figure 2.2 Transducer holders attachment

1. Slide the separation bar (D) into the front of the left hand holder, align the front edge of the holder with '0' on the ruler scale (E) and secure it in place by tightening the thumbscrew (C).
2. Slide the other end of the separation bar into the front of the right hand holder, align the front edge of the holder to the required separation distance (obtained from the PUF instrument) on the ruler (F), then secure it in place by tightening the thumbscrew.

3. On each holder, attach one end of a securing chain to a hook on the tensioning bar (B), wrap the chain around the pipe (G) and then attach it to the hook on the other end of the tensioning bar while keeping the chain as tight as possible.
4. Rotate the complete transducer holder assembly so that it is approximately 45° with respect to the top of the pipe. Then tighten the chain by turning the tensioning thumb-wheel (A) on each holder until the assembly is securely attached to the pipe.

Note: If you are unable to get sufficient tension on the chain to hold the assembly in place, fully slacken the tensioning thumb-wheel and shorten the effective length of the chain wrapped around the pipe by connecting the tensioning bar to the next link in the chain, then re-tension.

2.2.3 Fitting the transducers

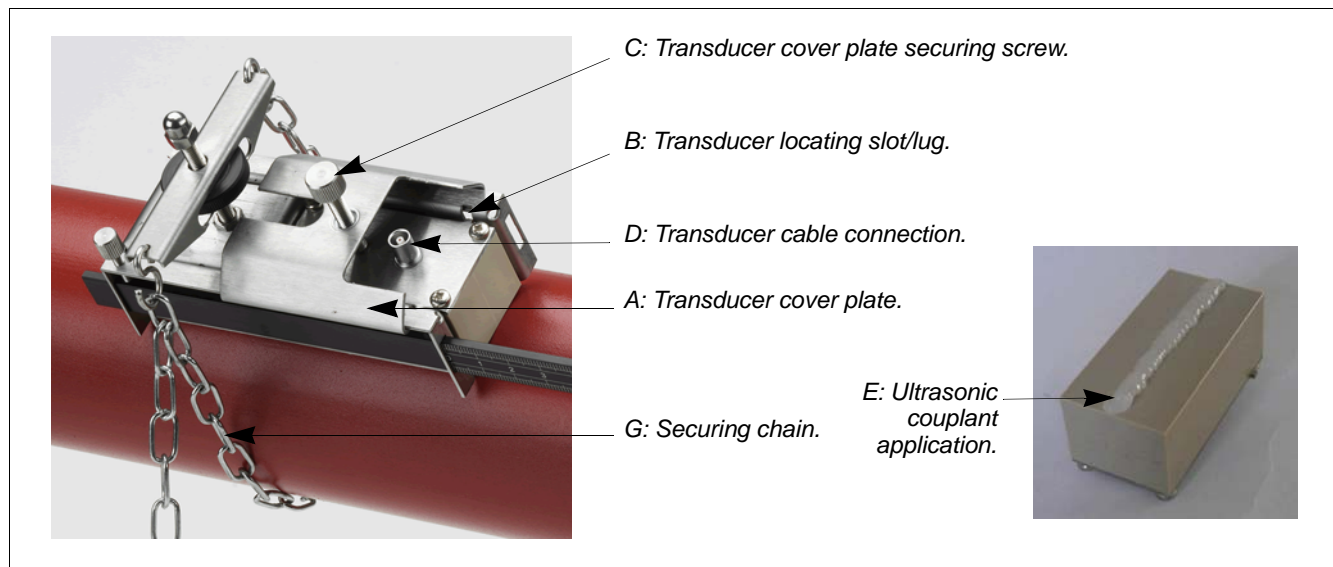


Figure 2.3 Fitting the transducers

1. Slide the transducer cover plate (A) fully towards the outside of the holder assembly to allow sufficient access to fit the transducer.
2. Clean the face of the transducer, removing all traces of dirt and grease.
3. Apply a 1/8" bead of ultrasonic couplant along the center length of the transducer (E).
4. Fit the transducer into the holder – ensuring the lugs on the sides of the transducer are correctly located into the slots on the sides of the transducer holder (B).
5. Slide the transducer cover plate (A) over the top of the transducer and tighten the thumbscrew (C) finger tight to secure the transducer in place. When securing the cover plate take care to leave sufficient room around the transducer connector (D) to connect the cable.
6. Repeat the above steps for the second transducer.
7. Connect the transducers to the PUF instrument using the coaxial cables provided. The RED cable must be connected to the upstream transducer and the BLUE cable to the downstream transducer. If you observe a negative flow, swap the red and blue cables at the sensor end.



2.3 Installing the USB Virtual Com. Port

If you have the CD supplied with the instrument, the USB drivers are included. Refer to the installation instructions for Portagraph III on the CD.

If you do not have the CD, follow the instructions below.

The USB connection requires a virtual com port to be installed on the computer. The necessary driver can be provided by Dwyer or downloaded from <http://www.ftdichip.com/Drivers/VCP.htm>.

1. Access the above url and download the driver for your particular operating system. The download takes the form of a zip file.
2. Extract all the files from the zip file into a folder and note its location (e.g. Desktop\USBDriver).
3. Switch ON the PUF instrument and connect it to the USB port on the PC.
4. A “New device found” message will appear and ask you for the location of the software installation files for the new device.
5. Use the Browse button to select the path to the unzipped driver files and then click OK.
6. Follow the on-screen instructions to install the driver.
7. At the end of the driver installation routine you must carry out a minor configuration change to the newly installed virtual com port. The way in which you gain access to the com port set-up window will vary depending on your operating system. The following example applies to Windows XP.
8. Select Control Panel>System to open the SYSTEM PROPERTIES window.
9. Click the Device Manager button to open the DEVICE MANAGER window.
10. Scroll down to the Ports region and you will find the new FDTI port installed (e.g. USB Serial Port with a high port number).
11. Right-click on the com port and select Properties.
12. From the PROPERTIES window select the Port Settings tab then click the Advanced button. The ADVANCED SETTINGS window should open similar to that shown in Figure 2.4.
13. In the BM Options area change the Latency Timer value from 16 msec (default) to 1 msec.
14. Select OK to implement the change, and then close the remaining windows that were opened.
15. Your computer should now be able to communicate with the PUF instrument via the USB port in the same way as any other standard USB device.

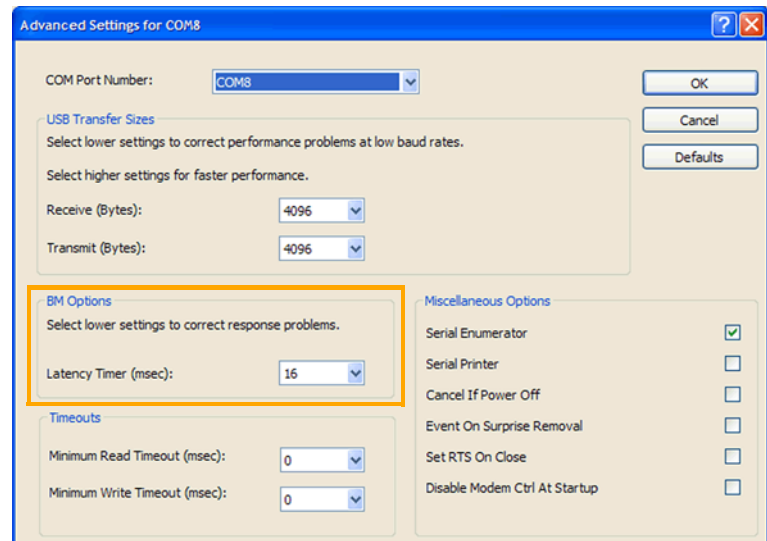
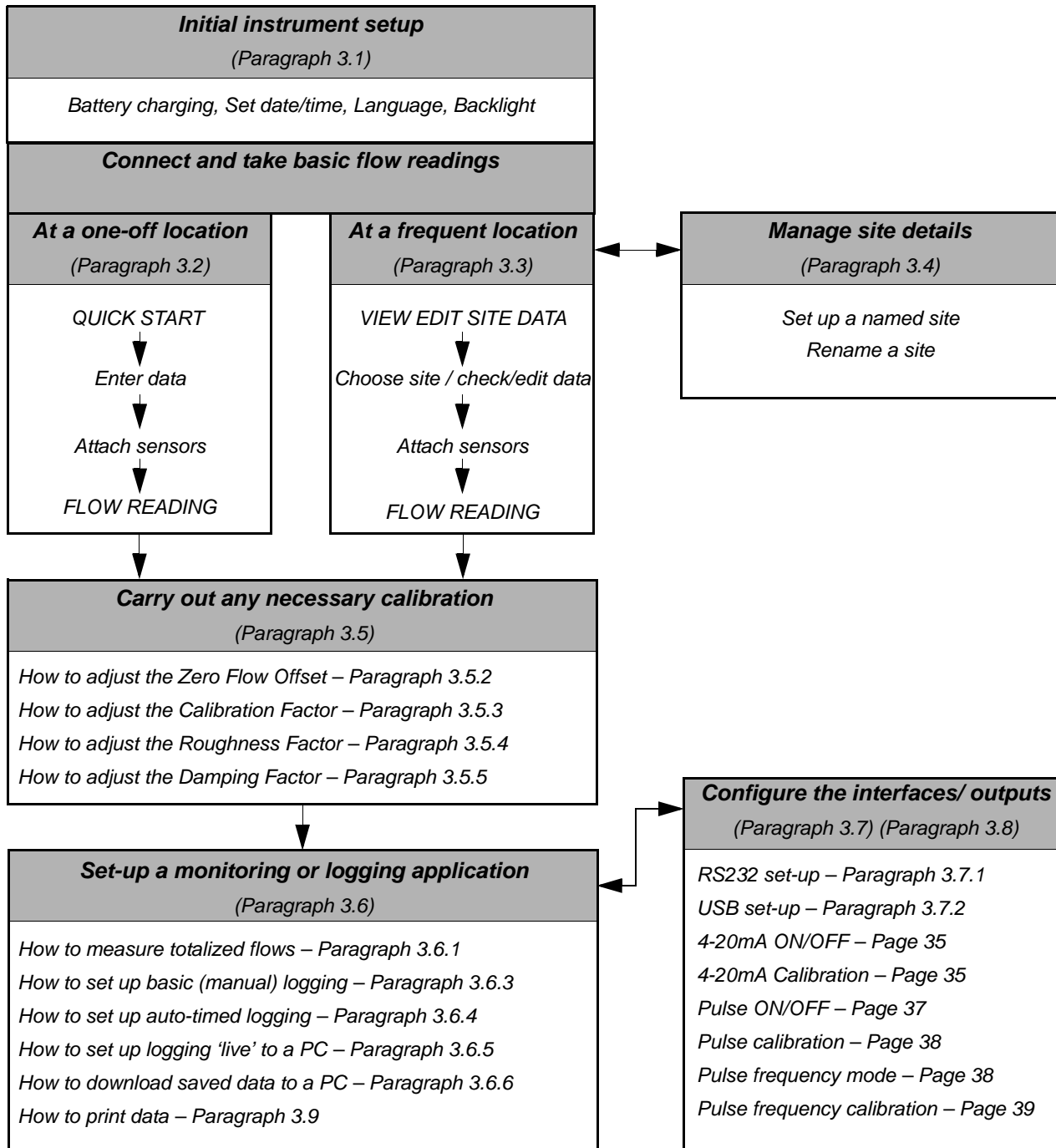


Figure 2.4 Com. Port configuration



3: Operating Procedures





3.1 Setting-up the Instrument

3.1.1 Using the instrument for the first time

Before you use your PUF for the first time you should first charge the battery, then select the display language and set-up the internal clock, as described below.

Charging the battery

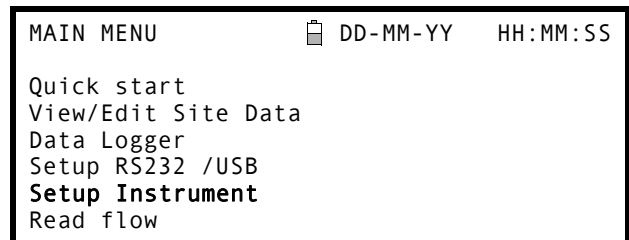
1. Connect the external battery charger to the charger socket at the bottom of the instrument then switch on the utility supply.
2. The instrument should indicate CHARGING and an animated battery symbol indicates that the battery is taking on charge.
3. Leave the instrument on charge for 6.5 hours before using it for the first time.



Selecting a language

The first time you switch on the instrument you may be asked to select a user language.

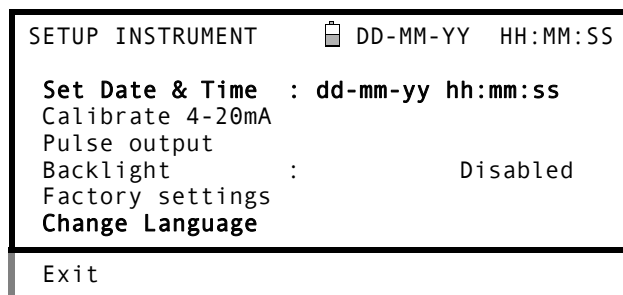
1. Switch on the instrument by pressing the ON/OFF button.
2. If necessary, select the required language using the UP/DOWN scroll keys then press the ENTER key.
3. The selected language will be the default when the instrument is next used. To change the language again select the Change Language option in the SETUP INSTRUMENT screen (see below).
4. The initialization screen will be displayed, giving details of the instrument's serial number and software revision details.
5. Press the ENTER key to start the instrument.
6. This is the MAIN MENU and is the starting point for all the operations described in this chapter.





Setting the Date & Time

1. Select **Setup Instrument** from the **MAIN MENU**. The screen shown here should be displayed.
2. Select **Set Date & Time** and press the **ENTER** key.
3. A flashing cursor should appear under the first date number. Enter the date sequence in dd-mm-yy order then press the **ENTER** key.
4. Repeat this action to set the time.
5. Select **Exit** then press the **ENTER** key to return to the **MAIN MENU**.

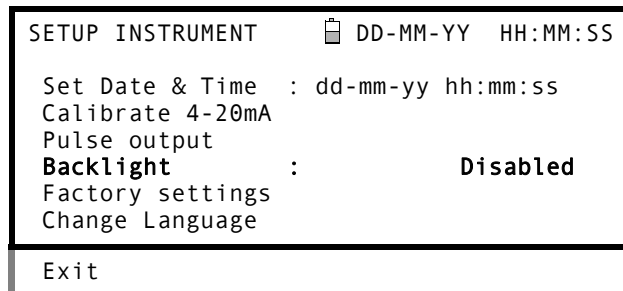


Note: If you make a mistake when entering the data press the **Delete** key to move the cursor back to the number you wish to change, then continue. If you enter an invalid number an 'ERR:Invalid Date or Time!' error message is displayed on the second line of the screen. If this occurs repeat the set date/time procedure.

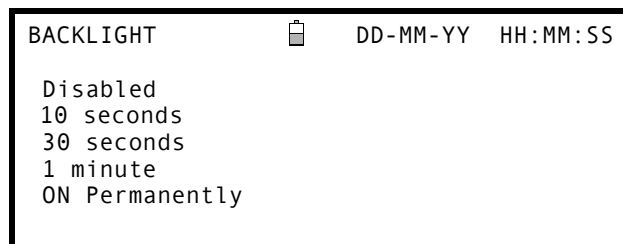
3.1.2 Enabling/disabling the backlight

The backlight can be selected to be either **Disabled**, illuminated for 10 seconds, 30 seconds or 1 minute every time a key is pressed, or **ON** permanently. If the backlight is not required it is recommended that you disable it to prolong the battery discharge time.

1. Select **Setup Instrument** from the **MAIN MENU**.
2. Select **Backlight** from the **SETUP INSTRUMENT** screen then press the **ENTER** key.



3. Select the required backlight operation.
4. Press the **ENTER** key to return to the **SETUP INSTRUMENT** screen.
5. Select **Exit** then press the **ENTER** key to return to the **MAIN MENU**.





3.2 Using the Quick Start Menu

If you want to perform a 'one time' flow reading at a particular pipe location, the Quick Start menu provides the quickest way to set up the PUF system and access the FLOW READING screen.

If the point at which you intend to take the measurement is likely to require regular monitoring, it is best to set it up as a 'Site' within the PUF, which then stores the site parameters (See Paragraph 3.4).

Before you can use the PUF system you need to obtain the following details (this information will be required when setting up the Quick Start menu):

- The pipe outside diameter.
- The pipe wall thickness and material.
- The pipe lining thickness and material.
- The type of fluid.
- The fluid temperature.

Entering the site data

1. Select Quick Start from the MAIN MENU and press the ENTER key. 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 the ENTER key.

DIMENSION UNIT	DD-MM-YY	HH:MM:SS
Select the dimension units:		
mm		
➔Inches		

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

OUTSIDE DIAMETER	DD-MM-YY	HH:MM:SS
Dimension:		Inches
Pipe outside diameter?		6.50

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

PIPE WALL THICKNESS	DD-MM-YY	HH:MM:SS
Dimension:		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 the ENTER key to continue.

PIPE LINING THICKNESS	DD-MM-YY	HH:MM:SS
Dimension:		Inches
Pipe outside diameter?		58.0
Pipe wall thickness?		4.0
Pipe lining thickness?		0.12



3: Operating Procedures

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

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 the ENTER key.
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 the ENTER key.

If the liquid is not listed select Other and enter a propagation rate in meters/second.

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

Select fluid type

Water
Glycol/water 50/50
Glycol/water 30/70
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 the ENTER key.

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

Enter Fluid Temperature

°C: 5.00
°F: 41.00
Continue..



- 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 B-ST (B 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  : B-ST      Reflex
Temperature : 10.00°C 50.00°F
Set sensor separation to 3.62 Inches
Press ← to continue,△▽ to select sens.
    
```

- Take a note of the displayed parameters, then press the ENTER key.
- The ATTACH SENSORS screen displays, giving instructions to attach the sensors.

```

ATTACH SENSORS  DD-MM-YY  HH:MM:SS

          Attach Sensor Set

          Red Connector UpStream
Press ← key to go to Flow Reading
    
```

Note: The SENSOR SELECTION menu can be entered by use of the Up/Down scroll keys. This allows the type and mode of the sensors being used to be selected. This menu will be entered automatically if the entered pipe OD and/or temperature are not valid for the currently selected sensors.

Note: Do not press the ENTER key until the transducers are fitted and connected to the instrument.

Attaching and connecting the transducers

- Fit the designated sensors to the pipe using the appropriate transducer holder as described in Paragraph 2.2. Take great care to set the separation distance as accurately as possible.
- Connect the red and blue coaxial cables between the sensors and the test instrument, ensuring that the red connector on the instrument is connected to the 'upstream' sensor.

Taking a flow reading

- Once the transducers have been fitted and connected, press the ENTER key from the ATTACH SENSORS screen.
- This will take you to the FLOW READING screen via a signal-checking screen (shown here).

```

Please wait..
Checking signals

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

- Check that the indicated signal strength on the left of the screen is 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 it could be due to an application problem.
- Qxx . xx% indicates the signal quality and should have a value of 60% or greater.

```

FLOW READING  DD-MM-YY  HH:MM:SS
Signal  Qxx .xx%
          0.000 gal/min
+Total: 0.00 gal
-Total: 0.00 gal
    
```



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, 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.

There are limitations on the use of these larger flow values with regards to logging of data and setting the current and pulse outputs. If the flow reading is less than 140000 US gallons/min, the value can be logged and downloaded via Portagraph III.

3.3 Using the System at a Regularly Monitored Location

Setting up the PUF system using the Quick Start method described in Paragraph 3.2 is easy and the recommended method to use in a 'one time' situation. But if you have a site location that you want to monitor on a frequent basis it is better to set up a named 'Site' for that location so that you can recall it when needed and so avoid the need to re-enter the site details every time you want to install the equipment there.

Note: See Paragraph 3.4 for details of how to set-up and manage site details.

Use this procedure to install the equipment at a named site.

1. Select View Edit Site Data from the MAIN MENU.
2. Select Choose from list of sites.
3. Select one of the sites listed and press the ENTER key.
4. The Site name will show the selected site and the site parameters will be listed on the screen.
5. Scroll down through the menu list and enter/change the data that might have changed since the last time the site was accessed.
6. When you are satisfied that the parameters are correct select Save current site & read flow.

```
VIEW EDIT SITE DATA  DD-MM-YY  HH:MM:SS
Choose from list of sites
Site name           : MySite
Dimension units     : Inches
Pipe outside diameter: 6.50
Pipe wall thickness : 0.50
Pipe lining thickness: 0.16

Pipe wall material  : Mild Steel
Lining material     : Steel
Sensor set          : B-ST (see note)
Sensor mode         : Reflex
Fluid type          : Water
Save current site & read flow
Delete this Site
Download & save current site
Exit
```

Note: If you select a different Sensor set (e.g. A-ST) when entering new site data you could receive an "invalid" error message if the previous Sensor set was operating at a temperature above 275°F. If this occurs, ignore the warning as it will disappear when you enter a temperature in the correct range for new sensors.



7. If you need to alter the fluid temperature from that shown, select either °C or °F with the cursor and press the ENTER key.
8. Enter the new temperature value and press the ENTER key.
9. The new temperature should now be indicated in both °C and °F.
10. Select Continue.. and press the ENTER key.
11. 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 3.62 Inches apart.
Take a note of these details.
12. Take a note of the displayed parameters, then press the ENTER key.
13. The ATTACH SENSORS screen displays, giving instructions to attach the sensors.

```

FLUID TEMPERATURE  DD-MM-YY HH:MM:SS
Enter Fluid Temperature

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

```

SENSOR SEPARATION  DD-MM-YY HH:MM:SS
Site               : MySite
Pipe               : 6.50 Inches
Wall              : 0.05 Inches
Sensors           : B-ST      Reflex
Temperature       : 10.00°C 50.00°F
Set sensor separation to 3.62 Inches
Press ← to continue,△▽ to select sens.
    
```

```

ATTACH SENSORS  DD-MM-YY HH:MM:SS

Attach Sensor Set

Red Connector UpStream
Press ← key to go to Flow Reading
    
```

Note: The SENSOR SELECTION menu can be entered by use of the Up/Down scroll keys. This allows the type and mode of the sensors being used to be selected. This menu will be entered automatically if the entered pipe OD and/or temperature are not valid for the currently selected sensors.

Note: Do not press ENTER until the transducers are fitted and connected to the instrument.

Attaching and connecting the transducers

14. Fit the designated sensors to the pipe using the appropriate transducer holders as described in Paragraph 2.2. Take great care to set the separation distance as accurately as possible.
15. Connect the red and blue coaxial cables between the sensors and the instrument, ensuring that the red connector on the instrument is connected to the 'upstream' sensor.

Taking a flow reading

16. Once the transducers have been fitted and connected, press the ENTER key on the ATTACH SENSORS screen.
17. This will take you to the FLOW READING screen via a signal-checking screen (shown here).

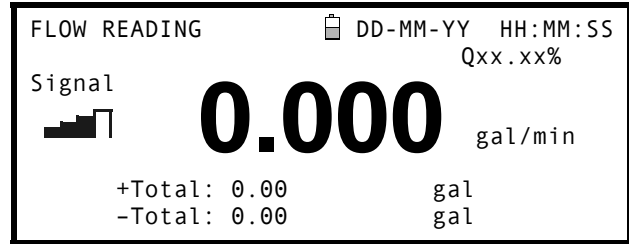
```

Please wait..
Checking signals

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




- 18. Check that the indicated signal strength on the left of the screen is 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 it could be due to an application problem.



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.

3.4 Managing Named Sites

If you want to monitor a particular site location frequently, you can set up a named 'Site' to store the installation details, such as pipe dimensions and material, required to set-up the PUF system. These can then be recalled later when revisiting that particular location.

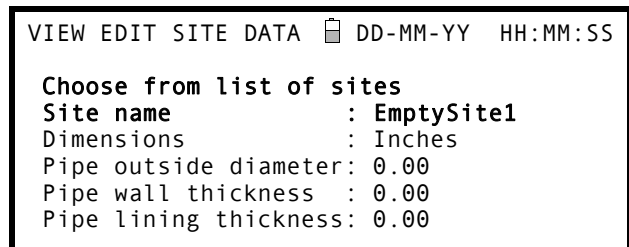
The instrument can store up to 20 sites, the first site is reserved for QUICK START and cannot be renamed; subsequent sites are initially named EmptySite1 through to EmptySite19.

3.4.1 Setting up a new site

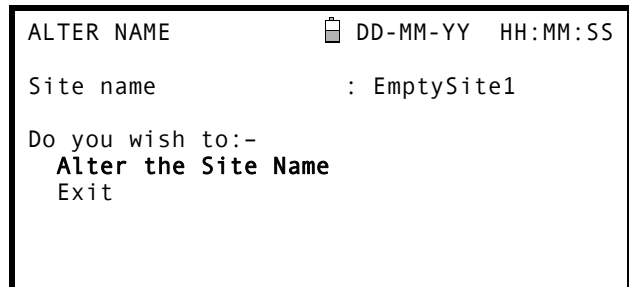


Key Point: Once you have set up a named site you are advised to log some data to the site in order to avoid the possibility of the site name being overwritten when the QuickStart data is saved. See Paragraph 3.6.3 for details.

- 1. Select View Edit Site Data from the MAIN MENU.
- 2. Select Choose from list of sites.
- 3. Select one of the EmptySites from the presented list (e.g. EmptySite 1 as shown).
- 4. Select Site name and press the ENTER key.

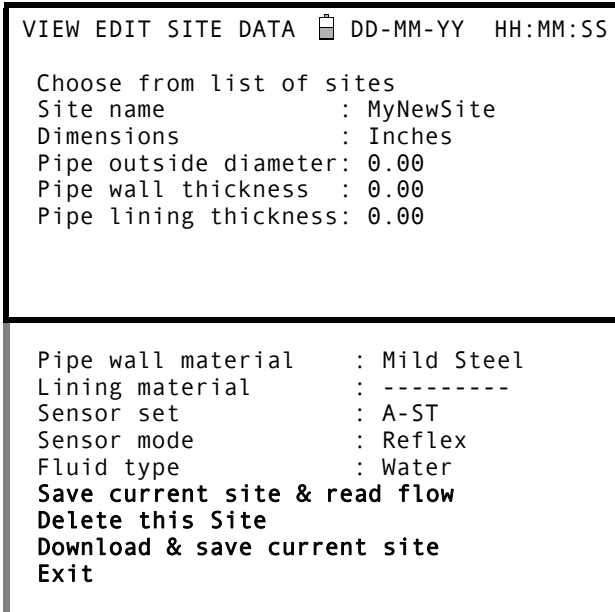


- 5. This opens the ALTER NAME screen.
- 6. Select Alter the Site Name and you will be presented with a screen which allows you to enter a new name in much the same way as when composing a mobile text message.
- 7. On completion press the ENTER key then select Exit. This will take you back to the VIEW EDIT SITE DATA screen.





8. Scroll down through the menu list and enter/change the pipe parameters and other data pertaining to the site.
Note that this menu allows you to choose a Sensor Set, unlike the QUICK START menu which recommended the sensor set to use. If you enter an inappropriate sensor set in this menu, you will be presented with an error message later when you go to the SENSOR SEPARATION screen.
9. When all the data is correct you can either:
 - a) Select Save current site & read flow to continue fitting the transducers and opening the FLOW READING screen.
 - b) Select Delete this site to delete the site name and values and restore it to the original EmptySite name.
 - c) Select Download & save current site to save the site details and download them to a PC via RS232/USB provided the RS232/USB link is connected and correctly set-up.
 - d) Select Exit to return to the MAIN MENU.



3.4.2 Changing a site name

To change a site name, use the same method described above for generating a new site: but in this case access a current site name to change rather than an EmptySite. If you change a site name while the site is logging, the logging will stop.

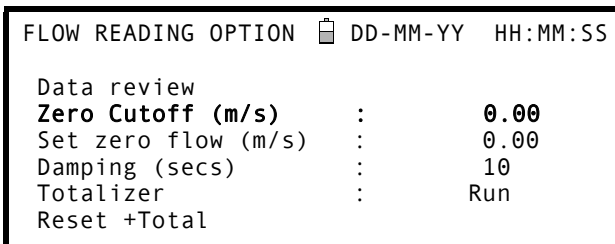
3.5 Instrument Calibration

The PUF 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 application where necessary. Apart from the zero flow offset adjustment, these are normally carried out only where the instrument is to be used in a permanent or semi-permanent location.

3.5.1 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 (0.33 ft/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.
2. Select Zero Cutoff (m/s) and press the ENTER key.
3. Enter the value for the Zero Cutoff (e.g. 0.06 m/s) then press the ENTER key.
4. Scroll down to select Exit and press the ENTER key to return to the FLOW READING screen.





3.5.2 Adjusting the set zero flow offset

The PUF 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.



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 calibrated 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 ± 0.005 m/s (0.016 ft/s) – possibly higher on smaller diameter pipes. If a greater figure is shown, it is worth calibrating 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 the ENTER key.
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 the ENTER key to return to the FLOW READING screen.

FLOW READING OPTION	DD-MM-YY	HH:MM:SS
Data review		
Zero Cutoff (m/s)	:	0.00
Set zero flow (m/s)	:	0.00
Damping (secs)	:	10
Totalizer	:	Run
Reset +Total		



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

3.5.3 Adjusting the calibration factor



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

The PUF 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 PUF's totalizer facility and zero it (Paragraph 3.6.1).
2. Run the PUF's totalizer to measure the total flow over a 30 to 60 minute period, and note the total flow indicated by the reference flow meter over the same period.
3. Calculate the % error between the PUF and reference meters. If the error is greater than $\pm 1\%$ calibrate the PUF as detailed below.



4. Press the Options key to access the FLOW READING OPTION screen shown.
5. Scroll down and select Calibration factor.
6. Change the calibration factor according to the error calculated in step 3. For example, if the PUF 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 the Enter key to apply the change.
8. Select Roughness factor or Exit as required.

FLOW READING OPTION		DD-MM-YY	HH:MM:SS
Data review			
Zero Cutoff (m/s)	:	0.00	
Set zero flow (m/s)	:	0.00	
Damping (secs)	:	10	
Totalizer	:	Run	
Reset +Total			
Reset -Total			
Calibration factor	:	1.000	
Roughness factor	:	0.01	
Diagnostics			
Select Totals	:	Both	
Exit			

3.5.4 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
Non ferrous metal Glass Plastics Light metal	0.01
Drawn steel pipes: <ul style="list-style-type: none"> • Fine planed, polished surface • Plane surface • Rough planed surface 	0.01
Welded steel pipes, new: <ul style="list-style-type: none"> • Long usage, cleaned • Lightly and evenly rusted • Heavily encrusted 	0.1
Cast iron pipes: <ul style="list-style-type: none"> • Bitumen lining • New, without lining • Rusted / Encrusted 	1.0



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.
3. Change the roughness factor according to the pipe material and condition as described above.
4. Press the ENTER key to apply the change.

FLOW READING OPTION	DD-MM-YY	HH:MM:SS
Data review		
Zero Cutoff (m/s)	:	0.00
Set zero flow (m/s)	:	0.00
Damping (secs)	:	10
Totalizer	:	Run
Reset +Total		
Reset -Total		
Calibration factor	:	1.000
Roughness factor	:	0.01
Diagnostics		
Select Totals	:	Both
Exit		

3.5.5 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, 10, 15, 20, 30, 50, seconds, with a default setting of 10.

With the system running in FLOW READNG mode:

1. Press the Options key to access the FLOW READING OPTION screen shown.
2. Scroll down and select Damping (secs).
3. This will open the DAMPING OPTIONS screen.

FLOW READING OPTIO	DD-MM-YY	HH:MM:SS
Data review		
Zero Cutoff (m/s)	:	0.00
Set zero flow (m/s)	:	0.00
Damping (secs)	:	10
Totalizer	:	Run
Reset +Total		
Reset -Total		
Calibration factor	:	1.000
Roughness factor	:	0.01
Diagnostics		
Select Totals	:	Both
Exit		

4. Select the value of the Damping factor as required to remove any unwanted display fluctuations. Increasing the value applies a greater smoothing affect.
5. Press the ENTER key to apply the selection and return to the FLOW READING OPTIONS screen.

DAMPING OPTIONS	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 it may exhibit large step changes when the value is updated.



3.6 Performing Monitoring & Logging Functions

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 downloaded to a PC at a later time. Either -Flow Rate or +Flow Rate and ±Totals can be logged to Memory, RS232 or both. Totals are always logged and can be selectively down loaded after the logging has stopped.



Key Point: To view the totals on the screen and send them to the RS232/USB output as they are logged, you have to select the required option in the Data Logger menu before setting up the flow reading.

3.6.1 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 to 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 the ENTER key.
3. Select Reset +Total and press the ENTER key.
4. Press the ENTER key from the subsequent screen to accept the reset.
5. Press the ENTER key again to return to the FLOW READING OPTIONS menu.

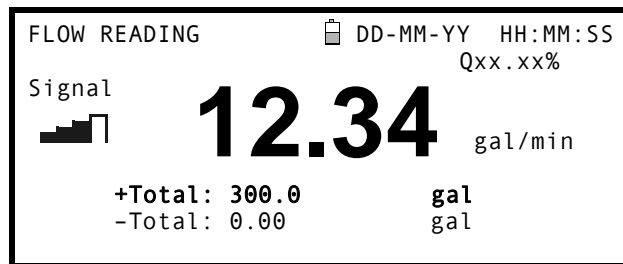
FLOW READING OPTION	DD-MM-YY	HH:MM:SS
Data review		
Zero Cutoff (m/s)	:	0.00
Set zero flow (m/s)	:	0.00
Damping (secs)	:	10
Totalizer	:	Stall
Reset +Total		

6. Select Reset -Total and press the ENTER key.
7. Press the ENTER key on the subsequent screen to accept the reset.
8. Press the ENTER key 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 the ENTER key.
Note: the totalizers begin to count up as soon as Totalizer is put to Run.

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		



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.



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.

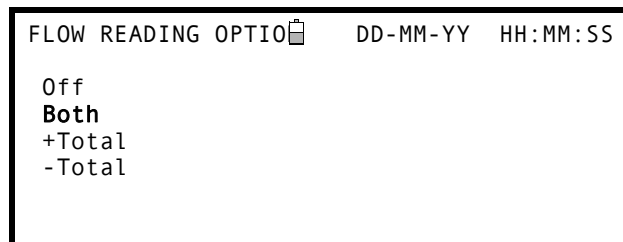
Note that in a bi-directional flow situation you must calculate the difference between the indicated positive and negative flow totals before carrying out the average flow rate calculation.

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.

3.6.2 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 Both totalizers.
4. Press the ENTER key.



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.

3.6.3 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. The logged data is saved to the instrument's memory and can be downloaded to a PC at a later time.

Starting point

This procedure assumes that the PUF instrument has been correctly installed and is operating in the FLOW READING mode.



Setting up and starting the logging

1. With the PUF 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. gal/min).
2. Press the Logger function key to access the REAL TIME LOGGER screen.
3. Select Log data to and choose Memory to store the log to the instrument's internal memory.
4. Select Logging interval and enter the required period (e.g. 10 seconds).
5. Select Clear log if you want to discard any existing logging data.
6. Select START NOW.
7. This screen appears only if a log already exists for the QuickStart site. It allows you to either delete or save the existing log, or cancel the START NOW request.

REAL TIME LOGGER	DD-MM-YY HH:MM:SS
4-20mA O/P is ON.	Qxx.xx%
Unit	: gal/min
Log name	: Quickstart
Log data to	: Memory
Logging interval	: 10 seconds
Start date & time	: dd-mm-yy hh:mm:ss
Stop date & time	: dd-mm-yy hh:mm:ss
Remaining time	: MM DD HH MM SS
Sleep Mode	: Off
Extended Intervals	: Stop
Graph Y axis max.	: 50
View log as text	
View log as graph	
START NOW	
Set Auto start	
Clear log	
Exit	
ERR:Log not empty	DD-MM-YY HH:MM:SS
Press ← to confirm deletion Press △ to save log and continue Press ▽ to cancel	

If you choose to save the existing log it will be saved to the highest number site that does not currently have an attached log (e.g. EmptySite19, EmptySite18.... etc). The name of the site to which the log is saved will be changed to CopyQS_xx (where xx is a numerical value which is incremented each time a log is saved).

For example: if EmptySite19 is available when you elect to save the QuickStart log, the log is saved to EmptySite19 and the sitename is changed to CopyQS_1



Key Point: When setting up a named site it is advisable to run a brief logging session on the new site to establish a data log file, as this will prevent the site name being overwritten when saving the QuickStart log, as described above.



View log as text

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

Note: Press key 5 to go to the top line of logged data or key 6 to go to the bottom line.

- 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		DD-MM-YY	HH:MM:SS
Logging to memory			
Log: Quickstart			
Date	Time	Flow	Totals
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	

DD-MM-YY	hh:mm:ss	xxx.xx	L/m

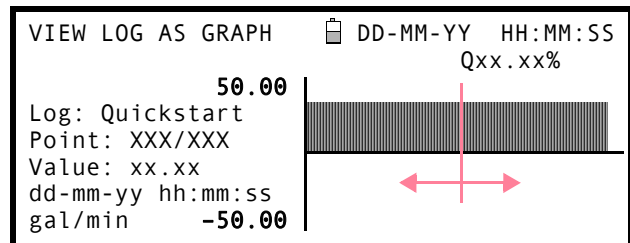


Key Point: There can be only one set of logged data per site. If a new data log is started on a site it will clear the existing data.

View log as a graphic

- If you want to view the logging progress graphically rather than as text, press the Logger function key to get to the REAL TIME LOGGER screen.
- Select Graph Y axis max and enter a value equal to the expected maximum flow.
- Select View log as graph. This will open the VIEW LOG AS GRAPH screen shown below.
- You can select the data at any point in time by scrolling along the time axis of the graph using the LEFT/RIGHT scroll keys (5 & 6). The data values for the selected point are then shown to the left of the graph. Keep the scroll key pressed for the cursor to move automatically.
- If you want to change the value of the Y axis to improve the resolution of the graph press the UP/DOWN scroll keys. The maximum values will then increase/decrease as appropriate.
- To exit the VIEW LOG AS GRAPH screen and return to the REAL TIME LOGGER screen press the ENTER key.

REAL TIME LOGGER	DD-MM-YY	HH:MM:SS
4-20mA O/P is ON. Qxx.xx%		
Unit	:	gal/min
Log name	:	Quickstart
Log data to	:	Memory
Logging interval	:	10 seconds
Start date & time	:	dd-mm-yy hh:mm:ss
Stop date & time	:	dd-mm-yy hh:mm:ss
Remaining time	:	MM DD HH MM SS
Sleep Mode	:	Off
Extended Intervals	:	Stop
Graph Y axis max.	:	50
View log as text		
View log as graph		
START NOW		
Set Auto start		
Clear log		
Exit		





Monitoring the logged events at a later time

16. If you wish to monitor the logging progress at any time while you are operating in FLOW READING mode, press the Logger function key as described above to switch to the REAL TIME LOGGER screen. You can then select View log as text or View log as graph, as required, without interfering with the logging operation.

Stop logging

17. From the FLOW READING screen, press the Logger function key to access the REAL TIME LOGGER screen.
18. Select STOP NOW to cease logging. Note that the START NOW and STOP NOW options toggle depending on which was last selected.
19. Select Exit to return to the FLOW READING screen.

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

REAL TIME LOGGER	☰ DD-MM-YY HH:MM:SS
4-20mA O/P is ON.	Qxx.xx%
Unit	: gal/min
Log name	: Quickstart
Log data to	: Memory
Logging interval	: 10 seconds
Start date & time	: dd-mm-yy hh:mm:ss
Stop date & time	: dd-mm-yy hh:mm:ss
Remaining time	MM DD HH MM SS : mm dd hh mm ss
Sleep Mode	: Off
Extended Intervals	: Stop
Graph Y axis max.	: 50
View log as text	
View log as graph	
STOP NOW	
Set Auto start	
Clear log	
Exit	

3.6.4 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 to a PC at a later time.

Starting point

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

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.

Key Point: If you enter a Start time later than the Stop time you will see an error message until the stop time has been set to be later. This does not however affect the operation of the equipment once the correct times have been set.

1. With the PUF 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. gal/min)



2. Press the Logger function key to access the REAL TIME LOGGER screen.
3. Select Log data to and choose Memory. This will store the log to the internal memory.
4. Select Logging interval and enter the required period.
5. Select Start date & time and enter the date and time you wish logging to commence. Note this must be in the future.

Note: If the log is not empty then a warning screen will be displayed, and when a key is pressed the menu will be displayed with the cursor at the Clear Log item. The log must be cleared before new times can be entered.

6. Select Stop date & time and enter the date and time you wish logging to cease. Note this must be later than the start time.
7. If the instrument is to be left unattended for a long logging period, it could possibly fill the log memory.

To determine how the instrument should react in such circumstances, select Extended Intervals from the REAL TIME LOGGER screen and select the required option from the EXTENDED INTERVALS screen as described below:

- a) Stop: The default state, and when the memory is full any active logging will stop.
- b) Overwrite: Allows logging to continue after the memory is full by erasing the oldest sample and replacing it with the latest.

Note: The three options below must be selected before the times and dates are entered in Start Time and Date and Stop Time and Date.

- c) Daily: Activates logging for part of each day as defined by the Start Time and Stop time. When selected, and the logging is started via the Set Auto start option, the flow value will be logged each day between the times specified. The Stop Time must be later than the Start Time. The data will be accumulated into a single file.
- d) Weekly: This is similar to Daily in that the active logging period is defined by the Start Time and Stop Time. The difference is that with Weekly the logging occurs every 7 days, with the start day being defined by the selected Start Date.
- e) Monthly: This is similar to Daily in that the active logging period is defined by the Start Time and Stop Time. The difference is that with Monthly the data is logged on the day of the month specified in the Start Date. If this is set to 29, 30 or 31, and the current month does not have this number of days, logging will occur on the last day of the month.

Note: if you select to clear all logs you will lose all the currently held log data.

```

REAL TIME LOGGER      DD-MM-YY  HH:MM:SS
4-20mA O/P is ON.    Qxx.xx%
Unit                  : gal/min
Log name              : Quickstart
Log data to          : Memory
Logging interval     : 10 seconds
Start date & time    : dd-mm-yy hh:mm:ss
Stop date & time     : dd-mm-yy hh:mm:ss
  
```

```

Remaining time       MM DD HH MM SS
Sleep Mode          : mm dd hh mm ss
Sleep Mode          : Off
Extended Intervals  : Stop
Graph Y axis max.   : 50
View log as text
View log as graph
START NOW
Set Auto start
Clear log
Exit
  
```

```

EXTENDED INTERVALS  DD-MM-YY  HH:MM:SS
                    Qxx.xx%
Stop
Overwrite
Daily
Weekly
Monthly
  
```



8. Select Set auto start. This enables the auto logging application.

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

9. To cancel the automatic logging session before it commences, click the Cancel Auto Start.
10. Select Exit to return to the FLOW READING screen.

REAL TIME LOGGER	DD-MM-YY HH:MM:SS
4-20mA O/P is ON.	Qxx.xx%
Unit	: gal/min
Log name	: Quickstart
Log data to	: Memory
Logging interval	: 10 seconds
Start date & time	: dd-mm-yy hh:mm:ss
Stop date & time	: dd-mm-yy hh:mm:ss
Remaining time	MM DD HH MM SS
Sleep Mode	: mm dd hh mm ss
Extended Intervals	: Off
Graph Y axis max.	: Stop
View log as text	: 50
View log as graph	
START NOW	
Cancel Auto Start	
Clear log	
Exit	

Monitoring the logged events

11. If you wish to view the logging progress at any time while you are operating in FLOW READING mode, press the Logger function key as described above to access the REAL TIME LOGGER screen. You can then select View log as text or View log as graph, as required, without interfering with the logging operation. This is described in detail in procedure Paragraph 3.6.3.

Manually stopping the auto logging session

12. The logging session will stop automatically at the programmed Stop date & time.
13. 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.
14. Select Exit to return to the FLOW READING screen.

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

REAL TIME LOGGER	DD-MM-YY HH:MM:SS
4-20mA O/P is ON.	Qxx.xx%
Unit	: gal/min
Log name	: Quickstart
Log data to	: Memory
Logging interval	: 10 seconds
Start date & time	: dd-mm-yy hh:mm:ss
Stop date & time	: dd-mm-yy hh:mm:ss
Remaining time	MM DD HH MM SS
Sleep Mode	: mm dd hh mm ss
Extended Intervals	: Off
Graph Y axis max.	: Stop
View log as text	: 50
View log as graph	
STOP NOW	
Set Auto start	
Clear log	
Exit	

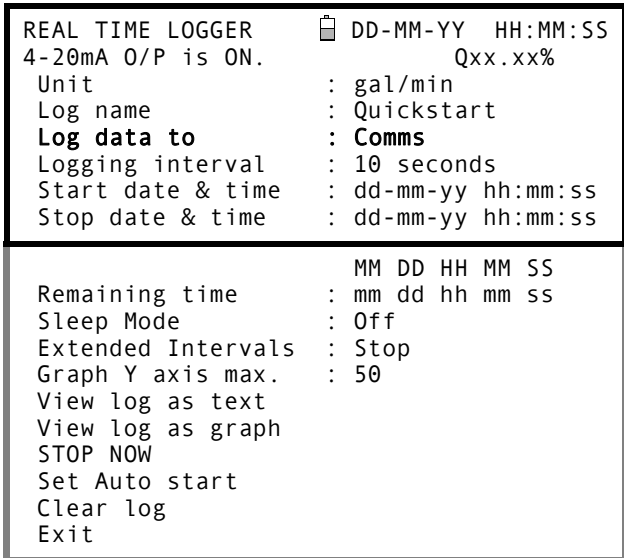
Note: The REAL TIME LOGGER Sleep Mode function is not implemented in the PUF instrument.



3.6.5 How to log directly to a PC

Selection made during logging set-up

1. In the previous procedures the logging data was routed to the PUF's internal memory where it was stored for later download to a PC/printer. However, you could have sent it directly to the PC or printer for 'live' data display by selecting Comms in the Log data to option in the REAL TIME LOGGER screen.
2. In order for this to work correctly, the PUF must be connected to the PC and the RS232/USB link already established.



Swapping data destinations during a logging session

When a logging session is in progress the PUF is normally in the FLOW READING mode. In this mode you can switch the logging data destination by pressing the Logger function key and then selecting either Memory or Comms in the Log data to field – see the screen above. You can also select Both, to route the data to both destinations simultaneously.



Key Point: This will only work if the PUF is connected to the PC and the RS232 link has already been established. If the RS232 protocol has not been configured, you can access the RS232 set-up screen by returning to the FLOW READING screen and then pressing the Comms button.



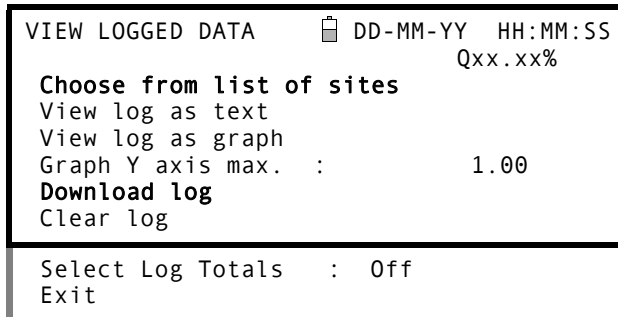
3.6.6 How to download logged data to a PC

This procedure describes how to download stored data to a PC. It assumes that the PUF is already connected to the PC's serial port and that RS232/USB communication has been established, as described in Paragraph 3.7.1.

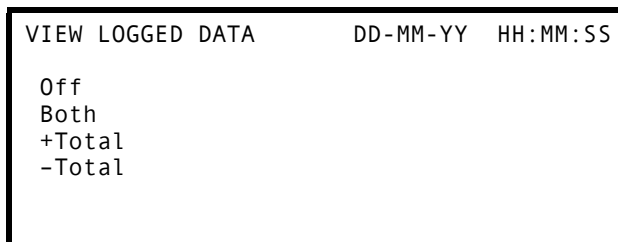
1. Access the MAIN MENU.

Note: *If this is done from the FLOW READING screen, any logging currently taking place will be terminated.*

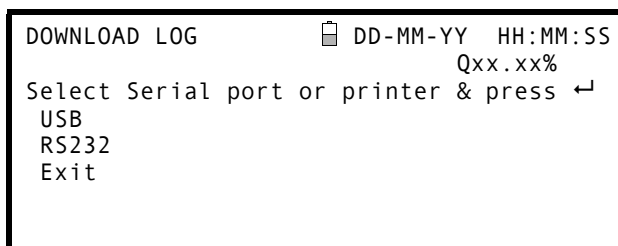
2. Select Data Logger from the MAIN MENU.
3. Select Choose from list of sites and select the name of the site to download.



4. The totals are always logged. If you wish to display them when either viewing a log or downloading it to a PC or printer, then use the options in Select Log Totals. The default is Off. (Portagraph III does not display the totals, even if they are enabled).
5. If you want to view the log prior to downloading it, you can do so using the View log as text or View log as graph options.
6. When you are ready to begin downloading the log, select Download log.



7. From the DOWNLOAD LOG screen select USB or RS232, then select Send from the subsequent confirmation screen.
8. The selected logged data is now downloaded to the PC.
9. Upon completion, select Exit to return to the VIEW LOGGED DATA screen.
10. On the VIEW LOGGED DATA screen you can now Clear the log if required, or Exit directly back to the MAIN MENU.



Key Point: When using the USB to download data, make sure that the USB driver has been installed and the correct COM port has been set (see Paragraph 2.3).



3.7 Configuring the PUF Communications Interfaces

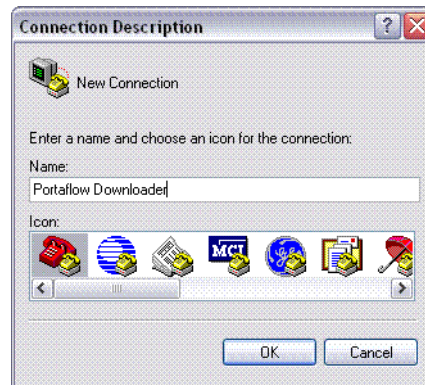
3.7.1 How to set-up an RS232 connection

If you want to download a stored data log, or output live data logging to a PC, you must first establish RS232 communication between the PC and the data logger. (Download is also possible using USB.)

This procedure provides step-by-step instructions for setting up a HyperTerminal connection, which is a standard Windows® XP application (not available on Vista). The default location of HyperTerminal is: Start>All Programs>Accessories>Communications>HyperTerminal

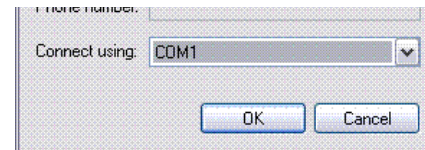
Setting up a HyperTerminal connection

1. Open HyperTerminal. The Connection Description dialogue box will appear.
2. Enter a name for the connection (PUF Download in the example) then click OK.



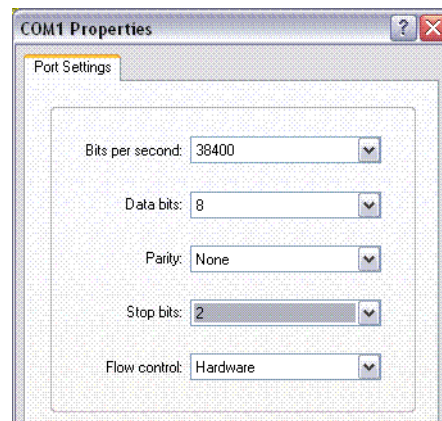
3. Select a COM port, then click OK.

Note: The available COM ports will vary between individual PC installations.



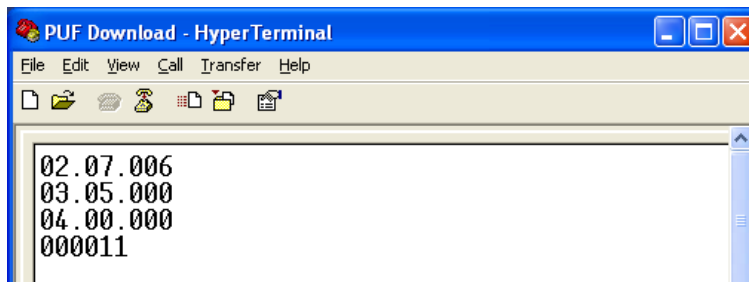
4. Enter values for the Port Settings as shown.
5. Click on OK.
6. The 'PUF Download' Terminal settings will now be saved.

Note: When you next start a HyperTerminal session, you can select the 'PUF Download' terminal from the File>Open menu rather than having to re-enter the parameters.





7. The main HyperTerminal window will now become active (note the connection name now shown in the title bar).
8. Leave this window open while you configure the PUF's RS232 parameters.



Configuring the PUF instrument

9. Select Setup RS232 / USB from the MAIN MENU. This will access the SETUP RS232/USB screen shown here.
10. Set the RS232 parameters as shown opposite.

Note: The selected Baud Rate must also be available on the receiving terminal.

SETUP RS232 / USB	DD-MM-YY	HH:MM:SS
Handshaking	:	None
Baud Rate	:	38400
Data Bits	:	8
Stop Bits	:	2
Parity	:	None
New line	:	CR+LF
Printer test	:	
Exit		

Testing the RS232 connection

11. Ensure the PUF is connected to the PC's serial port using the cable provided.
12. In the SETUP RS232/USB screen select Printer test.
13. The PUF's serial number should now appear in the HyperTerminal window – see Figure 3.1 on Page 40. This proves that the link is working.

3.7.2 How to set-up a USB connection

In order to use a USB connection, you must first install the special USB driver as detailed in Paragraph 2.3. This will set up a virtual port through which the PUF can communicate.

When you make the connection with the computer use the same technique as described above for setting up an RS232 communications session through HyperTerminal. But in this case when you are asked to select a Com Port, choose the virtual port set up by the driver installation.

Once this is done, provided the PUF and computer communications protocols are set to the same values (Handshaking, Start bits, Stop bits, Parity etc), the two devices should be able to communicate in the same manner as described for the RS232.

3.7.3 Working With Portagraph III

Dwyer supplies the 'Portagraph III Downloading and Graphing' software to make it easy for the user to download logged data to a PC. Once downloaded, the logged data can be analyzed using the Portagraph III graphing capability, or exported to Microsoft® Excel® for more detailed graphing and analysis. The software application connects to the PUF instrument via the RS232 or USB serial interface.

For full details of Portagraph III operation, refer to the Portagraph III User Manual.

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



3.8 Configuring the Current / Pulse Output

The Current/Pulse Output connector provides two output signals that are proportional to the measured fluid flow. The first is a current signal calibrated to a standard control range (e.g. 4 to 20 mA), and the second is a pulse output. It is permissible to use both outputs simultaneously.

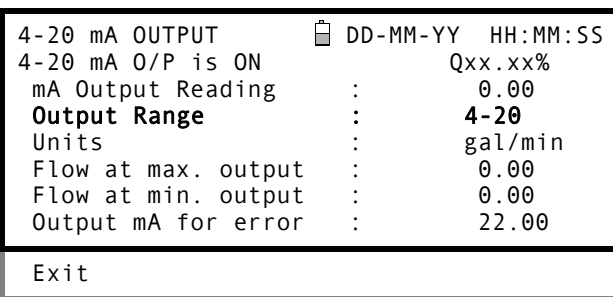
3.8.1 Current output

Using the instrument's menu system, the operator can use the following procedures to:

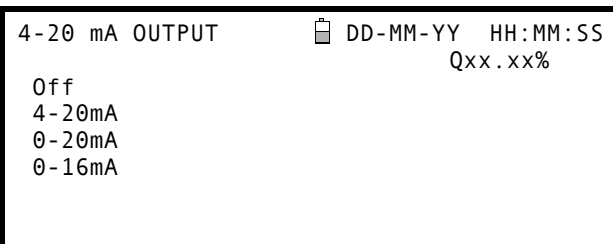
- Select the current output function Off/On .
- Select the current output signal range (4-20mA, 0-20mA, 0-16mA).
- Calibrate the current output signal to a required flow range.

Turning 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 the ENTER key.



4. Select Off, to turn OFF the 4-20mA Output or select one of the output ranges to turn it ON.
5. Press the ENTER key to return to the 4-20mA OUTPUT screen.



4 to 20 mA signal calibration and ranging

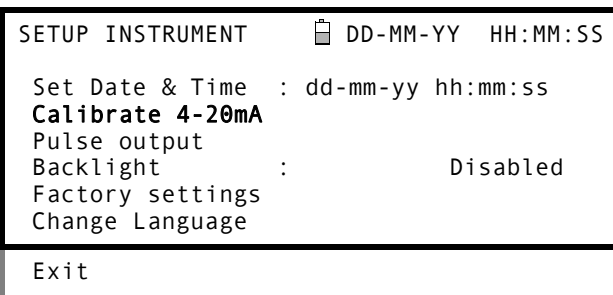


Key Point: The 4 to 20 mA output has been calibrated in the factory and should not require further adjustment. In the rare event that re-calibration is necessary, this procedure should be carried out only by a trained engineer.

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

Signal calibration

1. Select Setup Instrument from the MAIN MENU to access the SETUP INSTRUMENT screen.
2. Select Calibrate 4-20mA.





3. 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 4.0 mA. The DAC should indicate approximately 8000.
4. Press the ENTER key when done.

```

CALIBRATE 4mA      DD-MM-YY HH:MM:SS
Adjust the output current to 4mA
Use Δ∇ to set, 5/6 to trim

DAC Value:          8000

Press ↵ when done
    
```

5. With the meter still connected to the 4 to 20 mA output adjust the Scroll keys to obtain an output of exactly 20 mA. The DAC should indicate approximately 40000.
6. Press the ENTER key when done.

```

CALIBRATE 20mA     DD-MM-YY HH:MM:SS
Adjust the output current to 20mA
Use Δ∇ to set, 5/6 to trim

DAC Value:          40000

Press ↵ when done
    
```

4 to 20 mA 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.

7. With the instrument operating in the FLOW READING mode, press the 4-20mA function key. This will access the 4-20mA OUTPUT screen.
8. Select Flow at max. output and enter a value of the flow rate that you want to associate with a 20 mA output.
9. Select Flow at min. output and enter a value of the flow rate that you want to associate with a 4 mA output. This could be '0'.

```

4-20 mA OUTPUT      DD-MM-YY HH:MM:SS
4-20 mA O/P is ON   Qxx.xx%
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

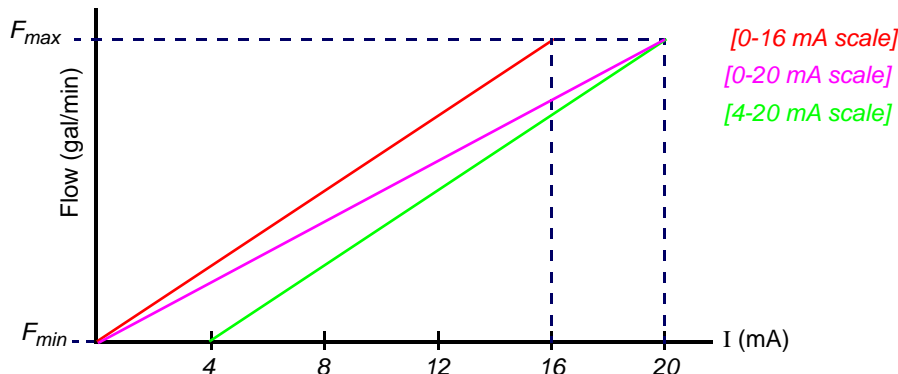
Exit
    
```

10. Select Output mA for error and enter a value (default is 22 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).
11. Upon completion press the ENTER key to return to the FLOW READING screen.



Converting 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 = $\frac{I \times (F_{max} - F_{min})}{20} + F_{min}$	Flow rate = $\frac{I \times (F_{max} - F_{min})}{16} + F_{min}$	Flow rate = $\frac{(I - 4) \times (F_{max} - F_{min})}{(16)} + F_{min}$

3.8.2 Pulse output

The pulse output can be used in two modes, 'volumetric' and 'frequency'. When operating in the 'volumetric' mode a pulse is produced every time a pre-selected volume of liquid passes through the pipe; and when in the 'frequency' mode the output is a continuous pulse-train with a frequency proportional to the flow rate (gal/min).

Using the instrument's menu system, the operator can use the following procedures to:

- Select the pulse output function Off/On/Frequency .
- Volumetric mode – select the output pulse width and volume per pulse.
- Frequency mode – select the maximum pulse frequency and the corresponding maximum flow rate.

Turning the pulse output OFF/ON (volumetric mode)

1. With the instrument operating in the FLOW READING mode, press the Pulse function key to access the PULSE OUTPUT screen.
2. A Pulse output is ON (or OFF) message appears in the second line of the display.
3. To change the pulse output operational status, select the Output menu option then select Off/On as required.
4. Select Exit and press the ENTER key to return to the FLOW READING screen.

PULSE OUTPUT		DD-MM-YY	HH:MM:SS
<i>Pulse output is ON</i>		Qxx.xx%	
Flow units	:	gal	
Output	:	On	
Vol per pulse	:	10.00	
Pulse width (ms)	:	10	
Max Pulse Freq (Hz)	:	10.00	
Flow at Max Freq	:	200.00	
Calculated Pulse Value:		20.0	
Exit			



Generating a 'Test' pulse

If the PULSE OUTPUT menu screen is accessed from the SETUP INSTRUMENT menu, you can generate a 'test' pulse by selecting Flow units and pressing the Option key.

Note: This does not apply if the PULSE OUTPUT menu is accessed by pressing the Pulse key when operating in the FLOW READING mode.

Calibrating the pulse output signal range (volumetric mode)

1. With the instrument operating in the FLOW READING mode, press the Pulse function key to access the PULSE OUTPUT screen.
2. To change the Flow units shown in this menu you must return to the FLOW READING screen and select the required units using keys 7,8 and 9.
3. Select Vol per pulse and enter the required value.
In the example shown, a 10 ms pulse is produced for every 10 gallons of flow.

PULSE OUTPUT	☰	DD-MM-YY	HH:MM:SS
<i>Pulse output is ON</i>		Qxx.xx%	
Flow units	:	gal	
Output	:	On	
Vol per pulse	:	10.00	
Pulse width (ms)	:	10	
Max Pulse Freq (Hz)	:	10.00	
Flow at Max Freq	:	200.00	
Calculated Pulse Value:			20.0
Exit			

Note: The pulse Output must be Off in order to change the Volume per pulse.

4. 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.
5. Select Exit and press the ENTER key to return to the FLOW READING screen.

Selecting the pulse output frequency mode

1. With the instrument operating in the FLOW READING mode, press the Pulse function key to access the PULSE OUTPUT screen.
2. To change the pulse output to 'frequency' mode, select the Output menu option then select Frequency as required.
3. A1 Pulse Frequency is ON message appears in the second line of the display.
4. Select Exit and press the ENTER key to return to the FLOW READING screen.

PULSE OUTPUT	☰	DD-MM-YY	HH:MM:SS
<i>A1 Pulse Frequency is ON</i>		Qxx.xx%	
Flow units	:	gal	
Output	:	Frequency	
Vol per pulse	:	10.00	
Pulse width (ms)	:	10	
Max Pulse Freq (Hz)	:	10.00	
Flow at Max Freq	:	200.00	
Calculated Pulse Value:			20.0
Exit			



Calibrating the pulse frequency range

1. With the instrument operating in the FLOW READING mode, press the Pulse function key to access the PULSE OUTPUT screen.
2. Select Max Pulse Freq (Hz) and enter the required value.
3. Select Flow at Max Freq and enter the required value (gal/min).
4. Select Exit and press the ENTER key to return to the FLOW READING screen

PULSE OUTPUT	☰	DD-MM-YY	HH:MM:SS
<i>AI Pulse Frequency is ON</i>		Qxx.xx%	
Flow units	:	gal	
Output	:	Frequency	
Vol per pulse	:	10.00	
Pulse width (ms)	:	10	
Max Pulse Freq (Hz)	:	10.00	
Flow at Max Freq	:	200.00	
Calculated Pulse Value:			20.0
Exit			

The Calculated Pulse Value field is automatically calculated as:

$$\text{Calculated Pulse Value} = \frac{\text{Flow at Max Freq}}{\text{Max Pulse Freq (Hz)}}$$

This value is often required to be programmed into the device that is receiving the pulses to enable it to calculate the correct flow rate – for example, when connecting the pulse output to an energy meter.

3.9 Printing

Logged data can be printed using an RS232-compatible printer.

3.9.1 How to print logged data using the RS232 printer

This procedure shows you how to set up and use the RS232 printer to print logged data.

Setting up an RS232 connection

1. Connect the PUF to the printer using the printer cable supplied. This cable is fitted with a 9-way D-Type plug terminated as follows:

- | | |
|--------------------------------------|--------------------------------------|
| Pin 1 – N/C (No connection) | Pin 2 – TxD data from PUF to printer |
| Pin 3 – RxD data from printer to PUF | Pin 4 – N/C |
| Pin 5 – Signal ground | Pin 6 – N/C |
| Pin 7 – N/C | Pin 8 – N/C |
| Pin 9 – N/C | |

2. Select Setup RS232 / USB from the MAIN MENU. This will access the SETUP RS232/USB screen shown here.
3. Set the RS232 parameters to comply with those for the printer.

SETUP RS232 / USB	☰	DD-MM-YY	HH:MM:SS
		Qxx.xx%	
Handshaking	:	Xon/Xoff	
Baud Rate	:	1200	
Data Bits	:	8	
Stop Bits	:	1	
Parity	:	None	
New line	:	CR+LF	
Printer test	:		
Exit			

4. Ensure that the printer has sufficient paper, is switched ON and ON LINE.



Printer test

- To check that the PUF printer interface is operational, select Printer test from the SETUP RS232/USB menu. If the RS232 interface is working correctly the software revisions and serial number will be printed:

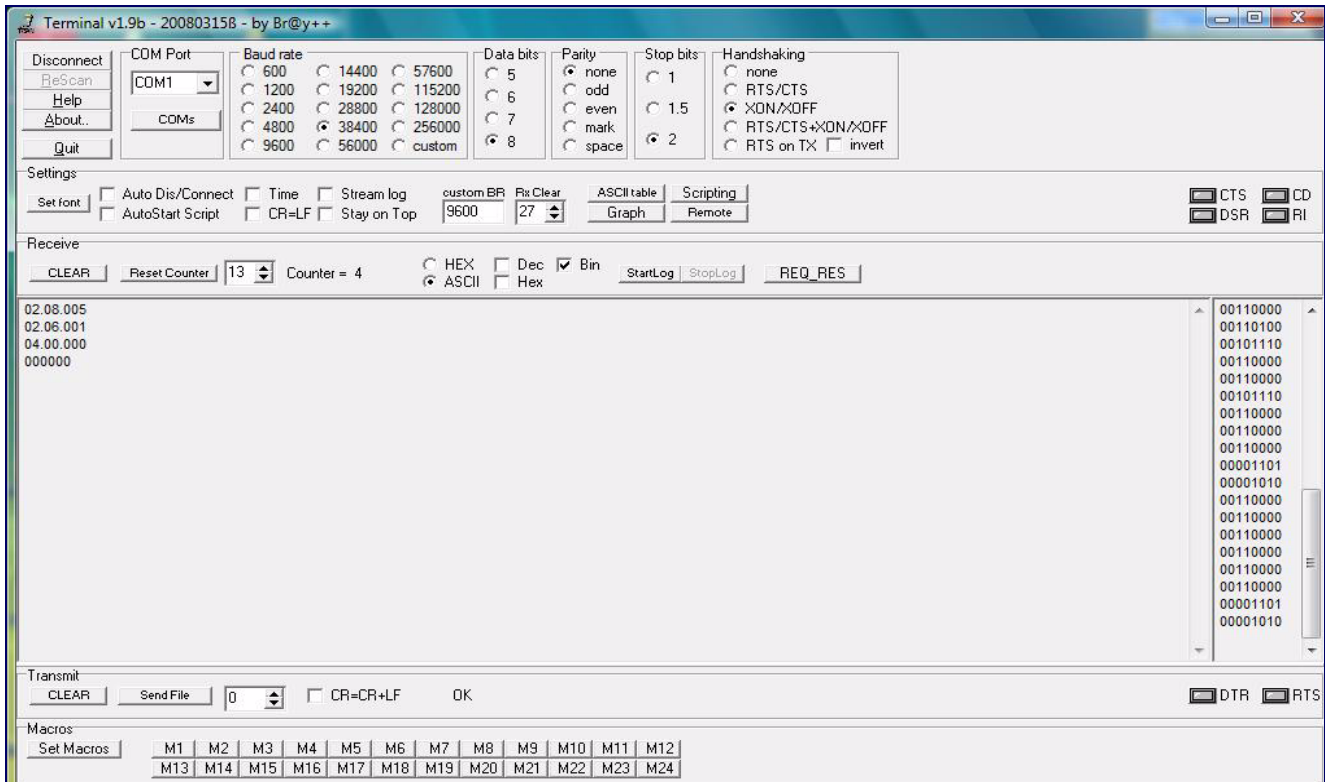


Figure 3.1 Printer test results in Terminal window

If nothing is printed, check that the RS232 parameter settings are correct for the printer and that the PUF TxD and RxD signals are compatible with the printer's RS232 interface. A gender changer may be required to swap the TxD and RxD signals.



Printing logged data

1. Select View Logged Data from the MAIN MENU. This will display the VIEW LOGGED DATA screen shown.
2. Select Choose from list of sites and select the site name for the log you want to print.
3. When you are ready to begin printing the log, select Download log.

```
VIEW LOGGED DATA  DD-MM-YY HH:MM:SS
Choose from list of sites
View log as text
View log as graph
Graph Y axis max. : 1.00
Download log
Clear log

Select Log Totals : Off
Exit
```

4. From the DOWNLOAD LOG screen select RS232. This will open the SETUP RS232/USB screen shown below.

```
DOWNLOAD LOG  DD-MM-YY HH:MM:SS
Select Serial port or printer & press ↵
USB
RS232
Exit
```

5. Select Send from the SETUP RS232/USB screen. The printer should now start printing.
6. The message screen will be displayed while printing takes place (see next page).

```
SETUP RS232/USB  DD-MM-YY HH:MM:SS

Send
Exit
```

7. Printing will continue until all logged data is output or until the ↵ key is pressed.

```
SETUP RS232/USB  DD-MM-YY HH:MM:SS

Data is being downloaded on RS232

This screen will clear
when download is completed.
Press↵to cancel Download
```

Note: The printer will continue printing until its print buffer is empty, which may take a few minutes.



4: Maintenance & Repair

4.1 Introduction

The Series PUF is not field serviceable and should be returned if repair is needed. Field repair should not be attempted and may void warranty



WARNING

**Do not disassemble this unit.
Return the unit to an approved service agent or place of purchase for
further advice.**

4.2 General care

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

1. Ensure the unit is switched off and disconnected from the mains, then wipe the exterior of the instrument with a clean, damp cloth or paper towel. The use of a solvent may damage the surface.
2. The instrument contains a rechargeable battery, dispose safely and in accordance with the local regulations in force in the country of operation.
3. 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.
4. 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.
5. 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.
6. Regularly check all cables/parts for damage. Replacement parts are available from Dwyer.
7. 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.
8. Ensure that suitable precautions are taken when using any materials to clean the instrument/sensors.
9. If the instrument was supplied with dust or dirt caps make sure they are re-fitted when the instrument is not in use.

4.3 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,



5: Troubleshooting

5.1 Overview

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

Faulty instrument

If you suspect the instrument is faulty, you can check it out using a test block as described in Paragraph 5.4. This will establish that the instrument is functional and receiving a healthy signal from the connected transducers.

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.



Automatic signal loss recovery

If the signal is lost or the Quality falls below 40%, the set up procedure, normally invoked by Read Flow in the main menu, is automatically run until a good quality signal is found.

5.2 General Troubleshooting Procedure

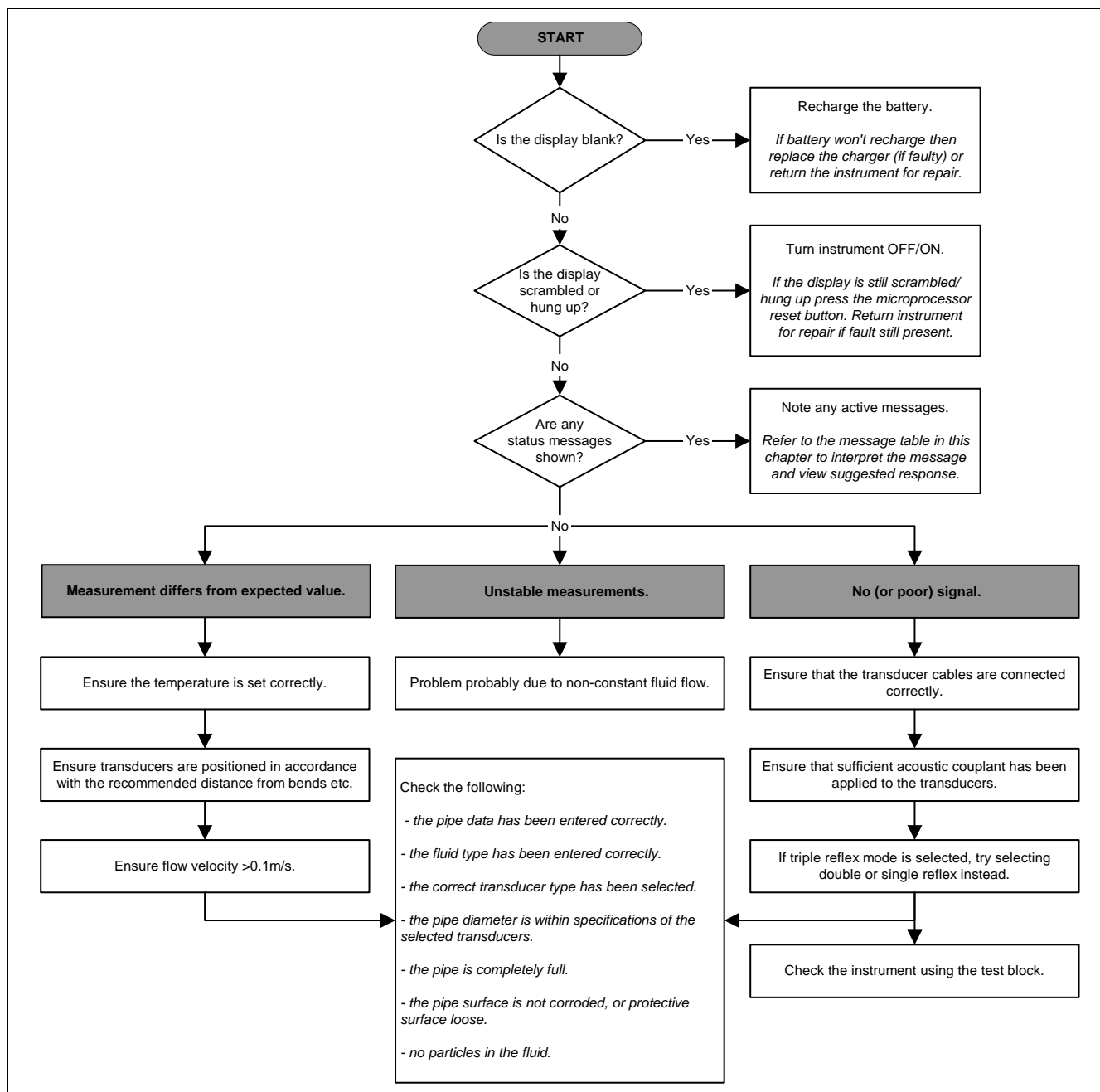


Figure 5.1 Troubleshooting chart



5.3 Warning & Status Messages

FLOW RATE ERRORS	
No flow signal	<p>Interpretation: This message appears when the transducers cannot send or receive signals to each other.</p> <p>Response: Check that all cables are connected, transducers are on the pipe correctly with sufficient couplant on the face.</p>
Flow signal is poor	<p>Interpretation: This warning appears when the signal is lower than 25%.</p> <p>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.</p>
Zero cut-off error!	<p>Interpretation: You have entered an out-of-range value in the Zero cutoff field in the Options menu.</p> <p>Response: Enter a valid number.</p>
Totalizer beyond maximum!	<p>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.</p> <p>Response: Reset the totalizer as described in Paragraph 3.6.1.</p>
PULSE ERRORS	
Pulse Rate > Max	<p>Interpretation: The flow rate exceeds the capability of the pulse output – i.e. too many pulses per second are required than can be achieved.</p> <p>Response: Narrow the pulse width time or increase the volume per pulse, as described on page 38.</p>
Pulse volume error!	<p>Interpretation: You have entered an out-of-range value in the Pulse volume error field in the PULSE OUTPUT menu – see page 38.</p> <p>Response: Enter a valid number.</p>
Pulse width error	<p>Interpretation: You have entered an out-of-range value in the Pulse width error field in the PULSE OUTPUT menu – see page 38.</p> <p>Response: Enter a valid number.</p>



4 to 20 mA ERRORS	
mA out > Max	<p>Interpretation: The actual flow is higher than the maximum set on the mA range.</p> <p>Response: Re-scale the 4 to 20 mA output to be able to cope with the higher flow – see page 35.</p>
Calibration 20mA Error!	<p>NOTE: The 4 to 20 mA output is calibrated before the instrument leaves the factory and should not require further adjustment.</p> <p>Interpretation: You have adjusted the DAC outside its accepted range when calibrating the 20 mA signal output.</p> <p>Response: Re-calibrate the 4 to 20 mA output – see page 35.</p>
Calibration 4mA Error!	<p>NOTE: The 4 to 20 mA output is calibrated before the instrument leaves the factory and should not require further adjustment.</p> <p>Interpretation: You have adjusted the DAC outside its accepted range when calibrating the 4 mA signal output.</p> <p>Response: Re-calibrate the 4 to 20 mA output – see page 35.</p>
DATA LOGGING ERRORS	
Log not empty!	<p>Interpretation: Not yet implemented.</p>
Log memory full	<p>Interpretation: This occurs when all the data logger memory locations are filled. The effect on the logging process will depend on the setting of the Memory rollover field in the REAL TIME LOGGER screen (which may be set to Stop or Overwrite).</p> <p>Response: Clear the logger memory, as described in Paragraph 3.6.4.</p>
BATTERY ERRORS	
Battery Low	<p>Interpretation: The battery has discharged to below 30% remaining. This leaves the instrument with approximately 4 hours remaining, depending on power usage, before it needs recharging.</p> <p>Response: Recharge the internal battery at the earliest opportunity. Do not leave the instrument for a prolonged period with a fully discharged battery.</p>
Battery Exhausted	<p>Interpretation: The battery is approaching a fully discharged state and the instrument is about to store the internal data and shut-down.</p> <p>Response: Recharge the battery.</p>



SET-UP ERRORS	
Pipe OD out of range	<p>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.</p> <p>Response: Enter a valid number.</p>
Wall thickness out of range	<p>Interpretation: You have entered an out-of-range value for the pipe wall thickness dimension – accepted range is 0.04 - 3.0 inches (1 to 75 mm).</p> <p>Response: Enter a valid number.</p>
Lining thickness out of range	<p>Interpretation: You have entered an out-of-range value for the lining thickness dimension – acceptable range is 0 - 0.4 inches (0 to 25 mm).</p> <p>Response: Enter a valid number.</p>
Temperature range	<p>Interpretation: You have entered an out-of-range value for the fluid temperature. Accepted temperature range -4°F to +572°F (-20°C to +300°C).</p> <p>Response: Enter a valid number.</p>
Invalid Date or Time	<p>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.</p> <p>Response: Enter a valid Date and Time.</p>
Sensors: INVALID	<p>Interpretation: The selected temperature is higher than the maximum allowed for the sensor type.</p> <p>Response: Select alternative sensors or change the temperature.</p>
Mode: Err Typ	<p>Interpretation: The selected sensors are invalid and the mode cannot be verified.</p> <p>Response: Select a valid sensor type and choose a mode that gives a non-zero separation distance.</p>

5.4 Test Block

A test block is included with the PUF equipment to allow the transducers and inter-connecting cables to be functionally checked.

1. Switch ON the instrument.
2. Select `Quick start` and enter the parameters shown in the table below for the appropriate transducer type (A or B):

Parameter	A Sensor	B Sensors
Pipe outside diameter	1.18 inch	1.97 inch
Pipe wall thickness	0.55 inch	0.87 inch
Pipe lining thickness	0.0	0.0
Pipe wall material	Plastic	Plastic
Fluid type	Water	Water
Mode	Diagonal	Diagonal
Temp	68°F	68°F

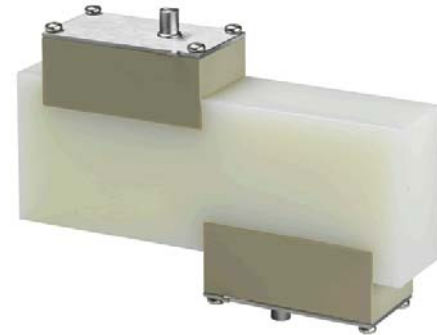


Figure 5.2 Test block

3. When the above data is entered, the `SENSOR SEPARATION` screen will be displayed.
4. Use the UP/DOWN scroll key to go to the `SENSOR SELECTION` menu. Select the appropriate sensor (the default will be "A") and press the ENTER key to return to the `SENSOR SEPARATION` menu.
5. Select `Sensor mode` and position the cursor at `Diagonal` and press ENTER to return to the `SENSOR SELECTION` menu.
6. Select `Exit` and press the ENTER key to return to the `SENSOR SEPARATION` screen.
7. Check that the parameters displayed are correct.
8. Apply acoustic couplant to the sensors and attach them to the test block with the connectors positioned towards the center of the test block as shown, and temporarily secure them in place using elastic bands or tape.
9. Connect the sensors to the PUF instrument using the cables provided.
10. Press ENTER to go to the `FLOW READING` screen.
11. Select the `Options` key to go to the `FLOW READING OPTION` menu and set the `Damping` to at least 10 seconds.
12. Select `Exit` and press the ENTER key to return to the `FLOW READING` menu.
13. The flow reading value displayed is not important. The fact that a reading is obtained indicates that the instrument is functioning. This value may fluctuate but this is normal.
14. The signal strength indicator at the left of the display should show 3–4 bars.



5.5 Microprocessor Reset Facility

In the rare event that the PUF instrument appears to totally hang-up, or the display is indistinguishable, you can reset its microprocessor by carefully inserting a straightened paperclip into the pinhole located in the right-hand side of the instrument to operate the internal reset switch. Hold the paperclip perpendicular to the instrument while doing this.

5.6 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 μs 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.



6: 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 65.6 ft/s, Bi-directional.
Turn Down Ratio:	100:1
Accuracy:	±0.5% to ±2% of flow reading for flow rate >0.66 ft/s and Pipe ID >3.0 inches (75 mm). ±3% of flow reading for flow rate >0.66 ft/s and Pipe ID in the range 0.5 to 3.0 inches (13 to 75 mm). ±6% of flow reading for flow rate < 0.66 ft/s.
Repeatability:	±0.5% of measured value or ±0.066 ft/s (±0.02 m/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/min, gal/h, USgals/min, USgals/h, Barrel/h, Barrel/day, m ³ /s, m ³ /min, m ³ /h.
Selectable Volume Units:	L, gal, USgals, Barrel, m ³ .
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 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 inch (13 to 115 mm) pipe OD (2 MHz). 'B-ST' (standard) 2 to 79 inch (50 to 2000 mm) pipe OD (1 MHz). '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).
DATA LOGGER	
Data Logged:	Log application details, flow rate. Logs data selected in setup, e.g L, gals, USgals, m ³ - units may be changed at time of download by selecting the corresponding unit on the keypad.
No. data points:	200K.
Time Stamping:	All data points are time stamped.
No. Sites:	20 sites.
No. Data Points Per Site:	All free memory can be allocated to any site up to a max of 200,000 data points.
Programmable Logging Interval:	5 seconds to 1 hour – Updating on screen the end time of memory remaining as sample units are selected. At overflow overwrite old data, or user selectable stop logging when memory is full. Logged data downloadable to PC via USB cable or RS232. Transfer to Windows® or Dwyer user-compatible software package (optional).
LANGUAGES	
Standard Supported Languages:	English, French, German, Italian, Spanish, Portuguese, Russian, Norwegian, Dutch, Swedish.
OUTPUTS	
USB Interface:	Supports USB 2.0 Full Speed (12Mbits/sec) mode, USB software driver provided.
Printer/Terminal:	Serial RS232-C inc. handshaking.
Analogue Output: Resolution: Alarm Currents: Isolation: Maximum Load:	4 to 20 mA, 0 to 20 mA, 0 to 16 mA. 0.1% of full-scale. Any between 0 to 26 mA. 1500 V Opto-isolated. 620 Ohms.
Pulse Output TTL: Max Current:	Opto-isolated MOSFET relay. 150 mA.
(Volumetric mode) Pulse Repetition Rate:	Up to 500 pulses/sec (depending on pulse width). 500 ms for 1 pulse/sec. 5 ms for 100 pulses/sec.
(Frequency mode) Max Pulse Frequency Flow at Max Frequency	200 Hz. 9999 gal/min.

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6: Specification



ELECTRICAL	
Supply Voltage:	
Input Voltage Range:	9 to 24 Vdc.
Power Consumption:	10.5 W.
Battery:	
Technology:	5-cell NiMH.
Capacity:	3.8 Ahr.
Operating time:	Typically 20 hours continuous with backlight and 4 to 20 mA output OFF.
Recharge Time:	6.5 Hours.
Service Life:	>500 charge/discharge cycles.
Power Supply/Charger:	
Manufacturer:	Mean Well type GE18I12-P1J.
Input Voltage Range:	90 to 264 Vac.
Input Frequency Range:	47 to 63 Hz.
Output Voltage:	12 Vdc.
Max. Output Current:	1.2 A.
Approvals:	CE.
MECHANICAL	
Carrying case:	
Rating:	All components are contained in a hard-wearing IP67 rated carrying case with a protective moulded foam insert.
Enclosure:	
Material:	Flame retardant injection moulded ABS.
Dimensions:	10.4 x 6.6 x 2.0 inches.
Weight (Including Battery):	2.4 lb.
Protection:	IP54.
Keypad:	
No. Keys:	16.
Display:	
Format:	240 x 64 pixel graphic display, high contrast black-on-white, with backlight.
Viewing Angle:	Min 30°, typically 40°.



ENVIRONMENTAL	
Operating Temperature:	-4°F to +125°F (-20°C to +50°C).
Storage Temperature:	-13°F to +150°F (-25°C to +65°C).
Operating Humidity:	90% RH MAX at +122°F.
Charging Temperature:	32°F to +104°F (0°C to +40°C).
APPROVALS	
Safety:	BS EN 61010.
EMC:	BS EN 61326 - 1:2006, BS EN 61326-2-3:2006.
Battery Charger:	EN61204 - 3.
SHIPPING INFORMATION	
Box Dimensions:	16.2 x 8 x 14 inches.
Weight:	16.5 lb.
Volumetric Weight:	11.0 lb.
<i>Dwyer reserve the right to alter any specification without notification.</i>	

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