



Series PUB 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 PUB 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 PUB 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 40 inches (13 to 1000 mm), depending on model, and constructed of almost any material. The instrument will also operate over a wide range of fluid temperatures.

The PUB series comprises two models which are identical in operation but designed to be used with a different range of pipe diameters. The PUB-A can be used with pipes in the range 0.5 to 4.5 inches (12.7 to 114 mm) and the PUB-B with pipes in the range 2 to 40 inches (50.8 to 1016 mm).

Easy to operate, the PUB standard features are:

- Large, easy to read graphic display with backlighting.
- Simple to follow dual function keypad.
- Simple 'Quick Start' set up procedure.
- Continuous signal monitoring.
- 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 PUB 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 waves to travel the same distance but in opposite directions is therefore directly proportional to the flow velocity of the liquid.

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

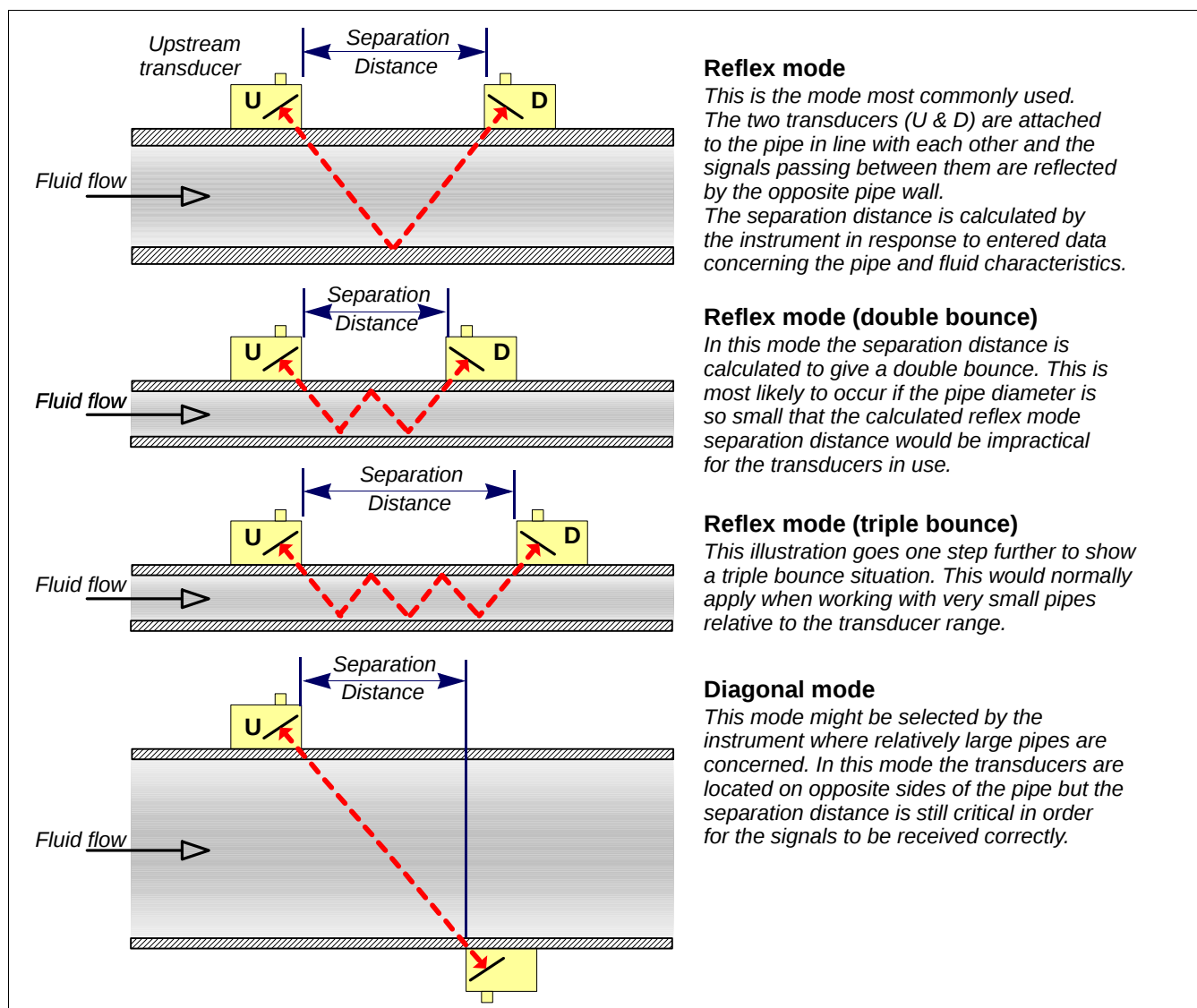


Figure 1.1 Operating modes



1.3 Supplied Hardware

The PUB equipment is supplied in a rugged polypropylene 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 PUB equipment

Standard equipment

- PUB instrument with backlit graphic display.
- Power supply - with UK, US, European adaptors. 110/240 VAC.
- 4 to 20 mA/Pulse Output cable.
- 2 lengths of chain.
- Test block.
- Transducer cables (x2) 79 inches (2m) long.
- Transducer set (x2) – type 'A' or type 'B' depending on model.
- Set of transducer holders used for mounting the transducers.
- Ruled separation bar (2-piece).
- Ultrasonic couplant with syringe dispenser used when mounting the transducers.
- Manual.



1.4 PUB Instrument

The PUB 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.

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

1.4.1 Connectors

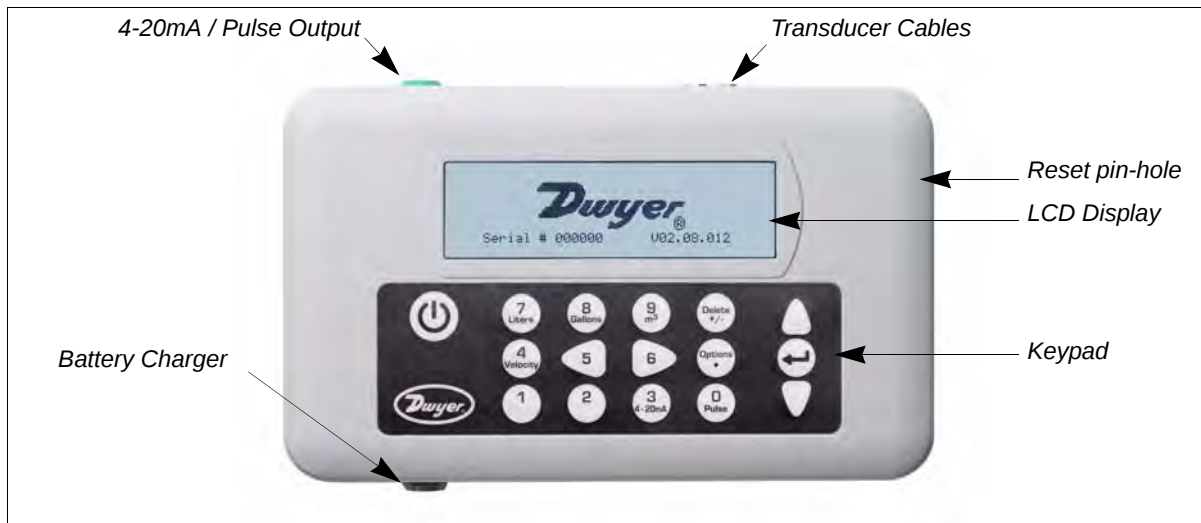


Figure 1.3 Instrument details

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.

4 to 20 mA and Pulse output connection

The 4 to 20mA / '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 PUB kit. The 'tails' on the free end of the cable must be terminated to suit the intended application.

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

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.

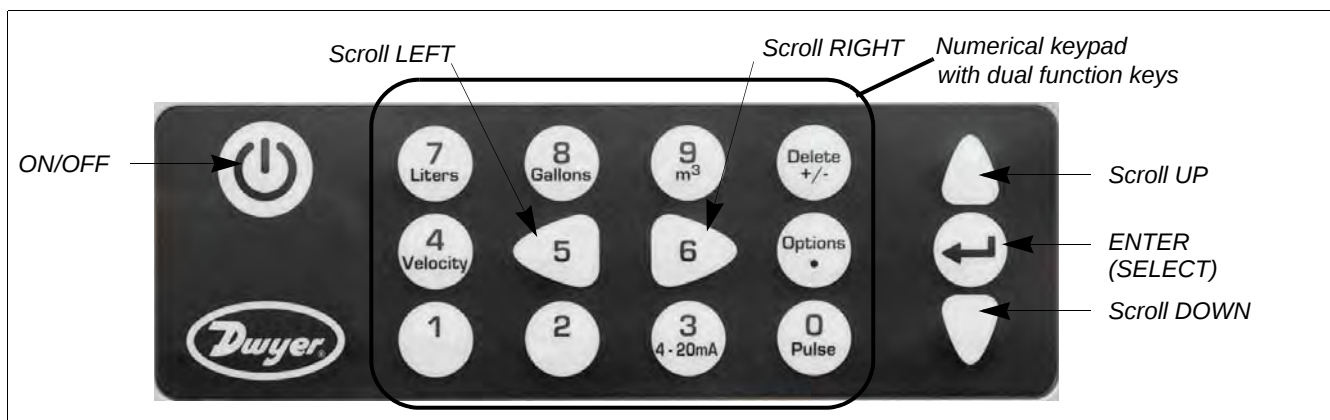


Figure 1.4 Keypad

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 PUB 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 beyond the bottom visible item. Menus generally 'loop around' if you scroll beyond the first or last items.

If you select Exit on any menu it usually takes you back up 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.

Note: Some of the features accessed by these keys are restricted in the PUB model range. An "Option not available" message is displayed if you select a restricted function.



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 20 hours 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

Different transducer sets are provided with the PUB-A and PUB-B models and are not interchangeable.



Key Point: Always use the transducers that were supplied with the instrument.

Transducer set 'A'

Supplied as standard with PUB-A for use on pipes in the range 0.5 to 4.5 inches (13 to 115 mm) OD.

Transducer set 'B'

Supplied as standard with PUB-B for use on pipes in the range 2 to 40 inches (50 to 1000 mm) OD.

2: Installation

2.1 Transducer Positioning

In many applications an even flow velocity profile over a full 360° is unattainable due, for example, to the presence of air turbulence at the top of the flow and possibly sludge in the bottom of the pipe. Experience has shown that the most consistently accurate results are achieved when the transducer holders are mounted at 45° with respect to the top of the pipe.

The PUB equipment expects a uniform flow profile as a distorted flow will produce unpredictable measurement errors. Flow profile distortions can result from upstream disturbances such as bends, tees, valves, pumps and other similar obstructions. To ensure a uniform profile, the transducers must be mounted far enough away from any cause of distortion such that it no longer has an effect.

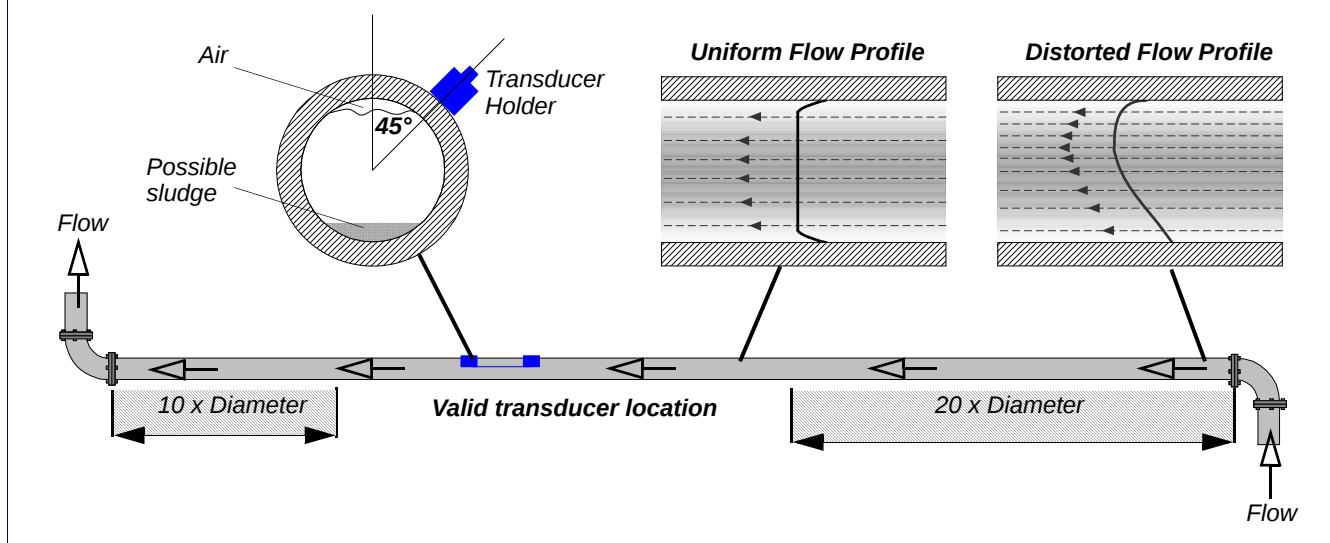


Figure 2.1 Locating the transducers

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

The transducers are fitted to adjustable transducer 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 PUB 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

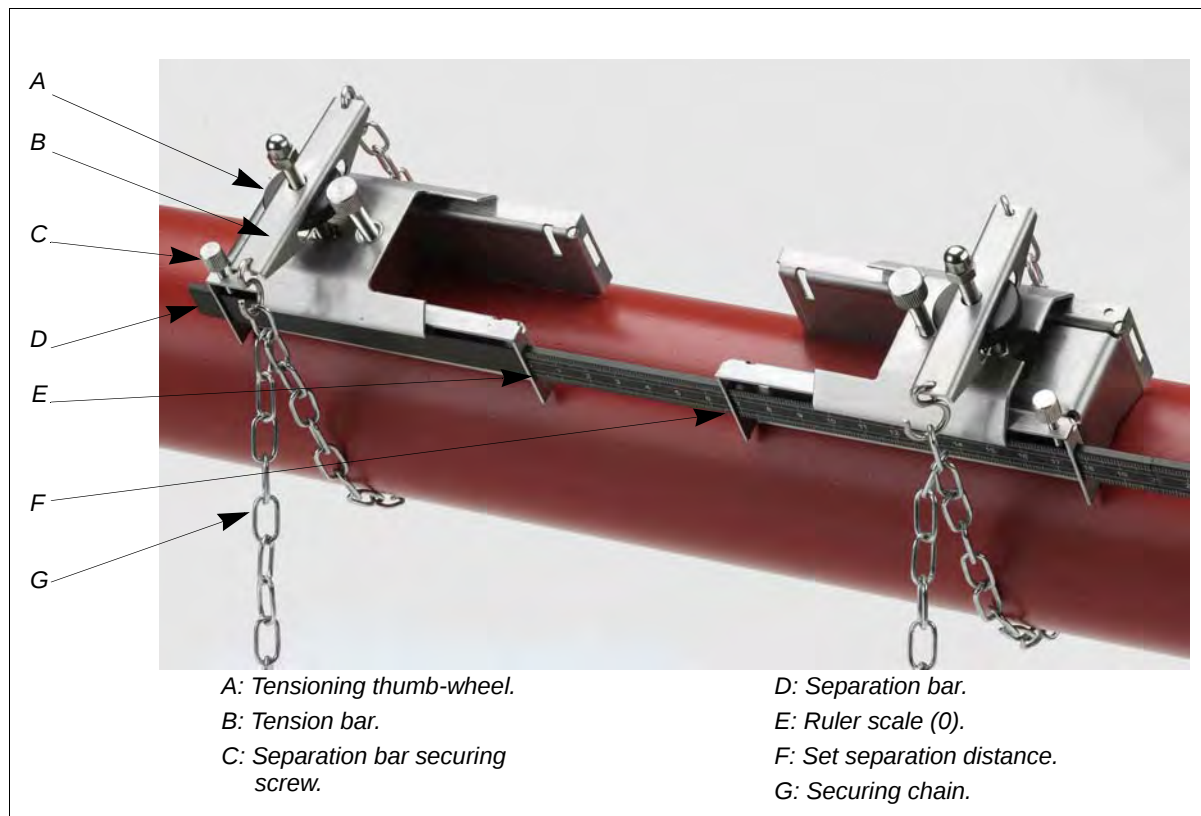


Figure 2.2 Transducer holder attachment

1. Slide the separation bar (D) into the front of the left hand transducer holder, align the front edge of the transducer 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 transducer holder, align the front edge of the transducer holder to the required separation distance (obtained from the PUB instrument) on the ruler (F), then secure it in place by tightening the thumbscrew.

3. On each transducer holder, attach one end of a securing chain to a hook on the tensioning bar (B), wrap the chain (G) around the pipe 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 guide block 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

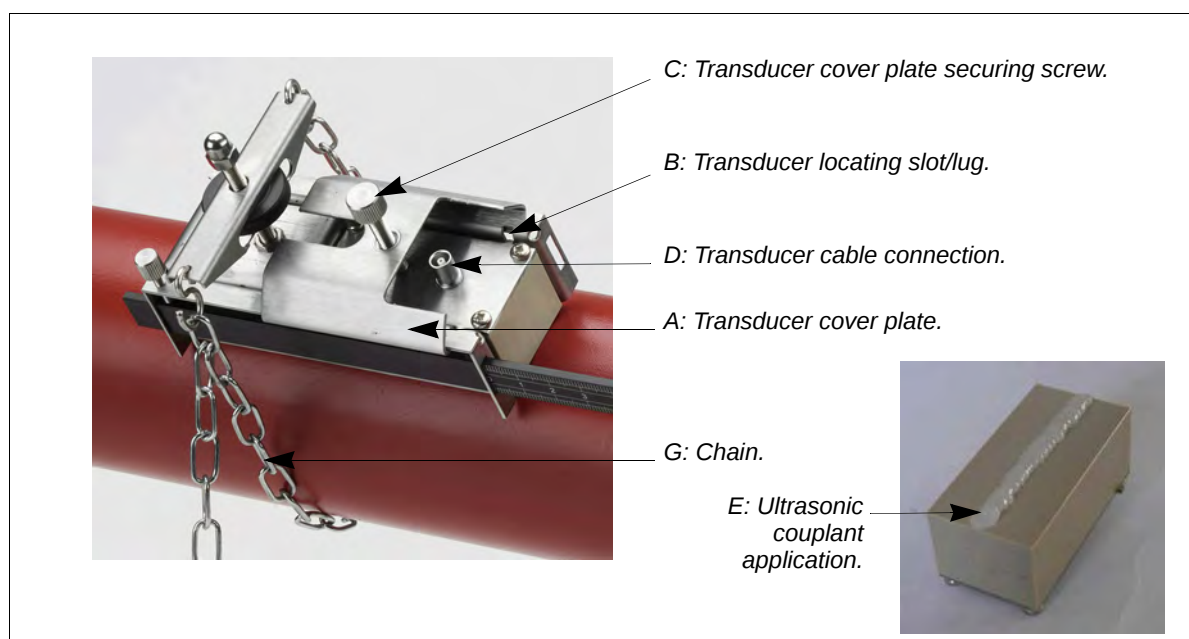
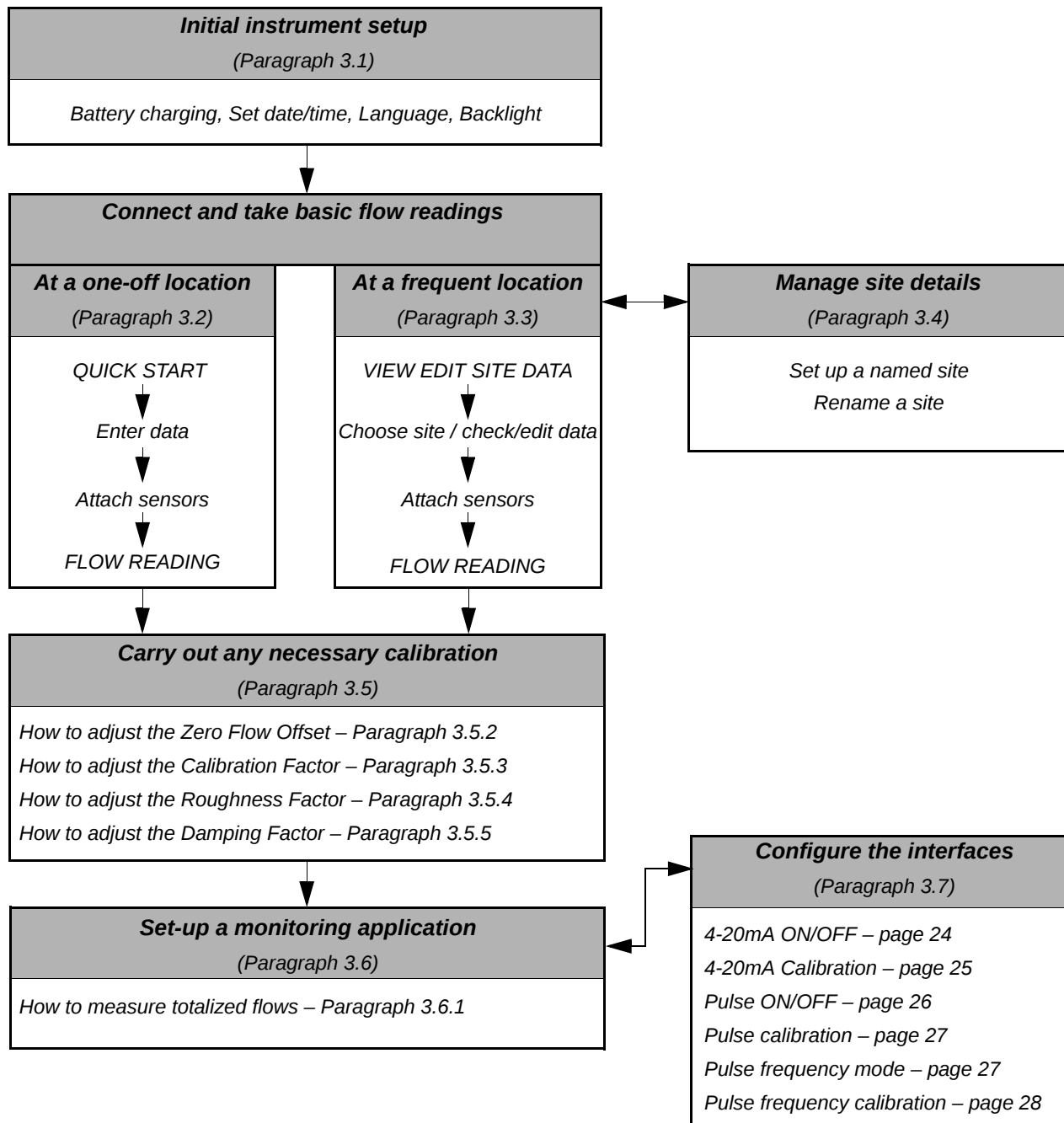


Figure 2.3 Fitting the transducers

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 1/10 inch 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 guide block (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 PUB 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 negative flow, swap the red and blue cables at the sensor end.



3: Operating Procedures





3.1 Setting-up the Instrument

3.1.1 Using the instrument for the first time

Before you use your PUB 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

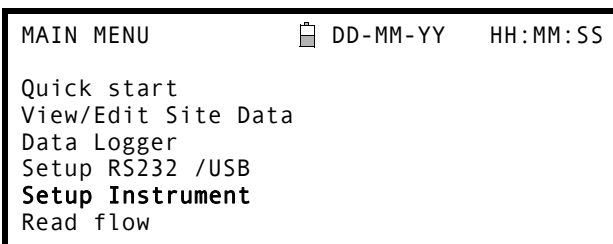
1. Connect the external battery charger to the charger socket at the bottom of the instrument then switch on the utility supply.
2. The instrument should indicate CHARGING and an animated battery symbol indicates that the battery is taking on charge.
3. Leave the instrument on charge for 6.5 hours before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



Note: Data Logger and RS232/USB functions are not implemented on the PUB.



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.

SETUP INSTRUMENT	DD-MM-YY HH:MM:SS
	Qxx.xx%
Set Date & Time	: dd-mm-yy hh:mm:ss
Calibrate 4-20mA	
Pulse status	
Backlight	: Disabled
Factory settings	
Change Language	
Exit	

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

3.1.2 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.

SETUP INSTRUMENT	DD-MM-YY HH:MM:SS
	Qxx.xx%
Set Date & Time	: dd-mm-yy hh:mm:ss
Calibrate 4-20mA	
Pulse output	
Backlight	: Disabled
Factory settings	
Change Language	
Exit	

3. Select the backlight time as required.
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.

BACKLIGHT	DD-MM-YY HH:MM:SS
	Qxx.xx%
Disabled	
10 seconds	
30 seconds	
1 minute	
ON-Permanently	



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 PUB 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 PUB, which then stores the site parameters (See Paragraph 3.4).

Before you can use the PUB 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? 3.0

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? 3.0
Pipe wall thickness? 0.2

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? 3.0
Pipe wall thickness? 0.2
Pipe lining thickness? 0.16

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%
Glycol/water 30%
Lubricating oil

Diesel
Freon
Other (m/s)

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

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

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

14. Select Continue . . and press the ENTER key.

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

Enter Fluid Temperature

°C: 5.00
°F: 41.00
Continue..



3: Operating Procedures

15. The SENSOR SEPARATION screen now displays a summary of the entered parameters and informs you of the mode of operation and the distance to set up between the sensors. It also shows the type of sensors in use – i.e. A-ST in the case of PUB-A and B-ST for PUB-B. In this example it shows the sensors operating in the 'Reflex' mode spaced at 1.7 Inches apart. Take a note of these details.

```
SENSOR SEPARATION  DD-MM-YY  HH:MM:SS
Site      : Quickstart
Pipe      : 0.40 Inches
Wall      : 0.20 Inches
Sensors   : A-ST      Reflex
Temperature : 5.00°C 41.00°F
Set sensor separation to 1.7 Inches
Press ← to continue, Δ▽ to select sens.
```

16. Take a note of the displayed parameters, then press the ENTER key.
17. 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: Do not press the ENTER key until the transducers are fitted and connected to the instrument.

Attaching and connecting the transducers

18. Fit the 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.
19. 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

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

```
Please wait..
Checking signals
```

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

22. 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.
23. 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 measurement units by pressing keys 7 (liters), 8 (Gallons, Barrels) or 9 (m³), or change the display to show velocity by pressing key 4.

3.3 Using the System at a Regularly Monitored Location

Setting up the PUB 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 any 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.
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.

VIEW EDIT SITE DATA DD-MM-YY HH:MM:SS
Qxx.xx%

Choose from list of sites

Site name : MySite

Dimensions : Inches

Pipe outside diameter: 4.00

Pipe wall thickness : 0.20

Pipe lining thickness: 0.16

Pipe wall material : Mild Steel

Lining material : -----

Sensor set : A-ST

Sensor mode : Reflex

Fluid type : Water

Save current site & read flow

Delete this Site

Download & save current site

Exit

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

Enter Fluid Temperature

°C: 5.00

°F: 41.00

Continue..



3: Operating Procedures

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 1.7 inches apart.

```
SENSOR SEPARATION  DD-MM-YY HH:MM:SS
Site      : MySite
Pipe      : 4.00 Inches
Wall      : 0.20
Sensors   : A-ST      Reflex
Temperature : 5.00°C  41.00°F
Set sensor separation to 1.7 Inches
Press ← to continue,△▽ to select sens.
```

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.

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

Attach Sensor Set

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

Note: If you press the ENTER key before the transducers are fitted and connected to the instrument, the instrument will detect a low signal strength and may indicate an ERROR condition.

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 from 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 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.



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 PUB 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

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.

```
VIEW EDIT SITE DATA  DD-MM-YY  HH:MM:SS
                        Qxx.xx%

Choose from list of sites
Site name              : EmptySite1
Dimensions              : Inches
Pipe outside diameter: 4.00
Pipe wall thickness   : 0.20
Pipe lining thickness : 0.16
```

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.

```
ALTER NAME  DD-MM-YY  HH:MM:SS

Site name              : EmptySite1

Do you wish to:-
  Alter the Site Name
  Exit
```

8. Scroll down through the menu list and enter/change the pipe parameters and other data pertaining to the site.

```
VIEW EDIT SITE DATA  DD-MM-YY  HH:MM:SS
                        Qxx.xx%

Choose from list of sites
Site name              : MyNewSite
Dimensions              : Inches
Pipe outside diameter: 4.00
Pipe wall thickness   : 0.20
Pipe lining thickness : 0.16
```

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 Exit to return to the MAIN MENU.

```
Pipe wall material      : Mild Steel
Lining material         : -----
Sensor set              : A-ST
Sensor mode             : Reflex
Fluid type              : Water
Save current site & read flow
Delete this Site
Exit
```

Note: The 'Download & save current site' option is disabled in the PUB range.



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 select a current site name to change rather than an EmptySite.

3.5 Instrument Calibration

The PUB 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 (0.033 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.

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			

3.5.2 Adjusting the set zero flow offset

The PUB 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 (0.0016 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 the ENTER key 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 the flow via Quick Start or switch the PUB 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 PUB 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 PUB's totalizer facility and zero it (Paragraph 3.6.1).
2. Run the PUB'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 PUB and reference meters. If the error is greater than $\pm 1\%$ calibrate the PUB 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 PUB 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		
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: - Fine planed, polished surface - Plane surface - Rough planed surface	0.01
Welded steel pipes, new: - Long usage, cleaned - Lightly and evenly rusted - Heavily encrusted	0.1
Cast iron pipes: - 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			
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 READING 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 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			
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 Functions

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 then press the ENTER key.
3. Select Reset +Total and press the ENTER key.
4. Press the ENTER key on 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 then 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 then press the ENTER key to return to the FLOW READING screen which will now indicate the instantaneous flow together with the totalized flow.
Note that in some installation the measured flow can be in either direction. When this is the case, the upstream flow is shown separately in the - Total field.

```
FLOW READING  DD-MM-YY  HH:MM:SS
Signal
12.34 gal/min
+Total: 300.0 gal
-Total: 0.00 gal
```

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 take the difference between the indicated positive and negative flow totals before carrying out the average flow rate calculation.



3.6.2 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.

3.7 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.

3.7.1 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.

4-20 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		

4-20 mA OUTPUT	DD-MM-YY	HH:MM:SS
Off	Qxx.xx%	
4-20mA		
0-20mA		
0-16mA		

4 to 20 mA signal calibration and ranging



Key Point: The 4 to 20 mA output has been calibrated at 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.



3: Operating Procedures

Signal calibration

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

```
SETUP INSTRUMENT      DD-MM-YY HH:MM:SS
                        Qxx.xx%
Set Date & Time : dd-mm-yy hh:mm:ss
Calibrate 4-20mA
Pulse output
Backlight : Disabled
Factory settings
Change Language
```

Exit

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
                    Qxx.xx%
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
                    Qxx.xx%
Adjust the output current to 20mA
Use Δ▽ to set, 5/6 to trim

DAC Value:          40000

Press ↵ when done
```

4-20mA Signal scaling

Note: The 4 to 20 mA output 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
```

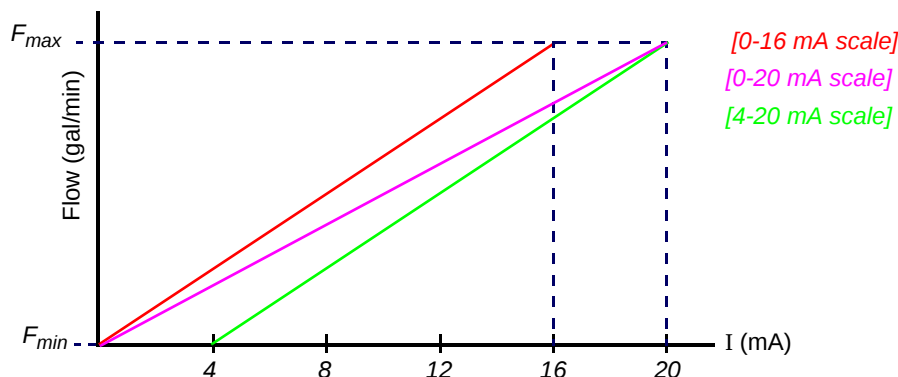
Exit

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.



Convert the measured current to flow rate

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



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

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

3.7.2 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
Pulse output is ON	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
Pulse output is ON	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 setting.

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
A1 Pulse Frequency is ON	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>All Pulse Frequency is ON</i>		
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.



4: Maintenance & Repair

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



WARNING

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

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.

4.1 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, which is normally invoked by selecting Read Flow in the main menu, is automatically run until a good quality signal is found.

5.2 General Troubleshooting Procedure

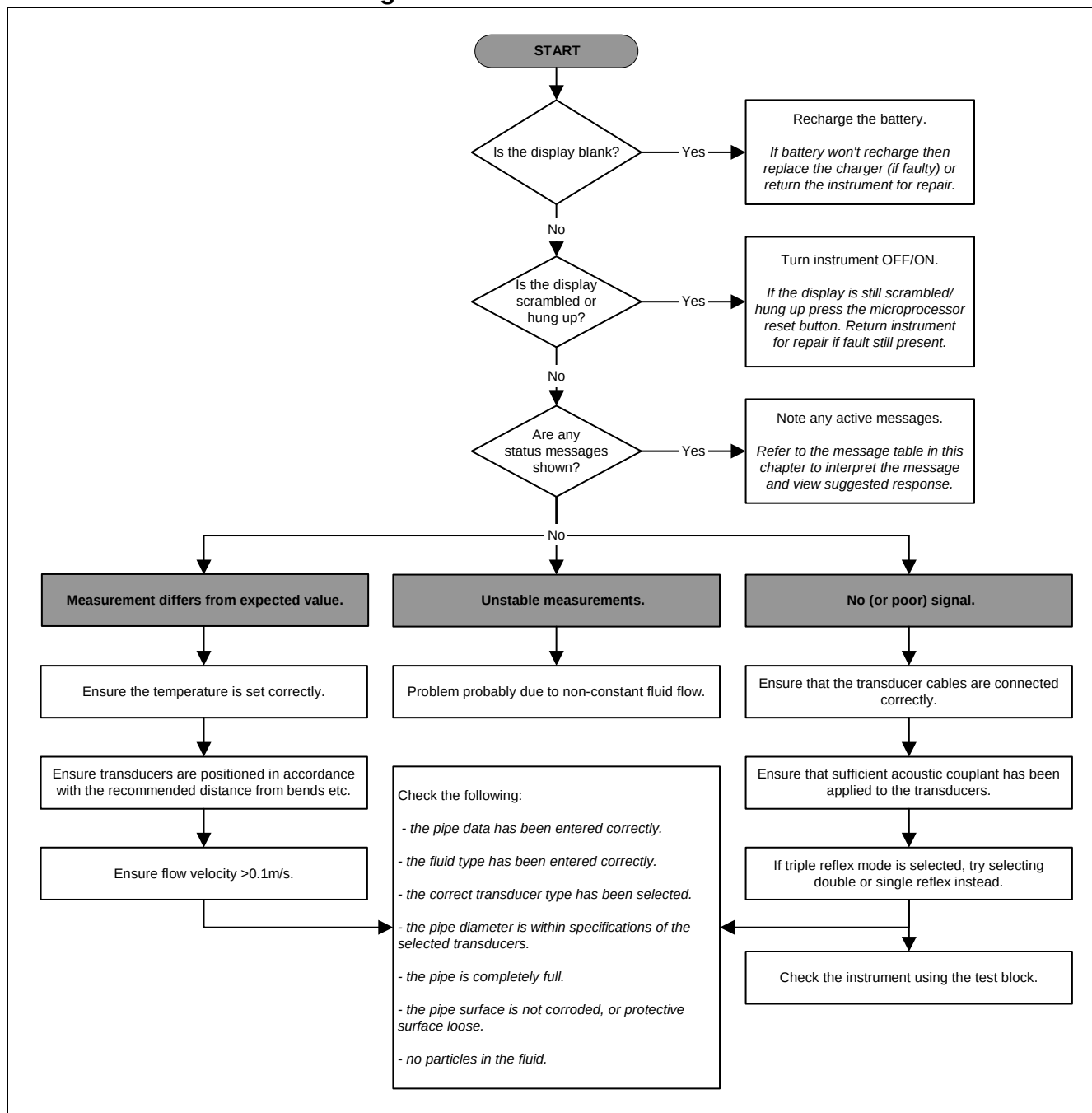


Figure 5.1 Troubleshooting chart



5.3 Warning & Status Messages

FLOW RATE ERRORS	
No flow signal	Interpretation: This message appears when the transducers cannot send or receive signals to each other. Response: Check that all cables are connected, transducers are on the pipe correctly with sufficient couplant on the face.
Flow signal is poor	Interpretation: This warning appears when the signal is lower than 25%. Response: This could be due to an application problem, a poor quality pipe – see also the conditions for No flow signal (above). Check for sufficient couplant.
Zero cut-off error!	Interpretation: You have entered an out-of-range value in the Zero cutoff field in the Options menu. Response: Enter a valid number.
Totalizer beyond maximum!	Interpretation: The totalizer has overflowed its maximum count. The counter will roll-over and restart from zero but this message alerts you to the fact. Response: Reset the totalizer as described on page 23.

PULSE ERRORS	
Pulse Rate > Max	Interpretation: The flow rate exceeds the capability of the pulse output – i.e. too many pulses per second are required than can be achieved. Response: Narrow the pulse width time or increase the volume per pulse, as described on page 27.
Pulse volume error!	Interpretation: You have entered an out-of-range value in the Pulse volume error field in the PULSE OUTPUT menu – see page 27. Response: Enter a valid number.
Pulse width error	Interpretation: You have entered an out-of-range value in the Pulse width error field in the PULSE OUTPUT menu – see page 27. Response: Enter a valid number.



4-20mA ERRORS	
mA out > Max	Interpretation: The actual flow is higher than the maximum set on the mA range. Response: Re-scale the 4 to 20 mA output to be able to cope with the higher flow – see page 24.
Calibration 20mA Error!	NOTE: The 4 to 20 mA output is calibrated before the instrument leaves the factory and should not require further adjustment. Interpretation: You have adjusted the DAC outside its accepted range when calibrating the 20 mA signal output. Response: Re-calibrate the 4 to 20 mA output – see page 24.
Calibration 4mA Error!	NOTE: The 4 to 20 mA output is calibrated before the instrument leaves the factory and should not require further adjustment. Interpretation: You have adjusted the DAC outside its accepted range when calibrating the 4 mA signal output. Response: Re-calibrate the 4 to 20 mA output – see page 24.

SET-UP ERRORS	
Pipe OD out of range	Interpretation: You have entered an out-of-range value for the pipe outside diameter dimension – i.e. larger or smaller than the unit or sensor can be used on. Response: Enter a valid number.
Wall thickness out of range	Interpretation: You have entered an out-of-range value for the pipe wall thickness dimension – accepted range is 0.4 to 3 inches (1 to 75 mm). Response: Enter a valid number.
Lining thickness out of range	Interpretation: You have entered an out-of-range value for the lining thickness dimension – acceptable range is 0 to 0.4 inches (0 to 25 mm). Response: Enter a valid number.
Temperature range	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). Response: Enter a valid number.
Invalid Date or Time	Interpretation: The entered Date or Time is invalid, or when setting up 'timed' data logging the Stop time is set earlier than the Start time. Response: Enter a valid Date and Time.

Sensors: INVALID	Interpretation: The selected temperature is higher than the maximum allowed for the sensor type. Response: Enter a different temperature.
Mode: Err Typ	Interpretation: The selected sensors are invalid and the mode cannot be verified. Response: Select a mode that gives a non-zero separation distance.

BATTERY ERRORS	
Battery Low	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. Response: Recharge the internal battery at the earliest opportunity. Do not leave the instrument for a prolonged period with a fully discharged battery.
Battery Exhausted	Interpretation: The battery is approaching a fully discharged state and the instrument is about to store the internal data and shut-down. Response: Recharge the battery.

5.4 Test Block

A test block is included with the PUB 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 Sensors	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	
Pipe wall material	Plastic	
Fluid type	Water	
Mode	Diagonal	
Temp	68°F	



Figure 5.2 Test block

3. When the above data is entered, the SENSOR SEPARATION screen will be displayed.
4. Press either the UP/DOWN cursor keys to go to the SENSOR SELECTION 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 **ENTER** 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 PUB 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 **ENTER** 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 PUB 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 (μ s)

This is a value the instrument predicts will be the time in μ secs 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 (μ s)

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 μ s below the calculated μ s 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-seconds, 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 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:	< 500ms 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, m³/s, m³/min, m³/h.
Selectable Volume Units:	L, gal, USgals, Barrel, m³.
Total Volume:	12 Digits - forward and reverse.
APPLICABLE FLUID TYPES	
Fluid Condition:	Clean liquids or oils that have less than 3% by volume of particulate content. Applications include river water, sea water, potable water, demineralized water, glycol/water mix, hydraulic systems and diesel oil.
APPLICABLE PIPE TYPES	
Pipe Materials:	Any sonic conducting medium such as Carbon Steel, Stainless Steel, Copper, UPVC, PVDF, Concrete, Galvanized Steel, Mild Steel, Glass, Brass. Including Lined Pipes - Epoxy, Rubber, Steel, Plastic.
Pipe Dimension (outside diameter):	PUB-A 0.5 to 4.5 inches (13 to 115 mm). PUB-B 2.0 to 40.0 inches (50 to 1000 mm).
Pipe Wall Thickness:	0.04 to 3.0 inches (1 to 75 mm).
Pipe Lining:	Applicable pipe linings include Rubber, Glass, Concrete, Epoxy, Steel.
Pipe Lining Thickness:	0.0 to 1.0 inches (0 to 25 mm).
Pipe Wall Temperature Range:	Sensor operating temperature is -4°F to +275°F (-20°C to +135°C).



TRANSDUCER SETS	
Standard transducers:	Temperature Range -4°F to +275°F (-20°C to +135°C). 'PUB-A' (standard) 0.5 to 4.5 inch (13 to 115 mm) pipe OD (2 MHz). 'PUB-B' (standard) 2 to 79 inch (50 to 2000 mm) pipe OD (1 MHz).
LANGUAGES	
Standard Supported Languages:	English, French, German, Italian, Spanish, Portuguese, Russian, Norwegian, Dutch, Swedish.
OUTPUTS	
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: (Volumetric mode) Pulse Repetition Rate: (Frequency mode) Max Pulse Frequency Flow at Max Frequency	Opto-isolated MOSFET relay. 150 mA. Up to 500 pulses/sec (depending on pulse width). 500 ms for 1 pulse/sec. 5 ms for 100 pulses/sec. 200 Hz. 9999 gals/min.
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 GE18112-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.



6: Specification

MECHANICAL	
Carrying case:	
Rating:	All components are contained in a hard-wearing polypropylene 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 +149°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:	20 x 5 x 16.5 inches.
Weight:	13.2 lb.
Volumetric Weight:	9.9 lb.
<i>Dwyer reserve the right to alter any specification without notification.</i>	