

USER'S GUIDE

Installation & Operation
Instructions

Portaflow
Model PT500
Manual Series A.2.3

PORTAFLOW PT500

Portable Ultrasonic Flowmeter

User's Guide



www.greyline.com

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1: General Description

1.1 Introduction

This manual describes the operation of the Greyline Portaflow PT500 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 Portaflow PT500 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 13mm up to 2000mm and constructed of almost any material. The instrument will also operate over a wide range of fluid temperatures.

Easy to operate, the Portaflow PT500 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
- 4-20mA, 0-20mA or 0-16mA 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 metres 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 demineralised water.

Typical Portaflow PT500 applications include:

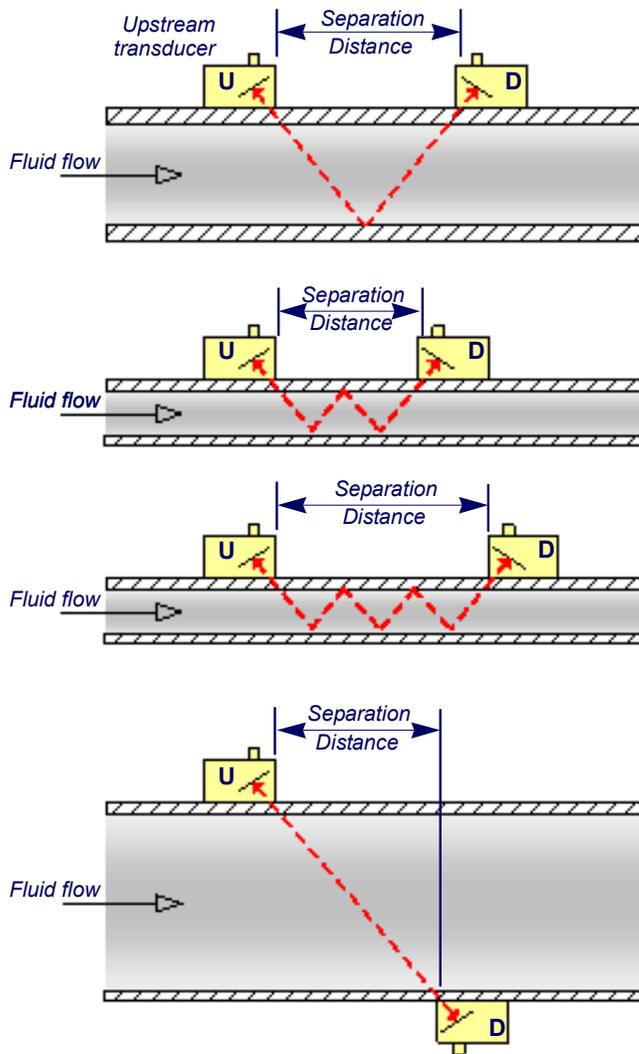
- River water
- Seawater
- Potable water
- Demineralised water
- Treated water

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 Portaflow PT500 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 Portaflow 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 Portaflow 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 Portaflow 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 Portaflow equipment

Standard equipment

- Portaflow PT500 instrument with backlit graphic display
- Power supply - with UK, US, European adaptors. 110/240VAC
- 4-20mA/Pulse Output cable, USB cable and RS232-C cable
- 2 lengths of chain each at 3.3 metres long
- Test block
- Transducer cables (x2) 2 metres long
- Transducer set 'A' (Transducers x2)
- Transducer set 'B' (Transducers x2)
- Set of guide rails for use with 'A' or 'B' transducers
- Ruled separation bar (2-piece)
- Manual (on CD)

Optional equipment

- High temperature transducer sets 'A' and 'B' (-20 to +200°C).
- Extreme temperature transducer sets 'A' and 'B' (-20 to +300°C) (future option, not yet available).
- Transducer set 'D' – used for monitoring pipes of 1500mm to 5000mm diameter, over a temperature range -20°C to +80°C. Kit is supplied in a separate case and includes the sensors together with ratchet straps and guide rails for attaching to the pipe.
- Bluetooth printer ASL Ap1300-BT (thermal type).

1.4 Portaflow PT500 Instrument

The Portaflow PT500 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 totalised 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 current or variable 'pulse' output proportional to the detected flow rate. These outputs, which can be used with a range of external interface devices such as those found in BMS or site monitoring systems, can be calibrated to suit a particular flow range.

1.4.1 Connectors

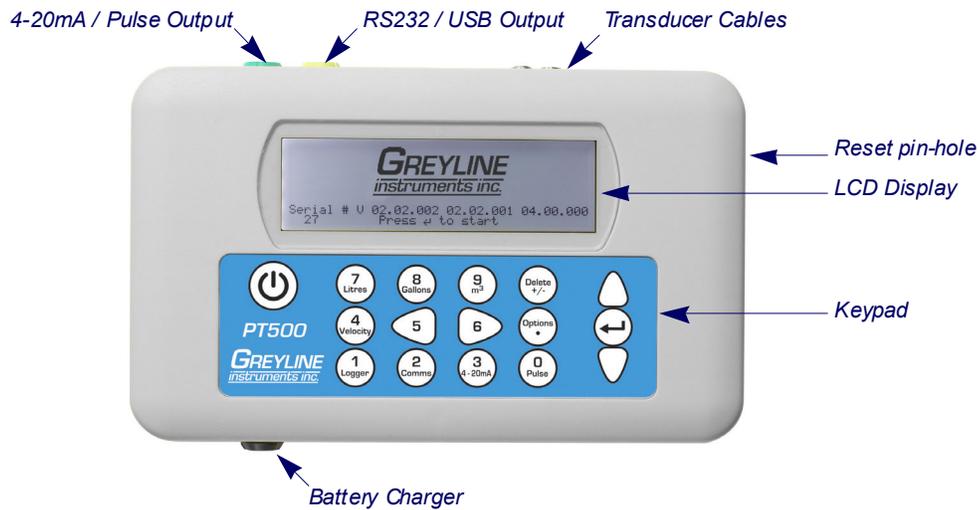


Figure 1.3 Instrument details

Transducer connections

The transducers are connected to two colour-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 Portaflow PT500 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.

4-20mA and Pulse output connection

The 4-20mA / '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 Portaflow PT500 kit. The 'tails' on the free end of the cable must be terminated to suit the intended application.

- Red – 4-20mA positive
- Black – 4-20mA negative
- White – Pulse output
- Green – Pulse return
- Brown – Set Point (not in present use)
- Blue – Set Point return (not in present use)
- Thick Black – Cable screen

Battery charger connection

The supplied battery charger is connected to the instrument by means of the grey 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.

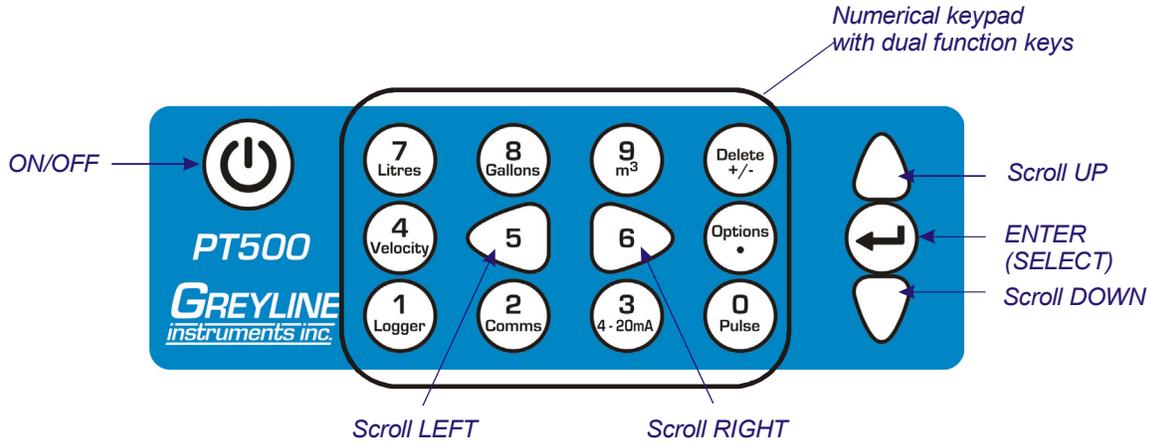


Figure 1.4 Keypad

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 initialisation 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 Portaflow PT500 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 centre 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 utilisation and backlight usage.

If the backlight has been enabled the display is illuminated for 10 seconds every time a key is pressed. If the backlight is active continuously it would reduce the available battery operating time to 8hrs. Similarly, if the 4-20mA output is used constantly at 20mA, the battery life would reduce by 20%. It is therefore beneficial to turn off the backlight and 4-20mA 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 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 programme 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 Greyline for advice if needed.

Transducer set 'A'

Supplied as standard for use on pipes 0.51" to 4.525" (13mm to 115mm) outside diameter.

Transducer set 'B'

Supplied as standard for use on pipes 1.97" to 78.74" (50mm to 2000mm) outside diameter.

Transducer set 'D'

Type 'D' transducers are optional equipment that can be used by the Portaflow PT500 on pipes from 59" to 196" (1500mm to 5000mm). They are supplied complete with ratchet straps for 'diagonal mode' attachment.

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 guide rails are mounted at 45° with respect to the top of the pipe.

The Portaflow 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.

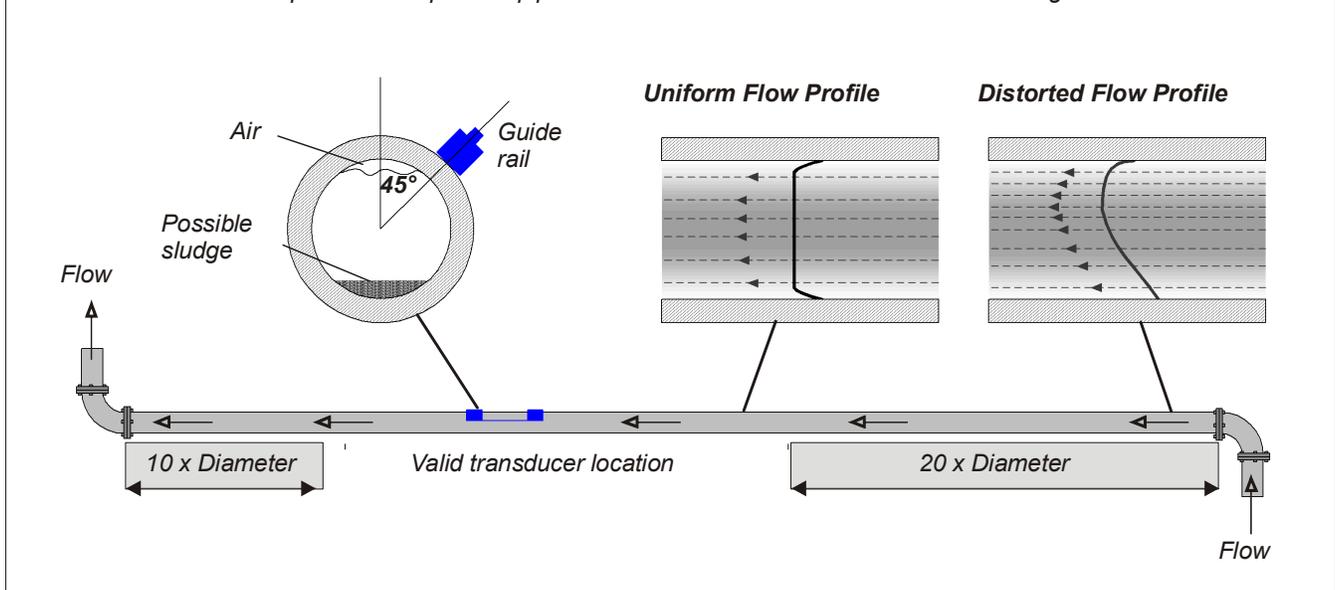


Figure 2.1 Locating the transducers

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 (Type 'A' & 'B')

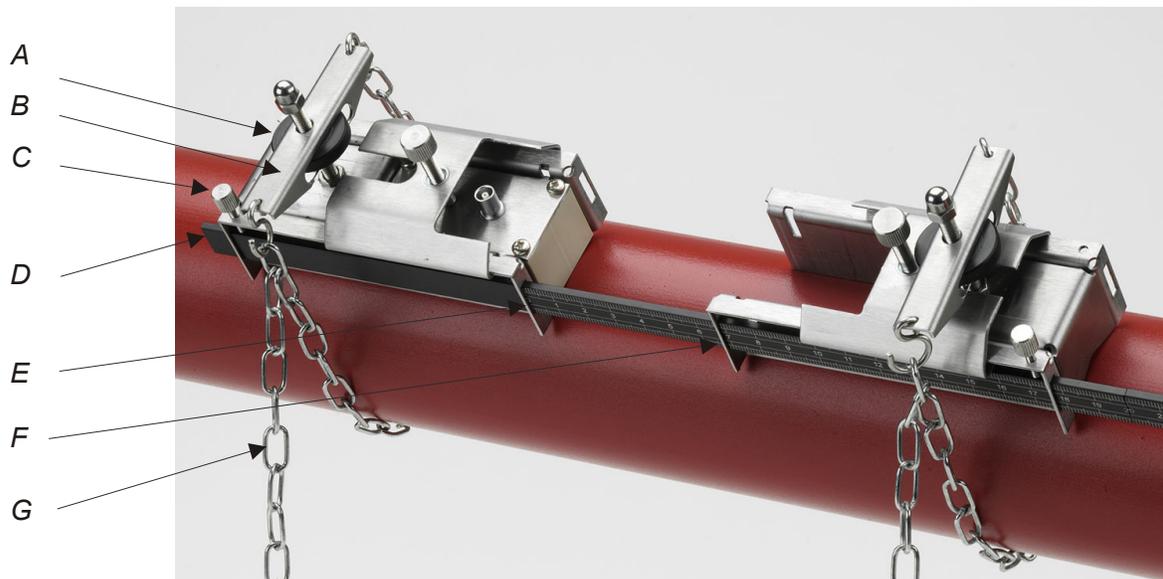
Type 'A' & 'B' transducers are fitted to adjustable guide rails which are secured to the pipe using wrap-around chains and mechanically connected together by a steel separation bar. The separation bar also acts as a ruler to allow the distance between the transducers to be accurately set to the value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

When fitting the guide rails 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 guide rails



- | | |
|-----------------------------------|-----------------------------|
| A: Tensioning thumb-wheel. | D: Separation bar. |
| B: Tension bar. | E: Ruler scale (0). |
| C: Separation bar securing screw. | F: Set Separation distance. |
| | G: Securing chain. |

Figure 2.2 Guide rail attachment

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

- 3 On each guide rail, 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 whilst keeping the chain as tight as possible.
4. Rotate the complete guide rail 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

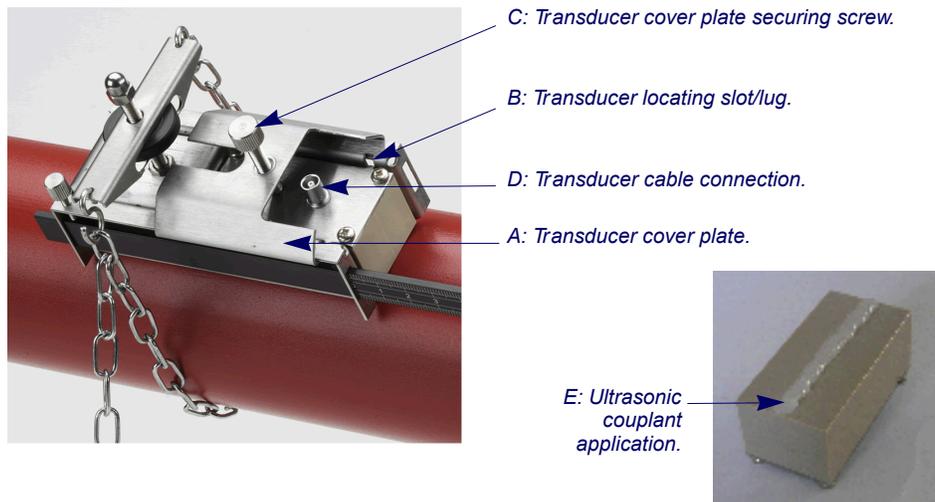


Figure 2.3 Fitting the transducers

1. Slide the transducer cover plate (A) fully towards the outside of the guide 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" (3mm) bead of ultrasonic couplant along the centre length of the transducer (E).
4. Fit the transducer into the guide block – 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 Portaflow instrument using the coaxial cables provided. The RED cable must be connected to the upstream transducer and the BLUE cable to the downstream transducer.

2.3 Installing the USB Virtual Com. Port

The USB connection requires a virtual com port to be installed on the computer. The necessary driver can be provided by Greyline 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 Portaflow PT500 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 below.

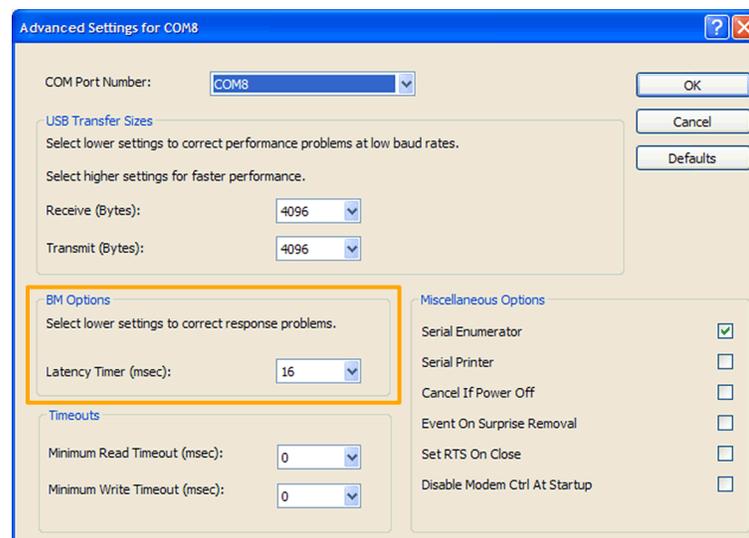
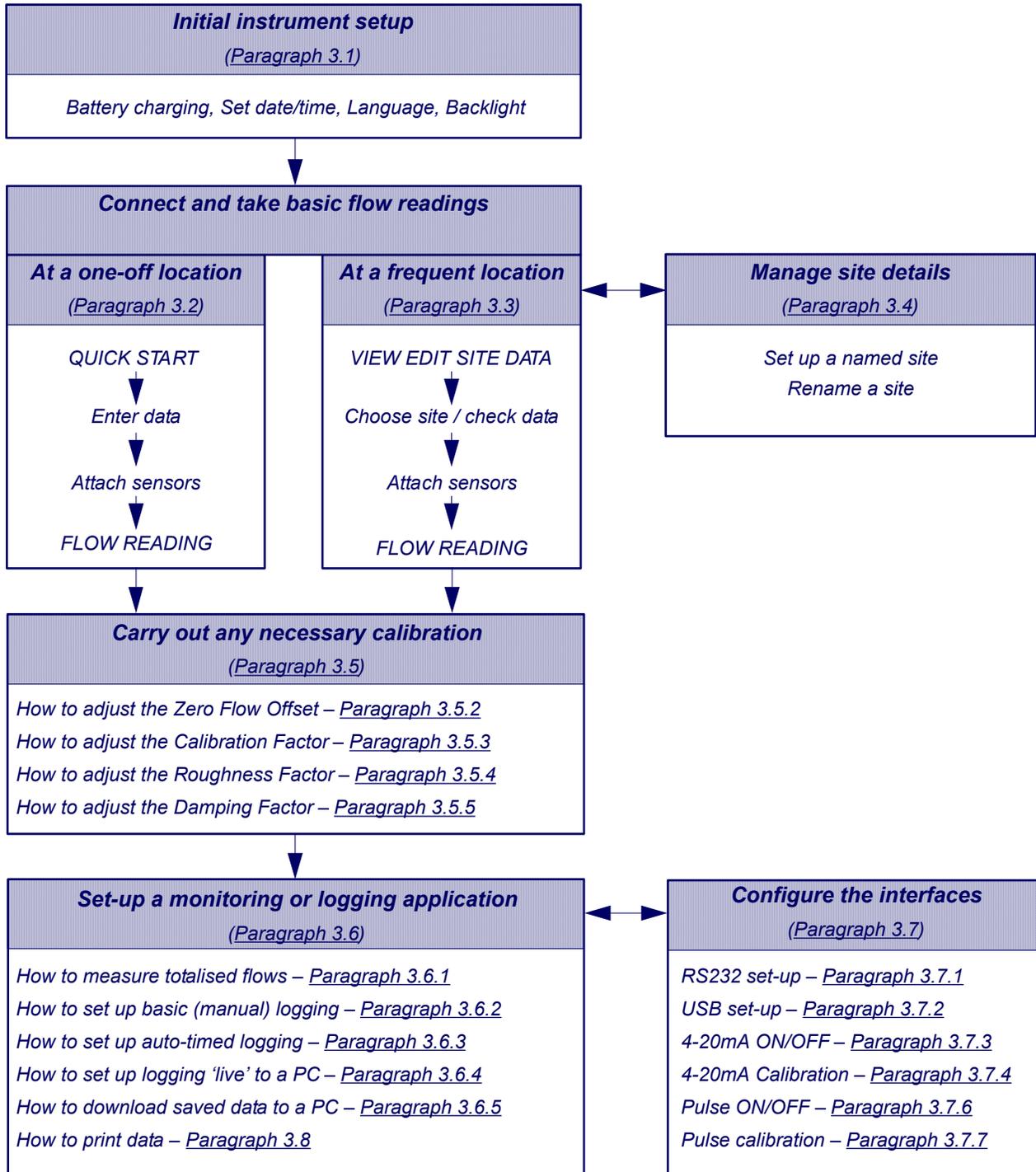


Figure 2.4 Com. Port configuration

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 Portaflow PT500 instrument via the USB port in the same way as any other standard USB device.

3: Operating Procedures



3.1 Setting-up the Instrument

3.1.1 Using the instrument for the first time

Before you use your Portaflow PT500 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

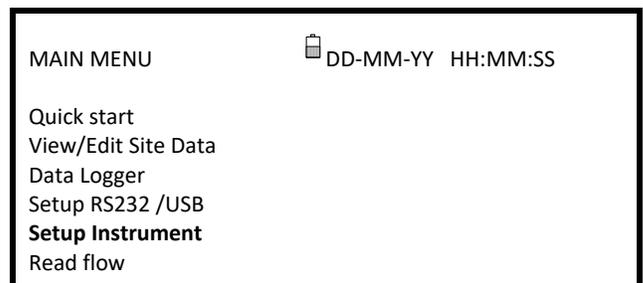
1. Connect the external battery charger to the charger socket at the bottom of the instrument then switch on the utility supply.
2. The instrument should indicate CHARGING and an animated battery symbol indicates that the battery is taking on charge.
3. Leave the instrument on charge for 6.5 hours before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



Selecting a language

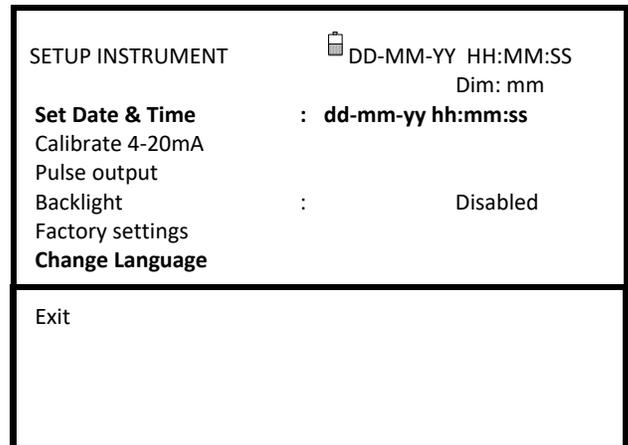
The first time you switch on the instrument you may be asked to select a user language.

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 initialisation screen will be displayed, giving details of the instrument's serial number and software revision details.
5. Press ENTER 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 click ENTER.
3. A flashing cursor should appear under the first date number. Enter the date sequence in dd-mm-yy order then press ENTER.
4. Repeat this action to set the time.
5. Select Exit then press ENTER to return to the MAIN MENU.

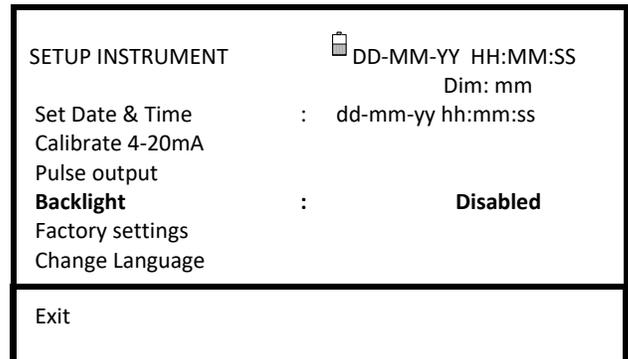


Note: If you make a mistake when entering the data press the Delete key to move the cursor back to the number you wish to change, then continue. If you enter an invalid number an 'ERR:Invalid Date or Time!' error message is displayed on the second line of the screen. If this occurs repeat the set date/time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

3.1.2 Enabling/disabling the backlight

When the backlight is enabled it will illuminate for 15 seconds every time a key is pressed so if it 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 ENTER.



3. Select Enable or Disable as required.
4. Press ENTER to return to the SETUP INSTRUMENT screen.
5. Select Exit then press ENTER to return to the MAIN MENU.



3.2 Using the Quick Start Menu

If you want to perform a 'one-off' flow reading at a particular pipe location the Quick Start menu provides the quickest way to set up the Portaflow 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 Portaflow PT500, which then stores the site parameters (See Managing Named Sites).

Before you can use the Portaflow 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 ENTER. You will then be presented with a series of screens in which to enter the data mentioned above.

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

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

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

OUTSIDE DIAMETER		DD-MM-YY HH:MM:SS
Dimension:		mm
Pipe outside diameter?		58.0

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

PIPE WALL THICKNESS		DD-MM-YY HH:MM:SS
Dimension:		mm
Pipe outside diameter?		58.0
Pipe wall thickness?		4.0

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

6. Press ENTER to continue.

PIPE LINING THICKNESS		DD-MM-YY HH:MM:SS
Dimension:		mm
Pipe outside diameter?		58.0
Pipe wall thickness?		4.0
Pipe lining thickness?		0.0

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

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

PIPE WALL MATERIAL	DD-MM-YY HH:MM:SS
Select pipe wall material	
Mild Steel S' less Steel 316 S' less Steel 303 Plastic	
Cast Iron Ductile Iron Copper Brass Concrete Glass Other (m/s)	

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

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

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

PIPE LINING MATERIAL	DD-MM-YY HH:MM:SS
Select pipe lining material	
Steel Rubber Glass Epoxy	
Concrete Other (m/s)	

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

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

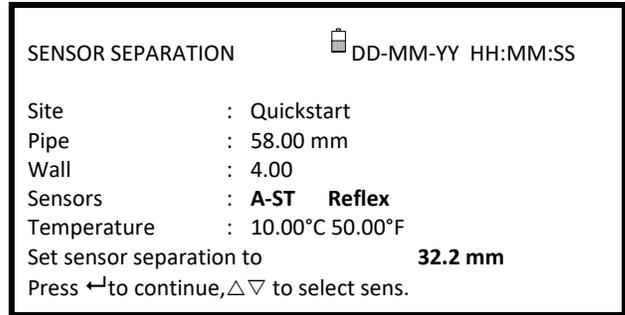
12. Enter the new temperature value and press the ENTER key.

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

14. Select Continue.. and press ENTER.

FLUID TEMPERATURE	DD-MM-YY HH:MM:SS
Enter Fluid Temperature	
°C: 5.00 °F: 41.00 Continue..	

15. The SENSOR SEPARATION screen now displays a summary of the entered parameters and informs you of the type of sensor to be used, the mode of operation and the distance to set up between the sensors.
In this example it recommends type A-ST (A standard) sensors operating in the 'Reflex' mode spaced at 32.2mm apart.
Take a note of these details



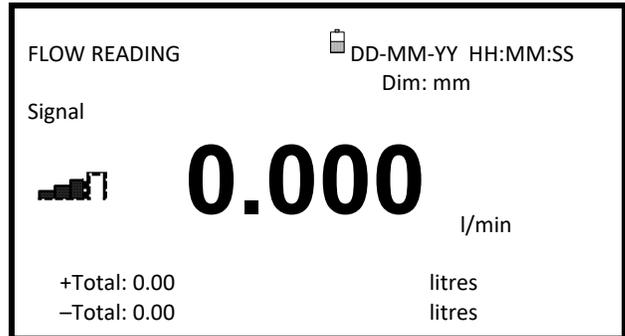
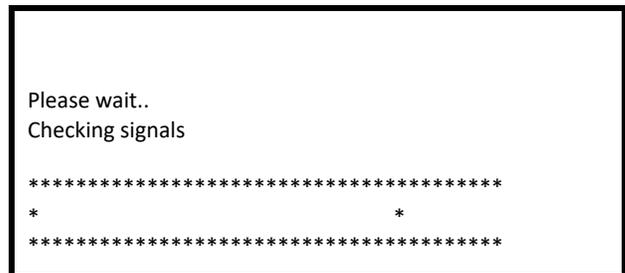
Note: Do not press ENTER until the transducers are fitted and connected to the instrument.

Attaching and connecting the transducers

16. Fit the designated sensors to the pipe using the appropriate guide rails as described in [Paragraph 2.2](#). Take great care to set the separation distance as accurately as possible.
17. 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

18. Once the transducers have been fitted and connected press the Enter key.
19. This will take you from the SENSOR SEPARATION screen to the FLOW READING screen via a signal-checking screen (shown here).
20. 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 totalised values (when enabled). In this mode you can select the flow rate measurement units by pressing keys 7 (litres), 8 (Gallons) 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 Portaflow system using the Quick Start method described in [Paragraph 3.2](#) is easy and the recommended method to use in a 'one-off' 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 ENTER.
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
	Dim: mm
Choose from list of sites	
Site name	: MySite
Dimension units	: mm
Pipe outside diameter	: 58.00
Pipe wall thickness	: 4.00
Pipe lining thickness	: 0.00
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	

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 ENTER.

FLUID TEMPERATURE	DD-MM-YY HH:MM:SS
Enter Fluid Temperature	
°C:	5.00
°F:	41.00
Continue..	

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 32.2mm apart.
 Take a note of these details.

SENSOR SEPARATION	DD-MM-YY HH:MM:SS
Site	: MySite
Pipe	: 58.00 mm
Wall	: 4.00
Sensors	: A-ST Reflex
Temperature	: 10.00°C 50.00°F
Set sensor separation to	32.2 mm
Press ← to continue, Δ ▽ to select sens.	

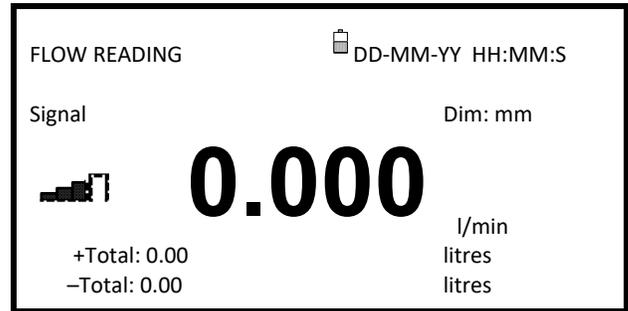
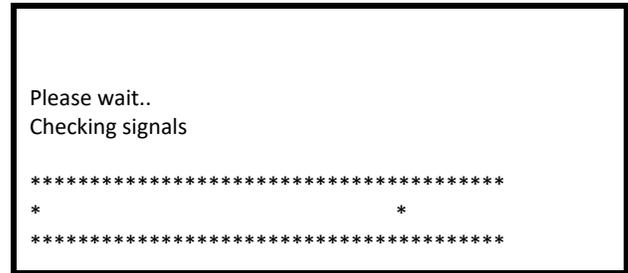
Note: If you press ENTER before the transducers are fitted and connected to the instrument, the instrument will detect a low signal strength and may indicate an ERROR condition.

Attaching and connecting the transducers

12. Fit the designated sensors to the pipe using the appropriate guide rails as described in [Paragraph 2.2](#). Take great care to set the separation distance as accurately as possible.
13. 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

14. Once the transducers have been fitted and connected press the ENTER key.
15. This will take you from the SENSOR SEPARATION screen to the FLOW READING screen via a signal-checking screen (shown here).
16. 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 totalised values (when enabled). In this mode you can select the flow rate measurement units by pressing keys 7 (litres), 8 (Gallons) or 9 (m³), or change the display to show velocity by pressing key 4.

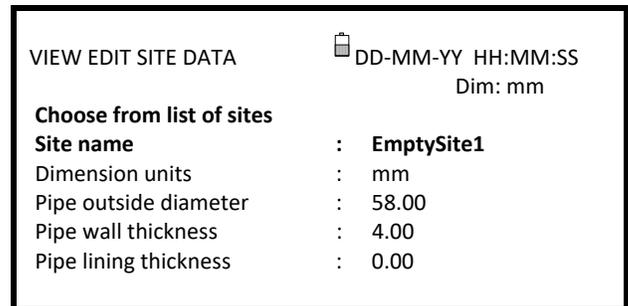
3.4 Managing Named Sites

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 Portaflow PT500 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 ENTER.



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 ENTER 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. 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.

VIEW EDIT SITE DATA	DD-MM-YY HH:MM:SS
	Dim: mm
Choose from list of sites	
Site name	: MyNewSite
Dimension units	: mm
Pipe outside diameter	: 58.00
Pipe wall thickness	: 4.00
Pipe lining thickness	: 0.00

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.

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	

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 Portaflow 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 0.02 m/s but you may adjust this value if required.

1. With the instrument operating in FLOW READING mode, press the Options key to access the FLOW READING OPTIONS menu shown.
2. Select Zero Cutoff (m/s) and press ENTER.
3. Enter the value for the Zero Cutoff (e.g. 0.06 m/s) then press ENTER.
4. Scroll down to select Exit and press ENTER to return to the FLOW READING screen.

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

3.5.2 Adjusting the set zero flow offset

The Portaflow 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 (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 ENTER.
5. Press ENTER on the subsequent screen to accept the change, which will return you to the screen shown.
6. Scroll down to select Exit and press ENTER to return to the FLOW READING screen.

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



Key Point: In order to cancel any applied offset you must either read flow via Quick Start or switch the Portaflow 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 Portaflow 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 Portaflow's totaliser facility and zero it ([Paragraph 3.6.1](#)).
2. Run the Portaflow's totaliser to measure the total flow over a 30-60 minute period, and note the total flow indicated by the reference flow meter over the same period.
3. Calculate the % error between the Portaflow and reference meters. If the error is greater than $\pm 1\%$ calibrate the Portaflow 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 Portaflow was reading 1% high then increase the Calibration factor value by 0.010. Conversely, if the reading is 1% low then decrease the calibration factor to 0.990.
7. Press Enter to apply the change.
8. Select Roughness factor or Exit as required.

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
Totaliser	:	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: <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 Enter 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
Totaliser	:	Run
Reset +Total		
<hr/>		
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 to 199, 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. Change the value of the Damping factor as required to remove any unwanted display fluctuations. Increasing the value applies a greater smoothing affect.
4. Press Enter to apply the change.

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
Totaliser	:	Run
Reset +Total		
<hr/>		
Reset -Total		
Calibration factor	:	1.000
Roughness factor	:	0.01
Diagnostics		
Exit		



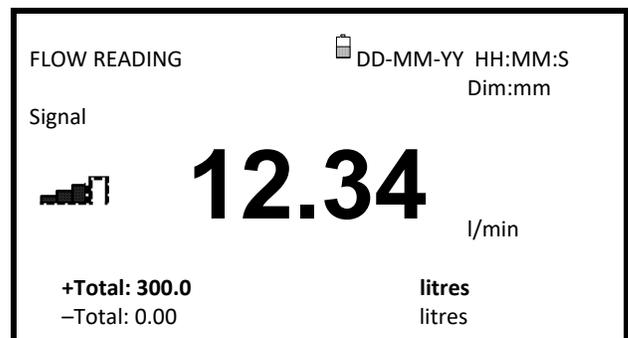
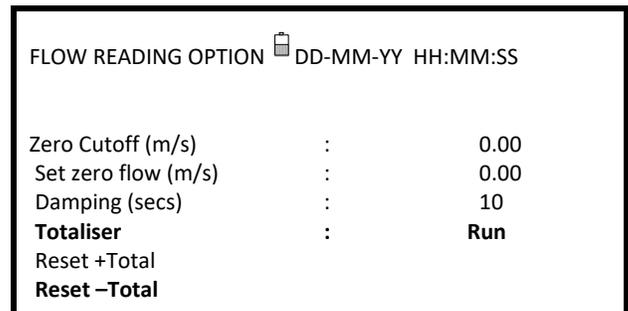
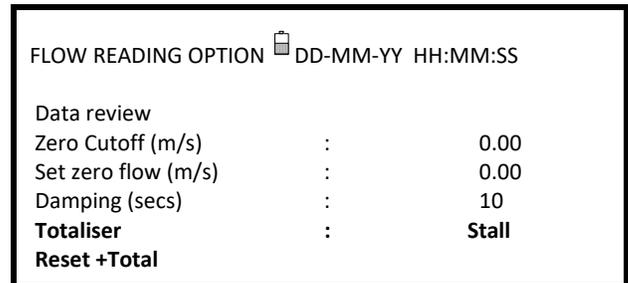
Key Point: If the damping factor is set too high the value displayed may appear stable but it may exhibit large step changes when the value is updated.

3.6 Performing Monitoring & Logging Functions

3.6.1 How to measure totalised flows (manually)

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

1. Press the Options key to access the FLOW READING OPTION screen shown.
2. If the Totaliser is indicating Run, select it and change it to Stall. Press ENTER.
3. Select Reset +Total and press ENTER.
4. Press ENTER on the subsequent screen to accept the reset.
5. Press ENTER again to return to the FLOW READING OPTIONS menu.
6. Select Reset –Total and press ENTER.
7. Press ENTER on the subsequent screen to accept the reset.
8. Press ENTER again to return to the FLOW READING OPTIONS menu.
9. Note and record the current time.
10. Select Totaliser and change it to Run. Press ENTER.
Note: the totalisers begin to count up as soon as Totaliser is put to Run.
11. Scroll down and select Exit to return to the FLOW READING screen which will now indicate the instantaneous flow together with the totalised flow. Note that in some installation the measured flow can be in either direction. Where 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/hours 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 totaliser temporarily

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

3.6.2 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 Portaflow has been correctly installed and is operating in the FLOW READING mode.

Setting up and starting the logging

- With the Portaflow now operating in FLOW READING mode, check that the indicated flow units are the same as those you want to appear on the logger output (e.g. l/min).
- Press the Logger function key to access the REAL TIME LOGGER screen.
- Select Log data to and choose Memory to store the log to the internal memory.
- Select Logging interval and enter the required period.
- Select Clear log if you want to discard any existing logging data.
- Select START NOW. Logging should begin, and a Logging to memory message should appear on the second line of the display.
- Select View log as text to check that logging is taking place.

REAL TIME LOGGER	DD-MM-YY HH:MM:SS
4-20mA O/P is ON.	Dim: mm
Unit	: l/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
Memory Rollover	: mm dd hh mm ss
Graph Y axis max.	: Overwrite
	: 50
View log as text	
View log as graph	
START NOW	
Set Auto start	
Clear log	
Exit	

- 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	Dim: mm	
Log:Quickstart		
Date	Time	Flow
DD-MM-YY	hh:mm:ss	xxx.xx l/m

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

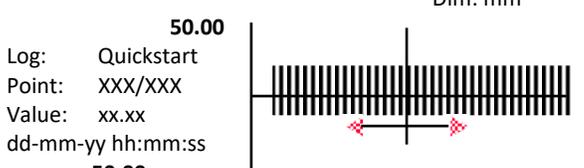


Key Point: There can be only one set of logged data per site. If a new data log is started on a site it will clear the existing data.

Monitoring the logged events as a graphic

10. 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.
11. Select Graph Y axis max and enter a value equal to the expected maximum flow.
12. Select View log as graph. This will open the VIEW LOG AS GRAPH screen shown below.
13. 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.
14. 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.
15. To exit the VIEW LOG AS GRAPH screen and return to the REAL TIME LOGGER screen press ENTER.

REAL TIME LOGGER 4-20mA O/P is ON.	DD-MM-YY HH:MM:SS Dim: mm
Unit	: l/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
Memory Rollover	: Overwrite
Graph Y axis max.	: 50
View log as text	
View log as graph	
START NOW	
Set Auto start	
Clear log	
Exit	

VIEW LOG AS GRAPH	DD-MM-YY HH:MM:SS Dim: mm
Log: Quickstart	
Point: XXX/XXX	
Value: xx.xx	
dd-mm-yy hh:mm:ss	
-50.00	

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 4-20mA O/P is ON.	DD-MM-YY HH:MM:SS Dim: mm
Unit	: l/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
Memory Rollover	: Overwrite
Graph Y axis max.	: 50
View log as text	
View log as graph	
STOP NOW	
Set Auto start	
Clear log	
Exit	

3.6.3 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 Portaflow has been correctly installed and is operating in the FLOW READING mode. Also that the date and time are correctly set.

Setting up and starting the 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 Portaflow operating in FLOW READING mode, check that the indicated flow units are the same as those you want to appear on the logger output (e.g. l/min).

2. Press the Logger function key to access the REAL TIME LOGGER screen.
3. Select 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 time you wish logging to commence. Note this must be in the future.
6. Select Stop date & time and enter the time you wish logging to cease. Note this must be later than the start time.

REAL TIME LOGGER	DD-MM-YY HH:MM:SS
4-20mA O/P is ON.	Dim: mm
Unit	: l/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
Memory Rollover	: mm dd hh mm ss
Graph Y axis max.	: Overwrite
View log as text	: 50
View log as graph	
START NOW	
Set Auto start	
Clear log	
Exit	

7. If the instrument is to be left unattended for a long logging period which could possibly fill the memory, select the Memory Rollover option to either Stop or Overwrite. This determines what happens to the stored data if the memory becomes full. Similarly, select Clear log if you want to ensure that maximum memory is available.

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

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

Note: To cancel the auto start you must select START NOW then STOP NOW to exit the auto mode.

9. Select Exit to return to the FLOW READING screen.

Monitoring the logged events

10. 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 3.6.2](#).

Manually stop the logging session

11. The logging session will stop automatically at the programmed Stop date & time.
12. 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.
13. 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.	Dim: mm
Unit	: l/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
Memory Rollover	: mm dd hh mm ss
Graph Y axis max.	: Overwrite
View log as text	: 50
View log as graph	
STOP NOW	
Set Auto start	
Clear log	
Exit	

3.6.4 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 Portaflow PT500'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 RS232 in the Log data to option in the REAL TIME LOGGER screen.
2. In order for this to work correctly the Portaflow PT500 must be connected to the PC and the RS232/USB link already established.

REAL TIME LOGGER	DD-MM-YY HH:MM:SS
4-20mA O/P is ON.	Dim: mm
Unit	: l/min
Log name	: Quickstart
Log data to	: RS232
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
Memory Rollover	: mm dd hh mm ss
Graph Y axis max.	: Overwrite
View log as text	: 50
View log as graph	
STOP NOW	
Set Auto start	
Clear log	
Exit	

Swapping data destinations during a logging session

When a logging session is in progress the Portaflow PT500 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 RS232 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 Portaflow PT500 is connected to the PC and the RS232 link has already been established. If the RS232 has not already been set you will have to go to the MAIN MENU to select the RS232 setup screen, and this will immediately stop the logging session.

3.6.5 How to download logged data to a PC

Note: To download logged data to a Bluetooth printer see [Paragraph 3.8](#).

This procedure describes how to download stored data to a PC. It assumes that the Portaflow PT500 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 View Logged Data from the MAIN MENU.
3. Select Choose from list of sites and select the name of the site to download.
4. 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.
5. When you are ready to begin downloading the log select Download log.

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

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

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



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 Portaflow PT500 Interfaces

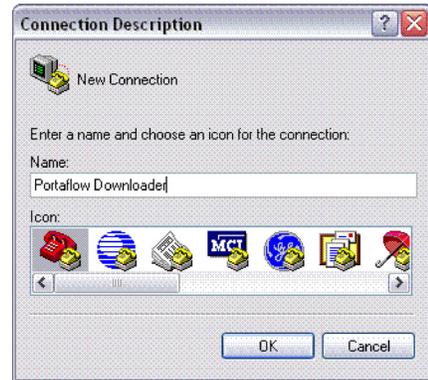
3.7.1 How to set-up an RS232 connection

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 (Portaflow Download in the example) then click OK.



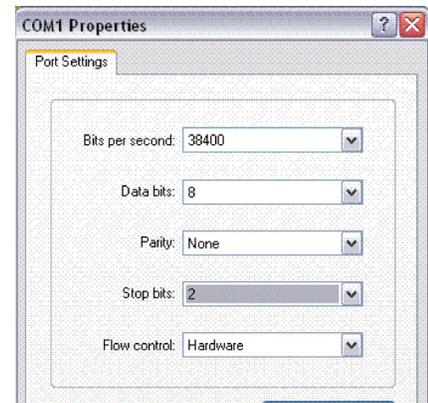
3. Select a COM port, then click OK.

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

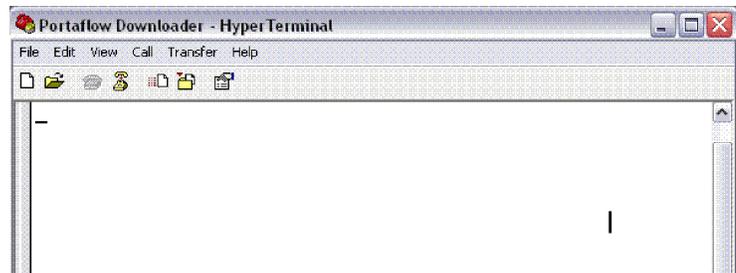


4. Enter values for the Port Settings as shown.
5. Click on OK.
6. The 'Portaflow Download' Terminal settings will now be saved.

Note: *When you next start a HyperTerminal session you can select the 'Portaflow 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 Portaflow PT500's RS232 parameters.



Configuring the Portaflow PT500 instrument

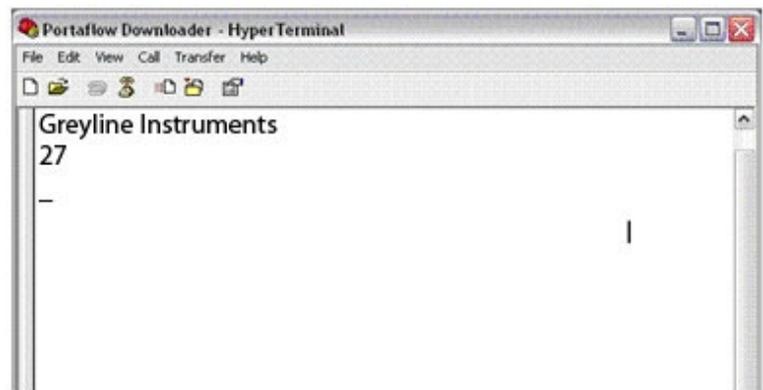
9. Select Setup RS232 / USB from the MAIN MENU. This will access the SETUP RS232/USB screen shown here.
10. Set the RS232 parameters as shown opposite.

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

SETUP RS232 / USB	DD-MM-YY HH:MM:SS	Dim: mm
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 Portaflow PT500 is connected to the PC's serial port using the cable provided.
12. In the SETUP RS232/USB screen select Printer test.
13. The Portaflow PT500's serial number should now appear in the HyperTerminal window. 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 Portaflow PT500 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 Portaflow 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 How to turn the 4-20mA output OFF/ON

1. With the instrument operating in the FLOW READING mode, press the 4-20mA function key. This will access the 4-20mA OUTPUT screen.
2. The ON/OFF status of the 4-20mA output is shown on line 2 of the display.
3. To change the ON/OFF status select Output Range and press ENTER.

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

3.7.3

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



3.7.4 4-20mA signal calibration and ranging



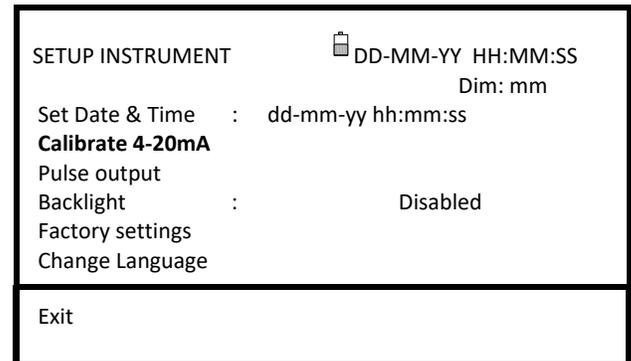
Key Point: The 4-20mA output has been calibrated in the factory and should not require further adjustment. In the rare event that re-calibration is necessary, this procedure should be carried out only by a trained engineer.

3.7.4

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

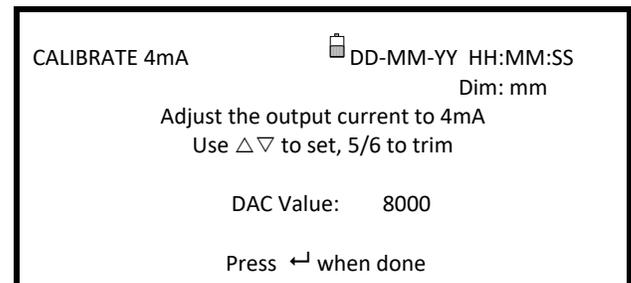
Signal calibration

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



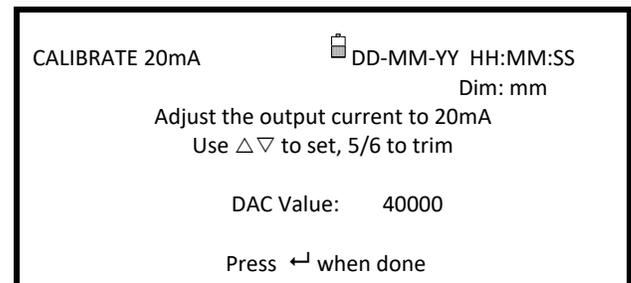
3. Connect a calibrated ammeter to the 4-20mA output and adjust the UP/DOWN Scroll keys (Coarse) and LEFT/RIGHT Scroll keys 5 & 6 (fine) until the output is exactly 4.0mA. The DAC should indicate approximately 8000.

4. Press ENTER when done.



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

6. Press ENTER when done.



4-20mA Signal scaling

Note: The 4-20mA 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.

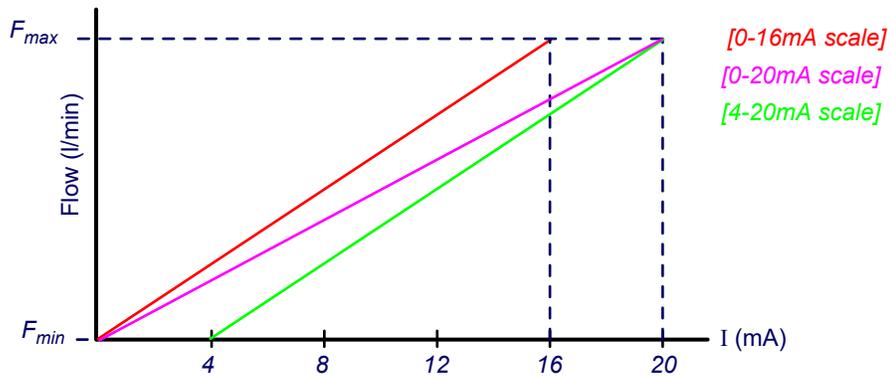
7. With the instrument operating in the FLOW READING mode, press the 4-20mA function key. This will access the 4-20mA OUTPUT screen.
8. Select Flow at max. output and enter a value of the flow rate that you want to associate with a 20mA output.
9. Select Flow at min. output and enter a value of the flow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

4-20 mA OUTPUT	DD-MM-YY HH:MM:SS
4-20 mA O/P is ON	Dim: mm
mA Output Reading	: 0.00
Output Range	: 4-20
Units	: l/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 (max of about 23mA) that you want the 4-20mA output to produce in the event of an error (e.g. if the flow-rate is outside the set range).
11. Upon completion press ENTER to return to the FLOW READING screen.

3.7.5 How to convert the measured current to flow rate

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



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

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

3.7.6 How to turn the pulse output OFF/ON

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 message appears in the second line of the display.
3. Select Exit and press ENTER to return to the FLOW READING screen.

PULSE OUTPUT	DD-MM-YY HH:MM:SS
<i>Pulse output is ON</i>	Dim: mm
Flow units	: litres
Output	: Off
Vol per pulse	: 10.00
Pulse width (ms)	: 10
Exit	

3.7.7 Pulse output signal calibration

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 measurement units select Flow units and press the required units function key (7), (8), (9).

PULSE OUTPUT	DD-MM-YY HH:MM:SS
<i>Pulse output is ON</i>	Dim: mm
Flow units	: litres
Output	: Off
Vol per pulse	: 10.00
Pulse width (ms)	: 10
Exit	

3.7.7

3. Select Vol per pulse and enter the required value. (In the example shown, a pulse is produced every 10 litres of flow).
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 ENTER to return to the FLOW READING screen.

3.8 Printing

Logged data can be printed using either an RS232-compatible printer or by wireless connection via the Bluetooth interface.

3.8.1 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 Portaflow PT500 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 Portaflow PT500 to printer
 - Pin 3 – RxD data from printer to Portaflow PT500
 - 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.

Note: The parameters shown here are for the Seiko DPU-414 Thermal Printer.

SETUP RS232 / USB	DD-MM-YY HH:MM:SS Dim: mm
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.
5. To check that the Portaflow PT500 printer interface is operational, select Printer test from the SETUP RS232/USB menu. If the RS232 interface is working correctly the following message will be printed:

Greyline Instruments
 <unit serial number>

If nothing is printed, check that the RS232 parameter settings are correct for the printer and that the PT500 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.

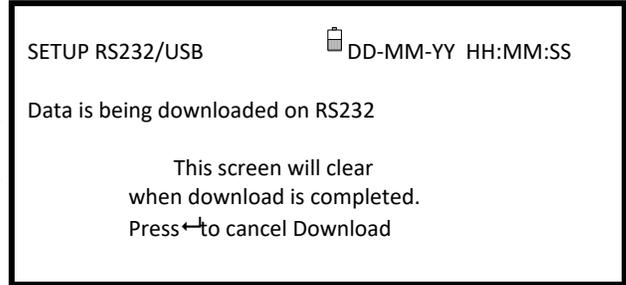
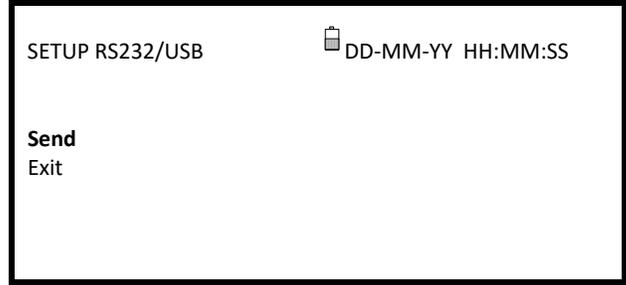
VIEW LOGGED DATA	DD-MM-YY HH:MM:SS Dim: mm
Choose from list of sites	
View log as text	
View log as graph	
Graph Y axis max. :	1.00
Download log	
Clear log	
Exit	

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 Dim: mm
Select Serial port or printer & press ↵	
USB	
RS232	
Bluetooth Printer	
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).
7. Printing will continue until all logged data is output or until the \leftarrow key is pressed.

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

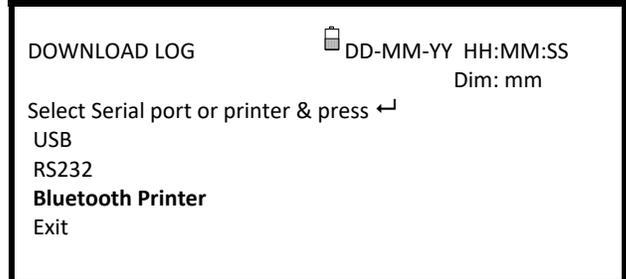
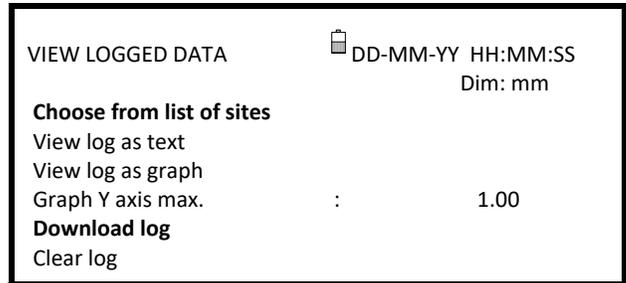


3.8.2 How to print logged data using the Bluetooth® printer

An Able Systems Ltd ASL Ap1300-BT Bluetooth-compatible printer can be used to provide wireless printing within a range of 100m direct line-of-sight.

Note: *Greyline Instruments cannot guarantee compatibility with any other Bluetooth printer.*

1. Ensure the printer has sufficient paper then switch ON the printer.
2. Select View Logged Data from the MAIN MENU. This will display the VIEW LOGGED DATA screen shown.
3. Select Choose from list of sites and select the site name for the log you want to print.
4. When you are ready to begin printing the log select Download log.
5. From the DOWNLOAD LOG screen select Bluetooth Printer. This will open the SETUP RS232/USB screen shown below.
6. Select Send. This will initiate a wireless communications link between the Portaflow PT500 and the printer before printing can commence. This can take up to 10 seconds. While attempting to establish the wireless communications link a number of status messages will be displayed (see next page).



Establishing communications – default printer

While communications are being established, the following status messages are displayed.

1. Initialising Bluetooth.

Checks for BT module fitted.

BT CONNECTION  DD-MM-YY HH:MM:SS
Initialising Bluetooth..

Connecting to printer
 Please wait...

2. Configuring BT printer.

Configures the BT module parameters to operate with the ASL Ap1300-BT printer.

BT CONNECTION  DD-MM-YY HH:MM:SS
Configuring BT printer..

Connecting to printer
 Please wait...

3. Connecting BT printer.

Looks for the ASL Ap1300-BT printer type and IP address.

BT CONNECTION  DD-MM-YY HH:MM:SS
Connecting BT printer..

Connecting to printer
 Please wait...

4. Sending data to BT printer.

If communications has been successfully established the Portaflow PT500 will send data to the printer.

BT CONNECTION  DD-MM-YY HH:MM:SS
Sending data to BT printer..

Press ← to cancel printing

Establishing communications – non-default printer

If the Bluetooth printer to be used is not the default printer then the Portaflow PT500 must first 'search' for the printer's ID address and type 'ASL Ap1300-BT'. When retrieved, these values are stored and the new printer becomes the 'default' printer.

Initially, the communication sequence will be the same as for the default printer, namely:

- Initialising Bluetooth
- Configuring BT printer
- Connecting BT printer

At this point the Portaflow PT500 cannot find its default printer and will automatically initiate a search for another ASL Ap1300-BT printer. During this time the following status messages will be displayed.

1. If another ASL Ap1300-BT printer is found then data will be sent to the printer.

BT CONNECTION 🔋 DD-MM-YY HH:MM:SS
Searching BT printer..

Connecting to printer
Please wait...

2. If no other ASL Ap1300-BT printer is found, this message will be displayed.

BT CONNECTION 🔋 DD-MM-YY HH:MM:SS

Failed to connect to printer!

Press ← to return to Menu
or △ ▽ to try again



Key Point: If the Portaflow PT500 fails to establish communication on the first attempt, you should press the △ or ▽ scroll key to try again. Communications failure is more likely if the printer battery is low.

3. This message is displayed if you select Bluetooth printer from the DOWNLOAD LOG menu but the Portaflow PT500 does not have a Bluetooth module fitted.

BT CONNECTION 🔋 DD-MM-YY HH:MM:SS

BT Module Not Found!

Press ← to return to Menu
or △ ▽ to try again

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 Greyline. 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 guide rails 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 Greyline.
7. Ensure the person who services your instrument is qualified to do so. If in doubt, return the instrument to Greyline 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. The instrument and sensors should be calibrated at least once every 12 months. Contact Greyline or your local service agent for details.
10. When returning product to Greyline make sure it is clean and please notify Greyline if the instrument has been in contact with any hazardous substances.
11. If the instrument was supplied with dust or dirt caps make sure they are re-fitted when the instrument is not in use.

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 galvanised-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.

5.2 General Troubleshooting Procedure

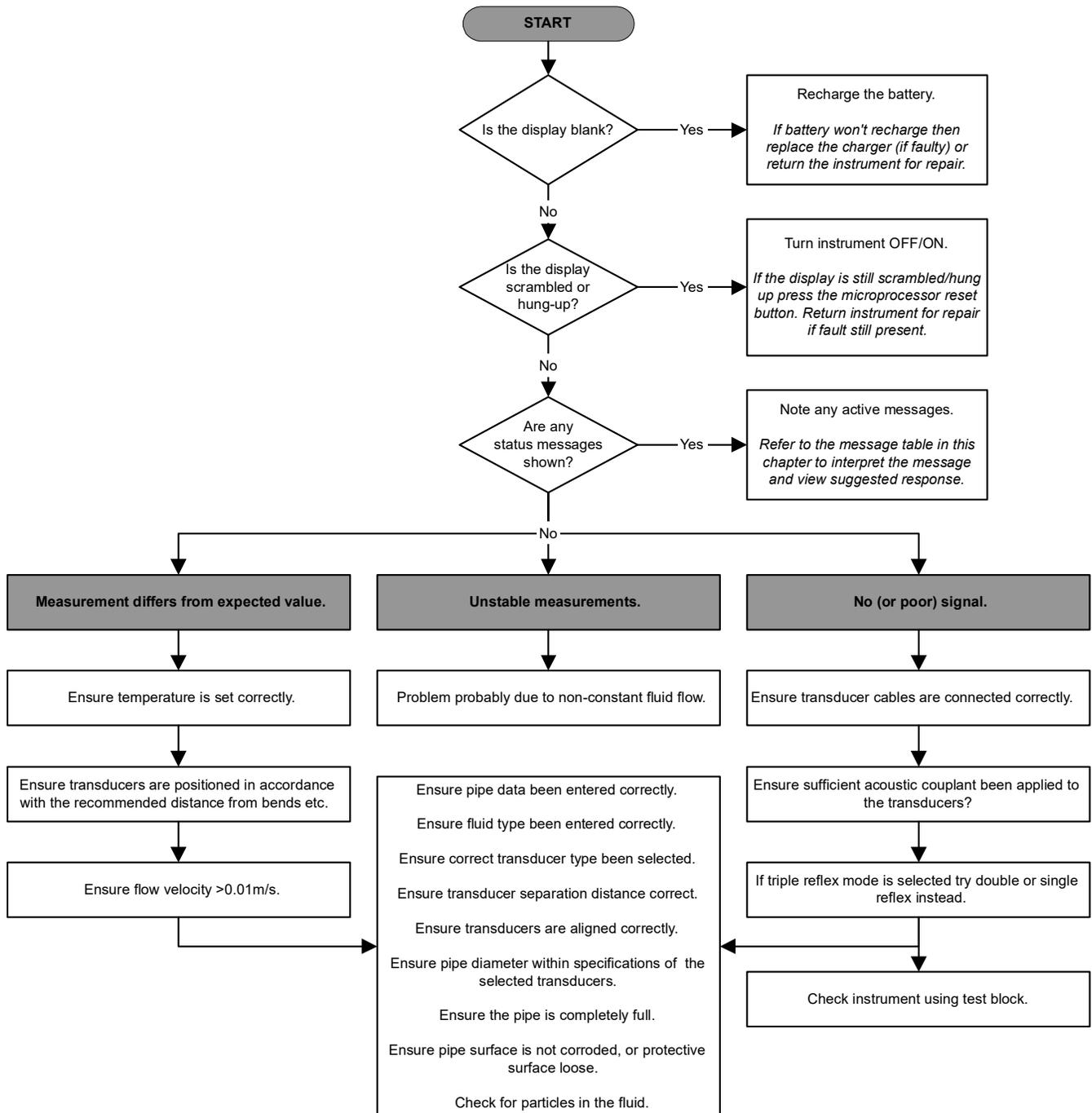


Figure 5.1 Troubleshooting chart

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: Firstly check that all cables are connected, transducers are on the pipe correctly with sufficient couplant on the face. This condition could also be due to a partially empty pipe, aerated liquid, particulate content too high or when the condition of the pipe being measured is poor.</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>
Damping error!	<p>Interpretation: You have entered an out-of-range value in the Damping field in the Options menu.</p> <p>Response: Enter a valid number.</p>
Totaliser beyond maximum!	<p>Interpretation: The totaliser 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 totaliser 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 in Paragraph 3.7.7.</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 Paragraph 3.7.7.</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 Paragraph 3.7.7.</p> <p>Response: Enter a valid number.</p>

BLUETOOTH PRINTING ERRORS	
BT Module Not Found!	<p>Interpretation: No response from the internal Bluetooth Module.</p> <p>Response: Try again. If still no response contact Greyline Instruments.</p>
Failed to connect to printer!	<p>Interpretation: The unit has failed to make connection with the default Bluetooth printer.</p> <p>Response: Try again. If connection still fails then start a search for another printer.</p>
4-20mA 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 4-20mA output to be able to cope with the higher flow – see Paragraph 3.7.4.</p>
Calibration 20mA Error!	<p>NOTE: The 4-20mA 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 20mA signal output.</p> <p>Response: Re-calibrate the 4-20mA output – see Paragraph 3.7.4.</p>
Calibration 4mA Error!	<p>NOTE: The 4-20mA 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 4mA signal output.</p> <p>Response: Re-calibrate the 4-20mA output – see Paragraph 3.7.4.</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 3.6.3.</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" - 2.95" (1mm - 75mm).</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" – 0.39" (0mm - 10mm).</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>

Test Block

A test block is included with the Portaflow PT500 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	1.02" (26.0mm)	2.09" (53.0mm)
Pipe wall thickness	0.24" (6.0mm)	0.28" (7.0mm)
Pipe lining thickness	0.0	0.0
Pipe wall material	Mild Steel	Mild Steel
Fluid type	Water	Water
Temp	68°F (20°C)	68°F (20°C)

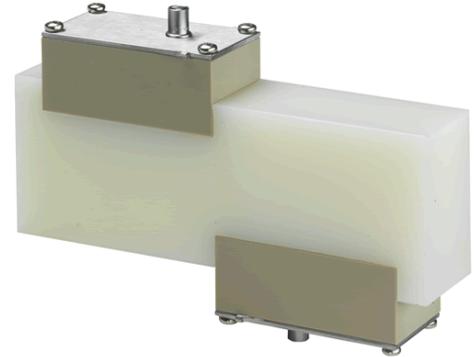


Figure 5.2 Test block

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 ENTER 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 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 centre of the test block as shown, and temporarily secure them in place using elastic bands or tape.
9. Connect the sensors to the Portaflow PT500 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 Portaflow PT500 instrument appears to totally hang-up, or displays total gibberish, 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 then there is a problem with the set-up.

Flow (m/s)

This displays flow velocity in m/sec 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%.

UP/DN time difference

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

Propagation μ s

Not currently in use.

Signal propagation

Not currently in use.

Fluid propagation rate

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

Fluid propagation rate

Calculated from the input data concerning the fluid type and temperature.

Sensor separation

The same value as displayed in the setup screen.

5.7 APPLICATIONS HOTLINE

For applications assistance, advice or information on any Greyline Instrument contact your Sales Representative, write to Greyline or phone the Applications Hotline below:

United States:	Tel: 315-788-9500	Fax: 315-764-0419
Canada:	Tel: 613-938-8956	Fax: 613-938-4857
Toll Free:	888-473-9546	
Email:	info@greyline.com	
Web Site:	www.greyline.com	

Greyline Instruments Inc.

Canada:	USA:
16456 Sixsmith Drive	11451 Belcher Road South
Long Sault, Ont. K0C 1P0	Largo, FL 33773

5.8 PRODUCT RETURN PROCEDURE

Instruments may be returned to Greyline for service or warranty repair.

1. Obtain an RMA Number from Greyline -

Before shipping a product to the factory please contact Greyline by telephone, fax or email to obtain an RMA number (Returned Merchandise Authorization). This ensures fast service and correct billing or credit.

When you contact Greyline please have the following information available:

1. Model number / Software Version
2. Serial number
3. Date of Purchase
4. Reason for return (description of fault or modification required)
5. Your name, company name, address and phone number

2. Clean the Sensor/Product -

Important: unclean products will not be serviced and will be returned to the sender at their expense.

1. Rinse sensor and cable to remove debris.
2. If the sensor has been exposed to sewage, immerse both sensor and cable in a solution of 1 part household bleach (Javex, Clorox etc.) to 20 parts water for 5 minutes. Important: do not immerse open end of sensor cable.
3. Dry with paper towels and pack sensor and cable in a sealed plastic bag.
4. Wipe the outside of the enclosure to remove dirt or deposits.
5. Return to Greyline for service.

LIMITED WARRANTY

Greyline Instruments warrants, to the original purchaser, its products to be free from defects in material and workmanship for a period of one year from date of invoice. Greyline will replace or repair, free of charge, any Greyline product if it has been proven to be defective within the warranty period. This warranty does not cover any expenses incurred in the removal and re-installation of the product.

If a product manufactured by Greyline should prove defective within the first year, return it freight prepaid to Greyline Instruments along with a copy of your invoice.

This warranty does not cover damages due to improper installation or handling, acts of nature, or unauthorized service. Modifications to or tampering with any part shall void this warranty. This warranty does not cover any equipment used in connection with the product or consequential damages due to a defect in the product.

All implied warranties are limited to the duration of this warranty. This is the complete warranty by Greyline and no other warranty is valid against Greyline. Some states do not allow limitations on how long an implied warranty lasts or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Greyline Instruments Inc.

Appendix A: Specifications

GENERAL	
NEW! DSP Measurement Technique:	Transit time.
Timing Resolution:	50 pico-second, continuous signal level indication on display.
Improved! Flow Velocity Range:	Minimum Velocity 0.1m/s; Max Velocity 20m/s; Bi-directional.
Turn Down Ratio:	100:1
Accuracy:	±0.5% to ±2% of flow reading for flow rate >0.2m/s and Pipe ID >75mm. ±3% of flow reading for flow rate >0.2m/s and Pipe ID in range 13mm - 75mm. ±6% of flow reading for flow rate < 0.2m/s.
Repeatability:	±0.5% of measured value or ±0.02m/s whichever is the greater.
NEW! 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, demineralised 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, Galvanised Steel, Mild Steel, Glass, Brass. Including Lined Pipes - Epoxy, Rubber, Steel, Plastic.
Pipe Dimension (outside diameter):	Min 13mm; Max 2000mm
Pipe Wall Thickness:	1mm - 75mm.
Pipe Lining:	Applicable pipe linings include Rubber, Glass, Concrete, Epoxy, Steel.
Pipe Lining Thickness:	0mm – 10mm.
Pipe Wall Temperature Range:	Standard sensor operating temperature is -4°F to 275°F (-20°C to +135°C). Optional high temperature sensor operating temperature is -4°F to 392°F (-20°C to +200°C).
TRANSDUCER SETS	
Standard:	Temperature Range -4°F to 275°F (-20°C to +135°C). 'A-ST' (standard) 0.51" to 4.525" (13 mm...115 mm pipe O.D. (2MHz). 'B-ST' (standard) 1.97" to 78.74" (50 mm...2000 mm pipe O.D. (1MHz).

High Temperature:	Temperature Range -4°F to 392°F (-20°C to +200°C) 'A-HT' (High Temp) 0.51" to 4.525" (13 mm...115mm pipe O.D. (2MHz) 'B-HT' (High Temp) 1.97" to 78.74" (50 mm...2000mm pipe O.D. (1MHz)
Improved! 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:	98K.
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 98,000 data points.
Programmable Logging Interval:	5 secs to 1hr – 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 Microsoft Windows or Greyline user-compatible software package (optional).
LANGUAGES	
Standard Supported Languages:	English, French, German, Italian, Spanish, Portuguese, Russian, Norwegian, Dutch.
OUTPUTS	
NEW! USB Interface:	Supports USB 2.0 Full Speed (12Mbps/sec) mode, USB software driver provided.
Printer/Terminal:	Serial RS232-C inc. handshaking.
Analogue Output: Resolution: Alarm Currents: Isolation: Maximum Load:	4–20mA, 0–20mA, 0–16mA. 0.1% of full scale. Any between 0–26mA. 1500V Opto-isolated. 620 Ohms.
Pulse Output TTL: Pulse Repetition Rate: Pulse Width: Max Current:	Number Available: One open collector opto-isolated digital output. Up to 500 pulses/sec (depending on pulse width). 500ms for 1 pulse/sec. 5ms for 100 pulses/sec. 150mA.
NEW! WIRELESS CONNECTIVITY – Bluetooth®: optional for use with printer only	
Range:	Class I Bluetooth radio, 100m range direct line of site.
Max. RF Power:	100mW.
Approvals:	Bluetooth 2.0 certified. FCC/CE certified with internal antenna.
ELECTRICAL	
Supply Voltage:	
Input Voltage Range:	9–24Vdc.

Power Consumption:	10.5W.
Battery:	
Technology:	5-cell NiMH.
Capacity:	3.8Ahr.
Operating time:	Typically 20 hours continuous with backlight and 4-20mA output OFF.
Recharge Time:	6.5 Hours.
Service Life:	>500 charge/discharge cycles.
Power Supply/Charger:	
Manufacturer:	ECOPAC Model ECO-181WP12.
Input Voltage Range:	90–264Vac.
Input Frequency Range:	47–63Hz.
Output Voltage:	12Vdc.
Max. Output Current:	1.5A.
Approvals:	UL, CUL, TUV, CB & 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:	264mm x 168mm x 50mm.
Weight (Including Battery):	2.5lbs (1.1 kg).
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 122°F (-20°C to +50°C).

Storage Temperature:	-13°F to 149°F (-25°C to +65°C).
Operating Humidity:	90% RH MAX at 122°F (+50°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:	16.15" x 8" x 14" (410mm x 205mm x 355mm).
Weight:	16.5lbs (7.5 kg).
Volumetric Weight:	11lbs (5. kg).
<i>Greyline Instruments reserves the right to alter specifications without notice.</i>	

PIPE CHARTS

Carbon Steel & PVC Pipe

Pipe Size	Pipe O.D.	Standard Schedule 40		Extra Heavy Schedule 80		Dbl. Extra Heavy		Schedule 10		Schedule 20		Schedule 30		Schedule 40	
		I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL
1/2	.840	.622	.109	.546	.147	.252	.294							.622	.109
3/4	1.050	.824	.113	.742	.154	.434	.308							.824	.113
1	1.315	1.049	.133	.957	.179	.599	.358							1.049	.133
1 1/4	1.660	1.380	.140	1.278	.191	.896	.382							1.380	.140
1 1/2	1.900	1.610	.145	1.500	.200	1.100	.400							1.610	.145
2	2.375	2.067	.154	1.939	.218	1.503	.436							2.067	.154
2 1/2	2.875	2.469	.203	2.323	.276	1.771	.552							2.469	.203
3	3.500	3.068	.216	2.900	.300	2.300	.600							3.068	.216
3 1/2	4.000	3.548	.226	3.364	.318	2.728	.636							3.548	.226
4	4.500	4.026	.237	3.826	.337	3.152	.674							4.026	.237
5	5.563	5.047	.258	4.813	.375	4.063	.750							5.047	.258
6	6.625	6.065	.280	5.761	.432	4.897	.864							6.065	.280
8	8.625	7.981	.322	7.625	.500	6.875	.875			8.125	.250	8.071	.277	7.981	.322
10	10.750	10.020	.365	9.750	.500	8.750	1.000			10.250	.250	10.136	.307	10.020	.365
12	12.750	12.000	.375	11.750	.500	10.750	1.000			12.250	.250	12.090	.330	11.938	.406
14	14.000	13.250	.375	13.000	.500			13.500	.250	13.376	.312	13.250	.375	13.124	.438
16	16.000	15.250	.375	15.000	.500			15.500	.250	15.376	.312	15.250	.375	15.000	.500
18	18.000	17.250	.375	17.000	.500			17.500	.250	17.376	.312	17.124	.438	16.876	.562
20	20.000	19.250	.375	19.000	.500			19.500	.250	19.250	.375	19.000	.500	18.814	.593
22	22.000	21.250	.375	21.000	.500			21.500	.250	21.250	.375	21.000	.500		
24	24.000	23.250	.375	23.000	.500			23.500	.250	23.250	.375	22.876	.562	22.626	.687
26	26.000	25.250	.375	25.000	.500			25.376	.312	25.000	.500				
28	28.000	27.250	.375	27.000	.500			27.376	.312	27.000	.500	26.750	.625		
30	30.000	29.250	.375	29.000	.500			29.376	.312	29.000	.500	28.750	.625		
32	32.000	31.250	.375	31.000	.500			31.376	.312	31.000	.500	30.750	.625		
34	34.000	33.250	.375	33.000	.500			33.376	.312	33.000	.500	32.750	.625		
36	36.000	35.250	.375	35.000	.500			35.376	.312	35.000	.500	34.750	.625		
42	42.000	41.250	.375	41.000	.500					41.000	.500	40.750	.625		

Ductile Iron Pipe - Standard Classes

Size INCH	OUTSIDE DIA. INCH	Class 50		Class 51		Class 52		Class 53		Class 54		Class 55		Class 56		CEMENT LINING	
		WALL	I.D.	**STD THICKNESS	**DOUBLE THICKNESS												
3	3.96			0.25	3.46	0.28	3.40	0.31	3.34	0.34	3.28	0.37	3.22	0.41	3.14		
4	4.80			0.26	4.28	0.29	4.22	0.32	4.16	0.35	4.10	0.38	4.04	0.44	3.93		
6	6.90	0.25	6.40	0.28	6.34	0.31	6.28	0.34	6.22	0.37	6.16	0.40	6.10	0.43	6.04	.125	.250
8	9.05	0.27	8.51	0.30	8.45	0.33	8.39	0.36	8.33	0.39	8.27	0.42	8.21	0.45	8.15		
10	11.10	0.39	10.32	0.32	10.46	0.35	10.40	0.38	10.34	0.41	10.28	0.44	10.22	0.47	10.16		
12	13.20	0.31	12.58	0.34	12.52	0.37	12.46	0.40	12.40	0.43	12.34	0.46	12.28	0.49	12.22		
14	15.30	0.33	14.64	0.36	14.58	0.39	14.52	0.42	14.46	0.45	14.40	0.48	14.34	0.51	14.28		
16	17.40	0.34	16.72	0.37	16.66	0.40	16.60	0.43	16.54	0.46	16.48	0.49	16.42	0.52	16.36		
18	19.50	0.35	18.80	0.38	18.74	0.41	18.68	0.44	18.62	0.47	18.56	0.50	18.50	0.53	18.44	.1875	.375
20	21.60	0.36	20.88	0.39	20.82	0.42	20.76	0.45	20.70	0.48	20.64	0.51	20.58	0.54	20.52		
24	25.80	0.38	25.04	0.41	24.98	0.44	24.92	0.47	24.86	0.50	24.80	0.53	24.74	0.56	24.68		
30	32.00	0.39	31.22	0.43	31.14	0.47	31.06	0.51	30.98	0.55	30.90	0.59	30.82	0.63	30.74		
36	38.30	0.43	37.44	0.48	37.34	0.62	37.06	0.58	37.14	0.63	37.04	0.68	36.94	0.73	36.84		
42	44.50	0.47	43.56	0.53	43.44	0.59	43.32	0.65	43.20	0.71	43.08	0.77	42.96	0.83	42.84	.250	.500
48	50.80	0.51	49.78	0.58	49.64	0.65	49.50	0.72	49.36	0.79	49.22	0.86	49.08	0.93	48.94		
54	57.10	0.57	55.96	0.65	55.80	0.73	55.64	0.81	55.48	0.89	55.32	0.97	55.16	1.05	55.00		

**REDUCE I.D. BY DIMENSION SHOWN

Stainless Steel, Hastelloy "C" & Titanium Pipe

Pipe Size	Pipe O.D.	Schedule 5 S (a)		Schedule 10 S (a)		Schedule 40 S		Schedule 80 S	
		I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL
½	.840	.710	.065	.674	.083	.622	.109	.546	.147
¼	1.050	.920	.065	.884	.083	.824	.113	.742	.154
1	1.315	1.185	.065	1.097	.109	1.049	.133	.957	.179
1¼	1.660	1.530	.065	1.442	.109	1.380	.140	1.278	.191
1½	1.900	1.770	.065	1.682	.109	1.610	.145	1.500	.200
2	2.375	2.245	.065	2.157	.109	2.067	.154	1.939	.218
2½	2.875	2.709	.083	2.635	.120	2.469	.203	2.323	.276
3	3.500	3.334	.083	3.260	.120	3.068	.216	2.900	.300
3½	4.000	3.834	.083	3.760	.120	3.548	.226	3.364	.318
4	4.500	4.334	.083	4.260	.120	4.026	.237	3.826	.337
5	5.563	5.345	.109	5.295	.134	5.047	.258	4.813	.375
6	6.625	6.407	.109	6.357	.134	6.065	.280	5.761	.432
8	8.625	8.407	.109	8.329	.148	7.981	.322	7.625	.500
10	10.750	10.482	.134	10.420	.165	10.020	.365	9.750	.500
12	12.750	12.438	.156	12.390	.180	12.000	.375	11.750	.500
14	14.000	13.688	.156	13.624	.188				
16	16.000	15.670	.165	15.624	.188				
18	18.000	17.670	.165	17.624	.188				
20	20.000	19.634	.188	19.564	.218				
22	22.000	21.624	.188	21.564	.218				
24	24.000	23.563	.218	23.500	.250				

Pipe Size	Pipe O.D.	Schedule 60		Schedule 80		Schedule 100		Schedule 120		Schedule 140		Schedule 160	
		I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL
½	.840			.546	.147							.466	.187
¼	1.050			.742	.154							.614	.218
1	1.315			.957	.179							.815	.250
1¼	1.660			1.278	.191							1.160	.250
1½	1.900			1.500	.200							1.338	.281
2	2.375			1.939	.218							1.689	.343
2½	2.875			2.323	.276							2.125	.375
3	3.500			2.900	.300							2.624	.438
3½	4.000			3.364	.318								
4	4.500			3.826	.337			3.624	.438			3.438	.531
5	5.563			4.813	.375			4.563	.500			4.313	.625
6	6.625			5.761	.432			5.501	.562			5.189	.718
8	8.625	7.813	.406	7.625	.500	7.439	.593	7.189	.718	7.001	.812	6.813	.906
10	10.750	9.750	.500	9.564	.593	9.314	.718	9.064	.843	8.750	1.000	8.500	1.125
12	12.750	11.626	.562	11.376	.687	11.064	.843	10.750	1.000	10.500	1.125	10.126	1.312
14	14.000	12.814	.593	12.500	.750	12.126	.937	11.814	1.093	11.500	1.250	11.188	1.406
16	16.000	14.688	.656	14.314	.843	13.938	1.031	13.564	1.218	13.124	1.438	12.814	1.593
18	18.000	16.500	.750	16.126	.937	15.688	1.156	15.250	1.375	14.876	1.562	14.438	1.781
20	20.000	18.376	.812	17.938	1.031	17.438	1.281	17.000	1.500	16.500	1.750	16.064	1.968
22	22.000	20.250	.875	19.750	1.125	19.250	1.375	18.750	1.625	18.250	1.875	17.750	2.125
24	24.000	22.064	.968	21.564	1.218	20.938	1.531	20.376	1.812	19.876	2.062	19.314	2.343

Cast Iron Pipe - ASA Standard

Pipe Size	Pipe O.D.	Class 50		Class 100		Class 150		Class 200		Class 250		Class 300		Class 350	
		WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.
3	3.96	0.32	3.32	0.32	3.32	0.32	3.32	0.32	3.32	0.32	3.32	0.32	3.32	0.32	3.32
4	4.80	0.35	4.10	0.35	4.10	0.35	4.10	0.35	4.10	0.35	4.10	0.35	4.10	0.35	4.10
6	6.90	0.38	6.14	0.38	6.14	0.38	6.14	0.38	6.14	0.38	6.14	0.38	6.14	0.38	6.14
8	9.05	0.41	8.23	0.41	8.23	0.41	8.23	0.41	8.23	0.41	8.23	0.41	8.23	0.41	8.23
10	11.10	0.44	10.22	0.44	10.22	0.44	10.22	0.44	10.22	0.44	10.22	0.48	10.14	0.52	10.06
12	13.20	0.48	12.24	0.48	12.24	0.48	12.24	0.48	12.24	0.52	12.16	0.52	12.16	0.56	12.08
14	15.30	0.48	14.34	0.51	14.28	0.51	14.28	0.55	14.20	0.59	14.12	0.59	14.12	0.64	14.02
16	17.40	0.54	16.32	0.54	16.32	0.54	16.32	0.58	16.24	0.63	16.14	0.68	16.04	0.68	16.04
18	19.50	0.54	18.42	0.58	18.34	0.58	18.34	0.63	18.24	0.68	18.14	0.73	18.04	0.79	17.92
20	21.60	0.57	20.46	0.62	20.36	0.62	20.36	0.67	20.26	0.72	20.16	0.78	20.04	0.84	19.92
24	25.80	0.63	24.54	0.68	24.44	0.73	24.34	0.79	24.22	0.79	24.22	0.85	24.10	0.92	23.96

Cast Iron Pipe - AWWA Standard

Pipe Size	Class A 100 Ft. 43 PSIG			Class B 200 Ft. 86 PSIG			Class C 300 Ft. 130 PSIG			Class D 400 Ft. 173 PSIG		
	O.D.	WALL	I.D.	O.D.	WALL	I.D.	O.D.	WALL	I.D.	O.D.	WALL	I.D.
3	3.80	0.39	3.02	3.96	0.42	3.12	3.96	0.45	3.06	3.96	0.48	3.00
4	4.80	0.42	3.96	5.00	0.45	4.10	5.00	0.48	4.04	5.00	0.52	3.96
6	6.90	0.44	6.02	7.10	0.48	6.14	7.10	0.51	6.08	7.10	0.55	6.00
8	9.05	0.46	8.13	9.05	0.51	8.03	9.30	0.56	8.18	9.30	0.60	8.10
10	11.10	0.50	10.10	11.10	0.57	9.96	11.40	0.62	10.16	11.40	0.68	10.04
12	13.20	0.54	12.12	13.20	0.62	11.96	13.50	0.68	12.14	13.50	0.75	12.00
14	15.30	0.57	14.16	15.30	0.66	13.98	15.65	0.74	14.17	15.65	0.82	14.01
16	17.40	0.60	16.20	17.40	0.70	16.00	17.80	0.80	16.20	17.80	0.89	16.02
18	19.50	0.64	18.22	19.50	0.75	18.00	19.92	0.87	18.18	19.92	0.96	18.00
20	21.60	0.67	20.26	21.60	0.80	20.00	22.06	0.92	20.22	22.06	1.03	20.00
24	25.80	0.76	24.28	25.80	0.89	24.02	26.32	1.04	24.22	26.32	1.16	24.00
30	31.74	0.88	29.98	32.00	1.03	29.94	32.40	1.20	30.00	32.74	1.37	30.00
36	37.96	0.99	35.98	38.30	1.15	36.00	38.70	1.36	39.98	39.16	1.58	36.00
42	44.20	1.10	42.00	44.50	1.28	41.94	45.10	1.54	42.02	45.58	1.78	42.02
48	50.50	1.26	47.98	50.80	1.42	47.96	51.40	1.71	47.98	51.98	1.96	48.06
54	56.66	1.35	53.96	57.10	1.55	54.00	57.80	1.90	54.00	58.40	2.23	53.94
60	62.80	1.39	60.02	63.40	1.67	60.06	64.20	2.00	60.20	64.82	2.38	60.06
72	75.34	1.62	72.10	76.00	1.95	72.10	76.88	2.39	72.10			
84	87.54	1.72	84.10	88.54	2.22	84.10						

Pipe Size	Class E 500 Ft. 217 PSIG			Class F 600 Ft. 260 PSIG			Class G 700 Ft. 304 PSIG			Class H 800 Ft. 347 PSIG		
	O.D.	WALL	I.D.									
6	7.22	0.58	6.06	7.22	0.61	6.00	7.38	0.65	6.08	7.38	0.69	6.00
8	9.42	0.66	8.10	9.42	0.71	8.00	9.60	0.75	8.10	9.60	0.80	8.00
10	11.60	0.74	10.12	11.60	0.80	10.00	11.84	0.86	10.12	11.84	0.92	10.00
12	13.78	0.82	12.14	13.78	0.89	12.00	14.08	0.97	12.14	14.08	1.04	12.00
14	15.98	0.90	14.18	15.98	0.99	14.00	16.32	1.07	14.18	16.32	1.16	14.00
16	18.16	0.98	16.20	18.16	1.08	16.00	18.54	1.18	16.18	18.54	1.27	16.00
18	20.34	1.07	18.20	20.34	1.17	18.00	20.78	1.28	18.22	20.78	1.39	18.00
20	22.54	1.15	20.24	22.54	1.27	20.00	23.02	1.39	20.24	23.02	1.51	20.00
24	26.90	1.31	24.28	26.90	1.45	24.00	27.76	1.75	24.26	27.76	1.88	24.00
30	33.10	1.55	30.00	33.46	1.73	30.00						
36	39.60	1.80	36.00	40.04	2.02	36.00						