PRECISION FLOW 190FD
ULTRASONIC FLOW METER MANUAL

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Measurement and data acquisition solutions

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1.0 Introduction

The Precision Flow 190FD is a fixed clamp-on non invasive flow meter that measures liquid flow in closed pipes or conduits.

1.1 Principle of operation

When using Transit time sensor probes ultrasonic waves are transmitted in the direction of flow. These are accelerated slightly by the velocity of the liquid in the channel. When ultra-sound is transmitted in the opposite direction, the flow of the liquid causes the transmitted sound to decelerate. The subsequent time difference is directly proportional to the flow velocity in the channel. Having measured the flow velocity and knowing the cross-sectional area, the volumetric flow is calculated. Time differences are resolved to a resolution of 20 pico seconds.

When using the combined transmit and receive Doppler transducer ultrasonic waves are transmitted from the transmitting part of transducer through the pipe wall into the flowing liquid. The ultrasonic waves are reflected by any particulates, bubbles or turbulence present and received by the receiving part of the transducer. The Doppler shift of the received ultrasonic wave is used to calculate the flow velocity in the channel. Having measured the flow velocity and knowing the cross-sectional area, the volumetric flow is calculated.

Doppler flow meters are used for slurries and liquids with bubbles and particulates. Transit time flow meters are used for clean fluids but can work with bubbles or particulates up to about 2-3 %. Then the Doppler transducer should be used. The exact proportion at which it is not possible to use the transit time transducers depends on the particular application. Both technologies work well with 1% particulates. If there are little or no particulates the Doppler transducer should not be used.

1.2 Standard instrument kit

A standard 190FD includes the following Items:

190F Wall mounted mains powered flow meter electronics assembly. This has a data logger, totaliser, 4-20mA output, pulse output and RS232 port.

Ultrasonic transducer (s) with cables, type is dependent on application.

Transducer mounting hardware.

Ultrasonic coupling compound.

Manual.

Your instrument kit may contain additional or alternative components according to your particular order. Please check you have all of these items.

1.3 Electronics connections and dimensions.

1.3.1 Wall mount enclosure

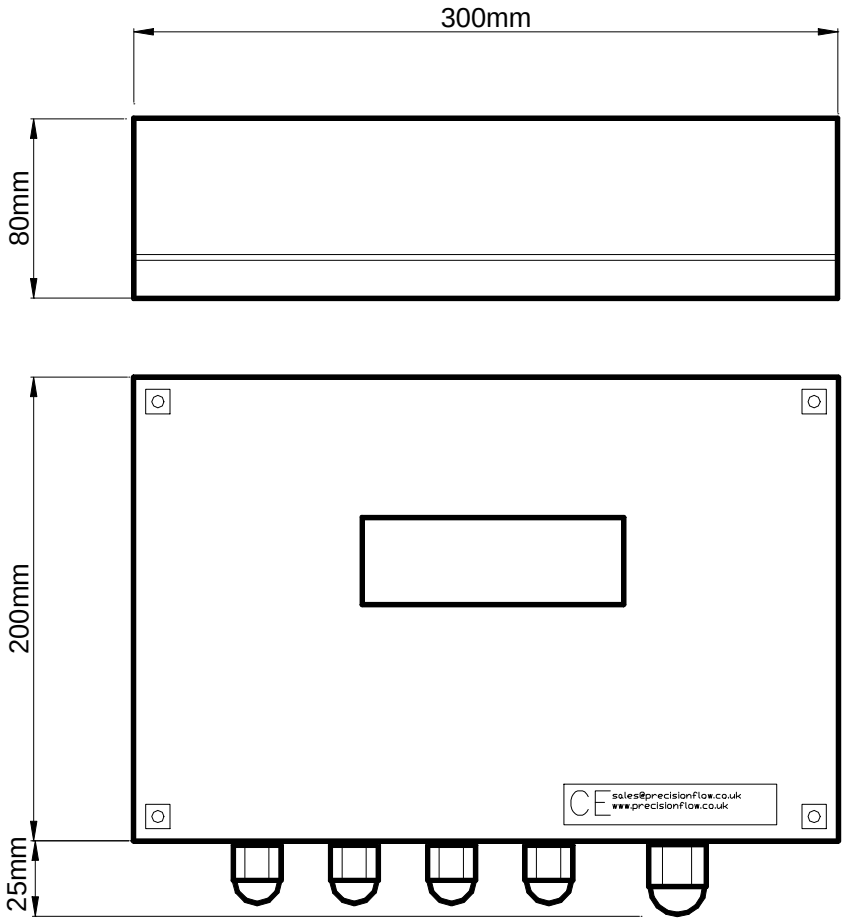


Figure 1

1.3.2 Mounting hole positions for wall mount enclosure.

Figure 2

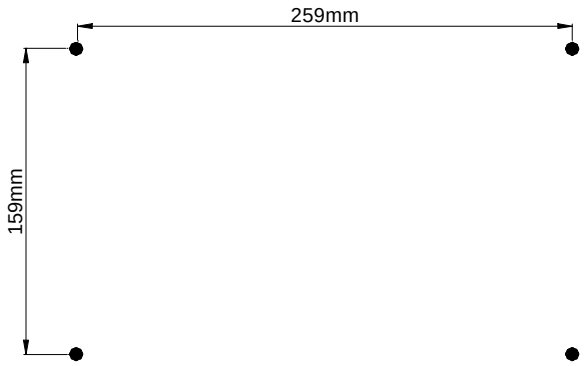


Figure 2a from Serial number 6040

1.3.3 Wall box internal

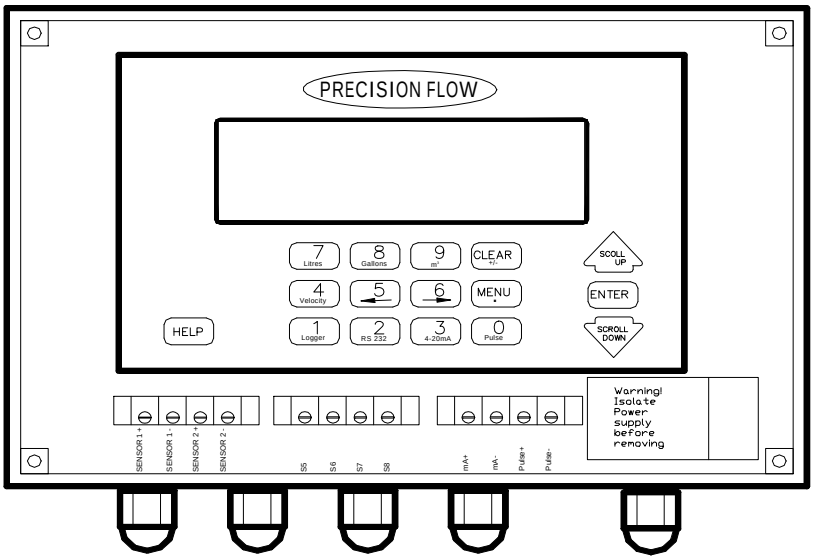


Figure 3

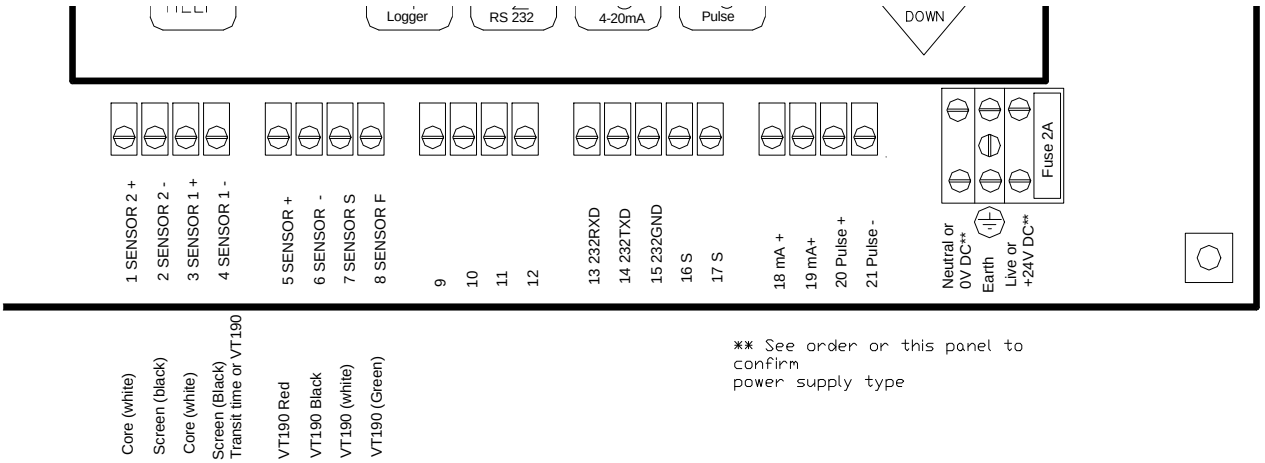


Figure 4 Internal connections

1.3.4 Instrument key pad

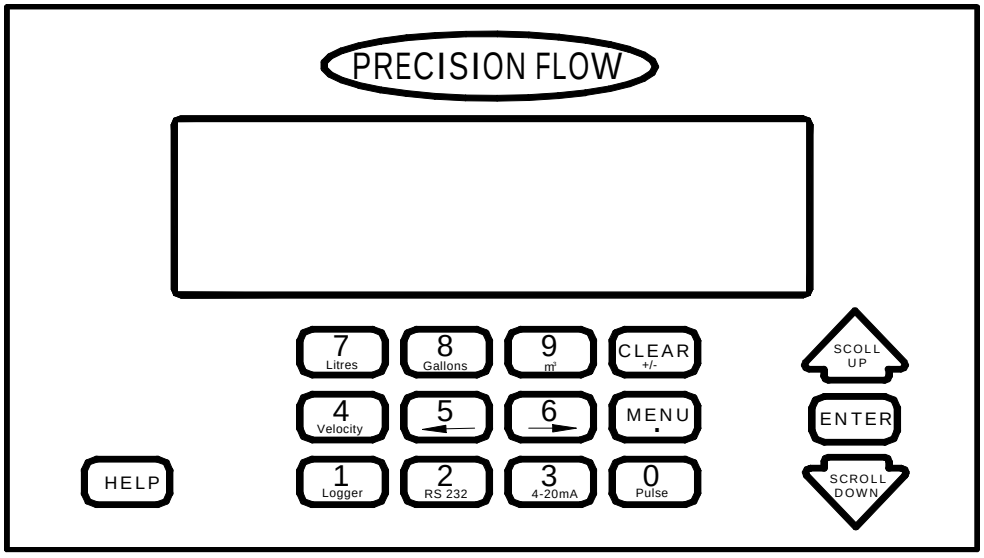


Figure 5

1.4 Battery back up (if fitted)

The internal battery is used to retain logged and totalized data.

1.5 Selection of a measuring point

To perform a reliable and accurate measurement the point of measurement must be selected carefully. To ensure this, the application must have a pipe and fluid that is sonically conductive and a fully developed flow profile (most standard pipe materials and fluids). Ensure the point on the pipe where the sensors are positioned is always filled completely with no bubbles or accumulated deposit material in the pipe at the measuring point.

Flow profile position guidelines:

Elbows, valves, pumps, T-sections, reducers, diffusers, and other pipefittings all cause flow profile distortion. As with all single beam ultrasonic flow meters it is important to have an axi – symmetrical shape flow profile.

The190F will still give accurate results even under non-ideal measuring conditions. Follow the guidelines below to ensure best performance.

Horizontal pipe: avoid mounting the transducers on the top or the bottom of the pipe as solid particles are deposited on the bottom of the pipe and gas pockets can develop at the top About 45 degrees from the vertical is usually a good place see figure:

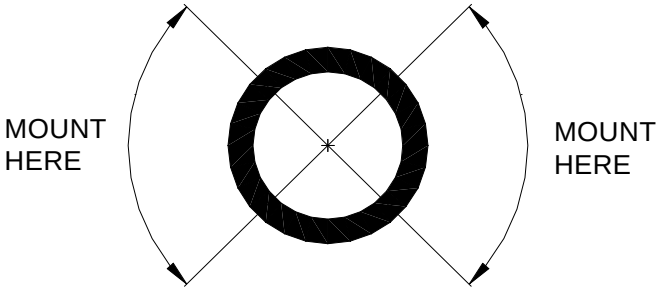


Figure 6

Vertical Pipe: Choose a site where the liquid flow is up this will help ensure the pipe is always completely filled.

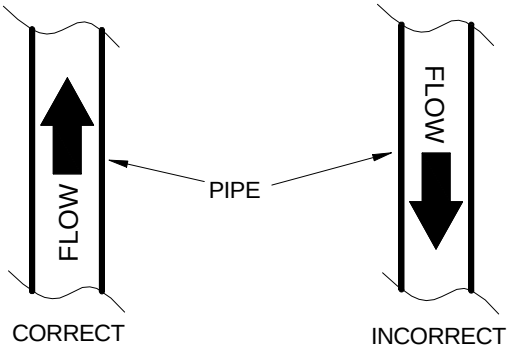


Figure 7

In the following table recommendations for straight inlet pipe lengths are given for common types of **up stream flow disturbance**, normally **20 diameters** will give acceptable results.

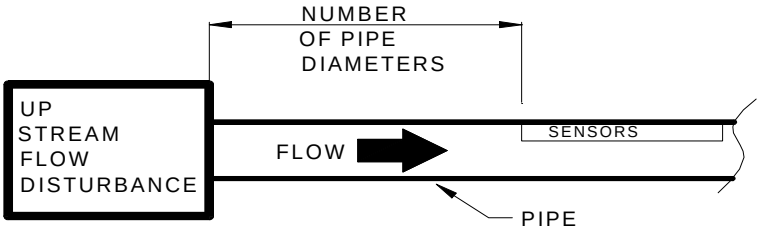


Figure 8

Disturbance source up Stream to measurement	**Pipe diameters to sensor position**
Valve non full bore or butterfly type	40
Fully open Ball valve	10
90^{o} elbow	15
2 90^{o} elbows in one plane	30
2 90^{o} elbows in different planes	40
T connector	50
Expander	30
Reducer	15
Pump	50

In the following table recommendations for straight outlet pipe lengths are given for common types of **down stream flow disturbance**, normally **10 diameters** will give acceptable results.

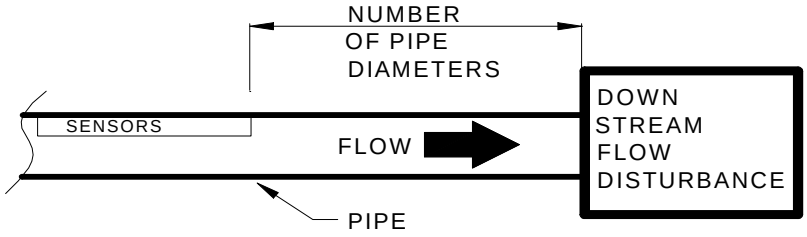


Figure 9

Disturbance source down Stream to measurement	**Pipe diameters to sensor position**
Valve non full bore or butterfly type	10
Fully open Ball valve	10
90^{o} elbow	10
2 90^{o} elbows in one plane	10
2 90^{o} elbows in different planes	10
T connector	10
Expander	10
Reducer	10
Pump	50

1.6 Application of ultrasonic couplant

Ensure pipe walls are clean and free from loose paint and rust before attaching the sensors.

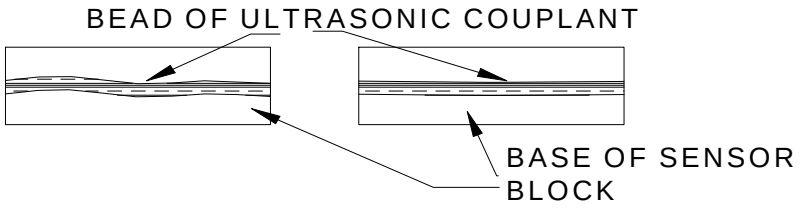


Figure 10a Transit time sensors

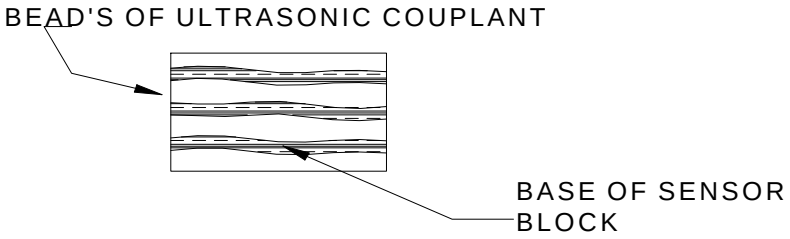


Figure 10b Doppler sensor

1.7 How to set the separation distance and transducer mounting instructions.

Instructions are the same for the Doppler transducer except there is no separation distance to set. Please check which style of Doppler mounting rail you have.

1.7.1 Reflex mode

Note the cables are outer most to each other.

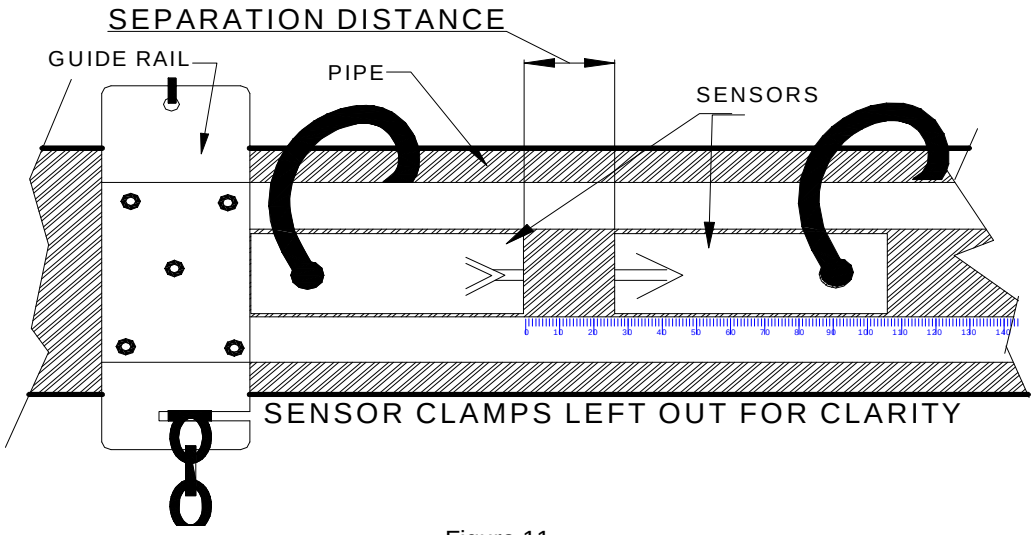


Figure 11

1.7.2 Diagonal Mode

Relationship of sensors:

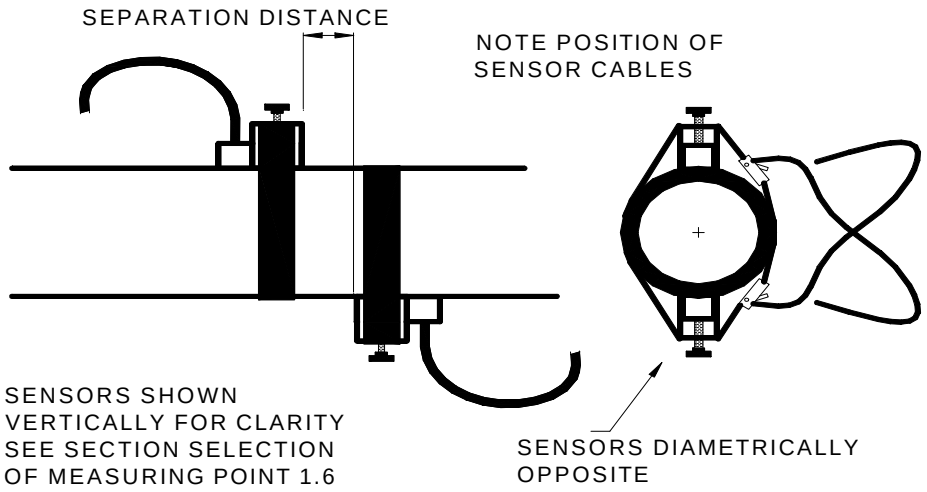


Figure 12

1.7.3 Marking pipe for sensor position

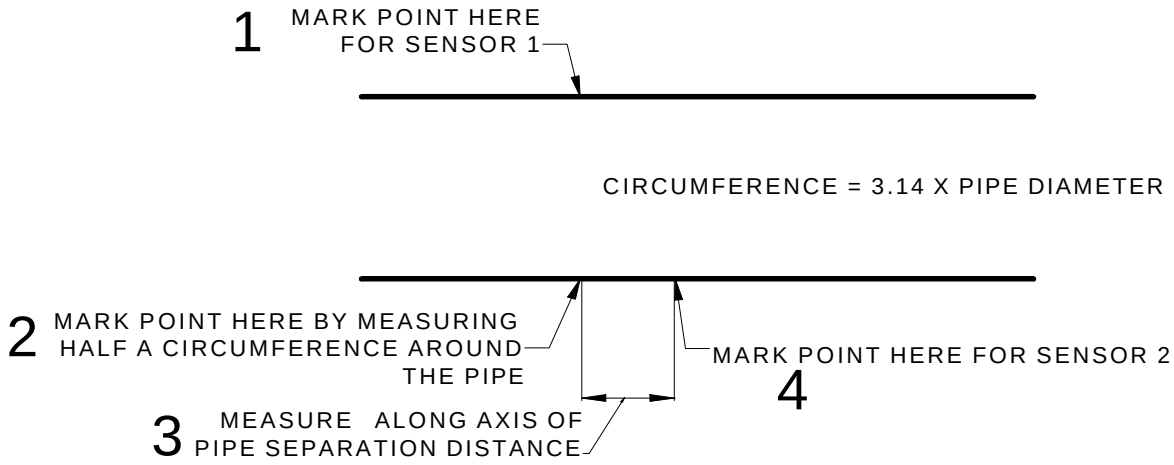


Figure 13

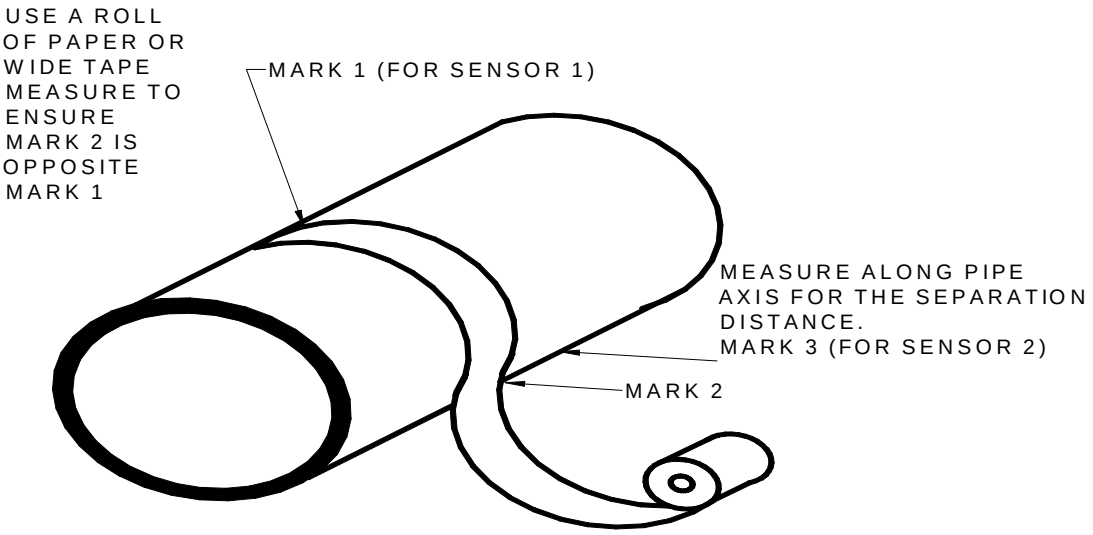

USE A ROLL OF PAPER OR WIDE TAPE MEASURE TO ENSURE MARK 2 IS OPPOSITE MARK 1
MARK 1 (FOR SENSOR 1)
MEASURE ALONG PIPE AXIS FOR THE SEPARATION DISTANCE.
MARK 3 (FOR SENSOR 2)
MARK 2

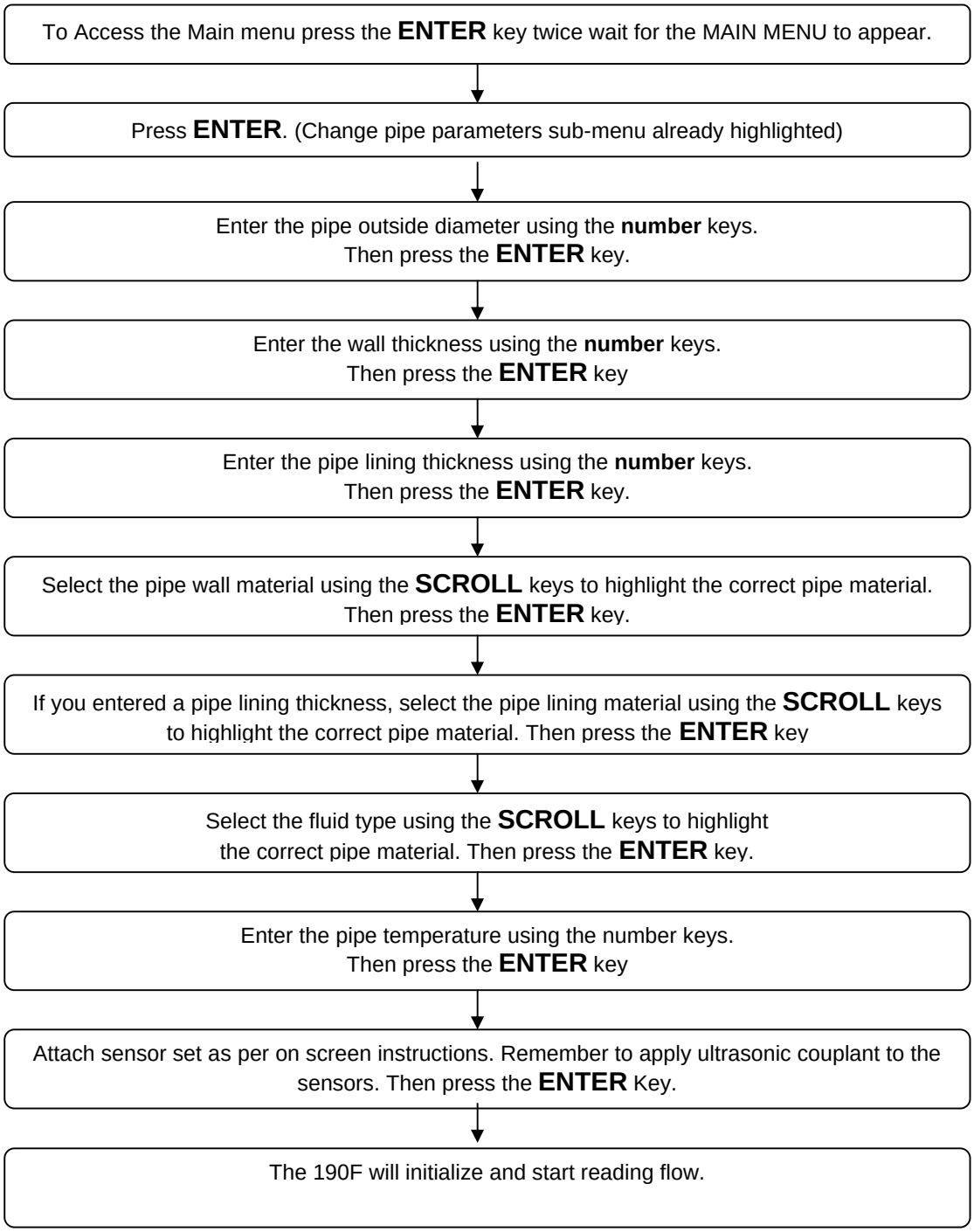
Figure 14

2.0 Basic operating system description.

The generic menu based operating system is easily navigated using the scroll keys to highlight a sub-menu title or variable. Press **ENTER** to display that menu or edit a variable. Pressing the **HELP** key at any time while navigating a menu gives information on that feature. Note: you must enter a menu for help on that menu, not just highlight it. All 190F configuration is easily performed by following the on screen instructions.

2.1 Start reading flow at a new pipe in easy steps.

Make sure the Unit is powered, the keypad is accessible and that you are familiar with section 1. After power up the instrument will initialise and go to the Flow Screen.



2.2 Data Logger

2.2.1 Overview

The built in data logger has the capacity to store 60,000/121,000 flow readings (depending on option selected). Data can be stored in 1-second to 1-hour intervals. Data from each Logging session can be saved with a unique name and is stored in the memory until it has been cleared. The stored data can be displayed on the instrument in text or graphical format. The instrument is also capable of downloading the stored data via the RS232/USB output port to a printer or PC onto a standard spreadsheet.

The data logger has 2 control menus one in the main menu and one accessible during the flow screen by pressing the logger button.
The logger menu accessible during the Flow Screen is used to: name the log, set start and stop times, set the log interval, view the logged data and clear the logged data.

The logger menu accessible from the Main Menu is used to: up load logger data and view logged data as text or in a graphical format change the logger units and clear the logged data.

To change the display units highlight the Units menu entry and press the relevant units button for example the 9 key will make the units m^3.

To edit the start and stop dates and time, highlight the date and time using the scroll keys then press the **ENTER** key to initialise editing the date and time. The value is adjusted by pressing the scroll keys. Pressing the **ENTER** key sets the value on the adjusted variable and moves the cursor to the next value to be adjusted until all are set.

To view logged data as text select the View log as text Menu item.

To view logged data as in graphical format first check and set if necessary the menu item Graph Y axis max value to a sensible value for your flow rates then select the View log as graph menu item.

Using the scroll keys to navigate the graph or logged text.

2.2.2 Down load instructions

To output the logger via RS232 / USB to another device make sure the device or program you are down loading the data to has the same RS232 configuration as the 190F.
To adjust the RS232 settings in the 190F see the section 2.5 RS232 configuration.

If you wish to connect to a PC using a USB port you must purchase the USB cable and adapter software. These are available from Your supplier and most computer hard wear stores.

Install the cable adapter by following the instructions supplied with the adapter.

To Access the Main menu press the **ENTER** twice wait for the MAIN MENU to appear.

Go to **MAIN MENU✍ Data logger✍Download log**

The logger is stored as 250/504 blocks of 240 points each. Set the first block to down load then set the last block to download. Set your equipment to capture or print a text file

Then highlight and select the Download range to RS232 menu entry.

2.2.3 How to capture logged data in windows XP, Vista, Windows 7,8,10

Either use our Logger data capture program **Log Simple (**Available from our web site) See section 2.2.4 for instruction on how to use this.

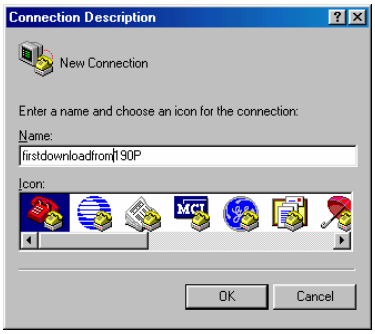
or start **Hyper Terminal,** this is supplied as part of your operating system usually under: **Start ✍Programs✍Accessories✍ Communications✍HyperTerminal**.

If this is not available see your system administrator or download and install the program from:

www.hilgraeve.com

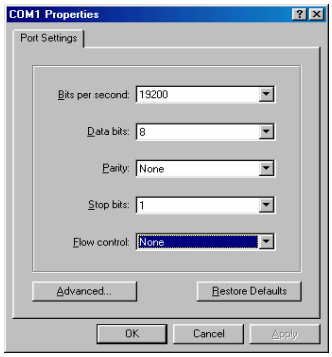
Alternatively use another Terminal emulation program.

Give your connection a name

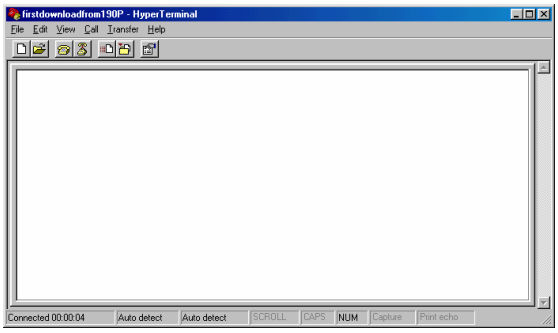


Then select connect direct to Com1 or whichever COM Port you are connecting to

Then set your RS232 settings to be the same as in RS232 configuration in the 190PD



Hyper terminal now shows the following window



To ensure the received data is placed on a separate line set the menu entry New Line to CR + LF (Go to **Main Menu**✍**Instrument config.**✍**RS232 Configuration** ✍**New Line**) in the 190PD.

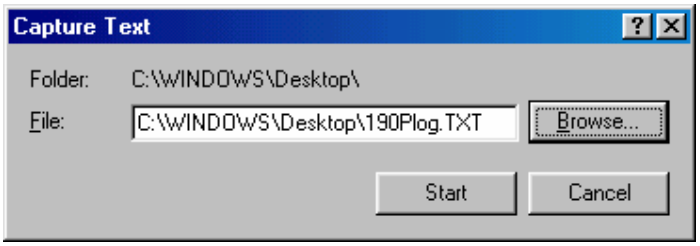
Or

Append a line feed to incoming line ends Hyper terminal setting under **File**✍ **properties**✍**settings**✍**ASCI setup**. (Terminal program)

Then

Select **Transfer** ✍**Capture Text**

Enter a name for the received text file



Select Start (Capture Text window)

Go to **MAIN MENU**✍ **Data logger**✍**Download log (190PD)**

Then highlight and select the Download range to RS232 menu entry.

When the 190PD has finished downloading the logged data
Stop the transfer by selecting:

Transfer✍ **Capture Text**✍ **Stop** (Hyper Terminal window)

The logged data is now a text file, 190PDlog.TXT in the example this can easily be imported in to Excel or many other spread sheet programs.

To open in Excel: Start Excel select **File**✍ **Open** set **Files of types** to **All Files (*.*)**

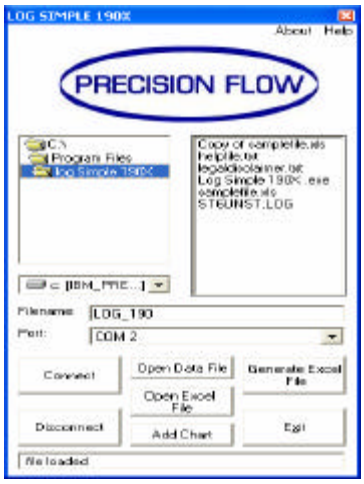
Navigate to your downloaded file and select open and follow the on screen instructions.

Note: The date is store in the format Year : Month: Day

2.2.4 Log simple installation and use .

1) Install the program by selecting setup.exe.
2) Run the program by selecting it from the program menu.
3) Select your preferred file location using the navigation windows.
4) Enter your file name.

5) Select the port you have connected the flow meter to. *
6) Select Connect.



On the Flow Meter

1) Navigate to the ✍ **"Main Menu"** ✍ **"Data logger"** ✍ **"Download Log" menu**
2) Select Download range to RS232. Change range before selecting if required.**

The data is down loaded from the Flow meter to the PC and saved in the entered file named.

Selecting the Open Data File button will open the selected file as a text file.
Selecting the Generate Excel File button will generate and export the data to an Excel file
Once the Excel file is open Selecting the Add Chart button will put the data into a chart.

Notes:
*If your PC does not have a Com port you will need to use a USB to Serial port adapter these are available from most computer stores or direct from us
**Ensure the instrument has its default communication settings set, these are:

Handshaking✍ None
Baud Rate ✍ 19200 or (38400 for later versions)
Data Bits ✍ 8
Stop bits✍ 1
Parity✍ None
New Line✍CR

These are located in: **"Main menu"** ✍ **"Instrument Config"** ✍ **"RS232 configuration"**

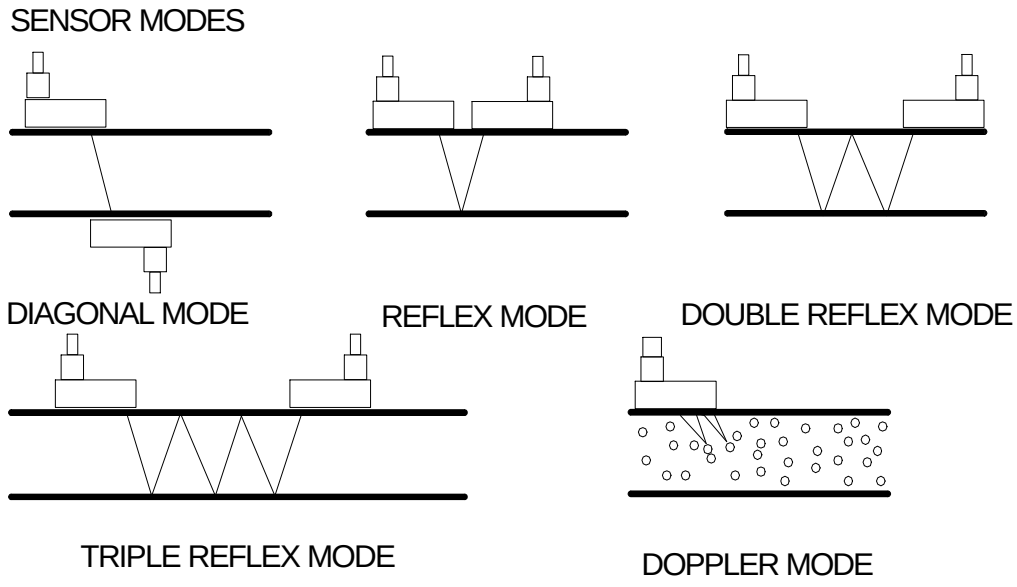
2.3 View pipe Parameters

Go to **Main menu** ✍ **View pipe parameters**

The pipe parameters can be viewed and edited as a list.

2.4 Sensor mode

Go to **Main menu** ✍ **Instrument config.**✍ **Sensor mode**
These should not need to be altered from the default settings. But can be useful for unusual applications.
Alternate sensor sets and modes of operation can be selected.



2.5 RS232 configuration

Go to **Main menu** ✍ **Instrument config.**✍**RS232 configuration** or from the flow screen press the **RS232** button
Navigated the menu using the scroll keys, highlight a variable, press **ENTER** to display the variable options **SCROLL** to highlight the desired setting and **ENTER** to select it.

Selecting test will output a text string indicating the settings selected via the RS232 port.

2.6 Calibrating the current output.

Go to **Main menu** ✍ **Instrument config.**✍ **Calibrate 4-20mA**
Press the **ENTER** key to initialise calibration.
Connect a reference current meter between the current output terminals and follow the on screen instructions.
All instruments are factory calibrated and adjustment is usually unnecessary.

2.7 Setting the date and time.

Go to **Main menu**✍ **Instrument config.**✍ **set date and time**
Press the **ENTER** key to initialise editing the date and time.

The value is adjusted by pressing the scroll keys. Pressing the **ENTER** key sets the value on the adjusted variable and moves the cursor to the next value to be adjusted until all are set.

2.8 Sensor parameters

Go to **Main menu** ✍ **Instrument config.**✍ **Sensor parameters**
These are only to be adjusted under guidance from the factory.

2.9 Application Options (Advanced users only)

Go to **Main menu** ✍ **Instrument config.**✍ **Application options**
Applications options allow the alteration of the profile correction settings. Reynolds Correction can be turned on or off. Fluid sound V correction can be enabled or disabled this should be enabled other than under guidance from the factory. When this feature is enabled there is no dependence on speed of sound of the fluid on the measurement other than to initially position the sensors to find a signal if the fluid sound speed changes drastically the signal may be lost and necessitate repositioning the sensors.

2.10 Correction settings (Advanced users only)

Go to **Main menu** ✍ **Instrument config.**✍ **Application options**✍**Correction settings**✍

2.10.1 Roughness um✍ is the pipe wall roughness in um it is only applied in conjunction with Reynolds correction. It is used to compensate for the profile distortion caused by unevenly lined or corroded pipes. Typical values are listed in help under the Correction settings help Screen (press the **HELP** button while in the Correction Settings Menu.)

The following 4 variables should only be adjusted under guidance from the factory.

2.10.2 Back wall adj ✍ when the received signal is reflected of the back wall of the pipe. Normally **DISABLED**

2.10.3 AZWT✍ Adaptive **Z**oom **W**indowing **T**echnology This automatic function ensures the correct signal is used for measurement by the correlation detection system, resulting in a quick and accurate flow measurement. Normally **ENABLED**

2.10.4 Window✍ Manual setting for signal setting only available for use when AZWT is **DISABLED**

2.10.5 Spipe✍ this function enable the small pipe (<35mm) correction algorithm
Normally **ENABLED**

2.11 Setting the Current output

From the flow screen press the **4-20mA** button. Configure the output to your requirements. Navigated the menu using the scroll keys, highlight a variable, press **ENTER** to display the variable options SCROLL to highlight the desired setting and ENTER to select it.

2.12 Pulse output

From the Flow screen press the **Pulse** button. Configure the output to your requirements. Navigated the menu using the scroll keys, highlight a variable, press **ENTER** to display the variable options SCROLL to highlight the desired setting and ENTER to select it.

2.13 Flow Menu

From the Flow screen press the **MENU** button. In this menu you can adjust flow settings such as Zero cut off, Set zero flow, Reset Totals, Damping and Site calibration factor. Selecting the Diagnostics menu line will display machine timing and signal quality information.

2.14 Pipe Dimension Units

Go to **Main menu ✍ Instrument config.✍ Pipe Dimension Units**
Choose the units you enter your pipe dimensions with this will become the instruments default entry units. Return here to change them at any time.

3.0 Other information

3.1 Operating conditions

The Precision Flow 190FD can be used where the application parameter values are within the temperature and pipe sizes given in the specification. In addition to this the pipe wall and liquid to be measured must be sonically conductive. This means the pipe walls must be made of a relatively homogenous material. For fluids free from or containing a minimal quantity of particulates or bubbles use transit time sensors. Typically < than 3% the meter may still function above this limit, depending on the distribution of the particulates. For applications above 3 % use the Doppler transducer.

There is no dependency on the electrical characteristics of the fluid.
Certain operating conditions may prevent a measurement being made these are:

Heavily corroded or pipes with deposits on the wall
The ultrasound may be too attenuated for the ultrasound to penetrate the wall. The sensitivity of the Precision Flow 190F is the best available and has been shown to work on applications where other leading manufactures machines fail to work.

Lined pipes
Lined pipes usually work well but can cause measurement difficulties if the lining is not bonded correctly to the pipe wall or consists of a material which is not sonically conductive. YPG sensors are specifically designed to work with concrete lined pipe.

Porous pipe materials e.g. concrete
Measurements are only possible for certain compositions of these materials and are some times impossible. YPG sensors are specifically designed to work with concrete lined pipe.

Unexpected gas pockets

Bubble free liquids can form gas pockets where there is a pressure change for example on a feed pipe to a pump or where the cross sectional area of the pipe expands by a large amount.

Incorrect pipe data

As in all single path ultrasonic meters the 190F measures the flow velocity and calculates the volumetric flow rate using the pipe dimensions given by the user.
Always try to measure pipe dimensions.

3.2 Error messages

These can be caused by adverse operating condition (see the section on operating conditions) or more commonly by incorrect data entry. Please check pipe dimensions, material, fluid type, temperature and that you have sensors with couplant correctly applied and attached to the pipe at the correct separation distance, before calling our help line.
The most common causes of errors are:
Not enough or the wrong type of ultrasonic coupling grease.
Sensor mounted back to front.

3.3 Specification

Wall mount Electronics
Protection Class: IP66
Material: Painted Mild Steel
Approval, CE, EN 61326; A1 A2 A3' EN 6100-6-3 2001, EN 61000-6-1 2001
Weight: < 5 Kg
Dimensions: 275 x 1 50 x 55mm
Display: 240 x 64 graphics LCD with backlight
Keypad: 1 6 key tactile membrane
Temperature range: 0ºC to +50ºC (operating) -0ºC to +50ºC (storage)
Power supply/charger Input: 1 2VDC
Volumetric flow units: m^3, gallons (Imperial and US), Litres
Velocity units: metres/sec, feet/sec
Flow velocity range: 0.0 m/sec to 25 m/sec to 4 significant figures
(Option higher if required)
Total volume: 1 2 digits forward and reverse
Continuous battery level indication
Continuous signal quality indication
ERROR messages
Analogue 4-20mA into 750 Ohms: User definable scaling
Resolution: 0.1 % of full scale
Pulse 5 Volts User definable scaling
Serial RS232, USB
Data logging memory capacity 60,000 or 120,000 data points
Data Logging output Via RS232 or displayed graphically/numerically
Transducer Standard VT 190 type Doppler Pipe size: 45mm and larger (lower with special mounting rail)
General service temp short term: -20 to 100 ^{o} C
General service temp long term: -20 to 80 ^{o} C
Transducer Standard WPG Pipe size: 15mm-300mm
General service temp short term: -30 to 1 30 ^{o} C
General service temp long term: -30 to 1 05 ^{o} C
Transducer Standard XPG type Pipe size: 50mm-1200mm
General service temp short term: -30 to 1 30 ^{o} C
General service temp long term: -30 to 1 05 ^{o} C
Transducer Standard YPG type Pipe size: 100mm 6500mm
General service temp short term: -30 to 1 30 ^{o} C
General service temp long term: -30 to 1 05 ^{o} C
Special application transducer design service is available please contact Precision Flow for details.

Repeatability ±0.5% with unchanged transducer positions
Accuracy ± 1 % to ± 2% or ± 0.02 m/sec whichever is the greater, depending on application.
Doppler:
Accuracy typically ± 1 % f.s.

The specification assumes turbulent flow profile with Reynolds numbers above 4000
The manufacturer reserve the right to alter any specification without notification

3.4 Tables

When fluid sound V correction is enabled, there is no dependence on speed of sound of the fluid on the measurement other than to initially position the sensors to find a signal. If the fluid sound speed changes drastically the signal may be lost and necessitate repositioning the sensors.

Speed of Sound in common materials

Material	Ctrans(m/s)		
304	3075	UPVC	2300
316	3175	Rubber	1900
347	3100		
Bitumen	2500		
Carbon Steel	3230		
Copper	2260		
Ductile cast iron	2650		
Lead	700		
Nylon 6	2620		
PE	2340		

Speed of Sound in common Liquids

Liquid	Velocity of sound m/s
Acetate, Butyl	1170
Acetate, Ethyl	1180
Acetate, Methyl	1150
Acetate, Propyl	1180
Acetone	1170
Acetonitrile	1290
Acetonyl Acetone	1400
Acetylendichloride	1020
Alcohol, Butyl	1240
Alcohol, Ethyl	1180
Alcohol, Furfuryl	1450
Alcohol, Methyl	1120
Alcohol, Propyl (n)	1220
Alcohol, t-Amyl	1200
Alkazene 13	1320
Analine	1690
Benzene	1300
Benzol	1330
Benzol, Ethyl	1340
Bromoform	920
Butylene Glycol (2.3)	1480
Butyrate, Ethyl	1170
Carbitol	1460
Carbon Bisulfide	1160
Carbon Disulfide	1150
Carbon Tetrachloride	930
Castor Oil	1480
Chlorobenzene	1300
Chloroform	987
Cyclohexanol	1450
Cyclohexanone	1420

Diacetyl	1240
Dichloroisobutane (1,3)	1220
Diesel Oil	1250
Diethyl Ketone	1310
Diethylene Glycol	1580
Dimethyl Phthalate	1460
Dioxane	1380
Diphenyl /oxide	1500
d-Penchone	1320
Ethanol Amide	1720
Ethyl Acetate	1190
Ethyl Ether	986
Ethylene Glycol	1660
Formamide	1620
Furfural	1450
Gasoline	1250
Glycerine	1920
Glycol	1658
Gravity Fuel Oil AA	1490
Isopentane	992
Kerosene	1320
Linalool	1400
Linseed Oil	1770
Mercury 20°C	1420
Mesityloxide	1310
Methyl Acetate	1210
Methyl Napthalene	1510
Methylene Iodide	980
Methylethylketone	1210
Monochlorobenzene	1270
Morpholine	1440
Motor Oil SAE 20	1740
M-xylol	1320
n-Hexanol	1300
Nitrobenzene	1460
Nitromethane	1330
Olive oil	1430
Parrafin	1300
Parrafin Oil	1420
Peanut Oil	1460
Pentane	1010
Petroleum	1290
Polypropylene oxide	1370
Pyridine	1410
Silicone	990
Silicone oil	1350
Sperm Oil	1440
Tert Butyl Chloride	980
Tetraethylene Glycol	1580
Transformer Oil	1390
Trichlorethylene	1050

Triethylene Glycol	1610
Turpentine	1280
Water	1480
Water Sea	1530
Water Salt Solution 10%	1470
Water Salt Solution 15%	1530
Water Salt Solution 20%	1600
Water D2O	1400
Xylene Hexaflouride	880

Standard pipe dimension tables

Other standard pipe tables are available on our web site

PVC Pipe data Schedule 40 (Standard water pipe) A4.2.2-1

Nominal pipe size(mm)	Nominal Pipe Size(inch)	Pipe OD (mm)	Pipe ID (mm)	Wall Thickness (mm)
19	0.75	26.67	20.57	3.1
25	1.0	33.4	26.24	3.6
32	1.3	42.16	34.65	3.8
38	1.5	48.26	40.44	3.9
51	2.0	60.33	52.04	4.1
64	2.5	73.03	62.1	5.5
76	3.0	88.9	77.27	5.8
102	4.0	114.3	101.55	6.4
152	6.0	168.28	153.19	7.5
203	8.0	219.08	201.75	8.7
254	10.0	273.05	253.39	9.8

MEDIUM WEIGHT (BLUE BAND) BS1387/1967

TUBE NOMINAL BORE		OUTSIDE DIAMETER MAX.		THICKNESS		WALL MIN.	
in.	mm	in.	mm	in.	mm	in.	mm
1/8	6	0.411	10.4	0.386	9.8	0.080	2.00
1/4	8	0.547	13.9	0.522	13.3	0.092	2.35
3/8	10	0.685	17.4	0.660	16.8	0.092	2.35
1/2	15	0.856	21.7	0.831	21.1	0.104	2.65
3/4	20	1.072	27.2	1.047	26.6	0.104	2.65
1	25	1.346	34.2	1.316	33.4	0.128	3.25
1 1/4	32	1.687	42.9	1.657	42.1	0.128	3.25
1 1/2	40	1.919	48.8	1.889	48.0	0.124	3.25
2	50	2.394	60.8	2.354	59.8	0.144	3.65
2 1/2	65	3.014	76.6	2.969	75.4	0.144	3.65
3	80	3.524	89.5	3.469	88.1	0.160	4.05
4	100	4.524	114.9	4.459	113.3	0.176	4.50
5	125	5.534	140.6	5.459	138.7	0.192	4.85
6	150	6.539	166.1	6.459	164.1	0.192	4.85

HEAVY WEIGHT (RED BAND) BS1387/1967

TUBE NOMINAL BORE		OUTSIDE DIAMETER MAX.		THICKNESS		WALL MIN.	
in.	mm	in.	mm	in.	mm	in.	mm
1/4	8	0.547	13.9	0.522	13.3	0.116	2.90
3/8	10	0.685	17.4	0.660	16.8	0.116	2.90
1/2	15	0.856	21.7	0.831	21.1	0.128	3.25
3/4	20	1.072	27.2	1.047	26.6	0.128	3.25
1	25	1.346	34.2	1.316	33.4	0.160	4.05
1 1/4	32	1.687	42.9	1.657	42.1	0.160	4.05
1 1/2	40	1.919	48.8	1.889	48.0	0.160	4.05
2	50	2.394	60.8	2.354	59.8	0.176	4.50
2 1/2	65	3.014	76.6	2.969	75.4	0.176	4.50
3	80	3.524	89.5	3.469	88.1	0.192	4.85
4	100	4.524	114.9	4.459	113.3	0.212	5.40
5	125	5.534	140.6	5.459	138.7	0.212	5.40
6	150	6.539	166.1	6.459	164.1	0.212	5.40

Copper Tube Size O.D. (mm)	Copper Pipe ASTM B Wall Thickness (mm)		
		Std	
	Table A4.4.2-3; Type C	Table A4.4.2-2; Type B	Table A4.4.2-1; Type A
10	0.6	0.8	0.9
12	0.6	0.9	1.2
15	0.7	1.0	1.2
18	0.7	1.0	1.2
22	0.8	1.1	1.6
28	0.9	1.2	1.6
35	1.1	1.4	1.6
42	1.2	1.5	1.8
54	1.5	1.7	2.1
67	1.6	2.0	2.4
79	1.8	2.3	2.8
105	2.4	2.8	3.4
130	2.7	3.1	4
156	3.1	3.5	4.8
206	4.3	5.0	6.8
257	5.4	6.3	8.5
308	6.4	7.1	10.3

Limited Warranty and Disclaimer

We warrant the end purchaser, for a period of one year from the date of shipment from our factory, that all new transmitters and transducers manufactured by it are free from defects in materials and workmanship. This warranty does not cover products that have been damaged due to normal use, misapplication, abuse, lack of maintenance, or improper installation. Our obligation under this warranty is limited to the repair or replacement of a defective product, if the product is inspected by Us and found to be defective. Repair or replacement is at the discretion of our selves. If the product is outside of the warranty period a purchase order must be received from the end purchaser before repair work will start. The product must be thoroughly cleaned and any process chemicals / contamination removed before it will be accepted for return. The purchaser must determine the applicability of the product for its desired use and assumes all risks in connection therewith. We assume no responsibility or liability for any omissions or errors in connection with the use of its products. We will under no circumstances be liable for any incidental, consequential, contingent or special damages or loss to any person or property arising out of the failure of any product, component or accessory. All expressed or implied warranties, including the implied warranty of merchantability and the implied warranty of fitness for a particular purpose or application are expressly disclaimed and shall not apply to any products sold or services rendered by Us. The above warranty supersedes and is in lieu of all other warranties, either expressed or implied and all other obligations or liabilities. No agent or representative has any authority to alter the terms of this warranty in any way.