BI-DIRECTIONAL INSERTION METER

INSTRUCTION MANUAL

1   Contents

1.1   General arrangement

Thank you for purchasing this Insertion Meter. It is important that you read this manual to gain a full understanding of the capability and operational aspects of the equipment you are about to install.

This information is provided only to assist in the installation of the product and does not diminish your obligation to read the manual.

1. Select a location that meets the requirements as illustrated in the Installation Guideline pages located at the rear of this manual. An ideal installation would provide for 25 diameters of straight pipe upstream from the meter and 10 diameters downstream.

You will also need to know the pipe internal diameter (NB) and pipe wall thickness for calculation of the insertion depth. *(refer page 5.)* Non ideal installations may require in-situ calibration *(refer to the factory for details).*

2. After screwing the Insertion Meter in place ensure the flow alignment mark located on the top positioning collar of the meter aligns with the flow in the pipe *(refer page 5).* This ensures the paddle is correctly aligned to the flow.
Note. The meter is bi-directional so a flow direction arrow is not provided.

3. Calculate and adjust the height of the Insertion Meter *(refer page 5).*

4. Electrical Installation depends on the model you have purchased.
If the Insertion Meter is fitted or supplied with a receiving instrument such as a totaliser or rate totaliser please refer to the appropriate manual and Page 10 of this manual. For pulse output meters, select the appropriate output and wire to your receiving device. *(refer pages 7 to 9).*

5. Calculate the Insertion Meter K *(scale)* factor to suit the installation. For ideal installations refer to page 11 or 12 or 13 of the Insertion Meter Manual. For non ideal installations the K-factor may be calculated by performing an in-situ calibration. Enter the appropriate K-factor into your receiving instrument.

1.2   Overview

The Insertion Meter provides a cost effective and simple means of measuring the flow of a wide range of low viscosity liquids. Installation is quick and inexpensive for pipe diameters ranging from 40mm to 900mm (1.5-36") and up to 2500mm (100") nominal bore for the Hot tap capable model DP525.

The Insertion Meter has a linear measuring range of 0.3~10.0 metres/sec. (1~33 ft/sec.). Minimum detectable flow velocity is 0.15 m/sec. (0.5 ft/sec.). When used in conjunction with the RT12 flow rate totaliser NLC feature the linear flow range is extended down to 0.15 m/sec. (0.5 ft/sec.) with an improved linearity.

The Insertion Meter is constructed from 316 L (1.4404) stainless steel enabling use in many applications for metering water and low viscosity chemicals.

Two independent pulse outputs are standard & can directly input to a wide range of ancillary instruments, PLC's and computers. Both pulse outputs have a high level of immunity to electrical interference. Options include a reed switch.

1.3 Operating principle

Flow passes through a pipe causing the rotor to spin. Magnets installed in the rotor pass by pulse sensors within the transducer body & inturn this produces frequency outputs proportional to flow rate.
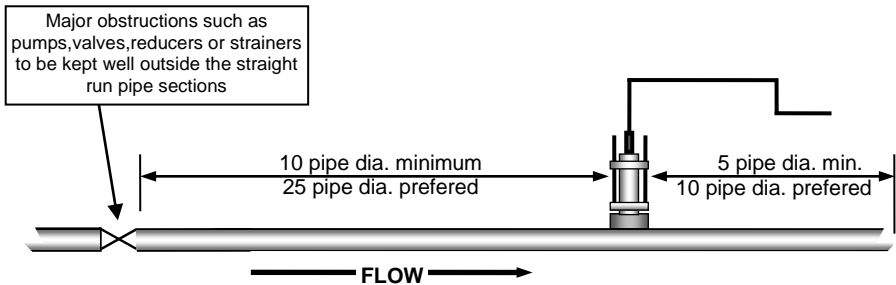
1.4 Specifications   *(subject to change without notice)*

| Model	490	525
Suits pipe sizes	40mm - 900mm (1.5 – 36 inches)	50mm - 2500mm (2 – 100 inches)
Flow range	0.25 - 6300 litres/sec. (4-99600 USGPM)	0.4 - 49000 litres/sec. (6-780000 USGPM)
Process connections	1.5" or 2" NPT or BSPT	2" NPT or BSPT
Velocity range	0.3 - 10 metres/sec. (1 - 33 feet/sec.)	
Linearity	typically $\pm$ 1.5% O.R. (1-10m/s) $\pm$ 1.5% F.S. (0.3-1m/s)	
Repeatability	typically $\pm$ 0.5%	
Pressure (max)	80 Bar (1200PSI)	
Temperature range	-40°C to 100°C (-40°F to 212°F) standard Other temperature ranges available	
Body material	316L stainless steel (1.4404)	
Rotor materials	Carbon Fibre filled PVDF *(standard)* or optional PEEK rotor with PEEK-HPV bearing	
O-Ring material	VITON - options available	
ELECTRICAL		
(a) Square wave (Hall Effect)	5-24vdc, 3wire NPN open collector (20mA max. current sink)	
(b) Reed Switch (to 100°C)	30vdc max. x 20mA max. (output freq. is 1/3 std. K-factor)	
Output freq. @ max. velocity	**(a)** outputs 220~240 Hz **(b)** output 73~80 Hz	
Transmission distance	1000 metres (3300 feet) maximum	
Wiring (standard)	5 core, screened cable length 1.5m/5ft (DP490) or 1m/3ft (DP525)	
Protection class	IP68 submersible (Nema 6X)	
Conduit entry (terminal box)	M20 x 1.5	
Shipping Weight	1.2 kg (2.7 lbs.)	1.5 kg (3.3 lbs.)

2.1 Meter location

Choose an appropriate section of horizontal or vertical pipe as per the guidelines below. With vertical pipe installations the media should be pumped up through the pipe past the flow sensor so that any entrained air will pass freely.

The Insertion Meter requires a fully developed turbulent flow profile to ensure maximum measurement accuracy and repeatability. This can be achieved by installing the Insertion Meter in a straight run of pipe. We recommend <u>at least</u> 10 but ideally 25 straight pipe diameters upstream & <u>at least</u> 5 but ideally 10 pipe diameters downstream of the Insertion Meter. Major obstructions such as pumps, valves or strainers will require longer straight runs before and after the Insertion Meter.

Major obstructions such as pumps, valves, reducers or strainers to be kept well outside the straight run pipe sections

10 pipe dia. minimum
25 pipe dia. prefered

5 pipe dia. min.
10 pipe dia. prefered

FLOW

2.2 Meter installation & orientation

Cut a 40mm diameter hole (1.6") on either the 2, 10 or 12 o'clock positions of the pipe. If there is any likelihood of air entrainment in a horizontal pipe do not locate the flow transducer in the 12 o'clock position.

10 o'clock   12 o'clock   2 o'clock

Other positions around the pipe are acceptable
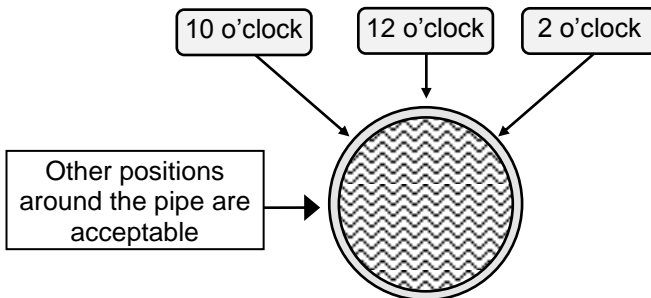
Install a female threaded weld on fitting (threadolet) or service saddle.
Wrap the threads of the Insertion Meter with Teflon tape or sealing compound & screw the unit into the installed fitting.

2.3 Height adjustment calculation

Calculate the adjustment height **A** for DP490 (or **AA** for the DP525) as follows:

A   (for DP490) = 175mm (6.9") - (B + C + D)
AA (for DP525) = 420mm (16.5") - (B + C + D)

Where :
B = Distance between the top of the pipe & the top of the hex adaptor.
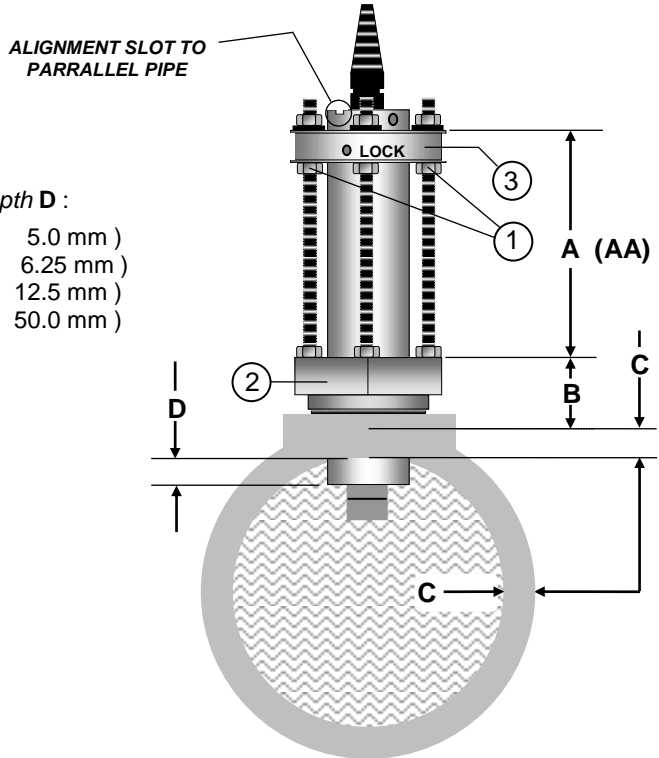**C** = Pipe wall thickness
D = Insertion depth (pipe ID $\div$ 8)

Examples of insertion depth **D** :

For   40mm pipe ID (**D=**   5.0 mm)
For   50mm pipe ID (**D=**   6.25 mm)
For 100mm pipe ID (**D=** 12.5 mm)
For 400mm pipe ID (**D=** 50.0 mm)

ALIGNMENT SLOT TO PARRALLEL PIPE

LOCK

Turn the height adjustment nuts (1) as required so that the distance between the top of the hex adaptor (2) and the top of the positioning collar (3) equals your calculated distance **A** (for DP490) or **AA** for model DP525. Retighten the height adjustment nuts (1).

2.4 Flow direction orientation
The unit is bi-directional however the paddle must be aligned with the direction of flow.

Using a 2mm hex key (Allen key), unlock the locking screw located on the positioning collar (3) then insert the hex key (as a lever) in the body rotating hole located above the collar, turn the body until the alignment slot is parallel with the direction of pipe. Retighten the locking screw.

2.5 Hot tap installation
(model DP525)

Clean & lubricate screw threads before withdrawing the Meter body in order to avoid nut seizure

IMPORTANT
Before removing the DP525 from the installation first withdraw the Meter body to the maximum distance allowed by the three height adjusting threaded rods. This will enable the isolating valve to be fully closed without damaging the paddle.

If necessary extend valve port using a 2" nipple & socket combination to ensure the paddle is clear of the ball valve.

CAUTION : Hot tap installation should only be performed by qualified personal. Installation procedures should be in accordance with the safety rules, regulations and requirements applying to the territory in which the Insertion Meter is being installed.

2" ball or gate isolation valve.
(Allow min. 40mm I.D. to clear metering head)

2" Nipple

2" Weld-O-let
(threadolet)

Hot tap clearance hole in pipe wall to be a minimum of 40mm diameter (1.6").
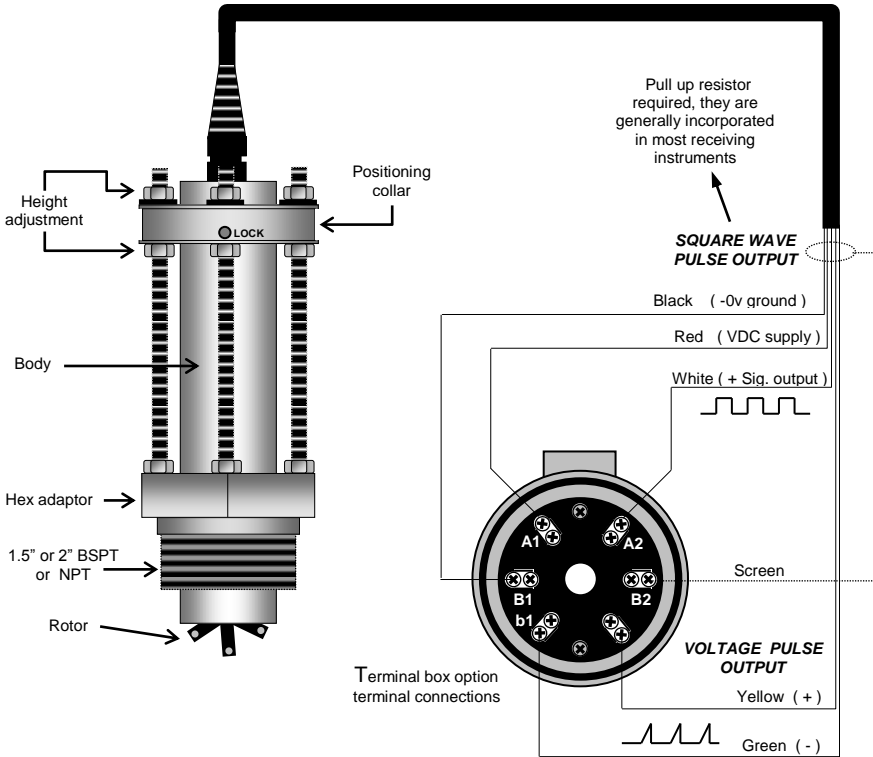
FLOW
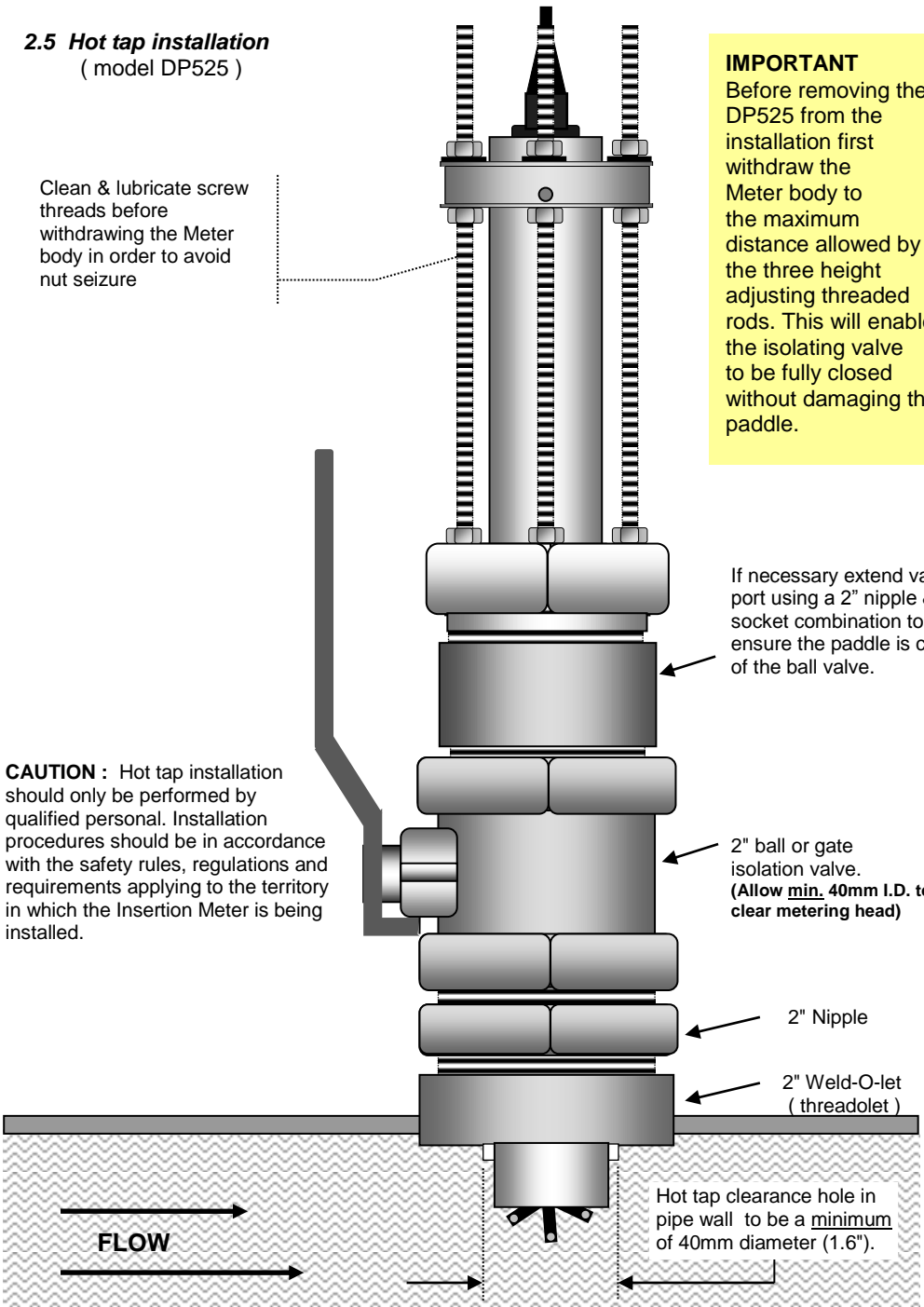
3.0   ELECTRICAL CONNECTIONS
(see page 10 for QP outputs)

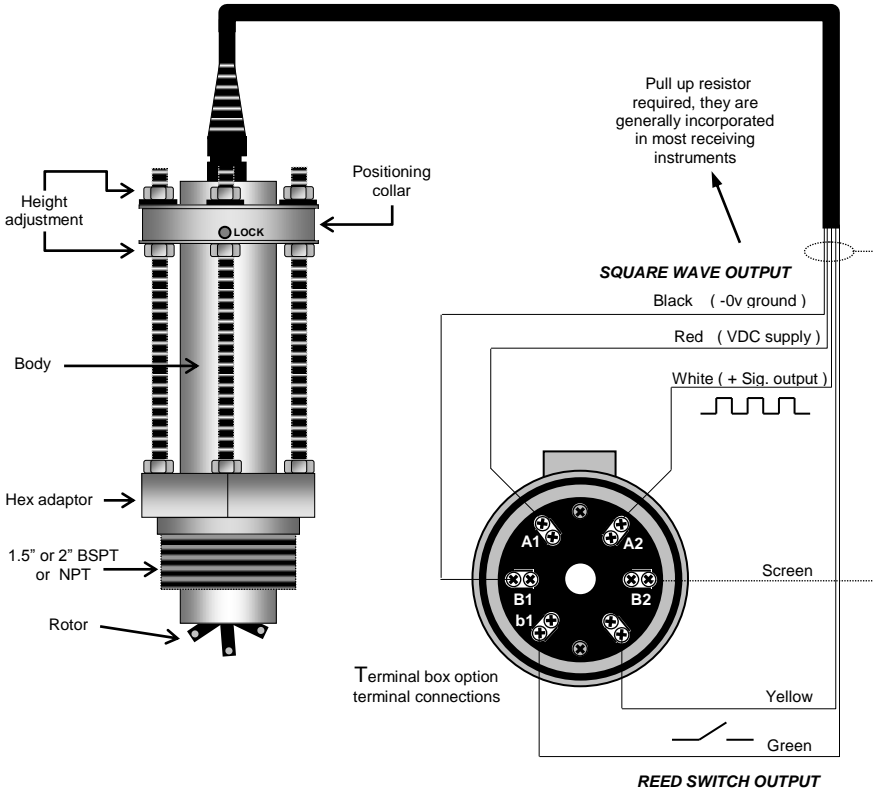### 3.1 Standard outputs – NPN Hall Effect + Voltage Pulse outputs

Conductor color coding also applies to the Non-magnetic
sensor and high temperature output options

Pull up resistor
required, they are
generally incorporated
in most receiving
instruments

Height
adjustment

Positioning
collar

LOCK

*SQUARE WAVE
PULSE OUTPUT*

Black   (-0v ground)

Red   (VDC supply)

White (+ Sig. output)

Body

Hex adaptor

A1   A2

1.5" or 2" BSPT
or NPT

B1   B2
b1

Screen

Rotor

Terminal box option
terminal connections

*VOLTAGE PULSE
OUTPUT*

Yellow (+)

Green (-)

3.2 Optional – NPN Hall Effect + Reed Switch outputs

Conductor color coding also applies to the Non-magnetic
sensor and high temperature output options

Pull up resistor
required, they are
generally incorporated
in most receiving
instruments

Height
adjustment

Positioning
collar

LOCK

Body

Hex adaptor

1.5" or 2" BSPT
or NPT

Rotor

SQUARE WAVE OUTPUT

Black   (-0v ground)

Red   (VDC supply)

White (+ Sig. output)

A1   A2

B1   B2

b1

Screen

Terminal box option
terminal connections

Yellow

Green

REED SWITCH OUTPUT

3.3 Optional - Reed switch only

HAZARDOUS AREAS

The REED SWITCH output is classed as a
"simple apparatus" as defined in the
CENELEC standard EN50020 &
recognized IEC & ATEX directive. It can
be connected to an approved I.S.
secondary instrument with both being
located in the hazardous area.
The Reed Switch may also be connected
through an approved I.S. barrier.

Note: The Reed switch produces 1/3rd
          the normal pulse output value
          (eg. 1/3 the standard K-factor)

*REED SWITCH
OUTPUT*

LOCK

Screen

To -0V

Yellow

Green
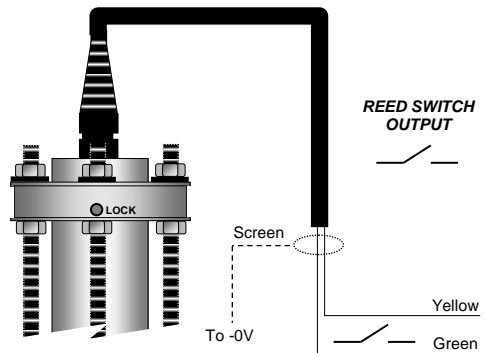
3.4 Instrument cable installation requirements
Use twisted multi-core low capacitance shielded instrument cable (22 AWG ~ 7x 0.3 stranded) for electrical connection between the Insertion Meter and the remote instrumentation. The screen should be earthed at the readout instrument end only to protect the transmitted signal from mutual inductive interference.

The cable should **not** be run in a common conduit or parallel with power and high inductive load carrying cables as power surges may induce erroneous noise transients onto the transmitted pulse signal. Run the cable in separate conduit or with other low energy instrument cables.

3.5 Pulse output selection (standard outputs)
The standard Insertion Meter has two independent pulse output signals that are linearly proportional to volumetric flow rate. Pulse transmission can be up to 1000 metres (3300 ft). An optional intrinsically safe (I.S.) Reed Switch only output is available *(see page 7).*

Voltage pulse *(pulse wire)* output
A self-generating pulse output which produces a strong 1.5 volt voltage spike of approximately 10 micro/second duration with no dependence on rotor speed.
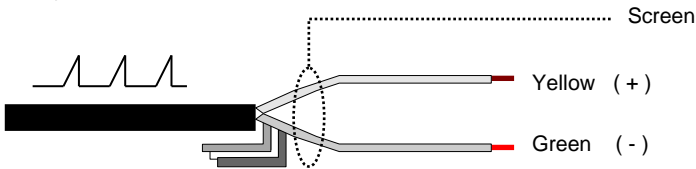

Square Wave Pulse *(Hall sensor)   (also applies to non-magnetic & QP Hall outputs)*
An NPN open collector transistor pulse output produced by a solid state Hall Effect device. This three wire device requires 5~24vdc and produces an NPN square wave output (20mA max. sink), pulse width is 2~75 mSec. The Hall output requires a pull up resistor, these are generally incorporated in most receiving instruments. For (QP) Quadrature pulse output refer details page 10.
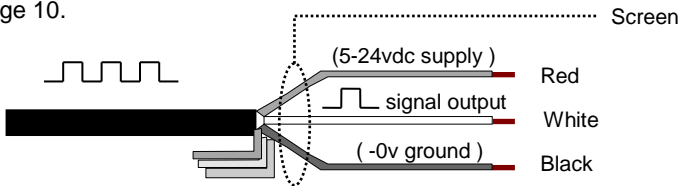

Reed Switch output
The Reed Switch has a fast response capable of frequencies in excess of 80hz. Receiving instruments should have the ability to suppress reed switch bounce (0.01µf capacitor) and a 1 meg pull up resistor would be typical.
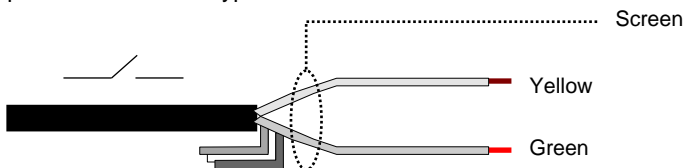
3.6   Quadrature outputs

Insertion Meters supplied with the QP option produce two NPN open collector pulse outputs from two Hall Effect sensors. The outputs are " phase offset " in their timing so that external electronics are able to differentiate. These outputs may be used to assure output signal integrity or to measure bi-directional flow.
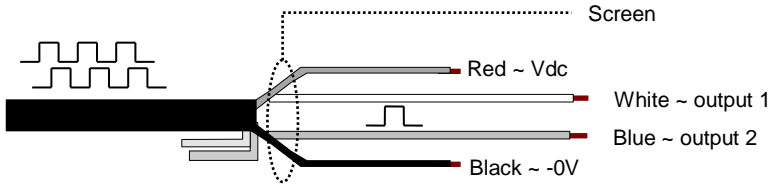

3.7   Bi-directional flow

The Insertion Meter is capable of accurately measuring flow in both directions without modification. Meters fitted with the QP output option (quadrature pulse output) may be interfaced with the Pulse Discriminator Module (PD2). The PD2 accepts the Quadrature pulse inputs & from these will discriminate between forward & reverse flow. Two individual & proportional pulse outputs can then be sent to appropriate totalising registers or an add and subtract flow rate totaliser.
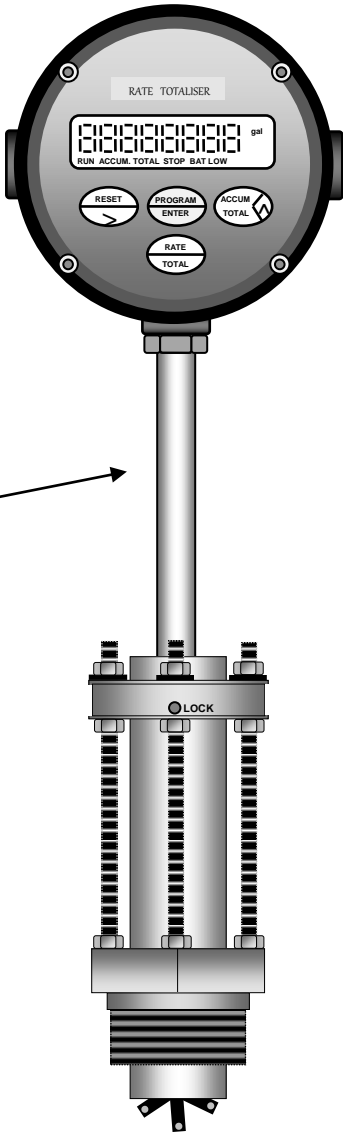
It is **important to note** that the Quadrature Pulse option has the same pulse resolution (pulses/unit volume) as a standard Insertion Meter for both forward & reverse outputs.
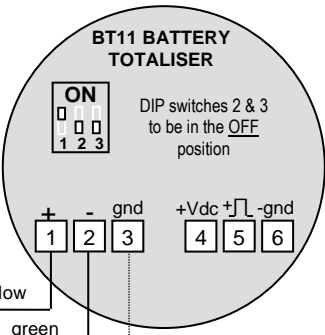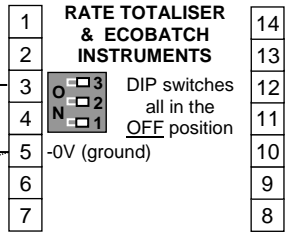
Flowmeter with QP outputs
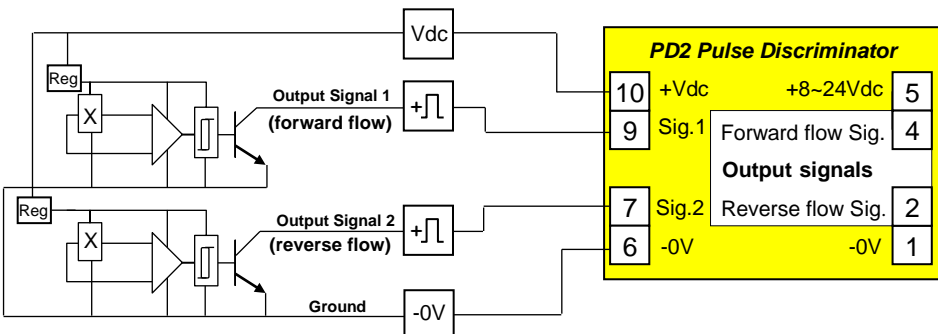
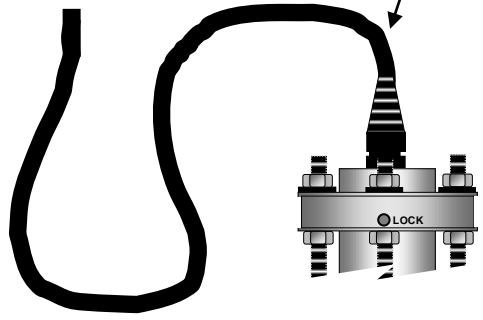### 3.8 Voltage Pulse Connection to family instruments

Note: For other output styles see receiving instrument manual

1		RATE TOTALISER	14
2		& ECOBATCH INSTRUMENTS	13
3	yellow	DIP switches	12
4		all in the OFF position	11
5	green -0V (ground)		10
6			9
7	Screen		8

O N 3 2 1

BT11 BATTERY TOTALISER

ON
1 2 3

DIP switches 2 & 3 to be in the OFF position

+	-	gnd	+Vdc	+⊓	-gnd
1	2	3	4	5	6

yellow

green

Screen

The Insertion Meter cable should not be run with other high energy cables (clause 3.3).

RATE TOTALISER

gal

RUN ACCUM. TOTAL STOP BAT LOW

RESET >

PROGRAM ENTER

ACCUM TOTAL

RATE TOTAL

LOCK

Flow instruments or a terminal box can be directly mounted to the Insertion Meter using kits

LOCK

4.0   K – FACTORS *(calibration factors for meter)*

The K-factor (pulses / litre, gallon etc.) will vary in relation to the bore size of the pipe in which the Insertion Meter is installed.

The K-factors and formula shown are a result of factory testing using smooth bore piping under ideal conditions. Variations to the given K-factors may occur when using rough bore piping or inadequate flow conditioning on either side of the Insertion Meter (refer clause 2.1). In these instances on site calibration may be used to determine the K-factor.

4.1 Insertion Meter K- factors for common pipe sizes

| Pipe detail		K-factors (standard K-factors for square wave output only)					
NB	pipe ID	Schedule 40 pipe			Schedule 80 pipe		
inches	mm	p / litre	p / m3	p / USgal	p / litre	p / m3	p / USgal
1.5"	40.9	18.678	18678	70.695	21.524	21524	81.468
2"	52.6	11.238	11238	42.534	12.818	12818	48.517
2.5"	62.7	7.880	7880	29.824	8.899	8899	33.682
3"	78.0	5.062	5062	19.161	5.676	5676	21.485
3.5"	90.2	3.768	3768	14.263	4.200	4200	15.896
4"	102.4	2.912	2912	11.021	3.233	3233	12.237
5"	128.3	1.839	1839	6.959	2.025	2025	7.665
6"	153.9	1.268	1268	4.798	1.402	1402	5.307
8"	203	0.719	719.0	2.721	0.787	787.2	2.980
10"	255	0.450	450.3	1.705	0.496	495.9	1.877
12"	303	0.316	316.0	1.196	0.347	347.4	1.315
14"	333	0.261	260.5	0.986	0.286	285.7	1.081
16"	381	0.198	198.0	0.750	0.217	217.0	0.821
18"	429	0.156	155.8	0.590	0.171	170.6	0.646
20"	478	0.125	125.4	0.475	0.138	137.8	0.521
24"	575	0.087	86.64	0.328	0.095	95.39	0.361

For other pipe sizes below 610mm (24") not listed above, use the graphs and apply the formula on the following pages (12 & 13).

4.2 K-factors for large pipes 460mm ID (18") and above use:

Pulses per litre   = 28647 ÷ pipe ID² (mm)
Pulses per M³   = 28647000 ÷ pipe ID² (mm)
Pulses per US gallon   = 168.14   ÷ pipe ID² (inches)
Pulses per Imp. gallon = 201.94 ÷ pipe ID² (inches)

NOTE : K-factors for Reed Switch output are 1/3 the standard factors of the square wave pulse output

4.3 Calculating K-factors (litres or m³)
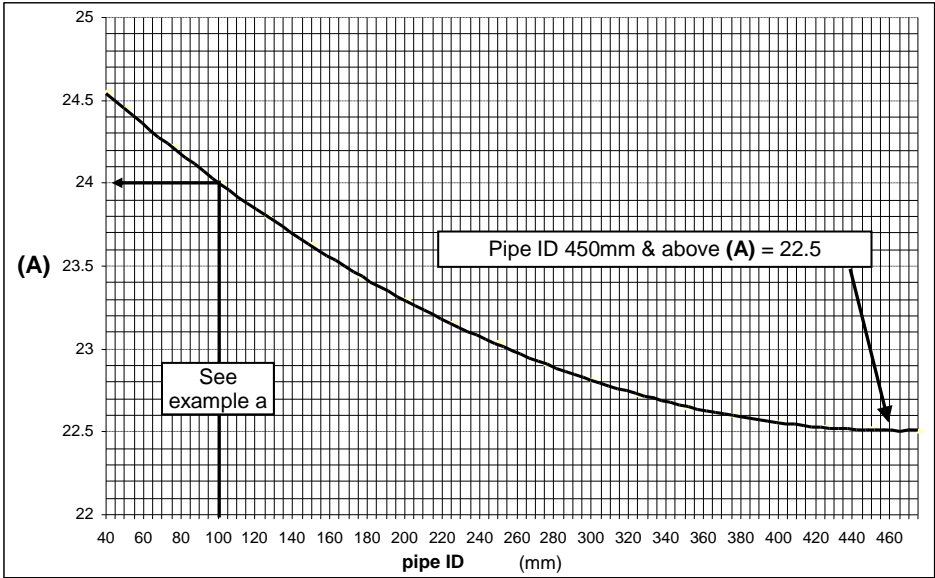
Calculate K-factor (pulses / litre) using the above graph and the metric constant of 1273.2 as follows :

$$\textbf{Pulses / litre} \;=\; \frac{1273.2 \;\times\; \textbf{(A)} \text{ from graph}}{\text{pipe ID}^2 \;\text{(mm)}}$$

Example 'a' :
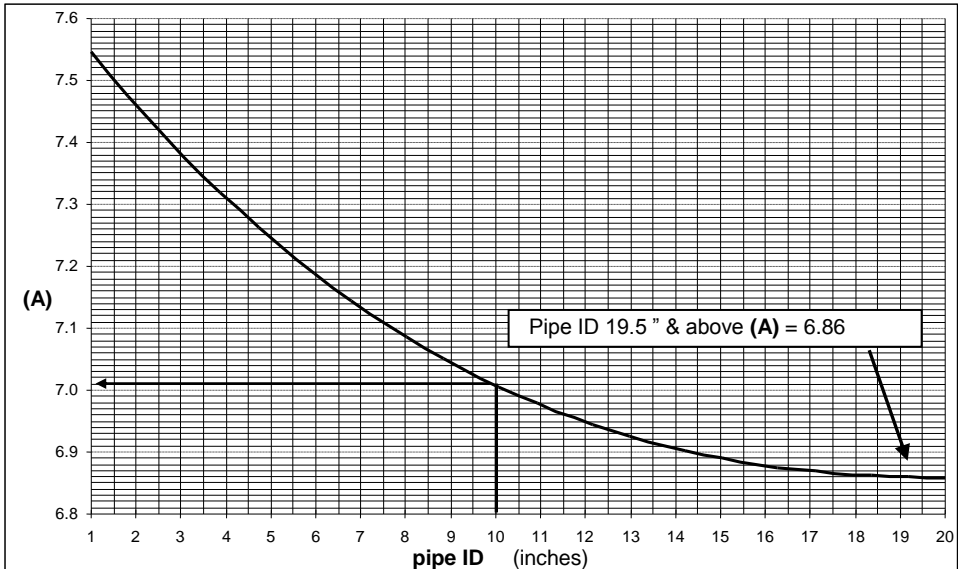K-factor for 100mm pipe: **1)** from graph 100mm ID **(A)** = 24.0

$$\textbf{2)} \text{ pulses/litre.} \;=\; \frac{1273.2 \;\times\; 24.0}{10000} \qquad = \underline{\textbf{3.056}} \text{ p/litre}$$

K-factor for m³   **:** multiply by 1000 eg.   K = 3056 p/m³
K-factor for megalitres   **:** multiply by 1000000 eg. K = 3056000 p/megalitre

NOTE : K-factors for Reed Switch output option are 1/3 the standard factors of voltage pulse output.

4.4 Calculating K-factors (US gallons)

Pipe ID 19.5 " & above **(A)** = 6.86

Calculate K-factor (pulses / gallon) using the above graph and the volumetric constant of 24.51 as follows :

$$\textbf{Pulses / US gal.} \ = \ \frac{24.51 \ \text{x} \ \textbf{(A)} \ \text{from graph}}{\text{pipe ID}^2 \ \text{(inches)}}$$

Example 'b' :
K-factor for 10" pipe: **1)** from graph 10" ID **(A)** = 7.01

                                 2) pulses/gal. = $\dfrac{24.51 \ \text{x} \ 7.01}{100}$ = **1.718** p/gal

NOTE : K-factors for Reed Switch output option are 1/3 the factors of the square wave pulse output.
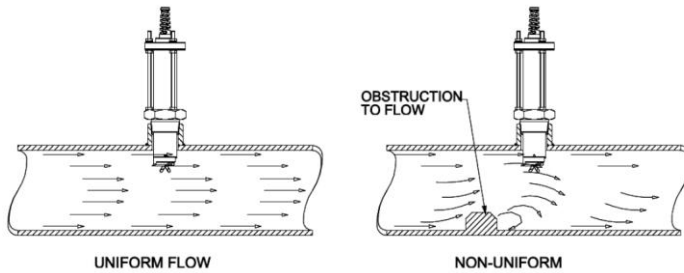
5.0 INSTALLATION GUIDELINES

1.   GENERAL

The flow profile must be uniform at the point where the Insertion Meter is to be installed, otherwise inaccurate and unstable readings will result.
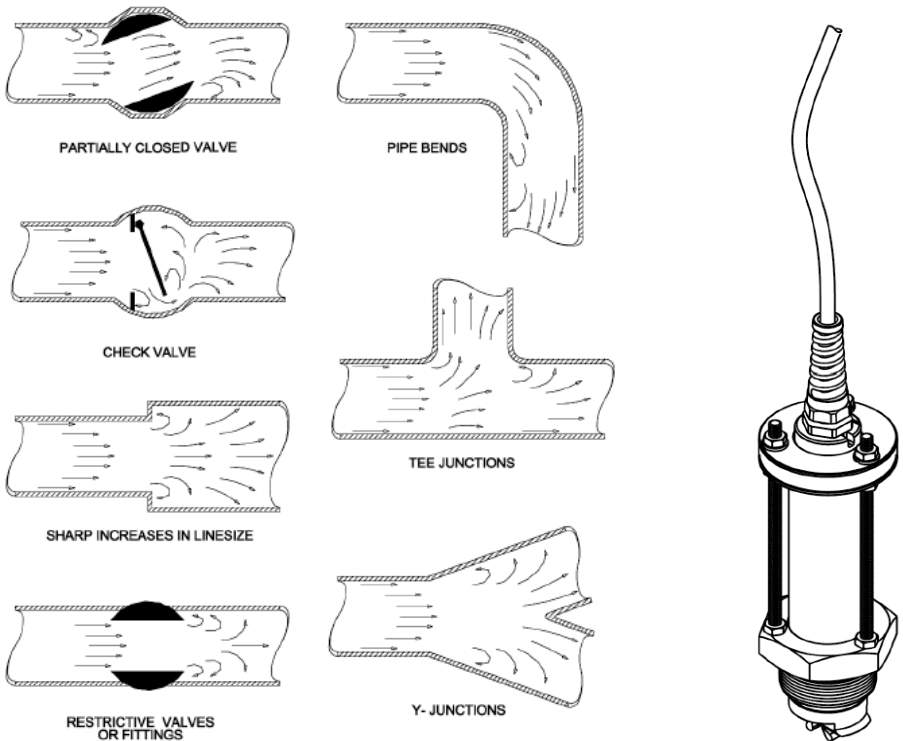
British Standard: BS 1042 gives a full insight into flow conditioning for inferential flow devices

The general rule is to have a minimum of 10 diameters of straight pipe runs before the flowmeter (upstream) and 5 diameters after (downstream). These straight runs must not contain any other items such as Valves, Bends, Tees, Probes, or Reducers etc.

Any Valves immediately outside the straight runs require doubling of the straight pipe run lengths.
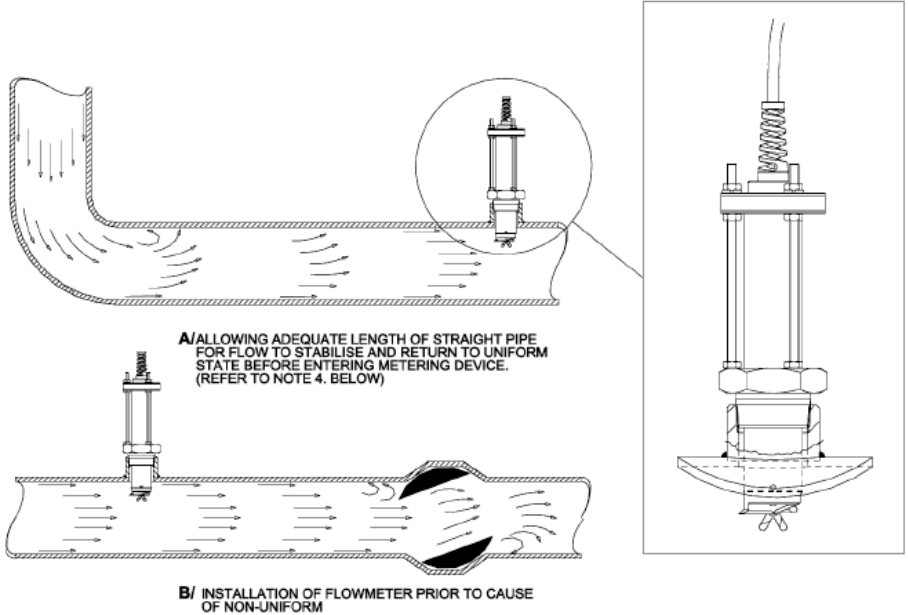

UNIFORM FLOW   NON-UNIFORM
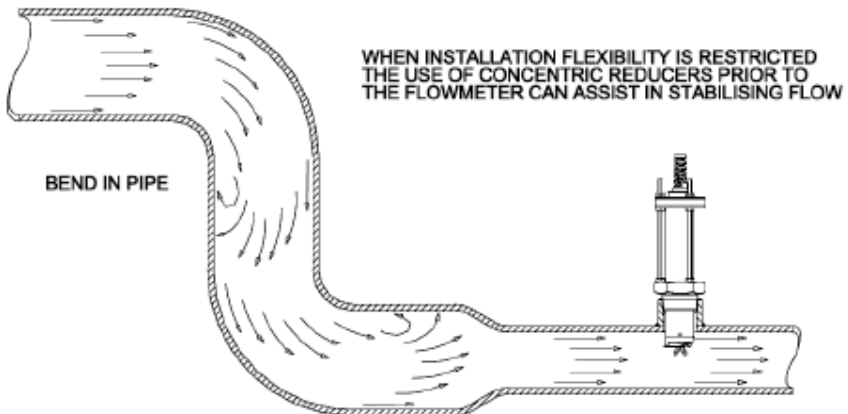
2.   COMMON CAUSES OF NON-UNIFORM FLOW

PARTIALLY CLOSED VALVE   PIPE BENDS

CHECK VALVE

TEE JUNCTIONS

SHARP INCREASES IN LINESIZE

RESTRICTIVE VALVES   Y- JUNCTIONS
OR FITTINGS

3. PRECAUTIONS FOR AVOIDING NON-UNIFORM FLOW

A/ ALLOWING ADEQUATE LENGTH OF STRAIGHT PIPE FOR FLOW TO STABILISE AND RETURN TO UNIFORM STATE BEFORE ENTERING METERING DEVICE. (REFER TO NOTE 4. BELOW)

B/ INSTALLATION OF FLOWMETER PRIOR TO CAUSE OF NON-UNIFORM

4. RECOMMENDED LENGHTS OF STRAIGHT PIPE FOR TYPICAL CASES

DEPENDING ON THE MAGNITUDE OF THE DISRUPTION TO FLOW RECOMENDATIONS ARE AS FOLLOWS:
A/ VALVES AND FILTERS: MINUMUM OF 10 DIAMETERS OF STRAIGHT PIPE PRIOR TO FLOWMETER
B/ ELBOWS: MINUMUM OF 6 DIAMETERS OF STRAIGHT PIPE PRIOR TO FLOWMETER
C/ INCREASES IN LINE SIZE: 4 - 8 DIAMETERS OF STRAIGHT PIPE DEPENDING ON INCREASE OF LINE SIZE
D/ CONCENTRIC DECREASES IN LINE SIZE: MINIMUM 4 DIAMETERS OF STRAIGHT PIPE PRIOR TO FLOWMETER
(AS SHOWN IN 5. BELOW)

5. RECOMMENDED SOLUTIONS FOR RESTRICTED CASES

WHEN INSTALLATION FLEXIBILITY IS RESTRICTED THE USE OF CONCENTRIC REDUCERS PRIOR TO THE FLOWMETER CAN ASSIST IN STABILISING FLOW

BEND IN PIPE

NOTES:

NOTES: