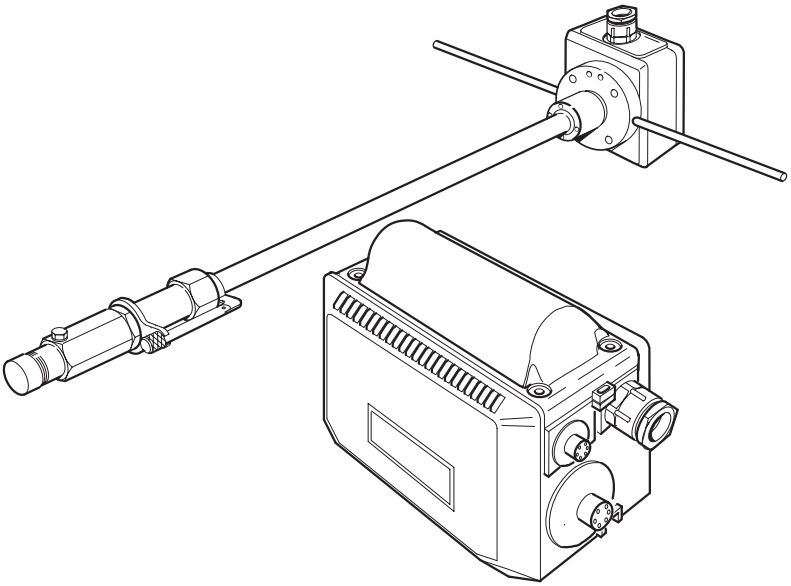
AquaProbe II

Installation Guide



ABB

The Company

We are an established world force in the design and manufacture of instrumentation for industrial process control, flow measurement, gas and liquid analysis and environmental applications.

As a part of ABB, a world leader in process automation technology, we offer customers application expertise, service and support worldwide.

We are committed to teamwork, high quality manufacturing, advanced technology and unrivalled service and support.

The quality, accuracy and performance of the Company's products result from over 100 years experience, combined with a continuous program of innovative design and development to incorporate the latest technology.

The NAMAS Calibration Laboratory (No. 0255) is just one of ten flow calibration plants operated by the Company, and is indicative of our dedication to quality and accuracy.

BS EN ISO 9001

Cert. No. Q5907

EN 29001 (ISO 9001)

Lenno, Italy – Cert. No. 9/90A

Stonehouse, U.K.

0255

Use of Instructions

Warning.
An instruction that draws attention to the risk of injury or death.

Note.
Clarification of an instruction or additional information.

Caution.
An instruction that draws attention to the risk of damage to the product, process or surroundings.

Information.
Further reference for more detailed information or technical details.

Although **Warning** hazards are related to personal injury, and **Caution** hazards are associated with equipment or property damage, it must be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process system performance leading to personal injury or death. Therefore, comply fully with all **Warning** and **Caution** notices.

Health and Safety

To ensure that our products are safe and without risk to health, the following points must be noted:

1. The relevant sections of these instructions must be read carefully before proceeding.
2. Warning labels on containers and packages must be observed.
3. Installation, operation, maintenance and servicing must only be carried out by suitably trained personnel and in accordance with the information given.
4. Normal safety precautions must be taken to avoid the possibility of an accident occurring when operating in conditions of high pressure and/or temperature.
5. Chemicals must be stored away from heat, protected from temperature extremes and powders kept dry. Normal safe handling procedures must be used.
6. When disposing of chemicals ensure that no two chemicals are mixed.

Safety advice concerning the use of the equipment described in this manual or any relevant hazard data sheets (where applicable) may be obtained from the Company address on the back cover, together with servicing and spares information.

CONTENTS

1 INTRODUCTION

The AquaProbe electromagnetic insertion flowmeter is designed for measurement of the velocity of water.

The flowmeter, available in four standard lengths, can be installed in any pipeline of internal diameter from 200mm (8in) to 8000mm (360in), through a small tapping.

The AquaProbe has been designed for use in survey applications such as leakage monitoring and network analysis and in permanent locations where cost or space limitations preclude the use of conventional closed pipe meters.

1.1 System Schematic – Fig. 1.1

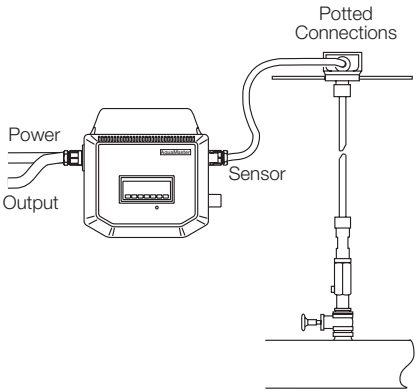
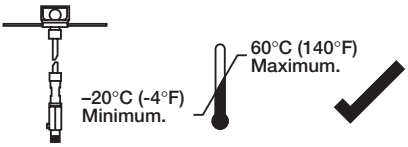


Fig. 1.1 System Schematic

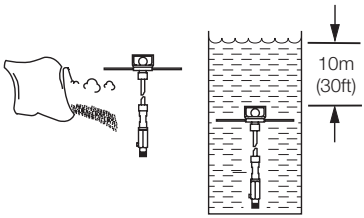
2 MECHANICAL INSTALLATION

2.1 Location – Environmental Conditions

2.1.1 AquaProbe – Fig. 2.1

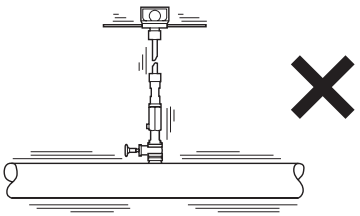


A – Within Temperature Limits



IP68 (NEMA 6)

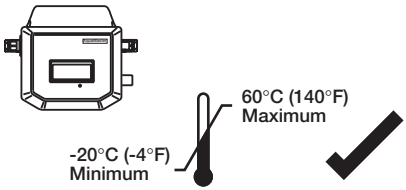
B – Within Environmental Rating



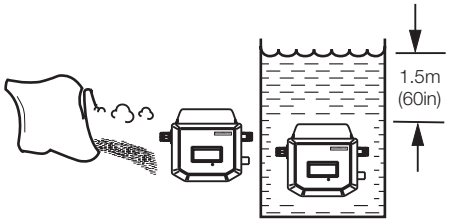
C – Avoid Excessive Vibration

Fig. 2.1 Environmental Requirements – AquaProbe

2.1.2 Transmitter – Fig. 2.2

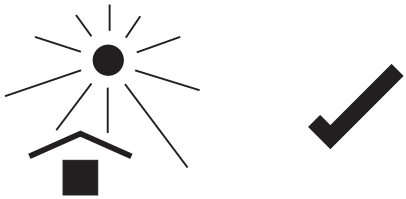


A – Within Temperature Limits



IP68 (NEMA 6)
ENCLOSURE 6P

B – Within Environmental Rating



C – Shade from Heat

Fig. 2.2 Environmental Requirements – AquaMaster Transmitter

2.2 Location – Flow Conditions

The probe may be installed in one of two positions in the pipe; either on the centre line or at the mean axial velocity point (1/8 pipe diameter). It may also be traversed across the pipe to determine the velocity profile.

Note. Ensure that the sensor is installed in the pipe with the flow direction arrow on the probe case matching the pipe flow.

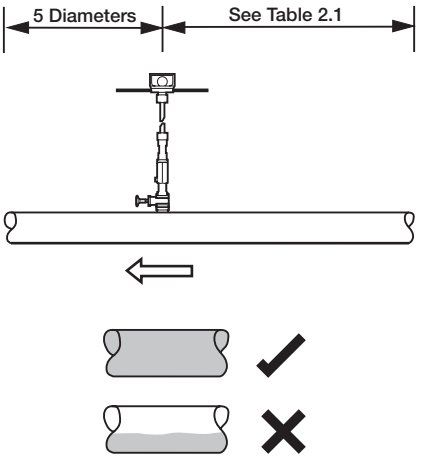


Fig. 2.3 Flow Conditions

2.2.1 International Standard for Flow Measurement

ISO 7145 '(BS 1042) Measurement of fluid flow in closed conduits' Part 2 'Velocity area methods' describes methods of calculating volumetric flow from velocity measurements.

Section 2.2: 1982 'Method of measurement of velocity at one point of a conduit of circular cross section' describes the inference of volumetric flow from measurement of velocity at a single point. Several conditions must be fulfilled to validate the method, which uses calculations based on empirical data.

Where the validating conditions can be met, the method described in Section 2.2 is the most practical. It is possible to measure the velocity either on the centre line, which reduces sensitivity to positional errors, or at the assumed point of mean flow velocity.

Table 2.1 is an extract from ISO 7145 (BS 1042): Section 2.2: 1982 and is reproduced with the permission of BSI. Complete copies of the standard can be obtained by post from BSI Publications, Linford Wood, Milton Keynes, MK14 6LE.

Information. Where the above ideal conditions cannot be achieved, the flow profile must be tested for symmetry in order to obtain reliable flow results.

Type of disturbance upstream from the measuring cross-section	Minimum upstream straight length*	
	For a measurement at the point of mean axial velocity	For a measurement on the axis of the conduit
90° elbow or a t-bend	50	25
Several 90° coplanar bends	50	25
Several 90° non- coplanar bends	80	50
Total angle convergent 18 to 36°	30	10
Total angle divergent 14 to 28°	55	25
Fully opened butterfly valve	45	25
Fully opened plug valve	30	15

* Expressed in multiples of the diameter of the conduit.
Downstream from the measurement cross-section, the straight length shall be at least equal to five duct diameters whatever the type of disturbance.

Table 2.1 Straight Pipe Lengths

2.2.2 Velocity Limitations – Figs. 2.4 to 2.6

All insertion probe devices are susceptible to the vortex shedding effect which can cause severe vibration of the probe, resulting in damage and/or measurement instability. Electromagnetic devices with no moving parts, such as AquaProbe, are less susceptible to this effect than mechanical devices.

The graphs below show the maximum permissible velocities, depending on the probe's location.

This information is provided as a guide only. Some installations may experience unwanted vibration resonance which may further limit the maximum velocity at which the AquaProbe may be used.

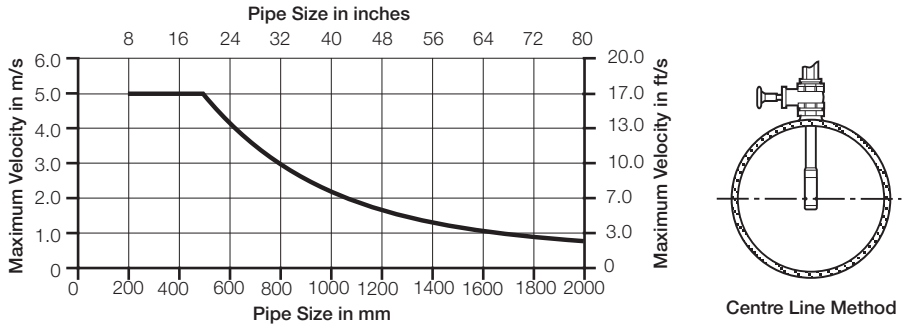


Fig. 2.4 Maximum Permissible Velocity for different Pipe Sizes

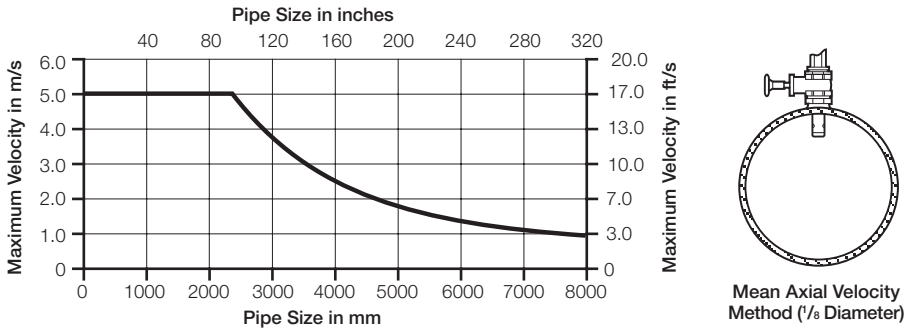


Fig. 2.5 Maximum Permissible Velocity for different Pipe Sizes

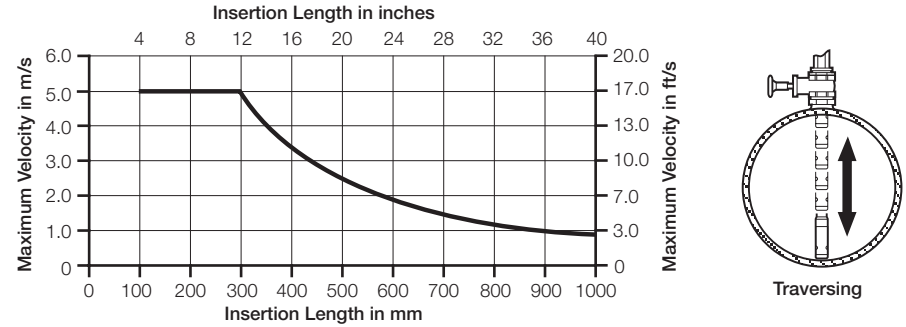
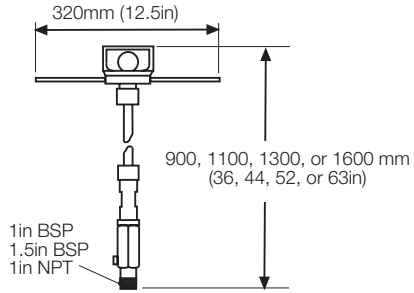


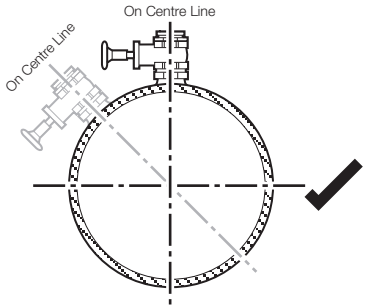
Fig. 2.6 Maximum Permissible Velocity for different Insertion Lengths

2.3 Location – Mechanical

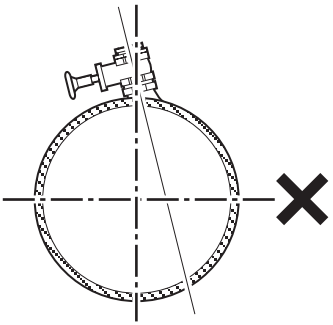
2.3.1 AquaProbe – Fig 2.7



A – Clearance Dimensions



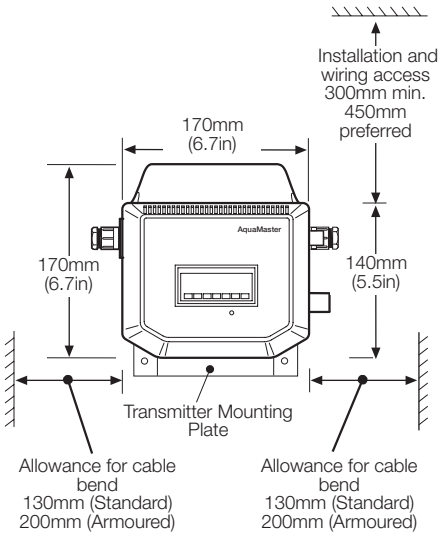
Note. Pipeline recommended to be metal for electrical screening.

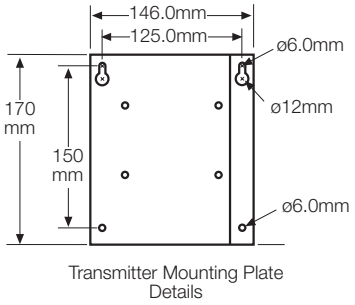


B – Orientation

Fig. 2.7 Mechanical Requirements – AquaProbe

2.3.2 Transmitter – Fig 2.8





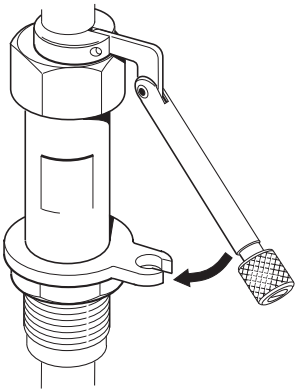
Transmitter Mounting Plate
Details

Fig. 2.8 Clearance Dimensions – Transmitter

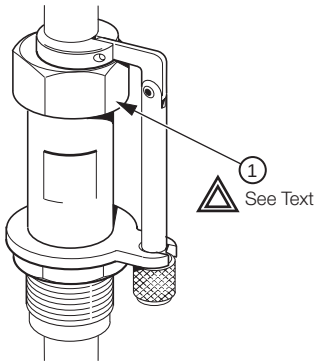
2.4 Safety – Fig. 2.9

Warning. The Aquaprobe is provided with a safety mechanism (see Fig. 2.9A) which should be attached to its securing collar as shown in Fig. 2.9B. This prevents rapid outward movement by the probe if the nut 1 is released.

Note. To ensure maximum safety, the positioning collar **MUST** be tightened in place using a 4mm hexagon key



A – Unsecured



B – Secured

Fig. 2.9 Safety Mechanism

2.5 Installing the AquaProbe – Figs 2.10 and 2.11

Warning. When inserting or removing the AquaProbe suitable restraining equipment must be used to prevent the probe being forced out under pressure.

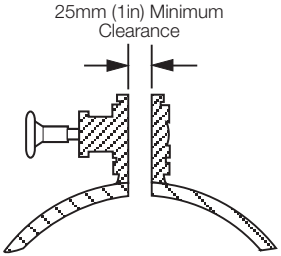


Fig. 2.10 Insertion Bore Clearance

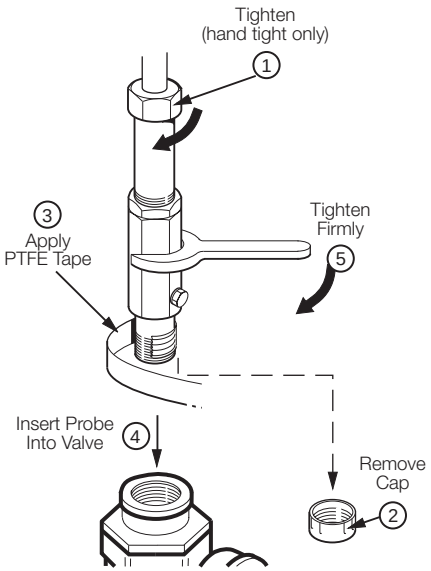


Fig. 2.11 Installing the AquaProbe

2.6 Setting the Insertion Depth

2.6.1 Centre Line Method for Pipe Diameters 1m (40in) – Fig. 2.12

Warning. When inserting or removing the AquaProbe, suitable restraining equipment must be used to prevent the probe being forced out under pressure.

Information. Safety restraint omitted for clarity.

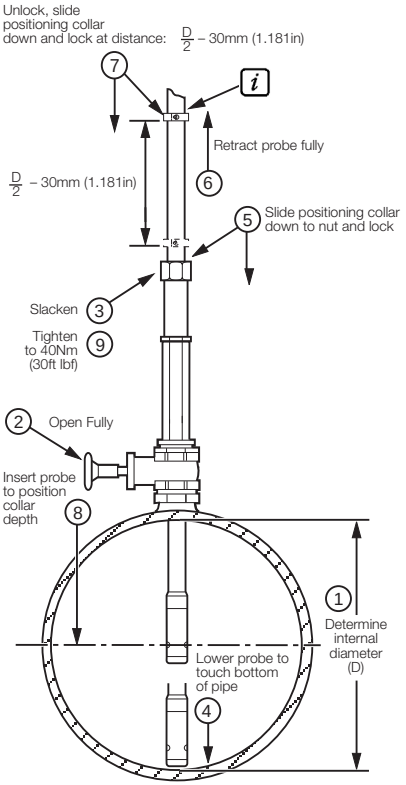


Fig. 2.12 Setting the insertion Depth – Centre Line Method for Pipe Diameters 1m (40in)

2.6.2 Centre Line Method for Pipe Diameters >1m 2m (>40in 80in) – Fig 2.13

Warning. When inserting or removing the AquaProbe, suitable restraining equipment must be used to prevent the probe being forced out under pressure.

Information. Safety restraint omitted for clarity.

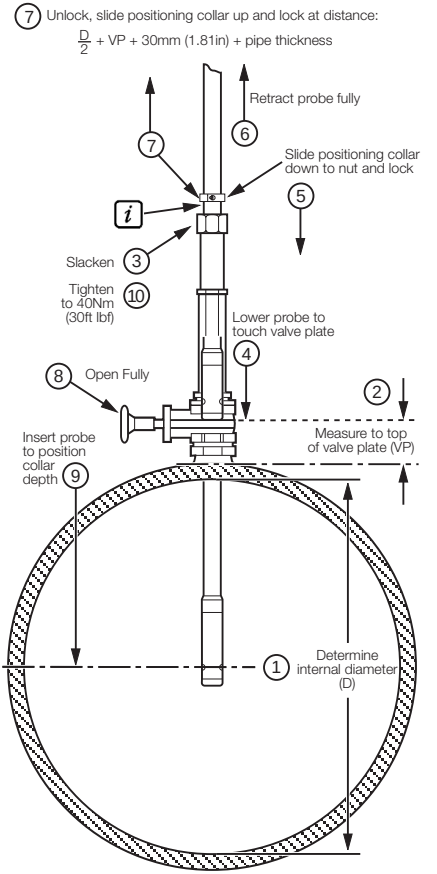


Fig. 2.13 Setting the Insertion Depth – Centre Line Method for Pipe Diameters >1m 2m (>40in 80in)

2.6.3 Mean Axial Velocity Method – Fig. 2.14

Warning. When inserting or removing the AquaProbe, suitable restraining equipment must be used to prevent the probe being forced out under pressure.

Information. Safety restraint omitted for clarity.

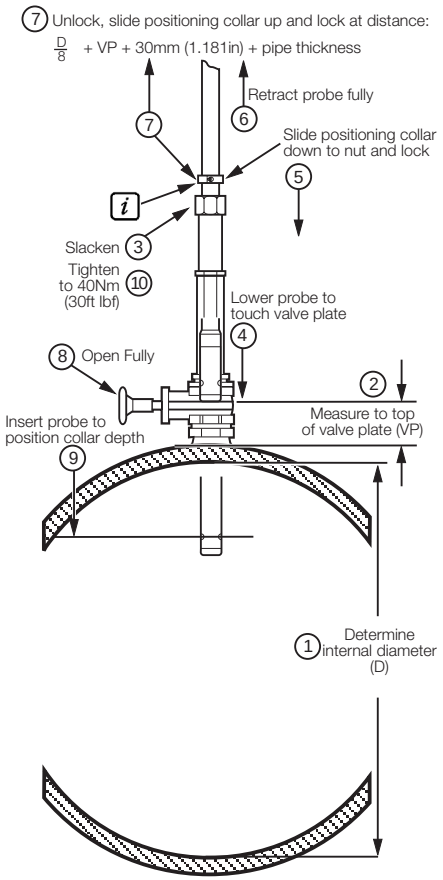


Fig. 2.14 Setting the Insertion Depth – Mean Axial Velocity Method

2.7 AquaProbe Alignment – Fig. 2.15

Warning. When inserting or removing the AquaProbe, suitable restraining equipment must be used to prevent the probe being forced out under pressure.

Information. Safety restraint omitted for clarity.

Information. Measurement error due to misalignment (of <2) is <0.15%.

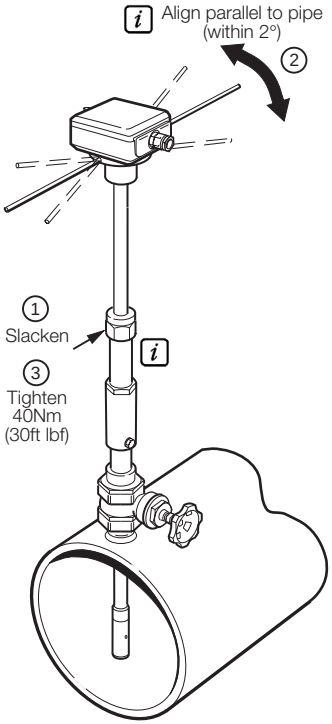


Fig. 2.15 Probe Alignment

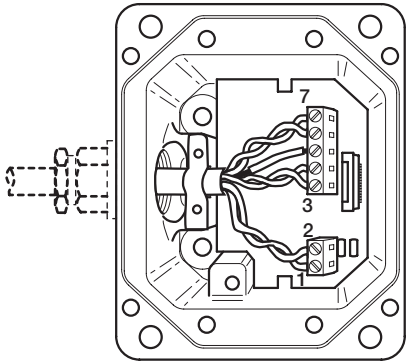
3 ELECTRICAL INSTALLATION

3.1 Connections

3.1.1 Sensor Terminal Box Connections (Remote Versions only)

Caution. (Remote versions)

- Make connections only as shown.
- Remove foil screens
- Twist the three screen wires together and sleeve them.
- Twist cable pairs together
- Maintain Environmental Protection at all times.
- Conduit connections must provide cable entry sealing.



CABLE	
Belden 8777	**ABB Limited**
7 White	7 Violet
6 Black	6 Blue
5 Sleeved Grounds	5 Sleeved Grounds
4 Red	4 Yellow
3 Black	3 Orange
2 Green	2 Red
1 Black	1 Brown
Maximum Cable Lengths	
≤80m	≤250m

Caution. With Belden Cable 8777, ensure that the black wires are not interchanged, and remain with the associated twisted pair.

Fig. 3.1 Sensor Terminal Box Connections (Remote Version)

3.1.2 Environmental Protection

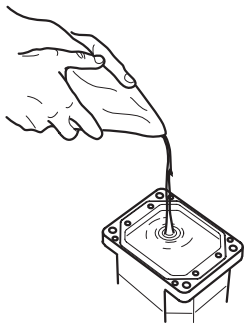


Fig. 3.2 Potting the Terminal Box

Warning.

- Potting materials are toxic – use suitable safety precautions.
- Read the manufacturers instructions carefully before preparing the potting material.
- The remote sensor terminal box connections must be potted immediately on completion to prevent the ingress of moisture.
- Check all connections before potting – see ELECTRICAL INSTALLATION.
- Do not overfill or allow the potting material to come into contact with 'O' rings or grooves.
- Do not let potting material enter conduit, if used.

3.1.3 Transmitter Connections

Caution.

- To ensure cable glands seal, use cable of diameter 7 to 11mm (0.28 to 0.43 in) only.
- Ensure cable glands are tightened after wiring.
- Ensure that 'O' ring seals and mating surfaces are clean, to maintain environmental rating.

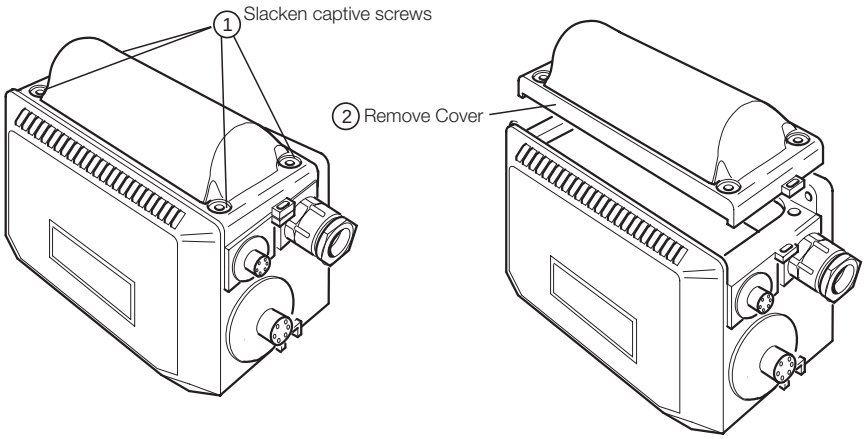


Fig. 3.3 Transmitter Connection Terminal Access

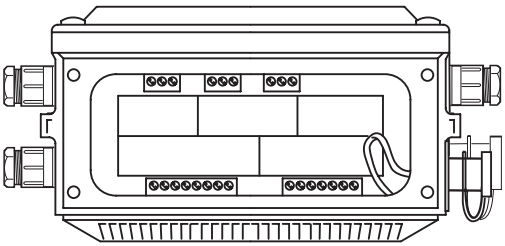
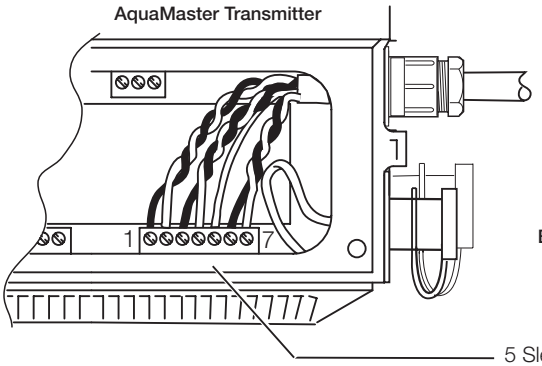


Fig. 3.4 Transmitter Connection (Glands/Conduit Entry)

...3.1.3 Transmitter Connections

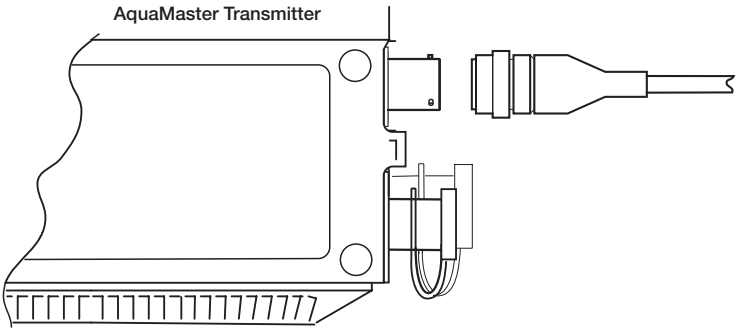
Caution.(Remote versions)

- Make connections only as shown.
- Remove foil screens
- Twist the three screen wires together and sleeve them.
- Twist cable pairs together
- Maintain Environmental Protection at all times.
- Conduit connections must provide cable entry sealing.



	CABLE	
	Belden 8777	**ABB Limited**
1	Black	Brown
2	Green	Red
3	Black	Orange
4	Red	Yellow
5	Sleeved Ground	Sleeved Ground
6	Black	Blue
7	White	Violet

Fig. 3.5 Sensor Cable Connections (Gland/Conduit, Remote version)



Note. This arrangement is an option.

Fig. 3.6 Sensor Cable Connections (Connector, Remote version)

3.2 Input/Output Connections

Caution.
- Refer to SPECIFICATION SHEET for Input/Output ratings.
- Inductive loads must be suppressed or clamped to limit voltage swings
- Capacitive loads must be inrush current limited.

3.2.1 Frequency Outputs – Fig. 3.7

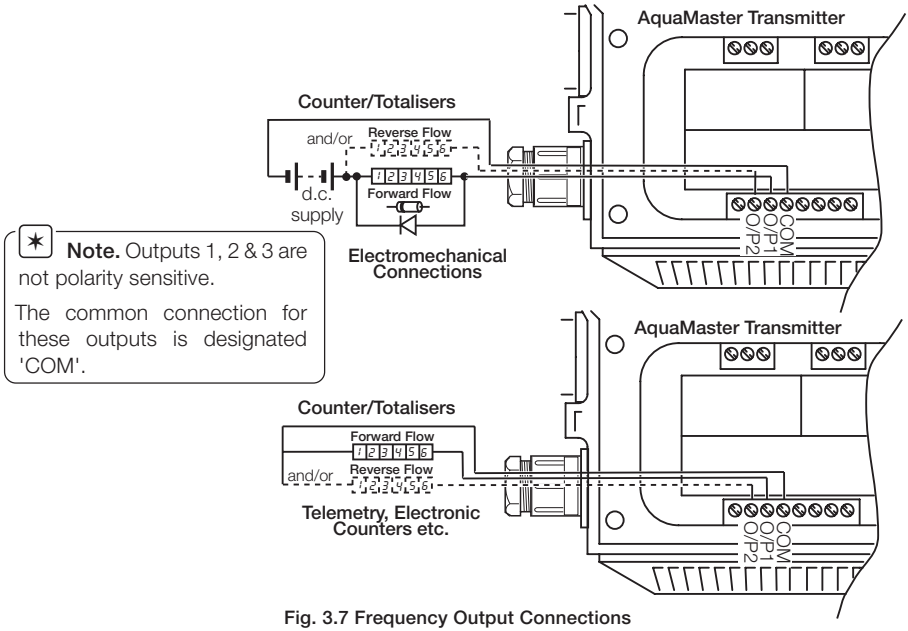


Fig. 3.7 Frequency Output Connections

3.2.2 PLC Interface – Fig. 3.8

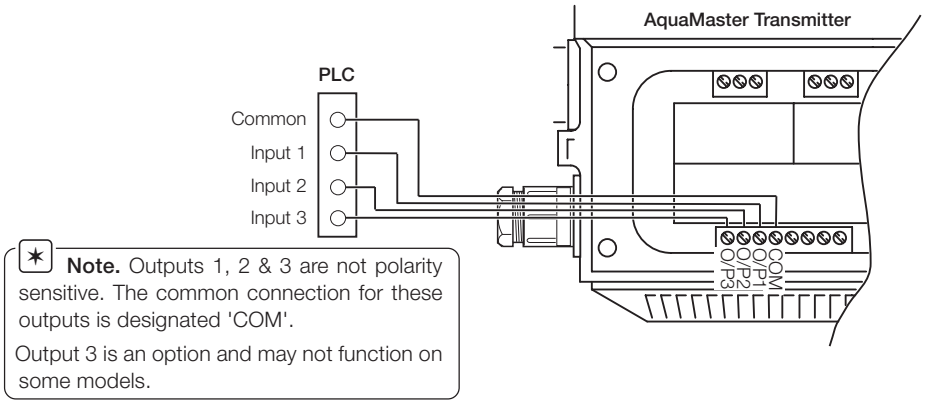
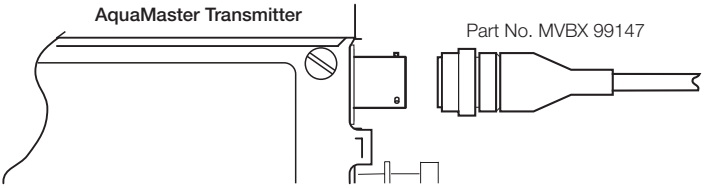


Fig. 3.8 Frequency and Alarm Output Connections

3.2.3 MIL Connector Input/Output Connections (Option) – Fig. 3.9



Pin	Name	Function	Colour (Output cable)
A	–	Reserved	
B	–	Reserved	
C	–	Reserved	
D	O/P 3	Output 3	Orange
E	O/P 1	Forward Pulses	White/Orange
F	–	Reserved	
G	O/P Com	Common	Drain Wire
H	O/P 2	Reverse Pulses or Direction	White/Blue or Yellow/Blue
J	I/P Gnd	Input Common	White
K	I/P+	Contact Input	Violet
L	RXD	Receive data (serial input connection)	Turquoise
M	TXD	Transmit data (serial output connection)	Brown
N	RTS	Request to send	Red/Black
P	CTS	Clear to send	Yellow/Red
R	–	Reserved	
S	–	Reserved	
T	RI	Ring Indicator	Yellow
U	–	Reserved	
V	Serial GND	Comms Ground	Green

Fig. 3.9 MIL Connector Connections

3.2.4 Local Computer Connection – Fig. 3.10

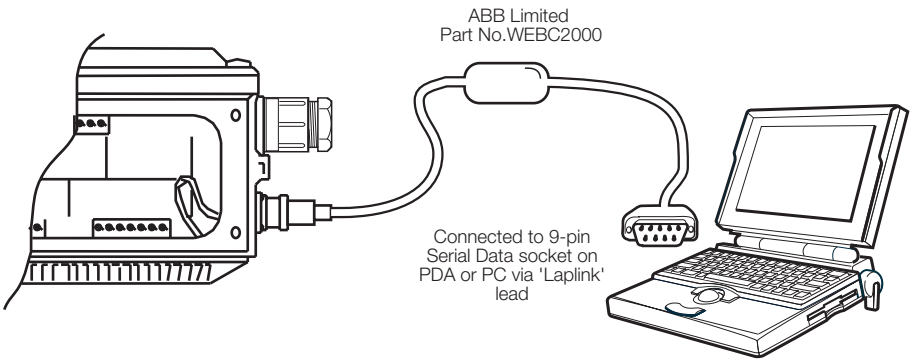


Fig. 3.10 Local Computer Connections

3.2.5 Remote Computer Connection (Option) – Fig. 3.11

AquaMaster Terminal	RS232	9-PIN PC Connector	25-PIN PC Connector
TXD	TXD	3	2
RXD	RXD	2	3
RTS	RTS	7	4
CTS	CTS	8	5
RI	RI	9	22
GND	GND	5	7

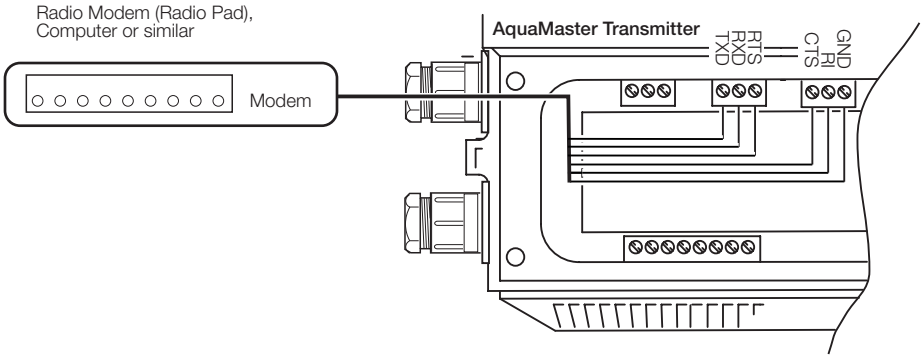


Fig. 3.11 RS232 Connections

3.2.6 Power Supply Connection Options – Figs. 3.12 and 3.13

Warning.
- DISCONNECT THE SUPPLY FROM ANY CABLES BEING TERMINATED ON THE TRANSMITTER.
- Electrical installation and earthing (grounding) must be in accordance with relevant national and local standards.

Note. Power Supply connections/earthing arrangements are identical for Cathodically Protected systems.

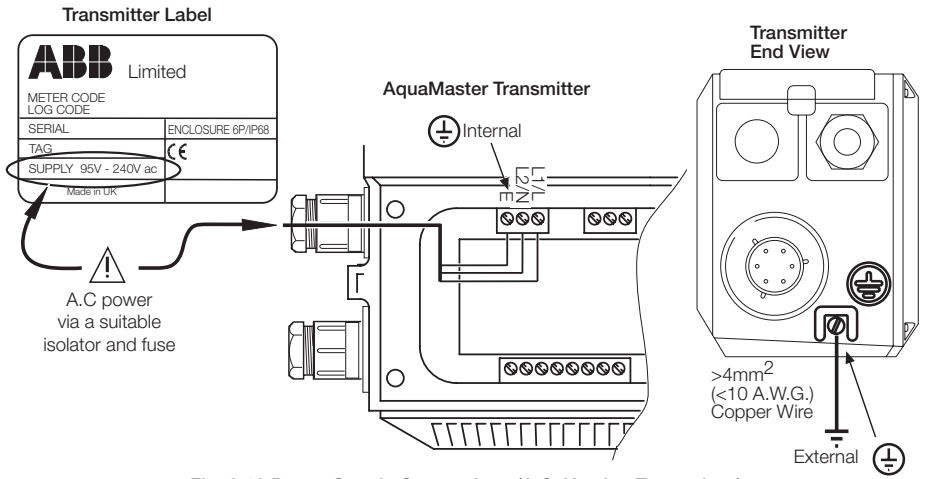


Fig. 3.12 Power Supply Connections (A.C. Version Transmitter)

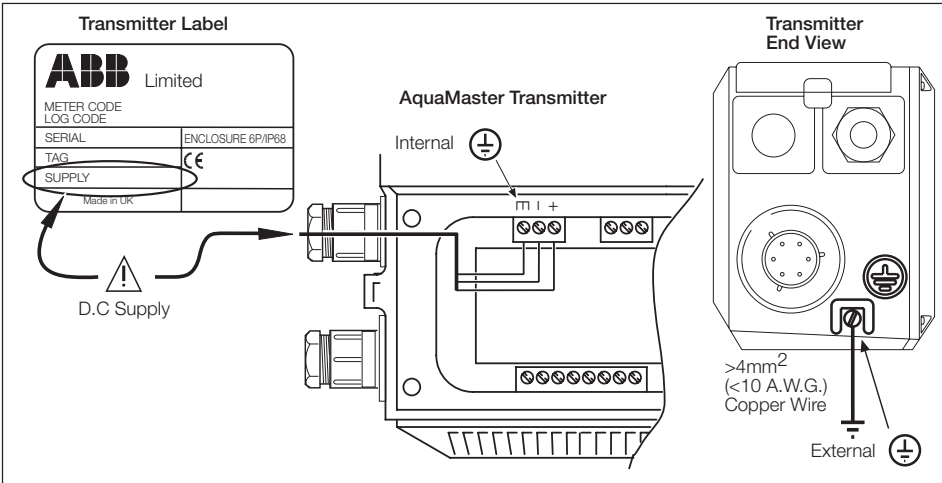


Fig. 3.13 Power Supply Connections (D.C. Version Transmitter)

3.2.7 Pressure Transducer (Optional)

Optional pressure transducer cables are available for a range of pressures and cable lengths.

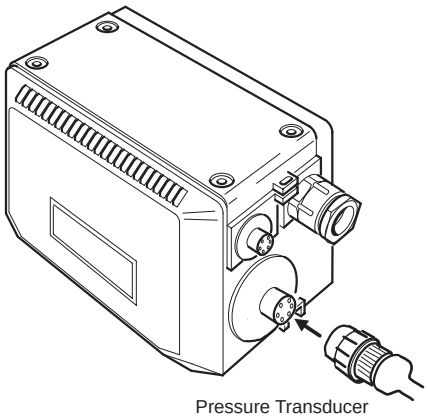


Fig. 3.14 AquaMaster Transmitter fitted with Optional Pressure Transducer Connector

Caution. Ensure that only the pressure transducer supplied with the transmitter is used.

Use of other pressure transducers requires alteration of the pressure span and zero factors in the transmitter – see Quick Reference Programming guide.

3.2.8 Environmental Protection (Option)

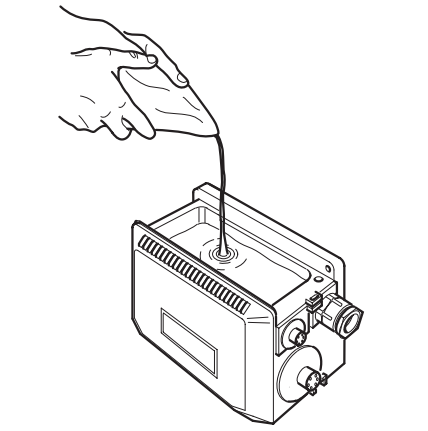


Fig. 3.15 Potting the Transmitter

Warning.

- Potting materials are toxic – use suitable safety precautions.
- Read the manufacturers instructions carefully before preparing the potting material.

Caution.

- For increased protection against accidental water ingress, for example by poor gland tightening, pot the termination area.
- Check all connections and operations before potting – see ELECTRICAL INSTALLATION.
- Do not overfill or allow the potting material to come into contact with 'O' rings or grooves.
- Do not let potting material enter conduit, if used.

4 SETTING UP

4.1 Introduction

The basic equation for volume measurement using AquaProbe is:

$$Q = A\ F_i\ F_P\ V$$

Where: Q = flow rate,
F_i = insertion factor
F_p = profile factor
V = velocity
A = area

The pipe diameter, profile factor and insertion factor must be determined as detailed in Sections 5.2 to 5.3, as applicable.

Note. Due to software configuration, all calculations are in metric units. Therefore if using an imperial pipe, the diameter **MUST** be converted into millimetres (1in = 25.4mm) i.e. a 36in pipe = 914mm

4.2 Centre Line Method

a) Determine the internal diameter D of the pipe, in millimetres, by the most accurate method available.

b) Determine the profile factor F_p from Fig. 4.1.

c) Calculate the insertion factor

$$F_i = \frac{1}{1 - (38/\pi D)}$$

Example – for a pipe of internal diameter 593mm (23.35in):

$F_p = 0.861$ (derived from Fig. 4.1)

$$F_i = \frac{1}{1 - (38/593\pi)}$$

$F_i = 1.021$

4.3 Mean Axial Velocity Method (1/8 Diameter)

a) Determine the internal diameter D of the pipe, in millimetres, by the most accurate method available.

b) A profile factor F_p of 1 must be used.

c) Calculate the insertion factor

$$F_i = \left[1 + \frac{12.09}{D} + \frac{1.3042}{\sqrt{D}}\right]$$

Example – for a pipe of internal diameter 593mm (23.35in):

$F_p = 1$

$$F_i = \left[1 + \frac{12.09}{593} + \frac{1.3042}{\sqrt{593}}\right]$$

$F_i = 1.074$

4.4 Partial Velocity Traverse

Refer to the Appendix A1 for procedure.

4.5 AquaProbe Transmitter Setup

The AquaProbe Transmitter can be set up to display point velocity, mean velocity or flow rate, as required. For full programming details refer to the AquaProbe Quick Reference Guide.

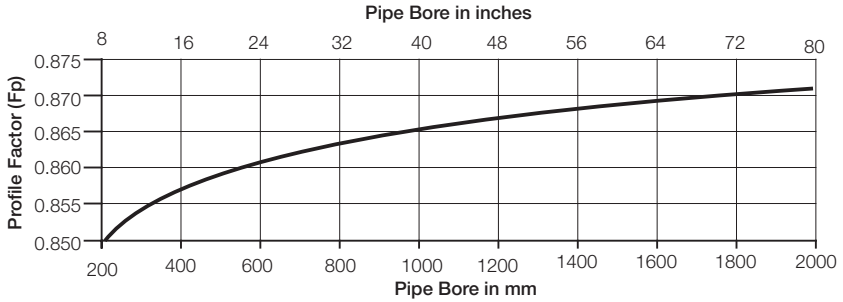


Fig. 4.1 Profile Factor vs Velocity for Pipe Sizes 200 to 2000mm (8in to 80in)

5 START UP AND OPERATION

Warning.

- The lithium battery used in this device may present a risk of fire or chemical burn if mistreated. Do not recharge, disassemble, heat above 100°C or incinerate.
- Replace battery with ABB Limited Part No. WABC2001 only. Use of another battery may present a risk of fire or explosion
- Dispose of used battery promptly. Keep away from children.
- Dispose of used batteries in accordance with your local regulations.
- Where possible, recycle used batteries.
- Contact your local environmental authority for further information regarding disposal or recycling schemes for used batteries.

Note.

- If fitting a battery on an external powered (a.c. or d.c.) unit, ensure the unit is powered during this operation.
- Each battery must be connected to the cable from the same side of the termination area as the battery position in the lid.

5.1 Fitting the Battery

If the AquaMaster has been supplied with one or two batteries, but not connected, then proceed as follows:

a. Remove the top cover of the transmitter – see Section 3.1.3.

b. Invert the cover.

c. Slide out the connector from behind the battery retaining clamp.

d. Connect the battery or batteries to the wire connector(s) inside the top of the transmitter unit; left hand battery to left hand connector and right hand battery to right hand connector.

e. Ensure that the end of the battery with the connection wires is pushed up against the inside end of the top cover.

f. Push the connection centrally behind the battery retaining clamp to secure the battery.

g. Fit the top cover to the transmitter and ensure the screws are tightened fully.

5.2 Start-up

If the AquaMaster is received with a protective plastic film over the display window, remove this film before commencing normal operation.

When the power is connected or the plastic film is removed, the AquaMaster performs a self test operation, and indicates a successful completion with 'EE Pass' displayed.

If the display shows 'EE Fail 1', remove all power, check the sensor wiring and apply power.

If the display shows 'EE Fail 2 or 3', contact ABB.

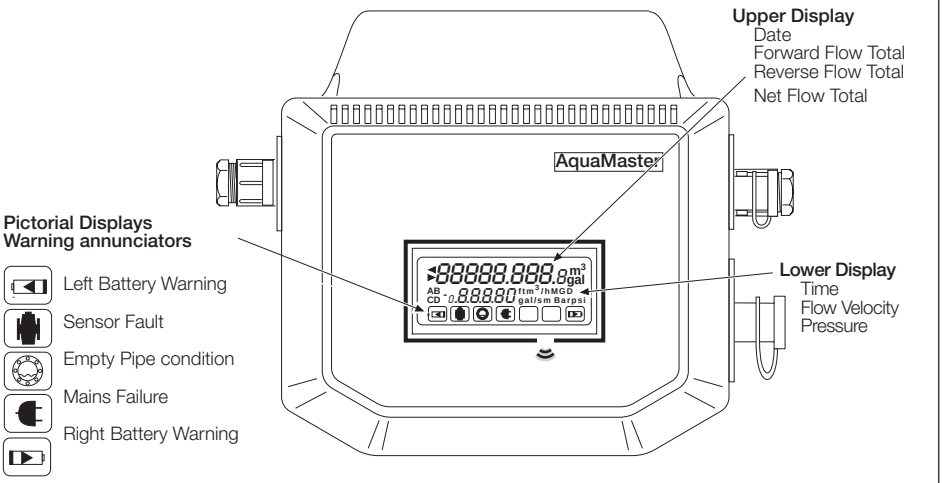


Fig. 5.1 Location of Controls

5.3 Display Activation

For normal operation, activate the light sensitive display by first covering the display area totally. On removing the covering, the display activates and cycles through the programmed set of display measurements.

With external power applied, the display is permanently activated.

To alter the displayed set of measurements, or instrument setup, see the Quick Reference Programming Guide

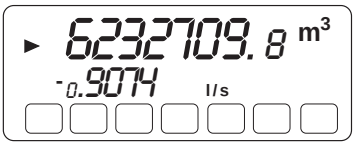
Information. For the use of local or remote serial communication, and configuration, see the Quick Reference Programming Guide.

5.4 Replacing the Battery

Caution. If replacing the battery on an external powered (a.c. or d.c.) unit, ensure it is powered during this operation. For dual battery units, replace only the battery above the indicated battery legend.

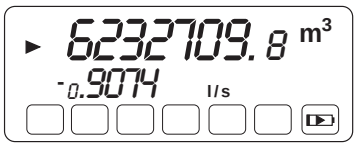
Note. Each battery must be connected to the cable from the same side of the termination area as the battery position in the lid.

Normal Operation



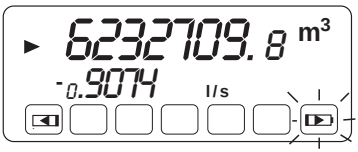
If both batteries are good, then no battery alarm is indicated.

Replace Battery



When a battery alarm is shown, replace the cell on the side indicated. (In this example, the Right Battery)

Replace both batteries



If both batteries require replacement, it is important to first change the cell indicated by the steady icon.

The flashing icon indicates the battery currently in use.

Proceed as follows:

a. Remove the top cover of the transmitter – see Section 3.1.3.

b. Invert the cover.

c. Slide out the connector from behind the battery retaining clamp and pull the connector apart.

d. Remove the battery.

e. Fit a new battery (ABB Limited Part No. WABC2001) ensuring that the end of the battery with the connection wires is pushed up against the inside end of the top cover.

f. Connect the battery connector to the connector previously removed.

g Push the connection centrally behind the battery retaining clamp to secure the battery.

h. Fit the top cover to the transmitter and ensure the screws are tightened fully.

APPENDIX

A1 Testing the Flow Profile for Symmetry

If there is any doubt as to the symmetry of the flow profile (see Section 2.2), a Partial Velocity Traverse should be carried out. This procedure involves comparing the value of velocity at two points at equal distances from the centre line.

It is normal to compare the flow velocities at insertion depths of 1/8 and 7/8 of the pipe diameter as these points are always on the 'knee' of the profile.

A1.1 Partial Velocity Traverse

Determine the internal diameter D of the pipe, in millimetres, by the most accurate method available. If the AquaProbe insertion length is greater than the internal diameter of the pipe, proceed with the **Single Entry Point Method** detailed in Section A1.2. If the AquaProbe insertion length is less than the internal diameter of the pipe, proceed with the **Dual Entry Point Method** detailed in Section A1.3.

A1.2 Single Entry Point Method

a) Insert the probe to a depth of 1/8 the pipe diameter – see Fig. 2.14.

> **Note.** Due to software configuration, all calculations are in metric units. Therefore if using an imperial pipe, the diameter **MUST** be converted into millimetres (1in = 25.4mm) i.e. a 36in pipe = 914mm.

b) Calculate the insertion factor

$$F_i = \left[1 + \frac{12.09}{D} + \frac{1.3042}{\sqrt{D}}\right].$$

c) Refer to the AquaProbe Transmitter Configuration Manual and enter a Blockage Factor (BL) of value equal to F_i.

d) Record the flow velocity reading.

e) Insert the probe to a depth of 7/8 the pipe diameter.

f) Calculate the insertion factor

$$F_i = \left[1 + \frac{12.09}{D} + \frac{1.3042}{\sqrt{D}}\right].$$

g) Refer to the AquaProbe Transmitter Configuration Manual and enter a Blockage Factor (BL) of value equal to F_i.

h) Record the flow velocity reading.

i) Calculate the ratio of the two values recorded.

If the ratio is between 0.95 and 1.05 the flow profile is acceptable and the procedure detailed in section 4.2 can be used. If outside this ratio the AquaProbe should be resited for optimum accuracy.

A1.3 Dual Entry Point Method

Refer to Section 2.5 and fit a second mounting boss directly opposite the one already fitted.

> **Note.** Due to software configuration, all calculations are in metric units. Therefore if using an imperial pipe, the diameter **MUST** be converted into millimetres (1in = 25.4mm) i.e. a 36in pipe = 914mm.

a) Insert the probe to a depth of 1/8 the pipe diameter through the original mounting boss.

b) Calculate the insertion factor

$$F_i = \left[1 + \frac{12.09}{D} + \frac{1.3042}{\sqrt{D}}\right].$$

c) Refer to the AquaProbe Transmitter Configuration Manual and enter a Blockage Factor (BL) of value equal to F_i.

d) Record the flow velocity reading.

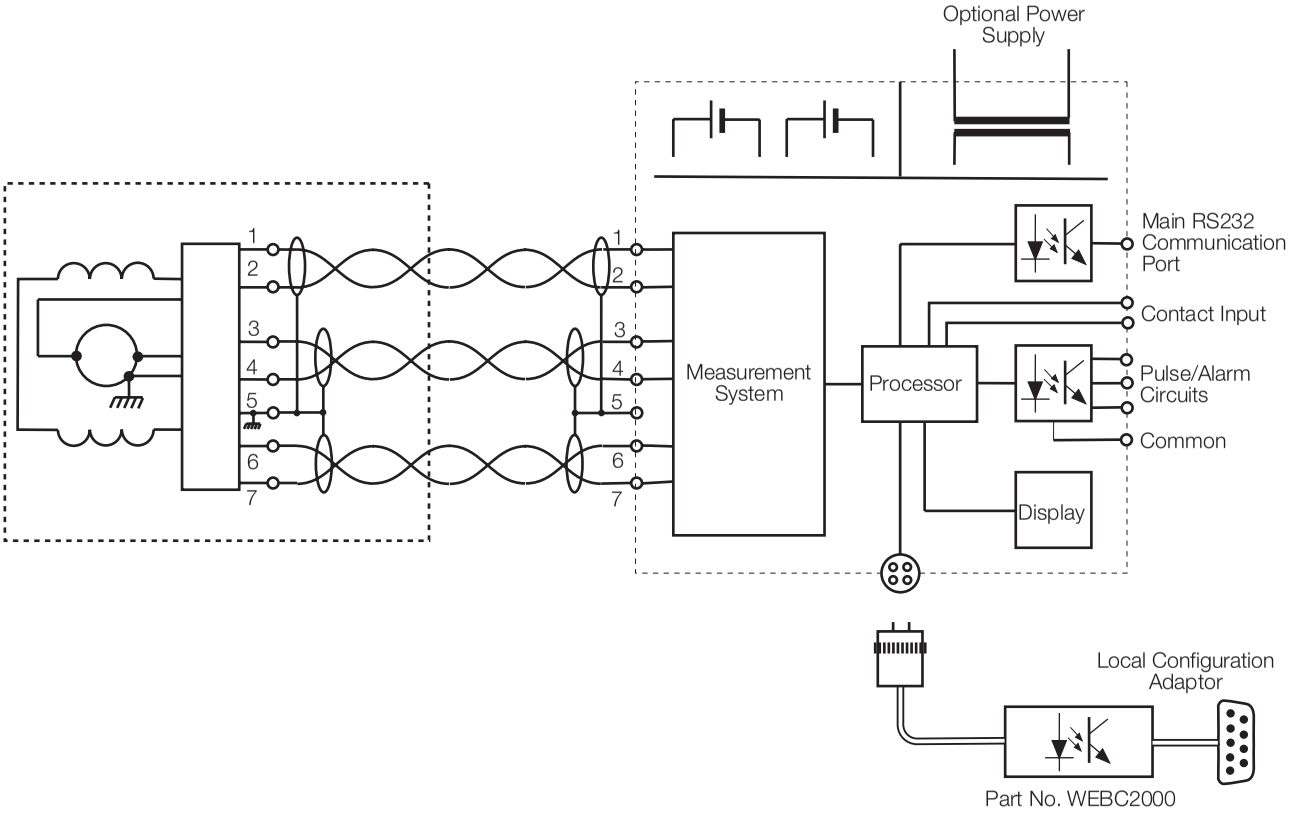
e) Insert the probe to a depth of 1/8 the pipe diameter through the second mounting boss.

f) Record the flow velocity reading.

g) Calculate the ratio of the two values recorded.

If the ratio is between 0.95 and 1.05 the flow profile is acceptable and the procedure detailed in Section 4.2 can be used. If outside this ratio the AquaProbe should be resited for optimum accuracy.

APPENDIX – AQUAMASTER BLOCK DIAGRAM



NOTES

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United States of America
ABB Inc.
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Fax: +1 215 674 7183

Client Warranty

Prior to installation, the equipment referred to in this manual must be stored in a clean, dry environment, in accordance with the Company's published specification. Periodic checks must be made on the equipment's condition.

In the event of a failure under warranty, the following documentation must be provided as substantiation:

1. A listing evidencing process operation and alarm logs at time of failure.
2. Copies of operating and maintenance records relating to the alleged faulty unit.

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