PSM INSTRUMENTATION LTD

SERIES 290 DENSITY TRANSMITTER USER MANUAL

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1.0 INTRODUCTION

PSM 290 Series transmitters are designed for monitoring the density of various liquids. Whereas the measurement principle remains the same for all duties, the specific construction will vary dependant upon the type of product being monitored. For example, in measurement of liquid foodstuffs a hygienic construction may be employed where the measurement elements are housed in flush mount crevice free fittings for mounting on the vessel wall. Conversely for offshore use in drilling mud measurement the unit is normally of submersible construction, and will incorporate a guard assembly for each of the measurement diaphragms.
The separation distance of the two pressure sensitive diaphragms may also vary dependant upon the Density range and depth of measured liquid.
Each unit will have been despatched with a specific General Arrangement drawing. This must be referred to for detailed information regarding construction.
The basic measurement principle is Differential Pressure. Two pressure sensitive diaphragms are mounted vertically in the liquid at a known separation distance. Provided both diaphragms remain covered a differential pressure will exist between them which is a function of the separation distance and the Density of the liquid. Since the separation distance is fixed any variation in differential pressure is attributable only to Density change. The diaphragms deflect progressively according to the applied pressure and are linked internally by an oil filled sealed capillary tube. Thus the deflection of the upper diaphragm opposes that of the lower, but since it is presented with a higher pressure, its displacement is still positive.
This lower diaphragm is "rated" to give a known displacement for a known applied pressure. Attached to the inside of this diaphragm (and not exposed to the process), is a ferro-magnetic core. This core is positioned centrally within a high resolution Linear Variable Differential Transformer. The LVDT has a central primary and a secondary coil at each end. Movement of the diaphragm results in a change in magnetic flux and hence output voltage from the secondaries.

The sensor output voltage is carried via a 4 core cable to a remotely sited amplifier module.This output signal is then processed by the amplifier to provide an industry standard 4-20mA signal. The amplifier also incorporates range and zero adjustment facilities.

The product is designed and approved for use in hazardous I.S. classified duties to EEx ia IIC T6

2.0 MODEL DESIGNATION

Each transmitter amplifier module bears an identification plate which carries both the model code and a unique serial number. The model code identifies the Nominal and set ranges and length of cable fitted. The Model Code may also be suffixed by a V number. This indicates a variation from standard product, for example a special process connection for a particular duty. Where a V code is found the accompanying order paperwork will identify it.

Note: The sensor is also marked with the Serial Number and the units MUST be employed as a matched pair to preserve factory calibration.

3.0 GENERAL SPECIFICATIONS

3.1 Sensor

Construction	*Body assembly 316L stainless Steel* *Diaphragms Hastelloy C276*
Mounting	*External flanged or threaded, or internal submersed*
Calibrated Range:	*Density span 0.5 to 3.00 with zero offset to suit*
Fluid fill	*Silicon or Mineral oil.*
Operating temperature:	*-10 to +120 Degrees Centigrade*
Temperature compensation:	*As required by application.*

3.2. Sensor Cable

Construction:	*Depending on duty either 4 core with overall screen or 2 core and miniature coaxial with overall screen. Outer sheathing either in XLPE or `Hytrel' Teflon. Maximum length: 100m. (200m to special order)*

3.3. Electronics Module

Housing:	*GRP surface mounting to IP65 (optionally IP67) . Equivalent to NEMA 4X*
Connection:	*1 x PG9 gland for sensor cable. 1 x PG9 gland for atmospheric reference (not required) 1 x PG9 gland for 4-20mA output (optionally M16 or M20)*
Power requirement:	*12-35 V dc.*
S*ignal output:*	*2 wire 4 to 20mA.dc.*
Maximum load:	*Dependent on supply (1000 ohms at 30V DC)*
Range adjustment:	*3 to 1 electronic turndown of sensor nominal range.*
Zero adjustment:	*±10% of set span.*

3.4. Performance

Maximum Error:	*± 0.25% of full range output (Optional 0.1% some variants)*
Temp Coefficient:	*Less than 0.05%/deg.c. range & zero (Optional 0.02%)*

3.5 Options

Intrinsically safe unit available to EEx ia IIC T6.

4.0 INSTALLATION

Pre-installation checks

Prior to installation it is recommended that the following checks are made.

Ensure that the factory calibration is in accordance with the actual process parameters. Of particular importance is the operating temperature range. Units will have been compensated for a particular range and operating outside this will result in errors of measurement due to the thermal expansion coefficient of the hydraulic filling fluid employed to link the two diaphragms. The actual volume of the fill fluid used during manufacture is a function of the in-service temperature. If the actual temperature is lower than that allowed for the unit will prove slow to react, and lose sensitivity. Where it is higher than allowed for, temperature induced errors and over-sensitivity will occur. The arrangements for mounting the sensor to the tank should also be examined. It is essential for correct operation that the unit is installed vertical such that it "sees" the correct hydrostatic pressure.

Ensure that the correct length of cable has been fitted to the sensor

Note: The cable is factory fitted to ensure a pressure tight seal on the submersible sensors. NO ATTEMPT SHOULD BE MADE TO REMOVE THE CABLE GLAND.

Each transducer and transmitter are factory calibrated as a matched pair and for both carry the same serial number. It should be ensured that these match.

4.1 MECHANICAL INSTALLATION

4.1.1. Sensor fitting position

As previously stated, the sensor must be vertically mounted. The actual position in the tank should be as far away from any agitators, inlets, outlets, and heating devices, as possible. Where the product being measured in liable to stratification bear in mind when considering the sensors location, that the output from the unit will represent an average of the Density above the lower diaphragm only. The sensor should not be mounted where it will be subject to excessive or continuous vibration, or risk of mechanical damage.

4.1.2. Fitting the sensor

During installation the sensor should be handled with care, especially with regard to the extremely sensitive diaphragms. Any mechanical damage to these will affect the performance and accuracy of the Instrument. Care must also be taken to avoid stressing or chafing of the cable insulation.

4.1.3. Electronic Transmitter

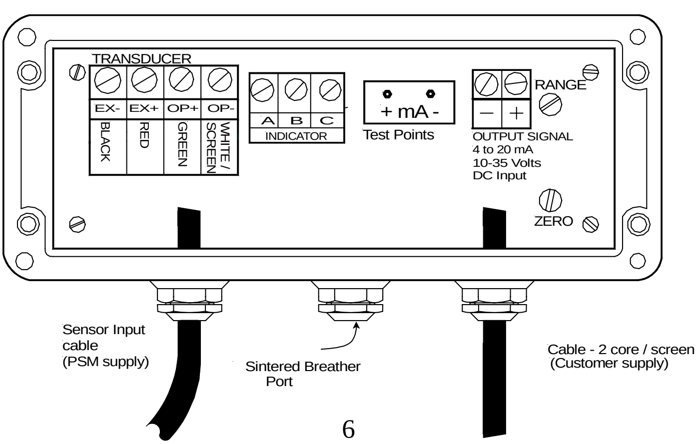
The RT168A provides the excitation supply for the sensor and amplifies and conditions the return signal to provide a standard 4-20mA output. The unit is housed in a weatherproof GRP enclosure suitable for wall mounting. Fixing details are given at the rear of the manual. In general this unit should be mounted away from extremes of temperature, eg. Not in direct sunlight, vibration, or where likely to be continuously sprayed with water. (in the last case an optional IP67 enclosure is available)

4.2. ELECTRICAL INSTALLATION

The unit should be wired in accordance with the following diagrams. The sensor cable is terminated in the RT168A electronic transmitter following the wire colour code marked on the printed circuit card.

The sensor cable consists of :

Black conductor -	*connect to EX-*
Red conductor -	*connect to EX+*
Green conductor -	*connect to OP+*
White conductor (inner screen)-	*connect to OP-*



4.2.1 Sensor cable

The cable is factory fitted to the transducer. The outer sheathing is a special material suitable for continuous immersion in water, and many oils and chemicals. When handling take special care not to damage this outer sheathing. Do not bend the cable to a radius less than 50mm. For submersible sensors the cable should not be used as a means of lowering or withdrawing the unit.

Where the cable is to be brought through to the tank wall it is recommended that where possible this be done above the maximum fill line using a suitable compression fitting. (Available from ***PSM****)*

The overall cable screen ***must*** *be terminated at the PG9 entry gland to preserve the RFI/EMC standards of the unit.*

The cable employed is a PSM standard approved cable also used on hydrostatic level transmitters. For these it requires a vent tube to provide an atmospheric reference for the sensor. For the 290 Series this vent tube is not required and may be cut back as convenient.
The sensor cable will have been supplied to suit the installation, and since it forms part of a tuned circuit any excess should be coiled rather than cut back.
The following diagrams illustrate the termination arrangements and correct procedure for connecting the sensor cable.

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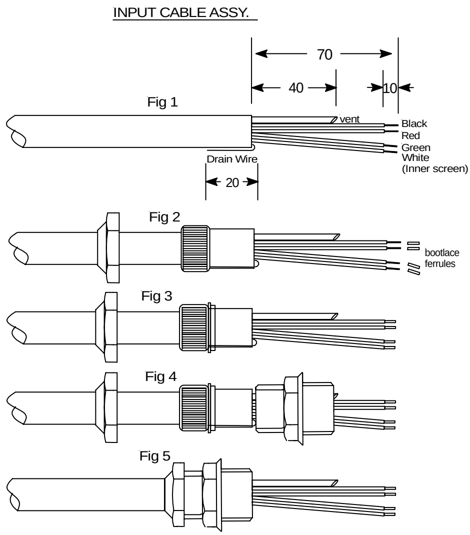


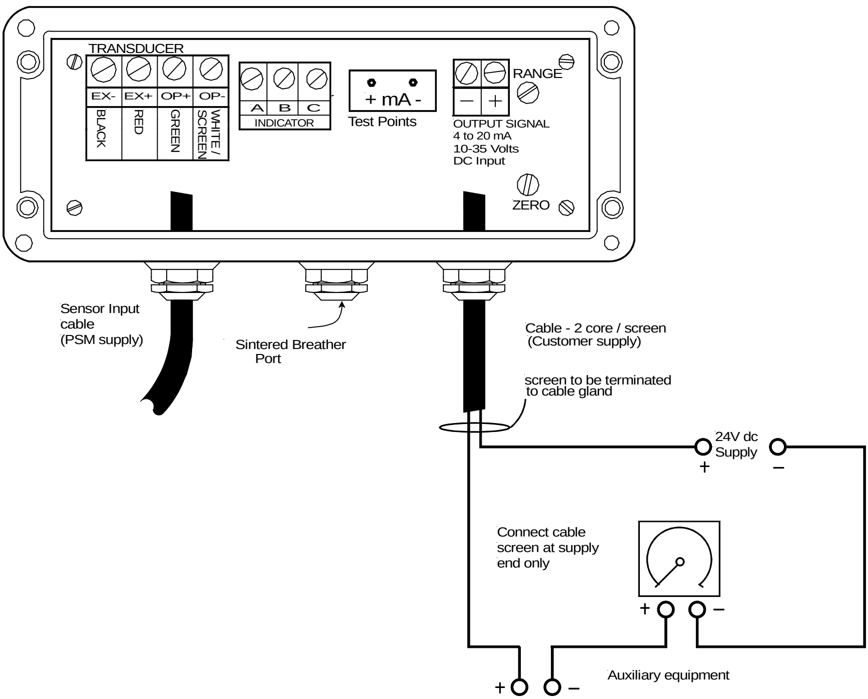
1. Input Cable
A) Remove outer sheath, trim back outer braid completely & cut drain wire to 20mm. Cut vent tube end at 45 deg 40mm long. Cut & strip wires as Fig 1.
B) Fit bootlace ferrules to black, red, green & white (inner screen) ends and crimp.
C) Fold back the drain wire & fit cable gland locknut & inner sleeve over the top as Fig 2.
D) Fit cable gland body over wires & vent as Fig 4 ('O' ring to outside).
E) Tighten cable gland in position as Fig 5.
2. Output cable: As note 1 omitting inner screen and vent tube.NB: Output cable screen must be earthed at supply end.

4.2.2 Output loop

As sensor cable omitting inner screen and vent tube. **The signal output cable screen must be earthed at supply end to preserve the Instruments RFI / EMC screening.**

The signal/power loop should be connected as shown in the following diagram. Two core screened cable should be used with a minimum conductor size of 0.5mm. A larger conductor size may be employed to reduce loop impedance. All connection should be made in series as illustrated.

The screen of the signal cable should be connected to the cable gland as described for the sensor cable.



NOTE:

A PG9 cable gland is fitted as standard for the output signal cable. However, if specified, a larger gland may be fitted during manufacture.
Following wiring the lid must always be refitted and tightly sealed

4.2.3.Power Supply

The transmitter requires a nominal supply of 24V.dc. but will operate between 12V to 30 V dc. The maximum permissible loop impedance for a given supply is derived from the following equation:.

$$\frac{\textbf{Supply Volts -12}}{\textbf{0.02}} \textbf{ = Load in ohms.} \qquad \textbf{example} \quad \frac{\textbf{30V -12}}{\textbf{0.02}} \textbf{ = 900}$$

4.2.4. Integral Indicator (Optional)

The three terminals A,B,C are for connection of a lid mounted 3.1/2 digit indicator which may be specified as an option. Where fitted this will be pre-wired, no other connection may be made to these terminals.

N.B.This is a non-IS approved item.

4.3 Atmospheric Reference

A further central PG9 gland is fitted to the RT168A and fitted with a sintered breather plug. For the Series 290 Density transmitter this has no function and may be left as fitted..

5.0 COMMISSIONING / RECALIBRATION

Each instrument is manufactured and calibrated in accordance with its intended application and should not need further setting up. Should the need arise however, the zero and range settings may be adjusted as follows.

***NB** As stated earlier the unit will have been calibrated at its normal operational temperature. It is essential that any recalibration is also carried out at this temperature. Failure to do so can introduce significant measurement errors.*

Note that this process requires the application of pressure to the lower diaphragm. The construction of a particular unit will determine the type of pressure adaptor required. It must ensure an effective pressure tight seal but must not connect with the diaphragm in any way. Consult PSM for assistance in this respect.

A pressure source and Ammeter are also required these should be of certified and traceable calibration Finally, the unit must be powered as described in section 4.2.2.

Note: It is common for a unit to be calibrated with an elevated zero representing the minimum SG. In such cases this pressure must be applied to the lower diaphragm before the signal rises above 4.00mA. When the entire assembly is in free air the output from the amplifier will be at quiescent of around 3.2mA.

The zero adjustment is +/- 10%, and range provides a 3:1 turndown, both of the nominal range.

Taking as an example the common application of Drilling Mud density measurement in the offshore sector and a typical span of 8 to 20 lbs/U.S. Gallon, and assuming a diaphragm separation if 12 inches (304.8mm), the actual differential pressure range is calculated as:-

@ 8lbs/USG Density is 0.95872	*12” x 0.958720*	*= 11.505” (292.2mm) WG*
@ 20lbs/USG Density is 2.3968	*12” x 2.3968*	*=28.762” (730.54mm) WG*

N.B. The sensor must be mounted vertically throughout the calibration process.

Test pins marked + & - are provided on the RT168A terminal board to allow monitoring of the 4-20mA loop without disconnecting the signal lines

5.1. Zero adjustment

Zero adjustment is by means of a potentiometer which can be found in the bottom right hand corner of the RT168 transmitter.
Apply a pressure equivalent to the minimum SG to the lower diaphragm and adjust the zero potentiometer to give a 4.00mA output.

5.2. Range adjustment

Adjustment of the range setting is as described for zero, having first applied a pressure equivalent to the maximum SG value..

6.0 INTRINSIC SAFETY

290 Series transmitters are covered by intrinsically safe certification for use in hazardous areas.

Approval certification.

RT168 Amplifier	*ITS03ATEX21770X*
Series 200/300 Sensors	*ITS03ATEX21771*

RT168 Amplifier *EEx ia IIC T5*

ia- *Intrinsic Safety*
IIC- *Acetylene & Hydrogen (Presence of Flammable/Combustible gas)*
T5- *100°C (Maximum Surface Temperature)*

Series 200/300 Sensor *EEx ia IIC T6*

ia- *Intrinsic Safety*
IIC- *Acetylene & Hydrogen (Presence of Flammable/Combustible gas)*
T6- *85°C (Maximum Surface Temperature)*

The above approval codes are defined as follows:-

E -	*Indicates the CENELEC standard.*
Ex ia -	*Indicates that the equipment cannot cause ignition in normal operation or with any combination of up to two faults applied. Refer to BS5501 Part 7 and EN50020.*
IIC -	*Indicates the group of gases/vapours defined in BS5502 Part 1 and EN50019.*
T5 -	*Indicates the maximum surface temperature category as defined in BS4683 Part 1.*

The installer is is responsible for matching the transmitter to the appropriate barrier, taking into account the cable capacitance and inductance and the required gas group. EN 60079-14:2008 gives instructions on the correct installation of simple IS systems and should be consulted for reference if the installer is unsure of how to proceed.

Input Parameters
RT168 Transmitter
Voltage 28V
Watts 0.84W

7.0 GENERAL OPERATION & MAINTENANCE

Where correctly installed, satisfactory continuous performance over a long period may be expected from the transmitter. The unit has no specific maintenance requirement. However, the following periodic checks are recommended to good working order.

I) *The system components should be checked visually for good condition of the housings (ensuring that doors and lids are kept firmly closed). Check that weatherproof gasketsand seals are in good condition and secure.*

ii) *Electrical cable runs between the system components should be inspected for condition and security and that cable glands are securely fastened.*

iii) *If the sensor is to be used in an application where the accumulation of sludge may be formed around the diaphragm assemblies after a period of time, cleaning may be necessary, otherwise a slow response to level changes or an inaccurate reading may result.*

The cleaning procedure is as follows:

a) *Remove the transmitter from service. Clean and dry the unit externally using clean water or suitable solvents.*

b) *Where fitted, carefully unscrew (by hand only) the diaphragm housing end cover or flange plate from the front of the transducer. If use of tools is required use extreme care.*
DO NOT INSERT ANY TOOLS OR OBJECTS THROUGH THE SENSOR END CAP OR THE FRONT PROTECTION GUARD. WHERE THEY MAY COME INTO CONTACT WITH THE DIAPHRAGM.

When unscrewed keep the assembly parallel and gently lift away from the body exposing the diaphragm.

c) *Using suitable solvents or clean water only, carefully clean the sludge deposits from the exposed diaphragm or pressure chamber (depending upon model). Great care must be taken not to damage, distort, or otherwise manipulate the diaphragm. A soft brush may be employed to work the solvent into accumulated sludge if required.*
On no account should high pressure cleaning devices be used

d) *Clean and inspect any gaskets or seals and ensure that the seating is thoroughly cleaned. Replace seals if necessary.*

e) *When refitting the end cover or flange plate ensure that it is kept parallel and clear of the diaphragm.*

It is also recommended that system calibration should be checked at least once a year following the procedure given under section 5.0, entitled 'Commissioning & Recalibration'

8.0. FAULT FINDING

During manufacture each instrument is exercised and calibrated in accordance with the application requirements. As such it is fully tested prior to shipment. If, however, on installation or subsequently in service, the system is believed to be providing an incorrect reading or no reading at all, the checks should be undertaken: Note that the sensor assembly is a fully welded construction and apart from removal of any diaphragm covers or protection, no on-site disassembly is possible.

1. *Check that the actual installation details are as the original manufacturing specification*

2. *Is the system wired in accordance with the instructions given in the electrical installation section.*

3. *Is the power connected and working? Is the correct 24 V dc signal present across the transmitter terminals? Connect a voltmeter suitable for 24V DC across the units positive and negative terminals offering correct polarities.*

4. *Does the current output from the transmitter appear at the receiving instruments terminals? Connect an ammeter suitable for 4 to 20mA in series in place of the loop indicator.*

5. *If possible, confirm by independent means the actual SG of the liquid. Be aware of any apparent errors introduced by stratification of fluids.*

6. *Check that the liquid is fluid, ie., no solids or other blockages are impeding the diaphragms.*

7. *For externally mounted transmitters check that any isolating valves fitted are open.*

8. *Where a number of transmitters have been installed check that each sensor is installed on its intended vessel and has the correct electronic transmitter connected.*

9. *Where the transmitter has an indicator connected check that this is not fitted with shipping stops or bridge.*

10. *Where there is more than one transmitter connected to a common power supply check that there is no cross channel interference or ground loop problems. How this is actually done will depend on each particular application but, in general, each transmitter should be connected individually to the supply (or a temporary supply to see if its output signal changes.)*

If the fault still exists after the foregoing have been checked the transmitter should be removed from service for further examination.

With the instrument throroughly cleaned and on the bench the following checks may be made:

Disconnect the sensor from the amplifier module and measure the resistance on the sensor signal cable which should be:

Black to Red -	*Approximately 56 ohms*
Green to white -	*Approximately 2200 ohms*

Check that the following are all open circuit:

Black to Green
Black to Outer Screen
Black to Sensor Body
Green to Outer Screen
Green to Sensor Body

If any of the above tests fail the sensor is faulty and will require factory repair or replacement.

Assuming the above to be OK, reconnect the sensor and the amplifier and connect a suitable 24V DC supply to the transmitter. Connect an ammeter across the test pins on the amplifier to monitor the 4 - 20mA loop.

A suitable pressure source will also be required.– Refer to section 5.0 for details of applying pressure to the unit.

Check for the following conditions:

1. *Responding to applied pressure ie. the output signal increases but unable to set 4mA output at zero using the zero potentiometer. Disconnect the **Black** and **Red** sensor wires.*
Can 4mA now be set?
*If **YES,** the sensor has a mechanical shift and will need replacing.*
*If **NO**, a component failure in the amplifier module is indicated. The amplifier should be replaced.*

***NB** Since the thermal compensation for the sensor is calibrated into the Amplifier the advisability of doing this depends upon the service conditions. Where there are no extremes of temperature involved it may be viable. Refer to PSM who will determine this from the factory calibration records.*

2. *Not responding to applied pressure. Dissconnect the **Red** and **Black** sensor wires*
Is it now possible to set 4mA output on the zero pot?
*If **YES**, it indicates a sensor problem or no exitation voltage being supplied by the amplifier module. To check the exitation voltage connect an AC voltmeter across the Ex+ & Ex- terminals. Output should read 0.7V . . If an oscilloscope is available the frequency of the excitation voltage can also be verified as 1.3KHz.*
*If **NO**, there is a problem with the amplifier module. To check the supply rails the amplifier must be removed from its housing to gain access to the lower board. Check that the voltage across Diode Z1 is 5.2V. Z1 is located in the centre of the board and its unbanded end is 0V. Measure also from this 0V to pin 13 of IC4. This should be 1.9V. Any variation from these two values indicates a problem with the amplifier module.*

Where the foregoing do not clearly indicate the faulty element, careful visual inspection of the sensor body / diaphragms should be made for signs of damage / corrosion, the sensor cable for signs of damage to the outer sheathing, and the circuit board for component failure or breakage, may indicate where the problem lies.
If the faulty area can be identified and a spare sensor or amplifier module is available, the following matching procedure should be undertaken.
NB As stated earlier please initially refer to PSM before undertaking the following procedure.

9.0 SENSOR/AMPLIFIER MODULE REPLACEMENT

1. *To access the potentiometers on the lower PCB of the amplifier module it is necessary to remove the assembly from its enclosure. Take care not to damage the boards or interconnecting ribbon cable.*
2. *Connect sensor to transmitter and apply power as previously described.*
3. *Set the potentiometer controls as follows:-*

RV1 *- Phase control - fully anti-clockwise. (Lower PCB)*

RV2 *- Zero control - mid-position. (Upper PCB)*

RV3 *- Gain control - fully anti-clockwise. (Lower PCB)*

RV4 *- Range control - fully anti-clockwise. (Upper PCB)*

4. *With a pressure equivalent to the minimum SG applied, adjust the zero control RV2 to give an output signal of 4.00mA.*
5. *Apply a pressure equal to the full nominal range of the instrument (refer to the model coding label) and adjust RV3 gain control to give an output signal of 18.4 – 18.5mA.*
6. *Reduce the pressure to the minimum SG level and recheck zero output, re-adjusting RV2 if necessary to give 4.00mA.*
7. *Re-apply the full nominal pressure and check output signal adjusting to 18.4 — 18.5mA using RV3 as necessary.*
8. *Now apply a pressure equivalent to the maximum SG for full scale and adjust RV4 to give 20.00mA output.*
9. *Release the pressure and recheck zero output. If it requires correction repeat step 8 afterwards. Repeat this process until a 4-20mA output is achieved.*

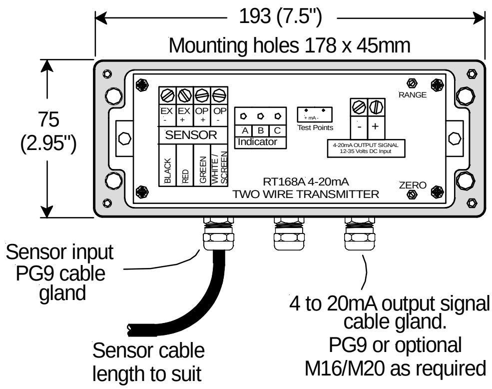
10.0 WARRANTY CONDITIONS

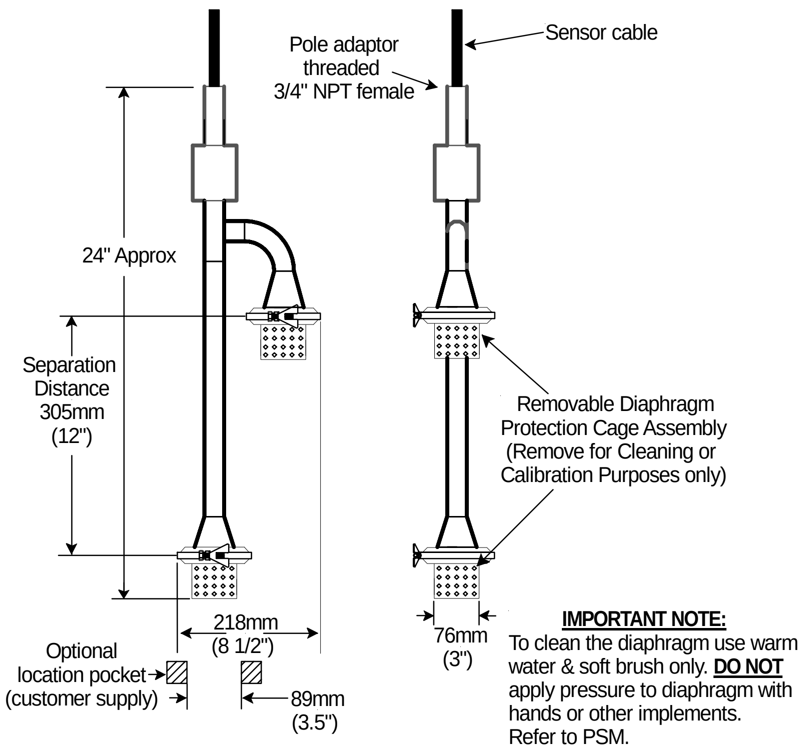
PSM products are covered for 12 months from the date of despatch against arising from faulty manufacture. Warranty terms are return to base. Shipping costs are to the account of the user. Should it prove necessary to return any equipment PSM must first be contacted to obtain a goods return authorisation number. In accordance with UK Health and Safety policy PSM can refuse unauthorised returns

An explanation of the apparent fault together with details of the service conditions are also requested. The Health & Safety requirements mean that we must be fully aware of any potential hazards prior to working on returns

11.0 GENERAL OUTLINE DRAWINGS

*Outline drawings for all models covered by this manual are available from **PSM**. Due to the variety of configuration possibilities details of the specific model supplied against a particular contract are included as part of the contract documentation.*





PSM WEEE Producer Registration No WEE/HC0106WW