Technical Manual
78355060_US, Rev. A
November 2007

Micro Motion® Exd 7835

Explosion Proof Liquid Density Transducer

Standard Electronics

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IMPORTANT NOTICE

DO NOT drop the transducer. **HANDLE WITH CARE**

DO NOT use liquids incompatible with **MATERIALS OF CONSTRUCTION**

DO NOT allow axial loading from **PIPEWORK STRESSES** to exceed ½ **TONNE**

DO NOT operate the transducer above its **RATED PRESSURE**

DO NOT **PRESSURE TEST** above the specified **TEST PRESSURE**

DO NOT expose the transducer to excessive vibration (**>0.5g continuous**)

DO NOT rotate the electrical housing because this may invalidate the **IP rating**.

ENSURE all **ELECTRICAL SAFETY** requirements are applied

ENSURE transducer and associated pipework are **PRESSURE TESTED** to 1½ times the maximum operating pressure after installation

ENSURE transducer is not **TRANSPORTED** when it contains hazardous fluids. This includes fluids that may have leaked into, and are still contained, within the case. The **Returns Forms** in Appendix F **MUST be copied, completed and returned** to the factory with the returned instrument

Contents

Chapter 1
Introduction

1.1 Product Overview

This meter will provide a continuous on-line measurement of **density** and **temperature** of the process fluid being measured. The construction of the meter is to **explosion proof** standards, allowing installation in hazardous areas. Operational parameters can be found in the specification in appendix A.

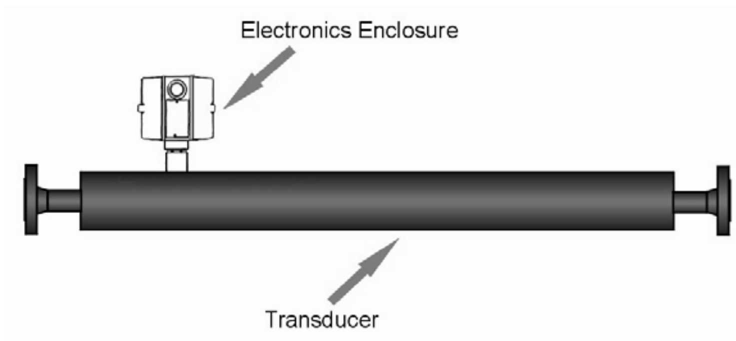


Figure 1.1: Sideways view of meter

Liquid density is determined from the resonant frequency of a vibrating tube containing the liquid, and liquid temperature is determined from a 100Ω Platinum Resistance Thermometer (PRT). For information on the calculation of density and temperature, please refer to chapter 4.

1.2 Product Range

The product range is summarised in Table 1.1 (below). The meters are identical mechanically, except for the material used in the wetted parts, and the flanges/couplings. A fully welded design is utilised to ensure maximum reliability in the most severe environments. In the unlikely event of a leak occurring in the centre tube assembly, the outer casing will withstand a line pressure rating of up to **1450psi** (**100 Bar**).

For further details of the product range, please refer to appendix A.

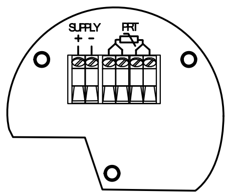
Table 1.1: Explosion proof meter range

Meter	Tube material (wetted parts)	Features
7835	NI-SPAN-C®	Low temperature coefficient and long term stability, appropriate for fiscal applications.

1.3 Electronics Product Range

The meters described above may be operated with frequency output electronics only. The electronics are not directly interchangeable due to the complex internal wiring. For details of the performance of the electronics, refer to Appendix B.

Table 1.2

Standard Electronics		○ Basic amplifier circuit providing a frequency signal (indicating liquid density) and PRT resistance (indicating liquid temperature). ○ Features 6 screw-terminals for power in, and outputs (See Figure 1.2). ○ Interfaces with a Signal Converter or Flow Computer (see Section 3).

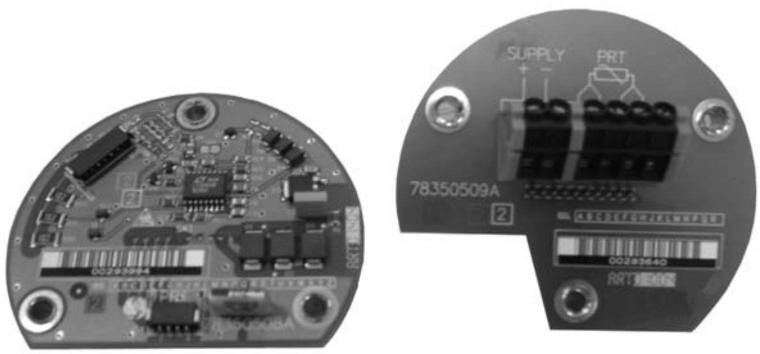


Figure 1.2: Standard Electronics

Chapter 2
Mechanical Installation

2.1 General

This chapter describes the **mechanical installation** of the 7835 liquid density meter.

Remember! Always handle the meters with care

When handling...

- Don't drop the meter or subject it to severe mechanical shock.
- Don't expose the meter to excessive vibration.

When installing…

- Ensure axial loading from pipework does not exceed ½ tonne.
- Ensure all electrical safety requirements are met (see safety instruction booklet 78355061/SI).
- Ensure that the meter and associated pipework are pressure tested to 1½ times the maximum operating pressure.
- Ensure that the electronics housing is not rotated. Rotating the housing may invalidate its' IP rating.

When operating...

- Don't use liquids incompatible with the construction.
- Don't operate the meter above its rated pressure.

When transporting...

- Ensure that the meter does not contain hazardous fluids, including those that may have leaked into the case.

2.2 Installation Planning

When planning the installation of a meter, it is important to consider the following factors:

Safety

When installing in a process line, it is important that the construction material of the wetted parts (tube) is matched to the non-corrosive performance of the liquid passing through the instrument. Failure to observe this requirement can cause deterioration of the central tube (the bellows) and loss in measurement accuracy, or even a failure if leaking occurs. For advice on which meter in the range is appropriate, please contact the factory.

Note: The **NI-SPAN-C®** material of the central tube is not rated for 'sour' service as defined in NACE specification MR071-2000. For advice in this application, please contact the factory.

Serviceability

Installing the meter in a by-pass configuration allows it to be removed for servicing, or calibration, without affecting the main pipeline. Possible by-pass configurations are shown in Figure 2.2c.

Whilst the electronics may be accessed via the electronics housing end-caps, ensure that the electronics housing is not rotated. **Rotating the housing may invalidate its' IP rating. If the housing is rotated, contact the factory (see back page).**

Performance

Pipe stresses and vibration

Axial load should not exceed ½ tonne, so pipe-work should have a degree of flexibility. Excessive pipe vibration should be avoided. See Figure 2.2b for preferable mounting positions.

Gas bubbles

The presence of gas bubbles can seriously affect the meter performance and so the following points should be considered:

- The liquid must always be at a pressure substantially above its vapour pressure.
- All pipe-work couplings and joints must be airtight.
- No vortex should be present at the inlet to the meter.
- Cavitations, caused by pumping, should not generate bubbles from dissolved gases.
- If a pump is used it should 'push' rather than 'pull' the product through the meter.

Meter orientation

For low flow rates, e.g. 750 litres/hour (2.7 gal/min.), the meter should preferably be mounted vertically or at an incline, with the flow in an upwards direction.
If the liquid contains solid particles, the direction of flow should be upwards unless the particles are large enough not to be carried with the flow, in which case the direction of flow should be reversed.

The meter should be mounted with the electric cable running downwards thereby minimising the ingress of water should a cable gland become defective.

Flow rate

A fast flow rate, e.g. 3000 litres/hour (11 gal/min.), will help to achieve good temperature equilibrium and have a self-cleaning action.

A low flow rate, e.g. 1000 litres/hour (3.7 gal/min.), is recommended if the product contains particles which may cause erosion.

The meters exhibit a small flow dependent density reading. For flow rates up to 15000 litres per hour (55 gal/min) and assuming no consequent line pressure or product changes, the maximum density offset will be less than 0.2kg/m^3.

Temperature Stability

The inlet pipework should be thermally lagged to ensure good temperature stabilisation.

2.3 Meter Mounting and Pipework

This section considers in more detail the mounting of the meters and the design of the associated pipework, including the calculation of pressure drop in the meter.

Installation drawings for all the meter versions are reproduced in the Appendices, along with detailed drawings of the flanges/couplings. The preferred methods of supporting the meter are shown in Figure 2.2a.

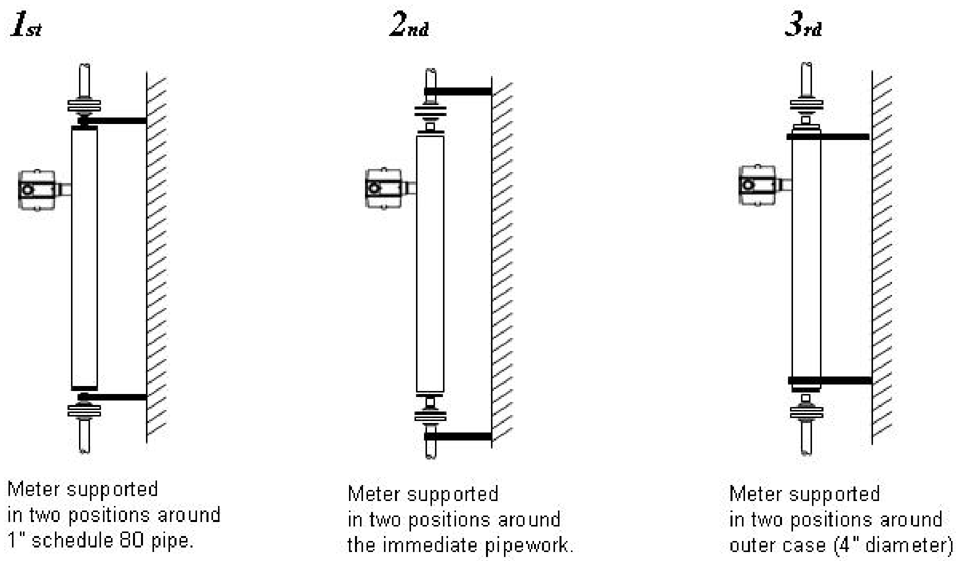


Figure 2.2a: Preferred Methods of Mounting Meter

For continuously high flow rates, the mounting position can be selected to simplify the associated pipework and help minimise the pressure and temperature losses (see Figure 2.2b below.)

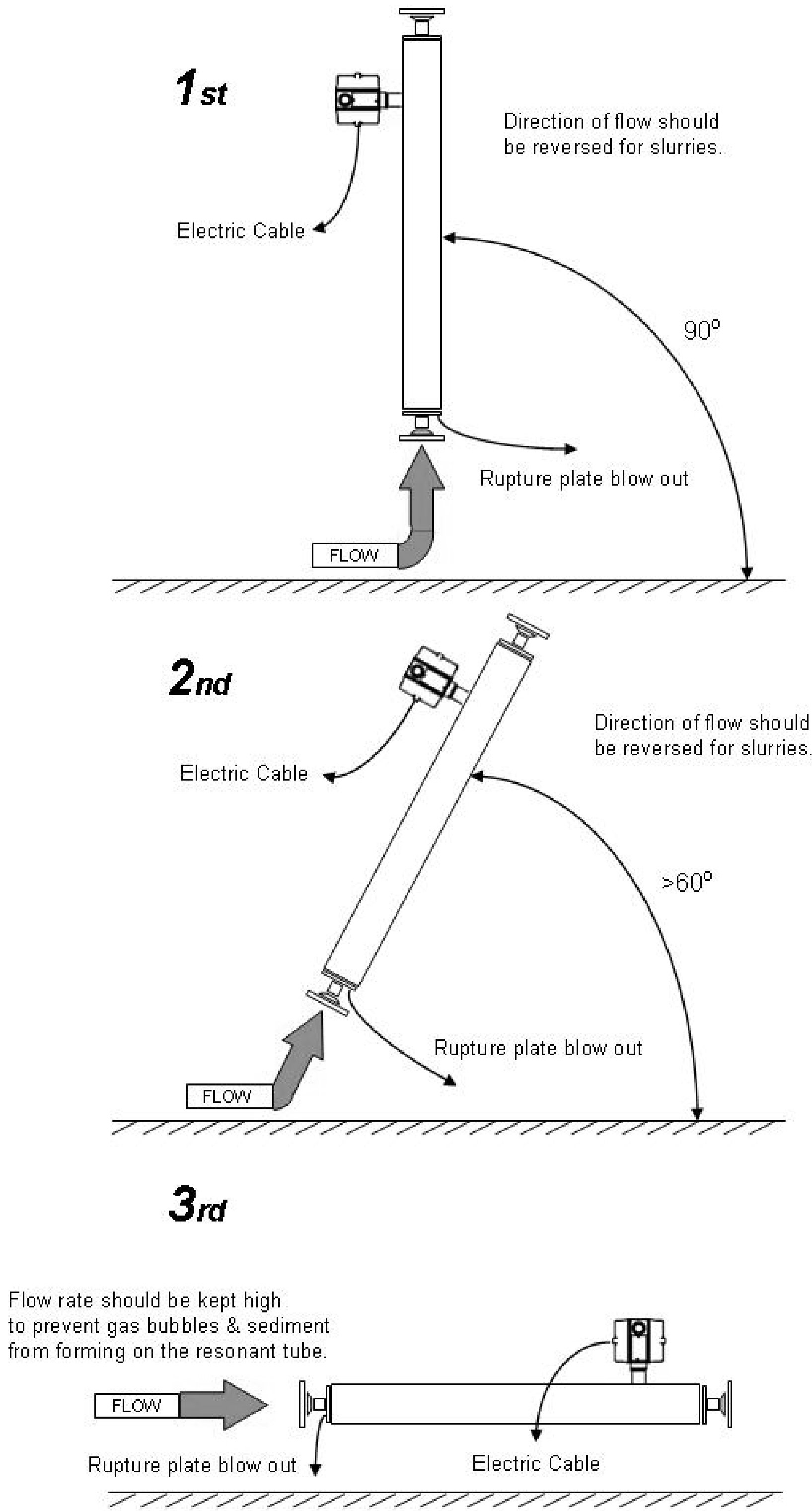


Figure 2.2b: Meter Preferred Mounting Angle

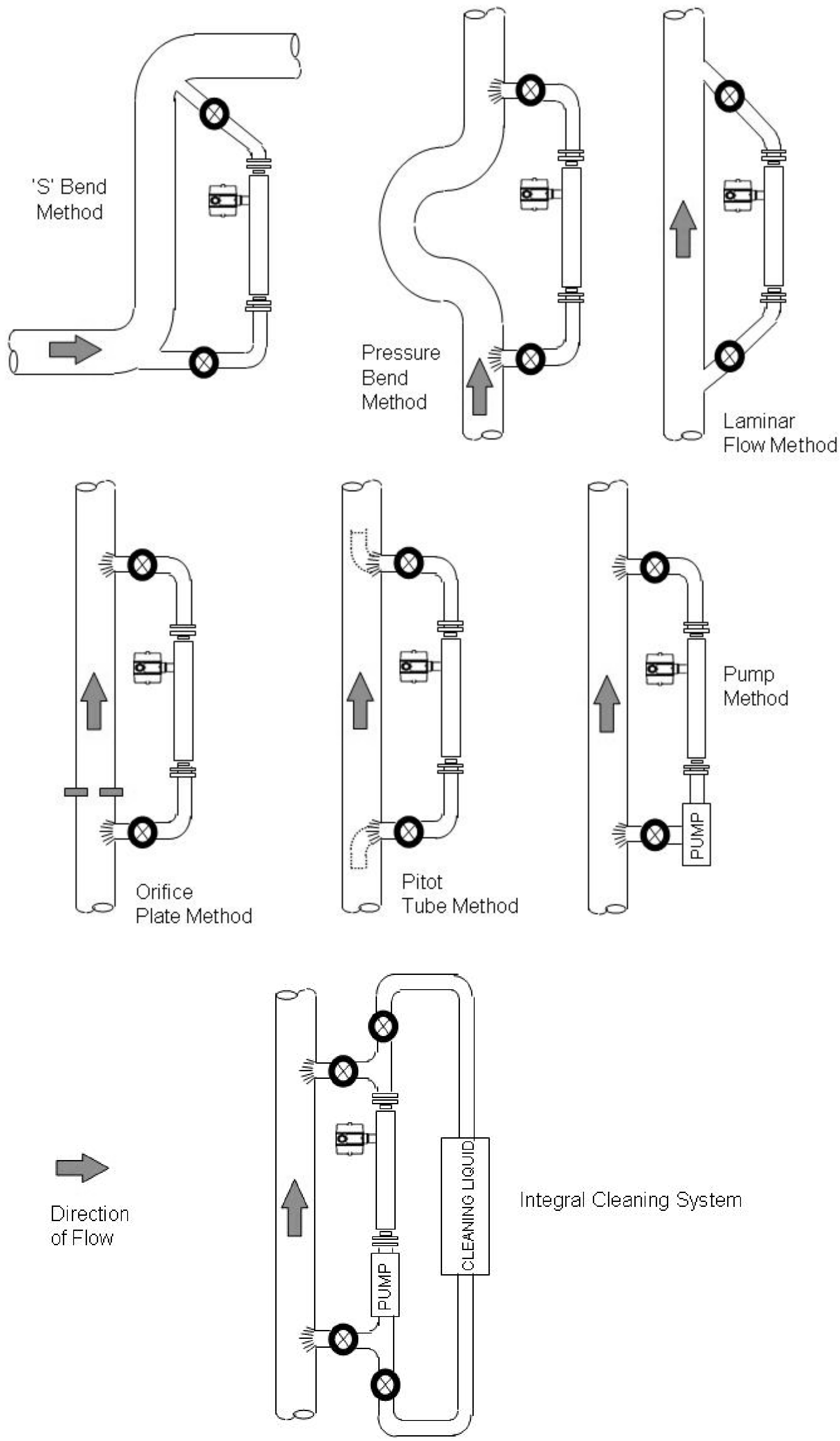


Figure 2.2c: Typical By-Pass Pipeline Configurations

2.4 Pressure Drop in the Meter

The pressure drop in the meter depends on:

- Flow rate (V), and
- Kinematic viscosity (υ)

The table below gives some examples of pressure drop at various flow rates.

Flow Rate (litres/hour)	Flow Velocity (V m/s)	Pressure Drop	
		υ = 2cS	υ =10cS
1000	0.6	0.003	0.004*
4000	2.5	0.033	0.048
12000	7.6	0.238	0.345

* Indicates laminar flow (Fluid Density 1.0g/cc)

Calculation of pressure drop in the meter

The meter should be considered as a straight pipe of 23.6mm (0.929”) internal diameter and 1.03m (40.551”) in length. The following formula has been proven to apply to the meter by measurements at 12000 litres per hour (44 gal/min).

$$\mathbf{h} = \frac{200 \times f \times L \times V^2 \times \rho}{g \times D}$$

Where : **h** = Pressure drop (bars)
f = Friction coefficient
L = Pipe length (m) = 1.03
D = Internal pipe diameter (mm) = 23.6
V = Mean fluid velocity (m/s)
ρ = Fluid density (g/cc)
g = 9.81 (m/s^2)

For viscous or laminar flow (Reynolds Number R_e less than 2000):

$$\text{Frictional Coefficient (f)} = \frac{16}{R_e}$$

For turbulent flow (R_e greater than 2500):

$$\text{Frictional Coefficient (f)} = \frac{0.064}{R_e^{0.23}}$$

Where: Pipe $R_e = \dfrac{1000 \times V \times D}{\upsilon}$

υ = Kinematic viscosity (cS)

In addition to the pressure drop caused by the liquid flow through the instrument, it will be necessary to calculate the pressure drop in any associated sample pipework before concluding the system design requirements.

2.5 Post-Installation Checks

After installation, the meter should be pressure tested to 1.5 times the maximum working pressure of the system but **NOT** to a value exceeding the meter test figure shown on the meter label.

> ⚠ **Caution:**
> If the pressure test figure is exceeded, the meter may be irrevocably damaged.

Chapter 3
Electrical Installation

3.1 General

This chapter describes the **electrical installation** of a **Exd 7835** liquid density meter with Standard Electronics fitted.

3.1.1 Power supply

The power supply to the meter must have the following specification:

Voltage: Nominally 24V dc, but in the range 18 to 30V dc.
Current: >30mA.

If several meters are to be used within a local area, one power supply can be used to power them all; where the meters are distributed over a wide area and cabling costs are high, it may be more cost effective to use several smaller, local power supplies.

3.1.2 Ground connections

It is not necessary to earth the meter through a separate connection; this is usually achieved directly through the metalwork of the installation.

3.1.3 Cabling

Cables should conform to BS2538. In the USA, use Belden 9402 (two-pair) or Beldon 85220 (single-pair). Other cables that are suitable are those that meet BS5308 Multi-pair Instrumentation Types 1 and 2, Belden Types 9500, 9873, 9874, 9773, 9774 etc.

The typical maximum recommended cable length for the above cable types is 1000m (3200ft.), but care must be taken to ensure that the power supply at the meter is at least 20V. Thus, for 24V power supply, the overall resistance for the power supply connections (both wires in series) must be less than 100 ohms.

In order to complete the wiring, you will need the following parts:

- ¾" NPT to M20 gland adapter.
- ¾" NPT blanking plug.
- M20 x 1 cable gland (not supplied).

The gland adapter and blanking plug are supplied with each meter. These two parts are "EExd" rated. However, you will need to get a suitably rated cable gland. Alternative parts may be required in order to meet local electrical installation regulations.

In hazardous areas, all parts must be explosion-proof.

3.1.4 Installation in explosive areas

The meter is an **explosion-proof** and **flameproof** device. Therefore, the connections shown in the wiring diagrams later are applicable. However, it is essential to observe the rules of compliance with current standards concerning flameproof equipment:

1. Electronics housing caps should be tightened securely and locked in position by their locking screws.
2. The electrical cable or conduit should have an appropriate explosion-proof cable gland fitted.
3. If any electrical conduit entry port is not used, it should be blanked off using the appropriate explosion-proof blanking plug, with the plug entered to a depth of at least five threads.
4. The spigot must be locked in place.

In addition, the electrical installation must strictly adhere to the safety information given in safety instruction booklet 78355061/SI, which will have accompanied this manual.

3.2 Use with Flow Computers and Signal Converters

When operated in conjunction with a flow computer or signal converter, **only the meter can be operated in the hazardous area**. The flow computer / signal converter **must** be sited in a non-hazardous (safe) area only.

Cable screens should only be earthed at one end of the cable to prevent "ground loops". This is normally done at the end of the cable which is in a control room panel. At the end of the cable which is connected to the meter, the screen is normally cut back and insulated. If the cable passes through a junction box, the screen continuity is assured by screen earth terminals on the junction box.

Cable braid is not the same as cable screen, but is another form of armouring and will be earthed at both ends through conductive glands

3.2.1 System Connections

The density system connections are illustrated in Figure 3.1 (below).

Note: The PRT within the Exd 7835 is designed to only operate in 4-wire mode. If the PRT is connected in 2-wire mode, an additional resistance will be seen that is a result of the EMC protection circuitry. When operating in 4-wire mode, this additional resistance is not seen and the operation is unaffected.

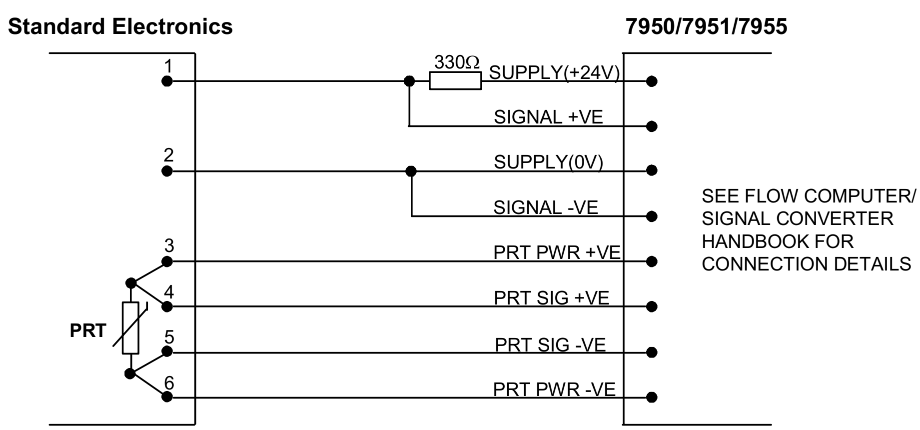


Figure 3.1 – Electrical connection diagram
7835 with Standard Electronics to Flow Computers / Signal Converters.

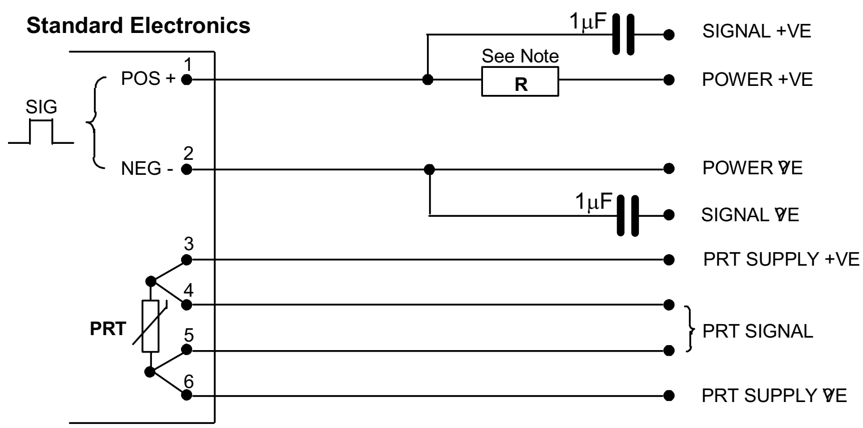
3.3 Use with Customer's Own Equipment

3.3.1 System Connections

Power supply to Density Meter:	15.5V to 33V d.c., 25mA min.
Power supply to PRT:	5mA max.

The frequency at which the meter is operating can be detected by using a series resistor in the +VE power line. The value of resistance to be used for a given supply voltage must not exceed the value obtained from the LOAD NOMOGRAM (Figure 3.3). The electrical connections to be made are shown in Figure 3.2.

Note: The PRT within the Exd-densitometer is designed to only operate in 4-wire mode. If the PRT is connected in 2-wire mode, an additional resistance will be seen that is a result of the EMC protection circuitry. When operating in 4-wire mode, this additional resistance is not seen and the operation is unaffected.



Note: See "Load Resistance" (Figure 4.3) to determine R value.

Figure 3.2 – Electrical connection diagram
7835 with Standard Electronics to Customer's Own Equipment

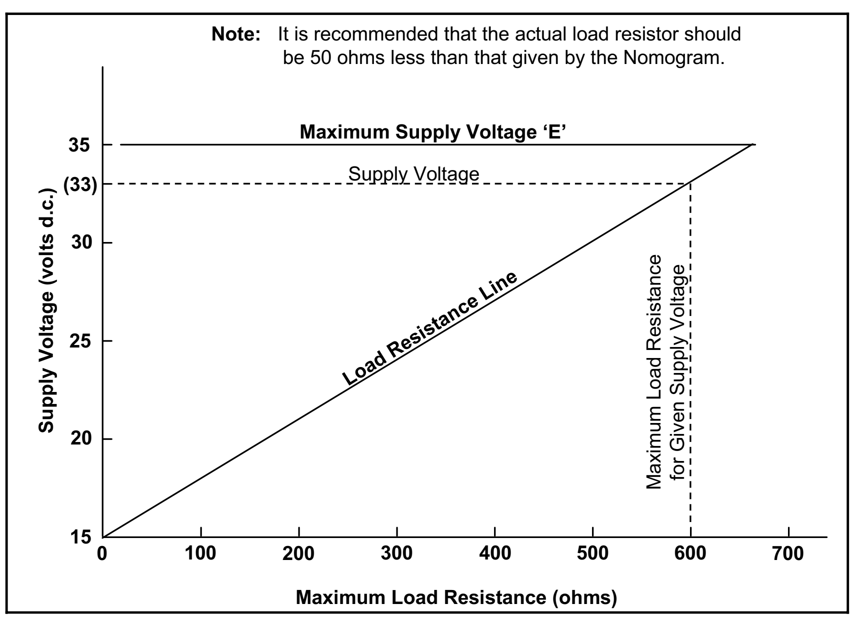


Figure 3.3 – Load Resistance

3.4 Post-Installation Checks

After installation, the following procedure will indicate to a high degree of confidence that the meter is operating correctly.

Measure the current consumption and the supply voltage at the meter amplifier. This should be within the limits:

15.5V to 30Vdc, 17mA ±1mA

With the meter empty, clean and dry, measure the periodic time of the output signal and check that it is as specified on the meter calibration certificate (air check), to within the limits given in the table below.

Table 3.1

Meter type	Air check limit at 20°C	Added temperature effect
7835	±60ns	±10ns / °C

Chapter 4 Calibration and Performance

4.1 General

The **Exd 7835** meters are calibrated at the factory, and are shipped with **test and calibration certificates**.

The calibration certificate specifies various **calibration constants** that allow the user to **convert** the output *periodic time* signal from the meter into a density value. (See Appendix C for **specimen** calibration certificates.)

For units with **Standard Electronics**, the calibration constants will need to be *programmed* into a signal processing instrument such as a signal converter. Density calculations are performed on the signal processing instrument.

4.2 Interpretation of Calibration Certificate

4.2.1 General Density Equation

The basic meter constants, **K0**, **K1** and **K2** are computed from the factory calibration on three fluids. Using these constants and the general density equation, the density of the liquid within the meter can be calculated.

The general density equation is:

$$D = K0 + K1.\tau + K2.\tau^2 \quad \text{.......(1)}$$

Where: D = Uncorrected density of liquid (kg/m^3).

τ = Periodic time (μs) of vibration = 1/f where 'f' is the frequency of vibration.

K0, K1, and K2 = Constants from the Calibration Certificate.

On the calibration certificate, you can see that the basic meter constants (**K0**, **K1**, and **K2**) are determined from a calibration at a temperature of 20°C (68°F) and at a pressure of 1 bar (14.5psi):

- On a metric certificate: `DENSITY CALIBRATION AT 20 DEG. C AND AT 1 BARA`
- On imperial certificate: `DENSITY CALIBRATION AT 68 DEG. F AND AT 14.5 PSIG`

If the operating conditions of the meter differ from that of the calibration conditions, the density calculated using *equation (1)* must be corrected.

4.2.2 Temperature Correction

If the meter operates at temperatures other than 20°C (68°F), a correction to the density calculated using *equation (1)* must be made using the **temperature coefficient** constants from your calibration certificate.

The equation used to apply temperature correction is:

$$D_t = D.[1 + K18.(t - 20)] + K19.(t - 20) \quad \text{.......(2)}$$

Where: D_t = Temperature corrected density (kg/m^3)

D = Density calculated using *equation (1)*.

t = Temperature (degrees C)

K18 and K19 = Constants from the Calibration Certificate

Note:

1. **K18** and **K19** are the **temperature coefficient** constants on the calibration certificate.

4.2.3 Pressure Correction

The meter design has a unique facility to *reduce* the influence of the line pressure on the density measurement, but a correction may be required for a **residual pressure effect**.

This residual pressure effect ***before*** a pressure correction is shown schematically for the Exd 7835 in Figure 4.1.

During the calibration of the meter, which is normally performed at a pressure of 1 bar (14.5psi), the **pressure influence** is also measured. This data is also shown on the calibration certificate.

The equation used to apply pressure correction is:

$$D_p = D_t.[1 + K20.(P - 1)] + K21.(P - 1) \qquad (3)$$

Where: D_p = Temperature and pressure corrected density (kg/m^3).

D_t = Temperature corrected density (kg/m^3) calculated using *equation (2)*.

P = Pressure in bar absolute.

And: K20 = K20A + K20B (P – 1)

K21 = K21A + K21B (P – 1)

This residual pressure effect *after* a pressure correction is shown schematically for the Exd 7835 in Figure 4.2.

Notes:

1. K20A, K20B, K21A and K21B are the **pressure coefficient** constants on the calibration certificate.

2. The pressure correction is further enhanced on units that operate above 41 Bar by having sets of **pressure coefficient** constants covering subsets of the full operating pressure range.

   *Note that only **one** set of pressure coefficient constants is selected from your calibration certificate according to your operating pressure range. If your operating pressure range falls within the range of two sets of **pressure coefficient** constants, contact the factory for a new calibration certificate.*

3. If it is required to apply temperature **and** pressure corrections, the temperature correction is applied first.

Figure 4.1: Pressure effect on 7835 *before* pressure correction

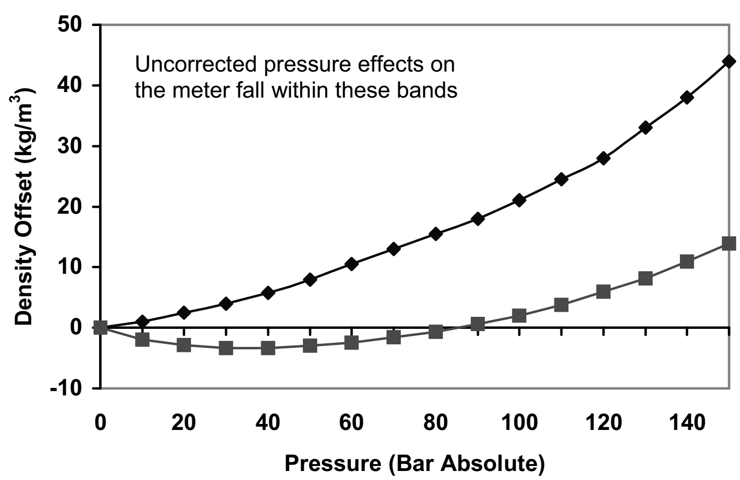
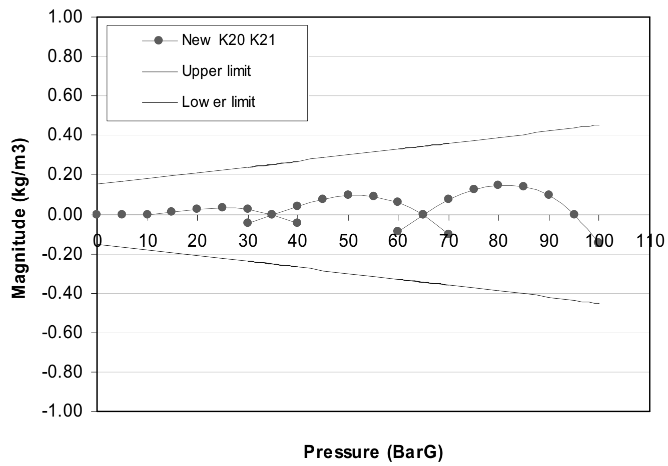


Figure 4.2: Residual pressure effect *after* pressure correction – 7835 (100Bar) units

This figure shows the typical residual error curves after pressure corrections for 7835 (100Bar) units using three sets of pressure coefficient constants. Each set covers a sub-set of the 100Bar range.

*Note that only **one** set of pressure coefficient constants is selected from your calibration certificate according to your operating pressure range.*
For specimen calibration certificates, see Appendix C.



The uncertainty specification for a 7835 is indicated by the upper and lower limit lines. The uncertainty for the 7835 pressure coefficients is ±0.003 kg/m^3. This is in addition to the instrument calibration uncertainty of +/-0.15kg/m^3.

4.2.4 Velocity of Sound Correction

The Velocity of Sound (VOS) in the process liquid may have an effect on the accuracy of the indicated density. The calibration of the Exd 7835 sensors has been optimised to a density/VOS relationship as indicated in Figure 4.3.

If the VOS of the process fluid deviates substantially from the relationship in Figure 4.5 it may be desirable to apply a correction. This may be achieved by the simple introduction of a calibration offset using the data in Figure 4.3. Adjustment of the value **K0** in the basic equation will achieve this.

Alternatively, the following equations may be used:

$$D_{VOS} = Dp\left[1 + \frac{1.4E06}{D_P + 1400} \times \left(\frac{1}{V_C^2} - \frac{1}{V_A^2}\right)\right]$$

Where: D_{VOS} = Velocity of sound and temperature corrected density (kg/m^3)

D_P = Temperature and pressure corrected density (kg/m^3)

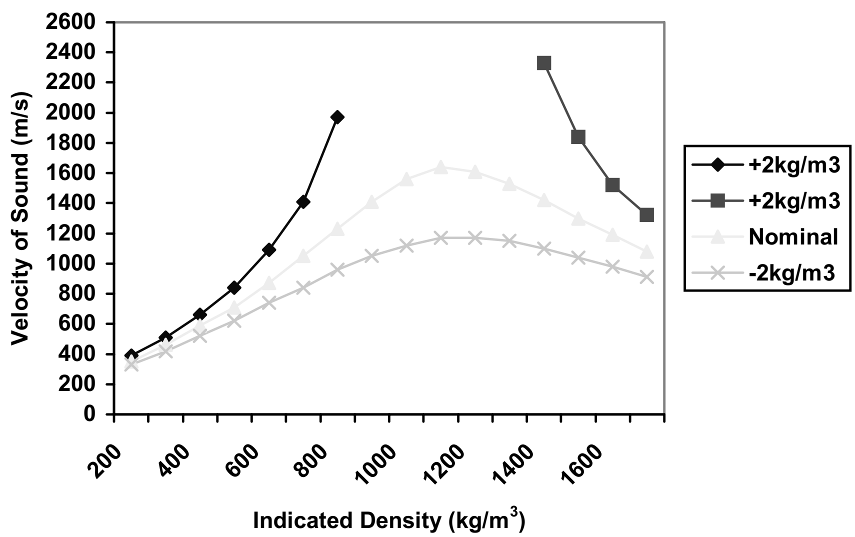
V_C = Calibration VOS (m/s)

V_A = Liquid VOS (m/s)

V_C may be obtained direct from Figure 6.3 or may be calculated as follows:

$V_C = 100 + 1.455D_P$ for a D_P of 300kg/m^3 to 1100kg/m^3

$V_C = 2690 - 0.9D_P$ for a D_P of 1100kg/m^3 to 1600kg/m^3



Values shown are the required corrections.
True Density = Indicated Density + Corrections

Figure 4.3: Optimised Velocity of Sound Relationship for 7835

4.3 Calibration

4.3.1 Factory Calibration

The Exd 7835 Liquid Density Meters are calibrated prior to leaving the factory against Transfer Standard instruments, traceable to National Standards.

Three fluids are used in the calibration - ambient air whose density is derived from tables, a hydrocarbon oil of about 815kg/m^3 density and a high-density fluid in the range 1400 to 1500kg/m^3 density. Several of the instruments-under-test are connected in parallel between two Transfer Standard Instruments on a special flow rig at the factory. During a calibration and as the liquid flows through the instruments, readings are only taken when the indicated densities on the two Transfer Standard Instruments agree. In this way, a high integrity of calibration is achieved.

Measurements are also made under conditions of changing temperature and pressure to establish the magnitude of these effects on the instrument. From all this data, a calibration certificate is generated for each instrument.

Samples of the instruments are further tested by a quality assurance team at the factory to verify the calibration.

4.3.2 Calibration of Transfer Standards

The Transfer Standard instruments used in the calibration are selected instruments that are calibrated and certified by the UKAS Certified Calibration Laboratory.

Transfer Standard calibration uses a number of 'density certified' liquids. The densities of these certified liquids are obtained using the Primary measurement system, whereby glass sinkers of defined volumes are weighed in samples of the liquids.

Calibration is performed by pumping each certified liquid through the Transfer Standard in a closely controlled manner and recording the output signal in each case. A calibration certificate is issued for each Transfer Standard. Calibrations are repeated, typically every six months, producing a well-documented density standard.

4.3.3 Instrument Calibration Certificate

Each instrument is issued with its own calibration certificate containing four important pieces of data:

(**a**) The instrument serial number.

(**b**) The output signal/density relationship. This is based on three calibration points - air, medium density and high-density fluids. The air and high density fluid points are offset to achieve the product velocity of sound/density profile described earlier, however, the signal value at Air Density is also given for check purposes.

(**c**) Temperature coefficient data, describing the correction which should be applied to achieve the best accuracy if the instrument is operating at product temperatures other than 20°C (68°F).

(**d**) Pressure coefficient data, describing the correction that should be applied to achieve the best accuracy if the instrument is operating at elevated pressures.

A second page of the calibration certificate is retained by the factory and contains all the calibration measurements.

See Appendix C for **specimen** calibration certificates.

4.3.4 Pressure Test

A hydrostatic pressure test is carried out to a pressure value specified on the instrument label and on the instrument calibration certificate. This test loads the instrument structure to a pressure which exceeds the maximum permitted operating pressure of the instrument.

Note: During manufacture, the welded structure is pressure tested to conform to the requirements of EN50018-1997. The outer case is able to withstand 100bar of internal pressure in the event of tube/bellows failure.

4.3.5 Calibration Check Methods

There are two methods employed in calibration checks:

(**a**) Air checkpoint, which is simple and convenient and highlights long term drift, corrosion and deposition.

(**b**) Liquid calibration verification comprising two choices:

- Drawing off a sample of the liquid being measured and obtaining its density, using a hydrometer (for stable liquids) or pyknometer (for unstable liquids).
- Using a second density meter.

Ambient Air Check

(**a**) Isolate, drain and if necessary, disconnect the meter from the pipeline.

(**b**) Clean and dry the wetted parts of the meter and leave them open to the ambient air.

(**c**) Apply power to the instrument and check that the time period of the output signal agrees with the 'Air Check' figure shown in the calibration certificate, to within acceptable limits (e.g. 60ns).

Some variation between the two figures is to be expected due to changes in ambient air conditions. The density indication if using the K0, K1 and K2 factors will be about -0.9kg/m^3 because the basic density equation has been optimised for best performance over the normal operating density range.

This test will indicate whether there has been a calibration offsets due to corrosion, deposition or long term drift. When this test is applied to the 7845 instruments, their temperature coefficient has a significant effect and must be considered (typically 0.3ms/°C).

Reconnect the meter to the pipeline if serviceable or remove it for further servicing.

Liquid Density Check

1. Sample Method

If it is necessary to verify the calibration using liquid at operating conditions, then the following sample methods are recommended:

(**a**) FOR STABLE LIQUIDS:

Draw off a sample of the liquid into a suitable container, at the same time noting the indicated density, temperature and pressure of the liquid.

Measure the density of the sample under defined laboratory conditions, using a hydrometer or other suitable instrument.

Refer the density measurement under laboratory conditions to that under the line operating conditions of temperature and pressure.

Compare the referred density figure with that indicated by the density meter.

Note: *It is essential that a good understanding of the physical properties (temperature coefficient, etc.) of the liquid is acquired when using this method.*

(**b**) FOR UNSTABLE LIQUIDS:

Couple a pressure pyknometer and its associated pipework to the pipeline so that a sample of the liquid flows through it.

When equilibrium conditions are reached, the meter density reading is noted as the pyknometer is isolated from the sample flow.

Remove the pyknometer for weighing to establish the product density.

Compare the pyknometer registered density with that obtained from the meter.

Sampling Techniques

Sampling should comply with the international sampling standards (ISO 3171, ASTM D 4177, API 8.2 and IP 6.2). For further details of these procedures, reference should be made to:

Institute of Petroleum:	Petroleum Measurement Manual Part VII Section 1 - Method IP 160 (Hydrometer Method) (BS2000-160, ISO3675, ASTM 1298)
Institute of Petroleum:	Petroleum Measurement Manual Part VII Section 2 - Continuous Density Measurement
American Petroleum Institute:	Manual of Petroleum Measurement Standards Chapter 14 - Natural Gas Fluids - Section 6: Installing and proving density meters used to measure hydrocarbon liquid with densities between 0.3 and 0.7gm/cc at 15.56°C (60°F) and saturation vapour pressure, 1991.

2. Second Density Meter

(**a**) Connect the second density meter to the pipeline adjacent to meter being checked so that it receives the same sample of fluid under the same conditions of temperature and pressure as the meter under test.

(**b**) Connect the second meter to its readout equipment, switch on and allow both systems to reach equilibrium conditions.

(**c**) Compare the two readings, making any necessary corrections.

It is often the practice, especially in fiscal metering applications, to use two or more density meters in a continuous measurement mode as a means of improving the integrity of the measurement system. Any unacceptable discrepancies between the measurements can immediately raise the necessary alarm signals.

This method of automatic checking has proved to be a very successful technique and where there is a facility for two instruments, the practice of exchanging one for a newly calibrated instrument is proving successful. This is sometimes referred to as the "Substitution Method".

It is very important when using one instrument to verify the performance of a second and similar instrument, to ensure there are no unaccounted for systematic errors which would are not highlighted.

4.4 Performance

Meters are generally calibrated at the factory using specified fluids at 20°C and 1 bar absolute. When operating at other conditions, it is necessary to increase the uncertainty of measurement by the magnitude of the offsets if no corrections are applied or increase by a fraction of the offsets if corrections are applied.

As a general guide, Table 4.1 lists the sources and magnitudes of the offsets affecting the meters covered in this manual, with an example given in Table 4.2.

Table 4.1: Source and Magnitude of Measurement Offsets

Error Source	7835
A Primary Standard	0.05 kg/m^3
B Transfer Standard	0.1 kg/m^3
C Instrument Accuracy (at calibration conditions)	0.15 kg/m^3
D Temperature (uncorrected) Temperature (corrected)	± 0.02 kg/m^3/deg C ± 0.005 kg/m^3/deg C
E Pressure (uncorr'd at 50bar) Pressure (uncorr'd at 100bar) Pressure (corrected)	-1 to +2 kg/m^3 +7 to +15 kg/m^3 ± 0.003 kg/m^3/bar
F Velocity of Sound (uncorr'd) Velocity of Sound (corrected)	See Section 4.2 20% of offset
G Long term stability	0.15 kg/m^3/year

For total operational accuracy, the square root of the sum of the squares of each error source (C to G) is recommended, i.e.

$$\text{Effective Total} = \sqrt{C^2 + D^2 + E^2 + F^2 + G^2}$$

For example, if we consider instruments operating at 50°C (122°F) and 50 bar, six months after calibration and with no VOS offset, the total operational accuracy after corrections have been applied is derived as follows:

Table 4.2: Total Operational Accuracy for Example Quoted

Error Source	7835
C	0.15
D	0.15
E	0.15
F	-
G	0.07
Effective Total	**0.27**

For better accuracy, it would be necessary to carry out an on-line calibration at the operating conditions.

Higher accuracy can be obtained, by request, for all instruments by the use of water calibration or by UKAS certified laboratory calibration of selected fluids.

Note:
The tables above relate to the effect of uncertainties on the time period output of the meter, and do not take into account any uncertainty in the measurement of the time period itself.

Chapter 5
General Maintenance

5.1 General

The Exd 7835 liquid density meters have no moving parts, which reduces the maintenance requirement to simple visual checks for leaks and physical damage.

Check calibrations should be carried out at specified intervals in order to highlight any malfunction or deterioration in meter performance. If a fault or a drop in meter performance is discovered, further tests are required to identify the cause of the fault. Remedial action is limited to cleaning the tube, making good any poor connections and replacing the maintaining amplifier or, in extreme cases, the entire instrument.

Caution:
Extreme care is required in the handling of the meter during transit, its installation into the pipeline and its removal from the pipeline.

5.2 Fault Analysis

Faults generally fall into two main categories: erratic readings or readings outside limits.

Erratic Readings: Normally caused by the presence of gas bubbles in the flowing liquid. Severe electrical interference or severe pipeline vibrations can also cause this effect.

Readings Outside Limits: Normally caused by deposition and/or corrosion on the resonating tube.

Since an electrical fault could also cause either of the two faults, and since examination for deposition or corrosion requires the removal off-line of the meter, it is recommended that the electrical system be checked first.

5.3 General Maintenance Procedure

This procedure is recommended for any periodic maintenance carried out on the system and forms the basis of any faultfinding task.

5.3.1 Physical Checks

Physical checks are as follows:

a. Examine the meter and its mounting bracket, pipe couplings and electrical cables for signs of damage and corrosion.

b. Check the meter for signs of fluid leakage and the state of the rupture plate.

Notes:

1. Any physical damage to the meter case or mounting brackets may have adverse effects on the meter performance and a full calibration would be advisable to verify its accuracy.

2. Any oil leakage can generally be remedied by servicing.

5.3.2 Check Calibration

Checking the calibration is as follows:

a. Carry out a check calibration using methods detailed in Chapter 4.

b. Compare the results obtained with the current calibration certificate figures to identify any substantial deterioration in the meter's performance or any malfunction.

Notes:

1. A substantial drop in meter performance is likely due to a build-up of deposition on the vibrating tube, which can be removed by the application of a suitable solvent. See 'Remedial Servicing' section below.

2. Malfunctions may be the result of electrical/electronic faults in either the meter circuit or the readout equipment. The readout equipment should be proved before attention is directed to the meter as detailed under 'remedial servicing'.

5.3.3 Remedial Servicing

The required servicing falls into two categories - electrical and mechanical.

1. Electrical Servicing

a) Carry out power supply and current consumption tests at the meter terminals. These should give:

17mA ±1mA at 15.5V to 30V

Remove the power supply to the meter. If current consumption is suspect, contact the factory.

2. Mechanical Servicing

Mechanical servicing comprises mainly of keeping the inner surface of the vibrating tube clear of deposition and corrosion. Deposition may be removed by the use of a suitable solvent. Alternatively, the instrument can be removed from the pipeline and cleaned mechanically. Care is required to prevent damage to the inner surface of the tube during the cleaning.

> ⚠ **Caution:** Great care is essential in handling the meter during transit, installation into the pipeline and removal from the pipeline.

Ensure that the meter is not transported when it contains **hazardous** fluids. This includes fluids which may have leaked into, and are still contained, within the case.

Appendix A
7835 Specification

This appendix describes the performance and the mechanical design of the various versions of 7835 liquid density meters. The flange / coupling variations do not affect the meter performance.

A.1 Performance

Density Range:	0 to 3000 kg/m^3	
Accuracy:	0.15 kg/m^3 (Over range 300 - 1100 kg/m^3) 0.1 kg/m^3 (with calibration in water)	
Repeatability:	0.02 kg/m^3	
Stability:	0.15 kg/m^3 per year	
Temperature Range:	-50°C (122°F) to +110°C (230°F)	
Temperature Coefficient:	Uncompensated at 850kg/m^3 Compensated	0.02 kg/m^3/°C typical 0.005 kg/m^3/°C
Pressure Range:	0 to 100 bar (1450psi) or as defined by flanges	
Pressure Coefficient:	Uncompensated	(see Chapter 4)
	(*The temperature and pressure coefficients for each instrument are as specified by the instrument calibration certificate.)*	
	Compensated	0.003 kg/m^3/bar
Test Pressure:	1.5 x maximum operating pressure.	

Temperature Sensor

- Technology: 100 ohm PRT (4 wire)
- Range: -200°C (-328°F) to 200°C (572°F)
- Accuracy: BS 1904 Class, DIN 43760 Class A.

A.2 Mechanical

Material:	Wetted parts - Case finish -	Ni-Span-C® and 316L stainless steel. 316 Stainless Steel
Run-out:	Flange 1MM	
Weight:	35 KG	
Dimensions:	See Figure A.1.	

The 7835 is primarily intended for use with hydrocarbon products but may also be used with other process liquids, if they are compatible with the NI-SPAN-C® material.

The typical composition of NI-SPAN-C® is:

Iron: 49.19%	Nickel: 42.00%	Chromium: 5.00%	Titanium: 2.50%
Manganese: .0.40%	Silicon: 0.40%	Aluminium: 0.40%	Phosphorus: 0.40%
Sulphur: 0.04%	Carbon: 0.03%		

A.3 7835 Meter Versions

There are various versions of the 7835 meter; each allocated an alphabetic suffix to identify the type of flange/coupling fitted. The installation drawing gives details of the meter's dimensions (see Figure A.1). Figure A.2 shows the general outline of a flange with the differing dimensions for each flange type tabulated.

The meter variations available are:

Meter Version	Flange/Coupling Type
7835A	ASA 900 RF
7835B	ASA 600 RF
7835D	ASA 600 RJF
7835E	ASA 900 RJF
7835F	ASA 600 RF Smooth Face
7835H	DIN 2635 RF DN25/PN40
7835J	DIN 2635/2512 GVD DN25/PN40
7835K	DIN 2637 RF DN25/PN100

A.4 Safety Approval

See safety instruction booklet 78355061/SI for safety approval information.

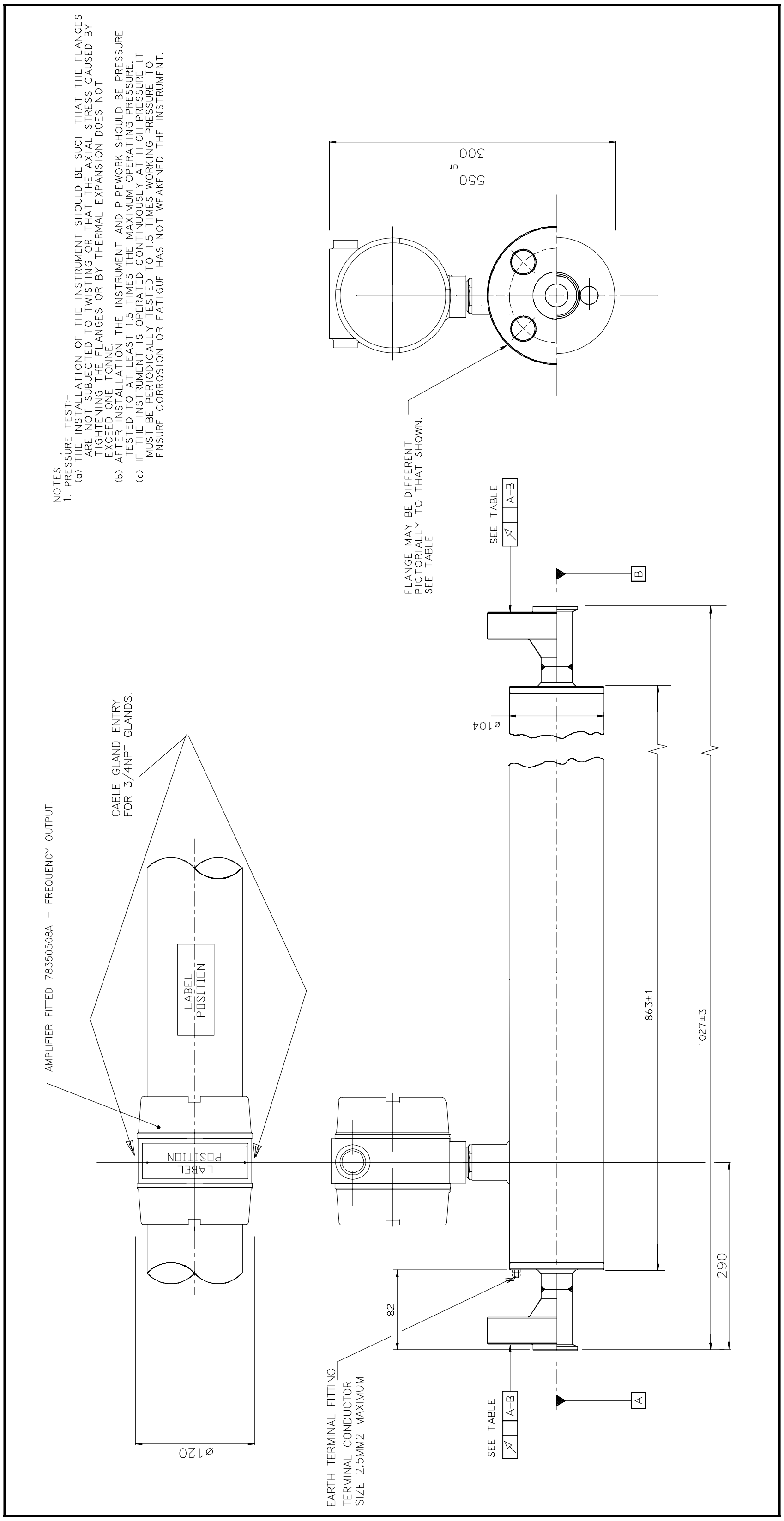
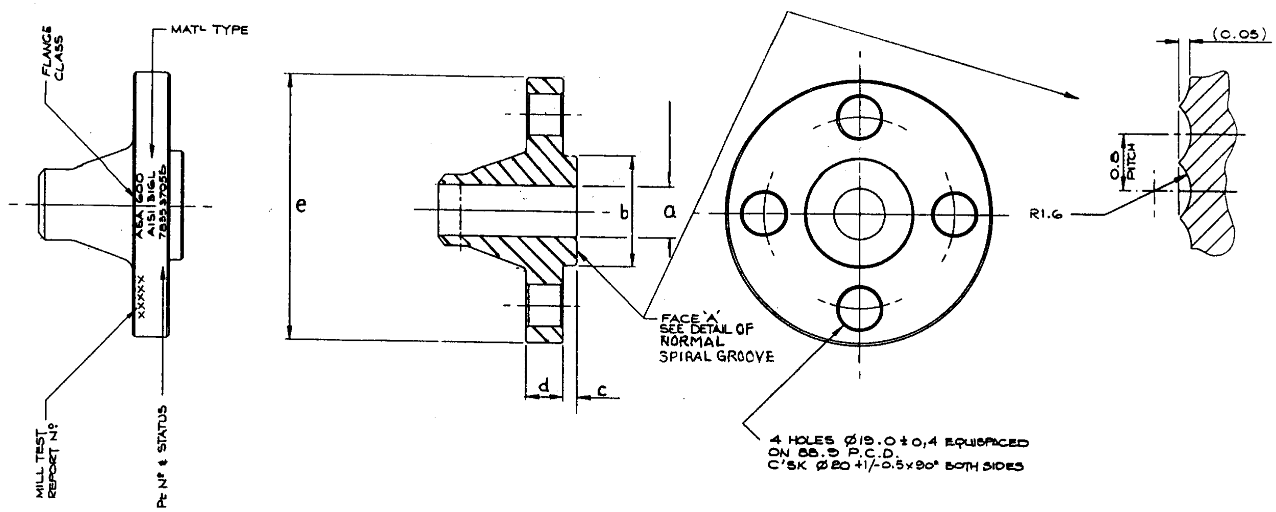


Figure A.1: Installation Drawing for 7835 with Standard Electronics



Weld Neck Flange Type	Material	Dimensions (in mm)					Raised Face	Ring Type Face	Spiral Groove	No. of Holes	Hole Dia.	P. C. D.
		a	b	c	d	e						
ASA 900 (78353702)	St. Stl. 316L	24.7	51	6.4	28.6	149	YES		Normal	4	25.4	101.6
ASA 600 (78353701)	St. Stl. 316L	24.7	51	6.4	17.5	124	YES		Normal	4	19	88.9
ASA 900 RJF (78353703)	St. Stl. 316L	24.7	69.8	6.4	17.5	124		YES		4	19	88.9
ASA 600 RJF (78353704)	St. Stl. 316L	24.7	71.4	6.4	28.6	149		YES		4	25.4	101.6
ASA 600 1" (78353705)	St. Stl. 316L	24.7	51	6.4	17.5	124	YES		Smooth	4	19	88.9
DIN–DN25/PN40 (78353707)	St. Stl. 316L	24.7	68	2	16	115	YES		Normal	4	14	85
DIN–DN25/PN40/DIN 2512 (78353708)	St. Stl. 316L	24.7	68	2	16	115		YES	Normal	4	14	85
DIN–DN25/PN100 (78353709)	St. Stl. 316L	24.7	68	2	22	140	YES		Smooth	4	18	100
ASA 300 (78453702)	St. Stl. 316L	24.7	51	1.6	17.5	124	YES		Normal	4	19	88.9
ASA 300 (78463702)	Hastelloy C22	24.7	51	1.6	17.5	124	YES		Normal	4	19	88.9
DIN–DN25/PN40 (78463707)	Hastelloy C2	24.7	68	2	16	115	YES		Normal	4	14	85
DIN–DN25/PN40/DIN 2512 (78463708)	Hastelloy C22	24.7	68	2	16	115		YES	Normal	4	14	85

Figure A.2: Flanges used on the 7835 Liquid Density Meter

Appendix B
Electronics Specifications

B.1 Standard Electronics

B.1.1 Meter Power Supply

Minimum Input Voltage:	> 15.5Vdc
Maximum Input Voltage:	30Vdc

B,1,2 Time Period Measurement

Frequency Output (two-wire):

Accuracy @ 20°C (68°F):	±5ppm
Accuracy over 10 to 60°C (50 to 140°F):	±50ppm
Accuracy over -40 to 85°C (-40 to 185°F):	±100ppm
Stability:	5ppm/year

B.1.3 Platinum Resistance Thermometer (P.R.T.)

Technology:	100 ohm PRT (4 wire)
Range:	-200°C (-328°F) to 300°C (572°F)
Accuracy:	BS 1904 Class, DIN 43760 Class A.

B.2 Environmental Performance

B.2.1 Temperature

Operating:	-40 to +85°C (-40 to 185°F)
Storage:	-40 to +85°C (-40 to 185°F)

B.2.2 IP Rating

Electronics enclosure:	IP66

Appendix C
Specimen Calibration Certificates

C.1 Specimen Calibration Certificates

Note: This is NOT the calibration certificate for your meter.

```
                                CALIBRATION CERTIFICATE

7845C  LIQUID DENSITY METER                          Serial No : 454664
           7845CBAFDJDDAA                             Cal. Date : 11MAY07
                                                 Pressure Test : 76 BARA

    DENSITY CALIBRATION AT 20 DEG. C AND AT 1 BARA

         DENSITY  PERIODIC TIME
         [KG/M3]      [uS]

             0    1099.763           DENSITY =  K0 + K1.T + K2.T**2
          (Air    1099.412)
           300    1208.663           K0 =  -1.21776E+03 \
           600    1307.659           K1 =  -3.74124E-01  } 600 - 1600 kg/m3
           800    1369.322           K2 =   1.34933E-03 /
           900    1399.044
          1000    1428.093
          1100    1456.513           K0 =  -1.26756E+03 \
          1200    1484.343           K1 =  -3.05320E-01  } 0   - 3000 Kg/m3
          1600    1590.423           K2 =   1.32565E-03 /

    TEMPERATURE COEFFICIENT DATA

         Dt=D(1+K18(t-20))+K19(t-20)       K18 =  -4.83311E-04
                                           K19 =  -5.73662E-01

    PRESSURE COEFFICIENT DATA

         DP=Dt(1+K20(P-1))+K21(P-1)        K20 = K20A + K20B(P-1)
                                           K21 = K21A + K21B(P-1)


                                          K20A =   1.48357E-05
                                          K20B =  -1.51498E-06
                                          K21A =   1.20918E-01
                                          K21B =  -2.32436E-03

        where      D = Density ( Uncorrected )
                  Dt = Density ( Temp Corrected )
                  DP = Density ( Pressure Corrected )
                   T = Periodic Time  ( uS )
                   t = Temperature  ( DEG.C )
                   P = Pressure  (BarA)
                                                      --------------
                                                     | FINAL TEST & |
                                                     |  INSPECTION  |
                                                     |              |
                                                     |              |
                                                      --------------
    Ref No:- LD7835/V5.0/FVA                          DATE : 15MAY07
```

Figure C.1: Example of certificate with 1 set of pressure coefficients (Metric Units)

Note: This is NOT the calibration certificate for your meter.

```
                              CALIBRATION CERTIFICATE

7845C  LIQUID DENSITY METER                   Serial No : 454664
       7845CBAFDJDDAA                          Cal. Date : 11MAY07
                                           Pressure Test : 1088 PSIG

DENSITY CALIBRATION AT 68 DEG. F AND AT 0 PSIG

     DENSITY  PERIODIC TIME
     [ g/cc]      [uS]

       0.000  1099.763            DENSITY =  K0 + K1.T + K2.T**2
      (Air    1099.412)
       0.300  1208.663            K0 =  -1.21776E+00 \
       0.600  1307.659            K1 =  -3.74124E-04  } 0.600 - 1.600 g/cc
       0.800  1369.322            K2 =   1.34933E-06 /
       0.900  1399.044
       1.000  1428.093
       1.100  1456.513            K0 =  -1.26756E+00 \
       1.200  1484.343            K1 =  -3.05320E-04  } 0.000 - 3.000 g/cc
       1.600  1590.423            K2 =   1.32565E-06 /

TEMPERATURE COEFFICIENT DATA

     Dt=D(1+K18(t-68))+K19(t-68)       K18 =  -2.68506E-04
                                       K19 =  -3.18701E-04

PRESSURE COEFFICIENT DATA

     DP=Dt(1+K20(P))+K21(P)            K20 = K20A + K20B(P)
                                       K21 = K21A + K21B(P)



                                      K20A =   1.02315E-06
                                      K20B =  -7.20562E-09
                                      K21A =   8.33916E-06
                                      K21B =  -1.10552E-08



    where      D = Density ( Uncorrected )
              Dt = Density ( Temp Corrected )
              DP = Density ( Pressure Corrected )
               T = Periodic Time ( uS )
               t = Temperature ( DEG.F )
               P = Pressure (PSIG)
                                                --------------
                                               | FINAL TEST & |
                                               |  INSPECTION  |
                                               |              |
                                               |              |
                                               |              |
                                                --------------
Ref No:- LD7835/V5.0/FVA                        DATE : 15MAY07
```

Figure C.2: Example of certificate with 1 set of pressure coefficients (US Units)

Note: This is NOT the calibration certificate for your meter.

```
                              CALIBRATION CERTIFICATE

7835B  LIQUID DENSITY METER                    Serial No : 356366
       7835BAAFAJTAAA                          Cal. Date : 14MAR07
                                           Pressure Test : 151 BARA

DENSITY CALIBRATION AT 20 DEG. C AND AT 1 BARA

     DENSITY  PERIODIC TIME
     [KG/M3]      [uS]

        0    1086.919            DENSITY =  K0 + K1.T + K2.T**2
      (Air    1086.520)
       300    1209.943            K0 =  -1.10786E+03 \
       600    1320.514            K1 =  -2.52754E-01  } 300 - 1100 kg/m3
       800    1388.922            K2 =   1.17101E-03 /
       900    1421.788
      1000    1453.850
      1100    1485.163            K0 =  -1.10439E+03 \
      1200    1515.779            K1 =  -2.61778E-01  } 0   - 3000 Kg/m3
      1600    1632.089            K2 =   1.17566E-03 /


TEMPERATURE COEFFICIENT DATA

     Dt=D(1+K18(t-20))+K19(t-20)       K18 =  -1.80459E-05
                                       K19 =   1.51725E-02

PRESSURE COEFFICIENT DATA

     DP=Dt(1+K20(P-1))+K21(P-1)        K20 = K20A + K20B(P-1)
                                       K21 = K21A + K21B(P-1)


    RANGE ( <41 BARA)                 RANGE (31-71 BARA)

    K20A =   1.02046E-05              K20A =   5.64682E-06
    K20B =  -1.38764E-06              K20B =  -1.25741E-06
    K21A =   1.70570E-01              K21A =   1.55537E-01
    K21B =  -2.75303E-03              K21B =  -2.32351E-03


    RANGE (61-101 BARA)

    K20A =  -3.58705E-06
    K20B =  -1.11536E-06
    K21A =   1.25081E-01
    K21B =  -1.85495E-03

    where      D = Density ( Uncorrected )
              Dt = Density ( Temp Corrected )
              DP = Density ( Pressure Corrected )
               T = Periodic Time ( uS )
               t = Temperature ( DEG.C )
               P = Pressure (BarA)
                                                 --------------
                                                | FINAL TEST & |
                                                |  INSPECTION  |
                                                |              |
                                                |              |
                                                |              |
                                                 --------------
Ref No:- LD7835/V5.0/FVA                         DATE : 17MAR07
```

Figure C.3: Example of certificate with 3 sets of pressure coefficients (Metric Units)

Note: This is NOT the calibration certificate for your meter.

```
                                CALIBRATION CERTIFICATE

7835B  LIQUID DENSITY METER            Serial No : 356366
           7835BAAFAJTAAA                      Cal. Date : 14MAR07
                                           Pressure Test : 2175 PSIG

    DENSITY CALIBRATION AT 68 DEG. F AND AT 0 PSIG

         DENSITY  PERIODIC TIME
         [ g/cc]      [uS]

           0.000  1086.919            DENSITY =  K0 + K1.T + K2.T**2
          (Air    1086.520)
           0.300  1209.943            K0 =  -1.10786E+00 \
           0.600  1320.514            K1 =  -2.52754E-04  } 0.300 - 1.100 g/cc
           0.800  1388.922            K2 =   1.17101E-06 /
           0.900  1421.788
           1.000  1453.850
           1.100  1485.163            K0 =  -1.10439E+00 \
           1.200  1515.779            K1 =  -2.61778E-04  } 0.000 - 3.000 g/cc
           1.600  1632.089            K2 =   1.17566E-06 /

    TEMPERATURE COEFFICIENT DATA

         Dt=D(1+K18(t-68))+K19(t-68)       K18 =  -1.00255E-05
                                           K19 =   8.42918E-06

    PRESSURE COEFFICIENT DATA

         DP=Dt(1+K20(P))+K21(P)            K20 = K20A + K20B(P)
                                           K21 = K21A + K21B(P)


        RANGE ( <580 PSIG)                RANGE (435-1015 PSIG)

        K20A =   7.03762E-07              K20A =   3.89436E-07
        K20B =  -6.59993E-09              K20B =  -5.98057E-09
        K21A =   1.17635E-05              K21A =   1.07267E-05
        K21B =  -1.30941E-08              K21B =  -1.10512E-08


        RANGE (870-1450 PSIG)

        K20A =  -2.47383E-07
        K20B =  -5.30490E-09
        K21A =   8.62626E-06
        K21B =  -8.82260E-09

        where      D = Density ( Uncorrected )
                  Dt = Density ( Temp Corrected )
                  DP = Density ( Pressure Corrected )
                   T = Periodic Time ( uS )
                   t = Temperature ( DEG.F )
                   P = Pressure (PSIG)
                                                         --------------
                                                        | FINAL TEST & |
                                                        |  INSPECTION  |
                                                        |              |
                                                        |              |
                                                        |              |
                                                         --------------
    Ref No:- LD7835/V5.0/FVA                             DATE : 17MAR07
```

Figure C.4: Example of certificate with 3 sets of pressure coefficients (US Units)

Note: This is NOT the calibration certificate for your meter.

```
                              CALIBRATION CERTIFICATE

7835A  LIQUID DENSITY METER                    Serial No : 356389
       7835AAAFAJTAAA                          Cal. Date : 29MAR07
                                           Pressure Test : 231 BARA

DENSITY CALIBRATION AT 20 DEG. C AND AT 1 BARA

     DENSITY  PERIODIC TIME
     [KG/M3]      [uS]

        0    1084.129           DENSITY =  K0 + K1.T + K2.T**2
      (Air   1083.744)
      300    1202.884           K0 =  -1.14114E+03 \
      600    1309.895           K1 =  -2.72571E-01  } 300 - 1100 kg/m3
      800    1376.201           K2 =   1.22303E-03 /
      900    1408.079
     1000    1439.191
     1100    1469.588           K0 =  -1.13720E+03 \
     1200    1499.318           K1 =  -2.82458E-01  } 0   - 3000 Kg/m3
     1600    1612.345           K2 =   1.22809E-03 /

TEMPERATURE COEFFICIENT DATA

     Dt=D(1+K18(t-20))+K19(t-20)       K18 =  -2.36285E-05
                                       K19 =   8.76969E-03

PRESSURE COEFFICIENT DATA

     DP=Dt(1+K20(P-1))+K21(P-1)        K20 = K20A + K20B(P-1)
                                       K21 = K21A + K21B(P-1)


    RANGE ( <41 BARA)                 RANGE (31-71 BARA)

    K20A =  -5.04078E-06              K20A =  -7.56755E-06
    K20B =  -1.14004E-06              K20B =  -1.06785E-06
    K21A =   1.24952E-01              K21A =   1.14822E-01
    K21B =  -2.11662E-03              K21B =  -1.82720E-03


    RANGE (61-101 BARA)               RANGE (101-151 BARA)

    K20A =  -1.26867E-05              K20A =  -2.46656E-05
    K20B =  -9.89092E-07              K20B =  -8.70957E-07
    K21A =   9.42991E-02              K21A =   4.62759E-02
    K21B =  -1.51146E-03              K21B =  -1.03786E-03

    where      D = Density ( Uncorrected )
              Dt = Density ( Temp Corrected )
              DP = Density ( Pressure Corrected )
               T = Periodic Time ( uS )
               t = Temperature ( DEG.C )
               P = Pressure (BarA)
                                                  --------------
                                                 | FINAL TEST & |
                                                 |  INSPECTION  |
                                                 |              |
                                                 |              |
                                                 |              |
                                                  --------------
Ref No:- LD7835/V5.0/FVA                          DATE : 03MAY07
```

Figure C.5: Example of certificate with 4 sets of pressure coefficients (Metric Units)

Note: This is NOT the calibration certificate for your meter.

```
                              CALIBRATION CERTIFICATE

7835A  LIQUID DENSITY METER              Serial No : 356389
       7835AAAFAJTAAA                        Cal. Date : 29MAR07
                                          Pressure Test : 3335 PSIG

DENSITY CALIBRATION AT 68 DEG. F AND AT 0 PSIG

     DENSITY  PERIODIC TIME
     [ g/cc]      [uS]

       0.000  1084.129            DENSITY =  K0 + K1.T + K2.T**2
      (Air    1083.744)
       0.300  1202.884            K0 =  -1.14114E+00 \
       0.600  1309.895            K1 =  -2.72571E-04  } 0.300 - 1.100 g/cc
       0.800  1376.201            K2 =   1.22303E-06 /
       0.900  1408.079
       1.000  1439.191
       1.100  1469.588            K0 =  -1.13720E+00 \
       1.200  1499.318            K1 =  -2.82458E-04  } 0.000 - 3.000 g/cc
       1.600  1612.345            K2 =   1.22809E-06 /

TEMPERATURE COEFFICIENT DATA

     Dt=D(1+K18(t-68))+K19(t-68)       K18 =  -1.31269E-05
                                       K19 =   4.87205E-06

PRESSURE COEFFICIENT DATA

     DP=Dt(1+K20(P))+K21(P)            K20 = K20A + K20B(P)
                                       K21 = K21A + K21B(P)


    RANGE ( <580 PSIG)                RANGE (435-1015 PSIG)

    K20A =  -3.47640E-07              K20A =  -5.21900E-07
    K20B =  -5.42232E-09              K20B =  -5.07895E-09
    K21A =   8.61736E-06              K21A =   7.91875E-06
    K21B =  -1.00672E-08              K21B =  -8.69060E-09


    RANGE (870-1450 PSIG)             RANGE (1450-2175 PSIG)

    K20A =  -8.74947E-07              K20A =  -1.70108E-06
    K20B =  -4.70436E-09              K20B =  -4.14248E-09
    K21A =   6.50339E-06              K21A =   3.19144E-06
    K21B =  -7.18888E-09              K21B =  -4.93632E-09

    where      D = Density ( Uncorrected )
              Dt = Density ( Temp Corrected )
              DP = Density ( Pressure Corrected )
               T = Periodic Time ( uS )
               t = Temperature ( DEG.F )
               P = Pressure (PSIG)
                                                 --------------
                                                | FINAL TEST & |
                                                |  INSPECTION  |
                                                |              |
                                                |              |
                                                |              |
                                                 --------------
Ref No:- LD7835/V5.0/FVA                         DATE : 03MAY07
```

Figure C.6: Example of certificate with 4 sets of pressure coefficients (US Units)

Appendix D
Conversion Tables and Product Data

D.1 Conversion Tables

To convert the left-hand column of units into the top row of units, multiply by the factor in the box.

Length units

	in	yd	m
in	1	0.0278	0.0254
yd	36	1	0.9144
m	39.37	1.0936	1

Mass units

	lb	ton	kg
lb	1	4.464E-4	0.4536
ton	2240	1	1016.05
kg	2.2046	9.832E-1	1

Mass flow units

	kg/s	kg/h	Tonne/h	lb/s	lb/m	lb/h	US GPM	US BPH
kg/s	1	3600	3.6	2.2046	132.28	7936.5	15.848/SG	22.624/SG
kg/h	0.000277	1	0.001	0.000612	0.03674	2.2046	0.0044/SG	0.0063/SG
Tonne/h	0.277777	1000	1	0.612384	36.74309	2204.585	4.4033/SG	6.2933/SG
lb/s	0.4536	1632.92	1.63296	1	60	3600	7.1891/SG	10.267/SG
lb/m	0.00756	27.215	0.027216	0.016666	1	60	0.1198/SG	0.1712/SG
lb/h	0.000126	0.4536	0.000453	0.000277	0.016666	1	0.002/SG	0.0029/SG
US GPM	0.0631 xSG	227.12 xSG	0.2271 xSG	0.1391 xSG	8.345 xSG	500.71 xSG	1	1.428571
US BPH	0.0442 xSG	158.98 xSG	0.1589 xSG	0.0974 xSG	5.8419 xSG	350.5 xSG	0.7	1

SG = Specific Gravity in g/cc

Volume flow units

	lt/m	m^3/s	m^3/h	m^3/d	US GPH	US GPM	US BPH	US BPD
lt/m	1	0.000016	0.06	1.44	0.004402	0.264171	0.377388	9.057315
m^3/s	60000	1	3600	86400	264.1717	15850.30	22643.28	543438.9
m^3/h	16.66666	0.000277	1	24	0.073381	4.402861	6.289802	150.9552
m^3/d	0.694444	1.16E-5	0.041666	1	0.003057	0.183452	0.262075	6.289802
US GPH	227.125	0.003785	13.6275	327.06	1	0.016666	0.023809	0.571428
US GPM	3.785416	6.31E-5	0.227125	5.451	60	1	1.428571	34.28571
US BPH	2.649791	4.42E-5	0.158987	3.8157	42	0.7	1	24
US BPD	0.110407	1.84E-6	0.006624	0.158987	1.75	0.029166	0.041666	1

Volume/capacity units

	in^3	ft^3	m^3	litres	gal
in^3	1	5.787E-4	1.639E-5	0.01639	4.329E-3
ft^3	1728	1	2.832E-2	28.32	7.4805 (US liq)
m^3	6.1024E+4	0.0353	1	1000	264.2 (US liq)
litres	61.02	0.0353	0.001	1	0.2642 (US liq)
gal	231.0	0.1357	3.785E-3	3.785	1

1 Imperial gallon = 1.20095 U.S. liquid gallons

Temperature units

	°C	°F	Kelvin
°C	1	(9x°C/5)+32	+273.15
°F	5/9 x(°F/5-32)	1	
Kelvin	-273.15		1

Pressure units

	Bar	PSI	kPa	kg/cm^2	mmHg
Bar	1	14.5	100	1.019716	750.2
PSI	0.0689476	1	6.89476	0.070307	51.737
kPa	0.01	0.145	1	0.009807	7.502
kg/cm^2	0.980665	14.22	102.02	1	735.683
mmHg	0.001333	0.0193285	0.1333	0.0013593	1

Density units

	kg/m^3	g/cc	lb/ft^3	lb/US gal
kg/m^3	1	0.001	0.062428	0.008345
g/cc	1000	1	62.428	8.34543
lb/ft^3	16.0185	0.01602	1	0.133681
lb/US gal	119.8264	0.119826	7.4805	1

Dynamic Viscosity units

	cP	Pa.s	$kgf.s/m^2$	Slug/ftS	$lbf.s/ft^2$
cP	1	0.001	0.000102	0.000021	0.000021
Pa.s	1000	1	0.101972	0.020885	0.020885
$kgf.s/m^2$	9806.65	9.80665	1		
Slug/ftS	47880.3	47.8803		1	1
$lbf.s/ft^2$	47880.3	47.8803		1	1

Kinematic Viscosity units

	cS	mm^2/s	m^2/s	in^2/s	ft^2/s	cm^2/s
cS	1	1	1.0E-6	0.00155	0.010765	0.01
mm^2/s	1	1	1.0E-6	0.00155	0.010765	0.01
m^2/s	1000000	1000000	1	1550	10.7649	10000
in^2/s	645.16	645.16	0.000645	1	0.006944	6.4516
ft^2/s	92.8944	92.8944	0.092864	144	1	0.928944
cm^2/s	100	100	0.0001	0.155	1.0765	1

Note:
The **dynamic viscosity** (η) of a Newtonian fluid is given by:

$$\eta = \tau \times dv / dr$$

Where: τ = shearing stress between two planes parallel with the direction of flow

dv / dr = Velocity gradient at right angles to the direction of flow.

The dimensions of dynamic viscosity are $M L^{-1} T^{-1}$ and the SI unit is Pascal seconds (Pa s).

The kinematic viscosity (ν) is the ratio of the dynamic viscosity to the density ρ

The dimensions of kinematic viscosity are $L^2 T^{-1}$ and the SI unit is square metres per second (m^2/s).

D.2 Product Data

D.2.1 Density/Temperature Relationship of Hydrocarbon Products

Crude Oil

Temp.(°C)	Density (kg/m^3)								
60	738.91	765.06	791.94	817.15	843.11	869.01	894.86	920.87	946.46
55	742.96	768.98	794.93	820.83	846.68	872.48	898.24	923.95	949.63
50	747.00	772.89	798.72	824.51	850.25	875.94	901.80	927.23	952.82
45	751.03	776.79	802.50	828.17	853.81	879.40	904.96	930.50	956.00
40	755.05	780.68	806.27	831.83	857.36	882.85	908.32	933.76	959.18
35	759.06	784.57	810.04	835.48	860.90	886.30	911.67	937.02	962.36
30	763.06	788.44	813.79	839.12	864.44	889.73	915.01	940.28	965.53
25	767.05	792.30	817.54	842.76	867.97	893.16	918.35	943.52	968.89
20	771.03	796.18	821.27	846.38	871.49	896.59	921.68	946.77	971.85
15.556	774.56	799.57	824.59	849.60	874.61	899.62	924.63	949.64	974.65
15	775.00	800.00	825.00	850.00	875.00	900.00	925.00	950.00	975.00
10	778.95	803.83	828.72	853.61	878.50	903.41	928.32	953.23	978.15
5	782.90	807.65	832.42	857.20	882.00	906.81	931.62	958.45	981.29
0	786.83	811.46	836.12	860.79	885.49	910.21	934.92	959.66	984.42

Refined Products

Temp.(°C)	Density (kg/m^3)								
60	605.51	657.32	708.88	766.17	817.90	868.47	918.99	969.45	1019.87
55	610.59	662.12	713.50	769.97	821.49	872.00	922.46	972.87	1023.24
50	615.51	666.91	718.11	773.75	825.08	875.53	925.92	976.28	1026.60
45	620.49	671.68	722.71	777.53	828.67	879.04	929.38	979.69	1029.96
40	625.45	676.44	727.29	781.30	832.24	882.56	932.84	983.09	1033.32
35	630.40	681.18	731.86	785.86	835.81	886.06	938.28	986.48	1038.67
30	635.33	685.92	736.42	788.81	839.37	889.56	939.72	989.87	1040.01
25	640.24	690.63	740.96	792.55	842.92	893.04	943.16	993.26	1043.35
20	645.13	695.32	745.49	796.28	846.46	896.53	946.58	996.63	1046.68
15.556	649.46	699.48	749.50	799.59	849.61	899.61	949.62	999.63	1049.63
15	650.00	700.00	750.00	800.00	850.00	900.00	950.00	1000.00	1050.00
10	654.85	704.66	754.50	803.71	853.53	903.47	953.41	1003.36	1053.32
5	659.67	709.30	758.97	807.41	857.04	906.92	956.81	1006.72	1056.63
0	664.47	713.92	763.44	811.10	860.55	910.37	960.20	1010.07	1059.93

The above tables are derived from equations, which form the basis of the data in the *Revised Petroleum Measurement Tables* (IP 200, ASTM D1250, API 2540 and ISO R91 Addendum 1).

The density temperature relationship used is:

$$\frac{\rho_t}{\rho_{15}} = \exp\left[-\alpha_{15}\Delta_t\left(1 + 0.8\alpha_{15}\Delta_t\right)\right]$$

Where: ρ_t = Density at line temperature t°C (kg/m^3)
ρ_{15} = Density at base temperature 15°C (kg/m^3)
Δ_t = t°C -15°C (ie t - base temperature)
α_{15} = Tangent thermal expansion coefficient per °C at base temperature 15°C

The tangent thermal expansion coefficient differs for each of the major groups of hydrocarbons. It is obtained using the following relationship:

$$\alpha_{15} = \frac{K_0 + K_1\rho_{15}}{\rho_{15}^2}$$

Where: K_0 and K_1 = API factors and are defined as follows:

Product	Density Range (kg/m^3)	K_0	K_1
Crude Oil	771 - 981	613.97226	0.00000
Gasolines	654 - 779	346.42278	0.43884
Kerosines	779 - 839	594.54180	0.00000
Fuel Oils	839 - 1075	186.96960	0.48618

Platinum Resistance Law (To DIN 43 760)

°C	Ohms	°C	Ohms	°C	Ohms	°C	Ohms	°F	Ohms	°F	Ohms
-50	80.31	5	101.91	60	123.24	115	144.17	0	93.03	100	114.68
-45	82.29	10	103.90	65	125.16	120	146.06	10	95.21	110	116.83
-40	84.27	15	105.85	70	127.07	125	147.94	20	97.39	120	118.97
-35	86.25	20	107.79	75	128.98	130	149.82	30	99.57	130	121.11
-30	88.22	25	109.73	80	130.89	135	151.70	32	100.00	140	123.24
-25	90.19	30	111.67	85	132.80	140	153.58	40	101.74	150	125.37
-20	92.16	35	113.61	90	134.70	145	155.45	50	103.90	160	127.50
-15	94.12	40	115.54	95	136.60	150	157.31	60	106.07	170	129.62
-10	96.09	45	117.47	100	138.50	155	159.18	70	108.23	180	131.74
-5	98.04	50	119.40	105	140.39	160	161.04	80	110.38	190	133.86
0	100.00	55	121.32	110	142.29	165	162.90	90	112.53	200	135.97

Density of Ambient Air (in kg/m^3)

Air Pressure	Air Temperature (°C)						
(mb)	**6**	**10**	**14**	**18**	**22**	**26**	**30**
900	1.122	1.105	1.089	1.073	1.057	1.041	1.025
930	1.159	1.142	1.125	1.109	1.092	1.076	1.060
960	1.197	1.179	1.162	1.145	1.128	1.111	1.094
990	1.234	1.216	1.198	1.180	1.163	1.146	1.129
1020	1.271	1.253	1.234	1.216	1.199	1.181	1.163

Taken at a relative humidity of 50%

Density of Water (in kg/m^3 to ITS - 90 Temperature Scale)

Temp °C	0	2	4	6	8	10	12	14	16	18
0	999.840	999.940	999.972	999.940	999.848	999.699	999.497	999.244	998.943	998.595
20	998.203	997.769	997.295	996.782	996.231	995.645	995.024	994.369	993.681	992.962
40	992.212	991.432	990.623	989.786	988.922	988.030	987.113	986.169	985.201	984.208
60	983.191	982.150	981.086	980.000	978.890	977.759	976.607	975.432	974.237	973.021
80	971.785	970.528	969.252	967.955	966.640	965.305	963.950	962.577	961.185	959.774
100	958.345									

Use pure, bubble-free water.

Velocity of Sound in Liquids

Liquid	Temperature (t °C)	Velocity of Sound (c ms^{-1})	Rate of Change($\delta c / \delta t$ $ms^{-1}K^{-1}$)
Acetic acid	20	1173	----
Acetone	20	1190	-4.5
Amyl acetate	29	1173	----
Aniline	20	1656	-4.0
Benzene	20	1320	-5.0
Blood (horse)	37	1571	----
Butyl acetate	30	1172	-3.2
Carbon disulphide	25	1142	----
Carbon tetrachloride	20	940	-3.0
Chlorine	20	850	-3.8
Chlorobenzene	20	1290	-4.3
Chloroform	20	990	-3.3
Ethanol amide	25	1724	-3.4
Ethyl acetate	30	1133	-3.9
Ethyl alcohol	20	1162	-3.6
Formic acid	20	1360	-3.5
Heptane	20	1160	-4.5
n-Hexane	30	1060	----
Kerosene	25	1315	-3.6
Menthol	50	1271	----
Methyl acetate	30	1131	-3.7
Methyl alcohol	20	1121	-3.5
Methylene Chloride	25	1070	----
Nitrogen	-189	745	-10.6
Nonane	20	1248	----

Velocity of sound in liquids (continued)

Oil (castor)	19	1500	-4.1
Oil (olive)	22	1440	-2.8
Octane	20	1197	----
Oxygen	-186	950	-6.9
n-Pentane	20	1044	-4.2
n-Propyl acetate	26	1182	----
Toluene	20	1320	-4.3
Turpentine	25	1225	----
Water (distilled)	10	1447.2	----
	20	1482.3	----
	30	1509.1	----
	50	1542.5	----
	70	1554.8	----
Water (sea)	-4	1430.2	----
	00	1449.5	----
	05	1471.1	----
	15	1507.1	----
	25	1534.7	----
o-Xylene	22	1352	----

Appendix E
Return Forms

The **Returns Forms**, contained in this Appendix, must be copied and completed whenever a meter is to be returned to the factory for servicing, calibration or repair. **This must be done before the product is shipped.**

There are separate Returns Forms for New/Unused equipment, and for Used equipment. Please select accordingly.

Micro Motion Return Policy

For Use in the U.S.A.
With New and Unused Micro Motion Equipment

Definitions

New and unused equipment

Only equipment that has not been removed from the original shipping package will be considered *new and unused*. New and unused equipment includes sensors, transmitters, or peripheral devices which:

- Were shipped as requested by the customer but are not needed, or
- Were shipped incorrectly by Micro Motion.

Used equipment

All other equipment is considered *used*. This equipment must be completely decontaminated and cleaned before being returned. Document all foreign substances that have come in contact with the equipment.

Before you begin

This document is for returning new and unused equipment to Micro Motion in the United States.

- For instructions on returning used equipment, our *used equipment return policy* is available as a separate document.
- For instructions on returning equipment to Emerson offices around the world, our *international return policies* are available as separate documents.

To obtain any of our return policies, procedures, and forms, contact the Micro Motion Customer Service Department during business hours:

- In the U.S.A., phone **1-800-522-6277** or **1-303-527-5200** between 6:00 a.m. and 5:30 p.m. (Mountain Standard Time), Monday through Friday, except holidays.
- In Europe, phone **+31 (0) 318 495 555**, or contact your local sales representative.
- In Asia, phone **(65) 6777-8211,** or contact your local sales representative.

The latest return policies, procedures, and forms are also available from the Micro Motion web site: **www.micromotion.com**.

Restock fees

Restock fees might apply, depending on the reason for return:

- If you ordered the wrong equipment, a restock fee will be charged.
- If you no longer require the equipment (for example, if your project has been cancelled), a restock fee will be charged.
- If we shipped the wrong equipment, a restock fee will not be charged.

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GI-00381 (5/07)

Step 1 Obtaining an RMA number

A Return Material Authorization (RMA) number must be obtained prior to returning any equipment to Micro Motion for any reason.

To obtain an RMA number, contact the Micro Motion Customer Service Department at **1-800-522-6277** or **1-303-527-5200** between 6:00 a.m. and 5:30 p.m. (Mountain Standard Time), Monday through Friday, except holidays.

- No product returns will be accepted without an RMA number.
- Each returned sensor must be issued a separate RMA number. A sensor and its associated transmitter may be shipped in the same package with a single RMA number.
- If no sensor is being returned, all transmitters and peripheral devices being returned may be shipped together, in one package, with a single RMA number.

Step 2 Preparing equipment for return

Only equipment that has not been removed from the original shipping package will be considered new and unused. New and unused equipment must be returned in its original packaging.

Before returning new and unused equipment:

a. Clearly mark the RMA number on the outside of the original shipping package(s).
b. Clearly mark on the outside of each package: “NEW AND UNUSED”.
c. Complete and sign the “New and Unused Statement” on page 4.
d. Include one copy of the statement inside the original shipping package, and attach one copy to the outside of each package.
e. Close and reseal all packages.

Step 3 Shipping instructions

Required shipping documents

The customer must provide a Packing List and Bill of Lading for each shipment. The Bill of Lading contains information necessary for the carrier to ship the freight, such as consignee of shipment, payment terms, number of pieces in shipment, weight, etc. The Bill of Lading should also contain the following address:

Ship-to Party

Micro Motion Inc.
C/O Veolia Environmental Services
9131 East 96 Avenue
Henderson, CO 80640
Attn: RMA #__________

Document submittal

Submit the following shipping documents inside the shipping container:

- One (1) copy of the Packing List.

Submit the following shipping documents to your Micro Motion customer service representative:

- One (1) copy of the Packing List.
- One (1) copy of the Bill of Lading.

Shipping charges

The customer is responsible for all shipping charges.

Veolia has been instructed to refuse any collect shipments.

Statement of New and Unused Equipment

1) Return Material Authorization (RMA) Number: ____________________

Equipment Identification

2) For each instrument being returned, list a description or model number and its serial number.

Description or Model Number	Serial number

3) Reason for return: ____________________

Shipping Requirements

4) Clearly mark RMA number and "NEW AND UNUSED" on each shipping package.

5) Include one copy of this document inside the original shipping package, and attach one copy to the outside of each package in a visible location.

6) Ship all equipment to:

Attn: RMA# _____________
Micro Motion Inc.
C/O Veolia Environmental Services
Sensor Department
9131 East 96 Avenue
Henderson CO 80640 USA

Address correspondence to:

Micro Motion, Inc.
7070 Winchester Circle
Boulder CO 80301 USA
Attn: Repairs

Definition and Restock Fees

Only equipment that has not been removed from the original shipping package will be considered new and unused. New and unused equipment includes sensors, transmitters, or peripheral devices which:

- Were shipped as requested by the customer but are not needed, or
- Were shipped incorrectly by Micro Motion.

Restock fees might apply, depending on the reason for return:

- If the customer ordered the wrong equipment, a restock fee will be charged.
- If the customer no longer requires the equipment (for example, if a project was cancelled), a restock fee will be charged.
- If Micro Motion shipped the wrong equipment, a restock fee will not be charged.

THIS EQUIPMENT IS BEING RETURNED AS "NEW AND UNUSED," PER THE DEFINITION STATED ABOVE. I UNDERSTAND A RESTOCK FEE MIGHT BE CHARGED.

By:

____________________ (Signature)

____________________ (Print name)

Title: ____________________

Date: ____________________

Company: ____________________

Phone: ____________________

Fax: ____________________

Micro Motion Return Policy

For Use in the U.S.A.
With Used Micro Motion Equipment

Definitions

New and unused equipment

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Before you begin

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- For instructions on returning equipment to Emerson offices around the world, our *international return policies* are available as separate documents.

To obtain any of our return policies, procedures, and forms, contact the Micro Motion Customer Service Department during business hours:

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- In Europe, phone **+31 (0) 318 495 555**, or contact your local sales representative.
- In Asia, phone **(65) 6777-8211,** or contact your local sales representative.

The latest return policies, procedures, and forms are also available from the Micro Motion web site: **www.micromotion.com**.

These procedures must be followed for you to meet governmental requirements. They also help us provide a safe working environment for our employees. Failure to follow these requirements will result in your equipment being refused delivery.

Micro Motion®

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Process Management

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Step 1 Obtaining an RMA number

A Return Material Authorization (RMA) number must be obtained prior to returning any equipment to Micro Motion for any reason.

To obtain an RMA number, contact the Micro Motion Customer Service Department at **1-800-522-6277** or **1-303-527-5200** between 6:00 a.m. and 5:30 p.m. (Mountain Standard Time), Monday through Friday, except holidays.

- No product returns will be accepted without an RMA number.
- Each returned sensor must be issued a separate RMA number. A sensor and its associated transmitter may be shipped in the same package with a single RMA number.
- If no sensor is being returned, all transmitters and peripheral devices being returned may be shipped together, in one package, with a single RMA number.

Step 2 Cleaning and decontamination

All equipment being returned must be thoroughly cleaned and decontaminated of all foreign substances, including all substances used for cleaning the equipment, prior to shipment. This requirement applies to the sensor tubes, sensor case exterior, sensor case interior, electronics, and any part that might have been exposed to process fluids or cleaning substances.

Shipping equipment that has not been decontaminated may cause a violation of U.S. Department of Transportation (DOT) regulations. For your reference, the requirements for packaging and labeling hazardous substances are listed in DOT regulations 49 CFR 172,178, and 179.

If you suspect that the sensor case interior may be contaminated, the case must be completely drained and flushed to remove contaminants.

Contents of sensor case may be under pressure. Contents of sensor case may be hazardous. Take appropriate measures to avoid the hazards associated with gaining access to a contaminated case interior. Avoid exposure to hazardous materials.

Decontamination/Cleaning Statement

A blank Decontamination/Cleaning Statement is provided on the final page of this document. You may copy and use this form to return any Micro Motion sensor.

- A Decontamination/Cleaning Statement is required for each sensor being returned.
- Each form must be fully completed and include a signature. If the statement is not completed, the customer may be charged for decontamination and cleaning.

If the equipment has been exposed to a known hazardous substance with any characteristic that can be identified in the Code of Federal Regulations, 40 CFR 261.20 through 261.24, the chemical abstracts number and hazardous waste number/hazard code must be stated in the space provided on the form.

Two (2) copies of each Decontamination/Cleaning Statement must be provided:

- One (1) copy must be attached to the outside of the package.
- One (1) copy must be provided inside the package.

Step 3 Material Safety Data Sheets (MSDS)

Included with the returned equipment, you must provide a Material Safety Data Sheet (MSDS) for each substance that has come in contact with the equipment being returned, including substances used for decontamination and cleaning.

An MSDS is required by law to be available to people exposed to specific hazardous substances, with one exception: if the equipment has been exposed only to food-grade substances or potable water, or other substances for which an MSDS is not applicable, the Decontamination/Cleaning Statement form alone is acceptable.

Two (2) copies of each MSDS must be provided:

- One (1) copy must be attached to the outside of the package.
- One (1) copy must be provided inside the package.

Step 4 Packaging

Shipping a sensor and transmitter or sensor only

To meet DOT requirements for identifying hazardous substances, ship only one sensor per package. A sensor and its associated transmitter may be shipped in the same package.

Shipping a transmitter or peripheral device without a sensor

If no sensor is being returned, all transmitters and peripheral devices being returned may be shipped together, in one package.

Equipment installed on a portable cart, in a protective cabinet or with special wiring and process connections

Micro Motion is equipped to repair sensors, transmitters and peripheral devices manufactured by Micro Motion only. Our repair department cannot work on equipment installed in a customer-supplied cabinet, on a portable cart as part of a system, or with any wiring or piping attached. Any returned equipment other than Micro Motion sensors, transmitters and peripheral devices will be considered the responsibility of the customer.

Step 5 Shipping

Required shipping documents

The customer must provide a Packing List and Bill of Lading for each shipment. The Bill of Lading contains information necessary for the carrier to ship the freight, such as consignee of shipment, payment terms, number of pieces in shipment, weight, etc. The Bill of Lading should also contain the following address:

Ship-to Party

Micro Motion Inc.
C/O Veolia Environmental Services
9131 East 96 Avenue
Henderson, CO 80640
Attn: RMA #__________

Document submittal

Submit the following shipping documents inside the shipping container:

- One (1) copy of the Packing List.

Submit the following shipping documents to your Micro Motion customer service representative:

- One (1) copy of the Packing List.
- One (1) copy of the Bill of Lading.

The address is listed as follows:

> Micro Motion, Inc.
> Attn: (Your customer service representative)
> 7070 Winchester Circle
> Boulder, CO 80301 USA
> RMA# ________________

Shipping charges

The customer is responsible for all shipping charges.

Veolia has been instructed to refuse any collect shipments.

Sensor Decontamination/Cleaning Statement

Refer to *Micro Motion Return Policy for Use in the U.S.A. with Used Micro Motion Equipment*

1) Return Material Authorization (RMA) Number: ____________________
2) Equipment to be returned Model Number: ____________________ Serial Number: ____________________
3) Reason for return ____________________

Process and Decontamination/Cleaning Fluids

4) List each substance to which the equipment was exposed. Attach additional documents if necessary.

Common name	CAS# if available	Used for hazardous waste (20 CFR 261)	EPA waste code if used for hazardous waste
		[ ] Yes [ ] No	
		[ ] Yes [ ] No	
		[ ] Yes [ ] No	
		[ ] Yes [ ] No	
		[ ] Yes [ ] No	
		[ ] Yes [ ] No	

5) Please circle any hazards and/or process fluid types that apply:

Infectious *Radioactive* *Explosive* *Pyrophoric* *Poison Gas*
Cyanides *Sulfides* *Corrosive* *Oxidizer* *Flammable* *Poison*
Carcinogen *Peroxide* *Reactive – Air* *Reactive – Water* *Reactive-Other (list)*
Other hazard category (list)

6) Describe decontamination/cleaning process. Include MSDS description for substances used in decontamination and cleaning processes. Attach additional documents if necessary.

Shipping Requirements

Failure to comply with this procedure will result in the shipment being refused

7) Ship only one sensor per box. RMA number must be noted on the shipping package.
8) Include inside the package: one copy of this document and all required Material Safety Data Sheets (MSDS).
9) Attach to the outside of the package: one copy of this document, and all required Material Safety Data Sheets (MSDS).
10) Ship equipment to:

Micro Motion Inc. Attn: RMA# _____________
C/O Veolia Environmental Services
Sensor Department
9131 East 96 Avenue
Henderson CO 80640 USA

Address correspondence to:

Micro Motion Inc.
7070 Winchester Circle
Boulder CO 80301 USA
Attn: Repairs

EQUIPMENT HAS BEEN CLEANED AND DECONTAMINATED OF ANY HAZARDOUS SUBSTANCES AND MEETS DOT AND EPA REGULATIONS.

By: ____________________ ____________________
(Signature) (Print name)

Title: ____________________ Date ____________________

Company: ____________________

Phone: ____________________ Fax ____________________

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