Installation and Configuration Manual
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Micro Motion® 7826/7828 Insertion Liquid Density Meters

Short and Long Stem Versions

Micro Motion®

EMERSON™
Process Management

INMETRO Certificate No.:
AEX-10966
AEX-10968

Contents

Chapter 1
Introduction

1.1 Safety guidelines

Handle the 7826/7828 liquid density meter with great care.

- Do not drop the meter.
- Do not use liquids incompatible with materials of construction.
- Do not operate the meter above its rated pressure or maximum temperature.
- Do not pressure test beyond the specified test pressure.
- Do not expose the meter to excessive vibration (> 0.5 g continuous).
- Do not modify this instrument in any way (mechanical or electrical) or the factory warranty will be invalidated. This meter can be ordered with Zirconium wetted parts. In this case, mechanical modifications of any kind may produce a safety hazard and must not be performed.
- Do not exceed the stated supply voltage range, otherwise the meter may be damaged and a hazard may exist.
- Ensure all explosion-proof requirements have been applied.
- Ensure the meter and associated pipework are pressure tested to 1-1/2 times the maximum operating pressure after installation.
- Ensure the transmitter housing covers are tightened properly after wiring to maintain ingress protection.
- Take great care not to damage the meter as this may affect the meter calibration and can result in failure. Take extra care when handling PFA-coated tines as the coating is not resistant to impact damage. Always fit the protective cover when the meter is not in use.
- Always store and transport the meter in its original packaging. For the long-stem meters, be sure to include the transit cover secured by the grub screws.
- To return a meter, refer to the Return Policy appendix for more information on the Micro Motion return policy.

Safety messages are provided throughout this manual to protect personnel and equipment. Read each safety message carefully before proceeding to the next step.

1.2 About the 7826/7828 liquid density meter

1.2.1 What is it?

The 7826/7828 liquid density meter is based on the proven tuning fork technology. It is an all-welded sensor that is designed for insertion into a pipeline, open tank, or closed tank.

Fluid density is determined directly from the resonant frequency of the tuning fork immersed in the fluid. A temperature sensor (RTD) is also fitted within the transmitter to indicate the operating temperature.

The 7826/7828 meter is available in the following options:

- a short-stem or long-stem version

  The long-stem version can come in lengths up to 13 ft (4 m). The long-stem version is ideally suited to open tank and closed tank applications.

- a frequency output version (7826 meter only) or an Advanced electronics version.

  The 7826 meter with frequency output outputs the density measurement as a square wave signal, and features a RTD to output the operating temperature measurement. It is typically used with a signal converter, such as the 795x Series, and offers a powerful tool in critical density applications.

  The 7826/7828 meter with Advanced electronics incorporates much of the 795x signal converter functionality, such that online density calculations are performed locally within the electronics housing of the 7826/7828 meter. It features two 4–20 mA outputs and RS-485/Modbus communications, providing simple accessibility to all calculated values.

1.2.2 What is it used for?

The 7826/7828 meter is ideally suited to applications where continuous, real-time measurement of density is required. For example, it can be used in process control where density is the primary control parameter for the end product, or is an indicator of some other quality control parameter such as % solids, or % concentration.

1.2.3 Measurements and calculations

The Advanced electronics version contains integral processing electronics to provide full in-situ configuration, enabling it to perform a variety of calculations.

The 7826/7828 meter continuously measures the following fluid properties:

- Line density (measured in kg/m^3, g/cc, lb/gal, or lb/ft^3)
- Operating temperature (measured in °C or °F)

From these properties, the following are calculated:

- API base density at 15 °C, 1.013 bar (60 °F, 14.5 psi)
- Base density (by using the matrix referral method)
- °API
- Specific gravity
- Special function calculations such as °Brix, °Baume, °Twaddle, % solids, etc.

1.2.4 Outputs from frequency output version (7826 meter only)

Outputs from the frequency output version of the 7826 meter include:

- Line density in g/cc – as a frequency (periodic time) signal
- Line (operating) temperature in °C – as a RTD signal

These outputs can be taken directly in by a 795x signal converter (or flow computer), which can then calculate live density-related parameters:

- Base/referred density (using API tables or a matrix referral)
- Specific gravity
- °API
- °Brix
- % Solids
- % Mass
- % Volume
- % Concentration

Note: Features vary between versions and issues of 795x liquid software.

For information on electrical connections between the 7826 meter and a *795x* unit, see the Electrical Connections (Frequency Output) chapter.

1.2.5 Outputs from the Advanced electronics version

No signal converter is required, which simplifies wiring and enables the 7826/7828 meter to be connected directly to plant monitoring and control systems and/or a local indicator.

Two forms of output are available:

- Two 4–20mA analog outputs, factory set but individually configurable span, bias, limits, and filter options. The standard factory settings for these outputs are Line density on Analog Output 1, and Line temperature on Analog Output 2. Alternatively, the analog outputs may be controlled by one of the following:
    - Line density
    - Line temperature
    - °API
    - Specific gravity
    - Base density (API)
    - Base density (matrix referral method)
    - Special calculation result
- An RS-485 (Modbus) interface, giving access to other measurement results, system information and configuration parameters.

  The 7826/7828 meter is factory set to perform either API or Matrix referrals. Re-configuration of the meter default settings (see Appendix A) is achieved by linking a PC to the Modbus (RS-485) connection and running ADView or ProLink II (version 2.9 or later) software. After the 7826/7828 meter is configured, the PC can be removed.

1.2.6 Typical meter application with Advanced electronics

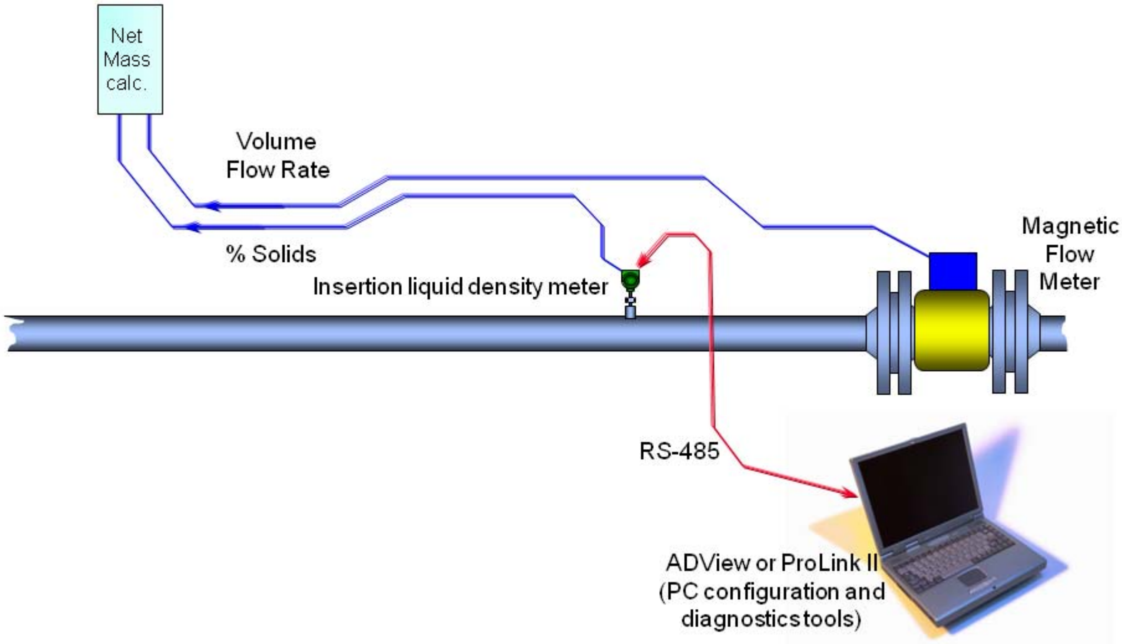
Net Mass flow rate calculation

Figure 1-1 shows an outline of a typical wet process mineral application where the 7826/7828 meter provides a 4–20 mA signal of the % solids determination from the slurry stream. From this signal and the measured volumetric flow rate, net mass flow rate is determined.

The output signal could also be used for % solids control, or for net mass flow rate ratio blend control.

The optional 7826/7828 meter (Modbus) connection to a PC running ADView or ProLink II software can be used for configuration and access to other measured values.

Figure 1-1. Typical meter application with Advanced electronics



1.3 Principle of Operation

The 7826/7828 liquid density meter operates on the vibrating element principle, the element in this case being a tuning fork structure that is immersed in the liquid being measured. The tuning fork is excited into oscillation by a piezoelectric device internally, secured at the root of one tine. The frequency of vibration is detected by a second piezoelectric device, which is secured in the root of the other tine.

The meter sensor is maintained at its natural resonant frequency, as modified by the surrounding liquid, by an amplifier circuit located in the electronic housing. This frequency of vibration is a function of the overall mass of the tine element and the density of the liquid in contact with it. As the density of the liquid changes, the overall vibrating mass changes, and therefore the resonant frequency changes.

By measuring this frequency and applying the following equation, the density of the liquid can be calculated.

$$\rho = K0 + K1\tau + K2\tau^2$$

Where:

- ρ = Fluid uncorrected density (kg/m^3)
- τ = Time period of meter (μs)
- K0, K1, K2 = meter calibration coefficients

Chapter 2
Installation (Short Stem)

For information on installing a long-stem version of the 7826/7828 liquid density meter, see Chapter 3.

2.1 Introduction

⚠ **All drawings and dimensions given in this manual are given here for planning purposes only. Before commencing fabrication, reference should always be made to the current issue of the appropriate drawings. Contact Micro Motion for details.**

⚠ **For further information on handling and using the meter, see "Safety guidelines" on page 1 and "Safety Information" on page 8.**

There are a variety of external factors that affect the ability of the 7826/7828 liquid density meter to operate successfully. In order to ensure that your system works correctly, the effects of these factors must be taken into consideration when designing your installation.

There are two main aspects to consider:

- The accuracy and repeatability of the measurements
- The relevance of the measurements to the overall purpose of the system

Factors which may adversely affect accuracy and repeatability include:

- The presence of gas or bubbles within the fluid being measured
- Non-uniformity of the fluid
- The presence of solids as contaminants
- Fouling of the meter
- Temperature gradients
- Cavitations and swirls
- Operating at temperatures below the wax point of crude oils
- The correct pipe diameter that corresponds to the calibration of the meter.

In some applications, absolute accuracy is less important than repeatability. For example, in a system where the control parameters are initially adjusted for optimum performance, and thereafter only checked periodically.

The term achievable accuracy can be used to describe a measure of the product quality that can be realistically obtained from a process system. It is a function of measurement accuracy, stability and system response. High accuracy alone is no guarantee of good product quality if the response time of the system is measured in tens of minutes, or if the measurement bears little relevance to the operation of the system. Similarly, systems which require constant calibration and maintenance cannot achieve good achievable accuracy.

Factors which may adversely affect the relevance of the measurements could include:

- Measurement used for control purposes being made too far away from the point of control, so that the system cannot respond properly to changes.
- Measurements made on fluid which is unrepresentative of the main flow.

2.2 Safety Information

2.2.1 General information applicable to the complete system

- These safety instructions are to be used whenever handling or operating this product. Suitably trained personnel shall carry out the installation both mechanical and electrical in accordance with the applicable local and national regulations and codes of practice for each discipline.
- Safe working practices for the media and process concerned must be followed during the installation and maintenance of the equipment. Depressurize and isolate the system before starting to loosen or remove any connection.
- If the equipment is likely to come into contact with aggressive substances, it is the responsibility of the user to take suitable precautions that prevent it from being adversely affected.
- It is the responsibility of the installer/user of this equipment to ensure:
  - This product is not used as a support for other equipment or personnel.
  - This product is protected from impact.
  - It is important that this sensor is handled with care due to its sensitivity to impact.

2.2.2 Pressure bearing parts

- It is the responsibility of the installer/user of this equipment to ensure:
  - The materials of construction are suitable for the application.
  - All piping connections conform to the local and national regulations and codes of practice.
  - The pressure and temperature limits for this equipment are not exceeded, if necessary by the use of suitable safety accessories. See Table 2-1 for pressure and temperature limits for Zirconium 702 process connections. Pressure and temperature ratings for other materials are in accordance with the relevant flange standard.

Table 2-1 Zirconium 702 Pressure and temperature flange ratings

Process flange type	Pressure and temperature ratings			
	100°F (37.8°C)	199.9°F (93.3°C)	299.8°F (148.8°C)	392°F (200°C)
2" ANSI 150	226.3 psi (15.6 bar)	197.3 psi (13.6 bar)	159.5 psi (11.0 bar)	110.2 psi (7.6 bar)
2" ANSI 300	588.9psi (40.6 bar)	513.4 psi (35.4 bar)	417.7 psi (28.8 bar)	336.5 psi (23.2 bar)
DN50 PN16	229.2 psi (15.8 bar)	175.5 psi (12.1 bar)	137.8 psi (9.5 bar)	107.3 psi (7.4 bar)
DN50 PN40	571.5 psi (39.4 bar)	439.5 (30.3 bar)	342.3 psi (23.6 bar)	266.9 psi (18.4 bar)

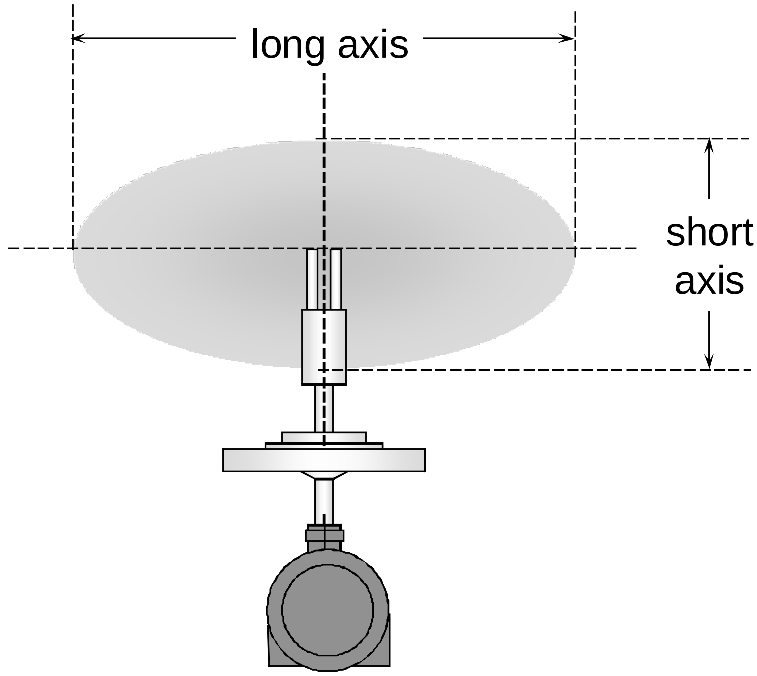
  - Correct gaskets/seals are fitted and are compatible with the media and process.
  - The installed sensor is adequately supported for weight and vibration effects.
  - Personnel are protected from hot burns by guards, thermal lagging or limited access. Allow time to cool prior to carrying out maintenance operations. It is recommended that "HOT" notices are fitted in the vicinity of the equipment where applicable.
  - Regular inspection for corrosion and wear are carried out, both internal and external.
- The sensor must not be fitted until all installation work and final precommissioning checks are carried out. Do not remove blanking plugs until the sensor is fitted.
- The sensor must be installed in compliance with this manual, to ensure correct fitting. This applies to all variants.
- The user should not repair this equipment, but general maintenance can be applied as described within this manual.

2.3 Boundary effects

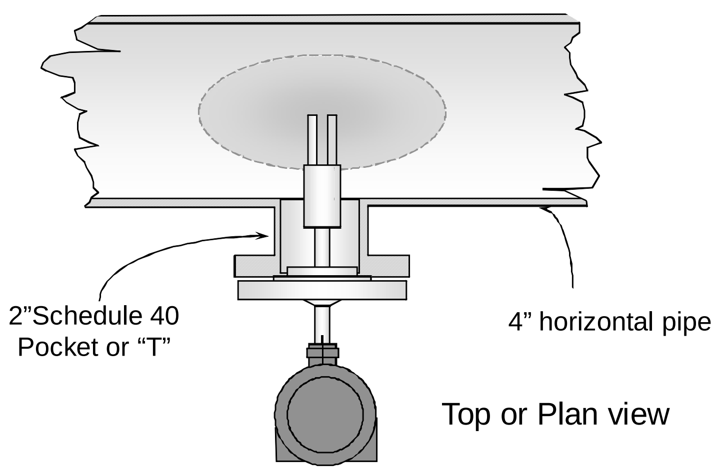
Any insertion device or meter can only measure the properties of the fluid within the region of fluid to which it is sensitive.

For practical reasons, it is helpful to consider the sensitive, or effective region, for the meter as an ovoid centered on the tips of the tines with its long axis aligned with the direction in which the tines vibrate, as shown below. The 7826/7828 meter is insensitive to the properties of the fluid outside this region and progressively more sensitive to fluid properties the closer the fluid is to the tines.

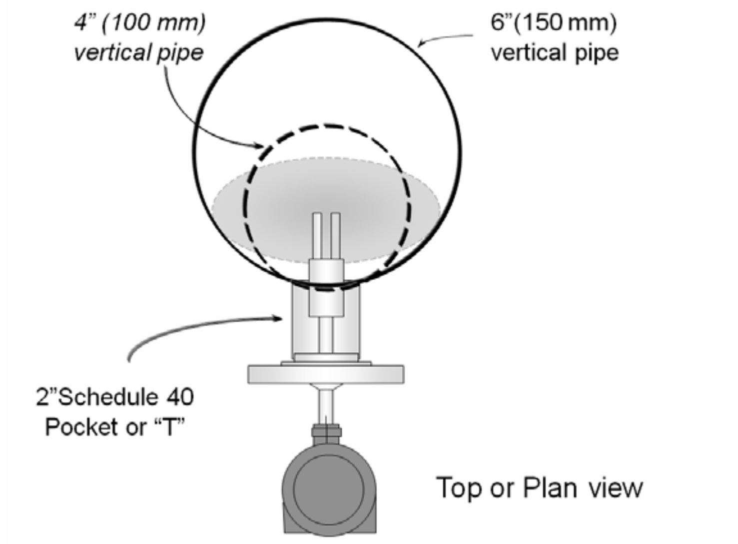
Introduction
Installation (Short Stem)
Installation (Long Stem)
Electrical Connections (Frequency Output) - 7826 Only



If part of this volume is taken up by the pipework or fittings there is said to be a boundary effect; i.e., the intrusion of the pipe walls will alter the calibration. The diagram below illustrates the 7826/7828 meter installed in a pocket on the side of a 4" (100 mm) horizontal pipe line (viewed from above). The effective region is completely enclosed within the pipe line and thus is completely fluid.

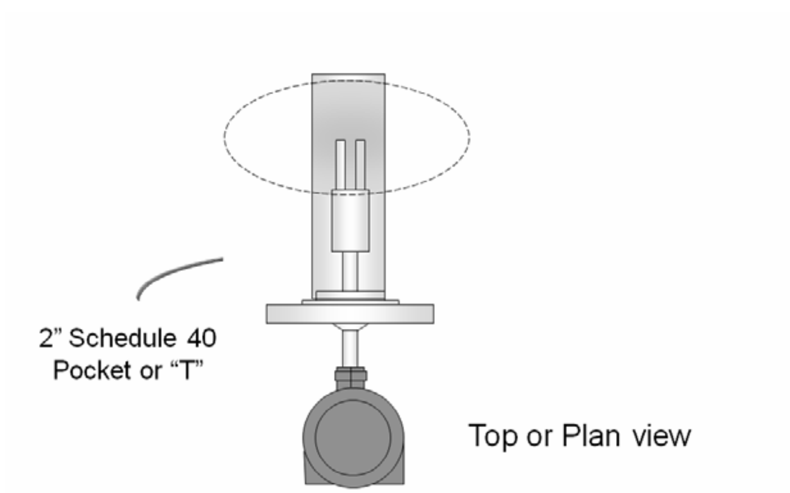


This next view shows other pipe outlines superimposed:



The smaller circle represents a 4" (100 mm) vertical pipe, which because the 7826/7828 meter orientation is constant irrespective of pipe orientation intersects the effective region. The 6" (150 mm) pipe is the smallest pipe diameter to completely enclose the effective region when the pipe is vertical. Thus smaller pipe diameters can lead to a variety of different geometries which would each require a separate calibration.

An alternative condition is shown in the next diagram where the side pocket is extended until it passes completely through the effective region producing a "core":



From this, it would appear that almost every installation requires a separate in-situ calibration – a very undesirable situation. The problem is resolved by providing standard calibration geometries which can be used in all pipe work configurations and thereby allow the factory calibration conditions to be reproduced in the process.

2.4 Viscosity effects

The 7826/7828 liquid density meter can be affected by the viscosity of the fluid surrounding it, which is manifested in two ways:

- An error in the density measurement, that is due to the effect of viscosity on the vibration of the fork tines.
- In T-piece installations, where the 7826/7828 meter is retracted into a pocket but away from the main fluid flow, high viscosity impedes the flushing of fluid near the tines. This may mean that, if a step change in density occurs, the fluid being measured will not representative of the fluid in the main flow, and the density response time may be extended significantly.

A summary of these effects and the action to be taken to minimize them is given in Table 2-2.

Table 2-2 Viscosity effects

Viscosity range	Remedy
T-piece installations only	
• Less than 100 cP	None required.
• Greater than 100 cP	Density measurements may be unpredictable; use flow-through chamber or free stream installation. (Where the main flow is greater than 1.5 m/s and there is no waxing present, the T-piece installation can be used for viscosities not exceeding 250 cP.)
All other installations	
• Up to 500 cP	None required
• Above 500 cP	Density measurements may be unpredictable.

2.5 Standard installations

2.5.1 Overview

To overcome the need for in-situ calibration for every installation, three standard installations are proposed. If an installation conforms to one of these standards, the factory calibration of the 7826/7828 meter is valid, and in-situ calibration unnecessary. Table 2-3 summarizes the three installations. For tank installations, consult Micro Motion.

Table 2-3. Types of standard installations

Installation type	Free stream	T-piece	Flow-through chamber
Description	7826/7828 meter tines are inserted directly into the main fluid flow.	7826/7828 meter tines are contained in a side pocket off the main flow.	7826/7828 meter tines are contained in a flow-through chamber in which fluid is circulated from the main flow.
Flow rate	0.3 to 0.5 m/s at the 7826/7828 meter.	0.5 to 3 m/s at main pipe wall.	10 to 30 l/min.
Viscosity	Up to 500 cP	Up to 100 cP (250 cP in some cases)	Up to 500 cP

Table 2-3. Types of standard installations *continued*

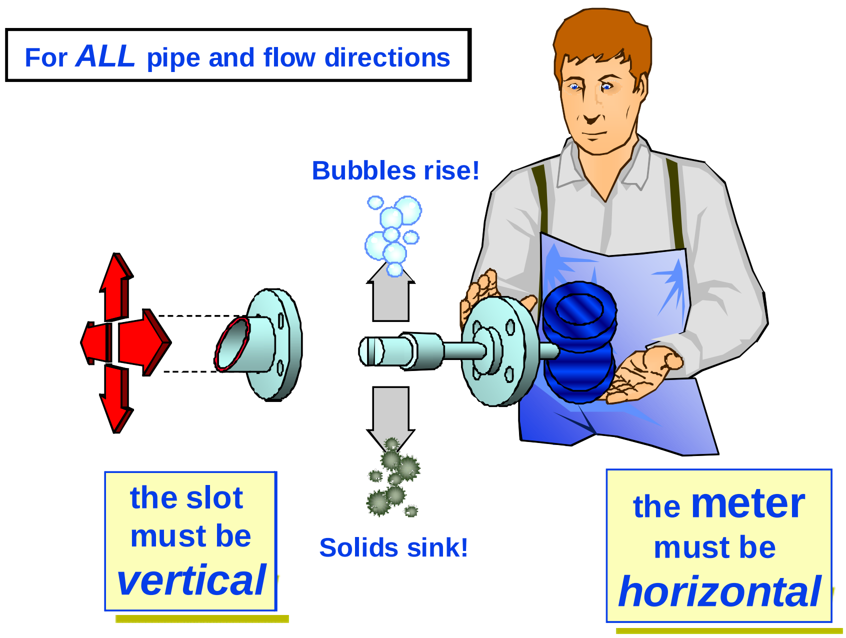
Installation type	Free stream	T-piece	Flow-through chamber
Temperature[(1)]	-50 to 200°C (-58 to 392°F)	-50 to 200°C (-58 to 392°F)	-50 to 200°C (-58 to 392°F)
Main flow pipe size	100 mm (4") horizontal 150 mm (6") vertical, or larger	100 mm (4") horizontal or larger	Any
Advantages	• Simple installation in large bore pipes. • Ideal for clean fluids and non-waxing oils. • Suitable for line viscosity measurement and simple referrals.	• Simple installation in large bore pipes. • Ideal for clean fluids and non-waxing oils. • Suitable for line viscosity measurement and simple referrals.	• Adaptable installation to any diameter main pipe and for tank applications. • Ideal for flow and temperature conditioning. • Suitable for complex referrals and for use with heat exchangers. • Suitable for step changes in viscosity. • Fast response. • Ideal for analyzer cubicles.
Not recommended for	• Dirty fluids. • Low or unstable flow rates. • Where step changes in viscosity can occur. • For small bore pipes.	• Dirty fluids • Low or unstable flow rates. • Where step changes in viscosity can occur. • for small bore pipes. • Where temperature effects are significant.	• Uncontrolled flow rates. • Careful system design required to ensure representative measurement. • Frequently requires the use of a pump.

(1) Approval for use in hazardous areas is limited to –40 to +200°C (–40 to +392°F)

2.5.2 Meter orientation

For free stream and T-piece installations, the meter must always be installed horizontally and orientated to allow flow in the gap between the tines. This is irrespective of the pipe line orientation, and helps to prevent the trapping of bubbles or solids on the meter.

Figure 2-1 **Meter orientation**



Note: All drawings and dimensions given in the following sections are derived from detailed dimensional drawings. They are given here for planning purposes only. Before commencing fabrication, reference should always be made to the current issue of the appropriate drawings - contact Micro Motion for details.

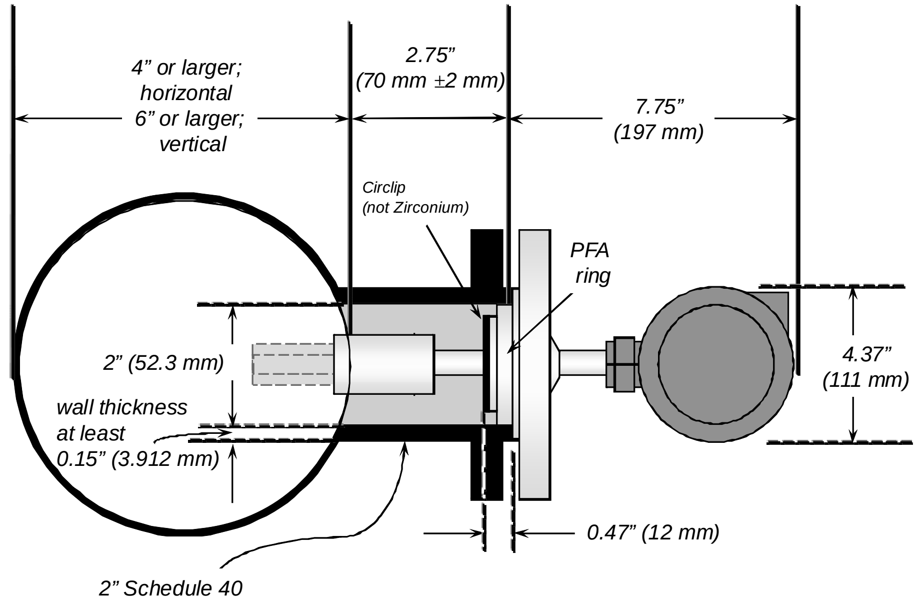
2.5.3 Free stream installation - flanged fitting

Conditions:

- Flow: 0.3 to 0.5 m/s (at the meter)
- Viscosity: Up to 500 cP
- Temperature: -50 °C to 200 °C (–58 °F to 392 °F)
  [-40 °C to 200 °C (-40 °F to 392 °F) in hazardous areas]

Note: The thermal mass of the flanges may affect the response time of the meter to temperature changes.

The view shown below is schematic to show the dimensions of the side pocket, which is fabricated by the end user.



Free Stream; flanged

The pocket geometry ***must be*** consistent with 2" schedule 40 tube in both internal diameter and minimum wall thickness, such as:

- Internal diameter: 2" (52.5 mm)
- Wall thickness: minimum 0.15" (3.912 mm)

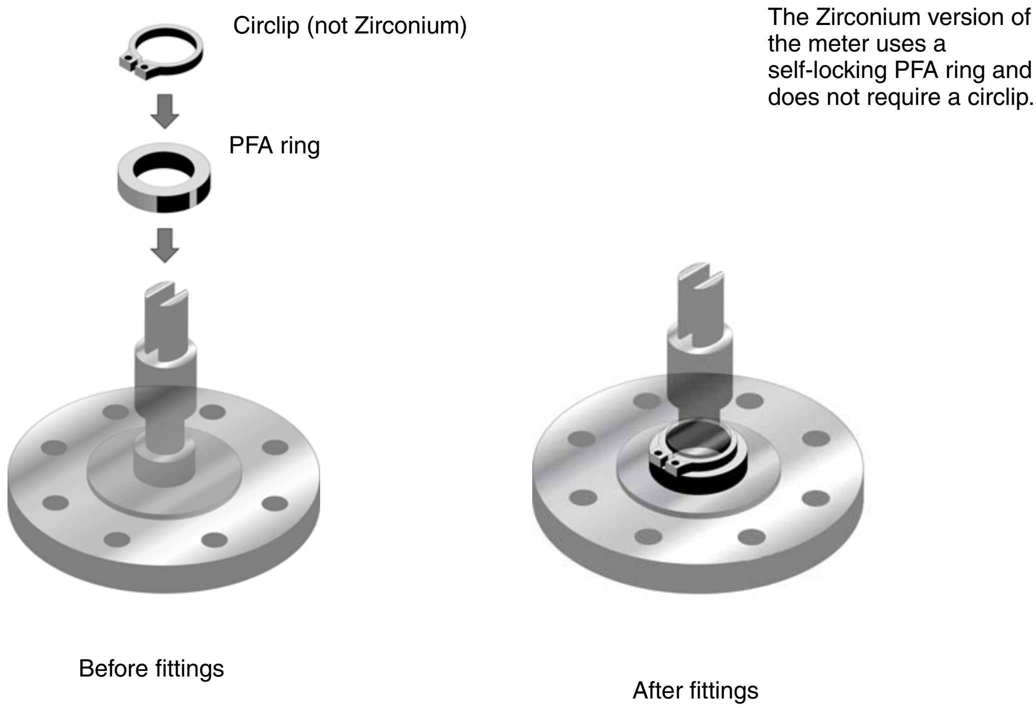
Weld neck or slip-on flanges may be used, according to the flange rating selected. However, for higher rated flanges, only slip-on flanges may give the necessary clearances.

How to fit the circlip and PFA ring

The meter is supplied with a PFA ring which may be attached to the location step with a circlip to center the tines within the 2" schedule 40 or 80 pipe. An exception is the Zirconium version of the meter, which uses a self-locking PFA ring and does not require a circlip.

Prior to installation, place the PFA ring around the boss on the underside of the meter flange. Then attach the circlip to hold the PFA ring in place (see Figure 2-2). The PFA ring and circlip are supplied with the meter.

Figure 2-2 How to fit the circlip and PFA ring



2.5.4 Free stream installation - weldolet

This is the preferred option where temperature variations are a critical factor. The reduced thermal mass of the weldolet's taper-lock fitting renders it more able to track rapid changes in temperature.

Conditions:

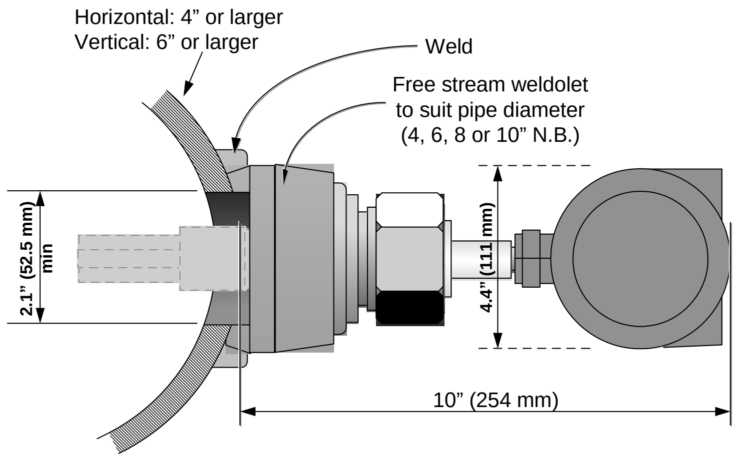
- Flow: 0.3 to 0.5 m/s (at the meter)
- Viscosity: Up to 500 cP
- Temperature: -50 °C to 200 °C (–58 °F to 392 °F)
  [-40 °C to 200 °C (-40 °F to 392 °F) in hazardous areas]

The weldolet has a 1.5" taper lock fitting, and is supplied to be welded on 4", 6", 8" or 10" pipelines. Use of the weldolet ensures that the tines of the 7826/7828 meter are orientated correctly and are fully inserted into the fluid stream.

Before fitting the weldolet, the pipeline must be bored through at 2.1" (52.5 mm) diameter to accept the meter. The weldolet must be welded to the pipeline concentrically with the pre-bored hole.

The view shown below is a schematic to show the relevant dimensions.

Figure 2-3 **Free stream 1.5" Swagelock fitting**



The installation will conform generally to Schedule 40 pressure ratings. The weldolet fabrication is rated to 100 Bar at ambient temperature.

Note: Correct installation and pressure testing of the fitting is the responsibility of the user.

2.5.5 T-piece installation

Conditions:

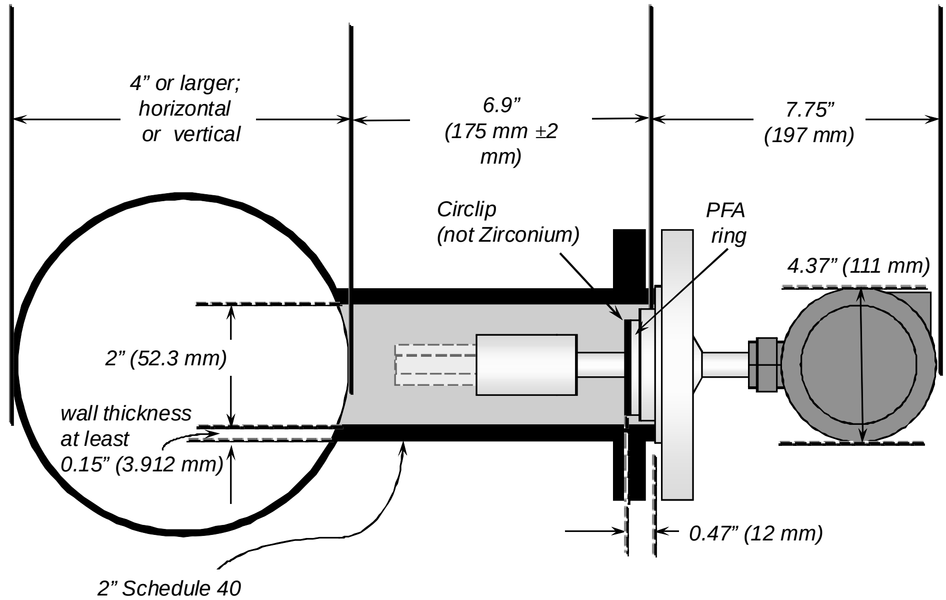
- Flow: 0.5 to 3.0 m/s (at the pipe wall)
- Viscosity: Up to 100 cP, or 250 cP under some conditions
- Temperature: -50 °C to 200 °C (–58 °F to 392 °F)

  [-40 °C to 200 °C (-40 °F to 392 °F) in hazardous areas]

The thermal mass of the flanges may affect the response time of the meter to temperature changes.

Flow velocity at the pipe wall and fluid viscosity must be within the limits shown to ensure that the fluid within the pocket is refreshed in a timely manner. This installation will not respond as rapidly as the free-stream installation to step changes in viscosity.

The view shown is a schematic to show the dimensions of the side pocket, which is fabricated by the end user.



"T" piece Flanged

The pocket geometry ***must be*** consistent with 2" schedule 40 tube in both internal diameter and minimum wall thickness, i.e.:

- Internal diameter: 2.1" (52.5 mm)
- Wall thickness : minimum 0.15" (3.912 mm)

Alternatively, schedule 80 tube may be used, but this affects the calibration, and must be specified when ordering the sensor.

Weld neck or slip-on flanges may be used, according to the flange rating selected. However, for higher rated flanges, only slip-on flanges may give the necessary clearances.

For normal flow conditions (up to 3 m/s at the pipewall), the tines should be retracted 1" (25 mm) from the main pipe wall. For higher flow rates, increase this by 10 mm for every 1 m/s increase in main flow rate.

For hygienic applications, normal 2" hygienic tube is too thin for this application; (it can vibrate in sympathy with the fork, causing measurement errors). Use 3" hygienic tube and fittings instead, or fabricate hygienic fittings with the same wall thickness and internal diameter as those shown in the diagram above.

Prior to installation, place the PFA ring around the boss on the underside of the meter flange, and then attach the circlip to hold the PFA ring in place. An exception is the Zirconium version of the meter, which uses a self-locking PFA ring and does not require a circlip. See "How to fit the circlip and PFA ring" on page 15.

2.5.6 T-piece weldolet installation

This is the preferred option where temperature variations are a critical factor. The reduced thermal mass of the weldolet's taper-lock fitting renders it more able to track rapid changes in temperature.

Conditions:

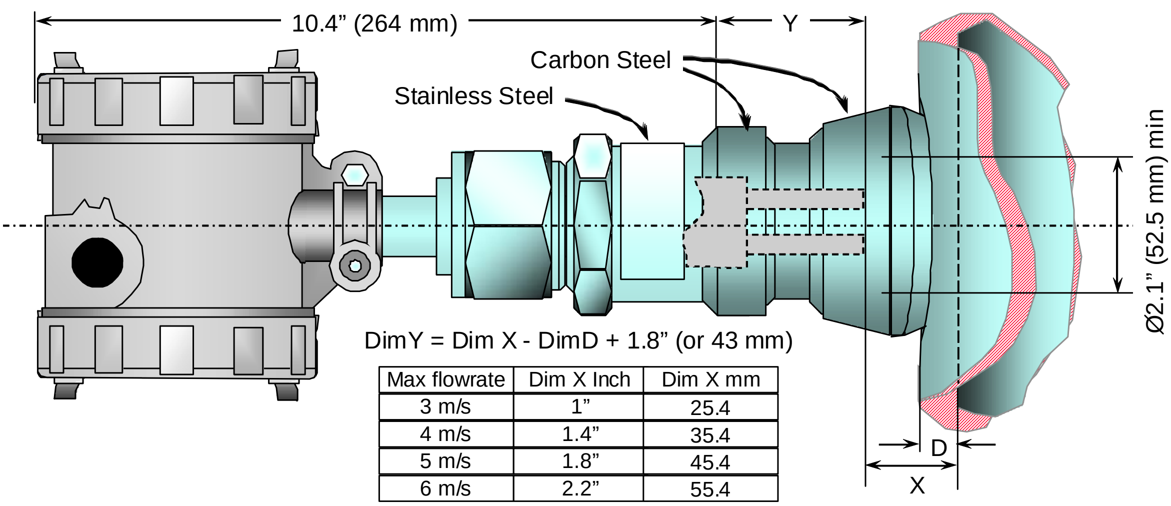
- Flow: 0.5 to 3.0 m/s at the main pipe wall. (Operation is possible with higher flow rates, if dimension X is increased (see diagram below).
- Viscosity limit: Up to 100 cP, or 250 cP under some conditionss
- Temperature: -58 to +392 °F (-50 °C to +200 °C)

The weldolet has a 1.5" taper lock fitting, and is supplied to be welded on 4", 6", 8" or 10" pipelines. Use of the weldolet ensures that the tines of the 7826/7828 meter are orientated correctly and are fully inserted into the fluid stream. The length of the weldolet is determined by the flow rate in the main pipeline (refer to the table in Figure 2-4), and is chosen to ensure that the tines of the 7826/7828 meter are sufficiently retracted from the main pipe wall. Dimension X should be the smallest possible, consistent with the maximum expected flow rate.

Before fitting the weldolet, the pipeline must be bored through at 2” (52.5 mm) diameter to accept the meter. The weldolet must be welded to the pipeline concentrically with the pre-bored hole. The view shown below is schematic to show the relevant dimensions.

Flow velocity at the pipe wall and fluid viscosity must be within the limits shown to ensure that the fluid within the pocket is constantly refreshed. This installation will not respond as rapidly as the free-stream installation to step changes in viscosity.

Figure 2-4 T-Piece weldolet installation



Max flowrate	Dim X Inch	Dim X mm
3 m/s	1”	25.4
4 m/s	1.4”	35.4
5 m/s	1.8”	45.4
6 m/s	2.2”	55.4

The installation must conform to Schedule 40 pressure ratings. Alternatively, schedule 80 tube may be used, but this will affect the calibration, and must be specified when ordering the sensor.

The weldolet fabrication is rated to 1450 psi (100 Bar) at ambient temperature.

Note: Correct installation and pressure testing of the fitting is the responsibility of the user.

2.5.7 Flow-through chamber installation

Flow-through chambers are fabricated by Micro Motion, and are available with either weld prepared ends or with flange or compression fittings for connection into the process pipe lines. They are available with 1" NB, 2" NB, or 3" NB inlet and outlet pipes.

Note: The length of the inlet and outlet pipes must not be altered, otherwise the temperature response and stability of the fitting may be adversely affected.

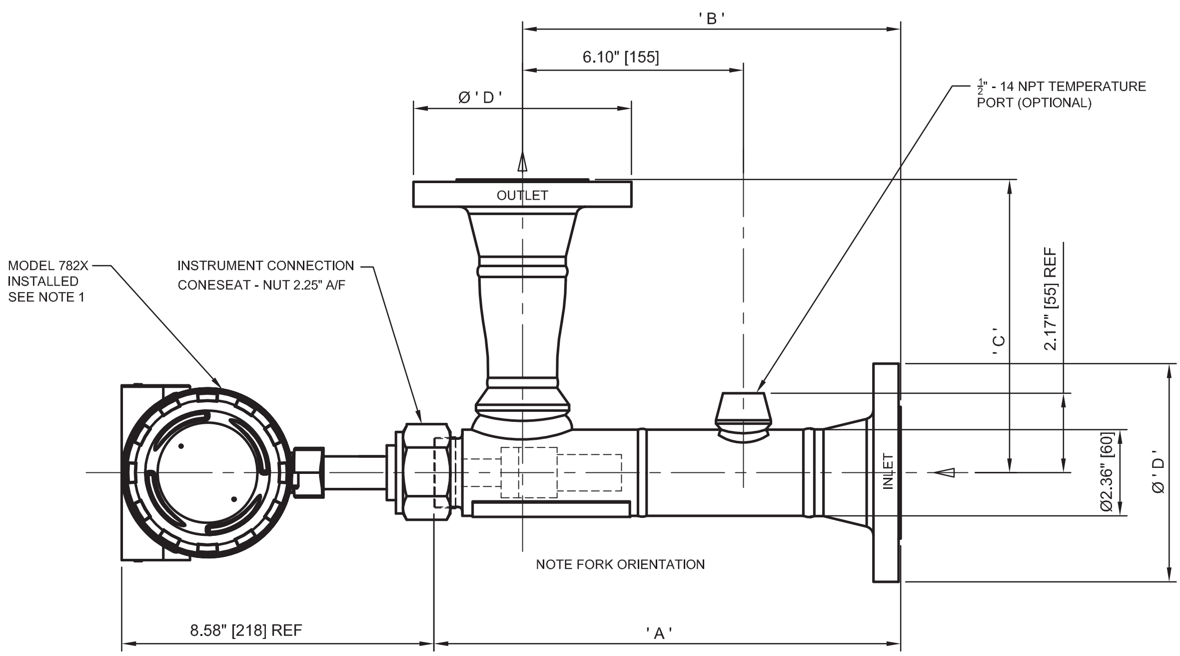
Conditions:

- Flow: constant, between 10 and 30 l/min for 2" sch 40 calibration bore section, 5–300 l/min for 3" sch 80 calibration bore.
- Viscosity: Up to 1000 cP
- Temperature: -50 °C to 200 °C (–58 °F to 392 °F)
  [-40 °C to 200 °C (-40 °F to 392 °F) in hazardous areas]
- Pressure: 70 bar @ 204 °C, subject to process connections.

The RTD is a direct insertion type, without a thermowell, and uses a ½" Swagelok connection.

The diagram below shows an example of this type of standard installation.

Dimensions shown in inches (mm)



PROCESS CONNECTIONS	'A' DIM	'B' DIM	'C' DIM	'D' DIA
2" ANSI 150RF	12.60" [320]	10.20" [259]	7.80" [198]	5.98" [150]
2" ANSI 300RF	12.84" [326]	10.43" [265]	8.03" [204]	6.5" [165]
2" ANSI 600RF	13.23" [336]	10.83" [275]	8.43" [214]	6.5" [165]
(50mm) DIN 2527 DN50 PN40	11.97" [304]	9.57" [243]	7.17" [182]	6.5" [165]
(50mm) DIN 2527 DN50 PN100	12.76" [324]	10.35" [263]	7.95" [202]	7.68" [195]

The three compression fittings on the flow pockets (½" drain, ¾" temp probe, and 1-½" mounting nut for the meter) are rated to above the working pressure of the flow pocket. The fittings may be Swagelok or Parker; both are used in manufacture.

The fittings are certified to the following standards:

- Swagelok: SO9001 / 9002, ASME,TUV,CSA,DNV
- Parker: ISO 9001 / 9002, TUV, DNV, LLOYDS

2.6 Installation in the pipeline or system

Density is a highly sensitive indicator of change in a fluid – a key reason why density measurement is increasingly being chosen as a process measurement.

This sensitivity means that the measurement can be very sensitive to extraneous effects and therefore great care must be taken to consider all the factors which affect measurement when assessing the installation requirements.

Like many other meters, the optimum performance of the meter depends upon certain conditions of the fluid and configuration of the process pipe-work. By introducing appropriate flow conditioning, the optimum performance of the 7826/7828 meter can be achieved at any chosen location in the process system.

You must first select a location which serves the application objective; e.g. installed close to the point of control. Then, consideration can be given to fluid conditioning at that point. Where the application requirements allow a degree of tolerance in the point chosen for installation, the installation may be able to take advantage of natural flow conditioning.

The choice of mechanical installation (free stream, "T" piece or flow-through chamber) will be dictated partly by application needs and partly by the fluid conditions, such as:

- Condition of fluid at the sensor
- Thermal effects
- Flow rate
- Entrained gas
- Solids contamination
- Lined pipework

Fluid at the sensor

The fluid in the effective zone of the 7826/7828 meter must be of uniform composition and at uniform temperature. It must be representative of the fluid flow as a whole.

This is achieved either by mixing of the fluid either using a static inline mixer or taking advantage of any natural pipe condition that tends to cause mixing, such as pump discharge, partially open valves. The meter should be installed downstream where the flow is just returning to laminar flow conditions.

Thermal effects

For high viscosity fluids, temperature gradients in the fluid and in the pipe work and fittings immediately upstream and downstream of the meter should be minimized in order to reduce the effect of viscosity changes.

Always insulate the meter and surrounding pipework thoroughly. Insulation must be at least 1" (25 mm) of rockwool, preferably 2" (50 mm) (or equivalent insulating heat jacket) and enclosed in a sealed protective casing to prevent moisture ingress, air circulation, and crushing of the insulation. Special insulation jackets are available from Micro Motion for the flow-through chambers, which, because of the low volumetric flow rates and hence low heat flow, are more vulnerable to temperature effects.

Avoid direct heating or cooling of the meter and associated pipe work upstream and downstream that is likely to create temperature gradients. If it is necessary to provide protection against cooling due to loss of flow, electrical trace heating may be applied, provided it is thermostatically controlled and the thermostat is set to operate below the minimum operating temperature of the system.

In cases where it is necessary to heat or cool the fluid - to bring it within the temperature range of the meter, for example - heat exchangers can be installed in the fluid flow. The factory can provide more details on this, or provide a complete system, if required.

Flow rate

Flow rates and velocities should be maintained relatively constant within the limits given. The fluid flow provides a steady heat flow into the meter section, and the flow rate influences the self cleaning of the sensor and the dissipation of bubbles and solid contaminants.

Where it is necessary to install the meter in a by-pass (either using the free stream installation in a 4" diameter horizontal by-pass, or a flow-through chamber), flow may be maintained using pressure drop, pitot scoop, or by a sample pump. Where a pump is used, the pump should be upstream of the meter.

Entrained gas

Gas pockets can disrupt the measurement. A brief disruption in the signal caused by transient gas pockets can be negated in the signal conditioning software, but more frequent disruptions or serious gas entrainment must be avoided. This can be achieved by observing the following conditions:

- Keep pipe lines fully flooded at all times
- Vent any gas prior to the meter
- Avoid sudden pressure drops or temperature changes which may cause dissolved gases to break out of the fluid
- Maintain a back pressure on the system sufficient to prevent gas break out (e.g. back pressure equivalent to twice the ‘head loss’ plus twice the vapor pressure)
- Maintain flow velocity at the sensor within the specified limits.

Solids contamination

- Avoid sudden changes of velocity that may cause sedimentation.
- Install the meter far enough downstream from any pipework configuration which may cause centrifuging of solids (e.g. bends).
- Maintain flow velocity at the sensor within the specified limits.
- Use filtration if necessary.

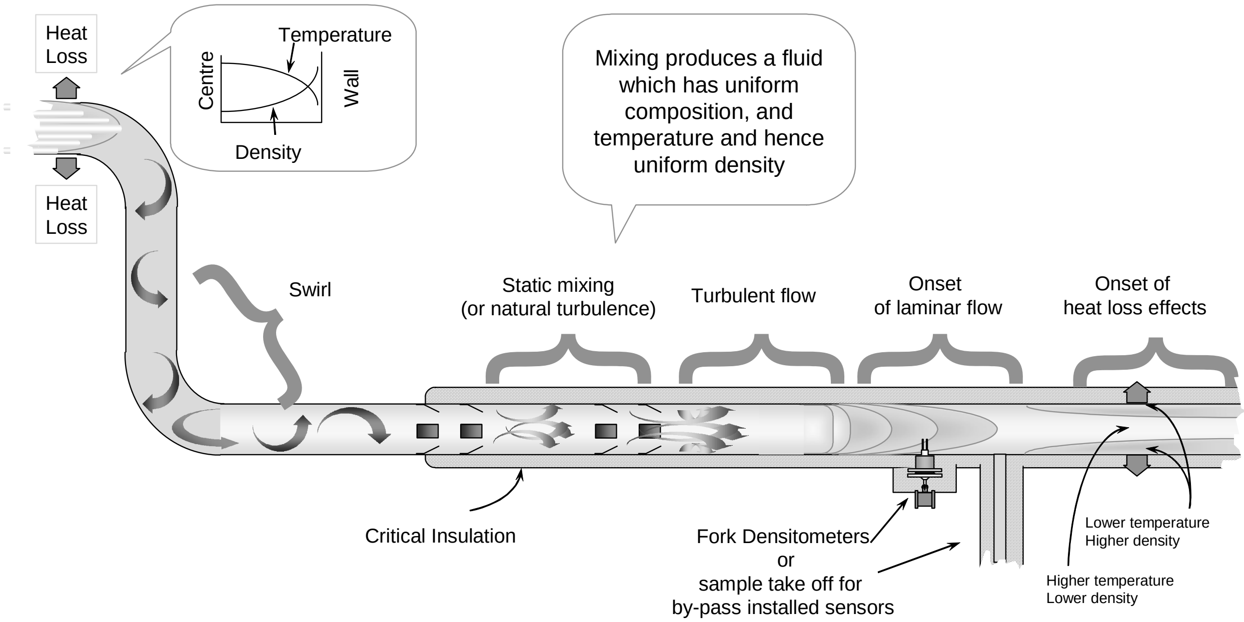
Lined pipe work

Some installations may require lined pipe work for corrosion resistance reasons. In such cases, if the internal diameter of the pipe work surrounding the fork differs from the ordered calibration boundary, an on-site calibration adjustment may be required.

Example installation

The diagram below illustrates some of the principles outlined in this section. It shows a free-stream meter installation with an additional sample take off. The position of both is such that the static mixing (which could be caused by pump discharge or partially closed valve), has negated the adverse effects of bends and established laminar flow, and has ensured that the fluid is thoroughly mixed and thus of uniform composition and temperature. The ideal place for a free stream or “T” piece installation, or for the by-pass take off point is where the flow has just begun to be laminar.

Note: The insulation extends upstream and downstream far enough to prevent conduction losses in the pipe walls from degrading the temperature conditioning of the fluid at the sensor.



2.7 Commissioning

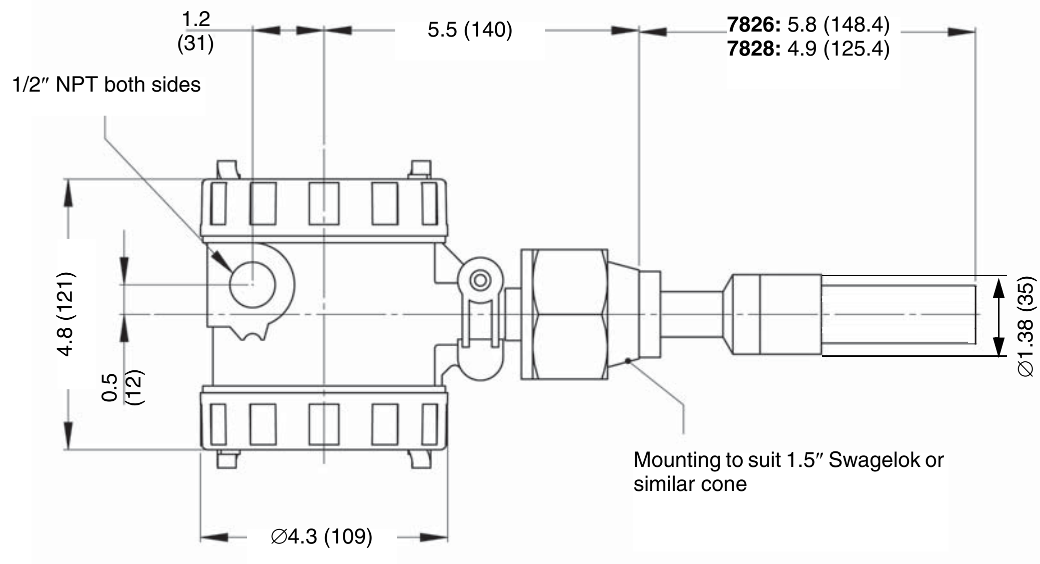
1. Once the pipework installation has been prepared, and before installing the meter, fit a blanking flange or compression nut to the meter mounting, and pressurize and flush the system.
2. Isolate the system, depressurize and remove the blanking flange or compression nut.
3. Install the meter.
4. Slowly pressurize the system and check for leaks, particularly if the normal operating temperature is high, or the sensor has been fitted cold; tighten as necessary.
5. Once the system has stabilized and is leak free, fit the insulation material, remembering also to insulate any flanges.

2.8 Short Stem Dimensional Drawings

2.8.1 Cone-seat connection

Figure 2-5 **Cone-seat connection details**

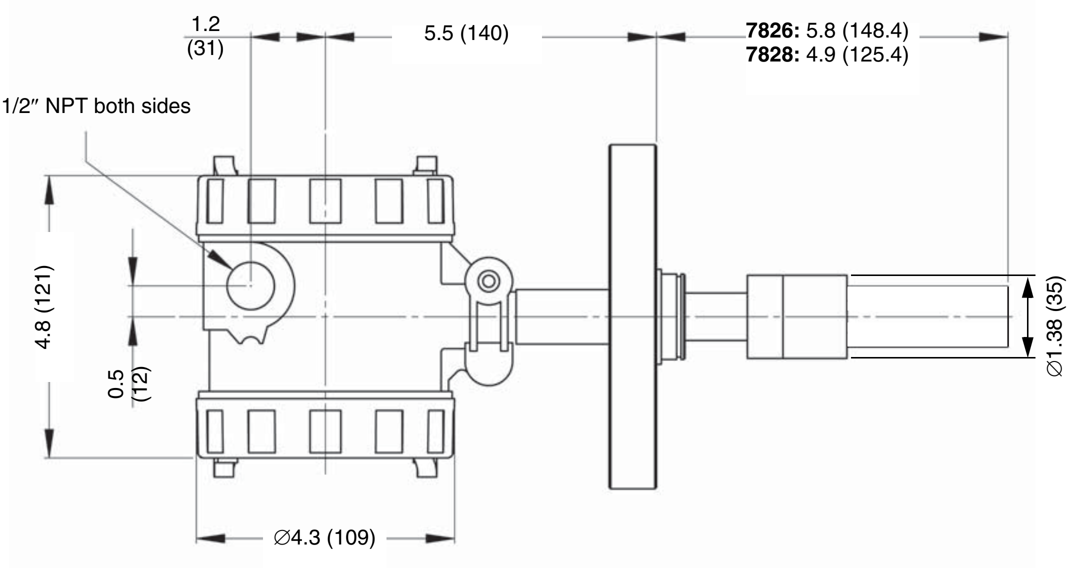
Dimensions in inches (mm)



2.8.2 Flange connection

Figure 2-6. Flange connection details

Dimensions in inches (mm)



Chapter 3
Installation (Long Stem)

For information on installing a short-stem version of the 7826/7828 liquid density meter, see Chapter 2.

3.1 Introduction

All drawings and dimensions given in this manual are given here for planning purposes only. Before commencing fabrication, reference should always be made to the current issue of the appropriate drawings. Contact Micro Motion for details.

To protect the tines from damage, a Transit Cover is fitted prior to shipment from the factory. The Transit Cover is held in place by 2 grub screws. Be sure to remove and store the Transit Cover prior to installation. Re-fit the Transit Cover if storing or transporting, such as for repair. If the Transit Cover has been lost, it can be purchased from Micro Motion.

For further information on handling and using the meter, see Safety Guidelines in Chapter 1.

There are a variety of external factors that affect the ability of the 7826/7828 liquid density meter to operate successfully. In order to ensure that your system works correctly, the effects of these factors must be taken into consideration when designing your installation.

There are two main aspects to consider:

- The accuracy and repeatability of the measurements
- The relevance of the measurements to the overall purpose of the system

Factors which may adversely affect accuracy and repeatability include:

- The presence of gas or bubbles within the fluid being measured
- Non-uniformity of the fluid
- The presence of solids as contaminants
- Fouling of the meter
- Temperature gradients
- Cavitations and swirls
- Operating at temperatures below the wax point of crude oils

In some applications, absolute accuracy is less important than repeatability. For example, in a system where the control parameters are initially adjusted for optimum performance, and thereafter only checked periodically.

The term achievable accuracy can be used to describe a measure of the product quality that can be realistically obtained from a process system. It is a function of measurement accuracy, stability and system response. High accuracy alone is no guarantee of good product quality if the response time of the system is measured in tens of minutes, or if the measurement bears little relevance to the operation of the system. Similarly, systems which require constant calibration and maintenance cannot achieve good achievable accuracy.

Factors which may adversely affect the relevance of the measurements could include:

- Measurement used for control purposes being made too far away from the point of control, so that the system cannot respond properly to changes.
- Measurements made on fluid which is unrepresentative of the main flow.

3.2 Safety Information

3.2.1 General information applicable to the complete system

- These safety instructions are to be used whenever handling or operating this product. Suitably trained personnel shall carry out the installation both mechanical and electrical in accordance with the applicable local and national regulations and codes of practice for each discipline.
- Safe working practices for the media and process concerned must be followed during the installation and maintenance of the equipment. Depressurize and isolate the system before starting to loosen or remove any connection.
- If the equipment is likely to come into contact with aggressive substances, it is the responsibility of the user to take suitable precautions that prevent it from being adversely affected.
- It is the responsibility of the installer/user of this equipment to ensure:
  - This product is not used as a support for other equipment or personnel.
  - This product is protected from impact.
  - It is important that this sensor is handled with care due to its sensitivity to impact.

3.2.2 Pressure bearing parts

- It is the responsibility of the installer/user of this equipment to ensure:
  - The materials of construction are suitable for the application.
  - All piping connections conform to the local and national regulations and codes of practice.
  - The pressure and temperature limits for this equipment are not exceeded, if necessary by the use of suitable safety accessories.
  - Correct gaskets/seals are fitted and are compatible with the media and process.
  - The installed sensor is adequately supported for weight and vibration effects.
  - Personnel are protected from hot burns by guards, thermal lagging or limited access. Allow time to cool prior to carrying out maintenance operations. It is recommended that "HOT" notices are fitted in the vicinity of the equipment where applicable.
  - Regular inspection for corrosion and wear are carried out, both internal and external.
- The sensor must not be fitted until all installation work and final precommissioning checks are carried out. Do not remove blanking plugs until the sensor is fitted.
- The sensor must be installed in compliance with this manual, to ensure correct fitting. This applies to all variants.
- The user should not repair this equipment, but general maintenance can be applied as described within this manual.

3.3 Installation considerations

Density is a sensitive indicator of change in a fluid - a key reason why density measurement is increasingly being chosen as a process measurement. However, density measurements can be sensitive to extraneous effects and, therefore, great care must be taken to consider all the factors which may affect measurement when assessing the installation requirements.

Like many other meters, the optimum performance of the meter depends upon certain conditions of the fluid. You must first select a suitable position where the fork's tines are always completely immersed in the fluid. Although tolerant of solids, turbulence and bubbles, there should be at least a 200 mm clearance from objects e.g. impellers, pipe stubs, etc.

Then consideration can be given to fluid conditioning at that point. Where the application requirements allow a degree of tolerance in the point chosen for installation, the installation may be able to take advantage of natural flow conditioning.

The choice of mechanical installation will be dictated partly by application needs and partly by the fluid conditions, such as:

- Condition of fluid at the sensor
- Flow rate
- Entrained gas
- Solids contamination

3.3.1 Fluid at the sensor

The fluid in the effective zone of the long stem 7826/7828 meter must be of uniform composition and at uniform temperature. It must be representative of the fluid as a whole. This is achieved by taking advantage of any natural tank condition that tends to cause mixing, such as pump discharge, partially open valves etc.

3.3.2 Flow rate

If there is flow in the tank, the rate of flow should ideally be not more than 0.5 m^3/s. If flow rates exceed this, a ‘shift’ will be introduced into density readings. The higher the flow rate is, the larger the ‘shift’. Measurements also become ‘noisy’.

3.3.3 Entrained gas

Gas pockets can disrupt the measurement. A brief disruption in the signal caused by transient gas pockets can be negated in the internal signal conditioning software, but more frequent disruptions or serious gas entrainment must be avoided. This can be achieved by observing the following conditions:

- Vent any gas prior to the meter.
- Avoid sudden pressure drops or temperature changes which may cause dissolved gases to break out of the fluid.

3.3.4 Solids contamination

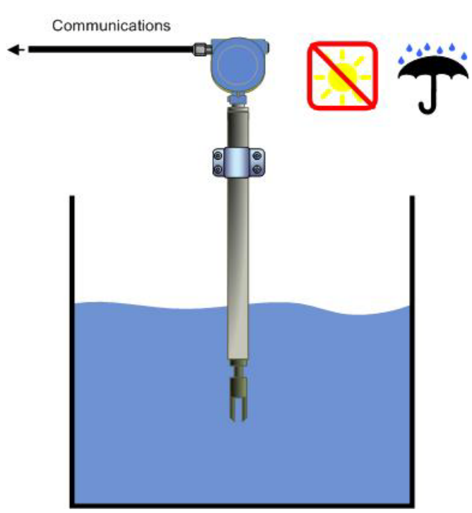
- Avoid sudden changes of velocity that may cause sedimentation.
- Install the meter far enough away from any build-up of solids.
- Maintain flow velocity at the sensor within the specified limits.
- Specify the long-stem 7826/7828 meter with a non-stick PFA protective layer.

3.4 Open-tank installation

Only the safe area model may be used in open-tank installation.

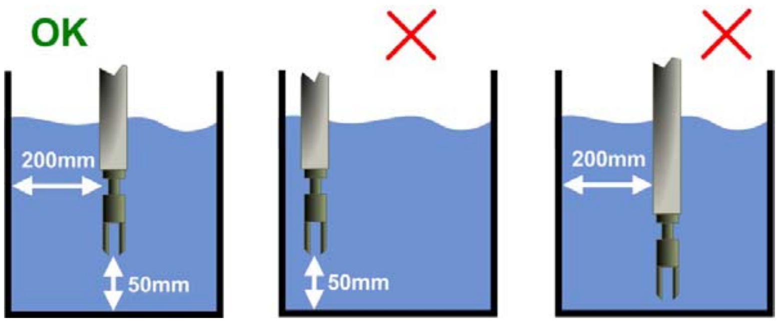
1. For open-tank installations, the long-stemmed 7826/7828 meter is clamped to a structure (see Figure 3-1). The position of the clamp determines the insertion depth.

Figure 3-1 Open-tank installation



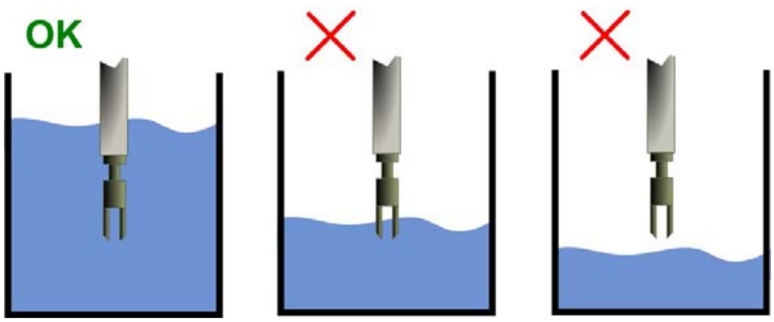
2. Keep the tines away from the tank wall (see Figure 3-2).

Figure 3-2 Keeping tines away from the tank wall (Open-tank)



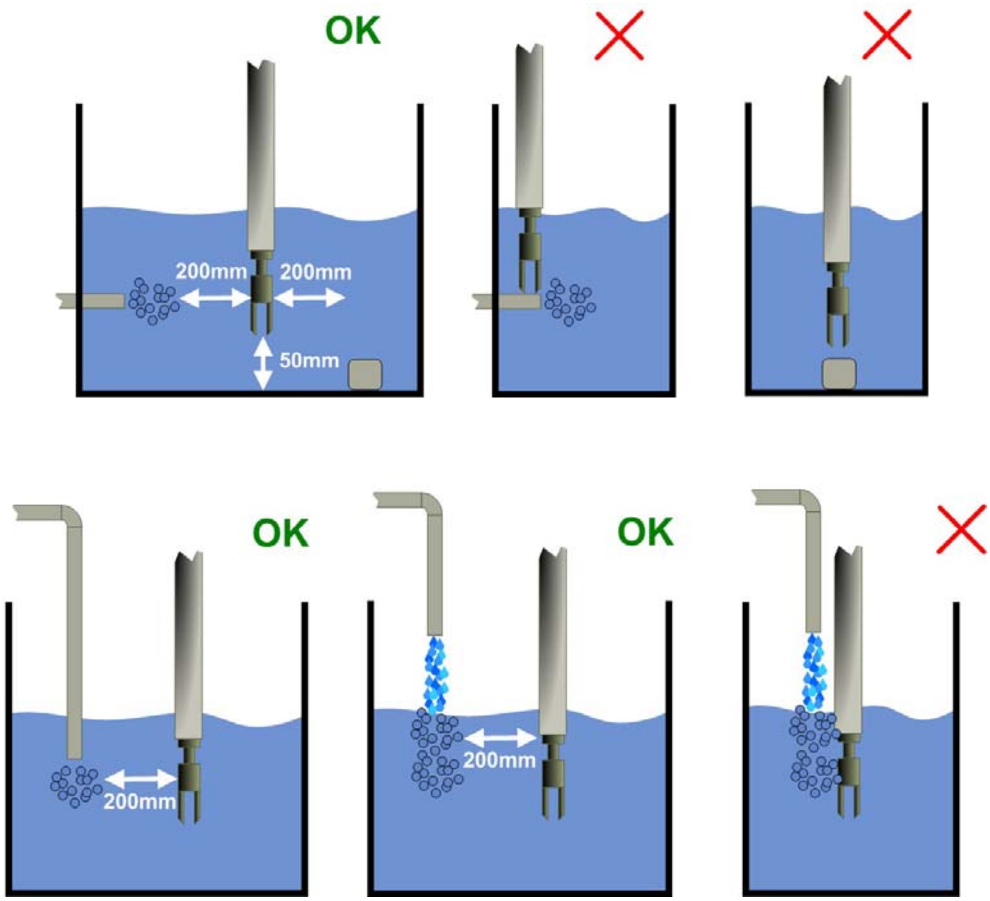
3. Keep the tines immersed in fluid (see Figure 3-3).

Figure 3-3 Keeping tines immersed (Open-tank)



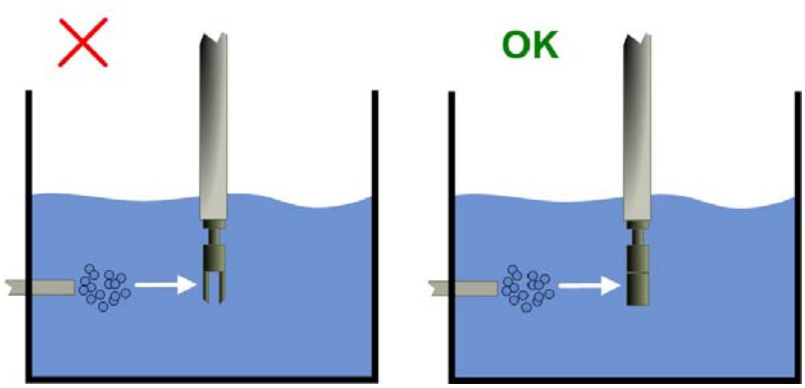
4. Keep tines away from objects and disturbed flow (see Figure 3-4).

Figure 3-4 **Keeping tines away from objects and disturbed flow (open tank)**



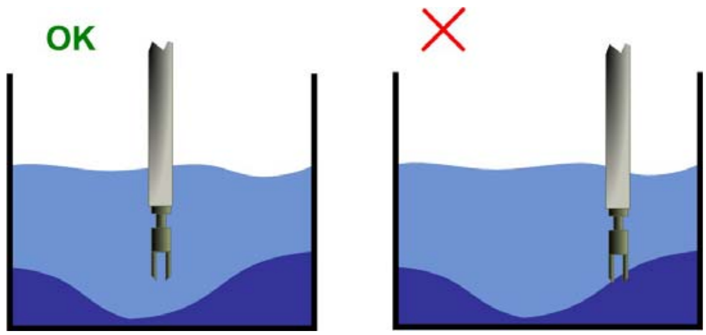
5. If there is flow, align the tines such that the flow is directed towards the gap between the tines (see Figure 3-5).

Figure 3-5 **Aligning the tines in flow (Open-tank)**



6. Keep away from deposit build-up (see Figure 3-6).

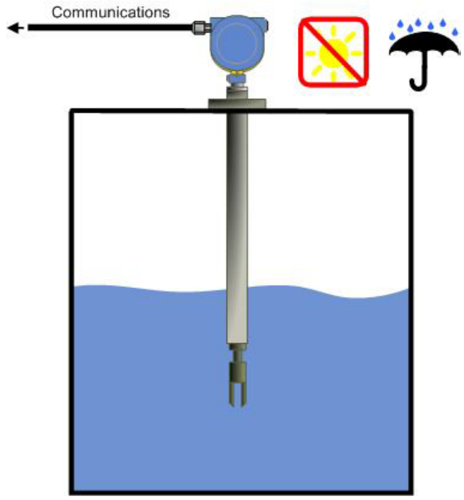
Figure 3-6 **Avoid deposit build-up (Open-tank)**



3.5 Closed-tank installation

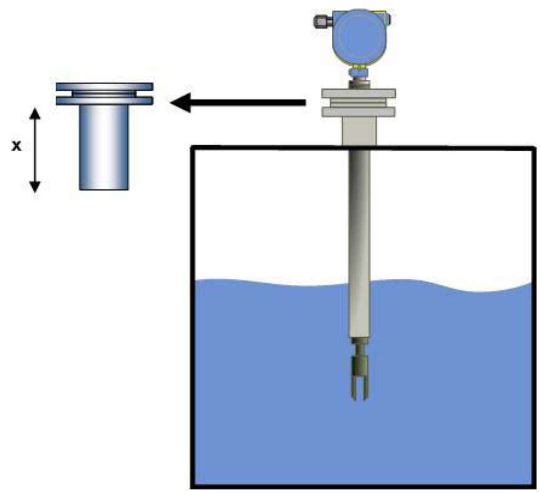
1. For closed-tank installations, the long-stemmed 7826/7828 meter should have a factory fitted flange attachment. (This is an option that is specified as a code in the part number – see a list of the product options in the product data sheet available at www.micromotion.com.) (See Figure 3-7).

Figure 3-7 **Closed-tank installation**



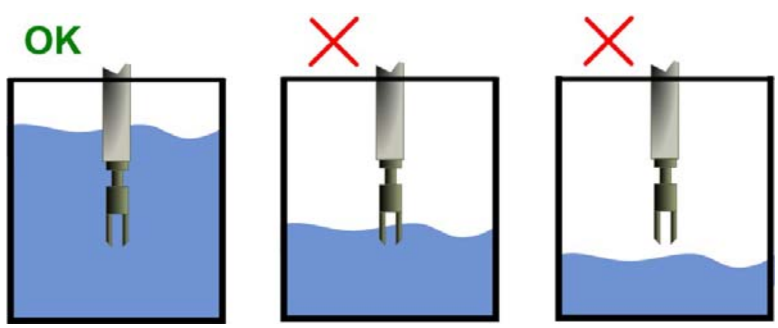
2. To vary the insertion depth, a standoff section with flange (not supplied) can be used (see Figure 3-8).

Figure 3-8 **Use of standoff section (not supplied)(closed-tank)**



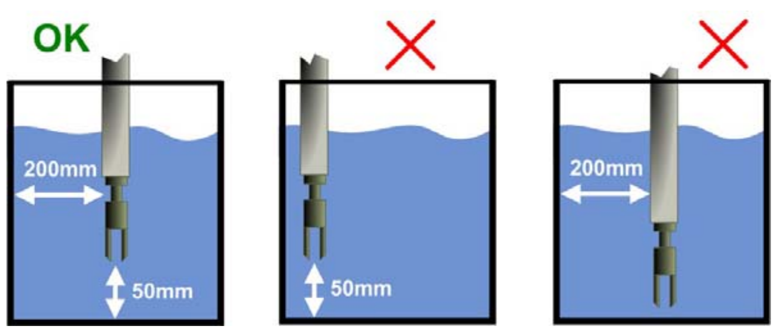
3. Keep the tines immersed in fluid (see Figure 3-9).

Figure 3-9 **Keeping tines immersed (closed tank)**



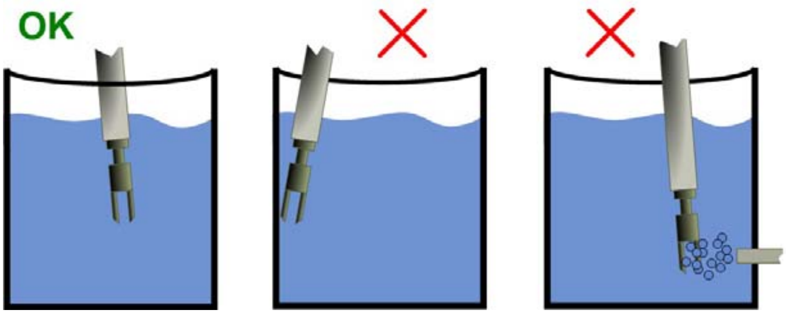
4. Keep the tines away from the tank wall (see Figure 3-10).

Figure 3-10 **Keeping away from tank wall (closed tank)**



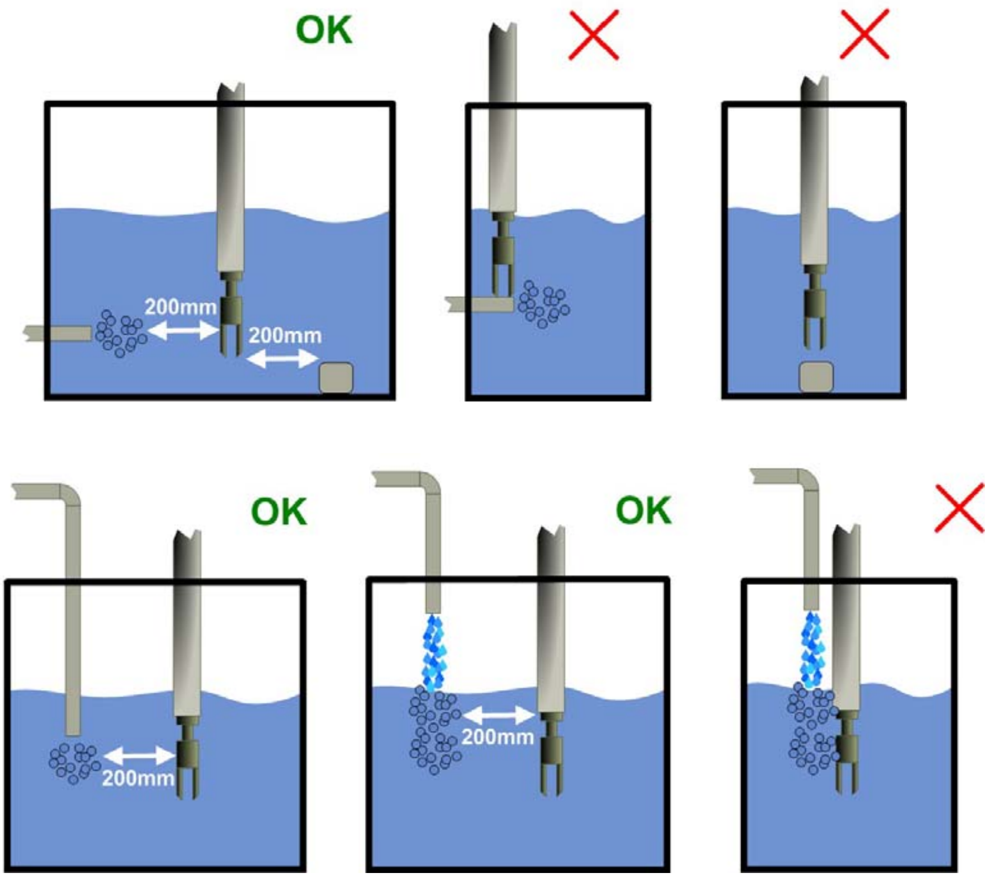
5. Allow for flexing of the tank lid, preventing the long-stemmed 7826/7828 meter from being pushed towards a tank wall or into the path of disturbed flow (see Figure 3-11).

Figure 3-11 **Allowing for tank lid flexing (closed tank)**



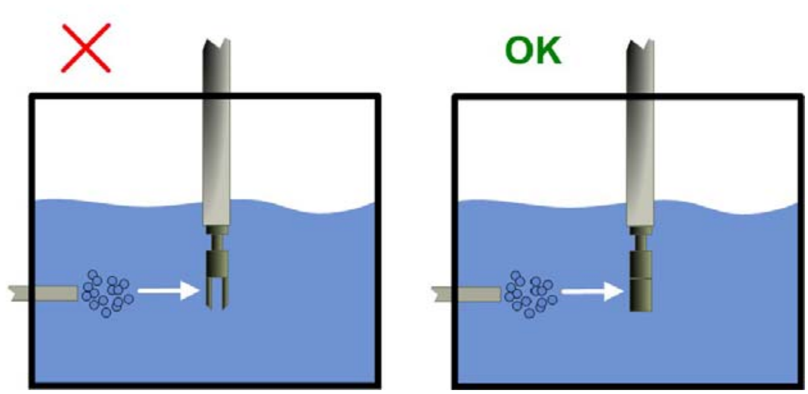
6. Keep tines away from objects and disturbed flow (see Figure 3-12).

Figure 3-12 **Keeping tines away from objects and disturbed flow (Closed-tank)**



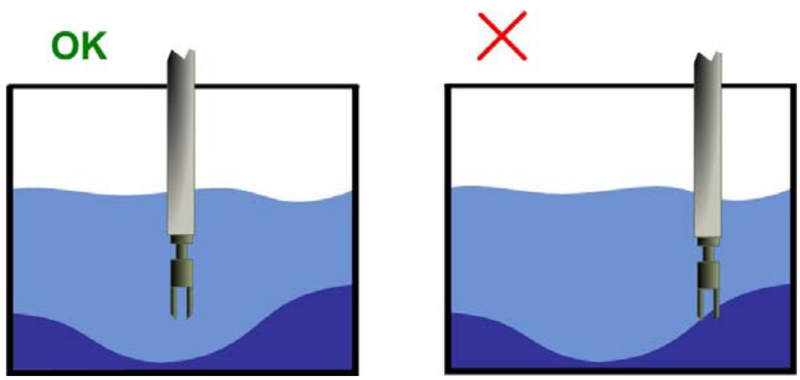
7. If there is flow, align the tines such that the flow is directed towards the gap in the tines (see Figure 3-13)

Figure 3-13 **Aligning the tines in flow (closed tank)**



8. Keep away from deposit build-up (see Figure 3-14).

Figure 3-14 **Avoid deposit build-up (closed tank)**



3.6 Calibration

The log-stemmed 7826/7828 meter is factory calibrated and no further calibration is necessary. The calibration is traceable to Micro Motion onsite ISO17025-accredited laboratory.

For calibration range, see the 7826/7828 liquid density meter product data sheet available at www.micromotion.com.

3.7 If the tank is pressurized

1. Once the installation has been prepared, and before installing the 7826/7828 meter, fit a blanking flange or compression nut to the 7826/7828 meter mounting, and pressurize and flush the system.
2. Isolate the system, depressurize and remove the blanking flange or compression nut.
3. Install the 7826/7828 meter.
4. Slowly pressurize the system and check for leaks, particularly if the normal operating temperature is high, or the sensor has been fitted cold; tighten as necessary.

5. Once the system has stabilized and is leak free, fit the insulation material, remembering also to insulate any flanges.

3.8 Long Stem Dimensional Drawings

3.8.1 Open-tank connection

Figure 3-15 Open-tank connection (cast housing)

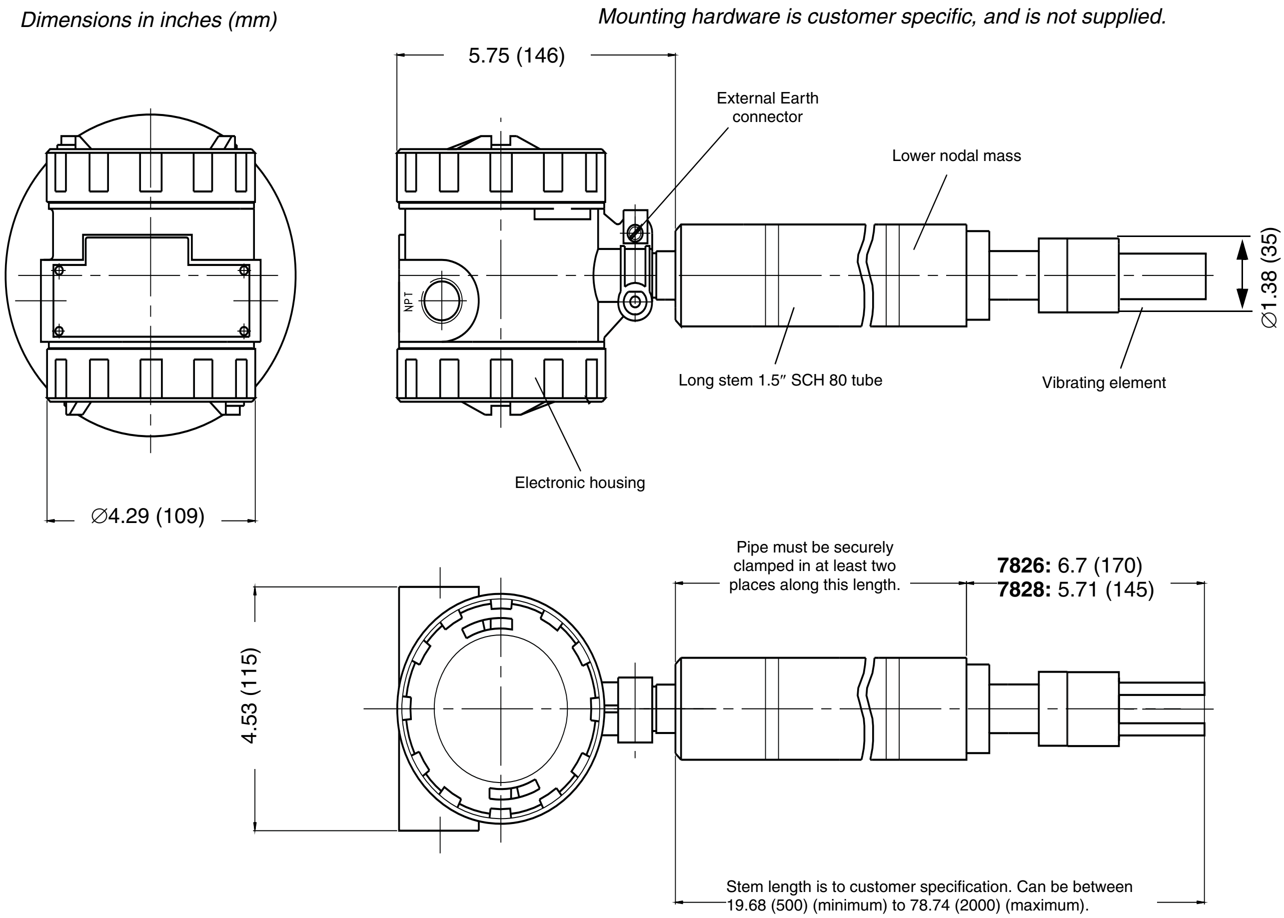
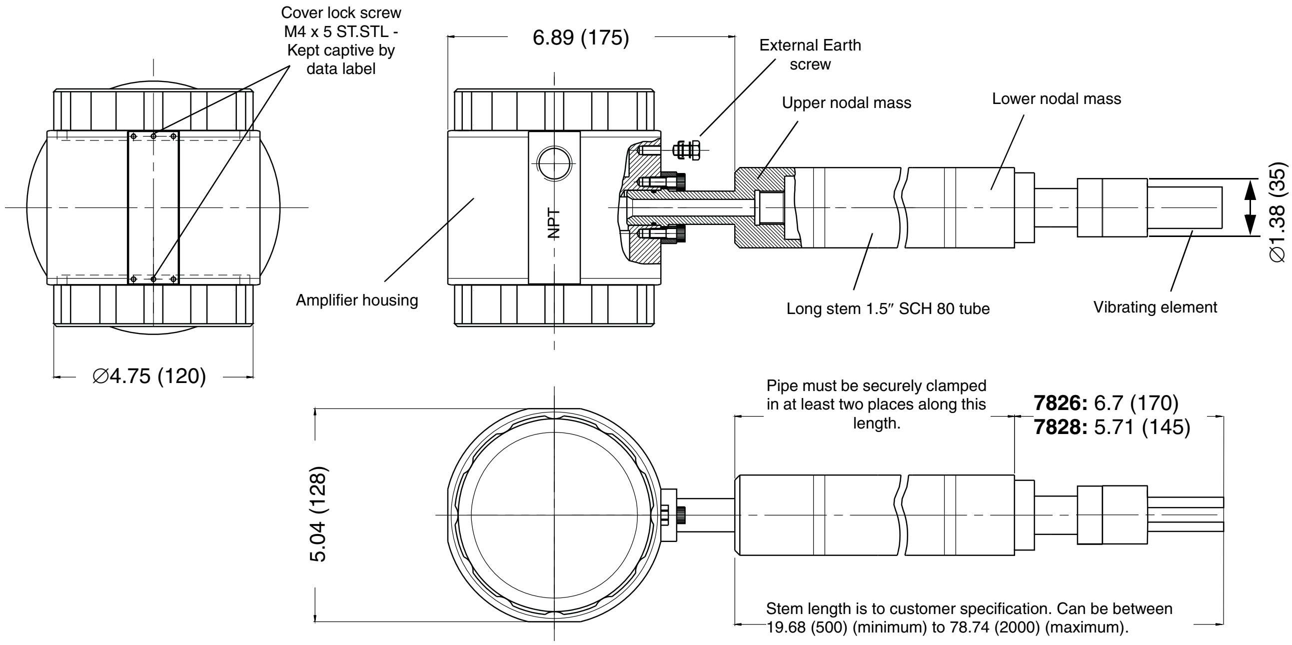


Figure 3-16 Open-tank connection (stainless steel housing)

Dimensions in inches (mm)

Mounting hardware is customer specific, and is not supplied.



3.8.2 Closed-tank connection

Figure 3-17 Closed-tank connection (cast housing)

Dimensions in inches (mm)

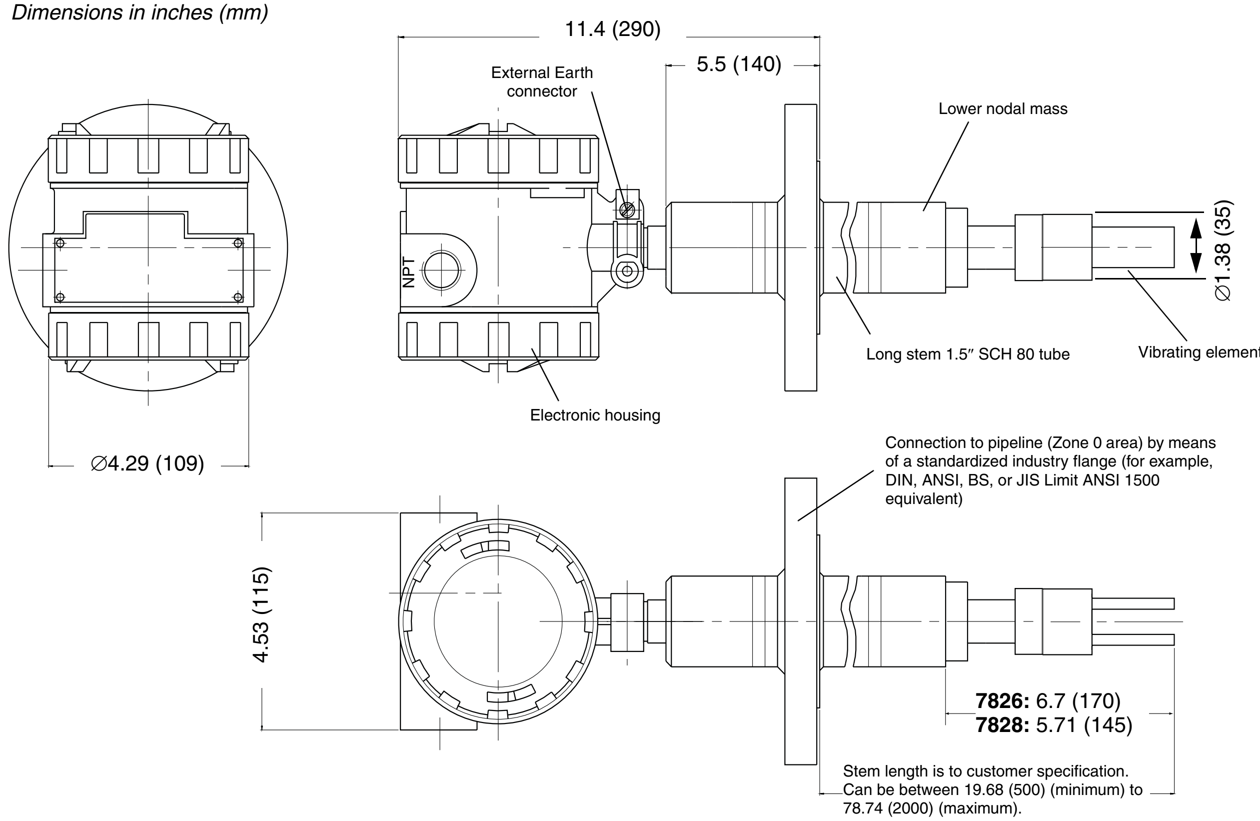
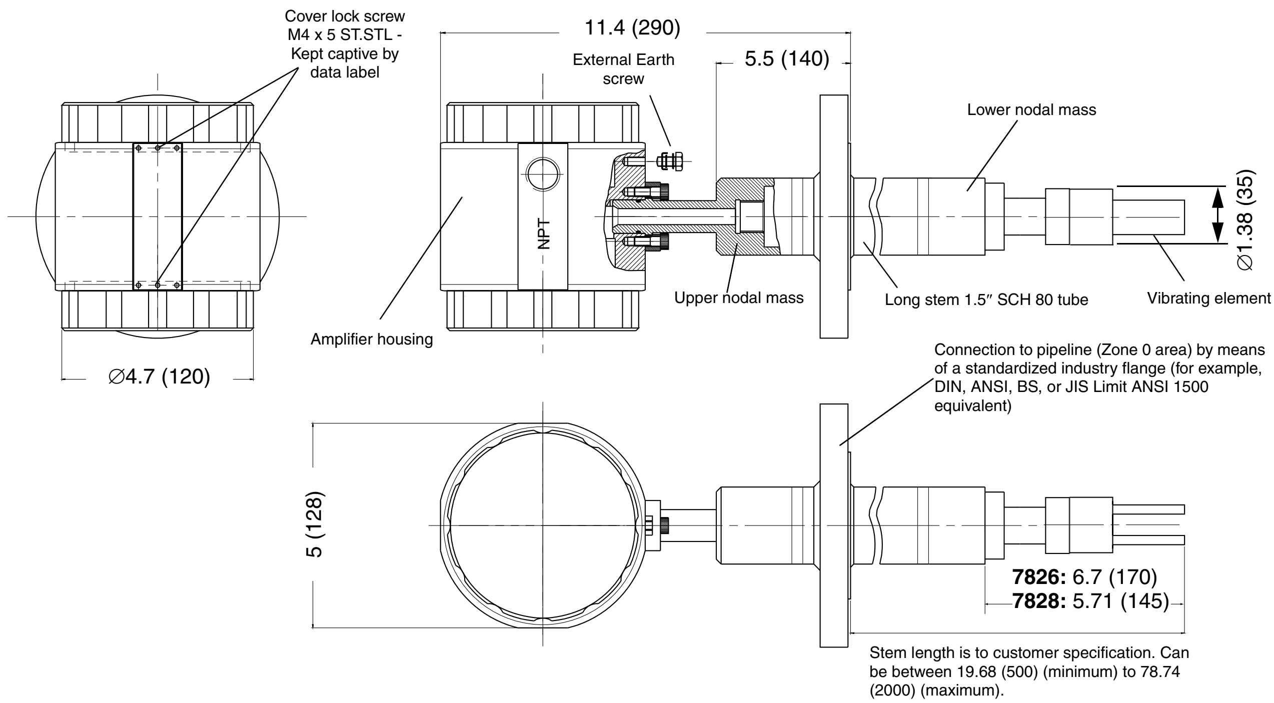


Figure 3-18 Closed-tank connection (stainless steel housing)

Dimensions in inches (mm)



Chapter 4
Electrical Connections (Frequency Output) – 7826 Only

The following information is applicable to the 7826 liquid density meter only. For information on making the electrical connections for the 7826 and 7828 liquid density meters with Advanced electronics, see Electrical Connnections (Advanced) chapter.

For installations in hazardous areas:

- **For ATEX installations, the electrical installation must strictly adhere to the safety information given in the ATEX safety instructions booklet shipped with this manual. See Safety Information in Chapter 1 for important information.**
- **For installations in USA and Canada, the electrical installation must strictly adhere to the Electrical Codes and a conduit seal is required within 2" (50 mm) of the enclosure.**

4.1 Introduction

This chapter shows you how to wire up the 7826 liquid density meter and then connect it to the Micro Motion® 795x series of computers.

4.2 Installation considerations

4.2.1 Power supply

The power supply to the 7826 liquid density meter must have the following requirements:

- Voltage: Nominally 24 VDC, but in the range 23 to 27 VDC.
- Current: 50 mA

4.2.2 EMC

To meet the EC Directive for EMC (Electromagnetic Compatibility), it is recommended that the 7826 meter be connected using a suitable instrumentation cable containing an overall screen. This should be earthed at both ends of the cable. At the 7826 meter, the screen can be earthed to the meter body (and therefore to the pipework), using a conductive cable gland.

4.2.3 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.

4.2.4 Cabling requirements

Although it is possible to connect separate cables to the 7826 meter for power and the signal outputs, it is recommended that all connections are made through one instrumentation-grade cable.

The instrumentation cable should be individually screened twisted-pairs with an overall screen, foil or braid for the cable. Where permissible, the screen should be connected to earth at both ends. (At the 7826 meter, this is best done using a conductive cable gland.)

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 1000 m (3200 ft), but care must be taken to ensure that the power supply at the meter is at least 23 V. Thus, for 24 V 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:

- ½” NPT to M20 gland adapter
- ½” NPT blanking plug
- M20 x 1 cable gland (not supplied).

The gland adapter and blanking plug are supplied with the 7826 meter – these two parts are Ex d rated. However, you will need to get a suitably rated cable gland:

- For non-hazardous area installations, use an IP68 or higher rated cable gland.
- For hazardous area installations use an Ex d-rated cable gland.

In hazardous areas, all parts must be explosion-proof. Alternative parts may be required in order to meet local electrical installation regulations.

4.2.5 Surge protection

Careful consideration should be given to the likelihood of power supply surges or lightning strikes. The power supply connections of the 7826 meter have a surge arrestor fitted that gives protection against power supply transients.

If there is a possibility of lightning strikes, external surge protection devices - one for each pair of signals and the power supply - should be installed as close to the 7826 meter as possible.

Another method of surge protection is to connect an MOV (Metal Oxide Varistor) (breakdown voltage >30 V) with an NE-2 neon bulb in parallel across each wire and ground. These can be mounted in a junction box close to the 7826 meter.

4.2.6 Installation in explosive areas

For installations in hazardous areas:

- **For ATEX installations, the electrical installation must strictly adhere to the safety information given in the ATEX safety instructions booklet shipped with this manual. See Safety Information in Chapter 1 for important information.**
- **For installations in USA and Canada, the electrical installation must strictly adhere to the Electrical Codes and a conduit seal is required within 2” (50 mm) of the enclosure.**

The 7826 meter is an explosion-proof and flameproof device. However, it is essential to observe the rules of compliance with current standards concerning flameproof equipment:

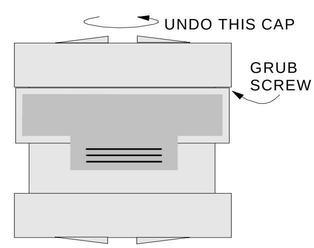
- Electronics housing caps should be tightened securely and locked in position by their locking screws.
- The electrical cable or conduit should have an appropriate explosion-proof cable gland fitted.
- If any electrical conduit entry port is not used, it should be blanked off using the appropriate explosion-proof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

4.2.7 Installation in non-hazardous areas

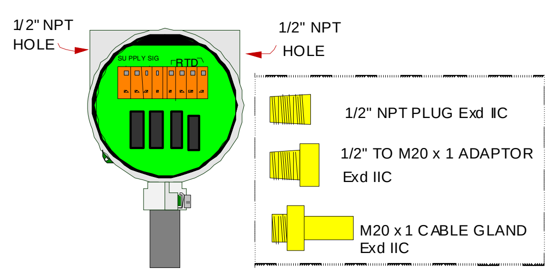
Typically the 7826 meter will operate over cable lengths up to 2 km from a 24 V supply. Micro Motion recommend cables similar to BS 5308 or RS 368.

4.3 Wiring the meter

1. Open the Terminal Board side of the meter's electronics housing by undoing the grub screw and unscrewing the lid anticlockwise.

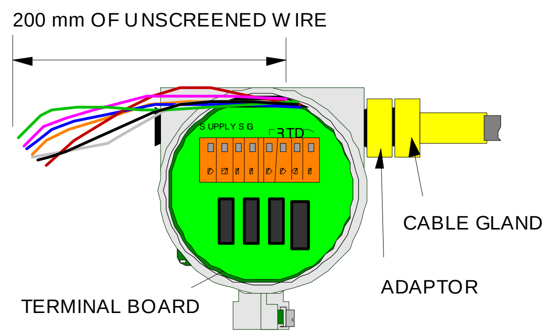


2. The meter is normally mounted horizontally such that the 1/2" NPT holes are on a vertical plane. This minimizes water ingress. Identify the 1/2" NPT hole which is lowest and attach the multi-core cable to it.

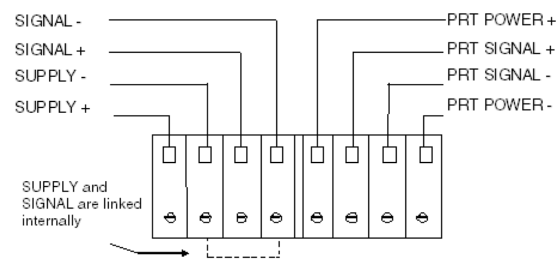


3. Assemble the adaptor, cable gland and cable so that the multi-core cable is gripped leaving 200 mm of free, unscreened wire to connect to the terminal blocks.

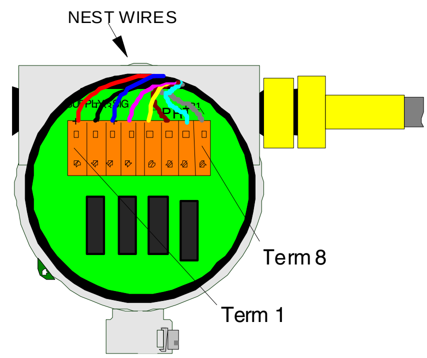
4. Fix the 1/2" NPT plug to the un-used hole.



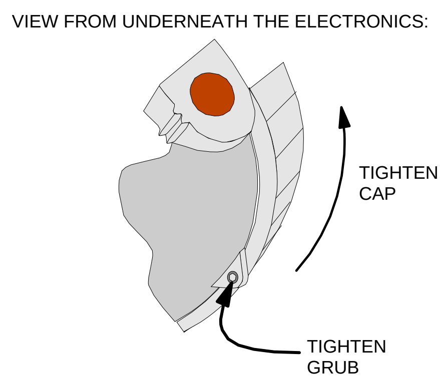
5. The adjacent diagram shows all the electrical connections to the meter terminal block.



6. When you have screwed the wires into the correct terminals, carefully tuck the wires around the electronics, and tighten the cable gland.



7. Screw the housing cap on fully and tighten the locking grub screw using the 2.5 mm AF hex drive.



4.4 Connecting the meter to a 795x series computer

4.4.1 Overview

The meter requires a 795x series computer (Signal Converter or Flow Computer) with liquid-based application software for it to be functional. This section provides a guide to possible wiring connections between the meter and the 795x. Configuration of the 795x is outside the scope of this manual. For this task, refer to the 795x operating manual that was supplied with the 795x instrument.

795x computers are available as a 7950 Wall Mount unit or 7951 Panel Mount unit. Each type of unit has a different position and layout for the physical connections. There is even a choice of two connection panels for the 7951 - Klippon or D-type (Cannon).

795x	Connectors used
7950	10-way Klippon
7951	25-way D-type (Cannon) or 10-way Klippon

Note: The choice of rear panel connectors for the 7951 is done prior to ordering the unit so that it is manufactured to satisfy the customers connector requirement.

Use this table to quickly find the appropriate connection diagrams.

795x		Figure
7950	Signal Converter/Flow Computer	Figure 4-1
7951	Signal Converter/Flow Computer	Figure 4-2

Note: "Signal Converter" and "Flow Computer" are terms that are often used to identify the basic purpose of the 795x application software. Refer to the supplied 795x operating manual if in doubt about identification.

4.4.2 Connection diagrams

Figure 4-1 **Connecting a meter to a 7950 Signal Converter/Flow Computer (non-hazardous area)**

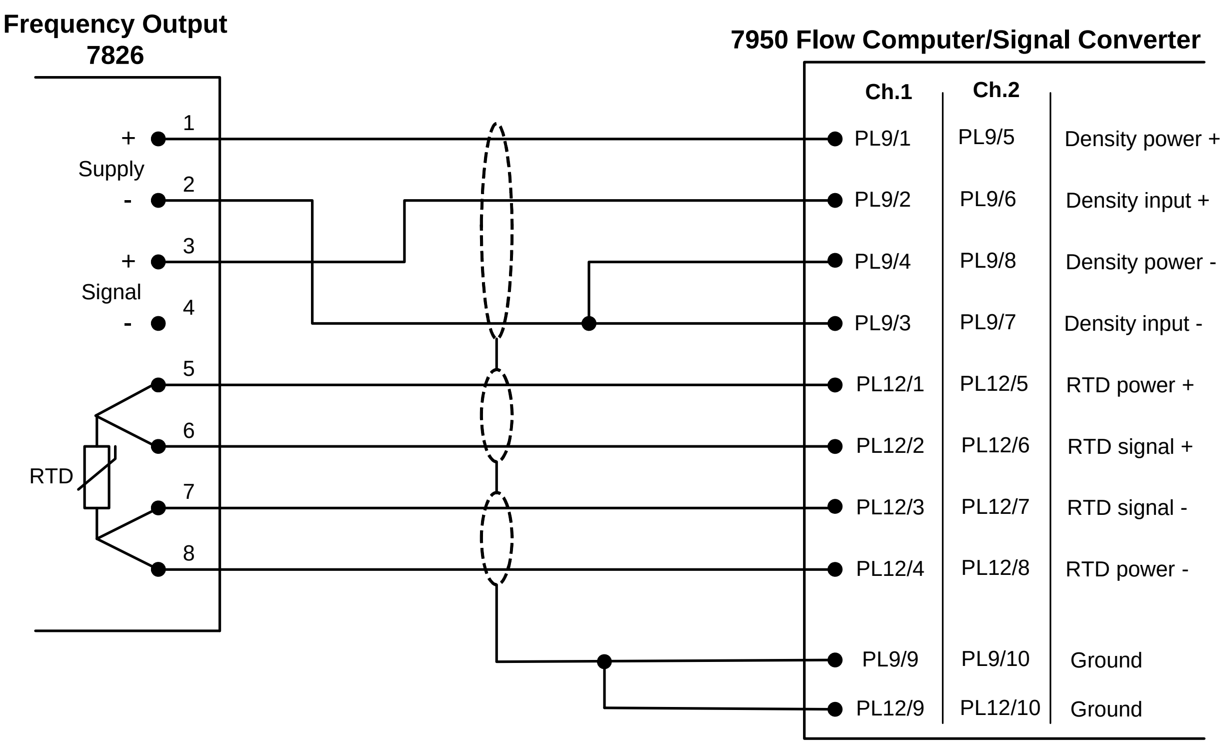
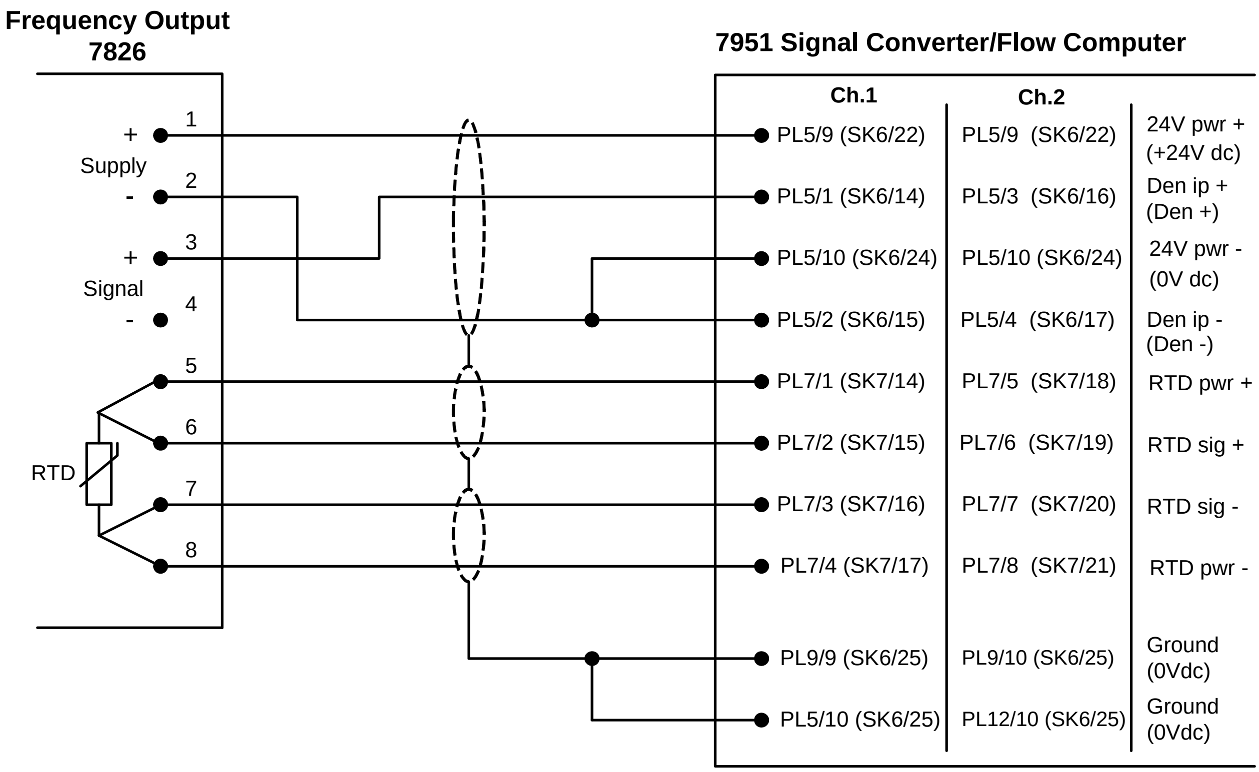


Figure 4-2 **Connecting a meter to a 7951 Signal Converter/Flow computer (non-hazardous area)**



4.5 System connections (customer's own equipment)

Incorrectly connecting the meter can damage the unit.

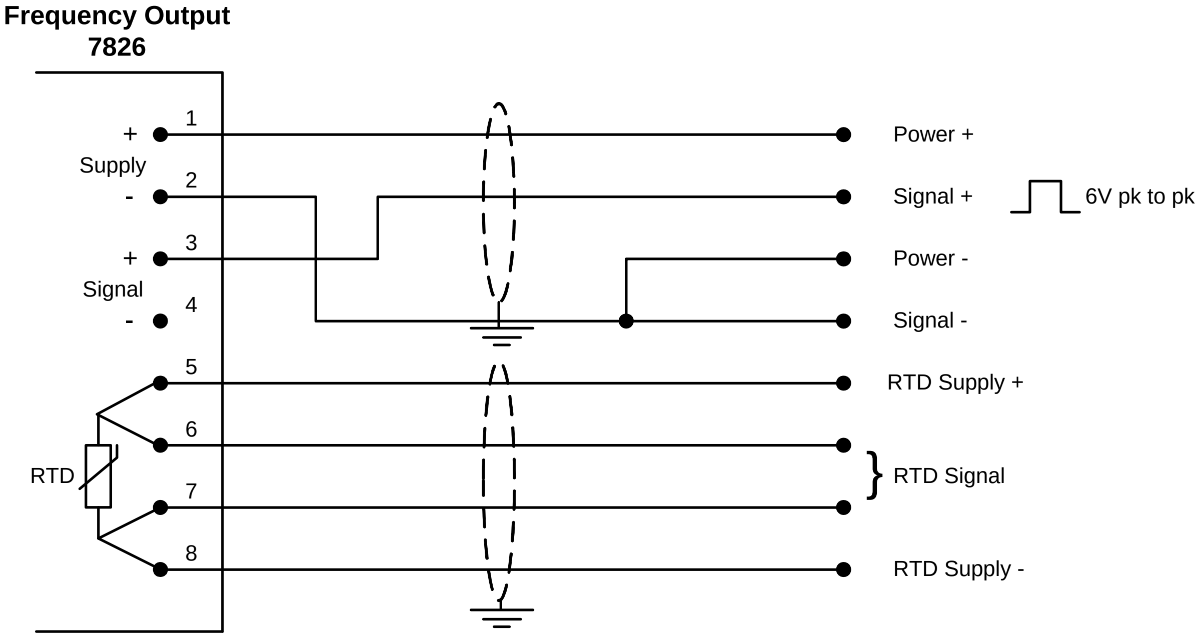
The power supply requirements from the customer's own equipment are as follows:

- For Density Meter: 23 to 27 VDC, 50 mA minimum
- For Meter RTD: 5 mA DC maximum

The frequency at which the meter is operating can be detected using a timer counter connected between the density output line and the negative power line.

The electrical connections to be made are shown in Figure 4-3.

Figure 4-3 Electrical connections for use with customer's own equipment (non-hazardous area)



4.6 Checking the installation

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

Electrical checks

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

- Current: 40 mA to 70 mA (Measured in series at the "**SUPPLY +**" terminal)
- Voltage: 22.8 V to 25.2 V (Measured between" **SUPPLY +**" and "**SUPPLY -**" terminals)

Functionality checks

1. With the meter clean and dry, and with the tines shielded from the wind, operate it in air and check that the meter frequency output (τ_B), is as specified on the meter calibration certificate density air point check. If the ambient conditions are not at 20°C (± 2 °C), use the formula below to calculate the resulting time period:
   - t_B @ 20 °C = t_B@ ambient temp – [0.25 * (ambient temp - 20)]

   The result (τ_B) from this equation should now correspond to the air check on the calibration certificate to within ± 0.5 µsec.

Note: The air check point is found in the Density Calibration section of the meter calibration certificate.

The τ_B value can be easily monitored by a 795x computer with the "**Health Check**" facility. Perform the following 795x front panel keyboard sequence if this facility is required:

a. Press the bottom-right grey **MAIN MENU** key.

b. Use the **DOWN-ARROW** key (at the left of the display) to page down through the menu options until "Health Check" (or similar) appears.

c. Select the "Health check" option using the appropriate blue key at the right side of the display.

d. Use the blue **DOWN-ARROW** key (at the left side) to page down through the menu options until "Time period inputs" (or similar) appears.

e. Select the relevant "Time Period i/p 2", "Time Period i/p 3" or "Time Period i/p 4" option according to the physical connections made to the 795x.

f. Refer to the supplied 795x operating manual for information about front panel key operations and navigating the menu structure.

Chapter 5
Electrical Connections (Advanced)

For information on making the electrical connections for the 7826 liquid density meter with Frequency Output electronics, see Electrical Connections (Frequency Output) chapter.

For installations in hazardous areas:

- **For ATEX installations, the electrical installation must strictly adhere to the safety information given in the ATEX safety instructions booklet shipped with this manual. See Safety Information in Chapter 1 for important information.**
- **For installations in USA and Canada, the electrical installation must strictly adhere to the Electrical Codes and a conduit seal is required within 2" (50 mm) of the enclosure.**

5.1 Introduction

The 7826/7828 liquid density meter with Advanced electronics has two types of output:

- Two off 4–20 mA analog outputs that give an output proportional to a user-specified range. The parameters that can be output on each analog output are as follows:

Analog Output 1	Analog Output 2
Line density (1)	Line density
Base or referred density(2)	Base or referred density
Line temperature	Line temperature (3)
Special function parameter	Special function parameter

(1) Factory default selection for product option codes A and C.
(2) Factory default selection for product option code B.
(3) Factory default selection for all product options.

- A Modbus (RS-485) interface, giving access to other measurement results, system information and configuration parameters. The Modbus interface is also used to configure the 7826/7828 meter, using a PC running the Micro Motion ADView or ProLink II software (see the Using ADView and ProLink II chapter).

It is recommended that both output types are installed, requiring a minimum of eight wires (two for each output, and two for power). Although you may not immediately require the Modbus connection, it may be required for in-situ calibration adjustment and future system enhancements, and the cost of the additional wires is trivial compared to the expense of installing them retrospectively.

A number of factors must be taken into account when planning the electrical installation. These include:

- Power supply
- EMC
- Ground connections
- Cables
- Surge protection
- Installation in explosive area
- Modbus connections
- Analog connections

5.2 Installation considerations

5.2.1 Power supply

The power supply to the 7826/7828 liquid density meter must have the following requirements:

- Voltage: Nominally 24 VDC, but in the range 20 to 28 VDC.
- Current: for transmitter – 50 mA; for mA outputs – 22 mA per output.

If several 7826/7828 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.

Upon leaving the factory, the two 4-20 mA analog outputs are non-isolated as they are powered through internal links to the power supply input. However, if split-pads “LNK A” (Analog Output 1) and “LNK B” (Analog Output 2) by the terminal block are ‘broken’, they become isolated and require a separate 20-28 VDC power supply (see the 4–20 mA outputs section for details).

If an RS-232 to RS-485 converter is used (for example to connect to a serial port on a PC), this may also require a power supply (see the Further information on RS-485 section for details).

Care should be taken where there is the possibility of significant common-mode voltages between different parts of the system. For example, if the 7826/7828 meter is locally powered from a power supply which is at a different potential to the RS-485 ground connection (if used).

5.2.2 EMC

To meet the EC Directive for EMC (Electromagnetic Compatibility), it is recommended that the 7826/7828 meter be connected using a suitable instrumentation cable containing an overall screen. This should be earthed at both ends of the cable. At the 7826/7828 meter, the screen can be earthed to the meter body (and therefore to the pipework), using a conductive cable gland.

5.2.3 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.

The electronics and communications connections (RS-485/Modbus and 4-20 mA analog output) of the 7826/7828 meter are not connected to the body of the meter. This means that the negative terminal of the power supply can be at a different potential to the earthed bodywork.

In the majority of applications, it is not necessary to connect the RS-485 ground connection. In areas where there is a significant amount of electrical noise, higher communications integrity may be obtained by connecting the negative power terminal (pin 2) of the 7826/7828 meter to the communications ground. If this is done, it is important to ensure that the possibility of ground loops (caused by differences in earth potential) is eliminated.

5.2.4 Cabling requirements

Although it is possible to connect separate cables to the 7826/7828 meter for power, RS-485 and the 4-20 mA analog output, it is recommended that all connections are made through one instrumentation-grade cable.

Connections for the Analog and Modbus signals should be individually screened twisted-pairs with an overall screen, foil or braid for the cable. Where permissible, the screen should be connected to earth at both ends. (At the 7826/7828 meter, this is best done using a conductive cable gland.)

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 1000 m (3200 ft), but care must be taken to ensure that the power supply at the meter is at least 20 V. Thus, for 24 V 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:

- ½" NPT to M20 gland adapter
- ½" NPT blanking plug
- M20 x 1 cable gland (not supplied).

The gland adapter and blanking plug are supplied with the 7826/7828 meter – these two parts are Exd rated. However, you will need to get a suitably rated cable gland:

- For non-hazardous area installations, use an IP68 or higher rated cable gland.
- For hazardous area installations use an Exd-rated cable gland.

In hazardous areas, all parts must be explosion-proof. Alternative parts may be required in order to meet local electrical installation regulations.

5.2.5 Surge protection

Careful consideration should be given to the likelihood of power supply surges or lightning strikes. The power supply connections of the 7826/7828 meter have a surge arrestor fitted that gives protection against power supply transients.

If there is a possibility of lightning strikes, external surge protection devices - one for each pair of signals and the power supply - should be installed as close to the 7826/7828 meter as possible.

Another method of surge protection is to connect an MOV (Metal Oxide Varistor) (breakdown voltage > 30 V) with an NE-2 neon bulb in parallel across each wire and ground. These can be mounted in a junction box close to the 7826/7828 meter.

If the RS-485/Modbus output is permanently connected to a PC, an independently powered, fully isolated RS-485 to RS-232 converter should be used. (See the Further information on RS-485 section for details).

5.2.6 Installation in explosive areas

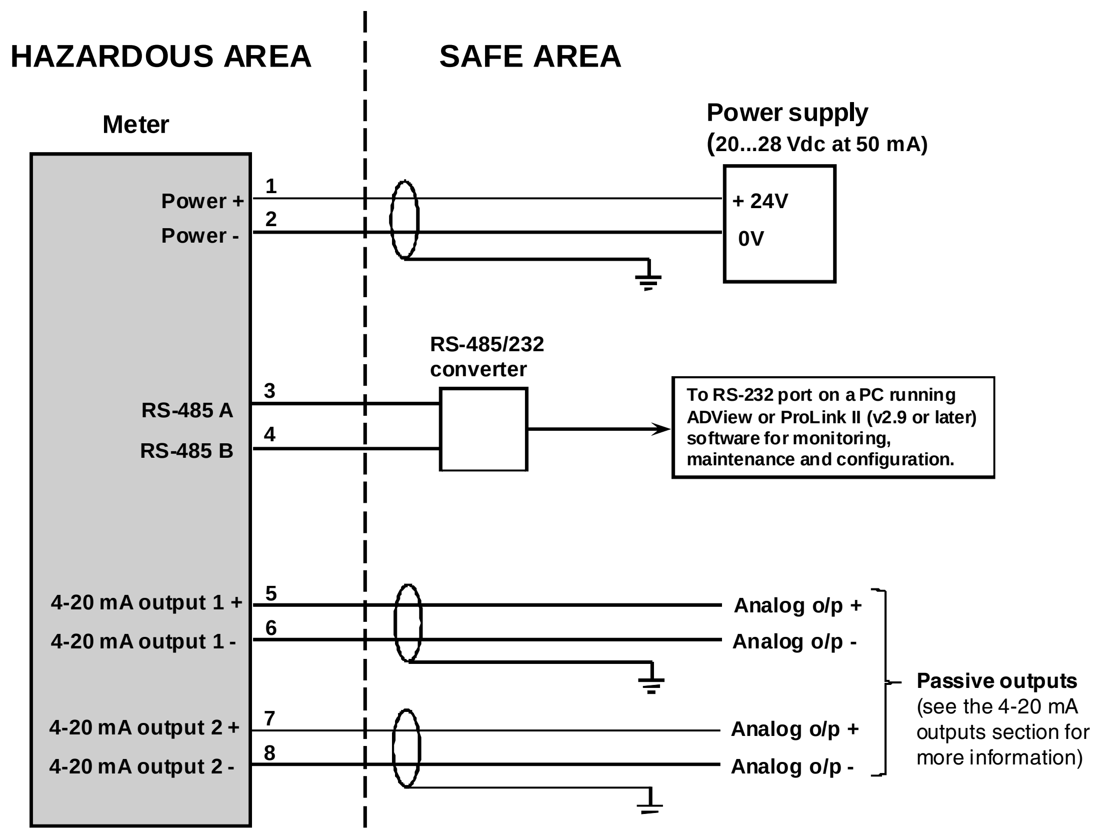
For installations in hazardous areas:

- **For ATEX installations, the electrical installation must strictly adhere to the safety information given in the ATEX safety instructions booklet shipped with this manual. See Safety Information in Chapter 1 for important information.**
- **For installations in USA and Canada, the electrical installation must strictly adhere to the Electrical Codes and a conduit seal is required within 2” (50 mm) of the enclosure.**

The 7826/7828 meter is an explosion-proof and flameproof device. However, it is essential to observe the rules of compliance with current standards concerning flameproof equipment:

- Electronics housing caps should be tightened securely and locked in position by their locking screws.
- The electrical cable or conduit should have an appropriate explosion-proof cable gland fitted.
- 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.
- The spigot must be locked in place.

Figure 5-1 **Wiring diagram**



Notes

1. The main 24 VDC power supply must supply the following: 20 to 28 VDC at 50 mA for transmitter; and, 22 mA per analog output used.
2. The RS-485/232 converter and PC are not normally installed permanently. However it is strongly recommended that the wiring to the 7826/7828 meter is made at installation.
3. Upon leaving factory, the two analog outputs are non-isolated as they are powered through internal links to Power Supply Input.
4. If split-pads “LNK A” (Analog Output 1) and “LNK B” (Analog Output 2) by the terminal block are broken, the two 4-20 mA analog outputs become isolated; direct connections to an external power supply is then required. A second or third external 20 to 28 VDC power supply can be used. (See 4-20 mA outputs section for more details).
5. Typically, four pairs of shielded 19/0.30 mm^2 (#16 AWG) to 19/0.15 mm^2 (#22 AWG) wires are used for wiring.
6. The naming conventions for RS-485 signals differ between manufacturers. If RS-485 communications do not function correctly, try swapping the ‘A’ and ‘B’ signals over at one end of the link.

5.3 Wiring the meter

Figure 5-2 shows the terminal board of the 7826/7828 liquid density meter. To reveal the terminal board, it is necessary to unscrew the housing cap; the procedure is described in the Wiring Procedure section.

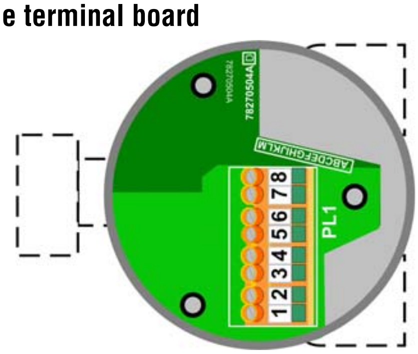
Note: If the 7826/7828 meter is to be used in hazardous areas, the electrical installation must strictly adhere to the safety information given in the ATEX safety instructions booklet that shipped with this manual. See Safety Information in Chapter 1 for more information.

The connections to the 7826/7828 meter are:

- Power
- Modbus (RS-485) communications
- Analog outputs (4-20 mA).

It is recommended that you install all connections (eight cores) at installation, to avoid the possibility of expensive alterations to the cabling at a later date. Typically, four pairs of shielded 19/0.30 mm^2 (#16 AWG) to 19/0.15 mm^2 (#22 AWG) wires are used.

Figure 5-2 View of the terminal board

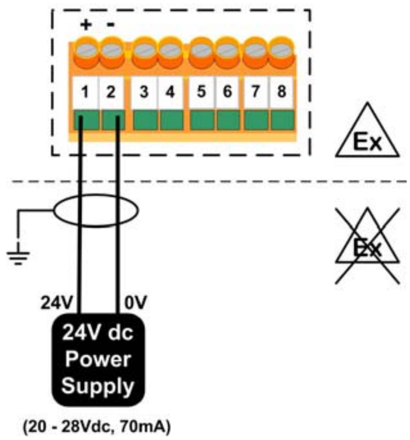


5.4 Power supply input

Terminals **1** and **2** are for connecting an external 24 VDC power supply, as guided in Figure 5-3.

Ensure that the loop resistance of the cable(s) is such that the voltage at the meter terminals is greater than 20 volts. (The maximum voltage at the meter terminals is 28 VDC.)

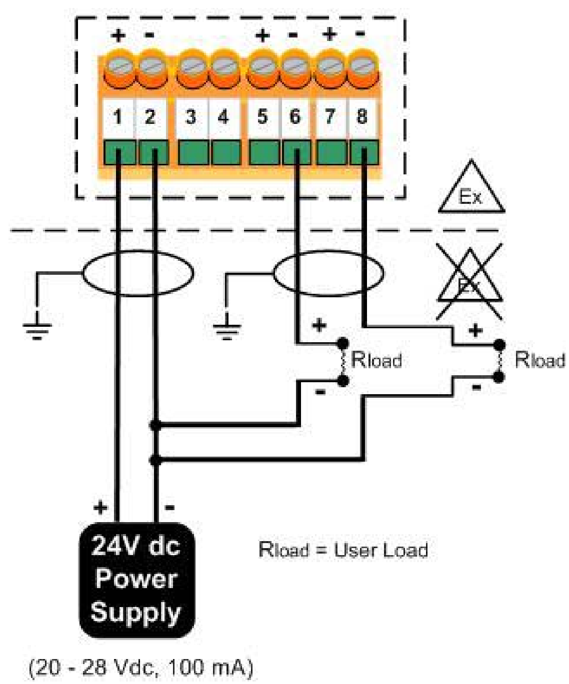
Figure 5-3 **Power supply connections**



5.5 4-20 mA outputs

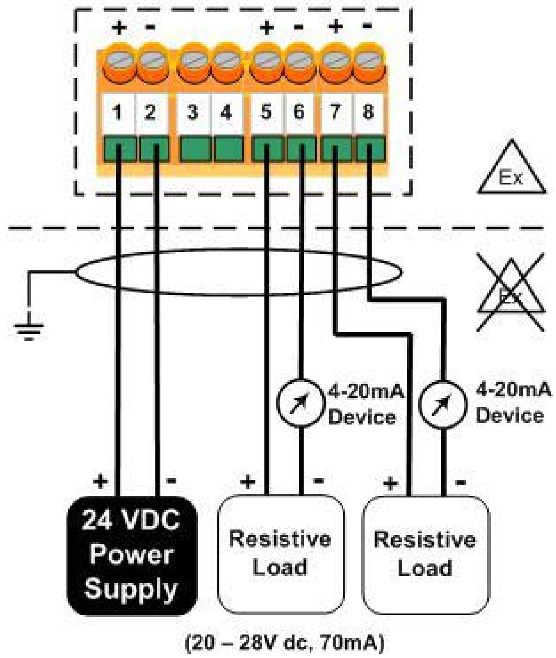
Terminals **5**, **6**, **7** and **8** are for connecting the two 4-20 mA analog outputs to external devices, such as a PLC or DCS. Upon leaving the factory, the two 4-20 mA analog outputs are non-isolated as they are powered through internal links to the Power Supply Input.

Figure 5-4 **4–20 mA output using a single power supply**



However, if split-pads "LNK A" (Analog Output 1) and "LNK B" (Analog Output 2) by the terminal block are 'broken', they become isolated and require direct connections to another external 20–28 VDC power supply (see Section 5.5.1 for more information on isolating the analog outputs). A second or third external 20–28 VDC supply can be used.

Figure 5-5 **4–20 mA output using up to three independent power supplies**



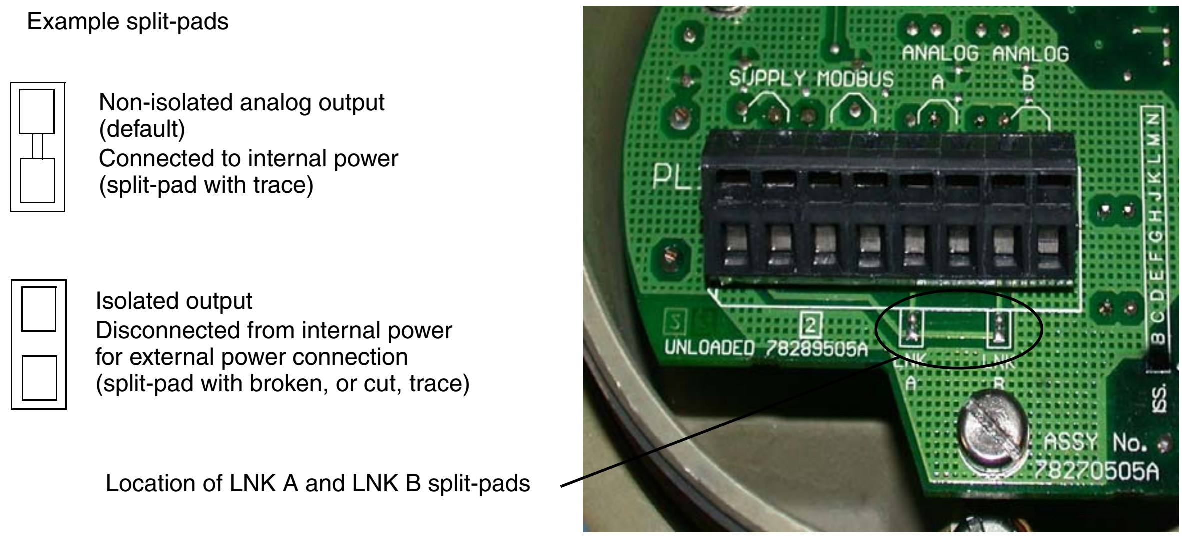
Note: The external device must be located in a non-hazardous (safe) area unless it is explosion proof and suitably certified.

Fault conditions within the 7826/7828 meter are indicated by a 2 mA output. If this is detected, the Modbus link can be used to interrogate the meter to establish the likely cause of the problem.

5.5.1 Isolating the analog outputs from internal power

To isolate the analog outputs from internal power, use a sharp knife to cut the fine metal strip (or trace) for the appropriate split-pad (see Figure 5-6).

Figure 5-6 **Isolating an analog output from internal power (for external power connection)**



5.6 Modbus (RS-485)

Terminals **3** and **4** are for RS-485/Modbus connections to a PC, as shown in Figure 5-7. Connect the RS-485/232 signal converter to your PC's serial or USB port, using adapters as required. Figure 5-7 shows a serial port connection, but a USB port connection is also available.

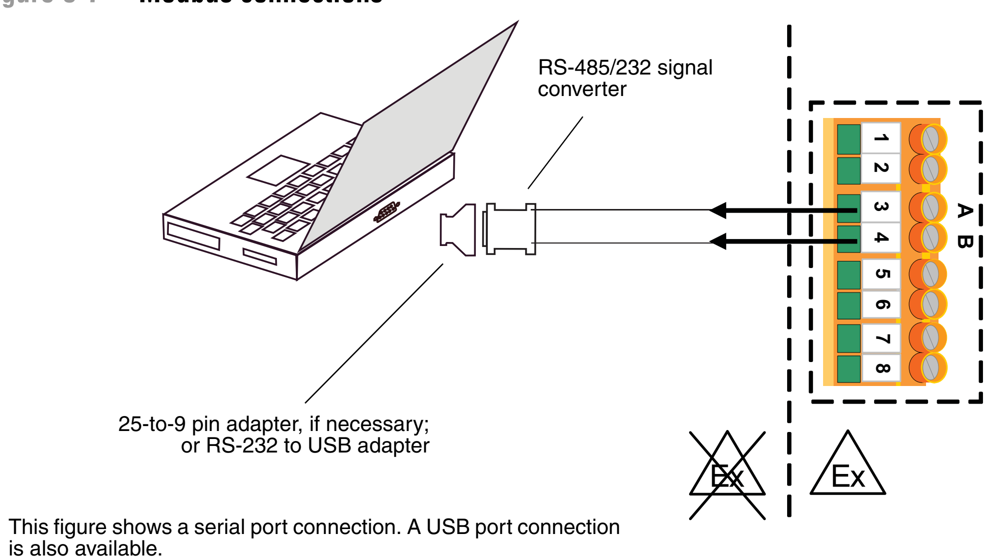
Note: The PC and converter are always located in a non-hazardous (safe) area.

The RS-485/232 converter and PC are not normally installed permanently. However it is strongly recommended that the wiring to the 7826/7828 meter is made at the time of installation.

For detailed information on RS-485, see the Further information on RS-485 section.

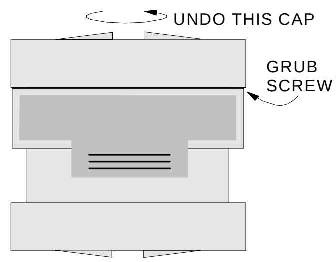
Note: If you encounter communication difficulties with RS-485, swap over the 'A' and 'B' signal connections at one end of the network.

Figure 5-7 **Modbus connections**

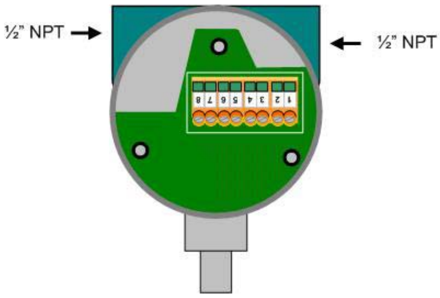


5.7 Wiring procedure

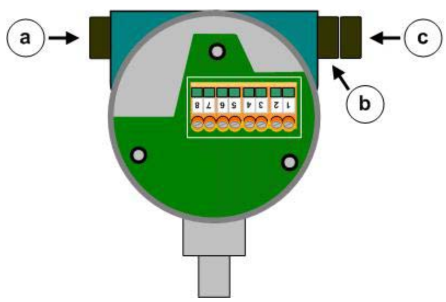
1. Open the Terminal Board side of the meter's electronics housing by undoing the 2.5 mm AF grub screw and unscrewing the lid anticlockwise.



2. Fit the M20 gland adaptor into the most convenient ½” NPT hole.

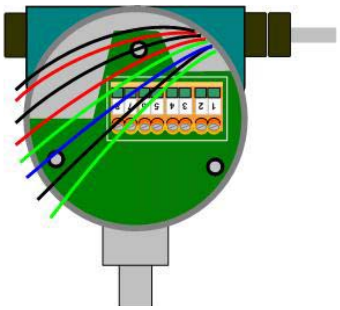


3. Fit the M20 x 1 cable gland to the adapter. Fit a ½” NPT blanking plug to the unused hole.

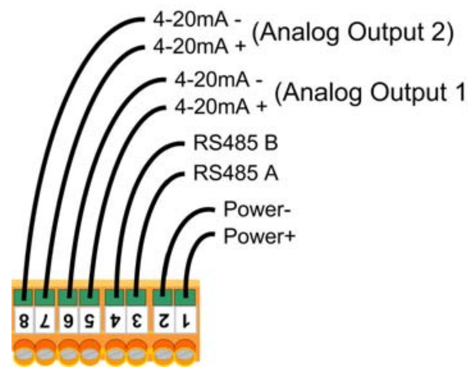


a: ¾” NPT Blanking Plug.
b: ¾” NPT to M20 adaptor.
c: M20 cable gland.

4. Insert the cable through the cable gland and adaptor so that the multi-core cable is gripped leaving 200 mm of free, unscreened wire to connect to the terminal blocks.

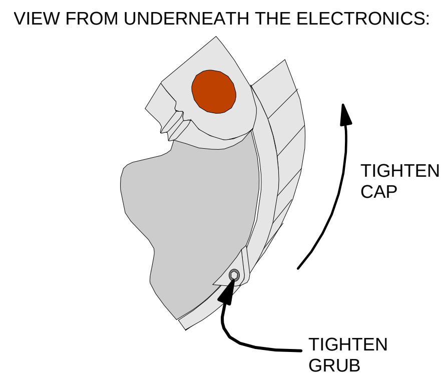


5. Wire up the cable cores as shown



6. When you have screwed the wires into the correct terminals, carefully tuck the wires around the electronics, and tighten the cable gland.

7. Screw the housing cap on fully and tighten the locking grub screw using the 2.5 mm AF hex drive.



5.8 Further information on RS-485

5.8.1 RS-485

The 7826/7828 meter's Modbus communications uses the RS-485 electrical standard. This uses the difference between the two signal cores to transmit and detect logic levels, and is therefore able to tolerate significantly higher levels of common mode noise than RS-232, which uses the voltage between the signal core and a common earth. A brief summary of some typical characteristics of the two standards is given below.

	RS-485	RS-232
Signal detection	Differential	Single-ended
Receiver threshold	200 mV	+1.5 V
Meter output swing	0 to +5 V (no load) +2 to +3 V (120 ohm load)	± 8 V

A converter is required for communication between the two standards. Further details are given in Section 5.8.2.

Only two signal connections are required for RS-485, usually called A and B, sometimes '+' and '–'.

Note: Unfortunately, different manufacturers have interpreted the standard in different ways. Some have a 'logic 1' represented by signal A being more positive than signal B, others have made the opposite interpretation. If you encounter communication difficulties with RS-485, the first remedy is to swap over the 'A' and 'B' signal connections at one end of the network.

For areas which may experience high common mode signals, a third conductor can be used as a ground reference for the communications signals. If used, this should be connected to Terminal 2 (Power supply negative) on the 7826/7828 meter.

5.8.2 RS-485 to RS-232

Converters are available from a number of sources, and can range from simple in-line devices that simply plug into a PC's RS-232 port, to programmable devices with full isolation between the two networks.

Note: The 7826/7828 meter uses a half-duplex implementation of RS-485, such that the A and B signals are used for data transmission in both directions. This requires that the RTS line is toggled to indicate the transmission direction. This can be done by the host computer, or automatically by an RS-485/232 converter which has the facility to do so. If you are using Windows 2000, XP or Vista on your PC, you should use a converter which automatically changes RTS (as detailed below) otherwise the link may not work correctly.

For simple installations**,** where the following conditions are valid, a simple in-line converter will be satisfactory:

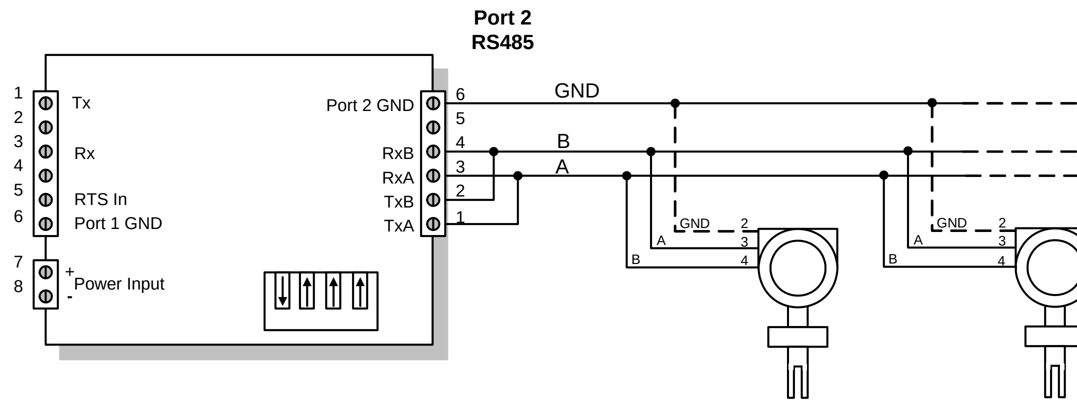
- The Modbus network is less than about 150 ft (50 m).
- The number of devices on the bus is low.
- No common mode problems.

The converter derives its power from the PC's RS-232 port RTS or DTR line, which must be held permanently in the high state. This is normally adequate for short distances where there are only a few devices on the network. However, the ability of the port to supply sufficient power is not guaranteed, especially for laptop PCs, and it may be necessary to connect an external power supply. This may also be necessary if using Windows 2000, XP, or Vista.

To check the voltage levels, measure the voltages on the RTS input and the DTR input while the converter is connected to the PC (or other RS-232 device). This procedure needs a break-out box (not supplied). Whichever input is powering the converter must have at least +6 V during communications. Where the power is found to be insufficient, a 9 VDC supply can be connected between (+) and GND of the RS-232 connector.

5.8.3 RS-485 multi-drop

When several devices are connected in parallel on an RS-485 network, this is known as a multi-drop network. Although it is theoretically possible to have up to 256 devices, in practice this is limited to around 32 or less, depending largely on the driving power of the Master. Each device has a unique slave address. For the 7826/7828 meter, this address must be individually programmed using the ADView or ProLink II (v2.9 or later) software, before being connected to the multi-drop network (see section 4.4.3 for details).



Wiring is quite straightforward: simply connect 'B' terminal to 'A' terminal, A to B. On some devices, the RS-485 signals may be marked + and –. The + signal generally corresponds to the A signal, and the – signal to B. If you encounter communication difficulties with RS-485, the first remedy is to swap over the 'A' and 'B' connections at one end of the network.

5.8.4 Transmission mode

The 7826/7828 meter's RS-485 interface uses the following parameter settings, which are not selectable:

- Baud rate: 9600
- Bits: 8
- Parity: None
- Stop bits: 2

Chapter 6
Using ADView and ProLink II (Advanced version)

6.1 Using ADView software

6.1.1 What is ADView?

ADView is a software package provided by Micro Motion to enable you to:

- Configure our density and viscosity meters.
- View and save data from them.
- Check that they are functioning correctly.

ADView is installed on a PC and interacts with the density/viscosity meter through one of the PC's standard serial (RS-232) ports.

ADView requires Microsoft's Windows operating system: Windows 95, 98, 2000, XP or Vista.

Note: To connect to an RS-485/Modbus device, such as the 7826/7828 meter, you will need an adapter between the PC and the meter (see Electrical Connections chapter).

ADView provides many useful facilities, such as:

- Setting up serial link to communicate with the meter
- Configuring the meter
- Displaying data in real time, or as a graph
- Logging data to a file
- Verifying correct operation of the system, and diagnosing faults
- Loading or storing Modbus register values
- Read/write to individual Modbus registers.

6.1.2 Installing ADView

ADView software is available for the PC on a variety of media (for example, CD-ROM) and is freely available to download from the Micro Motion web site (at www.micromotion.com).

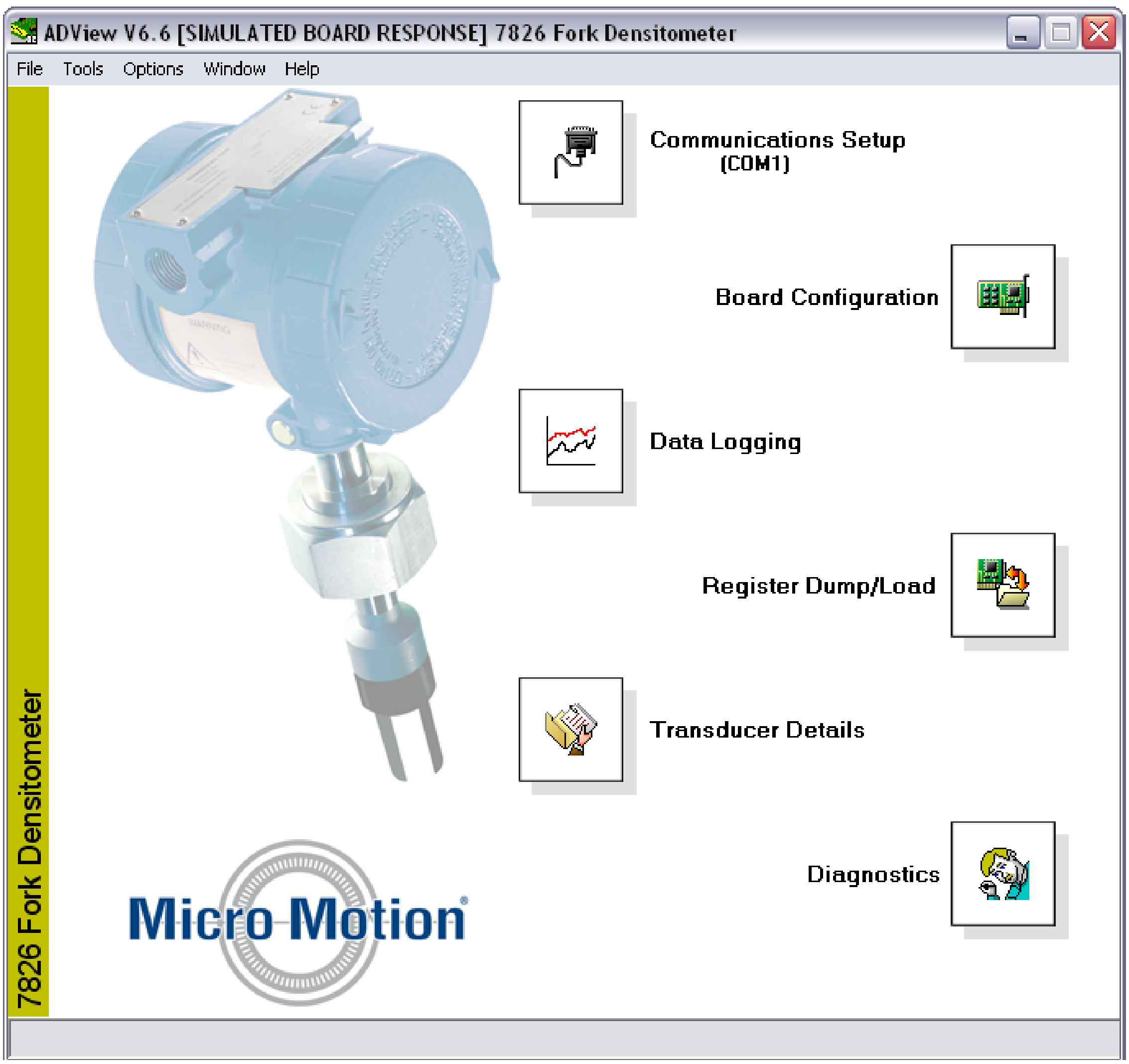
1. Identify the media containing the installation files for ADView.
2. Insert the media into an appropriate drive on your PC.
3. If the installation program does not begin automatically, run the set-up '.exe' file that is on the media. This does vary between different PC operating systems. In general, open the File Manager or Windows Explorer, browse the drive containing the media and double-click on the set-up '.exe'.)

4. When the installation program starts, you will be asked to supply your name and company name for registration purposes, and supply a directory path into which ADView's files can be loaded (a default directory path will be suggested).
5. Follow the installation instructions until installation is complete. It will normally only take a few minutes. You can abandon the installation if you need to do so.

6.1.3 Starting ADView

Start the ADView software by navigating through the Start Menu to the program entry of ADView 6. Left-click on it once and the window shown below will then appear.

Note: Developments in ADView may mean that the screen shots differ slightly from the ones you will see on your PC screen.



Each of the six icons gives you access to the various facilities of ADView. You can choose to connect a Modbus device to one of the PC's serial ports, or you can use ADView's built-in simulation of the meter.

To run the simulation, choose **Options > Simulate board response** from the menu bar and choose the appropriate densitometer option. Then, click on the **OK** buttons, as necessary, to return to the main ADView screen. When simulation is chosen, ADView ignores the serial port and supplies simulated data. However, you do still need to click on the **Communications Setup** button followed by the **Connect** button. Then, click on the **OK** buttons, as necessary, to return to the main ADView screen.

Setting up serial communications

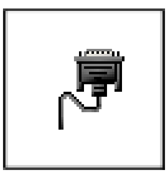
To operate with a real Modbus device, you will need to connect it to a suitable power supply (see the technical manual for the device) and need a connection to a serial port on the PC. Full details for connecting to the Modbus (RS-485) link on the meter are in Chapter 5.

ADView automatically configures the selected port with the correct settings for the device. For the meter, this is 9600 baud rate, 8 data bits, no parity, 1 stop bit, and Xon/Xoff (software) flow control.

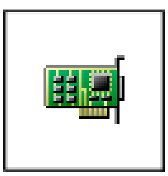
6.1.4 Understanding ADView features

ADView facilities

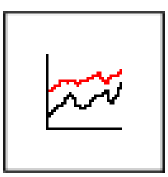
The main ADView window gives access to the various facilities available. A brief description of each is listed below. Using the facilities is largely intuitive so that you can quickly learn the system.



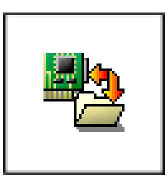
Communications Setup
Sets up and checks RS-232/RS-485 communications.



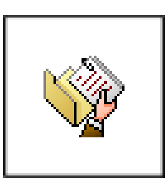
Board Configuration
- Enables you to select the measured parameter and range for the analog output, and to configure density referral by entering matrix values or K factors, as well as special calculations, line pressure and averaging time.
- Displays instantaneous values of a selectable output parameter and the analog output.



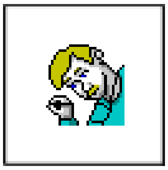
Data logging
- Provides tabular data from meters of line and base density, temperature and special function. One parameter can be displayed as a graph.
- Data can also be logged to a file in either Excel (tab delimited) or Notepad (space delimited) formats.
- The frequency at which results are logged can be set, and logging can be started and stopped.



Register dump/load
With this facility you can dump the contents of all (or selected) Modbus registers from the device, or alternatively transmit values to them. File format is selectable (Excel/tab delimited, or Notepad/Space delimited).



Meter details
Shows a list of meter details such as type, serial number, calibration dates, software version, etc.



Diagnostics
Enables you to view:
- live sensor readings
- the status of the meter
- values of working coefficients

You can also verify calculations.

Menu bar

File	Exit	Exit ADView program.
Tools	Health Check	Determines whether the system is functioning correctly.
	Register Read/Write	A facility for reading or writing to any of the Modbus registers (see Appendix D).
	Direct Comms.	Enables you to specify exactly what will be transmitted on the Serial link (see Appendix D).
	Engineer Status	Only used by Micro Motion service engineers.
Options	Simulate board response/ Actual Board	Allows you to select between these two options
	Enable / disable screensaver	Allows you to select between these two options. When enabled, the screensaver operates as configured by the Windows system settings.
Window		Provides a means of opening or selecting ADView's facilities.
Help	About ADView	Displays software version number.

Configuring a slave address

The factory configuration sets the slave address to 1. However, in many applications it will be necessary to allocate another address. In a multi-drop application, where several Modbus devices are connected on the same network, it is essential to configure unique slave addresses for each device.

To do this, you will need to run ADView and use the Register Read/Write facility, detailed in "Register Read / Write" on page 67. Check the value in Register 30 (Modbus Slave Address). If it is not the required value, enter the desired value and click on the write button. The meter will now be configured with the new slave address.

Board configuration

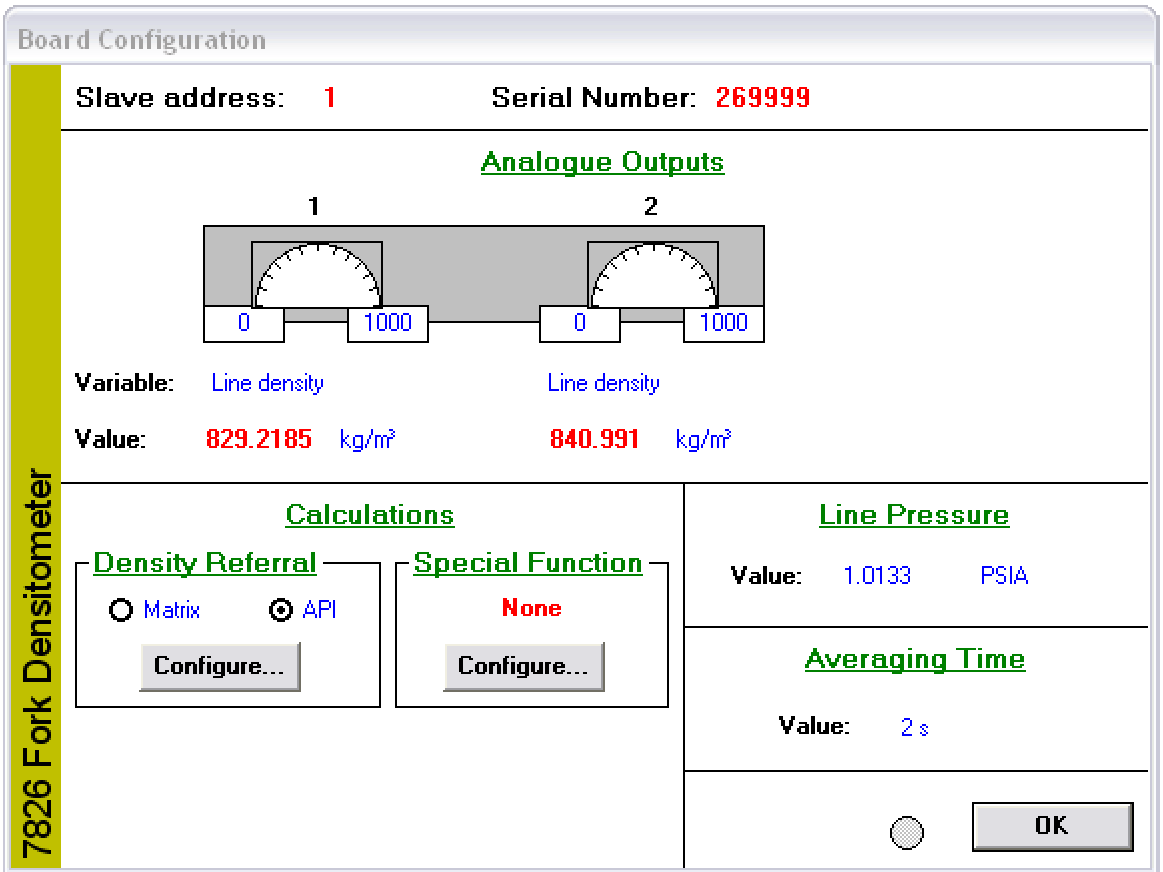
The board configuration controls the way in which the meter will process and present data, user settings, calibration constants and other factors. This data is stored in non-volatile memory known as registers; a full list of the registers used in the meter is given in Appendix D.

To configure the meter, it is necessary to write data into the configuration registers using the RS-485/Modbus link. ADView provides a convenient and graphical way of doing this without you needing to know about register addresses and data formats.

Certain parameters are not available for configuration by ADView, including the Density Offset value which may be required to fine tune the calibration of the meter. However, ADView does have tools for reading and writing to individual Modbus registers (using the **Tools > Register Read/Write** facility), and for direct communication on the Modbus (using **Tools > Direct Comms**). More details and examples are given in Appendix D, but for the significant majority of applications these tools will not be required.

There is no facility within ADView or the meter to ‘reset’ to a default configuration. Therefore, before attempting any alterations to the configuration, you are strongly advised to use the Register Dump/Load facility in ADView to store the existing configuration (see “Register Dump / Load” on page 67). Then, if any mishap occurs, you will be able to restore the configuration from the saved file.

ADView’s Board Configuration window is shown below:



To exit from any of the configuration windows without making any changes, press the **Esc** key on your computer keyboard.

Density referral (Configure… button)

To configure the density referral calculation, you will need to enter the relevant information.

- For *matrix referral*, this is a set of four values of density for each of up to five different temperatures; Appendix B gives more details on this.
- For *API referral*, you can select the product type, which automatically adjusts the coefficients of the General Density Equation, or enter your own values.

Special function (Configure… button)

The range of special functions (calculated parameters) that are available depends on the referral type selected.

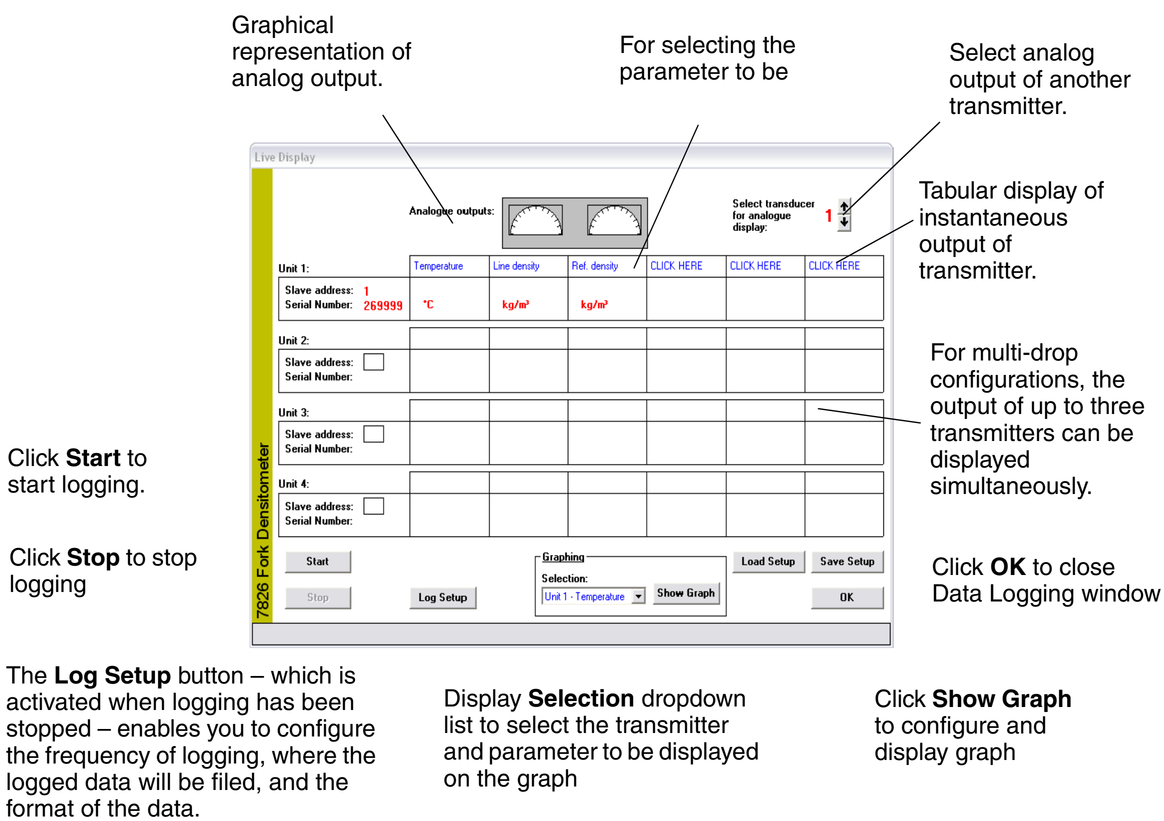
Special Function	API referral	Matrix referral
Specific Gravity	✓	✓
API°	✓	
% mass		✓
% volume		✓
° Baumé		✓
° Brix		✓
User defined quartic		✓
None	✓	✓

When you select the Special Function you require, the configuration window will alter to allow you to input the relevant parameters, if applicable. Note that you can only select one Special Function to be available at any one time.

When you are satisfied with the configuration, you should save it to a file, using the **Register Dump/Load** facility, as a safeguard against subsequent loss or alteration.

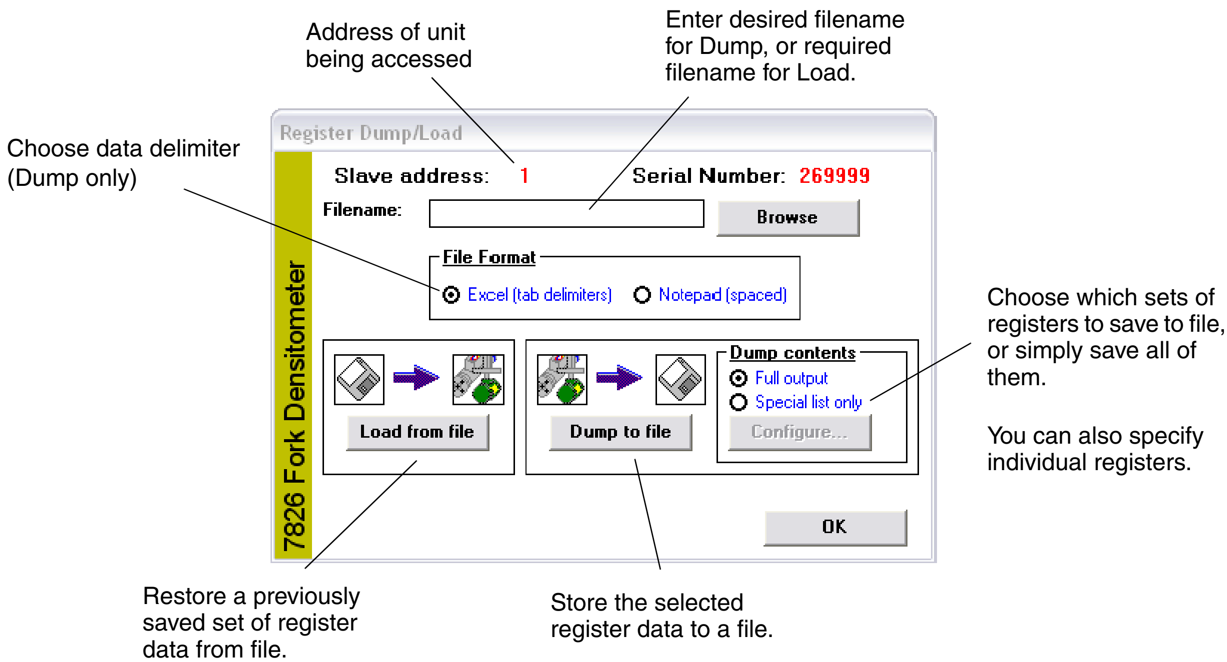
Data logging

ADView's Data Logging function is a useful tool for checking setups and performing experimental data capture. The diagram below explains some of the features.



Register Dump / Load

This facility is essential for saving the configuration of your meter. You should use it to save the current configuration before you start to alter it, in order to restore it if things go wrong for any reason. Also, if you send the meter away for servicing or re-calibration, you should save the current configuration. Details are given below.



Register Read / Write

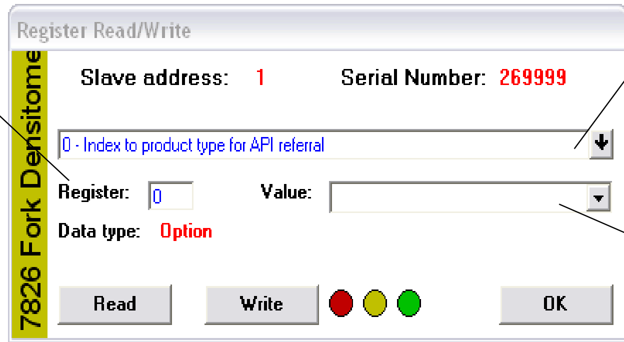
In a few cases, it may be useful to write directly to a single Modbus register. Two likely occasions for using this feature are to set the Slave Address of the unit and to configure a density offset. The Modbus Communications appendix has a complete list of the registers.

Before making any changes to individual registers, you should save the current configuration to a file to safeguard your configuration if anything goes wrong. See "Data Logging" for more information.

From ADView's menu bar, select **Tools > Register Read/Write**.

The current register number appears here.

The **Read** button causes the current value of the chosen register to be displayed.



To see a complete list of Modbus register numbers and descriptors, click here.

Choose the one you want to access.

For non-numerical values, click here to see complete list of possible entries and select one to write into the register.

Enter numerical values directly.

The **Write** button causes the current value to be written to the selected register.

You can read and write to any number of registers. When you have done all you want to, click **OK**.

6.2 Using ProLink II software

Note: For more detailed information on installing and using the ProLink II software application, see the user manual available at www.micromotion.com or on the Micro Motion product documentation CD.

6.2.1 Overview

ProLink II is a Windows-based configuration and management tool for Micro Motion meters. It provides complete access to meter functions and data.

This chapter provides basic information for connecting ProLink II to your meter. The following topics and procedures are discussed:

- Requirements (see Section 6.2.2)
- Configuration upload/download (see Section 6.2.4)

The instructions in this manual assume that users are already familiar with ProLink II software. For more information on using ProLink II, see the ProLink II manual.

6.2.2 Requirements

To use ProLink II with a 7826/7828 liquid density meter, the following are required:

- ProLink II v2.9 or later
- Signal converter(s), to convert the PC port's signal to the signal used by the meter
    - For RS-485 connections, an RS-485 to RS-232 signal converter.
    - 25-pin to 9-pin adapter (if required by your PC)

6.2.3 Connecting from a PC to a meter

The following table describes the options for connecting ProLink II to your meter.

Connection	Physical layer	Protocol
RS-485 terminals or RS-485 network	RS-485	Modbus

6.2.4 ProLink II configuration upload/download

ProLink II provides a configuration upload/download function which allows you to save configuration sets to your PC. This allows:

- Easy backup and restore of meter configuration
- Easy replication of configuration sets

Micro Motion recommends that all meter configurations be downloaded to a PC as soon as the configuration is complete.

To access the configuration upload/download function:

1. Connect ProLink II to your meter.
2. In the ProLink II software application, open the **File** menu.
   - To save a configuration file to a PC, use the **Load from Xmtr to File** option.
   - To restore or load a configuration file to a meter, use the **Send to Xmtr from File** option.

6.2.5 ProLink II language

ProLink II can be configured for the following languages:

- English
- French
- German

To configure the ProLink II language, choose **Tools > Options**.

In this manual, English is used as the ProLink II language.

Chapter 7
Calibration Check

7.1 Calibration

7.1.1 Factory calibration

Prior to leaving the factory, the 7826/7828 liquid density meter is calibrated within a standard physical boundary (typically 52.5 mm diameter) against Transfer Standard instruments traceable to National Standards.

Three fluids ranging in density from 1 to 1000 kg/m^3 are used to establish the general density equation constants K0, K 1, and K2 (see Section 7.1.4). The temperature coefficients (K18 and K19) are derived from the air-point and material properties.

The calibration procedure relies on units being immersed in fluids whose density is defined by Transfer Standards. Great attention is paid to producing temperature equilibrium between the fluid, the unit under test and the Transfer Standard (see Section 7.1.2). In this way, accurate calibration coefficients covering the required density range can be produced.

All instruments are over-checked on water to verify the density calibration, and with two different fluids to check the viscosity calibration. This check is monitored by the Micro Motion Quality Assurance Department.

7.1.2 Calibration of Transfer Standards

For density calibration, Transfer Standard instruments used in the calibration are selected instruments which are calibrated by the British Calibration Service Calibration Laboratory and are certified.

Transfer Standard calibration uses a number of density-certified liquids, one of which is water. The densities of these reference liquids are obtained using the Primary Measurement System whereby glass sinkers of defined volume are weighed in samples of the liquids.

Calibration of the Transfer Standard instruments is performed under closely controlled laboratory conditions and a calibration certificate is issued. Calibrations are repeated, typically every six months, producing a well-documented density standard.

7.1.3 Instrument calibration

Each meter is issued with its own calibration which is programmed into the instrument electronics before it leaves the factory. Under normal circumstances it should not be necessary to re-calibrate the 7826/7828 meter provided it is used in the environment for which it was calibrated originally.

The calibration data is shown on a calibration certificate supplied with the instrument. The calibration contains the following:

- The instrument serial number
- Several sample points from the output signal/density relationship. These have been calculated using the general density equation with the calibrated coefficients listed.
- Temperature coefficient data, K18 and K19; this defines the correction which should be applied to achieve the best density accuracy if the instrument is operating at product temperatures other than 20 °C.
- One instrument air (density) data point for check calibration purposes.

7.1.4 General density equation

The General Density Equation, used to calibrate the 7826/7828 meter and shown in the Calibration certificate is:

$$\rho = K0 + K1\tau + K2\tau^2$$

where ρ is the calculated density, τ is the time period (in µs) of the tuning fork, and K0, K1 and K2 are density coefficients, derived from the factory calibration data and selected to optimize the accuracy of the density measurement across the calibrated density range.

Temperature effects are also compensated for using a second equation:

$$\rho' = \rho(1 + K18(t - 20)) + K19(t - 20)$$

where ρ' is the new (temperature compensated) density value, t is the measurement temperature, and K18 and K19 are temperature correction coefficients.

Note: For the 7826/7828 meter with the Advanced electronics, values for the K coefficients, shown on the calibration certificate, are programmed into the meter registers and should not be altered. If the meter is used in an application dissimilar to the one for which it was originally calibrated, it may be necessary to recalculate the K coefficients. Contact the factory for further details.

7.2 Calibration certificate examples

Note: These certificates are examples only - they are NOT the calibration certificate for your 7826/7828 meter.

Figure 7-1 Example calibration certificate (in metric units)

```
                               CALIBRATION CERTIFICATE
7826F  LIQUID DENSITY METER                        Serial No : XXXXXX
                                                   Cal. Date : 09MAY06
                                               Pressure Test : 230 BARS

DENSITY CALIBRATION AT 20 DEG. C AND AT 1 BAR

      DENSITY  PERIODIC TIME
      [KG/M3]       [uS]

          0    1073.992            DENSITY =  K0 + K1.T + K2.T**2
        1.2   (1073.613)air check
        300    1190.859            K0 =  -1.17560E+03 \
        500    1262.255            K1 =  -2.31824E-01  } 300 - 1100 Kg/m3
        700    1329.508            K2 =   1.23558E-03 /
        800    1361.790
        900    1393.266
       1000    1423.993            K0 =  -1.16536E+03 \
       1100    1454.022            K1 =  -2.51436E-01  } 0   - 3000 Kg/m3
       1600    1595.144            K2 =   1.24443E-03 /

TEMPERATURE COEFFICIENT DATA

     Dt=D(1+K18(t-68))+K19(t-68)        K18 =   -2.1110E-05
                                        K19 =   +1.4825E-04

                                                   --------------
                                                  | FINAL TEST & |
                                                  |  INSPECTION  |
                                                  |              |
                                                  |              |
                                                  |              |
                                                  |              |
                                                   --------------

Ref No:- XX7826/Vx.x/XX/X                          DATE : 10MAY06
```

Example

Figure 7-2 Example calibration certificate (in imperial/US units)

```
                                   CALIBRATION CERTIFICATE
    7826F  LIQUID DENSITY METER                     Serial No : xxxxxx
                                                    Cal. Date : 09MAY06
                                                Pressure Test : 3.34 kpsig

DENSITY CALIBRATION AT 68 DEG. F AND 0 PSIG

          DENSITY  PERIODIC TIME
          [ g/cc]      [us]

              0    1073.992            DENSITY =  K0 + K1.T + K2.T
            air  (1073.613)  check
            0.30   1190.859            K0 =  -1.17560E+00 \
            0.50   1262.255            K1 =  -2.31824E-04  } 0.3 - 1.1 g/cc
            0.70   1329.508            K2 =  +1.23558E-06 /
            0.80   1361.790
            0.90   1393.266
            1.00   1423.993            K0 =  -1.16536E+00 \
            1.10   1454.022            K1 =  -2.51436E-04  } 0.0   - 3.0 g/cc
            1.60   1595.144            K2 =  +1.24443E-06 /

    TEMPERATURE COEFFICIENT DATA

         Dt=D(1+K18(t-68))+K19(t-68)        K18 =   -1.173E-05
                                            K19 =    8.236E-08

                              Example

                                                      --------------
                                                     | FINAL TEST & |
                                                     |  INSPECTION  |
                                                     |              |
                                                     |              |
                                                     |              |
                                                     |              |
                                                      --------------

    Ref No:- XX7826/Vx.x/XX/X                          DATE : 10MAY06
```

7.3 User calibration checks

7.3.1 Ambient air calibration check

An air check is a simple and convenient method to see if any long term drift or corrosion and deposition on the tines has occurred.

Ambient air check procedure:

1. Isolate and, if necessary, disconnect the meter from the pipeline.
2. Clean and dry the wetted parts of the meter and leave them open to the ambient air.
3. Apply power to the instrument and check that the time period of the instrument agrees with the figure shown on the calibration certificate to within ±100 ns. If the 7826/7828 meter is not at 20°C, compensate for this by adding an offset of +110 ns for every °C above 20°C, or by subtracting an offset of +110 ns/°C below 20°C.
4. Re-fit the meter to the pipeline if serviceable or remove for further servicing.

7.3.2 On-line calibration adjustment

An on-line calibration adjustment may be required if:

- The physical boundary surrounding the tines is different from the physical boundary used for the factory calibration.
- The unit has suffered long term drift or corrosion of the tines.

The 7826/7828 meter is a very accurate and stable instrument, and will normally provide good measurements. If it is suspected of giving incorrect results, you should confirm this by carefully checking the integrity of the fluid temperature measurement, and compare this with the temperature measurement given by 7826/7828 meter. You should also verify the integrity of the density check measurement. It is only after you have eliminated all other possible causes of error that you should attempt to make adjustments to the calibration of 7826/7828 meter.

Normally the density calibration adjustment is made by configuring a simple density offset into the instrument. If a more detailed calibration adjustment is required, such as a two- or three-fluid calibration adjustment for offset and scale, then refer to Micro Motion.

Calibration adjustment - stable liquids (with Frequency Output electronics) – 7826 meter only:

1. On the signal processing equipment, set the line density offset to 0, and the line density scaling factor to 1.
2. Ensure that the system has reached its stable operating temperature.
3. With the meter operating at typical process conditions, draw off a sample of the liquid into a suitable container, and note the meter density reading and the operating temperature.
4. Measure the density of the sample under defined laboratory conditions using a hydrometer or other suitable equipment. Refer this to the operating conditions at the meter.
5. Calculate the density offset required to make the meter measurement the same as the measured density of the sample.
6. On the signal processing equipment, enter the calculated line density offset.

Calibration adjustment - stable liquids (with Advanced electronics):

1. Using ADView (see Using ADView and ProLink II chapter), reset the line density offset (register 173) to 0, and the line density scaling factor (register 174) to 1.
2. Ensure that the system has reached its stable operating temperature.
3. With the meter operating at typical process conditions, draw off a sample of the liquid into a suitable container, and note the meter density reading and the operating temperature.
4. Measure the density of the sample under defined laboratory conditions using a hydrometer or other suitable equipment. Refer this to the operating conditions at the meter.
5. Calculate the density offset required to make the meter measurement the same as the measured density of the sample.
6. Using ADView's Register Read/Write tool, configure the meter with the calculated line density offset (Register 173).

Calibration adjustment - unstable or high vapor pressure liquids (with Frequency Output electronics) – 7826 meter only:

A pressure pyknometer and its associated pipework can be coupled to the pipeline so that a sample of the product flows through it.

1. On the signal processing equipment, set the line density offset to 0, and the line density scaling factor to 1.
2. Ensure that the system has reached its stable operating temperature.
3. When equilibrium conditions of product flow are reached, note the meter density reading and temperature and simultaneously isolate the pyknometer from the sample flow.
4. Remove the pyknometer for weighing to establish the product density.
5. Compare the pyknometer reading with the meter reading and compute the density offset required.
6. On the signal processing equipment, enter the calculated line density offset.

Calibration adjustment - unstable or high vapor pressure liquids (with Advanced electronics):

A pressure pyknometer and its associated pipework can be coupled to the pipeline so that a sample of the product flows through it.

1. Using ADView (see Using ADView and ProLink II chapter), reset the line density offset (register 173) to 0, and the line density scaling factor (register 174) to 1.
2. Ensure that the system has reached its stable operating temperature.
3. When equilibrium conditions of product flow are reached, note the 7826/7828 meter density reading and temperature and simultaneously isolate the pyknometer from the sample flow.
4. Remove the pyknometer for weighing to establish the product density.
5. Compare the pyknometer reading with the 7826/7828 meter reading and compute the density offset required.
6. Using ADView's Register Read/Write tool, configure the 7826/7828 meter with the calculated line density offset (Register 173).

For further details on these procedures, reference should be made to:

Energy Institute:	HM7. Density, sediment and water. Section 1: General guidance on test methods (formerly PMM Part VII, S1) 1st ed 1996 ISBN 978-0-85293-154-7

Energy Institute: HM8. Density, sediment and water. Section 2: Continuous density measurement (formerly PMM Part VII, S2)

2nd ed Sept 1997 ISBN 978-0-85293-175-2

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 0.7 g/cc at 15.56°C (60°F) and saturation vapour pressure, April 1991.

Chapter 8
General Maintenance

8.1 Overview

Care is essential in handling of the meter during its removal from and fitment to the pipeline/tank and during transportation. Wherever possible, retain and use the original packaging.

The 7826/7828 liquid density meter is rugged and robust, and has no moving parts. When correctly installed and operated, servicing is not normally required, even with poor quality fluid, and no periodic maintenance procedure is specified. It is recommended that a visual inspection is carried out at intervals to check for leaks and physical damage, and corrective maintenance carried out when required.

ADView's Data Logging facility can be used whenever necessary to verify that the meter is functioning correctly.

Check calibrations should be carried out at specified intervals in order to identify a malfunction or deterioration in meter performance. If a fault or a drop in performance is detected, further tests are required to identify the cause of the fault. Remedial action is limited to cleaning the meter tines, making good any poor connections, and replacing the internal electronics. In the extreme cases the complete meter may need to be replaced.

Note: The electronics within the 7826/7828 meter contain calibration information relevant to that particular meter only. The circuit boards operate as a pair, and therefore both boards must be changed together. Contact Micro Motion for more details if you need to change the boards.

8.2 General maintenance

No periodic maintenance procedure is specified, but the following procedure is recommended for periodic inspection. It can also be used when fault finding.

8.2.1 Physical checks

1. Examine the meter, its electronics housing and cables for any signs of damage and corrosion.
2. Make sure that the spigot connection is tight.
3. Check the meter for sign of leakage.
4. Check that there is no ingress of water/fluid into the electronics housing.
5. Ensure that the threads on the covers are well greased (graphite grease) and that the O-rings are in good condition.

Note: The covers MUST be completely screwed down and, in the case of an explosion-proof enclosure application, DO NOT FAIL to tighten the locking screws.

8.2.2 Electrical check (for meters with Frequency Output electronics)

1. Carry out power supply and current consumption test at the meter terminals T1 and T2. These should give:
   - **25 mA to 42 mA** at 22.8 VDC to 25.2 VDC

   If the current consumption is too high, replace the meter amplifier module.
2. For a 7826 meter with a frequency output, and with the power supply still connected, ensure that the periodic time signal is present at terminals T3 and T4 (or T12 and T4 as on older models). This should give a signal amplitude of:
   - Approximately 12V peak-to-peak (in air)
3. For a 7826 meter with a frequency output: check the 100 Ω RTD (Platinum Resistor Thermometer) element by disconnecting the wiring to terminals T5 to T8 (T7 to T10) inclusive and measuring the resistance between terminals T6 and T7 (T8 and T9 for older versions). The value of resistance is temperature dependent and can be found in the Appendix E of this manual.
4. Carry out an insulation test on the meter electrics as follows:
   a. Disconnect all external leads from the terminal board.
   b. Now short-circuit all the terminals together. Carry out an insulation test between the terminals and the meter body, using the 500 VDC insulation tester. The resistance must be greater than 2 MΩ (current limited to 5 mA).
   c. Remove all short-circuits and reconnect the leads if required.

8.2.3 Electrical check (for meters with Advanced electronics)

Check the power supply and current consumption at the meter terminals, pins 1 and 2, having disconnected all analog outputs. These should give 35 mA to 42 mA at 22.8 V to 25.2 V.

If the current consumption is outside this range, contact Micro Motion.

8.2.4 Performance check

When several systems are run in parallel and use the same fluid source, comparison of the line viscosity, base density and temperature readings between installations can be a useful indicator of possible system faults. Differences between readings, or changes from the normally observed conditions should always be investigated to confirm that instrumentation is functioning correctly.

8.2.5 Calibration check

1. Carry out a check calibration as detailed in the Calibration Check chapter.
2. Compare the results obtained with the previous calibration figures to identify any substantial deterioration in meter performance or any malfunction.

Note: A drop in meter performance is likely due to a build up of deposition on the tines which can be removed by the application of a suitable solvent. See Mechanical Servicing below.

Note: Malfunctions generally could be the result of electrical/electronic faults in either the meter or the readout equipment. Always check the readout equipment first before attention is directed to the meter.

8.3 Fault analysis and remedial action

A fault may be categorized as either an erratic reading or a reading which is outside limits.

Electrical faults can also cause symptoms which appear to affect the readings and it is recommended that the electrical system is checked first, before removing the meter for servicing.

8.3.1 Troubleshooting faults

Table 8-1 Faults and possible causes

Fault	Possible causes	Remedy
Readings fluctuate slightly, i.e., are noisy	Analog output averaging time not long enough	Increase the averaging time using ADView's Board Configuration facility (see the Using ADView and ProLink II chapter).
Erratic readings	One or more of: Gas bubbles around tines; cavitations; severe vibration or electrical interference; large amount of contaminants	Remove primary cause; e.g.: -install air release units to release gas; -apply back pressure to discourage formation of bubbles; -remove cause of vibration Alternatively, it may be necessary to adjust the Time Period Trap.
Readings outside limits	Deposition and/or corrosion on the tines.	Clean tines.
Analog output = 0 mA	No power to analog output	If voltage across pins 5 and 6 is not 15 to 28 V, replace power supply.
	Analog output circuit failure	Use ADView's facility to set the analog output to 4, 12 or 20 mA (in Board Configuration) to check whether the output is functioning. If not, replace circuit boards.
Analog output is 2 mA	Alarm condition caused by lack of power to 7826/7828 meter	If voltage across pins 1 and 2 is not 20 to 28 V, check and replace main power supply.
	Alarm condition caused by other internal failure	Use ADView Diagnostics to check that phase locked loop is in lock.
Temperature readings incorrect	If analog output and Modbus appear to be functioning correctly, the temperature sensor has probably failed.	Return the meter to Micro Motion for servicing.

Table 8-1 Faults and possible causes *continued*

Fault	Possible causes	Remedy
7826/7828 meter does not communicate with ADView	Power failure to 7826/7828 meter	Check power supply to 7826/7828 meter and converter; replace if necessary
	Power supply to RS-485/232 converter failed.	Check wiring
	A and B Modbus connections reversed	Check wiring
	RS-485/232 converter failed, wired incorrectly, or connected the wrong way round	Try another converter
	ADView incorrectly installed on PC	Re-install ADView
	Incorrect Slave address chosen for 7826/7828 meter	Check slave address
	RS-232 port on PC failed.	Connect to another free RS-232 port on the PC, if available. Alternatively connect a known working RS-232 device to the PC to check that the port is working.

8.3.2 Mechanical servicing

This mainly comprises the cleaning of any deposition or corrosion from the tines. Deposition is removed by the use of a suitable solvent. For corrosion, solvent and the careful use of a fine abrasive will usually be sufficient. Take care not to damage the PFA lamination if installed. However where extensive corrosion has been treated, it is highly recommended that a full calibration is carried out to check the meter characteristics.

Care is essential in handling the meter during transit, installation, and removal from the pipeline/tank.

8.3.3 Time period trap

Disturbances in the fluid caused by bubbles, cavitations or contaminants can cause sudden changes in the measured output, which may, under some circumstances, give rise to instability (i.e. hunting) in a control system relying on the measurement. The 7826/7828 meter can maintain the analog output during such perturbations by ignoring the aberrant measurement, and maintaining the output at the last good measured value. This facility is known as the Time Period Trap (TPT).

Under all normal circumstances, the factory settings for the TPT should be used. However, in extreme cases it may be necessary to alter the settings to meet the demands of a particular system. This should only be done after monitoring the behavior of the system for some time, to establish the normal running conditions.

Great care must be taken not to reduce the sensitivity of the meter so that normal response to fluctuations in the fluid is impaired.

The time period trap facility works as follows:

After each measurement of the time period (of the 7826/7828 meter's vibrating tines) the new value is compared with the previous value. If the difference between them is smaller than the allowable tolerance, the output is updated to correspond to the new measured value, and the TPT remains inoperative; i.e., operation is normal. If the difference exceeds the allowable tolerance, the output remains at the its previous level, and does not follow the apparent sudden change in value.

This process is repeated until either of the following:

- The latest measured value falls back to the level of the original value, indicating that the transient has passed; or
- The TPT count is reached. At this point it is assumed that the change in value is not due to a random disturbance, and the output adopts the value of the latest reading.

Two Modbus Registers control the operation of the Time Period Trap facility. These can be changed, if necessary, using ADView's Register Read/Write facility.

- **Modbus Register 138:** contains the maximum allowable change in the time period between readings, specified in µs. The preset value is 10.
- **Modbus Register 137:** contains the Time period count, which is the maximum number of measurements to be rejected before resuming normal operation; the preset value is 2. If the value is set to 0, TPT is disabled, and the output will always follow the time period measurement. If you want to program another value, it should be determined experimentally, and be equal to the length of the longest undesirable transients which are likely to arise. If the value is set too high, the meter will be slow to respond to genuine changes in the fluid properties.

Appendix A
7826/7828 Specifications

A.1 Density performance

Accuracy (1)	±0.001 g/cc	±1.0 kg/m^3	
Operating Range (2)	0 to 3 g/cc	0 to 3000 kg/m^3	0 to 187.4 lb/ft^3
Repeatability	±0.0001 g/cc	±0.1 kg/m^3	±0.006 lb/ft^3
Process Temperature Effect (Corrected) (3)	±0.0001 g/cc	±0.1 kg/m^3	(Per °C)
Process Pressure Effect (Corrected) (4)	Negligible		

(1) *Stated accuracy is for calibrated range 0.6–1.25 g/cc (600–1250 kg/m^3).*

(2) *With the 7826, the viscosity of the liquid can be up to a maximum of 500 cP. However, with the 7828, the viscosity of the liquid can be up to a maximum of 20,000 cP.*

(3) *Temperature effect is the maximum measurement offset due to process fluid temperature changing away from the factory calibration temperature.*

(4) *Pressure effect is defined as the change in sensor flow and density sensitivity due to process pressure changing away from the calibration pressure. To determine factory calibration pressure, refer to calibration document shipped with the 7826/7828. If data is unavailable, contact the factory.*

A.2 Temperature specification

Process	7826/7828 short-stem version 7826/7828 long-stem version	–58 °F to +392 °F (–50 °C to +200 °C) –40 °F to +302 °F (–40 °C to +150 °C)
Ambient	–40 °F to +185 °F (–40 °C to +85 °C)	

A.2.1 Integral temperature sensor

Technology	100-Ω RTD (4 wire)
Accuracy	RTD BS1904 Class B, DIN 43760 Class B.

A.3 Pressure ratings

Maximum operating pressure[(1) (2)]	7826/7828 short-stem version 7826/7828 long-stem version	3000 psi (207 bar) 1450 psi (100 bar)
Test pressure	Tested to 1.5 x the maximum operating pressure	
PED compliance	Outside the scope of European directive 97/23/EC on Pressure Equipment.	

(1) Actual maximum operating pressures are limited by the process connection rating.

(2) For Zirconium flanges, the maximum operating pressure is dependent on the working temperature. See "Zirconium 702 pressure and temperature flange ratings" for more information.

A.3.1 Zirconium 702 pressure and temperature flange ratings

Process flange type	**Pressure and temperature ratings**			
	100°F (37.8°C)	**199.9°F (93.3°C)**	**299.8°F (148.8°C)**	**392°F (200°C)**
2" ANSI 150	226.3 psi (15.6 bar)	197.3 psi (13.6 bar)	159.5 psi (11.0 bar)	110.2 psi (7.6 bar)
2" ANSI 300	588.9psi (40.6 bar)	513.4 psi (35.4 bar)	417.7 psi (28.8 bar)	336.5 psi (23.2 bar)
DN50 PN16	229.2 psi (15.8 bar)	175.5 psi (12.1 bar)	137.8 psi (9.5 bar)	107.3 psi (7.4 bar)
DN50 PN40	571.5 psi (39.4 bar)	439.5 (30.3 bar)	342.3 psi (23.6 bar)	266.9 psi (18.4 bar)

A.4 Hazardous area classifications

ATEX Explosion Proof

ATEX-approved: Certification for use in Europe

7826/7828	ATEX II2G Ex d IIC, T4

CSA C-US Explosion Proof

CSA-approved: Certification for use in Canada and USA

7826/7828	Class I, Division 1 Groups C & D, T4

A.5 General classifications

A.5.1 Electromagnetic compatibility

All versions conform to the latest international standards for EMC, and are compliant with EN 61326/IEC 61326.

A.5.2 Environment

- Weather rating: IP66

A.6 Materials of construction

Wetted parts	7826 (short stem)	Stainless steel 316L, Alloy C22, Alloy B3, Alloy 400, Zirconium or Titanium
	7828 (short stem)	Stainless steel 316L, Alloy C22, Alloy B3, Alloy 400, or Titanium
	7826/7828 (long stem)[(1)]	Stainless steel 316L
Tine finish	7826/7828	Standard, PFA coated, or Electro-polished
Electronics enclosure	7826/7828 (short stem)	Sand cast low copper alloy Polyurethane paint finish
	7826/7828 (long stem)	Sand cast low copper alloy, or stainless steel Polyurethane paint finish

(1) The 7826/7828 long-stem version is also available in Alloy C22 as an ETO purchase.

A.7 Weight

Weight	7826/7828 (short stem) 7826/7828 (long stem)	15 lb (6.7 kg) typical *Dependent on stem length (contact factory)*

A.8 Electrical

Power supply requirement	7826 frequency output 7826/7828 transmitter 7826/7828 mA outputs	23 to 27 VDC, 50 mA 20 to 28 VDC, 50 mA 22 mA per output
Outputs **(7826 frequency output)**	Frequency output	Current modulation on power supply line 2 wires (6V peak nominal)
	RTD output	100-Ω RTD (4 wire)
Outputs **(7826/7828 Advanced electronics)**	mA Accuracy Repeatability Out-of-range System alarm	Two passive 4–20 mA ±0.1% of reading, ±0.05% of full scale at 20 °C ±0.05% of full scale, over range –40 °C to +85 °C 3.9 or 20.8 mA on 4–20 mA 2 or 22 mA on 4–20 mA (Programmable alarm state)
	Communications	RS-485 (Modbus)

A.9 Default configuration

The 7826/7828 liquid density meter can be supplied in the following configurations. The default values for these configurations are shown in Table A-1.

Table A-1 Default configuration for analog outputs

		Option A	Option B	Options C &D
Analog Output 1	Variable	Special function (API°)	Referred density	Line density
	Units	API°	kg/m^3	kg/m^3
	4 mA setting	0	700	700
	20 mA setting	100	1000	1000
Analog Output 2	Variable	Temperature	Temperature	Temperature
	Units	°C	°C	°C
	4 mA setting	0	0	0
	20 mA setting	150	150	150
Alarms	Coverage	General system Analog output	General system Analog output	General system Analog output
	Hysteresis	0.5%	0.5%	0.5%
Density calculations	Temperature units	°C	°F	°C
	Temperature offset	0	0	0
	Pressure units	bar	psi	bar
	Pressure set value	1.1013	14.5	1.1013
	Line density units	kg/m^3	g/cc	kg/m^3
	Line density scale factor	1	1	1
	Line density offset	0	0	0
Matrix referral	Reference temperatures	All 20 (1)	All 68	All 20 (1)
	Reference densities	All 0 (1)	All 0	All 0 (1)
	Base temperature	20 (1)	68	20 (1)
API referral	Product type	General crude	General crude	General crude
	User K0	+0000E+00	+0000E+00	+0000E+00
	User K1	+0000E+00	+0000E+00	+0000E+00
	Base temperature	15	60	15
	Base pressure	1.1013	14.5	1.1013
Special Functions	Type	None	None	None
	Name	0 (None)	0 (None)	0 (None)
	Units	None	None	None
	Density of water (d)	0	0	0
	Density of Product A	0	0	0

Table A-1 Default configuration for analog outputs *continued*

		Option A	Option B	Options C &D
	Density of Product B	0	0	0
	Quadratic coefficients (A,B,C)	0	0	0
Output averaging time		5 s	5 s	5 s
Modbus	Slave address	1	1	1
	Byte order	Big Endian	Big Endian	Big Endian
	Register size	16 bit	16 bit	16 bit
Hardware type		Advanced fork	Advanced fork	Advanced fork

(1) For Option C, the Matrix referral constants will have been configured to the customer's specification.

Appendix B
Calculated Parameters (Advanced version)

B.1 Overview

The 7826/7828 liquid density meter is capable of calculating a number of parameters based on the measured line density and temperature. These calculated parameters are often referred to as ‘special functions.’ Only one calculated parameter is available at any one time; it can be used to control the analog (4-20 mA) output, and can also be accessed as a digital value (Modbus Register 260).

This section describes the algorithms used in these calculations.

The availability of the calculated parameters is dependent on whether Matrix or API is chosen as the density referral method.

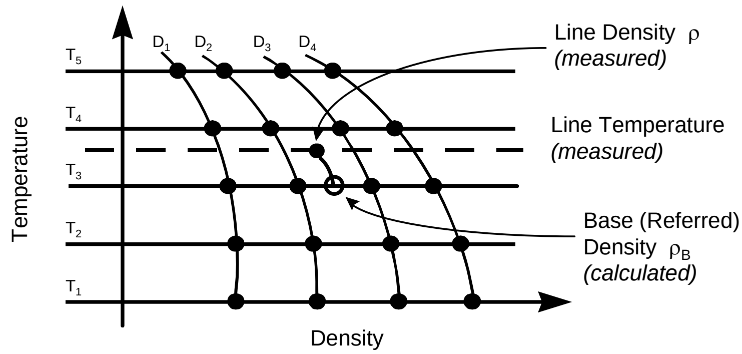
Special Function	API referral	Matrix referral
Specific Gravity	✓	✓
API°	✓	
% mass		✓
% volume		✓
° Baumé		✓
° Brix		✓
User defined quartic		✓
None	✓	✓

B.2 Base density referral

Base density is the density of the fluid at a specified base (or referral) temperature which is different to the line (i.e., the actual) temperature of the fluid. Base density can be calculated by either a Matrix referral method or by the API Referral method.

B.2.1 Matrix density referral

The Matrix Density Referral method uses a process of interpolation and extrapolation between a matrix of known density and temperature reference points to determine the liquid density at a specified base temperature different to the line temperature. A typical referral matrix is shown below.



The lines D_1 to D_4 plot the density of four product types for which the density is known at five different reference temperatures, T_1 to T_5. Using this information, and the measured line density and temperature, the 7826/7828 meter calculates the base density at the base temperature.

The information required for the referral is:

- Five reference temperatures
- The density for each of four product types at the five reference temperatures (20 reference points in all)
- The base temperature, which must be one of the five reference temperatures.

All 20 reference points must be specified, otherwise the 7826/7828 meter cannot calculate the base density. If you do not have all the relevant data, enter a sensible estimate for the missing reference points.

The easiest way of entering these values is by using the Board Configuration facility of ADView. Section 4 tells you how to do this.

B.2.2 API density referral

This calculation uses an iterative process to determine the density at the base temperature by applying temperature and pressure corrections using the API-ASTM-IP petroleum measurement tables.

The information required for the API density is:

- Reference pressure and reference temperature.
- Line pressure: This is not measured by 7826/7828 meter, and must be entered as part of the configuration.
- Product type: Refined product, crude product, or user defined.

Density / temperature relationship

Correction factors in the revised API-ASTM-IP petroleum measurement tables are based on the following correlation equations:

$$\rho t / \rho_{15} = \exp[-\alpha_{15} \Delta t (1 + 0.8\, \alpha_{15} \Delta t)]$$

where:

- ρt = Density at line temperature t °C
- ρ_{15} = Density at base temperature 15 °C.
- Δt = (t - 15) °C
- α_{15} = Tangent thermal expansion coefficient per °C at base temperature of 15 °C.

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

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

where K_0 and K_1 are known as the API factors.

Hydrocarbon group selection

The hydrocarbon group can be selected as:

- General refined products
- General crude products
- User defined

K_0 and K_1 are programmed into the 7826/7828 meter for the first two groups. For refined products the values of K_0 and K_1 are automatically selected according to the corrected density:

Hydrocarbon Group	Density Range (kg/m³)	K_0	K_1
Gasolines	654 to 779	346.42278	0.43884
Jet Fuels	779 to 839	594.54180	0.0000
Fuel Oils	839 to 1075	186.9696	0.48618

For Crude Oil the API factors are:

Product	K_0	K_1
Crude oil	613.972226	0.0000

User defined factors can be entered as any sensible value.

Density / pressure relationship

Isothermal secant compressibility can be defined by the simplified equation:

$$\beta = \frac{1}{V_0}\left[\frac{\delta V_1}{P_1}\right]_t$$

- where liquid volume changes from V_0 to V_1 as the gauge pressure changes from zero (atmospheric) to P_1
- where

  β = Isothermal secant compressibility at temperature t

δV_1 = Change of volume from V_0 to V_1

P_1 = Gauge pressure reading (P - 1.013) bars

- hence

$$\frac{\rho_0}{\rho_1} = 1 - \beta P_1$$

- where

ρ_0 = Corrected density at zero (atmospheric) gauge.

ρ_1 = Uncorrected density (Kg/m^3)

P_1 = (P - 1.013) where P is pressure in bars (P - base)

A correlation equation has been established for from the available compressibility data; such as,

$\log_e C = -1.62080 + 0.00021592t + 0.87096 \times 10^6(\rho_{15})^{-2} + 4.2092t \times 10^3(\rho_{15})^{-2}$ per bar

where

- $\beta = C \times 10^4$ Bar
- t = Temperature in deg C
- $\rho = \rho_{15} / 1000$ = oil density at 15 °C (kg/litre)

B.3 Calculated parameters

These are also known as Special Functions.

B.3.1 Specific gravity

Specific gravity (SG) = Base density (@ T_{ref}) / Density of water (@ T_{ref})

B.3.2 Degrees Baumé

Degrees Baumé = 145 – (145 / Base density)

(Where Base Density is in units of g/cc.)

B.3.3 Degrees Brix

$$\text{Degrees Brix} = 318.906 - \left(\frac{384.341}{SG}\right) + \left(\frac{66.1086}{SG^2}\right)$$

Where SG is Specific gravity.

B.3.4 Quartic equation

The following polynomial equation is implemented:

$$y = A + B \cdot \left(\frac{\rho_B}{d}\right) + C \cdot \left(\frac{\rho_B}{d}\right)^2 + E \cdot \left(\frac{\rho_B}{d}\right)^3 + F \cdot \left(\frac{\rho_B}{d}\right)^4$$

Where:

A, B, C, E, F = user programmable constants.

d = density of water (also a programmable constant).

ρ_B = base density.

B.3.5 % Mass

$$\text{\% of mass of product A} = \frac{(K_1(\rho_B - K_2))}{(\rho_B(K_1 - K_2))} * 100$$

Where:

K_1 = base density of product A

K_2 = base density of product B

ρ_B = base density of mixture

B.3.6 % Volume

$$\text{\% of volume of product A} = \frac{\rho_B - K_2}{K_1 - K_2} * 100$$

Where:

K_1 = base density of product A

K_2 = base density of product B

ρ_B = base density of mixture

B.3.7 API degrees

$$API = \frac{141.5}{SG} - 131.5$$

Where Base density value, used for specific gravity value (SG), is determined from API density referral.

Appendix C
Safety Certification

C.1 Safety certification

Please contact Micro Motion if you need to have copies of the latest safety certification for the 7826/7828 liquid density meter.

Appendix D
Modbus Communications (Advanced version)

D.1 Overview

The Modbus/RS-485 communications facility on the 7826/7828 liquid density meter can be useful in a number of ways. It is the only means of configuring the meter, and also gives access to diagnostic information not available on the analog output. Digital representations of the measured and calculated parameters are also available which lead to higher accuracy, and greater integration in digital networks and systems.

The RS-485 serial interface of the 7826/7828 liquid density meter communicates using the RTU Modbus protocol, which is a well established system used in many industrial applications. The protocol defines the way in which messages will be transmitted between Modbus devices, and details how the data will be formatted and ordered.

It is beyond the scope of this manual to give a full description of the protocol, but a useful reference on Modbus is the *Modbus Protocol Reference Guide* (PI-MBUS-200 Rev. D) (1992) published by Modicon Industrial Automation Systems Inc.

A Modbus network can have only one Master at any one time, with up to 32 Slaves. The 7826/7828 liquid density meter acts as a slave device, and only communicates on the network when it receives a request for information from a Master device such as a computer or a PLC.

The implementation used on the 7826/7828 liquid density meter is fully compliant with the Modicon Specification. All information is stored in memory locations in the 7826/7828 liquid density meter referred to as Modbus Registers**.** These store all the data required to control the operation, calculations and data output of the 7826/7828 liquid density meter. Modbus communication with the meter consists of reading or writing to these registers.

The 7826/7828 liquid density meter implements only two Modbus commands:-

- Command 3: Read Modbus Register
- Command 16 (10_{16}): Write Modbus Register

Any number of registers can be read with Command 3, but only one register can be written to for each Command 16. This restriction does not limit the performance of the system, since all functions are mapped into the register structure in one way or another.

In most cases, it is unnecessary to understand the detail of the protocol, as this is taken care of by the application program. For example, the Micro Motion ADView or ProLink II software program enables you to configure the meter, and even read or write to individual Modbus registers, without you needing to know about Modbus.

However, if you are using a proprietary software package, or developing your own application software, the information given in this section will be invaluable.

D.2 Accessing Modbus registers

Any device which can drive the RS-485 interface on the 7826/7828 liquid density meter can, in theory, access the Modbus registers. In practice, some sort of user interface is required to simplify the process.

ADView offers several ways of accessing the registers.

Board Configuration:	A graphical interface for viewing and setting the main configuration parameters of the 7826/7828 liquid density meter. Direct access to registers is not offered.
Register Read/Write	This tool provides a simple window from which to read and write to named and numbered registers. When you write to a register, you are presented with a set of allowable values from which to choose. Thus the tool is only useful for communicating with Micro Motion meters. This is the simplest and most foolproof way of directly accessing the registers. Section 4 gives full details.
Direct Communications	This is another tool which allows you to compose a sequence of data to be transmitted to/from the Modbus. This can be used to communicate with any Modbus device, providing that you know the register addresses, data format, indices, etc. The composition of the data is entirely up to the user, although the tool does compute and insert a checksum. Only those well versed in the use of Modbus protocol should attempt to use this facility. It is mainly designed for testing Modbus transmissions which are subsequently to be used in an application specific environment. A worked example of using this tool is given in section D.7.

D.2.1 Establishing Modbus communications

If the meter Slave address or the values of Registers 47 and 48 are not known, Modbus communications cannot be carried out successfully, and it will be necessary to establish the current values in these items. If you are using ADView, you can search for the addresses of all connected slaves, and then interrogate the appropriate registers for each one.

If you are not using ADView, Section D.2.1 gives a procedure which will enable you to get this information.

D.3 Modbus implementation

D.3.1 Register size and content

All registers are 32 bits (whether they are integer or floating point types), although the Modbus specification states that registers are 16 bits and addresses and ‘number of register’ fields assume all registers are 16 bits long. All floating point values are in IEEE single precision format.

Registers are contiguous in the Modbus register ‘address space’. There is a one-to-one mapping of 32-bit meter register numbers to 16-bit Modbus register numbers. Therefore, only the full 32 bits of any register can be accessed. The upper and lower 16-bit segments have the same Modbus register number and consequently cannot be individually read.

Registers 47 and 48 within the meter allow the Modbus ‘dialect’ to be changed to suit the communicating device if it cannot easily be re-programmed. This is most easily done using ADView’s Register Read/Write tool (see the Using ADView and ProLink II chapter).

Their usage is as follows:

Modbus byte ordering

Register 47 contents	Modbus byte ordering
00000000_{16}	Big Endian (i.e. MSB first)
$FFFFFFFF_{16}$	Little Endian (i.e. LSB first)

Modbus register size

Register 48 contents	Modbus register size
00000000_{16}	16 bits
$FFFFFFFF_{16}$	32 bits

16-Bit register size (Register 48 = 00000000_{16})

In order to read 32-bit registers when Modbus registers are dealt with in units of 16 bits, you must specify **twice** the number of 32-bit register you want to read in the ‘number of registers’ field. For example, to read one 32-bit register, use '2'. If an attempt is made to read an odd number of registers, the command will fail.

32-Bit register size (Register 48 = $FFFFFFFF_{16}$)

In order to read 32-bit registers when Modbus registers are dealt with in units of 32 bits, you specify the actual number of registers you want in the ‘number of registers’ field. (for example, to read two 32-bit register in this mode, use '2'.

D.4 Modbus register assignments

Each register is identified by a unique number, and the list is organized by this number. For each register, the contents are described, along with the data type of the contents.

The data type is always 32 bits unless stated otherwise. Variable names are given for reference purposes only. They have no other use.

Note: All units locations (registers 3, 4, 5 and 26) must be set before entering other values.

In some cases the data in a register is used to represent a non-numerical quantity, known as an index. For example, the units of density can be kg/m^3, g/cc, lb/gal or lb/ft^3 and these are represented by the numbers 91 to 94. Thus if Register 3 (line density) contains the value (index) 91, this means that the units of line density are kg/m^3. Index values may, of course, be used for more than one register.

Table D-1 Modbus register assignments

Register	Function	Data Type	Index Table (where applicable)
0	API product type	Long integer	D.5.1
1	API referral reference temperature	4-byte float	
2	API referral reference pressure	4-byte float	
3	Line density units	Long integer	D.5.2
4	Base density units	Long integer	D.5.2

Table D-1 Modbus register assignments *continued*

Register	Function	Data Type	Index Table (where applicable)
5	Temperature units	Long integer	D.5.2
6	Special function calculation type	Long integer	D.5.3
7	Special function quartic equation name	Long integer	D.5.4
8	Special function quartic equation units (1)	Long integer	D.5.5
9	Output averaging time	Long integer	D.5.6
10	Analog Output 1 selected variable	Long integer	D.5.7
11	Analog Output 2 selected variable	Long integer	D.5.7
14	PWM factor for 4mA on Analog Output 1	Long integer	
15	PWM factor for 20mA on Analog Output 1	Long integer	
16	PWM factor for 4mA on Analog Output 2	Long integer	
17	PWM factor for 20mA on Analog Output 2	Long integer	
20	RTD calibration factor	4-byte float	
21	Crystal oscillator calibration factor	4-byte float	
22	Diagnostics flags	Long integer	
23	Line density value when fixed by diagnostics	4-byte float	
24	Base density value when fixed by diagnostics	4-byte float	
25	Temperature value when fixed by diagnostics	4-byte float	
26	Pressure Units		D.5.2
27	Referral temperature for matrix referral	Long integer	D.5.8
30	Modbus Slave address	Long integer	
47	Modbus byte order		D.3.1
48	Modbus register size		D.3.1
49	Software type	Long integer	D.5.9
53	2nd referral temperature for referred density	4-byte float	
57	Full unit part number	String	
61	Hardware type	Long integer	D.5.10
64	Write-protected copy of RTD factor	4-byte float	
65	Write-protected copy of crystal factor	4-byte float	
66	Write-protected copy of Analog O/P 1 ‘4mA PWM factor’	Long integer	
67	Write-protected copy of Analog O/P 1 ‘20mA PWM factor’	Long integer	
68	Write-protected copy of Analog O/P 2 ‘4mA PWM factor’	Long integer	
69	Write-protected copy of Analog O/P 2 ‘20mA PWM factor’	Long integer	
72	Write-protected copy of Time Period Low Limit	4-byte float	
73	Write-protected copy of Time Period High Limit	4-byte float	
74	Write-protected copy of Q Factor Low Limit	4-byte float	
75	Write-protected copy of Q Factor High Limit	4-byte float	
127	Stored checksum for the FRAM	Long integer	
128	K0	4-byte float	
129	K1	4-byte float	

Table D-1 Modbus register assignments *continued*

Register	Function	Data Type	Index Table (where applicable)
130	K2	4-byte float	
131	K18	4-byte float	
132	K19	4-byte float	
137	Meter time period trap count	Long integer	
138	Meter time period trap (difference in µs)	4-byte float	
139	Time period value when fixed by diagnostics	4-byte float	
140	Value represented by 4mA on analog output	4-byte float	
141	Value represented by 20mA on analog output	4-byte float	
146	Line pressure	4-byte float	
147 – 151	Temperatures for matrix referral	4-byte float	
152 – 171	Densities for matrix referral	4-byte float	
172	Atmospheric pressure	4-byte float	
173	Line density offset	4-byte float	
174	Line density scaling factor	4-byte float	
175	Special function calculation parameter A	4-byte float	
176	Special function calculation parameter B	4-byte float	
177	Special function calculation parameter C	4-byte float	
178	Special function parameter d / density of water	4-byte float	
179	Density of product A for special function calc.	4-byte float	
180	Density of product B for special function calc.	4-byte float	
181	Temperature offset	4-byte float	
182	User K0 value for API referral	4-byte float	
183	User K1 value for API referral	4-byte float	
185	User range (alarm) high value	4-byte float	
186	User range (alarm) low value	4-byte float	
192	Write-protected copy of K0	4-byte float	
193	Write-protected copy of K1	4-byte float	
194	Write-protected copy of K2	4-byte float	
195	Write-protected copy of K18	4-byte float	
196	Write-protected copy of K19	4-byte float	
201	Unit's original calibration date	Long integer	
202	Unit's most recent calibration date	Long integer	
203	Unit's serial number	Long integer	
204	Unit type	Long integer	D.5.11
256	Status Register	Long integer	D.5.12
257	Corrected line density (2)	4-byte float	
258	Corrected base density (2)	4-byte float	
259	Line temperature (2)	4-byte float	
260	Special function calculation result (2)	4-byte float	

Table D-1 Modbus register assignments *continued*

Register	Function	Data Type	Index Table (where applicable)
261	Meter time period (in μs) (2)	4-byte float	
262	FRAM calculated checksums	Long integer	
263	RTD resistance (in ohms) (2)	4-byte float	
264	Meter coil pickup level (in volts) (2)	4-byte float	
265	Meter resonance Q value (3)	4-byte float	
266	Electronics board temperature (in °C)		
267/8	Software version string (2)	String	

(1) Special function units are not used in unit conversions (they are for indication only), so can be set at any time.
(2) This is a live value. Although it can be written to, it would be pointless.
(3) This value is only valid when bit 3 (hex 08) is set in the diagnostics flag register (22), after a one-second pause.

D.5 Index codes

This section provides an interpretation of the numerical indices used to represent non-numerical values.

D.5.1 API product type

Used in Register 0. (The user values for K0 and K1 are stored in Registers 182 and 183.)

Index	Product Type
0	Crude (general crude)
1	Refined (general product)
2	User K0 and K1

D.5.2 Pressure, Temperature, Density and other Units

Used in Registers 3, 4, 5 and 26.

Index	Units
6	psi A
7	bar A
10	kg / cm^2
11	Pa
12	kPa
32	°C
33	°F
57	%
90	SGU

91	g / cm³
92	kg / m³
93	lb / gal
94	lb / ft³
101	° Brix
102	° Baume heavy
104	° API

D.5.3 Special function

Used in Register 6.

Index	Calculation
0	none
1	% mass
2	% volume
3	Specific Gravity
4	° Baume
5	° Brix
6	General quartic equation
7	° API

D.5.4 Special function quartic equation name

Used in Register 7.

Index	Name
0	none
1	Density
2	% Mass
3	% Volume
4	° Baume
5	° Brix
6	Specific Gravity
7	Gravity
8	API
9	Plato
10	Twaddle
11	° Alcohol
12	(reserved)
13	(reserved)
14	(reserved)
15	(reserved)
16	(reserved)

17	(reserved)
18	(reserved)
19	(reserved)

D.5.5 Special function quartic equation units

Used in Register 8.

Index	Name
0	none
57	%

D.5.6 Output averaging time

Used in Register 9.

Index	Averaging Time
0	none
1	1 s
2	2 s
3	5 s
4	10 s
5	20 s
6	50 s
7	100 s

D.5.7 Analog output selection

Used in Register 10.

Index	Output
0	Density
1	Referred Density
2	Temperature
3	Special Function
4	4 mA
5	12 mA
6	20 mA

D.5.8 Referral temperature

Used in Register 27

Index	Referral Temperature
0	Lowest temperature value in matrix
1	↓
2	
3	
4	Highest temperature value in matrix

D.5.9 Software version

Used in Register 49.

Index	Density Referral
0	Matrix
1	API

D.5.10 Hardware type

Used in Registers 61.

Index	Meter Type
1	Advanced Fork

D.5.11 Unit type

Used on Register 204.

Index	Meter type
5	Advanced fork

D.5.12 Status register flags

Used in Register 256.

Bit	Hex Value	Flag Name	Definition
0	00000001	ST_IN_LOCK	P.L.L. is IN LOCK
1	00000002	ST_DIAG_ON	DIAGnostics ON
2	00000004	ST_FT1_ALM	4 to 20 mA output 1 in ALarM
3	00000008	ST_FT2_ALM [(1)]	4 to 20 mA output 2 in ALarM
4	00000010	ST_FT3_ALM [(1)]	4 to 20 mA output 3 in ALarM
5	00000020	ST_HART_BOARD [(1)]	whether HART BOARD is fitted
6	00000040	ST_RS232_BOARD [(1)]	whether RS232 BOARD is fitted
7	00000080	ST_SWITCH_BOARD [(1)]	whether SWITCH BOARD is fitted
8	00000100	ST_EXP0_BOARD	(reserved for future expansion)
9	00000200	ST_EXP1_BOARD	(reserved for future expansion)
10	00000400	ST_EXP2_BOARD	(reserved for future expansion)
11	00000800	ST_EXP3_BOARD	(reserved for future expansion)
12	00001000	ST_FT3_HART [(1)]	HART is in control of its 4 to 20 mA output
13	00002000	ST_BAD_STATUS	STATUS register corruption
14	00004000	ST_STAT_CORR	one or more STATus registers have been CORRected
15	00008000	ST_TOTAL_DEATH	status registers not updating - assume the worst
16	00010000	ST_USER_ALM	User defined variable in alarm
17	00020000		
18	00040000		

19	00080000		
20	00100000		
21	00200000	ST_TEMP_HI	TEMPerature reading too HIgh
22	00400000	ST_TEMP_LOW	TEMPerature reading too LOW
23	00800000	ST_ROM_CSF	ROM CheckSum Fail flag
24	01000000	ST_FRAM0_WPF	FRAM0 Write Protect Fail
25	02000000	ST_FRAM1_WPF (1)	FRAM1 Write Protect Fail
26	04000000	ST_FRAM0_RWE	FRAM0 Read/Write Error
27	08000000	ST_FRAM1_RWE (1)	FRAM1 Read/Write Error
28	10000000	ST_FRAM0_CSF	FRAM0 CheckSum Fail flag
29	20000000	ST_FRAM1_CSF (1)	FRAM1 CheckSum Fail flag
30	40000000	ST_FRAM0_ACK	FRAM0 ACK/data error
31	80000000	ST_FRAM1_ACK (1)	FRAM1 ACK/data error

(1) The status flags marked thus refer to hardware features not present in the 7826/7828 meter. They can safely be ignored.

D.6 Establishing Modbus communications

Using ADView, it is possible to establish which devices are available on the network, and their slave addresses. However, if you are not using ADView, the following procedure can be adopted.

If the meter Slave address or the values of Registers 47 and 48 are not known, Modbus communications cannot be carried out successfully, and it will be necessary to establish the current values in these items. The following procedure will do this.

The process is:

1. Find the slave address by trying all possible values until a response is received.
2. Establish whether the register size is 16 or 32 bits by reading register 48.
3. Find the byte order by reading register 47.

Step 1 Find the slave address

Make sure only the meter is connected to the Modbus Master, then send the following message (Read Register 47):

Slave Address	Command		Register Address			Checksum
00	03	00	47_{10}	00	02	checksum

Wait for a response. If there is none, repeat the same message, with the Slave address changed to 1, and await a response. Repeat the process until a response is obtained. This will show the slave address of the meter.

Step 2 Establish register size as 16-Bit versus 32-Bit

Send the following message (Read Register 48), where nn is the meter slave address:

Slave Address	Command		Register Address			Checksum
nn	03	00	48_{10}	00	02	checksum

The meter will respond with the following to show that the meter is set to 16-bits register size:

Slave Address	Command		Data Bytes	Checksum
nn	03	04	4 data bytes	checksum

Or, the meter will respond with the following to show that the meter is set to 32-bits register size.

Slave Address	Command		Data Bytes	Checksum
nn	03	08	8 data bytes	checksum

Thus, by reading the third byte of the response, you can deduce the value of Register 48.

Step 3 Find the byte order

Send the following message (Read Register 47), where nn is the meter's slave address:

Slave Address	Command		Register Address			Checksum
nn	03	00	47_{10}	00	02	checksum

The meter will respond with one of the following:

Slave Address	Command		Data Bytes	Checksum
nn	03	04	4 data bytes	checksum

Slave Address	Command		Data Bytes	Checksum
nn	03	08	8 data bytes	checksum

Examine the first four bytes of the data. If they are all 00, then the meter is in Big Endian mode; if they are all FF, then the mode is Little Endian.

D.7 Example of direct Modbus access

In many applications, direct access to Modbus will be unnecessary. ADView provides a way of configuring the 7826/7828 liquid density meter, and for accessing individual registers. This example describes how to access the 7826/7828 meter directly, without the help of ADView.

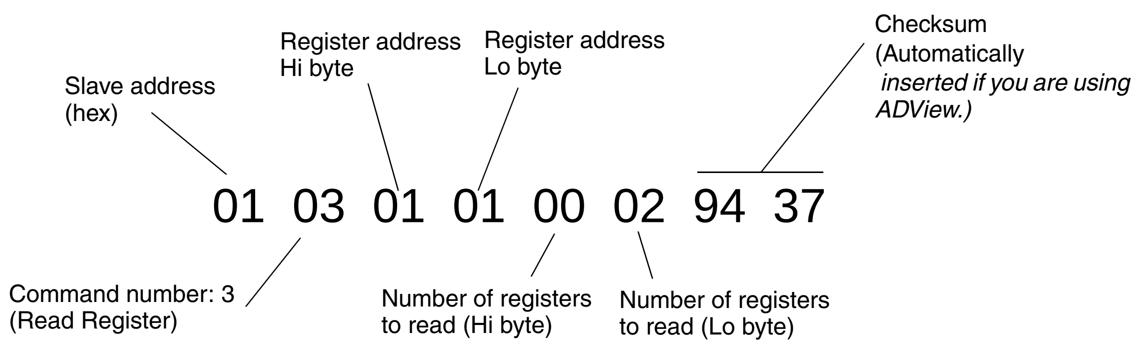
However, before you start, you should configure the meter using ADView (described in the Using ADView and ProLink II chapter), and also set the Modbus Byte Order and Register Size (see Modbus Communications appendix).

Note: You can use ADView's Direct Communications tool to test out the following sequences, or any others you want to try. This has the added advantage that ADView calculates and inserts the checksum value for you.

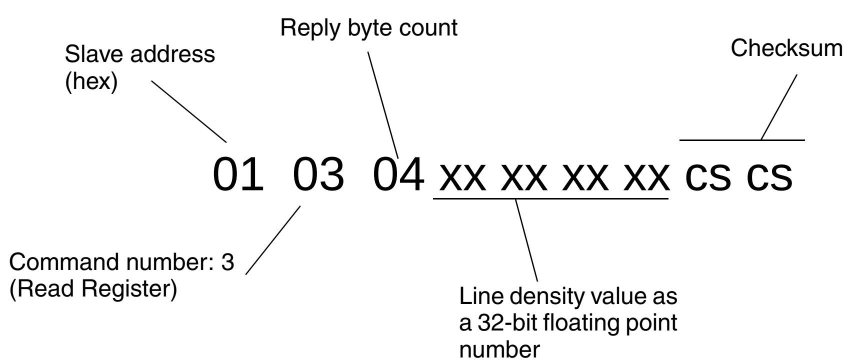
D.7.1 Example 1: Reading line density (16-bit register size)

The 7826/7828 meter is assumed to have been configured with Register Size = 16-bit (Register 48 = 0), and has slave address = 1.

The following string will read the line density, which is held in Register 257 (0101_{16}).



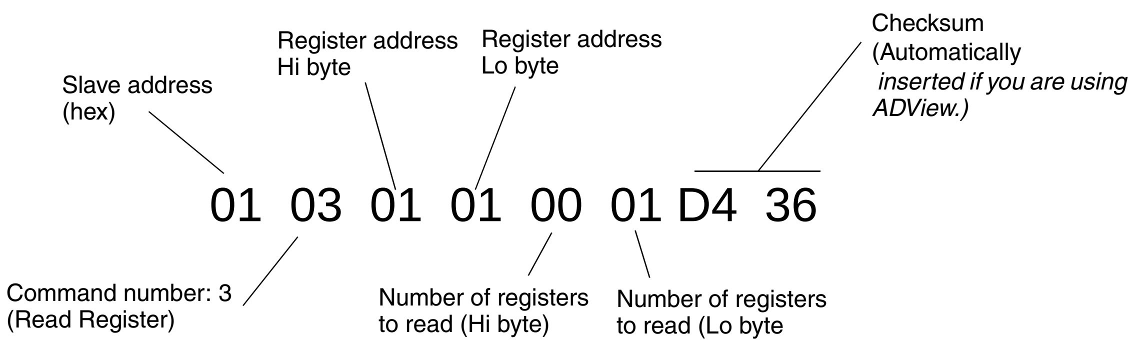
The reply from the 7826/7828 meter will be:



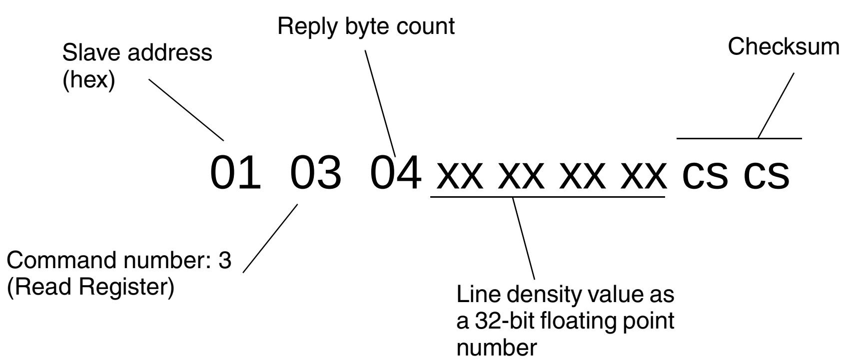
D.7.2 Example 2: Reading line density (32-bit register size)

The 7826/7828 meter is assumed to have been configured with Register Size = 32-bit (Register 48 = $FFFF_{16}$), and has slave address = 1.

The following string will read the line density, which is held in Register 257 (0101_{16}).



The reply from the 7826/7828 meter will be the same as for Example 1.



Appendix E
Return Policy

E.1 General guidelines

Micro Motion procedures must be followed when returning equipment. These procedures ensure legal compliance with government transportation agencies and help provide a safe working environment for Micro Motion employees. Failure to follow Micro Motion procedures will result in your equipment being refused delivery.

Information on return procedures and forms is available on our web support system at **www.micromotion.com**, or by phoning the Micro Motion Customer Service department.

E.2 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 requires a completed Return Materials Authorization form.

E.3 Used equipment

All equipment that is not classified as new and unused is considered used. This equipment must be completely decontaminated and cleaned before being returned.

Used equipment must be accompanied by a completed Return Materials Authorization form and a Decontamination Statement for all process fluids that have been in contact with the equipment. If a Decontamination Statement cannot be completed (for example, for food-grade process fluids), you must include a statement certifying decontamination and documenting all foreign substances that have come in contact with the equipment.

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