Heinrichs
KOBOLD Group

Vortex Flow Meter   **DVH / DVE**
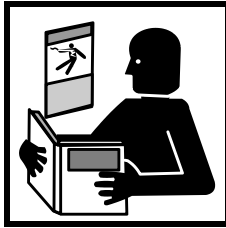
Instruction Manual
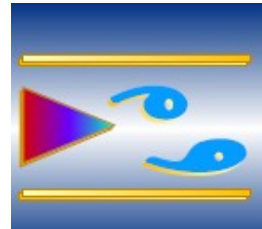
HART
COMMUNICATION FOUNDATION

Contents

1. Steps prior to operation

It is essential that you read these operating instructions before installing and operating the device. The device is to be installed and serviced by a qualified technician only. The DVH/DVE transmitter is to be used exclusively to measure mass and volume flow, as well as liquid and gas density and temperature, in conjunction with a Heinrichs Messtechnik DVH or DVE sensor.

Downloading of the present document from our web site www.heinrichs.eu and printing out this document is allowed only for purposes of using our mass flowmeters. All rights reserved. No instructions, wiring diagrams, and/or supplied software, or any portion thereof, may be produced, stored, in a retrieval system or transmitted by any means, electronic, mechanical, photocopying or otherwise, without the prior written permission of Heinrichs Messtechnik GmbH.

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Heinrichs Messtechnik GmbH extends no express or implied warranty in regard to the applicability of the present document for any purpose other than that described.

We reserve the right to change the technical data in this manual in the light of any technical progress that might be made. For updates regarding this product, visit our website at www.heinrichs.eu, where you will also find contact information for the Heinrichs Messtechnik distributor nearest you. For information regarding our own sales operations, contact us at info@heinrichs.eu.

1.1   Installation and servicing

The devices described in this manual are to be installed and serviced only by qualified technical personnel such as a qualified Heinrichs Messtechnik electronics engineer or service technician.

Warning

Before servicing the device, it must be completely switched off, and disconnected from all peripheral devices. The technician must also check to ensure that the device is completely off-circuit. Only original replacement parts are to be used.

Heinrichs Messtechnik GmbH accepts no liability for any loss or damage of any kind arising from improper operation of any product, improper handling or use of any replacement part, or from external electrical or mechanical effects, overvoltage or lightning. Any such improper operation, use or handling shall automatically invalidate the warranty for the product concerned.

In the event a problem arises with your device, please contact us at one of the following numbers to arrange to have your device repaired:

Phone: +49 221 49708-0
Fax: +49 221 49708-178

Contact our customer service department if your device needs repair or if you need assistance in diagnosing a problem with your device

1.2   Safety advisory for the user

The present document contains the information that you need in order to operate the product described herein properly. The document is intended for use by qualified personnel. This means personnel who are qualified to operate the device described herein safely, including electronics engineers, electrical engineers, or service technicians who are conversant with the safety regulations pertaining to the use of electrical and automated technical devices and with the applicable laws and regulations in their own country.

Such personnel must be authorized by the facility operator to install, commission and service the product described herein, and are to read and understand the contents of the present operating instructions before working with the device.

1.3   Hazard warnings

The purpose of the hazard warnings listed below is to ensure that device operators and maintenance personnel are not injured and that the flowmeter and any devices connected to it are not damaged.

The safety advisories and hazard warnings in the present document that aim to avoid placing operators and maintenance personnel at risk and to avoid material damage are prioritized using the terms listed below, which are defined as follows in regard to these instructions herein and the advisories pertaining to the device itself.

1.3.1   Danger

means that failure to take the prescribed precautions will result in death, severe bodily injury, or substantial material damage.

1.3.2   Warning

means that failure to take the prescribed precautions could result in death, severe bodily injury, or substantial material damage.

1.3.3   Caution

means that the accompanying text contains important information about the product, handling the product or about a section of the documentation that is of particular importance.

1.3.4   Note

means that the accompanying text contains important information about the product, handling the product or about a section of the documentation that is of particular importance.

1.4   Proper use of the device

Warning
The operator is responsible for ensuring that the material used in the sensor and housing is suitable and that such material meets the requirements for the fluid being used and the ambient site conditions. The manufacturer accepts no responsibility in regard to such material and housing.

Warning
In order for the device to perform correctly and safely, it must be shipped, stored, set up, mounted operated and maintained properly.

1.5   Note and Safety Information

We use note, caution and warning statements throughout this book to draw your attention to important information

Warning!
This statement appears with information that is important to protect people and equipment from damage. Pay very close attention to all warnings that apply to your application.

Caution!
This statement appears with information that is important for protecting your equipment and performance. Read and follow all cautions that apply to your application

Note
This statement appears with a short message to alert you to an important detail

1.6   Warnings and Cautions

Warning!
Consult the flow meter nameplate for specific flow meter approvals before any hazardous location installation.

Hot tapping must be performed by a trained professional. U.S. regulations often require a hot tap permit. The manufacturer of the hot tap equipment and/or the contractor performing the hot tap is responsible for providing proof of such a permit.

All flow meter connections, isolation valves and fittings for cold/hot tapping must have the same or higher pressure rating as the main pipeline.

For Series DVE insertion flow meter installations, an insertion tool must be used for any installation where a flow meter is inserted under pressure greater than 3,34 bar / 50 psig.

To avoid serious injury, DO NOT loosen a compression fitting under pressure.

To avoid potential electric shock, follow National Electric Code or your local code when wiring this unit to a power source. Failure to do so could result in injury or death. All AC power connections must be in accordance with published CE directives. All wiring procedures must be performed with the power Off.

Before attempting any flow meter repair, verify that the line is not pressurized. Always remove main power before disassembling any part of the mass flow meter.

1.7   Oxygen Service

Unless you have specifically ordered Heinrichs` optional O_2 cleaning, this flow meter may not be fit for oxygen service. Some models can only be properly cleaned during the manufacturing process. Heinrichs Messtechnik GmbH is not liable for any damage or personal injury, whatsoever, resulting from the use of Heinrichs Instruments standard mass flow meters for oxygen gas.

Caution!
Calibration must be performed by qualified personnel. Heinrichs Messtechnik GmbH strongly recommends that you return your flow meter to the factory for calibration.

In order to achieve accurate and repeatable performance, the flow meter must be installed with the specified minimum length of straight pipe upstream and downstream of the flow meter's sensor head.

When using toxic or corrosive gases, purge the line with inert gas for a minimum of four hours at full gas flow before installing the flow meter.

For Series DVE insertion flow meter installations, the sensor alignment pointer must point downstream in the direction of flow.

The AC wire insulation temperature rating must meet or exceed 85°C (185°F)

1.8   Maximum Pressure for Vortex Flowmeters with Pressure Sensors

Warning!
Vortex sensors Type
DVH-P...
DVH-M...
DVE-P...
DVE-M...
are equipped with Pressure sensors. (Model Number Information see Page107 Chapter 10)

The maximum working Pressure of these meters can be limited by the max measuring range of the pressure sensor. (e.g. 1 barg.).

On the Tagging / Nameplate may be marked a maximum test pressure PT (e.g. PT=60 bar).
This is a **factory test pressure** for the meter **without installed pressure sensor**

Any test pressure is not allowed to exceed the double Pressure marked on the Tagging / Nameplate under PS. In case the double of PS is bigger than PT (marked on the Tagging / Nameplate), PT is the maximum test pressure.

2. Identification

2.1   Supplier / Manufacturer

Heinrichs Messtechnik GmbH
Robert-Perthel-Str. 9 · D-50739 Cologne
Phone +49 (221) 49708 - 0
Fax   +49 (221) 49708 - 178
Internet: http://www.heinrichs.eu/
Email: mailto:info@heinrichs.eu

2.2   Product type

Multi Parameter Vortex Flow Meter.

Product name
DVH / DVE

2.3   Issue date
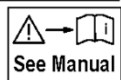
4/28/2015   (MM/DD/YYYY)

2.4   Version No.

9.1
File: DVH-DVE_BA_09_1_EN.DOC

2.5   Tagging / Nameplate

Example

3. Introduction

3.1 Multi-Parameter Vortex Flow Meters

Heinrichs Messtechnik Model DVH In-Line and Model DVE Insertion Vortex Flow Meters provide a reliable solution for process flow measurement. From a single point in the pipeline, meters offer a precise measurement of mass or volumetric flow

3.2 Multi-Parameter Mass Flow Meters

Mass flow meters utilize three primary sensing elements: a vortex shedding velocity sensor, an RTD temperature sensor, and a solid state pressure sensor to measure the mass flow rate of gases, liquids, and steam.
Meters are available as loop powered devices or with up to three 4-20 mA analog output signals for monitoring your choice of the five process variables (mass flow, volumetric flow, temperature, pressure and fluid density). The Energy Monitoring option permits real-time calculation of energy consumption for a facility or process.

3.3 Volumetric Flow Meters

The primary sensing element of a volumetric flow meter is a vortex shedding velocity sensor. Meters are loop powered. The analog 4-20 mA output signal offers your choice of volumetric or mass flow rate. Mass flow rate is based on a constant value for fluid density stored in the instrument's memory.

Both the mass and volumetric flow meters can be ordered with a local keypad/display which provides instantaneous flow rate, total, and process parameters in engineering units. A pulse output signal for remote totalization and MODBUS or HART communications are also available. DVH /DVE digital electronics allows for easy reconfiguration for most gases, liquids and steam. The Heinrichs Series DVH and DVE Meters' simple installation combines with an easy-to-use interface that provides quick set up, long term reliability and accurate mass flow measurement over a wide range of flows, pressures and temperatures

3.4 Usage of this Instruction Manual

This manual provides information needed to install and operate both the Series DVH In-Line and Series DVE Insertion Flow Meters.

Chapter 1   Steps prior to operation
Chapter 2   Identification
Chapter 3   Introduction
Chapter 4   Installation
Chapter 5   Operating Instructions
Chapter 6   Serial Communications
Chapter 7   Troubleshooting and Repair
Chapter 8   Product Specifications
Chapter 9   Product Dimensions
Chapter 10   Model Number Information
Chapter 11   Approvals and Declaration of Conformity
Chapter 12   Flow Meter Calculations
Chapter 13   Glossary

3.5   Receipt of System Components

When receiving a Heinrichs Vortex flow meter, carefully check the outside packing carton for damage incurred in shipment. If the carton is damaged, notify the local carrier and submit a report to the factory or distributor. Remove the packing slip and check that all ordered components are present. Make sure any spare parts or accessories are not discarded with the packing material. Do not return any equipment to the factory without first contacting Heinrichs Customer Service

3.6   Technical Assistance

If you encounter a problem with your flow meter, review the configuration information for each step of the installation, operation and set up procedures. Verify that your settings and adjustments are consistent with factory recommendations. Refer to Chapter 7, Troubleshooting, for specific information and recommendations.

If the problem persists after following the troubleshooting procedures outlined in Chapter 5, contact Heinrichs Messtechnik GmbH Technical Support at +49 (221) 49708-0 between 8:00 and 17:00. EST. When calling Technical Support, have the following information on hand:
- the serial number and Heinrichs order number (all marked on the meter nameplate)
- the problem you are encountering and any corrective action taken
- application information (fluid, pressure, temperature and piping configuration)

3.7   How the DVH / DVE Vortex Flow Meter Operates
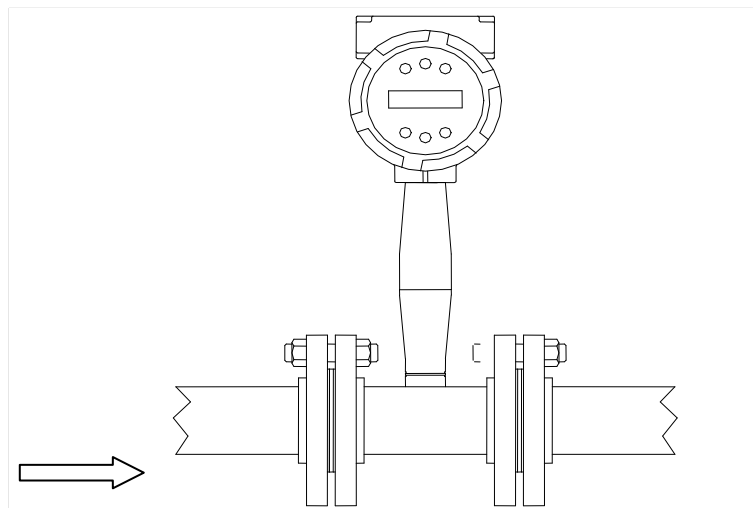
Figure 1   In-Line Vortex Multi-Parameter Mass Flow Meter

Heinrichs Series DVH and DVE Multi-Parameter Vortex Mass Flow Meters use a unique sensor head to monitor mass flow rate by directly measuring three variables–fluid velocity, temperature and pressure. The built-in flow computer calculates the mass flow rate and volumetric flow rate based on these three direct measurements. The velocity, temperature and pressure sensing head is built into the vortex meter's flow body. To measure fluid velocity, the flow meter incorporates a bluff body (shedder bar) in the flow stream and measures the frequency of vortices created by the shedder bar. Temperature is measured using a platinum resistance temperature detector (PRTD). Pressure measurement is achieved using a solid-state pressure transducer. All three elements are combined into an integrated sensor head assembly located downstream of the shedder bar within the flow body.

3.8   Velocity Measurement

The DVH /DVE vortex velocity sensor is a patented mechanical design that minimizes the effects of pipeline vibration and pump noise, both of which are common error sources in flow measurement with vortex flow meters. The velocity measurement is based on the well-known Von Karman vortex shedding phenomenon. Vortices are shed from a shedder bar, and the vortex velocity sensor located downstream of the shedder bar senses the passage of these vortices. This method of velocity measurement has many advantages including inherent linearity, high turndown, reliability and simplicity.

3.9   Vortex Shedding Frequency

Von Karman vortices form downstream of a shedder bar into two distinct wakes. The vortices of one wake rotate clockwise while those of the other wake rotate counterclockwise. Vortices generate one at a time, alternating from the left side to the right side of the shedder bar. Vortices interact with their surrounding space by over-powering every other nearby swirl on the verge of development. Close to the shedder bar, the distance (or wave length) between vortices is always constant and measurable. Therefore, the volume encompassed by each vortex remains constant, as shown below. By sensing the number of vortices passing by the velocity sensor, the DVH / DVE Flow Meter computes the total fluid volume
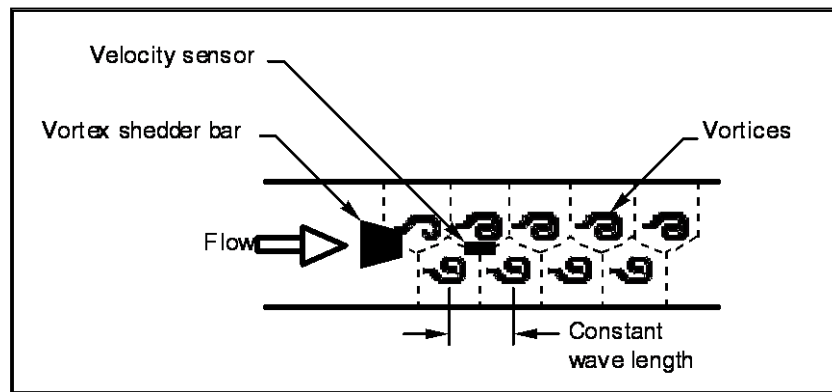
Figure 2   Measurement Principle of Vortex Flow Meters

3.10   Vortex Frequency Sensing

The velocity sensor incorporates a piezoelectric element that senses the vortex frequency. This element detects the alternating lift forces produced by the Von Karman vortices flowing downstream of the vortex shedder bar. The alternating electric charge generated by the piezoelectric element is processed by the transmitter's electronic circuit to obtain the vortex shedding frequency. The piezoelectric element is highly sensitive and operates over a wide range of flows, pressures and temperatures.

3.11   Flow Velocity Range

To ensure trouble-free operation, vortex flow meters must be correctly sized so that the flow velocity range through the meter lies within the measurable velocity range (with acceptable pressure drop) and the linear range.

The measurable range is defined by the minimum and maximum velocity using the following table.:

	Gas	**Liquid**	
Vmin	$\sqrt{\dfrac{25}{\rho}}$ ft/s	1 ft/s	English ρ (lb/ft^3)
Vmax	300 ft/s	30 ft/s	
Vmin	$\sqrt{\dfrac{37}{\rho}}$ m/s	0.3 m/s	Metric ρ (kg/m^3)
Vmax	91 m/s	9.1 m/s	

The pressure drop for series DVE insertion meters is negligible. The pressure drop for series DVH in-line meters is defined as:

$\Delta P = 0.00024\ \rho\ V^2$ English units (ΔP in psi, ρ in lb/ft^3, V in ft/sec)

$\Delta P = 0.000011\ \rho\ V^2$ Metric units   (ΔP in bar, ρ in kg/m^3, V in m/sec)

The linear range is defined by the Reynolds number. The Reynolds number is the ratio of the inertial forces to the viscous forces in a flowing fluid and is defined as:

$$Re = \frac{\rho V D}{\mu}$$

Where
Re = Reynolds Number
ρ = mass density of the fluid being measured
V = velocity of the fluid being measured
D = internal diameter of the flow channel
μ = viscosity of the fluid being measured

The Strouhal number is the other dimensionless number that quantifies the vortex phenomenon. The Strouhal number is defined as:
:

$$St = \frac{f d}{V}$$

Where
St = Strouhal Number
f = frequency of vortex shedding
d = shedder bar width
V = fluid velocity

As shown in Figure 3, DVH / DVE meters exhibit a constant Strouhal number across a large range of Reynolds numbers, indicating a consistent linear output over a wide range of flows and fluid types. Below this linear range, the intelligent electronics in DVH /DVE automatically corrects for the variation in the Strouhal number with the Reynolds number. The meter's smart electronics corrects for this non-linearity via its simultaneous measurements of the process fluid temperature and pressure. This data is then used to calculate the Reynolds number in real time. Meters automatically correct down to a Reynolds number of 5,000.
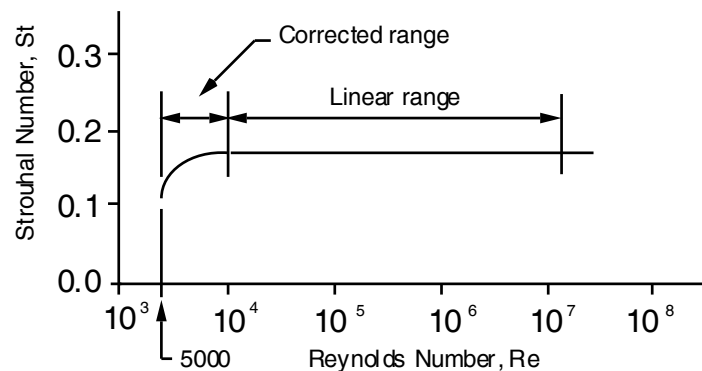
Figure 3   Reynolds Number Range

3.12   Temperature Measurement

DVH /DVE Flow Meters use a 1000 ohm platinum resistance temperature detector (PRTD) to measure fluid temperature.

3.13   Pressure Measurement

DVH /DVE Flow Meters incorporate a solid-state pressure transducer isolated by a 316 stainless steel diaphragm. The transducer itself is micro-machined silicon, fabricated using integrated circuit processing technology. A nine-point pressure/temperature calibration is performed on every sensor. Digital compensation allows these transducers to operate within a 0.3% of full scale accuracy band within the entire ambient temperature range of -40°F to 140°F / -40 to 60°C. Thermal isolation of the pressure transducer ensures the same accuracy across the allowable process fluid temperature range of -330°F to 750°F / -200 to 400°C.

3.14   Flow Meter Configurations

DVH / DVE Vortex Mass Flow Meters are available in two model configurations:
- Series DVH in-line flow meter (replaces a section of the pipeline)
- Series DVE insertion flow meter (requires a "cold" tap or a "hot" tap into an existing pipeline)

Both the in-line and insertion configurations are similar in that they both use identical electronics and have similar sensor heads. Besides installation differences, the main difference between an in-line flow meter and an insertion flow meter is their method of measurement.

For an in-line vortex flow meter, the shedder bar is located across the entire diameter of the flow body. Thus, the entire pipeline flow is included in the vortex formation and measurement. The sensing head, which directly measures velocity, temperature and pressure is located just downstream of the shedder bar.

Insertion vortex flow meters have a shedder bar located across the diameter of a short tube. The velocity, temperature and pressure sensor are located within this tube just downstream of a built-in shedder bar. This entire assembly is called the insertion sensing head. It fits through any entry port with a 1.875 inch minimum internal diameter.

The sensing head of an insertion vortex flow meter directly monitors the velocity at a point in the cross-sectional area of a pipe, duct, or stack (referred to as "channels"). The velocity at a point in the pipe varies as a function of the Reynolds number. The insertion vortex flow meter computes the Reynolds number and then computes the total flow rate in the channel. The output signal of insertion meters is the total flow rate in the channel. The accuracy of the total flow rate computation depends on adherence to the piping installation requirements given in Chapter 3. If adherence to those guidelines cannot be met, contact the factory for specific installation advice.

3.15   Multivariable Options

The DVH or DVE models are available with the following options:
V   volumetric flow meter;
VT   velocity and temperature sensors;
VTP   velocity, temperature, and pressure sensors;
VT-EM   energy output options;
VTP-EM   energy options with pressure;
VT-EP   external pressure transmitter input

3.16   Line Size / Process Connections / Materials

The DVH In-line model is built for line sizes DN15 / ½ through DN100 / 4 inch wafer or DN15 / ½ through DN200 / 8 inch flanged design using ANSI 150, 300, 600, PN16, 40, or 64 class flanges.

The DVE Insertion model can be used in line sizes DN50 / 2 inch and greater and is built with a compression fitting or packing gland design using DN50 / 2 inch NPT, or DN50 / 2 inch flanged connections (ANSI 150, 300, 600, PN16, 40, or 64 class flanges). The packing gland design can be ordered with a permanent or removable retractor.

3.17   Flow Meter Electronics

DVH /DVE Flow Meter electronics are available mounted directly to the flow body, or remotely mounted. The electronics housing may be used indoors or outdoors, including wet environments. Available input power options are: DC loop powered (2-wire), DC powered, or AC powered. Three analog output signals are available for your choice of three of the five process variables: mass flow rate, volumetric flow rate, temperature, pressure or fluid density. A pulse output signal for remote totalization and MODBUS or HART communications are also available.

DVH /DVE Flow Meters include a local 2 x 16 character LCD display housed within the enclosure. Local operation and reconfiguration is accomplished using six pushbuttons operated via finger touch. For hazardous locations, the six buttons can be operated with the electronics enclosure sealed using a hand-held magnet, thereby not compromising the integrity of the hazardous location certification.

The electronics include nonvolatile memory that stores all configuration information. The nonvolatile memory allows the flow meter to function immediately upon power up, or after an interruption in power. All flow meters are calibrated and configured for the customer's flow application.

4. Installation

4.1   Installation Overview

Heinrichs' DVH /DVE Vortex Flow Meter installations are simple and straightforward. Both the Series DVH In-Line and Series DVE Insertion type flow meter installations are covered in this chapter. After reviewing the installation requirements given below, see Page 17 Chapter 4.4 Series DVH In Line Flow Meter Installation. See for Series DVE installation instructions Page 20 Chapter 4.5 Series DVE Insertion Flow Meter Installation. Wiring instructions begin on page

4.2   Flow Meter Installation Requirements

Warning!
Consult the flow meter nameplate for specific flow meter approvals before any hazardous location installation

Before installing the flow meter, verify the installation site allows for these considerations.

1. Line pressure and temperature will not exceed the flow meter rating.

2. The location meets the required minimum number of pipe diameters upstream and downstream of the sensor head as illustrated in **Fehler! Verweisquelle konnte nicht gefunden werden.**

3. Safe and convenient access with adequate overhead clearance for maintenance purposes.

4. Verify that the cable entry into the instrument meets the specific standard required for hazardous area installations The cable entry device shall be certified flameproof type,, suitable for the conditions of use and correctly installed. The degree of protection of at least IP66 to EN60529 is only achieved if certified cable entries are used that are suitable for the application and correctly installed. Unused apertures shall be closed with suitable blanking elements.

5. For remote installations, verify the supplied cable length is sufficient to connect the flow meter sensor to the remote electronics

Also, before installation check your flow system for anomalies such as:
 - Leaks,
 - valves or restrictions in the flow path that could create disturbances in the flow profile that might cause unexpected flow rate indications

4.3   Unobstructed Flow Requirements

Select an installation site that will minimize possible distortion in the flow profile. Valves, elbows, control valves and other piping components may cause flow disturbances. Check your specific piping condition against the examples shown below. In order to achieve accurate and repeatable performance install the flow meter using the recommended number of straight run pipe diameters upstream and downstream of the sensor.

Note: For liquid applications in vertical pipes, avoid installing with flow in the downward direction because the pipe may not be full at all points. Choose to install the meter with flow in the upward direction if possible.

Example 1.
One 90° elbow before meter

Example 2.
Two 90° elbows before meter in one plane

Example 3.
Two 90° elbows before meter out of plane (if three 90° bends present, double recommended length)

Example 4.
Reduction before meter

Example 5.
Expansion before meter

Example 6.
Regulator or valve partially closed before meter (If valve is always wide open, base length requirements on fitting directly preceding it)

Figure 4   Recommended Pipe Length Requirements for Installation, Series DVH and DVE

	Minimum Required Upstream Diameters				Minimum Required Downstream Diameters	
	No Flow Conditioner	With Flow Conditioner			No Flow Conditioner	With Flow Conditioner
Example	A	A	C	C´	B	B
1	10 D	N/A	N/A	N/A	5 D	5 D
2	15 D	10 D	5 D	5 D	5 D	5 D
3	25 D	10 D	5 D	5 D	10 D	5 D
4	10 D	10 D	5 D	5 D	5 D	5 D
5	20 D	10 D	5 D	5 D	5 D	5 D
6	25 D	10 D	5 D	5 D	10 D	5 D

Table 1   Examples Pipe Length Requirements for Installation, Series DVH and DVE

4.4 Series DVH In Line Flow Meter Installation

Install the Series DVH In-Line Flow Meter between two conventional pipe flanges as shown on Page 17 Figure 5 and Page 19 Figure 7.

Figure 6 page 19 provides the recommended minimum stud bolt lengths for wafer-style meter body size and different flange ratings.

The meter inside diameter is equal to the same size nominal pipe ID in schedule 80. For example, a 2" meter has an ID of 1.939" / 49,35 mm (2" schedule 80). **Do not install the meter in a pipe with an inside diameter smaller than the inside diameter of the meter.** For schedule 160 and higher pipe, a special meter is required. Consult the factory before purchasing the meter.

Series DVH Meters require customer-supplied gaskets. When selecting gasket material make sure that it is compatible with the process fluid and pressure ratings of the specific installation. Verify that the inside diameter of the gasket is larger than the inside diameter of the flow meter and adjacent piping. If the gasket material extends into the flow stream, it will disturb the flow and cause inaccurate measurements.

4.4.1 Wafer Style Flow Meter Installation

Install the wafer-style meter between two conventional pipe flanges of the same nominal size as the flow meter. If the process fluid is a liquid, make sure the meter is located where the pipe is always full. This may require locating the meter at a low point in the piping system. Note: Vortex flow meters are not suitable for two-phase flows (i.e., liquid and gas mixtures). For horizontal pipelines having a process temperature above 300° F / 150°C, mount the meter at a 45 or 90-degree angle to avoid overheating the electronics enclosure. To adjust the viewing angle of the enclosure or display/keypad, see page 30 Figure 17 and page 30 Figure 18.
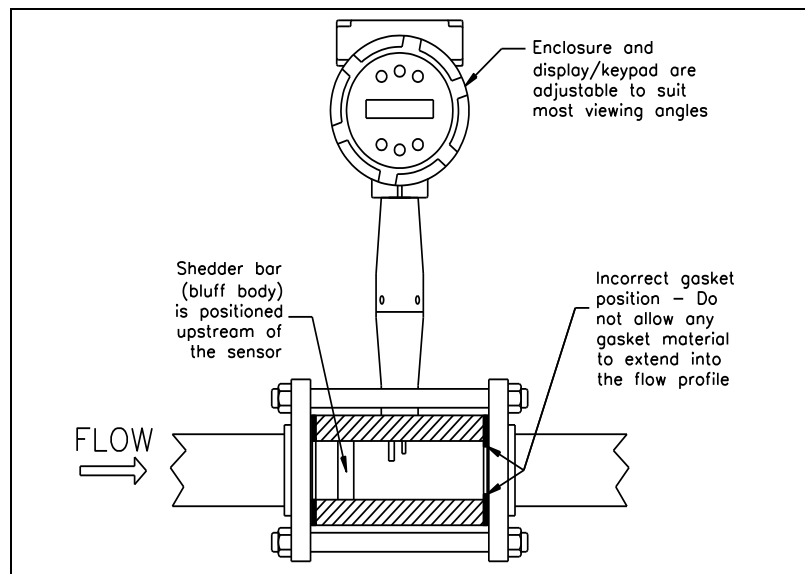
Figure 5   Wafer-Style Flow Meter Installations

⚠ Caution
When using toxic or corrosive gases, purge the line with inert gas for a minimum of four hours at full gas flow before installing the flow meter

When installing the meter make sure the section marked with a flow arrow is positioned upstream of the outlet, with the arrow head pointing in the direction of flow. (The mark is on the flange adjacent to the enclosure mounting neck.) This ensures that the sensor head is positioned downstream of the vortex shedder bar and is correctly aligned to the flow. Installing the meter opposite this direction will result in completely inaccurate flow measurement. To install the meter:

1. Turn off the flow of process gas, liquid or steam. Verify that the line is not pressurized. Confirm that the installation site meets the required minimum upstream and downstream pipe diameters.

2.   Insert the studs for the bottom side of the meter body between the pipe flanges. Place the wafer-style meter body between the flanges with the end stamped with a flow arrow on the upstream side, with the arrow head pointing in the direction of flow. Center the meter body inside the diameter with respect to the inside diameter of the adjoining piping.

3.   Position the gasket material between the mating surfaces. Make sure both gaskets are smooth and even with no gasket material extending into the flow profile. Obstructions in the pipeline will disturb the flow and cause inaccurate measurements.

4.   Place the remaining studs between the pipe flanges. Tighten the nuts in the sequence shown in Figure 6 Check for leaks after tightening the flange bolts.

4.4.2   Flange Bolt Specification for wafer style

Größe	DIN EN 1092-1			
	Nennweite	**PN40**	**PN64**	**-**
W1	DN15	4 Stk. M12 x 140 mm	4 Stk. M12 x 150 mm	-
W2	DN20	4 Stk. M12 x 140 mm	4 Stk. M16 x 160 mm	-
W3	DN25	4 Stk. M12 x 140 mm	4 Stk. M16 x 165 mm	-
W4	DN40	4 Stk. M16 x 150 mm	4 Stk. M20 x 180 mm	-
W5	DN50	4 Stk. M16 x 160 mm	4 Stk. M20 x 180 mm	-
W6	DN80	8 Stk. M16 x 165 mm	8 Stk. M20 x 185 mm	-
W7	DN100	8 Stk. M20 x 175 mm	8 Stk. M24 x 200 mm	-

Größe	ASME B16.5			
	Nennweite	**class 150**	**class 300**	**class 600**
W1	1/2"	4 Stk. 1/2" x 4.75 in.	4 Stk. 1/2" x 5.00 in.	4 Stk. 1/2" x 5.50 in.
W2	3/4"	4 Stk. 1/2" x 5.00 in.	4 Stk. 5/8" x 5.50 in.	4 Stk. 5/8" x 6.00 in.
W3	1"	4 Stk. 1/2" x 5.25 in.	4 Stk. 5/8" x 5.50 in.	4 Stk. 5/8" x 6.00 in.
W4	1 1/2"	4 Stk. 1/2" x 5.25 in.	4 Stk. 3/4" x 6.00 in.	4 Stk. 3/4" x 6.75 in.
W5	2"	4 Stk. 5/8" x 5.75 in.	8 Stk. 5/8" x 6.00 in.	8 Stk. 5/8" x 6.75 in.
W6	3"	4 Stk. 5/8" x 6.00 in.	8 Stk. 3/4" x 6.75 in.	8 Stk. 3/4" x 7.50 in.
W7	4"	8 Stk. 5/8" x 6.00 in.	8 Stk. 3/4" x 7.00 in.	8 Stk. 7/8" x 8.25 in.

Größe	JIS B2220			
	Nennweite	**10 k**	**-**	**-**
W1	DN15	4 Stk. M12 x 130 mm	-	-
W2	DN20	4 Stk. M12 x 130 mm	-	-
W3	DN25	4 Stk. M16 x 145 mm	-	-
W4	DN40	4 Stk. M16 x 150 mm	-	-
W5	DN50	4 Stk. M16 x 150 mm	-	-
W6	DN80	4 Stk. M16 x 150 mm	-	-
W7	DN100	4 Stk. M16 x 150 mm	-	-

Table 2   Minimum Recommended Stud Bolt Lengths for Wafer Meters

The required bolt load for sealing the gasket joint is affected by several application-dependent factors; therefore the required torque for each application may be different. Refer to the ASME Pressure Vessel Code guidelines for bolt tightening standards.
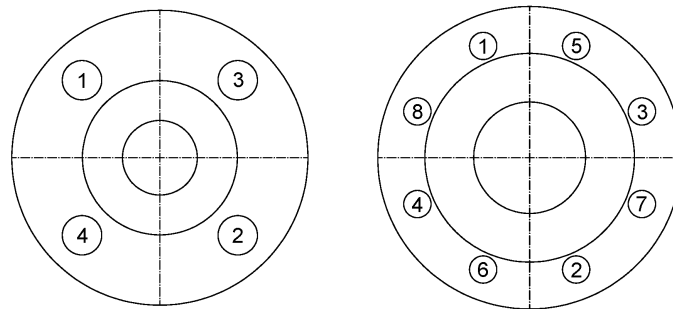
Figure 6   Flange Bolt Torquing Sequence

4.4.3   Flange Style Flow Meter Installation

Install the flange-style meter between two conventional pipe flanges of the same nominal size as the flow meter. If the process fluid is a liquid, make sure the meter is located where the pipe is always full. This may require locating the meter at a low point in the piping system. Note: Vortex flow meters are not suitable for two-phase flows (i.e., liquid and gas mixtures). For horizontal pipelines having a process temperature above 300° F / 150°C, mount the meter at a 45 or 90-degree angle to avoid overheating the electronics enclosure.. To adjust the viewing angle of the enclosure or display/keypad, see page 30 Figure 17 and page 30 Figure 18.
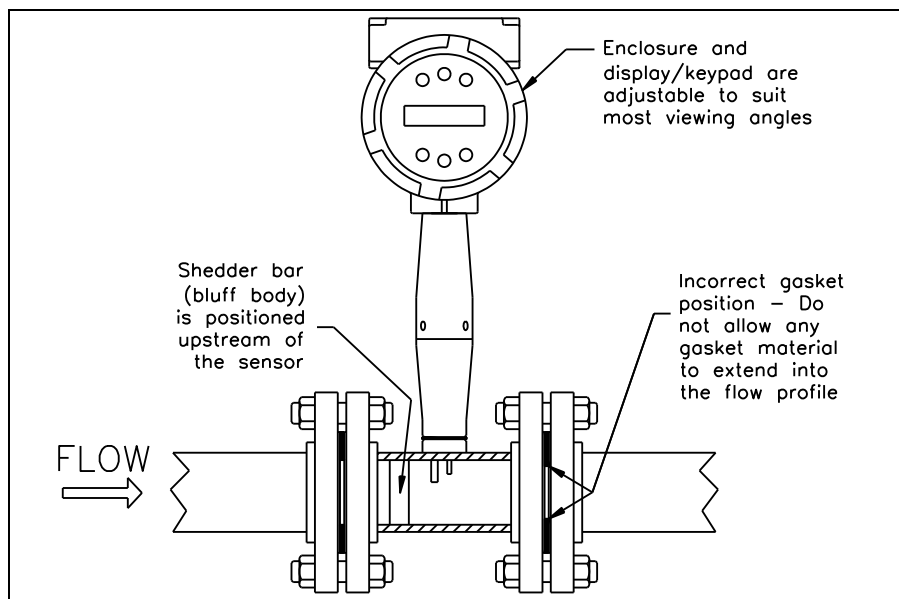
Figure 7   Flange Style Meter Installations

Caution!
When using toxic or corrosive gases, purge the line with inert gas for a minimum of four hours at full gas flow before installing the flow meter

When installing the meter make sure the flange marked with a flow arrow is positioned upstream of the outlet flange, with the arrow head pointing in the direction of flow. (The mark is on the flange adjacent to the enclosure mounting neck.) This ensures that the sensor head is positioned downstream of the vortex shedder bar and is correctly aligned to the flow. Installing the meter opposite this direction will result in completely inaccurate flow measurement:

To install the meter:

1. Turn off the flow of process gas, liquid or steam. Verify that the line is not pressurized. Confirm that the installation site meets the required minimum upstream and downstream pipe diameters.

2. Seat the meter level and square on the mating connections with the flange stamped with a flow arrow on the upstream side, with the arrow head pointing in the direction of flow. Position a gasket in place for each side. Make sure both gaskets are smooth and even with no gasket material extending into the flow profile. Obstructions in the pipeline will disturb the flow and cause inaccurate measurements.

3. Install bolts in both process connections. Tighten the nuts in the sequence shown in Figure 6 Check for leaks after tightening the flange bolts.

4.5   Series DVE Insertion Flow Meter Installation

Prepare the pipeline for installation using either a cold tap or hot tap method described on the following pages. Refer to a standard code for all pipe tapping operations. The following tapping instructions are general in nature and intended for guideline purposes only. Before installing the meter, review the mounting position and isolation value requirements given below.

Mounting Position
Allow clearance between the electronics enclosure top and any other obstruction when the meter is fully retracted.
.
Isolation Valve Selection
An isolation valve is available as an option with Series DVE meters. If you supply the isolation valve, it must meet the following requirements:

1. A minimum valve bore diameter of 47,63 mm / 1.875 inches is required and the valve's body size should be two inches. Normally, gate valves are used.

2. Verify that the valve's body and flange rating are within the Flow meter's maximum operating pressure and temperature.

3. Choose an isolation valve with at least two inches existing between the flange face and the gate portion of the valve. This ensures that the flow meter's sensor head will not interfere with the operation of the isolation valve.
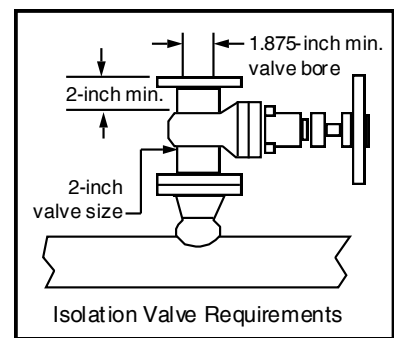
Figure 8 Isolation Valve Requirements

4.5.1   Cold Tap Guidelines

Refer to a standard code for all pipe tapping operations. The following tapping instructions are general in nature and intended for guideline purposes only.

Caution!
When using toxic or corrosive gases, purge the line with inert gas for a minimum of four hours at full gas flow before installing the flow meter

Warning!
All flow meter connections, isolation valves and fittings for cold tapping must have the same or higher pressure rating as the main pipeline

1. Turn off the flow of process gas, liquid or steam. Verify that the line is not pressurized.

2. Confirm that the installation site meets the minimum upstream and downstream pipe diameter requirements. See page 16 Figure 4.

3. Use a cutting torch or sharp cutting tool to tap into the pipe. The pipe opening must be at least 47,63mm / 1.875 inches in diameter. (Do not attempt to insert the sensor probe through a smaller hole.)

4. Remove all burrs from the tap. Rough edges may cause flow profile distortions that could affect flow meter accuracy. Also, obstructions could damage the sensor assembly when inserting into the pipe.

5. After cutting, measure the thickness of the cut-out and record this number for calculating the insertion depth.

6. Weld the flow meter pipe connection on the pipe. Make sure this connection is within ± 5° perpendicular to the pipe centerline.

7. Install the isolation valve (if used).

8. When welding is complete and all fittings are installed, close the isolation valve or cap the line. Run a static pressure check on the welds. If pressure loss or leaks are detected, repair the joint and re-test.

Correct Alignment   Incorrect Alignment

Figure 9   Alignment Correct/Incorrect

9. Connect the meter to the pipe process connection.

10. Calculate the sensor probe insertion depth and insert the sensor probe into the pipe as described on the following page.

4.5.2   Hot Tap Guidelines

Refer to a standard code for all pipe tapping operations. The following tapping instructions are general in nature and intended for guideline purposes only

Warning!
Hot tapping must be performed by a trained professional. US. regulations often require a hot tap permit. The manufacturer of the hot tap equipment and/or the contractor performing the hot tap is responsible for providing proof of such a permit

1. Confirm that the installation site meets the minimum upstream and downstream pipe diameter requirements.

2. Weld a DN50/2" mounting adapter on the pipe. Make sure the mounting adapter is within ± 5° perpendicular to the pipe centerline (see previous page). The pipe opening must be at least 47,3mm / 1.875 inches in diameter.

3. Connect a two inch process connection on the mounting adapter.

4. Connect an isolation valve on the process connection. The valve's full open bore must be at least 47,63mm / 1.875 inches in diameter.

Warning!
All flow meter connections, isolation valves, and fittings for hot tapping must have the same or higher pressure rating as the main pipeline

5. Run a static pressure check on the welds. If pressure loss or leaks are detected, repair the joint and re-test.

6. Connect the hot tapping equipment to the isolation valve, open the isolation valve and drill at least a 47,63mm / 1.875 inch diameter hole.

7. Retract the drill, close the isolation valve, and remove the hot tapping equipment.

8. Connect the flow meter to the isolation valve and open the isolation valve.

9. Calculate the sensor probe insertion depth and insert the sensor probe into the pipe as described on the following pages.
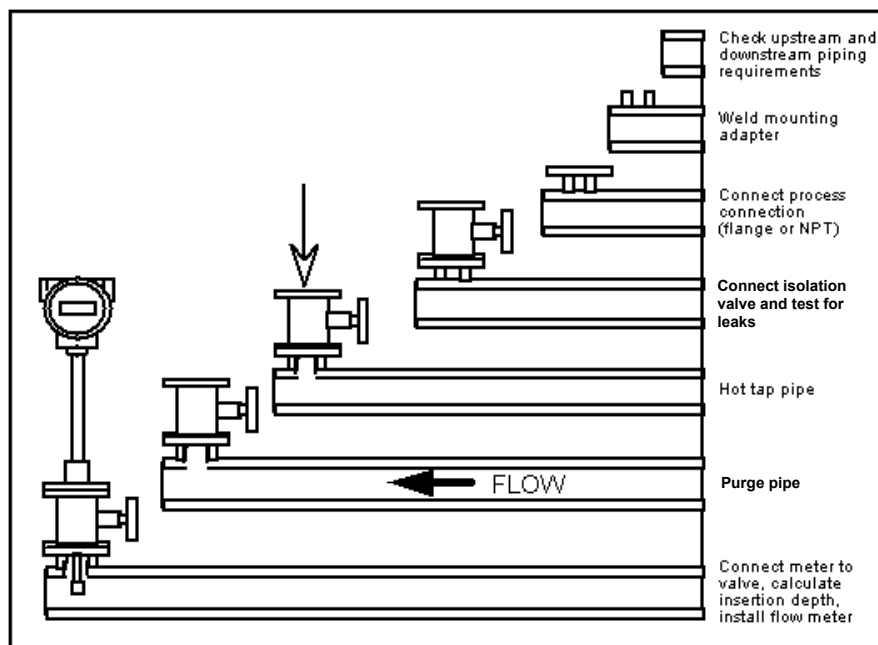
Figure 10   Hot Tap Sequence

4.5.3   Flow Meter Insertion

The sensor head must be properly positioned in the pipe. For this reason, it is important that insertion length calculations are carefully followed. A sensor probe inserted at the wrong depth in the pipe will result in inaccurate readings.

Insertion flow meters are applicable to pipes DN50 / 2 inches and larger. For pipe sizes DN250 / 10" and smaller, the centerline of the meter's sensing head is located at the pipe's centerline. For pipe sizes larger than DN250 / 10", the centerline of the sensing head is located in the pipe's cross section 127mm / 5" from the inner wall of the pipe; i.e., its "wetted" depth from the wall to the centerline of the sensing head is 127mm / 5".

Insertion flow meters are available in three probe lengths:

Standard Probe configuration is used with most flow meter process connections. The length, S, of the stem is 748,5 mm / 29.47 inches.

Compact Probe configuration is used with compression fitting process connections. The length, S, of the stem is 332,7 mm./ 13.1 inches.

304,8 mm / 12-Inch Extended Probe configuration is used with exceptionally lengthy flow meter process connections. The length, S, of the stem 1053,3 cm. / is 41.47 inches.

Use the Correct Insertion Formula
Depending on your flow meter's process connection, use the applicable insertion length formula and installation procedure as follows:

Warning!
An insertion tool must be used for any installation where a flow meter is inserted under pressure greater than 50 psig.

- Flow meters with a compression type connection (NPT or flanged) follow the instructions beginning on Page 24 Chapter 4.5.4.

- Flow meters with a packing gland type connection (NPT or flanged) configured with an insertion tool, follow the instructions beginning on Page 26 Chapter 4.5.6

- Flow meters with a packing gland type connection (NPT or flanged) without an insertion tool, follow the instructions beginning on Page 29 Chapter 4.5.10.

4.5.4   Installing Flow Meters with a Compression Connection

Use the following formula to determine insertion length for flow meters (NPT and flanged) with a compression process connection. The installation procedure is given on the next page.

Figure 11   Insertion Calculations (Compression Type)

Insertion Length Formula

$$I = S - F - R - t$$

Where:

I =   Insertion length.
S =   Stem length – the distance from the center of the sensor head to the base of the enclosure adapter (S = 29.47 inches / 748,5 mm for standard probes; S = 13.1 inches for compact; S = 41.47 inches / 1053,3 mm for 12-inch 304,8 mm extended).
F = Distance from the raised face of the flange or top of NPT stem housing to the outside of the pipe wall.
R =   Half pipe inside diameter for pipes ten inches / DN250 and smaller.
R =   Five inches / 127 mm for pipe diameters larger than ten inches./ DN250
 t =Thickness of the pipe wall. (Measure the disk cut-out from the tapping procedure or check a piping handbook for thickness.)

Example:
To install a Series DVE meter with a standard probe (S = 29.47 inches / 748,5 mm) into a 14 inch schedule 40 pipe, the following measurements are taken:

F= 76,2 mm / 3 inches
R= 127 mm / 5 inches
t= 11,1 mm / 0.438 inches

The insertion length for this example is 534,2 mm. / 21.03 inches. Insert the stem through the fitting until an insertion length of 534,2 cm / 21.03 inches is measured with a ruler.

4.5.5   Insertion Procedure for Meters with a Compression Connection
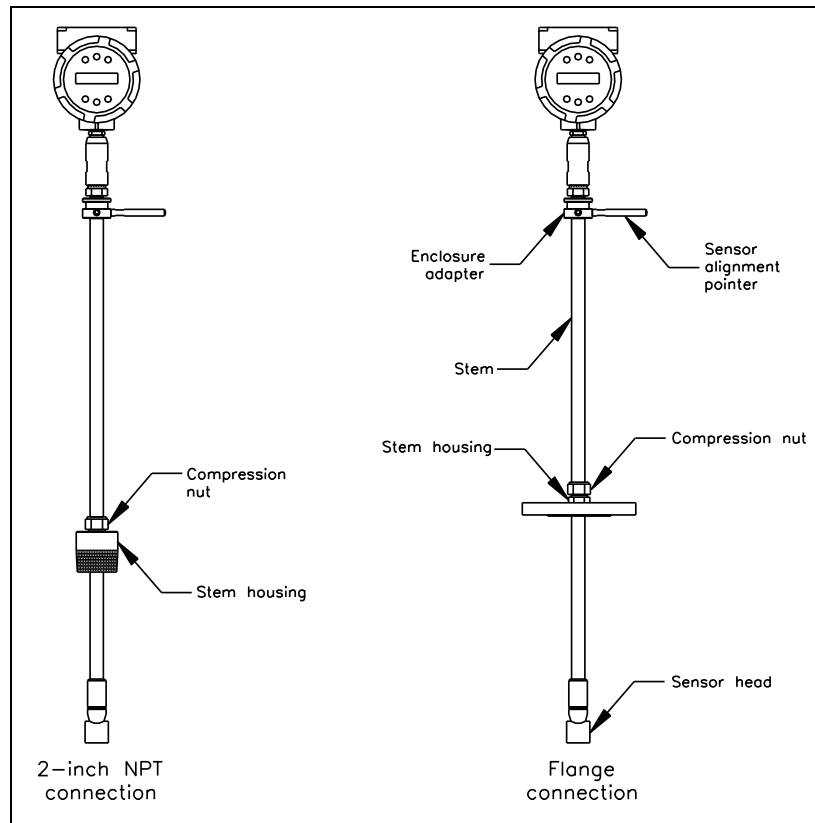
Figure 12   Flow Meter with Compression Type Fitting

1.   Calculate the required sensor probe insertion length.

⚠ Caution!
The sensor alignment pointer must point downstream, in the direction of flow.

2.   Fully retract the stem until the sensor head is touching the bottom of the stem housing. Slightly tighten the compression nut to prevent slippage.

3.   Bolt or screw the flow meter assembly into the process connection. Use Teflon tape or pipe sealant to improve the seal and prevent seizing on NPT styles.

4.   Hold the meter securely while loosening the compression fitting. Insert the sensor into the pipe until the calculated insertion length, I, is measured between the base of the enclosure adapter and the top of the stem housing, or to the raised face of the flanged version. Do not force the stem into the pipe.

⚠ Warning!
To avoid serious injury, DO NOT loosen the compression fitting under pressure.

5.   Align the sensor head using the sensor alignment pointer. Adjust the alignment pointer parallel to the pipe and pointing downstream.

6.   Tighten the compression fitting to lock the stem in position.

When the compression fitting is tightened, the position is permanent

4.5.6   Installing Flow Meters with a Packing Gland Connection

Use the formula below to determine the insertion depth for flow meters (NPT and flanged) equipped with an insertion tool. To install, see the next page for instructions for meters with a permanent insertion tool. For meters with a removable insertion tool, see Page 28 Chapter 4.5.9.

4.5.7   Insertion Length Formula
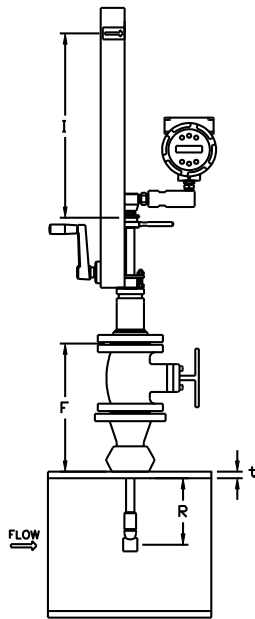
$$I = F + R + t - 34,3mm / 1.35inch$$

Where:

I = Insertion length.
F = Distance from the raised face of the flange or top of the process connection for NPT style meters to the top outside
f = the process pipe.

R = Half pipe inside diameter for pipes DN 250 / 10 inches and smaller.
R = 127 mm / 5" for pipe diameters larger than DN250 / 10 inch.
t = Thickness of the pipe wall.
(Measure the disk cut-out from the tapping procedure or check a piping hand book for thickness.)

Figure 13   Insertion Calculation (Meters with Insertion Tool)

Example 1: Flange Style Meters:
To install a Series DVE Flow Meter into a 14 inch schedule 40 pipe, the following measurements are taken:

F=   304,8 mm / 12 inches
R=   127 mm / 5 inches
t=   11,3 mm / 0.438 inches

The example insertion length is 408,8mm / 16.09 inches.

Example 2: NPT Style Meters:
The length of thread engagement on the NPT style meters is also subtracted in the equation. The length of the threaded portion of the NPT meter is 30mm. / 1.18 inches. Measure the thread portion still showing after the installation and subtract that amount from 30 mm. / 1.18 inches. This gives you the thread engagement length. If this cannot be measured use 14 mm / 0.55 inch for this amount.

F=   304,8 mm / 12 inches
R=   127 mm / 5 inches
t=   11,13 mm / 0.438 inches

The example insertion length is 394,63 mm / 15.54 inches.
(I = 304,8mm + 127mm + 11,13mm – 34,3mm -14mm / for metric dimensions)

4.5.8   Insertion Procedure for Flow Meters with Permanent Insertion Tool
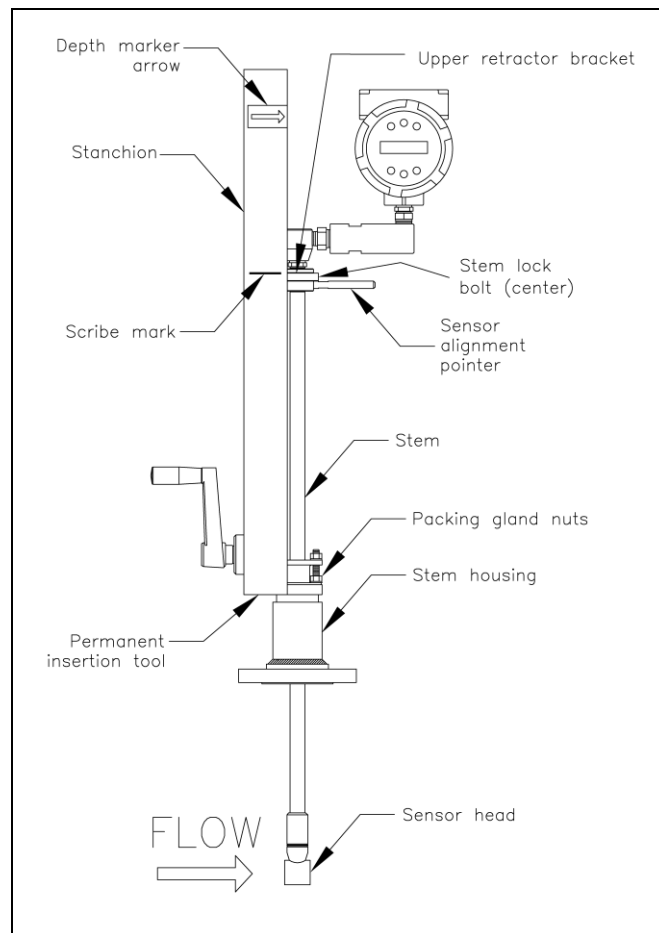
Figure 14   Flow Meter with Permanent Insertion Tool

Caution!
The sensor alignment pointer must point downstream, in the direction of flow.

Note
If line pressure is above 35 bar / 500 psig, it could require up to 34 Nm / 25 ft lb of torque to insert the flow meter.
Do not confuse this with possible interference in the pipe.

1. Calculate the required sensor probe insertion length (see previous page). Measure from the depth marker arrow down the stanchion and scribe a mark at the calculated insertion depth.

2. Fully retract the flow meter until the sensor head is touching the bottom of the stem housing. Attach the meter assembly to the two inch full-port isolation valve, if used. Use Teflon tape or pipe sealant to improve seal and prevent seizing on NPT style.

3. Loosen the two packing gland nuts on the stem housing of the meter. Loosen the stem lock bolt adjacent to the sensor alignment pointer. Align the sensor head using the sensor alignment pointer. Adjust the alignment pointer parallel to the pipe and pointing downstream. Tighten the stem lock bolt to secure the sensor position.

4. Slowly open the isolation valve to the full open position. If necessary, slightly tighten the two packing gland nuts to reduce the leakage around the stem.

5. Turn the insertion tool handle clockwise to insert the sensor head into the pipe. Continue until the top of the upper retractor bracket aligns with the insertion length position scribed on the stanchion. Do not force the stem into the pipe.

6. Tighten the packing gland nuts to stop leakage around the stem. Do not torque over 27 Nm / 20 ft-lb.

4.5.9   Insertion Procedure for Flow Meters with Removable Insertion Tool
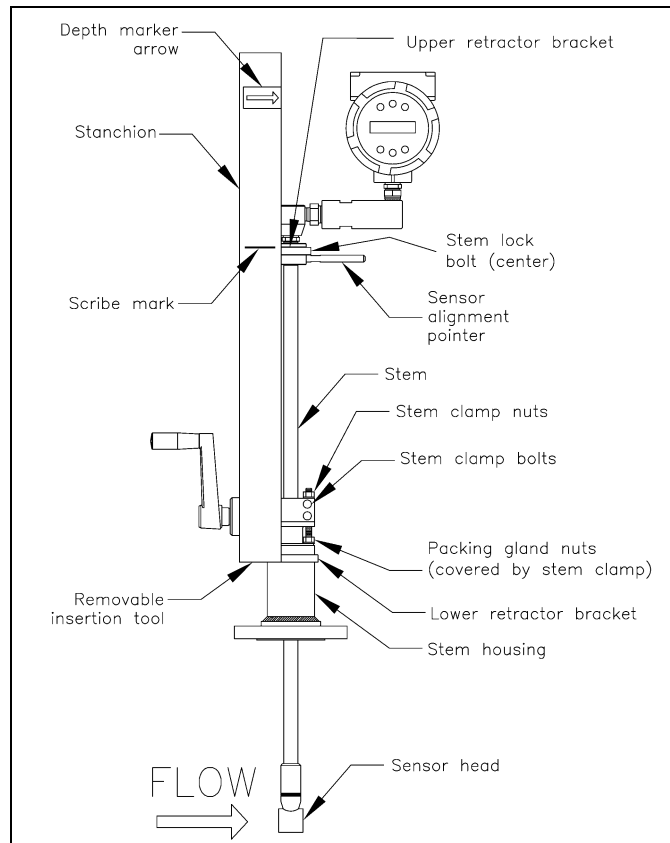
Figure 15   Flow Meter with Removable Insertion Tool

Caution!
The sensor alignment pointer must point downstream, in the direction of flow

Note
Do not confuse this with possible interference in the pipe.
If line pressure is above 500 psig, it could require up to 25 ft lb of torque to insert the flow meter.

1.   Calculate the required sensor probe insertion length. Measure from the depth marker arrow down the stanchion and scribe a mark at the calculated insertion depth.

2.   Fully retract the flow meter until the sensor head is touching the bottom of the stem housing. Attach the meter assembly to the DN50/2" full-port isolation valve, if used. Use Teflon tape or pipe sealant to improve seal and prevent seizing on NPT style.

3.   Remove the two top stem clamp nuts and loosen two stem clamp bolts. Slide the stem clamp away to expose the packing gland nuts.

4.   Loosen the two packing gland nuts. Loosen the stem lock bolt adjacent to the sensor alignment pointer. Align the sensor head using the sensor alignment pointer. Adjust the alignment pointer parallel to the pipe and pointing downstream. Tighten the stem lock bolt to secure the sensor position.

5.   Slowly open the isolation valve to the full open position. If necessary, slightly tighten the two packing gland nuts to reduce the leakage around the stem.

6.   Turn the insertion tool handle clockwise to insert the stem into the pipe. Continue until the top of the upper retractor bracket lines up with the insertion length mark scribed on the stanchion. Do not force the stem into the pipe.

7.   Tighten the packing gland nuts to stop leakage around the stem. Do not torque over 27 Nm / 20 ft-lbs.

8.   Slide the stem clamp back into position. Torque stem clamp bolts to 15 ft-lbs. Replace the stem clamp nuts and torque to13,6 - 20,3 Nm / 10 - 15 ft-lbs.

9.   To separate the insertion tool from the flow meter, remove four socket head cap bolts securing the upper and lower retractor brackets. Remove the insertion tool.

4.5.10 Installation of Meters with Packing Gland Connection (No Insertion Tool)

Use the following formula to determine insertion depth for meters with a packing gland connection (NPT and flanged) without an insertion tool.
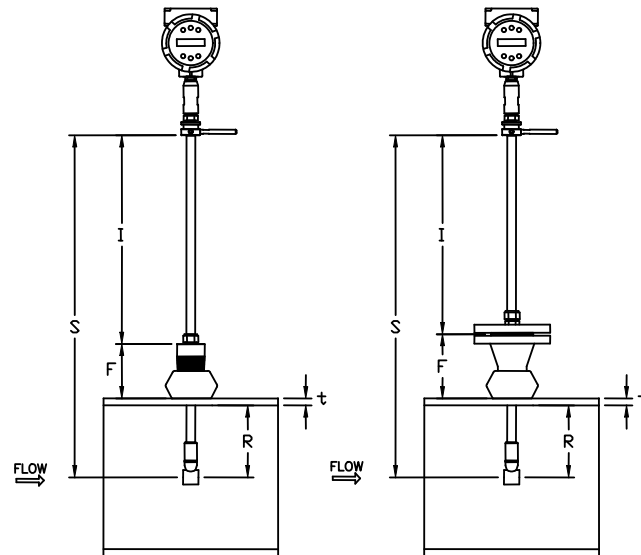
Insertion Length Formula
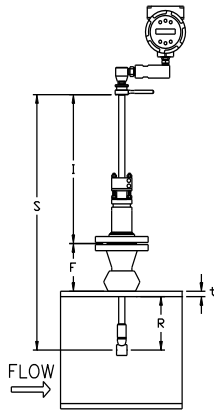
$$I = S - F - R - t$$

Where:
I = Insertion length.
S = Stem length – the distance from the center of the sensor head to the base of the enclosure adapter (S =748,5 mm / 29.47 inches for standard probes; S = 1053,3 mm / 41.47 inches for 304,8 mm / 12 inch extended probes).
F = Distance from the raised face of the flange or top of NPT stem housing to the outside of the pipe wall.
R = Half pipe inside diameter for pipes DN250 / 10 inches and smaller.
R = 127 mm / 5 inches for pipe diameters larger than DN250 / 10 inches.
t= Thickness of the pipe wall. (Measure the disk cut-out from the tapping procedure or check a piping handbook for thickness.)

Figure 16   Insertion Calculation (Meters without Insertion Tool)

Example:
To install a Series DVE Flow Meter with a standard probe (S = 748,5 mm / 29.47") into a 14 inch schedule 40 pipe, the following measurements are taken:

F= 76,2 mm / 3 inches
R= 127 mm / 5 inches
t= 11,1 mm / 0.438 inches

The example insertion length is 534,2 mm / 21.03 inches.

Insertion Procedure for Flow Meters with No Insertion Tool (Packing Gland Connection)

1. Calculate the required sensor probe insertion length.

Warning!
The line pressure must be less than 3,5bar/50 psig for installation

2. Fully retract the stem until the sensor head is touching the bottom of the stem housing. Remove the two top stem clamp nuts and loosen two stem clamp bolts. Slide the stem clamp away to expose the packing gland nuts. Loosen the two packing gland nuts.

3. Align the sensor head using the sensor alignment pointer. Adjust the alignment pointer parallel to the pipe and pointing downstream.

Caution!
The sensor alignment pointer must point downstream, in the direction of flow

4. Insert the sensor head into the pipe until insertion length, I, is achieved. Do not force the stem into the pipe.

5. Tighten the packing gland nuts to stop leakage around the stem. Do not torque over 27 Nm / 20 ft-lbs.

6. Slide the stem clamp back into position. Torque stem clamp bolts to 20,3 Nm / 15 ft-lbs. Replace the stem clamp nuts and torque to 13,6 - 20,3 Nm / 10-15 ft-lbs.

4.6   Adjusting Meter Orientation

Depending on installation requirements, you may need to adjust the meter orientation. There are two adjustments available. The first rotates the position of the LCD display/keypad and is available on both in-line and insertion meters. The second is to rotate the enclosure position. This adjustment is only allowed on Series DVH In-Line meters.

4.6.1   Display/Keypad Adjustment

Rotate display/keypad in
90−degree increments
(maximum 180−degrees
from original position)
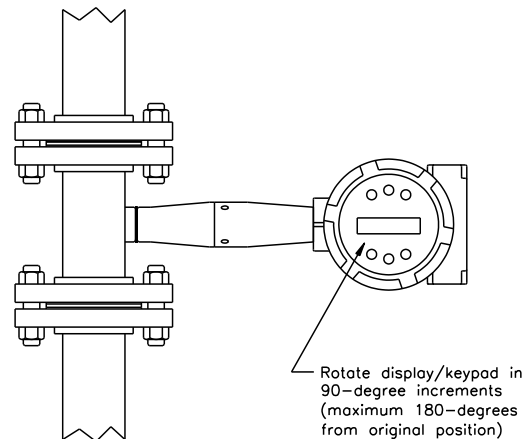
Figure 17   Display/Keypad Viewing Adjustments

The electronics boards are electro statically sensitive. Wear a grounding wrist strap and make sure to observe proper handling precautions required for static-sensitive components. To adjust the display:
1.   Disconnect power to the flow meter.
2.   Loosen the small set screw which secures the electronics enclosure cover. Unscrew and remove the cover.
3.   Loosen the 4 captive screws.
4.   Carefully pull the display/microprocessor board away from the meter standoffs. Make sure not to damage the connected ribbon cable.
5.   Rotate the display/microprocessor board to the desired position. Maximum turn, two positions left or two positions right (180-degrees).
6.   Align the board with the captive screws. Check that the ribbon cable is folded neatly behind the board with no twists or crimps.
7.   Tighten the screws. Replace the cover and set screw. Restore power to the meter.

4.6.2   Enclosure Adjustment

Loosen three setscrews
and rotate enclosure
(maximum 180−degrees
from original position)
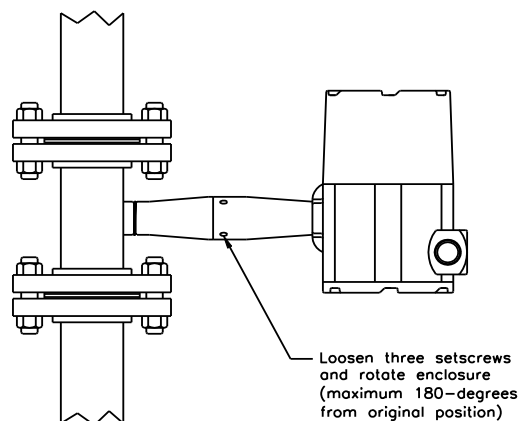
Figure 18   Enclosure Viewing Adjustments

To avoid damage to the sensor wires, do not rotate the enclosure beyond 180-degrees from the original position.

To adjust the enclosure:
1.   Remove power to the flow meter.
2.   Loosen the three set screws shown above. Rotate the display to the desired position (maximum 180-degrees).
3.   Tighten the three set screws. Restore power to the meter.

4.7   Loop Power Flow Meter Wiring Connections

Warning!

To avoid potential electric shock, follow National Electric Code safety practices or your local code when wiring this unit to a power source and to peripheral devices. Failure to do so could result in injury or death. All wiring procedures must be performed with the power off.

The NEMA 4X enclosure contains an integral wiring compartment with one dual strip terminal block (located in the smaller end of the enclosure). Two ¾-inch female NPT conduit cable entries are available for separate power and signal wiring. For all hazardous area installations, make sure to use an agency-approved fitting at each conduit entry. The cable entry device shall be of a certified flameproof type, suitable for the conditions of use and correctly installed. The degree of Protection of at least IP66 to EN60529 is only achieved if certified cable entries are used that are suitable for the application and correctly installed. Unused apertures shall be closed with suitable blanking elements. If conduit seals are used, they must be installed within 18 inches / 457mm of the enclosure.
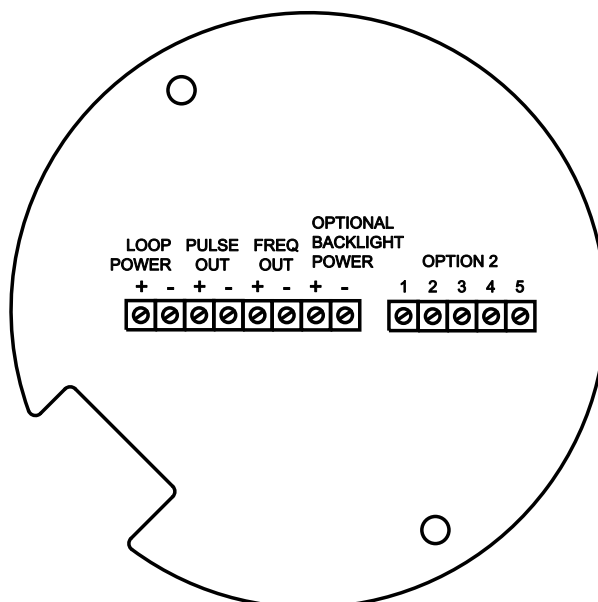
Figure 19   Loop Power Wiring Terminals

4.7.1   Input Power Connections

To access the wiring terminal blocks, locate and loosen the small set screw which locks the small enclosure cover in place. Unscrew the cover to expose the terminal block.

4.7.2   DC Power Wiring

Connect 4-20 mA loop power (12 to 36 VDC at 25 mA, 1W max.) to the +Loop Power and –Loop Power terminals on the terminal block. Torque all connections to 0.5 to 0.6 Nm / 4.43 to 5.31 in-lbs. The DC power wire size must be 20 to 10 AWG with the wire stripped 7 mm / 1/4 inch.
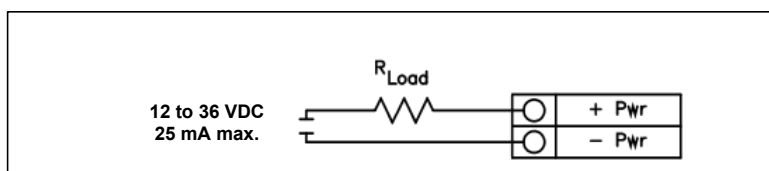
Figure 20   DC Power Connections

4.7.3   4-20 mA Output

The DVH /DVE meter has a single 4-20 mA loop. The 4-20 mA loop current is controlled by the meter electronics. The electronics must be wired in series with the sense resistor or current meter. The current control electronics require 12 volts at the input terminals to operate correctly.

The maximum loop resistance (load) for the current loop output is dependent upon the supply voltage and is given in Figure 19. The 4-20 mA loop is optically isolated from the flow meter electronics.

R_{load} is the total resistance in the loop, including the wiring resistance (R_{load} = R_{wire} + R_{sense}). To calculate R_{max}, the maximum R_{load} for the loop,
subtract the minimum terminal voltage from the supply voltage and divide by the maximum loop current, 20 mA. Thus:

The maximum resistance R_{load} = R_{max} = (V_{supply} − 12V) / 0.020 A

Vsupply (volts)	Rmax (ohms)
12	0
18	300
24	600
30	900
36	1200
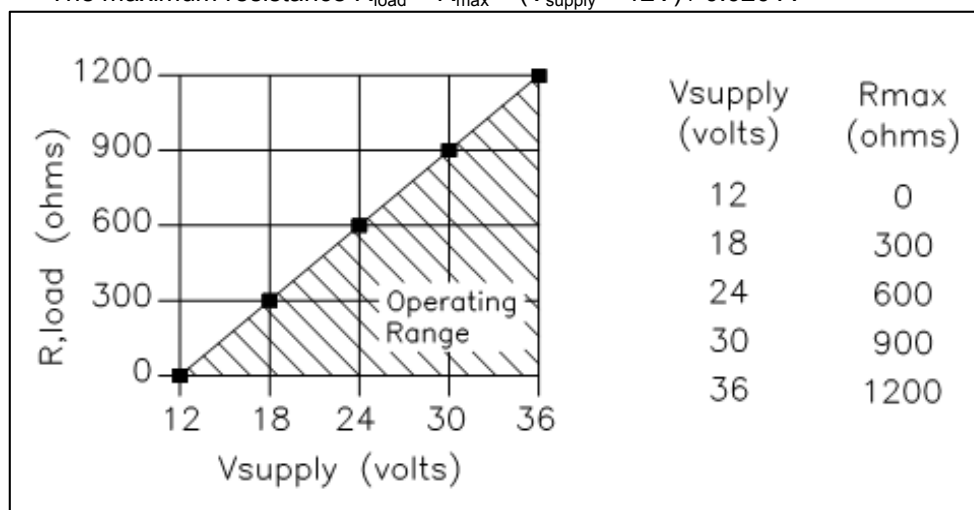
Figure 21   Load Resistance Versus Input Voltag

4.7.4   Pulse Output Connections

The pulse output is used for a remote counter. When the preset volume or mass (defined in the totalizer settings, see page 48) has passed the meter, the output provides a 50 millisecond square pulse.
The pulse output requires a separate 5 to 36 VDC power supply. The pulse output optical relay is a normally-open single-pole relay. The relay has a nominal 200 volt/160 ohm rating. This means that it has a nominal on-resistance of 160 ohms, and the largest voltage that it can withstand across the output terminals is 200 volts. However, there are current and power specifications that must be observed. The relay can conduct a current up to 40 mA and can dissipate up to 320 mW. The relay output is isolated from the meter electronics and power supply.
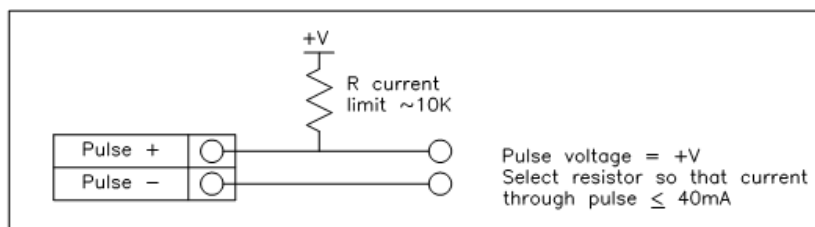
Figure 22   Isolated Pulse Output Using External Power
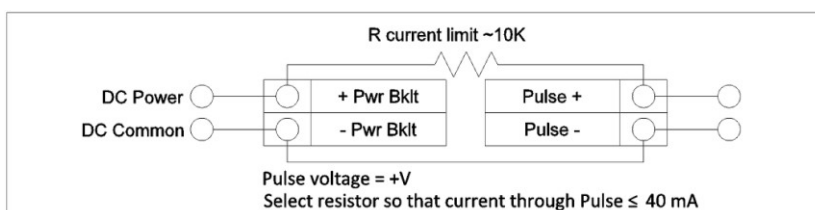
Figure 23   Non-Isolated Pulse Output Using External Power Supply

4.7.5   Frequency Output Connections

The frequency output is used for a remote counter. It can be scaled to output a 1 to 10 kHz signal proportional to mass or volume flow, temperature, pressure or density.
The frequency output requires a separate 5 to 36 VDC power supply; however, there are current and power specifications that must be observed. The output can conduct a co 40 mA and can dissipate up to 200 mW. The output is isolated from the meter electronics and power supply.
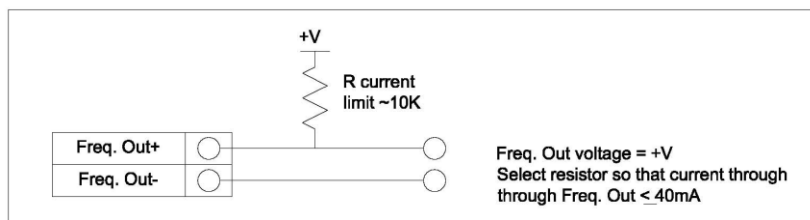
Figure 24   Isolated Pulse Output Using External Power
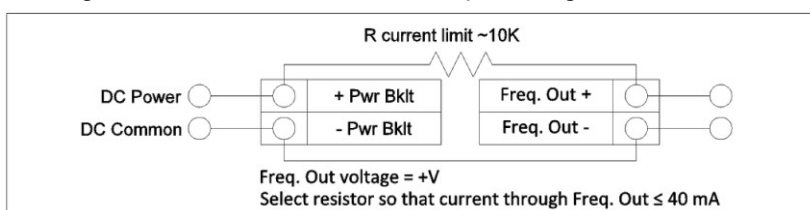
Figure 25 Non-Isolated Pulse Output Using External Power Supply

4.7.6   Optional Backlight Connection

The loop power meter has an optional backlight connection provided. It is intended to be powered by a separate 12 to 36 VDC at 35 mA max. power supply or by the pulse power input. Both options are shown below.
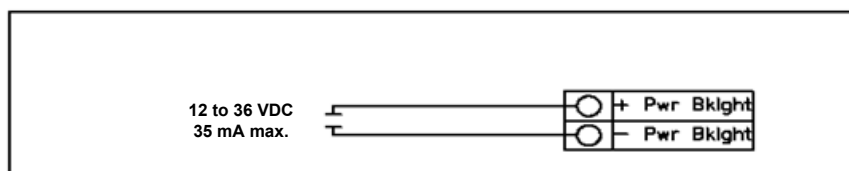
Figure 26   Backlight Using External Power Supply

4.8   Remote Electronics Wiring

The remote electronics enclosure should be mounted in a convenient, easy to reach location. For hazardous location installations, make sure to observe agency requirements for installation. Allow some slack in the interface cable between the junction box and the remote electronics enclosure. To prevent damage to the wiring connections, do not put stress on the terminations at any time.

The meter is shipped with temporary strain relief glands at each end of the cable. Disconnect the cable from the meter's terminal block inside the junction box–not at the remote electronics enclosure. Remove both glands and install appropriate conduit entry glands and conduit. The cable entry device shall be of a certified flameproof type, suitable for the conditions of use and correctly installed. The degree of Protection of at least IP66 to EN60529 is only achieved if certified cable entries are used that are suitable for the application and correctly installed. Unused apertures shall be closed with suitable blanking elements. When installation is complete, re-connect each labeled wire to the

corresponding terminal position on the junction box terminal block. Make sure to connect each wire pair's shield. Note: incorrect connection will cause the meter to malfunction.

Figure 27   Loop Power Volumetric Flow Meter Junction Box Sensor Connections
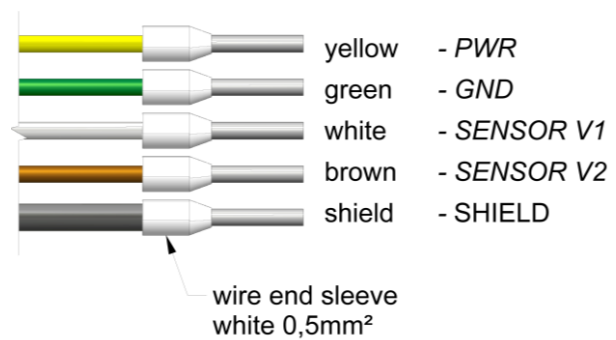
Figure 28 Wire Colors Loop Power Volimetric Meter
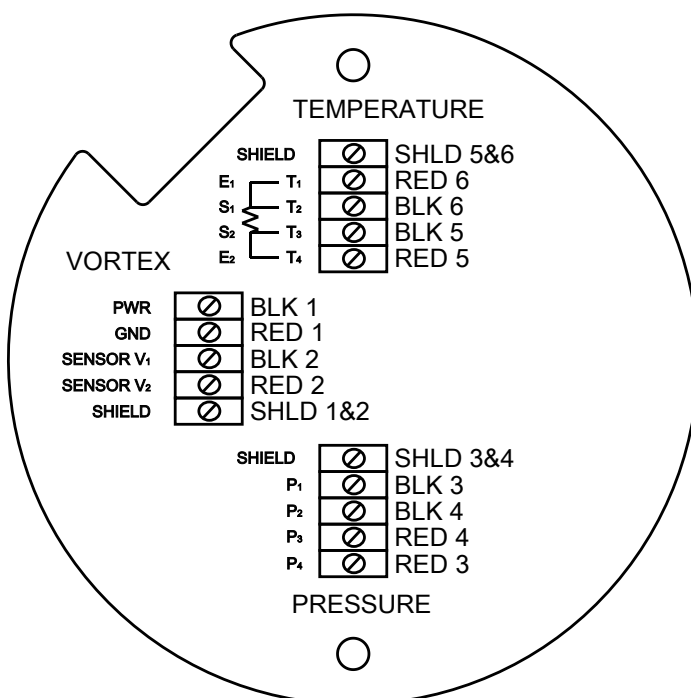
Figure 29 Loop Power Mass Flow Meter Junction Box Sensor Connections
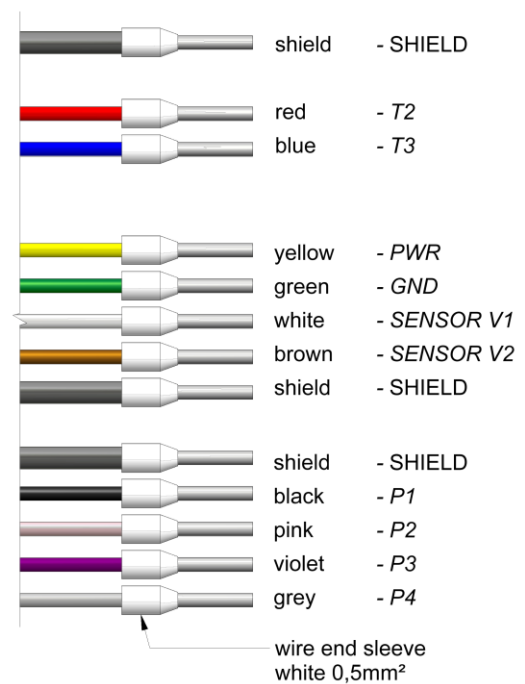
Figure 30 Wire Colors Loop Power Mass Meter

4.9   High Power Meter Wiring Connections

Warning!

To avoid potential electric shock, follow National Electric Code safety practices or your local code when wiring this unit to a power source and to peripheral devices. Failure to do so could result in injury or death. All AC power connections must be in accordance with published CE directives. All wiring procedures must be performed with the power off.

The NEMA 4X enclosure contains an integral wiring compartment with one dual strip terminal block (located in the smaller end of the enclosure). Two cable entries are available for separate power and signal wiring. For all hazardous area installations, make sure to use an agency-approved fitting at each conduit entry. The cable entry device shall be of a certified flameproof type, suitable for the conditions of use and correctly installed. The degree of Protection of at least IP66 to EN60529 is only achieved if certified cable entries are used that are suitable for the application and correctly installed. Unused apertures shall be closed with suitable blanking elements. If conduit seals are used, they must be installed within 18 inches / 457mm of the enclosure.
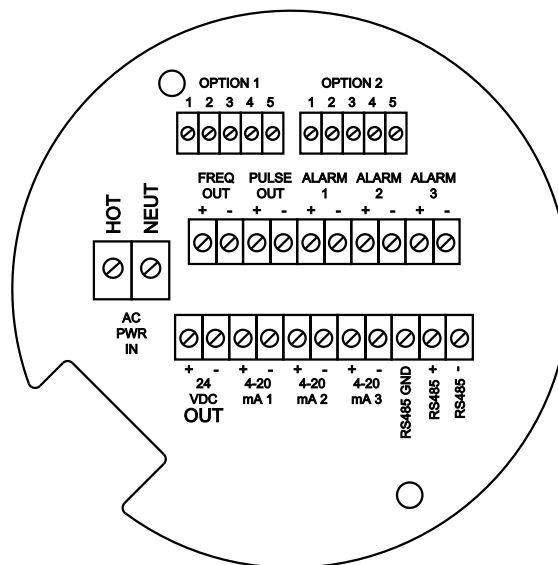
Figure 31   AC Wiring Terminals

4.9.1   Input Power Connections

To access the wiring terminal blocks, locate and loosen the small set screw which locks the small enclosure cover in place. Unscrew the cover to expose the terminal block.

4.9.2   AC Power Wiring

Caution!

The AC wire insulation temperature rating must meet or exceed 85°C (185°F).

The AC power wire size must be 20 to 10 AWG with the wire stripped 1/4 inch (7 mm). The wire insulation temperature must meet or exceed 85°C (185°F). Connect 100 to 240 VAC (5 W maximum) to the Hot and Neutral terminals on the terminal block. Connect the ground wire to the safety ground lug (⏚ Torque all connections to 0.5 to 0.6 Nm / 4.43 to 5.31 in-lbs. Use a separate conduit entry for signal lines to reduce the possibility of AC noise interference.
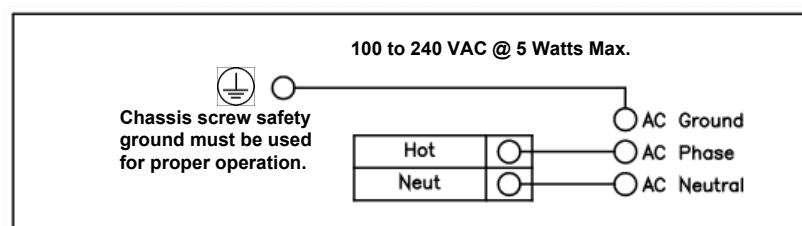
Figure 32   AC Power Connections

4.9.3   DC Power Wiring (DC)

⚠️ **Caution!**
The DC wire insulation temperature rating must meet or exceed 85°C (185°F).

The DC power wire size must be 20 to 10 AWG with the wire stripped 1/4 inch (7 mm). Connect 18 to 36 VDC (300 mA, 9 W maximum) to the +DC Pwr and –DC Pwr terminals on the terminal block.

Torque all connections to 0.5 to 0.6 Nm / 4.43 to 5.31 in-lbs.
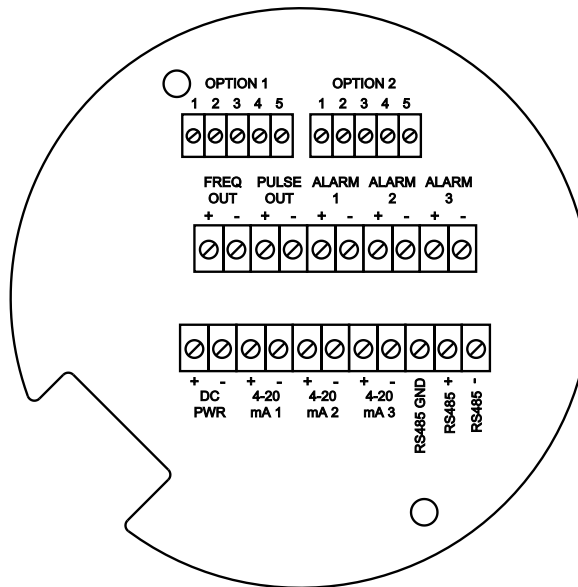
Figure 33   DC Wiring Terminals
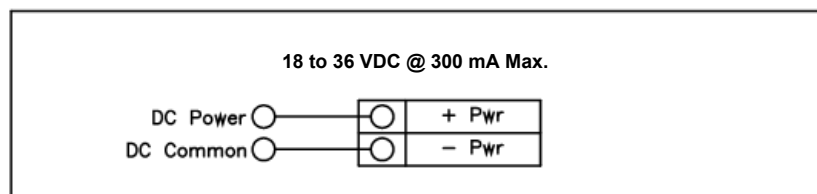
Figure 34   DC Power Connections

4.9.4   4-20 mA Output Connections

The standard DVH /DVE Flow Meter has a single 4-20 mA loop. Two additional loops are available on the optional communication board. The 4-20 mA loop current is controlled by the meter electronics. The electronics must be wired in series with the sense resistor or current meter. The current control electronics require 12 volts at the input terminals to operate correctly.

The maximum loop resistance (load) for the current loop output is dependent upon the supply voltage and is given in Figure 35. The 4-20 mA loop is optically isolated from the flow meter electronics.

R_{load} is the total resistance in the loop, including the wiring resistance ($R_{load} = R_{wire} + R_{sense}$). To calculate R_{max}, the maximum R_{load} for the loop, subtract the minimum terminal voltage from the supply voltage and divide by the maximum loop current, 20 mA. Thus:

The maximum resistance $R_{load} = R_{max} = (V_{supply} - 12V) / 0.020 A$
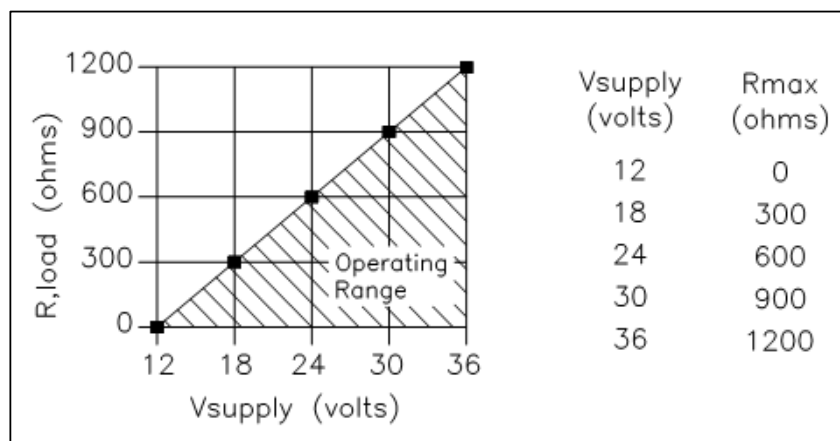
Figure 35   Load Resistance Versus Input Voltage
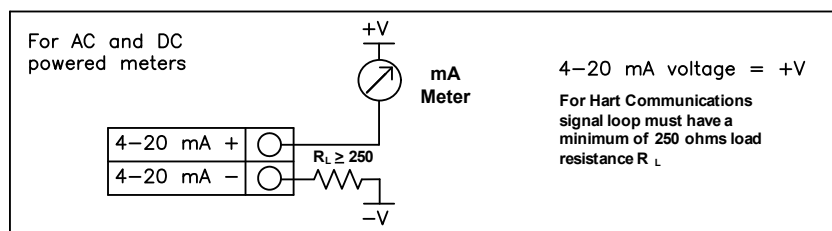
Figure 36   Isolated 4–20 mA Output with External Power Supply
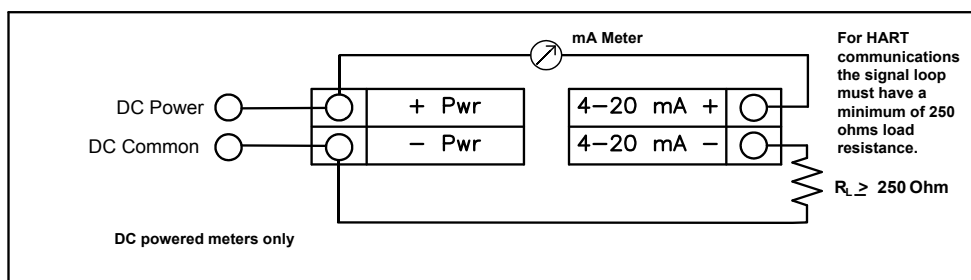
Figure 37   Non-Isolated 4–20 mA Output Using Meter Input Power Supply
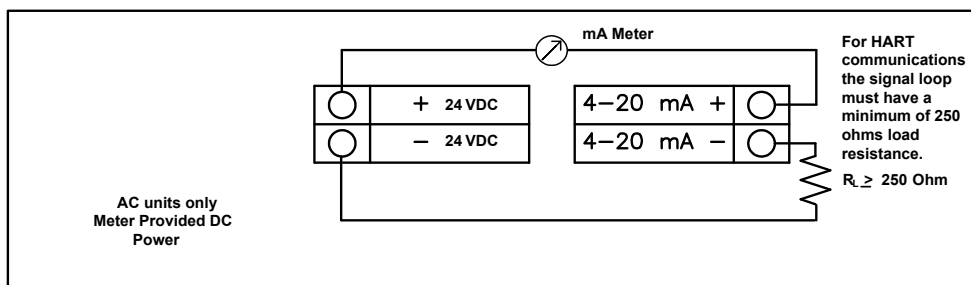
Figure 38   Isolated 4–20 mA Output using Meter Provided Power Supply

4.9.5   Frequency Output Connections

The frequency output is used for a remote counter. It can be scaled to output a 1 to 10 kHz signal proportional to mass or volume flow, temperature, pressure or density.

The frequency output requires a separate 5 to 36 VDC power supply; however, there are current and power specifications that must be observed. The output can conduct a co 40 mA and can dissipate up to 200 mW. The output is isolated from the meter electronics and power supply.

When the preset volume or mass (defined in the totalizer settings, see page 52) has passed the meter, the output provides a 50 millisecond square pulse.

The frequency output optical relay is a normally-open single-pole relay. The relay has a nominal 200 volt/160 ohm rating. This means that it has a nominal on-resistance of 160 ohms, and the largest voltage that it can withstand across the output terminals is 200 volts. However, there are current and power specifications that must be observed. The relay can conduct a current up to 40 mA and can dissipate up to 320 mW. The relay output is isolated from the meter electronics and power supply.

There are three connection options for the frequency output–the first with a separate power supply (Figure 39), the second using the flow meter power supply (Figure 40)(DC powered units only), and the third using the internal 24 VDC power supply (Figure 41) (AC powered units only). Use the first option with a separate power supply (5 to 36 VDC) if a specific voltage is needed for the frequency output. Use the second configuration if the voltage at the flow meter power supply is an acceptable driver voltage for the load connected. (Take into account that the current used by the pulse load comes from the meter's power supply). Use the third configuration if you have an AC powered unit only. In any case, the voltage of the frequency output is the same as the voltage supplied to the circuit
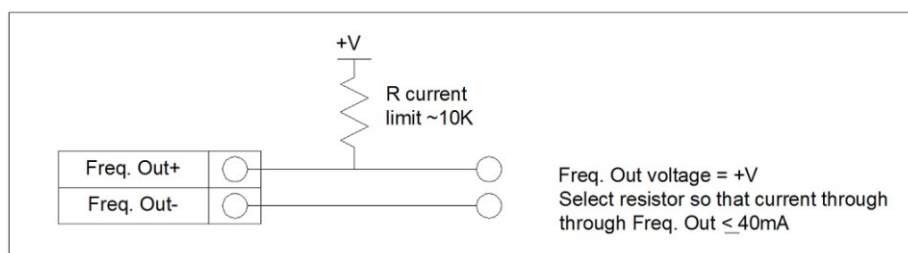
Figure 39   Isolated Frequency Output with External Power Supply
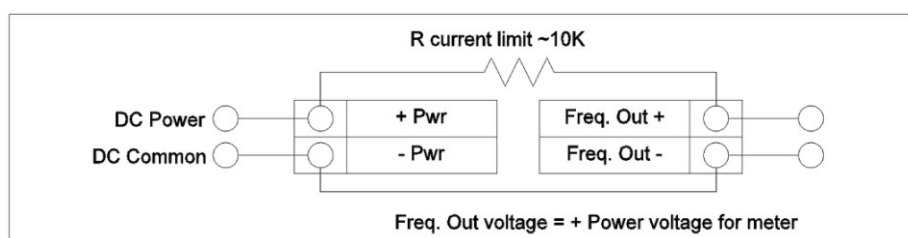
Figure 40   Non-Isolated Frequency Output Using Input Power
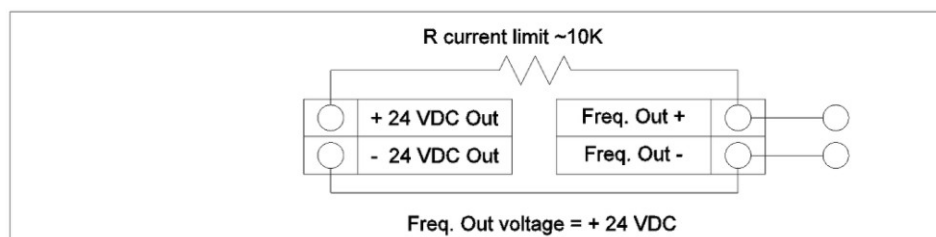
Figure 41 Isolated Frequency Output Using Meter Provided Power

4.9.6   Pulse Output Connections

The pulse output is used for a remote counter. When the preset volume or mass (defined in the totalizer settings, see page 52) has passed the meter, the output provides a 50 millisecond square pulse.

The pulse output optical relay is a normally-open single-pole relay. The relay has a nominal 200 volt/160 ohm rating. This means that it has a nominal on-resistance of 160 ohms, and the largest voltage that it can withstand across the output terminals is 200 volts. However, there are current and power specifications that must be observed. The relay can conduct a current up to 40 mA and can dissipate up to 320 mW. The relay output is isolated from the meter electronics and power supply.

There are three connection options for the pulse output–the first with a separate power supply (Figure 42), the second using the flow meter power supply (Figure 43)(DC powered units only), and the third using the internal 24 VDC power supply(Figure 44)(AC powered units only). Use the first option with a separate power supply (5 to 36 VDC) if a specific voltage is needed for the pulse output. Use the second configuration if the voltage at the flow meter power supply is an acceptable driver voltage for the load connected. (Take into account that the current used by the pulse load comes from the meter's power supply). Use the third configuration if you have an AC powered unit only. In any case, the voltage of the pulse output is the same as the voltage supplied to the circuit
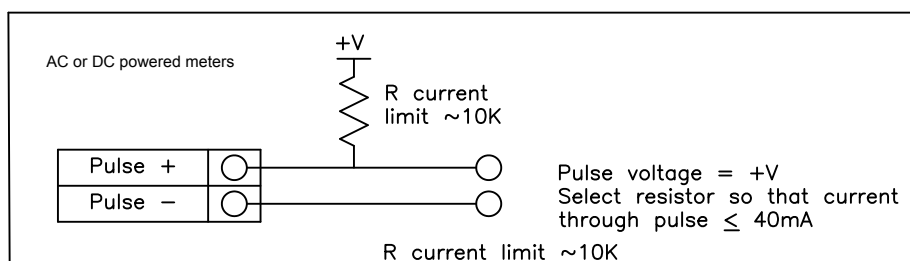
Figure 42   Isolated Pulse Output with External Power Supply
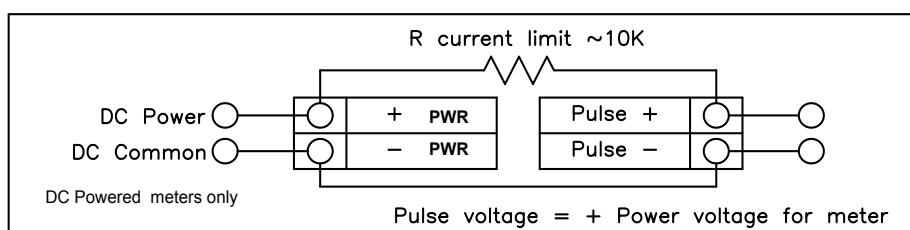
Figure 43   Non-Isolated Pulse Output Using Input Power Supply
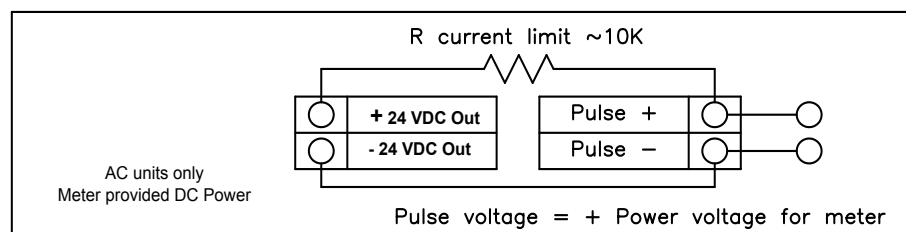
Figure 44   Isolated Pulse Output Using Meter Provided Power Supply

4.9.7   Alarm Output Connections

One alarm output (Alarm 1) is included on the standard DVH / DVE Flow Meter. Two or more alarms (Alarm 2 and Alarm 3) are included on the optional communication board. The alarm output optical relays are normally-open single-pole relays. The relays have a nominal 200 volt/160 ohm rating. This means that each relay has a nominal on-resistance of 160 ohms and the largest voltage that it can withstand across the output terminals is 200 volts. However, there are current and power specifications that must be observed. The relay can conduct a current up to 40 mA and can dissipate up to 320 mW. The relay output is isolated from the meter electronics and power supply. When the alarm relay is closed, the current draw will be constant. Make sure to size R_{load} appropriately.

There are three connection options for the alarm output–the first with a separate power supply (Figure 45), the second using the flow meter power supply (Figure 46) (DC powered units only) and the third with the meter provided power supply (Figure 47)(AC powered units only). Use the first option with a separate power supply (5 to 36 VDC) if a specific voltage is needed for the alarm output. Use the second configuration if the voltage at the flow meter power supply is an acceptable driver voltage for the load connected. (Take into account that the current used by the alarm load comes from the meter's power supply). Use the third if you have an AC powered unit only. In any case, the voltage of the alarm output is the same as the voltage supplied to the circuit.

The alarm output is used for transmitting high or low process conditions as defined in the Alarm Menu
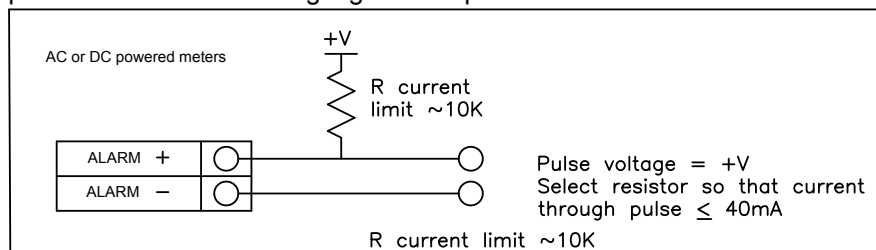
Figure 45   Isolated Alarm Output with External Power Supply
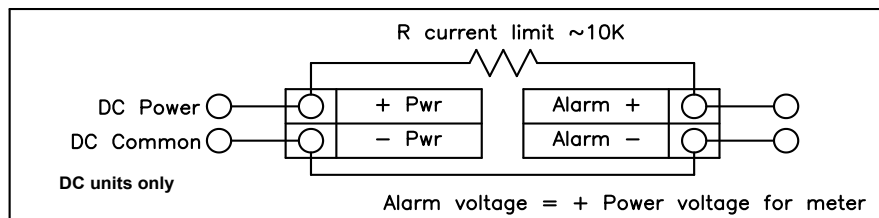
Figure 46   Non-Isolated Alarm Output Using Internal Power Supply
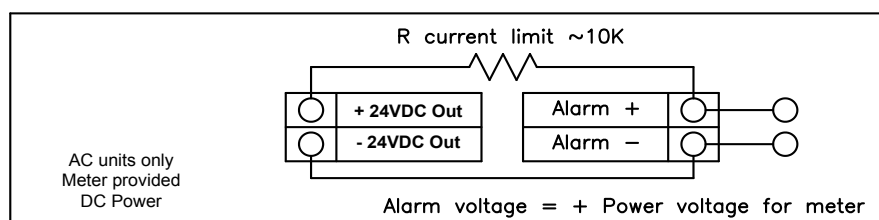
Figure 47   Alarm Output Using Meter Provided Power Supply

4.10   Remote Electronics Wiring

The remote electronics enclosure should be mounted in a convenient, easy to reach location. For hazardous location installations, make sure to observe agency requirements for installation. Allow some slack in the interface cable between the junction box and the remote electronics enclosure. To prevent damage to the wiring connections, do not put stress on the terminations at any time.

The meter is shipped with temporary strain relief glands at each end of the cable. Disconnect the cable from the meter's terminal block inside the junction box–not at the remote electronics enclosure. Remove both glands and install appropriate conduit entry glands and conduit. The cable entry device shall be of a certified flameproof type, suitable for the conditions of use and correctly installed. The degree of Protection of at least IP66 to EN60529 is only achieved if certified cable entries are used that are suitable for the application and correctly installed. Unused apertures shall be closed with suitable blanking elements. When installation is complete, re-connect each labeled wire to the corresponding terminal position on the junction box terminal block. Make sure to connect each wire pair's shield. Note: incorrect connection will cause the meter to malfunction.

Figure 48 High Power Flow Meter Junction Box Sensor Connections
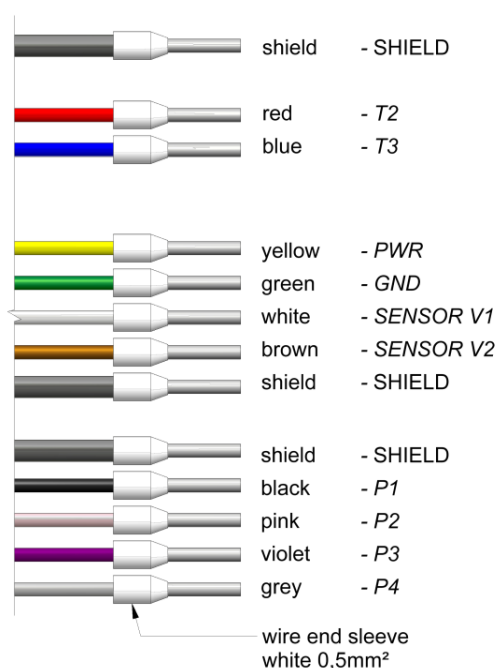
Figure 49 Wire Colors High Power Flow Meter

4.10.1 Optional Input Electronics Wiring

The meter has two optional input wiring terminals. These can be used to input a Remote or Second RTD input in the case of an Energy Monitoring meter, for the input of a Remote Pressure Transducer, to pass a Contact Closure or for a Remote Density measurement to name a few. In any case, the wiring diagram will be included with the meter if any of the options are specified. Otherwise, the optional terminal blocks will be left blank and non functional.

Figure 50   Optional Input Terminals
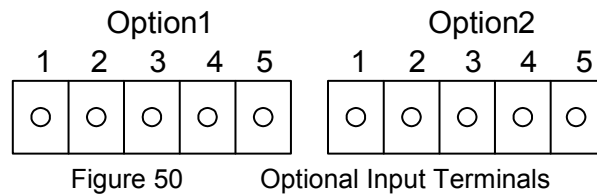
4.10.2 Optional Energy EMS RTD Input Wiring

Red Red   Black Black
R = 1000 ohm

Figure 51   Optional Energy Terminals
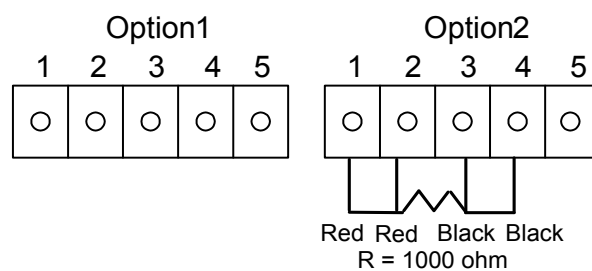
The recommended customer supplied second RTD is a Class A 1000 ohm 4-wire platinum RTD. If a second RTD is not being used, then the factory supplied 1000 ohm resistor needs to be installed in its place

4.10.3 Optional External 4-20 mA Input Wiring

The meter is set to have Option 1 used for the external input. Programming menus that pertain to the optional 4-20 mA input are located in the Hidden Diagnostics Menu on page 86in the Hidden Diagnostics Menu

Figure 52   External 4-20 mA Input Wiring - External Power Supply
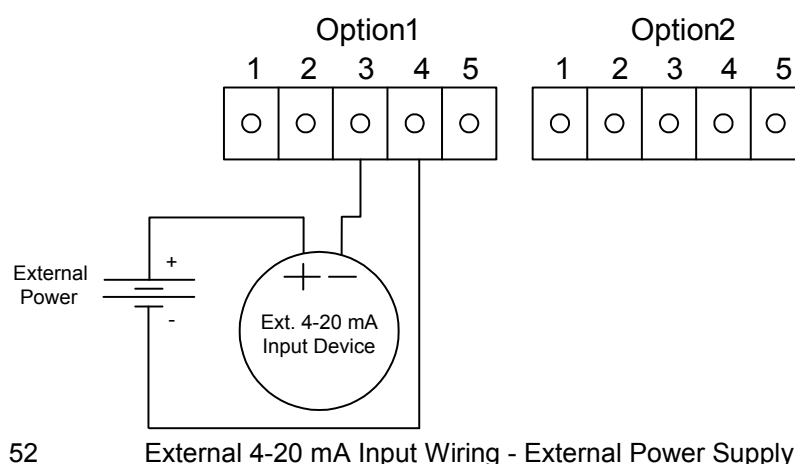
Follow the above diagram to wire the external 4-20 mA input into the flow meter using an external power supply.

Option1   Option2
1   2   3   4   5   1   2   3   4   5

DC powered meter only.

DC PWR   + DC PWR
DC COMMON   - DC PWR

Ext. 4-20 mA
Input Device
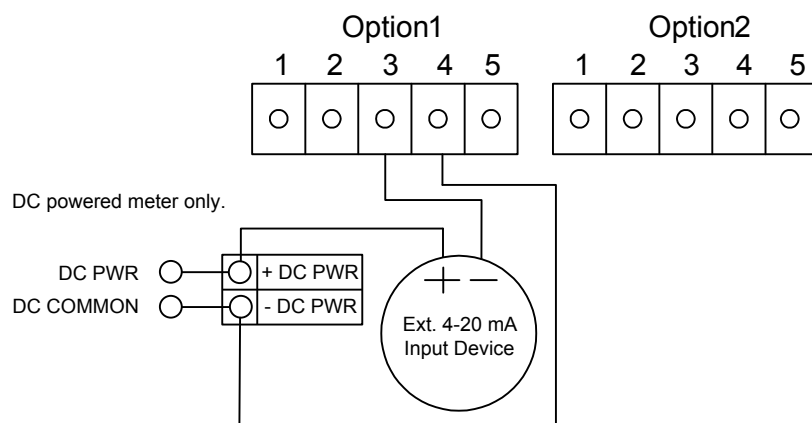
Figure 53   External 4-20 mA Input Wiring - DC Powered Meter

Follow the above diagram to wire the external 4-20 mA input into the flow meter using power supplied to the input of a DC powered meter.

Option1   Option2
1   2   3   4   5   1   2   3   4   5

AC units only. Meter provided DC power.

+ 24 VDC OUT
- 24 VDC OUT

Ext. 4-20 mA
Input Device
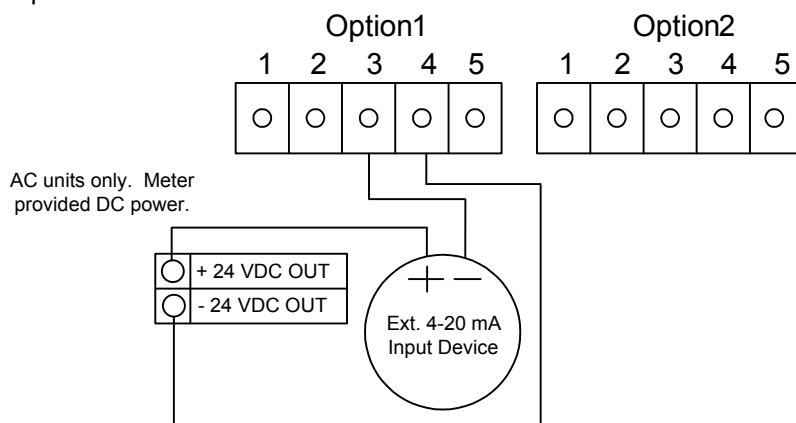
Figure 54   External 4-20 mA Input Wiring - AC Powered Meter

Follow the above diagram to wire the external 4-20 mA input into the flow meter using power from the 24 VDC output of an AC powered meter

4.10.4 Optional Contact Closure Input Wiring

Option1   Option2
1   2   3   4   5   1   2   3   4   5
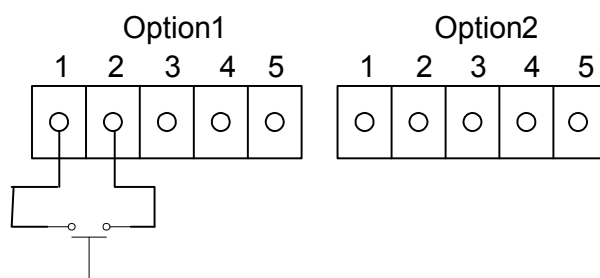
Figure 55   Optional Contact Closure Input Wiring

Follow the above diagram to wire an external switch input into the flow meter. The meter is configured to have Option 1 used for the external input. If the above switch is used to remotely reset the totalizer a pushbutton switch with a momentary contact closure is recommended

5. Operating Instructions

After installing the DVH /DVE Vortex Flow Meter, you are ready to begin operation. The sections in this chapter explain the display/keypad commands, meter start-up and programming. The meter is ready to operate at start up without any special programming. To enter parameters and system settings unique to your operation, see the following pages for instructions on using the setup menus.

5.1   Flow Meter Display/Keypad

The flow meter's digital electronics allow you to set, adjust and monitor system parameters and performance. A full range of commands are available through the display/keypad. The LCD display gives 2 x 16 characters for flow monitoring and programming. The six push-buttons can be operated with the enclosure cover removed. Or, the explosion-proof cover can remain in place and the keypad operated with a hand-held magnet positioned at the side of the enclosure as shown in the illustration at the left.

Figure 56 Display/Keypad

Display/Keypad
Commands

From the Run Mode, the **ENTER** key allows access to the Setup Menus (through a password screen). Within the Setup Menus, pressing **ENTER** activates the current field. To set new parameters, press the **ENTER** key until an underline cursor appears. Use the ⇧⇩⇦⇨ keys to select new parameters. Press **ENTER** to continue. (If change is not allowed, **ENTER** has no effect.) All outputs are disabled when using the Setup Menus.

The **EXIT** key is active within the Setup Menus. When using a Setup Menu, **EXIT** returns you to the Run Mode. If you are changing a parameter and make a mistake, **EXIT** allows you to start over.

The ⇧⇩⇦⇨ keys advance through each screen of the current menu. When changing a system parameter, all ⇧⇩⇦⇨ keys are available to enter new parameters.

Figure 57   Display/Keypad Commands

5.2   Start Up

Note!
Starting the flow meter or pressing EXIT will always display the Run Mode screens.

To begin flow meter operation:

1. Verify the flow meter is installed and wired as described in Chapter 4.Installation
2. Apply power to the meter. At start up, the unit runs a series of self-tests that check the RAM, ROM, EPROM and all flow sensing components. After completing the self-test sequence, the Run Mode screens appear.
3. The Run Mode displays flow information as determined by system settings. Some screens depicted on the next page may not be displayed based on these settings. Press the ⇧⇩ arrow keys to view the Run Mode screens.
4. Press the ENTER key from any Run Mode screen to access the Setup Menus. Use the Setup Menus to configure the meter's multi-parameter features to fit your application.

5.3   Run Mode Screen

Run Mode Screens

Mass Flow Rate	**ENTER** →	Password

Volume Flow Rate

Temperature

Pressure

*[Energy]

Density

Total

Alarm 1 Status

Alarm 2 Status

Alarm 3 Status

Fluid

Date & Time

Setup Menus

ENTER

Press Exit to return to Run Mode

* [Energy EMS Meters Only]

Use ⇑⇓ keys to access each item

Screen/Menu 1 Rum Mode

5.4   Using the Setup Menus

Setup Menus

Password Menu	Set Password

Calibration Menu	Meter Size or Pipe ID	Base Kf	Base Reynolds	Head Diameter	Abs Roughness	Vortex Coef Ck	Low Flow Cutoff	Serial Number

| Diagnostics Menu | Sim Vor Freq | Sim Temp 1, 2 | Sim Pressure | Highest Velocity | Highest Temp 1, 2 | Highest Pressure | Highest Int Temp | Lowest Int Temp | System Log | Clear Sys Log |

| Time & Date Menu | Set Time | Set Date |

| Units Menu | Mass Flow Unit | Volume Flow Unit | Temperature Unit | * Energy Unit | Density Unit | Pressure Unit | Gauge Pressure (Abs/Gauge) | Atm. Press 14.6959 |

| Fluid Menu | Flowing Fluid | STD Temp (F) | STD Press (PSIA) | NORM Temp (C) | NORM Press (KPA) |

| * Energy Menu | Loc in Sent Flow Yes / No | Heating System Yes / No | % Returned |

| * Totalizer #2 Menu | Totaling | Reset Total |

| Totalizer #1 Menu | Totaling | Unit per Pulse | Reset Total |

| Alarms Menu | Relay Alarm 1 | Relay Alarm 2 | Relay Alarm 3 | Alarm Log | Clear Alarm Log |

| Display Menu | Cycle Time (sec) | Number of Digits | Display TC (sec) | Mf Vf Te Pr De T | A1 A2 A3 Fl Dt *E |

| Output Menu | 4-20 mA Output 1 | 4-20 mA Output 2 | 4-20 mA Output 3 | Scaled Frequency | Modbus Units | Modbus Order | Comm Protocol | Baud Rate | Address | BACnet Device ID ** |

ENTER → Password → **ENTER**

* Energy EMS Meters Only
** BACnet Meters Only

Run Mode Screens

| Mass Flow Rate | Volume Flow Rate | Temperature | Pressure | *Energy | Density | Total | Alarm 1 Status | Alarm 2 Status | Alarm 3 Status | Fluid | Date & Time |

Screen/Menu 2 Setup Menus

5.5   Programming the Flow meter

1.   Enter the Setup Menu by pressing the ENTER key until prompted for a password. (All outputs are disabled while using the Setup Menus.)

2.   Use the ⇧⇩⇦⇨ keys to select the password characters (1234 is the factory-set password). When the password is correctly displayed, press ENTER to continue.

3.   Use the Setup Menus described on the following pages to customize the multi-parameter features of your DVH /DVE Flow Meter. (The entire lower display line is available for entering parameters.)   Some items depicted in the graphic on the preceding page may not be displayed based on flow meter configuration settings

4.   To activate a parameter, press ENTER. Use the ⇧⇩⇦⇨ keys to make selections. Press ENTER to continue. Press EXIT to save or discard changes and return to Run Mode.

5.   Program the UNITS menu first because later menus will be based on the units selected.

5.6　　　Output Menu

```
┌──────────┐  ENTER  ┌──────────┐
│ Run Mode │ ──────▶ │ Password │
└──────────┘         └──────────┘
                          │
                        ENTER
                          ▼
                    ┌──────────┐        Use ⇧ ⇩ ⇦ ⇨
              ◀──── │  Output  │ ────▶  keys to access menus
                    │   Menu   │
                    └──────────┘
```

4-20 mA Output 1 / More >
< Measure >
None
Mass
Volume
*** Energy
Temp 1,2
Press
Density
→ < 4 mA = xxxx > xxxx → < 20mA = xxxx > xxxx → < Time Const (Sec) > xxxx

4-20 mA Output 2 / More >   (* see below)
< Measure >
None
Mass
Volume
*** Energy
Temp 1,2
Press
Density
→ < 4 mA = xxxx > xxxx → < 20mA = xxxx > xxxx → < Time Const (Sec) > xxxx

4-20 mA Output 3 / More >   (* see below)
< Measure >
None
Mass
Volume
*** Energy
Temp 1,2
Press
Density
→ < 4 mA = xxxx > xxxx → < 20mA = xxxx > xxxx → < Time Const (Sec) > xxxx

Scaled Frequency / More >
→ < Max. Frequency > xxxxx →
< Measure >
None
Mass
Volume
*** Energy
Temp 1,2
Press
Density
→ < 0 Hz = (units) > xxxx → < Max Hz = (units) > xxxx → < Time Const (Sec) > xxxx

Modbus Units (Internal/Display)   (** see below)

Modbus Order
0-1:2-3
3-2:1-0
2-3:0-1
1-0:3-2   (** see below)

Comm Protocol
Modbus RTU
(None1, None2, Odd, Even)   (** see below)

Baud Rate
19200   (** see below)

Address
1   (** see below)

BACnet Device ID
558   (**** see below)

```
┌─────────────────────────────────────────────┐
│  *   - Physical Layer not available on Two   │
│        Wire Mass – Accessible via HART       │
│  **  - Modbus not available on Two           │
│        Wire Mass                             │
│  *** - Energy available on EMS meters only   │
│  **** - BACnet meters only                   │
└─────────────────────────────────────────────┘
```

Screen/Menu 3 Output Menu

Example for Setting an Output

The following shows how to set Output 1 to measure mass flow with 4 mA = 0 kg/h and 20 mA = 100 kg/h with a time constant of 5 seconds. (All outputs are disabled while using the Setup Menus.)

First, set the desired units of measurement:

1. Use ⇦⇨ keys to move to the Units Menu (Page56).
2. Press ⇩ key until Mass Flow Unit appears. Press ENTER.
3. Press ⇩ key until lb appears in the numerator. Press ⇨ key to move the underline cursor to the denominator. Press the ⇩ key until hr appears in the denominator. Press ENTER to select.
4. Press ⇧ key until Units Menu appears.

Second, set the analog output:

1. Use ⇦⇨ keys to move to the Output Menu.
2. Press the ⇩ key until 4-20 mA Output 1 appears.
3. Press ⇨ key to access Measure selections. Press ENTER and press the ⇩ key to select Mass. Press ENTER.
4. Press ⇨ key to set the 4 mA point in the units you have selected for mass of kg/h. Press ENTER and use ⇧⇩⇦⇨ keys to set 0 or 0.0. Press ENTER.
5. Press ⇨ key to set the 20 mA point. Press ENTER and use ⇧⇩⇦⇨ keys to set 100 or 100.0. Press ENTER.
6. Press ⇨ key to select the Time Constant. Press ENTER and use ⇧⇩⇦⇨ keys to select 5. Press ENTER.
7. Press the EXIT key and answer YES to permanently save your changes.

5.7   Display Menu

```
  ENTER
Run Mode ──────► Password
```

Display
Menu

Use ⇧ ⇩ ⇦ ⇨
keys to access menus

Cycle Time (sec)
0

If Cycle Time is set to zero, manual advance is required

Number of Digits
2

Used to set the number of digits displayed after the decimal point

Display TC (sec)
1

TC = Display Time constant, used to smooth display

MF Vf Te Pr De T
Y or N

MF = Mass Flow
Vf = Volume Flow
Te = Temperature
Pr = Pressure
De = Density
T = Total

For each parameter:
    Select Yes to view parameter in Run Mode
    Select No to hide parameter in Run Mode

A1 A2 A3 Fl Dt E
Y or N

A1 = Alarm 1 Status
A2 = Alarm 2 Status
A3 = Alarm 3 Status
Fl = Fluid
Dt = Density
*E = Energy

* Energy EMS Meters Only

Screen/Menu 4 Display Menu

Use the Display Menu to set the cycle time for automatic screen sequencing used in the Run Mode, change the precision of displayed values, smooth the values or enable or disable each item displayed in the Run Mode screens.

Example for Changing a Run Mode Display Item
The following shows how to remove the temperature screen from the Run Mode screens. Note: all outputs are disabled while using the Setup Menus.
1.   Use ⇦⇨ keys to move to the Display Menu.
2.   Press ⇩ key until Mf Vf Pr Te De T appears.
3.   Press ENTER to select. Press ⇨ key until the cursor is positioned below Te.
4.   Press ⇩ key until N appears. Press ENTER to select.
5.   Press EXIT and then ENTER to save changes and return to the Run Mode.

5.8   Alarm Menu

```
  ┌──────────┐   ENTER    ┌──────────┐
  │ Run Mode │ ─────────▶ │ Password │
  └──────────┘            └──────────┘
                               │ ENTER
                               ▼
  ┌ ─ ─ ─ ─ ┐           ┌──────────┐       Use ⇧ ⇩ ⇦ ⇨
  │*see below│ ◀ ─ ─ ─ ▶ │  Alarms  │ ───▶  keys to access menus
  └ ─ ─ ─ ─ ┘           │   Menu   │
                         └──────────┘
```
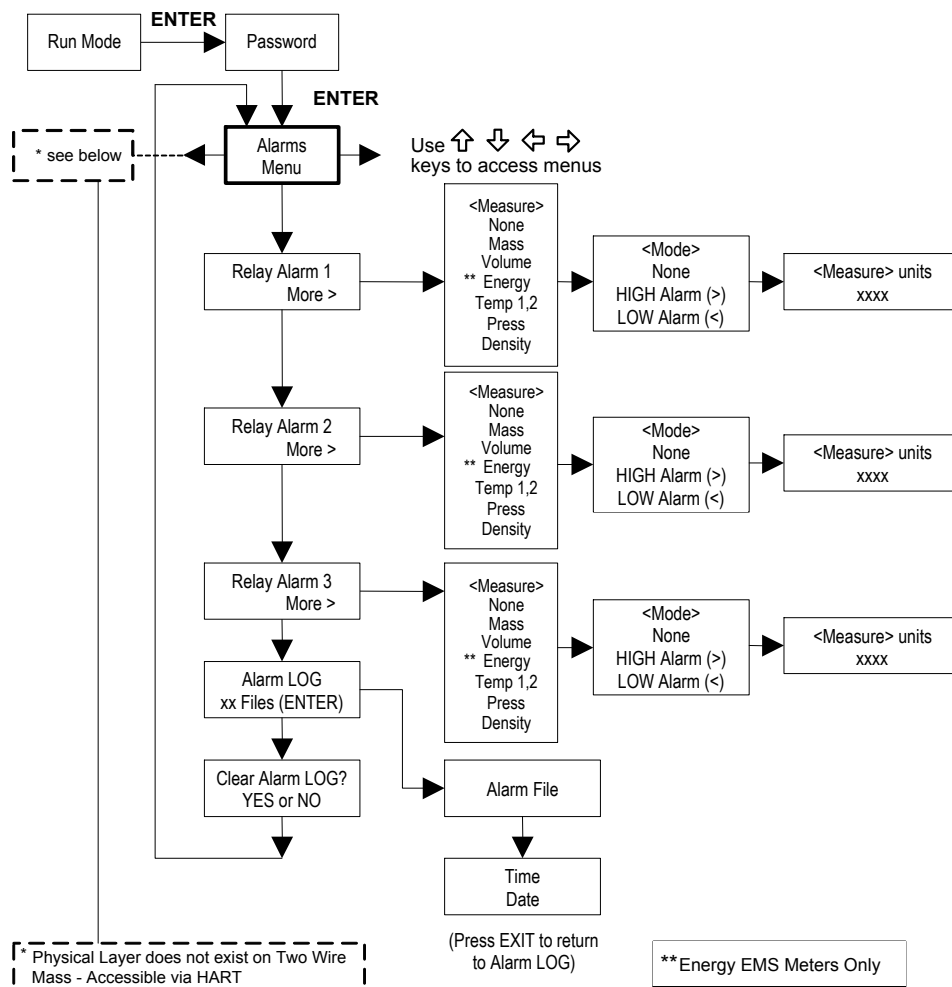

Screen/Menu 5 Alarm Menu

Example for Setting an Alarm
The following shows how to set Relay Alarm 1 to activate if the mass flow rate is greater than 100 kg/hr. You can check the alarm configuration in the Run Mode by pressing the ⇧⇩ keys until Alarm [1] appears. The lower line displays the mass flow rate at which the alarm activates. Note: all outputs are disabled while using the Setup Menus.

First, set the desired units of measurement:

1.   Use ⇦⇨ keys to move to the Units Menu (Page 56).
2.   Press ⇩ key until Mass Flow Unit appears. Press ENTER.
3.   Press ⇩ key until lb appears in the numerator. Press ⇨ key to move the underline cursor to the denominator. Press the ⇩ key until hr appears in the denominator. Press ENTER to select.
4.   Press ⇧ key until Units Menu appears.

Second, set the alarm:

1.   Use ⇦⇨ keys to move to the Alarms Menu.
2.   Press the ⇩ key until Relay Alarm 1 appears.
3.   Press ⇨ key to access Measure selections. Press ENTER and use the ⇩ key to select Mass. Press ENTER.
4.   Press ⇨ key to select the alarm Mode. Press ENTER and use ⇩ key to select HIGH Alarm. Press ENTER.
5.   Press ⇨ key to select the value that must be exceeded before the alarm activates. Press ENTER and use ⇧⇩⇦⇨ keys to set 100 or 100.0. Press ENTER.
6.   Press the EXIT key to save your changes. (Alarm changes are always permanently saved.) (Up to three relay alarm outputs are available depending on meter configuration.)

5.9 Totalizer #1 Menu
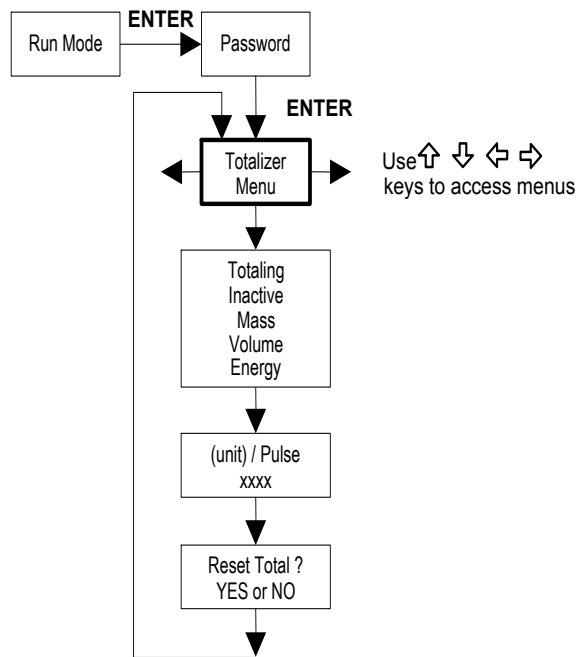
Screen/Menu 6 Totalizer#1 Menu

Use the Totalizer Menu to configure and monitor the totalizer. The totalizer output is a 50 millisecond (.05 second) positive pulse (relay closed for 50 milliseconds). The totalizer cannot operate faster than one pulse every 100 millisecond (.1 second). A good rule to follow is to set the unit per pulse value equal to the maximum flow in the same units per second. This will limit the pulse to no faster than one pulse every second

Example for Setting the Totalizer

First, set the desired units of measurement:
1. Use ⇦⇨ keys to move to the Units Menu (Page 56).
2. Press ⇩ key until Mass Flow Unit appears. Press ENTER.
3. Press ⇩ key until kg appears in the numerator. Press ⇨ key to move the underline cursor to the denominator. Press the ⇩ key until sec appears in the denominator. Press ENTER to select.
4. Press ⇧ key until Units Menu appears.

Second, set the pulse output:
1. Use ⇦⇨ keys to move to the Totalizer Menu.
2. Press the ⇩ key until Totaling appears.
3. Press ENTER and press the ⇩ key to select Mass. Press ENTER.
4. Press ⇩ key to set the pulse output in the units you have selected for mass flow of kg/sec. Press ENTER and use ⇧⇩⇦⇨ keys to set the pulse value equal to the maximum flow in the same units per second. Press ENTER.
5. To reset the totalizer, press ⇩ key until Reset Total? appears. Press ENTER and the ⇩ key to reset the totalizer if desired. Press ENTER.
   Press the EXIT key and answer YES to permanently save your changes

5.10   Totalizer #2 Menu

```
                    ENTER
  ┌──────────┐              ┌──────────┐
  │ Run Mode │ ──────────▶  │ Password │
  └──────────┘              └──────────┘
                                 │
                                 │  ENTER
                ┌────────────────┤
                │                ▼
                │         ┌──────────────┐
         ◀──────┤         │  Totalizer   │──────▶      Use ⇧ ⇩ ⇦ ⇨
                │         │    Menu      │             keys to access menus
                │         └──────────────┘
                │                │
                │                ▼
                │         ┌──────────────┐
                │         │   Totaling   │
                │         │   Inactive   │
                │         │    Mass      │
                │         │   Volume     │
                │         │   Energy     │
                │         └──────────────┘
                │                │
                │                ▼
                │         ┌──────────────┐
                │         │ Reset Total ?│
                │         │  YES or NO   │
                │         └──────────────┘
                │                │
                └────────────────┘
```

Screen/Menu 7 Totalizer #2 Menu
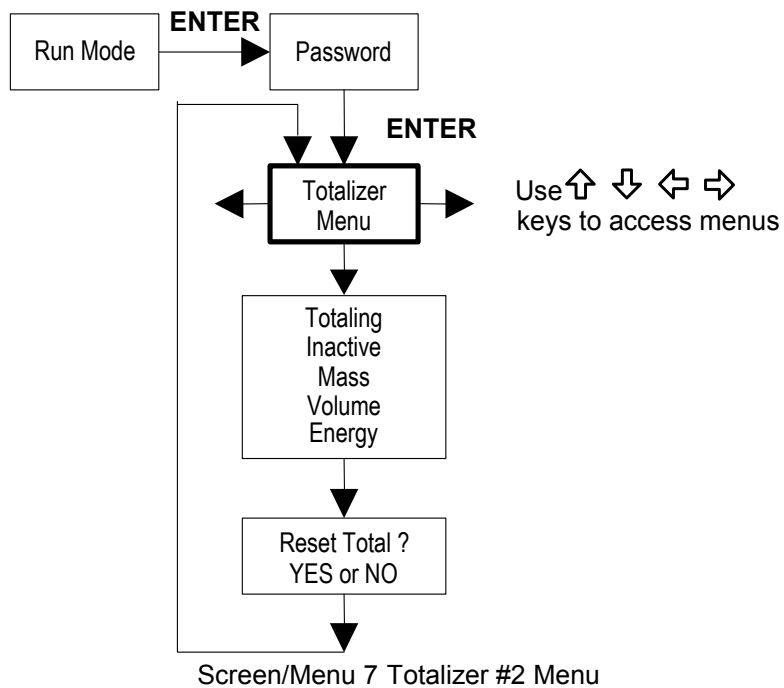
Use the Totalizer #2 to Monitor Flow or Energy. Note that Totalizer #2 does not operate a relay, it is for monitoring only.

5.11   Energy Menu – For EMS Energy Meters Only

```
                    ENTER
  ┌──────────┐              ┌──────────┐
  │ Run Mode │ ──────────▶  │ Password │
  └──────────┘              └──────────┘
                                 │
                                 │  ENTER
                ┌────────────────┤
                │                ▼
                │         ┌──────────────┐
         ◀──────┤         │   Energy     │──────▶      Use ⇧ ⇩ ⇦ ⇨
                │         │    Menu      │             keys to access menus
                │         └──────────────┘
                │                │
                │                ▼
                │         ┌──────────────┐
                │         │  Loc in Sent │
                │         │    Flow      │
                │         │  Yes or No   │
                │         └──────────────┘
                │                │
                │                ▼
                │         ┌──────────────┐
                │         │   Heating    │
                │         │   System     │
                │         │  Yes or No   │
                │         └──────────────┘
                │                │
                │                ▼
                │         ┌──────────────┐
                │         │  % Returned  │
                │         │    xxx       │
                │         └──────────────┘
                │                │
                └────────────────┘
```

Screen/Menu 8 Energy Menu
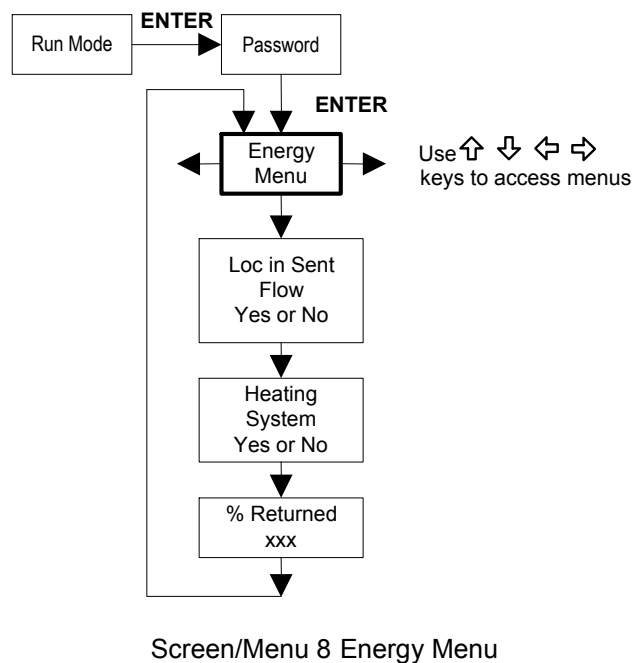
Configuration:

There are several possibilities regarding the measurement of water or steam energy given the location of the meter and the use of a second RTD. The table below summarizes the possibilities:

Fluid	Meter Location	Second RTD	Measurement
Water	"Sent" Flow Line	"Return Flow Line	Change in Energy
Water	"Return" Flow Line	"Sent" Flow Line	Change in Energy
Water	"Sent" Flow Line	None	Outgoing Energy
Steam	"Sent" Flow Line	"Return" Flow Line (condensate)	Change in Energy
Steam	"Sent" Flow Line	None	Outgoing Energy

Table 3   Possible Energy Measurement

As above, you must properly configure the meter in the Energy Menu.

1.   Loc in Sent Flow? Select Yes or No based on where the meter is located. Refer to the above table
2.   Heating System? Select Yes for a hot water system used for heating. Select No for a chilled water system used for cooling. Always select Yes for a steam system.
3.   % Returned. Select a number between 0% and 100%. Estimate the amount of water that returns. It is usually 100%, or can be less than 100% if historical data shows the amount of makeup water used. If a second RTD is not used, set to 0%. When 0% is selected, the energy calculation represents the outgoing energy only (no return energy is subtracted).

NOTE: the meter ships from the factory assuming 0% return and has a 1000 ohm resistor installed in the RTD #2 wiring location. This needs to be removed if the meter is to be used in a manner other than with 0% return and with the customer supplied RTD in its place.

5.12   Fluid Menu
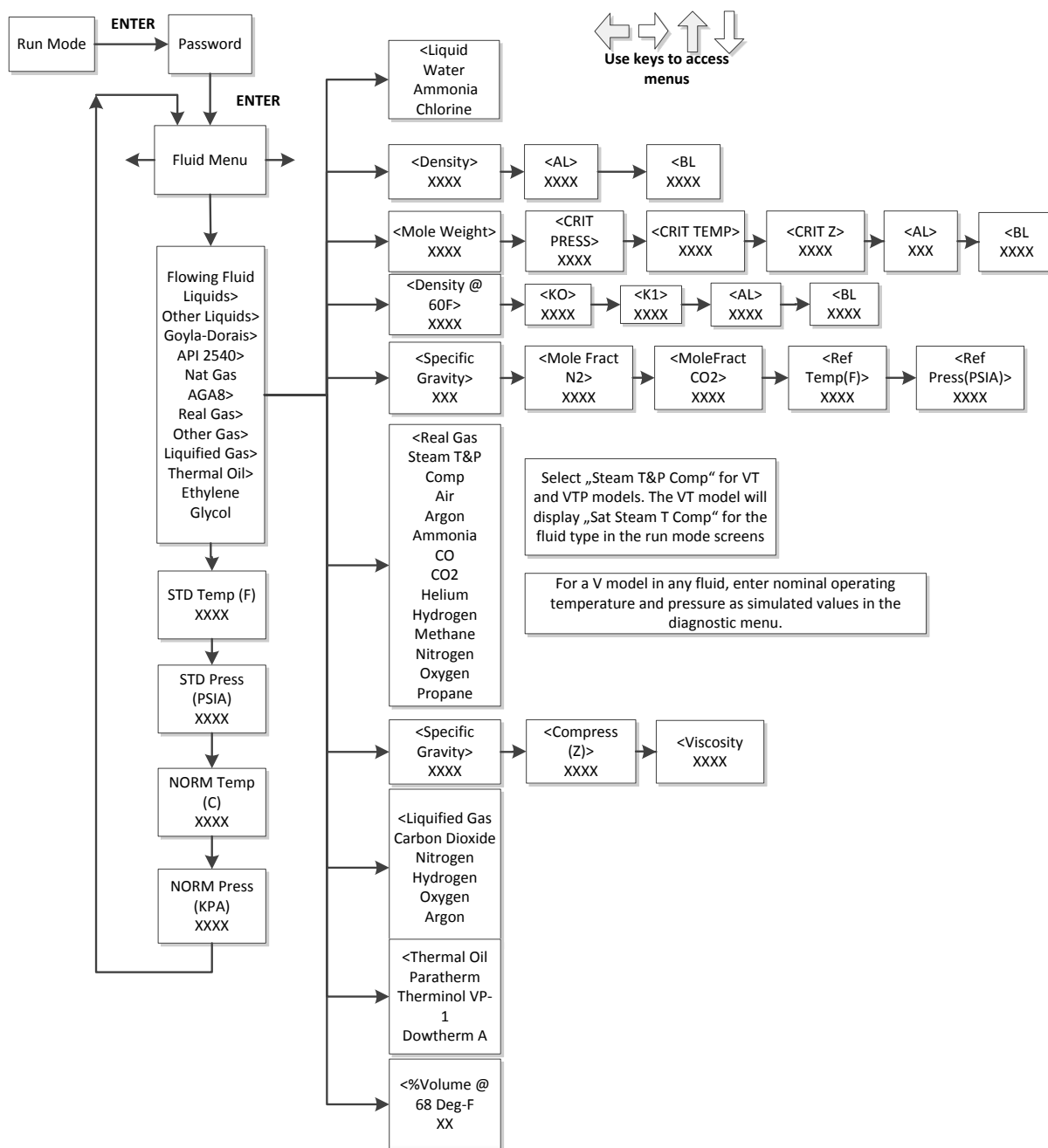
Screen/Menu 9 Fluid Menu

Use the Fluid Menu to configure the flow meter for use with common gases, liquids and steam. Your flow meter is pre-programmed at the factory for your application's process fluid.

Reference Richard W. Miller, *Flow Measurement Engineering Handbook (Third Edition, 1996),* page 2-75 for definition and use of the Goyal-Doraiswamy equation and 2-76 for the definition and use of the API 2540 equation. Also, see Chapter 12.3 Page 114 for Fluid Calculation equations.

The units of measurement used in the Fluid Menu are preset and are as follows:
Mole Weight = $lb_m/(lb_m \cdot mol)$, CRIT PRESS = psia, CRIT TEMP = °R, Density = Kg/m^3 and Viscosity = cP (centipoise).

5.13   Units Menu

```
┌──────────┐   ENTER    ┌──────────┐
│ Run Mode │ ────────▶  │ Password │
└──────────┘            └──────────┘
                              │ ENTER
                              ▼
                        ┌──────────┐      Use ⇧ ⇩ ⇦ ⇨
              ◀─────────│  Units   │──────▶
                        │   Menu   │      keys to access menus
                        └──────────┘
```

Mass Flow Unit

lb, Ston, Lton, gram
kg, Mton, scf, nm3   /   sec, min, hr, day

Ston = Short Ton = 2000 lb
Lton = Long Ton = 2240 lb
Mton = Metric Ton = 1000 kg

Volume Flow Unit

gal, MilG, ImpG, bbl
lit, MilL, m3, ft3   /   sec, min, hr, day

MilG = Million gallons
ImpG = Imperial gallon = 1.20095 US gallons
bbl = barrels = 42 US gallons
MilL = Million liters

Temperature Unit

Deg F, Deg C, Kelvin, Rankine

Energy Unit

BTU, MBTU, MMBT, MWHr
kWHr, HPHr, MCal,MJ   /   sec, min, hr, day

MBTU = Thousand BTU
MMBTU = Million BTU

Density Unit

lbm/ft3, kg/m3, gm/cc, lbm/gal,
gm/mlit, kg/lit, gm/lit, lbm/in3

Pressure Unit

psi, inH2O, ftH2O, mmH2O, in HG,
mmHG, ATM, Bar, mBar, gm/cm2, kg/cm2,
Pascal, KiloPa, MegaPa, Torr, 4inH20, 4mmH2O

4inH2O and 4mmH2O are based on
water at 4 degrees C.

Gauge Pressure Unit
Absolute / Gauge

Transducer reads in Absolute – if Gauge is desired
then atmospheric pressure at meter is needed

Atm. Pressure
14.6959

Menu is only activated if Gage Pressure is chosen
Enter the value in PSIA

Screen/Menu 10   Units Menu

Use the Units Menu to configure the flow meter with the desired units of measurement. (These are global settings and determine what appears on all screens.

5.14   Time & Date Menu

Screen/Menu 11   Time & Date Menu
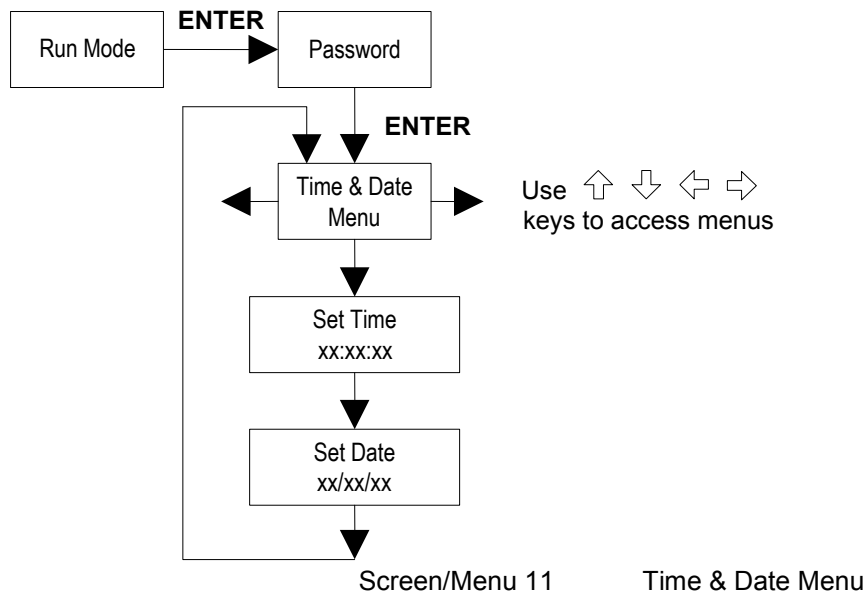
Use the Time and Date Menu to enter the correct time and date into the flow meter's memory. The parameters are used in the Run Mode and the alarm and system log files.

Note: Time is displayed in AM/PM format, but 24h format is used to set the time. For example, 1:00 PM is entered as 13:00:00 in the Set Time menu.

Example for Setting the time

How to set the time to 12:00:00. You can check the time in the Run Mode by pressing the ⇧⇩ keys until the Time & Date screen appears. Note: all outputs are disabled while using the Setup Menus.

1.   Use ⇦⇨ keys to move to the Time and Date Menu.
2.   Press ⇩ key until Set Time appears. Press ENTER.
3.   Press ⇩ key until 1 appears. Press ⇨ key to move the underline cursor to the next digit. Press the ⇩ key until 2 appears. Continue sequence until all desired parameters are entered. Press ENTER to return to the Time and Date Menu.
4.   Press **EXIT** to return to the Run Mode.

5.15   Diagnostics Menu

```
Run Mode  ──ENTER──▶  Password
                         │
                       ENTER
                         ▼
              ◀── Diagnositcs ──▶        Use ⬆ ⬇ ⬅ ➡
                    Menu                 keys to access menus
                         │
```

Simulate Vortex   Sim Vor Freq
Frequency (Hz)   xxx

* Simulate Temperature   Sim Temp 1, 2   ┌─────────────────────────────────────┐
                             xxx   │ *The unit of measure of the displayed value is the same as the unit │
                                             │   configured for the flow meter. │
* Simulate Pressure   Sim Pressure   └─────────────────────────────────────┘
                             xxx
                                             ┌─────────────────────────────────────┐
* Highest Recorded   Highest Velocity   │ For a V model in any fluid, enter nominal operating temperature and │
        Velocity   xxx   │ pressure as simulated values in the diagnostics menu. │
                                             │   │
* Highest Recorded   Highest Temp 1, 2 │ For a VT model in any fluid except steam, enter nominal operating │
      Temperature   xxx   │ pressure as a simulated value in the diagnostics menu. │
                                             └─────────────────────────────────────┘
* Highest Recorded   Highest Pressure
        Pressure   xxx

* Highest Electronics   Highest Int Temp
      Temperature   xx

* Lowest Electronics   Lowest Int Temp
      Temperature   xx

                                         Momentarily displayed
                        System LOG   ┌ ─ ─ ─ ─ ─ ─ ┐   System Log File   Use Left and Right
                        xx Files (ENTER) ▶ SysLog File #xx ▶   arrows to access all
                                         └ ─ ─ ─ ─ ─ ─ ┘   │   system log files
                        Clear Sys LOG?   Time
                        YES or NO   Date

                                                        Press EXIT to return
                                                           to System LOG

              Screen/Menu 12   Diagnostics Menu

Use the Diagnostics Menu to simulate operation and review the system files. The system log files contain time/date stamped messages including: power on, power off, programming time outs, parameter faults, incorrect password entry and other various information relative to system operation and programming.

The simulated inputs are for testing the meter to verify that the programming is correct. **They are also used to enter nominal operating temperature and pressure for the V only model.** Simulated vortex frequency allows you to enter any value for the sensor input in Hz. The meter will calculate a flow rate based on the corresponding value and update all analog outputs **(the totalizer display and output is not affected by a simulated frequency)**. The simulated pressure and temperature settings work the same way. The meter will output these new values and will use them to calculate a new density for mass flow measurement. **Note: when your diagnostic work is complete, make sure to return the values to zero to allow the electronics to use the actual transducer values**. **For the V only model keep the temperature and pressure at nominal operating conditions.**

If the meter display indicates a temperature or pressure fault, a substitute value can be entered to allow flow calculations to continue at a fixed value until the source of the fault is identified and corrected. **The units of measure of the displayed values are the same as the units configured for the flow meter.**

5.16   Calibration Menu

Screen/Menu 13   Calibration Menu
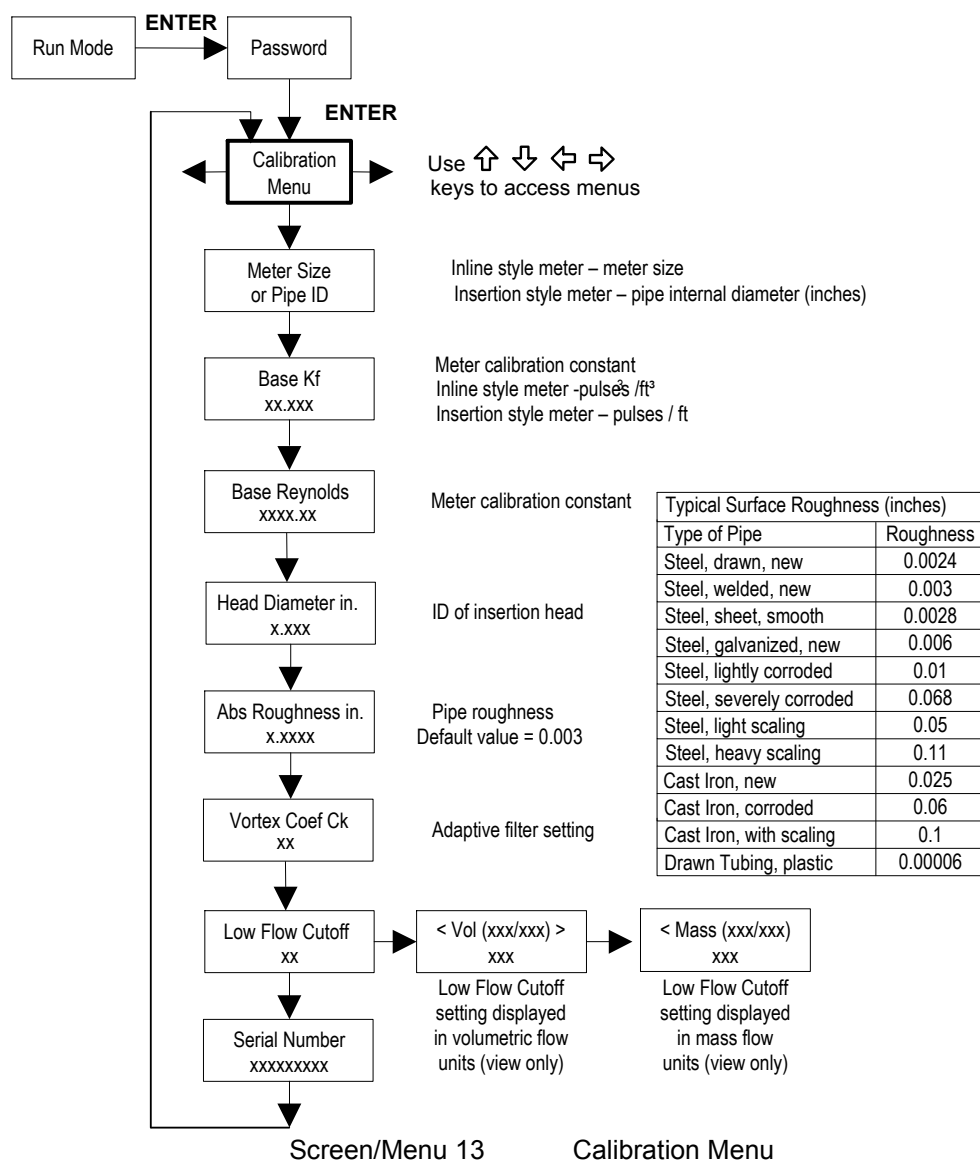
The Calibration Menu contains the calibration coefficients for the flow meter. These values should by changed only by properly trained personnel. The Vortex Coef Ck and Low Flow Cutoff are set at the factory. Consult the factory for help with these settings if the meter is showing erratic flow rate.

5.17   Password Menu

Screen/Menu 14   Password Menu
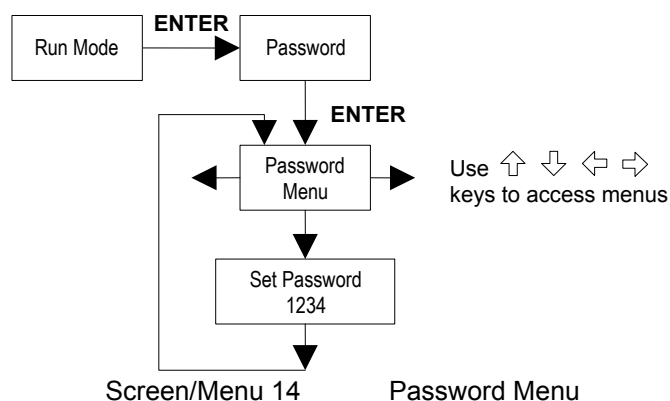
Use the Password Menu to set or change the system password. The factory-set password is 1234.

6. Serial Communications

6.1   HART Communications

The HART Communications Protocol (Highway Addressable Remote Transducer Protocol) is a bidirectional digital serial communications protocol. The HART signal is based on the Bell 202 standard and is superimposed on 4-20 mA Output 1. Peer-to-peer (analog / digital) and multi-drop (digital only) modes are supported.

6.1.1   Wiring

The diagrams below detail the proper connections required for HART communications:

6.1.1.1   Loop Powered Meter Wiring
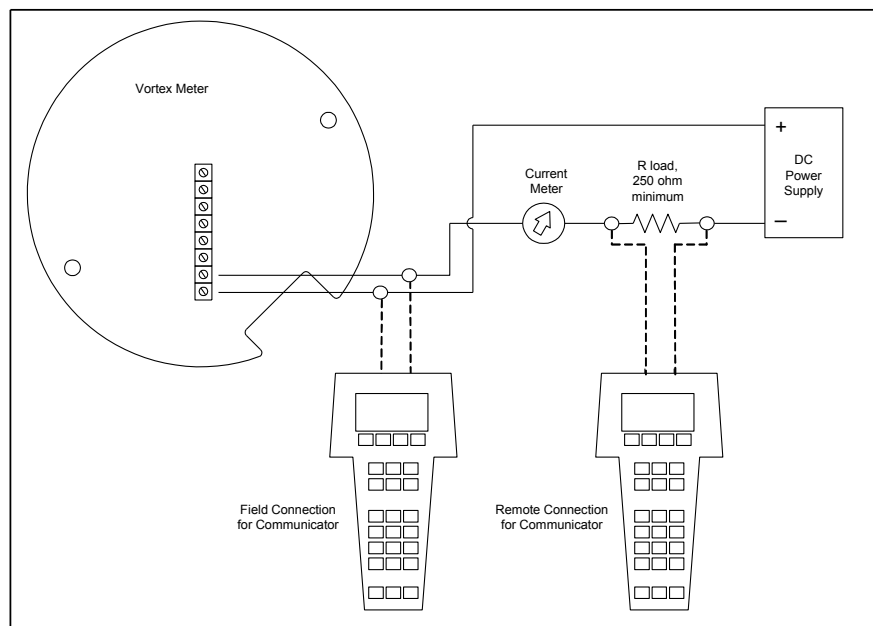
Figure 58   Loop Powered Meter Wiring (HART)

6.1.1.2   DC Powered Meter Wiring
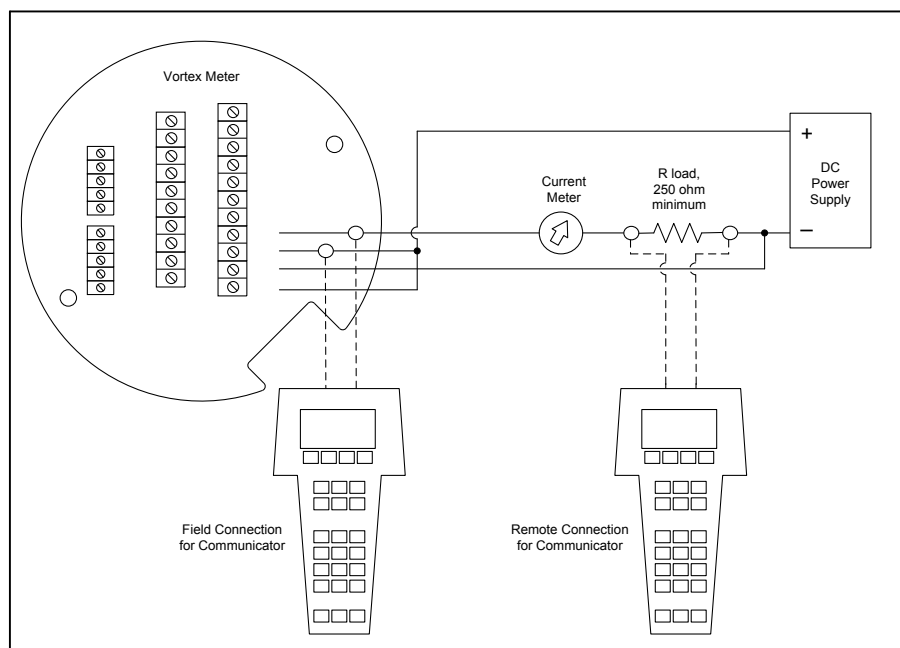
Figure 59   DC Powered Meter Wiring (HART)

6.1.1.3   AC Powered Meter Wiring

Figure 60   AC Powered Meter Wiring

6.1.2　HART Commands with the DD Menu

Online Menu

1 Device Setup	1 Display Unit	1 Mass flo unit 2 Vol unit 3 Temp unit 4 Energy flo unit 5 Line press unit 6 Dens unit 7 Totalizer units 8 Std & Norm Cond

1 Norm Temp 2 Norm Press 3 Std Temp 4 Std Press

2 Analog Output → To Analog Output Menu

3 External Loop	1 External Input 2 Set Ext. 4 mA 3 Set Ext. 20 mA

Inactive Temp1 Temp 2 Pressure

4 Meter Display	1 Disp Cycle 2 Disp Digits 3 Disp Damping 4 Init Displ. 5 Disp Show/Hide

5 Alarm Setup	1 Alarm Status 2 Alarm 1 Setup 3 Alarm 2 Setup 4 Alarm 3 Setup 5 Records in Log 6 Read Alarm Log 7 Alarm Log Clear

1 Alrm 1 var 2 Alrm 1 typ 3 Alrm 1 set pt

1 Alrm 2 var 2 Alrm 2 typ 3 Alrm 2 set pt

1 Alrm 3 var 2 Alrm 3 typ 3 Alrm 3 set pt

6 Totalizer	1 Total 2 Totalize 3 Amount/Pulse 4 Total 2 5 Totalize 2 6 Clear Totalizer

7 Fluid Menu → To Fluid Menu

8 Energy Setup	1 Meter Location 2 Heating or Cooling 3 % Return

9 Device Menu

Diagnostics → To Diagnostics Menu

Sensor Cal → To Sensor Cal Menu

Review → To Review Menu

1 Date 2 h 3 min 4 s 5 Password 6 Meter Size 7 Dev id 8 Tag 9 Descriptor 　Message 　Final assy num 　Poll adr 　Num req preams 　Config Code 　Compile Date 　Compile Time 　Signal Board Version 　Hardware rev 　Software rev 　Master reset

2 Process Variables	1 Mass Flo 2 Vol 3 Temp 4 Temp 2 5 Delta Temp. 6 Energy flo 7 Press 8 Dens 9 Totl 　Total 2

3 PV is
4 PV
5 AO1 Out
6 PV % rnge
7 Alrm Status

8 Diagnostics → To Diagnostics Menu

9 Calibration Review

From Sensor Cal Menu,
Calibration Review

1 K Factor 2 Ck Value 3 Lo Flo Cutoff 4 RTD1 Ro 5 RTD1 alpha 6 RTD1 beta 7 RTD2 Ro 8 RTD2 alpha 9 RTD2 beta Pcal B00, Pcal B01 Pcal B02, Pcal B10 Pcal B11, Pcal B12 Pcal B20, Pcal B21 Pcal B22 Ref. Resistance Internal Temp. Cal Cal current Flow 1 Deviation 1 Flow 2 Deviation 2 Flow 3 Deviation 3 Flow 4 Deviation 4 Flow 5 Deviation 5 Flow 6 Deviation 6 Flow 7 Deviation 7 Flow 8 Deviation 8 Flow 9 Deviation 9 Flow 10 Deviation 10

Screen/Menu 15　　　　HART Online Menu 1

HART Commands with the DD Menu Continued

Analog Output Menu

From Online Menu

```
1 Fix Analog Output
2 Trim Analog Output
3 Configure AO1
4 PV is
5 PV AO1 Out
6 PV % rnge
7 Configure AO2
8 SV is
9 SV AO2 Out
  SV % rnge
  Configure AO3
  TV is
  TV AO
  TV % rnge
  Configure AO4
  QV is
  QV AO
  QV % rnge
```

```
1 PV is
2 PV AO1 Out
3 PV
4 PV % rnge
5 Apply values
6 PV Rnge unit
7 PV LRV
8 PV URV
9 PV AO1 Lo end pt
  PV AO1 Hi end pt
  PV AO1 Added damp
```

```
1 SV is
2 SV AO2 Out
3 SV
4 SV % rnge
5 Apply values
6 SV Rnge unit
7 SV LRV
8 SV URV
9 SV AO2 Lo end pt
  SV AO2 Hi end pt
  SV AO2 Added damp
```

```
1 TV is
2 TV AO
3 TV
4 TV % rnge
5 Apply values
6 TV Rnge unit
7 TV LRV
8 TV URV
9 TV AO3 Lo end pt
  TV AO3 Hi end pt
  TV AO3 Added damp
```

```
1 QV is
2 QV AO
3 QV
4 QV % rnge
5 Apply values
6 QV Rnge unit
7 QV LRV
8 QV URV
9 QV AO1 Lo end pt
  QV AO1 Hi end pt
  QV AO1 Added damp
```

Screen/Menu 16   HART Online Menu 2

HART Commands with the DD Menu Continued

Fluid Menu

| From Online Menu > | 1 Fluid
2 Fluid Type | Liquid
Other Liquid
Goyal-Dorais
API-2540
Nat Gas AGA8
Real Gas
Other Gas
Liquified Gas | Water
Ammonia
Chlorine |
|---|---|---|---|

Other Liquid Density
Viscosity Coef AL
Viscosity Coef BL

Mol Weight
Crit Press
Crit Temp
Compressibility
AL
BL

Density @ 60F
API K0
API K1
API AL
API BL

AGA Ref Temp
AGA Ref Press
Specific Gravity
Mole Fract N2
Mole Fract CO2

Steam
Air
Argon
Ammonia
CO
CO2
Helium
Hydrogen
Methane
Nitrogen
Oxygen
Propane

Specific gravity
Compress
Viscosity

Carbon Dioxide
Nitrogen
Hydrogen
Oxygen
Argon

Screen/Menu 17   HART Online Menu 3

HART Commands with the DD Menu Continued

Diagnostics Menu

From Online Menu

| 1 Vortex Diag |
| 2 Press Diag |
| 3 Temp Diag |
| 4 Vel |
| 5 Temp |
| 6 Temp 2 |
| 7 Press |
| 8 Records in Log |
| 9 Read System Log |
| System Log Clear |
| Status |

| 1 Vtx Freq |
| 2 Sim Vtx Freq |
| 3 Vtx AtoD |
| 4 Filter Set |
| 5 Gain Set |
| 6 Re |
| 7 Vel |
| 8 Max Vel |
| 9 AD1 |
| AD2 |
| AD3 |
| AD4 |
| Ck |
| Level |

| 1 Press |
| 2 Sim Press |
| 3 Excite |
| 4 Excite AtoD |
| 5 Sense |
| 6 Sense AtoD |
| 7 Max Press |

| 1 Temp |
| 2 Sim Temp |
| 3 RTD1 |
| 4 RTD1 AtoD |
| 5 Max temp |
| 6 Temp 2 |
| 7 Sim Temp 2 |
| 8 RTD2 |
| 9 RTD2 AtoD |
| Max temp 2 |

| SPI not communicating |
| Freq. Input Overrange |
| FRAM CRC error |
| Signal Board Power ... |
| RTD1 Fault |
| RTD2 Fault |
| Press. Transducer Fault |

| Totalizer Relay Overrange |

| 1 Status group 1 |
| 2 Status group 2 |
| 3 Status group 3 |

| Alarm 1 Set |
| Alarm 2 Set |
| Alarm 3 Set |

Review Menu

From Online Menu

| 1 Model |
| 2 Distributor |
| 3 Write protect |
| 4 Manufacturer |
| 5 Dev id |
| 6 Tag |
| 7 Descriptor |
| 8 Message |
| 9 Date |
| Final asmbly num |
| Universal rev |
| Fld dev rev |
| Software rev |
| Burst mode |
| Burst option |
| Poll addr |
| Num req preams |

Screen/Menu 18   HART Online Menu 4

HART Commands with the DD Menu Continued

Sensor Cal Menu

To Calibration Review Menu

From Online Menu

| 1 Calibration Review |
| 2 Vortex Sensor |
| 3 Vortex Cal |
| 4 Press Sensor |
| 5 Press Cal |
| 6 Temp Sensor |
| 7 Temp 1 & 2 Cal |
| 8 Temp 2 Sensor |
| 9 Cal. Correction |

| 1 Vol snsr unit |
| 2 USL |
| 3 LSL |
| 4 Min Span |
| 5 Damp |
| 6 Snsr s/n |
| 7 Sim Vtx |
| 8 Max Vel |
| 9 Vortex Diag |

| 1 Vtx Freq |
| 2 Sim Vtx Freq |
| 3 Vtx AtoD |
| 4 Filter Set |
| 5 Gain Set |
| 6 Re |
| 7 Vel |
| 8 Max Vel |
| 9 AD1 |
| AD2 |
| AD3 |
| AD4 |
| Ck |
| Level |

| 1 K Factor |
| 2 Ck Value |
| 3 Lo flo cutoff |
| 4 Auto Set Ck |
| 5 Auto Set LFC |

| 1 Flow 1 |
| 2 Deviation 1 |
| 3 Flow 2 |
| 4 Deviation 2 |
| 5 Flow 3 |
| 6 Deviation 3 |
| 7 Flow 4 |
| 8 Deviation 4 |
| 9 Flow 5 |
| Deviation 5 |
| Flow 6 |
| Deviation 6 |
| Flow 7 |
| Deviation 7 |
| Flow 8 |
| Deviation 8 |
| Flow 9 |
| Deviation 9 |
| Flow 10 |
| Deviation 10 |

| 1 Pres snsr unit |
| 2 USL |
| 3 LSL |
| 4 Min span |
| 5 Damp |
| 6 Snsr s/n |
| 7 Sim Press |
| 8 Maximum |
| 9 Press Diag |

| 1 Press |
| 2 Sim Press |
| 3 Excite |
| 4 Excite AtoD |
| 5 Sense |
| 6 Sense AtoD |
| 7 Max Press |

| 1 PCal B00 |
| 2 PCal B01 |
| 3 PCal B02 |
| 4 PCal B10 |
| 5 PCal B11 |
| 6 PCal B12 |
| 7 PCal B20 |
| 8 PCal B21 |
| 9 PCal B22 |
| Ref. Resistance |
| Internal Temp. Cal |
| Cal Current |

| 1 Temp unit |
| 2 USL |
| 3 LSL |
| 4 Min span |
| 5 Damp |
| 6 Snsr s/n |
| 7 Sim Temp |
| 8 Maximum |
| 9 Temp Diag |

| 1 Temp |
| 2 Sim Temp |
| 3 RTD1 |
| 4 RTD1 AtoD |
| 5 Max Temp |
| 6 Temp 2 |
| 7 Sim Temp 2 |
| 8 RTD2 |
| 9 RTD2 AtoD |
| Max temp 2 |

| 1 RTD1 Ro |
| 2 RTD1 alpha |
| 3 RTD1 beta |
| 4 RTD2 Ro |
| 5 RTD2 alpha |
| 6 RTD2 beta |

| 1 Temp unit |
| 2 USL |
| 3 LSL |
| 4 Min span |
| 5 Damp |
| 6 Snsr s/n |
| 7 Sim Temp 2 |
| 8 Maximum |
| 9 Temp Diag |

| 1 Temp |
| 2 Sim Temp |
| 3 RTD1 |
| 4 RTD1 AtoD |
| 5 Max Temp |
| 6 Temp 2 |
| 7 Sim Temp 2 |
| 8 RTD2 |
| 9 RTD2 AtoD |
| Max temp 2 |

Screen/Menu 19 HART Online Menu 5

6.1.3   HART Commands with Generic DD Menu

Online Menu

| 1 Device Setup |
| 2 PV |
| 3 PV AO |

| 1 Process Variables |

| 1 Snsr |
| 2 AI % Rnge |
| 3 AO1 |

| 1 4 mA |
| 2 20 mA |
| 3 Other |
| 4 End |

| 2 Diag/Service |

| 1 Test Device |
| 2 Loop Test |
| 3 Calibration |
| 4 D/A Trim |

| 1 Apply Values |
| 2 Enter Values |

| 1 4 mA |
| 2 20 mA |
| 3 Exit |

| 1 PV LRV |
| 2 PV URV |
| 3 PV USL |
| 4 PV LSL |

| 3 Basic Setup |

| 1 Tag |
| 2 PV unit |
| 3 Range Values |
| 4 Device Information |
| 5 PV Xfer fnctn |
| 6 PV Damp |

| 1 PV LRV |
| 2 PV URV |
| 3 PV LSL |
| 4 PV USL |

| 1 Distributor |
| 2 Model |
| 3 Dev id |
| 4 Tag |
| 5 Date |
| 6 Write Protect |
| 7 Descriptor |
| 8 Message |
| 9 PV snsr s/n |
| Final assy # |
| Revision #'s |

| 1 Universal Rev |
| 2 Fld dev Rev |
| 3 Software Rev |

| 1 Sensors |

| 1 PV |
| 2 PV Sensor Unit |
| 3 Sensor information |

| PV LSL, PV USL, PV Min span |

| 2 Signal Condition |

| 1 Snsr Damp |
| 2 URV |
| 3 AI LRV |
| 4 Xfer Fnctn |
| 5 AI % rnge |

| 1 PV LRV |
| 2 PV URV |

| 4 Detailed Setup |
| 5 Review |

| 3 Output Condition |

| 1 Analog Output |
| 2 HART Output |

| 1 AO1 |
| 2 AO alarm typ |
| 3 Loop test |
| 4 D/A trim |
| 5 Scaled D/A trim |

| 1 4 mA |
| 2 20 mA |
| 3 Other |
| 4 End |

| 4 PV LRV |
| 5 URV |

| 1 PV LRV |
| 2 PV URV |

| 1 Distributor |
| 2 Model |
| 3 Dev id |
| 4 Tag |
| 5 Date |
| 6 Write Protect |
| 7 Descriptor |
| 8 Message |
| 9 PV snsr s/n |
| Final assy # |
| Revision #'s |

| 1 Poll addr |
| 2 Num req. preams |
| 3 Burst mode |
| 4 Burst option |

| 4 Device Information |

| 1 Universal Rev |
| 2 Fld dev Rev |
| 3 Software Rev |

Screen/Menu 20   HART Generic DD Menu

Use password 16363

6.1.4   Fast Key Sequence

Use password 16363

Sequence	Description	Access	Notes
1,1,1	Snsr	View	Primary variable value
1,1,2	AI % Rnge	View	Analog output % range
1,1,3	AO1	View	Analog output, mA
1,2,1	Test Device	N/A	Not used
1,2,2,1	4 mA	View	Loop test, fix analog output at 4 mA
1,2,2,2	20 mA	View	Loop test, fix analog output at 20 mA
1,2,2,3	Other	Edit	Loop test, fix analog output at mA value entered
1,2,2,4	End		Exit loop test
1,2,3,1,1	4 mA	N/A	Not used, apply values
1,2,3,1,2	20 mA	N/A	Not used, apply values
1,2,3,1,3	Exit		Exit apply values
1,2,3,2,1	PV LRV	Edit	Primary variable lower range value
1,2,3,2,2	PV URV	Edit	Primary variable upper range value
1,2,3,2,3	PV USL	View	Primary variable upper sensor limit
1,2,3,2,4	PV LSL	View	Primary variable lower sensor limit
1,2,4	D/A Trim	Edit	Calibrate electronics 4mA and 20mAvalues
1,3,1	Tag	Edit	Tag
1,3,2	PV unit	Edit	Primary variable units
1,3,3,1	PV LRV	Edit	Primary variable lower range value
1,3,3,2	PV URV	Edit	Primary variable upper range value
1,3,3,3	PV LSL	View	Primary variable upper sensor limit
1,3,3,4	PV USL	View	Primary variable lower sensor limit
1,3,4,1	Distributor	N/A	Not used
1,3,4,2	Model	N/A	Not used
1,3,4,3	Dev id	View	Device identification
1,3,4,4	Tag	Edit	Tag
1,3,4,5	Date	Edit	Date
1,3,4,6	Write Protect	View	Write protect
1,3,4,7	Descriptor	Edit	Vortex flowmeter
1,3,4,8	Message	Edit	32 character alphanumeric message
1,3,4,9	PV snsr s/n	View	Primary variable sensor serial number
1,3,4,menu	Final assy #	Edit	Final assembly number
1,3,4,menu,1	Universal Rev	View	Universal revision
1,3,4,menu,2	Fld dev Rev	View	Field device revision
1,3,4,menu,3	Software Rev	View	Software revision
1,3,5	PV Xfer fnctn	View	Linear
1,3,6	PV Damp	Edit	Primary variable damping (time constant) in seconds
1,4,1,1	PV	View	Primary variable value
1,4,1,2	PV Sensor Unit	Edit	Primary variable units
1,4,1,3	Sensor Information	View	PV LSL, PV USL, PV Min span
1,4,2,1	Snsr Damp	Edit	Primary variable damping (time constant) in seconds
1,4,2,2,1	PV LRV	Edit	Primary variable low range value
1,4,2,2,2	PV URV	Edit	Primary variable upper range value
1,4,2,3,1	PV LRV	Edit	Primary variable low range value
1,4,2,3,2	PV URV	Edit	Primary variable upper range value
1,4,2,4	Xfer Fnctn	View	Linear
1,4,2,5	AI % rnge	View	Analog output % range
1,4,3,1,1	AO1	View	Analog output, mA
1,4,3,1,2	AO alarm typ	N/A	Not used

Continued on next page

Sequence	Description	Access	Notes
1,4,3,1,3,1	4 mA	View	Loop test, fix analog output at 4 mA
1,4,3,1,3,2	20 mA	View	Loop test, fix analog output at 20 mA
1,4,3,1,3,3	Other	Edit	Loop test, fix analog output at mA value entered
1,4,3,1,3,4	End		Exit loop test
1,4,3,1,4	D/A trim	Edit	Calibrate electronics 4mA and 20mAvalues
1,4,3,1,5	Scaled D/A trim	N/A	Not used
1,4,3,2,1	Poll addr	Edit	Poll address
1,4,3,2,2	Num req. preams	View	Number of required preambles
1,4,3,2,3	Burst mode	N/A	Not used
1,4,3,2,4	Burst option	N/A	Not used
1,4,4,1	Distributor	N/A	Not used
1,4,4,2	Model	N/A	Not used
1,4,4,3	Dev id	View	Device identification
1,4,4,4	Tag	Edit	Tag
1,4,4,5	Date	Edit	Date
1,4,4,6	Write Protect	View	Write protect
1,4,4,7	Descriptor	Edit	Vortex flowmeter
1,4,4,8	Message	Edit	32 character alphanumeric message
1,4,4,9	PV snsr s/n	View	Primary variable sensor serial number
1,4,4,menu	Final assy #	Edit	Final assembly number
1,4,4,menu,1	Universal Rev	View	Universal revision
1,4,4,menu,2	Fld dev Rev	View	Field device revision
1,4,4,menu,3	Software Rev	View	Software revision
1,5	Review	N/A	Not used
2	PV	View	Primary variable value
3	PV AO	View	Analog output, mA
4,1	PV LRV	Edit	Primary variable lower range value
4,2	PV URV	Edit	Primary variable upper range value
5,1	PV LRV	Edit	Primary variable lower range value
5,2	PV URV	Edit	Primary variable upper range value

Table 4   Fast Key Descrition

6.2   Modbus Communications

⚠ Warning!
Place controls in manual mode when making configuration changes to the vortex meter.

Applicable Flow Meter Models
Heinrichs Vortex Flow Meters, Models DVH and DVE with Modbus communication protocol and firmware version 4.00.58 and above.

Overview
This document describes the preliminary implementation of the Modbus communication protocol for use in monitoring common process variables in the Heinrichs Vortex flow meter.
The physical layer utilizes the half-duplex RS-485 port, and the Modbus protocol.

Reference Documents
The following documents are available online from www.modbus.org.
Modbus Application Protocol Specification V1.1
Modbus Over Serial Line Specification & Implementation Guide V1.0
Modicon Modbus Protocol Reference Guide PI–MBUS–300 Rev. J

6.2.1   Wiring

An RS485 daisy chained network configuration as depicted below is recommended. Do not use a star, ring, or cluster arrangement.
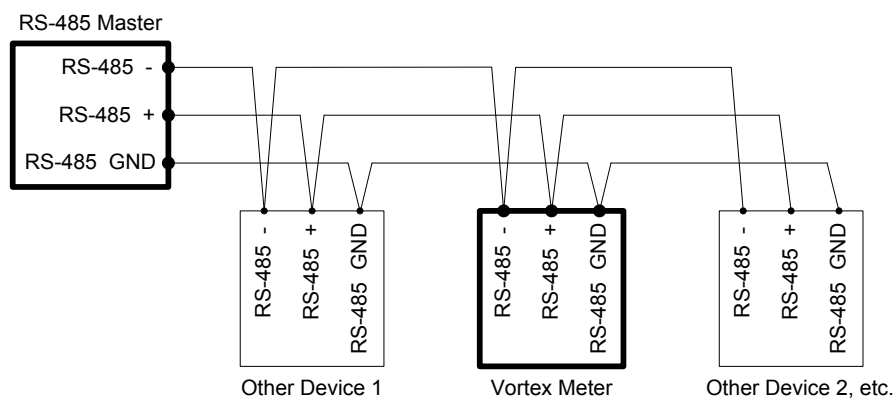
Figure 61   RS-485 Wiring (MODBUS)

6.2.2   Pin Labeling (among devices)

"RS-485 –" = "A" = "TxD-/RxD-" = "Inverting pin"
"RS-485 +" = "B" = "TxD+/RxD+" = "Non-Inverting pin"
"RS-485 GND" = "GND" = "G" = "SC" = "Reference"

6.2.3   Menu Items

The following menu items are in the Output Menu and allow selection and control of the Modbus communication protocol.

6.2.3.1   Address

When the Modbus protocol is selected, the Modbus address is equal to the user programmable device address if it is in the range 1…247, in accordance with the Modbus specification. If the device address is zero or is greater than 247, then the Modbus address is internally set to 1.

6.2.3.2   Comm Protocol

The Comm Protocol menu allows selection of "Modbus RTU Even," "Modbus RTU Odd," or "Modbus RTU None2," or "Modbus RTU None1," (non-standard Modbus) with Even, Odd and None referring to the parity selection. When even or odd parity is selected, the unit is configured for 8 data bits, 1 parity bit and 1 stop bit; with no parity, the number of stop bits is 1 (non-standard) or 2. When changing the protocol, the change is made as soon as the Enter key is pressed.

6.2.3.3   Modbus Units

The Modbus Units menu is to control what units, where applicable, the meter's variables will be displayed in. Internal – these are the base units of the meter, °F, psia, lbm/sec, ft3/sec, Btu/sec, lbm/ft3 Display – variables are displayed in user selected display unit.

6.2.3.4   Modbus Order

The byte order within registers and the order in which multiple registers containing floating point or long integer data are transmitted may be changed with this menu item. According to the Modbus specification, the most significant byte of a register is transmitted first, followed by the least significant byte. The Modbus specification does not prescribe the order in which registers are transmitted when multiple registers represent values longer than 16 bits. Using this menu item, the order in which registers representing floating point or long integer data and/or the byte order within the registers may be reversed for compatibility with some PLCs and PC software.

The following four selections are available in this menu; when selecting an item, the protocol is changed immediately without having to press the Enter key.

0-1:2-3	Most significant register first, most significant byte first (default)
2-3:0-1	Least significant register first, most significant byte first
1-0:3-2	Most significant register first, least significant byte first
3-2:1-0	Least significant register first, least significant byte first

Table 5   Modbus Bite Order

Note that all of the registers are affected by the byte order, including strings and registers representing 16-bit integers; the register order only affects the order of those registers representing 32-bit floating point and long integer data, but does not affect single 16-bit integers or strings.

6.2.3.5   Modbus Protocol

The Modbus RTU protocol is supported in this implementation. Supported baud rates are 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200. The default baud rate is 19200 baud. Depending upon the Modbus protocol selected, data are transmitted in 8-bit data frames with even or odd parity and 1 stop bit, or no parity and 2 or 1 (non-standard) stop bits.

The current Modbus protocol specification does not define register usage, but there is an informal register numbering convention derived from the original (now obsolete) Modicon Modbus protocol specification, and used by many vendors of Modbus capable products

Registers	Usage	Valid Function Codes
00001–09999	Read/write bits ("coils")	01 (read coils) 05 (write single coil) 15 (write multiple coils)
10001–19999	Read-only bits ("discrete inputs")	02 (read discrete inputs)
30001–39999	Read-only 16 bit registers ("input registers"), IEEE 754 floating point register pairs, arbitrary length strings encoded as two ASCII characters per 16-bit register	03 (read holding registers) 04 (read input registers)
40001–49999	Read/write 16-bit registers ("holding registers"), IEEE 754 floating point register pairs, arbitrary length strings encoded as two ASCII characters per 16-bit register	03 (read holding registers) 06 (write single register) 16 (write multiple registers)

Table 6   Modbus Register Usage

Each range of register numbers maps to a unique range of addresses that are determined by the function code and the register number. The address is equal to the least significant four digits of the register number minus one, as shown in the following table.

Registers	Function Codes	Data Type and Address Range
00001-09999	01, 05, 15	Read/write bits 0000-9998
10001-19999	02	Read-only bits 0000-9999
30001-39999	03, 04	Read-only 16-bit registers 0000-9998
40001-49999	03, 06, 16	Read/write 16-bit registers 0000-9998

Table 7   Modbus Registers Function Codes

6.2.4   Register Definitions

The meter serial number and those variables that are commonly monitored (mass, volume and energy flow rates, total, pressure, temperature, density, viscosity, Reynolds number, and diagnostic variables such as frequency, velocity, gain, amplitude and filter setting) are accessible via the Modbus protocol. Long integer and floating point numbers are accessed as pairs of 16-bit registers in the register order selected in the Modbus Order menu. Floating point numbers are formatted as single precision IEEE 754 floating point values.

The flow rate, temperature, pressure, and density variables may be accessed as either the flow meter internal base units or in the user-programmed display units, which is determined by the programming Output Menu's "Modbus Units" item. The display units strings may be examined by accessing their associated registers. Each of these units string registers contain 2 characters of the string, and the strings may be 2 to 12 characters in length with unused characters set to zero. Note that the byte order affects the order in which the strings are transmitted. If the Modbus Order menu (see Table 5 Modbus Bite Order Page 71) is set to 0-1:2-3 or 2-3:0-1, then the characters are transmitted in the correct order; if set to 1-0:3-2 or 3-2:1-0, then each pair of characters will be transmitted in reverse order.

Registers	Variable	Data type	Units	Function code	Addresses
65100-65101	Serial number	unsigned long	—	03, 04	
30525-30526	Totalizer	unsigned long	display units*	03, 04	524-525
32037-32042	Totalizer units	string	—	03, 04	2036-2041
30009-30010	Mass flow	float	display units*	03, 04	8-9
30007-30008	Volume flow	float	display units*	03, 04	6-7
30005-30006	Pressure	float	display units*	03, 04	4-5
30001-30002	Temperature	float	display units*	03, 04	0-1
30029-30030	Velocity	float	ft/sec	03, 04	28-29
30015-30016	Density	float	display units*	03, 04	14-15
30013-30014	Viscosity	float	cP	03, 04	12-13
30031-30032	Reynolds number	float	—	03, 04	30-31
30025-30026	Vortex frequency	float	Hz	03, 04	24-25
34532	Gain	char	—	03, 04	4531
30085-30086	Vortex amplitude	float	Vrms	03, 04	84-85
30027-30028	Filter setting	float	Hz	03, 04	26-27

Table 8   Modbus Register Definitions

The following registers are available with the energy meter firmware:

Registers	Variable	Data type	Units	Function code	Addresses
30527-30528	Totalizer #2	unsigned long	display units*	03, 04	526-527
32043-32048	Totalizer #2 units	string	—	03, 04	2042-2047
30003-30004	Temperature #2	float	display units*	03, 04	2-3
30011-30012	Energy flow	float	display units*	03, 04	10-11

Table 9   Modbus Register Definitions with Enery Firmware

The following registers contain the display units strings:

Registers	Variable	Data type	Units	Function code	Addresses
32007-32012	Volume flow units	string	—	03, 04	2006-2011
32001-32006	Mass flow units	string	—	03, 04	2000-2005
32025-32030	Temperature units	string	—	03, 04	2024-2029
32019-32024	Pressure units	string	—	03, 04	2018-2023
32031-32036	Density units	string	—	03, 04	2030-2035
32013-32017	Energy flow units	string	—	03, 04	2012-2017

Table 10   Modbus Register containing Display Units Strings

Function codes 03 (read holding registers) and 04 (read input registers) are the only codes supported for reading these registers, and function codes for writing holding registers are not implemented. We recommend that the floating point and long integer registers be read in a single operation with the number of registers being a multiple of two. If these data are read in two separate operations, each reading a single 16-bit register, then the value will likely be invalid.

The floating point registers with values in display units are scaled to the same units as are displayed, but are instantaneous values that are not smoothed. If display smoothing is enabled (non-zero value entered in the Display TC item in the Display Menu), then the register values will not agree exactly with the displayed values.

6.2.5 Exception Status Definitions

The Read Exception Status command (function code 07) returns the exception status byte, which is defined as follows. This byte may be cleared by setting "coil" register #00003 (function code 5, address 2, data = 0xff00).

Bit(s)	Definition

0-1	Byte order (see Modbus Order on page 2)
	          0 = 3-2:1-0 1 = 2-3:0-1
	          2 = 1-0:3-2 3 = 0-1:2-3

2	Not used
3	Not used
4	Not used
5	Not used
6	Not used
7	Configuration changed

Table 11   Modbus Exception Status Definitions

6.2.6 Discrete Input Definitions

The status of the three alarms may be monitored via the Modbus Read Discrete Input command (function code 02). The value returned indicates the state of the alarm, and will be 1 only if the alarm is enabled and active. A zero value is transmitted for alarms that are either disabled or inactive.

Registers	Variable	Function Code	Address
10001	Alarm #1 state	02	0
10002	Alarm #2 state	02	1
10003	Alarm #3 state	02	2

Table 12   Modbus Discrete Input Definitions

6.2.7 Control Register Definitions

The only writeable registers in this implementation are the Reset Exception Status, Reset Meter and Reset Totalizer functions, which are implemented as "coils" which may be written with the Write Single Coil command (function code 05) to address 7 through 9, respectively, (register #00008 through #00010). The value sent with this command must be either 0x0000 or 0xff00, or the meter will respond with an error message; the totalizer will be reset or exception status cleared only with a value of 0xff00.

6.2.8 Error Responses

If an error is detected in the message received by the unit, the function code in the response is the received function code with the most significant bit set, and the data field will contain the exception code byte, as follows:

If the first byte of a message is not equal to the unit's Modbus address, if the unit detects a parity error in any character in the received message (with even or odd parity enabled), or if the message CRC is incorrect, the unit will not respond.

Exception Code	Description
01	Invalid function code — function code not supported by device
02	Invalid data address — address defined by the start address and number of registers is out of range
03	Invalid data value — number of registers = 0 or >125 or incorrect data with the Write Single Coil command

Table 13   Modbus Error Responses

6.2.9   Command Message Format

The start address is to the desired first register numbers minus one. The addresses received from the start address and the number of the register must all be mapped to valid defined registers, or an invalid data address exception will occur.

Device Address 8 bits, 1…247	Function Code 8 bits	Start Address 16 bits, 0…9998	N = Number of Registers 16 bits, 1…125	CRC 16 bits

Table 14   Modbus Command Message Format

6.2.10 Normal Response Message Format

Device Address 8 bits, 1…247	Function Code 8 bits	Byte Count = 2 x N 8 bits	Data (N) 16-bit registers	CRC 16 bits

Table 15   Modbus Normal Response Message Format

6.2.11 Exception Response Message Format

Device Address 8 bits, 1…247	Function Code + 0x80 8 bits	Exception Code 8 bits	CRC 16 bits

Table 16   Modbus Exception Response Message Format

6.2.12 Examples

Read the exception status byte from the device with address 1: `01 07 41 E2`

```
01 Device address
07 Function code, 04 = read exception status
41 E2 CRC
```

A typical response from the device is as follows: `01 07 03 62 31`

```
01 Device address
07 Function code
03 Exception status byte
62 31 CRC
```

Request the first 12 registers from device with address 1:   `01 04 00 00 00 0C F0 0F`

```
01 Device address
04 Function code, 04 = read input register
00 00 Starting address
00 0C Number of regsisters = 12
F0 0F CRC
```

A typical response from the device is as follows: *note these are the older register definitions

```
01 04 18 00 00 03 E8 00 00 7A 02 6C 62 00 00 41 BA 87 F2 3E BF FC 6F 42 12 EC 8B 4D
D1
```

```
01 Device address
04 Function code
18 Number of data bytes = 24
00 00 03 E8 Serial number = 1000 (unsigned long)
00 00 7A 02 Totalizer = 31234 lbm (unsigned long)
6C 62 00 00 Totalizer units = "lb" (string, unused characters are 0)
41 BA 87 F2 Mass flow rate = 23.3164 lbm/sec (float)
3E BF FC 6F Volume flow rate = 0.3750 ft$^3$/sec (float)
42 12 EC 8B Pressure = 36.731 psia (float)
4D D1 CRC
```

An attempt to read register(s) that don't exist: 01 04 00 00 00 50 F1 D2

```
01 Device address
04 Function code 4 = read input register
00 00 Starting address
00 50 Number of registers = 80
F0 36 CRC
```

results in an error response as follows: 01 84 02 C2 C1

```
01 Device address
84 Function code with most significant bit set indicates error response
02 Exception code 2 = invalid data address
C2 C1 CRC
```

Request the state all three alarms: 01 02 00 00 00 03 38 0B

```
01 Device address
02 Function code 2 = read discrete inputs
00 00 Starting address
00 03 Number of inputs = 3
38 0B CRC
```

and the unit responds with: 01 02 01 02 20 49

```
01 Device address
02 Function code
01 Number of data bytes = 1
02 Alarm #2 on, alarms #1 and #3 off
20 49 CRC
```

To reset the totalizer: 01 05 00 00 FF 00 8C 3A

```
01 Device address
05 Function code 5 = write single coil
00 09 Coil address = 9
FF 00 Data to reset totalizer
8C 3A CRC (not the correct CRC EJS-02-06-07)
```

The unit responds with an identical message to that transmitted, and the totalizer is reset. If the "coil" is turned off as in the following message, the response is also identical to the transmitted message, but the totalizer is not affected.

```
01 05 00 00 00 00 CD C8
```

```
01 Device address
05 Function code 5 = write single coil
00 00 Coil address = 0
00 00 Data to "turn off coil" does not reset totalizer
CD C8 CRC
```

6.3   BACnet MS/TP Communications

6.3.1   BACnet MS/TP Description

The BACnet Master-Slave/Token-Passing (MSTP) driver implements a data link protocol that uses the services of the RS-485 physical layer. The MS/TP bus is based on BACnet standard protocol SSPC-135, Clause 9. BACnet MS/TP protocol is a peer-to-peer, multiple master protocols based on token passing. Only master devices can receive the token, and only the device holding the token is allowed to originate a message on the bus. The token is passed from master device to master device using a small message. The token is passed in consecutive order starting with the lowest address. Slave devices on the bus only communicate on the bus when responding to a data request from a master device.

6.3.2   Baud Rates on the MS/TP Bus

An MS/TP bus can be configured to communicate at one of four different baud rates. It is very important that all of the devices on an MS/TP bus communicate at the same baud rate. The baud rate setting determines the rate at which devices communicate data over the bus. The baud rate settings available on Pro-V™ Vortex Mass Flow Meters are 9600, 19200 and 38400.

6.3.3   Baud Rate and MAC address configuration

1. Power on the IUT

2. Press Enter to go to the configuration menu

3. Enter the factory password 16363 (Use Up and Down arrows to enter the digits)

4. Navigate with the left arrow to Diagnostics menu

5. Press Enter and press right button immediately

6. Navigate to Config Code screen by continuous pressing down button

7. After reaching config code screen, press right to navigate to Comm. Type screen

8. Change the comm. Type to "Modbus" and press Enter

Note: Modbus will enable Baud Rate and MAC address screens

9. Press Exit twice to go back to the Diagnostics menu

10. Navigate to Output Menu by using right or left arrow buttons

11. Press Down button and reach Baud Rate and MAC address screens

12. Change the required settings and press Exit & Enter buttons to save the configuration

13. Reboot the device by power off and on for the changes to take effect

Note:
IUT support 9600, 19200, 38400 baud rates
MAC address range is 0-127

6.3.4   Supported BACnet Objects

A BACnet object represents physical or virtual equipment information, as a digital input or parameters. The Pro-V™ Vortex Mass Flow Meters presents the following object types:

- a. Device Object
- b. Analog Input
- c. Binary Input
- d. Binary Value

Each object type defines a data structure composed by properties that allow the access to the object information. The below table shows the implemented properties for each Vortex Mass Flow Meters object type.

Properties	Object Types			
	Device	Analog Input	Binary Input	Binary Value
Object_Identifier	☑	☑	☑	☑
Object_Name	☑	☑	☑	☑
Object_Type	☑	☑	☑	☑
System_Status	☑			
Vendor_Name	☑			
Vendor_Identifier	☑			
Model_Name	☑			
Firmware_Revision	☑			
Application-Software-Version	☑			
Protocol_Version	☑			
Protocol_Revision	☑			
Protocol_Services_Supported	☑			
Protocol_Object_Types_Supported	☑			
Object_List	☑			
Max_ADPU_Length_Accepted	☑			
Segmentation_Supported	☑			
ADPU_Timeout	☑			
Number_Of_ADPU_Retries	☑			
Max_Masters	☑			
Max_Info_Frames	☑			
Device_Address_Binding	☑			
Database_Revision	☑			
Status_Flags				
Event_State		☑	☑	☑
Reliability				

Property		Col1	☑ (W)	☑ (W)	☑ (W)
Out_Of_Service			☑ (W)	☑ (W)	☑ (W)
Units			☑		
Polarity				☑ (W)	
Priority_Array					
Relinquish_Default					
Status_Flag			☑	☑	☑
Present_Value			☑ (W)	☑ (W)	☑ (W)
Inactive_Text					
Active_Text					

(W) – Writable Property.

<center>Table 17   BACnet Object Types</center>

6.3.4.1   Device Object:

The Device object default property values are as follows –

Property Name	Default Values
object-identifier	**7**
object-name	**Device,1**
object-type	**Device**
system-status	**operational**
vendor-name	**VorTek Instruments**
vendor-identifier	**558**
model-name	**Multivariable Flowmete**
firmware-revision	**N/A**
application-software-version	**1.07**
protocol-version	**1**
protocol-revision	**4**
protocol-services-supported	**{F,F,F,F,F,F,F,F,F,F,F,F,T,F,T,T,T,T,F,F,F,F,F,F,F,F,F,F,F,F,T,T,F,F,F,F,F}**
protocol-object-types-supported	**{T,F,F,T,F,T,F,F,T,F,F,F,F,F,F,F,F,F,F,F,F,F,F,F}**
object-list	**{(analog-input,1),(analog-input,2),(analog-input,3),(analog-input,4), (analog-input,5), (analog-input,6),(analog-input,7),(analog-input,8) (analog-input,9),(analog-input,10), (analog-input,11), (analog-input,12), (analog-input,13),(analog-input,14), (analog-input,15),(analog-input,16),(analog-input,17), (analog-**

	input,18),(analog-input,19),(binary-input,1),(binary-input,2),(binary-input,3),(binary-input,4), (binary-value,1), (device,7) }
max-apdu-length-accepted	**300**
segmentation-supported	**no-segmentation**
apdu-timeout	**3000**
number-of-APDU-retries	**1**
max-master	**127**
max-info-frames	**1**
device-address-binding	**()**
database-revision	**0**

Table 18   BACnet Default Values

Note - Device Communication Control: Password – "vortek"

6.3.4.2   Analog Input Object:

Vortex Mass Flow Meters Analog Input type objects are described in the below Table –

Object Instance	Object Name	Unit	Description
1	Volume Flow	cubic-feet-per-second, cubic-feet-per-minute, us-gallons-per-minute, imperial-gallons-per-minute, liters-per-minute, liters-per-second, liters-per-hour, cubic-meters-per-second, cubic-meters-per-minute, cubic-meters-per-hour	This AI object is used to measure volume flow.
2	Mass Flow	pounds-mass-per-second, grams-per-second, kilograms-per-second , kilograms-per-minute , kilograms-per-hour, pounds-mass-per-minute , pounds-mass-per-hour, tons-per-hour, grams-per-second , grams-per-minute	This AI object is used to measure mass flow.
3	Temperature 1	degrees-Celsius, degrees-Kelvin, degrees-Fahrenheit	This AI object measures Temperature in one of the given Unit.

4	Temperature 2	degrees-Celsius, degrees-Kelvin, degrees-Fahrenheit	This AI object measures Temperature in one of the given Unit.
5	Pressure	pounds-force-per-square-inch, inches-of-water, inches-of-mercury, millimeters-of-mercury, bars, millibars, pascals, kilopascals	TBD
6	Density	kilograms-per-cubic-meter	TBD
7	Energy Flow	Kilowatts, Horsepower, btus-per-hour,, kilo-btus-per-hour, megawatts	TBD
8	Totalizer 1 & Totalizer 2	If Totalizer selection for Mass measure – pounds-mass-per-second, grams-per-second, kilograms-per-second , kilograms-per-minute , kilograms-per-hour, pounds-mass-per-minute , pounds-mass-per-hour, tons-per-hour, grams-per-second , grams-per-minute If Totalizer selection for Volume measure – cubic-feet-per-second, cubic-feet-per-minute, us-gallons-per-minute, imperial-gallons-per-minute, liters-per-minute, liters-per-second, liters-per-hour, cubic-meters-per-second, cubic-meters-per-minute, cubic-meters-per-hour If Totalizer selection for Energy measure – Kilowatts, Horsepower, btus-per-hour,, kilo-btus-per-hour, megawatts	An electronic counter which records the total accumulated flow over a certain range of time.
10	StatusRegister	NO UNITS	TBD
11	Channel 1 (4-20mA)	milliamperes	TBD
12	Channel 2 (4-20mA)	milliamperes	TBD
13	Channel 3 (4-20mA)	milliamperes	TBD
14	Scaled Freq	hertz	TBD
15	Flow Velocity	feet-per-second	TBD
16	Viscosity	centipoises	TBD
17	Frequency	hertz	TBD

18	VorTex Amp	millivolts	TBD
19	FilterSetting	hertz	TBD

Table 19   BACnet Analog Input Object

6.3.4.3   Binary Input Object:

Vortex Mass Flow Meters Binary Input type objects are described in the below Table.

Object Instance	Object Name	Description
1	Alarm1	**The status of the three alarms may be monitored via the Modbus command. The value returned indicates the state of the alarm, and will be 1 only if the alarm is enabled and active. A zero value is transmitted for alarms that are either disabled or inactive**
2	Alarm2	
3	Alarm3	
4	External	TBD

Table 20   BACnet Binary Input Object

Note - Binary Input 4, Present value always read zero, because no information available from client, so the polarity property doesn't impact on Present value property when the Out of service property is false.

6.3.4.4   Binary Value Object:

Vortex Mass Flow Meters Binary Value type objects are described in the below Table.

Object Instance	Object Name	Description
1	Reset	Reset's Totalizer

Table 21   BACnet Binary Value Object

6.3.5   ANNEX - BACnet PROTOCOL IMPLEMENTATION CONFORMANCE STATEMENT

Date: 19-April-2012

Vendor Name: VorTek Instruments

Product Name: Pro-V M22/M23/M24 multivariable flow-meter

Product Model Number: M22/M23/M24 VT/VTP

Applications Software Version: 1.07

Firmware Revision: N/A

BACnet Protocol Revision: 4

Product Description: VorTek multivariable flow-meter

BACnet Standardized Device Profile (Annex L):
☐ BACnet Operator Workstation (B-OWS)
☐ BACnet Advanced Operator Workstation (B-AWS)
☐ BACnet Operator Display (B-OD)
☐ BACnet Building Controller (B-BC)
☐ BACnet Advanced Application Controller (B-AAC)
☑ BACnet Application Specific Controller (B-ASC)
☐ BACnet Smart Sensor (B-SS)
☐ BACnet Smart Actuator (B-SA)

List all BACnet Interoperability Building Blocks Supported (Annex K):

BIBBs
DS-RP-B
DS-WP-B
DM-DDB-B
DM-DOB-B
DM-DCC-B
DS-RPM-B
DS-WPM-B

Table 22   BACnet BIBBs

Services Supported	
Read Property	Execute
Write Property	Execute
Read Property Multiple	Execute
Write Property Multiple	Execute
Who-Is	Execute
I-Am	Initiate
Who-Has	Execute
I-Have	Initiate
Device Communication Control	Execute

Table 23   BACnet Services Supported

Segmentation Capability:
☐ Able to transmit segmented messages   Window Size
☐ Able to receive segmented messages   Window Size

Standard Object Types Supported:

Standard Object Types Supported				
Object Type	Dynamically Creatable	Dynamically Delete-able	Additional Writable Properties	Range Restrictions
Analog Input (AI)	No	No	None	None
Binary Input (BV)	No	No	None	None
Binary Value	No	No	None	None
Device	No	No	None	None

Table 24   BACnet Standard Object Types Supported

Table 25   BACnet Standard Object Types
Supported Writable Properties

Object List:

Properties of Analog Input/Value Objects Type						
ID	Name	Present Value	Status Flags	Event State	Out of Service	Units
AI1	Volume Flow	?	F,F,F,F	Normal	False	?
AI2	Mass Flow	?	F,F,F,F	Normal	False	?
AI3	Temperature 1	?	F,F,F,F	Normal	False	?
AI4	Temperature 2	?	F,F,F,F	Normal	False	?
AI5	Pressure	?	F,F,F,F	Normal	False	?
AI6	Density	?	F,F,F,F	Normal	False	?
AI7	Energy Flow	?	F,F,F,F	Normal	False	?
AI8	Totalizer 1	?	F,F,F,F	Normal	False	?
AI9	Totalizer 2	?	F,F,F,F	Normal	False	?
AI10	StatusRegister	?	F,F,F,F	Normal	False	?
AI11	Channel 1 (4-20mA)	?	F,F,F,F	Normal	False	?
AI12	Channel 2 (4-20mA)	?	F,F,F,F	Normal	False	?
AI13	Channel 3 (4-20mA)	?	F,F,F,F	Normal	False	?
AI14	Scaled Freq	?	F,F,F,F	Normal	False	?
AI15	Flow Velocity	?	F,F,F,F	Normal	False	?
AI16	Viscosity	?	F,F,F,F	Normal	False	?
AI17	Frequency	?	F,F,F,F	Normal	False	?
AI18	VorTex Amp	?	F,F,F,F	Normal	False	?
AI19	FilterSetting	?	F,F,F,F	Normal	False	?

Table 26   BACnet Object List

Properties of Analog Input/Value Objects Type						
ID	Name	Present Value	Status Flags	Event State	Out of Service	Polarity
BI1	Alarm1	?	F,F,F,F	Normal	False	Normal
BI2	Alarm2	?	F,F,F,F	Normal	False	Normal
BI3	Alarm3	?	F,F,F,F	Normal	False	Normal
BI4	External	?	F,F,F,F	Normal	False	Normal

Table 27   Properties of Analog Input/Value Objects Type

Properties of Analog Input/Value Objects Type						
ID	Name	Present Value	Status Flags	Event State	Out of Service	out-of-service
BV1	Reset	?	F,F,F,F	Normal	False	False

Table 28   BACnet Properties of Analog Input/Value Objects Type

Data Link Layer Options:

☐BACnet IP, (Annex J)
☐BACnet IP, (Annex J), Foreign Device
☐ISO 8802-3, Ethernet (Clause 7)
☐ANSI/ATA 878.1, 2.5 Mb. ARCNET (Clause 8)
☐ANSI/ATA 878.1, EIA-485 ARCNET (Clause 8), baud rate(s)
☑MS/TP master (Clause 9), baud rate(s): 9600, 19200, 38400
☐MS/TP slave (Clause 9), baud rate(s):
☐Point-To-Point, EIA 232 (Clause 10), baud rate(s):
☐Point-To-Point, modem, (Clause 10), baud rate(s):
☐LonTalk, (Clause 11), medium:
☐Other:

Device Address Binding:
Is static device binding supported? (This is currently necessary for two-way communication with MS/TP slaves and certain other devices.) : ☐Yes   ☑No

Networking Options:
☐ Router, Clause 6 - List all routing configurations, e.g., ARCNET-Ethernet, Ethernet-MS/TP, etc.
☐ Annex H, BACnet Tunneling Router over IP
☐ BACnet/IP Broadcast Management Device (BBMD)
        Does the BBMD support registrations by Foreign Devices?   ☐ Yes ☐ No
        Does the BBMD support network address translation?   ☐ Yes ☐ No

Network Security Options:
☐ Non-secure Device - is capable of operating without BACnet Network Security
☐ Secure Device - is capable of using BACnet Network Security (NS-SD BVBB)
☐ Multiple Application-Specific Keys:
☐ Supports encryption (NS-ED BVBB)
☐ Key Server (NS-KS BVBB)

Character Sets Supported:
Indicating support for multiple character sets does not imply that they can all be supported simultaneously.

☑ ANSI X3.4   ☐IBM™/Microsoft™DBCS   ☐ISO 8859-1
            ☐ISO 10646 (UCS-2)
☐ISO 10646 (UCS-4)   ☐JIS C 6226

If this product is a communication gateway, describe the types of non-BACnet

equipment/networks(s) that the gateway supports: N/A

6.3.6   Acronyms and Definitions

Item	Description
APDU	Application Protocol Data Unit
BACnet	Building Automation and Control Network- Data communication protocol
MS/TP	Master-Slave Token passing(a twisted pair RS485 network created by BACnet)
BIBB	BACnet Interoperability Building Block (Specific individual function blocks for data exchange between interoperable devices).
BV	Binary Value
BI	Binary Input
AI	Analog Input
RP	Read Property
WP	Write Property
RPM	Read Property Multiple
WPM	Write Property Multiple.
DDB	Dynamic Device Binding
DOB	Dynamic Object Binding
DCC	Device communication Control

Table 29   BACnet Acronyms and Definitions

7. Troubleshooting and Repair

7.1   Hidden Diagnostics Menus

Warning!

Before attempting any flow meter repair, verify that the line is not pressurized. Always remove main power before disassembling any part of the mass flow meter

The menus shown on the following page can be accessed using the password 16363, then moving to the display that reads "Diagnostics Menu" and pressing ENTER (rather than one of the arrow keys).

Use the right arrow key to move to the second column. Press EXIT to move from the second column back to the first, press EXIT while in the first column to return to the setup menus.

Caution: password 16363 will allow full access to the configuration and should be used carefully to avoid changes that can adversely alter the function of the meter.

Each of the menus on the following page will first be defined followed by specific troubleshooting steps.

{-----------Level One Values-----------}   {----------------------------------Level Two Values-----------------------------}

Level One Column 1	Level One Column 2	Level Two Column 1	Level Two Column 2	Level Two Column 3
f fi G A	Ck Lvi	4.20(1), Zero XXX	Alarm(1) Test Low	Output Type None
A1 A2 A3 A4	Adj. Filter XX dB	4.20(1), Fscale XXX	Alarm(2) Test Low	Calibration Mode
Kc lt Kb	Iso. Power Volts X.X vdc	4.20(2), Zero XXX	Alarm(3) Test Low	A2D Ref. Resistor 2700
V Re	0 I	4.20(2), Fscale XXX	Reynolds Corr.	Press Cal Current 0.0003
Profile Factor +Inf	Pulse Out Queue XXXXXXXXXX	4.20(3), Zero XXX	Gain Control	Press 9 C`s More >
Obscuration X.XXXXXX	TOF G f	4.20(3), Fscale XXX	Filter Control	RTD 1 More >
Rtd1 = X.X Rtd2 = X.X	Sig. Rev. Micro. Rv	Ext.4mA Cal. X	High Pass Filt. 0.33	RTD 2 More >
Pe(v) = 0.0 Pv(v) = 0.0	AD R T F PT V	Ext.20mA Cal. X	Factory Defaults	Correction Pairs
Std = 1.000 Nml = 1.000	Spi Err Rcv Sent	External Input Inactive Temp 1 Temp 2 Press	Meter Type	Roughness xe-xx
Visc = XXX Cp	Version Retries X		Config Code 1BFE	Force Recal ?
Enthalpy1 BTU/ hr X.XX	Internal Temp XX.XX Deg F	Ext. Full Scale X	Test Pulse Out	Min Delta H 1
Enthalpy2 BTU/ hr X.XX	Dens. Calc Time X.XXX Sec	Ext. Zero Scale X	Test Scaled Freq X	Init Displ. (sec) XXX
X Cnts Ext X.XXXmA	Rel. Roughness X.XXXXXX			

* Not Present on M22 Models
** Energy EMS Meters Only

Screen/Menu 21   Hidden Diagnostics Menu

Level One Hidden Diagnostics Values

- **f** = Vortex shedding frequency (Hz).

- **fi** = Adaptive filter – should be approximately 25% higher than the vortex shedding frequency, this is a low-pass filter. If the meter is using the Filter Control (see below) in the manual mode, **fi** will be displayed as **fm**.

- **G** = Gain (applied to vortex signal amplitude). Gain defaults to 1.0 and can be changed using the Gain Control (see below).

- **A** = Amplitude of vortex signal in Volts rms.

- **A1, A2, A3, A4** = A/D counts representing the vortex signal amplitude. Each stage (A1-A4) cannot exceed 512. Beginning with stage A1, the A/D counts increase as the flow increases. When stage A1 reaches 512, it will shift to stage A2. This will continue as the flow rate increases until all 4 stages read 512 at high flow rates. Higher flow rates (stronger signal strength) will result in more stages reading 512.

- **Kc, It, Kb** = Profile equation (factory use only). Model DVE only

- **V** = Calculated average pipe velocity (ft/sec).

- **Re** = Calculated Reynolds number.

- **Profile Factor** = Factory use only

- **Obscuration** = Factory use only

- **RTD1** = Resistance value of integral RTD in ohms.

- **RTD2** = Optional RTD resistance value in ohms.

- **Pe(v)** = Pressure transducer excitation voltage

- **Pv(v) =** Pressure transducer sense voltage.

- **Stnd** = Density of fluid at standard conditions.

- **Nrml =** Density of fluid at normal conditions.

- **Viscosity** = Calculated viscosity of flowing fluid.

- **Enthalpy1 BTU/hr** = Factory use only

- **Enthalpy2 BTU/hr** = Factory use only

- **x Cnts** = A/D counts from the external 4-20 mA input.

- **Ext x.xxx mA** = Calculated external 4-20 mA input from the digital counts.

- **Ck** = Calculated Ck at current operating conditions. Ck is a variable in the equation that relates signal strength, density, and velocity for a given application. It is used for noise rejection purposes. Ck directly controls the fi value (see above). If the Ck is set too low (in the calibration menu), then the fi value will be too low and the vortex signal will be rejected resulting in zero flow rate being displayed. The calculated Ck value in this menu can be compared to the actual Ck setting in the calibration menu to help determine if the Ck setting is correct.

- **Lvl** = Threshold level. If the Low Flow Cutoff in the calibration menu is set above this value, the meter will read zero flow. The Lvl level can be checked at no flow. At no flow, the Lvl must be below the Low Flow Cutoff setting or the meter will have an output at no flow.

- **Adj. Flilter** = Adjustable filter. Displays the filtering in decibels. Normally reads zero. If this value is consistently -5 or -10, for example, the Ck or density setting may be wrong.

- **Iso. Power Volts** = Nominally 2.7 VDC, if less than this check the flow meter input power.

- **O,I** = Factory use only.

- **Pulse Out Queue** = Pulse output queue. This value will accumulate if the totalizer is accumulating faster than the pulse output hardware can function. The queue will allow the pulses to "catch up" later if the flow rate decreases. A better practice is to slow down the totalizer pulse by increasing the value in the (unit)/pulse setting in the totalizer menu.

- **TOF, G, f** = Factory use only.

- **Sig. Rev** = Signal board hardware and firmware revision.

- **Miro Rev** = Microprocessor board hardware and firmware revision.

- **AD, R, T, F, PT, V** = Factory use only.

- **SPI Err, Rcv, Sent** = Factory use only.

- **Version Retries** = Factory use only.

- **Internal Temperature** = Electronics temperature.

- **Dens. Calc Time** = Factory use only.

- **Rel. Roughness** = Factory use only.

-

Level Two Hidden Diagnostics Values

- **4-20(1) Zero** = Analog counts to calibrate zero on analog output 1.

- **4-20(1) FScale** = Analog counts to cal. full scale on analog output 1.

- **4-20(2) Zero** = Analog counts to calibrate zero on analog output 2.

- **4-20(2) FScale** = Analog counts to cal. full scale on analog output 2.

- **4-20(3) Zero** = Analog counts to calibrate zero on analog output 3.

- **4-20(3) FScale** = Analog counts to cal. full scale on analog output 3.

- **Ext. 4 mA Cal.** = Enter 0 for auto calibration or enter factory supplied A/D counts. Note: You must connect a known 4.00 mA input if you are going to calibrate the unit.

- **Ext. 20 mA Cal.** = Enter 0 for auto calibration or enter factory supplied A/D counts. Note: You must connect a known 20.00 mA input if you are going to calibrate the unit.

- **External Input** = Enter what the external 4-20 mA input represents, i.e. Temperature 1, Temperature 2, or Pressure. The meter will use this for its internal calculations.

- **Ext. Full Scale** = Enter the full scale units that correlate to the 20 mA point. Note: It must be in the units for the selected input type such as Deg F, Deg C, PSIA, Bar A, etc.

- **Ext. Zero Scale** = Same as above but for the 4 mA point.

- **Alarm (1) Test** = Used as a test to verify that the alarm circuit is functioning. When low is selected the alarm will initiate a low alarm on the output. When High is selected it will give a high alarm on the output.

- **Alarm (2) Test** = Used as a test to verify that the alarm circuit is functioning. When low is selected the alarm will initiate a low alarm on the output. When High is selected it will give a high alarm on the output.

- **Alarm (3) Test** = Used as a test to verify that the alarm circuit is functioning. When low is selected the alarm will initiate a low alarm on the output. When High is selected it will give a high alarm on the output.

- **Reynolds Corr.** = Reynolds number correction for the flow profile. Set to Enable for DVE insertion and set to Disable for DVH inline.

- **Gain Control** = Manual gain control (factory use only). Leave set at 1.

- **Filter control** = Manual filter control. This value can be changed to any number to force the fi value to a constant. A value of zero activates the automatic filter control which sets fi at a level that floats above the f value.

- **High Pass Filter =** Filter setting – Factory use only

- **Factory Defaults** = Reset factory defaults. If you change this to Yes and press Enter, all the factory configuration is lost and you must reconfigure the entire program. Consult the factory before performing this process, it is required only in very rare cases.

- **Meter Type** = Insertion (DVE) or Inline (DVH) meter.

- **Config Code =** Factory use only.

- **Test Pulse Out** = Force totalizer pulse. Set to Yes and press enter to send one pulse. Very useful to test totalizer counting equipment.

- **Test Scaled Freq** = Enter a frequency value in order to test the scaled frequency output. Return to 0 to stop the test.

- **Output Type** = Factory use only

- **Calibration Mode** = Factory use only.

- **A2D Ref. Resistor =** Factory use only.

- **Pressure Cal Current** = Calibration value for the electronics and pressure transducer combination. Consult Factory for value.
- **Pressure 9Cs** = Nine pressure coefficients unique to the pressure transducer. Use the RIGHT ARROW to access all nine coefficients.
    - o **Press. Max psi** = Based on installed sensor.
    - o **Press. Min psi** = 0 psia
- **RTD1.**   Press the RIGHT ARROW to access:
    - o **Ro** = RTD resistance at 0°C (1000 ohms).
    - o **A** = RTD coefficient A (.0039083).
    - o **B** = RTD coefficient B (-5.775e-07).
    - o **RTD1 Max Deg. F =** 500
    - o **RTD1 Min Deg. F =** -330
- **RTD2** = Second RTD configuration, for special applications only.
- **Correction Pairs**
    - o **ft3/sec** (1 through 10)
    - o **%Dev.** (1 through 10)
- **Roughness** = Factory use only.
- **Force Recal?** = Factory use only.
- **Min. Delta H –** Energy EMS meters only. Sets the deadband for totalization to begin. Must be greater than this number (1 default) to initiate the totalizer.
- **Init Displ. (sec)** = Enter a value in seconds to initialize the display every xxx seconds. Enter a value of 0 to disable initializing the display.

7.2   Analog Output Calibration

To check the 4–20 mA circuit, connect a DVM in series with the output loop. Select zero or full scale (from the second column of the hidden diagnostics) and then actuate the enter key twice. This action will cause the meter to output its 4 mA or 20 mA condition. If the DVM indicates a current greater than ± 0.006 mA from 4 or 20, adjust the setting up or down until the output is calibrated.

Note: these settings are not for adjusting the output zero and span to match a flow range, that function is located in the Output Menu.

7.3   Troubleshooting the Flow Meter

Warning!
Before attempting any flow meter repair, verify that the line is not pressurized. Always remove main power before disassembling any part of the mass flow meter. Use hazardous area precautions if applicable. Static sensitive electronics - use electro-static discharge precautions.

7.3.1   First Check Items
☐   Installation Direction Correct
☐   Installation Depth Correct (Insertion style meter)
☐   Power and Wiring Correct
☐   Application Fluid Correct
         Please record what is the fluid_____
☐   Meter Range Correct for the Application
☐   Meter Configuration Correct
☐   Describe Installation Geometry i.e. upstream diameters, valve position, downstream diameters, etc.
☐

7.3.2   Record Values

Record the following values from the Run Menu with the meter installed in order to determine the operating state of the flow meter.

	With Flow	**With No Flow (if possible)**
Flow =		
Temperature=		
Pressure =		
Density =		
Error Messages? =		

Table 30   Records from the Run Menu (Page 45)

Record the following values from the Hidden Diagnostics Menu with the meter installed:
(Use password 16363 to access.)

	With Flow	**With No Flow (if possible)**
f =		
fi =		
A =		
A1 =		
A2 =		
A3 =		
A4 =		
V =		
Ck =		
Lvl =		
Adj. Filter =		
Iso. Power Volts =		

Table 31   Record from The Hidden Diagnostics Menu (Page 86)

Record the following values from the Calibration Menu.

Meter Size / Pipe ID =	
Meter Factor =	
Vortex Coef Ck =	
Low Flow Cutoff =	
Serial Number =	

Table 32   Records from the Calibration Menu (Page 59)

7.3.3   Determine Fault

7.3.3.1   Symptom Output at no Flow

1. The low flow cutoff is set too low. At no flow, go to the first column of the hidden diagnostics menu and record the Lvl value. The low flow cutoff must be set above this value.
2. Example: at no flow, Lvl = 25. Set the low flow cutoff in the Calibration Menu to approximately 28 and the meter will no longer read a flow rate at no flow.

7.3.3.2   Symptom Erratic Output

1. The flow rate may be too low, just at the cutoff of the meter range, and the flow cycles above and below the cutoff making an erratic output. Consult the factory if necessary to confirm the meter range based on current operating conditions. It may be possible to lower the low flow cutoff to increase the meter range. See the example above for output at no flow, only this time the low flow cutoff is set too high. You can lower this value to increase the meter range as long as you do not create the output at no flow condition previously described.

2. Mechanical installation may be incorrect. Verify the straight run is adequate as described in Chapter 2. For in-line meters, make sure the meter is not installed backwards and there are no gaskets protruding into the flow stream. For insertion meters, verify the insertion depth and flow direction.

3. The meter may be reacting to actual changes in the flow stream. The output can be smoothed using a time constant. The displayed values can be smoothed using the time constant in the Display Menu. The analog outputs can be smoothed using the time constant in the Output Menu. A time constant of 1 will result in the change in value reaching 63% of its final value in one second. A time constant of 4 is 22%, 10 is 9.5% and 50 is 1.9% of the final value in one second. The time constant equation is shown below (TC = Time Constant)

$$\text{\% change to final value in one second} = 100\left(1 - e^{(-1/TC)}\right)$$

4. The vortex coefficient Ck may be incorrectly set. The Ck is a value in the equation used to determine if a frequency represents a valid vortex signal given the fluid density and signal amplitude. In practice, the Ck value controls the adaptive filter, fi, setting. During flow, view the f and fi values in the first column of the hidden diagnostics. The fi value should be approximately 10-20 % higher than the f value. If you raise the Ck setting in the Calibration Menu, then the fi value will increase. The fi is a low pass filter, so by increasing it or lowering it, you can alter the range of frequencies that the meter will accept. If the vortex signal is strong, the fi value will increase to a large number – this is correct.
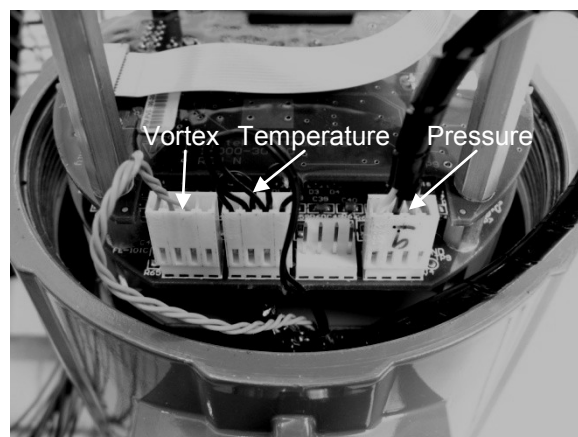
Figure 62   Electronics Stack Sensor Connections
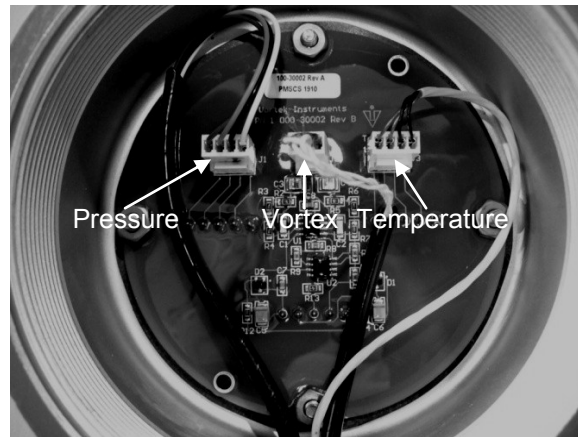
Figure 63   Remote Feed through Board Sensor Connections

7.3.3.3   Symptom: No Output

1. For remote mounted electronics, carefully check all the wiring connections in the remote mount junction box. There are 18 connections that must be correct, verify each color (black and red), shield, and wire number.

2. Turn on the pressure and temperature display in the Display Menu and verify that the pressure and temperature are correct.

3. Using ESD precautions and hazardous area precautions, remove the electronics enclosure window cover. Disconnect the vortex sensor from the electronics stack or remote feed through board. Refer to Figure 62 or Figure 63. Measure the resistance from each outside pin to the meter ground - each should be open. Measure the resistance from the center pin to the meter ground – this should be grounded to the meter.
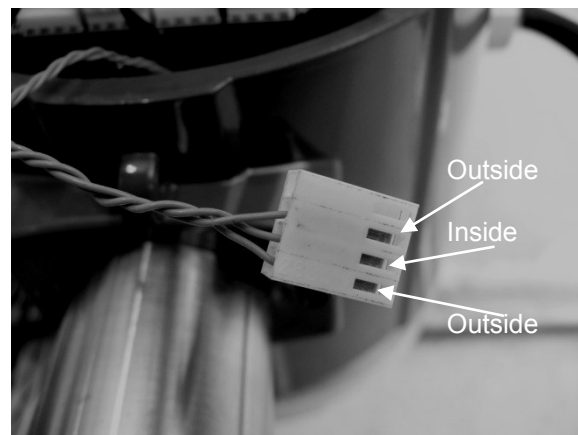
Figure 64   Vortex Sensor Connector

With the sensor still disconnected, go to the first column of the hidden diagnostics and display the vortex shedding frequency, f. Hold a finger on the three exposed pins on the analog board. The meter should read electrical noise, 60 Hz for example. If all readings are correct, re-install vortex sensor wires.

Verify all meter configuration and troubleshooting steps previously described.   There are many possible causes of this problem, consult factory if necessary.

7.3.3.4   Symptom Meter Displays Temperature Fault

1. For remote mounted electronics, carefully check all the wiring connections in the remote mount junction box. There are 18 connections that must be correct, verify each color (black and red), shield, and wire number.

2. Go to the first column of the hidden diagnostics and check the resistance of the rtd1. It should be about 1080 ohms at room temperature.

3. Using ESD precautions and hazardous area precautions, remove the electronics enclosure window cover. Disconnect the temperature sensor from the electronics stack or the remote feed through board. Refer to Figure 62 or Figure 63. Measure the resistance across the outside pins of the temperature sensor connector. It should read approximately 1080 ohms at room temperature (higher resistance at higher temperatures).
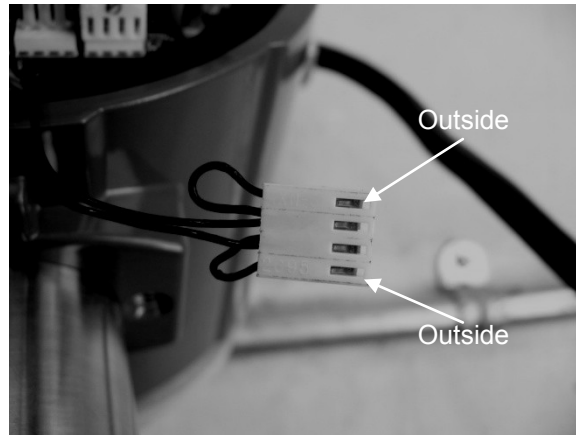
Figure 65   Temperature Sensor Connector

4. Consult factory with findings

7.3.3.5   Symptom Meter Displays Pressure Fault

1. For remote mounted electronics, carefully check all the wiring connections in the remote mount junction box. There are 15 connections that must be correct, verify each color (black and red), shield, and wire number.

2. Using ESD precautions and hazardous area precautions, remove the electronics enclosure window cover. Disconnect the pressure sensor from the electronics stack or the remote feed through board. Measure the resistance across the outside pins of the pressure sensor connector, then across the inside pins. Both readings should be approximately 4000 ohms.
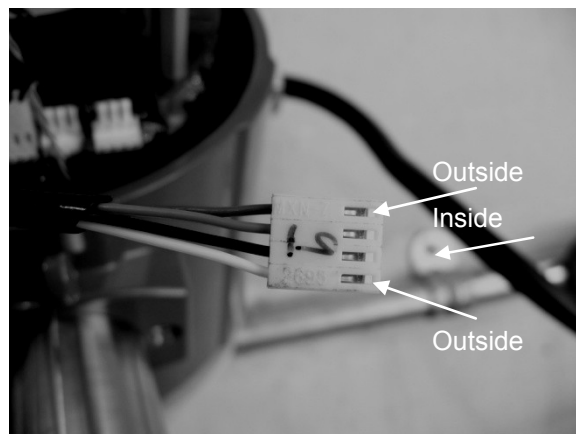
Figure 66   Pressure Sensor Connector

3. Go to the first column of the hidden diagnostics and record the Pe(V) and Pv(V) values and consult the factory with findings.

7.3.4   Electronics Assembly Replacement (All Meters)

The electronics boards are electrostatically sensitive. Wear a grounding wrist strap and make sure to observe proper handling precautions required for static-sensitive components.

Warning!
Before attempting any flow meter repair, verify that the line is not pressurized. Always remove main power before disassembling any part of the mass flow meter.

1. Turn off power to the unit.

2. Locate and loosen the small set screw which locks the larger enclosure cover in place. Unscrew the cover to expose the electronics stack.

3. Locate the sensor harnesses which come up from the neck of the flow meter and attaches to the circuit boards. Make note of the location of each sensor connection. Refer to Figure 62 or Figure 63. The vortex sensor connection is on the left, the temperature sensor connection (if present) is second form the left, and the pressure sensor connection (if present) is the right most connector. Use small pliers to pull the sensor wiring connectors off of the circuit boards.

4. Locate and loosen the small set screw which locks the smaller enclosure cover in place. Unscrew the cover to expose the field wiring strip. Tag and remove the field wires.

5. Remove the screws that hold the black wiring label in place, remove the label.

6. Locate the 4 Phillips head screws which are spaced at 90-degrees around the terminal board. These screws hold the electronics stack in the enclosure. Loosen these screws (Note: that these are captive screws, they will stay inside the enclosure).

7. Carefully remove the electronics stack from the opposite side of the enclosure. If the electronics stack will not come out, gently tap the terminal strip with the screw driver handle. This will loosen the rubber sealing gasket on the other side of the enclosure wall. Be careful that the stack does not hang up on the loose sensor harnesses.

8. Repeat steps 1 through 6 in reverse order to install the new electronics stack.

7.3.5   Pressure Sensor Replacement (Series DVH Only)

1. For local mounted electronics, remove the electronics stack as previously described. For remote mount electronics, remove all wires and sensor connectors from the remote feed through board in the junction box at the meter.

2. Loosen the three set screws at the center of the adapter between the meter and the enclosure.

3. Remove the top half of the adapter to expose the pressure transducer.

4. Remove the transducer and replace it with the new one using appropriate thread sealant.

5. Reassemble in reverse order.

7.4   Returning Equipment to the Factory

Before returning any DVH /DVE flow meter to the factory, you must obtain the correct shipping address, contact Customer Service at:

<div align="center">+49 (221) 49708-0 in Germany</div>

When contacting Customer Service, be sure to have the meter serial number and model code.

Please see the Meter Troubleshooting Checklist for additional items which may help with problem isolation. When requesting further troubleshooting guidance, please record the values on the checklist at no flow and during flow if possible.

7.4.1   Decontamination certificate for device cleaning

Company: ....   City: ....

Department: ....   Name: ....

Tel: ....

This Vortex Flow Meter

type DVH / DVE

was operated using the measured medium...

Since this measured medium is dangerous in water/poisonous/corrosive/flammable,

we have

-    checked that all hollow spaces of the device are free of these materials*

-    neutralized and flushed all hollow spaces of the device*

 *cross out what is not applicable.

We hereby confirm that in resending the device no danger to persons or the environment is posed by the residual measured substance.

Date: ....   Name: ……………   Signature: ....

Stamp

8. Product Specifications

Accuracy

Process Variables	DVH Series In-Line Meters		DVE Series Insertion Meters[1]	
	Liquids	Gas & Steam	Liquids	Gas & Steam
Mass Flow Rate	±1% of rate over a 30:1 range[3]	±1.5% of rate[2] over a 30:1 range[3]	±1.5% of rate over a 30:1 range[3]	±2% of rate[2] over a 30:1 range[3]
Volumetric Flow Rate	±0.7% of rate over a 30:1 range[3]	±1% of rate over a 30:1 range[3]	±1.2% of rate over a 30:1 range[3]	±1.5% of rate over a 30:1 range[3]
Temperature	± 2° F (± 1° C)	± 2° F (± 1° C)	± 2° F (± 1° C)	± 2° F (± 1° C)
Pressure	0.3% of transducer full scale	0.3% of transducer full scale	0.3% of transducer full scale	0.3% of transducer full scale
Density	0.3% of reading	0.5% of reading[2]	0.3% of reading	0.5% of reading[2]

Table 33   Product Accuracy

Notes: (1) Accuracies stated are for the total mass flow through the pipe.
(2) Over 50 to 100% of the pressure transducer's full scale.
(3) Nominal rangeability is stated. Precise rangeability depends on fluid and pipe size.

Repeatability   Mass Flow Rate: 0.2% of rate.
Volumetric Flow Rate: 0.1% of rate.
Temperature: ± 0.2° F (± 0.1° C).
Pressure: 0.05% of full scale.
Density: 0.1% of reading.

Stability Over 12 Months   Mass Flow Rate: 0.2% of rate maximum.
Volumetric Flow Rate: Negligible error.
Temperature: ± 0.1° F (± 0.5° C) maximum.
Pressure: 0.1% of full scale maximum.
Density: 0.1% of reading maximum.

Response Time   Adjustable from 1 to 100 seconds.

Material Capability   Series DVH In-Line Flow Meter:
Any gas, liquid or steam compatible with 316L stainless steel, (C276
Hastelloy or   A105 carbon steel). Not recommended for multi-phase fluids.

Series DVE Insertion Flow Meter:
Any gas, liquid or steam compatible with 316L stainless steel. Not
recommended   for multi-phase fluids.

Flow Rates   Typical mass flow ranges are given in the following table. Precise flow
depends on the fluid and pipe size. DVE insertion meters are
applicable to pipe sizes from 2 inch and above. Consult factory for
sizing program.

Water Minimum and Maximum Flow Rates								
½-inch	¾-inch	1-inch	1.5-inch	2-inch	3-inch	4-inch	6-inch	8-inch
15 mm	20 mm	25 mm	40 mm	50 mm	80 mm	100 mm	150 mm	200 mm
gpm	1 22	1.3 40	2.2 67	5.5 166	9.2 276	21 618	36 1076	81 2437	142 4270
m³/hr	.23 5	.3 9.1	0.5 15	1.3 38	2.1 63	4.7 140	8.1 244	18 554	32 970

Table 34   Water Flow Rates

Typical Air Minimum and Maximum Flow Rates (nm³/hr)									
Air at 20°C									
Nominal Pipe Size (mm)									
Pressure	15	20	25	40	50	80	100	150	200
0 barg	3	5	9	21	36	79	138	313	549
	28	66	142	350	584	1307	2275	5157	9034
5 barg	7	13	21	52	87	194	337	764	1339
	165	390	847	2080	3476	7775	13533	30682	53749
10 barg	9	17	29	70	117	262	457	1035	1814
	304	716	1554	3819	6381	14273	24844	56329	98676
15 barg	11	21	34	85	142	317	551	1250	2190
	442	1044	2265	5565	9299	20801	36205	82087	143801
20 barg	13	24	40	97	162	363	632	1434	2511
	582	1373	2979	7318	12229	27354	47612	107949	189105
30 barg	16	29	48	118	198	442	770	1745	3057
	862	2034	4414	10843	18119	40529	70544	159942	280187

Table 35   Metric Air Flow Rates

Typical Air Minimum and Maximum Flow Rates (SCFM)									
Air at 70°F									
Nominal Pipe Size (in)									
Pressure	0.5	0.75	1	1.5	2	3	4	6	8
0 psig	1.8	3	5	13	22	50	87	198	347
	18	41	90	221	369	826	1437	3258	5708
100 psig	5	9	15	38	63	141	245	555	972
	138	325	704	1730	2890	6466	11254	25515	44698
200 psig	7	13	21	52	86	193	335	761	1332
	258	609	1322	3248	5427	12140	21131	47911	83931
300 psig	8	15	25	63	104	234	407	922	1615
	380	896	1944	4775	7978	17847	31064	70431	123375
400 psig	10	18	29	72	120	269	467	1060	1857
	502	1183	2568	6309	10542	23580	41043	93057	163000
500 psig	11	20	33	80	134	300	521	1182	2071
	624	1472	3195	7849	13115	28034	51063	115775	203000

Table 36   Imperial Air Flow Rates

Linear Range
Smart electronics corrects for lower flow down to a Reynolds number of 5,000.
The Reynolds number is calculated using the fluid's actual temperature and pressure monitored by the meter.
Rangeability depends on the fluid, process connections and pipe size. Consult factory for your application.
Velocity rangeability under ideal conditions is as follows:

    Liquids 30:1 0,3m per second velocity minimum
                  9,2m per second velocity maximum
    Gases 30:1 30m per second velocity minimum
                92 m per second velocity maximum

Typical Saturated Steam Minimum and Maximum Flow Rates (kg/hr)									
	Nominal Pipe Size (mm)								
Pressure	15	20	25	40	50	80	100	150	200
0 barg	3	5	8	19	32	72	126	286	500
	18	42	91	224	375	838	1459	3309	5797
5 barg	6	11	18	45	75	167	290	658	1153
	95	224	485	1192	1992	4455	7754	17581	30799
10 barg	8	15	24	59	99	222	387	877	1537
	168	397	862	2118	3539	7915	13777	31237	54720
15 barg	9	17	29	71	119	266	463	1050	1840
	241	569	1236	3036	5073	11347	19750	44779	78444
20 barg	11	20	33	81	136	304	529	1199	2100
	314	742	1610	3956	6611	14787	25738	58355	102226
30 barg	13	24	40	99	165	369	642	1455	2548
	463	1092	2370	5822	9729	21763	37880	85884	150451

Table 37   Metric Saturated Steam Flow Rates

Typical Saturated Steam Minimum and Maximum Flow Rates (lb/hr)									
	Nominal Pipe Size (in)								
Pressure	0.5	0.75	1	1.5	2	3	4	6	8
5 psig	6.5	12	20	49	82	183	318	722	1264
	52	122	265	650	1087	2431	4231	9594	16806
100 psig	15	27	46	112	187	419	728	1652	2893
	271	639	1386	3405	5690	12729	22156	50233	87998
200 psig	20	37	62	151	253	565	983	2229	3905
	493	1163	2525	6203	10365	23184	40354	91494	160279
300 psig	24	45	74	182	304	680	1184	2685	4704
	716	1688	3664	9000	15040	33642	58556	132763	232575
400 psig	28	51	85	209	349	780	1358	3079	5393
	941	2220	4816	11831	19770	44222	76971	174516	305717
500 psig	31	57	95	233	389	870	1514	3433	6014
	1170	2760	5988	14711	24582	54987	95710	217001	380148

Table 38   Imperial Saturated Steam Flow Rates

Linear Range   Smart electronics corrects for lower flow down to a Reynolds number of 5,000.
The Reynolds number is calculated using the fluid's actual temperature and pressure monitored by the meter. Rangeability depends on the fluid, process connections and pipe size. Consult factory for your application. Velocity rangeability under ideal conditions is as follows:

Liquids 30:1   0,3m per second velocity minimum
9,2m per second velocity maximum
Gases 30:1   30m per second velocity minimum
92 m per second velocity maximum

Process Fluid Pressure

DVH Pressure Ratings		
Process Connection	Material	Rating
Flanged	316L SS, (A105 Carbon Steel, C276 Hastelloy)	150, 300, 600 lb, PN16, PN40, PN64
Wafer	316L SS, (A105 Carbon Steel, C276 Hastelloy)	600 lb, PN64

Table 39   DVH Pressure Ratings

DVE Pressure Ratings			
Probe Seal	Process Connection	Material	Rating
Compression Fitting	2-inch MNPT	316L SS	ANSI 600 lb, PN64
	2-inch 150 lb flange, DN50 PN16	316L SS	ANSI 150 lb, PN16
	2-inch 300 lb flange, DN50 PN40	316L SS	ANSI 300 lb, PN40
	2-inch 600 lb flange, DN50 PN64	316L SS	ANSI 600 lb, PN64
Packing Gland	2-inch MNPT	316L SS	50 psig, 3.5bar
	2-inch 150 lb flange, DN50 PN16	316L SS	50 psig, 3.5bar
	2-inch 300 lb flange, DN50 PN40	316L SS	50 psig, 3.5bar
Packing Gland with Removable Retractor	2-inch MNPT	316L SS	ANSI 300 lb, PN40
	2-inch 150 lb flange, DN50, PN16	316L SS	ANSI 150 lb, PN16
	2-inch 300 lb flange	316L SS	ANSI 300 lb, PN40
Packing Gland with Permanent Retractor	2-inch MNPT	316L SS	ANSI 600 lb, PN64
	2-inch 150 lb flange, DN50 PN16	316L SS	ANSI 150 lb, PN16
	2-inch 300 lb flange, DN50, PN40	316L SS	ANSI 300 lb, PN40
	2-inch 600 lb flange, DN50 PN64	316L SS	ANSI 600 lb, PN64

Table 40   DVE Pressure Ratings

Pressure Sensor Ranges[1], psia , bara			
Full Scale Operating Pressure		Maximum Over-Range Pressure	
psia	bara	psia	bara
30	2	60	4
100	7	200	14
300	20	600	40
500	35	1000	70
1500	100	2500	175

Table 41   Pressure Transducer Ranges

Note: (1) To maximize accuracy, specify the lowest full scale operating pressure range for the application. To avoid damage, the flow meter must never be subjected to pressure above the over-range pressure shown above.

Power Requirements   12 to 36 VDC, 25 mA, 1 W max., Loop Powered Volumetric or Mass
                              12 to 36 VDC, 300 mA, 9 W max. Multiparameter Mass options
                              100 to 240 VAC, 50/60 Hz, 5 W max. Multiparameter Mass options

                              Class I Equipment (Grounded Type)

Installation (Over-voltage) Category II for transient over-voltages

AC & DC Mains supply voltage fluctuations are not to exceed
+/-10% of the rated supply voltage range.
User is responsible for the provision of an external Disconnect Means (and Over-Current
Protection) for the equipment (both AC and DC models).

Display	Alphanumeric 2 x 16 LCD digital display. Six push-button switches (up, down, right, left, enter, exit) operable through explosion-proof window using hand-held magnet. Viewing at 90-degree mounting intervals.

Pocess Fluid and
Ambient Temperature

Process Fluid:
Standard temperature sensor: –330 to 500° F (–200 to 260°C)
High temperature sensor: to 750° F (400° C)

Ambient:
Operating temperature range: –40 to 140° F (–40 to 60° C)
Storage temperature range: –40 to 185° F (–40 to 85° C)
Maximum relative humidity: 0-98%, non-condensing conditions
Maximum altitude: -2000 to 14,000 feet (-610 to 4268 meters)

Pollution Degree 2 for the ambient environment

Output Signals [1]

Analog: Volumetric Meter: field rangeable linear 4-20 mA output signal (1200 Ohms maximum loop resistance) selected by user for mass flow rate or volumetric flow rate.

Communications: HART, MODBUS, RS485

Multiparameter Meter: up to three field rangeable linear 4-20 mA output signals (1200 Ohms maximum loop resistance) selected from the five parameters–mass flow rate, volumetric flow rate, temperature, pressure and density.

Pulse:Pulse output for totalization is a 50-millisecond duration pulse operating a solid-state relay capable of switching 40 VDC, 40 mA maximum.
Note: (1) All outputs are optically isolated and require external power for operation.

Alarms

Up to three programmable solid-state relays for high, low or window alarms capable of switching 40 VDC, 40 mA maximum.

Totalizer

Based on user-determined flow units, six significant figures in scientific notation. Total stored in non-volatile memory.

Wetted Materials

Series DVH In-Line Flow Meter:
316L stainless steel standard.

Series DVE Insertion Flow Meter:
316L stainless steel standard.
Teflon[®] packing gland below 500° F (260° C).
Graphite packing gland above 500° F (260° C).

Enclosure Protection
Classification

NEMA 4X and IP66 cast enclosure.

Electrical Ports

Two 3/4-inch female NPT ports.

Mounting Connections

Series DVH: Wafer, 150, 300, 600 lb ANSI flange, PN16, PN40, PN64 flange.
Series DVE Permanent installation: 2-inch MNPT; 150, 300, 600 lb ANSI flange, PN16, PN40, PN64 flange with compression fitting probe seal.
Series DVE Hot Tap[1] Installation: 2-inch MNPT; 150, 300, 600 lb ANSI flange, PN16, PN40, PN64 flange and optional retractor with packing gland probe seal.
Note: (1) Removable under line pressure.

Mounting Position   Series DVH In-Line Flow Meter: No effect.
Series DVE Insertion Flow Meter: Meter must be perpendicular within ± 5° of the pipe centline.

Certifications

Material Certificate on all wetted parts
Pressure Test Certificate
Certificate of Conformance
NACE Certification (MR0175)
Oxygen Cleaning.

9. Product Dimensions

9.1   Dimensions and weight, for wafer style with integral mount transmitter
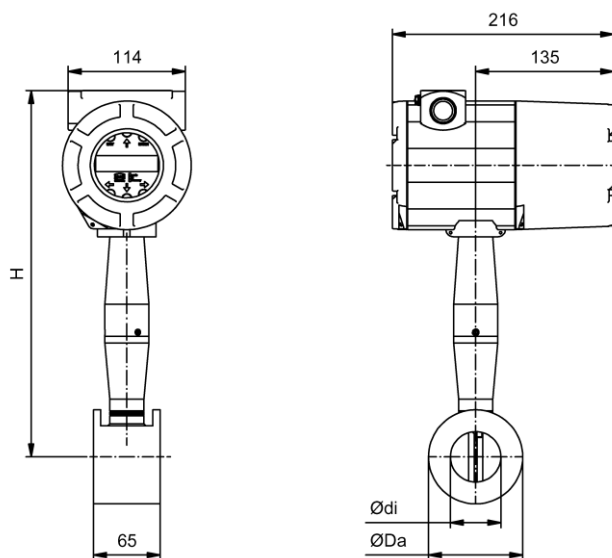
Figure 67   Wafer Dimensions

Size	Ødi	Øda	H	Weight	Nominal Size (Pressure Range see Modelcode)		
					DIN EN 1092-1	ASME B16.5	JIS B2220
W1	13,8 mm	35 mm	341 mm	4,8 kg	DN15	1/2"	DN15
W2	18,8 mm	43 mm	343 mm	5,0 kg	DN20	3/4"	DN20
W3	24,3 mm	50,8 mm	346 mm	5,2 kg	DN25	1"	DN25
W4	38,1 mm	73,1 mm	353 mm	5,9 kg	DN40	1 1/2"	DN40
W5	49,3 mm	92 mm	358 mm	6,7 kg	DN50	2"	DN50
W6	73,7 mm	127 mm	375 mm	9,0 kg	DN80	3"	DN80
W7	97,2 mm	157,3 mm	387 mm	11,0 kg	DN100	4"	DN100

Table 42   Wafer Dimensions

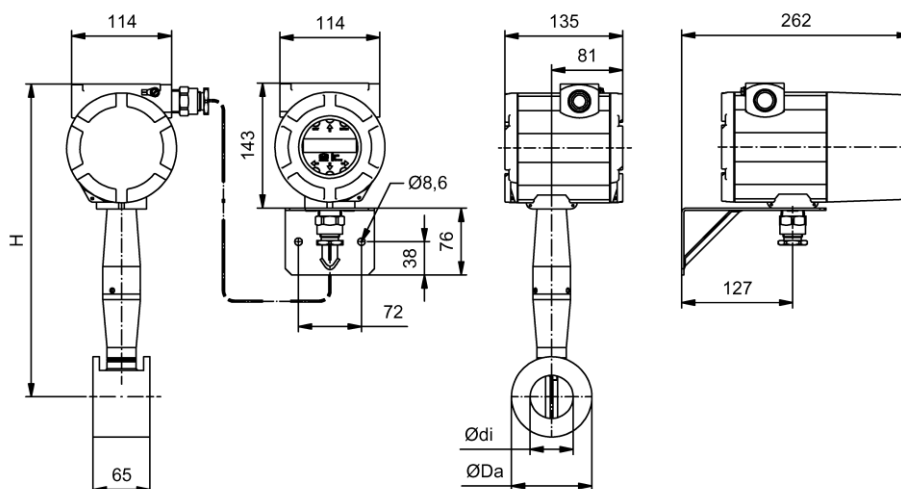## 9.2   Dimensions and weight for wafer style with remote mount transmitter

Figure 68   Wafer Remote Dimensions

Size	Ødi	Øda	H	Weight	Nominal Size (Pressure Range see Modelcode)		
					DIN EN 1092-1	ASME B16.5	JIS B2220
W1	13,8 mm	35 mm	341 mm	3,9 kg	DN15	1/2"	DN15
W2	18,8 mm	43 mm	343 mm	4,1 kg	DN20	3/4"	DN20
W3	24,3 mm	50,8 mm	346 mm	4,2 kg	DN25	1"	DN25
W4	38,1 mm	73,1 mm	353 mm	4,9 kg	DN40	1 1/2"	DN40
W5	49,3 mm	92 mm	358 mm	5,7 kg	DN50	2"	DN50
W6	73,7 mm	127 mm	375 mm	7,9 kg	DN80	3"	DN80
W7	97,2 mm	157,3 mm	387 mm	10,0 kg	DN100	4"	DN100

Table 43   Wafer Remote Dimensions

9.3   Dimensions and weight, Inline meter with integral mount transmitter

The numbers of screw holes are just one example and do not always correspond to the embodiment illustrated.
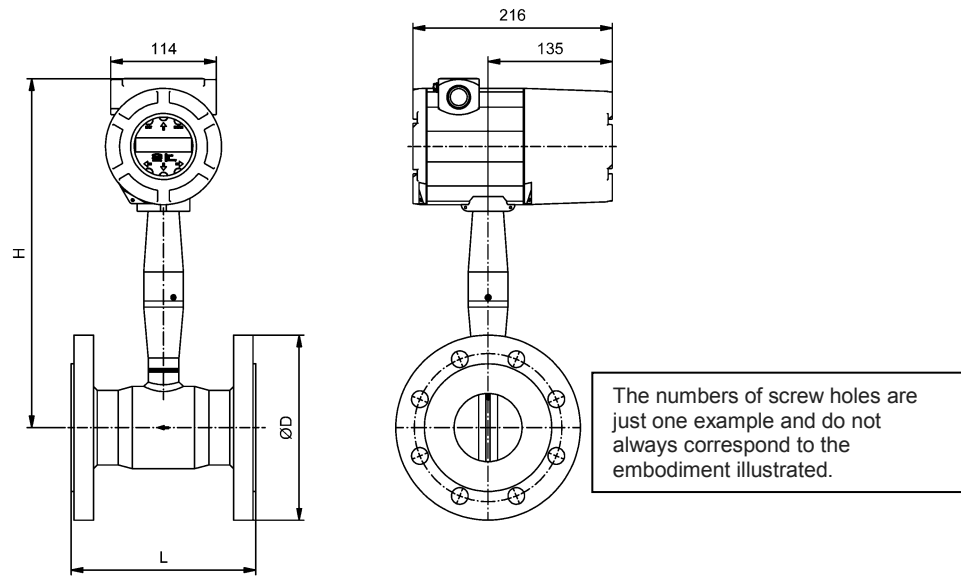
Figure 69   Inline Meter Dimensions

Nominal size	L	H	PN16		PN40		PN64		PN100	
			ØD	Weight	ØD	Weight	ØD	Weight	ØD	Weight
DN15	200 mm	341 mm	see PN40		Ø 95 mm	6,5 kg	see PN100		Ø 105 mm	7,3 kg
DN20	200 mm	343 mm	see PN40		Ø 105 mm	7,1 kg	see PN100		Ø 130 mm	9,0 kg
DN25	200 mm	344 mm	see PN40		Ø 115 mm	7,5 kg	see PN100		Ø 140 mm	10,0 kg
DN40	200 mm	357 mm	see PN40		Ø 150 mm	9,5 kg	see PN100		Ø 170 mm	13,0 kg
DN50	200 mm	363 mm	Ø 165 mm	10,5 kg	Ø 165 mm	11,0 kg	Ø 180 mm	14,0 kg	Ø 195 mm	16,2 kg
DN80	200 mm	377 mm	Ø 200 mm	13,9 kg	Ø 200 mm	15,4 kg	Ø 215 mm	18,6 kg	Ø 230 mm	22,2 kg
DN100	250 mm	390 mm	Ø 220 mm	17,2 kg	Ø 235 mm	20,5 kg	Ø 250 mm	25,5 kg	Ø 265 mm	31,5 kg
DN150	300 mm	417 mm	Ø 285 mm	29,5 kg	Ø 300 mm	35,8 kg	Ø 345 mm	52,6 kg	Ø 355 mm	67,5 kg
DN200	300 mm	442 mm	Ø 340 mm	42,0 kg	Ø 375 mm	61,0 kg	Ø 415 mm	86,0 kg	Ø 430 mm	108,0 kg

Table 44   Inline Meter Dimensions and Weight with Flanges according DIN EN 1092-1

Nominal size	L	H	class 150		class 300		class 600	
			ØD	Weight	ØD	Weight	ØD	Weight
½"	200 mm	341 mm	Ø 90 mm	5,8 kg	Ø 95 mm	6,2 kg	Ø 95 mm	6,4 kg
¾"	200 mm	343 mm	Ø 100 mm	6,3 kg	Ø 115 mm	7,2 kg	Ø 115 mm	7,5 kg
1"	200 mm	344 mm	Ø 110 mm	6,7 kg	Ø 125 mm	7,7 kg	Ø 125 mm	8,1 kg
1½"	200 mm	357 mm	Ø 125 mm	8,1 kg	Ø 155 mm	10,3 kg	Ø 155 mm	11,4 kg
2"	200 mm	363 mm	Ø 150 mm	10,5 kg	Ø 165 mm	11,0 kg	Ø 165 mm	14,0 kg
3"	200 mm	377 mm	Ø 190 mm	14,9 kg	Ø 210 mm	18,5 kg	Ø 210 mm	21,1 kg
4"	250 mm	390 mm	Ø 230 mm	20,6 kg	Ø 255 mm	28,6 kg	Ø 275 mm	39,0 kg
6"	300 mm	417 mm	Ø 280 mm	31,6 kg	Ø 320 mm	48,3 kg	Ø 355 mm	77,2 kg
8"	300 mm	442 mm	Ø 345 mm	48,3 kg	Ø 380 mm	71,0 kg	Ø 420 mm	116,0 kg

Table 45   Inline Meter Dimensions and Weight with Flanges according ASME B16.5

Nominal size	L	H	10k		16k		20k		30k	
			ØD	Weight	ØD	Weight	ØD	Weight	ØD	Weight
DN15	200 mm	341 mm	see 16k		Ø 95 mm	6,1 kg	Ø 95 mm	6,3 kg	Ø 115 mm	7,5 kg
DN20	200 mm	343 mm	see 16k		Ø 100 mm	6,5 kg	Ø 100 mm	6,7 kg	Ø 120 mm	7,8 kg
DN25	200 mm	344 mm	see 16k		Ø 125 mm	7,3 kg	Ø 125 mm	7,6 kg	Ø 130 mm	8,6 kg
DN40	200 mm	357 mm	see 16k		Ø 140 mm	8,4 kg	Ø 140 mm	8,8 kg	Ø 160 mm	11,0 kg
DN50	200 mm	363 mm	Ø 155 mm	8,8 kg	Ø 155 mm	9,1 kg	Ø 155 mm	9,5 kg	Ø 165 mm	11,3 kg
DN80	200 mm	377 mm	Ø 185 mm	12,0 kg	Ø 200 mm	13,7 kg	Ø 200 mm	14,4 kg	Ø 210 mm	18,0 kg
DN100	250 mm	390 mm	Ø 210 mm	15,7 kg	Ø 225 mm	18,5 kg	Ø 225 mm	19,4 kg	Ø 240 mm	25,3 kg
DN150	300 mm	417 mm	Ø 280 mm	29,0 kg	Ø 305 mm	33,6 kg	Ø 305 mm	36,7 kg	Ø 325 mm	49,6 kg
DN200	300 mm	442 mm	Ø 330 mm	38,5 kg	Ø 350 mm	45,6 kg	Ø 350 mm	49,3 kg	Ø 370 mm	67,2 kg

Table 46   Inline Meter Dimensions and Weight with Flanges according JIS B2220

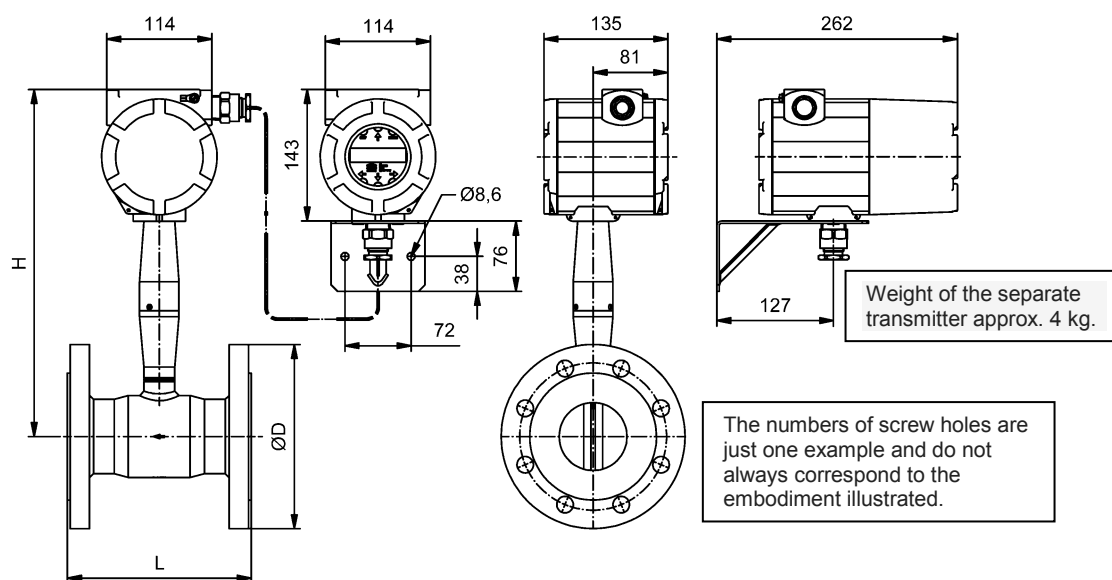## 9.4   Inline meter with remote mount transmitter

Weight of the separate transmitter approx. 4 kg.

The numbers of screw holes are just one example and do not always correspond to the embodiment illustrated.

Figure 70   Inline Meter Remote Dimensions

Nominal size	L	H	PN16		PN40		PN64		PN100	
			ØD	Weight	ØD	Weight	ØD	Weight	ØD	Weight
DN15	200 mm	341 mm	see PN40		Ø 95 mm	5,5 kg	see PN100		Ø 105 mm	6,3 kg
DN20	200 mm	343 mm	see PN40		Ø 105 mm	6,1 kg	see PN100		Ø 130 mm	8,0 kg
DN25	200 mm	344 mm	see PN40		Ø 115 mm	6,5 kg	see PN100		Ø 140 mm	9,0 kg
DN40	200 mm	357 mm	see PN40		Ø 150 mm	8,5 kg	see PN100		Ø 170 mm	12,0 kg
DN50	200 mm	363 mm	Ø 165 mm	9,5 kg	Ø 165 mm	10,0 kg	Ø 180 mm	13,0 kg	Ø 195 mm	15,2 kg
DN80	200 mm	377 mm	Ø 200 mm	12,9 kg	Ø 200 mm	14,4 kg	Ø 215 mm	17,6 kg	Ø 230 mm	21,1 kg
DN100	250 mm	390 mm	Ø 220 mm	16,2 kg	Ø 235 mm	19,5 kg	Ø 250 mm	14,5 kg	Ø 265 mm	30,5 kg
DN150	300 mm	417 mm	Ø 285 mm	28,5 kg	Ø 300 mm	34,8 kg	Ø 345 mm	51,6 kg	Ø 355 mm	66,5 kg
DN200	300 mm	442 mm	Ø 340 mm	41,0 kg	Ø 375 mm	60,0 kg	Ø 415 mm	85,0 kg	Ø 430 mm	107,0 kg

Table 47   Remote Inline Meter Dimensions and Weight with Flanges according DIN EN 1092-1

Nominal size	L	H	class 150		class 300		class 600	
			ØD	Weight	ØD	Weight	ØD	Weight
½"	200 mm	341 mm	Ø 90 mm	4,8 kg	Ø 95 mm	5,2 kg	Ø 95 mm	5,4 kg
¾"	200 mm	343 mm	Ø 100 mm	5,3 kg	Ø 115 mm	6,2 kg	Ø 115 mm	6,5 kg
1"	200 mm	344 mm	Ø 110 mm	5,7 kg	Ø 125 mm	6,7 kg	Ø 125 mm	7,1 kg
1½"	200 mm	357 mm	Ø 125 mm	7,1 kg	Ø 155 mm	9,3 kg	Ø 155 mm	10,4 kg
2"	200 mm	363 mm	Ø 150 mm	9,5 kg	Ø 165 mm	10,0 kg	Ø 165 mm	13,0 kg
3"	200 mm	377 mm	Ø 190 mm	13,9 kg	Ø 210 mm	17,5 kg	Ø 210 mm	20,1 kg
4"	250 mm	390 mm	Ø 230 mm	19,6 kg	Ø 255 mm	27,6 kg	Ø 275 mm	38,0 kg
6"	300 mm	417 mm	Ø 280 mm	30,6 kg	Ø 320 mm	47,3 kg	Ø 355 mm	76,2 kg
8"	300 mm	442 mm	Ø 345 mm	47,3 kg	Ø 380 mm	70,0 kg	Ø 420 mm	115,0 kg

Table 48   Remote Inline Meter Dimensions and Weight with Flanges according ASME B16.5

Nominal size	L	H	10k		16k		20k		30k	
			ØD	Weight	ØD	Weight	ØD	Weight	ØD	Weight
DN15	200 mm	341 mm	see 16k		Ø 95 mm	5,1 kg	Ø 95 mm	5,3 kg	Ø 115 mm	6,5 kg
DN20	200 mm	343 mm	see 16k		Ø 100 mm	5,5 kg	Ø 100 mm	5,7 kg	Ø 120 mm	6,8 kg
DN25	200 mm	344 mm	see 16k		Ø 125 mm	6,3 kg	Ø 125 mm	6,6 kg	Ø 130 mm	7,6 kg
DN40	200 mm	357 mm	see 16k		Ø 140 mm	7,4 kg	Ø 140 mm	7,8 kg	Ø 160 mm	10,0 kg
DN50	200 mm	363 mm	Ø 155 mm	7,8 kg	Ø 155 mm	8,1 kg	Ø 155 mm	8,5 kg	Ø 165 mm	10,3 kg
DN80	200 mm	377 mm	Ø 185 mm	11,0 kg	Ø 200 mm	12,7 kg	Ø 200 mm	13,4 kg	Ø 210 mm	17,0 kg
DN100	250 mm	390 mm	Ø 210 mm	14,7 kg	Ø 225 mm	17,5 kg	Ø 225 mm	18,4 kg	Ø 240 mm	24,3 kg
DN150	300 mm	417 mm	Ø 280 mm	28,0 kg	Ø 305 mm	32,6 kg	Ø 305 mm	35,7 kg	Ø 325 mm	48,6 kg
DN200	300 mm	442 mm	Ø 330 mm	37,5 kg	Ø 350 mm	44,6 kg	Ø 350 mm	48,3 kg	Ø 370 mm	66,2 kg

Table 49   Remote Inline Meter Dimensions and Weight with Flanges according JIS B2220

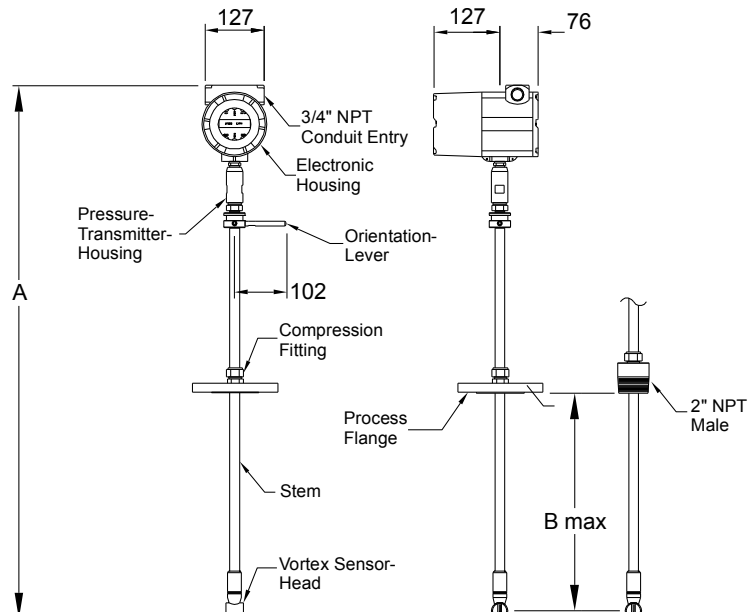## 9.5 Dimensions Insertion Version DVE Compression Fitting

Figure 71   DVE Insertion Version with Compression Fitting

Model DVE-V, T	CL / Compact Lenght		SL / Standard Length		EL / Extended Length		Weight kg		
	A	B	A	B	A	B	CL	SL	EL
Compression Fitting 2" NPT male	549 mm	249 mm	965 mm	665 mm	1270 mm	970 mm	5,7	6,2	6,7
Compression Fitting 150 lb / PN16 Flange	549 mm	277 mm	965 mm	693 mm	1270 mm	998 mm	6,8	7,3	7,8
Compression Fitting 300 lb / PN40 Flange	549 mm	274 mm	965 mm	691mm	1270 mm	996 mm	7,8	8,3	8,8
Compression Fitting 600 lb / PN64 Flange	549 mm	264 mm	965 mm	681 mm	1270 mm	986 mm	8,2	8,7	9,2

Table 50   Dimensions and Weight DVE-V,T with Compression Fitting Add 5 kg for remote electronics

Model DVE-V, P	CL / Compact Lenght		SL / Standard Length		EL / Extended Length		Weight kg		
	A	B	A	B	A	B	CL	SL	EL
Compression Fitting 2" NPT male	625 mm	249 mm	1041 mm	665 mm	1346 mm	970 mm	5,7	6,2	6,7
Compression Fitting 150 lb / PN16 Flange	625 mm	277 mm	1041 mm	693 mm	1346 mm	998 mm	6,8	7,3	7,8
Compression Fitting 300 lb / PN40 Flange	625 mm	274 mm	1041 mm	691mm	1346 mm	996 mm	7,8	8,3	8,8
Compression Fitting 600 lb / PN64 Flange	625 mm	264 mm	1041 mm	681 mm	1346 mm	986 mm	8,2	8,7	9,2

Table 51   Dimensions and Weight DVE-V,P with Compression Fitting Add 5 kg for remote electronics

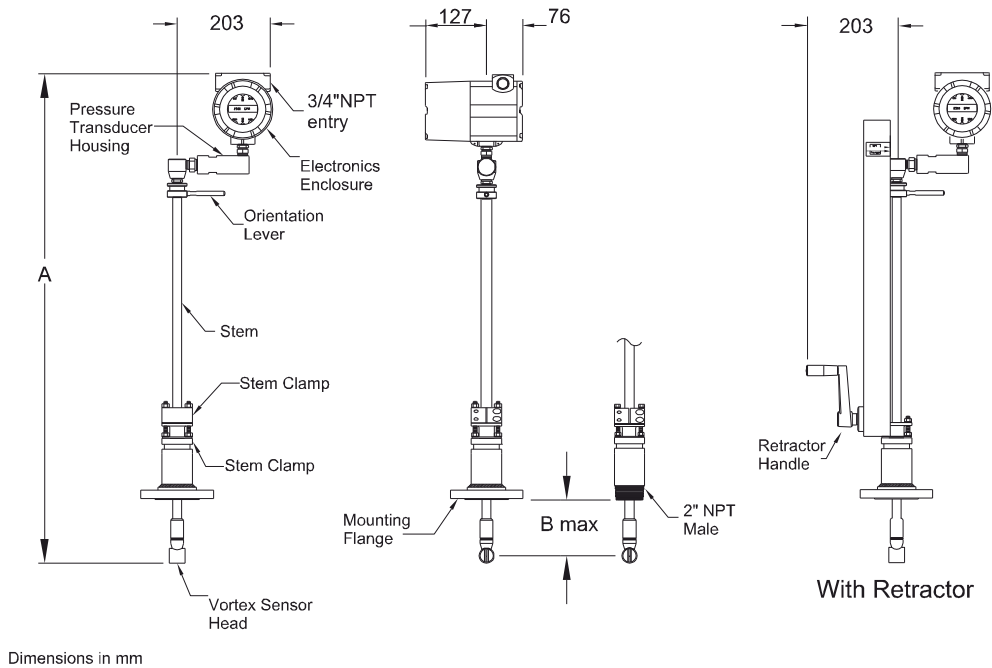## 9.6   Dimensions Insertion Version DVE Packing Gland / Retractor Device

Dimensions in mm

Figure 72   DVE Insertion Version with Packing Gland / Retractor

Model DVE with Retractor Device	SL / Standard Length		EL / Extended Length		Weigth kg		Weight kg incl. Retractor Device	
	A	B	A	B	SL	EL	SL	EL
Packing Gland NPT male	1029 mm	546 mm	1334 mm	851 mm	7,5	7,8	11,5	14,5
Packing Gland 150 lb / PN16 Flange	1029 mm	536 mm	1334 mm	841 mm	9,5	10	13,7	16,7
Packing Gland 300 lb / PN40 Flange	1029 mm	536 mm	1334 mm	841 mm	11,5	12	15,5	18,5
Packing Gland 600 lb / PN64 Flange	1029 mm	536 mm	1334 mm	841 mm	12,5	15	16	19

Table 52   Dimensions and Weight DVE-V,T with Packing Gland / Retractor for remote electronics

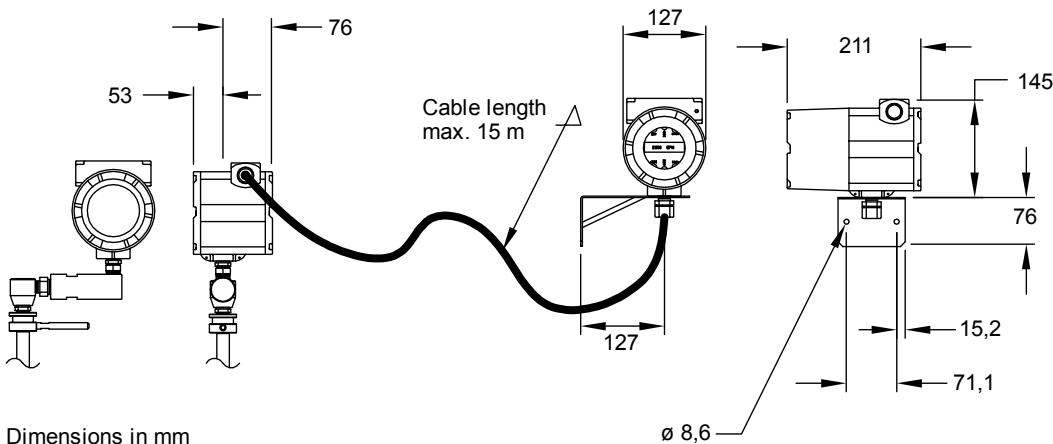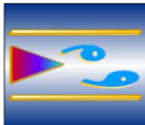## 9.7   Dimensions Insertion Version Remote Electronics

Dimensions in mm

Figure 73   Dimensions DVE Remote Insertion Version with Packing Gland / Retractor

10. Model Number Information

Multivariable VORTEX Flowmeter
Modell DVH
Inline Version

Model Code / Description

Model		Base Price							
DVH	**-**								
		Electronic - Options							
	V	Volume Measurement of Liquids, Gases and Steam							
	T	Flow Velocity including temperature sensor							
	P	Flow Velocity including temperature and pressure sensor							
	E	Energy Consumption Measurement including temperature sensor							
	M	Energy Consumption Measurement including temperature and pressure sensor							
	X	Special (on request)							
		Flow Body							
	15	DN15 DIN EN 1/2 inch ANSI	JIS 15						
	20	DN20 DIN EN 3/4 inch ANSI	JIS 20						
	25	DN 25 DIN EN 1 inch ANSI	JIS 25						
	40	DN 40 DIN EN 1,5 inch ANSI	JIS 40						
	50	DN 50 DIN EN 2 inch ANSI	JIS 50						
	80	DN 80 DIN EN 3 inch ANSI	JIS 80						
	1H	DN 100 DIN EN 4 inch ANSI	JIS 100						
	H5	DN 150 DIN EN 6 inch ANSI	JIS 150						
	2H	DN 200 DIN EN 8 inch ANSI	JIS 200						
	XX	Special (on request)							
		Process Connection							
	1	ANSI 150 lbs	ASME B16.5.2003						
	2	ANSI 300 lbs	ASME B16.5.2003						
	3	ANSI 600 lbs	ASME B16.5.2003						
	5	DIN PN 40	DIN EN 1092-1						
	6	DIN PN 64	DIN EN 1092-1						
	7	DIN PN 100	DIN EN 1092-1						
	J	JIS 10 K	B2220						
	K	JIS 16 K	B2220						
	L	JIS 20 K	B2220						
	X	Special (on request)							
		Material Flow Body							
	S	st.st. 1.4404 / 316 L	(standard)						0 €
	x	Special	(on request)						
		Sensor Configuration / Mounting Option							
	L	Compact incl. LCD Display	IP 66 / Nema 4						
	R	remote incl. LCD Display	IP 66 / Nema 4	Specify cable length in m (max.17m)					
	X	Special on request							
		Input Power							
	L	12-36 VDC loop powered							
	D	12-36 VDC 4-wire	requested for output options H / M / 3 / 4						
	A	85-240 VAC 50/60 Hz 12 W	requested for output options H / M / 3 / 4						
		Output Signal							
	2	Loop powered 1x 4-20mA, HART 1 x pulse		only with Input Power L		passive			
	H	1x 4-20mA HART 1x Alarm, 1x Pulse		only with Input Power D/ A		passive			
	M	1x 4-20mA 1x Alarm, 1x Pulse	MODBUS	only with Input Power D/ A		passive			
	3	3x 4-20 mA HART 3x Alarm, 1x Pulse		only with Input Power D/ A		passive			
	4	3x 4-20 mA 3x Alarm, 1x Pulse	MODBUS	only with Input Power D/ A		passive			
	X	Special (on request)							
		Process Temperature							
	S	Standard Temperature	-200….+2 -330….+500 °F						
	H	High Temperature	-200….+4 -330 …+750 °F						
	X	Special (on request)							
		Option Pressure Sensor (Electronic versions T/P/E/M)							
	0	w/o Pressure Sensor		Electr.version V / T / E	Max. test pressure				
	1	Incl. Pressure Sensor	2 bar abs (30 psia)	Electr.version P / M	4 bar abs.(60 psia)				
	2	Incl. Pressure Sensor	7 bar abs (100 psia)	Electr.version P / M	14 bar abs. (200 psia)				
	3	Incl. Pressure Sensor	20 bar abs (300 psia)	Electr.version P / M	41 bar abs. (600 psia)				
	4	Incl. Pressure Sensor	34 bar abs (500 psia)	Electr.version P / M	64 bar abs. (1000 psia)				
	5	Incl. Pressure Sensor	100 bar abs (1500 psia)	Electr.version P / M	175 bar abs. (2500 psia)				
	X	Special (on request)							
		Version							
	H	Heinrichs							
	X	Sonder a.Anfrage							

Multivariable VORTEX Flowmeter
Model DVE
Insertion Version

Model Code / Description

MODEL

DVE -		MODEL CODE Insertion Version			
		Electronic - Options			
	V	Volume Measurement of Liquids, Gases and Steam			
	T	Flow Velocity including temperature sensor			
	P	Flow Velocity including temperature and pressure sensor			
	E	Energy Consumption Measurement including temperature sensor			
	M	Energy Consumption Measurement including temperature and pressure sensor			
	X	Special	(on request)		
		Probe length			
	S	Standard length		(Max.Stem Length~ 690 mm)	
	C	Compact length		(Max.Stem Length~ 275 mm)	
	E	Extended version	Only with Process Connection T/U/V/W/Y/Z/1	(Max.Stem Length~ 995 mm)	
	X	Special	(on request)		
		Sensor Configuration / Mounting Option			
	L	Compact	incl. LCD Display	IP 66 / Nema 4	
	R	Remote	incl. LCD Display	IP 66 / Nema 4	Specify cable length in m (max.17m)
	X	Special	(on request)		
		Input Power			
	L	12-36 VDC	loop powered		
	D	12-36 VDC	4-Leiter	erforderlich für Ausgangs-Optionen H / M / 3 / 4	
	A	85-240 VAC	50/60 Hz 12 W	erforderlich für Ausgangs-Optionen H / M / 3 / 4	
		Output signal			
	2	1x 4-20mA, HART, Loop powered	1x Pulse	only with input power L	passive
	H	1x 4-20mA HART	1x Alarm, 1x Pulse	only with input power D/ A	passive
	M	1x 4-20mA	1x Alarm, 1x Pulse MODBUS	only with input power D/ A	passive
	3	3x 4-20 mA HART	3x Alarm, 1x Pulse	only with input power D/ A	passive
	4	3x 4-20 mA	3x Alarm, 1x Pulse MODBUS	only with input power D/ A	passive
	X	Special	(on request)		
		Process temperature			
	S	Standard temperature		-200….+260 °C	-330….+500 °F
	H	High Temperature		-200….+400 °C	-330 …+750 °F
	X	Special	(on request)		
		Option Pressure Sensor (Electronic versions T/P/E/M)			
	0	w/o Pressure Sensor		Electr.version V / T / E	Max. test pressure
	1	Incl. Pressure Sensor	2 bar abs (30 psia)	Electr.version P / M	4 bar abs.(60 psia)
	2	Incl. Pressure Sensor	7 bar abs (100 psia)	Electr.version P / M	14 bar abs. (200 psia)
	3	Incl. Pressure Sensor	20 bar abs (300 psia)	Electr.version P / M	41 bar abs. (600 psia)
	4	Incl. Pressure Sensor	34 bar abs (500 psia)	Electr.version P / M	64 bar abs. (1000 psia)
	5	Incl. Pressure Sensor	100 bar abs (1500 psia)	Electr.version P / M	175 bar abs. (2500 psia)
	X	Special	(on request)		
		Process Connection		**Sensor Bushing**	
	A	2 " NPT	Male thread	Compression fitting	
	B	2" 150lbs	Flange	Compression fitting	
	C	DN 50 PN16	Flange	Compression fitting	
	D	2" 300 lbs	Flange	Compression fitting	
	E	DN 50 PN 40	Flange	Compression fitting	
	F	2" 600 lbs	Flange	Compression fitting	
	G	DN 50 PN 64	Flange	Compression fitting	
	H	2 " NPT	Male thread	Packing gland	
	I	2" 150 lbs	Flange	Packing gland	
	J	DN 50 PN16	Flange	Packing gland	
	K	2" 300 lbs	Flange	Packing gland	
	L	DN 50 PN 40	Flange	Packing gland	
	M	2 " NPT	Male Thread	incl. Retraction device	Packing gland
	N	2" 150 lbs	Flange	incl. Retraction device	Packing gland
	O	DN 50 PN16	Flange	incl. Retraction device	Packing gland
	P	2" 300 lbs	Flange	incl. Retraction device	Packing gland
	Q	DN 50 PN 40	Flange	incl. Retraction device	Packing gland
	R	2" 600 lbs	Flange	incl. Retraction device	Packing gland
	S	DN 50 PN 64	Flange	incl. Retraction device	Packing gland
	T	2 " NPT (only Ext. length)	Male Thread	incl. Retraction device	Packing gland
	U	DN 50 PN16 (only Ext.length)	Flange	incl. Retraction device	Packing gland
	V	DN 50 PN 40 (only Ext.length)	Flange	incl. Retraction device	Packing gland
	W	DN 50 PN 64 (only Ext.length)	Flange	incl. Retraction device	Packing gland
	Y	2" 150 lbs (only Ext.length)	Flange	incl. Retraction device	Packing gland
	Z	2" 300 lbs (only Ext.length)	Flange	incl. Retraction device	Packing gland
	1	2" 600 lbs (only Ext.length)	Flange	incl. Retraction device	Packing gland
	X	Special	(on request)		

11. Approvals and Declaration of Conformity

ATEX-IEC Ex Specifications / Approval

EN IEC 60079-0 (2006)
Electrical Apparatus for explosive gas atmospheres
General Requirements

EN IEC 60079-1 (2007)
Electrical Apparatus for explosive gas atmospheres
Flameproof enclosures "d"

EN IEC 61241-0 (2006)
EN IEC 61241-1 (2004)

Directive 94/9/EC (1994)
Equipment Intended for use in Potentially Explosive Atmospheres
(ATEX)

$C\epsilon$ ID 0158

II 2 G Ex d IIB + H2 T6

II 2 D Ex tD A21 IP66 T85°C
DEKRA 11ATEX0140

Ex D IIB + H2 T6
Ex tD A21 IP66 T85°C
IECEx DEK 11.0052

Manufactured by:

Heinrichs Messtechnik GmbH
Robert-Perthel-Str. 9
50739 Cologne / Germany

DEKRA

SCHEDULE

(13)

(14) **to EC-Type Examination Certificate DEKRA 11ATEX0140**   Issue No. **1**

(15) **Description**

Multi-Parameter Vortex Mass Flow Meter, Series DVH / DVE measure the 5 parameters mass flow, volumetric flow, temperature, pressure and fluid density.

Ambient temperature range -40 °C to +60 °C.

Electrical data

Supply voltage:....................... 18 to 36 Vdc or 100 to 240 Vac
Analog output:....................... 4 to 20 mA
Supply voltage pulse output:......5 to 36 Vdc

Installation instructions

The instructions provided with the equipment shall be followed in detail to assure safe operation.

(16) **Test Report**

No. 214384800.

(17) **Special conditions for safe use**

None.

(18) **Essential Health and Safety Requirements**

Covered by the standards listed at (9).

(19) **Test documentation**

As listed in Test Report No. 214384800.

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Form 100
Version 2 (2011-01)

CERTIFICATE

EC-Type Examination

(1)

(2) **Equipment and protective systems intended for use in potentially explosive atmospheres - Directive 94/9/EC**

(3) EC-Type Examination Certificate Number: DEKRA 11ATEX0140   Issue Number: **1**

(4) Equipment: **Multi-Parameter Vortex Mass Flow Meter, Series DVH / DVE**

(5) Manufacturer: **Heinrichs Messtechnik GmbH**

(6) Address: **Robert-Perthel-Strasse 9, D-50739 Köln, Germany**

(7) This equipment and any acceptable variation thereto is specified in the schedule to this certificate and the documents therein referred to.

(8) DEKRA Certification B.V., notified body number 0344 in accordance with Article 9 of the Council Directive 94/9/EC of 23 March 1994, certifies that this equipment has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment and protective systems intended for use in potentially explosive atmospheres given in Annex II to the directive.

The examination and test results are recorded in confidential test report number 214384800.

(9) Compliance with the Essential Health and Safety Requirements has been assured by compliance with:

EN 60079-0 : 2006   EN 60079-1 : 2007   EN 61241-0 : 2006
EN 61241-1 : 2004

(10) If the sign "X" is placed after the certificate number, it indicates that the equipment is subject to special conditions for safe use specified in the schedule to this certificate.

(11) This EC-Type Examination Certificate relates only to the design, examination and tests of the specified equipment according to the Directive 94/9/EC. Further requirements of the directive apply to the manufacturing process and supply of this equipment. These are not covered by this certificate.

(12) The marking of the equipment shall include the following:

⟨Ex⟩   II 2 G Ex d IIB + H₂ T6
II 2 D Ex tD A21 IP66 T85 °C

DEKRA Certification B.V.

R.H.D. Pommé
Certification Manager

This certificate is issued on May 4, 2011 and, as far as applicable, shall be revised before the date of cessation of presumption of conformity of (one of) the standards mentioned above as communicated in the Official Journal of the European Union.

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° Integral publication of this certificate and adjoining reports is allowed. This Certificate may only be reproduced in its entirety and without any change.

All testing, inspection, auditing and certification activities of the former KEMA Quality are an integral part of the DEKRA Certification Group

DEKRA Certification B.V. Utrechtseweg 310, 6812 AR Arnhem P.O. Box 5185, 6802 ED Arnhem The Netherlands
T +31 26 3 56 20 00 F +31 26 3 52 58 00 www.dekra-certification.com Registered Arnhem 09085396

IECEx Certificate of Conformity

INTERNATIONAL ELECTROTECHNICAL COMMISSION
IEC Certification Scheme for Explosive Atmospheres
for rules and details of the IECEx Scheme visit www.iecex.com

Certificate No.:	IECEx DEK 11.0052	Issue No.:0	Certificate history:

Status: **Current**

Date of Issue: **2011-05-04**   Page 1 of 3

Applicant: **Heinrichs Messtechnik GmbH**
Robert-Perthel-Straße 9
D-50739 Köln
Germany

Electrical Apparatus: **Vortex Flow Meter Series DVH and DVE**
Optional accessory:

Type of Protection: **Ex d, Ex tD**

Marking: **Ex d IIB + H2 T6**
Ex tD A21 IP66 T85 °C

Approved for issue on behalf of the IECEx
Certification Body: R.H.D. Pommé

Position: Certification Manager

Signature:
(for printed version)

Date: 2011-05-04

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Certificate issued by:
DEKRA Certification B.V.
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6812 AR Arnhem
The Netherlands
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◤ DEKRA

IECEx Certificate of Conformity

Certificate No.:   IECEx DEK 11.0052

Date of Issue: **2011-05-04**   Issue No.: **0**

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Manufacturer: **Heinrichs Messtechnik GmbH**
Robert-Perthel-Straße 9
D-50739 Köln
Germany

Manufacturing location(s):
Heinrichs Messtechnik
GmbH
Robert-Perthel-Straße 9
D-50739 Köln
Germany

This certificate is issued as verification that a sample(s), representative of production, was assessed and tested and found to comply with the IEC Standard list below and that the manufacturer's quality system, relating to the Ex products covered by this certificate, was assessed and found to comply with the IECEx Quality system requirements. This certificate is granted subject to the conditions as set out in IECEx Scheme Rules, IECEx 02 and Operational Documents as amended.

STANDARDS:
The electrical apparatus and any acceptable variations to it specified in the schedule of this certificate and the identified documents, was found to comply with the following standards:

IEC 60079-0 : 2004 Edition: 4.0	Electrical apparatus for explosive gas atmospheres - Part 0: General requirements
IEC 60079-1 : 2007-04 Edition: 6	Explosive atmospheres - Part 1: Equipment protection by flameproof enclosures "d"
IEC 61241-0 : 2004 Edition: 1	Electrical apparatus for use in the presence of combustible dust - Part 0: General requirements
IEC 61241-1 : 2004 Edition: 1	Electrical apparatus for use in the presence of combustible dust - Part 1: Protection by enclosures "tD"

This Certificate does not indicate compliance with electrical safety and performance requirements other than those expressly included in the Standards listed above.

TEST & ASSESSMENT REPORTS:
A sample(s) of the equipment listed has successfully met the examination and test requirements as recorded in

Test Report:

NL/DEK/ExTR11.0055/00

Quality Assessment Report:

DE/BVS/QAR11.0001/00

IECEx Certificate of Conformity

Certificate No.:   IECEx DEK 11.0052

Date of Issue: **2011-05-04**   Issue No.: **0**

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Schedule

EQUIPMENT:
Equipment and systems covered by this certificate are as follows:

Multi-Parameter Vortex Mass Flow Meter Series DVH and DVE. Vortex Flow Meters measure the 5 parameters mass flow, volumetric flow, temperature, pressure and fluid density.

Ambient temperature range -40 °C to +60 °C.

Supply voltage: 18 to 36 Vdc or 100 to 240 Vac.
Analog output: 4 to 20 mA.
Supply voltage pulse output: 5 to 36 Vdc.

CONDITIONS OF CERTIFICATION: NO

$C\,E$

EG – Konformitätserklärung
EC – Declaration of conformity

Heinrichs Messtechnik GmbH, Robert-Perthel-Straße 9, 50739 Köln

erklärt in alleiniger Verantwortung, dass das Produkt / declares in sole responsibility that the product

Type / Model   **DVH / DVE**

mit den Vorschriften folgender Europäischer Richtlinien übereinstimmt:
conforms with the regulations of the European Directives:

EMV Richtlinie 2004/108/EG,   **EMC Directive 2004/108/EC**

Niederspannungsrichtlinie 2006/95/EG,   **Low Voltage Directive 2006/95/EC**

Druckgeräterichtlinie 97/23/EG,   **Pressure Equipment Directive 97/23/EC – Modul H**
                                             Benannte Stelle / Notified body – TÜV SÜD, N° 0036

Angewandte harmonisierte Normen oder normative Dokumente:
Applied harmonized standards or normative documents:

EMV Richtlinie 2004/108/EG,   EMC Directive 2004/108//EC

EN 61000-6-2:2005   Störfestigkeit Industriebereich / immunity industrial environment

EN 61000-6-3:2007 +A1:2011   Störaussendung Wohnbereich / emission residential, commercial

EN 55011:2009 +A1:2010   Funkstörungen Gruppe 1, Klasse A / ISM ratio-frequency equipment,
                             class A group 1

Niederspannungsrichtlinie 2006/95/EG,   Low Voltage Directive 2006/95/EC

EN 61010-1:2010   Sicherheitsbestimmungen für elektrische Mess-, Steuer-, Regel-
Laborgeräte /

                             Safety requirements for electrical measuring, control and laboratory

devices

Druckgeräterichtlinie 97/23/EG ,   Pressure Equipment Directive 97/23/EC

AD 2000-Merkblätter   Regulations for pressure vessel calculations

Köln, 20.05.2014

Frank Schramm
(Managing Director)

Heinrichs Messtechnik GmbH – Robert-Perthel Straße 9 – D 50739 Köln - Tel.   +49 - 221 - 49708-0 - Fax   +49 - 221 - 49708-178
Erfüllungsort und Gerichtsstand: Köln – Amtsgericht Köln HRB37040 - Ust. IDNr.: DE813416533 – Geschäftsführer Frank Schramm

12. Flow Meter Calculations

12.1   In Line Flow Meter Calculations

Volume Flow Rate

$$Q_V = \frac{f}{K}$$

Mass Flow Rate

$$Q_M = Q_V \rho$$

Flowing Velocity

$$V_f = \frac{Q_V}{A}$$

Where:
A   = Cross sectional area of the pipe (ft^2)
f   = Vortex shedding frequency (pulses / sec)
K   = Meter factor corrected for thermal expansion (pulses / ft^3)
Q_M = Mass flow rate (lbm / sec)
Q_v = Volume flow rate (ft^3 / sec)
V_f = Flowing velocity (ft / sec)
ρ = Density (lbm / ft^3)

12.2   Insertion Flow Meter Calculations
Flowing Velocity

$$V_f = \frac{f}{K_c}$$

Volume Flow Rate

$$Q_V = V_f A$$

Mass Flow Rate

$$Q_M = V_f A \rho$$

Where:
A = Cross sectional area of the pipe (ft^2)
f   = Vortex shedding frequency (pulses / sec)
K_c = Meter factor corrected for Reynolds Number (pulses / ft)
Q_v = Volume flow rate (ft^3 / sec)
Q_M = Mass flow rate (lbm / sec)
V_f = Flowing velocity (ft / sec)
ρ = Density (lbm / ft^3)

12.3   Fluid Calculations

12.3.1 Calculations for Steam T & P

When "Steam T & P" is selected in the "Real Gas" selection of the Fluid Menu, the calculations are based on the equations below.

12.3.1.1 Density

The density of steam is calculated from the formula given by Keenan and Keys. The given equation is for the volume of the steam.

$$v = \frac{4.555.04 \bullet T}{p} + B$$

$$B = B_0 + B_0^2 g_1(\tau\ \tau \cdot p + B_0^4 g_2(\tau\ \tau^1 \cdot p^3 - B_0^{13} g_3(\tau\ \tau^2 \cdot p^{12}$$

$$B_0 = .89 - 641.62 \cdot \tau \cdot 10^{8087(\tau)}$$

$$g_1(\tau) = 2.546 \cdot \tau - .6246 \cdot 10^5 \cdot \tau^3$$

$$g_2(\tau) = .21828 - .2697 \cdot 10^5 \cdot \tau^3$$

$$g_3(\tau) = .635 \cdot 10^- - .768 \cdot 10^{64} \cdot \tau^{14}$$

Where tau is 1/ temperature in Kelvin.

The density can be found from 1/(v/ standard density of water).

12.3.1.2 Viscosity

The viscosity is based on an equation given by Keenan and Keys.

$$\eta\ poise) = \frac{.501 \cdot 10^- \sqrt{T}}{1 + 46.8/T}$$

Where T is the temperature in Kelvin

12.3.2 Calculations for Gas ("Real Gas" and "Other Gas")

Use this formula to determine the settings for "Real Gas; Gas" selections and "Other Gas" selections entered in the Fluid Menu. The calculations for gas were taken from Richard W. Miller, *Flow Measurement Engineering Handbook (Third Edition, 1996)*.

12.3.2.1 Density

The density for real gases is calculated from the equation:

$$\rho = \frac{G M_{w,Air}\, p_f}{Z_f R_0 T_f}$$

Where G is the specific gravity, M_W is the molecular weight of air, p_f is the flowing pressure, Z is flowing compressibility, Ro is the universal gas constant, and T is the flowing temperature.

The specific gravity and Ro are known and are stored in a table used by the Vortex meter.

The hard coefficient to find is the compressibility, Z. Z is found using the Redlich-Kwong Equation (Miller page 2-18).

The Redlich-Kwong Equation uses the reduced temperature and pressure to calculate the compressibility factor. The equations are non linear and an iterative solution is used. The Vortex program uses Newton's Method on the Redlich-Kwong equations to iteratively find the compressibility factor. The critical temperature and pressure used in the Redlich-Kwong equation are stored in the fluid data table with the other coefficients.

12.3.2.2 Viscosity

The viscosity for real gases is calculated using the exponential equation for two known viscosities. The equation is:

$$\mu = a T_K^n$$

Where a and n are found from two known viscosities at two temperatures.

$$n = \frac{\ln[(\mu)_2 /(\mu)_1]}{\ln(T_{K2}/T_{K1})}$$

and

$$a = \frac{(\mu)_1}{T_{K1}^n}$$

12.3.3 Calculations for Liquid

Use this formula to determine the settings for "Goyal-Dorais" selections and "Other Liquid" selections entered in the Fluid Menu. The liquid calculations were taken from Richard W. Miller, *Flow Measurement Engineering Handbook (Third Edition, 1996)*.

12.3.3.1 Density

The liquid density is found using the Goyal-Doraiswamy Equation. Goyal-Doraiswamy uses the critical compressibility, critical pressure and critical temperature, along with the molecular weight to find the density. The equation for specific gravity is:

$$G_F = \frac{p_c Mw}{T_c} \left(\frac{0.008}{Z_c^{0.773}} - 0.01102 \frac{T_f}{T_C} \right)$$

The specific gravity can then be converted into density.

12.3.3.2 Viscosity

The liquid viscosity is found by Andrade's equation. This uses two viscosities at different temperatures to extrapolate the viscosity.

Andrade's equation:

$$\mu = A_L \exp \frac{B_L}{T_{\deg R}}$$

To find A and B

$$B_L = \frac{T_{\deg R1} T_{\deg R2} \ln(\mu / \mu)}{T_{\deg R2} - T_{\deg R1}}$$

$$A_L = \frac{\mu}{\exp(B_L / T_{\deg R1})}$$

The temperatures are all in degrees Rankin. Do not believe the subscript R means they are reduced temperatures.

12.3.4 Calculations for Liquid

Use this formula to determine the settings for "Goyal-Dorais" selections and "Other Liquid" selections entered in the Fluid Menu. The liquid calculations were taken from Richard W. Miller, *Flow Measurement Engineering Handbook (Third Edition, 1996)*.

12.3.4.1 Density

The liquid density is found using the Goyal-Doraiswamy Equation. Goyal-Doraiswamy uses the critical compressibility, critical pressure and critical temperature, along with the molecular weight to find the density. The equation for specific gravity is:

$$G_F = \frac{p_c Mw}{T_c}\left(\frac{0.008}{Z_c^{0.773}} - 0.01102\frac{T_f}{T_C} \right)$$

The specific gravity can then be converted into density.

12.3.4.2 Viscosity

The liquid viscosity is found by Andrade's equation. This uses two viscosities at different temperatures to extrapolate the viscosity.

Andrade's equation:

$$\mu = A_L \exp\frac{B_L}{T_{\deg R}}$$

To find A and B

$$B_L = \frac{T_{\deg R1}T_{\deg R2}\ln(\mu/\mu)}{T_{\deg R2} - T_{\deg R1}}$$

$$A_L = \frac{\mu}{\exp(B_L/T_{\deg R1})}$$

The temperatures are all in degrees Rankin. Do not believe the subscript R means they are reduced temperatures.

13. Glossary

A B C D

A	Cross sectional area.
ACFM	Actual Cubic Feet Per Minute (volumetric flow rate).
ASME	American Society of Mechanical Engineers.
Bluff Body	A non-streamlined body placed into a flow stream to create vortices. Also called a Shedder Bar
BTU	British Thermal Unit, an energy measurement.
Cenelec	European Electrical Code.
Compressibility	A factor used to correct for the non-ideal changes in
Factor	a fluid's density due to changes in temperature and/or pressure
CSA	Canadian Standards Association.
d	Width of a bluff body or shedder bar
D	Diameter of a flow channel.

E F G H

f	Frequency of vortices generated in a vortex flowmeter, usually in Hz.
Flow Channel	A pipe, duct, stack, or channel containing flowing fluid.
Flow Profile	A map of the fluid velocity vector (usually non-uniform) in a cross-sectional plane of a flow channel (usually along a diameter).
FM	Factory Mutual.
Ft	Foot, 12 inches, a measure of length.
Ft^2	Square feet, measure of area.
Ft^3	Cubic feet, measure of volume.
GPM	Gallons Per Minute.
Hz	Hertz, cycles per second.

I J K L

In-Line Flow Meter	A flow meter which includes a short section of piping which is put in-line with the user's piping.
Insertion Flow Meter	A flow meter which is inserted into a hole in the user's pipeline.
Joule	A unit of energy equal to one watt for one second. Also equal to a Newton-meter.
LCD	Liquid crystal display.

M N O P

$\overset{\bullet}{m}$	Mass flow rate.
mA	Milli-amp, one thousandth of an ampere of current.
μ	Viscosity, a measure of a fluid's resistance to shear stress. Honey has high viscosity, alcohol has low viscosity.
nm3/hr	Normal cubic meters per hour (flow rate converted to normal conditions, as shipped 101 kPa and 0° C). User definable.
ΔP	Permanent pressure loss.
P	Line pressure (psia or bar absolute).
ρ_{act}	The density of a fluid at the <u>actual</u> temperature and pressure operating conditions.
ρ_{std}	The density of a fluid at <u>standard</u> conditions (usually 14.7 psia and 20° C).
Permanent Pressure Loss	Unrecoverable drop in pressure.
Piezoelectric Crystal	A material which generates an electrical charge when the material is put under stress.
PRTD	An resistance temperature detector (RTD) with platinum as its element. Used because of high stability.
psia	Pounds per square inch absolute(equals psig + atmospheric pressure). Atmospheric pressure is typically 14.696 psi at sea level.
psig	Pounds per square inch gauge.
P_V	Liquid vapor pressure at flowing conditions (psia or bar absolute).

Q R S T

Q	Flow rate, usually volumetric.
Rangeability	Highest measurable flow rate divided by the lowest measurable flow rate.
Reynolds Number or Re	A dimensionless number equal to the density of a fluid times the velocity of the fluid times the diameter of the fluid channel, divided the fluid viscosity (i.e., Re = ▫VD/▫). The Reynolds number is an important number for vortex flow meters because it is used to determine the minimum measurable flow rate. It is the ratio of the inertial forces to the viscous forces in a flowing fluid.
RTD	Resistance temperature detector, a sensor whose resistance increases as the temperature rises.
scfm	Standard cubic feet per minute (flow rate converted to standard conditions, as shipped 14.696 psia and 59° F). User definable.
Shedder Bar	A non-streamlined body placed into a flow stream to create vortices. Also called a Bluff Body.
Strouhal Number or St	A dimensionless number equal to the frequency of vortices created by a bluff body times the width of the bluff body divided by the velocity of the flowing fluid (i.e., St = fd/V). This is an important number for vortex flow meters because it relates the vortex frequency to the fluid velocity.
Totalizer	An electronic counter which records the total accumulated flow over a certain range of time.
Traverse	The act of moving a measuring point across the width of a flow channel.

U V W X Y Z

VORTEX	An eddy of fluid.
Uncertainty	The closeness of agreement between the result of a measurement and the true value of the measurement.
V	Velocity or voltage.
VAC	Volts, alternating current.
VDC	Volts, direct current.

Version / printed: 28.04.2015 / 28.04.2015