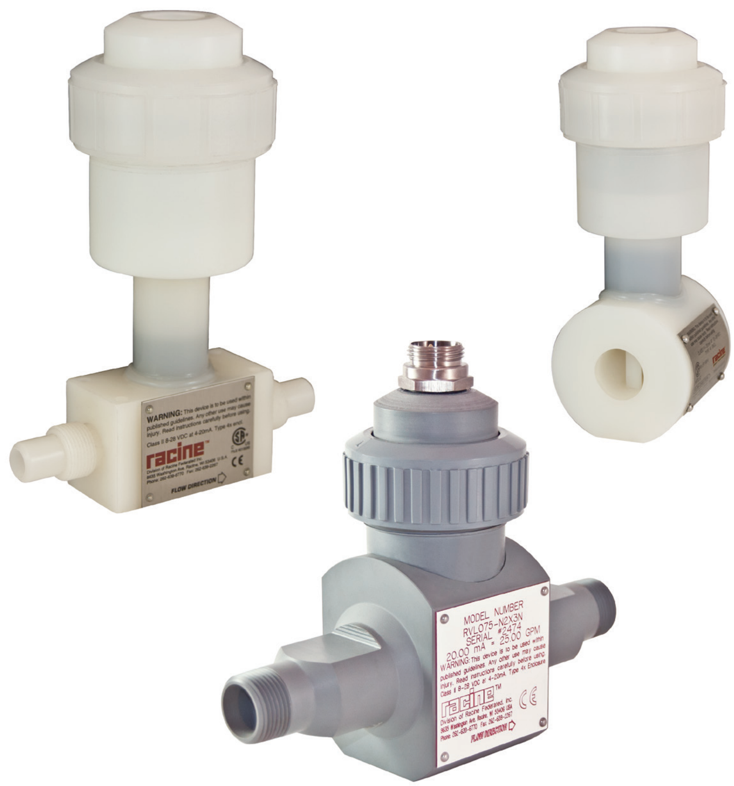
Vortex
Flow Meters

Vortex Flow Meters

Shedding Flow Meter

RVL Series



Badger Meter

VRX-UM-00371-EN-03 (April 2017)

User Manual

CONTENTS

DESCRIPTION

The RVL series meter uses vortex-shedding technology for repeatable flow measurement accurate to ±1 percent of full scale. The meter has no moving parts, and any potential for fluid contamination is eliminated by the corrosion-resistant all plastic construction. The meter includes a compact two-wire (4…20 mA) or three-wire (pulse) transmitter, contained within a conveniently replaceable plug-in electronics module. All electronics are housed in a corrosion-resistant enclosure.

Unlike meters containing metal or moving parts, the RVL is perfect for aggressive or easily contaminated fluids. Applications range from ultra-pure water to highly corrosive chemicals and slurries. Units can be recalibrated and the meter output span can be reprogrammed in the field.

OPERATING PRINCIPLE

Operation of the RVL vortex flow meter is based on the vortex shedding principle. As fluid moves around a body, vortices (eddies) are formed and move downstream. They form alternately, from one side to the other, causing pressure fluctuations. The pressure fluctuations are sensed by a piezoelectric crystal in the sensor tube, and are converted to a 4…20 mA or pulse signal. The frequency of the vortices is directly proportional to the flow rate. The results are extremely accurate and repeatable measurements using no moving parts.

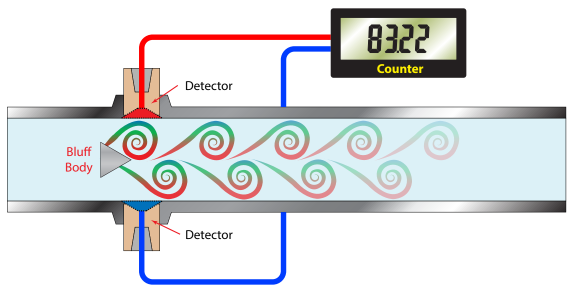


Figure 1: Operating principle

FLUIDS

Use any clean liquid compatible with the plastic material of construction that does not contain significant amounts of fibers or abrasive materials.

DANGER

DO NOT USE WITH EXPLOSIVE OR FLAMMABLE MATERIALS, FOOD OR BEVERAGES, OR GASEOUS FLUIDS.

Viscosities above 1 cSt raise the minimum usable flow rate and reduce the flow range. This effect is linear to viscosity. No adjustments are required for viscosities up to 2.0 cSt. Liquids with higher viscosities adversely affect the permissible amount and duration of over range flow. See *Table 1*.

Viscosity	Minimum	Maximum	Flow Range
1 cSt	1	12	12:1
2 cSt	2	12	6:1
3 cSt	3	12	4:1
4 cSt	4	12	3:1
5 cSt	5	12	2.4:1
6 cSt	6	12	2:1

Table 1: Viscosity and flow range

GENERAL INSTALLATION INFORMATION

Before installing the meter:

- Find an area for installation away from large electrical motors, transformers or other devices that can produce high electromagnetic or electrostatic fields. The vortex transmitter contains electric circuitry that can be affected by these interferences.
- Proper grounding is required to eliminate electrical noise which may be present within the fluid and piping system or in the near vicinity of the vortex transmitter. Use exterior grounding strap for non-conductive piping systems to provide a path to earth ground. Properly ground pipes in conductive piping systems.

Flow Rate and Range Requirements

Most manufacturers state flow range capabilities by publishing the maximum allowed flow rates. Then they provide a turndown ratio to determine minimum flow rate. To use the turndown ratio, simply divide the maximum rate by the ratio to determine the minimum rate. Vortex flow meters have a 12:1 turndown ratio at a viscosity of 1 cSt. Higher viscosities will reduce the turndown.

NOTE: The 1/4 in. NPT and 1/2 in. flare end meters have a standard turndown ratio of 8:1.

Piping Requirements

Turbulence in the pipeline can affect the accuracy of flow meters. Typical sources of turbulence are pumps, valves, change in pipe diameter or changes-in-direction in the line. Install the meter away from the turbulence source to avoid turbulence issues. These distances are indicated in Pipe Diameters (PD). For example, 10 PD is ten times the inside pipe diameter away from the source of turbulence. Follow upstream and downstream distances for all sources of turbulence. See *Figure 2 on page 7*, *Figure 3 on page 8*, *Figure 4 on page 9* and *Figure 5 on page 9* for proper piping distance requirements.

NOTE: Pulsating flow affects accuracy. Pressure pulses affect accuracy.

Configuration	Piping Requirements (pipe diameters)		Accuracy (full scale)	Repeatability (of point)
	Inlet	Outlet		
1 plane change	20	5	±1.00%	0.25%
1 plane change w/outlet valve		10		
2 plane changes	27	5		
2 plane changes w/outlet valve		10		

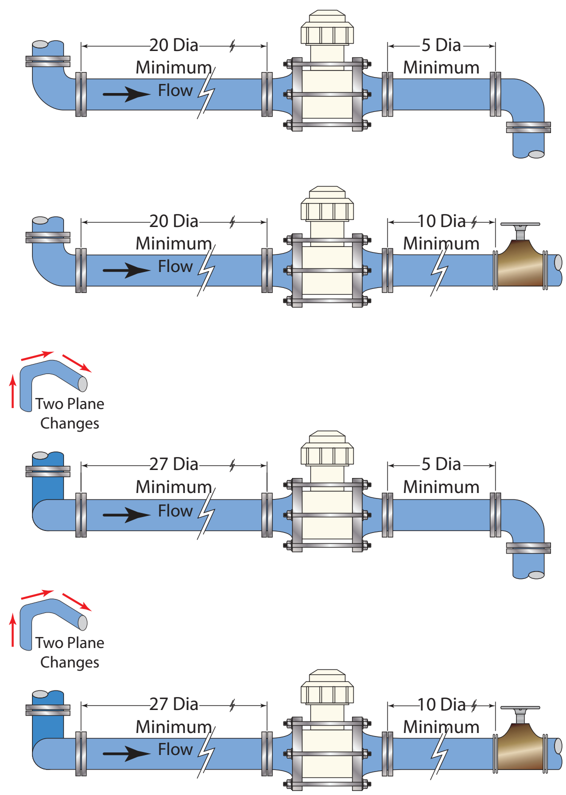


Figure 2: Horizontal flow with sensing element in vertical orientation

Configuration	Piping Requirements		Accuracy (full scale)	Repeatability (of point)
	Inlet	Outlet		
1 plane change	20 PD	5 PD	±1.50%	0.25%
1 plane change w/outlet valve		10 PD		
2 plane changes	27 PD	5 PD		
2 plane changes w/outlet valve		10 PD		

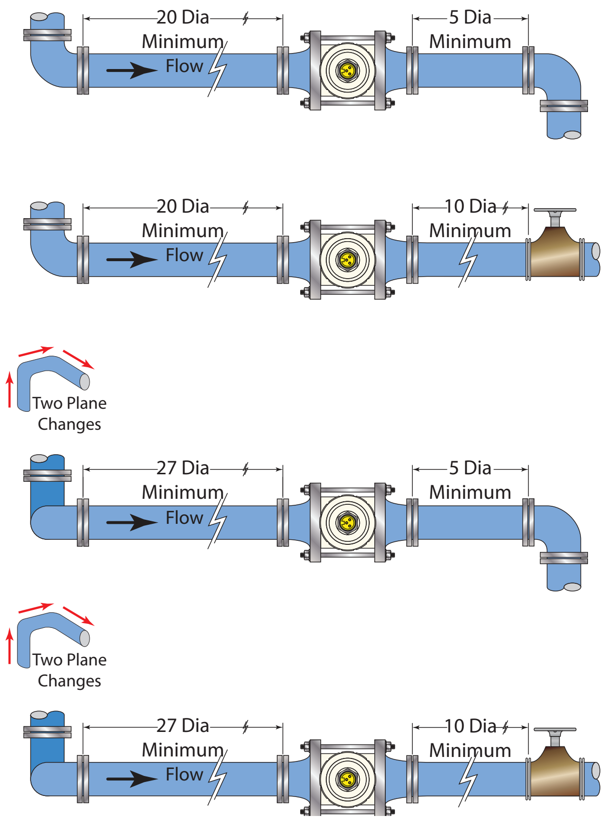


Figure 3: Horizontal flow with sensing element in horizontal position

Configuration	Piping Requirements		Accuracy (full scale)	Repeatability (of point)
	Inlet	Outlet		
1 plane change	20 PD	5 PD	±1.00%	0.25%
1 plane change w/outlet valve		10 PD		
2 plane changes	27 PD	5 PD		
2 plane changes w/outlet valve		10 PD		

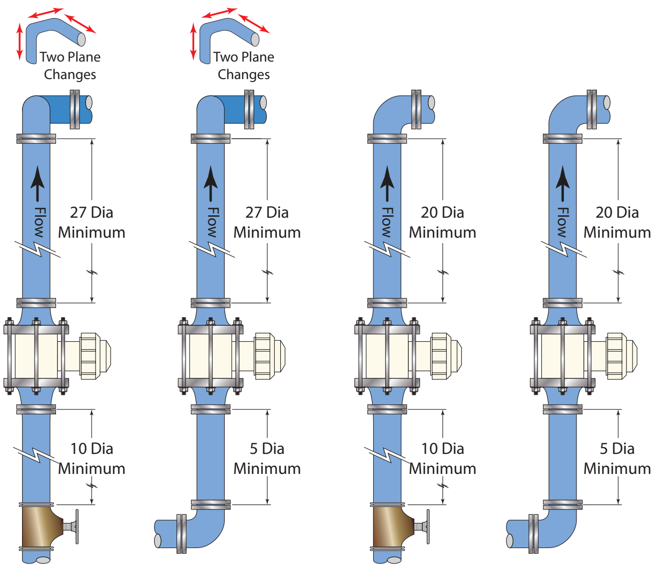


Figure 4: Vertical flow with a change in direction or valve

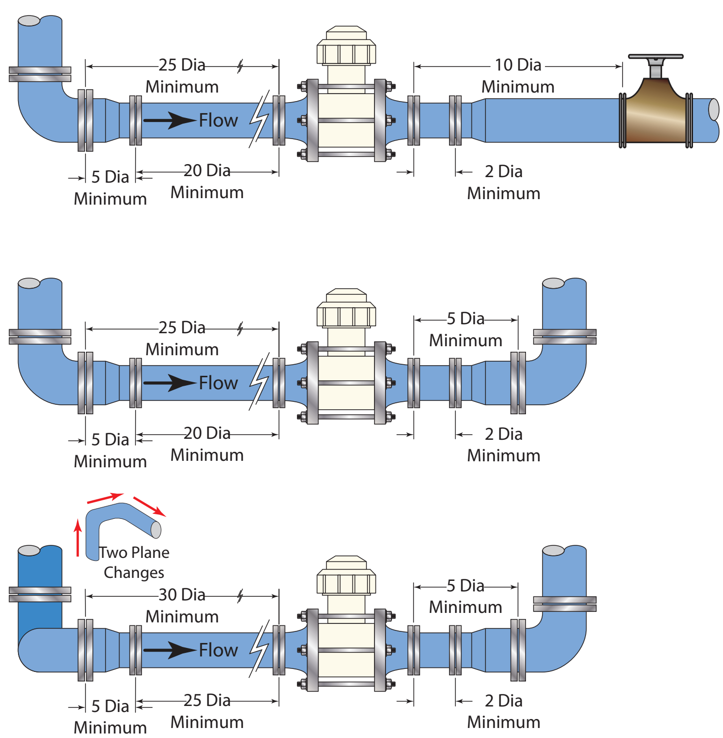


Figure 5: Horizontal flow with a change in pipe diameter

Back Pressure

Back pressure, the pressure immediately downstream of the meter, must be maintained above a minimum level to avoid cavitation. For most applications this may be ignored if the flow rate is less than 75% of maximum. For other applications, use the following formula to calculate the minimum back pressure.

$$\text{Back Pressure} = 2.75\,\Delta P + 1.25\,PV - 14.7$$

Where:

ΔP	=	Pressure drop in psi at max flow
PV	=	Vapor pressure in psia of the liquid at operating temp. (For example, the PV of water at 100° F is 0.42.)
BP	=	Back pressure (downstream of meter) in psig.

Example

For water, at 100° F (37° C) in a 1/2 in. (12.7 mm) meter, where the maximum pressure drop is 8 psi minimum back pressure is 7.8 psig.

$$BP = (2.75 \times 8) + (1.25 \times 0.42) - 14.7$$
$$BP = 22 + 0.525 - 14.7$$
$$BP = 7.825$$

Outputs

The RVL series meters can be ordered with a current output or a rate frequency output. The current output can be re-scaled in the field using a PC communications cable and programming software, which are both available as PN RVS220-954.

NOTE: The two outputs use unique circuit boards and cannot be changed in the field.

The rate frequency output produces pulses whose frequency is proportional to the flow going through the meter. Each meter has a slightly different output frequency which is listed on the calibration sheet that accompanies the meter. See *Table 2* for the long term average full scale output frequency for standard size meters.

Meter Size	Average Full Scale Frequency	Pulse Width
1/4 in. (6.35 mm)	1055 Hz	0.47 msec
1/2 in. (12.7 mm)	820 Hz	0.61 msec
1/2 in. (12.7 mm)	570 Hz	0.88 msec
3/4 in. (19.05 mm)	284 Hz	1.76 msec
1 in. (25.4 mm)	292 Hz	1.71 msec
1-1/2 in. (38.1 mm)	144 Hz	3.47 msec
2 in. (50.8 mm)	148 Hz	3.38 msec
3 in. (76.2 mm)	61 Hz	8.20 msec

Table 2: Full scale output frequency

The frequency output option generates a square wave with an amplitude that matches the input power level. The pulse width varies with frequency and is found by using the following formula.

$$\text{PW in sec.} = \frac{1}{2 \times \text{Maximum Frequency (Hz)}}$$

K-Factors

The K-factor is the number of pulses that must be accumulated to equal a particular volume of fluid. Think of each pulse as representing a small fraction of the totalizing unit.

Calibration reports that accompany RVL series meters include a nominal K-factor in both gallons and liters. See *"Calibration Certificate Sample" on page 23*.

ELECTRICAL INSTALLATION

Power

Use the following guidelines when selecting a power source:

- Use an 8…28V DC power supply. The specific connection depends on which output is option is used.
- Use clean electrical line power.
- Do not operate this unit on circuits with noisy components such as fluorescent lights, relays, compressors or variable frequency drives.
- Use linear power supplies.

NOTE: The power and output connections share a common ground.

Wiring

4…20 mA Loop

Connect a twisted pair wire (not provided) to the terminals of the transmitter marked *8…28V DC* and *Output*. Do not connect the shield to the transmitter if the twisted pair wire is shielded. The shield should be grounded at the receiver only. See *Figure 6*. The transmitter is reverse-polarity protected.

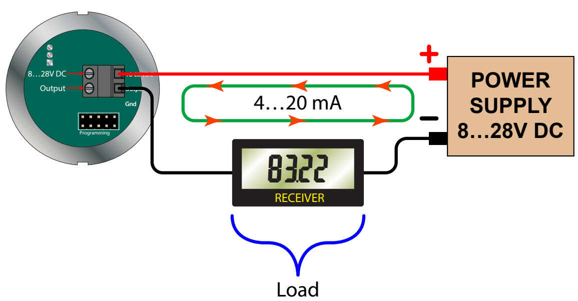


Figure 6: Loop connection with single load

The receiving equipment must accept industry standard true two-wire or loop powered 4…20 mA process transmitter inputs. The power can either be supplied by the receiving equipment or an external power supply that supplies 24V DC an 30 mA. See *Figure 6* for the wiring setup using an external power source and *Figure 7* using the receiver as the power source. Several receivers may be connected in a series as shown in *Figure 7*, but only one should provide power, and all should have isolated inputs.

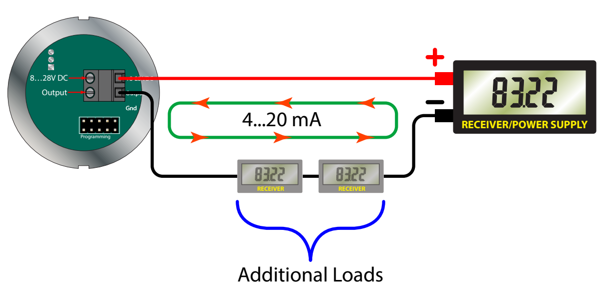


Figure 7: Loop connection with multiple loads

The voltage provided by the receiver must be within the limits shown in *Figure 8*.

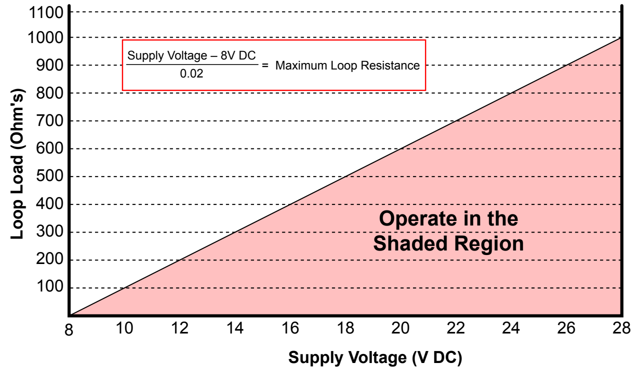


Figure 8: Supply voltage chart

To use this figure:

1. Add the resistance of all the receivers, indicators and the wire in the loop. If the wire resistance is unknown, use a value of 50 ohm for a twisted wire of 1000 feet or less with a gauge of #22 awg or heavier.
2. Find the total load (in ohms) on the left side of the chart in *Figure 8* and follow that value horizontally until it intersects with the shaded area.
3. From the intersection point look straight down to where a vertical line would intersect the voltage scale. This is the minimum voltage needed for the transmitter to operate properly under the specific load conditions.

Example

After checking the specification for all the loads in an application the total amounted to 800 ohms. Following the 800 ohm line to the right, the intersection point is about 3/4 of the way across the chart in *Figure 9*.

A vertical line through the intersection point crosses the voltage axis at about 24V DC, so with a load of 800 ohms a standard 24 volt power supply would be used.

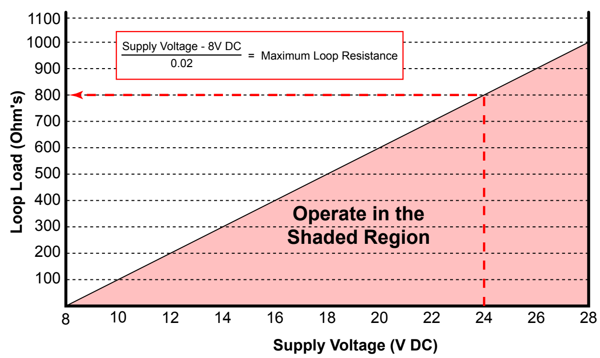


Figure 9: Supply voltage example

Pulse Output

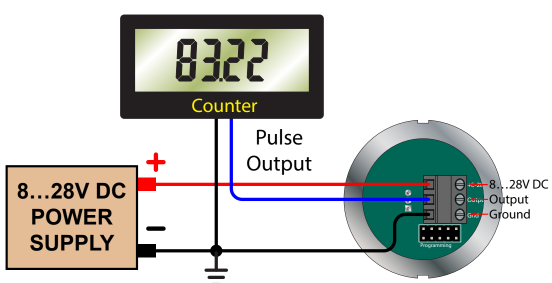


Figure 10: Pulse output wiring

Three-Pin Connection Option

An optional three-pin connection is available for when the transmitter/meter combination is mounted remotely from the power source/receiver. The mating connector is PN RF8687000.

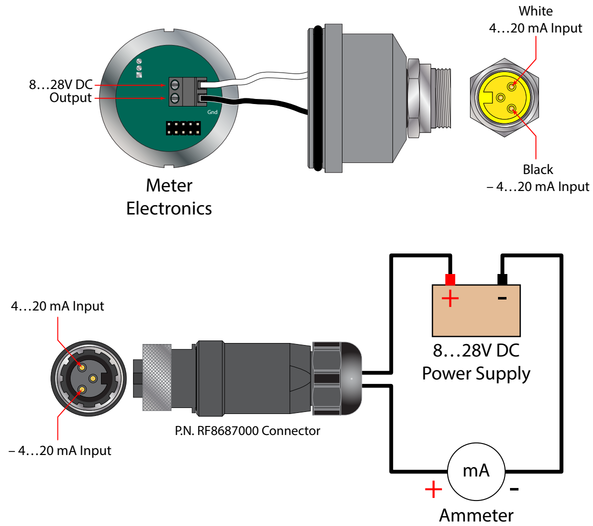


Figure 11: Remote connection loop power

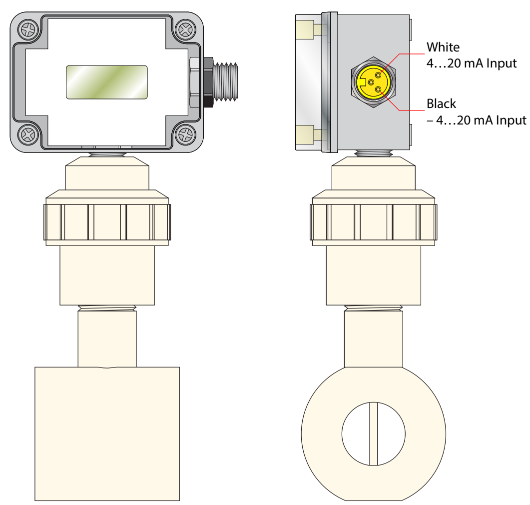


Figure 12: Integral configuration for rate indicator

MECHANICAL INSTALLATION

RVL Inline Installation

For proper installation, follow these guidelines:

- Install the meter where pipe vibration is minimal.
- Use the upstream and downstream piping requirements shown in *"Piping Requirements" on page 6*.
- Do not use upstream valves to control flow rate. Always keep upstream valves fully open.
- Connect good quality ball valves with integral unions directly to the flow meter if the valves are fully open during operation for easy isolation and removal of the flow meter. Cavitation and flow rate pulsation adversely affects the flow meter performance.
- Do not use diaphragm or piston pumps.
- Do not use Teflon tape or any kind of pipe dope when piping.
- Handle the meter with care.
- Do not use excessive force. Screw mating fittings (FNPT) and flanges into the meter hand-tight; then tighten an additional 1/2…3/4 turn.
- Always use two wrenches when turning the flow meter into a fitting; one across the flats on the flow meter end, close to the fitting, and one on the fitting.
- Do not use tools inside the flow meter, as this may damage the vortex sensor, and void the warranty.

The flow meter may be mounted in any orientation. Three holes, tapped 1/4-20 UNC-2B, 0.375 in.-deep, on 3/4 in. centers are provided on the 3/4 in. and smaller flow meters. Use these holes to provide support for the flow meter if pipe supports are not practical.

RVL Wafer Installation

The RVL Wafer series transmitters are designed with wafer style flow bodies, that mount easily between standard ANSI style pipe flanges.

For proper installation, follow these guidelines:

- Install the meter where pipe vibration is minimal.
- Use the upstream and downstream piping requirements shown in *"Piping Requirements" on page 6*.
- Do not use upstream valves to control flow rate. Always keep upstream valves fully open.
- Connect good quality ball valves with integral unions directly to the flow meter if the valves are fully open during operation for easy isolation and removal of the flow meter. Cavitation and flow rate pulsation adversely affects the flow meter performance.
- Do not use diaphragm or piston pumps.
- Do not use Teflon tape or any kind of pipe dope when piping.
- Do not allow gaskets to protrude into the flow stream on flanged meters.

Flange Size	Recommended Torque
1/2…1-1/2 in.	10…15 ft lbs
2…3 in.	20…30 ft lbs

Table 3: Torque rating

Follow these steps for proper installation and operation:

1. Space flanges to accommodate the width of the flow body. See *"RVL Wafer" on page 21* for dimensions.
2. Align the flow body centered with respect to flanges and gaskets, insert threaded rods, retaining nuts and lock washers.
3. Install all retaining nuts hand-tight, and then uniformly tighten the nuts in an alternating sequence, diametrically opposed to each other. Uniform stress across the flange prevents leakage at the gasket. Torque ratings are listed in *Table 3*.
4. Use grounding rings when metal pipes are used in conjunction with this meter. See *Figure 13*.

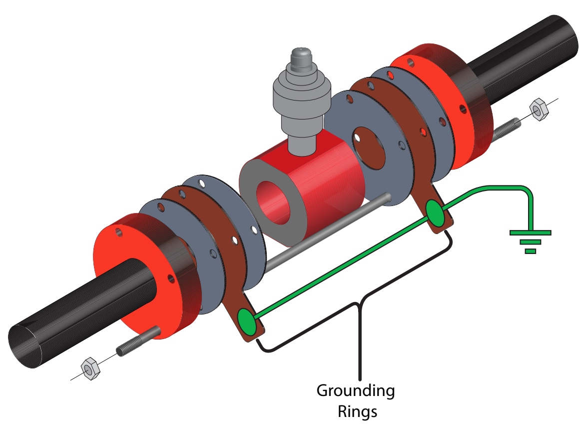


Figure 13: Grounding ring installation

RVL Tube Installation

For proper installation, follow these guidelines:

- Install the meter where pipe vibration is minimal.
- Use the upstream and downstream piping requirements shown in *"Piping Requirements" on page 6*.
- Do not use upstream valves to control flow rate. Always keep upstream valves fully open.
- Connect good quality ball valves with integral unions directly to the flow meter if the valves are fully open during operation for easy isolation and removal of the flow meter. Cavitation and flow rate pulsation adversely affects the flow meter performance.
- Do not use diaphragm or piston pumps.
- Do not use Teflon tape or any kind of pipe dope when piping.
- Handle the meter with care.

To install the meter:

1. Remove any burrs from the pipe ends.
2. Slide the flare nut onto the pipe.
3. Push the flare nut back far enough so that it will be out of the way when you use the flaring tool.
4. Clip the pipe in the flaring tool, keeping the end flush with the face of the tool.
5. Slowly turn the handle on the tool until it bottoms out.
6. Unscrew the handle and remove the tool to check the quality of the flare.
    a. If the flare is not smooth or even the first time, cut off the end with your pipe cutter, and repeat steps 4…6.
7. Line up and tighten the nut and flared pipe to the fitting body. Make the connection tight, but not so tight that the flow meter body is distorted.

- Always use two wrenches when turning a fitting onto the flow meter; one across the flats on the flow meter end close to the fitting, and one on the fitting.
- Do not use tools inside the flow meter, as this may damage the vortex sensor, and invalidate the warranty.

MAINTENANCE

RVL flow meters do not require maintenance in normal service if they are properly installed. Remove the meter from service for cleaning if the flow tube becomes clogged with debris. Significant clogging often results in high (up to 20%) and/or erratic output. Do not stick tools into the tube, as this may permanently damage the vortex sensor. The vortex sensor cannot be repaired in the field. To clean the flow tube, run hot, up to 160° F (71.1° C), soapy water into the downstream end of the flow tube. Dislodge large objects jammed against the bluff body by lightly tapping the upstream end of the flow tube against a firm surface.

⚠CAUTION

DO NOT REMOVE VORTEX METER DURING OPERATION. ALWAYS DISCONNECT THE PRIMARY POWER SOURCE BEFORE INSPECTION OF SERVICE. DO NOT TAP THE FLOW TUBE SO HARD THAT THE THREADS, ON THREADED UNITS, BECOME DAMAGED.

A schedule of maintenance checks should be determined based upon environmental conditions and frequency of use. Inspect the meter at least once a year.

- Visually check for evidence of overheating by noting discoloration of wires or other components.
- Check for damaged or worn parts, especially the bluff body, or indications of corrosion.
- Check for tight, clean electrical connections and that the device is operating properly.

SPECIFICATIONS

RVL Inline

Fluid	Liquids
Connection	NPT Female or Butt (PVDF only)
Turndown Ratio	12:1 for 1/2…2 in. (12.7…50.8 mm) meters
	8:1 for 1/4 in. (6.35 mm) meter
Accuracy	±1% of full scale (4…20 mA)
	±2% of full scale, frequency pulse
Repeatability	±0.25% of actual flow
Materials	PVC standard
	CPVC, PVDF optional
Output Signals	4…20 mA standard
	Frequency pulse optional push-pull driver 150 mA sink or source
Power Supply	8…28V DC
Response Time	2 seconds minimum, step-change-in flow
Enclosure	Type 4X (IP 66)

Nominal Flow Rates				
Tube Size	**Minimum Flow**	**Maximum Flow**	**Full Scale Frequency**	**Weight**
1/4 in. (6.35 mm)	0.6 gpm (2.3 lpm)	5 gpm (18.9 lpm)	1052 Hz	1.5 lbs (0.68 kg)
1/2 in. (12.7 mm)	1.3 gpm (4.7 lpm)	15 gpm (56.8 lpm)	570 Hz	1.6 lbs (0.72 kg)
3/4 in. (19.05 mm)	2.1 gpm (7.9 lpm)	25 gpm (94.6 lpm)	284 Hz	1.7 lbs (0.77 kg)
1 in. (25.4 mm)	4.2 gpm (15.8 lpm)	50 gpm (189.3 lpm)	292 Hz	1.8 lbs (0.80 kg)
1-1/2 in. (38.1 mm)	8.3 gpm (31.5 lpm)	100 gpm (378.5 lpm)	144 Hz	3.1 lbs (1.40 kg)
2 in. (50.8 mm)	16.7 gpm (63.1 lpm)	200 gpm (757.1 lpm)	142 Hz	2.7 lbs (1.22 kg)

Maximum Fluid Temperature	**Maximum Operating Pressure psig (KPa)**		
	PVC	**CPVC**	**PVDF**
203° F (95° C)	Not recommended	Consult factory	Consult factory
150° F (66° C)	Not recommended	63 psig (434 KPa)	130 psig (896 KPa)
100° F (38° C)	93 psig (641 KPa)	120 psig (827 KPa)	150 psig (1034 KPa)
70° F (21° C)	150 psig (1034 KPa)	150 psig (1034 KPa)	150 psig (1034 KPa)

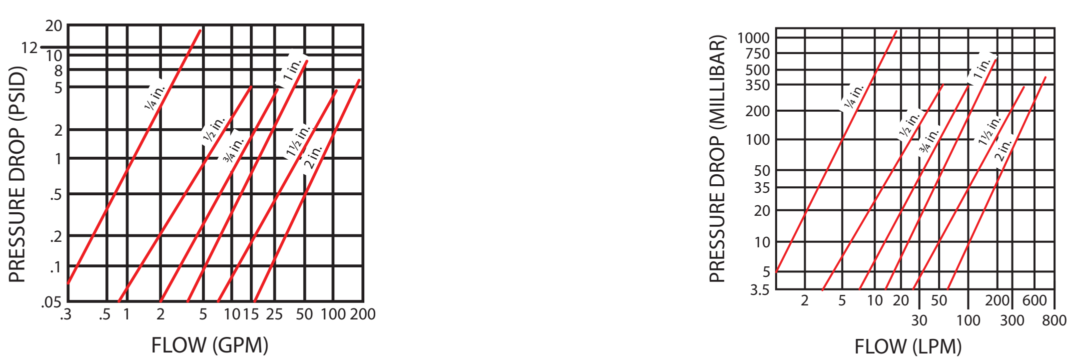


Figure 14: RVL inline pressure drop

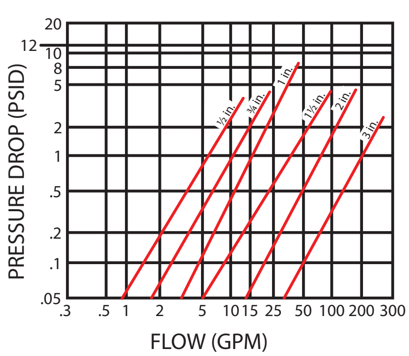
RVL Wafer

Fluid	Liquids
Connection	Wafer
Turndown Ratio	12:1
Accuracy	±1% of full scale (4…20 mA)
	±2% of full scale, frequency pulse
Repeatability	±0.25% of actual flow
Materials	PVC standard
	CPVC, Polypropylene, PVDF optional
Output Signals	4…20 mA standard
	Frequency pulse optional push-pull driver 150 mA sink or source
Power Supply	8…28V DC
Response Time	2 seconds minimum, step-change-in flow
Enclosure	Type 4X (IP 66)

Nominal Flow Rates				
Tube Size	**Minimum Flow**	**Maximum Flow**	**Full Scale Frequency**	**Weight**
1/2 in. (12.7 mm)	1.3 gpm (4.7 lpm)	15 gpm (56.8 lpm)	570 Hz	0.8 lbs (0.36 kg)
3/4 in.(19.05 mm)	2.1 gpm (7.9 lpm)	25 gpm (94.6 lpm)	284 Hz	0.9 lbs (0.41 kg)
1 in. (25.4 mm)	4.2 gpm (15.8 lpm)	50 gpm (189.3 lpm)	292 Hz	1.1 lbs (0.50 kg)
1-1/2 in. (38.1 mm)	8.3 gpm (31.5 lpm)	100 gpm (378.5 lpm)	144 Hz	1.7 lbs (0.77 kg)
2 in. (50.8 mm)	16.7 gpm (63.1 lpm)	200 gpm (757.1 lpm)	148 Hz	2.6 lbs (1.17 kg)
3 in. (76.2 mm)	25.0 gpm (94.6 lpm)	300 gpm (1136 lpm)	61 Hz	4.8 lbs (2.16 kg)

Maximum Fluid Temperature	Maximum Operating Pressure, Standard			
	PVC	**CPVC**	**Polypropylene**	**PVDF**
203° F (95° C)	Not recommended	Consult factory	Not recommended	Consult factory
150° F (66° C)	Not recommended	63 psig (434 KPa)	90 psig (621 KPa)	130 psig (896 KPa)
100° F (38° C)	100 psig (690 KPa)	120 psig (827 KPa)	130 psig (896 KPa)	150 psig (1034 KPa)
70° F (21° C)	150 psig (1034 KPa)	150 psig (1034 KPa)	150 psig (1034 KPa)	150 psig (1034 KPa)

Maximum Fluid Temperature	Maximum Operating Pressure, High Pressure			
	PVC	**CPVC**	**Polypropylene**	**PVDF**
203° F (95° C)	Not recommended	Not recommended	Not recommended	Consult factory
150° F (66° C)	Consult factory	Consult factory	90 psig (621 KPa)	300 psig (2068 KPa)
100° F (38° C)	Consult factory	Consult factory	130 psig (896 KPa)	400 psig (2750 KPa)
70° F (21° C)	Consult factory	Consult factory	150 psig (1034 KPa)	400 psig (2750 KPa)



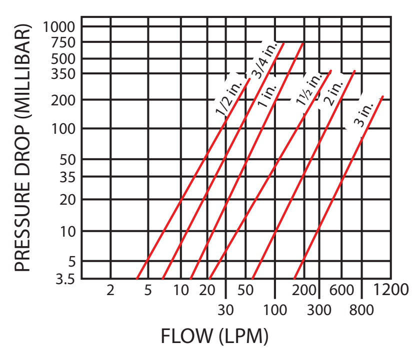


Figure 15: RVL wafer pressure drop

RVL Tube

Fluid	Liquids
Connection	Tube (Flare end)
Turndown Ratio	12:1 for 3/4 in. (19.05 mm) and 1 in. (25.4 mm) meters
	8:1 for 1/2 in. (12.7 mm) meter
Accuracy	±1% of full scale (4…20 mA)
	±2% of full scale, frequency pulse
Repeatability	±0.25% of actual flow
Materials	PVC standard
	CPVC, Polypropylene, PVDF optional
Output Signals	4…20 mA standard
	Frequency pulse optional push-pull driver 150 mA sink or source
Power Supply	8…28V DC
Response Time	2 seconds minimum, step-change-in flow.
Enclosure	Type 4X (IP 66)

Nominal Flow Rates			
Tube Size	**Minimum Flow**	**Maximum Flow**	**Weight**
1/2 in. (12.7 mm)	0.6 gpm (2.3 lpm)	5 gpm (18.9 lpm)	1.5 lbs (0.68 kg)
3/4 in. (19.05 mm)	1.3 gpm (4.7 lpm)	15 gpm (56.8 lpm)	1.6 lbs (0.72 kg)
1 in. (25.4 mm)	2.1 gpm (7.9 lpm)	25 gpm (94.6 lpm)	1.7 lbs (0.77 kg)

Maximum Fluid Temperature	**Maximum Operating Pressure**
	PVDF
150° F(66° C)	130 psig (896 KPa)
100° F (38° C)	150 psig (1034 KPa)
70° F (21° C)	150 psig (1034 KPa)

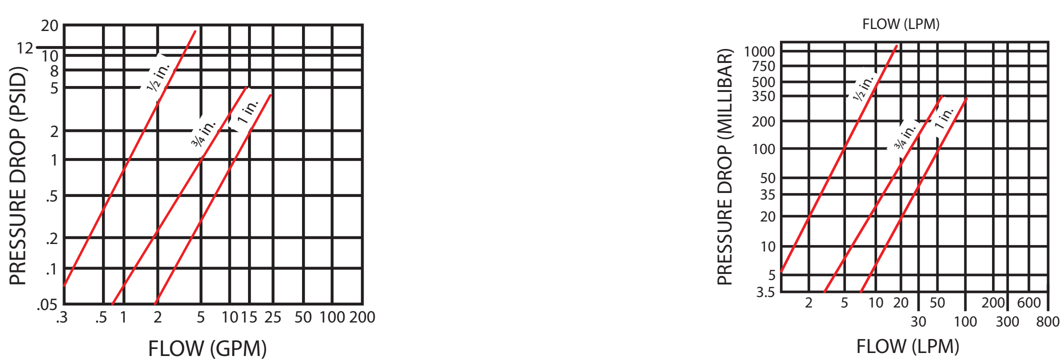


Figure 16: RVL tube pressure drop

DIMENSIONS

RVL Inline

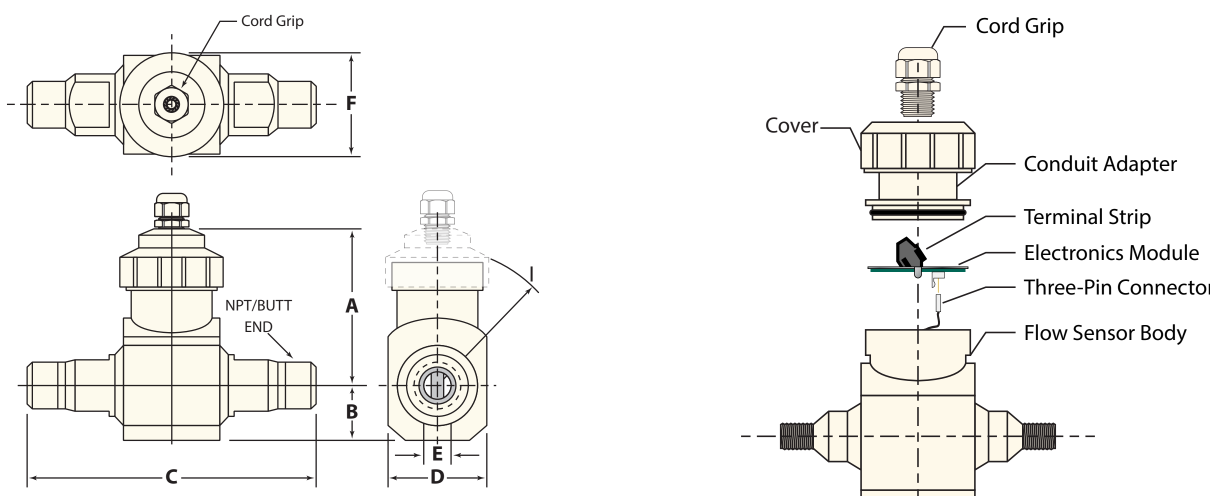
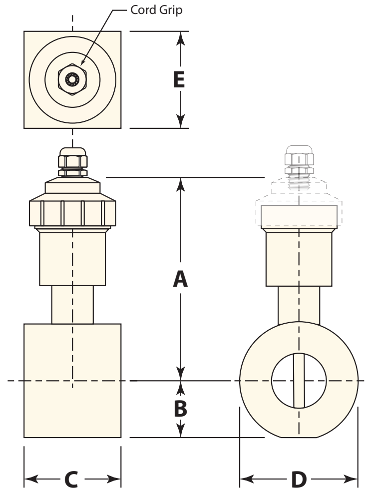


Figure 17: RVL inline dimensions

PVC/CPVC							
Size	**A in. (mm)**	**B in. (mm)**	**C in. (mm)**	**D in. (mm)**	**E in. (mm)**	**F in. (mm)**	**I in. (mm)**
1/4 in. (6.35 mm)	3.81 (97)	1.75 (45)	5.25 (133)	2.50 (64)	0.30 (8)	2.88 (73)	3.00 (76)
1/2 in. (12.7 mm)	3.81 (97)	1.75 (45)	7.13 (181)	2.50 (64)	0.55 (14)	2.88 (73)	3.00 (76)
3/4 in. (19.05 mm)	3.81 (97)	1.75 (45)	7.63 (194)	2.50 (64)	0.74 (19)	2.88 (73)	3.00 (76)
1 in. (25.4 mm)	3.92 (100)	1.75 (45)	8.03 (204)	2.50 (64)	0.96 (24)	2.88 (73)	3.00 (76)
1-1/2 in. (38.1 mm)	3.90 (99)	2.00 (51)	8.37 (213)	2.50 (64)	1.50 (38)	2.88 (73)	3.38 (86)
2 in. (50.8 mm)	4.31 (109)	2.00 (51)	8.37 (213)	2.50 (64)	1.94 (49)	2.88 (73)	3.38 (86)

PVDF (BUTT Fusion Only)							
Size	**A in. (mm)**	**B in. (mm)**	**C in. (mm)**	**D in. (mm)**	**E in. (mm)**	**F in. (mm)**	**I in. (mm)**
1/4 in. (6.35 mm)	5.90 (150)	0.63 (16)	4.87 (124)	1.31 (33)	0.30 (8)	2.88 (73)	3.00 (76)
1/2 in. (12.7 mm)	5.75 (146)	0.78 (20)	4.87 (124)	1.31 (33)	0.55 (14)	2.88 (73)	3.00 (76)
3/4 in. (19.05 mm)	5.75 (146)	0.94 (24)	4.87 (124)	1.44 (37)	0.74 (19)	2.88 (73)	3.00 (76)
1 in. (25.4 mm)	5.88 (149)	1.19 (30)	5.09 (129)	2.00 (51)	0.96 (24)	2.88 (73)	3.00 (76)
1-1/2 in. (38.1 mm)	6.21 (158)	1.50 (38)	6.24 (158)	2.50 (64)	1.50 (38)	2.88 (73)	3.38 (86)
2 in. (50.8 mm)	6.60 (168)	1.88 (48)	6.77 (172)	3.00 (76)	1.94 (49)	2.88 (73)	3.38 (86)

RVL Wafer



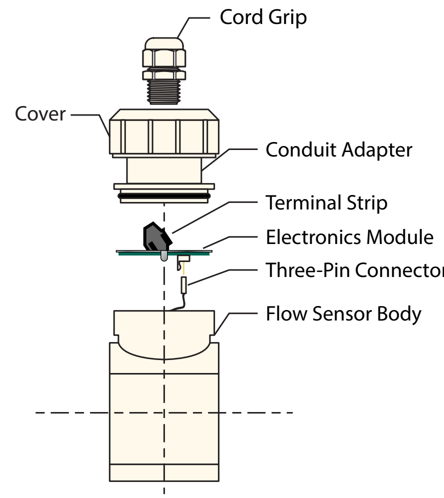
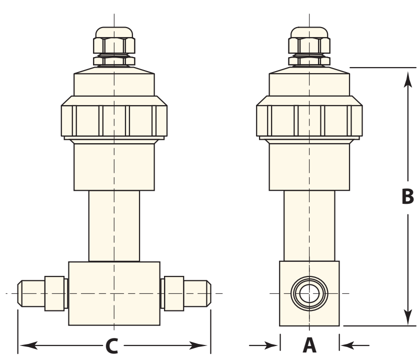


Figure 18: RVL wafer dimensions

RVL (Wafer) Dimensions PP/PVC/CPVC/PVDF					
Size	**A in. (mm)**	**B in. (mm)**	**C in. (mm)**	**D in. (mm)**	**E in. (mm)**
1/2 in. (12.7 mm)	5.85 (149)	0.78 (20)	2.03 (52)	1.75 (45)	2.88 (73)
3/4 in. (19.05 mm)	5.90(150)	0.94 (24)	2.03 (52)	1.75 (45)	2.88 (73)
1 in. (25.4 mm)	5.69 (145)	1.19 (30)	2.25 (57)	1.75 (45)	2.88 (73)
1-1/2 in. (38.1 mm)	6.00 (152)	1.50 (38)	2.63 (67)	1.75 (45)	2.88 (73)
2 in. (50.8 mm)	6.37 (162)	1.88 (48)	3.22 (82)	1.75 (45)	2.88 (73)
3 in. (76.2 mm)	6.88 (175)	2.50 (64)	4.25 (108)	1.75 (45)	2.88 (73)

RVL Tube



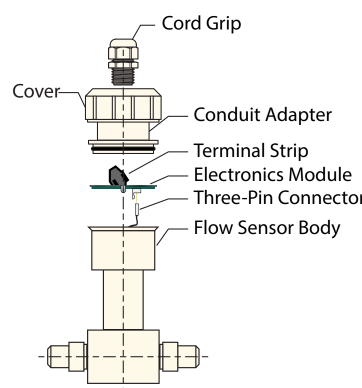


Figure 19: RVL tube dimensions

Tube Size	A in. (mm)	B) in. (mm)	C in. (mm)
1/2 in. (12.7 mm)	1.31 (33.3)	6.25 (158.8)	4.87 (123.7)
3/4 in. (19.05 mm)	1.31 (33.3)	6.25 (158.8)	4.66 (118.4)
1 in. (25.4 mm)	1.44 (36.6)	6.59 (167.4)	5.42 (137.7)

TROUBLESHOOTING

If difficulty is encountered, locate the symptom most likely present and follow the appropriate instructions.

Current Loop

No Current Output

- Place a DC voltmeter across the two terminal block screws. With the electronics module powered there must be at least 8V DC present. If there is less than 8V DC, but more than 0V DC, check the power source for sufficient voltage to drive the loop, as shown in *Figure 8 on page 12*.
    - ◊ If there is 0V DC present, check for a broken wire or connector in the loop.
- Check for the proper polarity of the current loop connections.
- Make sure the receiving device is configured to provide source current to the electronics module.

Zero Flow Indication (4 mA in Loop)

- Check that the flow is greater than the minimum specified for the particular size flow meter in use.
    - ◊ If the flow rate is too low, replace the flow meter with the proper size flow meter.
    - ◊ If the flow rate is sufficient, partially remove the electronic module. Check that the three pin connector that connects the electronics module to the flow transducers is positively connected. See *Figure 20*. Align and insert the connector on to the bottom of the electronics module if it is disconnected.

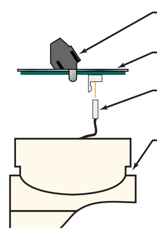


Figure 20: Electrical connection

Erratic Flow Indication

- Check that there is at least 8V DC present across the two terminal block screws.
- Check for material clogging the flow meter and in the upstream piping.
- Check for erosion of the bluff body by sighting down the meters bore. Erosion or damage to the bluff body causes erratic readings and compromise accuracy. If the erosion continues, the flow meter will need to be periodically replaced.
- Check upstream piping distance. See *"Piping Requirements" on page 6*.
- Check for excessive pipe vibration. Normal amounts of pipe vibration are easily tolerated. The transmitter module contains a highly effective active filter that rejects false signals caused by pipe vibration. This filter is most effective under flowing conditions. If vibration is causing the meter to indicate flow when the flow is stopped it will most likely not cause error under flowing conditions. The false flow indication may be ignored, or the pipe may be restrained by firm clamps.
- Check for electrical noise. Under some conditions there can be high common mode AC noise present between the fluid and the power supply ground. The flow meter is designed to reject up to 50 volts of AC common mode noise without loss of accuracy. If noise adjustment is used, accuracy is effected at low flow rates. Place a ground strap on the pipe on both sides of the flow meter (the flow meter is made of non-conductive plastic) and connect them both to the one point where the loop is grounded if metal piping is used. See *"Wiring" on page 11*. Use a grounding orifice if plastic piping is used. The transmitter module contains a highly effective active filter that will reject false signals due to high common mode voltage. This filter is most effective under flowing conditions. If a false indication of flow is encountered at zero flow, it will probably not cause error under flowing conditions.

Over-Stressed Sensor

The sensor can be over-stressed if the maximum permitted flow rate of 125% of recommended capacity (100% of HT meters) is exceeded.

CALIBRATION CERTIFICATE SAMPLE

Calibration Report

Unit Under Test (UUT) Information:

Description: ¾ in. In-Line NPT End Flow Meter
Model Number: RVL075-N 1 VNN
Serial Number: 99999
Sensor Type: Vortex Shedding
Output type: 0-5V
Minimum Flow: 2.1 GPM 7.9 LPM
Maximum Flow: 25 GPM 94.6 LPM
Calibration Date: October 24, 2007
Calibration Interval: 12 Months
Cal. Liquid: Water
Ambient Temperature: 71.74 °F
Ambient Humidity: 31.39 %RH
Linear Points: 5

Master Meter:

Std uncertainty: ±0.25%
Traceability No: 30400/31801
Model No: FT8-8N EXW-LEG-5/FT-16 NEXW-LEG-1
Serial No: 806890/16011903

Customer Information:

Customer Name:
Customer No.:
Order No.:

UUT Calibration Data Table In GPM:

Flow Standard	Actual GPM	UUT Hz	UUT Temp °F	Visc. cSt	UUT F/V Hz/cSt	UUT K CYC/GAL	(Hz*60)/NK GPM	Linear COEFF.	Raw Err % FS	Calc. 0-5V	Meas. 0-5V	Output Err % FS
1	25.00	100.000	72.00	0.949	105.406	240.00	24.57	1.0174	1.71	5.000	5.000	0.00
1	18.00	75.000	72.00	0.949	79.055	250.00	18.43	0.9767	-1.71	3.600	3.680	0.40
1	12.00	50.000	72.00	0.949	52.703	250.00	12.29	0.9767	-1.14	2.400	2.420	0.10
1	6.00	25.000	72.00	0.949	26.352	250.00	6.14	0.9767	-0.57	1.200	1.200	0.00
1	2.10	10.000	72.00	0.949	10.541	285.71	2.46	0.8547	-1.43	0.420	0.420	0.00

Nominal K (NK) 244.186

UUT Calibration Data Table In LPM:

Flow Standard	Actual GPM	UUT Hz	UUT Temp °F	Visc. cSt	UUT F/V Hz/cSt	UUT K CYC/GAL	(Hz*60)/NK GPM	Linear COEFF.	Raw Err % FS	Calc. 0-5V	Meas. 0-5V	Output Err % FS
1	94.64	100.000	72.00	0.949	105.406	63.40	93.01	1.0174	1.71	5.000	5.000	0.00
1	68.14	75.000	72.00	0.949	79.055	66.04	69.76	0.9767	-1.71	3.600	3.680	0.40
1	45.42	50.000	72.00	0.949	52.703	66.04	46.51	0.9767	-1.14	2.400	2.420	0.10
1	22.71	25.000	72.00	0.949	26.352	66.04	23.25	0.9767	-0.57	1.200	1.200	0.00
1	7.95	10.000	72.00	0.949	10.541	75.48	9.30	0.8547	-1.43	0.420	0.420	0.00

Nominal K (NK) 64.507

Status:	PASS
Meter Accuracy (of FS):	± 0.4 %
Average Calib. Temperature :	72 F
Average Calib. Specific Gravity :	1
Average Calib. Viscosity :	0.95 cSt
Flow Direction :	Forward

Calibrated By: Ramon Benedict

Certified By: Larry Perez

Racine calibrations are performed using standards traceable to National Institute of Standards and Technology.

The equipment and calibration procedures comply with ISO 9001.

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