Reference Manual
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Rosemount™ 8800D Series Vortex Flow Meter with Modbus Protocol

ROSEMOUNT™

EMERSON™

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1 Safety messages

WARNING

Explosion hazards. Failure to follow these instructions could cause an explosion, resulting in death or serious injury.

- Verify the operating atmosphere of the transmitter is consistent with the appropriate hazardous locations certifications.
- Installation of this transmitter in an explosive environment must be in accordance with the appropriate local, national, and international standards, codes, and practices. Review the approvals documents for any restrictions associated with a safe installation.
- Do not remove transmitter covers or thermocouple (if equipped) in explosive atmospheres when the circuit is live. Both transmitter covers must be fully engaged to meet explosion-proof requirements.
- Before connecting a hand-held communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.

WARNING

Electrical shock hazard. Failure to follow this instruction could result in death or serious injury. Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.

WARNING

General hazard. Failure to follow these instructions could result in death or serious injury.

- This product is intended to be used as a flowmeter for liquid, gas, or steam applications. Do not use for any other purpose.
- Make sure only qualified personnel perform the installation.

2 Introduction

2.1 Overview

System description

The Vortex Flow Meter consists of a meter body and transmitter, and measures volumetric flow rate by detecting the vortices created by a fluid passing by the shedder bar.

The meter body is installed in-line with process piping. A sensor is located at the end of the shedder bar which creates a sine wave signal due to the passing vortices. The transmitter measures the frequency of the sine wave and converts it into a flow rate.

Safety messages

Procedures and instructions in this manual may require special precautions to ensure the safety of the personnel performing the operations. Refer to the safety messages listed at the beginning of this document, before performing any operations.

Chapters

Section	Who uses	Description
Pre-installation	Planners and installers	Reference information to help you verify compatibility between the meter and its application and installation location
Basic installation	Planners and installers	Mechanical and electrical installation instructions typically required as initial setup in all applications
Basic configuration	Operations technicians	Configuration parameters typically required as initial setup in all applications
Advanced installation	Installers	Installation procedures required after initial setup for some applications
Advanced configuration	Operations technicians	Configuration procedures required after initial setup for some applications
Operation	Operations technicians	Information on advanced configuration parameters and functions that can aid in maintaining the flow meter
Troubleshooting	Installers and operations technicians	Troubleshooting techniques, diagnostic information, and transmitter verification procedures
Maintenance	Operations technicians	Information on maintaining the flow meter

Appendixes

Appendixes include supplementary information that may be useful in some situations.

3 Pre-installation

3.1 Planning

3.1.1 Sizing

To determine the correct meter size for optimal flow meter performance:

- Determine the limits of measuring flow.
- Determine the process conditions so that they are within the stated requirements for Reynolds number and velocity.

Sizing calculations are required to select the proper flow meter size. These calculations provide pressure loss, accuracy, and minimum and maximum flow rate data to guide in proper selection. Vortex sizing software can be found using the Selection and Sizing tool. The Selection and Sizing tool can be accessed online or downloaded for offline use using this link: www.Emerson.com/FlowSizing.

3.1.2 Wetted material selection

Ensure that the process fluid is compatible with the meter body wetted materials when specifying the Rosemount 8800D. Corrosion will shorten the life of the meter body. Consult recognized sources of corrosion data or contact technical support for more information.

Note
If Positive Material Identification (PMI) is required, perform test on a machined surface.

3.1.3 Orientation

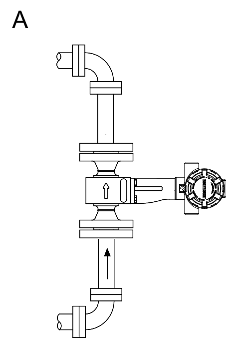
The best orientation for the meter depends on the process fluid, environmental factors, and any other nearby equipment.

Vertical installation

Vertical, upward, installation allows upward process liquid flow and is generally preferred. Upward flow ensures that the meter body always remains full and that any solids in the fluid are evenly distributed.

The meter can be mounted in the vertical down position when measuring gas or steam flows. This type of application is strongly discouraged for liquid flows, although it can be done with proper piping design.

Figure 3-1: Vertical installation



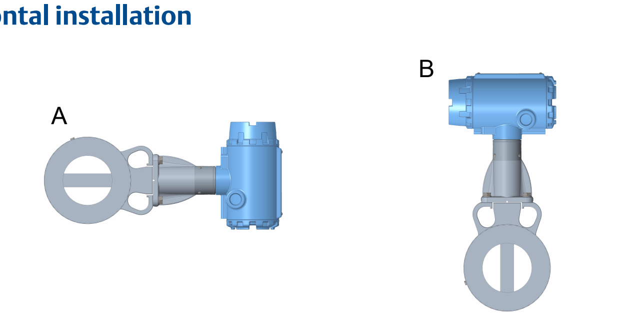
A. Liquid or gas flow
B. Gas flow

Note
To ensure the meter body remains full, avoid downward vertical liquid flows where back pressure is inadequate.

Horizontal installation

For horizontal installation, the preferred orientation is to have the electronics installed to the side of the pipe. In liquid applications, this helps prevent any entrained air or solids from striking the shedder bar and disrupting the shedding frequency. In gas or steam applications, this helps prevent any entrained liquid (such as condensate) or solids from striking the shedder bar and disrupting the shedding frequency.

Figure 3-2: Horizontal installation



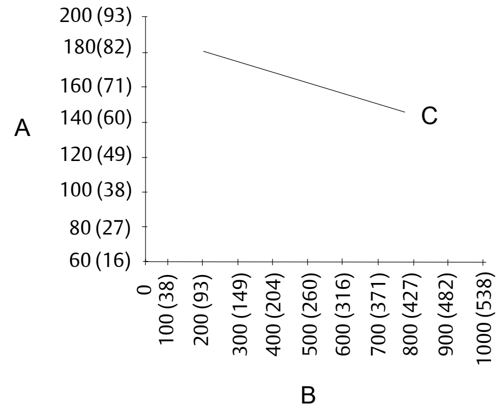
A. Preferred installation—meter body installed with electronics to side of pipe
B. Acceptable installation—meter body installed with electronics above pipe

High-temperature installations

The maximum process temperature for integral electronics is dependent on the ambient temperature where the meter is installed. The electronics must not exceed 185 °F (85 °C).

Figure 3-3 shows combinations of ambient and process temperatures needed to maintain a housing temperature of less than 185 °F (85 °C).

Figure 3-3: Ambient/Process temperature limits

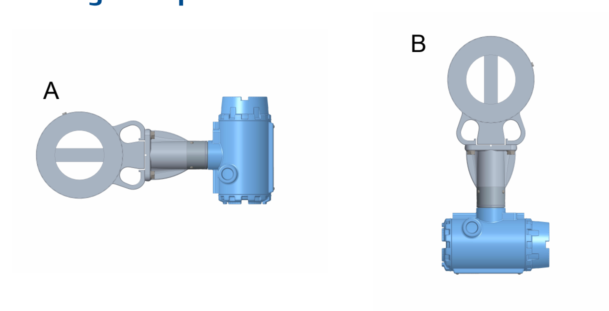


A. *Ambient temperature °F (°C)*
B. *Process temperature °F (°C)*
C. *185 °F (85 °C) Housing temperature limit.*

Note
The indicated limits are for horizontal pipe and vertical meter position, with meter and pipe insulated with 3 in. (77 mm) of ceramic fiber insulation.

Install the meter body so the electronics are positioned to the side of the pipe or below the pipe as shown in Figure 3-4. Insulation may also be required around the pipe to maintain an electronics temperature below 185 °F (85 °C). See Figure 4-2 for special insulation considerations.

Figure 3-4: Examples of high-temperature installations



A. *Preferred installation—The meter body installed with the electronics to the side of the pipe.*
B. *Acceptable installation—The meter body installed with the electronics below the pipe.*

3.1.4 Location

Hazardous area

The transmitter has an explosion-proof housing and circuitry suitable for intrinsically safe and non-incendive operation. Individual transmitters are clearly marked with a tag indicating the certifications they carry. For hazardous location installation, including Explosion-proof, Flameproof,or Intrinsic Safety (I.S.), please consult the Emerson 8800 Approval Document 00825-VA00-0001.

Environmental considerations

Avoid excessive heat and vibration to ensure maximum flow meter life. Typical problem areas include high-vibration lines with integrally mounted electronics, warm-climate installations in direct sunlight, and outdoor installations in cold climates.

Although the signal conditioning functions reduce susceptibility to extraneous noise, some environments are more suitable than others. Avoid placing the flow meter or its wiring close to devices that produce high intensity electromagnetic and electrostatic fields. Such devices include electric welding equipment, large electric motors and transformers, and communication transmitters.

Upstream and downstream piping

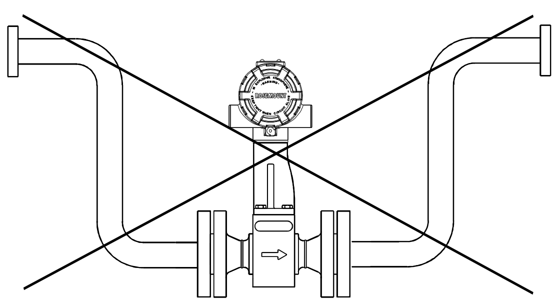
The meter may be installed with a minimum of ten diameters (D) of straight pipe length upstream and five diameters (D) of straight pipe length downstream.

To achieve reference accuracy, straight pipe lengths of 35D upstream and 5D downstream are required. The value of the K-factor may shift up to 0.5% when the upstream straight pipe length is between 10D and 35D. For optional K-factor corrections, see *Rosemount™ 8800 Vortex Installation Effects Technical Data Sheet*.

Steam piping

For steam applications, avoid installations such as the one shown in the following figure. Such installations may cause a water-hammer condition at start-up due to trapped condensation. The high force from the water hammer can stress the sensing mechanism and cause permanent damage to the sensor.

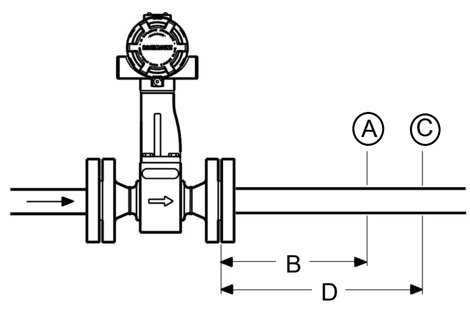
Figure 3-5: Wrong steam pipe installation



Pressure and temperature transmitter location

When using pressure and temperature transmitters in conjunction with the vortex flow meter for compensated mass flows, install the transmitter(s) downstream of the vortex flow meter.

Figure 3-6: Pressure and temperature transmitter location



A. *Pressure transmitter*
B. *Four straight pipe diameters downstream*
C. *Temperature transmitter*
D. *Six straight pipe diameters downstream*

3.1.5 Power supply

The transmitter requires 10 to 30 VDC. The maximum power consumption is 0.4 W.

3.2 Commissioning

For proper configuration and operation, commission the meter before putting it into operation. Bench commissioning also enables you to check hardware settings, test the flowmeter electronics, verify flowmeter configuration data, and check output variables. Any problems can be corrected—or configuration settings changed—before going out into the installation environment. To commission on the bench, connect a configuration device to the signal loop in accordance the device instructions.

3.2.1 Alarm and security jumper configuration

Two jumpers on the transmitter specify the alarm and security modes. Set these jumpers during the commissioning stage to avoid exposing the electronics to the plant environment. The two jumpers can be found on the electronics board stack or on the LCD display.

Alarm The jumper setting for Alarm has no effect when the HART address is set to 1, which is the required setting for the transmitter when configured for use on a Modbus network.

Security You can protect the configuration data with the security lockout jumper. With the security lockout jumper ON, any configuration changes attempted on the electronics are disallowed. You can still access and review any of the operating parameters and scroll through the available parameters, but no changes can be made. The factory sets the jumper according to the Configuration Data Sheet, if applicable, or OFF by default.

Note
If you will be changing configuration variables frequently, it may be useful to leave the security lockout jumper in the OFF position to avoid exposing the flow meter electronics to the plant environment.

To access the jumpers, remove the transmitter electronics housing or the LCD cover (if equipped) opposite of the terminal block, See Figure 3-7 and Figure 3-8.

Figure 3-7: Alarm and security jumpers (no LCD option)

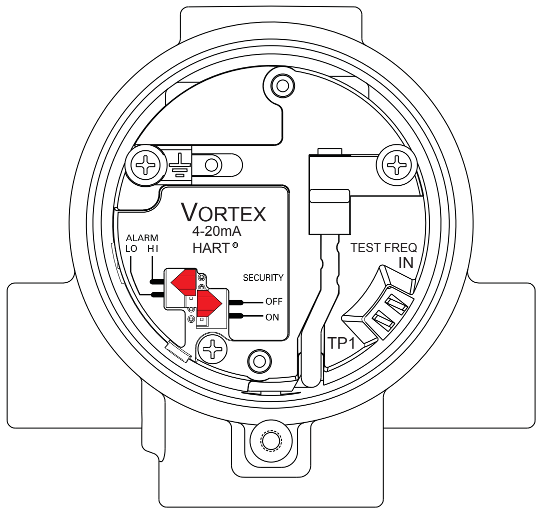
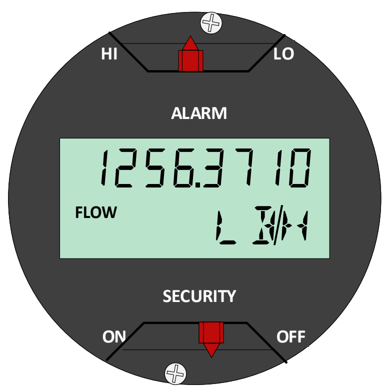


Figure 3-8: Alarm and security jumpers (with LCD option)



3.2.2 Calibration

The flow meter is wet-calibrated at the factory and needs no further calibration during installation. The calibration factor (K-factor) is indicated on each meter body and is entered into the electronics. Verification can be accomplished with a configuration device.

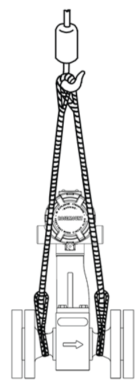
4 Basic installation

4.1 Handling

Handle all parts carefully to prevent damage. Whenever possible, transport the system to the installation site in the original shipping containers. Keep the shipping plugs in the conduit connections until you are ready to connect and seal them.

NOTICE
To avoid damage to the meter, do not lift the flow meter by the transmitter. Lift the meter by the meter body. Lifting supports can be tied around the meter body as shown.

Figure 4-1: Lifting supports



4.2 Flow direction

The meter can only measure flow in the direction indicated on the meter body. Be sure to mount the meter body so the FORWARD end of the flow arrow points in the direction of the flow in the pipe.

4.3 Gaskets

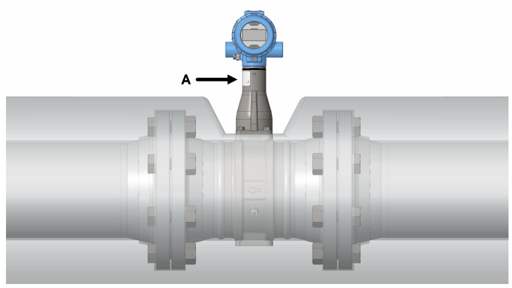
The flow meter requires gaskets supplied by the user. Be sure to select gasket material that is compatible with the process fluid and pressure ratings of the specific installation.

Note
Ensure the inside diameter of the gasket is larger than the inside diameter of the flow meter and adjacent piping. If gasket material extends into the flow stream, it will disturb the flow and cause inaccurate measurements.

4.4 Insulation

Insulation should extend to the end of the bolt on the bottom of the meter body and should leave at least 1-in. (25 mm) of clearance around the electronics bracket. The electronics bracket and electronics housing should not be insulated. See Figure 4-2.

Figure 4-2: Insulation best practice to prevent electronics overheating



A. Support tube

CAUTION

In high temperature installations, to avoid damage to the electronics on integral units or to the remote cable on remote units, only insulate the meter body as shown. Do not insulate the support tube. See also Orientation.

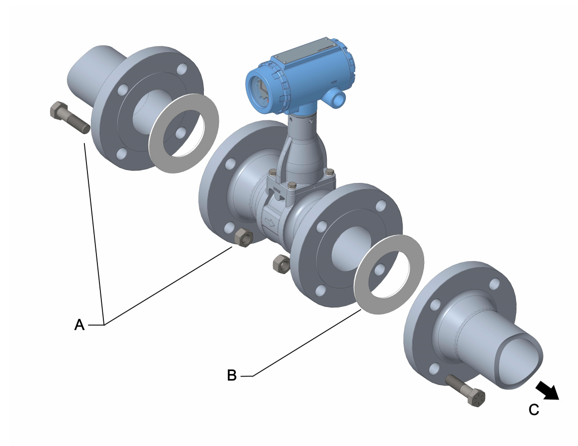
4.5 Flanged-style flow meter mounting

Most vortex flow meters use a flanged-style process connection. Physical mounting of a flanged-style flow meter is similar to installing a typical section of pipe. Conventional tools, equipment, and accessories (such as bolts and gaskets) are required. Tighten the nuts following the sequence shown in Figure 4-4.

Note

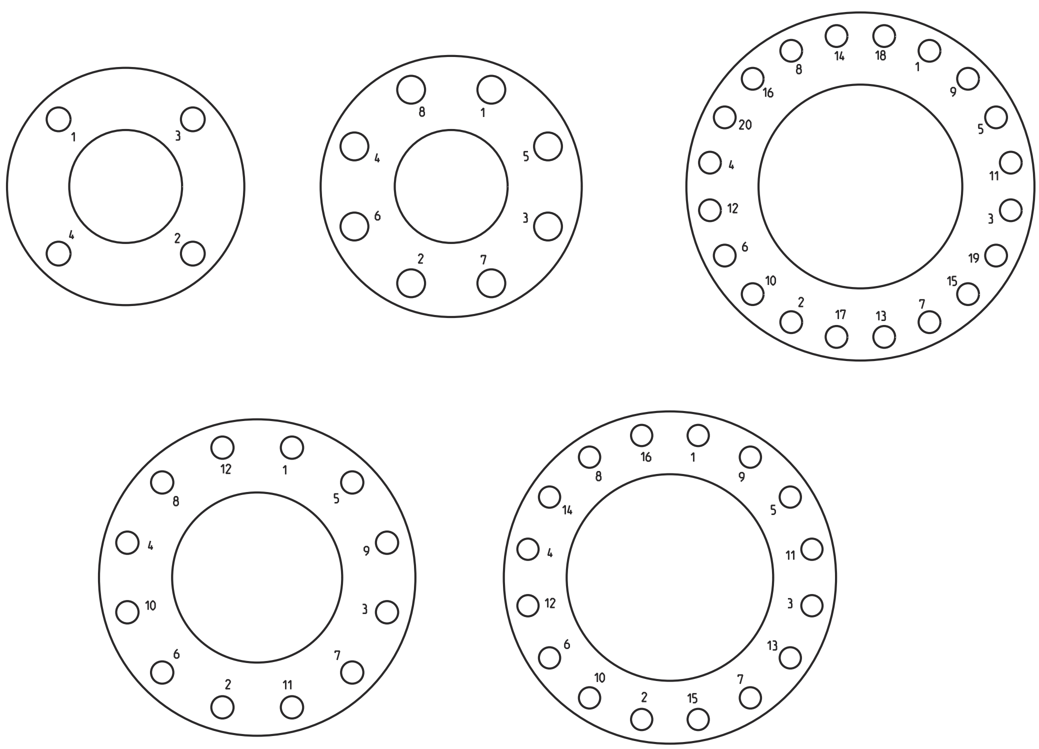
The required bolt load for sealing the gasket joint is affected by several factors, including operating pressure and gasket material, width, and condition. A number of factors also affect the actual bolt load resulting from a measured torque, including condition of bolt threads, friction between the nut head and the flange, and parallelism of the flanges. Due to these application-dependent factors, the required torque for each application may be different. Follow the guidelines outlined in ASME PCC-1 for proper bolt tightening. Make sure the flow meter is centered between flanges of the same nominal size and rating as the flow meter.

Figure 4-3: Flanged-style flow meter installation



A. Installation studs and nuts (supplied by customer)
B. Gaskets (supplied by customer)
C. Flow

Figure 4-4: Flange bolt torquing sequence



4.6 Wafer-style flow meter alignment and mounting

Center the wafer-style meter body inside diameter with respect to the inside diameter of the adjoining upstream and downstream piping. This will ensure the flow meter achieves its specified accuracy. Alignment rings are provided with each wafer-style meter body for centering purposes. Follow these steps to align the meter body for installation. Refer to Figure 4-5.

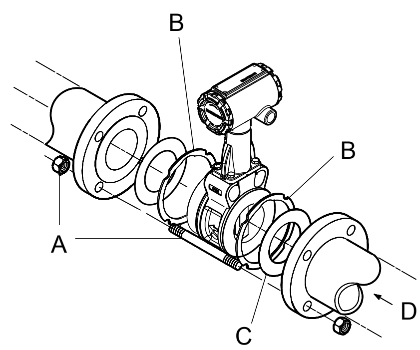
1. Place the alignment rings over each end of the meter body.
2. Insert the studs for the bottom side of the meter body between the pipe flanges.
3. Place the meter body (with alignment rings) between the flanges.
   - Make sure the alignment rings are properly placed onto the studs.
   - Align the studs with the markings on the ring that correspond to the flange you are using.

Note
Be sure to align the flow meter so the electronics are accessible, the conduits drain, and the flow meter is not subject to direct heat.

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

Note
The required bolt load for sealing the gasket joint is affected by several factors, including operating pressure and gasket material, width, and condition. A number of factors also affect the actual bolt load resulting from a measured torque, including condition of bolt threads, friction between the nut head and the flange, and parallelism of the flanges. Due to these application-dependent factors, the required torque for each application may be different. Follow the guidelines outlined in ASME PCC-1 for proper bolt tightening. Make sure the flow meter is centered between flanges of the same nominal size and rating as the flow meter.

Figure 4-5: Wafer-style flow meter installation with alignment rings



A. *Installation studs and nuts (supplied by customer)*
B. *Alignment rings*
C. *Spacer (for Rosemount 8800D to maintain Rosemount 8800A dimensions)*
D. *Flow*

Note
See for instructions on retrofitting 8800D to 8800A installations.

4.6.1 Stud bolts for wafer-style flow meters

The following tables list the recommended minimum stud bolt lengths for wafer-style meter body size and different flange ratings.

Table 4-1: Stud bolt length for wafer-style flow meters with ASME B16.5 flanges

Line size	Minimum recommended stud bolt lengths (in inches) for each flange rating		
	Class 150	Class 300	Class 600
½-inch	6.00	6.25	6.25
1-inch	6.25	7.00	7.50
1½-inch	7.25	8.50	9.00
2-inch	8.50	8.75	9.50
3-inch	9.00	10.00	10.50
4-inch	9.50	10.75	12.25
6-inch	10.75	11.50	14.00
8-inch	12.75	14.50	16.75

Table 4-2: Stud bolt length for wafer-style flow meters with EN 1092 flanges

Line size	Minimum recommended stud bolt lengths (in mm) for each flange rating			
	PN 16	PN 40	PN 63	PN 100
DN 15	160	160	170	170
DN 25	160	160	200	200
DN 40	200	200	230	230
DN 50	220	220	250	270
DN 80	230	230	260	280
DN 100	240	260	290	310
DN 150	270	300	330	350
DN 200	320	360	400	420

Line size	Minimum recommended stud bolt lengths (in mm) for each flange rating		
	JIS 10k	JIS 16k and 20k	JIS 40k
15mm	150	155	185
25mm	175	175	190
40mm	195	195	225
50mm	210	215	230
80mm	220	245	265
100mm	235	260	295
150mm	270	290	355
200mm	310	335	410

4.7 Cable glands

If you are using cable glands instead of conduit, follow the cable gland manufacturer's instructions for preparation and make the connections in a conventional manner in accordance with local or plant electrical codes. Be sure to properly seal unused ports to prevent moisture or other contamination from entering the terminal block compartment of the electronics housing.

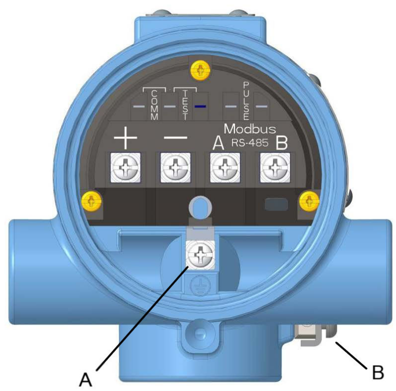
4.8 Flow meter grounding

Grounding is not required in typical vortex applications; however, a proper ground will eliminate possible noise pickup by the electronics. Grounding straps may be used to ensure that the meter is grounded to the process piping. If you are using the transient protection option (T1), grounding straps are required to provide a proper low impedance ground.

Note
Properly ground flow meter body and transmitter per the local code.

To use grounding straps, secure one end of the grounding strap to the bolt extending from the side of the meter body and attach the other end of each grounding strap to a suitable ground. See Figure 4-6.

Figure 4-6: Grounding connections



A. *Internal ground connection*
B. *External ground assembly*

4.9 Grounding the transmitter case

The transmitter case should always be grounded in accordance with national and local electrical codes. The most effective transmitter case grounding method is direct connection to earth ground with minimal impedance. Methods for grounding the transmitter case include:

Internal Ground Connection	The Internal Ground Connection screw is inside the FIELD TERMINALS side of the electronics housing. This screw is identified by a ground symbol (⏚), and is standard on all Rosemount 8800D transmitters.
External Ground Assembly	This assembly is located on the outside of the electronics housing and is included with the optional transient protection terminal block (Option Code T1). The External Ground Assembly can also be ordered with the transmitter (Option Code V5) and is automatically included with certain hazardous area approvals. See Figure 4-6 for the location of the external ground assembly.

Note
Grounding the transmitter case using the threaded conduit connection may not provide a sufficient ground. The transient protection terminal block (Option Code T1) does not provide transient protection unless the transmitter case is properly grounded. For transient terminal block grounding, see Transient protection. Use the above guidelines to

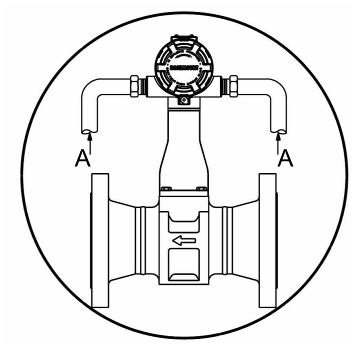
ground the transmitter case. Do not run the transient protection ground wire with signal wiring as the ground wire may carry excessive electric current if a lightning strike occurs.

4.10 Conduit installation

Prevent condensation in any conduit from flowing into the housing by mounting the flowmeter at a high point in the conduit run. If the flowmeter is mounted at a low point in the conduit run, the terminal compartment could fill with fluid.

If the conduit originates above the flowmeter, route conduit below the flowmeter to form a drip loop before entry. In some cases a drain seal may need to be installed.

Figure 4-7: Proper conduit installation

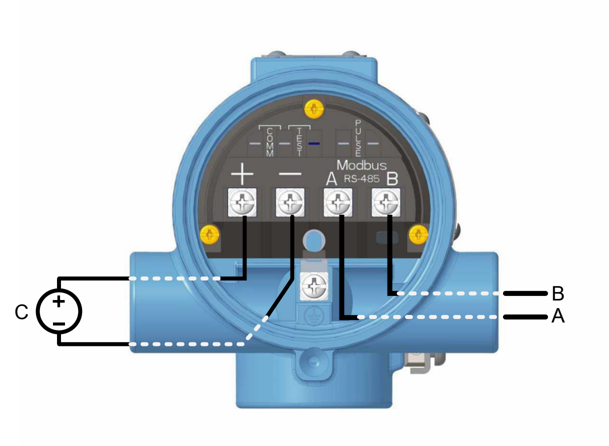


A. *Conduit line*

4.11 Wiring

1. Supply 10–30 VDC to the positive (+) and negative (–) terminals. The power terminals are polarity insensitive: the polarity of the DC power leads does not matter when connecting to the power terminals.

Figure 4-8: Modbus and power supply wiring



A. RS-485 (A)
B. RS-485 (B)
C. 10–30 VDC power supply

2. Connect Modbus RTU communication wires to the Modbus A and B terminals.

Note
Twisted pair wiring is required for RS-485 bus wiring. Wiring runs under 1000 ft (305 m) should be AWG 22 or larger. Wiring runs from 1000 to 4000 ft. (305 to 1219 m) should be AWG 20 or larger. Wiring should not exceed AWG 16.

4.12 Remote installation

If a remote electronics option (Rxx or Axx) was ordered, the flow meter assembly will be shipped in two parts:

- The meter body with an adapter installed in the support tube and an interconnecting coaxial cable attached to it.
- The electronics housing installed on a mounting bracket.

If an armored remote electronics option (Axx) was ordered, follow the same instructions as for the standard remote cable connection with the exception that the cable may not need to be run through conduit. Both standard and armored cable include cable glands. Information on remote installation can be found in Cable connections.

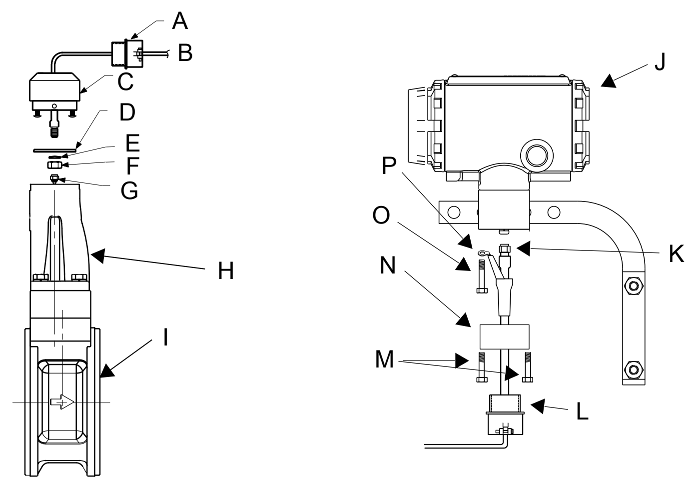
4.12.1 Mounting

Mount the meter body in the process flow line as described earlier in this section. Mount the bracket and electronics housing in the desired location. The housing can be repositioned on the bracket to facilitate field wiring and conduit routing.

4.12.2 Cable connections

Complete these steps for connecting the loose end of the coaxial cable to the electronics housing. If connecting/disconnecting the meter adapter to the meter body,.

Figure 4-9: Remote installation



A. *½ NPT conduit adapter or cable gland (supplied by customer for Rxx options)*
B. *Coaxial cable*
C. *Meter adapter*
D. *Union*
E. *Washer*
F. *Nut*
G. *Sensor cable nut*
H. *Support tube*
I. *Meter body*
J. *Electronics housing*
K. *Coaxial cable SMA nut*
L. *½ NPT conduit adapter or cable gland (supplied by customer for Rxx options)*
M. *Housing adapter screws*
N. *Housing adapter*
O. *Housing base screw (one of four)*
P. *Ground connection*

CAUTION

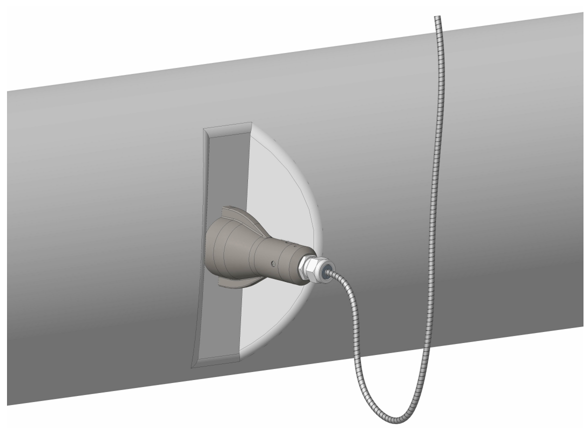
To prevent moisture from entering the coaxial cable connections, install the interconnecting coaxial cable in a single dedicated conduit run or use sealed cable glands at both ends of the cable.

In remote mount configurations when ordered with a hazardous area option code, the remote sensor cable and the interconnecting thermocouple cable are protected by separate intrinsic safety circuits, and must be segregated from each other, other intrinsically safe circuits, and non-intrinsically safe circuits per local and national wiring code.

CAUTION

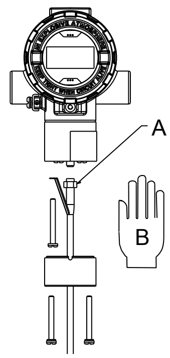
The coaxial remote cable cannot be field terminated or cut to length. Coil any extra coaxial cable with no less than a 2-in. (51 mm) radius.

1. If you plan to run the coaxial cable in conduit, carefully cut the conduit to the desired length to provide for proper assembly at the housing. A junction box may be placed in the conduit run to provide a space for extra coaxial cable length.
2. Slide the conduit adapter or cable gland over the loose end of the coaxial cable and fasten it to the adapter on the meter body support tube. If coaxial remote cable originates or any part of the cable is above the flow meter, route cable below the flow meter to form a drip loop before the meter body support tube.



3. If using conduit, route the coaxial cable through the conduit.
4. Place a conduit adapter or cable gland over the end of the coaxial cable.
5. Remove the housing adapter from the electronics housing.
6. Slide the housing adapter over the coaxial cable.
7. Remove one of the four housing base screws.
8. Attach the coaxial cable ground wire to the housing via the housing base ground screw.
9. Attach and hand tighten the coaxial cable SMA nut to the electronics housing to 7 in-lbs (0.8 N-m).

Figure 4-10: Attaching and tightening SMA nut



A. SMA nut
B. Hand tighten

Note
Do not over-tighten the coaxial cable nut to the electronics housing.

10. Align the housing adapter with the housing and attach with two screws.
11. Tighten the conduit adapter or cable gland to the housing adapter.

4.12.3 Housing rotation

The entire electronics housing may be rotated in 90° increments for easy viewing. Use the following steps to change the housing orientation,

1. Loosen the housing rotation set screws at the base of the electronics housing with a 5/32” hex wrench by turning the screws clockwise (inward) until they clear the support tube.
2. Slowly pull the electronics housing out of the support tube.

CAUTION
Do not pull the housing more than 1.5 in. (40 mm) from the top of the support tube until the sensor cable is disconnected. Damage to the sensor may occur if this sensor cable is stressed.

3. Unscrew the sensor cable from the housing with a 5/16” open end wrench.
4. Rotate the housing to the desired orientation.
5. Hold it in this orientation while you screw the sensor cable onto the base of the housing.

CAUTION
Do not rotate the housing while the sensor cable is attached to the base of the housing. This will stress the cable and may damage the sensor.

6. Place the electronics housing into the top of the support tube.

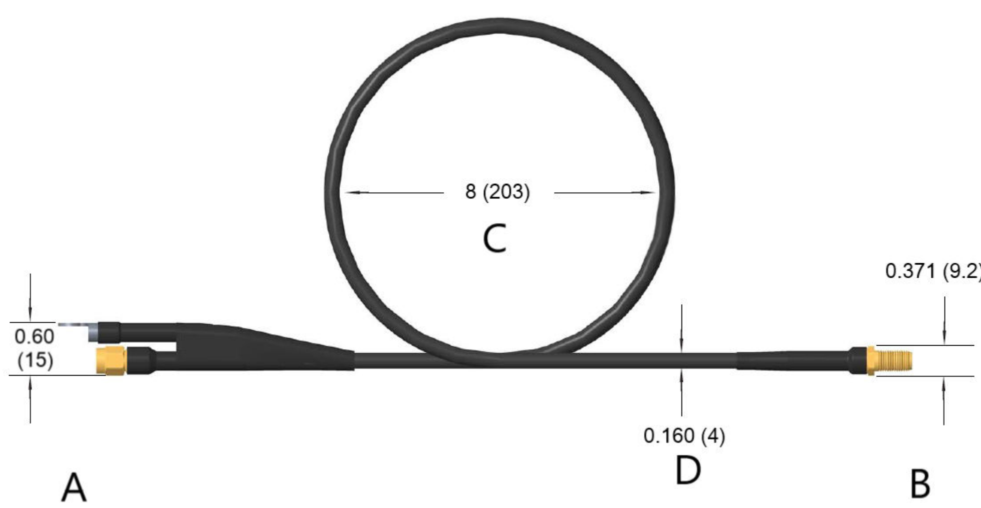
7. Use a hex wrench to turn the housing rotation screws counter-clockwise (outward) to engage the support tube.

4.12.4 Specifications and requirements for remote sensor cable

If using a Rosemount remote sensor cable, observe these specifications and requirements.

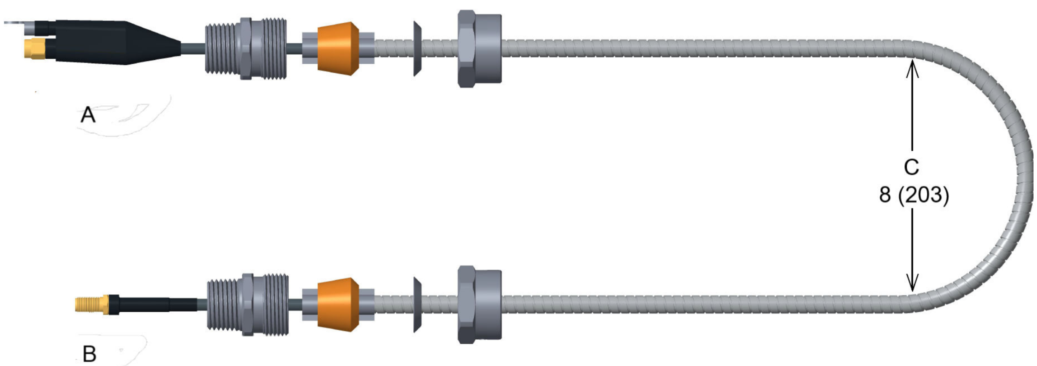
- The remote sensor cable is a proprietary design tri-axial cable
- It is considered a low voltage signal cable
- It is rated for and/or part of intrinsically safe installations
- Non armored version is designed to be run through metal conduit
- Cable is water resistant, but not submersible. As a best practice, exposure to moisture should be avoided if possible
- Rated operating temperature is –58°F to +392°F (–50°C to +200°C)
- Flame Resistant in accordance with IEC 60332-3
- Non-armored and armored version minimum bend diameter is 8 inches (203 mm)
- Nominal O.D. of the non-armored version is 0.160 inches (4 mm)
- Nominal O.D. of the armored version is 0.282 inches (7.1 mm)

Figure 4-11: Non-armored cable



A. Transmitter end
B. Sensor end
C. Minimum bend diameter
D. Nominal O.D.

Figure 4-12: Armored cable

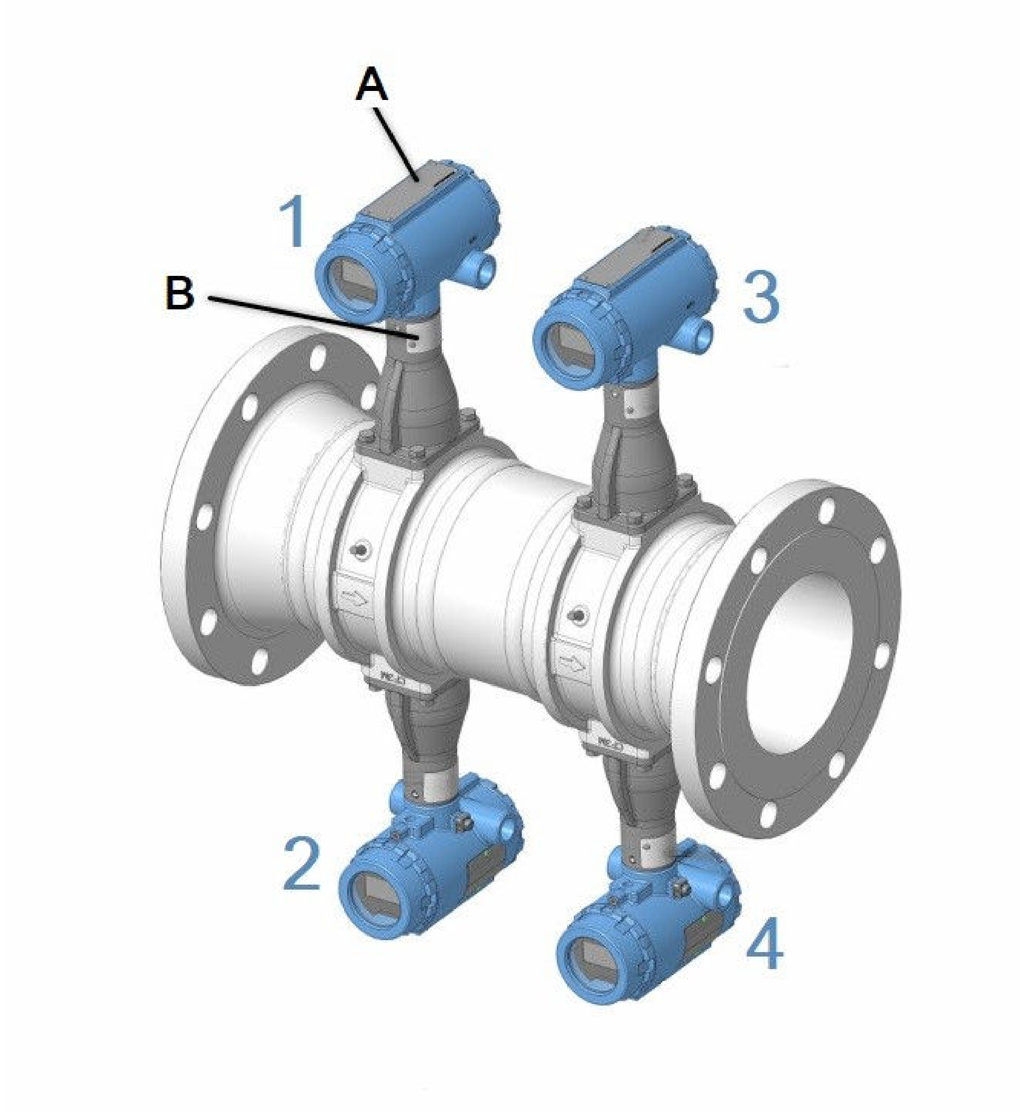


A. Transmitter end
B. Sensor end
C. Minimum bend diameter

4.13 Quad transmitter numbering and orientation

When quad vortex flow meters are ordered, for configuration purposes, the transmitters are identified as Transmitter 1, Transmitter 2, Transmitter 3, and Transmitter 4. The transmitter and meter body nameplate of a Quad Vortex flow meter can be used to identify and verify the transmitter number. See Figure 4-13 for Quad transmitter orientation and nameplate locations. See Figure 4-14 and 4-15 for Quad transmitter and meter body nameplate number location.

Figure 4-13: Quad transmitter numbering



A. Transmitter nameplate (Transmitter 1)
B. Meter body nameplate (Transmitter 1)

Figure 4-14: Quad transmitter nameplate

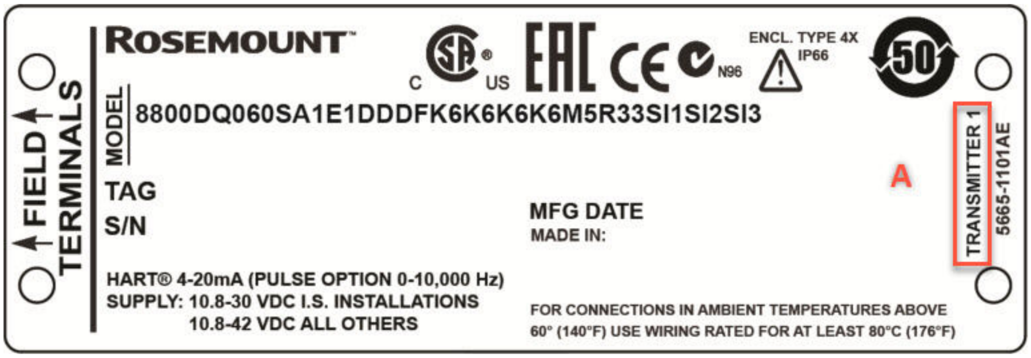
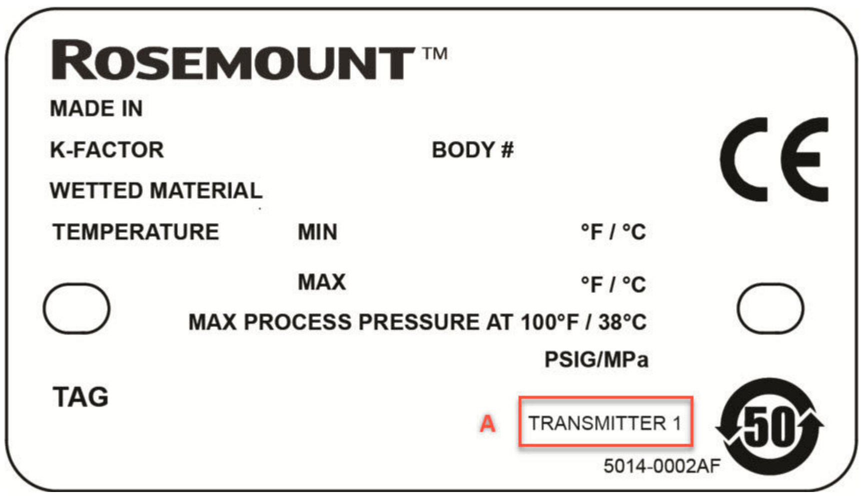


Figure 4-15: Quad meter body nameplate



5 Basic configuration

5.1 About basic configuration

The transmitter will be configured at the factory before shipment. If further configuration changes are required, note the following:

- A HART communication tool must be used. Examples are ProLink III Software or AMS Software with a HART modem, or Emerson AMS Trex Device Communicator or 475 Field Communicator.
- The transmitter leaves the factory at HART address 1. Verify that the HART communication tool is configured to poll beyond address 0.

  Important
  Do not change the transmitter HART address; it should always be set to 1.

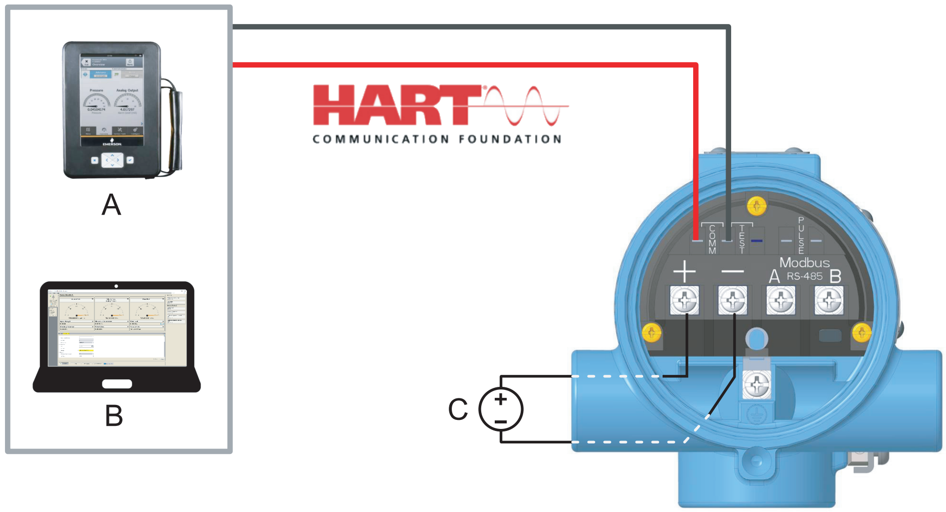
- The COMM terminals must be used for configuration. A built-in load resistor is provided for HART communication; an external load resistor is not required.

Note
After measurement configuration and Modbus communication settings are configured with a HART communicatoin tool, the flow meter can be used to output measurement data to a Modbus host.

5.2 Connect configuration tool

If configuration changes are needed, connect the configuration tool to the transmitter as shown in Figure 5-1.

Figure 5-1: HART configuration tool connection to COMM port



A. *Example AMS Trex Device Communicator*
B. *Example ProLink III software on PC*
C. *10–30 VDC power supply*

Tip
If you do not have an external power supply during configuration, you can temporarily power the transmitter directly through the COMM terminals using the AMS Trex Device Communicator.

5.3 Process variables

Process variables define the flow meter output. When commissioning a flow meter, review each process variable, its function and output, and take corrective action if necessary before using the flow meter in a process application.

5.3.1 Primary variable mapping

Allows the user to select which variables the transmitter will output.

ProLink III	**Device Tools → Configuration → Communications (HART)**

Flow variables are available as Corrected Volume Flow, Mass Flow, Velocity Flow, Volume Flow or Process Temperature (MTA option only).

When bench commissioning, the flow values for each variable should be zero and the temperature value should be the ambient temperature.

If the units for the flow or temperature variables are not correct, refer to Process variable units. Use the Process Variable Units function to select the units for your application.

5.3.2 Process variable units

ProLink III	**Device Tools → Configuration → Process Measurement → (select type)**

Allows for the viewing and configuration of Process Variable Units such as Volume, Velocity, Mass Flow, Electronics Temperature, Process Density, and Corrected Volume units, including corrected volume Special Units configuration.

Volume flow units

Allows the user to select the volumetric flow units from the available list.

Table 5-1: Volume flow units

gallons per second	gallons per minute	gallons per hour
gallons per day	cubic feet per second	cubic feet per minute
cubic feet per hour	cubic feet per day	barrels per second
barrels per minute	barrels per hour	barrels per day
imperial gallons per second	imperial gallons per minute	imperial gallons per hour
imperial gallons per day	liters per second	liters per minute
liters per hour	liters per day	cubic meters per second
cubic meters per minute	cubic meters per hour	cubic meters per day
mega cubic meters per day	special units	

Corrected volumetric flow units

Allows the user to select the corrected volumetric flow units from the available list.

Table 5-2: Corrected volume flow units

gallons per second	gallons per minute	gallons per hour
gallons per day	cubic feet per second	standard cubic feet per minute
standard cubic feet per hour	cubic feet per day	barrels per second
barrels per minute	barrels per hour	barrels per day
imperial gallons per second	imperial gallons per minute	imperial gallons per hour
imperial gallons per day	liters per second	liters per minute
liters per hour	liters per day	normal cubic meters per minute
normal cubic meters per hour	normal cubic meters per day	cubic meters per second
cubic meters per minute	cubic meters per hour	cubic meters per day
special units		

Note
When measuring corrected volumetric flow, a base density and process density must be provided. The base density and process density are used to calculate the density ratio which is a value used to convert actual volume flow to corrected volume flow.

Mass flow units

Allows the user to select the mass flow units from the available list. (1 STon = 2000 lb; 1 MetTon = 1000 kg)

Table 5-3: Mass flow units

grams per hour	grams per minute	grams per second
kilograms per day	kilograms per hour	kilograms per minute
kilograms per second	pounds per minute	pounds per hour
pounds per day	special units	short tons per day
short tons per hour	short tons per minute	pounds per second
tons (metric) per day	tons (metric) per hour	tons (metric) per minute

---

Note
If you select a Mass Flow Units option, you must enter process density in your configuration.

Velocity flow units

Allows the user to select the Velocity Flow Units from the available list.

- feet per second
- meters per second

Velocity measurement base

Determines if the velocity measurement is based on the mating pipe ID or the meter body ID. This is important for Reducer™ Vortex Applications.

5.4 Process configuration

ProLink III	**Device Tools → Configuration → Device Setup**

The flow meter can be used for liquid or gas/steam applications, but it must be configured specifically for the application. If the flow meter is not configured for the proper process, readings will be inaccurate. Select the appropriate process configuration parameters for your application:

Transmitter mode

For units with an integral temperature sensor, the temperature sensor can be activated here.

- Without Temperature Sensor
- With Temperature Sensor

Set process fluid

Select the fluid type—either Liquid, Gas/Steam, Tcomp Sat Steam, or Tcomp Liquids. Tcomp Sat Steam and Tcomp Liquids require the MTA Option and provide dynamic density compensation based on the process temperature reading.

Fixed process temperature

Needed for the electronics to compensate for thermal expansion of the flow meter as the process temperature differs from the reference temperature. Process temperature is the temperature of the liquid or gas in the line during flow meter operation.

May also be used as a back-up temperature value in the event of a temperature sensor failure if the MTA option is installed.

Fixed process density

A Fixed Process Density must be accurately configured if mass flow or corrected volume flow measurements are used. In mass flow it is used to convert volume flow to mass flow. In corrected volume flow it is used with the base process density to derive a density ratio which in turn is used to convert volume flow to corrected volume flow. In temperature compensated fluids the fixed process density is still required as it is used to convert volume flow sensor limits to sensor limits for temperature compensated fluids.

Note
If mass or corrected volume units are chosen, you must enter the density of your process fluid into the software. Be careful to enter the correct density. The mass flow rate and density ratio are calculated using this user-entered density, and unless the transmitter is in TComp Sat Steam or TComp Liquids mode where changes in density are automatically being compensated for, any error in this number will cause error in the measurement.

Base process density

The density of the fluid at base conditions. This density is used in corrected volume flow measurement. It is not required for volume flow, mass flow, or velocity flow. The Base Process Density is used with the Process Density to calculate the Density Ratio. In temperature compensated fluids, the Process Density is calculated by the transmitter. In non-temperature compensated fluids the Fixed Process Density is used to calculate a fixed Density Ratio. Density Ratio is used to convert actual volumetric flow to standard volumetric flow rates based on the following equation:

Density ratio = density at actual (flowing) conditions/density at standard (base) conditions

5.5 Reference K-factor

ProLink III	**Device Tools → Configuration → Device Setup**

A factory calibration number relating the flow through the meter to the shedding frequency measured by the electronics. Every vortex meter manufactured by Emerson is run through a water calibration to determine this value.

5.6 Flange type

ProLink III	**Device Tools → Configuration → Device Setup**

Enables the user to specify the type of flange on the flow meter for later reference. This variable is preset at the factory but can be changed if necessary.

Table 5-4: Flange types

Wafer	ASME 150	ASME 150 Reducer
ASME 300	ASME 300 Reducer	ASME 600
ASME 600 Reducer	ASME 900	ASME 900 Reducer
ASME 1500	ASME 1500 Reducer	ASME 2500
ASME 2500 Reducer	PN10	PN10 Reducer
PN16	PN16 Reducer	PN25
PN25 Reducer	PN40	PN40 Reducer
PN64	PN64 Reducer	PN100
PN100 Reducer	PN160	PN160 Reducer
JIS 10K	JIS 10K Reducer	JIS 16K/20K
JIS 16K/20K Reducer	JIS 40K	JIS 40K Reducer
Special (Spcl)		

5.7 Pipe I.D.

ProLink III	**Device Tools → Configuration → Device Setup**

The pipe I.D. (inside diameter) of the pipe adjacent to the flow meter can cause entrance effects that may alter flow meter readings. Configuring the actual mating pipe inside diameter will correct for theses effects. Enter the appropriate value for this variable.

Pipe I.D. values for schedule 10, 40, and 80 piping are given in the following table. If the mating pipe I.D. is not listed in the table, confirm it with the manufacturer or measure it yourself.

Table 5-5: Pipe IDs for Schedule 10, 40, and 80 piping

Pipe size inches (mm)	Schedule 10 inches (mm)	Schedule 40 inches (mm)	Schedule 80 inches (mm)
½ (15)	0.674 (17,12)	0.622 (15,80)	0.546 (13,87)
1 (25)	1.097 (27,86)	1.049 (26,64)	0.957 (24,31)
1½ (40)	1.682 (42,72)	1.610 (40,89)	1.500 (38,10)
2 (50)	2.157 (54,79)	2.067 (52,50)	1.939 (49,25)
3 (80)	3.260 (82,80)	3.068 (77,93)	2.900 (73,66)
4 (100)	4.260 (108,2)	4.026 (102,3)	3.826 (97,18)
6 (150)	6.357 (161,5)	6.065 (154,1)	5.761 (146,3)
8 (200)	8.329 (211,6)	7.981 (202,7)	7.625 (193,7)
10 (250)	10.420 (264,67)	10.020 (254,51)	9.562 (242,87)
12 (300)	12.390 (314,71)	12.000 (304,80)	11.374 (288,90)

5.8 Optimize Digital Signal Processing (DSP)

ProLink III	**Device Tools → Configuration → Process Measurement → Signal Processing**

A function that can be used to optimize the range of the flow meter based on the density of the fluid. The electronics uses process density to calculate the minimum measurable flow rate, while retaining at least a 4:1 signal to the trigger level ratio. This function will also reset all of the filters to optimize the flow meter performance over the new range. If the configuration of the device has changed, this method should be executed to ensure the signal processing parameters are set to their optimum settings. For dynamic process densities, select a density value that is lower than the lowest expected flowing density.

5.9 Modbus communication settings

Table 5-6: Modbus default and configurable communication settings

Parameter	Rosemount 8800D default settings[1]	HMC Default settings	Configurable values
Baud rate	9600		1200, 2400, 4800, 9600, 19200, 38400
Start bits[2]	One		
Data Bits[2]	Eight		
Parity	Even	None	None, Odd, Even
Stop Bits	One	One	One, two

Table 5-6: Modbus default and configurable communication settings *(continued)*

Parameter	Rosemount 8800D default settings(1)	HMC Default settings	Configurable values
Address range	1	246	1–247

(1) If the transmitter was ordered without communication settings, these will be configured at the factory.
(2) Start bits and data bits cannot be changed.

Configuring the HART Message field

ProLink III	**Device Tools → Configuration → Informational Parameters → Transmitter**

To implement the Modbus communication settings using a HART communication device, you must enter the parameters in the form of a text string into the HART Message field.

Note
The HART address must be set to 1 to ensure that the HART message field is implemented by the transmitter.

The string is in the following example format: HMC A44 B4800 PO S2

HMC These three characters are required at the beginning of the configuration string.

A44 A indicates that the following number is the new Address (address 44). Leading zeros are not needed.

B4800 B indicates that the following number is the new Baud rate (1200, 2400, 4800, 9600, 19200, 38400).

PO P identifies the following letter as Parity type (O = odd, E = even, and N = none).

S2 S indicates that the following figure is the number of Stop bits (1 = one, 2 = two).

Only values that differ from the current values need to be included. For example, if only the address is changed, the following text string is written into the HART Message: HMC A127.

Note
If the string is entered as only "HMC" the Modbus settings will be reset to their HMC default values shown in Table 5-6. This will not affect other transmitter configuration settings.

Note
Cycle power after sending the message and wait 60 seconds after the power is restored for changes to take effect.

Alarm handling

The output from the Modbus transmitter in case of an error (such as a field device malfunction) can be configured. The values for Modbus registers corresponding to PV, SV, TV, and QV will be changed accordingly (applicable registers in area 1300, 2000, 2100, and 2200).

Write HART Message field for HART address 1 device per Table 5-7.

Note
Cycle power after sending the message and wait 60 seconds after the power is restored for changes to take effect.

Table 5-7: Modbus alarm configuration settings

String	Alarm output
HMC EN	Not a number (NaN), default
HMC EF	Freeze, hold last value
HMC EU-0.1	User defined value. 0.1 in this example

6 Advanced installation

6.1 Insert integral temperature sensor

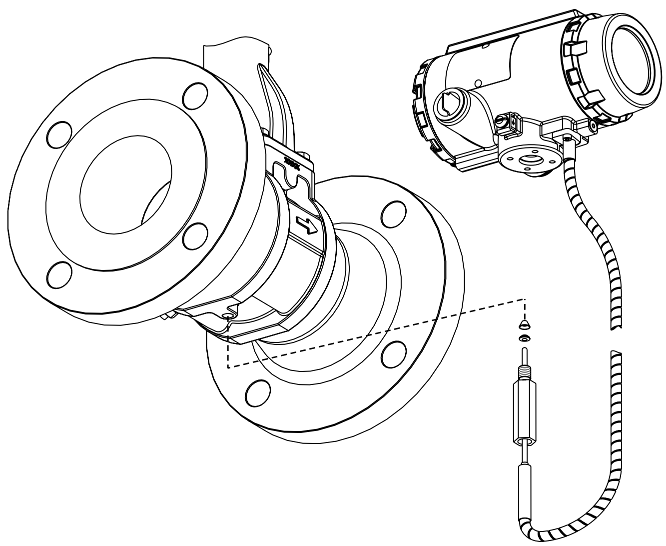
Follow these steps to install the integral temperature sensor, if equipped.

1. The temperature sensor is coiled and attached to the electronics bracket. Remove the Styrofoam around the sensor and insert the temperature sensor into the hole at the bottom of the meter body.

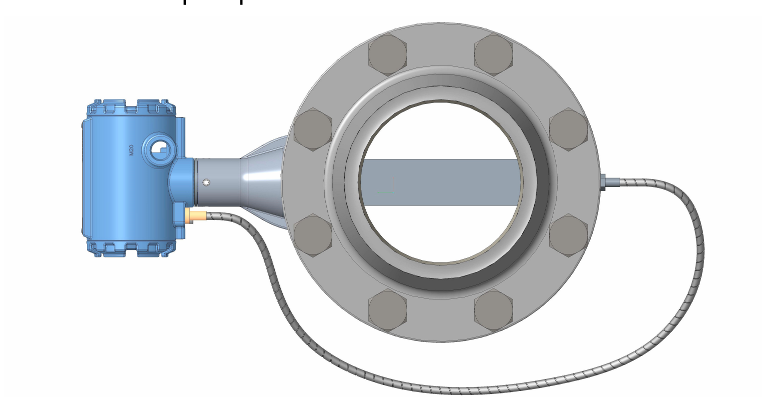
   There is no need to remove the opposite end from the electronics.

2. Insert temperature sensor into the hole in the bottom of meter body until it reaches the bottom of the hole.

Figure 6-1: Temperature sensor assembly for inserting into meter body



3. If any part of the temperature sensor cable is above the horizontal plane of where the temperature sensor enters the transmitter, route the sensor cable below the flow meter to form a drip loop.



4. Hold the temperature sensor in place and tighten the bolt with a ½ inch (13 mm) open end wrench until it reaches ¾ turns past finger tight. Do not over-tighten.
5. Verify that the insulation extends to the end of the bolt on the bottom of the meter body. Leave at least 1 inch (25 mm) clearance around the electronics bracket.

   The meter body should be insulated to achieve stated temperature accuracy. The electronics bracket and electronics housing should not be insulated. See Insulation.

   CAUTION
   Do not loosen or remove the temperature connection at the electronics when the housing integrity needs to be maintained.

6.2 Pulse output

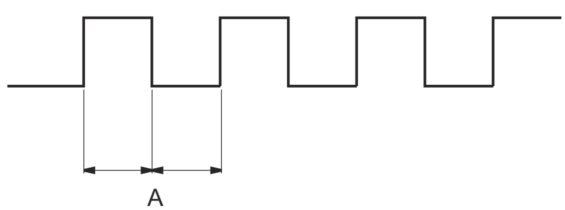
Note
When using the pulse output, all power to the electronics is still supplied by the Modbus power supply.

The flowmeter provides an isolated transistor switch-closure frequency output signal proportional to flow, as shown in the following figure. The frequency limits are as follows:

- Maximum frequency = 10000 Hz
- Minimum frequency = 0.0000035 Hz (1 pulse/79 hours)
- Duty cycle = 50%
- External supply voltage (Vs): 5 to 30 V dc
- Load Resistance (RL): 100 Ω to 100 kΩ
- Max switching current = 100 mA ≥ VS/RL
- Switch closure: transistor, open collector

In the following example, the pulse output will maintain a 50 percent duty cycle for all frequencies.

Figure 6-2: Example: Pulse output

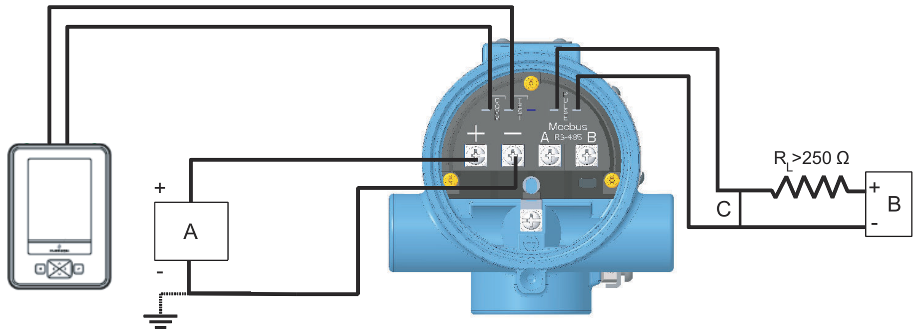


A. 50% duty cycle

6.2.1 Wire the pulse output

1. To connect the wires, remove the FIELD TERMINALS side cover of the electronics housing.
2. Connect the wires as shown in the following figure.

Figure 6-3: 4–20 mA and pulse wiring with electronic totalizer/counter



A. Power supply
B. Counter power supply
C. Counter

6.3 Transient protection

The optional transient terminal block prevents damage to the flowmeter from transients induced by lightning, welding, heavy electrical equipment, or switch gears. The transient protection electronics are located in the terminal block.

IEEE C62.41 - 2002 Category B

The transient terminal block was verified using the following test waveforms specified in the IEEE C62.41 - 2002 Category B standard:

- 3 kA crest (8 X 20 ms)
- 6 kV crest (1.2 X 50 ms)
- 6 kV/0.5 kA (0.5 ms, 100 kHz, ring wave)

6.3.1 Installing or replacing the transient protection

For flowmeters ordered with the transient protector option (T1), the protector is shipped installed.

The transient protection kit includes the following:

- One transient protection terminal block assembly
- Three captive screws

When purchased separately from the transmitter, install the protector using a small instrument screwdriver, a pliers, and the transient protection kit.

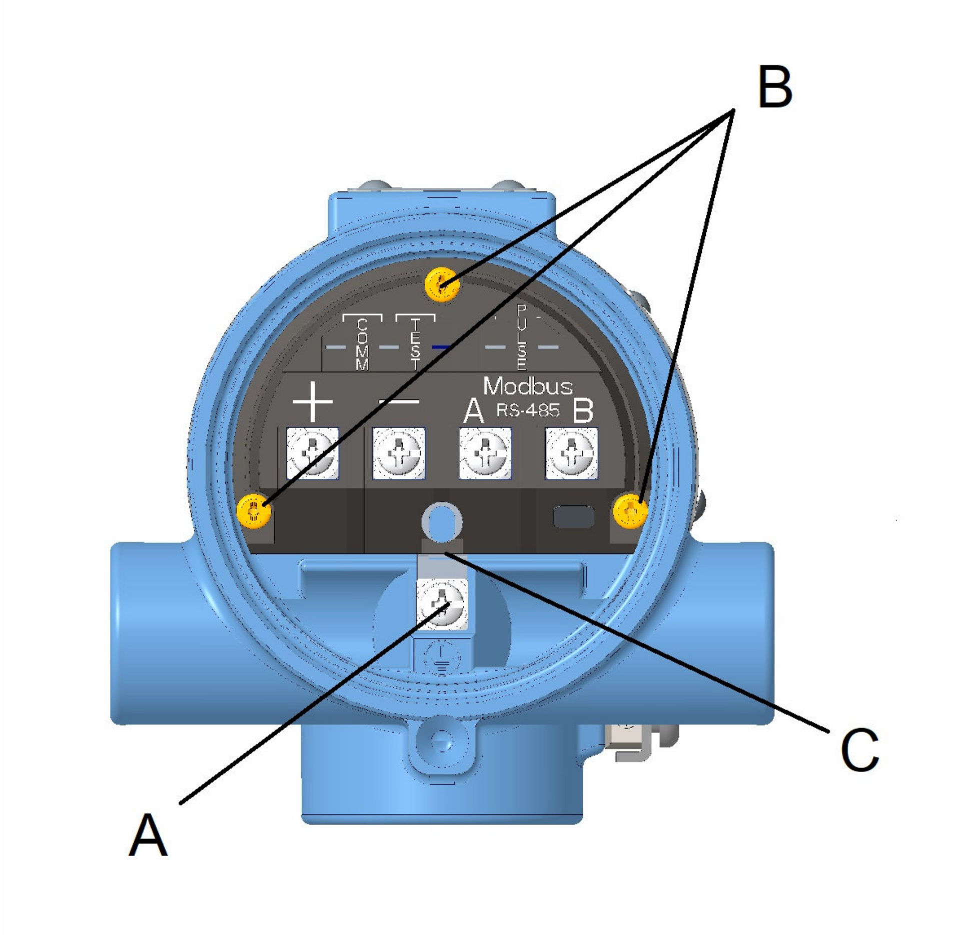
1. If the flowmeter is installed in a loop, secure the loop and disconnect power.
2. Remove the field terminal side flowmeter cover.
3. Remove the captive screws.

Refer to the following figure.

4. Remove the housing ground screw.
5. Use pliers to pull the terminal block out of the housing.
6. Inspect the connector pins for straightness.
7. Place the new terminal block in position and carefully press it into place.

   The terminal block may have to be moved back and forth to get the connector pins started into the sockets.
8. Tighten the captive screws.
9. Install and tighten the ground screw.
10. Replace the cover.

Figure 6-4: Transient Terminal Block



A. Housing ground screw
B. Captive screws
C. Transient terminal block ground tab

7 Advanced configuration

Advanced configuration options are used to configure the flow meter for a wider range of applications and special situations.

7.1 LCD display

ProLink III	**Device Tools → Configuration → Display Variables**

The LCD display (option M5) provides local indication of the output and abbreviated diagnostic messages governing operation of the flow meter. You can select any of the following variables to be displayed, where at least one must be selected:

- Primary Variable
- Percent of Range
- Totalizer Value
- Shedding Frequency
- Mass Flow
- Velocity Flow
- Volume Flow
- Process Temperature
- Pulse Frequency
- Shedding Frequency
- Electronics Temperature
- Signal Strength
- Corrected Volume Flow

Note
Analog Output and % of Range can be selected, but provide no useful information when Modbus protocol is used.

7.2 Compensated K-factor

ProLink III	**Device Tools → Configuration → Device Setup**

The compensated K-factor is based on the reference K-factor as compensated for the given process temperature, wetted materials, body number, and pipe ID. Compensated K-factor is an informational variable that is calculated by the electronics of the flow meter.

The reference K-factor is factory set and is displayed on the support tube label. The reference K-factor should only be re-configured in the device in the event of transmitter replacement. Contact technical support for details.

7.3 Meter body

ProLink III	**Device Tools → Configuration → Informational Parameters → Meter Body**

Meter body parameters are factory-set configuration variables that indicate the physical and manufacturing properties of the flow meter. These parameters need not be changed unless the transmitter is being configured in the field for use with a different meter body than originally configured.

Wetted Material The meter body material that is in contact with the process.

Flange Type The sensor flange type and rating.

Meter Body Serial Number The manufacturer's unique identification number for the sensor.

Body Number Suffix A number + letter or a number with no letter on the right side of the meter body tag indicating the construction of the meter.

Number + letter "A" or number only	Welded meter construction
Number + letter "B"	Cast meter construction

7.4 Meter factor

Compensates the flowmeter for installation effects such as those caused by less than ideal straight run piping. See the reference graphs in the *Technical Data Sheet (00816-0100-3250) on Installation Effects* for the percent of K-factor shift based on entrance effects of upstream disturbances. This value is entered as a flow multiplication factor of the range of 0.8 to 1.2.

7.5 Variable mapping

Allows the user to select which variables the transmitter will output.

ProLink III	**Device Tools → Configuration → Communications (HART)**

Primary Variable

The Primary Variable can be either Corrected Volume Flow, Mass Flow, Velocity Flow, or Volume Flow or Process Temperature. When bench commissioning, the flow values for each variable should be zero and the temperature value should be the ambient temperature.

If the units for the flow or temperature variables are not correct, refer to Process variable units. Use the Process Variable Units function to select the units for your application.

Secondary Variable

Selections for the secondary variable can be set to any of the following:

- Cold Junction Temperature (MTA)
- Totalizer Value
- Shedding Frequency
- Mass Flow
- Velocity Flow
- Volume Flow
- Process Temperature (MTA)
- Pulse Frequency
- Electronics Temperature
- Signal Strength
- Corrected Volume Flow

Third variable

Selections for the Third Variable are identical to those of the Secondary Variable.

Fourth variable

Selections for the Fourth Variable are identical to those of the Secondary Variable.

7.6 Pulse output

ProLink III	**Device Tools → Configuration → Outputs → Pulse Output**

Pulse output can be configured using the configuration tool guided setups.

The flow meter can provide a temporary pulse output to a test device. It may be configured for either pulse scaling (based on rate or unit) or shedding frequency output.

There are several options for configuring the pulse output:

- Off
- Direct (Shedding Frequency)
- Scaled Volume
- Scaled Velocity
- Scaled Mass
- Scaled Corrected Volumetric

Note
In order to totalize in compensated mass flow, set pulse output to Scaled Mass even if the pulse output was not ordered or will not be used.

Direct (shedding)

This mode provides the vortex shedding frequency as output. In this mode, the software does not compensate the K-factor for effects such as thermal expansion or differing mating pipe inside diameters. Scaled pulse mode must be used to compensate the K-factor for thermal expansion and mating pipe effects.

Scaled volumetric

This mode allows for configuration of the pulse output based on a volumetric flow rate. For example, set 100 gallons per minute = 10,000 Hz. (The user enterable parameters are flow rate and frequency.)

Scaled corrected volumetric

This mode allows for configuration of the pulse output based on a corrected volumetric flow rate.

Scaled velocity

This mode allows for configuration of the pulse output based on a velocity flow rate.

Scaled mass

This mode allows for configuration of the pulse output based on a mass flow rate if Actual Mass Compensation is Temperature Compensation.

When one of the scaled outputs is selected, choose one of two options:

Pulse scaling based on flow rate	Allows the user to set a certain flow rate to a desired frequency. For example: 1000 lbs/hr = 1000HZ • Enter a flow rate of 1000 lbs/hr. • Enter a frequency of 1000Hz.
Pulse scaling based on flow unit	Allows the user to set one pulse equal to a desired volume, mass, corrected volume, or distance. For example: 1 pulse = 1000lbs. • Enter 1000 for the mass.

7.6.1 Pulse Loop Test

Pulse Loop Test is a fixed frequency mode test that checks the integrity of the pulse loop. It tests that all connections are good and that pulse output is running on the loop.

Note
The Pulse Loop Test will not check for valid pulse scaling configuration. It will set a frequency without consideration of the pulse scaling configuration.

7.7 Signal processing

ProLink III	**Device Tools → Configuration → Process Measurement**

The transmitter can filter out noise and other frequencies from the vortex signal. The four user-alterable parameters associated with the digital signal processing include low-pass filter corner frequency, low-flow cutoff, trigger level, and damping. These four signal conditioning functions are configured at the factory for optimum filtering over the range of flow for a given line size, service type (liquid or gas), and process density. For most applications, leave these parameters at the factory settings. Some applications may require adjustment of the signal processing parameters.

Use signal processing only when recommended in the troubleshooting section of this manual. Some of the problems that may require signal processing include:

- High output (output saturation)
- Erratic output with or without flow present
- Incorrect output (with known flow rate)
- No output or low output with flow present
- Low total (missing pulses)
- High total (extra pulses)

If one or more of these conditions exist, and you have checked other potential sources (K-factor, service type, lower and upper range values, 4–20 mA trim, pulse scaling factor, process temperature, pipe ID), refer to Troubleshooting. If problems persist after signal processing adjustments, contact an Emerson representative (see back page).

Optimize DSP (Digital Signal Processing)

Used to optimize the range of the flow meter based on the density of the fluid. The electronics uses process density to calculate the minimum measurable flow rate, while retaining at least a 4:1 signal to the trigger level ratio. This function will also reset all of the filters to optimize the flow meter performance over the new range. For a stronger signal, select a density value that is lower than the actual flowing density. For dynamic process densities, select a density value that is lower than the lowest expected flowing density.

Signal strength

Variable that indicates the flow signal strength to trigger level ratio. This ratio indicates if there is enough flow signal strength for the meter to work properly. For accurate flow measurement, the value should be greater than 4. Values greater than 4 will allow increased filtering for noisy applications. For values greater than 4, with sufficient density, the Optimize DSP function can be utilized to optimize the measurable range of the flow meter.

Values less than 4 may indicate applications with very low densities and/or applications with excessive filtering.

Manual filter adjust

Allows for manual adjustment of the following settings: Low Flow Cutoff, Low Flow Cutoff Response, Low Pass Corner Frequency, and Trigger Level, while monitoring flow and or signal strength.

Low flow cutoff

Enables the adjustment of the filter for noise at no flow. It is set at the factory to handle most applications, but certain applications may require adjustment either to expand measurability or to reduce noise.

- Low Flow Cutoff offers two modes for adjustment:
- Decrease Low Flow Cutoff

- Increase Low Flow Cutoff

It also includes a dead band such that once flow goes below the cutoff value, output does not return to the normal flow range until flow goes above the dead band. The dead band extends to approximately 20 percent above the low flow cutoff value. The dead band prevents the output from bouncing between 4 mA and normal flow range if the flow rate is near the low flow cutoff value.

LFC response

Defines how the output of the Vortex meter will behave entering into and coming out of the Low Flow Cutoff. Options are stepped or damped. (See Technical Note 00840-0200-4004 for more information regarding Low Flow Measurement).

Low pass corner frequency

Sets the low-pass filter corner frequency to minimize the effects of high frequency noise. It is factory set based on line size and service type. Adjustments may be required only if you are experiencing problems. See Troubleshooting.

The Low Pass Filter corner frequency variable offers two modes for adjustment:

- Decrease Low Pass Corner Frequency
- Increase Low Pass Corner Frequency

Note
Do not adjust this parameter unless directed to do so by an Emerson representative.

Trigger level

Configured to reject noise within the flow range while allowing normal amplitude variation of the vortex signal. Signals of amplitude lower than the Trigger Level setting are filtered out. The factory setting optimizes noise rejection in most applications. Trigger Level offers two modes for adjustment:

- Increase Trigger Level
- Decrease Trigger Level

Note
Do not adjust this parameter unless directed to do so by an Emerson representative.

Restore default filter

Restores all of the signal conditioning variables to default values. Default values for signal conditioning variables will be set automatically depending on fluid type using the Optimize DSP function with a density setting of 40 lb/ft^3 (640 kg/m^3) for liquid or 0.15 lb/ft^3 (2.4 kg/m^3) for gas.

Flow damping

The default damping value is 2.0 seconds. Flow Damping can be reset to any value between 0.2 and 255 seconds.

Temperature damping

The default damping value is 2.0 seconds. Temperature Damping can be reset to any value between 0.4 and 32 seconds. Temperature Damping can only be configured if Temperature is assigned to be PV.

7.8 Special process variable units

ProLink III	**Device Tools → Configuration → Process Measurement → Flow → Special Units**

Allows the user to create flow rate units that are not among the standard options. Configuration of a special unit involves entry of these values: base flow unit, base time unit, user defined unit and conversion number. For example, the following settings would be used to display flow in beer barrels per minute instead of gallons per minute, with one beer barrel equal to 31 gallons:

- Base volume unit: gal
- Base time unit: min
- User defined unit: br
- Conversion number: 1/31.0

Base flow unit

The unit from which the conversion is made.

Table 7-1: Base flow unit

Volumetric flow	Mass flow	Corrected volume flow
U.S. gallon	gram	U.S. gallon
liter	kilogram	liter
imperial gallon	metric ton	imperial gallon
cubic meter	pound	barrel
barrel	short ton	standard cubic foot
cubic foot		normal cubic foot

Base time unit

Provides the time unit from which to calculate the special units. For example, if the special unit is a volume per minute, select minutes. Choose from the following units:

- Seconds (s)
- Minutes (min)
- Hours (h)
- Days (d)

Special flow unit

A user created custom flow unit. The special unit is limited to four characters. The LCD display will display the actual four character user defined special unit.

Conversion number

Used to relate base units to special units. For a straight conversion of volume units from one to another, the conversion number is the number of base units in the new unit.

For example, if it is desired to convert from gallons to beer barrels there are 31 gallons in a beer barrel. The conversion equation is as follows (where beer barrels is the new volume unit):

1 gallon = 0.032258 bbl.

7.9 Flow totalizer

ProLink III	**Device Tools → Totalizer Control → Totalizers**

The flow totalizer keeps a running total of the flow that has run through the meter in the user-selected flow variable (Corrected Volume Flow, Mass Flow, Velocity Flow, or Volume Flow). It can run continuously or be controlled using the **Start**, **Stop**, and **Reset** (to zero) commands.

Totalizer control

Allows the totalizer to be started, stopped, or reset.

Start Starts the totalizer counting from its current value.

Stop Interrupts the totalizer count until it is restarted again. This feature is often used during pipe cleaning or other maintenance operations.

Reset Returns the totalizer value to zero. If the totalizer was running, it will continue to run starting at zero.

Totalizer configuration

Used to configure the flow parameter (volume, mass, velocity, or corrected volume flow) that will be totaled.

Note
The totalizer value is saved in the non-volatile memory of the electronics every three seconds. Should power to the transmitter be interrupted, the totalizer value will start at the last saved value when the power is re-applied.

Note
Changes that affect the density, density ratio, or compensated K-Factor will affect the totalizer value being calculated. These changes will not cause the existing totalizer value to be recalculated.

Note

In order to totalize in compensated mass flow, set pulse output to Scaled Mass even if the pulse output was not ordered or will not be used. Please refer to section 7.9 for pulse output configuration.

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8 Troubleshooting

8.1 Communication problem with HART-based communicator

Before troubleshooting communication problems, ensure that 10–30 VDC is applied to the transmitter + and – terminals.

Recommended actions

1. If possible, visually verify transmitter is powered by viewing the LCD display.
2. Verify that the configuration tool is polling for the device at HART address 1.
3. Verify that the transmitter is not set to Burst Mode.
4. Cycle power and try again.
5. The device may require component replacement or advanced troubleshooting service. Contact an Emerson representative for assistance.

8.2 Incorrect Modbus communication output

Before troubleshooting communication problems, ensure that 10–30 VDC is applied to the transmitter + and – terminals.

Recommended actions

1. Verify that the configuration tool is polling for the device at HART address 1.
2. Cycle the power to the transmitter after the HART message is applied.
3. Wait at least 60 seconds after power is restored.
4. Confirm the proper Input or Holding registers to poll variables from based on Modbus host requirements. Please consult Appendix D for more information.
5. Confirm that there are no HART communication devices connected to the device.
6. Wait 10 seconds after HART communication device has been disconnected.

Note
Any communication settings configuration through the HART communication port will prevent Modbus output from updating with fresh data.

8.3 Modbus communication setting fails to apply

The HART address on the configuration tool was not set to 1.

Recommended actions

Ensure that the HART address of the configuration device is set to 1 when the HART message is applied.

The transmitter power was not cycled after the HART message was applied.

Recommended actions

1. Cycle the power to the transmitter after the HART message is applied.
2. Wait at least 60 seconds after power is restored.

8.4 Incorrect pulse output

Recommended actions

1. Confirm the wiring polarity as well as pulse power supply and resistance are within specifications. See Pulse output.
2. Check the pulse mode and the scaling factor. Make sure the scaling factor is not inverted.
3. Perform a pulse test.
4. Select the pulse scaling so that the pulse output is less than 10,000Hz at URV.

8.5 Error messages on a HART-based communicator

Recommended actions

See Diagnostic messages.

8.6 Flow in Pipe, No Output

Recommended actions for basic problems

1. Check sizing. Make sure the flow is within measurable flow limits. Use the online Emerson Size and Selection tool for best sizing results.
2. Check to make sure the meter is installed with the arrow in the direction of process flow.
3. For installations with transmitter mounted remotely from the meter, confirm remote cable connections.
4. Check and correct the configuration parameters in this order:
   a. Process fluid
   b. Process density
   c. Base density
   d. Reference K-factor
   e. Variable mapping
   f. PV unit
   g. Optimize signal processing

   h. Pulse mode
   i. Scaling (if used)

5. For the electronics verification procedure, see Electronics verification.

Recommended actions for electronics problems

1. Check for Diagnostic messages. See Diagnostic messages for more information about the messages.
2. Run a self test with a HART-based interface tool.
3. Using a sensor simulator, apply a test signal.
4. Check the configuration, LFC, trigger level, and STD vs. actual flow units.
5. Replace the electronics.

Recommended actions for application problems

1. Check sizing. Make sure the flow is within measurable flow limits. Use the online Emerson Size and Selection tool for best sizing results.
2. Calculate the expected frequency. If the actual frequency is the same, check the configuration.
3. Check that the application meets viscosity and density requirements for the line size.
4. Recalculate the back pressure requirement. If it is necessary and possible, increase the back pressure, flow rate, or operating pressure.

Recommended actions for sensor problems

1. Inspect sensor lead wire and sensor connection for damage. Replace if necessary.
2. Check tightness of SMA connector.

   The SMA nut should be gently secured to the nut with a 5/16 inch wrench to 7 in-lbs (0.8 N-m) to the electronics housing. Avoid over-tightening the coaxial sensor cable to the electronics housing.
3. Check that the sensor impedance at process temperature is > 1 Mega- Ohm. Replace the sensor if necessary. See Replacing the sensor.
4. Check the torque on the sensor nut and make sure it is at 32 ft lbf (43.4 N m). For a 1-8 inch (2.54-20.32 cm) meter body with ANSI 1500 flanges, the torque on the sensor nut should be 50 ft lbf (67.8 N m).

8.7 No flow, output

Recommended actions for basic problems

1. Check basic configuration and ADSP filter settings.
2. Check for excessive pipe vibration by monitoring Signal Strength and Shedding Frequency. Typically pipe vibration would be less than 30 Hz. Please refer to the product spec section for more information on vibration spec.

3. Check the shedding frequency to see if it is locked to 50/60 Hz for AC line noise. Remote installations are more susceptible.
4. Verify line is blocked or fully shut down
5. Check to make sure the meter is installed with the arrow in the direction of process flow.

8.8 Diagnostic messages

When a diagnostic event occurs, the transmitter posts information to the communication tools and the LCD. The following tables list the messages and descriptions as they appear in ProLink or AMS, as well as their associated display/communication tool messages.

Table 8-1: Faults

Display	ProLink III	Description
FAULt^^^ ELECT	Electronics Failure	This is a summary fault condition indicating a failure in the transmitter electronics. • Cycling power may resolve the problem. • Replace the electronics if the problem persists.
FAULt^^^ SFTWR	Software Detected Error	One of the software task stacks has overflowed. Resetting the transmitter will clear the faults. • Cycling power may resolve the problem. • Report the problem to the factory. • Replace the electronics if the problem persists.
FAULt^^^ COPHW	Output Board Electronics Failure	The coprocessor built in Self Test has detected a fault, or the coprocessor has detected a math or instruction fault. • Cycling power may resolve the problem. • Replace the electronics if the problem persists.
FAULt^^^ ^ASIC	Digital Filter Error	The digital filter in the transmitter electronics is not reporting. The transmitter will remain in ALARM until the digital signal processor resumes reporting flow data. • Cycling power may resolve the problem. • Replace the electronics if the problem persists.
FAULt^^^ ^COEFF	Coprocessor Coefficient Error	The area of non-volatile memory used to store the curve fit coefficients for the coprocessor calculations does not contain valid data. This data can only be loaded at the factory. • Cycling power may resolve the problem. • Replace the electronics if the problem persists

Table 8-1: Faults *(continued)*

Display	ProLink III	Description
FAULt^^^ NVMEM	Non-Volatile Memory Error	At least one segment of non-volatile memory has failed a checksum verification. If the 'Factory Non-Volatile Memory Error' is NOT also active this problem may be fixed by reconfiguring all transmitter parameters. The transmitter will remain in ALARM until the EEPROM checksum test passes. • Reconfigure all transmitter parameters. • Replace the electronics if the problem persists.
FAULt^^^ ^^ROM	ROM Checksum Error	The microprocessor ROM has failed a checksum test. This test is run at start-up and in the background. • Cycling power may resolve the problem • Replace the electronics if the problem persists
ALErt ^ ^ ^ or FAULT^^^ T/C	Thermocouple Failure	**Note** This message is a fault when Temperature Sensor Failure Mode is set to Go to Alarm. It is an alert when Temperature Sensor Failure Mode is set to Use Fixed Process Pressure. The thermocouple used to measure process temperature has failed. • Check the thermocouple connections to the transmitter. • Replace the thermocouple if the problem persists.
FAULt^^^ SDCOM	Internal Communications Fault	After several attempts the microprocessor has failed in communicating with an ASIC used in the conversion of the flow sensor signal. • Cycling power may resolve the problem. • Check the connector between electronics boards. • Replace the electronics if the problem persists.
FAULt^^^ SDPLS	Internal Signal Fault	The flow data from an ASIC used in the conversion of the flow sensor signal has been lost. • Cycling power may resolve the problem. • Check the connector between electronics boards. • Replace the electronics if the problem persists.
FAULt^^^ NVMEM	Factory Non-Volatile Memory Error	A segment of non-volatile memory that is written only at the factory has failed a checksum verification. This fault cannot be fixed by reconfiguring transmitter parameters. Replace the electronics.
FAULt^^^ PT HW	Process Temperature Electronics Failure	The electronics circuitry that supports the measurement of the Process Temperature has failed. The transmitter can still be used in a conventional volume flow mode. Replace the electronics if Process Temperature measurement is required.

Table 8-1: Faults *(continued)*

Display	ProLink III	Description
FAULt^^^ PT>CF	Process Temperature is above the Saturated Steam Limits	The Process Temperature is above the high limit for Saturated Steam density calculations. This status only occurs when the Process Fluid is Temperature Compensated Saturated Steam. The density calculation will continue using a process temperature of 320 ˚C.
FAULt^^^ PT<CF	Process Temperature is below the Saturated Steam Limits	The Process Temperature is below the low limit for Saturated Steam density calculations. This status only occurs when the Process Fluid is Temperature Compensated Saturated Steam. The density calculation will continue using a process temperature of 80 ˚C.

Table 8-2: Maintenance

Display	ProLink III	Description
	Trigger Overrange	The Trigger Level configuration of the Digital Filters is out of range. • Re-enter the Trigger Level configuration.
	Low-Pass Filter Overrange	The Low-pass Filter configuration of the Digital Filters is out of range. • Reconfigure the Low-pass Filter.
	Low Flow Cutoff Out of Range	The Low Flow Cutoff configuration of the Digital Filters is out of range. • Reconfigure the Low Flow Cutoff.
	Electronics Temperature Out of Limits	The temperature of the electronics is too high or too low. • Adjust the ambient conditions of the transmitter. • Consider remotely mounting the electronics.
FAULt^^^ CONFIG	Invalid Configuration	Parameters critical to the operation of the transmitter are not properly configured. Refer to the Configuration Status to determine which parameters should be reconfigured. The valid configuration of some parameters is dependent on the current configuration of other parameters. Consult the manual for assistance. • Re-enter the invalid configuration parameter.
FAULt^^^ LOOPV	Low Loop Voltage	The voltage reading at the COMM port is insufficient for operation. • Check the transmitter power supply voltage to ensure that it is within 10-30 VDC. • Replace the terminal block.
PT^^^ FIXED	Fixed Process Temperature Active	The Fixed Process Temperature value is being used for density calculations. The thermocouple used to measure process temperature has failed. • Check the thermocouple connections to the transmitter. • Replace the thermocouple if the problem persists.

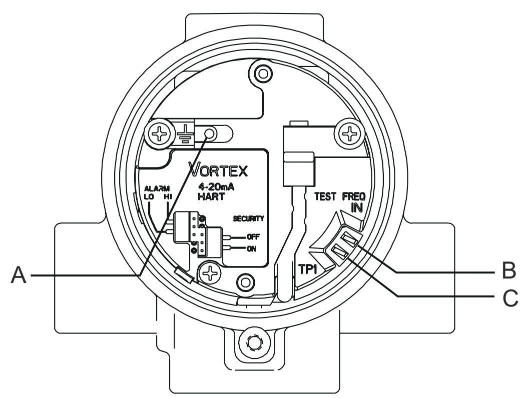
Table 8-3: Advisory

Display	ProLink III	Description
SIGnAL^^ SIMUL	Flow Simulation Mode	The flow signal is being produced from a signal generator internal to the Vortex transmitter. The flow value reported by the transmitter is NOT the process flow value. • This is informational only.
SEnSOr^^ OFFLN	Flow Signal Injection	The flow signal is being injected into the transmitter from an external signal generator. The flow value reported by the transmitter is NOT the process flow value. • This is informational only.
ALErt ^^^ PTOSL	Process Temperature Out of Range	The Process Temperature is beyond the defined sensor limits of –58 °F to +842 °F (–50 °C to +450 °C). • This is informational only.
(freq.) PULSE	Pulse Output Fixed	The transmitter has been commanded to output a fixed pulse output frequency. The pulse output does not reflect the process flow. • Exit the Pulse Loop test.

8.9 Electronics test points

As shown in the following figure, there are several test points located on the electronics.

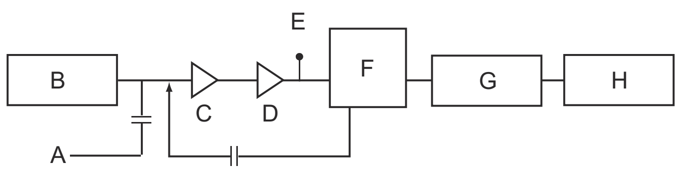
Figure 8-1: Electronics test points



A. Ground
B. Test frequency input
C. Test point 1

The electronics are capable of internally generating a flow signal that can be used to simulate a sensor signal to perform electronics verification with a handheld communicator or AMS Device Manager interface. The simulated signal amplitude is based on the transmitter required minimum process density. The signal being simulated can be one of several profiles – a simulated signal of constant frequency or a simulated signal representative of a ramping flow rate. The electronics verification procedure is described in Electronics verification. To verify the electronics, you can input a frequency on the TEST FREQ IN and GROUND pins to simulate flow via an external signal source such as a frequency generator. To analyze and/or troubleshoot the electronics, an oscilloscope (set for AC coupling) and a handheld communicator or AMS Device Manager interface are required. The following figure is a block diagram of the signal as it flows from the sensor to the microprocessor in the electronics.

Figure 8-2: Signal flow



A. *External test frequency input*
B. *Sensor*
C. *Charge amplifier*
D. *Amplifier/Low pass filter*
E. *TP1*
F. *A-to-D converter/internal frequency generator*
G. *Digital filter*
H. *Microprocessor*

TP1—Test point 1

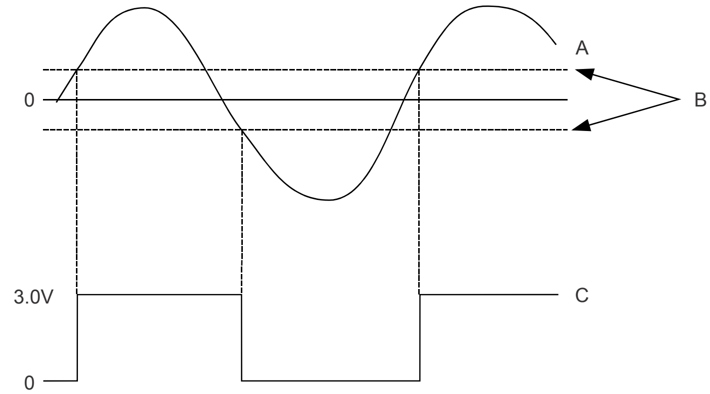
TP1 is the vortex shedding signal after it has gone through the charge amplifier and low pass filter stages and into the input of the sigma delta A-to-D converter ASIC in the electronics. The signal strength at this point will be in the mV to Volt range.

TP1 is easily measured with standard equipment.

Example: Correct waveform

Figure 8-3 shows an ideal (clean) waveform. Consult technical support if the waveform you detect is not similar in principle to this figure.

Figure 8-3: Clean signals

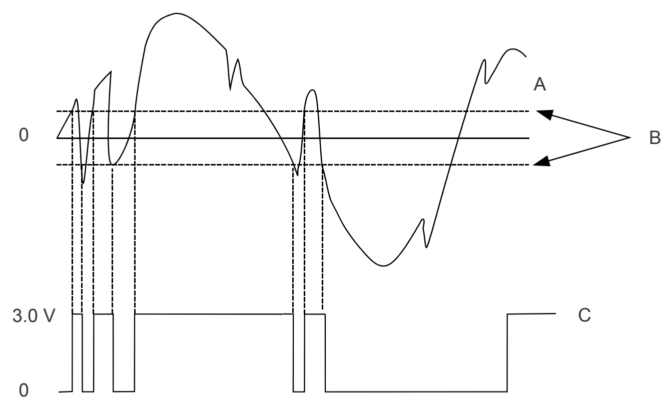


A. *Vortex signal (TP1)*
B. *Trigger level*
C. *Shedding frequency output*

Examples: Wrong waveforms

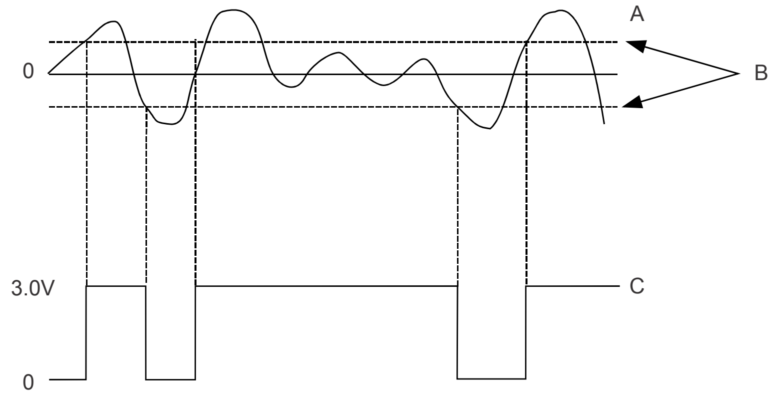
Figure 8-4 and Figure 8-5 show waveforms that may cause the output to be inaccurate.

Figure 8-4: Noisy signals



A. *Vortex signal (TP1)*
B. *Trigger level*
C. *Shedding frequency output*

Figure 8-5: Improper Sizing/Filtering



A. Vortex signal (TP1)
B. Trigger level
C. Shedding frequency output

9 Maintenance

9.1 Transient protection

The optional transient terminal block prevents damage to the flowmeter from transients induced by lightning, welding, heavy electrical equipment, or switch gears. The transient protection electronics are located in the terminal block.

IEEE C62.41 - 2002 Category B

The transient terminal block was verified using the following test waveforms specified in the IEEE C62.41 - 2002 Category B standard:

- 3 kA crest (8 X 20 ms)
- 6 kV crest (1.2 X 50 ms)
- 6 kV/0.5 kA (0.5 ms, 100 kHz, ring wave)

9.1.1 Installing or replacing the transient protection

For flowmeters ordered with the transient protector option (T1), the protector is shipped installed.

The transient protection kit includes the following:

- One transient protection terminal block assembly
- Three captive screws

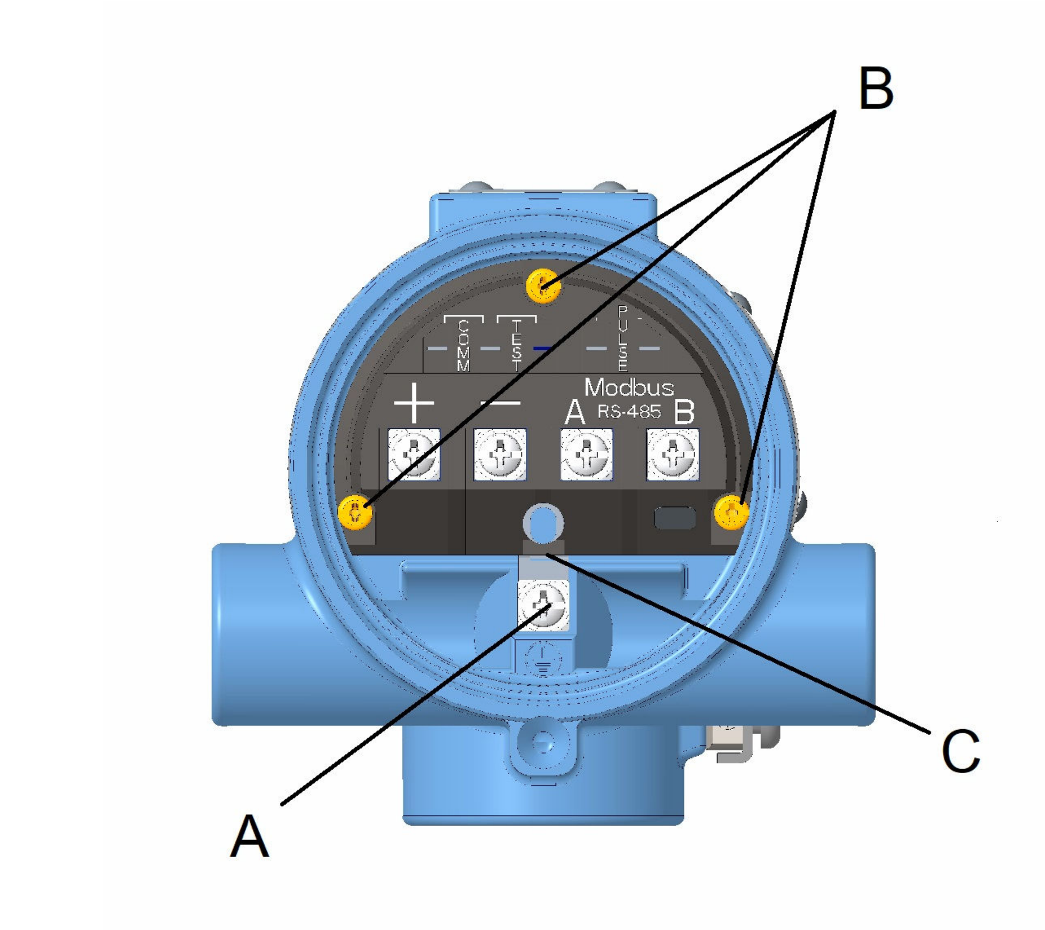
When purchased separately from the transmitter, install the protector using a small instrument screwdriver, a pliers, and the transient protection kit.

1. If the flowmeter is installed in a loop, secure the loop and disconnect power.
2. Remove the field terminal side flowmeter cover.
3. Remove the captive screws.

   Refer to the following figure.
4. Remove the housing ground screw.
5. Use pliers to pull the terminal block out of the housing.
6. Inspect the connector pins for straightness.
7. Place the new terminal block in position and carefully press it into place.

   The terminal block may have to be moved back and forth to get the connector pins started into the sockets.
8. Tighten the captive screws.
9. Install and tighten the ground screw.
10. Replace the cover.

Figure 9-1: Transient Terminal Block



A. Housing ground screw
B. Captive screws
C. Transient terminal block ground tab

9.1.2 Reconfiguring the Modbus module parameters

See Modbus communication settings.

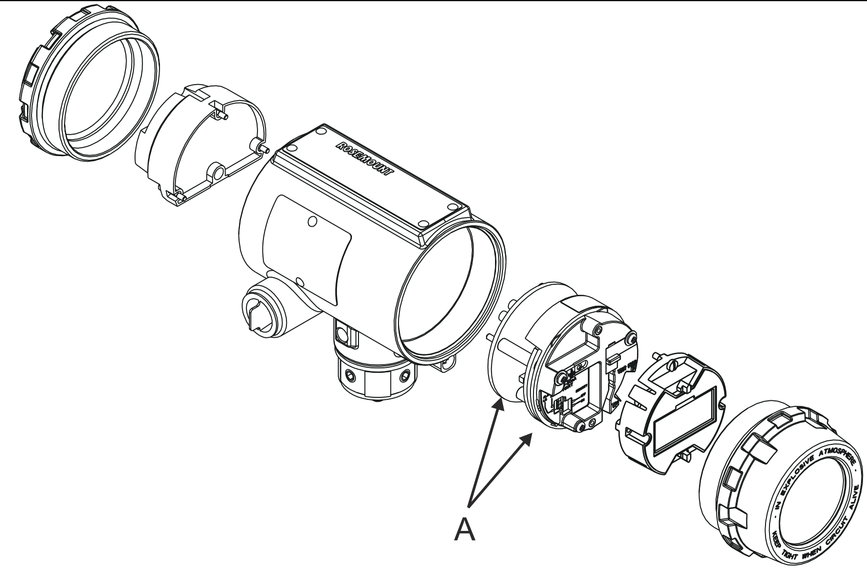
9.2 Installing the LCD indicator

For flowmeters ordered with the LCD indicator, the indicator is shipped installed. When purchased separately from the Rosemount 8800D, you must install the indicator using a small instrument screwdriver and the indicator kit. The indicator kit includes:

- One LCD indicator assembly
- One extended cover with o-ring installed

- One connector
- Two mounting screws
- Two jumpers

Refer to the following figure when using these steps to install the LCD indicator:



A. Electronics board

1. If the flowmeter is installed in a loop, secure the loop and disconnect the power.
2. Remove the flowmeter cover on the electronics side.

Note
The circuit board is electrostatically sensitive. Be sure to observe handling precautions for static-sensitive components.

3. Insert the mounting screws into the LCD indicator.
4. Remove the two jumpers on the circuit board that coincide with the Alarm and the Security settings.
5. Insert the connector into the Alarm/Security junction.
6. Gently slide the LCD indicator onto the connector and tighten the screws into place.
7. Insert jumpers into ALARM and SECURITY positions on the face of the LCD indicator.
8. Attach the extended cover and tighten at least one-third turn past O-ring contact.

Note
The indicator may be installed in 90-degree increments for easy viewing. Mounting screws may need to be installed in the alternative holes based on LCD display orientation. One of the four connectors on the back of the indicator assembly must be positioned to fit into the 10-pin connector on the electronic board stack.

Note the following LCD display temperature limits:

- Operating: –4 to 185 °F (–20 to 85 °C)

- Storage: –50 to 185 °F (–46 to 85 °C)

9.3 Hardware replacement

The following procedures will help you disassemble and assemble the Rosemount 8800D hardware if you have followed the troubleshooting guide earlier in this section of the manual and determined that hardware components need to be replaced.

Note
Use only the procedures and new parts specifically referenced in this manual. Unauthorized procedures or parts can affect product performance and the output signal used to control a process, and may render the instrument dangerous.

CAUTION
Process should be vented before the meter body is removed from service for disassembly. Flowmeters should not be left in service once they have been determined to be inoperable.

9.3.1 Replacing the terminal block in the housing

To replace the field terminal block in the housing, you will need a small screwdriver. Use the following procedure to replace the terminal block in the housing.

Note
After you replace the terminal block you must also reconfigure (reapply) the HART message field. See Modbus communication settings.

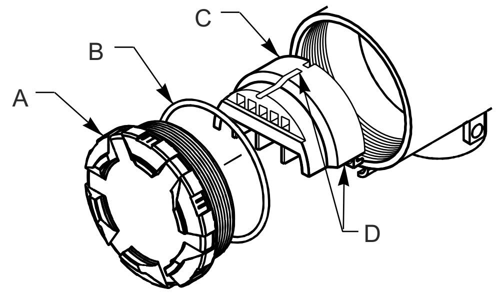
Remove the terminal block

WARNING
For complete warning information, see Safety messages.

1. **CAUTION**
   Remove power before removing the electronics cover.

   Turn off the power to the Rosemount 8800D.
2. Unscrew the cover. Refer to the following figure.

Figure 9-2: Terminal block assembly



A. Cover
B. O-ring
C. Terminal block
D. Captive screws (3x)

3. Disconnect the wires from the field terminals. Be sure to secure them out of the way.
4. Remove the ground screw.
5. Loosen the three captive screws.
6. Pull outward on the terminal block to remove it from the housing.

Install the terminal block

1. Align the socketed holes on the back side of the terminal block over the pins protruding from the bottom of the housing cavity in the terminal block side of the electronics housing.
2. Slowly press the terminal block into place. Do not force the block into the housing. Check the alignment if it does not glide into place.
3. Tighten the three captive screws to anchor the terminal block.
4. Connect the wires to the appropriate field terminals.
5. Reinstall and tighten the ground screw.
6. Screw on and tighten the cover.

9.3.2 Replacing the electronics boards

The Rosemount 8800D electronics boards may need to be replaced if they have been damaged or otherwise become dysfunctional. Use the following procedures to replace electronics boards in the Rosemount 8800D. You will need a small Phillips head screwdriver and pliers.

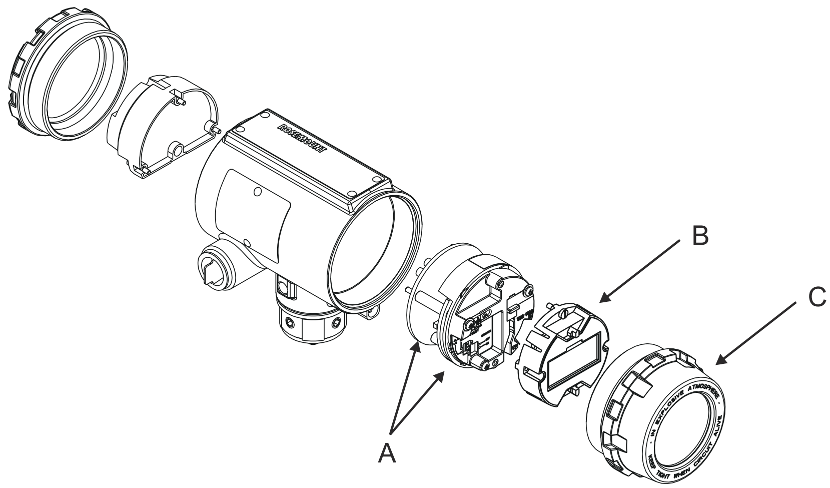
Note
The electronics boards are electrostatically sensitive. Be sure to observe handling precautions for static-sensitive components.

CAUTION
Remove power before removing the electronics cover.

Remove the electronics boards

1. Turn off the power to the Rosemount 8800D.
2. Unscrew and remove the electronics board compartment cover. (Unscrew and remove the LCD display cover if you have the LCD display option).

Figure 9-3: Electronics Boards Assembly



A. Electronics boards
B. LCD display
C. LCD display cover

3. If the meter has the LCD display option, loosen the two screws.
4. Remove the LCD display and the connector from the electronics board.
5. Loosen the three captive screws that anchor the electronics.
6. Use pliers or a flat head screwdriver to carefully remove the sensor cable clip from the electronics.
7. Remove thermocouple if applicable.
8. Use the handle molded into the black plastic cover to slowly pull the electronics boards out of the housing.

Install the electronics boards

1. Verify that power to the Rosemount 8800D is off.
2. Align the sockets on the bottom of the two electronics boards over the pins protruding from the bottom of the housing cavity.
3. Carefully guide the sensor cable through the notches on the edge of the circuit boards.
4. Slowly press the boards into place. Do not force the boards down. Check the alignment if they do not glide into place. Carefully insert sensor cable clip into electronics board.
5. Tighten the three captive screws to anchor the two electronics boards. Ensure that the SST washer is under the screw in the 2 o'clock position.

6. Reinsert the alarm and security jumpers into the correct location.
7. Re-install the thermocouple if applicable.
8. If the meter has LCD display option, insert the connector header into the LCD display board.
    a) Remove jumpers from the electronics board.
    b) Put the connector through the bezel on the electronics board.
    c) Carefully press the LCD display onto the electronics board.
    d) Tighten the two screws that retain the LCD display.
    e) Insert the alarm and security jumpers in the correct location.
9. Replace the electronics board compartment cover.

9.3.3 Replacing the electronics housing

The Rosemount 8800D electronics housing can be replaced easily when necessary. Use the following procedure:

Tools needed

- 5/32 inch (4 mm) hex wrench
- 5/16 inch (8 mm) open end wrench
- Screwdriver to disconnect wires
- Tools to disconnect conduit

Note
Remove power before removing the electronics housing.

Remove the electronics housing

1. Turn off the power to the Rosemount 8800D.
2. Remove the terminal block side cover.
3. Disconnect the wires and conduit from the housing.
4. Use a 5/32 inch (4 mm) hex wrench to loosen the housing rotation screws (at the base of the electronics housing) by turning screws clockwise (inward) until they clear the bracket.
5. Slowly pull the electronics housing no more than 1.5 inch (40 mm) from the top of the support tube.
6. Loosen the sensor cable nut from the housing with a 5/16 inch (8 mm) open end wrench.

    Note
    Lift the electronics housing until the sensor cable nut is exposed. Do not pull the housing more than 1.5 inch (40 mm) from the top of the support tube. Damage to the sensor may occur if this sensor cable is stressed.

Install the electronics housing

1. Verify that power to the Rosemount 8800D is off.
2. Screw the sensor cable nut onto the base of the housing.
3. Tighten the sensor cable nut with a 5/16 inch (8 mm) open end wrench.
4. Place the electronics housing into the top of the support tube.
5. Use a hex wrench to turn the three hex socket screws counterclockwise (outward) to engage support tube.
6. Place the access cover on the support tube (if applicable).
7. Tighten the screw on the access cover.
8. Connect conduit and wires.
9. Replace the terminal block cover.
10. Apply power.

9.3.4 Replacing the sensor

The sensor for the Rosemount 8800D is a sensitive instrument that should not be removed unless there is a problem with it. If you must replace the sensor, follow these procedures closely. Consult technical support before removing the sensor.

Note
Be sure to fully check all other troubleshooting possibilities before removing the sensor.

Do not remove the sensor unless it is determined that a problem exists with the sensor itself. The sensor may not fit on the post if it is removed and replaced more than two or three times, or replaced incorrectly.

Also, please note that the sensor is a complete assembly and cannot be further disassembled.

Tools needed

- 5/32 inch (4 mm) hex wrench
- 5/16 inch (8 mm) open end wrench
- 7/16 inch (11 mm) open end wrench
- ¾ inch (19 mm) open end wrench — for 3 inch (80 mm) and 4 inch (100 mm) SST wafers
- 1-1/8 inch (28 mm) open end wrench (for all other models)
- Suction or compressed air device
- Small, soft bristle brush
- Cotton swabs
- Appropriate cleaning liquid: water or cleaning agent

Removing the sensor

The following procedure applies to flowmeters equipped with a removable support tube.

Note
Sensor cavity could contain line pressure if an abnormal failure has occurred inside the meter body. For complete warning information, see Safety messages.

---

1. If the meter body is not a CriticalProcess™ Vortex (CPA Option) proceed to Step 6.
2. Welded onto the side of the meter body is a valve. Move any nearby equipment from the line of sight of the valve tube, if possible. Protect other equipment with shielding, cover, or other type of protection.
3. Position all personnel away from the line of sight of the valve tube.

   Note
   There are numerous tube fittings that could connect to the tube if there is a need to drain away process material. The tube on the valve has a 0.188 in (4.8 mm) OD with a 0.035 in (0.9 mm) wall thickness.

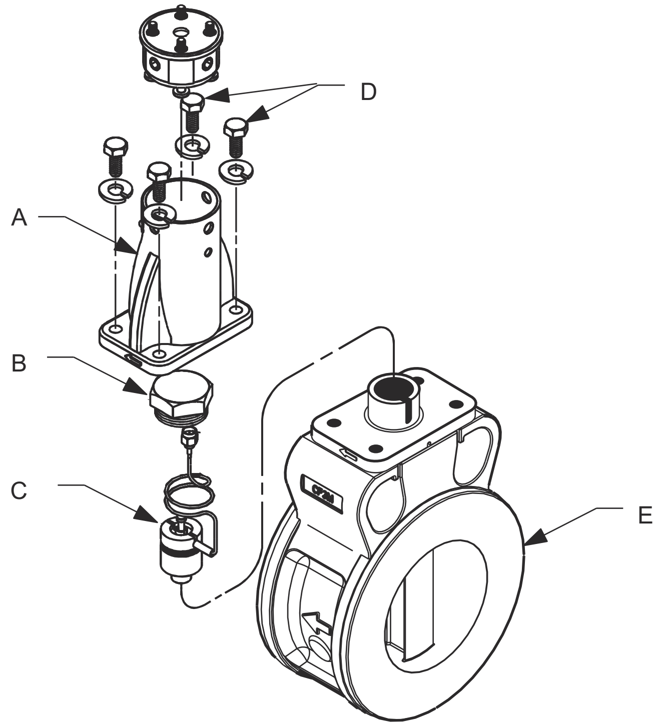
   ---

4. Using a 7/16 in (11 mm) open end wrench, slowly loosen the valve nut. Back out the nut until it stops. There is a set screw which prevents the nut from being completely removed.
5. Process fluid venting from the valve tube indicates that there is process fluid in the sensor cavity.

Option	Description
If there is no process fluid in the sensor cavity	Continue to Step 7.
If there is process fluid in the sensor cavity	Immediately re-tighten the valve nut until process fluid stops venting. Do **not** tighten any further. **Stop** and contact your technical support. The meter body may need to be replaced.

6. De-pressurize the flow line.
7. Remove the electronics housing (see Replacing the electronics housing).
8. Loosen the four support tube anchor bolts with a 7/16 in (11 mm) open end wrench.

Figure 9-4: Removable support tube assembly



A. *Removable support tube*
B. *Sensor nut*
C. *Sensor*
D. *Anchor bolts*
E. *Meter body*

9. Remove the support tube.
10. Loosen and remove the sensor nut from the sensor cavity with a 1-1/8 in (28 mm) open end wrench.

    Use a 3/4 in (19 mm) open end wrench for 3 in (80 mm) and 4 in (100 mm) SST wafers.
11. Lift the sensor from the sensor cavity. Be very careful to lift the sensor straight up. Do not rock, twist, or tilt the sensor during removal; this will damage the engagement diaphragm.
12. If Critical Process (CPA option) is present, tighten the valve to insure it is closed after the new Vortex sensor is installed. It is recommended that the nut be torqued to 50 in-lbs (5.7 N-m). Over tightening the valve nut could compromise its ability to seal.

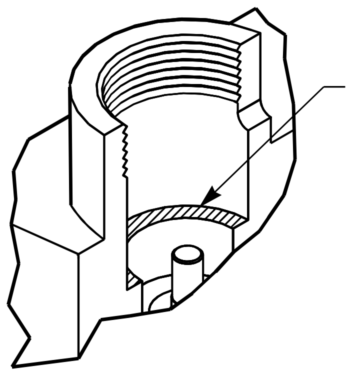
Clean the sealing surface

Before installing a sensor in the meter body, clean the sealing surface by completing the following procedure.

The metal o-ring on the sensor is used to seal the sensor cavity in the event that process fluid should corrode through the meter body and enter the sensor cavity. Be sure not to scratch or otherwise damage any part of the sensor, sensor cavity, or sensor nut threads. Damage to these parts may require replacement of the sensor or meter body, or may render the flowmeter dangerous.

Note
If you are installing a sensor that has been used before, clean the metal o-ring on the sensor using the procedure below. If you are installing a newly purchased sensor, cleaning the o-ring is not necessary.

Figure 9-5: O-Ring Sealing Surface in Sensor Cavity



A. Sealing surface

1. Use a suction or compressed air device to remove any loose particles from the sealing surface and other adjacent areas in the sensor cavity. See Figure 9-5.

   Note
   Do not scratch or deform any part of the sensor, sensor cavity, or sensor nut threads.

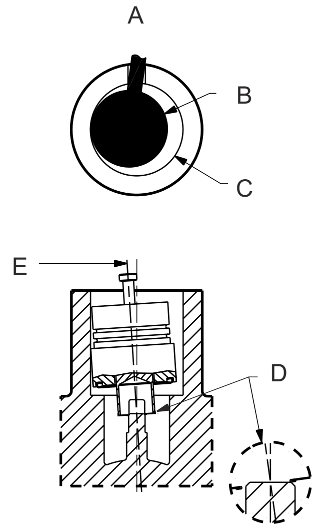
2. Carefully brush the sealing surface clean with a soft bristle brush.
3. Moisten a cotton swab with an appropriate cleaning liquid.
4. Wipe the sealing surface. Repeat several times if necessary with a clean cotton swab until there is minimal dirt residue picked up by the cotton swab.

Install the sensor

1. Carefully place sensor over the post in the sensor cavity.
2. Ensure that the sensor is centered on the post. See Figure 9-6 and Figure 9-7.

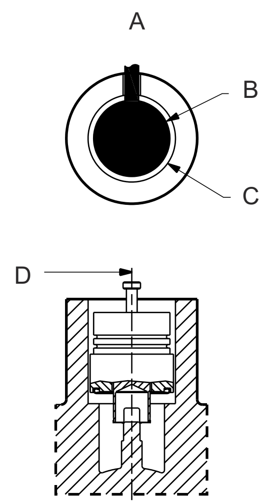
   Note
   If the sensor is installed in a high temperature application place the sensor in the sensor cavity and wait for it to come up to temperature before seating the sensor on the post.

Figure 9-6: Sensor installation – improper alignment (before seating)



A. *Top view of flowmeter*
B. *Sensor*
C. *Sensor cavity in flowmeter*
D. *Sensor not properly aligned*
E. *Sensor center line is not aligned with flowmeter center line. Damage to sensor will occur.*

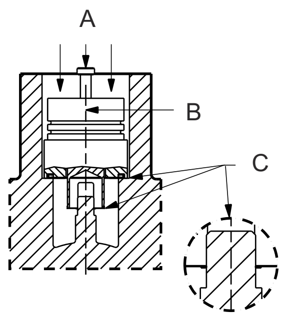
Figure 9-7: Sensor installation – proper alignment (before seating)



A. *Top view of flowmeter*
B. *Sensor*
C. *Sensor cavity in flowmeter*
D. *Sensor center line must be aligned with flowmeter center line.*

3. Sensor should remain as close to vertical as possible when applying force to seat. See Figure 9-8.

Figure 9-8: Sensor installation – applying force



A. Pressure
B. Sensor center line must be aligned with flowmeter center line
C. Sensor properly seated

4. Manually push down on the sensor by applying equal pressure for engagement onto the post.
5. Screw the sensor nut into the sensor cavity. Tighten the nut with a 1-1/8 inch (28 mm) open end torque wrench to 32 ft-lbs (43.4 N-m) (50 ft-lbs [67.8 N-m] for ANSI 1500 meter body).

   Use a 3/4 inch (19 mm) open end wrench for 3 inch (80 mm) and 4 inch (100 mm) SST wafers. Do not over-tighten the sensor nut.
6. Replace the support tube.
7. Tighten the four bolts that anchor the support tube in place with a 7/16 inch (11 mm) open end wrench.
8. Install the flowmeter electronics housing. See Replacing the electronics housing.

9.3.5 Remote electronics procedures

If the Rosemount 8800D electronics housing is mounted remotely, some replacement procedures are different than for the flowmeter with integral electronics. The following procedures are identical:

- Replacing the terminal block in the housing.
- Replacing the electronics boards .
- Replacing the sensor.

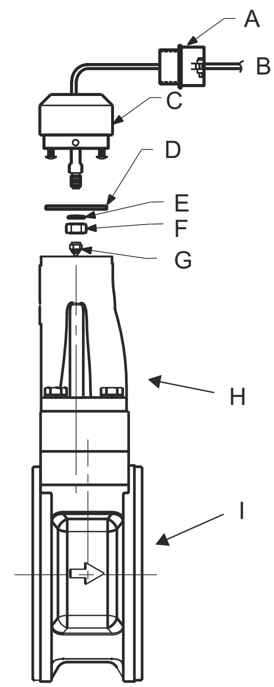
Disconnect the coaxial cable at the meter

1. Remove the access cover on the meter body support tube if present.
2. Loosen the three housing rotation screws at the base of the meter adapter with a 5/32 inch (4 mm) hex wrench by turning the screws clockwise (inward) until they clear the bracket.

3. Slowly pull the meter adapter no more than 1.5 inch (40 mm) from the top of the support tube.
4. Loosen and disconnect the sensor cable nut from the union using a 5/16 inch (8 mm) open end wrench.

Note
Do not pull the adapter more than 1.5 inch (40 mm) from the top of the support tube. Damage to the sensor may occur if the sensor cable is stressed.

Figure 9-9: Coaxial Cable Connections



A. ½ NPT conduit adapter or cable gland (supplied by customer)
B. Coaxial cable
C. Meter adapter
D. Union
E. Washer
F. Nut
G. Sensor cable nut
H. Support tube
I. Meter body

Detach the meter adapter

Use the following steps if it is necessary to remove the coaxial cable.

1. Loosen and remove the two screws that hold the union onto the meter adapter and pull the union away from the adapter.
2. Loosen and remove the sensor cable nut from the other end of the union.

3. Loosen and disconnect the conduit adapter or cable gland from the meter adapter.

Attach the meter adapter

1. If you are using a conduit adapter or cable gland, slide it over the plain end of the coaxial cable (the end without a ground wire).
2. Slide the meter adapter over the coaxial cable end.
3. Use a 5/16 inch (8 mm) open end wrench to securely tighten the sensor cable nut onto one end of the union.
4. Place the union onto the two screws extending out of the meter adapter and tighten the two screws.

Connect the coaxial cable at the meter body

1. Pull the sensor cable out of the support tube slightly and securely tighten the sensor cable nut onto the union.

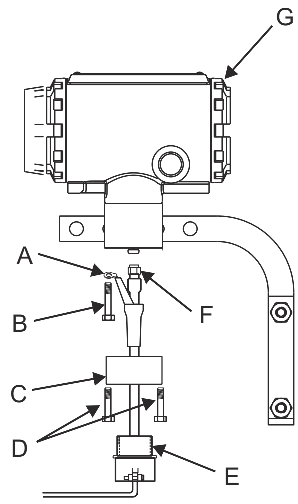
   Note
   Do not stretch the sensor cable over 1.5 inch (40 mm) beyond the top of the support tube. Damage to the sensor may occur if the sensor cable is stressed.

2. Place the meter adapter into the top of the support tube and line up the screw holes.
3. Use a hex wrench to turn the three adapter screws counterclockwise (outward) to engage the support tube.
4. Replace the access cover on the support tube — 6 inch (152.4 mm) to 8 inch (203.2 mm) wafer style only.
5. Tighten the conduit adapter or cable gland into the meter adapter.

Remove the coaxial cable from the electronics housing

1. Loosen the two housing screws from the housing adapter.
2. Remove the housing adapter from the housing.
3. Loosen and remove the coaxial cable nut from the base of the electronics housing.
4. Remove the coaxial cable ground connection from the housing base by loosening the housing base screw that is connecting it to the housing base.
5. Loosen the conduit adapter (or cable gland) from the housing adapter.

Figure 9-10: Remote electronics exploded view



A. Ground connection
B. Housing base screw
C. Housing adapter
D. Housing adapter screws
E. Conduit adapter (optional—supplied by customer)
F. Coaxial cable nut
G. Electronics housing

Attach the coaxial cable

1. Route the coaxial cable through the conduit (if you are using conduit).
2. Place a conduit adapter over the end of the coaxial cable.
3. Remove the housing adapter from the electronics housing (if attached).
4. Slide the housing adapter over the coaxial cable.
5. Remove one of the four housing base screws that is in closest proximity to the ground connection.
6. Re-install the housing base screw by passing it through the ground connection.
7. Attach and securely tighten the coaxial cable nut to the connection on the electronics housing.
8. Align the housing adapter with the housing base and attach with the two housing adapter screws.
9. Tighten the conduit adapter to the housing adapter.

9.3.6 Changing the housing orientation

The entire electronics housing may be rotated in 90 degree increments for better wiring access or improved viewing of the display.

1. Loosen the screw on the access cover on the support tube (if present) and remove the cover.
2. Loosen the three accessible housing rotation set screws at the base of the electronics housing with a 5/32 inch (4 mm) hex wrench by turning the screws clockwise (inward) until they clear the support tube.
3. Slowly pull the electronics housing out of the support tube.

   If the electronics housing is rotated more than 90 degrees and a thermocouple is present, remove the thermocouple from the transmitter housing. See Temperature sensor replacement for more information.
4. Unscrew the sensor cable from the housing with a 5/16 inch (8 mm) open end wrench.

   Note
   Do not pull the housing more than 1.5 inch (40 mm) from the top of the support tube until the sensor cable is disconnected. Damage to the sensor may occur if this sensor cable is stressed.

5. Rotate the housing to the desired orientation.
6. Hold it in this orientation while you screw the sensor cable onto the base of the housing.

   Note
   Do not rotate the housing while the sensor cable is attached to the base of the housing. This will stress the cable and may damage the sensor.

7. If applicable, re-install the thermocouple to the transmitter housing. See Temperature sensor replacement.
8. Place the electronics housing into the top of the support tube.
9. Use a hex wrench to turn the three accessible housing rotation screws counterclockwise to engage the support tube.
10. Replace the access cover on the support tube (if present).
11. Tighten the screw on the access cover (if present).

9.3.7 Temperature sensor replacement

Replacement of the temperature sensor should only be necessary in the event of a failure. Use the following procedure for replacement.

Note
Disconnect power before replacing temperature sensor.

1. Turn off power to the meter.
2. Remove temperature sensor from meter body by using a ½ inch (13 mm) open end wrench.

Note
Use plant approved procedure for removing a temperature sensor from a thermowell.

3. Remove temperature sensor from electronics by using a 2.5 mm hex wrench to remove hex socket screw from electronics.
4. Gently pull temperature sensor from electronics.

Note
This will expose the electronics to the atmosphere.

5. Insert new temperature sensor into electronics housing using care to align pin and cap head screw to align connector pins.
6. Tightening cap head screw with 2.5 mm hex wrench.
7. Slide bolt and ferrule assembly onto temperature sensor and hold into place.
8. Insert temperature sensor into hole in bottom of meter body until it reaches the bottom of the hole. Hold it in place and tighten bolt with ½ inch (13 mm) open end wrench until 3/4 turns past finger tight to seat ferrule.
9. Reapply power to the Rosemount 8800D.

9.4 Return of material

To expedite the return process, call the Rosemount North American Response Center at 800-654-RSMT (7768) toll-free number. This center, available 24 hours a day, will assist you with any needed information or materials.

The center will ask for product model and serial numbers, and will provide a Return Material Authorization (RMA) number. The center will also ask for the name of the process material to which the product was last exposed.

CAUTION
People who handle products exposed to a hazardous substance can avoid injury if they are informed and understand the hazard. If the product being returned was exposed to a hazardous substance as defined by OSHA, a copy of the required Material Safety Data Sheet (MSDS) for each hazardous substance identified must be included with the returned goods.

The Rosemount North American Response Center will detail the additional information and procedures necessary to return goods exposed to hazardous substances.

Toll-free assistance numbers

Within the United States, Emerson Process Management has two toll-free assistance numbers:

Technical support, quoting, and order-related questions:

1-800-522-6277 (7:00 am to 7:00 pm CST)

North American Response Center—Equipment service needs:

1-800-654-7768 (24 hours—includes Canada)

Outside of the United States, contact your local an Emerson Flow Sales Representative .

A Product Specifications

A.1 Physical specifications

Rosemount vortex flow meters are designed to the standards defined in ASME B31.3. This standard is used as the basis for all of our other pressure vessel certifications such as CRN and PED.

Process fluids

Liquid, **Gas**, and **Steam** applications. Fluids must be homogeneous and single-phase.

Flow calibration

Every Emerson Vortex flowmeter is water calibrated and given a unique calibration number called a reference K-factor. Emerson flow labs use traceable calibrations that reference internationally recognized standards such as NIST in the United States and Mexico, National Institute of Standards in China, and ISO 10725 in Europe.

Theoretical and experimental data have shown that the K-factor is independent of fluid density and viscosity, proving the K-factor is applicable in all types of fluid—liquid, gas and steam. The K-factor is a function of the shedder bar and meter geometry.

Line sizes and pipe schedules

Table A-1: Line sizes by process connection type

Line size		Process connection type (✓ indicates availability)							
Inch	DIN	Flanged				Wafer	Weld-end	Threaded	
		Standard	Dual	Reducer	Quad			Standard	Reducer
0.5	15	✓	✓			✓	✓	✓	
1	25	✓	✓	✓		✓	✓	✓	✓
1.5	40	✓	✓	✓		✓	✓	✓	✓
2	50	✓	✓	✓	✓	✓	✓	✓	✓
3	80	✓	✓	✓	✓	✓	✓		
4	100	✓	✓	✓	✓	✓	✓		
6	150	✓	✓	✓	✓	✓	✓		
8	200	✓	✓	✓	✓	✓	✓		
10	250	✓	✓	✓	✓		✓		
12	300	✓	✓	✓	✓		✓		
14	350			✓					

Process pipe schedules

Meters will be shipped from the factory at the Schedule 40 default value unless otherwise specified. The value can be changed in the field if necessary.

For a weld-end style meter, see Table A-5.

Pressure limits

Table A-2: Flanged/Dual/Quad style meter

ASME 16.5	EN1092-1	JIS
Class 150	PN 10	10K
Class 300	PN 16	20K
Class 600	PN 25	40K
Class 900	PN 40	
Class 1500	PN 63	
	PN 100	
	PN 160	

Table A-3: Reducer style meter

ASME 16.5	EN1092-1
Class 150	PN 10
Class 300	PN 16
Class 600	PN 25
Class 900	PN 40
Class 1500	PN 63
	PN 100
	PN 160

Table A-4: Wafer style meter

ASME 16.5	EN1092-1	JIS
Class 150	PN 10	10K
Class 300	PN 16	20K
Class 600	PN 25	40K
	PN 40	
	PN 63	
	PN 100	

Table A-5: Weld-end/Threaded-end style meter

	W1	W4	W8/T8	W9/T9
Mating pipe schedule:	Schedule 10	Schedule 40	Schedule 80	Schedule 160

Table A-5: Weld-end/Threaded-end style meter *(continued)*

	W1	W4	W8/T8	W9/T9
Pressure rating for 1 inch to 4 inch sizes:	720 psig (4.96 MPa-g)	1,440 psig (9.93 MPa-g)	2,160 psig (14.9 MPa-g)	3,600 psig (24.8 MPa-g)
Pressure rating for 6 inch to 12 inch sizes:	N/A	720 psig (4.96 MPa-g)	1,440 psig (9.93 MPa-g)	2,160 psig (14.9 MPa-g)

Temperature limits

Table A-6: Vortex sensor temperature limits

Vortex sensor	Temperature limit
Standard	–40 °F to +450 °F (–40 °C to +232 °C)
Extended	–330 °F to +800 °F (–201 °C to +427 °C)
Severe(1)	–330 °F to +800 °F (–201 °C to +427 °C)

(1) *The meter body and sensor, in remote mount configurations, is functionally rated to +842 °F process temperature. Process temperature may be further restricted depending on hazardous area options and PED certificates. Consult applicable certificates for particular installation limits.*
–320 °F to 800 °F (–196 to +427 °C) for European Pressure Equipment Directive (PED), Contact an Emerson Flow representative (see back page).
The Super Duplex material of construction is limited to use in applications with process temperatures from –40 to +450 °F (–40 to +232 °C). Contact an Emerson Flow representative (see back page).

Table A-7: Temperature sensor temperature limits

Temperature sensor	Temperature limit
Type N thermocouple	–40 °F to +842 °F (–40 °C to +450 °C)(1)

(1) *Meets ASTM E230/E230M-17 Special Tolerance Standard.*

Table A-8: Electronics temperature limits (remotely-mounted transmitter)

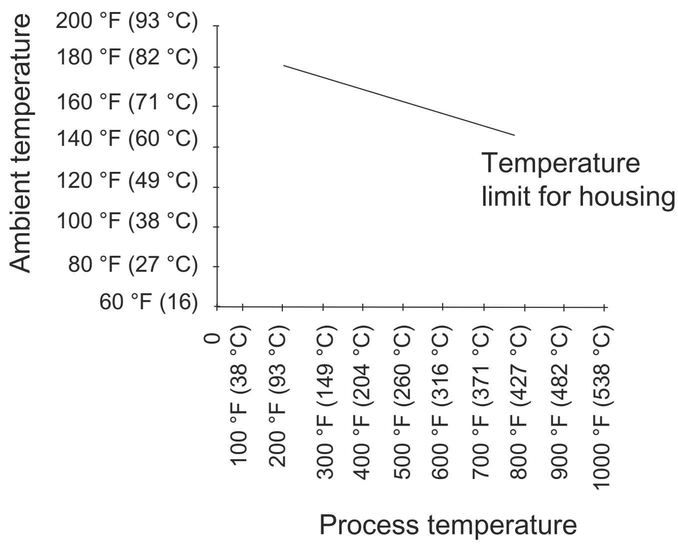
Ambient operating temperature range	–58 °F to +185 °F (–50 °C to +85 °C)
Ambient operating temperature range with LCD —Local Indicator(1)	–40 °F to +185 °F (–40 °C to +85 °C)
Storage temperature range	–58 °F to +250 °F (–50 °C to +121 °C)
Storage temperature range with LCD	–50 °F to +185 °F (–46 °C to +85 °C)

(1) *LCD contrast may be affected below –4 °F (–20 °C).*

Table A-9: Electronics temperature limits (integrally-mounted transmitter)

Operating and storage temperature range, with and without LCD	Same as remotely-mounted transmitter. See Table A-8. However, high process temperature lowers the maximum allowable ambient temperature. See Figure A-1.

Table A-9: Electronics temperature limits (integrally-mounted transmitter) *(continued)*

Maximum process temperature	Interdependent with ambient temperature. Figure A-1 indicates the combined ambient and process temperature limits under which the electronics temperature can be maintained below the maximum +185 °F (+85 °C). **Note** The indicated limit is with the integral transmitter directly above a horizontal pipe, and the pipe insulated with three inches of ceramic fiber. Other configurations may affect the actual electronics temperature. **Figure A-1: Maximum ambient/process temperature limit** 

EMI/RFI effect

- Meets EMC requirements to Directive 2014/30/EU.
- Output error less than ±0.025% of span with twisted pair from 80–1000 MHz for radiated field strength of 10 V/m.
- 1.4–2.0 GHz for radiated field strength of 3 V/m.
- 2.0–2.7 GHz for radiated field strength of 1 V/m.
- No affect on the values that are being given if using HART digital signal.
- Tested per EN61326.

Humidity limits

Operates in 0–95% relative humidity under noncondensing conditions (tested to IEC 60770, Section 6.2.11).

Remote transmitter mounting hardware and cables

- Mounting hardware is provided.
- The transmitter and meter body are interconnected by a standard or armored signal cable assembly.
  - Cable length is specified when ordered (see Ordering Information - Single/Dual Transmitter or Ordering information – Quad transmitter), and it cannot be altered in the field.
  - Standard cable is non-armored and is intended to be run through rigid metal conduit.
  - Armored cable includes glands/adapters to connect the cable to the meter body and transmitter.
  - Both types of cable are flame resistant in accordance with IEC 60322-3.

Tagging

- Standard tags are stainless steel.
- The standard tag is permanently attached to the flowmeter.
- Character height is 1/16 inch (1,6 mm).
- A wired-on tag is available on request.
- Character height on the wire-on tag is 0.236 inch (6 mm).
- Wire on tags can contain five lines with an average of 19 characters per line at standard character height.

A.2 Performance specifications

The following performance specifications are for all Rosemount models except where noted. Digital performance specifications applicable to both Digital HART and FOUNDATION Fieldbus output. Unless stated otherwise, all accuracy specifications include linearity, hysteresis, and repeatability.

Volume flow accuracy

Table A-10: Volume flow accuracy

Process fluid	Digital and pulse output
Liquids with Reynolds number over 20,000	±0.65% of rate(1)(2)(3)(4)
Gas and steam with Reynolds number over 15,000	±1.0% of rate(5)(2)
For all process fluids from stated limit to a Reynolds number of 10,000	From process limit specification to ±2% linear increase
For Reynolds numbers less than 10,000 to 5,000	±2% to ±6%, linear

(1) 6 inch to 12 inch reducer (150 mm to 300 mm) ±1.0% of rate.
(2) Analog ±0.025% of span
(3) 4 inch (100 mm) Quad, ±0.65% for velocities greater than 5.0 ft/sec (1.5 m/sec), ±1.00% of rate for velocities less than 5.0 ft/sec (1.5 m/sec)

(4) 6 inch (150 mm) Quad, ± 1.00% of rate.
(5) 6 inch to 12 inch reducer (150 mm to 300 mm): ±1.35% of rate.

Accuracy limitations for gas and steam:

- For ½ inch and 1 inch (DN 15 and DN 25); max velocity of 220 ft/s (67.06 m/s)
- For all dual shedder bar design meters: max velocity of 100 ft/s (30.5 m/s)
- For dual shedder bar design meters above 100 ft/s (30.5 m/s) contact an Emerson Flow representative (see back page).

Volume flow repeatability

±0.1 percent of actual flow rate.

Stability

±0.1% of rate over one year

Process temperature accuracy

Table A-11: Process temperature accuracy by installation type

Installation type	Process temperature accuracy
Integral mount	2.2 °F (1.2 °C) or 0.4% of reading, whichever is greater
Remote mount	Add ±0.018 °F/ft (±0.03 °C/m) of uncertainty to measurement

Temperature sensor accuracy meets ASTM E230/E230M-17 Special Tolerance Standard.

Mass flow accuracy

Table A-12: Mass flow accuracy by process fluid type

Process fluid type	MV option code	Compensation type	Accuracy
Steam	MTA or MCA	Temperature compensation(1)	±2.0% of rate (typical)
	MPA and MCA	Pressure compensation(1)(2)(3)	±1.3% of rate at 30 psia through 2,000 psia
	MCA	Pressure and Temperature Compensation(1)(2)(3)	±1.2% of rate at 150 psia ±1.3% of rate at 300 psia ±1.6% of rate at 800 psia ±2.5% of rate at 2,000 psia
Liquid (water)	MTA and MCA	Temperature Compensation	±0.70% of rate up to 500 °F (260 °C)(4)
Liquid (user-defined)	MTA and MCA	Temperature Compensation	Dependent on user input

(1) Temperature range +176 °F to +842 °F (+80 °C to + 450 °C)
(2) Pressure measurement accuracy is ±0.1% of span.
(3) Consult factory accuracy for < 30 psia and > 2,000 psia.
(4) ±0.85% of rate between +500 °F to +600 °F (+260 °C to +316 °C)

Process temperature effect on K-factor

The compensated K-factor is based on the reference K-factor as compensated for the given fixed process temperature and wetted materials. Compensated K-factor is calculated by the electronics.

The percentage change in K-factor for all materials is no greater than ±0.3 per 100 °F (56 °C).

Table A-13: Ambient temperature effect

Output type	Ambient temperature effect
Digital and pulse output	No effect
Analog output	±0.1% of span from –58 °F to 185 °F (–50 to 85 °C)

Measurable flow rates

Capable of processing signals from flow applications which meet the Reynolds number and velocity limitations listed in Table A-14, Table A-15, and Table A-16.

Table A-14: Minimum Measurable Meter Reynolds Numbers

Meter sizes	Reynolds number limitations
½ – 4 inch (DN 15 – DN100)	5000 minimum
6 – 12 inch (DN150 – DN300)	

Table A-15: Minimum measurable meter velocities

Process	Feet per second(1)	Meters per second(1)
Liquids(2)	$\sqrt{36/\rho}$	$\sqrt{54/\rho}$
Gases(2)	$\sqrt{36/\rho}$	$\sqrt{54/\rho}$
ρ is the process fluid density at flowing conditions in lb/ft³ for ft/s and kg/m³ for m/s.		

(1) Referenced to schedule 40 pipe.
(2) This minimum measurable meter velocity is based on default filter settings.

Table A-16: Maximum Measurable Meter Velocities (use the smaller of the two values)

Process	Feet per second(1)		Meters per second(1)	
Liquids	$\sqrt{90,000/\rho}$	or 25	$\sqrt{134,000/\rho}$	or 7.6
Gases(2)	$\sqrt{90,000/\rho}$	or 300	$\sqrt{134,000/\rho}$	or 91.4
ρ is the process fluid density at flowing conditions in lb/ft³ for ft/s and kg/m³ for m/s.				

(1) Referenced to schedule 40 pipe.
(2) Accuracy limitations for gas and steam for dual-style meters (½ to 4 inch): max velocity of 100 ft/s (30.5 m/s).

Note

Sizing calculations are required to select the proper flow meter size. These calculations provide pressure loss, accuracy, minimum and maximum flow rate data to guide in proper selection. Vortex sizing software can be found using the Selection and Sizing tool. The Selection and Sizing tool can be accessed online or downloaded for offline use using this link:

www.Emerson.com/FlowSizing

Permanent pressure loss

The approximate permanent pressure loss (PPL) from the flowmeter is calculated for each application in the Vortex sizing software. Go to the Rosemount 8800D Product Page, and select **Size** for detailed sizing on most applications, or complete a Configuration Data Sheet and contact an Emerson Flow representative (see back page).

The PPL is determined using the equation:

$$\mathrm{PPL} = \frac{A \times \rho_f \times Q^2}{D^4}$$

PPL Permanent pressure loss (psi or kPa)

ρ_f Density at operating conditions (lb/ft³ or kg/m³)

Q Actual volumetric flow rate (Gas = ft³/min or m³/hr; Liquid = gal/min or l/min)

D Flowmeter bore diameter (in. or mm)

A Constant depending on meter style, fluid type, and flow units. Determined per :

Meter style	English units		SI units	
	A_{liquid}	A_{gas}	A_{liquid}	A_{gas}
8800DF/W	3.4×10^{-5}	1.9×10^{-3}	0.425	118
8800DR	3.91×10^{-5}	2.19×10^{-3}	0.489	136
8800DD	6.12×10^{-5}	3.42×10^{-3}	0.765	212
8800DQ	6.12×10^{-5}	3.42×10^{-3}	0.765	212

Minimum upstream pressure (liquids)

Flow metering conditions that would allow cavitation, the release of vapor from a liquid, should be avoided. This flow condition can be avoided by remaining within the proper flow range of the meter and by following appropriate system design.

For some liquid applications, incorporation of a back pressure valve should be considered. To prevent cavitation, the minimum upstream pressure should be the smaller result of these two equations:

- $2.9 \times \Delta P + 1.3 \times p_v$
- $2.9 \times \Delta P + p_v + 0.5$ psia (3.45 kPa)

Where:

P Line pressure five pipe diameters downstream of the meter (psia or kPa abs)

ΔP Pressure loss across the meter (psi or kPa)

p_v Liquid vapor pressure at operating conditions (psia or kPa abs)

Vibration effect

High vibration may cause a false flow measurement when there is no flow. The meter design will minimize this effect, and the factory settings for signal processing are selected to eliminate these errors for most applications. If an output error at zero flow is still detected, it can be eliminated by adjusting the low flow cutoff, trigger level, or low-pass filter. As the process begins to flow through the meter, most vibration effects are quickly overcome by the flow signal.

Vibration specifications

- Integral aluminum housings, remote aluminum housings, and remote SST housings: At or near the minimum liquid flow rate in a normal pipe mounted installation, the maximum vibration should be 0.087 inch (2,21 mm) double amplitude displacement or 1 g acceleration, whichever is smaller. At or near the minimum gas flow rate in a normal pipe mounted installation, the maximum vibration should be 0.043 inch (1,09 mm) double amplitude displacement or ½ g acceleration, whichever is smaller.
- Integral SST housing: At or near the minimum liquid flow rate in a normal pipe mounted installation, the maximum vibration should be 0.044 inch (1,11 mm) double amplitude displacement or ⅓ g acceleration, whichever is smaller. At or near the minimum gas flow rate in a normal pipe mounted installation, the maximum vibration should be 0.022 inch (0,55 mm) double amplitude displacement or ⅙ g acceleration, whichever is smaller.

Mounting position effect

Meter will meet accuracy specifications when mounted in horizontal, vertical, or inclined pipelines. Best practice for mounting in a horizontal pipe is to orient the shedder bar in the horizontal plane. This will prevent solids in liquid applications and liquid in gas/steam applications from disrupting the shedding frequency.

Pipe length requirements

Rated accuracy is based on the number of pipe diameters from an upstream disturbance. No K-factor correction is required if the meter is installed with 35D upstream and 5D downstream. The value of the K-factor may shift up to 0.5% when the upstream straight pipe length is reduced down to the minimum recommended 10D. Refer to the Rosemount 8800 Vortex Installation Effects Technical Data Sheet for detailed information on K-factor correction.

Flow calibration information

Flowmeter calibration and configuration information is provided with every flowmeter. For a certified copy of flow calibration data, the Q4 option code must be ordered in the model number.

Transient protection

The optional transient terminal block prevents damage to the flowmeter from transients induced by lightning, welding, heavy electrical equipment, or switch gears. The transient protection electronics are located in the terminal block.

The transient terminal block meets the following specifications:

- IEEE C62.41 - 2002 Category B
- 3 kA crest (8 × 20 ms)
- 6 kV crest (1.2 × 50 ms)
- 6 kV/0.5 kA (0.5 ms, 100 kHz, ring wave)

A.3 Typical flow rates

This section provides typical flow ranges for some common process fluids with default filter settings. Consult an Emerson representative (see back page) to obtain a computer sizing program that describes in greater detail the flow range for an application.

Table A-17 is a reference of pipe velocities that can be measured for the standard Rosemount 8800D and the reducer Rosemount 8800DR Vortex Meters. It does not consider density limitations, as described in Table A-14 and Table A-15. Velocities are referenced in schedule 40 pipe.

Table A-17: Typical pipe velocity ranges for Rosemount 8800D and 8800DR

Process line size	Vortex meter (1)	Liquid velocity ranges		Gas velocity ranges	
(inches/ DN)		(ft/s)	(m/s)	(ft/s)	(m/s)
0.5/ 15	8800DF005	0.70 to 25.0	0.21 to 7.6	6.50 to 250.0	1.98 to 76.2
1/ 25	8800DF010	0.70 to 25.0	0.21 to 7.6	6.50 to 250.0	1.98 to 76.2
	8800DR010	0.25 to 8.8	0.08 to 2.7	2.29 to 87.9	0.70 to 26.8
1.5/ 40	8800DF015	0.70 to 25.0	0.21 to 7.6	6.50 to 250.0	1.98 to 76.2
	8800DR015	0.30 to 10.6	0.09 to 3.2	2.76 to 106.1	0.84 to 32.3
2/ 50	8800DF020	0.70 to 25.0	0.21 to 7.6	6.50 to 250.0	1.98 to 76.2
	8800DR020	0.42 to 15.2	0.13 to 4.6	3.94 to 151.7	1.20 to 46.2
3/ 80	8800DF030	0.70 to 25.0	0.21 to 7.6	6.50 to 250.0	1.98 to 76.2
	8800DR030	0.32 to 11.3	0.10 to 3.5	2.95 to 113.5	0.90 to 34.6
4/ 100	8800DF040	0.70 to 25.0	0.21 to 7.6	6.50 to 250.0	1.98 to 76.2
	8800DR040	0.41 to 14.5	0.12 to 4.4	3.77 to 145.2	1.15 to 44.3
6/ 150	8800DF060	0.70 to 25.0	0.21 to 7.6	6.50 to 250.0	1.98 to 76.2
	8800DR060	0.31 to 11.0	0.09 to 3.4	2.86 to 110.2	0.87 to 33.6
8/ 200	8800DF080	0.70 to 25.0	0.21 to 7.6	6.50 to 250.0	1.98 to 76.2
	8800DR080	0.40 to 14.4	0.12 to 4.4	3.75 to 144.4	1.14 to 44.0
10/ 250	8800DF100	0.90 to 25.0	0.27 to 7.6	6.50 to 250.0	1.98 to 76.2

Table A-17: Typical pipe velocity ranges for Rosemount 8800D and 8800DR *(continued)*

Process line size	Vortex meter (1)	Liquid velocity ranges		Gas velocity ranges	
(inches/ DN)		(ft/s)	(m/s)	(ft/s)	(m/s)
	8800DR100	0.44 to 15.9	0.13 to 4.8	4.12 to 158.6	1.26 to 48.3
12/ 300	8800DF120	1.10 to 25.0	0.34 to 7.6	6.50 to 250.0	1.98 to 76.2
	8800DR120	0.63 to 17.6	0.19 to 5.4	4.58 to 176.1	1.40 to 53.7

(1) Velocity range of the Rosemount 8800DW is the same as Rosemount 8800DF.

Note

Table A-18 is a reference of flow rates that can be measured for the standard Rosemount 8800D and the reducer 8800DR Vortex Meters. It does not consider density limitations, as described in Table A-14 and Table A-15.

Table A-18: Water flow rate limits for the Rosemount 8800D and 8800DR

Process line size	Vortex meter (1)	Minimum and maximum measurable water flow rates(2)	
(inches/ DN)		Gallons/minute	Cubic meters/hour
0.5/ 15	8800DF005	1.76 to 23.7	0.40 to 5.4
1/ 25	8800DF010	2.96 to 67.3	0.67 to 15.3
	8800DR010	1.76 to 23.7	0.40 to 5.4
1.5/ 40	8800DF015	4.83 to 158	1.10 to 35.9
	8800DR015	2.96 to 67.3	0.67 to 15.3
2/ 50	8800DF020	7.96 to 261	1.81 to 59.4
	8800DR020	4.83 to 158.0	1.10 to 35.9
3/ 80	8800DF030	17.5 to 576	4.00 to 130
	8800DR030	7.96 to 261.0	1.81 to 59.3
4/ 100	8800DF040	30.2 to 992	6.86 to 225
	8800DR040	17.5 to 576	4.00 to 130
6/ 150	8800DF060	68.5 to 2251	15.6 to 511
	8800DR060	30.2 to 992	6.86 to 225
8/ 200	8800DF080	119 to 3898	27.0 to 885
	8800DR080	68.5 to 2251	15.6 to 511
10/ 250	8800DF100	231 to 6144	52.2 to 1395
	8800DR100	119 to 3898	27.0 to 885
12/ 300	8800DF120	391 to 8813	88.8 to 2002
	8800DR120	231 to 6144	52.2 to 1395

(1) Velocity range of the 8800DW is the same as 8800DF.
(2) Conditions: 77 °F (25 °C) and 14.7 psia (1.01 bar absolute)

Table A-19: Air flow rate limits at 59 °F (15 °C)

Process pressure	Flow rate limits	Minimum and maximum air flow rates for line sizes 1/2-in./DN 15 through 1-in./DN 25							
		1/2-in./DN 15				1-in./DN 25			
		Rosemount 8800D		Rosemount 8800DR		Rosemount 8800D		Rosemount 8800DR	
		ACFM	ACMH	ACFM	ACMH	ACFM	ACMH	ACFM	ACMH
0 psig	max	27.9	47.3	Not Available	Not Available	79.2	134	27.9	47.3
(0 bar G)	min	4.62	7.84			9.71	16.5	4.62	7.84
50 psig	max	27.9	47.3	Not Available	Not Available	79.2	134	27.9	47.3
(3,45 bar G)	min	1.31	2.22			3.72	6.32	1.31	2.22
100 psig	max	27.9	47.3	Not Available	Not Available	79.2	134	27.9	47.3
(6,89 bar G)	min	0.98	1.66			2.80	4.75	0.98	1.66
150 psig	max	27.9	47.3	Not Available	Not Available	79.2	134	27.9	47.3
(10,3 bar G)	min	0.82	1.41			2.34	3.98	0.82	1.41
200 psig	max	27.9	47.3	Not Available	Not Available	79.2	134	27.9	47.3
(13,8 bar G)	min	0.82	1.41			2.34	3.98	0.82	1.41
300 psig	max	27.9	47.3	Not Available	Not Available	79.2	134	27.9	47.3
(20,7 bar G)	min	0.82	1.41			2.34	3.98	0.82	1.41
400 psig	max	25.7	43.9	Not Available	Not Available	73.0	124	25.7	43.9
(27,6 bar G)	min	0.82	1.41			2.34	3.98	0.82	1.41
500 psig	max	23.0	39.4	Not Available	Not Available	66.0	112	23.0	39.4
(34,5 bar G)	min	0.82	1.41			2.34	3.98	0.82	1.41

Table A-20: Air flow rate limits at 59 °F (15 °C)

Process pressure	Flow rate limits	Minimum and maximum air Flow rates for line sizes 11/2-in./DN 40 through 2-in./DN 50							
		11/2-in./DN 40				2-in./DN 50			
		Rosemount 8800D		Rosemount 8800DR		Rosemount 8800D		Rosemount 8800DR	
		ACFM	ACMH	ACFM	ACMH	ACFM	ACMH	ACFM	ACMH
0 psig	max	212	360	79.2	134	349	593	212	360
(0 bar G)	min	18.4	31.2	9.71	16.5	30.3	51.5	18.4	31.2
50 psig	max	212	360	79.2	134	349	593	212	360
(3,45 bar G)	min	8.76	14.9	3.72	6.32	14.5	24.6	8.76	14.9
100 psig	max	212	360	79.2	134	349	593	212	360
(6,89 bar G)	min	6.58	11.2	2.80	4.75	10.8	18.3	6.58	11.2
150 psig	max	212	360	79.2	134	349	593	212	360
(10,3 bar G)	min	5.51	9.36	2.34	3.98	9.09	15.4	5.51	9.36

Table A-20: Air flow rate limits at 59 °F (15 °C) *(continued)*

Process pressure	Flow rate limits	Minimum and maximum air Flow rates for line sizes 11/2-in./DN 40 through 2-in./DN 50							
		11/2-in./DN 40				2-in./DN 50			
		Rosemount 8800D		Rosemount 8800DR		Rosemount 8800D		Rosemount 8800DR	
		ACFM	ACMH	ACFM	ACMH	ACFM	ACMH	ACFM	ACMH
200 psig (13,8 bar G)	max min	212 5.51	360 9.36	79.2 2.34	134 3.98	349 9.09	593 15.4	212 5.51	360 9.36
300 psig (20,7 bar G)	max min	198 5.51	337 9.36	79.2 2.34	134 3.98	326 9.09	554 15.4	198 5.51	337 9.36
400 psig (27,6 bar G)	max min	172 5.51	293 9.36	73.0 2.34	124 3.98	284 9.09	483 15.4	172 5.51	293 9.36
500 psig (34,5 bar G)	max min	154 5.51	262 9.36	66.0 2.34	112 3.98	254 9.09	432 15.4	154 5.51	262 9.36

Table A-21: Air flow rate limits at 59 °F (15 °C)

Process pressure	Flow rate limits	Minimum and maximum air flow rates for line sizes 3-in./DN 80 through 4-in./DN 100							
		3-in./DN 80				4-in./DN 100			
		Rosemount 8800D		Rosemount 8800DR		Rosemount 8800D		Rosemount 8800DR	
		ACFM	ACMH	ACFM	ACMH	ACFM	ACMH	ACFM	ACMH
0 psig (0 bar G)	max min	770 66.8	1308 114	349 30.3	593 51.5	1326 115	2253 195	770 66.8	1308 114
50 psig (3,45 bar G)	max min	770 31.8	1308 54.1	349 14.5	593 24.6	1326 54.8	2253 93.2	770 31.8	1308 54.1
100 psig (6,89 bar G)	max min	770 23.9	1308 40.6	349 10.8	593 18.3	1326 41.1	2253 69.8	770 23.9	1308 40.6
150 psig (10,3 bar G)	max min	770 20.0	1308 34.0	349 9.09	593 15.4	1326 34.5	2253 58.6	770 20.0	1308 34.0
200 psig (13,8 bar G)	max min	770 20.0	1308 34.0	349 9.09	593 15.4	1326 34.5	2253 58.6	770 20.0	1308 34.0
300 psig (20,7 bar G)	max min	718 20.0	1220 34.0	326 9.09	554 15.4	1237 34.5	2102 58.6	718 20.0	1220 34.0
400 psig (27,6 bar G)	max min	625 20.0	1062 34.0	284 9.09	483 15.4	1076 34.5	1828 58.6	625 20.0	1062 34.0
500 psig (34,5 bar G)	max min	560 20.0	951 34.0	254 9.09	432 15.4	964 34.5	1638 58.6	560 20.0	951 34.0

Table A-22: Air flow rate limits at 59 °F (15 °C)

Process pressure	Flow rate limits	Minimum and maximum air flow rates for line sizes 6-in./DN 150 through 8-in./DN 200							
		6-in./DN 150				8-in./DN 200			
		Rosemount 8800D		Rosemount 8800DR		Rosemount 8800D		Rosemount 8800DR	
		ACFM	ACMH	ACFM	ACMH	ACFM	ACMH	ACFM	ACMH
0 psig (0 bar G)	max min	3009 261	5112 443	1326 115	2253 195	5211 452	8853 768	3009 261	5112 443
50 psig (3,45 bar G)	max min	3009 124	5112 211	1326 54.8	2253 93.2	5211 215	8853 365	3009 124	5112 211
100 psig (6,89 bar G)	max min	3009 93.3	5112 159	1326 41.1	2253 69.8	5211 162	8853 276	3009 93.3	5112 159
150 psig (10,3 bar G)	max min	3009 78.2	5112 133	1326 34.5	2253 58.6	5211 135	8853 229	3009 78.2	5112 133
200 psig (13,8 bar G)	max min	3009 78.2	5112 133	1326 34.5	2253 58.6	5211 135	8853 229	3009 78.2	5112 133
300 psig (20,7 bar G)	max min	2807 78.2	4769 133	1237 34.5	2102 58.6	4862 135	8260 229	2807 78.2	4769 133
400 psig (27,6 bar G)	max min	2442 78.2	4149 133	1076 34.5	1828 58.6	4228 136	7183 229	2442 78.2	4149 133
500 psig (34,5 bar G)	max min	2188 78.2	3717 133	964 34.5	1638 58.6	3789 136	6437 229	2188 78.2	3717 133

Table A-23: Saturated steam flow rate limits (assumes steam quality is 100%)

Process pressure	Flow rate limits	Minimum and maximum saturated steam flow rates for line sizes 1/2-in./DN 15 through 1-in./DN 25							
		1/2-in./DN 15				1-in./DN 25			
		Rosemount 8800D		Rosemount 8800DR		Rosemount 8800D		Rosemount 8800DR	
		lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr
15 psig (1,03 bar G)	max min	120 12.8	54.6 5.81	Not Available	Not Available	342 34.8	155 15.8	120 12.8	54.6 5.81
25 psig (1,72 bar G)	max min	158 14.0	71.7 6.35	Not Available	Not Available	449 39.9	203 18.1	158 14.0	71.7 6.35
50 psig (3,45 bar G)	max min	250 17.6	113 8.00	Not Available	Not Available	711 50.1	322 22.7	250 17.6	113 8.00
100 psig (6,89 bar G)	max min	429 23.1	194 10.5	Not Available	Not Available	1221 65.7	554 29.8	429 23.1	194 10.5

Table A-23: Saturated steam flow rate limits (assumes steam quality is 100%) *(continued)*

Process pressure	Flow rate limits	Minimum and maximum saturated steam flow rates for line sizes 1/2-in./DN 15 through 1-in./DN 25							
		1/2-in./DN 15				1-in./DN 25			
		Rosemount 8800D		Rosemount 8800DR		Rosemount 8800D		Rosemount 8800DR	
		lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr
150 psig (10,3 bar G)	max min	606 27.4	275 12.5	Not Available	Not Available	1724 78.1	782 35.4	606 27.4	275 12.5
200 psig (13,8 bar G)	max min	782 31.2	354 14.1	Not Available	Not Available	2225 88.7	1009 40.2	782 31.2	354 14.1
300 psig (20,7 bar G)	max min	1135 37.6	515 17.0	Not Available	Not Available	3229 107	1464 48.5	1135 37.6	515 17.0
400 psig (27,6 bar G)	max min	1492 44.1	676 20.0	Not Available	Not Available	4244 125	1925 56.7	1492 44.1	676 20.0
500 psig (34,5 bar G)	max min	1855 54.8	841 24.9	Not Available	Not Available	5277 156	2393 70.7	1855 54.8	841 24.9

Note

The Rosemount 8800D measures the volumetric flow under operating conditions (i.e. the actual volume at the operating pressure and temperature–acfm or acmh), as shown above. However, gas volumes are strongly dependent on pressure and temperature. Therefore, gas quantities are typically stated in standard or normal conditions (e.g. SCFM or NCMH). (Standard conditions are typically 59 °F and 14.7 psia. Normal conditions are typically 0 °C and 1.01 bar abs.)

The flow rate limits in standard conditions are found using the equations below:

Standard Flow Rate = Actual Flow Rate X Density Ratio

Density Ratio = Density at Actual (Operating) Conditions / Density at Standard Conditions

Table A-24: Saturated steam flow rate limits (assumes steam quality is 100%)

Process pressure	Flow rate limits	Minimum and maximum saturated steam flow rates for line sizes 1/2-in./DN 15 through 1-in./DN 25							
		11/2-in./DN 40				2-in./DN 50			
		Rosemount 8800D		Rosemount 8800DR		Rosemount 8800D		Rosemount 8800DR	
		lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr
15 psig (1,03 bar G)	max min	917 82.0	416 37.2	342 34.8	155 15.8	1511 135	685 61.2	917 82.0	416 37.2
25 psig (1,72 bar G)	max min	1204 93.9	546 42.6	449 39.9	203 18.1	1983 155	899 70.2	1204 93.9	546 42.6
50 psig (3,45 bar G)	max min	1904 118	864 53.4	711 50.1	322 22.7	3138 195	1423 88.3	1904 118	864 53.4

Table A-24: Saturated steam flow rate limits (assumes steam quality is 100%) *(continued)*

Process pressure	Flow rate limits	Minimum and maximum saturated steam flow rates for line sizes 1/2-in./DN 15 through 1-in./DN 25							
		11/2-in./DN 40				2-in./DN 50			
		Rosemount 8800D		Rosemount 8800DR		Rosemount 8800D		Rosemount 8800DR	
		lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr
100 psig (6,89 bar G)	max min	3270 155	1483 70.1	1221 65.7	554 29.8	5389 255	2444 116	3270 155	1483 70.1
150 psig (10,3 bar G)	max min	4616 184	2094 83.2	1724 78.1	782 35.4	7609 303	3451 137	4616 184	2094 83.2
200 psig (13,8 bar G)	max min	5956 209	2702 94.5	2225 88.7	1009 40.2	9818 344	4453 156	5956 209	2702 94.5
300 psig (20,7 bar G)	max min	8644 252	3921 114	3229 107	1464 48.5	14248 415	6463 189	8644 252	3921 114
400 psig (27,6 bar G)	max min	11362 295	5154 134	4244 125	1925 56.7	18727 487	8494 221	11362 295	5154 134
500 psig (34,5 bar G)	max min	14126 367	6407 167	5277 156	2393 70.7	23284 605	10561 274	14126 367	6407 167

Table A-25: Saturated steam flow rate limits (assumes steam quality is 100%)

Process pressure	Flow rate limits	Minimum and maximum saturated steam flow rates for line sizes 3-in./DN 80 through 4-in./DN 100							
		3-in./DN 80				4-in./DN 100			
		Rosemount 8800D		Rosemount 8800DR		Rosemount 8800D		Rosemount 8800DR	
		lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr
15 psig (1,03 bar G)	max min	3330 298	1510 135	1511 135	685 61.2	5734 513	2601 233	3330 298	1510 135
25 psig (1,72 bar G)	max min	4370 341	1982 155	1983 155	899 70.2	7526 587	3414 267	4370 341	1982 155
50 psig (3,45 bar G)	max min	6914 429	3136 195	3138 195	1423 88.3	11905 739	5400 335	6914 429	3136 195
100 psig (6,89 bar G)	max min	11874 562	5386 255	5389 255	2444 116	20448 968	9275 439	11874 562	5386 255
150 psig (10,3 bar G)	max min	16763 668	7603 303	7609 303	3451 137	28866 1150	13093 522	16763 668	7603 303
200 psig (13,8 bar G)	max min	21630 759	9811 344	9818 344	4453 156	37247 1307	16895 593	21630 759	9811 344

Table A-25: Saturated steam flow rate limits (assumes steam quality is 100%) *(continued)*

Process pressure	Flow rate limits	Minimum and maximum saturated steam flow rates for line sizes 3-in./DN 80 through 4-in./DN 100							
		3-in./DN 80				4-in./DN 100			
		Rosemount 8800D		Rosemount 8800DR		Rosemount 8800D		Rosemount 8800DR	
		lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr
300 psig (20,7 bar G)	max min	31389 914	14237 415	14248 415	6463 189	54052 1574	24517 714	31389 914	14237 415
400 psig (27,6 bar G)	max min	41258 1073	18714 487	18727 487	8494 221	71047 1847	32226 838	41258 1073	18714 487
500 psig (34,5 bar G)	max min	51297 1334	23267 605	23284 605	10561 274	88334 2297	40068 1042	51297 1334	23267 605

Table A-26: Saturated steam flow rate limits (assumes steam quality is 100%)

Process pressure	Flow rate limits	Minimum and maximum saturated steam flow rates for line sizes 6-in./DN 150 through 8-in./DN 200							
		6-in./DN 150				8-in./DN 200			
		Rosemount 8800D		Rosemount 8800DR		Rosemount 8800D		Rosemount 8800DR	
		lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr
15 psig (1,03 bar G)	max min	13013 1163	5903 528	5734 513	2601 233	22534 2015	10221 914	13013 1163	5903 528
25 psig (1,72 bar G)	max min	17080 1333	7747 605	7526 587	3414 267	29575 2308	13415 1047	17080 1333	7747 605
50 psig (3,45 bar G)	max min	27019 1676	12255 760	11905 739	5400 335	46787 2903	21222 1317	27019 1676	12255 760
100 psig (6,89 bar G)	max min	46405 2197	21049 996	20448 968	9275 439	80356 3804	36449 1725	46405 2197	21049 996
150 psig (10,3 bar G)	max min	65611 2610	29761 1184	28866 1150	13093 522	113440 4520	51455 2050	65611 2610	29761 1184
200 psig (13,8 bar G)	max min	84530 2965	38342 1345	37247 1307	16895 593	146375 5134	66395 2329	84530 2965	38342 1345
300 psig (20,7 bar G)	max min	122666 3572	55640 1620	54052 1574	24517 714	212411 6185	96348 2805	122666 3572	55640 1620
400 psig (27,6 bar G)	max min	161236 4192	73135 1901	71047 1847	32226 838	279200 7259	126643 3293	161236 4192	73135 1901
500 psig (34,5 bar G)	max min	200468 5212	90931 2364	88334 2297	40068 1042	347134 9025	157457 4094	200468 5212	90931 2364

Table A-27: Saturated steam flow rate limits (assumes steam quality is 100%)

Process pressure	Flow rate limits	Minimum and maximum saturated steam flow rates for line sizes 10-in./DN 250 through 12-in./DN 300							
		10-in./DN 250				12-in./DN 300			
		Rosemount 8800D		Rosemount 8800DR		Rosemount 8800D		Rosemount 8800DR	
		lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr
15 psig (1,03 bar G)	max min	35519 3175	16111 1440	22534 2015	10221 914	50994 4554	23130 2066	35519 3175	16111 1440
25 psig (1,72 bar G)	max min	46618 4570	21146 2073	29575 2308	13415 1047	66862 5218	30328 2367	46618 4570	21146 2073
50 psig (3,45 bar G)	max min	73748 4575	33452 2075	46787 2903	21222 1317	105774 6562	47978 2976	73748 4575	33452 2075
100 psig (6,89 bar G)	max min	126660 5996	57452 2720	80356 3804	36449 1725	181663 8600	82401 3901	126660 5996	57452 2720
150 psig (10,3 bar G)	max min	178808 7125	81106 3232	113440 4520	51455 2050	256457 10218	116327 4635	178808 7125	81106 3232
200 psig (13,8 bar G)	max min	230722 8092	104654 3670	146375 5134	66395 2329	330915 11607	150101 5265	230722 8092	104654 3670
300 psig (20,7 bar G)	max min	334810 9749	151867 4422	212411 6185	96348 2805	480203 13983	217816 6343	334810 9749	151867 4422
400 psig (27,6 bar G)	max min	440085 11442	199619 5190	279200 7259	126643 3293	631195 16411	286305 7444	440085 11442	199619 5190
500 psig (34,5 bar G)	max min	547165 14226	248190 6453	347134 9025	157457 4094	784775 20404	355968 9255	547165 14226	248190 6453

A.4 HART specifications

Output signals

Digital HART signal Bell 202 superimposed on 4–20 mA signal

Optional scalable pulse output 0 to 10000 Hz; transistor switch closure with adjustable scaling via HART communications; capable of switching from 5 to 30 Vdc, 120 mA maximum

Analog output adjustment

Engineering units and lower and upper range values are user-selected. Output is automatically scaled to provide 4 mA at the selected lower range value, 20 mA at the selected upper range value. No frequency input is required to adjust the range values.

Scalable frequency adjustment

The scalable pulse output can be set to a specific velocity, volume, or mass (i.e. 1 pulse = 1 lb). The scalable pulse output can also be scaled to a specific rate of volume, mass, or velocity (i.e. 100 Hz = 500 lb/hr).

Analog 4–20 mA Power supply

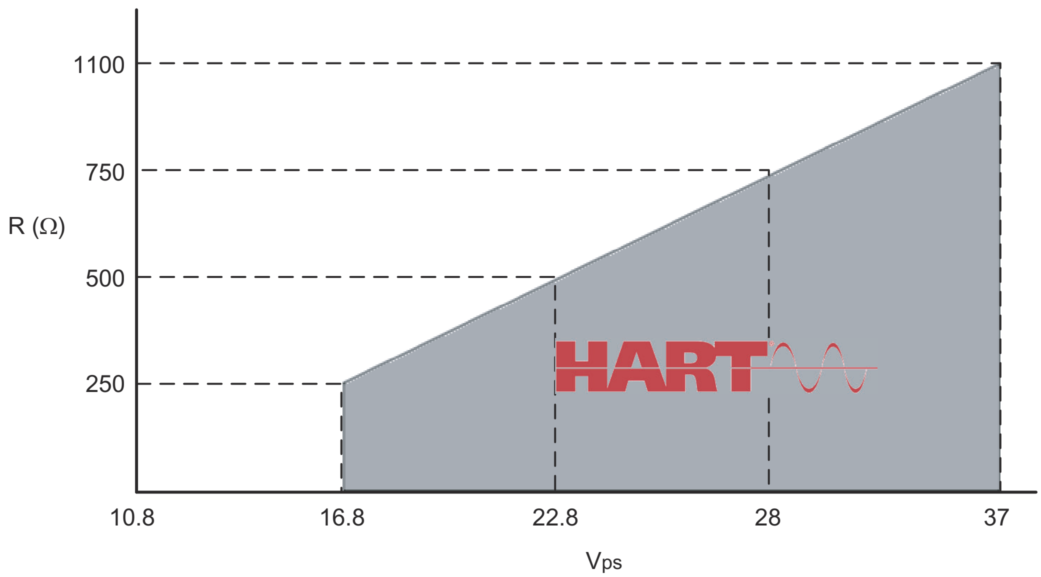
External power supply required. Each transmitter operates on 10.8 VDC to 42 VDC terminal voltage. See Figure A-2.

Power consumption

One watt maximum per transmitter.

HART communication

Figure A-2: HART communication voltage/resistance requirement



Maximum loop resistance is determined by the voltage level of the external power supply, as described in the graph.

Note that HART Communication requires a minimum loop resistance of 250 ohms up to a maximum of 1100 ohms.

R(Ω) Load resistor value.

V_{ps} Minimum power supply voltage required

$R(\Omega)max = 41.7 (V_{ps} – 10.8 V)$.

Failure mode alarm levels

If transmitter self-diagnostics detect a fault condition, the analog signal will be driven to the values in Table A-28.

Table A-28: mA outputs for low and high alarm

Alarm jumper position	mA output by Alarm Type setting(1)	
	Rosemount standard	NAMUR-compliant
Low	3.75	3.60
Hi	21.75	22.6

(1) *The Alarm and Saturation Type settings can be pre-configured at the factory (Options C4 and CN for NAMUR-compliance) or user-configured.*

Saturation output values

When the operating flow is outside the range points, the analog output continues to track the operating flow until reaching the saturation values in Table A-29. The output does not exceed the listed saturation value regardless of the operating flow.

Table A-29: mA output saturation values

	mA output saturation value by type(1)	
	Rosemount standard	NAMUR-Compliant
Low	3.9	3.8
Hi	20.8	20.5

(1) *The Alarm and Saturation Type settings can be pre-configured at the factory (Options C4 and CN for NAMUR-compliance) or user-specified.*

Damping

Flow Damping adjustable between 0.2 and 255 seconds.

Process temperature damping adjustable between 0.4 and 32.0 seconds (MTA/MCA Option only).

Response time

Three vortex shedding cycles or 300 ms, whichever is greater, maximum required to reach 63.2% of actual input with the minimum damping (0.2 seconds).

Turn-on time

Less than six seconds plus the response time to rated accuracy from power up (less than eight seconds with the MTA/MCA Option).

Security lockout

When the security lockout jumper is enabled, the electronics will not allow you to modify parameters that affect flowmeter output.

Output testing

Analog output Flow meter may be commanded to set the analog output to a specified value between 3.6 mA and 22.6 mA.

Pulse output Flow meter may be commanded to set the pulse output frequency to a specified value between 0 Hz and 10000 Hz.

Low flow cutoff

Optimized at the factory per the user's process conditions per Rosemount 8800D Configuration Data Sheet (00806-0100-4004) and typically required no adjustment. In certain cases, if required, it can be further adjusted after installation. Below selected value, output is driven to 4 mA and zero pulse output frequency.

Overrange capability

Analog signal output continues to 105 percent of span for Standard limits (or 103.1% for NAMUR), then remains constant with increasing flow. The digital and pulse outputs will continue to indicate flow up to the upper sensor limit of the flowmeter and a maximum pulse output frequency of 10400 Hz.

Magnetic-field interference

- Output error less than ±0.025% of span at 30 A/m (rms).
- Tested per EN 61326.

Note
During a surge event, devices with 4–20 mA (Outputs option codes D and P) or Modbus output (Output option code M) may exceed maximum EMC deviation limit or reset; however, device will self-recover and return to normal operation within specified start-up time.

Series mode noise rejection

Output error less than ±0.025% of span at 1 V rms, 60 Hz.

Common mode noise rejection

Output error less than ±0.025% of span at 30 V rms, 60 Hz.

Power supply effect

Less than 0.005% of span per volt

Transmitter electrical connections

Model	Terminal type
Analog 4–20 mA/HART	Compression screw terminal permanently fixed to the terminal block.
Analog 4–20 mA/HART + Pulse	

Field Communicator connections

Communication and test terminals	
All models	Clip connections permanently fixed to the terminal block.

The transmitter test function permits testing the loop output current without disconnecting the loop power.

A.5 Modbus RS-485 specifications

Modbus output is provided by a HART to Modbus output conversion.

Output signals

The Rosemount 8800 communicates via Modbus (RS-485) providing device status and 4 dynamic variables. Communication uses 1 start bit and 8 data bits. Baud rates supported are 1200, 2400, 4800, 9600, 19200, and 38400. One or two stop bits, and either none, odd, or even parity are available. All byte orders are supported.

Configuration

Configuration is only available through the HART communication port. No configuration is performed through Modbus.

Alarm handling

The output from the Modbus transmitter in case of an error (such as a field device malfunction) can be configured. The values for Modbus registers corresponding to PV, SV, TV, and QV will be changed accordingly (applicable registers in area 1300, 2000, 2100, and 2200).

Power supply

External power supply required. Each transmitter operates on 10 VDC to 30 VDC terminal voltage.

Scalable pulse output (for temporary testing only)

0 to 10000 Hz; transistor switch closure with adjustable scaling via HART communications; capable of switching from 5 to 30 Vdc, 120 mA maximum. The scalable pulse output can be set to a specific velocity, volume, or mass (i.e. 1 pulse = 1 lb). The scalable pulse output can also be scaled to a specific rate of volume, mass, or velocity (i.e. 100 Hz = 500 lb/hr).

A.6 LCD indicator functional specifications

Optional LCD indicator

The optional 11 digit, two-decimal, two-line integral LCD display can be configured to alternate between selected display options, which differ depending upon the output type selected.

Figure A-3: Examples

When more than one item is selected, the display will scroll through all items selected. In the event of a fault, the display shows the applicable fault code.

Indicator options

- Primary Variable
- Velocity Flow
- Volumetric Flow
- Corrected Volumetric Flow
- Mass Flow
- Signal Strength
- Percent of Range
- Analog Output
- Totalizer
- Shedding Frequency
- Pulse Output Frequency
- Electronics Temperature
- Process Temperature (MTA/MCA only)
- Process Pressure (MPA/MCA only)
- Calculated Process Density (MTA/MCA/MPA only)
- Elapsed Time Meter (ETM)

A.7 Quality certificate details

Table A-30: Weld examination certifications for Q70, Q71

			Helium report	Dye pen report	Radio-graphic report	CD of images
8800DF/8800DD/8800DQ Form Q70, Inspection Certificate Weld Examination, ISO 10747.3.1						
	0.5 inch	15 mm	✓		✓	
	1–4 inch	25–100 mm			✓	
	6–12 inch	150–300 mm		✓	✓	
8800DF/8800DD/8800DQ Form Q71, Inspection Certificate Weld Examination, ISO 10747.3.1						
	0.5 inch	15 mm	✓		✓	✓
	1–4 inch	25–100 mm			✓	✓
	6–12 inch	150–300 mm		✓	✓	✓
8800DR Form Q70, Inspection Certificate Weld Examination, ISO 10747.3.1						
	1 inch	25 mm	✓		✓	
	1.5–6 inch	40–150 mm			✓	
	8–12 inch	200–300 mm		✓	✓	
8800DR Form Q71, Inspection Certificate Weld Examination, ISO 10747.3.1						
	1 inch	25 mm	✓		✓	✓
	1.5–6 inch	40–150 mm			✓	✓
	8–12 inch	200–300 mm		✓	✓	✓
8800DW Form Q70, Inspection Certificate Weld Examination, ISO 10747.3.1						
	0.5 inch	15 mm	✓			
	6–8 inch	150–200 mm		✓		
8800DW Form Q71, Inspection Certificate Weld Examination, ISO 10747.3.1						
	0.5 inch	15 mm	✓			
	6–8 inch	150–200 mm		✓		

Table A-31: PMI Code Q76 for X-Ray Fluorescent Spectrometry (XFR)

Alloy	Elements to be identified
316L Stainless Steel	Cr (Chromium), Ni (Nickel), Mo (Molybdenum)
NiB (Nickel based) Alloys	Cr (Chromium), Ni (Nickel), Mo (Molybdenum)
25Cr Super Duplex	Cr (Chromium), Ni (Nickel), Mo (Molybdenum)

Table A-32: PMI Code Q77 for Optical Emission Spark Spectrometry (OES)

Alloy	Elements to be identified
316L Stainless Steel	Cr (Chromium), Ni (Nickel), Mo (Molybdenum), C (Carbon)
Carbon Steel	Cr (Chromium), Ni (Nickel), Mo (Molybdenum), C (Carbon)

B Spacers

Spacers are available with the Rosemount 8800D to maintain the Rosemount 8800A dimensions. Spacers are installed downstream from the meter body. The spacer kit comes with an alignment ring for ease of installation. Gaskets are placed on each side of the spacer.

Table B-1: Spacer dimensions for 8800A lay length

Line size	Dimensions inch (mm)
1.5 (40)	0.47 (11,9)
2 (50)	1.17 (29,7)
3 (80)	1.27 (32,3)
4 (100)	0.97 (24,6)

C Electronics verification

8800D electronics verification is done using either the internal signal simulation capability, or by applying an external signal source to the TEST FREQ IN and GROUND pins.

Electronics functionality is verified via two different verification methods:

- Flow Simulation Mode
- Using an External Frequency Generator

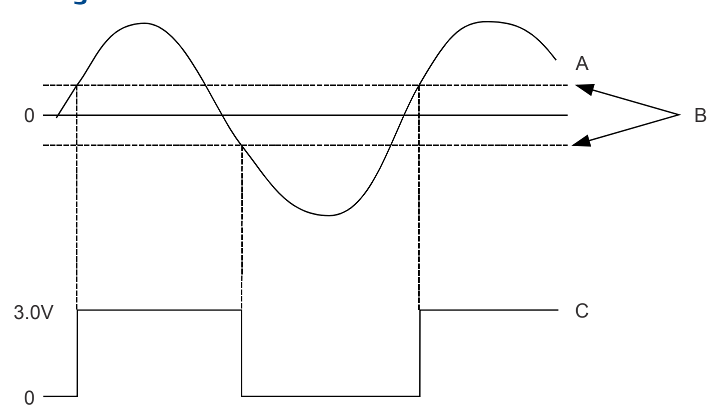
Both methods require a HART communication device or the AMS Device Manager. Disconnecting the sensor is not required when verifying electronics since the transmitter is capable of disconnecting the sensor signal at the input to the electronics. To physically disconnect the sensor from the electronics, refer to Replacing the electronics boards .

Note
The best method for flow simulation in this case is to change the process fluid to gas or steam and have Desired Compensation set to none.
Flow simulation cannot be enabled when the primary variable is Process Temperature.

C.1 Electronics verification using flow simulation mode

Electronics verification is done by using the internal flow simulation functionality. The Rosemount 8800D is capable of simulating either a fixed flow rate or a varying flow rate. The amplitude of the simulated flow signal is based on the minimum required process density for the given line size and service type. Either type of simulation (fixed or varying) will effectively disconnect the Rosemount 8800D sensor from the electronics charge amplifier input (see the following figure) and replace it with the simulated flow signal.

Figure C-1: Clean signals



A. Vortex signal (TP1)
B. Trigger level
C. Shedding frequency output

C.2 Fixed flow rate simulation

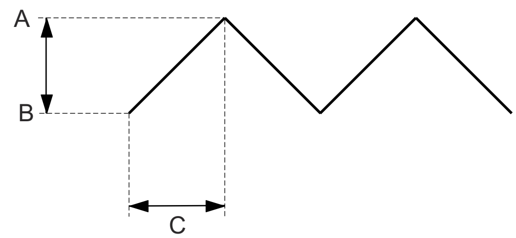
The fixed flow simulation signal is entered in either percent of range or flow rate in engineering units. The resulting flow rate and/or shedding frequency can be continuously monitored using a HART communication device or an AMS Device Manager.

C.3 Varying flow rate simulation

The profile of the varying flow simulation signal is a repetitive triangular waveform as illustrated in the following figure. The minimum and maximum flow rate is entered in either percent of range or entered as a flow rate in engineering units. The ramp time is entered in seconds from a minimum of 0.6 seconds to a maximum of 34,951 seconds. The resulting flow rate and/or shedding frequency can be continuously monitored using a HART communication device or an AMS Device Manager.

Note
To manually disconnect the sensor for precautionary measures, see Replacing the electronics housing.

Figure C-2: Profile of varying flow simulation signal



A. *Maximum flow rate*
B. *Minimum flow rate*
C. *Ramp time*

C.4 Verify electronics using an external frequency generator

Test points on the electronics are available for an external frequency.

Make sure you have the following tools:

- A HART communication device or AMS Device Manager
- A standard sinewave function generator

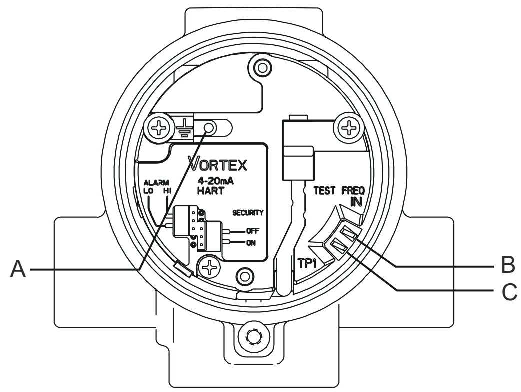
1. Remove the electronics compartment cover.
2. Remove the two screws and the LCD indicator, if applicable.
3. Connect a HART communication device or AMS Device Manager to the loop.
4. Access the flow simulation menu on the communicator and select Sim Flow External.

This option is used with an external frequency generator to disconnect the Rosemount 8800D sensor input from the charge amplifier input of the electronics (see Figure C-2). The simulated flow and/or the shedding frequency values are now accessible using a HART communication device or AMS Device Manager.

5. Connect the sinewave generator to the TEST FREQ IN and GROUND points as shown in the following figure.

   This step assumes that the flow sensor is still connected to the transmitter. If the flow sensor is not connected to the transmitter, attach the sinewave generator to the sensor header. This is the same connection point used by the flow sensor during normal installation.

Figure C-3: Test frequency output and chassis ground points



A. Ground
B. Test frequency input
C. Test point 1

6. Set the sinewave generator amplitude to 2Vpp±10%.
7. Select the desired sinewave generator frequency.
8. Verify the generator frequency against the frequency displayed on the HART communication device or AMS Device Manager.
9. Exit the Flow Simulation Mode.
10. Reconnect the LCD indicator option, if applicable, to the electronics board by replacing and tightening the two screws.
11. Replace and tighten the electronics compartment cover.

Note
To manually disconnect the sensor as a precaution, see Replacing the electronics housing.

C.5 Output variable calculations with known input frequency

Use the following equations with a known input frequency to verify a flow rate or a 4–20 mA output within a given calibrated range. Select the proper equation depending on whether you are verifying a flow rate, mass flow rate, 4–20 mA output, or special units. Use Example calculations to clarify how these equations are used.

Flow rate calculation

For a given input frequency F (Hz), and K-factor (compensated), find the flow rate Q where C_x is the unit conversion (see Unit conversion table) and K is the compensated K-factor in units of pulses/gallon:

$$Q = F(Hz)/(K \times C_x)$$

Standard or normal flow rate calculation

$$Q = F(Hz) \times ((DensityRatio)/K \times C_x))$$

Mass flow rate calculation

For a given mass frequency F (Hz), and K-factor (compensated), find the mass flow rate M where C is the unit conversion and ρ is density at operating conditions:

$$M = \frac{F}{(K/\rho) - C}$$

Where C_x is the unit conversion (see Unit conversion table) using density (ρ):

$$M = F(Hz)/(KC_x)$$

4-20 mA output calculation

For a given input frequency F (Hz), and K-factor (compensated), find output electrical current I:

$$I = \left(\left[\frac{F/(K \times C_x - LRV)}{URV - LRV}\right] \times (16)\right) + 4$$

Where C_x is the unit conversion (see Unit conversion table), URV is the upper range value (user units), and LRV is the lower range value (user units).

Special units output calculation

For special units, divide the special unit-conversion factor into the base unit factor C_x.

$$C_{20} = C_x/special\ units\ conversion\ factor$$

See Unit conversion table.

C.6 Unit conversion table

Use the following table when converting units of measure.

Unit conversions

C_x	Units (actual)	Conversion factor
C_1	gal/s	1.00000E+00
C_2	gal/m	1.66667E-02
C_3	gal/h	2.77778E-04
C_4	Impgal/s	1.20095E+00
C_5	Impgal/m	2.00158E-02
C_6	Impgal/h	3.33597E-04
C_7	L/s	2.64172E-01
C_8	L/m	4.40287E-03
C_9	L/h	7.33811E-05
C_{10}	CuMtr/m	4.40287E+00
C_{11}	CuMtr/h	7.33811E-02
C_{12}	CuFt/m	1.24675E-01
C_{13}	CuFt/h	2.07792E-03
C_{14}	bbl/h	1.16667E-02
C_{15}	kg/s	$C_{10} \times 60/\rho$ (kg/m^3)
C_{16}	kg/h	C_{11}/ρ (kg/m^3)
C_{17}	lb/h	C_{13}/ρ (lb/ft^3)
C_{18}	shTon/h	$C_{17} \times 2000$
C_{19}	mTon/h	$C_{16} \times 2000$
C_{20}	SPECIAL	C_x/(special units conversion factor)

C.7 Example calculations

The following examples describe the flowrate calculations that may be necessary for your application. Water, saturated steam, and natural gas applications are represented in the examples. The first set of three examples is in English units. The second set of three examples is in SI units.

C.7.1 Imperial unit examples

Example 1

Fluid	Water

Line size	3 inch
Line pressure	100 psi
Vortex frequency	75 Hz
URV	500 gpm
LRV	0 gpm
C_2	1.66667E-02 (from Unit conversion table)
K-factor compensated	10.79 pulses/gallon using a HART communication device or AMS Device Manager

$$Q = F/(K \times C_2)$$

$$= 75/(10.79 \times 0.0166667)$$

$$= 417.1 \text{ gpm}$$

An input frequency of 75 Hz represents a flow rate of 417.1 gpm in this example.

For a given input frequency, you can also determine the electrical current output. Use the values in the previous table with an input frequency of 75 Hz:

F_{in}	75 Hz

$$I = \left(\left[\frac{F/(K \times C_x - LRV)}{URV - LRV}\right] \times (16)\right) + 4$$

$$I = \left(\left[\frac{75/(10.79 \times 0.0166667) - 0)}{500 - 0}\right] \times (16)\right) + 4$$

$$= 17.35 \text{ mA}$$

An input frequency of 75 Hz represents an electrical current output of 17.35 mA.

Example 2

Fluid	Saturated steam
Line size	3 inch
Line pressure	500 psia
Operating temp	467 °F
Viscosity	0.017 cp
URV	40000 lb/hr
LRV	0 lb/hr
C_{17}	C_{13}/ρ (from Unit conversion table)
Density (ρ)	1.078 lb/cu-ft
Vortex frequency	400 Hz
K-factor (compensated)	10.79 pulses/gallon using a HART communication device or AMS Device Manager

M	F/(K x C_{17}) 400/ {10.678 x (C_{13}/ρ)} 400/{10.678 x (0.00207792/1.078)} 400/(10.678 x 0.0019276) 19433.6 lb/hr

An input frequency of 400 Hz represents a flow rate of 19433.6 lb/hr in this application.

For a given input frequency, you can also determine the electrical current output. Use the values in the previous table with an input frequency of 300 Hz:

F_{in}	300 Hz

$$I = \left(\left[\frac{F/(K \times C_{17} - LRV)}{URV - LRV}\right] \times (16)\right) + 4$$

$$I = \left(\left[\frac{300/(10.678 \times 0.0019276) - 0)}{40000 - 0}\right] \times (16)\right) + 4$$

$$I = 9.83mA$$

An input frequency of 300 Hz represents an electrical current output of 9.83 mA.

Example 3

Fluid	Natural gas
Line size	3 inch
Line pressure	140 psia
Operating temp	50 °F
Viscosity	0.01 cp
URV	5833 SCFM
LRV	0 SCFM
C_{20}	C_x/sp. units factor (from Unit conversion table)
Density (ρ)	0.549 lb/cu-ft (operating)
Input frequency	700 Hz
K-factor (compensated)	10.678 pulses/gallon using a HART communication device or AMS Device Manager
Q	F/(K x C_{20}) where: C_{20} = C_{12}/10.71 (*density ratio*) 700/{10.797 x (0.124675/10.71)} 5569.4 SCFM

An input frequency of 700 Hz represents a flow rate of 5569.4 SCFM in this application.

For a given input frequency, you can also determine the electrical current output. Use the values in the previous table with an input frequency of 200 Hz.

F_{in}	200 Hz

$$I = \left(\left[\frac{F/(K \times C_{20} - LRV)}{URV - LRV}\right] \times (16)\right) + 4$$

$$I = \left(\left[\frac{200/(10.797 \times 0.011641) - 0)}{5833-0}\right] \times (16)\right) + 4$$

$$I = 8.36mA$$

An input frequency of 200 Hz represents an electrical current output of 8.36 mA.

C.7.2 SI unit examples

Example 1

Fluid	Water
Line size	80 mm
Line pressure	700 kPas
Operating temp	16 °C
Input frequency	80 Hz
K-factor (compensated)	10.772 pulses/gallon using HART communication device or AMS Device Manager
URV	2000 lpm
LRV	0 lpm
C_8	4.40287E-03 (from Unit conversion table)
M	F/K x C_g 80/(10.722x0.00440287) 1694.6 lpm

An input frequency of 80 Hz represents a flow rate of 1694.6 lpm in this application.

For a given input frequency, you can also determine the electrical current output. Use the values in the previous table with an input frequency of 80 Hz:

F_{in}	80 Hz

$$I = \left(\left[\frac{F/(K \times C_8 - LRV)}{URV - LRV}\right] \times (16)\right) + 4$$

$$I = \left(\left[\frac{80/(10.772 \times 0.00440287) - 0}{2000 - 0}\right] \times (16)\right) + 4$$

$$I = 17.49mA$$

An input frequency of 80 Hz represents an electrical current output of 17.49 mA.

Example 2

Fluid	Saturated stream
Line size	80 mm
Line pressure	700 kPas

Operating temp	77 °C
Viscosity	0.015 cp
Input frequency	650 Hz
K-factor (compensated)	10.715 pulses/gallon using HART communication device or AMS Device Manager
URV	3600 kg/hr
LRV	0 kg/hr
C_{16}	C_{11}/ρ (from Unit conversion table)
M	F(Hz) /(K x C_{16}) 650/{10.715 x (C11/ρ)} 650/{10.715 x (0.0733811/4.169)} 650/(10.715 x 0.017602) 3446.4 kg/hr

An input frequency of 650 Hz represents a flow rate of 3446.4 kg/hr in this application.

For a given input frequency, you can also determine the electrical current output. Use the values in the previous table with an input frequency of 275 Hz:

F_{in}	275 Hz

$$I = \left(\left[\frac{F/(K \times C_{16} - LRV)}{URV - LRV}\right] \times (16)\right) + 4$$

$$I = \left(\left[\frac{275/(10.715 \times 0.017602) - 0}{3600 - 0}\right] \times (16)\right) + 4$$

$$I = 10.48mA$$

An input frequency of 275 Hz represents an output electrical current of 10.48 mA.

Example 3

Fluid	Natural gas
Line size	80 mm
Line pressure	1000 kPas
Operating temp	-12 °C
Viscosity	0.01 cp
Input frequency	700 Hz
K-factor (compensated)	10.797 pulses/gallon using HART communication device or AMS Device Manager
URV	10,000 NCMH
LRV	0 NCMH
C_{20}	C_x/sp. units factor (from Unit conversion table)
Density (ρ)	9.07754 kg/cu-mtr (operating)

Density ration	10.48
Q	F/K x C_{20} where C_{20} = C_{11}/(*density ratio*) 700/{10.797 x (.0733811/10.48)} 9259.2 NCMH

An input frequency of 700 Hz represents a flow rate of 9259.2 NCMH in this application.

For a given input frequency, you can also determine the electrical current output. Use the values in the previous table with an input frequency of 375 Hz.

F_{in}	375 Hz

$$I = \left(\left[\frac{F/(K \times C_{20} - LRV)}{URV - LRV}\right] \times (16)\right) + 4$$

$$I = \left(\left[\frac{375/(10.797 \times 0.0070020) - 0}{10000 - 0}\right] \times (16)\right) + 4$$

$$I = 11.94mA$$

An input frequency of 375 Hz represents an electrical current output of 11.94 mA.

D Modbus details

D.1 Byte transmission order

When using Modbus RTU, the registers to receive status and variables must be correctly configured in the host system.

The transmission of single-precision (4 bytes) IEEE 754 floating point numbers can be rearranged in different byte orders specified by the Floating Point Format Code. The format code information, stated for each Remote Terminal Unit (RTU) respectively, specifies which registers to poll from the transmitter in order for the RTU to correctly interpret floating point numbers. The byte transmission order for each format code is demonstrated in Table D-1.

Table D-1: Byte transmission order

Format code	Byte transmission order	Description
0	[AB] [CD]	Straight word order, most significant byte first
1	[CD] [AB]	Inverse word order, most significant byte first
2	[DC] [BA]	Inverse word order, least significant bye first
3	[BA] [DC]	Straight word order, least significant byte first

Note

Some Modbus hosts cannot read the information described here using Input Registers (Modbus function code 4). The Input Register information can also be read using Holding Register (Function code 3). In this case, Input Register number + 5000 are used as Holding Register number. Between host system and device, it is recommended to use 60 seconds or less between polls, and three retries.

D.2 Input registers (Modbus function code 4)

Note

Register addresses published in this manual are physical locations, as communicated in Modbus request messages. Some host systems expect users to enter logical addresses, which can be determined by adding 1 to the associated physical address.

Table D-2: Registers for floating point format code 0

Register name	Register number	Note
Slave Status	2000	Bit information in bit field. • Bit 0: Invalid Measurement Slave PV. • Bit 1: Invalid Measurement Slave SV. • Bit 2: Invalid Measurement Slave TV. • Bit 3: Invalid Measurement Slave FV. • Bit 14: HART bus busy (slave in burst or other master present). • Bit 15: HTM Task not running (option not available). **Note** Bit 1-3 is set when Invalid Measurement of Slave Non PV, i.e. all three bits are set simultaneously.
Slave PV	2002	Primary variable from slave represented in IEEE 754 format, using Floating Point Format Code 0.
Slave SV	2004	Secondary variable from slave represented in IEEE 754 format, using Floating Point Format Code 0.
Slave TV	2006	Tertiary variable from slave represented in IEEE 754 format, using Floating Point Format Code 0.
Slave FV (QV)	2008	Fourth variable from slave represented in IEEE 754 format, using Floating Point Format Code 0.

Table D-3: Registers for floating point format code 1

Register name	Register number	Note
Slave Status Conf	1300	Bit information in bit field. • Bit 0: Invalid Measurement Slave PV. • Bit 1: Invalid Measurement Slave SV. • Bit 2: Invalid Measurement Slave TV. • Bit 3: Invalid Measurement Slave FV. • Bit 14: HART bus busy (slave in burst or other master present). • Bit 15: HTM Task not running (option not available). **Note** Bit 1-3 is set when Invalid Measurement of Slave Non PV, i.e. all three bits are set simultaneously.
Slave PV Conf	1302	Primary variable from slave represented in IEEE 754 format, using Floating Point Format Code 1.

Table D-3: Registers for floating point format code 1 *(continued)*

Register name	Register number	Note
Slave SV Conf	1304	Secondary variable from slave represented in IEEE 754 format, using Floating Point Format Code 1.
Slave TV Conf	1306	Tertiary variable from slave represented in IEEE 754 format, using Floating Point Format Code 1.
Slave FV Conf	1308	Fourth variable from slave represented in IEEE 754 format, using Floating Point Format Code 1.

Table D-4: Registers for floating point format code 2

Register name	Register number	Note
Slave Status	2100	Bit information in bit field. • Bit 0: Invalid Measurement Slave PV. • Bit 1: Invalid Measurement Slave SV. • Bit 2: Invalid Measurement Slave TV. • Bit 3: Invalid Measurement Slave FV. • Bit 14: HART bus busy (slave in burst or other master present). • Bit 15: HTM Task not running (option not available). **Note** Bit 1-3 is set when Invalid Measurement of Slave Non PV, i.e. all three bits are set simultaneously.
Slave PV	2102	Primary variable from slave represented in IEEE 754 format, using Floating Point Format Code 2.
Slave SV	2104	Secondary variable from slave represented in IEEE 754 format, using Floating Point Format Code 2.
Slave TV	2106	Tertiary variable from slave represented in IEEE 754 format, using Floating Point Format Code 2.
Slave FV	2108	Fourth variable from slave represented in IEEE 754 format, using Floating Point Format Code 2.

Table D-5: Registers for floating point format code 3

Register name	Register number	Note
Slave Status	2200	Bit information in bit field. • Bit 0: Invalid Measurement Slave PV. • Bit 1: Invalid Measurement Slave SV. • Bit 2: Invalid Measurement Slave TV. • Bit 3: Invalid Measurement Slave FV. • Bit 14: HART bus busy (slave in burst or other master present). • Bit 15: HTM Task not running (option not available). **Note** Bit 1-3 is set when Invalid Measurement of Slave Non PV, i.e. all three bits are set simultaneously.
Slave PV	2202	Primary variable from slave represented in IEEE 754 format, using Floating Point Format Code 3.
Slave SV	2204	Secondary variable from slave represented in IEEE 754 format, using Floating Point Format Code 3.
Slave TV	2206	Tertiary variable from slave represented in IEEE 754 format, using Floating Point Format Code 3.
Slave FV	2208	Fourth variable from slave represented in IEEE 754 format, using Floating Point Format Code 3.

D.3 Holding registers (Modbus function code 3)

Note
Register addresses published in this manual are physical locations, as communicated in Modbus request messages. Some host systems expect users to enter logical addresses, which can be determined by adding 1 to the associated physical address.

Table D-6: Registers for floating point format code 0

Register name	Register number	Note
Slave Status	7000	Bit information in bit field. • Bit 0: Invalid Measurement Slave PV. • Bit 1: Invalid Measurement Slave SV. • Bit 2: Invalid Measurement Slave TV. • Bit 3: Invalid Measurement Slave FV. • Bit 14: HART bus busy (slave in burst or other master present). • Bit 15: HTM Task not running (option not available). **Note** Bit 1-3 is set when Invalid Measurement of Slave Non PV, i.e. all three bits are set simultaneously.
Slave PV	7002	Primary variable from slave represented in IEEE 754 format, using Floating Point Format Code 0.
Slave SV	7004	Secondary variable from slave represented in IEEE 754 format, using Floating Point Format Code 0.
Slave TV	7006	Tertiary variable from slave represented in IEEE 754 format, using Floating Point Format Code 0.
Slave FV (QV)	7008	Fourth variable from slave represented in IEEE 754 format, using Floating Point Format Code 0.

Table D-7: Registers for floating point format code 1

Register name	Register number	Note
Slave Status Conf	6300	Bit information in bit field. • Bit 0: Invalid Measurement Slave PV. • Bit 1: Invalid Measurement Slave SV. • Bit 2: Invalid Measurement Slave TV. • Bit 3: Invalid Measurement Slave FV. • Bit 14: HART bus busy (slave in burst or other master present). • Bit 15: HTM Task not running (option not available). **Note** Bit 1-3 is set when Invalid Measurement of Slave Non PV, i.e. all three bits are set simultaneously.
Slave PV Conf	6302	Primary variable from slave represented in IEEE 754 format, using Floating Point Format Code 1.

Table D-7: Registers for floating point format code 1 *(continued)*

Register name	Register number	Note
Slave SV Conf	6304	Secondary variable from slave represented in IEEE 754 format, using Floating Point Format Code 1.
Slave TV Conf	6306	Tertiary variable from slave represented in IEEE 754 format, using Floating Point Format Code 1.
Slave FV Conf	6308	Fourth variable from slave represented in IEEE 754 format, using Floating Point Format Code 1.

Table D-8: Registers for floating point format code 2

Register name	Register number	Note
Slave Status	7100	Bit information in bit field. • Bit 0: Invalid Measurement Slave PV. • Bit 1: Invalid Measurement Slave SV. • Bit 2: Invalid Measurement Slave TV. • Bit 3: Invalid Measurement Slave FV. • Bit 14: HART bus busy (slave in burst or other master present). • Bit 15: HTM Task not running (option not available). **Note** Bit 1-3 is set when Invalid Measurement of Slave Non PV, i.e. all three bits are set simultaneously.
Slave PV	7102	Primary variable from slave represented in IEEE 754 format, using Floating Point Format Code 2.
Slave SV	7104	Secondary variable from slave represented in IEEE 754 format, using Floating Point Format Code 2.
Slave TV	7106	Tertiary variable from slave represented in IEEE 754 format, using Floating Point Format Code 2.
Slave FV	7108	Fourth variable from slave represented in IEEE 754 format, using Floating Point Format Code 2.

Table D-9: Registers for floating point format code 3

Register name	Register number	Note
Slave Status	7200	Bit information in bit field. • Bit 0: Invalid Measurement Slave PV. • Bit 1: Invalid Measurement Slave SV. • Bit 2: Invalid Measurement Slave TV. • Bit 3: Invalid Measurement Slave FV. • Bit 14: HART bus busy (slave in burst or other master present). • Bit 15: HTM Task not running (option not available). **Note** Bit 1-3 is set when Invalid Measurement of Slave Non PV, i.e. all three bits are set simultaneously.
Slave PV	7202	Primary variable from slave represented in IEEE 754 format, using Floating Point Format Code 3.
Slave SV	7204	Secondary variable from slave represented in IEEE 754 format, using Floating Point Format Code 3.
Slave TV	7206	Tertiary variable from slave represented in IEEE 754 format, using Floating Point Format Code 3.
Slave FV	7208	Fourth variable from slave represented in IEEE 754 format, using Floating Point Format Code 3.

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