83F-A, E83FA, 83W-A, and E83WA
Vortex Flowmeters
Installation, Troubleshooting, and Maintenance
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<td></td>
<td>Single Elbow with Shedder Perpendicular to Elbow Plane</td>
<td></td>
</tr>
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Important Information

Read these instructions carefully and look at the equipment to become familiar with the device before trying to install, operate, service, or maintain it. The following special messages may appear throughout this manual or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of either symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

<table>
<thead>
<tr>
<th>DANGER</th>
</tr>
</thead>
<tbody>
<tr>
<td>DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOTICE is used to address practices not related to physical injury.</td>
</tr>
</tbody>
</table>

Please Note

Electrical equipment should be installed, operated, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction, installation, and operation of electrical equipment and has received safety training to recognize and avoid the hazards involved.
1. Introduction

Overview

The 83F-A and 83W-A Vortex Flowmeters measure fluid (liquid, gas, or steam) flow rates using the principle of vortex shedding. The flowmeters produce a 4 to 20 mA analog or a pulse signal proportional to the volumetric flow rate.

Fluid flowing through the flowmeter body passes a specially shaped vortex shedder that causes vortices to form and shed alternately from the sides of the shedder at a rate proportional to the flow rate of the fluid. These shedding vortices create an alternating differential pressure that is detected by a sensor located above the shedder. An electrical signal is generated by the sensor with a frequency that is proportional to the flow rate. This electrical signal is then processed by the electronic module to produce either a pulse rate or analog (4 to 20 mA dc) output signal.

Reference Documents

In addition to this instruction, there is other user documentation supporting the 83F-A and 83W-A Vortex Flowmeters, as listed in Table 1.

<table>
<thead>
<tr>
<th>Document Number</th>
<th>Document Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dimensional Prints</strong></td>
<td></td>
</tr>
<tr>
<td>DP 019-150</td>
<td>83F, Flanged Body, Single Measurement Configuration</td>
</tr>
<tr>
<td>DP 019-151</td>
<td>83F, Flanged Body, Dual Measurement Configuration</td>
</tr>
<tr>
<td>DP 019-152</td>
<td>83W, Wafer Body</td>
</tr>
<tr>
<td><strong>Parts Lists</strong></td>
<td></td>
</tr>
<tr>
<td>PL 008-708</td>
<td>83F-A, -D, and -T Vortex Flowmeters, Flanged Body, Style A</td>
</tr>
<tr>
<td>PL 008-709</td>
<td>83W-A, -D, and -T Vortex Flowmeters, Wafer Body, Style A</td>
</tr>
<tr>
<td><strong>Instructions</strong></td>
<td></td>
</tr>
<tr>
<td>B0800AB</td>
<td>Ensuring Premium Performance with 83 Series Foxboro Vortex Flowmeters</td>
</tr>
<tr>
<td>MI 019-179</td>
<td>Flow Products Safety Information</td>
</tr>
</tbody>
</table>
1. Introduction

## Standard Specifications

<table>
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<th>Specification</th>
</tr>
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<tbody>
<tr>
<td><strong>Process Temperature Limits:</strong></td>
<td></td>
</tr>
<tr>
<td>Standard Temperature Sensor</td>
<td>-20 and +200°C (0 and 400°F)</td>
</tr>
<tr>
<td>High Temperature Sensor</td>
<td>+200 and +430°C (400 and 800°F)</td>
</tr>
<tr>
<td><strong>Ambient Temperature Limits</strong></td>
<td>-40 and +85°C (-40 and +185°F)</td>
</tr>
<tr>
<td><strong>Power Supply Requirements:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Analog Mode</strong></td>
<td></td>
</tr>
<tr>
<td>Supply Voltage Limits</td>
<td>10.5 and 50 V dc</td>
</tr>
<tr>
<td>Supply Current</td>
<td>22 mA dc</td>
</tr>
<tr>
<td><strong>Pulse Mode</strong></td>
<td></td>
</tr>
<tr>
<td>Supply Voltage Limits</td>
<td>10.5 and 50 V dc</td>
</tr>
<tr>
<td>Supply Current</td>
<td>15 mA dc</td>
</tr>
<tr>
<td><strong>Product Safety Specification</strong></td>
<td>Refer to instrument data plate for type of certification and observe applicable wiring requirements. Electrical certifications and conditions of certification are listed on page 15.</td>
</tr>
<tr>
<td><strong>Flow Rate Requirements</strong></td>
<td>Refer to FlowExpertPro™ sizing program.</td>
</tr>
<tr>
<td><strong>Static Pressure Limits</strong></td>
<td>Full vacuum to pressure rating of mating flanges with maximum operative limit of 10 MPa (1500 psi; 100 bar or kg/cm²) at 24°C (75°F).</td>
</tr>
<tr>
<td><strong>Flowmeter Output</strong></td>
<td></td>
</tr>
<tr>
<td>Analog</td>
<td>4 to 20 mA dc into a maximum of 1450 ohms depending on power supply (refer to graph in Figure 15).</td>
</tr>
<tr>
<td>Pulse</td>
<td>Square wave voltage equals supply voltage minus two volts. Maximum current is 10 mA (sink or source). Shielded and twisted pair cable is recommended.</td>
</tr>
</tbody>
</table>

## Electrical Safety Specifications

--- **NOTE** ---

These flowmeters have been designed to meet the electrical safety descriptions listed in Table 2. For detailed information or status of testing laboratory approvals/certifications, contact Global Customer Support.
### Table 2. Electrical Safety Specifications

<table>
<thead>
<tr>
<th>Testing Laboratory, Type of Protection, and Area Classification</th>
<th>Application Conditions</th>
<th>Electrical Safety Design Code</th>
</tr>
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<tr>
<td><strong>FM</strong> explosionproof for Class I, Division 1, Groups C, D; dust-ignitionproof for Class II, Division 1, Groups E, F, G; and Class III, Division 1.</td>
<td>Temperature Class T5. Ta = 85°C.</td>
<td>A</td>
</tr>
<tr>
<td><strong>FM</strong> Nonincendive for Class I, Division 2, Groups A, B, C, D. Suitable for Class II, Division 2, Groups F, G; and Class III, Division 2.</td>
<td>Temperature Class T5. Ta = 85°C.</td>
<td></td>
</tr>
</tbody>
</table>
2. **Installation**

**Fundamental Installation Requirements**

Vortex flowmeters must be installed in accordance with all applicable local installation regulations and practices, such as hazardous location requirements, electrical wiring codes, and mechanical piping codes. Persons involved in the installation should be trained in these code requirements in order to ensure that the installation takes maximum advantage of the safety features designed into the vortex flowmeters.

**Unpacking**

The Foxboro Vortex Flowmeter is built to be durable, but it is part of a calibrated precision system and should be handled as such.

---

**NOTE**

83W Flowmeters may (depending on pressure rating of flanges with which they are used) have a set of centering spacers included. Do not discard these centering spacers. They must be used to install the flowmeter properly.

---

Flowmeters with remote-mounted electronics are rugged two-piece units. A remote cable connection is assembled to the flowmeter junction box and electronics housing. The cable may be cut to the required length per instructions beginning on page 31. Do not allow the weight of either the flowtube or electronics housing to be supported by the remote cable.

Remove the flowtube from the shipping carton using care to avoid dropping or otherwise subjecting it to impact, particularly at the flange or wafer faces. Never put anything through the flowtube for lifting purposes as damage to the shedder bar may occur.

After removing the flowtube form its shipping carton, inspect it the visible damage. If any damage is observed, notify the carrier immediately and request an inspection report. Obtain a signed copy of the report from the carrier. The calibration certificate and any other documentation shipped with the meter should be separated from the packing material and held for future reference. Re-install any flange covers or protective material to safeguard the meter until it is installed.

Packing material should be disposed of in accordance with local regulations. All packing material is non-hazardous and is generally acceptable to landfills.
Flowmeter Identification

Before installing your flowmeter, check its data plate to assure that it is correct for your application. Specifications such as maximum ambient temperature, process temperature, and working pressure are given on the data plate. The model code is also stamped on the data plate as shown in Figure 1. For interpretation of the complete model code, refer to PL 008-708 (83F Flanged Body) or PL 008-709 (83W Wafer Body).

Flowmeters are shipped from the factory configured for the mA output mode. Electronic Module Switch J must be moved to the ON or PULSE position to operate in the pulse mode.

![Figure 1. Sample Flowmeter Data Plate](image)

Mechanical Installation

Both the flanged and wafer body flowmeters are offered in two mounting arrangements: (1) integral, and (2) remote (electronics housing separate from the flowmeter body). The following sections deal with both the integrally and remotely mounted electronics flowmeter arrangements. The installation guidelines given below are also summarized for your convenience in B0800AB, Ensuring Premium Performance with Foxboro 83 Series Intelligent Vortex Flowmeters.

Dimensions

For overall dimensions of the flowmeter, refer to the appropriate dimensional print listed in “Reference Documents” on page 13.
Hydrostatic Piping Testing

The 83F Series Vortex Flowmeter is designed to meet the pressure limits of the flange rating specified in the model code.

If your flowmeter is being installed in an application where hydrostatic testing will be preformed, do not remove the sensor from the flowmeter.

Piping Considerations and Mounting Position

Flanges

The flange of the adjoining pipe must be the same nominal size and pressure rating as the flowtube. Flanges with a smooth bore, similar to weld neck flanges, are preferred.

Mating Pipe

Normal performance data and flow calibration are based on using Schedule 40 pipe upstream and downstream of the flowtube. For other schedule piping, refer to Appendix A on page 79.

Upstream and Downstream Disturbances

The flowmeter should normally be mounted in a straight, unobstructed pipe with a minimum of 30 pipe diameters upstream of the meter and five pipe diameters downstream. For those installations where this upstream requirement is not met, refer to Appendix A on page 79 to estimate the error due to the upstream disturbance. The effects of upstream disturbances have been evaluated in a Flow laboratory. The results are shown in Figures 38 through 42 in “Upstream Piping Disturbance Correction Factor (UCF)” on page 81.

Piping Alignment

The bore of the pipe (flange) and flowmeter must be aligned (see “Mechanically Installing the Flowmeter Body” on page 27), and the flange gaskets installed such that they do not protrude into the flow stream.

If the adjoining piping cannot be properly aligned, it is preferable to make the best possible alignment with the upstream flange. This minimizes the flow disturbance in the flowmeter.

--- NOTE ---

1. Flowmeters mounted near pump discharge or suction lines may be exposed to oscillatory flow that may affect vortex shedding or product pipe vibration. Also, flowmeters mounted near the discharge of a liquid positive displacement pump or near oscillating control valves may experience severe flow fluctuations that could damage the sensor. To avoid these adverse situations, install the meter at least 20 feet or 40 pipe diameters, whichever is larger, from the disturbance in question.

2. Good piping practice requires that the internal surface of the pipe shall be free from mill scale, pits, holes, reaming scores, rifling, bumps, or other irregularities for four pipe diameters upstream and two pipe diameters downstream of the meter.
Process Temperature

Your flowmeter was calibrated at 75°F (24°C). If your process temperature is different, calculate a Process Temperature Correction Factor as explained in Appendix A and use this factor in your calibration.

Pipe Position

Piping should be planned to maintain full pipe conditions at the flowmeter. When flow is moving with gravity, elevate the downstream pipe length above the meter installation level to maintain a full pipeline.

Mounting Position

For optimal performance, the mounting locations of the sensor and integral electronics relative to the piping must be considered. Factors that influence this decision include process fluid type, ambient temperature, and vibration. Mount the meter in accordance with the installation guidelines for various process fluids described below. Also see Table 3.
Liquid Installations

For liquid flow installations, it is recommended that the meter be mounted upstream at least 5 pipe diameters from the control valve. In vertical installations, the meter should be mounted in the upward flowing leg. This helps to maintain a full pipe and ensures that there is sufficient back pressure to prevent flashing or cavitation.

For liquid installations with occasional gas pockets or bubble formation, install piping as depicted in Figure 2 so as to not trap the gas pockets or bubbles inside the flowmeter.

*Figure 2. Piping for Liquid Applications*

For a clean liquid, the electronics housing can be mounted above or below the flowmeter body. Care should be taken so that entrapped air does not accumulate in the sensor cavity. A meter used on liquid should be mounted upstream from a control valve. Flowmeters can also be mounted with the electronics housing positioned to the side. This ensures escape of entrapped air.

Gas Installations

For gas flow installations, several choices for flowmeter location should be considered. For maximum rangeability, locate the flowmeter 30 or more pipe diameters downstream from a control valve. This ensures maximum velocity at the flowmeter and produces the most efficient signal from the sensor.
When the flow is more stable, the flowmeter can be mounted a minimum of 5 pipe diameters upstream of the control valve. Pressure fluctuations often are lower on the upstream side of a control valve flow than on the downstream side. This should be considered as a means of providing the most accurate density when a flow computer is not used.

On gas flow installations, avoid piping conditions that create standing pockets of liquids inside the meter. The best approach is to install the meter in a vertical line.

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>For condensate gas applications, take precautions to avoid any trapped condensate that can cause a “water hammer” during startup. If condensate cannot be drained, open the valve slowly, allowing any trapped condensate to travel downstream through the flowmeter at low velocity so that no damage occurs.</td>
</tr>
</tbody>
</table>

![Figure 3. Piping for Gas Applications](image)

When the process fluid is gas, the electronics housing can be above or below the flowmeter body. The normal recommended position of the electronics housing is above the flowmeter body.

**Steam Installations**

For steam control installations, it is recommended that the flowmeter be mounted 30 pipe diameters or more downstream of the control valve. This is particularly useful when measuring saturated steam to ensure that a minimum amount of condensate is present at the flowmeter.

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take precautions to avoid any trapped condensate that can cause a “water hammer” during startup. If condensate cannot be drained, open the valve slowly, allowing any trapped condensate to travel downstream through the flowmeter at low velocity so that no damage occurs.</td>
</tr>
</tbody>
</table>
Saturated Steam

When the process fluid is saturated steam, the electronics housing should be below the flowmeter body, so that the sensor cavity remains filled with condensate. Filling the sensor cavity with condensate results in a less noisy measurement caused by any flashing occurring in the flowmeter due to pressure drop.

*Figure 4. Piping for Saturated Steam Applications*

Superheated Steam

When the process fluid is superheated steam, the electronics housing may be above or below the flowmeter body. The flowmeter should be insulated to maintain superheat conditions inside the flowmeter as well as insulating the electronics from heat. Assure that the electronics temperature does not exceed 85°C (185°F) under all flow and environmental conditions.

Vibration

The vortex sheddor axis should be oriented to reduce or, in some cases, virtually eliminate vibration influence. Position the flowmeter so that the sensor axis is perpendicular to the direction of the vibration.

*Figure 5. Sensor Mounting to Minimize Effect of Vibration*
Ambient Temperature Limitations / Considerations

The temperature limits of the electronics housing is -40 to +85°C (-40° to +185°F). When installing the flowmeter, ambient temperature and proximity to other heat sources must be considered. For extended high temperature applications, this may require positioning the electronics housing to the side or bottom and/or piping insulation to assure the temperature limit is not exceeded.

Table 3. Mounting Arrangements

<table>
<thead>
<tr>
<th>Flowmeter Orientation for Single (Shown) or Dual Measurement Flowmeter</th>
<th>Liquid</th>
<th>Gas</th>
<th>Saturated Steam</th>
<th>Superheated Steam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing above and isolation valve is not used</td>
<td>Yes (a)</td>
<td>Yes</td>
<td>No</td>
<td>Yes (b)</td>
</tr>
<tr>
<td>Housing above and isolation valve is used</td>
<td>No (c)</td>
<td>Yes</td>
<td>No</td>
<td>Yes (b)</td>
</tr>
<tr>
<td>Housing below pipe</td>
<td>Yes (d) (e) (f)</td>
<td>Yes (4)</td>
<td>Yes</td>
<td>Yes (b)</td>
</tr>
<tr>
<td>Housing to side of pipe</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes (b)</td>
</tr>
<tr>
<td>Housing to side and below pipe</td>
<td>Yes (f)</td>
<td>Yes</td>
<td>No</td>
<td>Yes (b)</td>
</tr>
<tr>
<td>Vertical pipe, flow upward</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes (b)</td>
</tr>
</tbody>
</table>
2. Installation MI 019-189 – November 2017

Table 3. Mounting Arrangements (Continued)

<table>
<thead>
<tr>
<th>Flowmeter Orientation for Single (Shown) or Dual Measurement Flowmeter</th>
<th>Liquid</th>
<th>Gas</th>
<th>Saturated Steam</th>
<th>Superheated Steam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical pipe, flow downward</td>
<td>Yes (g)</td>
<td>Yes</td>
<td>No</td>
<td>Yes (b)</td>
</tr>
</tbody>
</table>

- a. Possibility of temporary startup error due to trapped air.
- b. Requires adequate insulation.
- c. Not recommended for liquids with isolation valve.
- d. Best choice when errors due to startup can not be tolerated.
- e. Recommended only for clean fluids.
- f. Preferred for liquids with isolation valve.
- g. Not preferred; must maintain full pipe with no voids in fluid.

Meter Servicing

When you install the meter, consider meter repair. The meter should be accessible for servicing. If the flow cannot be interrupted to replace a sensor, an isolation manifold should be mounted on the meter before it is installed.

Common practice is to install bypass piping so that the entire meter can be removed for servicing (see Figure 6).

Figure 6. Typical Piping Configuration
Insulation

The flowtube may be insulated up to the interface between the bonnet pad and the bonnet. No insulation is allowed beyond the bonnet pad. It is particularly important to insulate the flowtube on applications for superheated steam.

Figure 7. Insulation

Location of Pressure and Temperature Taps

--- NOTE ---
The inside of the pipe at the pressure and temperature taps must be free of burrs and obstructions.

Pressure Taps -- For density measurement (when required), locate the tap 3-1/2 to 4-1/2 pipe diameters downstream of the flowmeter. See Figure 8.

Figure 8. Pressure and Temperature Tap Locations
1. On a gas flow installation, the pressure tap should be located on the top of the pipe.
2. On a liquid installation, the pressure tap (if required) should be located on the side of the pipe.
3. On a steam installation, the pressure tap should be located on the top when the pressure measuring device (typically a pressure transmitter) is above the pipeline, and on the side when the measuring device is below the pipeline.
4. With vertical piping, the pressure tap can be located anywhere around the circumference of the pipeline.

**Temperature Taps** -- For temperature measurement (when required), locate the tap 5 to 6 pipe diameters downstream of the flowmeter. To reduce flow disturbance, use the smallest possible probe. See Figure 8.

### Mechanically Installing the Flowmeter Body

1. Gaskets are required and must be supplied by the user. Select a gasket material suitable for the process.
2. Insert gaskets between the body of the flowmeter and adjacent flanges. See Figure 9. Position the gaskets so that the ID of each gasket is centered on the ID of the flowmeter and adjacent piping.

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verify that the ID of the gaskets is larger than that of the flowtube bore and pipe and that the gaskets do not protrude into the flowtube entrance or exit. Protrusion into the flowstream has an adverse effect on performance.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaskets do not prevent flanges from being wetted by process fluids.</td>
</tr>
</tbody>
</table>

1. When you install new flanges in the process piping and use the meter as a gauge to set the flanges, protect the inside diameter of the flowmeter from weld splatter. Install a solid sheet of gasketing at each end of the meter during welding. Remove this sheet and install the flange gaskets after welding. Remove any splatter in either the pipe or the meter as it could affect flowmeter accuracy.
3. Visually inspect for concentricity (centering and alignment) of mating flanges.
4. Tighten bolts in accordance with conventional flange bolt tightening practice (that is, incremental and alternate tightening of bolts).

83W – Wafer Body

For optimal performance, the wafer body flowmeter should be centered with respect to the adjoining pipe. Normally, this requires the use of centering fixtures that are supplied with the meter.

--- NOTE ---
Centering fixtures are not required for meters with ANSI Class 150 flanges.

1. See Figure 10. Insert the first stud through the downstream flange at one of the lower holes, through the two hex-nut spacers, and then through the upstream flange. Place the nuts on both ends of the stud, but do not tighten.
2. Using the remaining hex-nut spacers, repeat Step 1 at the lower hole adjacent to the first.
3. Set the flowmeter between the flanges. Then, rotate spacers to the thickness that centers the flowmeter.

--- NOTE ---
By rotating the hex-nut spacers to the correct thickness, you can center the meter to any type of flange.

4. Gaskets are required and must be supplied by the user. Select a gasket material suitable for the process fluid.
5. Insert gaskets between the body of the flowmeter and adjacent flanges. Position the gaskets so that the ID of each gasket is centered on the ID of the flowmeter and adjacent piping.

--- CAUTION ---
Verify that the ID of the gaskets is larger than that of the flowtube bore and pipe and that the gaskets do not protrude into the meter entrance or exit. Protrusion into the flowstream has an adverse effect on performance.
NOTE
If welding the flanges to the process piping is required, protect the flowmeter from weld splatter, which could affect flowmeter accuracy. A solid sheet of gasketing should be installed at each end of the meter during welding. Remove this sheet and install the flange gaskets after welding.

6. Visually inspect for concentricity (centering and alignment) of mating flanges.
7. Install the rest of the studs and nuts and tighten the nuts in accordance with conventional flange bolt tightening practice (that is, incremental and alternate tightening of bolts). If flanges cannot be properly aligned, align the meter with the upstream flange rather than the downstream flange.

Figure 10. 83W Flowmeter Centering

Repositioning the Electrical Housing

The flowmeter housing may be repositioned up to a maximum of 270° from its original position by rotating the electrical housing.

WARNING
Stops are incorporated in the housing design. Do not remove the stops as further rotation from the 270° maximum may cause damage to the sensor wires. Additionally, this may violate safety code requirements for explosion-proof thread engagement in hazardous locations.

1. Unscrew housing locknut to bottom of thread. See Figure 11.
2. Square locking plate should slip down on shaft. If it does not, pry out with screwdriver.
3. Rotate electrical housing to desired position. See Warning above.
4. Note recess on bottom of electrical housing into which the locking plate fits. Screw the locking nut hand tight making sure locking plate fits into recess on bottom of electrical housing.

5. Secure the locknut firmly using a wrench.

Figure 11. Repositioning the Electrical Housing

Wiring

NOTE
Wiring must comply with local code requirements applicable to the specific site and classification of the area.

Flowmeter with Integrally Mounted Electronics

A flowmeter with a integrally mounted electronics requires only power and output signal wiring. To complete installation, refer to “Field Termination Wiring” on page 40.

Flowmeter with Remotely Mounted Electronics

The purpose of a flowmeter with remotely mounted electronics is to allow for separation of the flowtube and the electronics housing. The flowmeter consists of:

- An electronics housing mounted with a pipe or wall mounting bracket.
- A flowtube with a junction box. The junction box contains a preamplifier assembly. Refer to Figure 12.
- Up to 15 m (50 ft) of interconnecting cable attached to both the electronics housing and the flowtube junction box.
NOTE
1. 1/2 NPT conduit connections are provided on both the electronics housing and the flowtube junction box.
2. Oxygen cleaned flowmeters are shipped separated.

A flowmeter with a remotely mounted electronics requires the remote cabling to be installed before the field termination wiring can be completed. Proceed with the installation described below.

Installing the Flowtube
1. Mount the flowtube so that the junction box is serviceable.

   NOTE
   Also see the requirements discussed in “Piping Considerations and Mounting Position” on page 19.

2. Do not disconnect the cable at the junction box end. The cable is prewired to the junction box to ensure proper grounding of the shield.
3. If the cable must be disconnected, make sure the end labeled “Flowmeter End” is positioned at the junction box end.
4. If the cable is to be shortened or disconnected for some other reason, disconnect at the electronics housing end. Cut and prepare the electronics housing end per Table 4.

Installing the Remote Electronics Housing.

WARNING
For optimum flowmeter performance, the remote signal cable must be prepared and connected following the procedures outlined below.

If the Remote Signal Cable Does Not Need To Be Disconnected
1. Locate the electronic housing close enough to the flowtube so that the supplied cable reaches between the flowtube and the housing.
2. Mount the housing. The bracket assembly supplied with the housing can be mounted directly to a wall or a 2-inch pipe.

If the Remote Signal Cable Must Be Disconnected
Disconnect the remote signal cable at the electronics housing end as described below. It is not recommended that you disconnect the cable at the flowtube junction box end.
1. Remove the electronics compartment threaded cover from the electronics housing.
2. Unscrew the two captive screws, one on each side of the electronics module.
3. Pull out electronics module far enough to disconnect the remote signal cable.
4. Disconnect the four remote signal wires from the four position terminal block on the rear of the electronics module. See Figure 12.
5. Unscrew the knurled nut, pull it back onto the cable jacket. Also pull rubber bushing onto the cable jacket. Leave these parts on the cable jacket as they will be used when reconnecting the cable.

6. Locate the electronic housing close enough to the flowtube so that the supplied cable reaches between the flowtube and the housing.

7. Mount the housing. The bracket assembly supplied with the housing can be mounted directly to a wall or a 2-inch pipe.

8. Cut the electronics housing end of the remote signal cable as required. Prepare the cable end per the instructions in Table 4.

9. Push the prepared cable, taking care not to damage the copper braid, into the connector at bottom of the electronics housing until it comes to a stop, as shown in Step 1 of Table 6.

10. Ensure that the remote signal cable is pushed in until the outer jacket bottoms out inside the connector. Push the rubber bushing into position until it sits snugly inside the connector, as shown in Step 2 of Table 6.

11. Tighten the knurled nut on the connector to create a compression fit for a good seal.

12. Inside the electronic housing, connect the four remote signal wires to the color coded 4-position terminal block on the rear of the electronics module. See Figure 12.

13. Ensure that the remote signal and loop power wires are tucked under the electronics module. Taking care not to pinch the wires, place the module in the housing over the mounting screws. Tighten the two captive mounting screws.

14. Replace the threaded housing cover tightly to prevent moisture or other contaminants from entering the compartment.

Preparing the Remote Signal Cable

For installations where the provided pre-dressed remote signal cable is not used, both ends of the cable must be prepared per the instructions in Tables 4 and 5 of this document. The cable must be connected at both ends per instructions in Tables 6 and 7. Terminate wires at the junction box and at the 4-position terminal block on rear of electronic module as shown in Figure 12.
### Table 4. Preparation of Remote Signal Cable (Electronics Housing End)

1. Slide the knurled nut and then the rubber bushing onto outer jacket of cable as shown at right. Next, remove outer polyethylene jacket of cable to dimension shown.

2. Cut and remove braided copper shield to dimension shown at right. This will expose the barrier (plastic) tape and foil mylar that encloses the conductors.

3. Cut and remove the barrier tape, foil mylar and fillers to dimension shown at right. This will expose two twisted pairs of conductors (brown-yellow, orange-red) and an uninsulated drain wire. The barrier tape under the copper braid prevents the drain wire from shorting to the copper braid shield.

4. Cut off drain wire at end of barrier tape and foil mylar as shown at right. It is not used at this end.
5. Apply shrink tubing or electrical tape to end of barrier tape and foil mylar at location shown at right. Note that the shrink tube or tape covers end of barrier tape and mylar as well as a portion of the 2 twisted pairs of wires. This will prevent the barrier tape and foil mylar from unwrapping.

**Table 4. Preparation of Remote Signal Cable (Electronics Housing End) (Continued)**

**Extended Range Sensor**

6a. Cut and strip ends of the two twisted pairs to dimension shown at right. Label outer cable jacket “Electronic End” to avoid confusion during installation. Cable is now ready for installation.

**Standard Range Sensor**

6b. Cut and strip ends of the two twisted pairs to dimension shown at right. Label outer cable jacket “Electronic End” to avoid confusion during installation. Cut off RED & ORN pair as shown. Cable is now ready for installation.
**Table 5. Preparation of Remote Signal Cable (Junction Box End)**

1. Slide the knurled nut and then the rubber bushing onto outer jacket of cable as shown at right. Next, remove outer polyethylene jacket of cable to dimension shown.

   ![Diagram](image1)

   - Knurled Nut
   - Rubber Bushing
   - Copper Braid
   - Outer Polyethylene Jacket
   - 191 mm (7.5 in)

2. Cut and remove braided copper shield to dimension shown at right. This will expose the barrier (plastic) tape and foil mylar that encloses the conductors.

   ![Diagram](image2)

   - Knurled Nut
   - Rubber Bushing
   - Copper Braid
   - Barrier Tape and Foil Mylar
   - Outer Polyethylene Jacket
   - 25 (1.0) mm
   - 165 mm (6.5 in)

3. Cut and remove the barrier tape, foil mylar and fillers to dimension shown at right. This will expose two twisted pairs of conductors (brown-yellow, orange-red) and an uninsulated drain wire. The barrier tape under the copper braid prevents the drain wire from shorting to the copper braid shield.

   ![Diagram](image3)

   - Knurled Nut
   - Rubber Bushing
   - Copper Braid
   - Cut and Remove Barrier Tape and Foil Mylar
   - Two Twisted Pairs
   - Uninsulated Drain Wire
   - Outer Polyethylene Jacket
   - 25 (1.0) mm
   - 165 mm (6.5 in)
### 4a. Trim the uninsulated drain wire to dimension shown at right. To expose bare conductors for termination, cut and strip ends of the two twisted pairs to dimension shown. NOTE: For Standard Range Sensor, see Step 4b.

![Extended Range Sensor Diagram]

### 4b. Trim the uninsulated drain wire to dimension shown at right. Cut off red and orange twisted pair. To expose bare conductors for termination, cut and strip ends of brown and yellow twisted pair to dimension shown.

![Standard Range Sensor Diagram]

### 5. Fold drain wire back onto the copper braid as shown at right. Label outer cable jacket “Flowmeter End” to avoid confusion during installation. Cable is now ready for installation.

![Flowmeter End Labeling Diagram]
Figure 12. Remote Mounted Flowmeter

REMOTE CABLE TERMINATIONS
YEL & BRN FOR STANDARD RANGE SENSOR; YEL, ORN, RED, BRN FOR EXTENDED RANGE SENSOR

ELECTRONIC MODULE
(SEE DETAIL "A")

OUTSIDE BRAID MAKES CONTACT TO HOUSING. BRAID IS COMPRESSED FOR A GOOD ELECTRICAL CONNECTION
SEE TABLE 4 AND 5.

1/2 INCH CONDUIT MAY BE CONNECTED DIRECTLY TO FOXBORO CONNECTORS VIA 3-PIECE UNION/COUPLER.

BRAIDED SHIELD AND DRAIN WIRE MUST BE IN CONTACT AT THIS END OF CABLE. NOTE: DO NOT DISASSEMBLE TO INSTALL.

PRE-ASSEMBLED AND DRESSED JUNCTION BOX

FLOWMETER BODY

CABLE MUST BE PUSHED INTO STAINLESS STEEL FITTINGS WHEN INSTALLING COMPRESSION NUTS TO ENSURE THAT THE BRAID IS PROPERLY SEATED FOR A GOOD ELECTRICAL CONNECTION. (BOTH ENDS.) SEE TABLES 4 AND 5.

SEE TABLE 5 FOR DRESSING OF CABLE AT THIS END

PREAMPLIFIER - EXTENDED TEMPERATURE RANGE ONLY

NOTE: STANDARD TEMPERATURE RANGE SENSOR HAS TWO (BRN & YEL) WIRES. CONNECT TO COLOR CODED TERMINALS. EXTENDED TEMPERATURE RANGE SENSOR HAS FOUR WIRES AS SHOWN.
Connection of Remote Signal Cable

Table 6. Connection of Remote Signal Cable (Electronics Housing End)

1. Take electronics end of prepared remote signal cable and align it as shown at right. Ready for assembly.

2. As shown in the diagrams at right, push the prepared cable assembly into the remote connector. Push until the cable bottoms out (cannot be pushed in any further). Push rubber bushing into position and tighten the knurled nut onto the remote connector to create a good compression fit.
### Table 7. Connection of Remote Signal Cable (Junction Box End)

1. Take flowmeter end of prepared remote signal cable and align it as shown at right. Ready for assembly.

2. As shown in the diagrams at right, making sure that the drain wire is folded back against the copper braid, push the cable assembly into the remote connector. Push until the cable bottoms out (cannot be pushed in any further). Push rubber bushing into position and tighten the knurled nut onto the remote connector to create a good compression fit.
Installation with Conduit

1. The junction box is pre-wired. A conduit box or conduit can be mounted directly to the 1/2 NPT connection at the remote electronics housing. A box or a standard 3-piece union/coupler can be mounted directly over the knurled nut. Do not disassemble the pre-wired connection at the junction box.

2. Run the remote signal cable to the electronics housing via the conduit. If required, prepare the cable as shown in Table 4. Feed it into the electronics housing following Steps 9 through 11 in the procedure for “If the Remote Signal Cable Must Be Disconnected” on page 31 and the procedure in Table 6.

3. Mount the conduit box or conduit to the 1/2 NPT connector directly or via a 3-piece union/coupler, if necessary. Make connection to the 1/2 NPT connector after the knurled nut has been tightened to provide a compression fit for the cable. Refer to Table 6.

4. At this point, follow Steps 12 through 14 in the procedure “If the Remote Signal Cable Must Be Disconnected” on page 31.

Field Termination Wiring

The field termination wiring is the same for flowmeters with an integral or remote electronic module.

The electronics housing provides 1/2 NPT conduit openings for access from either side of the flowmeter for ease in wiring to the field terminals. One conduit opening contains a threaded plug. Do not discard this plug.

For access to the field terminals, remove the cover from the field terminals compartment as shown in Figure 13. Note that the embossed letters FIELD TERMINALS identify the proper compartment.
4 to 20 mA Output Mode

A dc power supply must be used with each transmitter and receiver wiring loop to supply power for the mA signal. The dc power supply may be either a separate signal unit, a multiple unit supplying power to several transmitters, or built into the receiver.

Connect the supply and receiver loop wiring (0.50 mm² or 20 AWG typical) to the terminals in the field-terminal compartment of the transmitter, as shown in Figure 14.

*Figure 14. Installation Wiring - 4 to 20 mA Output Mode*

Twisted pair wiring should be used to prevent electrical noise from interfering with the dc current output signal. In some instances, shielded cable may be necessary. Earthing (grounding) of the shield should be at one point only at the power supply. Do not earth (ground) the shield at the transmitter.

Transmitter connection polarities are indicated on the terminal block. If the loop is to contain additional instruments, install them between the negative terminal of the transmitter and the positive terminal of the receiver, as shown in Figure 14.
Power Supply and External Load

The required loop power supply voltage is based on the total loop resistance. To determine the total loop resistance, add the series resistance of each component in the loop (do not include transmitter). The required power supply voltage can be determined by referring to Figure 15.

As an example, for a transmitter with a loop resistance of 600 ohms, referring to Figure 15, the minimum power supply voltage is 24 V dc, while the maximum power supply voltage is 50 V dc. Conversely, given a power supply voltage of 24 V dc, the allowable loop resistance is from 0 to 600 ohms.

--- NOTE ---
1. The power supply must be capable of supplying 22 mA.
2. Power supply ripple must not allow the instantaneous voltage to drop below 10.5 V dc.

Replace cover. Tighten cover securely to engage O-ring. This will prevent moisture or other contaminants from entering the compartment. It will also assure sufficient thread engagement to meet explosionproof requirements.
Pulse Output Mode

A dc power supply must be used with each transmitter and receiver wiring loop to supply power for the pulse signal. The dc power supply may be either a separate signal unit, a multiple unit supplying power to several transmitters, or built into the receiver.

Connect the supply and receiver loop wiring for pulse out (0.50 mm² or 20 AWG typical) to the terminals in the field-terminal compartment of the transmitter, as shown in Figure 16.

Figure 16. Installation Wiring - Pulse Output Mode

The pulse signal by its very nature has high frequency components that may cause interference in adjacent signal cables. In some instances, shielded cable may be necessary. Earthing (grounding) of the shield should be at one point only at the power supply. Do not ground the shield at the transmitter. Transmitter connection polarities are indicated on the terminal block.
**Power Supply and Load**

The power supply voltage must be between 10.5 and 50 V dc. The pulse output current is a maximum of 5 mA. The pulse output is short circuit protected. Permissible load resistances can be determined by referring to Figure 17.

![Figure 17. Load Requirements - Pulse Output](image)

**Transmitter Grounding**

The transmitter case is normally grounded. Refer to the applicable electrical code for earthing (grounding) requirements. A case-grounding terminal (see Figure 14 or Figure 16) is provided in the field-terminal compartment in the topworks.

If the signal circuit must be grounded in either the 4 to 20 mA or pulse output mode, it is preferable to do so at the negative terminal on the dc power supply. To avoid circulating currents in ground loops, or the possibility of short-circuiting groups of instruments in a loop, there should be only one ground in a loop.

For external ground connections, an optional conduit plug with screw connection is available.
Electronic Module Switches

The switches on the front of the electronic module have the following functions. Refer to Figure 18 on page 45.

1. *Switches A through F*
   These switches set the high and low noise filters.

2. *Switches G and H*
   These switches set the Low Flow Cut-in.

3. *Switch J*
   This switch selects either the 4 to 20 mA or the pulse output mode.

4. *Switches K through R*
   These switches adjust the 4 to 20 mA output span to the approximate vortex frequency. A potentiometer is provided for final adjustment. They have no effect with pulse output.

![Figure 18. Electronic Module Switch Locations](image)

Signal Noise Filters

Electronic filtering is provided in the electronic module to reduce the effect of noise and vibration on the vortex signal. The electronic module noise filter is set at the factory based on the customer-specified flow range. The electronic module filter consists of both high and low frequency noise filters. Each filter can be independently set, allowing the filtering to be tailored to each application. The filters are settable by the switches on the front of the electronic module.

For most installations, there should be no need to change the filter. Consider changing the filter only if meter operation is unsatisfactory. Refer to the section on “General Troubleshooting” on page 49 to determine whether the filters need changing.
Approximate Filter Settings

If the filters have not been factory set, or if no information is available on either the frequency at maximum flow or the frequency at low flow cut-in, the following settings are recommended as initial settings.

### Table 8. Approximate Filter Settings

<table>
<thead>
<tr>
<th>Line Size</th>
<th>Set Steps per Table 9</th>
<th>Set Steps per Table 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid A,B,C</td>
<td>Gas A,B,C</td>
<td>Liquid D,E,F</td>
</tr>
<tr>
<td>3/4, 1</td>
<td>5</td>
<td>1/2</td>
</tr>
<tr>
<td>1-1/2, 2</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>3 - 12</td>
<td>7</td>
<td>4</td>
</tr>
</tbody>
</table>

### Setting the Electronic Module Filters

The high frequency noise filters are labeled A, B, and C, on the electronic module label board. They are set based on the upper range frequency (calibration frequency) using Table 9.

Choose a filter setting for which the upper range frequency falls within the correct step listed in the table. This frequency is shown on the label on the front of the electronic module.

The upper range frequency must be known even when the meter is to be used in the pulse output mode.

The low frequency filters are labeled D, E, and F and are set according to the low flow cut-in frequency. This may be determined from the rangeability factor shown on the sizing program. Simply divide the upper range frequency by the rangeability. Then refer to Table 10 to set the switch positions.

The approximate filter settings shown in Table 8 are satisfactory for many installations.

### Table 9. High Frequency Noise Filter Switches

<table>
<thead>
<tr>
<th>Step</th>
<th>Upper Range Frequency (in Hz)</th>
<th>Switch Positions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>1</td>
<td>2300 to 3300</td>
<td>off</td>
</tr>
<tr>
<td>2</td>
<td>1500 to 2300</td>
<td>off</td>
</tr>
<tr>
<td>3</td>
<td>700 to 1500</td>
<td>off</td>
</tr>
<tr>
<td>4</td>
<td>350 to 700</td>
<td>off</td>
</tr>
<tr>
<td>5</td>
<td>160 to 350</td>
<td>on</td>
</tr>
<tr>
<td>6</td>
<td>80 to 160</td>
<td>on</td>
</tr>
<tr>
<td>7</td>
<td>&lt; 80</td>
<td>on</td>
</tr>
</tbody>
</table>
Low Flow Cut-in

The low flow cut-in selection determines the minimum flow rate that the electronic module can measure and return a nonzero indication of flow. Occasionally, erratic output conditions can occur at low flows. This is due to system noise such as pulsing pumps, surging flows, or vibrating pipes.

To eliminate these false signals, the low flow cut-in can be raised. Raising the low flow cut-in by one step will increase the low flow cut-in by a factor of two.

All flowmeters are set at the factory to the “LOW” low flow cut-in position, which is the default setting. This setting can be increased to achieve greater noise immunity as described above. It may be decreased for lower flow rate measurement capability as shown in Table 11.

Output Mode Selection

The output mode selection is made by the setting of Switch J as shown in Table 12.
Calibration Switches

Switches K, L, M, N, P, R, and both potentiometers are used only for calibrating the 4 to 20 mA dc output. All flowmeters intended to be employed in the analog output mode are factory calibrated to the user-specified Upper Range Value (URV) flow rate. These flowmeters should not have to be changed unless the desired URV has changed. The calibration frequency corresponding to the URV is located on the front side of the electronic module as shown in Figure 18 on page 45. See “Electronic Module 4 to 20 mA Calibration” on page 60.

Every vortex flowmeter is shipped from the factory with a calibrated flow range. The factory set range is shown on the data label attached to the instrument. If the flow conditions were not specified on the purchase order, no range is shown on the data label. In such cases, the 4 to 20 mA signal is calibrated for 25 Hz full scale.

If the correct flow range was specified with the purchase order, the 4 to 20 mA signal and the upper and lower filters have been set correctly, and no further adjustment is required.

If the meter requires recalibration, refer to “Electronic Module 4 to 20 mA Calibration” on page 60.

— NOTE —

Setting switch J to the pulse output mode disables the calibration switches.
Calibration for URV is unnecessary in the pulse output mode.

Installation Effects on Calibration

Certain installations and flow conditions affect flowmeter performance. These effects can alter the calibrated K-factor in either the 4 to 20 mA or pulse mode. The effects can be accounted for. Refer to Appendix A, page 79, for determining the corrected K-factor and to Appendix B on page 85, for determining the Upper Range Frequency for the 4 to 20 mA calibration.

The customer K-factor has been corrected during factory calibration for the temperature stated on the data label.
3. Troubleshooting

General Troubleshooting
Read this General Troubleshooting section before attempting any troubleshooting. Then, follow the applicable procedures in the order presented. Anyone performing troubleshooting should be suitably trained and qualified.

Flowmeter Has Incorrect Output
Check the calibration. Refer to “Electronic Module 4 to 20 mA Calibration” on page 60.

Flowmeter Has No Output with Fluid Flowing in the Pipe
Refer to “No Output Troubleshooting” on page 51.

Flowmeter Output Indicates Flow When There Is No Flow
In some installations, the flowmeter can indicate flow when the line is shut down. This could be the effect of a leaking valve, sloshing fluid, or noise sources such as pump-induced pipe vibration. To eliminate these false signals, try the following:
1. Be sure there is no flow and that meter is fully charged with fluid.
2. Reduce the high frequency filter frequency by increasing the high frequency noise filter by one step. Check output.
   *Example:* Change the switch configuration from Step 2 to Step 3 or from Step 3 to Step 4 per Table 9, “High Frequency Noise Filter Switches,” on page 46.
4. Increase the Low frequency noise filter by one step. Check output.
   *Example:* Change switch configuration from Step 3 to Step 4. See Table 10, “Low Frequency Noise Filter Switches,” on page 47.
5. Repeat Steps 1 through 3 until output is suppressed.
Flowmeter Output Indicates Higher Flow Rate with Decreasing Flow

1. Reduce the high frequency filter frequency by increasing the high frequency noise filter by one step. 
   *Example:* Change switch configuration from Step 3 to Step 4 per Table 9, “High Frequency Noise Filter Switches,” on page 46.


3. Increase the lower frequency limit of the low frequency filter by one step. Example: Change switches from Step 3 to Step 4 per Table 10, “Low Frequency Noise Filter Switches,” on page 47.

4. Check the output after each filter change.

5. Repeat Steps 1 through 3 until output is suppressed, but do not change the high frequency noise filter by more than two steps from its original position.

Fluctuating Output During Flowing Conditions

1. Fluctuations may be a true picture of the actual flow.

2. A small offset of 1 to 2% with rapid fluctuations may be caused by gaskets protruding into the flow stream.

Fluctuating Trend Output

Fluctuations of the trend output may often be traced to the algorithm used for scanning. This can happen when the meter is set for pulse output. The J switch is in the ON position.

First determine if it is the meter output that is fluctuating.

1. Rewire the meter for analog output and add a recorder or some other device for reading the mA signal.

2. If the recorded output is steady, the problem is in the digital scanning system. The vortex pulse output requires continuous pulse counts in addition to the scan. This may require special considerations in many systems.

3. If the recorded output continues to fluctuate, the problem is in the piping system. The cause may be:
   a. Pumping oscillations
   b. Valve oscillations
   c. Pressure reducing oscillations

The cause is usually not high frequency noise or vibration.
No Output Troubleshooting

1. Be sure there is flow.
2. Check the power supply. The voltage across the + and - terminals must be between 10.5 and 50 V dc.
   a. If voltage is zero, check for blown fuse in power supply.
   b. If voltage is low, but not zero, the flowmeter may be loading the power supply. Remove the field terminal cover. Disconnect the + and - leads and measure the voltage from the power supply. If the voltage returns to normal, the circuit is good to this point. Reconnect the power to the + and - terminals.
   c. Remove the electronic module compartment cover and disconnect the red, yellow, and blue ribbon cable from the terminal block on the front of the electronic module. Measure the voltage across the red and blue wires. If the voltage has returned to normal, the electronic module is bad. Replace the electronic module.
   d. If the voltage remains low, the housing/field terminal wiring is bad. Replace the housing or return the meter for repair.
3. Checking the 4 to 20 mA Output Loop.
   a. The 4 to 20 mA loop may be monitored using the test jacks in the field output terminal board. The signal produced will be 0.1 - 0.5 volts, corresponding to 4 to 20 mA. Be sure the J switch is in the OFF position as these jacks cannot be used in the pulse output mode.
   b. Increase the flow to be sure that the lack of response is not caused by operation below the Low Flow Cut-in.
   c. If there is no response to increasing flow, perform one of the following tests:
      • Electronic Module Test Procedure in the next section
      • Preamplifier Test “Preamplifier Test Procedure” on page 52
      • Sensor Test “Sensor Test Procedure” on page 53.
Electronic Module Test Procedure

1. Calibrate the electronic module per “Electronic Module 4 to 20 mA Calibration” on page 60. If the electronic module does not respond to calibration, replace it.

2. For flowmeters with extended range sensors, check the electronic module power to the preamp. Loosen the mounting screws and remove the electronic module from the housing. The 4-position terminal block on the back of the electronic module provides power for the preamplifier board. The voltage at the terminal should read the following with the wires connected:

   Red to Yellow: +3.5±0.2 Volts dc
   Orange to Yellow: -3.5±0.2 Volts dc

   If the voltages are not within specifications, disconnect the wires to the preamp and measure the voltages again. If they do not return to + and - 3.5, replace the electronic module. (See “Electronic Module Replacement.” on page 59) If they do return to normal, replace the preamplifier.

Preamplifier Test Procedure

1. For meters with extended range sensors only, check the electronic module to be sure it can provide the required power for the preamplifier. Loosen the mounting screws and remove the electronic module from the housing. The 4-position terminal block on the back of the electronic module provides power for the preamplifier board. The voltage with the preamp connected should read:

   Red to Yellow: +3.5±0.2 Volts dc
   Orange to Yellow: -3.5±0.2 Volts dc

   If it does not, disconnect the preamp and measure again. If the voltage returns to normal, replace the preamplifier (See “Replacing the Preamplifier” on page 67)

2. If the voltage in Step 1 is satisfactory, use the electronic module to power the preamplifier. Connect the red, yellow, and orange leads to the electronic module and disconnect the brown lead. Disconnect the red and black sensor leads.

3. Connect a 68 pF capacitor to the red terminal of the sensor input board. Connect the sine wave generator across the input by connecting the positive lead of the sine wave generator to the capacitor and the negative lead to the black terminal.

4. The preamplifier must be shielded to prevent interference from 50 or 60 Hz external power sources. Fluorescent lighting is often a source of interference.

5. Set the generator for 500 Hz and 0.5 Volts peak to peak. The preamplifier output, brown to yellow leads, should be 500 Hz between 1.45 and 1.75 V peak to peak.

6. Increase the frequency to 4.3 kHz. The output should be between 1.00 and 1.20 V peak to peak.

7. If the output is not within the correct values, replace the preamplifier.
For this test, the preamplifier should be mounted in the housing in order to achieve the best shielding. Do not attempt this test with the preamplifier on the bench. It is very difficult to shield from 50 or 60 Hz interference.

Note that separate power supply may be used to provide power in place of the electronic module. If dual power supplies are not available, four 1.5 Volt batteries may be used to provide ±3 V dc.

Sensor Test Procedure

Standard Temperature Range Sensor

1. Remove electronic module from housing using the handle located in the center of the electronic module label board.
2. Disconnect the yellow and brown sensor leads from back of electronic module.
3. Connect sensor lead to an oscilloscope.
4. With fluid flow in the pipe, observe signal waveform on oscilloscope. Waveform should be similar to that shown in Figure 19.
   ♦ If waveform is similar to Figure 19, the sensor is good. If there is no output from the electronic module, the electronic module input stage has failed. The entire electronic module should be replaced.
   ♦ If there is no sensor output signal, the sensor has failed and should be replaced. See “Post-Assembly Dielectric Test” on page 69 for details.
Extended Temperature Range Sensor

1. Remove the electronic module from the housing, using the handle located in the center of the electronic module panel board. Remove the preamplifier from the housing. First pry the ears of the metal shield away from the sides of the housing. Then lift out the shield assembly.

2. Disconnect the red and black sensor leads from the preamplifier input terminal strip.

3. With flow in the pipe, use an oscilloscope to observe the sensor output. The scope probe impedance must be 10 megohms or greater. The waveform should be similar to that shown in Figure 19. When the preamplifier is not in the circuit, the minimum signal required for the sensor is about 2.5 mV.

For liquid flow, the minimum signal of 2.5 mV will require about 25 Hz. Be sure that flow is enough to produce 25 Hz.

For gas or steam flow, the minimum signal of 2.5 mV may require 100 Hz or more, depending on meter size.

If the waveform is similar to Figure 19, the sensor is functioning. If there is no output, replace the sensor.

For all meters, be sure the signal being read is not external interference, such as 50 or 60 Hz.

![Figure 19. Normal Vortex Frequency Waveform](image-url)
4. Maintenance

Introduction

Operation of the 83F-A and 83W-A Vortex Flowmeters consists of three basic functions: generation and shedding of vortices in the fluid stream, sensing of vortices, and amplification and conditioning of the signal from the vortex sensor. Should a malfunction of the flowmeter be suspected, the cause can normally be isolated to one of these three functions.

Personnel involved in maintenance of vortex meters should be trained and qualified in the use of the equipment required and in the removal and replacement of the meter in the piping and qualified for the routine maintenance of the meter components.

Vortex Generation and Shedding

The process of vortex generation and shedding can be degraded or destroyed by disturbances in the upstream flow, the nature of the flowing fluid, or by damage to the vortex shedding element (rare). Such flow disturbances may be created by gaskets protruding into the flowing stream, by some form of partial blockage in the upstream piping, by the piping configuration, or by the existence of two-phase flow. Should the vortex shedding element become heavily caked, coated, or physically damaged to such an extent that its basic shape or dimensions are changed, the vortex shedding process may be impaired. Also, the length of straight, unobstructed run of upstream piping is important (refer to “Piping Considerations and Mounting Position” on page 19).

Vortex Sensor

There are two basic types of sensors employed by both the 83F-A and 83W-A Vortex Flowmeters – Standard Temperature and Extended Temperature Range.

The Standard Temperature Range sensors consist of a piezoelectric crystal that is sealed inside a liquid-filled capsule by two diaphragms. The vortex shedding process creates an alternating differential pressure on the capsule diaphragms that is transmitted through the fill liquid to a piezoelectric crystal. The operating temperature range is -18 to +204°C (0 to 400°F).

The Extended Temperature Range sensor consists of a double-faced circular diaphragm flange with a mechanical shuttle. The vortex shedding process creates an alternating mechanical force on the shuttle that transfers this force to two piezoelectric crystals. The maximum operating temperature is 430°C (800°F).

The differential pressure or mechanical force acting on the crystals causes them to develop a pulsed voltage with a frequency equal to the vortex shedding frequency. Damage to sealing diaphragms or other physical damage could cause the sensors to operate improperly.
Amplification and Conditioning

The vortex sensor signal is amplified and conditioned in the output module (electronic module), which is located in the electronic module compartment of the electrical housing. The function of the electronic module, in addition to amplification and conditioning, is scaling of the raw sensor output for transmission as a 4 to 20 mA signal. A simplified block diagram of the flowmeter is shown in Figure 20.

As shown, the electronic module accepts the raw sensor output directly from Standard Temperature Range sensors. When used with an Extended Temperature Range sensor, the raw sensor output must be buffered by a preamplifier before being passed to the electronic module. In either case, the electronic module receives the vortex signal and then performs its conditioning, scaling, and amplification functions.

The electronic module also has several user selectable inputs located on an accessible label board on the front side of the Electronic Module. These inputs provide for output mode selection, noise filtering adjustment, and electronic module calibration. The label board of the electronic module is shown in Figure 21.

*Figure 20. Flowmeter Block Diagram*
Electronic Module

The Electronic Module is made up of two printed wiring assemblies (PWAs), a plastic enclosure with a label, and two captive screws. The Electronic Module is housed in the transmitter housing opposite the side labeled “FIELD TERMINALS.” The electronic module has two terminal blocks. See Table 13 for a summary of the terminal block connections.

Table 13. Electronic Module Terminal Block Connections

<table>
<thead>
<tr>
<th>Location of Connector</th>
<th>Letter Code</th>
<th>Color</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front</td>
<td>R</td>
<td>Red</td>
<td>Loop +</td>
</tr>
<tr>
<td></td>
<td>Y</td>
<td>Yellow</td>
<td>Scaled Pulse Out +</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>Blue</td>
<td>Loop –, Scaled Pulse Out –</td>
</tr>
<tr>
<td>Back</td>
<td>B</td>
<td>Brown</td>
<td>Sensor + or Preamp Out +</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>Red</td>
<td>Preamp Power +</td>
</tr>
<tr>
<td></td>
<td>O</td>
<td>Orange</td>
<td>Preamp Power –</td>
</tr>
<tr>
<td></td>
<td>Y</td>
<td>Yellow</td>
<td>Sensor – or Preamp –</td>
</tr>
</tbody>
</table>
Electronic Module Removal

1. Remove power from the flowmeter.
2. Remove Electronic Module compartment threaded cover.

![Figure 22. Electronic Module](image)

3. Disconnect the three signal leads (red-yellow-blue) at the terminal block on the front of the Electronic Module. See Figure 22.

4. Unscrew the two captive screws, one on each side of the Electronic Module.

5. To complete the removal for the standard range meter, continue the procedure as described below. Proceed to Steps 6 and 7 for either standard range or extended range flowmeters.

**Standard Temperature Range Flowmeter**

6. Pull electronic module (using handle in center of Electronic Module label board) out of the housing far enough to be able to disconnect the brown and yellow sensor leads from the terminal block on the back of the Electronic Module. Refer to Figure 22.

7. Pull the red/yellow/blue cable out of the holes in the PWAs and plastic enclosure and remove electronic module from housing.

---

**NOTE**

Do not cut the plastic tie wraps.
**Extended Temperature Range Flowmeter**

8. Pull electronic module (using handle in center of Electronic Module label board) out of the housing far enough to be able to disconnect the four Preamplifier leads (brown-red-orange-yellow cable) from terminal block on back of the electronic module. See Figure 23.

9. Pull the red/yellow/blue cable out of the holes in the PWAs and plastic enclosure and remove electronic module from housing.

---

**NOTE**

Do not cut the plastic tie wraps.

---

**Figure 23. Electronic Module - Extended Temperature Range**

![Diagram of Electronic Module Replacement](image)

**Electronic Module Replacement.**

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ensure that power is not applied to the flowmeter before proceeding.</td>
</tr>
</tbody>
</table>

1. Remove the electronic module following the appropriate procedure in the preceding section.

---

**NOTE**

The replacement electronic module is shipped in a protective antistatic plastic bag along with a small adhesive label. Do not remove the electronic module from this bag until it is ready to be installed in a flowmeter. This will minimize the possibility of damage due to accidental electrostatic discharge. Use of an electrostatic mat will prevent electrostatic discharge.
2. Remove the new electronic module from its protective bag.

3. Calibrate the electronic module according to the instructions in “Electronic Module 4 to 20 mA Calibration” on page 60. The procedure for connecting the sensor and signal leads continues with Step 4 in the applicable section below.

--- NOTE ---
The signal and sensor leads should already be held together with a plastic tie.

**Standard Temperature Range Flowmeter**

4. Refer to Figure 22. Connect the brown and yellow sensor wires to the color coded terminal block on the back of the electronic module. Refer to Figure 22.

5. Proceed to Step 6 below.

**Extended Temperature Range Flowmeter**

6. Refer to Figure 23. Connect brown-red-orange-yellow Preamplifier cable to the color coded terminal block on back of the electronic module.

7. Feed the signal leads (red-yellow-blue cable) through the holes in the PWAs and connect them to the terminal block at front of the electronic module following the color code on the label.

--- NOTE ---
Twist the wires together, if necessary, to fit them through the holes. Do not tin the leads.

8. After the sensor and signal leads are connected, rotate the electronic module one full turn clockwise before mounting. This will help prevent the wires from being pinched. Locate the electronic module in the housing over the two mounting holes. If a preamp is present, be sure to align it also. Tighten the captive mounting screws.


10. Replace the housing covers.

**Electronic Module 4 to 20 mA Calibration**

A vortex flowmeter may require calibration for the following reasons:

♦ A new meter was ordered without specifying the desired range.

♦ An existing installation requires a range change due to a change in process operating conditions.

♦ A replacement Electronic Module is being installed.

--- NOTE ---
The Electronic Module does not require calibration if the unit is being operated in the pulse mode, i.e., switch “J” is set to the “ON” position. Do not attempt to calibrate the 4-20mA output with the J switch in the “ON” position.
The equipment and procedure for calibrating the vortex flowmeter vary to a slight extent on whether or not a calibration cable (Part No. K0146HP) is available. This cable allows you to connect the test signal generator at the front of the Electronic Module, rather than to the sensor input terminals at the rear, thus avoiding the tasks of removing the module from its housing and disconnecting the sensor leads.

**Required Equipment**

1. Signal generator (10 to 3000 Hz), capable of being set to within 0.1% of upper range frequency. Chassis must be isolated from power ground; i.e., output must be floating. Do not ground or earth! A battery operated signal generator is recommended, if available.

If the calibration cable (Part No. K0146HP) is available, one of the following signal generators can be used:

- Pulse generator, +7 Volts, 50% duty cycle.
- Square wave generator, 7 Volts peak-to-peak centered on +3.5 V (+3.5V dc offset).
- Square or sine wave generator, 14 Volts peak-to-peak centered on zero (zero dc offset).

If the calibration cable is not available, the following signal generator must be used:

- Sine wave generator, 1 Volt peak-to-peak centered on zero (zero dc offset).

2. 250 ohm precision resistor (±0.1%), 1/4 Watt minimum.

3. Voltmeter, range 1 to 5 Volts dc, capable of being set to within 0.1% (used to measure 4 to 20mA loop current via the voltage drop across the precision resistor).

4. Power Supply (10.5 to 50.0 Volts dc), 24 Volts recommended.

**Calibration Procedure**

Calibration of an Electronic Module is a four step process:

1. Determine the Corrected K-Factor
2. Determine the Upper Range Frequency
3. Set the Electronic Module Switches
4. Adjust the Span Potentiometer

--- **NOTE**

If a replacement module is being installed, the upper range frequency can be read from the label on the front of the module being replaced (see Figure 21 on page 57). If this is the case, skip to Step III below. If a range change to an existing installation is required due to a change in operating conditions, or if a new meter was ordered without specifying the desired range (in this case the label will read 25 Hz), begin with Step I.
I. Determining the Corrected K-Factor

The first step in calibrating an analog Electronic Module is to determine the Corrected K-Factor. The Reference K-Factor stamped on the flowmeter data label is established under reference conditions. These reference conditions correspond to a flowing process temperature of 20°C (70°F) and 50 pipe diameters or greater of straight pipe upstream of the meter (Schedule 40 piping for flange and wafer meters; Schedule 5 for sanitary meters). For application conditions other than reference conditions, the Reference K-Factor should be corrected, as described in Appendix A, by multiplying it by the total bias correction factor (BCF) to obtain the Corrected K-Factor.

II. Determining the Upper Range Frequency (Full Scale Frequency)

To calibrate an analog Electronic Module, it is necessary to determine the vortex frequency corresponding to the desired upper range flow value. If a replacement module is being installed, this frequency can be read from the label on the front of the module being replaced (see Figure 21 on page 57). If this is the case, skip to Step III. If a range change to an existing installation is required because of a change in operating conditions, or if a new meter was ordered without specifying the desired range (in such cases, the label reads 25 Hz), the upper range frequency can be calculated by one of the following procedures:

1. Using FlowExpertPro - This meter selection/sizing software program displays a nominal upper range frequency, based on a built-in nominal K-factor and corrected for process temperature (see 2nd page of Vortex Sizing Results)

   **NOTE**
   During the sizing process, select the desired flow units for the upper range value and be sure to enter the flowing process temperature.

   To determine the actual upper range frequency, press <F3>, as instructed at the lower left hand side of the results screen, and then enter the Corrected K-factor (computed in Step I) and the desired upper range value. In computing the total bias correction factor in Step I, set the process temperature correction factor (TCF) equal to unity. FlowExpert incorporates this correction internally, based on the flowing process temperature that was input during the sizing process.

2. Manual Procedure – Compute the upper range frequency by following the procedures outlined in Appendix B.


1. **High Frequency Noise Filter (Switches A, B, and C)** — Use the upper range frequency determined in Step II to select the appropriate level setting for the high frequency noise filter (see Table 15 on page 65). Set switches A, B, and C accordingly. This is the proper setting for doing the calibration, and also the correct setting for the application.

   **Example:**
   Upper range frequency = 523 Hz
   Since this is between 350 and 700, A is set to “OFF”, B to “ON”, and C to “ON”.
2. **Low Frequency Noise Filter (Switches D, E, and F)** — If a replacement module is being installed, record the current positions of switches D, E, and F. These positions need to be reset after calibration is completed. During this calibration, set all three switches to “OFF”.

3. **Low Flow Cut-In (Switches G and H)** — If a replacement module is being installed, record the current positions of switches G and H. These positions need to be reset after calibration is completed. During calibration, set switch G to “OFF” and H to “ON”.

4. **Output Mode (Switch J)** — Set switch J to “OFF”. This sets the Output Mode to 4 to 20 mA.

5. **Span Switches (K-M, N, P, R)** — The span switches must be set to encompass the upper range frequency determined in Step II. This ensures that the span potentiometer can be used in the final step to calibrate the module. If a replacement module is being installed, set the span switches to duplicate the settings of the module being replaced. Otherwise, follow the procedure below.
   a. Set the coarse span switches (K, L, and M) per the intervals defined in Table 15 on page 65.
   
   **Example:**
   
   Upper range frequency = 312.
   Since this is between 200 and 400, K is set to “ON”, L to “OFF”, and M to “OFF”.
   
   b. The medium span switches (N, P, and R) are then set per Table 16.
   
   **Example:**
   
   The frequency, 312 Hz, represents a value that is 56% of the value between 200 and 400.
   
   \[
   \frac{312 - 200}{400 - 200} \times 100 = 56% 
   \]

   Since 56% lies between 50% and 75%, N is set to “ON”, P to “OFF”, and R to “ON”.

---

**IV. Adjusting the Span Potentiometer**

The procedure for adjusting the span potentiometer is as follows:

1. Hook up the power supply, precision load resistor, and voltmeter as shown in Figure 24 on page 65. Then connect power to the Red (+) and Blue (-) terminals on the 3-connector terminal block on the front of the Electronic Module.

2. If the calibration cable (K0146HP) is available, connect the signal generator (see “Required Equipment” on page 61) to the 3-pin input receptacle marked CAL IN on the front of the Electronic Module (see Figure 24 on page 65).

---

**NOTE**

Plugging the cable into the 3-pin receptacle electrically separates the sensor input from the module.
If the calibration cable is not available, remove the module from the housing as described in “Electronic Module Removal” on page 58), disconnect the sensor leads (Brown and Yellow wires) from the 4-connector terminal block on the back of the module, and connect the wires from the sine wave generator (1 Volt peak-to-peak, centered on zero) to the B(+) and Y(-) terminals.

3. Set the signal generator to the upper range frequency established in Step II. Adjust the span potentiometer until the voltage measured across the 250 ohm precision resistor is 5.00 Volts (\(\pm 0.1\%\)). This is equivalent to 20 mA following in the loop.

4. Set the signal generator frequency to zero. The voltage across the load resistor should read 1.00 Volt (\(\pm 0.1\%\)). If not, adjust the zero potentiometer until the voltage reading is as specified. This is equivalent to 4 mA flowing in the loop.

5. Disconnect the test equipment. If the Electronic Module has not yet been installed, reconnect the sensor leads and replace the module as described in Electronic Module Replacement (see page 59).

6. Write the calibrated upper range frequency on an adhesive label and stick it to the front face of the module.

--- **NOTE**

A blank label is included in the replacement module kit.

7. Calibration of the module is now complete. However, prior to putting the meter into service, the Low Frequency Noise Filter switches (D, E, and F) and the Low Flow Cut-In switches (G and H) must set to their proper positions. If a replacement module has been installed, reset switches D, E, F, G, and H to their original positions, as recorded earlier. In all other cases, and for a replacement module if any uncertainty exists, establish and set the appropriate switch settings (D through H) according to the instructions in the Installation section of this document (see “Electronic Module Switches” on page 45).

<table>
<thead>
<tr>
<th>Step</th>
<th>Upper Range Frequency (in Hz)</th>
<th>Switch Positions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2300 to 3300</td>
<td>off, off, off</td>
</tr>
<tr>
<td>2</td>
<td>1500 to 2300</td>
<td>off, off, on</td>
</tr>
<tr>
<td>3</td>
<td>700 to 1500</td>
<td>off, on, off</td>
</tr>
<tr>
<td>4</td>
<td>350 to 700</td>
<td>off, on, on</td>
</tr>
<tr>
<td>5</td>
<td>160 to 350</td>
<td>on, off, on</td>
</tr>
<tr>
<td>6</td>
<td>80 to 160</td>
<td>on, off, on</td>
</tr>
</tbody>
</table>
| 7    | < 80                         | on, on, off      

*Table 14. High Frequency Noise Filter Switches*
Table 15. Coarse Span Switches

<table>
<thead>
<tr>
<th>Coarse Span Frequency Step</th>
<th>Frequency (Hz) at the Upper Range Value</th>
<th>Switch Positions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>K</td>
</tr>
<tr>
<td>1</td>
<td>12.5 to 25</td>
<td>off</td>
</tr>
<tr>
<td>2</td>
<td>25 to 50</td>
<td>off</td>
</tr>
<tr>
<td>3</td>
<td>50 to 100</td>
<td>off</td>
</tr>
<tr>
<td>4</td>
<td>100 to 200</td>
<td>off</td>
</tr>
<tr>
<td>5</td>
<td>200 to 400</td>
<td>on</td>
</tr>
<tr>
<td>6</td>
<td>400 to 800</td>
<td>on</td>
</tr>
<tr>
<td>7</td>
<td>800 to 1600</td>
<td>on</td>
</tr>
<tr>
<td>8</td>
<td>1600 to 3200</td>
<td>on</td>
</tr>
</tbody>
</table>

Table 16. Medium Span Switches

<table>
<thead>
<tr>
<th>Percent of Coarse Span Frequency Step</th>
<th>Medium Span Switch Positions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td>0 to 25</td>
<td>on</td>
</tr>
<tr>
<td>25 to 50</td>
<td>off</td>
</tr>
<tr>
<td>50 to 75</td>
<td>on</td>
</tr>
<tr>
<td>75 to 100</td>
<td>off</td>
</tr>
</tbody>
</table>

Figure 24. Analog Electronic Module Calibration Hookup
Preamplifier

The Preamplifier assembly (shown in Figure 25) consists of the preamplifier with a shield for integral mounted electronics (or with a mounting plate for remote mounted electronics, as shown in Figure 26). The preamp has a sensor switch which must be set to **STD** for standard temperature sensors and set to **EXT** for extended temperature range sensors.

Preamplifier Removal

**Integral Mounted Flowmeter**

1. Disconnect power from the flowmeter.
2. Remove electronic module compartment cover (opposite “Field Terminal” side) and remove the electronic module as described in “Electronic Module Removal” on page 58. Remove the brown, red, orange and yellow preamplifier leads. Refer to Figure 23. It is not necessary to remove the display, if one is present.
3. Cut the two tie wraps holding the preamplifier leads and signal leads together.
4. Pry the retaining tabs of the metal shield away from the housing, using a straight blade screwdriver, and pull the whole assembly out. See Figure 25.
5. Turn the preamplifier upside down, disconnect the yellow and brown sensor leads from the terminal block, and loosen the strain relief clamp that holds the sensor cable.
6. Pull the preamplifier out of the housing.
7. Remove the Preamplifier from the shield by removing the two screws. See Figure 25. Save the two screws and metal shield.
8. The replacement procedure starts on page 67.

*Figure 25. Preamplifier Assembly - Integral Mount Extended Temperature Range*
Remote Mounted Flowmeter

On remote mounted electronics, the Preamplifier is housed in the junction box on top of the meter. The Electronic Module is in the transmitter housing.

1. Disconnect power to the flowmeter.
2. Remove the junction box cover. The Preamplifier and a 4-position two-sided terminal block are mounted on a round plate in the junction box, as shown in Figure 26.
3. Disconnect (brown-red-orange-yellow) wires from both sides of the terminal block and remove strain clamp holding remote cable.
4. Disconnect yellow and brown sensor leads from terminals on the preamplifier and loosen strain relief clamp holding the sensor cable.
5. Unscrew the two mounting screws to remove the mounting plate from the junction box.
6. Turn the mounting plate (with the preamplifier) upside down and unscrew the two screws to remove the preamplifier. Save the screws and the mounting plate assembly.

Figure 26. Preamplifier Assembly - Remote Mount Assembly

Replacing the Preamplifier

The replacement preamplifier is shipped in a protective anti-static plastic bag with two tie wraps for dressing of wires. Do not remove the preamplifier from this bag until it is ready to be installed in a flowmeter. This will prevent damage due to accidental electrostatic discharge.

--- NOTE 
An electrostatic mat will prevent electrostatic discharge.

Remove the new preamplifier from its protective bag and follow the installation procedure in “Integral Mounted Flowmeter” on page 68 and in “Remote Mounted Flowmeter” on page 69..

⚠️ CAUTION
Before proceeding, make sure that power to flowmeter is OFF.
**Integral Mounted Flowmeter**

1. Mount the new preamplifier to the metal shield using the original screws. See Figure 25.

2. Feed the yellow and brown sensor wires through the strain relief clamp on the bottom of the preamplifier board. Tighten the clamp and connect the sensor leads to the terminal block. The color coding is important. Check to see that this is correct. See Figure 27.

3. Set the sensor switch to “STD” for standard temperature sensors and to “EXT” for extended range temperature sensors.

4. Before placing the preamplifier into the housing, bend the retaining tabs of the metal shield outward slightly to ensure a snug fit against the housing walls. See Figure 23. Align the mounting slots with the screw holes for mounting the electronic module.

5. Once the preamplifier is in place, connect its four wires (brown-red-yellow-orange cable) to the color coded terminal block on back of the electronic module.

6. Connect the output signal leads (red-blue, and yellow-green cables) to terminal blocks on the electronic module, following the color code on the label.

7. Prior to mounting the main electronic module in the housing, bring all the cables from preamplifier and the housing neatly together as shown in Figure 23.

8. While pushing the slack in the cables away from the back of the electronic module, tie the cables together at two places, using plastic tie wraps.

9. Locate the electronic module in the housing by aligning the preamplifier shield with the mounting holes.

10. Rotate the electronic module one full turn clockwise before mounting. This will help prevent the wires from being pinched. Locate the electronic module over the mounting holes, align the preamplifier, and tighten the captive mounting screws.

11. Perform Post-Assembly Dielectric Test. Refer to page 69. Replace threaded housing cover.
Remote Mounted Flowmeter

1. Mount the new preamplifier on the mounting plate using the two screws. Refer to Figure 26.

2. Feed the yellow and brown sensor wires through the strain relief clamp on the preamplifier board. Tighten the clamp and connect the sensor leads to the terminal block. The color coding is important. Verify that it is correct. See Figure 27.

3. Connect (brown-red-orange-yellow) cable from preamplifier to one side of the two-sided terminal block on the mounting plate. See Figure 26.

4. Before placing assembly into the junction box, connect the four (brown-red-orange-yellow) wires entering the junction box through a conduit opening, to the other side of the terminal block on the mounting plate (following the same sequence as the cable from the preamplifier). See Figure 28.

5. Place mounting plate with preamplifier in the junction box and mount it using the two mounting screws.

6. Perform Post-Assembly Dielectric Test. Refer to page 69. Replace the threaded junction box cover.

Post-Assembly Dielectric Test

To ensure there are no faults to ground in any of the internal wiring, apply 500 V ac or 707 V dc dielectric strength test for 1 minute between shorted input terminals (+), (-), (A), (B), and housing ground as shown in Figure 29.
Sensor Replacement

The flowmeter housing must be in a vertical mounting position (as shown in Figure 30) so that the connector bolts can be properly torqued. Therefore, if the flowmeter housing is not in the vertical position, remove the flowmeter from the line while doing a sensor replacement. In all cases, the pipeline must be shut down and emptied before loosening the connector bolts.

Replacing the sensor does not cause a shift in the K-factor. Therefore, the flowmeter does not require recalibration.

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>The placement of colored wires in the correct position in the terminal blocks is important. Verify correctness.</td>
</tr>
</tbody>
</table>

Before beginning the replacement procedure, verify that you have the correct kit of parts. Kit part numbers can be found in PL 008-708 (for 83F) or PL 008-709 (for 83W).

Integrally Mounted Flowmeter

See Figure 30.

Sensor Assembly Removal

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before proceeding, ensure that power is removed from the flowmeter.</td>
</tr>
</tbody>
</table>

1. Remove the electronic module compartment threaded cover.

<table>
<thead>
<tr>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>If the cover cannot be removed by hand, insert a flat bar in the cover slot.</td>
</tr>
</tbody>
</table>

2. If a display is mounted to the electronic module, remove the display by loosening the two mounting screws and unplugging the ribbon cable from the electronic module.
3. Unscrew the two captive screws, one on each side of the electronic module.
4. Pull the electronic module out of the housing far enough to be able to disconnect the brown and yellow sensor wires from the electronic module (if standard temperature range) or the preamplifier (if extended temperature range). To access the preamplifier, remove the sheet metal cover,
5. Remove the mechanical connector bolts and lift off the electrical housing, mechanical connector, and sensor as a unit.
6. Slide the sensor assembly out of the mechanical connector.

**Sensor Assembly Installation**

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before proceeding, ensure that power is removed from the flowmeter.</td>
</tr>
</tbody>
</table>

1. If the flow dam has remained in the meter body, remove it before starting to re-assemble.
2. Slide the O-ring over the sensor lead and onto the neck of the sensor.
3. Place the flat gasket over the sensor in contact with serrated sealing surface. Center the gasket. Slide the flow dam into the groove of the sensor.
4. Feed sensor lead through hole in mechanical connector and gently pull sensor lead out of electrical housing until sensor is touching the mechanical connector.

---

**NOTE**
It may be helpful to use a straw as a tool to do this. Slide a straw over the sensor wires and feed the straw through the mechanical connector. Then remove the straw.

5. Insert the sensor with the connector into the flowmeter body and secure with four new connector bolts finger tight.

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do not use the connector bolts in the sensor replacement kit for 83F-xxxxxL flowmeters (dual measurement with isolation valves). Use four X0173TF bolts as shown in the parts list.</td>
</tr>
</tbody>
</table>
6. Tighten all connector bolts to 2.8 N•m (2 lb•ft) per the sequence shown in Figure 31.

**Figure 31. Connector Bolt Torquing Sequence**
7. Continue to tighten the bolts to 6.8 N•m (5 lb•ft) using the same sequence.

8. Continue to tighten the bolts in steps of 7 N•m (5 lb•ft) up to 34 N•m (25 lb•ft) using the same sequence.

9. Connect the brown and yellow sensor wires to the electronic module or preamplifier as applicable. Lightly tug on each sensor wire to assure that the wire is firmly clamped in the terminal block. Also check that it is clamped on the metal conductor and not on the insulation. Replace the preamplifier sheet metal cover (if applicable).

10. Back the two electronic module captive screws out of the module until the screws are captured by the plastic housing.

11. Turn the module to take up the slack in the wires. Locate the electronics module over the mounting holes and making sure that no wires are pinched under the plastic housing, tighten the captive mounting screws.

12. If the electronic module was equipped with a display, reinstall the display. Carefully fold the ribbon cable in the space between the display and the electronic module so that it is not pinched. The display molding should rest firmly against the module molding before tightening the screws.

13. Reinstall the electronic module compartment threaded cover.

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>In order to maintain agency certification of this product and to prove the integrity of the parts and workmanship in containing process pressure, a hydrostatic pressure test must be performed. The flowmeter must hold the pressure listed in Table 17 for one minute without leaking.</td>
</tr>
</tbody>
</table>

**Table 17. Maximum Test Pressure**

<table>
<thead>
<tr>
<th>Model</th>
<th>End Connection</th>
<th>Test Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>83F-A</td>
<td>ANSI Class 150</td>
<td>450 psi</td>
</tr>
<tr>
<td></td>
<td>PN 16</td>
<td>3.2 MPa</td>
</tr>
<tr>
<td>83F-A</td>
<td>ANSI Class 300</td>
<td>1125 psi</td>
</tr>
<tr>
<td></td>
<td>PN 40</td>
<td>6 MPa</td>
</tr>
<tr>
<td>83F-A</td>
<td>PN 64</td>
<td>9.6 MPa</td>
</tr>
<tr>
<td>83F-A</td>
<td>ANSI Class 600</td>
<td>2250 psi</td>
</tr>
<tr>
<td></td>
<td>PN 100</td>
<td>15 MPa</td>
</tr>
<tr>
<td>83W-A</td>
<td>All</td>
<td>15 MPa (2250 psi)</td>
</tr>
</tbody>
</table>

**Remotely Mounted Flowmeter**

See Figure 32.
Sensor Assembly Removal

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before proceeding, ensure that power is removed from the flowmeter.</td>
</tr>
</tbody>
</table>

1. Remove junction box cover
2. Disconnect the brown and yellow sensor wires from the terminal block on the preamplifier. Do not disconnect the interconnecting wiring to the remote electronics housing.
3. Remove mechanical connector bolts and lift off the junction box, mechanical connector and sensor as a unit.
4. Slide the sensor assembly out of the mechanical connector as shown in Figure 32.

Sensor Assembly Installation

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before proceeding, ensure that power is removed from the flowmeter.</td>
</tr>
</tbody>
</table>

1. If the flow dam has remained in the meter body, remove it before starting to reassemble.
2. Slide the O-ring over the sensor lead and onto the neck of the sensor.
3. Place the flat gasket over the sensor in contact with the serrated sealing surface. Center the gasket. Slide the flow dam into the groove on the sensor.
4. Carefully feed the sensor lead through the hole in the mechanical connector and gently pull the sensor lead out of the junction box until the sensor is touching the mechanical connector.

--- NOTE ---
It may be helpful to use a straw as a tool to do this. Slide a straw over the sensor wires and feed the straw through the mechanical connector. Then remove the straw.

5. Insert the sensor with the connector into the flowmeter body and secure with four new bolts finger tight.

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do not use the connector bolts in the sensor replacement kit for 83F-xxxxxL flowmeters (dual measurement with isolation valves). Use four X0173TF bolts as shown in the parts list.</td>
</tr>
</tbody>
</table>
6. Tighten all connector bolts to 2.8 N•m (2 lb•ft) per the sequence shown in Figure 31.

7. Continue to tighten the bolts to 6.8 N•m (5 lb•ft) using the same sequence.

8. Continue to tighten the bolts in steps of 7 N•m (5 lb•ft) up to 34 N•m (25 lb•ft) using the same sequence.

9. Connect the sensor wires to the brown and yellow sensor wires to the terminal block. Lightly tug on each sensor wire to assure that the wire is firmly clamped in the terminal block. Also check that it is clamped on the metal conductor and not on the insulation.

10. Replace junction box cover.

---

**WARNING**

It is important that the gasket be sealed uniformly to provide a good seal. The following steps will assure a uniform seal. Failure to follow these steps could result in personal injury due to gasket leakage.

---

**WARNING**

In order to maintain agency certification of this product and prove integrity of the parts and workmanship in containing process pressure, a hydrostatic pressure test must be performed. The flowmeter must hold the pressure listed in Table 17 for one minute without leaking.
Output Indicator

The output indicator is mounted on the field terminal block.
The analog, 4 to 20 mA, indicator plugs into the terminal board sockets (see Figure 34). No wiring is required. It is calibrated 0.1 to 0.5 volts dc. No field calibration is possible. The indicator is part number B0138YM.

The pulse indicator plugs into the terminal board sockets (see Figure 35). The black and white wires must also be connected as shown. Refer to the following pages for calibration procedure.

Figure 33. Output Indicator

Figure 34. Field Terminal Compartment and Indicator Connections - Analog Output
(No Wiring Required other than Plug-in Sockets)

Figure 35. Field Terminal Compartment and Indicator Connections - Pulse Output
Pulse Output Indicator Calibration

For approximate calibration check, adjust pipeline flow to 50%. Output meter should now read 50% of scale. If the output meter does not read 50% of scale, turn adjustment screw until correct reading is achieved. (See Figure 37.) If accurate calibration is required, the following procedure must be used.

1. Remove field terminal cover.
2. Unplug output meter and disconnect the output meter wiring.
3. Calculate the vortex shedding frequency (pps) at the upper range value (URV) of flow using the equations presented in “Determining the Upper Range Frequency (URF)” on page 85.
4. Verify that the proper pulse output meter is being used.
5. Hook up test equipment as shown in Figure 37.
6. Adjust frequency generator output to the correct URV in pps calculated in Step 3. The amplitude should be 5 to 10 V dc.
7. Frequency generator output on oscilloscope should look like Figure 36.

Table 18. Pulse Output Meters

<table>
<thead>
<tr>
<th>Pulse Output Meter</th>
<th>Part Number</th>
<th>Range - pps</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B0135PA</td>
<td>25 to 100</td>
</tr>
<tr>
<td></td>
<td>B0135PB</td>
<td>90 to 400</td>
</tr>
<tr>
<td></td>
<td>B0135PC</td>
<td>360 to 1600</td>
</tr>
<tr>
<td></td>
<td>B0135PD</td>
<td>1440 to 5000</td>
</tr>
</tbody>
</table>

8. Pulse output meter should read 100% of scale. If not, turn adjustment screw (see Figure 37) until 100% reading is indicated.
9. Disconnect test equipment.
10. Connect output meter wiring (see Figure 35), plug in output meter and replace field terminal cover.
Figure 37. Test Equipment Hook-up

- Pulse Output Indicator (Rear View)
- Plug-in Pins
- Adjustment Screw

- Power Supply: 14-30 V DC
- Oscilloscope
- Frequency Generator: 10 - 4000 Hz, 5 - 10 V dc, H-P 3310A or Equal
Appendix A. Determining the Corrected K-Factor

The correct K-factor to be used in a given application differs, in general, from the K-factor determined under calibration (reference) conditions. This is a result of process temperature and piping influences. The procedure for determining the Corrected K-Factor is described in this appendix.

Before proceeding, it is important to understand the difference in the three K-factors referred to in this MI. They are defined as follows:

♦ **Nominal K-Factor** — This is the median Reference K-Factor for all meters of a given line size. It should not be used in calibrating the 4 to 20mA output. The value of the Nominal K-Factor may differ from the Reference K-Factor for a given meter by as much as ±5%.

♦ **Reference K-Factor** — This is the K-factor determined by flow calibration for a specific vortex flowmeter, and the one to be used in this appendix for determining the Corrected K-Factor. The Reference K-Factor can be found on the flowmeter data plate.

♦ **Corrected K-Factor** — This is the K-factor used in Appendix B to determine the upper range frequency needed to calibrate the 4 to 20mA output. It includes process temperature and piping influences.

---

**NOTE**

The Corrected K-Factor computed in this appendix is used in Appendix B for determining the calibration frequency at the upper range flow rate. The total bias correction factor used to compute the Corrected K-Factor may also be applied directly to the flow rate or flow total to correct for process temperature and piping effects, if this correction has not been included in determining the calibration frequency at the upper range flow rate.
Process Temperature Correction Factor (TFC)

The K-factor of a vortex flowmeter is affected by dimensional changes arising from thermal expansion. The correction factor for this effect (TFC) is:

\[
TFC = 1 - 3 \times \alpha \times (T - T_0)
\]

where, for

<table>
<thead>
<tr>
<th>US Customary Units</th>
<th>SI Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha = 9.59 \times 10^{-6} , ^\circ F^{-1} )</td>
<td>( \alpha = 1.73 \times 10^{-5} , ^\circ C^{-1} )</td>
</tr>
<tr>
<td>( \alpha = 7.02 \times 10^{-6} , ^\circ F^{-1} )</td>
<td>( \alpha = 1.26 \times 10^{-5} , ^\circ C^{-1} )</td>
</tr>
</tbody>
</table>

\( T = \) Process Temp. (°F)  
\( T_0 = 70 \, ^\circ F \)

Example:

For a 316 stainless steel flowtube at a process temperature of 300°F

\[
TFC = 1 - 3 \times 9.59 \times 10^{-6} \times (300 - 70) = 0.993
\]

Mating Pipe Correction Factor (MCF)

Table 19 shows the K-factor offset caused by the use of pipe other than the Schedule 40 pipe used at the factory to determine the Reference K-Factor. For example, the K-factor of an 4-inch flowmeter installed in Schedule 10 pipe has an offset of +0.5%. Therefore, the K-factor value specified on the flowmeter data plate needs to be increased by 0.5%. The mating pipe correction factor (MFC) equals one plus the percent offset divided by 100.

\[
MFC = 1 + (+0.5)/100 = 1.005
\]

<table>
<thead>
<tr>
<th>Size</th>
<th>Schedule 10</th>
<th>Schedule 80</th>
<th>DIN Ser. 1 PN 40</th>
<th>DIN Ser. 1 PN 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>Inch</td>
<td>Wafer</td>
<td>Flange</td>
<td>Wafer</td>
</tr>
<tr>
<td>15</td>
<td>0.75</td>
<td>1.2%</td>
<td>1.0%</td>
<td>-0.8%</td>
</tr>
<tr>
<td>25</td>
<td>1</td>
<td>1.0%</td>
<td>0.8%</td>
<td>-0.5%</td>
</tr>
<tr>
<td>40</td>
<td>1.5</td>
<td>0.7%</td>
<td>0.5%</td>
<td>-0.3%</td>
</tr>
<tr>
<td>50</td>
<td>2</td>
<td>0.6%</td>
<td>0.4%</td>
<td>-0.4%</td>
</tr>
<tr>
<td>80</td>
<td>3</td>
<td>0.5%</td>
<td>0.5%</td>
<td>-0.4%</td>
</tr>
<tr>
<td>100</td>
<td>4</td>
<td>0.5%</td>
<td>0.5%</td>
<td>-0.7%</td>
</tr>
<tr>
<td>150</td>
<td>6</td>
<td>0.4%</td>
<td>0.3%</td>
<td>-0.4%</td>
</tr>
<tr>
<td>200</td>
<td>8</td>
<td>0.4%</td>
<td>0.3%</td>
<td>-0.4%</td>
</tr>
<tr>
<td>250</td>
<td>10</td>
<td>-</td>
<td>0.3%</td>
<td>-</td>
</tr>
<tr>
<td>300</td>
<td>12</td>
<td>-</td>
<td>0.3%</td>
<td>-</td>
</tr>
</tbody>
</table>
Upstream Piping Disturbance Correction Factor (UCF)

The flowmeter should be installed in straight unobstructed pipe to ensure that it will perform to its full capabilities. The information in Figures 38 through 42 shows the offset that can be expected by introducing various upstream disturbances.

Referring to Figure 38, for example, if a liquid installation requires one 90° elbow upstream of the flowmeter and the vortex shedder is parallel to the elbow plane, it is recommended that the elbow be placed at least 30 pipe diameters from the flowmeter, thus negating the effect of the elbow, and providing 0% change in the K-factor. If it is possible to allow only 20 pipe diameters of straight pipe, the K-factor offset can be derived from Figure 38 as follows:

Draw a vertical line at 20 pipe diameters in Figure 38. The point at which it crosses the curve indicates a K-factor offset of approximately +0.7% from the Reference K-Factor on the flowmeter data plate. Therefore, the Reference K-Factor needs to be increased by +0.7% to account for the elbow disturbance. The upstream piping disturbance correction factor (UCF) equals one plus the percent offset divided by 100.

UCF = 1 + (+0.7)/100 = 1.007

NOTE
1. The graphs shown in Figures 38 through 42 are a result of laboratory tests conducted using water as the process fluid, and using elbows and reducers at varying distances upstream of the flowmeter. The results are also applicable to gas and steam flow.
2. The distance axis of the graphs shown in Figures 38 through 42 apply specifically to wafer type vortex flowmeters. For flange meters, add 1-1/2 Pipe Diameters to the measured distance between flanges.

Figure 38. K-Factor Change vs. Distance from Elbow - Single Elbow with Shedder Parallel to Elbow Plane
Figure 39. K-Factor Change vs. Distance from Elbow - Single Elbow with Shedder Perpendicular to Elbow Plane

Figure 40. K-Factor Change vs. Distance from Elbow - Two Elbows with Shedder Parallel to Plane of Closest Elbow

Figure 41. K-Factor Change vs. Distance from Elbow - Two Elbows with Shedder Perpendicular to Plane of Closest Elbow
Total Bias Correction Factor (BCF)

The total bias correction factor (BCF) equals the product of the individual correction factors.

\[ \text{BCF} = \text{TCF} \times \text{MCF} \times \text{UCF} \]

Example: Using the individual examples above,

\[ \text{BCF} = 0.993 \times 1.005 \times 1.007 = 1.005 \]

Determination of Corrected K-Factor

The Corrected K-Factor is calculated by multiplying the Reference K-Factor by the Total Bias Correction Factor:

Corrected K-Factor = BCF \times \text{Reference K-Factor}
Appendix B. Determining the Upper Range Frequency (URF)

The upper range frequency (URF) is the frequency of vortex shedding at the upper range value (URV). The URF is the frequency that must be input to the transmitter to calibrate the 4 to 20mA output, so that 20mA corresponds to the URV. The URF may be calculated with the aid of FlowExpertPro, a meter sizing/selection software program (see “Electronic Module 4 to 20 mA Calibration” on page 60), or by following the procedure outlined below.

Calculation of Upper Range Frequency

The equation used to calculate the URF depends on the type of measurement units desired:

**Volume Flow at Flowing Conditions**

(1) \[ \text{URF} = \text{CRF} \times \text{CF} \times \frac{\text{URV}}{\text{Time}} \]

**Volume Flow at Base Conditions**

(2) \[ \text{URF} = \text{CRF} \times \text{CF} \times \frac{\text{URV}}{\text{Time}} \times \frac{\rho_b}{\rho_f} \]

**Mass Flow**

(3) \[ \text{URF} = \text{CRF} \times \text{CF} \times \frac{\text{URV}}{\text{Time}} \times \frac{1}{\rho_f} \]

where,

- URF = Vortex frequency corresponding to upper range flowrate (URV)
- CKF = Corrected K-factor in pulses/ft³ or pulses/l, from Appendix A
- Time = If flow rate is per second, Time = 1
  - If flow rate is per minute, Time = 60
  - If flow rate is per hour, Time = 3600
  - If flow rate is per day, Time = 86400
- CF = Conversion factor that converts CKF to actual volume or mass flowrate units (see Table 20)
- URV = Upper range value in desired flowrate units
- \( \rho_b \) = Base density in lbs/ft³ or kg/m³
- \( \rho_f \) = Flowing density in lbs/ft³ or kg/m³
Calculation of Gas Density

To find the gas density at base or flowing conditions, use one of the following equations:

When using SI units,

\[ \rho = \frac{3.48 \times G \times P_{\text{abs}}}{Z \times T_{\text{abs}}} \]

When using U.S. Customary units,

\[ \rho = \frac{2.70 \times G \times P_{\text{abs}}}{Z \times T_{\text{abs}}} \]

where

- \( r \) = Gas density at base or flowing conditions in lbs/ft\(^3\) or kg/m\(^3\), as applicable.
- \( G \) = Specific gravity of gas.
- \( P_{\text{abs}} \) = Absolute pressure at base or flowing conditions in psi or kPa, as applicable.
- \( T_{\text{abs}} \) = Absolute temperature at base or flowing conditions in R or K units, as applicable.
- \( Z \) = Gas compressibility factor at base or flowing conditions, as applicable.

Table 20. Conversion Factors (CF)

<table>
<thead>
<tr>
<th>To Convert (RF)</th>
<th>Multiply By (CF)</th>
<th>To Obtain (pulses per)</th>
</tr>
</thead>
<tbody>
<tr>
<td>p/L</td>
<td>1.0</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>3.7854</td>
<td>U.S. gal</td>
</tr>
<tr>
<td></td>
<td>4.546</td>
<td>IMP gal</td>
</tr>
<tr>
<td></td>
<td>28.32</td>
<td>ft(^3)</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>m(^3)</td>
</tr>
<tr>
<td></td>
<td>119.2</td>
<td>bbl (31.5 gal)</td>
</tr>
<tr>
<td></td>
<td>159.0</td>
<td>bbl (42.0 gal)</td>
</tr>
<tr>
<td>p/U.S. ft(^3)</td>
<td>0.13368</td>
<td>U.S. gal</td>
</tr>
<tr>
<td></td>
<td>0.16054</td>
<td>IMP gal</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>ft(^3)</td>
</tr>
<tr>
<td></td>
<td>35.32</td>
<td>m(^3)</td>
</tr>
<tr>
<td></td>
<td>0.03532</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>4.211</td>
<td>bbl (31.5 gal)</td>
</tr>
<tr>
<td></td>
<td>5.615</td>
<td>bbl (42.0 gal)</td>
</tr>
</tbody>
</table>
Examples of Upper Range Frequency Determination

The examples that follow show how to calculate the upper range frequency (URF) for liquid, gas, and steam applications.

--- NOTE ---

The minimum possible URF is 12.5 Hz for a 20 mA output. The maximum possible URF is 3000 Hz.

---

Liquid Example

Given:

- 80 mm (3 in) wafer Hastelloy C flowmeter
- Reference K-Factor = 80.8 pulses/ft³ (from the data plate)
- Upper Range Value = 300 Usgpm
- Flowing Temperature = 90°F
- 40 pipe diameters of straight pipe upstream of meter
- Schedule 80 piping

The Corrected K-Factor is, from Appendix A,

\[
\text{CKF} = \text{TCF} \times \text{MCF} \times \text{UCF} \times \text{RKF}
\]

\[
\begin{align*}
\text{TCF} &= 1 - 3 \times 7.02 \times 10^{-6} \times (90 - 70) = 1.000 \\
\text{MCF} &= 1 + (0.4)/100 = 0.996 \\
\text{UCF} &= 1 \\
\text{CKF} &= 1.000 \times 0.996 \times 1 \times 80.8 = 80.5 \text{ pulses/ft}^3
\end{align*}
\]

Since the desired flowrate is volume at flowing conditions (Usgpm), the URF is calculated using equation (1),

\[
\text{URF} = \text{CRF} \times \text{CF} \times \frac{\text{URV}}{\text{Time}}
\]

Also, since the flowrate is in Usgpm, CF = 0.13368 (from Table 20) and Time = 60 (# of seconds per minute).

Hence,

\[
\text{URF} = 80.5 \times 0.13368 \times \frac{300}{60} = 53.8 \text{ Hz}
\]
Gas Example (Air)

Given:
- 100 mm (4 in) flanged 316SS flowmeter
- Reference K-Factor = 34.6 pulses/ft³ (from the data plate)
- Upper Range Value = 300,000 SCFH
- Flowing Temperature = 100°F (560°R); Base Temperature = 59°F (519°R)
- Flowing Pressure = 65 psia
- S.G. = 1.0 for air
- Z = 1.0
- Single elbow in a plane perpendicular to the shedder, 20 pipe diameters upstream of meter
- Schedule 40 piping

The Corrected K-Factor is, from Appendix A

\[
CKF = TCF \times MCF \times UCF \times RKF
\]

TCF = 1 - 3 \times 9.59 \times 10^{-6} \times (100 - 70) = 0.999
MCF = 1
UCF = 1 + (+0.7)/100 = 1.007
CKF = 0.999 \times 1 \times 1.007 \times 34.6 = 34.8 \text{ pulses/ft}^3

Since the desired flowrate is volume at base conditions (SCFH), the URF is calculated using equation (2),

\[
URF = CRF \times CF \times \frac{URV}{\text{Time}} \times \frac{\rho_b}{\rho_f}
\]

Also, since the flowrate is in SCFH, CF = 1 (from Table 20) and Time = 3600 (# of seconds per hour).

The Flowing and Base Densities are calculated using Equation (5),

\[
\rho_f = \frac{2.70 \times G \times P_{\text{abs},f}}{Z \times T_{\text{abs},f}} = \frac{2.70 \times 1.0 \times 65}{1.0 \times 560} = 0.313 \text{ lbs/ft}^3
\]

\[
\rho_d = \frac{2.70 \times G \times P_{\text{abs},d}}{Z \times T_{\text{abs},d}} = \frac{2.70 \times 1.0 \times 14.7}{1.0 \times 519} = 0.0765 \text{ lbs/ft}^3
\]
Hence,

\[
URF = 34.8 \times 1 \times \frac{300000}{3600} \times \frac{0.0765}{0.3134} = 707.9 \text{ Hz}
\]

**Steam Example (Saturated)**

**Given:**
- 50 mm (2 in) wafer 316 SS flowmeter
- Reference K-Factor = 262.2 pulses/ft³ (from the data plate)
- Upper Range Value = 5000 lb/hr
- Flowing Temperature = 445°F
- Flowing Pressure = 400 pisa
- Close coupled double elbow with shedder parallel to plane of closest elbow, 10 pipe diameters upstream of meter
- Schedule 80 piping

The Corrected K-Factor is, from Appendix A,

\[
CKF = TCF \times MCF \times UCF \times RKF
\]

\[
TCF = 1 - 3 \times 9.59 \times 10^{-6} \times (445 - 70) = 0.989
\]

\[
MCF = 1 + (-0.4)/100 = 0.996
\]

\[
UCF = 1 + (+1.0)/100 = 1.010
\]

CKF = 0.989 \times 0.996 \times 1.010 \times 262.2 = 260.9 \text{ pulses/ft}^3

Since the desired flowrate is mass flow (lbs/hr), the URF is calculated using equation (3),

\[
URF = CRF \times CF \times \frac{URV}{Time} \times \frac{1}{\rho_f}
\]

Also, since the URV/\(\rho_f\) is in ft³/hr, CF = 1.0 (from Table 20) and Time = 3600 (# of seconds per hour).

From Steam Tables \(\rho_f = 0.8614 \text{ lbs/ft}^3\).

Hence,

\[
URF = 260.9 \times 1.0 \times \frac{5000}{3600} \times \frac{1}{0.8614} = 420.7 \text{ Hz}
\]
Appendix C. Isolation Valves

Isolation valving is available in single and dual measurement versions for standard and extended temperature range sensors. The following procedures apply to all versions. The following procedure applies to all versions. Replacing the sensor in this type of unit is essentially the same as replacing a sensor in units without isolation valving. However, particular care must be taken since the process does not need to be shut down.

⚠️ WARNING

The isolation valve must be in the closed position prior to loosening the mechanical connector bolts. The small sensor cavity above the isolation valve must be gradually depressurized. Once this space has been fully vented, the sensor can be removed. If the process fluid does not stop venting within a few seconds, retighten the mechanical connector bolts to reseal the connection as the ball/seat assembly may be damaged. The isolation valve should be replaced in this instance. Failure to close the isolation valve before sensor removal could result in personal injury. Follow site safety and lockout instructions applicable to the particular process fluid.

Replacing the Sensor

- **NOTE**

Before beginning this procedure, verify that you have the correct kit of parts. Kit part numbers may be found in PL 008-708 (for 83F) or PL 008-709 (for 83W).

1. Remove any insulation that may be covering the isolation valve and allow the isolation valve temperature to stabilize, if applicable.

2. Close the isolation valve. A torque wrench is required to operate the isolation valve. Turn clockwise one quarter turn to close. Part No. K0147UA is available for a 3/8-inch square drive wrench and Part No. K0147UB for a 1/2-inch square drive wrench. Do not exceed 13 lb-ft operating torque to open or close the isolation valve because higher torque may result in internal valve damage and cause a false indication of valve closure. The right angle valve position indicator attached to the stem is **not** a valve handle.

- **CAUTION**

Operating torque higher than 13 lb-ft could indicate that the isolation valve is jammed or fouled or that the sensor bolts have been over-torqued, in which case the ball may be damaged by the stem. See Figure 44.

3. Replace the sensor. See “Sensor Replacement” on page 70.

- **WARNING**

Do not loosen the bottom bolts which hold the isolation valve to the flowtube.

4. Open the isolation valve by turning it counterclockwise. Use care and check for leaks. Reinsulate, if applicable.

5. Resume operation. There should be no need to recalibrate the electronic module.
Replacing an Isolation Valve

NOTE
Isolation valves are not field serviceable. The flowmeter does not need to be removed from the pipeline to replace an isolation valve. However, the pipeline must be shut down and emptied before you loosen the mounting bolts.

1. Follow normal lockout procedures.
2. Disconnect power from the flowmeter.
3. Remove and discard the four connector bolts and lift off the electronic housing, mechanical connector, and sensor as a unit.
4. Remove and discard the old gasket, O-ring, and flow dam from the sensor.
5. Remove the four bolts which attach the isolation valve to the flowtube. Remove the isolation valve from the flowtube. Inspect and clean out the cavity into which the isolation valve is mounted. The gasket surfaces should be flat free from gouges.
6. Install a new gasket and flow dam on the isolation valve (see Table 21), and assemble the isolation valve to the flowtube. Reinstall the four bolts finger tight.

Table 21. Isolation Valve Replacement Parts

<table>
<thead>
<tr>
<th>Sensor Range Type</th>
<th>Flow Dam</th>
<th>Gasket</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Temperature</td>
<td>L0122KT</td>
<td>L0121DT</td>
</tr>
<tr>
<td>Extended Temperature (ss)</td>
<td>K0146HK</td>
<td>K0146HL</td>
</tr>
<tr>
<td>Extended Temperature (Hast)</td>
<td>K0146PU</td>
<td>K0146PT</td>
</tr>
</tbody>
</table>

WARNING
It is important that the gasket be sealed uniformly to provide a good seal. The following steps will assure a uniform seal. Failure to follow these steps could result in personal injury due to gasket leakage.

7. Tighten the bolts to 2.8 N•m (2 lb•ft) per the sequence shown in Figure 43.

Figure 43. Connector Bolt Torquing Sequence

8. Continue to tighten the bolts to 6.8 N•m (5 lb•ft) using the same sequence.
9. Continue to tighten the bolts in steps of 7 N•m (5 lb•ft) up to 34 N•m (25 lb•ft) using the same sequence.
10. Using the correct materials for the temperature range of the sensor being used, install a new gasket, O-ring, and flow dam on the sensor. Hold the sensor, mechanical connector, and housing together and carefully insert the sensor into the top of the isolation valve body. See Figures 44 and 45.

11. Install four new connector bolts on the top flange and tighten, using the procedure used in Steps 7 through 9.

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>In order to maintain agency certification of this product and to prove the integrity of the parts and workmanship in containing process pressure, a hydrostatic pressure test must be performed. Perform the test with the isolation valve in the open position. The flowmeter must hold the pressure listed in Table 17 on page 73 for 1 minute without leaking.</td>
</tr>
</tbody>
</table>

12. Verify that the isolation valve is in the **OPEN** position. If it is **CLOSED**, open the isolation valve in a counterclockwise direction. Use care and check for leaks.

13. Resume operation. There is no need to recalibrate the electronic module.

### Installing an Isolation Valve

Model 83 vortex flowmeters may be retrofitted with isolation valves. Isolation valves are available for either single or dual measurement.

When retrofiting a four-inch or larger vortex flowmeter with an isolation valve, a new mechanical connector is required (two if it is a dual measurement meter). The original factory installed mechanical connector on flowmeters four inch and larger will not fit into an isolation valve. A new mechanical connector is required.

---

**NOTE**

The flowmeter does not need to be removed from the pipeline to retrofit an isolation valve. However, the pipeline must be shut down and emptied before loosening the mechanical connector mounting bolts.

1. Follow normal lockout procedures.
2. Disconnect power from the flowmeter.
3. Remove and discard the four connector bolts and lift off the electronic housing, mechanical connector and sensor as a unit.
4. Remove and discard the old gasket, O-ring, and flow dam from the sensor.
5. Inspect and clean out the cavity into which the isolation valve is to be mounted. The gasket surface should be flat free from gouges.
6. Install a new gasket and flow dam on the isolation valve (see Table 21) and assemble it to the flowtube. Reinstall the four bolts finger tight.
7. Tighten the bolts to 2.8 N•m (2 lb•ft) per the sequence shown in Figure 43.

8. Continue to tighten the bolts to 6.8 N•m (5 lb•ft) using the same sequence.

9. Continue to tighten the bolts in steps of 7 N•m (5 lb•ft) up to 34 N•m (25 lb•ft) using the same sequence.

10. Using the correct materials for the temperature range of the sensor being used, install a new gasket, O-ring, and flow dam on the sensor. Hold the sensor, mechanical connector, and housing together and carefully insert the sensor into the top of the isolation valve body. See Figures 44 and 45.

11. Install four new connector bolts on the top flange and tighten, using the procedure used in Steps 7 through 9.

12. Verify that the isolation valve is in the OPEN position. If it is CLOSED, open the isolation valve in a counterclockwise direction. Use care and check for leaks.

13. Resume operation. There is no need to recalibrate the electronic module.
Figure 44. Single Measurement Isolation Valve
Figure 45. Dual Measurement Isolation Valve