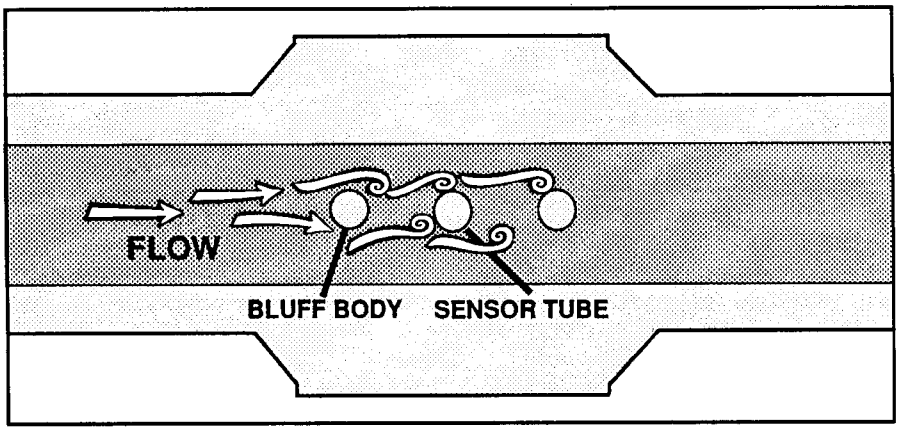
INSTALLATION AND MAINTENANCE INSTRUCTIONS FOR FV-600 SERIES VORTEX FLOW TRANSMITTERS

DESCRIPTION

This vortex-shedding flow meter is a general-purpose electronic liquid flow meter. It provides 4-20 mA dc linear (true two-wire) output. High accuracy is assured by individual flow testing. Since it uses no moving parts, maintenance is minimized. The flow meter consists of an all-plastic tube with an integrally mounted electronic transmitter module. Wetted material is PVC. CPVC is available on special request.



SPECIFICATIONS

Max. Pressure		Temperature PVC		Temperature CPVC	
psi	(kPa)	F°	(C)	F°	(C)
150	(1034)	70	(21)	70	(21)
100	(689)	100	(38)	150	(66)
50	(345)	140	(60)	200*	(93)*

**max. ambient temp. of 160° F (70° C)*

Minimum Temp.: -20° F (-29° C)
Turndown Ratio: 12:1 (except 1/4-in; 8:1 and 1/2-in. [model FV-605]; 10:1)
Accuracy: 1% of maximum scale
Repeatability: 0.25% of actual flow
Output signal: 4-20 mA
Power Supply Required: 13-30 Vdc
Maximum Overrange: 125% for 1/2 hour
Response time: 1.5 sec., first order: a 7.5-sec.delay until true flow rate is indicated.

Line Fluids

Use any liquid compatible with the plastic material of construction that does not contain significant amounts of fibers or abrasive material that will cause significant erosion. Do not use with: explosive or flammable materials, food or beverages, or air or gas.

Unit is calibrated for 32 SSU (1 CST) viscosity liquid. No adjustments are required for specific gravities up to 2.0. Liquids with higher specific gravities will adversely affect the permissible amount and duration of overrange flow.

Atmosphere: Non-explosive, non-flammable.

Piping Requirements

A straight pipe-run upstream of the meter equal to 20 pipe diameters (PD) after one plane change (an elbow), or 27 PD after two plane changes. A straight run downstream of 5 PD to a plane change, or 10 PD to a valve. Maximum PVC pipe thickness is schedule 80.

Pulsating flow will affect accuracy (pressure pulses will not).

HOW IT WORKS

As fluid moves across the bluff body, vorticies are released alternately from one side and the other. The frequency is proportional to the velocity of the flow. The movement of the vorticies across the sensing tube causes it to vibrate. Inside the tube is a piezoelectric element which creates a small voltage output when flexed. This output is amplified and converted to a 4-20 mA output. The signal can be transmitted to any device accepting this standard output.

INSTALLATION

This meter will provide years of accurate service if good flow meter installation practices are followed. The flow tube should be installed where pipe vibration is minimal.

Observe the upstream piping requirements listed under "Specifications". Upstream valves should not **be used to control flow rate. They should always be kept fully open.** Good quality ball valves with integral unions may be connected directly to the flow tube if the valves are fully open during operation. This allows easy isolation and removal of the flow tube, should maintenance be required. Cavitation and flow rate pulsation will adversely affect flow meter performance.

Diaphragm or piston pumps may not be used.

Do not use Teflon tape or any kind of pipe dope when piping.

If flanges are used, do not allow gaskets to protrude into the flow stream.

The simple appearance of the flow meter may tempt an installer to handle it as an ordinary nipple. **Remember, it is a precision electronic instrument.** Treat it with care.

Do not use excessive force.

Always use two wrenches when turning the flow tube into a fitting, one across the flats on the flow tube end, close to the fitting, and one on the fitting.

Do not use tools inside the flow tube, as this may damage the vortex sensor, and invalidate the warranty.

The flow tube may be mounted in any orientation. Three holes, tapped .250-20 UNC-2B, .375-inch deep, on .75-inch centers are provided on the 3/4-inch and smaller flow meters. These holes may be used (at the users discretion) to provide support for the flow meter should pipe supports not be practical.

WIRING

Connect a twisted wire pair (not provided) to the terminals marked + and -. **If the twisted wire pair is shielded, do not connect the shield to the transmitter. The shield should be grounded at the receiver only.** (See Fig.1) (The transmitter will automatically correct reversed polarity loop wires.)

The twisted wire pair should be connected to receiving equipment. Twisted wire pair length of up to 1,000 feet is generally acceptable, and lengths up to 10,000 feet are often usable if the twisted pair wire is kept dry, and distant from electrical noise sources. The receiving equipment must accept industry standard "true two wire" or "loop power" 4-20 mA process transmitter inputs. This means that the receiving equipment, such as a recorder or controller, must supply power for the transmitter, along the twisted wire pair. If the receiving equipment does not provide power, a separate power supply, typically 24 Vdc at 30 mA dc, must be used as shown in Fig. 1. Many brands of receivers provide 24 Vdc for this purpose.

Several receivers may be connected in a series as shown in Fig. 1, but only one should provide power, and all should have isolated inputs. If the receiver requires 1-5 Vdc, connect a 250.0 ohm .1% 1/2-watt precision resistor across its input. A 1-5 Vdc receiver never provides power for the transmitter. The voltage provided by the receiver must be within the limits shown in Fig. 2. To use the figure, first add up the resistance of all the receivers, indicators, etc., and the wire in the loop. If the wire resistance is unknown, use a value of 50 ohm for twisted wire pair 1,000 feet long or less and #22 AWG or heavier. If a 1-5 Vdc receiver is used with a 250.0 ohm resistor, its resistance is 250 ohm. One and only one point of the 4-20 mA loop should be grounded. Some receiving equipment inputs are grounded by their manufacturers. This is sufficient. Always follow the receiver manufacturer's recommendations for "loop powered" or "true two-wire" process transmitters. Always follow local electrical codes.

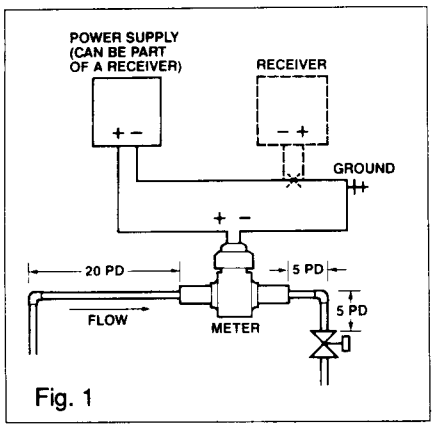


Fig. 1

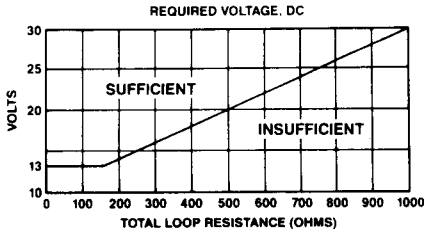
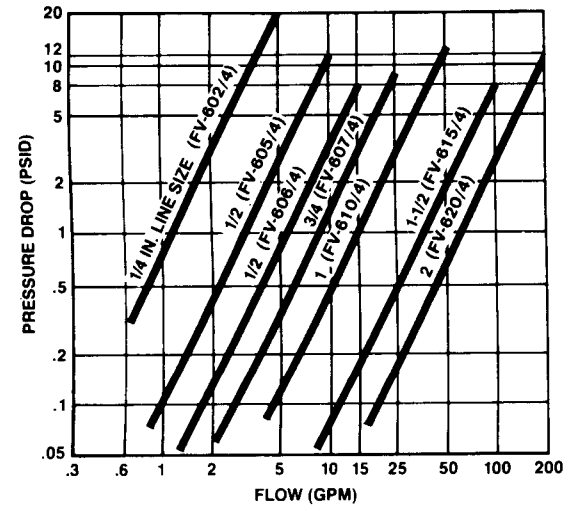
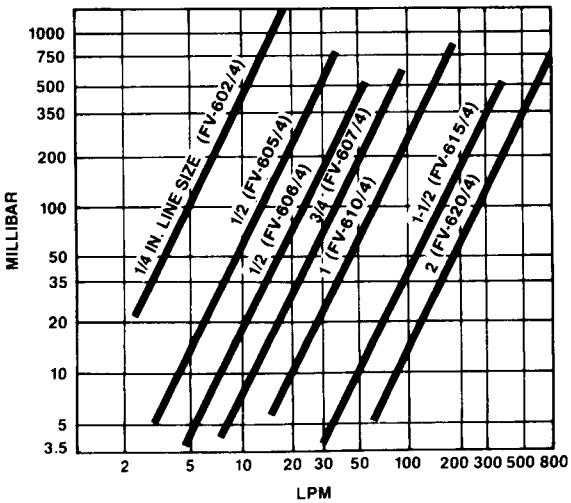


Fig. 2





flow meter (the flow meter is made of non-conductive plastic) and connect them both to the one point where the loop is grounded (see wiring diagram). If plastic piping is used, clamp a 6-inch long piece of sheet metal or foil to the pipe on both sides of the flow meter and connect them both to the one point where the loop is grounded (see wire diagram). The transmitter module contains a highly effective active filter that will reject false signals due to high common mode voltage. This filter is most effective under flowing conditions. If a false indication of flow is encountered at zero flow, it will probably not cause error under flowing conditions. In addition, the noise adjustment may be used, but it will reduce the ability of the flow meter to measure low flow rates. See the noise adjustment instructions before attempting to make this adjustment.

Over-stressed sensor. If the maximum permitted flow rate of 125% of rated capacity is exceeded, it is possible to over-stress the sensor. See "Checking the Vortex Signal" under the "Zero flow indication" in the symptom section.

CHECKING FOR PROPER VORTEX SHEDDING - The strength of the vortex shedding may be checked by following the instructions under "Checking the Vortex Signal" under "Zero flow indication" in the symptom section. The vortex-shedding phenomenon is a very strong and reliable one. If the proper flow conditions and pump requirements listed in the specifications section are met, and the flow meter has not been damaged, proper vortex shedding will occur. There are conditions, such as build-up of debris within the flow meter, that will cause the proper strength vortex-shedding to occur, but the quality of the shedding will cause erratic operation. This is best checked by inspecting the interior of the flow meter as previously described. If this is not possible, the vortex quality may be examined with an oscilloscope, preferably with storage capability.

Disconnect the transmitter module and insert a cable adapter (a three-pin male header type connector with .025 inch square pins on .100 inch centers) into the cable connector. If the adapter is not available, use a three-position male header type connector with .025-inch square pins on.100-inch centers. Use a "10X" probe if available. Connect the oscilloscope probe center to the center pin, and the probe ground to one of the two outer pins. Adjust the oscilloscope according to its manufacturer's instructions to obtain the most visible signal. If only 60 Hz ac noise is viewed, move the probe ground to the other of the two outer pins, as only one of the two outer pins is used. At the lowest rated flow rate, a signal of about .2 volts peak-to-peak should be measured. If a 1X probe is used, this voltage will be reduced at low flow rates. At one-half rated capacity a signal of approximately 5 volts peak-to-peak should be measured. At full-rated capacity a signal of approximately 20 volts peak-to-peak should be measured.

The signal waveshape is of importance. The signal should be sinusoidal. Small amounts of higher frequency signal may be present (800 to 1800 Hz). This is due to sensor resonance, and is normal. A peak-to-peak amplitude (similar to AM modulation) variation of up to 30% is normal.

A small variation of wave period (similar to FM modulation) is also normal. Severe amplitude variation or significant break-up of small groups of waves is indicative of improper vortex shedding. Even though the transmitter module may be missing vortex pulses the flow indication will usually be higher than it should be, because poor vortex shedding caused by debris or bluff body erosion will usually cause the vortex shedding to increase frequency. If poor vortex shedding is encountered, the flow meter should be removed for inspection of it and the upstream piping for debris, erosion, or improper piping.

NOISE ADJUSTMENT - The noise adjustment has been set at the factory and normally should not be readjusted for the life of the flow meter. The only times it should be readjusted are: 1) if the transmitter module has been replaced, or 2) if severe electrical noise or pipe vibration is encountered..

The noise adjustment sets the minimum pulse amplitude that the transmitter module will recognize as a vortex pulse. Turning the noise adjustment counter-clockwise makes the transmitter module more sensitive. This allows measuring lower flow rates, but may cause false flow indication due to electrical noise and pipe vibration. Turning the noise adjustment clockwise makes the transmitter module less sensitive. This will hinder measuring low flow rates but reduces false flow indication due to electrical noise or pipe vibration. Before making a noise adjustment, mark the initial position for later reference.

BACK PRESSURE

Back pressure (the pressure immediately downstream of the meter) must be maintained above a minimum level in order to avoid cavitation. For 100ºF (122ºC) water in a 1/2-in. meter, where the maximum pressure drop is 8 psi, 7.8 psig back pressure is sufficient. For other liquids, use the following formula to calculate the minimum back pressure.

$BP = 2.75\,\Delta P + 1.25\,PV - 14.7$ where

ΔP=pressure drop in psi at max flow

PV=Vapor pressure in psia of the liquid at operating temp eg. the PV of water at 100ºF is .42.

BP=back pressure (downstream of meter) in psig.

MAINTENANCE

This flow meter requires no maintenance in normal service if properly installed.

If the flow tube should become clogged with debris, it will be necessary to remove the flow tube from service for cleaning. Significant clogging will often result in high (up to 20%) and/or erratic output. Do not stick tools into the tube, as this may permanently damage the vortex sensor. The vortex sensor can not be repaired. To clean the flow tube, run hot (up to 160° F) soapy water into the downstream end of the flow tube. Large objects jammed against the bluff body may be dislodged by lightly tapping the upstream end of the flow tube against a firm surface. Do not tap the flow tube so hard that the threads become damaged.

TROUBLESHOOTING

If difficulty is encountered locate the symptom most like that encountered and follow the appropriate instructions.

SYMPTOM - *Zero mA in loop.*

Place a dc voltmeter across the two terminal block screws. There must be at least 10 Vdc present. If there is less than 10 Vdc, but more than 0 Vdc, check the power source for sufficient voltage to drive the loop, as shown in Fig. 2.

If there is 0 Vdc present check for a broken wire or connector in the loop. Check the power source for sufficient voltage.

SYMPTOM - *No flow indication (4 mA in loop).*

Check that the flow is greater than the minimum specified for the particular line size flow meter in use. If the flow rate is too low, replace the flow meter with the proper size flow meter. Under some conditions it may be possible to extend the low flow limit to slightly lower flow rates. (See Noise adjustment instructions.) If the flow rate is proper, check for the presence of at least 10 Vdc across the two terminal block screws. Check the position of the "N" noise adjustment. If the nub is not at approximately the 6 o'clock position see the noise adjustment instructions. If the adjustment appears to be proper, partially remove the transmitter module. Be sure to wear safety glasses when removing the retaining ring that holds the transmitter module. Check that the small cable that connects the transmitter module to the flow tube is positively connected. If it is disconnected, align the connector with the three pins in the transmitter module recess and insert the connector until it bottoms. If the connector is properly seated, check the vortex signal.

CHECKING THE VORTEX SIGNAL

Remove the transmitter module from the cable that connects it to the flow tube. Insert a signal adapter into the cable end. For a signal adapter, use a three-pin male header type connector with .025-inch square pins on .100-inch centers. Place an ac voltmeter with at least one megohm input impedance between the center pin and one of the two outer pins. There should be approximately .1 Vac present at minimum flow rate, approximately 2 volts at one half specified capacity flow rate, and approximately 10 Vac at full capacity flow rate. Note, the flow meter may be calibrated for a flow rate that is less than full specified capacity Use the full specified capacity when figuring the appropriate voltage. If low voltage is measured, move the voltmeter lead from the outer pin to the other outer pin. Only the center and one outer pin are active. The other outer pin is not used. If the voltage is lower than listed, the flow meter must be replaced. If the voltage is proper, check the transmitter module by following the transmitter module calibration procedure.

SYMPTOM -*Erratic Flow Indication*

Check that there is at least 10 Vdc present across the two terminal block screws.

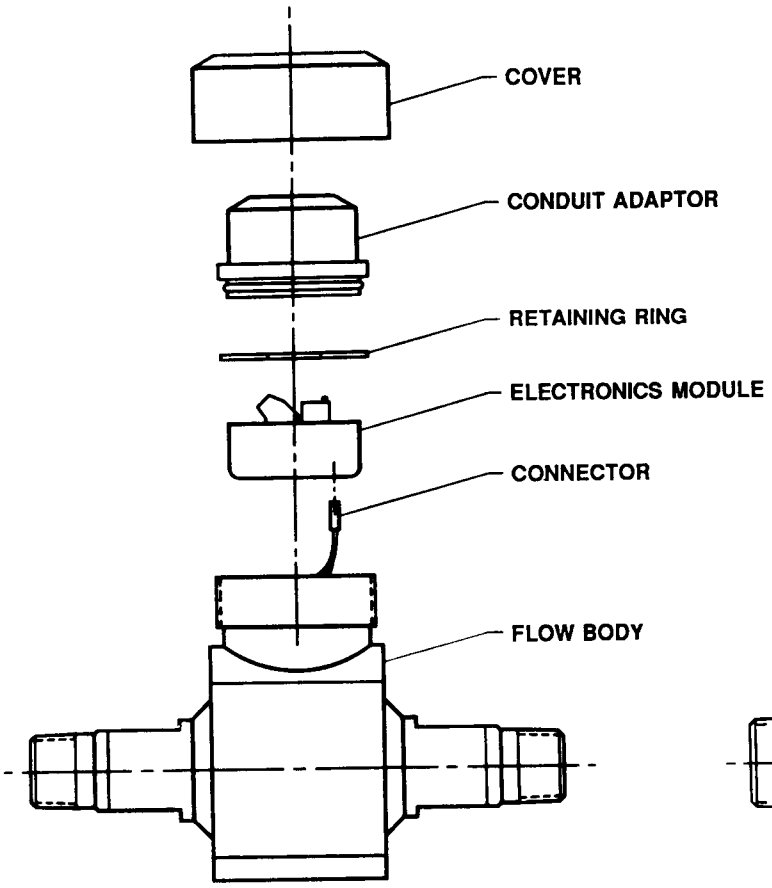
Check for clogging material in the flow meter and in the upstream piping.

Check for erosion of the upstream bluff body by sighting down the flow tube bore. If erosion is noticed, turn the flow meter around to utilize its second bluff body. If erosion continues, the flow meter will need to be periodically replaced.

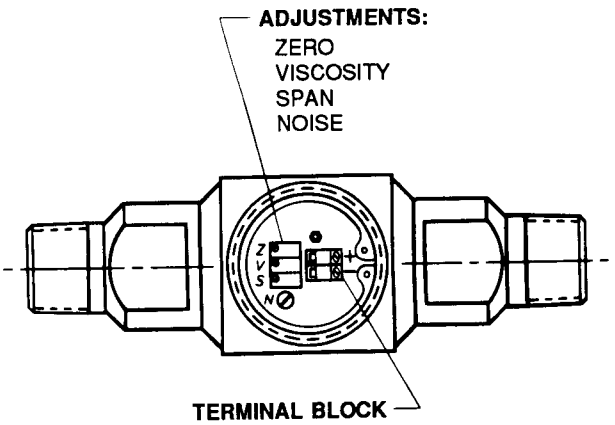
Check upstream piping to assure that the required piping and pump type are used. (See the specification section for this information.)

Check for pipe vibration. Normal amounts of pipe vibration are easily tolerated. In addition to this the transmitter module contains a highly effective active filter that rejects false signals caused by pipe vibration. This filter is most effective under flowing conditions. If vibration is causing the meter to indicate flow when the flow is stopped it will most likely not cause error under flowing conditions. The false flow indication may be ignored, or the pipe may be restrained by firm clamps, or the noise adjustment may be readjusted. Be sure to read the noise adjustment instructions.

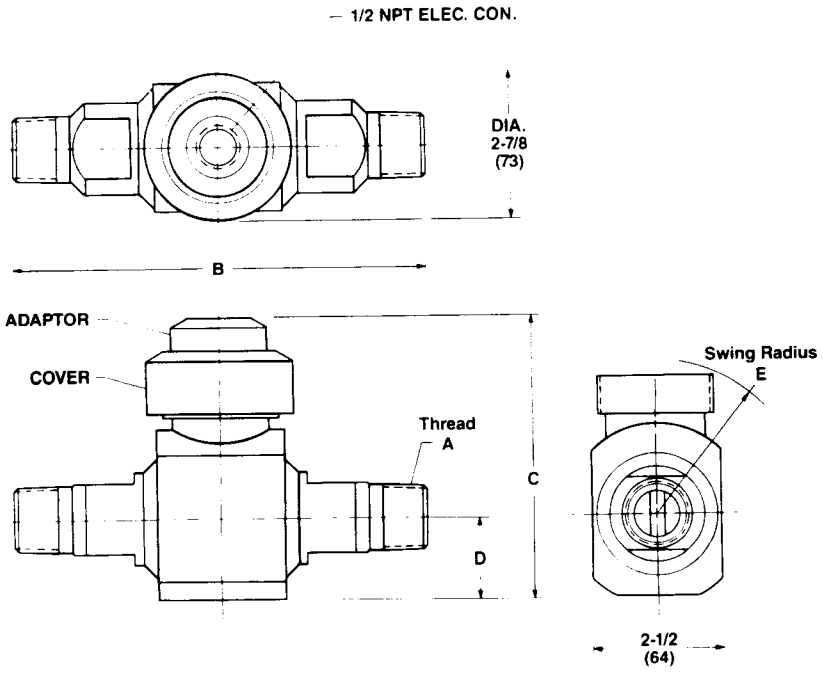
Check for electrical noise. Under some conditions there can be high common mode ac noise present between the fluid and the power supply ground. The flow meter is designed to reject up to 50 volts of ac common mode noise without loss of accuracy. If metal piping is used, place a ground strap on the pipe on both sides of the



ELECTRONICS MODULE CONTAINMENT



TOP VIEW OF ELECTRONICS MODULE



DIMENSIONS inches (mm)

A NPT	B	C	D	E
1/4	5-1/4 (133)	5-9/16 (141)	1-9/16 (40)	3 (76)
1/2	7-1/8 (181)	5-9/16 (141)	1-9/16 40	3 (76)
3/4	7-5/8 (194)	5-9/16 (141)	1-9/16 (40)	3 (76)
1	8 (203)	5-9/16 (141)	1-9/16 (40)	3 (76)
1-1/2	8-3/8 (213)	6-1/8 (156)	1-3/4 (44)	3-3/8 (86)
2	8-3/8 (213)	6-1/8 (156)	1-3/4 (44)	3-3/8 (86)

CALIBRATION

If you wish to recalibrate the meter you will require:

1. A 24-volt dc power supply.
2. An accurate frequency source, with isolated output, such as Altek Industries Corp. Model 241.
3. An accurate milliammeter.
4. A three-pin male header type connector with .025-inch square pins on .100-inch centers.

The frequency source must be isolated or a fault will exist between it and the power supply, causing high current draw. For the same reason do not allow the module case to be grounded.

1. Unscrew the cover and remove the retaining ring holding the electronics module in place. Caution: This snap ring can fly off at high velocity and cause injury. Use a Waldes Truarc 0500 tool or equivalent in conjunction with safety glasses.
2. Carefully remove the module from the meter housing and disconnect the sensor cable.
3. Connect a frequency generator to a three-pin male header type connector with .025-inch square pins on .100 inch centers.
4. Align the pin connector with the pins inside the transmitter module recess and insert the connector until it bottoms.
5. Connect the black (-) lead of a milliammeter to the (+) terminal on the transmitter module.
6. Connect the red (+) lead of the milliammeter to the (+) positive output of the dc power supply.
7. Connect the (-) negative output of the power supply to the (-) negative terminal on the transmitter module.
8. Apply power to the transmitter module and turn on the frequency generator.

Note: Do not make any adjustments to the "N" noise adjustment.

9. Set the "V" viscosity adjustment to the maximum clockwise position.
10. Set the frequency generator to O Hz output.
11. Adjust the "Z" zero adjustment for an output of 4.00 mA.
12. Set the frequency on the full-span frequency that appears on the name plate of the flow-meter. The amplitude should be 10V peak-to-peak with 5V above and below ground.
13. Adjust the "S" span adjustment to read the calibration current listed on the name tag.
14. Adjust the "V" viscosity adjustment to read 20.00 mA.
15. Set the input frequency to O Hz output.
16. Adjust the "Z" zero adjustment for 4.00 mA.
17. Adjust the generator for the full span frequency.
18. Adjust the "S" span adjustment for 20.00 mA.
19. Turn off power to the transmitter, disconnect the power supply and remove the signal generator.
20. Plug the sensor cable into the jack in the module. The cable may be reverse connected.
21. Place the transmitter module into the Vortex meter housing. Be sure the signal cable is not pinched under the transmitter module...Replace the retaining ring.
22. Connect the dc power to the transmitter module. The two loop wires may be reverse connected without problems.
23. Replace conduit adapter and hand-tighten hand nut.

Calibration is complete.

CHANGING FLOW SPAN

Changing flow span does not increase accuracy or make the reading of lower flows possible. The following equations may be used to change the flow span of the flow meter.

$$\text{NEW CALIBRATION CURRENT} = \left[(\text{NTCC} - 20\text{mA}) \times \left[\frac{\text{NTFSF}}{\text{NFSF}} + 20\text{mA}\right]\right]$$

$$\text{NEW CALIBRATION FREQUENCY} = \text{NTF} \left[\frac{\text{NTCC} - 20\text{mA}}{16\text{mA}} + \frac{\text{NFSF}}{\text{NTFSF}}\right]$$

Where NTCC is the name tag calibration current
NFSF is the new full-scale flow rate
NTFSF is the name tag full-scale flow rate
NTF is the name tag frequency

Specifications may be changed without notice.

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