



Manual F-20-TFP-G
June 2008
Revision 1



MODEL TFP-GI MODEL TFP-GV

Flow Sensors and Flow Meters For Gases Installation Manual & Operating Instructions



**READ THIS MANUAL COMPLETELY BEFORE ATTEMPTING TO CONNECT
OR OPERATE YOUR FLOW SENSOR. FAILURE TO DO SO MAY RESULT
IN INJURY TO YOU OR DAMAGE TO THE FLOW SENSOR.**



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A. Introduction

1. Unpacking

All sensors are suitably packaged to prevent damage during shipping. If external damage is noted upon receipt of the package, please contact *the shipping company* immediately. Dwyer Instruments is not liable for damage to the device once it has left the manufacturing premises.

Open the package from the top, taking care not to cut too deeply into the package. Remove all the documentation and contents. Take care to remove all the items and check them against the packing slip. The products should also be checked for any concealed shipping damage. If any shortages or damage is noted, please contact the shipping company and/or Dwyer Instruments to resolve the problem.

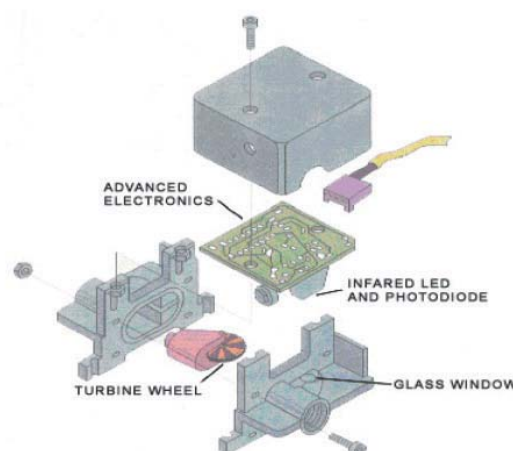
Typical Contents of Box
Sensor, Calibration Certificate & Instruction Manual
(Model TFP-GV shown, other models similar).



CAUTION: Take care not to **drop** your sensor or subject it to sudden impact. Read the installation section of this manual before providing power or tubing connections to the unit. Any damage caused by improper installation or careless handling will not be repaired under warranty (see limited warranty on page 27 for more details).

2. Product Overview and Principle of Operation

TFP Series Flow Meters and Flow Sensors for gases are capable of measuring volumetric flows as low as 20-100 ml/min or as high as 100-500 l/min. Highly repeatable results are achieved using a patented Pelton Turbine Wheel flow sensor design. This proven design minimizes zero drift while maintaining fast response and linear outputs with virtually no maintenance.



Patented technology measures flow using a miniature turbine wheel similar in size to a U.S. dime (16 mm diameter, 0.75 mm thick). The micro-turbine wheel is supported on a very small sapphire shaft that is held in position by two sapphire bearings.

As flow passes through the flow sensor, a precision machined nozzle directs the gas onto the very small teeth of the micro-turbine wheel. This causes the wheel to spin at a speed proportional to the volumetric flow rate.

The micro-turbine wheel has alternating white and black sections evenly spaced on one side of the wheel. An infrared light beam is directed onto the wheel. As the wheel rotates the infrared beam is reflected off each white section. The reflected beam is detected by a phototransistor that converts the reflections into electrical pulses. As the wheel spins faster the pulse rate increases. Processing circuitry provides analog and/or pulse output that are linearly proportional to the volumetric flow rate.

When the wheel stops (under zero flow conditions), no pulses are generated. Consequently, zero drift is not possible and zero adjustments are never required.

Every unit is supplied with a calibration certificate detailing the results obtained during calibration. Units are calibrated using AIR as the reference media. Flowing gases with different physical characteristics may affect the calibration.

B. Installation



CAUTION: Do not exceed the pressure, temperature or power operating ranges detailed in the Specifications section of this manual. Dwyer Instruments shall not be liable for any damage or injury caused by incorrect operation of their products.

1. General Considerations

It is recommended that a safety shut-off valve be installed upstream of (before) the sensor.

All wetted parts should be checked for compatibility with the gas to be used. If there are any incompatibilities e.g. highly corrosive gas, then the unit may be damaged or fail prematurely. Such damage will not be repaired under warranty.

Units should be installed in a clean, dry environment with an ambient temperature that is as stable as possible. Avoid areas with strong magnetic fields, strong air flows or excessive vibration.

If the gas to be used may contain particles larger than 25 microns then a filter (25 microns or less) should be installed upstream of (before) the unit.

2. Mounting The Flow Sensor Or Flow Meter.

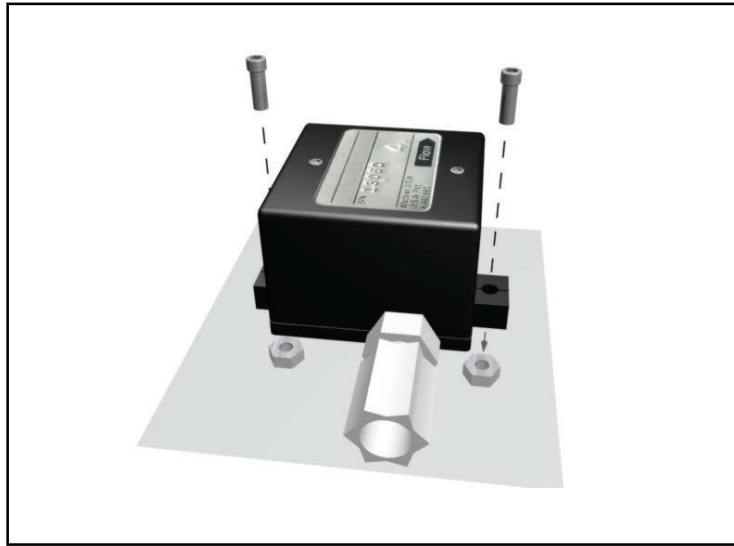


CAUTION: On high flow units (2.0-10.0 L/min and above) DO NOT disassemble the shunt / mounting plate assembly or the unit will not operate correctly and the warranty will be void.

The TFP Series of Flow Sensors and Flow Meters have no particular installation requirements so may be mounted in any convenient position. For optimum results the unit should be mounted with the mounting feet horizontal on top of a flat horizontal surface. This is the same position that the unit is calibrated in at the factory. Please contact Dwyer Customer Service if calibration for mounting in another orientation is desired.

It is recommended that units be fixed to a suitable substrate with #4 screws using the two mounting holes provided.

Mounting The Sensor
(Mounting hardware not included with sensor)



3. Tubing Connections



CAUTION: DO NOT FLOW ANY LIQUID THROUGH A GAS FLOW SENSOR OR FLOW METER. THIS WILL SERIOUSLY AFFECT THE PERFORMANCE AND VOID THE WARRANTY.



CAUTION: DO NOT FLOW A HIGH PRESSURE GAS THROUGH THE SENSOR. A burst of high pressure gas may cause the unit to be damaged. Always flow gas at a pressure and flow rate within the specifications of the unit.

All tubing must be clean, dry and without crimps, burrs or scratches.

Only use the factory installed fittings on the unit. If the fittings are removed the calibration of the unit may be effected and leaking may occur. If different fittings are required please contact the Dwyer Instruments Service Department for assistance.

When connecting the sensor to the tubing a wrench should be used to stop the fitting rotating in the sensor body. Take care not to over tighten the fittings or leaking may occur.

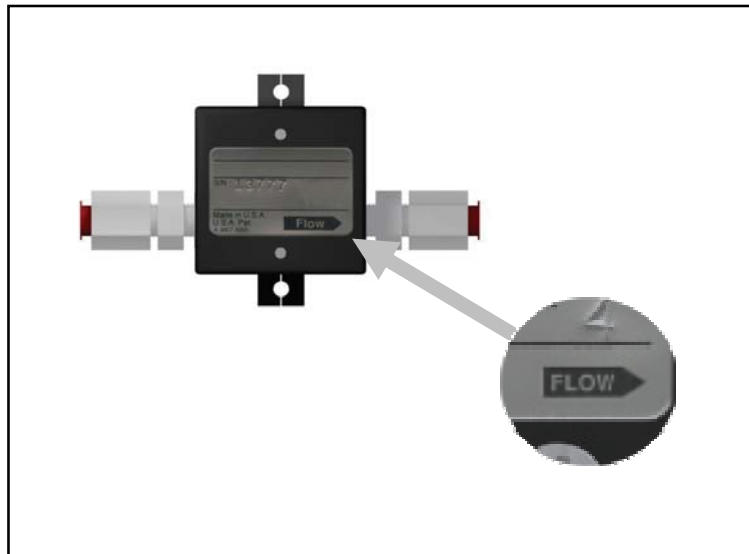
Connecting and tightening the Fittings



CAUTION: DO NOT over tighten the fittings into the sensor body. Excessive force may damage the sensor body. This type of damage will NOT be repaired under warranty.

The flow direction for the unit is clearly marked on the label. Do not reverse the flow direction or the unit will not function.

Close Up of Label Showing Flow Directions (All models similar)



The tubing ID should be as large as possible to avoid restrictions and turbulence. For the best results, a straight length of tubing before the unit is recommended. This should be 20 times the tubing I.D. or greater.

4. Electrical Connections



CAUTION: Incorrect wiring may cause severe damage to the unit. Applying an AC voltage (115VAC or 230VAC) directly to the unit will cause damage. Read the following instructions carefully before making any connections.

a) Overview

The TFP-GV Series provides a 0-5VDC output proportional to the volumetric flow rate. This output may be connected to a display, data acquisition system or voltmeter.

The TFP-GI Series features an integral display that provides a local flow reading. These units also have a 0-5VDC analog output available. If required, this may be connected to another display, data acquisition system or voltmeter.

A stable D.C. power supply is required to operate the unit. The voltage and current requirements depend on the configuration of the unit. Full details may be found in the Specification section of this manual.

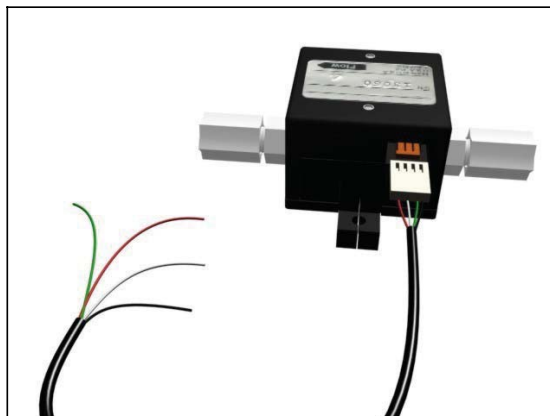
Connecting wires should be as short as possible to avoid voltage drops. Twisted 2 pair conductor cable of a suitable gauge should be used if the length of the power wires is to be longer than 1 meter (3.2 feet).

Units are supplied with an integral 4 pin connector. Connections to the unit are made using a mating cable assembly or power adapter package as detailed in the following sections. A connector pin and wire color cross reference may also be found in Appendix F (Page 18) of this manual.

b) Connecting a Cable Assembly

The connector on the cable assembly should be pushed into the mating socket on the sensor taking care to ensure that it is the correct way up.

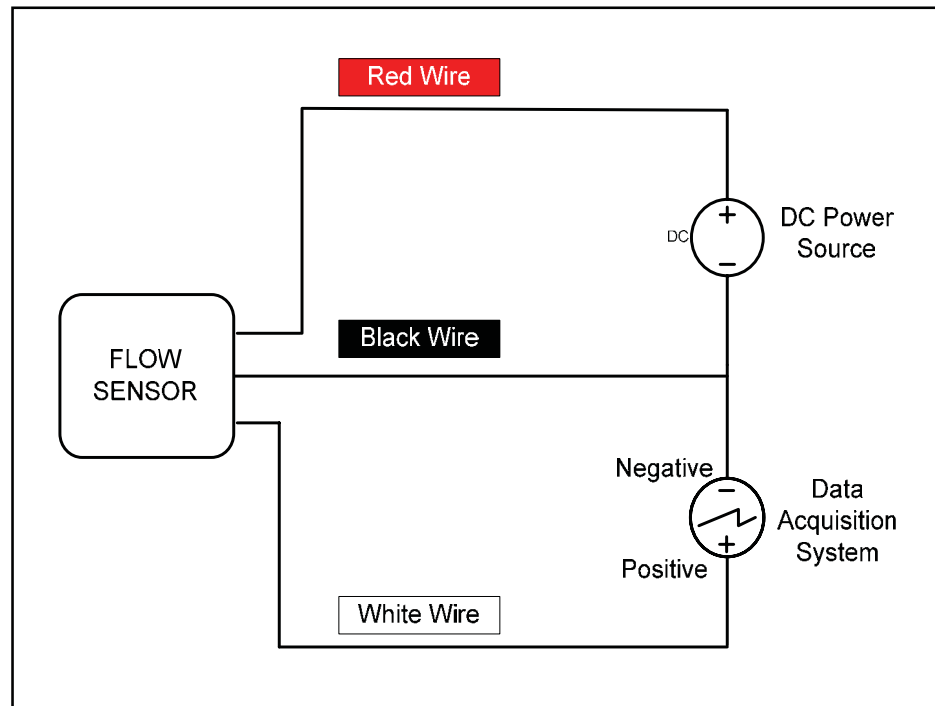
Connecting the Cable Assembly (All models similar)



c) Electrical Connections – Voltage Output Units

The cable assembly should be connected to the sensor as detailed in section 4(b) above. Do not apply power to the sensor until all the connections have been made and checked. Electrical connections should be made as follows:

Wiring Schematic For Voltage Output Units.



The **RED** wire should be connected to the Positive of the power source.

The **BLACK** wire should be connected to the Negative (Ground) of the power source.

The **WHITE** wire provides the signal output and should be connected to the positive terminal of the display, data acquisition system or voltmeter with an impedance greater than 2500Ω (Ohms).

The **GREEN** wire is not used.



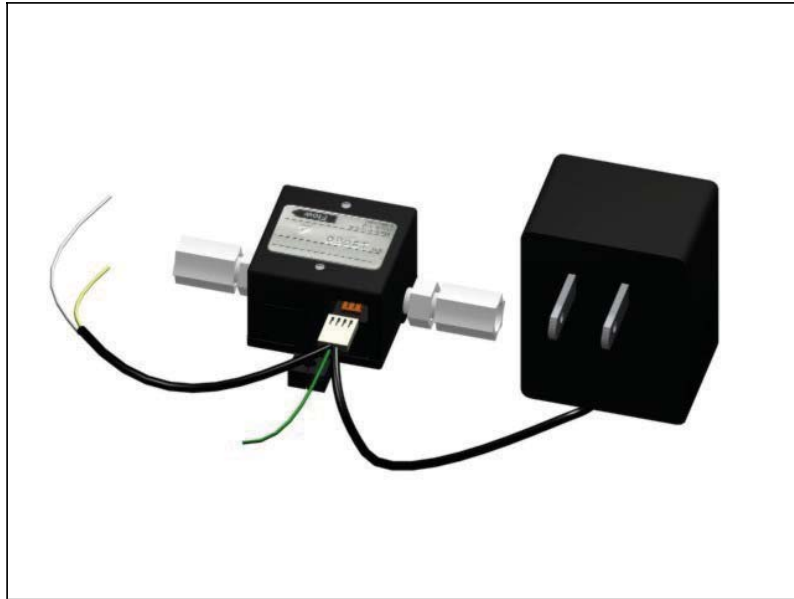
CAUTION: Avoid high voltage static discharges to any of the connections. Do not short the input/output signal wires or allow them to contact the power wires at any time. **DAMAGE WILL RESULT!**

d) Using a 0-5VDC Output Power Adapter Package.

An optional 0-5VDC Output Power Adapter Package is available for use with the TFP Series.

The 0-5VDC Output Power Adapter Package consists of a power source (115VAC or 230VAC) and cable assembly with pig-tail (soldered wire) ends for the signal output. This should be assembled as shown in the following diagram.

***Connecting the Power Adapter to the Flow Sensor
(All other models similar)***



Electrical connections to the cable assembly should be made as follows:

YELLOW WIRE: This provides the 0-5VDC signal output and should be connected to the positive terminal of the display, data acquisition system or voltmeter with an impedance of greater than 2500 Ω (Ohms).

GREEN WIRE: This is not used.

WHITE WIRE: This is the signal negative and should be connected to the negative (ground) terminal of the voltmeter, display or data acquisition system.



CAUTION: Avoid high voltage static discharges to any of the connections. Do not short the output signal wires or allow them to contact the power wires at any time. DAMAGE WILL RESULT!

C. **Operation**



CAUTION: DO NOT FLOW ANY LIQUID THROUGH A GAS FLOW SENSOR. THIS WILL SERIOUSLY AFFECT THE PERFORMANCE AND VOID THE WARRANTY.

1. **Start Up**

Before applying power to the unit check all tubing and electrical connections. Once correct installation is verified switch on the power.

2. **Flow Readings**

The TFP-GV Series for gases provides a 0-5VDC output proportional to the volumetric flow rate.

The TFP-GI Series features an integral 3.5 digit display that provides a local flow reading and a 0-5VDC analog output proportional to the volumetric flow rate.

Each unit is factory calibrated for a specific flow range. The flow range is shown on the unit's label and calibration certificate. Units are calibrated using AIR as the reference media unless otherwise noted. Calibrations are carried out with the mounting feet horizontal on a flat horizontal surface.

a) **0-5VDC Analog Outputs**

By monitoring the voltage output signal it is possible to determine the flow rate of the gas. Units are configured so that an output signal of 5.0VDC is provided when the maximum flow (i.e. Full Scale flow) is passing through the unit. The output signal is linear and scalable enabling calculation of flow rates within the sensor's range. For example:

For a flow range of 100-500ml/min:

At 500ml/min the output signal would be 5VDC

If the output signal were 3.5VDC then the flow rate would be:

$$(500 \div 5) \times 3.5 = 350\text{ml/min}$$

If the maximum flow rate is exceeded non-linear and inaccurate readings will result.

b) Units With An Integral Display

The TFP-GI Series features an integral 3.5 digit LCD display. This is configured to read in ml/min for flow ranges up to 100-500 ml/min and in l/min for all other flow ranges. The display will only operate if power is applied to the unit.

Flow readings may be taken directly from the display or by monitoring the 0-5VDC analog output provided (see above).

***LCD Flow Display
(TFM-LI Series Shown, TFP-GI models similar)***



3. Operating At Flow Rates Outside The Calibrated Flow Range



CAUTION: If the flow through the unit exceeds 120% of the maximum rated (full scale) flow the unit may be damaged. This type of damage will not be repaired under warranty.

Flow measurement is only accurate within the calibrated flow range for the unit. This is detailed on the calibration certificate. The unit will still operate, to some degree, outside this flow range.

Results obtained when operating outside the specified range of the unit are not accurate but may be considered repeatable.

a) Flows Above The Maximum Rated Flow.

If the flow rate is above the maximum rated (or full scale) flow, the unit will still operate and provide an output signal proportional to the flow rate.

Flows must not exceed 120% of the maximum rated flow or the unit may be damaged.

b) Flows Below The Minimum Rated Flow.

Signal outputs may be obtained at flow rates below the minimum specified for your unit. The amount of flow that may be measured below the minimum specified varies from unit to unit.

4. Zero Adjustments

It is impossible for there to be any zero drift so zero adjustments are never required.

5. Recalibration

Please contact Dwyer Customer Service if your flow sensor or flow meter needs recalibration.

6. Using Flow Sensors Or Flow Meters With Different Gases

The TFP Series For Gases will operate with most gases subject to compatibility of the wetted parts. *For information about calibrating for Hydrogen or Helium, contact Dwyer Customer Service.*

Units are calibrated with AIR at a pressure of 760mmHg and temperature of 23 °C unless otherwise detailed on the calibration certificate. Using other gases will affect the calibration. The amount of calibration error will depend on the characteristics of the gas being flowed.

The flow reading correction factor (or calibration factor) may be approximately calculated with the following formula:

$$C_f = (S_{\text{new}} \div S_{\text{current}})^{0.3}$$

C_f = Correction factor

S_{new} = Specific gravity of new gas

S_{current} = Specific gravity of original calibration gas

A corrected flow reading may then be calculated using the correction factor as follows:

$$\text{Corrected Flow} = \text{Flow Reading} \times \text{Correction Factor}$$

For example, if the unit is calibrated for AIR but the user wants to measure the flow of Carbon Dioxide (CO₂) with a specific gravity of 1.517 the flow reading correction factor would be calculated as follows:

$$S_{\text{new}} = \text{Specific gravity of CO}_2 = 1.517$$

$$S_{\text{current}} = \text{Specific gravity of Air} = 1.000$$

$$C_f = (S_{\text{current}} \div S_{\text{new}})^{0.3}$$

$$C_f = (1.000 \div 1.517)^{0.3}$$

$$C_f = 0.88$$

If the unit has a flow reading of 200ml/min then the corrected flow reading (for CO₂) would be:

$$\text{Corrected Flow} = 200 \times 0.88 = 176 \text{ ml/min}$$



CAUTION: The use of correction factors can be subject to inaccuracy and errors of up to $\pm 10\%$. Please contact Dwyer Customer Service if accurate, certified recalibration is required.

Calculating a correction factor for a gas enables the calibration of the unit to be adjusted for that gas. This is accomplished by:

- i) Calculate the corrected flow reading or VDC output at 100% of flow using the above formulas.
- ii) Adjust the flow of (the new) gas to give this flow reading
- iii) Maintain this flow and ensure a stable reading.
- iv) Adjust the gain potentiometer on the unit so that a 5VDC output is obtained. The unit is now calibrated for the new gas.

For example: A 2.0 -10.0 l/min unit that has been calibrated for Air is to be used with CO₂. The correction factor, calculated as above, is 0.88. When flowing CO₂ the unit will read high i.e. at 5VDC the flow of CO₂ would actually be 8.8 l/min and not 10 l/min. A flow of 10 l/min of CO₂ through the unit would give a reading of $10/0.88 = 11.36$ l/min or 5.68 VDC on the unit. Flow should be adjusted so that an output of 5.68VDC or reading of 11.36l/min is obtained. The gain potentiometer is then adjusted so that the voltage output becomes 5VDC or the display reads 10l/min. The unit has now been adjusted for CO₂ and no further corrections to flow readings are required (if flowing CO₂).

It should be noted that the maximum output voltage for the units is approximately 5.9VDC. It is not possible to adjust units if an output of greater than 5.9 VDC is required.

***Adjusting the Gain Potentiometer Using a Flat Head Screwdriver
(TFP-GV Series shown, other models similar)***



D. Maintenance And Product Care

1. General



CAUTION: Do not disassemble your flow meter or flow sensor for any reason. If the unit appears to be malfunctioning please contact Dwyer Customer Service.

The TFP Series requires no periodic maintenance if used within the recommended specifications.

The next recommended recalibration date is stated on the calibration certificate supplied with the unit. Please contact Dwyer Customer Service for further information.

Inlet filters should be periodically checked and cleaned / replaced as necessary.

Regularly check all electrical and process connections for damage or deterioration.

If the sensor is to be stored, keep both the inlet and outlet ports sealed.

2. Cleaning and Flushing

If there is a buildup of deposits or particles from the measured gases it may be necessary to clean *or flush* the unit. This should be done by flowing clean, particle free air (or Nitrogen) through the unit at a flow rate, pressure and temperature within the specifications of the unit. If necessary, flow may be reversed to assist flushing.



CAUTION: Do not flow a high pressure gas through the sensor. A burst of high pressure gas may cause the turbine wheel sensor to be damaged. Always flow gas at a pressure and flow rate within the specifications of the unit.

3. Returning Units For Repair Or Recalibration

To return units for repair or recalibration please contact Dwyer Customer Service. A Return Material Authorization (RMA) Number will then be issued to enable the unit to be returned. Please note that no returns will be accepted unless the RMA number is clearly indicated on the outside of all packages.

Once the unit has been received it will be evaluated and the cost of any repairs / recalibration determined. Once agreement has been received to pay for all the necessary work the unit will be processed and returned. No charges will be made for Warranty Repairs.

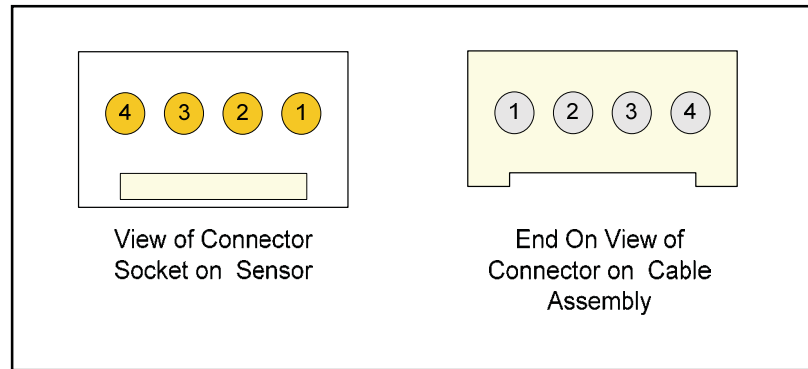
E. Specifications

	Model TFP-GV	Model TFP-GI
Display	None	3.5 Digit LCD, 0.39" (10mm) high digits
Accuracy (including linearity)	$\pm 3.0\%$ Full Scale *	
Repeatability	$\pm 0.5\%$ Full Scale *	
Pressure Rating	40 psig (2.8 bar)	
Temperature Rating	Operating Range: 5 to 55 °C Storage Range: 0 to 70 °C	
Temperature Sensitivity	$\pm 0.2\%$ F.S. * or less per °C	
Wetted Materials	Ryton® Epoxy Glass Sapphire	
O-Ring Material	Standard - Viton®	
Fitting Material (Standard)	Acetal	
Fitting Material Optional	Acetal, brass, or stainless steel	
Recommended Filtration	25 microns or less	
Compatible Gases	Clean, dry	
0-5VDC Output Signal	Standard. (Minimum 2.5 K Ω load)	
Typical Power Consumption	12 VDC @ 35 mA (11.5-15 VDC)	
Response Time	Typically <30 seconds for 67% of final value	
Reliability	100,000 hours MTBF	
Certifications	CE Approved 89/336/EEC (EN 55011 & EN 50082-1) 73/23/EEC Low Voltage Directive	
Ratings	IP10 (NEMA 1)	
Warranty	1 year limited	

* Specifications from 20-100% of rated flow. Linearity is best fit straight line. All calibrations performed with AIR unless otherwise stated on calibration certificate

F. Connector Pin And Wire Color Cross Reference

Pin Configuration For Connector Socket And Connector



Pin	Cable Wire Color	Description
1	Black	Signal & Power Negative (Ground)
2	White	Voltage Output
3	Red	Power Positive
4	Green	Not Used

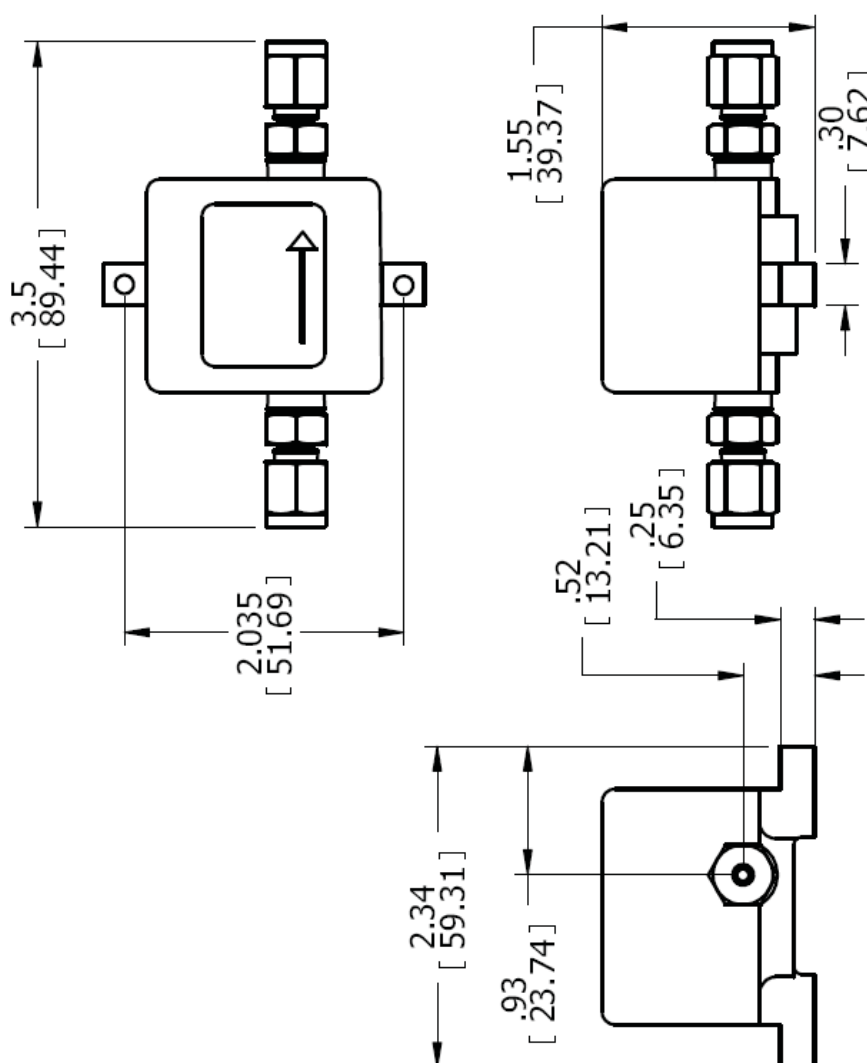
G. Dimensions

ALL DIMENSIONS IN INCHES (MILLIMETERS IN BRACKETS)

TFP-GV Series For Gases

20-200 ml/min To 1.0-5.0 l/min Units

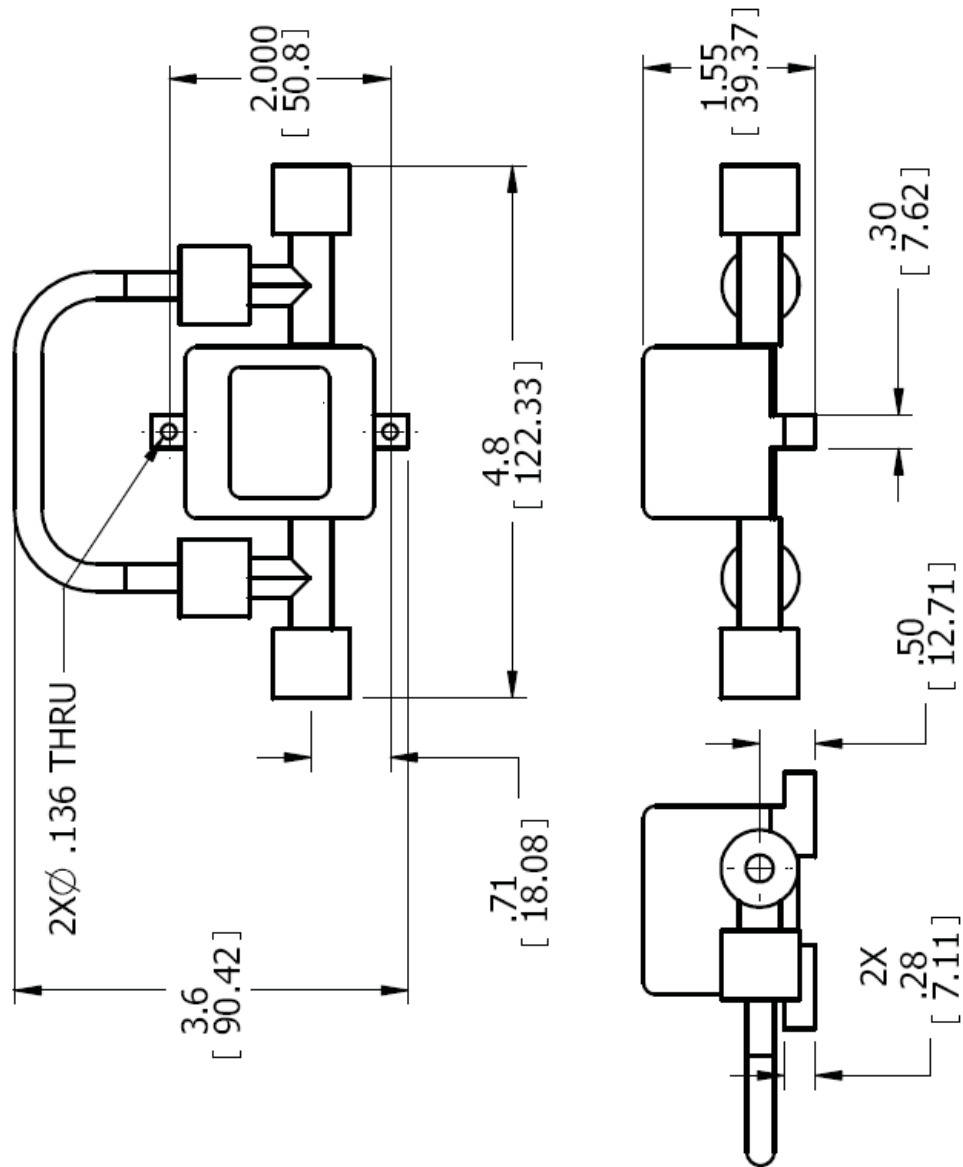
1/4" Acetal Fittings Shown



TFP-GV Series For Gases

2.0-10.0 l/min Units

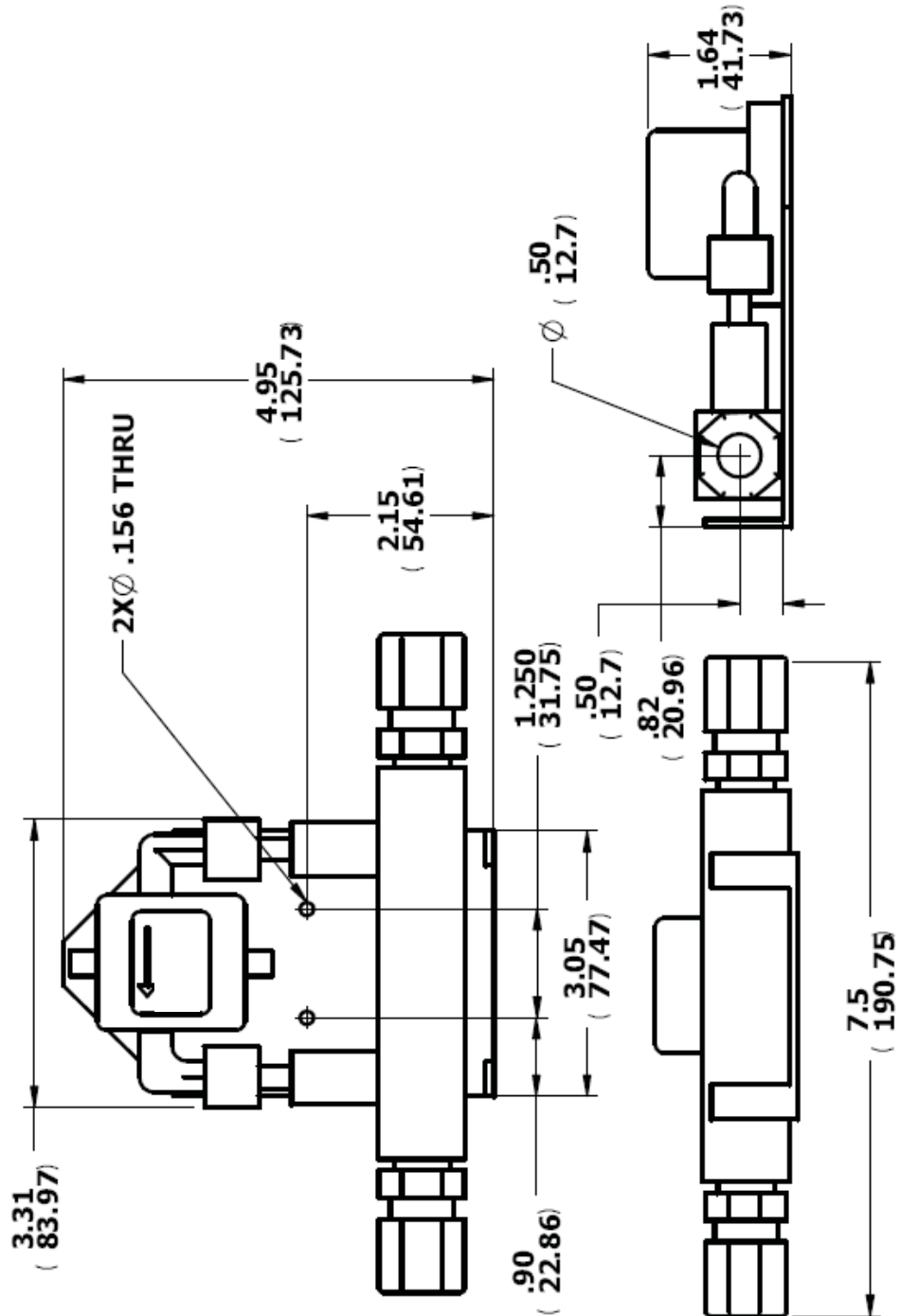
1/4" Acetal Fittings Shown



TFP-GV Series For Gases

4.0-20.0 l/min To 100-500 l/min Units

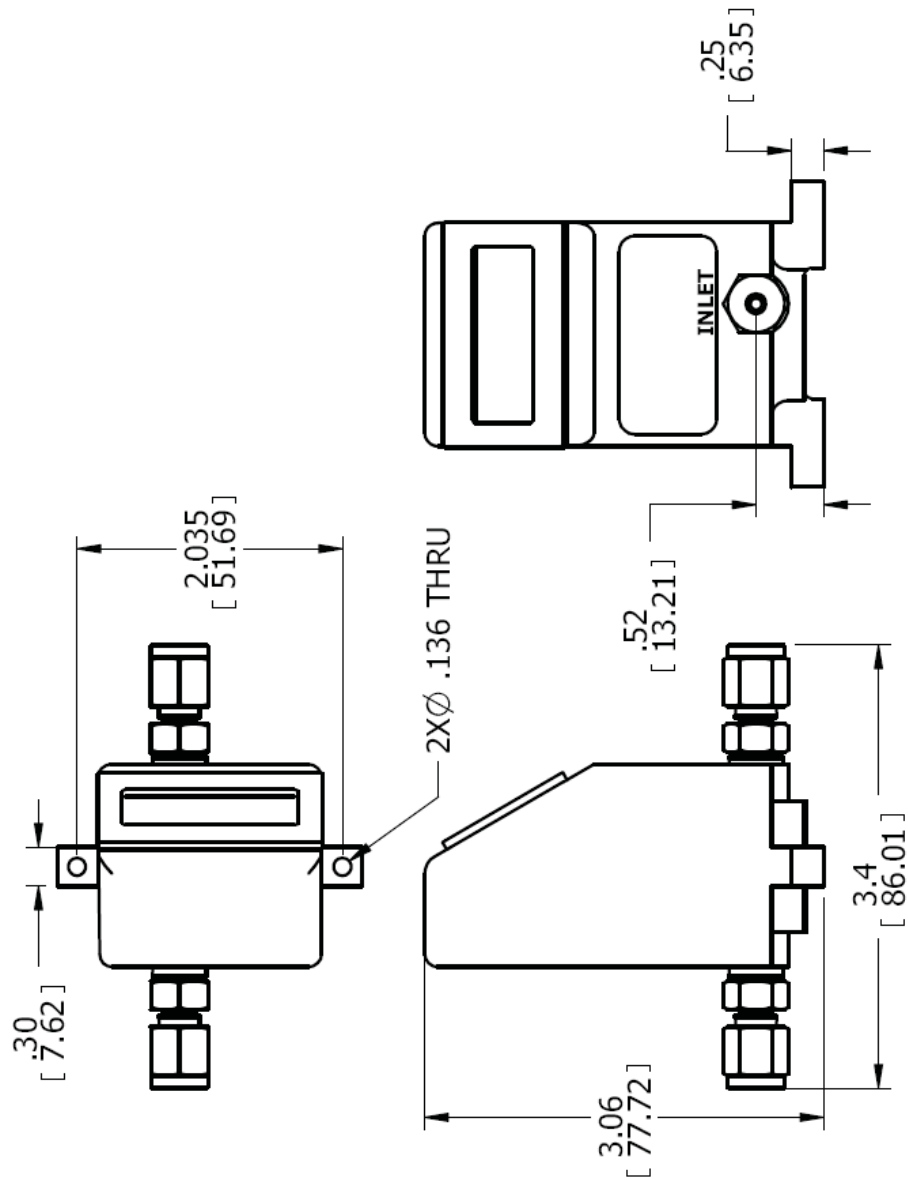
1/2" Acetal Fittings Shown



TFP-GI Series For Gases

20-200 ml/min To 1.0-5.0 l/min Units

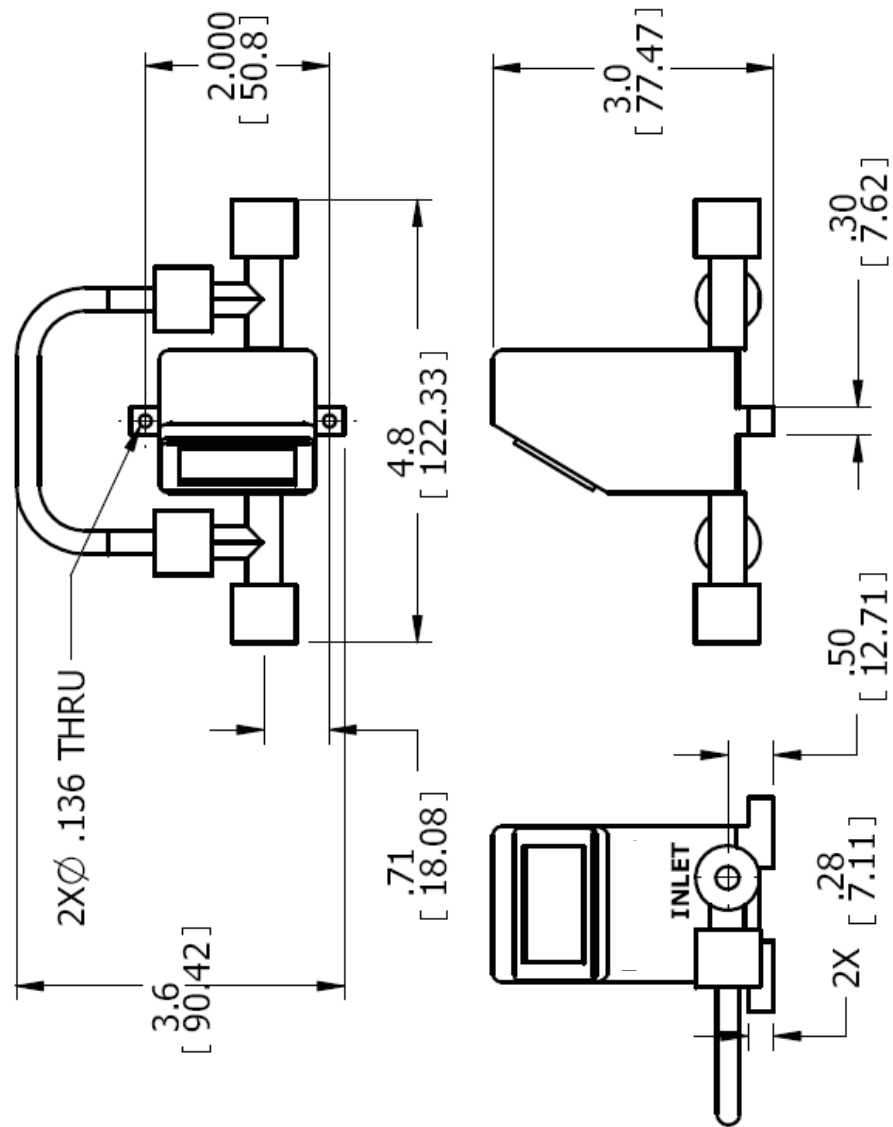
1/4" Acetal Fittings Shown



TFP-GI Series For Gases

2.0-10.0 l/min Units

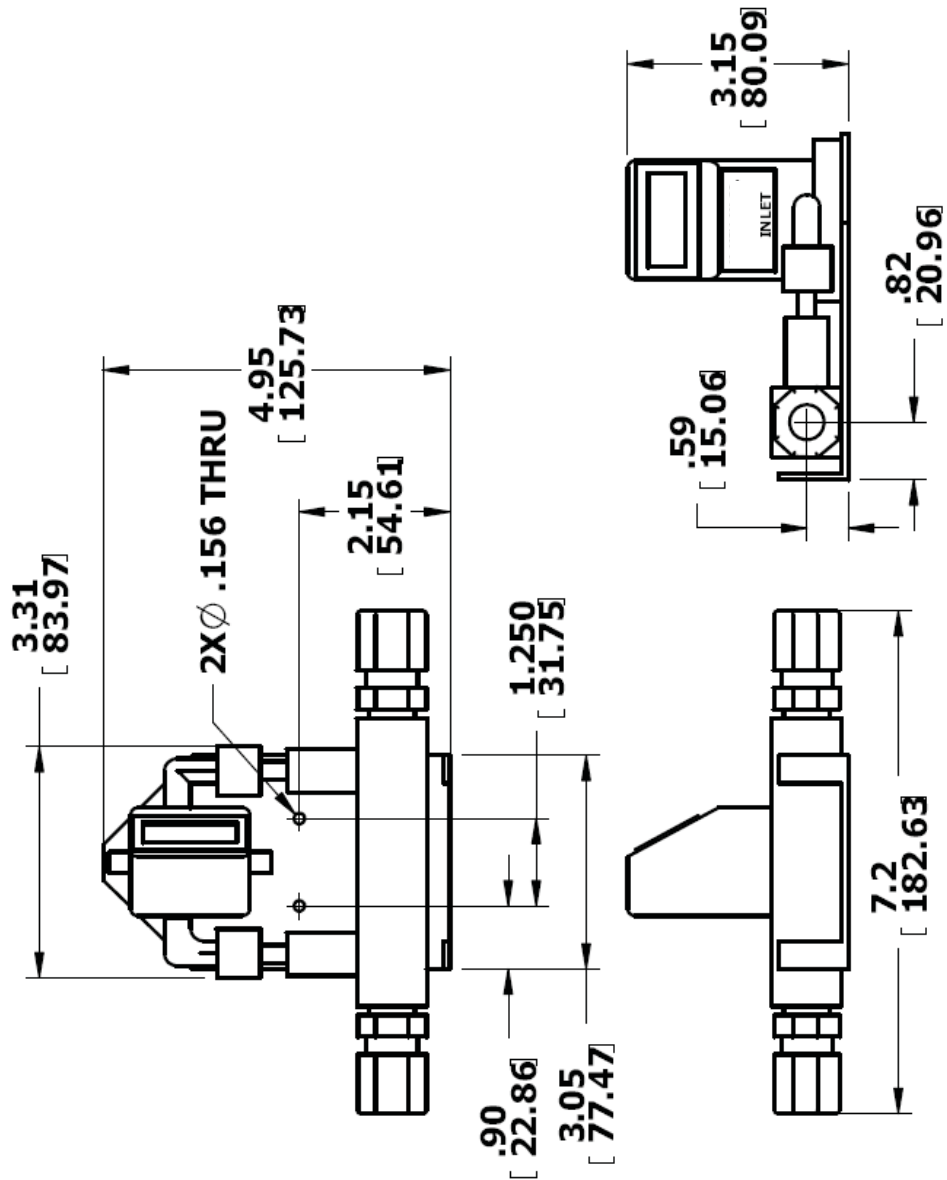
1/4" Acetal Fittings Shown



TFP-GI Series For Gases

4.0-20.0 l/min To 100-500 l/min Units

1/2" Acetal Fittings Shown



H. *Troubleshooting Guide*

Symptom	Possible Cause	Method of Correction
Unit Leaks.	Fittings not tight enough.	Tighten fittings (see section B3).
	Sensor assembly cracked.	Unit must be returned for repair (see Section D3).
No output signal or flow indication.	No power or low power.	Apply correct power.
	No flow passing through unit.	Display or output should read zero.
	Output shorted or overloaded.	Check electrical connections (see section B4).
	Improper connection.	Check electrical connections (see section B4) and ensure connector is correctly plugged in.
	Moisture on internal electronics.	Allow unit to dry out in a dry environment.
	Output circuitry damaged.	Unit must be returned for repair (see Section D3).
Flow indication "bounces" or fluctuates.	Flow is actually fluctuating.	Correct flow source to obtain steady flow.
	Using a pulsatile or piston pump that causes a pulsating flow of gas.	Switch to a stable source of gas.
	Not using the fittings supplied by the manufacturer.	Use the supplied fittings.
	Moisture in sensor.	Remove moisture and allow unit to dry out.
	Turbulence in tubing or sensor.	Straighten the inlet tubing or lengthen it to at least 6" (150mm).
	Fluctuating input power.	Correct the power source or change to a regulated supply.
	Mechanical sensor assembly damaged.	Unit must be returned for repair (see Section D3).

Symptom	Possible Cause	Method of Correction
Flow indication is not linear and output too low at lower flows.	Attempting to measure flows below the specified minimum for the unit.	Use higher flow rates.
	Moisture or liquid in sensor.	Remove moisture and allow sensor to dry out.
	Mechanical sensor assembly damaged.	Unit must be returned for repair (see Section D3).
Flow reading accuracy is outside the specification.	Gas has a specific gravity other than Air at 20 °C.	Calculate the flow reading error / offset as explained in section C6.
	Moisture in sensor.	Allow sensor to dry out. Ensure gas is dry.
	Mechanical sensor assembly damaged.	Unit must be returned for repair (see Section D3).
	Pressure drop issue.	Correct for the pressure drop (ΔP).
Flow indication is fixed at one value.	The maximum rated flow for the unit is being exceeded.	Reduce the flow
	Output circuits may be damaged.	Unit must be returned for repair (see Section D3).

I. Limited Warranty

After final installation of the flow meter, no routine maintenance is required. A periodic check of system calibration is suggested. The series TFP-GV and TFP-GI are not field repairable and should be returned if repair is needed (field repair should not be attempted and may void the warranty). Be sure to include a brief description of the problem plus any relevant application notes. Contact Dwyer Customer Service to receive a return goods authorization (R.M.A.) number before shipping.