



MODEL 100
MODEL 110
MODEL S-110
MODEL S-113
FLO-METERS® and FLO-SENSORS® For Gases

Installation Manual & Operating Instructions



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

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A. *Introduction*

1. Unpacking

McMillan suitably packages all sensors to prevent damage during shipping. If external damage is noted upon receipt of the package, please contact *the shipping company* immediately. McMillan Company 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 McMillan Company to resolve the problem.

*Typical Contents of Box
Sensor, Calibration Certificate & Instruction Manual
(Model 100 shown, other models similar).*

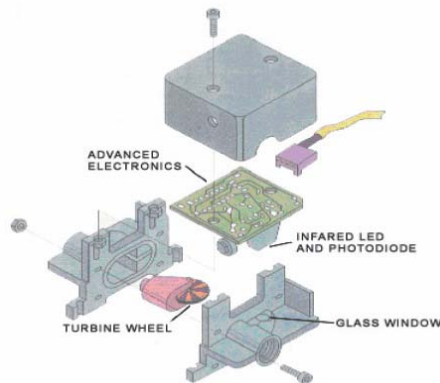


Caution: Take care not to *drop* your sensor or subject it to sudden impact. Read the installation section of this manual before providing power or tubing connections to the unit. Any damage caused by improper installation or careless handling will not be repaired under warranty (see limited warranty on page 30 for more details).

2. Product Overview and Principle of Operation

McMillan Micro Turbine Wheel FLO-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.



McMillan's 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 FLO-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 effect the calibration.

3. Non-Standard Products (Z Suffixes)

Please note that the installation instructions, operating instructions, and specifications included within this manual apply to standard production models only. If your FLO-SENSOR[®] or FLO-METER[®] has a "Z" suffix (e.g. 100-Z0123) then your unit is non-standard. Contact the factory to check if the installation, operation, or specifications of your sensor are different than detailed in this manual.

B. Installation



Caution: Do not exceed the pressure, temperature or power operating ranges detailed in the SPECIFICATIONS section of this manual. McMillan Company 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 eg. 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 FLO-SENSOR® or FLO-METER®.

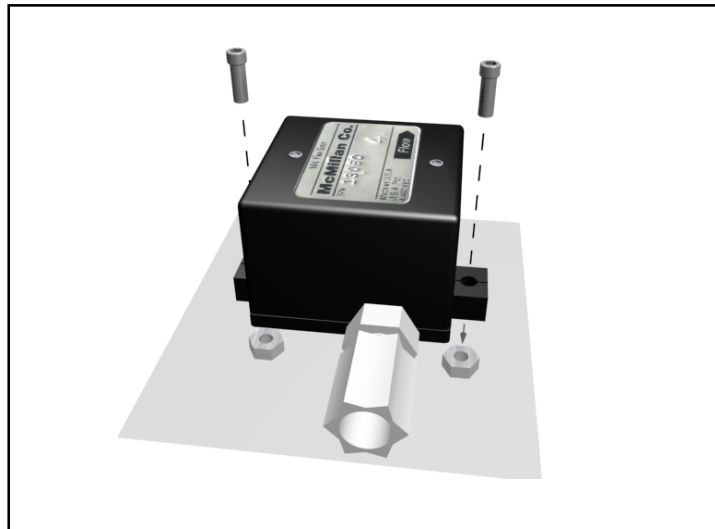


Caution: On high flow units (2.0-10.0 L/min, range 9, and above) DO NOT disassemble the shunt / mounting plate assembly or the unit will not operate correctly and the warranty will be void.

McMillan FLO-SENSORS® and FLO-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 the McMillan Service Department 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 FLO-SENSOR® OR FLO-METER®. THIS WILL SERIOUSLY EFFECT 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 McMillan Company 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.

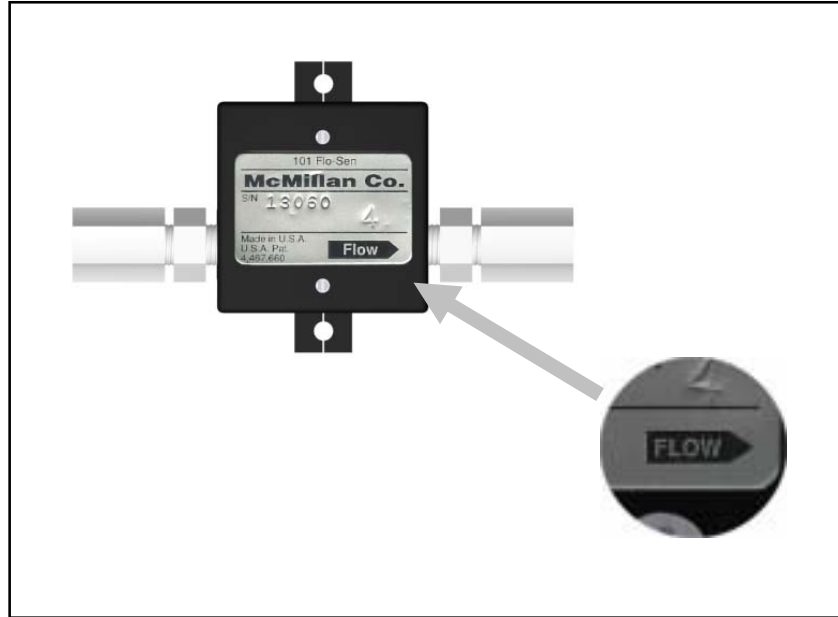
*Connecting and tightening the Fittings
(S Series shown, other models similar)*



Caution: DO NOT over tighten the fittings into the FLO-SENSOR® or FLO-METER® body. Excessive force may damage the sensor body. This type of damage will NOT be repaired under warranty.

The flow direction for the FLO-SENSORS® or FLO-METERS® is clearly marked on the label. Do not reverse the flow direction or the unit will not function correctly.

*Close Up of Label Showing Flow Directions
(Model 101 shown, other 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

McMillan FLO-SENSORS® for gases provide a 0-5VDC output proportional to the volumetric flow rate. This output may be connected to a display, data acquisition system or voltmeter. The Model 110, S-110 and S-113 FLO-METERS® feature 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.

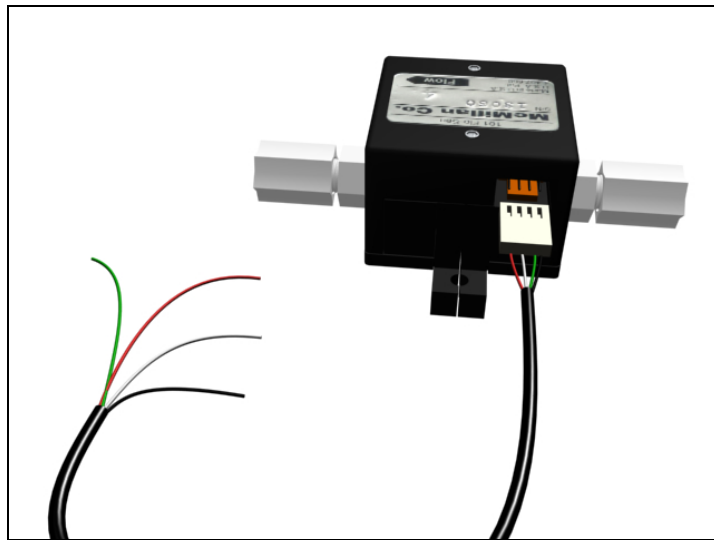
Connecting wires should be as short as possible to avoid voltage drops. Twisted 2 pair conductor cable of a suitable gauge should be used if the length of the power wires is to be longer than 1 meter (3.2 feet).

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 H (Page 20) of this manual.

b) Connecting a Cable Assembly

The connector on the end of 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
(Model 101 shown, other models similar)*

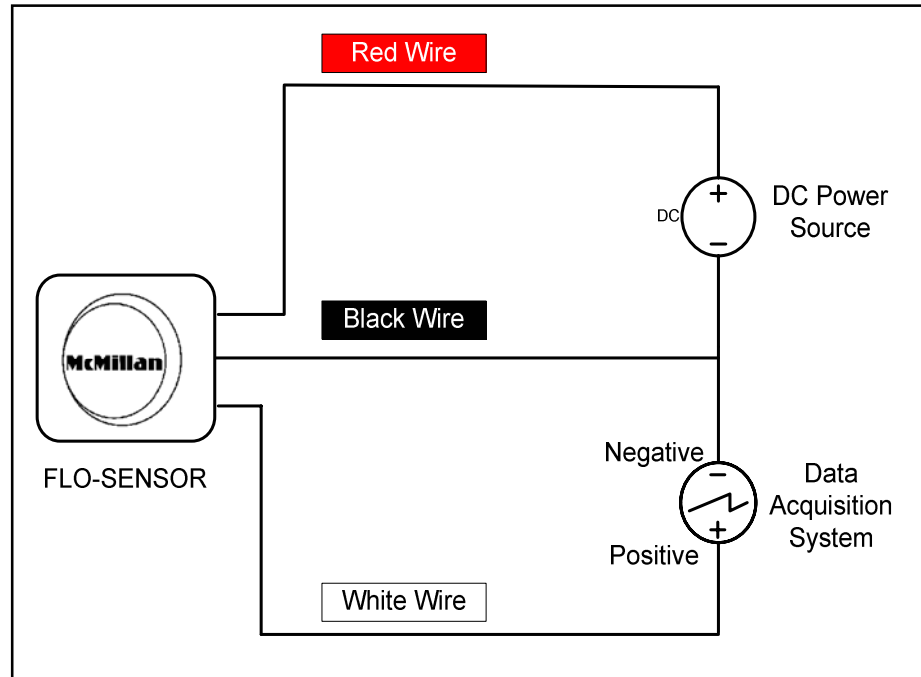


Electrical connections to the cable assembly are made as detailed in the following sections.

c) Electrical Connections – Voltage Output Units

The cable assembly should be connected to the sensor as detailed in section 5(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 2500 Ω (Ohms).

The **GREEN** wire is not used.



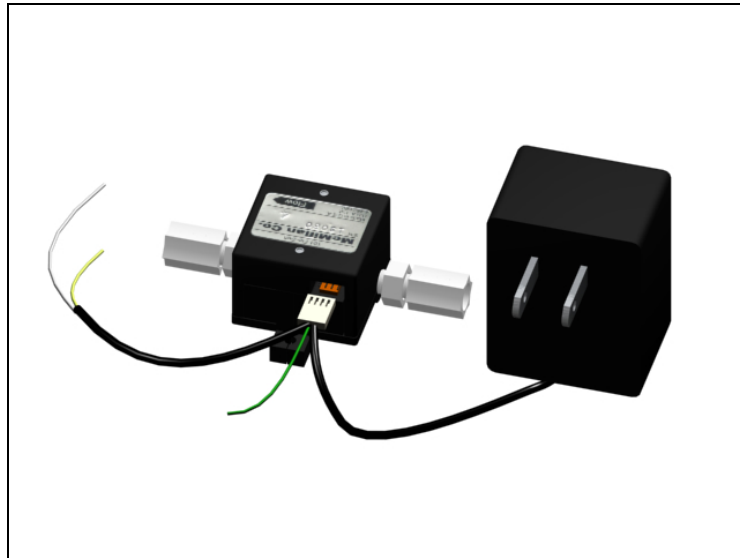
Caution: Avoid high voltage static discharges to any of the connections. Do not short the input/output signal wires or allow them to contact the power wires at any time. **DAMAGE WILL RESULT!**

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

An optional 0-5VDC Output Power Adapter Package is available for use with the Model 100, S-110 and S-113. The Model 110 is supplied complete with a 0-5VDC Output Power Adapter Package.

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
(Model 100 shown, other models similar)*



The 0-5VDC analog output may be connected to a display, data acquisition system or voltmeter with a minimum load of 2.5 k Ω (kilo ohms).

The **YELLOW** wire of the cable assembly provides the 0-5VDC signal output and should be connected to the positive terminal of the display, data acquisition system or voltmeter.

The **GREEN** wire is not used.

The **WHITE** wire of the cable assembly is the signal negative and should be connected to the negative (ground) terminal of the voltmeter, display or data acquisition system.

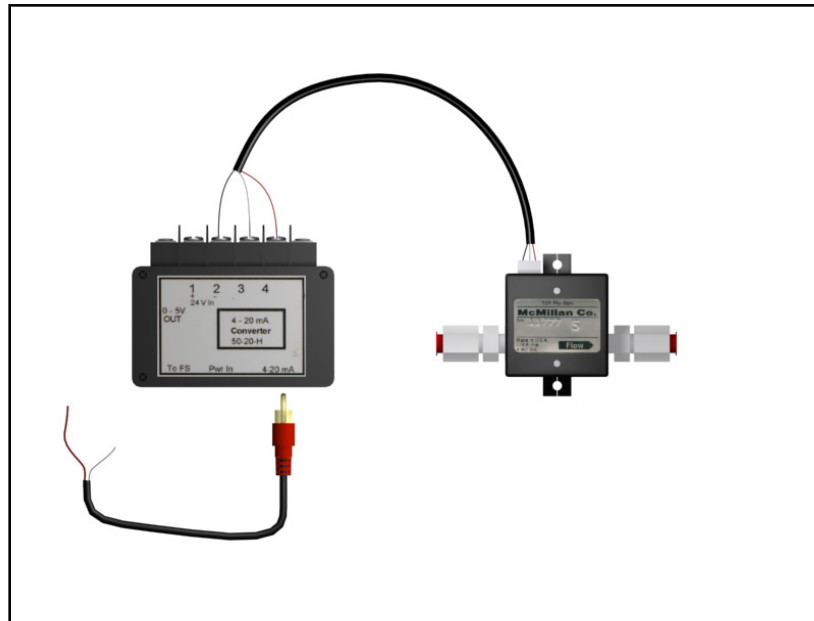


Caution: Avoid high voltage static discharges to any of the connections. Do not short the output signal wires or allow them to contact the power wires at any time. **DAMAGE WILL RESULT!**

e) **Using a 4-20mA Output Signal Converter Package (D-24 VDC).**

An optional 4-20mA Output Signal Converter Package is available for use with the Model 100, S-110 and S-113. This consists of a signal converter, a cable assembly to connect the converter to the sensor and a cable assembly to connect to the 4-20mA (active current) output signal. The signal converter requires 24VDC power to operate. This package should be assembled as shown in the following diagram.

Assembling the D-24VDC 4-20mA Signal Converter Package (Model 101 shown, other models similar)



i) Electrical connections to the **FLOW SENSOR** cable assembly

The **RED** wire should be connected to **PIN 4** of the signal converter unit.

The **BLACK** wire should be connected to **PIN 2** of the signal converter unit.

The **WHITE** wire should be connected to **PIN 3** of the signal converter unit.

The **GREEN** wire (if present) is NOT used

ii) Connecting a power supply.

A stable low noise 18-24 VDC power supply should be connected to the signal converter as follows:

PIN 1 of the signal converter unit should be connected to the Positive of the power source.

PIN 2 of the signal converter unit should be connected to the Negative (Ground) of the power source.

iii) Electrical connections to the **4-20mA FLOW SIGNAL OUTPUT** cable assembly:

The **CENTER** wire of the cable assembly provides the 4-20mA (active current) signal output and should be connected to the positive terminal of the display, data acquisition system or current meter with an impedance of 0 - 500Ω (Ohms).

The **SHIELD** wire of the cable assembly is the signal negative and should be connected to the negative (ground) terminal of the current meter, 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 FLO-SENSOR® OR FLO-METER®. THIS WILL SERIOUSLY EFFECT 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 McMillan Model 100 FLO-SENSOR® for gases provides a 0-5VDC output proportional to the volumetric flow rate.

The Model 110, S-110 and S-113 FLO-METERS® feature 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 FLO-SENSOR® or FLO-METER® 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 scaleable enabling calculation of flow rates within the sensor's range.

For example:

For a flow range of 100-500ml/min (Range 5) :

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) 4-20mA Outputs (Using the 4-20mA Signal Converter)

By monitoring the current output signal it is possible to determine the flow rate of the gas. Units are configured so that an output signal of 20mA is provided when the maximum flow (i.e. Full Scale flow) is passing through the unit. The output signal is 4mA when flow is at or below the specified low flow rate for the unit. The output signal is linear and scaleable enabling calculation of flow rates within the sensor's range. For example:

For a flow range of 2.0-10.0l/min (Range 9) :

At 10.0l/min the output signal would be 20mA

If the output signal were 9mA then the flow rate would be:

$$[10.0 \div (20-4)] \times 9 = 5.63\text{l/min}$$

c) Units With an Integral Display

The Model 110, S-110, and S-113 feature an integral 3 ½ digit LCD display. This is configured to read in ml/min for flow ranges 2-5 and in l/min for flow ranges 6-14. 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
(Model S-114 shown, other S Series 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 the McMillan Service Department if your FLO-SENSOR® or FLO-METER® needs recalibration.

6. Using FLO-SENSORS® or FLO-METERS® with Different Gases

McMillan FLO-SENSORS® or FLO-METERS® will operate with most gases subject to compatibility of the wetted parts. *For information about calibrating for Hydrogen or Helium, contact the McMillan Service Department.*

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 effect 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_{new} = Specific gravity of CO₂ = 1.517

S_{current} = 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 the McMillan Service Department if accurate, certified recalibration is required.

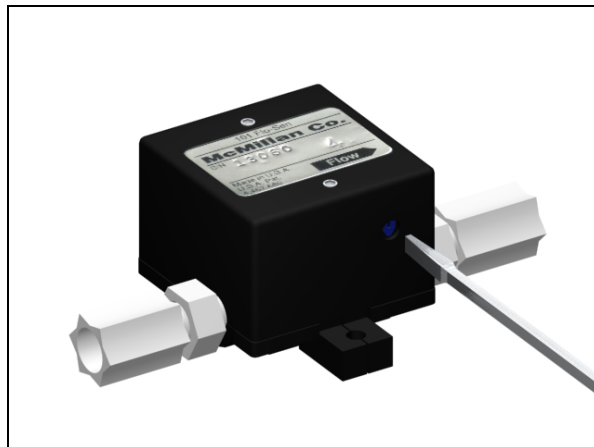
Calculating a correction factor for a gas enables the calibration of the unit to be adjusted for that gas. This is accomplished by:

- 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
(Model 100 shown, other models similar)***



D. Maintenance and Product Care

1. General



CAUTION: Do not disassemble your FLO-METER® or FLO-SENSOR® for any reason. If the unit appears to be malfunctioning please contact the McMillan Service Department.

McMillan FLO-SENSORS® and FLO-METERS® require 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 the McMillan Service Department 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 build up 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 a unit for repair or recalibration please contact the McMillan Service Department or follow the procedure detailed on the McMillan web site. A Return to Manufacturer 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 (see section I).

The McMillan Service Department may be contacted as follows:

Mailing address: McMillan Company
P.O. Box 1340
Georgetown, TX 78627
U.S.A.

Phone: U.S.A. (512) 863-0231
Fax: U.S.A. (512) 863-0671

Email: tech@mcmflow.com

Website: www.mcmflow.com

E. Part Number Information

DESCRIPTION	CODE
Model 100 FLO-SENSOR®	100
Model 110 FLO-METER®	110
Model S-110 FLO-METER®	S-110
Model S-113 FLO-METER®	S-113
Flow Range (ml/min of AIR)	
20-100 ml/min	3
40-200 ml/min	4
100-500 ml/min	5
200-1000 ml/min	6
0.4-2.0 l/min	7
1.0-5.0 l/min	8
2.0-10.0 l/min	9
4.0-20.0 l/min	10
10.0-50.0 l/min	11
20.0-100.0 l/min	12
40.0-200.0 l/min	13
100.0-500.0 l/min	14
Power / Output Signal	
11.5-15.0 VDC / 0-5 VDC Output	D (Standard)
22.0-25.0 VDC / 0-5 VDC Output	E
Seal Codes	
Viton®	Standard
EPDM	Q
Fittings	
1/8" acetal compression tube	A2
1/4" acetal compression tube	A4
3/8" acetal compression tube	A6
1/2" acetal compression tube	A7
1/8" Kynar PVDF compression tube	K2
1/4" Kynar PVDF compression tube	K4
3/8" Kynar PVDF compression tube	K6
1/8" brass compression	B2
1/4" brass compression	B4
3/8" brass compression	B6
1/8" stainless steel compression	S2
1/4" stainless steel compression	S4
3/8" stainless steel compression	S6
6 mm stainless steel compression	M6
10 mm stainless steel compression	M10
1/4" Nylon barb	AB
1/4" stainless steel barb	SB
Options	
NIST Traceable Calibration Certificate (Air Only)	NIST

Please refer to the product datasheet for the availability of specific options.

F. Accessories

DESCRIPTION	CODE
Cables and Power Adapters (Ordered Separately, Recommended For Operation)	
4-pin Mating Cable with Pigtail Leads, 36" (92 cm) length 3 wire, 12/24VDC Power Required	100-17
4-pin Mating Cable with Pigtail Leads, 36" (92 cm) length 4 wire, 12/24VDC Power Required	100-17T
110VAC Power Adapter Package, 0-5VDC Output <i>For 12VDC Models with 0-5VDC output</i>	S-PS-08
230VAC Power Adapter Package, 0-5VDC Output <i>For 12VDC Models with 0-5VDC output</i>	S-PS-18
Industrial Package, 4-20mA Output, 24VDC power required <i>For 12VDC Models with 0-5VDC output</i>	D-24VDC
Displays (Ordered Separately, More Information Available)	
210R Rate Display, 3½ digit, 5-30 VDC Power	210R
250 Multi-Function Display, 115 VAC Power	250
250E Multi-Function Display, 230 VAC Power	250E
Analog Output Card for Model 250/250E Display	250-10
Alarm Output Card for Model 250/250E Display	250-11

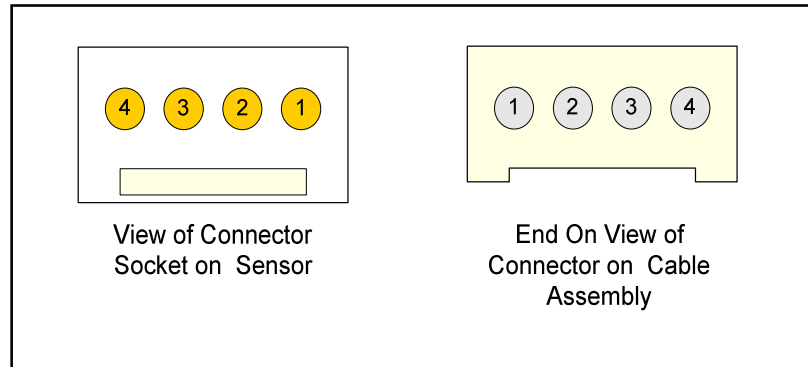
G. Specifications

	Model 100	Model 110	Model S-110	Model S-113
Display	None		3.5 Digit LCD, 0.39" (10mm) high digits	
Accuracy (including linearity)	±3.0% Full Scale*			
Repeatability	±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	±0.2% F.S.* or less per °C			
Wetted Materials	Ryton® 316 Stainless* Epoxy Glass Sapphire		Brass Ryton® 316 Stainless* Epoxy Glass Sapphire	
O-Ring Material	Standard - Viton® EPDM for "Q" Option			
Fitting Material (Standard)	Acetal		Brass	
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 KΩ load			
Typical Power Consumption	Standard: 12 VDC @ 35 mA (11.5-15 VDC) Model 110 Power Adapter 115/230VAC			
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

H. Connector Pin And Wire Color Cross Reference

Pin Configuration for Connector Socket and Connector

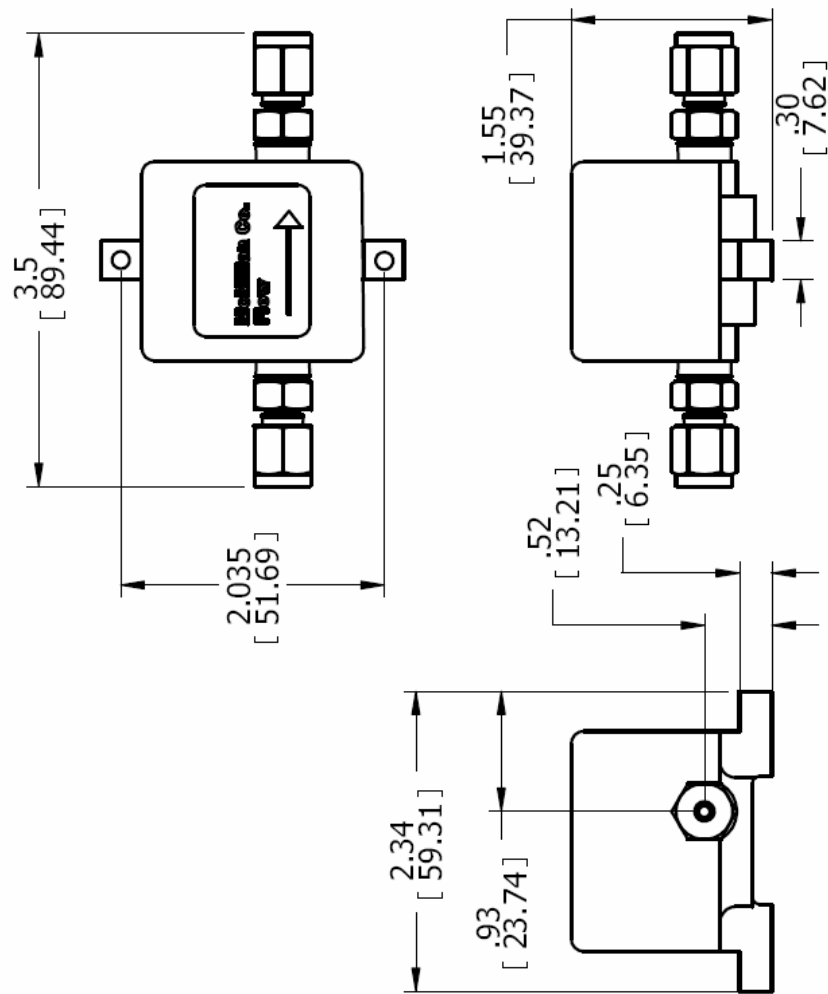


Pin	Cable Wire Color	Description
1	Black	Signal & Power Negative (Ground)
2	White	Voltage Output
3	Red	Power Positive
4	Green	Not Used

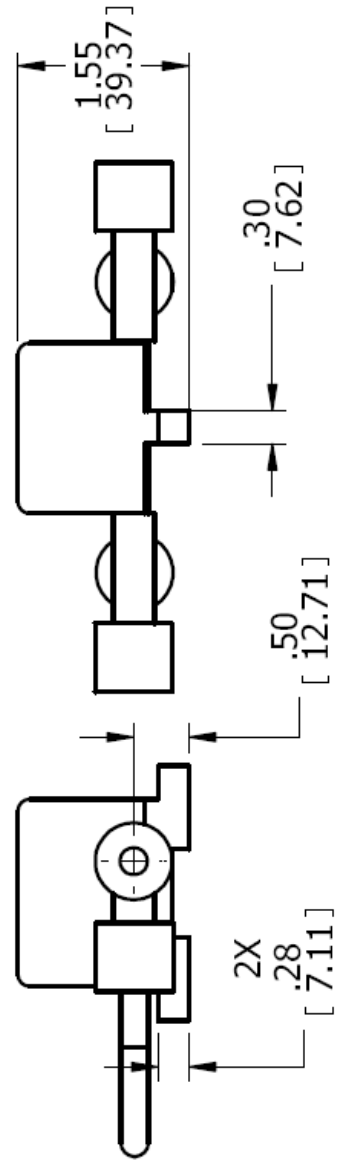
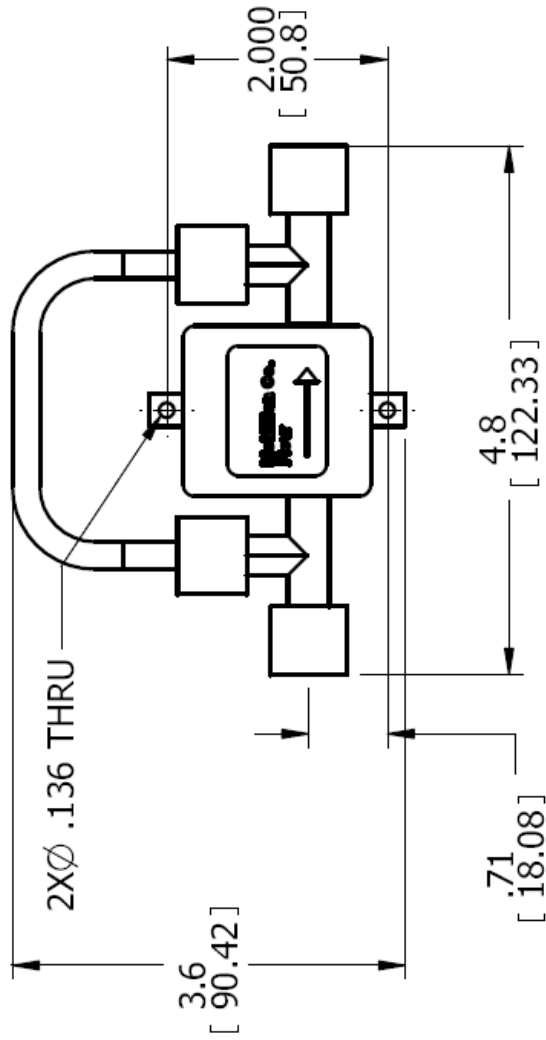
I. Dimensions

ALL DIMENSIONS IN INCHES (MILLIMETERS IN BRACKETS)

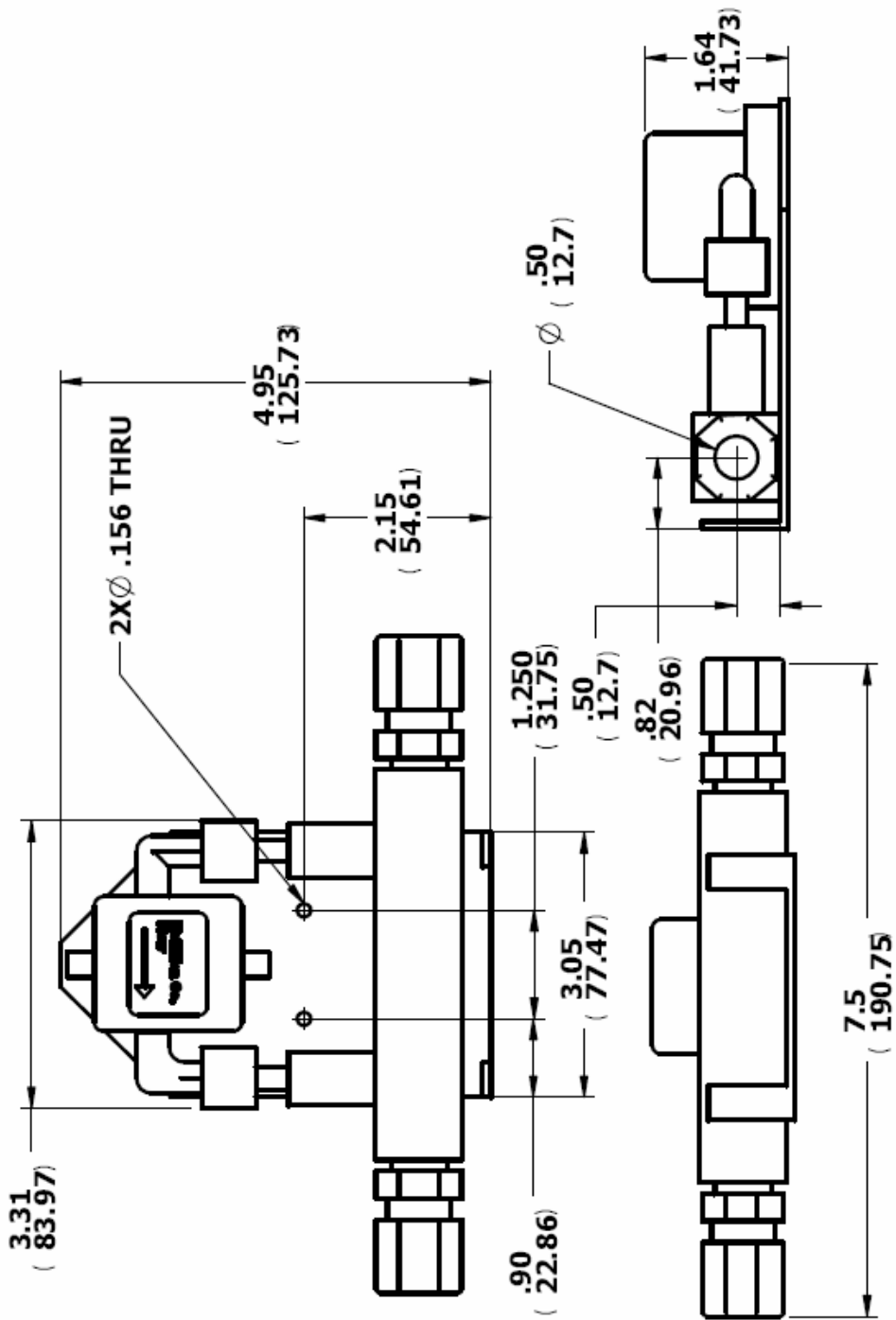
Model 100 - Flow Ranges 3-8,
"A4" Fittings Shown



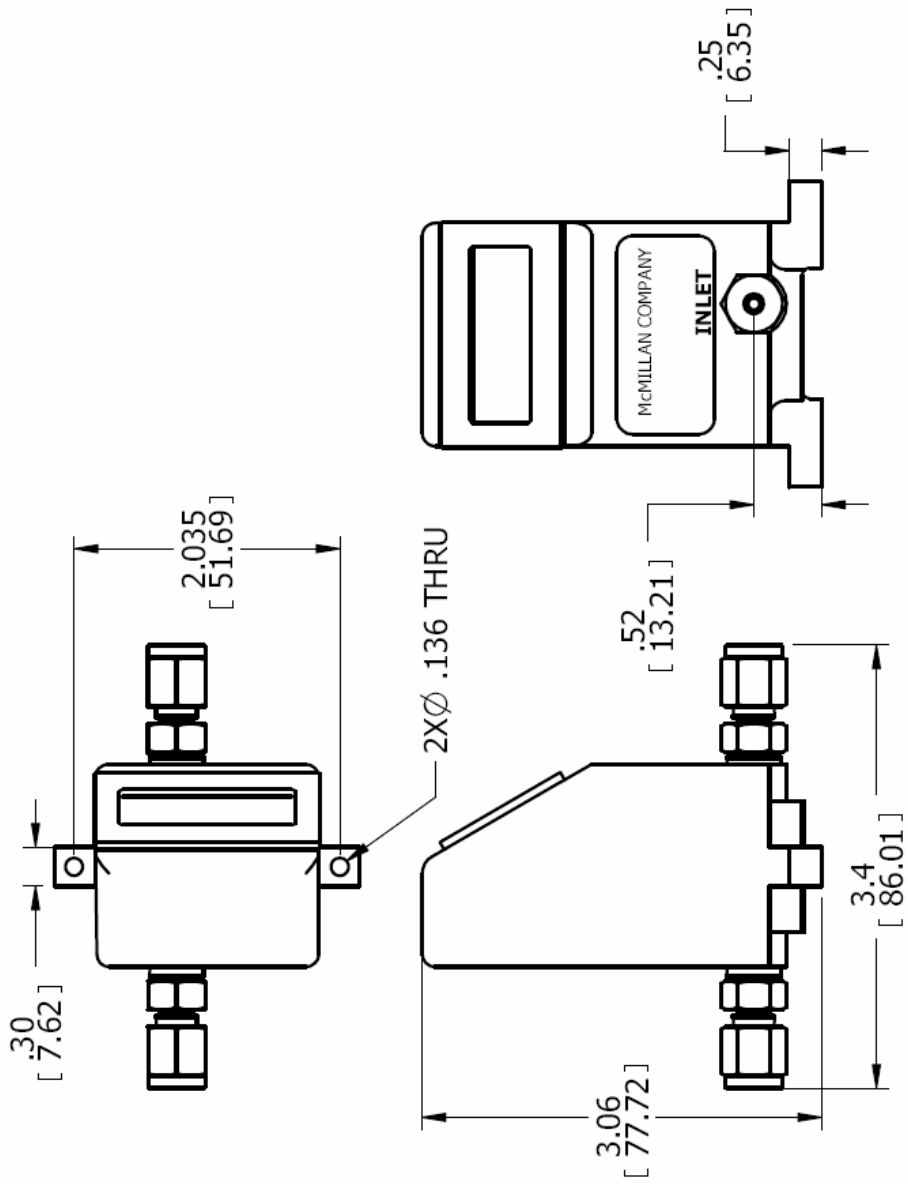
Model 100- Flow Range 9,
"A4" Fittings Shown



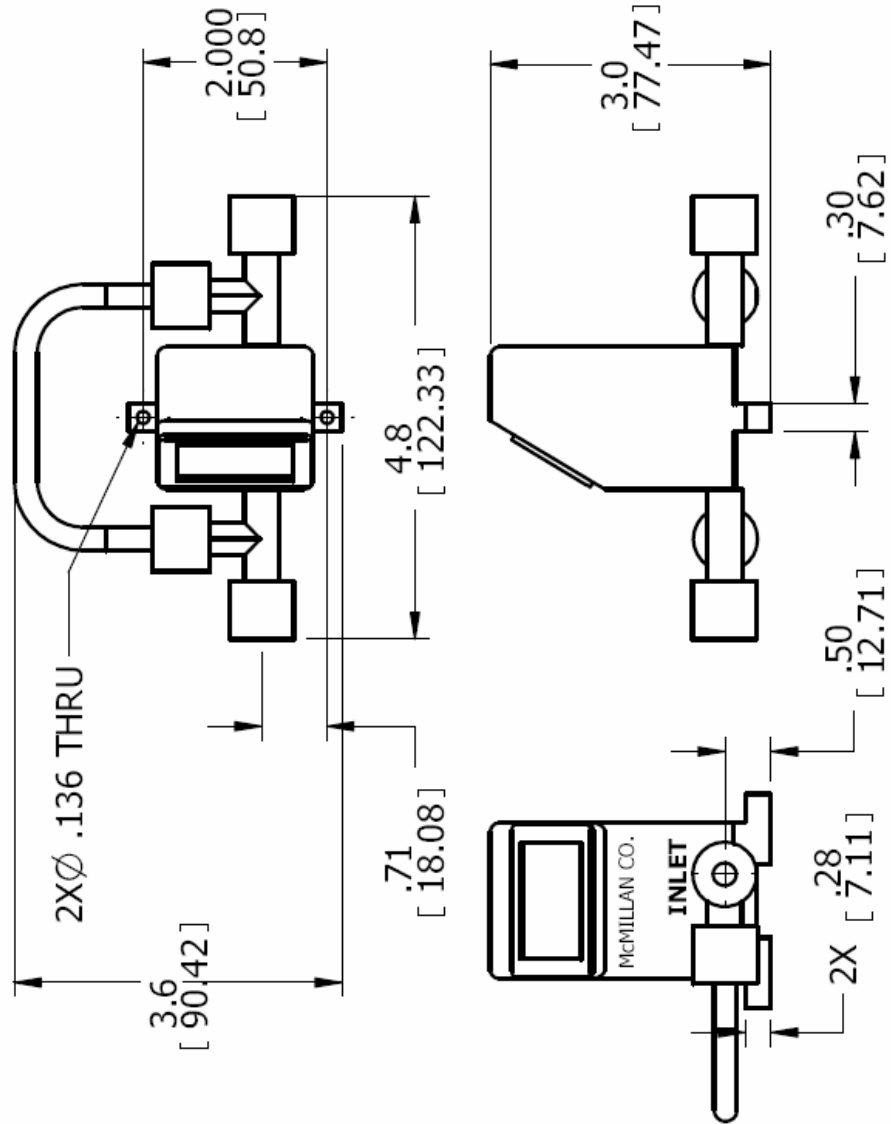
Model 100 - Flow Ranges 10-14,
"A7" Fittings Shown



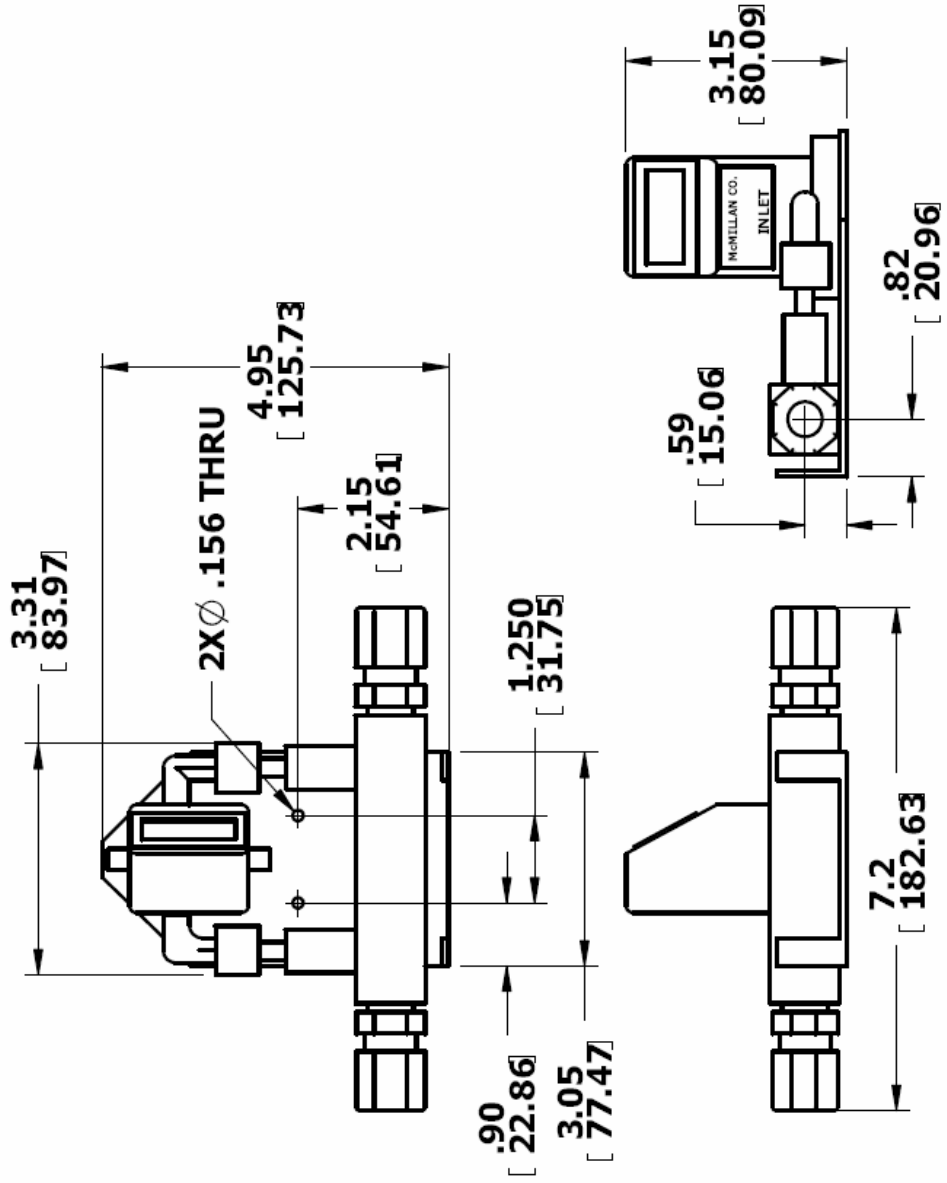
Model S-110 - Flow Ranges 3-8,
"A4" Fittings Shown



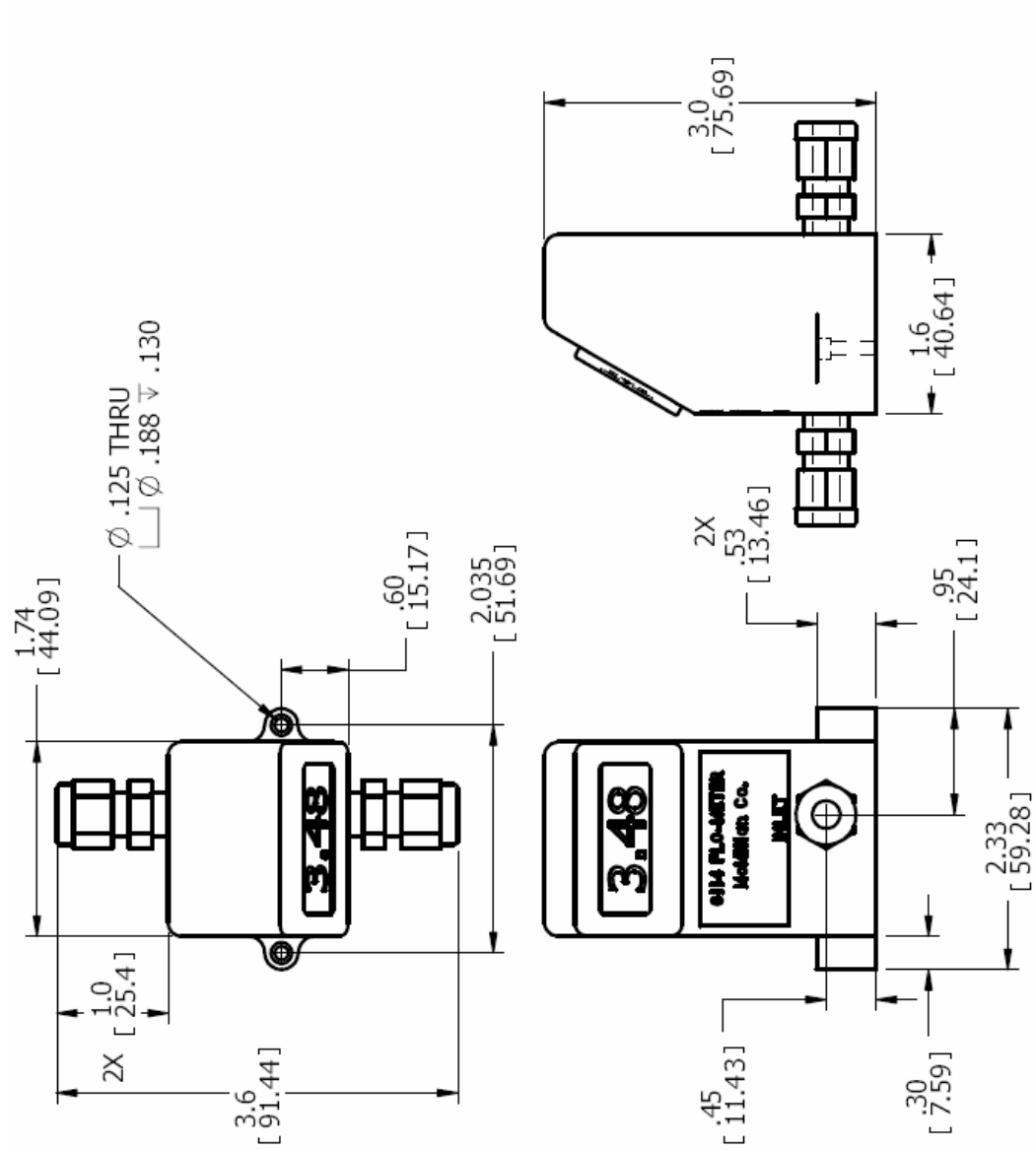
Model S-110 - Flow Range 9,
"A4" Fittings Shown



Model S-110 - Flow Ranges 10-14,
"A7" Fittings Shown



Model S-113 - Flow Ranges 3-9,
"A4" Fittings Shown



J. Limited Warranty For Gas and Liquid Micro-Turbine Flow Products and Associated Standard Accessories (Excludes Ultra High Purity Products)

DURATION OF LIMITED WARRANTY, MATERIALS & WORKMANSHIP

R.D. McMillan Co., Inc., hereinafter referred to as "McMillan", warrants these products and their associated standard accessories manufactured by McMillan and supplied hereunder, to be free from defects in materials and workmanship for a period of twelve (12) months from the date of shipment to the customer when installed, serviced and operated in its recommended environment. This warranty is not affected in any part by McMillan providing technical support or advice.

Replacement parts are warranted to be free from defects in material or workmanship for ninety (90) days or for the remainder of the Limited Warranty period of the McMillan product in which they are installed, whichever is longer. Parts not installed by factory authorized service centers may void the warranty.

PRODUCT RETURNS

(a) General Policy:

Any product or parts determined by McMillan's inspection to have failed per this warranty, will at McMillan's option, be repaired or replaced with an equivalent or comparable product without charge. McMillan's obligation hereunder shall be limited to such repair and/or replacement and shall be conditional upon McMillan's receiving written notice of any alleged defect within ten (10) days of its discovery. The customer will, however, be responsible for returning the product to McMillan's manufacturing facility in Georgetown, Texas, U.S.A., and for assuming the cost of removing the original product and reinstalling the repaired or replaced product. A written specific explanation of the problem must be included with each returned product. Returned goods should be properly packaged to prevent shipping damage and shipped prepaid to McMillan.

(b) Safety Requirements:

For safety reasons, McMillan must be advised of any hazardous fluid or toxic materials that were in or on the product to be returned. Customer must certify in writing that all such hazardous, corrosive or toxic substances have been completely removed, cleaned or neutralized from the returned product prior to shipment to McMillan. McMillan shall hold the returned items pending receipt of customer's statement for defect and certification of cleanliness of returned items, provided that, prior to such receipt, risk of loss of returned items shall remain with customer. Flow sensors, flow meters and flow controllers must be thoroughly cleaned to remove any toxic, corrosive or hazardous fluids that may internally remain therein before shipping product to McMillan.

(c) Shipping Requirements:

Customer is responsible for all shipping charges (except for those products under warranty, in which cases customer shall bear the cost of inbound shipping as described herein below, and McMillan shall bear the cost of outbound shipping). Customer is responsible for the costs of out of warranty repairs and/or recalibration. McMillan will ship items repaired under warranty back to customer by the most economical shipping means. Expedited shipping methods may be available at customer's expense. All returned items shall be returned to a McMillan authorized service center., freight prepaid, accompanied or preceded by a particularized statement of the claimed defect and with a clearly readable Returned Material Authorization ("RMA") number affixed to the shipping label. Contact McMillan Customer Service Department for RMA number. Warranty claims shall be made only by using the McMillan's Returned Material Authorization form, completely filled out and returned to McMillan in accord with McMillan's Product Return Policy and Procedure Form.

Contact McMillan's Customer Service Department as follows for instructions:

Telephone calls in U.S.A. (CST) 1-800-861-0231
Outside U.S.A. +1 512-863-0231 Or Fax: + 1-512-863-0671
E-mail: sales@mcmflow.com

DESIGN, PROCESS and MANUFACTURING CHANGES

McMillan may make changes in the design or manufacture of any products sold hereunder without incurring any obligation to incorporate such changes into products manufactured prior to incorporation of such design or manufacturing changes. McMillan reserves the right to make design or manufacturing changes without prior notice. McMillan products and replacement parts are manufactured using new materials or new and equivalent to new in appearance, performance and reliability. Due to continuous research, testing, product improvements and enhancements, McMillan reserves the right to change product specifications without notice, except to the extent an outstanding bid obligation exists.

LIMITATION of LIABILITY

Except as expressly set forth in this limited warranty, McMillan makes no other warranties or conditions, express or implied, including any implied warranties of merchantability and fitness for a particular purpose. McMillan expressly disclaims all warranties and conditions not stated in this limited warranty. Any implied warranties that may be imposed by law are limited in duration to the limited warranty period. Buyer/customer agrees that models or samples shown to buyer/customer were merely used to illustrate the purchased product and not to represent, promise or guarantee that any purchased products delivered hereunder would conform to such models or samples. McMillan's distributors or sales representatives have no authority to give warranties beyond those provided in this limited warranty.

If customer's product fails to work as warranted herein, customer's sole and exclusive remedy shall be the repair or replacement at McMillan's option. McMillan is not liable for any damages caused by the product or the failure of the product to perform, including any lost profits or savings, incidental or consequential damages. McMillan is not liable for any claim made by a third party or made by a buyer for a third party. No actions arising out of sale of the products sold hereunder or this limited warranty may be brought by either party more than two (2) years after the cause of action accrues. This limitation of liability applies whether damages are sought, or a claim made, under this limited warranty or as a tort claim (including negligence and strict product liability), a contract claim, or any other claim. This limitation of liability cannot be waived or amended by any person. This limitation of liability will be effective even if customer has advised McMillan or an authorized representative or distributor of McMillan of the possibility of any such damages

This limited warranty gives customer specific legal rights. Customer may also have other rights that may vary from state to state or country to country. Customer is hereby advised to consult applicable state or country laws for a full determination of customer's rights.

EXCLUSIONS FROM WARRANTY

This limited warranty provided herein shall not apply to any product which:

- (1) has been repaired or altered outside of McMillan's factory (or authorized service center) in any way so as, in McMillan's judgment, to affect such purchased item's reliability or performance.
- (2) has been subject to misuse, mishandling, negligence, accident, or acts of God.
- (3) has been operated other than in accordance with the printed instructions prepared by McMillan and provided by McMillan with the product.
- (4) has been returned to McMillan after more than thirty (30) days following the date of the alleged product failure.
- (5) has been returned to McMillan without complying with the Safety Requirements or the Shipping Requirements contained herein.
- (6) requires calibration and/or routine maintenance, unless this calibration or routine maintenance is required as a result of a product failure that is covered under terms of this warranty.

- (7) are consumable parts, such as filter elements, batteries or tube fittings.
- (8) requires replacement or repairs resulting from buyer's improper choice of product flow range, or require repair or replacement due to buyer subjecting product to corrosive fluids or other fluids not suited for use in product
- (9) has flow passages clogged due to failure to use a filter to protect product from particulates in fluid flow stream, or other cause to produce clogged passages
- (10) has been operated outside of recommended specifications (such as voltage, temperature, or flow range, etc.)
- (11) has been damaged or cracked due to negligence in failing to follow printed instructions to prevent excessive torque from being applied to product housing (generally polyphenylene sulfide plastic)
- (12) has been damaged as a result of gross over-speeding, or prolonged over-speeding of the micro-turbine wheel
- (13) has been damaged as a result of severe sudden impact forces (example: dropping the product)

METHOD OF SETTLEMENT OF ANY CLAIMS, DISPUTES AND CONTROVERSIES

The provisions of this warranty are severable and if one or more provisions are deemed invalid, the remaining provisions shall remain in effect. Further, in the event that any provision is held to be over broad as written, such provision shall be deemed amended to narrow its application to the extent necessary to make the provision enforceable according to applicable law and shall be enforced as amended. This warranty shall be construed and interpreted in English.

All claims, disputes and controversies arising out of or relating in any way to claims under any warranties, either express or implied (including implied warranty of merchantability), or claims based on any consumer protection act or deceptive trade practice act, contract, tort, statute, or common law, or any alleged breach, default, and/or misrepresentation, will be resolved by means of final and binding arbitration. This limited warranty, including any contests to the validity or enforceability of this limited warranty, shall be finally settled by arbitration under the Rules of Conciliation and Arbitration of the International Chamber of Commerce by one or more of its arbitrators appointed in accordance with the Rules, and judgment upon award rendered may be entered in any court having jurisdiction thereof. The place of arbitration shall be Austin, Texas U.S.A., and the Texas Uniform Commercial Code, as then enacted shall govern the rights and duties of the parties of this agreement without regard to conflicts-of-law principles. The arbitration shall be conducted in English. The UN Convention on Contracts for the International Sale of Goods shall not apply to this Limited Warranty.

R. D. McMillan Company, Inc.
7075 R.R. 2338
P. O. Box 1340
Georgetown, Texas U.S.A. 78627

K. Troubleshooting Guide

Symptom	Possible Cause	Method of Correction
Unit Leaks	Fittings not tight enough.	Tighten fittings (see section B4)
	Sensor assembly cracked	Unit must be returned for repair (see Section J)
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 B5)
	Improper connection	Check electrical connections (see section B5) 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 J)
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 J)

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

L. Contacting McMillan

Website: www.mcmflow.com
Email: tech@mcmflow.com

Mailing address: McMillan Company
P.O. Box 1340
Georgetown, TX 78627
U.S.A.

Shipping address: McMillan Company
7075 RR 2338
Georgetown, TX 78628
U.S.A.

Phone: (512) 863-0231
Fax: (512) 863-0671

For repairs and/or return information, please contact our service department any of the ways shown above.

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Revision 4
www.mcmflow.com