



MODEL 50K
MODEL 50S
MODEL 50D
MODEL 50SD
THERMAL MASS FLO-SENSORS® and FLO-METERS®

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.

*Contents of Box
Model 50K/50S shown; Model 50D and 50SD have an integrated display.*

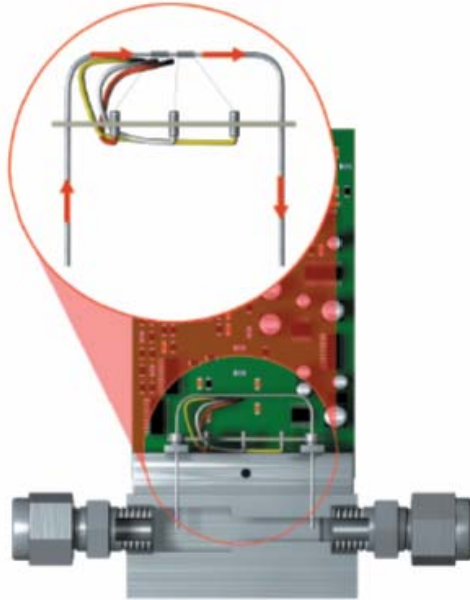


Caution: Take care not to **drop** your sensor. Read the installation section of this manual before providing power or tubing connections to the unit. Any damage caused by improper installation or careless handling will not be repaired under warranty (see limited warranty on page 25 for more details).

2. Product Overview and Principle of Operation

McMillan Model 50 Series Mass FLO-SENSORS® & FLO-METERS® are capable of measuring virtually any clean, dry gas as low as 0-20 sccm or as high as 0-500 l/min. Repeatable results are achieved using a patented thermal mass flow sensor

design. This proven design minimizes zero drift while maintaining fast response and linear outputs with virtually no maintenance.



The McMillan Company Model 50 Series utilizes thermal sensing technology. A portion of the gas flowing through the unit is redirected into a small sensor tube. This tube has two coils on the outside. The first coil introduces a small amount of heat into the gas stream. As the gas passes through the tube, heat is transferred from one coil to the other. The flow rate is proportional to the amount of heat transfer. Smart electronics analyze the amount of temperature change in the second coil and provide a linearized analog output. McMillan's patented* system insures that the zero remains stable and the sensor is extremely repeatable.

The output of the thermal mass flow sensor is directly related to the specific heat characteristic of the gas being measured. A sensor is calibrated for one gas but may be used with other gases by applying a correction factor to the output. The calibration gas for each specific FLO-SENSOR[®] or FLO-METER[®] is detailed on the product label.

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 (eg. 50K-Z1908) 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.

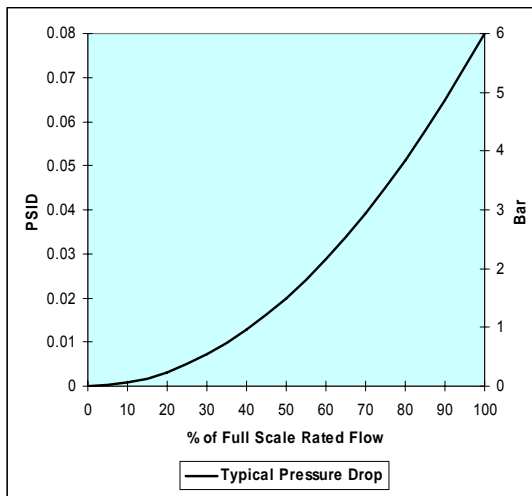
1. General Considerations

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

Pressure drop across the Model 50 Series is approximately 0.08 psi (6 millibar) at 100% of the rated flow.

Pressure Drop vs. Percentage of the Full Scale Rated Flow for the Model 50 Series



2. Mounting the FLO-METER® or FLO-SENSOR®.

McMillan Model 50 series sensors have no particular orientation requirements so may be mounted in any convenient position.

It is recommended that units be fixed to a suitable substrate using the two 4-40 mounting holes provided.

*Mounting View from Bottom
(mounting hardware not included with sensor)*



3. Tubing Connections

a) General

All tubing must be clean, dry and purged with clean dry air before installation of the FLO-SENSOR[®] or FLO-METER[®].

If the gas to be used may contain particles then a filter (20 microns or less) should be installed upstream of (before) the unit.



Caution: Use only the fittings factory installed 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, take care not to over-tighten the fittings or leaking may occur.

b) High Flow Units (Ranges 13, 14 and 15 : 0-100 L/min and above)

It is recommended that tubing with a 0.5" (12.7 mm) outside diameter, 0.40" – 0.42" (10.16 mm – 10.67 mm) inside diameter is used. Using any other tube size may effect the calibration.

High flow units should be installed with at least a 5" (127 mm) long straight length of tube immediately before the sensor. For flow rates above 200 L/min (Range 15) a straight length of at least 22" (559 mm) is recommended. Using lengths shorter than these recommendations will effect the calibration of the unit.

McMillan Company is able to calibrate high flow units for specific tubing configurations. Please contact the McMillan Service Department for further details.

4. Installing a McMillan Inline Filter (Optional).

An optional 20 Micron Aluminum filter is available for use with the Model 50 series. If this is ordered at the same time (recommended) as the FLO-SENSOR[®] or FLO-METER[®] it will be preinstalled at the factory.

To install the filter carefully remove the fitting from the INLET side of the sensor making sure that traces of PTFE tape are removed from the internal threads. Replace the PTFE tape on the fitting and screw it into the filter. The filter and fitting assembly should then be screwed into the sensor body.



Caution: The filter is supplied with PTFE tape pre-installed on the male fitting. Do not add to or remove the tape. Take care not to over-tighten the connections or leaking may occur.

Model 50 With Model 90 Inline Filter (ranges 3-8)



Model 50 With Model 91 Inline Filter (ranges 9-10)



5. 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 Model 50 Series provides a 0-5VDC analog output proportional to the flow rate. This output may be connected to a display, data acquisition system or voltmeter with an impedance of greater than 2.5 k Ω (kilo ohms).

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 conductor cable should be used if the length of the wiring is to be longer than 2 meters.

Units are supplied with either a 6 pin mini DIN type connector (requires mating cable assembly), a 9 Pin D Sub connector or 15 Pin D Sub connector.

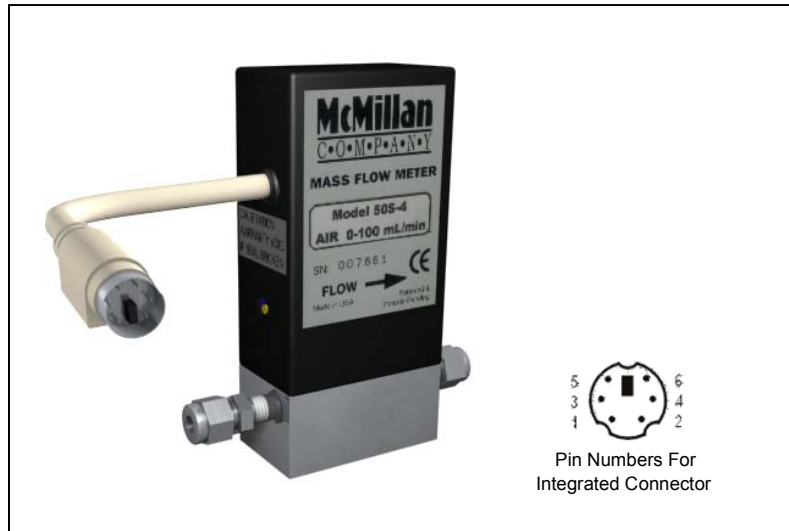


Caution: Cutting off the integrated connectors on the unit IS NOT RECOMMENDED and will void the product warranty. Mating cables should be ordered for each unit.

b) Connecting To The 6 Pin Mini Din Connector

Using a suitable mating connector the pins of the integrated connector should be wired as follows:

Connecting To The Integrated 6 Pin Connector



Pin 2 should be connected to the Positive of the power source.

Pin 6 should be connected to the Negative (Ground) of the power source.

Pin 3 provides the signal output and should be connected to the positive terminal of the display, data acquisition system or voltmeter.

PIN 1 is the signal negative (ground) and should be connected to the negative (Ground) terminal of the display, data acquisition system or voltmeter.

On the integrated 6-pin connector, **PINS 4 & 5** are unused.



Caution: Do not short the output signal pins or allow them to contact the power wires at any time. DAMAGE WILL RESULT!

c) Connecting The 6 Pin Mini Din Connector and Cable Assembly

The two mating connectors should be pushed together and the pigtail leads wired as follows:

Connecting To The Integrated 6 Pin Connector Using A 50-C-X Cable Assembly



The pigtail lead of the 50-C-X cable assembly should be connected as follows:

The **RED** wire (Pin 2 on connector) should be connected to the Positive of the power source.

The **BLACK** wire (Pin 6 on the connector) should be connected to the Negative (Ground) of the power source.

The **ORANGE** wire (Pin 3 on the connector) provides the signal output and should be connected to the positive terminal of the display, data acquisition system or voltmeter.

The **BROWN** wire (PIN 1 on the connector) is the signal negative (ground) and should be connected to the negative (Ground) terminal of the display, data acquisition system or voltmeter.

On the 50-C-X cable assembly, the **GREEN** and **YELLOW** wires, if present, are unused. On the integrated 6-pin connector, **PINS 4 & 5** are unused.

The wire colors above describe the pigtail leads of the 50-C-X cable assembly and may not correspond with the internal wiring of your flow sensor.



Caution: Do not short the output signal wires or allow them to contact the power wires at any time. **DAMAGE WILL RESULT!**

d) Connections For The 9 Pin D Sub Connector

Using a suitable mating connector the pins should be wired as follows:

Connecting To The Integrated 9 Pin Connector



PIN 3 should be connected to the Positive of the power source.

PIN 4 should be connected to the Negative (Ground) of the power source.

PIN 2 provides the signal output and should be connected to the positive terminal of the display, data acquisition system or voltmeter.

PIN 8 is the signal negative (ground) and should be connected to the negative (Ground) terminal of the display, data acquisition system or voltmeter.

Pins 1, 5, 6, 7 and 9 are not used.



Caution: Do not short the output signal pins or allow them to contact the power connections at any time. **DAMAGE WILL RESULT!**

e) Connections For The 15 Pin D Sub Connector

Using a suitable mating connector the pins should be wired as follows:

Connecting To The Integrated 15 Pin Connector



PIN 7 should be connected to the Positive of the power source.

PIN 5 should be connected to the Negative (ground) of the power source.

PIN 2 provides the signal output and should be connected to the positive terminal of the display, data acquisition system or voltmeter.

PIN 10 is the signal negative (ground) and should be connected to the negative (Ground) terminal of the display, data acquisition system or voltmeter.

Pins 1, 3, 4, 6, 8, 9, 11, 12, 13, 14, and 15 are not used.

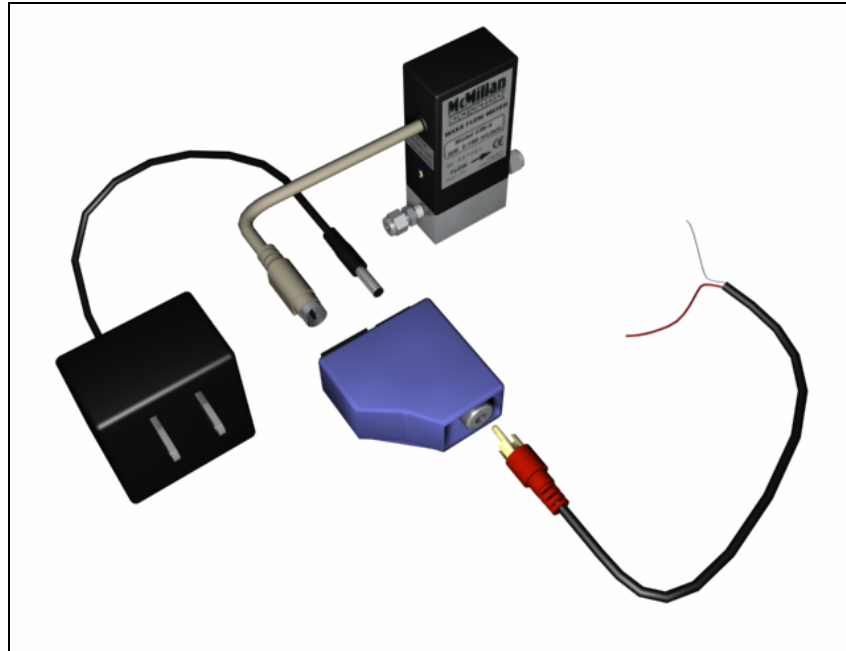


Caution: Do not short the output signal pins or allow them to contact the power connections at any time. **DAMAGE WILL RESULT!**

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

An optional 0-5VDC Output Power Adapter Package is available for use with the Model 50 series. This consists of a power source (115VAC or 230VAC), a connection hub and cable assembly with pig-tail (soldered wire) ends. This should be assembled as shown in the following diagram.

*Assembling an A-115VAC Power Adapter Package
(the A-230VAC Power Adapter Package is similar)*



A 0-5VDC analog output proportional to the flow rate may be made available by connecting the cable assembly to the connection hub. This output may then be connected to a display, data acquisition system or voltmeter with an impedance of greater than 2.5 k Ω (kilo ohms).

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

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

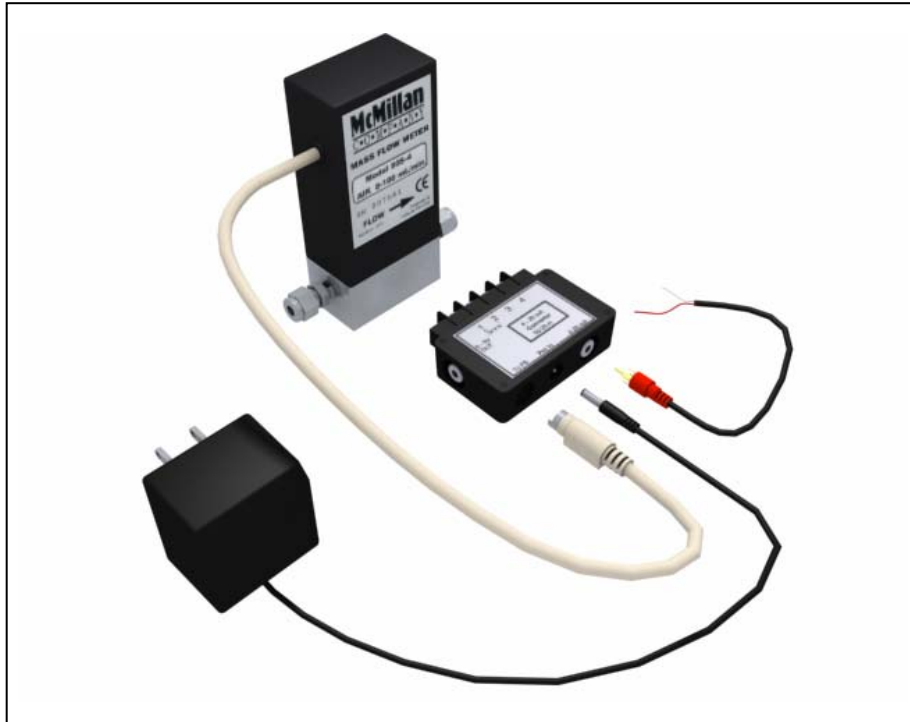


Caution: Do not short the output signal wires or allow them to contact the power wires at any time. **DAMAGE WILL RESULT!**

g) Using a 4-20mA Output Power Adapter Package.

An optional 4-20mA Output Power Adapter Package is available for use with the Model 50 series. This consists of a power source (115VAC or 230VAC), a connection hub and cable assembly with pig-tail (soldered wire) ends. This should be assembled as shown in the following diagram.

*Assembling a B-115VAC Power Adapter Package
(the B-230VAC Power Adapter Package is similar)*



A 4-20mA analog output proportional to the flow rate may be made available by connecting the cable assembly to the connection hub. This output may then be connected to a display, data acquisition system or current meter.

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

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



Caution: Do not short the output signal wires or allow them to contact the power wires at any time. **DAMAGE WILL RESULT!**

C. Operation

1. Warm Up

Before applying power to the unit check all tubing and electrical connections. Once correct installation is verified, you may switch on the power. The unit should then be allowed to warm up for 5 minutes.

2. Verification of Zero

Flow through the unit should be stopped by sealing or capping the inlet of the sensor. It is not adequate to only stop flow by turning off the gas supply or closing a valve as there may be a leak in the system. This would give a false reading.

After 5 minutes, the zero should be stable when there is no flow through the unit. If after 10-15 minutes the output is still not zero volts (within ± 0.5 volts) the unit should be adjusted as detailed in section C part 4.

It should be noted that power supply voltage variations and changes in ambient temperature can have an effect on zero readings.

3. Flow Readings

Each sensor is factory calibrated for a specific flow range and gas (or gas mixture). The calibration gas and flow range are shown on the unit's label and calibration certificate.

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 0-500sccm (Range 6) :

At 500sccm the output signal would be 5VDC

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

$$500 \div 5 \times 3.5 = 350\text{sccm}$$

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

Units may be used for gases other than the calibration gas. In this case a "K Factor" would need to be applied and a corrected value calculated using the following formula:

$$Q_1 / Q_2 = K_1 / K_2$$

Q_1 is the flow rate of the new gas

Q_2 is the flow rate of the original calibration gas

K_1 is the K factor of the new gas

K_2 is the K factor of the original calibration gas

$$Q_1 = (K_1 / K_2) Q_2$$

If K_2 is larger than K_1 then linear results will only be achieved if the unit does not exceed $5(K_1 / K_2)$ VDC for the full scale output.

The accuracy of readings using K factors is not as good as that achieved for the calibration gas. The accuracy obtained (typically $\pm 3\%$ for K factors similar to the calibration gas) depends on the gas being used and the flow rate.

For a list of common K Factors see Section J.

Example 1

For a 0-200sccm unit calibrated for air the flow at 5.0VDC would be 200sccm. The K factor for air is 1. If the unit is used with Helium (K factor 1.454 relative to air) then the flow at 5VDC (i.e. the maximum flow) would be $(1.454/1)200 = 290.8$ sccm

Example 2

For a 0-50.0 l/min unit calibrated for Argon the flow at 5.0VDC would be 50.0l/min. The K factor for Argon is 1.45. If the unit is used with Carbon Dioxide (K factor 0.74) then the flow rate 5.0VDC would be $(0.74/1.45)50.0 = 25.5$ l/min

4. Zero Adjustments

The zero should be checked as detailed in section C part 2. If an adjustment is needed the Zero Potentiometer should be carefully turned using a small flat head screwdriver until the output (VDC) becomes zero.



Caution: Do NOT adjust the Gain Potentiometer when adjusting the zero or the unit will need to be recalibrated.

Care should be taken to only make small adjustments to the zero potentiometer. If too much of an adjustment is made and difficulties are being experienced in

achieving a zero reading then turn the potentiometer fully anti-clockwise and begin making small clockwise adjustments until a zero reading is obtained.

Making Zero Adjustments Using a Small Flathead Screwdriver



5. Recalibration

If recalibration is required please contact the McMillan Service Department.

D. Maintenance and Product Care

1. General

Inlet filters should be periodically checked and cleaned or 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.

Do not allow any liquid or moisture to enter the sensor or damage will occur.

2. 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 website. 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).

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

Web Site: www.mcmflow.com

E. Part Number Information

DESCRIPTION	CODE
Model 50K Aluminum Mass FLO-SENSOR®	50
Model 50D Aluminum Mass FLO-METER® w/display	50D
Model 50S Stainless Steel Mass FLO-SENSOR®	50S
Model 50SD Stainless Steel Mass FLO-METER® w/display	50SD
Flow Range (sccm of air)	
0-50 sccm	3
0-100 sccm	4
0-200 sccm	5
0-500 sccm	6
0-1000 sccm	7
0-2000 sccm	8
0-5000 sccm	9
0-10 l/min	10
0-20 l/min	11
0-50 l/min	12
0-100 l/min	13
0-200 l/min	14
0-500 l/min	15
Power	
12.5-15.0 VDC	Standard
22.0-25.0 VDC	E
Fittings	
1/8" Acetal Compression Tube	A2
1/4" Acetal Compression Tube	A4
3/8" Acetal Compression Tube	A6
1/8" Brass	B2
1/4" Brass	B4
3/8" Brass	B6
1/8" Stainless Steel	S2
1/4" Stainless Steel	S4
3/8" Stainless Steel	S6
1/2" Stainless Steel	S8
3/4" Stainless Steel	S9
3 mm Stainless Steel	M3
6 mm Stainless Steel	M6
8 mm Stainless Steel	M8
12 mm Stainless Steel	M12
1/4" VCR	V4
1/2" VCR	V6
1/4" Nylon Barb	AB
1/4" Stainless Steel Barb	SB
Electrical Connector	
6-pin Mini-DIN (PS/2 type)	Standard
9-pin D-Sub	D1
15-pin D-Sub	D2
Calibration Gas	
Air	Standard
Nitrogen	G1
Oxygen	G2
Hydrogen	G3
Helium	G4
Argon	G5
Carbon Dioxide	G6
Other Single Gas (specify in item description)	G7
Other Gas Blend (specify gases and percentages)	G8
Options	
NIST-Traceable Calibration Certificate	NIST

F. Accessories

DESCRIPTION	CODE
Cables and Power Adapters (Order Separately, Recommended For Operation)	
6-pin Mating Cable with Pigtail Leads, 36" (92 cm) length <i>VDC Power Required</i>	50-C-X
9-pin Mating Cable with Pigtail Leads, 36" (92 cm) length <i>VDC Power Required</i>	50-C-X1
15-pin Mating Cable with Pigtail Leads, 36" (92 cm) length <i>VDC Power Required</i>	50-C-X2
115VAC Power Adapter Package <i>Not for E Models, requires Standard 6-pin Mini-DIN Connector</i>	A-115VAC
230VAC Power Adapter Package <i>Not for E Models, requires Standard 6-pin Mini-DIN Connector</i>	A-230VAC
4-20 mA Output Module, 24 VDC Power <i>Not for E Models, requires Standard 6-pin Mini-DIN Connector</i>	50-20-H
4-20 mA, 115VAC Power Adapter Package <i>Not for E Models, requires Standard 6-pin Mini-DIN Connector</i>	B-115VAC
4-20 mA, 230VAC Power Adapter Package <i>Not for E Models, requires Standard 6-pin Mini-DIN Connector</i>	B-230VAC
Displays (Order 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
Filters (Order Separately)	
Aluminum Filter, Ranges 3-8 <i>Screws into Inlet Port</i>	90
Aluminum Filter, Ranges 9-10 <i>Screws into Inlet Port</i>	91

G. Specifications

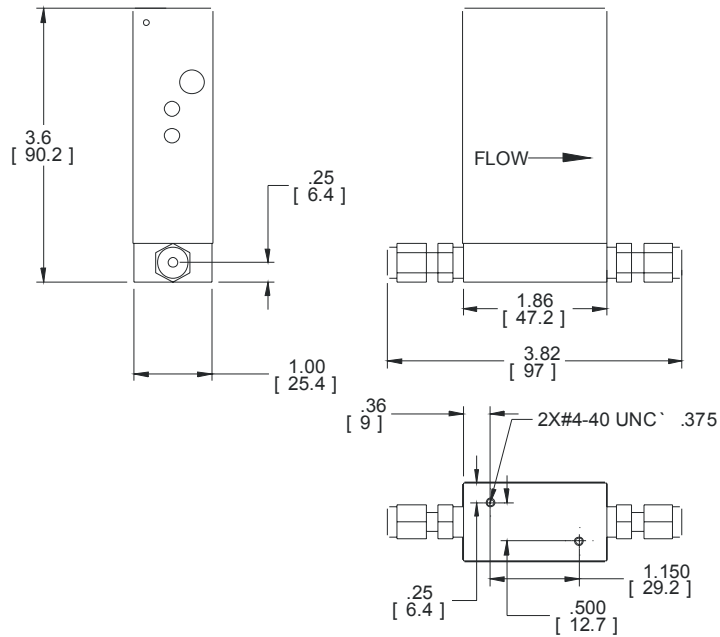
	Model 50	Model 50D	Model 50S	Model 50SD
Accuracy (including linearity)	±1.5% Full Scale*			
Repeatability	±0.25% Full Scale*			
Pressure Rating	150 psig (10.3 bar)		500 psig (34.5 bar)	
Pressure Sensitivity	±0.02% Full Scale* per psi (per 69 mbar)			
Temperature Rating	Operating Range: 5 to 55°C Recommended Range (for best performance) : 10 to 40°C Storage Range: 0 to 70°C			
Temperature Sensitivity	±0.15% F.S.* or less per °C			
Leak Integrity	1x10 ⁻⁷ sccs of He			
Wetted Materials	Aluminum 304 Stainless Steel 316 Stainless Steel		303 Stainless Steel 304 Stainless Steel 316 Stainless Steel Epoxy	
O-Ring Material	Viton®		N/A	
Fitting Material	Choose from acetal, brass, or stainless steel			
Recommended Filtration	20 microns or less Optional inline filters available			
Compatible gases	Clean, dry gases compatible with wetted materials			
0-5 VDC Output Signal	Impedance of greater than 2.5 KΩ			
Warm-Up Time	Less than 5 minutes			
Integrated Display	N/A	3½ digit	N/A	3½ digit
Typical Power Consumption	Standard: 12 VDC @ 100 mA (12.5-15 VDC) "E" Suffix: 24 VDC @ 80 mA (22-25 VDC)			
Peak Power Consumption	Standard: 12 VDC @ 180 mA (12.5-15 VDC) "E" Suffix: 24 VDC @ 160 mA (22-25 VDC)			
Electrical Connections	Integrated 36" (92 mm) cable, terminated with: Standard: 6-pin Mini-DIN male (PS/2 Style) D1 Option: 9-pin D-Sub male D2 Option: 15-pin D-Sub male			
Settling Time	Typically <1 second for 97% of final value			
Reliability	100,000 Hours MTBF (testing ongoing)			
Certifications	CE Approved 89/336/EEC (EN 55011 & EN 50082-1) 73/23/EEC Low Voltage Directive			
Ratings	IP10 (NEMA 1)			

*Specifications from 10-100% of rated flow. Linearity is best fit straight line. All calibrations performed with air unless otherwise stated on calibration certificate.

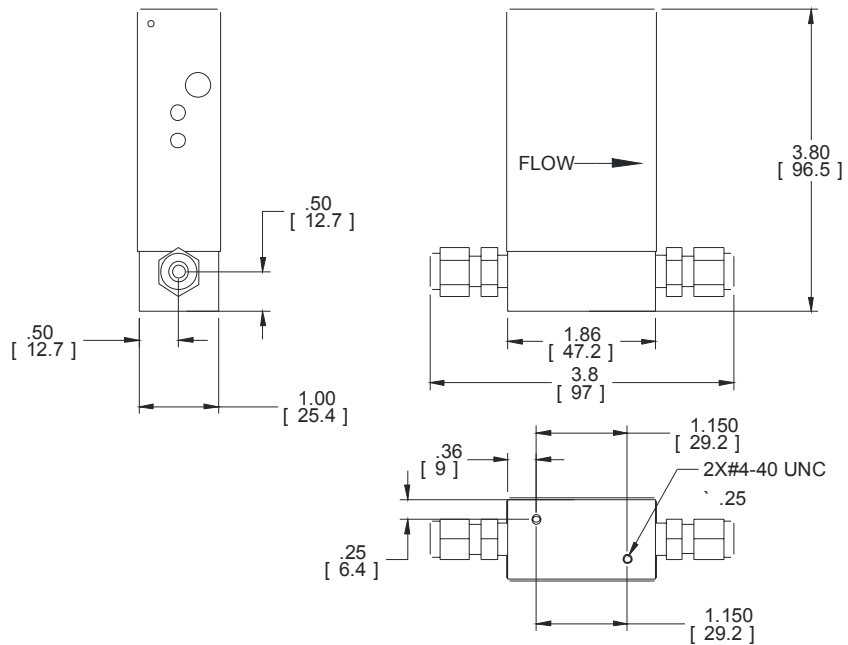
H. Dimensions

ALL DIMENSIONS IN INCHES (MILLIMETERS IN BRACKETS)

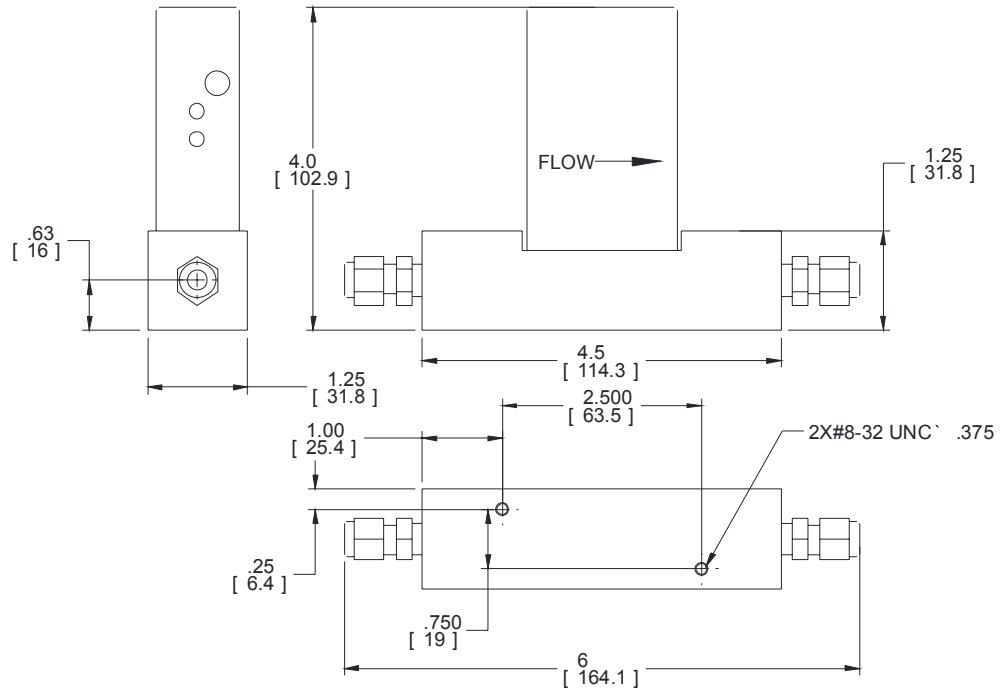
Model 50K Flow Ranges 2-6, "S4" Fittings Shown



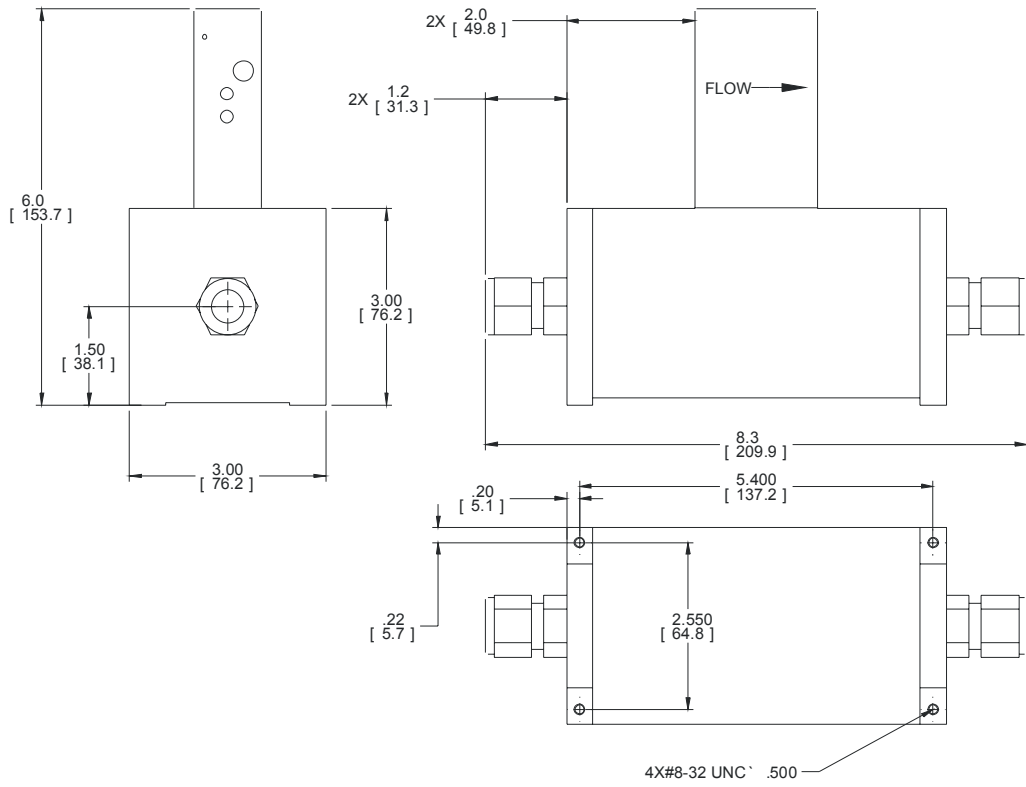
Model 50K Flow Ranges 7-10, Model 50S Ranges 2-10, "S4" Fittings Shown



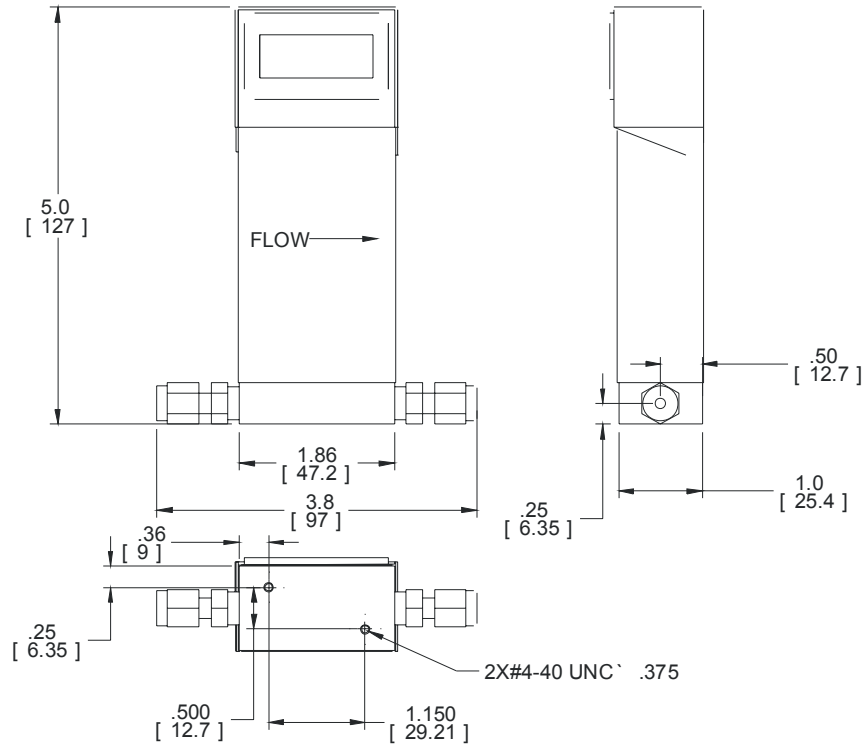
Model 50K / 50S Flow Ranges 11-13, "S6" Fittings Shown



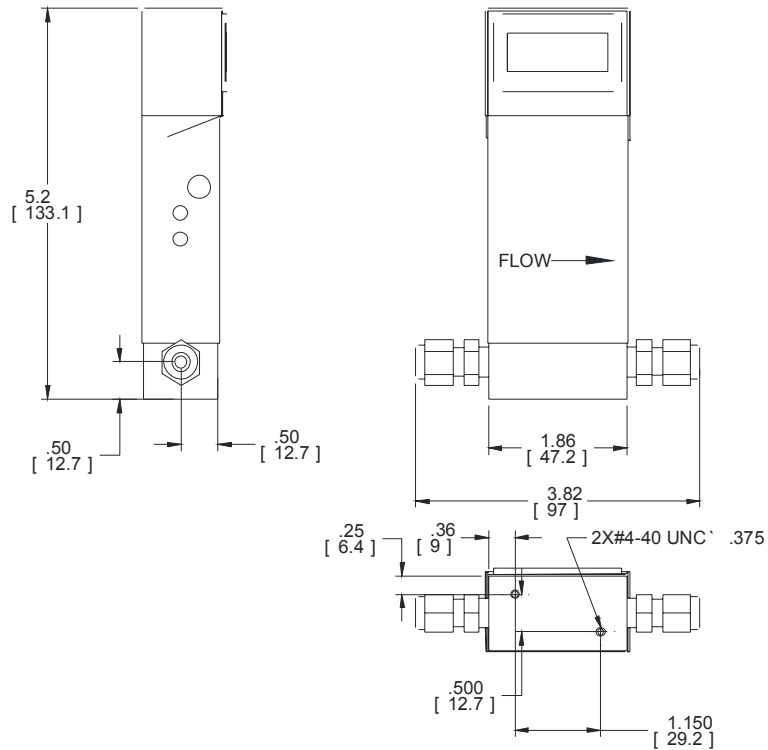
Model 50K Flow Ranges 14-15, "S7" Fittings Shown



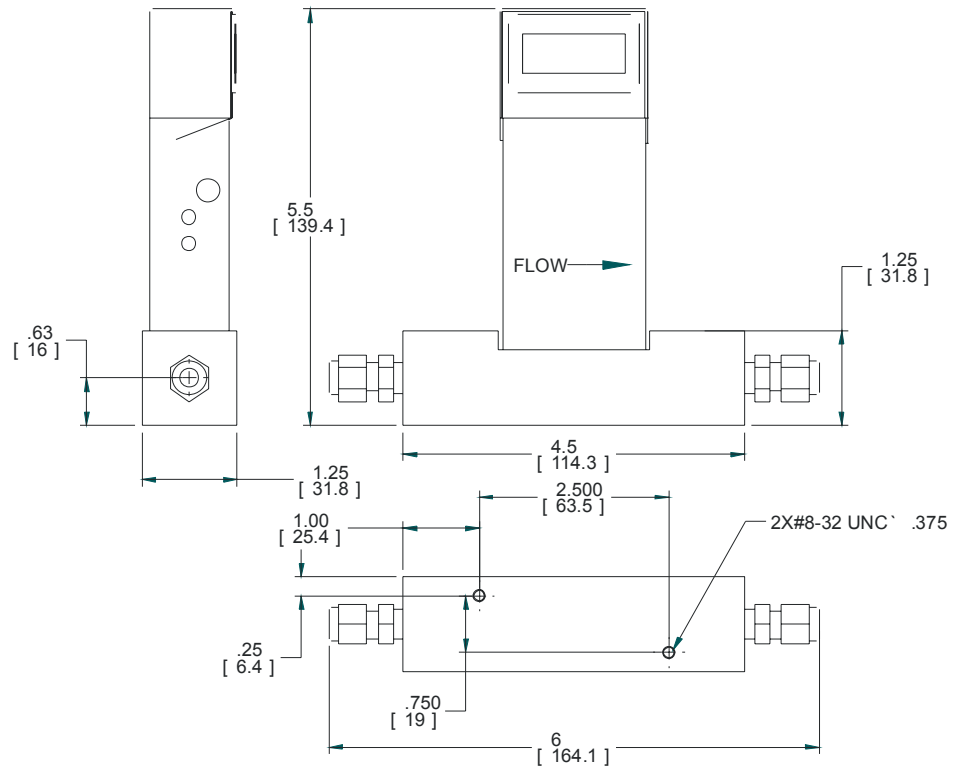
Model 50D Flow Ranges 2-6, "S4" Fittings Shown



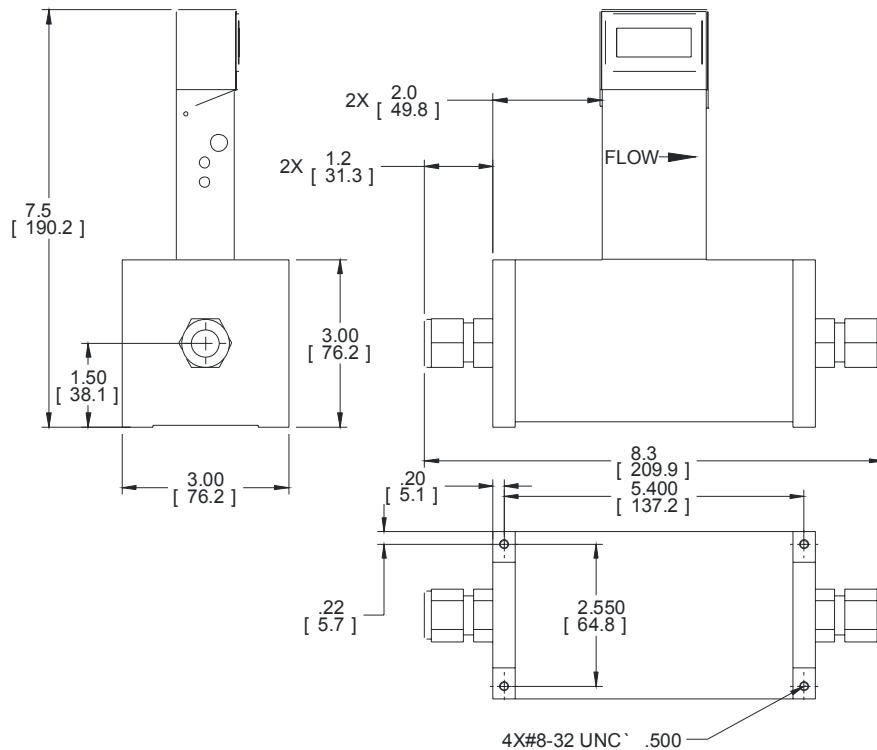
Model 50D Flow Ranges 7-10, Model 50SD Ranges 2-10, "S4" Fittings Shown



Model 50D / 50SD Flow Ranges 11-13, "S6" Fittings Shown



Model 50D Flow Ranges 14-15, "S7" Fittings Shown



I. Limited Warranty

DURATION OF LIMITED WARRANTY, MATERIALS & WORKMANSHIP

R.D. McMillan Co., Inc., hereinafter referred to as “McMillan”, warrants thermal mass flow 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 or Outside U.S.A.
512-863-0231 Or Fax: 1-512-863-0671 or 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.)

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

J. Gas K Factors

<i>Gas</i>	<i>Chemical Symbol</i>	<i>K Factor</i>
Acetylene	C ₂ H ₂	0.589
Air	-	1.000
Argon	Ar	1.438
Butane	C ₄ H ₁₀	0.260
Carbon Dioxide	CO ₂	0.739
Deuterium	D ₂	1.000
Ethylene	C ₂ H ₄	0.598
Freon 11	CCL ₃ F	0.330
Freon 12	CCL ₂ F ₂	0.354
Freon 13	CCLF ₃	0.385
Freon 14	CF ₄	0.420
Freon 22	CHCLF ₂	0.460
Germane	GeH ₄	0.570
Helium	He	1.458
Hydrogen	H ₂	1.011
Krypton	Kr	1.440
Methane	CH ₄	0.721
Neon	Ne	1.443
Nitric Oxide	NO	0.990
Nitrogen	N ₂	1.000
Nitrous Oxide	N ₂ O	0.710
Oxygen	O ₂	0.991
Ozone	O ₃	0.446
Propane	C ₃ H ₈	0.383
Sulfur Dioxide	SO ₂	0.690
Xenon	Xe	1.437

These K Factors are given for reference only and are not intended as a recommendation of application suitability. Accuracy and response will be affected depending on the gas and flow range. Check the compatibility of all wetted materials before using any gas other than the calibration gas for the unit.

K. Troubleshooting Guide

Symptom	Possible Cause	Method of Correction
No response	Unit wired incorrectly	Check wiring is according to Section B5
	Loose connection	Check all connectors and wiring
	Damaged connector pins	Contact factory
	Blocked flow path	Check flow path for obstructions.
	Piping leak before sensor	Check all piping and connections.
	Insufficient power	Check the power supply output and increase if necessary
	Output load resistance too low	Ensure the voltmeter or data acquisition system or display has an impedance of greater than of 2.5kohm
	Flow too low for the unit	Ensure that the flow being measured is within the capabilities of the unit
Inaccurate readings	Unit damaged or faulty	Contact factory
	Particles in flow path	Add filtration before the sensor.
	Flow path obscured	Remove any debris or blockage in the flow path eg. PTFE tape.
	Unit calibrated for a different gas	Check calibration certificate and apply a "K" Factor to readings if necessary.
	Gas composition is variable	Contact factory
	Fittings have been changed	Replace the factory installed fittings
	Moisture in gas	Ensure gas is clean and dry
	Insufficient warm-up period	Allow the unit to warm-up for at least 5 minutes.
	Zero drift	Verify the zero and adjust as necessary as explained in Section C
	The gain potentiometer has been adjusted	Contact the factory
	Unit needs recalibration	Contact the factory
Flow too high for the unit	Ensure that the flow being measured is within the capabilities of the unit	

Symptom	Possible Cause	Method of Correction
Inaccurate Readings	Output load resistance too low	Ensure the voltmeter or data acquisition system or display has an impedance of greater than of 2.5kohm
	Insufficient power	Check the power supply output and increase if necessary
	Ambient temperature too high or too low	Place the unit in a suitable environment
	Gas temperature too high or too low	Ensure the gas temperature is within the recommended operating range
	Unit damaged or faulty	Contact factory
Problems with rezeroing	Gas flow through unit not completely stopped	Ensure there is no flow through the unit. The easiest way to do this is to plug both the inlet and outlet.
	Severe fluctuations in the ambient temperature e.g. unit in direct sunlight	Carry out the rezero procedure in a stable environment
	Unstable power supply	Check the stability and suitability of the power source
	Insufficient warm-up period	Allow the unit to warm-up for at least 5 minutes.

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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