User's Guide

FMA 3100/3100ST/3300/3300ST Series
Thermal Mass Flow Sensors and Meters

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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.

TABLE OF CONTENTS

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 **Omega Engineering** immediately.

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 Omega Engineering to resolve the problem.

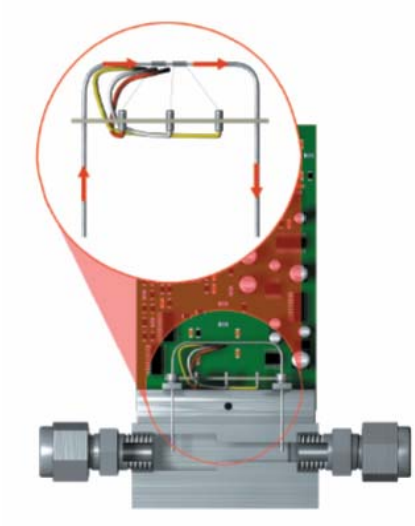
Contents of Box- Sensor, Calibration Certificate & Manual
FMA 3100 Series shown; FMA 3300 series has an integrated display.

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 28 for more details).

2. Product Overview and Principle of Operation

The FMA 3100/3300 Series flow sensors and flow meters from Omega Engineering 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 FMA 3100/3300 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. A 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 flow sensor or flow meter is detailed on the product label.

B. Installation

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

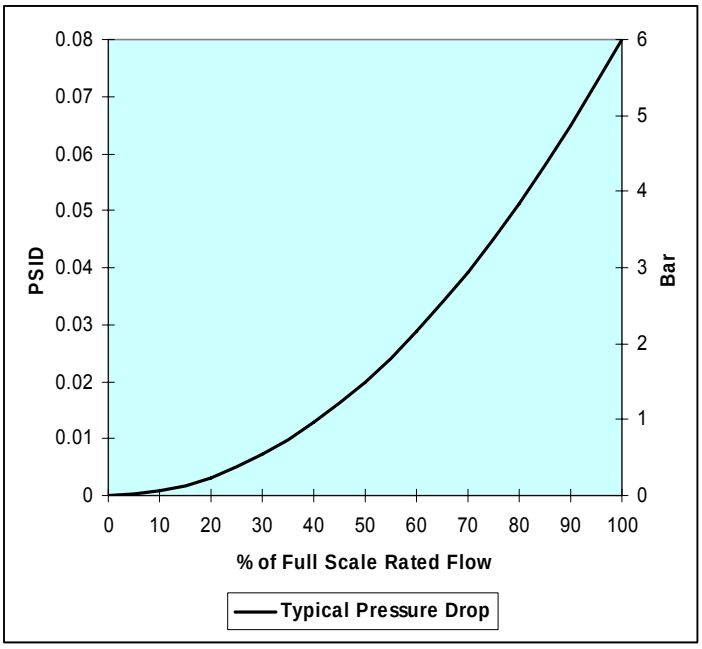
1. General Considerations

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 FMA 3100/3300 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 FMA 3100/3300 Series

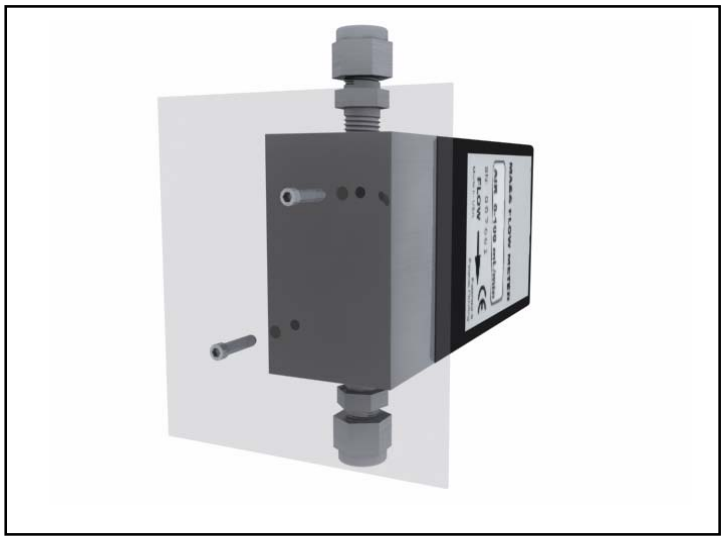


2. Mounting the Flow Sensor or Flow Meter.

The FMA 3100/3300 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 flow sensor or flow 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 Omega Engineering 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 (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 a straight length of at least 22" (559 mm) is recommended. Using lengths shorter than these recommendations will effect the calibration of the unit.

The manufacturer is able to calibrate high flow units for specific tubing configurations. Please contact Omega Engineering for further details.

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 FMA 3100/3300 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 kΩ (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 Numbers For Integrated 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.

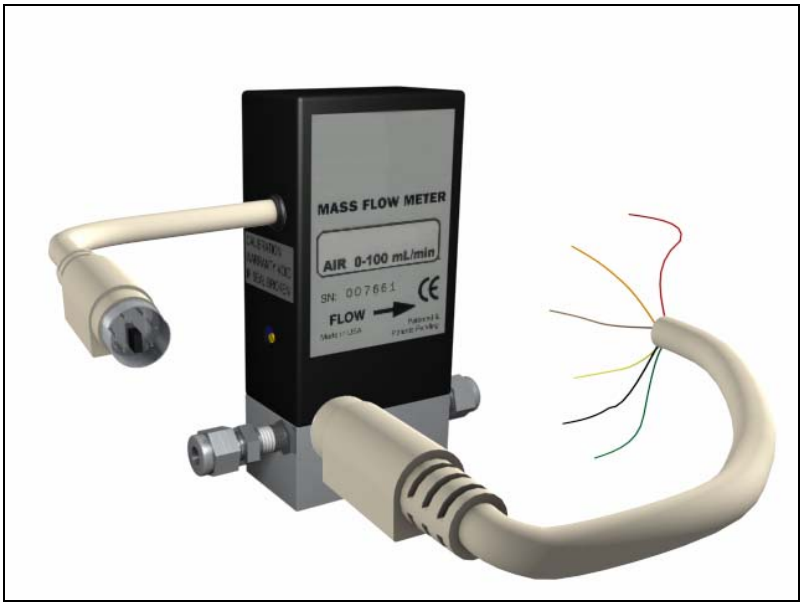
On the integrated 6-pin connector, **PINS 4 & 5** are unused.

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 FMA 3000C Cable

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

Connecting To The Integrated 6 Pin Connector Using A FMA 3000C Cable



The pigtail lead of the FMA 3000C 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 FMA 3000C cable, the **GREEN** and **YELLOW** wires, if present, are unused. On the integrated 6-pin connector, **PINS 4 & 5** are unused.

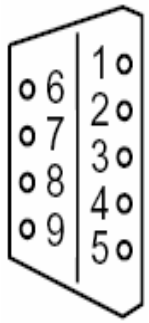
The wire colors above describe the pigtail leads of the 50-C-X cable assembly and may not correspond with the internal wiring of your flow sensor.

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 Numbers For
Integrated 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.

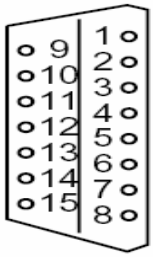
Pins 1, 5, 6, 7 and 9 are not used.

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 Numbers For
Integrated 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.

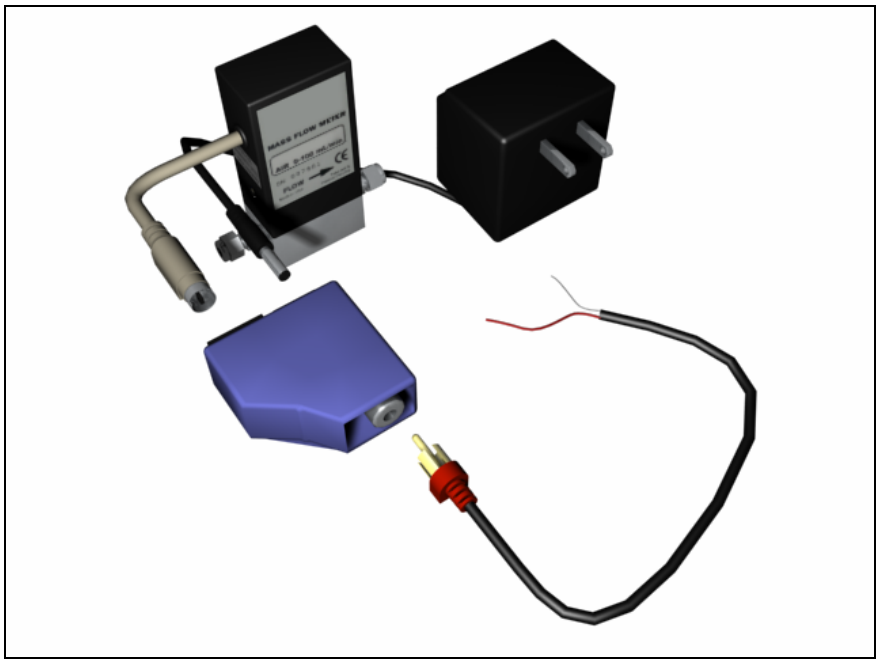
Pins 1, 3, 4, 6, 8, 9, 11, 12, 13, 14, and 15 are not used.

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 FMA 3100/3300 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 FMA 3115PW Power Adapter Package
(the FMA 3230PW 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 kΩ (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!

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 with in the sensor's range. For example:

> For a flow range of 0-500sccm:
>
> At 500sccm the output signal would be 5VDC
>
> If the output signal is 3.5VDC then the flow rate would be:
>
> $500 \div 5 \times 3.5 = 350$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 ±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 = 25.5l/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 Omega Engineering.

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 Omega Engineering Customer Service Department. An Authorized Return (AR) number will then be issued. The AR number should then be noted on the outside of the package and on any correspondence. Further details may be found on page 28 of this manual.

E. Specifications

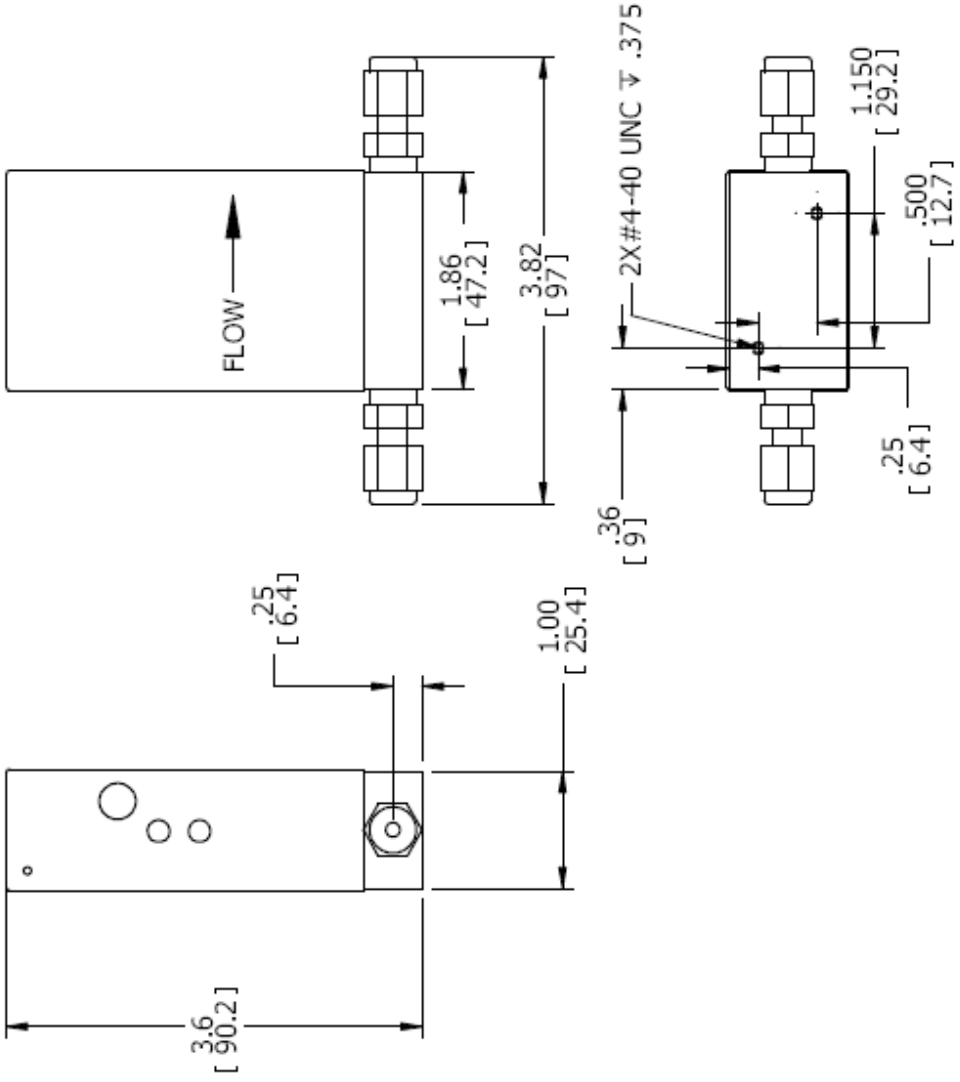
	FMA 3100	FMA 3300	FMA 3100ST	FMA 3300ST
Accuracy (including linearity)	±1.5% Full Scale*			
Repeatability	±0.25% Full Scale*			
Pressure Rating	150 psig (10.3 bar)		500 psig (34.5 bar)	
Pressure Sensitivity	±0.02% Full Scale* per psi (per 69 mbar)			
Temperature Rating	Operating Range: 5 to 55ºC Recommended Range (for best performance) : 10 to 40ºC Storage Range: 0 to 70ºC			
Temperature Sensitivity	±0.15% F.S.* or less per ºC			
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.

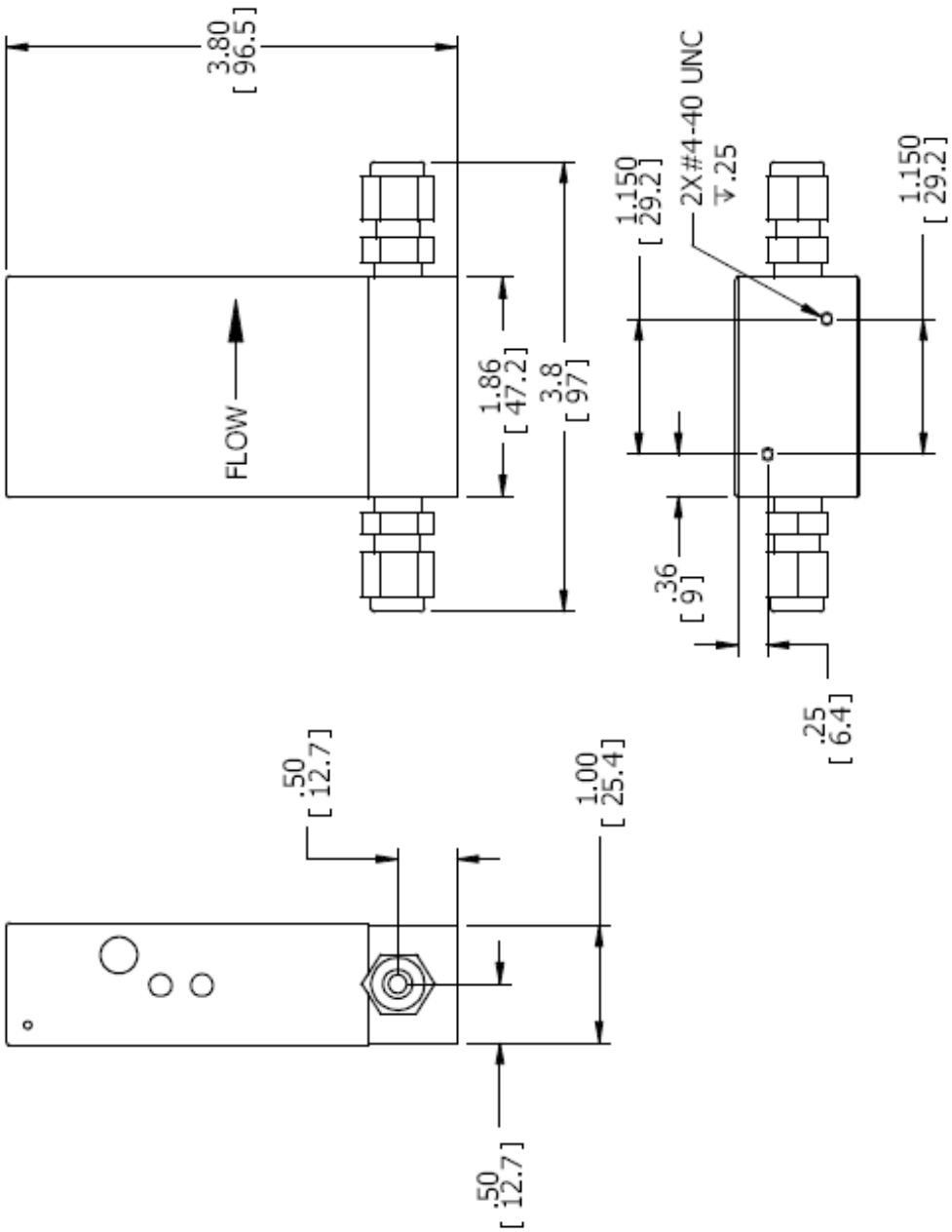
F. Dimensions

ALL DIMENSIONS IN INCHES (MILLIMETERS IN BRACKETS)

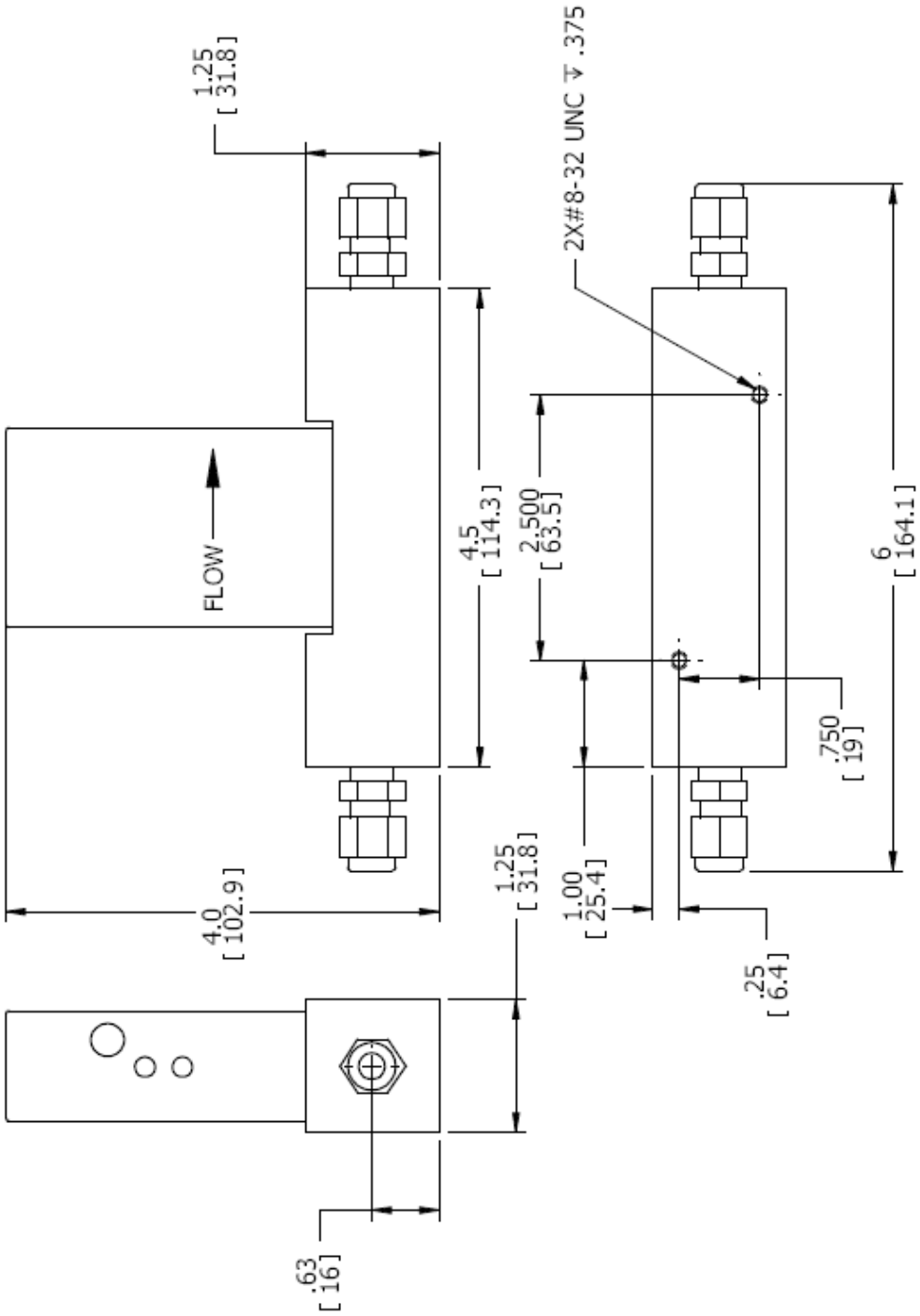
FMA 3100 - 0-500 sccm Flow Ranges and Below
¼" Stainless Fittings Shown



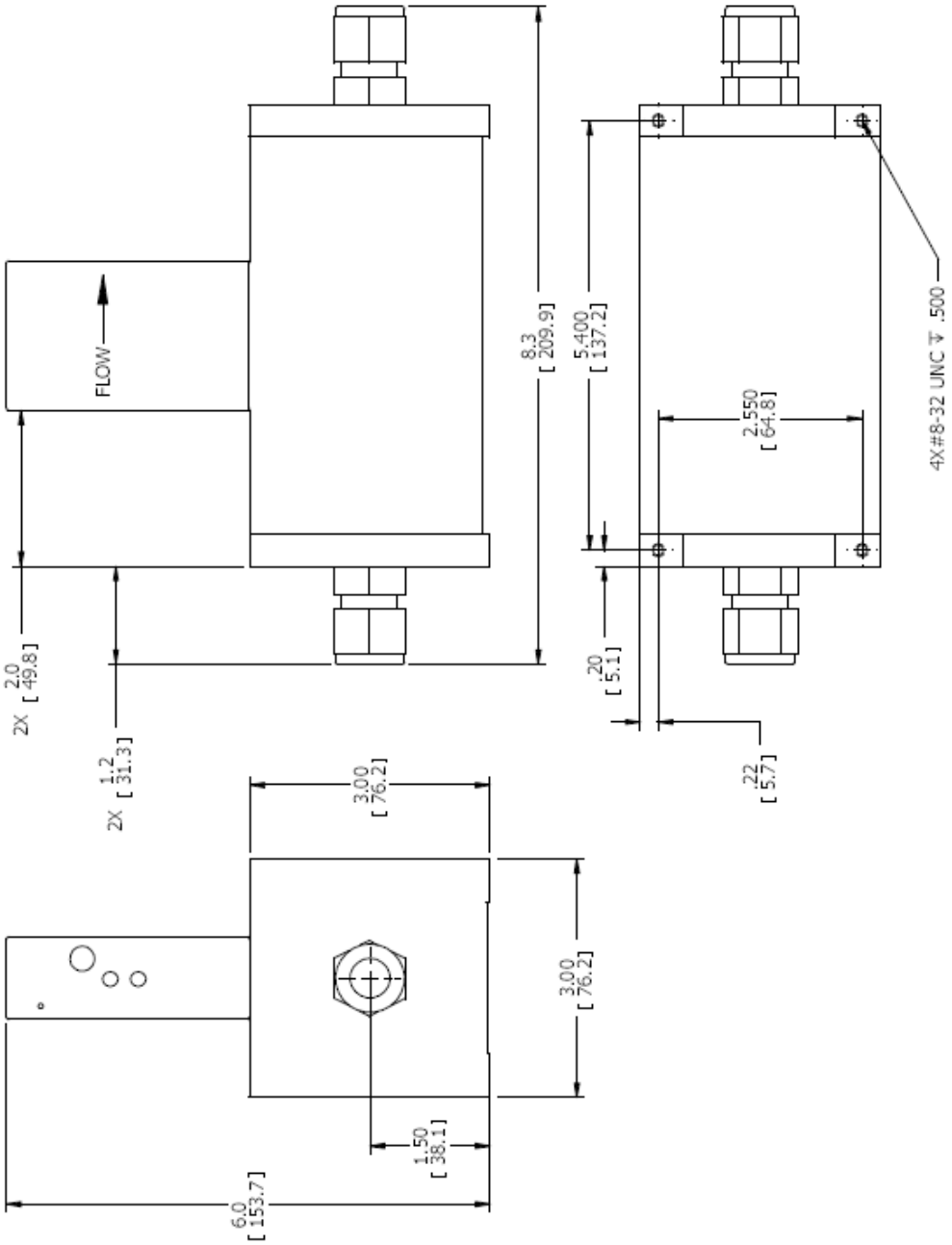
FMA 3100 - 0-1000sccm Up To 0-10 L/min &
FMA 3100ST - All Ranges Up To 0-10 L/min
¼" Stainless Fittings Shown



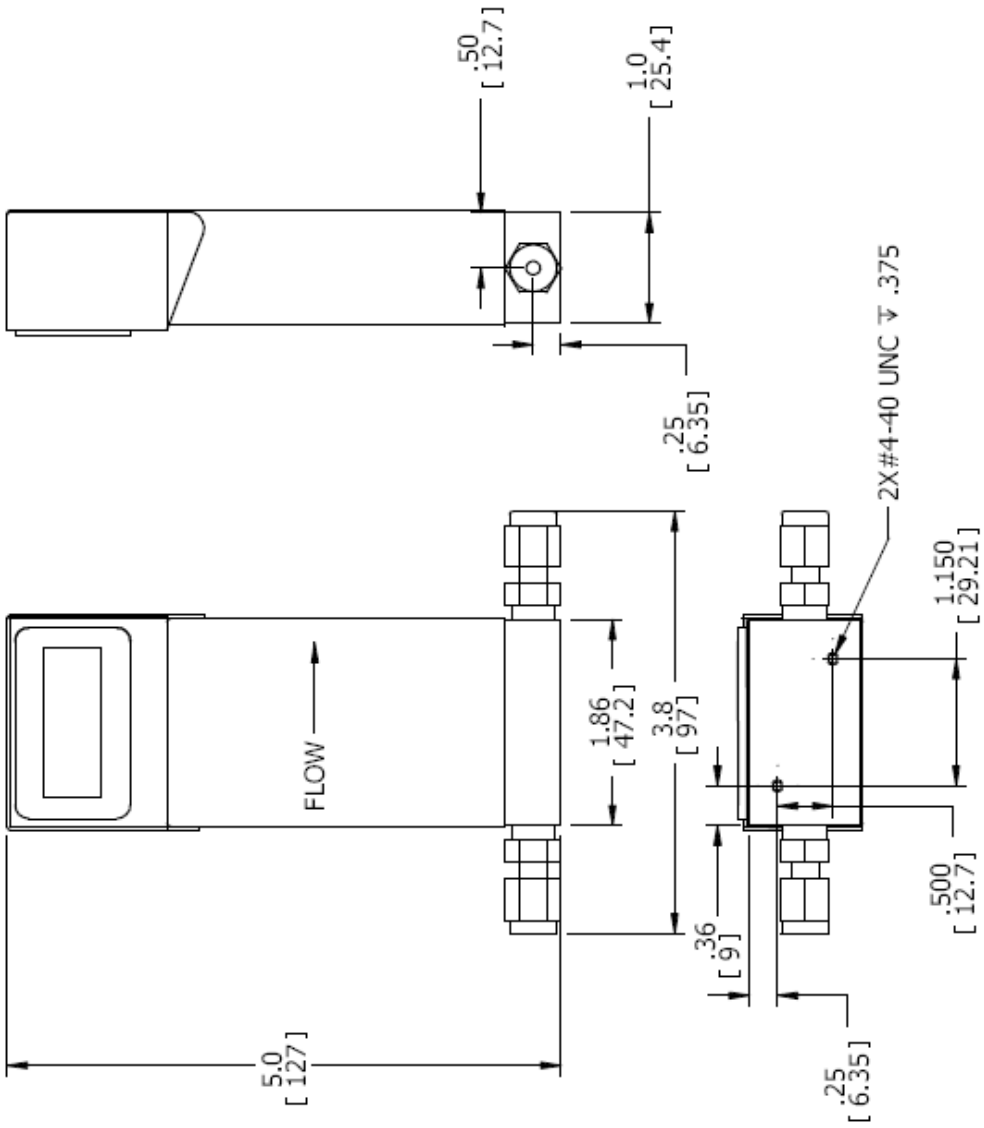
FMA 3100 / 3100ST - 0-20 L/min up to 0-100 L/min
3/8" Stainless Fittings Shown



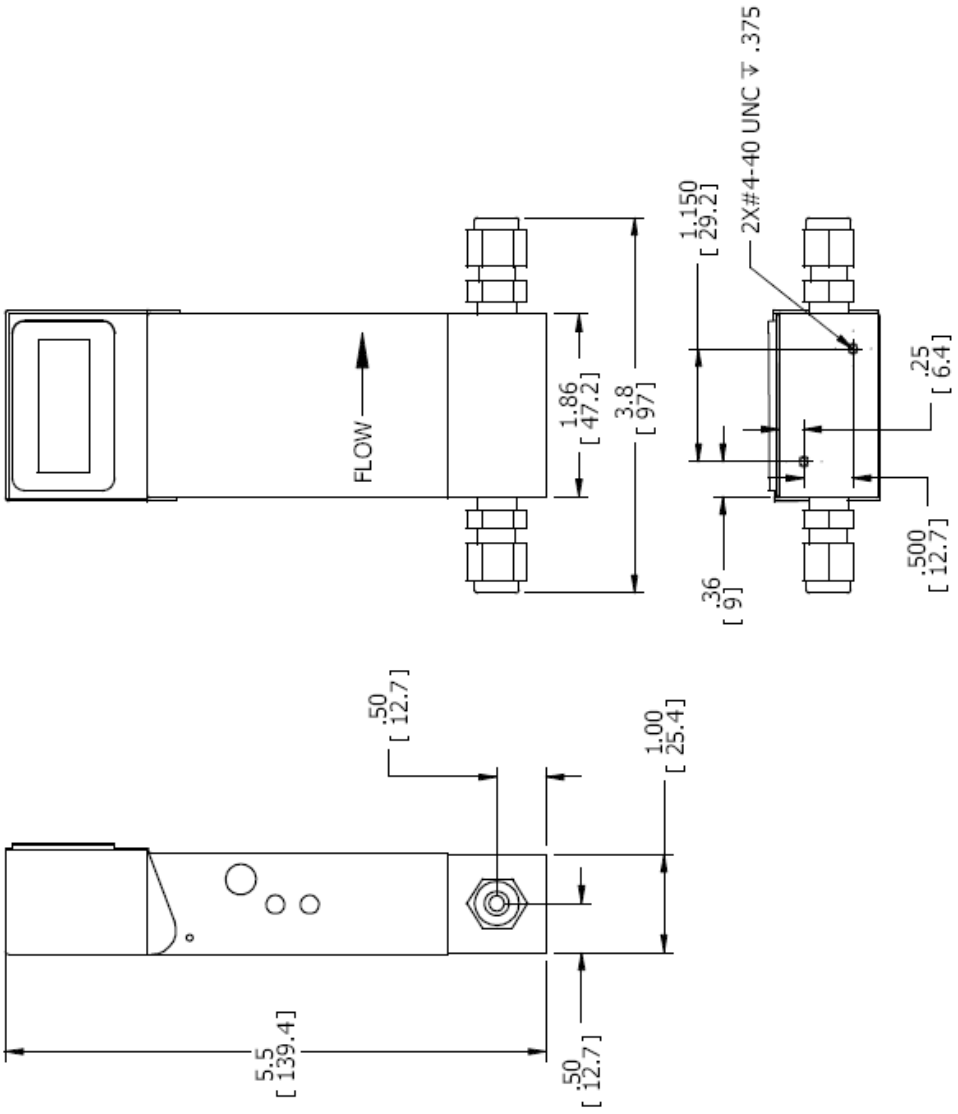
FMA 3100 – 0-200 L/min and 0-500 L/min
½" Stainless Fittings Shown



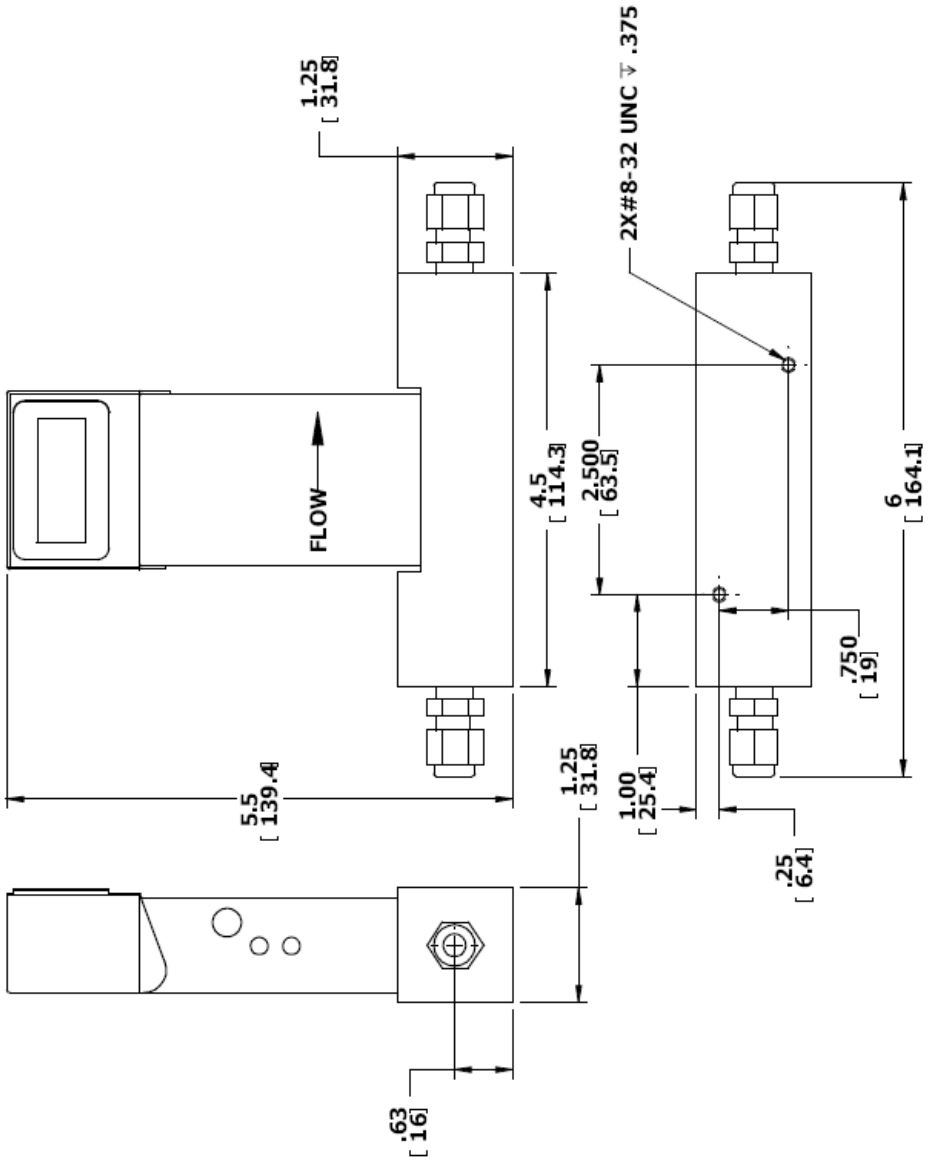
FMA 3300 – Flow Ranges Up To 0-500sccm
¼" Stainless Fittings Shown



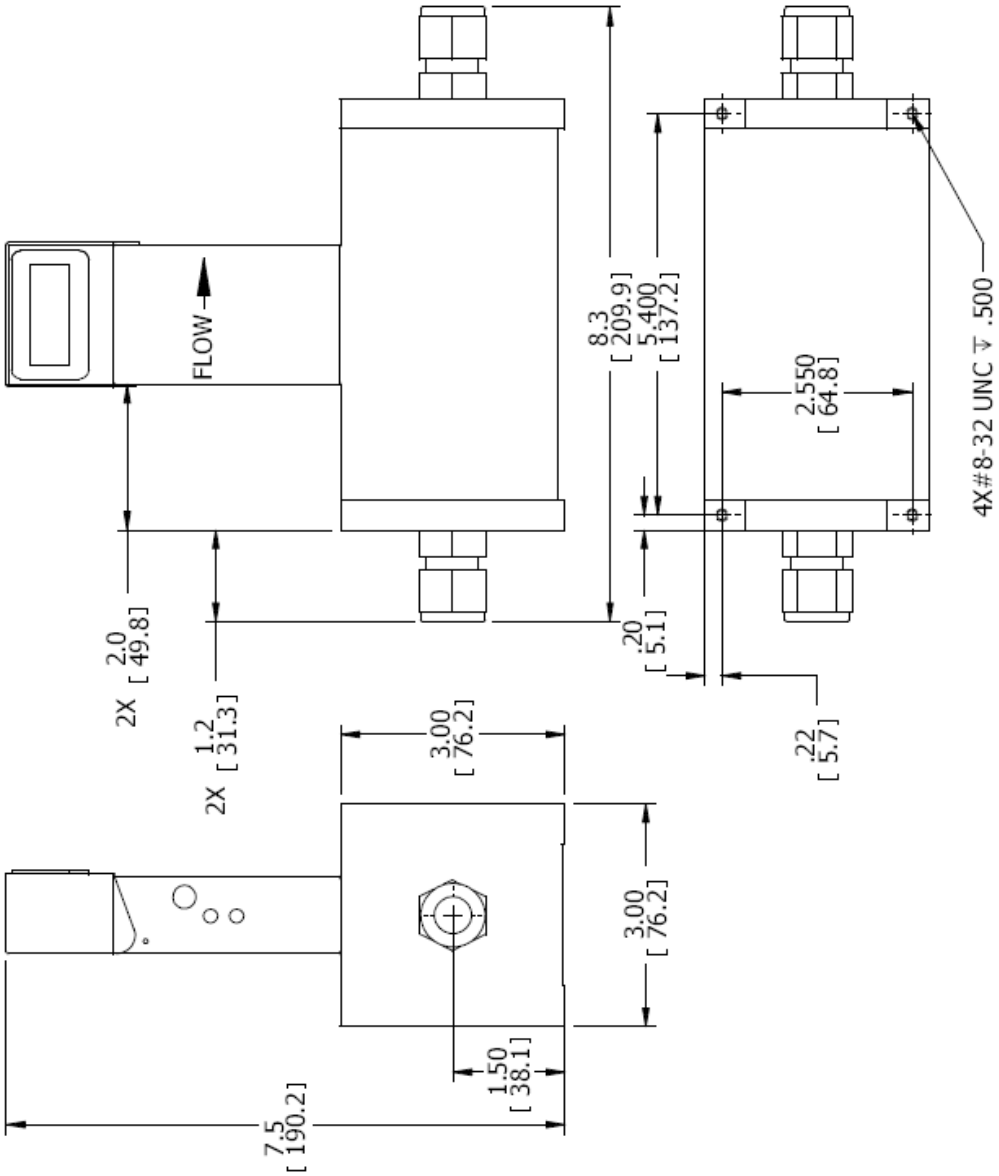
FMA 3300 - 0-1000sccm Up To 0-10 L/min &
FMA 3300ST - All Ranges Up To 0-10 L/min
¼" Stainless Fittings Shown



FMA 3300 / 3300ST - 0-20 L/min up to 0-100 L/min
3/8" Stainless Fittings Shown



FMA 3100 – 0-200 L/min and 0-500 L/min
½" Stainless Fittings Shown



G. Gas K Factors

Gas	Chemical Symbol	K Factor
Acetylene	C_2H_2	0.589
Air	-	1.000
Argon	Ar	1.438
Butane	C_4H_{10}	0.260
Carbon Dioxide	CO_2	0.739
Deuterium	D_2	1.000
Ethylene	C_2H_4	0.598
Freon 11	CCL_3F	0.330
Freon 12	CCL_2F_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_2O	0.710
Oxygen	O_2	0.991
Ozone	O_3	0.446
Propane	C_3H_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.

H. 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 Omega Engineering
	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
	Unit damaged or faulty	Contact Omega Engineering
Inaccurate readings	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 Omega Engineering
	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 Omega Engineering
	Unit needs recalibration	Contact the Omega Engineering
	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 Omega Engineering
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.

WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components in which wear is not warranted, include but are not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by the company will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive, and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and, additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

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