



YEAR  
2000  
COMPLIANT



# User's Guide

**omega.com™**

Ω OMEGA®

[www.omega.com](http://www.omega.com)

*e-mail: info@omega.com*



## **FMA3200 SERIES** **Mass Controller**

<b>OMEGAnet® On-Line Service</b> www.omega.com	<b>Internet e-mail</b> info@omega.com
---	--

**Servicing North America:**

**USA:** One Omega Drive, P.O. Box 4047  
ISO 9001 Certified Stamford CT 06907-0047  
TEL: (203) 359-1660 FAX: (203) 359-7700  
e-mail: info@omega.com

**Canada:** 976 Bergar  
Laval (Quebec) H7L 5A1  
TEL: (514) 856-6928 FAX: (514) 856-6886  
e-mail: info@omega.ca

**For immediate technical or application assistance:**

**USA and Canada:** Sales Service: 1-800-826-6342 / 1-800-TC-OMEGA<sup>†</sup>  
Customer Service: 1-800-622-2378 / 1-800-622-BEST<sup>†</sup>  
Engineering Service: 1-800-872-9436 / 1-800-USA-WHEN<sup>†</sup>  
TELEX: 996404 EASYLINK: 62968934 CABLE: OMEGA

**Mexico:** TEL: (001) 800-826-6342 FAX: (001) 203-359-7807  
En Español: (001) 203-359-7803 e-mail: espanol@omega.com  
info@omega.com.mx

**Servicing Europe:**

**Benelux:** Postbus 8034, 1180 LA Amstelveen, The Netherlands  
TEL: +31 (0)20 6418405 FAX: +31 (0)20 6434643  
Toll Free in Benelux: 0800 0993344  
e-mail: nl@omega.com

**Czech Republic:** Rudé armády 1868, 733 01 Karviná 8  
TEL: +420 (0)69 6311899 FAX: +420 (0)69 6311114  
Toll Free: 0800-1-66342 e-mail: czech@omega.com

**France:** 9, rue Denis Papin, 78190 Trappes  
TEL: +33 (0)130-621-400 FAX: +33 (0)130-699-120  
Toll Free in France: 0800-4-06342  
e-mail: france@omega.com

**Germany/Austria:** Daimlerstrasse 26, D-75392 Deckenpfronn, Germany  
TEL: +49 (0)7056 3017 FAX: +49 (0)7056 8540  
Toll Free in Germany: 0800 TC-OMEGA<sup>SM</sup>  
e-mail: germany@omega.com

**United Kingdom:** One Omega Drive, River Bend Technology Centre  
ISO 9002 Certified Northbank, Irlam, Manchester  
M44 5EX United Kingdom  
TEL: +44 (0)161 777 6611 FAX: +44 (0)161 777 6622  
Toll Free in United Kingdom: 0800-488-488  
e-mail: sales@omega.co.uk

It is the policy of OMEGA to comply with all worldwide safety and EMC/EMI regulations that apply. OMEGA is constantly pursuing certification of its products to the European New Approach Directives. OMEGA will add the CE mark to every appropriate device upon certification.

The information contained in this document is believed to be correct, but OMEGA Engineering, Inc. accepts no liability for any errors it contains, and reserves the right to alter specifications without notice.

**WARNING:** These products are not designed for use in, and should not be used for, patient-connected applications.

**! CAUTION !**  
**PLEASE READ INSTRUCTION MANUAL**  
**BEFORE USE OF FLOW CONTROLLER!**

**Table of Contents:**

*Section I. Introduction*

- 1.a First things first.....2
- 1.b Unpacking the Flow Controller .....2
- 1.c Cautions and warnings .....2
- 1.d Product overview and principle of operation.....2

*Section II. Installation*

- 2.a Safety considerations.....2
- 2.b Tubing connections .....3
- 2.c Mounting of the Flow Controller .....3
- 2.d Operating Environment.....3
- 2.e Electrical connections (power).....4
- 2.f Electrical connections (signal) Output & Control Input.....4
- 2.g Electrical connections (other).....4

*Section III. Operation*

- 3.a Warm-up.....5
- 3.b Flow ranges.....5
- 3.c Gas calibration .....5

*Section IV. Maintenance and Product Care* ..... 6

*Section V. Specifications* .....6

*Appendix A. Gas "K" Factor Table*..... 8

## **Section I. INTRODUCTION.....**

### **1.a First things first**

Your FMA3200 Flow Controller was packed by the manufacturer in such a way that you should receive it with no damage. If external damage is noted upon receipt of the package, please contact Omega Engineering.

### **1.b Unpacking the Flow Controller**

After external inspection of the product, proceed to open the package from the top, taking care not to cut too deep. Remove all documentation (if any) resting on top of the packing material. Inspect all products for concealed shipping damage.

When unpacking the products from the shipment, please take care to remove *all* products from the box. Check thoroughly for extra cables, power adapters, and other options listed on the packing slip, if any.

### **1.c Cautions and warnings**

Take care not to **drop** the FMA3200. Keep the inlet and outlet ports covered and protected from foreign particles. Read the INSTALLATION section before providing power to the Model 80.

### **1.d Product overview and principle of operation**

The FMA3200 Mass Flow Controllers use a thermal gas flow sensing technique. The unit responds to the heat transferred due to the mass of gases flowing through a miniature tube. Sensitive sensor coils detect the heat transfer, and the electronics amplify and linearize the result to provide the user with a 0-5 VDC output which is proportional to flow rate. The user supplied input control voltage (0 to 5.0 VDC) is used to control a servo valve to maintain flow setpoint actively, as compared to sensor output flow rate.

## **Section II. INSTALLATION.....**

### **2.a Safety considerations**

Be careful not to exceed pressure, temperature, or voltage as specified under SPECIFICATIONS. It is best to provide safety shut-off valves in the flow path prior to the FMA3200 inlet port and to use reliable pressure regulators and flow restriction devices (not included), especially with combustible gases. Make certain that the FMA3200 wetted materials are compatible with your gases. The FMA3200 will provide flow rates from approx. 1 or 2% to 100% of full scale. To ensure zero flow, use a separate shut-off solenoid valve or manual valve. **Do not** allow moisture or particulates in the gas flow stream.

If you loosen or replace the fittings that have been supplied with your Flow Controller, leaking may occur. (See 2.b for tube fitting additional precautions)

### **2.b Tubing connections**

Be sure to use **clean and dry** tubing. Purge tubes *first* with clean dry air before attaching to the flowmeter. Install an inlet filter (10-20 microns, not provided) if the gas or gases that will be used may contain particles so that the Model 80 will be protected. Use the tubing connectors that are supplied. If tubing connectors are removed it is possible that calibration may be affected and that leaking may occur. **Never** allow liquids or thread tape particles to enter the FMA3200.

### **2.c Mounting of the Flo-Controller**

Two 4-40 mounting holes are provided on the bottom of the FMA3200. The 2 holes are at diagonal corners of a rectangle that is approx. 0.50" x 2.20".

The FMA3200 has no particular attitude sensitivity so it may be mounted in any convenient position. All factory calibrations are made with the Flow Controller upright, with the mounting holes on the bottom.

### **2.d Operating environment**

Provide a clean, dry environment with an ambient temperature that is as stable as possible. Avoid areas with strong magnetic fields, strong air flows and vibrations to obtain the best possible performance.

**FIGURE 1. Electrical Connections**

<b>+ 12 to 15 VDC Input</b>	<b>PIN # 2</b>	<b>RED</b>
<b>- Power Return (Ground)</b>	<b>PIN # 6</b>	<b>BLACK</b>
<b>Signal Output (0 - 5VDC)</b>	<b>PIN# 3</b>	<b>ORANGE</b>
<b>Signal Return (Ground)</b>	<b>PIN # 1</b>	<b>BROWN</b>
<b>Control Input (0 - 5VDC)</b>	<b>PIN # 4</b>	<b>YELLOW</b>
<b>Control Return (Ground)</b>	<b>PIN # 5</b>	<b>GREEN</b>

### *2.e Electrical connections (power)*

Provide a single, stable D.C. power source that runs between 12.5 and 15 volts D.C. (see Figure 2). The FMA3200 has internal voltage regulation for inputs from 12.5 volts to 15 volts. Use optional Power adapters and connector hub or customer provided well regulated power supply.

See below for wiring information. If using the attach cable then: the RED wire is for the +12 to +15 VDC power and the BLACK wire is for the negative (return) side. The current requirement for this power source is approx. 170 mA average and 250 mA during warmup and solenoid full open conditions. The power supply wiring should be as short as possible to avoid voltage drops. Use twisted 2-conductor cable if the length of the power lines will be longer than 1 meter. Take care to observe power polarity - or damage may result!

**CAUTION: Tape wires so they will not touch each other. DAMAGE may result.**

### *2.f Electrical Control and Output connections to FMA3200 (see Fig. 1)*

The ORANGE wire will provide the signal output of the unit, which will be a 0-5 VDC signal. The BROWN wire is the output return (ground). These two wires can be used to display flowrate using a standard voltmeter , or can connect to a data acquisition system. Output load resistance should be 2.5 K ohms or higher. For signal wire lengths longer than 1 meter use 2-conductor twisted or shielded cable. The YELLOW wire provides for the control input signal. This input should be from a low-impedance source, long lines should be shielded or twisted pair. The input impedance is several megohms in the FMA3200. Avoid high voltage static charges to this input. The return for the control input is the GREEN wire (ground). The control signal is usually a 0 to 5.0 VDC input for flow control of generally 1-2% up to 100% of full scale flow rates.

To ensure the “best zero flow”  $\ll$  1% it is suggested that a **negative** voltage (approx. from 1 volt up to 5 volts) be provided to the YELLOW control input This will force the control solenoid to close fully - and it also will reduce power required to the minimum possible “sleep” condition (approx. 80 mA , 1 watt). The normal control input voltage is a **positive** voltage from 0 to 5.0 VDC.

**Take care not to short wires or contact power wires at any time - DAMAGE WILL RESULT!**

### *2.g Electrical connections - Also See BACK COVER for more information*

Other *optional* connectors are available to connect to the standard 6 pin connector. Technical data sheets illustrating wiring will be included with options. PIN numbers for 6 PIN connection is: (1) Signal OUT Return (Brown), (2) + Power IN (Red), (3) Signal Out (Orange), (4) Control IN (Yellow), (5) Signal IN Return (Green) , (6) Power Return Ground (Black) - (See Fig. 1)

### Section III. OPERATION.....

#### 3.a Warm up

Verify all electrical connections and tubing connections. Apply power to the unit and wait a minimum of five minutes. The zero should stabilize if there is **no** flow. Disconnect inlet tube and cover the inlet port with tape to be certain that no gas or air is flowing through the unit. After 10-15 minutes, if the output is not zero volts (within  $\pm 0.05$  volts), it may be adjusted (**READ 3.c** first) using the zero trimpot (see Figure 2). Power supply voltage variations and changes in ambient temperature may have a slight effect on the zero readings. See 3.c for more ZERO info.

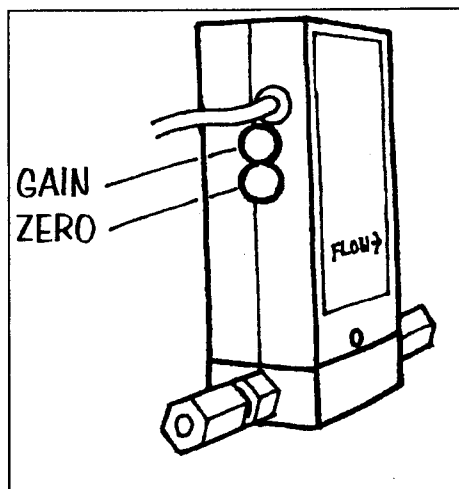


Figure 3. Zero and Gain adjustments.

#### 3.b Flow ranges

Each FMA3200 Flow Controller is factory calibrated to provide 5.0 VDC output at a certain flow rate of a particular gas (or gas mixture). This gas and the maximum flow rate to be used for this gas is indicated on the label in front of the FMA3200. Do not exceed the maximum flow rate as non-linear, inaccurate outputs will result. Gases *other* than the one indicated on the front label may or may not provide useful flow rate outputs. See the table in Appendix A for typical "K" factors for common gases. These factors are **NOT** exact over wide ranges of flow but they may be useful for part or all of factory calibrated flow range.

#### 3.c Gas calibration

To calibrate the FMA3200, first provide a stable flow of **the gas indicated** on the front label. Be sure flow conditions are standard (20°C and 760 mmHg). When stable flow is obtained (& all lines are purged with the calibration gas) it

is possible to adjust the gain trimpot (see Figure 2) to provide the exact flow output. Use the Control input voltage to set the desired flowrate. *For example: if full-scale is 100 cc/min then a control input voltage of 2.50 volts should produce an output flow of 50 cc/min. If the actual flow is found to be 52 cc/min - then turn the GAIN trimpot slowly clockwise to increase the gain slightly. The true output flowrate will Drop as GAIN is increased. Of course the Signal output will still say 2.5 volts, since the servo continues to compare the Control input to the Sensor output. Yet the ACTUAL flowrate is dropping as GAIN is adjusted higher (clockwise).*

If using a gas other than the one specified on the label, it is possible to obtain useful outputs. To do so, determine the K factors (see table in Appendix A) for the calibration gas, and the K factors for the new gas to be used. Use the following formula to figure the ratio:

$$V_{OUT} = \frac{K_1}{K_2} \text{ (original calibration gas K factor)}$$

The result of this equation will give you the percent of error the Flow Controller will output for the new gas. For instance, if K1/K2 was 0.85, then the Model 50 would read 85% of actual flow, or 15% low. In other words, if a 0-100 mL/min unit indicated 100 mL/min (5.0 VDC), the actual flow would be 85 mL/min. If K2 is larger than K1, linear results will only be achieved if the user does not exceed 5\*(K1/K2) VDC recording output full scale value.

**ZERO Adjustments:** Take care to make only minor adjustments with the ZERO POT. Turn fully COUNTERCLOCKWISE if you have made a large zero adjustment and are having calibration problems - Next slowly turn Zero Pot Clockwise to obtain the proper ZERO reading.

#### ***Section IV. MAINTENANCE AND PRODUCT CARE***

Keep all protective filters well maintained. All inlet filters should be periodically checked and replaced if necessary.

Keep tubing connections tight and all tubing free of moisture and particles. If the Flow Controller is to be stored, keep the inlet and outlet ports sealed.

#### ***Section V. SPECIFICATIONS.....***

<b>Accuracy:</b>	±1.5% Full Scale for temperatures from 18 to 25 °C for 10% to 100% of range , add ±0.5% above 500 ml/min ranges
<b>Repeatability:</b>	±0.5% Full Scale
<b>Response Time</b>	2 seconds to within +-2% of final value (typical)
<b>Constant:</b>	
<b>Temp. Coefficient:</b>	±0.15% per °C
<b>Pressure Coefficient:</b>	±0.02% per PSI



<b>Operating Pressure Range:</b>	150 PSI maximum (at or below ambient +25°C) Differential pressure typical 10 to 40 psi (see specs with each device)
<b>Gas &amp; Ambient Temperature:</b>	+10°C to +50°C operating range
<b>Input Power:</b>	+12 to +15 VDC, 250 mA (3.75 watts maximum)
<b>Wetted Materials:</b>	Anodized aluminum, Viton O-rings, 316 Stainless Steel, epoxy, Acetal compression tube fittings standard, (other fittings optional), brass (valve)
<b>Inlet &amp; Outlet Porting:</b>	1/8" NPT female threads, Acetal compression tube fittings standard, brass or S.steel optional
<b>Flow Rates:</b>	See label on unit. Various flow rates and gases.
<b>Control Input:</b>	0 to 5.0 VDC standard. (Use - 1.0 VDC for true zero)
<b>Output Signal:</b>	0 to 5.0 VDC standard.
<b>Compatible Gases:</b>	Most gases (e.g.: nitrogen, carbon dioxide, argon, methane, air, oxygen, helium) as long as they are compatible with wetted materials
<b>Mechanical Dimensions:</b>	3.8"H x 3.2"L x 1.03"D (without fittings)
<b>Weight:</b>	0.75 lb. with acetal fittings , (3 lbs. shipping)

**Appendix A. GAS "K" FACTOR TABLES.....**

<b>GAS</b>	<b>"K" FACTOR</b>
Acetylene	0.589
Air	1.000
Argon	1.438
Carbon Dioxide	0.739
Deuterium	1.000
Ethylene	0.598
Freon 11	0.330
Freon 12	0.354
Freon 13	0.385
Freon 14	0.420
Freon 22	0.460
Germane	0.570
Helium	1.458
Hydrogen	1.011
Krypton	1.440
Methane	0.721
Neon	1.443
Nitrogen	1.000
Oxygen	0.991
Propane	0.383
Xenon	1.437

*Please consult Omega for compatibility and "K" factors for other gases not listed. Linearization in the FMA3200 for some gases may cause errors over wide flow ranges when using another gas and its K factor.*



## 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 which wear are not warranted, including but 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 it will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESS 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.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

OMEGA is a registered trademark of OMEGA ENGINEERING, INC.

© Copyright 1999 OMEGA ENGINEERING, INC. All rights reserved. This document may not be copied, photocopied, reproduced, translated, or reduced to any electronic medium or machine-readable form, in whole or in part, without the prior written consent of OMEGA ENGINEERING, INC.

# Where Do I Find Everything I Need for Process Measurement and Control? OMEGA...Of Course!

## TEMPERATURE

- Thermocouple, RTD & Thermistor Probes, Connectors, Panels & Assemblies
- Wire: Thermocouple, RTD & Thermistor
- Calibrators & Ice Point References
- Recorders, Controllers & Process Monitors
- Infrared Pyrometers

## PRESSURE, STRAIN AND FORCE

- Transducers & Strain Gages
- Load Cells & Pressure Gages
- Displacement Transducers
- Instrumentation & Accessories

## FLOW/LEVEL

- Rotameters, Gas Mass Flowmeters & Flow Computers
- Air Velocity Indicators
- Turbine/Paddlewheel Systems
- Totalizers & Batch Controllers

## pH/CONDUCTIVITY

- pH Electrodes, Testers & Accessories
- Benchtop/Laboratory Meters
- Controllers, Calibrators, Simulators & Pumps
- Industrial pH & Conductivity Equipment

## DATA ACQUISITION

- Data Acquisition & Engineering Software
- Communications-Based Acquisition Systems
- Plug-in Cards for Apple, IBM & Compatibles
- Datalogging Systems
- Recorders, Printers & Plotters

## HEATERS

- Heating Cable
- Cartridge & Strip Heaters
- Immersion & Band Heaters
- Flexible Heaters
- Laboratory Heaters

## ENVIRONMENTAL MONITORING AND CONTROL

- Metering & Control Instrumentation
- Refractometers
- Pumps & Tubing
- Air, Soil & Water Monitors
- Industrial Water & Wastewater Treatment
- pH, Conductivity & Dissolved Oxygen Instruments

M3413/0699