1 YEAR
WARRANTY

User's Guide

FMA-A2100's, FMA-A2300's
Massflow Meters
FMA-A2200's, FMA-A2400's
Massflow Controllers

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It is the policy of OMEGA Engineering, Inc. 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.

WARNING: These products are not designed for use in, and should not be used for, human applications.

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Omega FMA Series Instruction Manual

1.0 Description

Omega's FMA Series mass flow meters and controllers utilize a capillary type thermal technology to directly measure mass flow. No temperature, pressure, or square root corrections are required.

The FMA Series is available with an LCD display and linear 0-5 or 4-20 ma output. Display and outputs read in direct Engineering units. Engineering units may be mass units such as Gr/s, LB/H, Kg/H...or in volumetric units referenced to a standard pressure and temperature I.E. SCCM, SLPM, SCFH. Omega uses 70° F and 29.92" Hg or 21° C and 760 Torr as standard reference conditions. (Others available on request).

The FMA Series is available in Polyoxymethylene (POM) or 316 Stainless Steel. Polyoxymethylene (POM) is compatible with most non-corrosive gases. The user is responsible to check wetted materials against gas compatibility.

Omega mass flow meters are calibrated to NIST standards for a specific gas and range selected by the customer, however K Factors can be used to measure other gases.

FMA Series controllers use an integral electromagnetic proportional valve to control the mass flow rate. Command signal is supplied by the onboard set point pot or a external 0-5 VDC supplied to the D connector.

Omega cost savings design supplies a complete flow measurement and control system in one compact package making it ideal for OEM, laboratories, and process control applications.

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2.0 Specifications

Wetted Material		
Flow Bodies	Plastic Model	Stainless Steel Model
	(POM), 316 SS & 17-4SS	316/174 SS

Elastomers	Standard - FKM Optional - Buna, Perfluoroelastomer, or EPDM.
Output Signal	Linear 0-5 VDC Linear or 4-20 MA
Input Power	Standard: 24 VDC @ 350 MA Optional: 12, 15 VDC / 115, 220 VAC with AC adapter
Accuracy	±1% FS (including Linearity)
Connection	9 pin Sub D
Control Signal	Integral or 0-5 VDC
Control Valve	Electromagnetic Norm. Closed
Max Pressure	Plastic Model - 250 PSIG, Stainless Steel Model - 500 PSIG
Response Time	1-2 second

3.0 Installation

3.1 Plumbing

(Caution: The FMA Series has a maximum temperature or 150 F and a maximum pressure of 500 psig.)

The FMA Series has 2 x 4-40 mounting holes on the bottom. Standard fittings are 1/4” compression fitting. When plumbing meters insure the flow arrow on the front label is in the direction of flow. Before operation insure system is leak free.

Capillary mass meters are susceptible to clogging. If your line or gas has particulate entrained use a 50 - 100 micron filter up stream of the meter.

3.20 Power

Omega FMA series meters require 24 VDC @ 250 ma for meters and 320ma for controllers, via the 9 pin sub D connector. Power is typically supplied with a wall mounted AC adapter.

3.21 Output

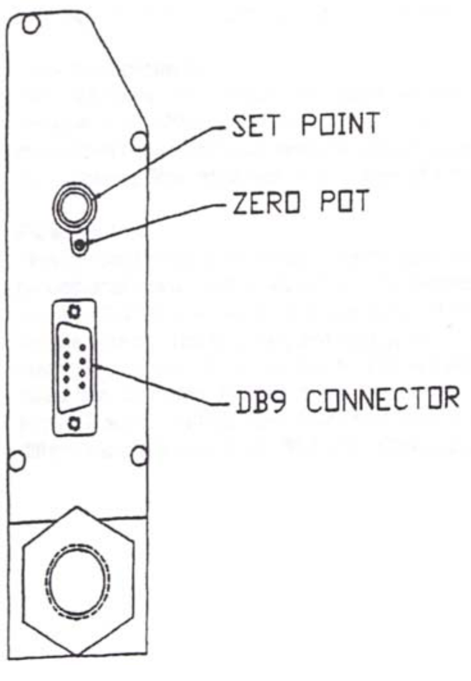
Omega FMA series has a standard 0 - 5 VDC and 4-20 ma linear output from the 9 pin sub D connector. The 4 - 20 MA signal is a self powered “4 wire type” referenced from ground, do not apply power to this line.

3.22 Setpoint

The FMA series controllers require a linear 0 - 5 VDC setpoint. This signal can be supplied from the integral setpoint pot located on the right side of the controller or from a remote source. The integral setpoint is jumpered through the mating sub D connector from pins 9 to 5. To use a remote setpoint signal, open the mating sub D connector housing and remove the jumper between pins 5 & 9 and input the remote 0-5 VDC on pins #5(+), #2(common) and wire remote 0 - 5 to pins 5 (Hi) & 2 (Common).

3.24 D Conn. Pin Out

Pin Number	Function
1	Power Supply Ground
2	Set Point input Lo
3	4-20 MA Output High (blue wire)
4	0-5 VDC Output High (orange wire)
5	Set Point Input High
6	NC
7	24 VDC Power Input
8	Output Ground (brown wire)
9	Local Set Point Supply (Must be jumpered to pin 5 for local set point.)



4.0 Operation

Apply power through the sub D connector and allow 5-10 minutes warm up time. Controllers should have a zero setpoint. For local setpoint models turn the setpoint adjustment knob fully clockwise.

4.1 Zero Check

Zero may shift in shipping or installation. Zero should be adjusted after installation to insure accuracy.

Insure there is no flow through the transducer and check the 0 - 5 output or display for a zero reading.

4.11 Set Zero

The zero adjustment screw is available on the right hand side of the meter. Turn the screw slowly until the display or 0 - 5 VDC output is at zero.

4.2 Flow Measurement

The FMA Series transducers measure mass flow directly and read out in mass units per time. When calibrated for volumetric units measurements are referenced from a standard temperature and pressure. Outputs are linear over the calibrated flow range with an accuracy of $\pm$1% of Full Scale, 100:1 Turn Down.

4.3 Flow Control

Flow controllers combine a mass flow transducer with a normally closed electromagnetic proportional valve. Controllers use a 0 - 5 VCD linear setpoint signal supplied from the local setpint pot or from a remote source. The local setpoint voltage must be connected through the external mating D connector from pins 9 to 5. This will enable the knob on the side of the mass flow controller. For remote setpoint remove this jumper and wire 0 - 5 VDC to pins #2(common) and #5(+). Valves have a standard minimum and maximum operating differential pressures of 10 - 50 PSIG. Others available on request.

5.0 Using K Factors

The FMA Series uses a thermal sensor technology which allows the use of conversion factors from the calibrated gas to other gases. To change to a new gas multiply the flow rate reading by the ratio of the K factor for the new gas to the K factor of the calibrated gas.

$$\text{Reading} \times \frac{\text{K Factor New Gas}}{\text{K Factor Cal. Gas}}$$

Accuracy is $\pm$4% using this method.

Actual Gas	Reference Gas	K Factor Rel. to Ref. Gas	K Factor Relative N_2	C_p (Cal/g)	Density (g/1) @ 0°C	Molecular Weight
Acetylene C_2H_2	C_2H_4	.973	.58	.4036	1.162	
Air	N_2	1.00	1.00	.240	1.293	
Allene (Propadiene) C_3H_4	CF_4	.934	.43	.352	1.787	
Ammonia NH_3	N_2O	1.028	.73	.492	.760	
Argon Ar	Ar	1.000	1.45	.1244	1.782	
Arsine AsH_3	N_20	.943	.67	.1167	3.478	
Boron Trichloride BCl_3	CF_4	.891	.41	.1279	5.227	
Boron Trifluoride BF_3	CF_4	1.108	.51	.1778	3.025	
Bromine Br_2	N_2O	1.140	.81	.0539	7.130	
Boron Tribromide Br_3	CF_4	.826	.38	.0647	11.18	
Bromine Pentafluoride BrF_5	CF_4	.565	.26	.1369	7.803	
Bromine Trifluoride BrF_3	CF_4	.826	.38	.1161	6.108	
Bromotrifluoromethane (Freon-13 B1) $CBrF_3$	CF_4	.804	.37	.1113	6.644	
1,3-Butadiene C_4H_6	CF_4	.695	.32	.3514	2.413	
Butene C_4H_{10}	CF_4	.565	.26	.4007	2.593	
1-Butene C_4H_8	CF_4	.652	.30	.3648	2.503	
2-Butene C_4H_8 CIS	CF_4	.704	.324	.336	2.503	
2-Butene C_4H_8 TRANS	CF_4	.632	.291	.374	2.503	
Carbon Dioxide CO_2	N_20	1.042	.74	.2016	1.964	
Carbon Disulfide CS_2	C_2H_4	1.007	.60	.1428	3.397	
Carbon Monoxide CO	N_2	1.000	1.00	.2488	1.250	
Carbon Tetrachloride CCl_4	CF_4	.673	.31	.1655	6.860	
Carbon Tetrafluoride (Freon-14) CF_4	CF_4	1.000	.42	.1654	3.926	
Carbonyl Fluoride COF_2	C_2H_4	.907	.54	.1710	2.945	
Carbonyl Sulfide COS	N_20	.929	.66	.1651	2.680	

Actual Gas	Reference Gas	K Factor Rel. to Ref. Gas	K Factor Relative N_2	C_p (Cal/g)	Density (g/1) @ 0°C	Molecular Weight
Chlorine Cl_2	N_2	.860	.86	.114	3.163	
Chlorine Trifluoride ClF_3	CF_4	.869	.40	.1650	4.125	
Chlorodifluoromethane (Freon-22) $CHClF_2$	CF_4	1.000	.46	.1544	3.858	
Chloroform $CHCl_3$	CF_4	.847	.39	.1309	5.326	
Chloropentafluoroethane (Freon-115) C_2ClF_5	CF_4	.521	.24	.164	6.892	
Chlorotrifluromethane (Freon-13) $CClF_3$	CF_4	.826	.38	.153	4.660	
Cyanogen C_2N_2	C_2H_4	.7526	.61	.2613	2.322	
Cyanogen Chloride ClCN	C_2H_2	1.024	.61	.1739	2.742	
Cychlopropane C_3H_5	CF_4	1.00	.46	.3177	1.877	
Deuterium D_2	N_2	1.00	1.00	.1722	1.799	
Diborane B_2H_6	CF_4	.956	.44	.508	1.235	
Dibromodifluoromethane CBr_2F_2	CF_4 CF_4	.413 1.021	.19 .47	.15 .075	9.362 7.76	
Dichlorodifluoromethane (Freon-12) CCl_2F_2	CF_4	.760	.35	.1432	5.395	
Dichlorofluoromethane (Freon-21) $CHCl_2F$	CF_4	.913	.42	.140	4.592	
Dichloromethylsilane $(CH_3)_2SiCl_2$	CF_4	.543	.25	.1882	5.758	
Dichlorosilane SiH_2Cl_2	CF_4	.869	.40	.150	4.506	
Dichlorotetrafluoroethane (Freon-114) $C_2Cl_2F_4$	CF_4	.478	.22	.1604	7.626	
1,1-Difluoroethylene (Freon-1132A) $C_2H_2F_2$	CF_4	.934	.43	.224	2.857	
Dimethylamine $(CH_3)_2NH$	CF_4	.804	.37	.366	2.011	
Dimethyl Ether $(CH_3)_2O$	CF_4	.847	.39	.3414	2.055	
2,2-Dimethylpropane C_3H_{12}	CF_4	.423	.22	.3914	3.219	
Ethane C_2H_6	CF_4	1.086	.50	.4097	1.342	
Ethanol C_2H_6O	CF_4	.856	.39	.3395	2.055	

Actual Gas	Reference Gas	K Factor Rel. to Ref. Gas	K Factor Relative N_2	C_p (Cal/g)	Density (g/1) @ 0°C	Molecular Weight
Ethyl Acetylene C_4H_6	CF_4	.703	.32	.3513	2.413	
Ethyl Chloride C_2H_5Cl	CF_4	.84	.39	.244	2.879	
Ethylene C_2H_4	C_2H_4	1.000	.60	.1365	1.251	
Ethylene Oxide C_2H_4O	CF_4	1.130	.52	.268	1.965	
Fluorine F_2	N_2	.980	.98	.1873	1.695	
Fluoroform (Freon-23) CHF_3	CF_4	1.086	.50	.176	3.127	
Freon-11 CCl_3F	CF_4	.717	.33	.1357	6.129	
Freon-12 CCl_2F_2	CF_4	.760	.35	.1432	5.395	
Freon-13 $CClF_3$	CF_4	.826	.38	.153	4.660	
Freon-13 B1 $CBrF_3$	CF_4	.804	.37	.1113	6.644	
Freon-14 CF_4	CF_4	1.000	.42	.1654	3.926	
Freon-21 $CHCl_2F$	CF_4	.913	.42	.140	4.592	
Freon-22 $CHClF_2$	CF_4	1.000	.46	.1544	3.858	
Freon-113 CCl_2FCClF_2	CF_4	.434	.20	.161	8.360	
Freon-114 $C_2Cl_2F_4$	CF_4	.478	.22	.160	7.626	
Freon-115 C_2ClF_5	CF_4	.521	.24	.164	6.892	
Freon-C318 C_4F_6	CF_4	.369	.17	.185	8.397	
Germane GeH_4	C_2H_4	.950	.57	.1404	3.418	
Germanium Tetrachloride $GeCl_4$	CF_4	.586	.27	.1071	9.565	
Helium He	He	1.000	1.454	1.241	.1786	
Hexafluoroethane C_2F_6 (Freon-116)	CF_4	.521	.24	.1834	6.157	
Hexane C_6H_{14}	CF_4	.391	.18	.3968	3.845	
Hydrogen H_2	H_2	1.000	1.01	3.419	.0899	
Hydrogen Bromide HBr	N_2	1.000	1.00	.0861	3.610	
Hydrogen Chloride HCl	N_2	1.000	1.00	.1912	1.627	
H MOS	N_2	1.000	1.00			

Actual Gas	Reference Gas	K Factor Rel. to Ref. Gas	K Factor Relative N_2	C_p (Cal/g)	Density (g/1) @ 0°C	Molecular Weight
Hydrogen Cyanide HCN	N_2	1.070	.76	.3171	1.206	
Hydrogen Fluoride HF	N_2	1.000	1.00	.3479	.893	
Hydrogen Iodide HI	N_2	1.000	1.00	.0545	5.707	
Hydrogen Selenide H_2Se	N_2O	1.112	.79	.1025	3.613	
Hydrogen Sulfide H_2S	N_2O	1.126	.80	.2397	1.520	
Iodine Pentafluoride IF_5	CF_4	.543	.25	.1108	9.90	
Isobutane $CH(CH_3)_3$	CF_4	.586	.27	.3872	2.67	
Isobutylene C_4H_8	CF_4	.630	.29	.3701	2.503	
Krypton Kr	Ar	1.002	1.453	.0593	3.739	
Methane CH_4	N_2O	1.014	.72	.5328	.715	
Methanlo CH_3	C_2H_4	.966	.58	.3274	1.429	
Methyl Acetylene C_3H_4	CF_4	.934	.43	.3547	1.787	
Methyl Bromide CH_2Br	C_2H_4	.966	.58	.1106	4.236	
Methyl Chloride CH_3Cl	C_2H_4	1.050	.63	.1926	2.253	
Methyl Fluoride CH_3F	C_2H_4	.957	.68	.3221	1.518	
Methyl Mercaptan CH_3SH	CF_4	1.130	.52	.2459	2.146	
Methyl Trichlorosilane $(CH_3)SiCL_3$	CF_4	.543	.25	.164	6.669	
Molybdenum Hexafluoride MoF_6	CF_4	.456	.21	.1373	9.366	
Monoethylamine $C_2H_5NH_2$	CF_4	.760	.35	.387	2.011	
Monomethylamine CH_3NH_2	CF_4	.850	.51	.4343	1.386	
Neon NE	Ar	1.006	1.46	.246	.900	
Nitric Oxide NO	N_2	.990	.99	.2328	1.339	
Nitrogen N_2	N_2	1.000	1.00	.2485	1.25	
Nitrogen Dioxide NO_2	N_2O	1.042	.74	.1933	2.052	
Nitrogen Trifluoride NF_3	CF_4	1.043	.48	.1797	3.168	

Actual Gas	Reference Gas	K Factor Rel. to Ref. Gas	K Factor Relative N_2	C_p (Cal/g)	Density (g/1) @ 0°C	Molecular Weight
Nitrosyl Chloride NOCl	C_2H_4	1.016	.61	.1632	2.920	
Nitrous Oxide N_2O	N_2O	1.000	.71	.2088	1.964	
Octafluorocyclobutane (Freon-C318) C_4F_6	CF_4	.369	.17	.185	8.397	
Oxygen O_2	N_2	1.000	1.00	.2193	1.427	
Oxygen Difluoride OF_2	C_2H_4	1.050	.63	.1917	2.406	
Pentaborane B_5H_9	CF_4	.565	.26	.38	2.816	
Pentane C_5H_{12}	CF_4	.456	.21	.398	3.219	
Perchloryl Fluoride ClO_3F	CF_4	.847	.39	.1514	4.571	
Perfluoropropane C_3F_8	CF_4	.369	.174	.197	8.388	
Phosgene $COCl_2$	CF_4	.956	.44	.1394	4.418	
Phosphine PH_3	N_2O	1.070	.76	.2374	1.517	
Phosphorous Oxychloride $POCl_3$	CF_4	.782	.36	.1324	6.843	
Phosphorous Pentafluoride PH_5	CF_4	.652	.30	.1610	5.620	
Phosphorous Trichloride PCl_3	CF_4	.652	.30	.1250	6.127	
Propane C_3H_8	CF_4	.782	.36	3.885	1.967	
Propylene C_3H_6	CF_4	.891	.41	.3541	1.877	
Silane SiH_4	C_2H_4	1.000	.60	.3189	1.433	
Silicon Tetrachloride $SiCl_4$	CF_4	.608	.28	.1270	7.580	
Silicon Tetrafluoride SiF_4	CF_4	.760	.35	.1691	4.643	
Sulfur Dioxide SO_2	N_2O	.900	.69	.1488	2.858	
Sulfur Hexafluoride SF_6	CF_4	.565	.26	.1592	6.516	
Sulfuryl Fluoride SO_2F_2	CF_4	.847	.39	.1543	4.562	
Tetrafluorahydrazine N_2F_4	CF_4	.695	.32	.182	4.64	
Trichlorofluoromethane (Freon-11) CCl_3F	CF_4	.717	.33	.1357	6.129	
Trichlorosilane $SiHCl_3$	CF_4	.717	.33	.1380	6.043	

Actual Gas	Reference Gas	K Factor Rel. to Ref. Gas	K Factor Relative N_2	C_p (Cal/g)	Density (g/1) @ 0°C	Molecular Weight	Liquid or Gas Source
1,1,2-Trichloro-1,2,2 Trifluoroethane (Freon-113) CCl_2FCClF_2	CF_4	.434	.20	.161	8.360		
Trisobutyl Aluminum $(C_4H_9)Al$	CF_4	.132	.061	.508	8.848		
Titanium Tetrachloride $TiCl_4$	CF_4	.586	.27	.120	8.465		
Trichloro Ethylene C_2HCl_3	CF_4	.695	.32	.163	5.95		
Trimethylamine $(CH_3)_3N$	CF_4	.608	.28	.3710	2.639		
Tungsten Hexafluoride WF_6	CF_4	.552	.25	.0810	13.28		
Uranium Hexafluoride UF_6	CF_4	.434	.20	.0888	15.70		
Vinyl Bromide CH_2CHBr	CF_4	1.000	.46	.1241	4.772		
Vinyl Chloride CH_2CHCl	CF_4	1.043	.48	.12054	2.788		
Xenon Xe	Ar	.993	1.44	.0378	5.858		

MADE IN USA

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, moistur e 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.

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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 theproduct, 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.

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