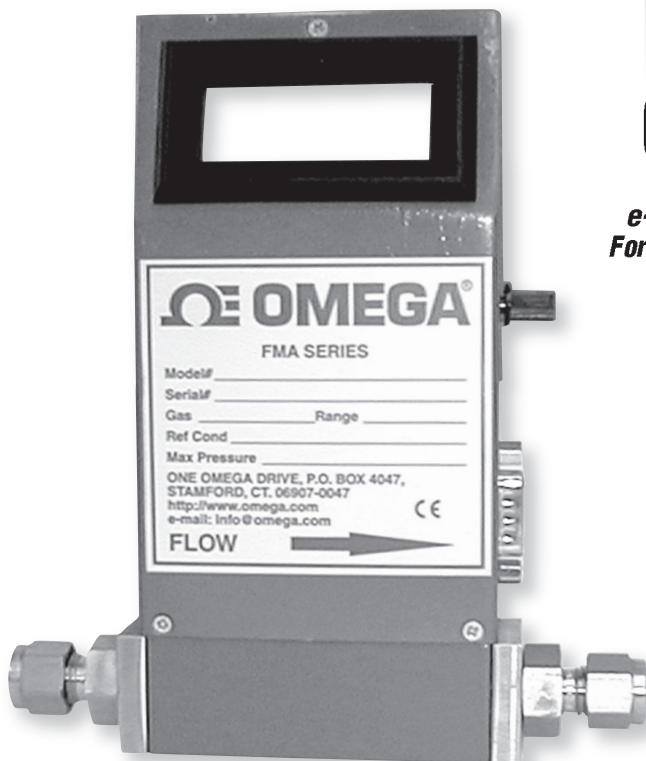




User's Guide



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Stainless Steel Mass Flowmasters & 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.

The information contained in this document is believed to be correct, but OMEGA 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, human applications.

FMA 2700, 2800,3700, & 3800

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1.0 Description

FMA 2700, 2800, 3700, & 3800

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...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 wetted materials include 316 Stainless Steel, 17-4 Stainless Steel, and FKM elastomers (standard, others available on request). 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 inline electromagnetic proportional valve to control the mass flow rate. Command signal is supplied by the onboard set point pot or an external 0-5 VDC supplied to the D connector.

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



2.0 Specifications

Wetted Material	
Flow Bodies	<u>Stainless Steel Model</u> 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, supplied via AC adapter Optional: 12, 15 VDC / 115, 220 VAC with
Accuracy	$\pm 1\%$ FS (including Linearity)
Connection	9 pin Sub D
Control Signal	Integral or 0-5 VDC
Control Valve	Electromagnetic Norm. Closed
Max Pressure	500 PSIG
Response Time	1-2 second

3.0 Installation

3.1 Plumbing

(Caution: The FMA Series has a maximum temperature of 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 upstream 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

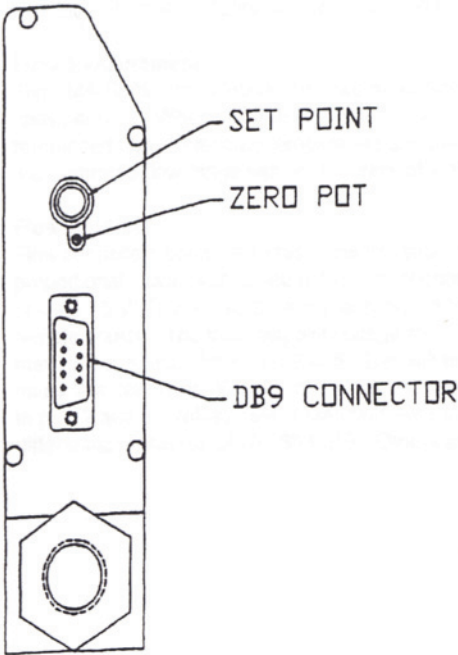
Omega FMA series has a standard 0 - 5 VDC and 4-20 ma linear output from the 9 pin sub D connector. The 4 - 20 MA signal is a self powered "4 wire type" referenced from ground, do not apply power to this line.

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

<u>Pin Number</u>	<u>Function</u>
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 setpoint 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/l) @ 0°C	Molecular Weight
Acetylene C ₂ H ₂	C ₂ H ₄	.973	.58	.4036	1.162	
Air	N ₂	1.00	1.00	.240	1.293	
Allene (Propadiene) C ₃ H ₄	CF ₄	.934	.43	.352	1.787	
Ammonia NH ₃	N ₂ O	1.028	.73	.492	.760	
Argon Ar	Ar	1.000	1.45	.1244	1.782	
Arsine AsH ₃	N ₂ O	.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 ₂ O	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 ₄ H ₆	CF ₄	.695	.32	.3514	2.413	
Butene C ₄ H ₁₀	CF ₄	.565	.26	.4007	2.593	
1-Butene C ₄ H ₈	CF ₄	.652	.30	.3648	2.503	
2-Butene C ₄ H ₈ CIS	CF ₄	.704	.324	.336	2.503	
2-Butene C ₄ H ₈ TRANS	CF ₄	.632	.291	.374	2.503	
Carbon Dioxide CO ₂	N ₂ O	1.042	.74	.2016	1.964	
Carbon Disulfide CS ₂	C ₂ H 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 ₂ H ₄	.907	.54	.1710	2.945	
Carbonyl Sulfide COS	N ₂ O	.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/l) @ 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 ₂ ClF ₅	CF ₄	.521	.24	.164	6.892	
Chlorotrifluoromethane (Freon-13) CClF ₃	CF ₄	.826	.38	.153	4.660	
Cyanogen C ₂ N ₂	C ₂ H ₄	.7526	.61	.2613	2.322	
Cyanogen Chloride ClCN	C ₂ H ₂	1.024	.61	.1739	2.742	
Cyclopropane C ₃ H ₅	CF ₄	1.00	.46	.3177	1.877	
Deuterium D ₂	N ₂	1.00	1.00	.1722	1.799	
Diborane B ₂ H ₆	CF ₄	.956	.44	.508	1.235	
Dibromodifluoromethane CBr ₂ F ₂	CF ₄	.413	.19	.15	9.362	
	CF ₄	1.021	.47	.075	7.76	
Dichlorodifluoromethane (Freon-12) CCl ₂ F ₂	CF ₄	.760	.35	.1432	5.395	
Dichlorofluoromethane (Freon-21) CHCl ₂ F	CF ₄	.913	.42	.140	4.592	
Dichloromethylsilane (CH ₃) ₂ SiCl ₂	CF ₄	.543	.25	.1882	5.758	
Dichlorosilane SiH ₂ Cl ₂	CF ₄	.869	.40	.150	4.506	
Dichlorotetrafluoroethane (Freon-114) C ₂ Cl ₂ F ₄	CF ₄	.478	.22	.1604	7.626	
1,1-Difluoroethylene (Freon-1132A) C ₂ H ₂ F ₂	CF ₄	.934	.43	.224	2.857	
Dimethylamine (CH ₃) ₂ NH	CF ₄	.804	.37	.366	2.011	
Dimethyl Ether (CH ₃) ₂ O	CF ₄	.847	.39	.3414	2.055	
2,2-Dimethylpropane C ₃ H ₁₂	CF ₄	.423	.22	.3914	3.219	
Ethane C ₂ H ₆	CF ₄	1.086	.50	.4097	1.342	
Ethanol C ₂ H ₆ O	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/l) @ 0°C	Molecular Weight
Ethyl Acetylene C ₄ H ₆	CF ₄	.703	.32	.3513	2.413	
Ethyl Chloride C ₂ H ₅ Cl	CF ₄	.84	.39	.244	2.879	
Ethylene C ₂ H ₄	C ₂ H ₄	1.000	.60	.1365	1.251	
Ethylene Oxide C ₂ H ₄ O	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 ₃ F	CF ₄	.717	.33	.1357	6.129	
Freon-12 CCl ₂ F 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 ₂ F	CF ₄	.913	.42	.140	4.592	
Freon-22 CHClF ₂	CF ₄	1.000	.46	.1544	3.858	
Freon-113 CCl ₂ FCF ₂	CF ₄	.434	.20	.161	8.360	
Freon-114 C ₂ Cl ₂ F ₄	CF ₄	.478	.22	.160	7.626	
Freon-115 C ₂ ClF ₅	CF ₄	.521	.24	.164	6.892	
Freon-C318 C ₄ F ₆	CF ₄	.369	.17	.185	8.397	
Germane GeH ₄	C ₂ H 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 ₂ F ₆ (Freon-116)	CF ₄	.521	.24	.1834	6.157	
Hexane C ₆ H 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/l) @ 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 ₂ Se	N ₂ O	1.112	.79	.1025	3.613	
Hydrogen Sulfide H ₂ S	N ₂ O	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 ₄ H ₈	CF ₄	.630	.29	.3701	2.503	
Krypton Kr	Ar	1.002	1.453	.0593	3.739	
Methane CH ₄	N ₂ O	1.014	.72	.5328	.715	
Methanol CH ₃	C ₂ H ₄	.966	.58	.3274	1.429	
Methyl Acetylene C ₃ H ₄	CF ₄	.934	.43	.3547	1.787	
Methyl Bromide CH ₃ Br	C ₂ H ₄	.966	.58	.1106	4.236	
Methyl Chloride CH ₃ Cl	C ₂ H ₄	1.050	.63	.1926	2.253	
Methyl Fluoride CH ₃ F	C ₂ H ₄	.957	.68	.3221	1.518	
Methyl Mercaptan CH ₃ SH	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 ₂ H ₅ NH ₂	CF ₄	.760	.35	.387	2.011	
Monomethylamine CH ₃ NH 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 ₂ O	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/l) @ 0°C	Molecular Weight
Nitrosyl Chloride NOCl	C ₂ H ₄	1.016	.61	.1632	2.920	
Nitrous Oxide N ₂ O	N ₂ O	1.000	.71	.2088	1.964	
Octafluorocyclobutane (Freon-C318) C ₄ F 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 ₂ H ₄	1.050	.63	.1917	2.406	
Pentaborane B ₅ H ₉	CF ₄	.565	.26	.38	2.816	
Pentane C ₅ H ₁₂	CF ₄	.456	.21	.398	3.219	
Perchloryl Fluoride ClO ₃ F	CF ₄	.847	.39	.1514	4.571	
Perfluoropropane C ₃ F ₈	CF ₄	.369	.174	.197	8.388	
Phosgene COCl ₂	CF ₄	.956	.44	.1394	4.418	
Phosphine PH ₃	N ₂ O	1.070	.76	.2374	1.517	
Phosphorous Oxychloride POCl ₃	CF ₄	.782	.36	.1324	6.843	
Phosphorous Pentafluoride PF ₅	CF ₄	.652	.30	.1610	5.620	
Phosphorous Trichloride PCl ₃	CF ₄	.652	.30	.1250	6.127	
Propane C ₃ H ₈	CF ₄	.782	.36	3.885	1.967	
Propylene C ₃ H ₆	CF ₄	.891	.41	.3541	1.877	
Silane SiH ₄	C ₂ H 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 ₂ O	.900	.69	.1488	2.858	
Sulfur Hexafluoride SF ₆	CF ₄	.565	.26	.1592	6.516	
Sulfuryl Fluoride SO ₂ F ₂	CF ₄	.847	.39	.1543	4.562	
Tetrafluorahydrazine N ₂ F ₄	CF ₄	.695	.32	.182	4.64	
Trichlorofluoromethane (Freon-11) CCl ₃ F	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/l) @ 0°C	Molecular Weight	Liquid or Gas Source
1,1,2-Trichloro-1,2,2 Trifluoroethane (Freon-113) CCl ₂ FCF ₂	CF ₄	.434	.20	.161	8.360		
Trisobutyl Aluminum (C ₄ H ₉)Al	CF ₄	.132	.061	.508	8.848		
Titanium Tetrachloride TiCl ₄	CF ₄	.586	.27	.120	8.465		
Trichloro Ethylene C ₂ HCl ₃	CF ₄	.695	.32	.163	5.95		
Trimethylamine (CH ₃) ₃ N	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 ₂ CHBr	CF ₄	1.000	.46	.1241	4.772		
Vinyl Chloride CH ₂ CHCl	CF ₄	1.043	.48	.12054	2.788		
Xenon Xe	Ar	.993	1.44	.0378	5.858		



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.

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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