



User's Guide

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FLR 1000/1000BR/1000ST Series
Flow Sensors & Meters For Liquids



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



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.

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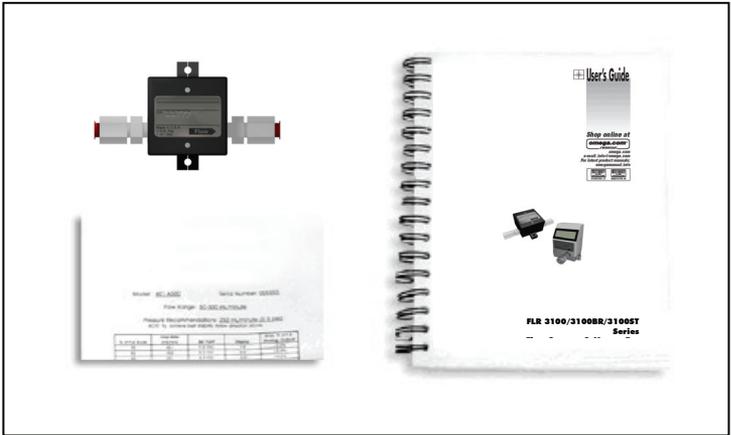
A. Introduction

1. Unpacking

All units 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 the shipping company and/or Omega Engineering to resolve the problem.

**Typical Contents of Box:
Sensor, Calibration Certificate & Instruction Manual
(Model FLR 1000 shown, other models similar).**



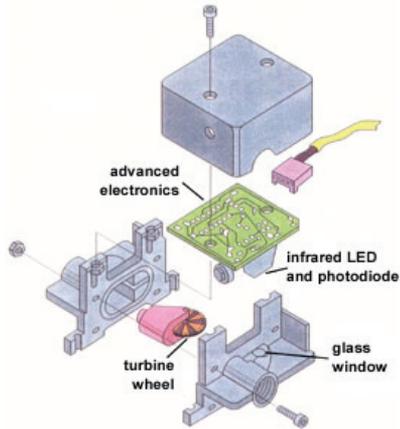
CAUTION: Take care not to **drop** your sensor or subject it to sudden impact. Read the installation section of this manual before providing power or tubing connections to the unit. Any damage caused by improper installation or careless handling will not be repaired under warranty (see limited warranty on page **33** for more details).

2. Product Overview and Principle of Operation

The FLR 1000 series of flow meters and sensors for liquids from Omega Engineering are capable of measuring flows as low as 13-100 ml/min or as high as 1.0-10.0 l/min. Highly repeatable results are achieved using a patented Pelton Turbine Wheel flow sensor design. This proven design

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

Flow is measured using a miniature turbine wheel similar in size to a U.S. dime (16 mm diameter, 0.75 mm thick). The micro-turbine wheel is



supported on a very small sapphire shaft that is held in position by two sapphire bearings. The micro-turbine assembly is so light that it virtually floats in the liquid. This relieves force on the bearings and almost eliminates wear.

As flow passes through the sensor, a precision machined nozzle directs the fluid onto the very small teeth of the micro-turbine wheel. This causes the wheel to spin at a speed proportional to the flow rate.

The micro-turbine wheel has alternating white and black sections evenly spaced on one side of the wheel. An infrared light beam is directed onto the wheel. As the wheel rotates the infrared beam is reflected off each white section. The reflected beam is detected by a phototransistor that converts the reflections into electrical pulses. As the wheel spins faster the pulse rate increases. Processing circuitry provides analog and/or pulse output that are linearly proportional to the flow rate

When the wheel stops (under zero flow conditions), no pulses are generated. Consequently, zero drift is not possible and zero adjustments are never required.

Every unit is supplied with a calibration certificate detailing the results obtained during calibration. Units are calibrated using deionized water as the reference media. Flowing liquids with different specific gravities or viscosities may affect the calibration.

B. Installation



CAUTION: Do not flow any gas through a liquid flow sensor. This may damage the micro-turbine assembly and void the warranty. 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 of (before) the sensor.

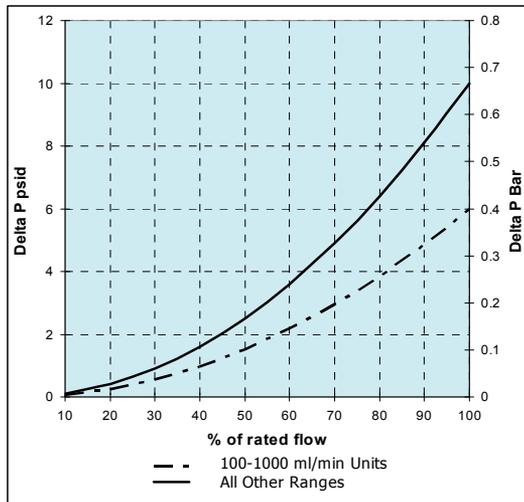
All wetted parts should be checked for compatibility with the liquid to be used. If there are any incompatibilities e.g. highly corrosive liquid, then the unit may be damaged or fail prematurely. Such damage will not be repaired under warranty.

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.

If the liquid to be used may contain particles larger than 25 microns then a filter (25 microns or less) should be installed upstream of (before) the unit.

The required differential press (or pressure drop across the unit) decreases exponentially with decreases in flow rate.

Pressure Drop vs. Percentage of the Full Scale Rated Flow (may vary $\pm 10\%$ of indicated psid)



To calculate the pressure drop at a certain flow rate use the formula

$$\mathbf{PD = (YourFlow / MaxFlow)^2 \times PD_{max}}$$

PD = Pressure drop at YourFlow.

YourFlow = flow rate (ml/min or l/min)

MaxFlow = 100% rated flow for the sensor (in same units as YourFlow)

PD_{max} = Pressure drop at 100% rated flow (see chart above)

If the pressure available for the flow sensor is BELOW the pressure drop at the required flow then flow through the unit will not be possible.

For example: You have a sensor with a 50-500ml/min flow range and want to know the pressure drop (or minimum differential pressure required) at 300ml/min. According to the chart above, the pressure drop at 100% of flow is approx 10psi. Using the formula above:

$$PD = (300 / 500)^2 \times 10 = 3.6 \text{ psid}$$

Therefore, at 300ml/min the minimum required differential pressure for this unit is 3.6 psid. This means that if the available pressure is below 3.6psid then flow through the unit may not be possible.

Pressure drop through a system is cumulative. If the total pressure drop across all the components in a system exceeds the minimum pressure available then flow will not be possible.

For example: A system has a pressure of 30-40psi. There are several components and the sum of their pressure drops at the required flow rate is 32psid. If the system is operating at 30psi flow would not be possible as the total of the pressure drops would be greater than the pressure available. The system will only operate if the system pressure is above 32psi.

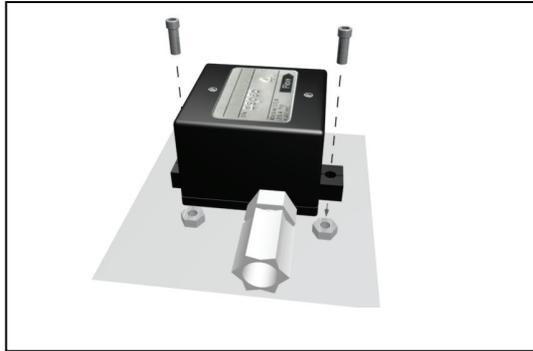
If there is any possibility that there may be bubbles or entrapped gas in the system then the outlet tubing should be elevated above the inlet port. This will enable any gas that may become entrapped in the unit to escape (see section C2 for details of how to remove entrapped air or gas).

2. Mounting the Flow Sensor or Flow Meter

The Omega Engineering FLR 1000 Series units have no particular installation requirements so may be mounted in any convenient position.

It is recommended that units be fixed to a suitable substrate with #4 screws using the two mounting holes provided.

***Mounting The Sensor
(mounting hardware not included with sensor)***



3. Tubing Connections



CAUTION: DO NOT FLOW ANY GAS THROUGH A LIQUID FLOW SENSOR OR FLOW METER. THIS WILL DAMAGE THE MICRO-TURBINE ASSEMBLY AND VOID THE WARRANTY.

All tubing must be clean and without crimps, burrs or scratches.

Only use the fittings factory installed on the unit. If the fittings are removed the calibration of the unit may be affected and leaking may occur. If different fittings are required please contact the Omega Engineering Service Department for assistance.

When connecting the sensor to the tubing a wrench should be used to stop the fitting rotating in the sensor body. Take care not to over tighten the fittings or leaking may occur.

***Connecting and tightening the Fittings
(FLR 1000-ST-D shown, other models similar)***

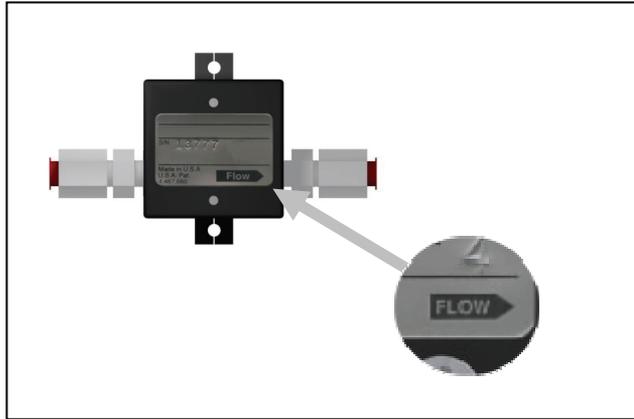




CAUTION: DO NOT over tighten the fittings into the sensor body. Excessive force may damage the sensor body and will NOT be repaired under warranty.

The flow direction for the sensor is clearly marked on the label. Do not reverse the flow direction or the unit will not function.

***Close Up of Label Showing Flow Direction
(FLR 1000 shown, other models similar)***



For the best results precautions should be taken to minimize the amount of turbulence in the flow stream. Avoid valves, fittings, curves in the tube, changes in the internal diameter or any other restrictions close to the inlet of the sensor. The tubing ID should be as large as possible and preferably not smaller than the ID of the fittings installed on the sensor.

For 0.2-2.0 L/min units a 10 cm straight length of tube before the sensor is recommended. For higher flow range units (0.5-5.0 L/min and 1.0-10.0 L/min), a 20 cm straight length of tubing before the sensor is recommended. If this is not possible it is recommended that straight lengths between all connections on the inlet side of the sensor are as long as possible and 90 degree fittings (with a large enough ID) are used instead of curves in the tubing.

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 FLR 1000 series of flow sensors and flow meters provide a 0-5 V DC, or 4-20 mA, or 0-5 V DC and pulse output proportional to the flow rate. This output may be connected to a display, data acquisition system or voltmeter/current meter.

The FLR 1000-D, 1000-ST-D and 1000-BR-D series feature an integral display that provides a local flow reading. These units also have a 0-5 V DC analog output available. If required, this may be connected to another display, data acquisition system or voltmeter.

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.

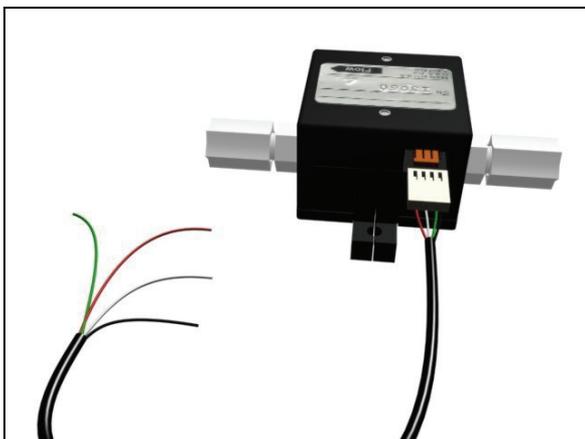
Connecting wires should be as short as possible to avoid voltage drops. Twisted 2 pair conductor cable should be used if the length of the power wires is to be longer than 1 meter.

Units are supplied with an integral 4 pin connector. Connections to the unit are made using a mating cable assembly or power adapter package as detailed in the following sections (parts 5.b to 5.f of this manual). A connector pin and wire color cross reference may also be found in Appendix G (Page 30) of this manual.

b) Connecting the Cable Assembly

The connector on the end of the cable assembly should be pushed into the mating socket on the sensor taking care to ensure that it is the correct way up.

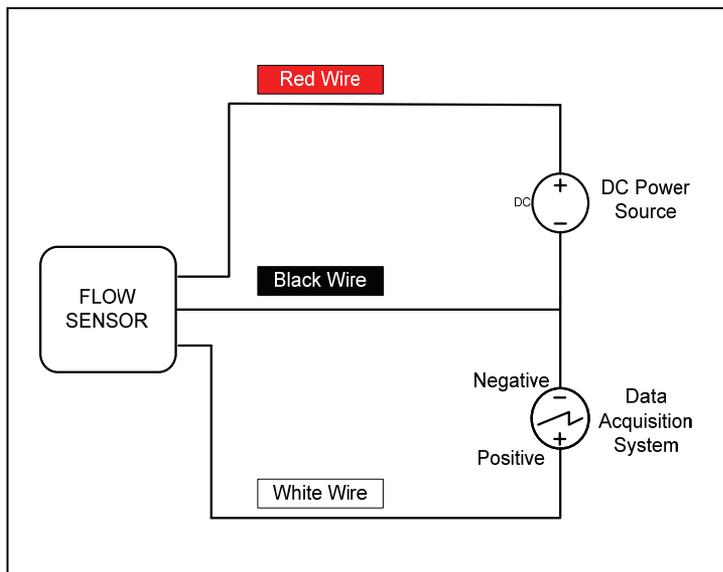
Connecting the Cable Assembly (FLR 1000 shown, other models similar)



c) Electrical Connections – Voltage Output Units

The cable assembly should be connected to the sensor as detailed in section 5(b) above. Power should not be applied to the sensor until all the connections have been made and checked. Electrical connections should be made as follows:

Wiring Schematic For Voltage Output Units.



The **RED** wire should be connected to the Positive of the power source.

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

The **WHITE** wire provides the signal output and should be connected to the positive terminal of the display, data acquisition system or voltmeter with an impedance of greater than 2500 Ω (Ohms).

The **GREEN** wire (if present) is NOT used

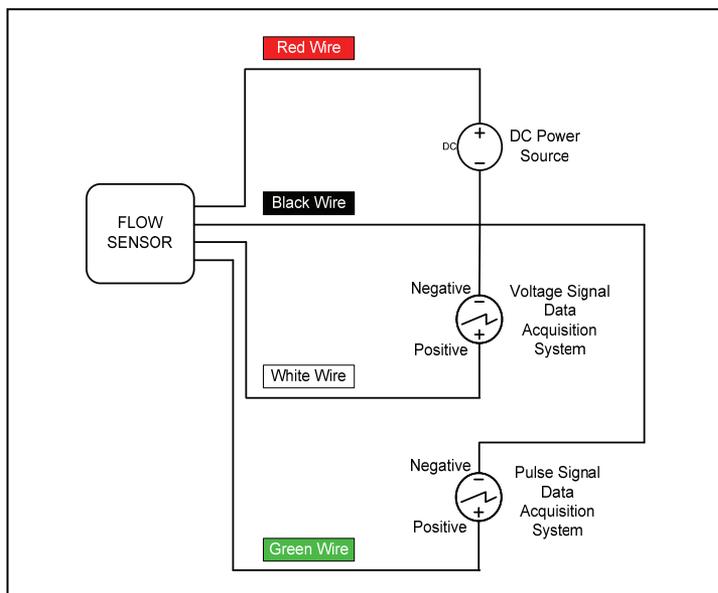


CAUTION: Avoid high voltage static discharges to any of the connections. Do not short the input/output signal wires or allow them to contact the power wires at any time. **DAMAGE WILL RESULT!**

d) Electrical Connections –Units with Both Voltage and Pulse Outputs

The cable assembly should be connected to the sensor as detailed in section 5(b) above. Power should not be applied to the sensor until all the connections have been made and checked. Electrical connections should be made as follows:

Wiring Schematic For Voltage and Pulse Output.



The **RED** wire should be connected to the Positive of the power source.

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

The **WHITE** wire provides the signal output and should be connected to the positive terminal of the display, data acquisition system or voltmeter with an impedance of greater than 2500Ω (Ohms).

The **GREEN** wire ("P" suffix only) is the pulse output and should be connected to the Positive terminal of the data acquisition system with an impedance of greater than $10K\Omega$ (Ohms).

The PULSE and VOLTAGE output may be monitored simultaneously.



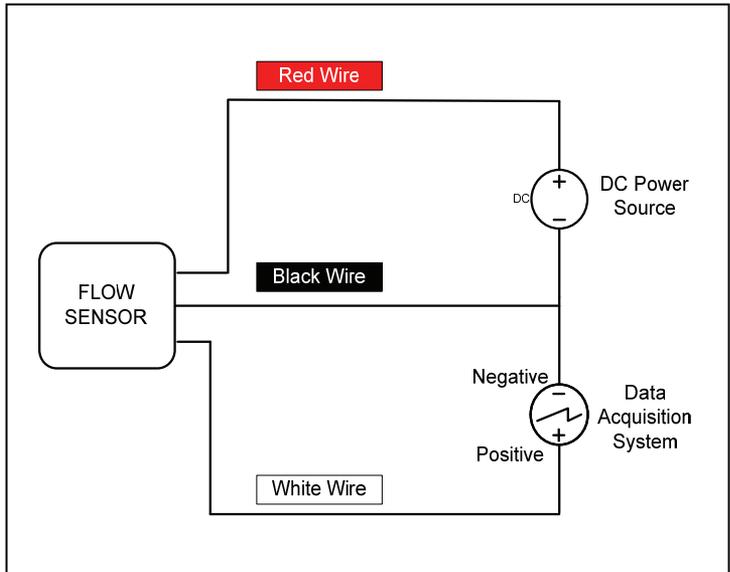
CAUTION: Avoid high voltage static discharges to any of the connections. Do not short the input/output signal wires or allow them to contact the power wires at any time. **DAMAGE WILL RESULT!**

e) Electrical Connections – Current Output Units (“I” Suffix)

The FLR 1000–ST-I provides a 4-20mA active current output proportional to the flow rate.

The cable assembly should be connected to the sensor as detailed in section 5(b) above. Power should not be applied to the sensor until all the connections have been made and checked. Electrical connections should be made as follows:

Wiring Schematic For Current Output Units (“I” suffix only).



The **RED** wire should be connected to the Positive of the power source.

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

The **WHITE** wire provides the signal output (active current) and should be connected to the positive terminal of the display, data acquisition system or current meter with an impedance of 0 - 500Ω (Ohms).

The **GREEN** wire is NOT used.

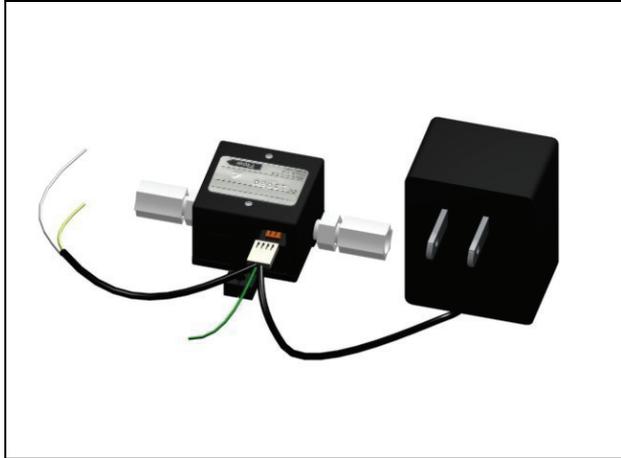


CAUTION: Avoid high voltage static discharges to any of the connections. Do not short the input/output signal wires or allow them to contact the power wires at any time. **DAMAGE WILL RESULT!**

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

An optional 0-5 V DC Output Power Adapter Package is available for use with the FLR 1000 series (not the FLR 1000-ST-I). This consists of a power source (115VAC or 230VAC) and cable assembly with pig-tail (soldered wire) ends for the signal output. This should be assembled as shown in the following diagram.

Connecting the Power Adapter to the Flow Sensor (FLR 1000 shown, other models similar)



Electrical connections to the cable assembly should be made as follows:

YELLOW WIRE: This provides the 0-5 V DC signal output and should be connected to the positive terminal of the display, data acquisition system or voltmeter with an impedance of greater than 2500 Ω (Ohms).

GREEN WIRE: For Pulse output units ("P" suffix only) the green wire provides the pulse output and should be connected to the positive terminal of the data acquisition system with an impedance of greater than 10K Ω (Ohms).

WHITE WIRE: This is the signal negative and should be connected to the negative (ground) terminal of the voltmeter, display or data acquisition system.



CAUTION: Avoid high voltage static discharges to any of the connections. Do not short the output signal wires or allow them to contact the power wires at any time. **DAMAGE WILL RESULT!**

C. Operation



CAUTION: USE WITH LIQUIDS ONLY. FLOWING GAS OR AIR THROUGH YOUR LIQUID FLOW SENSOR WILL DAMAGE THE MICRO-TURBINE ASSEMBLY. THIS TYPE OF DAMAGE WILL NOT BE REPAIRED UNDER WARRANTY.

1. Start Up

Before applying power to the unit check all tubing and electrical connections. Once correct installation is verified switch on the power.

2. Entrapped Air or Gas

There may be a lot of air or gas trapped in your sensor after installation. This will usually escape the unit when flow (within the range of the unit) is first started.



CAUTION: The system should be primed with liquid and flow started gradually. This will prevent trapped air or gas from being forced through the sensor at a high velocity that may damage the sensor.

If gas remains entrapped in the unit it may be necessary to elevate the outlet tubing above the inlet of the unit. This should enable the trapped gas to escape the unit. The unit may be returned to its original position once all the gas has escaped.

If elevating the outlet tubing does not work, block or pinch the outlet tube whilst there is flow in the system. After approximately 5 seconds, release the restriction to allow normal flow. Doing this will build up pressure in the flow path that when released will help remove the entrapped gas. Repeat this until the entrapped gas is removed from the unit.

3. Flow Readings

The FLR 1000 Series provide a 0-5 V DC, or 4-20 mA (I suffix), or 0-5 V DC and pulse output (P suffix) proportional to the flow rate. The type of output signal is detailed by the part number reference and on the calibration certificate.

The FLR 1000-D, FLR 1000-BR-D and FLR 1000-ST-D series features an integral display that provides a local flow reading and a 0-5 V DC analog output.

Each unit is factory calibrated for a specific flow range. The flow range is shown on the unit's label and calibration certificate. Units are calibrated using deionized water as the reference media.

a) 0-5VDC Analog Outputs

By monitoring the voltage output signal it is possible to determine the flow rate of the liquid. Units are configured so that an output signal of 5.0 V DC 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 50-500ml/min:

At 500ml/min the output signal would be 5 V DC

If the output signal were 3.5 V DC then the flow rate would be:

$$(500 \div 5) \times 3.5 = 350\text{ml/min}$$

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

b) Pulse Outputs

By monitoring the Pulse output frequency it is possible to determine the flow rate of the liquid. The pulse frequency for maximum flow through the unit (i.e. full scale flow) is detailed on the calibration certificate. This differs from unit to unit. This output is approximately linear and scaleable within the sensor's range. For example:

For a flow range of 1.0-10.0l/min:

The calibration certificate gives the following:

At 10.0l/min the pulse output signal is 312Hz

At 5.0l/min the pulse output signal is 150Hz

At 2.0l/min the pulse output signal is 58Hz

If the output signal were 120Hz then the flow rate would be:

$$(5.0 \div 150) \times 120 = 4.0 \text{ l/min (using the closest calibration point)}$$

c) 4-20 mA Outputs

By monitoring the current output signal it is possible to determine the flow rate of the liquid. Units are configured so that an output signal of 20 mA is provided when the maximum flow (i.e. Full Scale flow) is passing through the unit. The output signal is 4 mA when there is zero flow 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 20-200ml/min:

At 200ml/min the output signal would be 20mA

If the output signal were 9mA then the flow rate would be:

$$200 \div (20-4) \times (9-4) = 62.5\text{ml/min}$$

d) Units With an Integral Display

The FLR 1000-D, FLR 1000-BR-D and FLR 1000-ST-D series features an integral 3 1/2 digit LCD display. This is configured to read in ml/min for flow ranges up to 50-500 ml/min and in l/min for flow ranges of 0.1 – 1.0 L/min. The display will only operate if power is applied to the unit.

Flow readings may be taken directly from the display or by monitoring the 0-5 V DC analog output provided by using a cable assembly or power adapter package (see above).

LCD Flow Display (Model FLR1000-ST-D shown, other models with displays similar)



4. Operating at Flow Rates Outside the Calibrated Flow Range



CAUTION: If the flow through the unit exceeds 120% of the maximum rated (full scale) flow the unit may be damaged. This type of damage will not be repaired under warranty.

Flow measurement is only accurate within the calibrated flow range for the unit. This is detailed on the calibration certificate. The unit will still operate, to some degree, outside this flow range.

Results obtained when operating outside the specified range of the unit are not accurate but may be considered repeatable.

a) Flows Above the Maximum Rated Flow

If the flow rate is above the maximum rated (or full scale) flow, the unit will still operate and provide an output signal proportional to the flow rate.

Flows must not exceed 120% of the maximum rated flow or the unit may be damaged.

b) Flows Below the Minimum Rated Flow

Signal outputs may be obtained at flow rates below the minimum specified for your unit. The amount of flow that may be measured below the minimum specified varies from unit to unit.

5. Zero Adjustments

It is impossible for there to be any zero drift so zero adjustments are never required.

6. Recalibration

The calibration of the unit may be easily verified using empirical methods.

It should be noted that the use of empirical methods outside a certified calibration laboratory is subject to inaccuracy and error. These methods should only be used to gain an indication of a sensor's performance. Please contact the Omega Engineering Service Department if accurate, certified recalibration is required.

A typical empirical calibration check may be carried out as follows:

Carefully adjust the flow rate so that the maximum output signal is obtained. With the flow rate constant, liquid flowing through the unit should be gathered in a container over a timed interval. The total volume flowed over

the timed period should then be measured using a measuring cylinder. The actual flow rate (in the same units as the flow sensor calibration certificate) may then be calculated. The actual maximum flow rate should then be compared to the specified maximum flow rate to determine the error in calibration. For example:

For a unit with a flow range of 20-200ml/min and a 0-5 V DC output:

With a constant flow and constant 5 V DC output the actual volume measured over 30 seconds was 102ml.

Therefore the actual flow rate is:

$$(102 / 30) \times 60 = 204\text{ml/min}$$

The error is therefore $204 - 200 = 4\text{ml/min}$ or 2%

A second empirical check should be made at a flow rate below the maximum for the unit eg at 50% of full scale. The calculated percentage error at this flow should then be compared to the error at maximum flow. If there is a big difference in the percentage errors then the flow signal is no longer linear and the unit may be damaged (consult the Omega Engineering Service Department).

Once it has been determined that the linearity is still acceptable and the error in flow reading at maximum flow has been calculated, there are 3 options:

i.) Minor adjustments to actual calibration of the unit may be made by turning the gain potentiometer on the side of the unit. For example:

For a unit with a flow range of 13-100ml/min and a 0-5 V DC output:

With a constant flow and constant 5 V DC output the actual volume measured over 60 seconds was 103ml.

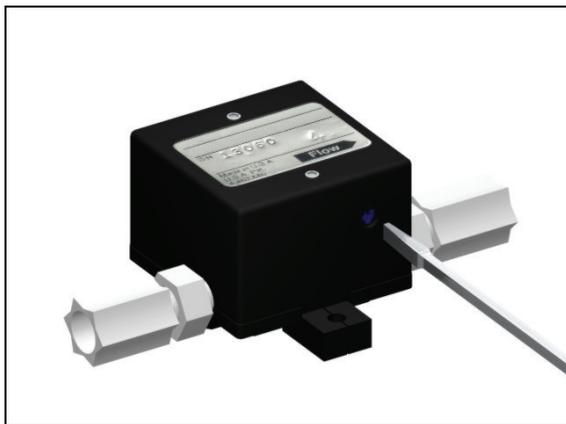
The correct voltage output for a flow of 103 ml/min is:

$$(5/100) \times 103 = 5.15 \text{ V}$$

With the flow at a constant 103 ml/min the gain potentiometer should be carefully adjusted so that a voltage output reading of 5.15 V is obtained.

If the unit cannot be suitably adjusted please contact the Omega Engineering Service Department. Pulse outputs are not adjustable.

***Adjusting the Gain Potentiometer Using a Flat Head Screwdriver
(FLR 1000 shown, other models similar)***



ii.) Adjust the scaling endpoints in the display or data acquisition system. For example:

For a unit with a flow range of 50-500ml/min and a 0-5 V DC output:

With a constant flow and constant 5 V DC output the actual volume measured over 60 seconds was 405ml.

Therefore the actual flow rate is:

$$(405 / 60) \times 60 = 405\text{ml}/\text{min}$$

The display or data acquisition system may now be configured as follows:

0 V DC = Zero flow
5 V DC = 405ml/min

iii.) Apply the error factor to each flow reading taken. For example:

For a unit with a flow range of 0.2-2.0l/min connected to a display:

With a constant flow rate of 2.0 l/min on the display, the actual volume measured over 20 seconds was 0.7l

Therefore the actual flow rate is:

$$(0.7 / 20) \times 60 = 2.1 \text{ l/min}$$

The error is therefore $2.1 - 2.0 = 0.1 \text{ l/min}$ or 5%

If the display shows an uncorrected flow rate of 1.4 l/min then :

$$\text{Corrected flow rate} = \text{Uncorrected flow rate} + \text{error} = 1.4 + 5\% = 1.47 \text{ l/min}$$

7. Calibrating Units for Different Liquids

The FLR 1000 Series will operate with most translucent liquids subject to compatibility of the wetted parts. Best results are obtained with low viscosity (less than 10 centistokes) liquids. For information regarding higher viscosity liquids, contact the Omega Engineering Service Department.

Units are calibrated with deionized water as the reference media. Using other liquids will affect the calibration. The amount of calibration error will depend on the characteristics of the liquid being flowed.

The error in flow reading (or calibration) should be calculated and utilized as detailed in section 6 above.

D. Maintenance and Product Care

1. General



CAUTION: Do not disassemble your unit for any reason. If the unit appears to be malfunctioning please contact the Omega Engineering Service Department.

The FLR 1000 Series of flow meters and sensors require no periodic maintenance if used within the recommended specifications.

The next recommended recalibration date is stated on the calibration certificate supplied with the unit. Please contact the Omega Engineering Service Department for further information.

Inlet filters should be periodically checked and cleaned / 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 store a unit with any chemical other than water (or air) inside it over an extended period of time. Prolonged exposure to chemicals other than water may lead to precipitation or corrosion.

2. Cleaning and Flushing

If there is a build up of deposits or residues from the measured chemicals it may be necessary to clean *or flush* the unit. This should be done by flowing clean, particle free water through the unit at a flow rate, pressure and temperature within the specifications of the unit. If necessary, flow may be reversed to assist flushing.

Under no circumstances should gas or air be flowed through the unit. This will cause severe damage.

3. Returning Units for Repair or Recalibration

To return units 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 33 of this manual.

E. Specifications For Liquid Units

	FLR 1000	FLR 1000-BR	FLR 1000-ST	FLR 1000-ST-I
Accuracy (including linearity)	Analog Signal: $\pm 1.0\%$ Full Scale ¹ Optional Pulse Signal: $\pm 3.0\%$ F.S. ¹			$\pm 1.0\%$ Full Scale ¹
Repeatability	$\pm 0.2\%$ Full Scale ¹			
Pressure Rating	100 psig (6.8 bar)	500 psig (34.5 bar)		
Temperature Rating	Operating Range: 5 to 55°C Storage Range: 0 to 70°C			
Temperature Sensitivity	$\pm 0.2\%$ F.S. ¹ or less per °C			
Wetted Materials	Ryton® 316 Stainless ² Epoxy Glass Sapphire	Brass Ryton® 316 Stainless ² Epoxy Glass Sapphire	316 Stainless Ryton® Epoxy Glass Sapphire	
O-Ring Material	Standard - FKM EPDM Optional			
Fitting Material (Standard)	Acetal	Brass	Stainless Steel	
Fitting Material (Optional)	PVDF Brass Stainless Steel	Acetal PVDF Stainless Steel	Acetal PVDF Brass	
Recommended Filtration	25 microns or less			
Compatible Liquids	Low viscosity (ideally <10cS) Translucent or transparent Minimum amount of entrapped air or gas			
0-5 V DC Output Signal	Standard Minimum 2.5 KΩ load			N/A
Pulse Output Signal	"P" Suffix Only 7.5 V DC peak buffered square wave Typically 0-400Hz $\pm 3.0\%$ Full Scale accuracy			N/A
4-20mA Output Signal	N/A			Non Isolated Current loop <500Ω
Typical Power Consumption	Standard: 12 V DC @ 35 mA (11.5-15 V DC)			24 V DC @ 65mA
Response Time	Typically <1 second for 63% of final value			
Reliability	100,000 hours MTBF			
Certifications	CE Approved 89/336/EEC (EN 55011 & EN 50082-1) 73/23/EEC Low Voltage Directive			
Ratings	IP10 (NEMA 1)			
Warranty	1 year limited			

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

	FLR 1000-D	FLR 1000-BR-D	FLR 1000-ST-D
Display	3.5 Digit Non Backlit LCD, 0.39" (10mm) high digits		
Accuracy (including linearity)	±1.0% Full Scale ¹		
Repeatability	±0.2% Full Scale ¹		
Pressure Rating	100 psig (6.8 bar)	500 psig (34.5 bar)	
Temperature Rating	Operating Range: 5 to 55°C Storage Range: 0 to 70°C		
Temperature Sensitivity	±0.2% F.S. ¹ or less per °C		
Wetted Materials	Ryton [®] 316 Stainless ² Epoxy Glass Sapphire	Brass Ryton [®] 316 Stainless ² Epoxy Glass Sapphire	316 Stainless* Ryton [®] Epoxy Glass Sapphire)
O-Ring Material	Standard - FKM EPDM Optional		
Fitting Material (Standard)	Acetal	Brass	Stainless Steel
Fitting Material Optional	Acetal, PVDF, brass, or stainless steel		
Recommended Filtration	25 microns or less		
Compatible Liquids	Low viscosity (ideally <10cS) Translucent or transparent Minimum amount of entrapped air or gas		
0-5 V DC Output Signal	Standard Minimum 2.5 KΩ load		
Typical Power Consumption	Standard: 12 V DC @ 35 mA (11.5-15 V DC)		
Response Time	Typically <1 second for 97% of final value		
Reliability	100,000 hours MTBF		
Certifications	CE Approved 89/336/EEC (EN 55011 & EN 50082-1) 73/23/EEC Low Voltage Directive		
Ratings	IP10 (NEMA 1)		
Warranty	1 year limited		

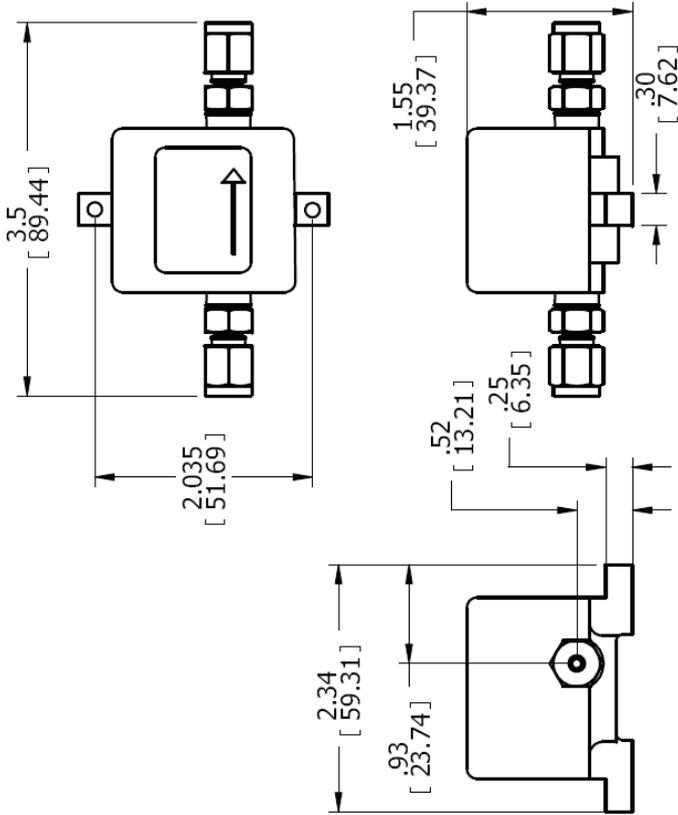
1. Specifications from 10-100% of rated flow. Linearity is best fit straight line. All calibrations performed with deionized water unless otherwise stated on calibration certificate

F. Dimensions

ALL DIMENSIONS IN INCHES (MILLIMETERS IN BRACKETS)

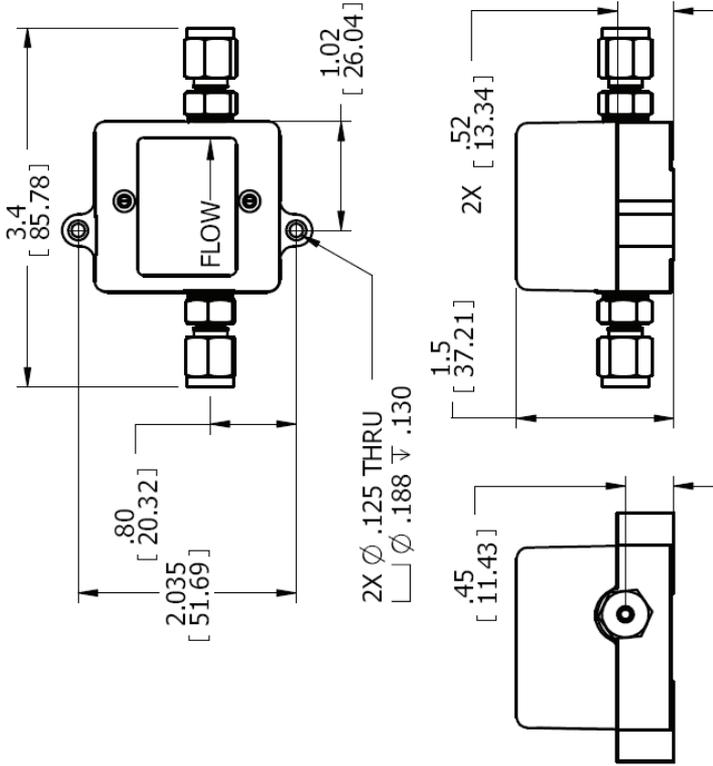
FLR 1000 For Liquids

1/4" Acetal Fittings Shown



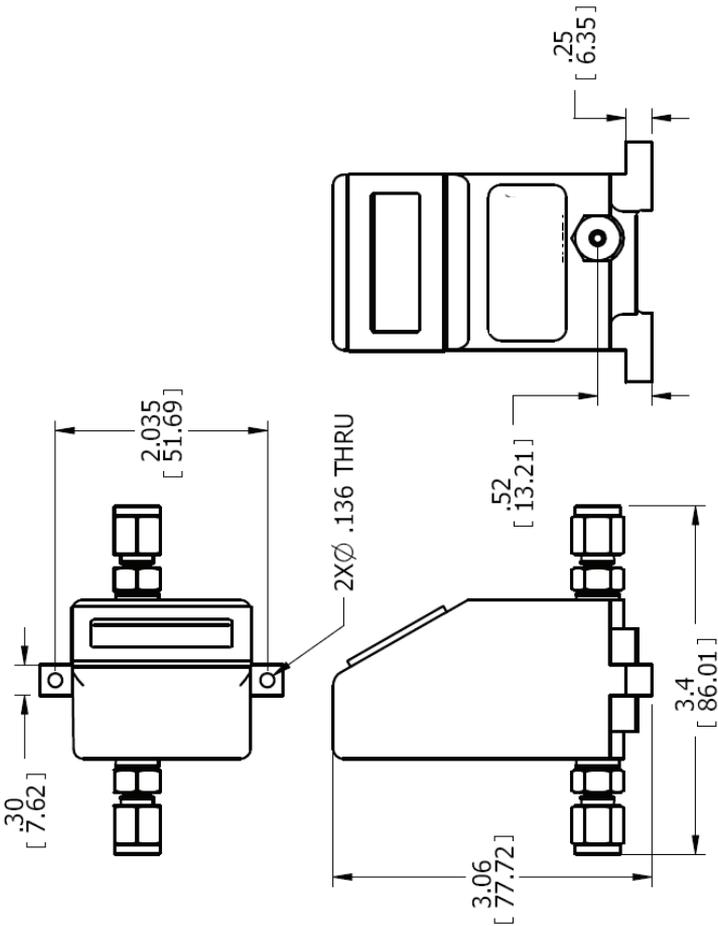
FLR 1000-BR & FLR 1000-ST For Liquids

1/4" Compression Fittings Shown



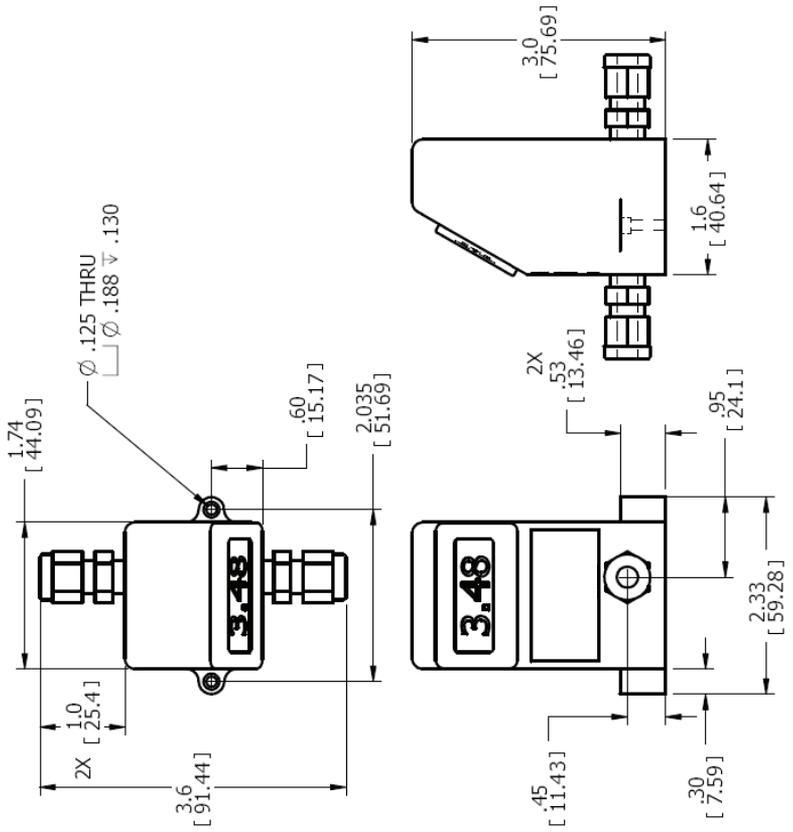
FLR 1000-D For Liquids

1/4" Acetal Fittings Shown



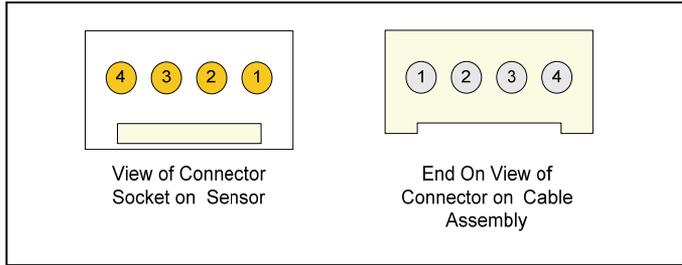
FLR 1000-BR-D & FLR 1000-ST-D For Liquids

1/4" Compression Fittings Shown



G. Connector Pin And Wire Color Cross Reference

End On View of Connector Socket and Connector



Standard Units:

Pin	Cable Wire Color	Unit Output		
		Voltage	Voltage & Pulse	Current
1	Black	Signal & Power Negative (Ground)	Signal & Power Negative (Ground)	Signal & Power Negative (Ground)
2	White	Voltage Output	Voltage Output	Current Output
3	Red	Power Positive	Power Positive	Power Positive
4	Green	Not Used	Pulse Output	Not Used

H. Troubleshooting Guide

Symptom	Possible Cause	Method of Correction
No output signal or flow indication	No power or low power	Apply correct power
	No flow passing through unit	Display or output should read zero if there is no flow. Increase the flow rate until a reading is obtained. (Do not exceed the specified maximum flow!)
	Output shorted or overloaded	Check electrical connections (see section B)
	Improper connection	Check electrical connections (see section B) and ensure connector is correctly plugged in
	Moisture on internal electronics	Allow unit to dry out in a dry environment
	Output circuitry damaged	Unit must be returned for repair (see Section D3)
	Liquid not translucent enough.	Contact the Omega Engineering Service Department for assistance
Flow indication is not linear and output too low at lower flows	Attempting to measure flows below the specified minimum for the unit	Use higher flow rates
	Liquid is too viscous	Best results are obtained with liquids that have a viscosity of 10cS or less. Contact the Omega Engineering Service Department for further information
	Entrapped air or gas	Remove entrapped air (see section C2)
	Mechanical sensor assembly damaged	Unit must be returned for repair (see Section D3)

Symptom	Possible Cause	Method of Correction
Flow indication "bounces" or fluctuates	Flow is actually fluctuating	Correct flow source to obtain steady flow
	Not using the fittings supplied by the manufacturer	Use the supplied fittings
	Entrapped air or gas	Remove entrapped air (see section C2)
	Turbulence in tubing or sensor	Straighten the inlet tubing or lengthen it to at least 6" (150mm)
	Fluctuating input power	Correct the power source or change to a regulated supply
	Mechanical sensor assembly damaged	Unit must be returned for repair (see Section D3)
Flow reading accuracy is outside the specification	Liquid has a different viscosity and / or specific gravity than water at 20°C	Calculate the flow reading error / offset as explained in section C6
	Entrapped air or gas	Remove the entrapped air (see section C2)
	Mechanical sensor assembly damaged	Unit must be returned for repair (see Section D3)
Flow indication is fixed at one value	The maximum rated flow for the unit is being exceeded.	Reduce the flow
	Output circuits may be damaged	Unit must be returned for repair (see Section D3)
Unit Leaks	Fittings not tight enough.	Tighten fittings (see section B)
	Sensor assembly cracked	Unit must be returned for repair (see Section D3)

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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