



User's Guide

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FSW 530 Series Flow Switches For Liquids



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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.



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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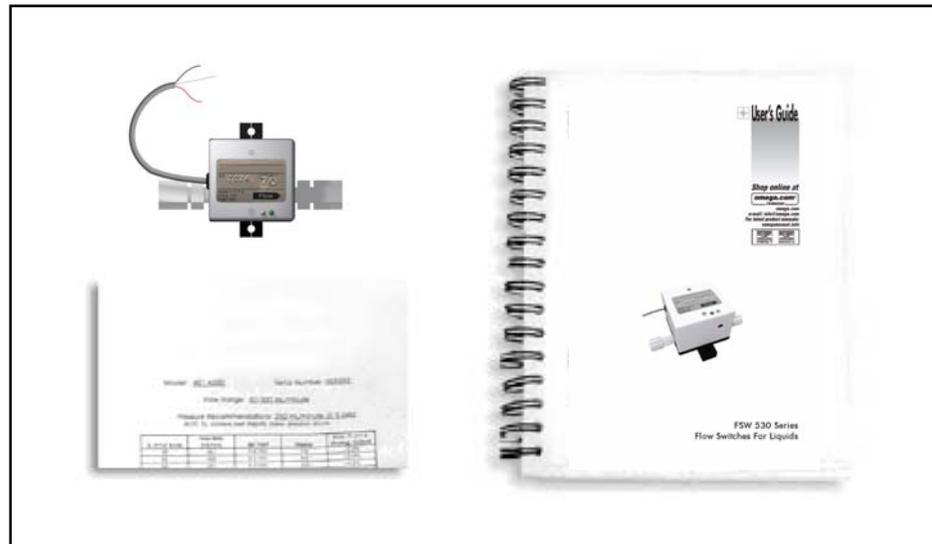
A. Introduction

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** 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 to resolve the problem.

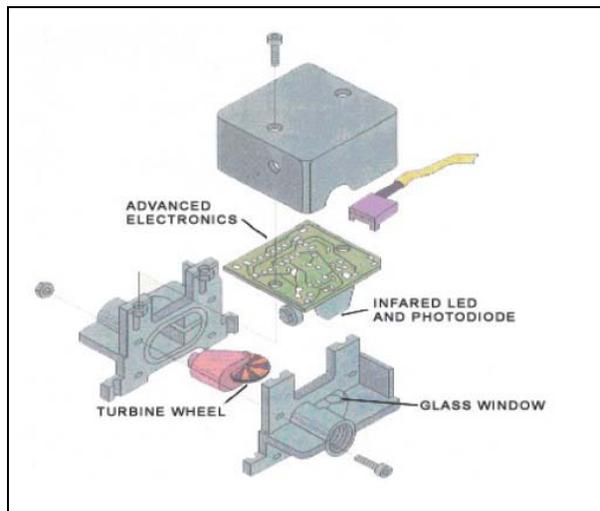
Typical Contents of Box: FSW 530, Calibration Certificate & Instruction Manual



CAUTION: Take care not to **drop** your FSW 530. 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.

2. Product Overview and Principle of Operation

The FSW 530 Series of flow switches for liquids from Omega are capable of monitoring flow ranges 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 FSW 530, 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 monitors the flow rate. When the configured set-point is achieved a solid state relay is activated.

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.

3. Non-Standard Products

Please note that the installation instructions, operating instructions, and specifications included within this manual apply to standard production models only. If your FSW 530 has a custom alteration then your unit is non-

standard. Contact the factory to check if the installation, operation, or specifications of your sensor are different than detailed in this manual.

B. Installation



CAUTION: Do not flow any gas through a liquid flow switch. This will damage the micro-turbine assembly and void the warranty.



CAUTION: Do not exceed the pressure, temperature or power operating ranges detailed in the SPECIFICATIONS section of this manual. Omega 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 FSW 530.

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.

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

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

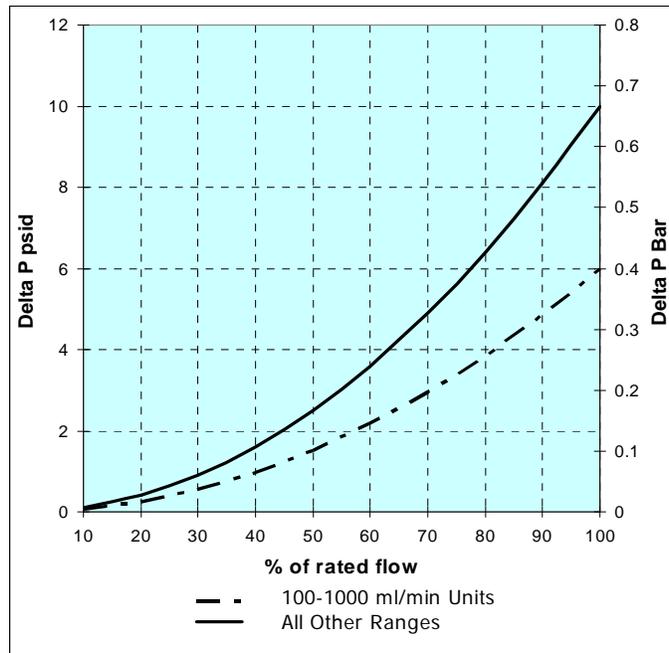
PD = Pressure drop at YourFlow.

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)

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



If the pressure available for the FSW 530 is BELOW the pressure drop at the required flow then flow through the unit will not be possible.

For example: You have a FSW 530 with a 60-500ml/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 3.6psid. This means that if the available pressure is below 3.6psid then flow through the unit will 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.

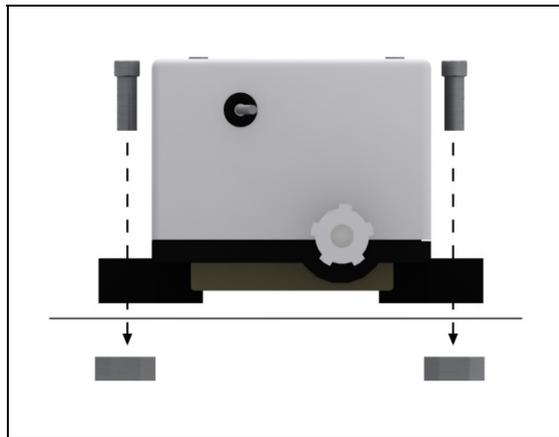
If there is any possibility that there may be bubbles or entrapped gas in the system then the outlet tubing should be elevated above the inlet port. This will enable any gas that may become entrapped in the unit to escape.

2. Mounting the FSW 530.

FSW 530 units have no particular installation requirements so may be mounted in any convenient position. It is recommended that the outlet of the FSW 530 is parallel with, or elevated above the inlet. This will enable entrapped air in the system to pass through the unit more easily.

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

***Mounting View From Bottom
(Mounting hardware not included with FSW 530).***



3. Tubing Connections



CAUTION: DO NOT FLOW ANY GAS THROUGH A LIQUID FLOW SWITCH. THIS MAY DAMAGE THE MICRO-TURBINE ASSEMBLY AND VOID THE WARRANTY.

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

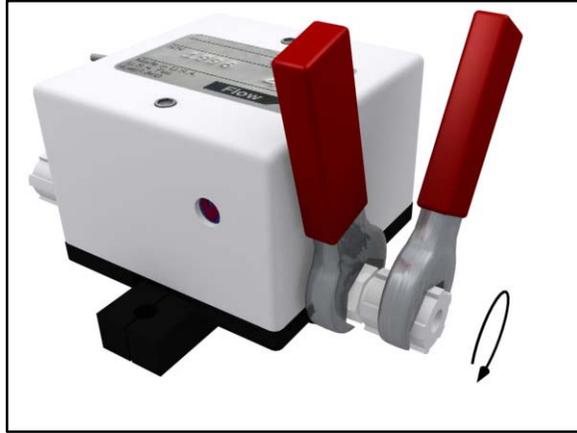
Only use the fittings factory installed on the unit. If the fittings are removed the calibration of the unit may be effected and leaking may occur. If different fittings are required please contact Omega for assistance.



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

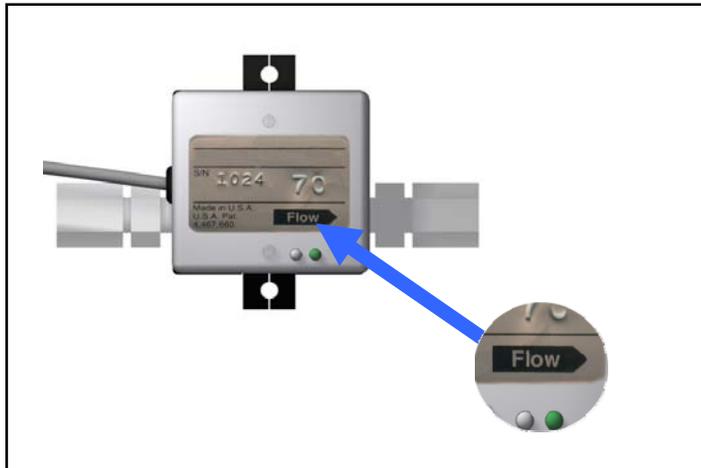
When connecting the FSW 530 to the tubing a wrench should be used to stop the fitting rotating in the FSW 530 body. Take care not to over tighten the fittings or leaking may occur.

Connecting and Tightening the Fittings



The flow direction for the FSW 530 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



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 0.3-2.0 L/min units a 10 cm straight length of tube before the sensor is recommended. For higher flow range units (0.6-5.0 L/min and 1.1-10.0 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 FSW 530 provides connections to a solid state relay that operates at a set flow rate. This output may be connected to an indicator light, alarm, small relay with inductive kick suppression or other resistive device (do not use with AC loads, for DC use only).

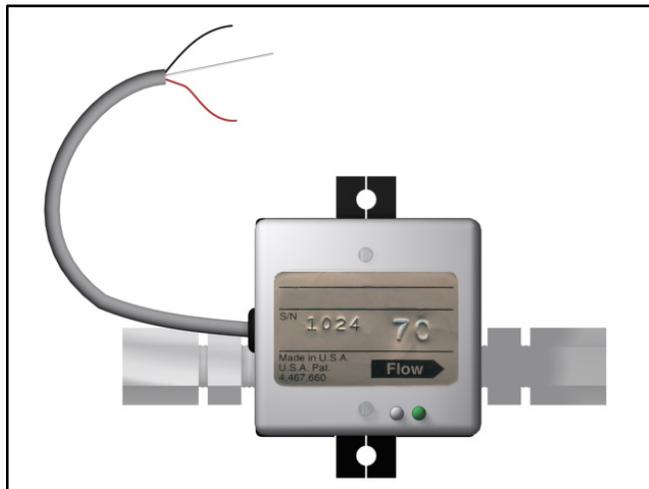
The FSW 530 is designed to activate loads that require less than 250mA and/or 24 VDC to operate. Loads that operate at more than 250mA and/or 24VDC may damage the FSW 530. Please contact the Omega Service Department for further information.

A stable, low noise 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 conductor cable of a suitable gauge should be used if the length of the power wires is to be longer than 1 meter.

Units are supplied with an integral cable. Connections to the unit are made using this cable.

Integral Cable Terminated with Pigtail Leads



b) Connecting to the FSW 530



CAUTION: Avoid high voltage static discharges to any of the wires. Do not connect the relay output wire to a voltage without a suitable load or allow it to contact the power wires at any time. **DAMAGE WILL RESULT!**

Connections to the cable of the FSW 530 should be made as follows:

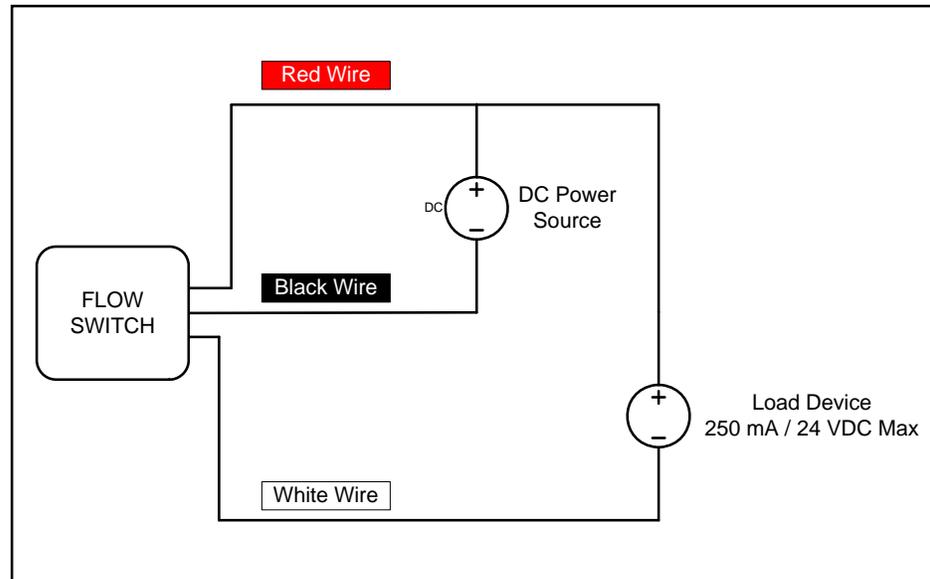
The **RED** wire should be connected to the Positive of the power source.

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

The **WHITE** wire provides the relay output and should be connected to the Negative (Ground) side terminal of the load device.

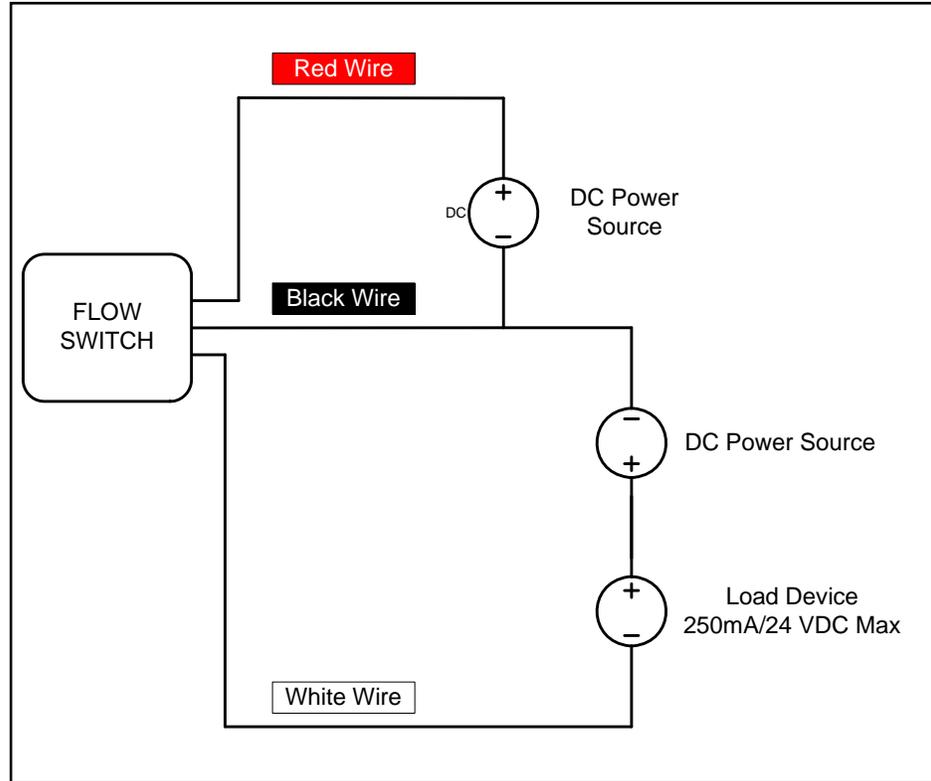
The load device 250 mA / 24 VDC maximum may be operated using the same power source as the FSW 530 as follows:

Using The Same Power Supply For The FSW 530 And Load.



The load device 250 mA / 24 VDC maximum may also be operated using a different DC power source as follows:

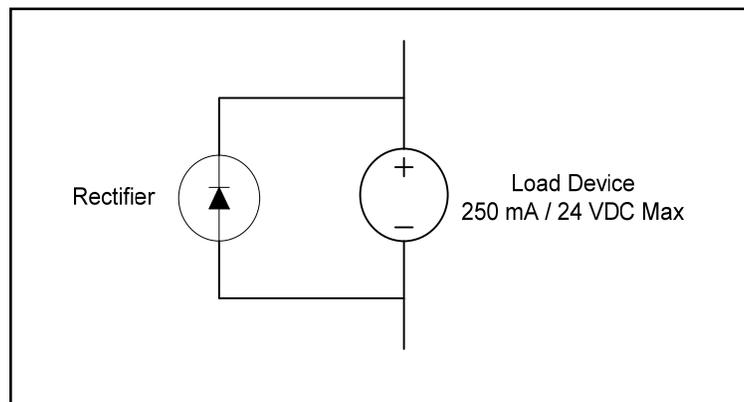
Using A Different DC Power Supply For The FSW 530 And Load.



c) Inductive Loads

If an inductive load such as a relay is being used, then a voltage spike suppressor e.g. a 1 Amp rectifier (1N4006), should be used as follows:

Connecting A Voltage Spike Suppressor



C. *Operation*



CAUTION: USE WITH LIQUIDS ONLY. FLOWING GAS OR AIR THROUGH YOUR FSW 530 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. The GREEN LED on the unit will turn on.

2. **Entrapped Air or Gas**

There may be a lot of air or gas trapped in your FSW 530 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 FSW 530. This should enable the trapped gas to escape the unit. The FSW 530 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. This can take some time for units with full scale flow rates of 500 ml/min and below.

3. **General Operation**

When power is applied to the unit (with no flow) the GREEN LED will begin to pulsate slowly. The frequency of the LED pulsations will increase as the flow through the unit increases. When the GREEN LED appears to be on constantly this will indicate a significant flow through the unit.

When the FSW 530 set point is reached the RED LED will light and remain on whilst the switch is on.

For NORMALLY OPEN (“NO”) operation the switch will be open from no flow up to the set point and will close when the flow reaches or exceeds the set point.

For NORMALLY CLOSED (“NC”) operation the switch will be closed from no flow up to the set point and will open when the flow reaches or exceeds the set point.

4. Verifying the Set Point

An indication of the approximate set point may be obtained by examining the position of the set point potentiometer on the side of the FSW 530.

Determining The Approximate Set Point

Potentiometer Position	Set Point Proportion of Max Rated Flow	“Clock Position”
	100%	8 o'clock
	50%	1 o'clock
	10%	4 o'clock

For example: A unit with a flow range of 60-500 ml/min has the set point potentiometer in approximately the 1 o'clock position. From the table above this equates to approximately 50% of the full scale rated flow. This would be equivalent to a set point of approximately 250 ml/min.

The FSW 530 set point may be more accurately 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 FSW 530's performance. Please contact Omega if accurate, certified recalibration is required.

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

Carefully adjust the flow rate in the system to the point that the RED LED becomes lit. 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 FSW 530 calibration certificate) may then be calculated.

The actual flow rate should then be compared to the specified flow rate set point to determine the error in calibration. For example:

For a unit with a flow range of 30-200ml/min and set point of 70ml/min:

With a constant flow the actual volume measured over 30 seconds was 36ml.

Therefore the actual flow rate is: $(36 / 30) \times 60 = 72\text{ml/min}$

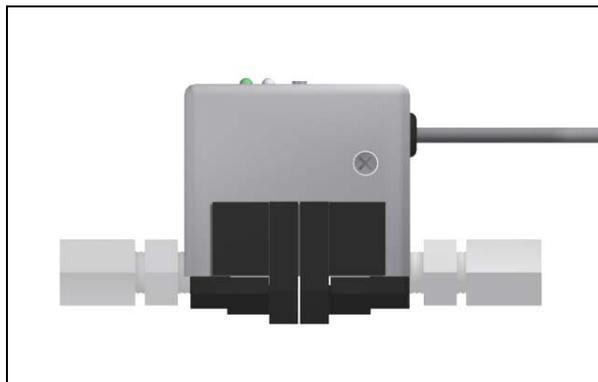
The error is therefore $72 - 70 = 2\text{ml/min}$ or 2.9%

5. Adjusting the Set Point

Adjustments to the FSW 530 set point may be made by turning the trim potentiometer on the side of the unit next to the cable exit point.

Using an empirical method (see section 4 above) or reference flow sensor adjust the flow rate through the switch to the required amount for activation of the relay. With the flow rate constant, carefully adjust the trim potentiometer to the point where the RED LED is just activated. The FSW 530 is now set to the required set point.

Set Point Adjustment Potentiometer



If the unit cannot be suitably adjusted please contact Omega.

6. 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.

The FSW 530 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.

If the flow rate is above the maximum rated (or full scale) flow, the unit will still operate but the set point may only be adjusted up to 100% of the maximum rated flow.

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

7. Zero Adjustments

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

8. Recalibration

Please contact Omega if recalibration is required.

9. Calibrating the FSW 530 for Different Liquids

The FSW 530 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.

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 the set point (or calibration) should be calculated and utilized as detailed in section 3 above. The set point may be adjusted using the required liquid as detailed in section 5 above.

D. Maintenance and Product Care

1. General



CAUTION: Do not disassemble your FSW 530 for any reason. If the unit appears to be malfunctioning please contact Omega.

The FSW 530 requires no periodic maintenance if used within the recommended specifications.

Inlet filters should be periodically checked and cleaned / replaced as necessary.

Regularly check all electrical and process connections for damage or deterioration.

If the FSW 530 is to be stored, keep both the inlet and outlet ports sealed.

Do not store a FSW 530 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 buildup 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 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 at the end of this manual.

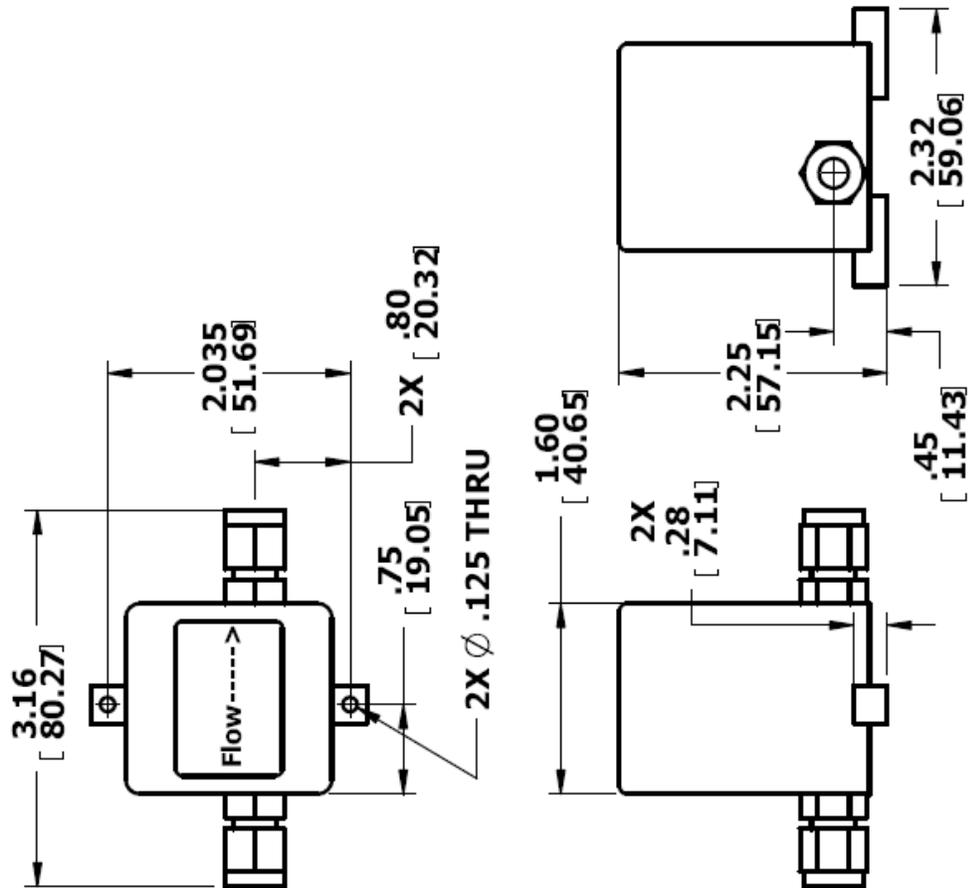
E. Specifications

	FSW 530
Accuracy	±1.0% Full Scale at one point only
Repeatability	±0.5% Full Scale
Switching Hysteresis	±2.0% Full Scale Typical
Pressure Rating	Ryton Body - 100 psig(6.8 bar) Stainless Steel Body - 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. or less per °C
Wetted Materials	Ryton Stainless Steel Epoxy Glass Sapphire
O-Ring Material	Standard - FKM Optional - EPDM
Fitting Material	Acetal or Stainless Steel
Recommended Filtration	25 microns or less
Compatible Liquids	Low viscosity (<10cS) Translucent or transparent Minimum amount of entrapped air or gas
Relay Output Type	Electronic FET Switch Normally Open or Normally Closed Configuration
Relay Ratings (Maximum)	Voltage: 24 VDC Current: 250mA
Typical Power Consumption	12 -24 VDC @ 40 mA (plus load)
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

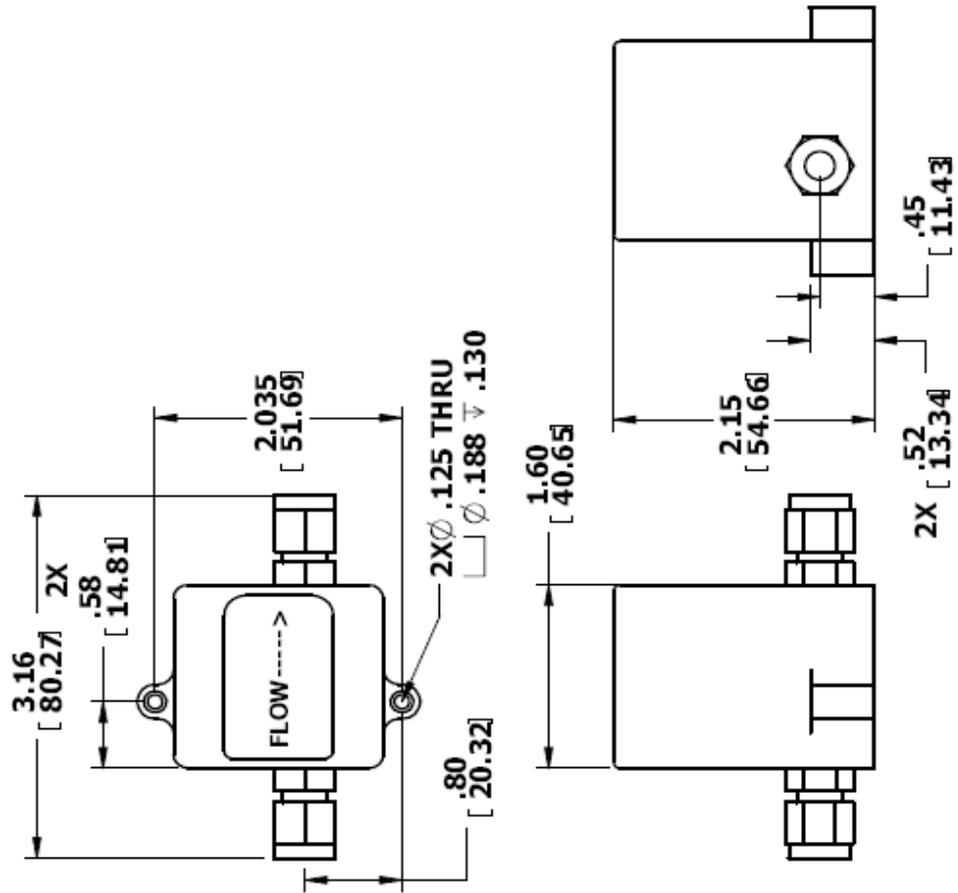
All calibrations performed with deionized water unless otherwise stated on calibration certificate

F. *Dimensions*

1. FSW 530 With Ryton Body & 1/4" Fittings



2. FSW 530 With Stainless Steel Body & 1/4" Fittings



G. Troubleshooting Guide

Symptom	Possible Cause	Method of Correction
Unit Leaks.	Fittings not tight enough.	Tighten fittings (see section B3).
	Unit assembly cracked.	Unit must be returned for repair (see Section D3).
Green LED does not light at all.	No power or low power.	Apply correct power.
	Incorrect wiring.	Check electrical connections (see section B4).
	Unit damaged.	Unit must be returned for repair (see Section D3).
Red LED does not operate when set point achieved and relay output activated.	Unit damaged.	Unit must be returned for repair (see Section D3).
Relay does not activate.	No power or low power.	Apply correct power.
	No flow or flow below the specified minimum for the unit.	Use higher flow rates.
	Output shorted or overloaded.	Check electrical connections (see section B4).
	Improper connection.	Check electrical connections (see section B4).
	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 Omega for assistance.

Symptom	Possible Cause	Method of Correction
Inaccurate switch activation.	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 unit.	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).
	Liquid is too viscous.	Best results are obtained with liquids that have a viscosity of 10cS or less. Contact Omega for further information.

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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