



MODEL U707 / 708
MODEL 108

Liquid Flo-Sensors

Installation Manual & Operating Instructions



READ THIS MANUAL COMPLETELY BEFORE ATTEMPTING TO CONNECT OR OPERATE YOUR FLO-DEVICE. FAILURE TO DO SO MAY RESULT IN INJURY TO YOU OR DAMAGE TO THE FLO-SENSOR.

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A. *Introduction*

1. **Unpacking the Flo-Sensor**

The Flo-Sensor was packed by the manufacturer in such a way that you should receive it with no damage. If external damage is noted upon receipt of the package, please contact *the shipping company* immediately. McMillan Company is not liable for damage to the device once it has left the manufacturing premises.

After external inspection of the package, proceed to open the package from the top, taking care not to cut too deeply into the package. Remove all documentation. Inspect all products for concealed shipping damage. If any damage is noted, please contact the shipping company and/or McMillan Company to resolve the problem.

While unpacking the products from the shipment, please take extra care to remove all enclosed devices and documentation. Check thoroughly for cables, adapters, and other options listed on the packing slip.

2. **Caution**

Take care not to *drop* your Flo-Sensor. Read the installation section 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 for more details).

Note that your Flo-Sensor has been assembled, tested, and sealed under cleanroom conditions (U707/8 only). To maintain the clean condition, only open under cleanroom conditions.

3. **Product Overview and Principle of Operation**

The Model 108 and U707/708 Liquid Flo-Sensors provide precision flow rate measurement for many low viscosity liquids.

Principle of operation: a microturbine rotates as the liquid passes through the Flo-Sensor. The rotation is electro-optically detected by patented technique requiring no windows. The liquid flow rate can then be precisely measured by an electronic output from the Flo-Sensor. This family of flow measurement instruments is ideal for use with most corrosive and pure liquids.

The 707 Flo-Sensor usually requires a 12 to 15VDC power supply.

Most U708 and 108 versions require 24VDC Power. (see label) The DC input is protected from accidental polarity reversal. Internal circuitry provides a flow sensor output which is in the form of a frequency "pulse" output for U707. Other versions provide 0-5V, 0-10V or 4-20 mA. The flow rate of the liquid is thus represented as a frequency (or voltage, or current). At zero flow the sensor will produce a frequency of zero Hz (or 0 volts, or 4 mA).

4. What is the difference between the 108 and U707/708?

108 – This product is primarily designed for most chemical & industrial fluids that are compatible with PTFE wetted surfaces.

In applications where ultraclean fluids are to be used, it is recommended to upgrade to the U707 or U708.

U707/708 – This product is designed for ultra-high-purity (UHP) applications. It features additional cleaning and clean room assembly, test & packaging. It is also suitable for concentrated acids and alkalis, as well as solvents or other UHP fluids.



B. Installation

1. Tubing Connections

The Flo-Sensor provides male flare connections or some Models provide ¼" FNPT connections. Flare nuts for flare Models are required to facilitate installation – they may be ordered as options from McMillan or may be provided by the customer. FNPT Models require ¼" MNPT fittings (usually made from PFA)

The flow direction of the flow Sensor is clearly marked on the label. Flare connections are either ¼", 3/8", or ½" depending on flow range (see specifications for size). Flare connections are designed to mate to standard Fluoroware/Entegris-type PFA flare fittings.

For best results, keep tubing I.D. as large as possible to avoid restrictions and turbulence. Keep flow restrictions and valves as far away from the sensor as possible to minimize turbulence (especially at the inlet to Flow-Sensor).

The outlet tubing should be elevated above the outlet port to allow any air that may accumulate inside the sensor to more easily escape. For this reason, the flow connections should never be pointed down, but either level or at an upward angle from the ground. Alternately, provide an upward loop in the exit tubing before going down below the sensor outlet.

As long as the outlet tubing is elevated above the sensor and air/gas is expelled, the Flo-Sensor can be mounted in any orientation. Straight lengths of tubing are not required before or after the Flo-Sensor.

Care should be taken to eliminate as much air or gas from the liquid flow path as possible. Once the unit is connected in the flow path, air or gas should be removed from the Sensor by alternately blocking and releasing the outlet (to build pressure in the lines and then suddenly release it). It may be possible to either pinch or kink the outlet tubing for 5 seconds, then release for 5 seconds, and so on until no more air bubbles are released from the unit. For flow rates above 1 L/min the gases are more readily expelled due to motion of the liquid through the flow path. At low flow rates gas bubbles can lodge along the insides of the tubing and inside the Flo-sensor, and will take more effort to remove.

The maximum recommended system pressure the Flo-Sensor can safely handle is 80 psig*. Any pressure higher than 80 psig could result in leakage and injury to the operator.

* unless otherwise indicated on calibration data sheet

Required differential pressure decreases exponentially with decrease in flow rate; to calculate minimum required differential pressure at a certain flow rate, use the formula:

$$DP = (\text{YourFlow} \div \text{MaxFlow})^2 \times \text{MinDP} \quad \text{where:}$$

DP = minimum required differential pressure at YourFlow

YourFlow = flow rate (in mLpm or Lpm) where you wish to calculate DP

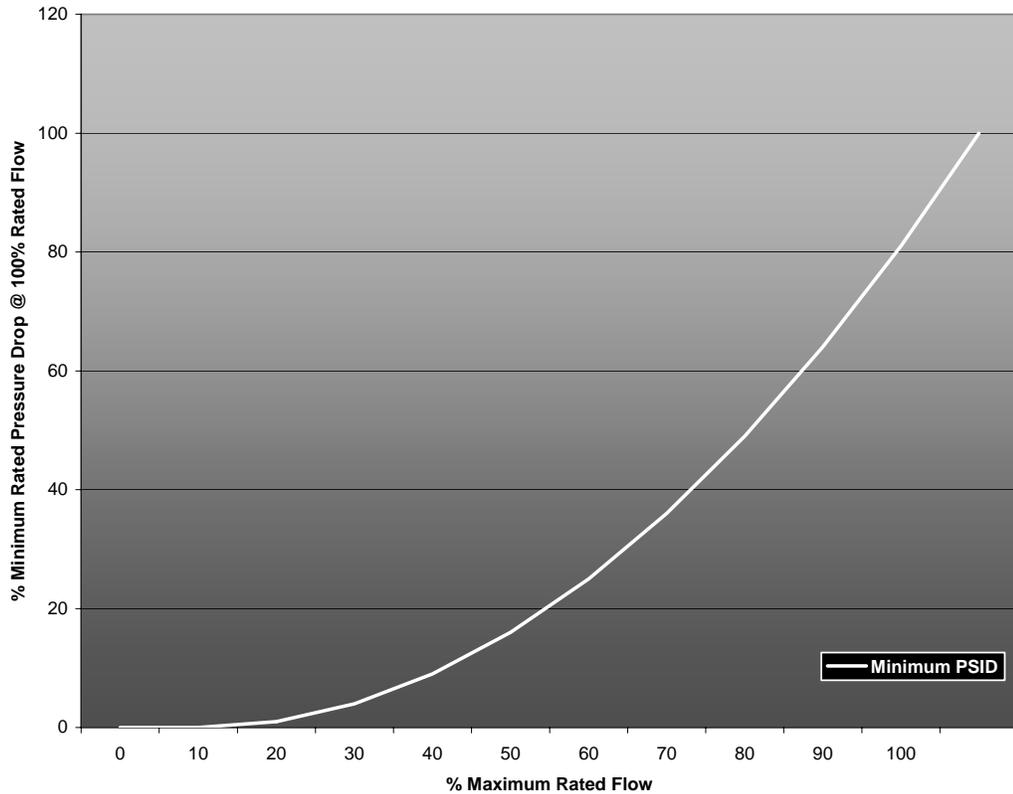
MaxFlow = 100% rated flow rate for your Flo-Sensor (in same units at YourFlow)

MinDP = Minimum differential pressure required at 100% rated flow (see chart above) in psid

For example: You have a Flo-Sensor with a 100-**1000** mLpm range. The recommended differential pressure for maximum flow, according to the test data, is **8** psid. You wish to calculate the minimum pressure drop at **200** mLpm. Your formula would be:

$$DP = (200 \div 1000)^2 \times 8 \quad \text{or} \quad DP = 0.32 \text{ psid @ } 200 \text{ mLpm}$$

All Flo-Sensors follow this general graph for pressure drop (minimum differential pressure required) vs. flow:



Differential pressure, or pressure drop, in a system is cumulative. If for example the inlet pressure starts with 30 psig of supply pressure, yet if other components in the same path have a pressure drop that has a total of 28 psid – leaves only 2 psid pressure for the Flo-Sensor. Either the supply pressure would have to be increased, and/or a source of pressure drop would have to be eliminated.

2. Electrical Connections

CAUTION: Mis-wiring of the Flo-Sensor may cause damage to the unit. Please read instructions carefully! Applying AC voltage (115VAC or 230VAC) to the Flo-Sensor will cause damage! Applying DC voltages above label indication will cause damage. Power supply leads are protected from accidental reversal of voltage applied.

A regulated, stable, low noise power supply will work best.

An optional cable is required to make electrical connections. There are 2 different color codes for 2 different styles of cables.



CABLE with CONNECTOR



OPTIONAL PTFE CONNECTOR COVER

When wiring is completed, insert cable connector into receptacle on the Inlet end of the Flo-Sensor. Make sure it snaps and locks into place. **To remove the cable, simply squeeze in on “ears” of the cable connector very close to the Flo-Sensor and then pull away carefully.**

***** Squeeze points are generally at 12 & 6 o'clock locations.**

PULSE OUTPUT MODELS

CABLE	DESCRIPTION	Pulse Output (U707)
<i>Pin #</i>	<i>Description</i>	<i>Notes</i>
6	RED Power +	Power Input Positive** 12 to 15VDC Use as common for pin #1 output Pulse Output (frequency) (*Some versions may use 24V)
2	BLACK Common -	
5	WHITE (or ORG) Output	
3	(GRN (or Brown) - extra GND)	

4-20 mA option Output

CABLE	DESCRIPTION	Output
<i>Pin #</i>	<i>Description</i>	<i>Notes</i>
6	RED Power +	Power Input Positive 24 VDC Power negative - Gnd Output – 4 to 20 mA Use as return Gnd for Output
2	BLACK Common -	
5	WHITE Output	
4	GREEN Output Gnd	

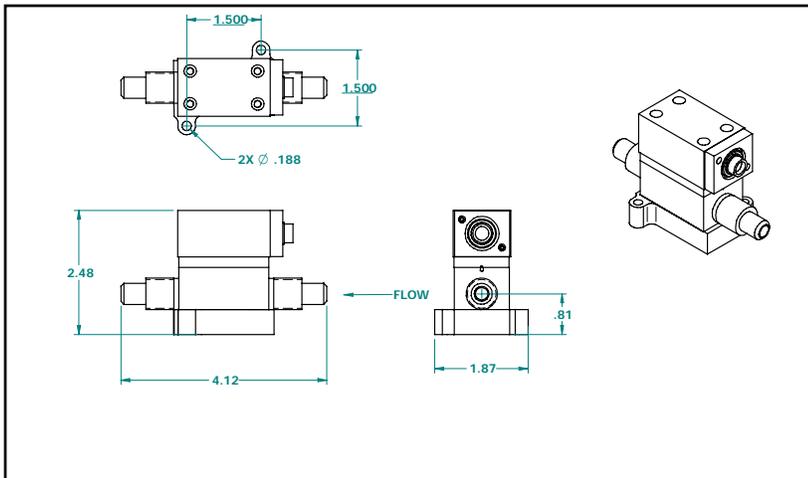
0-5V or 0-10V Outputs

CABLE	DESCRIPTION	Output
<i>Pin #</i>	<i>Description</i>	<i>Notes</i>
6	RED Power +	Power Input Positive 24 VDC Power negative - Gnd Output – Voltage 5 (or 10V) Use as return Gnd for Output
2	BLACK Common -	
5	WHITE (or Org) Output	
3	GREEN (or Brown) Gnd	

3. Mounting the Flo-Sensor

The Flo-Sensor should be mounted preferably in a dry, moisture free location. The outer sealed case can protect against some wet location situations, yet more dry clean environment is recommended. Two mounting ears 1/2 " thick (polypropylene) are provided. See drawings below.

DIMENSIONS – Flare Models (Below is FNPT Example)



C. Operation

1. Use for **LIQUIDS ONLY**
2. Do not purge with gas or air – damage may result!

3. **Calibration data is obtained with deionized water testing.**
4. **No adjustments are necessary.**
5. **No maintenance is required other than periodic cleaning and flushing with a clean liquid to remove deposits/residues from measured chemicals**
6. **Calibrating for liquids other than water**

All Flo-Sensors come precalibrated from the factory for deionized water. Most low viscosity liquids will produce similar results to water.

If you will be measuring a fluid other than deionized water, to obtain maximum accuracy you must determine the calibration when flowing that specific fluid.

The unit should be set to produce flow at 100% rated flow. Once the flow rate has stabilized, use a primary standard (i.e., accumulation over time with stopwatch and graduated cylinder, or total weight over time with stopwatch and weight scale) to establish calibration. Several test points can be done in a similar manner. Record the output frequency at each test point.

Disassembly of the Flo-Sensor itself is not recommended. Doing so will void the warranty.

D. Specifications

Patents: 5,728,949 and 5,542,302 and others apply.

1. Specifications

Accuracy, including Linearity & Hysteresis

±1.0% Full Scale Typical*

Repeatability

±0.20% Full Scale Typical* (based on data accumulated over thousands of cycles)

Power Requirements (always read labels)

12 - 15 VDC; 0.1 A peak, 60 mA typical or (24V models 0.1A)

Pressure Rating

Over pressure limit is 80 psig (5.4 bar).

Recommended maximum pressure is 60 psig (4.08 bar)

Temperature Rating

Standard fluid temperature range (internal): 5 to 60°C **

Option Code "HT" fluid temperature range (internal): 5 to 80°C **

Ambient environment range (external): 0 to 50°C

Storage range: -10 to 70°C

Materials of Construction

Wetted parts - PTFE, sapphire, Kal-Rez®

Exterior surfaces - PTFE, polypropylene, PVC or FEP-jacketed cable,

Viton® seals for external cover

Recommended Filtration

25 microns or less

Compatible Fluids

Most all liquids compatible with wetted materials.

Contact the factory for calibration information on fluids with very high viscosities.

Output

PULSE

Typical full scale output pulse rate (Hz) is approx. 200 to 400Hz.

Exact calibration points are provided with each Flo-Sensor.

Output pulse is approx. a total height of (V+ Power minus 1 volt)

Voltage/Current

Available as 0-5V with 2.K min load, 0-10V with min 5K load

Or as 4-20 mA output with max. 500 ohm loads for the loop.

Reliability

Testing shows no long-term performance degradation with deionized water at room temperature.

Reliability tests are ongoing. Microturbine flow sensor life is over 50,000 hours MTBF

Flow Connections

PTFE male flare-type connections for flare units. If PVDF flare nuts are required, add option code "FN".

Some models (ie M108) use ¼" FNPT connections.

Electrical Connections

CABLE OPTIONS

1) PVC jacket cable with connector

Lengths: 6 ft, 12 ft.

2) FEP-jacketed cable with connector

Lengths: 6 ft, 12 ft.

3) Connector PTFE Cover (photo – see pg. 7)

contact factory for custom cable lengths.

Packaging

Final packaging performed in Class 100 environment for UHP versions.

*Full Scale is from 10% to 100% of rated flow (except range 3, which is 15 to 100%). Linearity is best fit straight line. All calibrations performed with deionized water.

**Temperature affects fluid viscosity, and changes in viscosity will have effect on full scale output. Zero is unaffected by temperature.

CE Declaration of Conformity: Complies to 89/336/EEC and FCC 47 CFR, Part 15 Subpart B, Class A: ANSI C63.4, EN 61326-1, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6

E. Limited Warranty

DURATION OF LIMITED WARRANTY, MATERIALS & WORKMANSHIP

R.D. McMillan Co., Inc., hereinafter referred to as "McMillan", warrants these products and their associated standard accessories manufactured by McMillan and supplied hereunder, to be free from defects in materials and workmanship for a period of twelve (12) months from the date of shipment to the customer when installed, serviced and operated in its recommended environment. This warranty is not affected in any part by McMillan providing technical support or advice.

Replacement parts are warranted to be free from defects in material or workmanship for ninety (90) days or for the remainder of the Limited Warranty period of the McMillan product in which they are installed, whichever is longer. Parts not installed by factory authorized service centers may void the warranty.

PRODUCT RETURNS

(a) General Policy:

Any product or parts determined by McMillan's inspection to have failed per this warranty, will at McMillan's option, be repaired or replaced with an equivalent or comparable product without charge. McMillan's obligation hereunder shall be limited to such repair and/or replacement and shall be conditional upon McMillan's receiving written notice of any alleged defect within ten (10) days of its discovery. The customer will, however, be responsible for returning the product to McMillan's manufacturing facility in Georgetown, Texas, U.S.A., and for assuming the cost of removing the original product and reinstalling the repaired or replaced product. A written specific explanation of the problem must be included with each returned product. Returned goods should be properly packaged to prevent shipping damage and shipped **prepaid** to McMillan.

(b) Safety Requirements:

For safety reasons, McMillan must be advised of any hazardous fluid or toxic materials that were in or on the product to be returned. Customer must certify in writing that all such hazardous, corrosive or toxic substances have been completely removed, cleaned or neutralized from the returned product prior to shipment to McMillan. McMillan shall hold the returned items pending receipt of customer's statement for defect and certification of cleanliness of returned items, provided that, prior to such receipt, risk of loss of returned items shall remain with customer. Flow sensors, flow meters and flow Sensors must be thoroughly cleaned to remove any toxic, corrosive or hazardous fluids that may internally remain therein before shipping product to McMillan.

(c) Shipping Requirements:

Customer is responsible for all shipping charges (except for those products under warranty, in which cases customer shall bear the cost of inbound shipping as described herein below, and McMillan shall bear the cost of outbound shipping). Customer is responsible for the costs of out of warranty repairs and/or recalibration. McMillan will ship items repaired under warranty back to customer by the most economical shipping means. Expedited shipping methods may be available at customer's expense. All returned items shall be returned to a McMillan authorized service center., freight prepaid, accompanied or preceded by a particularized statement of the claimed defect and with a clearly readable Returned Material Authorization ("RMA") number affixed to the shipping label. Contact McMillan Customer Service Department for RMA number. Warranty claims shall be made only by using the McMillan's Returned Material Authorization form, completely filled out and returned to McMillan in accord with McMillan's Product Return Policy and Procedure Form.

Contact McMillan's **Customer Service Department** as follows for instructions:

Telephone calls in U.S.A. (CST) 1-800-861-0231 or Outside U.S.A. 512-863-0231

Or Fax: 1-512-863-0671 or e-mail: sales@mcmflow.com

DESIGN, PROCESS and MANUFACTURING CHANGES

McMillan may make changes in the design or manufacture of any products sold hereunder without incurring any obligation to incorporate such changes into products manufactured prior to incorporation of such design or manufacturing changes. McMillan reserves the right to make design or manufacturing changes without prior notice. McMillan products and replacement parts are manufactured using new materials or new and equivalent to new in appearance, performance and reliability. Due to continuous research, testing, product improvements and

enhancements, McMillan reserves the right to change product specifications without notice, except to the extent an outstanding bid obligation exists.

LIMITATION of LIABILITY

Except as expressly set forth in this limited warranty, McMillan makes no other warranties or conditions, express or implied, including any implied warranties of merchantability and fitness for a particular purpose. McMillan expressly disclaims all warranties and conditions not stated in this limited warranty. Any implied warranties that may be imposed by law are limited in duration to the limited warranty period. Buyer/customer agrees that models or samples shown to buyer/customer were merely used to illustrate the purchased product and not to represent, promise or guarantee that any purchased products delivered hereunder would conform to such models or samples. McMillan's distributors or sales representatives have no authority to give warranties beyond those provided in this limited warranty.

If customer's product fails to work as warranted herein, customer's sole and exclusive remedy shall be the repair or replacement at McMillan's option. McMillan is not liable for any damages caused by the product or the failure of the product to perform, including any lost profits or savings, incidental or consequential damages. McMillan is not liable for any claim made by a third party or made by a buyer for a third party. No actions arising out of sale of the products sold hereunder or this limited warranty may be brought by either party more than two (2) years after the cause of action accrues. This limitation of liability applies whether damages are sought, or a claim made, under this limited warranty or as a tort claim (including negligence and strict product liability), a contract claim, or any other claim. This limitation of liability cannot be waived or amended by any person. This limitation of liability will be effective even if customer has advised McMillan or an authorized representative or distributor of McMillan of the possibility of any such damages. This limited warranty gives customer specific legal rights. Customer may also have other rights that may vary from state to state or country to country. Customer is hereby advised to consult applicable state or country laws for a full determination of customer's rights.

EXCLUSIONS FROM WARRANTY

this limited warranty provided herein **shall not apply** to any product which:

- (1) has been repaired or altered outside of McMillan's factory (or authorized service center) in any way so as, in McMillan's judgment, to affect such purchased item's reliability or performance.
- (2) has been subject to misuse, mishandling, negligence, accident, or acts of God.
- (3) has been operated other than in accordance with the printed instructions prepared by McMillan and provided by McMillan with the product.
- (4) has been returned to McMillan after more than thirty (30) days following the date of the alleged product failure.
- (5) has been returned to McMillan without complying with the Safety Requirements or the Shipping Requirements contained herein.
- (6) requires calibration and/or routine maintenance, unless this calibration or routine maintenance is required as a result of a product failure that is covered under terms of this warranty.
- (7) are consumable parts, such as filter elements, batteries or tube fittings.
- (8) requires replacement or repairs resulting from buyer's improper choice of product flow range, or require repair or replacement due to buyer subjecting product to corrosive fluids or other fluids not suited for use in product
- (9) has flow passages clogged due to failure to use a filter to protect product from particulates in fluid flow stream, or other cause to produce clogged passages
- (10) has been operated outside of recommended specifications (such as voltage, temperature, or flow range, etc.)
- (11) has been damaged as a result of gross over-speeding , or prolonged over-speeding of the micro-turbine wheel
- (12) has been damaged as a result of severe sudden impact forces (example: dropping the product)

METHOD OF SETTLEMENT OF ANY CLAIMS, DISPUTES AND CONTROVERSIES

The provisions of this warranty are severable and if one or more provisions are deemed invalid, the remaining provisions shall remain in effect. Further, in the event that any provision is held to be over broad as written, such provision shall be deemed amended to narrow its application to the extent necessary to make the provision enforceable according to applicable law and shall be enforced as amended. This warranty shall be construed and interpreted in English.

All claims, disputes and controversies arising out of or relating in any way to claims under any warranties, either express or implied (including implied warranty of merchantability), or claims based on any consumer protection act or deceptive trade practice act, contract, tort, statute, or common law, or any alleged breach, default, and/or misrepresentation, will be resolved by means of final and binding arbitration. This limited warranty, including any contests to the validity or enforceability of this limited warranty, shall be finally settled by arbitration under the Rules of Conciliation and Arbitration of the International Chamber of Commerce by one or more of its arbitrators appointed in accordance with the Rules, and judgment upon award rendered may be entered in any court having jurisdiction thereof. The place of arbitration

shall be Austin, Texas U.S.A., and the Texas Uniform Commercial Code, as then enacted shall govern the rights and duties of the parties of this agreement without regard to conflicts-of-law principles. The arbitration shall be conducted in English. The UN Convention on Contracts for the International Sale of Goods shall not apply to this Limited Warranty.

F. Contacting McMillan

Website: www.mcmflow.com

Email: tech@mcmflow.com

Mailing address:

P.O. Box 1340
Georgetown, TX 78627
U.S.A.

Shipping address:

7075 RR 2338
Georgetown, TX 78628
U.S.A.

Phone: (512) 863-0231

Fax: (512) 863-0671

For repairs and/or return information, please contact our service department any of the ways shown above.