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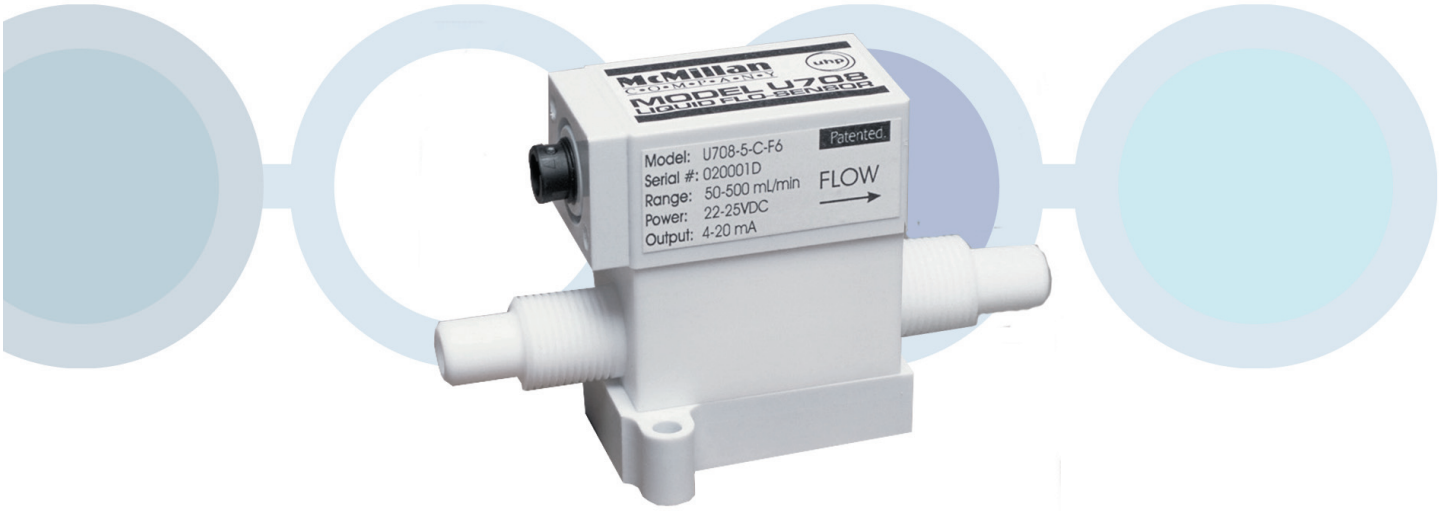
McMillan COMPANY

# Compact Liquid Flow Rate Meters for UHP Applications

## Model U707 & U708 MICROTURBINE LIQUID FLO-SENSORS®

UHP LIQUID




## APPLICATION IDEAS

Flow rate monitoring to improve management of consumables

CMP slurry delivery closed-loop control

High and low flow rate alarm systems

Injection and dispensing systems

## PRODUCT DESCRIPTION

McMillan Model U707 & U708 UHP FLO-SENSORS® will precisely measure flow rates of virtually any fluid as low as 15 mLpm or as high as 10 Lpm. Repeatable results are achieved by using a patented* microturbine flow sensor design. This design, unlike traditional paddlewheel designs, provides accurate flow measurement with no particle generation. PTFE, perfluoroelastomers, and sapphire wetted parts ensure compatibility with chemicals commonly found in microelectronics manufacturing processes, including deionized water, CMP slurries, acids, solvents, and photoresist.

These UHP FLO-SENSORS integrate the sensing element with advanced electronics to provide output signals proportional to flow rate. Each unit is individually calibrated before shipment, and a certificate of calibration accompanies all FLO-SENSORS. A repeatability specification of ±0.2% full scale reassures process engineers of consistent results.

## PRINCIPLE OF OPERATION

The Model U707 Liquid FLO-SENSOR for UHP applications provides a proportional pulse output based on volumetric flow rate. The Model U708 Liquid FLO-SENSOR provides an analog output.

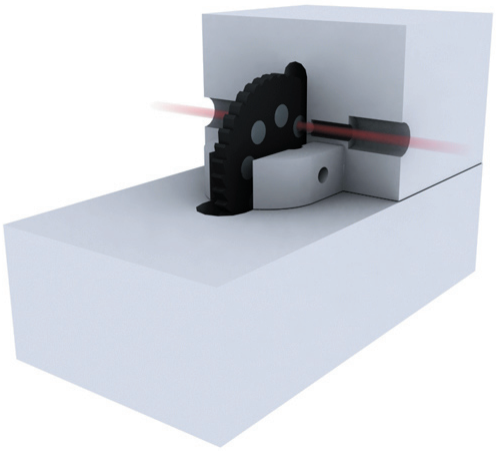


**Figure 1. Cutaway of sensor technology.**

McMillan's patented* microturbine wheel technology utilizes the Pelton turbine wheel concept. This design allows for use of a minature microturbine wheel about 0.8 inches (20 mm) in diameter. The wheel is supported on a very small sapphire shaft, held in position by two sapphire bearings. Due to the low mass of both the wheel and the shaft, the microturbine wheel virtually floats in the liquid. This flotation effect causes the turbine wheel to be suspended in the middle of the bearings and thus eliminates shaft and bearing wear. Therefore, no particles are generated

As flow passes through the FLO-SENSOR, it is directed onto the very small teeth of the wheel using a precision-machined nozzle. This nozzle is sized according to the flow range of the unit. The rotational speed of the turbine wheel increases proportionally to the volumetric flow rate.

The microturbine wheel features 8 small windows, evenly spaced around the center of the wheel. As the wheel rotates, a light beam is projected through a PTFE window and onto the wheel. A light detector on the other side of the wheel detects each window and translates those signals into pulses. As the wheel spins faster, pulse rate increases. When the wheel stops (under zero flow conditions), no pulses are generated. Consequently, zero drift is not possible and zero adjustments are never required. Processing circuitry provides analog or pulse outputs that are linearly proportional to the flow rate.

**Figure 2: Wheel and bearing assembly.**

McMillan UHP

* US Patents 4,467,660; 5,542,302; 5,728,949. Other patents pending.

# FEATURES AND OPTIONS

## FLOW RANGES
Flow ranges from 15-100 mLpm up to 1,000-10,000 mLpm are available. Consult the factory for custom requirements.

## POWER
Units may be specified to operate with either 12 VDC or 24 VDC power. Various power adapters are available for use with 12 VDC versions.

## SIGNAL OUTPUTS
The Model U707 features a pulse output, typically 0-400 Hz (consult calibration certificate for exact frequency output). The Model U708 can be ordered with a 4-20 mA, 0-5 VDC, or 0-10 VDC output.

## ACCURACY/LINEARITY
Analog output models have an accuracy specification of ±1.0% full scale (including linearity). Pulse output models have an accuracy specification of ±3.0% full scale (including linearity).

## CALIBRATION
All units are calibrated at the factory using deionized water. Calibration curves may be requested for fluids with viscosities differing from water.

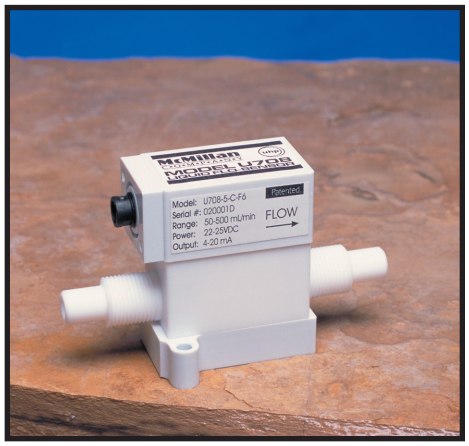
## FLUID CONNECTIONS
All units have male Flaretek®- compatible connections. Non-standard connection types may be available upon request.

## ELECTRICAL CONNECTIONS
All units have an integrated 7-pin connector. Several mating cable options are available.

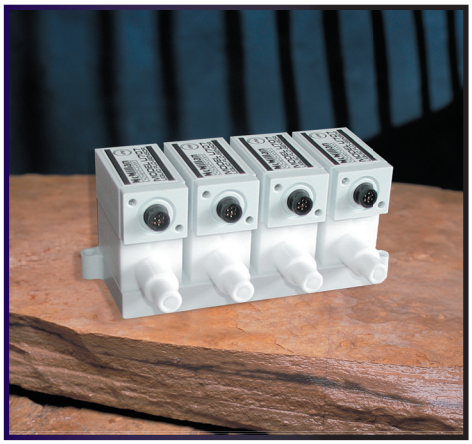
## WETTED MATERIALS
All units have only PTFE, perfluoroelastomers, and sapphire as wetted parts.

## DISPLAYS
McMillan has a comprehensive range of remote displays for use with UHP FLO-SENSORS. Please request further information from the factory.

## GANGS OF MULTIPLE UNITS
To reduce overall footprint in multiple-channel applications, McMillan can assemble custom gangs of U707/U708 FLO-SENSORS and assign a custom part number for the entire assembly. Please request details from the factory.



Model U708 FLO-SENSOR


Gang of Multiple U707 FLO-SENSORS (custom)

# SPECIFICATIONS

| | U707 | U708 |
|---|---|---|
| **Accuracy (including linearity, best fit straight line)** | ±3.0% Full Scale | ±1.0% Full Scale |
| **Repeatability** | ±0.2% Full Scale | |
| **Pressure Rating** | 80 psig (5.4 bar) working<br>100 psig (6.8 bar) overpressure | |
| **Temperature Rating (Fluid)** | Standard: 0 to 55ºC<br>"HT" Suffix: 0 to 90ºC | |
| **Temperature Rating (Environmental)** | Operating: 0 to 50ºC<br>Storage: 0 to 70ºC | |
| **Wetted Materials** | PTFE<br>Sapphire | |
| **O-Ring Material** | Perfluoroelastomer* | |
| **Exterior Surfaces** | PTFE<br>Polypropylene<br>Epoxy<br>Viton®<br>Polyester | |
| **Fitting Material (Optional)** | Perfluoroelastomer* | |
| **Recommended Filtration** | 20 microns or less | |
| **Compatible Fluids** | Low viscosity (<10 cS)<br>Translucent or Transparent<br>Minimum amount of entrained air | |
| **Pulse Output** | Square-wave<br>Collector output<br>Pulls up to V+ | N/A |
| **0-5 VDC Output** | N/A | Optional<br>0 VDC at zero flow<br>2.5 Kohm or greater load output<br>Not isolated |
| **0-10 VDC Output** | N/A | Optional<br>0 VDC at zero flow<br>5 Kohm or greater load output<br>Not isolated |
| **4-20 mA Output Signal** | N/A | Optional<br>4 mA at zero flow<br>500 ohm maximum current loop<br>Not isolated |
| **Zero Drift** | None | |
| **Warm-Up Time** | None | |
| **Calibration Interval** | Calibration should typically be verified once every 12 months | |
| **Power Requirements** | 12-15 VDC Units: 12-15 VDC, 50 mA typical<br>15-25 VDC Units: 15-25 VDC, 75 mA typical<br>22-25 VDC Units: 22-25 VDC, 50 mA typical | |
| **Electrical Connections** | 7-pin connector<br>PTFE housing when used with CFx cables<br>Nylon housing when used with CPx cables | |
| **Response Time** | Typically <300 milliseconds for 97% of final value | Typically <1 second for 97% of final value |
| **Reliability** | 100,000 Hours MTBF(testing ongoing) | |
| **Certifications** | CE Approved<br>89/336/EEC (EN 55011 & EN 50082-1)<br>73/23/EEC Low Voltage Directive | |
| **Ratings** | IP64 (NEMA 4X) | |

* contact factory for current compound

# ORDERING INFORMATION

| Form part number: (Model Code) - (Flow Range)-(Power/Signal) - (Fittings) - (Options) - (Mating Cable). | Code | U707 | U708 |
|---|---|---|---|
| U707 UHP Liquid FLO-SENSOR®<br>U708 UHP Liquid FLO-SENSOR® | U707<br>U708 | ✓ | <br>✓ |
| Flow Range (mLpm of $H_2O$) Code | | | |
| 15-100 | 3 | ✓ | ✓ |
| 20-200 | 4 | ✓ | ✓ |
| 50-500 | 5 | ✓ | ✓ |
| 100-1000 | 6 | ✓ | ✓ |
| 200-2000 | 7 | ✓ | ✓ |
| 500-5000 | 8 | ✓ | ✓ |
| 1000-10000 | 9 | ✓ | ✓ |
| Power / Signal Configuration | | | |
| 12-15 VDC Power / Pulse Output | A | ✓ | |
| 22-25 VDC Power / Pulse Output | E | ✓ | |
| 12-15 VDC Power / 0-5 VDC Output | D | | ✓ |
| 22-25 VDC Power / 0-5 VDC Output | B | | ✓ |
| 12-15 VDC Power / 0-10 VDC Output | K | | ✓ |
| 22-25 VDC Power / 0-10 VDC Output | J | | ✓ |
| 15-25 VDC Power / 4-20 mA Output | C | | ✓ |
| Fittings (see Fitting Chart for available sizes based on flow range) | | | |
| 1/4" male flare (Flaretek® compatible) | F4 | ✓ | ✓ |
| 3/8" male flare (Flaretek® compatible) | F6 | ✓ | ✓ |
| Options | | | |
| High Temperature Operation | HT | ✓ | ✓ |
| Include Pair of PVDF Flare Nuts | FN | ✓ | ✓ |
| Mating Cable | | | |
| None (not recommended) | C0 | ✓ | ✓ |
| FEP-jacketed, splashproof, 3 feet long (0.92 m) | CF3 | ✓ | ✓ |
| FEP-jacketed, splashproof, 6 feet long (1.85 m) | CF6 | ✓ | ✓ |
| FEP-jacketed, splashproof, 12 feet long (3.7 m) | CF12 | ✓ | ✓ |
| FEP-jacketed, splashproof, 25 feet long (7.7 m) | CF25 | ✓ | ✓ |
| PVC-jacketed, 6 feet long (1.85 m) | CP6 | ✓ | ✓ |
| PVC-jacketed, 12 feet long (3.7 m) | CP12 | ✓ | ✓ |
| **ACCESSORIES**<br>Power Adapters (Order Separately) | | | |
| 115 VAC Power Adapter for 15 VDC models | 108-10-08 | ✓ | ✓ |
| 230 VAC Power Adapter for 15 VDC models | 108-10-18 | ✓ | ✓ |
| Displays<br>(Order Separately, More Information Available) | | | |
| 210R Rate Display, 3½ digit, 5-30 VDC Power | 210R | | ✓ |
| 220 Rate/Total Display, 8 digit, battery powered | 220 | ✓ | |
| 250 Multi-Function Display, 115 VAC Power | 250 | | ✓ |
| 250E Multi-Function Display, 230 VAC Power | 250E | | ✓ |
| 251 Multi-Function Display, 115 VAC Power | 251 | ✓ | |
| 251E Multi-Function Display, 230 VAC Power | 251E | ✓ | |

**Example #1:**

U707-3-A-F4-HT-CF6 would give you a U707 FLO-SENSOR rated for 15-100 mLpm. The power required would be 12-15VDC, and the output would be pulse. Fluid connections would be ¼" male flare fittings. The maximum fluid operating temperature would be 90ºC, and a FEP-jacketed 6 foot (1.85 m) cable would be included.

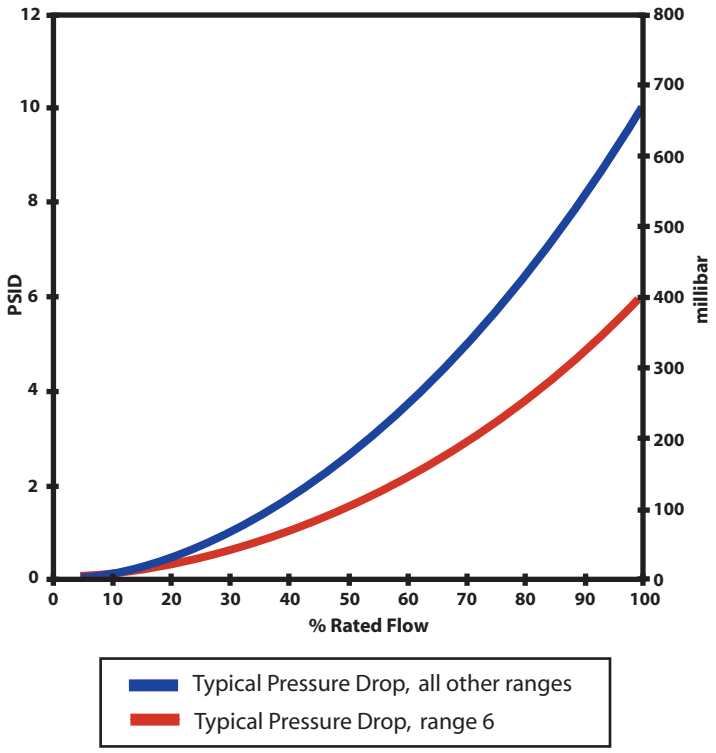
**Example #2:**

U708-9-C-F6-CF3 would include a U708 FLO-SENSOR rated for 1,000-10,000 mLpm. 15-25 VDC power would be required, and a 4-20 mA output would be provided. Fluid connections would be 3/8" male flare. A FEP-jacketed 3 foot (0.92 m) cable would be included.

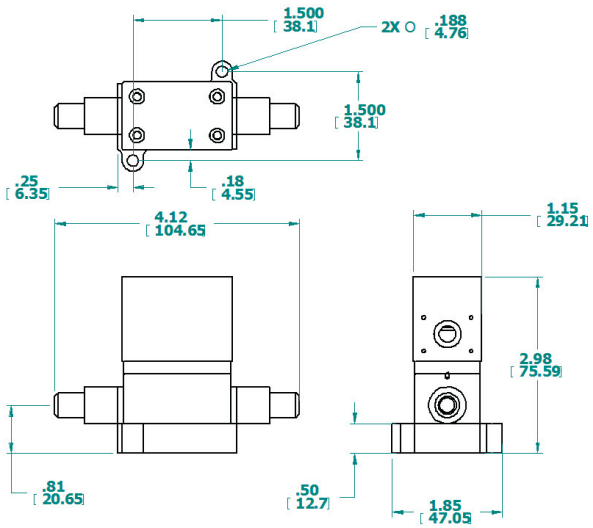
## FITTING CHART

| Flow Range | F4 | F6 |
|---|---|---|
| 3 | ✓ | ✓ |
| 4 | ✓ | ✓ |
| 5 | ✓ | ✓ |
| 6 | ✓ | ✓ |
| 7 | | ✓ |
| 8 | | ✓ |
| 9 | | ✓ |

## PRESSURE DROP




## DIMENSIONS




Dimensions shown are in inches(mm). All dimensions shown are for Model U708 FLO-SENSOR with 3/8" male flare fittings (F6) and are similar for other models. Please note that U707 units are shorter (less height) than U708 units. Specific model dimensional drawings may be requested from the factory.


**McMillan Company**
**P.O. Box 1340**
**Georgetown, Texas 78627**

**Toll-Free: 800.861.0231 (U.S.A. only)**
**Direct: 512.863.0231**
**Fax: 512.863.0671**

**Email: sales@mcmflow.com**
**Website: www.mcmflow.com**


McMillan UHP


Viton – Reg TM E.I. DuPont Dow Elastomers LLC
FLO-SENSOR -- Reg TM McMillan Co
Flaretek – Reg TM Entegris, Inc.



Bulletin U707-S001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