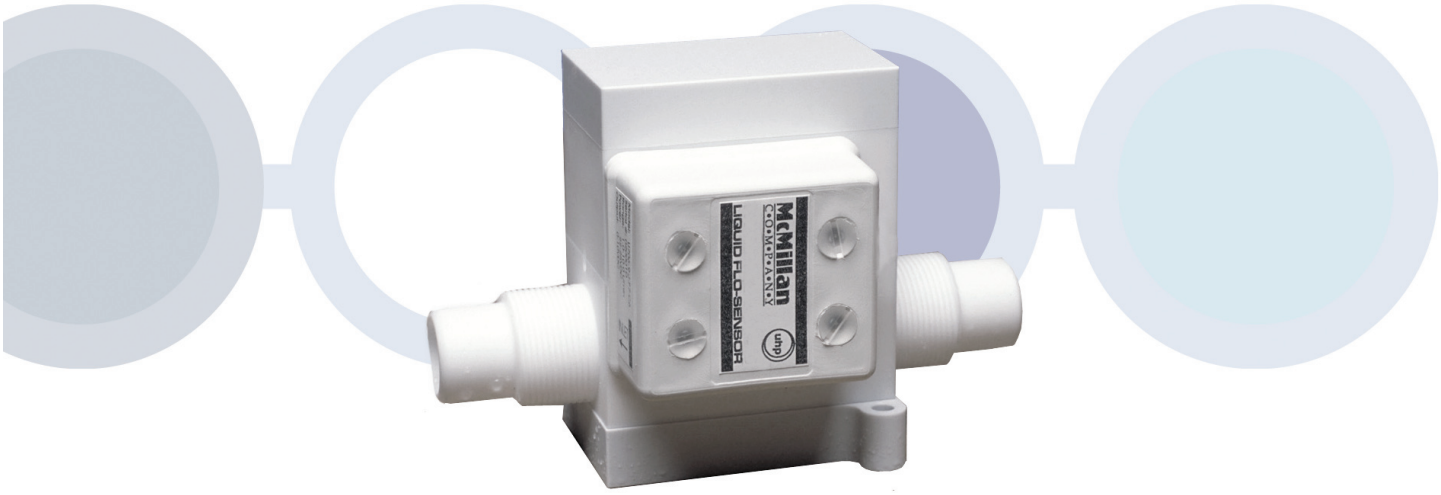
McMillan COMPANY

Liquid Flow Rate Meters for UHP Applications

Model U701, U702, U705 & U706 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 U701/U702/U705/U706 UHP FLO-SENSORS® will precisely measure flow rates of virtually any fluid as low as 15 mLpm or as high as 50 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 U701/U705 Liquid FLO-SENSORS for UHP applications provide a proportional pulse output based on volumetric flow rate. The Model U702/U706 Liquid FLO-SENSORS provide an analog output.

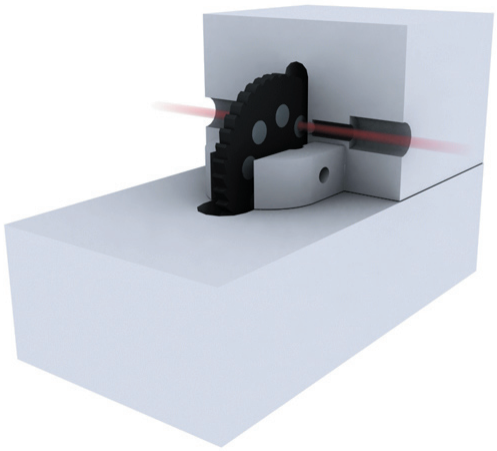


Figure 1. Cutaway of sensor technology.

McMillan's patented* microturbine wheel technology utilizes the Pelton turbine wheel concept. This design allows for use of a miniature 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.

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* 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 5-50 Lpm are available. Consult the factory for custom requirements.

FLOW PATH
U701/U702 FLO-SENSORS feature a U-shaped flow path, which allows all fluid connections on one side of the unit to effectively reduce footprint. U705/U706 FLO-SENSORS feature a straight flow path.

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

SIGNAL OUTPUTS
The Model U701 & U705 feature a pulse output, typically 0-400 Hz (consult calibration certificate for exact frequency output). The Model U702 & U706 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 as standard. Nippon Pillar® Super 300 or other non-standard connection types may be available upon request.

ELECTRICAL CONNECTIONS
All units have an integrated FEP-jacketed cable terminated with pigtail leads.

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.

Model U701 & U702 FLO-SENSORS

Model U705 & U706 FLO-SENSORS

SPECIFICATIONS

	U701	U705	U702	U706
Accuracy (including linearity, best fit straight line)	±3.0% Full Scale		±1.0% Full Scale	
Repeatability	±0.20% Full Scale			
Pressure Rating	80 psig (5.4 bar) working 100 psig (6.8 bar) overpressure			
Temperature Rating (Fluid)	Standard: 0 to 55ºC "HT" Suffix: 0 to 90ºC			
Temperature Rating (Environment)	Operating: 0 to 50ºC Storage: 0 to 70ºC			
Wetted Materials	PTFE Sapphire			
O-Ring Material	Perfluoroelastomer*			
Exterior Surfaces	PTFE Polypropylene Epoxy Viton® Polyester			
Recommended Filtration	20 microns or less			
Compatible liquids	Low viscosity (<10 cS recommended) Translucent or transparent Minimum amount of entrained air		Low viscosity (<10 cS recommended) Minimum amount of entrained air	
Pulse Output	Square-wave Passive BOSFET Opto-Isolated up to 2500 V 0-400 Hz typical		N/A	
0-5 VDC Output	N/A		Optional 0 VDC at zero flow 2.5 Kohm or greater output load Not isolated	
0-10 VDC Output	N/A		Optional 0 VDC at zero flow 5 Kohm or greater output load Not isolated	
4-20 mA Output Signal	N/A		Optional 4 mA at zero flow 500 ohm maximum loop resistance 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 15-25 VDC Units: 15-25 VDC, 75 mA typical 22-25 VDC Units: 22-25 VDC, 50 mA typical			
Electrical Connections	Integrated FEP-jacketed cable with pigtail leads			
Response Time	Typically <300 milliseconds for 97% of final value		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	IP53 (NEMA 2)			

*contact factory for current compound

McMillan UHP

ORDERING INFORMATION

Form part number: (Model Code) - (Flow Range) - (Power/Signal) - (Fittings) - (Cable Length) - (Options).	Code	U701	U702	U705	U706
U701 UHP Liquid FLO-SENSOR® U702 UHP Liquid FLO-SENSOR® U705 UHP Liquid FLO-SENSOR® U706 UHP Liquid FLO-SENSOR®	U701 U702 U705 U706	✓	✓	✓	✓
Flow Range (mLpm of H_2O)					
15-100	3	✓	✓	✓	✓
20-200	4	✓	✓	✓	✓
50-500	5	✓	✓	✓	✓
100-1000	6	✓	✓	✓	✓
200-2000	7	✓	✓	✓	✓
500-5000	8	✓	✓	✓	✓
1000-10000	9	✓	✓	✓	✓
Flow Range (Lpm of H_2O)					
2 - 20	20	✓	✓	✓	✓
3 - 30	30	✓	✓	✓	✓
5 - 50	50	✓	✓	✓	✓
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	✓	✓	✓	✓
1/2" male flare (Flaretek® compatible)	F7			✓	✓
3/4" male flare (Flaretek® compatible)	F8	✓	✓	✓	✓
1/4" Super 300 (Pillar® compatible)	S4			✓	✓
3/8" Super 300 (Pillar® compatible)	S6			✓	✓
1/2" Super 300 (Pillar® compatible)	S7			✓	✓
3/4" Super 300 (Pillar® compatible)	S8			✓	✓
1" Super 300 (Pillar® compatible)	S9			✓	✓
Cable Length					
3 feet (0.92 m)	C3	✓	✓	✓	✓
6 feet (1.85 m)	C6	✓	✓	✓	✓
10 feet (3.1 m)	C10	✓	✓	✓	✓
15 feet (4.6 m)	C15	✓	✓	✓	✓
20 feet (6.2 m)	C20	✓	✓	✓	✓
25 feet (7.7 m)	C25	✓	✓	✓	✓
Options					
High Temperature Operation	HT	✓	✓	✓	✓
Include Pair of PVDF Flare Nuts	FN	✓	✓	✓	✓
ACCESSORIES					
Power Adapters (Order Separately)					
115 VAC Adapter for 15 VDC models	106-10-08	✓	✓	✓	✓
230 VAC Adapter for 15 VDC models	106-10-18	✓	✓	✓	✓
Displays					
(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:

U701-3-A-F4-C6-HT would give you a U701 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 cable would be included.

Example #2:

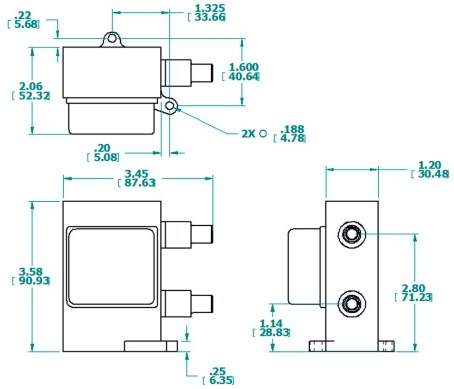
U706-30-C-F8-C25 would include a U706 FLO-SENSOR rated for 3-30 Lpm. 15-25 VDC power would be required, and a 4-20 mA output would be provided. Fluid connections would be ¾" male flare. A FEP-jacketed 25-foot cable would be included.

FITTING CHART

FLOW RANGE	F4	F6	F7	F8	S4	S6	S7	S8	S9
3	✓	✓			✓	✓			
4	✓	✓			✓	✓			
5	✓	✓			✓	✓			
6	✓	✓			✓	✓			
7		✓				✓			
8		✓				✓			
9		✓	✓			✓	✓		
20			✓	✓			✓	✓	✓
30				✓				✓	✓
50				✓				✓	✓

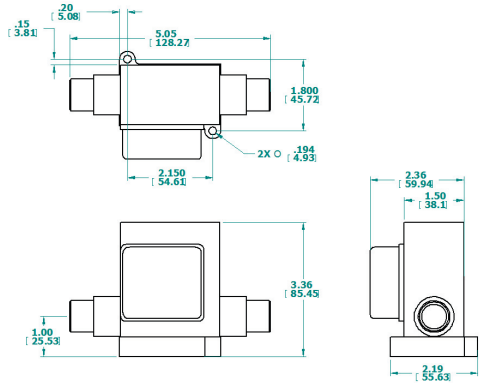
S=Standard; O=Optional.

DIMENSIONS



DIMENSIONS (U701/U702)

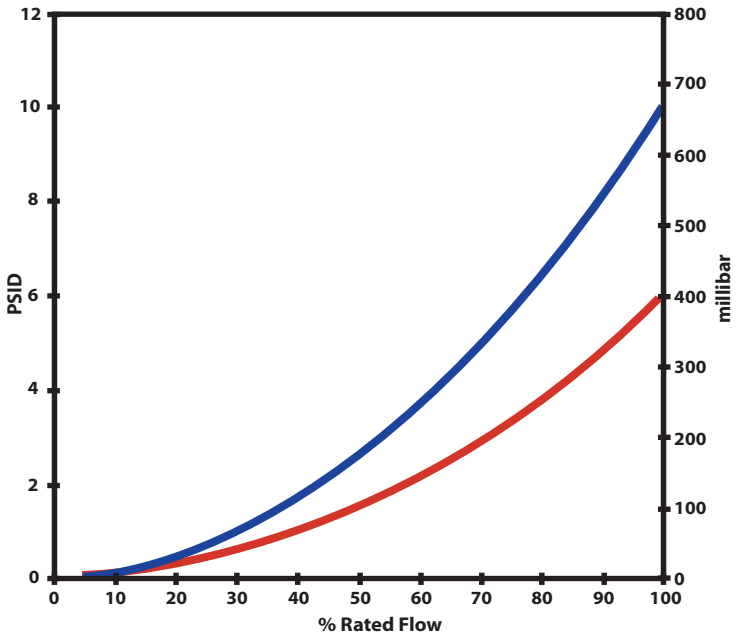
Dimensions shown are in inches(mm). All dimensions shown are for Model U702 FLO-SENSOR with 3/8" male flare fittings (F6) and are similar for other models. Specific model dimensional drawings may be requested from the factory.



DIMENSIONS (U705/U706)

Dimensions shown are in inches(mm). All dimensions shown are for Model U706 FLO-SENSOR with 3/4" male flare fittings (F8) and are larger than models with smaller connections. Specific model dimensional drawings may be requested from the factory.

PRESSURE DROP



Viton – Reg TM E.I. DuPont Dow Elastomers LLC

FLO-SENSOR -- Reg TM McMillan Co

Flaretek – Reg TM Entegris, Inc.

Pillar – Reg TM Nippon Pillar Packing Company, Ltd.

Bulletin U701-S002

Specifications subject to change without notice.

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