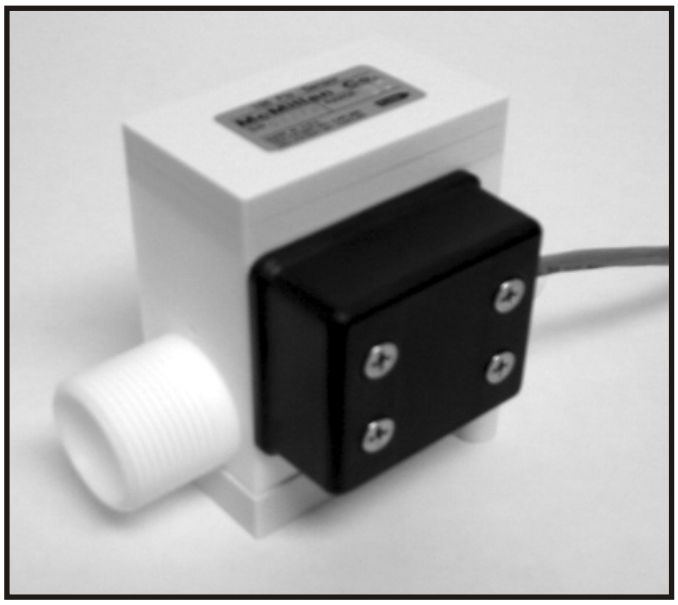
McMillan C•O•M•P•A•N•Y

MODEL 106S
PTFE Flo-Sensor for Liquid Applications

PRELIMINARY



- ✓ Patented* microturbine design provides *no zero drift* and *highly repeatable* flow measurement data
- ✓ All high-purity wetted surfaces: PTFE, Kal-Rez®, and sapphire only
- ✓ Fully compatible with CMP slurries, acids, solvents, and most other high-purity fluids
- ✓ Pulse Output (Hz) proportional to flow rate

DESCRIPTION

The Model 106S Flo-Sensor will precisely measure flow rates of virtually any fluid as low as 15 mL/minute or as high as 50 LPM. Repeatable results are achieved by utilizing a patented* microturbine flow sensor design. This concept allows accurate flow measurement with no zero drift and *no particle generation!* PTFE, Kal-Rez®, and sapphire wetted surfaces insure compatibility with CMP slurries, acids, solvents, deionized water, photodeveloper solutions, and most other high-purity fluids.

The Model 106S Flo-Sensor integrates this microturbine design with advanced electronics to provide a passive BOSFET pulse signal, frequency proportional to flow rate. Patented* McMillan design means long life expectancy under normal operating conditions - over 50,000 hours MTBF (ongoing testing).

Each unit is individually calibrated before shipment, and a certificate of calibration accompanies all Flo-Sensors. ±0.2% full-scale repeatability reassures process engineers that results will be consistent. An optional temperature rating of 0-90°C allows use in most semiconductor applications.

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

Kal-Rez - Reg TM E.I. duPont de Nemours Co.

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COMMON APPLICATIONS

- **Flow rate monitoring to improve yield management**
- **Chemical delivery monitoring for CMP polish tools**
- **High & low flow rate alarm systems**
- **Injection and dispensing systems**

PRINCIPLE OF OPERATION

The Model 106S Liquid Flo-Sensor provides a proportional pulse output based on volumetric flow rate. *Figure 1* shows the internal design.

The flow sensor design utilized in the 106S is McMillan's patented microturbine design. McMillan's microturbine wheel technology utilizes the Pelton turbine wheel concept. This type of design allows usage of a sub-minature microturbine wheel, only about 0.8 inches (20 mm) in diameter. The turbine wheel is then supported on a very small sapphire shaft held in position by two sapphire bearings - see *Figure 2*. Because of the very light weight 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 is evident in *Figure 3*, which shows a new sensor virtually at background levels in just a few minutes (data obtained by a third party).

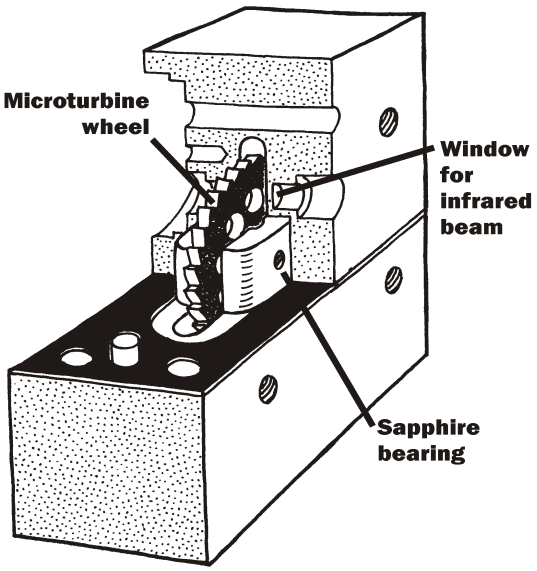


Figure 1. Cutaway of sensor technology.

As flow passes through the flow sensor, it is directed onto the teeth of the wheel using a precision-machined orifice, which is sized according to flow range. The flow is projected onto the wheel, spinning the wheel faster as flow increases. This speed increase is directly proportional to the increase in flow rate.

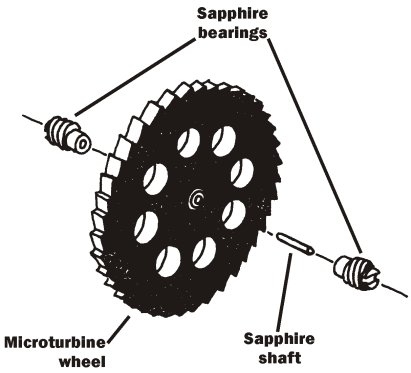


Figure 2. Microturbine wheel assembly.

The microturbine wheel features 8 small windows, spaced evenly around the center of the wheel. As the wheel spins, a light beam is projected through a PTFE window and onto the wheel. A sensor on the other side of the wheel detects each hole and translates those signals into pulses. Thus, as the wheel spins faster, more pulses are generated. When the wheel stops, no pulses are generated.

The pulse output is then processed and provided as a passive opto-isolated BOSFET output, similar to a solid-state relay.

Alternate Configurations

For an advanced flow controller for UHP liquids, please request information on the Model U801.

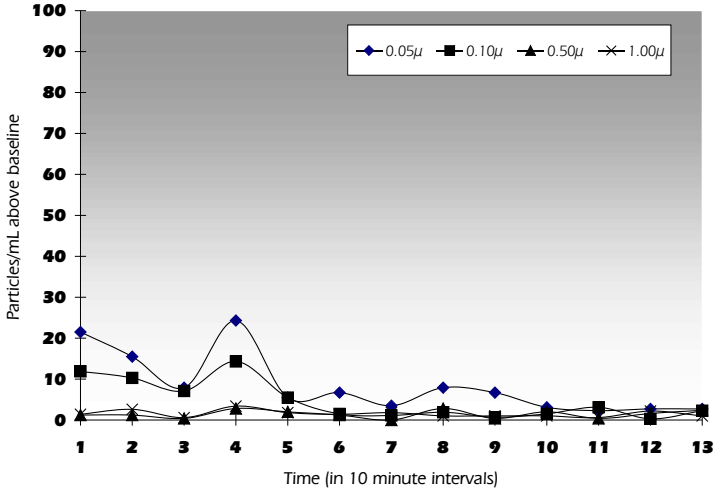


Figure 3. Flow sensor particle release in first 130 minutes.

PURITY ANALYSIS

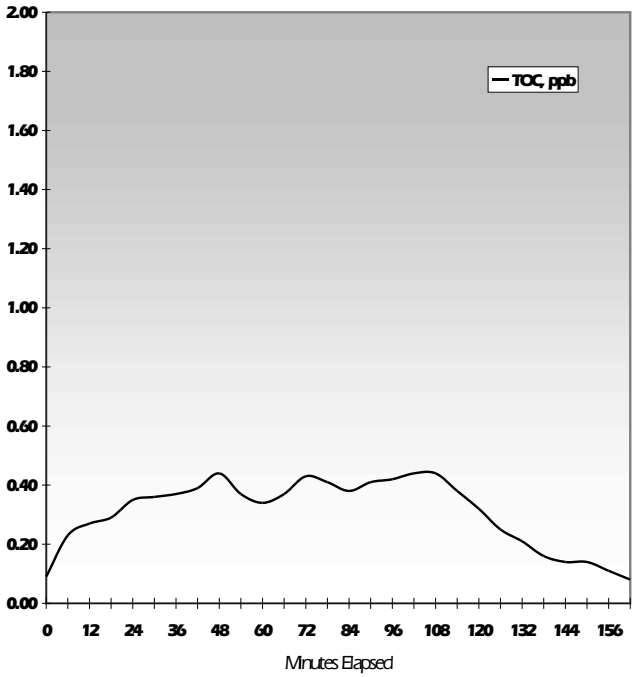
All data collected by third party from randomly chosen microturbine flow sensor.
Asterisk (*) indicates below detectable levels.

METALLIC ELEMENT	Detection Level (ppb)	Upon Install	After 270 Min
Aluminum (Al)	0.003	*	*
Antimony (Sb)	0.002	*	*
Arsenic (As)	0.005	*	*
Barium (Ba)	0.001	*	*
Berylium (Be)	0.003	*	*
Bismuth (Bi)	0.001	*	*
Boron (B)	0.05	*	*
Cadmium (Cd)	0.003	*	*
Calcium (Ca)	0.2	*	*
Cerium (Ce)	0.001	*	*
Cesium (Cs)	0.001	*	*
Chromium (Cr)	0.004	*	*
Cobalt (Co)	0.001	*	*
Copper (Cu)	0.003	*	*
Dysprosium (Dy)	0.001	*	*
Erbium (Er)	0.001	*	*
Europium (Eu)	0.001	*	*
Gadolinium (Gd)	0.001	*	*
Gallium (Ga)	0.002	*	*
Germanium (Ge)	0.003	*	*
Gold (Au)	0.006	*	*
Hafnium (Hf)	0.001	*	*
Holmium (Ho)	0.001	*	*
Indium (In)	0.001	*	*
Iridium (Ir)	0.002	*	*
Iron (Fe)	0.02	*	*
Lanthanum (La)	0.001	*	*
Lead (Pb)	0.003	*	*
Lithium (Li)	0.002	*	*
Lutetium (Lu)	0.001	*	*
Magnesium (Mg)	0.002	*	*
Manganese (Mn)	0.002	*	*
Mercury (Hg)	0.02	*	*
Molybdenum (Mo)	0.004	*	*

METALLIC ELEMENT	Detection Level (ppb)	Upon Install	After 270 Min
Neodymium (Nd)	0.001	*	*
Nickel (Ni)	0.004	*	*
Niobium (Nb)	0.001	*	*
Osmium (Os)	0.002	*	*
Palladium (Pd)	0.002	*	*
Platinum (Pt)	0.009	*	*
Potassium (K)	0.1	*	*
Praseodymium (Pr)	0.001	*	*
Rhenium (Re)	0.003	*	*
Rhodium (Rh)	0.001	*	*
Rubidium (Rb)	0.001	*	*
Ruthenium (Ru)	0.002	*	*
Samarium (Sm)	0.002	*	*
Scandium (Sc)	0.01	*	*
Selenium (Se)	0.02	*	*
Silicon (Si)	0.5	*	*
Silver (Ag)	0.001	*	*
Sodium (Na)	0.007	0.015	*
Strontium (Sr)	0.001	*	*
Tantalum (Ta)	0.004	*	*
Tellurium (Te)	0.005	*	*
Terbium (Tb)	0.001	*	*
Thallium (Tl)	0.006	*	*
Thorium (Th)	0.003	*	*
Thulium (Th)	0.001	*	*
Tin (Sn)	0.005	*	*
Titanium (Ti)	0.002	*	*
Tungsten (W)	0.005	*	*
Uranium (U)	0.002	*	*
Vanadium (V)	0.003	*	*
Ytterbium (Yb)	0.001	*	*
Yttrium (Y)	0.001	*	*
Zinc (Zn)	0.005	*	*
Zirconium (Zr)	0.005	*	*

Anion	Detection Level (ppb)	Baseline 0 Min	After 270 Min
Fluoride (F^-)	0.1	*	*
Chloride (Cl^-)	0.02	0.05	*
Nitrite ($NO2^-$)	0.02	*	*
Bromide (Br^-)	0.02	*	*
Nitrate (NO_3^{-2})	0.02	*	*
Phosphate (PO_4^{-2})	0.02	*	*
Sulfate (SO_4^{-2})	0.05	*	*

Cation	Detection Level (ppb)	Baseline 0 Min	After 270 Min
Lithium (Li+)	0.01	*	*
Sodium (Na+)	0.01	0.01	*
Ammonium (NH4+)	0.05	*	*
Potassium (K+)	0.02	*	*
Magnesium (Mg+2)	0.02	*	*
Calcium (Ca+2)	0.02	*	*



DETAILED SPECIFICATIONS

Accuracy, including Linearity & Hysteresis

±3.0% Full Scale*

Repeatability

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

Power Requirements

Code "A"

11-15 VDC, 60 mA typical

Code "E"

22-25 VDC, 60 mA typical

Pressure Rating

Over pressure limit is 100 psig (6.8bar)

Recommended maximum pressure is 80 psig (5.4 bar)

Temperature Rating

Standard fluid temperature range (internal): 0 to 60°C **

Option Code "HT" temperature range (internal): 0 to 90°C **

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

Storage range: -10 to 70°C

Materials of Construction

Wetted parts - PTFE, Kal-Rez®, sapphire

Exterior surfaces - PTFE, polypropylene, Viton®, epoxy, PVC-jacketed cable, Ryton, stainless steel

Recommended Filtration

25 microns or less

Compatible Fluids

Most all liquids compatible with wetted materials.

Contact the factory for calibration information on fluids with higher viscosities.

Output Signals

Passive BOSFET pulse output, opto-isolated. Typical pulse output 0-400 Hz; each unit may vary - consult calibration certificate for pulse output. 2500 volts isolation. Pulse height selectable using external voltage source.

Reliability

Testing shows no flow sensor performance degradation or excessive wear with over 50,000 hours in service. Testing is ongoing - longer sensor life may be experienced in many applications. For best performance, factory calibrations should be performed every 12 months.

Flow Connections

PTFE male flare-type connections on all units. If PVDF flare nuts are required, add option code "FN". For alternative nut materials, or to specify other connection types, please contact the factory.

Electrical Connections

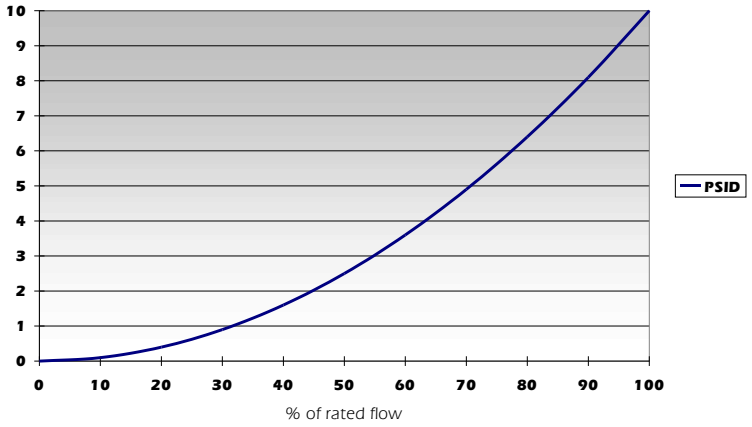
4-conductor PVC-jacketed cable, terminated with pigtail leads. Length determined by part number - contact factory for custom cable lengths.

Response Time

typically <300 milliseconds for 97% of final value

Pressure Drop

typically 2.5 psid at 50% of rated flow using deionized water (see chart on right for typical pressure drop)



Packaging

Final packaging performed in Class 100 environment. All units double-bagged before shipment.

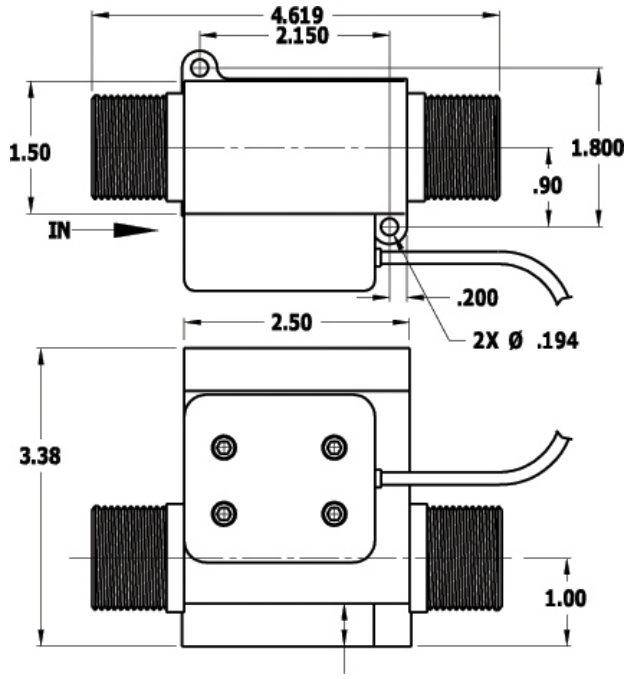
*Full Scale is from 10% to 100% of rated flow (except for range 3, which is 15-100%). Linearity is best fit straight line. All calibrations performed with deionized water.

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

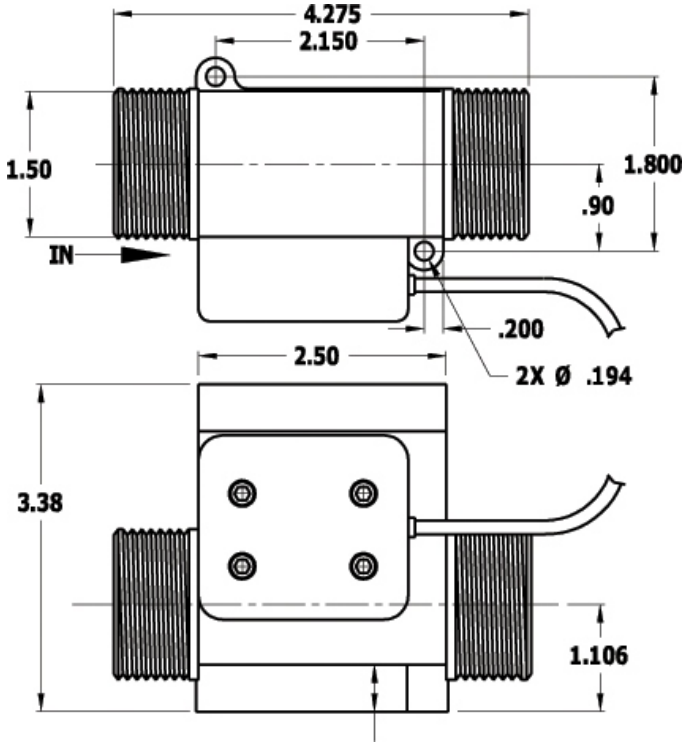
SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

DIMENSIONS (in inches)

For units with 3/4" Super 300 fittings:



For units with 1" Super 300 fittings:



ORDERING INFORMATION

Build your Part Number: 106S - <range> - <opt>

Flow Range	<range>
1.5-15.0 L/minute	<range>="15"
2.0-20.0 L/minute	<range>="20"
3.0-30.0 L/minute	<range>="30"
5.0-50.0 L/minute	<range>="50"

Additional Options (leave off if none)	<opt>
High Temperature Option (Fluid Temp: 0-90°C)	<opt>="HT"
Include Pair of PVDF Flare Nuts	<opt>="FN"

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