McMillan C•O•M•P•A•N•Y

MODEL U801
PTFE Flo-Controller for UHP 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**

DESCRIPTION

The Model U801 Ultra-High-Purity (UHP) Flo-Controller will precisely measure and control flow rates of virtually any fluid as low as 15 mL/minute or as high as 10 LPM. Repeatable results are achieved by utilizing a patented* microturbine flow sensor design. The system includes both a valve module (shown above) where fluid connections are made and a control module (below) where electrical connections are made.

The Model U801 UHP Flo-Controller integrates a proportional double-diaphragm valve to accurately control flow rate. McMillan design* insures long life expectancy under normal operating conditions - millions of cycles with no valve degradation.

±1.0% full-scale accuracy (including linearity & hysteresis) provides the critical control required for modern microelectronic applications. Unparalleled repeatability reassures process engineers that results will be consistent. An optional temperature rating of 0-90°C allows use in most UHP 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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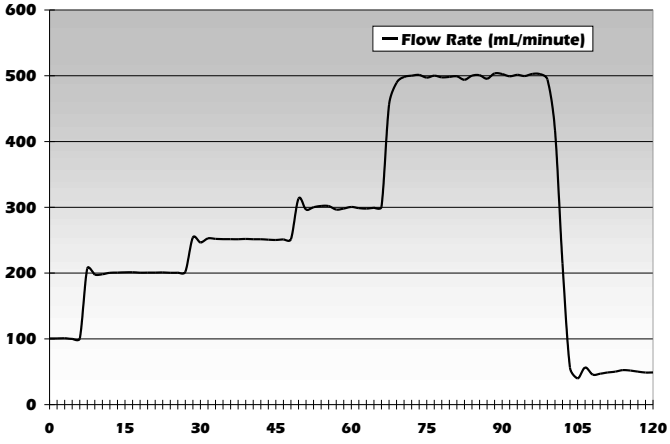
CONTROL MODULE

Included with U801. Provides digital display for flow rate and setpoint display. Also provides removable terminal connector for easy connections.

RESPONSE



Tests run on a new, randomly chosen McMillan 500 mL/minute (range 5) liquid flow controller on deionized water with 20 psig input pressure.

PRINCIPLE OF OPERATION

The Model U801 Liquid Flo-Controller for UHP applications functions with liquids much the same way a mass flow controller (MFC) operates with gases. A signal is passed to the controller from a user or other external device (such as a computer). That signal is processed and compared to the actual flow rate, which is provided in real-time by the integrated flow sensor. Any difference between the two signals results in adjustments to the internal valve, therefore maintaining the requested flow rate automatically. *Figure 1* shows the internal design.

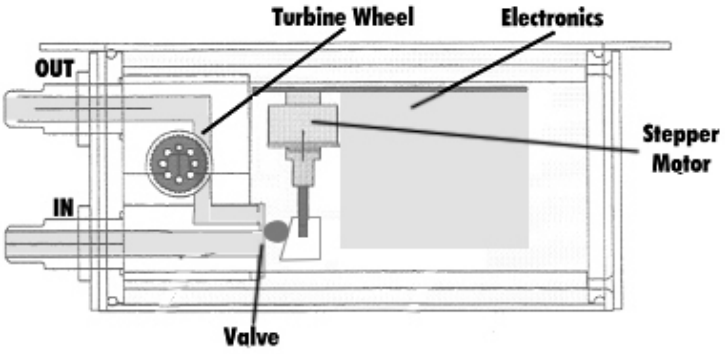


Figure 1. McMillan U801 Liquid Flo-Controller.

The flow sensor utilized in the U801 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 (20mm) 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).

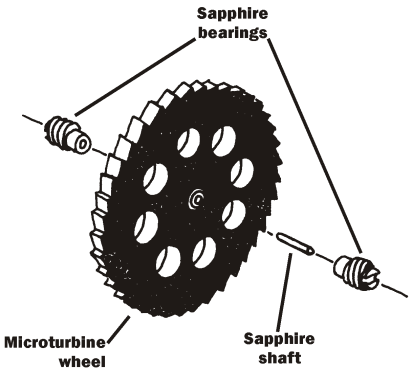


Figure 2. Microturbine wheel assembly.

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.

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 U801 incorporates a double-diaphragm type valve, common in the semiconductor industry. This valve is actuated by an advanced stepper motor to provide precise control and repeatable results. Diaphragm valves require minimum maintenance and the McMillan U801 valve has been tested to millions of cycles with no degradation of performance - which equates to many years of reliable service.

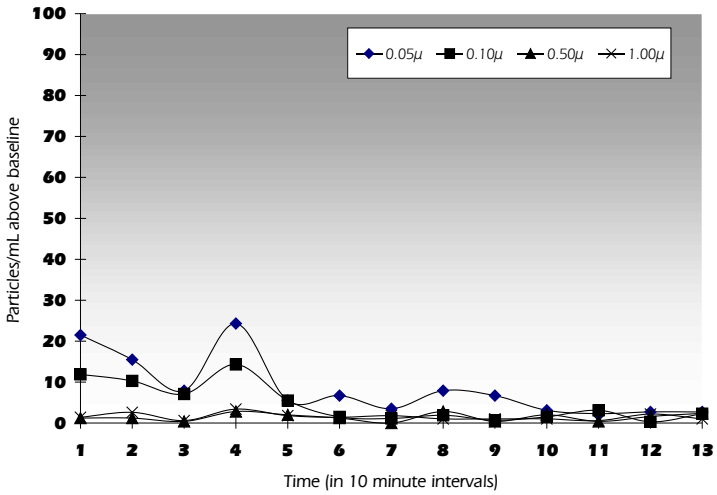


Figure 3. Flow sensor particle release in first 130 minutes. Data shown is typical with U801 microturbine design.

DETAILED SPECIFICATIONS

Accuracy, including Linearity & Hysteresis

±1.0% Full Scale*

Repeatability

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

Power Requirements

22-25 VDC; 1.0 A peak, 250 mA typical

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): 0 to 60°C **
Option Code "HT" fluid 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, sapphire, Kal-Rez®
Exterior surfaces - PTFE, polypropylene, PVC, FEP-jacketed cable, PVDF, Viton®

Recommended Filtration

25 microns or less

Compatible Fluids

Most all liquids compatible with wetted materials.
Contact the factory for calibration information on fluids with high viscosities.

Input/Output

Code "B"

Analog voltage input/output, 0-5 VDC. Voltage level is proportional to flow rate (zero VDC is zero flow). Input load approximately 100 Kohms; output load should be at least 2.5 Kohms.

Code "C"

Analog current input/output, 4-20 mA. Current level is proportional to flow rate (4 mA is zero flow). Input load loop is 250 ohms; output current loop should not exceed 500 ohms.

Code "J"

Analog voltage input/output, 0-10 VDC. Voltage level is proportional to flow rate (zero VDC is zero flow). Input load is approximately 100 Kohms; output load should be at least 5 Kohms.

Optional Relay Error Output"R"

This provides three-wire connections to a relay - common, normally closed, and normally open. The relay is activated when the controller cannot maintain the desired flow rate. Current load should not exceed 500 mA.

All units also provide internal setpoint selection, which defeats setpoint input and allows user to adjust setpoint using provided potentiometer.

Reliability

Testing shows no valve performance degradation with over 1 million full cycles on deionized water at room temperature. At a typical rate of 0.5 million cycles per year, units in similar installations should perform well for at least two years before service. Longer valve life will be experienced in many applications. Reliability tests are ongoing. Microturbine flow sensor life is over 50,000 hours MTBF (tests ongoing).

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

Connections between valve unit and control module

FEP-jacketed shielded cable, terminated with 15-pin connector. Length determined by part number - contact factory for custom cable lengths.

Connections to control module (all power and signal connections)

12-pin removable connector plug. Connector plug features screw-type terminals that accept wires up to 18 gauge.

Standby Mode

Standby mode inhibits the valve function upon command. Flow sensor output continues, but all controller functions (including error output and control functions) are disabled. Standby mode may be activated externally by a 24VDC signal applied to pin #8, or will automatically be enabled when the external setpoint falls below 5% of full scale.

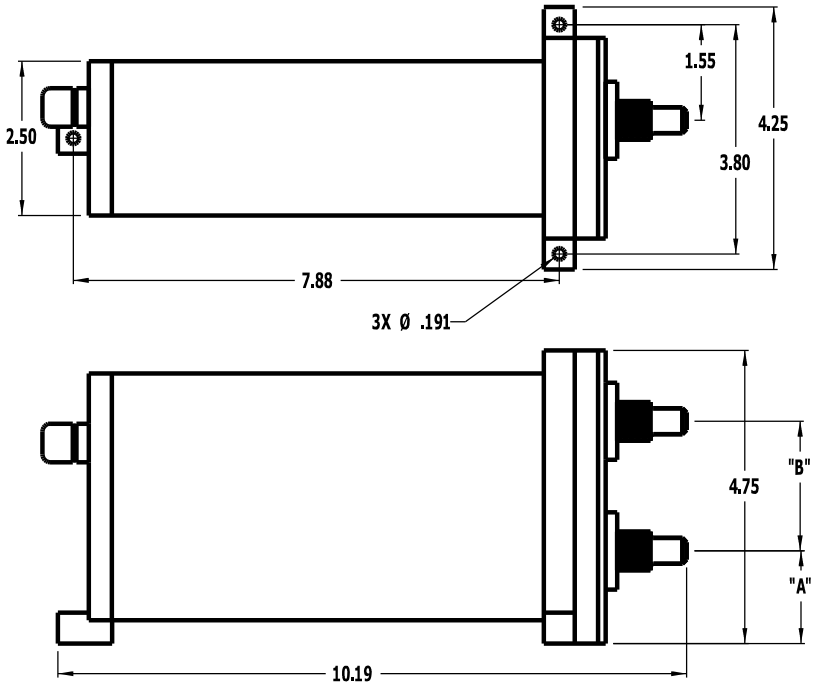
Packaging

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

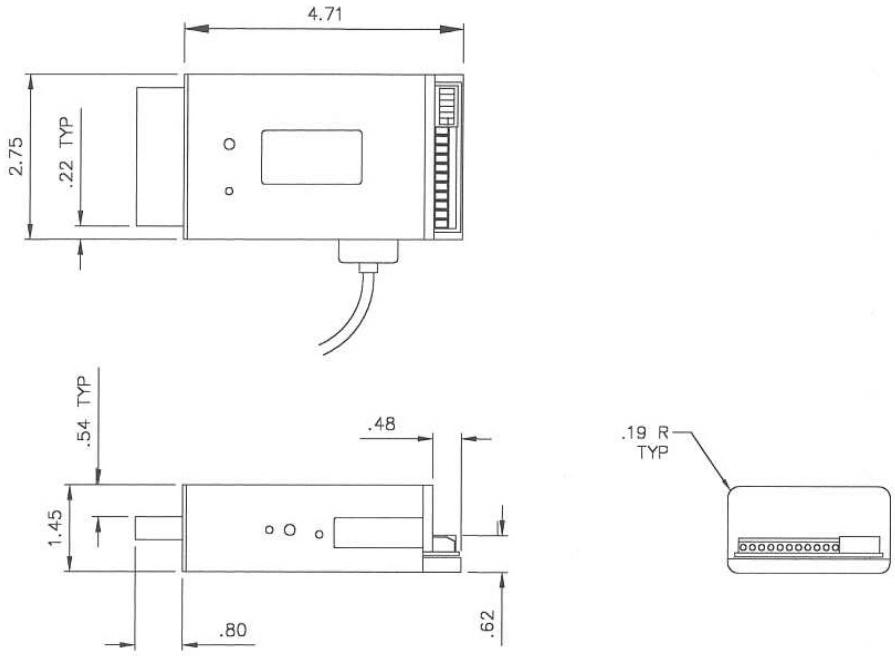
*Full Scale is from 10% to 100% of rated flow (except range 3, which is 15 to 100%). Linearity is best fit straight line. All calibrations performed with deionized water.
**Temperature affects fluid viscosity, and changes in viscosity will have effect on full scale output. Zero is unaffected by temperature.

DIMENSIONS (in inches)

Valve module:



Control Module:



MODEL U801

PTFE LIQUID FLO-CONTROLLER FOR UHP APPLICATIONS

ORDERING INFORMATION

Build your Part Number: U801 - <range> - <signal> - <fitting> - <cable> - <valve> - <opt>

Flow Range	**<range>**
15-100 mL/minute	<range>="3"
20-200 mL/minute	<range>="4"
50-500 mL/minute	<range>="5"
100-1000 mL/minute	<range>="6"
0.2-2.0 L/minute	<range>="7"
0.5-5.0 L/minute	<range>="8"
1.0-10.0 L/minute	<range>="9"

I/O Signal Configuration	**<signal>**
0-5 VDC	<signal>="B"
4-20 mA	<signal>="C"
0-10 VDC	<signal>="J"

For relay error output, add "R" after the signal code (i.e. "JR")

Fitting Type	**<fitting>**	Range:	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1/4" male flare	<fitting>="F4"	available:	✓	✓	✓	no	no	no	no
3/8" male flare	<fitting>="F6"	available:	no	✓	✓	✓	✓	no	no
1/2" male flare	<fitting>="F7"	available:	no	no	no	no	✓	✓	✓

Cable Length (cable between valve and control module)	**<cable>**
3 feet (0.92 meters)	<cable>="C3"
6 feet (1.85 meters)	<cable>="C6"
10 feet (3.1 meters)	<cable>="C10"
15 feet (4.6 meters)	<cable>="C15"
20 feet (6.2 meters)	<cable>="C20"
25 feet (7.7 meters)	<cable>="C25"

Differential Pressure / ΔP*	**<valve>**	Range:	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2-10 psid (5 psid*)	<valve>="P5"		no	✓	✓	✓	✓	no	no
4-20 psid (10 psid*)	<valve>="P10"		no	✓	✓	✓	✓	no	no
5-40 psid (20 psid*)	<valve>="P20"		✓	✓	✓	✓	✓	✓	no
7-50 psid (25 psid*)	<valve>="P25"		no	no	no	no	no	no	✓
10-60 psid (40 psid*)	<valve>="P40"		✓	✓	✓	✓	✓	✓	✓

* Range shown indicates recommended **differential pressure** operating range. Low number of range indicates minimum pressure required to flow 50% of rated flow. High number of range indicates maximum differential pressure recommended for stable control. Value in parentheses indicates minimum pressure required to flow 100% of rated flow. **Please note that P5 and P10 will only control 20-100% of rated flow.** P20, P25 and P40 will control 10-100% of rated flow range (except on range 3, which is 15-100% of rated flow).

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

***Example:** "U801-8-CR-F7-C10-P20-HT" would give you a U801 Flo-Controller rated for 0.4-5.0 L/minute. The input and output signals would be 4-20 mA. A relay error output would be included. The fluid connections would be 1/2" male flare. The cable length would be 10 feet, and the recommended differential pressure range would be 5-40 psid. The unit would be rated for fluid temperature from 0 to 90°C.*

P.O. Box 1340
Georgetown, TX 78627
Phone: (800) 861-0231 / (512) 863-0231
Fax: (512) 863-0671
sales@mcmflow.com

www.mcmflow.com