



6000 Series Pulse Flow Meters

TECHNICAL REFERENCE MANUAL

Can we Improve? Tell our President!

Can we improve our product, our support or this manual?

We are committed to continuous improvement and welcome your help.

Fax, mail or e-mail your ideas to me, Jon Heiner.

If you include your phone number, I will give you a personal reply.

Or if you prefer, call me on my direct line.

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Table of Contents

	Page
1. Introduction	2
2. Features and functions	2
3. How the flow sensor works	4
4. Specifications and performance	5
5. Product certifications	6
6. Installation	7
7. Electrical Connection	11
8. Measuring Flow Rate	11
9. Cleaning and Maintenance	12
10. Calibration and Re-calibration	14
11. Replacement Parts	15

Section 1 Introduction

6000 Series Flow Meters have been created to provide rugged, sensitive and repeatable measurement of liquid flow rates up to 60 GPM (265 LPM) over extended temperature and pressure ranges.

The 6000 Series Flow Meters have been developed from Proteus' experience in satisfying the needs of thousands of demanding users in widely diverse applications since 1978.

FMEA methodology has been used to eliminate the root cause of reported defects – wiring errors during installation. Electronic elements have been added to protect the Hall Effect sensor from excessive voltage and reverse wiring.

New capability has been added to allow direct connection to opto-isolator protected inputs and other controller inputs requiring current sourcing.

Section 2 Features and Functions

- Flow ranges from 0.06 to 60 GPM, 0.1 to 300 LPM
- 5 – 24 V-DC pulsed PNP and NPN outputs for easy interfacing with your PLC.

The amplitude of the pulse output signal is within 5% of the input voltage.

The output frequency is proportional to flow rate through the meter. At the maximum flow range the output frequency is approximately 240 Hz. At the minimum flow rate the frequency is approximately 10 Hz.

- Directly interface to batching, data logging and multi-channel controller accessories.

The 6000 Series Flow Meter provides a digital pulse input to compatible programmable

- Hall Effect sensor, protected from reverse polarity and over-voltage, provides reliable outputs in noisy electrical environments.
- Temperature range –40 to 140°C, pressure to 250 psi with metal faceplates.

- **Calibration**

There is no actual calibration available for this type of device. Flow response curves developed for water at 22 to 25C are available for each model.

The flow curve varies slightly from unit to unit. Individual flow response curves for a particular 6000 Series Flow Meter can be provided at an additional charge.

- **Compact Design**

The depth of the flow meters vary with connection size. Dimensioned outline drawings and 3D renderings are available at <http://proteusind.com/6000/6000drawings.htmlb>

- **Stainless Steel faceplate extends operating range**

Adding stainless steel or brass faceplates permits brass and stainless steel versions of the 6000 Series Flow Meter to be operated from –40 to 140°C and to 250 psi(1720 kPa).

- **A Viton® O-ring provides the liquid seal.**

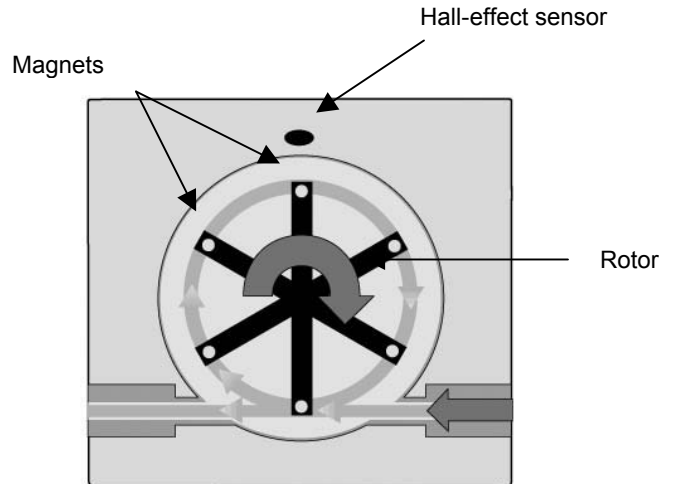
Other materials are optionally available for enhanced chemical compatibility with specialized coolants.

Section 3 How the flow sensor works

The rotor spins when liquid flows through the meter.

Magnets in the rotor switch a Hall-effect sensor mounted in the meter body.

The resulting pulse train is converted by the electronics to a voltage that is equal to the supply voltage. The proportional frequency pulses may be read by your electronics or a display or intelligent multi-channel monitor supplied by Proteus.



Metering

Calibration flow curves are traceable to a NIST reference. Linearity is better than $\pm 0.5\%$.

Section 4 Specifications and performance

The most current information on the performance capability of these Meters is accessible at the Proteus web site, at www.proteusind.com.

Flow Ranges, Materials and Connections

Flow Ranges		Connection	Part Numbers		
GPM	LPM		Polypropylene	Brass	316 Stainless Steel
0.06 – 0.6	0.2 – 2.2	1/4" FNPT		06004BN06	06004SN06
0.08 – 0.8	0.3 – 3.0	1/4" FNPT	06004PN08		
0.1 – 1.0	0.4 – 3.8	1/4" FNPT	06004PN1	06004BN1	06004SN1
0.2 – 2.5	0.75 – 9.5	1/4" FNPT	06004PN2	06004BN2	06004SN2
0.2 – 2.5	0.75 – 9.5	9/16-18 SAE			06006SA2
0.3 – 4.5	1.1 – 17	1/4" FNPT	06004PN4	06004BN4	06004SN4
0.3 – 4.5	1.1 – 17	9/16-18 SAE			06006SA4
0.6 – 9.0	2.2 – 34	3/8" FNPT		06006BN9	06006SN9
0.6 – 10.0	2.2 – 38	3/8" FNPT	06006PN10		
0.8 – 10	3 – 38	3/4-16 SAE			06008SA10
1.0 – 14	3.8 – 53	1/2" FNPT		06008BN14	06008SN14
1.0 – 15	3.8 – 57	1/2" FNPT	06008PN15		
1.2 – 16	4.5 – 60	3/4" FNPT		06012BN16	06012SN16
1.2 – 16	4.5 – 60	1 1/16-12 SAE			06012SA16
1.5 – 19	6 – 72	3/4" FNPT	06012PN19		
3 – 40	11 – 150	3/4" FNPT		06012BN40	06012SN40
4 – 40	15 – 150	1" FNPT		06016BN40	06012SN40
4 – 40	15 – 150	1 5/16-12 SAE			06016SA40
4 – 50	15 – 190	1" FNPT	06016PN50		
5 – 60	18 – 225	1" FNPT		06016BN60	06016SN60

Temperature & Pressure Operating Limits

Flow Sensor Material	Faceplate Material	Temperature Range*		Pressure Range	
		°C	°F	PSI	kPA
Brass	Clear polysulfone	100	212	100	690
Polypropylene	Clear polysulfone	70	167	75	515
Stainless Steel	Clear polysulfone	100	212	100	690

Extend Pressure Range with metal faceplates

Flow Sensor Material	Faceplate Material	Temperature Range*		Pressure Range	
		°C	°F	PSI	kPA
Brass	Brass	110	230	250	1720
Stainless Steel	Stainless Steel	110	230	250	1720

* **This is the fluid temperature that can be sustained with the flow meter cooled by ambient air at 20°C.**

Need to operate above 100°C? Customized versions of the 6000 Series Flow Meters have been proven in operation with fluid temperatures from -40°C to 170°C.

For information on low and high temperature capability contact Tech@proteusind.com or call Technical Support at (650) 964-4163.

Operating Characteristics

Output Frequency	~ 240 Hz at maximum flow rate. <i>Calibration curves are available at extra cost.</i>
Pressure Drop	< 10 psi at maximum flow rate for all versions except 06004BN06, 06004SN06 and 06004PN08. <i>Contact Technical Support at (650) 964-4163 for information on these..</i>
Input Voltage	5 – 24 VDC \pm 10% with over-voltage and reverse polarity protection.
Output Voltage	Square wave with same amplitude as input voltage.
Output Sourcing	Current sinking (NPN) & current sourcing (PNP) outputs
Linearity	Better than \pm 0.5% from 10 to 100% of flow range
Repeatability	Better than \pm 0.4% above 10% of flow range
Electrical Connection	4 x 22 AWG stranded, cabled conductors, with FEP insulation & jacket.
Power requirement	< 10 mA
Materials of construction	All materials are RoHS compliant.
Kinematic Viscosity	For use with liquids with kinematic viscosities to 120 centistokes at operating temperature.

Other Wetted Materials

Component	Available Materials	
	Standard	Optional
Rotor	PPS	Kynar®
O-ring	Viton®	Buna-N, silicone rubber
Rotor Shaft	316 Stainless Steel	alumina, sapphire

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Section 5 Product certifications

6000 Series Flow Meters are certified to be ROHS compliant.

Certification of EC compliance is in progress. Contact Tech@proteusind.com for status on these and other certifications.

Section 6 Installation

- **Caution:** Do not mount the flow meter directly above electronic controls of instruments that could be damaged by leakage from connectors. It is generally undesirable to mount any plumbing connections directly over electronic controls or instruments.
- **Warning:** If the 6000 Series Flow Meter sensor is mounted in a vertical pipeline, any leakage from the topmost connection could enter the unit and cause permanent damage to the electronics.
- **Warning:** Before connecting a flow meter into your fluid line, verify that the normal flow rates expected in that line are within the operating range of the sensor.

Extended use above the rated maximum flow rate of the meter will reduce its useable life.

- It is recommended that connections to the stainless steel meters be made with stainless steel or materials of similarly chemical inertness to minimize potential corrosion damage.
- If rigid piping or tubing is used, the 6000 Series Flow Meter sensor may be supported by direct connection to the pipe or tubing.
- The flow response of 6000 Series Meters may be dependent on the form of the device attached to the inlet connection and other closely located up-stream devices. Elbows, T-pieces, valves and filters located immediately up-stream from the flow meter can introduce swirling motion to the liquid flow. The swirling motion reduces the linear velocity of the flow stream.

We recommend that a straight run of pipe of more than 10 x pipe ID be used between the flow meter and any up-stream devices to minimize these effects.

Appropriate calibration procedures must be used to provide an accurate flow response when elbows, T-pieces or other flow perturbing devices must be attached directly to the inlet port.

- The 6000 Series meter is typically unaffected by the form or proximity of devices on its downstream side.
- For the best results, 6000 Series Meters should be mounted with the faceplate in the vertical plane.
- Mounting the device with the flow connections uppermost can help eliminate entrained air from your system.
- The flow response of the meter may be dependent on the internal diameter (ID) of an incoming pipe, or the ID of a tube connection.

If the ID of your pipe or tube fitting where it connects to the inlet port is LESS than the value shown in Table 1 the flow response values may be incorrect.

Correct response characteristics can be developed to allow the 6000 Series flow meter to be used with pipes and connections with ID's smaller than those shown in Table 2. Contact Tech@proteusind.com for assistance.

Panel mounting

To mount the sensor behind a panel, two of the faceplate securing screws will need to be replaced with longer screws to compensate for the thickness of the panel. Ensure that the screws are not so long that they will touch the bottom of the tapped hole, or rip through the back of a plastic body if over-tightened.

Evenly space up to six holes for 8-32 screws on a 2.5" circle. Using the two holes on the horizontal plane is usually sufficient to support smaller flow sensors and all plastic sensors. If you wish the rotor to be visible, cut a 1 $\frac{3}{4}$ " diameter hole with the same center.

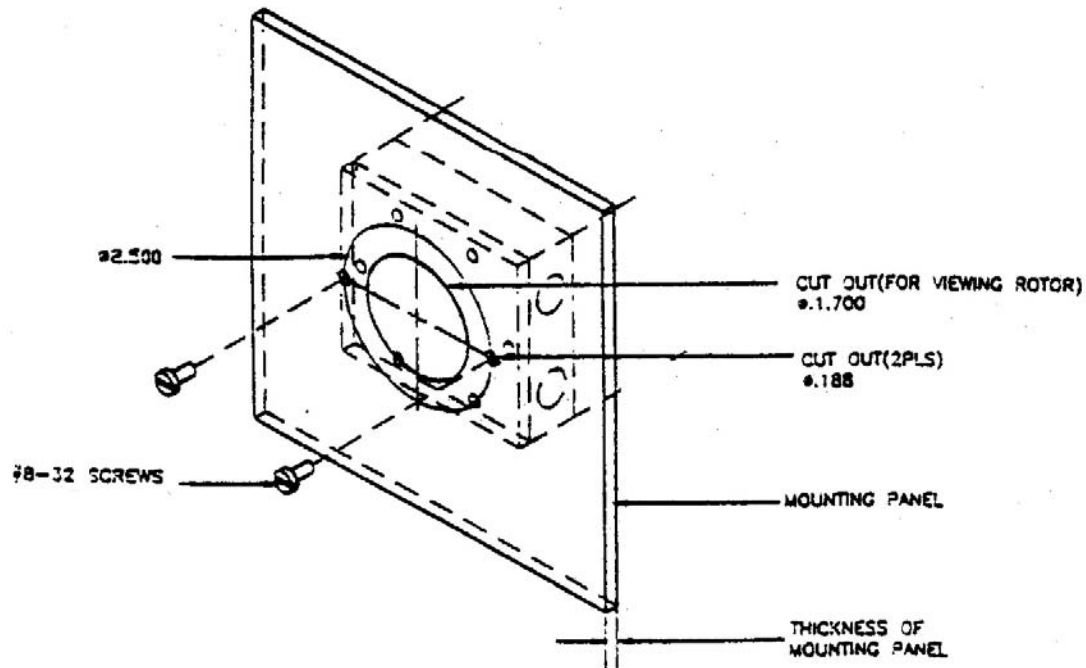
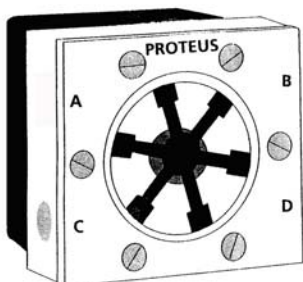


Figure 1: Panel Mounting of 100 Series Flow Switch

1. Remove screws holding the faceplate to the sensor body.
2. Place the sensor behind the panel and insert the longer screws you have selected.
3. Secure the screws in the body with a torque of ~ 10 in-lb. (Finger tight with a flat-blade screwdriver.)

Plumbing Connections



Flow Direction

The inlet ports of the 06004BN06, 06004PN08 and 06004SN06 flow meters have smaller orifices than the outlet ports.

Be sure that liquid enters the meter at the smaller orifice at position D.

All other meters have identical orifices ID's at both ports and liquid flow can be introduced from either side.

Part Number	Flow Ranges		Connection	Minimum ID	
	GPM	LPM		Inch	mm
06004BN06 06004SN06	0.04 – 0.6	0.15 – 2.3	1/4" FNPT	0.063	1.6
06004PN08	0.05 – 0.8	0.2 - 3.0	1/4" FNPT	See note on Flow Direction	
06004BN1 06004PN1 06004SN1	0.1 – 1.0	0.4 – 3.8	1/4" FNPT	0.125	3.18
06004BN2 06004SN2 06004PN2	0.2 – 2.5	0.75 – 9.5	1/4" FNPT	0.188	4.8
06006SA2	0.2 – 2.5	0.75 – 9.5	9/16-18 SAE		
06004BN4 06004SN4 06004PN4	0.3 – 4.5	1.1 – 13	1/4" FNPT	0.270	6.9
06006SA4	0.3 – 4.5	1.1 – 13	9/16-18 SAE		
06006BN9 06006SN9	0.6 – 9.0	2.2 – 34	3/8" FNPT	0.370	9.4
06006PN10	0.6 – 10.0	2.2 – 38	3/8" FNPT		
06008SA10	0.8 – 10	3 – 38	3/4-16 SAE	0.400	10.2
06008BN14 06008SN14	1.0 – 14	3.8 – 53	1/2" FNPT	0.460	11.7
06008PN15	1.0 – 15	3.8 – 57	1/2" FNPT		
06012BN16 06012SN16	1.2 – 16	4.5 – 60	3/4" FNPT	0.610	15.5
06012SA16	1.2 – 16	4.5 – 60	1 1/16-12 SAE		
06012PN19	1.5 – 19	6 – 72	3/4" FNPT		
06012BN40 06012SN40	3 – 40	11 – 150	3/4" FNPT	0.800	20.3
06016BN40 06016SN40	4 – 40	15 – 150	1" FNPT	0.870	22.1
06016PN50	4 – 50	15 – 190			
06016SA40	4 – 40	15 – 150	1 5/16-12 SAE		
06016BN60 06016SN60	5 – 60	18 – 225	1" FNPT	1.000	25.4

Table 1: Minimum ID of pipe or connection for valid flow response

Making NPT pipe thread connections

Pipe threads seal by making metal-to-metal contact between male and female components. Consequently they are particularly prone to the damaging effects of galling, which occurs when two surfaces move against each other under pressure. When installing pipe threads it is essential to use a high quality lubricating and sealing material.

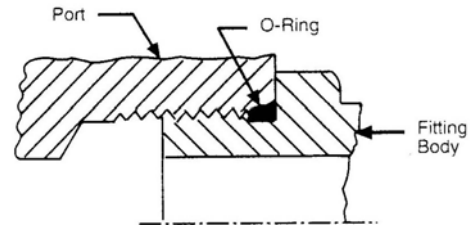
- Use Teflon tape or a PTFE-based liquid sealant to provide lubrication for the junction and a leak-tight connection at both input and output connections. Real-Tuff and Hercules are two of many suitable brands of PTFE-based sealants.
- Do not over-tighten the connection. Refer to instructions for installation of the mating fittings for information on torque requirements.
- Leak testing of all connections in your flow circuit is recommended. Pressurizing the system with air and external testing with a dilute soap solution can help identify leaking connections.

Making SAE straight thread connections

With these connectors, an O-ring makes the seal while the threads hold the connecting assembly in place. Straight thread connections should receive a small amount of high-pressure lubricant before installation to prevent galling.

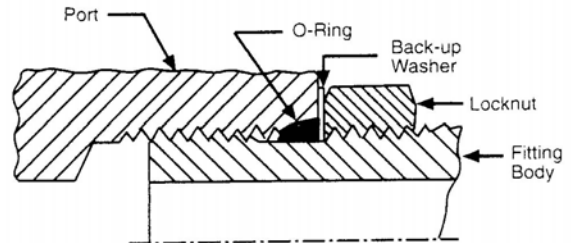
Non-adjustable fittings

1. Bring the non-adjustable fitting into firm contact with the face of the port, using a wrench.
2. Check to be certain that the O-ring fits easily into the non-threaded receiving area of the port, and is not pinched.



Adjustable fittings

1. Ensure that the locknut is positioned so the back-up washer is in contact with the beginning of the threads farthest from the end of the fitting.
2. Screw the fitting into the port until the back-up washer contacts the sealing face.
3. Check to be certain that the O-ring fits easily into the non-threaded receiving area of the port, and is not pinched or damaged.
4. Unscrew the fitting a maximum of one turn to position it in the desired direction.
5. Tighten the locknut firmly against the back-up washer so the fitting assembly is held securely in place.



Filtering

Your circulating fluid may contain particles. While not essential to the operation of the flow sensor, it is good practice to filter your fluid. A 100-micron filter is often used to remove rust and other particles from the fluid. This can increase the lifetime of pumps and other fluid system components as well as reducing wear in the sensor.

Section 7 Electrical Connections

Note

Only personnel familiar with the electrical circuit and control functions of the system in which the sensor is to be included should perform installation of this product.

CAUTION

Electronic components used in the 6000 Series Flow Meter are sensitive to discharges of static electricity. Use proper ESD precautions if removing the back cover from the flow meter!

Color	Function
Red	Supply Voltage +5 to 24 VDC
Black	Supply Common 0 VDC
Green	Current sinking output (NPN)
White	Current sourcing output (PNP)

1. Locate the source of 5 – 24 VDC power source and turn it OFF.
2. Connect the BLACK wire to the ground or -VDC power connection.
3. If connecting to an input such as an optoisolator or current loop that requires a current source connect the input to the WHITE wire.
For other applications connect the input to the GREEN wire.
4. Connect the RED wire to the + output of the DC power source.
5. Turn the DC power source ON.
6. If necessary adjust the DC voltage to between 5 and 24 VDC.

Section 8 Measuring Flow Rate

The frequency output by the 6000 Series Flow Meter allows the flow rate of the liquid passing through the device to be measured.

While the flow response curves of the 6000 Series Flow Meters are extremely linear, they do NOT pass through zero.

Calibration curves and derived look-up tables obtained from measurement of multiple Meters are shown below.

The equations under each graph may be used with a PLC or other control devices to obtain a more accurate measure of flow.





FLOW RESPONSE CURVES ARE IN PREPARATION




Contact Tech@proteusind.com and request the flow response curve you require.

Section 9 Cleaning and Maintenance

Maintenance of the 6000 Series Flow Meter is normally limited to cleaning the chamber in which the rotor spins.

The frequency of cleaning will vary with the type of fluid being run and the cleanliness of that fluid. In most cases, annual cleaning immediately prior to recalibration is sufficient.

Cleaning the 6000 Series Flow Meter	
<p>1. Turn OFF the liquid flow in your flow circuit and remove the flow meter from your system.</p> <p>Place the unit on a clean surface.</p>	
<p>2. Remove the 6 screws securing the faceplate.</p>	
<p>3. Remove the faceplate from the flow meter.</p>	
<p>4. Remove the rotor and stainless steel shaft from the flow cavity.</p> <p>Remove the O-ring from the faceplate</p>	

Cleaning the 6000 Series Flow Meter	
<p>5. Using a soft cloth dampened with water, alcohol or a light detergent solution, clean debris and dirt from the rotor, the stainless steel shaft, the inside surfaces of faceplate and the surfaces of the flow cavity</p>	
<p>6. Inspect the bearing surface of the rotor. If the bearing surface is worn or not round, replace the rotor.</p> <p>Inspect the stainless steel shaft. If the shaft shows signs of scoring or other wear, replace the shaft or the whole faceplate assembly.</p>	
<p>7. Inspect the O-ring to ensure that it is not brittle, cracked or otherwise damaged.</p> <p>If necessary replace with a #132 O-ring of a material compatible with the liquid being passed through the flow meter.</p> <p>Position the O-ring on the inner rim of the faceplate.</p>	
<p>8. Place the rotor in the flow cavity.</p> <p>Position the shaft (or the faceplate) to locate the shaft in the rotor.</p>	
<p>9. Position the faceplate so that the holes in the faceplate are aligned with the screw holes in the front of the flow sensor body.</p> <p>Replace the 6 securing screws.</p> <p>Tighten the screws to a torque of 10 in-lbs (hand tighten with a normal screwdriver).</p>	
<p>11. Install the flow meter in your system.</p> <p>Turn on liquid flow and check for leaks at the faceplate and connecting ports.</p> <p>Tighten all connections as required to eliminate leaks.</p>	

Section 10 Calibration & Recalibration

Note

6000 Series Flow Meters are characterized at Proteus with water at temperatures ranging from 22 to 28C.

***Changes in fluid type can alter the flow response of the sensor.
Large changes in liquid temperature can alter the flow response of the sensor.***

Please contact Proteus Technical Support if a specialized flow curve is needed.

Note

As described in the Installation section on page 7, the response of the 6000 Series flow sensor may be affected by the way in which the sensor is connected to your system.

Checking Flow Meter Response

The frequency at which the flow response curve of the 6000 Series Flow Meter should be checked is determined by the accuracy and stability requirements of each application.

Note that no actual calibration adjustments can be made with this flow meter – the response factor or response curve of the flow meter must be measured and the new response characteristic or flow response coefficients entered to the controlling processor.

Characterization by Proteus

To obtain a price quotation and a Return Material Authorization number for re-characterization of your flow sensor, contact Sales@proteusind.com or call (650) 964 4163.

When received at Proteus your flow meter will:

1. Have its output measured and recorded in the as-received state.
2. The rotor, stainless steel shaft and sealing O-ring will be replaced.
3. The flow cavity will be cleaned and the device reassembled..
4. The unit will be re-characterized against reference standards whose calibrations are statistically controlled against NIST-traceable standards.
5. If characterization is requested a new characterization certificate will be issued
6. A new calibration label will be attached to the flow meter.

Direct characterization against NIST-traceable standards is optionally available.

Section 11 Replacement Parts

Same day delivery is available for orders for replacement parts received by Proteus by 1.00 pm PST.

Prices and part numbers for replacement parts for the 6000 Series Flow Meter are located at http://proteusind.com/eprice/6000_Meter_Price_List.html

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