

AutoPSI Pressure Sensor Operating Instructions



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1. Overview

The AutoPSI-S Pressure Sensor is a fully self-contained unit. The sensing element is coupled via an optical fiber to an enclosure that houses all electronic circuitry. The enclosure has four or five color-coded leads (depending upon system grounding requirements) for terminating to a power source and data acquisition system.

2. Specifications

<i>Over Pressure:</i>	2 x Pressure Range (typical)
<i>Non-Linearity & Hysteresis:</i>	±0.5% FS under non-combustion conditions, under constant temperature ±1% FS under combustion conditions, i.e., varying temperature within one combustion cycle
<i>Diaphragm Resonant Frequency:</i>	120 kHz min.
<i>Frequency Range:</i>	0.1 Hz to 20 kHz (Standard)
<i>Sensor Housing Temperature Range:</i>	-40°C to 350°C
<i>Cable Operating Temperature:</i>	-40°C to 200°C
<i>Fiber optic Cable Length:</i>	1.5m (5')
<i>Fiber optic Cable Min. Bending Radius:</i>	5mm (3/16")
<i>Sensor Type:</i>	Sealed Gauge
<i>Interface Unit:</i>	Integrated with Sensor
<i>Pressure Output Signal:</i> (Analog)	9-18V DC input: 0.5 – 4.5 V 5V DC input: 0.5 - 4.5 V
<i>Diagnostic Output Signal:</i> (Analog)	9-18V DC input: 0.5 – 2.5 V 5V DC input: 0.5 – 2.5 V
<i>Power Supply Voltage:</i>	9-18V DC <i>or</i> 5V DC
<i>Current Draw:</i>	85 mA Max, 50 mA Typical
<i>Interface Temperature Range:</i>	AutoPSI-S,A,TC: -20°C to 60°C AutoPSI-HT: -20°C to 125°C
<i>Pressure Media:</i>	Gaseous or Liquid
<i>Vibration:</i>	100G
<i>Guaranteed Lifetime:</i>	1, 2 or 3 Years depending on sensor package or application

3. Operating Instructions

To operate simply install the pressure sensor, apply power, and start measuring the pressure signals. The rest of this section describes each step in detail.

3.1 Pressure Sealing/Installation Torque

There are several sealing methods for the sensor. The sealing option is part of the sensor model number:

Conical Tip or Tapered Shoulder: Pressure sealing surface is located at the front of the sensor. Recommended sealing torque: 50-100 in-lb. Example: Conical – C31242-Q

Shoulder: Requires a brass or copper washer at the step of the sensor housing. Recommended sealing torque: 25 in-lb. Example: C31273-Q

Flange: Requires a brass or copper washer over the threads of the housing. The flange (or hex) part of the housing squeezes the washer. Recommended sealing torque: 15 to 25 in-lb. Example: C21224-Q

Flange/Face: (M5 sensors only) Sensor can be sealed either on the flange or the face (which has a 118 Deg taper seat). Recommended sealing torque: 12 to 17 in-lb

Flange Washer: These sensors are designed for the Optrand's PSIplug, a modified production spark plug (Model SP-D6/J6). When installing these sensors, verify the washer is not damaged with each installation. Apply installation torque of 6 to 7 in-lb.

Glow plug/Spark plug: Use manufacture recommended torque

3.2 Installation General: Install the sensor into a drilled and tapped hole. Verify the sealing techniques are properly implemented. Tighten the sensor to the recommended torque.

Optrand, Inc. will not be liable for any injury or property damage that results from improper use or installation of Optrand products.

PSIplug/Sensor Assemblies: In order to avoid damage to the sensor extreme care must be exercised when installing miniature sizes, specifically in the PSIplug. With each installation of the PSIplug use a new spark plug washer. Inspect o-rings for wear and tear on a regular basis and replace them when necessary.

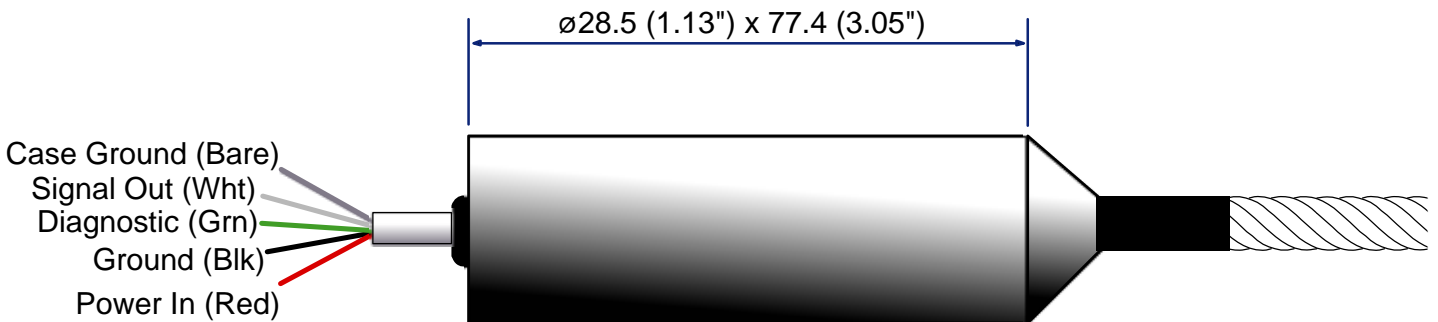
3.3 AutoPSI Signal Conditioner

The AutoPSI system is designed to continuously monitor dynamic pressure. The patented circuitry is designed to provide auto referencing which maintains sensor accuracy at extreme temperatures and over long periods of time.

The sensor has either four or five wires extending out of the electronic enclosure tube. The following describes the purpose of each wire:

White Wire	Sensor Output Signal
Blue or Green Wire	Diagnostic, Static Calibration
Red Wire	Power
Black Wire	Ground (Power and Signal)
Bare Wire	Case (if present, otherwise case is connected to Ground)

Power: Apply 9 - 18V DC for -S sensors and 5V DC for -A Sensors between the Red and Black wires. 12V DC is the recommended operating voltage for -S sensors.



Sensor Output Signal: Connect between the White and Black wires. The output signal is analog, 0.5 – 4.5 Volts for all sensors. The analog signal and Sensor Sensitivity Value must be used to calculate the correct pressure. Each sensor comes with a Sensitivity Value Label attached to signal conditioner. If the sensitivity label is destroyed or lost, the sensor can be calibrated. Refer to section 4 in this manual.

Diagnostic Output Signal: Connect between the Blue or Green wire and the Black wire. The diagnostics output signal is a DC Voltage, proportional to the LED current level, and indicates when the sensor is in or out of calibration. This voltage is typically in the 1.0 – 2.0 Volts range for all sensors and can vary from sensor to sensor. The LED current is continuously adjusted to compensate for the sensor electronics temperature fluctuations, fiber bending, or aging of the opto-electronic components (Optrand's patented auto-referencing technique). A diagnostic voltage greater than 2.5 Volts a faulty sensor. In dynamic operation the diagnostic wire does not require any connection unless the user wants to continuously monitor the sensor health.

The auto-referencing feature, uniquely available to Optrand sensors, is particularly useful in long term monitoring and control applications.

4. Static Pressure Calibration

The AutoPSI sensor can measure static pressure when the diagnostic (blue or green) wire is used as input instead of an output. If the diagnostic wire is connected through a potentiometer to ground the sensor will measure static pressure. This mode is useful for calibrating the sensor with a dead weight tester or other static pressure calibration technique. The two recommended procedures for static calibration of the AutoPSI sensor are as follows:

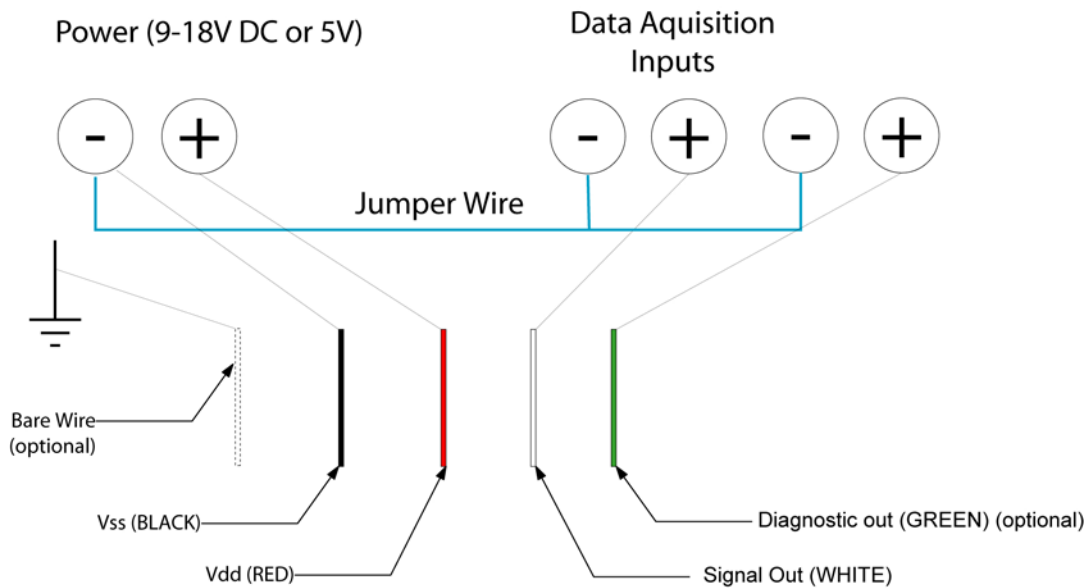
- 4.1 Install the sensor to the test instrument.
- 4.2 Apply power to the sensor.
- 4.3 Drive the diagnostic wire (blue or green wire) with a variable voltage source starting at zero volts.
- 4.4 Monitor the Sensor Output voltage (white wire) and adjust the voltage source (on the diagnostic) until the output signal drops to 0.52V. The output signal will be 5V with zero volts on diagnostic wire. The output voltage will decrease as the diagnostic voltage is increased.
- 4.5 Allow up to 10 minutes for the circuit to stabilize; some readjustment may be required.
- 4.6 Start the calibration process.
- 4.7 After the calibration is complete, remove pressure from the sensor. If the zero pressure output voltage is changed significantly, the circuit was not stabilized before calibration.

A second technique connects a potentiometer from the diagnostic wire (either blue or green) to ground. Steps 4.3 & 4.4 of the above procedure are as follows:

- 4.3 Connect a 2 kOhm twenty-turn potentiometer (or variable resistor) from the diagnostic wire (blue or green) to ground (black wire). Adjust the potentiometer to zero Ohms.
- 4.4 Monitor the sensor output voltage (white wire) and adjust the potentiometer until the output signal drops to 0.52V.

5. Connecting to Data Acquisition Equipment

If connections of Optrand Sensors to Data Acquisition System are not made correctly, noisy signals or damage to electronics may occur. All data acquisition systems require a ground reference whether the input signals are differential or single ended. This is often done with a resistor between the input signal ground and system or digital ground on the data acquisition card. National Instruments recommends a 100kOhm resistor for a ground reference. Other manufacturers of data acquisition cards may recommend other values, consult your user manual for optimum results. The ground for the power input is shared with the signal output so all DAQ inputs should have their negative terminal wired together.



To calculate the pressure from the sensors output voltage, the following formula should be used:

$$P = (V - V_{min}) / S$$

P= Pressure [psi]

V= Output voltage [V]

Vmin= Minimum output voltage [V]

S= Sensitivity[V/psi], please note sensitivity on sensor label is in mV/psi

Example:

Sensor sensitivity: 1.33 mV/psi (0.00133 V/psi)

Measured sensor output: 4.5 V

Measured sensor minimum voltage: 0.5 V

$$P = (4.5V - 0.5V) / 0.00133 \text{ V/psi} = 3007 \text{ psi (207 Bar)}$$

6. Sensor Model Numbering Guide

AutoPSI-A and AutoPSI-S Sensors

The 5V powered AutoPSI-A Sensor is identified with a Hxxxxx (i.e. H32394-Q) model number.

The 9-18 V powered AutoPSI Sensors are available as either and AutoPSI-S (standard) or AutoPSI-TC (temperature compensated) variants. The AutoPSI-S Sensor will always have a Cxxxxx (i.e. C32394-Q) model number and the AutoPSI-TC Sensors will always have a Dxxxxx (i.e. D32394-Q) model number.

Sensors with “-Q” Model Number Extension

Sensors with the "-Q" model number extension are suitable for all internal combustion applications: gasoline, natural gas or Diesel engines. All “-Q” sensors incorporate a flame-arresting/heat-shielding element inside the sensor housing. Example: C21294-Q

Sensors with “-GPA” Model Number Extensions

-GPA Sensors denote the PSIGlow-A sensor package which does not have glow plug functionality.

Sensors for Non-Combustion Applications

Sensors without the incorporated flame-arresting/heat-shielding element are suitable for non-combustion applications. Model numbers of all non-combustion sensors do not have the application-specific model number extensions.

PSIplug Mountable Sensors

The M3 sensors can be used for combustion applications, when mounted in the PSIplug - modified production spark plug.

Sensor Model Numbering Guide

Sensor Type	Pressure Range	Bandwidth	Length	Sensor Package	
(C) AutoPSI-S	(1) 0 – 7 bar (100 psi)	(1) 0.1 Hz-10 kHz	(1) 1m (3')	Thread Size	Pressure Sealing
(D) AutoPSI-TC	(2) 0 – 70 bar (1,000 psi)	(2) 0.1 Hz-20 kHz*	(2) 1.5m (5')*	(1) M8 x 1.0	(1) Conical Tip (118°)
(E) AutoPSI-HT	(3) 0 – 200 bar (3,000 psi)	(3) 0.1 Hz-30 kHz	(3) Custom	(2) 1/4-20	(2) Conical Tip (60°)
(F) AutoPSI-TC/HT	(4) 0 – 14 bar (200 psi)	(4) 0.1 Hz-70 kHz		(3) M7 x 0.75	(3) Shoulder, Washer
(H) AutoPSI-A	(5) 0 – 340 bar (5,000 psi)	(5) 10 Hz- 20 kHz		(5) M3.5 x 0.6	(4) Flange/Face
	(7) 0 – 700 bar (10,000 psi)			(6) M4.5 x 0.5	(5) O-ring
	(8) 0 – 100 bar (1,500 psi)			(7) 3/8-24	(6) Flange Washer
	(9) 0 – 2000 bar (30,000 psi)			(8) M10 x 1.0	(8) Taper Shoulder
				(9) M5 x 0.5	
				(A) 1/2-20	
				(B) 5/16-24	
				(C) M10x1.25	
			(D) M3x0.5		
			(E) M4x0.7		
			(G) 1/4-28		
			(H) M6x0.75		
			(J) M3x0.35		

Accessories/Series	Description
(A)	Armored Cable
(Q)	Integrated Flame Quencher
(GPA)	PSIglow Adapter (Non glowing)
(GP)	PSIglow Sensor (Integrated with glowing glow plug)
(SP)	Spark plug (PSIplug)

Example:

C	2	1	3	7	1
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Q	A	
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AutoPSI-S Sensor Type, 0-70 bar (1,000 psi) Pressure Range, Standard 0.1 Hz to 5 kHz Bandwidth, Custom 5m Fiber-Optic Cable Length, 3/8-24 Thread Size, Conical Tip (118°) Pressure Sealing , Integrated Flame Quencher, Armored Cable.

7. Notes on NEC Class 1, Div 2 Installations

Certain Optrand sensor models are UL Listed for use in NEC Class 1, Division 2 hazardous locations. Approved use requires that these models be properly installed using an Appleton Electric conduit connector, type TMCX118100. A current limit of 400mA at a potential limit of 18V is the maximum allowable on any wire without having special approval for the device from a safety regulatory organization such as UL for Class 1, Div 2 installations. Since each sensor draws approximately 85mA, the maximum number of sensors that can be powered from one power supply is four. We recommend using a 12V DC power source with a 0.4A fuse. Please contact Optrand if you need additional information.

8. PSIplug Installation Notes

Special care is required when installing the spark plug boot or ignition coil. Since the sensor can potentially sit very close to the ceramic, the boot may cause damage by prying the sensor off the spark plug. It may be necessary to remove some of the boot material prior to installing the sensor to allow clearance for the sensor and cable.

The sensor hex size is 9/64" (3.57mm) and should be installed using an appropriate miniature box wrench or miniature adjustable wrench. Although the torque specification is 10 in-lbs, a 1/3 turn from finger tight is appropriate to seal the sensor. The O-ring is designed for several uses only should be inspected after each removal of the sensor. If tears or cracks are found, the O-ring should be replaced. O-rings should be installed with care as not to damage them on the threads. Moistening the O-ring can also help in achieving a good fit inside the sensor adapter.

The spark plug and sensor assembly should be installed as a whole using an appropriate slotted socket. Sockets are available from Optrand or can be machined by the user. A user machined socket must have a slot to accommodate both the adapter on the plug and the sensor cable to prevent pinching of the cable between the plug well and outside of the socket (0.25" /6.5mm wide for the adapter and 0.125"/3.5mm wide for the cable).

Please contact Raph Wlodarczyk @ 734-451-3480 or sales@optrand.com if you have any questions regarding PSIplug installations.

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