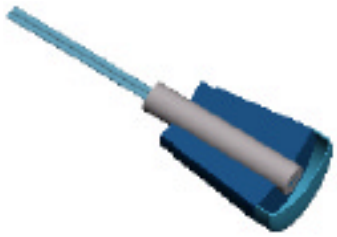
OPTRAND
INCORPORATED

Fiber Optic Sensors for Extreme Environments

High Temperature Miniature Pressure Sensors

www.optrand.com



OPTRAND Inc. specializes in the development and manufacturing of dynamic and static pressure sensors for continuous monitoring and control, as well as testing and diagnostic applications. The sealed-gauge sensors utilize multiple optical fibers positioned in front of a flexing metal diaphragm. The intensity of the reflected light is proportional to the pressure induced deflections of the diaphragm. The patented sensor head, diaphragm, and auto-referencing technique guarantee the long-term reliability required in OEM monitoring and control systems.

The long-life (up to 1 billion cycles), low-cost sensors are designed for continuous operation in harsh conditions of temperatures up to 300°C (570°F), combustion, high Electro-Mechanical and Radio Frequency Interference fields (EMI/RFI) and chemically volatile, explosive and radioactive environments. Sensors require neither water nor air-cooling and are available in a variety of pressure ranges and sensor packages. Miniature size, dielectric nature and resistance to high temperature make Optrand sensors ideal for integration with spark plugs (PSIplug and CALplug), glow plugs (PSIglow) and fuel injectors (PSIjet).

Targeted Applications

Optrand sensors address the needs of the following industries:

- Internal combustion engines:
  diesel, gasoline, natural gas and alternative fuels
- Natural Gas Compressors
- Marine
- Fuel Injection
- Plastic industry
- Avionics
- Nuclear

AutoPSI Dynamic Pressure Sensors

AutoPSI-S, AutoPSI-TC and AutoPSI-HT sensors eliminate the need for a separate signal conditioner by incorporating all electric and optoelectronic components into a small, rugged metal shell, permanently connected to a fiber-optic cable. These sensors offer an unprecedented service lifetime of 1 billion cycles and typical linearity of ±0.25% Full Scale Output. While the AutoPSI-S pressure detection sensitivity increases slightly with sensor housing temperature, the AutoPSI-TC is temperature compensated, matching the performance of water-cooled sensors. AutoPSI-HT sensors are equipped with a signal conditioner rated for use up to 125°C (260°F).

The AutoPSI sensors have been designed for OEM monitoring and control use, however, they also serve as a tool for testing and diagnostics. They are ideal for a number of internal combustion applications, for example: in-vehicle engine calibrations (mapping), engine knocking studies and peak pressure measurement and location. The transfer-pin free, fiber-optic sensing design makes these sensors resistant to damage caused by extreme knock. Other sensor uses include injection molding, compressor pressure monitoring, and non-combustion automotive applications such as fuel injection, braking, transmission and exhaust system pressure monitoring and control.

The AutoPSI sensors compensate for all major temperature effects encountered in internal combustion engines. 1. The auto-referencing circuitry corrects for the ambient temperature effects on the sensor's signal conditioner. 2. The sensor head materials and dimensions are optimized to compensate for mid-term thermal errors associated with engine load changes. 3. The specially shaped miniature diaphragm, as small as 1.5mm in diameter, results in minimal thermal shock and high accuracy at low pressures.

AutoPSI-DC Static Pressure Sensors

The AutoPSI-DC is designed for static and dynamic pressure measurements in harsh environments characterized by temperatures up to 300°C, high levels of EMI and RFI fields and chemically volatile media. The sensor targets applications in the plastic industry, specifically the monitoring of injection molding and extrusion, compressor pressure in natural gas pumping stations and all other applications where high temperature and long-life are concerns. Similar to the construction of AutoPSI dynamic pressure sensors, the AutoPSI-DC consists of a sensor head attached to a fiber-optic cable and terminated by a small signal conditioner. Current and variable voltage outputs are available.

PSIplug/CALplug

PSIplug and CALplug are non-intrusive combustion pressure indicating devices for spark-ignited engines utilizing modified production spark plugs. Since no modifications to the electrodes are necessary, the modified spark plug retains its original electrical and thermal properties. The PSIplug uses a detachable sensor which detects pressure through a passage linking the sensor diaphragm to the cylinder chamber. The CALplug utilizes a sensor which is flush mounted with the spark plug face and offers high accuracy pressure measurement at all engine speeds and operating conditions.

PSIglow

PSIglow combines a functional glow plug with an integrated miniature pressure sensor with the sensing diaphragm directly exposed to the combustion chamber without any connecting passages. PSIglow-A features a non-functioning glow plug adapter with a permanently mounted pressure sensor directly exposed to the combustion chamber and is available in all glow plug styles and dimensions.

SPECIFICATIONS

Dynamic Pressure Sensors

AutoPSI-S, AutoPSI-TC, and AutoPSI-HT sensors.

Overpressure	2x typical
Natural Frequency	>100 kHz
Pressure Media	Gaseous or liquid
Operating Temperature Range *Values for continuous operation, combustion temperatures acceptable.*	
Sensor Housing/Process:	-40 to 300°C (570°F)
Cable:	-40 to 200°C (390°F)
Interface Unit/Signal Conditioner:	-20°C to 65°C (150°F)
AutoPSI-HT:	-20°C to 125°C (260°F)
Non-linearity & Hysteresis *Full Scale Output*	
	±1% Combustion
	±0.5% Non-Combustion
	±0.25% Available
Temperature Coefficient Sensitivity	+0.03%/°C
AutoPSI-TC	±0.005%/°C
Interface Unit	
AutoPSI	Integrated with sensor
Frequency Response	0.1 Hz to 10 kHz
	0.1 Hz to 20 kHz
	1.0 Hz to 30 kHz
Power Supply	9 to 18 Vdc
Current	85 mA max 50 mA typical
Output Signal	0.5 to 5 V Analog 0 to 5 V Analog
Impedance (output)	250 Ohm
Diagnostic Signal	
AutoPSI	0 to 3.6 V
Wiring Scheme	
White	Output Signal
Green	Diagnostic Signal
Red	Power Supply
Black	Power Supply Ground
Bare	Case Ground
Vibration	100 g
Operational Mode	Sealed Gauge
Warranty	Intermittent Operation: 2 years.
	Continuous Operation: 3 years (Unlimited cycles). OEM: 5-10 years

Static Pressure Sensors

AutoPSI-DC sensors.

Overpressure	2x typical
Pressure Media	Gaseous or liquid
Operating Temperature Range *Values for continuous operation,*	
Sensor Housing/Processs:	-40 to 300°C (570°F)
Cable:	-40 to 200°C (390°F)
Interface Unit/Signal Conditioner:	-20 to 65°C (150°F)
Linearity *Full Scale*	±0.5%
Hysteresis *Full Scale*	0.2%
Repeatability *Full Scale*	0.2%
Thermal Zero Shift	
Sensor Housing/Process:	0.04%/°C (0.02%/°F)
Interface Unit/Signal Conditioner:	0.04%/°C (0.02%/°F)
Thermal Sensitivity Shift	0.04%/°C (0.02%/°F)
Frequency Response	0 to 1 kHz 0 to 5 kHz Available
Power Supply	13 to 28 Vdc
Current	120 mA max 60 mA typical
Power Loss Calibration Retention Time	1 hour
Output Signal	
Differential:	0 to 5 Vdc Analog 0 to 10 Vdc Analog 4 to 20 mA
Single Ended:	1 to 6 Vdc Analog 1 to 11 Vdc Analog

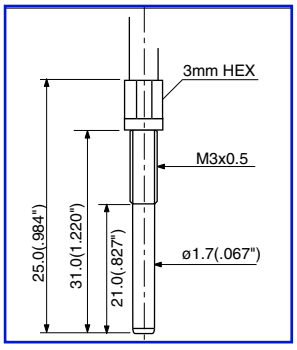
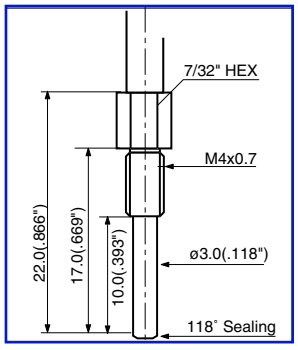
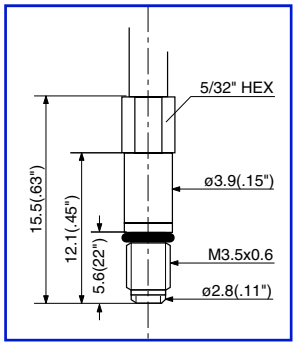
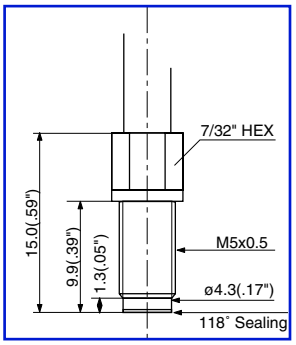
Reset/RCAL

Sensor outputs 80% of its Full Scale value when the Blue wire is connected to Ground. When disconnected, the sensor is reset, causing the output reading to be 0 psi.

Wiring Scheme	
White	Output High
Gray	Output Low
Blue	Reset/RCAL
Red	Input Power
Black	Ground
Output Impedance	250 Ohm
Vibration	100 g
Operational Mode	Sealed Gauge
Warranty	Intermittent Operation: 2 years.
	Continuous Operation: 3 years.
	5 years available for OEM applications.

Continuing development may necessitate specification changes without notice.

STANDARD SENSOR PACKAGES

Thread & Seal	 M3x0.5 Flange	 M4x0.7 118° Conical Tip	 M3.5x0.6 O-Ring	 M5x0.5 Flange/Face
Pressure Range	0 - 100 bar (1,500 psi) 0 - 200 bar (3,000 psi)	0 - 100 bar (1,500 psi) 0 - 200 bar (3,000 psi)	0 - 100 bar (1,500 psi) 0 - 200 bar (3,000 psi)	0 - 7 bar (100 psi) 0 - 14 bar (200 psi) 0 - 70 bar (1,000 psi) 0 - 100 bar (1,500 psi) 0 - 200 bar (3,000 psi) 0 - 340 bar (5,000 psi)
Features & Accessories	•Smallest diameter sensor (1.5/1.7mm) •Very low thermal shock •Miniature size allows installation where space is restricted. •Variable shaft lengths available. •No water cooling needed. •Steel or rubber cable.	•Front sealing design •Miniature size allows installation where space is restricted. •Very low thermal shock. •Variable shaft lengths available. •No water cooling needed. •Suitable for OEM applications. •Swivel nut - no cable twisting during installation.	•SP series sensor adapts to PSIplug. •Miniature size allows installation where space is restricted. •100 bar range makes it applicable to passenger car and small engine applications. •No water cooling needed. •Steel or rubber cable. •MW-532 Installation wrench. •MT-532 Slotted socket.	•SP series sensor adapts to PSIplug for use in heavy industrial engines without secondary port. •Industry standard M5x0.5 threaded pressure sensor. •Available with Ø3.8mm or Ø1.7mm diaphragm. •High-temp, long-life, uncooled, stand-alone, miniature size and high accuracy combustion pressure measurement.
Physical Dimensions				

Spark Plug Integrated Sensors

PRESSURE MEASURING SPARK PLUGS

PSIplug

Features

- PSIplug is a customer selected production spark plug modified to accept a detachable pressure sensor.
- Low cost solution for general engine development and testing.
- Spark plugs of all sizes can be modified, from M8 to M18 threads.
- Pressure ranges from 100 psi to 4000 psi fit small and large engines.
- Ideal for peak pressure measurement and location (LPP).
- O-ring max. Temperature 230°C (440°F)

Features

- CALplug is a customer selected production spark plug with a permanently mounted Ø1.7/1.5mm sensor.
- Flush mounted diaphragm eliminates channel resonance.
- Ideal for high speed engines (motorsports).
- Low thermal shock and high accuracy at low pressure.
- Available in temperature compensated version with total accuracy of 1-2% FSO.
- Available in 100 bar (1500 psi) and 200 bar (3000 psi) versions.

CALplug

STANDARD SENSOR PACKAGES

1/4-20 UNC Flange

0 - 7 bar (100 psi)
0 - 14 bar (200 psi)
0 - 70 bar (1,000 psi)
0 - 100 bar (1,500 psi)
0 - 200 bar (3,000 psi)
0 - 340 bar (5,000 psi)

- Small, durable, course threaded sensor with excellent thermal properties.
- High-temp, long-life and high accuracy pressure measurement.
- Non water-cooled, stand alone sensor in a miniature size.
- Steel, rubber or armored cable.

M7x0.75 Shoulder Washer

0 - 7 bar (100 psi)
0 - 14 bar (200 psi)
0 - 70 bar (1,000 psi)
0 - 100 bar (1,500 psi)
0 - 200 bar (3,000 psi)
0 - 340 bar (5,000 psi)

- Convenient rotating hex and thread allow easy installation/removal.
- English and metric thread sizes available.
- Available with Ø3.8mm or Ø1.7mm diaphragm.
- 7 to 200 bar pressure ranges fit a wide variety of applications.
- Many OEM custom sensors based on this small robust design.
- Lightweight, general purpose sensor.

3/8-24 UNF 118° Conical Tip

0 - 7 bar (100 psi)
0 - 14 bar (200 psi)
0 - 70 bar (1,000 psi)
0 - 100 bar (1,500 psi)
0 - 200 bar (3,000 psi)
0 - 340 bar (5,000 psi)

- Designed for rugged industrial use.
- High-temp and extreme lifetime meet continuous monitoring needs.
- Proven sensor in Natural Gas power cylinder applications.
- Short length and thread size allow installation in tight areas.
- English and metric thread sizes.
- Drill point angle front seal.
- Rubber or armored metal cable.
- ADP -DE, NG Diesel and Natural gas valve adapters.

M10x1.0 Shoulder Washer

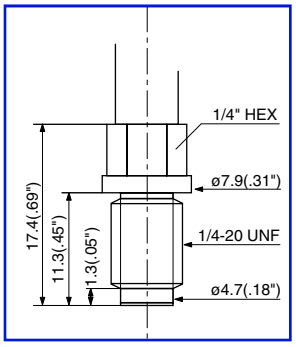
0 - 7 bar (100 psi)
0 - 14 bar (200 psi)
0 - 70 bar (1,000 psi)
0 - 100 bar (1,500 psi)
0 - 200 bar (3,000 psi)
0 - 340 bar (5,000 psi)

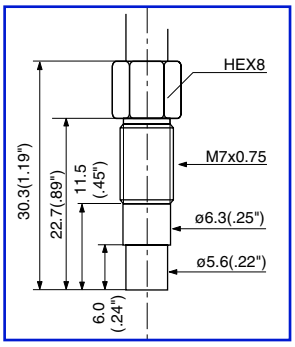
- Universal sensor package.
- Withstands engine knock.
- DC analog output for high data acquisition resolution.
- Durable general purpose sensor.
- English and metric thread sizes.
- Rubber or armored cable.

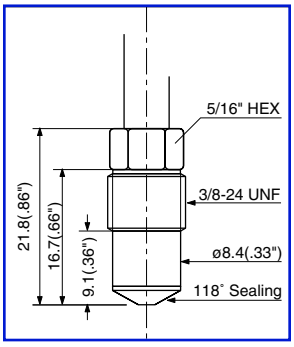
1/2-20 UNC Taper Shoulder

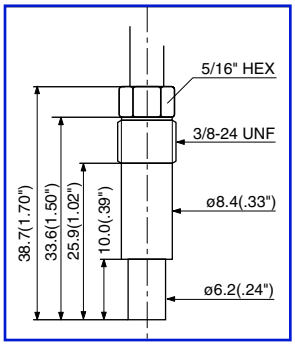
0 - 70 bar (1,000 psi)
0 - 100 bar (1,500 psi)
0 - 200 bar (3,000 psi)
0 - 340 bar (5,000 psi)
0 - 700 bar (10,000 psi)
0 - 2000 bar (30,000 psi)

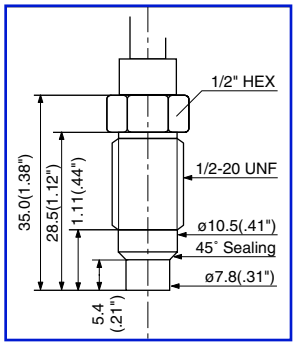
- Up to 2000 bar (30,000 psi) pressure range for fuel injection and hydraulic pressures.
- Available with copper insert for operation in Kiene/Thompson adapters.
- Flush mounted, flat diaphragm for critical mold surface integrity.
- Larger diaphragm and tapered sealing surface provide durable package.











Glow Plug Integrated Sensors

PSIglow-A

GLOW PLUG ADAPTER

Features

- PSIglow-A: Adapter that combines a customer selected, non-glowing glow plug with a cylinder pressure sensor.
- Miniature sensor is permanently mounted near the sealing area or in the glow plug tip.
- PSIglow: Fully functional glow plug permanently fitted with a 1.5mm or 1.7mm diameter sensor.
- PSIglow sensor diaphragm is located in the glow plug sealing surface.
- PSIglow/PSIglow-A are free from pressure measurement errors associated with long and narrow channels of alternative systems.

PSIglow

GLOW PLUG INTEGRATED SENSOR

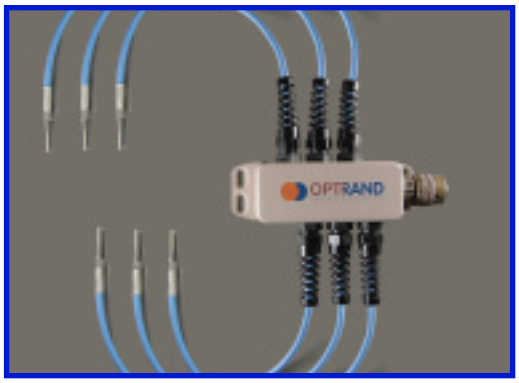
CUSTOM & OEM PACKAGES

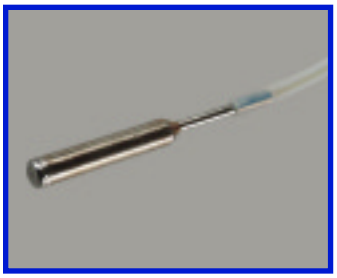
Industrial/Marine Packages

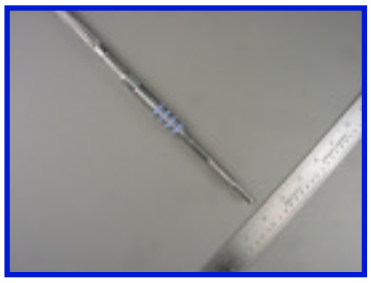
Optrand fiber optic sensors offer unique benefits for the monitoring and control of industrial and marine engines and compressors. For use in large-bore stationary and marine engines with external mounting adapters (Kiene, Thompson), ruggedized industrial sensor packages feature a sensor diaphragm resistant to fuel fouling, high adapter temperature, or detonation. Optrand sensors are UL listed for use in Class 1 Division 2 hazardous locations and are offered with the signal conditioner electronics mounted in explosion proof enclosures.

OEM Packages

Current Optrand product offering includes sensors targeting use in production engines. The AutoPSI-A sensor features miniature signal processing electronics mounted inside a modified 4 or 5 pin electrical connector. The AutoPSI-AO sensor system, which targets passenger car use, has multiple sensors permanently connected to the Sensor Processing Unit. The unit processes the sensor signals and transmits information to the engine's Electronics Control Unit (ECU) via a CAN bus connection. AutoPSI-AO sensors utilize a rotating nut eliminating problems associated with twisted sensor cables.







Miniature/Integrated Sensors

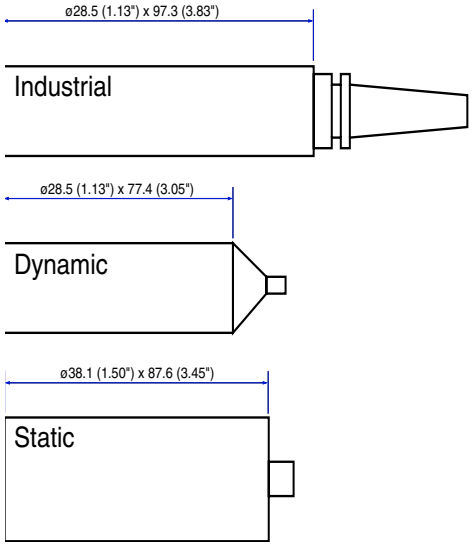
Optrand has developed a wide range of custom miniature and integrated sensor packages. The building block is the 1.7mm diameter, 5mm long sensor. For high performance applications where there is limited space for mounting in the engine head, slender packages several centimeters long are possible with thread sizes as small as M3x0.5. Integrated packages can be fitted into existing engine components, such as fuel injectors, without compromising functionality and reliability, or the need for major redesign.

A C C E S S O R I E S

AutoPSI Sensor Assembly

Consisting of permanently attached sensor housing, cable, and signal conditioner

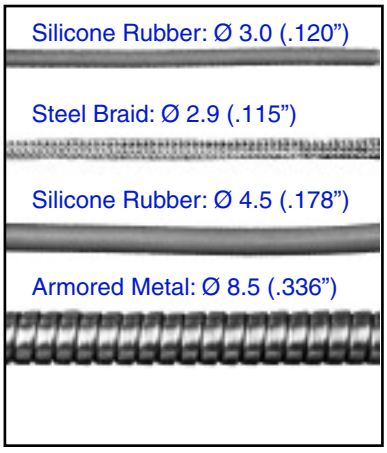
SIGNAL CONDITIONER: Dimensions



Signal Conditioner Features

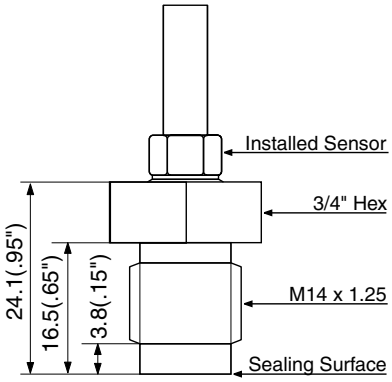
- Contains all electric and opto-electronic components.
- Housed in a rugged metal shell.
- Industrial package available with hermetic seal.
- Dynamic sensor has diagnostic output; can be used for static calibration.
- Operating Temperature Ranges: -20 to 65 or 125 [°C]

CABLE: Diameter



All cables not available with all sensors.

Adapters



Features and Applications

- Convenient indicator valve mounting for diesel and large bore natural gas cylinders.
- Standard mounting valves offered by KIENE Diesel Accessories Inc.
- Valve adapters provide intermittent or continuous use without removing sensor.
- Does not interrupt functions of valve. e.g. gas sampling, diesel start up procedures.
- Custom adapters allow Optrand sensors to fit nearly any current control or monitoring system.
- Integrated baffle for protection against high intensity knock.

AutoPSI Static Pressure Calibration Interface

D3.50" x W4.50" x H2.00"

Model	n = Voltage
SPCAL-n	(1) 110V AC
	(2) 220V AC
	(3) 240V AC

Features

- Interface Unit for calibration of AutoPSI dynamic pressure sensors with static pressure calibrator or dead weight tester.
- Can be used for short-term static pressure measurements.
- Single reset-button operation.
- Recommended as a excitation unit for AutoPSI dynamic pressure sensors to insure a clean power supply.
- AC wall plug adapter included.
- Interface output connector: BNC.

Installation Tools

Model	Description
MW-532	Wrench for 5/32" sensor package
MT-532	Slotted socket for 5/32" hex sensor package
MT-732	Slotted socket for 7/32" hex sensor package
MT-14	Slotted socket for 1/4" hex sensor package
MT-516	Slotted socket for 5/16" and 8mm hex sensor package
MT-16	Slotted socket for PSIplug, 5/8"(16mm hex)
MT-20	Slotted socket for PSIplug, 13/16"(20mm hex)
OR-55	10 Spare O-rings for 55 sensor package
OR-65	10 Spare O-rings for 65 sensor package
WS-94	10 Spare washers for 94 sensor package
WS-24	10 Spare washers for 24 sensor package
WS-33	10 Spare washers for 33 and B3 sensor package
WS-73	10 Spare washers for 73 and 83 sensor package
WS-ADPS	10 Spare washers for front seal steel adapters
OT-55	Installation kit for 55 sensor package and PSIplug Wrench, spark plug socket and 10 O-rings.
OT-65	Installation kit for 65 sensor package and PSIplug Wrench, spark plug socket and 10 O-rings.

Contact Optrand for specific dimensions or further installation assistance.

SENSOR MODEL NUMBERING GUIDE

Sensor Type
(C) AutoPSI-S
(D) AutoPSI-TC
(E) AutoPSI-HT
(F) AutoPSI-TC/HT
(G) AutoPSI-DC

Pressure Range
(1) 0 - 7 bar (100 psi)
(2) 0 - 70 bar (1,000 psi)
(3) 0 - 200 bar (3,000 psi)
(4) 0 - 14 bar (200 psi)
(5) 0 - 340 bar (5,000 psi)
(7) 0 - 700 bar (10,000 psi)
(8) 0 - 100 bar (1,500 psi)
(9) 0 - 2000 bar (30,000 psi)

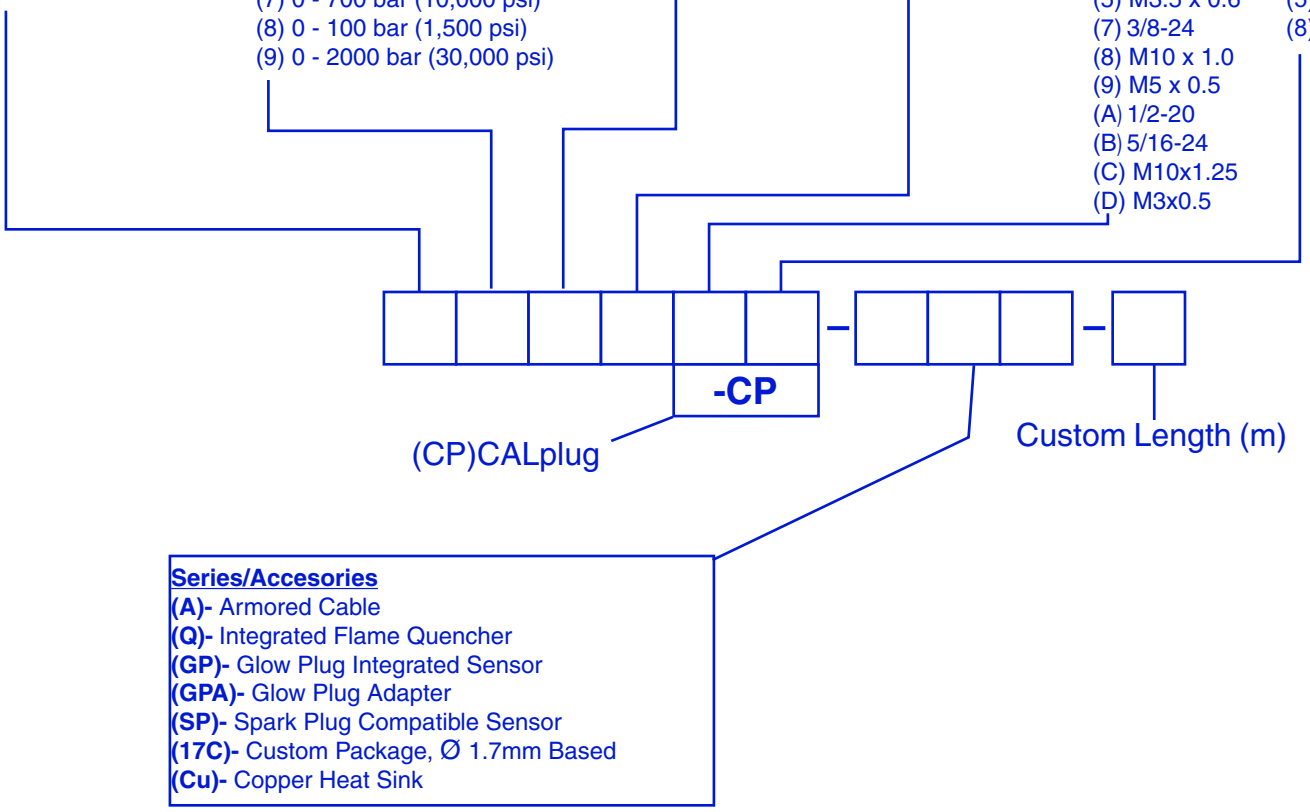
Bandwidth
(1) 0.1 Hz-10 kHz*
(2) 1.0 Hz-20 kHz
(3) 1.0 Hz-30 kHz

Length
(1) 1m (3')
(2) 2m (6.5')*
(3) Custom

Sensor Package

Thread Size
(1) M8 x 1.0
(2) 1/4-20
(3) M7 x 0.75
(4) 1/2 NPT
(5) M3.5 x 0.6
(7) 3/8-24
(8) M10 x 1.0
(9) M5 x 0.5
(A) 1/2-20
(B) 5/16-24
(C) M10x1.25
(D) M3x0.5

Pressure Sealing
(1) Conical Tip (118°)
(2) Conical Tip (60°)
(3) Shoulder, Washer
(4) Flange, Washer
(5) O-ring
(8) Shoulder, Taper



Series/Accesories
(A)- Armored Cable
(Q)- Integrated Flame Quencher
(GP)- Glow Plug Integrated Sensor
(GPA)- Glow Plug Adapter
(SP)- Spark Plug Compatible Sensor
(17C)- Custom Package, Ø 1.7mm Based
(Cu)- Copper Heat Sink

*Standard sensor values.
NL&H - Non-linearity & Hysteresis.
FSO - Full Scale Output.

Custom Packages Available
Pressure Range, NL&H, Cable Length, Frequency Range, and Sensor Package.

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