PPT89 General Purpose Digital Pressure Transducer

Digital I²C / SPI pressure & temperature sensing — stainless steel, -14.5 to 15,000 psi

FEATURES

- High pressure — -14.5 to 15,000 psi
- Operating temperature -40 to 125 °C (150 °C HT option)
- 1.5 ms response time
- ±1% FS accuracy · 0.25% linearity
- Digital output — SPI or I²C (address 0x28)
- Low power — <5 µA standby (Sleep Mode)
- IP65 standard, IP67 option
- Gauge, absolute, compound (vacuum) & sealed gauge

DESCRIPTION

The PPT89 is a digital (I²C, SPI) pressure and temperature transducer built for a high operating temperature range and the most challenging applications. The design also measures media temperature with fast response time. Stainless steel construction and high-temperature analog component selection let the sensor run where conventional transducers cannot.

The series uses MEMS piezoresistive sensors pressurized on the passive backside of the SS housing, giving superior long-term stability and accuracy. The result is simple, cost-effective, and reliable for OEM programs — contact us for custom designs.

APPLICATIONS

- Mil / aero
- Industrial automation
- HVAC systems
- Automotive engine
- Compressors
- Pneumatic systems

MAXIMUM ENVIRONMENTAL RATINGS

Operating Temperature	**-40 to 125 °C · -40-257 °F**	Proof Pressure	**1.5× full scale**
Storage Temperature	**-40 to 125 °C · -40-257 °F**	Burst Pressure	**2× full scale**
Ingress Protection	**IP65 – IP67**	Pressure Range	**-14.5 to 15,000 psi**

Digital output (SPI, I²C) — electrical & performance

V+ = 5 V, temperature = 25 °C unless otherwise noted.

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
Supply Voltage	VDD	2.7	5.0	5.5	V
Operating Temperature	Ts	-40	–	125	°C
Supply Current (1)	IDD	70	120	2500	µA
Sleep Mode Supply Current	Istdby	–	0.5	32	µA
Compensated Temperature	–	-40°C	–	85°C	°C
Accuracy	%FS	-1	–	+1	%FS
Linearity (2)	–	-0.25	–	+0.25	%FS
Temperature Error (3)	–	-1.5	0.5	1.5	°C
Response Time	tR	1	2	20	ms
Resolution	ADC	–	0.004	–	%FS
Temperature Resolution	–	–	0.05	–	%FS
Input Low Level	Vin_low	0	–	0.2	Vdd%
Input High Level	Vin_high	0.8	–	1	Vdd%
Output Low Level	Vo_low	–	–	0.1	Vdd%
Load Capacitance @ SDA (400 kHz)	Csda	–	–	200	pF
Pull-Up Resistor	RI2C_PU	–	4.7	–	kΩ
Input Capacitance (each pin)	CI2C_In	–	10	–	pF

Notes: 1) Measured at zero pressure. 2) Defined as best straight line. 3) Measured from 0 °C to 70 °C.

WIRING — FIG. 1

Electrical pin configuration — digital (SPI / I²C)

WIRE	FUNCTION
Red	V+ In
Black	GND
White	SDA / MISO
Brown / Yellow	SCL / SCLK
Green	INT / SS

Flying-lead pinout, digital (SPI / I²C) configuration. Standard cable length 24" (2 ft); specify custom lengths for OEM builds.

Package, media & installation

Package

The one-piece body is machined from stainless steel (SS316L) for easy manufacturability and long-term stability. The automotive-grade, vibration-proof design is suitable for engine-mount installation.

Stability

The silicon MEMS sensing element is media-isolated and hermetically sealed into the SS housing. Thermally matched materials reduce mechanical stress on the element, giving greater stability over time and temperature. Additional stability comes from factory stabilization of every sensor.

Pressure port

1/4"-18 NPT and 1/8"-18 NPT stainless steel threads are standard. Other fittings such as 7/16-20 UNF and 1/4" BSP are available for OEM customers.

Media

The pressure port tolerates most media including — but not limited to — oil, air, gas, some corrosive media, and salt water.

Wetted parts

When checking media compatibility, note that the wetted surface is composed of stainless steel (316) only.

Pressure ranges

Full range spans -14.5 to 15,000 psi in gauge, absolute, compound (vacuum), and sealed gauge references. Typical standard builds: 100, 1,000, and 15,000 psi. Custom ranges are available for OEM customers.

±0.15%	15,000	150 °C	<5 µA
FS accuracy	Max range psi	Max temp, HT option	Standby current

HIGH-TEMPERATURE OPTION (-HT)

The -HT build extends continuous operation to 150 °C through high-temperature analog component selection and the all-stainless housing — for automotive engine, compressor, and process applications beyond the 125 °C standard rating. Specify `-HT` as the final part-number field.

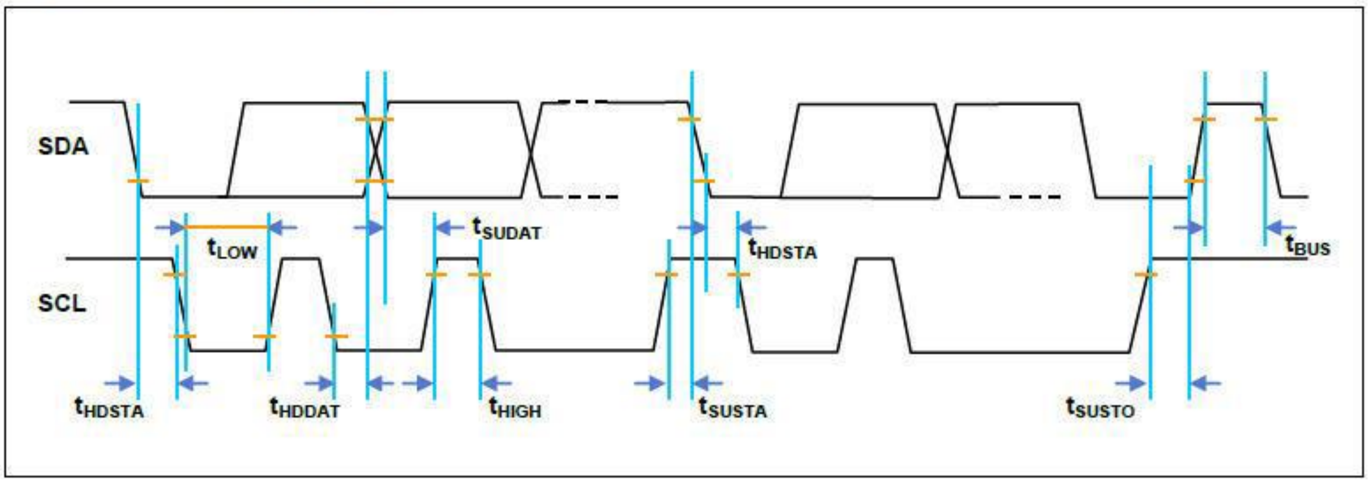
I²C & SPI communication

An internal DSP corrects the converted bridge signal and computes the temperature value for digital output. Two normal-operation modes are available — Update Rate Mode (continuous conversion at a selectable rate) and Sleep Mode (low power) — both over I²C or SPI, selected at the factory with SPI as the default. The on-board EEPROM holds calibration coefficients and configuration bits and is **locked at the factory**.

FIG. 2 · I²C

Timing diagram & bit rates

Figure 2.6 I²C™ Timing Diagram



(See section 3.1 for data transmission details.)

CLOCK SETTING	BIT RATES
4 MHz (factory set)	400 kHz or 100 kHz
1 MHz	100 kHz

TABLE 2.8 — I²C PARAMETERS f_{SCL} 100–400 kHz · t_{HDSTA} 0.1 μs min · t_{LOW} 0.6 μs min · t_{HIGH} 0.6 μs min · t_{SUSTA} 0.1 μs min · t_{HDDAT} 0 μs min · t_{SUDAT} 0.1 μs min · t_{SUSTO} 0.1 μs min · t_{BUS} 2 μs min. Combined low and high widths must equal or exceed the minimum SCL period.

PROTOCOL DIFFERENCES vs. STANDARD I²C 1) A start-stop condition with no CLK transitions in between causes a communication error on the next transfer; send an additional start condition to restore it. 2) A restart condition — a falling SDA edge during transmission while CLK is still high — has the same effect. 3) A falling SDA edge is not allowed between the start condition and the first rising SCL edge; with an address whose first bit is 0, hold SDA low through the first bit.

Read & write command reference

The sensor begins A/D conversions 10 ms after power-up — **do not issue any command during start-up** . With a 4 MHz clock and the EEPROM locked, the first corrected data is written to the digital interface within 6 ms of power-on. Operation afterward depends on whether the part was factory-programmed in Update Mode (data taken at a fixed, selectable rate) or Sleep Mode (waits for a master command before measuring).

COMMAND	BUS	MODE	ACTION & RETURNED DATA
Read_MR	I²C / SPI	Sleep	Wakes the part and runs a full measurement cycle — temperature, auto-zero, bridge — then DSP correction. I²C: slave address + READ bit, then master issues stop. SPI: drop SS low ≥8 µs and raise; the rise triggers the measurement.
Write_MR	I²C only	Sleep	Wakes the part and measures the bridge only, correcting with previously measured temperature and auto-zero values. Slave address + WRITE bit (0). A Read_DF is then required to fetch the result.
Read_DF2	I²C / SPI	Both	Two bytes of bridge data (2 status MSBs). Used when corrected temperature is not required.
Read_DF3	I²C / SPI	Both	Two bytes of bridge data plus one byte of temperature (8-bit accuracy). Master sends NACK + stop to terminate.
Read_DF4	I²C / SPI	Both	Four bytes: high/low bridge data plus the full corrected 11-bit temperature T[10:0]. The last 5 bits of the final byte are undetermined and must be masked in the application.
I²C WRITE	I²C only	Command	32-bit packet: address + WRITE, command byte, then a 16-bit data field. Command Mode only; supply all zeros when the command needs no data.

STATUS BITS & POLLING After a valid output is read, the status bits are set to "stale," so the application can read at any time and be assured the data is no older than the selected update period. Poll no faster than 20% above the update-rate period. In I²C mode the INT/SS pin acts as an interrupt — a rise signals new valid data is ready, removing the need to poll.

DATA VALIDITY AT POWER-ON Data is invalid from power-on reset until the first measured value is written to the digital register. An I²C Write_MR issued as the first command after power-on returns invalid data even though the status bits report "valid," because the correction uses uninitialized temperature and auto-zero values.

Half-duplex read interface & timing

SPI is read-only (half duplex) and cannot be used in the calibration Command Mode, which requires receiving commands. Speeds up to 800 kHz are supported in 4 MHz mode, 200 kHz in 1 MHz mode. MISO change is programmable for falling or rising edge; falling edge is the factory default. Data changes after the falling edge of SCLK — the master should sample MISO on the rise.

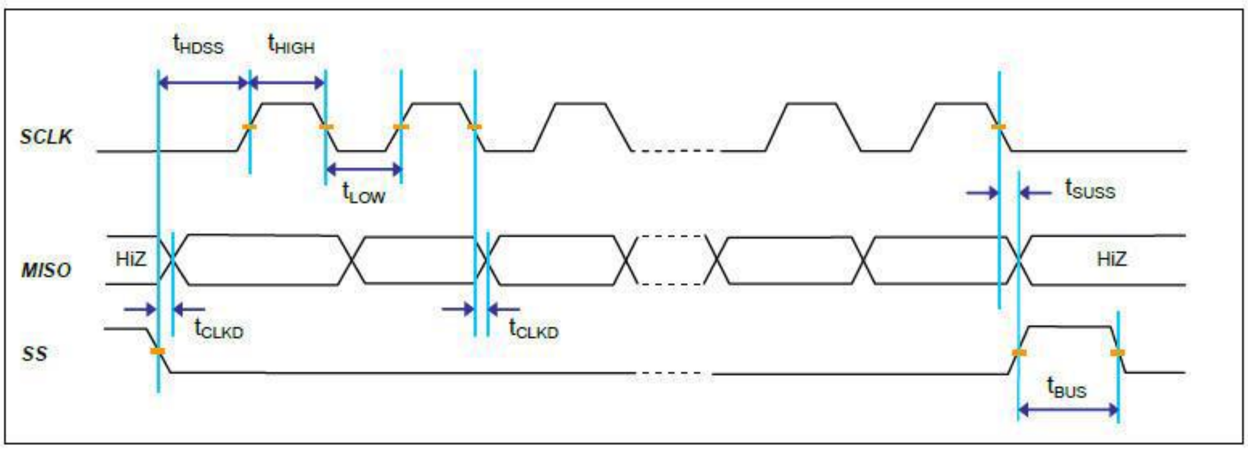
FIGURE 2.7 — SPI TIMING DIAGRAM

Table 2.9 SPI Parameters

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
SCLK clock frequency (4MHz clock)	f_{SCL}	50		800	kHz
SCLK clock frequency (1MHz clock)	f_{SCL}	50		200	kHz
SS drop to first clock edge	t_{HDSS}	2.5			µs
Minimum SCLK clock low width	t_{LOW}	0.6			µs[1]
Minimum SCLK clock high width	t_{HIGH}	0.6			µs[1]
Clock edge to data transition	t_{CLKD}	0		0.1	µs
Rise of SS relative to last clock edge	t_{SUSS}	0.1			µs
Bus free time between rise and fall of SS	t_{BUS}	2			µs

[1] *Combined low and high widths must equal or exceed minimum SCLK period.*

Figure 2.7 SPI Bus Data Output Timing



(See section 3.1 for data transmission details.)

CLOCK GENERATOR / POWER-ON RESET An internal 4 MHz temperature-compensated oscillator provides the time base for all operations, feeding a 4:1 post-scalar. Factory default is the 4 MHz core clock; 1 MHz can be factory-selected for better resolution where fast response is not required. Factory update rate is Update_Rate 00 (0.5 ms), adjustable by request — slower rates reduce power consumption.

SPI DATA PACKET The full output packet is 4 bytes: high bridge byte, low bridge byte, then 11 bits of corrected temperature T[10:0] — the T[10:3] byte followed by the {T[2:0], xxxxx} byte. The last 5 bits are undetermined and must be masked. Terminate after byte 2 for bridge value only, or after byte 3 for 8-bit temperature resolution.

Read & write packet formats

FIGURE 3.6 — I²C READ OPERATIONS

Figure 3.6 I²C™ Measurement Packet Reads

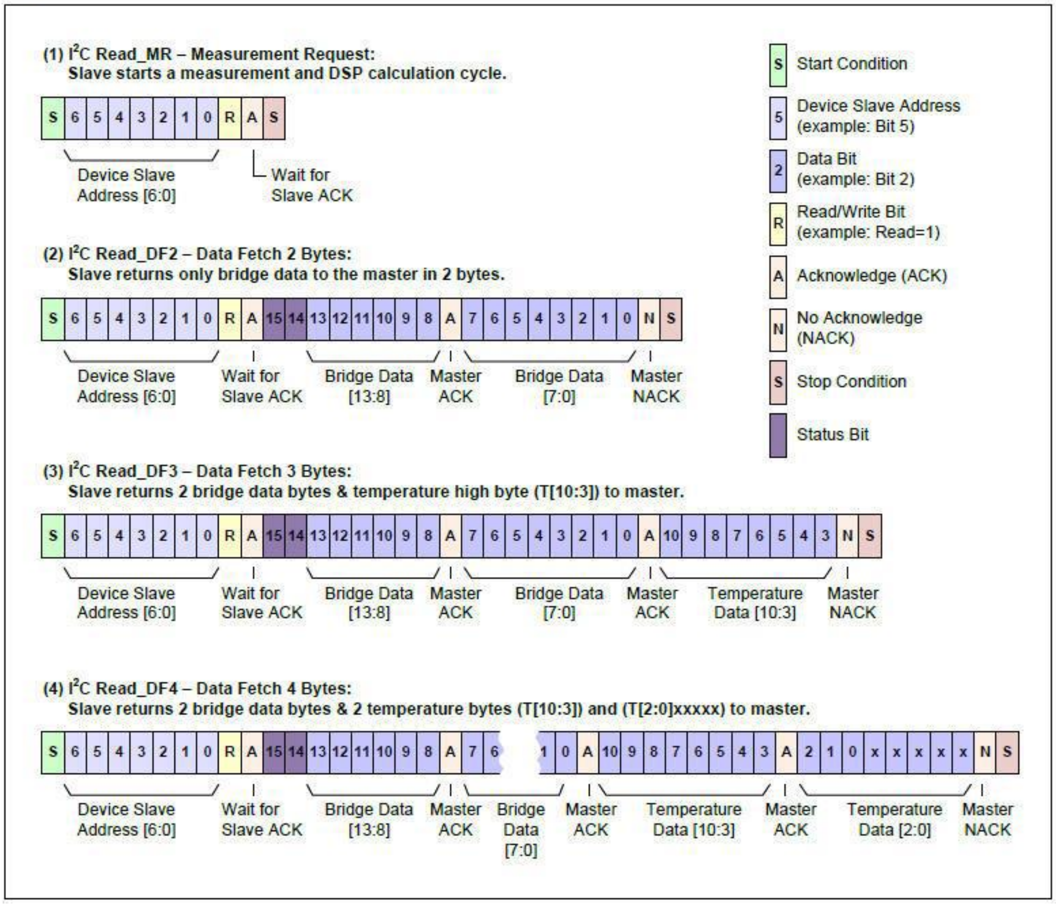
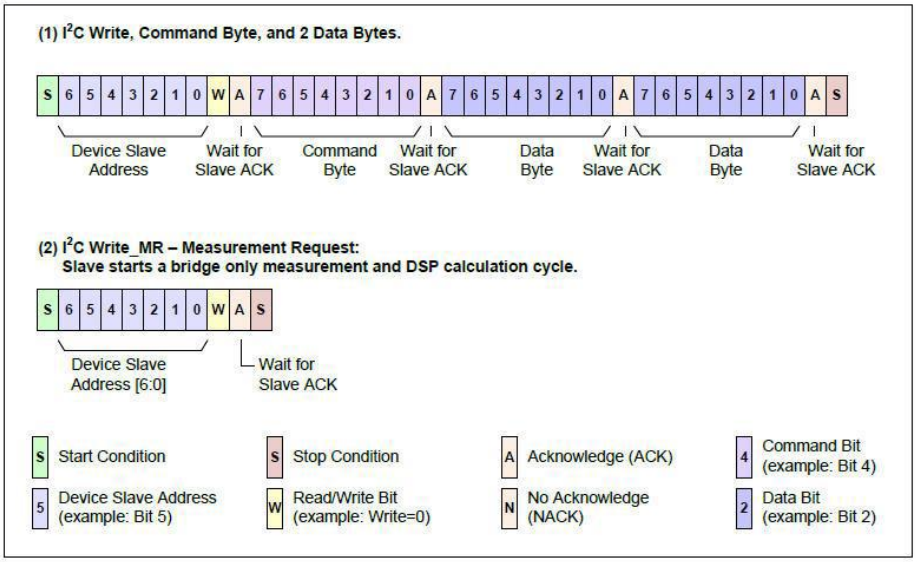


FIGURE 3.9 — I²C WRITE OPERATIONS

Figure 3.9 I²C™ Measurement Packet Writes



Outline drawings — inches

FIGURE 1 — IP67

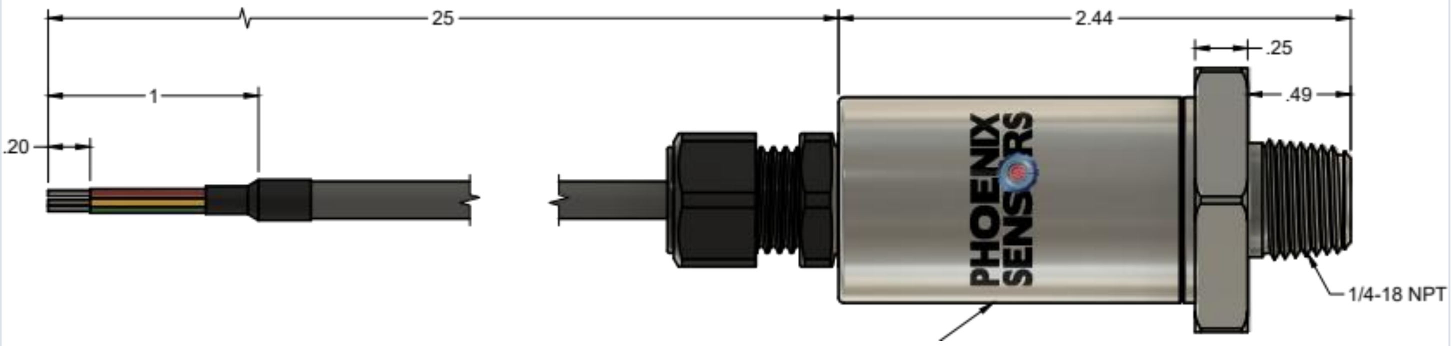
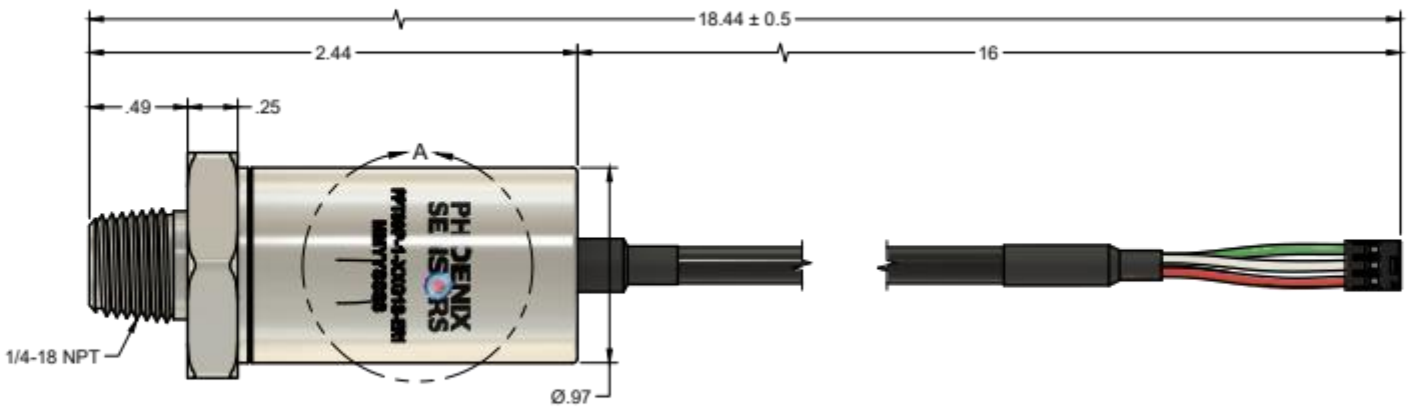


FIGURE 2 — IP65



FEATURE	DETAIL
Housing	One-piece stainless steel SS316L
Wetted parts	Stainless steel 316 only
Hex	7/8"
Process connections	1/4"-18 NPT · 1/8"-18 NPT · 7/16-20 UNF · 1/4" BSP
Electrical interface	Flying leads, 24" (2 ft) standard

NOTES 1) Standard cable length 24" (2 ft); specify custom length for OEM builds. 2) IP65 standard (Figure 2); IP67 available (Figure 1). 3) Dimensions in inches — consult factory for tolerances. 4) Automotive-grade, vibration-proof design suitable for engine mount.

CALCULATION FORMULAS
Pressure: Y = 130.07·X + 1638 (offset ±125 counts)
Temperature: Y = 10.3·X + 511 (25 °C = 768 counts)
Y = integer value (counts) · X = pressure (%FS) or temperature (°C)

Part-number configuration

PPT89	–	0	–	100	A	1	S	L	–	HT
MODEL		COMMS		RANGE	TYPE	PORT	IP RATING	POWER		HIGH TEMP

Model	Communication	Pressure range	Type	Port	Environmental rating	Power	High temp
PPT89	0 = SPI 1 = I²C (0x28)	-14.5 to 15,000 psi e.g. 50 = 50 psi 100 = 100 psi 15K = 15,000 psi	G = Gauge A = Absolute C = Compound S = Sealed Gauge	1 = 1/4"-18 NPT 2 = 1/8"-18 NPT 3 = 7/16-20 UNF 4 = 1/4" BSP	S = IP65 P = IP67	L = Low power (Sleep Mode) S = Standard (no Sleep Mode)	Blank = 125°C HT = 150 °C option

EXAMPLE PART NUMBERS

PART NUMBER	PRESSURE RANGE (PSI)	TYPE	MAX OVER PRESSURE
PPT89-0-50A1SL	50	Absolute	150
PPT89-0-100A1SL	100	Absolute	300
PPT89-1-300G2PL-HT	300	Gauge · IP67 · 150 °C	900

Configure your PPT89

Custom pressure ranges, port fittings, and cable lengths available for OEM volumes. Talk to an engineer to spec your part.

REQUEST A QUOTE
sales@phoenixsensors.com
(480) 462-1810