

PPT89M Miniature High Accuracy Digital Pressure Transducer

Ø0.5" × 1.5" one-piece stainless package · I²C or SPI · ±0.25% FS · to 500 PSI



FEATURES

- Miniature Ø0.5" × 1.5" one-piece SS316L body
- ±0.25% FS total error band (±0.15% typical)
- ±0.15% FS linearity · 5 ms response
- Digital output: I²C (0x28) or SPI
- Corrected pressure and media temperature
- Ranges to 500 PSI · gauge, absolute or sealed
- 2.7–5.5 VDC supply · <5 µA standby
- –40 to 125 °C operating temperature
- IP65 standard; IP67 option

MINIATURE

I²C / SPI

SS316L

DESCRIPTION

The PPT89M packs a high-accuracy digital pressure transducer into a Ø0.5" × 1.5" stainless steel body — small enough for handheld instruments, manifolds and densely packed OEM assemblies. A media-isolated MEMS piezoresistive element is welded into the one-piece SS316L housing for long-term stability.

An on-board DSP corrects for offset, span and temperature, then writes calibrated pressure and media temperature to an I²C or SPI register. A low-power Sleep Mode keeps standby current below 5 µA for battery-powered equipment.

APPLICATIONS

- Mil/Aero
- Industrial automation
- Portable & handheld instruments
- HVAC
- Automotive engine
- Compressors & pneumatics

MAXIMUM ENVIRONMENTAL RATINGS

Operating Temperature	–40 to 125 °C	Proof Pressure	1.5× full scale
Storage Temperature	–55 to 130 °C	Burst Pressure	3× full scale
Ingress Protection	IP65 – IP67	Pressure Range	Up to 500 PSI

Electrical & performance specifications

$V_{DD} = 5\text{ V}$, $T = 25\text{ }^{\circ}\text{C}$ unless noted

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
Supply voltage	V_{DD}	2.7	5.0	5.5	VDC
Supply current (active)	I_{DD}	—	—	5	mA
Supply current (standby)	I_{SL}	—	—	5	μA
Output – option 0 / 1	—	SPI, read-only / I ² C (0x28)			—
Pressure / temperature resolution	—	14-bit / 11-bit			—
Total error band	TEB	−0.25	±0.15	0.25	%FS
Linearity	±%FS	−0.15	—	0.15	%FS
Hysteresis	±%FS	−0.05	—	0.05	%FS
Repeatability	±%FS	−0.05	—	0.05	%FS
Temperature error	—	−1.5	—	1.5	%FS
Response time	t_R	—	5	—	ms
Compensated temperature	T_C	−20	—	85	$^{\circ}\text{C}$
Operating temperature	T_{OP}	−40	—	125	$^{\circ}\text{C}$
Pressure range	—	—	—	500	PSI

NOTES

Operation to 150 $^{\circ}\text{C}$ available on request. RS-485, RS-232 and Modbus interface options – consult factory.

Electrical connections

WIRE	I ² C	SPI
Red	VDD	VDD
Black	GND	GND
White	SDA	MISO
Yellow	SCL	SCLK
Green	INT	SS

Flying leads, 1 ft standard (specify length).

BUS NOTES

SDA and SCL require external pull-ups sized for the bus capacitance and selected bit rate. INT/SS is a data-ready interrupt in I²C mode and slave select in SPI mode.

Pin configuration

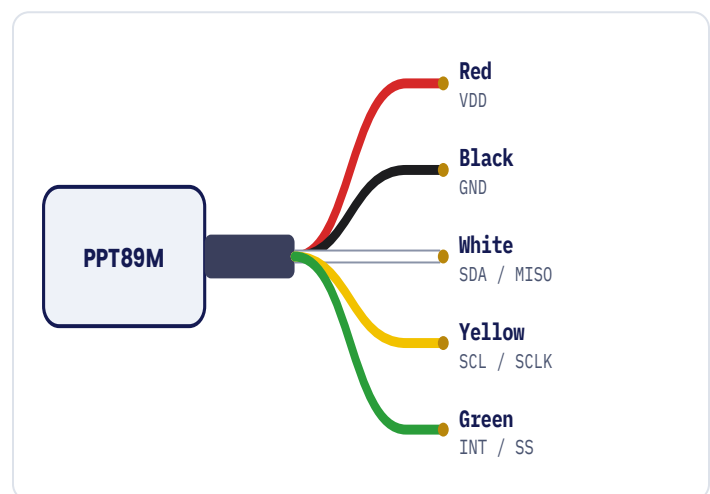


Fig. 1 – Flying-lead wiring.

Package, media & installation

Package

Miniature $\varnothing 0.5" \times 1.5"$ one-piece SS316L body (17-4PH on request) with flying-lead exit. IP65 standard; IP67 option.

Pressure ports

1/4" NPT, 1/8" NPT and 7/16-20 UNF; custom miniature fittings for OEM customers.

Pressure ranges

Standard ranges are 50, 100, 300 and 500 PSI — gauge, absolute or sealed gauge. Custom ranges available.

Bus integration

Keep bus runs short and terminate pull-ups close to the master. Specify the 1 MHz core clock or 100 kHz bit rate for long or noisy runs.

Stability

A media-isolated MEMS piezoresistive element, welded into the stainless housing. Material selection minimizes mounting stress; calibration is locked in EEPROM at the factory.

Media

Liquids, air and gases compatible with SS316L.

Temperature output

Corrected media temperature is returned with every 3- or 4-byte data fetch.

Power sequencing

Allow 10 ms after power-up before issuing any command; first corrected data is available within 6 ms at 4 MHz.

$\pm 0.25\%$

Total error band FS

$\varnothing 0.5"$

Body diameter

$< 5 \mu A$

Standby current

14-bit

Corrected pressure data

Digital interface — I²C & SPI

A digital signal processor conditions the converted bridge signal, applies temperature correction, and computes the corrected temperature value. Calibration coefficients and configuration bits — output mode, update rate, core clock, SPI polarity — are held in EEPROM, which is **locked at the factory**. Output protocol and timing are therefore fixed for a given PPT89M part number; specify them when ordering.

I²C interface

The PPT89M communicates over an addressable two-wire interface at slave address 0x28 (other addresses available on request). Commands are supported for starting a measurement in Sleep Mode and for reading data.

CORE CLOCK	SUPPORTED I ² C BIT RATES
4 MHz (factory default)	400 kHz or 100 kHz
1 MHz	100 kHz

SPI interface

SPI is half duplex and read-only — it cannot receive commands, so it is not available in the factory calibration environment. MISO data change may be programmed for the falling or rising edge of SCLK; falling edge is the factory default.

CORE CLOCK	MAXIMUM SCLK
4 MHz (factory default)	800 kHz
1 MHz	200 kHz

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 that can optionally source the digital core. The 4 MHz core clock is the factory default; where fast response and sampling are not required, the 1 MHz clock yields better overall resolution performance. Once the supply exceeds ≈1.9 V the reset de-asserts and the clock starts at the selected frequency; an on-chip regulator supplies the oscillator block to minimize drift with VDD.

Status bits — 2 MSBs of the output packet

BITS	DEFINITION
00	Normal operation — good data packet
01	Device in Command Mode
10	Stale data — already fetched since the last measurement cycle
11	Diagnostic condition exists (see page 7)

If a data fetch occurs before or during the first measurement after power-on reset, "stale" is returned but the data is invalid — the first measurement has not completed.

FACTORY CONFIGURATION DEFAULTS

Protocol: per part number · I²C address: 0x28 · Core clock: 4 MHz · Update_Rate 00 (0.5 ms period) · SPI polarity: falling edge · Operating mode: Update Mode
EEPROM is locked before shipment. Any change to protocol, address, clock, update rate, or mode must be specified at order time.

Bus parameters & timing

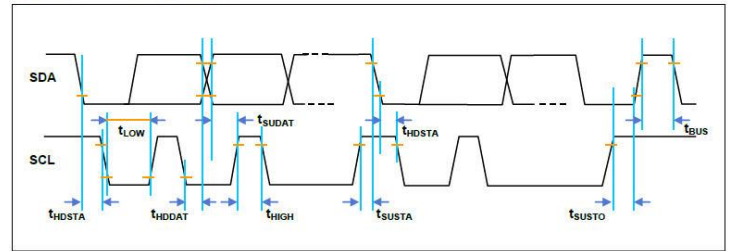
I ² C PARAMETER	SYM	MIN	MAX	UNIT
SCL clock frequency	f_{SCL}	100	400	kHz
Start condition hold time to SCL edge	t_{HSDTA}	0.1	—	μ s
Minimum SCL low width	t_{LOW}	0.6	—	μ s
Minimum SCL high width	t_{HIGH}	0.6	—	μ s
Start condition setup to SCL edge	t_{SUSTA}	0.1	—	μ s
Data hold time on SDA	t_{HDDAT}	0	—	μ s
Data setup time on SDA	t_{SUDAT}	0.1	—	μ s
Stop condition setup time on SCL	t_{SUSTO}	0.1	—	μ s
Bus free time, stop to start	t_{BUS}	2	—	μ s

SPI PARAMETER	SYM	MIN	MAX	UNIT
SCLK frequency — 4 MHz core	f_{SCL}	50	800	kHz
SCLK frequency — 1 MHz core	f_{SCL}	50	200	kHz
SS drop to first clock edge	t_{HDSS}	2.5	—	μ s
Minimum SCLK low width	t_{LOW}	0.6	—	μ s
Minimum SCLK high width	t_{HIGH}	0.6	—	μ s
Clock edge to data transition	t_{CLKD}	0	0.1	μ s
SS rise relative to last clock edge	t_{SUSS}	0.1	—	μ s
Bus free time between SS rise and fall	t_{BUS}	2	—	μ s

THREE DEVIATIONS FROM STANDARD I²C

- 1) A start-stop condition sent with no CLK transitions in between causes the next communication to fail, even if its start condition is correct; an additional start condition restores proper communication.
- 2) A restart condition — a falling SDA edge during data transmission while CLK is still high — creates the same failure and likewise requires an additional start condition.
- 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 from the start condition through the first bit.

Figure 2.6 I²C™ Timing Diagram



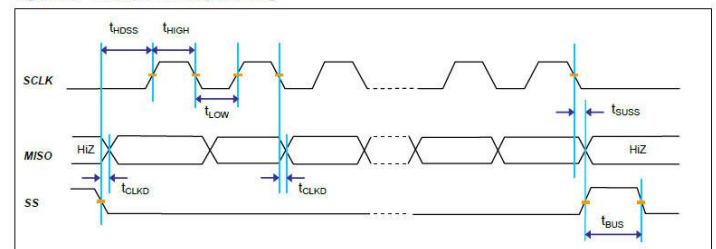
(See section 3.1 for data transmission details.)

Fig. 2 – I²C timing diagram. Combined SCL low and high widths must equal or exceed the minimum SCL period.

Rise of SS relative to last clock edge	t_{SUSS}	0.1		μ s
Bus free time between rise and fall of SS	t_{BUS}	2		μ s

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.)

Fig. 3 – SPI bus data output timing, falling-edge polarity (factory default).

Operating modes & update rates

Conversions begin 10 ms after power-up — **do not issue any command during this start-up window**. With a 4 MHz clock and locked EEPROM, the first corrected value is written to the digital output register within 6 ms of power-on. Operation thereafter depends on whether the PPT89M is factory-programmed for Update Mode or Sleep Mode.

Update Mode

The digital core measures and corrects continuously at the selected update rate and refreshes the I²C/SPI output register. Between conversions the part powers down — slower update rates therefore save power. Temperature and auto-zero are measured periodically as special measurements; the update period lengthens by one conversion time when a special measurement occurs. The host reads the register at any time with a Read_DF and is assured data no older than the selected update period.

Sleep Mode

After the command window the part powers down and waits. A Read_MR (I²C or SPI) or Write_MR (I²C) wakes it and starts a measurement cycle: Read_MR runs temperature, auto-zero, and bridge measurements; Write_MR measures the bridge only and corrects using previously stored temperature and auto-zero data. The host then issues a Read_DF to fetch the result without waking the part again.

Figure 3.2 Power-Up Sequence and Timing for Update Mode with EEPROM Locked™

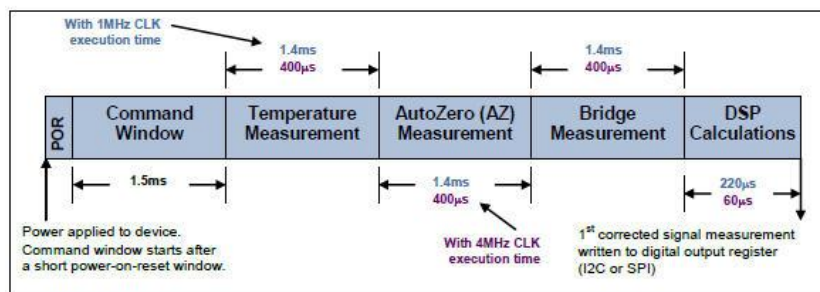


Fig. 4 – Power-up sequence and timing, Update Mode with EEPROM locked. When EEPROM is unlocked the command window is 4.5 ms longer (6 ms). Values are typical.

Update rate settings

UPDATE_RATE	PERIOD · 1 MHz	PERIOD · 4 MHz	CYCLES BETWEEN SPECIAL MEASUREMENTS
00 (default)	1.6 ms	0.5 ms	255
01	5.0 ms	1.5 ms	127
10	25.0 ms	6.5 ms	31
11	125.0 ms	32.0 ms	15

Normal integration mode. Typical values — multiply by 1.15 for worst case. At Update_Rate 00 there is no power-down period between measurements.

Sleep Mode response

REQUEST	1 MHz	4 MHz
Read_MR	4.5 ms	1.5 ms
Write_MR	1.5 ms	0.5 ms

POLLING & INT PIN

Poll no faster than 20% beyond the update period or Sleep Mode response time. In I²C mode the INT/SS pin acts as a data-ready interrupt — watch for its rise instead of polling.

Commands, data packets & conversion

Figure 3.6 I²C™ Measurement Packet Reads

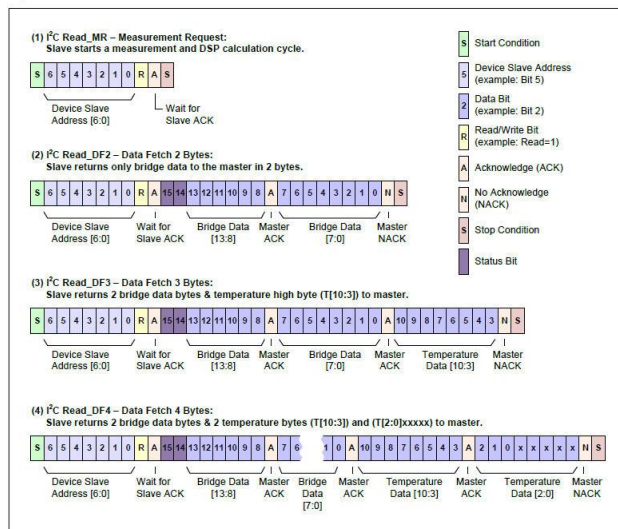


Fig. 5 – I²C measurement packet reads. The master sends the 7-bit slave address with the 8th bit = 1; the device ACKs and returns 2, 3, or 4 bytes depending on when the master sends NACK + stop.

Diagnostics

A diagnostic state is signalled when the two status MSBs read 11: invalid EEPROM signature, bridge input short, loss of bridge positive or negative, or loss of bridge source or sink. EEPROM contents are protected by a 16-bit signature re-checked at every power-on reset, and comparators verify the bridge inputs stay within 0.15-VDD to 0.85-VDD during all conversions.

COMMAND	RETURNS / ACTION	BUS
Read_MR	Wakes the part in Sleep Mode, starts a full measurement cycle	I ² C SPI
Read_DF2	2 bytes – bridge data + 2 status MSBs	I ² C SPI
Read_DF3	3 bytes – bridge data + 8-bit temperature	I ² C SPI
Read_DF4	4 bytes – bridge + 11-bit temperature (mask last 5 bits)	I ² C SPI
Write_MR	Bridge-only measurement using stored temp / auto-zero	I ² C
Command write	32-bit calibration packet – EEPROM factory locked	I ² C

Figure 3.8 SPI Output Packet with Falling Edge SPI Polarity

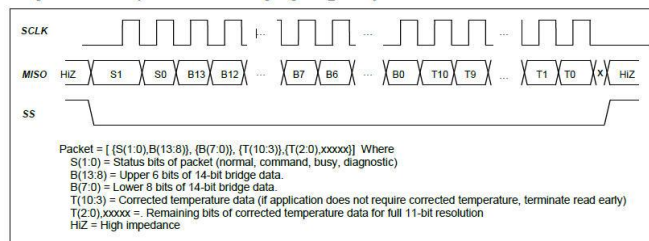


Fig. 6 – SPI output packet, falling-edge polarity. Terminate after byte 2 for pressure only, or byte 3 for 8-bit temperature.

Faults are detected in the next measurement cycle and reported in the following data fetch. Status bits will not clear until the cause is corrected **and** a power-on reset is performed.

FULL PROTOCOL REFERENCE

Command byte definitions, the EEPROM register map, Command Mode calibration sequences and long-integration timing are in the Phoenix Sensors Digital Communication Manual – available on request. Pressure and temperature conversion is on page 8.

Data conversion — pressure & temperature

Corrected pressure is returned as a 14-bit count and corrected temperature as an 11-bit count. The output is calibrated so 10% and 90% of the 14-bit span correspond to 0% and 100% of the PPT89M full-scale pressure range.

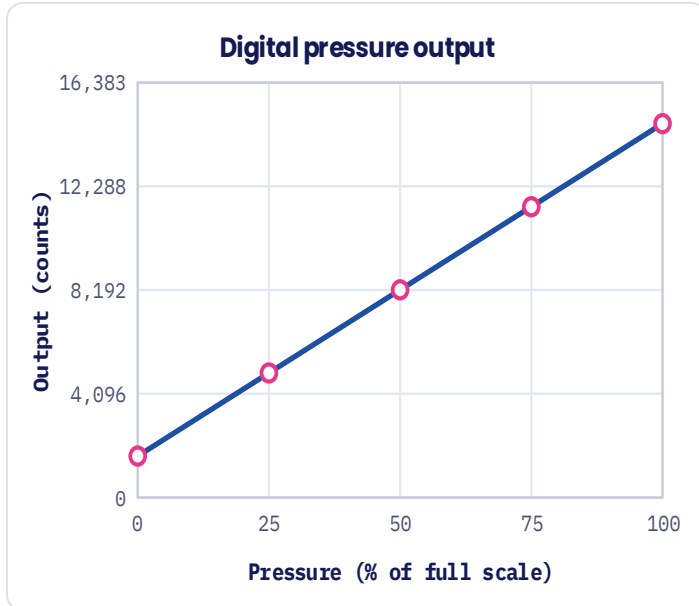


Fig. 7 – Pressure output counts vs. % of full scale.

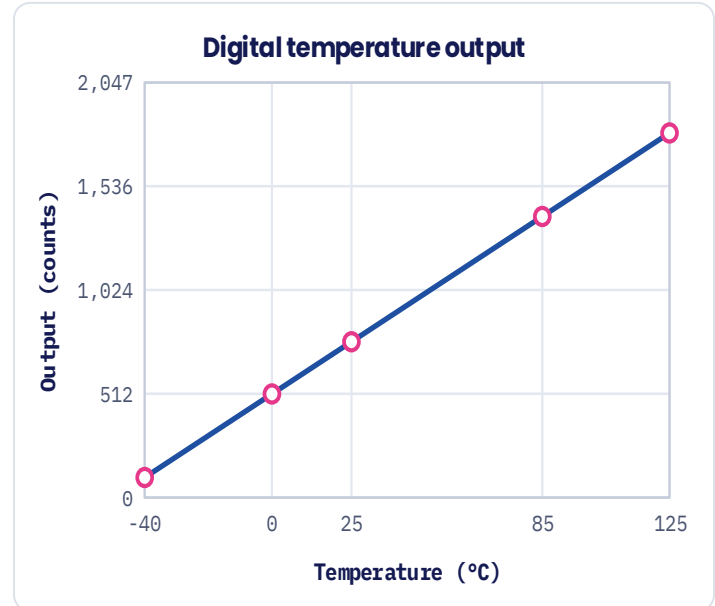


Fig. 8 – Temperature output counts vs. temperature.

Pressure counts

PRESSURE	COUNTS (DEC)	COUNTS (HEX)
0%	1,638	0x0666
25%	4,919	0x1337
50%	8,201	0x2009
75%	11,482	0x2CDA
100%	14,763	0x39AB

Temperature counts

TEMPERATURE	COUNTS (DEC)	COUNTS (HEX)
-40 °C	99	0x063
0 °C	511	0x1FF
25 °C	769	0x301
85 °C	1,387	0x56B
125 °C	1,799	0x707

CALCULATION FORMULAS

Pressure counts: $Y = 131.25 \cdot X + 1638$ (offset ± 125 counts) – X = pressure in % FS

Pressure from counts: $X = (Y - 1638) / 131.25 \rightarrow P = P_{MIN} + (P_{MAX} - P_{MIN}) \cdot X / 100$

Temperature counts: $Y = 10.3 \cdot T + 511$ (25 °C $\approx$ 768 counts) – T in °C

Temperature from counts: $T = (Y - 511) / 10.3$

Mechanical dimensions – inches [mm]

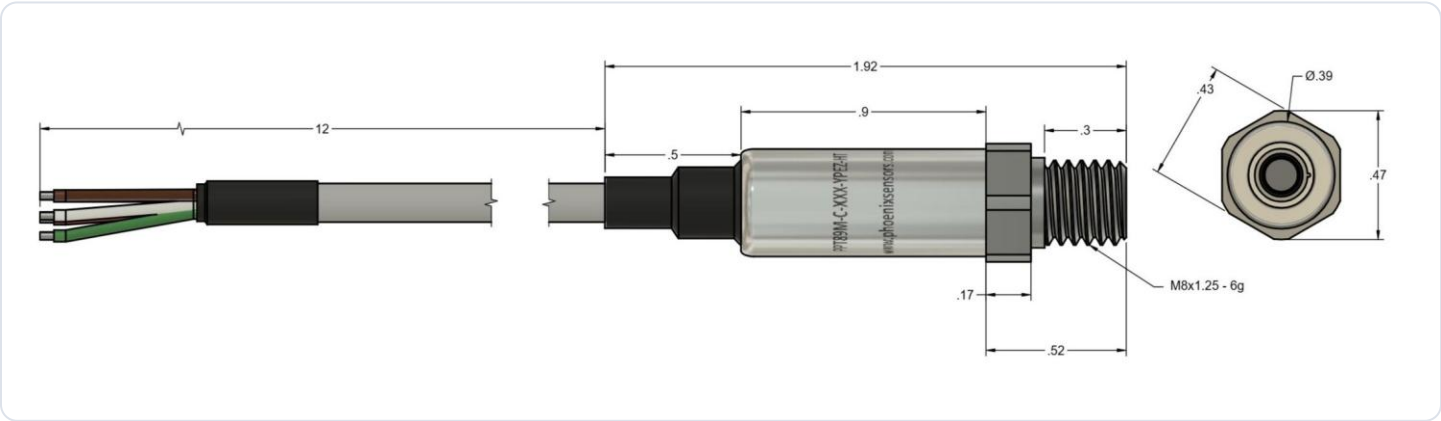


Fig. 9 – PPT89M outline, M8x1.25-6g port (drawing PPT89M-C-XXX-YPEZ-HT).

Key dimensions

FEATURE	VALUE
Body diameter	Ø0.39 [9.9]
Hex	0.43 [10.9]
Body length	0.90 [22.9]
Overall length (excl. leads)	1.92 [48.8]
Thread length, M8x1.25	0.30 [7.6]
Lead length (std)	12 [305]

Construction

Body / port	One-piece SS316L (17-4PH opt.)
Electrical	5-wire flying leads
Sealing	IP65 · IP67 option

Ordering information — part-number configuration

PPT89M	—	1	—	50	G	1	S	L	—	5FT
MODEL		OUTPUT		RANGE	TYPE	PORT	IP	POWER		CABLE

OUTPUT		RANGE (PSI)		TYPE		PORT	
0	SPI	50	50	G	Gauge	1	1/4" NPT
1	I ² C (0x28)	100	100	A	Absolute	2	1/8" NPT
2 / 3 / 4	RS-485 / RS-232 / Modbus	300	300	S	Sealed gauge	3	7/16-20 UNF
		500	500			4	Custom

IP RATING		POWER		CABLE	
S	IP65	—	Update mode	IFT...	Flying-lead length
P	IP67	L	Low power (Sleep)		

SPECIFY WITH YOUR ORDER — FACTORY-LOCKED SETTINGS

Core clock (4 MHz / 1 MHz) · Update_Rate · Operating mode (Update / Sleep) · I²C address if other than 0x28 · SPI polarity (falling default / rising).

EXAMPLES

PPT89M-1-50G1SL-5FT → I²C · 0-50 PSI gauge · 1/4" NPT · IP65 · low power · 5 ft leads

PPT89M-0-300A3P-1FT → SPI · 0-300 PSI absolute · 7/16-20 UNF · IP67 · update mode · 1 ft leads

Configure your PPT89M

REQUEST A QUOTE

Custom ranges, fittings, interfaces and lead lengths are available for OEM volumes. Talk to an engineer to spec your part. sales@phoenixsensors.com
(480) 462-1810

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