PPT87 Digital High Temperature Pressure Transducer

-40 to 150 °C pressure and media temperature over I²C / SPI — 50 to 20,000 PSI

FEATURES

- High-temperature operation — -40 to 150 °C
- Standard accuracy ±1.0% FS
- 50 to 20,000 PSI, absolute or gauge
- Digital output — SPI or I²C (0x28)
- Media isolated — SS316 housing
- Unique 9/16-18 UNF-3A autoclave port option
- Flying leads (24 AWG, 150 °C), Molex, or M12 connector
- 1.5 ms response time
- Low power (<5 µA stand-by) · IP65 / IP67

DESCRIPTION

The PPT87 is a digital (I²C, SPI) pressure and temperature transducer built for a high operating temperature range and the most challenging applications. Its design measures media temperature with fast response time. The stainless steel construction and high-temperature component selection make it suitable for high-temperature industrial and commercial use.

MEMS piezoresistive sensors, pressurized on the passive backside of the stainless housing, deliver superior long-term stability and accuracy (0.25% linearity). The design is simple, cost-effective, and proven reliable for OEM customers — contact us for custom designs.

APPLICATIONS

- Mil / Aero
- Industrial automation
- HVAC
- Automotive engine
- Compressors
- Pneumatic systems
- Harsh liquid, air & gas media

MAXIMUM ENVIRONMENTAL RATINGS

Operating Temperature	**-40 to 150 °C · -40–302 °F**	Proof Pressure	**3× full scale**
Storage Temperature	**-55 to 130 °C · -67–266 °F**	Burst Pressure	**5× full scale**
Ingress Protection	**IP65 – IP67**	Pressure Range	**50 to 20,000 PSI**

Electrical & performance specifications

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

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
Supply voltage	VDD	2.7	5	5.5	V
Supply current (note 1)	IDD	70	120	2500	µA
Sleep mode supply current	Istdby	—	0.5	32	µA
Accuracy — total error band	—	-1.0	—	+1.0	%FS
Temperature error (note 3)	—	-1.5	0.5	1.5	°C
Response time	tR	1	2	20	ms
ADC resolution	ADC	—	0.004	—	%FS
Temperature resolution	—	—	0.05	—	%FS
Operating temperature	Ts	-40	—	150	°C
Pressure range	—	50	—	20,000	PSI
Proof pressure	—	—	3×	—	FS
Burst pressure	—	—	5×	—	FS

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

I²C & SPI interface

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
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

Electrical connections

PIN	WIRE	I²C	SPI
P1	Red	VIN	VIN
P2	Black	GND	GND
P3	Yellow	SCL	SCLK
P4	White	SDA	MISO
P5	Green	INT	SS

BUS NOTES

Pin numbers apply to the Molex 502578-0500 and M12 connectors. SDA and SCL require external pull-ups (4.7 kΩ typ). INT/SS is a data-ready interrupt in I²C mode and slave select in SPI mode.

Package, media & installation

Package

The one-piece body is stainless steel (SS316L), for easy manufacturability and long-term stability. An automotive-grade, vibration-proof design suits engine mounting. Electrical options: 24 AWG, 150 °C flying leads with cord grip, a Molex 502578-0500 connector, or an M12 connector.

Stability

The silicon MEMS pressure element is media isolated and hermetically sealed into the stainless housing. Thermally compatible materials reduce mechanical stress on the sensor for greater stability over time and temperature. Every sensor also undergoes factory stabilization.

Pressure port

Standard ports: 1/4" male NPT, 1/8" male NPT, 7/16-20 UNF-3A, and 9/16-18 UNF-3A autoclave for high-pressure service. Custom fittings are available for OEM customers.

Media

Tolerant of most media, including oil, air, gas, some corrosive media, and salt water.

Wetted parts

The wetted surface is stainless steel (316) only.

Pressure ranges

50 PSI to 20,000 PSI, absolute and gauge. Custom pressure ranges are available for OEM customers.

Bus integration

Keep bus runs short and terminate pull-ups close to the master. Where cable length or noise is a concern, specify the 1 MHz core clock for improved resolution, or the 100 kHz I²C bit rate.

Power sequencing

Allow 10 ms after power-up before issuing any command; the first corrected data is written to the digital register within 6 ms of power-on with a 4 MHz clock and locked EEPROM.

±1.0%	20,000	1.5 ms	150 °C
Standard accuracy FS	Max range PSI	Response time	Max operating temperature

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 part number; specify them when ordering.

I²C interface

The device 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 I²C 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

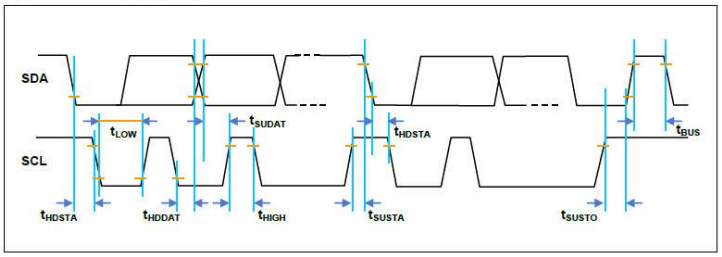
Protocol: SPI · I²C address: 0x28 · Core clock: 4 MHz · Update_Rate 00 (0.5 ms period) · SPI polarity: falling edge · Operating mode: Update Mode

EEPROM is locked before shipment. Any change to protocol, address, clock, update rate, or mode must be specified at order time.

Bus parameters & timing

I²C PARAMETER	SYM	MIN	MAX	UNIT
SCL clock frequency	f_{SCL}	100	400	kHz
Start condition hold time to SCL edge	t_{HDSTA}	0.1	–	µs
Minimum SCL low width	t_{LOW}	0.6	–	µs
Minimum SCL high width	t_{HIGH}	0.6	–	µs
Start condition setup to SCL edge	t_{SUSTA}	0.1	–	µs
Data hold time on SDA	t_{HDDAT}	0	–	µs
Data setup time on SDA	t_{SUDAT}	0.1	–	µs
Stop condition setup time on SCL	t_{SUSTO}	0.1	–	µs
Bus free time, stop to start	t_{BUS}	2	–	µs

Figure 2.6 I²C™ Timing Diagram



(See section 3.1 for data transmission details.)

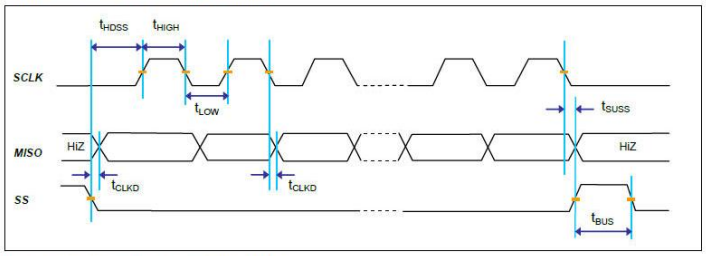
Fig. 2 — I²C timing diagram. Combined SCL low and high widths must equal or exceed the minimum SCL period.

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	–	µs
Minimum SCLK low width	t_{LOW}	0.6	–	µs
Minimum SCLK high width	t_{HIGH}	0.6	–	µs
Clock edge to data transition	t_{CLKD}	0	0.1	µs
SS rise relative to last clock edge	t_{SUSS}	0.1	–	µs
Bus free time between SS rise and fall	t_{BUS}	2	–	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.)

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

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.

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 part 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 slower-moving quantities, measured periodically as special measurements; the update period lengthens by one conversion time when a special measurement occurs. The host simply 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 **

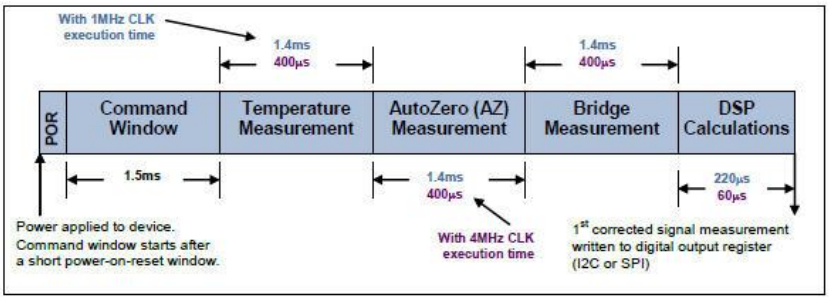


Fig. 4 — Power-up sequence and timing, Update Mode with EEPROM locked. When EEPROM is unlocked the command window is 4.5 ms longer (6 ms). Values are typical.

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 (9 coarse + 5 fine). Typical values — multiply by 1.15 for worst case. At Update_Rate 00 there is no power-down period between measurements. Long-integration timing is given in the digital communication manual.

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 & diagnostics

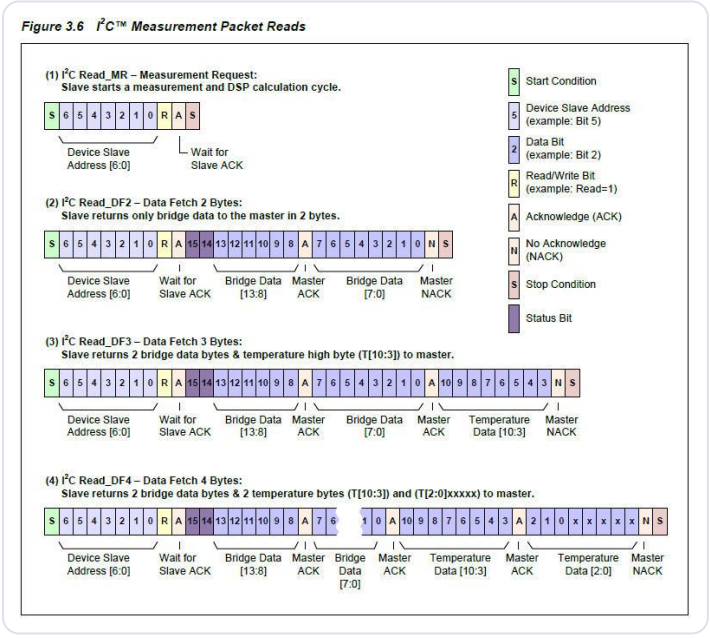


Fig. 5 — I²C measurement packet reads. The master sends the 7-bit slave address with the 8th bit = 1; the device ACKs and returns 2, 3, or 4 bytes depending on when the master sends NACK + stop.

COMMAND	RETURNS / ACTION	BUS
Read_MR	Wakes the part in Sleep Mode, starts a full measurement cycle	I²C · SPI
Read_DF2	2 bytes — bridge data + 2 status MSBs	I²C · SPI
Read_DF3	3 bytes — bridge data + 8-bit temperature	I²C · SPI
Read_DF4	4 bytes — bridge + 11-bit temperature (mask last 5 bits)	I²C · SPI
Write_MR	Bridge-only measurement using stored temp / auto-zero	I²C
Command write	32-bit calibration packet — EEPROM factory locked	I²C

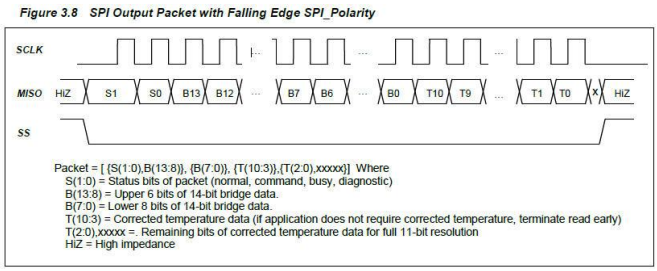


Fig. 6 — SPI output packet, falling-edge polarity. Terminate after byte 2 for pressure only, or byte 3 for 8-bit temperature.

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 MISR signature re-checked at every power-on reset, and four comparators verify the bridge inputs stay within 0.15·VDD to 0.85·VDD during all conversions.

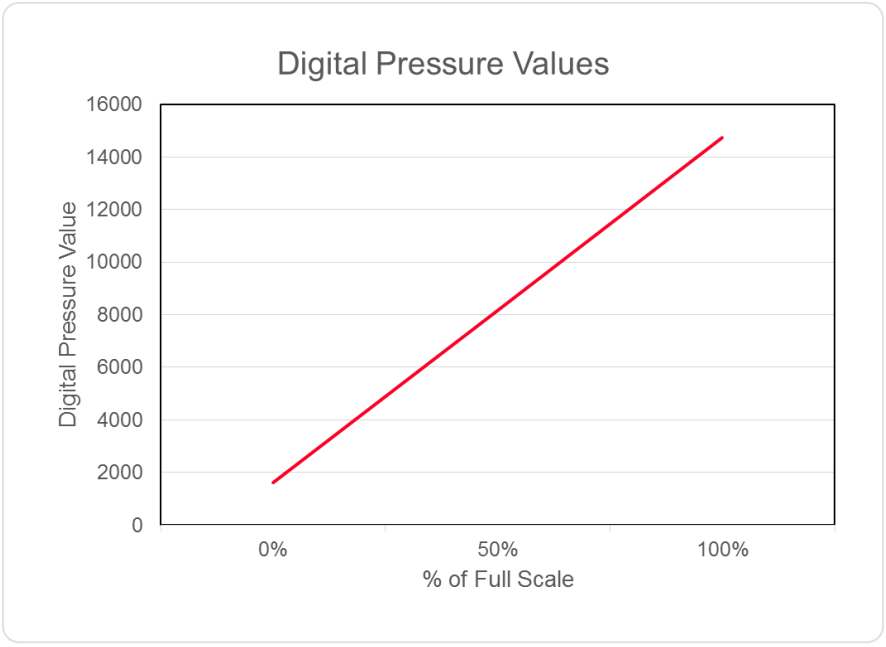
Faults are detected in the next measurement cycle and reported in the following data fetch. Status bits will not clear until the cause is corrected **and** a power-on reset is performed.

FULL PROTOCOL REFERENCE

Command byte definitions, the EEPROM register map, Command Mode calibration sequences, and long-integration timing are documented in the Phoenix Sensors Digital Communication Manual — available on request.

Data conversion

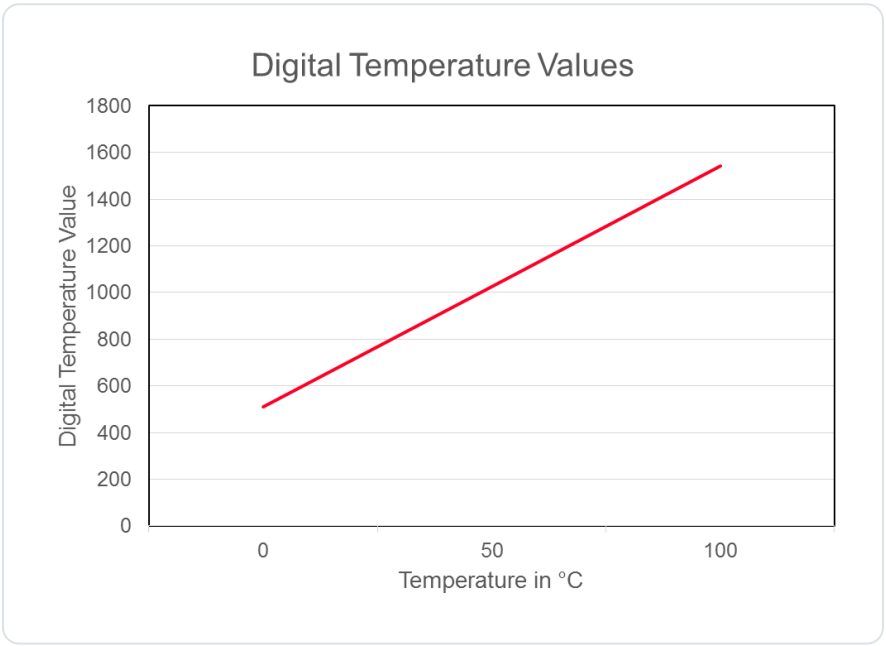
Corrected pressure and temperature are read as integer counts (Y). Use the transfer functions below to convert counts to engineering units.



Pressure

Y = 130.07·X + 1638 Offset ±125 counts X = pressure as % of full scale

Fig. 7 — Digital pressure output (counts) vs. % of full scale.

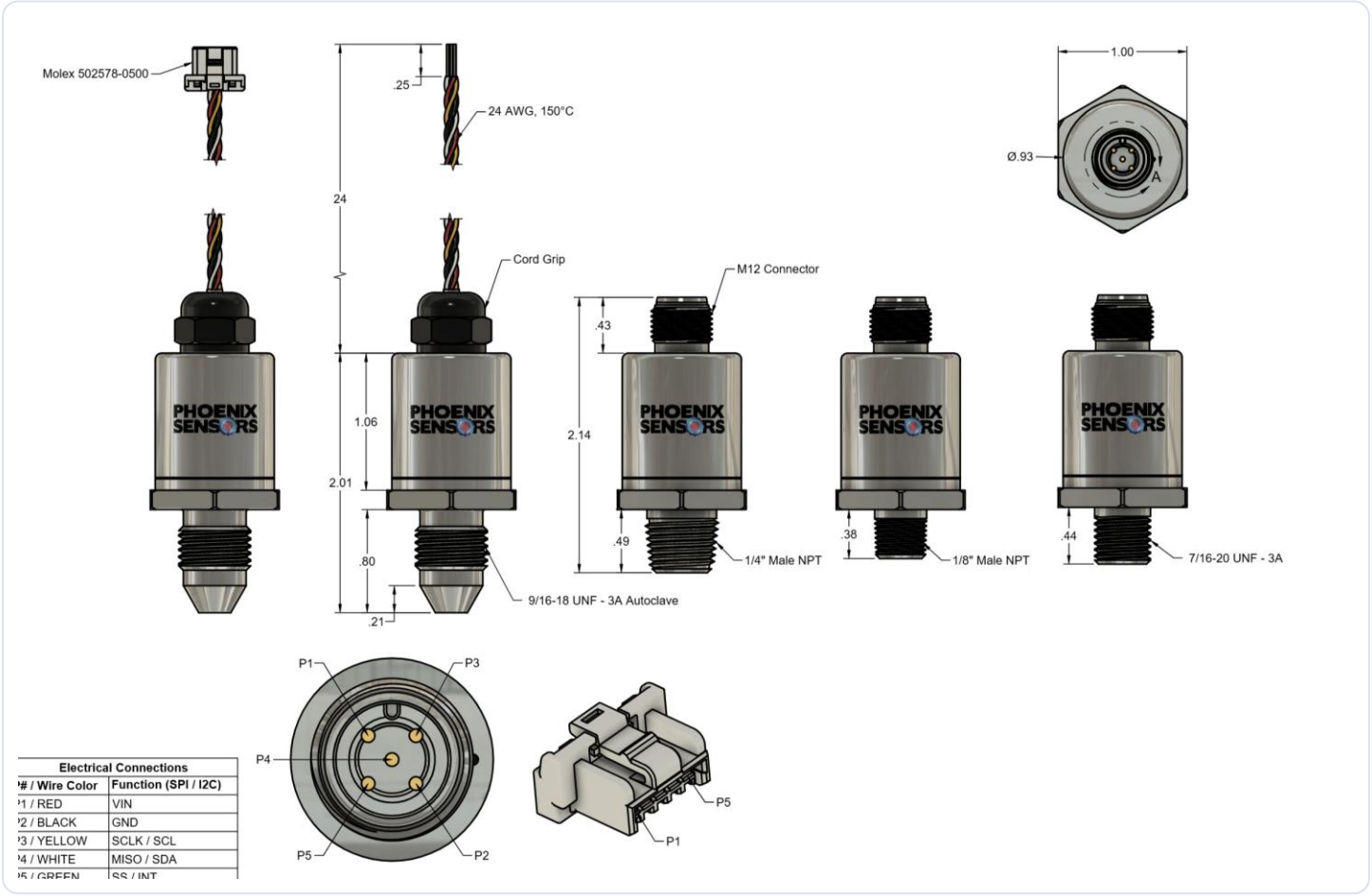


Temperature

Y = 10.3·X + 511 25 °C = 768 counts X = temperature in °C

Fig. 8 — Digital temperature output (counts) vs. temperature (°C).

Mechanical dimensions — inches



Electrical Connections	
'# / Wire Color	Function (SPI / I2C)
'1 / RED	VIN
'2 / BLACK	GND
'3 / YELLOW	SCLK / SCL
'4 / WHITE	MISO / SDA
'5 / GREEN	SS / INT

Fig. 9 — Part variants: flying leads with Molex 502578-0500 or tinned ends (cord grip), M12 connector, and 9/16-18 UNF-3A autoclave, 1/4" NPT, 1/8" NPT, and 7/16-20 UNF-3A ports. M12 pinout shown at view A.

FEATURE	DETAIL
Body	SS316L · Ø0.93" · 1.00" hex
Overall length (M12, 1/4" NPT)	2.14"
Body length (cord grip, autoclave)	2.01"
Port length	1/4" NPT .49 · 1/8" NPT .38 · 7/16-20 .44 · 9/16-18 autoclave .80
Electrical	Flying leads · Molex 502578-0500 · M12
Leads	24 AWG, 150 °C, 24" standard

NOTES

1) Standard lead length 24"; specify custom length at order.
2) Tolerances: X.XX ±0.010 · X.XXX ±0.005 in.
3) Autoclave port: 59° cone, 0.21" tip.
4) Keep bus wiring as short as practical and route away from switched loads.

Ordering information — part-number configuration

PPT87	–	0	–	50	A	–	1	S	–	0	L
MODEL		OUTPUT		RANGE	TYPE		PORT	IP		ELECTRICAL	POWER

Model	Output	Range (PSI)	Type	Port	IP	Electrical	Power
PPT87	0 = SPI 1 = I²C	50 = 50 PSI 20K = 20,000 PSI	A = Absolute G = Gauge	1 = 1/4" MNPT 2 = 1/8" MNPT 3 = 7/16-20 UNF 4 = Custom 5 = 9/16-18 UNF 3A Autoclave	S = IP65 P = IP67	0 = Flying leads 1 = Molex conn 2 = M12 conn	L = Low power S = Standard

SPECIFY WITH YOUR ORDER — FACTORY-LOCKED SETTINGS

Core clock (4 MHz default / 1 MHz) · Update_Rate 00–11 (0.5 ms default at 4 MHz) · Operating mode (Update / Sleep) · I²C slave address if other than 0x28 · SPI polarity (falling default / rising). Maximum over-pressure is 3× the rated range (e.g. 50 PSI → 150 PSI).

EXAMPLE PART NUMBERS

PPT87-0-50A-1S-0L → SPI · 0–50 PSI absolute · 1/4" MNPT · IP65 · flying leads · low power

PPT87-0-15KG5P-2S → SPI · 0–15,000 PSI gauge · 9/16-18 UNF-3A autoclave · IP67 · M12 connector · standard power

Configure your PPT87

Custom ranges, Inconel ports, RS-485 output, and cable lengths available for OEM volumes. Talk to an engineer to spec your part.

REQUEST A QUOTE
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(480) 462-1810