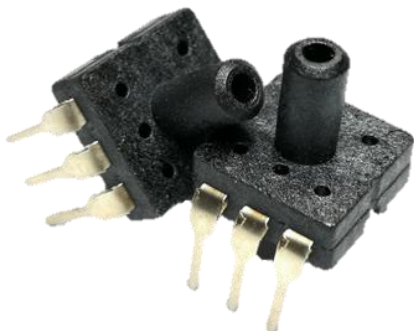


PPS35 Digitally Compensated Pressure Sensor

Back-side die, media-isolated 6-pin sensor with 14-bit I²C / SPI pressure and temperature output



GAUGE

6-PIN DIP / SMD

I²C · SPI

DESCRIPTION

The PPS35 is an amplified, digitally compensated pressure sensor in a compact 6-pin package. It is designed for applications where size and cost matter but the media is harsh. A MEMS piezoresistive die is pressurized from its passive back side and isolated from the media by a stainless steel cap, for long-term stability in a range of liquids.

A 14-bit sigma-delta ADC and DSP correct offset, span and temperature on board, then deliver calibrated pressure and temperature over I²C or SPI. Response time is as low as 5 ms.

FEATURES

- Pressure ranges from 50 PSI to 300 PSI gauge
- 14-bit corrected pressure + 11-bit corrected temperature
- I²C (addressable) or SPI (read-only) digital output
- Total error band $\pm 0.75\%$ FS over 0–50 °C
- Non-linearity $\pm 0.5\%$ FS (BFSL)
- Response time 5 ms typical
- Back-side die with stainless steel cap for harsh, wet media
- Operating temperature –40 to 105 °C
- Update Mode or low-power Sleep Mode, factory set

APPLICATIONS

- Weather stations
- Small water pumps
- Sports & dive watches
- Aviation & ballooning
- Industrial applications
- Portable instruments

MAXIMUM ENVIRONMENTAL RATINGS

Operating Temperature	–40 to 105 °C · –40–221 °F	Proof Pressure	2× full scale
Storage Temperature	–40 to 110 °C · –40–230 °F	Burst Pressure	2.5× full scale
Supply Voltage	4.5 to 5.5 V	Pressure Range	50 to 300 PSI gauge

Electrical & performance specifications

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

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
Supply voltage	V_{DD}	4.5	5.0	5.5	V
Supply current (Note 1)	I_{DD}	2	3	5	mA
Digital output	—	I ² C or SPI			counts
Pressure resolution	—	14-bit			—
Temperature resolution	—	—	0.1	—	$^{\circ}\text{C}$
Total error band (Note 2)	TEB	-0.75	—	0.75	%FS
Non-linearity (Note 3)	NL	-0.5	—	0.5	%FS
Response time	t_R	4	5	10	ms
Operating temperature	T_{OP}	-40	—	105	$^{\circ}\text{C}$
Pressure range	—	50	—	300	PSI

1) Measured at zero pressure. 2) $0\text{--}50\text{ }^{\circ}\text{C}$; includes hysteresis, non-linearity and thermal effects. 3) Best-fit straight line.

I²C & SPI interface — electrical

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
Input low level	V_{IN_L}	0	—	0.2	$\times V_{DD}$
Input high level	V_{IN_H}	0.8	—	1.0	$\times V_{DD}$
Output low level	V_{OL}	—	—	0.1	$\times V_{DD}$
Supply decoupling (V_{DD} —GND)	C_L	—	4.7	—	μF
I ² C pull-up resistor	R_{PU}	—	1	—	$\text{k}\Omega$

Pin connections

PIN	I ² C	SPI
1	GND	GND
2	INT (data ready)	SS (slave select)
3	V_{DD}	V_{DD}
4	SCL	SCLK
5	SDA	MISO
6	TEST — do not connect	TEST — do not connect

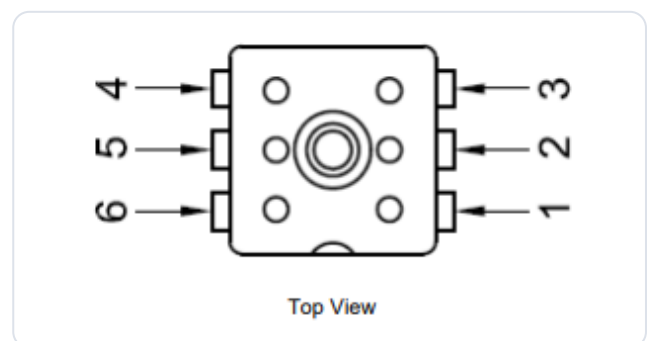


Fig. 1 — Pin locations, top view.

Package, media & installation

Package

A 6-pin nylon package in through-hole DIP or SMD form. A long cylindrical port accepts 0.120 in tubing or an O-ring seal, and an engineered RTV fill protects against water ingress.

Media

Air, gas, water and other liquids compatible with the wetted materials. The back-side die keeps the active circuit and wire bonds out of the media path.

Calibration

Every PPS35 is calibrated and compensated at the factory. Coefficients for gain, offset and temperature are stored in EEPROM, which is locked at the factory.

Stability

The silicon MEMS die has an SiO₂ base and is pressurized from its passive back side. A stainless steel cap isolates it from the media. A low-stress die attach and factory stabilization of every sensor improve stability over time and temperature.

Wetted parts

SiO₂, Pyrex glass, RTV, nylon, and the stainless steel cap.

Pressure ranges

Standard ranges from 50 PSI to 300 PSI gauge. Custom ranges are available for OEM customers.

Application examples

Application Examples



Dive Watch



Satellite Balloon



Skydiving



14-bit

Pressure resolution

±0.75%

Total error band

5 ms

Typical response

105 °C

Max operating temp

Digital interface overview

Digital signal processor

A DSP processes the converted bridge signal, applies temperature correction and computes the temperature value for the digital output.

EEPROM

Stores the calibration coefficients for gain and offset, plus the configuration bits for output mode and update rate. **The EEPROM is locked at the factory.**

I²C interface

An addressable 2-wire interface, used to start measurements in Sleep Mode and to read data.

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

Operating modes

Two normal modes are available: Update Mode (continuous conversion at a selectable rate) and Sleep Mode (low power, measures on request). Both work over I²C or SPI. The mode and interface are set at the factory; the default is SPI.

Clock & power-on reset

An internal 4 MHz temperature-compensated oscillator, with an optional 4:1 post-scaler (1 MHz), sets all timing. The 4 MHz default gives the fastest response; 1 MHz improves resolution. Reset releases once V_{DD} exceeds ≈ 1.9 V.

SPI interface

Half duplex, read-only from the PPS35. SPI does not accept commands, so it cannot be used for calibration (Command Mode).

CLOCK SETTING	MAX SPI CLOCK
4 MHz (factory)	800 kHz
1 MHz	200 kHz

PPS35 I²C PROTOCOL DIFFERENCES

- 1) A start-stop with no clock pulses between them causes an error on the next transfer. Send an extra start condition to recover.
- 2) A restart condition (SDA falling while SCL is high, mid-transfer) has the same effect and needs the same recovery.
- 3) SDA must not fall between the start condition and the first rising SCL edge. If the first address bit is 0, hold SDA low from the start condition through that bit.

I²C & SPI timing

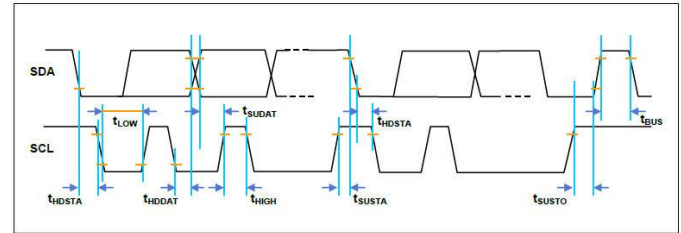
I²C parameters & timing diagram

Table 2.8 I²C™ Parameters

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
SCL clock frequency	f_{SCL}	100		400	kHz
Start condition hold time relative to SCL edge	t_{HDSTA}	0.1			μ s
Minimum SCL clock low width ¹	t_{LOW}	0.6			μ s
Minimum SCL clock high width ¹	t_{HIGH}	0.6			μ s
Start condition setup time relative to SCL edge	t_{SUSTA}	0.1			μ s
Data hold time on SDA relative to SCL edge	t_{HDDAT}	0			μ s
Data setup time on SDA relative to SCL edge	t_{SDAT}	0.1			μ s
Stop condition setup time on SCL	t_{SUSTO}	0.1			μ s
Bus free time between stop condition and start condition	t_{BUS}	2			μ s

¹ Combined low and high widths must equal or exceed minimum SCL period.

Figure 2.6 I²C™ Timing Diagram



(See section 3.1 for data transmission details.)

Table 2.8 / Fig. 2.6 – I²C parameters and timing. Combined low and high widths must equal or exceed the minimum SCL period.

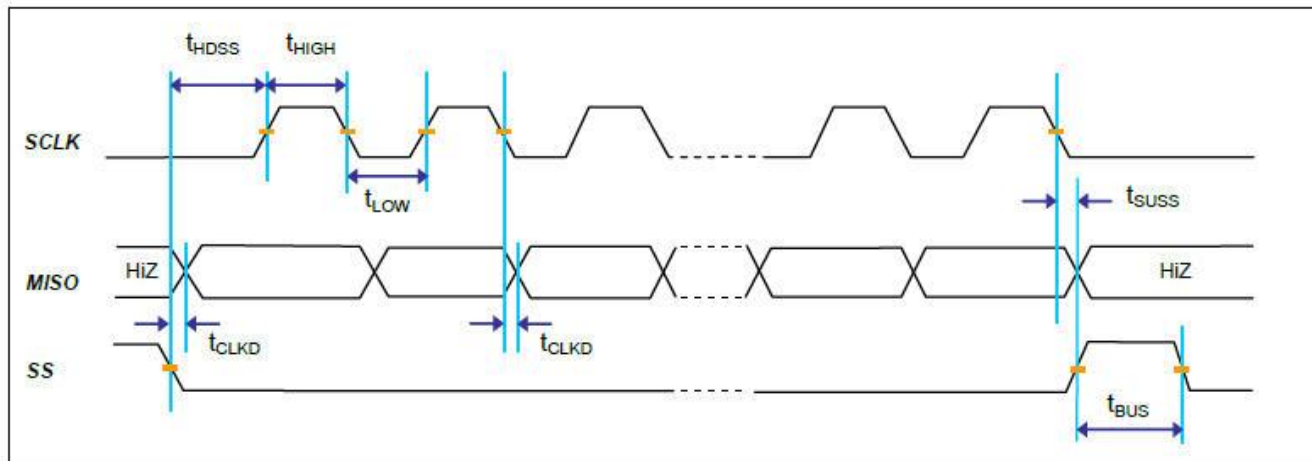
SPI parameters & timing diagram

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			μ s
Minimum SCLK clock low width	t_{LOW}	0.6			μ s ¹
Minimum SCLK clock high width	t_{HIGH}	0.6			μ s ¹
Clock edge to data transition	t_{CLKD}	0		0.1	μ s
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.)

Table 2.9 / Fig. 2.7 – SPI parameters and bus timing (falling-edge polarity, factory default).

Functional description

The PPS35 accepts three types of commands (Table 3.1). The sensor starts its A/D conversions **10 ms after power-up – do not issue any command during this start-up time**. With a 4 MHz clock and locked EEPROM, the first corrected data is written to the interface within 6 ms of power-on.

Table 3.1 Command Types

Type	Description	Communication Supported	Reference Sections
Data Fetch (DF)	Used to fetch data in any mode	I ² C and SPI	Sections 3.2.2 and 3.3.2
Measurement Request (MR)	Used to start measurements in Sleep Mode	I ² C and SPI	Sections 3.1.2, 3.3.1, and 3.4.1
Calibration Commands	Used to calibrate part in Command Mode	I ² C Only	Section 3.5

Table 3.1 – Command types: Data Fetch (DF), Measurement Request (MR), Calibration commands.

General working mode

After power-on

Operation after power-on depends on how the factory programmed the part. In **Sleep Mode** it waits for a command from the master before measuring. In **Update Mode** it measures at a fixed, selectable rate.

The status bits in each data packet report **valid** (new, unread data) or **stale** (already read, or a measurement still in progress).

Figure 3.1 General Working Mode

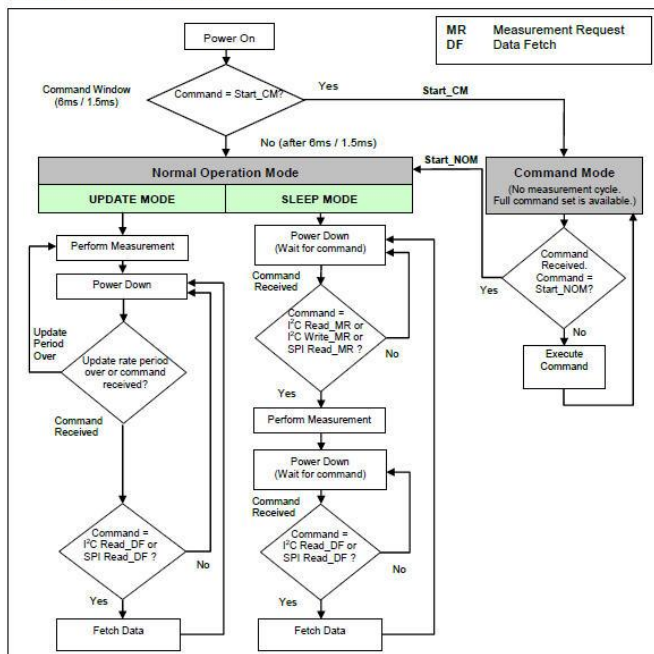


Fig. 3.1 – General working mode: Update Mode and Sleep Mode paths.

Update Mode & Sleep Mode

Update Mode

The core measures, corrects and refreshes the output register at the selected rate. Except at the fastest rate, the part powers down between measurements. Temperature and auto-zero are re-measured periodically ("special measurements"). The factory default is Update_Rate 00, a 0.5 ms update period at 4 MHz.

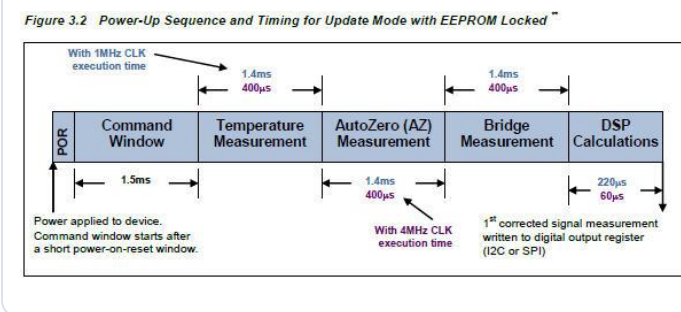


Fig. 3.2 / 3.3 – Update Mode power-up and measurement sequence.

Sleep Mode

The part stays powered down until the master sends Read_MR (I²C or SPI) or Write_MR (I²C only). Read_MR measures temperature, auto-zero and bridge. Write_MR measures the bridge only, reusing the previous temperature and auto-zero values. Fetch the result with Read_DF.

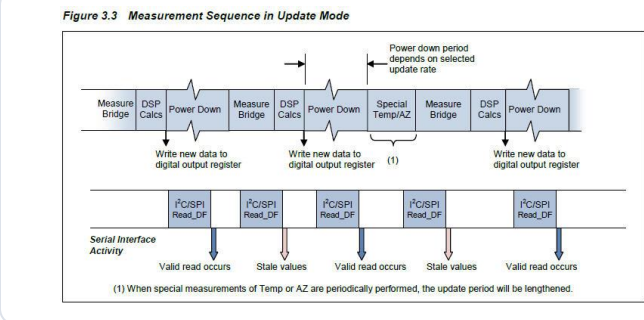


Table 3.2 Update Rate Settings (Normal Integration Mode: 9 Coarse + 5 Fine) ¹

Update_Rate	Update Period/1MHz Clock	Update Period/4MHz Clock	Measurement Cycles between Special Measurements (Temperature or AZ)
00 ²	1.6ms	0.5ms	255
01	5.0ms	1.5ms	127
10	25.0ms	6.5ms	31
11	125.0ms	32.0ms	15

¹ All time values shown are typical, for worst case values, multiply by 1.15 (nominal frequency $\pm 15\%$).
² With the fastest update rate setting, there is no power down period between measurements.

Table 3.3 Update Rate Settings (Long Integration Mode: 10 Coarse + 5 Fine) ¹

Update_Rate	Update Period/1MHz Clock	Update Period/4MHz Clock	Number of Measurement Cycles between Special Measurements (Temperature or AZ)
00 ²	5ms	1.5ms	255
01	8.5ms	2.5ms	127
10	30.0ms	7.5ms	31
11	130.0ms	33.0ms	15

¹ All time values shown are typical, for worst case values, multiply by 1.15 (nominal frequency $\pm 15\%$).
² With the fastest update rate setting, there is no power down period between measurements.

Table 3.4 Sleep Mode Response Times (Normal Integration Mode: 9 Coarse + 5 Fine) ¹

Measurement Request	Response/1MHz Clock	Response/4MHz Clock
Read MR	4.5ms	1.5ms
Write MR	1.5ms	0.5ms

¹ All time values shown are typical, for worst case values, multiply by 1.15 (nominal frequency $\pm 15\%$).

Table 3.5 Sleep Mode Response Times (Long Integration Mode: 10 Coarse + 5 Fine) ¹

Measurement Request	Response/1MHz Clock	Response/4MHz Clock
Read MR	12ms	4.5ms
Write MR	5.5ms	1.5ms

¹ All time values shown are typical, for worst case values, multiply by 1.15 (nominal frequency $\pm 15\%$).

Tables 3.2 / 3.3 – Update rate settings. Tables 3.4 / 3.5 – Sleep Mode response times. Worst-case values: multiply typical by 1.15.

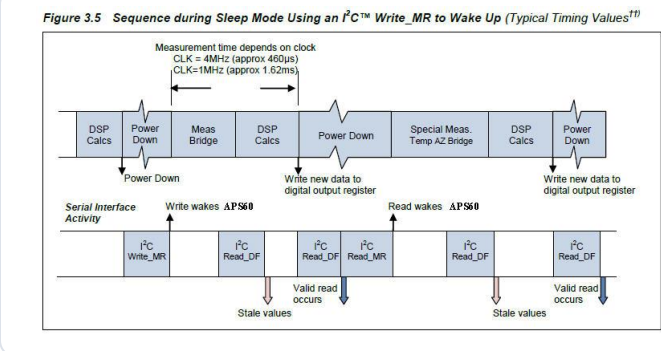
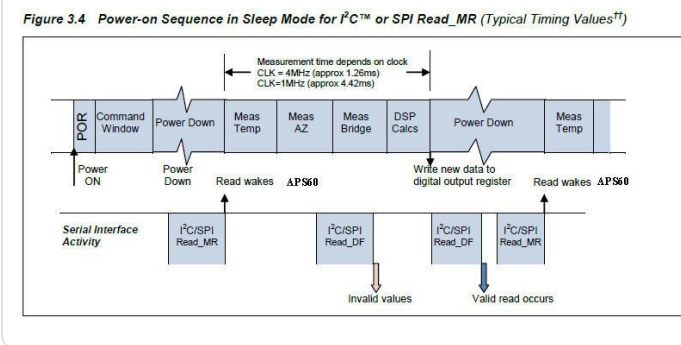


Fig. 3.4 / 3.5 – Sleep Mode power-on with Read_MR, and wake-up with I²C Write_MR.

NOTE

Data is invalid from power-on reset until the first measurement is written. An I²C Write_MR sent as the first command after power-on returns invalid data even though its status reads "valid", because temperature and auto-zero are not yet initialized.

Read & write operations

I²C reads

Read_MR sends only the address with READ = 1, then a stop. It wakes the part from Sleep Mode. **Read_DF2** returns 2 bytes of bridge data with 2 status bits as the MSBs. **Read_DF3** adds 1 byte of 8-bit temperature. **Read_DF4** returns the full 11-bit temperature; mask off the last 5 bits.

SPI reads

SPI Read_MR: pull SS low for at least 8 μ s, then release it. **Read_DF**: clock out up to 4 bytes — bridge high, bridge low, T[10:3], then {T[2:0], xxxxx}. Data changes on the falling edge of SCLK; sample MISO on the rising edge (factory default). Stop after 2 bytes if temperature is not needed.

Figure 3.6 I²C™ Measurement Packet Reads

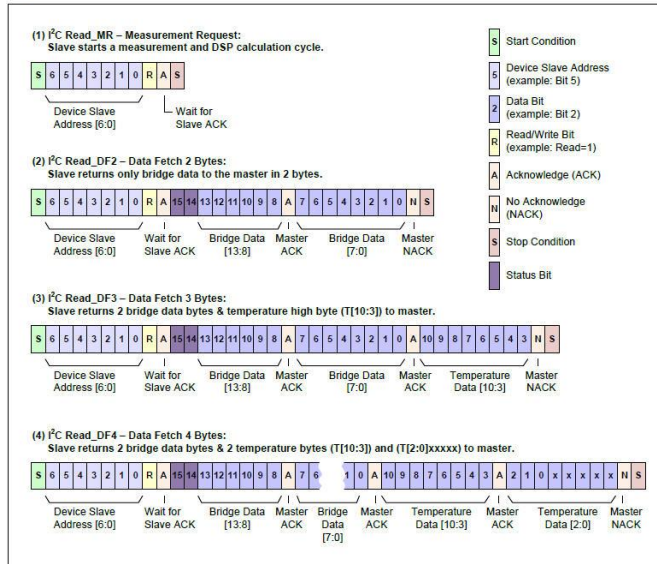


Figure 3.8 SPI Output Packet with Falling Edge SPI Polarity

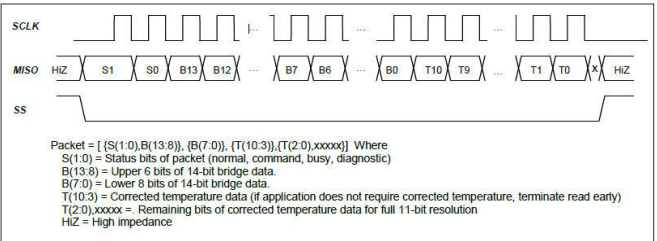


Fig. 3.8 – SPI output packet, falling-edge polarity.

I²C writes

Write_MR (Sleep Mode only) sends the address with WRITE = 0 and measures the bridge only. Command Mode writes are 32-bit packets: address byte, command byte, 16-bit data. Supply zeros if no data is needed.

Figure 3.9 I²C™ Measurement Packet Writes

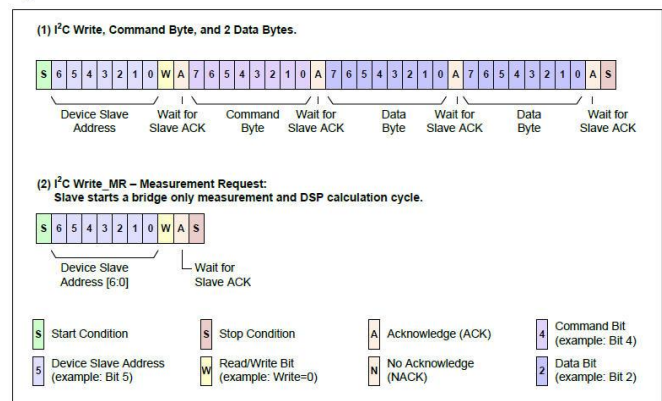


Fig. 3.6 – I²C Read MR, Read DF2, Read DF3 and Read DF4 packets.

Fig. 3.9 – I²C write packets.

Mechanical dimensions & ordering

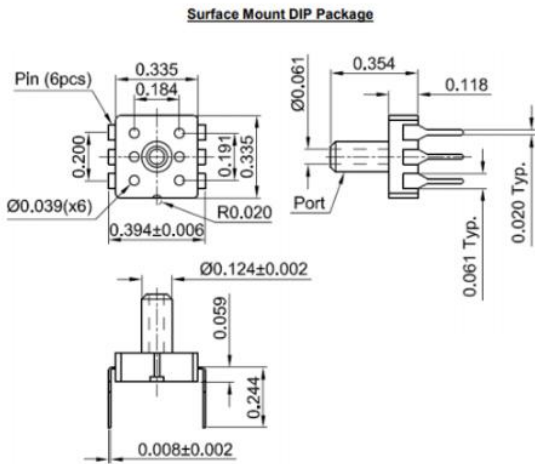


Fig. 4 – PPS35 6-pin package, inches [mm]. Port Ø0.124.

PPS35

1

50

G

1

0

MODEL

OUTPUT

RANGE

TYPE

PORT

LEADS

Model	Output	Range (PSI)	Type	Port	Leads
PPS35	1 = I ² C 2 = SPI	50 = 50 PSI 100 · 150 300 = 300 PSI	G = Gauge	1 = Single port 2 = Custom	0 = DIP 1 = SMD

EXAMPLE PART NUMBERS

PPS35-1-50G10 → I²C · 0-50 PSI gauge · single port · DIP

PPS35-2-300G11 → SPI · 0-300 PSI gauge · single port · SMD

Configure your PPS35

Custom ranges, interface settings and update rates for OEM volumes. Talk to an engineer.

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