

Integrated Silicon Pressure Sensor for Manifold Absolute Pressure Applications On-Chip Signal Conditioned, Temperature Compensated and Calibrated

The Motorola MPX4101A/MPXA4101AC series Manifold Absolute Pressure (MAP) sensor for engine control is designed to sense absolute air pressure within the intake manifold. This measurement can be used to compute the amount of fuel required for each cylinder. The small form factor and high reliability of on-chip integration makes the Motorola MAP sensor a logical and economical choice for automotive system designers.

The MPX4101A/MPXA4101AC series piezoresistive transducer is a state-of-the-art, monolithic, signal conditioned, silicon pressure sensor. This sensor combines advanced micromachining techniques, thin film metallization, and bipolar semiconductor processing to provide an accurate, high level analog output signal that is proportional to applied pressure.

Figure 1 shows a block diagram of the internal circuitry integrated on a pressure sensor chip.

Features

- 1.72% Maximum Error Over 0° to 85°C
- Specifically Designed for Intake Manifold Absolute Pressure Sensing in Engine Control Systems
- Temperature Compensated Over -40°C to +125°C
- Durable Epoxy Unibody Element or Thermoplastic (PPS) Surface Mount Package

Application Examples

- Manifold Sensing for Automotive Systems
- Ideally Suited for Microprocessor or Microcontroller-Based Systems
- Also Ideal for Non-Automotive Applications

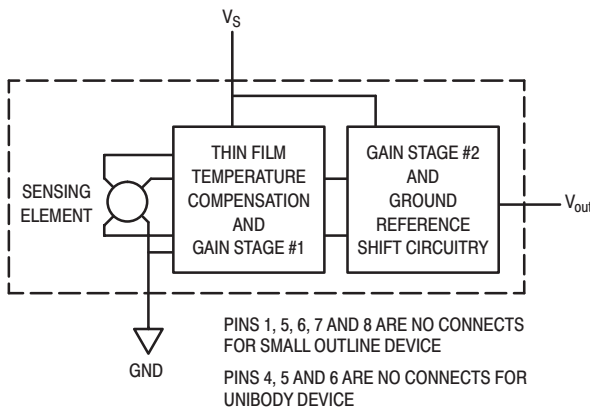
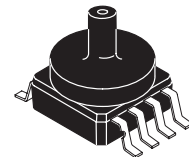


Figure 1. Fully Integrated Pressure Sensor Schematic

MPX4101A MPXA4101AC SERIES

INTEGRATED
PRESSURE SENSOR
15 to 102 kPa
(2.18 to 14.8 psi)
0.25 to 4.95 V Output

SMALL OUTLINE PACKAGE



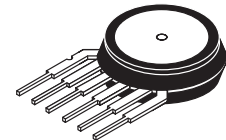
MPXA4101AC6U
CASE 482A

PIN NUMBER

1	N/C	5	N/C
2	V _S	6	N/C
3	Gnd	7	N/C
4	V _{out}	8	N/C

NOTE: Pins 1, 5, 6, 7, and 8 are not device connections. Do not connect to external circuitry or ground. Pin 1 is noted by the notch in the lead.

UNIBODY PACKAGE



MPX4101A
CASE 867

PIN NUMBER

1	V _{out}	4	N/C
2	Gnd	5	N/C
3	V _S	6	N/C

NOTE: Pins 4, 5, and 6 are internal device connections. Do not connect to external circuitry or ground. Pin 1 is noted by the notch in the lead.

MPX4101A MPXA4101AC SERIES

MAXIMUM RATINGS(NOTE)

Parametric	Symbol	Value	Unit
Maximum Pressure (P1 > P2)	P_{max}	400	kPa
Storage Temperature	T_{stg}	-40 to +125	°C
Operating Temperature	T_A	-40 to +125	°C

NOTE: Exposure beyond the specified limits may cause permanent damage or degradation to the device.

OPERATING CHARACTERISTICS ($V_S = 5.1$ Vdc, $T_A = 25^\circ\text{C}$ unless otherwise noted, P1 > P2. Decoupling circuit shown in Figure 3 required to meet electrical specifications.)

Characteristic	Symbol	Min	Typ	Max	Unit
Pressure Range ⁽¹⁾	P_{OP}	15	—	102	kPa
Supply Voltage ⁽²⁾	V_S	4.85	5.1	5.35	Vdc
Supply Current	I_o	—	7.0	10	mAdc
Minimum Pressure Offset ⁽³⁾ @ $V_S = 5.1$ Volts	V_{off}	0.171	0.252	0.333	Vdc
Full Scale Output ⁽⁴⁾ @ $V_S = 5.1$ Volts	V_{FSO}	4.870	4.951	5.032	Vdc
Full Scale Span ⁽⁵⁾ @ $V_S = 5.1$ Volts	V_{FSS}	—	4.7	—	Vdc
Accuracy ⁽⁶⁾ (0 to 85°C)	—	—	—	±1.72	% V_{FSS}
Sensitivity	V/P	—	54	—	mV/kPa
Response Time ⁽⁷⁾	t_R	—	15	—	ms
Output Source Current at Full Scale Output	I_{o+}	—	0.1	—	mAdc
Warm-Up Time ⁽⁸⁾	—	—	20	—	ms
Offset Stability ⁽⁹⁾	—	—	±0.5	—	% V_{FSS}

NOTES:

- 1.0 kPa (kiloPascal) equals 0.145 psi.
- Device is ratiometric within this specified excitation range.
- Offset (V_{off}) is defined as the output voltage at the minimum rated pressure.
- Full Scale Output (V_{FSO}) is defined as the output voltage at the maximum or full rated pressure.
- Full Scale Span (V_{FSS}) is defined as the algebraic difference between the output voltage at full rated pressure and the output voltage at the minimum rated pressure.
- Accuracy (error budget) consists of the following:
 - Linearity: Output deviation from a straight line relationship with pressure over the specified pressure range.
 - Temperature Hysteresis: Output deviation at any temperature within the operating temperature range, after the temperature is cycled to and from the minimum or maximum operating temperature points, with zero differential pressure applied.
 - Pressure Hysteresis: Output deviation at any pressure within the specified range, when this pressure is cycled to and from the minimum or maximum rated pressure, at 25°C.
 - TcSpan: Output deviation over the temperature range of 0 to 85°C, relative to 25°C.
 - TcOffset: Output deviation with minimum rated pressure applied, over the temperature range of 0 to 85°C, relative to 25°C.
 - Variation from Nominal: The variation from nominal values, for Offset or Full Scale Span, as a percent of V_{FSS} , at 25°C.
- Response Time is defined as the time for the incremental change in the output to go from 10% to 90% of its final value when subjected to a specified step change in pressure.
- Warm-up Time is defined as the time required for the product to meet the specified output voltage after the Pressure has been stabilized.
- Offset Stability is the product's output deviation when subjected to 1000 hours of Pulsed Pressure, Temperature Cycling with Bias Test.

MECHANICAL CHARACTERISTICS

Characteristics	Typ	Unit
Weight, Basic Element (Case 867)	4.0	grams
Weight, Small Outline Package (Case 482)	1.5	grams

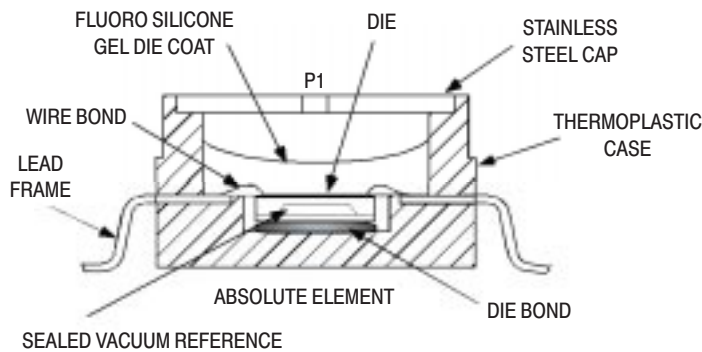


Figure 2. Cross Sectional Diagram SOP (not to scale)

Figure 2 illustrates an absolute sensing chip in the basic chip carrier (Case 482).

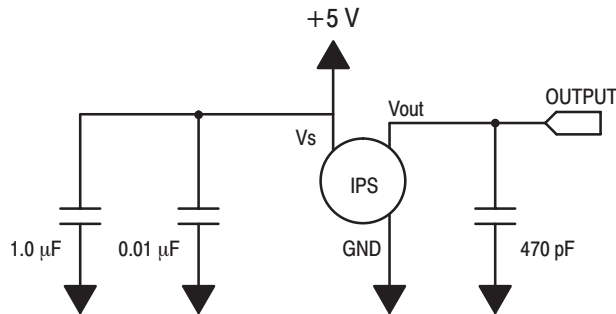


Figure 3. Recommended power supply decoupling and output filtering.
For additional output filtering, please refer to Application Note AN1646.

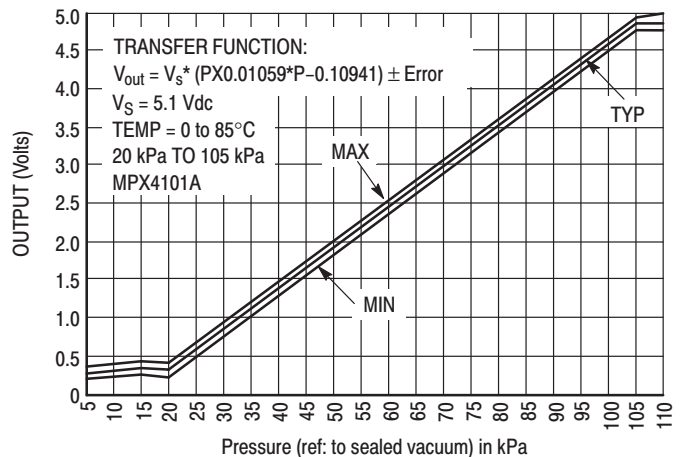


Figure 4. Output versus Absolute Pressure

Figure 4 shows the sensor output signal relative to pressure input. Typical, minimum, and maximum output curves are shown for operation over a temperature range of 0° to 85°C. The output will saturate outside of the specified pressure range.

A fluorosilicone gel isolates the die surface and wire bonds from the environment, while allowing the pressure signal to be transmitted to the sensor diaphragm. The MPX4101A/MPXA4101AC series pressure sensor operating

characteristics, and internal reliability and qualification tests are based on use of dry air as the pressure media. Media, other than dry air, may have adverse effects on sensor performance and long-term reliability. Contact the factory for information regarding media compatibility in your application.

Figure 3 shows the recommended decoupling circuit for interfacing the output of the integrated sensor to the A/D input of a microprocessor or microcontroller. Proper decoupling of the power supply is recommended.

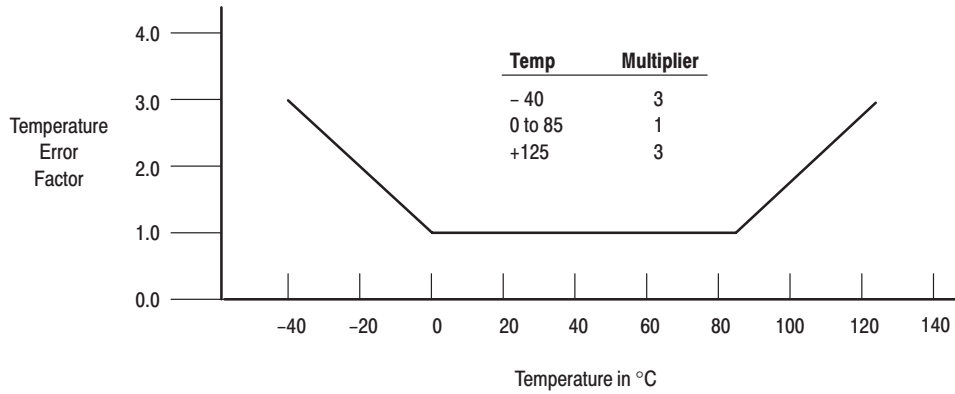
MPX4101A MPXA4101AC SERIES

Transfer Function (MPX4101A, MPXA4101AC)

Nominal Transfer Value: $V_{out} = V_S (P \times 0.01059 - 0.10941)$
 $\pm (\text{Pressure Error} \times \text{Temp. Factor} \times 0.01059 \times V_S)$
 $V_S = 5.1 \text{ V} \pm 0.25 \text{ Vdc}$

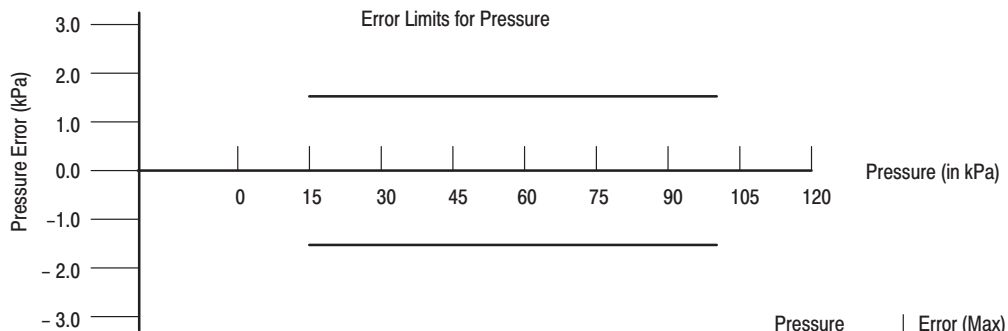
Temperature Error Band

MPX4101A, MPXA4101AC Series



NOTE: The Temperature Multiplier is a linear response from 0° to -40°C and from 85° to 125°C.

Pressure Error Band



Pressure	Error (Max)
15 to 102 (kPa)	± 1.5 (kPa)

PRESSURE (P1)/VACUUM (P2) SIDE IDENTIFICATION TABLE

Motorola designates the two sides of the pressure sensor as the Pressure (P1) side and the Vacuum (P2) side. The Pressure (P1) side is the side containing fluorosilicone gel which protects the die from harsh media. The Motorola MPX

pressure sensor is designed to operate with positive differential pressure applied, P1 > P2.

The Pressure (P1) side may be identified by using the table below:

Part Number	Case Type	Pressure (P1) Side Identifier
MPX4101A	867	Stainless Steel Cap
MPXA4101AC6U	482A	Side with Port Attached

ORDERING INFORMATION — UNIBODY PACKAGE

The MPX4101A series MAP silicon pressure sensors are available in the Basic Element, or with pressure port fittings that provide mounting ease and barbed hose connections.

Device Type	Options	Case Type	MPX Series	
			Order Number	Device Marking
Basic Element	Absolute, Element Only	867	MPX4101A	MPX4101A

ORDERING INFORMATION — SMALL OUTLINE PACKAGE

Device Type	Options	Case No.	MPX Series Order No.	Packing Options	Marking
Ported Element	Absolute, Axial Port	482A	MPXA4101AC6U	Rails	MPXA4101A

INFORMATION FOR USING THE SMALL OUTLINE PACKAGE (CASE 482)

MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the surface mount packages must be the correct size to ensure proper solder connection interface between the board and the package. With the correct

footprint, the packages will self align when subjected to a solder reflow process. It is always recommended to design boards with a solder mask layer to avoid bridging and shorting between solder pads.

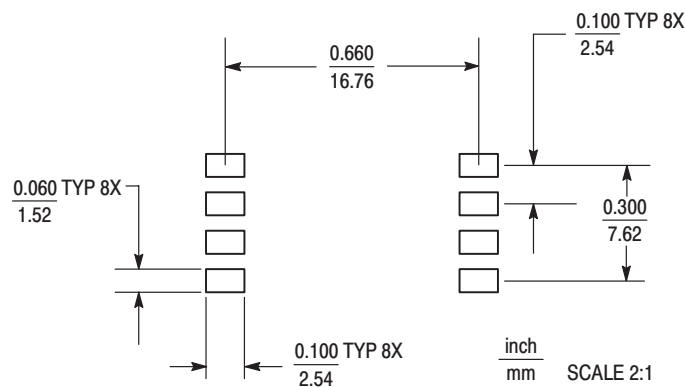
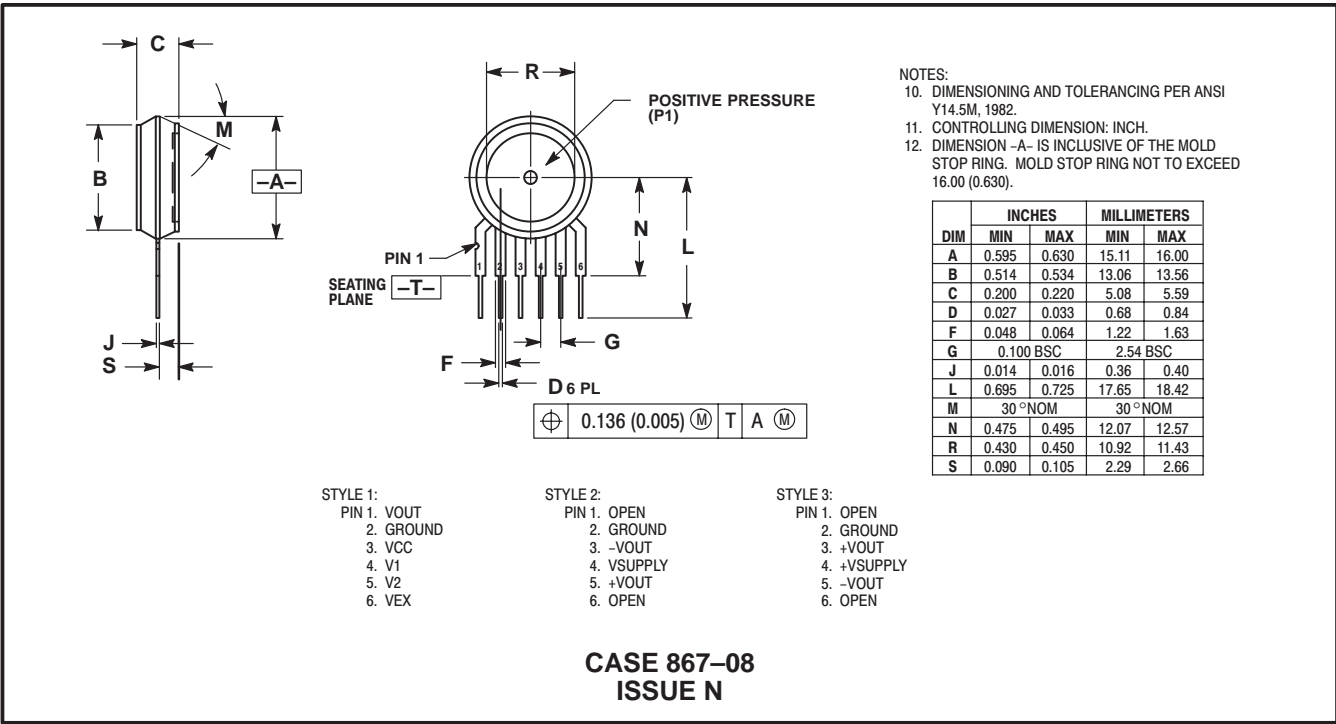


Figure 5. SOP Footprint (Case 482)

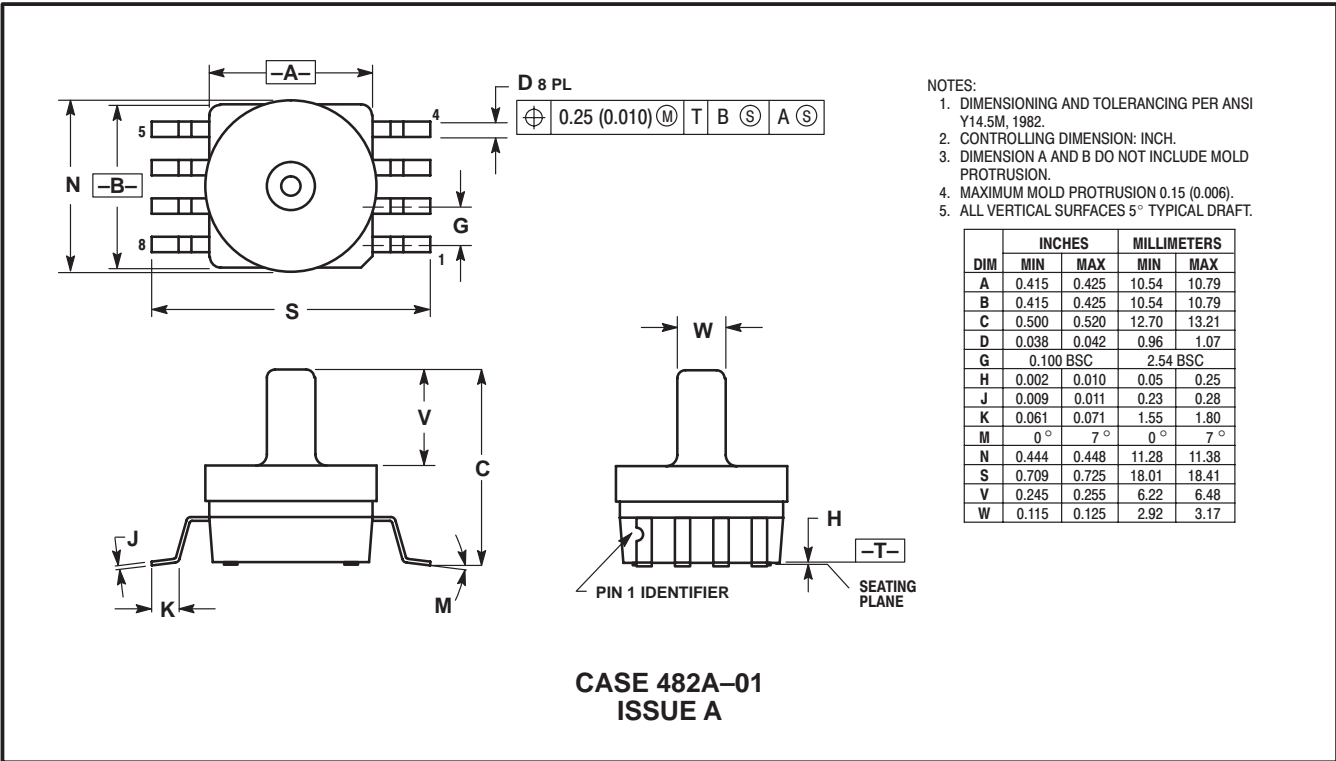
MPX4101A MPXA4101AC SERIES


UNIBODY PACKAGE DIMENSIONS



BASIC ELEMENT

SMALL OUTLINE PACKAGE DIMENSIONS



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How to reach us:

USA/EUROPE/Locations Not Listed: Motorola Literature Distribution;
P.O. Box 5405, Denver, Colorado 80217. 1-303-675-2140 or 1-800-441-2447

JAPAN: Motorola Japan Ltd.; SPS, Technical Information Center, 3-20-1,
Minami-Azabu, Minato-ku, Tokyo 106-8573 Japan. 81-3-3440-3569

Technical Information Center: 1-800-521-6274

ASIA/PACIFIC: Motorola Semiconductors H.K. Ltd.; Silicon Harbour Centre,
2, Dai King Street, Tai Po Industrial Estate, Tai Po, N.T., Hong Kong.
852-26668334

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