

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

The Freescale MPXAZ4100A 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 Freescale MAP sensor a logical and economical choice for automotive system designers.

The MPXAZ4100A 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

- Resistant to high humidity and common automotive media
- 1.8% Maximum Error Over 0° to 85°C
- Specifically Designed for Intake Manifold Absolute Pressure Sensing in Engine Control Systems
- Ideally Suited for Microprocessor or Microcontroller Based Systems
- Temperature Compensated Over -40°C to +125°C
- Durable Thermoplastic (PPS) Surface Mount Package

Typical Applications

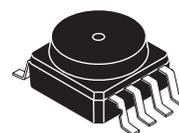
- Manifold Sensing for Automotive Systems
- Also Ideal for Non-Automotive Applications

| ORDERING INFORMATION | | | | | |
|---|------------------------|----------|----------------------|-----------------|----------------|
| Device Type | Options | Case No. | MPX Series Order No. | Packing Options | Device Marking |
| SMALL OUTLINE PACKAGE (MPXAZ4100A SERIES) | | | | | |
| Basic Elements | Absolute, Element Only | 482 | MPXAZ4100A6U | Rails | MPXAZ4100A |
| | Absolute, Element Only | 482 | MPXAZ4100A6T1 | Tape & Reel | MPXAZ4100A |
| Ported Elements | Absolute, Axial Port | 482A | MPXAZ4100AC6U | Rails | MPXAZ4100A |
| | Absolute, Axial Port | 482A | MPXAZ4100AC6T1 | Tape & Reel | MPXAZ4100A |

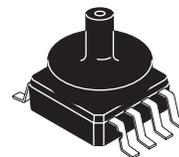
MPXAZ4100A SERIES

INTEGRATED
PRESSURE SENSOR
20 TO 105 kPA (2.9 TO 15.2 psi)
0.3 TO 4.9 V OUTPUT

SMALL OUTLINE PACKAGES



MPXA4100A6U/6T1
CASE 482-01



MPXA4100AC6U/AC6T1
CASE 482A-01

PIN NUMBER⁽¹⁾

| | | | |
|---|------------------|---|-----|
| 1 | N/C | 5 | N/C |
| 2 | V _S | 6 | N/C |
| 3 | GND | 7 | N/C |
| 4 | V _{OUT} | 8 | N/C |

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

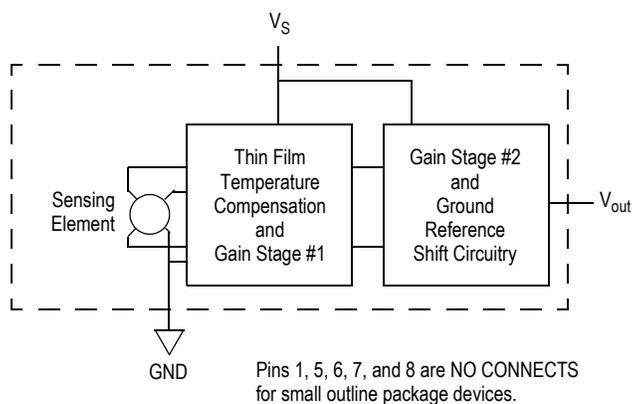


Figure 1. Fully Integrated Pressure Sensor Schematic

Table 1. Maximum Ratings⁽¹⁾

| Rating | 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 |

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

Table 2. Operating Characteristics ($V_S = 5.1$ Vdc, $T_A = 25^\circ\text{C}$ unless otherwise noted, $P_1 > P_2$. Decoupling circuit shown in Figure 3 required to meet electrical specifications.)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|-----------|-------|-----------|-----------|-------------|
| Pressure Range ⁽¹⁾ | P_{OP} | 20 | — | 105 | kPa |
| Supply Voltage ⁽²⁾ | V_S | 4.85 | 5.1 | 5.35 | Vdc |
| Supply Current | I_o | — | 7.0 | 10 | mAdc |
| Minimum Pressure Offset @ $V_S = 5.1$ Volts ⁽³⁾ | V_{off} | 0.225 | 0.306 | 0.388 | Vdc |
| Full Scale Output @ $V_S = 5.1$ Volts ⁽⁴⁾ | V_{FSO} | 4.870 | 4.951 | 5.032 | Vdc |
| Full Scale Span @ $V_S = 5.1$ Volts ⁽⁵⁾ | V_{FSS} | — | 4.59 | — | Vdc |
| Accuracy ⁽⁶⁾ | — | — | — | ± 1.8 | % V_{FSS} |
| Sensitivity | V/P | — | 54 | — | mV/kPa |
| Response Time ⁽⁷⁾ | t_R | — | 1.0 | — | 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} |

1. 1.0 kPa (kiloPascal) equals 0.145 psi.
2. Device is ratiometric within this specified excitation range.
3. Offset (V_{off}) is defined as the output voltage at the minimum rated pressure.
4. Full Scale Output (V_{FSO}) is defined as the output voltage at the maximum or full rated pressure.
5. 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.
6. 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 .
7. 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.
8. Warm-up Time is defined as the time required for the product to meet the specified output voltage after the Pressure has been stabilized.
9. Offset Stability is the product's output deviation when subjected to 1000 hours of Pulsed Pressure, Temperature Cycling with Bias Test.

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

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 using the decoupling circuit shown in Figure 3. The output will saturate outside of the specified pressure range.

A gel die coat isolates the die surface and wire bonds from the environment, while allowing the pressure signal to be transmitted to the sensor diaphragm. The gel die coat and

durable polymer package provide a media resistant barrier that allows the sensor to operate reliably in high humidity conditions as well as environments containing common automotive media. Contact the factory for more information regarding media compatibility in your specific 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.

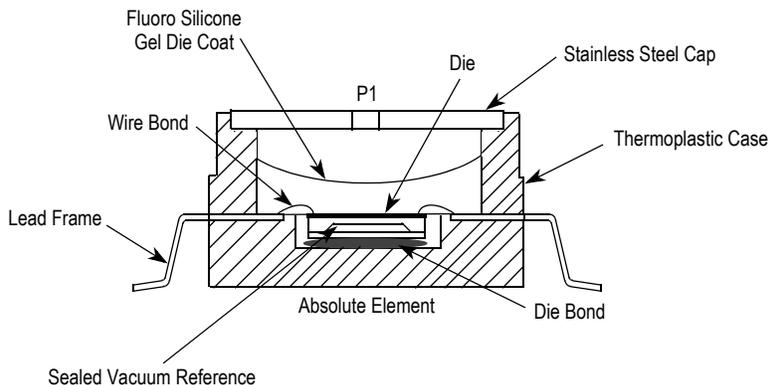


Figure 2. Cross Sectional Diagram SOP (not to scale)

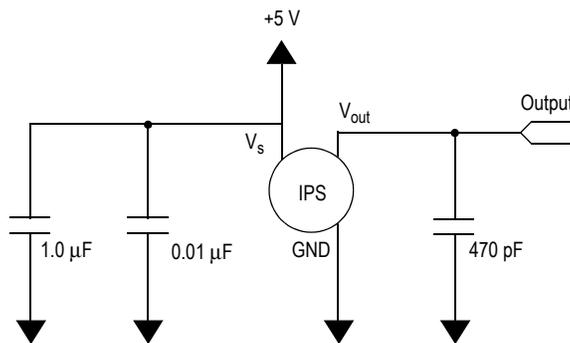


Figure 3. Recommended Power Supply Decoupling and Output Filtering (For additional output filtering, please refer to Application Note AN1646.)

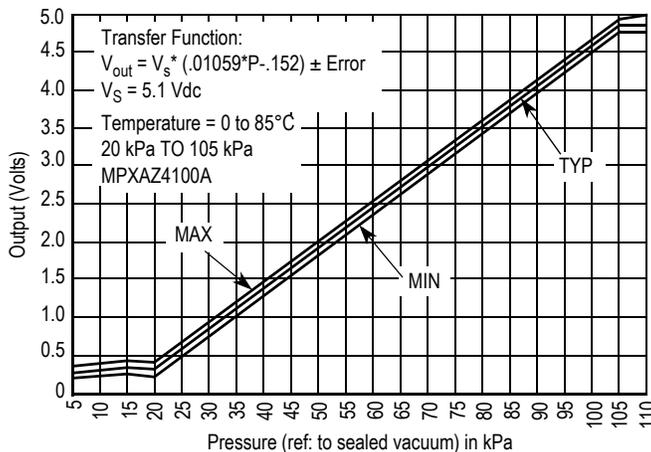


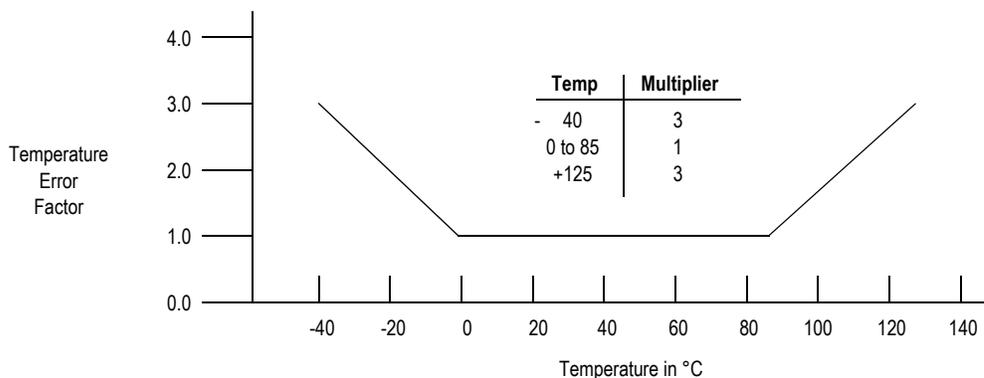
Figure 4. Output versus Absolute Pressure

Transfer Function (MPXAZ4100A)

Nominal Transfer Value: $V_{out} = V_S (P \times 0.01059 - 0.1518)$
 $\pm (\text{Pressure Error} \times \text{Temp. Factor} \times 0.01059 \times V_S)$
 $V_S = 5.1 \text{ V} \pm 0.25 \text{ Vdc}$

Temperature Error Band

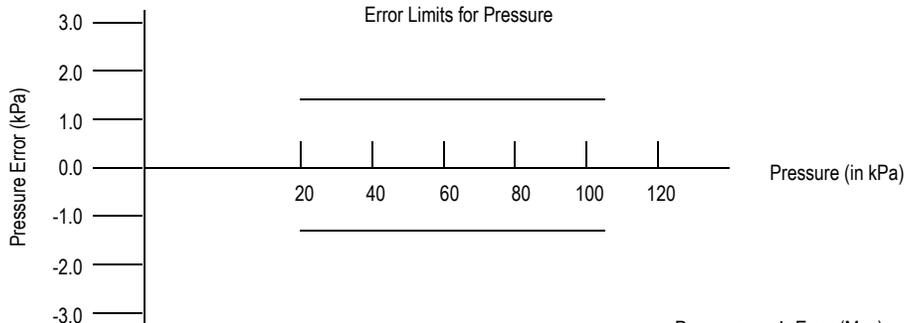
MPXAZ4100A Series



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

Pressure Error Band

Error Limits for Pressure



| Pressure | Error (Max) |
|-----------------|-------------|
| 20 to 105 (kPa) | ±1.5 (kPa) |

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.

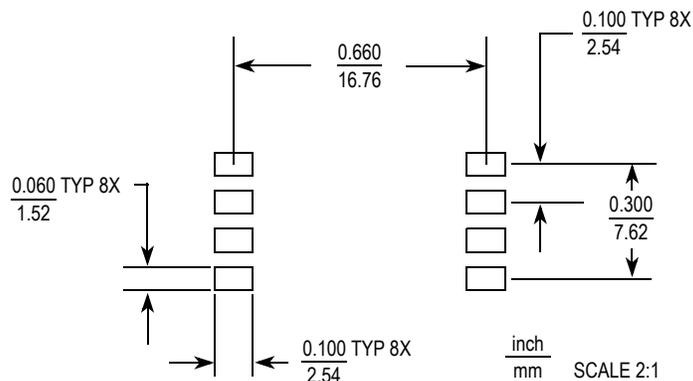
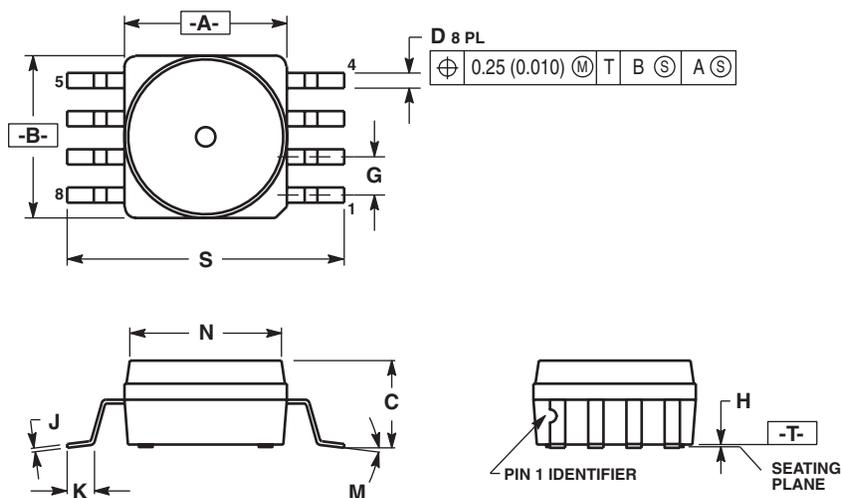


Figure 5. SOP Footprint (Case 482)

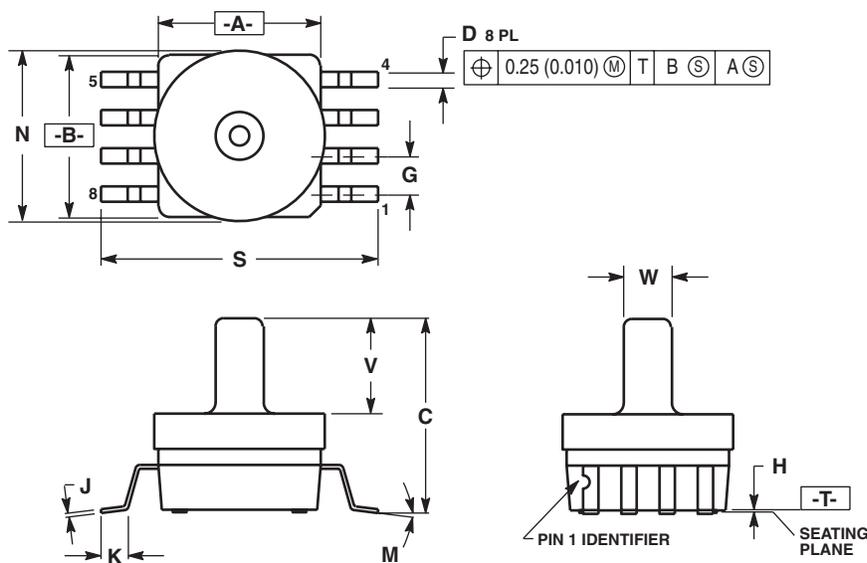
PACKAGE DIMENSIONS



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
 4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
 5. ALL VERTICAL SURFACES 5° TYPICAL DRAFT.

| DIM | INCHES | | MILLIMETERS | |
|-----|-----------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.415 | 0.425 | 10.54 | 10.79 |
| B | 0.415 | 0.425 | 10.54 | 10.79 |
| C | 0.212 | 0.230 | 5.38 | 5.84 |
| D | 0.038 | 0.042 | 0.96 | 1.07 |
| G | 0.100 BSC | | 2.54 BSC | |
| H | 0.002 | 0.010 | 0.05 | 0.25 |
| J | 0.009 | 0.011 | 0.23 | 0.28 |
| K | 0.061 | 0.071 | 1.55 | 1.80 |
| M | 0" | 7" | 0" | 7" |
| N | 0.405 | 0.415 | 10.29 | 10.54 |
| S | 0.709 | 0.725 | 18.01 | 18.41 |

**CASE 482-01
ISSUE O
SMALL OUTLINE PACKAGE**



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
 4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
 5. ALL VERTICAL SURFACES 5° TYPICAL DRAFT.

| DIM | INCHES | | MILLIMETERS | |
|-----|-----------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.415 | 0.425 | 10.54 | 10.79 |
| B | 0.415 | 0.425 | 10.54 | 10.79 |
| C | 0.500 | 0.520 | 12.70 | 13.21 |
| D | 0.038 | 0.042 | 0.96 | 1.07 |
| G | 0.100 BSC | | 2.54 BSC | |
| H | 0.002 | 0.010 | 0.05 | 0.25 |
| J | 0.009 | 0.011 | 0.23 | 0.28 |
| K | 0.061 | 0.071 | 1.55 | 1.80 |
| M | 0" | 7" | 0" | 7" |
| N | 0.444 | 0.448 | 11.28 | 11.38 |
| S | 0.709 | 0.725 | 18.01 | 18.41 |
| V | 0.245 | 0.255 | 6.22 | 6.48 |
| W | 0.115 | 0.125 | 2.92 | 3.17 |

**CASE 482A-01
ISSUE A
SMALL OUTLINE PACKAGE**

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