Integrated Pressure Sensor

The Freescale MPX4100A/MPXA4100A 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 MPX4100A/MPXA4100A 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.

Features

- 1.8% 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

Typical Applications

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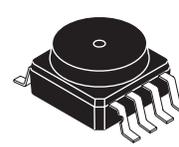- Also Ideal for Non-Automotive Applications

MPX4100A MPXA4100A 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/T1 CASE 482-01	MPXA4100AC6U CASE 482A-01
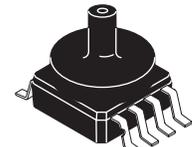
SMALL OUTLINE PACKAGE PIN NUMBERS[1]

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.

UNIBODY PACKAGE PIN NUMBERS[1]

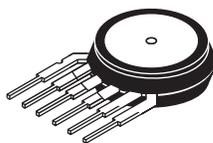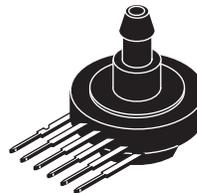| 1	V_{OUT}	4	N/C
2	GND	5	N/C
3	V_S	6	N/C

1. 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.
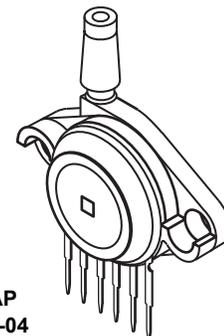
ORDERING INFORMATION
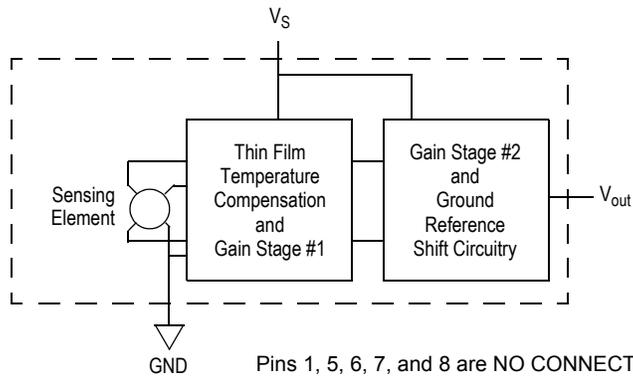
Device Type	Options	Case No.	MPX Series Order No.	Packing Options	Device Marking
SMALL OUTLINE PACKAGE (MPXA4100A SERIES)					
Basic Element	Absolute, Element Only	482	MPXA4100A6U	Rails	MPXA4100A
		482	MPXA4100A6T1	Tape & Reel	MPXA4100A
Ported Element	Absolute, Axial Port	482A	MPXA4100AC6U	Rails	MPXA4100A
UNIBODY PACKAGE (MPX4100A SERIES)					
Basic Element	Absolute, Element Only	867	MPX4100A	—	MPX4100A
Ported Element	Absolute, Ported	867B	MPX4100AP	—	MPX4100AP
	Absolute, Stove Pipe Port	867E	MPX4100AS	—	MPX4100A

UNIBODY PACKAGES

MPX4100A CASE 867-08	MPX4100AS CASE 867E-03	MPX4100AP CASE 867B-04

freescale
semiconductor

Figure 1. Fully Integrated Pressure Sensor Schematic

VOLTAGE OUTPUT VERSUS APPLIED DIFFERENTIAL PRESSURE

The output voltage of the differential or gauge sensor increases with increasing pressure applied to the pressure side (P1) relative to the vacuum side (P2). Similarly, output voltage increases as increasing vacuum is applied to the vacuum side (P2) relative to the pressure side (P1).

Figure 1 shows a block diagram of the internal circuitry on the stand-alone pressure sensor chip.

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.

MPX4100A

Table 2. Operating Characteristics (V_S = 5.1 Vdc, T_A = 25°C unless otherwise noted, P1 > P2.   Decoupling circuit shown in Figure 4 required to meet electrical specifications.)

| Characteristic	Symbol	Min	Typ	Max	Units
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[3] (0 to 85°C) @ V_S = 5.1 Volts	V_{off}	0.225	0.306	0.388	Vdc
Full Scale Output[4] (0 to 85°C) @ V_S = 5.1 Volts	V_{FSO}	4.870	4.951	5.032	Vdc
Full Scale Span[5] (0 to 85°C) @ V_S = 5.1 Volts	V_{FSS}	—	4.59	—	Vdc
Accuracy[6] (0 to 85°C)	—	—	—	±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 related 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.

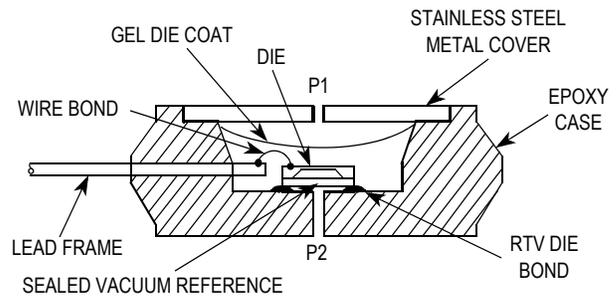### Table 3. Mechanical Characteristics

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

MPX4100A

# ON-CHIP TEMPERATURE COMPENSATION AND CALIBRATION
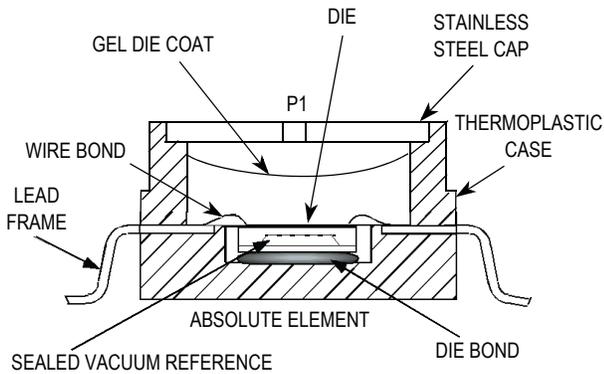
**Figure 2. Cross Sectional Diagram SOP
(not to scale)**

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

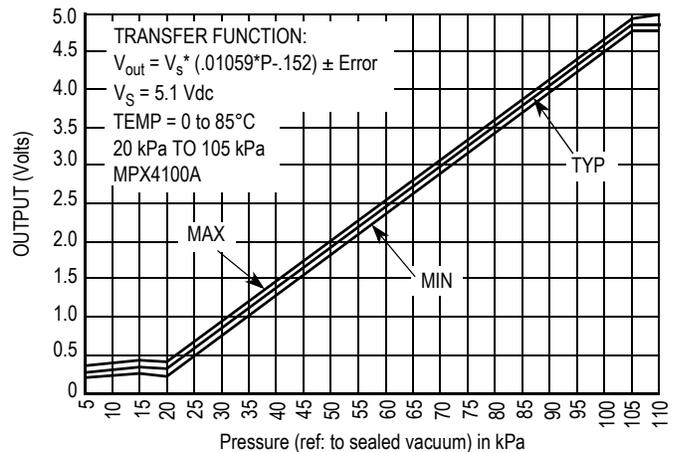**Figure 3. Cross Sectional Diagram
(not to scale)**

Figure 3 illustrates the absolute pressure sensing chip in the basic chip carrier (Case 867). 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.
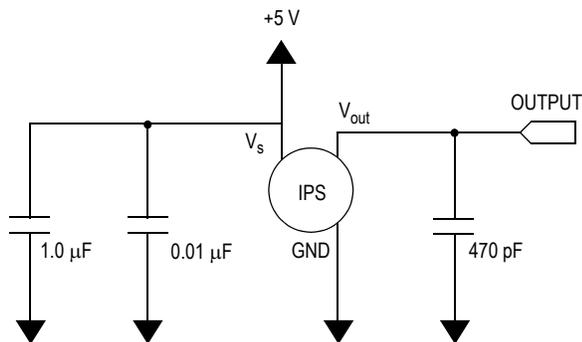
**Figure 4. Recommended Power Supply Decoupling
and Output Filtering
(For additional output filtering, please refer to
Application Note AN1646.)**

Figure 5. Output versus Absolute Pressure

TRANSFER FUNCTION:
$V_{out} = V_s * (.01059*P-.152) \pm Error$
$V_S = 5.1$ Vdc
TEMP = 0 to 85°C
20 kPa TO 105 kPa
MPX4100A

Figure 4 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 5 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.

The MPX4100A/MPXA4100A 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.

MPX4100A

Transfer Function (MPX4100A, MPXA4100A)

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

Temperature Error Band

MPX4100A, MPXA4100A Series

Temp	Multiplier
–40	3
0 to 85	1
+125	3

Temperature Error Factor
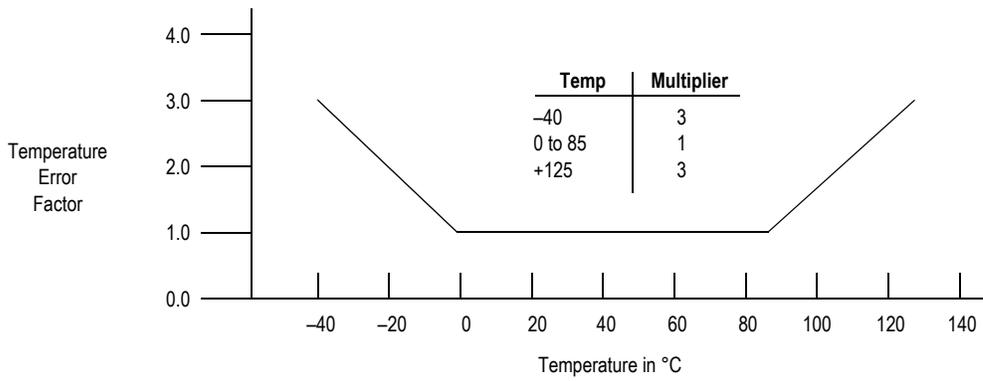
Temperature in °C

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 (kPa)

Pressure (in kPa)

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

MPX4100A
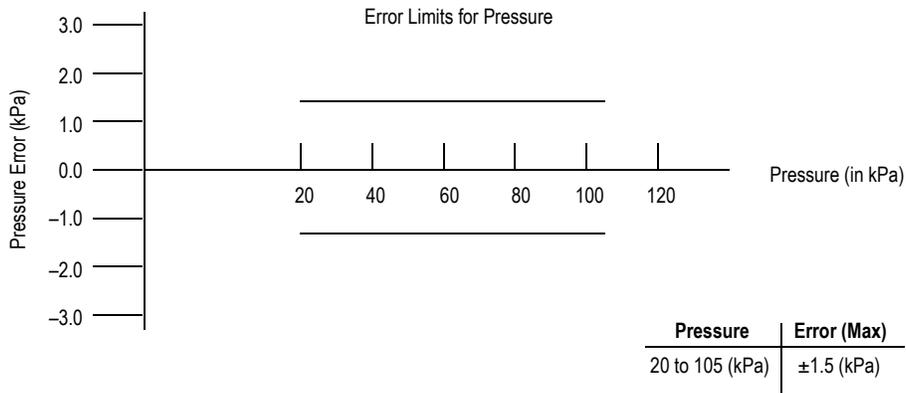
PRESSURE (P1)/VACUUM (P2) SIDE IDENTIFICATION TABLE

Freescale 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 silicone gel which isolates the die from the environment. The Freescale MPX pressure sensor is designed to operate with positive differential pressure applied, P1 > P2.

The Pressure (P1) side may be identified by using the following table.
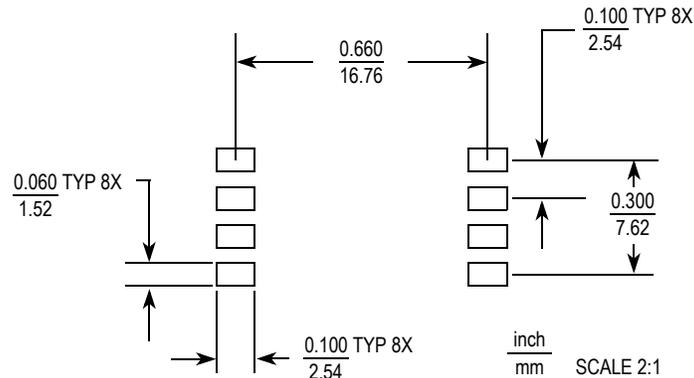
Table 4. Pressure (P1) Side Delineation

Part Number	Case Type	Pressure (P1) Side Identifier
MPX4100A	867	Stainless Steep Cap
MPX4100AP	867B	Side with Port Marking
MPX4100AS	867E	Side with Port Attached
MPXA4100A6U/T1	482	Stainless Steel Cap
MPXA4100AC6U	482A	Side with Port Attached

INFORMATION FOR USING THE SMALL OUTLINE PACKAGE (CASE 482)

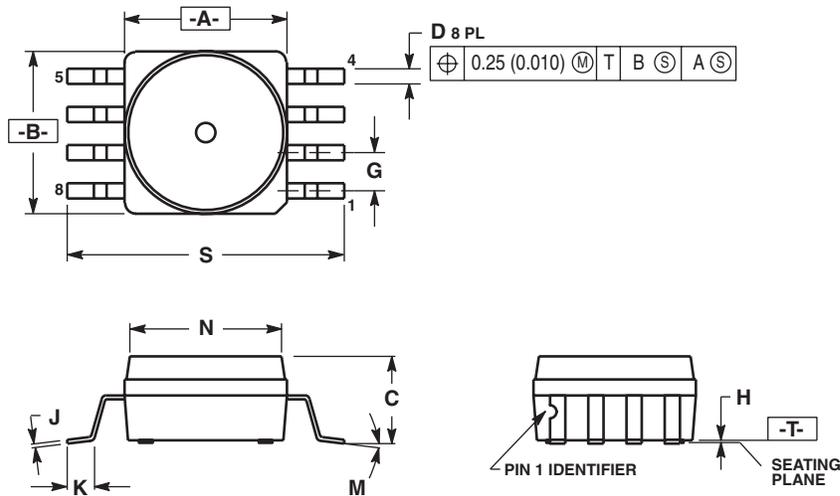### MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

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.

$\dfrac{0.660}{16.76}$

$\dfrac{0.100 \text{ TYP 8X}}{2.54}$

$\dfrac{0.060 \text{ TYP 8X}}{1.52}$

$\dfrac{0.300}{7.62}$

$\dfrac{0.100 \text{ TYP 8X}}{2.54}$

$\dfrac{\text{inch}}{\text{mm}}$ SCALE 2:1
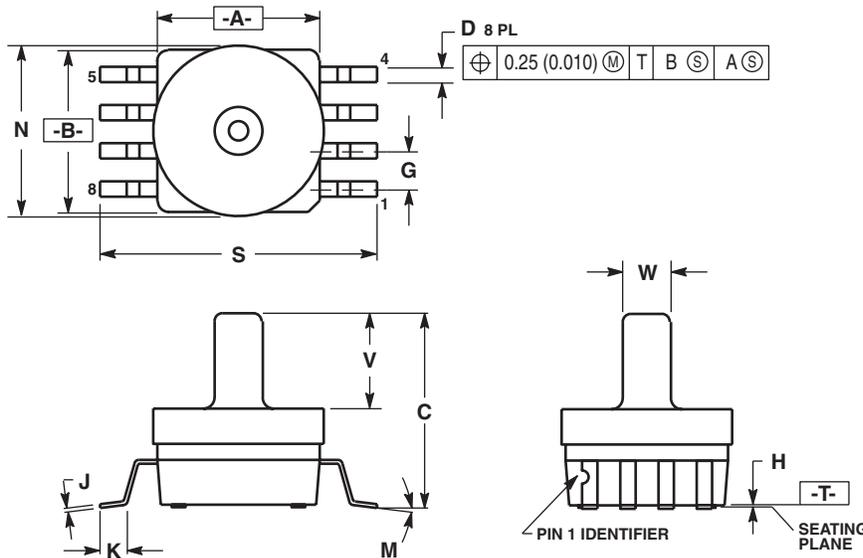
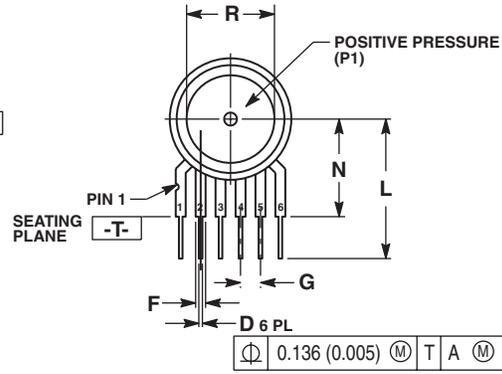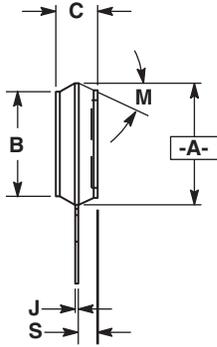**Figure 6. SOP Footprint (Case 482)**

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

MPX4100A

PACKAGE DIMENSIONS

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.595	0.630	15.11	16.00
B	0.514	0.534	13.06	13.56
C	0.200	0.220	5.08	5.59
D	0.027	0.033	0.68	0.84
F	0.048	0.064	1.22	1.63
G	0.100 BSC		2.54 BSC	
J	0.014	0.016	0.36	0.40
L	0.695	0.725	17.65	18.42
M	30° NOM		30° NOM	
N	0.475	0.495	12.07	12.57
R	0.430	0.450	10.92	11.43
S	0.090	0.105	2.29	2.66

POSITIVE PRESSURE (P1)

PIN 1

SEATING PLANE

-T-

D 6 PL

⌖ 0.136 (0.005) Ⓜ T A Ⓜ

STYLE 1:
PIN 1. VOUT
2. GROUND
3. VCC
4. V1
5. V2
6. VEX

STYLE 2:
PIN 1. OPEN
2. GROUND
3. -VOUT
4. VSUPPLY
5. +VOUT
6. OPEN

STYLE 3:
PIN 1. OPEN
2. GROUND
3. +VOUT
4. +VSUPPLY
5. -VOUT
6. OPEN

**CASE 867-08
ISSUE N
UNIBODY**

PACKAGE DIMENSIONS

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TITLE: SENSOR, 6 LEAD UNIBODY CELL, AP & GP 01ASB09087B	DOCUMENT NO: 98ASB42796B	REV: G	
	CASE NUMBER: 867B-04	28 JUL 2005	
	STANDARD: NON-JEDEC		

PAGE 1 OF 2

CASE 867B-04
ISSUE G
UNIBODY PACKAGE

MPX4100A

PACKAGE DIMENSIONS

NOTES:

1. DIMENSIONS ARE IN MILLIMETERS.

2. DIMENSIONS AND TOLERANCES PER ASME Y14.5M−1994.

3. 867B−01 THRU −3 OBSOLETE, NEW STANDARD 867B−04.

STYLE 1:

PIN 1: V OUT
    2: GROUND
    3: VCC
    4: V1
    5: V2
    6: V EX

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TITLE: SENSOR, 6 LEAD UNIBODY CELL, AP & GP 01ASB09087B	DOCUMENT NO: 98ASB42796B		REV: G
	CASE NUMBER: 867B−04		28 JUL 2005
	STANDARD: NON−JEDEC		

PAGE 2 OF 2

CASE 867B-04
ISSUE G
UNIBODY PACKAGE

MPX4100A

PACKAGE DIMENSIONS
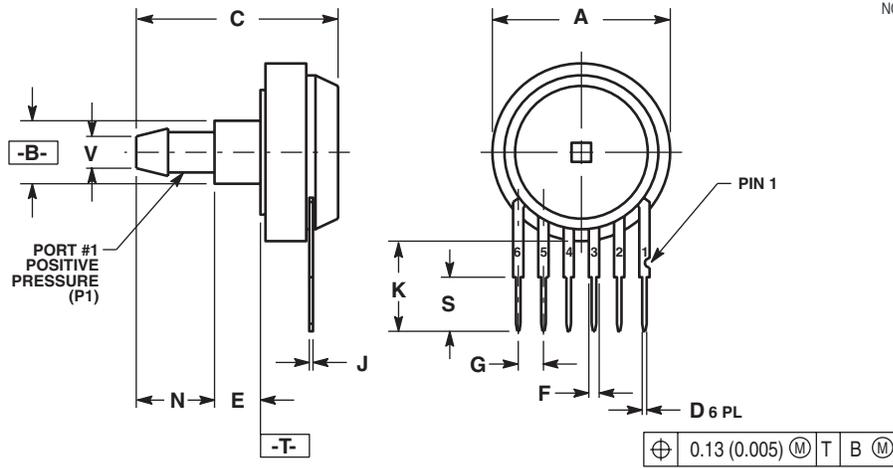
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.690	0.720	17.53	18.28
B	0.245	0.255	6.22	6.48
C	0.780	0.820	19.81	20.82
D	0.027	0.033	0.69	0.84
E	0.178	0.186	4.52	4.72
F	0.048	0.064	1.22	1.63
G	0.100 BSC		2.54 BSC	
J	0.014	0.016	0.36	0.41
K	0.345	0.375	8.76	9.53
N	0.300	0.310	7.62	7.87
S	0.220	0.240	5.59	6.10
V	0.182	0.194	4.62	4.93

STYLE 1:
PIN 1. V_{OUT}
2. GROUND
3. V_{CC}
4. V1
5. V2
6. V_{EX}

CASE 867E-03
ISSUE D
UNIBODY PACKAGE

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