

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

The Freescale MPX4101A/MPXA4101A/MPXH6101A 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 MPX4101A/MPXA4101A/MPXH6101A 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

- 1.72% 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

## Typical Applications

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

UNIBODY PACKAGE PIN NUMBERS <sup>(1)</sup>			
1	V <sub>OUT</sub>	4	N/C
2	GND	5	N/C
3	V <sub>S</sub>	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.

SMALL OUTLINE PACKAGE PIN NUMBERS <sup>(1)</sup>			
1	N/C	5	N/C
2	V <sub>S</sub>	6	N/C
3	GND	7	N/C
4	V <sub>OUT</sub>	8	N/C

SUPER SMALL OUTLINE PACKAGE PIN NUMBERS <sup>(1)</sup>			
1	N/C	5	N/C
2	V <sub>S</sub>	6	N/C
3	GND	7	N/C
4	V <sub>OUT</sub>	8	N/C

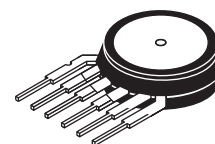
1. Pins 1, 5, 6, 7, and 8 are internal device connections. Do not connect to external circuitry or ground. Pin 1 is noted by the notch in the lead.

ORDERING INFORMATION					
Device Type	Options	Case No.	MPX Series Order No.	Packing Options	Device Marking
UNIBODY PACKAGE (MPX4101A SERIES)					
Basic Element	Absolute, Element Only	867	MPX4101A	—	MPX4101A
SMALL OUTLINE PACKAGE (MPXA4101A SERIES)					
Ported Element	Absolute, Axial Port	482A	MPXA4101AC6U	Rails	MPXA4101A
SUPER SMALL OUTLINE PACKAGE (MPXA6101A SERIES)					
Basic Element	Absolute, Element Only	1317	MPXH6101A6U	Rails	MPXH6101A
	Absolute, Element Only	1317	MPXH6101A6T1	Tape and Reel	MPXH6101A

**MPX4101A  
MPXA4101A  
MPXH6101A  
SERIES**

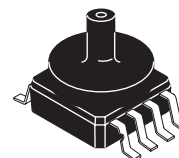
**INTEGRATED  
PRESSURE SENSOR  
15 TO 102 kPA  
(2.18 TO 14.8 psi)  
0.25 TO 4.95 V OUTPUT**

## UNIBODY PACKAGE



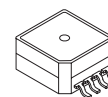
**MPX4101A  
CASE 867-08**

## SMALL OUTLINE PACKAGE

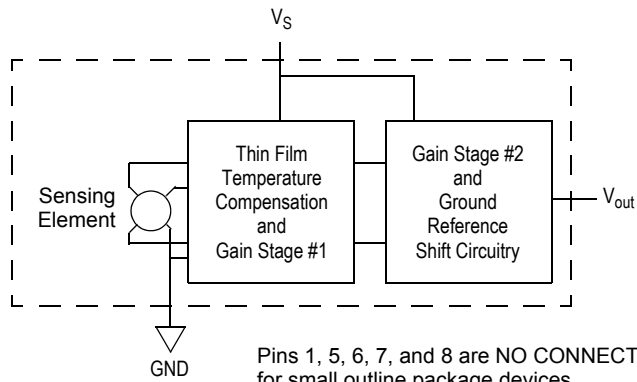


**MPXA4101AC6U  
CASE 482A-01**

## SUPER SMALL OUTLINE PACKAGE



**MPXH6101A6U/6T1  
CASE 1317-04**



Pins 1, 5, 6, 7, and 8 are NO CONNECTS for small outline package devices.

Pins 4, 5, and 6 are NO CONNECTS for unibody devices.

**Figure 1. Temperature Compensated and Calibrated Pressure Sensor Schematic**

**Table 1. Maximum Ratings<sup>(1)</sup>**

Rating	Symbol	Value	Unit
Maximum Pressure ( $P_1 > P_2$ )	$P_{MAX}$	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 <sup>(1)</sup>	$P_{OP}$	15	—	102	kPa
Supply Voltage <sup>(2)</sup>	$V_S$	4.85	5.1	5.35	Vdc
Supply Current	$I_o$	—	7.0	10	mAdc
Minimum Pressure Offset @ $V_S = 5.1$ Volts <sup>(3)</sup>	$V_{off}$	0.171	0.252	0.333	Vdc
Full Scale Output @ $V_S = 5.1$ Volts <sup>(4)</sup>	$V_{FSO}$	4.870	4.951	5.032	Vdc
Full Scale Span @ $V_S = 5.1$ Volts <sup>(5)</sup>	$V_{FSS}$	—	4.7	—	Vdc
Accuracy <sup>(6)</sup>	—	—	—	$\pm 1.72$	$\%V_{FSS}$
Sensitivity	V/P	—	54	—	mV/kPa
Response Time <sup>(7)</sup>	$t_R$	—	15	—	ms
Output Source Current at Full Scale Output	$I_{o+}$	—	0.1	—	mAdc
Warm-Up Time <sup>(8)</sup>	—	—	20	—	ms
Offset Stability <sup>(9)</sup>	—	—	$\pm 0.5$	—	$\%V_{FSS}$

- 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  $25^\circ\text{C}$ .
  - TcSpan: Output deviation over the temperature range of 0 to  $85^\circ\text{C}$ , relative to  $25^\circ\text{C}$ .
  - TcOffset: Output deviation with minimum rated pressure applied, over the temperature range of 0 to  $85^\circ\text{C}$ , relative to  $25^\circ\text{C}$ .
  - Variation from Nominal: The variation from nominal values, for Offset or Full Scale Span, as a percent of  $V_{FSS}$ , at  $25^\circ\text{C}$ .
- 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.

## ON-CHIP TEMPERATURE COMPENSATION AND CALIBRATION

Figure 2 illustrates an absolute sensing chip in the super small outline package (Case 1317).

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/

MPXA4101A/MPXH6101A 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.

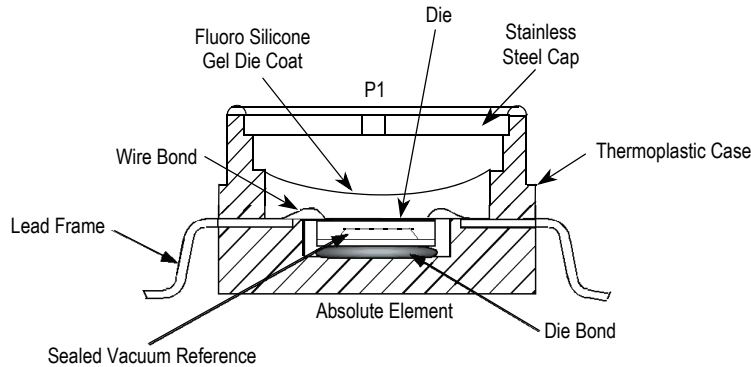


Figure 2. Cross Sectional Diagram SSOP (not to scale)

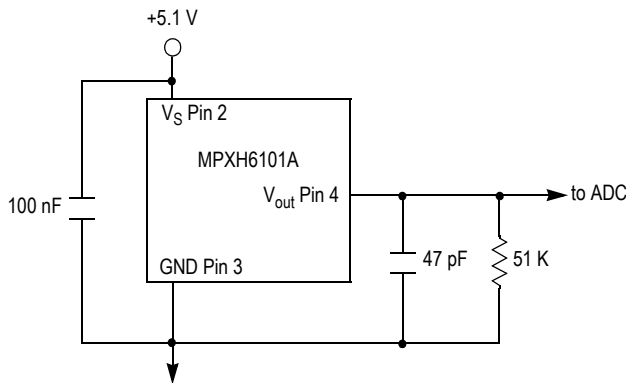


Figure 3. Recommended Power Supply Decoupling and Output Filtering

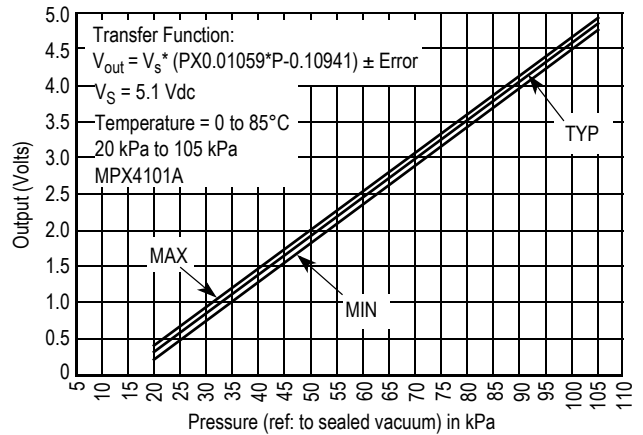


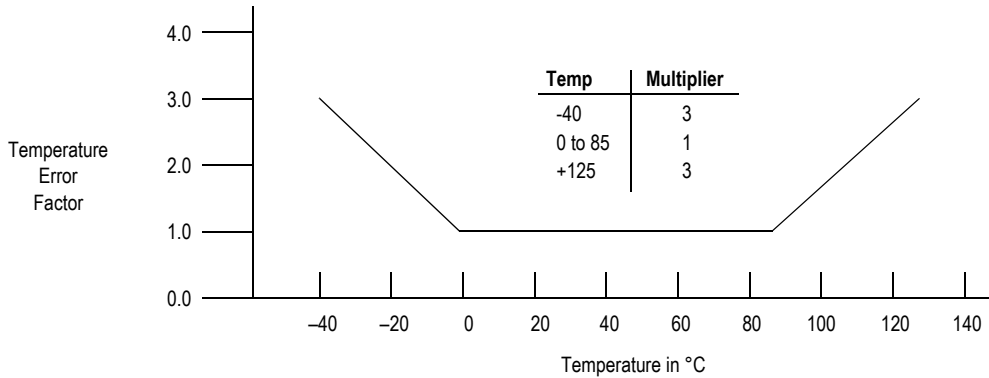
Figure 4. Output versus Absolute Pressure

## Transfer Function (MPX4101A, MPXA4101A, MPXH6101A)

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

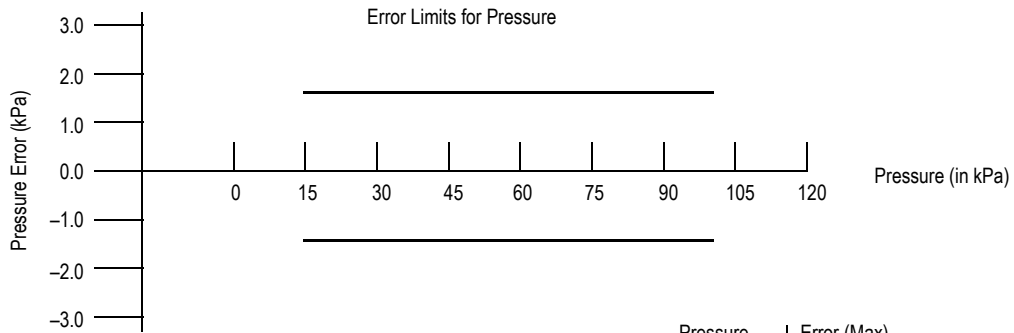
## Temperature Error Band

### MPX4101A, MPXA4101A MPXH6101A 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



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

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

Freescle 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 Freescle pressure sensor is designed to operate with positive differential pressure applied,  $P_1 > P_2$ .

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
MPXH6101A6U	1317	Stainless Steel Cap
MPXH6101A6T1	1317	Stainless Steel Cap

## INFORMATION FOR USING THE SMALL OUTLINE PACKAGES

### 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.

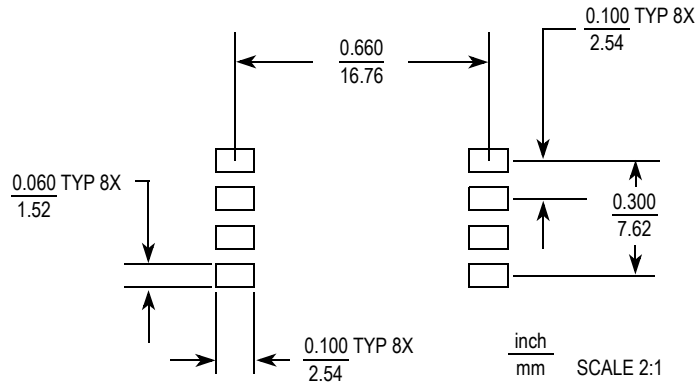


Figure 5. SOP Footprint (Case 482)

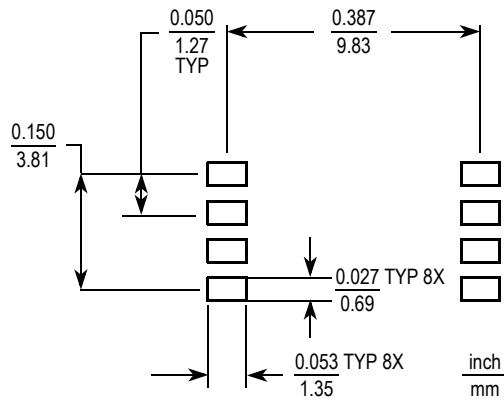
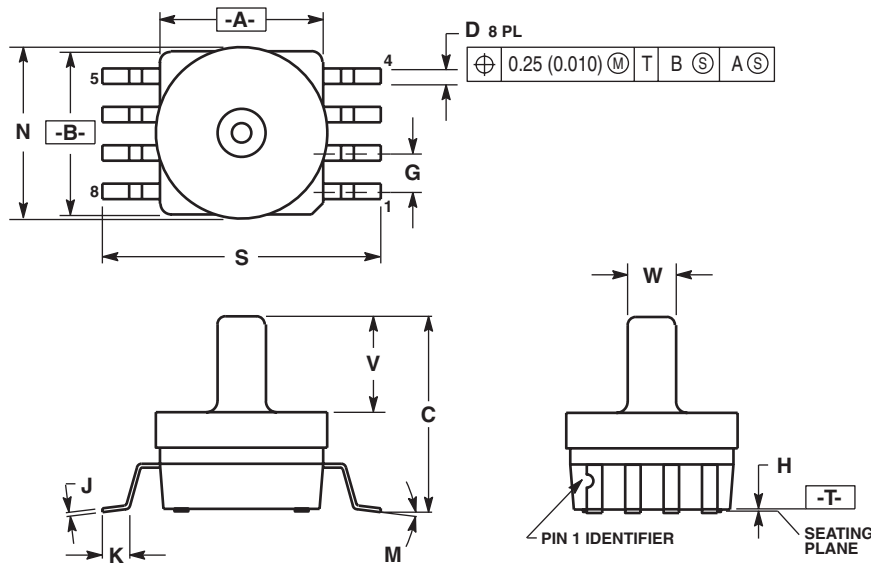


Figure 6. SSOP Footprint (Case 1317)

## PACKAGE DIMENSIONS

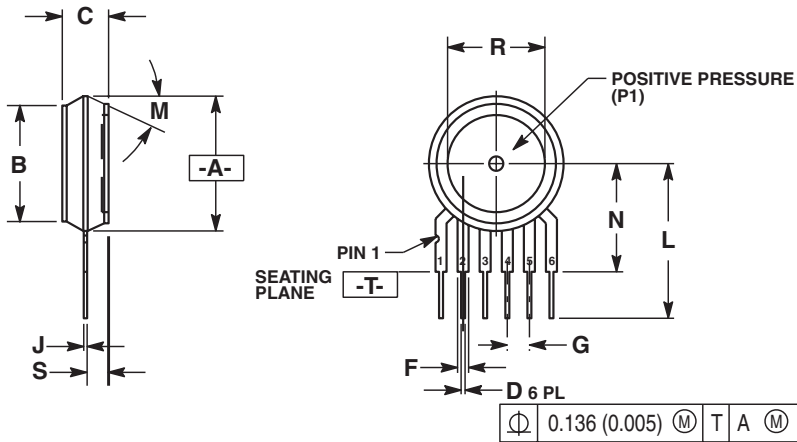


**NOTES:**

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	0.500	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



**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION -A- IS INCLUSIVE OF THE MOLD STOP RING. MOLD STOP RING NOT TO EXCEED 16.00 (0.630).

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

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

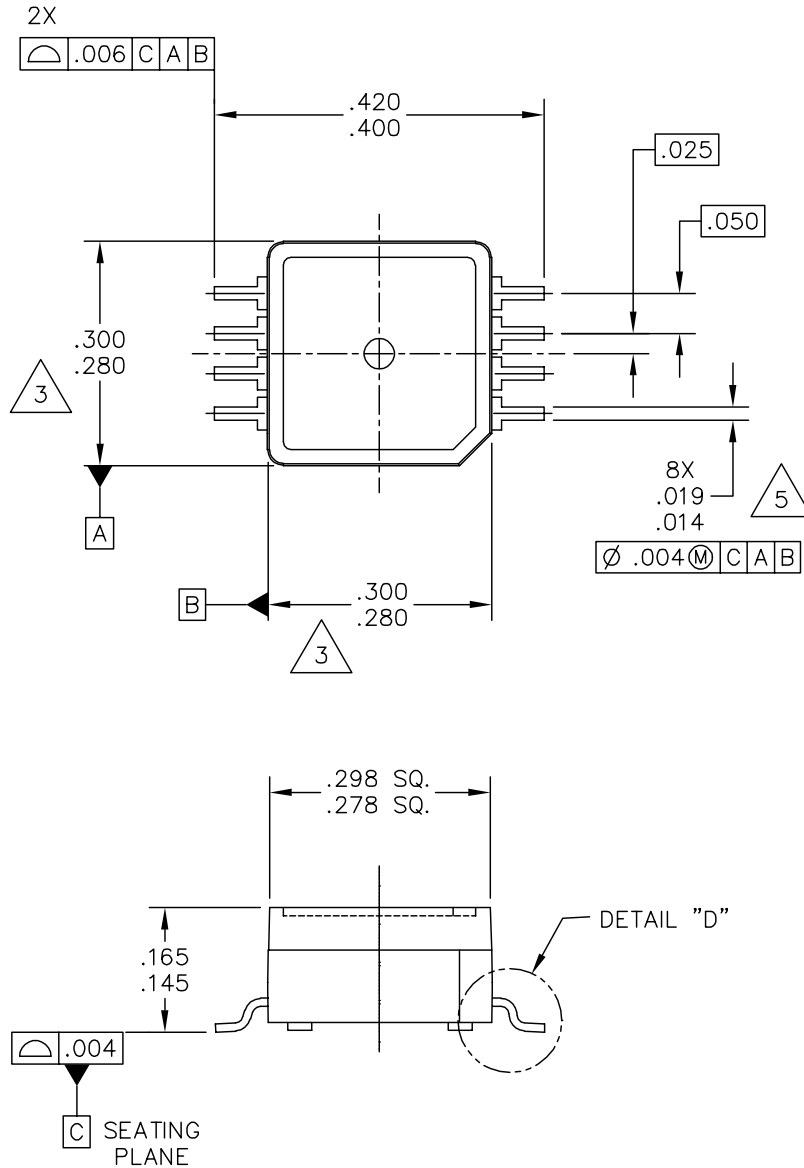
STYLE 2:  
PIN 1. OPEN  
2. GROUND  
3. -VOUT  
4. VSUPPLY  
5. +VOUT  
6. OPEN

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

### CASE 867-08 ISSUE N UNIBODY PACKAGE

MPX4101A

# PACKAGE DIMENSIONS



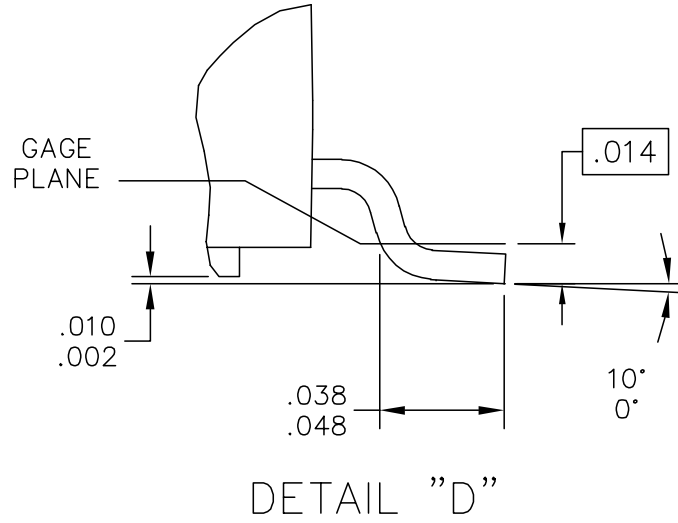
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			CASE NUMBER: 1317-04		24 MAY 2005
			STANDARD: NON-JEDEC		

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**CASE 1317-04  
ISSUE F  
SUPER SMALL OUTLINE PACKAGE**



**PACKAGE DIMENSIONS**



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	STANDARD: NON-JEDEC		

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**CASE 1317-04  
ISSUE F  
SUPER SMALL OUTLINE PACKAGE**

**MPX4101A**

## PACKAGE DIMENSIONS

NOTES:

1. ALL DIMENSIONS IN INCHES.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.
3. DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.  
MOLD FLASH OR PROTRUSION SHALL NOT EXCEED .006 INCHES PER SIDE.
4. ALL VERTICAL SURFACES TO BE 5° MAXIMUM.
5. DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION.  
ALLOWABLE DAMBAR PROTRUSION SHALL BE .008 INCHES MAXIMUM.

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	CASE NUMBER: 1317-04	24 MAY 2005	
	STANDARD: NON-JEDEC		

PAGE 3 OF 3

**CASE 1317-04**  
**ISSUE F**  
**SUPER SMALL OUTLINE PACKAGE**

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