

## Media Resistant, Integrated Silicon Pressure Sensor for Manifold Absolute Pressure, Altimeter or Barometer Applications On-Chip Signal Conditioned, Temperature Compensated and Calibrated

### MPX4115A Series

INTEGRATED  
PRESSURE SENSOR  
15 to 115 kPa (2.2 to 16.7 psi)  
0.2 to 4.8 V Output

The MPX4115A series is designed to sense absolute air pressure in altimeter or barometer (BAP) applications. Freescale's BAP sensor integrates on-chip, bipolar op amp circuitry and thin film resistor networks to provide a high level analog output signal and temperature compensation. The small form factor and high reliability of on-chip integration makes the Freescale BAP sensor a logical and economical choice for application designers.

### Features

- 1.5% Maximum Error Over 0° to 85°C
- Ideally Suited for Microprocessor Interfacing or Microcontroller-Based Systems
- Temperature Compensated Over -40°C to +125°C
- Durable Epoxy Unibody Element or Thermoplastic (PPS) Surface Mount Package
- Available as Standard Fluorosilicone Gel (MPXA4115A, MPX4115A) or Media Resistant Gel (MPXAZ4115A)

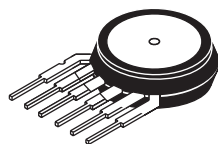
### Application Examples

- Altimeter
- Barometer
- Aviation Altimeters
- Industrial Controls
- Engine Control
- Weather Stations and Weather Reporting Devices

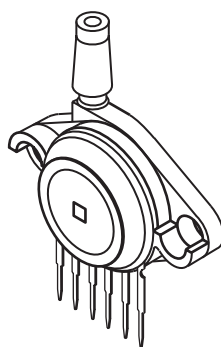
### ORDERING INFORMATION

Device Name	Package Options	Case No.	# of Ports			Pressure Type			Device Marking
			None	Single	Dual	Gauge	Differential	Absolute	
<b>Unibody Package (MPX4115A Series)</b>									
MPX4115A	Tray	867-08	•					•	MPX4115A
MPX4115AP	Tray	867B-04		•				•	MPX4115AP
MPX4115AS	Tray	867E-03		•				•	MPX4115A
<b>Small Outline Package (Media Resistant Gel) (MPXAZ4115A Series)</b>									
MPXAZ4115A6U	Rails	482	•					•	MPXAZ4115A
MPXAZ4115AC6U	Rails	482A		•				•	MPXAZ4115A
MPXAZ4115A6T1	Tape and Reel	482	•					•	MPXAZ4115A
<b>Small Outline Package (MPXA4115A Series)</b>									
MPXA4115AC6U	Rails	482A		•				•	MPXA4115A
MPXA4115AP	Tray	1369-01		•				•	MPXA4115AP
MPXA4115A6T1	Tape and Reel	482	•					•	MPXA4115A
MPXA4115A6U	Rails	482	•					•	MPXA4115A

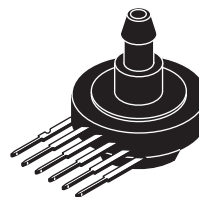
UNIBODY PACKAGES



**MPX4115A  
CASE 867-08**

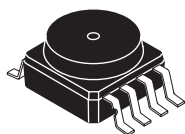


**MPX4115AP  
CASE 867B-04**

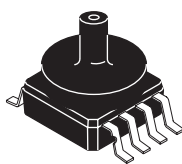


**MPX4115AS  
CASE 867E-03**

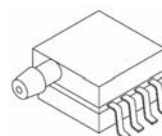
SMALL OUTLINE PACKAGES



**MPXAZ4115A6U/T1  
MPXA4115A6U/T1  
CASE 482-01**



**MPXAZ4115AC6U  
MPXA4115AC6U  
CASE 482A-01**



**MPXA4115AP  
CASE 1369-01**

## Operating Characteristics

**Table 1. 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 <sup>(1)</sup>	$P_{OP}$	15	—	115	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>	$V_{off}$	0.135	0.204	0.273	Vdc
Full Scale Output @ $V_S = 5.1$ Volts <sup>(4)</sup>	$V_{FSO}$	4.725	4.794	4.863	Vdc
Full Scale Span @ $V_S = 5.1$ Volts <sup>(5)</sup>	$V_{FSS}$	4.521	4.59	4.659	Vdc
Accuracy <sup>(6)</sup>	—	—	—	$\pm 1.5$	$\%V_{FSS}$
Sensitivity	V/P	—	46	—	mV/kPa
Response Time <sup>(7)</sup>	$t_R$	—	1.0	—	ms
Output Source Current at Full Scale Output	$I_{o+}$	—	0.1	—	mAdc
Warm-Up Time <sup>(8)</sup>	—	—	20	—	mSec
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.

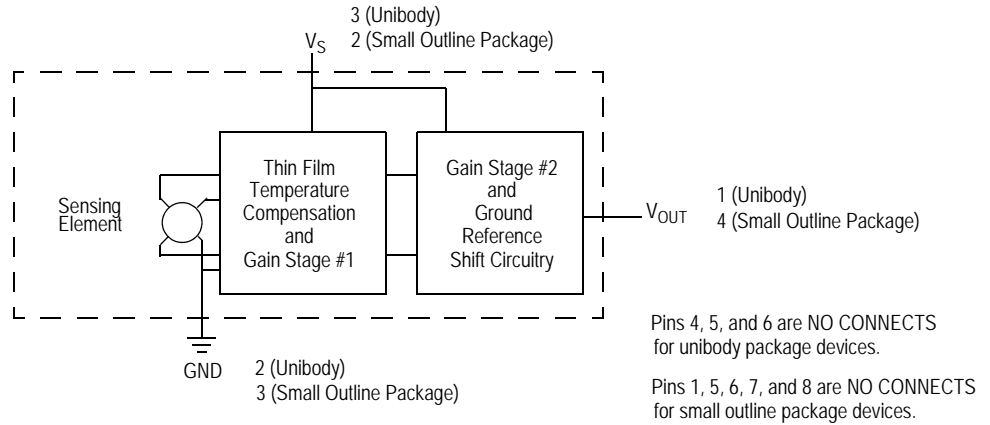
## Maximum Ratings

**Table 2. MAXIMUM RATINGS<sup>(1)</sup>**

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.

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



**Figure 1. Fully Integrated Pressure Sensor Schematic for Unibody Package and Small Outline Package**

## On-chip Temperature Compensation and Calibration

Figure 2 illustrates an absolute sensing chip in the basic chip carrier (Case 867) and the small outline chip carrier (Case 482). 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 MPX4115A 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.

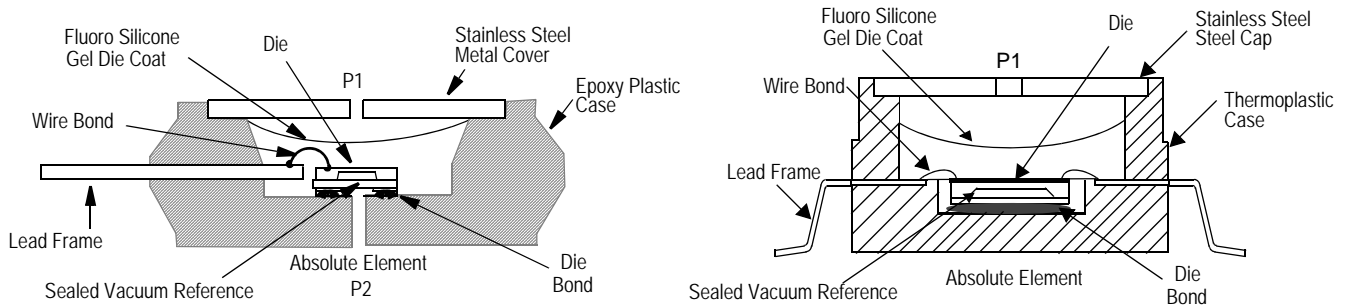


Figure 2. Cross-Sectional Diagram (not to scale)

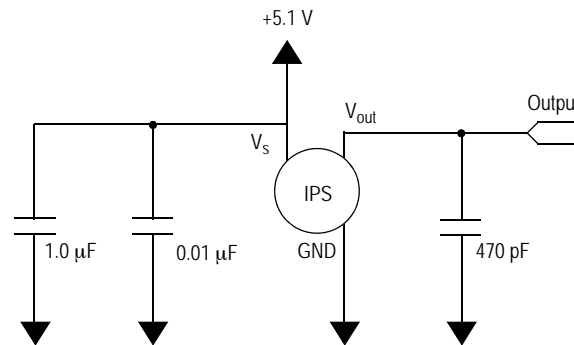


Figure 3. Recommended Power Supply Decoupling and Output Filtering  
(For output filtering recommendations, refer to Application Note AN1646.)

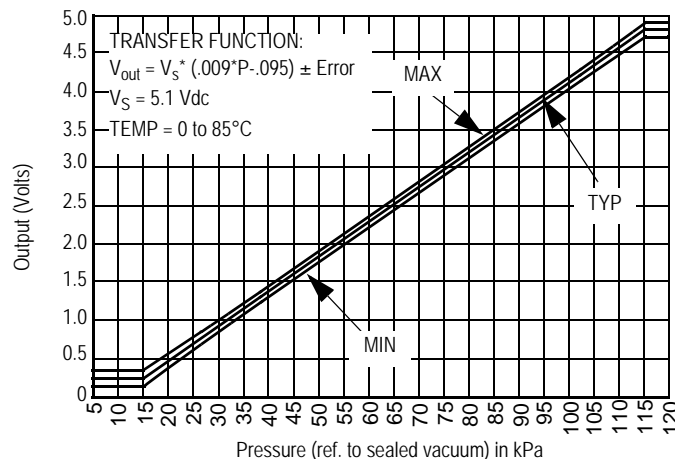


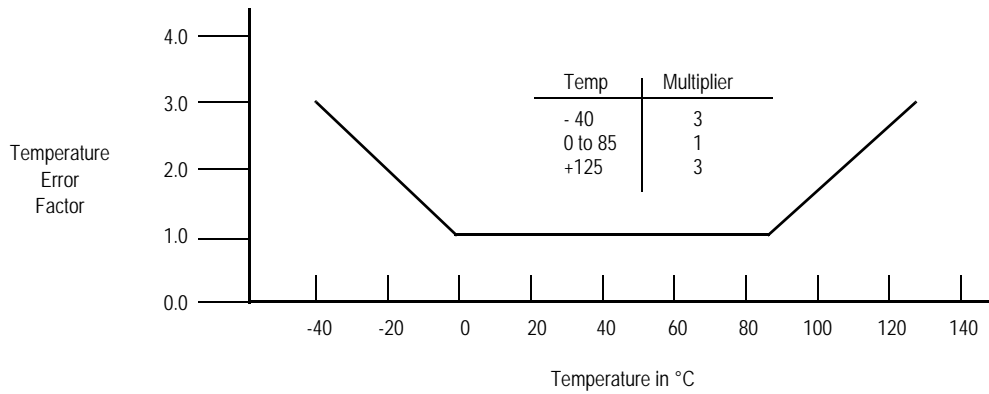
Figure 4. Output versus Absolute Pressure

## Transfer Function (MPX4115A)

**Nominal Transfer Value:**  $V_{out} = V_S (P \times 0.009 - 0.095)$   
 $\pm (\text{Pressure Error} \times \text{Temp. Factor} \times 0.009 \times V_S)$   
 $V_S = 5.1 \text{ V} \pm 0.25 \text{ Vdc}$

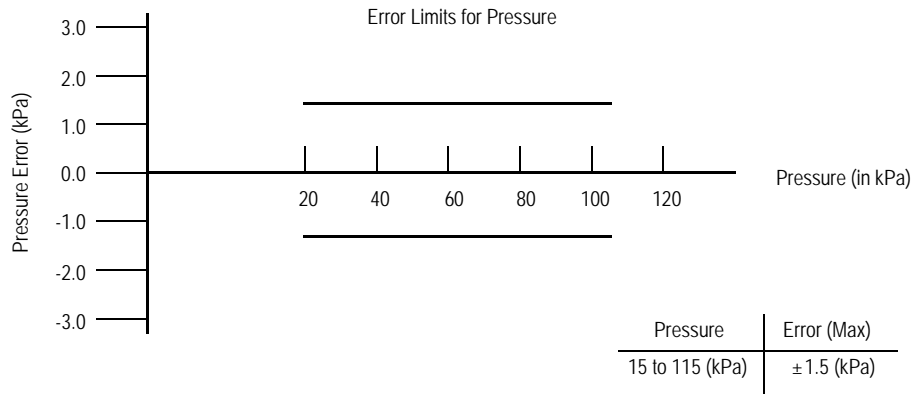
## Temperature Error Band

### MPX4115A 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 (P1)/VACUUM (P2) SIDE IDENTIFICATION TABLE**

The two sides of the pressure sensor are designated 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 MPX pressure

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

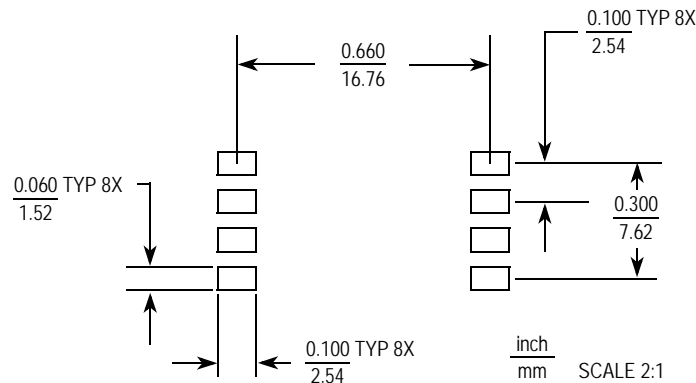
The Pressure (P1) side may be identified by using the following table:

Part Number	Case Type	Pressure (P1) Side Identifier
MPX4115A	867	Stainless Steel Cap
MPX4115AP	867B	Side with Part Marking
MPX4115AS	867E	Side with Port Attached
MPXAZ4115A6U/T1, MPXA4115A6U/T1	482	Side with Part Marking
MPXAZ4115AC6U, MPXA4115AC6U	482A	Side with Port Attached
MPXA4115AP	1369	Side with Port Attached

**INFORMATION FOR USING THE SMALL OUTLINE PACKAGE (CASE 482)****MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS**

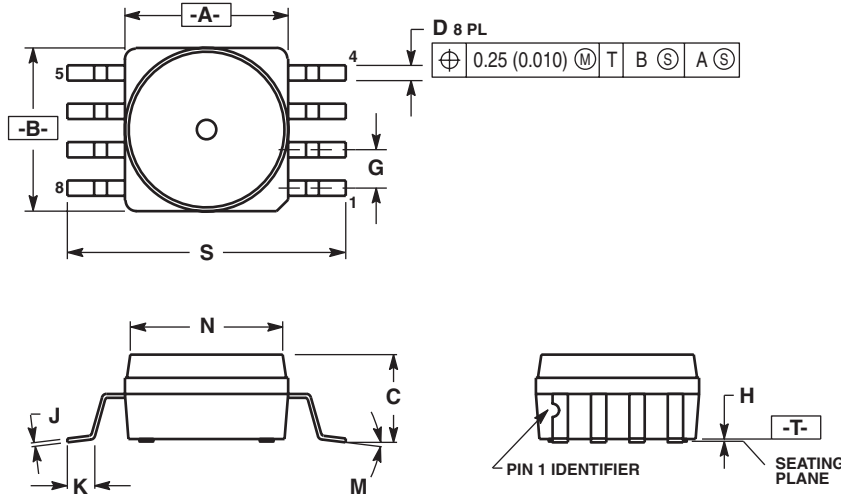
Surface mount board layout is a critical portion of the total design. The footprint for the surface mount packages must be the correct size to ensure proper solder connection interface between the board and the package. With the correct

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.



**Figure 5. SOP Footprint (Case 482)**

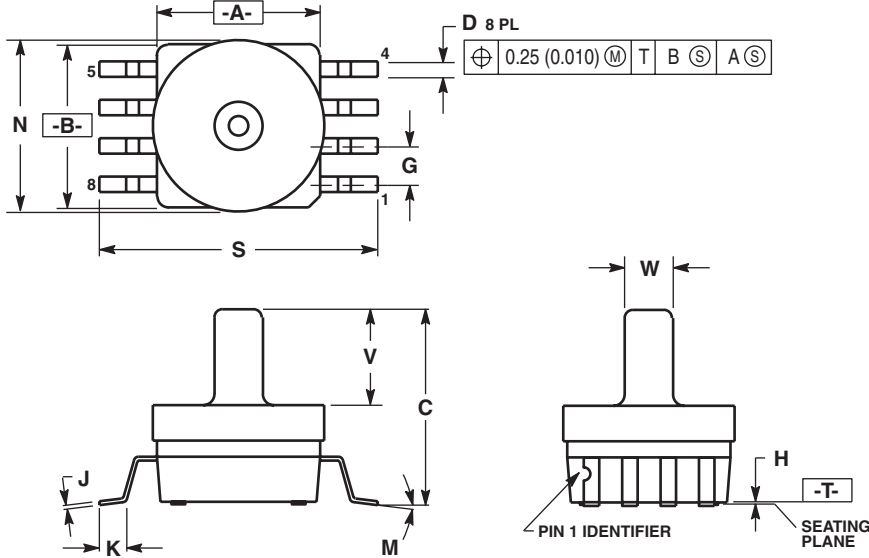
PACKAGE DIMENSIONS



- 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



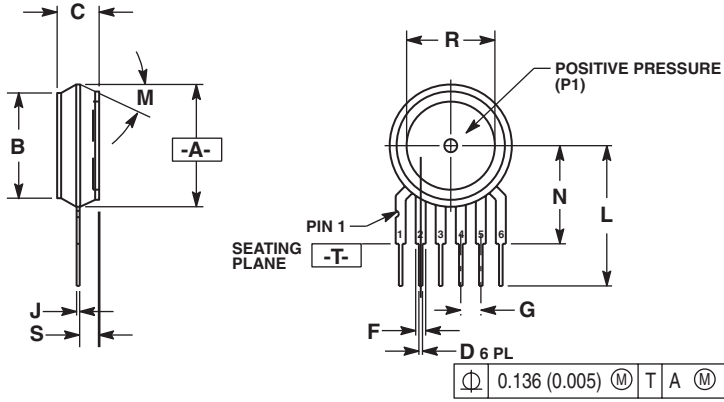
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
  5. ALL VERTICAL SURFACES 5° TYPICAL DRAFT.

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



**PACKAGE DIMENSIONS**



- 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

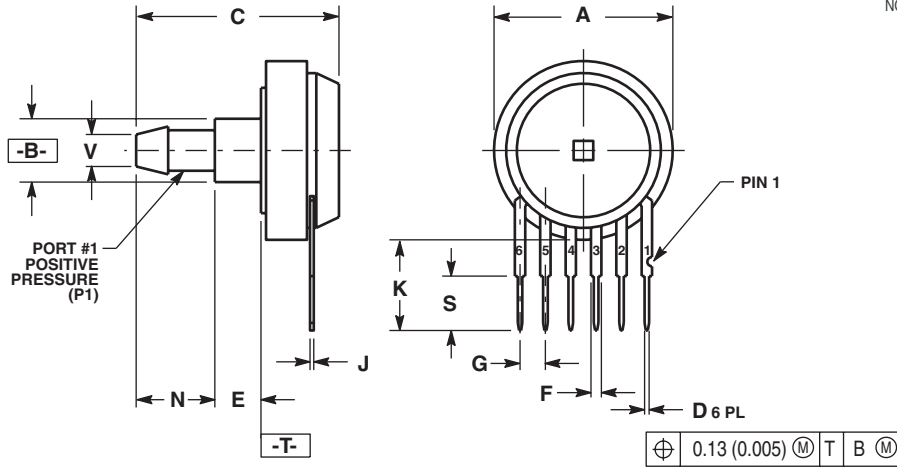
- STYLE 1:  
 PIN 1. VOUT  
 2. GROUND  
 3. VCC  
 4. V1  
 5. V2  
 6. VEX

- 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  
 BASIC ELEMENT**

PACKAGE DIMENSIONS



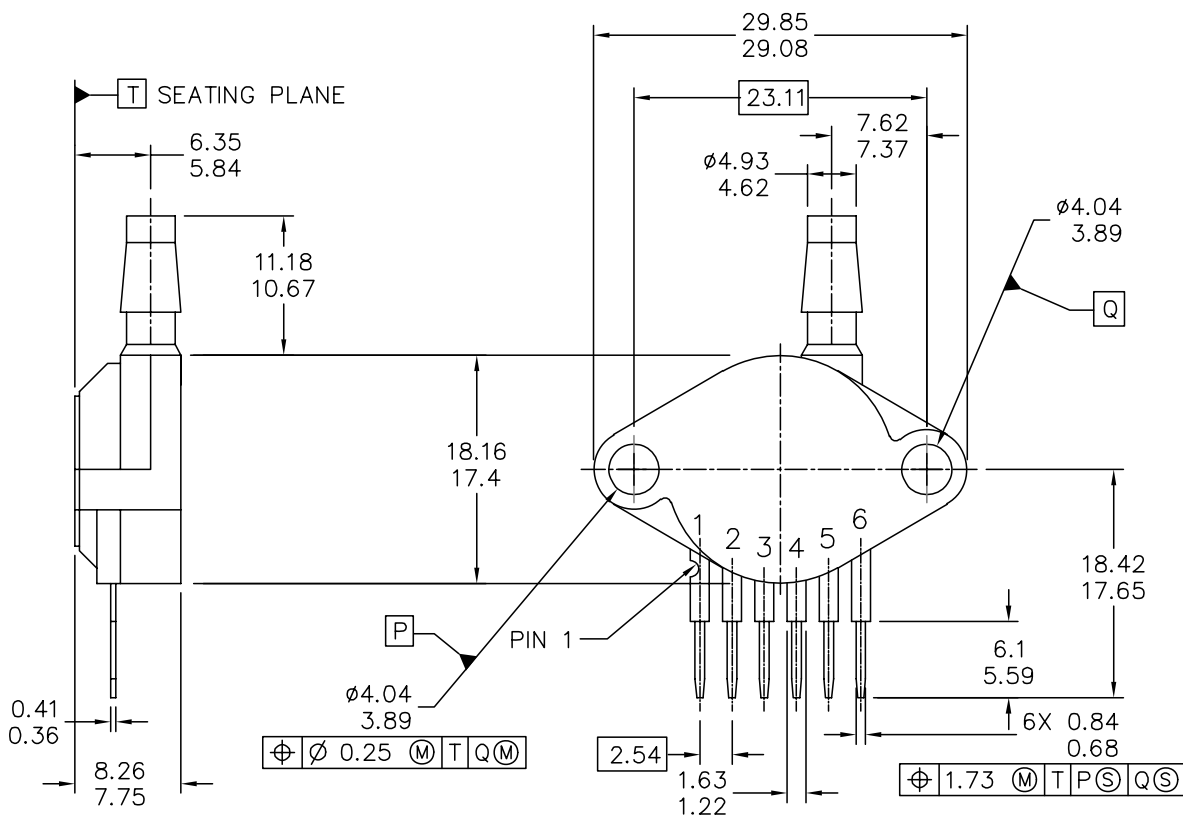
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	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.  $V_1$   
 5.  $V_2$   
 6.  $V_{EX}$

CASE 867E-O3  
 ISSUE D  
 STOVE PIPE PORT (AS)

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	

**CASE 867B-04  
ISSUE G  
PORTED (AP)**

**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:

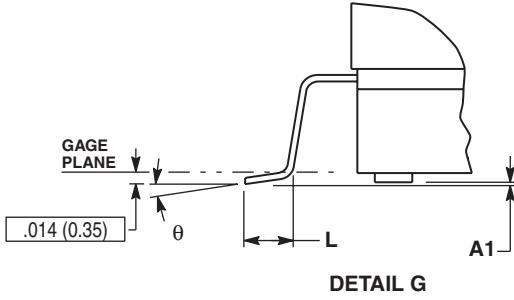
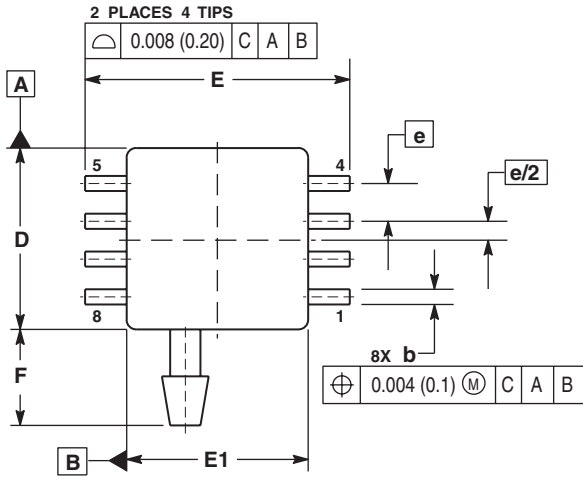
- PIN 1: V OUT  
 2: GROUND  
 3: VCC  
 4: V1  
 5: V2  
 6: V EX

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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		

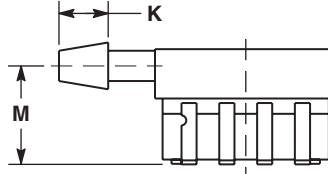
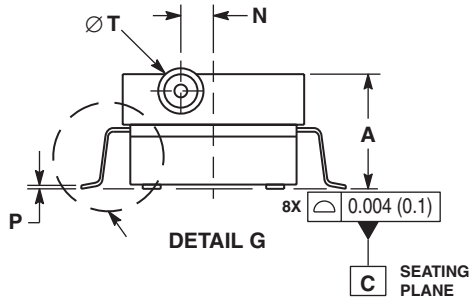
PAGE 2 OF 2

**CASE 867B-04  
 ISSUE G  
 PORTED (AP)**

PACKAGE DIMENSIONS



- NOTES:
1. CONTROLLING DIMENSION: INCH.
  2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
  3. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.006 (0.152) PER SIDE.
  4. DIMENSION "b" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.008 (0.203) MAXIMUM.



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.300	0.330	7.11	7.62
A1	0.002	0.010	0.05	0.25
b	0.038	0.042	0.96	1.07
D	0.465	0.485	11.81	12.32
E	0.717 BSC		18.21 BSC	
E1	0.465	0.485	11.81	12.32
e	0.100 BSC		2.54 BSC	
F	0.245	0.255	6.22	6.47
K	0.120	0.130	3.05	3.30
L	0.061	0.071	1.55	1.80
M	0.270	0.290	6.86	7.36
N	0.080	0.090	2.03	2.28
P	0.009	0.011	0.23	0.28
T	0.115	0.125	2.92	3.17
$\theta$	0°	7°	0°	7°

CASE 1369-01  
 ISSUE O  
 SMALL OUTLINE PACKAGE

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