# Freescale Semiconductor

MPX4115A
Rev 5, 1/2009

# 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.

## Application Examples

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

## 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)

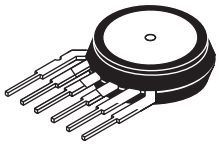
**ORDERING INFORMATION**

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

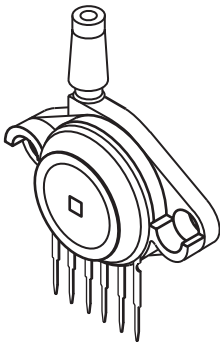


freescale™ semiconductor

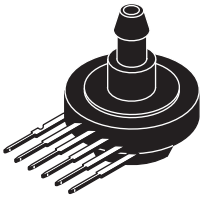
## UNIBODY PACKAGES



**MPX4115A**
**CASE 867-08**

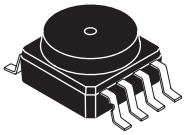


**MPX4115AP**
**CASE 867B-04**

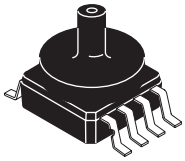


**MPX4115AS**
**CASE 867E-03**

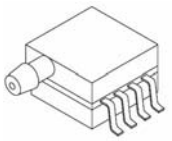
## SMALL OUTLINE PACKAGES



**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°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 | — | 115 | 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] | (0 to 85°C) | $V_{off}$ | 0.135 | 0.204 | 0.273 | Vdc |
| Full Scale Output @ $V_S$ = 5.1 Volts[4] | (0 to 85°C) | $V_{FSO}$ | 4.725 | 4.794 | 4.863 | Vdc |
| Full Scale Span @ $V_S$ = 5.1 Volts[5] | (0 to 85°C) | $V_{FSS}$ | 4.521 | 4.59 | 4.659 | Vdc |
| Accuracy[6] | (0 to 85°C) | — | — | — | ±1.5 | $\%V_{FSS}$ |
| Sensitivity | | V/P | — | 46 | — | 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 | — | mSec |
| 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.

## Maximum Ratings

**Table 2. 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.

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

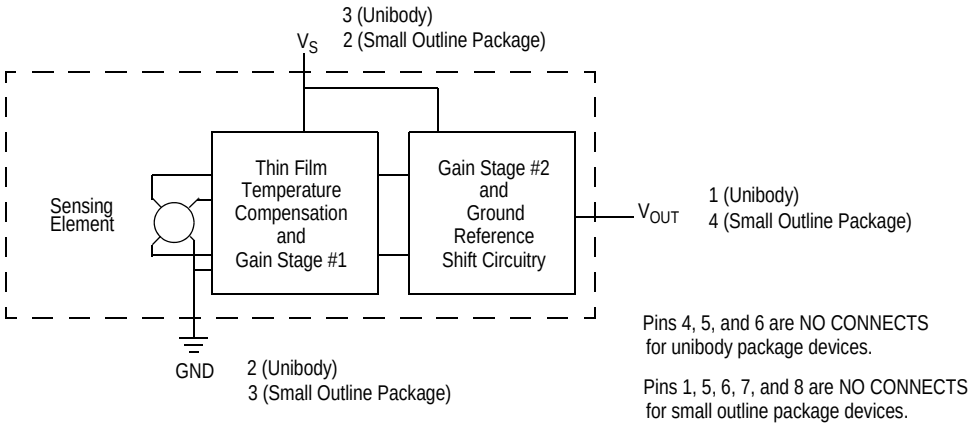



**Figure 1. Fully Integrated Pressure Sensor Schematic for Unibody Package and Small Outline Package**

## 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 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 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.)

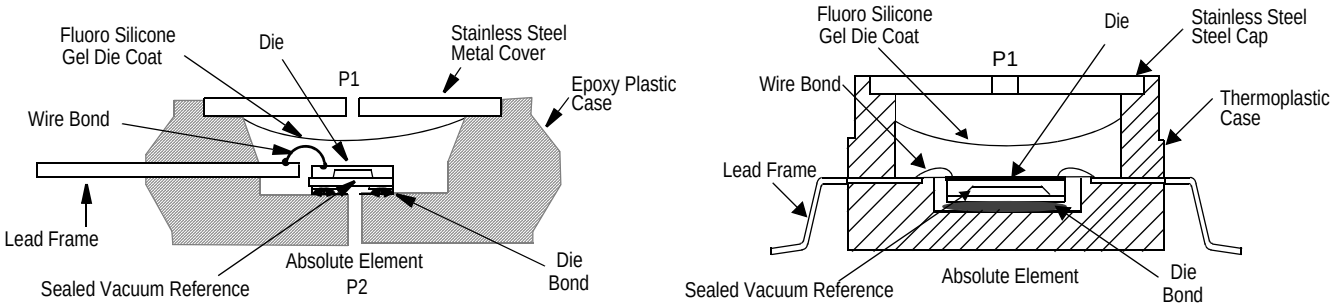



**Figure 2. Cross-Sectional Diagram (not to scale)**

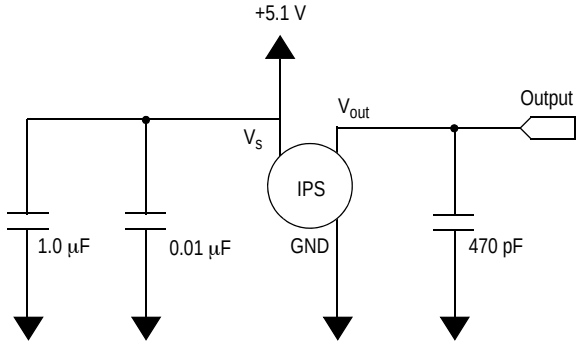



**Figure 3. Recommended Power Supply Decoupling and Output Filtering**
(For output filtering recommendations, refer to Application Note AN1646.)

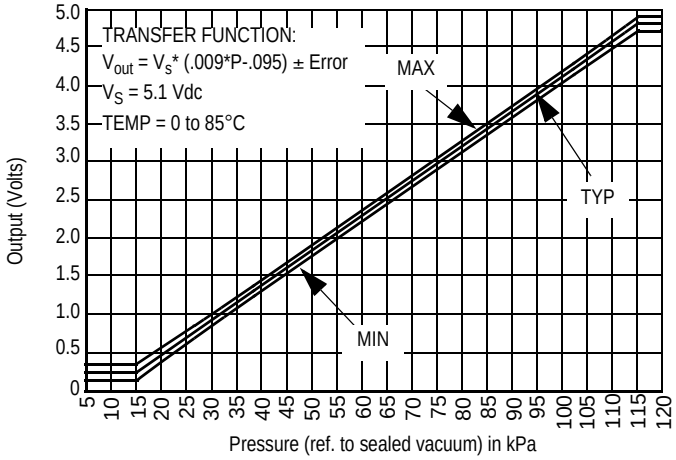


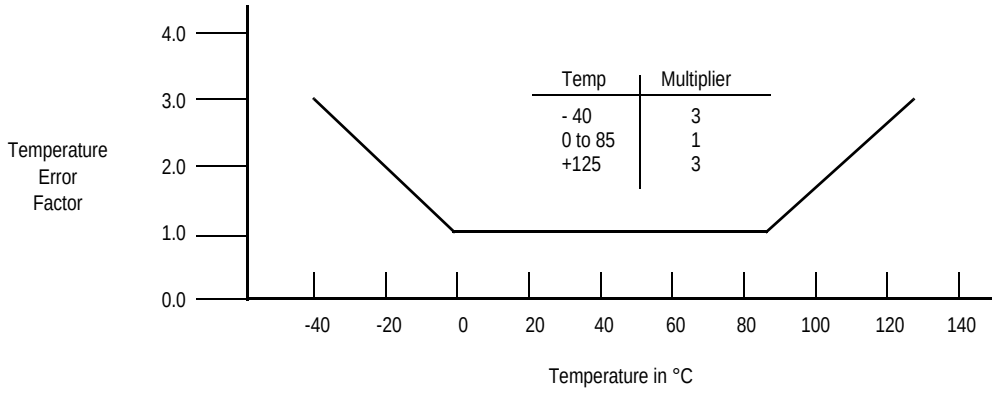

**Figure 4. Output versus Absolute Pressure**

## Transfer Function (MPX4115A)

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

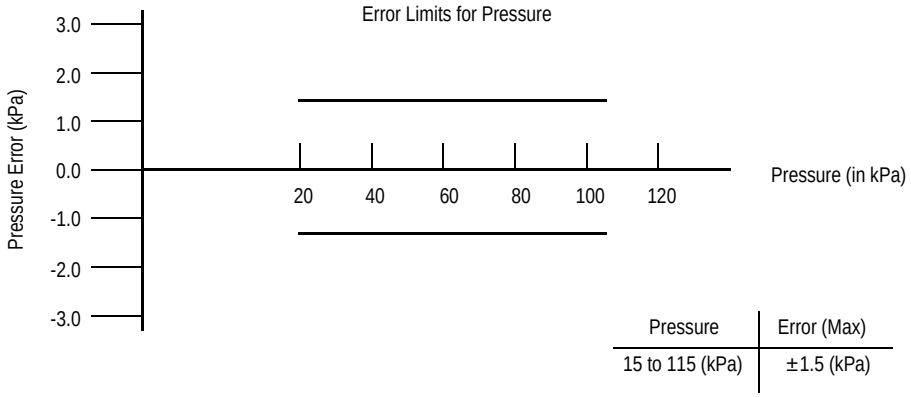
## Temperature Error Band

**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 | Error (Max) |
|---|---|
| 15 to 115 (kPa) | ±1.5 (kPa) |

## 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.

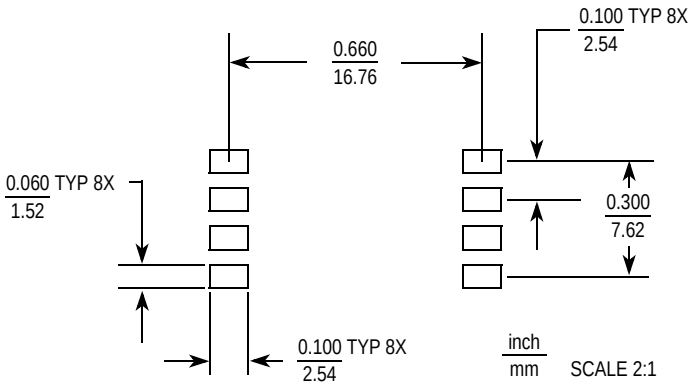
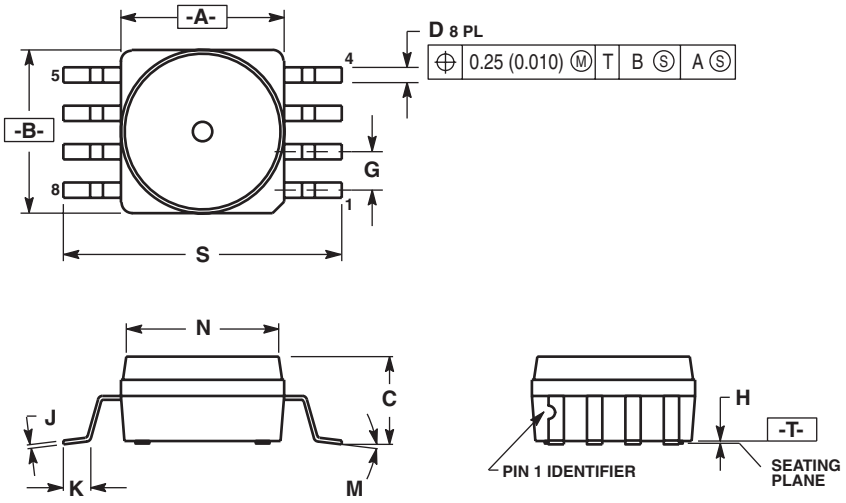



**Figure 5. SOP Footprint (Case 482)**

## 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.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | 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**

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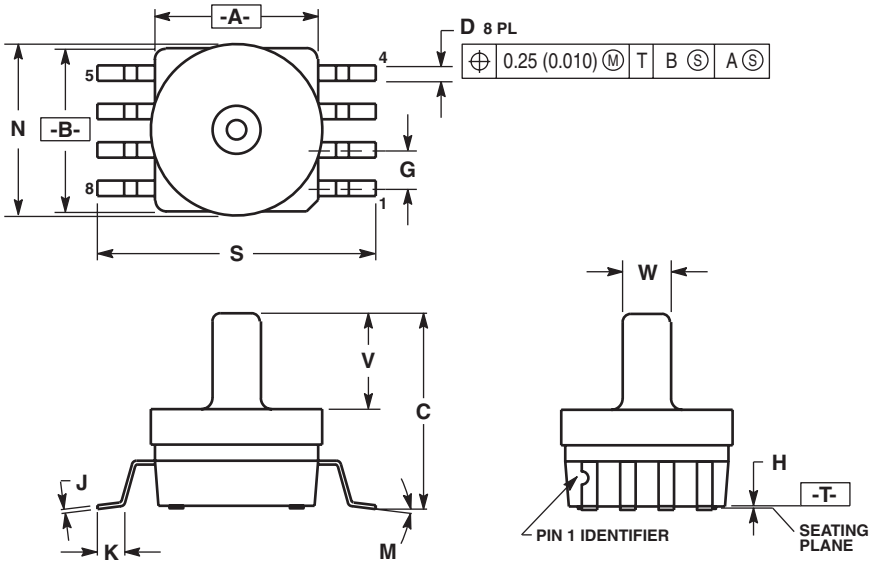
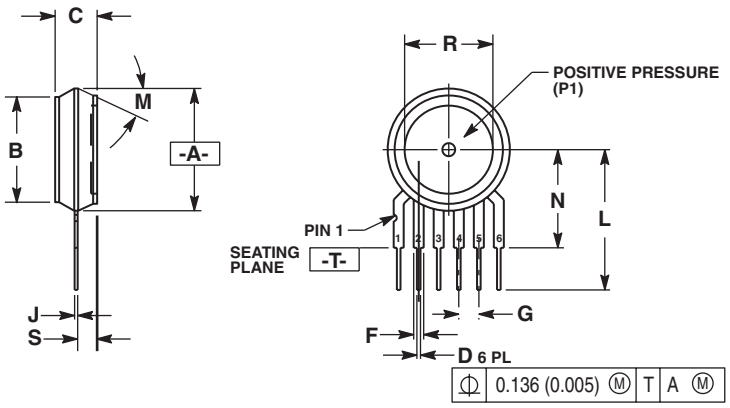



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
5. ALL VERTICAL SURFACES 5° TYPICAL DRAFT.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | 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).

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | 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 |

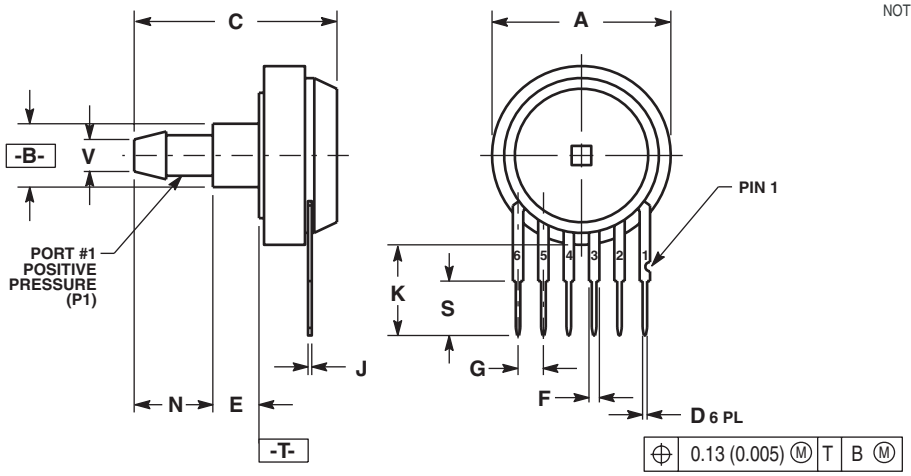
STYLE 1:
PIN 1. VOUT
2. GROUND
3. VCC
4. V1
5. V2
6. VEX

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



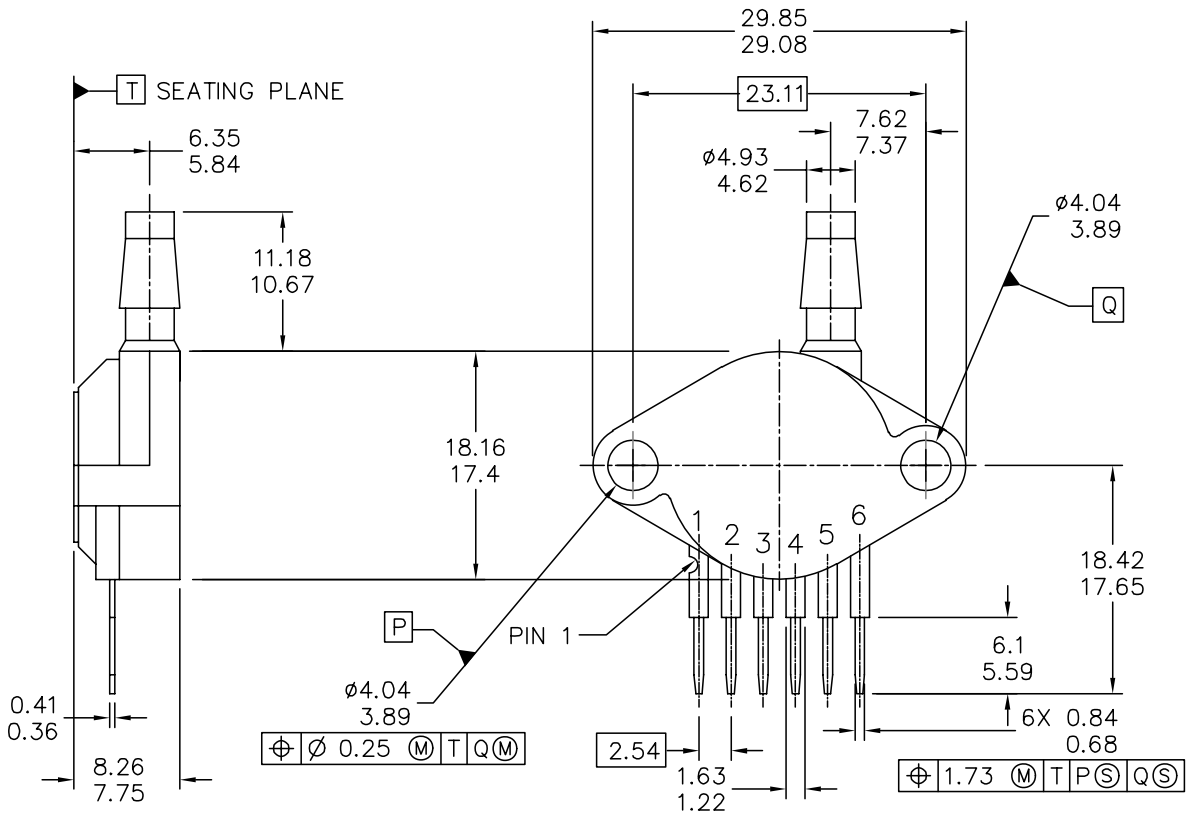

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | 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. V1
5. V2
6. $V_{EX}$

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

## PACKAGE DIMENSIONS




| © FREESCALE SEMICONDUCTOR, INC. ALL RIGHTS RESERVED. | MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE |
|---|---|---|
| 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



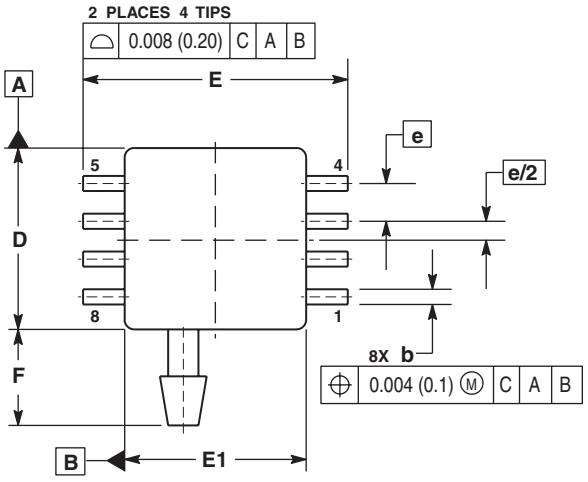
| MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE |
|---|---|

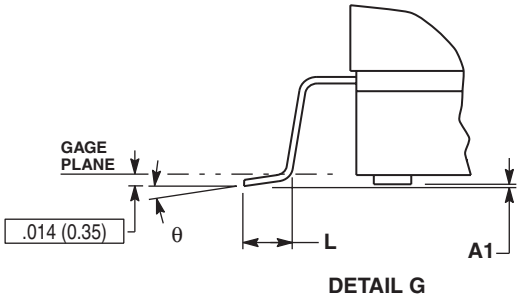
| TITLE: | DOCUMENT NO: 98ASB42796B | REV: G |
|---|---|---|
| SENSOR, 6 LEAD UNIBODY CELL, AP & GP 01ASB09087B | CASE NUMBER: 867B–04 | 28 JUL 2005 |
| | STANDARD: NON–JEDEC | |



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

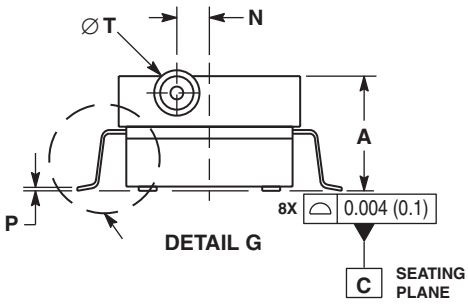
## PACKAGE DIMENSIONS



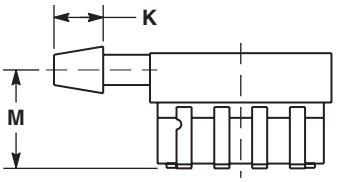




DETAIL G

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.




DETAIL G




| 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 |
| θ | 0° | 7° | 0° | 7° |

**CASE 1369-01**
**ISSUE O**
**SMALL OUTLINE PACKAGE**

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