

# Integrated Silicon Pressure Sensor On-Chip Signal Conditioned, Temperature Compensated and Calibrated

**MPX5700  
 Series**

0 to 700 kPa (0 to 101.5 psi)  
 15 to 700 kPa (2.18 to 101.5 psi)  
 0.2 to 4.7 V Output

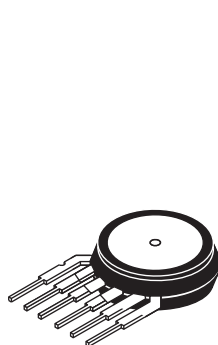
The MPX5700 series piezoresistive transducer is a state-of-the-art monolithic silicon pressure sensor designed for a wide range of applications, but particularly those employing a microcontroller or microprocessor with A/D inputs. This patented, single element transducer combines advanced micromachining techniques, thin-film metallization, and bipolar processing to provide an accurate, high level analog output signal that is proportional to the applied pressure.

**Features**

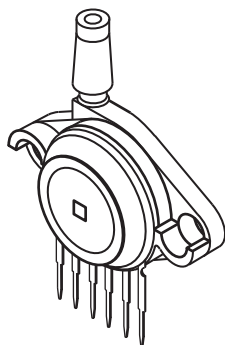
- 2.5% Maximum Error over 0° to 85°C
- Ideally Suited for Microprocessor or Microcontroller-Based Systems
- Available in Absolute, Differential and Gauge Configurations
- Patented Silicon Shear Stress Strain Gauge
- Durable Epoxy Unibody Element

| ORDERING INFORMATION                    |          |            |        |      |               |              |          |             |
|---|----------|------------|--------|------|---------------|--------------|----------|-------------|
| Device Name                             | Case No. | # of Ports |        |      | Pressure Type |              |          | Device Name |
|   |          | None       | Single | Dual | Gauge         | Differential | Absolute |             |
| <b>Unibody Package (MPX5700 Series)</b> |          |            |        |      |               |              |          |             |
| MPX5700A                                | 867      | •          |        |      |               |              | •        | MPX5700A    |
| MPX5700AP                               | 867B     |            | •      |      |               |              | •        | MPX5700AP   |
| MPX5700AS                               | 867E     |            | •      |      |               |              | •        | MPX5700A    |
| MPX5700ASX                              | 867F     |            | •      |      |               |              | •        | MPX5700A    |
| MPX5700D                                | 867      | •          |        |      |               | •            |          | MPX5700D    |
| MPX5700DP                               | 867C     |            |        | •    |               | •            |          | MPX5700DP   |
| MPX5700GP                               | 867B     |            | •      |      | •             |              |          | MPX5700GP   |
| MPX5700GP1 <sup>(1)</sup>               | 867B     |            | •      |      | •             |              |          | MPX5700GP   |
| MPX5700GS                               | 867E     |            | •      |      | •             |              |          | MPX5700D    |

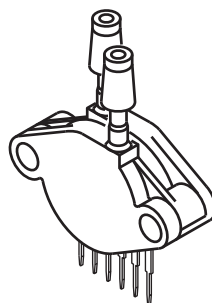
1. MPX5700GP1 has 90 degree lead form.

**UNIBODY PACKAGES**


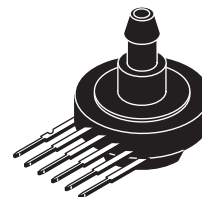
**MPX5700A/D**  
 CASE 867-08



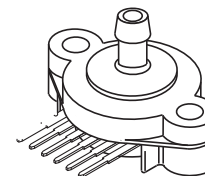
**MPX5700AP/GP/GP1**  
 CASE 867B-04



**MPX5700DP**  
 CASE 867C-05



**MPX5700AS/GS**  
 CASE 867E-03



**MPX5700ASX**  
 CASE 867F-03

## Operating Characteristics

**Table 1. Operating Characteristics** ( $V_S = 5.0$  Vdc,  $T_A = 25^\circ\text{C}$  unless otherwise noted,  $P_1 > P_2$ . Decoupling circuit shown in required to meet electrical specifications.)

| Characteristic   | Symbol    | Min            | Typ      | Max            | Unit        |
|--|-----------|----------------|----------|----------------|-------------|
| Pressure Range <sup>(1)</sup><br>Gauge, Differential: MPX5700D<br>Absolute: MPX5700A           | $P_{OP}$  | 0<br>15        | —<br>—   | 700<br>700     | kPa         |
| Supply Voltage <sup>(2)</sup>  | $V_S$     | 4.75           | 5.0      | 5.25           | Vdc         |
| Supply Current   | $I_O$     | —              | 7.0      | 10             | mAdc        |
| Zero Pressure Offset <sup>(3)</sup><br>Gauge, Differential (0 to 85°C)<br>Absolute (0 to 85°C) | $V_{off}$ | 0.088<br>0.184 | 0.2<br>— | 0.313<br>0.409 | Vdc         |
| Full Scale Output <sup>(4)</sup><br>(0 to 85°C)  | $V_{FSO}$ | 4.587          | 4.7      | 4.813          | Vdc         |
| Full Scale Span <sup>(5)</sup><br>(0 to 85°C)  | $V_{FSS}$ | —              | 4.5      | —              | Vdc         |
| Accuracy <sup>(6)</sup><br>(0 to 85°C)   | —         | —              | —        | ±2.5           | % $V_{FSS}$ |
| Sensitivity  | V/P       | —              | 6.4      | —              | 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       | —              | ms          |

- 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°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.
- 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 device to meet the specified output voltage after the pressure has been stabilized.

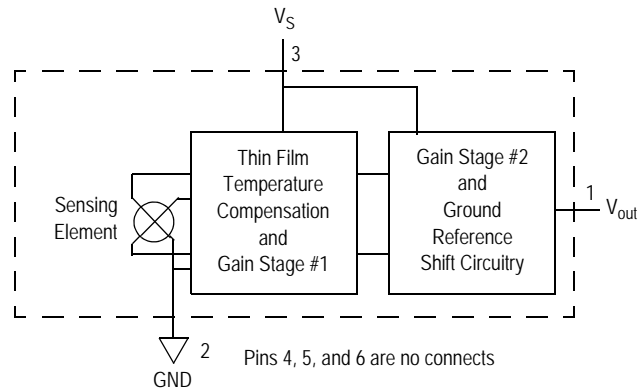
## Maximum Ratings

**Table 2. Maximum Ratings<sup>(1)</sup>**

| Parametrics   | Symbol     | Value       | Unit |
|---|------------|-------------|------|
| Maximum Pressure <sup>(2)</sup> ( $P2 \leq 1$ Atmosphere) | $P1_{max}$ | 2800        | kPa  |
| Storage Temperature                                       | $T_{stg}$  | -40 to +125 | °C   |
| Operating Temperature                                     | $T_A$      | -40 to +125 | °C   |

- Maximum Ratings apply to Case 867 only. Extended exposure at the specified limits may cause permanent damage or degradation to the device.
- This sensor is designed for applications where  $P1$  is always greater than, or equal to  $P2$ .  $P2$  maximum is 500 kPa.

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



**Figure 1. Fully Integrated Pressure Sensor Schematic**

## On-chip Temperature Compensation and Calibration

Figure 3 illustrates both the Differential/Gauge and the Absolute Sensing Chip in the basic chip carrier (Case 867). 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. (For use of the MPX5700D in a high-pressure cyclic application, consult the factory.)

The MPX5700 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 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 . The output will saturate outside of the specified pressure range.

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.

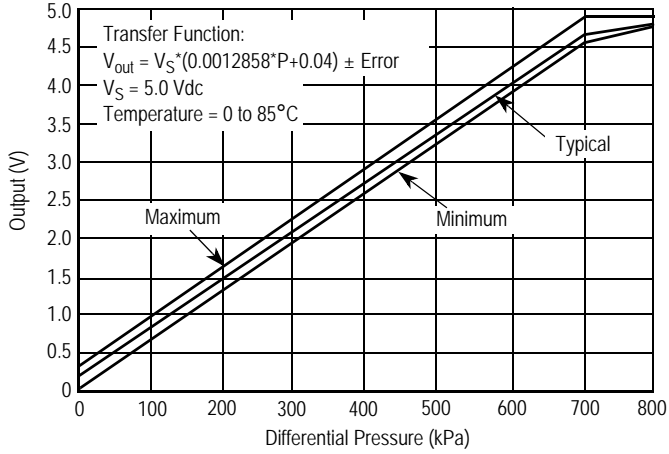


Figure 2. Output vs. Pressure Differential

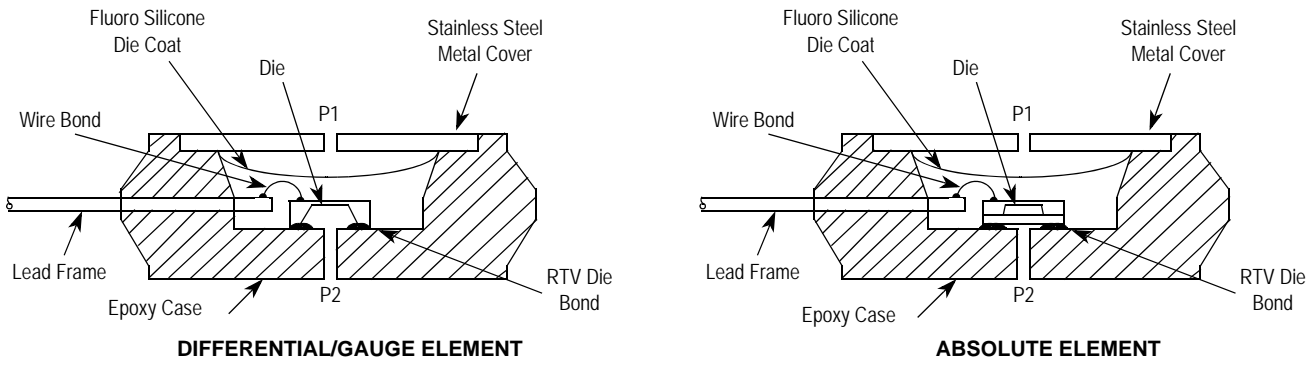


Figure 3. Cross-Sectional Diagrams (not to scale)

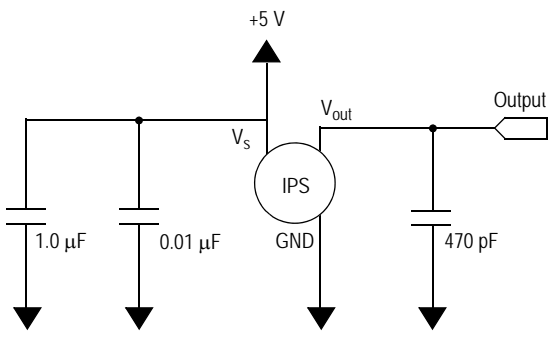


Figure 4. Recommended Power Supply Decoupling and Output Filtering (For additional output filtering, please refer to Application Note AN1646)

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

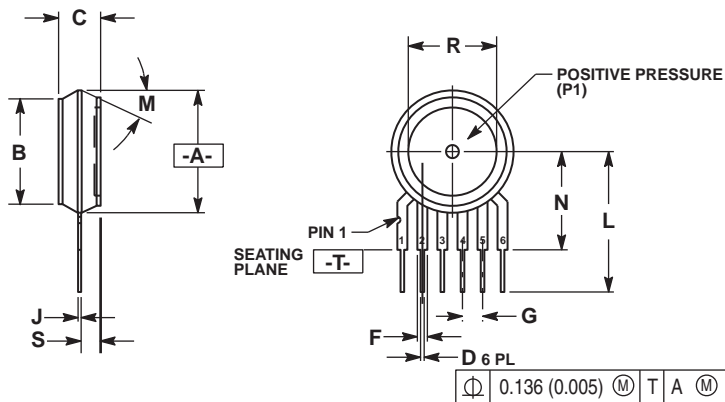
Freescale designates the two sides of the pressure sensor as the Pressure (P1) side and the Vacuum (P2) side. The Pressure (P1) side is the side containing fluorosilicone gel which protects the die from harsh media. The Freescale MPX

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.

| Part Number  | Case Type | Pressure (P1) Side Identifier |
|--------------|-----------|-------------------------------|
| MPX5700A/D   | 867       | Stainless Steel Cap           |
| MPX5700DP    | 867C      | Side with Part Marking        |
| MPX5700GP/AP | 867B      | Side with Port Attached       |
| MPX5700GS/AS | 867E      | Side with Port Attached       |
| MPX5700ASX   | 867F      | Side with Port Attached       |

### 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).

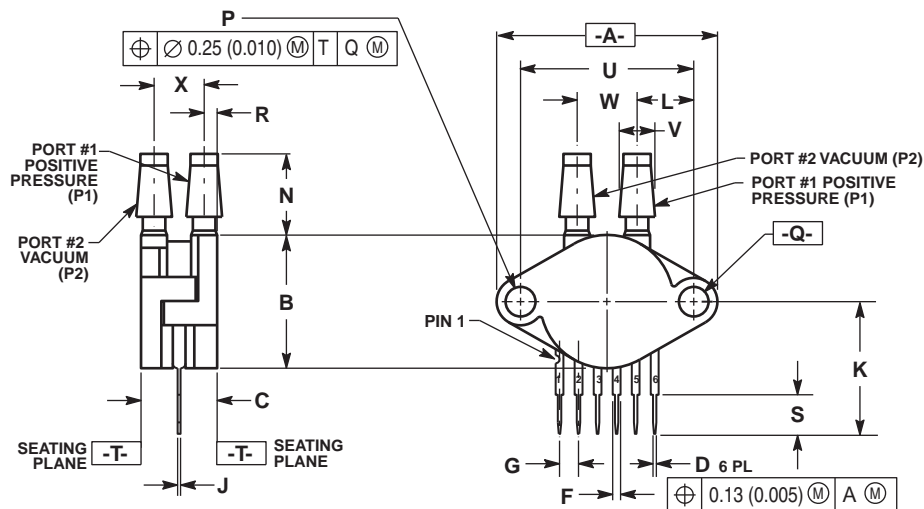
| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.595     | 0.630 | 15.11       | 16.00 |
| B   | 0.514     | 0.534 | 13.06       | 13.56 |
| C   | 0.200     | 0.220 | 5.08        | 5.59  |
| 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



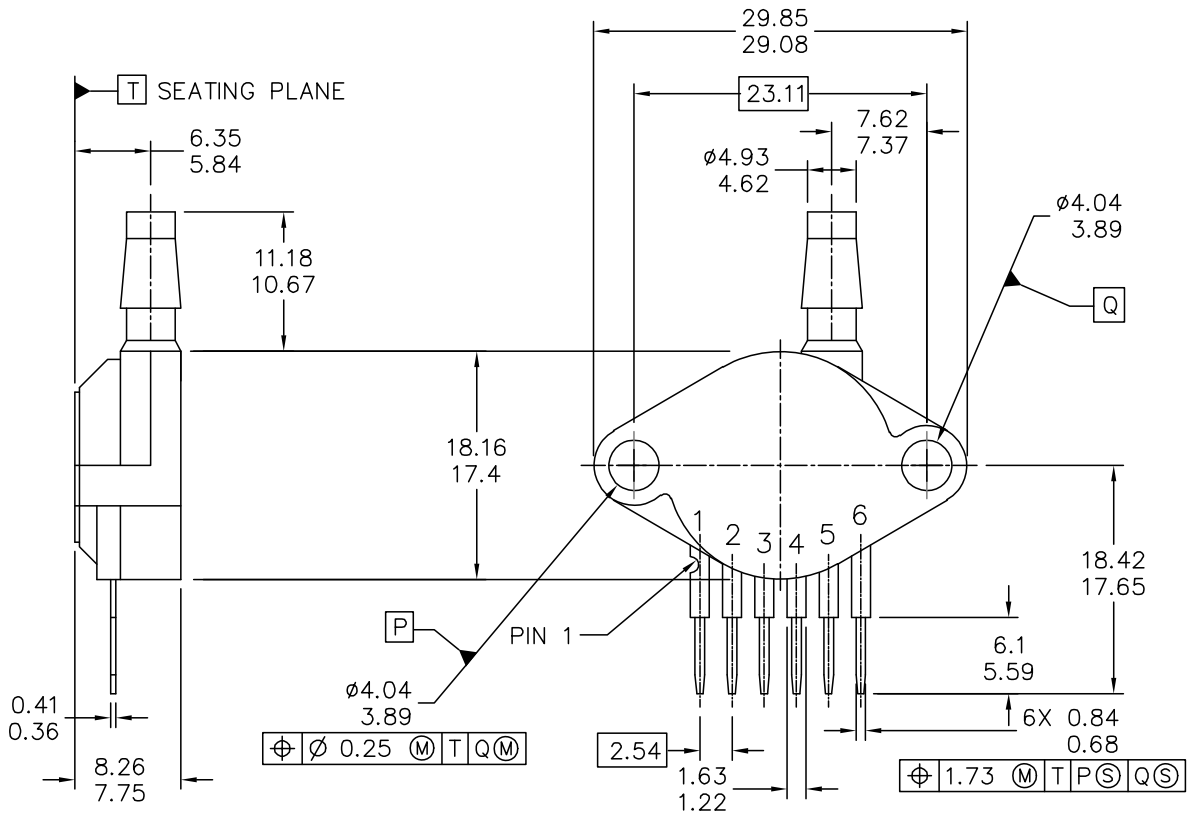
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
  2. CONTROLLING DIMENSION: INCH.

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 1.145     | 1.175 | 29.08       | 29.85 |
| B   | 0.685     | 0.715 | 17.40       | 18.16 |
| C   | 0.405     | 0.435 | 10.29       | 11.05 |
| 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        | 0.41  |
| K   | 0.695     | 0.725 | 17.65       | 18.42 |
| L   | 0.290     | 0.300 | 7.37        | 7.62  |
| N   | 0.420     | 0.440 | 10.67       | 11.18 |
| P   | 0.153     | 0.159 | 3.89        | 4.04  |
| Q   | 0.153     | 0.159 | 3.89        | 4.04  |
| R   | 0.063     | 0.083 | 1.60        | 2.11  |
| S   | 0.220     | 0.240 | 5.59        | 6.10  |
| U   | 0.910 BSC |       | 23.11 BSC   |       |
| V   | 0.182     | 0.194 | 4.62        | 4.93  |
| W   | 0.310     | 0.330 | 7.87        | 8.38  |
| X   | 0.248     | 0.278 | 6.30        | 7.06  |

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

### CASE 867C-05 ISSUE F PRESSURE AND VACUUM SIDES PORTED (DP)

**PACKAGE DIMENSIONS**



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

**CASE 867B-04**  
**ISSUE G**  
**PRESSURE SIDE PORTED (AP, GP)**

**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

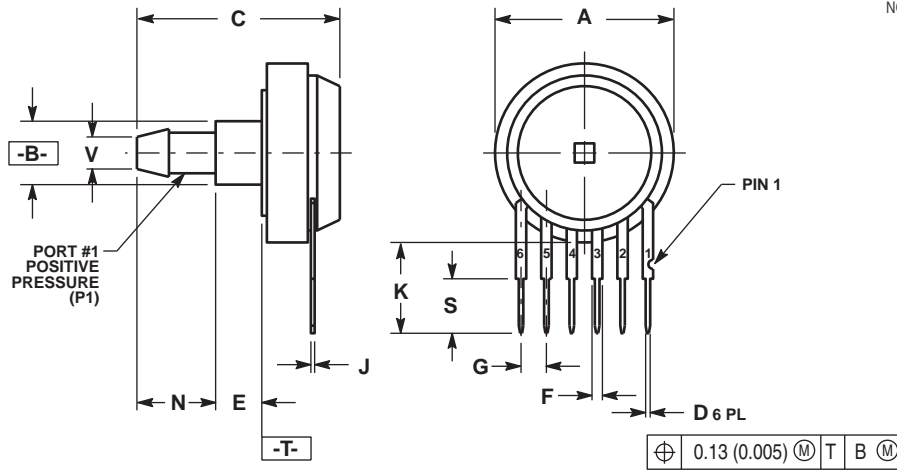
|   |                           |                            |  |
|---|---------------------------|----------------------------|--|
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| TITLE:<br>SENSOR, 6 LEAD UNIBODY CELL,<br>AP & GP 01ASB09087B | DOCUMENT NO: 98ASB42796B  | REV: G               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

PAGE 2 OF 2

**CASE 867B-04  
 ISSUE G  
 PRESSURE SIDE PORTED (AP, GP)**



### PACKAGE DIMENSIONS

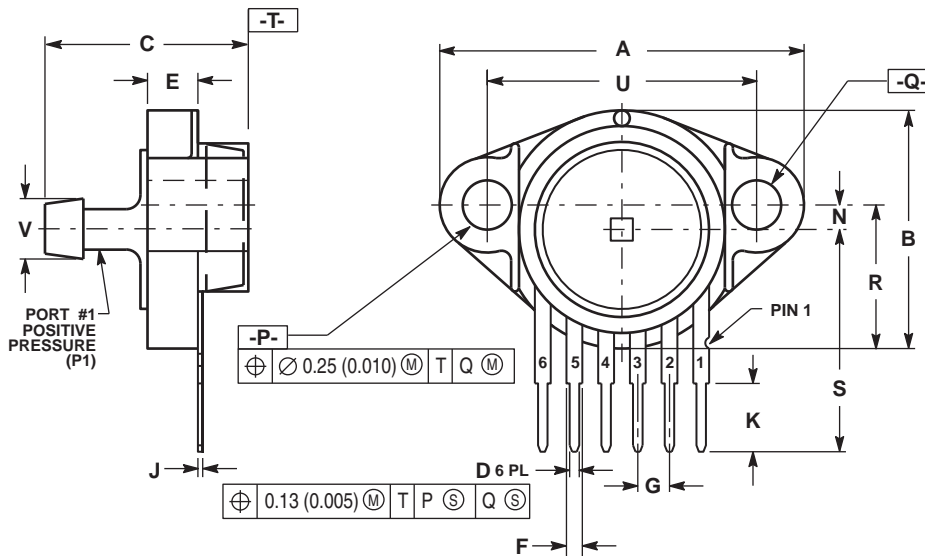


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.

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

**CASE 867E-03  
ISSUE D  
PRESSURE SIDE PORTED (AS, GS)**



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

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 1.080     | 1.120 | 27.43       | 28.45 |
| B   | 0.740     | 0.760 | 18.80       | 19.30 |
| C   | 0.630     | 0.650 | 16.00       | 16.51 |
| D   | 0.027     | 0.033 | 0.68        | 0.84  |
| E   | 0.160     | 0.180 | 4.06        | 4.57  |
| 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   | 0.220     | 0.240 | 5.59        | 6.10  |
| N   | 0.070     | 0.080 | 1.78        | 2.03  |
| P   | 0.150     | 0.160 | 3.81        | 4.06  |
| Q   | 0.150     | 0.160 | 3.81        | 4.06  |
| R   | 0.440     | 0.460 | 11.18       | 11.68 |
| S   | 0.695     | 0.725 | 17.65       | 18.42 |
| U   | 0.840     | 0.860 | 21.34       | 21.84 |
| V   | 0.182     | 0.194 | 4.62        | 4.93  |

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

**CASE 867F-03  
ISSUE D  
PRESSURE SIDE AXIAL PORT (ASX)**

**Table 3. Revision History**

| Revision number | Revision date | Description of changes   |
|-----------------|---------------|--|
| 10              | 10/2012       | <ul style="list-style-type: none"> <li>On page 1, added a table note to the Ordering Information table indicating that the device MPX5700GP1 has 90 degree lead form.</li> </ul> |

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