

# 10 kPa Uncompensated Silicon Pressure Sensors

The MPVZ12 series is a silicon piezoresistive pressure sensor providing a very accurate and linear voltage output — directly proportional to the applied pressure. This standard, low cost, uncompensated sensor permits manufacturers to design and add their own external temperature compensating and signal conditioning networks. Compensation techniques are simplified because of the predictability of Freescale's single element strain gauge design.

## Features

- Low Cost
- Patented Silicon Shear Stress Strain Gauge Design
- Ratiometric to Supply Voltage
- Easy to Use Chip Carrier Package Options
- Differential and Gauge Options
- Durable Epoxy Package
- Increased media compatibility fluorocarbon gel

## Application Examples

- Air Movement Control
- Environmental Control Systems
- Level Indicators
- Leak Detection
- Medical Instrumentation
- Industrial Controls
- Pneumatic Control Systems
- Robotics

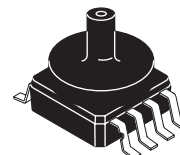
| ORDERING INFORMATION <sup>(1)</sup> |         |          |              |                |
|-------------------------------------|---------|----------|--------------|----------------|
| Device Type                         | Options | Case No. | Order Number | Device Marking |
| Ported                              | Gauge   | 482A     | MPVZ12GC6U   | MPVZ12G        |
|                                     |         | 482C     | MPVZ12GC7U   | MPVZ12G        |
|                                     |         | 1735     | MPVZ12GW6U   | MZ12GW         |
|                                     |         | 1560     | MPVZ12GW7U   | MZ12GW         |

1. MPVZ12 series pressure sensors are available in differential and gauge configurations. Devices are available in the basic element package or with pressure port fittings which provide printed circuit board mounting ease and barbed hose pressure connections.

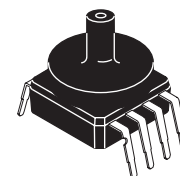
## MPVZ12 SERIES

**UNCOMPENSATED PRESSURE  
SENSOR**  
**0 TO 10 kPa (0–1.45 psi)**  
**55 mV FULL SCALE SPAN**  
**(TYPICAL)**

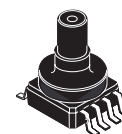
## SMALL OUTLINE PACKAGE



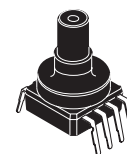
MPVZ12GC6U  
CASE 482A-01



MPVZ12GC7U  
CASE 482C-03



MPVZ12GW6U  
CASE 1735-01

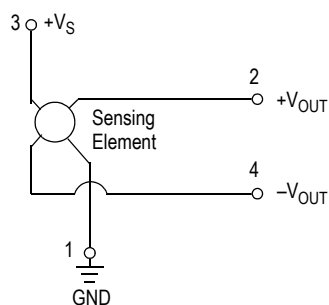


MPVZ12GW7U  
CASE 1560-02

## PIN NUMBERS

|   |                   |   |     |
|---|-------------------|---|-----|
| 1 | GND               | 5 | N/C |
| 2 | +V <sub>out</sub> | 6 | N/C |
| 3 | V <sub>s</sub>    | 7 | N/C |
| 4 | –V <sub>out</sub> | 8 | N/C |

NOTE: Pin 1 is noted by the notch in the lead.



**Figure 1. Uncompensated 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).

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

| Rating                     | Symbol      | Value       | Unit |
|----------------------------|-------------|-------------|------|
| Maximum Pressure (P1 > P2) | $P_{MAX}$   | 75          | kPa  |
| Burst Pressure (P1 > P2)   | $P_{BURST}$ | 100         | 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** ( $V_S = 3.0$  Vdc,  $T_A = 25^\circ\text{C}$  unless otherwise noted,  $P_1 > P_2$ )

| Characteristic                                                                        | Symbol              | Min   | Typ       | Max   | Unit                         |
|---------------------------------------------------------------------------------------|---------------------|-------|-----------|-------|------------------------------|
| Differential Pressure Range <sup>(1)</sup>                                            | $P_{OP}$            | 0     | —         | 10    | kPa                          |
| Supply Voltage <sup>(2)</sup>                                                         | $V_S$               | —     | 3.0       | 6.0   | Vdc                          |
| Supply Current                                                                        | $I_o$               | —     | 6.0       | —     | mAdc                         |
| Full Scale Span <sup>(3)</sup>                                                        | $V_{FSS}$           | 45    | 55        | 70    | mV                           |
| Offset <sup>(4)</sup>                                                                 | $V_{off}$           | 0     | 20        | 35    | mV                           |
| Sensitivity                                                                           | $\Delta V/\Delta P$ | —     | 5.5       | —     | mV/kPa                       |
| Linearity <sup>(5)</sup>                                                              | —                   | -0.5  | —         | 5.0   | % $V_{FSS}$                  |
| Pressure Hysteresis <sup>6</sup> (0 to 10 kPa)                                        | —                   | —     | $\pm 0.1$ | —     | % $V_{FSS}$                  |
| Temperature Hysteresis <sup>(5)</sup> ( $-40^\circ\text{C}$ to $+125^\circ\text{C}$ ) | —                   | —     | $\pm 0.5$ | —     | % $V_{FSS}$                  |
| Temperature Coefficient of Full Scale Span <sup>(5)</sup>                             | $TCV_{FSS}$         | -0.22 | —         | -0.16 | % $V_{FSS}/^\circ\text{C}$   |
| Temperature Coefficient of Offset <sup>(5)</sup>                                      | $TCV_{off}$         | —     | $\pm 15$  | —     | $\mu\text{V}/^\circ\text{C}$ |
| Temperature Coefficient of Resistance <sup>(5)</sup>                                  | $TCR$               | 0.28  | —         | 0.34  | % $Z_{in}/^\circ\text{C}$    |
| Input Impedance                                                                       | $Z_{in}$            | 400   | —         | 550   | W                            |
| Output Impedance                                                                      | $Z_{out}$           | 750   | —         | 1250  | W                            |
| Response Time <sup>(6)</sup> (10% to 90%)                                             | $t_R$               | —     | 1.0       | —     | ms                           |
| Warm-Up Time <sup>(7)</sup>                                                           | —                   | —     | 20        | —     | ms                           |
| Offset Stability <sup>(8)</sup>                                                       | —                   | —     | $\pm 0.5$ | —     | % $V_{FSS}$                  |

1. 1.0 kPa (kiloPascal) equals 0.145 psi.

2. Device is ratiometric within this specified excitation range. Operating the device above the specified excitation range may induce additional error due to device self-heating.

3. 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.

4. Offset ( $V_{OFF}$ ) is defined as the output voltage at the minimum rated pressure.

5. Accuracy (error budget) consists of the following:

- Linearity: Output deviation from a straight line relationship with pressure, using end point method, 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 with 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 at full rated pressure 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  $25^\circ\text{C}$ .
- TCR:  $Z_{IN}$  deviation with minimum rated pressure applied, over the temperature range of  $-40^\circ\text{C}$  to  $\pm 125^\circ\text{C}$ , relative to  $25^\circ\text{C}$ .

6. Response Time is defined as the time form 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.

7. Warm-up Time is defined as the time required for the product to meet the specified output voltage after the pressure is stabilized.

8. Offset stability is the product's output deviation when subjected to 1000 hours of Pulsed Pressure, Temperature Cycling with Bias Test.

## TEMPERATURE COMPENSATION

Figure 2 shows the typical output characteristics of the MPVZ12 series over temperature.

Because this strain gauge is an integral part of the silicon diaphragm, there are no temperature effects due to differences in the thermal expansion of the strain gauge and the diaphragm, as are often encountered in bonded strain gauge pressure sensors. However, the properties of the strain gauge itself are temperature dependent, requiring that the device be temperature compensated if it is to be used over an extensive temperature range.

Temperature compensation and offset calibration can be achieved rather simply with additional resistive components, or by designing your system using the MPX2010D series sensor.

Several approaches to external temperature compensation over both  $-40$  to  $+125^{\circ}\text{C}$  and  $0$  to  $+80^{\circ}\text{C}$  ranges are presented in Applications Note AN840.

## LINEARITY

Linearity refers to how well a transducer's output follows the equation:  $V_{\text{out}} = V_{\text{off}} + \text{sensitivity} \times P$  over the operating pressure range (Figure 3). There are two basic methods for calculating nonlinearity: (1) end point straight line fit or (2) a least squares best line fit. While a least squares fit gives the "best case" linearity error (lower numerical value), the calculations required are burdensome.

Conversely, an end point fit will give the "worst case" error (often more desirable in error budget calculations) and the calculations are more straightforward for the user. Freescale's specified pressure sensor linearities are based on the end point straight line method measured at the midrange pressure.

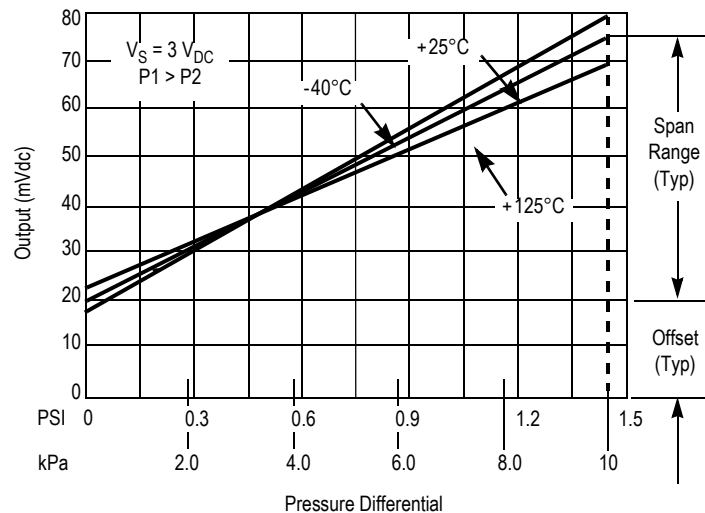


Figure 2. Output versus Pressure Differential

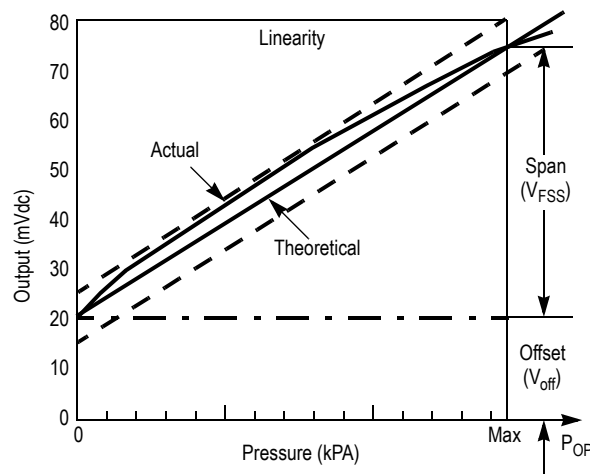
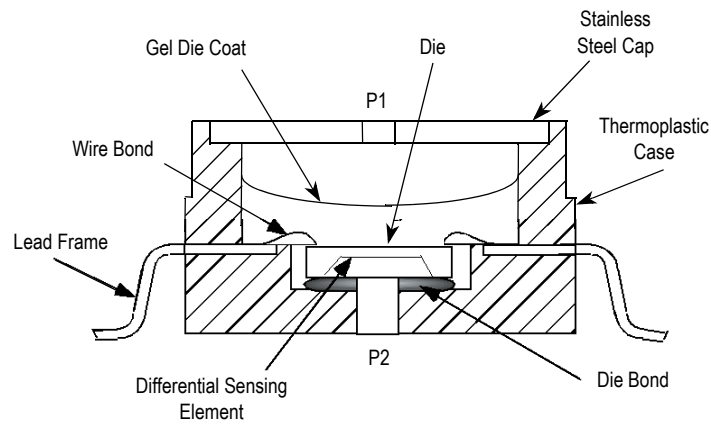


Figure 3. Linearity Specification Comparison



**Figure 4. Cross-Sectional Diagram (not to scale)**

Figure 4 illustrates the differential or gauge configuration in the basic chip carrier (applicable to cases 482, 1560 and 1735). A gel isolates the die surface and wire bonds from the environment, while allowing the pressure signal to be transmitted to the silicon diaphragm.

Operating characteristics, internal reliability and qualification tests are based on use of dry clean air as the pressure media. Media other than dry clean air may have adverse effects on sensor performance and long term reliability. Contact the factory for information regarding media compatibility in your application.

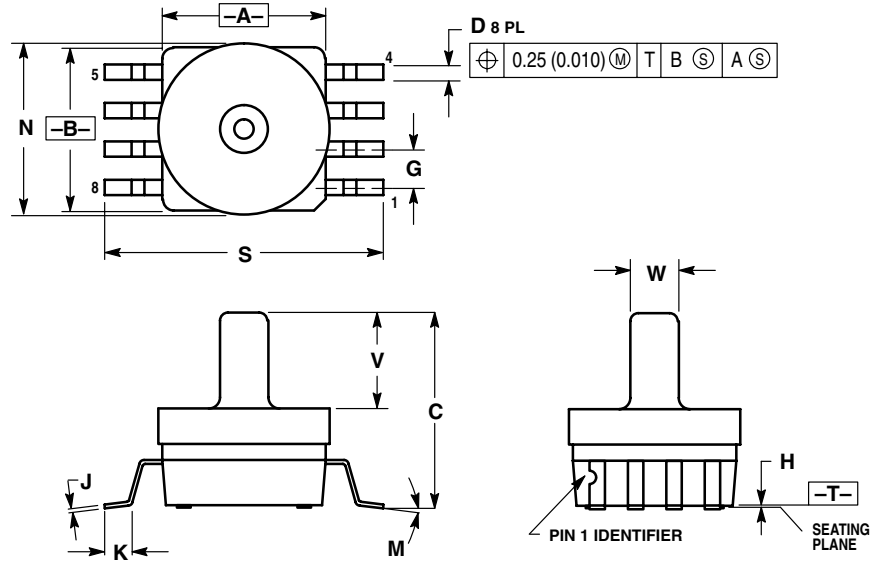
#### **PRESSURE (P1)/VACUUM (P2) SIDE IDENTIFICATION TABLE**

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 gel which isolates the die from the environment. The Freescale MPVZ12 series 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 |
|-------------|---------------------|-------------------------------|
| MPVZ12GC6U  | 482A<br>98ASB17757C | Top with Port Attached        |
| MPVZ12GC7U  | 482C<br>98ASB17759C | Top with Port Attached        |
| MPVZ12GW6U  | 1735<br>98ASA10686D | Top with Port Attached        |
| MPVZ12GW7U  | 1560<br>98ASA10611D | Top with Port Attached        |

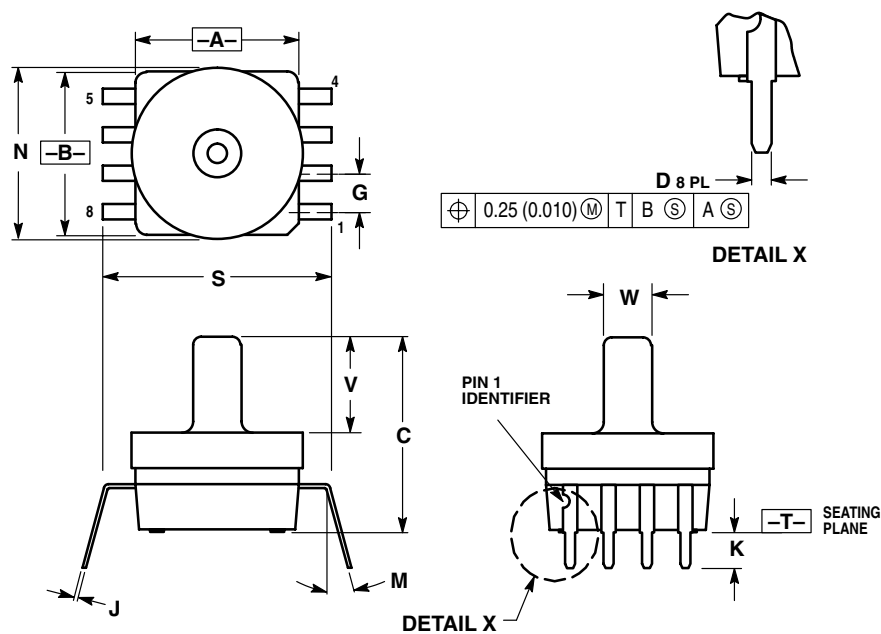
## PACKAGE DIMENSIONS



- 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**

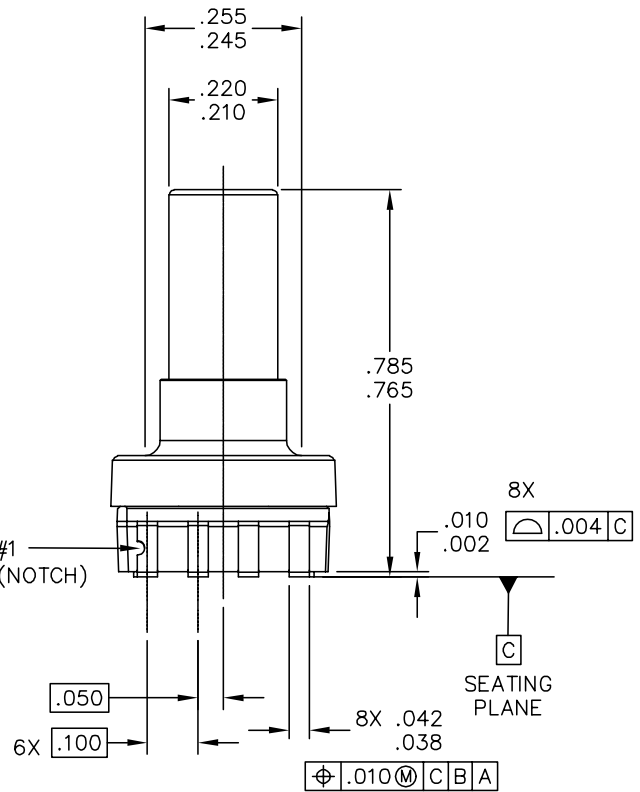
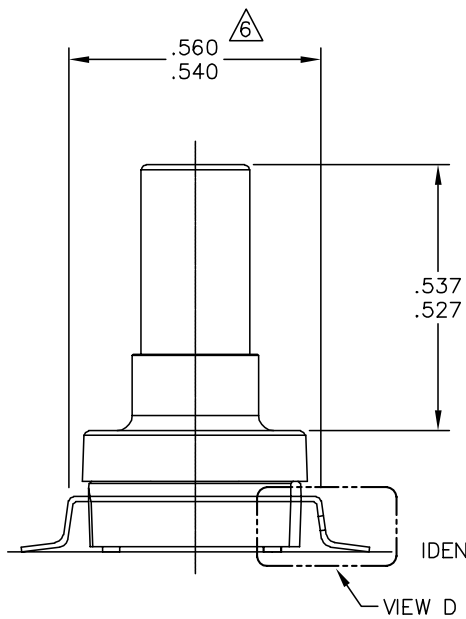
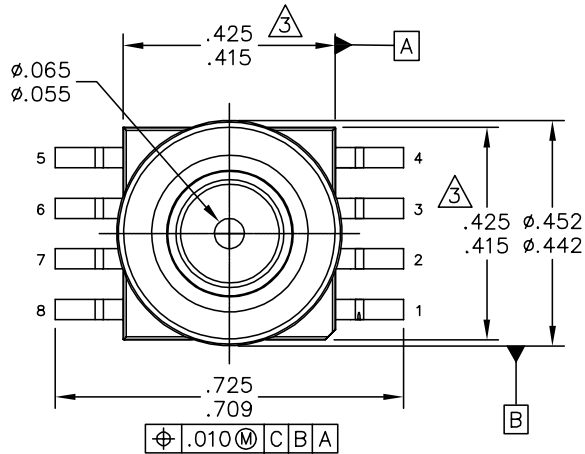


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  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
  5. ALL VERTICAL SURFACES 5° TYPICAL DRAFT.
  6. DIMENSION S TO CENTER OF LEAD WHEN FORMED PARALLEL.

| 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   | 0.026     | 0.034 | 0.66        | 0.864 |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| J   | 0.009     | 0.011 | 0.23        | 0.28  |
| K   | 0.100     | 0.120 | 2.54        | 3.05  |
| M   | 0°        | 15°   | 0°          | 15°   |
| N   | 0.444     | 0.448 | 11.28       | 11.38 |
| S   | 0.540     | 0.560 | 13.72       | 14.22 |
| V   | 0.245     | 0.255 | 6.22        | 6.48  |
| W   | 0.115     | 0.125 | 2.92        | 3.17  |

**CASE 482C-03  
ISSUE B  
SMALL OUTLINE PACKAGE**

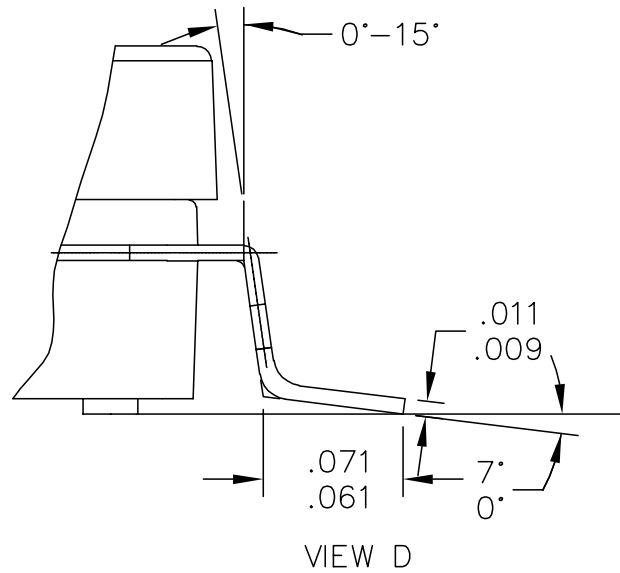
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|                                                            |  |                    | CASE NUMBER: 1735-01     |                            | 16 AUG 2005 |
|                                                            |  |                    | STANDARD: NON-JEDEC      |                            |             |

**CASE 1735-01  
ISSUE A  
SMALL OUTLINE PACKAGE**

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|                                                         | STANDARD: NON–JEDEC       |                            |             |

**CASE 1735-01  
ISSUE A  
SMALL OUTLINE PACKAGE**

## PACKAGE DIMENSIONS

### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M – 1994.

2. CONTROLLING DIMENSION: INCH.

3. DIMENSIONS DO NOT INCLUDE MOLD PROTRUSION.

4. MAXIMUM MOLD PROTRUSION IS .006.

5. ALL VERTICAL SURFACES 5° TYPICAL DRAFT.

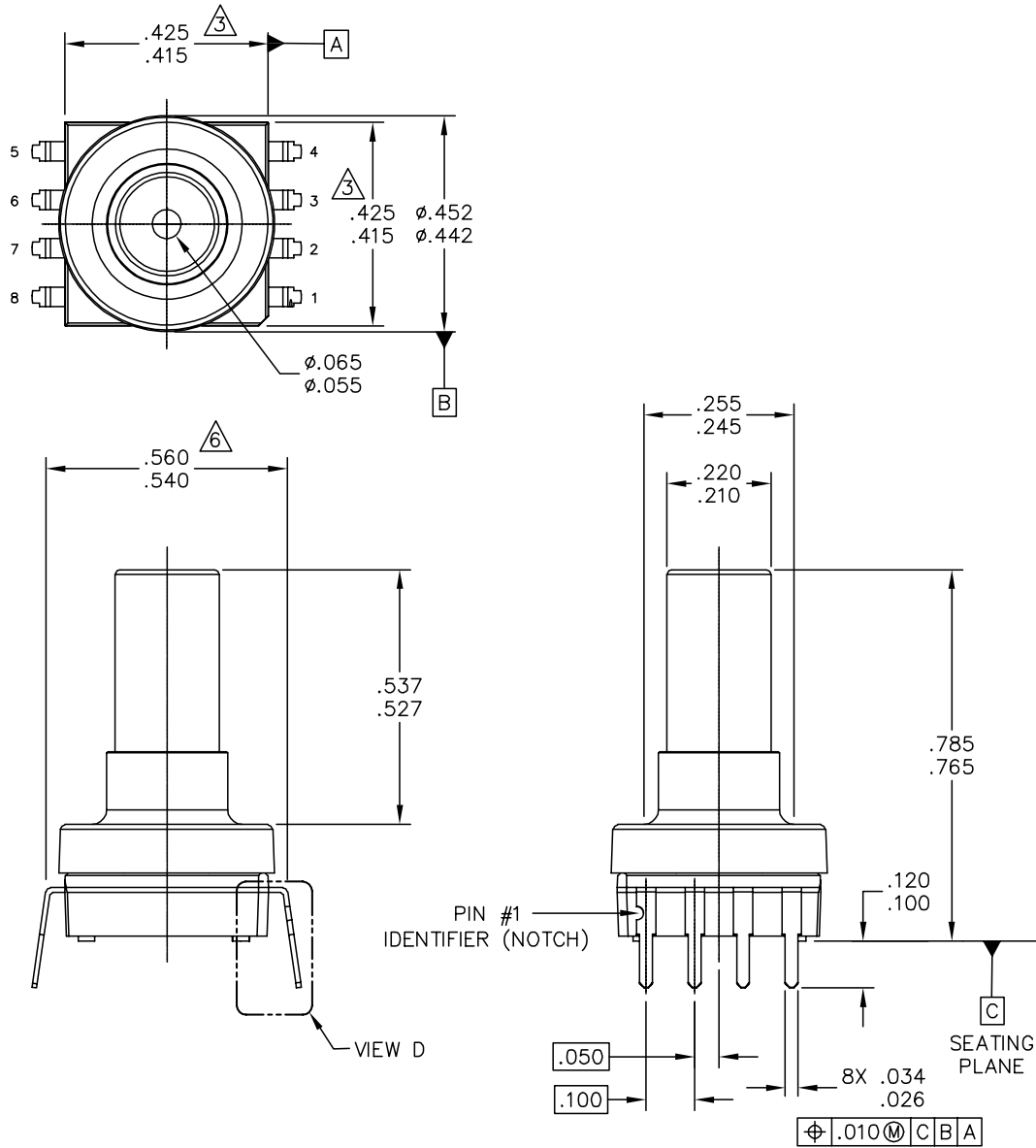
6. DIMENSION TO CENTER OF LEAD WHEN FORMED PARALLEL.

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|                                                            | STANDARD: NON-JEDEC       |                            |             |

### CASE 1735-01 ISSUE A SMALL OUTLINE PACKAGE

**MPVZ12**

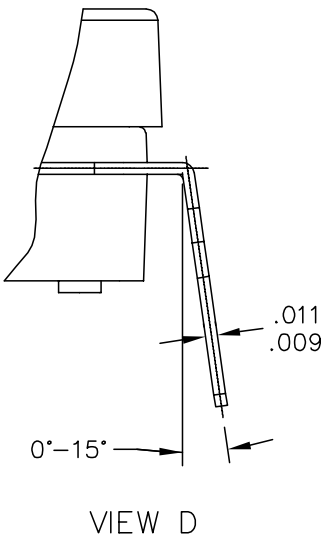
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|                                                         | CASE NUMBER: 1560-02      |                            | 26 MAY 2005 |
|                                                         | STANDARD: NON-JEDEC       |                            |             |

### CASE 1560-02 ISSUE C SMALL OUTLINE PACKAGE

PACKAGE DIMENSIONS



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|                                                            |  |                    | CASE NUMBER: 1560-02     |                            | 26 MAY 2005 |
|                                                            |  |                    | STANDARD: NON-JEDEC      |                            |             |

CASE 1560-02  
ISSUE C  
SMALL OUTLINE PACKAGE

## PACKAGE DIMENSIONS

### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M – 1994.

2. CONTROLLING DIMENSION: INCH.

3. DIMENSIONS DO NOT INCLUDE MOLD PROTRUSION.

4. MAXIMUM MOLD PROTRUSION IS .006.

5. ALL VERTICAL SURFACES 5° TYPICAL DRAFT.

6. DIMENSION TO CENTER OF LEAD WHEN FORMED PARALLEL.

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### CASE 1560-02 ISSUE C SMALL OUTLINE PACKAGE

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