

# Freescale Semiconductor

MPX10  
Rev 14, 10/2008

## 10 kPa Uncompensated Silicon Pressure Sensors

The MPX10 series silicon piezoresistive pressure sensors provide a very accurate and linear voltage output, directly proportional to the applied pressure. These standard, low cost, uncompensated sensors permit manufacturers to design and add their own external temperature compensation 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
- Differential and Gauge Options
- Durable Epoxy Unibody Element or Thermoplastic (PPS) Surface Mount Package

## MPX10 Series

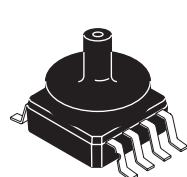
0 to 10 kPa (0 to 1.45 psi)  
35 mV Full Scale Span  
(Typical)

### Application Examples

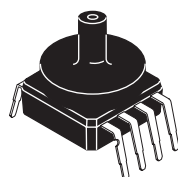
- Air Movement Control
- Environmental Control Systems
- Level Indicators
- Leak Detection
- Medical Instrumentation
- Industrial Controls
- Pneumatic Control Systems
- Robotics

| ORDERING INFORMATION                   |                 |          |            |        |      |               |              |          |                |
|----------------------------------------|-----------------|----------|------------|--------|------|---------------|--------------|----------|----------------|
| Device Name                            | Package Options | Case No. | # of Ports |        |      | Pressure Type |              |          | Device Marking |
|                                        |                 |          | None       | Single | Dual | Gauge         | Differential | Absolute |                |
| Unibody Package (MPX10 Series)         |                 |          |            |        |      |               |              |          |                |
| MPX10D                                 | Tray            | 344      | •          |        |      |               | •            |          | MPX10D         |
| MPX10DP                                | Tray            | 344C     |            |        | •    |               | •            |          | MPX10DP        |
| MPX10GP                                | Tray            | 344B     |            | •      |      | •             |              |          | MPX10GP        |
| Small Outline Package (MPXV10G Series) |                 |          |            |        |      |               |              |          |                |
| MPXV10GC6U                             | Rail            | 482A     |            | •      |      | •             |              |          | MPXV10G        |
| MPXV10GC7U                             | Rail            | 482C     |            | •      |      | •             |              |          | MPXV10G        |

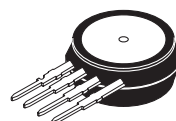
### SMALL OUTLINE PACKAGE



MPXV10GC6U  
CASE 482A-01

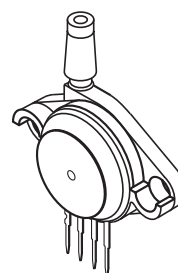


MPXV10GC7U  
CASE 482C-03

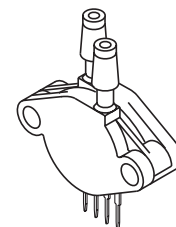


MPX10D  
CASE 344-15

### UNIBODY PACKAGE



MPX10GP  
CASE 344B-01



MPX10DP  
CASE 344C-01

## Operating Characteristics

**Table 1. 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   | Units                      |
|--------------------------------------------|---------------------|-------|------|-------|----------------------------|
| Differential Pressure Range <sup>(1)</sup> | $P_{OP}$            | 0     | —    | 10    | kPa                        |
| Supply Voltage <sup>(2)</sup>              | $V_S$               | —     | 3.0  | 6.0   | V <sub>DC</sub>            |
| Supply Current                             | $I_O$               | —     | 6.0  | —     | mAdc                       |
| Full Scale Span <sup>(3)</sup>             | $V_{FSS}$           | 20    | 35   | 50    | mV                         |
| Offset <sup>(4)</sup>                      | $V_{OFF}$           | 0     | 20   | 35    | mV                         |
| Sensitivity                                | $\Delta V/\Delta P$ | —     | 3.5  | —     | mV/kPa                     |
| Linearity                                  | —                   | −1.0  | —    | 1.0   | % $V_{FSS}$                |
| Pressure Hysteresis (0 to 10 kPa)          | —                   | —     | ±0.1 | —     | % $V_{FSS}$                |
| Temperature Hysteresis                     | —                   | —     | ±0.5 | —     | % $V_{FSS}$                |
| Temperature Coefficient of Full Scale Span | $TCV_{FSS}$         | −0.22 | —    | −0.16 | % $V_{FSS}/^\circ\text{C}$ |
| Temperature Coefficient of Offset          | $TCV_{OFF}$         | —     | ±15  | —     | μV/ $^\circ\text{C}$       |
| Temperature Coefficient of Resistance      | TCR                 | 0.21  | —    | 0.27  | % $Z_{IN}/^\circ\text{C}$  |
| Input Impedance                            | $Z_{IN}$            | 400   | —    | 550   | Ω                          |
| Output Impedance                           | $Z_{OUT}$           | 750   | —    | 1250  | Ω                          |
| Response Time <sup>(5)</sup> (10% to 90%)  | $t_R$               | —     | 1.0  | —     | ms                         |
| Warm-Up Time <sup>(6)</sup>                | —                   | —     | 20   | —     | ms                         |
| Offset Stability <sup>(7)</sup>            | —                   | —     | ±0.5 | —     | % $V_{FSS}$                |

- 1.0 kPa (kiloPascal) equals 0.145 psi.
- 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.
- 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.
- Offset ( $V_{OFF}$ ) is defined as the output voltage at the minimum rated pressure.
- 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 is 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 ( $P_1 > P_2$ ) | $P_{MAX}$   | 75          | kPa  |
| Burst Pressure ( $P_1 > P_2$ )   | $P_{BURST}$ | 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.

Figure 1 shows a schematic of the internal circuitry on the stand-alone pressure sensor chip.

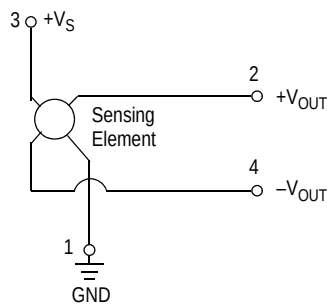


Figure 1. Uncompensated Pressure Sensor Schematic

## Voltage Output versus Applied Differential Pressure

The output voltage of the differential or gauge sensor increases with increasing pressure applied to the pressure side ( $P_1$ ) relative to the vacuum side ( $P_2$ ). Similarly, output

voltage increases as increasing vacuum is applied to the vacuum side ( $P_2$ ) relative to the pressure side ( $P_1$ ).

## Temperature Compensation

Figure 2 shows the typical output characteristics of the MPX10 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.

### LINEARITY

Linearity refers to how well a transducer's output follows the equation:  $V_{out} = V_{off} + \text{sensitivity} \times P$  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 4 illustrates the differential or gauge configuration in the basic chip carrier (Case 344). A silicone gel isolates the die surface and wire bonds from the environment, while allowing the pressure signal to be transmitted to the silicon diaphragm.

The MPX10 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. Refer to application note AN3728, for more information regarding media compatibility.

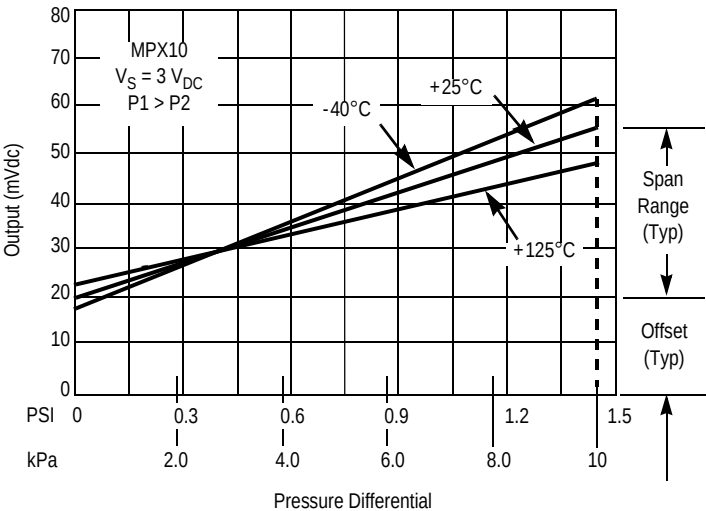


Figure 2. Output vs. Pressure Differential

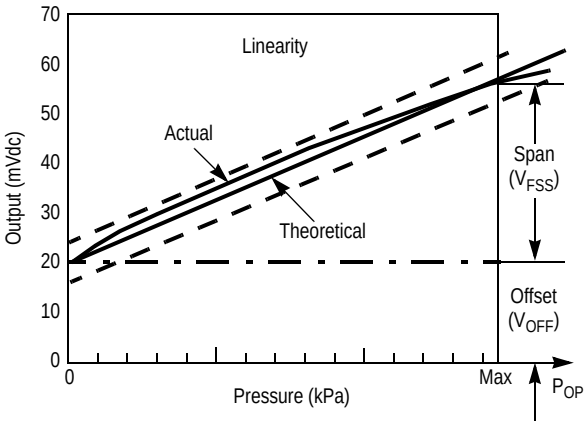


Figure 3. Linearity Specification Comparison

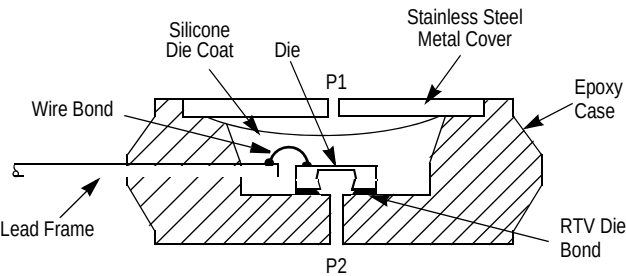


Figure 4. Unibody Package — Cross-Sectional Diagram (Not to Scale)

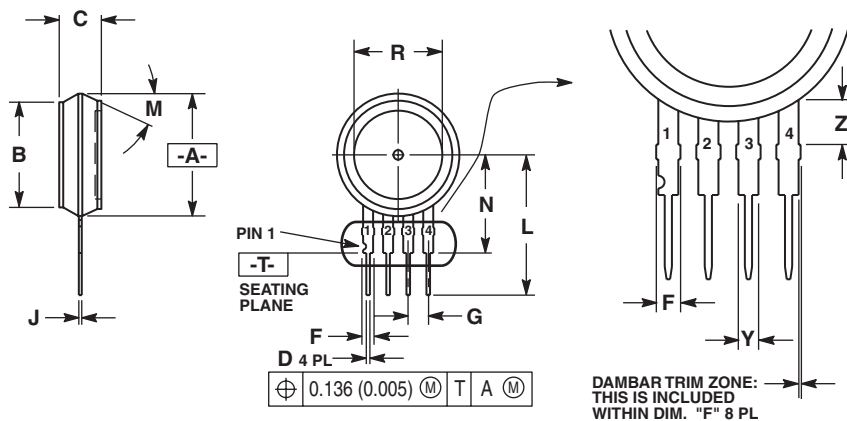
### PRESSURE (P1)/VACUUM (P2) SIDE IDENTIFICATION TABLE

Freescall 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 silicone gel which isolates the die from the environment. The 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 |
|-------------|-----------|-------------------------------|
| MPX10D      | 344       | Stainless Steel Cap           |
| MPX10DP     | 344C      | Side with Part Marking        |
| MPX10GP     | 344B      | Side with Port Attached       |
| MPXV10GC6U  | 482A      | Side with Port Attached       |
| MPXV10GC7U  | 482C      | Side with Port Attached       |

# PACKAGE DIMENSIONS

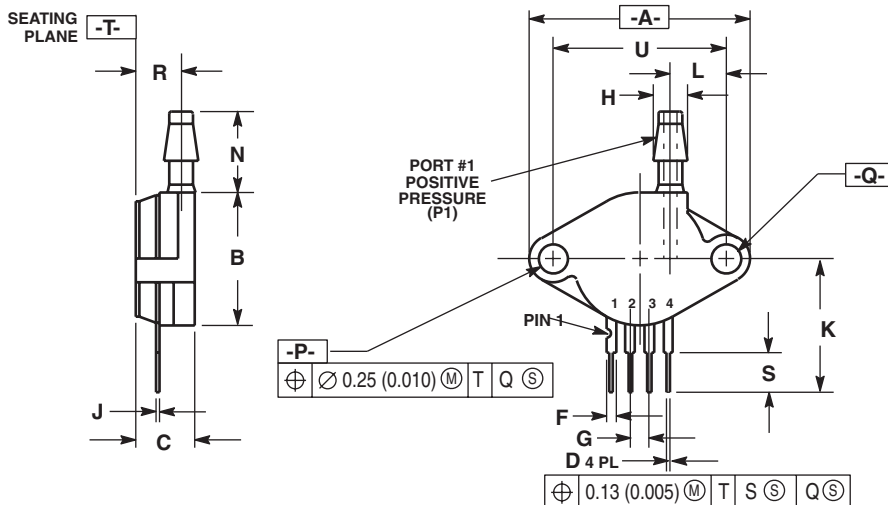


## NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
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   | 0.016     | 0.020 | 0.41        | 0.51  |
| 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 |
| Y   | 0.048     | 0.052 | 1.22        | 1.32  |
| Z   | 0.106     | 0.118 | 2.68        | 3.00  |

## CASE 344-15 ISSUE AA UNIBODY PACKAGE



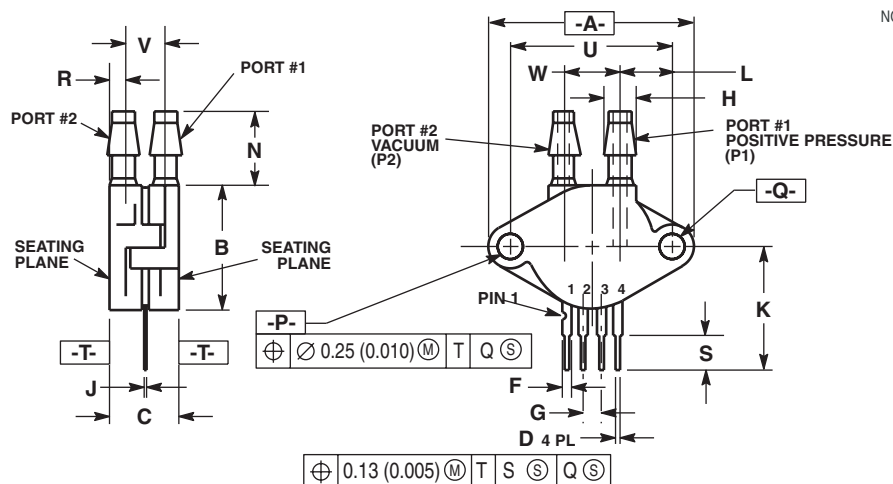
## NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
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   | 0.305     | 0.325 | 7.75        | 8.26  |
| D   | 0.016     | 0.020 | 0.41        | 0.51  |
| F   | 0.048     | 0.064 | 1.22        | 1.63  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| H   | 0.182     | 0.194 | 4.62        | 4.93  |
| 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   | 0.230     | 0.250 | 5.84        | 6.35  |
| S   | 0.220     | 0.240 | 5.59        | 6.10  |
| U   | 0.910 BSC |       | 23.11 BSC   |       |

## CASE 344B-01 ISSUE B UNIBODY PACKAGE

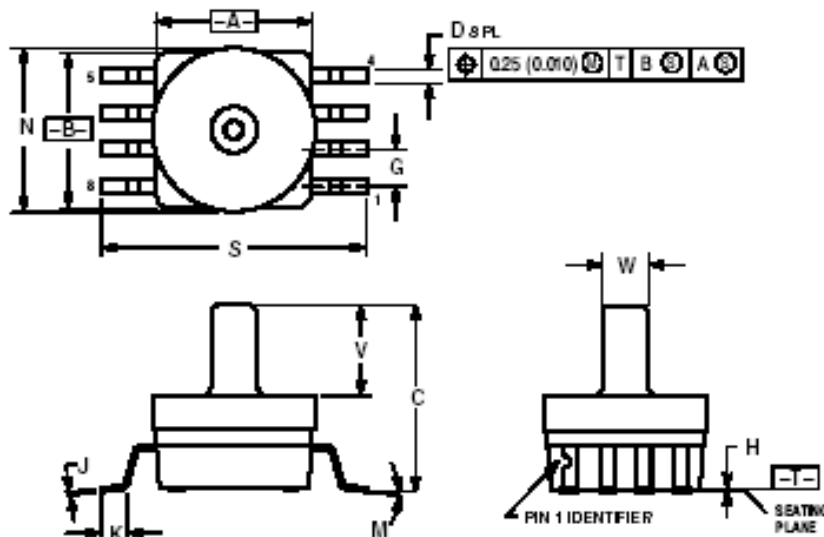
# PACKAGE DIMENSIONS



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

|     | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
| DIM | 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   | 0.016     | 0.020 | 0.41        | 0.51  |
| F   | 0.048     | 0.064 | 1.22        | 1.63  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| H   | 0.182     | 0.194 | 4.62        | 4.93  |
| 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   | 0.248     | 0.278 | 6.30        | 7.06  |
| W   | 0.310     | 0.330 | 7.87        | 8.38  |

**CASE 344C-01  
ISSUE B  
UNIBODY PACKAGE**

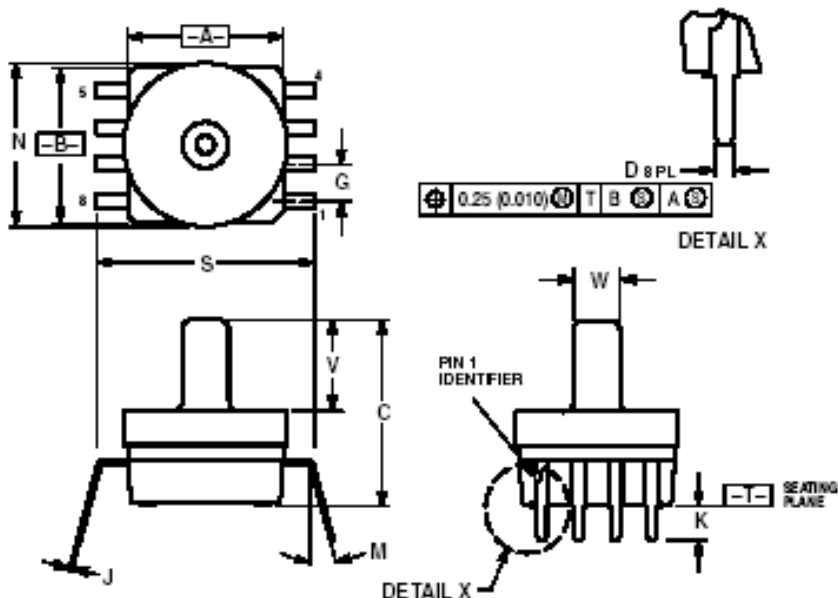


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.015 (0.006).
  5. ALL VERTICAL SURFACES 5° TYPICAL DRAFT.

|     | 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   | 0.000     | 0.010 | 0.05        | 0.25  |
| J   | 0.000     | 0.011 | 0.23        | 0.28  |
| K   | 0.061     | 0.071 | 1.55        | 1.80  |
| L   | 0.000     | 0.000 | 0.00        | 0.00  |
| M   | 0.444     | 0.448 | 11.28       | 11.38 |
| S   | 0.702     | 0.725 | 18.01       | 18.41 |
| V   | 0.245     | 0.255 | 6.22        | 6.48  |
| W   | 0.115     | 0.125 | 2.93        | 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. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
  5. ALL VERTICAL SURFACES 5° TYPICAL DRAFT.
  6. DIMENSIONS 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   | 0.028     | 0.034 | 0.66        | 0.864 |
| E   | 0.100 BSC |       | 2.54 BSC    |       |
| F   | 0.009     | 0.011 | 0.23        | 0.28  |
| G   | 0.100     | 0.120 | 2.54        | 3.05  |
| H   | 0°        | 15°   | 0°          | 15°   |
| I   | 0.444     | 0.448 | 11.28       | 11.38 |
| J   | 0.540     | 0.560 | 13.72       | 14.22 |
| K   | 0.245     | 0.265 | 6.22        | 6.48  |
| L   | 0.115     | 0.125 | 2.92        | 3.17  |

CASE 482C-03  
ISSUE B  
SMALL OUTLINE PACKAGE



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