

200 kPa On-Chip Temperature Compensated Silicon Pressure Sensors

The MPX2202 devices series are silicon piezoresistive pressure sensor providing a highly accurate and linear voltage output directly proportional to the applied pressure. The sensor is a single monolithic silicon diaphragm with the strain gauge and a thin-film resistor network integrated on chip. The chip is laser trimmed for precise span and offset calibration and temperature compensation. They are designed for use in applications such as pump/motor controllers, robotics, level indicators, medical diagnostics, pressure switching, barometers, altimeters, etc.

Features

- Temperature Compensated Over 0°C to +85°C
- Easy-to-Use Chip Carrier Package Options
- Available in Absolute, Differential and Gauge Configurations
- Ratiometric to Supply Voltage
- Available in Easy-to-Use Tape and Reel

MPX2202 Series

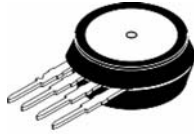
0 to 200 kPa (0 to 29 psi)
40 mV Full Scale
(Typical)

Application Examples

- Pump/Motor Controllers
- Robotics
- Level Indicators
- Medical Diagnostics
- Pressure Switching
- Barometers
- Altimeters

| ORDERING INFORMATION | | | | | | | | |
|--|----------|------------|--------|------|---------------|--------------|----------|----------------|
| Device Name | Case No. | # of Ports | | | Pressure Type | | | Device Marking |
| | | None | Single | Dual | Gauge | Differential | Absolute | |
| Unibody Package (MPX2202 Series) | | | | | | | | |
| MPX2202A | 344 | • | | | | | • | MPX2202A |
| MPX2202DP | 344C | | | • | | • | | MPX2202DP |
| MPX2202AP | 344B | | • | | | | • | MPX2202AP |
| MPX2202GP | 344B | | • | | • | | | MPX2202GP |
| MPX2202ASX | 344F | | • | | | | • | MPX2202A |
| Small Outline Package (MPXV2202 Series) | | | | | | | | |
| MPXV2202GP | 1369 | | • | | • | | | MPXV2202GP |
| MPXV2202DP | 1351 | | | • | | • | | MPXV2202DP |
| MPXV2202GC6T1 | 482A | | • | | • | | | MPXV2202G |
| MPAK Package (MPXM2202 Series) | | | | | | | | |
| MPXM2202D | 1320 | • | | | | • | | MPXM2202D |
| MPXM2202DT1 | 1320 | • | | | | • | | MPXM2202D |
| MPXM2202A | 1320 | • | | | | | • | MPXM2202A |
| MPXM2202GS | 1320A | | • | | • | | | MPXM2202GS |
| MPXM2202GST1 | 1320A | | • | | • | | | MPXM2202GS |
| MPXM2202AS | 1320A | | • | | | | • | MPXM2202AS |

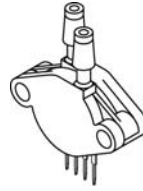
UNIBODY PACKAGES



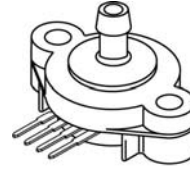
MPX2202A
CASE 344-15



MPX2202AP/GP
CASE 344B-01

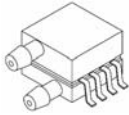


MPX2202DP
CASE 344C-01

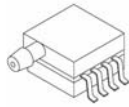


MPX2202ASX
CASE 344F-01

SMALL OUTLINE PACKAGES



MPXV2202DP
CASE 1351-01

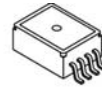


MPXV2202GP
CASE 1369-01

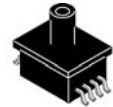


MPXV2202GC6T1
CASE 482A-01

MPAK



MPXM2202A
CASE 1320-02



MPXM2202GS/AS
CASE 1320A-02

Operating Characteristics

Table 1. Operating Characteristics
 $(V_S = 10 \text{ Vdc}, T_A = 25^\circ\text{C}$ unless otherwise noted, $P_1 > P_2$)

| Characteristics | Symbol | Min | Typ | Max | Unit |
|---|---------------------|------|-----------|------|-------------|
| Pressure Range ⁽¹⁾ | | | | | |
| Absolute Pressure Range MPX2202A | P_{OP} | 20 | — | 200 | kPa |
| Differential Pressure Range MPX2202D | P_{OP} | 0 | — | 200 | kPa |
| Supply Voltage ⁽²⁾ | V_S | — | 10 | 16 | Vdc |
| Supply Current | I_o | — | 6.0 | — | mAdc |
| Full Scale Span ⁽³⁾ | V_{FSS} | 38.5 | 40 | 41.5 | mV |
| Offset ⁽⁴⁾ | | | | | |
| MPX2202D, MPXM2202D/G Series | V_{off} | -1.0 | — | 1.0 | mV |
| MPX2202A, MPXM2202A Series | | -2.0 | — | 2.0 | |
| Sensitivity | $\Delta V/\Delta P$ | — | 0.2 | — | mV/kPa |
| Linearity ⁽⁵⁾ | | | | | |
| MPXM2202D/G, MPX2202D Series | — | -0.6 | — | 0.4 | % V_{FSS} |
| MPXM2202A, MPX2202A Series | | -1.0 | — | 1.0 | |
| Pressure Hysteresis ⁽⁵⁾ (0 to 200 kPa) | — | — | ± 0.1 | — | % V_{FSS} |
| Temperature Hysteresis ⁽⁵⁾ (-40°C to +125°C) | — | — | ± 0.5 | — | % V_{FSS} |
| Temperature Effect on Full Scale Span ⁽⁵⁾ | TCV_{FSS} | -2.0 | — | 2.0 | % V_{FSS} |
| Temperature Effect on Offset ⁽⁵⁾ | TCV_{off} | -1.0 | — | 1.0 | mV |
| Input Impedance | Z_{in} | 1000 | — | 2500 | Ω |
| Output Impedance | Z_{out} | 1400 | — | 3000 | Ω |
| Response Time ⁽⁶⁾ (10% to 90%) | t_R | — | 1.0 | — | ms |
| Warm-Up | — | — | 20 | — | ms |
| Offset Stability ⁽⁷⁾ | — | — | ± 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 rated 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 within the specified range, when this pressure is cycled to and from the minimum or maximum rated pressure, at 25°C.

TcSpan: Output deviation at full rated pressure 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.

6. 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.

7. 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 | Max Value | Unit |
|----------------------------|------------|------|
| Maximum Pressure (P1 > P2) | 400 | kPa |
| Storage Temperature | -40 to 125 | °C |
| Operating Temperature | -40 to 125 | °C |

1. Exposure beyond the specified limits may cause permanent damage or degradation to the device.

Voltage Output versus Applied Differential

The differential voltage output of the sensor is directly proportional to the differential pressure applied.

The absolute sensor has a built-in reference vacuum. The output voltage will decrease as vacuum, relative to ambient, is drawn on the pressure (P1) side.

The output voltage of the differential or gauge sensor increases with increasing pressure applied to the pressure

(P1) side relative to the vacuum (P2) side. Similarly, output voltage increases as increasing vacuum is applied to the vacuum (P2) side relative to the pressure (P1) side.

Figure 1 illustrates a block diagram of the internal circuitry on the stand-alone pressure sensor chip.

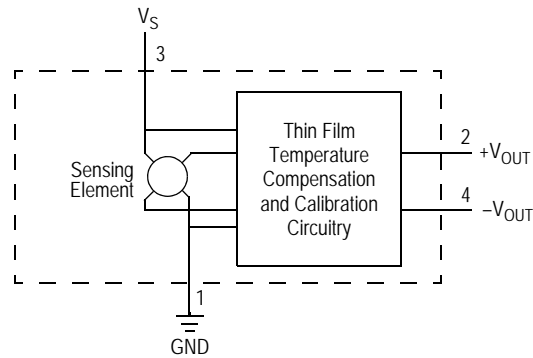


Figure 1. Temperature Compensated and Calibrated Pressure Sensor Schematic

On-Chip Temperature Compensation and Calibration

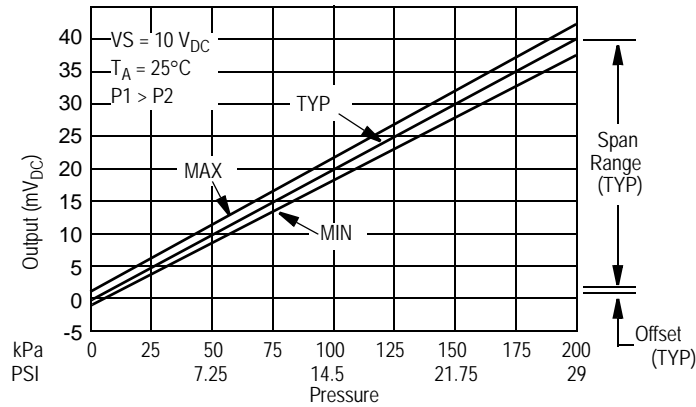


Figure 2. Output vs. Pressure Differential

Figure 2 shows the output characteristics of the MPX2202 series at 25°C. The output is directly proportional to the differential pressure and is essentially a straight line.

The effects of temperature on full scale span and offset are very small and are shown under Operating Characteristics.

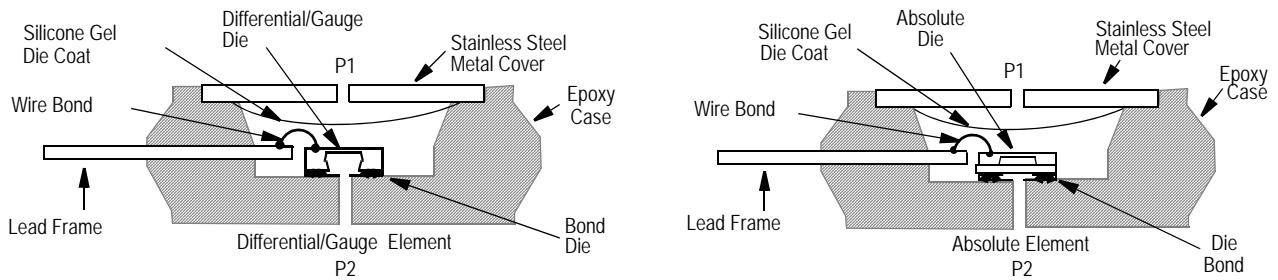


Figure 3. Cross Sectional Diagram (not to scale)

Figure 3 illustrates the differential/gauge die 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 MPX2202 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.

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. There are two basic methods for calculating nonlinearity: (1) end point straight line fit (see Figure 4) 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.

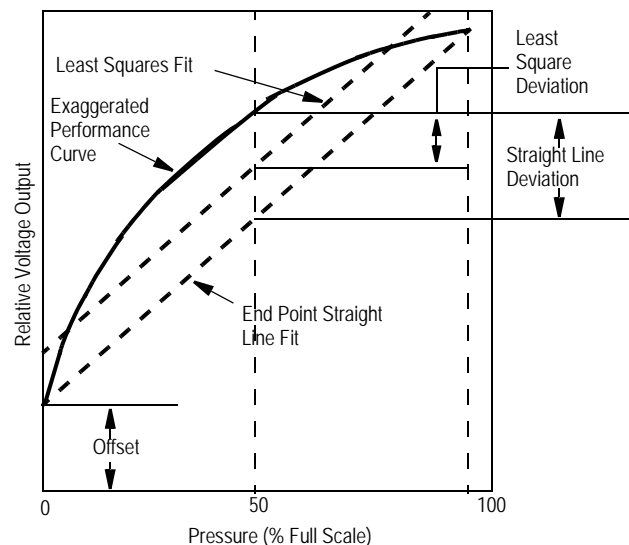


Figure 4. Linearity Specification Comparison

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 silicone gel which isolates the die from the environment. The Freescale MPX

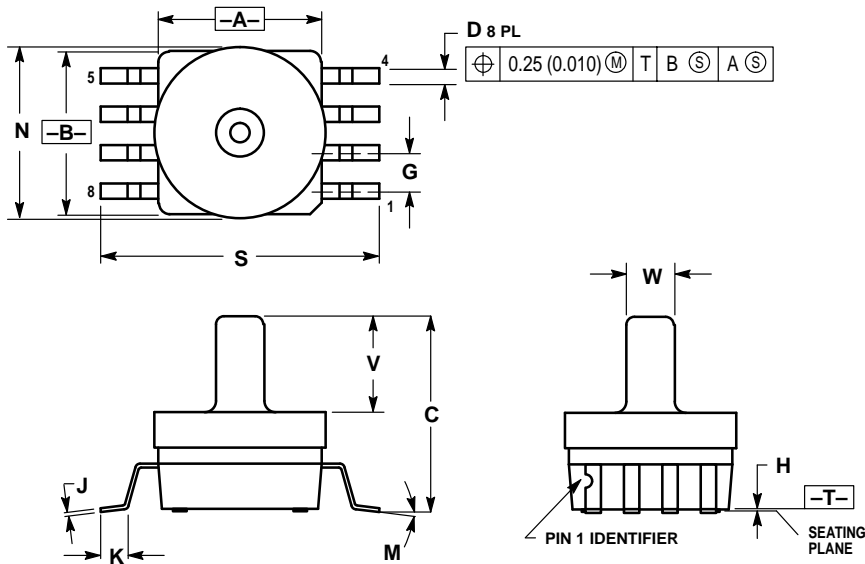
pressure sensor is designed to operate with positive differential pressure applied, $P1 > P2$.

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

Table 3. Pressure (P1) Side Delineation

| Part Number | Case Type | Pressure (P1) Side Identifier |
|-------------------------|-----------|-------------------------------|
| MPX2202A | 344 | Stainless Steel Cap |
| MPX2202DP | 344C | Side with Part Marking |
| MPX2202GP/AP | 344B | Side with Port Attached |
| MPX2202ASX | 344F | Side with Port Attached |
| MPX2202GP | 1369 | Side with Port Attached |
| MPX2202DP | 1351 | Side with Part Marking |
| MPXV2202GP | 1369 | Side with Port Attached |
| MPXV2202DP | 1351 | Side with Part Marking |
| MPXV2202GC6TI | 482A | Side with Port Attached |
| MPXM2202A/ATI/DT/DTI | 1320 | Side with Part Marking |
| MPXM2202GS/GSTI/AS/ASTI | 1320A | Side with Port Attached |

PACKAGE DIMENSIONS



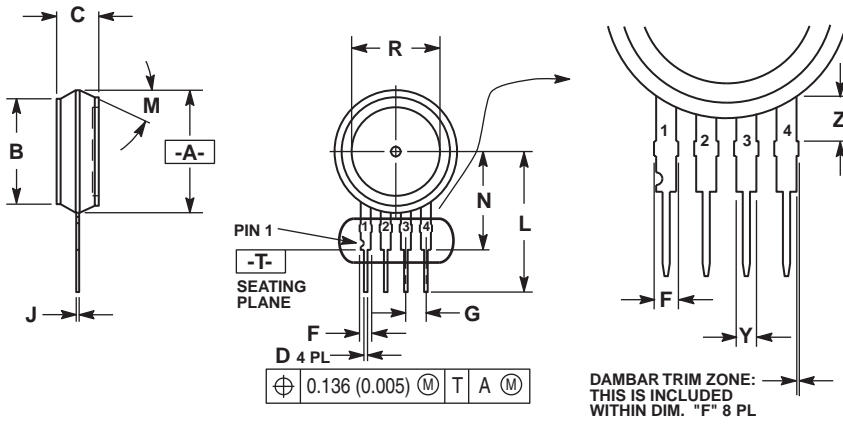
NOTES:

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

PACKAGE DIMENSIONS



NOTES:

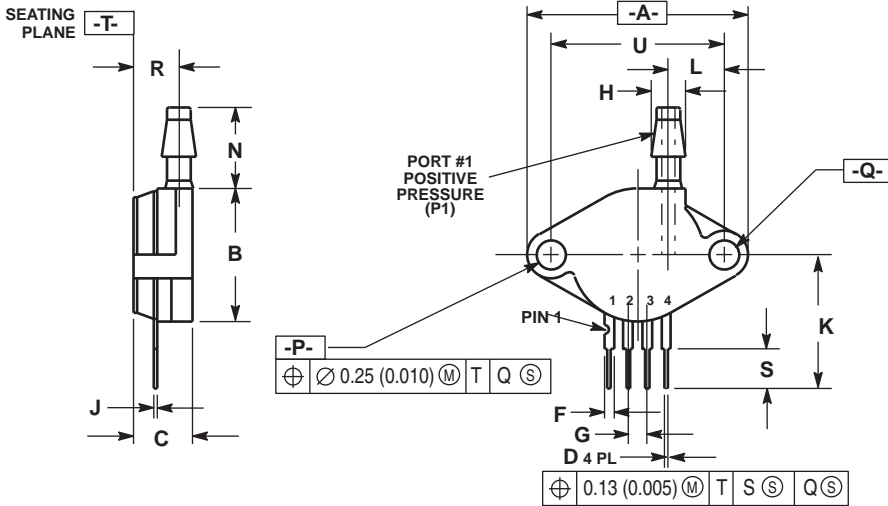
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION -A- IS INCLUSIVE OF THE MOLD STOP RING. MOLD STOP RING NOT TO EXCEED 16.00 (0.630).

STYLE 1:
PIN 1. GROUND
2. + OUTPUT
3. + SUPPLY
4. - OUTPUT

STYLE 2:
PIN 1. V_{cc}
2. - SUPPLY
3. + SUPPLY
4. GROUND

STYLE 3:
PIN 1. GND
2. -VOUT
3. VS
4. +VOUT

CASE 344-15
ISSUE AA
UNIBODY PACKAGE



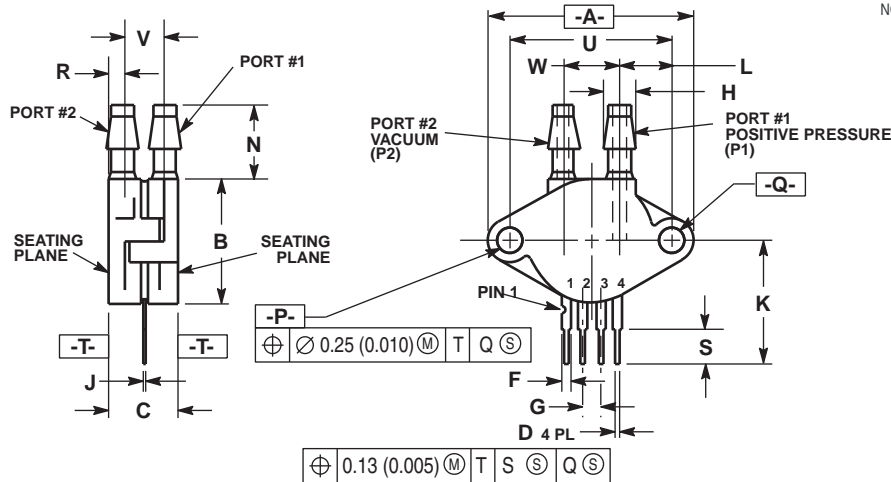
NOTES:

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

STYLE 1:
PIN 1. GROUND
2. + OUTPUT
3. + SUPPLY
4. - OUTPUT

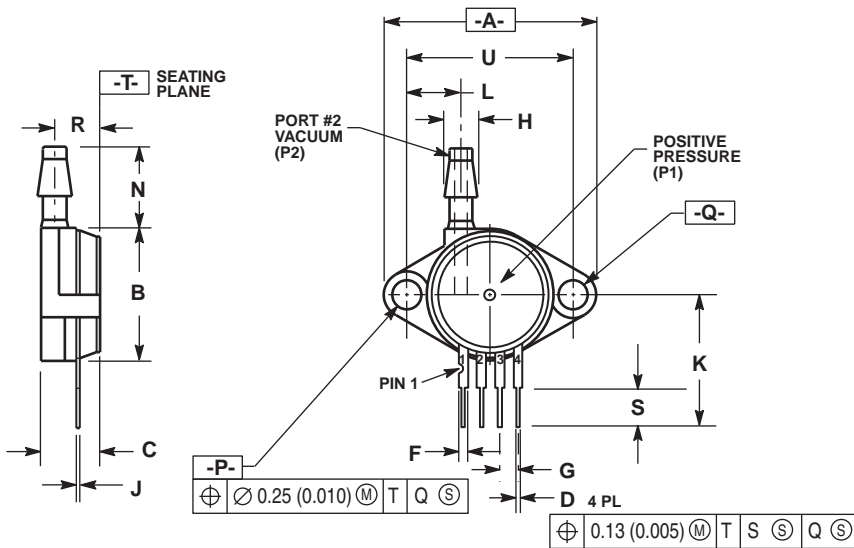
CASE 344B-01
ISSUE B
UNIBODY PACKAGE

PACKAGE DIMENSIONS



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

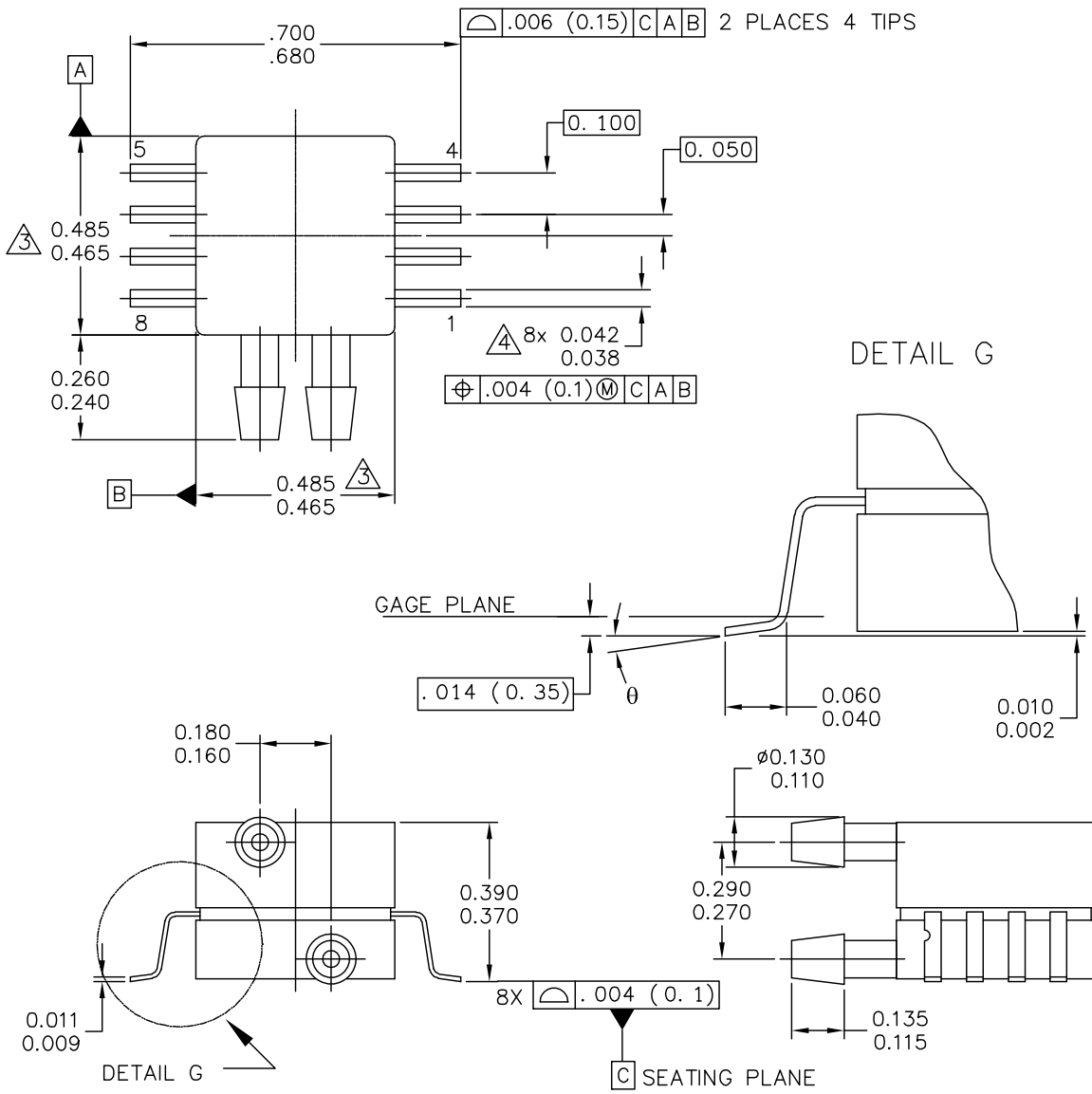
CASE 344C-01
 ISSUE B
 UNIBODY PACKAGE



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

CASE 344D-01
 ISSUE B
 UNIBODY PACKAGE

PACKAGE DIMENSIONS



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| TITLE: 8 LD SNSR, DUAL PORT | DOCUMENT NO: 98ASA99255D | REV: A |
| | CASE NUMBER: 1351-01 | 27 JUL 2005 |
| | STANDARD: NON-JEDEC | |

**CASE 1351-01
ISSUE A
SMALL OUTLINE PACKAGE**

NOTES:

1. CONTROLLING DIMENSION: INCH
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH AND PROTRUSIONS SHALL NOT EXCEED .006 PER SIDE.
4. DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .008 MAXIMUM.

STYLE 1:

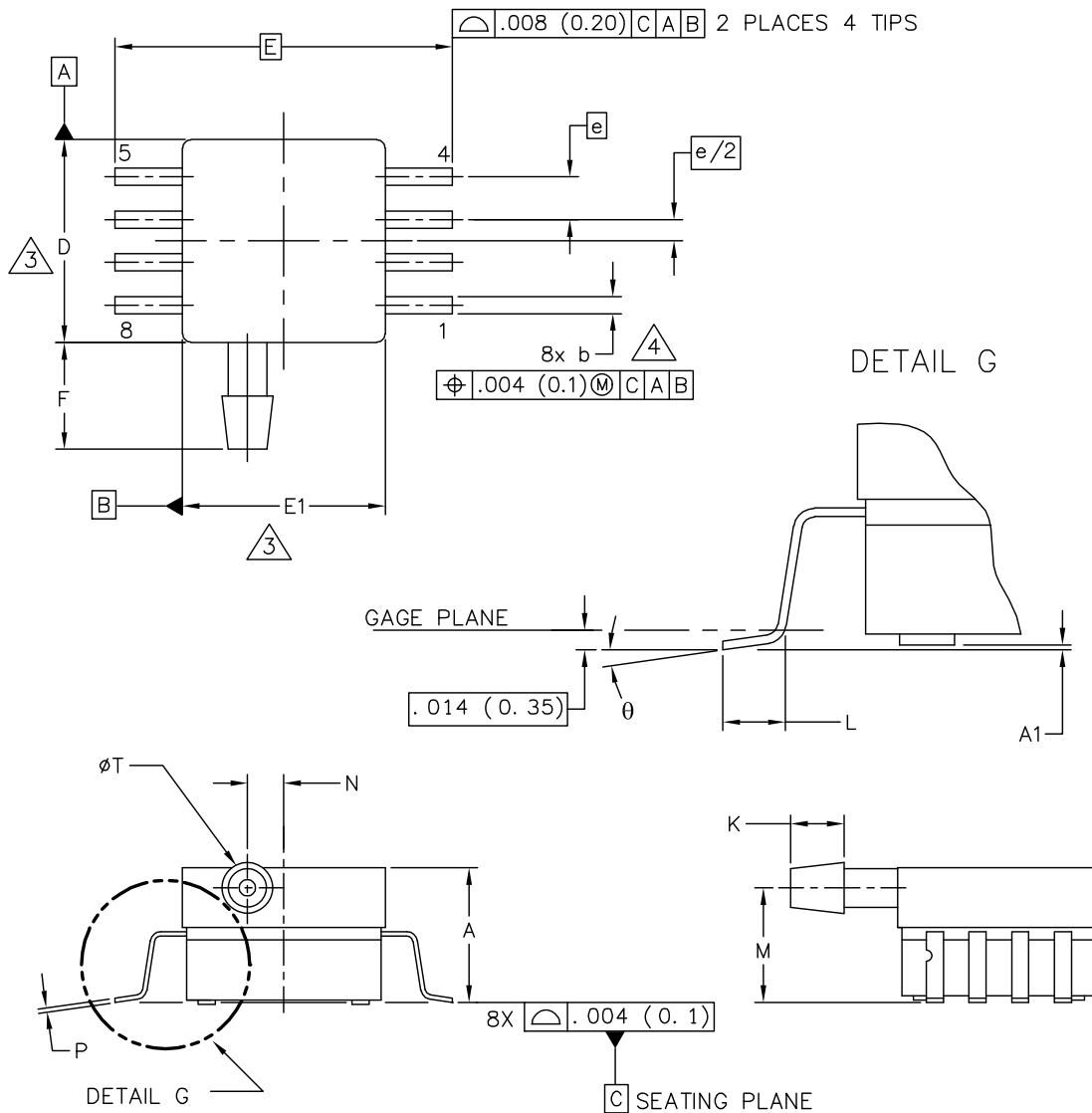
PIN 1: GND
 PIN 2: +Vout
 PIN 3: Vs
 PIN 4: -Vout
 PIN 5: N/C
 PIN 6: N/C
 PIN 7: N/C
 PIN 8: N/C

STYLE 2:

PIN 1: N/C
 PIN 2: Vs
 PIN 3: GND
 PIN 4: Vout
 PIN 5: N/C
 PIN 6: N/C
 PIN 7: N/C
 PIN 8: N/C

| | | | |
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| | CASE NUMBER: 1351-01 | 27 JUL 2005 | |
| | STANDARD: NON-JEDEC | | |

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 ISSUE A
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| TITLE: 8 LD SOP, SIDE PORT | DOCUMENT NO: 98ASA99303D | REV: B |
| | CASE NUMBER: 1369-01 | 24 MAY 2005 |
| | STANDARD: NON-JEDEC | |

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

PACKAGE DIMENSIONS

NOTES:

1. CONTROLLING DIMENSION: INCH

2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.

⚠ DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH AND PROTRUSIONS SHALL NOT EXCEED .006 (0.152) PER SIDE.

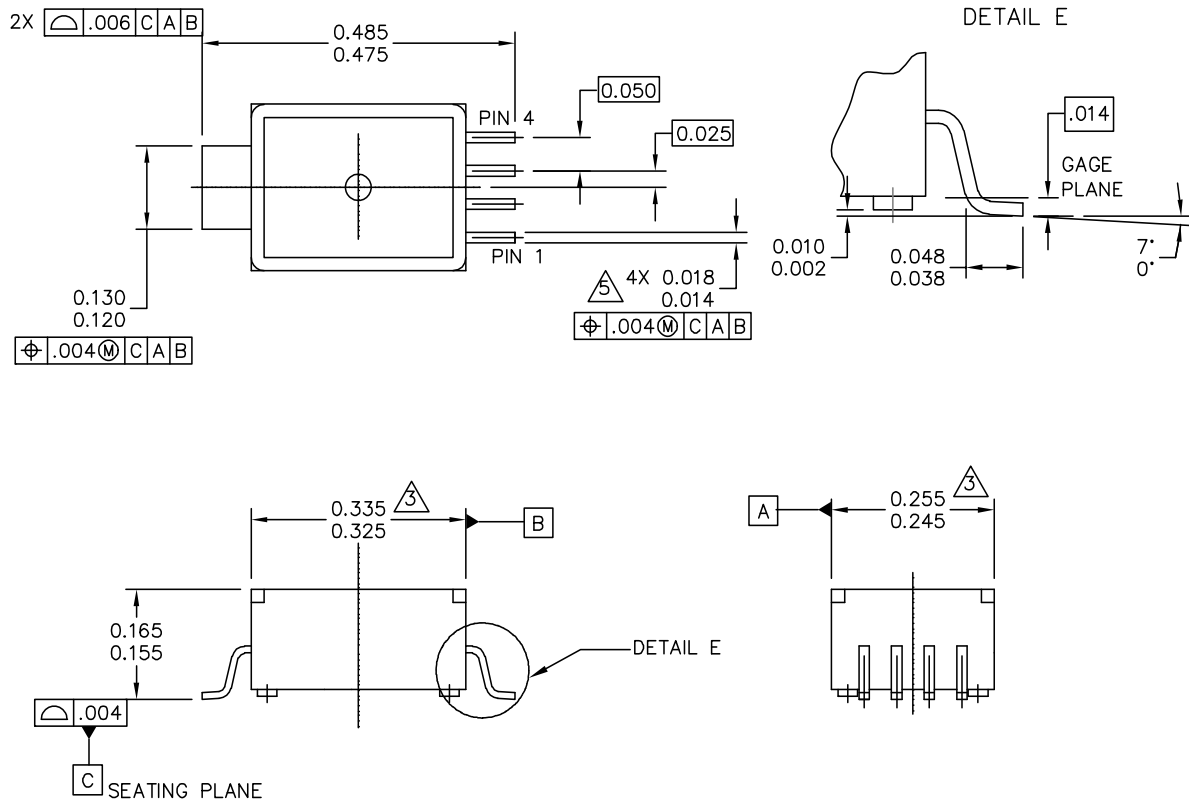
⚠ DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR
PROTRUSION SHALL BE .008 (0.203) MAXIMUM.

| DIM | INCHES | | MILLIMETERS | | DIM | INCHES | | MILLIMETERS | |
|---|----------|------|---------------------------|-------|--------------------------|----------------------------|-----|-------------|-----|
| | MIN | MAX | MIN | MAX | | MIN | MAX | MIN | MAX |
| A | .300 | .330 | 7.11 | 7.62 | θ | 0° | 7° | 0° | 7° |
| A1 | .002 | .010 | 0.05 | 0.25 | - | --- | --- | --- | --- |
| b | .038 | .042 | 0.96 | 1.07 | - | --- | --- | --- | --- |
| D | .465 | .485 | 11.81 | 12.32 | - | --- | --- | --- | --- |
| E | .717 BSC | | 18.21 BSC | | - | --- | --- | --- | --- |
| E1 | .465 | .485 | 11.81 | 12.32 | - | --- | --- | --- | --- |
| e | .100 BSC | | 2.54 BSC | | - | --- | --- | --- | --- |
| F | .245 | .255 | 6.22 | 6.47 | - | --- | --- | --- | --- |
| K | .120 | .130 | 3.05 | 3.30 | - | --- | --- | --- | --- |
| L | .061 | .071 | 1.55 | 1.80 | - | --- | --- | --- | --- |
| M | .270 | .290 | 6.86 | 7.36 | - | --- | --- | --- | --- |
| N | .080 | .090 | 2.03 | 2.28 | - | --- | --- | --- | --- |
| P | .009 | .011 | 0.23 | 0.28 | - | --- | --- | --- | --- |
| T | .115 | .125 | 2.92 | 3.17 | - | --- | --- | --- | --- |
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| TITLE: 8 LD SOP, SIDE PORT | | | | | DOCUMENT NO: 98ASA99303D | | | REV: B | |
| | | | | | CASE NUMBER: 1369-01 | | | 24 MAY 2005 | |
| | | | | | STANDARD: NON-JEDEC | | | | |

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

MPX2202

PACKAGE DIMENSIONS



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| TITLE: 5 LD M-PAC | DOCUMENT NO: 98ARH99088A | REV: B | |
| | CASE NUMBER: 1320-02 | 22 JUL 2005 | |
| | STANDARD: NON-JEDEC | | |

**CASE 1320-02
ISSUE B
MPAK**

PACKAGE DIMENSIONS

NOTES:

1. DIMENSIONS ARE IN INCHES.

2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.

3. DIMENSION DOES NOT INCLUDE MOLD FLASH OR PROTRUSION. MOLD FLASH OR PROTRUSION SHALL NOT EXCEED .006" PER SIDE.

4. ALL VERTICAL SURFACES TO BE 5° MAXIMUM.

5. DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .008 MAXIMUM.

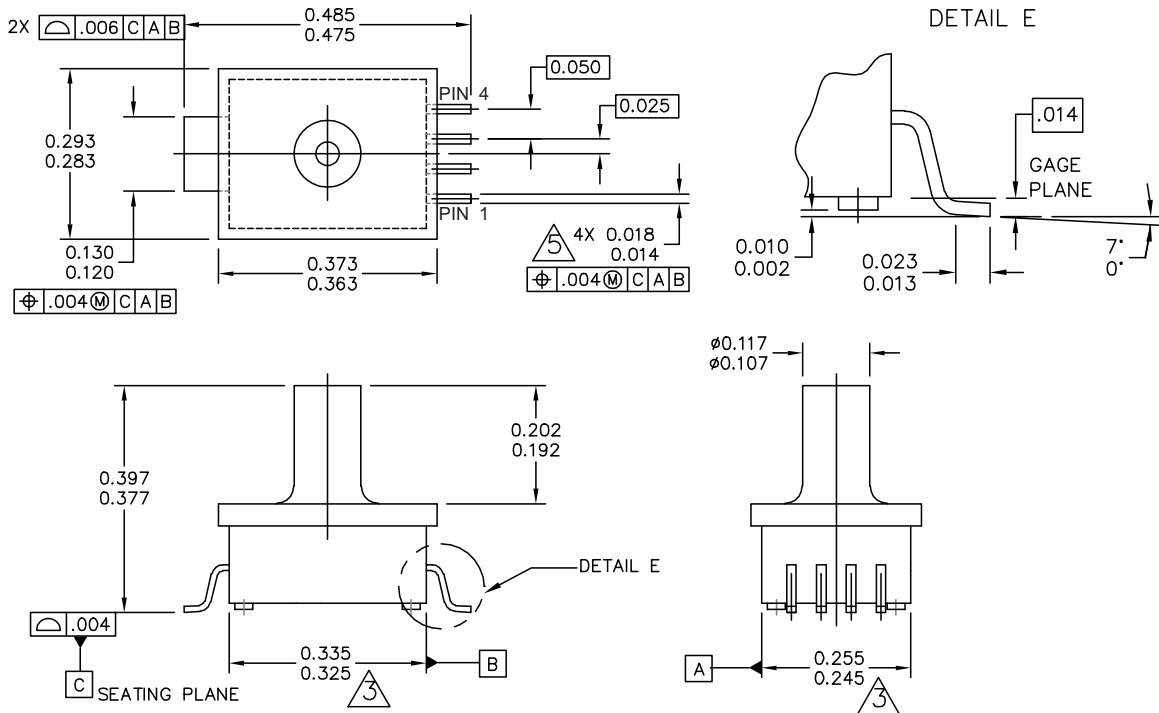
PIN 1: GND
 PIN 2: +Vout
 PIN 3: Vs
 PIN 4: -Vout

| | | | |
|---|---------------------------|----------------------------|--|
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| | CASE NUMBER: 1320-02 | 22 JUL 2005 | |
| | STANDARD: NON-JEDEC | | |

CASE 1320-02
ISSUE B
MPAK

MPX2202

PACKAGE DIMENSIONS



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| <p>TITLE: 5 LD M-PAC, PORTED</p> | <p>DOCUMENT NO: 98ARH99087A</p> | <p>REV: A</p> |
| | <p>CASE NUMBER: 1320A-02</p> | <p>22 JUL 2005</p> |
| | <p>STANDARD: NON-JEDEC</p> | |

**CASE 1320A-02
ISSUE A
MPAK**

PACKAGE DIMENSIONS

NOTES:

1. DIMENSIONS ARE IN INCHES.

2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.

3. DIMENSIONS DOES NOT INCLUDE MOLD FLASH OR PROTRUSION. MOLD FLASH OR PROTRUSION SHALL NOT EXCEED .006" PER SIDE.

4. ALL VERTICAL SURFACES TO BE 5" MAXIMUM.

5. DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .008 MAXIMUM.

| | | | |
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| TITLE: 5 LD M-PAC, PORTED | DOCUMENT NO: 98ARH99087A | REV: A | |
| | CASE NUMBER: 1320A-02 | 22 JUL 2005 | |
| | STANDARD: NON-JEDEC | | |

**CASE 1320A-02
ISSUE A
MPAK**

REVISION HISTORY

| Revision number | Revision date | Description of changes |
|------------------------|----------------------|--|
| 7 | 01/2012 | <ul style="list-style-type: none">• In Table 1. Operating Characteristics, in the Characteristic column under Pressure Range, added rows for Absolute Pressure Range MPX2202A and Differential Pressure Range MPX2202D devices |
| 8 | 10/2012 | <ul style="list-style-type: none">• Deleted references to device number MPXV2022GC6U throughout the document |

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