

10 kPa On-Chip Temperature Compensated & Calibrated Silicon Pressure Sensors

The MPX2010/MPXV2010G series silicon piezoresistive pressure sensors provide a very accurate and linear voltage output directly proportional to the applied pressure. These sensors house a single monolithic silicon die with the strain gauge and thin film resistor network integrated on each chip. The sensor is laser trimmed for precise span, offset calibration and temperature compensation.

Features

- Temperature Compensated over 0°C to +85°C
- Ratiometric to Supply Voltage
- Differential and Gauge Options

Typical Applications

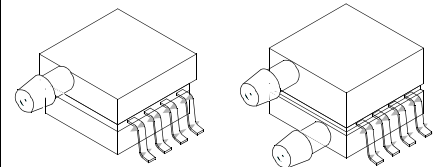
- Respiratory Diagnostics
- Air Movement Control
- Controllers
- Pressure Switching

| ORDERING INFORMATION | | | | | |
|--|------------------------------|----------|----------------------|-----------------|----------------|
| Device Type | Options | Case No. | MPX Series Order No. | Packing Options | Device Marking |
| SMALL OUTLINE PACKAGE (MPXV2010G SERIES) | | | | | |
| Ported Elements | Gauge, Side Port, SMT | 1369 | MPXV2010GP | Trays | MPXV2010G |
| | Differential, Dual Port, SMT | 1351 | MPXV2010DP | Trays | MPXV2010G |
| UNIBODY PACKAGE (MPX2010 SERIES) | | | | | |
| Basic Element | Differential | 344 | MPX2010D | — | MPX2010D |
| Ported Elements | Differential, Dual Port | 344C | MPX2010DP | — | MPX2010DP |
| | Gauge | 344B | MPX2010GP | — | MPX2010GP |
| | Gauge, Axial | 344E | MPX2010GS | — | MPX2010D |
| | Gauge, Axial PC Mount | 344F | MPX2010GSX | — | MPX2010D |

MPX2010 MPXV2010G SERIES

**COMPENSATED
 PRESSURE SENSOR**
 0 to 10 kPa (0 to 1.45 psi)
 FULL SCALE SPAN: 25 mV

SMALL OUTLINE PACKAGES



MPXV2010GP
 CASE 1369-01

MPXV2010DP
 CASE 1351-01

SMALL OUTLINE PACKAGE PIN NUMBERS

| | | | |
|---|--------------------|---|-----|
| 1 | GND ⁽¹⁾ | 5 | N/C |
| 2 | +V _{OUT} | 6 | N/C |
| 3 | V _S | 7 | N/C |
| 4 | -V _{OUT} | 8 | N/C |

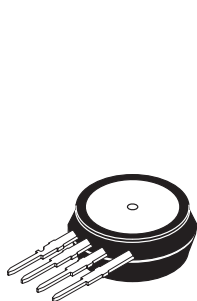
1. Pin 1 in noted by the notch in the lead.

UNIBODY PACKAGE PIN NUMBERS

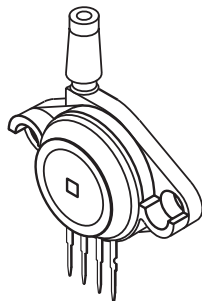
| | | | |
|---|--------------------|---|-------------------|
| 1 | GND ⁽¹⁾ | 3 | V _S |
| 2 | +V _{OUT} | 4 | -V _{OUT} |

1. Pin 1 in noted by the notch in the lead.

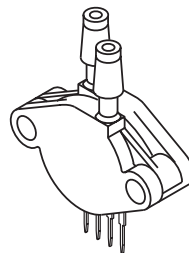
UNIBODY PACKAGES



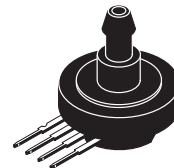
MPX2010GP
 CASE 344-15



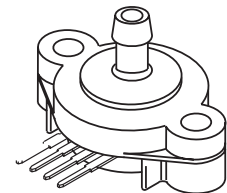
MPX2010GP
 CASE 344B-01



MPX2010DP
 CASE 344C-01



MPX2010GS
 CASE 344E-01



MPX2010GSX
 CASE 344F-01

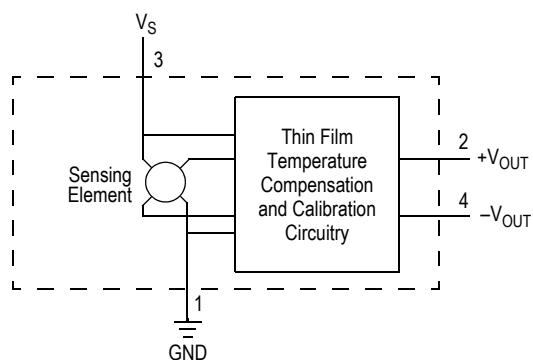


Figure 1. Temperature Compensated and Calibrated Pressure Sensor Schematic

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).

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

Table 1. Maximum Ratings⁽¹⁾

| Rating | Symbol | Value | Unit |
|----------------------------|-----------|-------------|------|
| Maximum Pressure (P1 > P2) | P_{MAX} | 75 | 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 ($V_S = 10 V_{DC}$, $T_A = 25^\circ C$ unless otherwise noted, $P_1 > P_2$)

| Characteristic | Symbol | Min | Typ | Max | Units |
|---|---------------------|------|------|------|------------------|
| Pressure Range ⁽¹⁾ | P_{OP} | 0 | — | 10 | kPa |
| Supply Voltage ⁽²⁾ | V_S | — | 10 | 16 | V_{DC} |
| Supply Current | I_O | — | 6.0 | — | mA _{dc} |
| Full Scale Span ⁽³⁾ | V_{FSS} | 24 | 25 | 26 | mV |
| Offset ⁽⁴⁾ | V_{OFF} | -1.0 | — | 1.0 | mV |
| Sensitivity | $\Delta V/\Delta P$ | — | 2.5 | — | mV/kPa |
| Linearity ⁽⁵⁾ | — | -1.0 | — | 1.0 | % V_{FSS} |
| Pressure Hysteresis ⁽⁵⁾ (0 to 50 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} | -1.0 | — | 1.0 | % V_{FSS} |
| Temperature Effect on Offset ⁽⁵⁾ | TCV_{OFF} | -1.0 | — | 1.0 | mV |
| Input Impedance | Z_{IN} | 1000 | — | 2550 | W |
| Output Impedance | Z_{OUT} | 1400 | — | 3000 | W |
| Response Time ⁽⁶⁾ (10% to 90%) | t_R | — | 1.0 | — | ms |
| Warm-Up Time | — | — | 2.0 | — | ms |
| Offset Stability ⁽⁷⁾ | — | — | ±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 related pressure.
- Offset (V_{OFF}) is defined as 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 from 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.
- Offset stability is the product's output deviation when subjected to 1000 hours of Pulsed Pressure, Temperature Cycling with Bias Test.

ON-CHIP TEMPERATURE COMPENSATION AND CALIBRATION

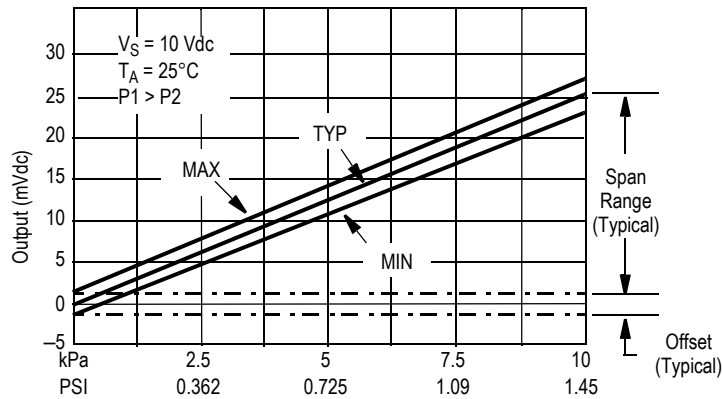


Figure 2. Output vs. Pressure Differential

Figure 2 shows the output characteristics of the MPX2010/MPXV2010G 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.

This performance over temperature is achieved by having both the shear stress strain gauge and the thin-film resistor circuitry on the same silicon diaphragm. Each chip is dynamically laser trimmed for precise span and offset calibration and temperature compensation.

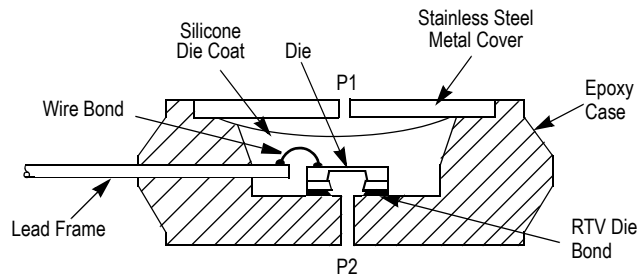


Figure 3. Unibody Package: Cross Sectional Diagram (Not to Scale)

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 MPX2010/MPXV2010G 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.

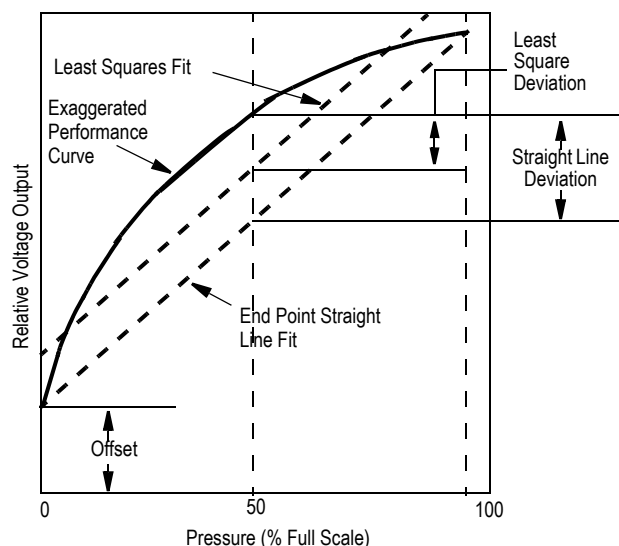


Figure 4. Linearity Specification Comparison

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

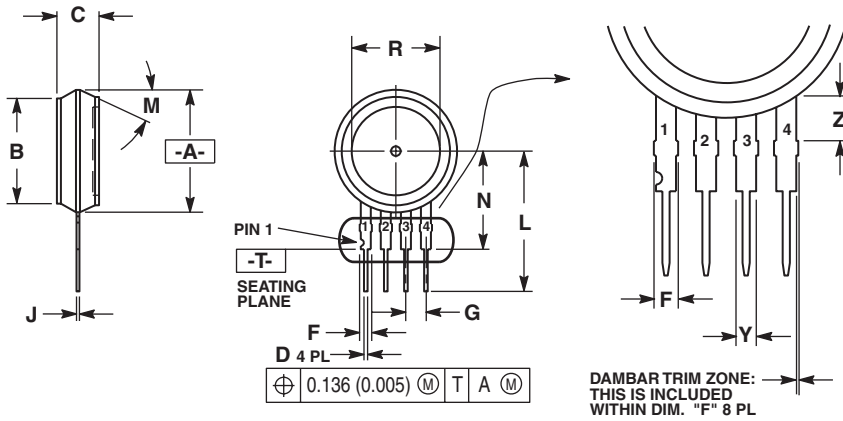
Freescale designates the two sides of the pressure sensor as the Pressure (P1) side and the Vacuum (P2) side. The Pressure (P1) side is the side containing silicone gel which isolates the die from the environment. The Freescale MPX pressure sensor is designed to operate with positive differential pressure 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 |
|-------------|-----------|-------------------------------|
| MPX2010D | 344 | Stainless Steep Cap |
| MPX2010DP | 344C | Side with Part Marking |
| MPX2010GP | 344B | Side with Port Attached |
| MPX2010GS | 344E | Side with Port Attached |
| MPX2010GSX | 344F | Side with Port Attached |
| MPXV2010GP | 1369 | Side with Port Attached |
| MPXV2010DP | 1351 | Side with Part Marking |

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).

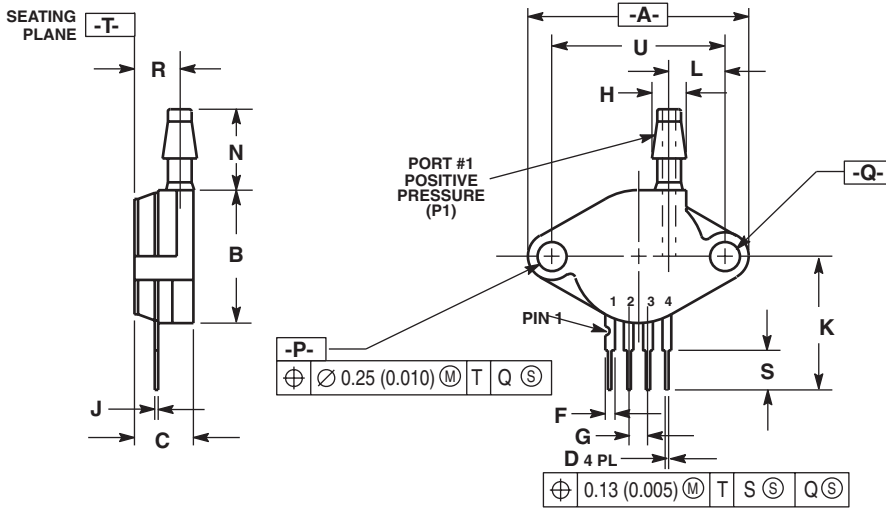
| DIM | INCHES | | MILLIMETERS | |
|-----|-----------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.595 | 0.630 | 15.11 | 16.00 |
| B | 0.514 | 0.534 | 13.06 | 13.56 |
| C | 0.200 | 0.220 | 5.08 | 5.59 |
| D | 0.016 | 0.020 | 0.41 | 0.51 |
| F | 0.048 | 0.064 | 1.22 | 1.63 |
| G | 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 |

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:

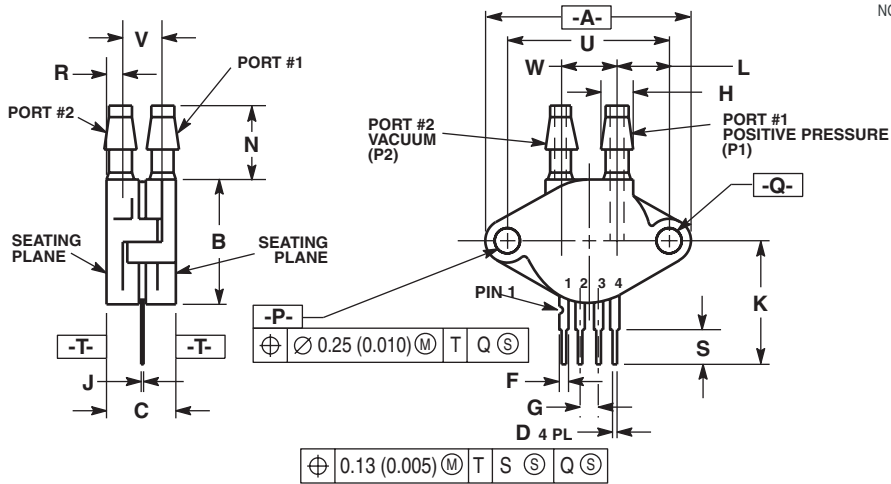
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

| 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 | |

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

CASE 344B-01 ISSUE B UNIBODY PACKAGE

PACKAGE DIMENSIONS

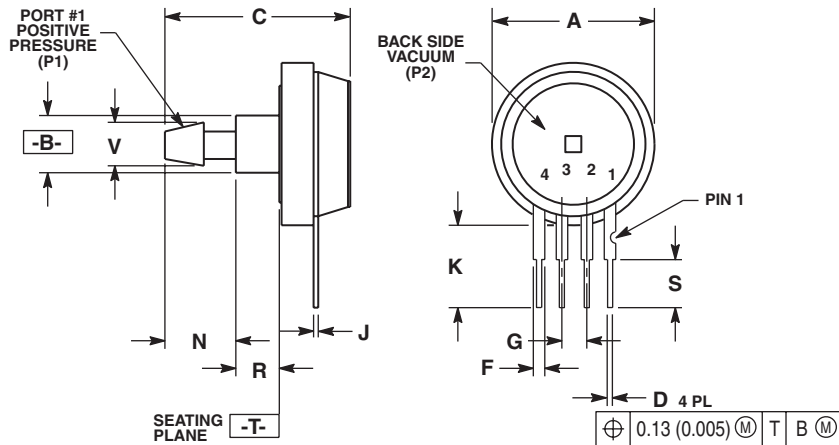


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

| 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 | 0.016 | 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 |

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

CASE 344C-01 ISSUE B UNIBODY PACKAGE



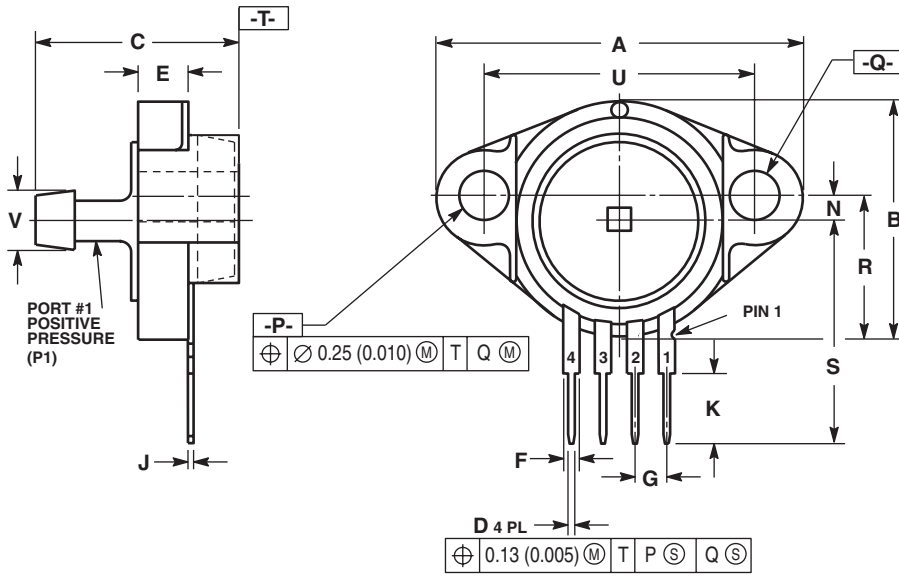
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

| 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 | 0.016 | 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 | 0.41 |
| K | 0.345 | 0.375 | 8.76 | 9.53 |
| N | 0.300 | 0.310 | 7.62 | 7.87 |
| R | 0.178 | 0.186 | 4.52 | 4.72 |
| S | 0.220 | 0.240 | 5.59 | 6.10 |
| V | 0.182 | 0.194 | 4.62 | 4.93 |

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

CASE 344E-01 ISSUE B UNIBODY PACKAGE

PACKAGE DIMENSIONS



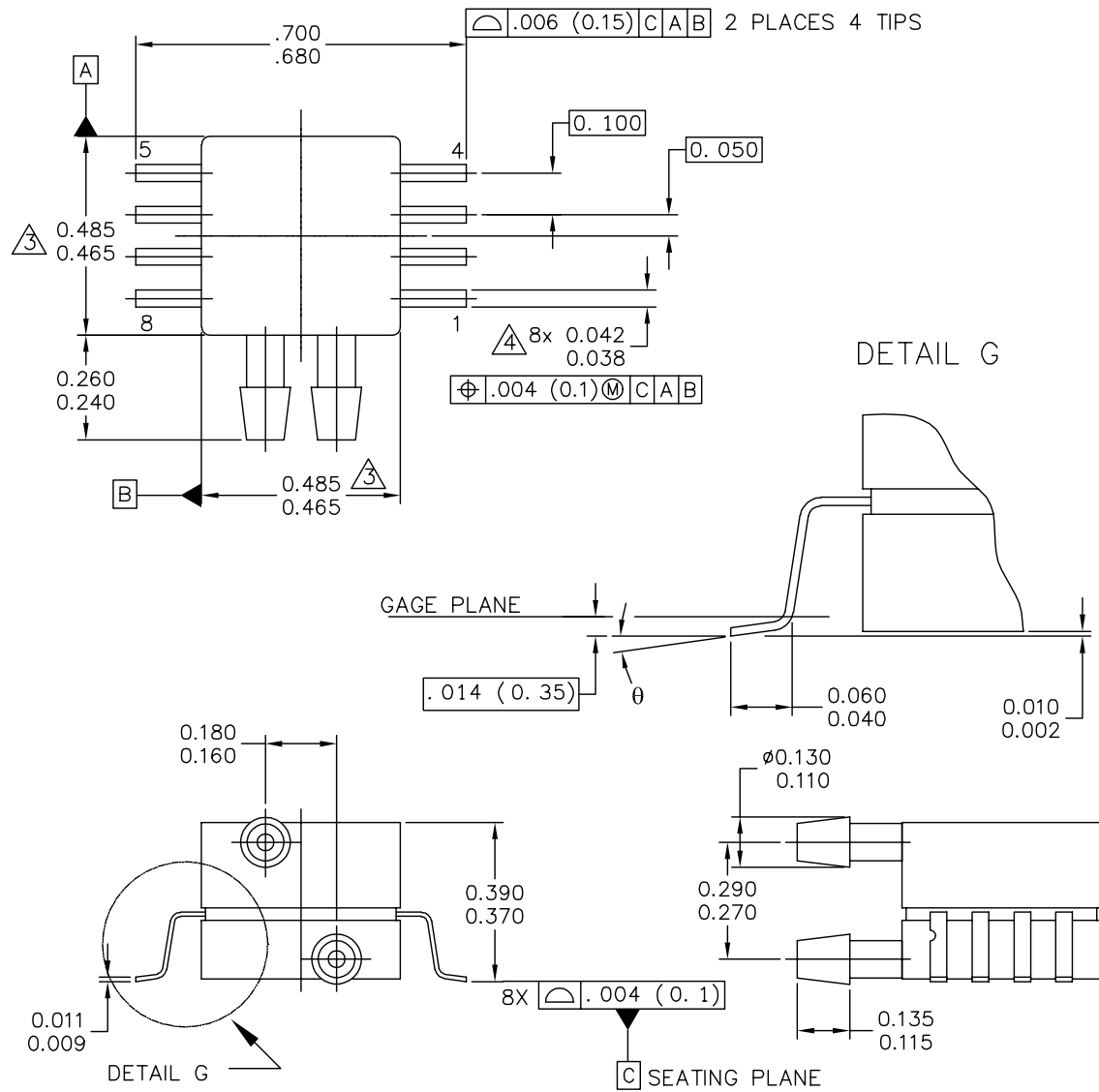
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

| 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 | 0.016 | 0.020 | 0.41 | 0.51 |
| 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 | 4.92 |

- STYLE 1:
 PIN 1: GROUND
 2: V (+) OUT
 3: V SUPPLY
 4: V (-) OUT

CASE 344F-01 ISSUE B UNIBODY PACKAGE

PACKAGE DIMENSIONS



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

PAGE 1 OF 2

**CASE1351-01
ISSUE A
SMALL OUTLINE PACKAGE**

PACKAGE DIMENSIONS

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:

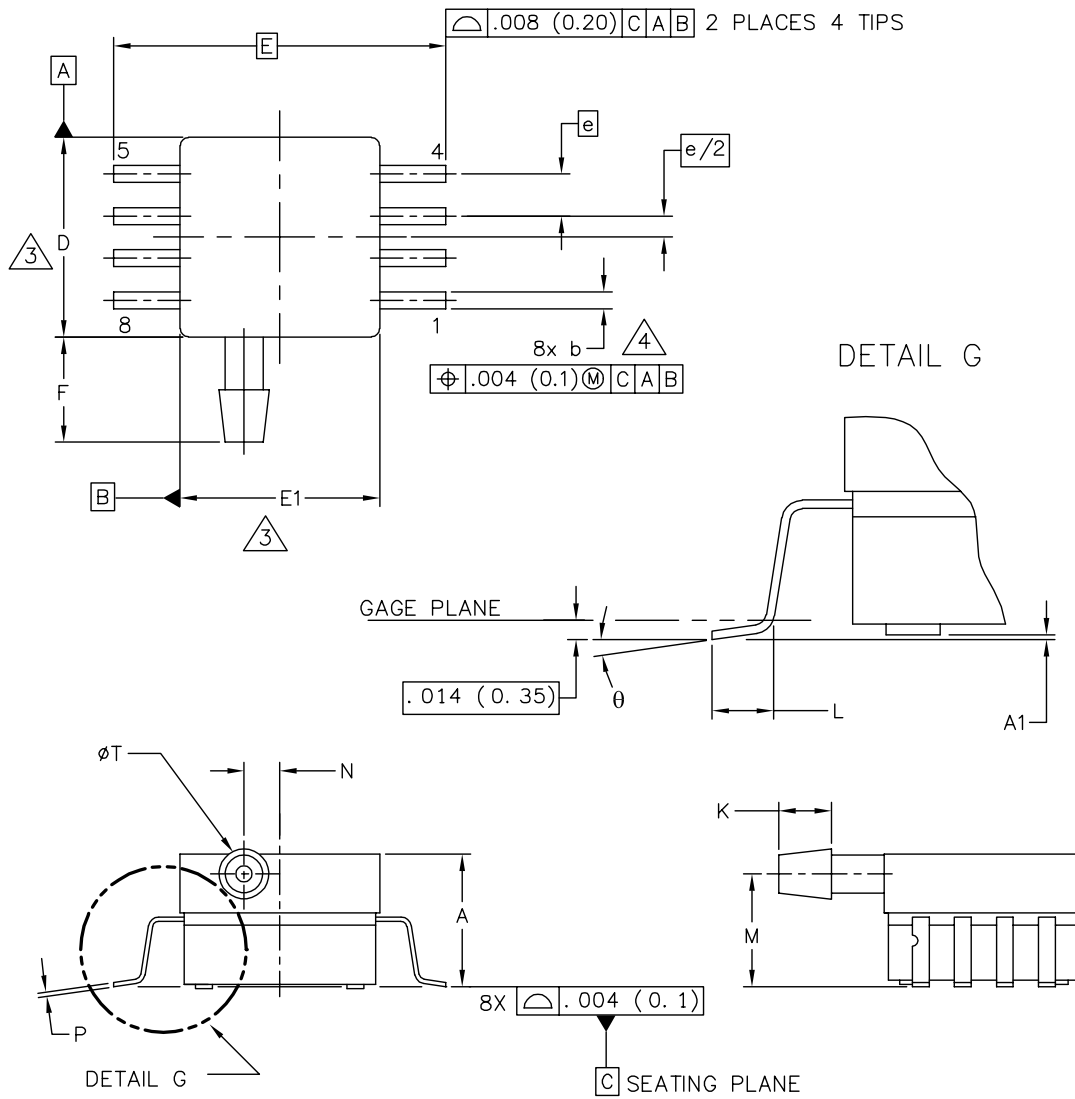
PIN 1: N/C
 PIN 2: Vs
 PIN 3: GND
 PIN 4: Vout
 PIN 5: N/C
 PIN 6: N/C
 PIN 7: N/C
 PIN 8: N/C

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

PAGE 2 OF 2

**CASE1351-01
 ISSUE A
 SMALL OUTLINE PACKAGE**

PACKAGE DIMENSIONS



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

PAGE 1 OF 2

CASE 1369-01 ISSUE B SMALL OUTLINE PACKAGE

MPX2010

PACKAGE DIMENSIONS

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 (0.152) PER SIDE.
- ④ 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 | | | | |

PAGE 2 OF 2

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

NOTES

How to Reach Us:

Home Page:

www.freescale.com

Web Support:

<http://www.freescale.com/support>

USA/Europe or Locations Not Listed:

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