

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

The MPX5100 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
- Patented Silicon Shear Stress Strain Gauge
- Available in Absolute, Differential and Gauge Configurations
- Durable Epoxy Unibody Element
- Easy-to-Use Chip Carrier Option

Typical Applications

- Patient Monitoring
- Process Control
- Pump/Motor Control
- Pressure Switching

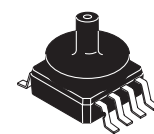
ORDERING INFORMATION

| Device Type | Options | Case No. | MPX Series Order Number | Device Marking |
|----------------------------------|-------------------------|------------|-------------------------|----------------|
| UNIBODY PACKAGE (MPX5100 SERIES) | | | | |
| Basic Elements | Absolute | 867 | MPX5100A | MPX5100A |
| | Differential | 867 | MPX5100D | MPX5100D |
| Ported Elements | Differential Dual Ports | 867C | MPX5100DP | MPX5100DP |
| | Absolute, Single Port | 867B | MPX5100AP | MPX5100AP |
| | Gauge, Single Port | 867B | MPX5100GP | MPX5100GP |
| | Gauge, Axial PC Mount | 867F | MPX5100GSX | MPX5100D |
| | Gauge, Axial Port, SMT | 482A | MPXV5100GC6U | MPXV5100G |
| | Gauge, Axial Port, DIP | 482C | MPX5V100GC7U | MPXV5100G |
| | Gauge, Dual Port, SMT | 1351 | MPXV5100DP | MPXV5100 |
| Gauge, Side Port, SMT | 1369 | MPXV5100GP | MPXV5100G | |

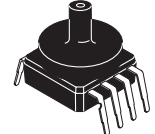
MPX5100/MPXV5100 SERIES

INTEGRATED PRESSURE SENSOR
 0 to 100 kpa (0 to 14.5 psi)
 15 to 115 kPa
 (2.2 to 16.7 psi)
 0.2 to 4.7 V Output

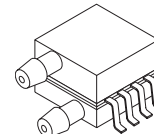
SMALL OUTLINE PACKAGES



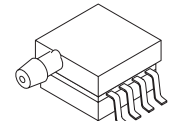
MPXV5100GC6U
 CASE 482A-01



MPXV5100GC7U
 CASE 482C-03



MPXV5100DP
 CASE 1351-01



MPXV5100GP
 CASE 1369-01

PIN NUMBER⁽¹⁾

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

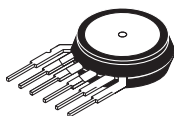
1. Pins 1, 5, 6, 7, and 8 are internal device connections. Do not connect to external circuitry or ground. Pin 1 is noted by the notch in the lead.

PIN NUMBER⁽¹⁾

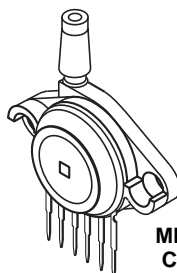
| | | | |
|---|------------------|---|-----|
| 1 | V _{OUT} | 4 | N/C |
| 2 | GND | 5 | N/C |
| 3 | V _S | 6 | N/C |

1. Pins 4, 5, and 6 are internal device connections. Do not connect to external circuitry or ground. Pin 1 is noted by the notch in the lead.

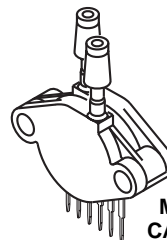
UNIBODY PACKAGES



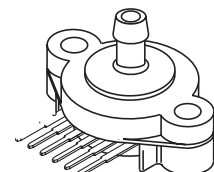
MPX5100A/D
 CASE 867-08



MPX5100AP/GP
 CASE 867B-04



MPX5100DP
 CASE 867C-05



MPX5100GSX
 CASE 867F-03

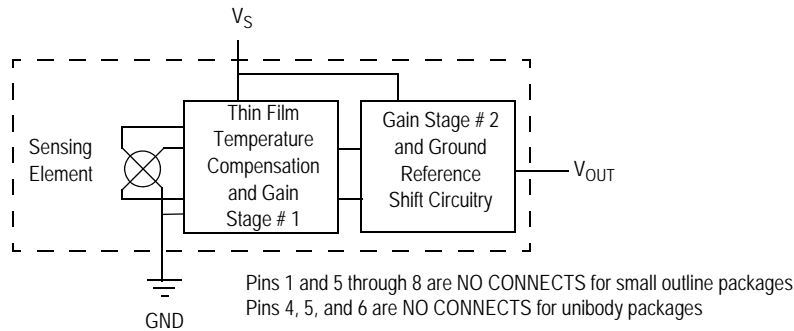


Figure 1. Fully Integrated Pressure Sensor Schematic

TABLE 1. Maximum Ratings⁽¹⁾

| Rating | Symbol | Value | Unit |
|----------------------------|------------------|----------------|------|
| Maximum Pressure (P1 > P2) | P _{MAX} | 400 | kPa |
| Storage Temperature | T _{STG} | -40° to +125°C | °C |
| Operating Temperature | T _A | -40° to +125°C | °C |

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

TABLE 2. Operating Characteristics (V_S = 5.0 V_{DC}, T_A = 25°C unless otherwise noted, P1 > P2. Decoupling circuit shown in Figure 4 required to meet electrical specifications.)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|------------------|---------|--------|------------|-------------------|
| Pressure Range ⁽¹⁾ Gauge, Differential: MPX5100D/MPX5100G/MPXV5100G Absolute: MPX5100A | P _{OP} | 0 15 | — — | 100 115 | kPa |
| Supply Voltage ⁽²⁾ | V _S | 4.75 | 5.0 | 5.25 | V _{DC} |
| Supply Current | I _O | — | 7.0 | 10 | mAdc |
| Minimum Pressure Offset ⁽³⁾ @ V _S = 5.0 V | V _{OFF} | 0.088 | 0.20 | 0.313 | V _{DC} |
| Full Scale Output ⁽⁴⁾ @ V _S = 5.0 V | V _{FSO} | 4.587 | 4.700 | 4.813 | V _{DC} |
| Full Scale Span ⁽⁵⁾ @ V _S = 5.0 V | V _{FSS} | — | 4.500 | — | V _{DC} |
| Accuracy ⁽⁶⁾ | — | — | — | ±2.5 | %V _{FSS} |
| Sensitivity | V/P | — | 45 | — | mV/kPa |
| Response Time ⁽⁷⁾ | t _R | — | 1.0 | — | ms |
| Output Source Current at Full Scale Output | I _{O+} | — | 0.1 | — | mAdc |
| Warm-Up Time ⁽⁸⁾ | — | — | 20 | — | ms |
| Offset Stability ⁽⁹⁾ | — | — | ±0.5 | — | %V _{FSS} |

1. 1 kPa (kiloPascal) equals 0.145 psi.
2. Device is ratiometric within this specified excitation range.
3. Offset (V_{OFF}) is defined as the output voltage at the minimum rated pressure.
4. Full Scale Output (V_{FSO}) is defined as the output voltage at the maximum or full rated pressure.
5. 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.
6. 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 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 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.

7. 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.
8. Warm-Up Time is defined as the time required for the product to meet the specified output voltage after the Pressure has been stabilized.
9. 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, CALIBRATION AND SIGNAL CONDITIONING

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°C to 85°C using the decoupling circuit shown in Figure 4. The output will saturate outside of the specified pressure range.

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.

The MPX5100 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.

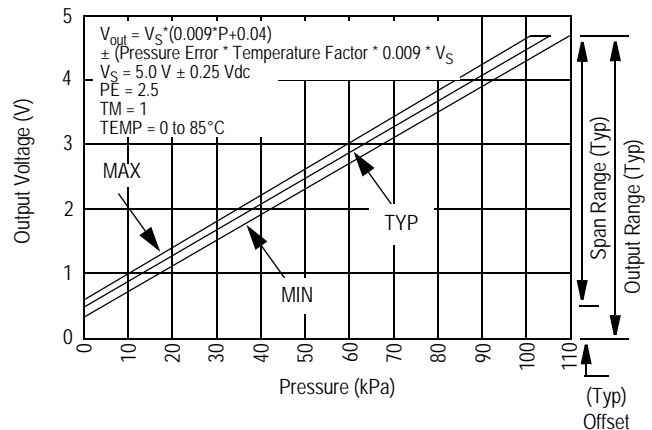


Figure 2. Output Vs. Pressure Differential

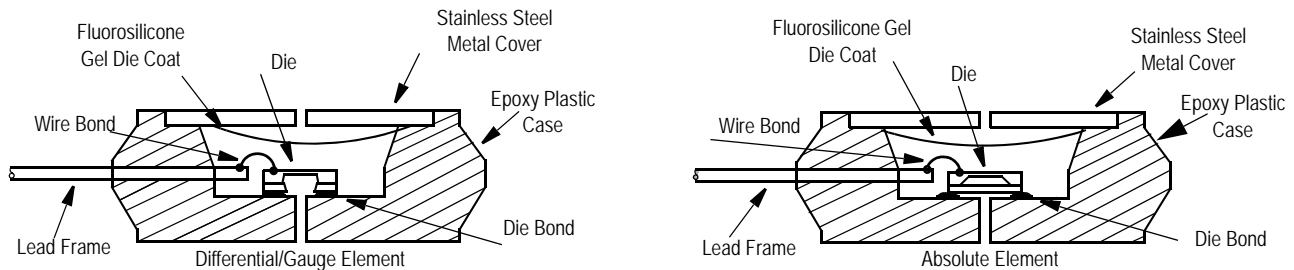


Figure 3. Cross Sectional Diagrams (Not to Scale)

Figure 4 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.

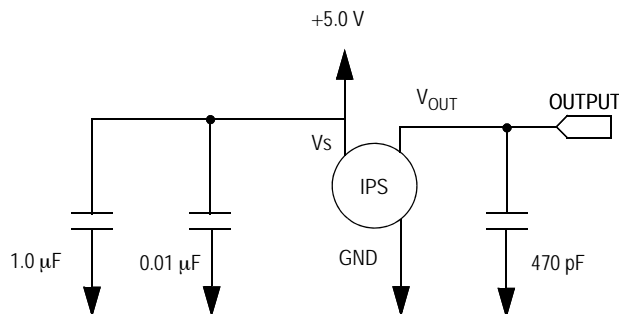


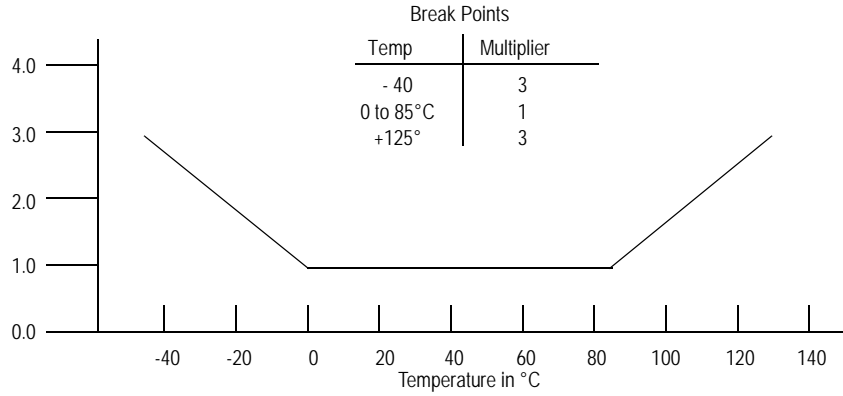
Figure 4. Recommended Power Supply Decoupling and Output Filtering
(For additional output filtering, please refer to Application Note AN1646.)

Transfer Function (MPX5100D, MPX5100G, MPXV5100G)

Nominal Transfer Value: $V_{OUT} = V_S (P \times 0.009 + 0.04)$
 $\pm (\text{Pressure Error} \times \text{Temp. Mult.} \times 0.009 \times V_S)$
 $V_S = 5.0 \text{ V} \pm 5\% \text{ P kPa}$

Temperature Error Multiplier

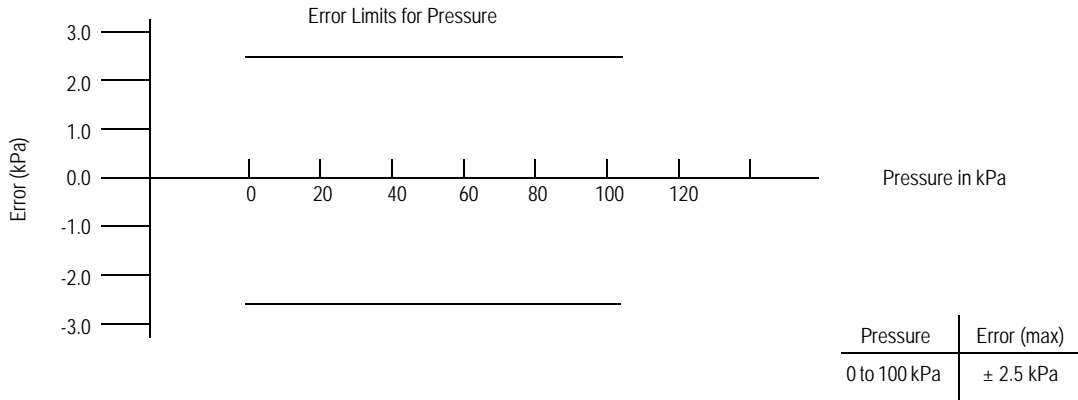
MPX5100D/MPX5100G/MPXV5100G Series



Note: The Temperature Multiplier is a linear response from 0° to -40°C and from 85° to 125°C.

Pressure Error Band

MPX5100D/MPX5100G/MPXV5100G Series

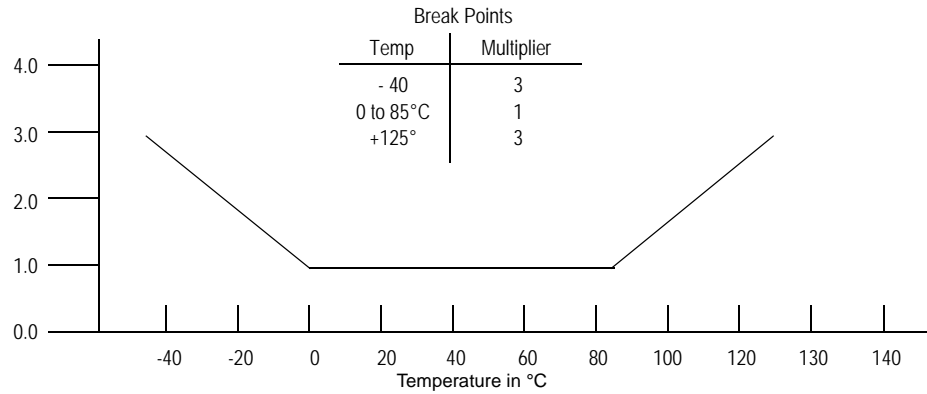


Transfer Function (MPX5100A)

Nominal Transfer Value: $V_{OUT} = V_S (P \times 0.009 - 0.095)$
 $\pm (\text{Pressure Error} \times \text{Temp. Mult.} \times 0.009 \times V_S)$
 $V_S = 5.0 \text{ V} \pm 5\% \text{ P kPa}$

Temperature Error Multiplier

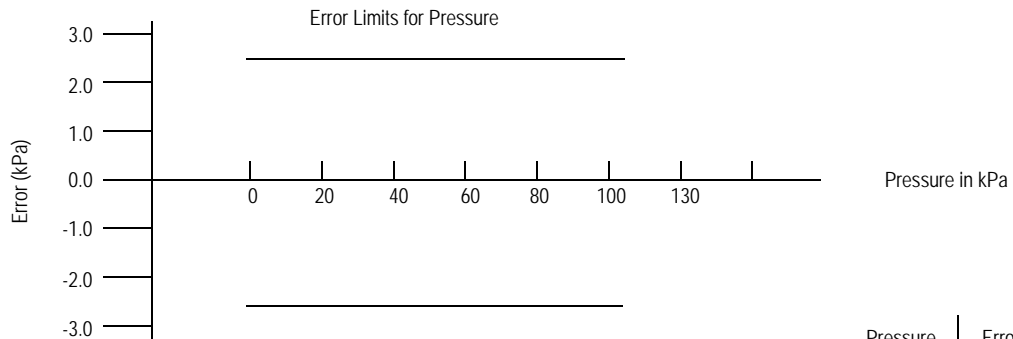
MPX5100A Series



Note: The Temperature Multiplier is a linear response from 0° to -40°C and from 85° to 125°C.

Pressure Error Band

MPX5100A Series



| Pressure | Error (max) |
|---------------|-----------------------|
| 15 to 115 kPa | $\pm 2.5 \text{ kPa}$ |

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 fluoro silicone gel which protects the die from harsh media. The MPX pressure

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

The Pressure (P1) side may be identified by using [Table 3](#) below.

TABLE 3. PRESSURE (P1)/VACUUM (P2) SIDE IDENTIFICATION TABLE

| Part Number | Case Type | Pressure (P1) Side Identifier |
|----------------------|-----------|-------------------------------|
| MPX5100A, MPX5100D | 867 | Stainless Steel Cap |
| MPX5100DP | 867C | Side with Part Marking |
| MPX5100AP, MPX5100GP | 867B | Side with Port Attached |
| MPX5100GSX | 867F | Side with Port Attached |
| MPXV5100GC6U | 482A | Side with Port Attached |
| MPXV5100GC7U | 482C | Side with Port Attached |
| MPXV5100DP | 1351 | Side with Part Marking |
| MPXV5100GP | 1369 | Side with Port Attached |

INFORMATION FOR USING THE SMALL OUTLINE PACKAGE

MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the surface mount packages must be the correct size to ensure proper solder connection interface between the board and the package. With the correct

footprint, the packages will self align when subjected to a solder reflow process. It is always recommended to design boards with a solder mask layer to avoid bridging and shorting between solder

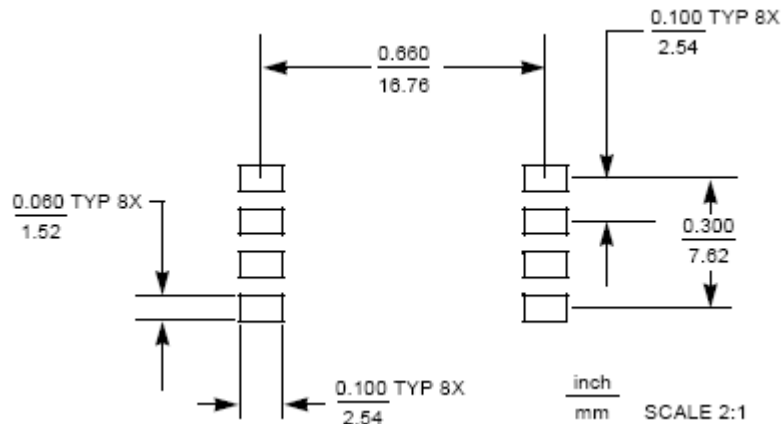
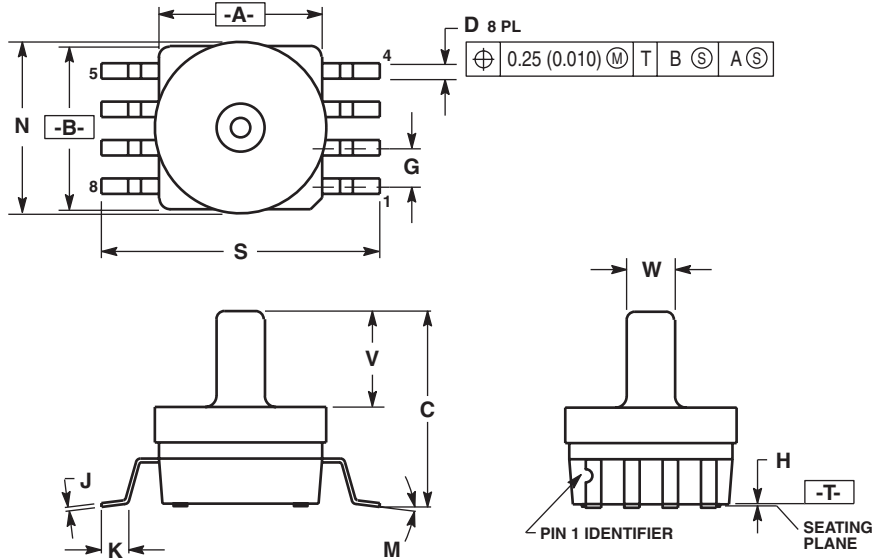


Figure 5. Small Outline Package Footprint

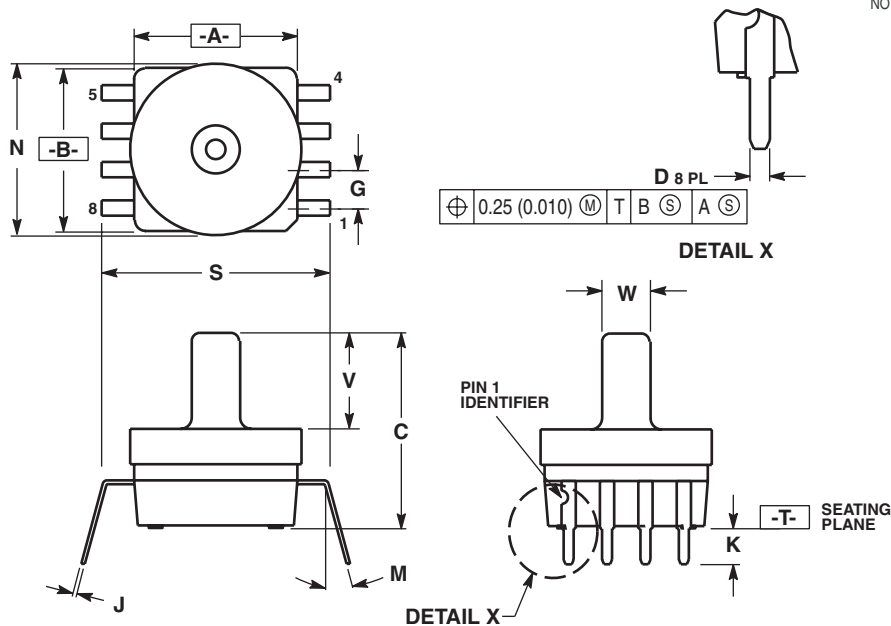
PACKAGE DIMENSIONS



- 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

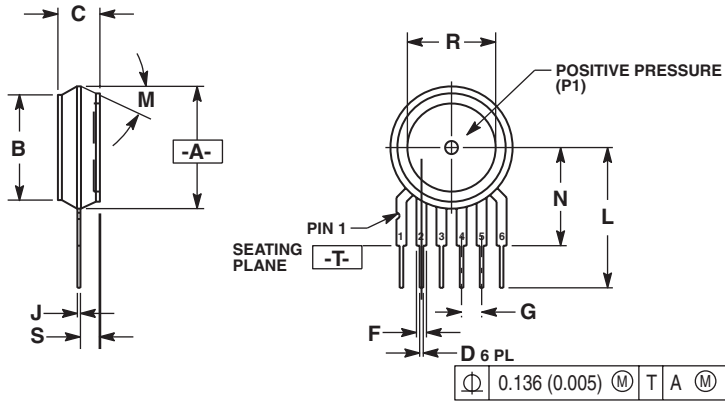


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
 4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
 5. ALL VERTICAL SURFACES 5° TYPICAL DRAFT.
 6. DIMENSION S TO CENTER OF LEAD WHEN FORMED PARALLEL.

| 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

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 |

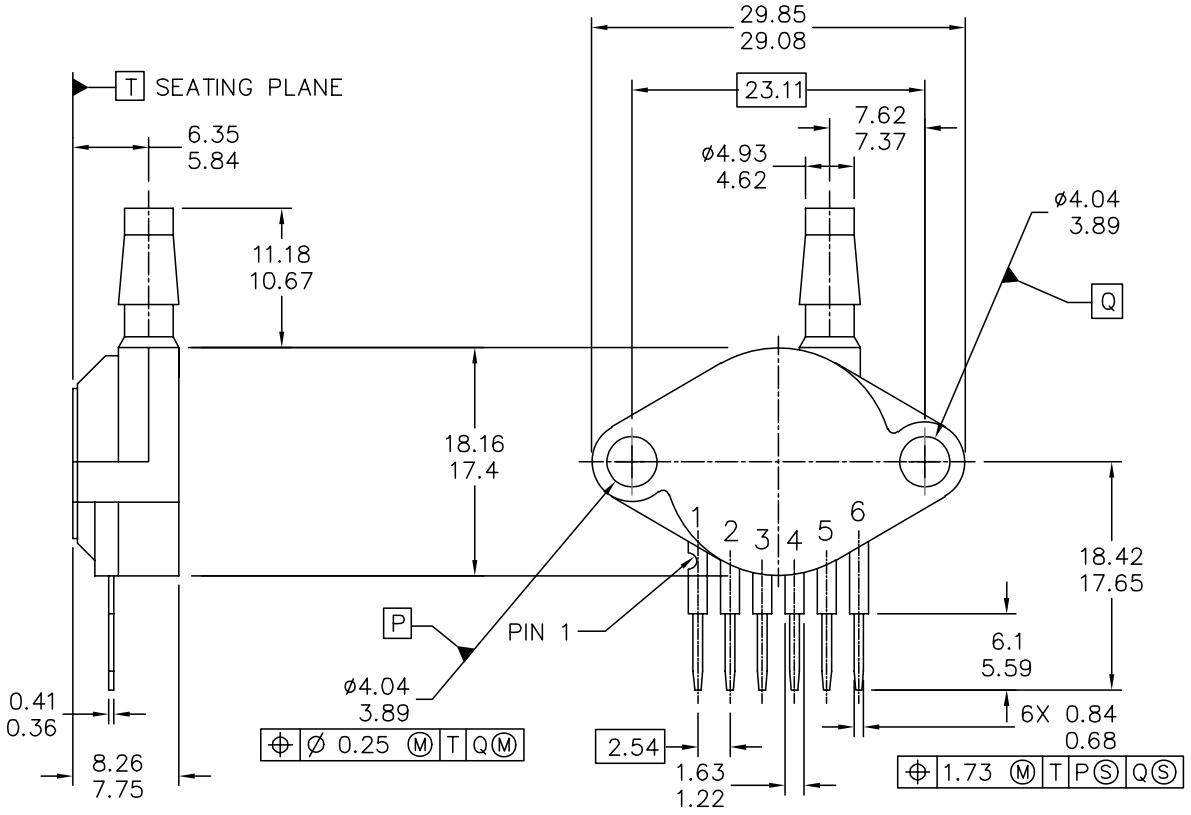
- STYLE 1:
 PIN 1: VOUT
 2. GROUND
 3. VCC
 4. V1
 5. V2
 6. VEX

- 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 UNIBODY PACKAGE

PACKAGE DIMENSIONS



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

PAGE 1 OF 2

**CASE 867B-04
ISSUE G
UNIBODY PACKAGE**

MPX5100

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:

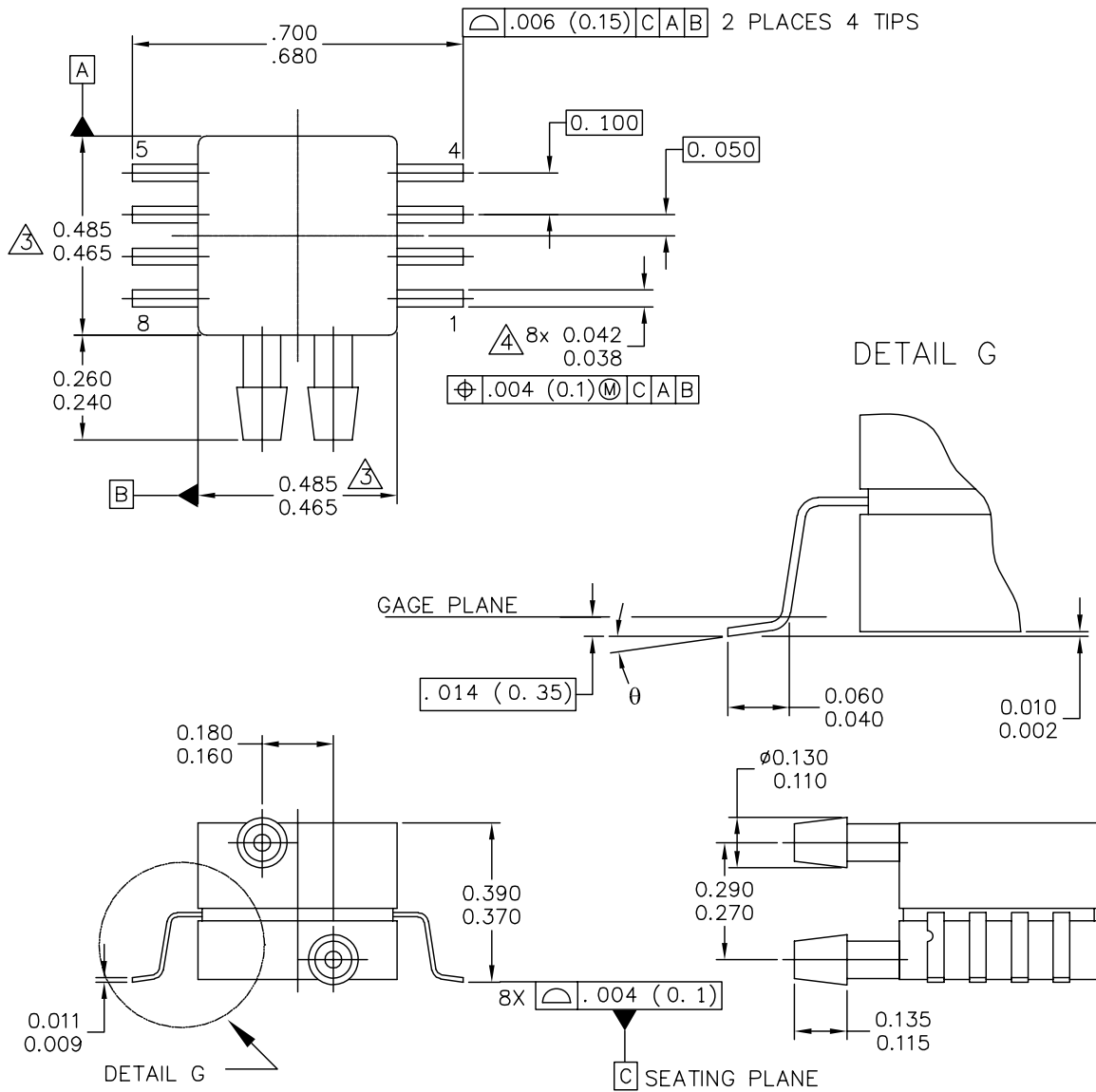
PIN 1: V OUT
2: GROUND
3: VCC
4: V1
5: V2
6: V EX

| | | | |
|---|---------------------------|----------------------------|--|
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| TITLE: SENSOR, 6 LEAD UNIBODY CELL, 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
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 | |

PAGE 1 OF 2

**CASE 1351-01
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

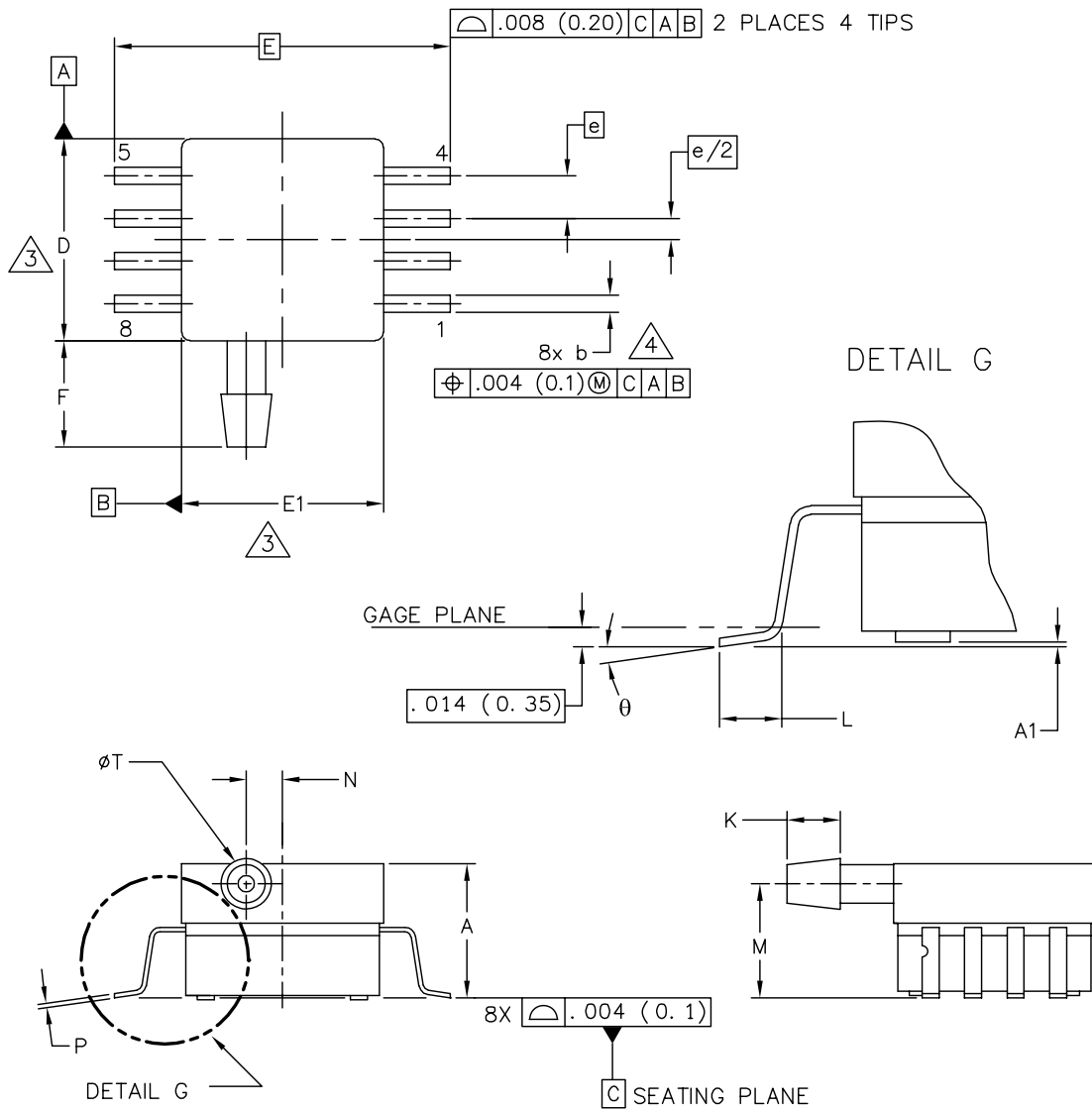
| | | |
|---|---|----------------------------|
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| TITLE: 8 LD SNSR, DUAL PORT | DOCUMENT NO: 98ASA99255D CASE NUMBER: 1351-01 STANDARD: NON-JEDEC | REV: A 27 JUL 2005 |

PAGE 2 OF 2

CASE 1351-01
ISSUE A
SMALL OUTLINE PACKAGE

MPX5100

PACKAGE DIMENSIONS



| | | | | |
|---|---------------------------|--|----------------------------|--|
| © FREESCALE SEMICONDUCTOR, INC. ALL RIGHTS RESERVED. TITLE: 8 LD SOP, SIDE PORT | MECHANICAL OUTLINE | | PRINT VERSION NOT TO SCALE | |
| | 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.
- 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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| | | | | | CASE NUMBER: 1369-01 | | | 24 MAY 2005 | |
| | | | | | STANDARD: NON-JEDEC | | | | |

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SMALL OUTLINE PACKAGE**

MPX5100

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