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

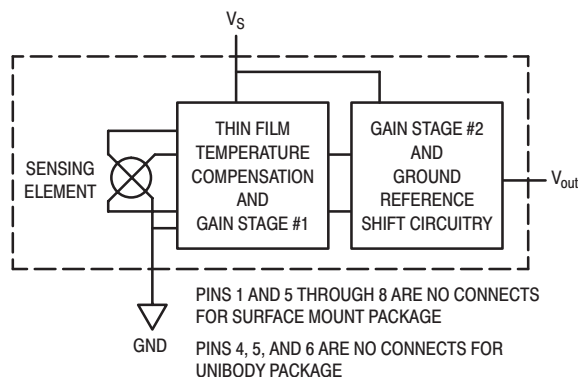
The MPX5010/MPXV5010G series piezoresistive transducers are state-of-the-art monolithic silicon pressure sensors designed for a wide range of applications, but particularly those employing a microcontroller or microprocessor with A/D inputs. This transducer combines advanced micromachining techniques, thin-film metalization, and bipolar processing to provide an accurate, high level analog output signal that is proportional to the applied pressure.

## Features

- 5.0% Maximum Error over 0° to 85°C
- Ideally Suited for Microprocessor or Microcontroller-Based Systems
- Durable Epoxy Unibody and Thermoplastic (PPS) Surface Mount Package
- Temperature Compensated over -40° to +125°C
- Patented Silicon Shear Stress Strain Gauge
- Available in Differential and Gauge Configurations
- Available in Surface Mount (SMT) or Through-hole (DIP) Configurations

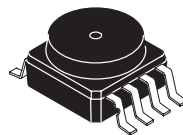
## Application Examples

- Hospital Beds
- HVAC
- Respiratory Systems
- Process Control

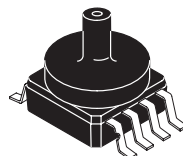


**Figure 1. Fully Integrated Pressure Sensor Schematic**

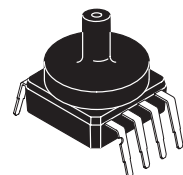
## SMALL OUTLINE PACKAGE



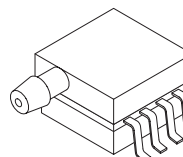
**MPXV5010G6U  
CASE 482**



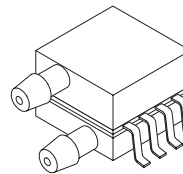
**MPXV5010GC6U  
CASE 482A**



**MPXV5010GC7U  
CASE 482C**



**MPXV5010GP  
CASE 1369**



**MPXV5010DP  
CASE 1351**

## PIN NUMBER

|   |                  |   |     |
|---|------------------|---|-----|
| 1 | N/C              | 5 | N/C |
| 2 | V <sub>S</sub>   | 6 | N/C |
| 3 | Gnd              | 7 | N/C |
| 4 | V <sub>out</sub> | 8 | N/C |

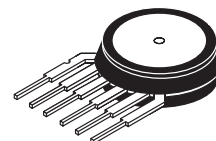
NOTE: Pins 1, 5, 6, 7, and 8 are internal device connections. Do not connect to external circuitry or ground. Pin 1 is noted by the notch in the lead.

# MPX5010 MPXV5010G SERIES

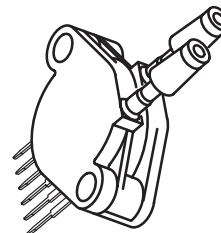
Motorola Preferred Device

**INTEGRATED  
PRESSURE SENSOR**  
0 to 10 kPa (0 to 1.45 psi)  
0.2 to 4.7 V Output

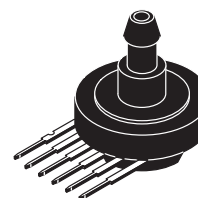
## UNIBODY PACKAGE



**MPX5010D  
CASE 867**



**MPX5010DP  
CASE 867C**



**MPX5010GS  
CASE 867E**

## PIN NUMBER

|   |                  |   |     |
|---|------------------|---|-----|
| 1 | V <sub>out</sub> | 4 | N/C |
| 2 | Gnd              | 5 | N/C |
| 3 | V <sub>S</sub>   | 6 | N/C |

NOTE: 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.

## MPX5010 MPXV5010G SERIES

### MAXIMUM RATINGS(NOTE)

| Parametrics                | Symbol           | Value       | Unit |
|----------------------------|------------------|-------------|------|
| Maximum Pressure (P1 > P2) | P <sub>max</sub> | 75          | kPa  |
| Storage Temperature        | T <sub>stg</sub> | –40 to +125 | °C   |
| Operating Temperature      | T <sub>A</sub>   | –40 to +125 | °C   |

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

**OPERATING CHARACTERISTICS** (V<sub>S</sub> = 5.0 Vdc, T<sub>A</sub> = 25°C unless otherwise noted, P1 > P2. Decoupling circuit shown in Figure 3 required to meet specification.)

| Characteristic                                                         | Symbol           | Min   | Typ  | Max   | Unit              |
|------------------------------------------------------------------------|------------------|-------|------|-------|-------------------|
| Pressure Range <sup>(1)</sup>                                          | P <sub>OP</sub>  | 0     | —    | 10    | kPa               |
| Supply Voltage <sup>(2)</sup>                                          | V <sub>S</sub>   | 4.75  | 5.0  | 5.25  | Vdc               |
| Supply Current                                                         | I <sub>o</sub>   | —     | 5.0  | 10    | mAdc              |
| Minimum Pressure Offset <sup>(3)</sup><br>@ V <sub>S</sub> = 5.0 Volts | V <sub>off</sub> | 0     | 0.2  | 0.425 | Vdc               |
| Full Scale Output <sup>(4)</sup><br>@ V <sub>S</sub> = 5.0 Volts       | V <sub>FSS</sub> | 4.475 | 4.7  | 4.925 | Vdc               |
| Full Scale Span <sup>(5)</sup><br>@ V <sub>S</sub> = 5.0 Volts         | V <sub>FSS</sub> | 4.275 | 4.5  | 4.725 | Vdc               |
| Accuracy <sup>(6)</sup><br>(0 to 85°C)                                 | —                | —     | —    | ±5.0  | %V <sub>FSS</sub> |
| Sensitivity                                                            | V/P              | —     | 450  | —     | mV/kPa            |
| Response Time <sup>(7)</sup>                                           | t <sub>R</sub>   | —     | 1.0  | —     | ms                |
| Output Source Current at Full Scale Output                             | I <sub>O+</sub>  | —     | 0.1  | —     | mAdc              |
| Warm-Up Time <sup>(8)</sup>                                            | —                | —     | 20   | —     | ms                |
| Offset Stability <sup>(9)</sup>                                        | —                | —     | ±0.5 | —     | %V <sub>FSS</sub> |

#### NOTES:

- 1.0 kPa (kiloPascal) equals 0.145 psi.
- Device is ratiometric within this specified excitation range.
- Offset (V<sub>off</sub>) is defined as the output voltage at the minimum rated pressure.
- Full Scale Output (V<sub>FSS</sub>) is defined as the output voltage at the maximum or full rated pressure.
- Full Scale Span (V<sub>FSS</sub>) is defined as the algebraic difference between the output voltage at full rated pressure and 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<sub>FSS</sub>, at 25°C.
- 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 has been stabilized.
- Offset Stability is the product's output deviation when subjected to 1000 hours of Pulsed Pressure, Temperature Cycling with Bias Test.

### MECHANICAL CHARACTERISTICS

| Characteristics                  | Typ | Unit  |
|----------------------------------|-----|-------|
| Weight, Basic Element (Case 867) | 4.0 | grams |
| Weight, Basic Element (Case 482) | 1.5 | grams |

## ON-CHIP TEMPERATURE COMPENSATION, CALIBRATION AND SIGNAL CONDITIONING

The performance over temperature is achieved by integrating the shear-stress strain gauge, temperature compensation, calibration and signal conditioning circuitry onto a single monolithic chip.

Figure 2 illustrates the Differential or Gauge configuration in the basic chip carrier (Case 482). 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 MPX5010 and MPXV5010G 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 3 shows the recommended decoupling circuit for interfacing the integrated sensor to the A/D input of a microprocessor or microcontroller. Proper decoupling of the power supply is recommended.

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

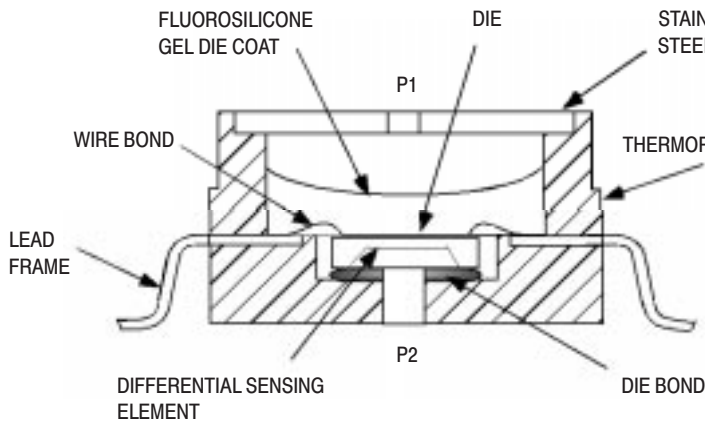


Figure 2. Cross-Sectional Diagram SOP (Not to Scale)

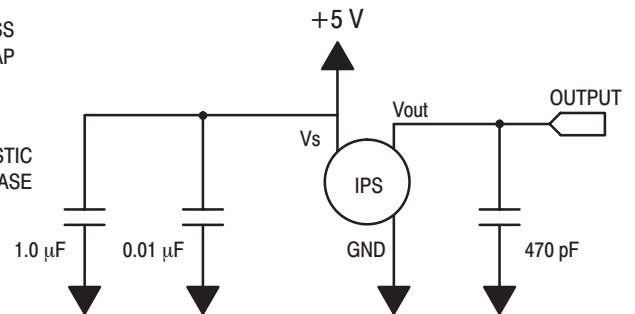


Figure 3. Recommended power supply decoupling and output filtering.  
For additional output filtering, please refer to Application Note AN1646.

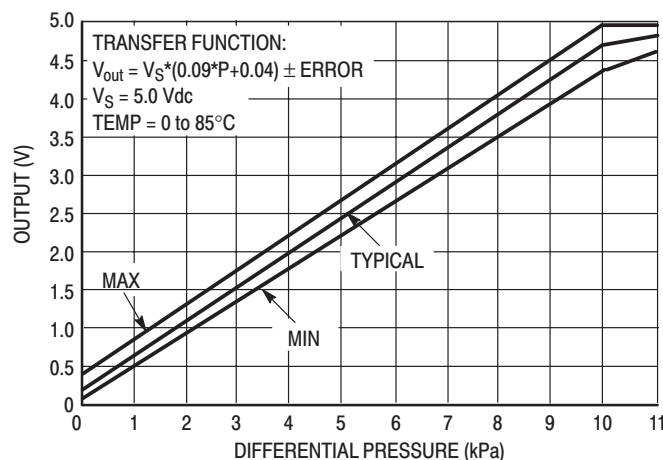


Figure 4. Output versus Pressure Differential

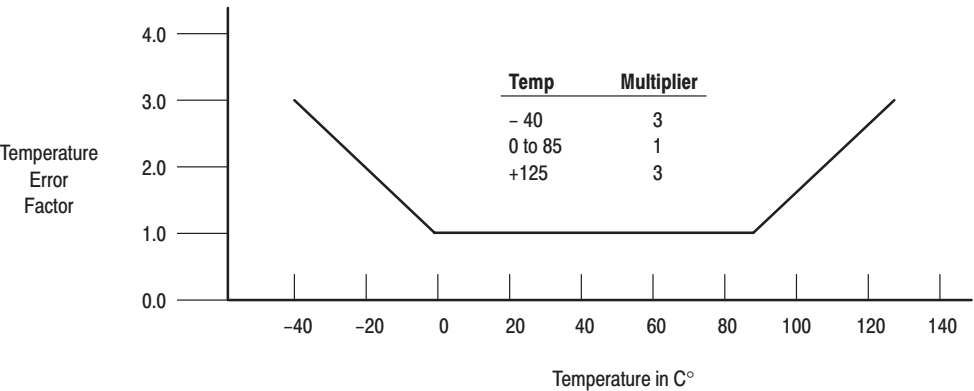
**MPX5010 MPXV5010G SERIES**

**Transfer Function (MPX5010, MPXV5010G)**

**Nominal Transfer Value:**  $V_{out} = V_S \times (0.09 \times P + 0.04)$   
 $\pm (\text{Pressure Error} \times \text{Temp. Factor} \times 0.09 \times V_S)$   
 $V_S = 5.0 \text{ V} \pm 0.25 \text{ Vdc}$

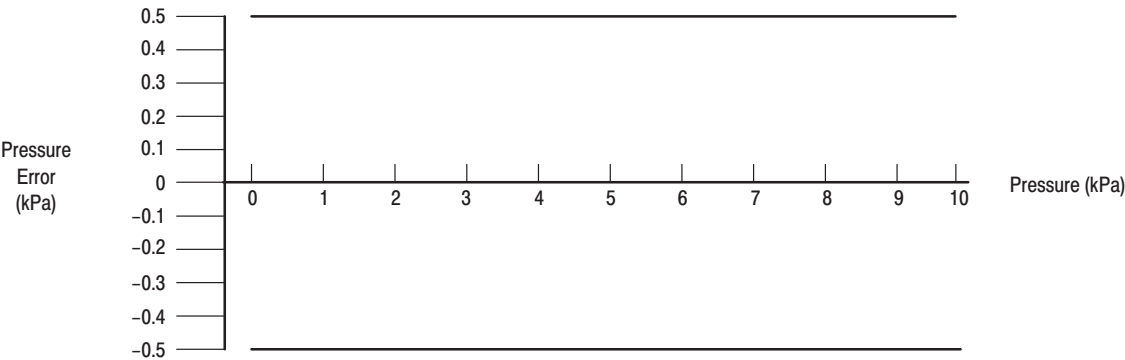
**Temperature Error Band**

**MPX5010, MPXV5010G Series**



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

**Pressure Error Band**



| Pressure    | Error (Max) |
|-------------|-------------|
| 0 to 10 kPa | ± 0.5 kPa   |

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

Motorola 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 Motorola MPX

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

The Pressure (P1) side may be identified by using the table below:

| Part Number     | Case Type | Pressure (P1)<br>Side Identifier |
|-----------------|-----------|----------------------------------|
| MPX5010D        | 867       | Stainless Steel Cap              |
| MPX5010DP       | 867C      | Side with Part Marking           |
| MPX5010GP       | 867B      | Side with Port Attached          |
| MPX5010GS       | 867E      | Side with Port Attached          |
| MPX5010GSX      | 867F      | Side with Port Attached          |
| MPXV5010G6U     | 482       | Stainless Steel Cap              |
| MPXV5010G7U     | 482B      | Stainless Steel Cap              |
| MPXV5010GC6U/T1 | 482A      | Side with Port Attached          |
| MPXV5010GC7U    | 482C      | Side with Port Attached          |
| MPXV5010GP      | 1369      | Side with Port Attached          |
| MPXV5010DP      | 1351      | Side with Part Marking           |

**ORDERING INFORMATION — UNIBODY PACKAGE (MPX5010 SERIES)**

| Device Type     | Options                 | Case Type | MPX Series   |                |
|-----------------|-------------------------|-----------|--------------|----------------|
|                 |                         |           | Order Number | Device Marking |
| Basic Element   | Differential            | 867       | MPX5010D     | MPX5010D       |
| Ported Elements | Differential, Dual Port | 867C      | MPX5010DP    | MPX5010DP      |
|                 | Gauge                   | 867B      | MPX5010GP    | MPX5010GP      |
|                 | Gauge, Axial            | 867E      | MPX5010GS    | MPX5010D       |
|                 | Gauge, Axial PC Mount   | 867F      | MPX5010GSX   | MPX5010D       |

**ORDERING INFORMATION — SMALL OUTLINE PACKAGE (MPXV5010G SERIES)**

| Device Type     | Options                      | Case No. | MPX Series Order No. | Packing Options | Marking   |
|-----------------|------------------------------|----------|----------------------|-----------------|-----------|
| Basic Elements  | Gauge, Element Only, SMT     | 482      | MPXV5010G6U          | Rails           | MPXV5010G |
|                 | Gauge, Element Only, DIP     | 482B     | MPXV5010G7U          | Rails           | MPXV5010G |
| Ported Elements | Gauge, Axial Port, SMT       | 482A     | MPXV5010GC6U         | Rails           | MPXV5010G |
|                 | Gauge, Axial Port, DIP       | 482C     | MPXV5010GC7U         | Rails           | MPXV5010G |
|                 | Gauge, Axial Port, SMT       | 482A     | MPXV5010GC6T1        | Tape and Reel   | MPXV5010G |
|                 | Gauge, Side Port, SMT        | 1369     | MPXV5010GP           | Trays           | MPXV5010G |
|                 | Differential, Dual Port, SMT | 1351     | MPXV5010DP           | Trays           | MPXV5010G |

## MPX5010 MPXV5010G SERIES

### 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 pads.

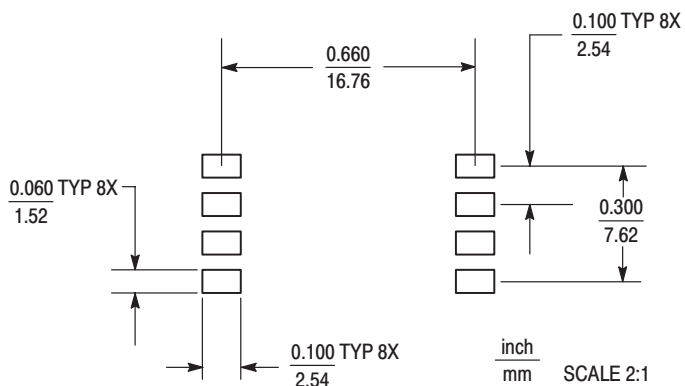
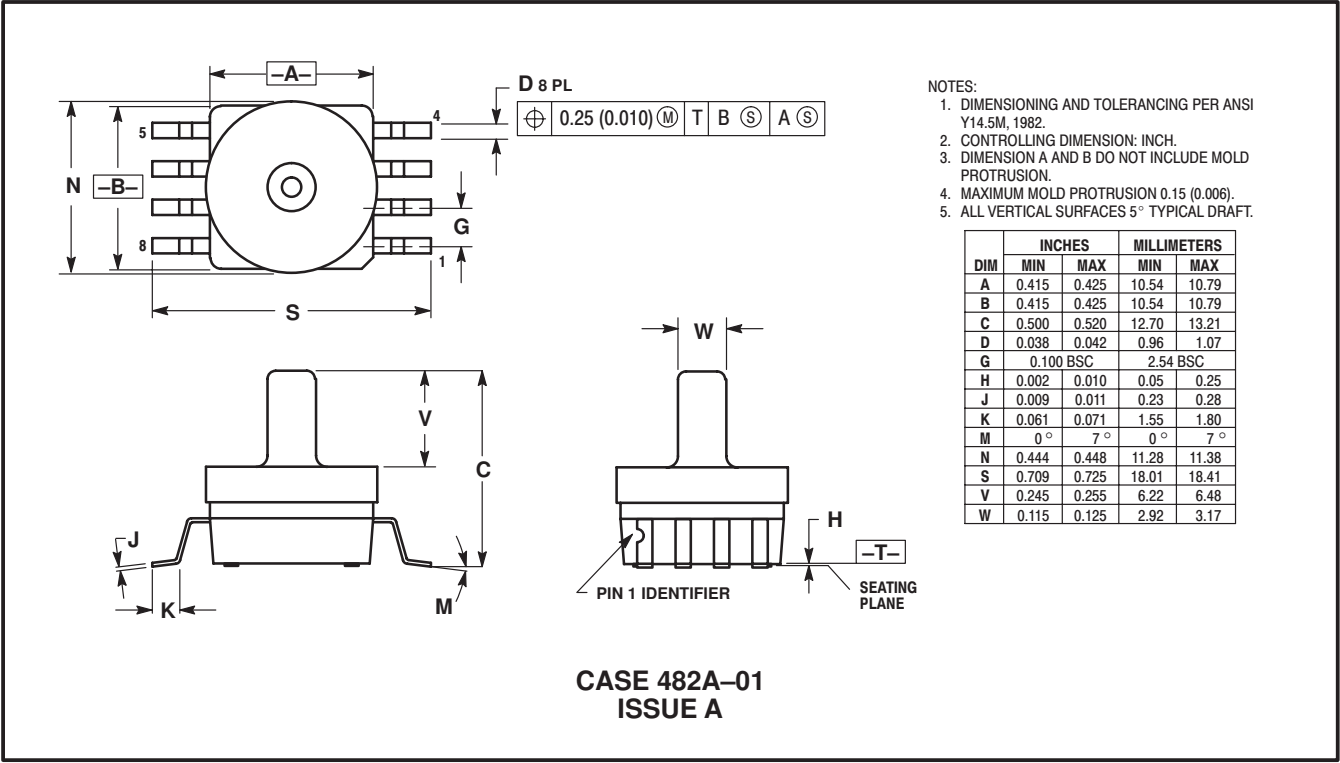
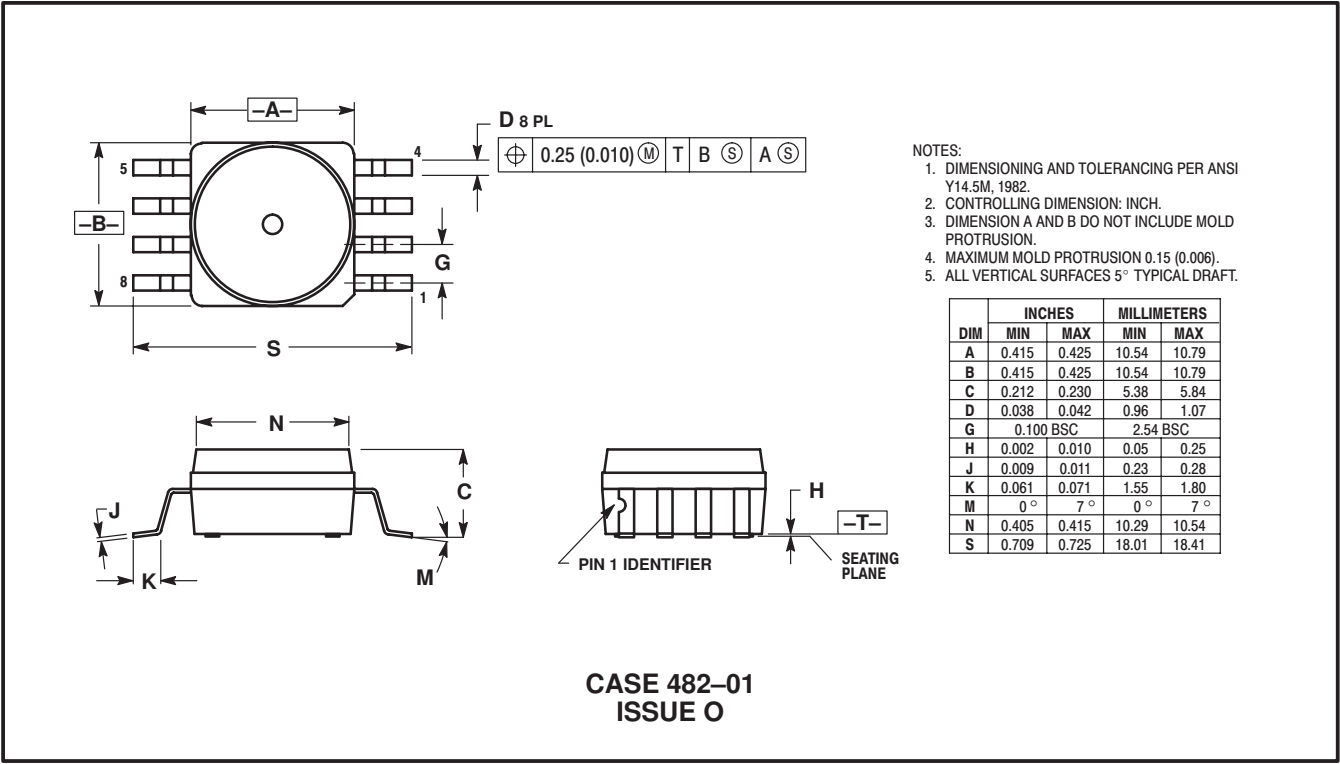


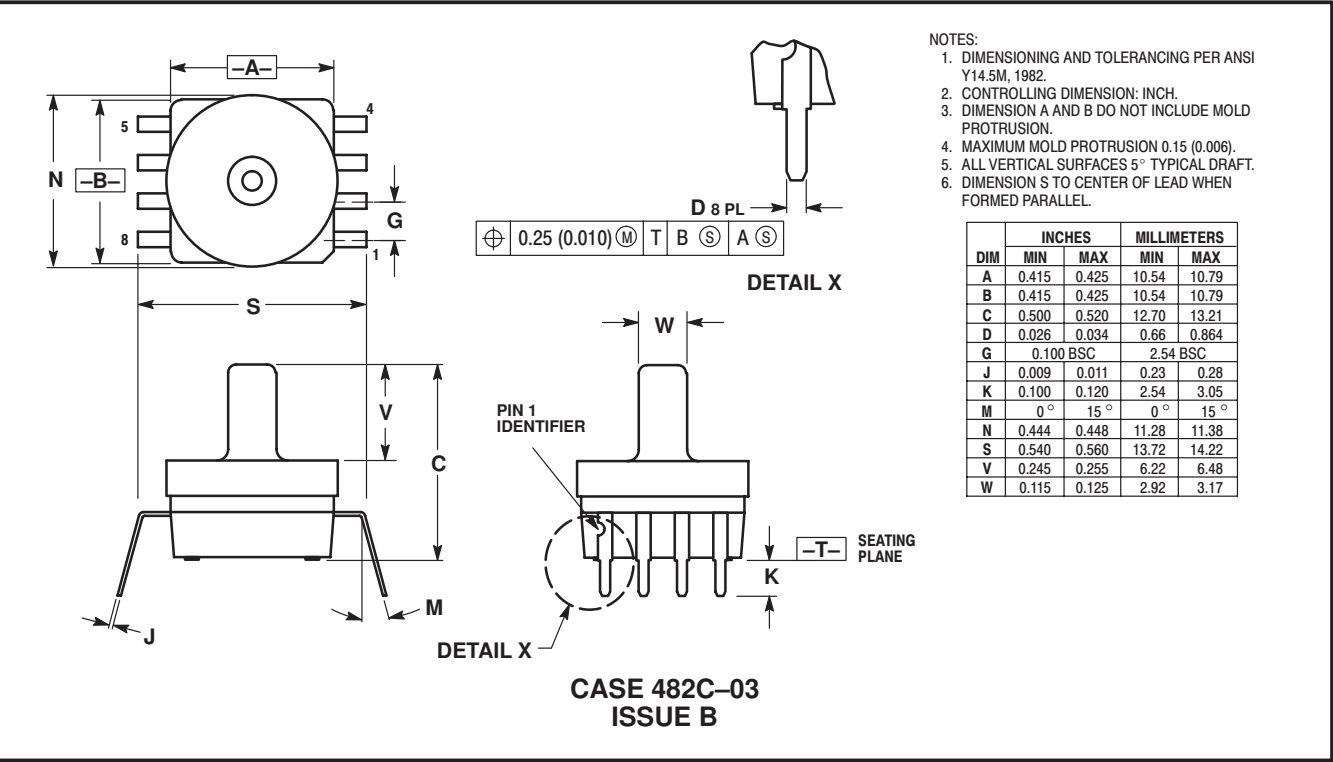
Figure 5. SOP Footprint (Case 482)

SMALL OUTLINE PACKAGE DIMENSIONS



**MPX5010 MPXV5010G SERIES**

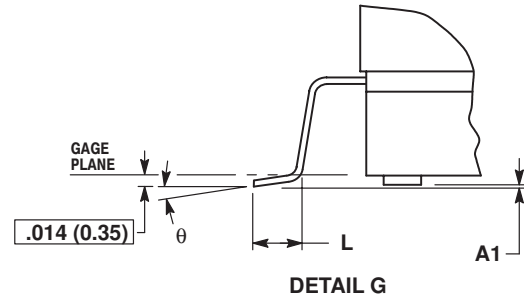
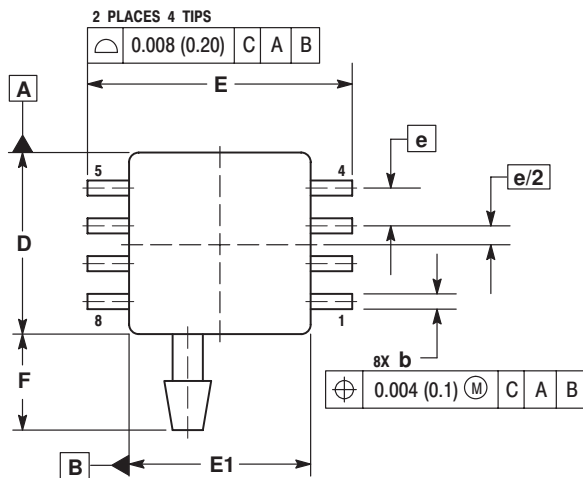
**SMALL OUTLINE PACKAGE DIMENSIONS—CONTINUED**



- 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.

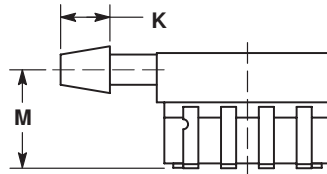
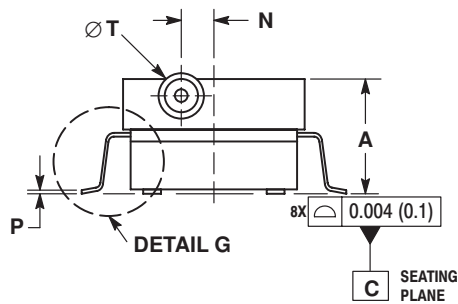
| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.415     | 0.425 | 10.54       | 10.79 |
| B   | 0.415     | 0.425 | 10.54       | 10.79 |
| C   | 0.500     | 0.520 | 12.70       | 13.21 |
| 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  |

## SMALL OUTLINE PACKAGE DIMENSIONS—CONTINUED



## NOTES:

1. CONTROLLING DIMENSION: INCH.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.006 (0.152) PER SIDE.
4. DIMENSION "b" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.008 (0.203) MAXIMUM.

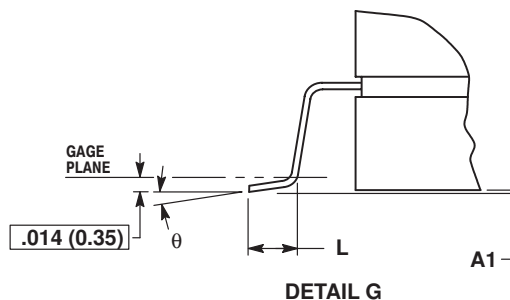
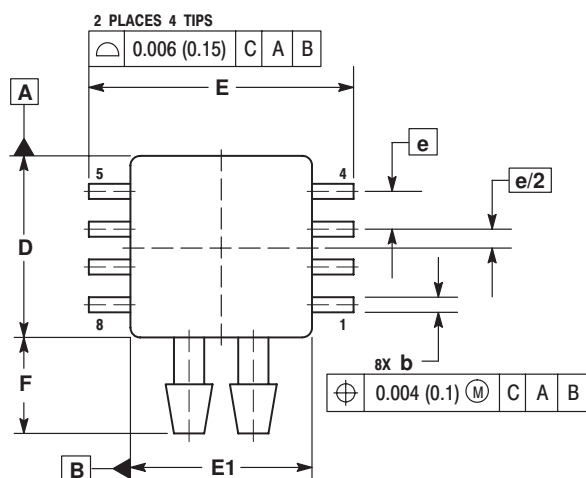


| DIM      | INCHES    |       | MILLIMETERS |       |
|----------|-----------|-------|-------------|-------|
|          | MIN       | MAX   | MIN         | MAX   |
| A        | 0.300     | 0.330 | 7.11        | 7.62  |
| A1       | 0.002     | 0.010 | 0.05        | 0.25  |
| b        | 0.038     | 0.042 | 0.96        | 1.07  |
| D        | 0.465     | 0.485 | 11.81       | 12.32 |
| E        | 0.717 BSC |       | 18.21 BSC   |       |
| E1       | 0.465     | 0.485 | 11.81       | 12.32 |
| e        | 0.100 BSC |       | 2.54 BSC    |       |
| F        | 0.245     | 0.255 | 6.22        | 6.47  |
| K        | 0.120     | 0.130 | 3.05        | 3.30  |
| L        | 0.061     | 0.071 | 1.55        | 1.80  |
| M        | 0.270     | 0.290 | 6.86        | 7.36  |
| N        | 0.080     | 0.090 | 2.03        | 2.28  |
| P        | 0.009     | 0.011 | 0.23        | 0.28  |
| T        | 0.115     | 0.125 | 2.92        | 3.17  |
| $\theta$ | 0°        | 7°    | 0°          | 7°    |

CASE 1369-01  
ISSUE O

# MPX5010 MPXV5010G SERIES

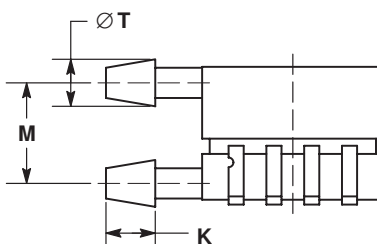
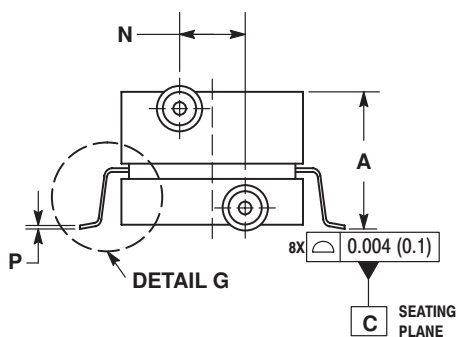
## SMALL OUTLINE PACKAGE DIMENSIONS—CONTINUED



### NOTES:

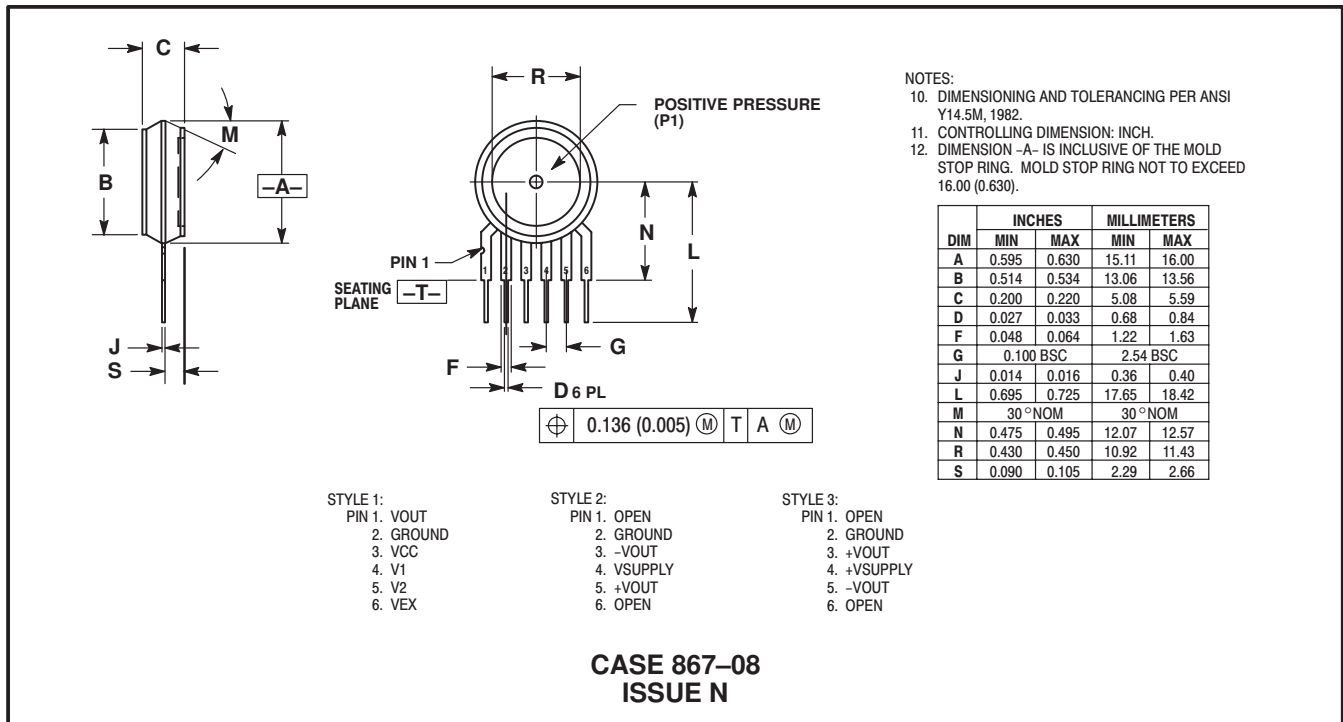
1. CONTROLLING DIMENSION: INCH.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.006 (0.152) PER SIDE.
4. DIMENSION "b" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.008 (0.203) MAXIMUM.

| DIM      | INCHES    |       | MILLIMETERS |       |
|----------|-----------|-------|-------------|-------|
|          | MIN       | MAX   | MIN         | MAX   |
| A        | 0.370     | 0.390 | 9.39        | 9.91  |
| A1       | 0.002     | 0.010 | 0.05        | 0.25  |
| b        | 0.038     | 0.042 | 0.96        | 1.07  |
| D        | 0.465     | 0.485 | 11.81       | 12.32 |
| E        | 0.680     | 0.700 | 17.27       | 17.78 |
| E1       | 0.465     | 0.485 | 11.81       | 12.32 |
| e        | 0.100 BSC |       | 2.54 BSC    |       |
| F        | 0.240     | 0.260 | 6.10        | 6.60  |
| K        | 0.115     | 0.135 | 2.92        | 3.43  |
| L        | 0.040     | 0.060 | 1.02        | 1.52  |
| M        | 0.270     | 0.290 | 6.86        | 7.37  |
| N        | 0.160     | 0.180 | 4.06        | 4.57  |
| P        | 0.009     | 0.011 | 0.23        | 0.28  |
| T        | 0.110     | 0.130 | 2.79        | 3.30  |
| $\theta$ | 0°        | 7°    | 0°          | 7°    |

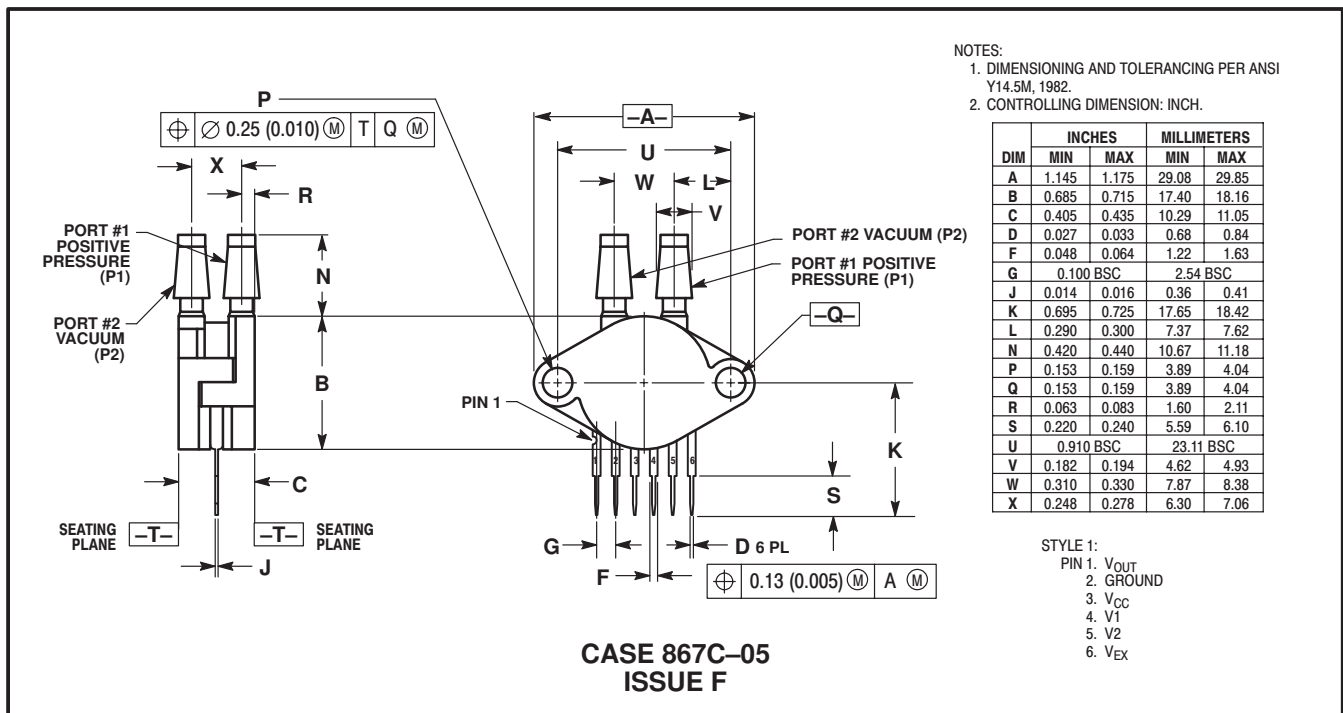


CASE 1351-01  
ISSUE O

## UNIBODY PACKAGE DIMENSIONS



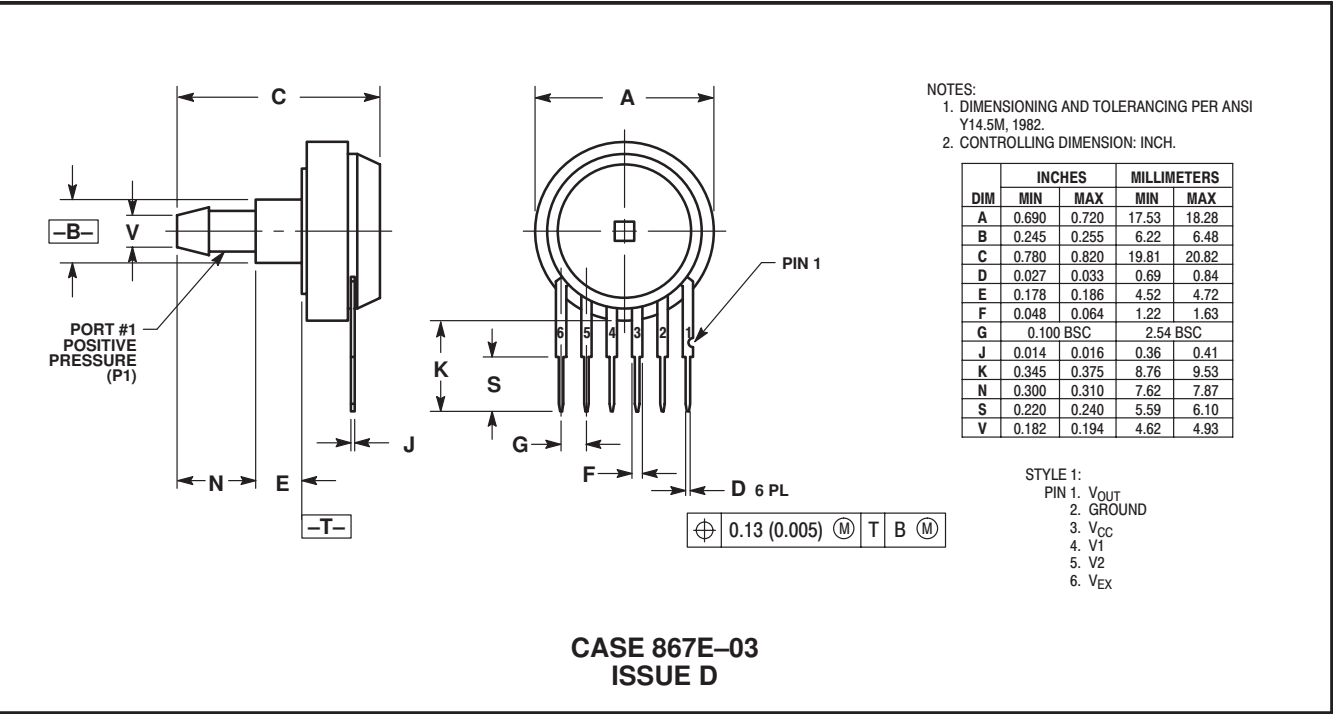
## BASIC ELEMENT



## PRESSURE AND VACUUM SIDES PORTED (DP)

**MPX5010 MPXV5010G SERIES**

**UNIBODY PACKAGE DIMENSIONS—CONTINUED**



**PRESSURE SIDE PORTED (AS, GS)**

# NOTES

## NOTES

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