

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

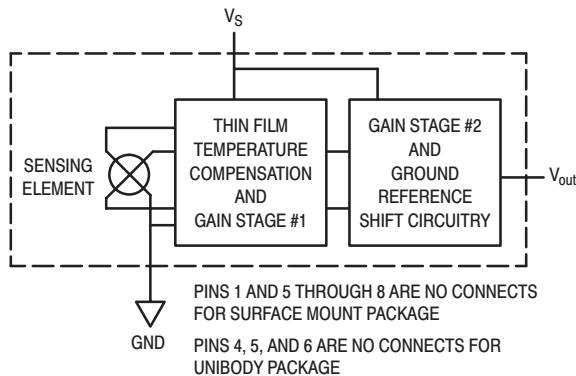
The MPX5010/MPXV5010G series piezoresistive transducers are state-of-the-art monolithic silicon pressure sensors designed for a wide range of applications, but particularly those employing a microcontroller or micro-processor with A/D inputs. This transducer combines advanced micromachining techniques,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

### Features

- 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



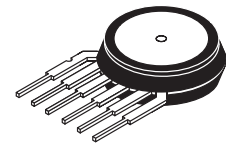
**Figure 1. Fully Integrated Pressure Sensor Schematic**

## MPX5010 MPXV5010G SERIES

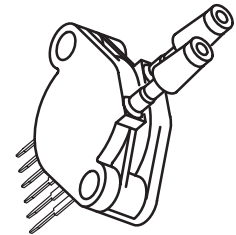
Motorola Preferred Device

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

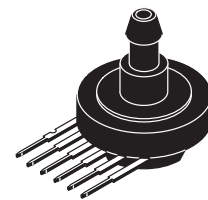
### UNIBODY PACKAGE



**MPX5010D  
 CASE 867**

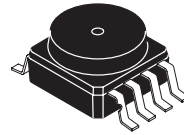


**MPX5010DP  
 CASE 867C**

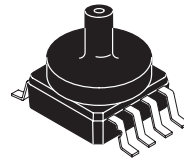


**MPX5010GS  
 CASE 867E**

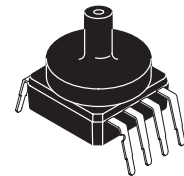
### SMALL OUTLINE PACKAGE



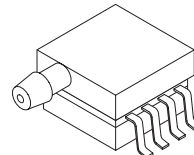
**MPXV5010G6U  
 CASE 482**



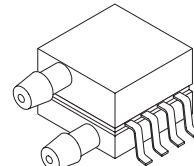
**MPXV5010GC6U  
 CASE 482A**



**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.

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.

**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> @ V <sub>S</sub> = 5.0 Volts (0 to 85°C)	V <sub>off</sub>	0	0.2	0.425	Vdc
Full Scale Output <sup>(4)</sup> @ V <sub>S</sub> = 5.0 Volts (0 to 85°C)	V <sub>FSSO</sub>	4.475	4.7	4.925	Vdc
Full Scale Span <sup>(5)</sup> @ V <sub>S</sub> = 5.0 Volts (0 to 85°C)	V <sub>FSS</sub>	4.275	4.5	4.725	Vdc
Accuracy <sup>(6)</sup> (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>FSSO</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.

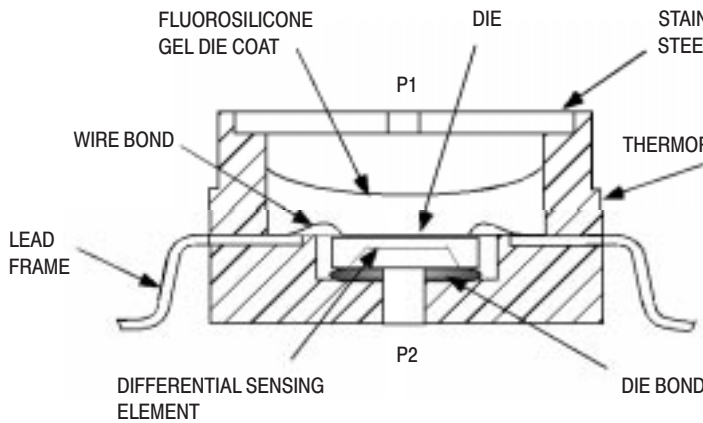
Figure 2 illustrates the Differential or Gauge configuration in the basic chip carrier (Case 482). A fluorosilicone gel isolates the die surface and wire bonds from the environment, while allowing the pressure signal to be transmitted to the sensor diaphragm.

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

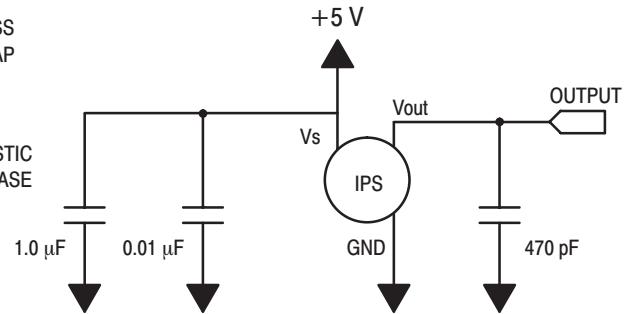
sensor performance and long-term reliability. Contact the factory for information regarding media compatibility in your application.

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.

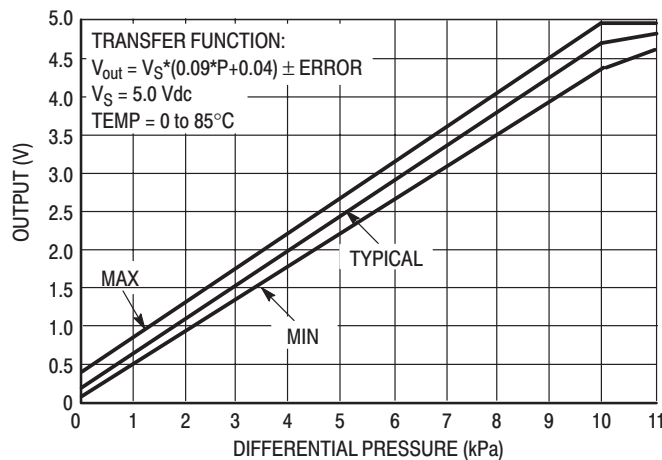
Figure 4 shows the sensor output signal relative to pressure input. Typical, minimum, and maximum output curves are shown for operation over a temperature range of 0° to 85°C using the decoupling circuit shown in Figure 4. The output will saturate outside of the specified pressure range.



**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.



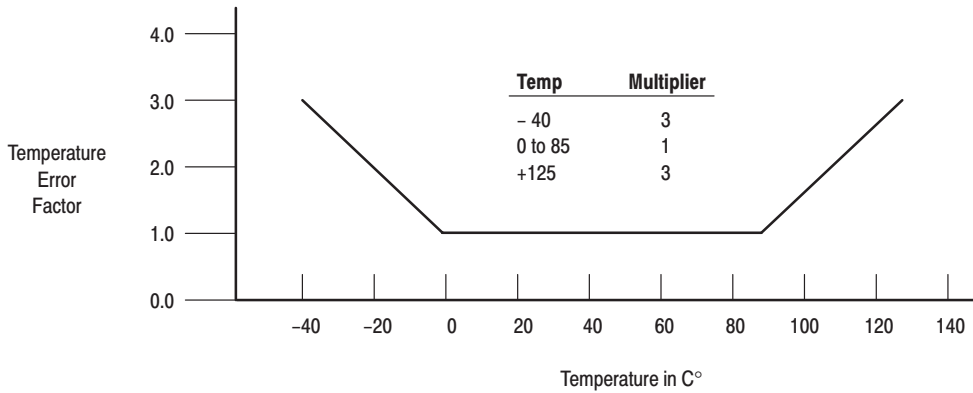
**Figure 4. Output versus Pressure Differential**

**Transfer Function (MPX5010, MPXV5010G)**

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

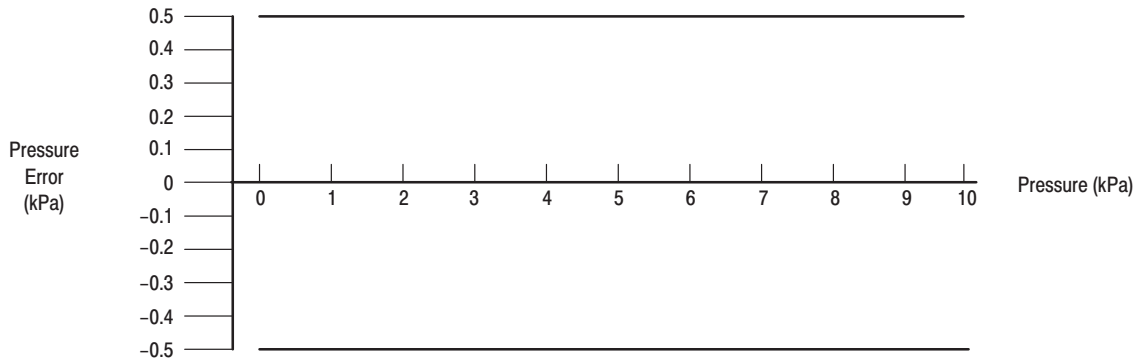
**Temperature Error Band**

**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

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## 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) 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

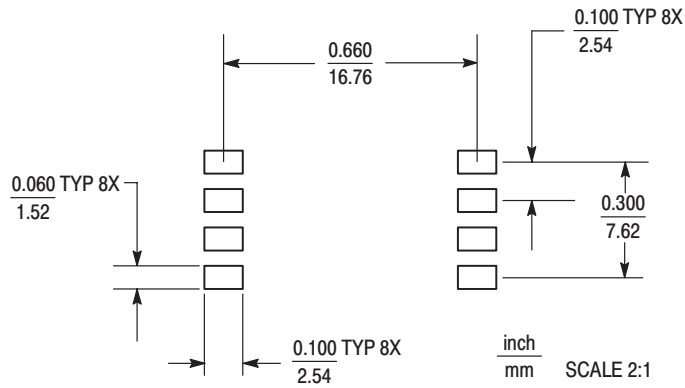
### ORDERING INFORMATION — SMALL OUTLINE PACKAGE (MPXV5010G SERIES)

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

**MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS**

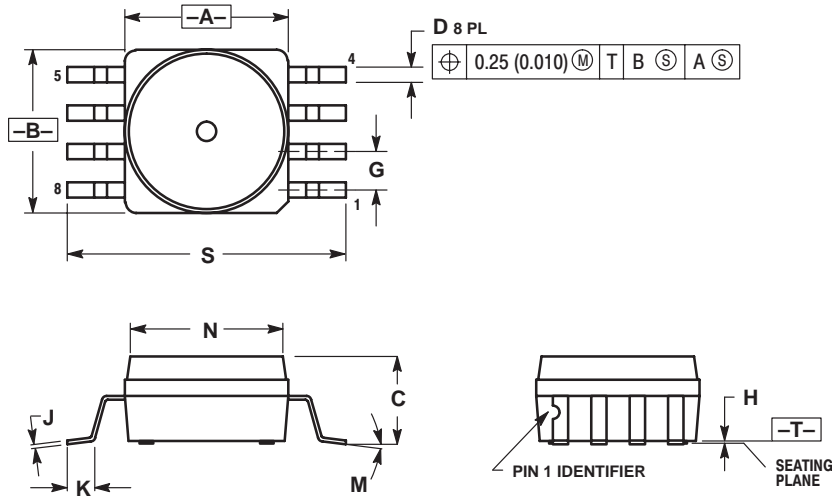
Surface mount board layout is a critical portion of the total design. The footprint for the surface mount packages must be the correct size to ensure proper solder connection interface between the board and the package. With the correct

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.



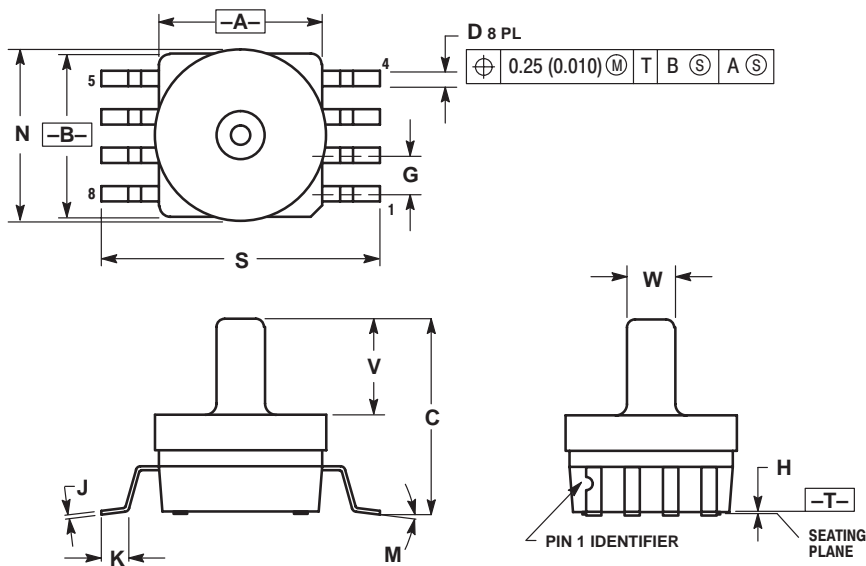
**Figure 5. SOP Footprint (Case 482)**

SMALL OUTLINE PACKAGE DIMENSIONS



- 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.

CASE 482-01  
ISSUE O



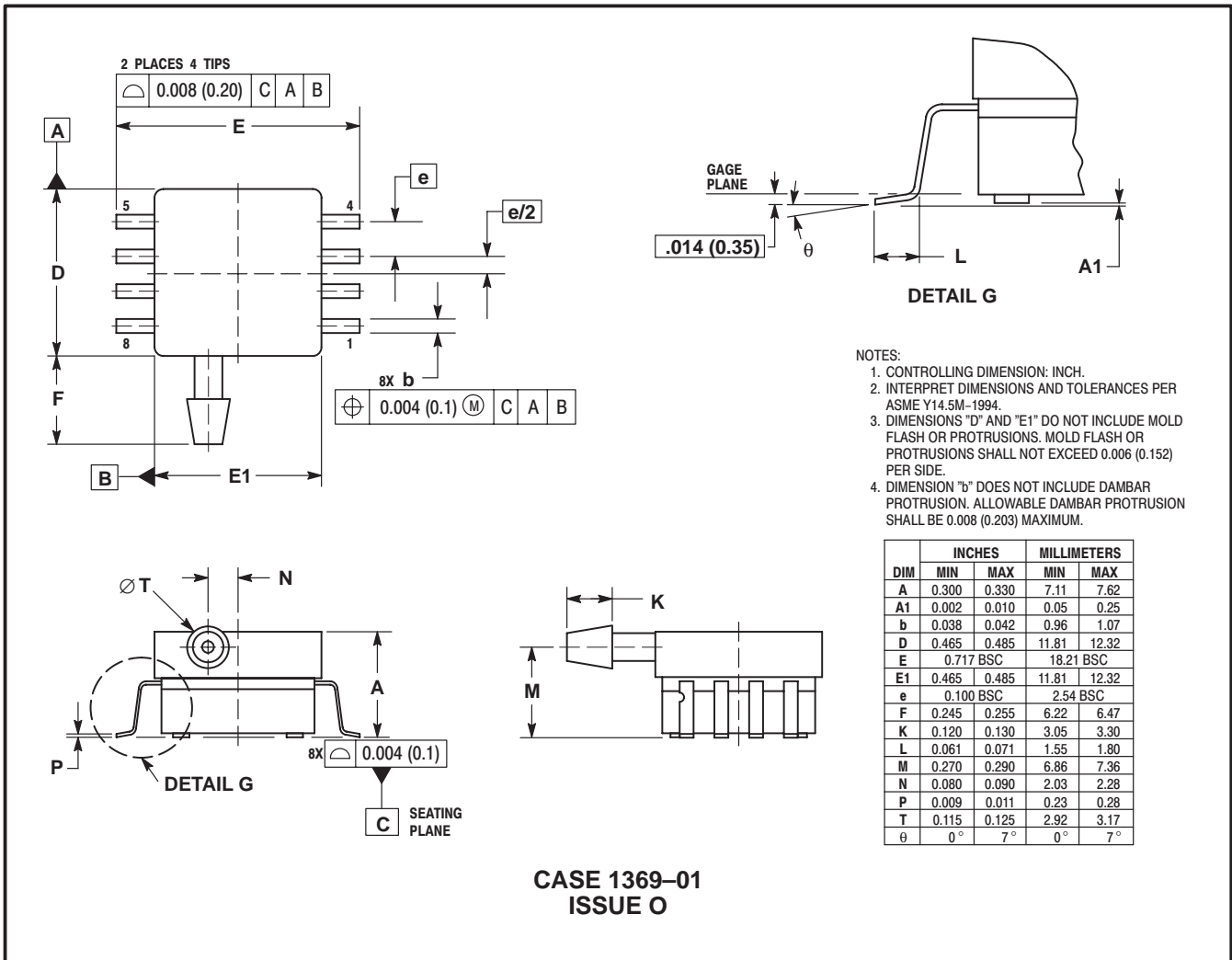
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  2. CONTROLLING DIMENSION: INCH.
  3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
  5. ALL VERTICAL SURFACES 5° TYPICAL DRAFT.

CASE 482A-01  
ISSUE A



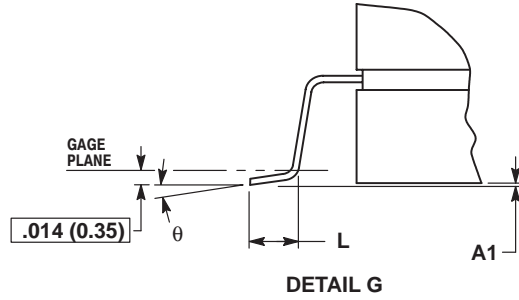
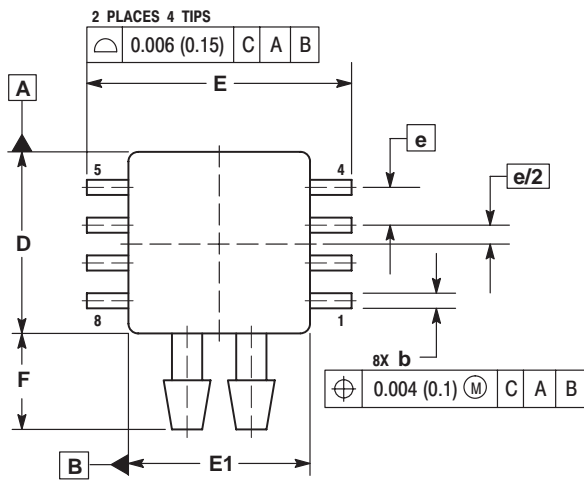


SMALL OUTLINE PACKAGE DIMENSIONS—CONTINUED

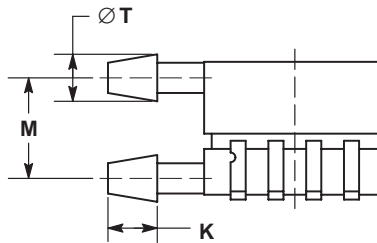
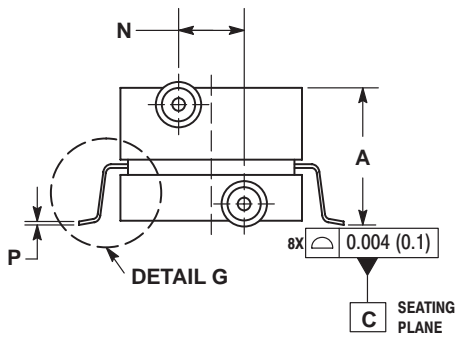


- NOTES:
1. CONTROLLING DIMENSION: INCH.
  2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
  3. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.006 (0.152) PER SIDE.
  4. DIMENSION "b" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE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

SMALL OUTLINE PACKAGE DIMENSIONS—CONTINUED



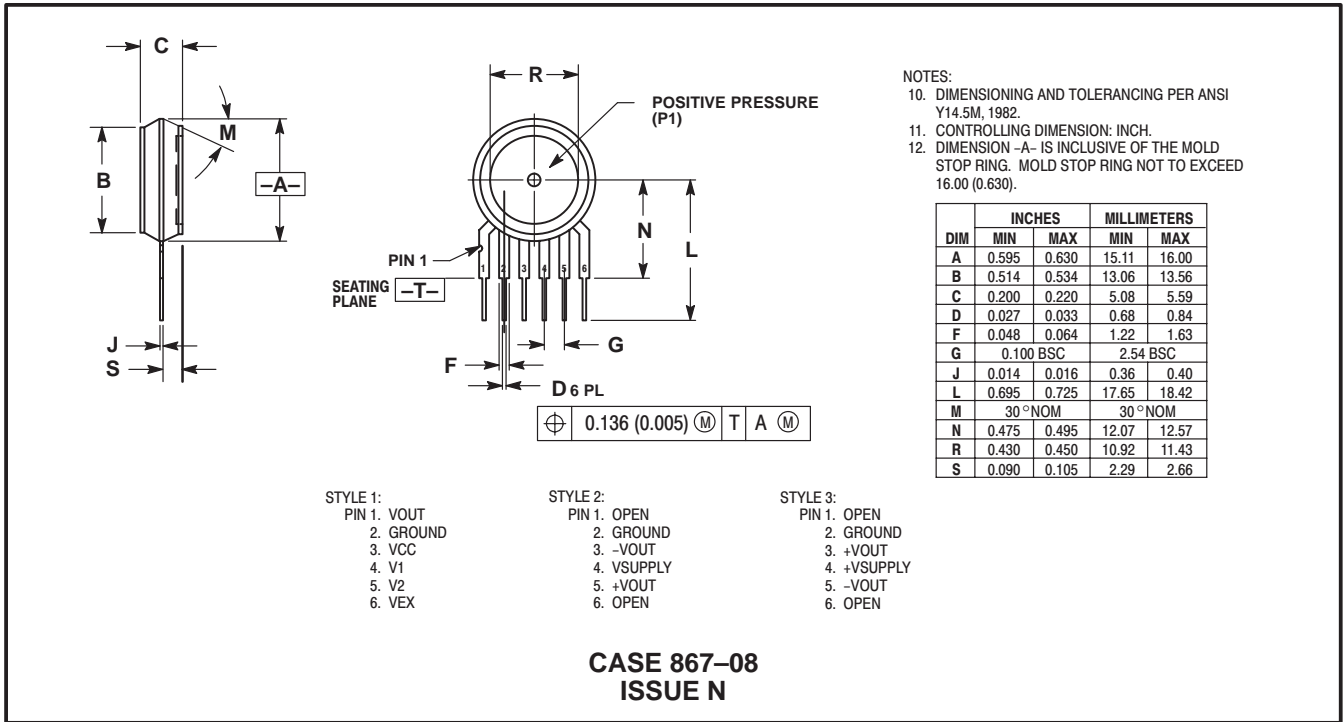
- NOTES:
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  4. DIMENSION "b" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.008 (0.203) MAXIMUM.
- STYLE 1:  
 PIN 1. GND  
 2. +Vout  
 3. Vs  
 4. -Vout  
 5. N/C  
 6. N/C  
 7. N/C  
 8. N/C
- STYLE 2:  
 PIN 1. N/C  
 2. Vs  
 3. GND  
 4. Vout  
 5. N/C  
 6. N/C  
 7. N/C  
 8. N/C



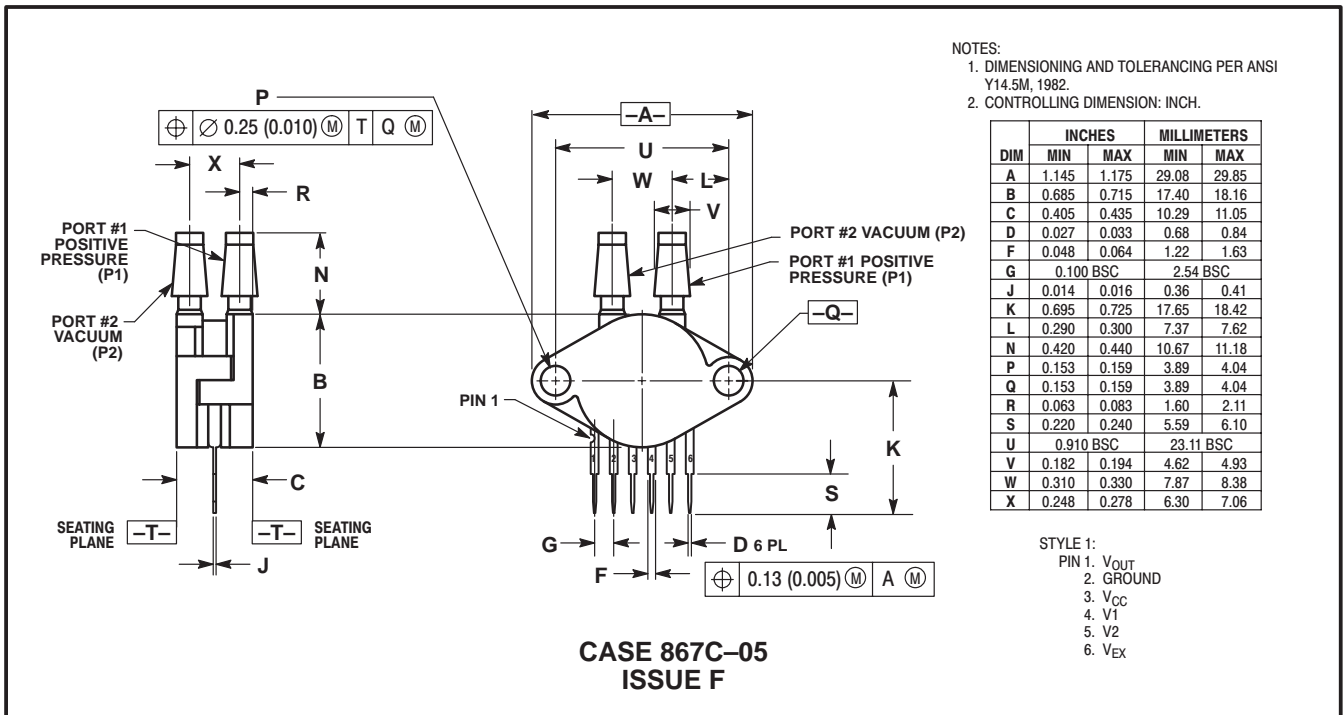
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.370	0.390	9.39	9.91
A1	0.002	0.010	0.05	0.25
b	0.038	0.042	0.96	1.07
D	0.465	0.485	11.81	12.32
E	0.680	0.700	17.27	17.78
E1	0.465	0.485	11.81	12.32
e	0.100 BSC		2.54 BSC	
F	0.240	0.260	6.10	6.60
K	0.115	0.135	2.92	3.43
L	0.040	0.060	1.02	1.52
M	0.270	0.290	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
θ	0°	7°	0°	7°

CASE 1351-01  
 ISSUE O

UNIBODY PACKAGE DIMENSIONS

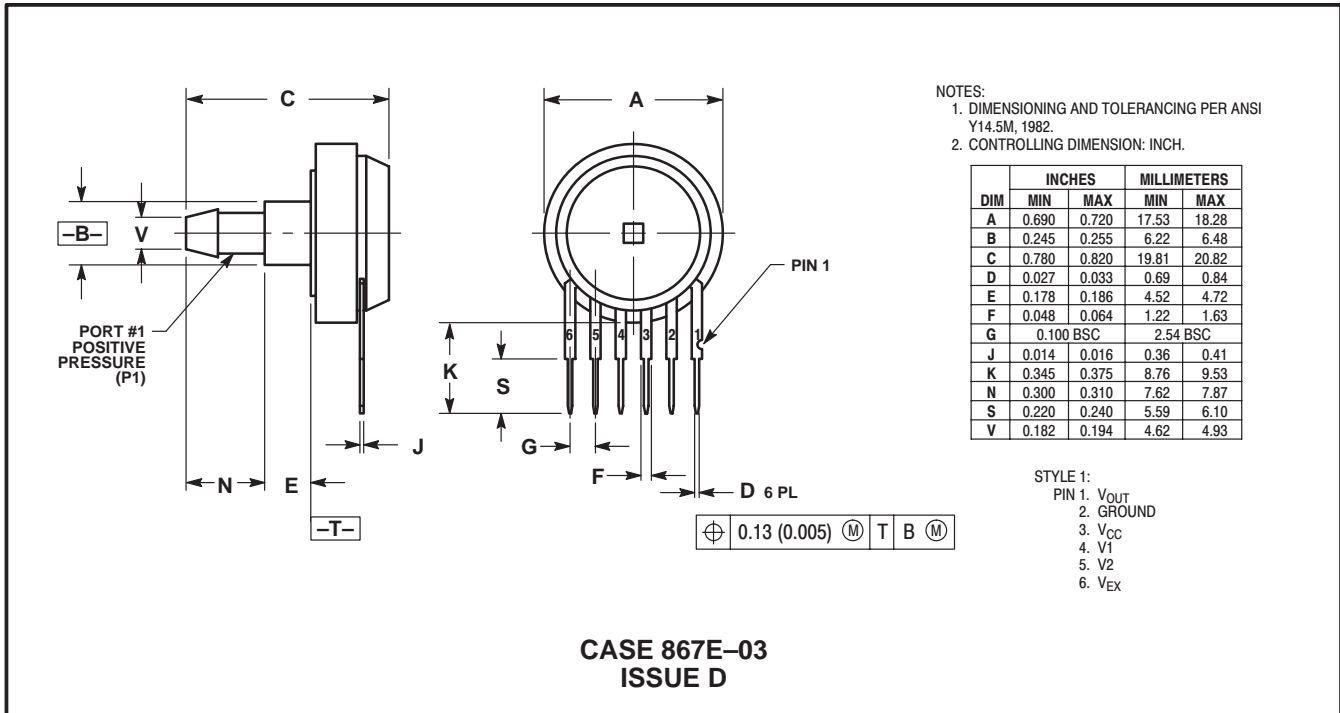


BASIC ELEMENT



PRESSURE AND VACUUM SIDES PORTED (DP)

UNIBODY PACKAGE DIMENSIONS—CONTINUED



PRESSURE SIDE PORTED (AS, GS)

# NOTES

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# NOTES

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**MPX5010/D**