

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

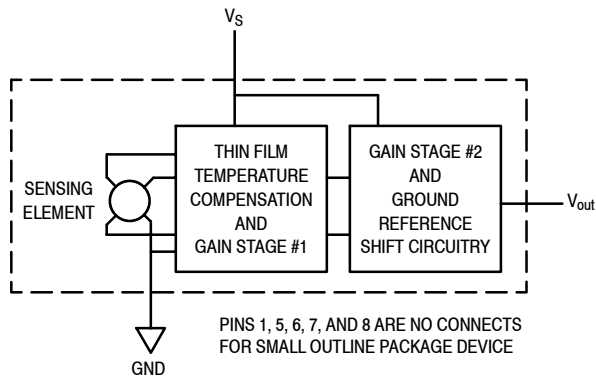
The MPXV5004G series piezoresistive transducer is a state-of-the-art monolithic silicon pressure sensor designed for a wide range of applications, but particularly those employing a microcontroller or microprocessor with A/D inputs. This sensor combines a highly sensitive implanted strain gauge with 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**

- Temperature Compensated over 10° to 60°C
- Available in Gauge Surface Mount (SMT) or Through-hole (DIP) Configurations
- Durable Thermoplastic (PPS) Package

**Application Examples**

- Washing Machine Water Level
- Ideally Suited for Microprocessor or Microcontroller-Based Systems

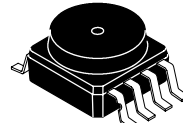


**Figure 1. Fully Integrated Pressure Sensor Schematic**

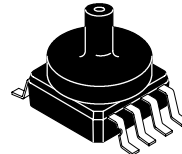
## MPXV5004G SERIES

**INTEGRATED  
 PRESSURE SENSOR**  
 0 to 3.92 kPa  
 (0 to 400 mm H<sub>2</sub>O)  
 1.0 to 4.9 V OUTPUT

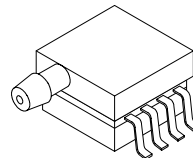
**SMALL OUTLINE PACKAGE  
 SURFACE MOUNT**



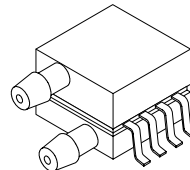
**MPXV5004G6U  
 CASE 482**



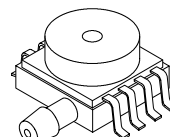
**MPXV5004GC6U  
 CASE 482A**



**MPXV5004GP  
 CASE 1369**

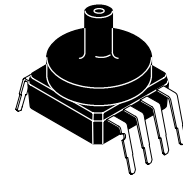


**MPXV5004DP  
 CASE 1351**

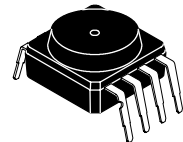


**MPXV5004GVP  
 CASE 1368**

**SMALL OUTLINE PACKAGE  
 THROUGH-HOLE**



**MPXV5004GC7U  
 CASE 482C**



**MPXV5004G7U  
 CASE 482B**

**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.

**MAXIMUM RATINGS(NOTE)**

Parameters	Symbol	Value	Unit
Maximum Pressure (P1 > P2)	P <sub>max</sub>	16	kPa
Storage Temperature	T <sub>stg</sub>	-30 to +100	°C
Operating Temperature	T <sub>A</sub>	0 to +85	°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 electrical specifications)

Characteristic	Symbol	Min	Typ	Max	Unit	
Pressure Range	P <sub>OP</sub>	0	—	3.92 400	kPa mm H <sub>2</sub> O	
Supply Voltage <sup>(1)</sup>	V <sub>S</sub>	4.75	5.0	5.25	Vdc	
Supply Current	I <sub>S</sub>	—	—	10	mAdc	
Span at 306 mm H <sub>2</sub> O (3 kPa) <sup>(2)</sup>	V <sub>FSS</sub>	—	3.0	—	V	
Offset <sup>(3)(5)</sup>	V <sub>off</sub>	0.75	1.00	1.25	V	
Sensitivity	V/P	—	1.0 9.8	—	V/kPa mV/mm H <sub>2</sub> O	
Accuracy <sup>(4)(5)</sup>	0 to 100 mm H <sub>2</sub> O 100 to 400 mm H <sub>2</sub> O	(10 to 60°C) (10 to 60°C)	—	—	—	±1.5 ±2.5 %V <sub>FSS</sub> %V <sub>FSS</sub>

**NOTES:**

- Device is ratiometric within this specified excitation range.
- Span is defined as the algebraic difference between the output voltage at specified pressure and the output voltage at the minimum rated pressure.
- Offset (V<sub>off</sub>) 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.
  - Offset Stability: Output deviation, after 1000 temperature cycles, -30 to 100°C, and 1.5 million pressure cycles, with minimum rated pressure applied.
  - TcSpan: Output deviation over the temperature range of 10 to 60°C, relative to 25°C.
  - TcOffset: Output deviation with minimum rated pressure applied, over the temperature range of 10 to 60°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.
- Auto Zero at Factory Installation: Due to the sensitivity of the MPXV5004G, external mechanical stresses and mounting position can affect the zero pressure output reading. Autozeroing is defined as storing the zero pressure output reading and subtracting this from the device's output during normal operations. Reference AN1636 for specific information. The specified accuracy assumes a maximum temperature change of ±5° C between autozero and measurement.

## 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 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 silicon diaphragm.

The MPXV5004G series sensor operating characteristics are based on use of dry air as pressure media. Media, other than dry air, may have adverse effects on sensor performance and long-term reliability. Internal reliability and qualification

test for dry air, and other media, are available from the factory. Contact the factory for information regarding media tolerance in your application.

Figure 3 shows the recommended decoupling circuit for interfacing the output of the MPXV5004G to the A/D input of the 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 10°C to 60°C using the decoupling circuit shown in Figure 3. The output will saturate outside of the specified pressure range.

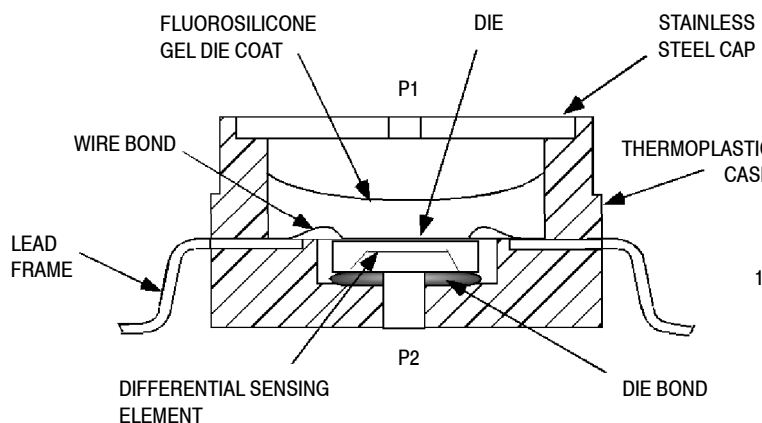


Figure 2. Cross-Sectional Diagram (Not to Scale)

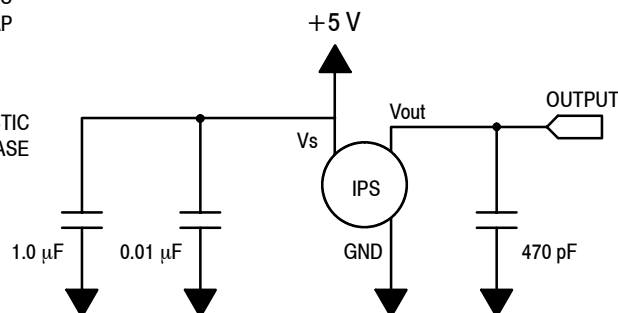


Figure 3. Recommended power supply decoupling and output filtering.

For additional output filtering, please refer to Application Note AN1646.

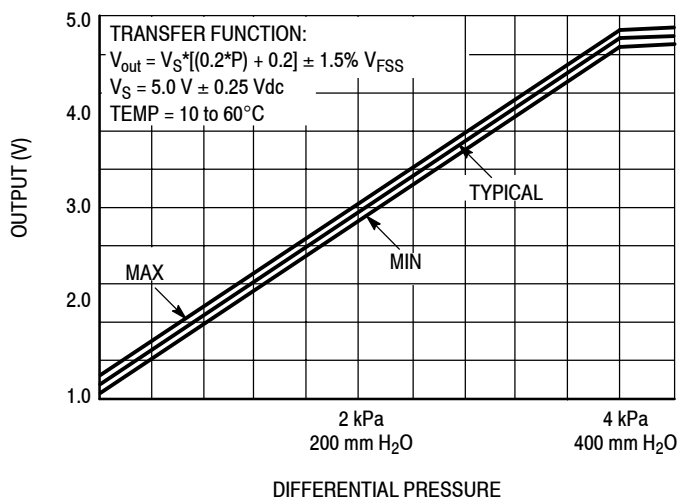


Figure 4. Output versus Pressure Differential

(See Note 5 in Operating Characteristics)

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

Freescale Semiconductor 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 Semiconductor 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
MPXV5004GC6U/T1	482A	Side with Port Attached
MPXV5004G6U/T1	482	Stainless Steel Cap
MPXV5004GC7U	482C	Side with Port Attached
MPXV5004G7U	482B	Stainless Steel Cap
MPXV5004GP	1369	Side with Port Attached
MPXV5004DP	1351	Side with Port Marking
MPXV5004GVP	1368	Stainless Steel Cap

### ORDERING INFORMATION

MPXV5004G series pressure sensors are available in the basic element package or with a pressure port. Two packing options are offered for the surface mount configuration.

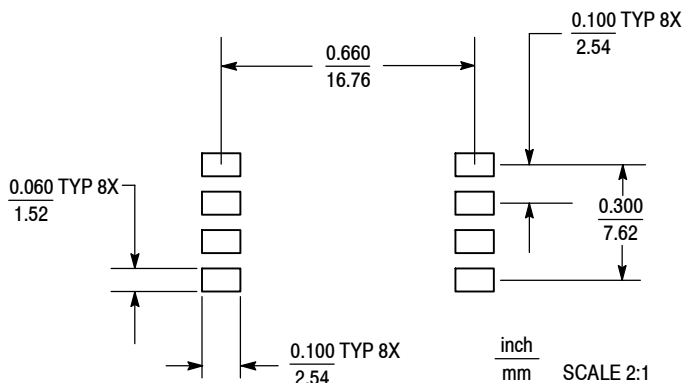
Device Type / Order No.	Case No.	Packing Options	Device Marking
MPXV5004G6U	482	Rails	MPXV5004G
MPXV5004G6T1	482	Tape and Reel	MPXV5004G
MPXV5004GC6U	482A	Rails	MPXV5004G
MPXV5004GC6T1	482A	Tape and Reel	MPXV5004G
MPXV5004GC7U	482C	Rails	MPXV5004G
MPXV5004G7U	482B	Rails	MPXV5004G
MPXV5004GP	1369	Trays	MPXV5004G
MPXV5004DP	1351	Trays	MPXV5004G
MPXV5004GVP	1368	Trays	MPXV5004G

## INFORMATION FOR USING THE SMALL OUTLINE PACKAGE (CASE 482)

### 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.



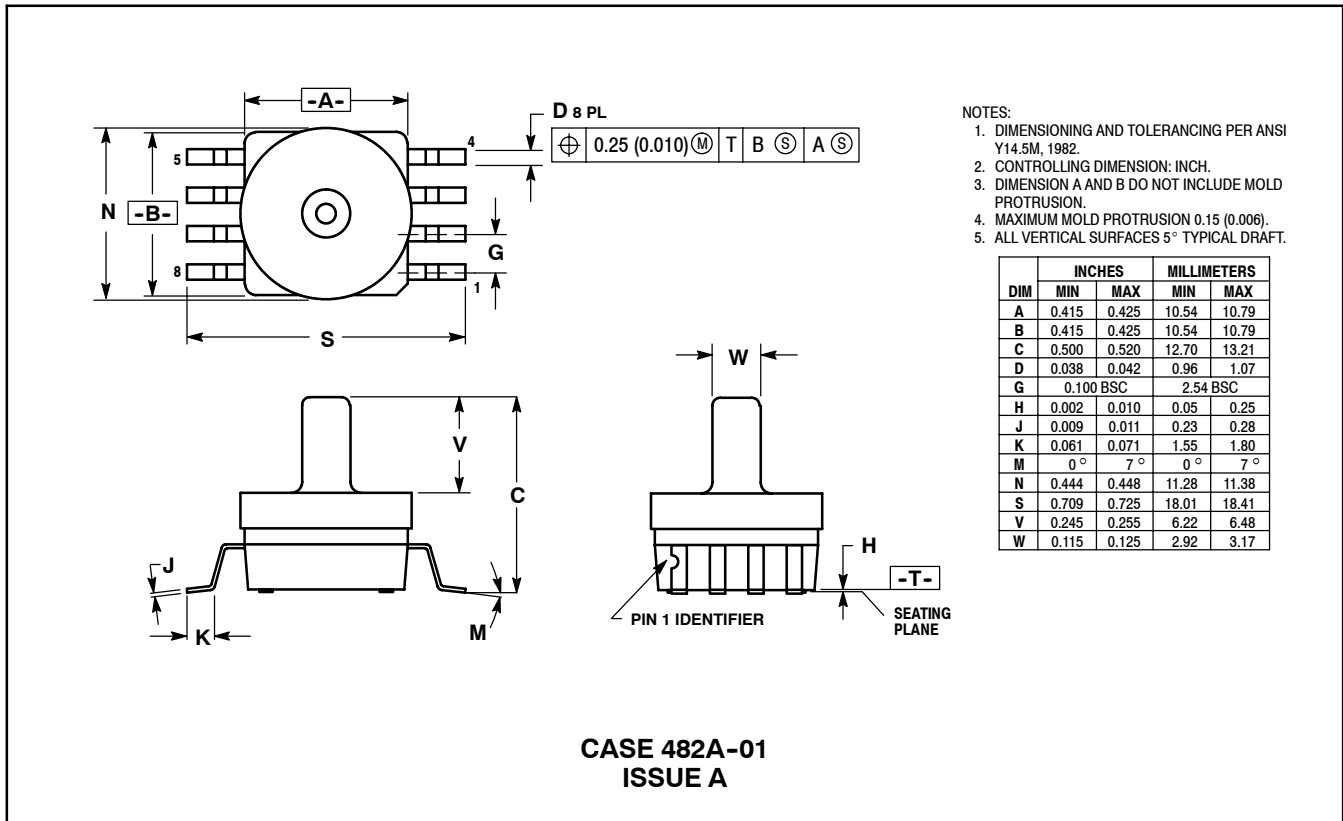
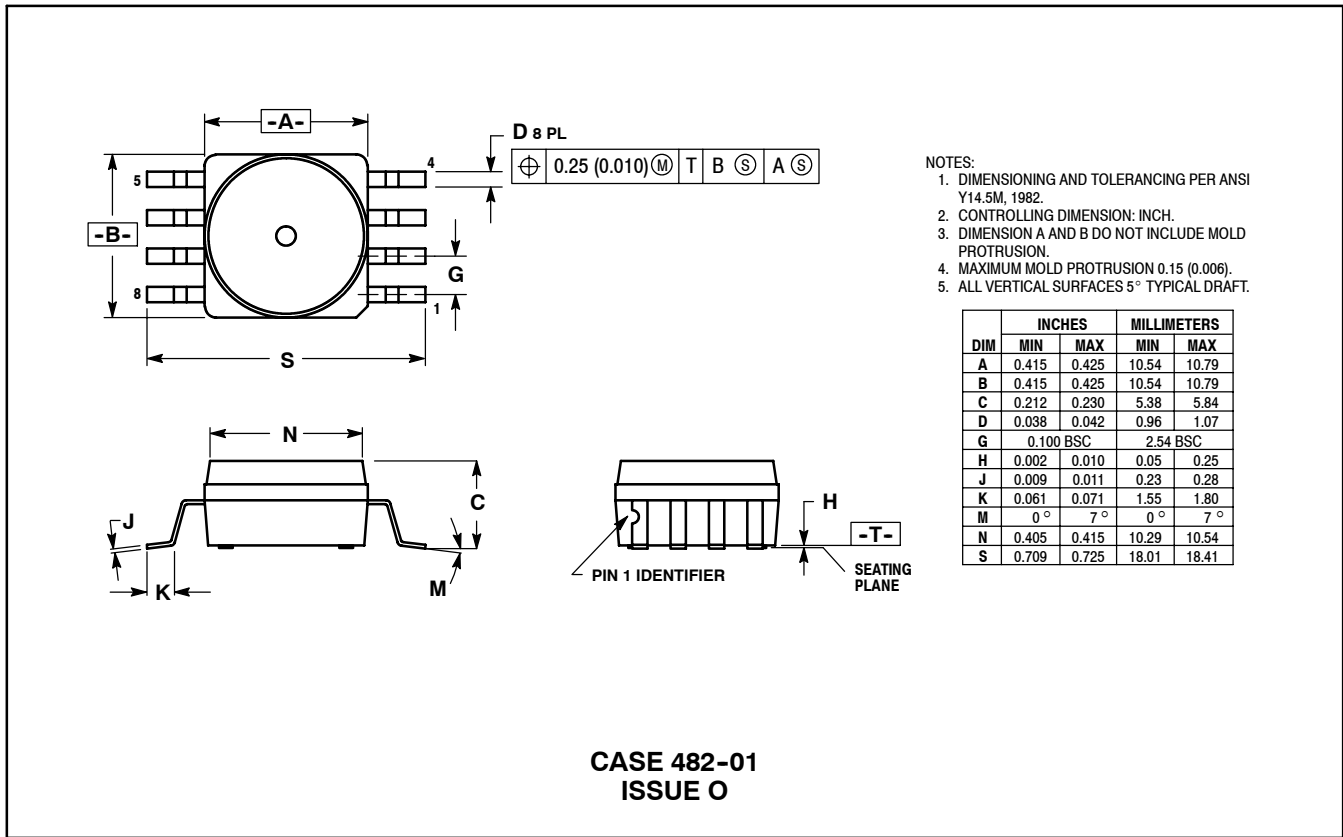
**Figure 5. SOP Footprint (Case 482)**



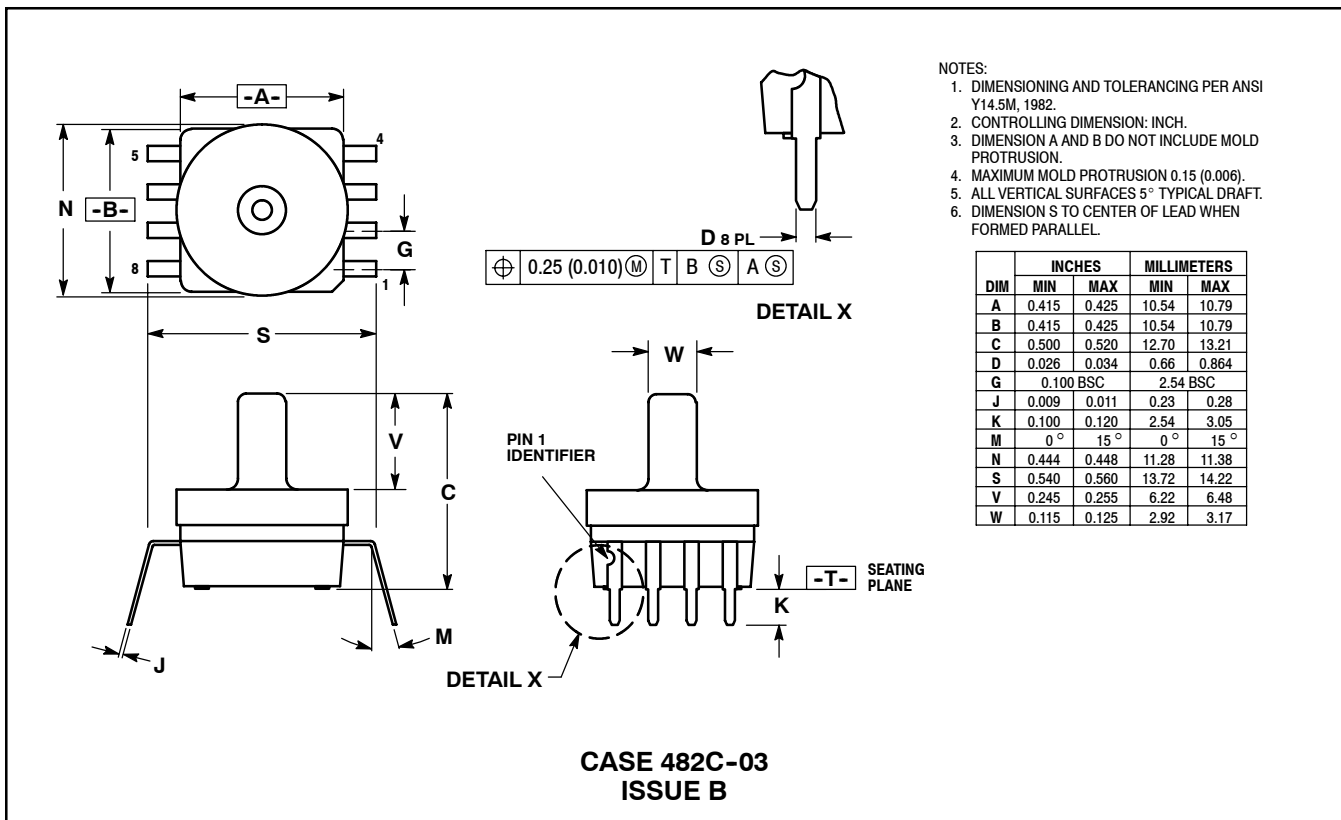
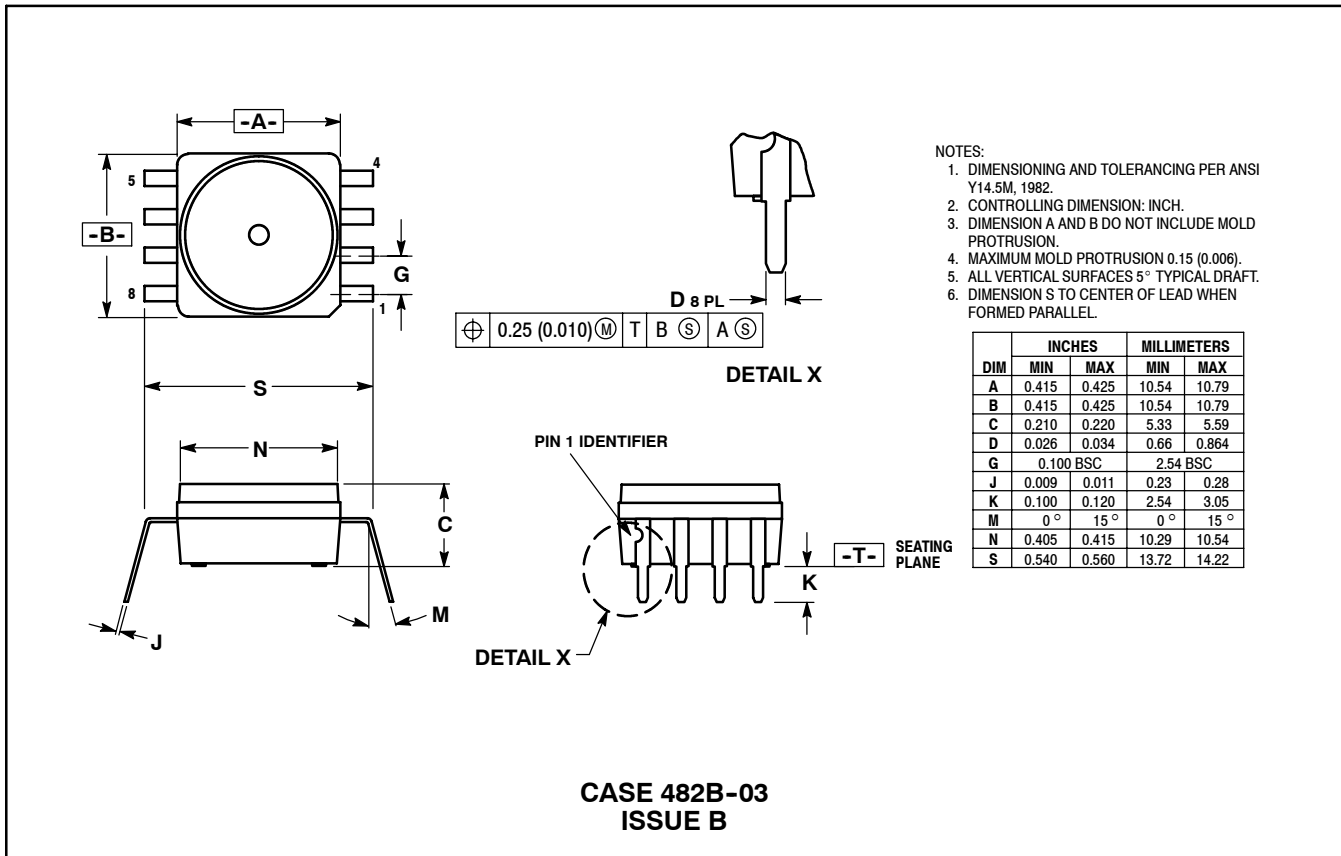
# NOTES

# NOTES

## SMALL OUTLINE PACKAGE DIMENSIONS

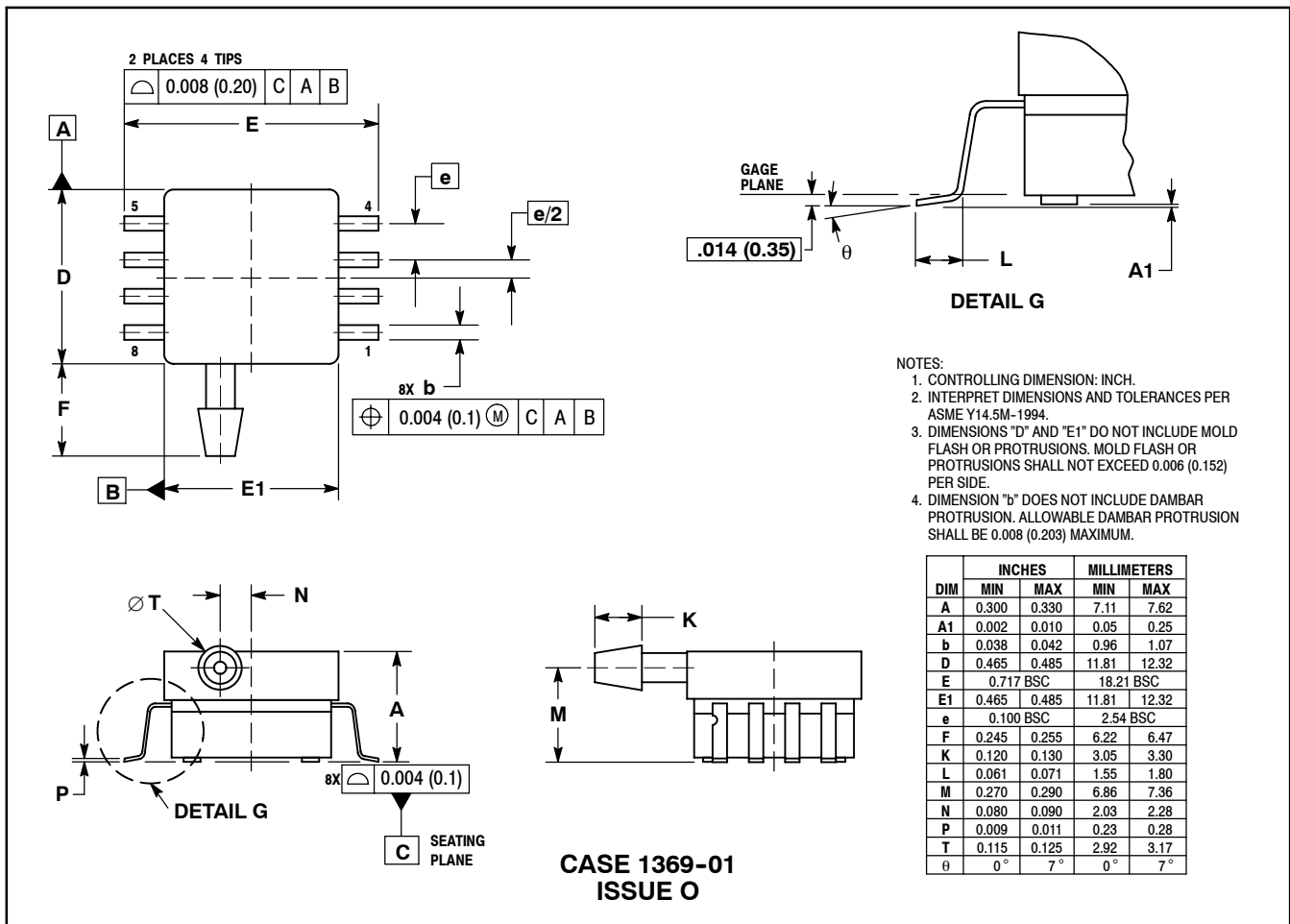


## SMALL OUTLINE PACKAGE DIMENSIONS (CONTINUED)





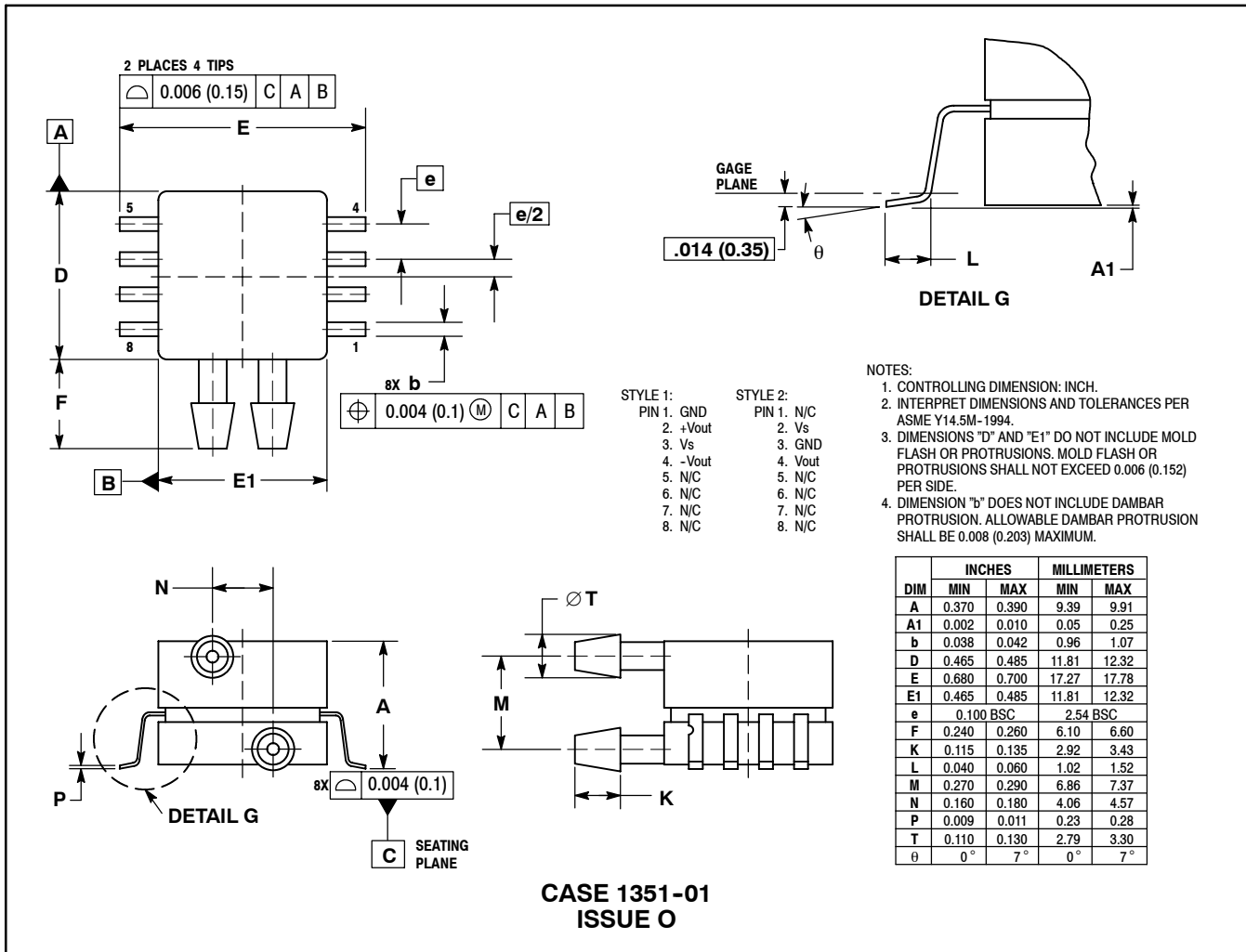
### SMALL OUTLINE PACKAGE DIMENSIONS (CONTINUED)



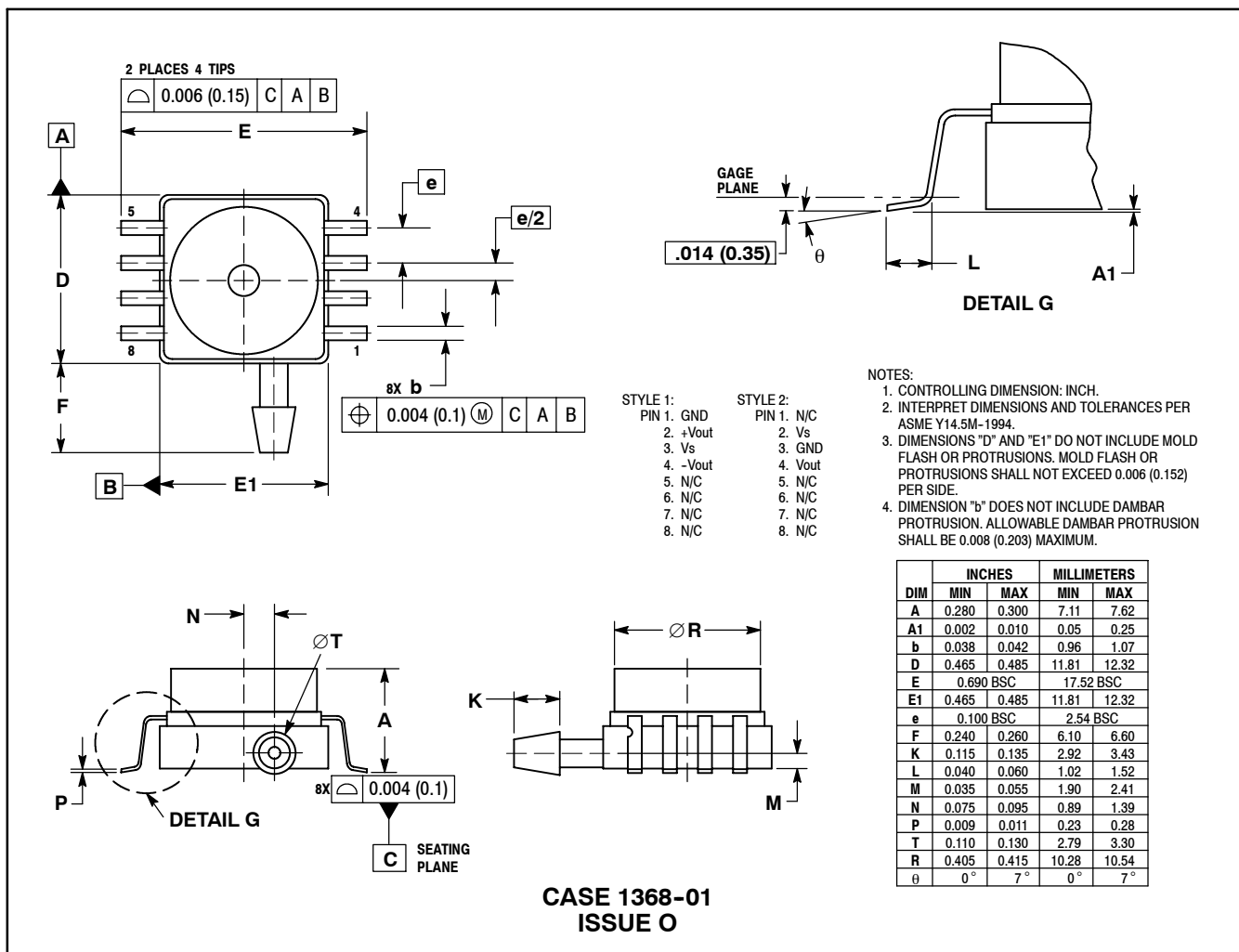
- NOTES:
1. CONTROLLING DIMENSION: INCH.
  2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
  3. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.006 (0.152) PER SIDE.
  4. DIMENSION "b" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE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

## SMALL OUTLINE PACKAGE DIMENSIONS (CONTINUED)



## SMALL OUTLINE PACKAGE DIMENSIONS (CONTINUED)



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