

# 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

## Typical Applications

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

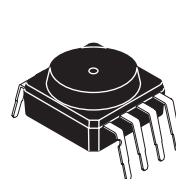
ORDERING INFORMATION <sup>(1)</sup>				
Device Type	Case No.	MPXV Series Order No.	Packing Options	Device Marking
Through-Hole	482B	MPXV5004G7U	Rails	MPXV5004G
	482C	MPXV5004GC7U	Rails	MPXV5004G
Surface Mount	482	MPXV5004G6U	Rails	MPXV5004G
	482	MPXV5004G6T1	Tape & Reel	MPXV5004G
	482A	MPXV5004GC6U	Rails	MPXV5004G
	482A	MPXV5004GC6T1	Tape & Reel	MPXV5004G
	1351	MPXV5004DP	Trays	MPXV5004G
	1368	MPXV5004GVP	Trays	MPXV5004G
	1369	MPXV5004GP	Trays	MPXV5004G

1. 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.

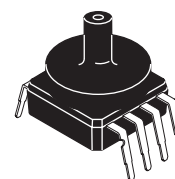
## MPXV5004G SERIES

**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 PACKAGES THROUGH-HOLE



**MPXV5004G7U**  
**CASE 482B-03**



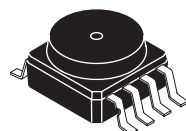
**MPXV5004GC7U**  
**CASE 482C-03**

## PIN NUMBERS<sup>(1)</sup>

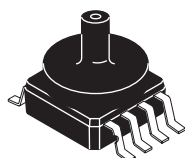
1	N/C	5	N/C
2	V <sub>S</sub>	6	N/C
3	GND	7	N/C
4	V <sub>OUT</sub>	8	N/C

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.

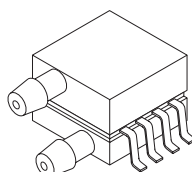
## SMALL OUTLINE PACKAGES SURFACE MOUNT



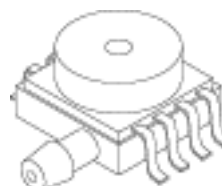
**MPXV5004G6U**  
**CASE 482-01**



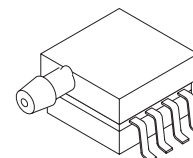
**MPXV5004GC6U**  
**CASE 482A-01**



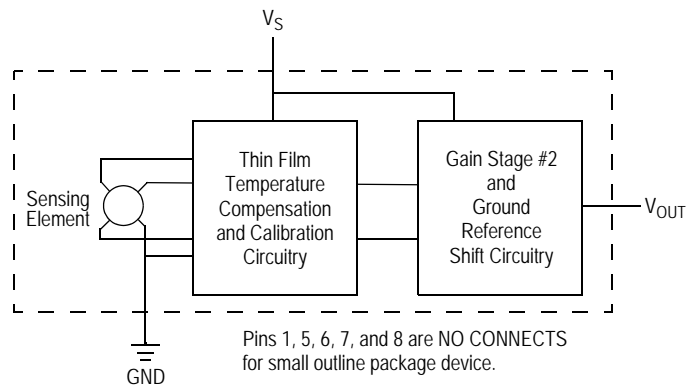
**MPXV5004DP**  
**CASE 1351-01**



**MPXV5004GVP**  
**CASE 1368-01**



**MPXV5004GP**  
**CASE 1369-01**



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

**Table 1. Maximum Ratings<sup>(1)</sup>**

Rating	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

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

**Table 2. Operating Characteristics** (V<sub>S</sub> = 5.0 V<sub>DC</sub>, T<sub>A</sub> = 25°C unless otherwise noted, P1 > P2)

Characteristic	Symbol	Min	Typ	Max	Units
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	V <sub>DC</sub>
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) (4)</sup>	V <sub>OFF</sub>	0.75	1.0	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 (10 to 60°C)	—	—	±1.5	%V <sub>FSS</sub>
	100 to 400 mm H <sub>2</sub> O (10 to 60°C)	—	—	±2.5	%V <sub>FSS</sub>

- 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.

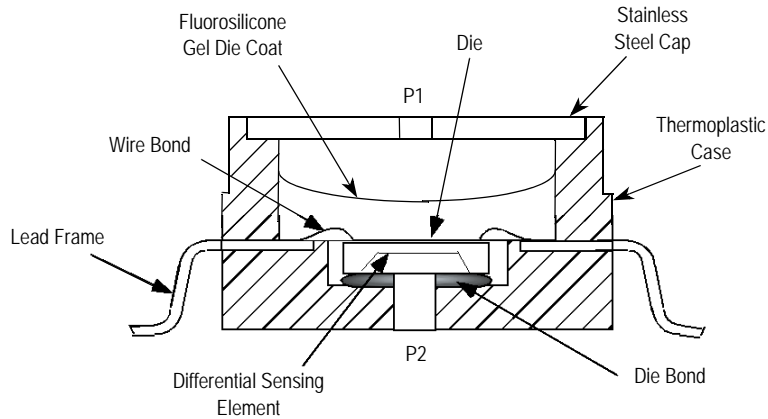


Figure 2. Cross-Sectional Diagram (Not to Scale)

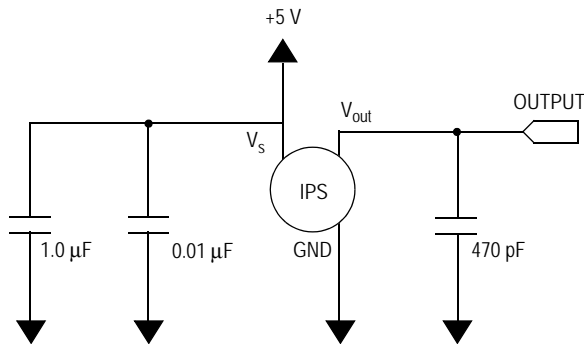


Figure 3. Recommended Power Supply Decoupling and Output Filtering.

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

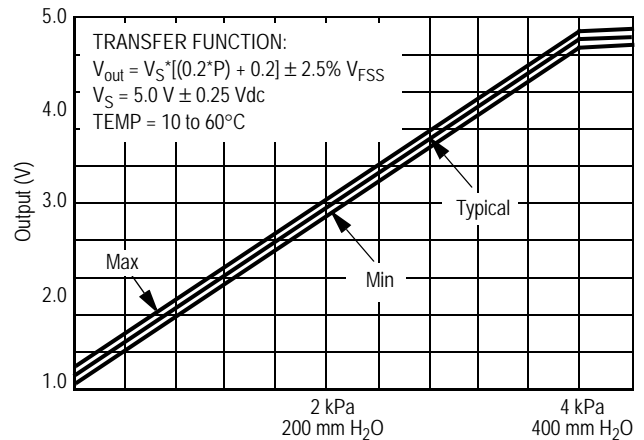


Figure 4. Output versus Pressure Differential at  $\pm 2.5\% V_{FSS}$

(See Note 5 in Operating Characteristics)

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

Freescall 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 the silicone gel which isolates the die from the environment. The

Freescall 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

## 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.

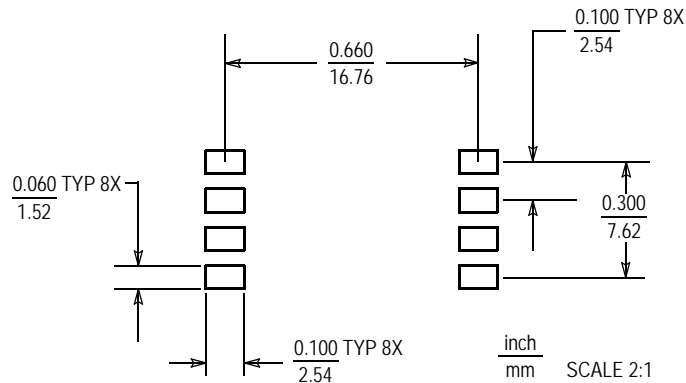
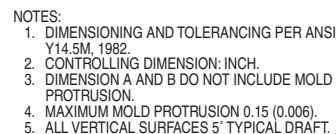
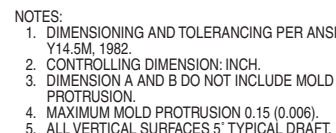


Figure 5. SOP Footprint (Case 482)

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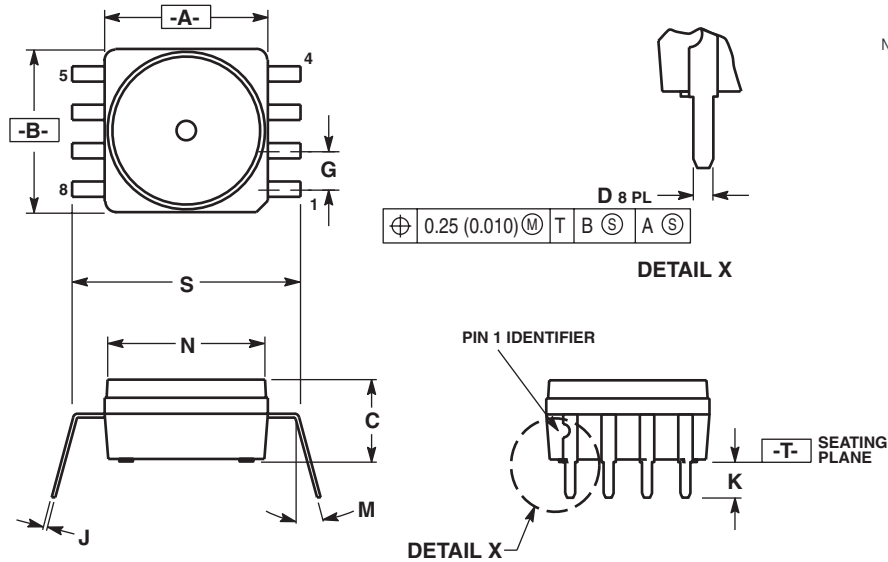
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.415	0.425	10.54	10.79
B	0.415	0.425	10.54	10.79
C	0.212	0.230	5.38	5.84
D	0.038	0.042	0.96	1.07
G	0.100 BSC		2.54 BSC	
H	0.002	0.010	0.05	0.25
J	0.009	0.011	0.23	0.28
K	0.061	0.071	1.55	1.80
M	0"	7"	0"	7"
N	0.405	0.415	10.29	10.54
S	0.709	0.725	18.01	18.41



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

Sensors  
Freescale Semiconductor

## PACKAGE DIMENSIONS

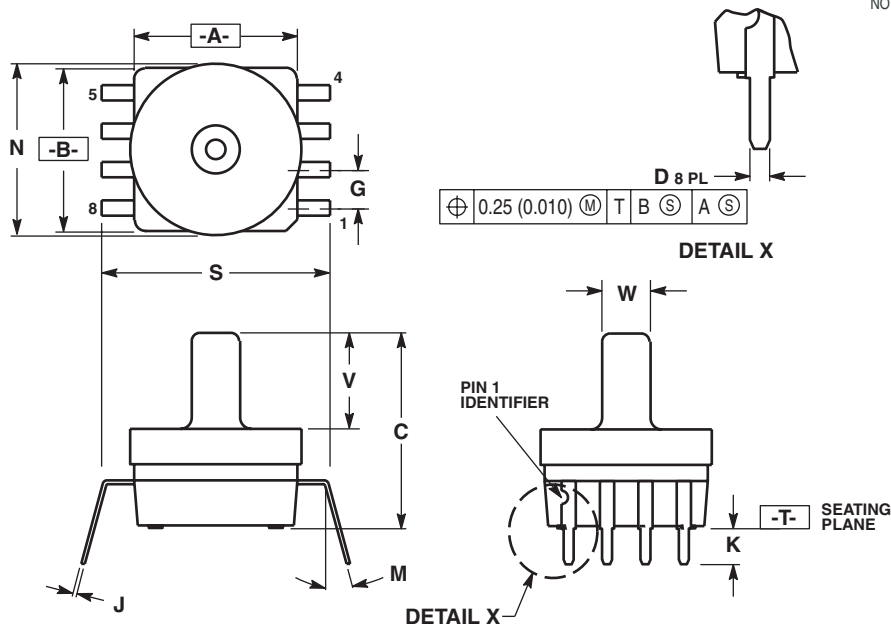


### NOTES:

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.
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	0.210	0.220	5.33	5.59
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	0.405	0.415	10.29	10.54
S	0.540	0.560	13.72	14.22

### CASE 482B-03 ISSUE B SMALL OUTLINE PACKAGE THROUGH-HOLE



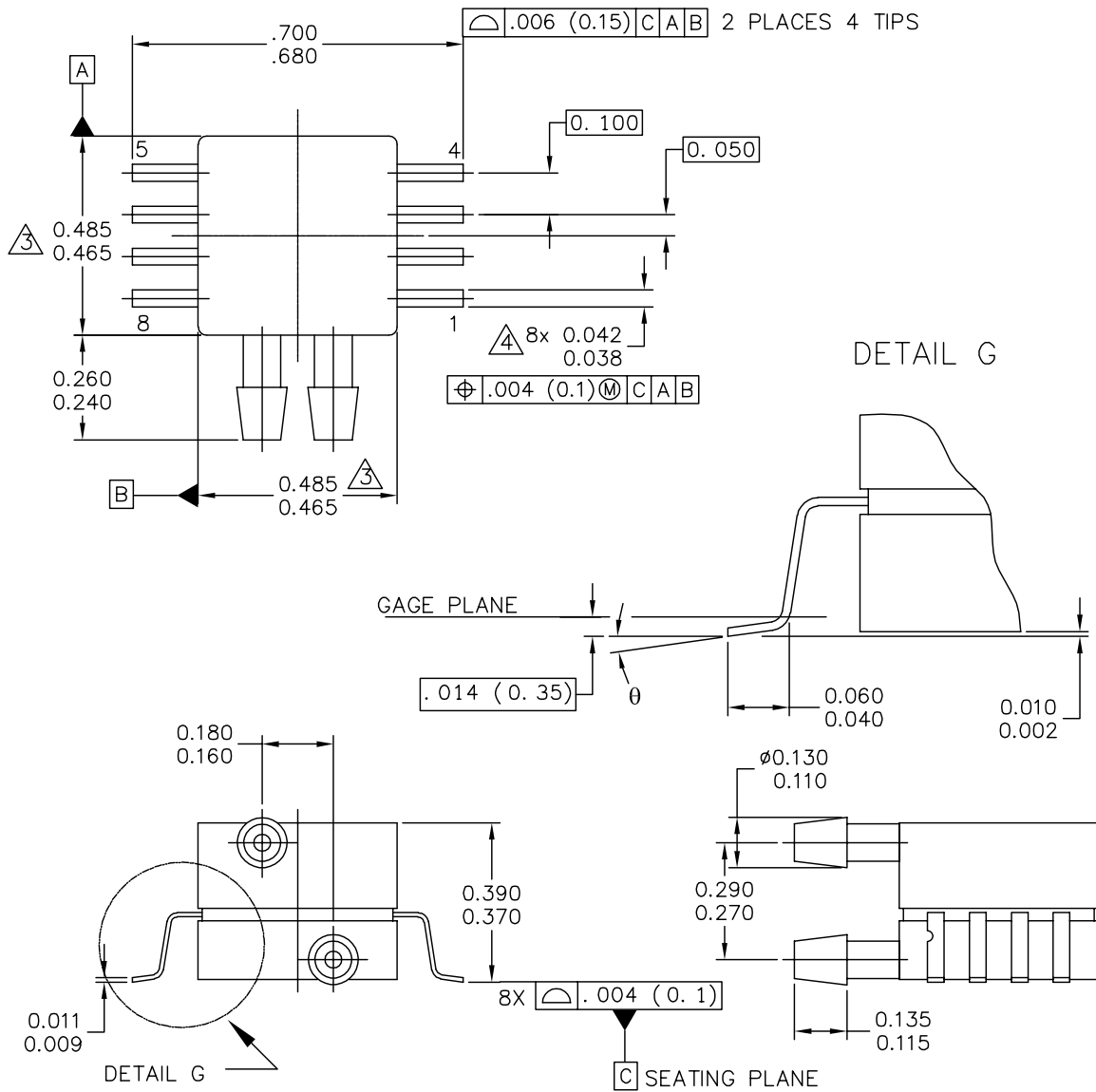
### NOTES:

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 THROUGH-HOLE

## 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  
SURFACE MOUNT**

**MPXV5004G**

## 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: +V<sub>out</sub>  
PIN 3: V<sub>s</sub>  
PIN 4: -V<sub>out</sub>  
PIN 5: N/C  
PIN 6: N/C  
PIN 7: N/C  
PIN 8: N/C

#### STYLE 2:

PIN 1: N/C  
PIN 2: V<sub>s</sub>  
PIN 3: GND  
PIN 4: V<sub>out</sub>  
PIN 5: N/C  
PIN 6: N/C  
PIN 7: N/C  
PIN 8: N/C

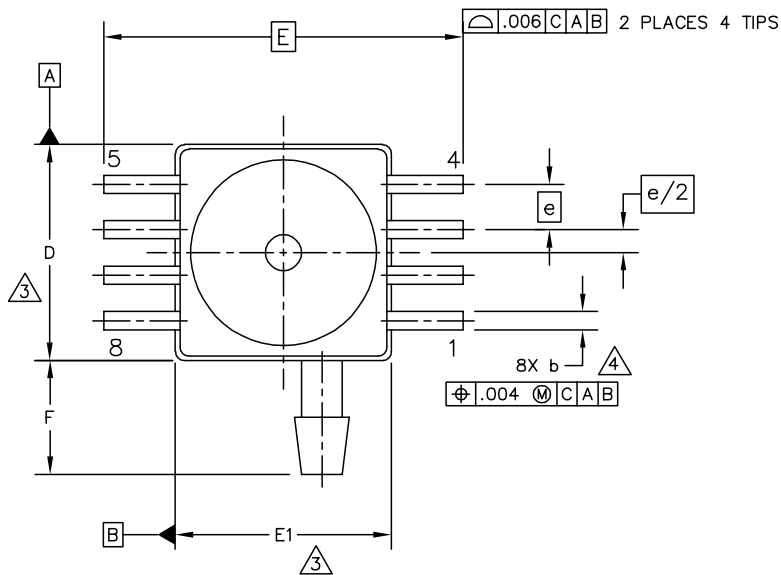
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	CASE NUMBER: 1351-01		27 JUL 2005
	STANDARD: NON-JEDEC		

PAGE 2 OF 2

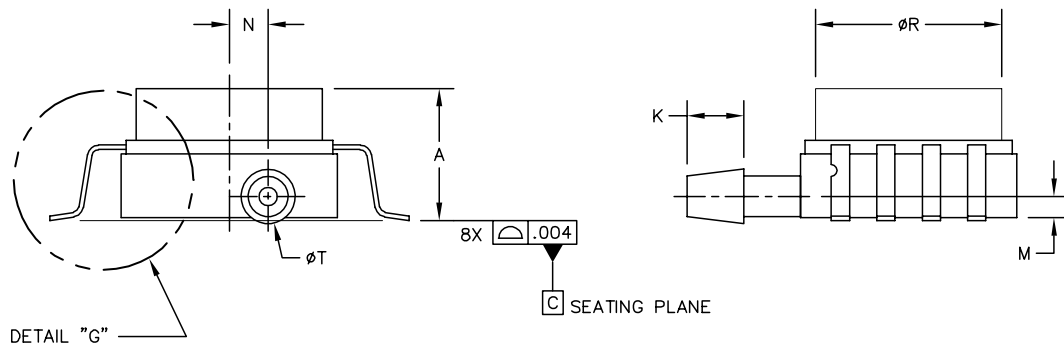
**CASE 1351-01  
ISSUE A  
SMALL OUTLINE PACKAGE**



## PACKAGE DIMENSIONS



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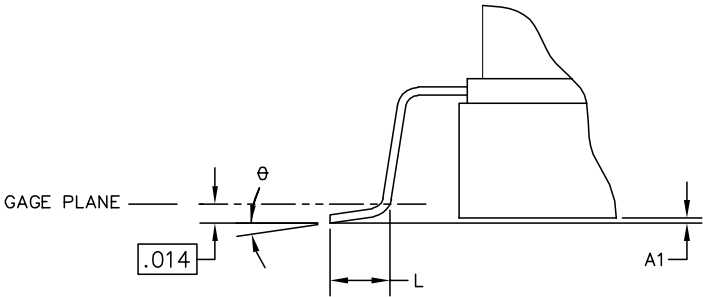
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		CASE NUMBER: 1368-01		23 MAY 2005	
		STANDARD: NON-JEDEC			

PAGE 1 OF 3

**CASE 1368-01  
ISSUE B  
SMALL OUTLINE PACKAGE  
SURFACE MOUNT**

**MPXV5004G**

PACKAGE DIMENSIONS



DETAIL "G"

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TITLE:  8 LD SOP, GVP	DOCUMENT NO: 98ASA99302D		REV: B
	CASE NUMBER: 1368-01		23 MAY 2005
	STANDARD: NON-JEDEC		

CASE 1368-01  
ISSUE B  
SMALL OUTLINE PACKAGE  
SURFACE MOUNT

## PACKAGE DIMENSIONS

### NOTES:

1. CONTROLLING DIMENSION: INCH

2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.

3. THIS DIMENSIONS DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS.  
MOLD FLASH AND PROTRUSIONS SHALL NOT EXCEED .006 PER SIDE.

4. THIS 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

DIM	INCHES		MILLIMETERS		DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
A	.280	.300	7.11	7.62	R	.405	.415	10.28	10.54
A1	.002	.010	0.05	0.25	θ	0°	7°	0°	7°
b	.038	.042	0.96	1.07	—	---	---	---	---
D	.465	.485	11.81	12.32	—	---	---	---	---
E	.690 BSC		17.52 BSC		—	---	---	---	---
E1	.465	.485	11.85	12.32	—	---	---	---	---
e	.100 BSC		2.54 BSC		—	---	---	---	---
F	.240	.260	6.10	6.60	—	---	---	---	---
K	.115	.135	2.92	3.43	—	---	---	---	---
L	.040	.060	1.02	1.52	—	---	---	---	---
M	.035	.055	1.90	2.41	—	---	---	---	---
N	.075	.095	0.89	1.39	—	---	---	---	---
P	.009	.011	0.23	0.28	—	---	---	---	---
T	.110	.130	2.79	3.30	—	---	---	---	---

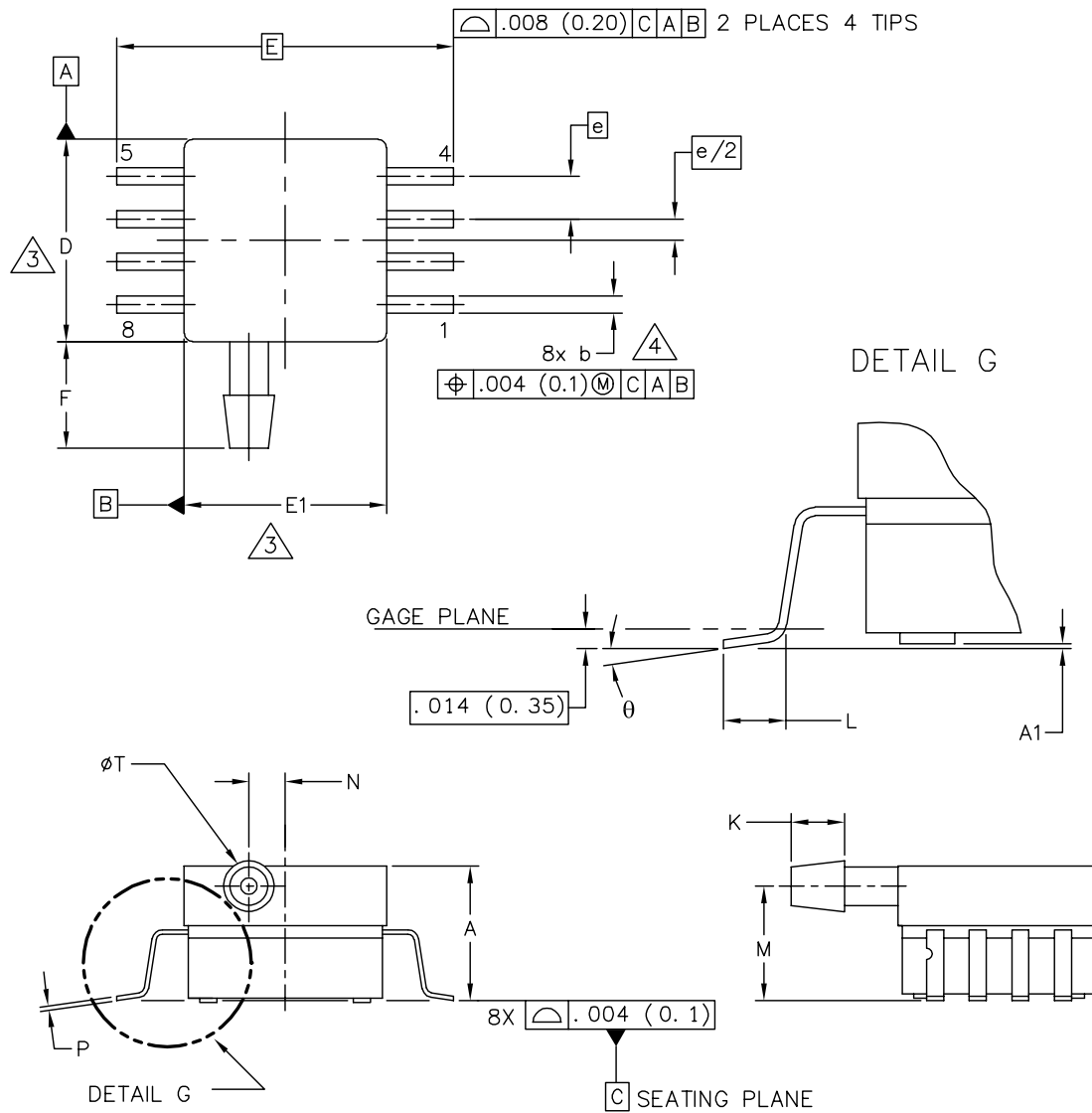
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			CASE NUMBER: 1368-01		23 MAY 2005
			STANDARD: NON-JEDEC		

PAGE 3 OF 3

**CASE 1368-01  
ISSUE B  
SMALL OUTLINE PACKAGE  
SURFACE MOUNT**

**MPXV5004G**

## PACKAGE DIMENSIONS



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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 1 OF 2

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

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**CASE 1369-01  
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SMALL OUTLINE PACKAGE**

**MPXV5004G**

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