

## Freescale Semiconductor

MP3V5004G  
Rev 2, 06/2010

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

The MP3V5004G 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 from 10°C to 60°C
- Available in Gauge Surface Mount (SMT) Configuration
- Durable Thermoplastic (PPS) Package

## MP3V5004G Series

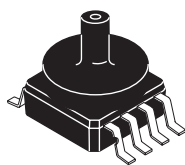
0 to 3.92 kPa (0 to 400 mm H<sub>2</sub>O)  
0.6 to 3.0 V Output

## Typical Applications

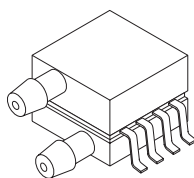
- Washing Machine Water Level
- Ideally Suited for Microprocessor or Microcontroller-Based Systems

| ORDERING INFORMATION                    |                 |          |            |        |      |               |              |          |                |
|-----------------------------------------|-----------------|----------|------------|--------|------|---------------|--------------|----------|----------------|
| Device Name                             | Package Options | Case No. | # of Ports |        |      | Pressure Type |              |          | Device Marking |
|                                         |                 |          | None       | Single | Dual | Gauge         | Differential | Absolute |                |
| Small Outline Package (MP3V5004 Series) |                 |          |            |        |      |               |              |          |                |
| MP3V5004GC6U                            | Rail            | 482A     |            | •      |      | •             |              |          | MP3V5004G      |
| MP3V5004GC6T1                           | Tape & Reel     | 482A     |            | •      |      | •             |              |          | MP3V5004G      |
| MP3V5004DP                              | Trays           | 1351     |            |        | •    |               | •            |          | MP3V5004DP     |
| MP3V5004GVP                             | Trays           | 1368     |            | •      |      | •             |              |          | MP3V5004GV     |
| MP3V5004GP                              | Trays           | 1369     |            | •      |      | •             |              |          | MP3V5004GP     |

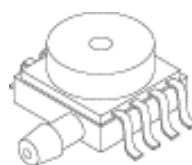
## SMALL OUTLINE PACKAGES



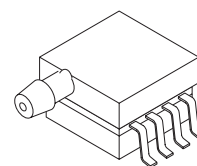
MP3V5004GC6U/6T1  
CASE 482A



MP3V5004DP  
CASE 1351



MP3V5004GVP  
CASE 1368



MP3V5004GP  
CASE 1369

## Operating Characteristics

**Table 1. Operating Characteristics** ( $V_S = 3.0$  Vdc,  $T_A = 25^\circ\text{C}$  unless otherwise noted,  $P_1 > P_2$ ).

| Characteristic                                         | Symbol                                      | Min  | Typ        | Max         | Unit                            |
|--------------------------------------------------------|---------------------------------------------|------|------------|-------------|---------------------------------|
| Pressure Range                                         | $P_{OP}$                                    | 0    | —          | 3.92<br>400 | kPa<br>mm H <sub>2</sub> O      |
| Supply Voltage <sup>(1)</sup>                          | $V_S$                                       | 2.7  | 3.0        | 3.3         | $V_{DC}$                        |
| Supply Current                                         | $I_S$                                       | —    | —          | 10          | mAdc                            |
| Span at 306 mm H <sub>2</sub> O (3 kPa) <sup>(2)</sup> | $V_{FSS}$                                   | —    | 1.8        | —           | V                               |
| Offset <sup>(3)</sup> (4)                              | $V_{OFF}$                                   | 0.45 | 0.6        | 0.75        | V                               |
| Sensitivity                                            | V/P                                         | —    | 0.6<br>5.9 | —           | V/kPa<br>mV/mm H <sub>2</sub> O |
| Accuracy <sup>(4)</sup> (5)                            | 0 to 100 mm H <sub>2</sub> O (10 to 60°C)   | —    | —          | ±1.5        | % $V_{FSS}$                     |
|                                                        | 100 to 400 mm H <sub>2</sub> O (10 to 60°C) | —    | —          | ±2.5        | % $V_{FSS}$                     |

- 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 ( $V_{off}$ ) 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  $V_{FSS}$ , at 25°C.
- Auto-Zero at Factory Installation: Due to the sensitivity of the MP3V5004G, external mechanical stresses and mounting position can affect the zero pressure output reading. Auto-zeroing 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 auto-zero and measurement.

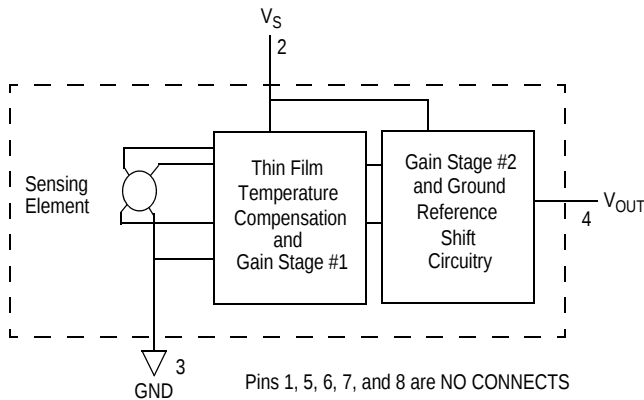
# Maximum Ratings

**Table 2. Maximum Ratings<sup>(1)</sup>**

| Rating                     | Symbol    | Value       | Units |
|----------------------------|-----------|-------------|-------|
| Maximum Pressure (P1 > P2) | $P_{MAX}$ | 16          | kPa   |
| Storage Temperature        | $T_{STG}$ | -30 to +100 | °C    |
| Operating Temperature      | $T_A$     | 0 to +85    | °C    |

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

Figure 1 shows a block diagram of the internal circuitry integrated on a pressure sensor chip.



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

## On-chip Temperature Compensation and Calibration

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 482A). 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 MP3V5004G series sensor operating characteristics are based on the 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 MP3V5004G 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.

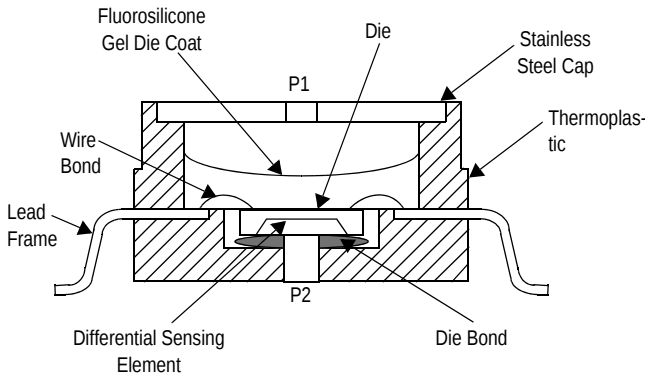


Figure 2. Cross Sectional Diagram SSOP (not to scale)

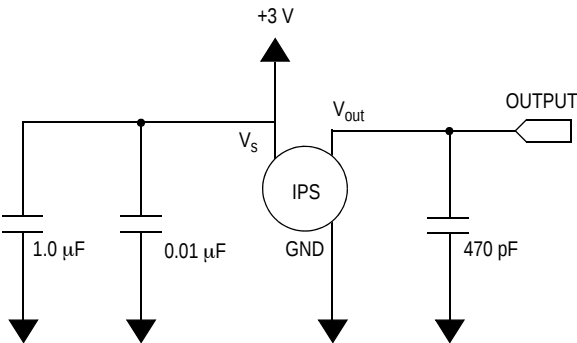


Figure 3. Recommended Power Supply Decoupling and Output Filtering.  
(For additional output filtering, please refer to Application Note AN1646.)

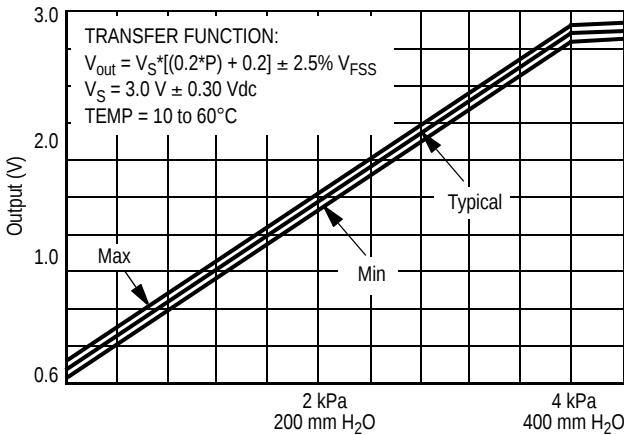


Figure 4. Output vs. Pressure Differential at  $\pm 2.5\% V_{FSS}$   
(See Note 5 in Operating Characteristics table)

### 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 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 |
|-----------------|-----------|-------------------------------|
| MP3V5004GC6U/T1 | 482A      | Side with Port Attached       |
| MP3V5004GP      | 1369      | Side with Port Attached       |
| MP3V5004DP      | 1351      | Side with Part Marking        |
| MP3V5004GVP     | 1368      | Stainless Steel Cap           |

### MINIMUM RECOMMENDED FOOTPRINT FOR SMALL OUTLINE PACKAGES

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor package must be the correct size to ensure proper solder connection interface between the board and the package. With the correct pad geometry, the packages will self-align when subjected to a

solder reflow process. It is always recommended to fabricate boards with a solder mask layer to avoid bridging and/or shorting between solder pads, especially on tight tolerances and/or tight layouts.

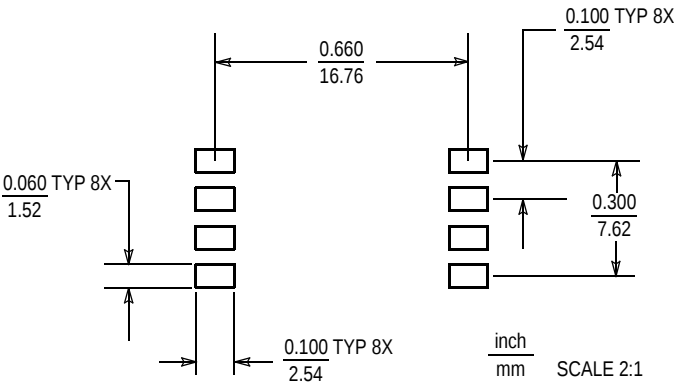
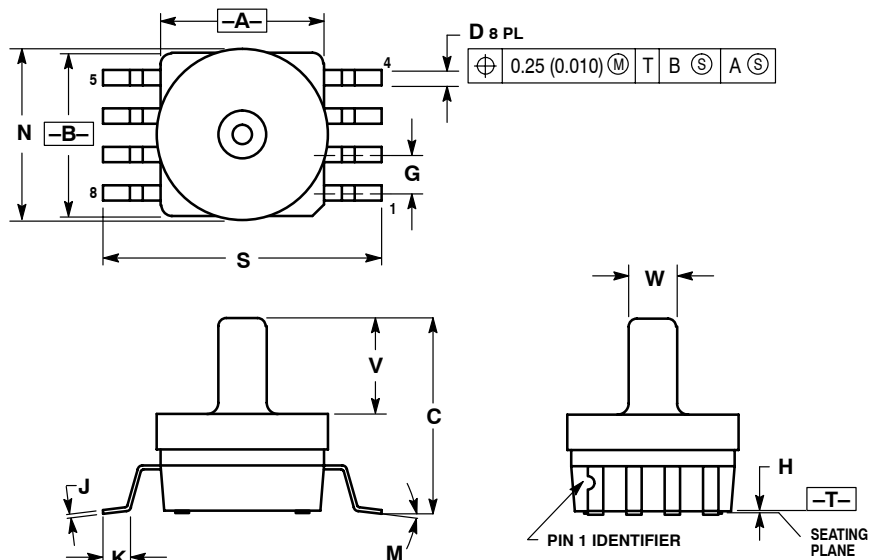


Figure 5. SOP Footprint

# PACKAGE DIMENSIONS



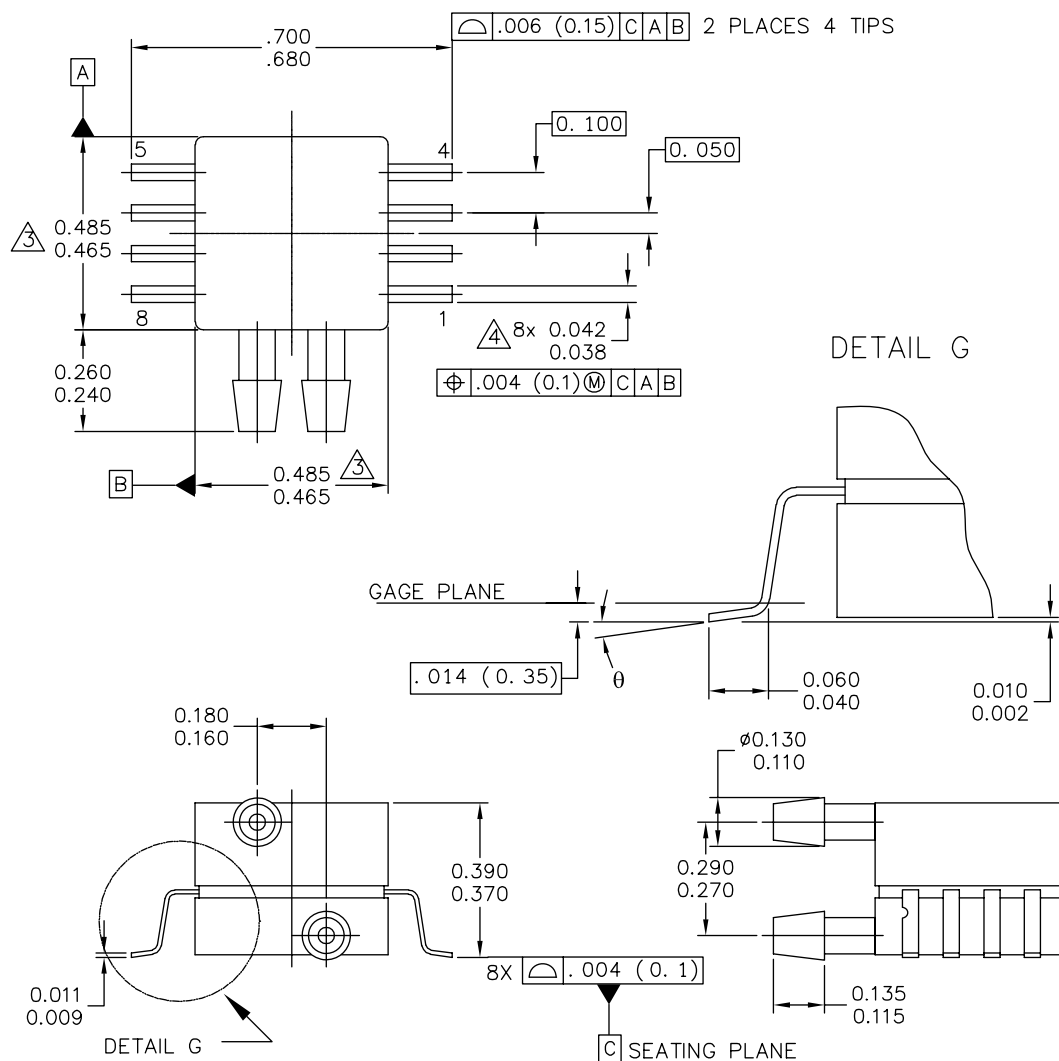
## NOTES:

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**

# PACKAGE DIMENSIONS



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

**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

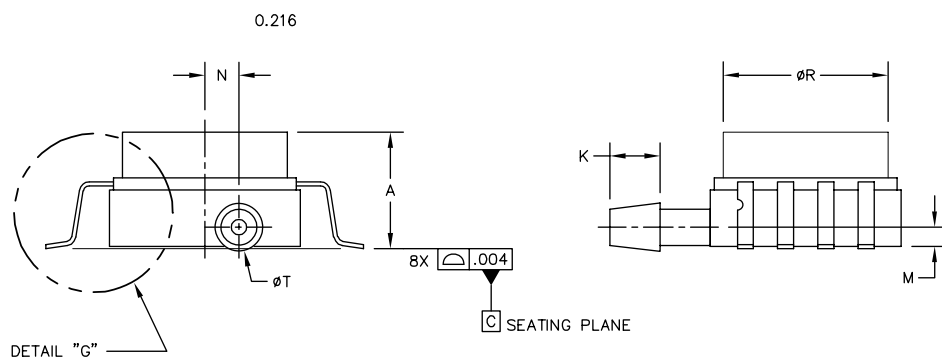
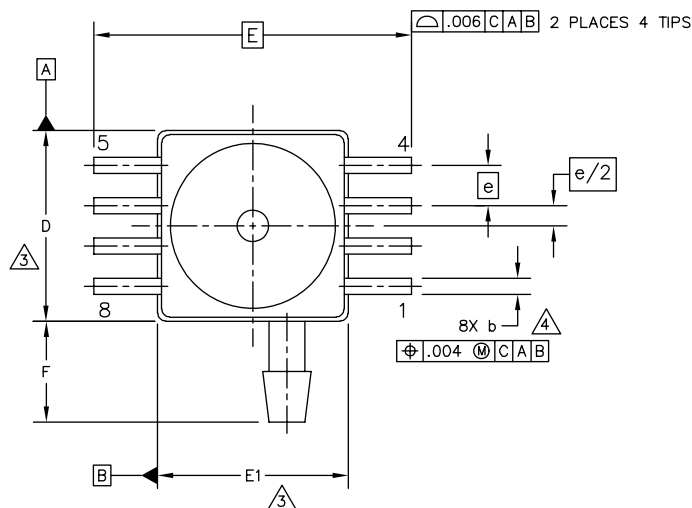
## STYLE 2:

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

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

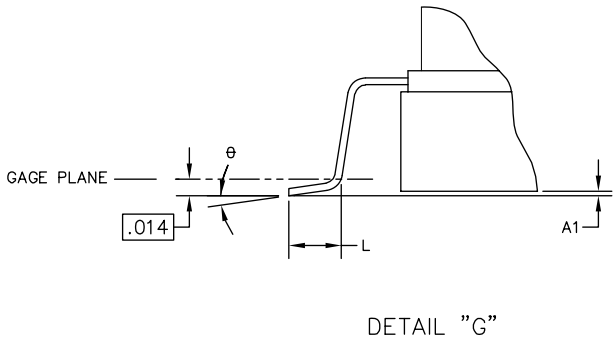
# PACKAGE DIMENSIONS



|                                                         |                           |                            |
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| TITLE:<br><br>8 LD SOP, GVP                             | DOCUMENT NO: 98ASA99302D  | REV: C                     |
|                                                         | CASE NUMBER: 1368-01      | 18 DEC 2008                |
|                                                         | STANDARD: NON-JEDEC       |                            |

## CASE 1368-01 ISSUE C SMALL OUTLINE PACKAGE

PACKAGE DIMENSIONS



|                                                         |  |                          |                            |
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| TITLE:<br><br>8 LD SOP, GVP                             |  | DOCUMENT NO: 98ASA99302D | REV: C                     |
|                                                         |  | CASE NUMBER: 1368-01     | 18 DEC 2008                |
|                                                         |  | STANDARD: NON-JEDEC      |                            |

CASE 1368-01  
ISSUE C  
SMALL OUTLINE PACKAGE

# PACKAGE DIMENSIONS

## NOTES:

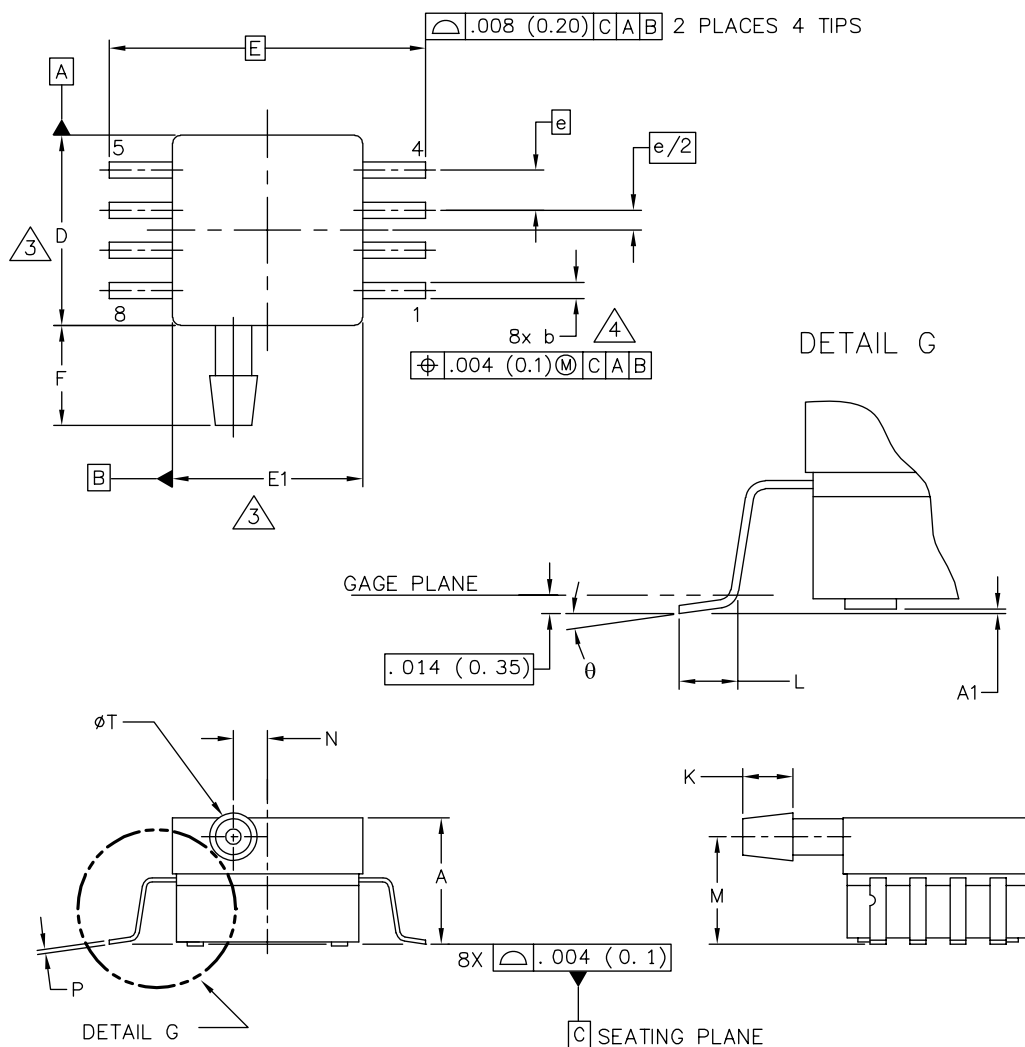
- CONTROLLING DIMENSION: INCH
  - INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
- THIS DIMENSIONS DOES NOT INCLUDE MOLD FLASH OR PPROTRUSIONS. MOLD FLASH AND PROTRUSIONS SHALL NOT EXCEED .006 PER SIDE.
- THIS DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .008 MAXIMUM.

|              |             |
|--------------|-------------|
| STYLE 1:     | STYLE 2:    |
| PIN 1: GND   | PIN 1: N/C  |
| PIN 2: +Vout | PIN 2: Vs   |
| PIN 3: Vs    | PIN 3: GND  |
| PIN 4: -Vout | PIN 4: Vout |
| PIN 5: N/C   | PIN 5: N/C  |
| PIN 6: N/C   | PIN 6: N/C  |
| PIN 7: N/C   | PIN 7: N/C  |
| PIN 8: N/C   | PIN 8: N/C  |

| INCHES                                                  |          |      | MILLIMETERS        |       | INCHES                   |                            |      | MILLIMETERS |       |
|---------------------------------------------------------|----------|------|--------------------|-------|--------------------------|----------------------------|------|-------------|-------|
| DIM                                                     | MIN      | MAX  | MIN                | MAX   | DIM                      | 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 | 11.81              | 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 | 0.89               | 1.39  | —                        | ---                        | ---  | ---         | ---   |
| N                                                       | .075     | .095 | 1.90               | 2.41  | —                        | ---                        | ---  | ---         | ---   |
| P                                                       | .009     | .011 | 0.23               | 0.28  | —                        | ---                        | ---  | ---         | ---   |
| T                                                       | .110     | .130 | 2.79               | 3.30  | —                        | ---                        | ---  | ---         | ---   |
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| TITLE:<br><br>8 LD SOP, GVP                             |          |      |                    |       | DOCUMENT NO: 98ASA99302D |                            |      | REV: C      |       |
|                                                         |          |      |                    |       | CASE NUMBER: 1368-01     |                            |      | 18 DEC 2008 |       |
|                                                         |          |      |                    |       | STANDARD: NON-JEDEC      |                            |      |             |       |

## CASE 1368-01 ISSUE C SMALL OUTLINE PACKAGE

# PACKAGE DIMENSIONS



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

## CASE 1369-01 ISSUE B SMALL OUTLINE PACKAGE

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Freescale Semiconductor, Inc.  
Technical Information Center, EL516  
2100 East Elliot Road  
Tempe, Arizona 85284  
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Freescale Halbleiter Deutschland GmbH  
Technical Information Center  
Schatzbogen 7  
81829 Muenchen, Germany  
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+49 89 92103 559 (German)  
+33 1 69 35 48 48 (French)  
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### **Japan:**

Freescale Semiconductor Japan Ltd.  
Headquarters  
ARCO Tower 15F  
1-8-1, Shimo-Meguro, Meguro-ku,  
Tokyo 153-0064  
Japan  
0120 191014 or +81 3 5437 9125  
[support.japan@freescale.com](mailto:support.japan@freescale.com)

### **Asia/Pacific:**

Freescale Semiconductor China Ltd.  
Exchange Building 23F  
No. 118 Jianguo Road  
Chaoyang District  
Beijing 100022  
China  
+86 010 5879 8000  
[support.asia@freescale.com](mailto:support.asia@freescale.com)

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Тел: +7 (812) 336 43 04 (многоканальный)

Email: [org@lifeelectronics.ru](mailto:org@lifeelectronics.ru)

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