

# Freescale Semiconductor

 MP3V5100  
 Rev 0, 4/2009

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

The MP3V5100 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 metallization, and bipolar processing to provide an accurate, high level analog output signal that is proportional to the applied pressure.

### Features

- 2.5% Maximum Error Over 0° to 85°C
- Ideally Suited for Microprocessor or Microcontroller-Based Systems
- Thermoplastic (PPS) Surface Mount Package
- Patented Silicon Shear Stress Strain Gauge
- Available in Differential and Gauge Configurations

## MP3V5100 Series

 0 to 100 kPa (0 to 14.5 psi)  
 0.1 to 3.1 V Output

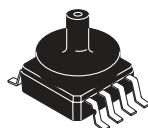
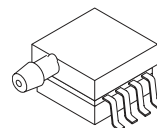
### Application Examples

- Process Control
- Patient Monitoring
- Pump/Motor Control
- Pressure Switching

### ORDERING INFORMATION

Device Name	Package Options	Case No.	# of Ports			Pressure Type			Device Marking
			None	Single	Dual	Gauge	Differential	Absolute	
<b>Small Outline Package (MP3V5100 Series)</b>									
MP3V5100GC6U	Rails	482A		•		•			MP3V5100G
MP3V5100GC6T1	Tape & Reel	482A		•		•			MP3V5100G
MP3V5100GP	Trays	1369		•		•			MP3V5100GP

### SMALL OUTLINE PACKAGE


 MP3V5100GC6U/C6T1  
 CASE 482A-01

 MP3V5100GP  
 CASE 1369-01

## Operating Characteristics

**Table 1. Operating Characteristics** ( $V_S = 3.0$  Vdc,  $T_A = 25^\circ\text{C}$  unless otherwise noted,  $P_1 > P_2$ . Decoupling circuit shown in Figure 3 required to meet specification.)

Characteristic	Symbol	Min	Typ	Max	Unit
Pressure Range <sup>(1)</sup>	$P_{OP}$	0	—	100	kPa
Supply Voltage <sup>(2)</sup>	$V_S$	2.7	3.0	3.3	Vdc
Supply Current	$I_o$	—	7.0	10	mAdc
Minimum Pressure Offset <sup>(3)</sup> @ $V_S = 3.0$ Volts	$V_{off}$	0.11	0.18	0.25	Vdc
Full Scale Output <sup>(4)</sup> @ $V_S = 3.0$ Volts	$V_{FSO}$	2.81	2.88	2.95	Vdc
Full Scale Span <sup>(5)</sup> @ $V_S = 3.0$ Volts	$V_{FSS}$	—	2.7	—	Vdc
Accuracy <sup>(6)</sup>	—	—	—	2.5	% $V_{FSS}$
Sensitivity	V/P	—	27	—	mV/kPa
Response Time <sup>(7)</sup>	$t_R$	—	1.0	—	ms
Output Source Current at Full Scale Output	$I_{O+}$	—	0.1	—	mAdc
Warm-Up Time <sup>(8)</sup>	—	—	20	—	ms
Offset Stability <sup>(9)</sup>	—	—	±0.5	—	% $V_{FSS}$

- 1.0 kPa (kiloPascal) equals 0.145 psi.
- Device is ratiometric within this specified excitation range.
- Offset ( $V_{off}$ ) is defined as the output voltage at the minimum rated pressure.
- Full Scale Output ( $V_{FSO}$ ) is defined as the output voltage at the maximum or full rated pressure.
- Full Scale Span ( $V_{FSS}$ ) 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  $25^\circ\text{C}$ .
  - TcSpan: Output deviation over the temperature range of  $0^\circ$  to  $85^\circ\text{C}$ , relative to  $25^\circ\text{C}$ .
  - TcOffset: Output deviation with minimum rated pressure applied, over the temperature range of  $0^\circ$  to  $85^\circ\text{C}$ , relative to  $25^\circ\text{C}$ .
  - Variation from Nominal: The variation from nominal values, for Offset or Full Scale Span, as a percent of  $V_{FSS}$ , at  $25^\circ\text{C}$ .
- 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.

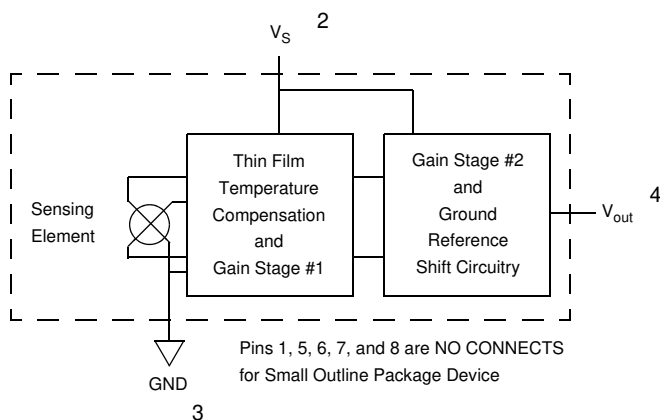
## Maximum Ratings

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

Rating	Symbol	Value	Unit
Maximum Pressure (P1 > P2)	$P_{max}$	400	kPa
Storage Temperature	$T_{stg}$	-40 to +125	°C
Operating Temperature	$T_A$	-40 to +125	°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. Integrated Pressure Sensor Schematic**

## 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.

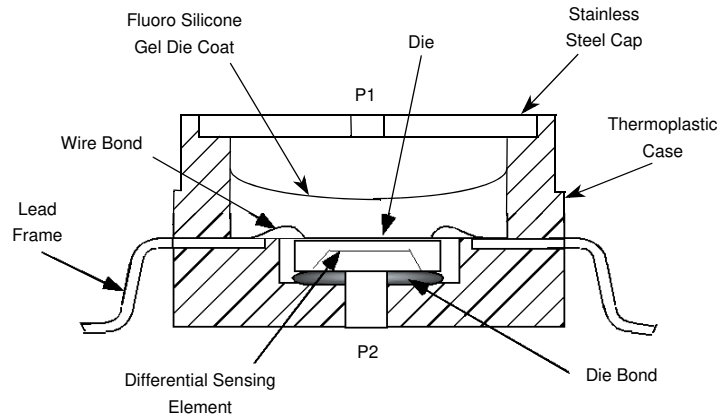
Figure 2 illustrates the Differential or Gauge configuration in the basic chip carrier (Case 482). A fluorosilicone gel isolates the die surface and wire bonds from the environment, while allowing the pressure signal to be transmitted to the sensor diaphragm.

The MP3V5100 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

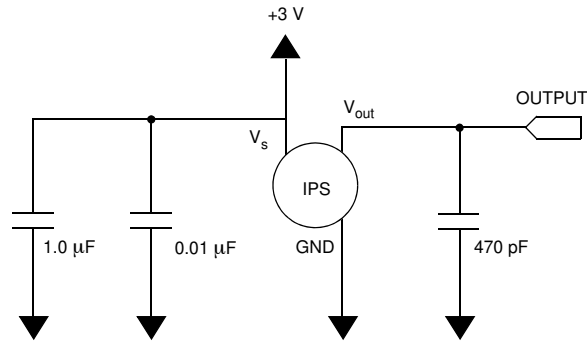
performance and long-term reliability. Contact the factory for information regarding media compatibility in your application.

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 3. 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.)**

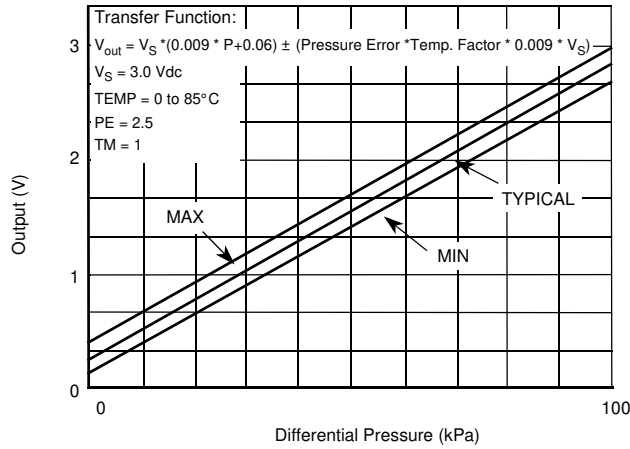


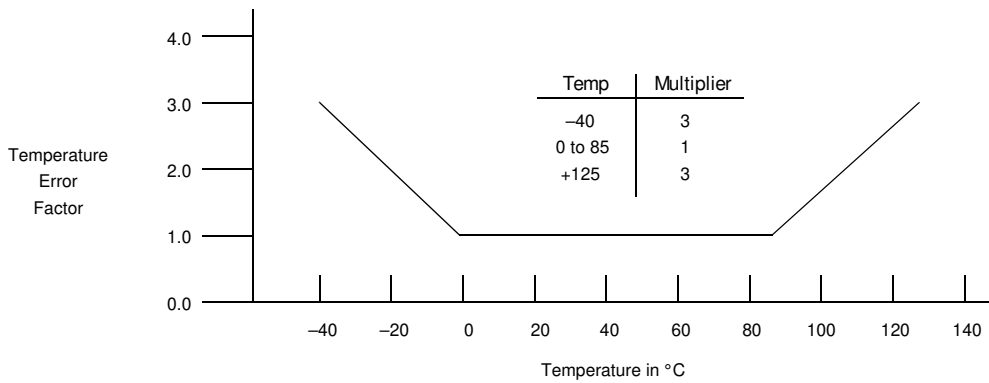
Figure 4. Output versus Pressure Differential

Transfer Function

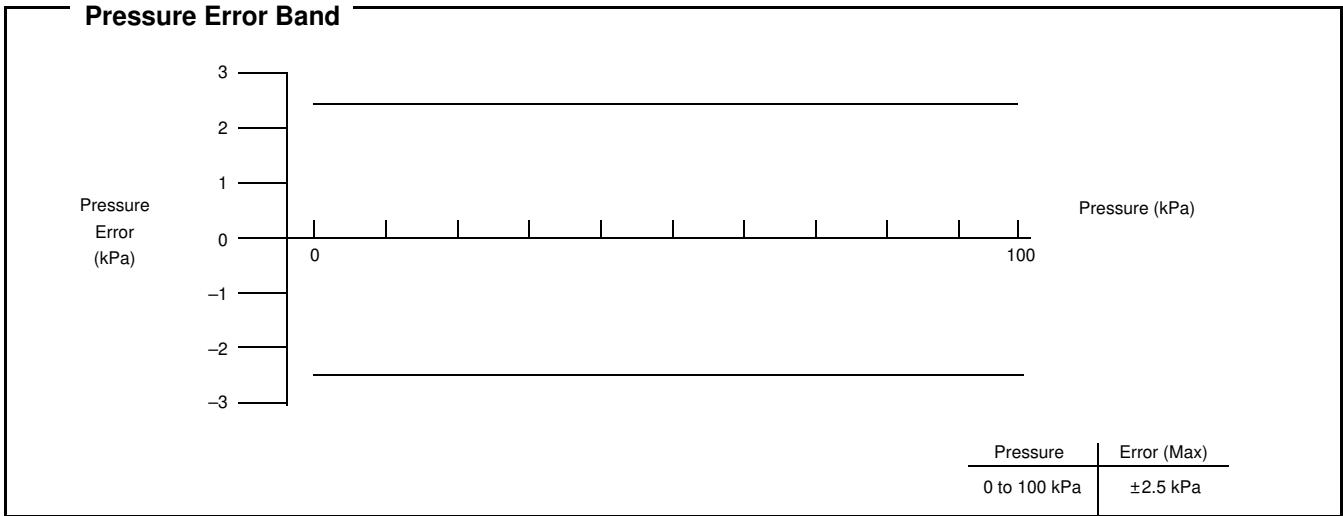
**Nominal Transfer Value:**  $V_{out} = V_S \times (0.009 \times P + 0.06)$   
 $\pm (\text{Pressure Error} \times \text{Temp. Factor} \times 0.009 \times V_S)$   
 $V_S = 3.0 \text{ V} \pm 0.30 \text{ Vdc}$

Temperature Error Band

MP3V5100 SERIES



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



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

Freescale 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 pressure

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

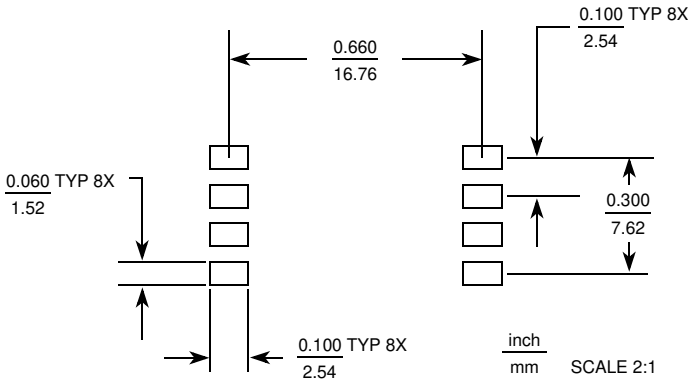
The Pressure (P1) side may be identified by using the following table:

Part Number	Case Type	Pressure (P1) Side Identifier
MP3V5100GC6U/C6T1	482A	Side with Port Attached
MP3V5100GP	1369	Side with Port Attached

**MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS**

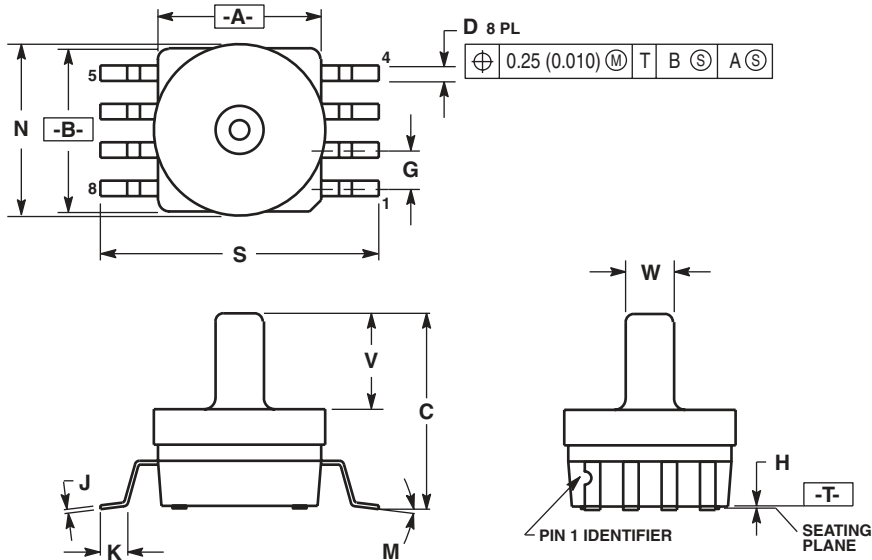
Surface mount board layout is a critical portion of the total design. The footprint for the surface mount packages must be the correct size to ensure proper solder connection interface between the board and the package. With the correct

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. Small Outline Package Footprint**

### PACKAGE DIMENSIONS

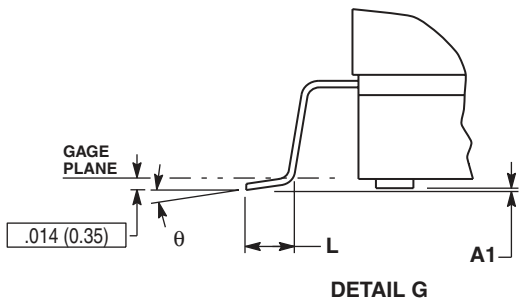
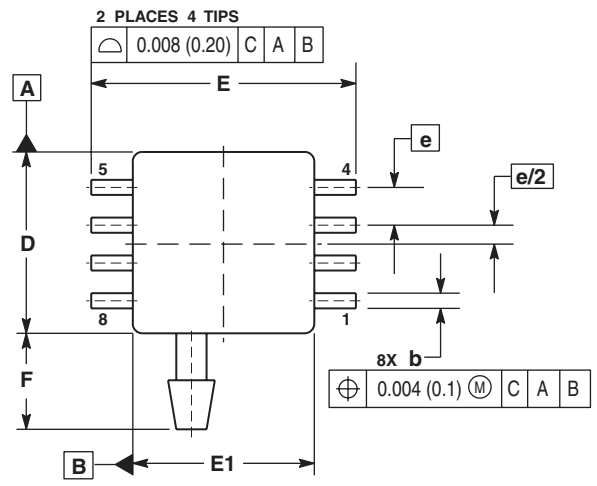


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
  5. ALL VERTICAL SURFACES 5° TYPICAL DRAFT.

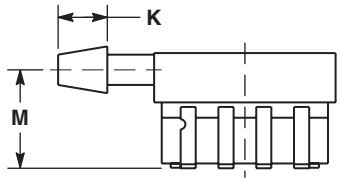
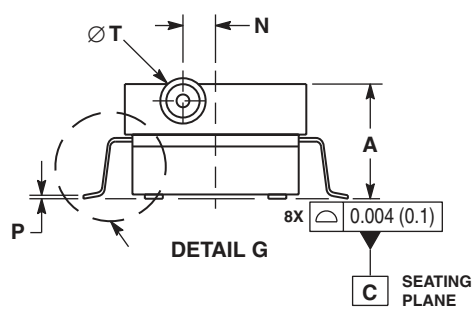
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.415	0.425	10.54	10.79
B	0.415	0.425	10.54	10.79
C	0.500	0.520	12.70	13.21
D	0.038	0.042	0.96	1.07
G	0.100 BSC		2.54 BSC	
H	0.002	0.010	0.05	0.25
J	0.009	0.011	0.23	0.28
K	0.061	0.071	1.55	1.80
M	0'	7'	0'	7'
N	0.444	0.448	11.28	11.38
S	0.709	0.725	18.01	18.41
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**



- 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  
 SMALL OUTLINE PACKAGE**



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