## **Freescale Semiconductor**

MP3V5050 Rev 1, 11/2009

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

The MP3V5050 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 patented, single element 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.

# MP3V5050 Series

0 to 50 kPa (0 to 7.25 psi) 0.06 to 2.82 V Output

#### **Features**

- 2.5% Maximum Error over 0° to 85°C
- Ideally suited for Microprocessor or Microcontroller-Based Systems
- Temperature Compensated Over -40° to +125°C
- Patented Silicon Shear Stress Strain Gauge
- · Thermoplastic (PPS) Surface Mount Package
- · Multiple Porting Options for Design Flexibility
- · Barbed Side Ports for Robust Tube Connection

| ORDERING INFORMATION  |   |            |        |      |               |              |          |           |  |
|-----------------------|---|------------|--------|------|---------------|--------------|----------|-----------|--|
| Davies News           | Case                                    | # of Ports |        |      | Pressure Type |              |          | Device    |  |
| Device Name           | No.                                     | None       | Single | Dual | Gauge         | Differential | Absolute | Marking   |  |
| Small Outline Package | Small Outline Package (MP3V5050 Series) |            |        |      |               |              |          |           |  |
| MP3V5050DP            | 1351                                    |            |        | •    |               | •            |          | MP3V5050G |  |
| MP3V5050GP            | 1369                                    |            | •      |      | •             |              |          | MP3V5050G |  |
| MP3V5050GC6U          | 482A                                    |            | •      |      | •             |              |          | MP3V5050G |  |
| MP3V5050GC6T1         | 482A                                    |            | •      |      | •             |              |          | MP3V5050G |  |

#### **SMALL OUTLINE PACKAGES**



MP3V5050GC6U/6T1 CASE 482A-01



MP3V5050DP CASE 1351-01



MP3V5050GP CASE 1369-01



### **Operating Characteristics**

**Table 1. Operating Characteristics** ( $V_S = 3.0 \text{ Vdc}$ ,  $T_A = 25^{\circ}\text{C}$  unless otherwise noted, P1 > P2. Decoupling circuit shown in Figure 4 required to meet electrical specifications.)

| Characteristic  |             | Symbol           | Min   | Тур  | Max   | Unit              |
|---|-------------|------------------|-------|------|-------|-------------------|
| Pressure Range <sup>(1)</sup>                                       |             | P <sub>OP</sub>  | 0     | _    | 50    | kPa               |
| Supply Voltage <sup>(2)</sup>                                       |             | V <sub>S</sub>   | 2.7   | 3.0  | 3.3   | Vdc               |
| Supply Current  |             | I <sub>o</sub>   | _     | 7.0  | 10    | mAdc              |
| Minimum Pressure Offset <sup>(3)</sup> @ V <sub>S</sub> = 3.0 Volts | (0 to 85°C) | V <sub>off</sub> | 0.053 | 0.12 | 0.188 | Vdc               |
| Full Scale Output <sup>(4)</sup> $@V_S = 3.0 \text{ Volts}$         | (0 to 85°C) | V <sub>FSO</sub> | 2.752 | 2.8  | 2.888 | Vdc               |
| Full Scale Span <sup>(5)</sup><br>@ V <sub>S</sub> = 3.0 Volts      | (0 to 85°C) | V <sub>FSS</sub> | _     | 2.7  | _     | Vdc               |
| Accuracy <sup>(6)</sup>   | (0 to 85°C) | _                | _     | _    | ±2.5  | %V <sub>FSS</sub> |
| Sensitivity   |             | V/P              | _     | 54   | _     | 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> |

- 1.1.0 kPa (kiloPascal) equals 0.145 psi.
- 2. Device is ratiometric within this specified excitation range.
- 3. Offset ( $V_{\text{off}}$ ) is defined as the output voltage at the minimum rated pressure.
- 4.Full Scale Output ( $V_{\mbox{FSO}}$ ) is defined as the output voltage at the maximum or full rated pressure.
- 5. 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.
- 6. 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 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.

- 7. 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.
- 8. Warm-up Time is defined as the time required for the product to meet the specified output voltage after the Pressure has been stabilized.
- 9. 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 <sub>max</sub> | 200           | kPa  |
| Storage Temperature        | T <sub>stg</sub> | -40° to +125° | °C   |
| Operating Temperature      | T <sub>A</sub>   | -40° to +125° | °C   |

<sup>1.</sup> 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.

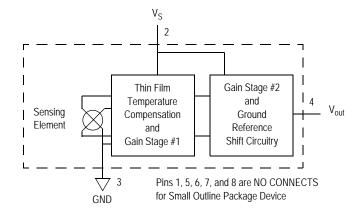


Figure 1. Fully Integrated Pressure Sensor Schematic

### **On-chip Temperature Compensation and Calibration**

Figure 3 illustrates the Differential/Gauge Sensing Chip 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 sensor diaphragm.

The MP3V5050 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 2 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 4 shows the recommended decoupling circuit for interfacing the output of the integrated sensor to the A/D input of a microprocessor or microcontroller. Proper decoupling of the power supply is recommended.

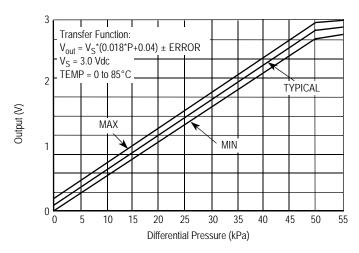


Figure 2. Output vs. Pressure Differential

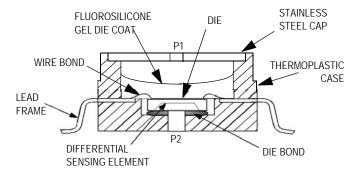


Figure 3. Cross-Sectional Diagram SOP (not to scale)

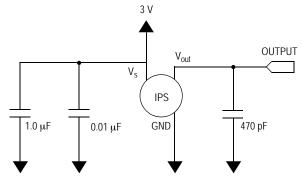


Figure 4. Recommended Power Supply Decoupling and Output Filtering (For additional output filtering, please refer to Application Note AN1646)

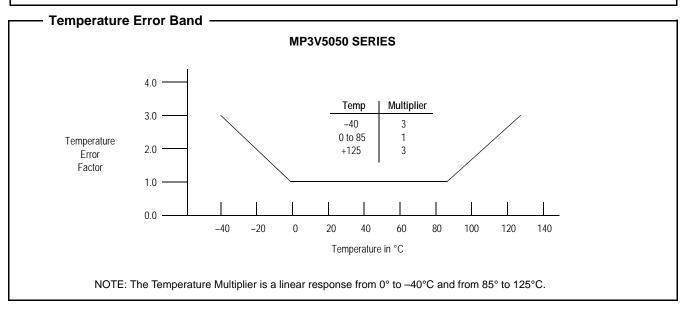
#### PRESSURE (P1)/VACUUM (P2) SIDE IDENTIFICATION TABLE

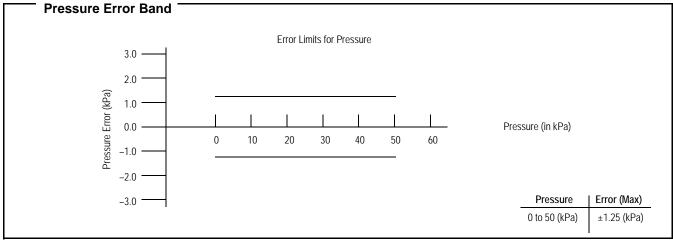
#### Transfer Function

**Nominal Transfer Value:**  $V_{out} = V_{S} (P \times 0.018 + 0.04)$ 

± (Pressure Error x Temp. Factor x 0.018 x V<sub>S</sub>)

 $V_S = 3.0 \text{ V} \pm 0.30 \text{ Vdc}$ 





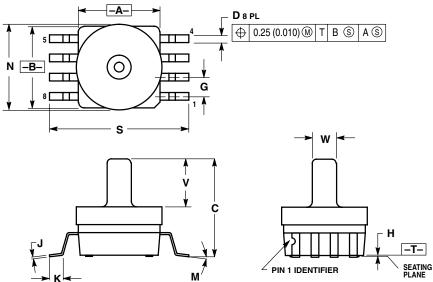
#### PRESSURE (P1)/VACUUM (P2) SIDE IDENTIFICATION TABLE

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 fluorosilicone gel which protects the die from

harsh media. The MP3V 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:

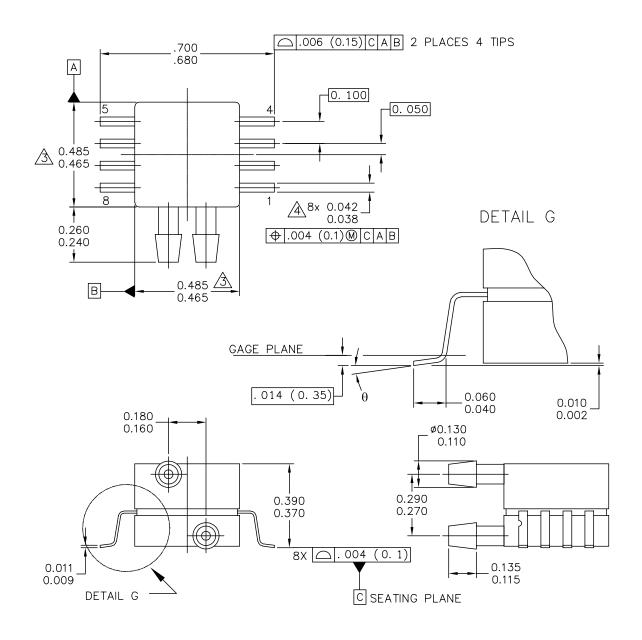
| Part Number     | Case Type | Pressure (P1) Side Identifier |
|-----------------|-----------|-------------------------------|
| MP3V5050GP      | 1369      | Side with Port Attached       |
| MP3V5050DP      | 1351      | Side with Part Marking        |
| MP3V5050GC6U/T1 | 482A      | Vertical Port Attached        |



- 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.

|     | INC   | HES   | MILLIN   | IETERS |  |
|-----|-------|-------|----------|--------|--|
| DIM | MIN   | MAX   | MIN      | MAX    |  |
| Α   | 0.415 | 0.425 | 10.54    | 10.79  |  |
| В   | 0.415 | 0.425 | 10.54    | 10.79  |  |
| С   | 0.500 | 0.520 | 12.70    | 13.21  |  |
| D   | 0.038 | 0.042 | 0.96     | 1.07   |  |
| G   | 0.100 | BSC   | 2.54 BSC |        |  |
| Н   | 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   |  |
| М   | 0°    | 7°    | 0°       | 7 °    |  |
| N   | 0.444 | 0.448 | 11.28    | 11.38  |  |
| S   | 0.709 | 0.725 | 18.01    | 18.41  |  |
| ٧   | 0.245 | 0.255 | 6.22     | 6.48   |  |
| W   | 0.115 | 0.125 | 2.92     | 3.17   |  |

**CASE 482A-01 ISSUE A UNIBODY PACKAGE** 



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| TITLE:   |           | DOCUMENT NO  | ): 98ASA99255D   | REV: A               |  |
| 8 LD SNSR. DUAL PO                                   | PORT      | CASE NUMBER  | R: 1351–01       | 27 JUL 2005          |  |
| 3 23 3 (6), 7  |           | STANDARD: NO | N-JEDEC          |                      |  |

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CASE 1351-01 ISSUE A SMALL OUTLINE PACKAGE

#### NOTES:

- 1. CONTROLLING DIMENSION: INCH
- 2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.

DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PPROTRUSIONS.

MOLD FLASH AND PROTRUSIONS SHALL NOT EXCEED .006 PER SIDE.

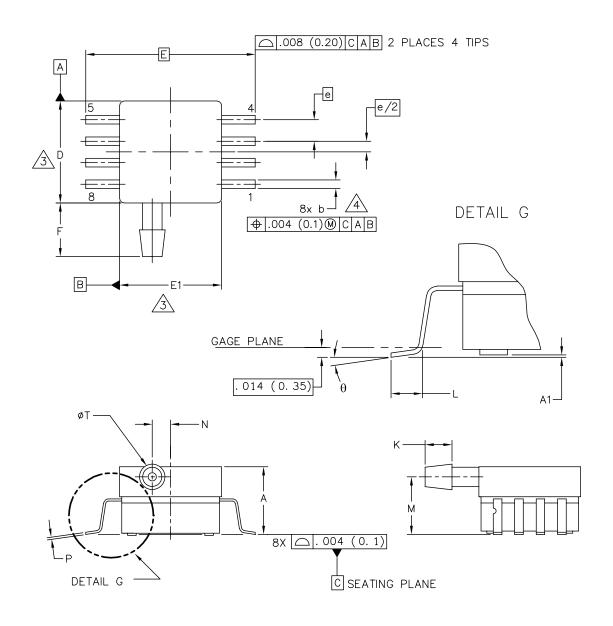
4 DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .008 MAXIMUM.

| STYLE 1: |       | STYLE 2: |    |      |
|----------|-------|----------|----|------|
| PIN 1:   | GND   | PIN      | 1: | N/C  |
| PIN 2:   | +Vout | PIN      | 2: | ٧s   |
| 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  |

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| 8 LD SNSR, DUAL                                      | PORT      | CASE NUMBER  | R: 1351–01       | 27 JUL 2005 |
|  |           | STANDARD: NO | N-JEDEC          |             |

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CASE 1351-01 ISSUE A SMALL OUTLINE PACKAGE



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| TITLE:   | DOCUMENT N         | 0: 98ASA99303D                  | REV: B      |  |  |
| 8 LD SOP, SIDE PO                                    | ORT CASE NUMBE     | CASE NUMBER: 1369-01 24 MAY 200 |             |  |  |
|  | STANDARD: N        | ON-JEDEC                        |             |  |  |

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#### CASE 1369-01 ISSUE B SMALL OUTLINE PACKAGE

#### NOTES:

- 1. CONTROLLING DIMENSION: INCH
- 2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
- △ DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PPROTRUSIONS.

  MOLD FLASH AND PROTRUSIONS SHALL NOT EXCEED .006 (0.152) PER SIDE.
- DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .008 (0.203) MAXIMUM.

|                     | ING   | CHES         | MIL    | LIMETERS   |      | I         | NCHES         | ΜI      | MILLIMETERS |  |
|---------------------|---|--------------|--------|------------|------|-----------|---------------|---------|-------------|--|
| DIM                 | MIN   | MAX          | MIN    | MAX        | DIM  | MIN       | MAX           | MIN     | MAX         |  |
| A                   | . 300   | . 330        | 7. 11  | 7. 62      | θ    | 0,        | 7 <b>°</b>    | 0°      | 7 <b>°</b>  |  |
| A 1                 | . 002   | . 010        | 0. 05  | 0. 25      | _    |           |               |         |             |  |
| b                   | . 038   | . 042        | 0. 96  | 1. 07      | _    |           |               |         |             |  |
| D                   | . 465   | . 485        | 11. 81 | 12. 32     | -    |           |               |         |             |  |
| E                   | . 717   | 7 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      | _    |           |               |         |             |  |
| М                   | . 270   | . 290        | 6. 86  | 7. 36      | _    |           |               |         |             |  |
| N                   | . 080   | . 090        | 2. 03  | 2. 28      | -    |           |               |         |             |  |
| Р                   | . 009   | . 011        | 0. 23  | 0. 28      | _    |           |               |         |             |  |
| Т                   | . 115   | . 125        | 2. 92  | 3. 17      | _    |           |               |         |             |  |
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| TITL                | TITLE:  |              |        |            |      | JMENT NO  | ): 98ASA99303 | 3D      | REV: B      |  |
| 8 LD SOP, SIDE PORT |   |              |        |            | CASI | E NUMBEF  | R: 1369–01    |         | 24 MAY 2005 |  |
|                     | ,   |              |        |            |      | NDARD: NO | N-JEDEC       |         |             |  |
|                     |   |              |        |            |      |           |               |         |             |  |

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