Pressure

Freescale Semiconductor

50 kPa On-Chip Temperature Compensated and Calibrated Silicon Pressure Sensors

The MPX2050 series devices are silicon piezoresistive pressure sensors providing a highly accurate and linear voltage output, directly proportional to the applied pressure. The sensor is a single, monolithic silicon diaphragm with the strain gauge and a thin-film resistor network integrated on-chip. The chip is laser trimmed for precise span and offset calibration and temperature compensation.

Features

- Temperature Compensated Over 0°C to +85°C
- Unique Silicon Shear Stress Strain Gauge
- · Easy to Use Chip Carrier Package Options
- Ratiometric to Supply Voltage
- Differential and Gauge Options
- ±0.25% Linearity

MPX2050 Rev 9, 10/2008

MPX2050 Series

0 to 50 kPa (0 to 7.25 psi) 40 mV Full Scale Span (Typical)

Application Examples

- Pump/Motor Controllers
- Robotics
- Level Indicators
- Medical Diagnostics
- Pressure Switching
- Non-Invasive Blood Pressure

| ORDERING INFORMATION | | | | | | | | | |
|----------------------|----------------------------------|--------------|------------|--------|---------------|-------|--------------|----------------|----------------|
| Device Name | Package | Package Case | # of Ports | | Pressure Type | | | Davias Marking | |
| Device Name Options | | ns No. | None | Single | Dual | Gauge | Differential | Absolute | Device Marking |
| Unibody Packa | Unibody Package (MPX2050 Series) | | | | | | | | |
| MPX2050D | Tray | 344 | • | | | | • | | MPX2050D |
| MPX2050GP | Tray | 344B | | • | | • | | | MPX2050GP |
| MPX2050DP | Tray | 344C | | | • | | • | | MPX2050DP |
| MPX2050GSX | Tray | 344F | | • | | • | | | MPX2050D |

PACKAGES



MPX2050D CASE 344-15



MPX2050GP CASE 344B-01



MPX2050DP CASE 344C-01



MPX2050GSX CASE 344F-01



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Figure 1 shows a block diagram of the internal circuitry on the stand-alone pressure sensor chip.

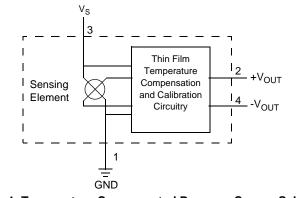


Figure 1. Temperature Compensated Pressure Sensor Schematic

Voltage Output versus Applied Differential Pressure

The differential voltage output of the sensor is directly proportional to the differential pressure applied.

The output voltage of the differential or gauge sensor increases with increasing pressure applied to the pressure side (P1) relative to the vacuum side (P2). Similarly, output voltage increases as increasing vacuum is applied to the vacuum side (P2) relative to the pressure side (P1).

Operating Characteristics

Table 1. Operating Characteristics

 $(V_S = 10 \text{ Vdc}, T_A = 25^{\circ}\text{C} \text{ unless otherwise noted}, P1 > P2)$

| Characteristics | Symbol | Min | Тур | Max | Unit |
|---|--------------------|-------|------|------|-------------------|
| Pressure Range ⁽¹⁾ | P _{OP} | 0 | — | 50 | kPa |
| Supply Voltage ⁽²⁾ | V _S | | 10 | 16 | Vdc |
| Supply Current | ۱ _o | | 6.0 | | mAdc |
| Full Scale Span ⁽³⁾ | V _{FSS} | 38.5 | 40 | 41.5 | mV |
| Offset ⁽⁴⁾ | V _{off} | -1.0 | — | 1.0 | mV |
| Sensitivity | ΔV/ΔΡ | | 0.8 | | mV/kPa |
| Linearity ⁽⁵⁾ | — | -0.25 | _ | 0.25 | %V _{FSS} |
| Pressure Hysteresis ⁽⁵⁾ (0 to 50 kPa) | — | — | ±0.1 | _ | %V _{FSS} |
| Temperature Hysteresis ⁽⁵⁾ (-40°C to +125°C) | — | | ±0.5 | _ | %V _{FSS} |
| Temperature Effect on Full Scale Span ⁽⁵⁾ | TCV _{FSS} | -1.0 | - | 1.0 | %V _{FSS} |
| Temperature Effect on Offset ⁽⁵⁾ | TCV _{off} | -1.0 | - | 1.0 | mV |
| Input Impedance | Z _{in} | 1000 | - | 2500 | Ω |
| Output Impedance | Z _{out} | 1400 | - | 3000 | Ω |
| Response Time ⁽⁶⁾ (10% to 90%) | t _R | | 1.0 | _ | ms |
| Warm-Up | — | _ | 20 | | ms |
| Offset Stability ⁽⁷⁾ | - | — | ±0.5 | — | %V _{FSS} |

1. 1.0 kPa (kiloPascal) equals 0.145 psi.

2. Device is ratiometric within this specified excitation range. Operating the device above the specified excitation range may induce additional error due to device self-heating.

3. 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.

- 4. Offset (V_{off}) is defined as the output voltage at the minimum rated pressure.
- 5. Accuracy (error budget) consists of the following:

Linearity:Output deviation from a straight line relationship with pressure, using end point method, 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 at full rated pressure over the temperature range of 0 to 85°C, relative to 25°C.

TcOffset:Output deviation with minimum rated pressure applied, over the temperature range of 0 to 85°C, relative to 25°C.

6. 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.

7. 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⁽¹⁾

| Rating | Symbol | Value | Unit |
|----------------------------|------------------|-------------|------|
| Maximum Pressure (P1 > P2) | P _{max} | 200 | 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.

LINEARITY

Linearity refers to how well a transducer's output follows the equation: $V_{out} = V_{off}$ + sensitivity x P over the operating pressure range. There are two basic methods for calculating nonlinearity: (1) end point straight line fit (see Figure 2) or (2) a least squares best line fit. While a least squares fit gives the "best case" linearity error (lower numerical value), the calculations required are burdensome.

Conversely, an end point fit will give the "worst case" error (often more desirable in error budget calculations) and the calculations are more straightforward for the user. Motorola's specified pressure sensor linearities are based on the end point straight line method measured at the midrange pressure.

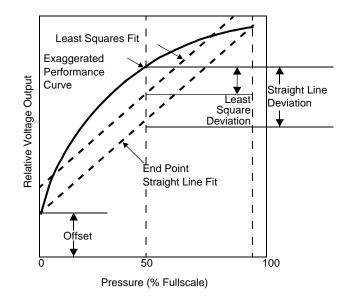


Figure 2. Linearity Specification Comparison

On-Chip Temperature Compensation and Calibration

Figure 3 shows the minimum, maximum and typical output characteristics of the MPX2050 series at 25°C. The output is directly proportional to the differential pressure and is essentially a straight line.

The effects of temperature on Full-Scale Span and Offset are very small and are shown under Operating Characteristics.

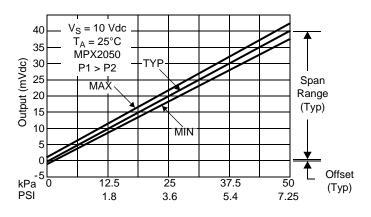


Figure 3. Output versus Pressure Differential

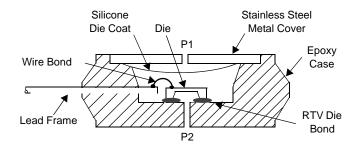




Figure 4 illustrates the differential or gauge configuration in the basic chip carrier (Case 344). A silicone gel isolates the die surface and wire bonds from the environment, while allowing the pressure signal to be transmitted to the silicon diaphragm. The MPX2050 series pressure sensor operating characteristics 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.

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 the silicone gel which isolates the die. The pressure sensor is designed to operate with positive differential pressure applied, P1 > P2.

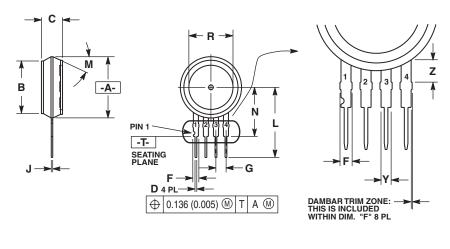
The Pressure (P1) side may be identified by using the following table.

Table 3. Pressure (P1) Side Delineation

| Part Number | Case Type | Pressure (P1) Side Identifier |
|-------------|-----------|----------------------------------|
| MPX2050D | 344 | Stainless Steel Cap |
| MPX2050DP | 344C | Side with Part Marking |
| MPX2050GP | 344B | Side with Port Attached |
| MPX2050GSX | 344F | Side with Port Attached |

Pressure

PACKAGE DIMENSIONS



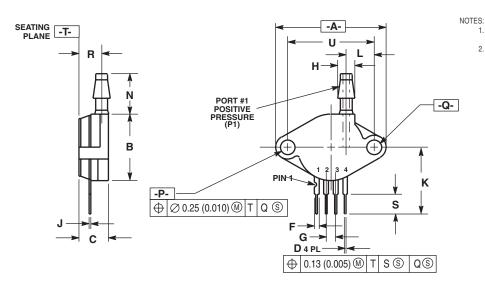
| NOTES: | | |
|--------|--------------|---|
| 4 | DIMENCIONING | 1 |

- ONING AND TOLERANCING PER ASME 1. DIMEN

DIMENSIONING AND TOLERANDING PER ASME Y14.5M, 1994.
CONTROLLING DIMENSION: INCH.
DIMENSION -A- IS INCLUSIVE OF THE MOLD STOP RING. MOLD STOP RING NOT TO EXCEED 16.00 (0.630).

| | INC | HES | MILLIMETER | | |
|-----|-----------|-------|------------|-------|--|
| DIM | MIN | MAX | MIN | MAX | |
| Α | 0.595 | 0.630 | 15.11 | 16.00 | |
| В | 0.514 | 0.534 | 13.06 | 13.56 | |
| С | 0.200 | 0.220 | 5.08 | 5.59 | |
| D | 0.016 | 0.020 | 0.41 | 0.51 | |
| F | 0.048 | 0.064 | 1.22 | 1.63 | |
| G | 0.100 BSC | | 2.54 BSC | | |
| J | 0.014 | 0.016 | 0.36 | 0.40 | |
| L | 0.695 | 0.725 | 17.65 | 18.42 | |
| Μ | 30° | NOM | 30° I | MON | |
| Ν | 0.475 | 0.495 | 12.07 | 12.57 | |
| R | 0.430 | 0.450 | 10.92 | 11.43 | |
| Υ | 0.048 | 0.052 | 1.22 | 1.32 | |
| Z | 0.106 | 0.118 | 2.68 | 3.00 | |

CASE 344-15 **ISSUE AA UNIBODY PACKAGE**



DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982. 1.

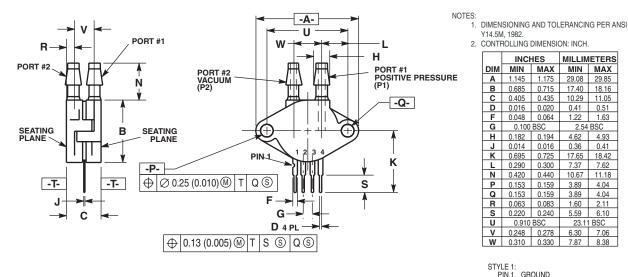
2. CONTROLLING DIMENSION: INCH.

| | INC | HES | MILLIMETERS | | |
|-----|-------|-------|-------------|-------|--|
| DIM | MIN | MAX | MIN | MAX | |
| Α | 1.145 | 1.175 | 29.08 | 29.85 | |
| В | 0.685 | 0.715 | 17.40 | 18.16 | |
| С | 0.305 | 0.325 | 7.75 | 8.26 | |
| D | 0.016 | 0.020 | 0.41 | 0.51 | |
| F | 0.048 | 0.064 | 1.22 | 1.63 | |
| G | 0.10 |) BSC | 2.54 BSC | | |
| н | 0.182 | 0.194 | 4.62 | 4.93 | |
| J | 0.014 | 0.016 | 0.36 | 0.41 | |
| K | 0.695 | 0.725 | 17.65 | 18.42 | |
| L | 0.290 | 0.300 | 7.37 | 7.62 | |
| Ν | 0.420 | 0.440 | 10.67 | 11.18 | |
| Р | 0.153 | 0.159 | 3.89 | 4.04 | |
| Q | 0.153 | 0.159 | 3.89 | 4.04 | |
| R | 0.230 | 0.250 | 5.84 | 6.35 | |
| S | 0.220 | 0.240 | 5.59 | 6.10 | |
| U | 0.910 |) BSC | 23.11 | I BSC | |

STYLE 1: PIN 1. GROUND 2. + OUTPUT 3. + SUPPLY 4. - OUTPUT

CASE 344B-01 ISSUE B UNIBODY PACKAGE

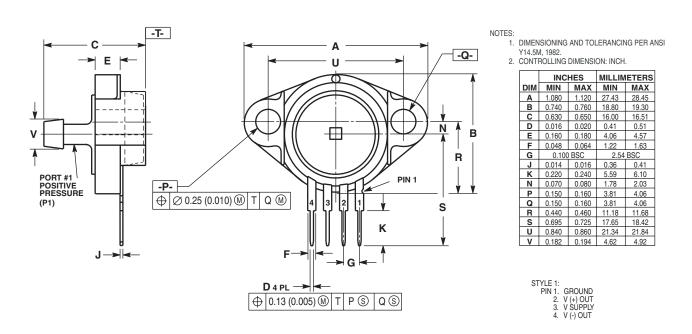
PACKAGE DIMENSIONS



| | INC | IES | MILLIMETERS | | |
|-----|-----------|-------|-------------|-------|--|
| DIM | MIN | MAX | MIN | MAX | |
| Α | 1.145 | 1.175 | 29.08 | 29.85 | |
| В | 0.685 | 0.715 | 17.40 | 18.16 | |
| С | 0.405 | 0.435 | 10.29 | 11.05 | |
| D | 0.016 | 0.020 | 0.41 | 0.51 | |
| F | 0.048 | 0.064 | 1.22 | 1.63 | |
| G | 0.100 BSC | | 2.54 | BSC | |
| н | 0.182 | 0.194 | 4.62 | 4.93 | |
| J | 0.014 | 0.016 | 0.36 | 0.41 | |
| К | 0.695 | 0.725 | 17.65 | 18.42 | |
| L | 0.290 | 0.300 | 7.37 | 7.62 | |
| Ν | 0.420 | 0.440 | 10.67 | 11.18 | |
| Р | 0.153 | 0.159 | 3.89 | 4.04 | |
| Q | 0.153 | 0.159 | 3.89 | 4.04 | |
| R | 0.063 | 0.083 | 1.60 | 2.11 | |
| S | 0.220 | 0.240 | 5.59 | 6.10 | |
| U | 0.910 | BSC | 23.11 | BSC | |
| V | 0.248 | 0.278 | 6.30 | 7.06 | |
| w | 0.310 | 0.330 | 7.87 | 8.38 | |

STYLE 1: PIN 1. GROUND 2. + OUTPUT 3. + SUPPLY 4. - OUTPUT

CASE 344C-01 ISSUE B UNIBODY PACKAGE



CASE 344F-01 **ISSUE B UNIBODY PACKAGE**

MPX2050

How to Reach Us:

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Web Support: http://www.freescale.com/support

USA/Europe or Locations Not Listed:

Freescale Semiconductor, Inc. Technical Information Center, EL516 2100 East Elliot Road Tempe, Arizona 85284 1-800-521-6274 or +1-480-768-2130 www.freescale.com/support

Europe, Middle East, and Africa:

Freescale Halbleiter Deutschland GmbH Technical Information Center Schatzbogen 7 81829 Muenchen, Germany +44 1296 380 456 (English) +46 8 52200080 (English) +49 89 92103 559 (German) +33 1 69 35 48 48 (French) www.freescale.com/support

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

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

For Literature Requests Only:

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