# Freescale Semiconductor

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

The MPXM2051G device is a silicon piezoresistive pressure sensor 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
- Available in Easy-to-Use Tape & Reel
- Ratiometric to Supply Voltage
- Gauge Ported

## MPXM2051G 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 Measurement

## ORDERING INFORMATION

| Device Name | Case No. | # of Ports | | | Pressure Type | | | Device Marking |
|---|---|---|---|---|---|---|---|---|
| | | None | Single | Dual | Gauge | Differential | Absolute | |
| **MPAK Package (MPXM2051 Series)** | | | | | | | | |
| MPXM2051GS | 1320A | | • | | • | | | MPXM2051GS |
| MPXM2051GST1 | 1320A | | • | | • | | | MPXM2051GS |

**MPAK PACKAGE**
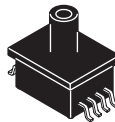


**MPXM2051GS/GST1**
**CASE 1320**

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## Operating Characteristics

**Table 1. Operating Characteristics** ($V_S$ = 10 Vdc, $T_A$ = 25°C.)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Pressure Range[1] | $P_{OP}$ | 0 | — | 50 | kPa |
| Supply Voltage[2] | $V_S$ | — | 10 | 16 | Vdc |
| Supply Current | $I_o$ | — | 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 | $\Delta V/\Delta P$ | — | 0.8 | — | mV/kPa |
| Linearity | — | -0.3 | — | 0.3 | %$V_{FSS}$ |
| Pressure Hysteresis(0 to 50 kPa) | — | — | ±0.1 | — | %$V_{FSS}$ |
| Temperature Hysteresis (-40°C to +125°C) | — | — | ±0.5 | — | %$V_{FSS}$ |
| Temperature Effect on Full Scale Span | $TCV_{FSS}$ | -1.0 | — | 1.0 | %$V_{FSS}$ |
| Temperature Effect on Offset | $TCV_{off}$ | -1.0 | — | 1.0 | mV |
| Input Impedance | $Z_{in}$ | 1000 | — | 2500 | Ω |
| Output Impedance | $Z_{out}$ | 1400 | — | 3000 | Ω |
| Response Time[5] (10% to 90%) | $t_R$ | — | 1.0 | — | ms |
| Warm-Up | — | — | 20 | — | ms |
| Offset Stability[6] | — | — | ±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.  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.

6.  Offset stability is the product's output deviation when subjected to 1000 hours of Pulsed Pressure, Temperature Cycling with Bias Test.

**MPXM2051G**

## Maximum Ratings

**Table 2. Maximum Ratings[1]**

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Maximum Pressure | $P_{max}$ | 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.

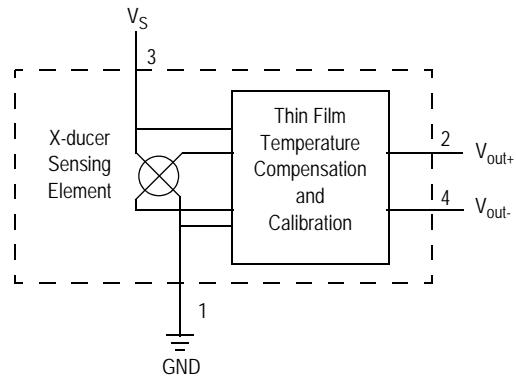Figure 1 shows a block diagram of the internal circuitry integrated on a pressure sensor chip.



**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 relative to the vacuum side. Similarly, output voltage increases as increasing vacuum is applied to the vacuum side relative to the pressure side.

**MPXM2051G**

## On-chip Temperature Compensation and Calibration

Figure 2 shows the minimum, maximum and typical output characteristics of the MPXM2051G series at 25°C. The output is directly proportional to the differential pressure and is essentially a straight line.

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.
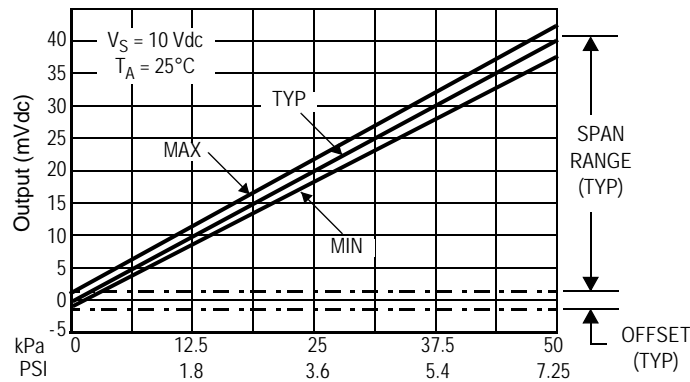


**Figure 2. Output vs. Pressure Differential**

### LINEARITY

Linearity refers to how well a transducer's output follows the equation: $V_{out} = V_{off} + \text{sensitivity} \times P$ over the operating pressure range. There are two basic methods for calculating nonlinearity: (1) end point straight line fit (see Figure 3) 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. The specified pressure sensor linearities are based on the end point straight line method measured at the midrange pressure.
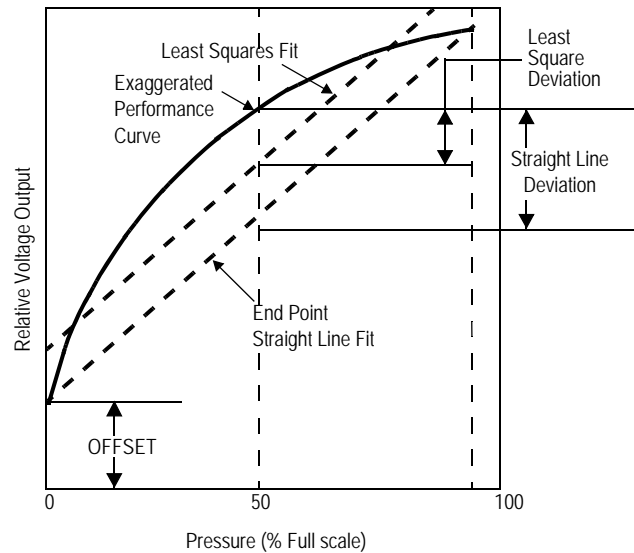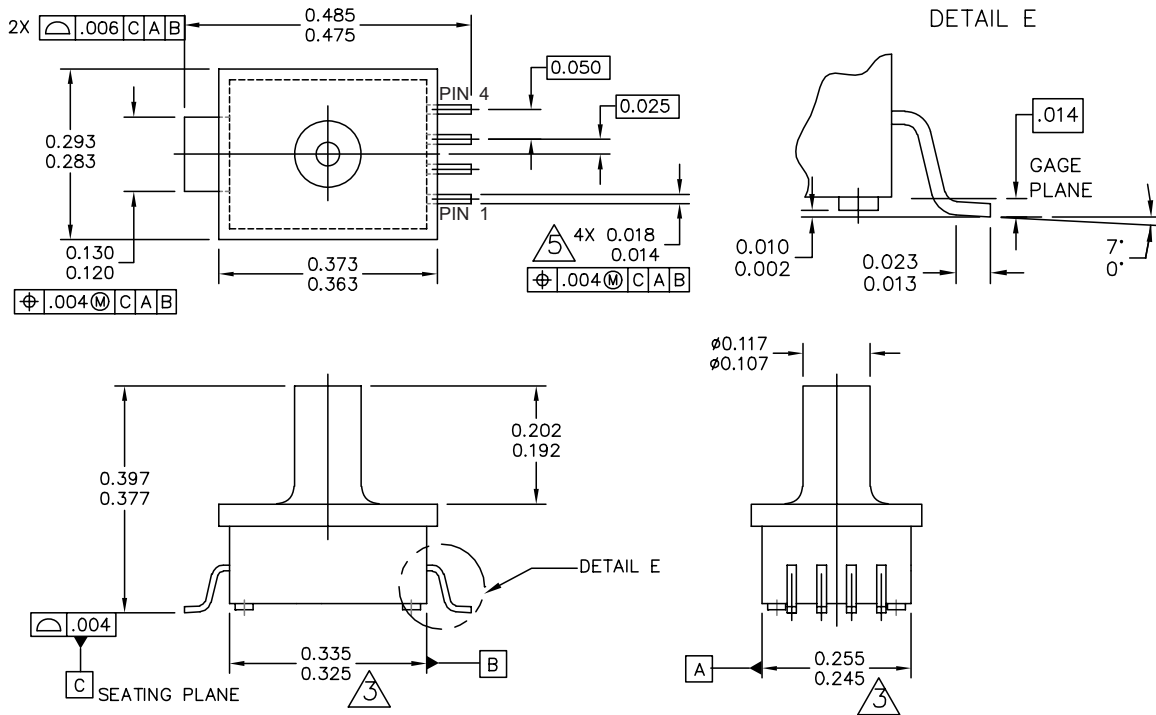


**Figure 3. Linearity Specification Comparison**

**MPXM2051G**

# PACKAGE DIMENSIONS



2X [⌒|.006|C|A|B]

0.485
0.475

PIN 4

0.050

0.025

PIN 1

0.293
0.283

0.130
0.120

0.373
0.363

[⊕|.004Ⓜ|C|A|B]

⑤ 4X 0.018
0.014

[⊕|.004Ⓜ|C|A|B]

DETAIL E

.014

GAGE
PLANE

0.010
0.002

0.023
0.013

7°
0°

0.397
0.377

0.202
0.192

DETAIL E

[⌒|.004]

[C] SEATING PLANE

0.335
0.325

△3

[B]

ø0.117
ø0.107

[A]

0.255
0.245

△3

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| | CASE NUMBER: 1320A-02 | | 22 JUL 2005 |
| | STANDARD: NON-JEDEC | | |

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**ISSUE A**

**MPXM2051G**

## PACKAGE DIMENSIONS

NOTES:

1. DIMENSIONS ARE IN INCHES.

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

△3. DIMENSIONS DOES NOT INCLUDE MOLD FLASH OR PROTRUSION. MOLD FLASH OR
   PROTRUSION SHALL NOT EXCEED .006" PER SIDE.

4. ALL VERTICAL SURFACES TO BE 5" MAXIMUM.

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

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www.freescale.com

**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 10 5879 8000
support.asia@freescale.com

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Freescale Semiconductor Literature Distribution Center
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