

# 10 kPa On-Chip Temperature Compensated & Calibrated Silicon Pressure Sensors

The MPXM2010 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 & Non Ported Options

## Application Examples

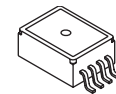
- Respiratory Diagnostics
- Air Movement Control
- Controllers
- Pressure Switching

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

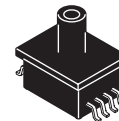
ORDERING INFORMATION		
Device Type/Order No.	Options	Case No.
MPXM2010D	Non-ported	1320
MPXM2010DT1	Non-ported, Tape and Reel	1320
MPXM2010GS	Ported	1320A
MPXM2010GST1	Ported, Tape and Reel	1320A

## MPXM2010 SERIES

**FREESCALE PREFERRED  
DEVICE**  
0 to 10 kPa (0 to 1.45 psi)  
25 mV FULL SCALE SPAN  
(TYPICAL)



MPXM2010D/DT1  
CASE 1320-02



MPXM2010GS/GST1  
CASE 1320A-02

## PIN NUMBERS

1	GND	3	$V_S$
2	$+V_{out}$	4	$-V_{out}$

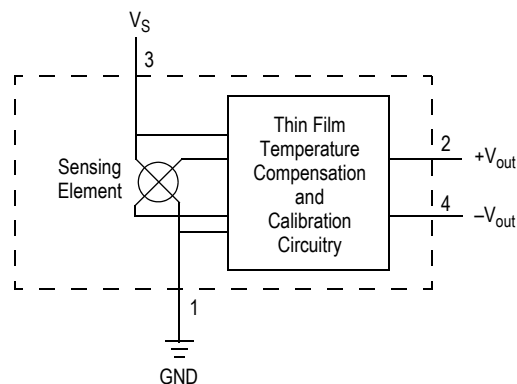


Figure 1. Fully Integrated Pressure Sensor Schematic

## 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.

**NOTE:** Preferred devices are Freescale recommended choices for future use and best overall value.

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

Rating	Symbol	Value	Unit
Maximum Pressure	$P_{MAX}$	75	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.

**Table 2. Operating Characteristics** ( $V_S = 10$  Vdc,  $T_A = 25^\circ\text{C}$ .)

Characteristic	Symbol	Min	Typ	Max	Unit
Pressure Range <sup>(1)</sup>	$P_{OP}$	0	—	10	kPa
Supply Voltage <sup>(2)</sup>	$V_S$	—	10	16	Vdc
Supply Current	$I_o$	—	6.0	—	mAdc
Full Scale Span <sup>(3)</sup>	$V_{FSS}$	24	25	26	mV
Offset <sup>(4)</sup>	$V_{off}$	-1.0	—	1.0	mV
Sensitivity	$\Delta V/\Delta P$	—	2.5	—	mV/kPa
Linearity <sup>(5)</sup>	—	-1.0	—	1.0	% $V_{FSS}$
Pressure Hysteresis <sup>(5)</sup> (0 to 10 kPa)	—	—	$\pm 0.1$	—	% $V_{FSS}$
Temperature Hysteresis <sup>5</sup> (-40°C to +125°C)	—	—	$\pm 0.5$	—	% $V_{FSS}$
Temperature Effect on Full Scale Span <sup>(5)</sup>	$TCV_{FSS}$	-1.0	—	1.0	% $V_{FSS}$
Temperature Effect on Offset <sup>(5)</sup>	$TCV_{off}$	-1.0	—	1.0	mV
Input Impedance	$Z_{in}$	1000	—	2550	$\Omega$
Output Impedance	$Z_{out}$	1400	—	3000	$\Omega$
Response Time <sup>(6)</sup> (10% to 90%)	$t_R$	—	1.0	—	ms
Warm-Up	—	—	20	—	ms
Offset Stability <sup>(7)</sup>	—	—	$\pm 0.5$	—	% $V_{FSS}$

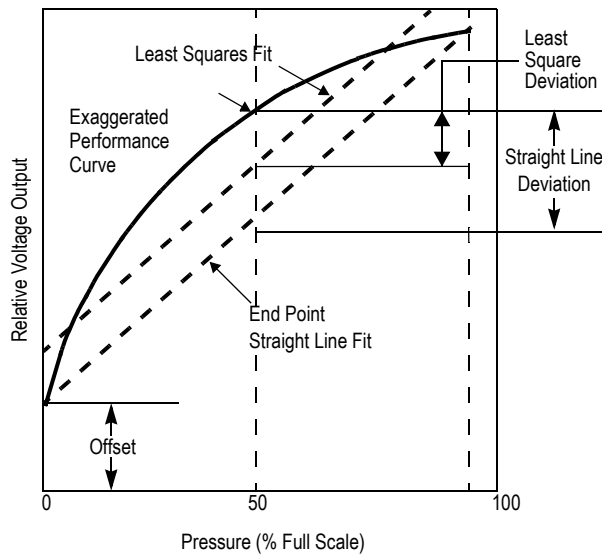
- 1.0 kPa (kiloPascal) equals 0.145 psi.
- Device is ratiometric within this specified excitation range. Operating the device above the specified excitation range may induce additional error due to device self-heating.
- Full Scale Span ( $V_{FSS}$ ) is defined as the algebraic difference between the output voltage at full rated pressure and the output voltage at the minimum rated pressure.
- 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, 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.
- 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.
- Offset stability is the product's output deviation when subjected to 1000 hours of Pulsed Pressure, Temperature Cycling with Bias Test.

## 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 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. Freescale's specified pressure sensor linearities are based on the end point straight line method measured at the midrange pressure.

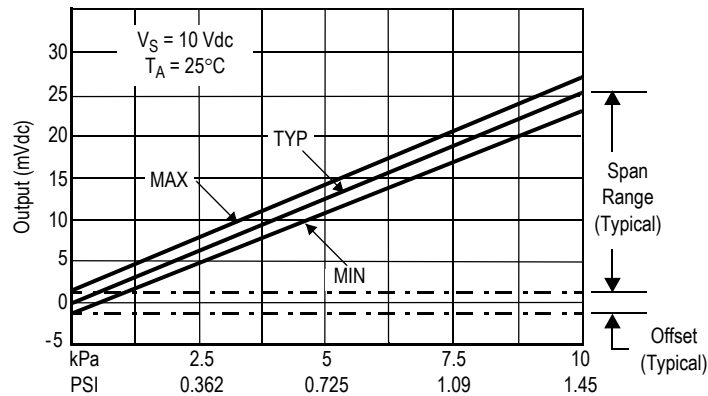


**Figure 2. Linearity Specification Comparison**

**ON-CHIP TEMPERATURE COMPENSATION AND CALIBRATION**

Figure 3 shows the minimum, maximum and typical output characteristics of the MPXM2010 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 3. Output versus Pressure Differential**



## PACKAGE DIMENSIONS

NOTES:

1. DIMENSIONS ARE IN INCHES.

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

3. DIMENSION 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.

PIN 1: GND  
 PIN 2: +Vout  
 PIN 3: Vs  
 PIN 4: -Vout

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PAGE 2 OF 2

**CASE 1320-02  
ISSUE B**



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PAGE 2 OF 2

**CASE 1320A-02  
ISSUE A**



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### **E-mail:**

support@freescale.com

### **USA/Europe or Locations Not Listed:**

Freescale Semiconductor  
Technical Information Center, CH370  
1300 N. Alma School Road  
Chandler, Arizona 85224  
+1-800-521-6274 or +1-480-768-2130  
support@freescale.com

### **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)  
support@freescale.com

### **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 Hong Kong Ltd.  
Technical Information Center  
2 Dai King Street  
Tai Po Industrial Estate  
Tai Po, N.T., Hong Kong  
+800 2666 8080  
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