Freescale Semiconductor

MPX2010
Rev 13, 10/2008

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

The MPX2010 series silicon piezoresistive pressure sensors provide a very accurate and linear voltage output directly proportional to the applied pressure. These sensors house a single monolithic silicon die with the strain gauge and thin film resistor network integrated. The sensor is laser trimmed for precise span, offset calibration and temperature compensation.

Features

- Temperature Compensated over 0°C to +85°C
- Ratiometric to Supply Voltage
- Differential and Gauge Options
- Available in Easy-to-Use Tape & Reel

MPX2010 Series

0 to 10 kPa (0 to 1.45 psi)
25 mV Full Scale
(Typical)

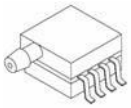
Application Examples

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

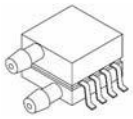
ORDERING INFORMATION

Device Name	Package Options	Case No.	# of Ports			Pressure Type			Device Marking
			None	Single	Dual	Gauge	Differential	Absolute	
Small Outline Package (MPXV2010 Series)									
MPXV2010GP	Tray	1369		•		•			MPXV2010GP
MPXV2010DP	Tray	1351			•		•		MPXV2010DP
Unibody Package (MPX2010 Series)									
MPX2010D	Tray	344	•				•		MPX2010D
MPX2010DP	Tray	344C			•		•		MPX2010DP
MPX2010GP	Tray	344B		•		•			MPX2010GP
MPX2010GS	Tray	344E		•		•			MPX2010D
MPX2010GSX	Tray	344F		•		•			MPX2010D
MPAK Package (MPXM2010 Series)									
MPXM2010D	Rail	1320	•				•		MPXM2010D
MPXM2010DT1	Tape and Reel	1320	•				•		MPXM2010D
MPXM2010GS	Rail	1320A		•		•			MPXM2010GS
MPXM2010GST1	Tape and Reel	1320A		•		•			MPXM2010GS

SMALL OUTLINE PACKAGES

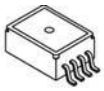


MPXV2010GP
CASE 1369-01



MPXV2010DP
CASE 1351-01

MPAK PACKAGES



MPXM2010D/DT1
CASE 1320-02

MPXM2010GS/GST1
CASE 1320A-02

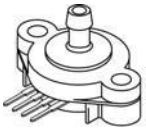
UNIBODY PACKAGES

MPX2010D
CASE 344-15

MPX2010GP
CASE 344B-01

MPX2010DP
CASE 344C-01

MPX2010GS
CASE 344E-01



MPX2010GSX
CASE 344F-01

freescale™ semiconductor

Operating Characteristics

Table 1. Operating Characteristics (V_S = 10 V_{DC}, T_A = 25°C unless otherwise noted, P1 > P2)

Characteristic	Symbol	Min	Typ	Max	Units
Pressure Range[1]	P_{OP}	0	—	10	kPa
Supply Voltage[2]	V_S	—	10	16	V_{DC}
Supply Current	I_O	—	6.0	—	mAdc
Full Scale Span[3]	V_{FSS}	24	25	26	mV
Offset[4]	V_{OFF}	–1.0	—	1.0	mV
Sensitivity	$\Delta V/\Delta P$	—	2.5	—	mV/kPa
Linearity	—	–1.0	—	1.0	$\%V_{FSS}$
Pressure Hysteresis (0 to 10 kPa)	—	—	±0.1	—	$\%V_{FSS}$
Temperature Hysteresis (–40°C to +125°C)	—	—	±0.5	—	$\%V_{FSS}$
Temperature Coefficient on Full Scale Span	TCV_{FSS}	–1.0	—	1.0	$\%V_{FSS}$
Temperature Coefficient on Offset	TCV_{OFF}	–1.0	—	1.0	mV
Input Impedance	Z_{IN}	1300	—	2550	Ω
Output Impedance	Z_{OUT}	1400	—	3000	Ω
Response Time[5] (10% to 90%)	t_R	—	1.0	—	ms
Warm-Up Time	—	—	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 at a different 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.

Maximum Ratings

Table 2. Maximum Ratings(1)

Rating	Symbol	Value	Unit
Maximum Pressure (P1 > P2)	P_{MAX}	75	kPa
Burst Pressure (P1 > P2)	P_{BURST}	100	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.

Voltage Output versus Applied Differential Pressure

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).

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

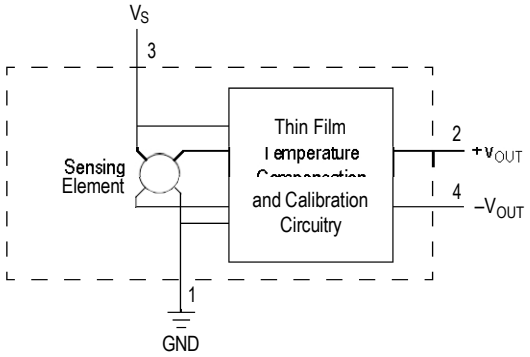


Figure 1. Temperature Compensated and Calibrated Pressure Sensor Schematic

On-Chip Temperature Compensation and Calibration

Figure 2. shows the output characteristics of the MPX2010 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.

This performance over temperature is achieved by having both the shear stress strain gauge and the thin-film resistor circuitry on the same silicon diaphragm. Each chip is dynamically laser trimmed for precise span and offset calibration and temperature compensation.

Figure 3. illustrates the differential/gauge die 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 MPX2010 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.

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 4.) 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.

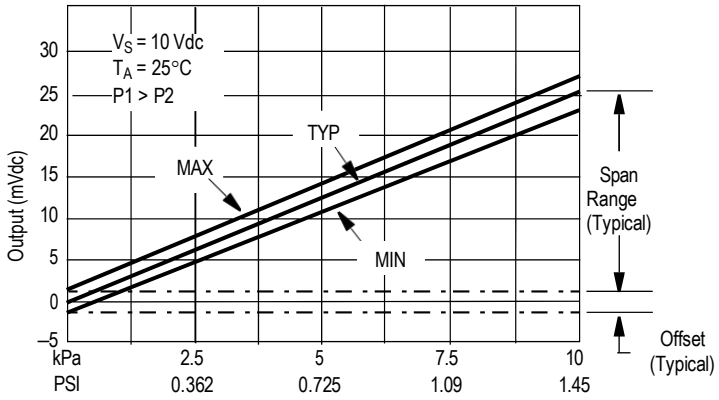


Figure 2. Output vs. Pressure Differential

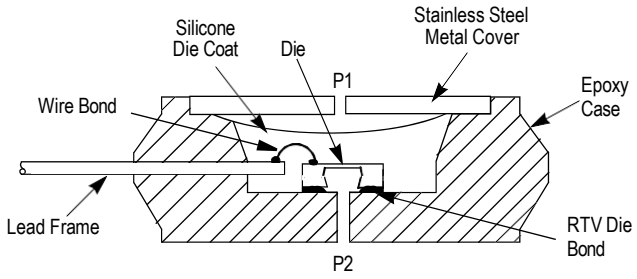


Figure 3. Unibody Package: Cross Sectional Diagram (not to scale)

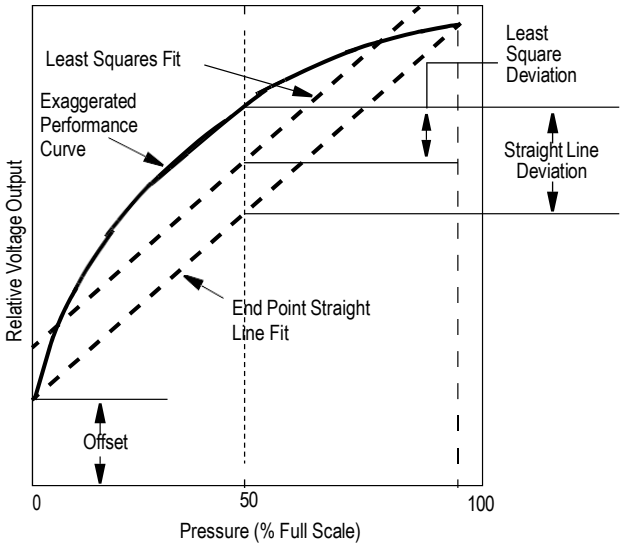


Figure 4. Linearity Specification Comparison