Silicon Pressure Sensor On-Chip Temperature Compensated and Calibrated

MPXT2010 SERIES

The MPXT2010 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 on each chip. The sensor is laser trimmed for precise span and offset, both calibrated and temperature compensated.

**COMPENSATED PRESSURE SENSOR
0 to 10 kPa (0 to 1.45 psi)
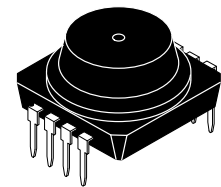FULL SCALE SPAN: 25 mV**

Features

- Stress Isolated Top Piston Fit Package
- Gauge Pressure Measurement
- Temperature Compensated over $0°$ to $+85°C$
- Unique Silicon Shear Stress Strain Gauge
- Ratiometric to Supply Voltage
- Available in Unibody Package (Case 344), See MPX2010 Series Data Sheet

Application Examples

- Respiratory Diagnostic Devices and Systems
- Air Movement Control (HVAC)
- Level Indicators
- Controllers
- Pressure Switching

**BASIC ELEMENT
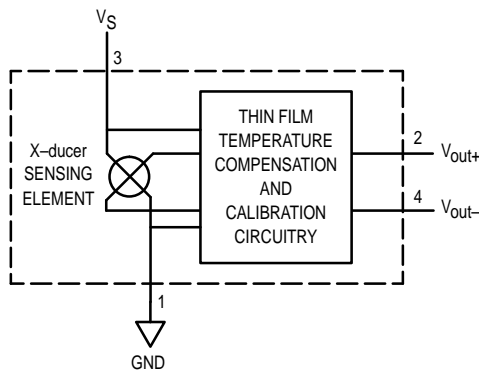CASE 473A–01**

PIN NUMBER			
1	Gnd	5	N/C
2	$+V_{out}$	6	N/C
3	V_S	7	N/C
4	$-V_{out}$	8	N/C

NOTE: Pins 5, 6, 7, and 8 are not device connections. Do not connect to external circuitry or ground. Pin 1 is noted by the notch in the Lead.

**Figure 1. Calibrated and Temperature Compensated
Pressure Sensor Schematic**

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MPXT2010 SERIES

MAXIMUM RATINGS[1]

Parametrics	Symbol	Value	Unit
Overpressure[9] (P1 > P2)	P_{max}	75	kPa
Burst Pressure[9] (P1 > P2)	P_{burst}	100	kPa
Storage Temperature	T_{stg}	−40 to +125	°C
Operating Temperature	T_A	−40 to +125	°C

1. T_C = 25°C unless otherwise noted.
2. Exposure beyond the specified limits may cause permanent damage or degradation to the device.

OPERATING CHARACTERISTICS (V_S = 10 Vdc, T_A = 25°C unless otherwise noted, P1 > P2)

Characteristic	Symbol	Min	Typ	Max	Unit
Pressure Range[1]	P_{OP}	0	—	10	kPa
Supply Voltage[2]	V_S	—	10	16	Vdc
Supply Current	I_o	—	6.0	—	mAdc
Offset[3]	V_{off}	−1.0	—	+1.0	mV
Full Scale Span[4]	V_{FSS}	24	25	26	mV
Sensitivity	V/P	—	2.5	—	mV/kPa
Linearity[5]	—	−1.0	—	+1.0	%V_{FSS}
Pressure Hysteresis[5] (0 to 10 kPa)	—	—	±0.1	—	%V_{FSS}
Temperature Hysteresis[5] (−40°C to +125°C)	—	—	±0.5	—	%V_{FSS}
Temperature Effect on Offset[5]	TCV_{off}	−1.0	—	+1.0	mV
Temperature Effect on Full Scale Span[5]	TCV_{FSS}	−1.0	—	+1.0	%V_{FSS}
Input Impedance	Z_{in}	1300	—	2550	Ω
Output Impedance	Z_{out}	1400	—	3000	Ω
Response Time[6] (10% to 90%)	t_R	—	1.0	—	ms
Warm–up Time[7]	—	—	20	—	ms
Offset Stability[8]	—	—	±0.5	—	%V_{FSS}

MECHANICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Weight, Basic Element	—	—	2.0	—	Grams

NOTES:
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. Offset (V_{off}) is defined as the output voltage at the minimum rated pressure.
4. 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.
5. 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 rated 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_{FSS}, at 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. Warm–up is defined as the time required for the product to meet the specified output voltage after the Pressure has been stabilized.
8. Offset stability is the product's output deviation when subjected to 1000 hours of Pulsed Pressure, Temperature Cycling with Bias Test.
9. Exposure beyond these limits may cause permanent damage or degradation to the device.

ON–CHIP TEMPERATURE COMPENSATION and CALIBRATION

Figure 2 shows the output characteristics of the MPXT2010 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 small and are shown under Operating Characteristics.
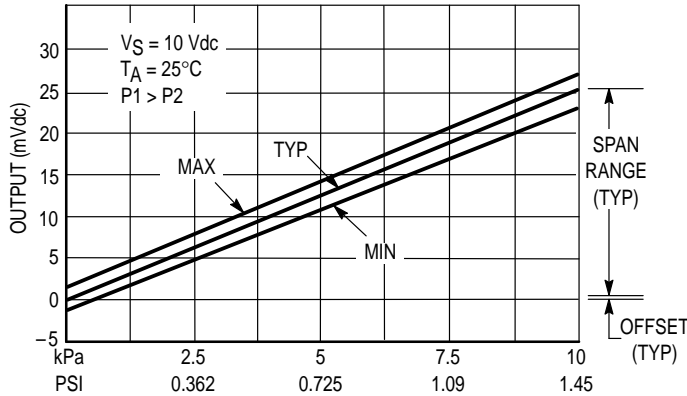
Figure 3 illustrates the differential/gauge die in the basic chip carrier (Case 473). A silicone gel isolates the die surface and wire bonds from the environment, while allowing the pressure signal to be transmitted to the silicon diaphragm.

Figure 2. Output versus Pressure Differential
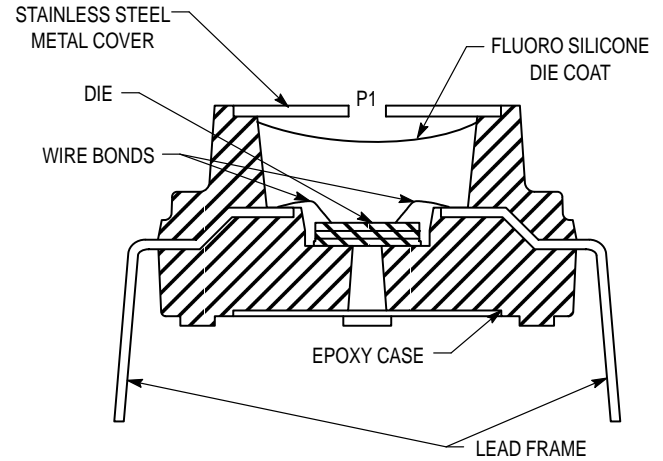
Figure 3. Cross–Sectional Diagram (not to scale)

The MPXT2010 series pressure sensor operating characteristics, 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: $V_{out} = V_{off} + (\text{sensitivity} \times P)$ over the operating pressure range. There are two basic methods for calculating nonlinearity: (1) end–point straight line fit, or (2) a least squares best line fit (see Figure 4).

When calculating linearity, Motorola uses the end–point straight line fit. This method measures the two end and the mid range pressure points and compares to ideal. This typically represents the "worst case" error which is often more desirable for the customers when calculating an error budget in their designs.
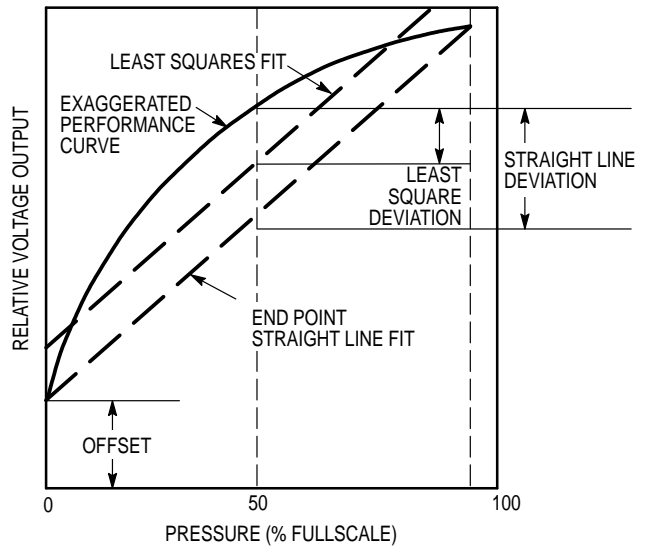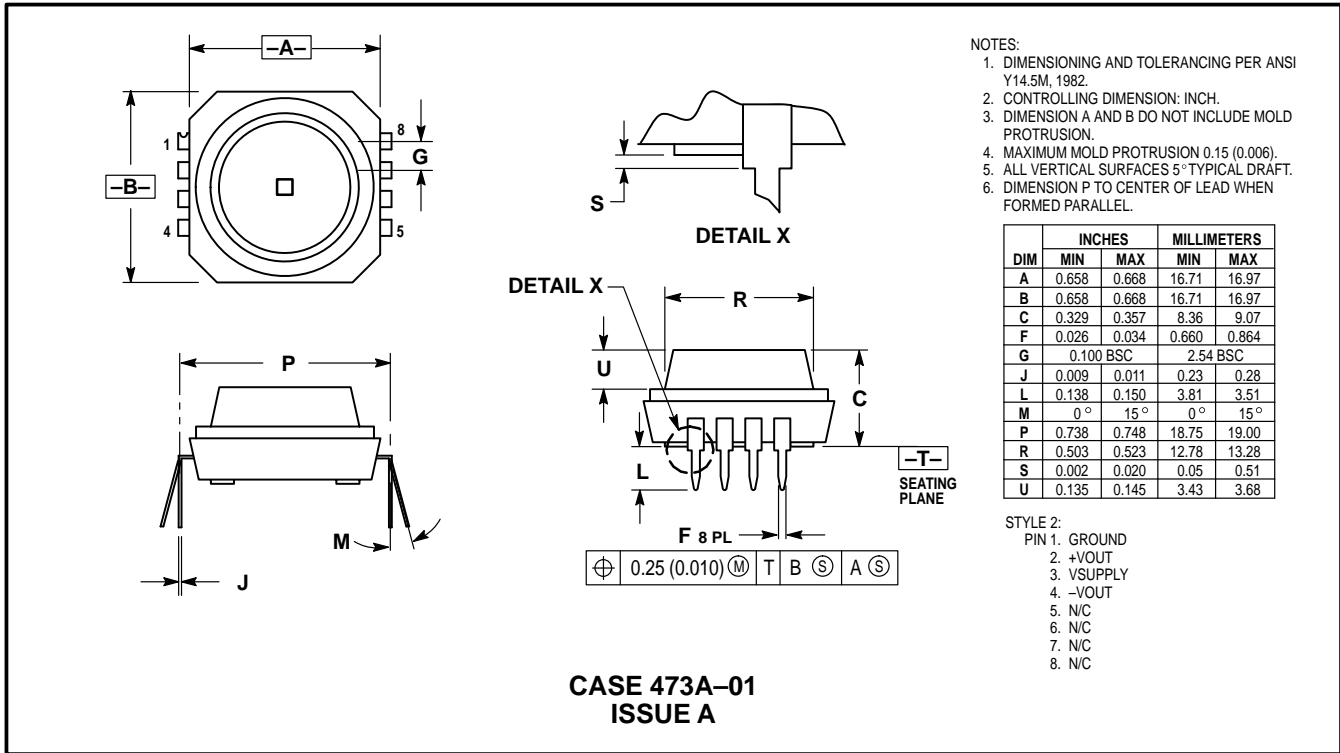

Figure 4. Linearity Specification Comparison

ORDERING INFORMATION

The MPXT2010G7U pressure sensor is available to be shipped in Rails.

Packing Options	Port Options	Leadform	Case No.	MPXS Series Order No.	Marking
Rails	Element	84 degree	473A–01	MPXT2010G7U	MPXT2010G

PACKAGE DIMENSIONS

DETAIL X

DETAIL X

–T–
SEATING PLANE

F 8 PL

$\oplus$ | 0.25 (0.010) Ⓜ | T | B Ⓢ | A Ⓢ

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.
6. DIMENSION P TO CENTER OF LEAD WHEN FORMED PARALLEL.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.658	0.668	16.71	16.97
B	0.658	0.668	16.71	16.97
C	0.329	0.357	8.36	9.07
F	0.026	0.034	0.660	0.864
G	0.100 BSC		2.54 BSC	
J	0.009	0.011	0.23	0.28
L	0.138	0.150	3.81	3.51
M	0 °	15 °	0 °	15 °
P	0.738	0.748	18.75	19.00
R	0.503	0.523	12.78	13.28
S	0.002	0.020	0.05	0.51
U	0.135	0.145	3.43	3.68

STYLE 2:
PIN 1. GROUND
2. +VOUT
3. VSUPPLY
4. –VOUT
5. N/C
6. N/C
7. N/C
8. N/C

CASE 473A–01
ISSUE A

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