0 to 200 kPa (0 to 29 PSI) On-Chip Temperature Compensated & Calibrated, Pressure Sensors

MPX2200
MPX2201
SERIES
Motorola Preferred Devices

The MPX2200 and MPX2201 series 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. They are designed for use in applications such as pump/motor controllers, robotics, level indicators, medical diagnostics, pressure switching, barometers, altimeters, etc.

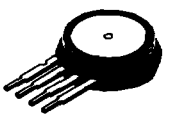
X–ducer™
SILICON
PRESSURE SENSORS

Features

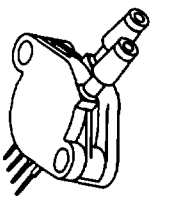
- Temperature Compensated Over 0°C to +85°C
- Patented Silicon Shear Stress Strain Gauge
- ±0.25% Linearity (MPX2200D)
- Easy to Use Chip Carrier Package
- Available in Absolute, Differential and Gauge Configurations

Application Examples

- Pump/Motor Controllers
- Robotics
- Level Indicators
- Medical Diagnostics
- Pressure Switching
- Barometers
- Altimeters



BASIC CHIP
CARRIER ELEMENT
CASE 344–08
Style 1



DIFFERENTIAL
PORT OPTION
CASE 352–02
Style 1

Pin Number			
1	2	3	4
Ground	$+V_{out}$	V_S	$-V_{out}$

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Overpressure[8] (P1 > P2)	P_{max}	400	kPa
Burst Pressure[8] (P1 > P2)	P_{burst}	2000	kPa
Storage Temperature	T_{stg}	−50 to +150	°C
Operating Temperature	T_A	−40 to +125	°C

VOLTAGE OUTPUT versus APPLIED DIFFERENTIAL PRESSURE

The differential voltage output of the X–ducer is directly proportional to the differential pressure applied.

The absolute sensor has a built–in reference vacuum. The output voltage will decrease as vacuum, relative to ambient, is drawn on the pressure (P1) side.

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

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

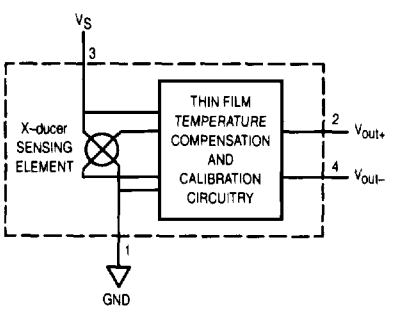


Figure 1. Temperature Compensated Pressure Sensor Schematic

Preferred devices are Motorola recommended choices for future use and best overall value.

REV 6

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

Characteristics		Symbol	Min	Typ	Max	Unit
Pressure Range[1]		P_{OP}	0	—	200	kPa
Supply Voltage		V_S	—	10	16	Vdc
Supply Current		I_o	—	6.0	—	mAdc
Full Scale Span[3]	MPX2200A, MPX2200D, MPX2201D MPX2201A	V_{FSS}	38.5 37.5	40 40	41.5 42.5	mV
Offset[4]	MPX2200A, MPX2200D MPX2200A MPX2201A	V_{off}	−1.0 −2.0 −3.0	— — —	1.0 2.0 3.0	mV
Sensitivity		ΔV/ΔP	—	0.2	—	mV/kPa
Linearity[5]	MPX2200D MPX2200A MPX2201D MPX2201A	—	−0.25 −1.0 −0.5 −2.0	— — — —	0.25 1.0 0.5 2.0	$\%V_{FSS}$
Pressure Hysteresis[5] (0 to 200 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}	1300	—	2500	Ω
Output Impedance		Z_{out}	1400	—	3000	Ω
Response Time[6] (10% to 90%)		t_R	—	1.0	—	ms
Offset Stability[5]		—	—	±0.5	—	$\%V_{FSS}$

MECHANICAL CHARACTERISTICS

Characteristics	Symbol	Min	Typ	Max	Unit
Weight, (Basic Element Case 344)	—	—	2.0	—	Grams
Warm–Up	—	—	15	—	Sec
Cavity Volume	—	—	—	0.01	IN^3
Volumetric Displacement	—	—	—	0.001	IN^3
Common Mode Line Pressure[7]	—	—	—	690	kPa

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. 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.
   - Offset Stability: Output deviation, after 1000 temperature cycles, − 40 to 125°C, and 1.5 million pressure cycles, with zero differential pressure applied.
   - 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. Common mode pressures beyond specified may result in leakage at the case–to–lead interface.
8. Exposure beyond these 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.

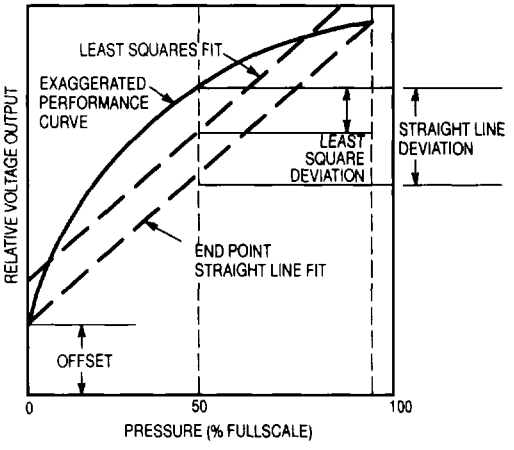


Figure 2. Linearity Specification Comparison

ON–CHIP TEMPERATURE COMPENSATION and CALIBRATION

Figure 3 shows the output characteristics of the MPX2200 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.

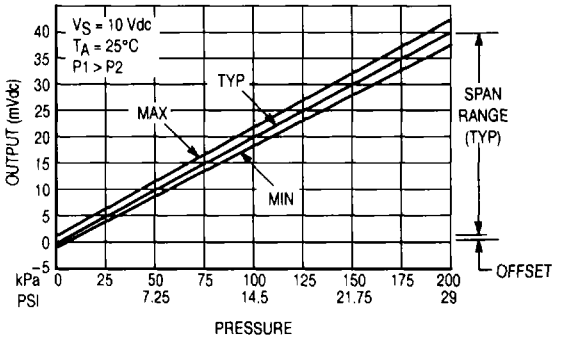


Figure 3. Output versus Pressure Differential

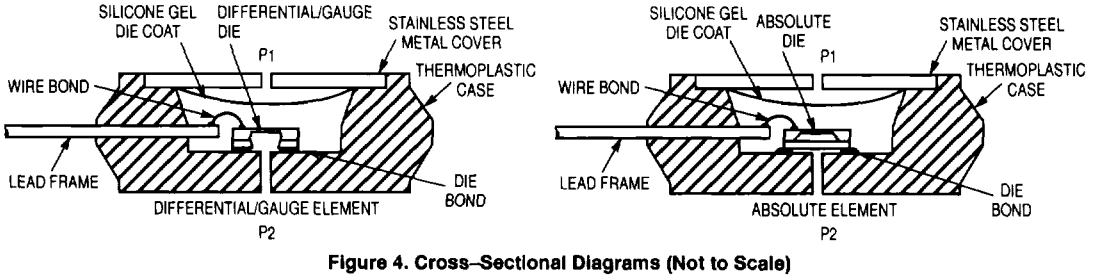


Figure 4. Cross–Sectional Diagrams (Not to Scale)

Figure 4 illustrates an absolute sensing die (right) and the differential or gauge die in the basic chip carrier (Case 344). A silicone gel isolates the die surface and wire bonds from harsh environments, while allowing the pressure signal to be transmitted to the silicon diaphragm.

The MPX2200 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

Motorola 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 protects the die from harsh media. The differential or gauge sensor is designed to operate with positive differential pressure applied, P1 > P2. The absolute sensor is designed for vacuum applied to P1 side.

The Pressure (P1) side may be identified by using the table below:

Part Number				Case Type	Pressure (P1) Side Identifier
MPX2200A	MPX2200D	MPX2201A	MPX2201D	344–08	Stainless Steel Cap
MPX2200DP		MPX2201DP		352–02	Side with Part Marking
MPX2200AP	MPX2200GP	MPX2201AP	MPX2201GP	350–03	Side with Port Attached
MPX2200GVP		MPX2201GVP		350–04	Stainless Steel Cap
MPX2200AS	MPX2200GS	MPX2201AS	MPX2201GS	371–06	Side with Port Attached
MPX2200GVS		MPX2201GVS		371–05	Stainless Steel Cap
MPX2200ASX	MPX2200GSX	MPX2201ASX	MPX2201GSX	371C–02	Side with Port Attached
MPX2200GVSX		MPX2201GVSX		371D–02	Stainless Steel Cap

ORDERING INFORMATION

MPX2200 series pressure sensors are available in absolute, differential and gauge configurations. Devices are available in the basic element package or with pressure port fittings which provide printed circuit board mounting ease and barbed hose pressure connections.

Device Type	Options	Case Type	MPX Series	
			Order Number	Device Marking
Basic Element	Absolute, Differential	Case 344–08	MPX2200A MPX2200D MPX2201A MPX2201D	MPX2200A MPX2200D MPX2201A MPX2201D
Ported Elements	Differential	Case 352–02	MPX2200DP MPX2201DP	MPX2200DP MPX2201DP
	Absolute, Gauge	Case 350–03	MPX2200AP MPX2200GP MPX2201AP MPX2201GP	MPX2200AP MPX2200GP MPX2201AP MPX2201GP
	Gauge Vacuum	Case 350–04	MPX2200GVP MPX2201GVP	MPX2200GVP MPX2201GVP
	Absolute, Gauge Stove Pipe	Case 371–06	MPX2200AS MPX2200GS MPX2201AS MPX2201GS	MPX2200A MPX2200D MPX2201A MPX2201D
	Gauge Vacuum Stove Pipe	Case 371–05	MPX2200GVS MPX2201GVS	MPX2200D MPX2201D
	Absolute, Gauge Axial	Case 371C–02	MPX2200ASX MPX2200GSX MPX2201ASX MPX2201GSX	MPX2200A MPX2200D MPX2201A MPX2201D
	Gauge Vacuum Axial	Case 371D–02	MPX2200GVSX MPX2201GVSX	MPX2200D MPX2201D