

# 200 kPa On-Chip Temperature Compensated & Calibrated Pressure Sensors

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.

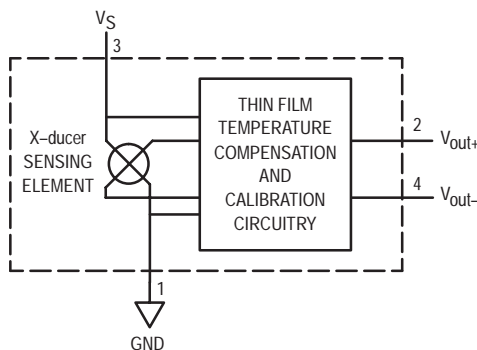
**Features**

- 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

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



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

**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.

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

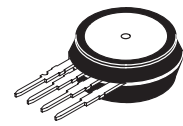
X-ducer is a trademark of Motorola, Inc.

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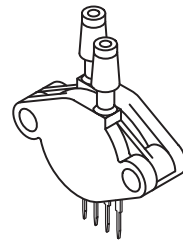
## MPX2200 MPX2201 SERIES

Motorola Preferred Device

0 to 200 kPa (0 to 29 psi)  
40 mV FULL SCALE SPAN  
(TYPICAL)



**BASIC CHIP  
CARRIER ELEMENT  
CASE 344-15, STYLE 1**



**DIFFERENTIAL  
PORT OPTION  
CASE 344C-01, STYLE 1**

NOTE: Pin 1 is the notched pin.

PIN NUMBER			
1	Gnd	3	VS
2	+Vout	4	-Vout

## MPX2200 MPX2201 SERIES

### MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Overpressure <sup>(8)</sup> (P1 > P2)	P <sub>max</sub>	400	kPa
Burst Pressure <sup>(8)</sup> (P1 > P2)	P <sub>burst</sub>	2000	kPa
Storage Temperature	T <sub>stg</sub>	-40 to +125	°C
Operating Temperature	T <sub>A</sub>	-40 to +125	°C

### OPERATING CHARACTERISTICS (V<sub>S</sub> = 10 Vdc, T<sub>A</sub> = 25°C unless otherwise noted, P1 > P2)

Characteristics	Symbol	Min	Typ	Max	Unit
Pressure Range <sup>(1)</sup>	P <sub>OP</sub>	0	—	200	kPa
Supply Voltage	V <sub>S</sub>	—	10	16	Vdc
Supply Current	I <sub>o</sub>	—	6.0	—	mAdc
Full Scale Span <sup>(3)</sup>	V <sub>FSS</sub>	38.5	40	41.5	mV
Offset <sup>(4)</sup>	V <sub>off</sub>	-1.0	—	1.0	mV
Sensitivity	ΔV/ΔP	—	0.2	—	mV/kPa
Linearity <sup>(5)</sup>					%V <sub>FSS</sub>
	MPX2200D Series	-0.25	—	0.25	
	MPX2200A Series	-1.0	—	1.0	
	MPX2201GP	-0.5	—	0.5	
Pressure Hysteresis <sup>(5)</sup> (0 to 200 kPa)	—	—	±0.1	—	%V <sub>FSS</sub>
Temperature Hysteresis <sup>(5)</sup> (-40°C to +125°C)	—	—	±0.5	—	%V <sub>FSS</sub>
Temperature Effect on Full Scale Span <sup>(5)</sup>	TCV <sub>FSS</sub>	-1.0	—	1.0	%V <sub>FSS</sub>
Temperature Effect on Offset <sup>(5)</sup>	TCV <sub>off</sub>	-1.0	—	1.0	mV
Input Impedance	Z <sub>in</sub>	1300	—	2500	Ω
Output Impedance	Z <sub>out</sub>	1400	—	3000	Ω
Response Time <sup>(6)</sup> (10% to 90%)	t <sub>R</sub>	—	1.0	—	ms
Warm-Up	—	—	20	—	ms
Offset Stability <sup>(9)</sup>	—	—	±0.5	—	%V <sub>FSS</sub>

### MECHANICAL CHARACTERISTICS

Characteristics	Symbol	Min	Typ	Max	Unit
Weight, (Basic Element Case 344-15)	—	—	2.0	—	Grams
Common Mode Line Pressure <sup>(7)</sup>	—	—	—	690	kPa

#### NOTES:

- 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<sub>FSS</sub>) 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<sub>off</sub>) 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.
- Common mode pressures beyond specified may result in leakage at the case-to-lead interface.
- Exposure beyond these limits may cause permanent damage or degradation to the device.
- 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. Motorola's specified pressure sensor linearities are based on the end point straight line method measured at the midrange pressure.

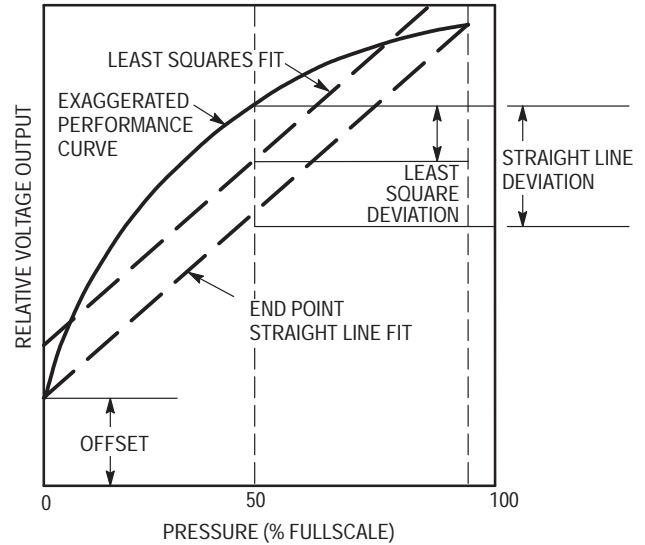


Figure 2. Linearity Specification Comparison

**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.

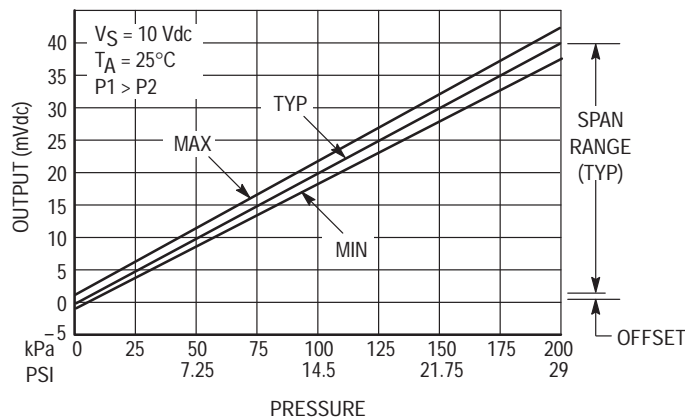


Figure 3. Output versus Pressure Differential

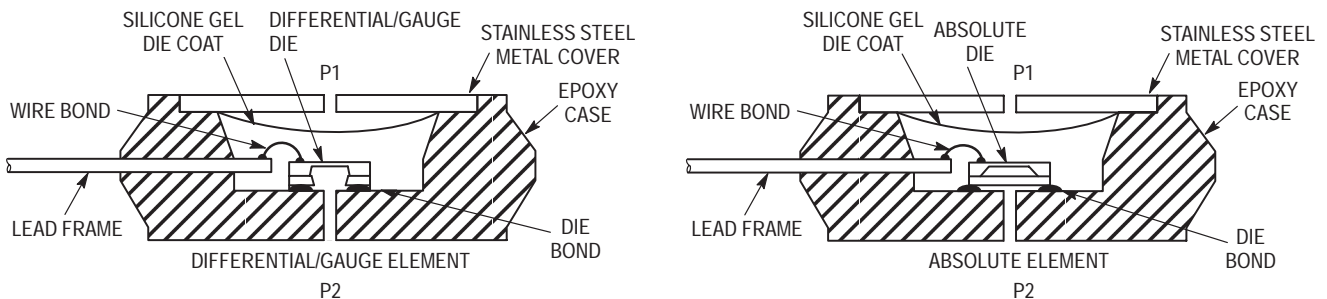


Figure 4. Cross-Sectional Diagrams (Not to Scale)

Figure 4 illustrates an absolute sensing die (right) and the differential or gauge die in the basic chip carrier (Case 344-15). 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 MPX2200 series pressure sensor operating charac-

teristics 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.

## MPX2200 MPX2201 SERIES

### 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 isolates the die from the environment. The differential or gauge sensor is designed to operate with positive differen-

tial 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:

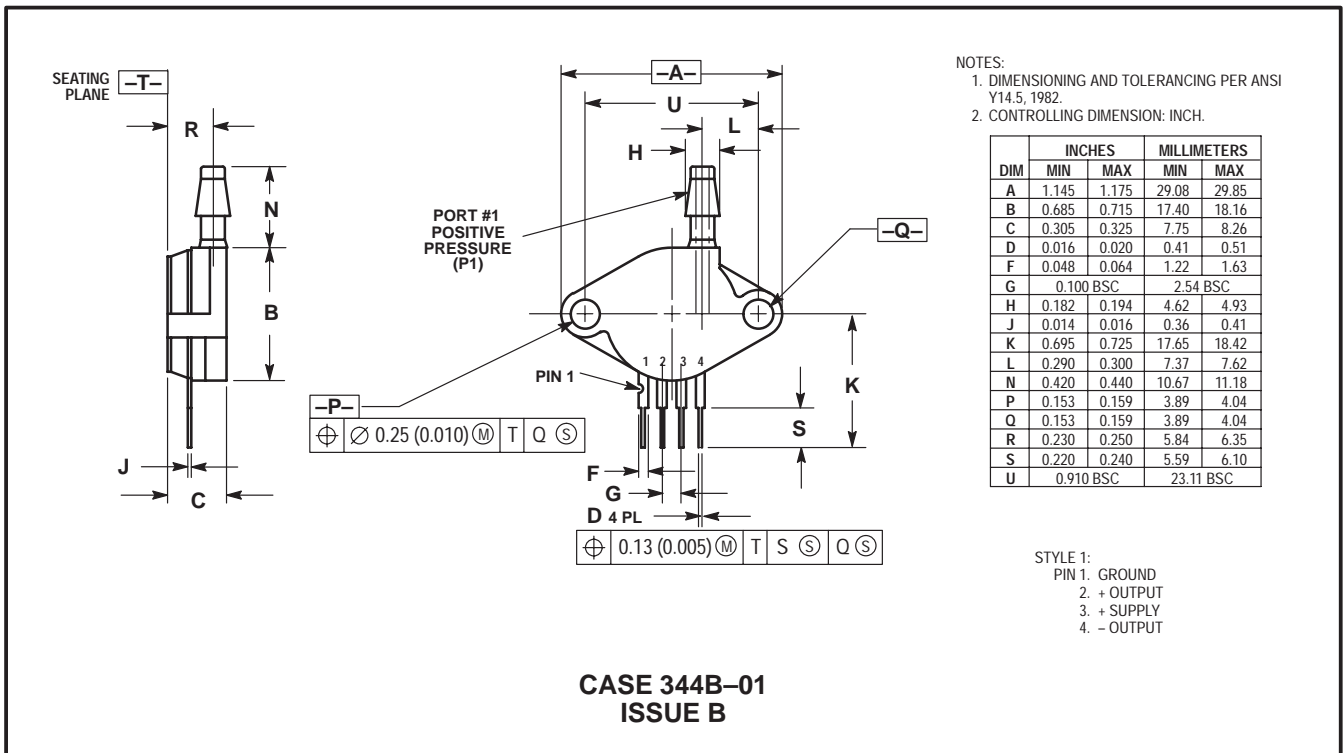
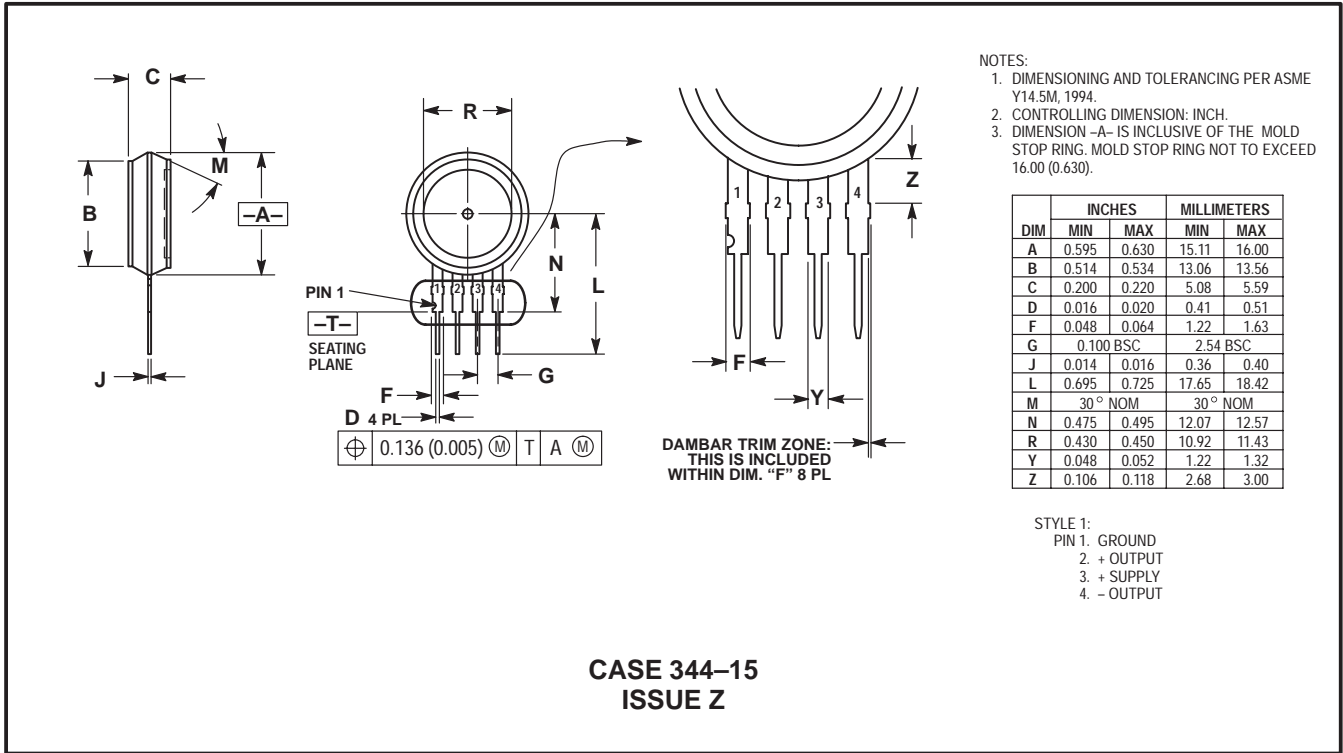
Part Number				Case Type	Pressure (P1) Side Identifier
MPX2200A	MPX2200D			344-15	Stainless Steel Cap
MPX2200DP				344C-01	Side with Part Marking
MPX2200AP	MPX2200GP		MPX2201GP	344B-01	Side with Port Attached

### 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.

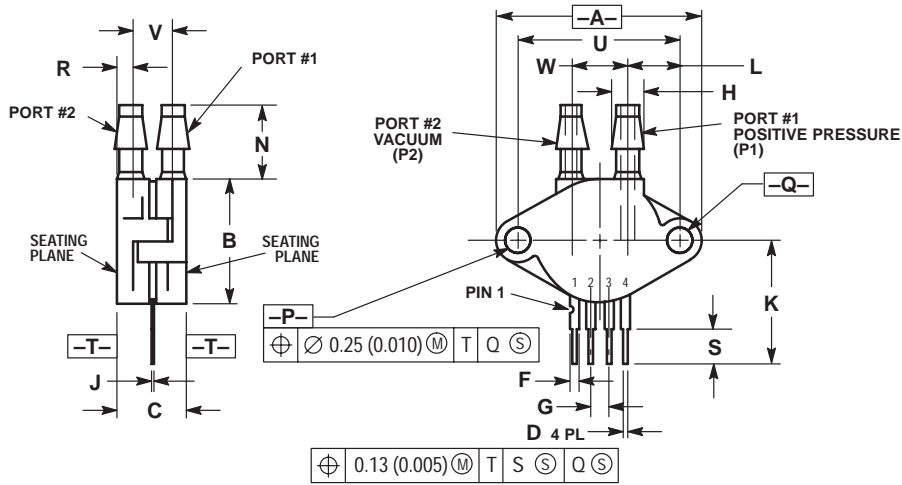
Device Type	Options	Case Type	MPX Series	
			Order Number	Device Marking
Basic Element	Absolute, Differential	Case 344-15	MPX2200A MPX2200D	MPX2200A MPX2200D
Ported Elements	Differential	Case 344C-01	MPX2200DP	MPX2200DP
	Absolute, Gauge	Case 344B-01	MPX2200AP MPX2200GP MPX2201GP	MPX2200AP MPX2200GP MPX2201GP

PACKAGE DIMENSIONS



**MPX2200 MPX2201 SERIES**

**PACKAGE DIMENSIONS — CONTINUED**




- NOTES:  
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.  
 2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.145	1.175	29.08	29.85
B	0.685	0.715	17.40	18.16
C	0.405	0.435	10.29	11.05
D	0.016	0.020	0.41	0.51
F	0.048	0.064	1.22	1.63
G	0.100 BSC		2.54 BSC	
H	0.182	0.194	4.62	4.93
J	0.014	0.016	0.36	0.41
K	0.695	0.725	17.65	18.42
L	0.290	0.300	7.37	7.62
N	0.420	0.440	10.67	11.18
P	0.153	0.159	3.89	4.04
Q	0.153	0.159	3.89	4.04
R	0.063	0.083	1.60	2.11
S	0.220	0.240	5.59	6.10
U	0.910 BSC		23.11 BSC	
V	0.248	0.278	6.30	7.06
W	0.310	0.330	7.87	8.38

STYLE 1:  
 PIN 1. GROUND  
 2. + OUTPUT  
 3. + SUPPLY  
 4. - OUTPUT

**CASE 344C-01  
 ISSUE B**

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MPX2200/D