

50 kPa On-Chip Temperature Compensated & Calibrated Silicon Pressure Sensors

The MPX2053 device is a silicon piezoresistive pressure sensors 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
- Unique Silicon Shear Stress Strain Gauge
- Easy to Use Chip Carrier Package Options
- Ratiometric to Supply Voltage
- Differential and Gauge Options

Application Examples

- Pump/Motor Controllers
- Robotics
- Level Indicators
- Medical Diagnostics
- Pressure Switching
- Non-Invasive Blood Pressure Measurement

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

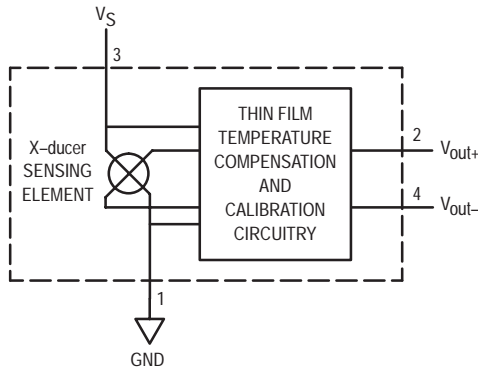


Figure 1. Temperature Compensated Pressure Sensor Schematic

VOLTAGE OUTPUT versus APPLIED DIFFERENTIAL PRESSURE

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

The 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).

Preferred devices are Motorola recommended choices for future use and best overall value. X-ducer is a trademark of Motorola, Inc.

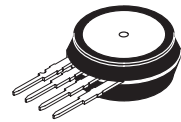
Replaces MPX2050/D

REV 1

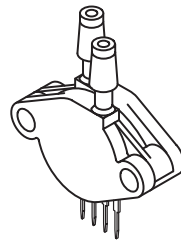
MPX2053 SERIES

Motorola Preferred Device

**0 to 50 kPa (0 to 7.25 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	V _S
2	+V _{out}	4	-V _{out}

MPX2053 SERIES

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Overpressure ⁽⁸⁾ (P1 > P2)	P _{max}	200	kPa
Burst Pressure ⁽⁸⁾ (P1 > P2)	P _{burst}	500	kPa
Storage Temperature	T _{stg}	-40 to +125	°C
Operating Temperature	T _A	-40 to +125	°C

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	—	50	kPa
Supply Voltage ⁽²⁾	V _S	—	10	16	Vdc
Supply Current	I _o	—	6.0	—	mAdc
Full Scale Span ⁽³⁾	V _{FSS}	38.5	40	41.5	mV
Offset ⁽⁴⁾	V _{off}	-1.0	—	1.0	mV
Sensitivity	ΔV/ΔP	—	0.8	—	mV/kPa
Linearity ⁽⁵⁾	—	-0.6	—	0.4	%V _{FSS}
Pressure Hysteresis ⁽⁵⁾ (0 to 50 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}	-2.0	—	2.0	%V _{FSS}
Temperature Effect on Offset ⁽⁵⁾	TCV _{off}	-1.0	—	1.0	mV
Input Impedance	Z _{in}	1000	—	2500	Ω
Output Impedance	Z _{out}	1400	—	3000	Ω
Response Time ⁽⁶⁾ (10% to 90%)	t _R	—	1.0	—	ms
Warm-Up	—	—	20	—	ms
Offset Stability ⁽⁹⁾	—	—	±0.5	—	%V _{FSS}

MECHANICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Weight (Basic Element Case 344-15)	—	—	2.0	—	Grams
Common Mode Line Pressure ⁽⁷⁾	—	—	—	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_{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.
- 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.

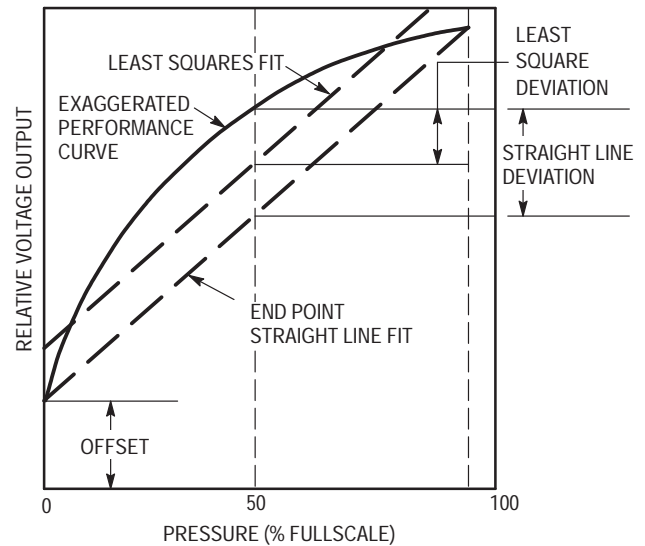


Figure 2. Linearity Specification Comparison

ON-CHIP TEMPERATURE COMPENSATION and CALIBRATION

Figure 3 shows the minimum, maximum and typical output characteristics of the MPX2053 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.

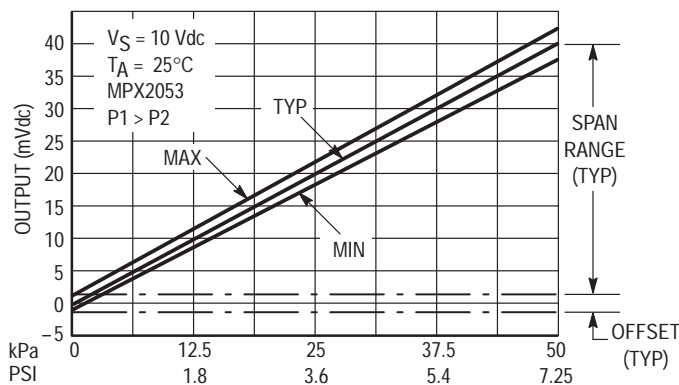


Figure 3. Output versus Pressure Differential

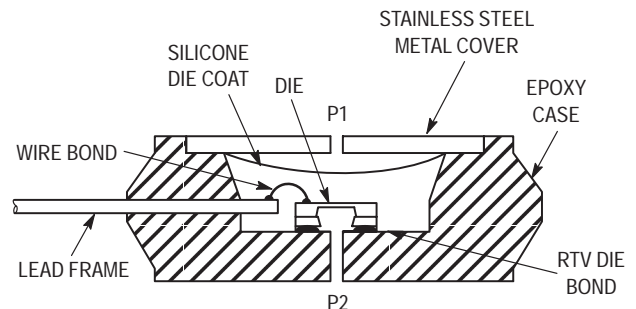


Figure 4. Cross-Sectional Diagram (not to scale)

Figure 4 illustrates the differential or gauge configuration 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 MPX2053 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.

MPX2053 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. The Motorola MPX pressure sensor is

designed to operate with positive differential pressure applied, $P1 > P2$.

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

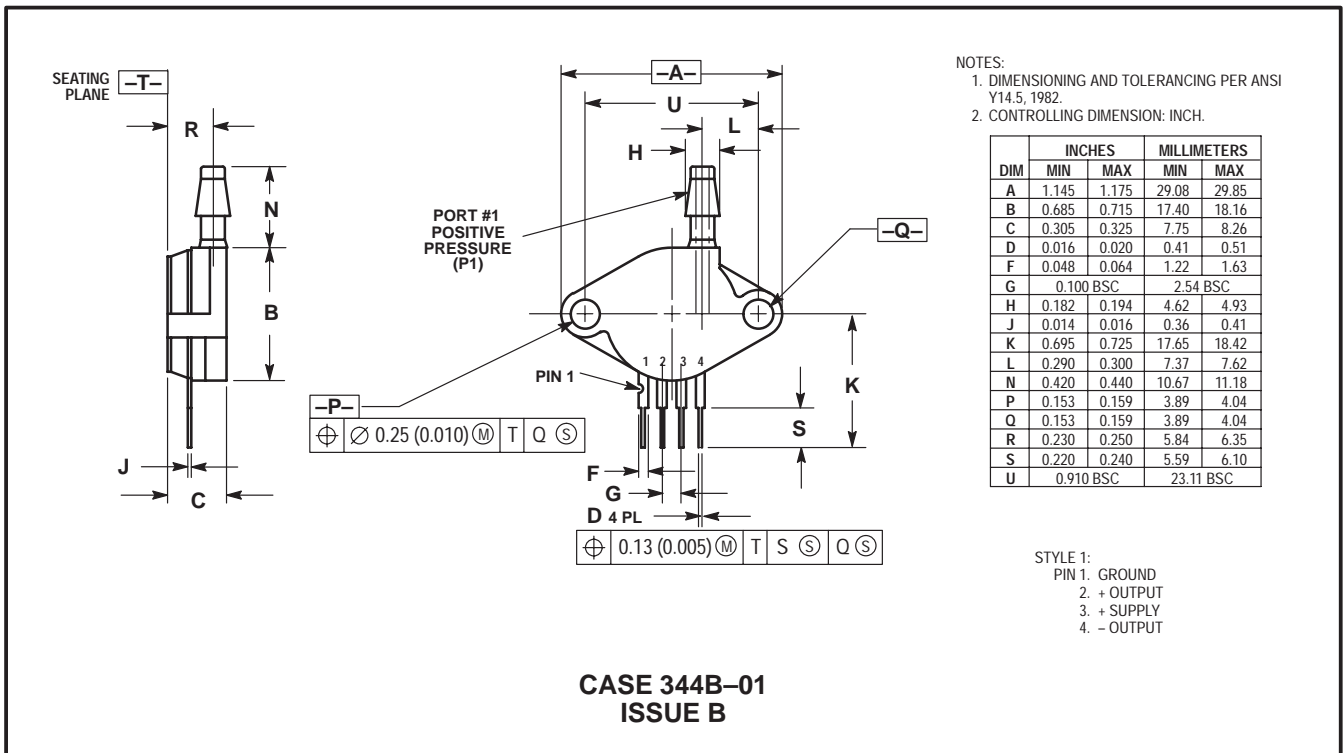
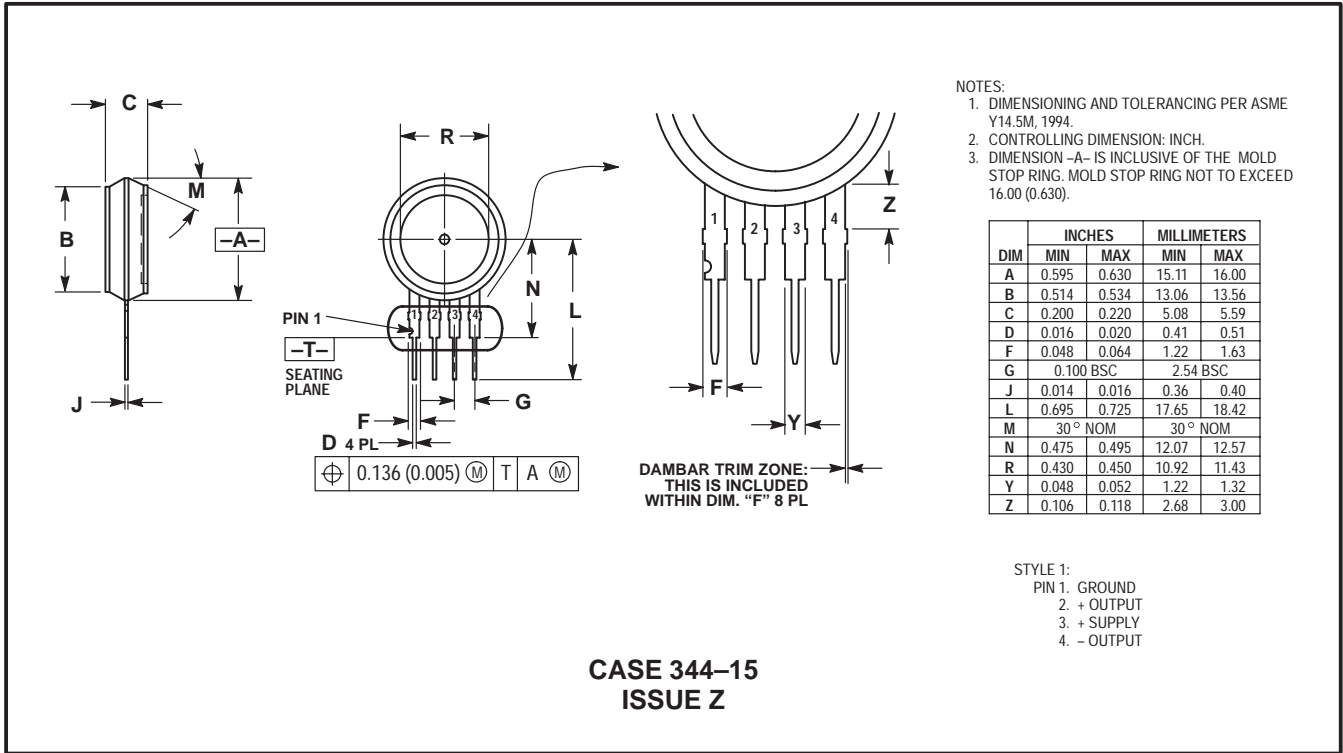
Part Number	Case Type	Pressure (P1) Side Identifier
MPX2053D	344-15	Stainless Steel Cap
MPX2053DP	344C-01	Side with Part Marking
MPX2053GP	344B-01	Side with Port Attached

ORDERING INFORMATION

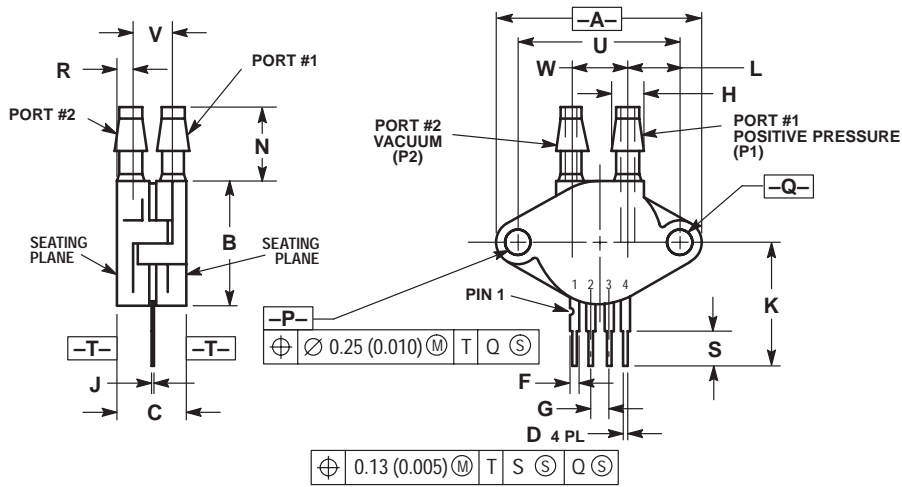
MPX2053 series pressure sensors are available in differential and gauge configurations. Devices are available in the basic element package or with pressure port fittings which provide printed circuit board mounting ease and barbed hose pressure connections.

Device Type	Options	Case Type	MPX Series	
			Order Number	Device Marking
Basic Element	Differential	344-15	MPX2053D	MPX2053D
Ported Elements	Differential	344C-01	MPX2053DP	MPX2053DP
	Gauge	344B-01	MPX2053GP	MPX2053GP

PACKAGE DIMENSIONS



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

NOTES

MPX2053 SERIES

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