# 10 kPa Uncompensated Silicon Pressure Sensors

The MPX10 and MPXV10GC series devices are silicon piezoresistive pressure sensors providing a very accurate and linear voltage output — directly proportional to the applied pressure. These standard, low cost, uncompensated sensors permit manufacturers to design and add their own external temperature compensation and signal conditioning networks. Compensation techniques are simplified because of the predictability of Freescale's single element strain gauge design. Figure 1 shows a schematic of the internal circuitry on the stand-alone pressure sensor chip.

#### **Features**

- Low Cost
- Patented Silicon Shear Stress Strain Gauge Design
- Ratiometric to Supply Voltage
- Easy to Use Chip Carrier Package Options
- Differential and Gauge Options
- Durable Epoxy Unibody Element or Thermoplastic (PPS) Surface Mount Package

#### **Functional Description**

- Air Movement Control
- **Environmental Control Systems**
- Level Indicators
- Leak Detection
- **Medical Instrumentation**
- **Industrial Controls**
- Pneumatic Control Systems
- Robotics

ORDERING INFORMATION <sup>(1)</sup>					
Device Type	Options	Case No.	Order Number	Device Marking	
SMALL OUTLIN	E PACKAGE (MP)	V10G SERIE	S)		
Ported	Rails	482A	MPXV10GC6U	MPXV10G	
Elements	Tape and Reel	482A	MPXV10GC6T1	MPXV10G	
	Rails	482C	MPXV10GC7U	MPXV10G	
UNIBODY PACE	KAGE (MPX10 SEI	RIES)	77		
Basic Element	Differential	344	MPX10D	MPX10D	
Ported	Differential	344C	MPX10DP	MPX10DP	
Elements	Gauge	344B	MPX10GP	MPX10GP	
	Gauge	344E	MPX10GS	MPX10D	

1. MPX10 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.

# MPX10 MPXV10GC **SERIES**

**UNCOMPENSATED PRESSURE** SENSOR 0 TO 10 kPA (0-1.45 psi) 35 mV FULL SCALE SPAN (TYPICAL)

#### **SMALL OUTLINE PACKAGES**





MPXV10GC6U **CASE 482A-01** 

MPXV10GC7U **CASE 482C-03** 

SMALL OUTLINE PACKAGE PIN NUMBERS				
1	GND	5	N/C	
2	+V <sub>out</sub>	6	N/C	
3	V <sub>s</sub>	7	N/C	
4	-V <sub>out</sub>	8	N/C	

NOTE: Pin 1 is noted by the notch in the lead.

UNIBODY PACKAGE PIN NUMBERS					
1	GND	3	V <sub>s</sub>		
2	+V <sub>out</sub>	4	–V <sub>out</sub>		

NOTE: Pin 1 is noted by the notch in the lead.

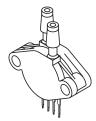
# **UNIBODY PACKAGES**



MPX10D **CASE 344-15** 



MPX10GP **CASE 344B-01** 



MPX10DP CASE 344C-01



**CASE 344E-01** 



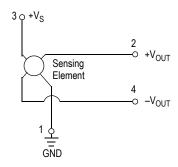


Figure 1. Uncompensated Pressure Sensor Schematic

## **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).

Table 1. Maximum Ratings<sup>(1)</sup>

Rating	Symbol	Value	Unit
Maximum Pressure (P1 > P2)	P <sub>MAX</sub>	75	kPa
Burst Pressure (P > P2)	P <sub>BURST</sub>	100	kPa
Storage Temperature	T <sub>STG</sub>	-40 to +125	°C
Operating Temperature	T <sub>A</sub>	-40 to +125	°C

<sup>1.</sup> Exposure beyond the specified limits may cause permanent damage or degradation to the device.

Table 2. Operating Characteristics (V<sub>S</sub> = 3.0 Vdc, T<sub>A</sub> = 25°C unless otherwise noted, P1 > P2)

Characteristic	Symbol	Min	Тур	Max	Units
Differential Pressure Range <sup>(1)</sup>	P <sub>OP</sub>	0	_	10	kPa
Supply Voltage <sup>(2)</sup>	V <sub>S</sub>	_	3.0	60	V <sub>DC</sub>
Supply Current	Io	_	6.0	_	mAdc
Full Scale Span <sup>(3)</sup>	V <sub>FSS</sub>	20	35	50	mV
Offset <sup>(4)</sup>	V <sub>OFF</sub>	0	20	35	mV
Sensitivity	ΔV/ΔΡ	_	3.5	_	mV/kPa
Linearity <sup>(5)</sup>	_	-1.0	_	1.0	%V <sub>FSS</sub>
Pressure Hysteresis <sup>(5)</sup> (0 to 10 kPa)	_	_	±0.1	_	%V <sub>FSS</sub>
Temperature Hysteresis <sup>(5)</sup> (–40°C to +125°C)	_	_	±0.5	_	%V <sub>FSS</sub>
Temperature Coefficient of Full Scale Span <sup>(5)</sup>	TCV <sub>FSS</sub>	-0.22	_	-0.16	%V <sub>FSS</sub> /°C
Temperature Coefficient of Offset <sup>(5)</sup>	TCV <sub>OFF</sub>	_	±15	_	μV/°C
Temperature Coefficient of Resistance <sup>(5)</sup>	TCR	0.28	_	0.34	%/Z <sub>IN</sub> /°C
Input Impedance	Z <sub>IN</sub>	400	_	550	Ω
Output Impedance	Z <sub>OUT</sub>	750	_	1250	Ω
Response Time <sup>(6)</sup> (10% to 90%)	t <sub>R</sub>	_	1.0	_	ms
Warm-Up Time <sup>(7)</sup>	_	_	20	_	ms
Offset Stability <sup>(8)</sup>	_	_	±0.5	_	%V <sub>FSS</sub>

- 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<sub>FSS</sub>) is defined as the algebraic difference between the output voltage at full rated pressure and the output voltage at the minimum related pressure.
- 4. Offset (VOFF) 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 with 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.
  - TCR: Z<sub>IN</sub> deviation with minimum rated pressure applied, over the temperature range of -40°C to ±125°C, relative to 25°C.
- 6. Response Time is defined as the time form 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 Time is defined as the time required for the product to meet the specified output voltage after the pressure is stabilized.
- 8. Offset stability is the product's output deviation when subjected to 1000 hours of Pulsed Pressure, Temperature Cycling with Bias Test.

#### **TEMPERATURE COMPENSATION**

Figure 2 shows the typical output characteristics of the MPX10 and MPXV10GC series over temperature.

Because this strain gauge is an integral part of the silicon diaphragm, there are no temperature effects due to differences in the thermal expansion of the strain gauge and the diaphragm, as are often encountered in bonded strain gauge pressure sensors. However, the properties of the strain gauge itself are temperature dependent, requiring that the device be temperature compensated if it is to be used over an extensive temperature range.

Temperature compensation and offset calibration can be achieved rather simply with additional resistive components, or by designing your system using the MPX2010D series sensor.

Several approaches to external temperature compensation over both –40 to +125°C and 0 to +80°C ranges are presented in Application Note AN840.

#### **LINEARITY**

Linearity refers to how well a transducer's output follows the equation:  $V_{out} = V_{off} + sensitivity \times P$  over the operating pressure range (Figure 3). There are two basic methods for calculating nonlinearity: 1) end point straight line fit 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.

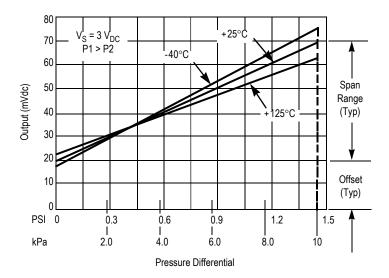


Figure 2. Output versus Pressure Differential

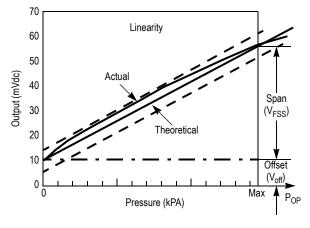


Figure 3. Linearity Specification Comparison

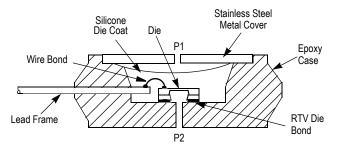


Figure 4. Unibody Package — Cross-Sectional Diagram (Not to Scale)

Figure 4 illustrates the differential or gauge configuration 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 MPX10 and MPXV10GC 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.

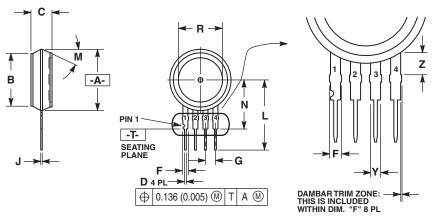
# PRESSURE (P1)/VACUUM (P2) SIDE IDENTIFICATION TABLE

Freescale 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 silicone gel which isolates the die from the environment. The Freescale pressure sensor is designed to operate with positive differential pressure applied, P1 > P2.

The Pressure (P1) side may be identified by using the following table.

Part Number	Case Type	Pressure (P1) Side Identifier
MPX10D	344	Stainless Steep Cap
MPX10DP	344C	Side with Part Marking
MPX10GP	344B	Side with Port Attached
MPX10GS	344E	Side with Port Attached
MPX10GC6U	482A	Side with Part Marking
MPXV10C7U	482C	Side with Part Marking

## **PACKAGE DIMENSIONS**



#### NOTES:

- DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
- CONTROLLING DIMENSION: INCH.
- 3. DIMENSION -A- IS INCLUSIVE OF THE MOLD STOP RING. MOLD STOP RING NOT TO EXCEED 16.00 (0.630).

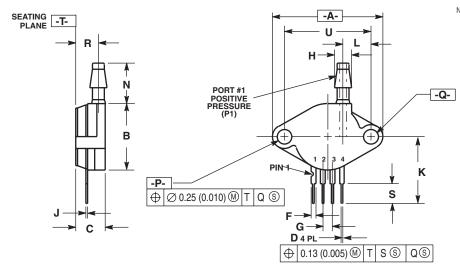
	INCHES		MILLIM	ETERS
DIM	MIN	MAX	MIN	MAX
Α	0.595	0.630	15.11	16.00
В	0.514	0.534	13.06	13.56
С	0.200	0.220	5.08	5.59
D	0.016	0.020	0.41	0.51
F	0.048	0.064	1.22	1.63
G	0.100	BSC	2.54 BSC	
J	0.014	0.016	0.36	0.40
L	0.695	0.725	17.65	18.42
M	30°	NOM	30° 1	MOV
N	0.475	0.495	12.07	12.57
R	0.430	0.450	10.92	11.43
Υ	0.048	0.052	1.22	1.32
Z	0.106	0.118	2.68	3.00

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

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

STYLE 3:
 PIN 1. GND
 2. -VOUT
 3. VS
 4. +VOUT

## CASE 344-15 ISSUE AA UNIBODY PACKAGE



#### NOTES:

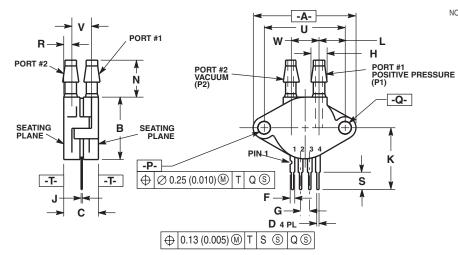
- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: INCH.

MIN			
	MAX	MIN	MAX
1.145	1.175	29.08	29.85
0.685	0.715	17.40	18.16
0.305	0.325	7.75	8.26
0.016	0.020	0.41	0.51
0.048	0.064	1.22	1.63
0.100	BSC	2.54	BSC
0.182	0.194	4.62	4.93
0.014	0.016	0.36	0.41
0.695	0.725	17.65	18.42
0.290	0.300	7.37	7.62
0.420	0.440	10.67	11.18
0.153	0.159	3.89	4.04
0.153	0.159	3.89	4.04
0.230	0.250	5.84	6.35
0.220	0.240	5.59	6.10
0.910	BSC	23.11	BSC
	0.685 0.305 0.016 0.048 0.100 0.182 0.014 0.695 0.290 0.420 0.153 0.153 0.230 0.220	0.685 0.715 0.305 0.325 0.016 0.020 0.048 0.064 0.100 BSC 0.182 0.194 0.014 0.016 0.995 0.725 0.290 0.300 0.420 0.440 0.153 0.159 0.250 0.250	0.685         0.715         17.40           0.305         0.325         7.75           0.016         0.020         0.41           0.048         0.064         1.22           0.100 BSC         2.54           0.182         0.194         4.62           0.014         0.016         0.36           0.695         0.725         17.65           0.290         0.300         7.37           0.420         0.440         10.67           0.153         0.159         3.89           0.230         0.250         5.84           0.220         0.240         5.59

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

CASE 344B-01 ISSUE B UNIBODY PACKAGE

## **PACKAGE DIMENSIONS**



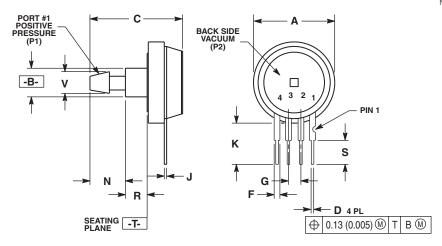
#### NOTES:

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

	INCHES		MILLIN	IETERS
DIM	MIN	MAX	MIN	MAX
Α	1.145	1.175	29.08	29.85
В	0.685	0.715	17.40	18.16
С	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
Н	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
Р	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		23.1	1 BSC
٧	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 UNIBODY PACKAGE**



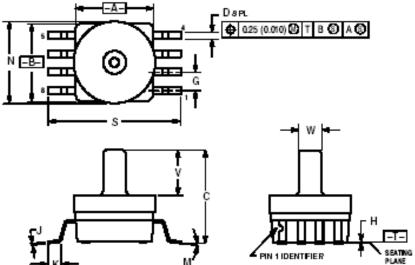
- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- 2. CONTROLLING DIMENSION: INCH.

	INCHES		MILLIM	<b>ETERS</b>
DIM	MIN	MAX	MIN	MAX
Α	0.690	0.720	17.53	18.28
В	0.245	0.255	6.22	6.48
С	0.780	0.820	19.81	20.82
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	
J	0.014	0.016	0.36	0.41
K	0.345	0.375	8.76	9.53
N	0.300	0.310	7.62	7.87
R	0.178	0.186	4.52	4.72
S	0.220	0.240	5.59	6.10
٧	0.182	0.194	4.62	4.93

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

**CASE 344E-01 ISSUE B UNIBODY PACKAGE** 

## **PACKAGE DIMENSIONS**



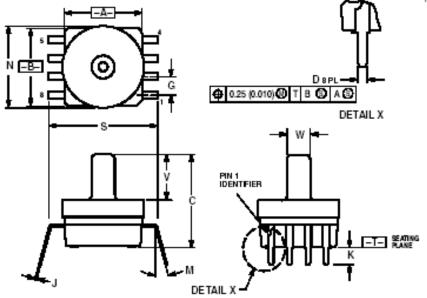
#### NOTES:

- NO TES:

  1. DIMENSIONING AND TOLERANDING PER ANSI
  Y14 SM, 1962.
  2. CONTROLLING DIMENSION: NICH.
  3. DIMENSION AND B DO NOT INCLUDE MOLD PROTRUSION.
  IMAXIMUM NOLD PROTRUSION 0.15 (0.008).
  ALL VERTICAL SURRACES 5° TYPICAL DRAFT.

	NCHES			
DIN	MIN	MAX	ž	NAX
	0.415			
	0.415			
c	0.500	0.520	12.70	1321
0	0.038	0.042	0.96	1.07
ø	0.100	BSC	254	BSC
H	0.002	0.010	0.05	0.25
3	0.009	0.011	0.23	0.28
K	0.061	0.071	1.55	1.80
2	0.0	70	0.0	7 0
N	0.444	0.448	11.28	11.38
	0.709			18.41
٧	0.245	0.255	6.22	6.48
W	0.115	0.125	2.92	3.17

**CASE 482A-01 ISSUE A SMALL OUTLINE PACKAGE** 



NOTES:

- NOTES:

  1. DIMENSIONING AND TO LETANDING PER ANSI-Y145M, 1982.

  2. CONTROLLINGDIMENSION: INCH.

  3. DIMENSION A AND BID ONOT INCLUDE MOLD PROTRUSION.

  4. MAXIMUM MOLD PROTRUSION 0.15 (0.008).

  5. ALL VERTICAL SURFACES 5° TYPICAL DRAFT.

  6. DIMENSION BITO CENTER OF LEAD WHEN PORMED PARAMLEL.

	NCHES		MILLIN	ETERS
DIN	MIN	MAX	NE	NAX
	0.415			
	0.415			
	0.500			
0	0.026	0.034	0.66	0.864
ø	0.100	BBC	254	BSC
7	0.009	0.011	0.23	0.28
K	0.100			3.05
2		15 ∘		15 ₽
N		0.448		11.38
		0.560		14.22
٧	0.245	0.255	6.22	6.48
W	0.115	0.125	2.92	3.17

**CASE 482C-03 ISSUE B SMALL OUTLINE PACKAGE** 

# **NOTES**

# NOTES

# **NOTES**

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