

# **Operating Characteristics**

**Table 1. Operating Characteristics** ( $V_S = 10 V_{DC}$ ,  $T_A = 25$ °C unless otherwise noted, P1 > P2)

Characteristic	Symbol	Min	Тур	Max	Units
Pressure Range <sup>(1)</sup>	P <sub>OP</sub>	0	_	10	kPa
Supply Voltage <sup>(2)</sup>	V <sub>S</sub>	_	10	16	$V_{DC}$
Supply Current	Io	_	6.0	_	mAdc
Full Scale Span <sup>(3)</sup>	V <sub>FSS</sub>	24	25	26	mV
Offset <sup>(4)</sup>	V <sub>OFF</sub>	-1.0	_	1.0	mV
Sensitivity	ΔV/ΔΡ	_	2.5	_	mV/kPa
Linearity	_	-1.0	_	1.0	%V <sub>FSS</sub>
Pressure Hysteresis (0 to 10 kPa)	_	_	±0.1	_	%V <sub>FSS</sub>
Temperature Hysteresis (–40°C to +125°C)	_	_	±0.5	_	%V <sub>FSS</sub>
Temperature Coefficient on Full Scale Span	TCV <sub>FSS</sub>	-1.0	_	1.0	%V <sub>FSS</sub>
Temperature Coefficient on Offset	TCV <sub>OFF</sub>	-1.0	_	1.0	mV
Input Impedance	Z <sub>IN</sub>	1300	_	2550	Ω
Output Impedance	Z <sub>OUT</sub>	1400	_	3000	Ω
Response Time <sup>(5)</sup> (10% to 90%)	t <sub>R</sub>	_	1.0	_	ms
Warm-Up Time	_	_	20	_	ms
Offset Stability <sup>(6)</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 at a different 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.
- 4. Offset (V<sub>OFF</sub>) is defined as the output voltage at the minimum rated pressure.
- 5. 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.
- 6. Offset stability is the product's output deviation when subjected to 1000 hours of Pulsed Pressure, Temperature Cycling with Bias Test.



# **Maximum Ratings**

Table 2. Maximum Ratings<sup>(1)</sup>

Rating	Symbol	Value	Unit
Maximum Pressure (P1 > P2)	P <sub>MAX</sub>	75	kPa
Burst Pressure (P1 > 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.

# **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).

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

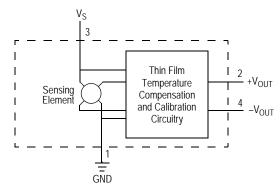


Figure 1. Temperature Compensated and Calibrated Pressure Sensor Schematic

# **On-Chip Temperature Compensation and Calibration**

Figure 2. shows the output characteristics of the MPX2010 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.

This performance over temperature is achieved by having both the shear stress strain gauge and the thin-film resistor circuitry on the same silicon diaphragm. Each chip is dynamically laser trimmed for precise span and offset calibration and temperature compensation.

Figure 3. illustrates the differential/gauge die 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 MPX2010 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.

## **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 4.) 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.

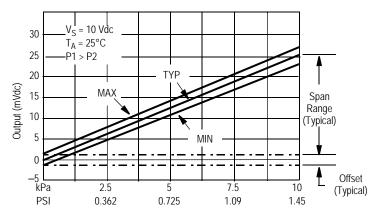


Figure 2. Output vs. Pressure Differential

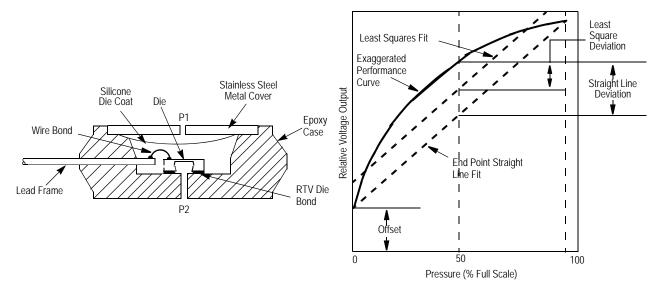


Figure 3. Unibody Package: Cross Sectional Diagram (not to scale)

Figure 4. Linearity Specification Comparison



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

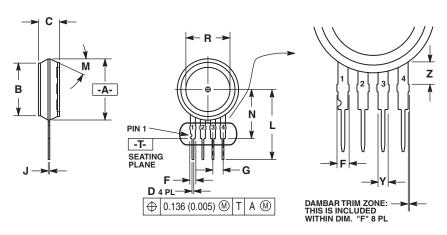
Freescale designates the two sides of the pressure sensor as the Pressure (P1) side and the Vacuum (P2) side. The Pressure (P1) side is the side containing silicone gel which isolates the die from the environment. The pressure sensor is designed to operate with positive differential pressure applied, P1 > P2.

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

Table 3. Pressure (P1) Side Delineation

Part Number	Case Type	Pressure (P1) Side Identifier
MPX2010D	344	Stainless Steel Cap
MPX2010DP	344C	Side with Part Marking
MPX2010GP	344B	Side with Port Attached
MPX2010GS	344E	Side with Port Attached
MPX2010GSX	344F	Side with Port Attached
MPXV2010GP	1369	Side with Port Attached
MPXV2010DP	1351	Side with Part Marking
MPXM2010D/DTI	1320	Side with Part Marking
MPXM2010GS/GSTI	1320A	Side with Port Attached



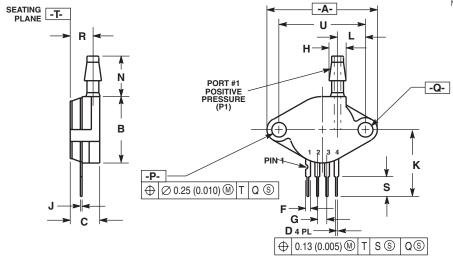


#### NOTES:

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

	INC	HES	MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
Α	0.595	0.630	15.11	16.00
В	0.514	0.534	13.06	13.56
C	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	
7	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
7	0.106	0.118	2 68	3.00

## **CASE 344-15 ISSUE AA UNIBODY PACKAGE**



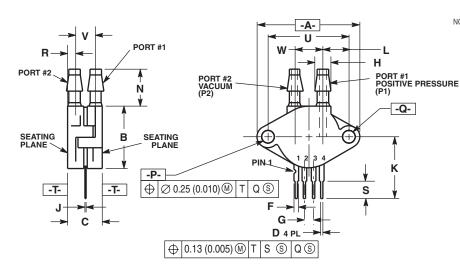
#### NOTES:

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

	INCHES		MILLIM	ETERS
DIM	MIN	MAX	MIN	MAX
Α	1.145	1.175	29.08	29.85
В	0.685	0.715	17.40	18.16
C	0.305	0.325	7.75	8.26
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	0.230	0.250	5.84	6.35
S	0.220	0.240	5.59	6.10
U	0.910	BSC	23.11	BSC

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



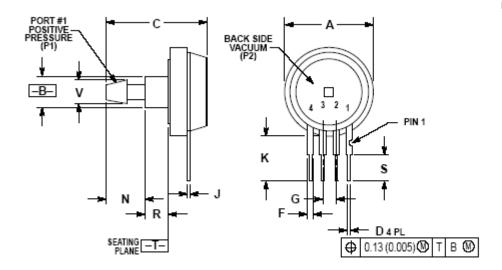


- DIMENSIONING AND TOLERANCING PER ANSI
- 2. CONTROLLING DIMENSION: INCH.

	INCHES MILLIMETE		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**



#### NOTES:

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

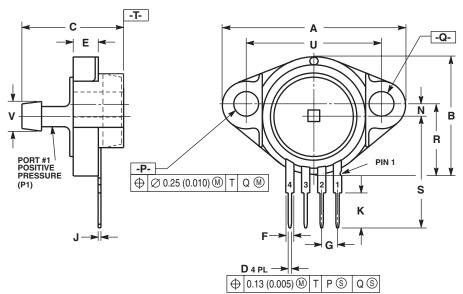
	INCHES		MILLIM	ETERS
DIM	MIN	MAX	MIN	MAX
Α	0.690	0.720	17.53	18.28
В	0.245	0.255	6.22	6.48
С	0.780	0.820	19.81	20.82
D	0.016	0.020	0.41	0.51
F	0.048	0.064	1.22	1.63
G	0.100	BSC	2.54 BSC	
J	0.014	0.016	0.36	0.41
K	0.345	0.375	8.76	9.53
N	0.300	0.310	7.62	7.87
R	0.178	0.186	4.52	4.72
S	0.220	0.240	5.59	6.10
V	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** 





- NOTES:

  1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

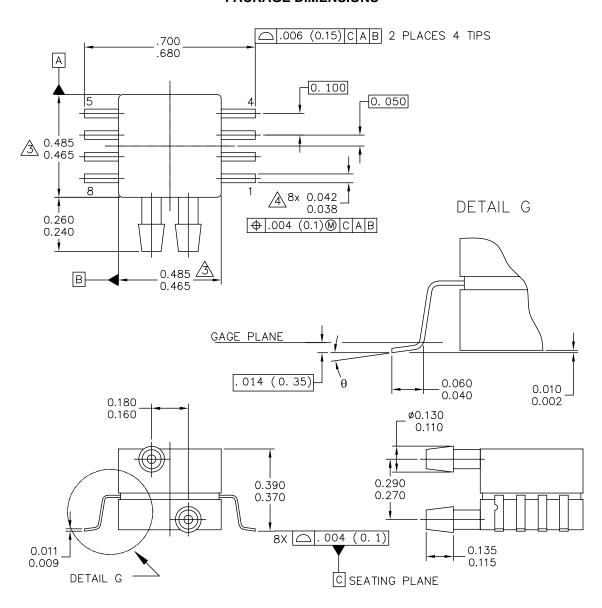
  2. CONTROLLING DIMENSION: INCH.

	INCHES		MILLIM	IETERS
DIM	MIN	MAX	MIN	MAX
Α	1.080	1.120	27.43	28.45
В	0.740	0.760	18.80	19.30
С	0.630	0.650	16.00	16.51
D	0.016	0.020	0.41	0.51
E	0.160	0.180	4.06	4.57
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	0.220	0.240	5.59	6.10
N	0.070	0.080	1.78	2.03
Р	0.150	0.160	3.81	4.06
Q	0.150	0.160	3.81	4.06
R	0.440	0.460	11.18	11.68
S	0.695	0.725	17.65	18.42
U	0.840	0.860	21.34	21.84
٧	0.182	0.194	4.62	4.92

STYLE 1: PIN 1. GROUND 2. V (+) OUT 3. V SUPPLY 4. V (-) OUT

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## CASE1351-01 ISSUE A SMALL OUTLINE PACKAGE



#### NOTES:

- 1. CONTROLLING DIMENSION: INCH
- 2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
- DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PPROTRUSIONS.

  MOLD FLASH AND PROTRUSIONS SHALL NOT EXCEED .006 PER SIDE.
- DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .008 MAXIMUM.

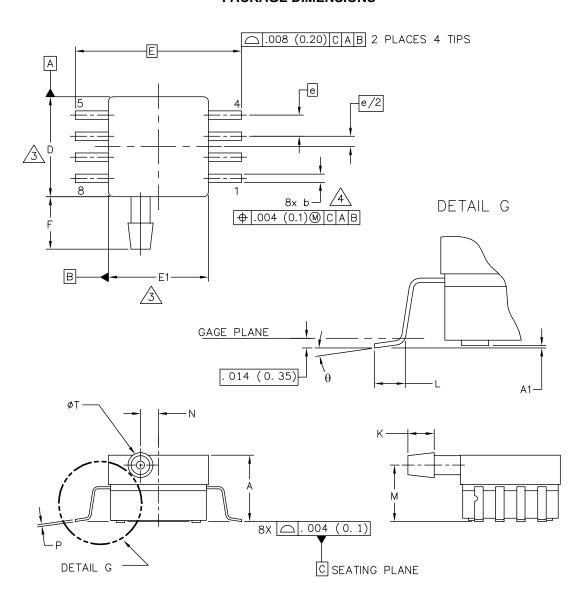
STYLE 1:		STYLE 2:		
PIN 1:	GND	PIN	1:	N/C
PIN 2:	+Vout	PIN	2:	٧s
PIN 3:	Vs	PIN	3:	GND
PIN 4:	−Vout	PIN	4:	Vout
PIN 5:	N/C	PIN	5:	N/C
PIN 6:	N/C	PIN	6:	N/C
PIN 7:	N/C	PIN	7:	N/C
PIN 8:	N/C	PIN	8:	N/C

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8 LD SOP, SIDE PORT		CASE NUMBER	: 1369–01	24 MAY 2005
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PAGE 1 OF 2

## CASE 1369-01 ISSUE B SMALL OUTLINE PACKAGE



NOTES:

- 1. CONTROLLING DIMENSION: INCH
- 2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
- △ DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PPROTRUSIONS.

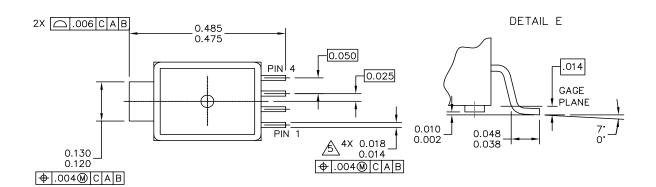
  MOLD FLASH AND PROTRUSIONS SHALL NOT EXCEED .006 (0.152) PER SIDE.
- A DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .008 (0.203) MAXIMUM.

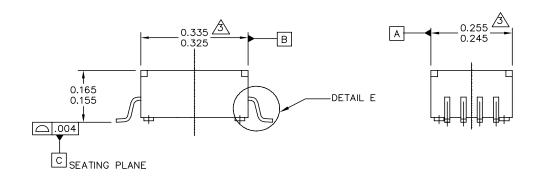
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A 1	. 002	. 010	0. 05	0. 25	_				
b	. 038	. 042	0. 96	1. 07	_				
D	. 465	. 485	11. 81	12. 32	_				
E	. 717 BSC		18	.21 BSC	-				
E1	. 465	. 485	11. 81	12. 32	_				
е	. 100	BSC	2.	54 BSC	_				
F	. 245	. 255	6. 22	6. 47	_				
K	. 120	. 130	3. 05	3. 30	-				
L	. 061	. 071	1. 55	1. 80	_				
М	. 270	. 290	6. 86	7. 36	-				
N	. 080	. 090	2. 03	2. 28	_				
Р	. 009	. 011	0. 23	0. 28	-				
Т	. 115	. 125	2. 92	3. 17	_				
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CASE 1320-02 ISSUE B MPAK



#### NOTES:

- 1. DIMENSIONS ARE IN INCHES.
- 2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.

DIMENSION DOES NOT INCLUDE MOLD FLASH OR PROTRUSION. MOLD FLASH OR PROTRUSION SHALL NOT EXCEED .006" PER SIDE.

4. ALL VERTICAL SURFACES TO BE 5' MAXIMUM.

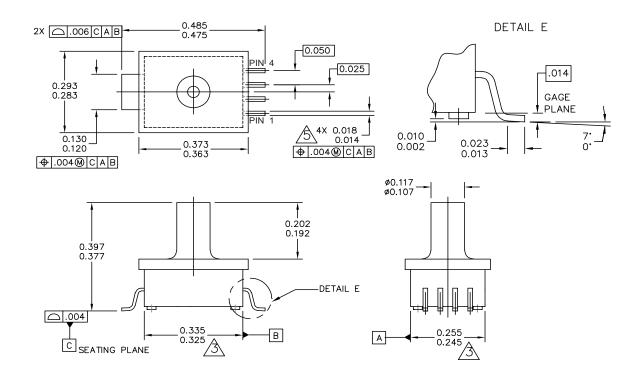
DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION.
ALLOWABLE DAMBAR PROTRUSION SHALL BE .008 MAXIMUM.

PIN 1: GND PIN 2: +Vout PIN 3: Vs PIN 4: -Vout

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CASE 1320-02 ISSUE A MPAK





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CASE 1320A-02 ISSUE A MPAK



### NOTES:

- 1. DIMENSIONS ARE IN INCHES.
- 2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.

DIMENSIONS DOES NOT INCLUDE MOLD FLASH OR PROTRUSION. MOLD FLASH OR PROTRUSION SHALL NOT EXCEED .006" PER SIDE.

4. ALL VERTICAL SURFACES TO BE 5" MAXIMUM.

DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .008 MAXIMUM.

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5 LD M-PAC, POR	CASE NUMBER	R: 1320A-02	22 JUL 2005	
		STANDARD: NO	N-JEDEC	

CASE 1320-02 ISSUE A MPAK



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