

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

The MPX2053/MPXV2053G 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.

## Features

- Temperature Compensated Over 0°C to +85°C
- 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

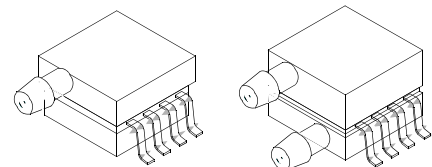
## ORDERING INFORMATION

Device Type	Options	Case No.	MPX Series Order No.	Packing Options	Device Marking
<b>SMALL OUTLINE PACKAGE (MPXV2053G SERIES)</b>					
Ported Elements	Gauge, Side Port, SMT	1369	MPXV2053GP	Trays	MPXV2053G
	Differential Dual Port, SMT	1351	MPXV2053DP	Trays	MPXV2053G
<b>UNIBODY PACKAGE (MPX2053 SERIES)</b>					
Basic Element	Differential	344	MPX2053D	—	MPX2053D
Ported Elements	Differential, Dual Port	344C	MPX2053DP	—	MPX20153DP
	Gauge	344B	MPX2053GP	—	MPX2053GP
	Gauge, Axial PC Mount	344F	MPX2053GSX	—	MPX2053D
	Gauge, Vacuum	344D	MPX2053GVP	—	MPX2053GVP

## MPX2053 MPXV2053G SERIES

0 TO 50 kPa (0 TO 7.25 psi)  
40 mV FULL SCALE SPAN  
(TYPICAL)

## SMALL OUTLINE PACKAGES



MPXV2053GP  
CASE 1369-01

MPXV2053DP  
CASE 1351-01

## SMALL OUTLINE PACKAGE PIN NUMBERS

1	GND <sup>(1)</sup>	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

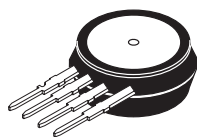
1. Pin 1 in noted by the notch in the lead.

## UNIBODY PACKAGE PIN NUMBERS

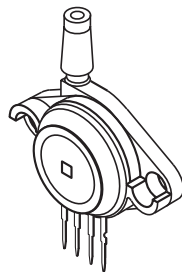
1	GND <sup>(1)</sup>	3	V <sub>S</sub>
2	+V <sub>OUT</sub>	4	-V <sub>OUT</sub>

1. Pin 1 in noted by the notch in the lead.

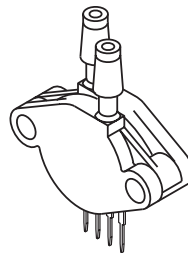
## UNIBODY PACKAGES



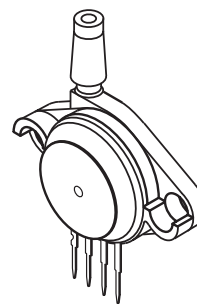
MPX2053GP  
CASE 344-15



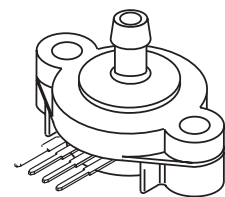
MPX2053GP  
CASE 344B-01



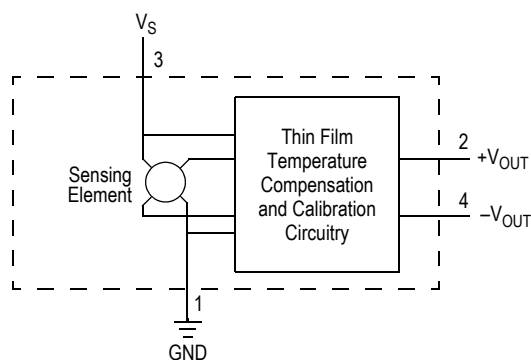
MPX2053DP  
CASE 344C-01



MPX2053GVP  
CASE 344D-01



MPX2053GSX  
CASE 344F-01



**Figure 1. Temperature Compensated and Calibrated 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).

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

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

Rating	Symbol	Value	Unit
Maximum Pressure (P1 > P2)	$P_{MAX}$	20	kPa
Storage Temperature	$T_{STG}$	-40 to +125	°C
Operating Temperature	$T_A$	-40 to +125	°C

1. Exposure beyond the specified limits may cause permanent damage or degradation to the device.

**Table 2. Operating Characteristics** ( $V_S = 10 V_{DC}$ ,  $T_A = 25^\circ C$  unless otherwise noted,  $P1 > P2$ )

Characteristic	Symbol	Min	Typ	Max	Units
Pressure Range <sup>(1)</sup>	$P_{OP}$	0	—	50	kPa
Supply Voltage <sup>(2)</sup>	$V_S$	—	10	16	$V_{DC}$
Supply Current	$I_O$	—	6.0	—	mAdc
Full Scale Span <sup>(3)</sup>	$V_{FSS}$	38.5	40	41.5	mV
Offset <sup>(4)</sup>	$V_{OFF}$	-1.0	—	1.0	mV
Sensitivity	$\Delta V/\Delta P$	—	0.8	—	mV/kPa
Linearity <sup>(5)</sup>	—	-0.6	—	0.4	% $V_{FSS}$
Pressure Hysteresis <sup>(5)</sup> (0 to 50 kPa)	—	—	$\pm 0.1$	—	% $V_{FSS}$
Temperature Hysteresis <sup>(5)</sup> ( $-40^\circ C$ to $+125^\circ C$ )	—	—	$\pm 0.5$	—	% $V_{FSS}$
Temperature Effect on Full Scale Span <sup>(5)</sup>	$TCV_{FSS}$	-2.0	—	2.0	% $V_{FSS}$
Temperature Effect on Offset <sup>(5)</sup>	$TCV_{OFF}$	-1.0	—	1.0	mV
Input Impedance	$Z_{IN}$	1000	—	2550	$\Omega$
Output Impedance	$Z_{OUT}$	1400	—	3000	$\Omega$
Response Time <sup>(6)</sup> (10% to 90%)	$t_R$	—	1.0	—	ms
Warm-Up Time	—	—	2.0	—	ms
Offset Stability <sup>(7)</sup>	—	—	$\pm 0.5$	—	% $V_{FSS}$

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 related pressure.

4. Offset ( $V_{OFF}$ ) is defined as the output voltage at the minimum rated pressure.

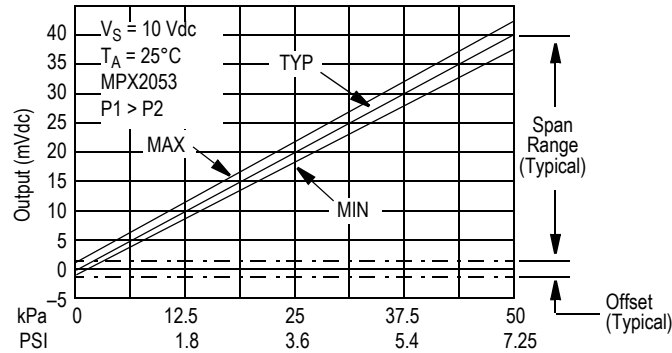
5. Accuracy (error budget) consists of the following:

- Linearity: Output deviation from a straight line relationship with pressure 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  $25^\circ C$ .
- TcSpan: Output deviation over the temperature range of  $0^\circ$  to  $85^\circ C$ , relative to  $25^\circ C$ .
- TcOffset: Output deviation with minimum rated pressure applied, over the temperature range of  $0^\circ$  to  $85^\circ C$ , relative to  $25^\circ C$ .
- Variation from Nominal: The variation from nominal values, for Offset or Full Scale Span, as a percent of  $V_{FSS}$ , at  $25^\circ C$ .

6. Response Time is defined as the time from 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. Offset stability is the product's output deviation when subjected to 1000 hours of Pulsed Pressure, Temperature Cycling with Bias Test.

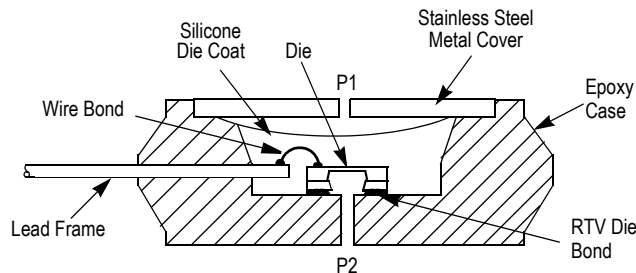
## ON-CHIP TEMPERATURE COMPENSATION AND CALIBRATION



**Figure 2. Output vs. Pressure Differential**

Figure 2 shows the output characteristics of the MPX2053/MPXV2053G 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. Unibody Package: Cross Sectional Diagram (Not to Scale)**

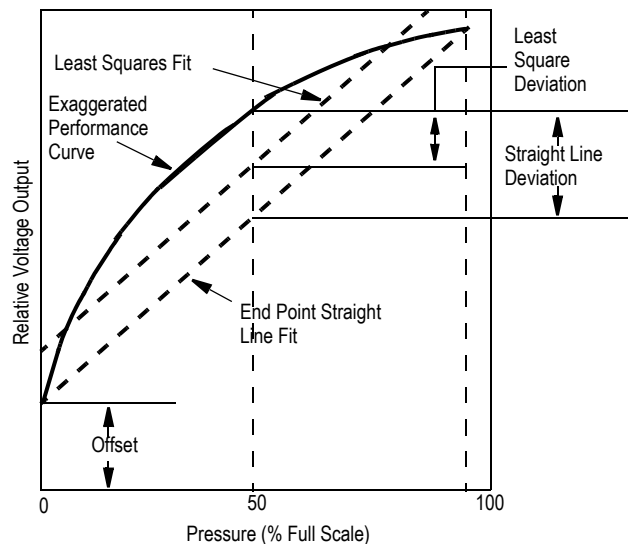
Figure 3 illustrates the differential/gauge die in the basic chip carrier (Case 344). A silicone gel isolates the die surface and wire bonds from the environment, while allowing the pressure signal to be transmitted to the silicon diaphragm.

The MPX2053/MPXV2053G 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 4. Linearity Specification Comparison**

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

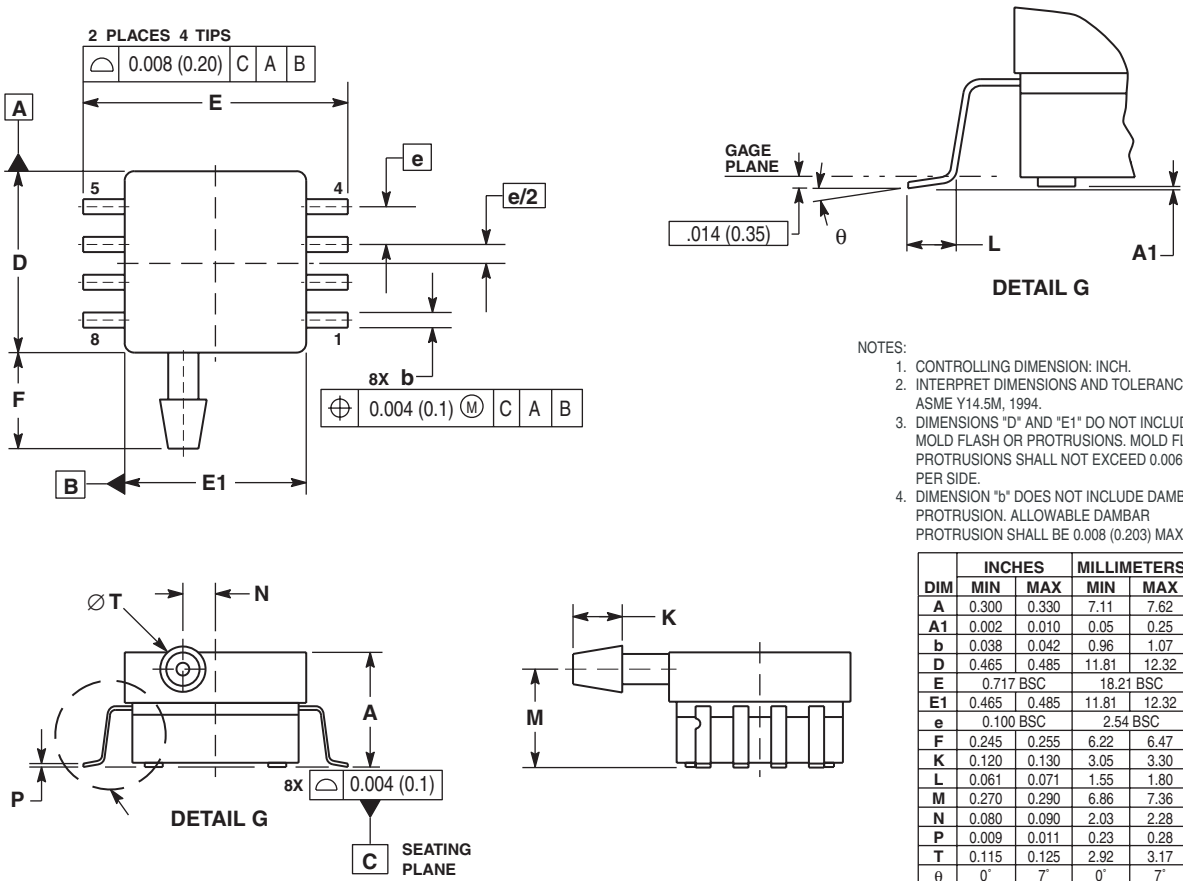
Freescale designates the two sides of the pressure sensor as the Pressure (P1) side and the Vacuum (P2) side. The Pressure (P1) side is the side containing silicone gel which isolates the die from the environment. The Freescale MPX pressure sensor is designed to operate with positive differential pressure 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
MPX2053D	344	Stainless Steep Cap
MPX2053DP	344C	Side with Part Marking
MPX2053GP	344B	Side with Port Attached
MPX2053GSX	344F	Side with Port Attached
MPXV2053GVP	344D	Stainless Steep Cap
MPXV2053GP	1369	Side with Port Attached
MPXV2053DP	1351	Side with Part Marking

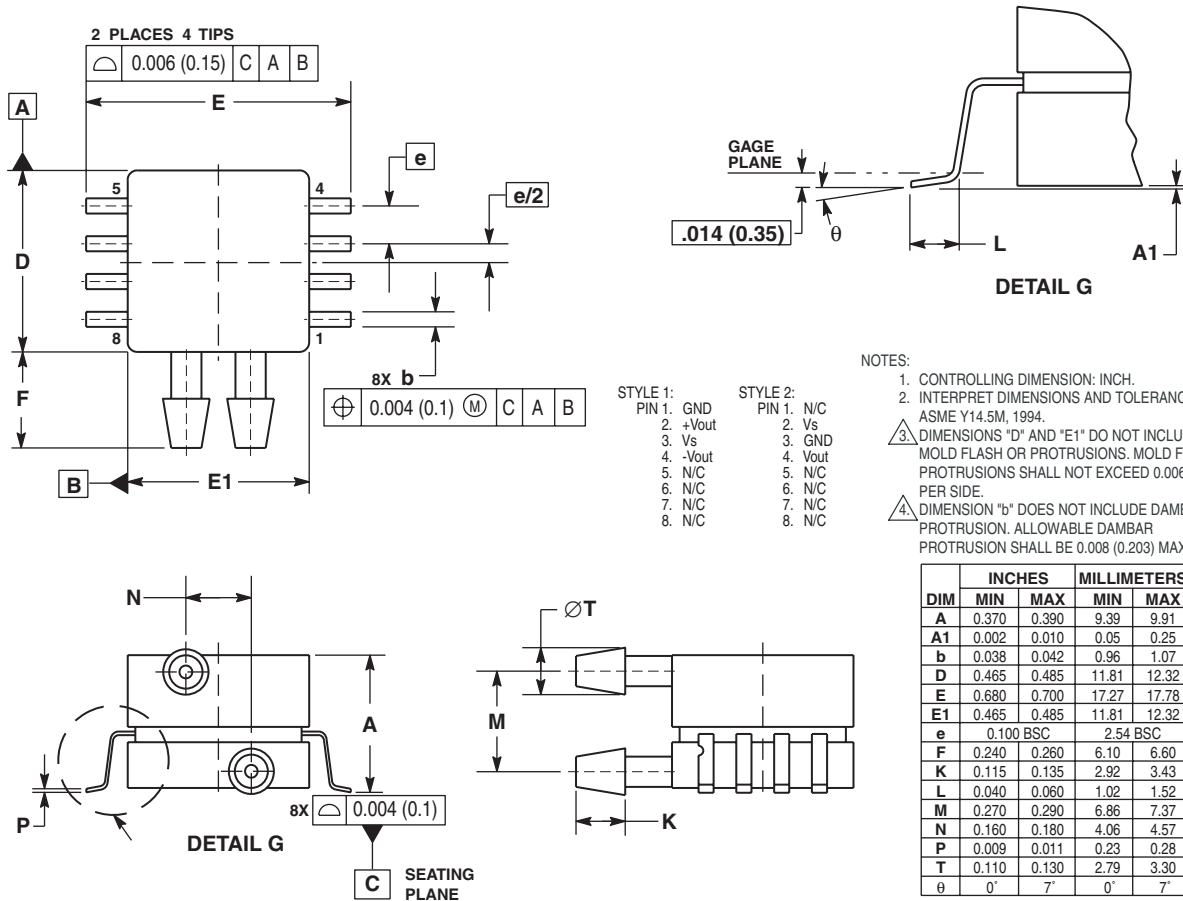
## PACKAGE DIMENSIONS



- NOTES:
1. CONTROLLING DIMENSION: INCH.
  2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
  3. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.006 (0.152) PER SIDE.
  4. DIMENSION "b" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.008 (0.203) MAXIMUM.

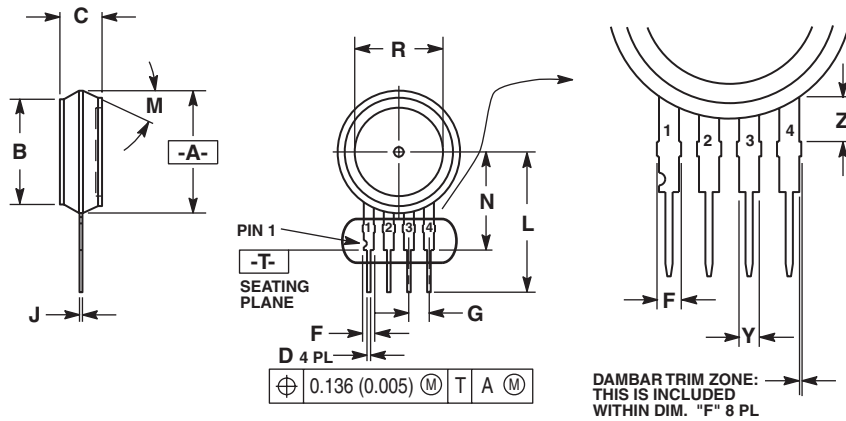
### CASE 1369-01 ISSUE O SMALL OUTLINE PACKAGE

## PACKAGE DIMENSIONS



### CASE 1351-01 ISSUE O SMALL OUTLINE PACKAGE

## PACKAGE DIMENSIONS

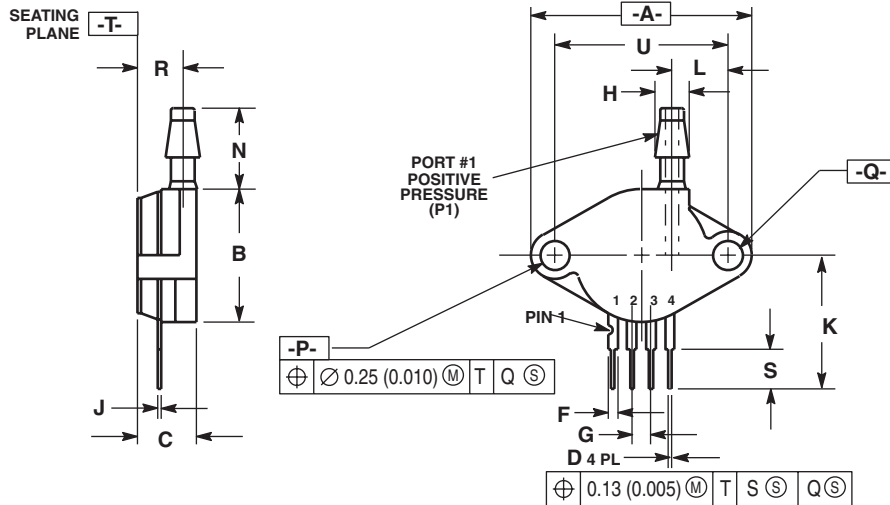


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
  2. CONTROLLING DIMENSION: INCH.
  3. DIMENSION -A- IS INCLUSIVE OF THE MOLD STOP RING. MOLD STOP RING NOT TO EXCEED 16.00 (0.630).

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.595	0.630	15.11	16.00
B	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	
J	0.014	0.016	0.36	0.40
L	0.695	0.725	17.65	18.42
M	30° NOM		30° NOM	
N	0.475	0.495	12.07	12.57
R	0.430	0.450	10.92	11.43
Y	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. V<sub>CC</sub>  
 2. - SUPPLY  
 3. + SUPPLY  
 4. GROUND
- STYLE 3:  
 PIN 1. GND  
 2. -VOUT  
 3. VS  
 4. +VOUT

### CASE 344-15 ISSUE AA UNIBODY PACKAGE



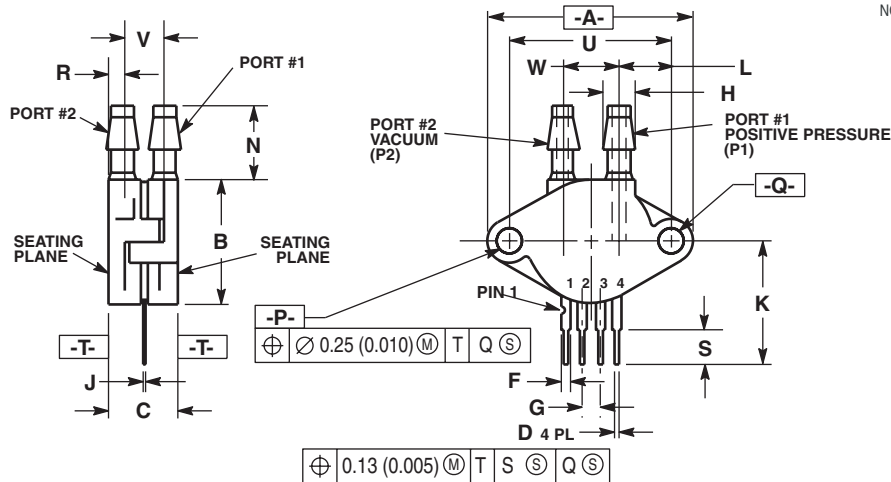
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.

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	0.305	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	
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	0.230	0.250	5.84	6.35
S	0.220	0.240	5.59	6.10
U	0.910 BSC		23.11 BSC	

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

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

## PACKAGE DIMENSIONS

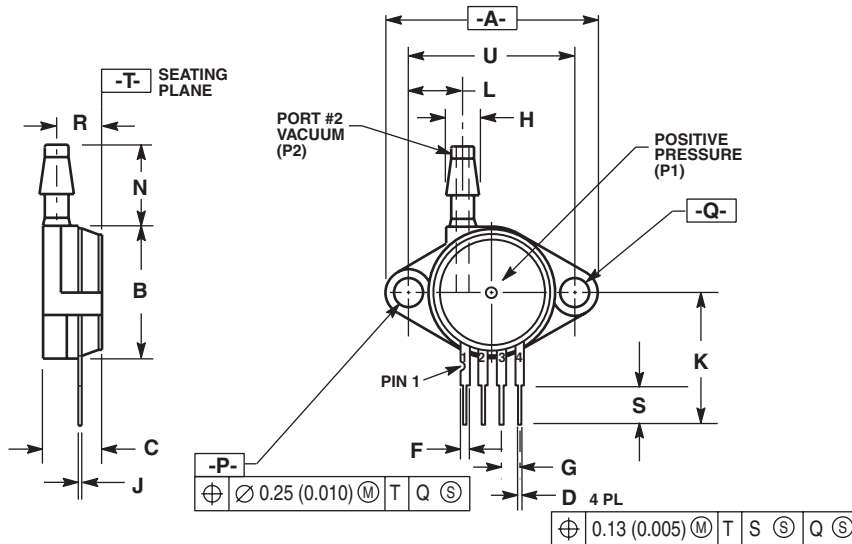


- NOTES:  
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.  
 2. CONTROLLING DIMENSION: INCH.

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 UNIBODY PACKAGE



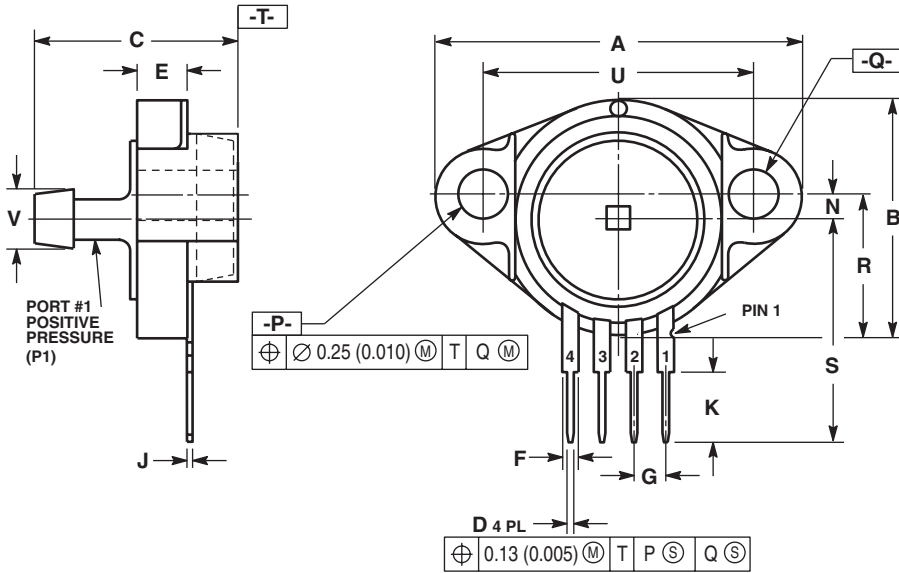
- NOTES:  
 1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.  
 2. CONTROLLING DIMENSION: INCH.

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	0.305	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	
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	0.158	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	

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

### CASE 344D-01 ISSUE O UNIBODY PACKAGE

## PACKAGE DIMENSIONS



**NOTES:**

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

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.080	1.120	27.43	28.45
B	0.740	0.760	18.80	19.30
C	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
P	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
V	0.182	0.194	4.62	4.92

**STYLE 1:**

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

### CASE 344F-01 ISSUE B UNIBODY PACKAGE

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## NOTES

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### **USA/Europe or Locations Not Listed:**

Freescale Semiconductor  
Technical Information Center, CH370  
1300 N. Alma School Road  
Chandler, Arizona 85224  
+1-800-521-6274 or +1-480-768-2130  
support@freescale.com

### **Europe, Middle East, and Africa:**

Freescale Halbleiter Deutschland GmbH  
Technical Information Center  
Schatzbogen 7  
81829 Muenchen, Germany  
+44 1296 380 456 (English)  
+46 8 52200080 (English)  
+49 89 92103 559 (German)  
+33 1 69 35 48 48 (French)  
support@freescale.com

### **Japan:**

Freescale Semiconductor Japan Ltd.  
Headquarters  
ARCO Tower 15F  
1-8-1, Shimo-Meguro, Meguro-ku,  
Tokyo 153-0064  
Japan  
0120 191014 or +81 3 5437 9125  
support.japan@freescale.com

### **Asia/Pacific:**

Freescale Semiconductor Hong Kong Ltd.  
Technical Information Center  
2 Dai King Street  
Tai Po Industrial Estate  
Tai Po, N.T., Hong Kong  
+800 2666 8080  
support.asia@freescale.com

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