

200 kPa On-Chip Temperature Compensated & Calibrated Pressure Sensors

The MPX2202/MPXV2202G device series 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
- Easy-to-Use Chip Carrier Package Options
- 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.

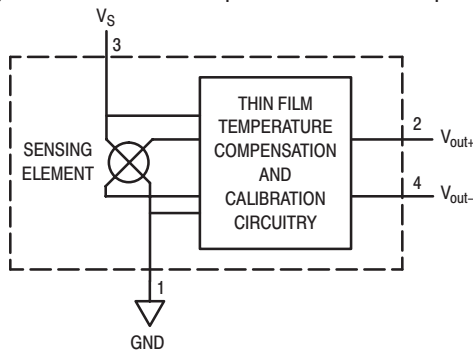


Figure 1. Temperature Compensated Pressure Sensor Schematic

VOLTAGE OUTPUT versus APPLIED DIFFERENTIAL PRESSURE

The differential voltage output of the sensor 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.

Replaces MPX2200/D

REV 2

**MPX2202
MPXV2202G
SERIES**

Motorola Preferred Device

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

**SMALL OUTLINE PACKAGE
SURFACE MOUNT**

**MPXV2202GP
CASE 1369**

**MPXV2202DP
CASE 1351**

PIN NUMBER			
1	Gnd	5	N/C
2	+V _{out}	6	N/C
3	V _S	7	N/C
4	-V _{out}	8	N/C

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

UNIBODY PACKAGE

**MPX2202A/D
CASE 344**

**MPX2202AP/GP
CASE 344B**

**MPX2202DP
CASE 344C**

**MPX2202ASX/GSX
CASE 344F**

PIN NUMBER			
1	Gnd	3	V _S
2	+V _{out}	4	-V _{out}

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

**MPX2202GVP
CASE 344D**

Freescale Semiconductor, Inc.

MAXIMUM RATINGS(NOTE)

Rating	Symbol	Value	Unit
Maximum Pressure (P1 > P2)	P _{max}	800	kPa
Storage Temperature	T _{stg}	-40 to +125	°C
Operating Temperature	T _A	-40 to +125	°C

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

OPERATING CHARACTERISTICS (V_S = 10 Vdc, T_A = 25°C unless otherwise noted, P1 > P2)

Characteristics	Symbol	Min	Typ	Max	Unit	
Pressure Range ⁽¹⁾	P _{OP}	0	—	200	kPa	
Supply Voltage	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	—	0.2	—	mV/kPa	
Linearity ⁽⁵⁾	MPX2202D Series MPX2202A Series	—	-0.6	—	0.4	%V _{FSS}
		—	-1.0	—	1.0	%V _{FSS}
Pressure Hysteresis ⁽⁵⁾ (0 to 200 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 ⁽⁷⁾	—	—	±0.5	—	%V _{FSS}	

NOTES:

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 rated 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, 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.
6. 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.
7. 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.

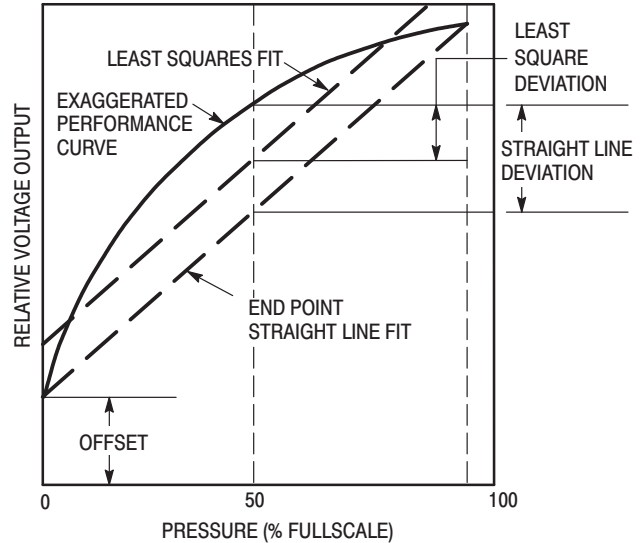


Figure 2. Linearity Specification Comparison

ON-CHIP TEMPERATURE COMPENSATION and CALIBRATION

Figure 3 shows the output characteristics of the MPX2202/MPXV2202G 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.

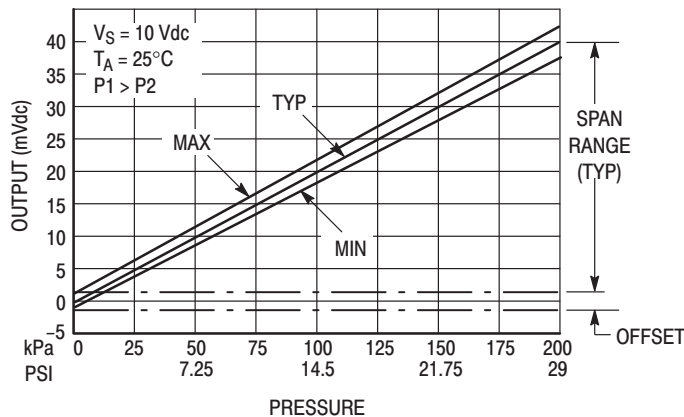


Figure 3. Output versus Pressure Differential

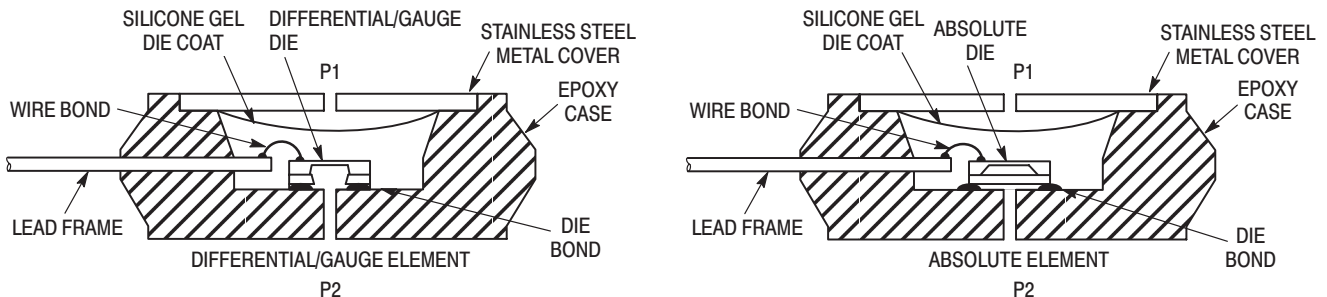


Figure 4. Cross-Sectional Diagrams (Not to Scale)

Figure 4 illustrates an absolute sensing die (right) and the differential or gauge die in the basic chip carrier (Case 344). 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 MPX2202/MPXV2202G series pressure sensor oper-

ating 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

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
MPX2202A	MPX2202D	344	Stainless Steel Cap
MPX2202DP		344C	Side with Part Marking
MPX2202AP	MPX2202GP	344B	Side with Port Attached
MPX2202GVP		344D	Stainless Steel Cap
MPX2202ASX	MPX2202GSX	344F	Side with Port Attached
MPXV2202GP		1369	Side with Port Attached
MPXV2202DP		1351	Side with Part Marking

ORDERING INFORMATION — UNIBODY PACKAGE (MPX2202 SERIES)

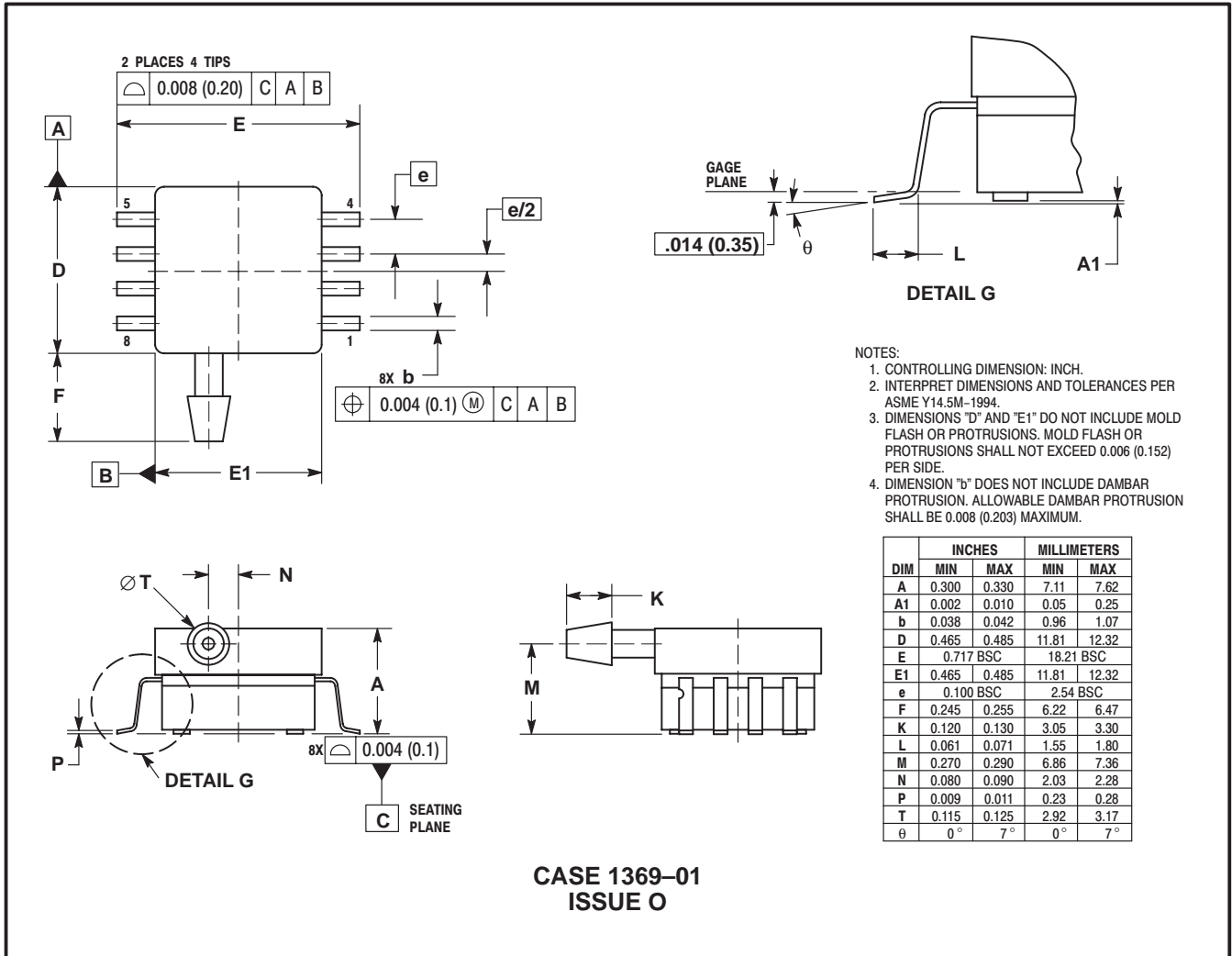
Device Type	Options	Case Type	MPX Series	
			Order Number	Device Marking
Basic Element	Absolute, Differential	344	MPX2202A MPX2202D	MPX2202A MPX2202D
Ported Elements	Differential, Dual Port	344C	MPX2202DP	MPX2202DP
	Absolute, Gauge	344B	MPX2202AP MPX2202GP	MPX2202AP MPX2202GP
	Absolute, Gauge Axial	344F	MPX2202ASX MPX2202GSX	MPX2202A MPX2202D
	Gauge, Vacuum	344D	MPX2202GVP	MPX2202GVP

ORDERING INFORMATION — SMALL OUTLINE PACKAGE (MPXV2202G SERIES)

Device Type	Options	Case No.	MPX Series Order No.	Packing Options	Marking
Ported Elements	Gauge, Side Port, SMT	1369	MPXV2202GP	Trays	MPXV2202G
	Differential, Dual Port, SMT	1351	MPXV2202DP	Trays	MPXV2202G

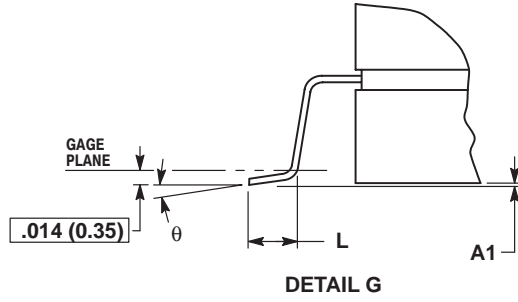
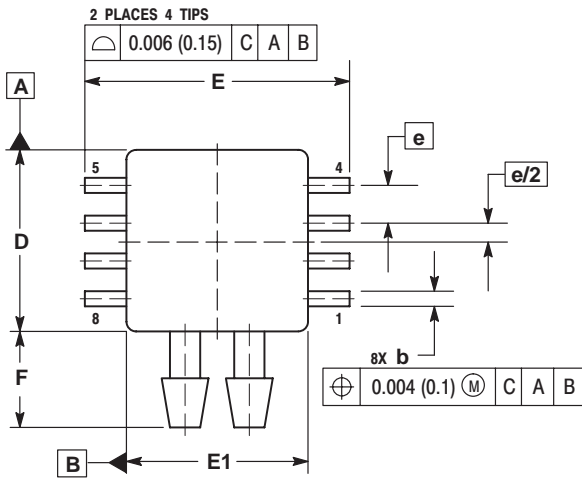
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SMALL OUTLINE PACKAGE DIMENSIONS

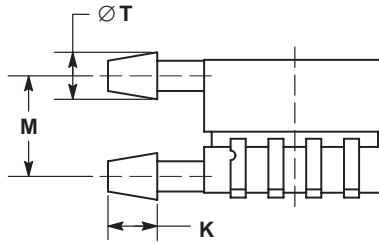
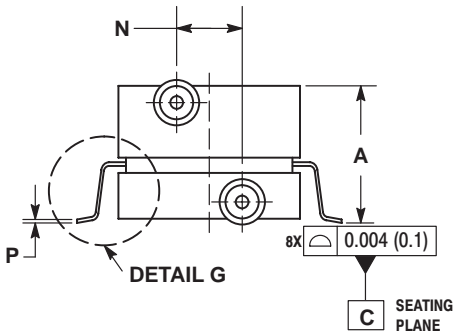


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SMALL OUTLINE PACKAGE DIMENSIONS—CONTINUED



- 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.
- | | |
|------------|------------|
| STYLE 1: | STYLE 2: |
| PIN 1. GND | PIN 1. N/C |
| 2. +Vout | 2. Vs |
| 3. Vs | 3. GND |
| 4. -Vout | 4. Vout |
| 5. N/C | 5. N/C |
| 6. N/C | 6. N/C |
| 7. N/C | 7. N/C |
| 8. N/C | 8. N/C |



**CASE 1351-01
 ISSUE O**

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.370	0.390	9.39	9.91
A1	0.002	0.010	0.05	0.25
b	0.038	0.042	0.96	1.07
D	0.465	0.485	11.81	12.32
E	0.680	0.700	17.27	17.78
E1	0.465	0.485	11.81	12.32
e	0.100 BSC		2.54 BSC	
F	0.240	0.260	6.10	6.60
K	0.115	0.135	2.92	3.43
L	0.040	0.060	1.02	1.52
M	0.270	0.290	6.86	7.37
N	0.160	0.180	4.06	4.57
P	0.009	0.011	0.23	0.28
T	0.110	0.130	2.79	3.30
θ	0°	7°	0°	7°

Freescale Semiconductor, Inc. MPX2202 MPXV2202G SERIES

UNIBODY 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_{CC}
 2. - SUPPLY
 3. + SUPPLY
 4. GROUND

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

**CASE 344-15
 ISSUE Z**

NOTES:

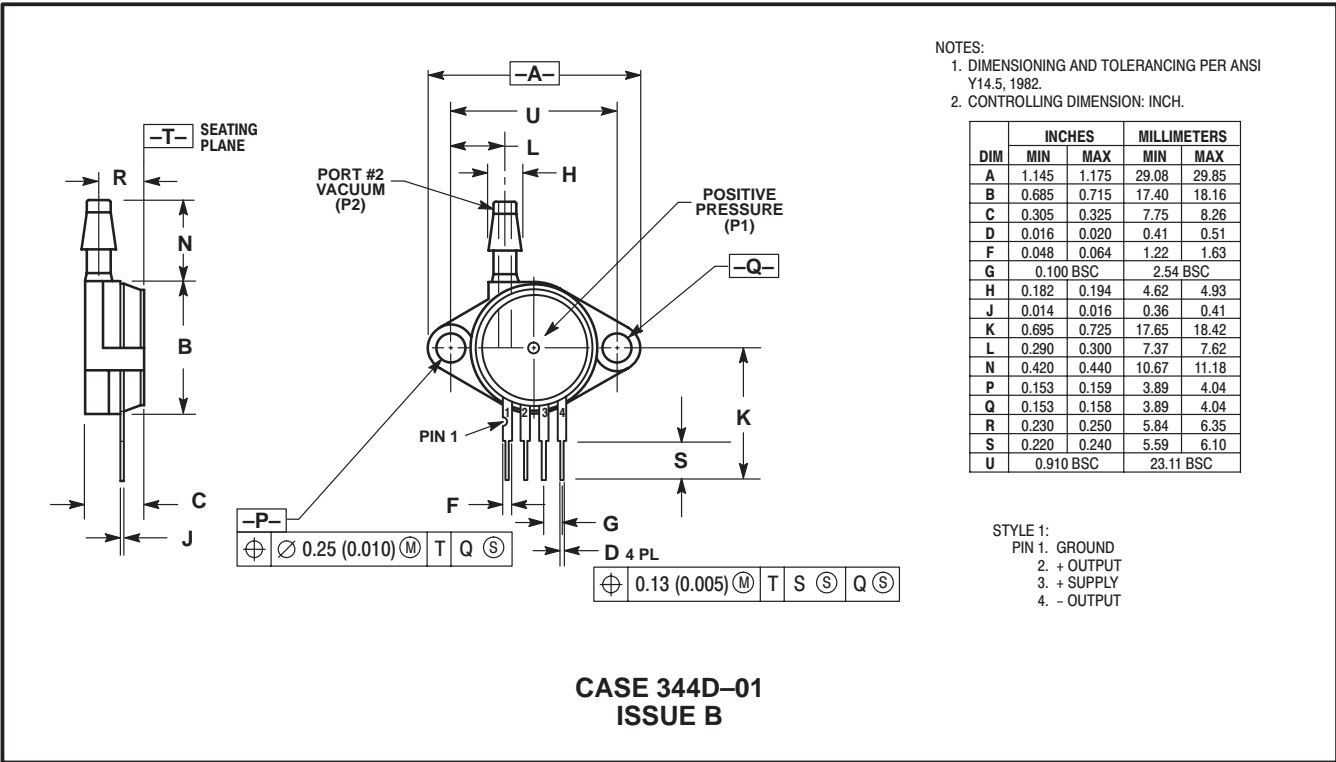
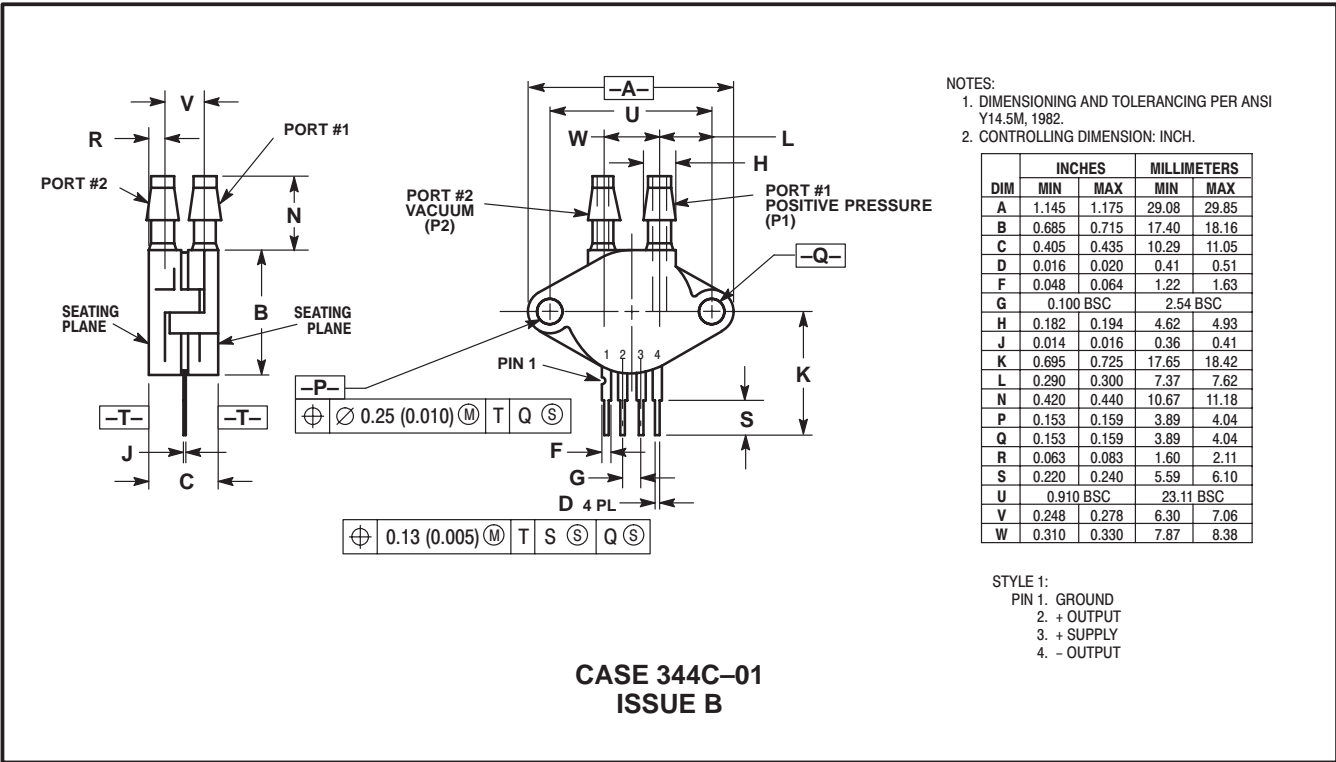
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1982.
2. CONTROLLING DIMENSION: INCH.

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

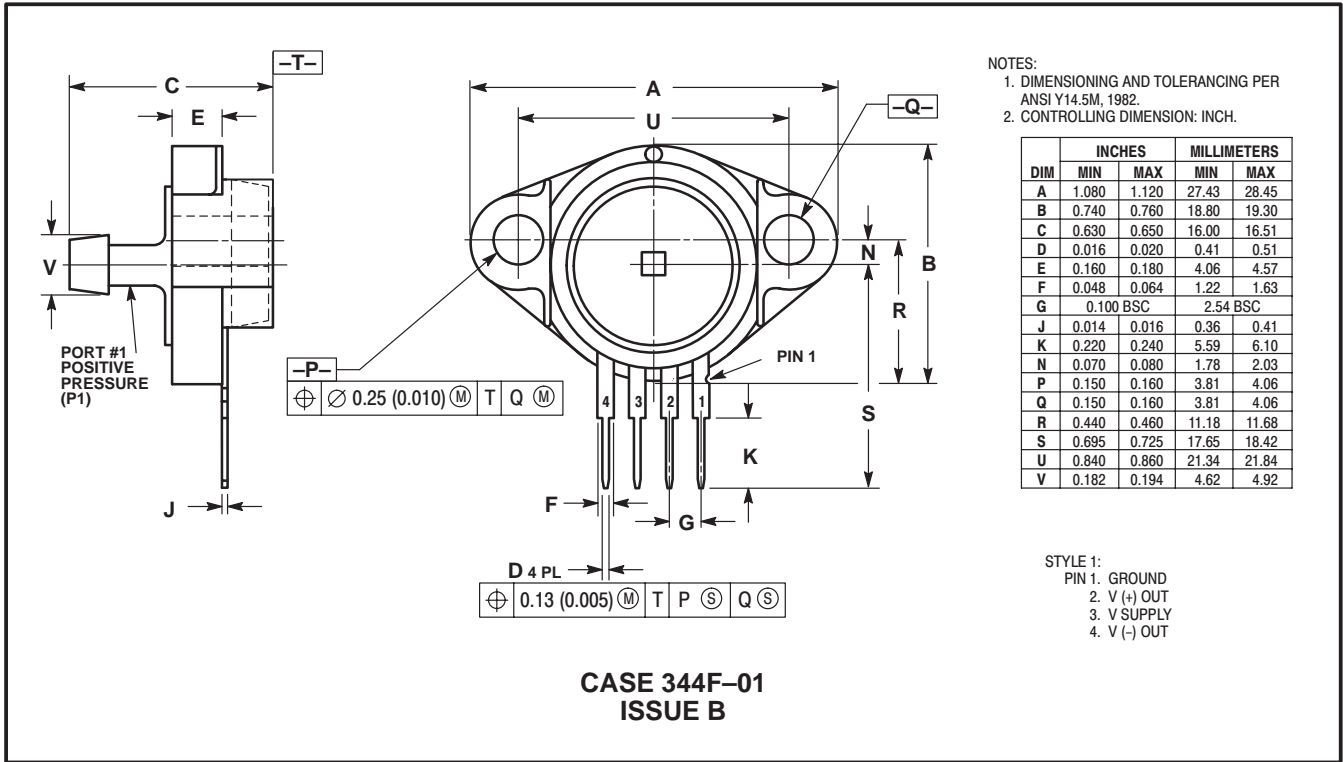
**CASE 344B-01
 ISSUE B**

UNIBODY PACKAGE DIMENSIONS — CONTINUED



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UNIBODY PACKAGE DIMENSIONS — CONTINUED



NOTES

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NOTES

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MPX2202/D