

0 to 200 kPa (0 to 29 PSI) Uncompensated, Silicon Pressure Sensors

The MPX200 series device is a silicon piezoresistive pressure sensors provide a very accurate and linear voltage output — directly proportional to the applied pressure. This standard, low cost, uncompensated sensor permits manufacturers to design and add their own external temperature compensating and signal conditioning networks. Compensation techniques are simplified because of the predictability of Motorola's single element strain gauge design.

Features

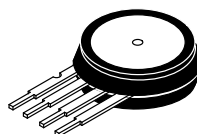
- Low Cost
- Patented Silicon Shear Stress Strain Gauge
- $\pm 0.25\%$ (max) Linearity
- Full Scale Span 60 mV (Typ)
- Easy to Use Chip Carrier Package Options
- Ratiometric to Supply Voltage
- Absolute, Differential and Gauge Options

Application Examples

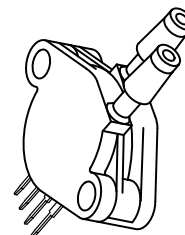
- Pump/Motor Controllers
- Robotics
- Level Indicators
- Medical Diagnostics
- Pressure Switching
- Barometers
- Altimeters

MPX200 SERIES

X-ducer™ SILICON PRESSURE SENSORS



**BASIC CHIP
CARRIER ELEMENT
CASE 344-08
Style 1**



**DIFFERENTIAL
PORT OPTION
CASE 352-02
Style 1**

Pin Number			
1	2	3	4
Ground	+V _{out}	V _S	-V _{out}

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Overpressure ⁽⁸⁾ (P ₁ > P ₂)	P _{max}	400	kPa
Burst Pressure ⁽⁸⁾ (P ₁ > P ₂)	P _{burst}	2000	kPa
Storage Temperature	T _{stg}	-50 to +150	°C
Operating Temperature	T _A	-40 to +125	°C

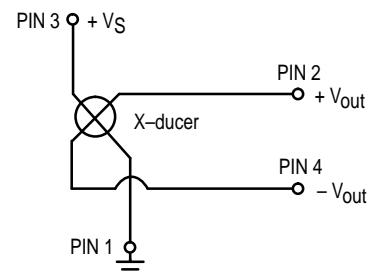
VOLTAGE OUTPUT versus APPLIED DIFFERENTIAL PRESSURE

The differential voltage output of the X-ducer 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.

Figure 1 illustrates a schematic of the internal circuitry on the stand-alone pressure sensor chip.



**Figure 1. Uncompensated Pressure
Sensor Schematic**

X-ducer is a trademark of Motorola, Inc.

MPX200 SERIES

OPERATING CHARACTERISTICS ($V_S = 3.0$ Vdc, $T_A = 25^\circ\text{C}$ unless otherwise noted, $P_1 > P_2$)

Characteristic	Symbol	Min	Typ	Max	Unit
Pressure Range ⁽¹⁾	P_{OP}	0	—	200	kPa
Supply Voltage ⁽²⁾	V_S	—	3.0	6.0	Vdc
Supply Current	I_o	—	6.0	—	mAdc
Full Scale Span ⁽³⁾	V_{FSS}	45	60	90	mV
Offset ⁽⁴⁾	V_{off}	0	20	35	mV
Sensitivity	$\Delta V/\Delta P$	—	0.3	—	mV/kPa
Linearity ⁽⁵⁾	—	-0.25	—	0.25	% V_{FSS}
Pressure Hysteresis ⁽⁵⁾ (0 to 200 kPa)	—	—	± 0.1	—	% V_{FSS}
Temperature Hysteresis ⁽⁵⁾ (-40°C to $+125^\circ\text{C}$)	—	—	± 0.5	—	% V_{FSS}
Temperature Coefficient of Full Scale Span ⁽⁵⁾	TCV_{FSS}	-0.22	—	-0.16	% $V_{FSS}/^\circ\text{C}$
Temperature Coefficient of Offset ⁽⁵⁾	TCV_{off}	—	± 15	—	$\mu\text{V}/^\circ\text{C}$
Temperature Coefficient of Resistance ⁽⁵⁾	TCR	0.21	—	0.27	% $Z_{in}/^\circ\text{C}$
Input Impedance	Z_{in}	400	—	550	Ω
Output Impedance	Z_{out}	750	—	1800	Ω
Response Time ⁽⁶⁾ (10% to 90%)	t_R	—	1.0	—	ms
Offset Stability ⁽⁵⁾	—	—	± 0.5	—	% V_{FSS}

MECHANICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Weight (Basic Element Case 344)	—	—	2.0	—	Grams
Warm-Up	—	—	15	—	Sec
Cavity Volume	—	—	—	0.01	IN^3
Volumetric Displacement	—	—	—	0.001	IN^3
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 .
 - Offset Stability: Output deviation, after 1000 temperature cycles, -40 to 125°C , and 1.5 million pressure cycles, with zero differential pressure applied.
 - 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_{in} deviation with minimum rated pressure applied, over the temperature range of -40°C to $+125^\circ\text{C}$, 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.

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 (see Figure 2). 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 "worse 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.

TEMPERATURE COMPENSATION

Figure 3 shows the typical output characteristics of the MPX200 series over temperature. The output is directly proportional to the pressure and is essentially a straight line.

The X-ducer piezoresistive pressure sensor element is a semiconductor device which gives an electrical output signal

proportional to the pressure applied to the device. This device uses a unique transverse voltage diffused semiconductor strain gauge which is sensitive to stresses produced in a thin silicon diaphragm by the applied pressure.

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 MPX2200/MPX7200 series sensors.

Several approaches to external temperature compensation over both -40 to $+125^{\circ}\text{C}$ and 0 to $+80^{\circ}\text{C}$ ranges are presented in Motorola Applications Note AN840.

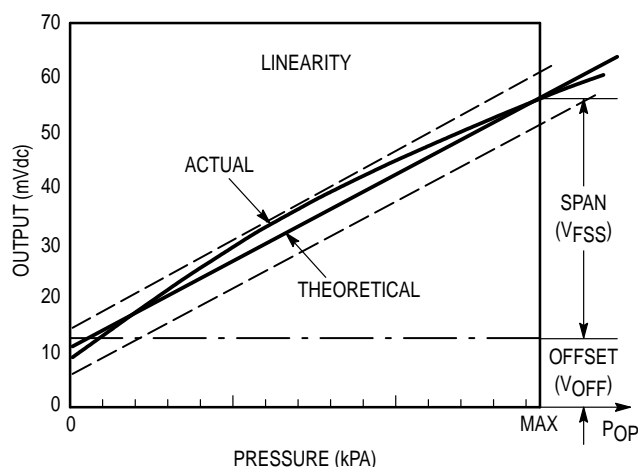


Figure 2. Linearity Specification Comparison

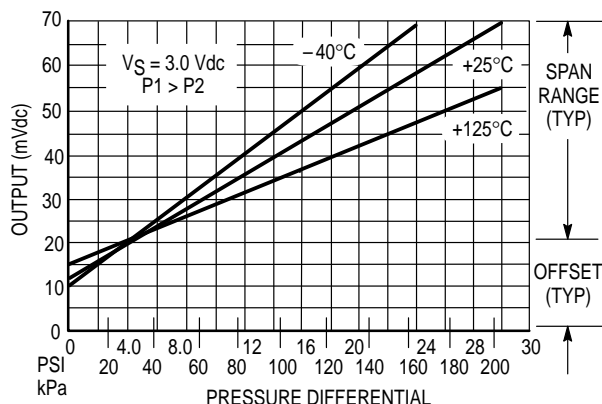


Figure 3. Output versus Pressure Differential

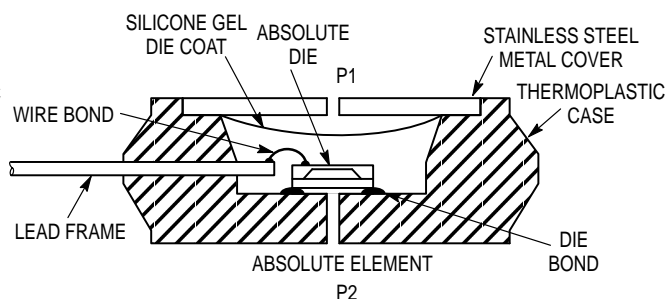
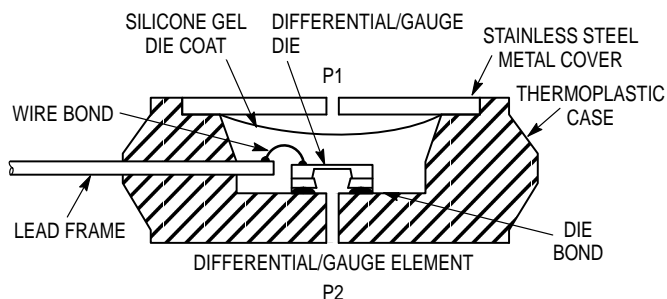


Figure 4. Cross-Sectional Diagrams (Not to Scale)

Figure 4 illustrates the absolute sensing configuration (right) and the differential or gauge configuration in the basic chip carrier (Case 344). A silicone gel isolates the die surface and wire bond from harsh environments, while allowing the pressure signal to be transmitted to the silicon diaphragm. The MPX200 series pressure sensor operating characteris-

tics 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.

MPX200 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 protects the die from harsh media. The differential or gauge sensor is designed to operate with positive differential

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
MPX200A, MPX200D	344-08	Stainless Steel Cap
MPX200DP	352-02	Side with Part Marking
MPX200AP, MPX200GP	350-03	Side with Port Attached
MPX200GVP	350-04	Stainless Steel Cap
MPX200AS, MPX200GS	371-06	Side with Port Attached
MPX200GVS	371-05	Stainless Steel Cap
MPX200ASX, MPX200GSX	371C-02	Side with Port Attached
MPX200GVSX	371D-02	Stainless Steel Cap

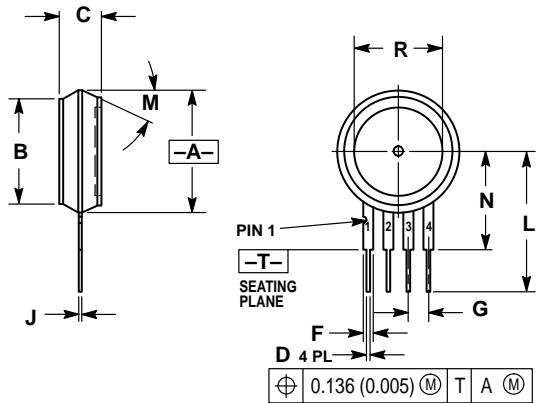
ORDERING INFORMATION

MPX200 series pressure sensors are available in absolute, 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	Absolute, Differential	Case 344-08	MPX200A MPX200D	MPX200A MPX200D
Ported Elements	Differential	Case 352-02	MPX200DP	MPX200DP
	Absolute, Gauge	Case 350-03	MPX200AP MPX200GP	MPX200AP MPX200GP
	Gauge Vacuum	Case 350-04	MPX200GVP	MPX200GVP
	Absolute, Gauge Stove Pipe	Case 371-06	MPX200AS MPX200GS	MPX200A MPX200D
	Gauge Vacuum Stove Pipe	Case 371-05	MPX200GVS	MPX200D
	Absolute, Gauge Axial	Case 371C-02	MPX200ASX MPX200GSX	MPX200A MPX200D
	Gauge Vacuum Axial	Case 371D-02	MPX200GVSX	MPX200D

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PACKAGE DIMENSIONS



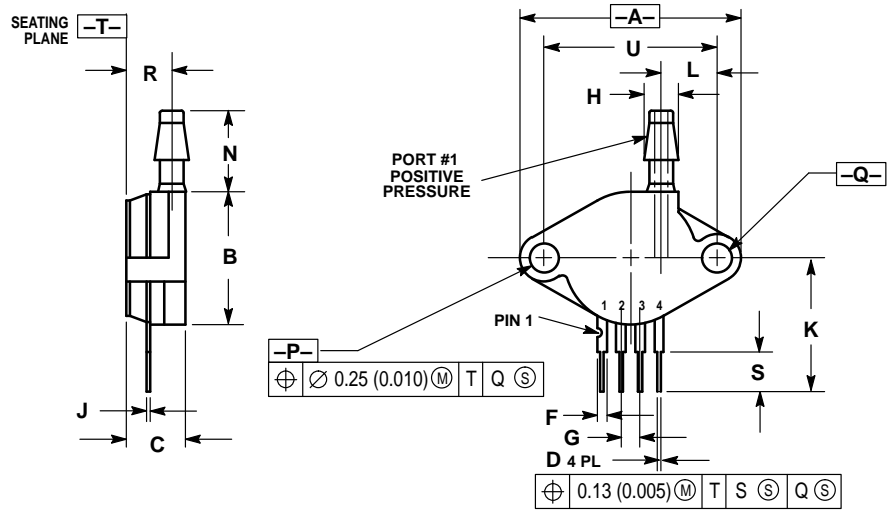
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1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.590	0.615	14.99	15.62
B	0.505	0.525	12.83	13.34
C	0.195	0.225	4.95	5.72
D	0.016	0.020	0.41	0.51
F	0.048	0.052	1.22	1.32
G	0.100 BSC		2.54 BSC	
J	0.014	0.016	0.36	0.40
L	0.685	0.715	17.40	18.16
M	30° NOM		30° NOM	
N	0.480	0.500	12.19	12.70
R	0.420	0.450	10.67	11.43

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

CASE 344-08
ISSUE M

BASIC ELEMENT (A, D)



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

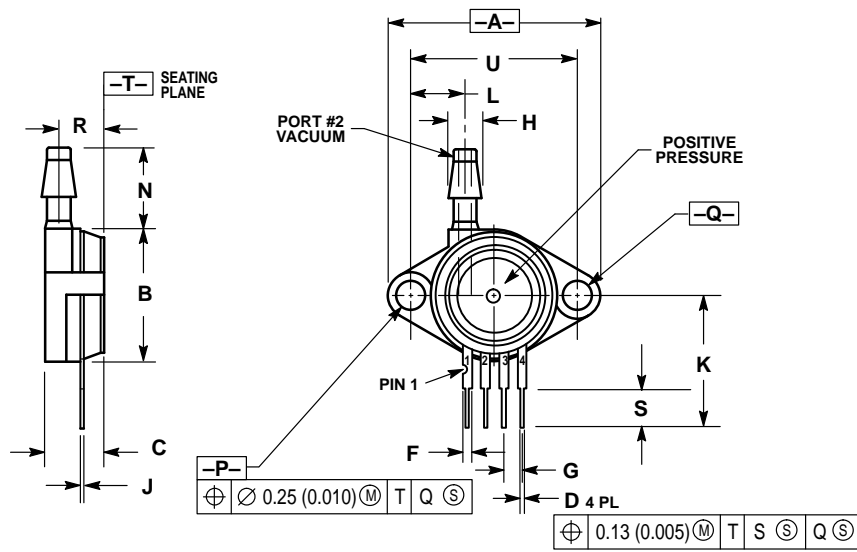
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.140	1.180	28.95	29.97
B	0.685	0.751	17.39	18.16
C	0.305	0.321	7.74	8.15
D	0.016	0.020	0.40	0.50
F	0.048	0.052	1.21	1.32
G	0.100 BSC		2.54 BSC	
H	0.182	0.194	4.62	4.92
J	0.014	0.016	0.35	0.40
K	0.685	0.715	17.39	18.16
L	0.290	0.300	7.34	7.62
N	0.420	0.440	10.67	11.12
P	0.153	0.158	3.88	4.01
Q	0.153	0.158	3.88	4.01
R	0.231	0.250	5.86	6.35
S	0.230 REF		5.84 REF	
U	0.910 BSC		23.11 BSC	

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

CASE 350-03
ISSUE H

PRESSURE SIDE PORTED (AP, GP)

PACKAGE DIMENSIONS — CONTINUED



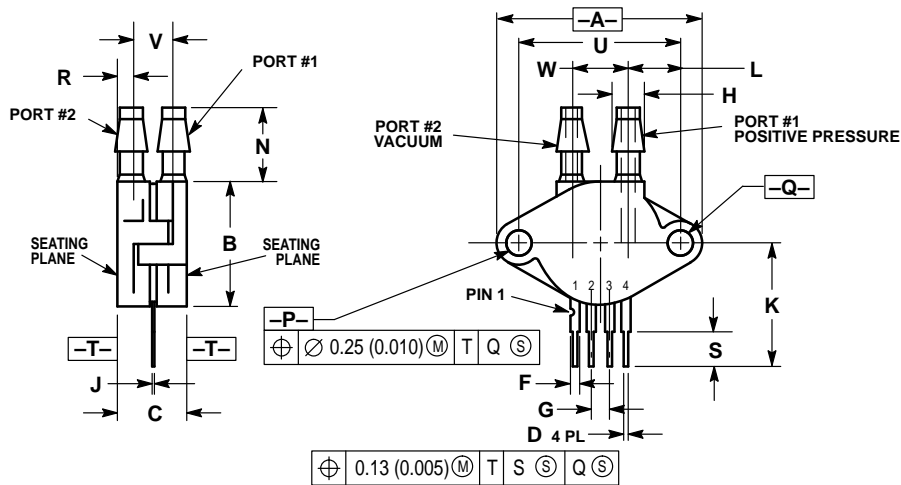
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1982.
 2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.140	1.180	28.95	29.97
B	0.685	0.751	17.39	18.16
C	0.305	0.321	7.74	8.15
D	0.016	0.020	0.40	0.50
F	0.048	0.052	1.21	1.32
G	0.100 BSC		2.54 BSC	
H	0.182	0.194	4.62	4.92
J	0.014	0.016	0.35	0.40
K	0.685	0.715	17.39	18.16
L	0.290	0.300	7.34	7.62
N	0.420	0.430	10.67	10.92
P	0.153	0.158	3.88	4.01
Q	0.153	0.158	3.88	4.01
R	0.231	0.250	5.86	6.35
S	0.230 REF		5.84 REF	
U	0.910 BSC		23.11 BSC	

- STYLE 1:
- PIN 1. GROUND
 - + OUTPUT
 - + SUPPLY
 - OUTPUT

CASE 350-04
ISSUE H

VACUUM SIDE PORTED (GVP)



- NOTES:
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 2. CONTROLLING DIMENSION: INCH.

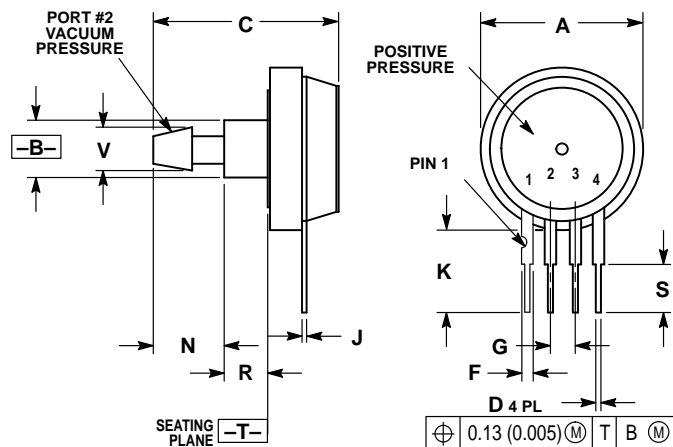
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.140	1.180	28.95	29.97
B	0.685	0.715	17.39	18.16
C	0.380	0.420	9.65	10.66
D	0.016	0.020	0.40	0.50
F	0.048	0.052	1.21	1.32
G	0.100 BSC		2.54 BSC	
H	0.182	0.194	4.62	4.92
J	0.014	0.016	0.35	0.40
K	0.685	0.715	17.39	18.16
L	0.290	0.300	7.34	7.62
N	0.420	0.430	10.67	10.92
P	0.153	0.158	3.88	4.01
Q	0.153	0.158	3.88	4.01
R	0.063	0.083	1.60	2.10
S	0.230 REF		5.84 REF	
U	0.910 BSC		23.11 BSC	
V	0.243	0.273	6.17	6.93
W	0.310	0.330	7.87	8.38

- STYLE 1:
- PIN 1. GROUND
 - + OUTPUT
 - + SUPPLY
 - OUTPUT

CASE 352-02
ISSUE F

PRESSURE AND VACUUM SIDES PORTED (DP)

PACKAGE DIMENSIONS — CONTINUED



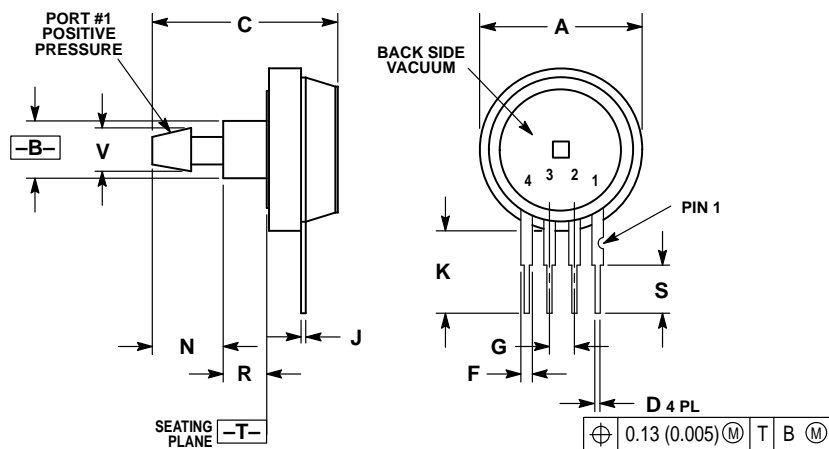
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.690	0.720	17.53	18.28
B	0.247	0.253	6.28	6.42
C	0.780	0.820	19.81	20.82
D	0.016	0.020	0.41	0.50
F	0.048	0.052	1.22	1.32
G	0.100 BSC		2.54 BSC	
J	0.014	0.016	0.36	0.40
K	0.335	0.365	8.51	9.27
N	0.305	0.315	7.75	8.00
R	0.178	0.185	4.53	4.69
S	0.230 REF		5.84 REF	
V	0.182	0.194	4.63	4.92

- STYLE 1:
- PIN 1. GROUND
 - + OUTPUT
 - + SUPPLY
 - OUTPUT

CASE 371-05
ISSUE D

VACUUM SIDE PORTED (GVS)



- NOTES:
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 2. CONTROLLING DIMENSION: INCH.

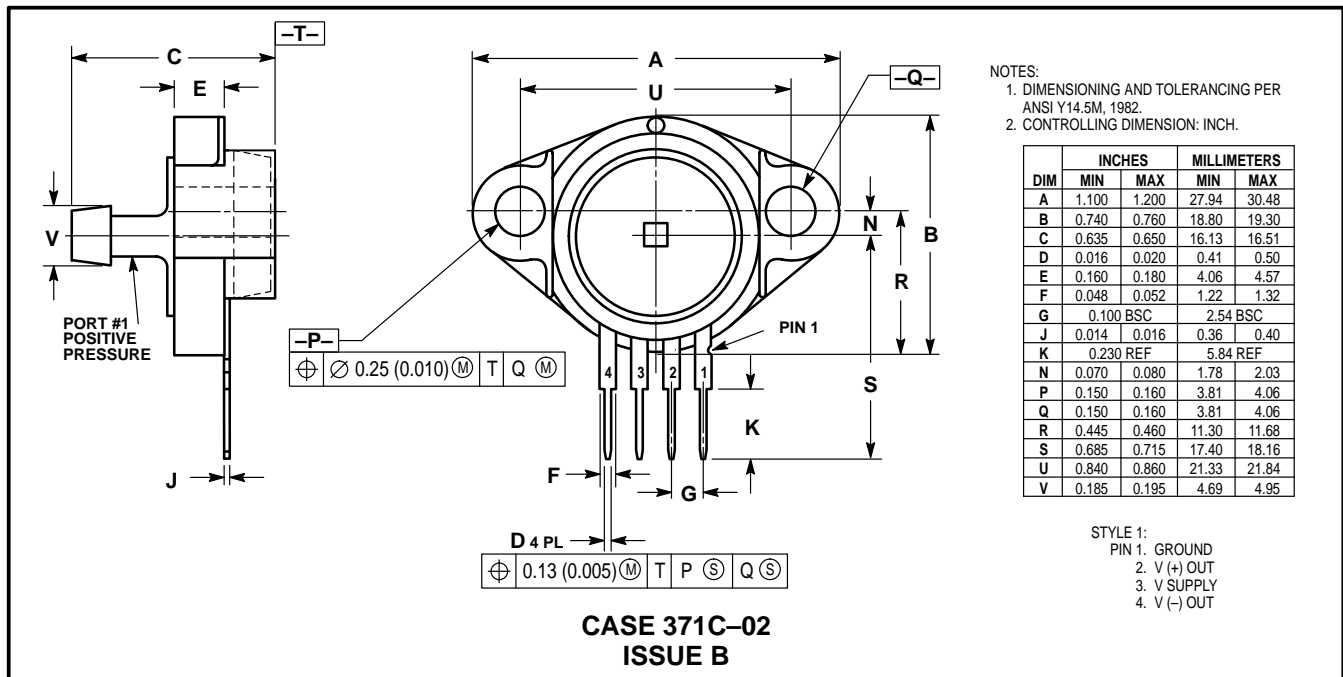
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.690	0.720	17.53	18.28
B	0.247	0.253	6.28	6.42
C	0.780	0.820	19.81	20.82
D	0.016	0.020	0.41	0.50
F	0.048	0.052	1.22	1.32
G	0.100 BSC		2.54 BSC	
J	0.014	0.016	0.36	0.40
K	0.335	0.365	8.51	9.27
N	0.305	0.315	7.75	8.00
R	0.178	0.185	4.53	4.69
S	0.230 REF		5.84 REF	
V	0.182	0.194	4.63	4.92

- STYLE 1:
- PIN 1. GROUND
 - + OUTPUT
 - + SUPPLY
 - OUTPUT

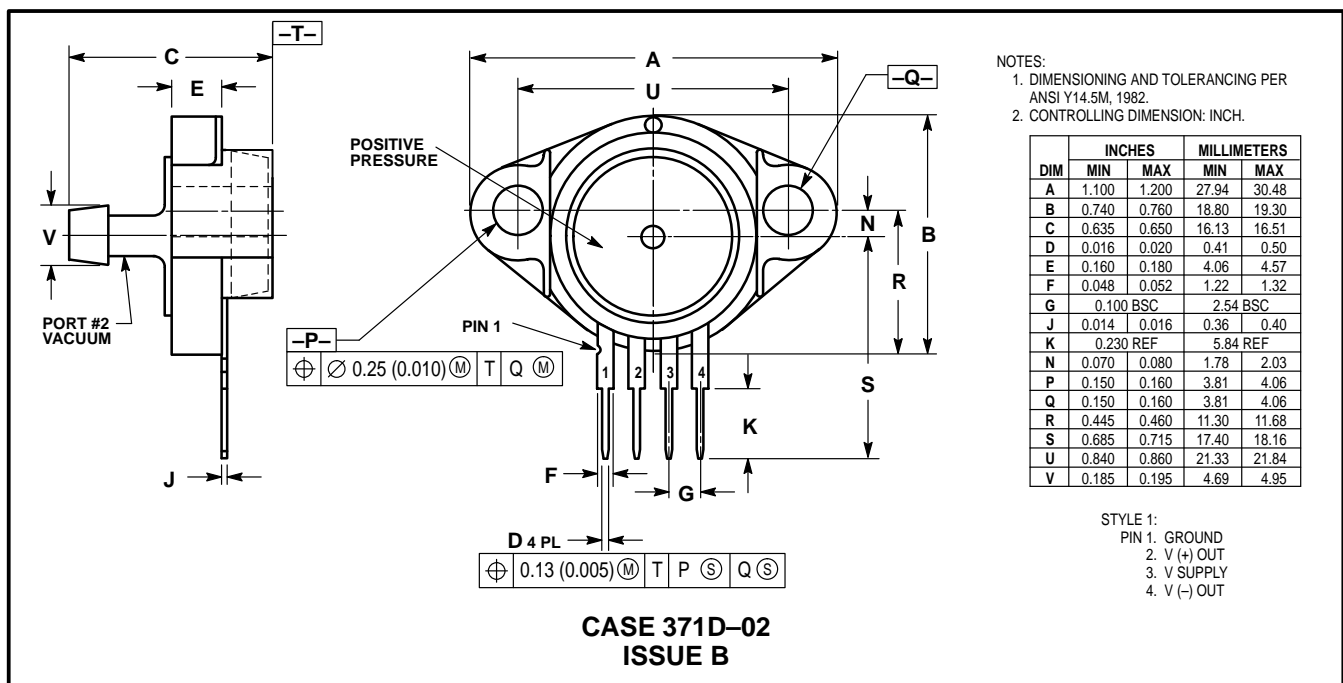
CASE 371-06
ISSUE D

PRESSURE SIDE PORTED (AS, GS)

PACKAGE DIMENSIONS — CONTINUED



PRESSURE SIDE PORTED (ASX, GSX)



VACUUM SIDE PORTED (GVSX)

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