

# 0 to 700 kPa (0 to 100 PSI) Uncompensated, Silicon Pressure Sensors

The MPX700 series device is a silicon piezoresistive pressure sensor providing 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

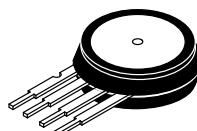
- Low Cost
- Patented, Silicon Shear Stress Strain Gauge Design
- Linearity to  $\pm 0.5\%$  (Max) Linearity
- Easy to Use Chip Carrier Package Options
- Ratiometric to Supply Voltage
- 60 mV Span (typical)
- Absolute, Differential and Gauge Options

## Application Examples

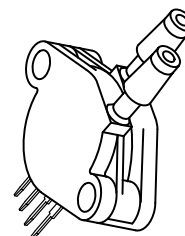
- Environmental Control Systems
- Pneumatic Control Systems
- Appliances
- Automotive Performance Controls
- Medical Instrumentation
- Industrial Controls

## MPX700 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 <sub>out</sub>	V <sub>S</sub>	-V <sub>out</sub>

## MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Overpressure <sup>(8)</sup> (P <sub>1</sub> > P <sub>2</sub> )	P <sub>max</sub>	2800	kPa
Burst Pressure <sup>(8)</sup> (P <sub>1</sub> > P <sub>2</sub> )	P <sub>burst</sub>	5000	kPa
Storage Temperature	T <sub>stg</sub>	-50 to +150	°C
Operating Temperature	T <sub>A</sub>	-40 to +125	°C

## VOLTAGE OUTPUT versus APPLIED DIFFERENTIAL PRESSURE

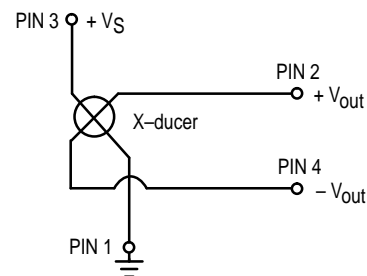
The differential voltage output of the X-ducer is directly proportional to the differential pressure applied.

The absolute sensor has a built-in reference vacuum. The output voltage will decrease as vacuum, relative to ambient, is drawn on the pressure (P<sub>1</sub>) side.

The output voltage of the differential or gauge sensor increases with increasing pressure applied to the pressure side (P<sub>1</sub>) relative to the vacuum side (P<sub>2</sub>). Similarly, output voltage increases as increasing vacuum is applied to the vacuum side (P<sub>2</sub>) relative to the pressure side (P<sub>1</sub>).

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

X-ducer is a trademark of Motorola, Inc.



**Figure 1. Uncompensated Pressure  
Sensor Schematic**

## MPX700 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 <sup>(1)</sup>	P <sub>OP</sub>	0	—	700	kPa
Supply Voltage <sup>(2)</sup>	V <sub>S</sub>	—	3.0	6.0	Vdc
Supply Current	I <sub>O</sub>	—	6.0	—	mAdc
Full Scale Span <sup>(3)</sup>	V <sub>FSS</sub>	45	60	90	mV
Offset <sup>(4)</sup>	V <sub>off</sub>	0	20	35	mV
Sensitivity	$\Delta V/\Delta P$	—	86	—	$\mu\text{V}/\text{kPa}$
Linearity <sup>(5)</sup>	MPX700D MPX700A	— —	—0.5 —1.0	—0.5 1.0	%V <sub>FSS</sub>
Pressure Hysteresis <sup>(5)</sup> (0 to 700 kPa)	—	—	$\pm 0.1$	—	%V <sub>FSS</sub>
Temperature Hysteresis <sup>(5)</sup> ( $-40^\circ\text{C}$ to $+125^\circ\text{C}$ )	—	—	$\pm 0.5$	—	%V <sub>FSS</sub>
Temperature Coefficient of Full Scale Span <sup>(5)</sup>	TCV <sub>FSS</sub>	—0.21	—	—0.15	%V <sub>FSS</sub> /°C
Temperature Coefficient of Offset <sup>(5)</sup>	TCV <sub>off</sub>	—	$\pm 15$	—	$\mu\text{V}/^\circ\text{C}$
Temperature Coefficient of Resistance <sup>(5)</sup>	TCR	0.34	—	0.4	%Z <sub>in</sub> /°C
Input Impedance	Z <sub>in</sub>	400	—	550	$\Omega$
Output Impedance	Z <sub>out</sub>	750	—	1800	$\Omega$
Response Time <sup>(6)</sup> (10% to 90%)	t <sub>R</sub>	—	1.0	—	ms
Offset Stability <sup>(5)</sup>	—	—	$\pm 0.5$	—	%V <sub>FSS</sub>

### 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 <sup>3</sup>
Volumetric Displacement	—	—	—	0.001	IN <sup>3</sup>
Common Mode Line Pressure <sup>(7)</sup>	—	—	—	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<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.
- Offset (V<sub>off</sub>) 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  $125^\circ\text{C}$ , 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  $85^\circ\text{C}$ , relative to  $25^\circ\text{C}$ .
  - TcOffset: Output deviation with minimum rated pressure applied, over the temperature range of 0 to  $85^\circ\text{C}$ , relative to  $25^\circ\text{C}$ .
  - TCR: Z<sub>in</sub> deviation with minimum rated pressure applied, over the temperature range of  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$ , relative to  $25^\circ\text{C}$ .
- 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.

### TEMPERATURE COMPENSATION

Figure 2 shows the typical output characteristics of the MPX700 series over temperature.

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.

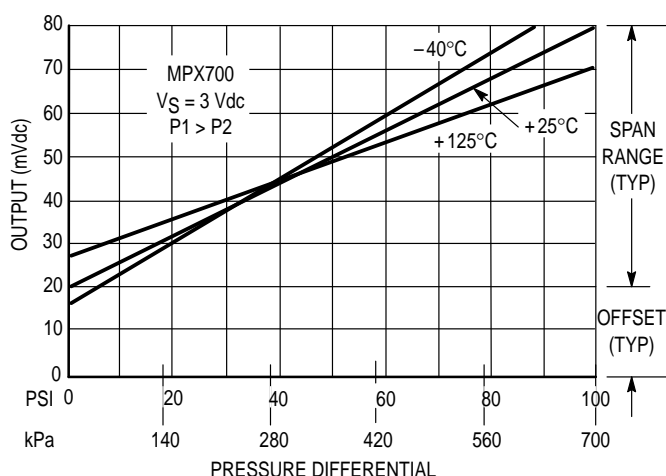


Figure 2. Output versus Pressure Differential

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.

### LINEARITY

Linearity refers to how well a transducer's output follows the equation:  $V_{\text{out}} = V_{\text{off}} + \text{sensitivity} \times P$  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. Motorola's specified pressure sensor linearities are based on the end point straight line method measured at the midrange pressure.

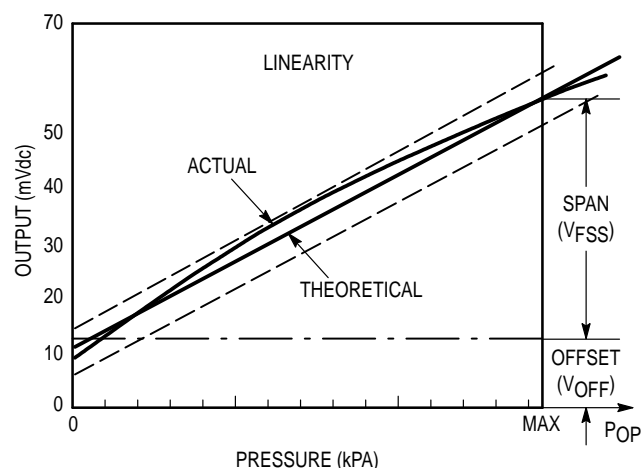


Figure 3. Linearity Specification Comparison

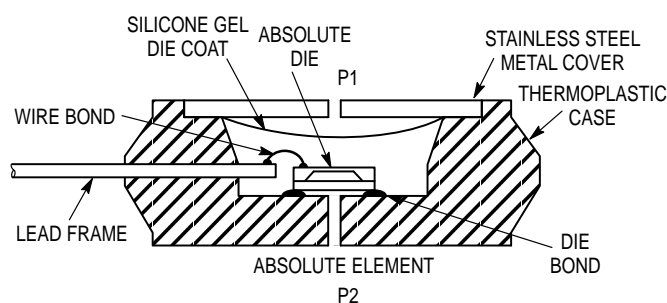
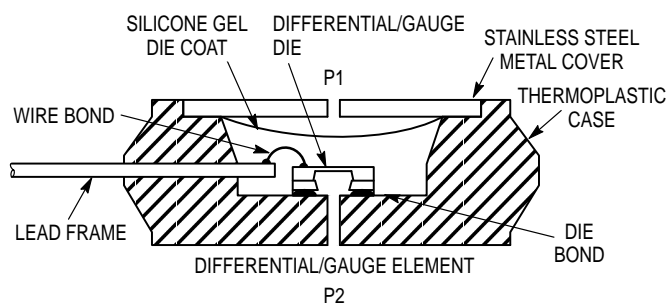


Figure 4. Cross-Sectional Diagrams (not to scale)

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 harsh environments, while allowing the pressure signal to be transmitted to the silicon diaphragm.

The MPX700 series pressure sensor operating character-

istics 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.

## MPX700 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 silicone gel which protects the die from harsh media. The differential or gauge sensor is designed to operate with positive differential pres-

sure 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 on the below:

Part Number	Case Type	Pressure (P1) Side Identifier
MPX700A, MPX700D	344-08	Stainless Steel Cap
MPX700DP	352-02	Side with Part Marking
MPX700AP, MPX700GP	350-03	Side with Port Attached
MPX700GVP	350-04	Stainless Steel Cap
MPX700AS, MPX700GS	371-06	Side with Port Attached
MPX700GVS	371-05	Stainless Steel Cap
MPX700ASX, MPX700GSX	371C-02	Side with Port Attached
MPX700GVSX	371D-02	Stainless Steel Cap

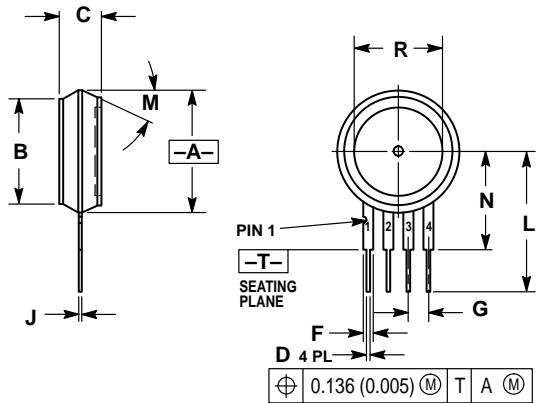
### ORDERING INFORMATION

MPX700 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.

Device Type	Options	Case Type	MPX Series	
			Order Number	Device Marking
Basic Element	Absolute, Differential	Case 344-08	MPX700A MPX700D	MPX700A MPX700D
Ported Elements	Differential	Case 352-02	MPX700DP	MPX700DP
	Absolute, Gauge	Case 350-03	MPX700AP MPX700GP	MPX700AP MPX700GP
	Gauge Vacuum	Case 350-04	MPX700GVP	MPX700GVP
	Absolute, Gauge Stove Pipe	Case 371-06	MPX700AS MPX700GS	MPX700A MPX700D
	Gauge Vacuum Stove Pipe	Case 371-05	MPX700GVS	MPX700D
	Absolute, Gauge Axial	Case 371C-02	MPX700ASX MPX700GSX	MPX700A MPX700D
	Gauge Vacuum Axial	Case 371D-02	MPX700GVSX	MPX700D

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PACKAGE DIMENSIONS



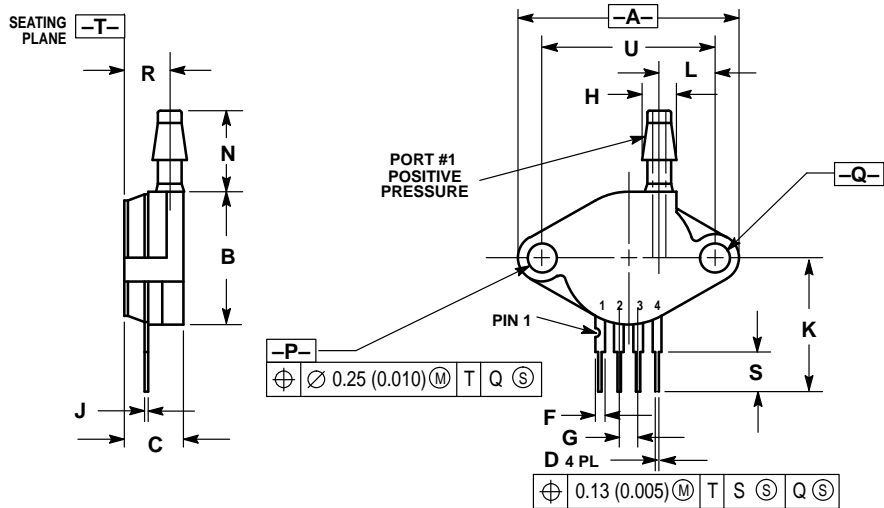
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.

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.

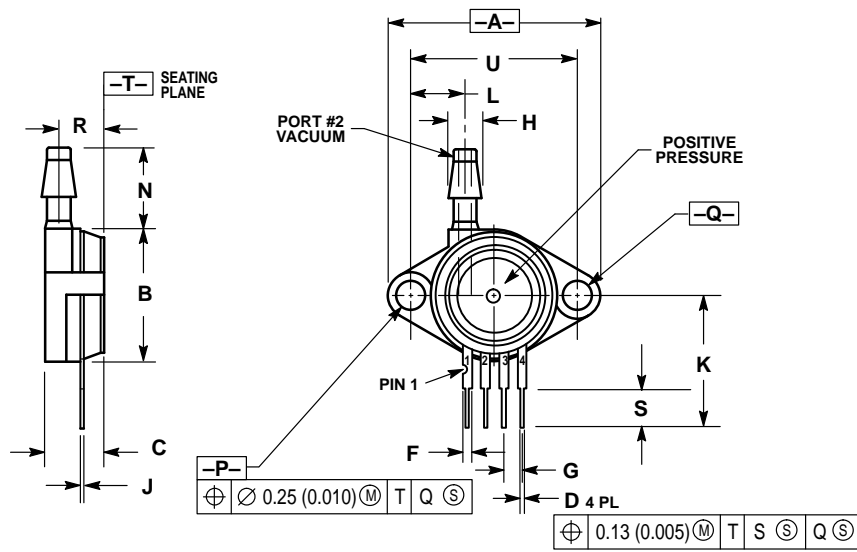
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.140	1.180	28.95	29.97
B	0.685	0.751	17.39	18.16
C	0.305	0.321	7.74	8.15
D	0.016	0.020	0.40	0.50
F	0.048	0.052	1.21	1.32
G	0.100 BSC		2.54 BSC	
H	0.182	0.194	4.62	4.92
J	0.014	0.016	0.35	0.40
K	0.685	0.715	17.39	18.16
L	0.290	0.300	7.34	7.62
N	0.420	0.440	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

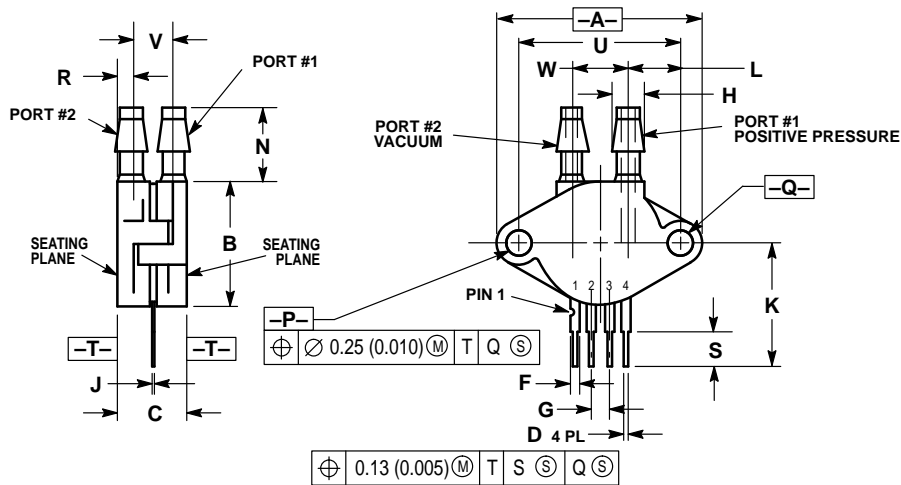
CASE 350-03  
ISSUE H

PRESSURE SIDE PORTED (AP, GP)

## PACKAGE DIMENSIONS — CONTINUED

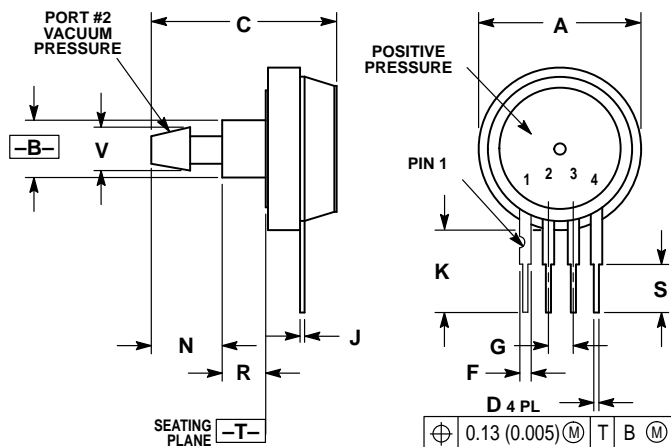
CASE 350-04  
ISSUE H

VACUUM SIDE PORTED (GVP)

CASE 352-02  
ISSUE F

PRESSURE AND VACUUM SIDES PORTED (DP)

## PACKAGE DIMENSIONS — CONTINUED



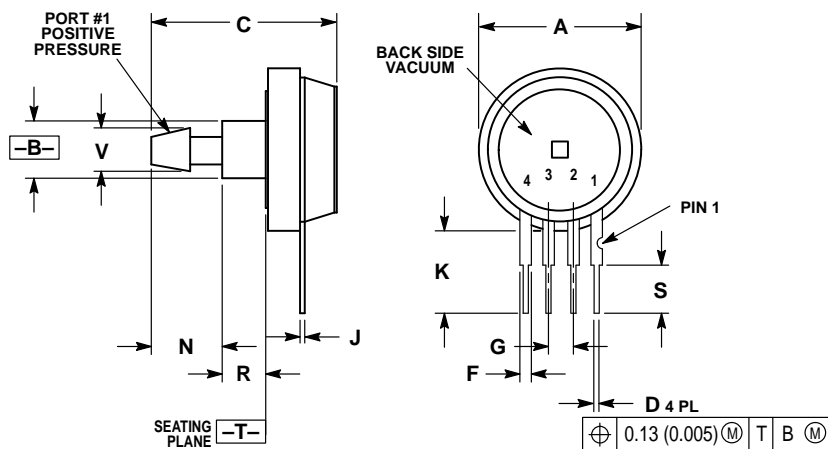
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.

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

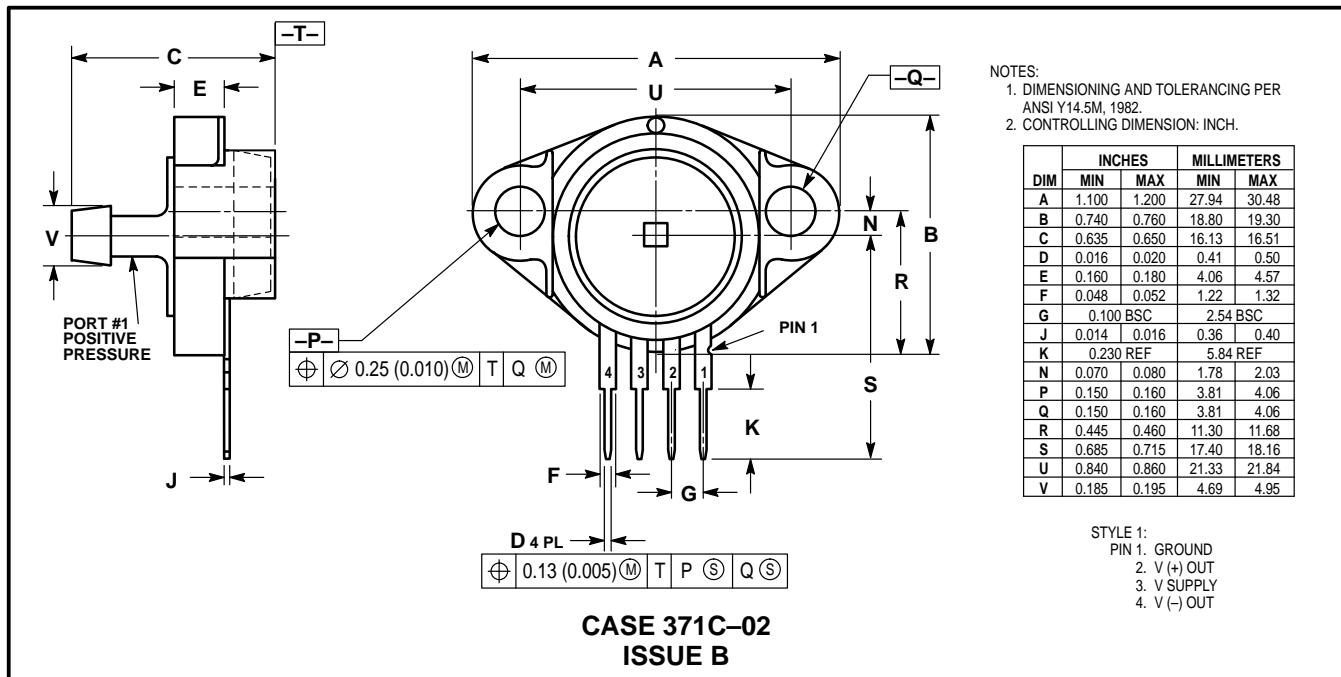
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.690	0.720	17.53	18.28
B	0.247	0.253	6.28	6.42
C	0.780	0.820	19.81	20.82
D	0.016	0.020	0.41	0.50
F	0.048	0.052	1.22	1.32
G	0.100 BSC		2.54 BSC	
J	0.014	0.016	0.36	0.40
K	0.335	0.365	8.51	9.27
N	0.305	0.315	7.75	8.00
R	0.178	0.185	4.53	4.69
S	0.230 REF		5.84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

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

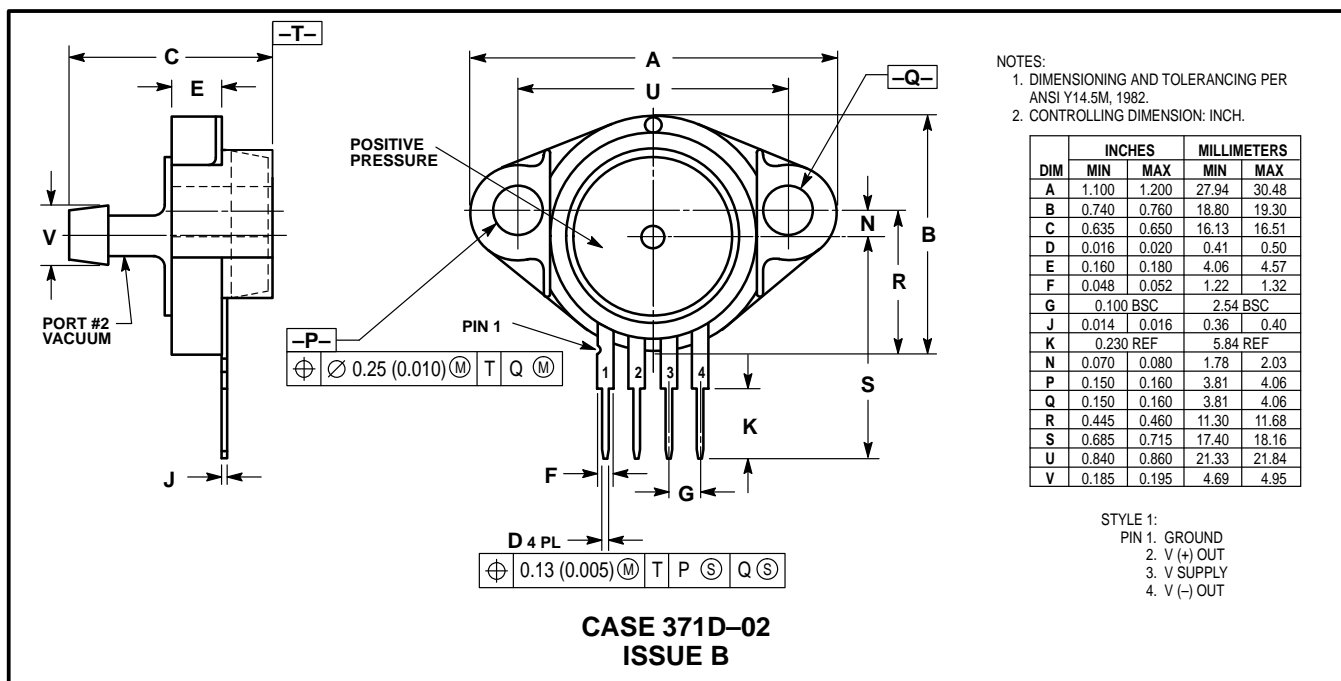
**CASE 371-06  
ISSUE D**

**PRESSURE SIDE PORTED (AS, GS)**

## PACKAGE DIMENSIONS — CONTINUED



PRESSURE SIDE PORTED (ASX, GSX)



VACUUM SIDE PORTED (GV SX)

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