

# 0 to 50 kPa (0 to 7.25 PSI) High $Z_{in}$ , On-Chip Temperature Compensated & Calibrated, Silicon Pressure Sensors

## MPX7050 SERIES

The new MPX7050 series pressure sensor incorporates all the innovative features of Motorola's MPX2000 series family including the patented, single piezoresistive strain gauge (X-ducer) and on-chip temperature compensation and calibration. In addition, the MPX7050 series has a high input impedance of typically 10 k $\Omega$  for those portable, low power and battery-operated applications. This device is suitable for those systems in which users must have a dependable, accurate pressure sensor that will not consume significant power. The MPX7050 series device is a logical and economical choice for applications such as portable medical instrumentation, and remote sensing systems with 4–20 mA transmission.

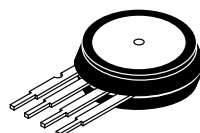
### X-ducer™ HIGH $Z_{in}$ SILICON PRESSURE SENSORS

#### Features

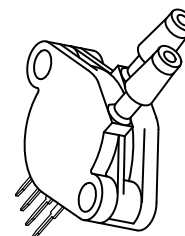
- Temperature Compensated Over 0°C to +85°C
- Unique Silicon Shear Stress Strain Gauge
- Full Scale Span Calibrated to 40 mV (typical)
- Easy to Use Chip Carrier Package Options
- Available in Differential and Gauge Configurations
- Ratiometric to Supply Voltage

#### Application Examples

- Portable Medical Instrumentation
- Remote Sensing Systems



**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

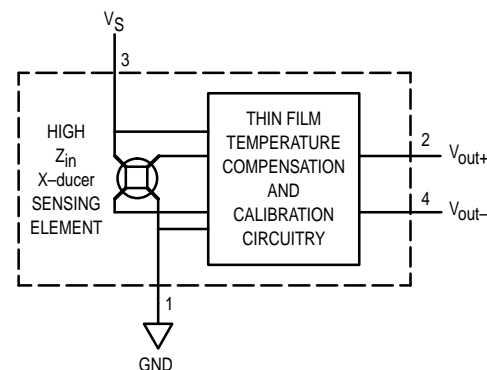
Rating	Symbol	Value	Unit
Overpressure <sup>(8)</sup> (P <sub>1</sub> > P <sub>2</sub> )	P <sub>max</sub>	200	kPa
Burst Pressure <sup>(8)</sup> (P <sub>1</sub> > P <sub>2</sub> )	P <sub>burst</sub>	500	kPa
Storage Temperature	T <sub>stg</sub>	-50 to +150	°C
Operating Temperature	T <sub>A</sub>	-40 to +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 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.



**Figure 1. Temperature Compensated  
Pressure Sensor Schematic**

X-ducer is a trademark of Motorola, Inc.

## MPX7050 SERIES

**OPERATING CHARACTERISTICS** ( $V_S = 10$  Vdc,  $T_A = 25^\circ\text{C}$  unless otherwise noted,  $P_1 > P_2$ )

Characteristics	Symbol	Min	Typ	Max	Unit
Pressure Range <sup>(1)</sup>	$P_{OP}$	0	—	50	kPa
Supply Voltage <sup>(2)</sup>	$V_S$	—	10	16	Vdc
Supply Current	$I_o$	—	1.0	—	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	$\Delta V/\Delta P$	—	0.80	—	mV/kPa
Linearity <sup>(5)</sup>	—	-0.25	—	0.25	% $V_{FSS}$
Pressure Hysteresis <sup>(5)</sup> (0 to 50 kPa)	—	—	$\pm 0.1$	—	% $V_{FSS}$
Temperature Hysteresis <sup>(5)</sup> ( $-40^\circ\text{C}$ to $+125^\circ\text{C}$ )	—	—	$\pm 0.5$	—	% $V_{FSS}$
Temperature Effect on Full Scale Span <sup>(5)</sup>	$TCV_{FSS}$	-1.0	—	1.0	% $V_{FSS}$
Temperature Effect on Offset <sup>(5)</sup>	$TCV_{off}$	-1.0	—	1.0	mV
Input Impedance	$Z_{in}$	5000	—	15,000	$\Omega$
Output Impedance	$Z_{out}$	2500	—	6000	$\Omega$
Response Time <sup>(6)</sup> (10% to 90%)	$t_R$	—	1.0	—	ms
Offset Stability <sup>(5)</sup>	—	—	$\pm 0.5$	—	% $V_{FSS}$

## MECHANICAL CHARACTERISTICS

Characteristics	Symbol	Min	Typ	Max	Unit
Weight (Basic Element Case 344)	—	—	2.0	—	Grams
Warm-Up	—	—	15	—	Sec
Cavity Volume	—	—	—	0.01	$\text{IN}^3$
Volumetric Displacement	—	—	—	0.001	$\text{IN}^3$
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 ( $V_{FSS}$ ) 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  $25^\circ\text{C}$ .
  - 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  $25^\circ\text{C}$ .
- 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. 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.

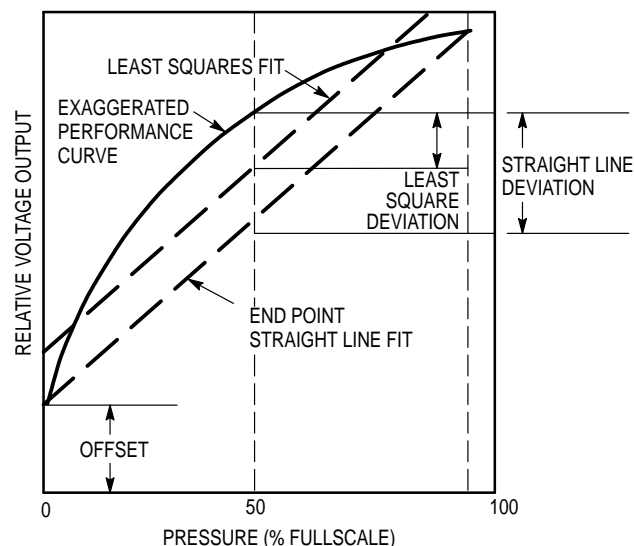


Figure 2. Linearity Specification Comparison

### ON-CHIP TEMPERATURE COMPENSATION and CALIBRATION

Figure 3 shows the output characteristics of the MPX7050 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.

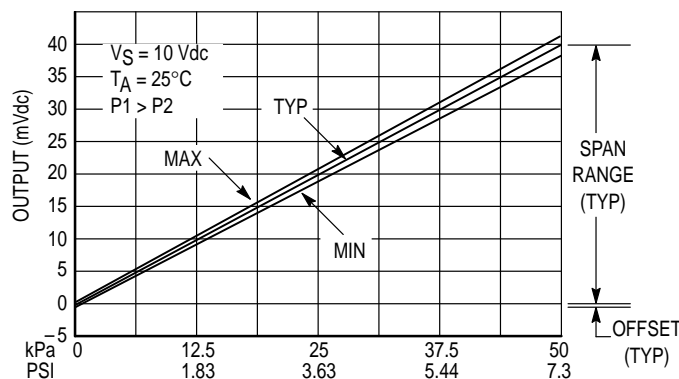


Figure 3. Output versus Pressure Differential

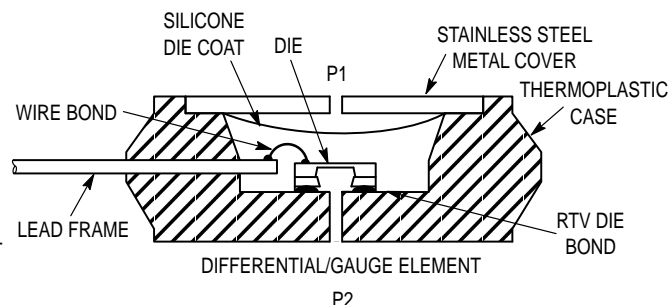


Figure 4. Cross-Sectional Diagram (not to scale)

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 MPX7050 series pressure sensor operating charac-

teristics 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.

## MPX7050 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 Motorola MPX

pressure sensor is designed to operate with positive differential pressure applied,  $P1 > P2$ .


The Pressure (P1) side may be identified by using the table below:

Part Number	Case Type	Pressure (P1) Side Identifier
MPX7050D	344-08	Stainless Steel Cap
MPX7050DP	352-02	Side with Part Marking
MPX7050GP	350-03	Side with Port Attached
MPX7050GVP	350-04	Stainless Steel Cap
MPX7050GS	371-06	Side with Port Attached
MPX7050GVS	371-05	Stainless Steel Cap
MPX7050GSX	371C-02	Side with Port Attached
MPX7050GVSX	371D-02	Stainless Steel Cap

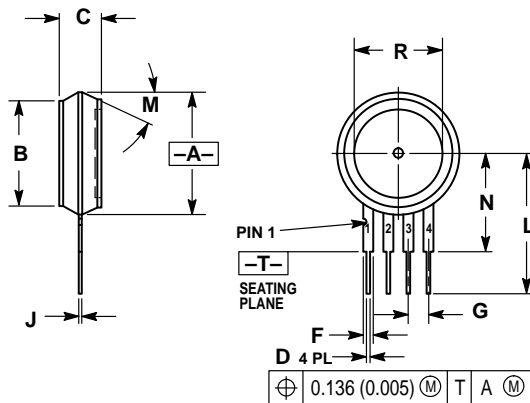
### ORDERING INFORMATION

MPX7050 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	Differential	Case 344-08	MPX7050D	MPX7050D
Ported Elements	Differential, Dual Ported	Case 352-02	MPX7050DP	MPX7050DP
	Gauge	Case 350-03	MPX7050GP	MPX7050GP
	Gauge, Vacuum	Case 350-04	MPX7050GVP	MPX7050GVP
	Gauge, Stove Pipe	Case 371-06	MPX7050GS	MPX7050D
	Gauge, Vacuum Stove Pipe	Case 371-05	MPX7050GVS	MPX7050D
	Gauge, Axial	Case 371C-02	MPX7050GSX	MPX7050D
	Gauge, Vacuum Axial	Case 371D-02	MPX7050GVSX	MPX7050D

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## PACKAGE DIMENSIONS



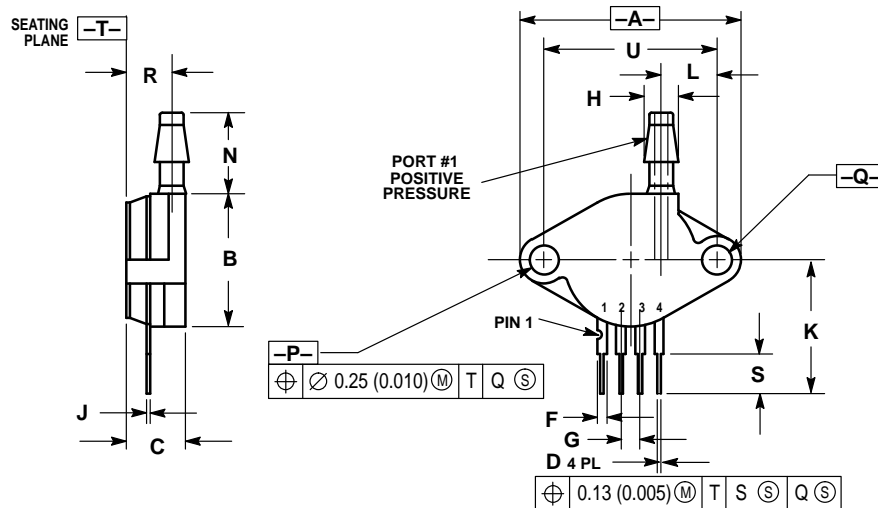
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.

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.

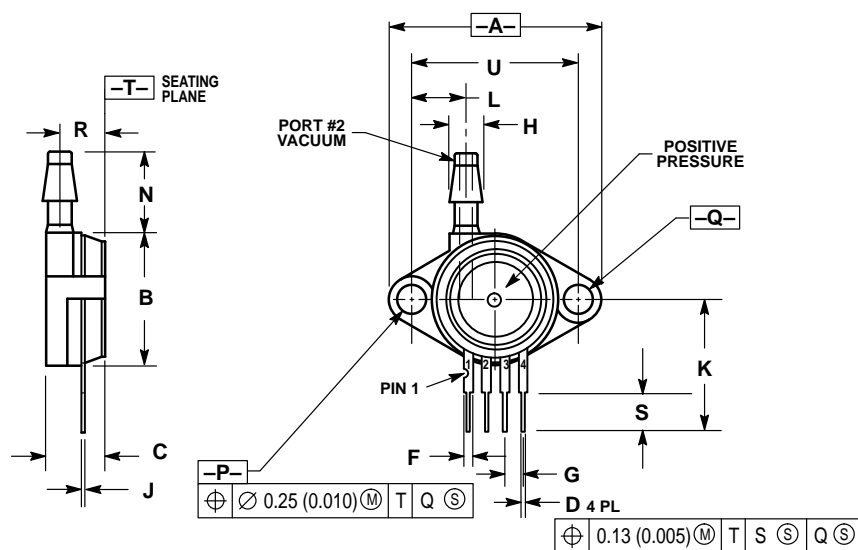
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.140	1.180	28.95	29.97
B	0.685	0.751	17.39	18.16
C	0.305	0.321	7.74	8.15
D	0.016	0.020	0.40	0.50
F	0.048	0.052	1.21	1.32
G	0.100 BSC		2.54 BSC	
H	0.182	0.194	4.62	4.92
J	0.014	0.016	0.35	0.40
K	0.685	0.715	17.39	18.16
L	0.290	0.300	7.34	7.62
N	0.420	0.440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

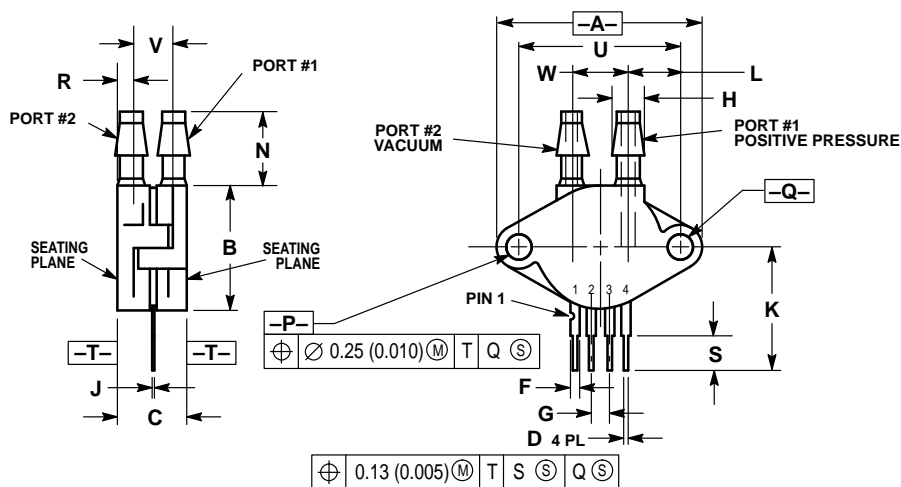
CASE 350-03  
ISSUE H

## PRESSURE SIDE PORTED (AP, GP)

## PACKAGE DIMENSIONS — CONTINUED

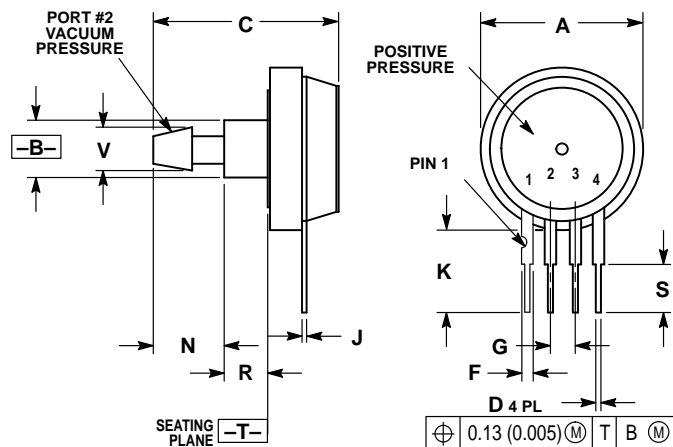
CASE 350-04  
ISSUE H

VACUUM SIDE PORTED (GVP)

CASE 352-02  
ISSUE F

PRESSURE AND VACUUM SIDES PORTED (DP)

## PACKAGE DIMENSIONS — CONTINUED



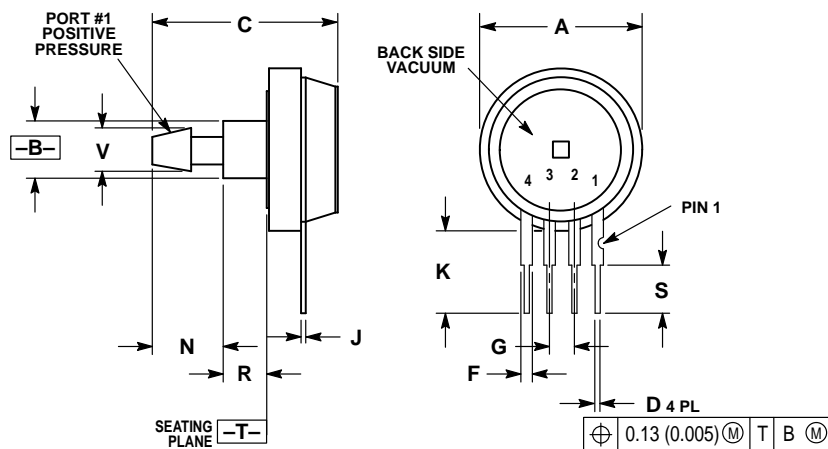
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.

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

CASE 371-05  
ISSUE D

VACUUM SIDE PORTED (GVS)



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

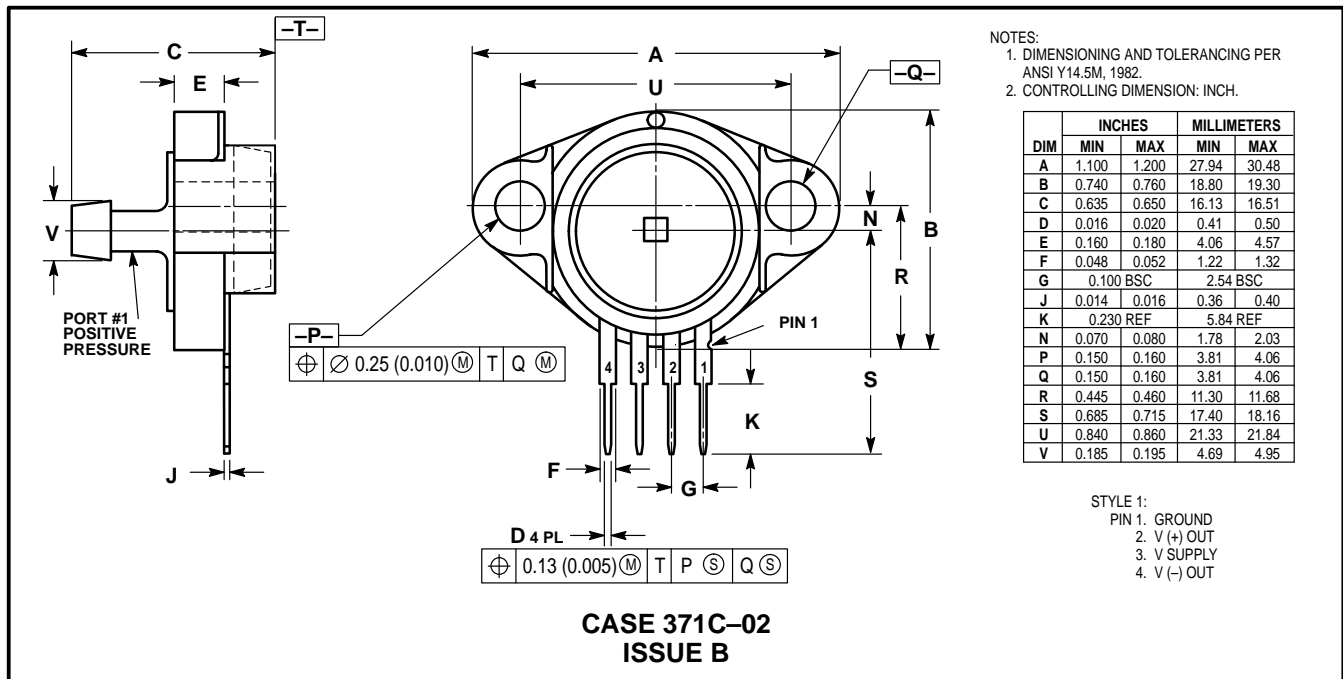
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.690	0.720	17.53	18.28
B	0.247	0.253	6.28	6.42
C	0.780	0.820	19.81	20.82
D	0.016	0.020	0.41	0.50
F	0.048	0.052	1.22	1.32
G	0.100 BSC		2.54 BSC	
J	0.014	0.016	0.36	0.40
K	0.335	0.365	8.51	9.27
N	0.305	0.315	7.75	8.00
R	0.178	0.185	4.53	4.69
S	0.230 REF		5.84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

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

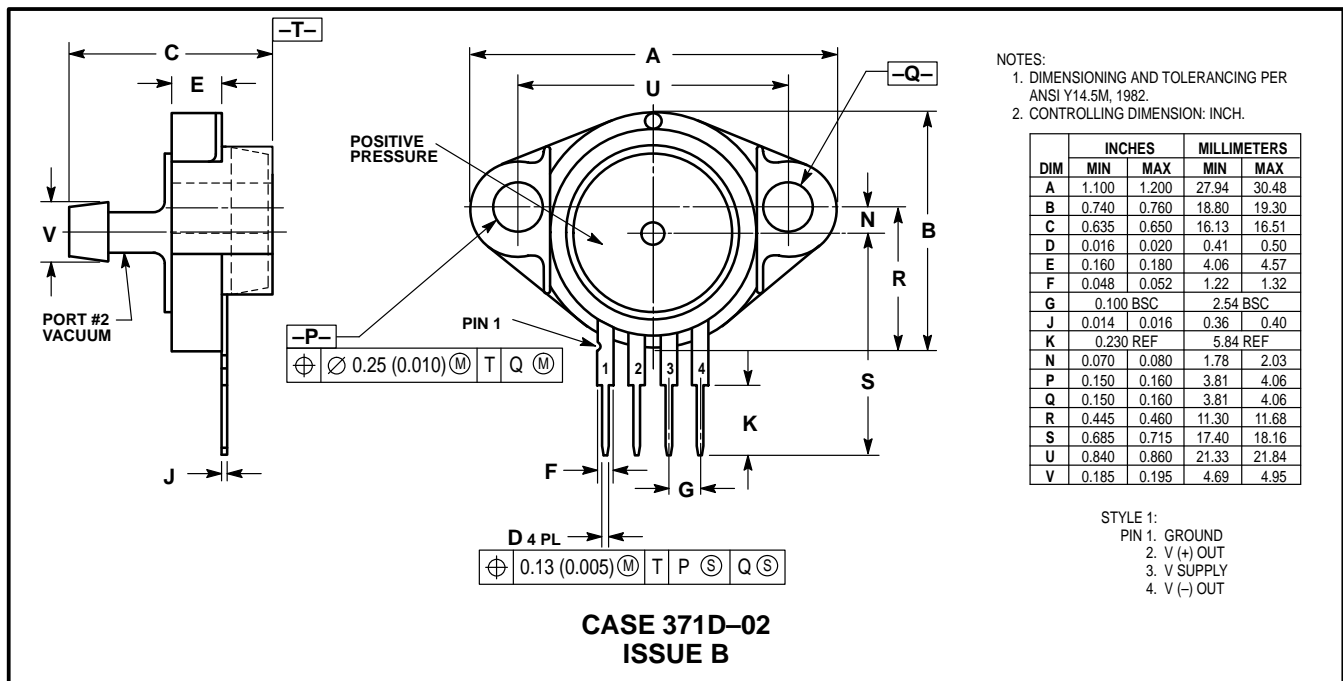
CASE 371-06  
ISSUE D

PRESSURE SIDE PORTED (AS, GS)

## PACKAGE DIMENSIONS — CONTINUED



PRESSURE SIDE PORTED (ASX, GSX)



VACUUM SIDE PORTED (GV SX)

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