

# 0 to 100 kPa (0 to 14.5 PSI) Uncompensated, Silicon Pressure Sensors

The MPX100 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

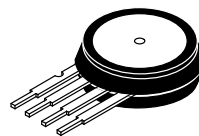
- Low Cost
- Patented, Silicon Shear Stress Strain Gauge Design
- Easy to Use Chip Carrier Package Options
- Ratiometric to Supply Voltage
- 60 mV Span (typical)
- Absolute, Differential and Gauge Options

### Application Examples

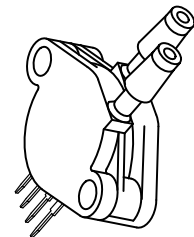
- Pump/Motor Controllers
- Robotics
- Level Indicators
- Medical Diagnostics
- Pressure Switching
- Barometers
- Altimeters

**MPX100  
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> (P1 > P2)	P <sub>max</sub>	200	kPa
Burst Pressure <sup>(8)</sup> (P1 > P2)	P <sub>burst</sub>	2000	kPa
Storage Temperature	T <sub>stg</sub>	-50 to +150	°C
Operating Temperature	T <sub>A</sub>	-40 to +125	°C

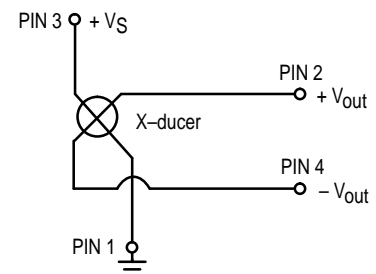
### VOLTAGE OUTPUT versus APPLIED DIFFERENTIAL PRESSURE

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 (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.

## MPX100 SERIES

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

Characteristic	Symbol	Min	Typ	Max	Unit
Pressure Range <sup>(1)</sup>	$P_{OP}$	0	—	100	kPa
Supply Voltage <sup>(2)</sup>	$V_S$	—	3.0	6.0	Vdc
Supply Current	$I_o$	—	6.0	—	mAdc
Full Scale Span <sup>(3)</sup>	$V_{FSS}$	45	60	90	mV
Offset <sup>(4)</sup>	$V_{off}$	0	20	35	mV
Sensitivity	$\Delta V/\Delta P$	—	0.6	—	mV/kPa
Linearity <sup>(5)</sup>	—	-0.25	—	0.25	% $V_{FSS}$
Pressure Hysteresis <sup>(5)</sup> (0 to 100 kPa)	—	-0.1	—	0.1	% $V_{FSS}$
Temperature Hysteresis <sup>(5)</sup> ( $-40^\circ\text{C}$ to $+125^\circ\text{C}$ )	—	—	$\pm 0.5$	—	% $V_{FSS}$
Temperature Coefficient of Full Scale Span <sup>(6)</sup>	$TCV_{FSS}$	-0.22	—	-0.16	% $V_{FSS}/^\circ\text{C}$
Temperature Coefficient of Offset <sup>(5)</sup>	$TCV_{off}$	—	$\pm 15$	—	$\mu\text{V}/^\circ\text{C}$
Temperature Coefficient of Resistance <sup>(5)</sup>	$TCR$	0.21	—	0.27	% $Z_{in}/^\circ\text{C}$
Input Impedance	$Z_{in}$	400	—	550	$\Omega$
Output Impedance	$Z_{out}$	750	—	1800	$\Omega$
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

Characteristic	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  $25^\circ\text{C}$ .
  - TCR:  $Z_{in}$  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.

**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 MPX100 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 or by designing your system using the MPX2100/MPX7100 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.

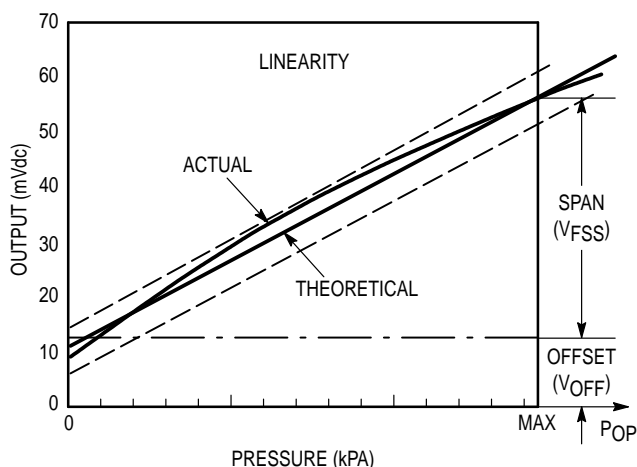


Figure 2. Linearity Specification Comparison

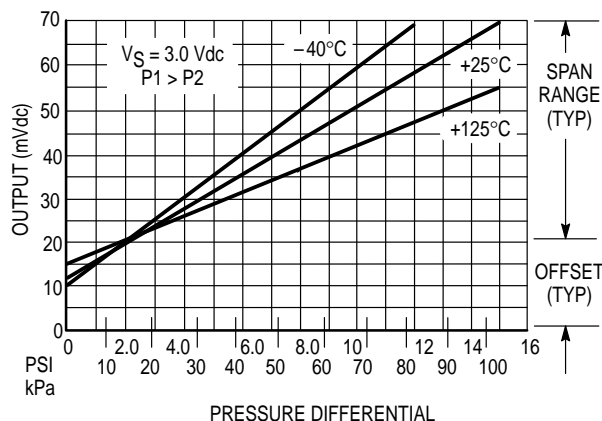


Figure 3. Output versus Pressure Differential

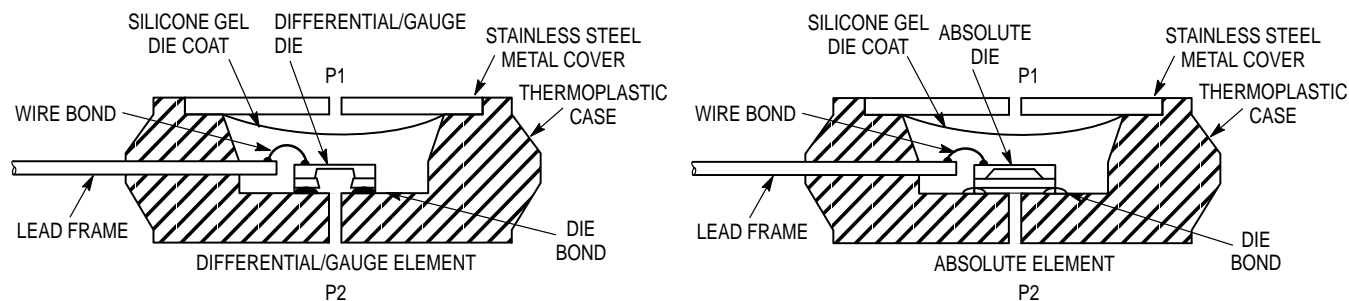


Figure 4. Cross-Sectional Diagrams (Not to Scale)

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

The MPX100 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.

## MPX100 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
MPX100A, MPX100D	344-08	Stainless Steel Cap
MPX100DP	352-02	Side with Part Marking
MPX100AP, MPX100GP	350-03	Side with Port Attached
MPX100GVP	350-04	Stainless Steel Cap
MPX100AS, MPX100GS	371-06	Side with Port Attached
MPX100GVS	371-05	Stainless Steel Cap
MPX100ASX, MPX100GSX	371C-02	Side with Port Attached
MPX100GVSX	371D-02	Stainless Steel Cap

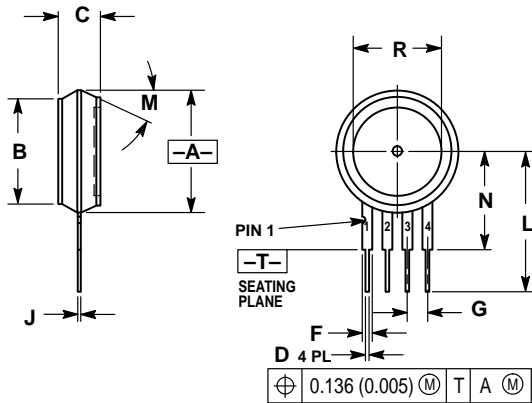
### ORDERING INFORMATION

MPX100 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	Device Marking
Basic Element	Absolute, Differential	Case 344-08	MPX100A MPX100D	MPX100A MPX100D
Ported Elements	Differential	Case 352-02	MPX100DP	MPX100DP
	Absolute, Gauge	Case 350-03	MPX100AP MPX100GP	MPX100AP MPX100GP
	Gauge Vacuum	Case 350-04	MPX100GVP	MPX100GVP
	Absolute, Gauge Stove Pipe	Case 371-06	MPX100AS MPX100GS	MPX100A MPX100D
	Gauge Vacuum Stove Pipe	Case 371-05	MPX100GVS	MPX100D
	Absolute, Gauge Axial	Case 371C-02	MPX100ASX MPX100GSX	MPX100A MPX100D
	Gauge Vacuum Axial	Case 371D-02	MPX100GVSX	MPX100D

Motorola reserves the right to make changes without further notice to any products herein. Motorola makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Motorola assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters can and do vary in different applications. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. Motorola does not convey any license under its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part. Motorola and  are registered trademarks of Motorola, Inc. Motorola, Inc. is an Equal Opportunity/Affirmative Action Employer.

PACKAGE DIMENSIONS



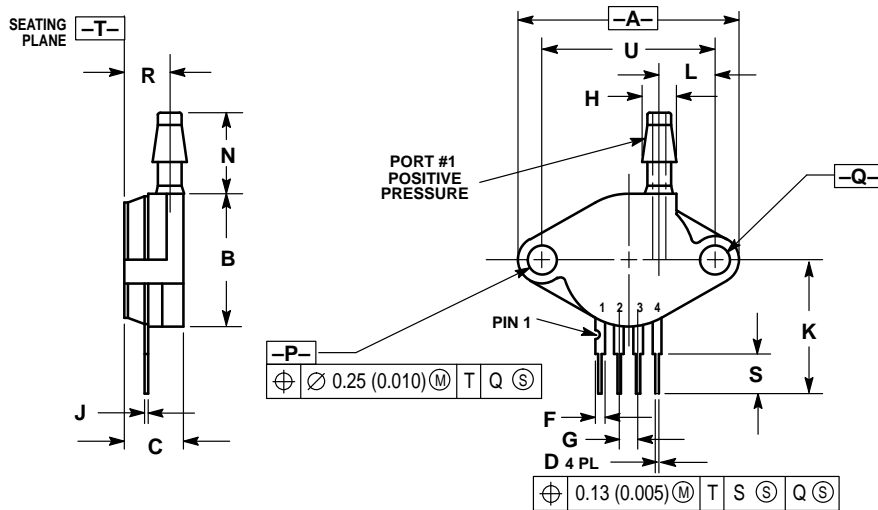
- NOTES:  
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.  
 2. CONTROLLING DIMENSION: INCH.

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.

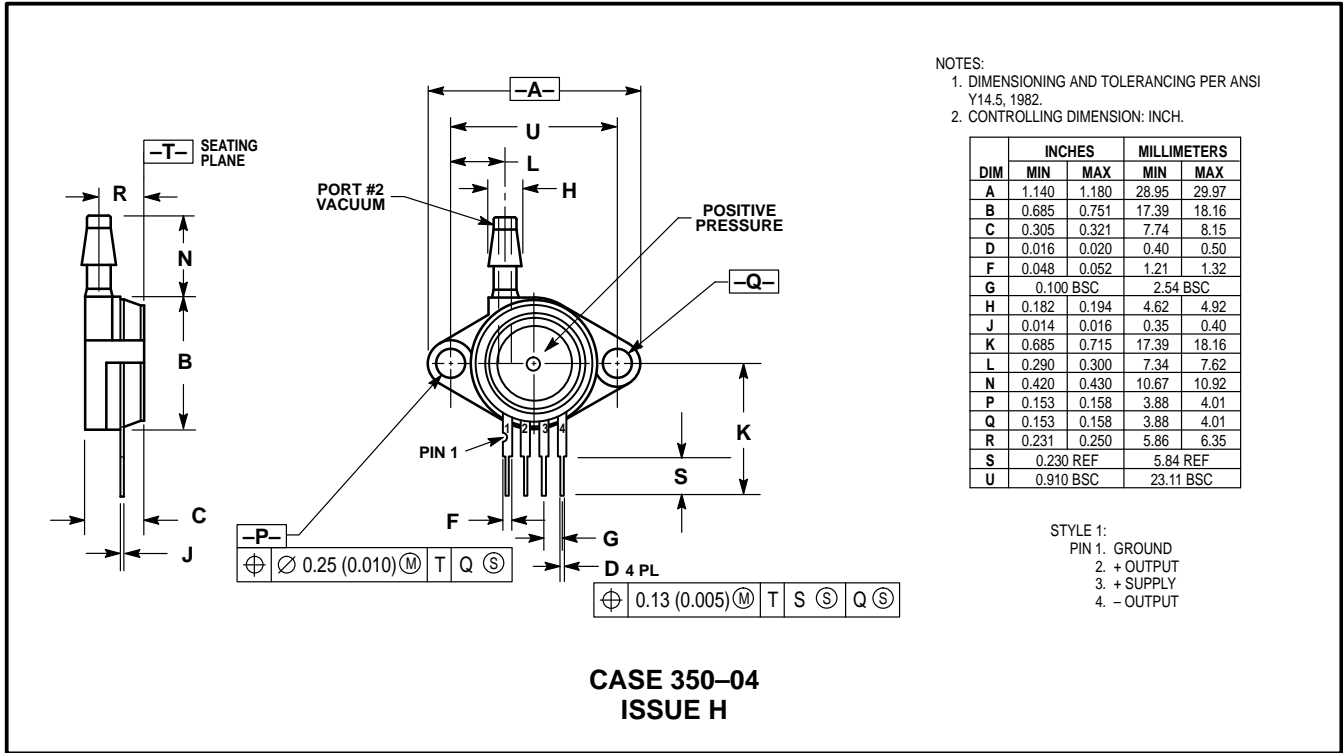
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.140	1.180	28.95	29.97
B	0.685	0.751	17.39	18.16
C	0.305	0.321	7.74	8.15
D	0.016	0.020	0.40	0.50
F	0.048	0.052	1.21	1.32
G	0.100 BSC		2.54 BSC	
H	0.182	0.194	4.62	4.92
J	0.014	0.016	0.35	0.40
K	0.685	0.715	17.39	18.16
L	0.290	0.300	7.34	7.62
N	0.420	0.440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

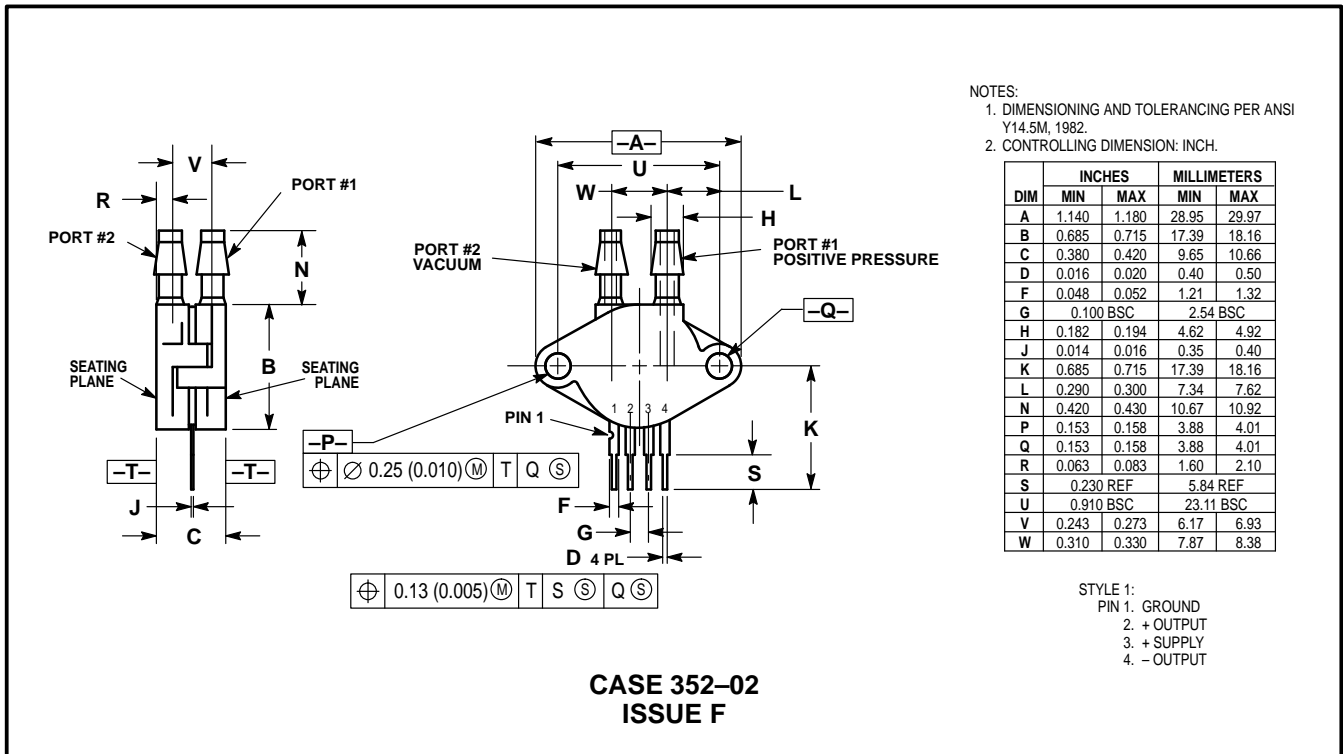
CASE 350-03  
 ISSUE H

PRESSURE SIDE PORTED (AP, GP)

PACKAGE DIMENSIONS — CONTINUED

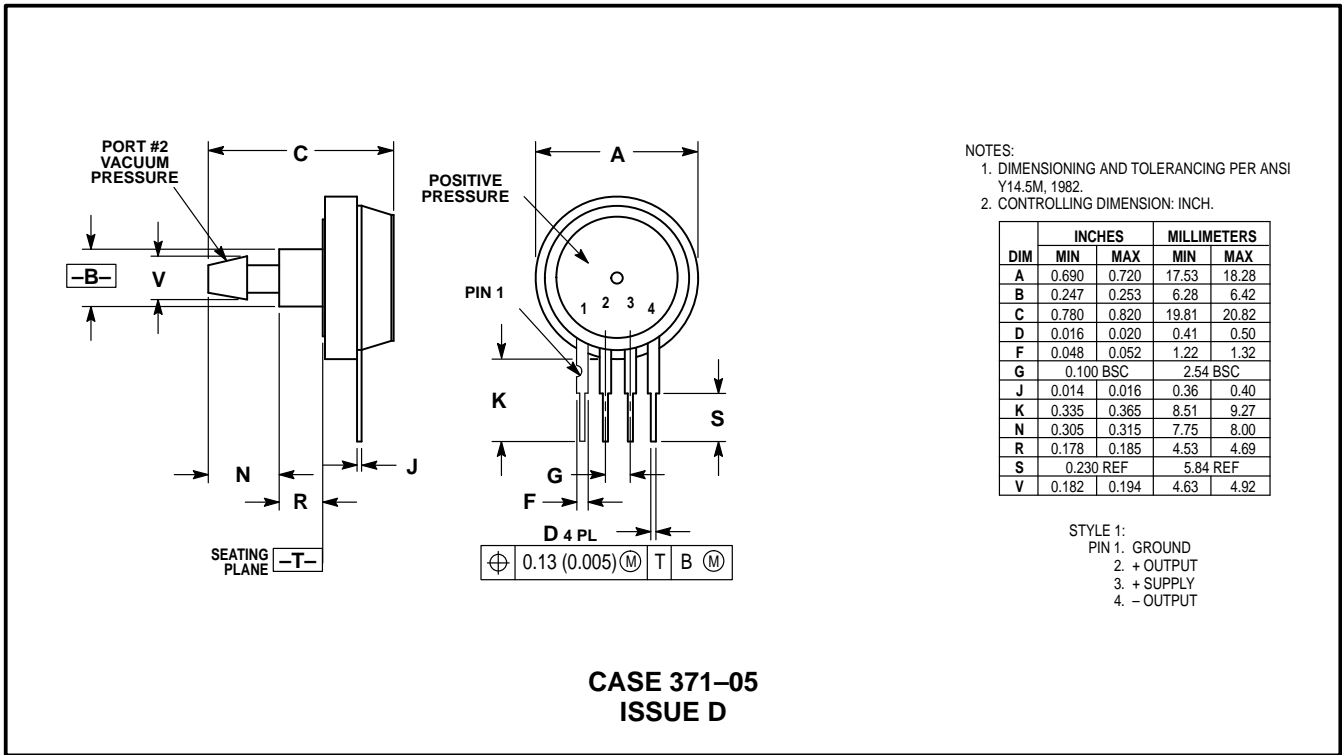


VACUUM SIDE PORTED (GVP)

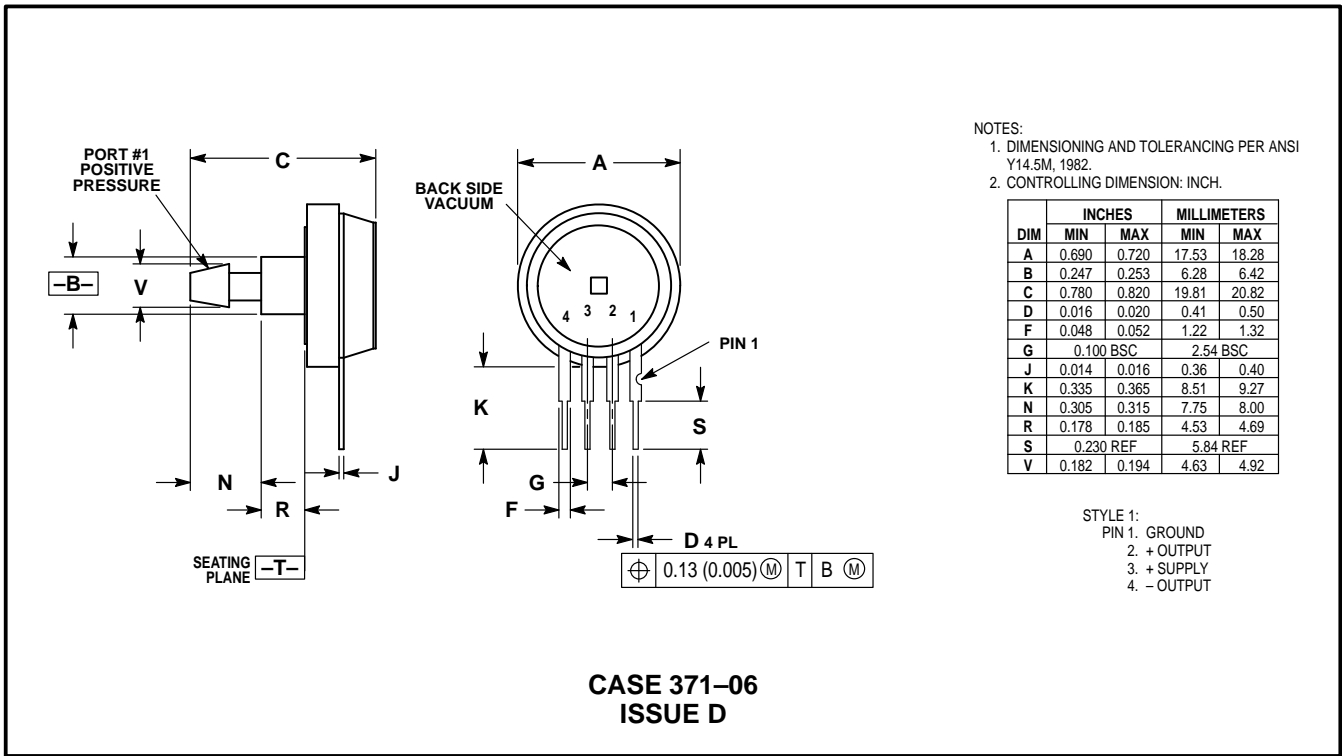


PRESSURE AND VACUUM SIDES PORTED (DP)

PACKAGE DIMENSIONS — CONTINUED



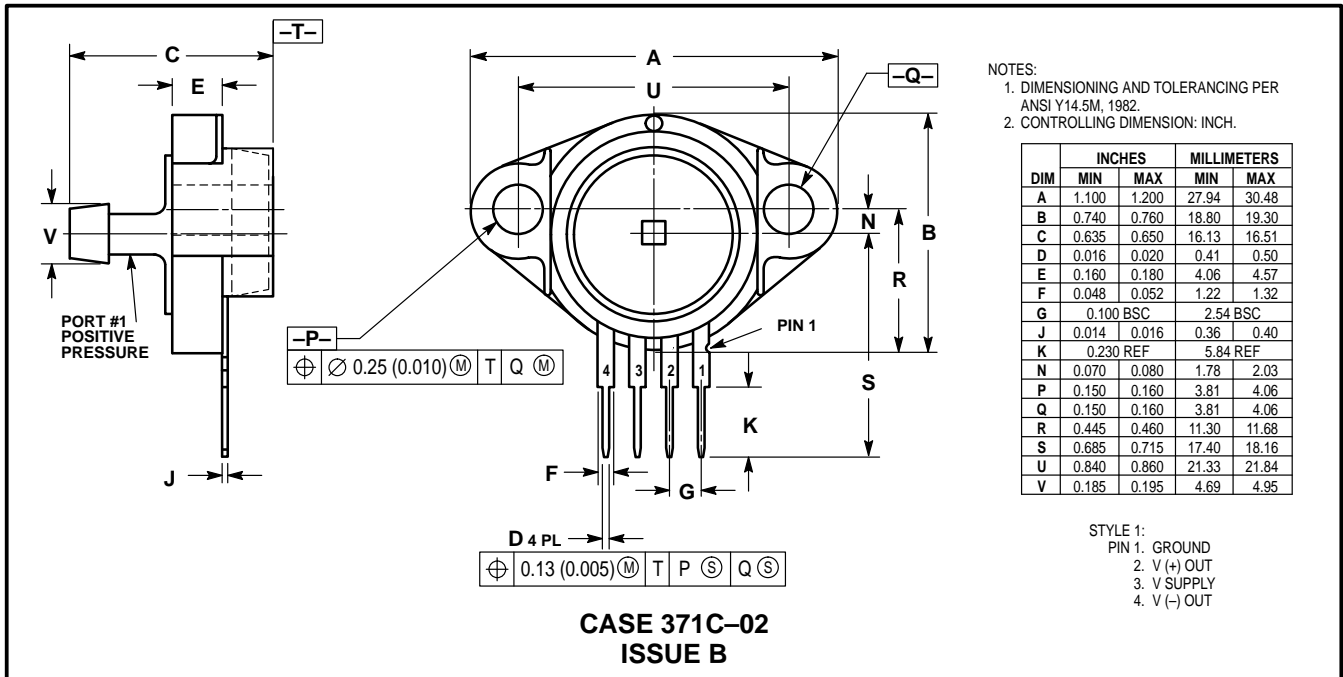
VACUUM SIDE PORTED (GVS)



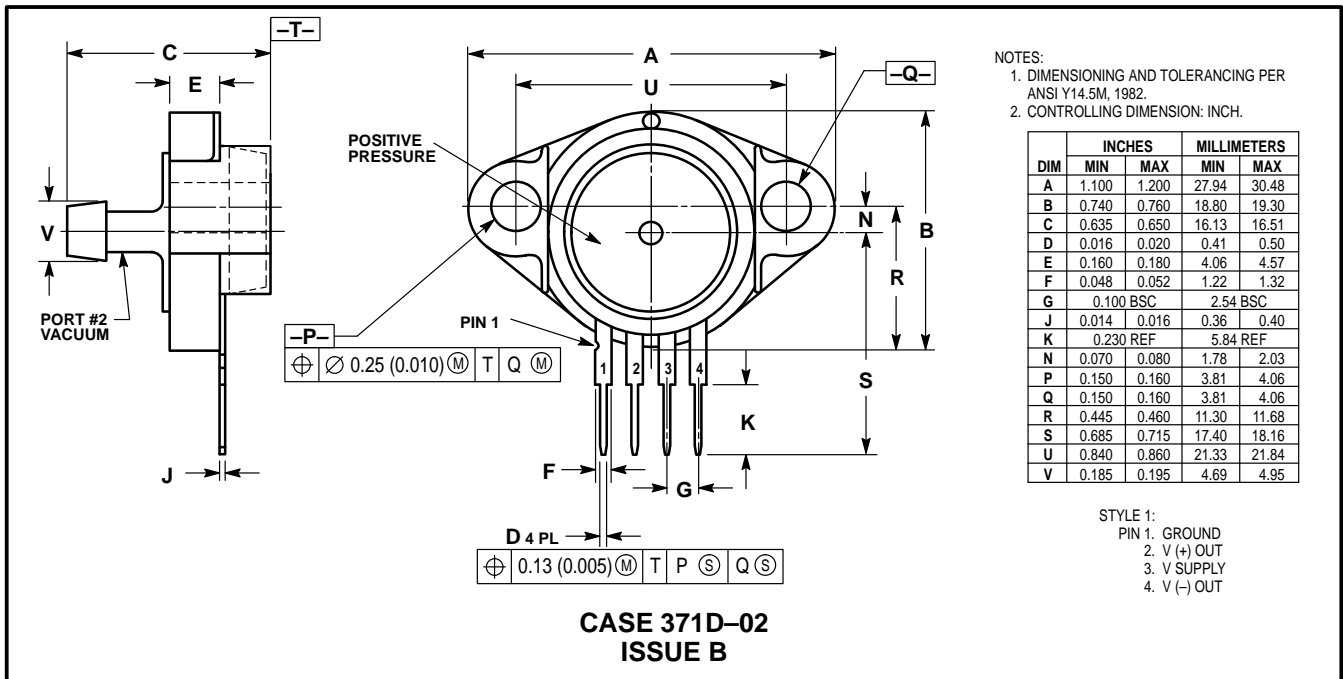
PRESSURE SIDE PORTED (AS, GS)

**MPX100 SERIES**

**PACKAGE DIMENSIONS — CONTINUED**



**PRESSURE SIDE PORTED (ASX, GSX)**



**VACUUM SIDE PORTED (GV SX)**

**Literature Distribution Centers:**

USA: Motorola Literature Distribution; P.O. Box 20912; Phoenix, Arizona 85036.

EUROPE: Motorola Ltd.; European Literature Centre; 88 Tanners Drive, Blakelands, Milton Keynes, MK14 5BP, England.

JAPAN: Nippon Motorola Ltd.; 4-32-1, Nishi-Gotanda, Shinagawa-ku, Tokyo 141, Japan.

ASIA PACIFIC: Motorola Semiconductors H.K. Ltd.; Silicon Harbour Center, No. 2 Dai King Street, Tai Po Industrial Estate, Tai Po, N.T., Hong Kong.

