0 to 10 kPa (0 to 1.45 PSI) Uncompensated, Silicon Pressure Sensors

MPX10
MPX12
SERIES

X–ducer™
SILICON
PRESSURE SENSORS

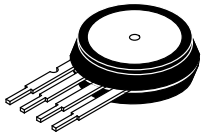
The MPX10 and MPX12 series device is a silicon piezoresistive pressure sensor providing a very accurate and linear voltage output — directly proportional to the applied pressure. This standard, low cost, uncompensated sensor permits manufacturers to design and add their own external temperature compensating and signal conditioning networks. Compensation techniques are simplified because of the predictability of Motorola's single element strain gauge design.

Features

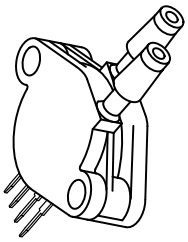
- Low Cost
- Patented Silicon Shear Stress Strain Gauge Design
- ±1.0% (Max) Linearity (MPX10D)
- Ratiometric to Supply Voltage
- Easy to Use Chip Carrier Package Options
- Differential and Gauge Options

Application Examples

- Air Movement Control
- Environmental Control Systems
- Level Indicators
- Leak Detection
- Medical Instrumentation
- Industrial Controls
- Pneumatic Control Systems
- Robotics



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) (P1 > P2)	P_{max}	75	kPa
Burst Pressure(8) (P1 > P2)	P_{burst}	100	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 output voltage of the differential or gauge sensor increases with increasing pressure applied to the pressure side (P1) relative to the vacuum side (P2). Similarly, output voltage increases as increasing vacuum is applied to the vacuum side (P2) relative to the pressure side (P1).

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

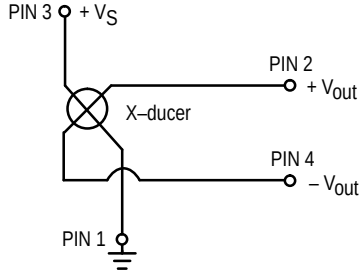


Figure 1. Uncompensated Pressure Sensor Schematic

X–ducer is a trademark of Motorola, Inc.

OPERATING CHARACTERISTICS (V_S = 3.0 Vdc, T_A = 25°C unless otherwise noted, P1 > P2)

Characteristic		Symbol	Min	Typ	Max	Unit
Differential Pressure Range(1)		P_{OP}	0	—	10	kPa
Supply Voltage(2)		V_S	—	3.0	6.0	Vdc
Supply Current		I_o	—	6.0	—	mAdc
Full Scale Span(3)	MPX10 MPX12	V_{FSS}	20 45	35 55	50 70	mV
Offset(4)		V_{off}	0	20	35	mV
Sensitivity	MPX10 MPX12	$\Delta V/\Delta P$	—	3.5 5.5	—	mV/kPa
Linearity(5)	MPX10 MPX12	—	–1.0 0	—	1.0 5.0	$\%V_{FSS}$
Pressure Hysteresis(5) (0 to 10 kPa)		—	—	± 0.1	—	$\%V_{FSS}$
Temperature Hysteresis(5) (–40°C to +125°C)		—	—	± 0.5	—	$\%V_{FSS}$
Temperature Coefficient of Full Scale Span(5)		TCV_{FSS}	–0.22	—	–0.16	$\%V_{FSS}$/°C
Temperature Coefficient of Offset(5)		TCV_{off}	—	±15	—	µV/°C
Temperature Coefficient of Resistance(5)		TCR	0.21	—	0.27	$\%Z_{in}$/°C
Input Impedance		Z_{in}	400	—	550	Ω
Output Impedance		Z_{out}	750	—	1250	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. 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.
   - 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°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. Common mode pressures beyond specified may result in leakage at the case–to–lead interface.
8. Exposure beyond these limits may cause permanent damage or degradation to the device.

TEMPERATURE COMPENSATION

Figure 2 shows the typical output characteristics of the MPX10 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 MPX2010D series sensor.

Several approaches to external temperature compensation over both −40 to +125°C and 0 to +80°C ranges are presented in Motorola Applications Note AN840.

LINEARITY

Linearity refers to how well a transducer's output follows the equation: $V_{out} = V_{off}$ + sensitivity x 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.

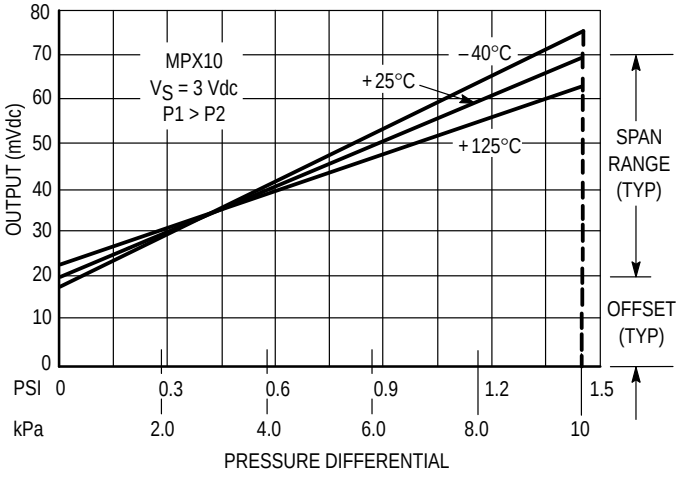


Figure 2. Output versus Pressure Differential

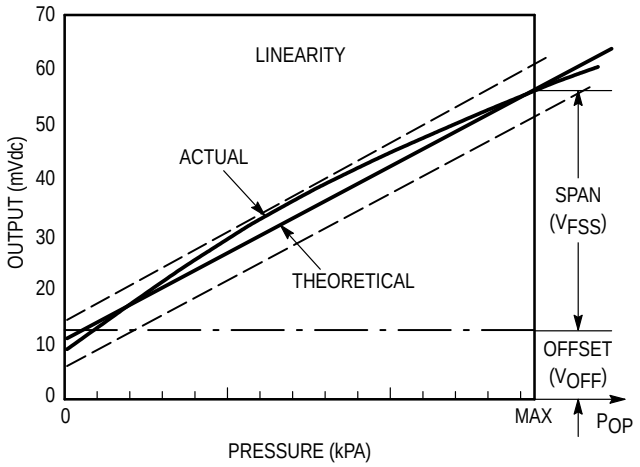


Figure 3. Linearity Specification Comparison

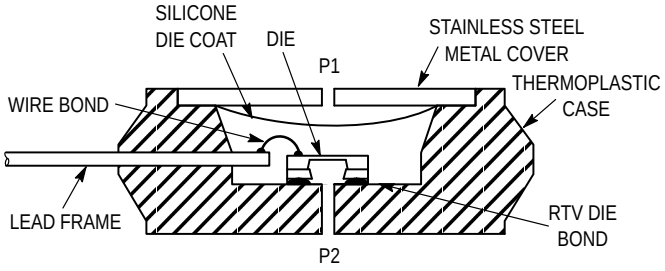


Figure 4. Cross–Sectional Diagram (not to scale)

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 MPX10 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.

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 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:

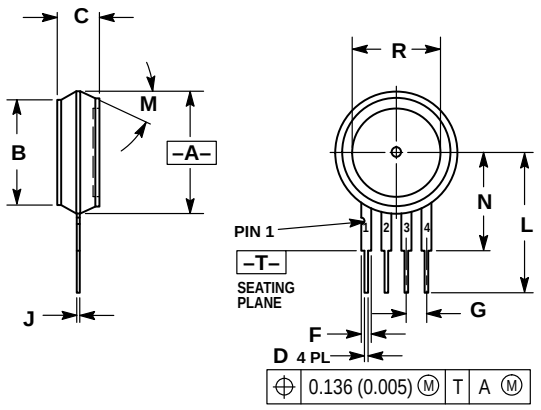
Part Number		Case Type	Pressure (P1) Side Identifier
MPX10D	MPX12D	344–08	Stainless Steel Cap
MPX10DP	MPX12DP	352–02	Side with Part Marking
MPX10GP	MPX12GP	350–03	Side with Port Attached
MPX10GVP	MPX12GVP	350–04	Stainless Steel Cap
MPX10GS	MPX12GS	371–06	Side with Port Attached
MPX10GVS	MPX12GVS	371–05	Stainless Steel Cap
MPX10GSX	MPX12GSX	371C–02	Side with Port Attached
MPX10GVSX	MPX12GVSX	371D–02	Stainless Steel Cap

ORDERING INFORMATION

MPX10 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	MPX10D MPX12D	MPX10D MPX12D
Ported Elements	Differential	Case 352–02	MPX10DP MPX12DP	MPX10DP MPX12DP
	Gauge	Case 350–03	MPX10GP MPX12GP	MPX10GP MPX12GP
	Gauge Vacuum	Case 350–04	MPX10GVP MPX12GVP	MPX10GVP MPX12GVP
	Gauge Stove Pipe	Case 371–06	MPX10GS MPX12GS	MPX10D MPX12D
	Gauge Vacuum Stove Pipe	Case 371–05	MPX10GVS MPX12GVS	MPX10D MPX12D
	Gauge Axial	Case 371C–02	MPX10GSX MPX12GSX	MPX10D MPX12D
	Gauge Vacuum Axial	Case 371D–02	MPX10GVSX MPX12GVSX	MPX10D MPX12D

PACKAGE DIMENSIONS



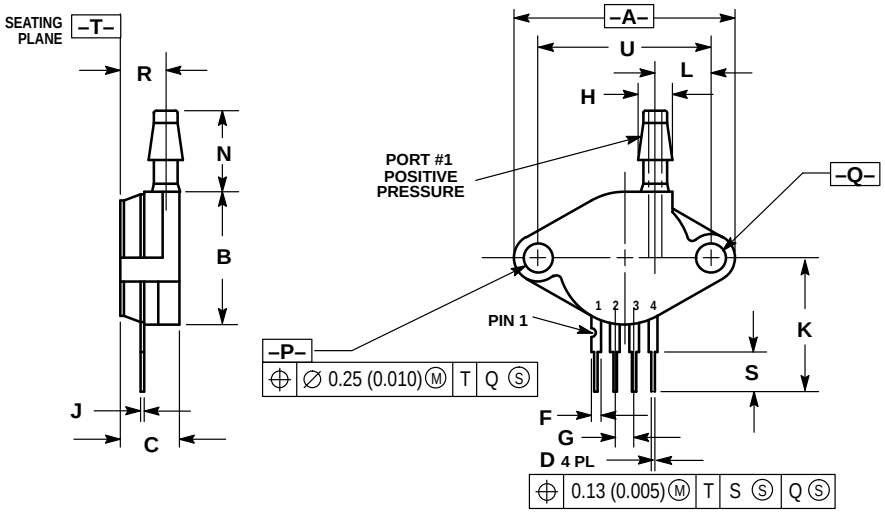
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

	INCHES		MILLIMETERS	
DIM	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.

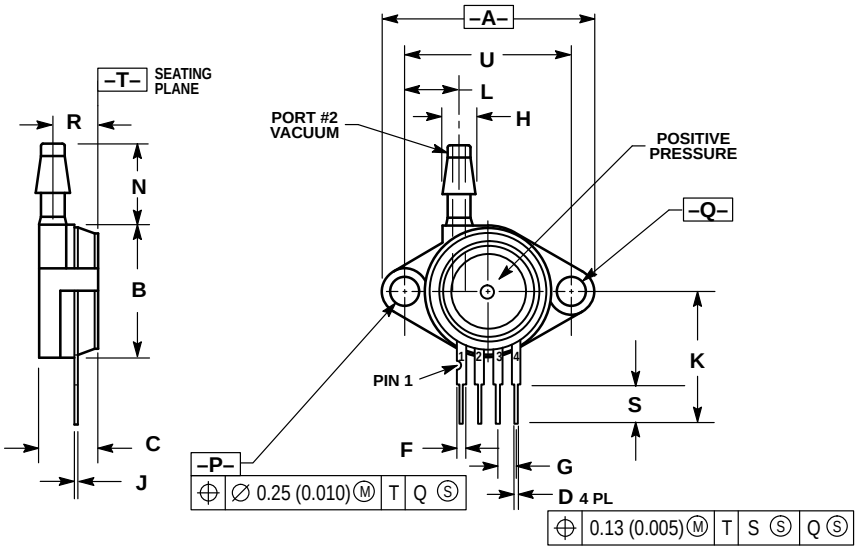
	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	1.140	1.180	28.95	29.97
B	0.685	0.751	17.39	18.16
C	0.305	0.321	7.74	8.15
D	0.016	0.020	0.40	0.50
F	0.048	0.052	1.21	1.32
G	0.100 BSC		2.54 BSC	
H	0.182	0.194	4.62	4.92
J	0.014	0.016	0.35	0.40
K	0.685	0.715	17.39	18.16
L	0.290	0.300	7.34	7.62
N	0.420	0.440	10.67	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



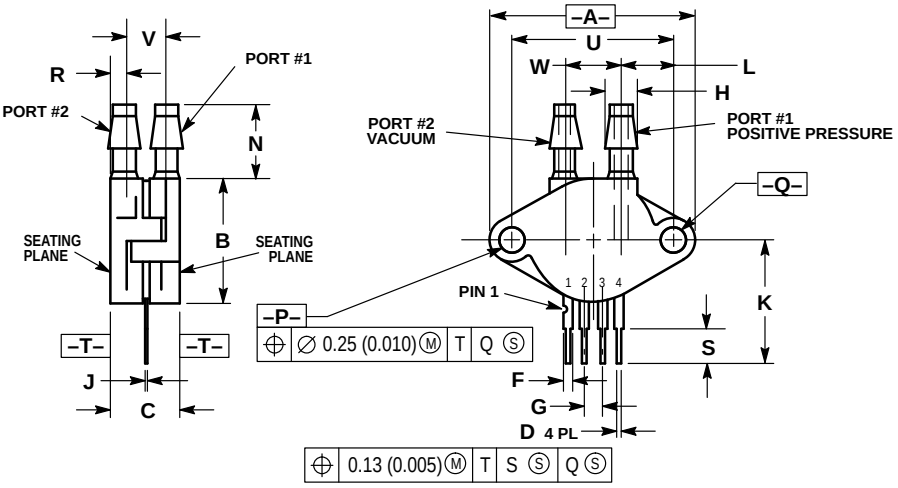
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1982.
2. CONTROLLING DIMENSION: INCH.

	INCHES		MILLIMETERS	
DIM	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
2. + OUTPUT
3. + SUPPLY
4. – OUTPUT

CASE 350–04
ISSUE H

VACUUM SIDE PORTED (GVP)



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

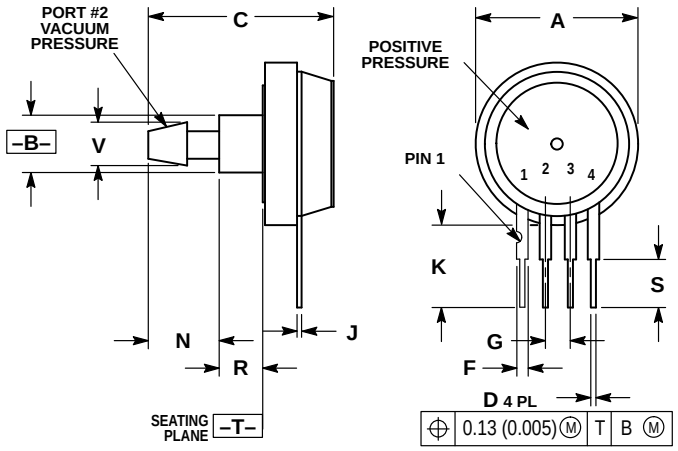
	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	1.140	1.180	28.95	29.97
B	0.685	0.715	17.39	18.16
C	0.380	0.420	9.65	10.66
D	0.016	0.020	0.40	0.50
F	0.048	0.052	1.21	1.32
G	0.100 BSC		2.54 BSC	
H	0.182	0.194	4.62	4.92
J	0.014	0.016	0.35	0.40
K	0.685	0.715	17.39	18.16
L	0.290	0.300	7.34	7.62
N	0.420	0.430	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
2. + OUTPUT
3. + SUPPLY
4. – OUTPUT

CASE 352–02
ISSUE F

PRESSURE AND VACUUM SIDES PORTED (DP)

PACKAGE DIMENSIONS — CONTINUED



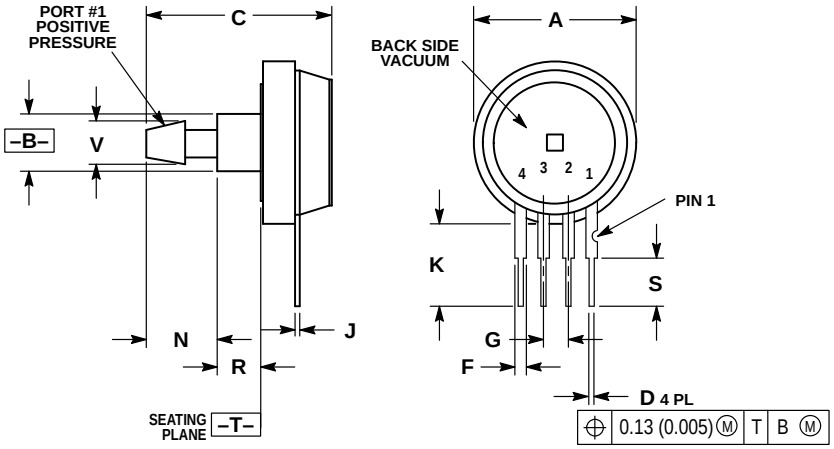
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

	INCHES		MILLIMETERS	
DIM	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
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.

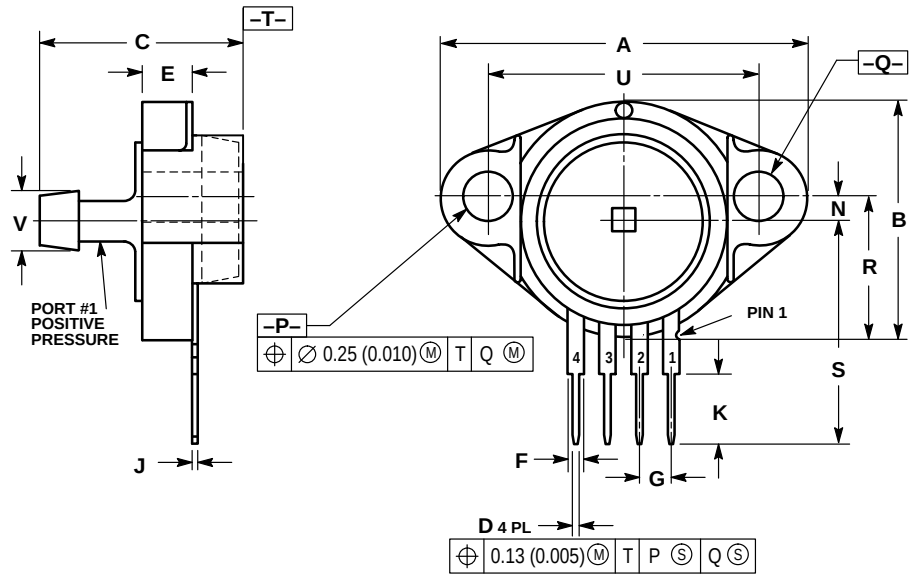
	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.690	0.720	17.53	18.28
B	0.247	0.253	6.28	6.42
C	0.780	0.820	19.81	20.82
D	0.016	0.020	0.41	0.50
F	0.048	0.052	1.22	1.32
G	0.100 BSC		2.54 BSC	
J	0.014	0.016	0.36	0.40
K	0.335	0.365	8.51	9.27
N	0.305	0.315	7.75	8.00
R	0.178	0.185	4.53	4.69
S	0.230 REF		5.84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

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

CASE 371–06
ISSUE D

PRESSURE SIDE PORTED (AS, GS)

PACKAGE DIMENSIONS — CONTINUED



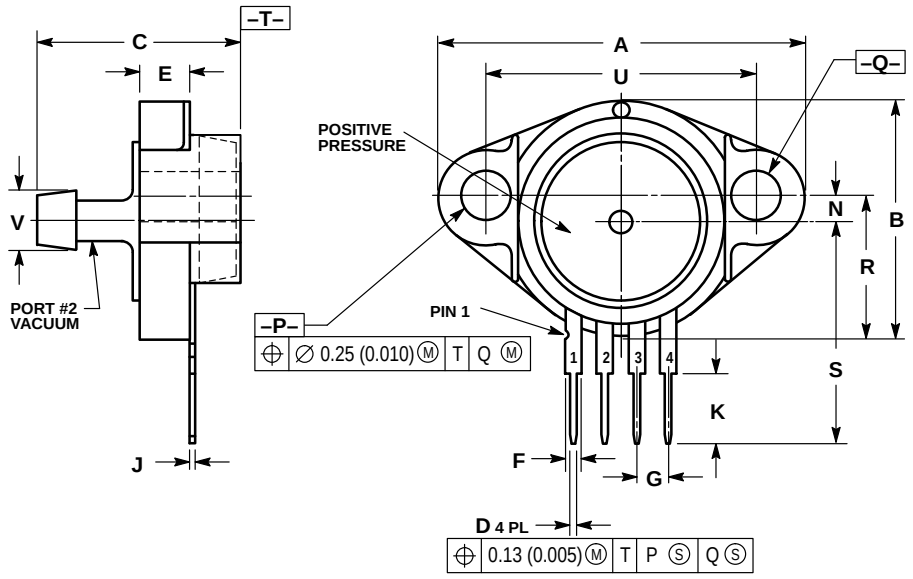
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	1.100	1.200	27.94	30.48
B	0.740	0.760	18.80	19.30
C	0.635	0.650	16.13	16.51
D	0.016	0.020	0.41	0.50
E	0.160	0.180	4.06	4.57
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	0.230 REF		5.84 REF	
N	0.070	0.080	1.78	2.03
P	0.150	0.160	3.81	4.06
Q	0.150	0.160	3.81	4.06
R	0.445	0.460	11.30	11.68
S	0.685	0.715	17.40	18.16
U	0.840	0.860	21.33	21.84
V	0.185	0.195	4.69	4.95

STYLE 1:
PIN 1. GROUND
2. V (+) OUT
3. V SUPPLY
4. V (–) OUT

CASE 371C–02
ISSUE B

PRESSURE SIDE PORTED (ASX, GSX)



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

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	1.100	1.200	27.94	30.48
B	0.740	0.760	18.80	19.30
C	0.635	0.650	16.13	16.51
D	0.016	0.020	0.41	0.50
E	0.160	0.180	4.06	4.57
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	0.230 REF		5.84 REF	
N	0.070	0.080	1.78	2.03
P	0.150	0.160	3.81	4.06
Q	0.150	0.160	3.81	4.06
R	0.445	0.460	11.30	11.68
S	0.685	0.715	17.40	18.16
U	0.840	0.860	21.33	21.84
V	0.185	0.195	4.69	4.95

STYLE 1:
PIN 1. GROUND
2. V (+) OUT
3. V SUPPLY
4. V (–) OUT

CASE 371D–02
ISSUE B

VACUUM SIDE PORTED (GVSX)

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.