



## 200 kPa 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.

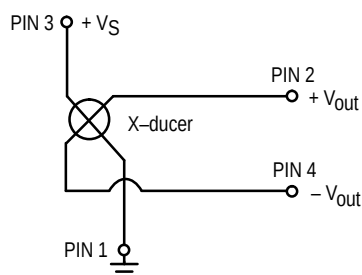
### Features

- 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

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



**Figure 1. Uncompensated Pressure Sensor Schematic**

### 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.

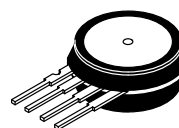
The output voltage of the differential or gauge sensor increases with increasing pressure applied to the pressure (P1) side relative to the vacuum (P2) side. Similarly, output voltage increases as increasing vacuum is applied to the vacuum (P2) side relative to the pressure (P1) side.

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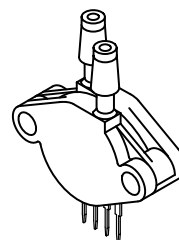
REV 7

## MPX200 SERIES

0 to 200 kPa (0–29 psi)  
60 mV FULL SCALE SPAN  
(TYPICAL)



**BASIC CHIP  
CARRIER ELEMENT  
CASE 344–15, STYLE 1**



**DIFFERENTIAL  
PORT OPTION  
CASE 344C–01, STYLE 1**

NOTE: Pin 1 is the notched pin.

| PIN NUMBER |            |   |            |
|------------|------------|---|------------|
| 1          | Gnd        | 3 | $V_S$      |
| 2          | $+V_{out}$ | 4 | $-V_{out}$ |



**MOTOROLA**

## MPX200 SERIES

### MAXIMUM RATINGS

| Rating                                  | Symbol             | Value       | Unit |
|-----------------------------------------|--------------------|-------------|------|
| Overpressure <sup>(8)</sup> (P1 > P2)   | P <sub>max</sub>   | 400         | kPa  |
| Burst Pressure <sup>(8)</sup> (P1 > P2) | P <sub>burst</sub> | 2000        | kPa  |
| Storage Temperature                     | T <sub>stg</sub>   | –40 to +125 | °C   |
| Operating Temperature                   | T <sub>A</sub>     | –40 to +125 | °C   |

### OPERATING CHARACTERISTICS (V<sub>S</sub> = 3.0 Vdc, T<sub>A</sub> = 25°C unless otherwise noted, P1 > P2)

| Characteristic                                            | Symbol             | Min   | Typ  | Max   | Unit                  |
|-----------------------------------------------------------|--------------------|-------|------|-------|-----------------------|
| Pressure Range <sup>(1)</sup>                             | P <sub>OP</sub>    | 0     | —    | 200   | 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                                               | ΔV/ΔP              | —     | 0.3  | —     | mV/kPa                |
| Linearity <sup>(5)</sup>                                  | —                  | –0.25 | —    | 0.25  | %V <sub>FSS</sub>     |
| Pressure Hysteresis <sup>(5)</sup> (0 to 200 kPa)         | —                  | —     | ±0.1 | —     | %V <sub>FSS</sub>     |
| Temperature Hysteresis <sup>(5)</sup> (–40°C to +125°C)   | —                  | —     | ±0.5 | —     | %V <sub>FSS</sub>     |
| Temperature Coefficient of Full Scale Span <sup>(5)</sup> | TCV <sub>FSS</sub> | –0.22 | —    | –0.16 | %V <sub>FSS</sub> /°C |
| Temperature Coefficient of Offset <sup>(5)</sup>          | TCV <sub>off</sub> | —     | ±15  | —     | μV/°C                 |
| Temperature Coefficient of Resistance <sup>(5)</sup>      | TCR                | 0.21  | —    | 0.27  | %Z <sub>in</sub> /°C  |
| Input Impedance                                           | Z <sub>in</sub>    | 400   | —    | 550   | Ω                     |
| Output Impedance                                          | Z <sub>out</sub>   | 750   | —    | 1800  | Ω                     |
| Response Time <sup>(6)</sup> (10% to 90%)                 | t <sub>R</sub>     | —     | 1.0  | —     | ms                    |
| Warm-Up                                                   | —                  | —     | 20   | —     | ms                    |
| Offset Stability <sup>(9)</sup>                           | —                  | —     | ±0.5 | —     | %V <sub>FSS</sub>     |

### MECHANICAL CHARACTERISTICS

| Characteristic                           | Symbol | Min | Typ | Max | Unit  |
|------------------------------------------|--------|-----|-----|-----|-------|
| Weight (Basic Element Case 344–15)       | —      | —   | 2.0 | —   | Grams |
| 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.
  - 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<sub>in</sub> deviation with minimum rated pressure applied, over the temperature range of –40°C to +125°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.
- Offset stability is the product's output deviation when subjected to 1000 hours of Pulsed Pressure, Temperature Cycling with Bias Test.

## 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.

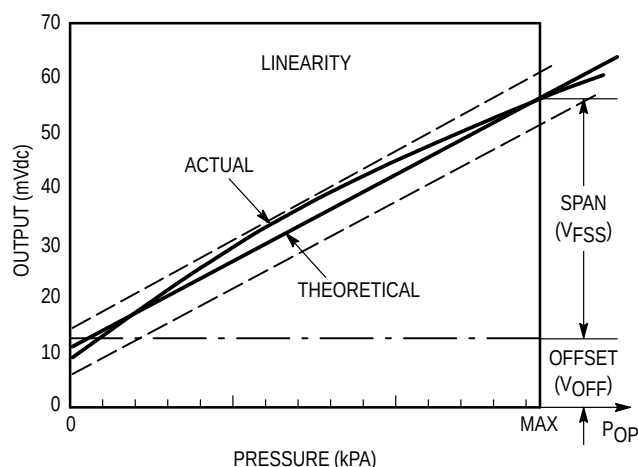
The X-ducer piezoresistive pressure sensor element is a semiconductor device which gives an electrical output signal

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.

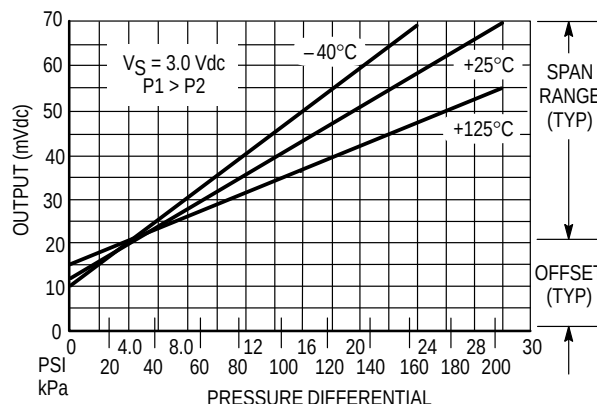
Because this strain gauge is an integral part of the silicon diaphragm, there are no temperature effects due to differences in the thermal expansion of the strain gauge and the diaphragm, as are often encountered in bonded strain gauge pressure sensors. However, the properties of the strain gauge itself 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 series sensors.

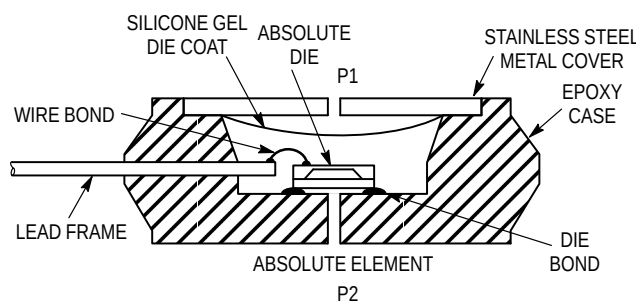
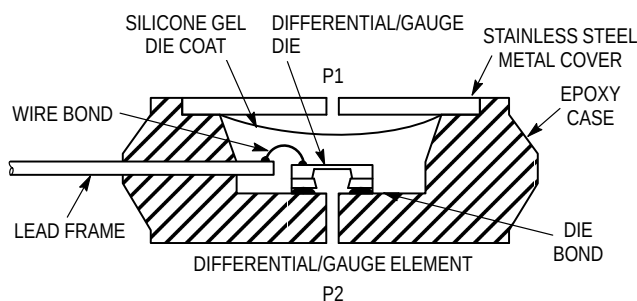
Several approaches to external temperature compensation over both  $-40$  to  $+125^\circ\text{C}$  and  $0$  to  $+80^\circ\text{C}$  ranges are presented in Motorola Applications Note AN840.



**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 344-15). A silicone gel isolates the die surface and wire bond from the environment, while allowing the pressure signal to be transmitted to the silicon diaphragm. The MPX200 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.

## 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 isolates the die from the environment. The differential or gauge sensor is designed to operate with positive differen-

tial 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:

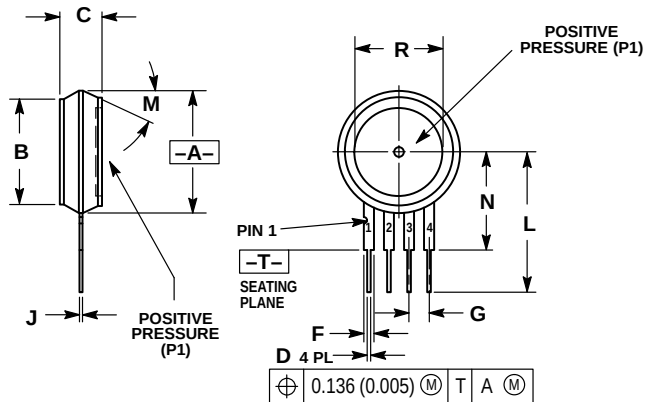
| Part Number        | Case Type | Pressure (P1) Side Identifier |
|--------------------|-----------|-------------------------------|
| MPX200A, MPX200D   | 344-15    | Stainless Steel Cap           |
| MPX200DP           | 344C-01   | Side with Part Marking        |
| MPX200AP, MPX200GP | 344B-01   | Side with Port Attached       |
| MPX200GVP          | 344D-01   | Stainless Steel Cap           |
| MPX200AS, MPX200GS | 344E-01   | Side with Port Attached       |
| MPX200GSX          | 344F-01   | Side with Port Attached       |
| MPX200GVSX         | 344G-01   | 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 344-15  | MPX200A<br>MPX200D     | MPX200A<br>MPX200D   |
| Ported Elements | Differential               | Case 344C-01 | MPX200DP               | MPX200DP             |
|                 | Absolute, Gauge            | Case 344B-01 | MPX200AP<br>MPX200GP   | MPX200AP<br>MPX200GP |
|                 | Gauge Vacuum               | Case 344D-01 | MPX200GVP              | MPX200GVP            |
|                 | Absolute, Gauge Stove Pipe | Case 344E-01 | MPX200AS<br>MPX200GS   | MPX200A<br>MPX200D   |
|                 | Gauge Axial                | Case 344F-01 | MPX200ASX<br>MPX200GSX | MPX200A<br>MPX200D   |
|                 | Gauge Vacuum Axial         | Case 344G-01 | MPX200GVSX             | MPX200D              |

## PACKAGE DIMENSIONS



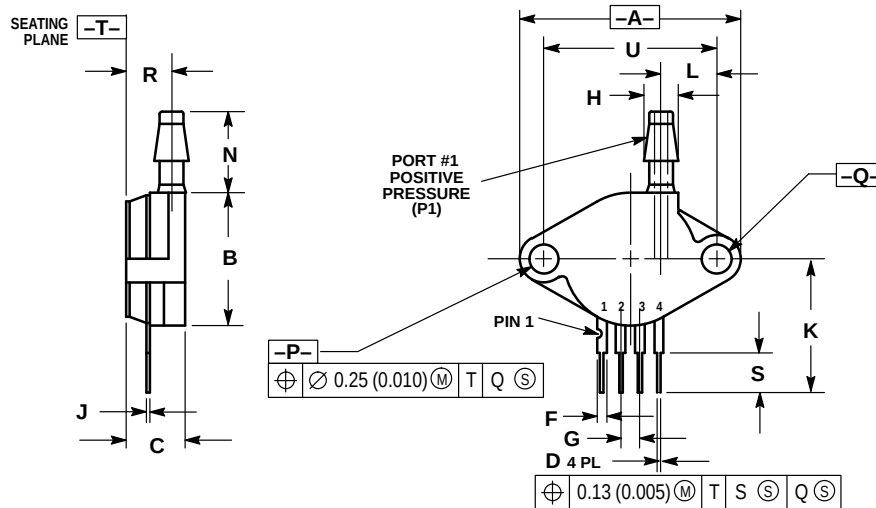
## NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION -A- IS INCLUSIVE OF THE MOLD STOP RING. MOLD STOP RING NOT TO EXCEED 16.00 (0.630).

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.595     | 0.630 | 15.11       | 16.00 |
| B   | 0.514     | 0.534 | 13.06       | 13.56 |
| C   | 0.200     | 0.220 | 5.08        | 5.59  |
| D   | 0.016     | 0.020 | 0.41        | 0.51  |
| F   | 0.048     | 0.064 | 1.22        | 1.63  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| J   | 0.014     | 0.016 | 0.36        | 0.40  |
| L   | 0.695     | 0.725 | 17.65       | 18.42 |
| M   | 30° NOM   |       | 30° NOM     |       |
| N   | 0.475     | 0.495 | 12.07       | 12.57 |
| R   | 0.430     | 0.450 | 10.92       | 11.43 |

## STYLE 1:

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

CASE 344-15  
ISSUE W

## NOTES:

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

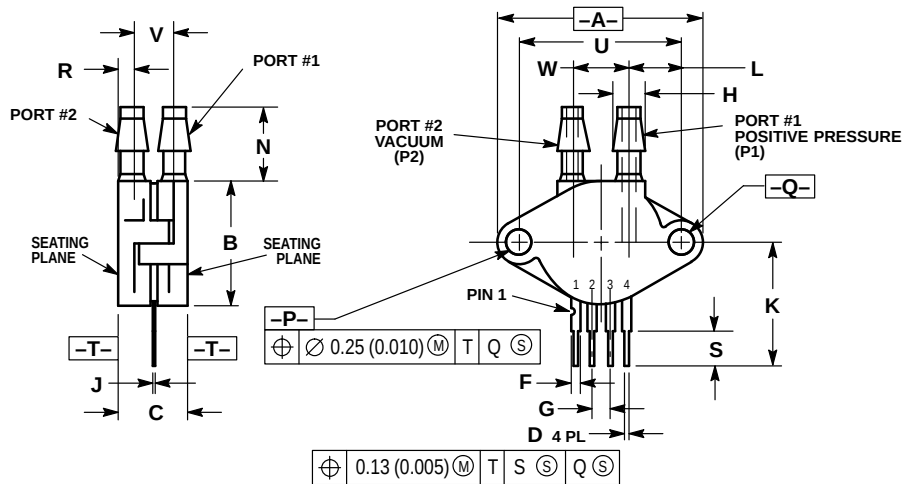
| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 1.145     | 1.175 | 29.08       | 29.85 |
| B   | 0.685     | 0.715 | 17.40       | 18.16 |
| C   | 0.305     | 0.325 | 7.75        | 8.26  |
| D   | 0.016     | 0.020 | 0.41        | 0.51  |
| F   | 0.048     | 0.064 | 1.22        | 1.63  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| H   | 0.182     | 0.194 | 4.62        | 4.93  |
| J   | 0.014     | 0.016 | 0.36        | 0.41  |
| K   | 0.695     | 0.725 | 17.65       | 18.42 |
| L   | 0.290     | 0.300 | 7.37        | 7.62  |
| N   | 0.420     | 0.440 | 10.67       | 11.18 |
| P   | 0.153     | 0.159 | 3.89        | 4.04  |
| Q   | 0.153     | 0.159 | 3.89        | 4.04  |
| R   | 0.230     | 0.250 | 5.84        | 6.35  |
| S   | 0.220     | 0.240 | 5.59        | 6.10  |
| U   | 0.910 BSC |       | 23.11 BSC   |       |

## STYLE 1:

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

CASE 344B-01  
ISSUE B

## PACKAGE DIMENSIONS — CONTINUED



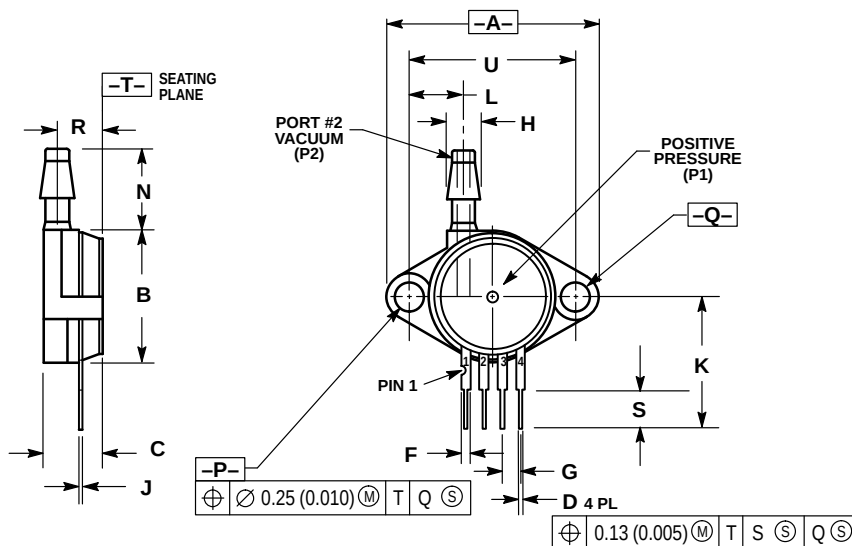
## NOTES:

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

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 1.145     | 1.175 | 29.08       | 29.85 |
| B   | 0.685     | 0.715 | 17.40       | 18.16 |
| C   | 0.405     | 0.435 | 10.29       | 11.05 |
| D   | 0.016     | 0.020 | 0.41        | 0.51  |
| F   | 0.048     | 0.064 | 1.22        | 1.63  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| H   | 0.182     | 0.194 | 4.62        | 4.93  |
| J   | 0.014     | 0.016 | 0.36        | 0.41  |
| K   | 0.695     | 0.725 | 17.65       | 18.42 |
| L   | 0.290     | 0.300 | 7.37        | 7.62  |
| N   | 0.420     | 0.440 | 10.67       | 11.18 |
| P   | 0.153     | 0.159 | 3.89        | 4.04  |
| Q   | 0.153     | 0.159 | 3.89        | 4.04  |
| R   | 0.063     | 0.083 | 1.60        | 2.11  |
| S   | 0.220     | 0.240 | 5.59        | 6.10  |
| U   | 0.910 BSC |       | 23.11 BSC   |       |
| V   | 0.248     | 0.278 | 6.30        | 7.06  |
| W   | 0.310     | 0.330 | 7.87        | 8.38  |

## STYLE 1:

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

CASE 344C-01  
ISSUE B

## NOTES:

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

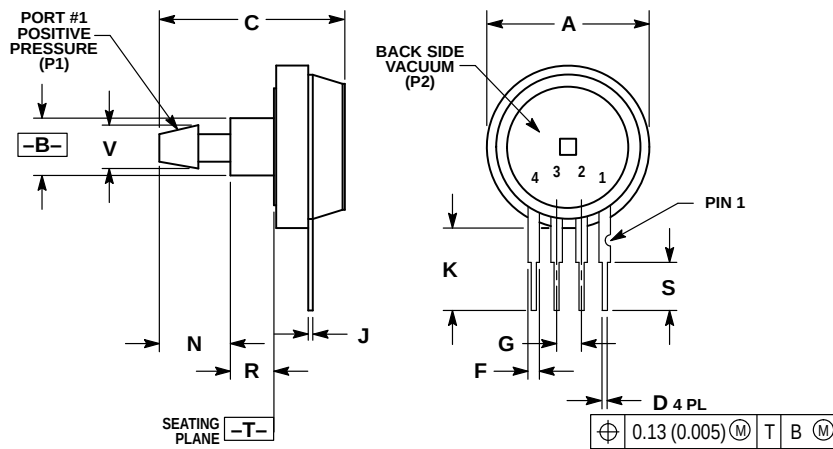
| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 1.145     | 1.175 | 29.08       | 29.85 |
| B   | 0.685     | 0.715 | 17.40       | 18.16 |
| C   | 0.305     | 0.325 | 7.75        | 8.26  |
| D   | 0.016     | 0.020 | 0.41        | 0.51  |
| F   | 0.048     | 0.064 | 1.22        | 1.63  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| H   | 0.182     | 0.194 | 4.62        | 4.93  |
| J   | 0.014     | 0.016 | 0.36        | 0.41  |
| K   | 0.695     | 0.725 | 17.65       | 18.42 |
| L   | 0.290     | 0.300 | 7.37        | 7.62  |
| N   | 0.420     | 0.440 | 10.67       | 11.18 |
| P   | 0.153     | 0.159 | 3.89        | 4.04  |
| Q   | 0.153     | 0.158 | 3.89        | 4.04  |
| R   | 0.230     | 0.250 | 5.84        | 6.35  |
| S   | 0.220     | 0.240 | 5.59        | 6.10  |
| U   | 0.910 BSC |       | 23.11 BSC   |       |

## STYLE 1:

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

CASE 344D-01  
ISSUE B

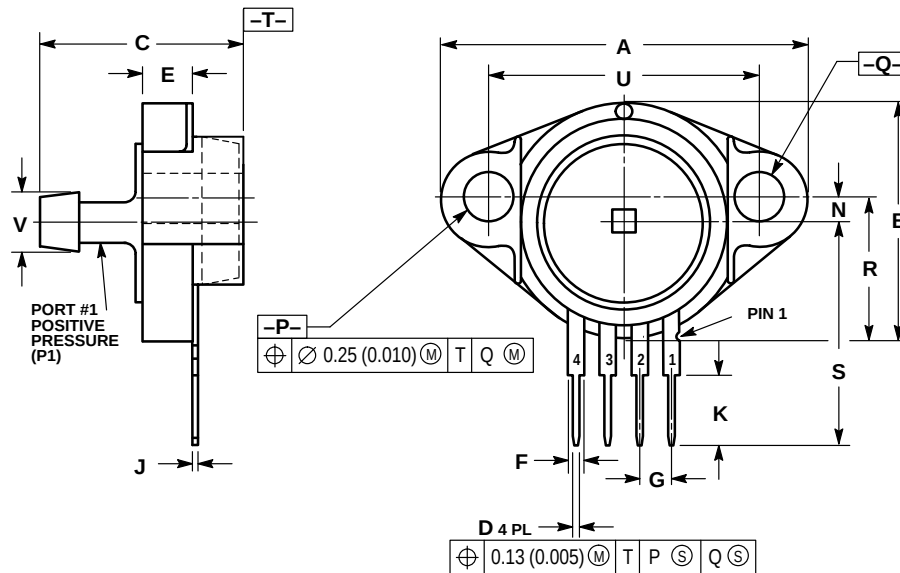
## PACKAGE DIMENSIONS — CONTINUED



- 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   | 0.245     | 0.255 | 6.22        | 6.48  |
| C   | 0.780     | 0.820 | 19.81       | 20.82 |
| D   | 0.016     | 0.020 | 0.41        | 0.51  |
| F   | 0.048     | 0.064 | 1.22        | 1.63  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| J   | 0.014     | 0.016 | 0.36        | 0.41  |
| K   | 0.345     | 0.375 | 8.76        | 9.53  |
| N   | 0.300     | 0.310 | 7.62        | 7.87  |
| R   | 0.178     | 0.186 | 4.52        | 4.72  |
| S   | 0.220     | 0.240 | 5.59        | 6.10  |
| V   | 0.182     | 0.194 | 4.62        | 4.93  |

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

CASE 344E-01  
ISSUE B

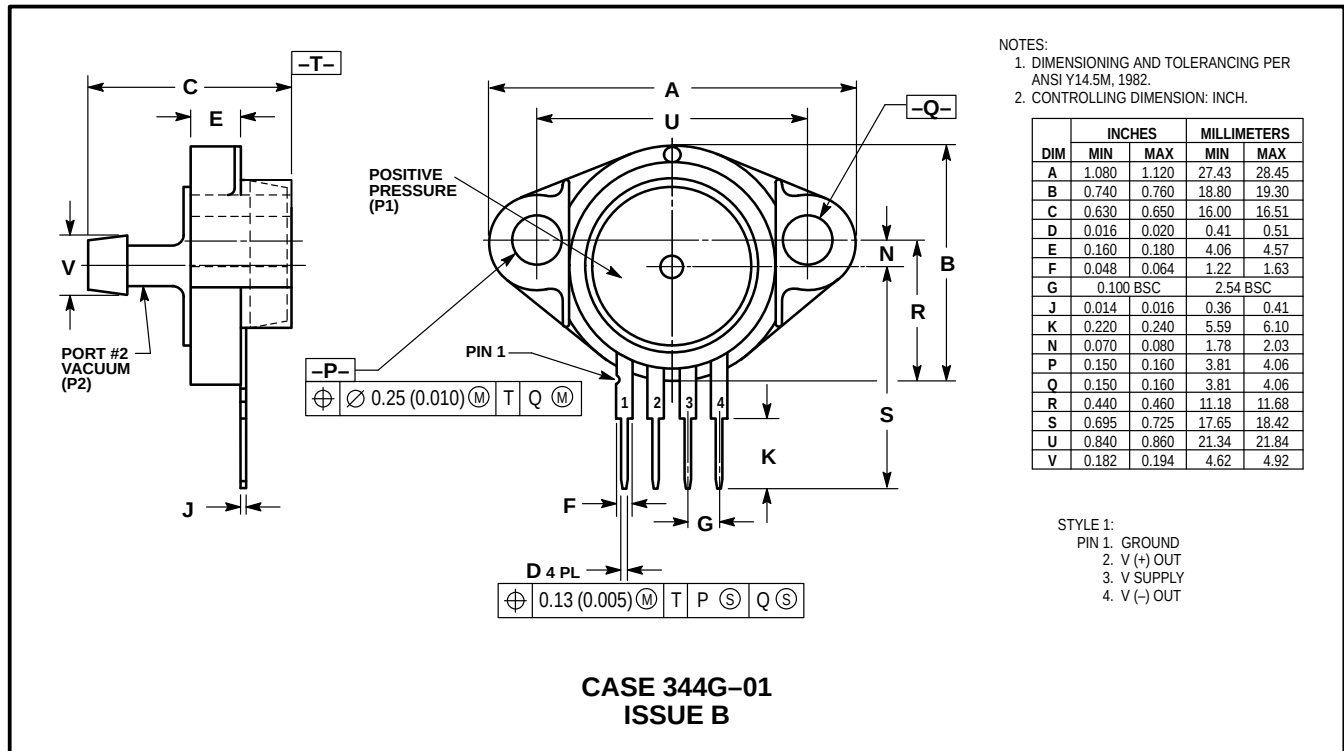
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 1.080     | 1.120 | 27.43       | 28.45 |
| B   | 0.740     | 0.760 | 18.80       | 19.30 |
| C   | 0.630     | 0.650 | 16.00       | 16.51 |
| D   | 0.016     | 0.020 | 0.41        | 0.51  |
| E   | 0.160     | 0.180 | 4.06        | 4.57  |
| F   | 0.048     | 0.064 | 1.22        | 1.63  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| J   | 0.014     | 0.016 | 0.36        | 0.41  |
| K   | 0.220     | 0.240 | 5.59        | 6.10  |
| 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   | 0.440     | 0.460 | 11.18       | 11.68 |
| S   | 0.695     | 0.725 | 17.65       | 18.42 |
| U   | 0.840     | 0.860 | 21.34       | 21.84 |
| V   | 0.182     | 0.194 | 4.62        | 4.92  |

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

CASE 344F-01  
ISSUE B

## PACKAGE DIMENSIONS — CONTINUED



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**ASIA/PACIFIC:** Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,  
51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-26629298

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