

# Integrated Silicon Pressure Sensor On-Chip Signal Conditioned, Temperature Compensated and Calibrated

The MPX5100 series piezoresistive transducer is a state-of-the-art monolithic silicon pressure sensor designed for a wide range of applications, but particularly those employing a microcontroller or microprocessor with A/D inputs. This patented, single element transducer combines advanced micromachining techniques, thin-film metallization, and bipolar processing to provide an accurate, high level analog output signal that is proportional to the applied pressure.

## Features

- 2.5% Maximum Error over 0° to 85°C
- Ideally suited for Microprocessor or Microcontroller-Based Systems
- Patented Silicon Shear Stress Strain Gauge
- Available in Absolute, Differential and Gauge Configurations
- Durable Epoxy Unibody Element
- Easy-to-Use Chip Carrier Option

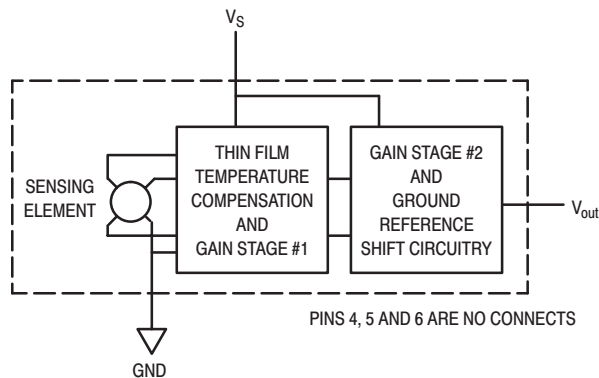
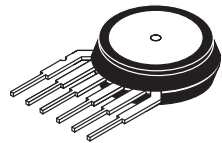


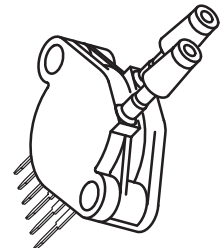
Figure 1. Fully Integrated Pressure Sensor Schematic

## MPX5100 SERIES

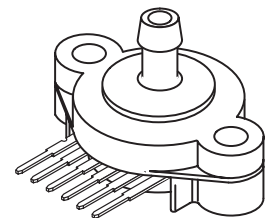
**INTEGRATED PRESSURE  
SENSOR**  
0 to 100 kPa (0 to 14.5 psi)  
15 to 115 kPa  
(2.18 to 16.68 psi)  
0.2 to 4.7 Volts Output



MPX5100D  
CASE 867



MPX5100DP  
CASE 867C



MPX5100GSX  
CASE 867F

| PIN NUMBER |                  |   |     |
|------------|------------------|---|-----|
| 1          | V <sub>out</sub> | 4 | N/C |
| 2          | Gnd              | 5 | N/C |
| 3          | V <sub>S</sub>   | 6 | N/C |

NOTE: Pins 4, 5, and 6 are internal device connections. Do not connect to external circuitry or ground. Pin 1 is noted by the notch in the lead.



## MPX5100 SERIES

### MAXIMUM RATINGS(NOTE)

| Parametrics                | Symbol           | Value          | Unit |
|----------------------------|------------------|----------------|------|
| Maximum Pressure (P1 > P2) | P <sub>max</sub> | 400            | kPa  |
| Storage Temperature        | T <sub>stg</sub> | –40° to +125°  | °C   |
| Operating Temperature      | T <sub>A</sub>   | – 40° to +125° | °C   |

NOTE: Exposure beyond the specified limits may cause permanent damage or degradation to the device.

**OPERATING CHARACTERISTICS** (V<sub>S</sub> = 5.0 Vdc, T<sub>A</sub> = 25°C unless otherwise noted, P1 > P2. Decoupling circuit shown in Figure 4 required to meet electrical specifications.)

| Characteristic                                                                                                                | Symbol           | Min            | Typ            | Max            | Unit              |
|-------------------------------------------------------------------------------------------------------------------------------|------------------|----------------|----------------|----------------|-------------------|
| Pressure Range <sup>(1)</sup> Gauge, Differential: MPX5100D<br>Absolute: MPX5100A                                             | P <sub>OP</sub>  | 0<br>15        | —<br>—         | 100<br>115     | kPa               |
| Supply Voltage <sup>(2)</sup>                                                                                                 | V <sub>S</sub>   | 4.75           | 5.0            | 5.25           | Vdc               |
| Supply Current                                                                                                                | I <sub>o</sub>   | —              | 7.0            | 10             | mAdc              |
| Minimum Pressure Offset <sup>(3)</sup> (0 to 85°C)<br>@ V <sub>S</sub> = 5.0 Volts                                            | V <sub>off</sub> | 0.088          | 0.20           | 0.313          | Vdc               |
| Full Scale Output <sup>(4)</sup> Differential and Absolute (0 to 85°C)<br>@ V <sub>S</sub> = 5.0 Volts Vacuum <sup>(10)</sup> | V <sub>FSO</sub> | 4.587<br>3.688 | 4.700<br>3.800 | 4.813<br>3.913 | Vdc               |
| Full Scale Span <sup>(5)</sup> Differential and Absolute (0 to 85°C)<br>@ V <sub>S</sub> = 5.0 Volts Vacuum <sup>(10)</sup>   | V <sub>FSS</sub> | —<br>—         | 4.500<br>3.600 | —<br>—         | Vdc               |
| Accuracy <sup>(6)</sup>                                                                                                       | —                | —              | —              | ± 2.5          | %V <sub>FSS</sub> |
| Sensitivity                                                                                                                   | V/P              | —              | 45             | —              | mV/kPa            |
| Response Time <sup>(7)</sup>                                                                                                  | t <sub>R</sub>   | —              | 1.0            | —              | ms                |
| Output Source Current at Full Scale Output                                                                                    | I <sub>o+</sub>  | —              | 0.1            | —              | mAdc              |
| Warm-Up Time <sup>(8)</sup>                                                                                                   | —                | —              | 20             | —              | ms                |
| Offset Stability <sup>(9)</sup>                                                                                               | —                | —              | ± 0.5          | —              | %V <sub>FSS</sub> |

#### NOTES:

- 1.0kPa (kiloPascal) equals 0.145 psi.
- Device is ratiometric within this specified excitation range.
- Offset (V<sub>off</sub>) is defined as the output voltage at the minimum rated pressure.
- Full Scale Output (V<sub>FSO</sub>) is defined as the output voltage at the maximum or full rated pressure.
- 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.
- Accuracy (error budget) consists of the following:
  - Linearity: Output deviation from a straight line relationship with pressure 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 minimum or maximum rated pressure at 25°C.
  - TcSpan: Output deviation over the temperature range of 0° to 85°C, relative to 25°C.
  - TcOffset: Output deviation with minimum pressure applied, over the temperature range of 0° to 85°C, relative to 25°C.
  - Variation from Nominal: The variation from nominal values, for Offset or Full Scale Span, as a percent of V<sub>FSS</sub> at 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.
- Warm-up Time is defined as the time required for the product to meet the specified output voltage after the Pressure has been stabilized.
- Offset Stability is the product's output deviation when subjected to 1000 hours of Pulsed Pressure, Temperature Cycling with Bias Test.

### MECHANICAL CHARACTERISTICS

| Characteristics                  | Typ | Unit  |
|----------------------------------|-----|-------|
| Weight, Basic Element (Case 867) | 4.0 | grams |

## ON-CHIP TEMPERATURE COMPENSATION, CALIBRATION and SIGNAL CONDITIONING

Figure 2 shows the sensor output signal relative to pressure input. Typical, minimum, and maximum output curves are shown for operation over a temperature range of 0° to 85°C using the decoupling circuit shown in Figure 4. The output will saturate outside of the specified pressure range.

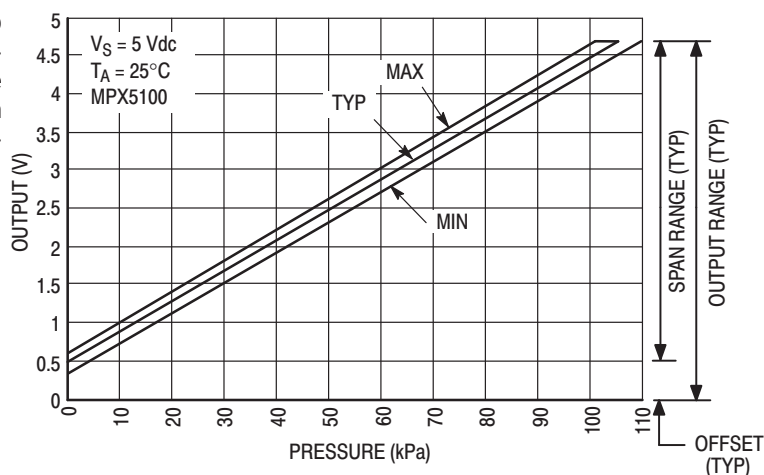


Figure 2. Output versus Pressure Differential

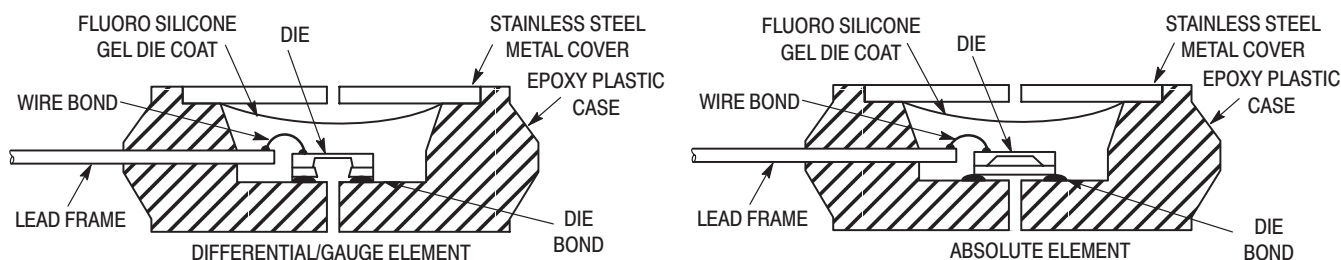


Figure 3. Cross-Sectional Diagrams  
(Not to Scale)

Figure 3 illustrates both the Differential/Gauge and the Absolute Sensing Chip in the basic chip carrier (Case 867). A fluorosilicone gel isolates the die surface and wire bonds from the environment, while allowing the pressure signal to be transmitted to the sensor diaphragm.

The MPX5100 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.

Figure 4 shows the recommended decoupling circuit for interfacing the output of the integrated sensor to the A/D input of a microprocessor or microcontroller. Proper decoupling of the power supply is recommended.

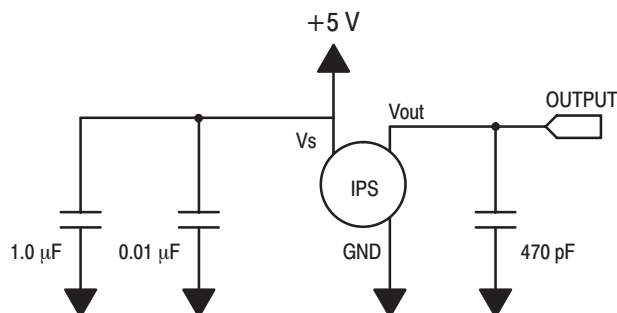


Figure 4. Recommended power supply decoupling  
and output filtering.  
For additional output filtering, please refer to  
Application Note AN1646.

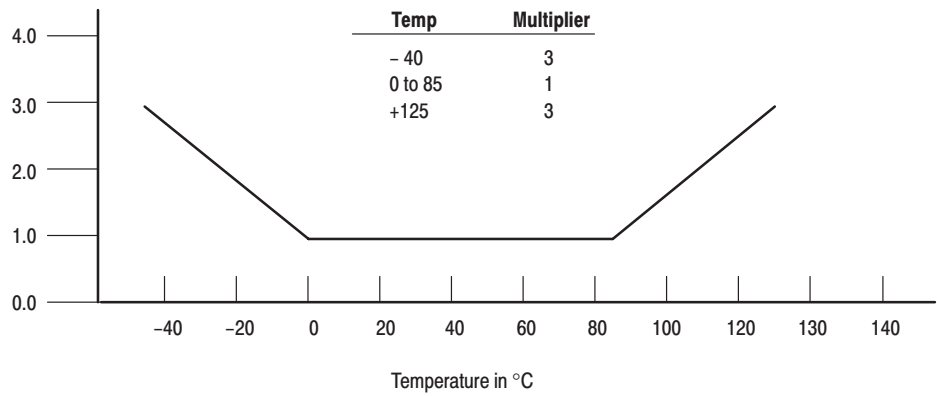
**MPX5100 SERIES**

**Transfer Function (MPX5100D, MPX5100G)**

**Nominal Transfer Value:**  $V_{out} = V_S (P \times 0.009 + 0.04)$   
+/- (Pressure Error x Temp. Mult. x 0.009 x  $V_S$ )  
 $V_S = 5.0\text{ V} \pm 5\% \text{ P kPa}$

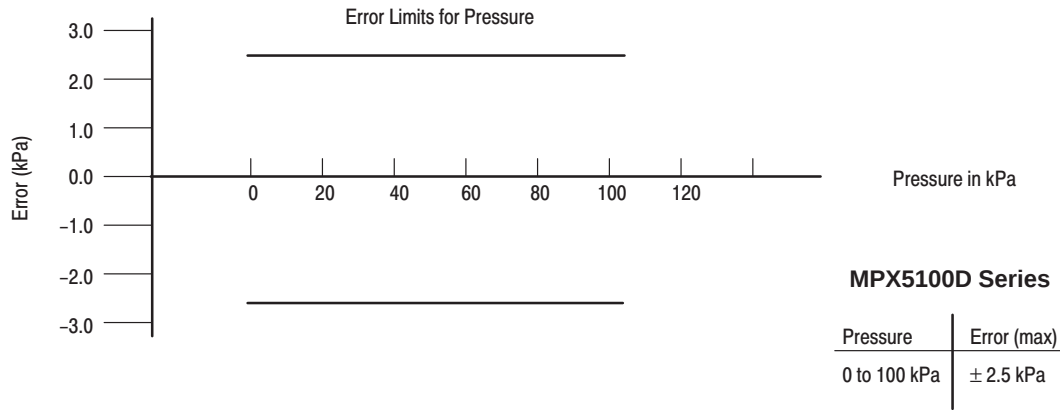
**Temperature Error Multiplier**

**MPX5100D Series**



NOTE: The Temperature Multiplier is a linear response from 0° to -40°C and from 85° to 125°C.

**Pressure Error Band**

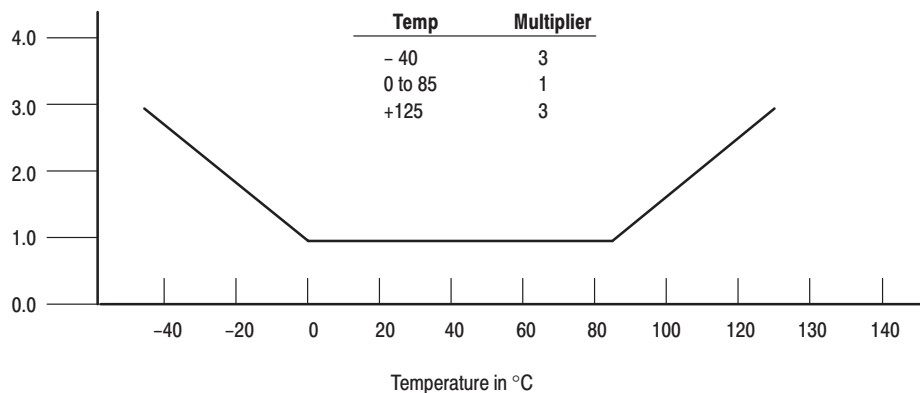


## Transfer Function (MPX5100A)

**Nominal Transfer Value:**  $V_{out} = V_S (P \times 0.009 - 0.095)$   
 $\pm (\text{Pressure Error} \times \text{Temp. Mult.} \times 0.009 \times V_S)$   
 $V_S = 5.0 \text{ V} \pm 5\% \text{ P kPa}$

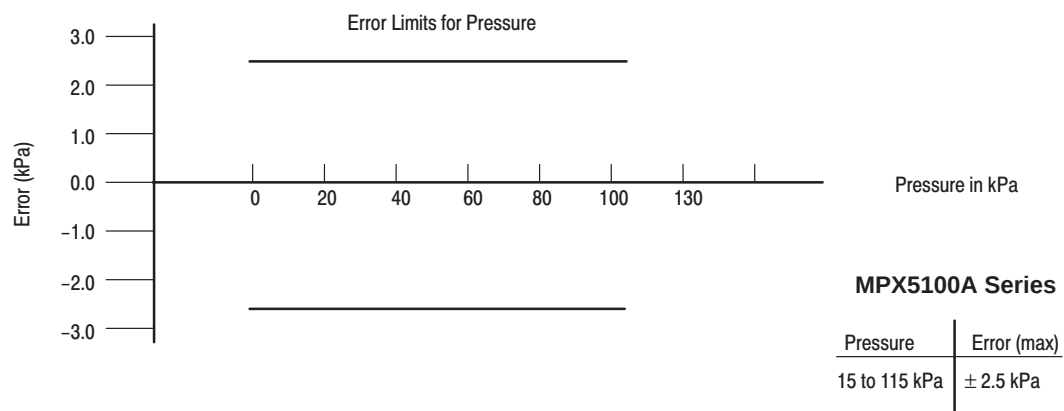
## Temperature Error Multiplier

MPX5100A Series



NOTE: The Temperature Multiplier is a linear response from 0° to -40°C and from 85° to 125°C.

## Pressure Error Band



## MPX5100 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 fluoro 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:

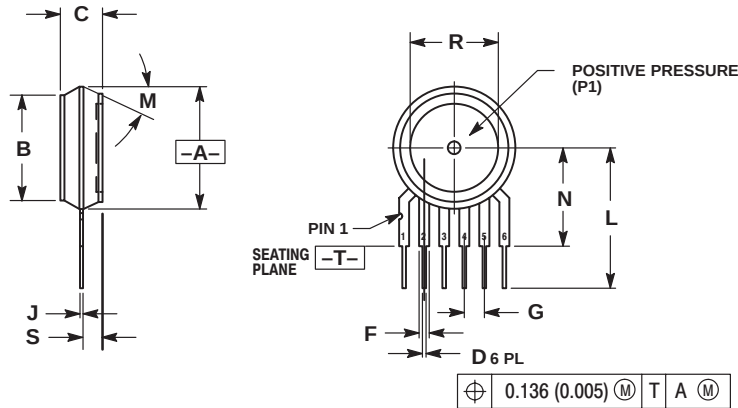
| Part Number          | Case Type | Pressure (P1)<br>Side Identifier |
|----------------------|-----------|----------------------------------|
| MPX5100A, MPX5100D   | 867       | Stainless Steel Cap              |
| MPX5100DP            | 867C      | Side with Part Marking           |
| MPX5100AP, MPX5100GP | 867B      | Side with Port Attached          |
| MPX5100GSX           | 867F      | Side with Port Attached          |

### ORDERING INFORMATION:

The MPX5100 pressure sensor is available in absolute, differential, and gauge configurations. Devices are available in the basic element package or with pressure port fittings that provide printed circuit board mounting ease and barbed hose pressure connections.

| Device Name     | Options                 | Case Type | MPX Series   |                |
|-----------------|-------------------------|-----------|--------------|----------------|
|                 |                         |           | Order Number | Device Marking |
| Basic Element   | Absolute                | 867       | MPX5100A     | MPX5100A       |
|                 | Differential            | 867       | MPX5100D     | MPX5100D       |
| Ported Elements | Differential Dual Ports | 867C      | MPX5100DP    | MPX5100DP      |
|                 | Absolute, Single Port   | 867B      | MPX5100AP    | MPX5100AP      |
|                 | Gauge, Single Port      | 867B      | MPX5100GP    | MPX5100GP      |
|                 | Gauge, Axial PC Mount   | 867F      | MPX5100GSX   | MPX5100D       |

## PACKAGE DIMENSIONS



## NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
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   | 0.027     | 0.033 | 0.68        | 0.84  |
| 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 |
| S   | 0.090     | 0.105 | 2.29        | 2.66  |

## STYLE 1:

1. VOUT
2. GROUND
3. VCC
4. V1
5. V2
6. VEX

## STYLE 2:

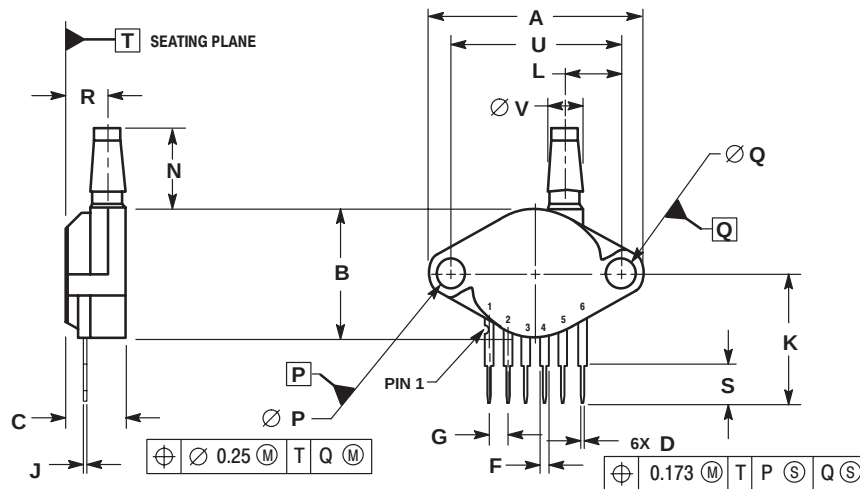
1. OPEN
2. GROUND
3. -VOUT
4. VSUPPLY
5. +VOUT
6. OPEN

## STYLE 3:

1. OPEN
2. GROUND
3. +VOUT
4. +VSUPPLY
5. -VOUT
6. OPEN

CASE 867-08  
ISSUE N

## BASIC ELEMENT



## NOTES:

1. DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.

| DIM | MILLIMETERS |       |
|-----|-------------|-------|
|     | MIN         | MAX   |
| A   | 29.08       | 29.85 |
| B   | 17.4        | 18.16 |
| C   | 7.75        | 8.26  |
| D   | 0.68        | 0.84  |
| F   | 1.22        | 1.63  |
| G   | 2.54 BSC    |       |
| J   | 0.36        | 0.41  |
| K   | 17.65       | 18.42 |
| L   | 7.37        | 7.62  |
| N   | 10.67       | 11.18 |
| P   | 3.89        | 4.04  |
| Q   | 3.89        | 4.04  |
| R   | 5.84        | 6.35  |
| S   | 5.59        | 6.1   |
| U   | 23.11 BSC   |       |
| V   | 4.62        | 4.93  |

## STYLE 1:

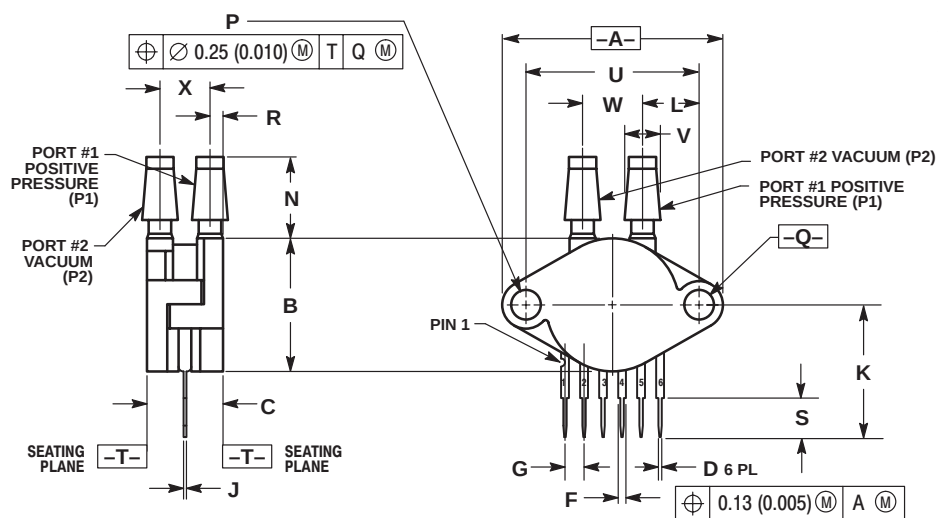
1. VOUT
2. GROUND
3. VCC
4. V1
5. V2
6. VEX

CASE 867B-04  
ISSUE F

## PRESSURE SIDE PORTED (AP, GP)

## PACKAGE DIMENSIONS--CONTINUED

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

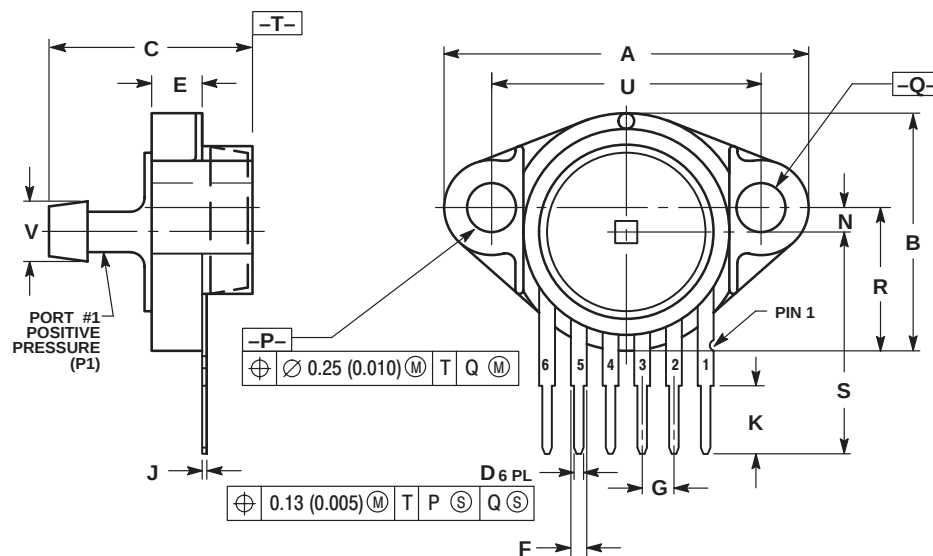


| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 1.145     | 1.175 | 29.08       | 29.85 |
| B   | 0.685     | 0.715 | 17.40       | 18.16 |
| C   | 0.405     | 0.435 | 10.29       | 11.05 |
| D   | 0.027     | 0.033 | 0.68        | 0.84  |
| 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   | 0.695     | 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   | 0.182     | 0.194 | 4.62        | 4.93  |
| W   | 0.310     | 0.330 | 7.87        | 8.38  |
| X   | 0.248     | 0.278 | 6.30        | 7.06  |

- STYLE 1:
1.  $V_{OUT}$
  2. GROUND
  3.  $V_{CC}$
  4.  $V_1$
  5.  $V_2$
  6.  $V_{EX}$

CASE 867C-05  
ISSUE F

## PRESSURE AND VACUUM SIDES PORTED (DP)



- 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   | 0.027     | 0.033 | 0.68        | 0.84  |
| 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        | 4.93  |

- STYLE 1:
1.  $V_{OUT}$
  2. GROUND
  3.  $V_{CC}$
  4.  $V_1$
  5.  $V_2$
  6.  $V_{EX}$

CASE 867F-03  
ISSUE D

## PRESSURE SIDE AXIAL PORT (GSX)

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