



## Preliminary Information

# Altimeter or Barometer Applications Integrated Silicon Pressure Sensor On-Chip Signal Conditioned, Temperature Compensated and Calibrated

The Motorola MPX4115A/MPXS4115A series Manifold Absolute Pressure (MAP) sensor for engine control is designed to sense absolute air pressure.

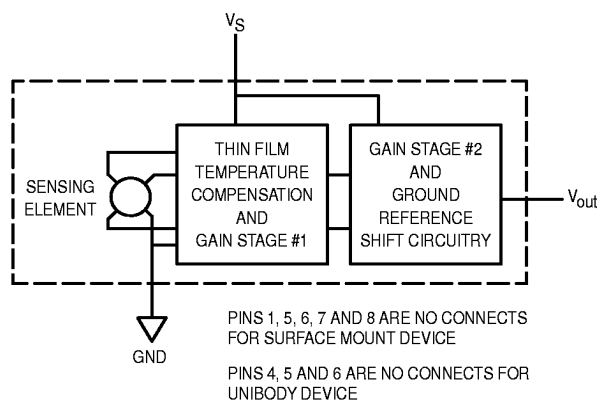
Motorola's MAP sensor integrates on-chip, bipolar op amp circuitry and thin film resistor networks to provide a high output signal and temperature compensation. The small form factor and high reliability of on-chip integration make the Motorola MAP sensor a logical and economical choice for the automotive system designer.

### Features

- 1.5% Maximum Error over 0° to 85°C
- Ideally suited for Microprocessor or Microcontroller-Based Systems
- Temperature Compensated from -40° to +125°C
- Durable Epoxy Unibody Element or Surface Mount Package

### Application Examples

- Aviation Altimeters
- Industrial Controls
- Engine Control
- Weather Stations and Weather Reporting Devices



**Figure 1. Fully Integrated Pressure Sensor Schematic**

This document contains information on a new product. Specifications and information herein are subject to change without notice.

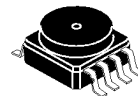
Senseon is a trademark of Motorola, Inc.

**Replaces MPX4115 and MPXS4115A**

## MPX4115A MPXS4115A PPXA4115A SERIES

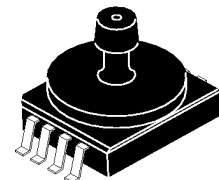
**OPERATING OVERVIEW**  
**INTEGRATED**  
**PRESSURE SENSOR**  
15 to 115 kPa (2.2 to 16.7 psi)  
0.2 to 4.8 Volts Output

### SMALL OUTLINE PACKAGE



**PPXA4115A**  
**CASE 482-01**

### SURFACE MOUNT PACKAGE



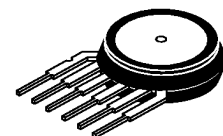
**MPXS4115A**  
**AXIAL PORT OPTION**  
**CASE 471B-01, STYLE 1**

### PIN NUMBER

|   |                |   |                  |   |     |   |     |
|---|----------------|---|------------------|---|-----|---|-----|
| 1 | N/C            | 3 | Gnd              | 5 | N/C | 7 | N/C |
| 2 | V <sub>S</sub> | 4 | V <sub>out</sub> | 6 | N/C | 8 | N/C |

NOTE: Pins 1, 5, 6, 7, and 8 are internal device connections. Do not connect to external circuitry or ground.

### UNIBODY PACKAGE



**MPX4115A**  
**BASIC CHIP CARRIER ELEMENT**  
**CASE 867-08, STYLE 1**

### 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.

The MPX4115A/MPXS4115A series piezoresistive transducer is a state-of-the-art, monolithic, signal conditioned, silicon pressure sensor. This sensor combines advanced micromachining techniques, thin film metallization, and bipolar semiconductor processing to provide an accurate, high level analog output signal that is proportional to applied pressure.

Figure 1 shows a block diagram of the internal circuitry integrated on a pressure sensor chip.



**MOTOROLA**

## MPX4115A MPXS4115A PPXA4115A SERIES

### MAXIMUM RATINGS(1)

| Parameters                  | Symbol             | Value         | Units |
|-----------------------------|--------------------|---------------|-------|
| Overpressure(9) (P1 > P2)   | P <sub>max</sub>   | 400           | kPa   |
| Burst Pressure(9) (P1 > P2) | P <sub>burst</sub> | 1000          | kPa   |
| Storage Temperature         | T <sub>stg</sub>   | −40° to +125° | °C    |
| Operating Temperature       | T <sub>A</sub>     | −40° to +125° | °C    |

1. T<sub>C</sub> = 25°C unless otherwise noted.

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

### OPERATING CHARACTERISTICS (V<sub>S</sub> = 5.1 Vdc, T<sub>A</sub> = 25°C unless otherwise noted, P1 > P2)

| Characteristic                                                         | Symbol           | Min   | Typ   | Max   | Unit              |
|------------------------------------------------------------------------|------------------|-------|-------|-------|-------------------|
| Pressure Range                                                         | P <sub>OP</sub>  | 15    | —     | 115   | kPa               |
| Supply Voltage(1)                                                      | V <sub>S</sub>   | 4.85  | 5.1   | 5.35  | Vdc               |
| Supply Current                                                         | I <sub>o</sub>   | —     | 7.0   | 10    | mAdc              |
| Minimum Pressure Offset(2) (0 to 85°C)<br>@ V <sub>S</sub> = 5.1 Volts | V <sub>off</sub> | 0.135 | 0.204 | 0.273 | Vdc               |
| Full Scale Output(3) (0 to 85°C)<br>@ V <sub>S</sub> = 5.1 Volts       | V <sub>FSO</sub> | 4.725 | 4.794 | 4.863 | Vdc               |
| Full Scale Span(4) (0 to 85°C)<br>@ V <sub>S</sub> = 5.1 Volts         | V <sub>FSS</sub> | 4.521 | 4.590 | 4.659 | Vdc               |
| Accuracy(5) (0 to 85°C)                                                | —                | —     | —     | ±1.5  | %V <sub>FSS</sub> |
| Sensitivity                                                            | V/P              | —     | 45.9  | —     | mV/kPa            |
| Response Time(6)                                                       | t <sub>R</sub>   | —     | 1.0   | —     | mS                |
| Output Source Current at Full Scale Output                             | I <sub>o+</sub>  | —     | 0.1   | —     | mAdc              |
| Warm-Up Time(7)                                                        | —                | —     | 20    | —     | mSec              |
| Offset Stability(8)                                                    | —                | —     | ±0.5  | —     | %V <sub>FSS</sub> |

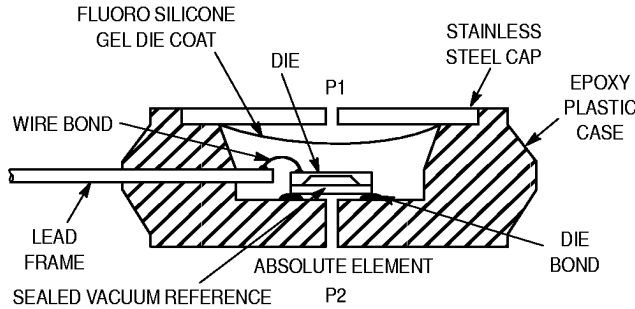
Decoupling circuit shown in Figure 2 required to meet Electrical Specifications.

### MECHANICAL CHARACTERISTICS

| Characteristic                   | Symbol | Min | Typ | Max | Unit  |
|----------------------------------|--------|-----|-----|-----|-------|
| Weight, Basic Element (Case 471) | —      | —   | 1.5 | —   | Grams |
| Weight, Basic Element (Case 867) | —      | —   | 4.0 | —   | Grams |

#### NOTES:

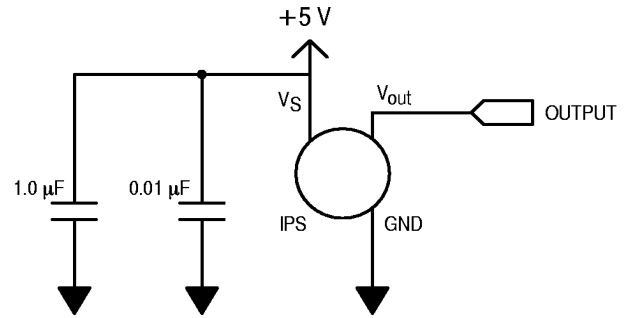
- Device is ratiometric within this specified excitation range.
- Offset (V<sub>off</sub>) is defined as the output voltage at the minimum rated pressure.
- Full Scale Output (V<sub>FSO</sub>) is defined as the output voltage at the maximum or full rated pressure.
- Full Scale Span (V<sub>FSS</sub>) is defined as the algebraic difference between the output voltage at full rated pressure and the output voltage at the minimum rated pressure.
- Accuracy is the deviation in actual output from nominal output over the entire pressure range and temperature range as a percent of span at 25°C due to all sources of error including 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.
- 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 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 cycles of Pulsed Pressure, Temperature Cycling with Bias Test.
- Exposure beyond these limits may cause permanent damage or degradation to the device.



**Figure 2. Cross Sectional Diagram (not to scale)**

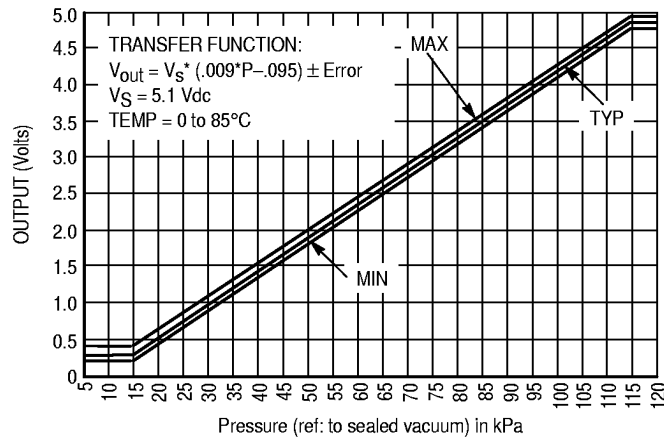
Figure 2 illustrates the absolute sensing chip in the basic chip carrier (Case 867).

This surface mount package (Case 471-01) is an absolute sensing configuration package.



**Figure 3. Recommended Power Supply Decoupling. For output filtering recommendations, please refer to Application Note AN1646.**

Figure 3 shows the recommended decoupling circuit for interfacing the output of the integrated BAP sensor to the A/D input of a microprocessor.



**Figure 4. Output versus Absolute Pressure**

Figure 4 shows the sensor output signal relative to pressure input. Typical minimum and maximum output curves are shown for operation over 0 to 85°C temperature range. (Output will saturate outside of the rated pressure range.)

A fluorosilicone gel isolates the die surface and wire bonds from the environment, while allowing the pressure signal to be transmitted to the silicon diaphragm. The

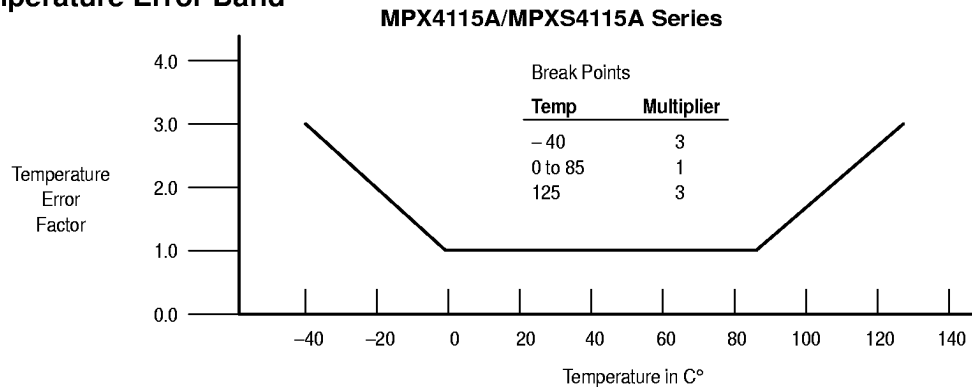
MPX4115A/MPXS4115A series pressure sensor operating characteristics, internal reliability and qualification tests are based on use of dry air as the pressure media. Media other than dry air may have adverse effects on sensor performance and long-term reliability. Contact the factory for information regarding media compatibility in your application.

## MPX4115A MPXS4115A PPXA4115A SERIES

### Transfer Function (MPX4115A, MPXS4115A)

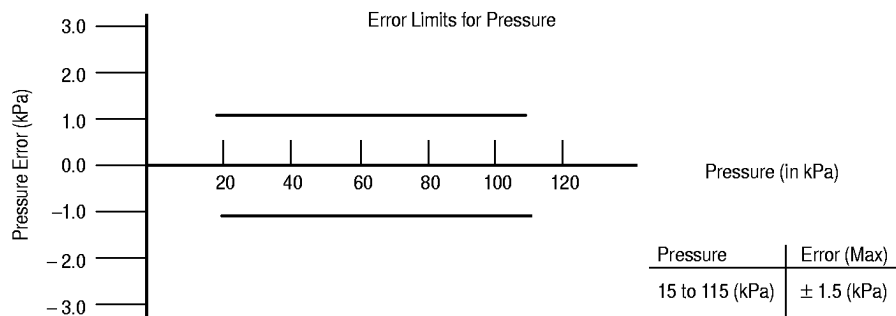
**Nominal Transfer Value:**  $V_{\text{out}} = V_S \times (0.009 \times P - 0.095)$   
 $\pm (\text{Pressure Error} \times \text{Temp. Factor} \times 0.009 \times V_S)$   
 $V_S = 5.1 \pm 0.25 \text{ Vdc}$

### Temperature Error Band



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

### Pressure Error Band



### ORDERING INFORMATION — SURFACE MOUNT PACKAGE

The MPX4115A BAP Sensor is available in the Basic Element package or with pressure port fittings that provide mounting ease and barbed hose connections.

Depending upon the Options, the MPXS4115A pressure sensors are available shipped in Sleeves, Tape and Reel, and Trays.

| Packing Options | Port Options | Leadform  | Case No. | MPXS Series Order No. | Marking   |
|-----------------|--------------|-----------|----------|-----------------------|-----------|
| Sleeve Pack     | Axial        | Gull Wing | 471B-01  | MPXS4115AC6U          | MPXS4115A |
| Sleeve Pack     | —            | Gull Wing | 471-01   | MPXS4115A6U           | MPXS4115A |
| Tape and Reel   | —            | Gull Wing | 471-01   | MPXS4115A6T1          | MPXS4115A |

### ORDERING INFORMATION — UNIBODY PACKAGE

| Device Type     | Options                   | Case No. | MPX Series Order No. | Marking   |
|-----------------|---------------------------|----------|----------------------|-----------|
| Basic Element   | Absolute, Element Only    | 867-08   | MPX4115A             | MPX4115A  |
| Ported Elements | Absolute, Ported          | 867B-04  | MPX4115AP            | MPX4115AP |
|                 | Absolute, Stove Pipe Port | 867E-03  | MPX4115AS            | MPX4115A  |
|                 | Absolute, Axial Port      | 867F-03  | MPX4115ASX           | MPX4115A  |

### ORDERING INFORMATION — SMALL OUTLINE PACKAGE

Small outline package is currently available as a prototype status device. Please contact factory for more information or mechanical samples.

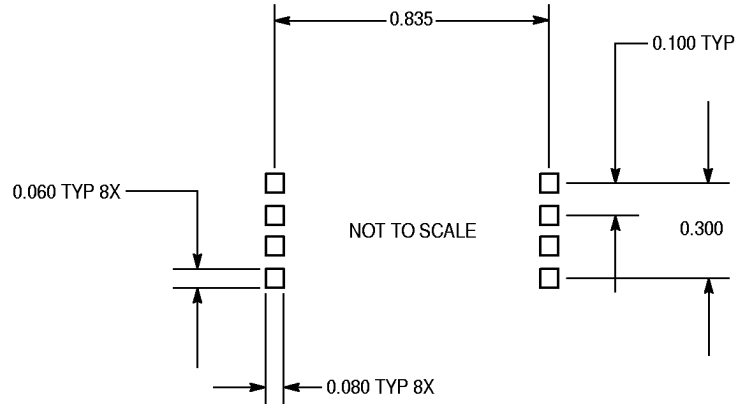
| Device       | Case No. | Packing Options | Marking   |
|--------------|----------|-----------------|-----------|
| PPXA4115A6U  | 482-01   | Rails           | PPXA4115A |
| PPXA4115AC6U | 482A-01  | Rails           | PPXA4115A |

## INFORMATION FOR USING THE SURFACE MOUNT PACKAGE

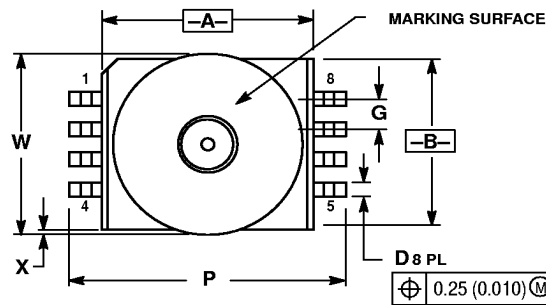
### MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to ensure proper solder connection inter-

face between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.

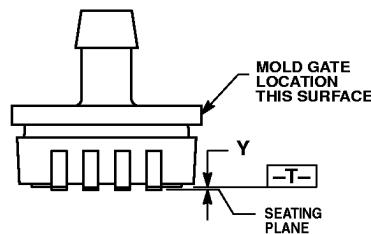
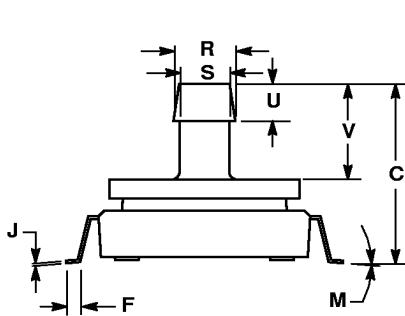


### SURFACE MOUNT PACKAGE DIMENSIONS



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
  5. ALL VERTICAL SURFACES 5° TYPICAL DRAFT.

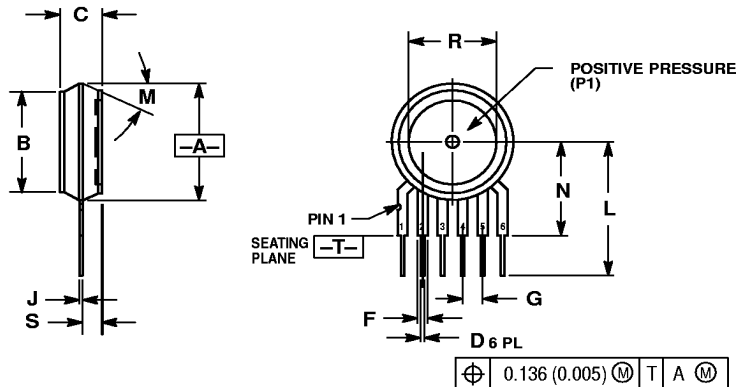
| DIM | INCHES |       | MILLIMETERS |       |
|-----|--------|-------|-------------|-------|
|     | MIN    | MAX   | MIN         | MAX   |
| A   | 0.658  | 0.668 | 16.71       | 16.97 |
| B   | 0.541  | 0.551 | 13.74       | 13.99 |
| C   | 0.555  | 0.585 | 14.10       | 14.86 |
| D   | 0.046  | 0.054 | 1.17        | 1.37  |
| F   | 0.037  | 0.053 | 0.94        | 1.34  |
| G   | 0.100  | BSC   | 2.54        | BSC   |
| J   | 0.009  | 0.011 | 0.23        | 0.28  |
| M   | 0°     | 7°    | 0°          | 7°    |
| P   | 0.856  | 0.880 | 21.74       | 22.35 |
| R   | 0.185  | 0.195 | 4.69        | 4.95  |
| S   | 0.155  | 0.165 | 3.94        | 4.19  |
| U   | 0.120  | 0.130 | 3.05        | 3.30  |
| V   | 0.305  | 0.315 | 7.75        | 8.00  |
| W   | 0.561  | 0.571 | 14.25       | 14.50 |
| X   | 0.010  | 0.025 | 0.25        | 0.63  |
| Y   | 0.002  | 0.010 | 0.05        | 0.25  |



**CASE 471B-01  
ISSUE O**

- STYLE 1:
1. NC
  2. VSUPPLY
  3. GROUND
  4. VOUT
  5. NC
  6. NC
  7. NC
  8. NC

## UNIBODY 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).

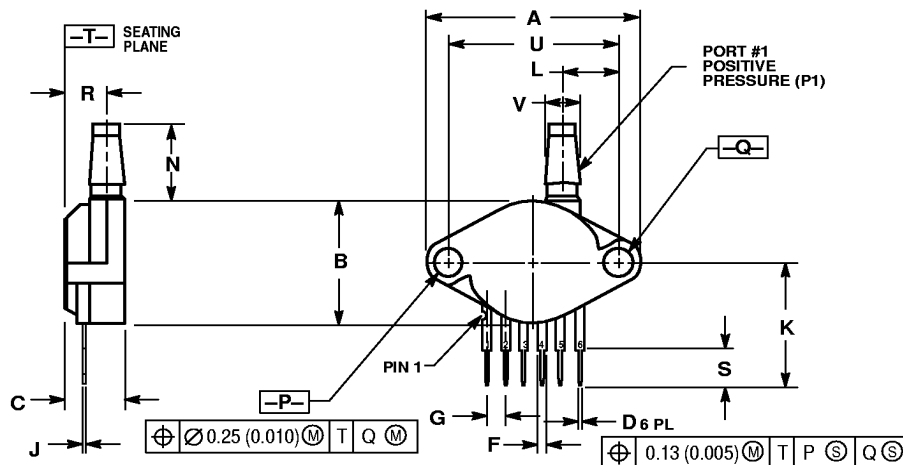
| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.595     | 0.630 | 15.11       | 16.00 |
| B   | 0.514     | 0.534 | 13.06       | 13.56 |
| C   | 0.200     | 0.220 | 5.08        | 5.59  |
| 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:

- PIN 1. VOUT
- GROUND
- VCC
- V1
- V2
- VEX

CASE 867-08  
ISSUE N

## BASIC ELEMENT (A, D)



## 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   | 0.305     | 0.325 | 7.75        | 8.26  |
| 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   | 0.230     | 0.250 | 5.84        | 6.35  |
| 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  |

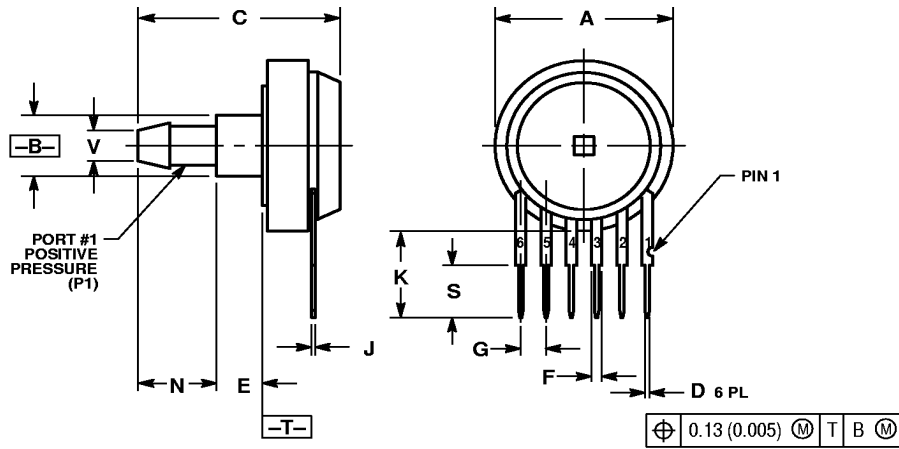
## STYLE 1:

- PIN 1. VOUT
- GROUND
- VCC
- V1
- V2
- VEX

CASE 867B-04  
ISSUE E

## PRESSURE SIDE PORTED (AP, GP)

## UNIBODY PACKAGE DIMENSIONS—CONTINUED



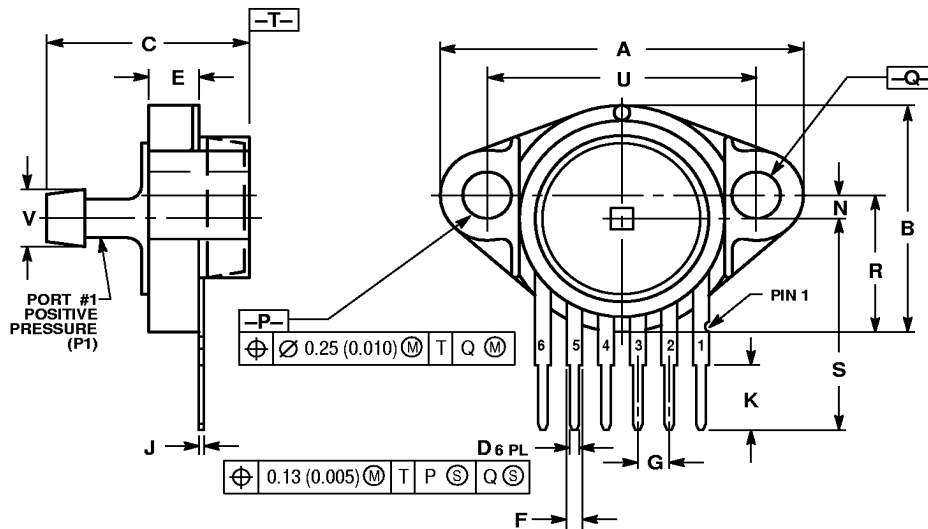
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.

| 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   | 0.027     | 0.033 | 0.69        | 0.84  |
| E   | 0.178     | 0.186 | 4.52        | 4.72  |
| 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  |
| S   | 0.220     | 0.240 | 5.59        | 6.10  |
| V   | 0.182     | 0.194 | 4.62        | 4.93  |

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

CASE 867E-03  
ISSUE D

PRESSURE SIDE PORTED (AS, GS)



- 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  |

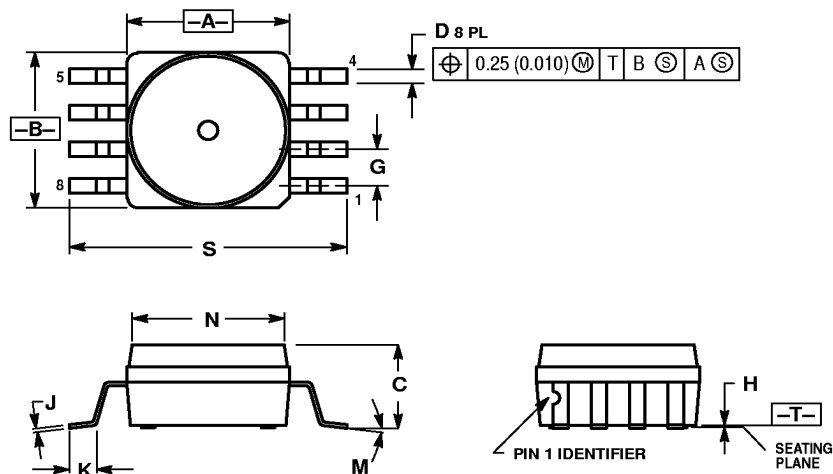
- STYLE 1:
1. VOUT
  2. GROUND
  3. VCC
  4. V1
  5. V2
  6. VEX

CASE 867F-03  
ISSUE D

PRESSURE SIDE PORTED (ASX, GSX)

# MPX4115A MPXS4115A PPXA4115A SERIES

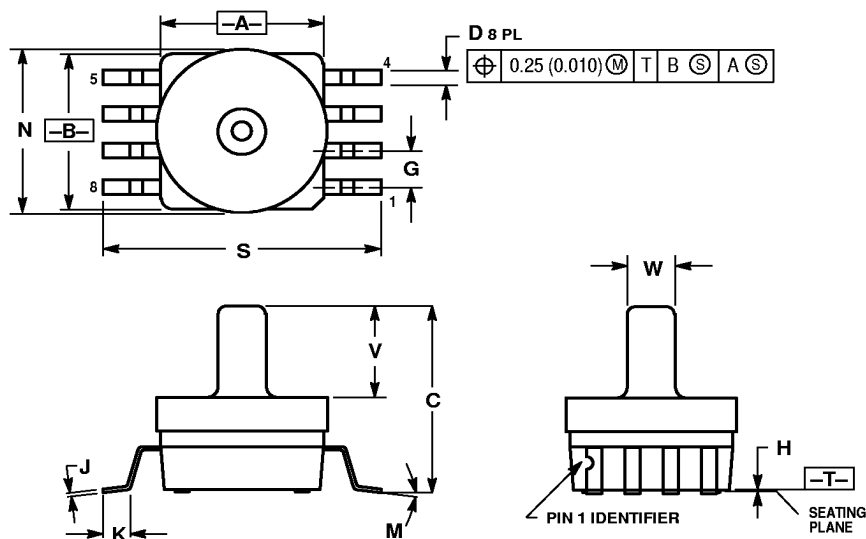
## SMALL OUTLINE PACKAGE DIMENSIONS



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
  5. ALL VERTICAL SURFACES 5° TYPICAL DRAFT.

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.415     | 0.425 | 10.54       | 10.79 |
| B   | 0.415     | 0.425 | 10.54       | 10.79 |
| C   | 0.212     | 0.230 | 5.38        | 5.84  |
| D   | 0.038     | 0.042 | 0.96        | 1.07  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| H   | 0.002     | 0.010 | 0.05        | 0.25  |
| J   | 0.009     | 0.011 | 0.23        | 0.28  |
| K   | 0.061     | 0.071 | 1.55        | 1.80  |
| M   | 0°        | 7°    | 0°          | 7°    |
| N   | 0.405     | 0.415 | 10.29       | 10.54 |
| S   | 0.709     | 0.725 | 18.01       | 18.41 |

CASE 482-01  
ISSUE O



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
  5. ALL VERTICAL SURFACES 5° TYPICAL DRAFT.

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.415     | 0.425 | 10.54       | 10.79 |
| B   | 0.415     | 0.425 | 10.54       | 10.79 |
| C   | 0.500     | 0.520 | 12.70       | 13.21 |
| D   | 0.038     | 0.042 | 0.96        | 1.07  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| H   | 0.002     | 0.010 | 0.05        | 0.25  |
| J   | 0.009     | 0.011 | 0.23        | 0.28  |
| K   | 0.061     | 0.071 | 1.55        | 1.80  |
| M   | 0°        | 7°    | 0°          | 7°    |
| N   | 0.444     | 0.448 | 11.28       | 11.38 |
| S   | 0.709     | 0.725 | 18.01       | 18.41 |
| V   | 0.245     | 0.255 | 6.22        | 6.48  |
| W   | 0.115     | 0.125 | 2.92        | 3.17  |

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