

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

Motorola's MPX4115A/MPXA4115A series 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 pressure sensor a logical and economical choice for the system designer.

The MPX4115A/MPXA4115A 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.

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 Thermoplastic (PPS) Surface Mount Package

Application Examples

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

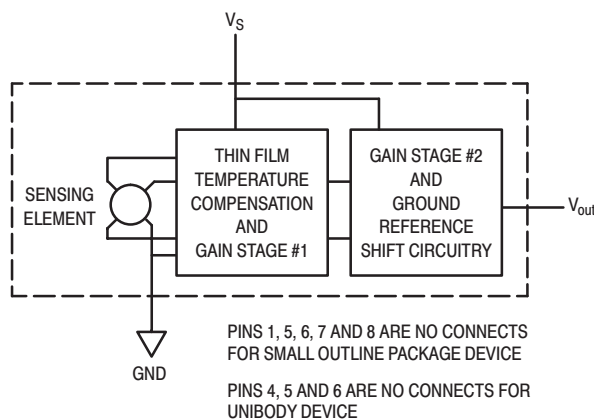
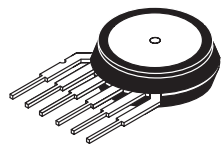


Figure 1. Fully Integrated Pressure Sensor Schematic

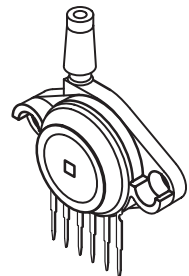
**MPX4115A
 MPXA4115A
 SERIES**

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

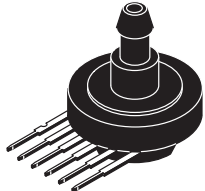
UNIBODY PACKAGE



**MPX4115A
 CASE 867**

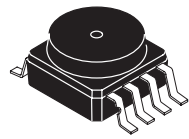


**MPX4115AP
 CASE 867B**

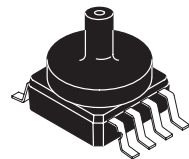


**MPX4115AS
 CASE 867E**

SMALL OUTLINE PACKAGE



**MPXA4115A6U
 CASE 482**



**MPXA4115AC6U
 CASE 482A**

PIN NUMBER			
1	N/C	5	N/C
2	V _S	6	N/C
3	Gnd	7	N/C
4	V _{out}	8	N/C

NOTE: Pins 1, 5, 6, 7, and 8 are internal device connections. Do not connect to external circuitry or ground. Pin 1 is noted by the notch in the lead.

PIN NUMBER			
1	V _{out}	4	N/C
2	Gnd	5	N/C
3	V _S	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.

Freescale Semiconductor, Inc.

MAXIMUM RATINGS^(NOTE)

Parametrics			Units
Maximum Pressure (P1 > P2)	P _{max}	400	kPa
Storage Temperature	T _{stg}	-40° to +125°	°C
Operating Temperature	T _A	-40° to +125°	°C

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

OPERATING CHARACTERISTICS (V_S = 5.1 Vdc, T_A = 25°C unless otherwise noted, P1 > P2. Decoupling circuit shown in Figure 3 required to meet Electrical Specifications.)

Characteristic	Symbol	Min	Typ	Max	Unit
Pressure Range	P _{OP}	15	—	115	kPa
Supply Voltage ⁽¹⁾	V _S	4.85	5.1	5.35	Vdc
Supply Current	I _o	—	7.0	10	mAdc
Minimum Pressure Offset ⁽²⁾ @ V _S = 5.1 Volts	V _{off}	0.135	0.204	0.273	Vdc
Full Scale Output ⁽³⁾ @ V _S = 5.1 Volts	V _{FSO}	4.725	4.794	4.863	Vdc
Full Scale Span ⁽⁴⁾ @ V _S = 5.1 Volts	V _{FSS}	4.521	4.590	4.659	Vdc
Accuracy ⁽⁵⁾	—	—	—	±1.5	%V _{FSS}
Sensitivity	V/P	—	45.9	—	mV/kPa
Response Time ⁽⁶⁾	t _R	—	1.0	—	ms
Output Source Current at Full Scale Output	I _{o+}	—	0.1	—	mAdc
Warm-Up Time ⁽⁷⁾	—	—	20	—	ms
Offset Stability ⁽⁸⁾	—	—	±0.5	—	%V _{FSS}

NOTES:

- Device is ratiometric within this specified excitation range.
- Offset (V_{off}) is defined as the output voltage at the minimum rated pressure.
- Full Scale Output (V_{FSO}) is defined as the output voltage at the maximum or full rated pressure.
- 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.
- 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 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 cycles of Pulsed Pressure, Temperature Cycling with Bias Test.

MECHANICAL CHARACTERISTICS

Characteristics	Typ	Unit
Weight, Basic Element (Case 867)	4.0	grams
Weight, Small Outline Package (Case 482)	1.5	grams

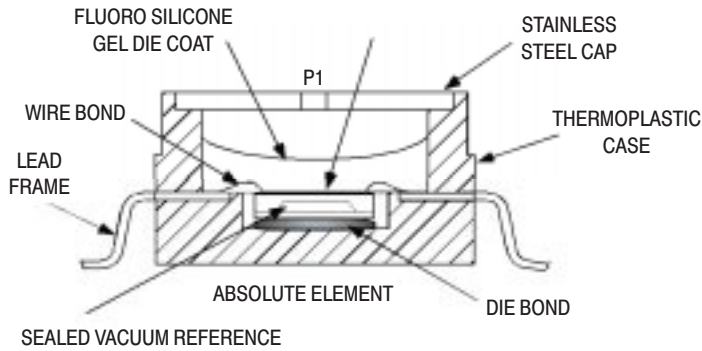


Figure 2. Cross Sectional Diagram SOP (not to scale)

Figure 2 illustrates the absolute sensing chip in the basic chip carrier (Case 482).

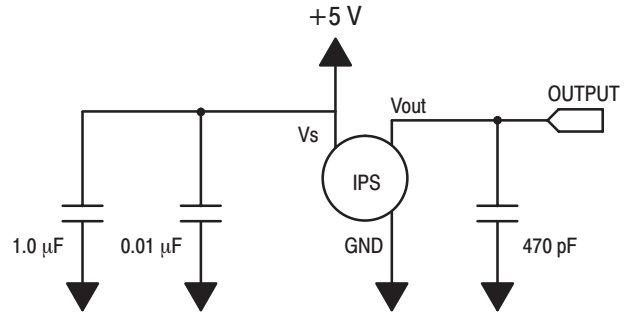


Figure 3. Recommended power supply decoupling and output filtering.
 For additional output filtering, please refer to Application Note AN1646.

Figure 3 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.

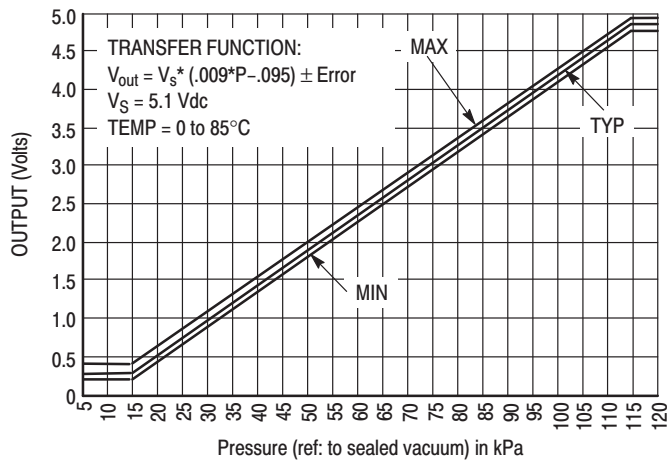


Figure 4. Output versus Absolute Pressure

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. The output will saturate outside of the rated pressure range.

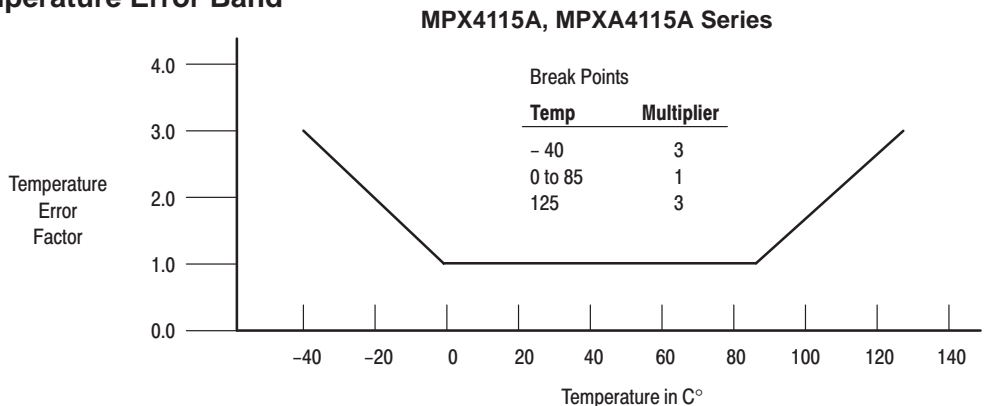
A fluorosilicone gel isolates the die surface and wire bonds from the environment, while allowing the pressure signal to be transmitted to the silicon diaphragm. The

MPX4115A/MPXA4115A 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.

Transfer Function (MPX4115A, MPXA4115A)

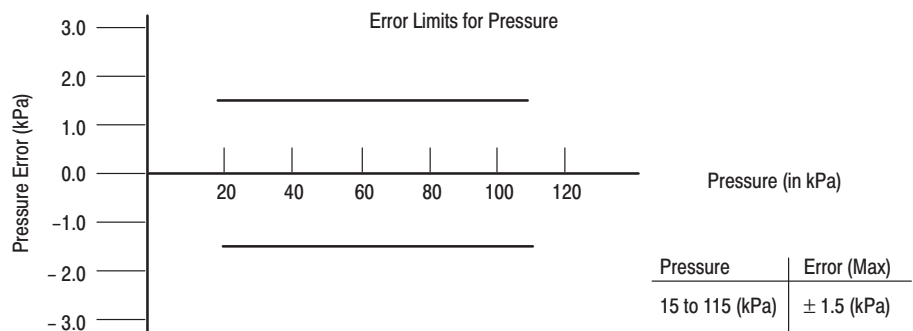
Nominal Transfer Value: $V_{out} = V_S \times (0.009 \times P - 0.095)$
 $\pm (\text{Pressure Error} \times \text{Temp. Factor} \times 0.009 \times V_S)$
 $V_S = 5.1 \pm 0.25 \text{ Vdc}$

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 — UNIBODY PACKAGE

Device Type	Options	Case No.	MPX Series Order No.	Marking
Basic Element	Absolute, Element Only	867	MPX4115A	MPX4115A
Ported Elements	Absolute, Ported	867B	MPX4115AP	MPX4115AP
	Absolute, Stove Pipe Port	867E	MPX4115AS	MPX4115A

ORDERING INFORMATION — SMALL OUTLINE PACKAGE

Device Type	Options	Case No.	MPX Series Order No.	Packing Options	Marking
Basic Element	Absolute, Element Only	482	MPXA4115A6U	Rails	MPXA4115A
	Absolute, Element Only	482	MPXA4115A6T1	Tape and Reel	MPXA4115A
Ported Element	Absolute, Axial Port	482A	MPXA4115AC6U	Rails	MPXA4115A
	Absolute, Axial Port	482A	MPXA4115AC6T1	Tape and Reel	MPXA4115A

MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the surface mount packages must be the correct size to ensure proper solder connection interface between the board and the package. With the correct

footprint, the packages will self-align when subjected to a solder reflow process. It is always recommended to design boards with a solder mask layer to avoid bridging and shorting between solder pads.

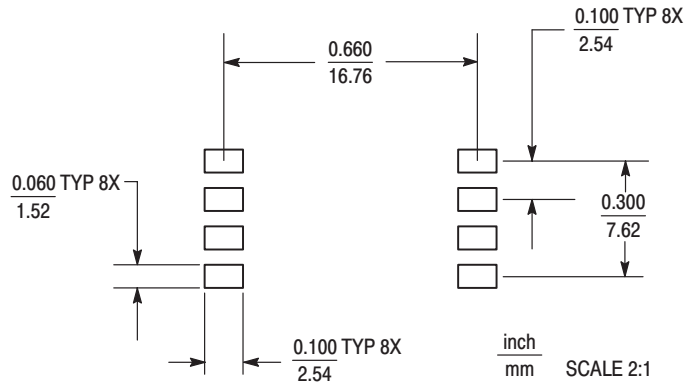
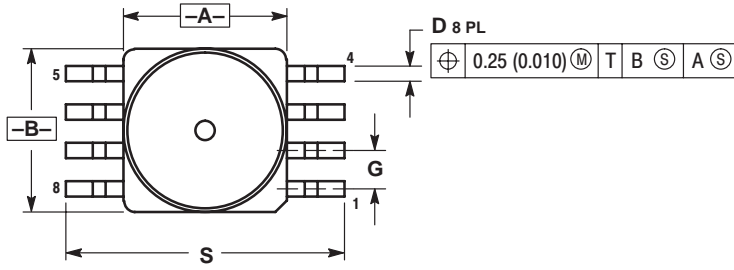
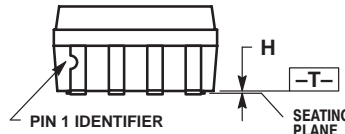
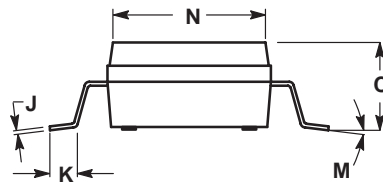


Figure 5. SOP Footprint (Case 482)

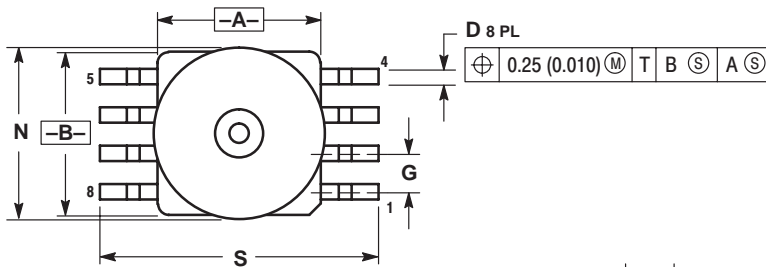


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
 4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
 5. ALL VERTICAL SURFACES 5° TYPICAL DRAFT.

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

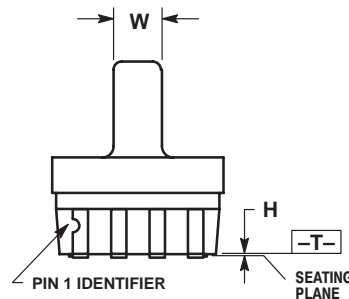
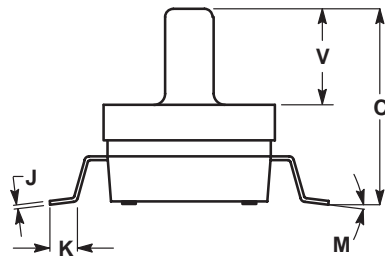


**CASE 482-01
ISSUE O**

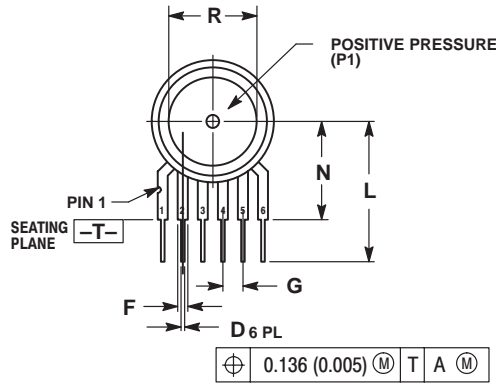
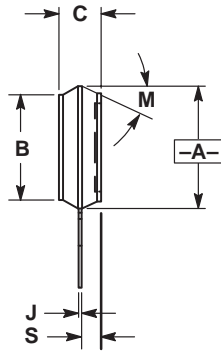


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
 4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
 5. ALL VERTICAL SURFACES 5° TYPICAL DRAFT.

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



**CASE 482A-01
ISSUE A**



- NOTES:
 9. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 10. CONTROLLING DIMENSION: INCH.
 11. 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

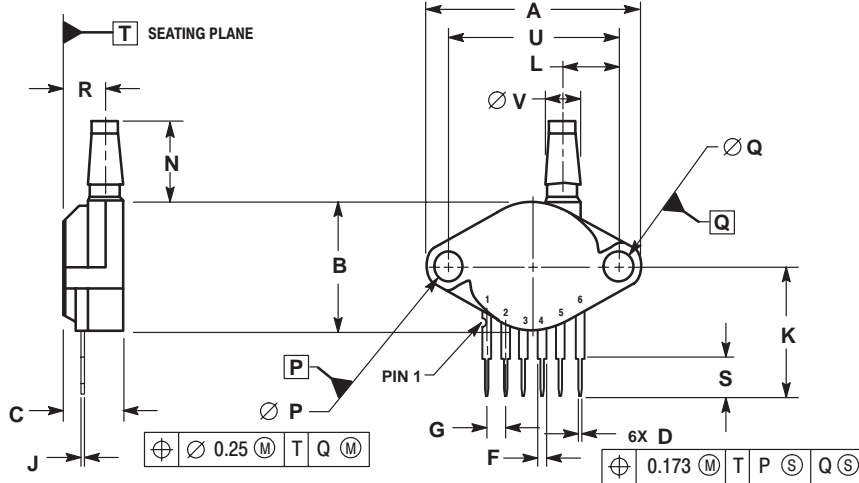
- STYLE 1:
 PIN 1: VOUT
 2. GROUND
 3. VCC
 4. V1
 5. V2
 6. VEX

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

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

CASE 867-08
ISSUE N

BASIC ELEMENT



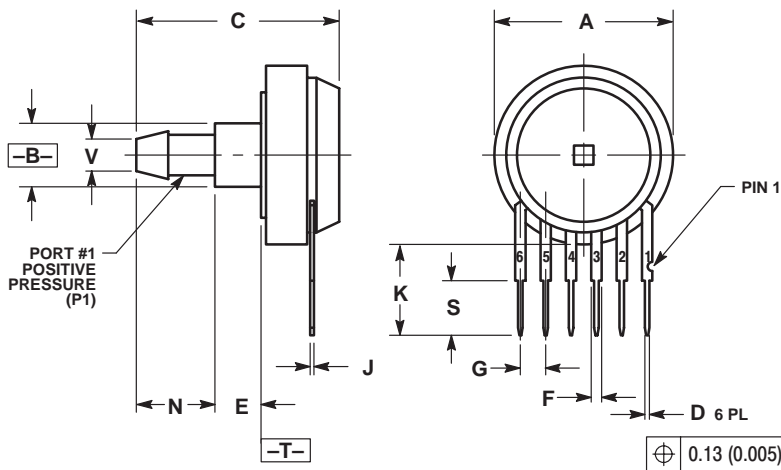
- NOTES:
 1. DIMENSIONS ARE IN MILLIMETERS.
 2. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.

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

CASE 867B-04
ISSUE F

PRESSURE SIDE PORTED (AP, GP)




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

CASE 867E-03
 ISSUE D

PRESSURE SIDE PORTED (AS, GS)

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MOTOROLA

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MPXA4115A/D