



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

The Motorola MPX4101 series Manifold Absolute Pressure (MAP) sensor for engine control is designed to sense absolute air pressure within the intake manifold. This measurement can be used to compute the amount of fuel required for each cylinder. The small form factor and high reliability of on-chip integration makes the Motorola MAP sensor a logical and economical choice for automotive system designers.

Features

- 1.7% Maximum Error Over 0° to 85°C
- Specifically Designed for Intake Manifold Absolute Pressure Sensing in Engine Control Systems
- Ideally Suited for Microprocessor Interfacing
- Patented Silicon Shear Stress Strain Gauge
- Temperature Compensated Over -40°C to +125°C
- Durable Epoxy Unibody Element
- Ideal for Non-Automotive Applications

Application Examples

- Manifold Sensing for Automotive Systems

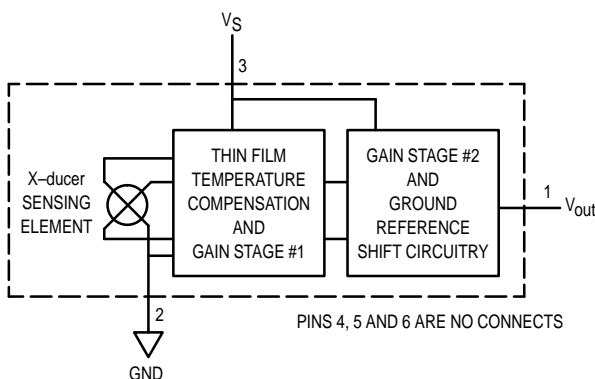
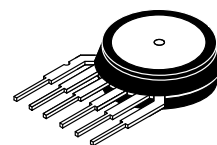


Figure 1. Fully Integrated Pressure Sensor Schematic

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MPX4101 SERIES

INTEGRATED
PRESSURE SENSOR
15 to 102 kPa
(2.18 to 14.8 psi)
0.25 to 4.95 V Output



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

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.

The MPX4101 series piezoresistive transducer is a state-of-the-art, monolithic, signal conditioned, silicon pressure sensor. This sensor, with its patented transducer, 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.



MPX4101 SERIES

MAXIMUM RATINGS(1)

Parametric	Symbol	Value	Unit
Overpressure ⁽²⁾ (P1 > P2)	P _{max}	400	kPa
Burst Pressure ⁽²⁾ (P1 > P2)	P _{burst}	1000	kPa
Storage Temperature	T _{stg}	–40 to +125	°C
Operating Temperature	T _A	–40 to +125	°C

1. T_C = 25°C unless otherwise noted.

2. 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)

Characteristic	Symbol	Min	Typ	Max	Unit
Pressure Range ⁽¹⁾	P _{OP}	15	—	102	kPa
Supply Voltage ⁽¹⁾	V _S	4.85	5.1	5.35	Vdc
Supply Current	I _o	—	7.0	10	mAdc
Minimum Pressure Offset ⁽³⁾ @ V _S = 5.1 Volts (0 to 85°C)	V _{off}	0.171	0.252	0.333	Vdc
Full Scale Output ⁽⁴⁾ @ V _S = 5.1 Volts (0 to 85°C)	V _{FSO}	4.870	4.951	5.032	Vdc
Full Scale Span ⁽⁵⁾ @ V _S = 5.1 Volts (0 to 85°C)	V _{FSS}	—	4.7	—	Vdc
Accuracy ⁽⁶⁾ (0 to 85°C)	—	—	—	±1.72	%V _{FSS}
Sensitivity	V/P	—	54	—	mV/kPa
Response Time ⁽⁷⁾	t _R	—	1.0	—	ms
Output Source Current at Full Scale Output	I _{o+}	—	0.1	—	mAdc
Warm-Up Time ⁽⁸⁾	—	—	20	—	ms
Offset Stability ⁽⁹⁾	—	—	±0.5	—	%V _{FSS}

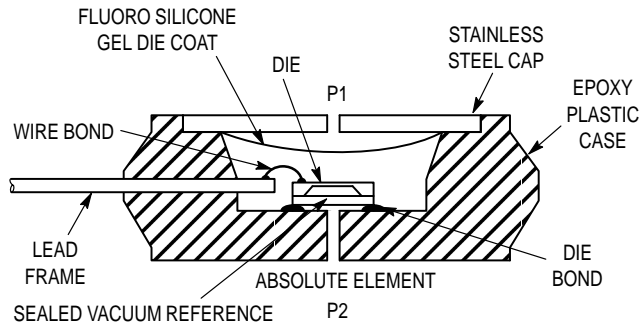
Decoupling circuit shown in Figure 3 required to meet electrical specifications.

MECHANICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Weight, Basic Element (Case 867)	—	—	4.0	—	Grams
Common Mode Line Pressure ⁽¹⁰⁾	—	—	—	690	kPa

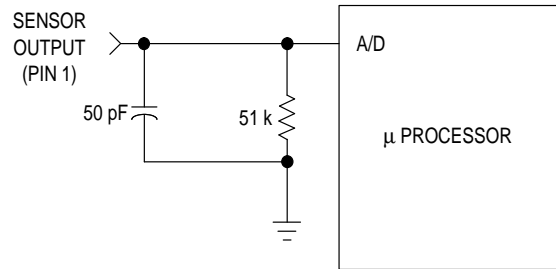
NOTES:

- 1.0 kPa (kiloPascal) equals 0.145 psi.
- 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 (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 the 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 rated 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_{FSS}, 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 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.
- Common mode pressures beyond specified may result in leakage at the case-to-lead interface.



**Figure 2. Cross Sectional Diagram
(Not to Scale)**

Figure 2 illustrates an 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 MPX4101A 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 3. Decoupling Filter for Sensor to
Microprocessor Interface**

Figure 3 shows a typical decoupling circuit for interfacing the integrated MAP sensor to the A/D input of a microprocessor. Proper decoupling of the power supply is recommended.

Figure 4 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. (The output will saturate outside of the specified pressure range.)

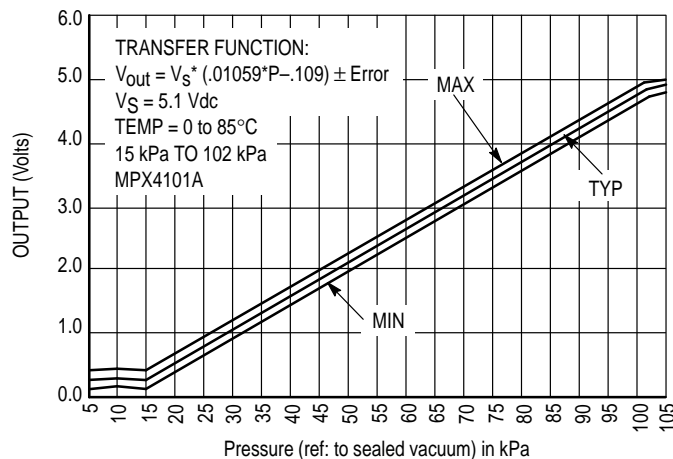


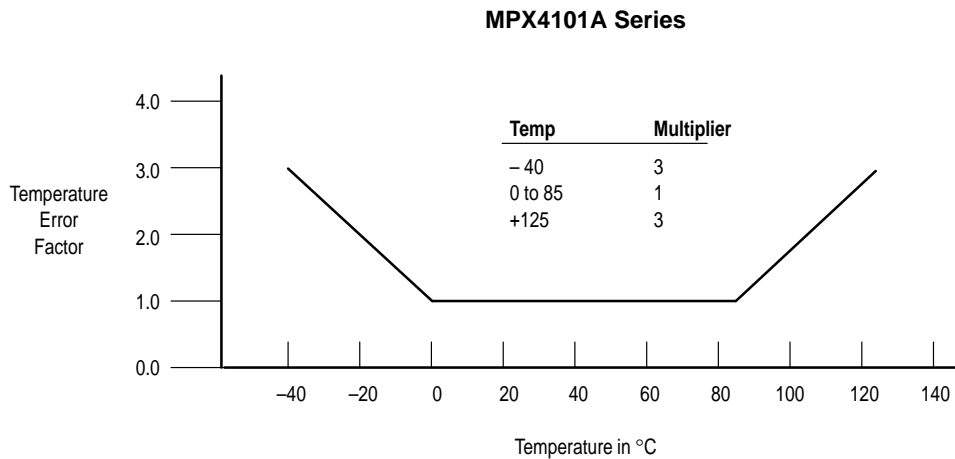
Figure 4. Output versus Absolute Pressure

MPX4101 SERIES

Transfer Function (MPX4101A)

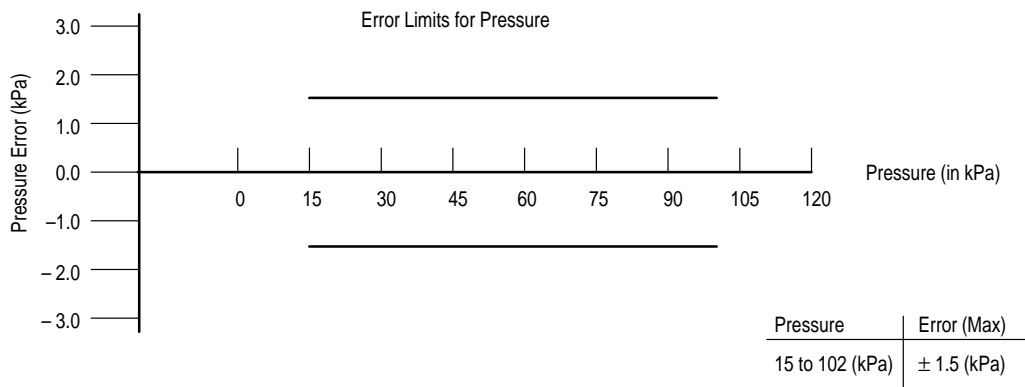
Nominal Transfer Value: $V_{out} = V_S (P \times 0.01059 - 0.10941)$
 $\pm (\text{Pressure Error} \times \text{Temp. Factor} \times 0.01059 \times V_S)$
 $V_S = 5.1 \text{ V} \pm 0.25 \text{ Vdc}$

Temperature Error Band



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

Pressure Error Band



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 fluorosilicone 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:

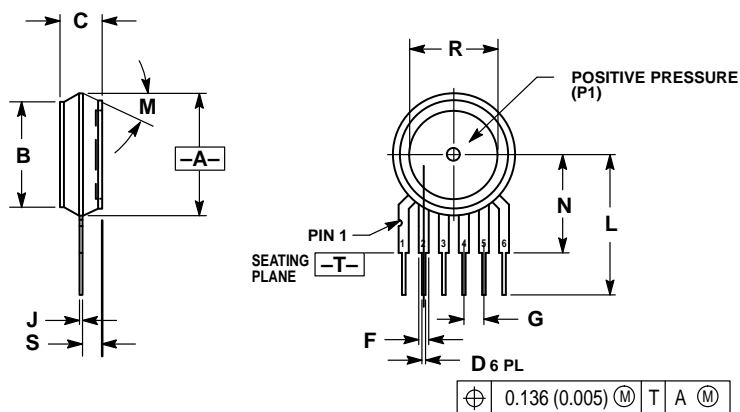
Part Number	Case Type	Pressure (P1) Side Identifier
MPX4101A	867-08	Stainless Steel Cap
MPX4101AP	867B-04	Side with Port Marking
MPX4101AS	867E-03	Side with Port Attached
MPX4101ASX	867F-03	Side with Port Attached

ORDERING INFORMATION

The MPX4101A series MAP silicon pressure sensors are available in the Basic Element, or with pressure port fittings that provide mounting ease and barbed hose connections.

Device Type	Options	Case Type	MPX Series	
			Order Number	Device Marking
Basic Element	Absolute, Element Only	867-08	MPX4101A	MPX4101A
Ported Elements	Absolute, Ported	867B-04	MPX4101AP	MPX4101AP
	Absolute, Stove Pipe Port	867E-03	MPX4101AS	MPX4101A
	Absolute, Axial Port	867F-03	MPX4101ASX	MPX4101A

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).

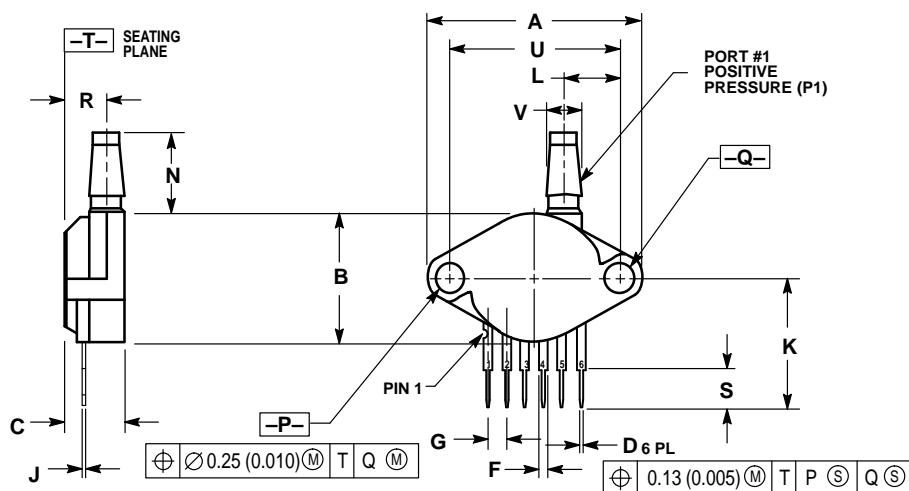
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.595	0.630	15.11	16.00
B	0.514	0.534	13.06	13.56
C	0.200	0.220	5.08	5.59
D	0.027	0.033	0.68	0.84
F	0.048	0.064	1.22	1.63
G	0.100 BSC		2.54 BSC	
J	0.014	0.016	0.36	0.40
L	0.695	0.725	17.65	18.42
M	30° NOM		30° NOM	
N	0.475	0.495	12.07	12.57
R	0.430	0.450	10.92	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

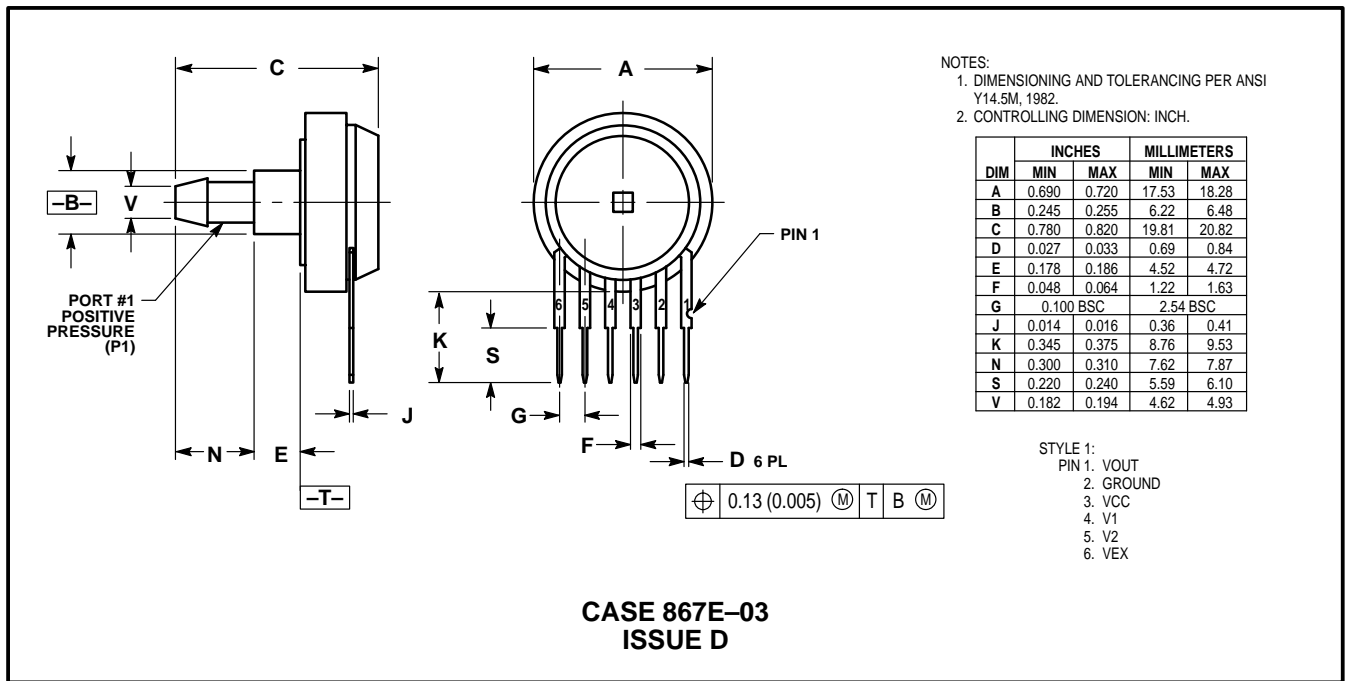
STYLE 1:

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

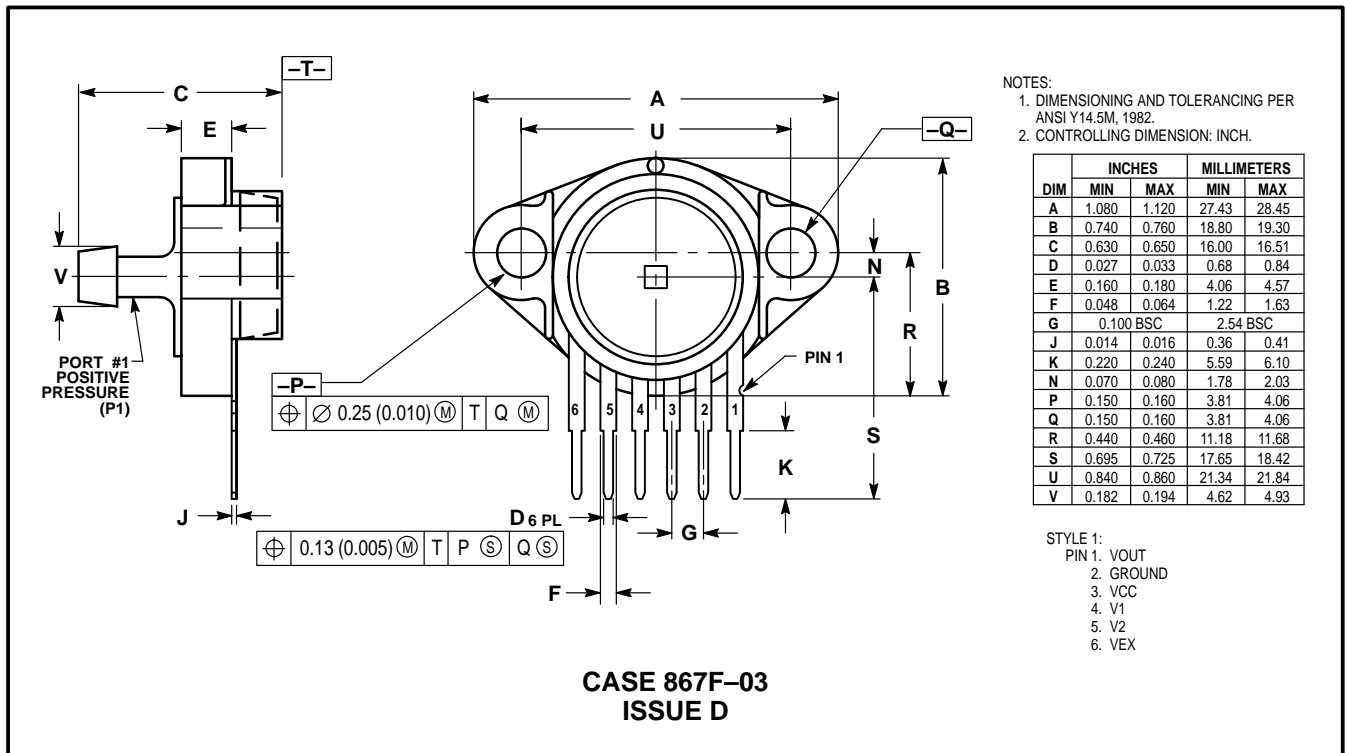
CASE 867B-04
ISSUE E

PRESSURE SIDE PORTED (AP, GP)

PACKAGE DIMENSIONS—CONTINUED




PRESSURE SIDE PORTED (AS, GS)



PRESSURE SIDE PORTED (ASX, GSX)

MPX4101 SERIES

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MPX4101/D