

Manifold Absolute Pressure Sensor On-Chip Signal Conditioned, 0.25 V to 4.9 V Output, Temperature Compensated & Calibrated

MPX4100 MPX4101 SERIES

Motorola Preferred Devices

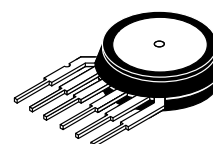
The Motorola MPX4100A/4101A series Manifold Absolute Pressure (MAP) sensor for engine control is designed to sense absolute air pressure within the intake manifold. This measurement can be used to compute the amount of fuel required for each cylinder.

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

- 1.8% Maximum Error Over 0–85°C
- Specifically Designed for Intake Manifold Absolute Pressure Sensing in Engine Control Systems
- Ideally Suited for Direct Microprocessor Interfacing
- Patented Silicon Shear Stress Strain Gauge
- Temperature Compensated Over –40 to +125°C
- Durable Epoxy Unibody Element
- Ideal for Non–Automotive Applications, Too

**4100A: 20–105 kPa
4101A: 15–102 kPa
X–ducer™
SILICON
PRESSURE SENSOR**



**CASE 867–04
Style 1**

MAXIMUM RATINGS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Overpressure ⁽⁷⁾ ($P_1 > P_2$)	P_{\max}	400	kPa
Burst Pressure ⁽⁷⁾ ($P_1 > P_2$)	P_{burst}	1000	kPa
Storage Temperature	T_{stg}	–50 to +150	°C
Operating Temperature	T_A	–40 to +125	°C

Pin Number					
1	2	3	4	5	6
V_{out}	Ground	V_S	N/C	N/C	N/C

NOTE: Pins 4, 5 and 6 are internal device connections. Do not connect to external circuitry or ground.

The MPX4100A/4101A series piezoresistive transducer is a state-of-the-art, monolithic, signal conditioned, silicon pressure sensor. This sensor, with its patented X–ducer, combines advanced micromachining techniques, thin film metalization and bipolar semiconductor processing to provide an accurate, high level analog output signal that is proportional to applied pressure. A vacuum is sealed behind the sensor diaphragm providing a reliable pressure reference. (See Figure 2.)

Figure 1 shows a block diagram of the internal circuitry integrated on the stand-alone pressure sensing chip.

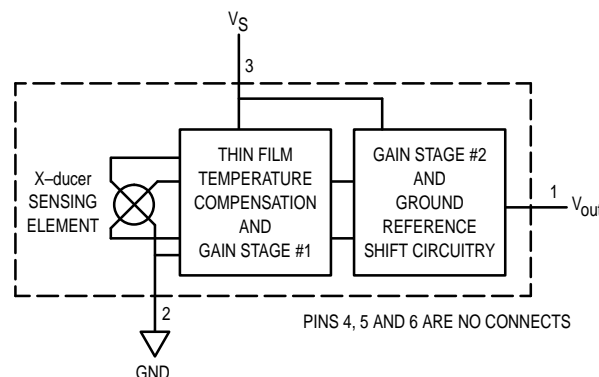


Figure 1. Fully Integrated Pressure Sensor Schematic

X–ducer is a trademark of Motorola, Inc.

Preferred devices are Motorola recommended choices for future use and best overall value.

MPX4100 MPX4101 SERIES

MPX4100A SERIES OPERATING CHARACTERISTICS ($V_S = 5.1 \text{ Vdc}$, $T_A = 25^\circ\text{C}$ unless otherwise noted, $P_1 > P_2$)

Characteristic	Symbol	Min	Typ	Max	Unit
Pressure Range	P_{OP}	20	—	105	kPa
Supply Voltage (1)	V_S	4.85	5.1	5.35	Vdc
Supply Current	I_o	—	7.0	10	mAdc
Full Scale Span (2) (0 to 85°C)	V_{FSS}	4.510	4.591	4.672	V
Offset (3) (0 to 85°C)	V_{off}	0.225	0.306	0.388	V
Sensitivity	$\Delta V/\Delta P$	—	54	—	mV/kPa
Accuracy (4) (0 to 85°C)	—	—	—	± 1.8	% V_{FSS}
Response Time (5)	t_R	—	1.0	—	ms
Output Source Current at Full Scale Output	I_{O+}	—	0.1	—	mA

MECHANICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Weight, Basic Element (Case 867)	—	—	4.0	—	Grams
Warm-Up Time	—	—	15	—	Sec
Cavity Volume	—	—	—	0.01	IN ³
Volumetric Displacement	—	—	—	0.001	IN ³
Common Mode Line Pressure (6)	—	—	—	690	kPa

NOTES:

- Device is ratiometric within this specified excitation range.
- 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.
- Offset (V_{off}) 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 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 .
 - Offset Stability: Output deviation, after 1000 temperature cycles, -40 to 125°C , and 1.5 million pressure cycles, with minimum rated pressure applied.
 - 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.
- 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.

MPX4101A SERIES OPERATING CHARACTERISTICS ($V_S = 5.1 \text{ Vdc}$, $T_A = 25^\circ\text{C}$ unless otherwise noted, $P_1 > P_2$)

Characteristic	Symbol	Min	Typ	Max	Unit
Pressure Range	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
Full Scale Span (2)	V_{FSS}	4.618	4.700	4.782	V
Offset (3)	V_{off}	0.171	0.252	0.333	V
Sensitivity	$\Delta V/\Delta P$	—	54	—	mV/kPa
Accuracy(4)	—	—	—	± 1.8	% V_{FSS}
Response Time (5)	t_R	—	1.0	—	ms
Output Source Current at Full Scale Output	I_{o+}	—	0.1	—	mA

MECHANICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Weight, Basic Element (Case 867)	—	—	4.0	—	Grams
Warm-Up Time	—	—	15	—	Sec
Cavity Volume	—	—	—	0.01	IN ³
Volumetric Displacement	—	—	—	0.001	IN ³
Common Mode Line Pressure (6)	—	—	—	690	kPa

NOTES:

- Device is ratiometric within this specified excitation range.
- 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.
- Offset (V_{off}) 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 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 .
 - Offset Stability: Output deviation, after 1000 temperature cycles, -40 to 125°C , and 1.5 million pressure cycles, with minimum rated pressure applied.
 - 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.
- 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.

MPX4100 MPX4101 SERIES

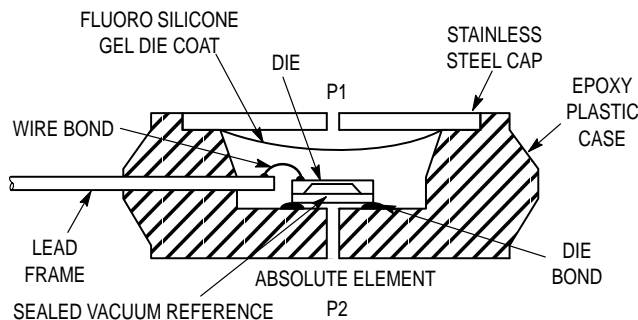


Figure 2. Cross Sectional Diagram (Not to Scale)

Figure 2 illustrates an absolute sensing configuration package in the basic chip carrier (Case 867). A fluoro silicone gel isolates the die surface and wire bonds from harsh environments, while allowing the pressure signal to be transmitted to the silicon diaphragm. The MPX4100A 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.

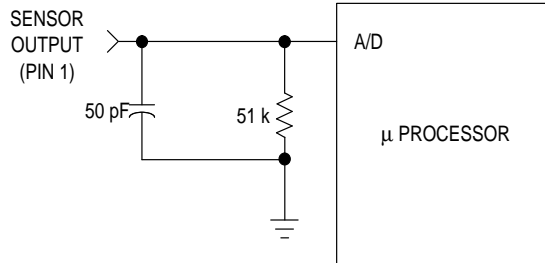


Figure 3. Typical Decoupling Filter for Sensor to Microprocessor Interface

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

Figures 4 and 5 show 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 may be nonlinear outside of the rated pressure range.)

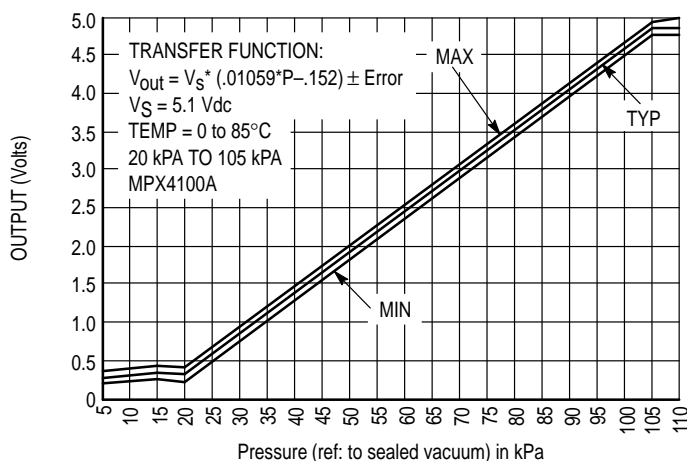


Figure 4. Output versus Absolute Pressure

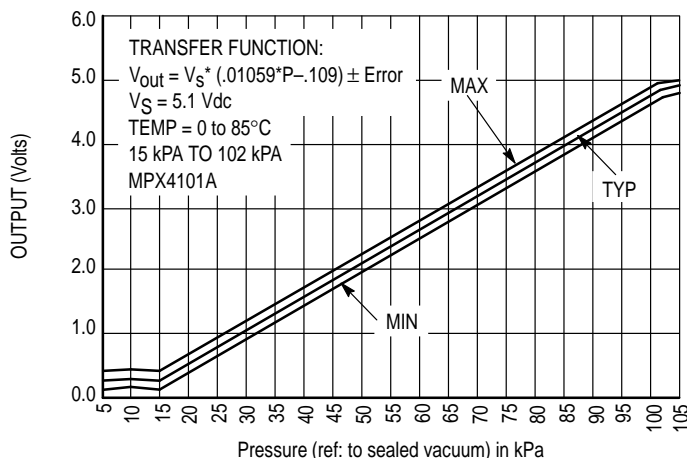


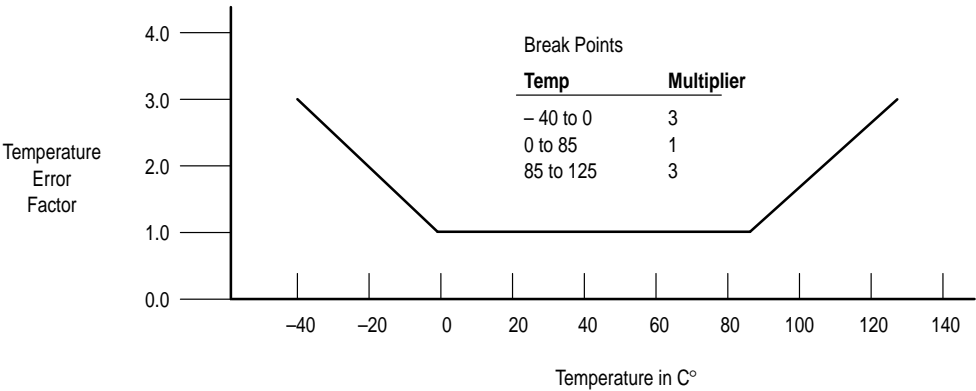
Figure 5. Output versus Absolute Pressure

Transfer Function (MPX4100A)

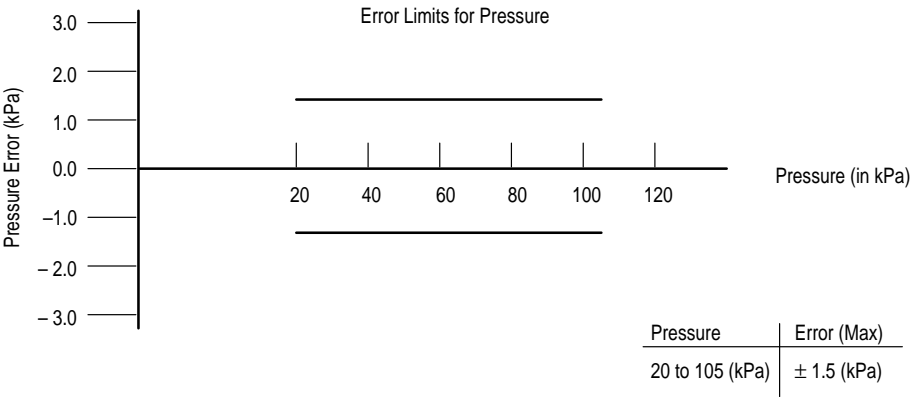
Nominal Transfer Value: $V_{out} = V_S (P \times 0.01059 - 0.1518)$
+/- (Pressure Error x Temp. Factor x 0.01059 x V_S)
 $V_S = 5.1 \text{ V} \pm 0.25 \text{ Vdc}$

Temperature Error Band

MPX4100A Series



Pressure Error Band

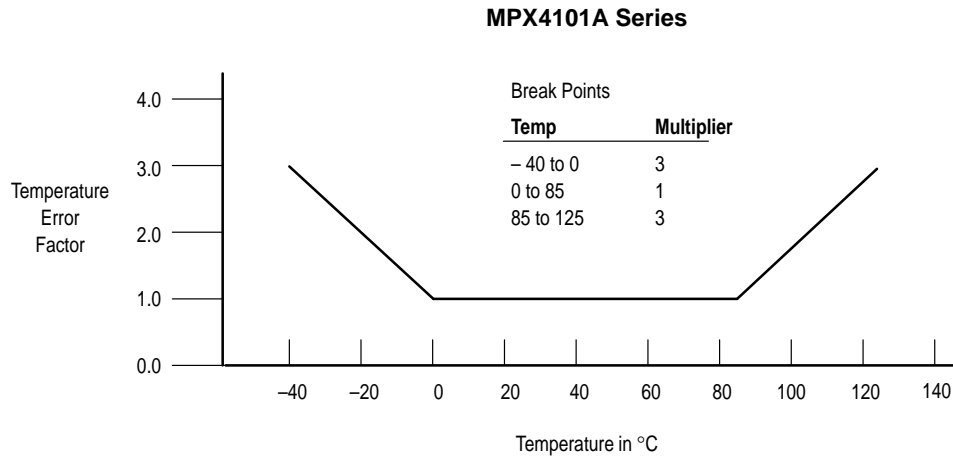


MPX4100 MPX4101 SERIES

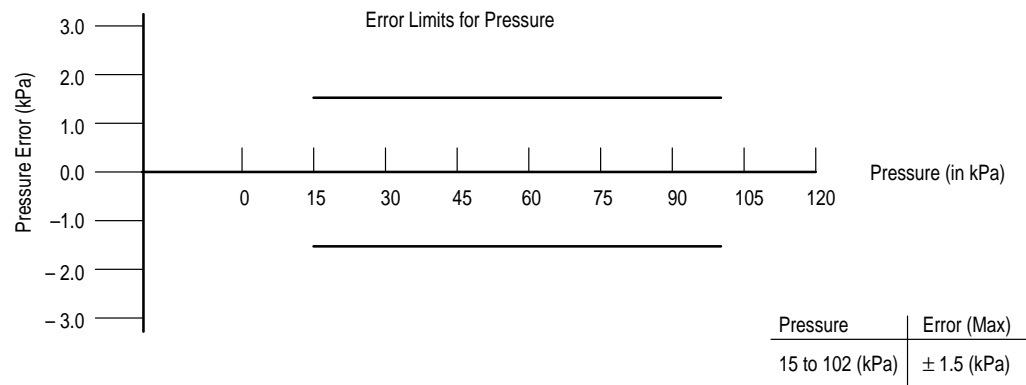
Transfer Function (MPX4101A)

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

Temperature Error Band



Pressure Error Band

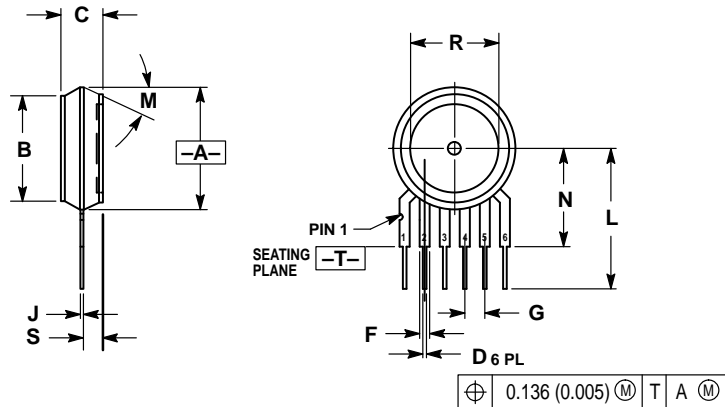


ORDERING INFORMATION

The MPX4100A and 4101A series MAP silicon pressure sensors 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 Type	Options	Case No.	MPX Series Order No.	Marking
Basic Element	Absolute, Element	867-04	MPX4100A MPX4101A	MPX4100A MPX4101A
Ported Elements	Absolute, Ported	867B-03	MPX4100AP MPX4101AP	MPX4100AP MPX4101AP
	Absolute, Stove Pipe Port	867E-02	MPX4100AS MPX4101AS	MPX4100A MPX4101A
	Absolute, Axial Port	867F-02	MPX4100ASX MPX4101ASX	MPX4100A MPX4101A

PACKAGE DIMENSIONS

CASE 867-04
ISSUE H

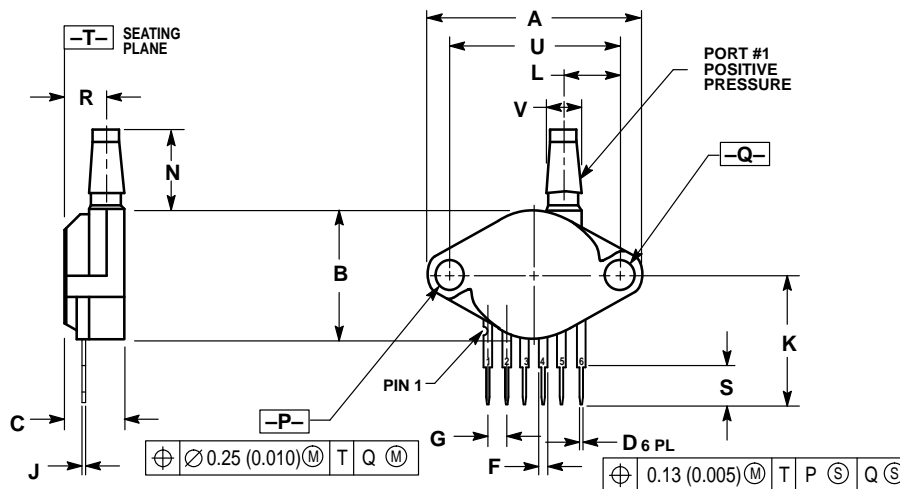
- NOTES:
8. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 9. CONTROLLING DIMENSION: INCH.
 10. DIMENSION -A- DOES NOT INCLUDE MOLDED FLASH RING. MOLDED FLASH RING NOT TO EXCEED 16.00 (0.630).

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.590	0.615	14.99	15.62
B	0.505	0.525	12.83	13.34
C	0.195	0.225	4.95	5.72
D	0.027	0.033	0.68	0.84
F	0.048	0.052	1.22	1.32
G	0.100 BSC		2.54 BSC	
J	0.014	0.016	0.36	0.40
L	0.685	0.715	17.40	18.16
M	30° NOM		30° NOM	
N	0.490	0.510	12.45	12.95
R	0.420	0.450	10.67	11.43
S	0.090	0.105	2.29	2.66

STYLE 1:

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

BASIC ELEMENT (A, D)

CASE 867B-03
ISSUE C

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

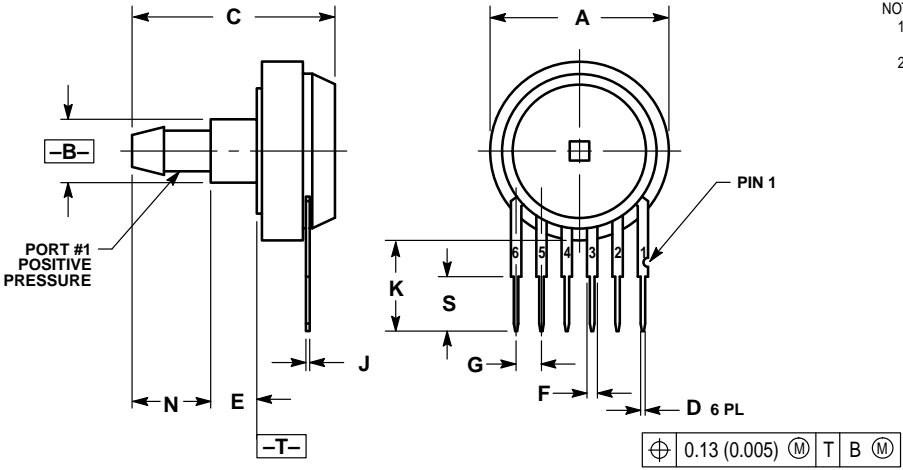
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.140	1.180	28.95	29.97
B	0.685	0.715	17.40	18.16
C	0.310	0.325	7.87	8.26
D	0.027	0.033	0.68	0.84
F	0.048	0.052	1.22	1.32
G	0.100 BSC		2.54 BSC	
J	0.014	0.016	0.36	0.41
K	0.680	0.710	17.27	18.03
L	0.290	0.300	7.34	7.62
N	0.420	0.440	10.67	11.12
P	0.153	0.159	3.89	4.03
Q	0.153	0.159	3.89	4.03
R	0.231	0.250	5.87	6.35
S	0.230 REF		5.84 REF	
U	0.910 BSC		23.11 BSC	
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}

PRESSURE SIDE PORTED (AP, GP)

PACKAGE DIMENSIONS—CONTINUED



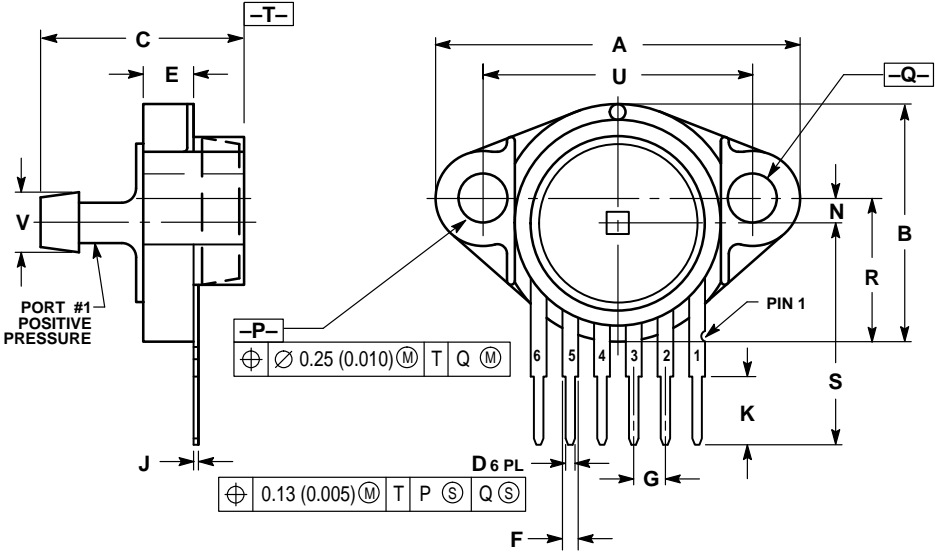
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.690	0.720	17.53	18.28
B	0.247	0.253	6.28	6.42
C	0.780	0.820	19.81	20.82
D	0.027	0.033	0.68	0.84
E	0.178	0.185	4.52	4.69
F	0.048	0.052	1.22	1.32
G	0.100 BSC		2.54 BSC	
J	0.014	0.016	0.36	0.40
K	0.335	0.360	8.51	9.14
N	0.350	0.315	7.75	8.00
S	0.220	0.240	5.59	6.10

- STYLE 1:
- PIN 1: V_{OUT}
2. GROUND
3. V_{CC}
4. V₁
5. V₂
6. V_{EX}

CASE 867E-02
ISSUE B

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	1.075	1.130	27.30	28.70
B	0.740	0.760	18.80	19.30
C	0.635	0.670	16.13	17.02
D	0.027	0.033	0.68	0.84
E	0.160	0.180	4.06	4.57
F	0.048	0.052	1.22	1.32
G	0.100 BSC		2.54 BSC	
J	0.014	0.016	0.36	0.40
K	0.230 REF		5.84 REF	
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	0.445	0.460	11.30	11.68
S	0.685	0.715	17.40	18.16
U	0.840	0.860	21.33	21.84
V	0.185	0.195	4.69	4.95

- STYLE 1:
- PIN 1: V_{OUT}
2. GROUND
3. V_{CC}
4. V₁
5. V₂
6. V_{EX}

CASE 867F-02
ISSUE B

PRESSURE SIDE PORTED (ASX, GSX)

MPX4100 MPX4101 SERIES

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MPX4100/D

