

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

The Motorola MPX4105A 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.

The MPX4105A 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

- 1.8% Maximum Error Over 0° to 85°C
- Specifically Designed for Intake Manifold Absolute Pressure Sensing in Engine Control Systems
- Temperature Compensated Over -40 to +125°C
- Durable Epoxy Unibody Element

Application Examples

- Manifold Sensing for Automotive Systems
- Ideally Suited for Microprocessor or Microcontroller-Based Systems
- Also Ideal for Non-Automotive Applications

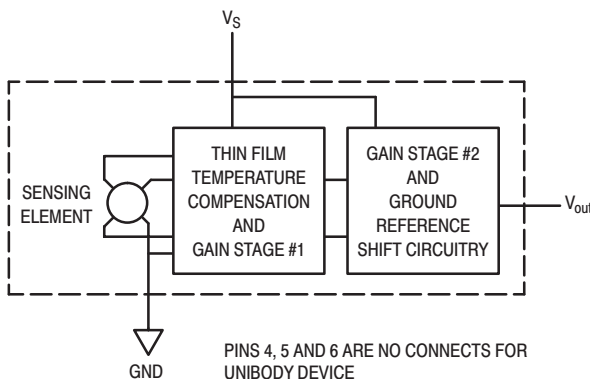
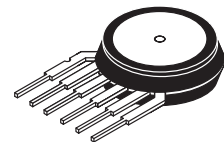


Figure 1. Fully Integrated Pressure Sensor Schematic

MPX4105A SERIES

INTEGRATED
PRESSURE SENSOR
15 to 105 kPa
(2.2 to 15.2 psi)
0.3 to 4.9 V Output

UNIBODY PACKAGE



MPX4105A
CASE 867

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.

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MAXIMUM RATINGS(NOTE)

Parametrics	Symbol	Value	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, $T_A = 25^\circ\text{C}$ unless otherwise noted. Decoupling circuit shown in Figure 3 required to meet specification.)

Characteristic	Symbol	Min	Typ	Max	Unit
Pressure Range	P_{OP}	15	—	105	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⁾ (0 to 85°C)	V_{off}	0.184	0.306	0.428	Vdc
Full Scale Output ⁽³⁾ (0 to 85°C)	V_{FSO}	4.804	4.896	4.988	Vdc
Full Scale Span ⁽⁴⁾ (0 to 85°C)	V_{FSS}	—	4.590	—	Vdc
Accuracy ⁽⁵⁾ (0 to 85°C)	—	—	—	±1.8	% V_{FSS}
Sensitivity	$\Delta V/\Delta P$	—	51	—	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⁾	—	—	15	—	ms
Offset Stability ⁽⁸⁾	—	—	±0.65	—	% 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 minimum specified 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: Span deviation per °C over the temperature range of 0° to 85°C, as a percent of span at 25°C.
 - TcOffset: Output deviation per °C with minimum pressure applied, over the temperature range of 0° to 85°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.
- 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

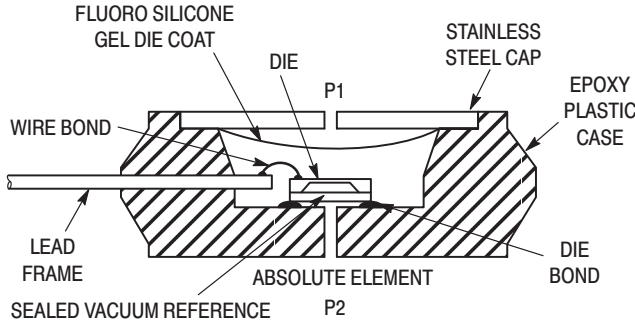


Figure 2. Cross-Sectional Diagram (not to scale)

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 MPX4105A 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

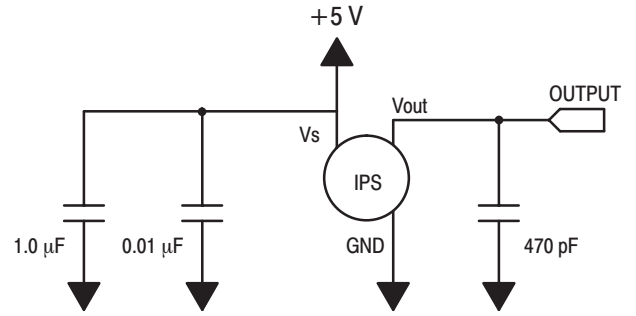


Figure 3. Recommended power supply decoupling and output filtering. For additional output filtering, please refer to Application Note AN1646.

have adverse effects on sensor performance and long-term reliability. Contact the factory for information regarding media compatibility in your application.

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.

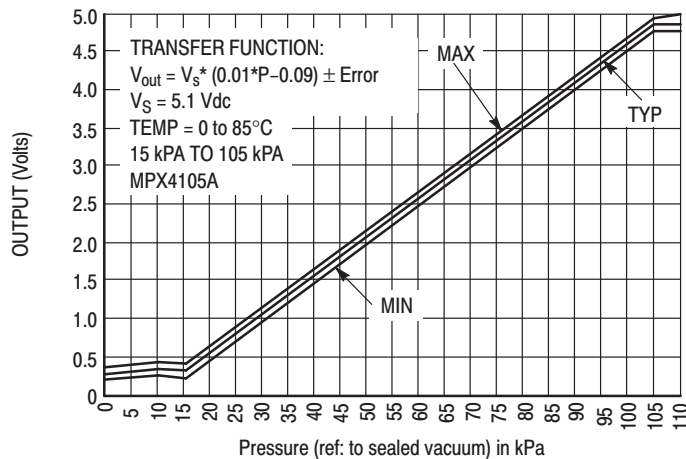


Figure 4. Output versus Absolute Pressure

Figure 4 shows the sensor output signal relative to pressure input. Typical minimum and maximum output curves are shown for operation over a temperature range of 0° to

85°C. The output will saturate outside of the specified pressure range.

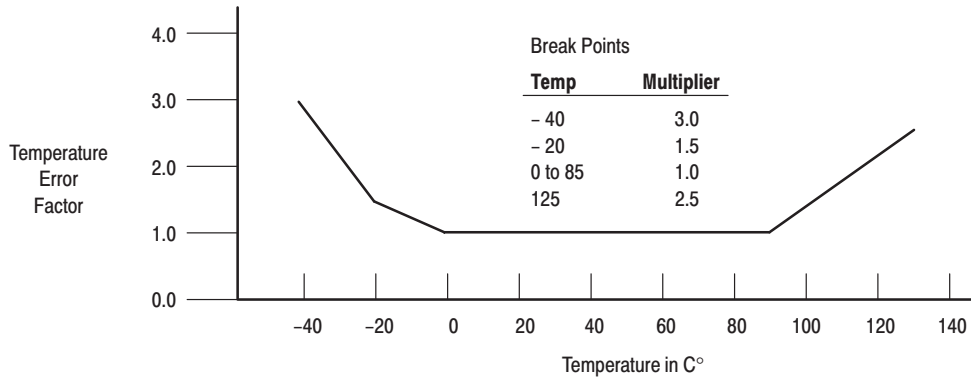
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Transfer Function (MPX4105A)

Nominal Transfer Value: $V_{out} = V_S (P \times 0.01 - 0.09)$
 \pm (Pressure Error x Temp. Factor x 0.01 x V_S)
 $V_S = 5.1 \text{ V} \pm 0.25 \text{ Vdc}$

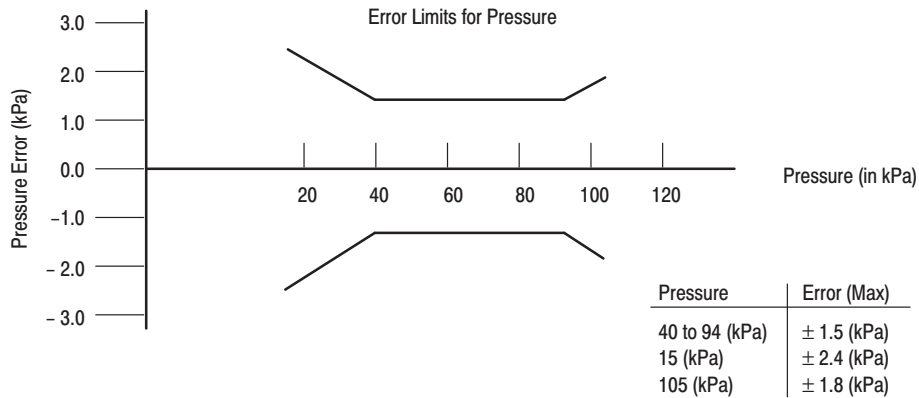
Temperature Error Band

MPX4105A Series



NOTE: The Temperature Multiplier is a linear response from -40°C to -20°C, -20°C to 0°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	867	MPX4105A	MPX4105A

UNIBODY PACKAGE DIMENSIONS

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

MPX4105A SERIES

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MPX4105A/D