Section One

Introduction

Selector Guide Information

ELECTRICAL CHARACTERISTICS

Table 1. Uncompensated

Device Series	Pressure Range kPa/psi (Max)	Over Pressure (kPa)	Offset mV (Typ)	Full Scale Span mV (Typ)	Sensitivity (mV/kPa) (Typ)	Linearity % of FSS[1] (Min)	(Max)	Temperature Coefficient of Span %/°C (Typ)	Input Impedance Ohms (Typ)
MPX10D	10/45	100	20	35	3.5	–1	1	–0.19	475
MPX12D	10/45	100	20	55	5.5	0	5	–0.19	475
MPX50D	50/7.3	200	20	60	1.2	–0.1	0.1	–0.19	475
MPX100D,A	100/14.5	200	20	60	0.6	–0.1	0.1	–0.19	475
MPX200D,A	200/29	400	20	60	0.3	–0.25	0.25	–0.19	475
MPX201D,A	200/29	400	20	60	0.3	–0.35	0.35	–0.19	475
MPX700D	700/100	2100	20	60	0.086	–0.50	0.50	–0.18	475

Table 2. Compensated and Calibrated (On–Chip)

								$\%V_{FSS}$	
MPX2010D	10/1.45	75	±0.05	25	2.5	–1.0	1.0	±0.5	1800
MPX2050D	50/7.3	200	±0.05	40	0.8	–0.25	0.25	± 0.5	1800
MPX2052D	50/7.3	200	±0.1	40	0.8	–0.55	0.25	±0.5	1800
MPX2100D,A	100/14.5	400	±0.05	40	0.4	–0.25	0.25	±0.5	1800
MPX2200D,A	200/29	400	±0.05	40	0.2	–0.25	0.25	±0.5	1800
MPX2700D	700/100	2800	±0.05	40	0.057	–0.5	0.5	±0.5	1800

Table 3. High Impedance

MPX7050D	50/7.3	400	±0.1	40	0.8	–0.25	0.25	±0.5	10K
MPX7100D,A	100/14.5	400	±0.1	40	0.2	–0.25	0.25	±0.5	10K
MPX7200D,A	200/29	400	±0.1	40	0.2	–0.25	0.25	±0.5	10K

Table 4. Signal Conditioned

Device Series	Pressure kPa/psi (Max)	Voltage Source	Full Scale Span V (Typ)	Sensitivity (mV/kPa) (Typ)	Accuracy (0–85°C)
MPX4100A	105/15.5	5.1	4.59	54	1.5%
MPX4101A	102/15.2	5.1	4.70	54	1.5%
MPX4115A	115/17	5.1	4.59	54	1.5%
MPX4250A	250/35	5.1	4.69	58	1.5%
MPX5050D	50/7.3	5.0	4.70	90	2.5%
MPX5100A	115/17	5.0	4.50	45	2.5%
MPX5100D	100/14.5	5.0	4.50	45	2.5%
MPX5500D	500/75	5.0	4.50	9.0	2.5%
MPX5700D	700/100	5.0	4.50	6.0	2.5%
MPX5999D	1000/150	5.0	4.50	5.0	2.5%

Table 5. Temperature Sensors

Device Series	$V_{(BR)EBO}$ Min Vdc	V_{BE} mV (Typ)	ΔV_{BE} mV	ΔT °C	T_C mV/°C (Typ)
MTS102	4	595	3	2	–2.265
MTS105	4	595	7	5	–2.265

(1) Based on end point straight line fit method. Best fit straight line linearity error is approximately 1/2 of listed value.

Devices listed in bold, italic are Motorola preferred devices.

General Product Information

Performance and price advantage all are part of the technology associated with the MPX transducer series. The unique design, coupled with computer controlled laser trimming and semiconductor batch processing techniques, makes these devices highly cost competitive.

PERFORMANCE

The performance of Motorola's MPX series of pressure sensors is based on its patented strain gauge design. Unlike the more conventional pressure sensors which utilize four closely matched resistors in a Wheatstone bridge configuration, the MPX series uses only a single piezoresistive element ion implanted on an etched silicon diaphragm to sense the stress induced on the diaphragm by an external pressure. The extremely linear output is an analog voltage that is proportional to pressure input and ratiometric with supply voltage. High sensitivity and excellent long-term repeatability make these units suitable for the most demanding applications.

ACCURACY

Computer controlled laser trimming of on-chip calibration and compensation resistors provide the most accurate pressure measurement over a wide temperature range. Temperature effect on span is typically ±0.5% of full scale over a temperature range from 0 to 85°C, while the effect on offset voltage over a similar temperature range is a maximum of only ±1 mV.

UNLIMITED VERSATILITY

Choice of Specifications:

MPX pressure sensors are available in pressure ranges to fit a wide variety of automotive, biomedical, consumer and industrial applications.

Choice of Measurement:

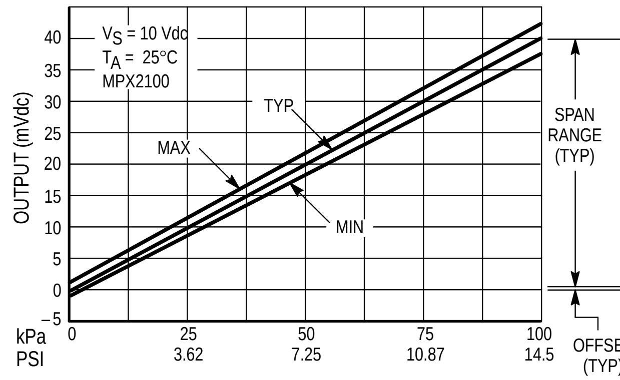
Devices are available for differential, absolute, or gauge pressure measurements.

Choice of Chip Complexity:

MPX pressure sensors are available as the basic sensing element, with temperature compensation and calibration, or with full signal conditioning circuitry included on the chip. Purchase of uncompensated units permits external compensation to any degree desired.

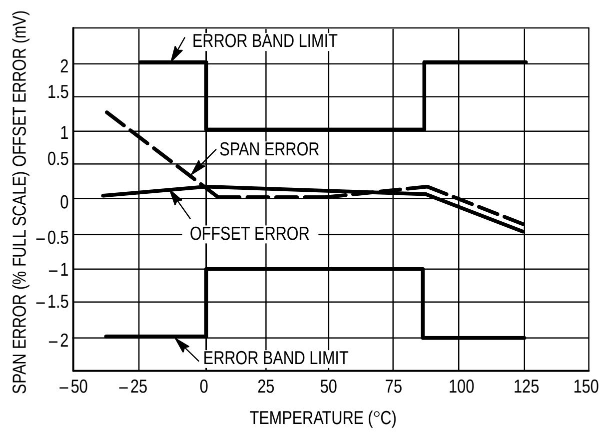
Choice of Packaging:

Buy it as a basic element for custom mounting, or in conjunction with one or two Motorola designed ports that provide printed circuit board mounting ease and barbed hose pressure connections. Alternate packaging material, which has been designed to meet biomedical compatibility requirements, is also available. Consult factory for information.



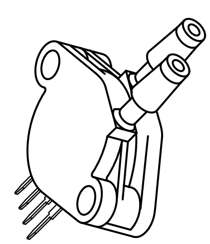
Linearity of output and less than ±1 mV variation in Offset over a temperature range from –40 to 125°C attest to the excellent performance of the compensated series of MPX pressure sensors.

Output versus Pressure Differential



Curves of span and offset errors indicate the accuracy resulting from on-chip compensation and laser trimming.

Temperature Error Band Limit and Typical Span and Offset Errors



DIFFERENTIAL PORT OPTION
CASE 352

Motorola MPX pressure sensors are available as basic elements, or with standard ports that facilitate mounting and media accessibility for differential, absolute or gauge pressure measurements.

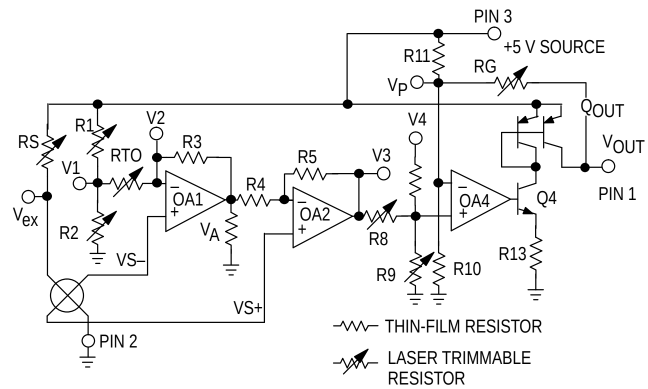
Packaging Flexibility

Integration

ON-CHIP SIGNAL CONDITIONING

To make the designer's job even easier, Motorola's integrated devices carry sensor technology one step further. Besides the on-chip temperature compensation and calibration offered currently on the MPX2000 series, amplifier signal conditioning has been integrated *on-chip* in the MPX5000 series to allow interface directly to any microcomputer with an on-board A/D converter.

The signal conditioning is accomplished by means of a four-stage amplification network, incorporating linear bipolar processing, thin-film metallization techniques, and interactive laser trimming to provide the state-of-the-art in sensor technology.



Fully Integrated Pressure Sensor

Introduction to Motorola Pressure Sensors

THE BASIC STRUCTURE

The Motorola pressure sensor is designed utilizing a monolithic silicon piezoresistor, which generates a changing output voltage with variations in applied pressure. The resistive element, which constitutes a strain gauge, is ion implanted on a thin silicon diaphragm.

Applying pressure to the diaphragm results in a resistance change in the strain gauge, which in turn causes a change in the output voltage in direct proportion to the applied pressure. The strain gauge is an integral part of the silicon diaphragm, hence there are no temperature effects due to differences in thermal expansion of the strain gauge and the diaphragm. The output parameters of the strain gauge itself are temperature dependent, however, requiring that the device be compensated if used over an extensive temperature range. Simple resistor networks can be used for narrow temperature ranges, i.e., 0°C to 85°C. For temperature ranges from –40°C to +125°C, more extensive compensation networks are necessary.

MOTOROLA'S PATENTED X-ducer™

Excitation current is passed longitudinally through the resistor (taps 1 and 3), and the pressure that stresses the diaphragm is applied at a right angle to the current flow. The stress establishes a transverse electric field in the resistor that is sensed as voltage at taps 2 and 4, which are located at the midpoint of the resistor. The single-element transverse voltage strain gauge can be viewed as the mechanical analog of a Hall effect device.

Using a single element eliminates the need to closely match the four stress and temperature sensitive resistors that form a Wheatstone bridge design. At the same time, it greatly simplifies the additional circuitry necessary to accomplish calibration and temperature compensation. The offset does not depend on matched resistors but instead on how well the transverse voltage taps are aligned. This alignment is accomplished in a single photolithographic step, making it easy to control, and is only a positive voltage, simplifying schemes to zero the offset.

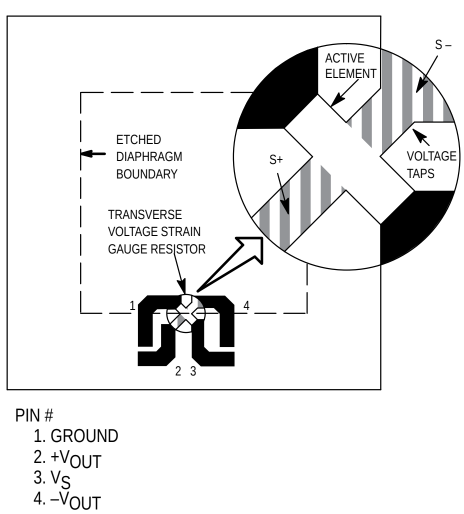


Figure 1. Basic Uncompensated Sensor Element — Top View

THE BASIC ELEMENTS

Motorola silicon pressure sensors are available in three different configurations that permit measurement of *absolute, differential* and *gauge* pressure. Absolute pressure, such as barometric pressure, is measured with respect to a built-in vacuum reference. A pressure differential, such as the pressure drop across a damper or filter in an air duct, is measured by applying pressure to opposite sides of the sensor simultaneously. Gauge pressure, as in blood pressure measurement, is a special case of differential pressure, where atmospheric pressure is used as a reference.

Figure 2 illustrates an absolute pressure sensing die (left) and a differential or gauge die in the chip carrier package. The difference in die structure between a differential pressure sensor and absolute pressure sensor is that the latter does not have a hole in the constraint wafer, and the chamber formed by the etched cavity and the solid constraint wafer contains the sealed-in reference vacuum.

The cross-section of the differential die in its chip carrier package shows a silicone gel which isolates the die surface and wire bonds from harsh environments while allowing a pressure signal to be transmitted to the silicon diaphragm.

The MPX 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 stability. Contact the factory for information regarding media compatibility in your application.

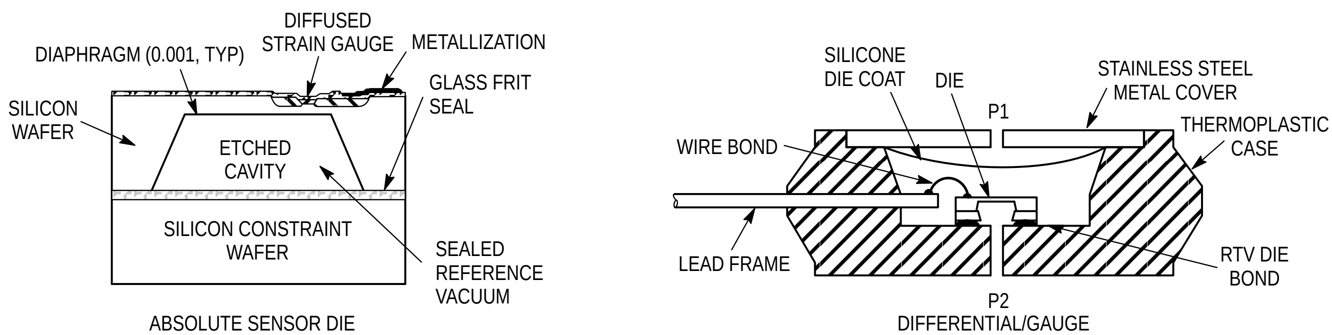


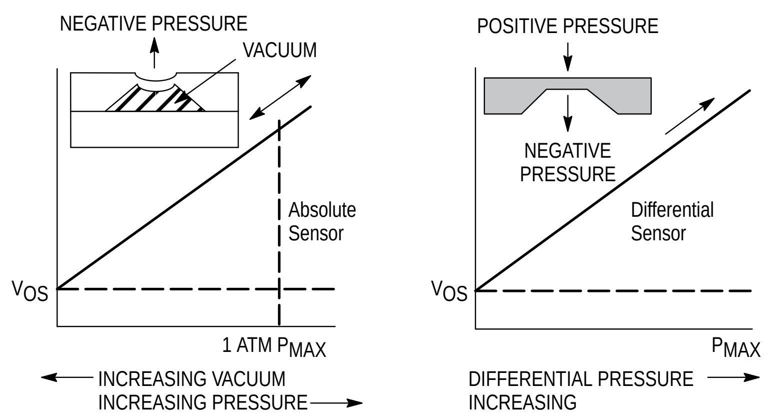
Figure 2. Cross-Sectional Diagrams (Not to Scale)

Operation

Motorola pressure sensors support three types of pressure measurements: Absolute Pressure, Differential Pressure and Gauge Pressure.

Absolute Pressure Sensors measure an external pressure relative to a zero-pressure reference (vacuum) sealed inside the reference chamber of the die during manufacture. This corresponds to a deflection of the diaphragm equal to approximately 15 PSI (one atmosphere), generating a quiescent full-scale output for the MPX100A (15 PSI) sensor, and a half-scale output for the MPX200A (30 PSI) device. Measurement of external pressure is accomplished by applying a relative negative pressure to the "Pressure" side of the sensor.

Differential Pressure Sensors measure the difference between pressures applied simultaneously to opposite sides of the diaphragm. A positive pressure applied to the "Pressure" side generates the same (positive) output as an equal negative pressure applied to the "Vacuum" side.



Motorola sensing elements can withstand pressure inputs as high as four times their rated capacity, although accuracy at pressures exceeding the rated pressure will be reduced. When excessive pressure is reduced, the previous linearity will immediately be restored.

Figure 3. Pressure Measurements

Gauge Pressure readings are a special case of differential measurements in which the pressure applied to the Pressure side is measured against the ambient atmospheric pressure applied to the Vacuum side through the vent hole in the chip of the differential pressure sensor elements.