Freescale Semiconductor

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

The MPXV7002 series piezoresistive transducers are state-of-the-art monolithic silicon pressure sensors designed for a wide range of applications, but particularly those employing a microcontroller or microprocessor with A/D inputs. This transducer combines advanced micromachining techniques, thin-film metallization, and bipolar processing to provide an accurate, high level analog output signal that is proportional to the applied pressure.

Features

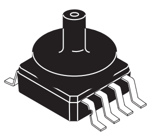
- 2.5% Typical Error over +10℃ to +60℃ with Auto Zero
- 6.25% Maximum Error over +10℃ to +60℃ without Auto Zero
- Ideally Suited for Mi croprocessor or Microcontroller-Based Systems
- Thermoplastic (PPS) Surface Mount Package
- Temperature Compensated over +10 ° to +60℃
- Patented Silicon Shear Stress Strain Gauge
- Available in Differential and Gauge Configurations

Application Examples

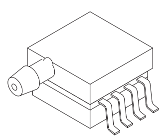
- Hospital Beds
- HVAC
- Respiratory Systems
- Process Control

ORDERING INFORMATION									
Device Name	Package Options	Case No.	# of Ports			Pressure Type			Device Marking
			None	Single	Dual	Gauge	Differential	Absolute	
Small Outline Package (MPXV7002 Series)									
MPXV7002GC6U	Rails	482A		•		•			MPXV7002G
MPXV7002GC6T1	Tape & Reel	482A		•		•			MPXV7002G
MPXV7002GP	Trays	1369		•		•			MPXV7002G
MPXV7002DP	Trays	1351			•		•		MPXV7002DP

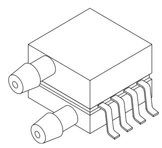
SMALL OUTLINE PACKAGE



MPXV7002GC6U/C6T1
CASE 482A-01



MPXV7002GP
CASE 1369-01



MPXV7002DP
CASE 1351-01

Operating Characteristics

Table 1. Operating Characteristics (V_S = 5.0 Vdc, T_A = 25°C unless otherwise noted. Decoupling circuit shown in Figure 3 required to meet specification.)

Characteristic		Symbol	Min	Typ	Max	Unit
Pressure Range[1]		P_{OP}	–2.0	—	2.0	kPa
Supply Voltage[2]		V_S	4.75	5.0	5.25	Vdc
Supply Current		I_o	—	—	10	mAdc
Pressure Offset[3] @ V_S = 5.0 Volts	(10 to 60°C)	V_{off}	2.25	2.5	2.75	Vdc
Full Scale Output[4] @ V_S = 5.0 Volts	(10 to 60°C)	V_{FSO}	4.25	4.5	4.75	Vdc
Full Scale Span[5] @ V_S = 5.0 Volts	(10 to 60°C)	V_{FSS}	3.5	4.0	4.5 V	Vdc
Accuracy[6]	(10 to 60°C)	—	—	±2.5[7]	±6.25	%V_{FSS}
Sensitivity		V/P	—	1.0	—-	V/kPa
Response Time[8]		t_R	—	1.0	—-	ms
Output Source Current at Full Scale Output		I_{O+}	—	0.1	—-	mAdc
Warm-Up Time[9]		—	—	20	—-	ms

1. 1.0 kPa (kiloPascal) equals 0.145 psi.
2. Device is ratiometric within this specified excitation range.
3. Offset (V_{off}) is defined as the output voltage at the minimum rated pressure.
4. Full Scale Output (V_{FSO}) is defined as the output voltage at the maximum or full rated pressure.
5. 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.
6. 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 10° to 60°C, relative to 25°C.
   - TcOffset: Output deviation with minimum rated pressure applied, over the temperature range of 10° to 60°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.
7. Auto Zero at Factory Installation: Due to the sensitivity of the MPXV7002 Series, external mechanical stresses and mounting position can affect the zero pressure output reading. Auto zero is defined as storing the zero pressure output reading and subtracting this from the device's output during normal operations. Reference AN1636 for specific information. The specified accuracy assumes a maximum temperature change of ± 5°C between auto zero and measurement.
8. 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.
9. Warm-up Time is defined as the time required for the product to meet the specified output voltage after the Pressure has been stabilized.

Maximum Ratings

Table 2. Maximum Ratings[1]

Rating	Symbol	Value	Unit
Maximum Pressure (P1 > P2)	P_{max}	75	kPa
Storage Temperature	T_{stg}	–30 to +100	°C
Operating Temperature	T_A	10 to 60	°C

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

Figure 1 shows a block diagram of the internal circuitry integrated on a pressure sensor chip.

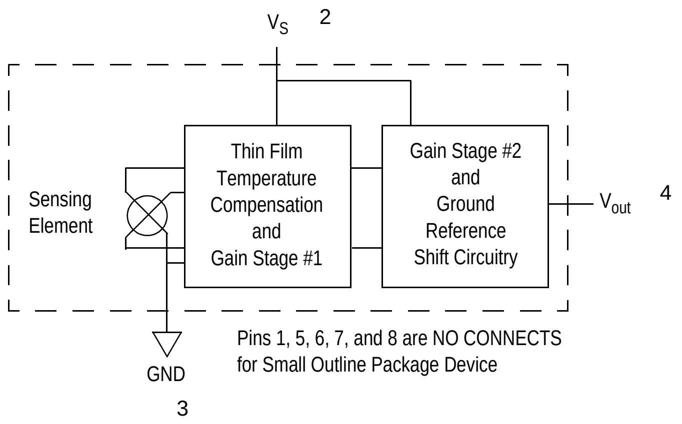


Figure 1. Integrated Pressure Sensor Schematic

ON-CHIP TEMPERATURE COMPENSATION, CALIBRATION AND SIGNAL CONDITIONING

The performance over temperature is achieved by integrating the shear-stress strain gauge, temperature compensation, calibration and signal conditioning circuitry onto a single monolithic chip.

Figure 2 illustrates the Differential or Gauge configuration in the basic chip carrier (Case 482). A gel die coat isolates the die surface and wire bonds from the environment, while allowing the pressure signal to be transmitted to the sensor diaphragm.

The MPXV7002 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 shows the recommended decoupling circuit for interfacing the integrated sensor to the A/D input of a microprocessor or microcontroller. 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 10° to 60°C using the decoupling circuit shown in Figure 3. The output will saturate outside of the specified pressure range.

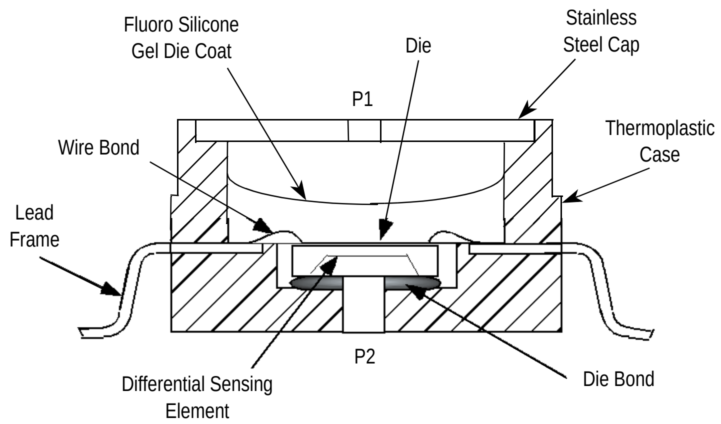


Figure 2. Cross-Sectional Diagram SOP (not to scale)

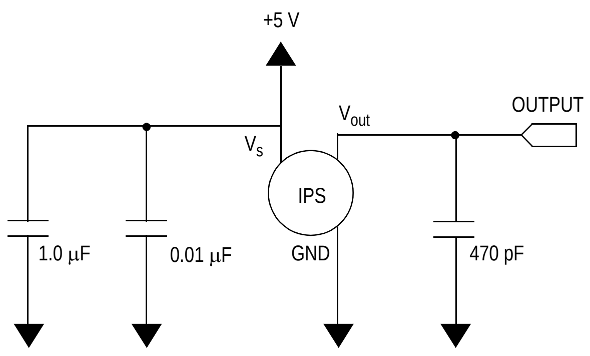


Figure 3. Recommended Power Supply Decoupling and Output Filtering
(For additional output filtering, please refer to Application Note AN1646.)

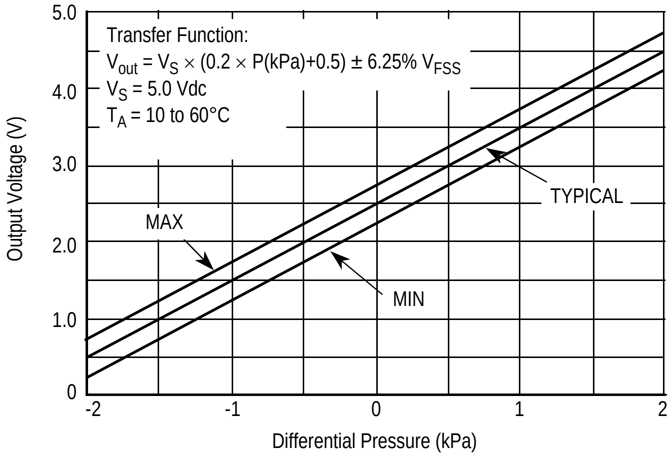


Figure 4. Output versus Pressure Differential

PRESSURE (P1)/VACUUM (P2) SIDE IDENTIFICATION TABLE

Freescale 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 a gel die coat which protects the die from harsh media.

The Pressure (P1) side may be identified by using the following table:

Part Number	Case Type	Pressure (P1) Side Identifier
MPXV7002GC6U/GC6T1	482A-01	Side with Port Attached
MPXV7002GP	1369-01	Side with Port Attached
MPXV7002DP	1351-01	Side with Part Marking

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.

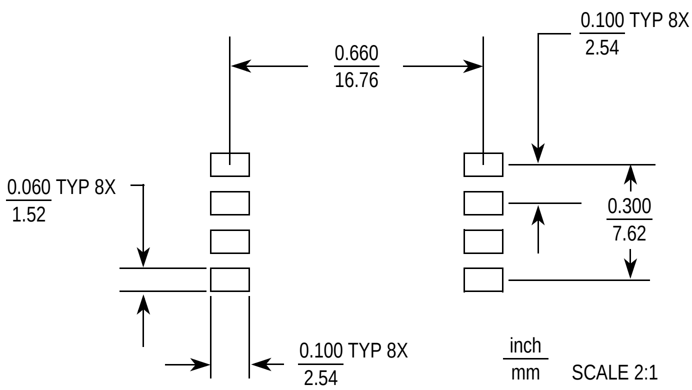
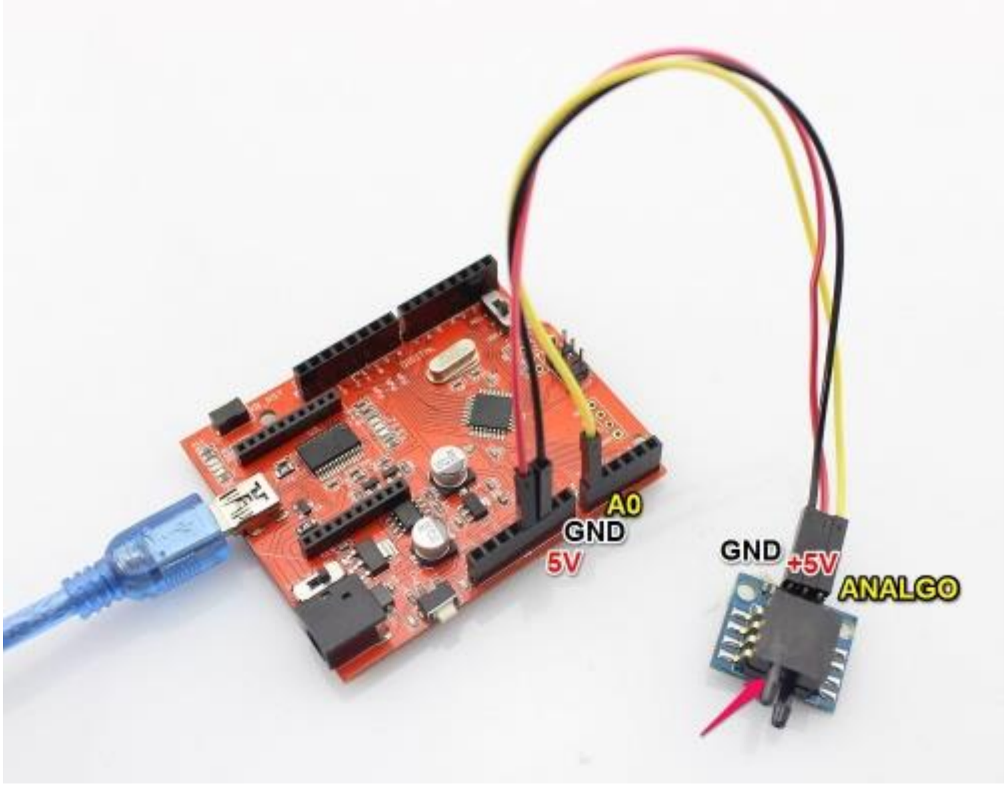


Figure 5. Small Outline Package Footprint

The MPXV7002 series piezoresistive transducer in the small outline package (SOP) is a state-of-the-art monolithic silicon pressure sensor designed for a wide range of applications, but particularly those employing a microcontroller or microprocessor with A/D inputs. This patented, single element transducer combines advanced micromachining techniques, thin-film metallization, and bipolar processing to provide an accurate, high level analog output signal that is proportional to the applied pressure.
The MPXV7002 is designed to measure positive and negative pressure. In addition, with an offset specifically at 2.5V instead of the conventional 0V, this new series allows to measure pressure up to 7kPa through each port for pressure sensing but also for vacuum sensing

Usage

1.Hardware Installation



2.copy the demo code to your sketch, then upload to Arduino or Crowduino board.

```
int sensorPin = A0;
int sensorValue = 0;
float Vout=0;
float P=0;
void setup() {

  // declare the ledPin as an OUTPUT:
   Serial.begin(9600);
}

void loop() {
    int i=0;
```

```
    int sum=0;
    int offset=0;
    Serial.println("init...");
    for(i=0;i<10;i++)
    {
         sensorValue = analogRead(sensorPin)-512;
         sum+=sensorValue;
    }
    offset=sum/10.0;
    Serial.println("Ok");
    while(1)
    {
       sensorValue = analogRead(sensorPin)-offset;
       Vout=(5*sensorValue)/1024.0;
       P=Vout-2.5;
       Serial.print("Presure = " );
       Serial.print(P*1000);
       Serial.println("Pa");
       delay(1000);
    }
}
```

3.Open the monitor of Arduino IDE,then blow the air to the MPXV7002DP, you can see the test result like flow.