SenSym

SX01, 05, 15, 30, 100, 150
0 to 1 psi and 0 to 150 psi
PRESSURE SENSORS

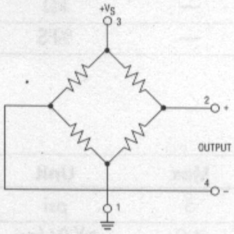
FEATURES

- **Low Cost**
- **High Impedance Bridge**
- **Absolute and Differential (Gage)**
- **Low Power Consumption for Batt**
- **Low Noise**

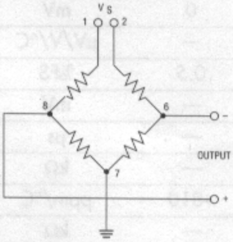
APPLICATIONS

- **Medical Instrumentation**
- **Barometry**
- **Industrial Controls**
- **Pneumatic Controls**
- **Battery Powered Equipment**

EQUIVALENT CIRCUITS



Button Sensor or "N" Package



(Open Bridge)

TO can Packages

GENERAL DESCRIPTION

The SX Series of pressure sensors provide the lowest cost components for measuring pressures up to 150 psi. These sensors were specifically designed to be used with non-corrosive and non-ionic media, such as air, dry gases and the like. Convenient pressure ranges are available to measure differential, gage, and absolute pressures from 0 to 1 psi (SX01) up to 0 to 150 psi (SX150).

The Absolute (A) devices have an internal vacuum reference and an output vcoltage proportional to absolute pressure. The Differential (D) devices allow application of pressure to either side of the diaphragm and can be used for gage or differential pressure measurements.

This product is packaged either in SenSym's standard low cost chip carrier "button" package, a plastic ported "N" package, a metal TO can package with or without gel fill or a surface mount packaging. All packages are designed for applications where the sensing element is to be integral to the OEM equipment. These packages can be o-ring sealed, epoxied, and/or clamped onto a pressure fitting. A closed bridge four-pin SIP configuration is provided for electrical connection to the button or "N" package. The TO can offers a 5-pin open bridge configuration.

Because of its high-impedance bridge, the SX Series is ideal for portable and low power or battery operated systems. Due to its low noise, the SX is an excellent choice for medical and other low pressure measurements.

For further technical information, please contact your local SenSym office or the factory.

PRESSURE SENSOR CHARACTERISTICS

Maximum Ratings (For All Devices)

Supply Voltage, V_S	$+12V_{DC}$
Temperature Ranges	
Operating	−40°C to +85°C
Storage	−55°C to +125°C
Common-Mode Pressure	150 psig
Lead Temperature (Soldering 2-4 seconds)	250°C
Maximum Pressure[10]	
SX01	20 psi
SX05	20 psi
SX15	30 psi
SX30	60 psi
SX100	150 psi
SX150	200 psi

SX01 PERFORMANCE CHARACTERISTICS(1)

Characteristic	Min	Typ	Max	Unit
Operating Pressure Range	—	—	1	psi
Sensitivity $T_A = 25°C$	3.0	4.0	5.0	mV/V/psi
Full-scale Span[2] $T_A = 25°C$	15	20	25	mV
Temperature Coefficient of Span[6, 9]	−2550	−2300	−2050	ppm/°C
Zero Pressure Offset $T_A = 25°C$[11]	−35	−20	0	mV
Temperature Coefficient of Offset[5, 9]	—	+4	—	µV/V/°C
Combined Linearity and Hysteresis[3]	—	0.2	0.5	%FS
Long Term Stability of Offset and Sensitivity[8]	—	0.1	—	mV
Response Time (10% to 90%)[7]	—	100	—	µs
Input Resistance $T_A = 25°C$	—	4.1	—	kΩ
Temperature Coefficient of Resistance[6, 9]	+690	+750	+810	ppm/°C
Output Impedance	—	4.1	—	kΩ
Repeatability[4]	—	0.5	—	%FS

SX05 PERFORMANCE CHARACTERISTICS(1)

Characteristic	Min	Typ	Max	Unit
Operating Pressure Range	—	—	5	psi
Sensitivity $T_A = 25°C$	2.0	3.0	4.0	mV/V/psi
Full-scale Span[2] $T_A = 25°C$	50	75	100	mV
Temperature Coefficient of Span[6, 9]	−2550	−2300	−2050	ppm/°C
Zero Pressure Offset $T_A = 25°C$[11]	−35	−20	0	mV
Temperature Coefficient of Offset[5, 9]	—	+4	—	µV/V/°C
Combined Linearity and Hysteresis[3]	—	0.2	0.5	%FS
Long Term Stability of Offset and Sensitivity[8]	—	0.1	—	mV
Response Time (10% to 90%)[7]	—	100	—	µs
Input Resistance $T_A = 25°C$	—	4.1	—	kΩ
Temperature Coefficient of Resistance[6, 9]	+690	+750	+810	ppm/°C
Output Impedance	—	4.1	—	kΩ
Repeatability[4]	—	0.5	—	%FS

SX15A/SX15D PERFORMANCE CHARACTERISTICS(1)

Characteristic	Min	Typ	Max	Unit
Operating Pressure Range	—	—	15	psi
Sensitivity T_A = 25°C	1.0	1.5	2.0	mV/V/psi
Full-scale Span(2) T_A = 25°C	75	110	150	mV
Temperature Coefficient of Span(6, 9)	−2400	−2150	−1900	ppm/°C
Zero Pressure Offset T_A = 25°C(12)	−35	−20	0	mV
Temperature Coefficient of Offset(5, 9)	—	+4	—	µV/V/°C
Combined Linearity and Hysteresis(3)	—	0.2	0.5	%FS
Long Term Stability of Offset and Sensitivity(8)	—	0.1		%FS
Response Time (10% to 90%)(7)	—	100		µs
Input Resistance T_A = 25°C	—	4.1	—	kΩ
Temperature Coefficient of Resistance(6, 9)	+690	+750	+810	ppm/°C
Output Impedance	—	4.1	—	kΩ
Repeatability(4)	—	0.5	—	%FS

SX30A/SX30D PERFORMANCE CHARACTERISTICS(1)

Characteristic	Min	Typ	Max	Unit
Operating Pressure Range	—	—	30	psi
Sensitivity T_A = 25°C	0.5	0.75	1.0	mV/V/psi
Full-scale Span(2) T_A = 25°C	75	110	150	mV
Temperature Coefficient of Span(6, 9)	−2400	−2150	−1900	ppm/°C
Zero Pressure Offset T_A = 25°C(12)	−35	−20	0	mV
Temperature Coefficient of Offset(5, 9)	—	+4	—	µV/V/°C
Combined Linearity and Hysteresis(3)	—	0.2	0.5	%FS
Long Term Stability of Offset and Sensitivity(8)	—	0.1		%FS
Response Time (10% to 90%)(7)	—	100	—	µs
Input Resistance T_A = 25°C	—	4.1	—	kΩ
Temperature Coefficient of Resistance(6, 9)	+690	+750	+810	ppm/°C
Output Impedance	—	4.1	—	kΩ
Repeatability(4)	—	0.5	—	%FS

SX100A/SX100D PERFORMANCE CHARACTERISTICS(1)

Characteristic	Min	Typ	Max	Unit
Operating Pressure Range	—	—	100	psi
Sensitivity $T_A = 25°C$	0.2	0.3	0.4	mV/V/psi
Full-scale Span(2) $T_A = 25°C$	100	150	200	mV
Temperature Coefficient of Span(6, 9)	−2400	−2150	−1900	ppm/°C
Zero Pressure Offset $T_A = 25°C$(12)	−35	−20	0	mV
Temperature Coefficient of Offset(5, 9)	—	+4	—	µV/V/°C
Combined Linearity and Hysteresis(3)	—	0.2	0.5	%FS
Long Term Stability of Offset and Sensitivity(8)	—	0.1	—	%FS
Response Time (10% to 90%)(7)	—	100	—	µs
Input Resistance $T_A = 25°C$	—	4.1	—	kΩ
Temperature Coefficient of Resistance(6, 9)	+690	+750	+810	ppm/°C
Output Impedance	—	4.1	—	kΩ
Repeatability(4)	—	0.5	—	%FS

SX150A/SX150D PERFORMANCE CHARACTERISTICS(1)

Characteristic	Min	Typ	Max	Unit
Operating Pressure Range	—	—	150	psi
Sensitivity $T_A = 25°C$	0.1	0.15	0.2	mV/V/psi
Full-scale Span(2) $T_A = 25°C$	75	110	150	mV
Temperature Coefficient of Span(6, 9)	−2400	−2150	−1900	ppm/°C
Zero Pressure Offset $T_A = 25°C$(12)	−35	−20	0	mV
Temperature Coefficient of Offset(5, 9)	—	+4	—	µV/V/°C
Combined Linearity and Hysteresis(3)	—	0.2	0.5	%FS
Long Term Stability of Offset and Sensitivity(8)	—	0.1	—	%FS
Response Time (10% to 90%)(7)	—	100	—	µs
Input Resistance $T_A = 25°C$	—	4.1	—	kΩ
Temperature Coefficient of Resistance(6, 9)	+690	+750	+810	ppm/°C
Output Impedance	—	4.1	—	kΩ
Repeatability(4)	—	0.5	—	%FS

SPECIFICATION NOTES: (For All Devices)

Note 1: Reference Conditions: Supply Voltage, V_S, = $5V_{DC}$, T_A = 0°C to 70°C, Common-mode Line Pressure = 0 psig, Pressure Applied to P_1, unless otherwise noted.

Note 2: Span is the algebraic difference between the output voltage at full-scale pressure and the output at zero pressure.

Note 3: See Definition of Terms.
Hysteresis - the maximum output difference at any point within the operating pressure range for increasing and decreasing pressure.

Note 4: Maximum difference in output at any pressure with the operating pressure range and temperature within 0°C to +70°C after:
a) 100 temperature cycles, 0°C to +70°C
b) 1.0 million pressure cycles, 0 psi to full-scale span.

Note 5: Slope of the best straight line from 0°C to +70°C.

Note 6: This is the best straight line fit for operation between 0°C and 70°C. For operation outside this temperature, contact factory for more specific applications information.

Note 7: Response time for a 0 psi to full-scale span pressure step change.

Note 8: Long term stability over a one year period.

Note 9: This parameter is not 100% tested. It is guaranteed by process design and tested on a sample basis only.

Note 10: If the maximum pressure is exceeded, even momentarily, the package may leak or burst, or the pressure sensing die may fracture.

Note 11: Maximum pressure at any port is the maximum operating plus common-mode pressure which can be applied.

Note 12: The zero pressure offset is 0 mV Min, 20 mV Typ and 35 mV Max for part nos. SXxxxGD2 and SXxxxDD4.

MECHANICAL AND MOUNTING CONSIDERATIONS

Button Sensor Element

The button sensor element was designed to allow easy interface with additional cases and housings which then allow pressure connection. The device can be mounted with an o-ring, gasket, or RTV seals on one or both sides of the device. The device can then be glued or clamped into a variety of fixtures and the leads can be bent as necessary to allow for ease of electrical connection. However, caution is advised as repeated bending of the leads will cause eventual breakage.

For most gage applications, pressure should be applied to the top side of the device. (See Physical Construction Drawing.) For differential applications, the top side of the device (P_1) should be used as the high pressure port and the bottom (P_2) as the low pressure port.

The button SX package has a very small internal volume of 0.06 cubic centimeters for P_1 and 0.001 cubic centimeters for P_2.

"N" Packaged Sensor

The "N" packaged sensor is designed for convenient pressure connection and easy PC board mounting. To mount the device horizontally to a PC board, the leads can be bent downward and the package attached to the board using either tie wraps or mounting screws. For pressure attachment, tygon or silicon tubing is recommended.

The "N" package version of the sensor has two (2) tubes available for pressure connection. For gage devices, pressure should be applied to port P_1. For differential pressure applications, port P_1 should be used as the high pressure port and P_2 should be used as the low pressure port.

TO Package

The TO package parts are available with pressure access only to P_1 for absolute and gauge pressure. Therefore, on gauge devices the bottom of the TO package must be left open to atmosphere.

Typically, tubing is attached directly around the top of the TO can or the package can be glued or o-ring sealed into a fixture. As always, care should be taken not to stress the package.

For all sensor packages care should be taken not to expose the parts to caustic media. This includes washers for board cleaning, etc..

GENERAL DISCUSSION

Output Characteristics

The SX Series devices give a voltage output which is directly proportional to applied pressure. The devices will give an increase positive going output when increasing pressure is applied to pressure port P_1 of the device. If the devices are operated in the backward gage mode, the output will increase with decreases in pressure. The devices are ratiometric to the supply voltage. Changes in supply voltage will cause proportional changes in the offset voltage and full-scale span.

User Calibration

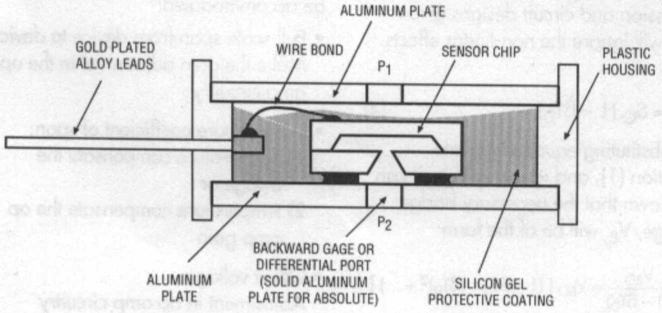
SX Series devices feature the button IC pressure sensor element. This will keep overall system costs down by allowing the user to select calibration and temperature compensation circuits which specifically match individual application needs. In most cases, the primary signal conditioning elements to be added to the SX by the user are: offset and span calibration and temperature compensation. Some typical circuits are shown in the application section.

Vacuum Reference (Absolute Devices)

Absolute sensors have a hermetically sealed vacuum reference chamber. The offset voltage on these units is therefore measured at vacuum, 0 psia. Since all pressure is measured relative to a vacuum reference, all changes in barometric pressure or changes in altitude will cause changes in the device output.

Media Compatibility

SX devices are compatible with most non-corrosive gases. Because the circuitry is coated with a protective silicon gel (parylene coating for all TO can devices), some otherwise corrosive environments can be compatible with the sensors. As shown in the physical construction diagram below for the button sensor element and "N" package, fluids must generally be compatible with silicon gel, RTV, plastic, and aluminum for forward gage use and RTV, silicon, glass and aluminum for backward gage or differential applications. For questions concerning media compatibility, contact the factory.



Physical Construction

(Drawing not to scale.)

APPLICATION INFORMATION

General

The SX family of pressure sensors functions as a Wheatstone bridge. When pressure is applied to the device (see Figure I) the resistors in the arms of the bridge change by an amount, Δ.

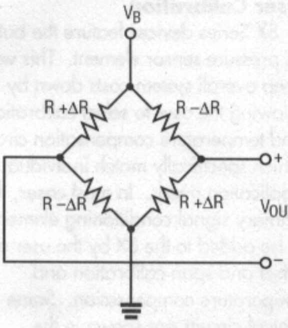


Figure I. Button Sensor Bridge Schematic

The resulting differential output voltage V_O, is easily shown to be $V_O = V_B \times \Delta R/R$. Since the change in resistance is directly proportional to pressure, V_O, can be written as:

$$V_O = S \times P \times V_B \pm V_{OS} \qquad (1)$$

Where: V_O is the output voltage in mV
S is the sensitivity in mV/V per psi
P is the pressure in psi
V_B is the bridge voltage in volts.

V_{OS} is the offset error (the differential output voltage when the applied pressure is zero). The offset voltage presents little problem in most applications, since it can easily be corrected for in the amplifier circuitry, or corrected digitally if a microprocessor is used in the system.

Temperature Effects

In this discussion, for simplicity of notation, the change of a variable with temperature will be designated with a dot (•) over the variable. For example,

$$\dot{S} = \frac{\text{change in sensitivity}}{\text{change in temperature}} = \frac{\partial S}{\partial T}$$

From equation (1), and ignoring the V_{OS} term, it is seen that for a given constant pressure, the output voltage change, as a function of temperature*, is:

$$\dot{V}_O = SP\dot{V}_B \qquad (2)$$

Thus, in order for output voltage to be independent of temperature, the voltage across the bridge, V_B, must change with temperature in the "opposite direction" from the sensitivity change with temperature. From the typical curves for the temperature dependence of span (span = S x P x V_B), it can be seen that the sensitivity change with temperature is slightly non-linear and can be correlated very well with an equation of the form:

$$S = S_O\,[\,(1 - \beta T_D) + \rho T_D{}^2\,] \qquad (3)$$

where T_D is the temperature difference between 25°C and the temperature of interest, S_O is the sensitivity at 25°C, and beta (ß) and rho (ρ) are correlation constants. Fortunately, between 0°C and 70°C the change in sensitivity with temperature is quite linear, and excellent results can be obtained over this temperature range by ignoring the second-order temperature dependent term. Operating outside the 0°C and 70°C temperature range will require a more rigorous mathematical approach and the use of non-linear compensating circuitry, if accuracy of better than ±1% is required. Because the majority of SX applications fall within the 0°C to 70°C operating temperature range, the discussion and circuit designs given here will ignore the non-linear effects. Thus:

$$S = S_O\,(1 - \beta T_D) \qquad (4)$$

Substituting equation (4) into equation (1), and ignoring V_{OS}, it can be shown that the necessary bridge voltage, V_B, will be of the form:

$$V_B = \frac{V_{BO}}{(1 - \beta T_D)} = V_{BO}\,[\,(1 + \beta T_D + (\beta T_D)^2 + \ldots)\,]$$

where V_{BO} is the bridge voltage at 25°C.

This equation is again non-linear. However, for the temperature range of interest, and since ß is small (0.230%/°C from the electrical tables), the above expression can be approximated by:

$$V_B = V_{BO}\,[\,1 + \beta T_D\,]$$

with less than 1% error. Thus to compensate for a negative 2300 ppm/°C sensitivity change with temperature, the bridge voltage should increase with temperature at a rate of +2300 ppm/°C.

The above value of bridge voltage change will be used in the circuit discussions that follow. That is to say, the required change in terms of ppm/°C is:

$$\left(\frac{\dot{V}_B}{V_B}\right) = +2300 \text{ ppm/°C}.$$

The bridge input resistance*, R_B, also changes with temperature and is quite linear in the temperature range of interest. The bridge resistance has a temperature co-efficient of typically:

$$\left(\frac{\dot{R}_B}{R_B}\right) = +750 \text{ ppm/°C}.$$

This term enters into several compensation circuit equations, particularly when the bridge excitation is from a constant current source.

To summarize, the following list indicates how the sensor variables can be accommodated:

- Full-scale span from device to device. Make the gain adjustment in the op amp circuitry
- Temperature coefficient of span:
  1) temperature compensate the bridge or
  2) temperature compensate the op amp gain
- Offset voltage: Adjustment in op amp circuitry

APPLICATION INFORMATION (Continued)

- Offset voltage temperature coefficient:
  Usually can be ignored. For more precise design requirements, contact the factory for information on how to compensate for this term.

Bridge Compensation Circuits

Although thermistors can be used to temperature compensate the bridge (and in fact will be required for extended temperature operation), they are inherently non-linear, difficult to use in volume production, and more expensive than the circuit approaches shown here, which use inexpensive semiconductor devices. The circuits shown have been designed to incorporate a minimum number of adjustments and allow inter-changeability of devices with little variation from device to device.

In general, equations for the bridge voltage and its change with temperature are given to enable the user to modify or adjust the circuitry as required.

1. Diode String (Figure II)

For systems using 6V supplies, this method of compensating for the effects of span over temperature is the lowest cost solution. The diodes are small signal silicon diodes, such as 1N914 or 1N4148, and do not have to be matched.

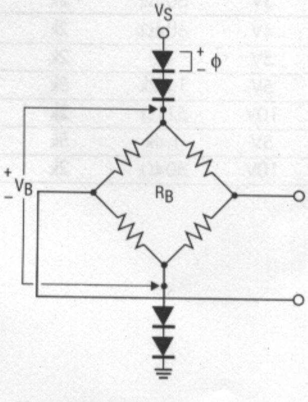


Figure II. Diode String Span Compensation

a) $V_B = V_S - 4\,\phi$

b) $$\left(\frac{\dot{V}_B}{V_B}\right) = \frac{-4\left(\frac{\dot{\phi}}{\phi}\right)}{\left(\frac{V_S}{\phi} - 4\right)}$$

c) $\left(\frac{\dot{\phi}}{\phi}\right) \approx -2500$ ppm/°C for silicon diodes

Figure II. Equations

For example, solving equation (b) for $\dot{V}_B/V_B$ when

$$V_S = 6.0\text{V}$$
$$\phi = 0.7\text{V}$$

Yields:

$$\frac{\dot{V}_B}{V_B} = 2188 \text{ ppm/°C}$$

Since the sensor's span changes with temperature at −2150 ppm/°C, this technique will typically result in an overall negative TC of 38 ppm/°C. This error is acceptable in most applications.

For operation with V_S above 6V, it is recommended to use the transistor or constant current compensation technique.

2. Transistor Compensation Network

Figure III uses a single transistor to simulate a diode string, with the equations as shown. The values shown in Table I were found to give excellent results over 0°C to 70°C. Again, if precision temperature compensation is required for each device, the fixed value resistors shown for R_1 in Table I can be replaced by a 3.24k resistor in series with a 1k pot. Then, each device's temperature compensation can be individually adjusted.

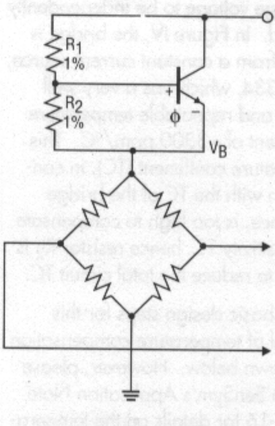


Figure III. Transistor/Resistor Span TC Compensation

a) $V_B = V_S - \alpha\,\phi$

b) $$\left(\frac{\dot{V}_B}{V_B}\right) = -\left(\frac{\dot{\phi}}{\phi}\right)\left(\frac{\alpha}{\frac{V_S}{\phi} - \alpha}\right)$$

c) $\alpha = 1 + \frac{R_1}{R_2}$

d) $\left(\frac{\dot{\phi}}{\phi}\right) \approx -2500$ ppm/°C

Table I. Selected R Values vs V_S for Figure III

V_S	$R_1(\Omega)$	$R_2(\Omega)$
5V	3.32k	1.43k
9V	4.02k	806
12V	4.22k	604

3. Constant Current Excitation (Figure IV)

The circuits shown in Figures II and III, although simple and inexpensive, have one drawback in that the voltage across the bridge is determined by the compensation network. That is, the compensation network is determined and what voltage is "leftover" is across the bridge. The circuit of Figure IV solves this problem and allows the

APPLICATION INFORMATION (Continued)

bridge voltage to be independently selected. In Figure IV, the bridge is driven from a constant current source, the LM334, which has a very well known and repeatable temperature coefficient of +3300 ppm/°C. This temperature coefficient (TC), in conjunction with the TC of the bridge resistance, is too high to compensate the sensitivity TC, hence resistor R_2 is added to reduce the total circuit TC.

The basic design steps for this method of temperature compensation are shown below. However, please refer to SenSym's Application Note SSAN–16 for details on the temperature compensation technique.

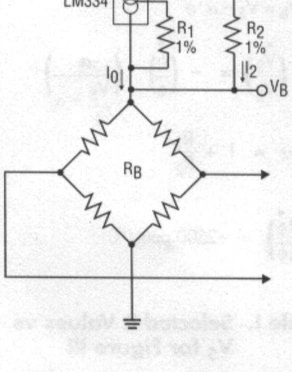


Figure IV. Constant Current Span TC Compensation

a) $V_B = \alpha\ (V_S + I_O R_2)$

b) $\left(\frac{V_B}{V_B}\right) = \left(\frac{\dot{R}_B}{R_B}\right)(1-\alpha) + \left(\frac{\dot{I}_O}{I_O}\right)\left[1-\alpha\left(\frac{V_S}{V_B}\right)\right]$

c) $\alpha = \frac{R_B}{R_2 + R_B}$

d) $\left(\frac{\dot{I}_O}{I_O}\right) = 3360\ \text{ppm/°C},\ \left(\frac{\dot{R}_B}{R_B}\right) = +750\ \text{ppm/°C}$

e) $I_O = \frac{67.7\text{mV}}{R_1}$

The design steps are straightforward:

1) Knowing V_S and the desired bridge voltage V_B, solve equation (b) for α.
2) Now, solve equation (c) for R_2, letting $R_B = 4650\Omega$.
3) Solve equation (a) for I_O.
4) Find R_1, or its nearest 1% tolerance value from equation (e).

Table II gives specific 1% resistor values in ohms, for several popular system voltages. For best results, the resistors should be 1% metal film with a low temperature coefficient.

Table II. Selected R Values vs V_S for Figure IV

V_S	V_B	$R_1(\Omega)$	$R_2(\Omega)$
5V	3V	147	11.0k
6V	4V	105	9.53k
9V	6V	68.1	9.53k
12V	9V	43.2	8.25k
15V	10V	41.2	9.53k

Amplifier Design

There are hundreds of instrumentation amplifier designs, and the intent here will be to briefly describe one circuit which:

- does not load the bridge
- involves minimal components
- provides excellent performance

The choice of the operational amplifiers to use is based on individual cost/performance trade-offs. The accuracy will be primarily limited by the amplifier's common-mode rejection, offset voltage drift with temperature and noise performance. Low cost, low performance devices, such as the LM324 can be used if the temperature range is limited to 25°C ±15°C and an accuracy of ±2% is adequate. For more precise applications, amplifiers such as the LT1014 and LT1002 have been found to be excellent.

An amplifier that uses a single supply is shown in Figure V. Table III gives resistor values for various supply and full-scale output combinations. Details of this button amplifier are shown in SenSym Application Note #17 (SSAN–17).

Table III. For 0 to 70°C Operation

				SPAN		
V_S	V_B	R_2	R_1	FS	R_5	R_P
5V	3.5V	9.09k	118Ω	3V	604Ω	2k
6V	4.5V	8.45k	86.6Ω	4V	604Ω	2k
9V	7V	7.87k	54.9Ω	5V	1k	2k
12V	10V	7.15k	36.5Ω	5V	1.82k	5k
12V	10V	7.15k	36.5Ω	10V	511Ω	2k
15V	12V	7.68k	31.6Ω	5V	1.4k	5k
15V	12V	8.87k	31.6Ω	10V	604Ω	2k

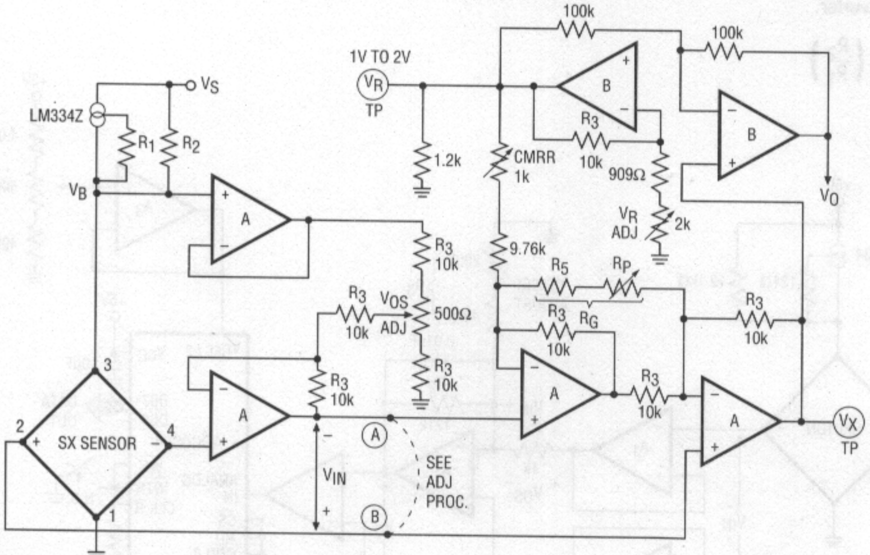
APPLICATION INFORMATION (Continued)

Amplifier Adjustment Procedure

1. Without pressure applied,
   (a) Short points A and B together as shown in Figure V. Adjust the 1k common-mode rejection (CMRR) pot until the voltage at test point (T_P) V_X is equal to the voltage at test point (T_P) V_R. This is easily accomplished by placing a digital voltmeter between these test points and adjusting for 0.000.
   (b) Remove the short and adjust the 500Ω offset adjust pot until V_X is again equal to V_R.
   (c) Adjust the 2k reference (V_R) adjust pot to get an output voltage (V_O) equal to 1.00 V.
2. Apply the full-scale pressure and adjust the span adjust pot, R_5, to get the output voltage that is desired to represent full-scale.

Factory Compensated Devices

This application note provides the necessary information for temperature compensating and calibrating the SX sensors. In some cases, the customer may find that SX devices which have been factory adjusted for temperature compensation and span are more economical for a particular application. SenSym does offer devices with this feature. For more information on these factory calibrated and compensated devices, the SCX Series, please contact your nearest SenSym sales office or the SenSym factory.



A LT1014CN
B LM10CN

$$V_0 = 4\left[1 + \frac{10k}{R_G}\right] V_{IN} + V_R$$

Resistors Labled R_3, R4 Are 5-Element Resistor Arrays, 10kΩ. Two Required.

Figure V. Button Sensor Amplifier Circuit

A/D CONVERTER

The circuit shown in Figure VI, is an example of a circuit that provides an 8-bit parallel output for a 0-1 psig input pressure. This design can be easily adapted to other pressure ranges and/or a serial data output.

Circuit Description

The LM334 network at the top of the SX sensor bridge provides the span temperature compensation. (See SenSym's Application Note SSAN–16 for details.)

The bridge voltage, V_{IN} is impressed across R_1 by buffer amplifiers A_1 and A_2 as shown. The resultant current flows thru R_2 to provide a differential output voltage V_O which is the input to the A/D converter.

$$V_O = V_{IN}\left(\frac{R_2}{R_1}\right)$$

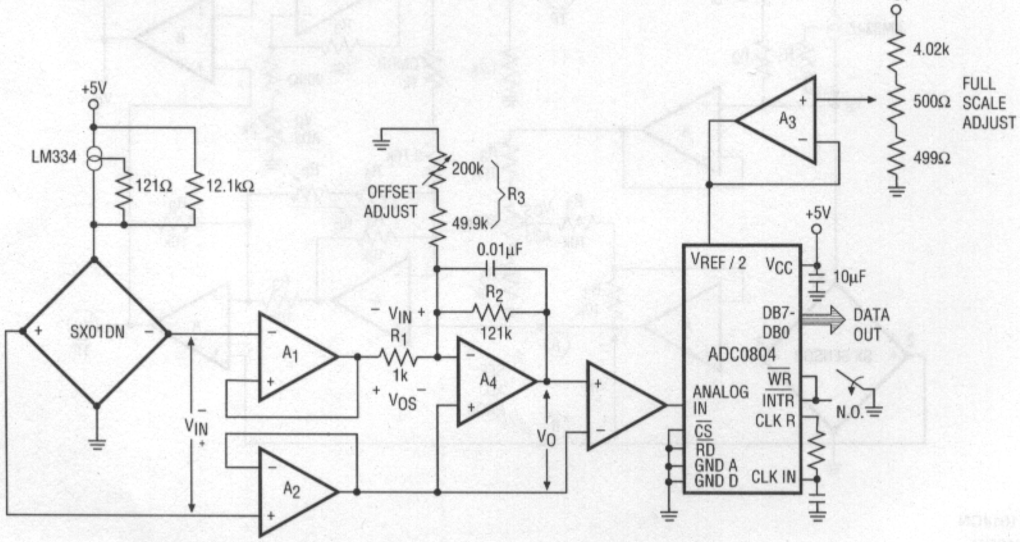
Because the offset voltage of the bridge is always negative, it will cause an error current thru R_1 which is always into the inverting input of amplifier A_4. Resistor network R_3 is used to remove this error current (shunt it to ground) so that is does not flow thru R_2 to the output.

Amplifier A_3 provides a buffered reference to the A/D to adjust the full-scale span.

The A/D is connected such that the completion of one conversion automatically begins the next conversion. See National Semiconductor ADC0804 data sheet for other applications and configurations.

Adjustment Procedure

1. Without pressure applied, adjust the offset adjust pot until the digital output gives all zero's with the LSB flickering between one and zero.
2. Apply 1 psig (full-scale pressure) and adjust the full-scale adjust pot until the output code is all ones. Again, the LSB should be flickering between one and zero.



LM334, National Semiconductor Corp.
Amplifier A: LT1014 (N) (Quad), Linear Technology Inc.
A/D: ADC0804, National Semiconductor Corp.
All Resistors 1% Metal Film.
All Pots Cermet 10-Turn.

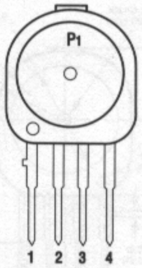
Figure VI. 0 to 1 psig Input, 8-Bit Parallel Output

ORDERING INFORMATION

To order, use the following part numbers:

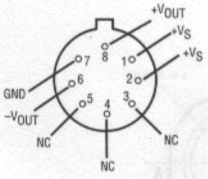
	Order Part Number				
Pressure Range	Sensor in Button Package	Sensor in "N" Package	Sensor in TO Package (Open Bridge)	Sensor in Nipple Package	Sensor in DIP Package
0 to 1 psid or psig	SX01D	SX01DN	SX01GSO	SX01DP1	SX01GD2, SX01DD4
0 to 5 psid or psig	SX05D	SX05DN	SX05GSO	SX05DP1	SX05GD2, SX05DD4
0 to 15 psia	SX15A	SX15AN	SX15AHO	SX15AP1	SX15AD2
0 to 30 psia	SX30A	SX30AN	SX30AHO	SX30AP1	SX30AD2
0 to 100 psia	SX100A	SX100AN	SX100AHO	—	SX100AD2
0 to 150 psia	SX150A	SX150AN	SX15AHO	—	—
0 to 15 psid or psig	SX15D	SX15DN	SX15GSO	SX15DP1	SX15GD2, SX15DD4
0 to 30 psid or psig	SX30D	SX30DN	SX30GSO	SX30DP1	SX30GD2, SX30DD4
0 to 100 psid or psig	SX100D	SX100DN	SX100GSO	—	SX100GD2, SX100DD4
0 to 150 psid or psig	SX150D	—	SX150GSO	—	—

ELECTRICAL CONNECTIONS



1) GROUND 2) +OUTPUT
3) $+V_S$ 4) –OUTPUT

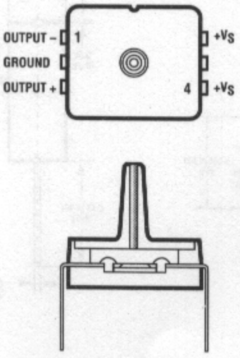
Button/"N"/Nipple Package Pinout



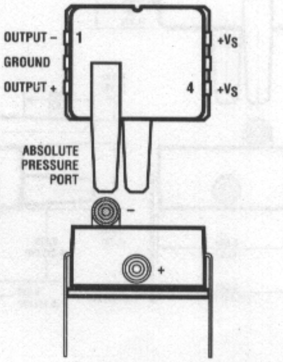
Bottom View
(Open Bridge)

TO can Pinout

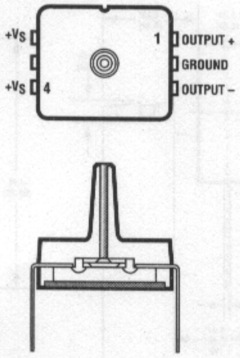
NOTE: Polarity applies for positive pressure applied to the high pressure port, P_1.
TO Package only available in an Open Bridge configuration.



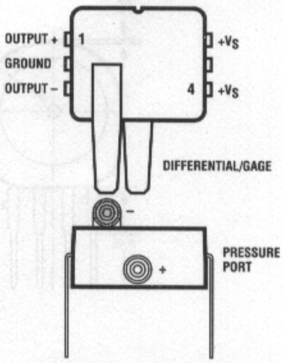
SXxxxAD2



SXxxxAD4



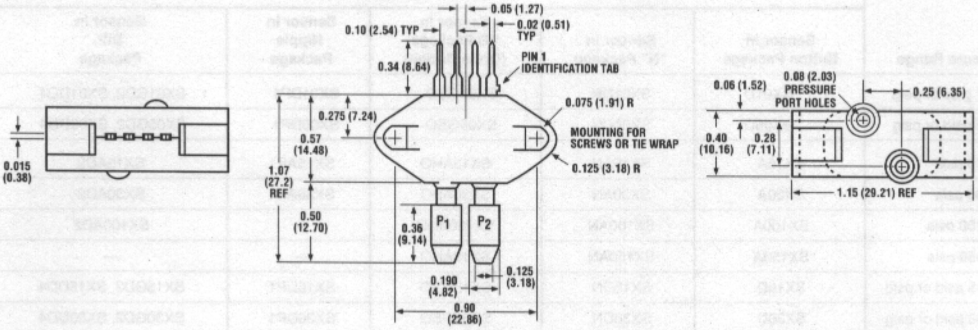
SXxxxGD2



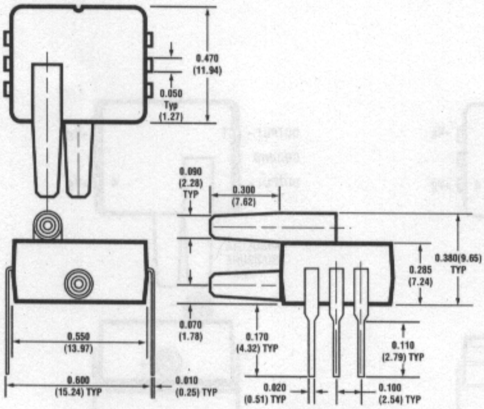
SXxxxDD4

PACKAGE OUTLINES

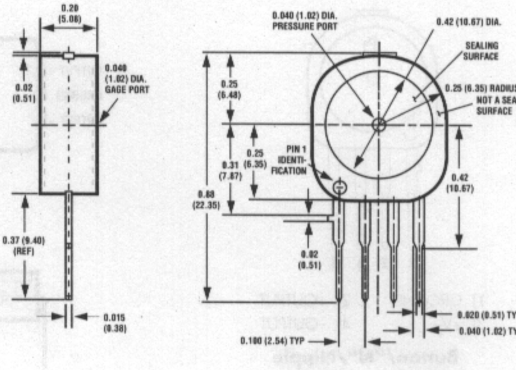
N Package



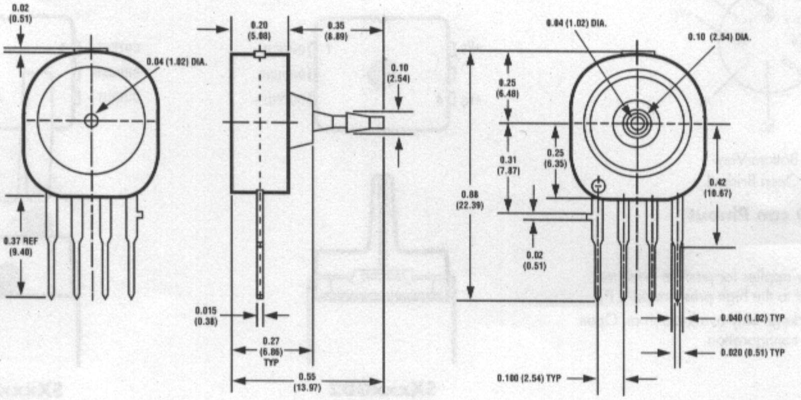
Basic Sensor Sideport 'D4' DIP Package



Button Sensor

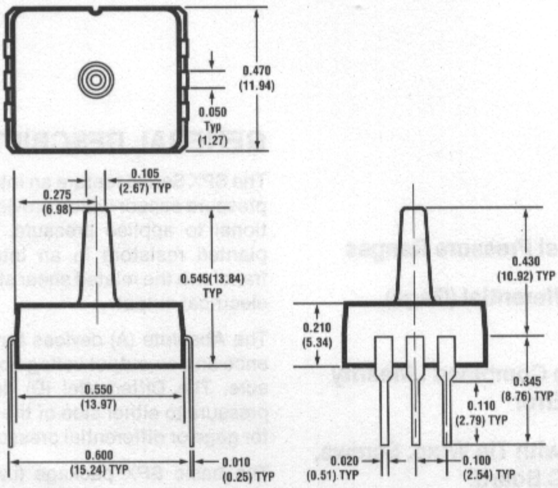


P1 Button Package

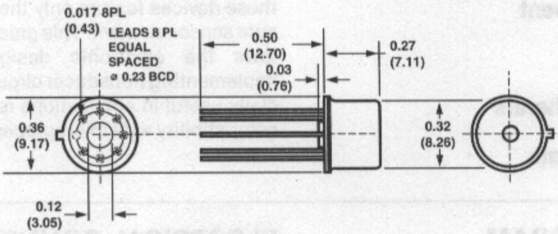


PACKAGE OUTLINES

Basic Sensor 'D2' DIP Package



AH (TO-5) Package



GSO (TO-39) Package