SBP270 BAROMETRIC PRESSURE SENSOR
INSTRUCTION MANUAL

REVISION: 29/11/01

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SBP270 BAROMETRIC PRESSURE SENSOR

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DESCRIPTION

The SBP270 Barometric Pressure Sensor (SBP270) is a high accuracy barometer designed for use with the CR7, 21X, and CR10 dataloggers. Figure 1 shows the SBP270, which includes the Setra Model 270 variable capacitance barometer, interface circuitry, 5 foot cable, and a rain-tight enclosure. Mounting brackets allow the SBP270 to be mounted either to a flat surface, or 1 - 1.5" NPT pipe.

SPECIFICATIONS

Pressure Range:	800 to 1100 millibars (mbar)
Operating Temperature:	0 - 175 °F
*Accuracy:	+/- 0.2 mbar
Zero Pressure Output:	0 mbar, internally adjustable, factory set within < +/- 0.3 mbar
Long Term Stability:	< +/- 0.1% FS over 6 months 70°F
Thermal zero shift:	< +/- 0.2% FS/100°F (30° to 120°F)
Warm-up time:	10 milliseconds (ms)
Power requirements:	9.6 - 16 VDC 35 ma @ 12 VDC active < 25 ua quiescent
Output:	0 - 250 millivolts (mv)
Enclosure:	9.5" (H) x 7.5" (W) x 5.0" (D)
Weight:	6 lbs

* Accuracy as RSS of non-linearity, hysteresis, and non-repeatability.

OPERATION

Interface circuitry contained in the SBP270 (Figure 1) has a "control" input which wires to a switched excitation or control port on the datalogger. When the datalogger applies voltage (+1.5 to +5.0 volts) to the "control" input, circuitry is enabled which doubles the 12 volt supply voltage and applies this voltage to the barometer.

Output from the SBP270 is a differential 0 - 250mv. A 10ms warm-up period is required before the measurement is made. After the measurement the "control" input should be returned to 0 volts, which switches power off to the barometer.

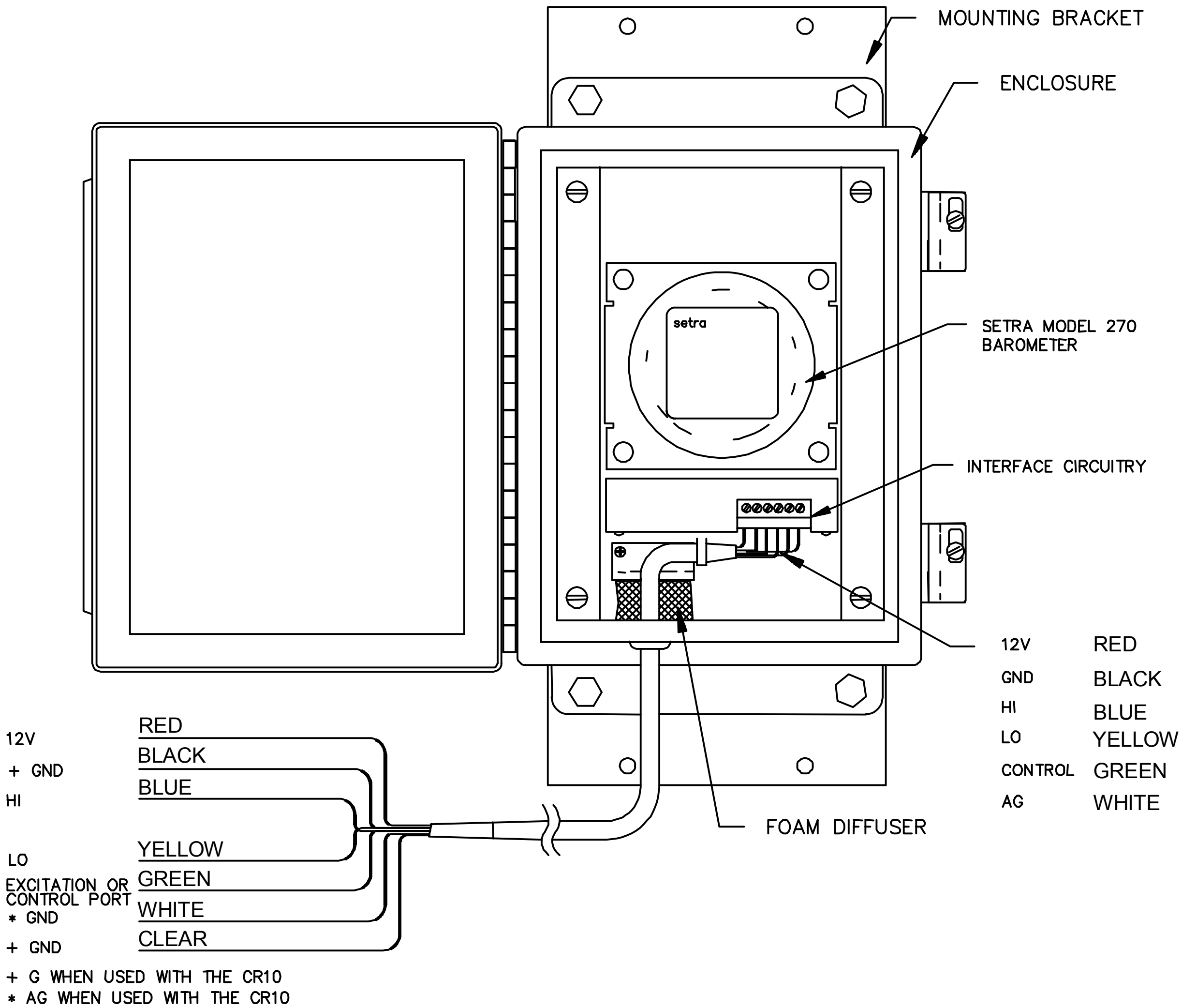

Figure 1. SBP270 Barometric Pressure Sensor

> **NOTE:** The black outer jacket of the cable is Santoprene® rubber. This compound was chosen for its resistance to temperature extremes, moisture, and UV degradation. However, this jacket will support combustion in air. It is rated as slow burning when tested according to U.L. 94 H.B. and will pass FMVSS302. Local fire codes may preclude its use inside buildings.

DATALOGGER CONNECTIONS

A 5 foot cable is included with the SBP270 which connects to the CR7, 21X, or CR10 datalogger. Lead wires are connected to the datalogger as shown in Figure 1. Note that when used with the CR10, the black lead wire (of the white/black pair) connects to an Analog Ground (AG); the other 2 lead wires labeled GND connect to power ground (G).

MULTIPLIER AND OFFSET CALCULATION

Output from the SBP270 is 0 to 250mv, which corresponds to 800 to 1100 mbars of pressure. The multiplier and offset used to convert voltage to mbars of pressure is:

mbar = (mv * 1.2) + 800mbar

Multiplier = 1.2

Offset = 800

The measurement result using a multiplier of 1.2 and an offset of 800 is true barometric pressure in mbars. The weather service and most airports, radio stations and TV stations correct the pressure recorded at a particular station to what it would be if the station was located at sea level. This is done so that weather forecasters can obtain a clearer picture of what is happening as a storm crosses over mountains or high plateaus.

Use Equation 1 to determine the pressure correction factor, which is added to the 800 mbar offset to have the datalogger output barometric pressure corrected to sea level. Because barometric pressure is strongly affected by elevation, the elevation of the site should be as accurate as possible.

$$P = 1013.25\left[1-\left(1-\frac{\text{ELEVATION}}{44307.69231}\right)^{5.253283}\right] \quad \text{Equation 1**}$$

where elevation is in meters above sea level.

For example, the correction factor (P) for Logan Utah at 4450 ft elevation is:

4450 ft * m/3.281 ft = 1356.29 m

pressure correction factor (P) = 152.67 mbar

transducer offset = 800 mbar
pressure correction factor (P) = 152.67 mbar

offset for sea level correction = 952.67 mbar

** Wallace, John M., and Peter V. Hobbs. 1977. Atmospheric Science an Introductory Survey. Academic
Press, New York, NY, p 59 - 61.

MAINTENANCE

The SBP270 requires minimal maintenance. The foam diffuser (see Figure 1) should be kept clean and unobstructed. Desiccant packs inside of the enclosure must be replaced as necessary. The desiccant packs can be reactivated by placing in an oven at 250 degrees F for 16 hours, or extra desiccant packs can be ordered from CSI.

CONVERSION FACTORS

mbar * 0.0145 PSI/mbar = PSI
mbar * 0.75006 mm of Hg/mbar = mm of Hg
mbar * 0.02953 in. of Hg/mbar = in. of Hg
mbar * 0.00102 kg/cm^2/mbar = kg/cm^2
mbar * 0.1 kPa/mbar = kPa

RESOLUTION CONSIDERATIONS

The value stored in final storage with the low resolution format is reduced to 3 significant digits when the first (left most) digit is 7 or greater. This rounding will occur when the SBP270 measurement result is in mbars or mmhg. For example, 860.65 mbars would be stored as 861.

One way to preserve the resolution of the measurement is to specify the high resolution format using Instruction 78. For example, 860.65 mbars would be stored as 860.65 in final storage. The disadvantage of using high resolution is that it takes twice as much memory per data point. An alternative to high resolution would be to use an offset in the measurement instruction to keep the result less than 700. For example, 400 mbars could be used as an offset instead of 800 mbars, and then compensated for in the computer. This method would use low resolution, maximizing the number of data values which could be stored in final storage.

PROGRAMMING EXAMPLE 1 - CR10, 21X

Programming Example 1 uses Instruction 8, contained in the CR10 and 21X instruction set, to switch power to the SBP270 and to measure its output. Instruction 8 applies 2500 mv to excitation Channel 1 (wired to the "control" input to the SBP270), delays for 10ms, and then measures the output on differential Channel 1. The multiplier and offset are applied, and the result placed in Input Location 1. Every 15 minutes the output flag is set, and the average barometric pressure is stored in final storage using the high resolution format.

```
*         1       Table 1 programs
  01:   300       Sec. Execution Interval

01:      P8       Excite,Delay,Volt(DIFF)
  01:     1       Rep
  02:     4       250 mV slow Range CR10, 500 mV slow range 21X
  03:     1       IN Chan
  04:     1       Excite all reps w/EXchan 1 Switches power on to barometer
  05:     1       Delay (units=.01sec) 10 ms delay
  06:  2500       mV Excitation
  07:     1       Loc :  Corrected BP in mbars
  08:     1.2     Mult
  09:   952.67    Offset (800 @ sea level corrected to Logan Utah elevation)
```

```
02:      P92        If time is
  01:      0        minutes into a
  02:     15        minute interval
  03:     10        Set high Flag 0 (output)

03:      P77        Real Time
  01:   0110        Day,Hour-Minute

04:      P78        Resolution
  01:      1        High Resolution

05:      P71        Average
  01:      1        Reps
  02:      1        Loc
```

PROGRAMMING EXAMPLE 2 - CR7

Programming Example 2 uses a control port to switch power to the SBP270, which is necessary when the SBP270 is used with the CR7 datalogger (the CR7 doesn't contain Instruction 8, used in example 1). In the following example, control port 1 (wired to the white "control" input to the SBP270) is set high to switch power on to the barometer. Instruction 22 delays for 10ms to allow the sensor to warm-up. Output from the SBP270 is measured using Instruction 2; the multiplier and offset are applied, and the result placed in Input Location 1. Control Port 1 is set low, which switches power off to the barometer. Every 15 minutes the output flag is set, and the average barometric pressure is stored in final storage using the high resolution format.

```
*          1        Table 1 Programs
  01:    300        Sec. Execution Interval

01:      P20        Set Port Switches power on to barometer
  01:      1        Set high
  02:      1        EX Card
  03:      1        Port Number

02:      P22        Excitation with Delay 10ms delay
  01:      1        EX Card
  02:      1        EX Chan
  03:      0        Delay w/EX (units=.01sec)
  04:      1        Delay after EX (units=.01sec)
  05:      0        mV Excitation

03:       P2        Volt (DIFF) Measure output
  01:      1        Rep
  02:      6        500 mV slow Range
  03:      1        IN Card
  04:      1        IN Chan
  05:      1        Loc :  Corrected BP in mbars
  06:      1.2      Mult
  07:    952.67     Offset (800 @ sea level corrected to Logan UT elevation)
```

04:	P20	Set Port **Switches power off to barometer**
01:	0	Set low
02:	1	EX Card
03:	1	Port Number
05:	P92	If time is
01:	0	minutes into a
02:	15	minute interval
03:	10	Set high Flag 0 (output)
06:	P77	Real Time
01:	0110	Day,Hour-Minute
07:	P78	Resolution
01:	1	High Resolution
08:	P71	Average
01:	1	Reps
02:	1	Loc

Appendix A. Mean Sea Level Pressure

Symbol: P_{MSL}(millibars)

Input:

P_{stn}	- station pressure (mb)
H	- station elevation (m)
T	- station temperature (degrees C)
T_{12}	- station temperature 12 hours prior to observation time (degrees C)

Process: $P_{MSL} = P_{stn} * \ EXP(0.0341636 * H / T_{mv})$

where $T_{mv} = 273.16 + t + (a*H/2) + e_s Ch + F(t)$

$t = (T + T_{12})/2$

a = lapse rate (0.0065 degrees C/metre)

$e_s = (273.16+T)**(-0.00014t^2 + 0.0116t + 0.279)$

$Ch = 2.8322E\text{-}9 * H^2 + 2.225E\text{-}5 * H + 0.10743$

F(t) – Plateau correction

$F(t) = at^2 + bt + c$

a, b, c are empirically derived and site specific (available from AES).

NOTE: The Plateau Correction can cause a significant error in cold temperatures.

Reference: Savdie, I. “AES Barometery Program – A Technical Record”, Data Acquisition Branch Publication TR9, August 1982.

Appendix B. Altimeter Setting Computations

Two Setra 270 pressure transducers are required to do altimeter setting computations for aviation interests. The reading should consist of an average of at least 60 samples taken uniformly from the sensors over a period of 40 to 120 seconds.

If the maximum scatter of sample points around the mean is greater than 3 millibars, the pressure reading will default to MISSING.

If the DC/DC converter voltage falls below the specified minimum sensor supply voltage of 22 volts, the pressure reading will be considered MISSING.

The procedure for computing altimeter setting follows:

1. The lower of the two pressure readings is taken provided the difference between the two readings is less than or equal to 1.4 mb.

2. If the difference is unacceptable, both the altimeter setting and the station pressure are set to MISSING.

3. If the pressure readings are acceptable, the altimeter setting is calculated as follows:

$$AS = 0.029530 * (P_{stn}^{0.19026} + 8.41717*10^{-5} H_P)^{5.25593}$$

where	AS	Altimeter Setting (inches)
	P_{stn}	Stations Pressure (millibars)
	H_P	Station Elevation (Geopotential Metres)