INSTRUCTION MANUAL

CS100 Barometric Pressure Sensor

3/05

Warranty and Assistance

The **CS100 BAROMETRIC PRESSURE SENSOR** is warranted by CAMPBELL SCIENTIFIC, INC. to be free from defects in materials and workmanship under normal use and service for thirty-six (36) months from date of shipment unless specified otherwise. Batteries have no warranty. CAMPBELL SCIENTIFIC, INC.'s obligation under this warranty is limited to repairing or replacing (at CAMPBELL SCIENTIFIC, INC.'s option) defective products. The customer shall assume all costs of removing, reinstalling, and shipping defective products to CAMPBELL SCIENTIFIC, INC. CAMPBELL SCIENTIFIC, INC. will return such products by surface carrier prepaid. This warranty shall not apply to any CAMPBELL SCIENTIFIC, INC. products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. CAMPBELL SCIENTIFIC, INC. is not liable for special, indirect, incidental, or consequential damages.

Products may not be returned without prior authorization. The following contact information is for US and International customers residing in countries served by Campbell Scientific, Inc. directly. Affiliate companies handle repairs for customers within their territories. Please visit www.campbellsci.com to determine which Campbell Scientific company serves your country. To obtain a Returned Materials Authorization (RMA), contact CAMPBELL SCIENTIFIC, INC., phone (435) 753-2342. After an applications engineer determines the nature of the problem, an RMA number will be issued. Please write this number clearly on the outside of the shipping container. CAMPBELL SCIENTIFIC's shipping address is:

CAMPBELL SCIENTIFIC, INC.
RMA#_____
815 West 1800 North
Logan, Utah 84321-1784

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CS100 Barometric Pressure Sensor

1. Introduction

The CS100 is a capacitive pressure transducer that uses the Setra's electrical capacitor technology for barometric pressure measurements over the 600 to 1100 millibar range. The transducer's compact and rugged polyester housing with stainless blackplate contains two closely-spaced, parallel, electrically-isolated metallic surfaces. One of the surfaces is essentially a diaphragm constructed of a Setra's proprietary compound of fused glass and ceramic (Setraceram™) or a low-hysteresis material, such as 17-4 PH SS. The diaphragm is capable of detecting a slight change in the applied pressure, which is then converted to an analog voltage signal by Setra's custom Application Specific Integrated Circuit (ASIC). The analog signal generated by the barometer can be directly measured by a Campbell Scientific datalogger, such as 21X, CR7, CR500, CR510, CR10(X), CR23X, CR200's, CR1000, CR5000, and CR9000.

The CS100 is supplied in the triggered mode, in which the datalogger switches 12 VDC power to the barometer before the measurement. The datalogger then powers down the barometer after the measurements to conserve power.

Other measurement range options such as 500 to 1100 millibar, and 800 to 1100 millibar are also available. Please contact Campbell Scientific, Inc. for ordering these special versions.

FIGURE 1. CS100 Barometric Pressure Sensor

2. Specifications

2.1 Performance

2.1.1 Performance for "Standard" Range Option

Measurement Range:	600 mb to 1100 mb (hPa)
Operating Temperature Range:	-40°C to +60°C (-40°F to +140°F)
Storage Temperature Range:	-60°C to +120°C (-76°F to +248°F)
Proof Pressure:	1500 mb
Burst Pressure:	2000 mb
Humidity Range:	non-condensing (up to 95% RH)
Media Compatibility:	non-corrosive, non-condensing air or gas
Resolution:	0.01 mb
Total Accuracy[1]:	±0.5 mb @ 20°C
	±1.0 mb @ 0°C to +40°C
	±1.5 mb @ -20°C to +50°C
	±2.0 mb @ -40°C to +60°C
Linearity:	±0.4 mb
Hysteresis:	±0.05 mb
Repeatability:	±0.03 mb
Long-term Stability:	±0.1 mb per year

2.1.2 Performance for "500 to 1100 mb" Range Option

Measurement Range:	500 to 1100 mb
Total Accuracy[2]:	±0.6 mb @ 20°C
	±1.2 mb @ 0°C to +40°C
	±2.0 mb @ -20°C to +50°C
	±2.5 mb @ -40°C to +60°C
Linearity:	±0.5 mb
Hysteresis:	±0.06 mb
Repeatability:	±0.04 mb

2.1.3 Performance for "800 to 1100 mb" Range Option

Measurement Range:	800 to 1100 mb
Total Accuracy[3]:	±0.3 mb @ 20°C
	±0.6 mb @ 0°C to +40°C
	±1.0 mb @ -20°C to +50°C
	±1.5 mb @ -40°C to +60°C
Linearity:	±0.25 mb
Hysteresis:	±0.03 mb
Repeatability:	±0.02 mb

[1] The root sum squared (RSS) of end point non-linearity, hysteresis, non-repeatability and calibration uncertainty.

[2] The root sum squared (RSS) of end point non-linearity, hysteresis, non-repeatability and calibration uncertainty.

[3] The root sum squared (RSS) of end point non-linearity, hysteresis, non-repeatability and calibration uncertainty.

2.2 Electrical

Supply Voltage:	9.5 V to 28 Vdc
Current Consumption:	3 mA nominal (operating mode) 1 µA quiescent (sleep mode)
Signal Output	0 to 2.5 Vdc
Warm-up Time:	<1 second from shutdown mode
Response Time:	<100 msec
Benefits:	Calibration NIST traceable Meets CE conformance standards

2.3 Physical

Dimensions (Main Box):	3.6" x 2.4" x 1.0" (9.1 x 6.1 x 2.5 cm)
Weight:	4.8 oz (135 g)
Mounting Hole Centers:	3 inches (7.62 cm)
Pressure Connector:	1/8" ID barbed fitting

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 building.

3. Installation

3.1 Venting and Condensation

To prevent condensation, install the sensor in an environmentally protected enclosure, complete with desiccant, which should be changed at regular intervals. As the sensor must detect the external ambient pressure the enclosure must *not* be 'hermetically sealed'.

CAUTION Failure to protect the sensor from condensation may result in permanent damage.

NOTE If it is necessary to make a vent hole on the outer wall of an enclosure, do not make the hole on one of the vertical side walls, as wind blowing around it can cause transient changes in pressure.

3.2 Mounting

The mounting holes for the sensor are one-inch-centered (three inches apart), and will mount directly onto the holes on the backplates of the Campbell Scientific enclosures. Mount the sensor with the pneumatic connector pointing vertically downwards to prevent condensation collecting in the pressure cavity, and also to ensure that water cannot enter the sensor.

4. Wiring

The CS100 wiring instructions for the example programs are shown in Table 1 below.

TABLE 1. Wiring for Example Programs

Wire Color	Description	CR10(X)	CR1000
Blue	VOUT – Pressure Signal Out	SE6	SE15
Red	SUPPLY – 12 Vdc Power In	12V	12V
Black	GND – Power Ground	G	G
Yellow	AGND – Signal Ground	AG	⏚
Green	ETX. TRIG. – External Trigger	C8	C4
Clear	Shield	G	G

5. Programming

The CS100 sensor is measured using the singled-ended voltage measurement instruction.

Atmospheric pressure changes little with time. In most weather station applications measuring pressure once an hour is adequate.

In Program Example 1 the CR10X datalogger (classic datalogger) turns on the CS100 one minute before the top of the hour using a control port. On the hour the datalogger measures the CS100, and then it turns the CS100 off.

Program Example 2 is for the dataloggers that use the CRBasic language, such as CR200, CR1000, CR5000, and CR9000. In the example, the CR1000 measures the CS100 once an hour in a program that runs at 1 Hz. In order to keep the CR1000 running in a pipeline mode, the measurement instruction is placed outside the “If” statement. The measurement is made every scan, and the measured value is first written into a temporary variable called "CS100_temp". Once the CS100 is turned on one minute before the hour, the CS100 starts to make the correct pressure measurements. At the top of the hour, the correct value is copied into the current variable called "pressure", and the sensor is turned off immediately.

5.1 Conversion Factors

In the example programs, the pressure is reported in millibars (mb). To report pressure in different units, multiply the measured pressure by the appropriate conversion factor using the P37 (Z=X*F) instruction for CR500, CR510, CR10(X), CR23X, 21X, and CR7, or by adding an expression for CR200, CR1000, CR5000, and CR9000 dataloggers. See Table 2 below for conversion factors.

TABLE 2. Conversion Factors for Alternative Pressure Units

To Find	Multiply by
hPa	1.0
kPa	0.1
mm of Hg	0.75006
in of Hg	0.02953
Psi	0.0145
Atm	0.00099
Torr	0.75006

5.2 Multipliers and Offsets for Different Measurement Range Options

For CS100 barometric pressure transducers with measurement range options other than the standard 600 to 1100 mb option, please refer to the table below for proper multipliers and offsets.

TABLE 3. Multipliers and Offsets

Range Options	Multiplier	Offset
600 to 1100 mb (Standard range)	0.2	600
500 to 1100 mb	0.24	500
800 to 1100 mb	0.12	800

5.3 Program Examples

Example 1. Sample Program for CR10X (Classic) Datalogger

```
;{CR10X}
;
*Table 1 Program
  01: 1              Execution Interval (seconds)

;Turn on CS100 one minute before the hour
;
1: If time is (P92)
  1:  59             Minutes (Seconds --) into a
  2:  60             Interval (same units as above)
  3:  48*            Set Port 8* High

;Measure CS100 at the top of the hour
;
2: If time is (P92)
  1:  0              Minutes (Seconds --) into a
  2:  60             Interval (same units as above)
  3:  30             Then Do
```

```
3:  Volt (SE) (P1)
   1:   1              Reps
   2:   15             2500 mV Fast Range
   3:   6              SE Channel
   4:   1              Loc [ P_mb      ]
   5:   0.2            Multiplier
   6:   600            Offset

;Turn off CS100
;
4:  Do (P86)
   1:   58*            Set Port 8* Low

5:  End (P95)

6:  If time is (P92)
   1:   0              Minutes (Seconds --) into a
   2:   60             Interval (same units as above)
   3:   10             Set Output Flag High (Flag 0)

7:  Real Time (P77)
   1:   0110           Day,Hour/Minute (midnight = 0000)

;Store in high resolution mode to retain 0.01mb resolution
;
8:  Resolution (P78)
   1:   1              High Resolution

9:  Sample (P70)
   1:   1              Reps
   2:   1*             Loc [ P_mb      ]

*Table 2 Program
   02:  0.0000         Execution Interval (seconds)

*Table 3 Subroutines

End Program

-Input Locations-
1 P_mb

* Proper entries will vary with program and datalogger channel, and input location assignments.
```

Example 2. Sample Program for CR1000 (CRBasic) Datalogger

```
'CR1000 Datalogger

Public CS100_temp
Public pressure
Units pressure = mbar
```

```
DataTable (met_data,True,-1)
    DataInterval (0,60,min,10)
        Sample (1,pressure,IEEE4)
EndTable

BeginProg
    Scan (1,sec,3,0)

'Measurement is made every scan outside the "If" statement
        VoltSe (CS100_temp,1,mV2500,15,False,200,250,0.2,600)

'Turn on CS100 one minute before the hour
        If (IfTime (59,60,min)) Then WriteIO (&b1000,&b1000)

 'Copy the correct value to a current variable called "pressure" at the top of the hour
'Turn off CS100 after measurement
        If (IfTime (0,60,min)) Then
            pressure = CS100_temp
            WriteIO (&b1000,&b0)
        EndIf

        CallTable met_data

    NextScan
EndProg
```

5.4 Output Resolution

When storing the values from the CS100 to a datalogger's final storage location, or to a data table, care must be taken to choose suitable scaling of the reading, or to store the value with adequate resolution to avoid losing useful resolution of the pressure measurement. The default resolution (low resolution) for Campbell Scientific dataloggers is limited to a maximum of four digits. Even then, the maximum digit value that can be displayed is 6999 for classic dataloggers, and 7999 for the CRBasic dataloggers. If you use this option with barometric data scaled in millibars (hPa), a reading above 699.9 mb (799.9 mb for CR5000/9000) will lose one digit of resolution, e.g. at 900 mb, the resolution is limited to 1 mb.

To retain 0.01 mb resolution, you either need to deduct a fixed offset from the reading before it is stored to avoid exceeding the 699.9 (or 799.9 for CRBasic dataloggers) threshold, or output the barometric reading in high resolution format. This can be done by using the Resolution (P78) instruction in the CR500, CR510, CR10(X), CR23X, CR7, and 21X dataloggers, or the IEEE4 format for CR1000, CR5000, and CR9000 dataloggers. The default data output format for CR200 series datalogger is IEEE4.

6. Correcting Pressure to Sea Level

The weather service, most airports, radio stations, and television stations reduce the atmospheric pressure to a common reference (sea level). Equation 1 can be used to find the difference in pressure between the sea level and the site. That value (*dP*) is then added to the offset (600 mb in our example programs)

in the measurement instruction. U. S. Standard Atmosphere and dry air were assumed when Equation 1 was derived (Wallace, J. M. and P. V. Hobbes, 1977: *Atmospheric Science: An Introductory Survey*, Academic Press, pp. 59-61).

$$dP = 1013.25\left\{1-\left(1-\frac{E}{44307.69231}\right)^{5.25328}\right\} \quad (1)$$

The value *dP* is in millibars and the site elevation, *E*, is in meters. Add *dP* value to the offset in the measurement instruction.

Use Equation (2) to convert feet to meters.

$$E(m) = \frac{E(ft)}{3.281 ft/m} \quad (2)$$

The corrections involved can be significant: e.g. at 1000mb and 20°C, barometric pressure will decrease by 1.1mb for every 10 meter increase in altitude.

7. Maintenance and Calibration

Since the sensor is semi-sealed, minimum maintenance is required:

1. Visually inspect the cable connection to ensure it is clean and dry.
2. Visually inspect the casing for damage.
3. Ensure that the pneumatic connection and pipe are secure and undamaged.

The external case can be cleaned with a damp, lint-free cloth and a mild detergent solution.

Contact Campbell Scientific, Inc. (435-753-2342) for an RMA number before returning the sensor for recalibration. You may also return the unit directly to Setra for recalibration.

Should you lose the five terminal connector (p/n 16004), the replacement part can be purchased from Campbell Scientific, Inc. Contact Campbell Scientific, Inc. to purchase the part.

CAUTION The CS100 is sensitive to static when the backplate is removed. To avoid damage, take adequate anti-static measures when handling.

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