INSTRUCTION MANUAL

CS106 Barometric Pressure Sensor

Revision: 5/09

Warranty and Assistance

The **CS106 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

For all returns, the customer must fill out a "Declaration of Hazardous Material and Decontamination" form and comply with the requirements specified in it. The form is available from our website at www.campbellsci.com/repair. A completed form must be either emailed to shanna@campbellsci.com or faxed to 435-750-9579. Campbell Scientific will not process any returns until we receive this form. If the form is not received within three days of product receipt or is incomplete, the product will be returned to the customer at the customer's expense. Campbell Scientific reserves the right to refuse service on products that were exposed to contaminants that may cause health or safety concerns for our employees.

CAMPBELL SCIENTIFIC, INC. does not accept collect calls.

CS106 Table of Contents

PDF viewers note: These page numbers refer to the printed version of this document. Use the Adobe Acrobat® bookmarks tab for links to specific sections.

Figures

Tables

CS106 Barometric Pressure Sensor

1. General

The CS106 analog barometer uses Vaisala's Barocap® silicon capacitive pressure sensor. The Barocap sensor has been designed for accurate and stable measurement of barometric pressure. The CS106 outputs a linear 0 to 2.5 VDC signal that corresponds to 500 to 1100 mb. It can be operated in a shutdown or normal mode. In the shutdown mode the datalogger switches 12 VDC power to the barometer during the measurement. The datalogger then powers down the barometer between measurements to conserve power.

2. Specifications

Operating Range

Pressure:	500 mb to 1100 mb
Temperature:	-40°C to +60°C
Humidity:	non-condensing

Accuracy

Total Accuracy***	±0.3 mb @ +20°C
	±0.6 mb @ 0°C to +40°C
	±1 mb @ -20°C to +45°C
	±1.5 mb @ -40°C to +60°C
Linearity*:	±0.25 mb @ 20°C
Hysteresis*:	±0.03 mb @ 20°C
Repeatability*:	±0.03 mb @ 20°C
Calibration uncertainty**:	±0.15 mb @ 20°C
Long-Term Stability:	±0.1 mb per year

* Defined as ±2 standard deviation limits of end-point non-linearity, hysteresis error, or repeatability error

** Defined as ±2 standard deviation limits of inaccuracy of the working standard at 1000 mb in comparison to international standards (NIST)

*** Defined as the root sum of the squares (RSS) of end-point non-linearity, hysteresis error, repeatability error and calibration uncertainty at room temperature

General

Dimensions: 9.7 cm x 6.8 cm x 2.8 cm (3.8" x 2.7" x 1.1")

Weight: 90 g (3.2 oz)

Housing material: ABS/PC blend

Supply Voltage: 10 to 30 VDC

Supply Voltage Control: When enabled with an internal jumper, the CS106 is on continually. When disabled, the CS106 can be turned on/off with 5 VDC/0 VDC.

Supply voltage sensitivity: negligible

Current Consumption: <4 mA (active); <1 μA (quiescent)

Output Voltage: 0 to 2.5 VDC

Warm Up Time: 1 second

Pressure fitting: barbed fitting for 1/8" I.D. tubing

Overpressure limit: 2000 mb

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.

3. Installation and Wiring

3.1 Jumper Settings

The CS106 can be operated in one of two modes: shutdown and normal. The mode is selected by a jumper located underneath the plastic cover of the barometer. When the jumper is not installed, the CS106 is in shutdown mode and the datalogger turns the CS106 on and off with a control port or excitation channel; to use the excitation channel the datalogger must be able to provide an excitation voltage of 5 VDC. When the jumper is installed the CS106 is in normal mode and powered continuously.

NOTE CS106s shipped from Campbell Scientific are configured for shutdown mode (jumper open).

The location of the jumper is shown in Figure 3-1.

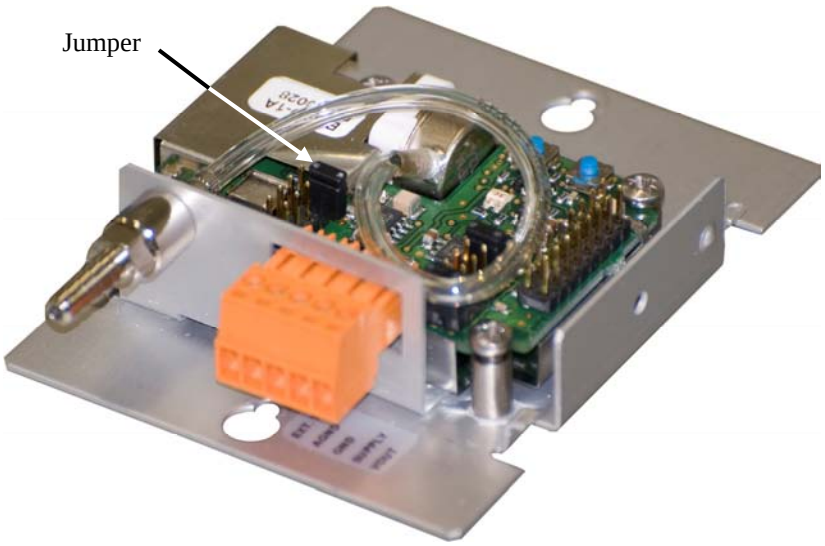

FIGURE 3-1. CS106 Jumper Set to Shutdown Mode

3.2 Datalogger Connection

Before connecting the barometer to the datalogger, a yellow warning label must be removed from the pigtails. The warning label reminds the user of the importance of properly connecting the barometer to the datalogger. Wiring is shown in Figure 3-2 and Table 3-1.

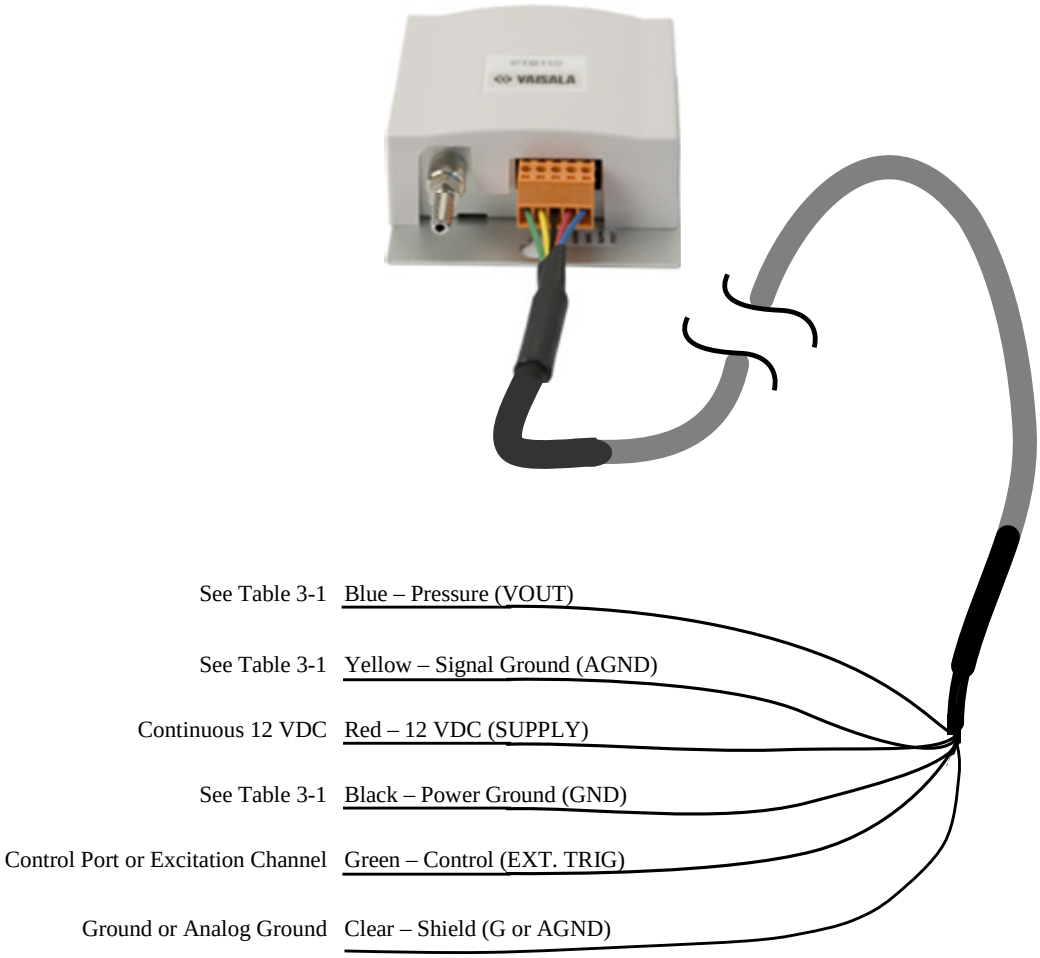

FIGURE 3-2. CS106 Wiring Diagram

TABLE 3-1. Signal and Ground Connectors for CS106

Wire	CS106 Terminal	Datalogger Single-Ended Measurement	Datalogger Differential Measurement
Blue	VOUT	S.E. Input	High Side of Diff Input
Yellow	AGND	AG (CR10(X), CR500, CR510) ⏚ (Other Dataloggers)	Low Side of Diff. Input
Black	GND	⏚ (21X, CR7, CR9000(X)) G (Other Dataloggers)	⏚ (21X, CR7, CR9000(X)) G (Other Dataloggers)
Green	EXT TRIG	Control port (use to turn power on/off)	Control port (use to turn power on/off)
Red	SUPPLY	12 VDC	12 VDC
Shield	Shield	G (CR10(X), CR500, CR510) ⏚ (Other Dataloggers)	G (CR10(X), CR500, CR510) ⏚ (Other Dataloggers)

WARNING **Improper wiring may damage the CS106 beyond repair.**

3.3 5-pin Screw Terminal Plug Connector

The datalogger connects to the CS106 via a 5-pin screw terminal plug connector. This connector is removable and may be replaced. The replacement connector may come with a connector key attached to it to ensure that the connector is plugged into the CS106 right side up (see Figure 3-3). When the connector is right side up, it will easily plug into the barometer.

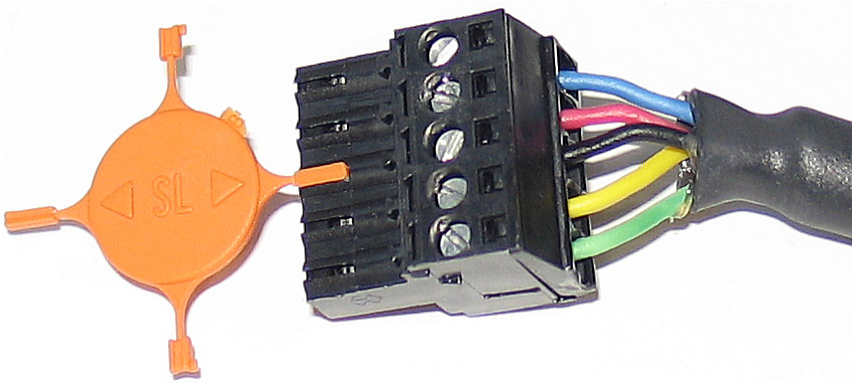

FIGURE 3-3. Connector Key Attached to 5-pin Screw Terminal Plug Connector

WARNING **A 5-pin screw terminal that is plugged in upside down will damage the sensor—perhaps beyond repair.**

3.4 Mounting in Enclosure

The CS106 mounts to the enclosure backplate next to the datalogger.

4. Programming

The CS106 sensor is measured using the singled-ended voltage measurement instruction (VoltSe in CRBasic or P1 in Edlog).

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 (Edlog datalogger) turns on the CS106 one minute before the top of the hour using a control port. On the hour the datalogger measures the CS106, and then it turns the CS106 off.

Program Example 2 is for the dataloggers that use the CRBasic language, such as CR200, CR800, CR850, CR1000, CR3000, CR5000, and CR9000(X). In the example, the CR1000 measures the CS106 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 "CS106_temp". Once the CS106 is turned on one minute before the hour, the CS106 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.

In Program Example 2, the integration parameter for the VoltSe instruction is _60Hz. However, for Eddy Covariance programs or other datalogger programs that are executed at a higher frequency, the integration parameter should be 250 µsec instead of _60Hz or _50Hz. This prevents skipped scans.

4.1 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, C800, CR850, CR1000, CR3000, CR5000, and CR9000(X) dataloggers. See Table 4-1 below for conversion factors.

TABLE 4-1. 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

4.2 Program Examples

Example 1. Sample Program for CR10X (Classic) Datalogger

```
;{CR10X}

*Table 1 Program
  01:  1              Execution Interval (seconds)

;Turn on CS106 one minute before the hour
;
1:  If time is (P92)
   1:   59             Minutes (Seconds --) into a
   2:   60             Interval (same units as above)
   3:   41             Set Port 1 High
```

```
;Measure CS106 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:   25             2500 mV 60 Hz Rejection Range
         3:   1              SE Channel
         4:   1              Loc [ CS106     ]
         5:   0.240          Multiplier
         6:   500            Offset

;Turn off CS106
;
      4:  Do (P86)
         1:   51             Set Port 1 Low

5:  End (P95)

;Store CS106 data once an hour
;
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 [ CS106     ]

*Table 2 Program
   01:  0              Execution Interval (seconds)

*Table 3 Subroutines

End Program

-Input Locations-
1 CS106     1 1 1
```

Example 2. Sample Program for CR1000 (CRBasic) Datalogger

```
'CR1000 Datalogger

Public CS106_temp, pressure
Units pressure = mbar

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

BeginProg
PipeLineMode
    Scan (1,sec,3,0)

'Measurement is made every scan outside the "If" statement
        VoltSe (CS106_temp,1,mV2500,1,False,0,_60Hz,0.240,500)

'Turn on CS106 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 CS106 after the measurement
        If (IfTime (0,60,min)) Then
            pressure = CS106_temp
            WriteIO (&b1000,&b0)
        EndIf

        CallTable met_data

    NextScan
EndProg
```

4.3 Long Lead Lengths

There is a 0.06 mV/foot voltage drop in the CS106 signal leads. This voltage drop, in long lead lengths, will raise the barometric reading by approximately 1.44 mb per 100 feet.

For lead lengths greater than 20 feet, use the differential instruction (Instruction 2) to measure the CS106.

4.4 Output Resolution

When storing the values from the CS106 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 Edlog 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 CRBasic dataloggers) 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 subtract 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 Edlog dataloggers, or the IEEE4 format for CRBasic dataloggers. The default data output format for CR200 series datalogger is IEEE4.

5. 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 (500 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 1000 mb and 20°C, barometric pressure will decrease by 1.1 mb for every 10 meter increase in altitude.

6. 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.

Vaisala recommends recalibration every two years under normal use. In areas where a lot of contaminants are present, recalibration every year is recommended.

Contact Campbell Scientific, Inc. (435-753-2342) for an RMA number before returning the sensor 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 CS106 is sensitive to static when the backplate is removed. To avoid damage, take adequate anti-static measures when handling.

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