INSTRUCTION MANUAL

CS105/CS105MD
Barometric Pressure Sensor

Revision: 2/04

Warranty and Assistance

The **CS105/CS105MD BAROMETRIC PRESSURE SENSOR** is warranted by CAMPBELL SCIENTIFIC, INC. to be free from defects in materials and workmanship under normal use and service for twelve (12) 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.

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RMA#_____
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CS105/CS105MD Barometric Pressure Sensor

1. General

The CS105 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 CS105 outputs a linear 0 to 2.5 VDC signal that corresponds to 600 to 1060 mb. It can be operated in a powerup or continuous mode. In the powerup 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:	600 mb to 1060 mb
Temperature:	-40°C to +60°C
Humidity:	non-condensing

Accuracy

Total Accuracy***	±0.5 mb @ +20°C ±2 mb @ 0°C to +40°C ±4 mb @ -20°C to +45°C ±6 mb @ -40°C to +60°C
Linearity*:	±0.45 mb @ 20°C
Hysteresis*:	±0.05 mb @ 20°C
Repeatability*:	±0.05 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 5.9 cm x 2.1 cm (3.8" x 2.3" x 0.8")

Weight: 110 g (4 oz)

Housing material: anodized aluminum

Supply Voltage: 10 to 30 VDC

Supply Voltage Control: When enabled with an internal jumper, the CS105 is on continually. When disabled, the CS105 can be turned on/off with 5 VDC/0 VDC.

Supply voltage sensitivity: Less than 0.1 mb

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

The CS105 can be operated in one of two modes: powerup and continuous. The mode is selected by a jumper located underneath a black plug on the face of the barometer. When the jumper is not installed, the CS105 is in powerup mode and the datalogger turns the CS105 on and off with a control port (CR10, 21X) or excitation channel (21X). When the jumper is installed the CS105 is powered continuously.

NOTE CS105s shipped from Campbell Scientific are configured for powerup mode (jumper open).

NOTE CS105MDs shipped from Campbell Scientific are configured for continuous power mode (jumper closed).

Mount the CS105 to the backplate in the same enclosure that the datalogger is located in (Figures 1 and 2).

NOTE On the older (grey jacketed) cable pressure (VOUT) was brown and signal ground (AGND) was white.

FIGURE 1. CS105 Mounted on the Backplate of an ENC 12/14 Enclosure

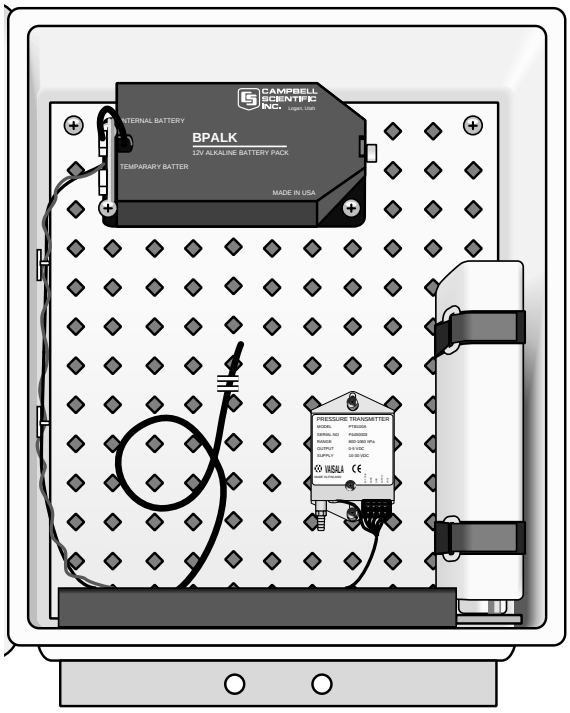

FIGURE 2. CS105MD Mounted on the Backplate of MetData1 Enclosure

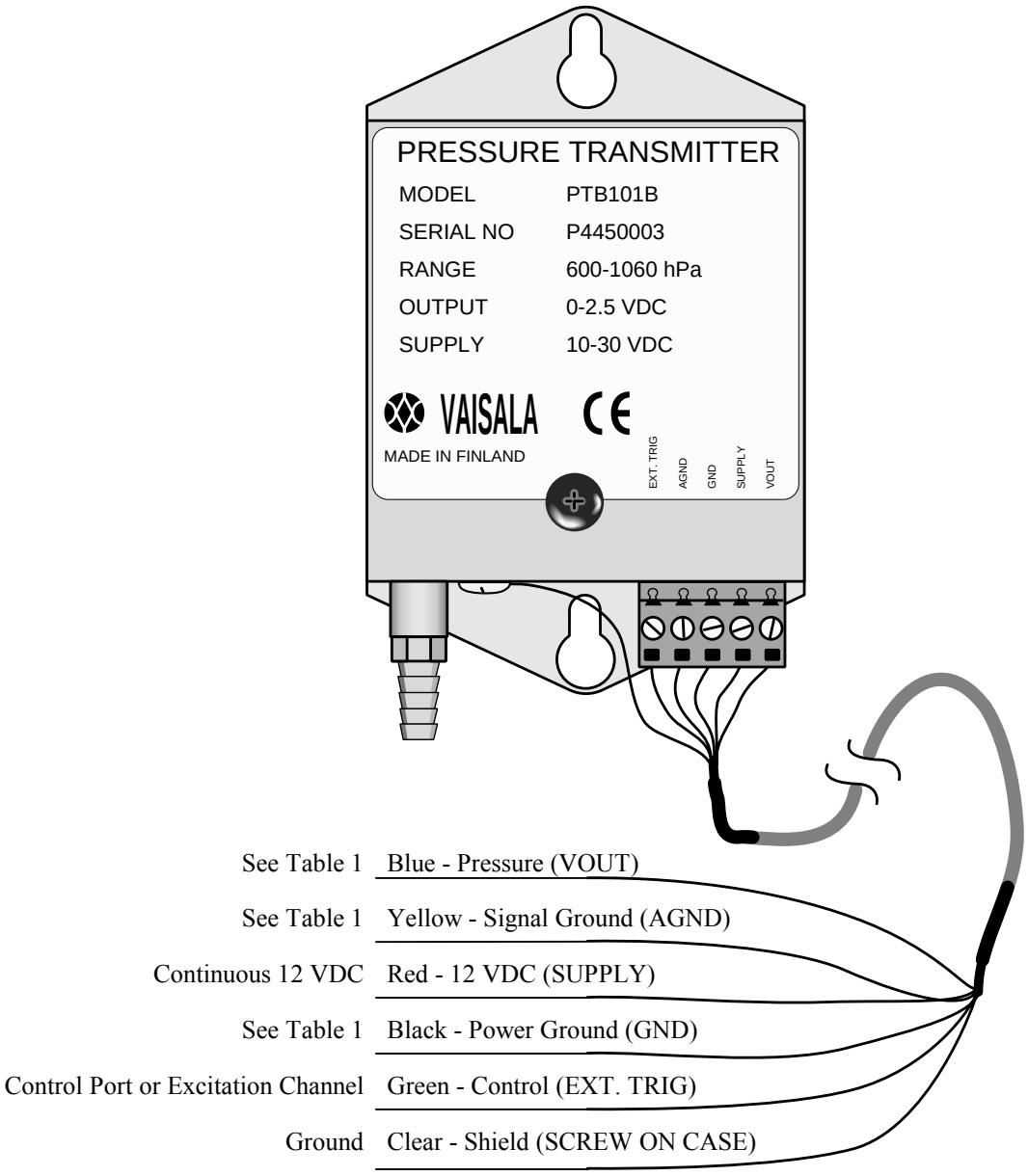

FIGURE 3. CS105 Wiring Diagram

TABLE 1. Signal and Ground Connectors for CS105

	Single-Ended Measurement	**Differential Measurement**
Blue	S.E. Input, S.E. 7 (4H)	High side of Diff Input (4H)
Yellow	Analog Ground (CR10) Ground (21X)	Low Side of Diff. Input (4L)
Black	Ground (CR10) Ground (21X)	Ground (CR10, 21X)

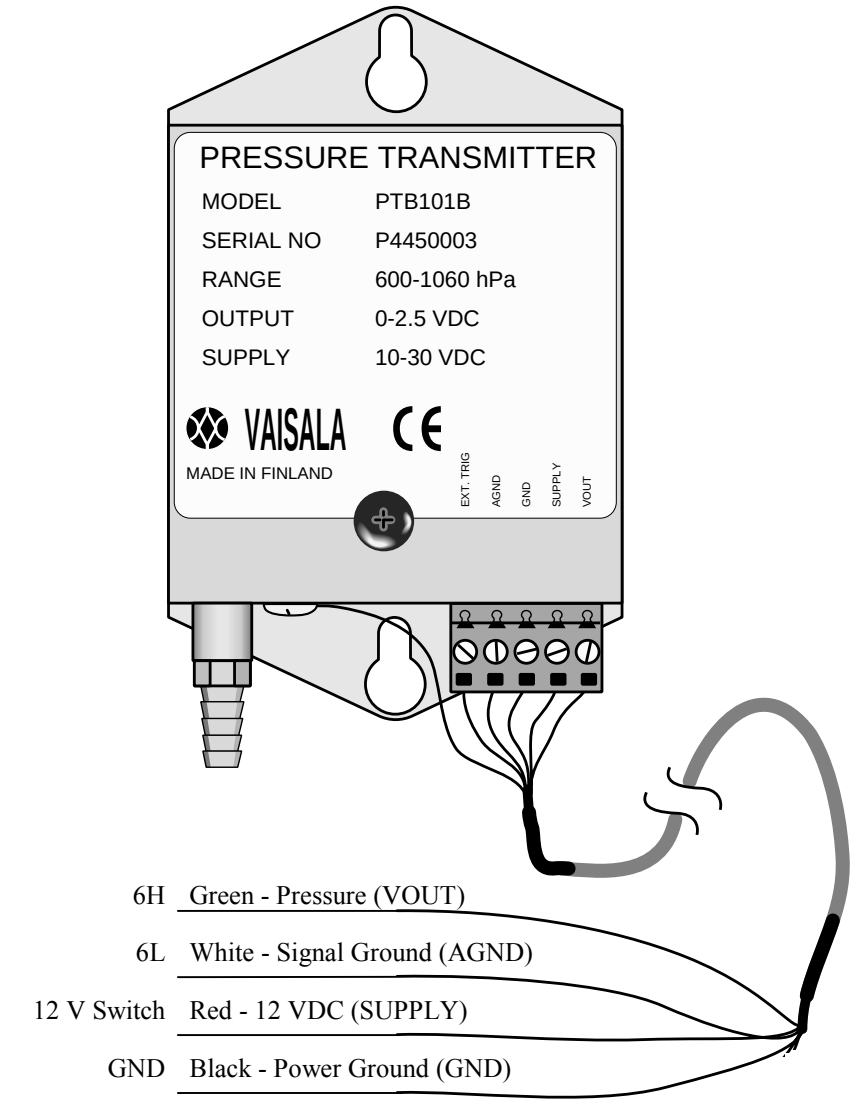

FIGURE 4. CS105MD Wiring Diagram

4. Programming

4.1 CS105MD

Programming the MetData1 station for the CS105MD is done through Campbell Scientific's Short Cut program. Short Cut includes code in the .DLD file to correct for elevation.

4.2 CS105

Atmospheric pressure changes little with time. In most weather station applications measuring pressure once an hour is adequate. In Example 1 the datalogger turns on the CS105 one minute before the top of the hour with a control port. As in the example, the execution interval must be one minute or less. On the hour the datalogger measures the CS105, records the pressure, and turns off the CS105.

In Example 2 the CS105 is measured every execution interval. The datalogger turns the CS105 on and waits one second for the CS105 to warm up, before the measurement is made.

The execution interval must be long enough to accommodate the one second delay, to warm up the CS105, and all the other measurement and processing instructions in the program.

In Example 3, the CS105 is measured every execution interval with a 21X. An excitation channel is used to turn the CS105 on and off.

WARNING

A CR10(X) excitation channel cannot be used to turn the CS105 on and off because the maximum excitation voltage is 2.5 volts. The CS105 control requires 5 VDC.

In the example programs the pressure is reported in millibars (mb). To report pressure in different units, multiply (Instruction 37) the measured pressure by the appropriate conversion factor (Table 2).

TABLE 2. Conversion Factors for Alternative Pressure Units

To Find	Multiply by
kPa	0.1
mm of Hg	0.75006
in of Hg	0.02953
PSI	0.0145

Example 1. CR10(X) Program for Measuring the CS105 Once Every Hour

```
;{CR10X}
;
*Table 1 Program
  01:  30           Execution Interval (seconds)

01:  If time is (P92)
  1:   59           Minutes (Seconds --) into a
  2:   60           Interval (same units as above)
  3:   41*          Set Port 1* High

02:  If time is (P92)
  1:   0            Minutes (Seconds --) into a
  2:   60           Interval (same units as above)
  3:   30           Then Do

03:  Volts (SE) (P1)
  1:   1            Reps
  2:   25**         ± 2500 mV 60 Hz Rejection Range
  3:   7*           SE Channel
  4:   1*           Loc [ P_mb      ]
  5:   .184         Mult
  6:   600          Offset

04:  Do (P86)
  1:   51*          Set Port 1* Low

05:  End (P95)

06:  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)

07:  Real Time (P77)
  1:   0110         Day,Hour/Minute

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

-Input Locations-
1 P_mb

*    Proper entries will vary with program and datalogger channel, and input location assignments.
**   On the 21X use the 5000 mV slow range.
```

Example 2. CR10(X) Program for Measuring the CS105 every Execution Interval

```
;{CR10X}
;
*Table 1 Program
  01:  2              Execution Interval (seconds)

01:  Do (P86)
  1:   41*            Set Port 1* High

02:  Excitation with Delay (P22)
  1:   1              Ex Channel
  2:   0              Delay W/Ex (units = 0.01 sec)
  3:   100            Delay After Ex (units = 0.01 sec)
  4:   0              mV Excitation

03:  Volts (SE) (P1)
  1:   1              Reps
  2:   25**           ± 2500 mV 60 Hz Rejection Range
  3:   7*             SE Channel
  4:   1*             Loc [ P_mb      ]
  5:   .184           Mult
  6:   600            Offset

04:  Do (P86)
  1:   51*            Set Port 1* Low

05:  If time is (P92)
  1:   0              Minutes (Seconds --) into a
  2:   30             Interval (same units as above)
  3:   10             Set Output Flag High (Flag 0)

06:  Real Time (P77)
  1:   0110           Day,Hour/Minute

07:  Average (P71)
  1:   1              Reps
  2:   1*             Loc [ P_mb      ]

-Input Locations-
1 P_mb

*    Proper entries will vary with program and datalogger channel, and input location assignments.
**   On the 21X use the 5000 mV slow range.
```

Example 3. 21X Program for Measuring the CS105 Every Execution Interval Using an Excitation Channel to Turn the CS105 On and Off.

```
;{21X}
;
*Table 1 Program
  01: 2             Execution Interval (seconds)

01: Excite Delay Volt (SE) (P4)
  1:  1             Reps
  2:  5             SE Channel
  4:  1*            Excite all reps w/Exchan 1
  5:  100           Delay (units 0.01 sec)
  6:  5000          mV Excitation
  7:  1*            Loc [ P_mb     ]
  8:  .184          Mult
  9:  600           Offset

02: If time is (P92)
  1:  0             Minutes into a
  2:  30            Minute Interval
  3:  10            Set Output Flag High

03: Real Time (P77)
  1:  0110          Day,Hour/Minute

04: Average (P71)
  1:  1             Reps
  2:  1*            Loc [ P_mb     ]

-Input Locations-
1 P_mb

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

5. Long Lead Lengths

There is a 0.06 mV/foot voltage drop in the CS105 signal leads. This voltage drop, in long lead lengths, will raise the barometric reading by approximately 1.1 mb per 100 feet.

For lead lengths greater than 20 feet, use the differential instruction (Instruction 2) to measure the CS105.

Example 4. CR10(X) Program for Measuring the CS105 Once Every Hour with Instruction 2 (Differential Measurement)

```
;{CR10X}
;
*Table 1 Program
  01:  10            Execution Interval (seconds)

01:  If time is (P92)
  1:   59            Minutes (Seconds --) into a
  2:   60            Interval (same units as above)
  3:   41*           Set Port 1* High

02:  If time is (P92)
  1:   0             Minutes (Seconds --) into a
  2:   60            Interval (same units as above)
  3:   30            Then Do

03:  Volt (Diff) (P2)
  1:   1             Reps
  2:   25*           ± 2500 mV 60 Hz Rejection Range
  3:   4*            DIFF Channel
  4:   1*            Loc [ P_mb      ]
  5:   .184          Mult
  6:   600           Offset

04:  Do (P86)
  1:   51*           Set Port 1* Low

05:  End (P95)

06:  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)

07:  Real Time (P77)
  1:   0110          Day,Hour/Minute

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

-Input Locations-
1 P_mb

*    Proper entries will vary with program and datalogger channel, and input location assignments.
**   On the 21X use the 5000 mV slow range.
```

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 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* to the offset in the measurement instruction.

Use Equation (2) to convert from feet to meters.

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

Sea level correction is automatically coded into datalogger programs when using Short Cut.

7. Maintenance

There are no user-serviceable parts on CS105. Vaisala recommends recalibrating the CS105 every year. Contact Campbell Scientific, Inc., phone (435) 753-2342, for an RMA number before returning the sensor for recalibration.

Appendix A. Daily Average

If the CS105 will be measured every minute or faster, and a daily average is required, follow Example 5. In Example 5 the daily average, maximum, and minimum pressure is recorded at midnight. A constant is subtracted from the pressure before the average instruction is executed. This prevents the loss of significant digits when adding small numbers to large numbers in floating point arithmetic.

Example 5. Recording a Daily Average, Maximum, and Minimum Pressure

```
;{CR10X}
;
*Table 1 Program
  01: 5              Execution Interval (seconds)

01: Do (P86)
  1:  41*            Set Port 1* High

02: Excitation with Delay (P22)
  1:  1              Ex Channel
  2:  0              Delay W/Ex (units = 0.01 sec)
  3:  100            Delay After Ex (units = 0.01 sec)
  4:  0              mV Excitation

03: Volts (SE) (P1)
  1:  1              Reps
  2:  25**           ± 2500 mV 60 Hz Rejection Range
  3:  1*             SE Channel
  4:  1*             Loc [ P_mb     ]
  5:  .184           Mult
  6:  600            Offset

04: Do (P86)
  1:  51*            Set Port 1 Low*

05: Z=X+F (P34)
  1:  1*             X Loc [ P_mb     ]
  2:  -800           F
  3:  2*             Z Loc [ P_const     ]

06: If time is (P92)
  1:  0              Minutes (Seconds --) into a
  2:  1440           Interval (same units as above)
  3:  10             Set Output Flag High (Flag 0)

07: Set Active Storage Area (P80)
  1:  3              Input Storage Area
  2:  3*             Loc [ P_mb_avg  ]
```

```
08:  Average (P71)
   1:   1              Reps
   2:   2*             Loc [ P_const   ]

09:  If Flag/Port (P91)
   1:   10             Do if Output Flag is High (Flag 0)
   2:   30             Then Do

10:  Z=X+F (P34)
   1:   3*             X Loc [ P_mb_avg  ]
   2:   800            F
   3:   3*             Z Loc [ P_mb_avg  ]

11:  End (P95)

12:  If time is (P92)
   1:   0              Minutes (Seconds --) into a
   2:   1440           Interval (same units as above)
   3:   10             Set Output Flag High (Flag 0)

13:  Set Active Storage Area (P80)
   1:   1              Final Storage Area 1
   2:   10             Array ID

14:  Real Time (P77)
   1:   0110           Day,Hour/Minute

15:  Sample (P70)
   1:   1              Reps
   2:   3*             Loc [ P_mb_avg  ]

16:  Maximize (P73)
   1:   1              Reps
   2:   10             Value with Hr-Min
   3:   1*             Loc [ P_mb      ]

17:  Minimize (P74)
   1:   1              Reps
   2:   10             Value with Hr-Min
   3:   1*             Loc [ P_mb      ]

-Input Locations-
1 P_mb
2 P_const
3 P_mb_avg

*     Proper entries will vary with program and datalogger channel, and input location assignments.
**    With a 21X, use the 5000 mV measurement range.
```

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