Product Manual

Sensor

Wind Monitor Series

05103, 05103-45, 05106, 05108, 05108-45, and 05305

Revision: 12/2020

RELIABLE SINCE 1974 MONITORING

CAMPBELL SCIENTIFIC

Table of contents

1. Introduction

Wind monitors measure horizontal wind speed and direction. The different models are designed for different applications (Table 1-1 (p. 1)). The wind monitors are manufactured by R.M. Young.

Table 1-1: R.M. Young wind monitors models

Model	Description
05103	Standard wind monitor
05103-45	Alpine wind monitor (discourages ice buildup)
05106	Marine wind monitor
05108	Heavy-duty wind monitor that greatly extends service life
05108-45	Heavy-duty wind monitor for alpine applications
05305	High-performance wind monitor for air quality applications

NOTE:
This manual provides information only for CRBasic data loggers. For retired Edlog data logger support, see an older manual at www.campbellsci.com/old-manuals.

2. Precautions

- READ AND UNDERSTAND the Safety section at the back of this manual.
- The wind monitor is a precision instrument. Please handle it with care.
- Do not use cable lengths greater than 30 m (9 ft) in electrically noisy environments.
- The black outer jacket of the cable is Santoprene® rubber. This compound was chosen for its resistance to temperature extremes, moisture, and ultraviolet (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.

- Wire color and functions of sensors purchased through Campbell Scientific may not correspond with the wire colors and functions given in the manufacturer's manual. To ensure proper function, follow the wiring provided in ***Short Cut*** or in the Campbell Scientific manual.
- Wind monitors purchased directly from R.M. Young may not have the 1 MΩ resistor used to short the readings in the dead band to ground.

3. Initial inspection

- Upon receipt of the wind monitor, inspect the packaging and contents for damage. File damage claims with the shipping company. Immediately check package contents against the shipping documentation. Contact Campbell Scientific about any discrepancies.
- The model number and cable length are printed on a label at the connection end of the cable. Check this information against the shipping documents to ensure the expected product and cable length are received.

The wind monitors ship with:

(1) 1/16 inch hex key wrench from manufacturer (used for bearing replacement)

(1) Bearing gap gauge (spacer) from manufacturer (used for bearing replacement)

(1) Calibration sheet

(1) Ferrite choke from manufacturer

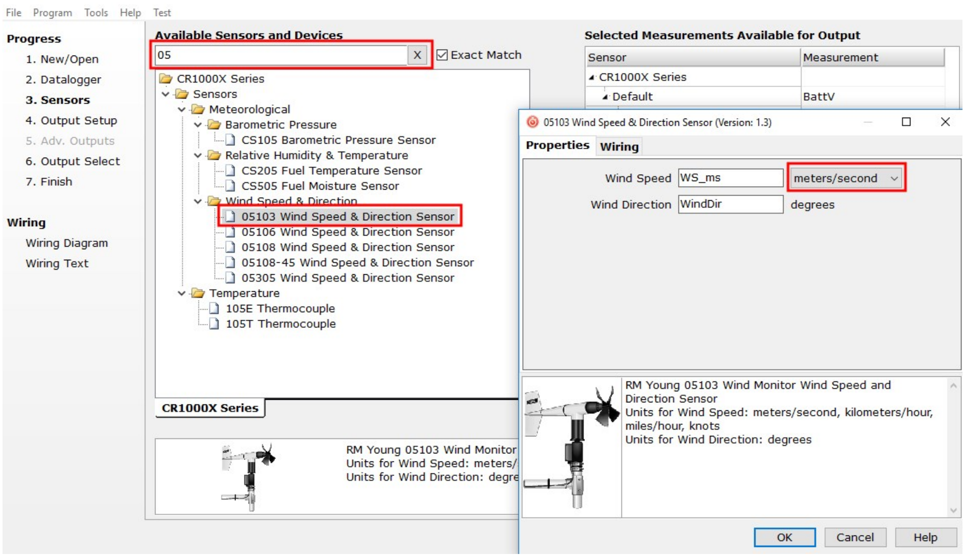
(1) Unthreaded aluminum pipe, 1-inch IPS, 12-inch length

4. QuickStart

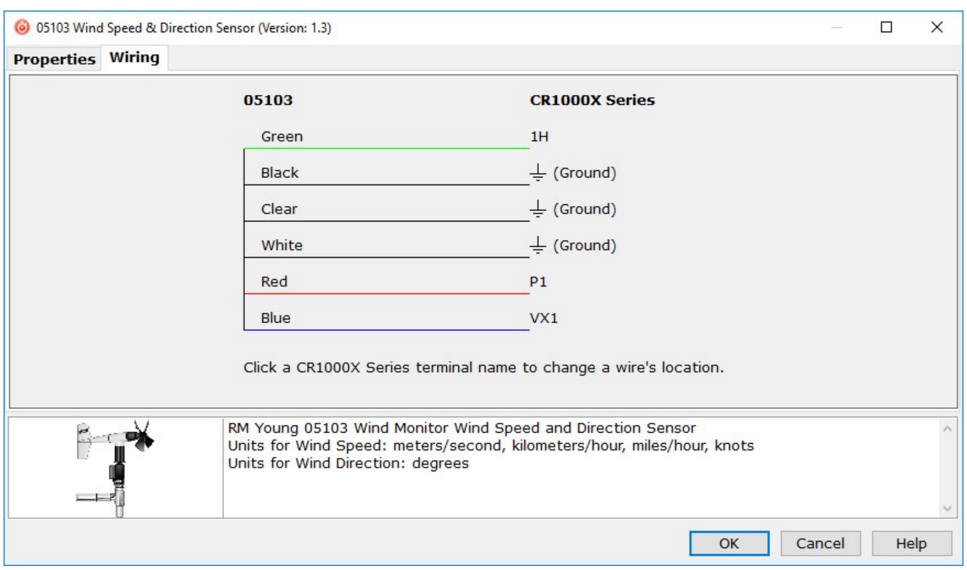
A video that describes data logger programming using ***Short Cut*** is available at: www.campbellsci.com/videos/cr1000x-datalogger-getting-started-program-part-3 ▶. ***Short Cut*** is an easy way to program your data logger to measure this sensor and assign data logger wiring terminals. ***Short Cut*** is available as a download on www.campbellsci.com. It is included in installations of ***LoggerNet***, ***RTDAQ***, ***PC400***, or ***PC200W***.

The following procedure also describes programming with ***Short Cut***.

1. Open ***Short Cut*** and create a new program.
2. Double-click the data logger model.
3. In the **Available Sensors and Devices** box, type 05103, 05106, or 05305 AQ or locate the sensor in the **Sensors** > **Meteorological** > **Wind Speed & Direction** folder. Double-click **05103 Wind Speed & Direction Sensor**, **05106 Wind Speed & Direction Sensor**, or **05305-AQ Wind Speed & Direction Sensor**. The wind speed defaults to meters/second. This can be changed by clicking the Wind Speed box and selecting one of the other options.

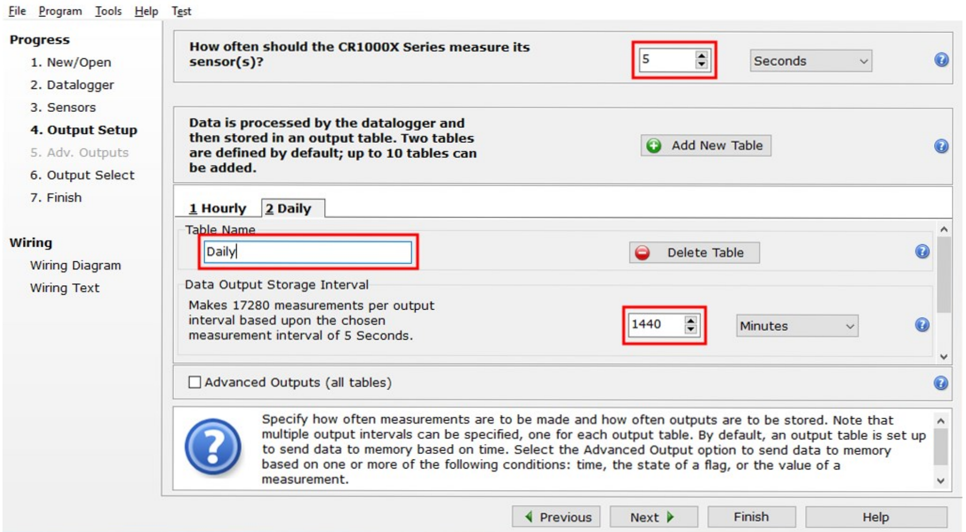


4. Click on the **Wiring** tab to see how the sensor is to be wired to the data logger. Click **OK** after wiring the sensor.

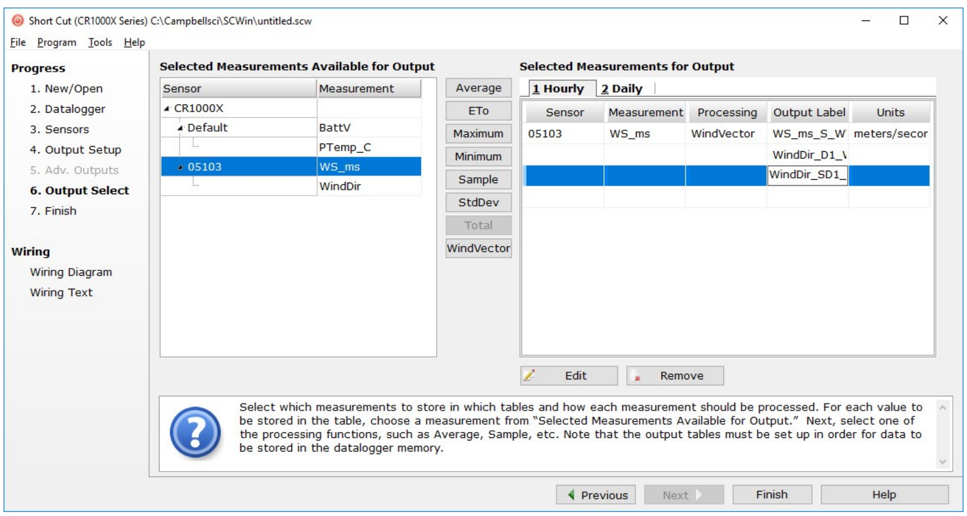


5. Repeat steps three and four for other sensors. Click **Next**.

6. In **Output Setup**, enter the scan rate, **Data Output Storage Intervals**, and meaningful table names.



7. Select the measurement and its associated output options.



8. Click **Finish** and save the program. Send the program to the data logger if the data logger is connected to the computer.

9. If the sensor is connected to the data logger, check the output of the sensor in the data display in ***LoggerNet***, ***RTDAQ***, ***PC400***, or ***PC200W*** to make sure it is making reasonable measurements.

5. Overview

Wind speed is measured by using a helicoid-shaped, four-blade propeller. Rotation of the propeller produces an AC sine wave signal with frequency proportional to wind speed.

Vane position is transmitted by a 10 kΩ potentiometer. With a precision excitation voltage applied, the output voltage is proportional to wind direction.

The R.M. Young Instruction Manual includes additional information on the operating principles, installation, and maintenance of the sensor.

The wind monitors are manufactured by R.M. Young and cabled by Campbell Scientific for use with our data loggers. Cable lengths for the wind monitors are specified when the sensors are ordered. Table 5-1 (p. 5) gives the recommended cable length for mounting the sensor at the top of the tripod/tower by using a CM200-series crossarm.

Table 5-1: Recommended cable lengths

CM106B	CM110	CM115	CM120	UT10	UT20	UT30
4.2 m (14 ft)	4.2 m (14 ft)	5.8 m (19 ft)	7.3 m (24 ft)	4.2 m (14 ft)	7.3 m (24 ft)	11.3 m (37 ft)

> NOTE:
> Maximum cable length is 304.8 m (1000 ft).

> CAUTION:
> Do not use cable lengths greater than 30 m (9 ft) in electrically noisy environments.

Features:

- Rugged enough for harsh environments
- Constructed with thermoplastic material that resists corrosion from sea-air environments and atmospheric pollutants
- Ideal for wind profile studies
- Compatible with the LLAC4 4-channel Low Level AC Conversion Module, which increases the number of anemometers one data logger can measure
- Compatible with Campbell Scientific CRBasic data loggers: CR6, CR3000, CR1000X, CR800 series, CR300 series, and CR1000

6. Specifications

Table 6-1 (p. 6) Table 6-2 (p. 7), and Table 6-3 (p. 8) provide the wind speed, wind direction, and physical specifications, respectively.

Table 6-1: Wind speed specifications

	05103 Wind Monitor	05103-45 Wind Monitor-Alpine	05106 Wind Monitor-MA	05108 Heavy Duty Wind Monitor	05108-45 Heavy Duty Wind Monitor-Alpine	05305 Wind Monitor-AQ
Range	0 to 100 m/s (0 to 224 mph)					0 to 50 m/s (0 to 112 mph)
Accuracy	±0.3 m/s (±0.6 mph) or 1% of reading					±0.2 m/s (±0.4 mph) or 1% of reading
Starting threshold	1.0 m/s (2.2 mph)		2.4 mph (1.1 m/s)	1.0 m/s (2.2 mph)		0.4 m/s (0.9 mph)
Distance constant (63% recovery)	2.7 m (8.9 ft)					2.1 m (6.9 ft)
Output	AC voltage (3 pulses per revolution); 1800 rpm (90 Hz) = 8.8 m/s (19.7 mph)			AC voltage (3 pulses per revolution); 1800 rpm (90 Hz) = 14.9 m/s (33.3 mph)		AC voltage (3 pulses per revolution); 1800 rpm (90 Hz) = 9.2 m/s (20.6 mph)
Resolution	(0.0980 m/s) / (scan rate in seconds) or (0.2192 mph) / (scan rate in seconds)			(0.1666 m/s) / (scan rate in seconds) or (0.3726 mph) / (scan rate in seconds)		(0.1024 m/s) / (scan rate in sec.) or (0.2290 mph) / (scan rate in sec.)

Table 6-2: Wind direction specifications						
	05103 Wind Monitor	05103-45 Wind Monitor-Alpine	05106 Wind Monitor-MA	05108 Heavy Duty Wind Monitor	05108-45 Heavy Duty Wind Monitor-Alpine	05305 Wind Monitor-AQ
Range	0° to 360° mechanical, 355° electrical (5° open)					
Accuracy	±3°	±5°	±3°			
Starting threshold	1.1 m/s (2.4 mph)			1.0 m/s (2.0 mph)		0.5 m/s (1.0 mph)
Distance constant (50% recovery)	1.3 m (4.3 ft)					1.2 m (3.9 ft)
Damping ratio	0.3			0.25		0.45
Damped natural wavelength	7.4 m (24.3 ft)					4.9 m (16.1 ft)
Undamped natural wavelength	7.2 m (23.6 ft)					4.4 m (14.4 ft)
Output	analog DC voltage from potentiometer—resistance 10 kΩ; linearity 0.25%; life expectancy 50 million revolutions					
Power	switched excitation voltage supplied by data logger					

Table 6-3: Physical specifications

	05103 Wind Monitor	05103-45 Wind Monitor-Alpine	05106 Wind Monitor-MA	05108 Heavy Duty Wind Monitor	05108-45 Heavy Duty Wind Monitor-Alpine	05305 Wind Monitor-AQ
Operating temperature range	–50 to +50 °C, assuming non-riming conditions			–50 to +60 °C, assuming non-riming conditions		-50 to +50 °C, assuming non-riming conditions
Overall height	37 cm (14.6 in)				40 cm (15.7 in)	38 cm (15 in)
Overall length	55 cm (21.7 in)				57 cm (22.4 in)	65 cm (25.6 in)
Propeller diameter	18 cm (7.1 in)	14 cm (5.5 in)	18 cm (7.1 in)			20 cm (7.9 in)
Mounting pipe description	34 mm (1.34 in) outer diameter; standard 1.0 in IPS schedule 40					
Weight	1.5 kg (3.2 lb)	1 kg (2.2 lb)	1.5 kg (3.2 lb)	1 kg (2.2 lb)		1.1 kg (2.5 lb)

7. Installation

If you are programming your data logger by using ***Short Cut***, skip Wiring (p. 8) and Programming (p. 9). ***Short Cut*** does this work for you. See QuickStart (p. 2) for a ***Short Cut*** tutorial.

7.1 Wiring

Connections to Campbell Scientific data loggers are given in Table 7-1 (p. 9). When ***Short Cut*** software is used to create the data logger program, the sensor is wired to the terminals shown in the wiring diagram created by ***Short Cut***.

Table 7-1: Wire color, wire function, and data logger connection		
Wire color	Wire function	Data logger connection terminal
Red	WS signal	**U** configured for pulse input[1], **P** (pulse input), or **P_LL** (pulse, low-level AC)
Black	WS signal reference	⏚
Green	WD signal	**U** configured for single-ended analog input[1], **SE** (single-ended, analog input)
Blue	WD voltage excitation	**U** configured for voltage excitation[1], **EX**, **VX** (voltage excitation)
White	WD signal reference	⏚ (analog ground)
Clear	Shield	⏚ (analog ground)
[1]U terminals are automatically configured by the measurement instruction.		

7.2 Programming

Short Cut is the best source for up-to-date data logger programming code. If your data acquisition requirements are simple and you are connecting the sensor to a pulse terminal, you can probably create and maintain a data logger program exclusively by using ***Short Cut***. If your data acquisition needs are more complex, the files that ***Short Cut*** creates are a great source for programming code to start a new program or add to an existing custom program.

NOTE:
Short Cut cannot edit programs after they are imported and edited in ***CRBasic Editor***.

A ***Short Cut*** tutorial is available in QuickStart (p. 2). If you wish to import ***Short Cut*** code into ***CRBasic Editor*** to create or add to a customized program, follow the procedure in Importing Short Cut code into CRBasic Editor (p. 17). Programming basics for CRBasic data loggers are provided in the following sections. Complete program examples for select CRBasic data loggers can be found in Example programs (p. 18). Programming basics and programming examples for Edlog data loggers are provided at www.campbellsci.com\old-manuals.

7.2.1 Wind speed

Wind speed is measured by using the `PulseCount()` instruction. Syntax of the the `PulseCount()` instruction is:

```
PulseCount(Dest, Reps, PChan, PConfig, POption, Mult, Offset)
```

Set the `PConfig` parameter to **Low Level AC** and the `POption` parameter to **Frequency**.

The expression for wind speed (U) is:

$U = Mx + B$

where

M = multiplier
x = number of pulses per second (Hertz)
B = offset

Table 7-2 (p. 10) lists the multipliers to obtain miles/hour or meters/second when the measurement instruction is configured to output Hz.

Table 7-2: Wind speed multiplier

Model	Miles/Hour Output	Meters/Second Output
05103, 05103-45, or 05106	0.2192	0.0980
05108 or 05108-45	0.3726	0.1666
05305	0.2290	0.1024

Set the offset to zero since the helicoid propeller calibration passes through zero (Gill, 1973; Baynton, 1976).

7.2.2 Wind direction

The wind vane is coupled to a 10 kΩ potentiometer, which has a 5-degree electrical dead band between 355 and 360 degrees. A 1 MΩ resistor between the signal and ground pulls the signal to 0 mV (0 degrees) when wind direction is in the dead band (between 355 and 360 degrees).

Wind direction is measured by the `BRHalf()` instruction.

Some CRBasic measurement sequences can cause the measurement of the wind direction to return a negative wind direction (–30°) while in the dead band. To overcome this problem, all program examples use a delay of 20 ms (20,000 µs) and set any negative wind direction values to 0.0: If WindDir < 0, then WindDir = 0.0.

The excitation voltage, range codes, and multipliers for the different data logger types are listed in Table 7-3 (p. 11). Wind direction measurement theory (p. 24) has additional information on the `BRHalf()` measurement instruction.

Table 7-3: Parameters for wind direction

	CR300 Series	CR800, CR850, CR1000	CR1000X	CR6	CR3000
Measurement range	mV2500	mV2500	mV5000	mV5000	mV5000
Excitation voltage	2500 mV	2500 mV	2500 mV	2500 mV	5000 mV
Reverse excitation	NA	True	True	True	True
Delay or settling time	20000 µs	20000 µs	20000 µs	20000 µs	20000 µs
Multiplier	355	355	355	355	355
Offset	0	0	0	0	0

7.2.3 WindVector processing instruction

The `WindVector` output is used to process and store mean wind speed, unit vector mean wind direction, and standard deviation of the wind direction (optional) by using the measured wind speed and direction samples.

7.3 Siting

Locate wind sensors away from obstructions such as trees or buildings. Generally, there should be a horizontal distance of at least ten times the height of the obstruction between the wind monitor and the obstruction. If the sensors need to be mounted on a roof, the height of the sensors above the roof, should be at least 1.5 times the height of the building. See References (p. 16) for a list of references that discuss siting wind speed and direction sensors.

7.4 Assembly and mounting

Tools required:

- 5/64 inch hex key wrench
- 1/2 inch open end wrench
- Compass and declination angle for the site (see Wind direction sensor orientation (p. 21))
- Small screw driver provided with data logger
- UV resistant cable ties
- 6 to 10 inch torpedo level

7.4.1 Mounting the wind monitor to a crossarm

Install the wind monitor by using:

- Unthreaded aluminum pipe, 1-inch IPS, 12-inch length
- CM220 Right-Angle Mounting Kit (FIGURE 7-2 (p. 13)), or
- 1-inch-by-1-inch Nu-Rail Crossover Fitting (FIGURE 7-3 (p. 13))

1. Secure the propeller to its shaft by using a wrench to tighten the nut provided with the sensor.
2. Mount a crossarm to a tripod or tower.
3. If a pyranometer is also being mounted on the crossarm, orient the crossarm north-south with the Nu-Rail on the end farthest from the equator. Otherwise, the crossarm may be oriented north-south, east west, or any other angle desired. Wind direction sensor orientation (p. 21) contains detailed information on determining true north by using a compass and the magnetic declination for the site.
4. Secure the 12-inch aluminum pipe to the Nu-Rail fitting. The aluminum pipe is shipped with the wind monitor.
5. Place the orientation ring, followed by the wind monitor on the aluminum pipe.
6. Orient the junction box to the south, and tighten the band clamps on the orientation ring and aluminum pipe. Final sensor orientation is done after the data logger has been programmed to measure wind direction as described in Wind direction sensor orientation (p. 21).
7. Use the torpedo level to ensure that the wind monitor is level.
8. Insert the cable through the ferrite choke center hole, loop the cable over the top of the ferrite choke, and reinsert the cable through the ferrite choke center hole (see the following figure).

> **CAUTION:**
> Must install the ferrite choke on the cable near the sensor to meet EMC compliance.

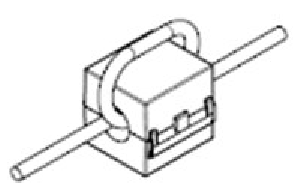


FIGURE 7-1. Ferrite choke installed on cable

9. Route the sensor cable along the underside of the crossarm to the tripod or tower, and to the instrument enclosure.
10. Secure the cable to the crossarm and tripod or tower by using cable ties.

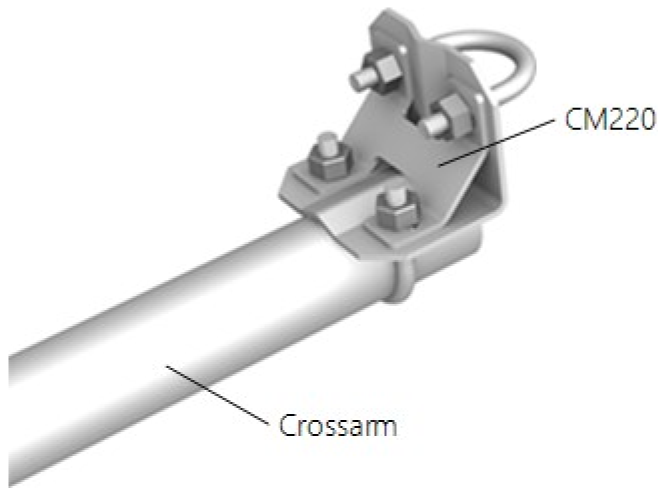


FIGURE 7-2. CM220 Right Angle Mounting Kit mounted to a crossarm

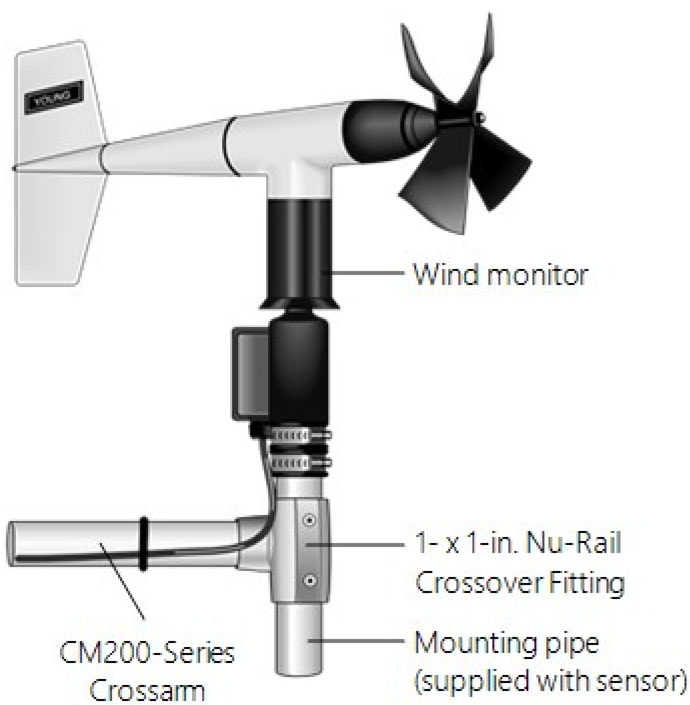


FIGURE 7-3. Wind monitor mounted to a crossarm by using 1- x 1-in. Nu-Rail Crossover Fitting

7.4.2 Mounting the wind monitor atop a tripod mast

The wind monitor mounts on top of a CM106B, CM110, CM115, or CM120 tripod by using the CM216 (see FIGURE 7-4 (p. 14)). The CM216 extends 10 cm (4 in) above the mast of the tripod.

FIGURE 7-4. The CM216 allows the wind monitor to mount atop a tripod mast

8. Sensor maintenance

Every month do a visual/audio inspection of the anemometer at low wind speeds. Verify that the propeller and wind vane bearing rotate freely. Inspect the sensor for physical damage.

Replace the anemometer bearings when they become noisy, or the wind speed threshold increases above an acceptable level. The condition of the bearings can be checked by using the Propeller Torque Disc as described in the R.M. Young manual (see www.youngusa.com/products/7/).

The potentiometer has a life expectancy of fifty million revolutions. As it becomes worn, the element can produce noisy signals or become non-linear. Replace the potentiometer when the noise or non-linearity becomes unacceptable. The condition of the vertical shaft (vane) bearings can be checked by using R.M. Young Vane Torque Gauge.

NOTE:
Campbell Scientific recommends factory replacement of the bearings and potentiometer. Refer to the Assistance page of this document for the procedure of acquiring a Returned Materials Authorization (RMA). Mechanically-adept users may choose to replace the bearings or potentiometer themselves. Instructions for replacing the bearings and potentiometer are given in R.M. Young manuals (www.youngusa.com/products/7/). A video that describes changing the bearings is available at: www.campbellsci.com/videos/wind-monitor-bearing-replacement.

9. Troubleshooting

9.1 Wind direction

Symptom: NAN, –9999, or no change in direction

1. Check that the sensor is wired to the excitation and single-ended terminal specified by the measurement instruction.
2. Verify that the excitation voltage and range code are correct for the data logger type.
3. Disconnect the sensor from the data logger and use an ohmmeter to check the potentiometer. Resistance should be about 10 kΩ between the blue and white wires. The resistance between either the blue/green or white/green wires should vary between about 1 kΩ to 11 kΩ depending on vane position. Resistance when the vane is in the 5 degree dead band should be about 1 MΩ.

Symptom: Incorrect wind direction

1. Verify that the excitation voltage, range code, multiplier and offset parameters are correct for the data logger type.
2. Check orientation of sensor as described in Installation (p. 8).

9.2 Wind speed

Symptom: No wind speed

1. Check that the sensor is wired to the pulse terminal specified by the pulse count instruction.

2. Disconnect the sensor from the data logger and use an ohmmeter to check the coil. The resistance between the red and black wires should be about 2075 Ω. Infinite resistance indicates an open coil; low resistance indicates a shorted coil.
3. Verify that the configuration code, and multiplier and offset parameters for the pulse count instruction are correct for the data logger type.

10. References

Gill, G.C., 1973: *The Helicoid Anemometer Atmosphere*, II, 145–155.

Baynton, H.W., 1976: *Errors in Wind Run Estimates from Rotational Anemometers*, Bul. Am. Met. Soc., vol. 57, No. 9, 1127–1130.

The following references give detailed information on siting wind speed and wind direction sensors.

EPA, 1989: *Quality Assurance Handbook for Air Pollution Measurements System*, Office of Research and Development, Research Triangle Park, NC, 27711.

EPA, 1987: *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*, EPA-450/4-87-013, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711.

The State Climatologist, 1985: *Publication of the American Association of State Climatologists: Height and Exposure Standards*, for Sensors on Automated Weather Stations, vol. 9, No. 4.

WMO, 1983: *Guide to Meteorological Instruments and Methods of Observation*, World Meteorological Organization, No. 8, 5th edition, Geneva, Switzerland.

Appendix A. Importing ***Short Cut*** code into ***CRBasic Editor***

Short Cut creates a .DEF file that contains wiring information and a program file that can be imported into the ***CRBasic Editor***. By default, these files reside in the C:\campbellsci\SCWin folder.

Import ***Short Cut*** program file and wiring information into ***CRBasic Editor***:

1. Create the ***Short Cut*** program. After saving the ***Short Cut*** program, click the **Advanced** tab then the **CRBasic Editor** button. A program file with a generic name will open in CRBasic. Provide a meaningful name and save the CRBasic program. This program can now be edited for additional refinement.

   > **NOTE:**
   > Once the file is edited with ***CRBasic Editor***, ***Short Cut*** can no longer be used to edit the program it created.

2. To add the ***Short Cut*** wiring information into the new CRBasic program, open the .DEF file located in the C:\campbellsci\SCWin folder, and copy the wiring information, which is at the beginning of the .DEF file.
3. Go into the CRBasic program and paste the wiring information into it.
4. In the CRBasic program, highlight the wiring information, right-click, and select **Comment Block**. This adds an apostrophe (') to the beginning of each of the highlighted lines, which instructs the data logger compiler to ignore those lines when compiling. The **Comment Block** feature is demonstrated at about 5:10 in the CRBasic | Features video ▶.

Appendix B. Example programs

The following programs measure the 05103 every 5 s, and store mean wind speed, unit vector mean direction, and standard deviation of the direction every 60 minutes. Wiring for the examples is given in Table B-1 (p. 18).

Table B-1: Wiring for example programs

Color	Wire Label	CR1000X	CR6
Red	WS Signal	P1	U4
Black	WS Reference	⏚	⏚
Green	WD Signal	SE 1	U2
Blue	WD Volt Excit	VX 1	U1
White	WD Reference	⏚	⏚
Clear	Shield	⏚	⏚

B.1 CR1000X example program

CRBasic Example 1: CR1000X example program

```
'CR1000X
'Declare Variables and Units
Public Batt_Volt
Public WS_ms
Public WindDir
Units Batt_Volt=Volts
Units WS_ms=meters/second
Units WindDir=Degrees

'Define Data Tables
DataTable(Hour,True,-1)
  DataInterval(0,60,Min,10)
  WindVector (1,WS_ms,WindDir,FP2,False,0,0,0)
  FieldNames("WS_ms_S_WVT,WindDir_D1_WVT,WindDir_SD1_WVT")
EndTable

'Main Program
BeginProg
  Scan(5,Sec,1,0)
    'Default Data Logger Battery Voltage measurement Batt_Volt:
    Battery(Batt_Volt)

    '05103 Wind Speed & Direction Sensor measurements WS_ms and WindDir:
    'WS_ms
    PulseCount(WS_ms,1,P1,5,1,0.098,0)
    'WindDir
    BrHalf(WindDir,1,mV5000,1,Vx1,1,2500,True,20000,60,355,0)

    If WindDir>=360 OR WindDir<0 Then WindDir=0

    'Call Data Tables and Store Data
    CallTable(Hour)
  NextScan
EndProg
```

B.2 CR6 example program

CRBasic Example 2: CR6 example program

```
'CR6 Series

'Declare Variables and Units
Public BattV
Public PTemp_C
Public WS_ms
Public WindDir

Units BattV=Volts
Units PTemp_C=Deg C
Units WS_ms=meters/second
Units WindDir=degrees

'Define Data Tables
DataTable(Hour,True,-1)
  DataInterval(0,60,Min,10)
  WindVector(1,WS_ms,WindDir,FP2,False,0,0,0)
  FieldNames("WS_ms_S_WVT,WindDir_D1_WVT,WindDir_SD1_WVT")
EndTable

'Main Program
BeginProg
  'Main Scan
  Scan(5,Sec,1,0)
    'Default Data Logger Battery Voltage measurement 'BattV'
    Battery(BattV)

    'Default Wiring Panel Temperature measurement 'PTemp_C'
    PanelTemp(PTemp_C,60)

    '05103 Wind Speed & Direction Sensor measurements 'WS_ms' and 'WindDir'
    'WS_ms
    PulseCount(WS_ms,1,U4,5,1,0.098,0)

    'WindDir
    BrHalf(WindDir,1,mV5000,U2,U1,1,2500,True,20000,60,355,0)
    If WindDir>=360 OR WindDir<0 Then WindDir=0

    'Call Data Tables and Store Data
    CallTable Hour
  NextScan
EndProg
```

Appendix C. Wind direction sensor orientation

C.1 Determining true north and sensor orientation

Orientation of the wind direction sensor is done after the data logger has been programmed, and the location of true north has been determined. True north is usually found by reading a magnetic compass and applying the correction for magnetic declination; where magnetic declination is the number of degrees between true north and magnetic north. The preferred method to obtain the magnetic declination for a specific site is to use a computer service offered by NOAA at www.ngdc.noaa.gov/geomag. The magnetic declination can also be obtained from a map or local airport. A general map showing magnetic declination for the contiguous United States is shown in FIGURE C-1 (p. 22).

Declination angles east of true north are considered negative, and are subtracted from 360 degrees to get true north as shown FIGURE C-2 (p. 22) (0° and 360° are the same point on a compass). For example, the declination for Logan, Utah is 11.78° East (11 August 2015). True north is 360° – 11.78°, or 348.22° as read on a compass. Declination angles west of true north are considered positive, and are added to 0 degrees to get true north as shown in FIGURE C-3 (p. 23).

Orientation is most easily done with two people, one to aim and adjust the sensor, while the other observes the wind direction displayed by the data logger.

1. Establish a reference point on the horizon for true north.
2. Sighting down the instrument center line, aim the nose cone, or counterweight at true north. Display the input location or variable for wind direction by using a laptop or keyboard display.
3. Loosen the U-bolt on the CM220 or the set screws on the Nu-Rail that secure the base of the sensor to the crossarm. While holding the vane position, slowly rotate the sensor base until the data logger indicates 0 degrees. Tighten the set screws.

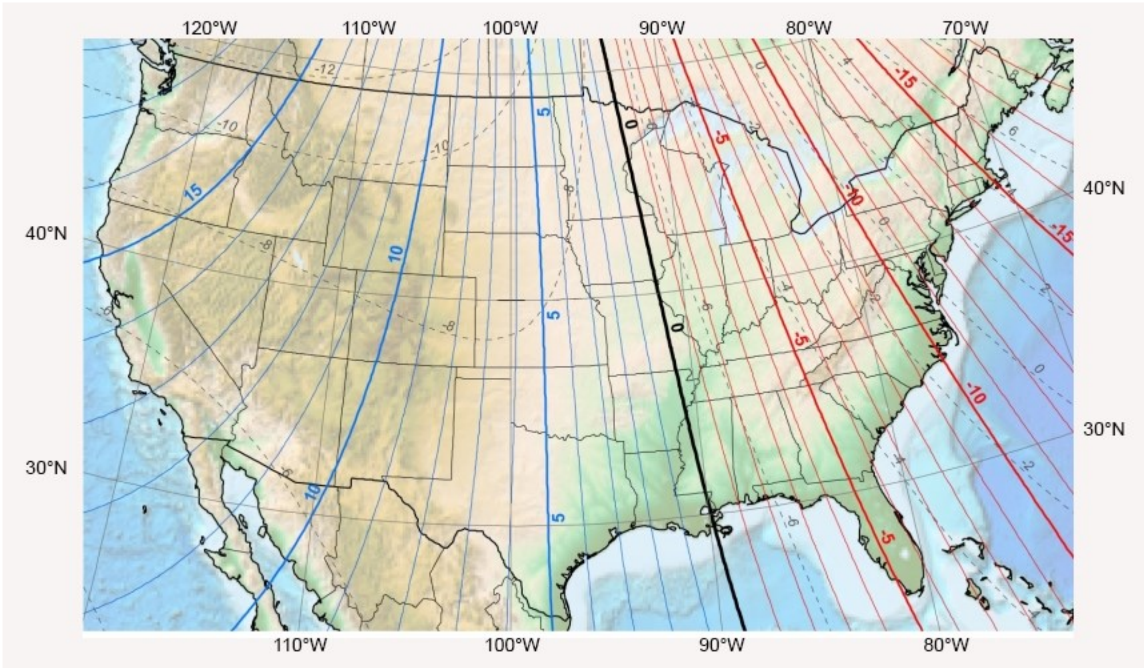


FIGURE C-1. Magnetic declination for the contiguous United States (2015)

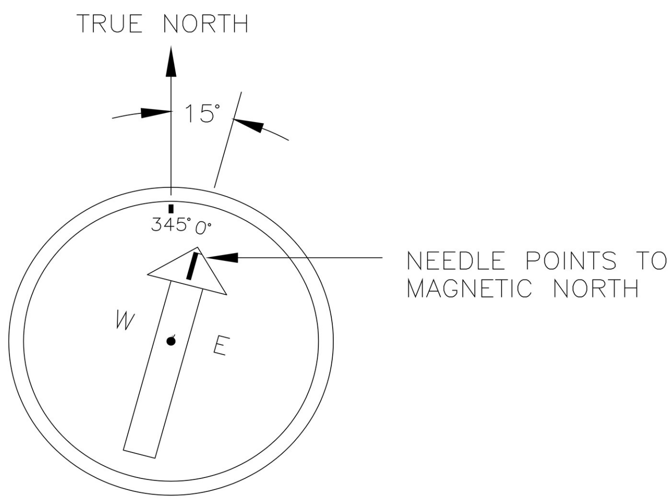


FIGURE C-2. Declination angles east of true north are subtracted from 0 to get true north

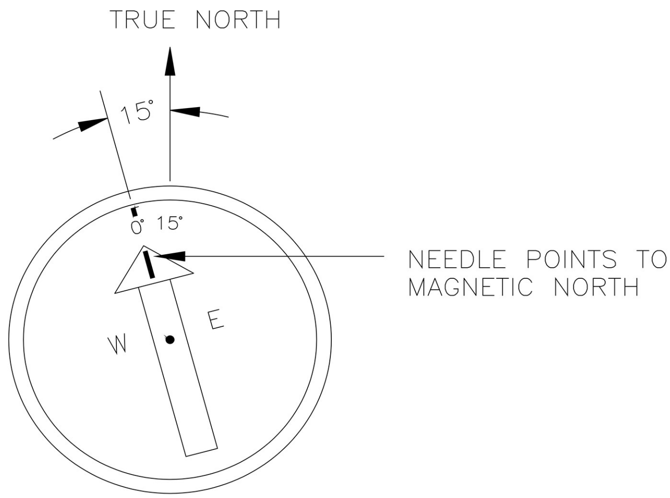


FIGURE C-3. Declination angles west of true north are added to 0 to get true north

Appendix D. Wind direction measurement theory

It is not necessary to understand the concepts in this section for the general operation of the 05103 with a Campbell Scientific data logger.

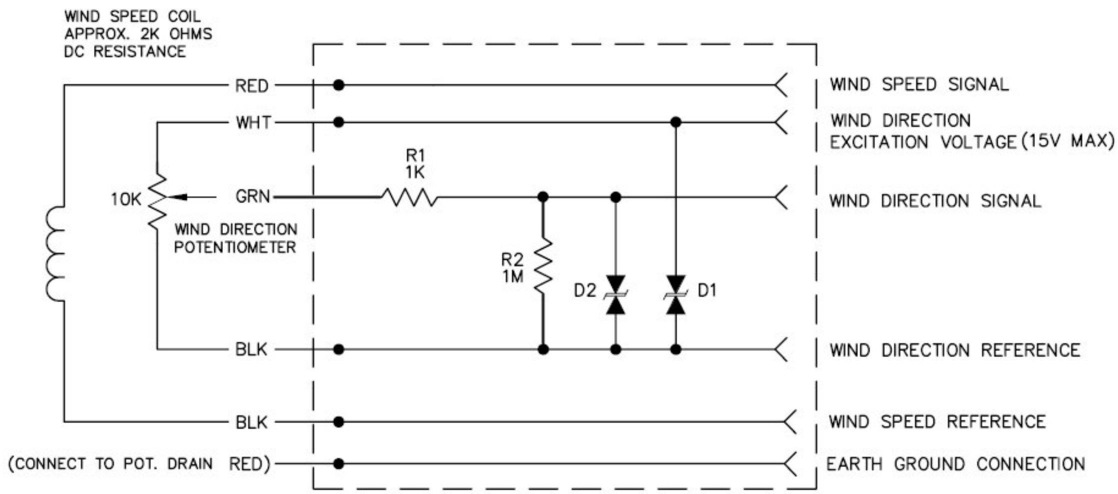


FIGURE D-1. 05103 potentiometer in a half bridge circuit

The **BRHalf** CRBasic instruction outputs a precise excitation voltage (V_x), and measures the voltage between the wiper and ground (V_s). The resistance between the wiper and ground (R_s), and V_s vary with wind direction. The measurement result is the ratio of the measured voltage to the excitation voltage (V_s/V_x). This ratio is related to the resistance as shown in this equation:

$$V_s/V_x = R_s/(R_t + R_s)$$

The maximum value that R_s will reach is R_f, just before it crosses over from the west side of north to the east side of north (at this point R_t = 0). V_s / V_x reaches its maximum value of 1.0 mV/mV at 355 degrees. The multiplier to convert V_s/V_x to degrees is 355 degrees / 1.0 V_s/V_x = 355. Refer to the data logger manual for more information on the bridge measurements.

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DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND **TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.** FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.com. You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General

- Protect from over-voltage.
- Protect electrical equipment from water.
- Protect from electrostatic discharge (ESD).
- Protect from lightning.
- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a **hardhat** and **eye protection**, and take **other appropriate safety precautions** while working on or around tripods and towers.
- **Do not climb** tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical

- **You can be killed** or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in **contact with overhead or underground utility lines**.
- Maintain a distance of at least one-and-one-half times structure height, 6 meters (20 feet), or the distance required by applicable law, **whichever is greater**, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.
- Only use power sources approved for use in the country of installation to power Campbell Scientific devices.

Elevated Work and Weather

- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Maintenance

- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

Internal Battery

- Be aware of fire, explosion, and severe-burn hazards.
- Misuse or improper installation of the internal lithium battery can cause severe injury.
- Do not recharge, disassemble, heat above 100 °C (212 °F), solder directly to the cell, incinerate, or expose contents to water. Dispose of spent batteries properly.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CUSTOMER ASSUMES ALL RISK FROM ANY INJURY RESULTING FROM IMPROPER INSTALLATION, USE, OR MAINTENANCE OF TRIPODS, TOWERS, OR ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.

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