

INSTRUCTION MANUAL



Wind Monitor Series

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

Revision: 9/17



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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.

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General

- Prior to performing site or installation work, obtain required approvals and permits.
- 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.

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.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CLIENT 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.

PLEASE READ FIRST

About this manual

Please note that this manual was originally produced by Campbell Scientific Inc. (CSI) primarily for the US market. Some spellings, weights and measures may reflect this origin.

Some useful conversion factors:

Area:	1 in ² (square inch) = 645 mm ²
Length:	1 in. (inch) = 25.4 mm
	1 ft (foot) = 304.8 mm
	1 yard = 0.914 m
	1 mile = 1.609 km
Mass:	1 oz. (ounce) = 28.35 g
	1 lb (pound weight) = 0.454 kg
Pressure:	1 psi (lb/in ²) = 68.95 mb
Volume:	1 US gallon = 3.785 litres

In addition, part ordering numbers may vary. For example, the CABLE5CBL is a CSI part number and known as a FIN5COND at Campbell Scientific Canada (CSC). CSC Technical Support will be pleased to assist with any questions.

About sensor wiring

Please note that certain sensor configurations may require a user supplied jumper wire. It is recommended to review the sensor configuration requirements for your application and supply the jumper wire is necessary.

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Wind Monitor Series

1. Introduction

Wind monitors measure horizontal wind speed and direction. The different models are designed for different applications (TABLE 1-1). 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 dataloggers. It is also compatible with most of our retired Edlog dataloggers. For Edlog datalogger support, see an older manual at www.campbellsci.com/old-manuals.

2. Precautions

- READ AND UNDERSTAND the [Safety](#) section at the front of this manual.
- The wind monitor is a precision instrument. Please handle it with care.
- Do not use long lead lengths 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 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 M Ω 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 (see Section 3.1, *Ships With* (p. 2)). 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.

3.1 Ships With

The wind monitors ship with:

- (1) Allen wrench from manufacturer
- (1) Bearing spacer from manufacturer
- (1) Calibration sheet
- (1) 3659 mounting pipe

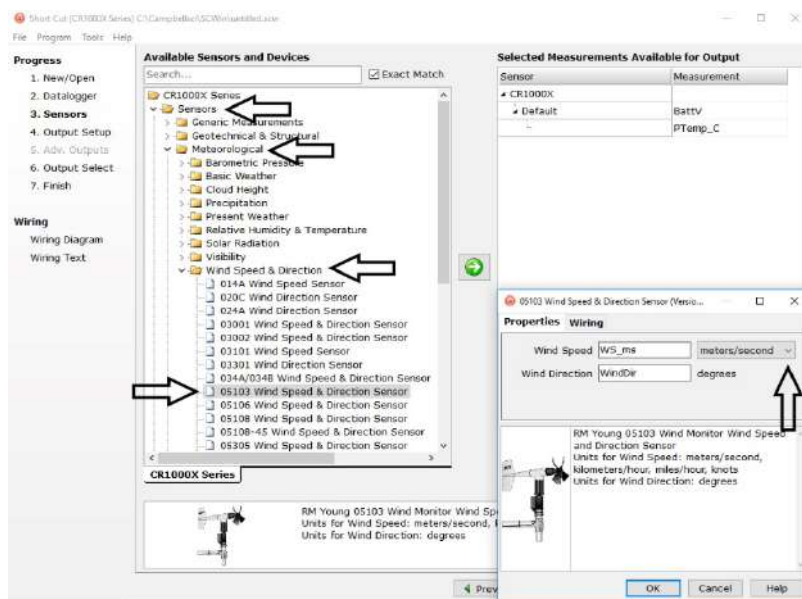
4. QuickStart

Short Cut is an easy way to program your datalogger to measure this sensor and assign datalogger wiring terminals. *Short Cut* is available as a download on www.campbellsci.com and the *ResourceDVD*. It is included in installations of *LoggerNet*, *PC200W*, *PC400*, or *RTDAQ*.

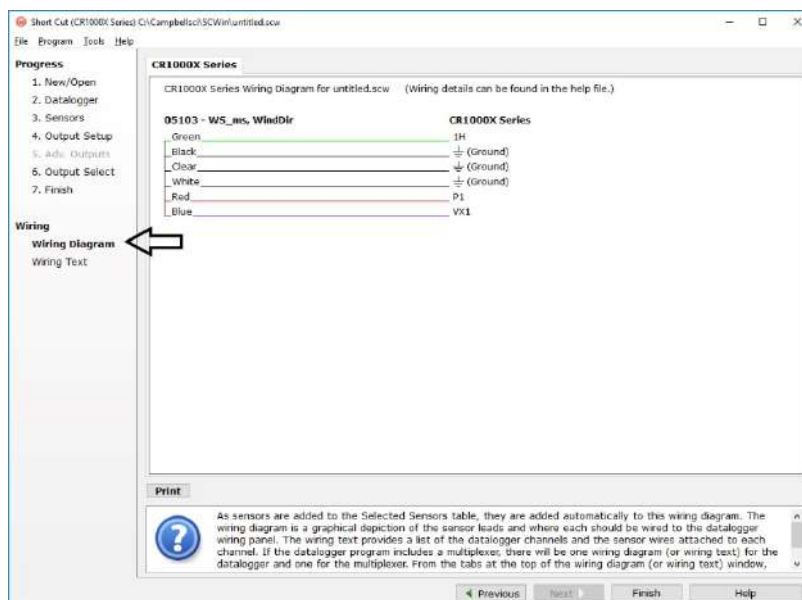
The following procedure shows using *Short Cut* to program the sensor.

1. Open *Short Cut* and create a new program.
2. Double-click the datalogger model.

- Under **Available Sensors and Devices**, select the **Sensors** | **Meteorological** | **Wind Speed & Direction** folder and 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.



- After selecting the sensor, click **Wiring Diagram** to see how the sensor is to be wired to the datalogger. The wiring diagram can be printed now or after more sensors are added.



- Select any other sensors you have, then finish the remaining *Short Cut* steps to complete the program. The remaining steps are outlined in *Short Cut Help*, which is accessed by clicking on **Help** | **Contents** | **Programming Steps**.

6. If *LoggerNet*, *PC400*, *RTDAQ*, or *PC200W* is running on your PC, and the PC to datalogger connection is active, you can click **Finish** in *Short Cut* and you will be prompted to send the program just created to the datalogger.
7. If the sensor is connected to the datalogger, as shown in the wiring diagram in step 4, check the output of the sensor in the datalogger support software data display to make sure it is making reasonable measurements.

5. Overview

Wind speed is measured with 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 k Ω 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 dataloggers. Lead lengths for the wind monitors are specified when the sensors are ordered. TABLE 5-1 gives the recommended lead length for mounting the sensor at the top of the tripod/tower with a CM200-series crossarm.

TABLE 5-1. Recommended Lead Lengths						
CM106B	CM110	CM115	CM120	UT10	UT20	UT30
13 ft	13 ft	19 ft	24 ft	13 ft	24 ft	34 ft

NOTE

Maximum cable length is 1000 feet.

CAUTION

Do not use long lead lengths in electrically noisy environments.

The cable can terminate in:

- Pigtails that connect directly to a Campbell Scientific datalogger (option –PT).
- Connector that attaches to a prewired enclosure (option –PW). Refer to www.campbellsci.com/prewired-enclosures for more information.
- Connector that attaches to a CWS900 Wireless Sensor Interface (option –CWS). The CWS900 allows the wind monitor to be used in a wireless sensor network. Refer to www.campbellsci.com/cws900 for more information.
- Connector for attachment to a CS110 Electric Field Meter or ET107 weather station (option –C). This option is only available for the 05103.

6. Specifications

TABLE 6-1, TABLE 6-2, and TABLE 6-3 provide the wind speed, wind direction, and physical specifications, respectively.

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 datalogger can measure
- Compatible with Campbell Scientific CRBasic dataloggers: CR200(X) series, CR300 series, CR6 series, CR800 series, CR1000X, CR1000, CR3000, CR5000, and CR9000(X)

TABLE 6-1. Wind Speed Specifications

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 ⁻¹ (0 to 224 mph)					0 to 50 m s ⁻¹ (0 to 112 mph)
Accuracy	±0.3 m s ⁻¹ (±0.6 mph) or 1% of reading					±0.2 m s ⁻¹ (±0.4 mph) or 1% of reading
Starting Threshold	1.0 m s ⁻¹ (2.2 mph)		2.4 mph (1.1 m s ⁻¹)	1.0 m s ⁻¹ (2.2 mph)		0.4 m s ⁻¹ (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 ⁻¹ (19.7 mph)					ac voltage (3 pulses per revolution); 1800 rpm (90 Hz) = 9.2 m s ⁻¹ (20.6 mph)
Resolution	(0.0980 m s ⁻¹)/(scan rate in seconds) or (0.2192 mph)/(scan rate in seconds)					(0.1024 m s ⁻¹)/ (scan rate in sec.) or (0.2290 mph)/(scan rate in sec.)

TABLE 6-2. Wind Direction Specifications

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 ⁻¹ (2.4 mph)			1.0 m s ⁻¹ (2.0 mph)		0.5 m s ⁻¹ (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 datalogger					

TABLE 6-3. Physical Specifications

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 datalogger with *Short Cut*, skip Section 7.3, *Wiring* (p. 10), and Section 7.4, *Programming* (p. 10). *Short Cut* does this work for you. See Section 4, *QuickStart* (p. 2), for a *Short Cut* tutorial.

7.1 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 Section 10, *References* (p. 14), for a list of references that discuss siting wind speed and direction sensors.

7.2 Assembly and Mounting

Tools required:

- 5/64 inch Allen wrench
- 1/2 inch open end wrench
- Compass and declination angle for the site (see Appendix C, *Wind Direction Sensor Orientation* (p. C-1))
- Small screw driver provided with datalogger
- UV resistant cable ties
- Small pair of diagonal-cutting pliers
- 6 to 10 inch torpedo level

7.2.1 Mounting the Wind Monitor to a Crossarm

Install the wind monitor using:

- 3659 12 inch aluminum pipe
 - CM220 Right-Angle Mounting Kit (FIGURE 7-1), or
 - 17953 1 x 1 inch Nu-Rail Crossover Fitting (FIGURE 7-2)
1. Secure the propeller to its shaft using 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 17953 Nu-Rail on the end farthest from the equator. Otherwise, the crossarm may be oriented north-south, east-west, or any other angle desired. Appendix C, *Wind Direction Sensor Orientation* (p. C-1), contains detailed information on determining True North using a compass and the magnetic declination for the site.
 4. Secure the 3659 12-inch aluminum pipe to the 17953 Nu-Rail. The 3659 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 datalogger has been programmed to measure wind direction as described in Appendix C, *Wind Direction Sensor Orientation (p. C-1)*.

7. Use the torpedo level to ensure that the wind monitor is level.
8. Route the sensor cable along the underside of the crossarm to the tripod or tower, and to the instrument enclosure.
9. Secure the cable to the crossarm and tripod or tower using cable ties.

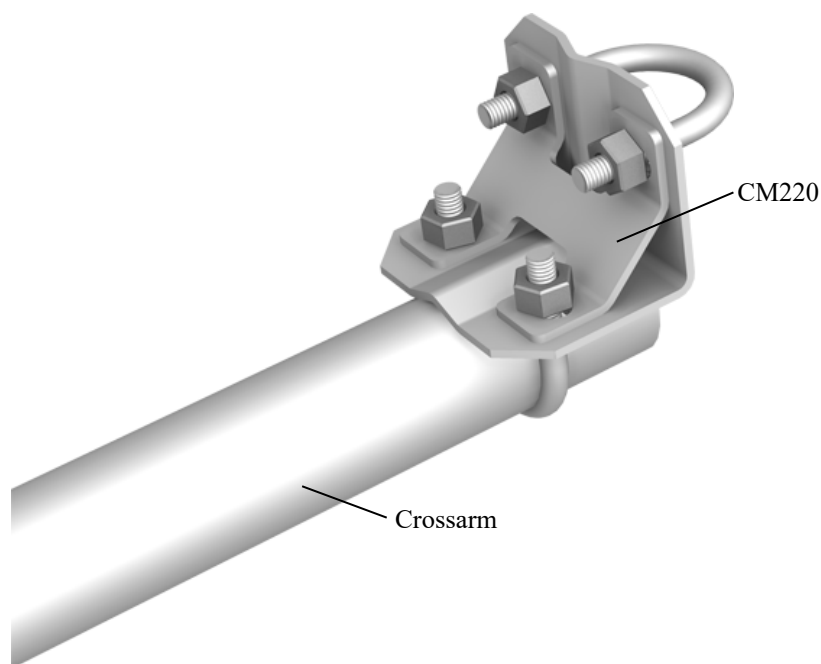


FIGURE 7-1. *CM220 Right Angle Mounting Kit mounted to a crossarm*

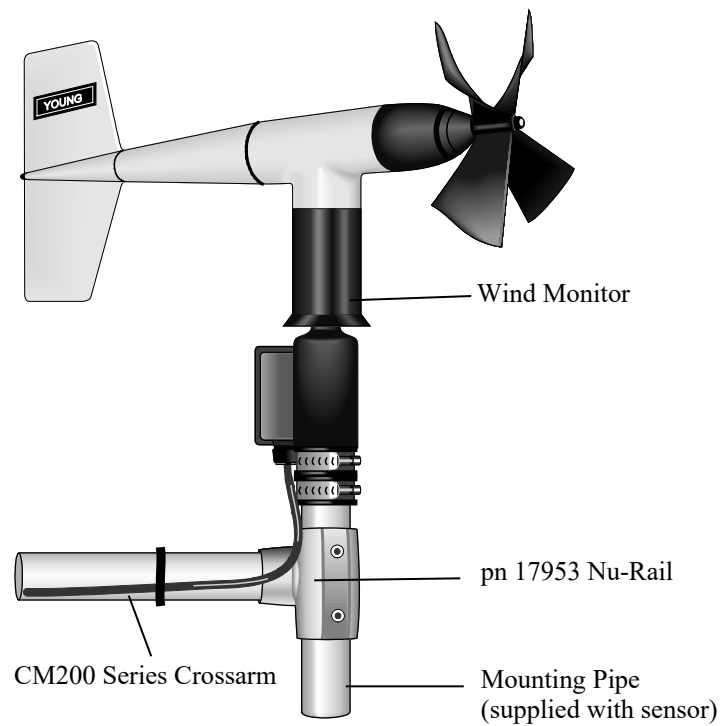


FIGURE 7-2. Wind monitor mounted to a crossarm with pn 17953 Nu-Rail

7.2.2 Mounting the Wind Monitor Atop a Tripod Mast

The wind monitor mounts at the top of a CM106B, CM110, CM115, or CM120 tripod with the CM216 (see [FIGURE 7-3](#)). The CM216 extends 10 cm (4 in) above the mast of the tripod.



FIGURE 7-3. The CM216 allows the wind monitor to mount atop a tripod mast

7.3 Wiring

Connections to Campbell Scientific dataloggers are given in TABLE 7-1. When *Short Cut* software is used to create the datalogger program, the sensor should be wired to the channels shown in the wiring diagram created by *Short Cut*.

TABLE 7-1. Wire Color, Wire Function, and Datalogger Connection		
Wire Color	Wire Function	Datalogger 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	\perp
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, or VX (voltage excitation)
White	WD Signal Reference	\perp (analog ground)
Clear	Shield	\perp (analog ground)
¹ U channels are automatically configured by the measurement instruction.		

7.4 Programming

Short Cut is the best source for up-to-date datalogger programming code. Programming code is needed when:

- Creating a program for a new datalogger installation
- Adding sensors to an existing datalogger program

If your data acquisition requirements are simple and you are connecting the sensor to a pulse port, you can probably create and maintain a datalogger program exclusively with *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 Section 4, *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 Appendix A, *Importing Short Cut Code* (p. A-1). Programming basics for CRBasic dataloggers are provided in the following sections. Complete program examples for select CRBasic dataloggers can be found in Appendix B, *Example Programs* (p. B-1). Programming basics and

programming examples for Edlog dataloggers are provided at www.campbellsci.com/old-manuals.

7.4.1 Wind Speed

For CRBasic dataloggers, wind speed is measured using the **PulseCount()** instruction. Syntax of the **PulseCount()** instruction is:

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

The *PConfig* parameter should be set to 1 (*Low Level AC*) and the *POption* parameter should be set to 1 (*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 lists the multipliers to obtain miles/hour or meters/second when the measurement instruction is configured to output Hz.

The helicoid propeller has a calibration that passes through zero, so the offset is zero (Gill, 1973; Baynton, 1976).

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

7.4.2 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).

The CR200(X) datalogger uses the **ExDelSE()** instruction to measure wind direction. All other CRBasic dataloggers use 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 datalogger types are listed in TABLE 7-3. Appendix D, *Wind Direction Measurement Theory (p. D-1)*, has additional information on the **BRHalf()** measurement instruction.

TABLE 7-3. Parameters for Wind Direction

	CR200(X)	CR300 Series	CR800, CR850, CR1000	CR1000X	CR6	CR5000, CR3000
Measurement Range	NA	mV2500	mV2500	mV5000	mV5000	mV5000
Excitation Voltage	2500 mV	2500 mV	2500 mV	2500 mV	2500 mV	5000 mV
Reverse Excitation	NA	NA	True	True	True	True
Delay or Settling Time	20000 μ s	20000 μ s	20000 μ s	20000 μ s	20000 μ s	20000 μ s
Multiplier	0.142	355	355	355	355	355
Offset	0	0	0	0	0	0

7.4.3 Wind Vector Processing Instruction

The *Wind Vector* output is used to process and store mean wind speed, unit vector mean wind direction, and *Standard Deviation* of the wind direction (optional) using the measured wind speed and direction samples.

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 with R.M. Young's Propeller Torque Disc (pn 18310) 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 with R.M. Young's Vane Torque Gauge (pn 18331).

NOTE

Often 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's manuals (www.youngusa.com/products/7/).

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 channel specified by the measurement instruction.
2. Verify that the excitation voltage and range code are correct for the datalogger type.
3. Disconnect the sensor from the datalogger and use an ohmmeter to check the potentiometer. Resistance should be about 10 k Ω between the blue and white wires. The resistance between either the blue/green or white/green wires should vary between about 1 k Ω to 11 k Ω depending on vane position. Resistance when the vane is in the 5 degree dead band should be about 1 M Ω .

Symptom: Incorrect wind direction

1. Verify that the excitation voltage, range code, multiplier and offset parameters are correct for the datalogger type.
2. Check orientation of sensor as described in Section 7, *Installation* (p. 7).

9.2 Wind Speed

Symptom: No wind speed

1. Check that the sensor is wired to the pulse channel specified by the pulse count instruction.
2. Disconnect the sensor from the datalogger 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 datalogger type.

Symptom: Wind speed does not change

1. For the dataloggers programmed with Edlog, the input location for wind speed is not updated if the datalogger is getting "Program Table Overruns". Increase the execution interval (scan rate) to prevent overruns.

10. References

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

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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

This tutorial shows:

- How to import a *Short Cut* program into a program editor for additional refinement
- How to import a wiring diagram from *Short Cut* into the comments of a custom program

Short Cut creates files, which can be imported into *CRBasic Editor*. Assuming defaults were used when *Short Cut* was installed, these files reside in the C:\campbellsci\SCWin folder:

- .DEF (wiring and memory usage information)
- .CR2 (CR200(X)-series datalogger code)
- .CR300 (CR300-series datalogger code)
- .CR6 (CR6-series datalogger code)
- .CR8 (CR800-series datalogger code)
- .CR1X (CR1000X datalogger code)
- .CR1 (CR1000 datalogger code)
- .CR3 (CR3000 datalogger code)
- .CR5 (CR5000 datalogger code)

Use the following procedure to import *Short Cut* code and wiring diagram into *CRBasic Editor*.

1. Create the *Short Cut* program following the procedure in Section 4, *QuickStart* (p. 2). Finish the program and exit *Short Cut*. Make note of the file name used when saving the *Short Cut* program.
2. Open *CRBasic Editor*.
3. Click **File | Open**. Assuming the default paths were used when *Short Cut* was installed, navigate to C:\CampbellSci\SCWin folder. The file of interest has the .CR2, .CR300, .CR6, .CR8, .CR1X, .CR1, .CR3, or .CR5 extension. Select the file and click **Open**.
4. Immediately save the file in a folder different from C:\Campbellsci\SCWin, or save the file with a different file name.

NOTE

Once the file is edited with *CRBasic Editor*, *Short Cut* can no longer be used to edit the datalogger program. Change the name of the program file or move it, or *Short Cut* may overwrite it next time it is used.

5. The program can now be edited, saved, and sent to the datalogger.
6. Import wiring information to the program by opening the associated .DEF file. Copy and paste the section beginning with heading “-Wiring for CRXXX-” into the *CRBasic* program, usually at the head of the file. After pasting, edit the information such that an apostrophe (') begins each line. This character instructs the datalogger compiler to ignore the line when compiling.

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.

TABLE B-1. Wiring for Example Programs				
Color	Wire Label	CR1000	CR6	CR200X
Red	WS Signal	P1	U4	P_LL
Black	WS Reference	\perp	\perp	\perp
Green	WD Signal	SE 1	U2	SE 1
Blue	WD Volt Excit	VX 1	U1	VX1
White	WD Reference	\perp	\perp	\perp
Clear	Shield	\perp	\perp	\perp

B.1 CR1000 Example Program

CRBasic Example B-1. CR1000 Example Program

```
'CR1000
'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 Datalogger Battery Voltage measurement Batt_Volt:
Battery(Batt_Volt)

'05103 Wind Speed & Direction Sensor measurements WS_ms and WindDir:
'WS_ms
PulseCount(WS_ms,1,1,1,1,0.098,0)
'WindDir
BrHalf(WindDir,1,mV2500,1,1,1,2500,True,20000,_60Hz,355,0) 'mV5000
'range, 5000 mV excitation for CR3000 and CR5000 dataloggers
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 B-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 Datalogger 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

```

B.3 CR200(X) Example Program

CRBasic Example B-3. CR200(X) Example Program

```
'CR200/CR200X Series

'Declare Variables and Units
Public BattV
Public WS_ms
Public WindDir

Units BattV=Volts
Units WS_ms=meters/second
Units WindDir=degrees

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

'Main Program
BeginProg
  'Main Scan
  Scan(5,Sec)
    'Default Datalogger Battery Voltage measurement 'BattV'
    Battery(BattV)
    '05103 Wind Speed & Direction Sensor measurements 'WS_ms' and 'WindDir'
    'WS_ms
    PulseCount(WS_ms,P_LL,1,1,0.098,0)
    'WindDir
    ExDeISE(WindDir,1,1,1,mV2500,20000,0.142,0)
    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 datalogger 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.

Declination angles east of True North are considered negative, and are subtracted from 360 degrees to get True North as shown FIGURE C-2 (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 $360^\circ - 11.78^\circ$, 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.

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 datalogger.

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 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 datalogger indicates 0 degrees. Tighten the set screws.

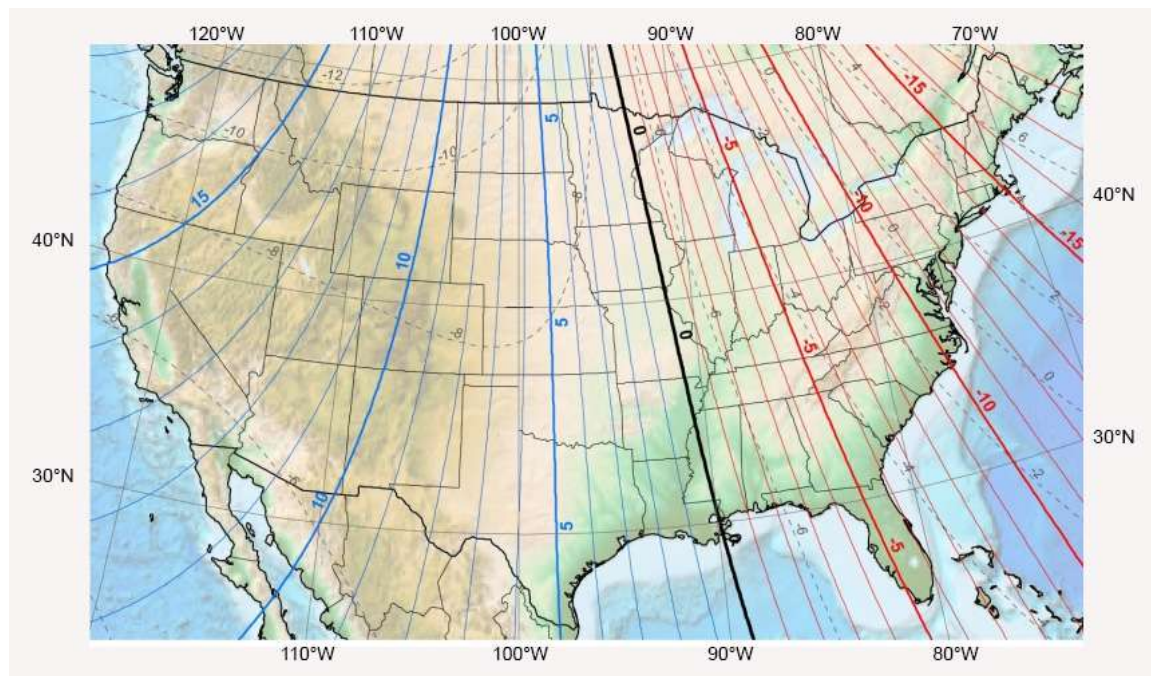


FIGURE C-1. Magnetic declination for the contiguous United States (2015)

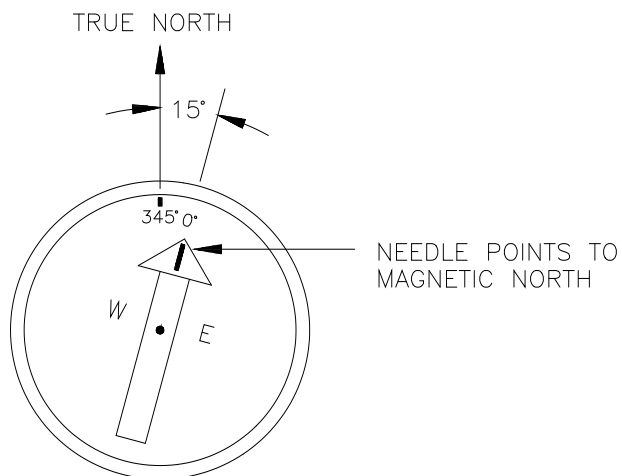


FIGURE C-2. Declination angles east of True North are subtracted from 0 to get True North

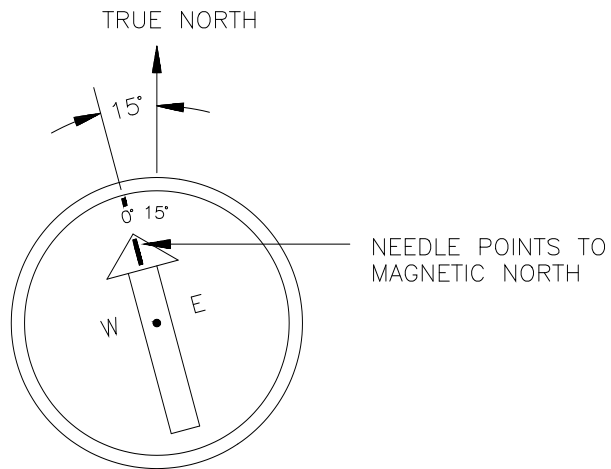
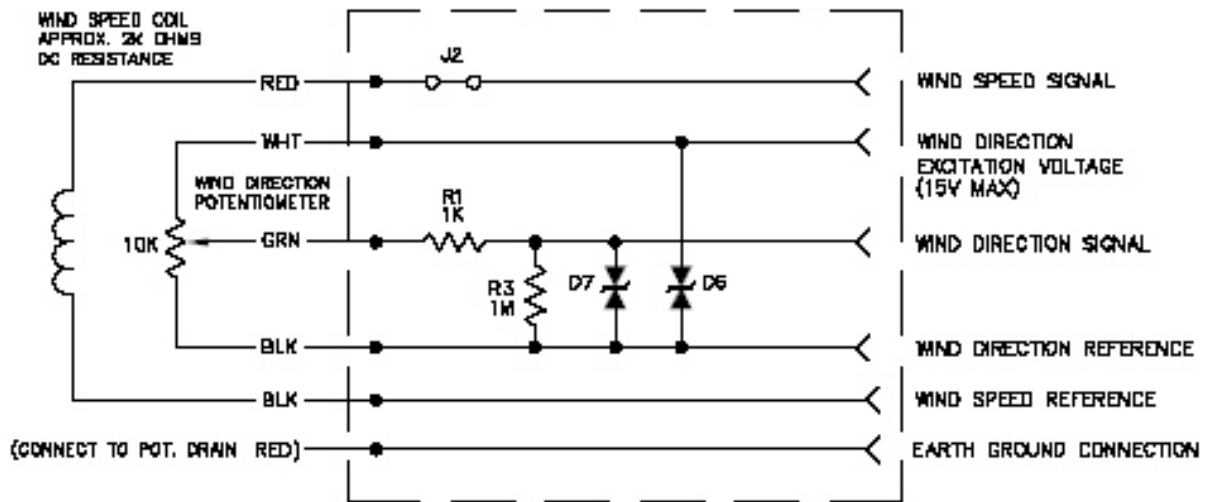


FIGURE C-3. Declination angles west of True North are added to 0 to get True North

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 Campbell Scientific's datalogger.



D6 AND D7 ARE TRANSZORB TRANSIENT PROTECTION DEVICES.

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 varies 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 below:

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

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. Since the datalogger outputs the ratio V_s/V_x , the multiplier is the same for the CR3000, even though it uses a different excitation voltage. See Section 13.5 in the datalogger manual for more information on the bridge measurements.

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