INSTRUCTION MANUAL

03002 R.M. Young Wind Sentry Set
03101 R.M. Young Wind Sentry Anemometer
03301 R.M. Young Wind Sentry Vane

Revision: 9/13

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R.M. Young Wind Sentry

1. Introduction

The 03002 Wind Sentry Set measures both wind speed and direction. It consists of a 3-cup anemometer and a wind vane mounted on a small crossarm. The anemometer (pn 03101) and vane (pn 03301) may be purchased separately.

Before installing the 03002, please study

- Section 2, *Cautionary Statements*
- Section 3, *Initial Inspection*
- Section 4, *Quickstart*

2. Cautionary Statements

- The 03002 is a precision instrument. Please handle it with care.

- If the 03002 is to be installed at heights over 6 feet, be familiar with tower safety and follow safe tower climbing procedures.

- Danger — Use extreme care when working near overhead electrical wires. Check for overhead wires before mounting the 03002 or before raising a tower.

- 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. Initial Inspection

- Upon receipt of the 03002, 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 List*). 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 List

The 03002 Wind Sentry ships with:

(1) 03002 Wind Sentry including
  03102 anemometer
  03302 vane
  crossarm
  band clamp (pn 4919)
(1) 12" x 1.0" unthreaded aluminium pipe (pn 3659)
(1) Allen wrench (pn 5201)

The 03101 anemometer ships with:

(1) 03101 anemometer
(1) 10" x 3/4" threaded galvanized pipe (pn 12243)
(1) Allen wrench (pn 5201)

The 03301 Vane ships with:

(1) 03301 vane
(1) 10” x 3/4” threaded galvanized pipe (pn 12243)
(1) Allen wrench (pn 5201)

4. Quickstart

4.1 Step 1 — Mount the Sensor

This quick start is for the 03002 wind set. Refer to Section 7, *Installation*, if installing just the 03101 anemometer or 03301 vane. Section 7, *Installation*, also provides siting information.

Tools required:

- 5/64” Allen wrench
- Allen wrench provided with sensor
- 1/2” open end wrench
- compass and declination angle for the site (see Appendix A)
- small screw driver provided with datalogger
- UV resistant cable ties
- small pair of diagonal-cutting pliers
- 6 – 10” torpedo level

Install the 03002 using:

- Standard 1.0-in. IPS schedule 40 pipe (pn 3659)
- CM220 Right-Angle Mounting Kit (FIGURE 4-1 and FIGURE 4-2), or
- 17953 1 x 1 inch NU-RAIL Crossover Fitting (FIGURE 4-3)

1. Install the cup wheel to the anemometer shaft using the Allen wrench provided with the sensor.

2. Mount a CM202, CM204, or CM206 crossarm to the tripod or tower.

3. Orient the crossarm North-South, with the CM220 mount or 17953 NU-RAIL on the north end. Appendix A contains detailed information on determining True North using a compass and the magnetic declination for the site.

4. Secure the 12 in. aluminum pipe to the CM220 mount or 17953 NU-RAIL. The 3659 aluminum pipe is shipped with the 03002.

5. Place the 03002 on the pipe, and orient the sensor crossarm North-South with the vane to the North.

6. Tighten the mounting post band clamp. Final sensor orientation is done after the datalogger has been programmed to measure wind direction as described in Appendix A.

7. Route the sensor cable along the underside of the crossarm to the tripod or tower, and to the instrument enclosure.

8. Secure the cable to the crossarm and tripod or tower using cable ties.

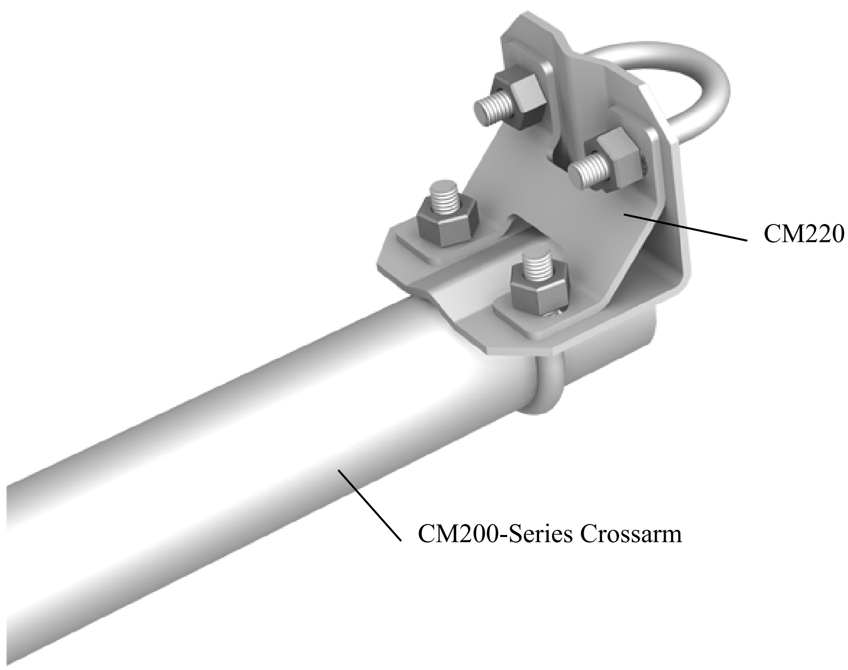


FIGURE 4-1. CM200-Series Crossarm with CM220 Right Angle Mounting Bracket

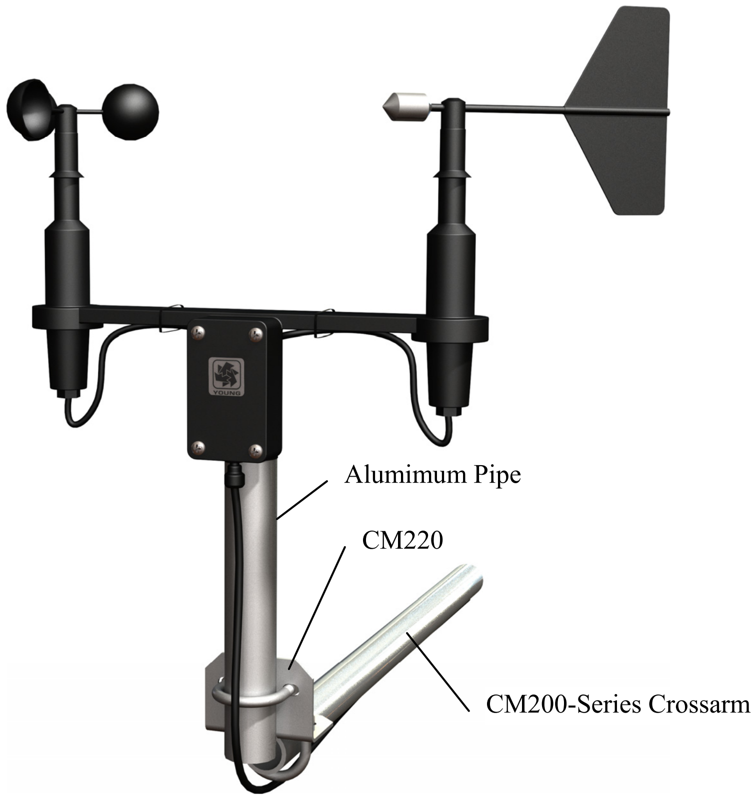


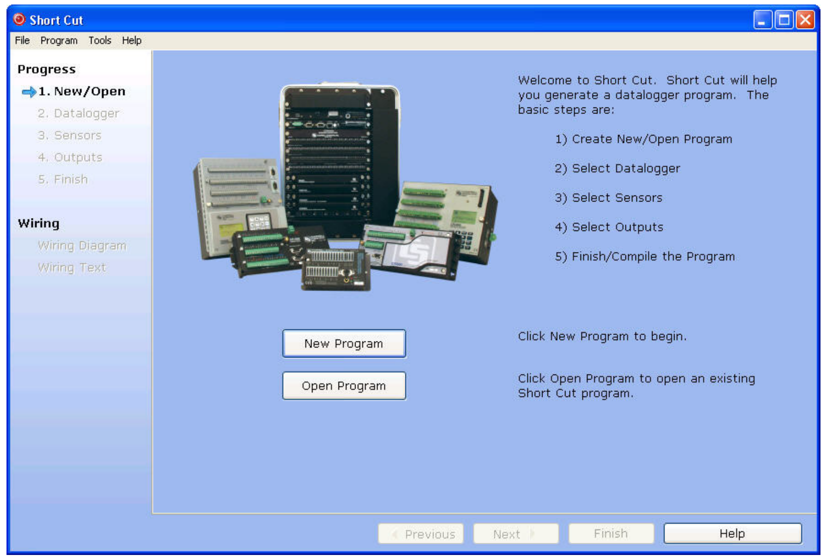
FIGURE 4-2. 03002 mounted to CM200-Series Crossarm with CM220

FIGURE 4-3. 03002 mounted to CM200-Series Crossarm with pn 17953

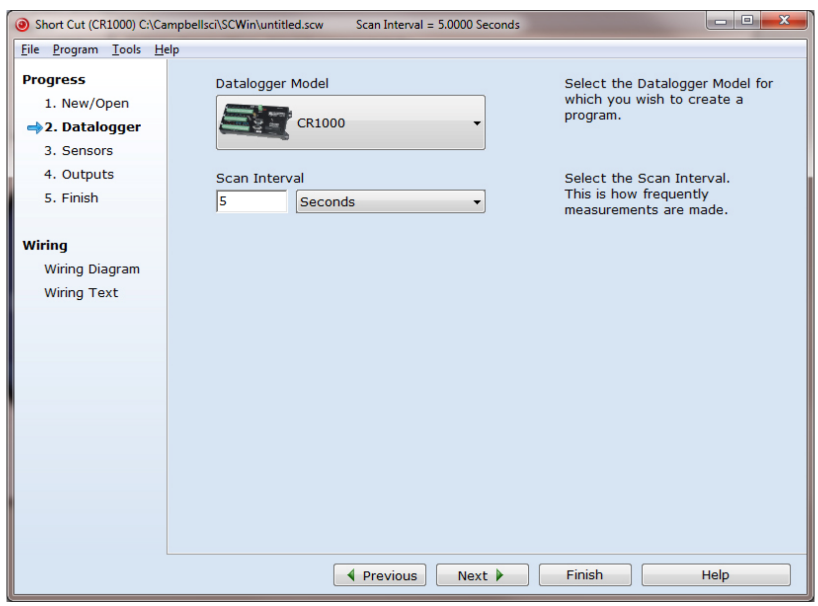
4.2 Step 2 — Use SCWin Short Cut to Program Datalogger and Generate Wiring Diagram

The simplest method for programming the datalogger to measure the 03002 is to use Campbell Scientific's SCWin Short Cut Program Generator.

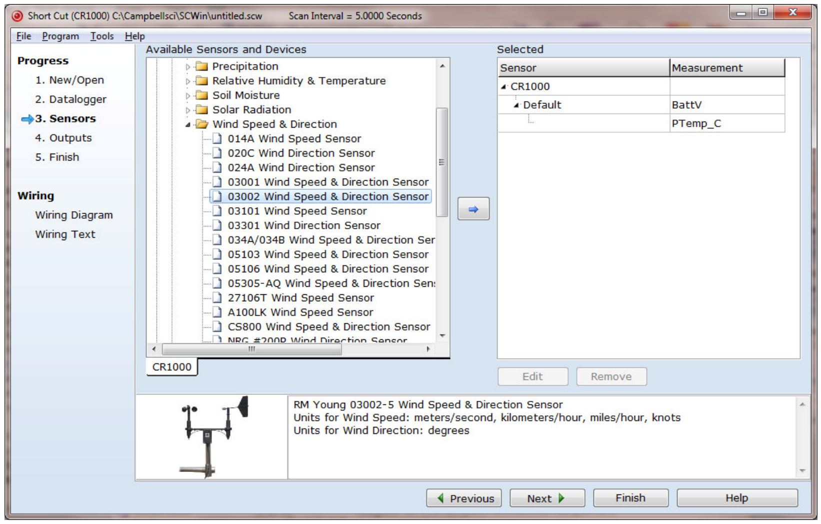
1. Open **Short Cut** and click on **New Program**.



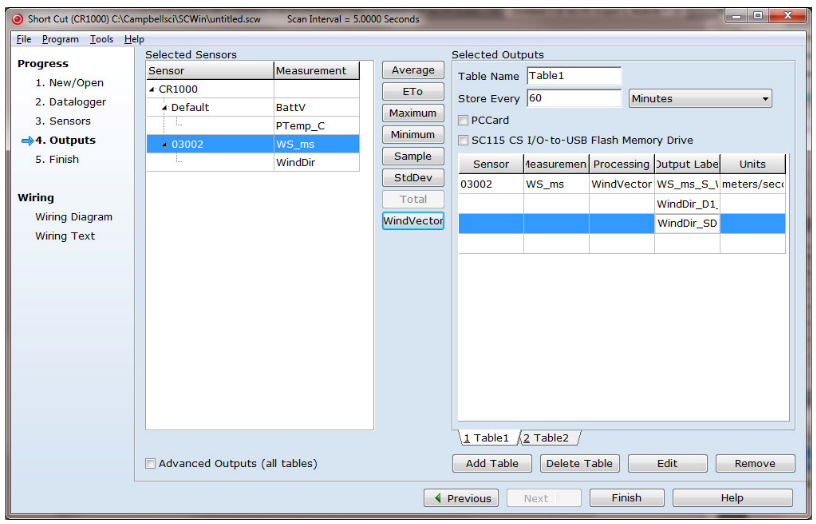
2. Select the **Datalogger** and enter the **Scan Interval** and select **Next**.



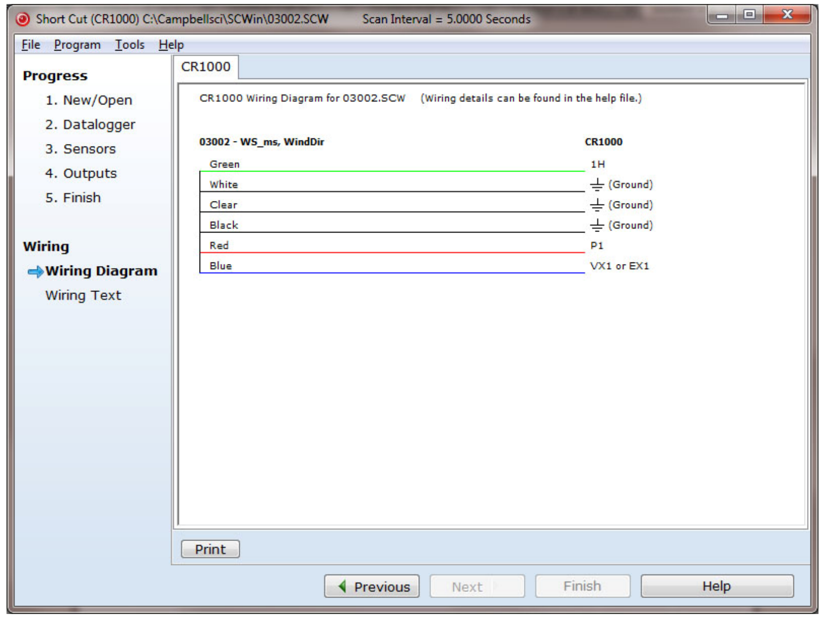
3. Select **03002 Wind Speed & Direction Sensor** and select the **right arrow** (in center of screen) to add it to the list of sensors to be measured then select **Next**.



4. Select **Wind Vector** for the output and then select **Finish**.



5. Wire according to the wiring diagram generated by Short Cut.



5. Overview

The 03002 Wind Sentry Set is used to measure horizontal wind speed and direction.

Wind speed is measured with a three cup anemometer. Rotation of the cup wheel produces an ac sine wave voltage with frequency proportional to wind speed. This is a special version of the 03102 built for Campbell Scientific by R.M. Young that has shielded bearings rather than sealed bearings. The shielded bearings provide a lower starting threshold than sealed bearings.

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

The 03101 Anemometer and 03301 Vane can be ordered as separate sensors, which are also covered in this manual. These two sensors combined differ from the 03002 only by the absence of a junction box. The R.M. Young Instruction Manual includes additional information on the operating principles, installation, and maintenance of the sensor.

Cable length for the Wind Sentry is specified when the sensor is 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 Cable Lengths

CM106	CM110	CM115	CM120	UT10	UT20	UT30
12 ft	15 ft	20 ft	25 ft	15 ft	25 ft	38 ft

The 03002's 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 03002 to be used in a wireless sensor network. Refer to *www.campbellsci.com/cws900* for more information.

6. Specifications

Features:

- Designed for continuous, long term, unattended operation in adverse conditions
- Small size, simplicity, and rugged construction provide a quality instrument for a modest price
- 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
- Campbell Scientific version uses shielded bearings, which lowers the anemometer's starting threshold

Compatible Dataloggers:	CR200(X)-series CR800 series CR1000 CR3000 CR5000 CR510 CR10(X) CR23X CR7 21X

6.1 Wind Speed (Anemometer)

Range:	0 to 50 m s^{-1} (112 mph), gust survival 60 m s^{-1} (134 mph)
Sensor:	12 cm diameter cup wheel assembly, 40 mm diameter hemispherical cups
Accuracy:	±0.5 m s^{-1} (1.1 mph)
Turning Factor:	75 cm (2.5 ft)
Distance Constant (63% recovery):	2.3 m (7.5 ft)

Threshold:	0.5 m s^{-1} (1.1 mph)
Transducer:	Stationary coil, 1300 ohm nominal resistance
Output:	AC sine wave signal induced by rotating magnet on cup wheel shaft 100 mV peak-to-peak at 60 rpm; 6 V peak-to-peak at 3600 rpm
Output Frequency:	1 cycle per cup wheel revolution; 0.75 m s^{-1} per Hz
Cup Wheel Diameter:	12 cm (4.7 in)
Weight:	113 g (4 oz)

6.2 Wind Direction (Vane)

Range:	360° mechanical, 352° electrical (8° open)
Sensor:	Balanced vane, 16 cm turning radius
Accuracy:	±5°
Damping Ratio:	0.2
Delay Distance (50% recovery):	0.5 m (1.6 ft)
Threshold:	0.8 m s^{-1} (1.8 mph) at 10° displacement (1.8 m s^{-1} (4 mph) at 5° displacement)
Transducer:	Precision conductive plastic potentiometer; 10 kΩ resistance; 1.0% linearity; life expectancy 50 million revolutions Rated 1 W at 40°C, 0 W at 125°C
Transducer Excitation Requirement:	Regulated dc voltage, 15 Vdc max
Output:	Analog dc voltage proportional to wind direction angle with regulated excitation voltage supplied by the datalogger
Vane Length:	22 cm (8.7 in)
Vane Weight:	170 g (6 oz)

6.3 Wind Sentry Assembly

Operating Temperature:	–50° to +50°C assuming non-riming conditions
Overall Height:	32 cm (12.6 in)
Crossarm Length:	40 cm (15.7 in) between instruments (center-to-center)
Mounting Diameter:	34 mm (1.34 in), mounts on standard 1 in. IPS pipe

7. Installation

7.1 Siting

Locate wind sensors away from obstructions (e.g. trees and building). As a general rule of thumb, there should be a horizontal distance of at least ten times the height of the obstruction between the wind set and the obstruction. If it is necessary to mount the sensors on the roof of a building, the height of the sensors above the roof, should be at least 1.5 times the height of the building. See Section 10, *References*, for a list of references that discuss siting wind speed and direction sensors.

7.2 Assembly and Mounting

Tools required:

- 5/64” Allen wrench
- Allen wrench provided with sensor
- 1/2” open end wrench
- compass and declination angle for the site (see Appendix A)
- small screw driver provided with datalogger
- UV resistant cable ties
- small pair of diagonal-cutting pliers
- 6 - 10” torpedo level

7.2.1 03002 Wind Sentry Set

The 03002 mounts to a standard 1.0 in. IPS schedule 40 pipe (1.34 in. O.D.). A 12” long mounting pipe ships with the 03002. The mounting pipe typically fastens to a CM200-series crossarm via the CM220 mount or 17953 NU-RAIL fitting. Section 4, *Quickstart*, describes mounting the 03002 using a CM220 mount or a 17953 NU-RAIL fitting. The 03002 can also be mounted at the top of a CM110, CM115, or CM120 tripod with the CM216 (see FIGURE 7-1).

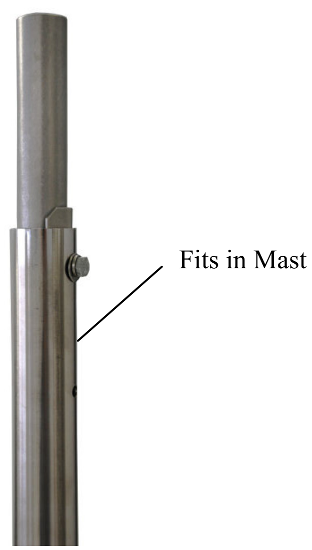


FIGURE 7-1. The CM216 allows an 03002 or 03101 to mount atop the mast of a CM110, CM115, or CM120 tripod

7.2.2 03101 Anemometer

Install the cupwheel to the anemometer shaft using the Allen wrench provided with the sensor.

The 03101 mounts to a threaded 0.75 in. IPS schedule 40 pipe (1.05 in. O.D.). A 10 in. long mounting pipe ships with the 03101. The mounting pipe typically fastens to a CM200-series crossarm via the CM220 mount (see FIGURE 4-1 in Quickstart) or 1049 NU-RAIL fitting (FIGURE 7-2). The

03101 can also be mounted at the top of a tripod using the CM216 (see FIGURE 7-1).

Mount the CM200-series crossarm to the tripod or tower. Screw the mounting pipe into the base of the 03101, and attach the sensor / mounting pipe to the crossarm.

Route the sensor cable along the underside of the crossarm to the tower/tripod mast, and to the instrument enclosure. Secure the sensor cable to the crossarm and mast using cable ties.

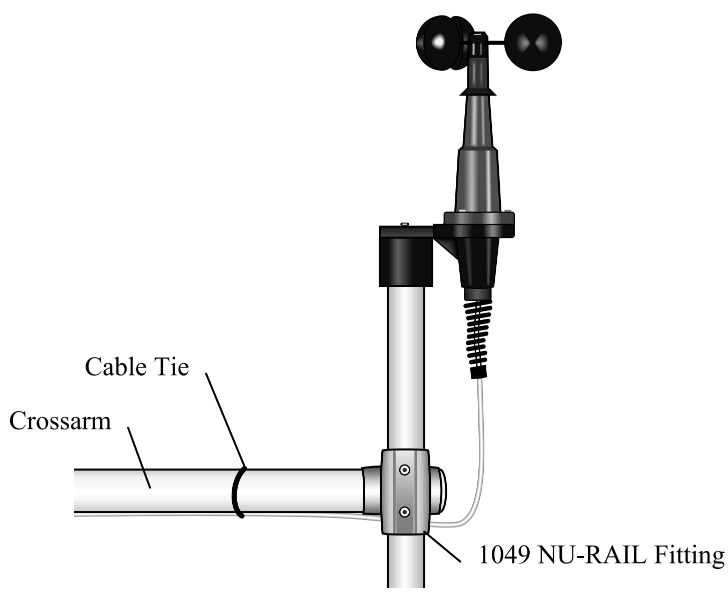


FIGURE 7-2. 03101 mounted to a crossarm via a 1049 NU-RAIL

7.2.3 03301 Vane

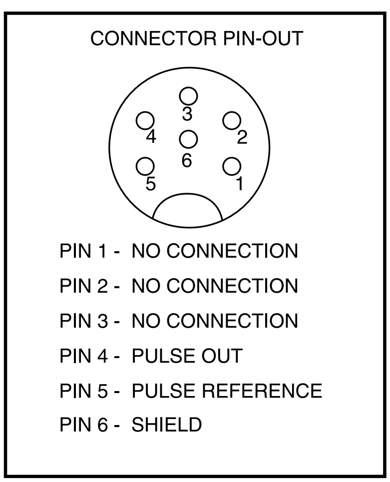
The 03301 vane is typically ordered as a replacement vane for the 03002 Wind Sentry Set, and includes the bracket for attaching it to the 03002 small crossarm. Part number 4913 pipe mount (not included with the sensor) can be used to attach the 03301 to a CM200-series crossarm (with the CM220 or pn 1049), and the mounting pipe that ships with the sensor.

7.3 Wiring

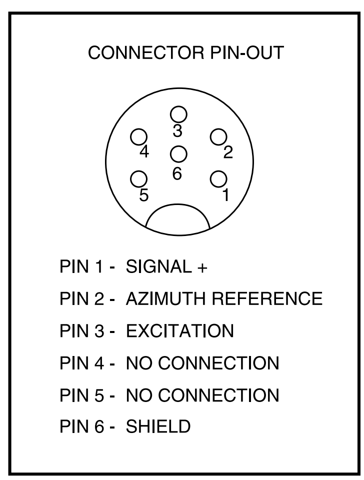
Connections to Campbell Scientific dataloggers are given in TABLE 7-1 and TABLE 7-2. When Short Cut is used to create the datalogger program, the sensor should be wired to the channels shown on the wiring diagram created by Short Cut.

TABLE 7-1. 03002-L Wiring					
Color	**Description**	**CR800 CR5000 CR3000 CR1000**	**CR510 CR10(X)**	**CR21X CR7 CR23X**	**CR200(X)**
Red	Wind Spd. Signal	Pulse	Pulse	Pulse	P_LL
Black	Wind Spd. Reference	⏚	G	⏚	⏚
Clear	Shield	⏚	G	⏚	⏚
White	Wind Dir. Reference	⏚	AG	⏚	⏚
Green	Wind Dir. Signal	SE Analog	SE Analog	SE Analog	SE Analog
Blue	Wind Dir. Excitation	Excitation	Excitation	Excitation	Excitation

TABLE 7-2. 03101 and 03301 Wiring					
Color	**Description**	**CR800 CR5000 CR3000 CR1000**	**CR510 CR10(X)**	**CR21X CR7 CR23X**	**CR200(X)**
Black	Wind Spd. Signal	Pulse	Pulse	Pulse	P_LL
White	Wind Spd. Reference	⏚	G	⏚	⏚
Clear	Wind Spd. Shield	⏚	G	⏚	⏚
Red	Wind Dir. Signal	SE Analog	SE Analog	SE Analog	SE Analog
Black	Wind Dir. Excitation	Excitation	Excitation	Excitation	Excitation
White	Wind Dir. Reference	⏚	AG	⏚	⏚
Clear	Wind Dir. Shield	⏚	G	⏚	⏚



Wind Speed 03101



Wind Direction 03301

7.4 Programming

This section is for users who write their own programs. A datalogger program to measure this sensor can be created using Short Cut. You do not need to read this section to use Short Cut.

7.4.1 Wind Speed

Wind speed is measured with the Pulse Count instruction (**PulseCount()** in CRBasic and **Instruction 3** in Edlog). Use the low level AC configuration. For dataloggers programmed with Edlog, specify configuration code 21 to output frequency in hertz.

The expression for wind speed (U) is:

$$U = MX + B$$

where

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

TABLE 7-3 lists the multipliers (M) and offsets (Off) to obtain meters/second or miles/hour when the **Pulse Count** instruction is configured to output the result in hertz.

TABLE 7-3. Wind Speed Multiplier
(With Pulse Channel Configuration Set to Low Level AC, Output "Hz")

Model	Meters/Second	Miles/Hour
03002 / 03101	M = 0.750 Off = 0.2	M = 1.677 Off = 0.4

*When the pulse channel configuration is set to Low Level AC, output "counts", the multiplier above is divided by the execution interval in seconds.

7.4.2 Wind Direction

The wind vane is coupled to a 10 kΩ potentiometer, which has a 8 degree electrical dead band between 352 and 360 degrees.

The CR200(X) dataloggers use the **ExDelSE()** instruction to measure wind direction. All other CRBasic dataloggers use the **BRHalf()** instruction. Edlog dataloggers (CR510, CR10X, CR23X) use Edlog Instruction 4—Excite, Delay (**P4**).

Excitation voltages, range codes, and multipliers for Campbell Scientific dataloggers are listed in TABLE 7-4. Appendix B has additional information on the **BRHalf()** measurement instructions.

TABLE 7-4. Parameters for Wind Direction

	CR10(X) CR510 CR200(X)	CR7 21X CR23X	CR800 CR1000	CR5000 CR3000
Measurement Range	2500 mV, slow	5000 mV, slow/60 Hz	2500 mV, 60 Hz, reverse excitation	5000 mV, 60 Hz, reverse excitation
Excitation Voltage	2500 mV	5000 mV	2500 mV	5000 mV
Multiplier	0.1408	0.0704	352	352
Offset	0	0	0	0

7.4.3 Wind Vector Processing Instruction

The **Wind Vector** output instruction is used to process and store mean wind speed, unit vector mean wind direction, and standard deviation of the wind direction (optional) from the measured wind speed and direction values.

7.4.4 Example Programs

The following programs measure the 03002 every 5 seconds, 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 7-5.

TABLE 7-5. Wiring for Example Programs using the 03002-L

Color	Description	CR1000	CR10X
Red	Wind Spd. Signal	P1	P1
Black	Wind Spd. Reference	⏚	G
Clear	Wind Spd. Shield	⏚	G
Green	Wind Dir. Signal	SE 1	SE 1
Blue	Wind Dir. Excitation	VX 1 or EX 1	E1
White	Wind Dir. Reference	⏚	AG

7.4.4.1 CR1000 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(Table1,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)

    '03002 or 03101 RM Young Wind Sentry Wind Speed Sensor measurement - WS_ms:
    PulseCount(WS_ms,1,1,1,1,0.75,0.2)
    If WS_ms<0.21 Then WS_ms=0

    '03002 or 03301 RM Young Wind Sentry Wind Direction Sensor measurement -
WindDir:
    BrHalf(WindDir,1,mV2500,1,1,1,2500,True,0,_60Hz,352,0)
    'Use mV5000 range and 5000 mV excitation for CR3000 and CR5000 dataloggers.
    If WindDir>=360 OR WindDir<0 Then WindDir=0

    'Call Data Tables and Store Data
    CallTable(Table1)
  NextScan
EndProg
```

7.4.4.2 CR10X Program

```
;{CR10X}
*Table 1 Program
  01:  5.0000        Execution Interval (seconds)

1:  Batt Voltage (P10)
  1:   1             Loc [ Batt_Volt ]

;03002 or 03101 RM Young Wind Sentry Wind Speed Sensor measurement - WS_ms:
2:  Pulse (P3)
  1:   1             Reps
  2:   1             Pulse Channel 1
  3:   21            Low Level AC, Output Hz
  4:   2             Loc [ WS_ms     ]
  5:   0.75          Multiplier
  6:   0.2           Offset
```

```
;If WS < starting threshold then set WS = 0
3:  If (X<=>F) (P89)
   1:  2           X Loc [ WS_ms    ]
   2:  4           <
   3:  0.21        F
   4:  30          Then Do

      4:  Z=F x 10^n (P30)
         1:  0           F
         2:  0           n, Exponent of 10
         3:  2           Z Loc [ WS_ms    ]

5:  End (P95)

;03002 or 03301 RM Young Wind Direction Sensor measurement - WindDir:
6:  Excite-Delay (SE) (P4)
   1:  1           Reps
   2:  5           2500 mV Slow Range       ;5000 mV(slow/60hz) range for CR23X, 21X, or CR7
   3:  1           SE Channel
   4:  1           Excite all reps w/Exchan 1
   5:  2           Delay (0.01 sec units)
   6:  2500        mV Excitation            ;5000 mV for CR23X, 21X, or CR7
   7:  3           Loc [ WindDir  ]
   8:  0.1408      Multiplier               ;0.0704 for CR23X, 21X, or CR7
   9:  0           Offset

7:  If (X<=>F) (P89)
   1:  3           X Loc [ WindDir  ]
   2:  3           >=
   3:  360         F
   4:  30          Then Do

      8:  Z=F x 10^n (P30)
         1:  0           F
         2:  0           n, Exponent of 10
         3:  3           Z Loc [ WindDir  ]

9:  End (P95)

10:  If (X<=>F) (P89)
   1:  3           X Loc [ WindDir  ]
   2:  4           <
   3:  0           F
   4:  3           Then Do

      11:  Z=F x 10^n (P30)
         1:  0           F
         2:  0           n, Exponent of 10
         3:  3           Z Loc [ WindDir  ]

12:  End (P95)

13:  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)
```

```
14:  Set Active Storage Area (P80)^15464
  1:   1               Final Storage Area 1
  2:   101             Array ID

15:  Real Time (P77)^6687
  1:   1220            Year,Day,Hour/Minute (midnight = 2400)

16:  Wind Vector (P69)^28601
  1:   1               Reps
  2:   0               Samples per Sub-Interval
  3:   0               S, theta(1), sigma(theta(1)) with polar sensor
  4:   2               Wind Speed/East Loc [ WS_ms     ]
  5:   3               Wind Direction/North Loc [ WindDir   ]
```

7.4.5 Long Lead Lengths

When sensor lead length exceeds 100 feet, the settling time allowed for the measurement of the vane should be increased to 20 milliseconds.

For dataloggers programmed with Edlog (and the CR200(X)), the EX-DEL-SE (**P4**) measurement instruction should be used. Enter a **2** in the **P4** "Delay" parameter for a 20 millisecond delay.

For dataloggers programmed with CRBasic, increase the *Settling Time* parameter of the **BRHalf()** instruction to 20 milliseconds (20,000 microseconds).

CAUTION The 60 Hz rejection option can not be used with the DC Half Bridge instruction, when the delay is not zero. Do not use long lead lengths in electrically noisy environments.

8. Sensor Maintenance

Every month do a visual/audio inspection of the anemometer at low wind speeds. Verify that the cup assembly and wind vane 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 a paper clip as described in the R.M. Young manual.

The potentiometer has a life expectancy of fifty million revolutions. As it becomes worn, the element can produce noisy signals or become nonlinear. Replace the potentiometer when the noise or nonlinearity becomes unacceptable.

Contact Campbell Scientific for a Return Materials Authorization (RMA) number at (435) 227-9000. A "Statement of Product Cleanliness and Decontamination" form also needs to be filled out.

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 ohm meter to check the potentiometer. Resistance should be about 10 kΩ between the black and white wires. The resistance between either the black/red or white/red wires for the 03301 and blue/red or white/red for the 03002 should vary from 1 kΩ to 11 kΩ depending on vane position. Resistance when the vane is in the 8 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 datalogger type.

2. Check orientation of sensor as described in Section 4.1, *Step 1 — Mount the Sensor*.

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 ohm meter to check the coil. The resistance between the white and black wires for the 03101 and black and red wires for the 03002 should be a nominal 1300 ohms. 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 that are 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

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. Wind Direction Sensor Orientation

A.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*. 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 A-1.

Declination angles east of True North are considered negative, and are subtracted from 360 degrees to get True North as shown FIGURE A-2 (0° and 360° are the same point 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 A-3. For example, the declination for Logan, Utah is 14° East. True North is 360° - 14°, or 346° as read on a compass.

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 hand-held keyboard display, PC, or laptop.
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.

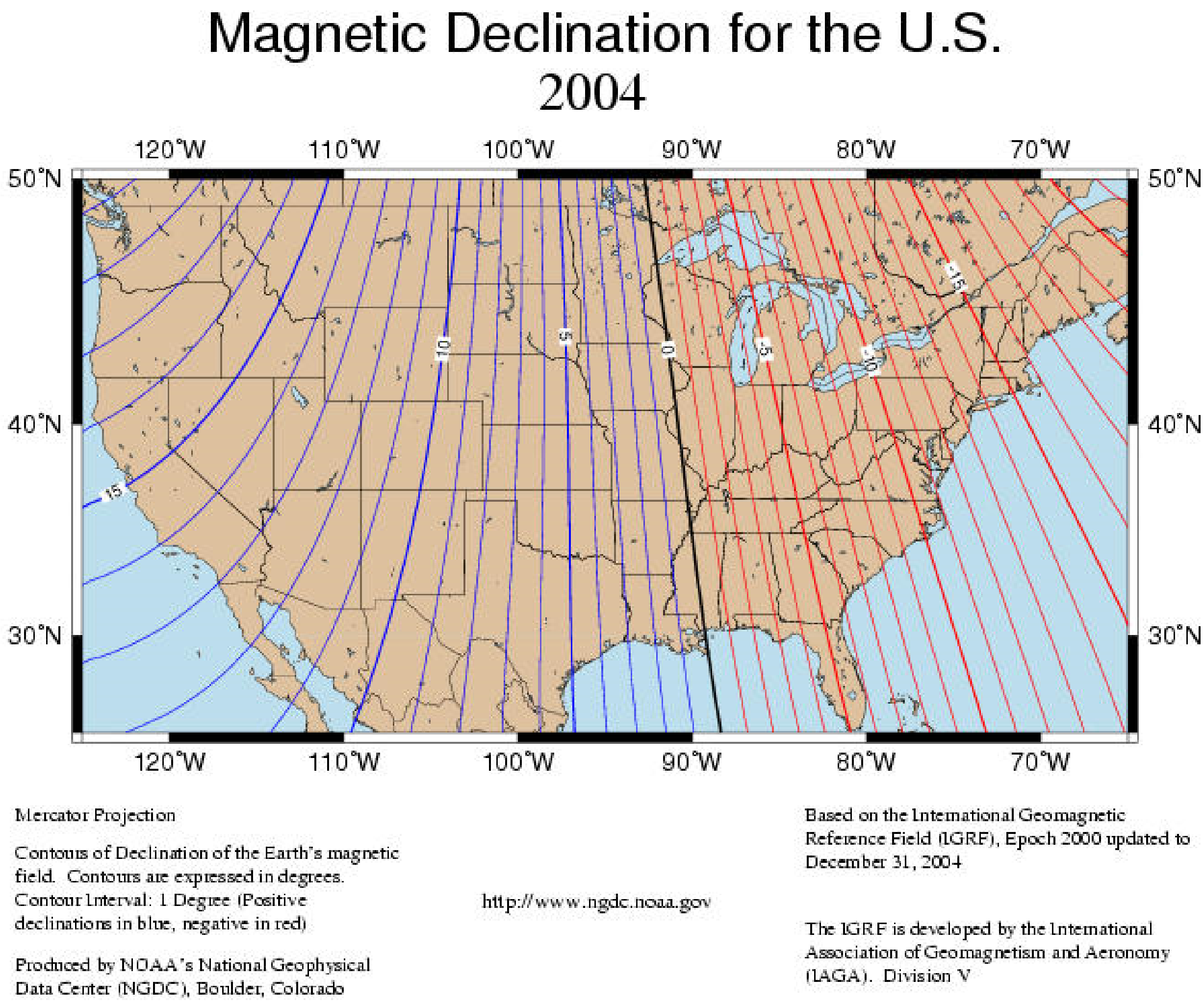


FIGURE A-1. Magnetic declination for the contiguous United States (2004)

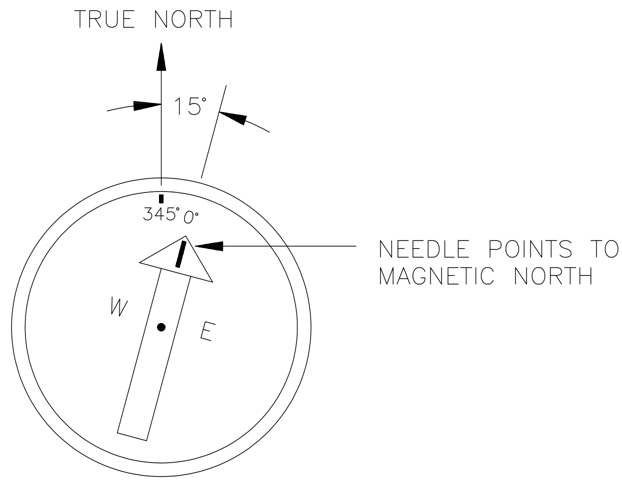


FIGURE A-2. Declination angles east of True North are subtracted from 0 to get True North

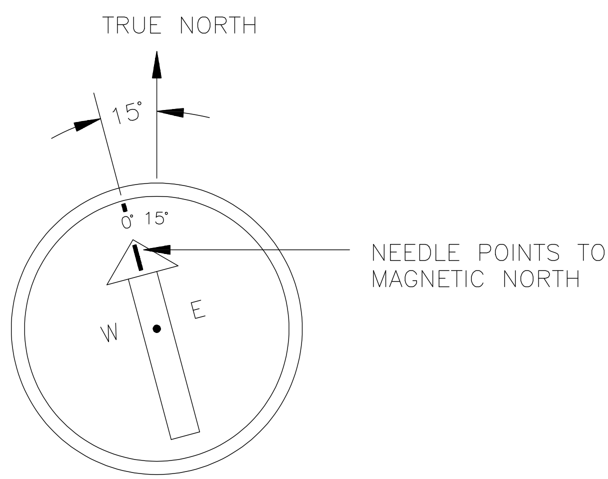


FIGURE A-3. Declination angles west of True North are added to 0 to get True North

Appendix B. Wind Direction Measurement Theory

It is not necessary to understand the concepts in this section for the general operation of the 03002 with Campbell Scientific's datalogger.

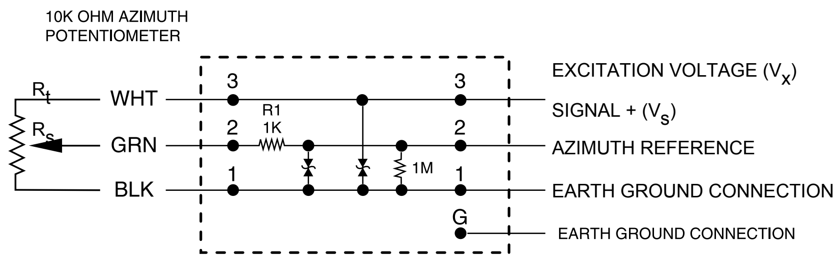


FIGURE B-1. 03002 and 03301 potentiometer in a half bridge circuit

B.1 BRHalf Instruction

The **BRHalf()** 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 352 degrees. The multiplier to convert V_s/V_x to degrees is 352 degrees / 1.0 V_s/V_x = 352. Since the datalogger outputs the ratio V_s / V_x, the multiplier is the same for both the CR10(X) and CR3000, even though they use a different excitation voltage. See Section 13.5 in the CR10X manual, Section 4.3 in the CR1000 manual, or Section 3.5 in the CR3000 manual for more information on the bridge measurements.

B.2 EX-DEL-SE (P4) Instruction

Instruction 4 outputs a precise excitation voltage (V_x) and measures the voltage between the wiper and analog ground, V_s. The resistance between the wiper and analog ground, R_s, and V_s varies with wind direction. Instruction 4 outputs the measured voltage, V_s. This measured voltage is related to resistance as shown below:

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

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 reaches its maximum value of V_x. This maximum voltage equals 2500 mV for an excitation voltage of 2500 mV recommended for the CR10(X) and 5000 mV for an excitation voltage of 5000 mV recommended for the CR23X at 352 degrees. The multiplier to convert V_s to degrees is 352 degrees / 2500 mV = 0.1408 for the CR10X, or, 352 degrees / 5000 mV = 0.0704 for the CR23X. See Section 13.5 in the datalogger manual from more information on the bridge measurements.

METEOROLOGICAL INSTRUMENTS

YOUNG

INSTRUCTIONS

WIND SENTRY

MODEL 03002-5

CE

R.M. YOUNG COMPANY 2801 AERO PARK DRIVE, TRAVERSE CITY, MICHIGAN 49686, USA
TEL: (231) 946-3980 FAX: (231) 946-4772 WEB: www.youngusa.com

P/N: 03002-5-90
REV: D110210

MODEL 03002-5
WIND SENTRY
INCLUDES MODELS 03102 & 03302

WIND SPEED SPECIFICATION SUMMARY

Range	0 to 50 m/s (112 mph), gust survival 60 m/s (134 mph)
Sensor	12 cm diameter cup wheel assembly, 40 mm diameter hemispherical cups
Turning Factor	75 cm (2.46 ft)
Distance Constant	2.3 m (7.5 ft) (63% recovery)
Threshold	0.5 m/s (1.1 mph)
Transducer	Stationary coil, 1300 ohm nominal resistance
Transducer Output	AC sine wave signal induced by rotating magnet on cup wheel shaft 100 mV p-p at 60 rpm. 6V p-p at 3600 rpm.
Output Frequency	1 cycle per cup wheel revolution.

WIND DIRECTION (AZIMUTH) SPECIFICATION SUMMARY

Range	360° mechanical, 352° electrical (8° open)
Sensor	Balanced vane, 16 cm turning radius.
Damping Ratio	0.2
Delay Distance	(50% recovery) 0.5 m (1.6 ft)
Threshold	0.8 m/s (1.8 mph) at 10° displacement
Transducer	Precision conductive plastic potentiometer, 10K ohm ±20% resistance 1.0% linearity, life expectancy 50 million revolutions Rated 1 watt at 40°C, 0 watts at 125°C
Transducer Excitation	Requirement Regulated DC voltage, 15 VDC max
Transducer Output	Analog DC voltage proportional to wind direction angle with regulated excitation voltage applied across potentiometer

GENERAL

Operating Temperature	-50 to 50°C (-58 to 122°F)

INTRODUCTION

The Wind Sentry Anemometer and Vane measure horizontal wind speed and wind direction. The small size, simplicity, and corrosion resistant construction provide a professional quality instrument at a modest cost. The cup wheel and vane shafts use stainless steel precision instrument grade ball bearings which are lubricated with a wide temperature range high quality instrument oil. Standard bearings have light contacting seals to exclude contamination and help retain lubricant for longer service life.

Cup wheel rotation produces an AC sine wave voltage signal with frequency directly proportional to wind speed. This AC signal is induced in a stationary coil by a two pole ring magnet mounted on the cup wheel shaft. One complete sine wave cycle is produced for each cup wheel revolution.

Wind vane position is transmitted by a 10K ohm precision conductive plastic potentiometer which requires a regulated excitation voltage. With a constant voltage applied to the potentiometer, the output signal is an analog voltage directly proportional to wind direction angle.

The instrument mounts on standard 1 inch pipe, outside diameter 34mm (1.34") and is supplied with a crossarm and junction box for cable connections. Wind Sentry anemometers and windvanes are available separately with similar mounting and junction box.

INITIAL CHECK-OUT

When the Wind Sentry is unpacked, check it carefully for any signs of shipping damage. Place the cup wheel on the anemometer shaft and secure it by tightening the set screw on the side of the hub. The instrument is aligned, balanced, and fully calibrated before shipment; however, it should be checked both mechanically and electrically before installation. The vane and cup wheel should easily rotate 360° without friction. Check vane balance by holding the instrument so the vane surface is horizontal. It should have near-neutral torque without any particular tendency to rotate. A slight imbalance will not degrade performance.

The wind direction potentiometer requires a stable DC excitation voltage. Do not exceed 15 volts. When the potentiometer wiper is in the 8° deadband region, the output signal is "floating" and may show varying or unpredictable values. To prevent false readings, signal conditioning electronics should clamp the signal to excitation or reference level when this occurs. **Note: All YOUNG signal conditioning devices clamp the signal to excitation level.** Avoid a short circuit between the wind direction signal line and either the excitation or ground reference lines. Although there is a current limiting resistor in series with the wiper for protection, damage to the potentiometer may occur if a short circuit condition exists.

Before installation, connect the instrument to a signal conditioning device as shown in the wiring diagram and check for proper wind speed and direction values. To check wind speed, temporarily remove the cup wheel and connect an Anemometer Drive to the cup wheel shaft. Details appear in the CALIBRATION section.

INSTALLATION

Proper placement of the instrument is very important. Eddies from trees, buildings, or other structures can greatly influence wind speed and direction observations. To get meaningful data for most applications, locate the instrument well above or upwind of such obstructions. As a general rule, the air flow around a structure is disturbed to twice the height of the structure upwind, six times the height downwind, and twice the height of the structure above ground. For some observations it may not be practical or necessary to meet these guidelines.

03002-5-90(D)

FAILURE TO PROPERLY GROUND THE WIND SENTRY MAY RESULT IN ERRONEOUS SIGNALS OR TRANSDUCER DAMAGE.

Grounding the Wind Sentry is vitally important. Without proper grounding, static electrical charge can build up during certain atmospheric conditions and discharge through the transducers. This discharge can cause erroneous signals or transducer failure. To direct the discharge away from the transducers, the instrument is made with a special anti-static plastic. It is very important that the instrument be connected to a good earth ground. There are two ways this may be accomplished. First, the Wind Sentry may be mounted on a metal pipe which is connected to earth ground. The mounting pipe should not be painted where the Wind Sentry is mounted. Towers or masts set in concrete should be connected to one or more grounding rods. If it is difficult to ground the mounting post in this manner, the following method should be used. Inside the junction box the terminal labeled EARTH GND is internally connected to the anti-static housings. This terminal should be connected to an earth ground (Refer to wiring diagram).

Initial installation is most easily done with two people; one to adjust the instrument position and the other to observe the indicating device. When anemometer and vane are mounted on the same cross arm (Model 03002), the azimuth potentiometer has been aligned at the factory such that the mounting cross arm should be oriented North-South with the vane on the North end.

To install the Wind Sentry, follow these steps:

1. MOUNT WIND SENTRY
   a) Connect sensor cable to Wind Sentry junction box.
   b) Place Wind Sentry on mounting post. Do Not tighten band clamp yet.
   c) Connect sensor cable to indicator.

2. ALIGN VANE
   a) Select a known azimuth reference point on the horizon.
   b) Sighting down vane centerline, point counterweight at reference point on horizon.
   c) While holding vane in position, slowly turn base until indicator displays proper value.
   d) Tighten mounting post band clamp.

CALIBRATION

The Wind Sentry is fully calibrated before shipment and should require no adjustments. Recalibration may be necessary after some maintenance operations. Periodic calibration checks are desirable and may be necessary where the instrument is used in programs which require auditing of sensor performance.

For wind direction calibration, the following method can yield an accuracy of ±5° or better if carefully done. Begin by connecting the instrument to a signal conditioning circuit which indicates wind direction value. This may be an indicator which displays wind direction values in angular degrees or simply a voltmeter monitoring the output. Hold or mount the instrument so the vane center of rotation is over the center of a sheet of paper which has 30° or 45° crossmarkings. Position the instrument so the mounting crossarm is oriented north-south with the vane on the north and the anemometer on the south. With the counterweight pointing directly at the anemometer the wind direction signal should correspond to 180° or due south. Looking from above, visually align the vane with each of the crossmarkings and observe the indicator display. It should correspond to vane position within 5°. If not, it may be necessary to adjust the relative position of the vane skirt and shaft. See step 3 in the MAINTENANCE section under potentiometer replacement.

It is important to note that while the sensor mechanically rotates through 360°, the full scale wind direction signal from the signal conditioning occurs at 352°. For example, in a circuit where 0 to 1.00 VDC represents 0° to 360°, the output must be adjusted for 0.978 VDC when the instrument is at 352° full scale. (352°/360° X 1.00 volts = 0.978 volts)

Wind speed calibration is determined by the cup wheel turning factor and the output characteristics of the transducer. Calibration formulas showing cup wheel rpm and frequency output vs. wind speed are included below.

To calibrate wind system electronics using an actual signal from the instrument, temporarily remove the cup wheel and connect an Anemometer Drive to the cup wheel shaft. Calculate wind speed by applying the appropriate calibration formula to the motor rpm and adjust the signal conditioning electronics for proper value. For example, with the cup wheel shaft turning at 1800 rpm, adjust the indicator to display 22.7 meters per second. ([(0.01250 X 1800) + 0.2] = 22.7)

CALIBRATION FORMULAS

Model 03102 Wind Sentry Anemometer

WIND SPEED vs CUP WHEEL RPM

m/s	=	(0.01250 x rpm) + 0.2
knots	=	(0.02427 x rpm) + 0.4
mph	=	(0.02795 x rpm) + 0.4
km/hr	=	(0.04499 x rpm) + 0.7

WIND SPEED vs OUTPUT FREQUENCY - Hz

m/s	=	(0.7500 x Hz) + 0.2
knots	=	(1.4562 x Hz) + 0.4
mph	=	(1.6770 x Hz) + 0.4
km/hr	=	(2.6994 x Hz) + 0.7

MAINTENANCE

Given proper care, the Wind Sentry should provide years of service. Because of its durable, corrosion resistant construction, the instrument requires little maintenance. The only components likely to require replacement due to normal wear are the precision ball bearings and the azimuth potentiometer. Replacement of these components should only be performed by a qualified instrument technician. If service facilities are not available, return the instrument to the factory. Refer to the accompanying drawings to become familiar with part names and locations. Maximum torque on all set screws is 80 oz-in.

POTENTIOMETER REPLACEMENT

The potentiometer has a life expectancy of fifty million revolutions. As it becomes worn, the element may produce noisy signals or become non-linear. When the signal noise or non-linearity become unacceptable, replace the potentiometer as follows:

1. REMOVE POTENTIOMETER
   a) Remove three screws which secure upper and lower sections of main housing.
   b) Carefully remove upper housing exposing wiring connections to circuit board.
   c) Unsolder potentiometer wires from circuit board. Note color coding.
   d) Using a knife blade or similar instrument, loosen potentiometer assembly from upper housing and slide it out.

2. INSTALL NEW POTENTIOMETER
   a) Slide new potentiometer cell into upper housing. Be sure to engage cell key into housing notch.
   b) Solder potentiometer wires to circuit board. Observe color code.
   c) Join two sections of main housing. Secure with screws removed in step 1a.

3. ALIGN VANE
   a) Connect excitation voltage and signal conditioning electronics to instrument according to wiring diagram.
   b) Loosen set screw in side of vane hub.
   c) Position instrument so crossarm is oriented north-south with vane on north side. Orient vane to a known angular reference. (See CALIBRATION section.)
   d) While holding vane in reference position, slowly turn vane skirt until signal conditioning system indicates proper value.
   e) Tighten set screw on side of vane hub. Do not exceed 80 oz-in torque.

ANEMOMETER FLANGE BEARING REPLACEMENT

If anemometer bearings become noisy or wind speed threshold increases above an acceptable level, replace the bearings. Check bearing condition by hanging an ordinary paper clip (0.5 gm) on the outside edge of one cup while the instrument is held in a horizontal position. The cup should rotate downward. Failure to rotate due to the weight of the paper clip indicates anemometer bearings need replacement. Repeat this test at different positions to check full bearing rotation. Replace bearings as follows:

1. REMOVE BEARINGS
   a) Loosen set screw on side of cup wheel hub. Remove cup wheel.
   b) Remove three screws which hold two sections of main housing.
   c) Carefully separate upper and lower housing. Remove coil transducer assembly from upper housing. Do not disconnect from circuit board.
   d) Loosen screw and remove ring magnet on end of shaft inside upper housing.
   e) Slide shaft and skirt assembly out of both upper and lower bearings.
   f) Using knife blade under bearing flange, carefully remove upper bearing.
   g) Using a pencil, gently push out lower bearing from above.

2. INSTALL NEW BEARINGS
   a) Insert new upper bearing. Use care not to apply excessive pressure.
   b) Slide cup wheel shaft through upper bearing.
   c) Slide lower bearing on shaft inside upper housing.
   d) Using ring magnet assembly, push lower bearing into its seat in upper housing.
   e) Secure ring magnet to shaft using screw removed in step 1d. Use a small amount of sealant on screw to prevent it from loosening.
   f) Join two housing sections. Secure using three screws removed in step 1b.
   g) Place cup wheel on shaft. Tighten set screw on side of hub. Do not exceed 80 oz-in torque.

VANE FLANGE BEARING REPLACEMENT

If vane bearings become noisy or if wind direction threshold increases above an acceptable level, replace the bearings. Check bearing condition by adding two ordinary paper clips (0.5 gm each) to the back edge of the vane fin while the instrument and vane are held in a horizontal position. Gently release the vane. It should rotate downward. Failure to do so indicates the bearings need replacement. Repeat this test at various positions to check full bearing rotation. Since this procedure is similar to anemometer bearing replacement, only the major steps are shown here:

1. REMOVE BEARINGS
   (Remove coupling disc - same as ring magnet)
2. INSTALL NEW BEARINGS
3. ALIGN VANE (See CALIBRATION section)

WARRANTY

This product is warranted to be free of defects in materials and construction for a period of 12 months from date of initial purchase. Liability is limited to repair or replacement of defective item. A copy of the warranty policy may be obtained from R. M. Young Company.

CE COMPLIANCE

This product has been tested and shown to comply with European CE requirements for the EMC Directive. Please note that shielded cable must be used.

Declaration of Conformity

R. M. Young Company
2801 Aero Park Drive
Traverse City, MI 49686 USA

Models 03002, 03102, 03302

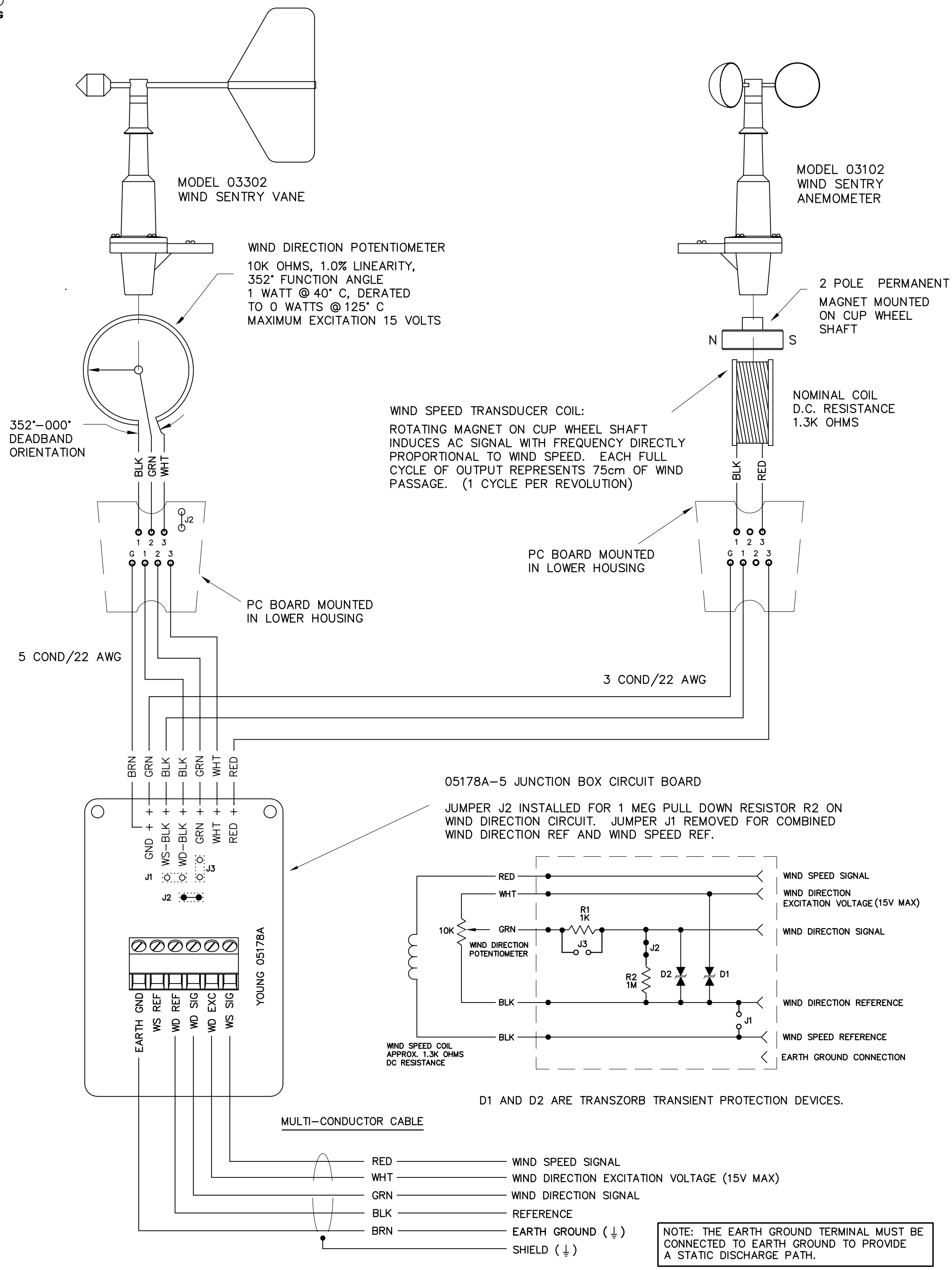
The undersigned hereby declares on behalf of R. M. Young Company that the above-referenced product, to which this declaration relates, is in conformity with the provisions of:

Council Directive 2004/108/EC (December 15, 2004) on Electromagnetic Compatibility

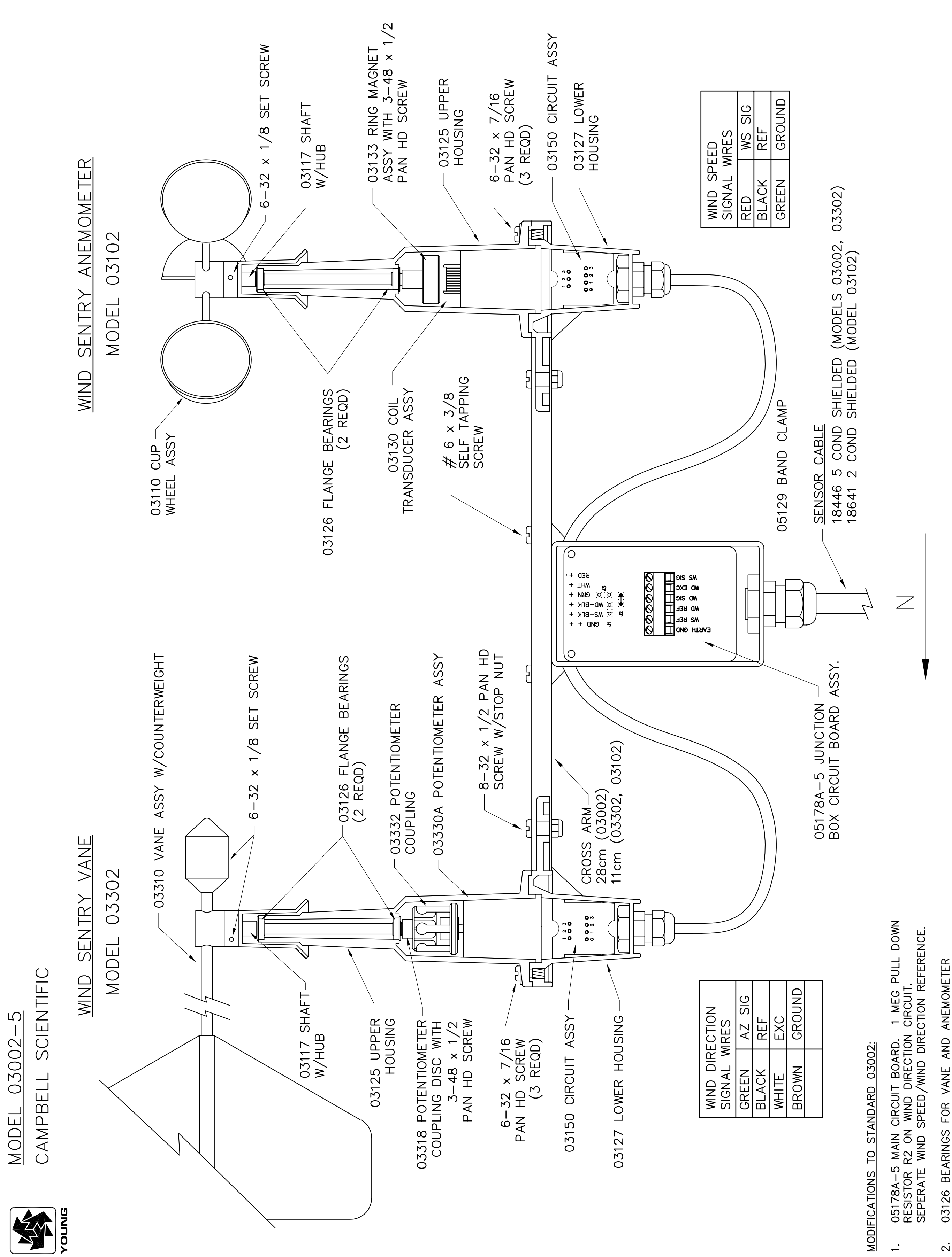
David Poinsett
R&D Manager

CABLE & WIRING DIAGRAM

MODEL 03002–5 CAMPBELL SCIENTIFIC



GENERAL ASSEMBLY & REPLACEMENT PARTS



WIND SPEED SIGNAL WIRES	
RED	WS SIG
BLACK	REF
GREEN	GROUND

WIND DIRECTION SIGNAL WIRES	
GREEN	AZ SIG
BLACK	REF
WHITE	EXC
BROWN	GROUND

MODIFICATIONS TO STANDARD 03002:

1. 05178A-5 MAIN CIRCUIT BOARD. 1 MEG PULL DOWN RESISTOR R2 ON WIND DIRECTION CIRCUIT. SEPERATE WIND SPEED/WIND DIRECTION REFERENCE.
2. 03126 BEARINGS FOR VANE AND ANEMOMETER

03002-5-90(D)

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