INSTRUCTION MANUAL

03001 R.M. Young Wind Sentry Set
03101 R.M. Young Wind Sentry Anemometer
03301 R.M. Young Wind Sentry Vane

Revision: 8/07

Warranty and Assistance

The **03001 R.M. YOUNG WIND SENTRY SET, 03101 R.M. YOUNG WIND SENTRY ANEMOMETER, AND 03301 R.M. YOUNG WIND SENTRY VANE** are warranted by CAMPBELL SCIENTIFIC, INC. to be free from defects in materials and workmanship under normal use and service for twelve (12) months from date of shipment unless specified otherwise. Batteries have no warranty. CAMPBELL SCIENTIFIC, INC.'s obligation under this warranty is limited to repairing or replacing (at CAMPBELL SCIENTIFIC, INC.'s option) defective products. The customer shall assume all costs of removing, reinstalling, and shipping defective products to CAMPBELL SCIENTIFIC, INC. CAMPBELL SCIENTIFIC, INC. will return such products by surface carrier prepaid. This warranty shall not apply to any CAMPBELL SCIENTIFIC, INC. products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. CAMPBELL SCIENTIFIC, INC. is not liable for special, indirect, incidental, or consequential damages.

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> **CAMPBELL SCIENTIFIC, INC.**
> RMA#_____
> 815 West 1800 North
> Logan, Utah 84321-1784

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R.M. Young Wind Sentry

1. Introduction

The 03001 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.

Vane position is transmitted by a 10K ohm 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. The R.M. Young Instruction Manual includes additional information on the operating principles, installation and maintenance of the sensor.

Lead length for the Wind Sentry is specified when the sensor is ordered. Table 1-1 gives the recommended lead length for mounting the sensor at the top of the tripod/tower with a 019ALU or CM200 series crossarm.

TABLE 1-1. Recommended Lead Lengths							
CM6	CM10	CM110	CM115	CM120	UT10	UT20	UT30
12'	15'	15'	20'	25'	15'	25'	38'

The 03001 Wind Sentry ships with:

(1) 03001 Wind Sentry including
    03101 Anemometer
    03301 Vane
    crossarm
    band clamp (P/N 4919)
(1) 10" x 3/4" unthreaded aluminium pipe (P/N 6332)
(1) Allen wrench (P/N 5201)

The 03101 Anemometer ships with:

(1) 03101 Anemometer
(1) 10" x 3/4" threaded galvanized pipe (P/N 12243)
(1) Allen wrench (P/N 5201)

The 03301 Vane ships with:

(1) 03301 Vane
(1) 10" x 3/4" threaded galvanized pipe (P/N 12243)
(1) Allen wrench (P/N 5201)

2. Specifications

Wind Speed (Anemometer) Specifications

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, 1350 ohm nominal resistance
Transducer 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)

Wind Direction (Vane) Specifications

Range:	360° mechanical, 355° electrical (5° 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 K ohm resistance; 0.5% linearity; life expectancy 20 million revolutions.
	Rated 1 watt at 40°C, 0 watts at 125°C.
Transducer 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)

Wind Sentry Assembly Specifications

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:	26.7 mm (1.05 in), mounts on standard 3/4 in. pipe

| NOTE | The black outer jacket of the cable is Santoprene® rubber. This compound was chosen for its resistance to temperature extremes, moisture, and UV degradation. However, this jacket will support combustion in air. It is rated as slow burning when tested according to U.L. 94 H.B. and will pass FMVSS302. Local fire codes may preclude its use inside buildings. |

3. Installation

3.1 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 windset 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 9 for a list of references that discuss siting wind speed and direction sensors.

3.2 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

3.3 03001 Wind Sentry Set

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

The 03001 mounts to a standard 0.75" IPS schedule 40 pipe (1.05" O.D.). A 12" long mounting pipe ships with the 03001 for attaching the sensor to a 019ALU or CM200 series crossarm with the CM220 or PN 1049 (Figures 3-1 and 3-2). The 03001 can also be mounted at the top of a CM6/CM10 tripod mast, or to a CM110 series tripod with the CM216 as shown in Figure 3-4.

Mount the 019ALU or CM200 series crossarm to the tripod or tower. Orient the crossarm North-South, with the 3/4" Nu-Rail or CM220 on the North end. Appendix A contains detailed information on determining true north using a compass and the magnetic declination for the site.

Secure the mounting pipe to the 019ALU or CM220. Place the 03001 on the pipe, and orient the sensor crossarm North-South with the vane to the North. 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.

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.
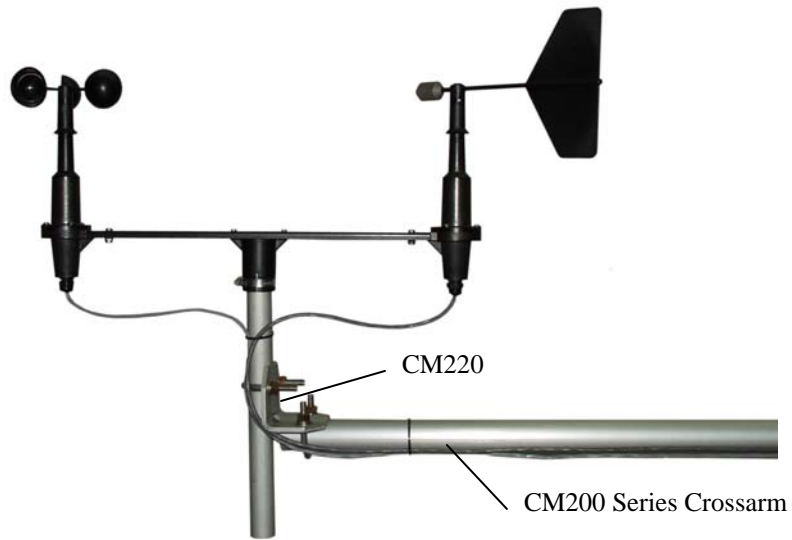
FIGURE 3-1. 03001 Mounted to CM200 Series Crossarm with CM220
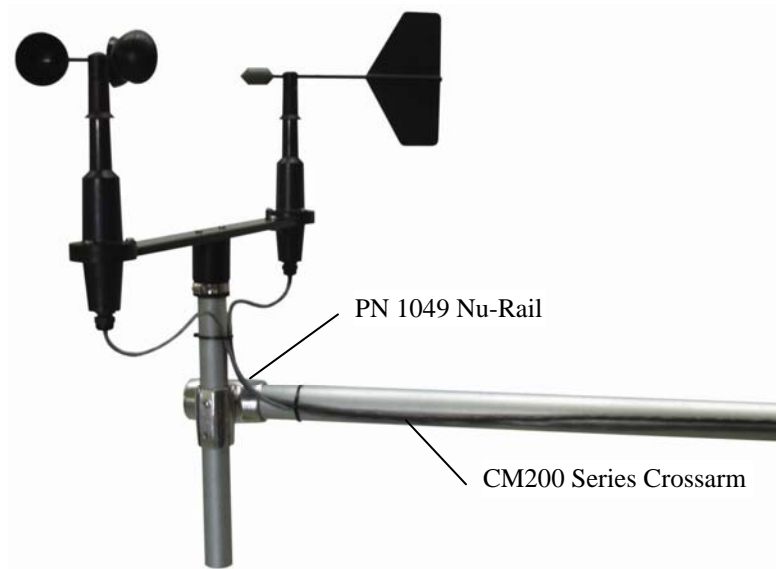
FIGURE 3-2. 03001 Mounted to 019ALU or CM200 Series Crossarm with PN 1049

CM220

CM200 Series Crossarm

*FIGURE 3-3. 03101 Anemometer Mounted to CM200 Series Crossarm
with CM220*

CM216

*FIGURE 3-4. 03001 Mounted to CM100 Series Tripod Mast
with CM216*

3.4 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" IPS schedule 40 pipe (1.05" O.D.). A 10" long mounting pipe ships with the 03101 for attaching the sensor to a 019ALU or CM200 series crossarm with CM220 (Figures 3-3) or PN 1049. The 03001 can also be mounted at the top of a CM6/CM10 tripod mast, or to a CM110 series tripod with the CM216.

Mount the 019ALU or 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.

3.5 03301 Vane

The 03301 Vane is typically ordered as a replacement vane for the 03001 Wind Sentry Set, and includes the bracket for attaching it to the 03001 crossarm. PN 4913 pipe mount (not included with the sensor) can be used to attach the 03301 to a 019ALU or CM200 series crossarm (with the CM220 or PN 1049), and the mounting pipe that ships with the sensor.

4. Wiring

Connections to Campbell Scientific dataloggers are given in Table 4-1. When Short Cut for Windows software 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>
<tr><td colspan="6" align="center">TABLE 4-1. Connections to Campbell Scientific Dataloggers</td></tr>
<tr><td>Color</td><td>Description</td><td>CR800
CR5000
CR3000
CR1000</td><td>CR510
CR500
CR10(X)</td><td>CR21X
CR7
CR23X</td><td>CR200</td></tr>
<tr><td>Black</td><td>Wind Spd. Signal</td><td>Pulse</td><td>Pulse</td><td>Pulse</td><td>P_LL</td></tr>
<tr><td>White</td><td>Wind Spd. Reference</td><td>⏚</td><td>G</td><td>⏚</td><td>⏚</td></tr>
<tr><td>Clear</td><td>Wind Spd. Shield</td><td>⏚</td><td>G</td><td>⏚</td><td>⏚</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Red</td><td>Wind Dir. Signal</td><td>SE Analog</td><td>SE Analog</td><td>SE Analog</td><td>SE Analog</td></tr>
<tr><td>Black</td><td>Wind Dir. Excitation</td><td>Excitation</td><td>Excitation</td><td>Excitation</td><td>Excitation</td></tr>
<tr><td>White</td><td>Wind Dir. Reference</td><td>⏚</td><td>AG</td><td>⏚</td><td>⏚</td></tr>
<tr><td>Clear</td><td>Wind Dir. Shield</td><td>⏚</td><td>G</td><td>⏚</td><td>⏚</td></tr>
</table>

```
       CONNECTOR PIN-OUT                      CONNECTOR PIN-OUT

              3                                      3
          4   6   2                             4    6    2
            5   1                                  5    1


   PIN 1 -  NO CONNECTION              PIN 1 -  SIGNAL +
   PIN 2 -  NO CONNECTION              PIN 2 -  AZIMUTH REFERENCE
   PIN 3 -  NO CONNECTION              PIN 3 -  EXCITATION
   PIN 4 -  PULSE OUT                  PIN 4 -  NO CONNECTION
   PIN 5 -  PULSE REFERENCE            PIN 5 -  NO CONNECTION
   PIN 6 -  SHIELD                     PIN 6 -  SHIELD
```

Wind Speed   **Wind Direction**
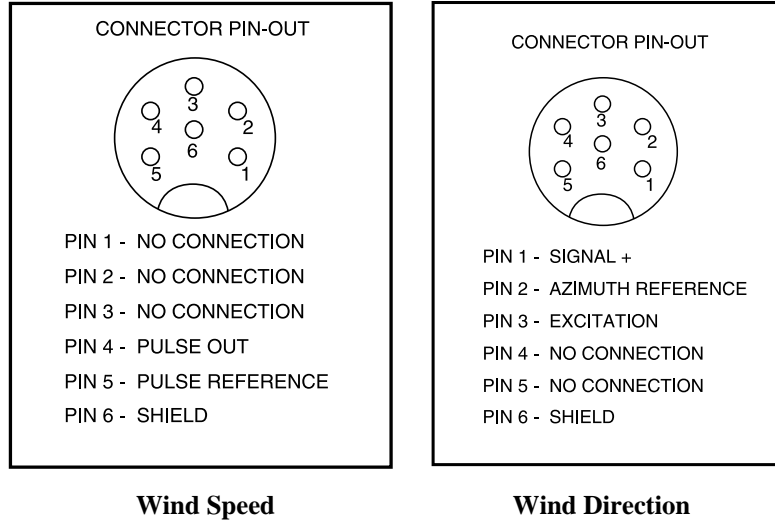
5. Example Programs

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

5.1 Wind Speed

Wind speed is measured with the Pulse Count instruction, and with 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 5-1 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 Hz.

TABLE 5-1. Wind Speed Multiplier (With Configuration Code 21*)		
Model	**Meters/Second**	**Miles/Hour**
03001 / 03101	M = 0.750 Off = 0.2	M = 1.677 Off = 0.4
*When configuration code 11 is used, the multiplier above is divided by the execution interval in seconds.		

5.2 Wind Direction

The wind vane is coupled to a 10K potentiometer, which has a 5 degree electrical dead band between 355 and 360 degrees.

The EX-DEL_SE measurement instruction (P4) is used for dataloggers that are programmed with Edlog (e.g. CR10X, CR23X) and the CR200. The multiplier to convert the measurement result (mV) to degrees is 355 deg/excitation mV.

The BRHalf measurement instruction is used for dataloggers that are programmed with CRBasic (e.g. CR1000, CR3000). The multiplier to convert the measurement result (mV/excitation mV) to degrees is 355.

Excitation voltages, range codes, and multipliers for CSI dataloggers are listed in Table 5-2. Appendix B has additional information on the P4 and BRHalf measurement instructions.

TABLE 5-2. Parameters for Wind Direction				
	CR10(X) CR510 CR200	**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	0.142	0.071	355	355
Offset	0	0	0	0

5.3 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.

5.4 Example Programs

The following programs measure the 03001 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 5-3.

TABLE 5-3. Wiring for Example Programs			
Color	**Description**	**CR1000**	**CR10X**
Black	Wind Spd. Signal	P1	P1
White	Wind Spd. Reference	⏚	G
Clear	Wind Spd. Shield	⏚	G
Red	Wind Dir. Signal	SE 1	SE 1
Black	Wind Dir. Excitation	EX 1	E1
White	Wind Dir. Reference	⏚	AG
Clear	Wind Dir. Shield	⏚	G

5.4.1 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(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)

        '03001 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

        '03001 or 03301 RM Young Wind Sentry Wind Direction Sensor measurement - WindDir:
        BrHalf(WindDir,1,mV2500,1,1,1,2500,True,0,_60Hz,355,0)
        '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
```

5.4.2 CR10X Example Program

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

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

;03001 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

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)

;03001 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:  0.142          Multiplier ;0.071 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   ]
```

5.5 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), 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.

6. 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 non-linear. Replace the potentiometer when the noise or non-linearity becomes unacceptable.

Contact Campbell Scientific for a Return Materials Authorization (RMA) number at (801) 753-2342.

7. Troubleshooting

7.1 Wind Direction

Symptom: -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 10K ohms between the black and white wires. The resistance between either the black/red or white/red wires should vary from 1K to 11K depending on vane position. Resistance when the vane is in the 5 degree dead band should be about 1M ohm.

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 3.

7.2 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 should be a nominal 1350 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.

8. 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. Magnetic declination for a specific site can be obtained from a USGS map, local airport, or through a computer service offered by the USGS at www.ngdc.noaa.gov/seg/geomag/. 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 0 degrees to get True North as shown Figure A-2. 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 palm.

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.

Subtract declination from 360°   Add declination to 0°
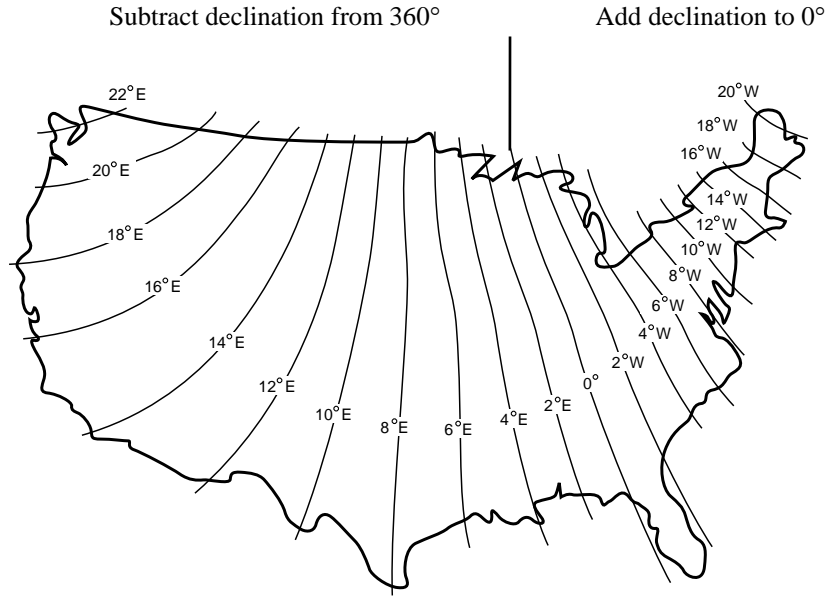

FIGURE A-1. Magnetic Declination for the Contiguous United States
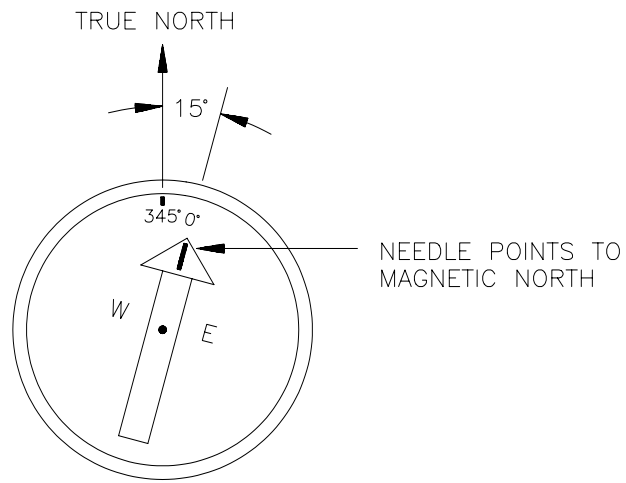

FIGURE A-2. Declination Angles East of True North Are Subtracted
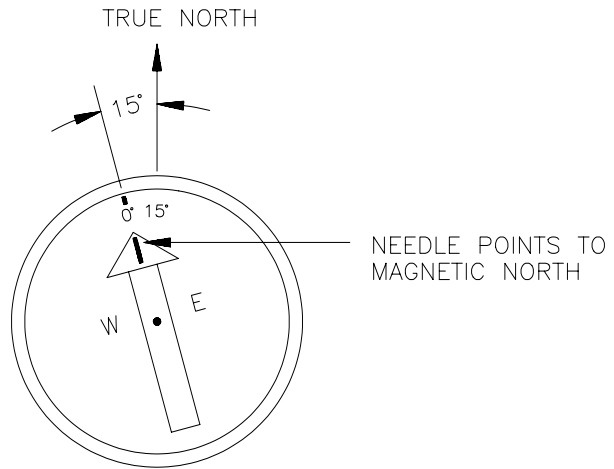*From 0 to Get True North*

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 03001 with Campbell Scientific's datalogger.
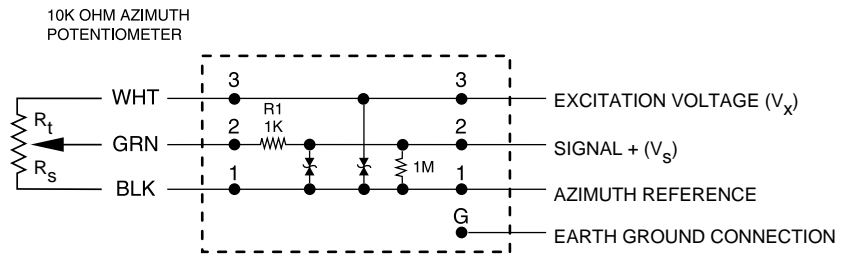
FIGURE B-1. 03001 / 03301 Potentiometer in a Half Bridge Circuit

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 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 both the CR10(X) and CR3000, even though they use a different excitation voltage. See Section 13.5 in the datalogger manual from 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 355 degrees. The multiplier to convert V_s to degrees is 355 degrees / 2500 mV = 0.142 for the CR10X, or, 355 degrees / 5000 mV = 0.071 for the CR23X. See Section 13.5 in the datalogger manual from more information on the bridge measurements

MODEL 03001-5
WIND SENTRY

WIND DIRECTION (AZIMUTH) SPECIFICATION SUMMARY:

Range	360° mechanical, 355° electrical (5° 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 (1.8mph) at 10° displacement 1.8 m/s (4.0 mph) at 5° displacement
Transducer	Precision conductive plastic potentiometer, 10K ohm ±20% resistance 0.5% 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

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 metal shields to exclude contamination. Optional sealed bearings are available to help retain lubricant for longer service life. The light contacting seals result in slightly higher threshold values.

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 azimuth angle.

The sensors are normally supplied with an anodized aluminum crossarm which mounts on a vertical standard 3/4" pipe, outside diameter 27mm (1.06"). The crossarm mounting is secured to the pipe by a stainless steel band clamp. Separately supplied Sentry anemometers or windvanes normally mount on vertical 3/4" threaded pipe. A variety of devices are available for signal conditioning, display, and recording of wind speed and direction. These sensors will also interface directly with data loggers from several different manufacturers.

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 in 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, however a slight imbalance will not degrade performance.

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 (63% recovery)	2.3 m (7.5 ft)
Threshold	0.5 m/s (1.1 mph)
Transducer	Stationary coil, 1350 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. 0.75 m/s per Hz

The wind direction potentiometer requires a stable DC excitation voltage. Do not exceed 15 volts. When the potentiometer wiper is in the 5° deadband region, the output signal is "floating" and may show varying or unpredictable values. Azimuth signal conditioning electronics should properly process this condition. (All YOUNG signal conditioning electronics meet these requirements.) Avoid a short circuit between the azimuth signal line and either the excitation or ground reference lines. Although there is a 1K ohm 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 Wind Sentry to a signal conditioning device and check for proper wind speed and direction values. Make electrical connections to the sensor cables supplied with the instrument as shown in the wiring diagram. Positioning the vane over the center of a sheet of paper with 35° or 45° cross markings allows easy visual alignment of the vane. To check wind speed, temporarily remove the cup wheel and connect its shaft to a Model 18810 Anemometer Drive. 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.

Initial installation is most easily done with two people during the vane alignment step; one to adjust the instrument position and the other to observe the indicating device. The standard Wind Sentry includes a 3 meter (10 ft.) length of cable. Additional cable may be connected by splicing or termination in a user supplied junction box. Make sure the connection is waterproof.

To install the Wind Sentry, follow these steps:

1. MOUNT WIND SENTRY
   a) Place Wind Sentry on mounting post. Do Not tighten band clamp yet.
   b) 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 toward azimuth reference 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 has some way to indicate azimuth value. This may be an indicator which displays azimuth 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 azimuth 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 full scale azimuth on signal conditioning electronics may be 360°, full scale azimuth signal from the instrument is 355°. The signal conditioning electronics must be adjusted accordingly. For example, in a circuit where 0 to 1.00 VDC represents 0° to 360°, the output must be adjusted for 0.986 VDC when the instrument is at 355° full scale. (355°/360° X 1.00 volts = 0.986 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 in this manual. These formulas are accurate to within 2 percent.

To calibrate wind system electronics using an actual signal from the instrument, temporarily remove the cup wheel and connect a Model 18801 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 trim the indicator to display 22.7 meters per second. (0.01250 X 1800 + 0.2 = 22.7)

MAINTENANCE

Given proper care, the Wind Sentry should provide years of service. Constructed entirely of non-corrosive materials and using components which are conservatively rated, 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. The asterisk * which appears in the following outlines is a reminder that 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 usually begins to 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 electron-
      ics 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* in side of vane hub.

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 re-
      moved in step 1b.
   g) Place cup wheel on shaft. Tighten set screw* on side of hub.

VANE FLANGE BEARING REPLACEMENT:

If vane bearings become noisy or if wind direction threshold in-
creases 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 replace-
ment. 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)

*Max set screw torque 80 oz-in

CUP WHEEL RPM

4200
3600
3000
2400
1800
1200
600
0

WIND SPEED: meters per second, miles per hour, feet per second, knots, kilometers per hour

WIND SPEED vs CUPWHEEL RPM

m/s	=	(0.01250 × RPM) + 0.2
mph	=	(0.02795 × RPM) + 0.4
fps	=	(0.04100 × RPM) + 0.7
knots	=	(0.02427 × RPM) + 0.4
km/hr	=	(0.04499 × RPM) + 0.7

CALIBRATION POINTS

1800 RPM (30 Hz)
1500 RPM (25 Hz)

19.0 m/s
22.7 m/s
36.8 knots
44.1 knots
42.3 mph
50.7 mph
62.2 fps
68.2 km/h
74.5 fps
81.7 km/h

meters per second (m/s)
kilometers per hour (km/hr)
knots
miles per hour (mph)
feet per second (fps)

WIND SPEED vs OUTPUT FREQENCY — Hz

m/s	=	(0.7500 × Hz) + 0.2
mph	=	(1.6770 × Hz) + 0.4
fps	=	(2.4600 × Hz) + 0.7
knots	=	(1.4562 × Hz) + 0.4
km/hr	=	(2.6994 × Hz) + 0.7

WIND SENTRY ANEMOMETER
MODEL 03101
WIND SPEED vs CUP WHEEL RPM
and
WIND SPEED vs OUTPUT FREQUENCY — Hz

A03110.DWG
JUNE 87

OUTPUT FREQUENCY — Hz

0 10 20 30 40 50 60 70

0 10 20 30 40 50 60 70 80 90 100

WIND SENTRY
MODEL 03101-5 ANEMOMETER - MODEL 03301-5 VANE
REPLACEMENT PARTS

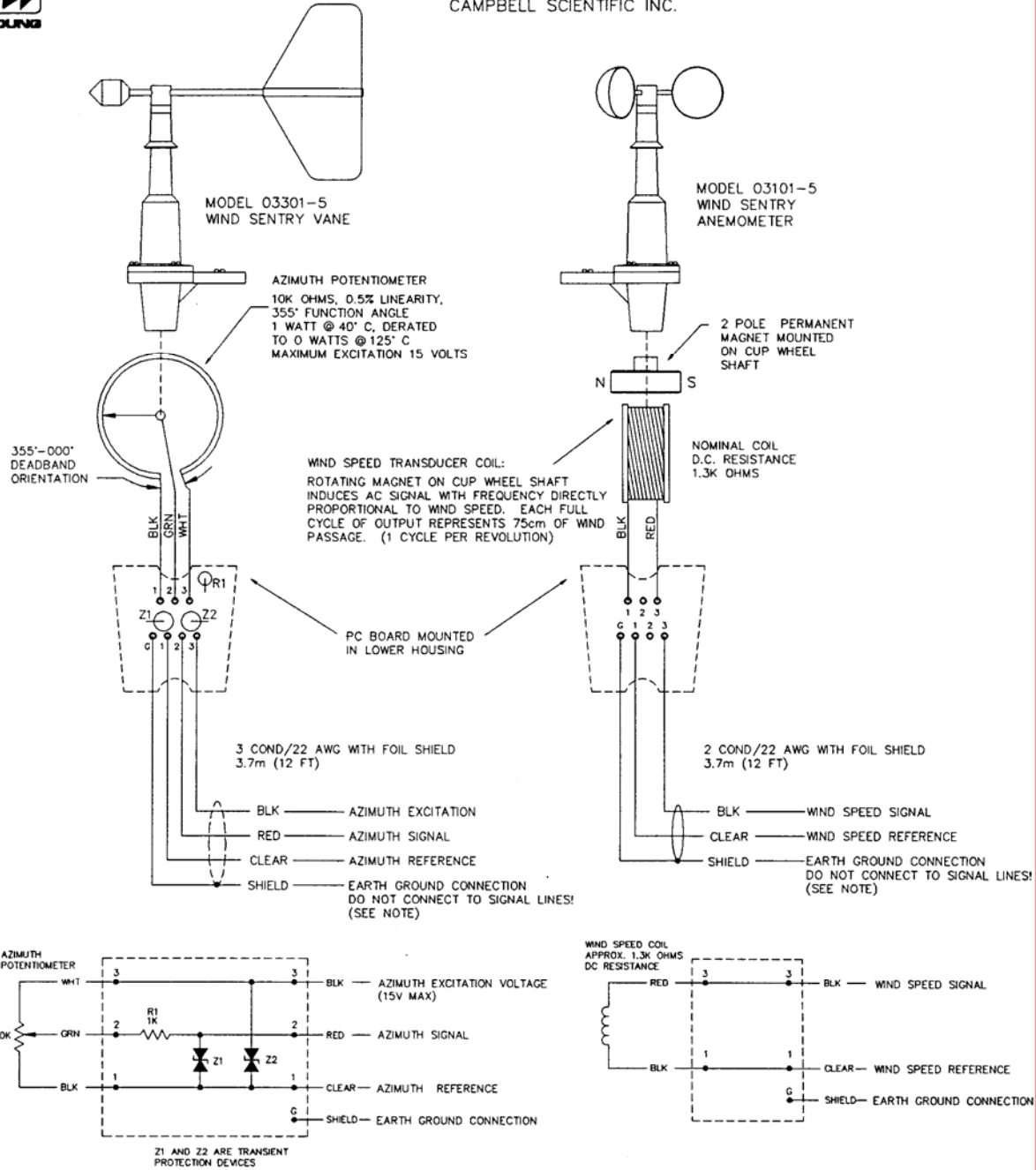| PART NO.	PART NAME
03011	CROSSARM - 40cm
03015-01	CROSSARM MOUNTING
03015-02	BAND CLAMP FOR 3/4" IPS
03101-5	WIND SENTRY ANEMOMETER - LESS MOUNTING
03110	CUP WHEEL ASSEMBLY
03117	SHAFT W/HUB
03120-5	MAIN HOUSING WITH COIL TRANSDUCER
03125	UPPER HOUSING
03126	FLANGE BEARING (2 REQD)
03127	LOWER HOUSING
03130	COIL TRANSDUCER ASSY .
03133	RING MAGNET ASSEMBLY W/ 3-48 X 1/2 PAN HD SCREW
03141	12 FT CABLE - 2 COND SHIELDED (BELDEN 8641)
03145	OFFSET MOUNTING 3/4" IPS
03301-5	WIND SENTRY VANE - LESS MOUNTING
03310	VANE ASSY W/ COUNTERWEIGHT
03318	POTENTIOMETER COUPLING DISC W/3-48 x 1/2 PAN HD SCREW
03320-5	MAIN HOUSING W/POTENTIOMETER TRANSDUCER
03330A	POTENTIOMETER ASSEMBLY
03341	12 FT CABLE - 3 COND SHIELDED (BELDEN 8771)
12316B	POTENTIOMETER COUPLING

MODEL 03001-5 WIND SENTRY ANEMOMETER AND VANE

CAMPBELL SCIENTIFIC INC.

MODEL 03301-5
WIND SENTRY VANE

MODEL 03101-5
WIND SENTRY
ANEMOMETER

AZIMUTH POTENTIOMETER
10K OHMS, 0.5% LINEARITY,
355° FUNCTION ANGLE
1 WATT @ 40° C, DERATED
TO 0 WATTS @ 125° C
MAXIMUM EXCITATION 15 VOLTS

2 POLE PERMANENT
MAGNET MOUNTED
ON CUP WHEEL
SHAFT

N   S

355°-000°
DEADBAND
ORIENTATION

WIND SPEED TRANSDUCER COIL:

ROTATING MAGNET ON CUP WHEEL SHAFT
INDUCES AC SIGNAL WITH FREQUENCY DIRECTLY
PROPORTIONAL TO WIND SPEED. EACH FULL
CYCLE OF OUTPUT REPRESENTS 75cm OF WIND
PASSAGE. (1 CYCLE PER REVOLUTION)

NOMINAL COIL
D.C. RESISTANCE
1.3K OHMS

BLK GRN WHT

R1

Z1   Z2

C 1 2 3

G 1 2 3

BLK RED

PC BOARD MOUNTED
IN LOWER HOUSING

3 COND/22 AWG WITH FOIL SHIELD
3.7m (12 FT)

2 COND/22 AWG WITH FOIL SHIELD
3.7m (12 FT)

BLK —— AZIMUTH EXCITATION

RED —— AZIMUTH SIGNAL

CLEAR —— AZIMUTH REFERENCE

SHIELD —— EARTH GROUND CONNECTION
DO NOT CONNECT TO SIGNAL LINES!
(SEE NOTE)

BLK —— WIND SPEED SIGNAL

CLEAR —— WIND SPEED REFERENCE

SHIELD —— EARTH GROUND CONNECTION
DO NOT CONNECT TO SIGNAL LINES!
(SEE NOTE)

AZIMUTH
POTENTIOMETER

WHT   3   3   BLK —— AZIMUTH EXCITATION VOLTAGE
                                              (15V MAX)

R1
1K

10K   GRN   2   2   RED —— AZIMUTH SIGNAL

Z1   Z2

BLK   1   1   CLEAR —— AZIMUTH REFERENCE

G   SHIELD —— EARTH GROUND CONNECTION

Z1 AND Z2 ARE TRANSIENT
PROTECTION DEVICES

WIND SPEED COIL
APPROX. 1.3K OHMS
DC RESISTANCE

RED   3   3   BLK —— WIND SPEED SIGNAL

BLK   1   1   CLEAR —— WIND SPEED REFERENCE

G   SHIELD —— EARTH GROUND CONNECTION
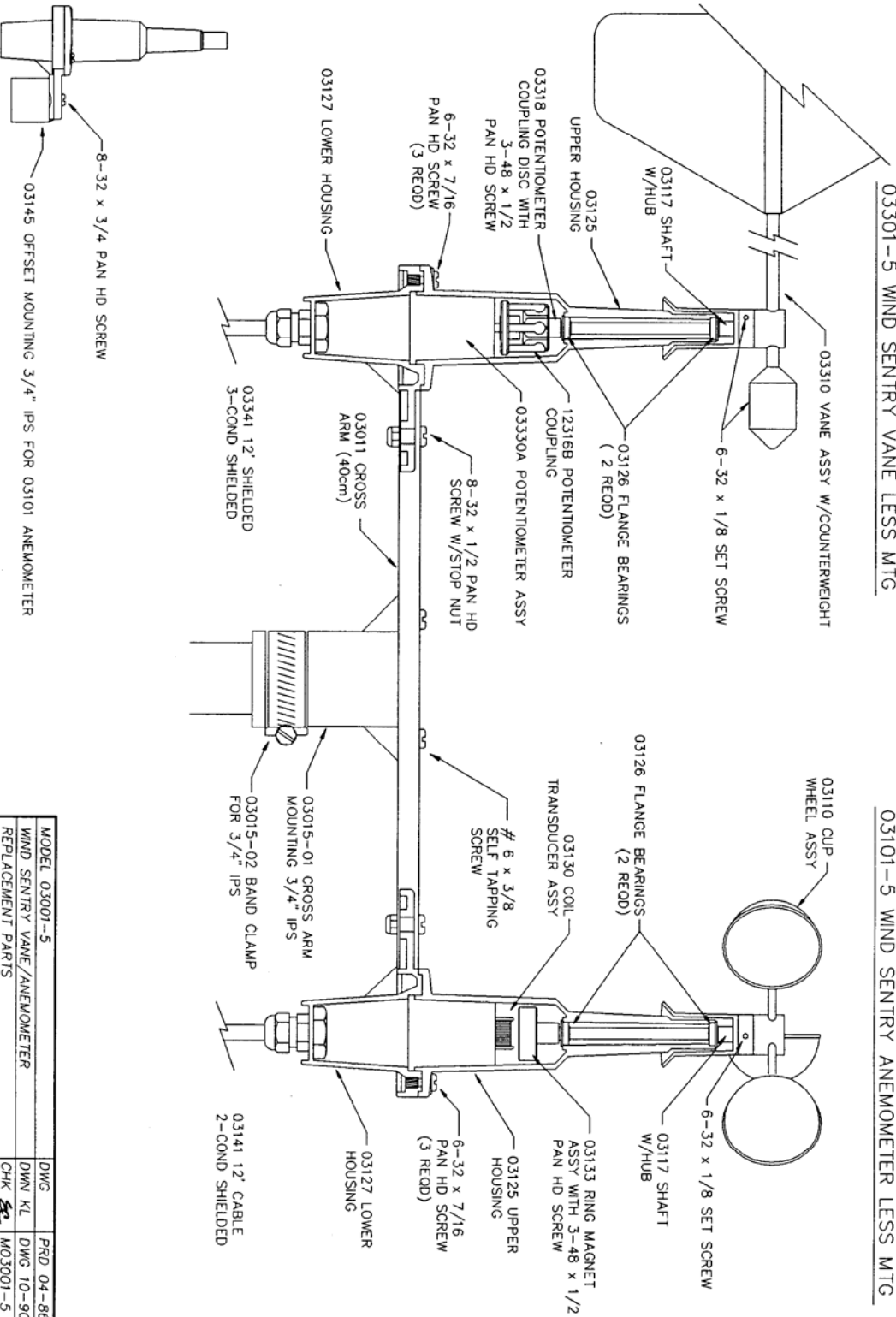
NOTE:

THE EARTH GROUND CONNECTIONS MUST BE CONNECTED TO EARTH GROUND TO PROVIDE A STATIC
DISCHARGE PATH. CONNECT THESE WIRES TO AN EARTH GROUND IN THE PROXIMITY OF THE SENSOR.

MODEL 03001-5	DWG A	PRD 08-90
WIND SENTRY CABLE & WIRING DIAGRAM	DWN KL	DWG 08-90
CAMPBELL SCIENTIFIC INC.	CHK Ec	W03001
R.M. YOUNG CO. TRAVERSE CITY, MI 49684 U.S.A. 616-946-3980		

03301-5 WIND SENTRY VANE LESS MTG

03101-5 WIND SENTRY ANEMOMETER LESS MTG

8-32 × 3/4 PAN HD SCREW

03145 OFFSET MOUNTING 3/4" IPS FOR 03101 ANEMOMETER

03127 LOWER HOUSING

03318 POTENTIOMETER COUPLING DISC WITH 3-48 × 1/2 PAN HD SCREW

6-32 × 7/16 PAN HD SCREW (3 REQD)

03125 UPPER HOUSING

03317 SHAFT W/HUB

03310 VANE ASSY W/COUNTERWEIGHT

6-32 × 1/8 SET SCREW

03126 FLANGE BEARINGS (2 REQD)

12316B POTENTIOMETER COUPLING

03330A POTENTIOMETER ASSY

8-32 × 1/2 PAN HD SCREW W/STOP NUT

03011 CROSS ARM (40cm)

03341 12' SHIELDED 3-COND SHIELDED

03015-01 CROSS ARM MOUNTING 3/4" IPS

03015-02 BAND CLAMP FOR 3/4" IPS

#6 × 3/8 SELF TAPPING SCREW

03130 COIL TRANSDUCER ASSY

03126 FLANGE BEARINGS (2 REQD)

03110 CUP WHEEL ASSY

03133 RING MAGNET ASSY WITH 3-48 × 1/2 PAN HD SCREW

6-32 × 7/16 PAN HD SCREW (3 REQD)

03125 UPPER HOUSING

03117 SHAFT W/HUB

6-32 × 1/8 SET SCREW

03127 LOWER HOUSING

03141 12' CABLE 2-COND SHIELDED

MODEL 03001-5
WIND SENTRY VANE/ANEMOMETER
REPLACEMENT PARTS
R.M. YOUNG CO. TRAVERSE CITY, MI 49684 U.S.A. 616-946-3980

DWG		PRD 04-86
DWN KL	DWG 10-90	
CHK	M03001-5	

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