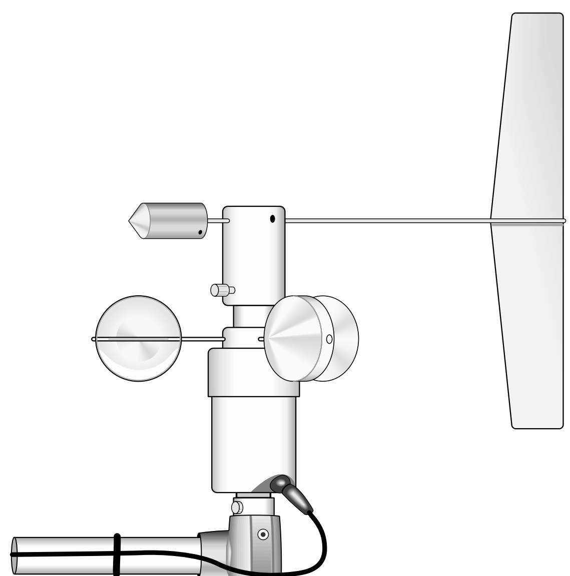
INSTRUCTION MANUAL

Met One 034B Windset

Revision: 8/07



Warranty and Assistance

The **MET ONE 034B WINDSET** is warranted by CAMPBELL SCIENTIFIC, INC. to be free from defects in materials and workmanship under normal use and service for twelve (12) months from date of shipment unless specified otherwise. Batteries have no warranty. CAMPBELL SCIENTIFIC, INC.'s obligation under this warranty is limited to repairing or replacing (at CAMPBELL SCIENTIFIC, INC.'s option) defective products. The customer shall assume all costs of removing, reinstalling, and shipping defective products to CAMPBELL SCIENTIFIC, INC. CAMPBELL SCIENTIFIC, INC. will return such products by surface carrier prepaid. This warranty shall not apply to any CAMPBELL SCIENTIFIC, INC. products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. CAMPBELL SCIENTIFIC, INC. is not liable for special, indirect, incidental, or consequential damages.

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Logan, Utah 84321-1784

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Figures

Tables

Met One 034B Windset

1. General

The 034B Windset is used to measure horizontal wind speed and direction.

Wind speed is measured with a three cup anemometer. Rotation of the cup wheel opens and closes a reed switch at a rate 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 accompanying Met One manual contains additional information on the operating principals, installation, and maintenance of the sensor.

Lead length for the 034B 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
11’	14’	14’	19’	24’	14’	24’	37’

The 034B Windset ships with:

(1) 1/16” Allen wrench
(1) Bushing
(1) Calibration Sheet
(3) Direction hub stickers
(1) Instruction Manual
(1) Wind Vane
(1) Sensor cable of user specified length

2. Specifications

Wind Speed

Operating Range: 0 to 49 m s^{-1} (0 to 110 mph)

Threshold: 0.4 m s^{-1} (0.9 mph)

Accuracy:

±0.12 m s^{-1} (±0.25 mph) for wind speed < 10.1 m s^{-1} (22.7 mph)
±1.1% of reading for wind speeds > 10.1 m s^{-1} (22.7 mph)

Output Signal: contact closure (reed switch)

Wind Direction

Range: 0 to 360° mechanical, 356° electrical (4° open)

Threshold: 0.4 m s^{-1} (0.9 mph)

Accuracy: ±4°

Resolution: 0.5°

Potentiometer Specifications:

Resistance: 0 to 10 kΩ open at crossover

General Specifications

Operating Temperature Range: -30° to +70°C

Weight: 907 g (2.0 lb.)

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 8 for a list of references that discuss siting wind speed and direction sensors.

3.2 Assembly and Mounting

Tools Required:

- 1/2” open end wrench (for CM220)
- 5/64” and 1/16” Allen wrenches
- 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

The wind vane tail must be attached to the hub. Install the tail assembly with the tail vertical. After tightening the set screw in the side of the hub that fastens the tail, cover the set screw hole with one of the small round labels included with the 034B. One of these labels is already installed on the hub covering the set screw that attaches the hub to the sensor. Extra labels are included with the 034B to recover the holes if the sensor has to be disassembled for maintenance.

CAUTION The set screw holes must be covered with the labels to prevent corrosion and assure the warranty.

Mount the 019ALU or CM200 series crossarm to the tripod or tower. Orient the crossarm North-South, with the 1" Nu-Rail or CM220 on the North end.

Remove the alignment screw at the base of the 034B (Figure 3-1). Insert the 034B into the aluminum bushing provided with the sensor. Align the hole in the bushing with that in the 034B base and replace the screw. Insert the 034B/bushing into the 3/4 x 1 inch Nu-Rail on the 019ALU or CM220 (Figure 3-2). Align the sensor so that the counter weight points to true south and tighten the set screws on the Nu-Rail or U-bolts on the CM220. Remove the shoulder screw to allow the vane to rotate.

Appendix A contains detailed information on determining true north using a compass and the magnetic declination for the site.

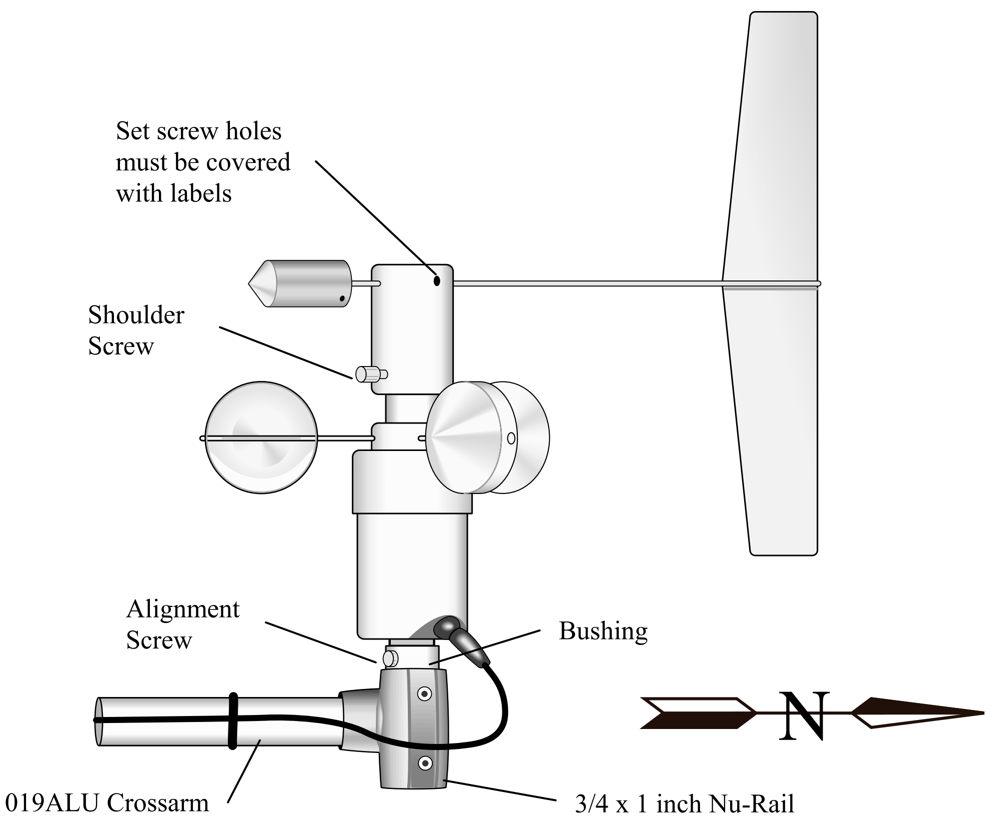


FIGURE 3-1. 034B Mounted on a 019ALU Crossarm.

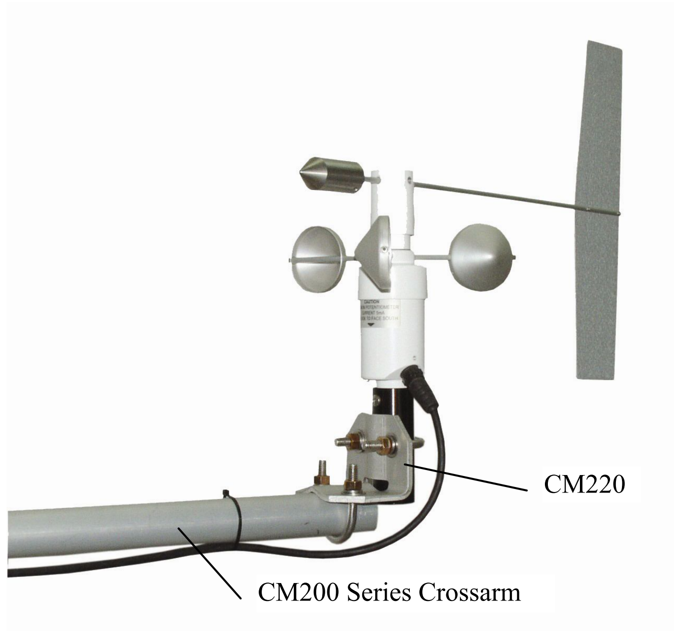


FIGURE 3-2. 034B Mounted on a CM200 Series Crossarm with CM220

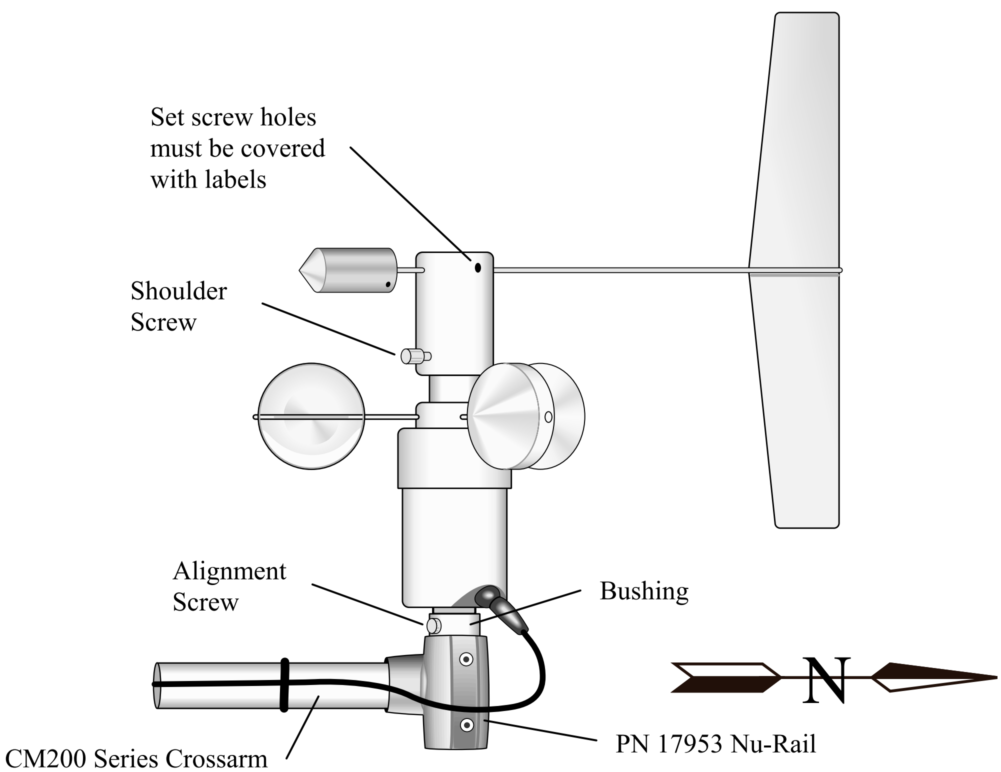


FIGURE 3-3. 034B Mounted on a CM200 Series Crossarm with PN 17953 Nu-Rail

Attach the sensor cable to the six pin male connector on the 034B. Make sure the connector is properly keyed. Finger tighten the knurled ring. Route the sensor cable along the underside of the crossarm to the tripod/tower, and to the instrument enclosure. Secure the cable to the crossarm and tripod/tower using cable ties.

4. Wiring

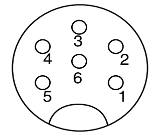
Connections to Campbell Scientific dataloggers are given in Table 4-1. When Short Cut for Windows software is used to create the datalogger program, the sensor should be wired to the channels shown on the wiring diagram created by Short Cut.

TABLE 4-1. Connections to Campbell Scientific Dataloggers

Color	**Description**	**CR800 CR5000 CR3000 CR1000**	**CR510 CR500 CR10(X)**	**CR21X CR7 CR23X**	**CR200**
Red	Wind Spd. Signal	Pulse	Pulse	Pulse	P_LL
Black	Wind Spd. Reference	⏚	G	⏚	⏚
Green	Wind Dir. Signal	SE Analog	SE Analog	SE Analog	SE Analog
Blue	Wind Dir. Excitation	Excitation	Excitation	Excitation	Excitation
White	Wind Dir. Reference	⏚	AG	⏚	⏚
Clear	Wind Dir. Shield	⏚	G	⏚	⏚

The CR10X, CR23X, and dataloggers programmed with CRBasic can also measure wind speed on a control port. With this option the black wire is connected to the 5 V terminal.

CONNECTOR PIN-OUT



PIN 1 - AZIMUTH SIGNAL
PIN 2 - AZIMUTH REFERENCE
PIN 3 - AZIMUTH EXCITATION
PIN 4 - PULSE OUT
PIN 5 - PULSE REFERENCE
PIN 6 - SHIELD

NOTE 034A-L Windsets purchased directly from Met One Instruments have a different configuration on the 6 pin connector. In addition, they do not have the 10 kΩ resistance on the excitation line. The wiring diagram and the multiplier and offset, for wind direction, are different than the examples in this document.

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, with the Switch Closure configuration. For dataloggers programmed with Edlog, specify configuration code 22 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 22*)

Model	Meters/Second	Miles/Hour
034B	M = 0.7990 Off = 0.2811	M = 1.789 Off = 0.629
*When configuration code 12 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 ohm potentiometer, which has a 4 degree electrical dead band between 356 and 360 degrees. 034B sensors purchased from CSI have a 10K ohm resistance is series with the potentiometer as shown in Appendix B.

The AC Half Bridge measurement instruction (P5), is used for dataloggers that are programmed with Edlog (e.g. CR10X, CR23X) to measure wind direction. The multiplier to convert the measurement result (mV/excitation mV) to degrees is 712.

The EX-DEL_SE measurement instruction (P4) can also be used for dataloggers that are programmed with Edlog (e.g. CR10X, CR23X) and the CR200, and is recommended for sensor leads longer than 100'. The multiplier to convert the measurement result (mV) to degrees is 712 excitation mV.

The BRHalf measurement instruction is used for dataloggers that are programmed with CRBasic (e.g. CR100, CR3000). The multiplier to convert the measurement result (mV/excitation mV) to degrees is 712/excitation mV.

Excitation voltages, range codes, and multipliers for CSI dataloggers are listed in Table 5-2. Appendix B has additional information on the P4, P5 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 (P5)	712	712	712	712
Multiplier (P4)	0.285	0.142		
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 034B 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**
Red	Wind Spd. Signal	P1	P1
Black	Wind Spd. Reference	⏚	G
Green	Wind Dir. Signal	SE 1	SE 1
Blue	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)
        '034A/034B Wind Speed & Direction Sensor measurements WS_ms and WindDir:
        PulseCount(WS_ms,1,1,2,1,0.799,0.2811)
        If WS_ms=0.2811 Then WS_ms=0
        BrHalf(WindDir,1,mV2500,1,1,1,2500,True,0,_60Hz,712.0,0)  'mV5000 'range, 5000 mV
'excitation for the CR3000 and CR5000 dataloggers
        If WindDir>=360 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:  Pulse (P3)
  1:   1             Reps
  2:   1             Pulse Channel 1
  3:   22            Switch Closure, Output Hz
  4:   3             Loc [ WS_ms     ]
  5:   0.799         Multiplier
  6:   0.2811        Offset

2:  If (X<=>F) (P89)
  1:   3             X Loc [ WS_ms     ]
  2:   1             =
  3:   0.2811        F
  4:   30            Then Do

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

4:  End (P95)

5:  AC Half Bridge (P5)
  1:   1             Reps
  2:   25            2500 mV 60 Hz Rejection Range   ; 5000 mV(slow/60 hz) for CR23X, 21X
  3:   1             SE Channel
  4:   1             Excite all reps w/Exchan 1
  5:   2500          mV Excitation                   ; 5000 mV for CR23X, 21X, CR7
  6:   4             Loc [ WindDir   ]
  7:   712           Multiplier
  8:   0.0           Offset

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

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

8:  End (P95)
```

```
9:  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)

10:  Set Active Storage Area (P80)
   1:    1               Final Storage Area 1
   2:    101             Array ID

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

12:  Wind Vector (P69)
   1:    1               Reps
   2:    0               Samples per Sub-Interval
   3:    0               S, theta(1), sigma(theta(1)) with polar sensor
   4:    3               Wind Speed/East Loc [ WS_ms     ]
   5:    4               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 measurement instruction (P4), rather than the AC Half Bridge (P5), should be used. Enter a 2 in the 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).

With a CR10(X), use a 2500 mV excitation and the 2500 mV measurement range. With a CR23X, use a 5000 mV excitation and the 5000 mV measurement range.

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.

TABLE 5-4. Multiplier and Offset for Wind Direction when using Lead Lengths Greater than 100 Feet

Units	Datalogger Type	Instruction Number	Multiplier Offset
degrees	CR10(X)	4	0.285 0
degrees	CR23X	4	0.142 0

5.5.1 Sample CR10(X) Program when Long Leads are Required

```
;{CR10X}
;

*Table 1 Program
  01:  10          Execution Interval (seconds)

01:  Pulse (P3)
  1:   1           Reps
  2:   2*          Pulse Channel 2
  3:   22          Switch Closure, Output Hz
  4:   1*          Loc [ WndS_m_s  ]
  5:   0.7990      Mult
  6:   0.2811      Offset

;Set the wind speed to zero if the wind is not blowing.
;

02:  If (X<=>F) (P89)
  1:   1*          X Loc [ WndS_m_s  ]
  2:   1           =
  3:   0.2811      F
  4:   30          Then Do

03:  Z=F (P30)
  1:   0           F
  2:   0           Exponent of 10
  3:   1*          Z Loc [ WndS_m_s  ]

04:  End (P95)

05:  Excite-Delay (SE) (P4)
  1:   1           Reps
  2:   5**         ± 2500 mV Slow Range
  3:   5*          SE Channel
  4:   3*          Excite all reps w/Exchan 3
  5:   2           Delay (units 0.01 sec)
  6:   2500**      mV Excitation
  7:   2*          Loc [ WndD_deg  ]
  8:   0.285       Mult
  9:   0           Offset

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

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

```
08:  Wind Vector (P69)
   1:   1            Reps
   2:   0            Samples per Sub-Interval
   3:   00           S, θu, & σ(θu) Polar***
   4:   1*           Wind Speed [ WndS_m_s  ]
   5:   2*           Wind Direction [ WndD_deg  ]

-Input Locations-
1 WndS_m_s
2 WndD_deg

*     Proper entries will vary with program and datalogger channel and input location assignments.
**    On the 21X use the 5000 mV input range and the a 5000 mV excitation voltage.
***   Average wind speed, average unit vector wind direction, standard deviation of unit vector wind
      direction
```

6. Sensor Maintenance

1 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. Verify cups and vane are tight.

6 Months

- Replace anemometer bearings if operating under harsh conditions

1 Year

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

2 Years

- Replace the wind vane potentiometer and bearings. 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 vary from 11K to 21K ohms between the blue and green wires depending on vane position. Resistance should be vary from 1K to 11K ohms between the white and green wires depending on vane position.

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 reed switch. The resistance between the red and black wires should vary from infinite (switch open) to less than 1 ohm (switch closed) as the cupwheel is slowly turned.

3. Verify that the Configuration Code (Switch Closure, hertz), 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.

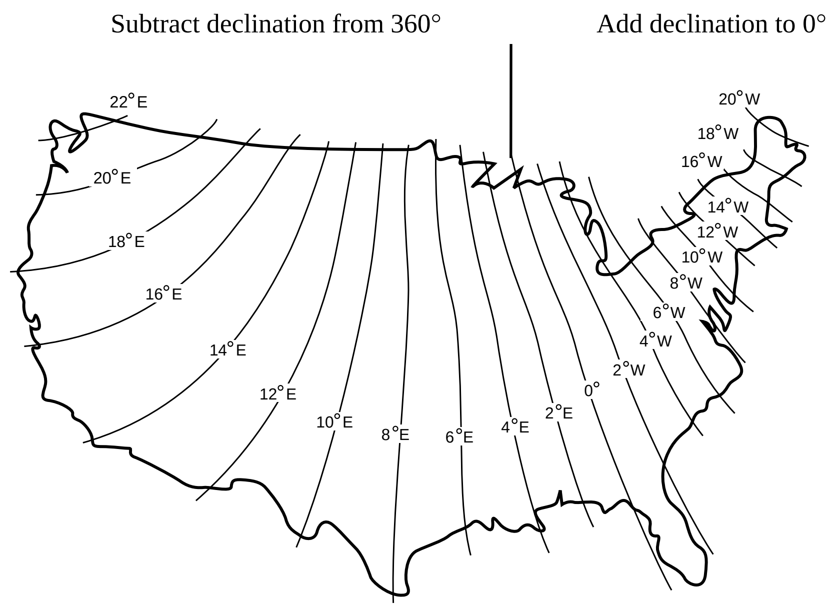


FIGURE A-1. Magnetic Declination for the Contiguous United States

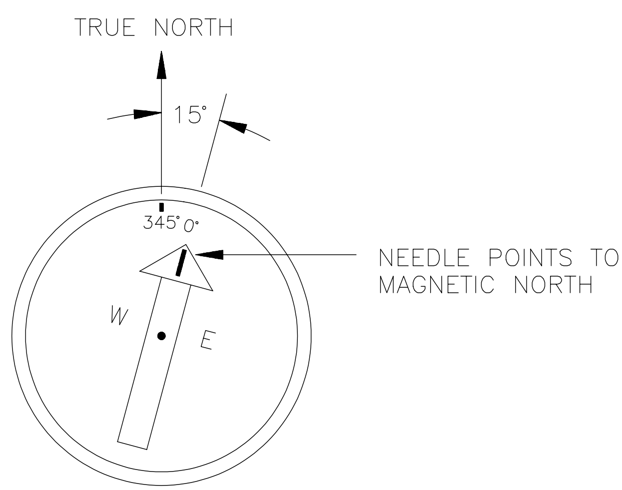


FIGURE A-2. Declination Angles East of True North Are Subtracted From 0 to Get True North

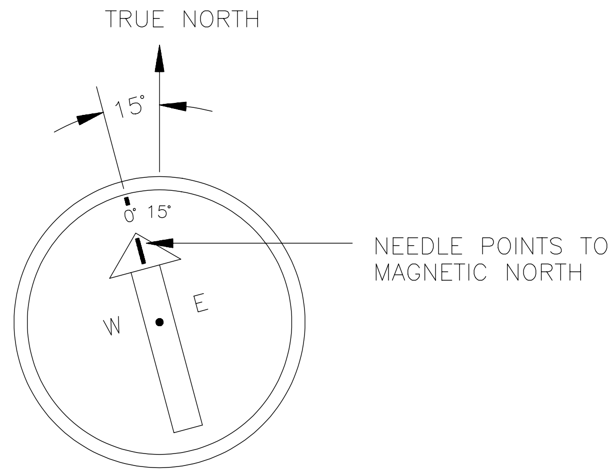


FIGURE A-3. Declination Angles West of True North Are Added to 0 to Get True North

Appendix B. Wind Direction Measurement Theory

It is not necessary to understand the concepts in this section for the general operation of the 034B Windset with Campbell Scientific's datalogger.

The 034B Windsets purchased from Campbell Scientific have a 9.53 kΩ fixed resistor and a variable resistor on the excitation line. The variable resistor is adjusted by the manufacturer so its resistance plus the 9.53 k resistor equals the resistance of the potentiometer ($R_f = R_s + R_t$).

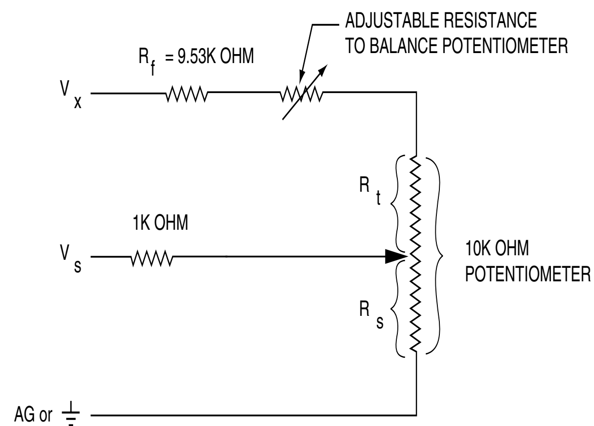


FIGURE B-1. 034B Potentiometer in a Half Bridge Circuit

B.1 AC Half Bridge (P5) and BRHalf Instructions

The P5 and BRHalf instructions output a precise excitation voltage (V_x), and measure 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:

$$V_s / V_x = R_s / \left(R_f + R_t + R_s\right)$$

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 0.5 mV/mV at 356 degrees. The multiplier to convert V_s/V_x to degrees is 356 degrees / 0.5 V_s/V_x = 712. 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:

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

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 0.5 V_x. This maximum voltage equals 1250 mV for an excitation voltage of 2500 mV recommended for the CR10(X) and 2500 mV for an excitation voltage of 5000 mV recommended for the CR23X at 356 degrees. The multiplier to convert V_s to degrees is 356 degrees / 1250 mV = 0.285 for the CR10X, or, 356 degrees / 2500 mV = 0.142 for the CR23X. See Section 13.5 in the datalogger manual from more information on the bridge measurements

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