MET ONE
034B-L WINDSET

8/02

Warranty and Assistance

The **MET ONE 034B-L 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.

Products may not be returned without prior authorization. To obtain a Returned Materials Authorization (RMA), contact CAMPBELL SCIENTIFIC, INC., phone (435) 753-2342. After an applications engineer determines the nature of the problem, an RMA number will be issued. Please write this number clearly on the outside of the shipping container. CAMPBELL SCIENTIFIC's shipping address is:

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

CAMPBELL SCIENTIFIC, INC. does not accept collect calls.

Non-warranty products returned for repair should be accompanied by a purchase order to cover the repair.

CAMPBELL SCIENTIFIC, INC.

815 W. 1800 N.	Campbell Scientific Canada Corp.	Campbell Scientific Ltd.
Logan, UT 84321-1784	11564 -149th Street	Campbell Park
USA	Edmonton, Alberta T5M 1W7	80 Hathern Road
Phone (435) 753-2342	CANADA	Shepshed, Loughborough
FAX (435) 750-9540	Phone (780) 454-2505	LE12 9GX, U.K.
www.campbellsci.com	FAX (780) 454-2655	Phone +44 (0) 1509 601141
		FAX +44 (0) 1509 601091

Met One 034B-L Table of Contents

Figures

Tables

Met One 034B-L Windset

1. General

The Met One 034B-L Windset is an integrated cup anemometer and wind vane. The anemometer consists of three cups that sense the wind speed. These cups rotate on a vertical shaft that magnetically activates a sealed reed switch. The read switch opens and closes at a rate proportional to wind speed. The wind direction is sensed by a vane. The vane drives a 10 kΩ potentiometer.

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 355°, open between 356° and 360°

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

3.2 Mounting

Tools Required:

- 5/64" and 1/16" allen wrenches
- compass and declination angle for the site
- small screw driver provided with datalogger
- UV resistant cable ties
- small pair of diagonal-cutting pliers
- 6 - 10" torpedo level

Mount the 019ALU crossarm to the top of the tripod/tower. Orient the 019ALU north and south with the 3/4 x 1 inch 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.

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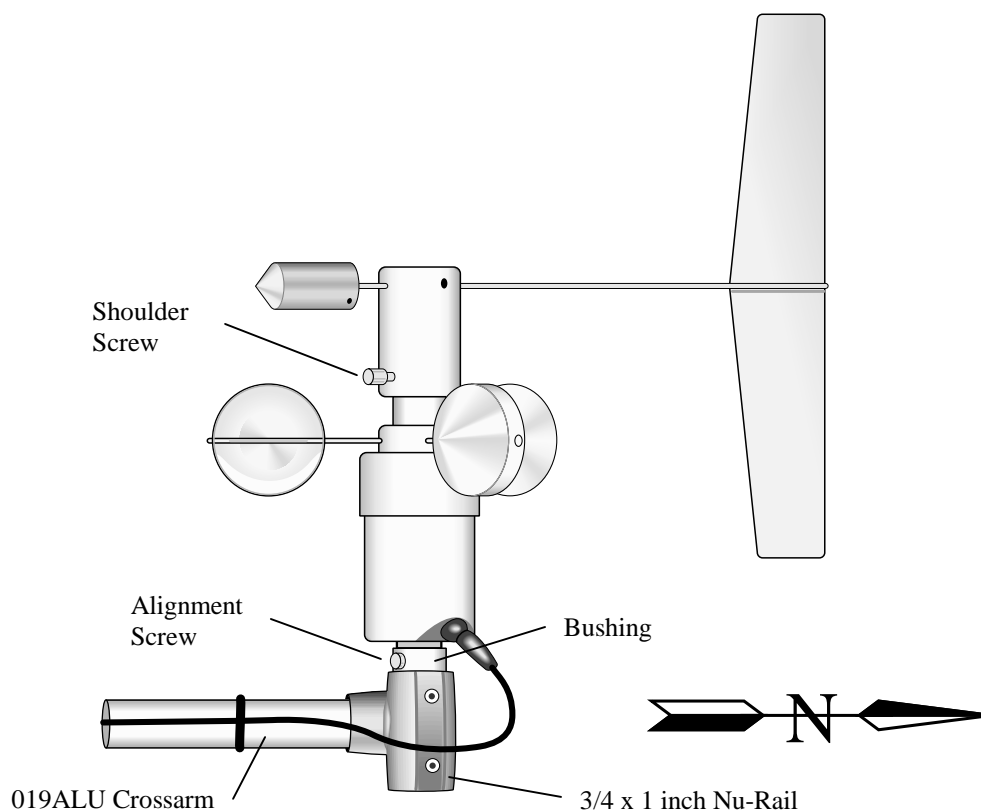
FIGURE 3-1. 034B-L Mounted on a 019ALU Horizontal Crossarm.

Attach the sensor cable to the six pin male connector on the 034B-L. 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 mast and down a tripod/tower leg to the instrument enclosure. Secure the cable to the crossarm and mast using cable ties.

4. Wiring

The connection to the datalogger for the 034B-L are shown in Figure 4-1. The wind speed is measured by a pulse input channel. The wind direction is measured by a single-ended analog input channel.

Connect the red lead to a pulse input channel (wind speed) and the black lead to a ground, labeled G on the CR10(X) or $\equiv$ on the 21X. Connect the green lead (wind direction) to a single-ended input channel, the blue lead to an excitation channel, and white lead to an analog ground, labeled AG on the CR10(X), or ground, labeled $\equiv$ on the 21X. Connect the clear lead to ground, labeled G on the CR10(X) or $\equiv$ on the 21X.
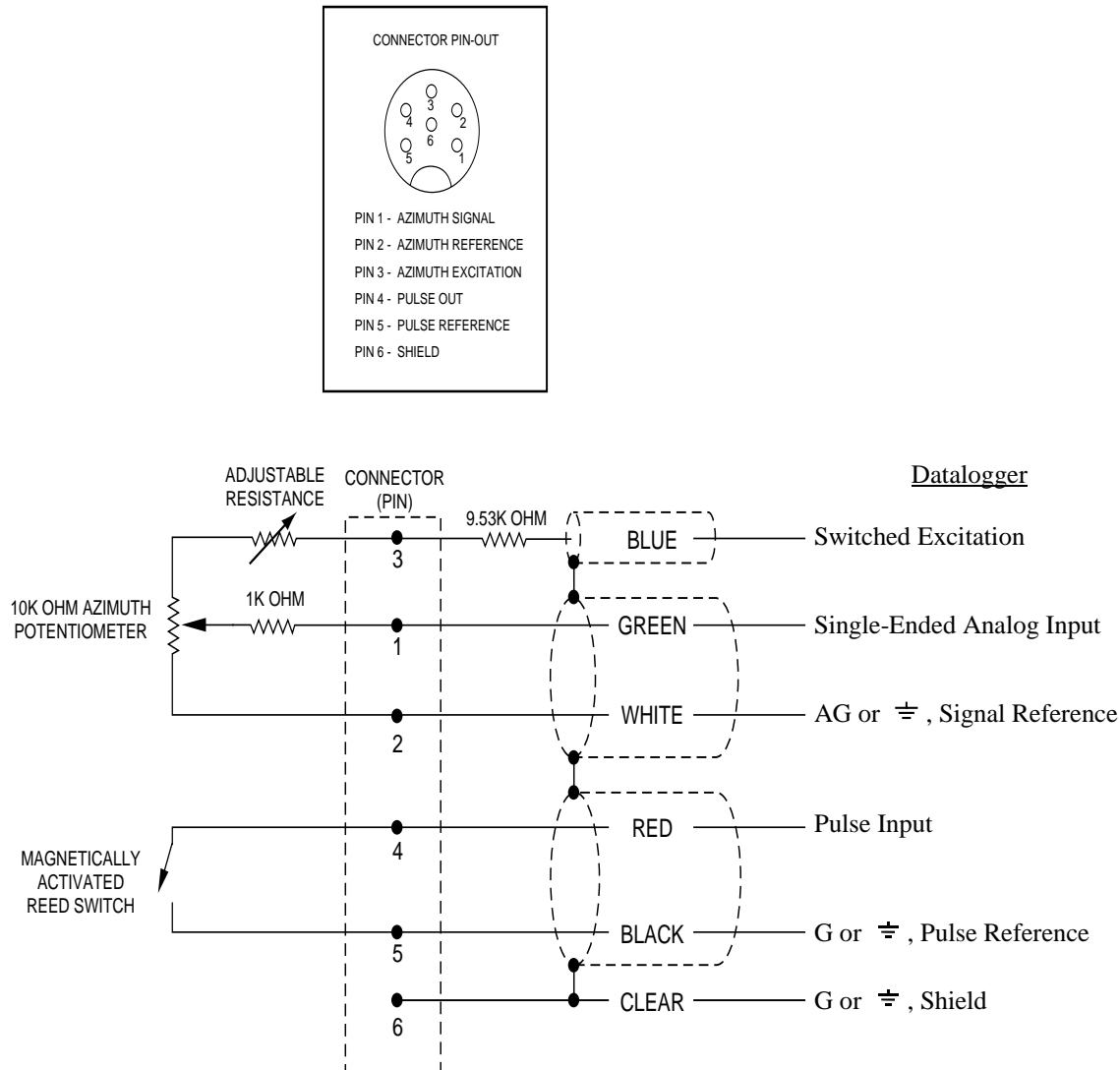
CONNECTOR PIN-OUT

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

ADJUSTABLE RESISTANCE   CONNECTOR (PIN)   Datalogger

9.53K OHM   BLUE   Switched Excitation
3

10K OHM AZIMUTH POTENTIOMETER   1K OHM   GREEN   Single-Ended Analog Input
1

WHITE   AG or ⏚ , Signal Reference
2

RED   Pulse Input
4

MAGNETICALLY ACTIVATED REED SWITCH   BLACK   G or ⏚ , Pulse Reference
5

CLEAR   G or ⏚ , Shield
6

FIGURE 4-1. 034B-L Windset Wiring Diagrams

5. Datalogger Programming

The Pulse instruction, Instruction 3, with an option code of 22, is used to measure the wind speed. Instruction 3 counts the number of switch closures that have occurred during the datalogger's execution interval. When option code 22 is selected, the datalogger reports the counts as a frequency. In addition, counts beyond the execution interval, caused by table overruns, are discarded, see Section 9 of the Datalogger manual for details. The frequency is converted into wind speed using the multiplier and offset listed in Table 5-1.

The AC Half Bridge instruction, Instruction 5, is used to measure wind direction. The AC Half Bridge (P5) instruction provides a precision voltage to the potentiometer and measures the voltage between the wiper and ground. The voltage is linearly proportional to the azimuth and is converted to degrees by the multiplier and offset listed in Table 5-1.

TABLE 5-1. Multipliers and Offsets for Wind Speed and Direction

Units	Multiplier Offset
m s^{-1}	0.7990 0.2811
mph	1.789 .629
degrees	720 0

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.

TABLE 5-2. Wiring for Example Programs

Wire Color	Description	CR10(X)	CR23X	CR5000
Blue	Excitation for Direction	E3	EX3	VX3
Green	Direction Signal	SE5	SE5	SE5
White	Direction Ground	AG	$\perp$	$\perp$
Red	Speed Signal	P2	P2	P2
Black	Speed Ground	G	$\perp$	$\perp$
Clear	Shield Ground	G	$\perp$	$\perp$

EXAMPLE 1. Sample CR10(X) Instructions

```
;{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: AC Half Bridge (P5)
  1:  1           Reps
  2:  25          ± 2500 mV 60 Hz Rejection Range
  3:  5*          SE Channel
  4:  3*          Excite all reps w/Exchan 3
  5:  2500        mV Excitation
  6:  2*          Loc [ WndD_deg ]
  7:  720         Mult
  8:  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,   u, &   ( u) Polar**
  4:  1*          Wind Speed [ WndS_m_s ]
  5:  2*          Wind Direction [ WndD_deg ]

-Input Locations-
1 WndS_m_s
2 WndD_deg
```

EXAMPLE 2. Sample 23X Instructions

```
;{CR23X}
;
*Table 1 Program
  01: 10          Execution Interval (seconds)

1:  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:

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

3:  Z=F x 10^n (P30)
  1:   0.0        F
  2:   0          n, Exponent of 10
  3:   1          Z Loc [ WndS_m_s  ]

4:  End (P95)

5:  AC Half Bridge (P5)
  1:   1          Reps
  2:   25         5000 mV, 60 Hz Reject, Fast Range
  3:   5          SE Channel
  4:   3          Excite all reps w/Exchan 3
  5:   5000       mV Excitation
  6:   2          Loc [ WndD_deg  ]
  7:   720        Mult
  8:   0.0        Offset

6:  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)

7:  Real Time (P77)
  1:   110        Day,Hour/Minute (midnight = 0000)
```

```
8:  Wind Vector (P69)
  1:   1              Reps
  2:   0              Samples per Sub-Interval
  3:   0              S, é1, & å(é1) Polar
  4:   1              Wind Speed/East Loc [ WndS_m_s ]
  5:   2              Wind Direction/North Loc [ WndD_deg ]

*Table 2 Program
  02: 0.0000          Execution Interval (seconds)

*Table 3 Subroutines

End Program

-Input Locations-
1 WndS_m_s  1 2 2
2 WndD_deg  1 1 1
```

EXAMPLE 3. CR5000 Program

```
'CR5000
'Example for 034B Wind Sensor

Public WindSpeed, WindDirection

DataTable (WndVect,1,-1)
    DataInterval (0,30,Min,10)
    WindVector (1,WindSpeed,WindDirection,IEEE4,0,0,0,0)
EndTable

BeginProg
    Scan (1,Sec,3,0)
        PulseCount (WindSpeed,1,2,2,1,0.7990,0.2811)
        'Set the Wind Speed to zero if the wind is not blowing:
        If WindSpeed = 0.2811 Then WindSpeed = 0
        BrHalf (WindDirection,1,mV5000,5,Vx3,1,5000,True ,0,_60Hz,720,0)
        CallTable WndVect
    NextScan
EndProg
```

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. Long Lead Lengths

When lead lengths greater than 200 feet are required to measure the 034B-L, use the DC Half Bridge instruction, Instruction 4, with a 20 millisecond delay to measure wind direction. The delay increases the settling time before the measurement is made.

With a CR10(X), use a 2500 mV excitation and the 2500 mV measurement range. With a 21X, 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 7-1. Multiplier and Offset for Wind Direction when using Lead Lengths Greater than 200 Feet			
Units	Datalogger type	Instruction number	Multiplier Offset
degrees	CR10(X)	4	0.288 0
degrees	21X	4	0.144 0

EXAMPLE 4. 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:   0.288          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,   u, &    ( u) 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
```

8. Wind Direction Measurement Theory

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

The 034B-L 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 ($R_f = R_s + R_t$).
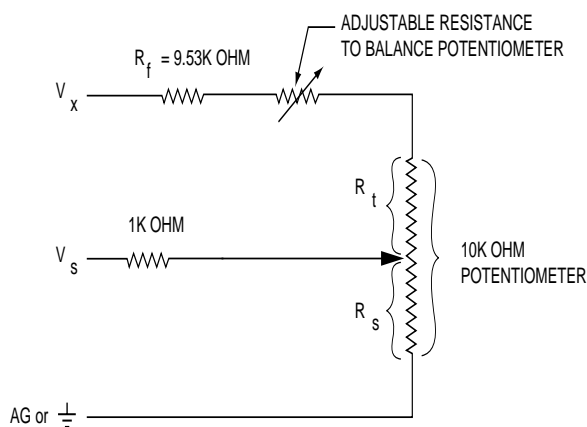

FIGURE 8-1. 034B-L Potentiometer in a Half Bridge Circuit

8.1 AC Half Bridge, Instruction 5

Instruction 5 outputs a precise 2500 mV AC excitation (5000 mV AC excitation with the 21X) 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 5 outputs the ratio of the measured voltage to the excitation voltage (V_s / V_x). This ratio is related to 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 360 degrees. Thus, the multiplier is 720 degrees. Since the datalogger outputs the ratio V_s/V_x, the multiplier is the same for both the CR10(X) and 21X dataloggers, even though they use a different excitation voltage. See Section 13.5 in the datalogger manual from more information on the bridge measurements.

8.2 DC Half Bridge, Instruction P4

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 360 degrees. Thus, the multiplier is 0.144 degrees/mV for the CR10(X) and 0.288 degrees/mV for the CR23X. See Section 13.5 in the datalogger manual from more information on the bridge measurements

9. 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 called GEOMAG (Section A.2). 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 con-sidered 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 for wind direction using the ∗6 Mode of the datalogger, or, the Monitor Mode of GraphTerm with an on-line PC.

3. Loosen the set screws, on the Nu-Rail, that secure the base of the sensor to the 019ALU crossarm. While holding the vane position, slowly rotate the sensor base until the datalogger indicates 0 degrees. Tighten the set screws.
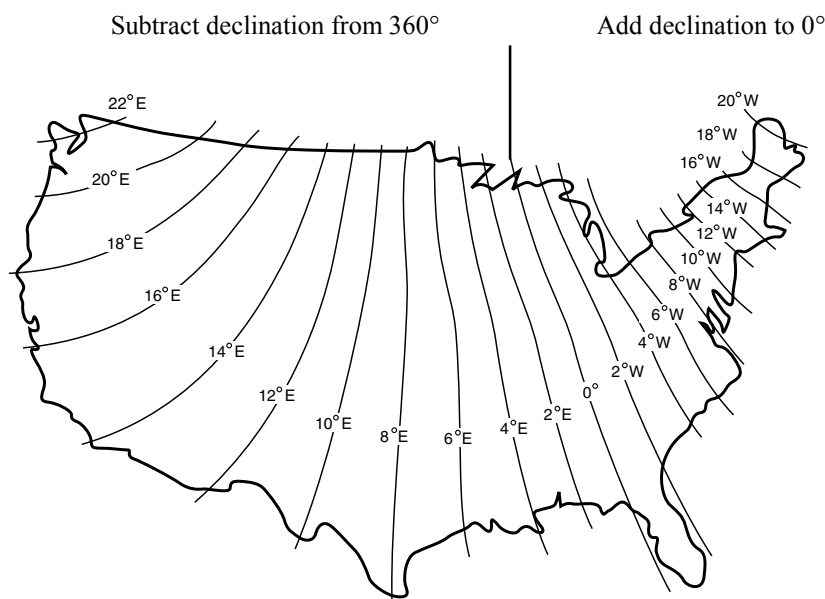
Subtract declination from 360°   Add declination to 0°

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

A.2 Prompts from GEOMAG

GEOMAG is accessed by calling (303) 273-8672 with a computer and telephone modem, and communications program such as GraphTerm (PC208E Software). Use the following setting: 1200 baud, even parity, 7 data bits, and 1 stop bit. Upon a carrier-signal detection, press <enter> once or twice. Enter the following at the appropriate prompt.

GLDSV1> c neis <enter>
Username: QED <enter>

GEOMAG may also be accessed through the internet. Telnet to the site neis.cr.usgs.gov. When GEOMAG responds, enter the following:

Username: QED <enter>

GEOMAG prompts the caller for site latitude, longitude, and elevation, which it uses to determine the magnetic declination and annual change. The following Menu and prompts are from GEOMAG:

MAIN MENU

Type
    Q   for Quick Epicenter Determinations (QED)
    L   for Earthquake Lists (EQLIST)
    M for Geomagnetic Field Values (GEOMAG)
    X to log out

Enter program option: M

Would you like information on how to run GEOMAG (Y/N)? N

Options:

1 = Field Values (D, I, H, X, Z, F)
2 = Magnetic Pole Positions
3 = Dipole Axis and Magnitude
4 = Magnetic Center   [1] : 1

Display values twice   [N]: press enter
Name of field model   [USCON90]: press enter
Date   [current date]: press enter
Latitude   : 42/2 N
Longitude   : 111/51/2 W
Elevation   : 4454
Units (m/km/ft)   : ft

Example of report generated by GEOMAG:

    Model: USCON90   Latitude: 42/2 N
    Date : 7/27/93   Longitude: 111/51/2 W
                       Elevation: 4454.0 ft

D
<u>deg min</u>

14 21.9

Annual change:

0 -1.8

The declination in the example above is listed as 14 degrees and 21.9 minutes. Expressed in degrees, this would be 14.375 degrees. As shown in Figure A-1, the declination for Utah is east, so True North for this site is 360 - 14.375, or 346 degrees. The annual change is -1.8 minutes.
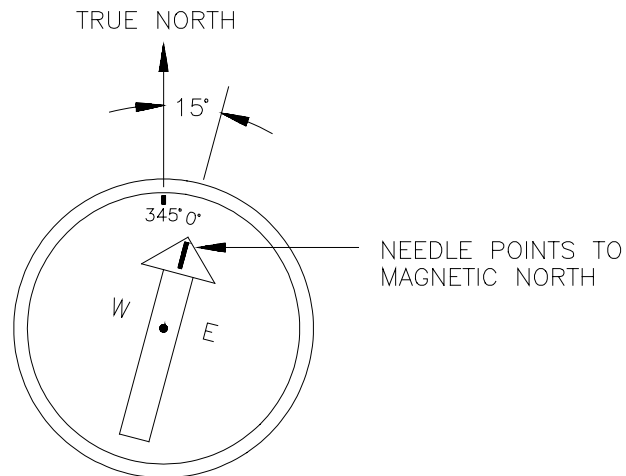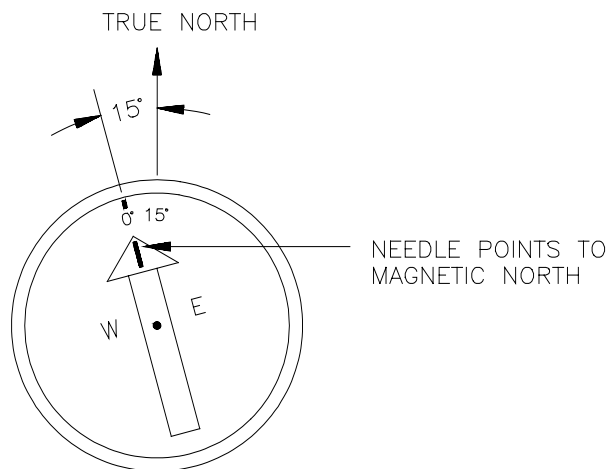

FIGURE A-2. Declination Angles East of True North Are Subtracted From 0 to Get True North

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