INSTRUCTION MANUAL

Met One 034A-L Windset

Revision: 7/97

Warranty and Assistance

The **MET ONE 034A-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. The following contact information is for US and International customers residing in countries served by Campbell Scientific, Inc. directly. Affiliate companies handle repairs for customers within their territories. Please visit www.campbellsci.com to determine which Campbell Scientific company serves your country. 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.

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Table

MET ONE 034A-L WINDSET

1. GENERAL

The Met One 034A-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:

$\pm$0.12 m s^{-1} ($\pm$0.25 mph) for wind
speed < 10.1 m s^{-1} (22.7 mph)
$\pm$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°, shorting to ground between 356° to 360°

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

Accuracy: $\pm$4°

Resolution: 0.5°

Potentiometer Specifications:

Resistance: 0 to 10 kΩ shorting 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 resistance 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 034A-L (Figure 3-1). Insert the 034A-L into the aluminum bushing provided with the sensor. Align the hole in the bushing with that in the 034A-L base and replace the screw. Insert the 034A-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.
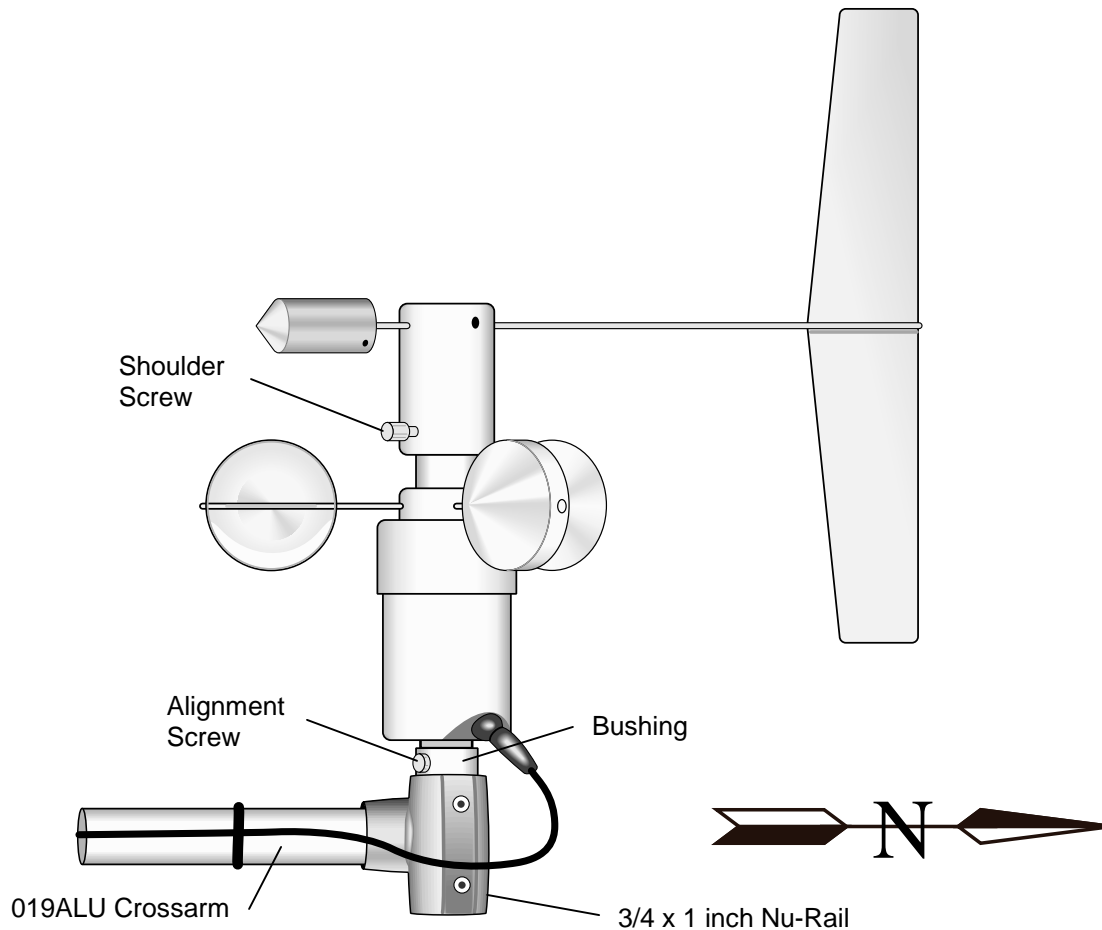
FIGURE 3-1. 034A-L Mounted on a 019ALU Horizontal Crossarm.

Attach the sensor cable to the six pin male connector on the 034A-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 034A-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 ⏚ 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 ⏚ on the 21X. Connect the clear lead to ground, labeled G on the CR10(X) or ⏚ on the 21X.

CONNECTOR PIN-OUT

PIN 1 - AZIMUTH SIGNAL
PIN 2 - AZIMUTH REFERENCE
PIN 3 - AZIMUTH EXCITATION
PIN 4 - PULSE OUT
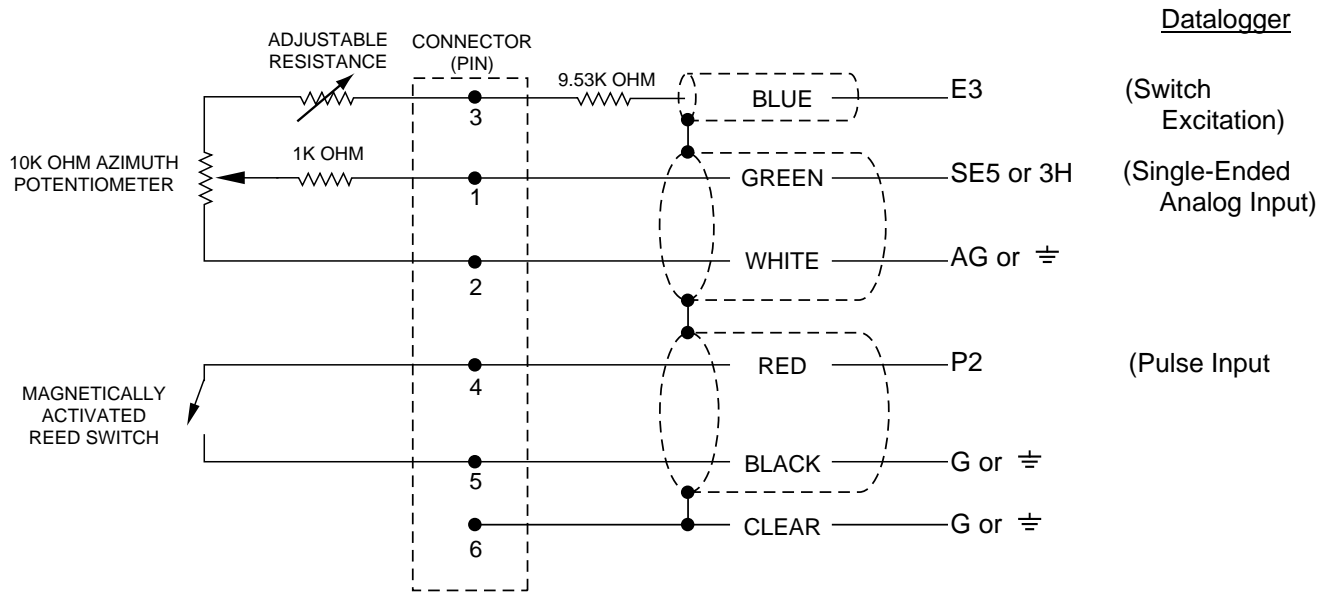PIN 5 - PULSE REFERENCE
PIN 6 - SHIELD
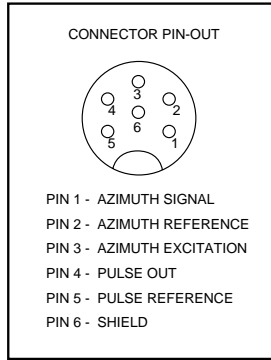
FIGURE 4-1. 034A-L Windset Wiring Diagram

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.

3

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

Units	Datalogger type	Instruction number	Multiplier Offset
m s^{-1}	CR10(X) or 21X	3	0.7990 0.2811
mph	CR10(X) or 21X	3	1.789 .629
degrees	CR10(X) or 21X	5	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 resistor on the excitation line. The wiring diagram and the multiplier and offset, for wind direction, are different than the examples in this document.

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)

4

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

EXAMPLE 2. Sample 21X Instructions

;{21X}
;
*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: 1*   Z Loc [WndS_m_s]

04:     End (P95)

05:     AC Half Bridge (P5)
  1: 1   Reps
  2: 5   ± 5000 mV Slow 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   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, & $\sigma(\theta u)$ 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.
**   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. LONG LEAD LENGTHS

When lead lengths greater than 200 feet are required to measure the 034A-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 used 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 3. 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, θu, & $\sigma(\theta u)$ 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 034A-L Windset with Campbell Scientific's datalogger.

The 034A-L Windsets purchased from Campbell Scientific have a 10 kΩ resistor on the excitation line. This resistor prevents erroneous measurements when the potentiometer shorts to ground as the wind direction crosses over from the west side of north to the east side of north.

FIGURE 8-1. 034A-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:

$$V_s/V_x = R_s\big/\left(R_f + R_t + R_s\right) = R_s/20K\Omega$$

The maximum value that R_s will reach is 10 kΩ, just before it crosses over from the west side of north to the east side of north. 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 2500 mV excitation (5000 mV 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 4 outputs the measured voltage, V_s. This measured voltage is related to resistance as shown below:

$$V_s = V_x \cdot R_s\big/\left(R_f + R_t + R_s\right) = V_x \cdot R_s/20K\Omega$$

The maximum value that R_s will reach is 10 kΩ just before it crosses over from the west side of north to the east side of north. V_s reaches its maximum value of 1250 mV for the CR10(X) and 2500 mV for the 21X at 360 degrees. Thus, the multiplier is 0.144 degrees/mV for the CR10(X) and 0.288 degrees/mV for the 21X. 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.

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