INSTRUCTION MANUAL

Model 014A Met One Wind Speed Sensor

Revision: 6/11

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PLEASE READ FIRST

About this manual

Please note that this manual was originally produced by Campbell Scientific Inc. (CSI) primarily for the US market. Some spellings, weights and measures may reflect this origin.

Some useful conversion factors:

Area:	1 in^2 (square inch) = 645 mm^2
Length:	1 in. (inch) = 25.4 mm 1 ft (foot) = 304.8 mm 1 yard = 0.914 m 1 mile = 1.609 km
Mass:	1 oz. (ounce) = 28.35 g 1 lb (pound weight) = 0.454 kg
Pressure:	1 psi (lb/in2) = 68.95 mb
Volume:	1 US gallon = 3.785 litres

In addition, part ordering numbers may vary. For example, the CABLE5CBL is a CSI part number and known as a FIN5COND at Campbell Scientific Canada (CSC). CSC Technical Support will be pleased to assist with any questions.

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Met-One 014A Wind Speed Sensor

1. General

The 014A is a three-cup anemometer that is used to measure horizontal wind speed. Rotation of the cup wheel opens and closes a reed switch at a rate proportional to wind speed.

The accompanying Met One manual contains additional information on operating principals, installation, and maintenance.

Lead length for the 014A 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 014A ships with:

(1) Calibration Sheet
(1) Instruction Manual
(1) 014ACBL-L Sensor Cable w/user specified length

2. Specifications

Threshold	0.45 m/s (1 mph)
Calibrated Range	0-45 m/s (0-100 mph)
Gust Survival	0-53 m/s (0-120 mph)
Accuracy	1.5% or .11 m/s (0.25 mph)
Temperature Range	-50 C to +70 C
Distance Constant*	
Standard:	Less than 4.6m (15 ft.) (Aluminum Cups)
Optional Fast Response:	Less than 1.5 m (5 ft.) (Lexan Cups)
Output Signal	Contact Closure, Reed Switch
Weight	680 grams (1.5 lbs)

* The distance traveled by the air after a sharp-edged gust has occurred for the anemometer to reach 63% of the new speed.

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
- 5/64" Allen wrench
- 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 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.

Insert the base of the 014A into the Nu-Rail or CM220 (Figures 3-1, 3-2) and tighten the set screws on the Nu-Rail, or U-bolts on the CM220 (do not over tighten).

Attach the sensor cable to the connector on the 014A. Make sure the connector is properly keyed, and 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.

FIGURE 3-1. 014A Mounted on a CM200 Series Crossarm with PN 1049 (or 019ALU Crossarm)

FIGURE 3-2. 014A Mounted on a CM200 Series Crossarm with CM220

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 Pulse Channels					
Color	**Wire Label**	**CR800 CR850 CR5000 CR3000 CR1000**	**CR510 CR500 CR10(X)**	**21X CR7 CR23X**	**CR200(X)**
Black	Signal	Pulse	Pulse	Pulse	P_SW
White	Signal Reference	⏚	G	⏚	⏚
Clear	Shield	⏚	G	⏚	⏚

A control port may also be used to measure the 014A. With this option the white wire is connected to the 5V terminal. Please note that the control port method cannot be used with a CR200(X), CR500, CR510, CR7, 21X, or CR10 datalogger.

TABLE 4-2. Connections to Campbell Scientific Dataloggers Control Ports				
Color	**Wire Label**	**CR800 CR850 CR5000 CR3000 CR1000**	**CR10X**	**CR23X**
Black	Signal	C1-C8	C6-C8	C5-C8
White	Signal Reference	5 V	5 V	5 V
Clear	Shield	⏚	G	⏚

5. Programming

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 typically measured with a pulse count instruction, using 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
014A	M = 0.8000 Off = 0.447	M = 1.789 Off = 1.0
*When configuration code 12 is used, the multiplier above is divided by the execution interval in seconds.		

5.2 Example Programs

5.2.1 Pulse Port Examples

The following CR1000 and CR10X programs use a pulse port to measure the 014A every 5 seconds. The programs store mean wind speed (in m/s) every 60 minutes. Wiring for the examples is given in Table 5-2.

TABLE 5-2. Wiring for Pulse Port Example Programs

Color	Description	CR1000	CR10X
Black	Signal	P1	P1
White	Signal Reference	⏚	G
Clear	Shield	⏚	G

5.2.1.1 CR1000 Example Program

```
'CR1000
'Created by Short Cut (2.5)

'Declare Variables and Units
Public Batt_Volt
Public WS_ms

Units Batt_Volt=Volts
Units WS_ms=meters/second

'Define Data Tables
DataTable(Table1,True,-1)
    DataInterval(0,60,Min,10)
    Average(1,WS_ms,FP2,False)
EndTable

'Main Program
BeginProg
    Scan(5,Sec,1,0)
        'Default Datalogger Battery Voltage measurement Batt_Volt:
        Battery(Batt_Volt)
```

```
        '014A Wind Speed Sensor measurement WS_ms:
        PulseCount(WS_ms,1,1,2,1,0.8,0.447)
        If WS_ms<0.448 Then WS_ms=0
        'Call Data Tables and Store Data
        CallTable(Table1)
    NextScan
EndProg
```

5.2.1.2 CR10X Example Program

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

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

2:  Pulse (P3)
  1:   1              Reps
  2:   1              Pulse Channel 1
  3:   22             Switch Closure, Output Hz
  4:   2              Loc [ WS_ms     ]
  5:   0.8            Multiplier
  6:   0.447          Offset

3:  If (X<=>F) (P89)
  1:   2              X Loc [ WS_ms     ]
  2:   4              <
  3:   0.448          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)

6:  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)

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

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

9:  Average (P71)
  1:   1              Reps
  2:   2              Loc [ WS_ms     ]
```

5.2.2 Control Port Example Program

The following CR5000 program uses control ports to measure three 014A anemometers. The program measures them every second and stores the mean wind speed (in m/s) every 15 seconds.

```
'CR5000 Series Datalogger
'Wind Speed using TimerIO Instruction

'Declare Variables and Units
Public J, WindSpeed(3)

'Define Data Tables
DataTable(Test,1,-1)
    DataInterval(0,15,Sec,10)
    Average(3,WindSpeed(),IEEE4,False)
EndTable

'Define Subroutines
'Sub
    'Enter Sub instructions here
'EndSub

'Main Program
BeginProg
    Scan (1,Sec,0,0)
        'Measure the WindSpeed Profile 014A, 3 anemometers connected to C4, C5, C6 ports

        TimerIO (WindSpeed(1),11000111,00222000,100,0)    'Frequency on falling edge
        'Convert measurement to m/s
        For j = 1 to 3
            WindSpeed(j) = 0.447 + WindSpeed(j)/1.25
        Next j
        CallTable Test
    Next Scan
End Prog
```

6. Maintenance

6.1 Suggested Maintenance Schedules

6.1.1 6-12 Month Periodic Service

Visually inspect the anemometer cups for cracks and breaks, and make sure that each arm is securely attached to the cup assembly hub. Also check to see that the vent hole, located at the base of the sensor, is unobstructed.

Special caution is advised under adverse conditions of high winds, heat, and/or sandy areas. Look for abrupt stopping of the cup assembly with slow cup rotation. If this occurs, the bearings may need to be replaced.

6.1.2 12-24 Month Service

Replace sensor bearings.

6.1.3 24-36 Month Service

A complete factory overhaul of the sensor is recommended. Contact Met-One directly for Wind Speed sensor repair and recalibration service. This repair and calibration service includes disassembly and detailed inspection of all moving mechanical parts and all electronic components. Service includes replacement of bearings, shaft, and set screws as well as a functional test of the sensor. Charges above the basic service charge may be added for replacement of additional materials.

Met-One Instruments Inc.
479 California Avenue
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FAX (541) 479-3057

7. Troubleshooting

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 white and black wires should vary from infinite (switch open) to less than 1 ohm (switch closed) as the cup wheel 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. Sensor Maintenance

A.1 Reed Switch Replacement Procedure

To verify parts and locations, refer to the parts diagram (Figure A-3) and the parts list (Table A-1).

A. Remove sensor from mounting arm and disconnect cable.

B. Remove the cup assembly.

C. Remove the three phillips screws at the top of the sensor and lift out the bearing mount assembly.

D. Unsolder the leads of the reed switch and remove the switch from the two mounting terminals, see the parts diagram.

E. Solder the new switch onto the sides of the switch mount terminals (form a loop in the relay leads to obtain proper lead length -- **DO NOT CUT THE RELAY LEADS.**) Measure the distance between the bottom of the rotating magnet and the top of the switch envelope, as shown in Figure A-1. The spacing should measure between 0.01 and 0.02 inches.

F. Spin the shaft to verify switch operation by listening for a faint sound of the switch closure. If the switch cannot be heard, move the switch slightly closer to the magnet assembly.

G. Reassemble sensor.

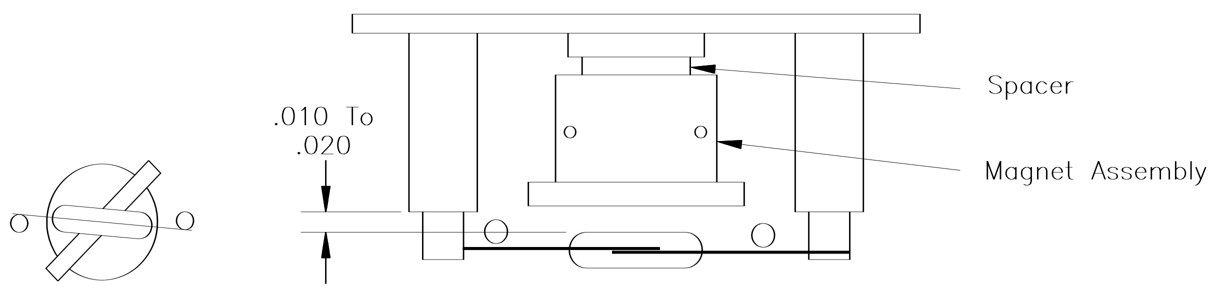

FIGURE A-1. Reed Switch Assembly

A.2 Bearing Replacement Procedure

The bearings used in the 014A Sensor are special stainless steel ball bearings with a protective shield. Bearings are lubricated and sealed. **DO NOT LUBRICATE BEARINGS AS THE LUBRICATION WILL ATTRACT DUST AND INHIBIT BEARING OPERATION.**

A. Follow steps 6.2 A, B, and C in reed switch replacement procedures.

B. Loosen set screws in magnet assembly, lift shaft and collar up and out of bearing mount. Be sure to retain lower spacer.

C. Insert a right-angle type of tool, such as an allen wrench, into bearing. Cock it slightly to one side and remove both bearings.

D. Install new bearings. Be careful not to introduce dirt particles into bearings. **CLEAN HANDS ONLY! DO NOT ADD LUBRICATION OF ANY KIND**.

E. Reassemble the sensor in reverse order. Be sure to include spacers over the bearings when replacing the shaft in the bearing mount. After the magnet assembly has been tightened, a barely perceptible amount of endplay should be felt when the shaft is moved up and down.

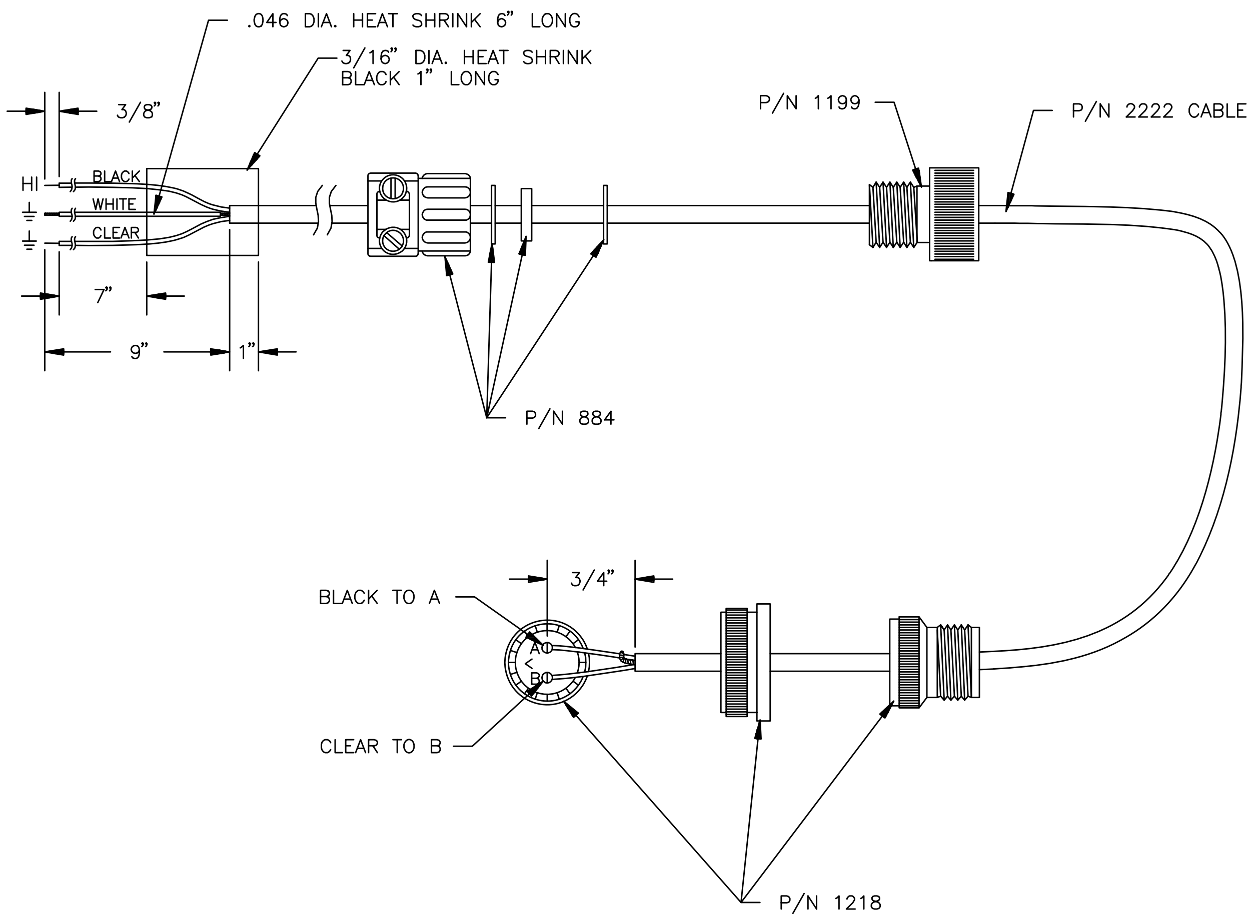

FIGURE A-2. Cable Diagram

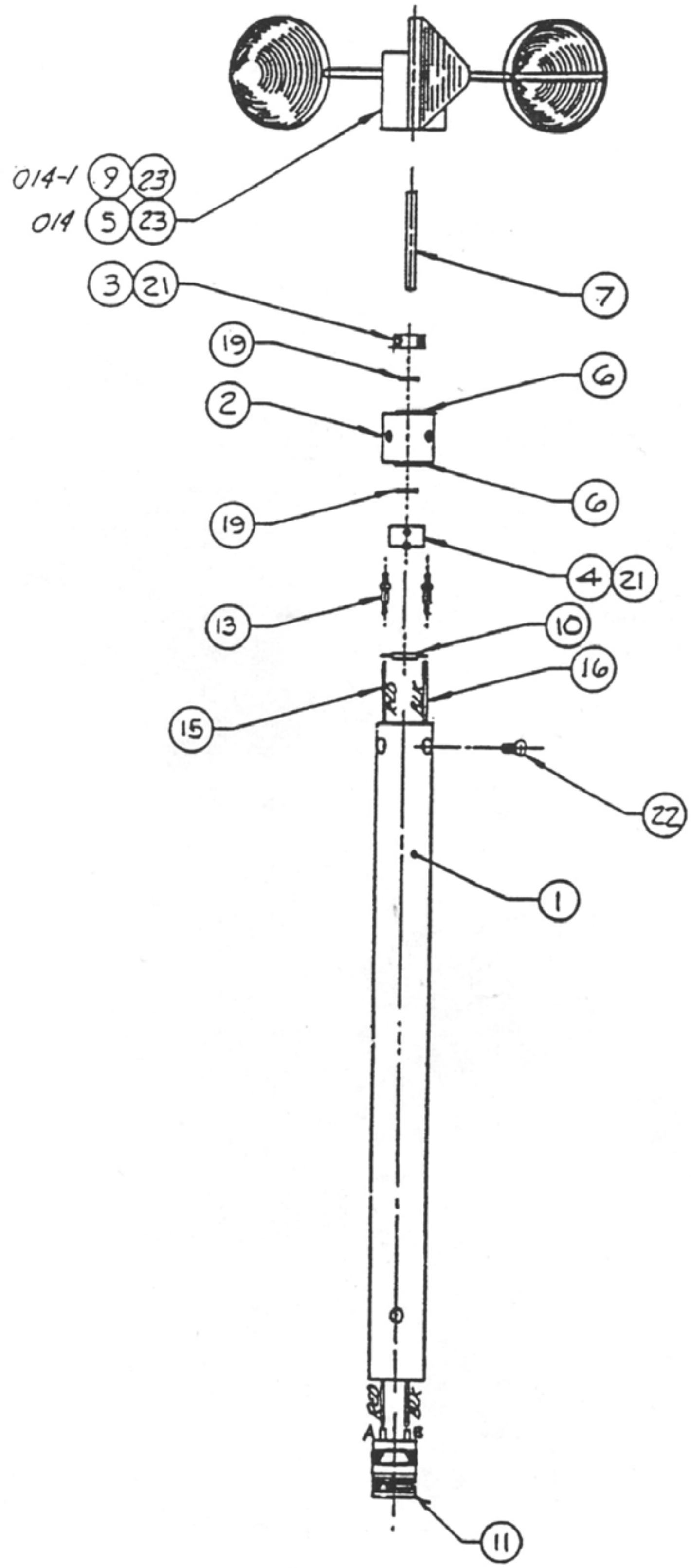

FIGURE A-3. Parts Diagram

TABLE A-1. Met-One Parts List

Reproduced by Campbell Scientific, Inc.

Item	Part No.	Description	Qty./Assy
1	1011685-2	Housing	1
2	101685-4	Bearing Mount	1
3	101685-7	Collar	1
4	101715	Magnet Assembly	1
5	101812	Assy, Cup (Alum)	1
6	101898	Bearing	2
7	86001	Shaft	1
8	101048-2	Label	1
9	1812-1	Assy, Cup (Lexan)	1
10	880160	Switch, Reed	1
11	500295	Conn, 2 Pin Male	1
12	510020	Cap	1
13	970062	Terminal	2
14			
15	9980480	Wire, 22G Red	18"
16	980445	Wire, 22GA Black	18"
17			
18			
19	860250	Spacer	2
20			
21	601250	SCR, SET A/H C/P 4-40x1/8	4
22	601230	SCR,FLT HD PHIL 4-40x1/4	3
23	601680	SCR,SET A/H C/P 8-23x3/8	2
24			
25	995120	Adhesive, (RTV 108)	A/R
26	995100	Adhesive, Epoxy (907)	A/R
27	995425	Locite 222-21	A/R
28	995060	Adhesive, Silicone	5 ml
29	995430	Locite 290-21	A/R
30	400010	Cable, 2 Cond.	REF
31	500372	Conn, 2 Pin Socket	REF
32	480500	Clamp	REF

Appendix B. Theory of Operation

B.1 Mechanical

The anemometer cup assembly consists of three aluminum cups mounted on a cup assembly hub. A stainless steel shaft, which rotates on precision-sealed ball bearings, connects the cup assembly to a magnet assembly. When the shaft is rotated, the turning magnet assembly causes a reed switch to close. There are two contacts (reed switch closures) per revolution. The frequency of closures is linear from threshold to 45 m/s.

B.2 Calibration

The 014A Anemometer has a threshold speed of 0.447 m/s and follows the equation:

V = 0.447 + f/1.250 where
V = wind speed (m/s), and
f = output frequency (hz,)

or, V = 1.0 + f/0.5589
where V = wind speed (mph), and
f = output frequency (hz.)

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