INSTRUCTION MANUAL

ICEFREE3A and ICEFREE3V

Revision: 3/17

Limited Warranty

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Logan, Utah 84321-1784

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Safety

DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND **TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC**. FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.com or by telephoning (435) 227-9000 (USA). You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General

- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations, such as those of the FAA in the USA.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a **hardhat** and **eye protection**, and take **other appropriate safety precautions** while working on or around tripods and towers.
- **Do not climb** tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical

- **You can be killed** or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in **contact with overhead or underground utility lines**.
- Maintain a distance of at least one-and-one-half times structure height, 20 feet, or the distance required by applicable law, **whichever is greater**, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.

Elevated Work and Weather

- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Maintenance

- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CUSTOMER ASSUMES ALL RISK FROM ANY INJURY RESULTING FROM IMPROPER INSTALLATION, USE, OR MAINTENANCE OF TRIPODS, TOWERS, OR ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.

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ICEFREE3A and ICEFREE3V

1. Introduction

The ICEFREE3 anemometer and vane are electrically-heated wind sensors for ice-prone sites. They are manufactured by NRG. Campbell Scientific uses the model number ICEFREE3A for the anemometer, and ICEFREE3V for the vane.

These sensors are reliable in heavy and light winds. They can accurately measure winds in excess of 90 m s^{-1} (200 mph), yet their relatively low moment of inertia permits them to respond rapidly to gusts and lulls. Please note that these sensors have a high-power draw and should be used in applications where ac power is available.

2. Precautions

- READ AND UNDERSTAND the *Safety* section at the front of this manual.
- Although the ICEFREE3A and ICEFREE3V are rugged, they should be handled as precision scientific instruments.
- A 15 A slow-blow fuse should be placed in line with the heater.
- Do not apply greater than 30 V to the outputs at any time.
- When wiring the sensor, first connect the ground terminals and then connect the signal wires.

3. Initial Inspection

- Upon receipt of the ICEFREE3A and ICEFREE3V, inspect the packaging and contents for damage. File damage claims with the shipping company.

4. Overview

The ICEFREE3V senses wind direction with a potentiometer. With the precision excitation voltage from the datalogger applied to the potentiometer element, the output signal is an analog voltage that is directly proportional to the azimuth of the wind direction.

The ICEFREE3A monitors wind speed using a three-cup anemometer. Rotation of the cup wheel produces a sine-wave that is directly proportional to wind speed. The frequency of the sine wave is measured by the datalogger pulse count channel, then converted to engineering units (mph, m s^{-1}, knots).

5. Specifications

Features:

- Made of cast aluminum with black anodized finish and heat-resistant paint
- Efficiently transfers heat from encapsulated, self-regulating heaters
- Easily mounts to a 27 mm (1.05 in) diameter mounting pipe
- Powered by 24 V ac/dc
- Compatible with Campbell Scientific CRBasic dataloggers: CR200(X) series, CR300 series, CR6 series, CR800 series, CR1000, and CR3000

Mounting: Mounts to a pipe with a 27 mm (1.05 in) outer diameter

5.1 Wind Direction (ICEFREE3V)

Range Mechanical:	360° Electrical: 352° (8° open)
Potentiometer Linearity:	within 1%
Potentiometer Resistance:	0 to 10 kΩ
Operating Temperature Range:	–40 to 80 °C
Operating Humidity Range:	0 to 100% RH
Overall Assembly Height:	23.9 cm (9.41 in)
Body Diameter:	7.0 cm (2.75 in)
Swept Diameter:	21.2 cm (8.38 in)
Center-to-Tail Radius:	10.6 cm (4.19 in)
Cable Lengths (signal and power):	8 m (26 ft)
Weight:	1.58 kg (2 lb)
Supply Voltage:	24 V ac/dc
Supply Current Inrush:	8 A maximum
Supply Current Steady State:	1 A at 20 °C, 4 A under maximum thermal load (head frozen in clear ice then powered on)

5.2 Wind Speed (ICEFREE3A)

Range:	0 to 90 m s^{-1} (0 to 200 mph)

Sensor to Sensor Variation:	99.7% of sensors fall within 4.3% of stated transfer function (based on over 800 samples)
Distance Constant (63% recovery):	7.6 m (25 ft)
Sensor Output Signal Range:	0 Hz to 155 Hz
Operating Temperature Range:	–40 to 60 °C
Operating Humidity Range:	0 to 100% RH
Overall Assembly Height:	22.4 cm (8.82 in)
Body Diameter:	7.0 cm (2.75 in)
Swept Diameter of Rotor:	12.7 cm (5 in)
Cable Lengths (signal and power):	8 m (26 ft)
Weight:	1.45 kg (3.2 lb)
Supply Voltage:	24 V ac/dc
Supply Current Inrush:	8 A maximum
Supply Current Steady State:	1 A at 20 °C, 4 A under maximum thermal load (head frozen in clear ice then powered on)

6. Installation

6.1 Siting

Locate wind sensors away from obstructions such as trees and buildings. As a general rule, there should be a horizontal distance of at least ten times the height of the obstruction between the wind set 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, *References (p. 7)*, for a list of references that discuss siting wind speed and direction sensors.

The ICEFREE3V vane needs to be oriented to true north (Appendix B, *Wind Direction Sensor Orientation (p. B-1)*).

6.2 Wiring

6.2.1 ICEFREE3A Anemometer Wiring

The grey cable connects the anemometer to the datalogger (TABLE 6-1), and the red cable connects the anemometer's heater to a 24 V power supply (TABLE 6-2).

TABLE 6-1. ICEFREE3A Datalogger Connections (grey cable)		
Wire Color	**Wire Function**	**Datalogger Connection Terminal**
Clear	Signal	**U** configured for pulse input[1], **P** (pulse input), or **P_SW** (pulse, switch closure input)
Black	Signal Reference	⏚
Shield	Shield	**AG** or ⏚ (analog ground)
[1]**U** channels are automatically configured by the measurement instruction.		

TABLE 6-2. ICEFREE3A Heater-to-24 V Power Supply Connections (red cable)		
Color	**Description**	**24 V Heater**
Black	Voltage	24 V
White	Ground	G

6.2.2 ICEFREE3V Vane Wiring

The grey cable connects the vane to the datalogger (TABLE 6-3), and the red cable connects the vane's heater to a 24 V power supply (TABLE 6-4).

TABLE 6-3. ICEFREE3V Datalogger Connections (grey cable)		
Wire Color	**Wire Function**	**Datalogger Connection Terminal**
Red	Voltage excitation input	**U** configured for voltage excitation[1], **EX, VX** (voltage excitation)
White	Analog voltage output	**U** configured for single-ended analog input[1], **SE** (single-ended, analog input)
Black	Reference	**AG** or ⏚ (analog ground)
Shield	Shield	**AG** or ⏚ (analog ground)
[1]**U** channels are automatically configured by the measurement instruction.		

TABLE 6-4. ICEFREE3V Heater-to-24 V Power Supply Connections (red cable)		
Color	**Description**	**24 V Heater**
Black	Voltage	24 V
White	Ground	G

6.3 Datalogger Programming

6.3.1 ICEFREE3A Wind Speed

Wind speed is measured with the **PulseCount()** instruction, using the low-level AC configuration and set to output frequency in hertz. The **PulseCount()** has the following form:

PulseCount(*Dest, Reps, PChan, PConfig, POption, Mult, Offset*)

Where,

- *PConfig*: Enter 1 for Low level AC (pulse channels only)
- *POption*: Enter 1 for output in hertz

The following expression for wind speed (U) is used to determine the multiplier and offset:

U = MX + B

where

M = multiplier

X = number of pulses per second (hertz)

B = offset

TABLE 6-5 lists the multipliers (M) and offsets (Off) to obtain meters/second when the **PulseCount()** instruction is configured to output the result in hertz.

TABLE 6-5. Wind Speed Multiplier for m/s*	
Multiplier	0.572
Offset	1
*When configured to output counts, the multiplier above is divided by the execution interval in seconds.	

6.3.2 ICEFREE3V Wind Direction

Except for the CR200(X) series, the **BRHalf()** instruction measures wind direction. The **BRHalf()** instruction has the following form:

BrHalf(*Dest, Reps, Range, SEChan, ExChan, MeasPEx, ExmV, RevEx, SettlingTime, Integ* or f_{N1}, *Mult, Offset*)

TABLE 6-6 provides the excitation voltages, range codes, multipliers, and offsets for the **BRHalf()** instruction. The multiplier value converts the sensor's millivolt output to degrees.

TABLE 6-6. Parameters for BRHalf Instruction			
	CR800 CR850 CR1000	**CR6 CR3000**	**CR300**
Measurement Range	2500 mV	5000 mV	2500 mV
Integration or f_{N1}	60 Hz, reverse excitation	60 Hz, reverse excitation	60 Hz
Excitation Voltage	2500 mV	2500 mV	2500 mV
Multiplier	360	360	360
Offset	0	0	0

For the CR200(X)-series dataloggers, the **ExDelSE()** measures wind direction. The **ExDelSE()** has the following form:

```
ExDelSE( Dest,Reps, SEChan, ExChan, ExmV, Delay, Mult, Offset )
```

Choose 2500 mV for the excitation millivolts and enter 0.144 for the multiplier and 0.0 for the offset.

7. Troubleshooting

7.1 Wind Direction

Symptom: NAN, –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.

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 6, *Installation* *(p. 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. Verify that the configuration code (low level ac, hertz), and multiplier and offset parameters for the pulse count instruction are correct for the datalogger type.

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. Example Program

The following is a CR1000 program that measures the ICEFREE3A and ICEFREE3V.

CRBasic Example A-1. CR1000 Program Measuring the ICEFREE3A and ICEFREE3V

```
'CR1000

'Declare Variables and Units
Public Batt_Volt
Public Wind_Speed
Public Wind_Dir

Units Batt_Volt=Volts
Units Wind_Speed =meters/second

'Define Data Tables
DataTable(Table1,True,-1)
  DataInterval(0,10,Min,10)
  Average(1,Wind_Speed,FP2,False)
  WindVector(1,Wind_Speed,Wind_Dir,FP2,False,0,0,4)
  FieldNames("Wind_Dir_D1_WVT,Wind_Dir_SD1,WVT")
EndTable

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

    'Measure Wind Speed with ICEFREE3 Anemometer in m/s:
    PulseCount(Wind_Speed,1,1,1,1,0.572,1)
    If Wind_Speed <= 1 Then Wind_Speed = 0

    'ICEFREE3V Wind Direction Sensor measurement Wind_Dir
    BrHalf(Wind_Dir,1,mV2500,1,Vx1,1,2500,True,0,_60Hz,360,0)

    'Call Data Tables and Store Data
    CallTable(Table1)
  NextScan
EndProg
```

Appendix B. Wind Direction Sensor Orientation

B.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. The preferred method to obtain the magnetic declination for a specific site is to use a computer service offered by NOAA at *www.ngdc.noaa.gov/geomag*. Magnetic declination can also be obtained from a map or local airport. A general map showing magnetic declination for the contiguous United States is shown in FIGURE B-1.

Declination angles east of True North are considered negative, and are subtracted from 360 degrees to get True North as shown FIGURE B-2 (0° and 360° are the same point on a compass). For example, the declination for Logan, Utah is 14° East. True North is 360° – 14°, or 346° as read on a compass. Declination angles west of True North are considered positive, and are added to 0 degrees to get True North as shown in FIGURE B-3.

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 laptop.

3. Loosen the hardware that secures 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 mounting hardware.

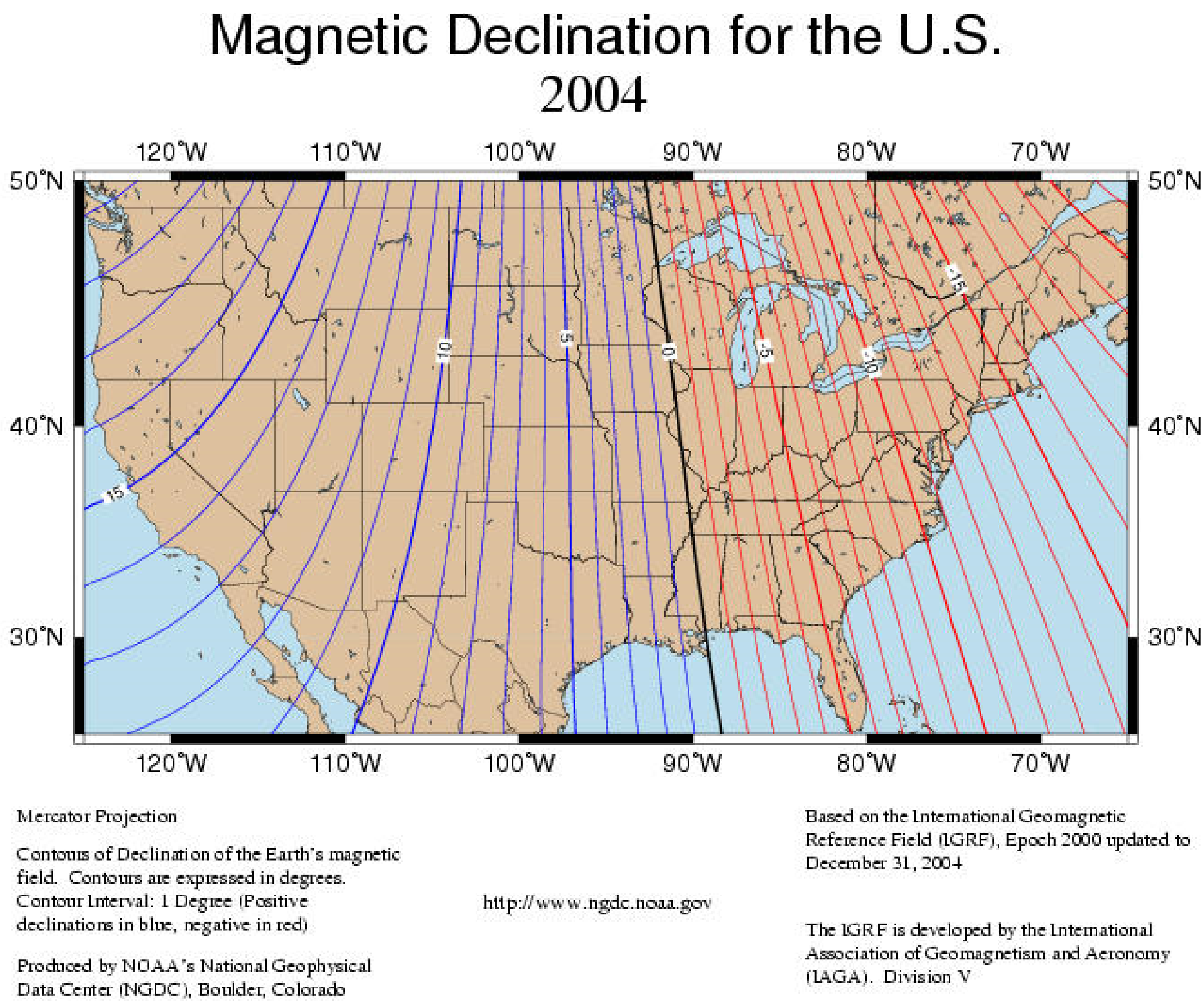

FIGURE B-1. Magnetic declination for the contiguous United States (2004)

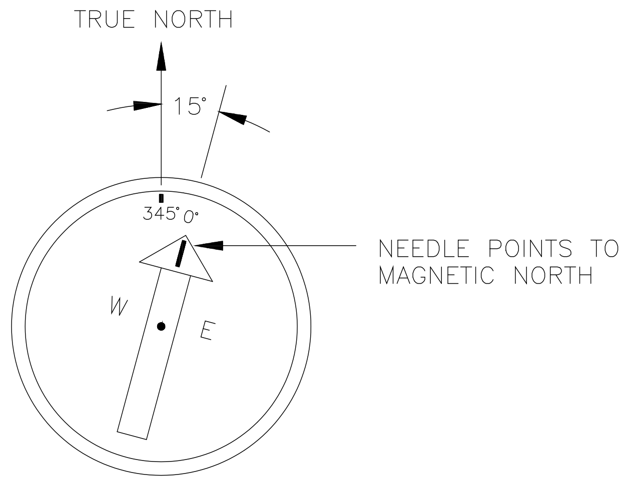

FIGURE B-2. Declination angles east of True North are subtracted from 0 to get True North

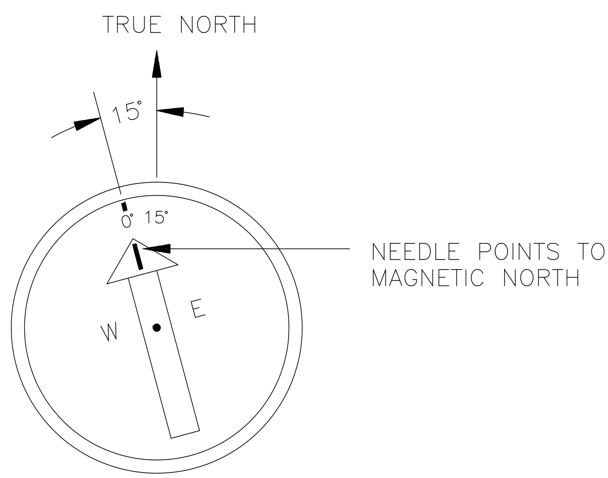

FIGURE B-3. Declination angles west of True North are added to 0 to get True North

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