INSTRUCTION MANUAL

27106T Vertical Propeller Anemometer

Revision: 4/16

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RMA#_____
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Logan, Utah 84321-1784

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Safety

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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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CRBasic Example

27106T Vertical Propeller Anemometer

1. Introduction

The 27106T Vertical Propeller Anemometer is a low threshold precision air velocity sensor that is especially suited for monitoring the vertical wind component. It connects directly to a Campbell Scientific datalogger, which measures the 27106T signal and converts the signal to engineering units (mph, m/s, knots).

NOTE This manual provides information only for CRBasic dataloggers. It is also compatible with most of our retired Edlog dataloggers. For Edlog datalogger support, see an older manual at *www.campbellsci.com/old-manuals* or contact a Campbell Scientific application engineer for assistance.

2. Precautions

- READ AND UNDERSTAND the *Safety* section at the front of this manual.
- The 27106T is a precision instrument. Please handle it with care.
- Make sure you have removed and accounted for all items from the shipping carton before discarding the shipping foam and shipping carton. The foam can hide some of the items.
- 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. Initial Inspection

Upon receipt of your shipment, immediately open the shipping carton and ensure that you have all of the 27106T's components. If an item is not initially visible, remove the foam from the shipping carton and thoroughly inspect both sides of the foam for the item. Immediately contact Campbell Scientific if any item is missing.

The shipping carton should include:

- 16-inch-by-2-inch-by-2-inch box labeled *Propeller Anemometer*, which contains the propeller shaft
- 9-inch-by-9-inch-by-2-inch box labeled *Carbon Fiber Propeller*
- Cable (routed through the mounting pipe to mating connector)
- 3/4-inch IPS threaded pipe (pn 1180)

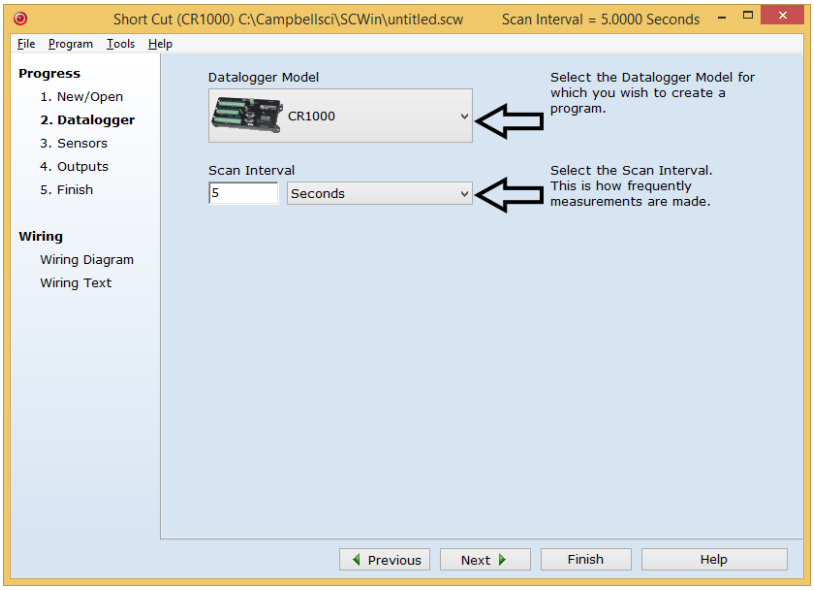
4. QuickStart

Short Cut is an easy way to program your datalogger to measure the 27106T and assign datalogger wiring terminals. *Short Cut* is available as a download on www.campbellsci.com and the *ResourceDVD*. It is included in installations of *LoggerNet*, *PC200W*, *PC400*, or *RTDAQ*.

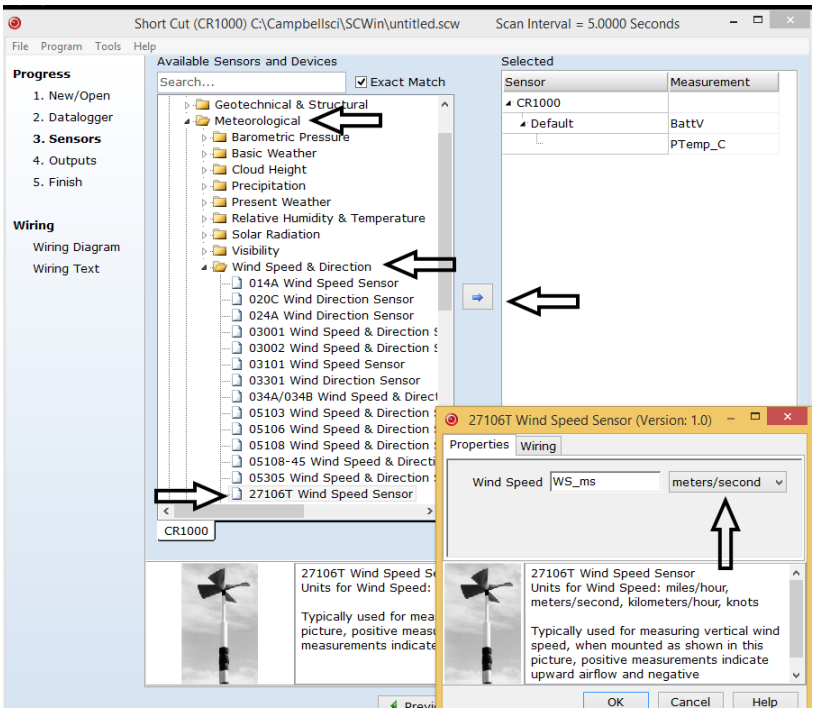
Use the following procedure to get started.

1. Open *Short Cut*. Click **New Program**.

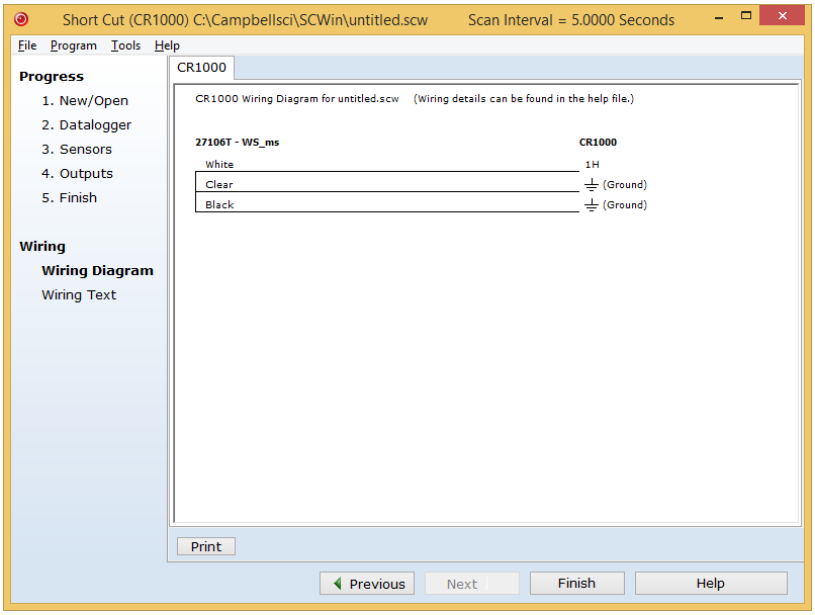
2. Select **Datalogger Model** and **Scan Interval** (default of **5** seconds is **OK** for most applications). Click **Next**.



3. Under the **Available Sensors and Devices** list, select the **Sensors** | **Meteorological** | **Wind Speed & Direction** folder. Select **27106T Wind Speed Sensor** and click  to move the selection to the selected device window. The units default to **meters/second**, which can be changed by clicking the **Wind Speed** box and selecting one of the other options.



4. After selecting the sensor, click **Wiring Diagram** to see how the sensor is to be wired to the datalogger. The wiring diagram can be printed now or after more sensors are added.



5. Select any other sensors you have, then finish the remaining *Short Cut* steps to complete the program. The remaining steps are outlined in *Short Cut Help*, which is accessed by clicking on **Help** | **Contents** | **Programming Steps**.

6. If *LoggerNet*, *PC400*, *RTDAQ*, or *PC200W* is running on your PC, and the PC to datalogger connection is active, you can click **Finish** in *Short Cut* and you will be prompted to send the program just created to the datalogger.

7. If the sensor is connected to the datalogger, as shown in the wiring diagram in step 4, check the output of the sensor in the datalogger support software data display to make sure it is making reasonable measurements.

5. Overview

The 27106T measures air velocity using a fast-response, four-blade helicoid propeller that drives a high quality tech-generator transducer. The transducer converts the propeller's rotation to a dc voltage that is linearly proportional to air velocity. The 27106T connects directly to a Campbell Scientific datalogger, which measures the 27106T's signal and converts the signal to engineering units (mph, m s^{-1}, knots).

The 27106T is manufactured by R.M. Young (Traverse City, MI) and cabled by Campbell Scientific for use with our dataloggers. The R.M. Young instruction manual includes additional information on the operating principles, installation, and maintenance of the sensor.

6. Specifications

Features:

- Especially suited for monitoring vertical wind, but can be mounted to monitor the wind in whatever direction is desired
- Carbon-fiber thermoplastic (CFT) propeller provides greater range and durability than other propeller anemometers offered by R.M. Young.
- Compatible with Campbell Scientific CRBasic dataloggers: CR200(X) series, CR300 series, CR6 series, CR800 series, CR1000, CR3000, CR5000, and CR9000(X)

Range

Axial Flow:	0 to 40 m/s (0 to 90 mph)
All Angles:	0 to 35 m/s (0 to 80 mph)
Threshold Sensitivity[1]:	0.4 m/s (0.8 mph)
Distance Constant[1]:	<2.1 m (6.9 ft)
Pitch:	30.0 cm (11.8 in) air passage per revolution
Signal Output:	Analog dc voltage proportional to axial wind component. Polarity reverses with reverse rotation. 1800 rpm (500 mV) = 9.0 m/s (20.1 mph)

Operating Temperature:	–50 to 50 °C
Propeller Description:	4-blade helicoids propeller molded of carbon fiber thermoplastic
Dimensions	
Overall Length:	43 cm (17 in)
Propeller Diameter:	20 cm (8 in)
Housing Diameter:	2.5 cm (1 in)
1180 Mounting Pipe Description:	12-in. long, 3/4-in. IPS schedule 40 pipe (1.05 in. OD)
Weight:	0.5 kg (1.2 lb)

[1]Threshold and Distant Constant values are for axial flows.

7. Installation

If you are programming your datalogger with *Short Cut*, skip Section 7.3, *Wiring* (p. 7), and Section 7.4, *Programming* (p. 8). *Short Cut* does this work for you. See Section 4, *QuickStart* (p. 2), for a *Short Cut* tutorial.

7.1 Siting

The 27106T should be oriented with the propeller facing the predominant flow of air being measured. No obstacle should interfere with the vertical air flow from either the up or down direction.

The propeller responds only to the component of the air flow, which is parallel to the axis of its rotation. Off-axis response closely approximates a cosine curve with appropriate polarity. With perpendicular air flow, the propeller does not rotate.

7.2 Assembly and Mounting

Tools Required:

- 1/2-inch open-end wrench for the CM220 Right-Angle Mount or 5/32-inch Allen wrench for the 1049 NU-RAIL fitting
- UV resistant cable ties
- small pair of diagonal-cutting pliers
- 6-inch to 10-inch torpedo level

Mount the 27106T to a tripod or tower using the tools listed above:

1. Mount a Campbell Scientific crossarm to a tripod or tower.

2. Remove the nut that is on the top of the propeller shaft (FIGURE 7-1 or FIGURE 7-2).

3. Place the propeller on top of the propeller shaft. Replace the nut and tighten to secure the propeller to the shaft (FIGURE 7-1 or FIGURE 7-2).

4. Remove the dust cap from the mating connector and mate it with the sensor connector. The cable comes routed through the 3/4-inch IPS pipe (pn 1180) to the mating connector.

5. Secure the pipe to the CM220 mount (FIGURE 7-1) or 1049 NU-RAIL (FIGURE 7-2).

6. Route the sensor cable along the underside of the crossarm to the tripod or tower, and to the instrument enclosure.

7. Secure the cable to the crossarm and tripod or tower using cable ties.

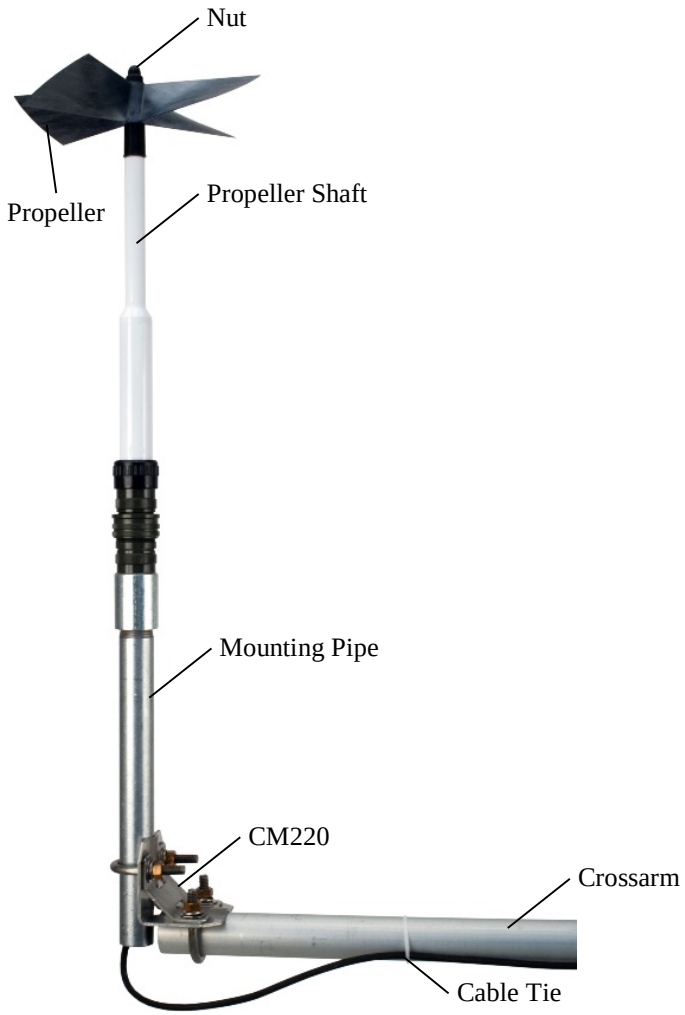


FIGURE 7-1. 27106T Mounted to a Crossarm via the CM220

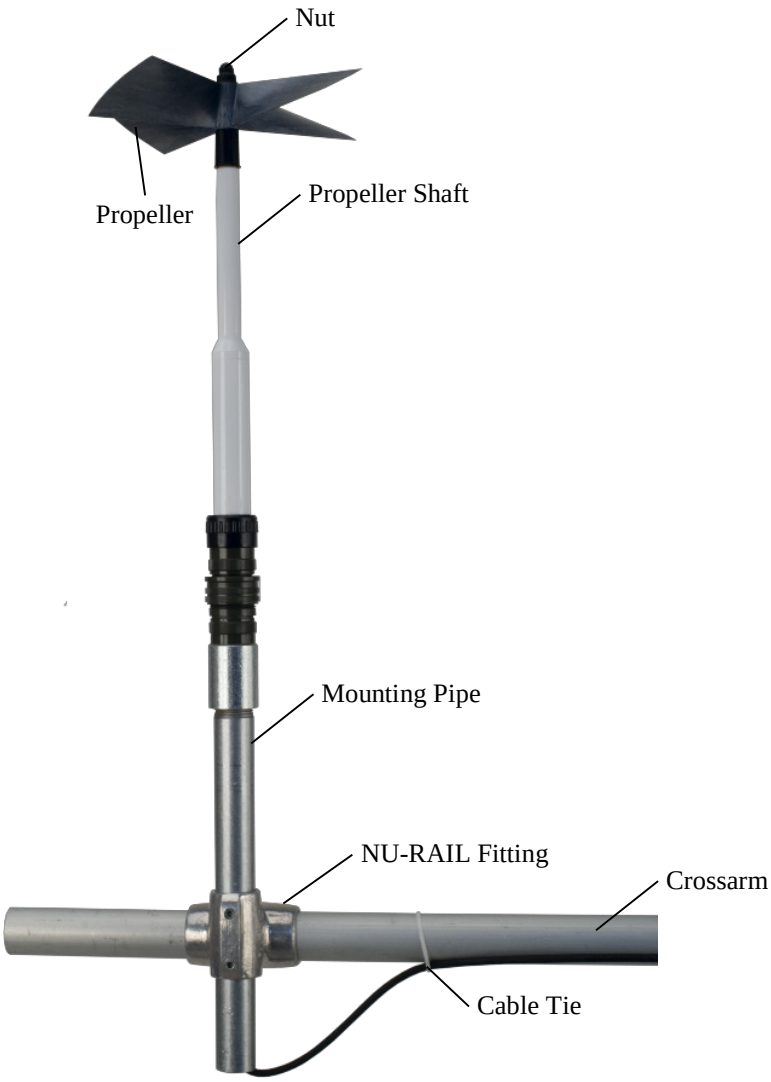


FIGURE 7-2. 27106T Mounted to a Crossarm via a NU-RAIL Fitting

7.3 Wiring

Connections to Campbell Scientific dataloggers are given in TABLE 7-1.

TABLE 7-1. Wire Color, Wire Function, and Datalogger Connection

Wire Color	Wire Function	Datalogger Connection Terminal
White	Signal	**U** configured for single-ended analog input[1], **SE** (single-ended, analog-voltage input)
Black	Signal Reference	⏚ (analog ground)
Clear	Shield	⏚ (analog ground)

[1]**U** channels are automatically configured by the measurement instruction.

7.4 Programming

Short Cut is the best source for up-to-date datalogger programming code. Programming code is needed when:

- Creating a program for a new datalogger installation
- Adding sensors to an existing datalogger program

If your data acquisition requirements are simple, you can probably create and maintain a datalogger program exclusively with *Short Cut*. If your data acquisition needs are more complex, the files that *Short Cut* creates are a great source for programming code to start a new program or add to an existing custom program.

NOTE *Short Cut* cannot edit programs after they are imported and edited in *CRBasic Editor*.

A *Short Cut* tutorial is available in Section 4, *QuickStart* *(p. 2)*. If you wish to import *Short Cut* code into *CRBasic Editor* to create or add to a customized program, follow the procedure in Appendix A, *Importing Short Cut Code Into CRBasic Editor* *(p. A-1)*. Programming basics for CRBasic dataloggers are in the following section. Complete program examples for select CRBasic dataloggers can be found in Appendix B, *Example Program* *(p. B-1)*. Programming basics and programming examples for Edlog dataloggers are provided at *www.campbellsci.com\old-manuals*.

7.4.1 VoltSE Instruction

The **VoltSE()** measurement instruction programs the datalogger to measure the 27106T.

```
VoltSE( Dest, Reps, Range, SEChan, MeasOff, SettlingTime,
Integ/fnotch, Mult, Offset )
```

For ***Range***, use ***mV2500*** (CR300, CR1000) or ***mV5000*** (CR3000, CR5000). If the anemometer will be in electrically noisy environments, use 50 Hz or 60 Hz rejection for ***Integ/f_{notch}***.

7.4.2 Multiplier and Offset

The expression for wind speed (U) is:

$$U = MX + B$$

Where,

M = multiplier
X = voltage measured by the datalogger
B = offset

TABLE 7-2 lists the multipliers to obtain miles/hour, meters/second, km/H, and knots. The helicoid propeller has a calibration that passes through zero, so the offset is zero.

TABLE 7-2. Wind Speed Multiplier[1]	
Unit	**Multiplier**
Miles per Hour	0.04025
Meters/Second	0.01800
Kilometers/Hour	0.06480
Knots	0.03496

[1]When the propeller is used for measuring the vertical wind component, users may want to apply an additional multiplier of 1.25 to the output signal. This may be done numerically in the data processing operations or electronically in the signal conditioning. Using the additional multiplier brings the anemometer output signal within ±3% of the cosine response for elevation angles between –30° and 30°. Since the standard deviation of wind elevation angle in open terrain rarely exceeds 12°, 98% (2.5 standard deviations) of observations will be within ±30°. Using the multiplier is not necessary when the anemometer is used in a UVW configuration with R.M. Young model 26601UVW Translator.

8. Maintenance and Troubleshooting

NOTE All factory repairs and replacements require a returned material authorization (RMA) and completion of the "Declaration of Hazardous Material and Decontamination" form. Refer to the *Assistance* page at the beginning of this manual for more information.

8.1 Maintenance

Given proper care, the 27106T should provide years of service. Components are conservatively rated and require little maintenance. The only parts likely to need replacement due to normal wear are the precision ball bearings and the tach-generator.

CAUTION Campbell Scientific recommends returning the sensor to the factory and having our qualified technicians replace the bearings and tach-generator. When available, a qualified technician can replace the bearings and/or generator by following the procedures included in this document. These replacement procedures are from *R.M. Young 27106T Operational Manual*.

8.1.1 Flange Bearing Replacement

If anemometer bearings become noisy or wind speed threshold increases above an acceptable level, bearings may need replacement. You can check bearing condition using a Model 18310 Anemometer Bearing Torque Disk (available from R.M. Young). If, after replacing bearings, the torque is still too high, check the tach-generator.

If the bearings need to be replaced, have either Campbell Scientific or a qualified technician replace them by using the following procedure:

1. Remove old bearings:

    a. Remove propeller from anemometer.

    b. Unthread and separate shaft housing assembly from generator housing.

    c. Loosen set screw on shaft collar/coupling disk and remove from propeller shaft.

    d. Slide propeller shaft through both bearings and out of housing.

    e. Pull front bearing dust shield off housing.

    f. Using the edge of a pocket knife, gently pry front and rear bearings out of housing.

2. Install new bearings:

    a. Gently insert front bearing into housing.

    b. Push front bearing dust shield back onto housing.

    c. Carefully slide propeller shaft through front bearing and into housing.

    d. Slide rear bearing over propeller shaft and gently push it into housing.

    e. Place shaft collar/coupling disk on propeller shaft.

    f. Allow 0.010 inch (0.25 mm) end play gap between shaft collar/coupling disk and bearing. Tighten set screw (80 oz in, 5600 gm-cm max torque).

    g. Thread shaft housing assembly into generator housing. Tighten firmly.

    h. Check bearing torque to confirm it is within specifications.

8.1.2 Tach-Generator Replacement

When the tach-generator output becomes erratic (usually due to brush failure) or begins to show signs of bearing failure (high torque), the entire generator assembly should be removed and replaced. Before replacing the tach-generator due to excessive torque, ensure it is caused by a worn tach-generator, and not the anemometer flange bearings.

If the tach-generator needs to be replaced, have either Campbell Scientific or a qualified technician replace it by using the following procedure:

1. Remove old generator assembly:

    a. Remove propeller from anemometer.

b. Unthread generator housing collar. Pull generator housing away from sensor connector and generator assembly.

c. Note position of generator wires on sensor connector pins. Unsolder wires from pins and remove old generator assembly.

2. Install new generator assembly:

a. Solder wires from new generator assembly onto proper sensor connector pins. Verify correct polarity; CCW rotation produces negative output voltage.

b. Slide generator housing over generator assembly. Firmly tighten housing collar onto connector threads.

c. Check bearing torque to confirm it is within specification.

8.2 Troubleshooting

Symptom: No wind speed

1. Check that the sensor is wired to the single-ended channel specified by the **VoltSE** instruction.

2. Disconnect the sensor from the datalogger and use an ohm meter to check the tach-generator. The resistance between the white and black wires should be about 32 Ω. Infinite resistance indicates an open coil; low resistance indicates a shorted coil.

3. Verify that the ***Range*** parameter for the **VoltSE** instruction is correct for the datalogger type.

9. References

References containing additional information about the 207106T are listed below in chronological order.

Holmes, R.M., Gill, G.C., and Carson, H.W., “A Propeller Type Vertical Anemometer”, Journal of Applied Meteorology, Vol 3, 1964, pp. 802-804

Drinkow, R., “A Solution to the Paired Gill-Anemometer Response Function”, Journal of Applied Meteorology, Vol 11, 1972, pp. 7-80.

Hicks, B. B., “Propeller Anemometers as Sensors of Atmospheric Turbulence”, Boundary-Layer Meteorology, Vol 3, 1972, pp. 214-228

Fichtl, G. H., and Kumar, P., “The Response of Propeller Anemometer to Turbulent Flow with the Mean Wind Vector Perpendicular to the Axis of Rotation”, Boundary-Layer Meteorology, Vol 6, 1974, pp. 363-379.

McMichael, J.M., and Klebanoff, P. S., “The Dynamic Response of Helicoid Anemometers”, NBSIR 75-772, National Bureau of Standards, 1975.

R.M Young Model 27106 Gill Propeller Anemometer Manual PN: 27106-90, Rev: D030106

Appendix A. Importing Short Cut Code Into CRBasic Editor

This tutorial shows:

- How to import a *Short Cut* program into a program editor for additional refinement
- How to import a wiring diagram from *Short Cut* into the comments of a custom program

Short Cut creates files, which can be imported into *CRBasic Editor*. Assuming defaults were used when *Short Cut* was installed, these files reside in the C:\campbellsci\SCWin folder:

- .DEF (wiring and memory usage information)
- .CR2 (CR200(X)-series datalogger code)
- .CR300 (CR300-series datalogger code)
- .CR6 (CR6-series datalogger code)
- .CR8 (CR800-series datalogger code)
- .CR1 (CR1000 datalogger code)
- .CR3 (CR3000 datalogger code)
- .CR5 (CR5000 datalogger code)
- .CR9 (CR9000(X) datalogger code)

Use the following procedure to import *Short Cut* code and wiring diagram into *CRBasic Editor*.

1. Create the *Short Cut* program following the procedure in Section 4, *QuickStart* *(p. 2)*. Finish the program and exit *Short Cut*. Make note of the file name used when saving the *Short Cut* program.
2. Open *CRBasic Editor*.
3. Click **File** | **Open**. Assuming the default paths were used when *Short Cut* was installed, navigate to C:\CampbellSci\SCWin folder. The file of interest has the .CR2, .CR300, .CR6, .CR8, .CR1, .CR3, .CR5, or .CR9 extension. Select the file and click **Open**.
4. Immediately save the file in a folder different from C:\Campbellsci\SCWin, or save the file with a different file name.

NOTE Once the file is edited with *CRBasic Editor*, *Short Cut* can no longer be used to edit the datalogger program. Change the name of the program file or move it, or *Short Cut* may overwrite it next time it is used.

5. The program can now be edited, saved, and sent to the datalogger.
6. Import wiring information to the program by opening the associated .DEF file. Copy and paste the section beginning with heading "-Wiring for CRXXX–" into the CRBasic program, usually at the head of the file. After pasting, edit the information such that an apostrophe (') begins each line. This character instructs the datalogger compiler to ignore the line when compiling.

Appendix B. Example Program

The following program measure the 27106T every second, and store the maximum, minimum, and average wind speed every 10 minutes. Wiring for the examples is given in TABLE B-1.

TABLE B-1. Wiring for Example Program

Color	Wire Label	CR1000
White	Signal	**SE1**
Black	Signal Reference	⏚
Clear	Shield	⏚

CRBasic Example B-1. CR1000 Example Program

```
'CR1000 Series Datalogger
'Declare Public Variables
Public Batt_Volt
Public WS_ms

Units Batt_Volt=Volts
Units WS_ms=meters/second

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

'Main Program
BeginProg
  Scan (1,Sec,1,0)
    Battery (Batt_Volt)
    '27106T Wind Speed Sensor measurement
    VoltSe (WS_ms,1,mV2500,1,1,0,250,0.01800,0)
    'mV5000 range code for CR3000 and CR5000 dataloggers

  'Call Output Tables
  CallTable Table1
  NextScan
EndProg
```

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