

INSTRUCTION MANUAL



T.Weather 106 Weather Station

Revision: 9/02

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RMA#_____

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Section 1. Preparation and Siting

These guidelines apply to several Campbell Scientific weather stations.

1.1 Installation Tasks

1.1.1 Indoors

- Immediately upon receipt of your shipment...
 - ⇒ Open shipping cartons.
 - ⇒ Check contents against invoice. Contact CSI immediately about any shortages.
- Several days prior to the planned installation date...
 - ⇒ Collect tools and site information (Section 1)
 - ⇒ Trial run the tower, assembling as much as possible (Section 2)
 - ⇒ Repackage equipment for transport to the field site

1.1.2 Outdoors

- Locate suitable site (Section 1)
- Prepare tower (Section 2)
- T.Weather 106 Stations:
 - ⇒ Place instrumentation enclosure low on the T.Weather 106 Tower (Section 3)
 - ⇒ Install sensor option (Section 4)
 - ⇒ Slide enclosure to top of tower and secure with correct orientation (Section 3)

1.2 Tools Required

Tools required to install and maintain a weather station are listed below.

1.2.1 Tools For Tower Installation

All Towers

Shovel

Rake

Open end wrenches: 3/8", 7/16", 1/2", (2) 9/16"

Magnetic compass

6' Step ladder

T. Weather 106 Tower

Tape measure (12' to 20')

Claw hammer

Level (24" to 36")

Hand saw

Materials for concrete form:

(4) 1" x 2" x 12" stakes

(2) 2" x 4" x 96" lumber

(12) 8p double-head nails

(8) 16p double-head nails

20 ft form wire

½ Yard concrete

Concrete trowel, edger

Electrical Fish tape or 20 feet of small diameter rope

Wheelbarrow

1.2.2 Tools For Instrumentation And Maintenance

All Towers

Lock and key for enclosure

Magnetic declination angle (Section 4)

Magnetic compass

Straight bit screwdrivers (small, medium, large)

Phillips-head screwdrivers (small, medium)

Small diagonal side-cuts

Needle-nose pliers

Wire strippers

Pocket knife

Calculator

Volt / Ohm Meter

Electrical Tape

Step ladder (6')

Datalogger prompt sheet (Section 6)

Station manuals

Station log and pen

Open end wrenches: 3/8", 7/16", 1/2", (2) 9/16"

Socket wrench and 7/16" deep well socket

Adjustable wrench

Pliers

Conduit and associated tools (as required)

Felt-tipped marking pen

Claw hammer

Pipe wrench (12")

1.2.3 Supplies for Power and Communications Options

AC Power

Wire, conduit, and junction boxes as needed

Phone Modem

Hayes compatible calling modem for PC

Phone line to weather station or junction box

Short-Haul Modem

4 Conductor communications cable from PC to weather station or junction box

6' copper ground rod and clamp for PC surge protection (optional)

1.3 Siting and Exposure

CAUTION

If any part of the weather station comes in contact with power lines, you could be killed. Contact local utilities for the location of buried utility lines before digging or driving ground rods.

Selecting an appropriate site for the weather station is critical in order to obtain accurate meteorological data. In general, the site should be representative of the general area of interest, and away from the influence of obstructions such as buildings and trees.

The weather station should not be located where sprinkler irrigation water will strike sensors or instrument enclosure.

Some general guidelines for site selection are listed below, which were condensed from EPA (1988)¹, WMO (1983)², and AASC (1985)³ publications.

1.3.1 Wind Speed and Direction

Wind sensors should be located over open level terrain, and at a distance of at least ten times (EPA) the height of any nearby building, tree or other obstruction, as illustrated in Figure 1.3-1.

1.3.2 Temperature and Relative Humidity

Sensors should be located over an open level area at least 9 m (EPA) in diameter. The surface should be covered by short grass, or where grass does not grow, the natural earth surface. Sensors should be located at a distance of at least four times the height of any nearby obstruction and at least 30 m (EPA) from large paved areas. Sensors should be protected from thermal radiation, and adequately ventilated.

Situations to avoid include:

- large industrial heat sources
- rooftops
- steep slopes
- sheltered hollows
- high vegetation
- shaded areas
- swamps
- areas where snow drifts occur
- low places holding standing water after rains

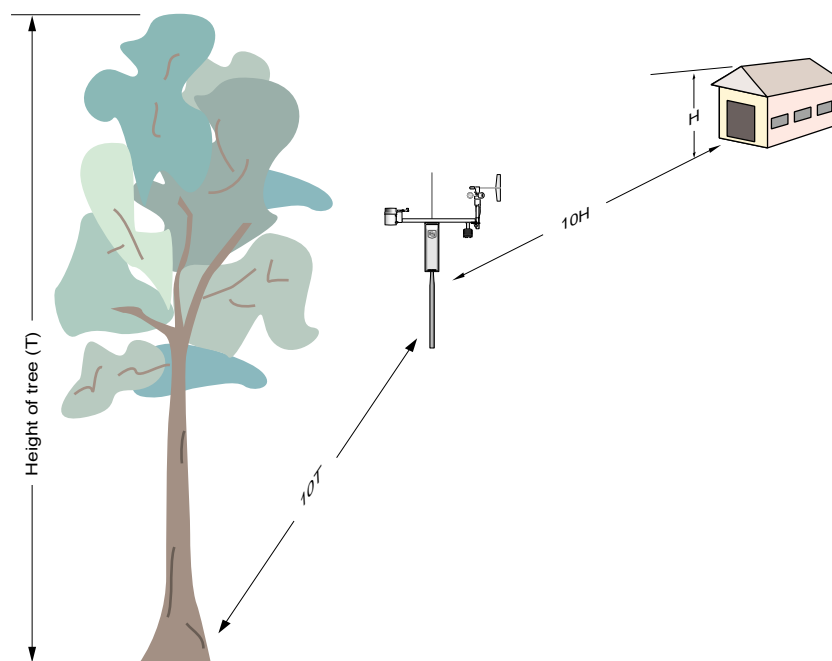


FIGURE 1.3-1. Effect of Structure on Wind Flow

1.4 Determining True North for Wind Vane Orientation

Magnetic declination, or other methods to find True North, should be determined prior to installing the weather station. 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 USFA map, local airport, or through a computer service offered by the USFS called GEOMAG (Section 1.4.1). A general map showing magnetic declination for the contiguous United States is shown in Figure 1.4-1.

Declination angles east of True North are considered negative, and are subtracted from 0 degrees to get True North as shown Figure 1.4-2. Declination angles west of True North are considered positive, and are added to 0 degrees to get True North as shown in Figure 1.4-3. For example, the declination for Logan, Utah is 16° East. True North is $360^\circ - 16^\circ$, or 344° as read on a compass.

* Other methods employ observations using the North Star or the sun, and are discussed in the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV - Meteorological Measurements⁴.

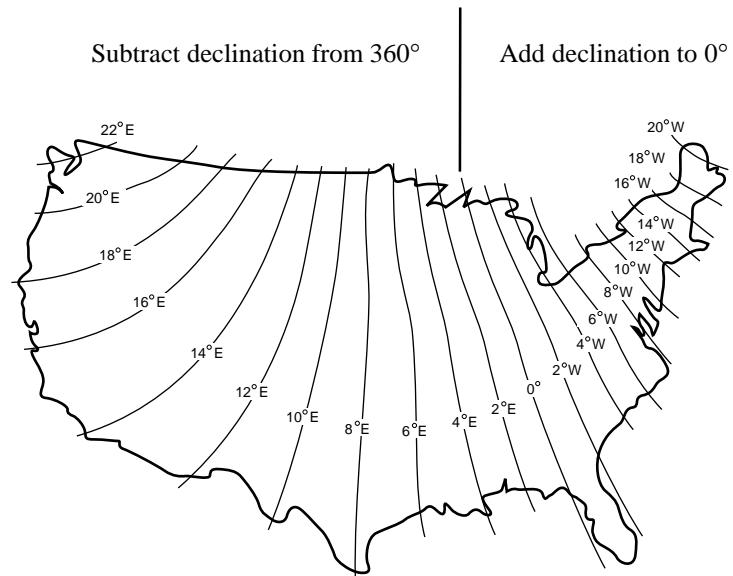


FIGURE 1.4-1. Magnetic Declination for the Contiguous United States

1.4.1 Prompts from GEOMAG

GEOMAG is accessed by phone with a PC and telephone modem, and a communications program such as GraphTerm (PC208 Software). GEOMAG prompts the caller for site latitude, longitude, and elevation, which it uses to determine the magnetic declination and annual change. The following information, menu, and prompts are from GEOMAG:

GEOMAG is a user-friendly program that provides estimates of the geomagnetic field elements, including declination and total field intensity, based upon Magnetic Models. The program is accessible by modem.

Modem Access:

Modem settings: No parity, 8 data bits, and 1 stop bit (i.e., N81)

Telephone numbers:

| Phone Number | Baud Rates |
|--------------|------------|
| 303-273-8672 | 2400 |
| 303-273-8673 | 1200 |
| 303-273-8678 | 1200 |

Upon carrier-signal detection, press Return once or twice.

If you are using one of the commercial numbers, the following prompts will appear. Type the responses shown (followed by pressing RETURN):

```
GLDSV1>      c neis  [RETURN]
Username:    QED    [RETURN]
```

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 return
Name of field model [USCON90]: press return
Date [current date]: press return
Latitude : 42/2 N
Longitude : 111/51/2 W
Elevation : 4454 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
deg min

15 59.6

Annual change:

0 -6.1

Exiting:

Press "Cntrl-Z" to exit GEOMAG.

When the main menu reappears either select another option or type "X" to log out.

If you used one of the commercial numbers, the GLDSV1> prompt will reappear.

Type "LO" to disconnect.

Use of GEOMAG is free (except for telephone charges). If possible, please avoid using

GEOMAG between 9 a.m. and 4 p.m., mountain time, Monday through Friday.

The declination in the example above is listed as 15 degrees and 59.6 minutes. Expressed in degrees, this would be 15.99 degrees. As shown in Figure 1.4-1, the declination for Utah is east, so True North for this site is 360 - 15.99, or 344 degrees. The annual change is -6.1 minutes.

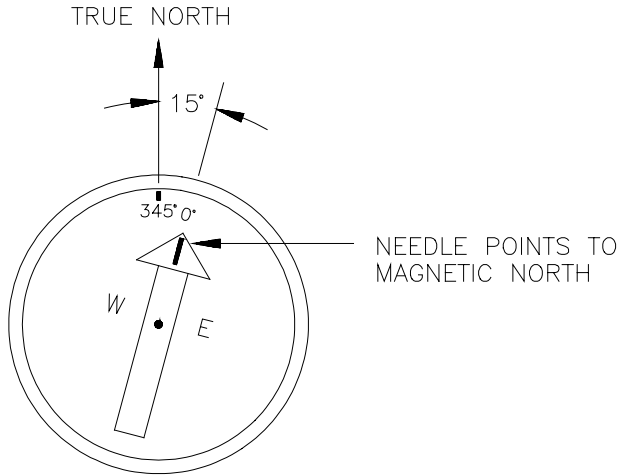


FIGURE 1.4-2. Declination Angles East of True North Are Subtracted From 0 to Get True North

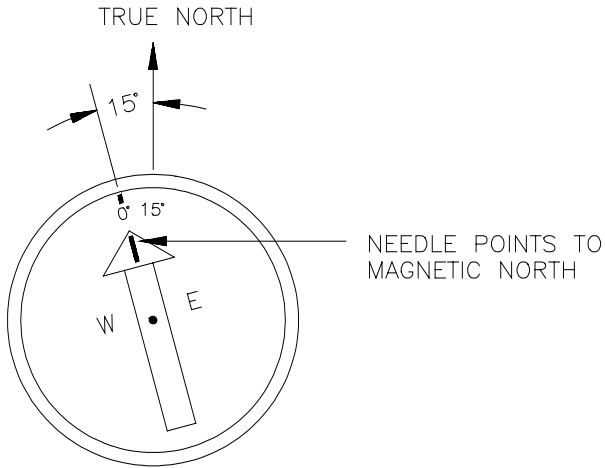


FIGURE 1.4-3. Declination Angles West of True North Are Added to 0 to Get True North

Section 2. T.Weather 106 Tower Installation

DANGER: Do not install near power lines. If any part of the tower comes in contact with power lines you could be KILLED. Contact local utilities for the location of buried utility lines before digging or driving grounding rods.

CAUTION: Do not fit the 3 meter T.Weather 106 Tower sections together until the appropriate time. Once attached, they cannot be detached.

The T.Weather 106 Tower provides a support structure for mounting the T.Weather 106 weather station components. Figure 2.1-1 shows a typical T.Weather 106 Tower installation option. The tower is designed to withstand winds of 100 mph. The lightning rod assembly is attached after the instrumentation enclosure is installed (Section 3.1).

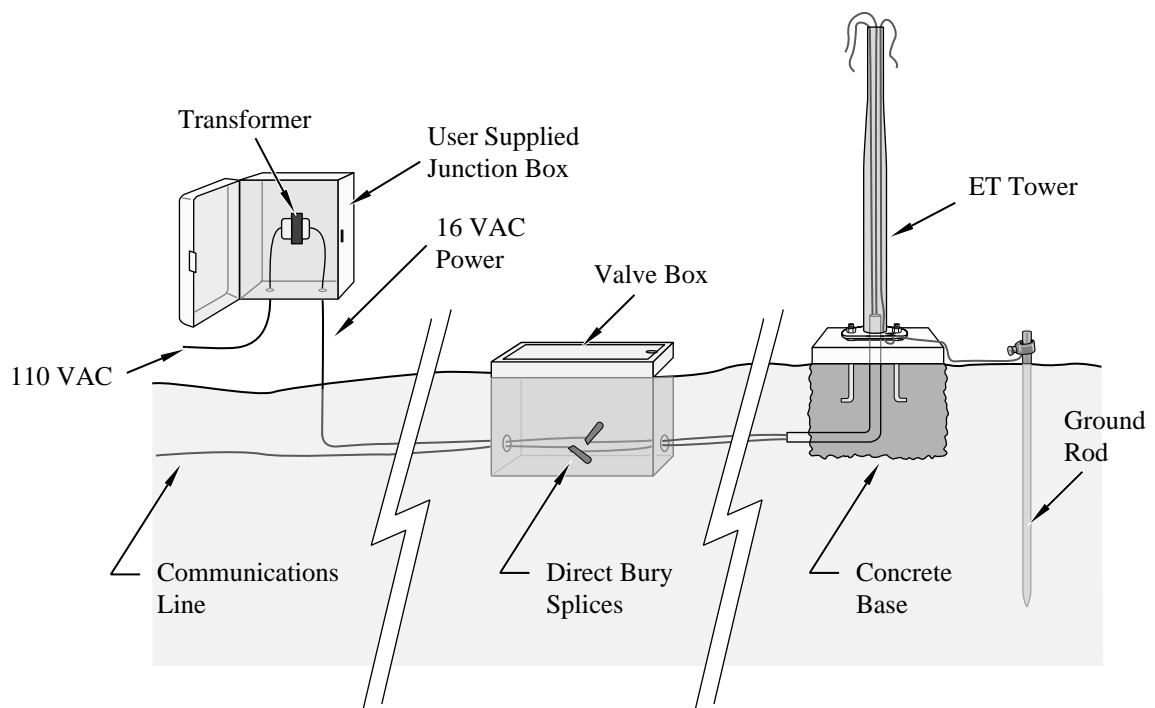


FIGURE 2.1-1. T.Weather 106 Tower Installation

2.1 Base Installation

2.1.1 Supplied Components

- (3) 1/2 inch L-Bolts
- (9) 1/2 inch Nuts
- (1) Anchor Template

Refer to Section 1 for components supplied by installer.

2.1.2 Installation

1. The T.Weather 106 Tower attaches to a user supplied concrete foundation constructed as shown in Figure 2.1-1.
2. Construct the concrete form with 2" x 4" lumber and 16p nails.
3. Assemble the template and anchor bolts. There should be two nuts below and one nut above the template on each bolt.
4. Clear an area large enough to set the form at the desired elevation.
5. Dig a hole 2 feet x 2 feet x 2 feet. Lighter soils may require a deeper hole. About 20 inches below the top of the hole, gouge a small cavity in one wall of the hole. The cavity should be about 4 inches deep and just large enough in diameter to insert one end of the conduit. Make certain the cavity "points" in the direction from which power and communications cables will come.
6. Center the form over the hole. Adjacent to the form, drive four stakes into the soil. Secure the leveled form to the stakes with the 8p nails.
7. Cap the ends of the conduit with duct tape. Position the conduit and wire into place by securing the wire to nails in the form.
8. Fill the hole and form with approximately 1/2 yard of concrete. Screed the concrete level with the top of the form. Center the template assembly over the conduit and press into the concrete. Put 2 x 4 spacers between the template and the top of the form. The bottom of the bolt threads should be about 1/2 inch above the concrete. The template must be level in two dimensions. Use a trowel and edger to finish.
9. Wait 24 hours before removing the concrete form. Wait 7 days before mounting the T.Weather 106 Tower.

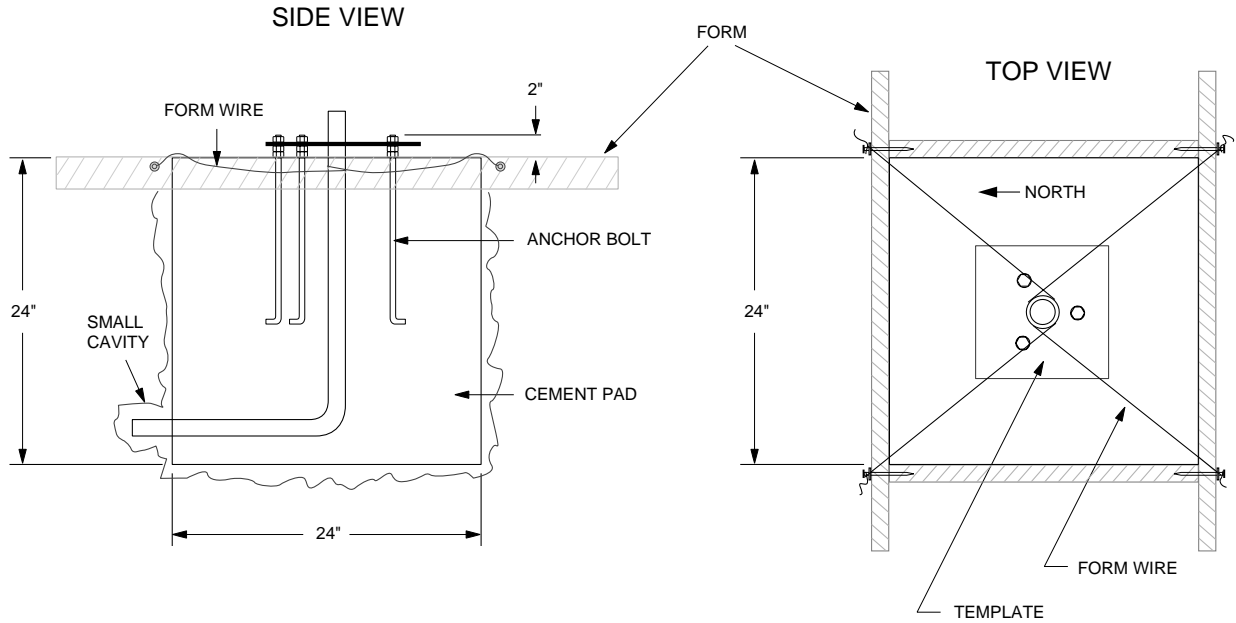


FIGURE 2.1-1. T.Weather 106 Tower Base Installation

2.2 Tower Installation

2.2.1 Supplied Components

- (1) Upper Tower Section (Tapered)
- (1) Lower Tower Section
- (6) 1/2 inch Washers
- (1) 12 foot 12 AWG Ground Cable
- (1) Tower Cap
- (1) 20' communications cable
- (1) 20' power cable

Refer to Section 1 for components supplied by installer.

2.2.2 Installation

Attach the tower to the base as shown in Figure 2.2-1.

1. Dig a hole close to the concrete base to access the lower conduit opening. From the hole, trench to the power and communications sources. Remove the duct tape from both ends of the conduit.
2. Remove the template. Attach the two pieces of the tower. This is a permanent connection and cannot be undone. Lay the tower on the ground with the base next to the concrete foundation.
3. Thread communications and power cables through the tower and conduit. Electrical fish tape will help.

4. Cut and save a 9-inch piece of 12 AWG ground wire from the 12-foot length provided. Thread the remaining 11 foot ground wire through the tower. Secure all wiring so it does not slip back into the tower or conduit.
5. Place the tower cap over the tower end.
6. Raise the tower on a still day. Place a washer on top of the two nuts on each foundation bolt. Taking great care not to damage cables between the tower and conduit, raise the tower and lower it onto the conduit and mounting bolts. Install a washer and nut on each bolt and hand tighten. Check plumb of the tower by placing a level on the north and east sides of the lower tower section. Adjust the topmost of the two lower nuts (leveling nut) on each bolt as necessary. When plumb is established, lock the leveling nut in place by tightening the lowest nut against it. Tighten the three top nuts with the wrench.

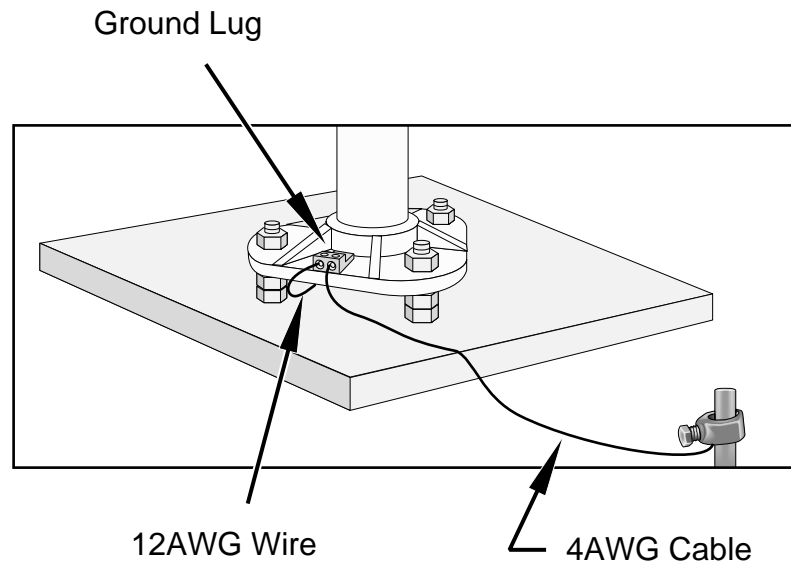


FIGURE 2.2-1. Raising and Grounding the T.Weather 106 Tower

2.3 Tower Grounding

2.3.1 Supplied Components

- (1) 5 foot 4 AWG Ground Cable
- (1) Copper Ground Lug, Bolt
- (1) Ground Rod, Clamp

Refer to Section 1 for components supplied by installer.

2.3.2 Grounding Procedure

Ground the tower as shown in Figure 2.2-1.

1. Place the ground rod clamp on the rod. Secure it about 3 inches from the top. Do this before the rod is driven into the ground. Be careful not to damage the clamp with the hammer
2. Taking care not to damage power or communications lines, drive the ground rod close to the foundation using a fence post driver or sledge hammer. Drive the rod at an angle if an impenetrable hardpan layer exists. Soften hard clay soils with water if necessary.
3. Strip 1 inch of insulation from both ends of the 4 AWG ground cable. Strip 1 inch of insulation from the lower end of the 14 AWG ground wire. Install the tower grounding lug to the tower base with the 7/16 bolt provided (Figure 2.2-1). Loosen the lug's set screw and insert the 4 AWG and 14 AWG wire. Tighten the set screw.
4. Loosen the ground rod clamp. Insert the 4 AWG wire. Tighten the clamp (Figure 2.2-1).

Section 3. T.Weather 106 Instrumentation Installation

The weather station datalogger, power supply, sensor connection panel, communications devices, and data retrieval peripherals are mounted in the T.Weather 106 enclosure at the locations shown in Figure 3-1. Components include:

- (1) T.Weather 106 Enclosure
- (1) 4 unit Desiccant Pack
- (1) Flat Point Screw Driver
- (1) Phillips Screwdriver
- (1) Power Supply Option
- (1) Telecommunications Option
- (1) 9-inch piece of 12 AWG ground wire
- (1) Lightning rod and clamp

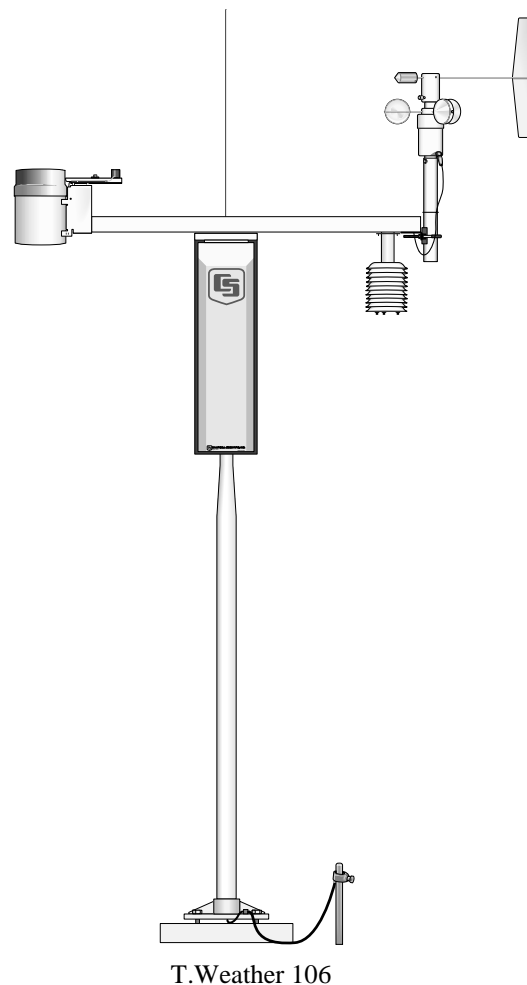


FIGURE 3-1. T.Weather 106 Instrumentation Mounted on the ET Tower

3.1 Enclosure, Datalogger, Power Supply

3.1.1 Battery Option Installation

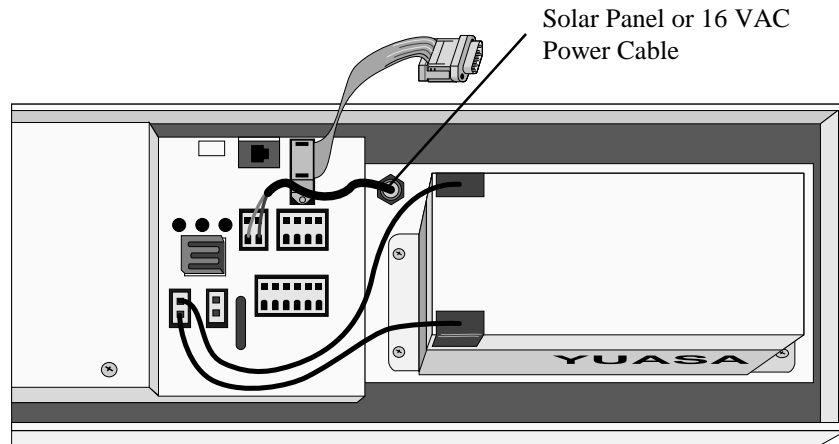


FIGURE 3.1-1. Rechargeable Power Mounting and Connections

- a) Sealed Rechargeable Battery Option: Install the kit as shown in Figure 3.1-1. An unregulated solar panel or 17 to 24 VAC must be used with the rechargeable battery at all times. In either case, power is routed through the Heyco fitting on the enclosure back and connected to the CHG ports by depressing connector levers. Polarity of the CHG connection does not matter. Install the rechargeable battery and plug the battery lead into the connector labeled "LA".

NOTE Press the connector levers gently or they might break.

3.1.2 Solar Panel Installation

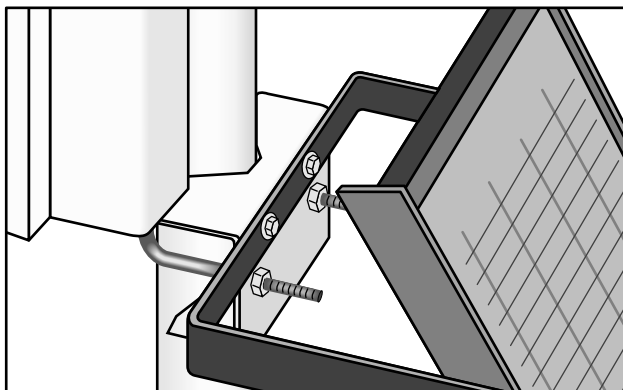


FIGURE 3.1-2. Solar Panel Mounting

- a) Mount the solar panel to the tower using the mounting brackets as shown in Figure 3.1-2. Mount the solar panel to the tower so it faces south (northern hemisphere). Position it as high off the ground as practical, ensuring it cannot interfere with air flow or sunlight around the sensors. The solar panel should be oriented to receive maximum insolation over the course of the year. Suggested tilt angles (referenced to the horizontal plane) are listed below.

| <u>Site Latitude</u> | <u>Tilt Angle</u> |
|----------------------|-----------------------|
| 0 to 10 degrees | 10 degrees |
| 11 to 20 | Latitude + 5 degrees |
| 21 to 45 | Latitude + 10 degrees |
| 46 to 65 | Latitude + 15 degrees |
| >65 | 80 degrees |

- b) After determining the tilt angle, loosen the two bolts that attach the mounting bracket to the panel. Adjust the angle, then tighten the bolts. Secure the lead wire to the mast using wire ties. Make electrical connections as described in 3.1.1a above.

3.1.3 AC Power Installation

- a) The AC power option includes a 120 VAC to 16 VAC. The transformer should be mounted inside a user supplied junction box according to local electrical codes. Dangerous electrical accidents may be avoided by locating the transformer remotely and burying a low voltage line to the station. The low voltage will carry up to 500 feet on an 18 AWG power cable.
- b) Shut off 110 VAC power at the main breaker. Connect the primary leads of the transformer to 110 VAC following instructions provided with the transformer. Connect a two conductor cable to the secondary terminals of the transformer. Route the cable from the transformer to the T.Weather 106 Enclosure according to local electrical codes.

3.1.4 Enclosure Installation

1. Mount and ground the T.Weather 106 enclosure on the T.Weather 106 Tower as shown in Figure 3.1-3.
 - a) Place the enclosure low on the tower. Do not tighten clamps.
 - b) Install the sensor arm (T.Weather 106) as described in Section 4.

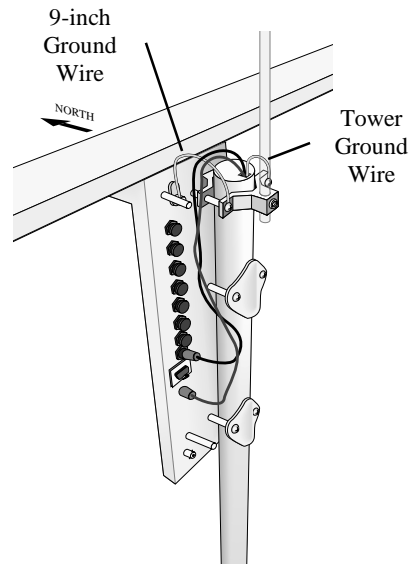


FIGURE 3.1-3. Mounting and Grounding the T.Weather 106 Enclosure

- c) Slide the enclosure to the top of the T.Weather 106 tower. Position it on the north side of the tower (northern hemisphere). The top of the enclosure should be flush with the top of the tower, with the width of the sensor arm extending above the tower. Tighten the clamps until the enclosure is snug. Do not over-tighten since doing so may damage the tower or enclosure.
- d) Carefully mount the lightning rod and clamp to the top of the T.Weather 106 Tower. Clearance between the clamp and the enclosure is minimal. Care should be taken not to scratch the enclosure or sensor assembly. Strip 1 inch of insulation from the top end of the 12 AWG green tower ground wire, curl the end and place the curled end under the head of one of the lightning rod clamp bolts. Tighten the bolt.
- e) Strip 1 inch of insulation from each end of the 9 inch piece of 12 AWG ground wire. Insert one end into the brass ground lug located at the top back of the enclosure. Curl the other end and place under the head of one of the lightning rod clamp bolts. Tighten the bolt.

3.2 Sensor Connection

- 1) Install the sensor set as described in Section 4.
- 2) Remove the protective connector cover from the back of the T.Weather 106 Enclosure by removing the two Phillips head screws. Sensors connect to one of seven labeled bulkhead connectors as shown in Figure 3.2-1.

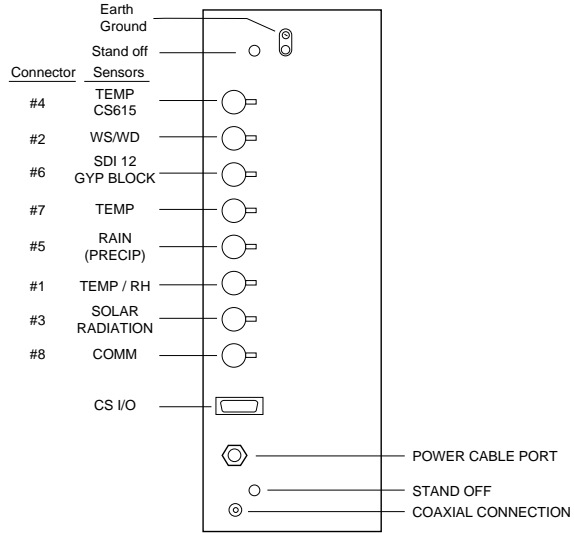


FIGURE 3.2-1. Position of Sensor Bulkhead Connectors

- 3) Replace the protective connector cover after sensors are connected and power and communications cables are installed. Ensure that all cables and connector caps are under the cover before tightening the screws.
- 4) Configure sensor switch settings as shown in Figure 3.2-2 if necessary.

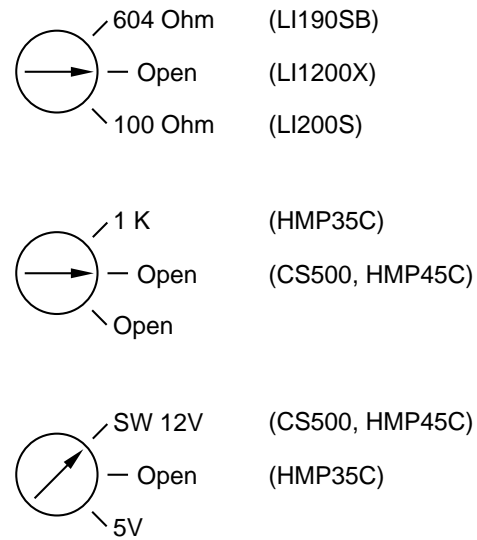


FIGURE 3.2-2. Default Sensor Switch Settings

3.3 Communication and Data Storage Peripherals

One communications kit can be mounted to the T.Weather 106 Enclosure back plate. Communication kits ordered with the T.Weather 106 Enclosure are pre-mounted and pre-wired; no further connections inside the enclosure are

necessary. Follow the "External Installation" procedures outlined below to make the external connections.

If you received a telecommunications kit separate from the T.Weather 106 Enclosure, follow the "Internal Installation" procedures outlined below.

3.3.1 Phone Modems

Phone modems enable communications between the T.Weather 106 Enclosure and a Hayes compatible modem in your PC over a dedicated phone line. Phone line surge protection is built into the T.Weather 106 Enclosure.

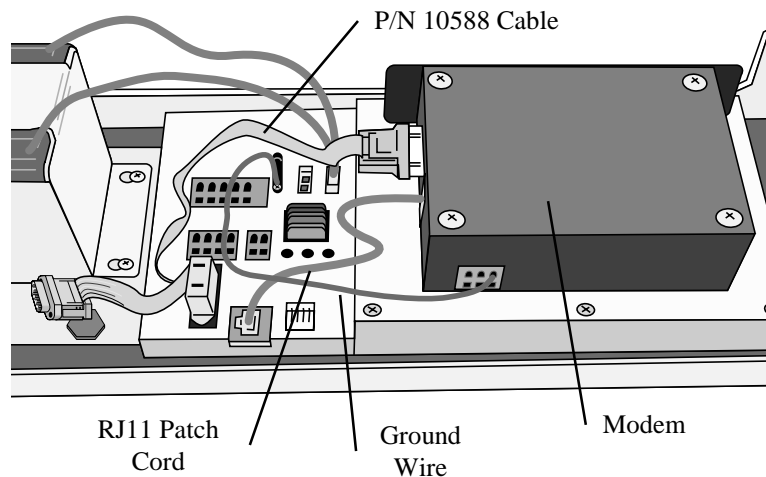


FIGURE 3.3-1. Phone Modem Mounting and Connections

3.3.1.1 Internal Installation

For installation inside the T.Weather 106 Enclosure, the following components are provided in the phone modem kit:

- (1) COM200 or COM300 Phone Modem
- (1) 12 inch RJ-11 Patch Cord
- (1) Mounting Bracket
- (4) Screws
- (1) 12 inch 14 AWG Ground Wire

Install the phone modem as shown in Figure 3.3-1.

1. Attach the modem to the modem bracket with the 4 screws provided. Mount the modem and bracket into the T.Weather 106 Enclosure with the 3 pre-threaded screws on the mounting plate.
2. Connect the modem 9-pin port to the T.Weather 106 Enclosure port with the P/N 10588 ribbon cable supplied with the T.Weather 106 Enclosure.
3. Connect the modem RJ-11 jack to the T.Weather 106 Enclosure RJ-11 jack with the RJ-11 patch cord.

4. Connect the modem ground port to the T.Weather 106 Enclosure ground with the 14 AWG ground wire.

3.3.1.2 External Installation

The following modem kit components are used to make the external connections:

- (1) Direct Burial Splice Kit
 - (1) 20 foot Telephone Patch Cord with Connector
- 1) Connect the 20 foot patch cord to the connector marked "comm" on the external back panel, under the protective cover.
 - 2) Splice the labeled "Tip" and "Ring" lines of the patch cord to the telephone service line. Use the direct burial splice kit when splices are in a valve box or buried.

3.3.2 Short-Haul Modem

Short-haul modems enable communication between a datalogger and computer over two twisted pairs of wires. The maximum distance between modems is determined by baud rate and wire gauge. At 9600 baud, the approximate range is 4.0 miles. DCE / DTE switches on the modems are set to DCE.

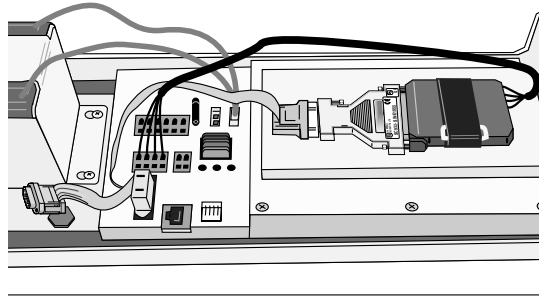


FIGURE 3.3-2. Short-Haul Modem Mounting and Connection

3.3.2.1 Internal Installation

For installation inside the T.Weather 106 Enclosure, the following components are provided in the short-haul modem kit:

- (1) SC932C Interface
- (1) Rad Modem
- (1) Rad/SC932C Mounting Bracket
- (4) Screws
- (1) 12 inch 4-wire patch cable

Install the short-haul modems as shown in Figure 3.3-2 and 3.3-3.

1. Mount the Rad / SC932C mounting bracket into the T.Weather 106 Enclosure with the 3 pre-threaded screws provided.
2. Connect the Rad Modem and SC932C. Strap them into the mounting bracket under the Velcro strap.
3. Connect the SC932C 9-pin port to the internal T.Weather 106 Enclosure 9-pin port with the blue ribbon cable provided.
4. Wire the Rad Modem to the T.Weather 106 Enclosure with the 12 inch patch cord. Match wire labels to wiring panel labels on both the T.Weather 106 Enclosure and the Rad Modem (+XMT to +XMT, etc.). A small screw driver is provided with the T.Weather 106 Enclosure to access the Rad Modem connections.

3.3.2.2 External Installation

The following short-haul kit components are used to make the external connections:

At the T.Weather 106 Enclosure:

- (1) 20 foot 4-Wire Patch Cable
- (2) 2 Direct Burial Splice Kits
- (1) Length of User Supplied Wire (Supplier: Anixter, p/n F-02P22BPN, Phone 847-677-2600)

At the PC:

- (1) Rad Modem
 - (1) 5 foot 4-wire Patch Cable
 - (1) 10 foot 14 AWG Ground Wire
 - (1) Surge Protector and Case
- 1) Connect the 20 foot patch cable to the connector marked "comm" on the external back panel of the T.Weather 106 Enclosure. Splice this cable to the user supplied cable, using the direct burial splice kits.
 - 2) Mount the surge protector to a flat surface near the PC's serial port. Ground the center terminal to an earth (or building) ground using the 14 AWG wire.
 - 3) Connect the 5 foot patch cord to the Rad Modem. Fasten the cable to the strain relief tab with a cable tie. Connect the Rad to the PC's serial port either directly (25 pin port) or through a 9 to 25 pin serial converter.
 - 4) Route the user-supplied cable from the remote splice to the surge protector. Connect it and the 5 foot patch cord to the surge protector.

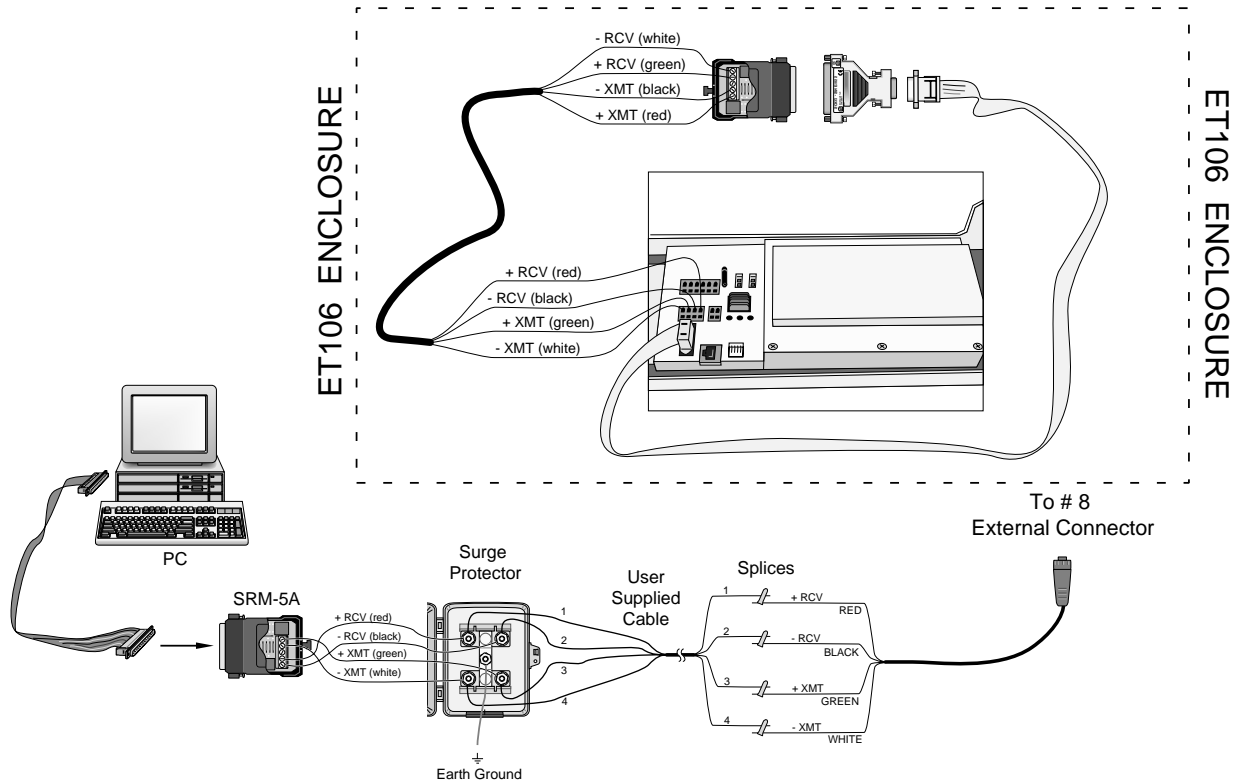


FIGURE 3.3-3. Short-Haul Modem Wiring Diagram

3.4 Sealing and Desiccating the Enclosure

The T.Weather 106 Enclosure is supplied with a desiccant pack. The desiccant maintains a low humidity in the enclosure to minimize the chance of condensation on the instrumentation. Desiccant should be changed when the internal T.Weather 106 Enclosure humidity sensor measures 30% or higher. Install the desiccant as shown in Figure 3.4-1. Keep unused desiccant tightly sealed in an airtight container.

- 1) Take the desiccant pack out of its sealed plastic bag. Place it under the desiccant strap just before leaving the station.
- 2) Be sure to close the enclosure hasp securely. A padlock may be used on the latch for extra security.

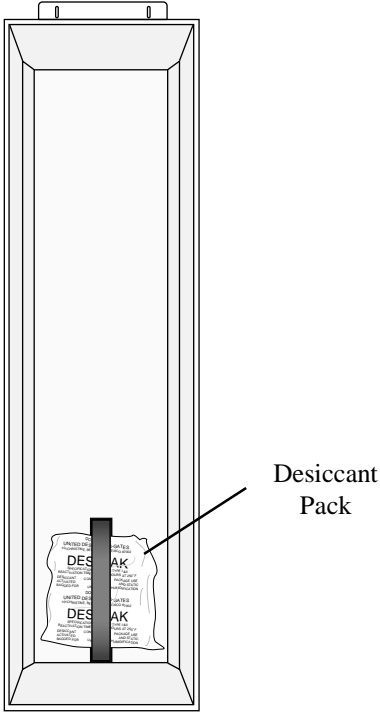


FIGURE 3.4-1. Desiccant Installation

Section 4. T.Weather 106 Sensor Arm Installation

4.1 Components

- (1) T.Weather 106 Sensor Arm
- (1) Met One 034A Wind Sensor
- (1) 034A Mounting Shaft
- (1) Radiation Shield

4.2 Installation

Install the T.Weather 106 Sensor Arm after the Enclosure is mounted low on the Tower. You may need to temporarily remove communications option. Mount the sensor arm as shown in Figure 4.2-1 without the wind sensor attached.

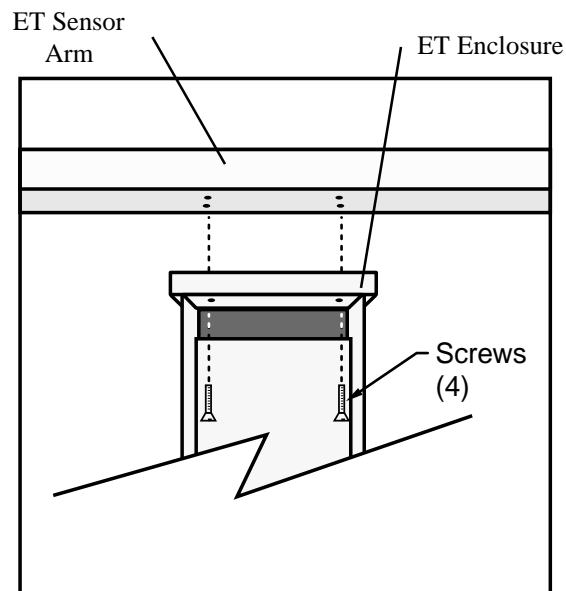


FIGURE 4.2-1. T.Weather 106 Sensor Arm Mounting

- 1) Remove the cover from the Enclosure.
- 2) Place the sensor arm on top of the enclosure, lining up the four threaded holes on the under side of the arm with the four holes in the top of the enclosure. Attach the arm to the enclosure by inserting and tightening four Phillips head screws. Adjust the position of the Enclosure so that the sensor arm is oriented along a due east to due west axis.

4.3 Sensor Connection

Refer to Section 3 for sensor connection details.

4.4 034A Wind Sensor Installation

Install the 034A Wind Sensor as shown in Figure 4.4-1 after the sensor arm is securely installed. The wind vane is oriented after the datalogger has been programmed (Section 5), and the location of True North has been determined (Section 1.2). Orientation is most easily done with two people, one to aim and adjust the sensor, while the other observes the wind direction displayed by CR10KD Keyboard Display or a laptop PC.

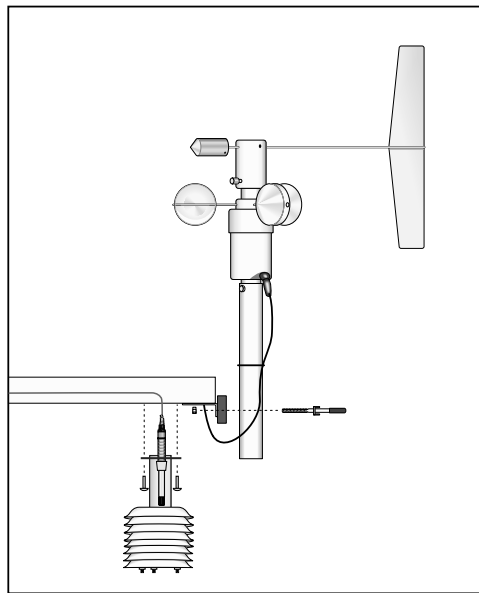


FIGURE 4.4-1. Wind and RH/Temperature Sensor Installation

- 1) Place the 034A in the 034A Mounting Shaft pointing the vane due south. Tighten the alignment screw.
- 2) Attach the 034A and mounting shaft to the sensor arm. Insert the mounting shaft into the U-bolt clamp. Adjust sensor height to 2 or 3 meters by moving the mounting shaft up or down in the clamp. Lightly tighten clamp nuts.
- 3) Attach the 034A connector to the 034A.
- 4) Establish a reference point on the horizon for True North.
- 5) Sighting down the instrument center line, aim the counter weight at True North.
- 6) While holding the wind vane position, slowly rotate the sensor base until the sensor is aligned properly. Securely tighten the clamp nuts.

4.5 RH and Temperature Radiation Shield

Mount the radiation shield to the sensor arm as shown in Figure 4.4-1. Remove yellow cap. Place the RH and temperature assembly inside the shield shaft. Attach the shield to the sensor arm with the two screws.

4.6 Pyranometer

Level the pyranometer as indicated in Figure 4.6-1. Adjust the three leveling screws until the bubble level indicates plumb. Remove the red cap from the pyranometer.

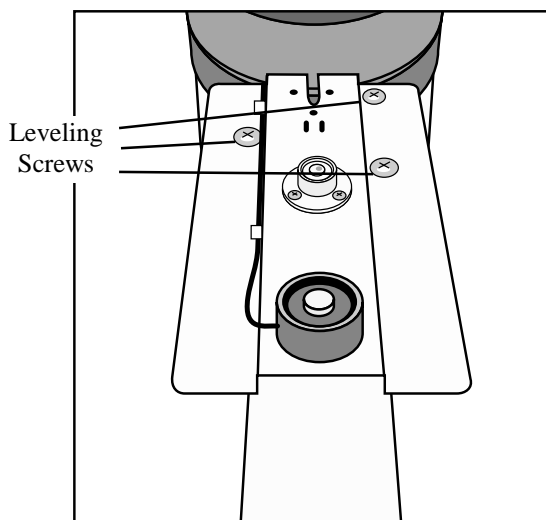


FIGURE 4.6-1. Pyranometer Leveling

Check the measurements of all sensors after the datalogger is programmed. Display measurements using the *6 Mode with the CR10KD.

| Input Location | Parameter | Normal Range |
|-----------------------|---------------------------------------|---|
| 1 | Enclosure Temperature (°C) | Close to air temperature |
| 3 | Solar Radiation (kW m ⁻²) | 0 to 1.2 kW m ⁻² |
| 4 | Air Temperature (°C) | -40° to +50° |
| 5 | RH (%) | 0 to 100% |
| 6 | Wind Speed (mph) | 0 to 110 mph |
| 7 | Rain Fall (inches) | 0 to .2 |
| 8 | Wind Direction (°) | 0 to 359 |
| 10 | Battery (Volt) | 9.6 to 14.0 Volts |
| 12 | Air Temperature (°F) | -40° to +122° |
| 13 | Enclosure RH | 0% to 30% when sealed for several hours |

Display and set clock time using the *5 mode with the CR10KD.

4.7 Sensor Schematics

Schematics of T.Weather 106 sensors and associated connectors are provided in Figures 4.7-1, 4.7-2, 4.7-3, and 4.7-4 for help in troubleshooting. Knowledge of the schematics is not necessary for routine installation and maintenance.

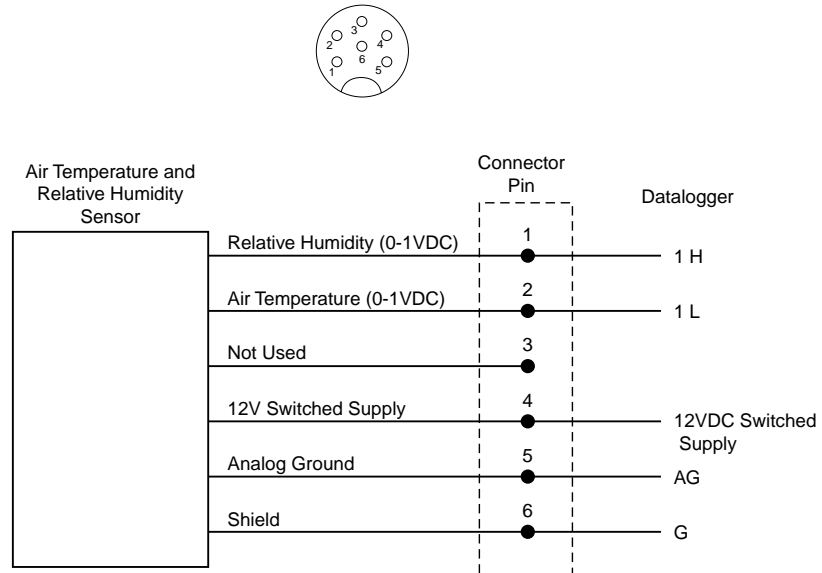


FIGURE 4.7-1. Schematic of HMP45C-LC RH and Temperature Probe and Connector #1

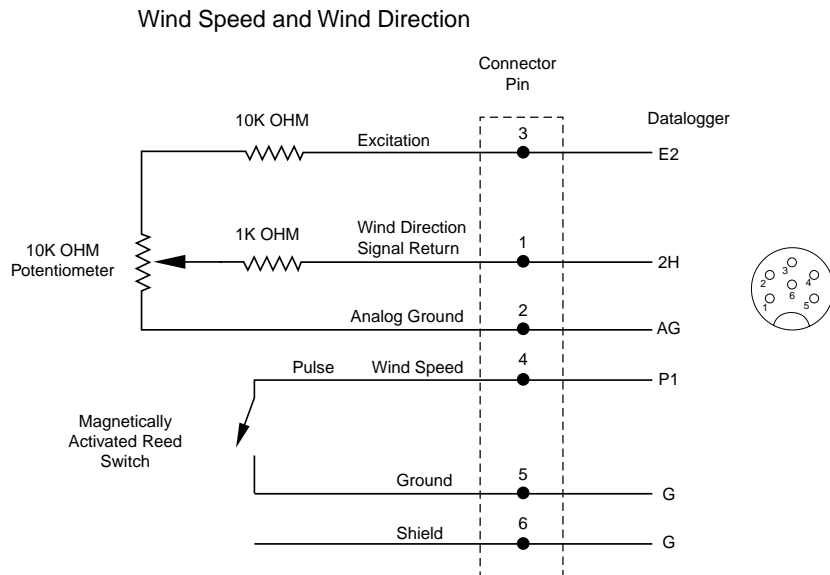


FIGURE 4.7-2. Schematic of 034A-LC Wind Speed and Direction Probe and Connector #2

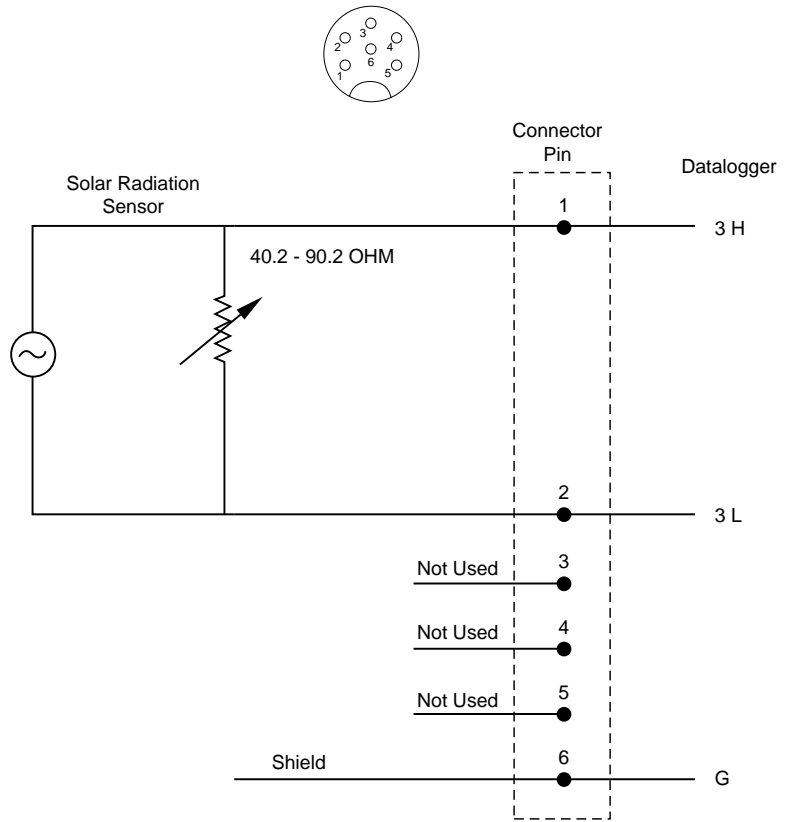


FIGURE 4.7-3. Schematic of LI200X-LC Solar Radiation Sensor and Connector #3

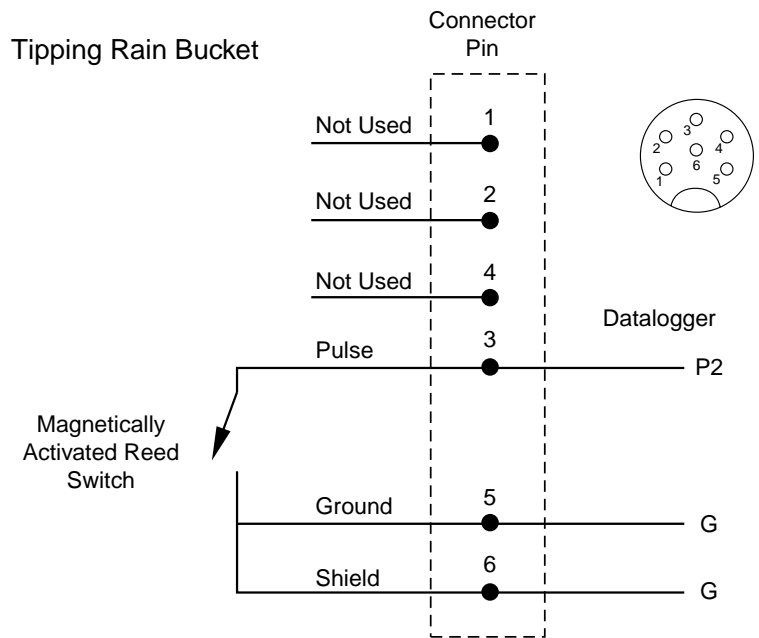


FIGURE 4.7-4. Schematic of TE525-LC Rain Sensor and Connector #5

Section 5. Maintenance and Troubleshooting

These guidelines apply to several Campbell Scientific weather stations.

5.1 Maintenance

Proper maintenance of weather station components is essential to obtain accurate data. Equipment must be in good operating condition, which requires a program of regular inspection and maintenance. Routine and simple maintenance can be accomplished by the person in charge of the weather station. More difficult maintenance such as sensor calibration, sensor performance testing (i.e., bearing torque), and sensor component replacement, generally requires a skilled technician, or that the instrument be sent to Campbell Scientific or the manufacturer.

A station log should be maintained for each weather station that includes serial numbers, dates that the site was visited, and maintenance that was performed.

5.1.1 Instrumentation Maintenance

The instrumentation requires a minimum of routine maintenance. A few preventative maintenance steps will optimize battery life and decrease the chances of datalogger failure.

5.1.2 Batteries

Rechargeable power supplies should be connected to an AC transformer or unregulated solar panel at all times. Be aware of battery voltage that consistently decreases over time, which indicates a failure in the charging circuitry.

5.1.3 Desiccant

Enclosure humidity is monitored in the ET Enclosure systems by an RH chip incorporated into the connector board. Change the desiccant packs when the enclosure RH exceeds 35%.

Desiccant may be ordered through Campbell Scientific (DSC 20/4) or item #4905.

Desiccant packs inside of the dataloggers do not require replacement under normal conditions.

5.1.4 Sensor Maintenance

Sensor maintenance should be performed at regular intervals, depending on the desired accuracy and the conditions of use. A suggested maintenance schedule is outlined below.

1 week

- Check the pyranometer for level and contamination. Gently clean, if needed.
- Visually inspect the wind sensors and radiation shield.

1 month

- Check the rain gage funnel for debris and level.
- Do a visual/audio inspection of the anemometer at low wind speeds.
- Check the filter of the temperature/humidity sensor for contamination.

General Maintenance

- An occasional cleaning of the glass on the solar panel will improve its efficiency.
- Check sensor leads and cables for cracking, deterioration, proper routing, and strain relief.
- Check the tripod or tower for structural damage, proper alignment, and for level/plumb.

6 months

- Clean the temperature/humidity sensor.
- Clean the Gill Radiation Shield.

1 year

- Replace anemometer bearings.
- Calibrate the rain gage.
- Calibrate the HMP45C probe.

2 years

- Calibrate the pyranometer (some users suggest yearly).
- Calibrate the HMP45C temperature/humidity sensor.
- Replace the wind vane potentiometer and bearings.

4 - 5 years

- Replace sensor cables as required.

Rain Gage Calibration Check

1. Secure a metal can that will hold at least one quart of water.

2. Punch a very small hole in the bottom of the can.
3. Place the can in the top funnel of the rain gage and pour 16 fluid ounces (1 pint) of water into the can. (A 16 oz. soft drink bottle filled to within 2.5 inches of the top may be used for a rough field calibration. An exact volume will allow for a more precise calibration).
4. If it takes less than 45 minutes for this water to run out, the hole in the can is too large.
5. One hundred tips plus or minus three tips should occur.
6. Adjusting screws are located on the bottom adjacent to the large center drain hole. Adjust both screws the same number of turns. Rotation clockwise increases the number of tips per 16 oz. of water; counter clockwise rotation decreases the number of tips per 16 oz. of water. One half turn of both screws causes a 2% to 3% change.
7. Check and re-level the rain gage lid.

5.2 TroubleShooting

5.2.1 No Response Using the Keypad

Check keypad response after each of the following steps.

- A. Make sure the battery has been installed, and the power switch, if any, is "ON" (Section 6.5).
- B. Use a voltmeter to measure the voltage on the 12 V and G terminals; the voltage must be between 9.6 and 16 VDC.
- C. Disconnect any sensor or peripheral wires connected to the 5 V and 12 V terminals.
- D. Disconnect any communications or storage peripherals from the datalogger.
- E. Reset the datalogger by turning the power switch to "OFF", then to "ON" or disconnect the solar panel or switch off AC power to the station then disconnect and reconnect the battery. Remember to reconnect the solar panel or switch on the AC power.
- F. If still no response, call Campbell Scientific.

5.2.2 No Response from Datalogger through SC32A or Modem Peripheral

At the datalogger:

- A. Make sure the battery has been installed, and the power switch, if any, is "ON" (Section 6.5).
- B. Use a voltmeter to measure the voltage on the 12 V and G terminals; the voltage must be between 9.6 and 16 V DC.
- C. Make sure the datalogger is connected to the modem, and the modem is properly configured and cabled (Section 6.6).

At the computer:

- D. Make sure the Station File is configured correctly.
- E. Check the cable(s) between the serial port and the modem. If cables have not been purchased through Campbell Scientific, check for the following configuration using an ohm meter:

25-pin serial port:

| <u>computer end</u> | <u>modem end</u> |
|---------------------|------------------|
| 2 | 2 |
| 3 | 3 |
| 7 | 7 |
| 20 | 20 |

9-pin serial port:

| <u>computer end</u> | <u>modem end</u> |
|---------------------|------------------|
| 2 | 3 |
| 3 | 2 |
| 4 | 20 |
| 5 | 7 |

- F. Make sure the modem is properly configured and cabled (Section 6.6).
- G. If still no response, call Campbell Scientific.

5.2.3 -99999 Displayed in an Input Location

- A. Make sure the battery voltage is between 9.6 and 16 VDC.
- B. With the T.Weather 106, verify that the sensor is connected to the proper bulkhead connector.

5.2.4 Unreasonable Results Displayed in an Input Location

- A. Inspect the sensor for damage and/or contamination.
- B. Make sure the sensor is properly wired to the datalogger.
- C. Check the multiplier and offset parameters in the measurement instruction.

Section 6. Troubleshooting

6.1 Tools Required

With this manual you should have the following items:

- *3.5" or 5.25" floppy disk entitled "CAMPBELL SCIENTIFIC TORO TOOLBOX DOS 5.0 BOOT DISK".
- Volt/Ohm meter that reads AC/DC volts and ohms.
- Small and medium bladed screwdrivers, both Phillips and straight bit.
- Several pieces of wire (about 8 inches long), or paper clips.
- CR10KD CR10 keypad.

* Call Campbell Scientific for the disk.

6.2 What's Inside the Enclosure at the Weather Station

The inside of the enclosure can be broken up into three basic areas (see Figure 6.2-1):

1. The communication option, short haul or phone modem, which mounts towards the top.
2. The area in the middle of the enclosure where the terminal blocks, enclosure RH chip, and the serial/phone jacks reside (see Figure 6.2-2).
3. The bottom where the battery is mounted.

The desiccant pack is strapped to the inside of the lid of the enclosure. The datalogger, charging circuitry, and all spark gaps used for surge and lightning protection are located underneath the housing where the communication option is mounted and are not easily accessible.

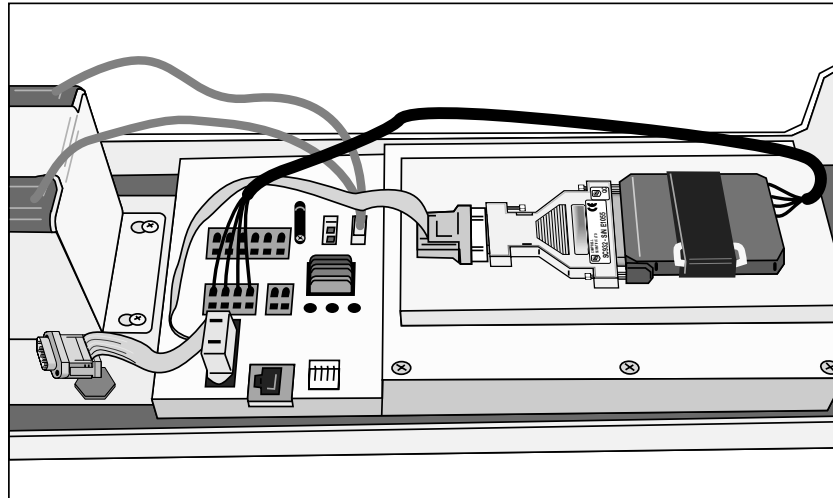


FIGURE 6.2-1. Short Haul Modem Mounting and Connection

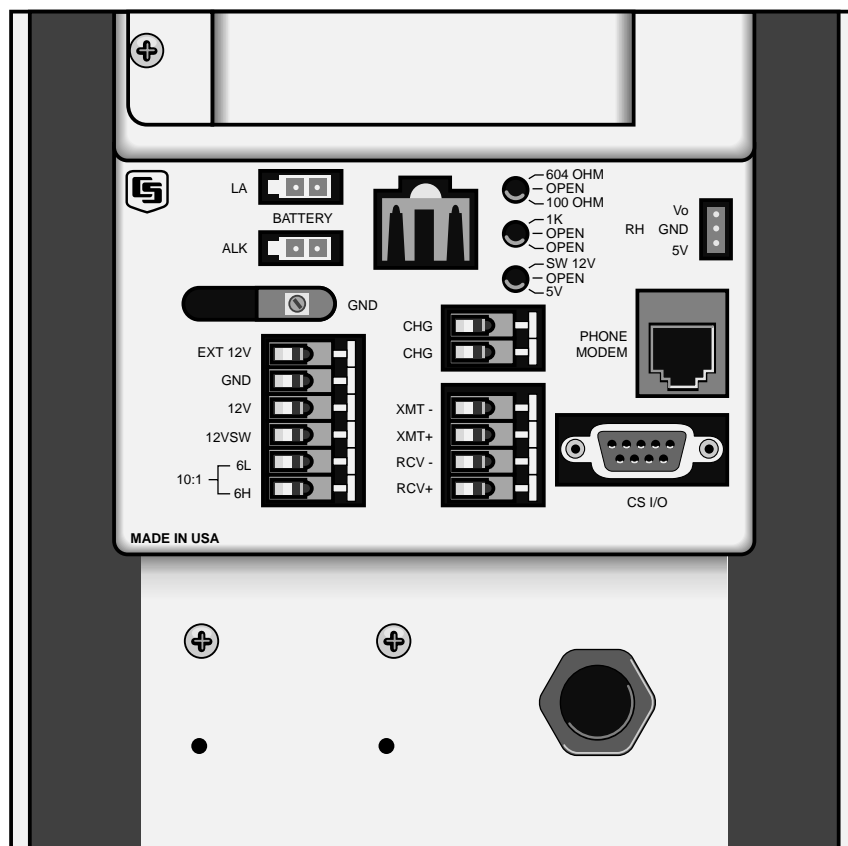


FIGURE 6.2-2. T.Weather 106 Terminal Blocks and Sensor Switch Settings

6.3 Communication Options

HARD WIRED DIRECT CONNECT SHORT HAUL MODEM — The RAD SRM-5A short haul modem plugs into the SC932C. There is a short cable that runs from out the back of the RAD to the terminal blocks in the middle of the enclosure. A ribbon cable runs between one side of the SC932C and the 9-pin plug marked “CS I/O”. The RAD modem and SC932C get their power through the ribbon cable from the datalogger. Both devices run off of 5 VDC that comes from pin 1 on the 9-pin plug. Ground is pin 2.

WARNING

The SC932C is NOT a simple 9 to 25 pin adapter plug. It contains active circuitry and must be replaced by an identical device or damage will occur to the RAD modem and the protective circuitry. The SC932C replaces the older SC932. The devices are interchangeable.

NOTE

The 9-pin plug marked “CS I/O” is NOT an RS232 port and cannot be plugged directly into a laptop.

PHONE MODEM — The COM200 phone modem is a specially made data modem that runs off of DC voltage. The modem plugs directly into the RJ-11 jack inside the enclosure for phone line access. A ribbon cable runs between the COM200 and the 9-pin plug marked “CS I/O”. The COM200 requires two power supplies to operate. It requires 12 VDC from pin 8 of the 9-pin plug as well as 5 VDC from pin 1 of the same plug. Ground is pin 2. If either supply should fail, the modem will not work.

6.4 What’s at the Computer

HARD WIRED DIRECT CONNECT SHORT HAUL MODEM — A RAD SRM-5A short haul modem plugs into one of the serial COM ports at the computer. Between the RAD modem and the incoming communication cable from the weather station should be a box marked “JOSLYN”. This box contains surge protection for the communication cable. Inside this box are four posts that have a center “foot” that should be going to a good earth ground. If the spark gaps are not properly grounded, then there is no protection.

PHONE MODEM — An internal or external phone modem is required at the computer to call up a phone modem station. It’s a good idea to have computer grade surge protection on AC power going to the computer, modem, printer, and monitor. Also get surge protection for the phone line coming into the computer’s modem.

6.5 Troubleshooting

6.5.1 What Should Always be Checked Regardless of the Problem

Always check the incoming AC voltage to the weather station. It should always be 17 VAC or higher. AC voltage from the transformer should be going to the two terminal blocks in the enclosure marked “CHG”. There is no polarity. Check to make sure that all plugs are connected to the back of the enclosure.

Measure the 12 VDC voltage across the two terminal blocks marked “12 V” and “G”. Also check the voltage at the battery. These voltages should be identical. The voltages should be somewhere between 13.2 and 14.0 VDC. The voltage from the charging circuitry is temperature dependent—the higher the air temperature the lower the charging voltage.

NOTE

AC power or the charging circuitry has been lost if the voltage measured is 12.5 VDC or less. The datalogger needs a minimum of 9.6 VDC to operate. The battery cannot be deep discharged. Once voltages get below 11.0 VDC the battery is damaged and will never take a full charge!

Always verify there are no loose wires. Give each wire going to a terminal block a gentle tug to see if it easily pulls out. If it does, then make sure the terminal block is clean and free of debris and reinsert the wire. **IF VOLTAGE IS PRESENT, BE CAREFUL NOT TO SHORT THE WIRE AGAINST THE ENCLOSURE OR OTHER WIRES.**

6.5.2 Identifying What is Wrong with the Station

If the Toro software is NOT receiving data:

1. See Section 6.5.3 “Power Supply Problems”
2. See Section 6.6 “Communication Problems”

If the Toro software is receiving data, but some of the data looks wrong or out of range:

1. See Section 6.5.3 “Power Supply Problems”
2. See Section 6.7 “Sensor Problems”
3. See Section 6.8 “ToroPro” if you are using the Campbell Scientific ToroPro software package.

6.5.3 Power Supply Problems

1. Check the system as indicated in Section 6.5.1. One additional check is to measure the voltage coming out of the ribbon cable that connects the communication option to the plug marked "CS I/O". You will need a voltmeter with very fine probe tips or two small pieces of fine gage wire. Paper clips are too big.

Unplug the ribbon cable from the communication option. Hold the plug so that you are looking at the sockets with the two rows of sockets running horizontal, longest row of sockets on the top. Socket one is on the far right, top row. There is a molded bar between sockets 1 and 2. The count of the sockets goes from 1 to 5 right to left on the top row of sockets and from 6 to 9 right to left on the bottom row of sockets. To measure the 5 VDC supply measure between sockets 1 and 2. Socket 1 is the +5 VDC side and socket 2 is ground. The measurement should be from 4.95 - 5.03 VDC. If it's outside this range, it could be damaged and cause the datalogger not to communicate. Call Campbell Scientific.

WARNING

If you are using wire inserted into the sockets to measure from, do not let them touch! The 5 VDC supply can be shorted out and damaged.

If a phone modem is being used, then also measure between socket 8 which is the 12 VDC supply voltage and socket 2. Whatever is measured here should be identical to the battery voltage.

If these voltages are not present or incorrect, then unplug the ribbon cable from the "CS I/O" plug and repeat the measurements at the plug. If the measurements are fine at the plug, then the ribbon cable could be bad. Call your local Toro Distributor for a replacement. If the measurements are also bad at the plug, then the station could be damaged internally. Call your local Toro Distributor for support.

2. If AC power is present but less than 17.0 VAC, then disconnect the transformer from the weather station and measure the transformer under a no load condition. If the voltage remains the same, then the transformer is bad or there is a problem with the wire path between the weather station and the transformer. The transformer is a heavy duty doorbell transformer that can be bought at any hardware store. The manufacturer and model number is Nutone 301-T 16VAC 30W. The transformer is unregulated and the voltage output is usually between 18.0 - 20.0 VAC when connected to the weather station. Make sure that voltages going into the transformer on the primary side are at least 115 VAC.

NOTE

The regulator circuitry is limited to 24 AC input voltage. Any higher voltage will damage the circuitry.

If the voltage goes up when disconnected from the station, then check the battery voltage to see if it quickly drops off when disconnected from AC power. The battery could have a shorted cell which is loading up the system. If this is the problem, then call your local Toro distributor for a

replacement. If the station has been running on battery for quite some time, then it's normal for the system to load up the transformer. As long as transformer voltages don't drop below 17 VAC the charging circuitry is operational. It will take the battery about a day to charge back up.

3. Reattach all wires and always check the power again before closing the enclosure. Make sure all leads have no stray wires that might touch an adjacent terminal block. If the transformer and battery all appear to be fine but the weather station still isn't working, then call your local Toro distributor or Campbell Scientific for support.

6.6 Communication Problems

Communication problems can exist at the host computer, at the datalogger, the modem, the communication line between modem and datalogger, or combinations of all the above.

The Toro software used with DOS does not have the capability of being used to troubleshoot the weather station. Call Campbell Scientific for a copy of Toro Toolbox. Windows software has some built in troubleshooting programs like HyperTerminal but it isn't complete. Toro Toolbox will also work in a Windows 95 environment.

One of the best troubleshooting tools is the CR10KD from Campbell Scientific. The keypad can quickly verify whether the 5 VDC supply is operational, if the program in the weather station is running, battery voltage level, datalogger self diagnostics, and check on sensor performance. Call your local Toro distributor to get one on loan or have them come out if this is required. Not all Toro distributors have them and they aren't always completely necessary, but they speed up the diagnostics.

6.6.1 A Campbell Scientific Term Primer

1. The best trouble shooting tool you have is the TERM program in your Toro Toolbox diskette. Do the following in order to run TERM.
2. Put the Toro Toolbox diskette in the "A" drive of the computer.
3. Turn the computer off and on again, or with the computer still on, press the following sequence of keys, holding them down together, then releasing them together. Press <Ctrl> <Alt> <Delete> release.
4. The computer will reboot itself off the disk in the "A" drive. It will next ask you for a date. Press <Enter>.
5. The computer will next ask you for a time. Press <Enter>.
6. You should now see "A:>" on your screen. Type in "TERM" and press <Enter>.
7. TERM will ask you for a station file. Type in "Toro", then <Enter>.
8. You should see Figure 6-1 on your screen.

This is the main TERM menu window. All testing of the system will work out of this window.

Normally you will not use the following options: D, S, P, R, or X

10. Call the station by pressing <m>. The screen should momentarily change while TERM is attempting to call the station. If you don't get the screen as shown in Figure 6-3, or it takes longer than a couple of minutes to call the station, then there is something wrong with the communication line (See Section 6.6.2).
11. If you do get a window similar to Figure 6-3 then the communication line is fully functional. You should see a different datalogger time and the values in the input locations should be different. Check these values and make sure they look right. These values should change every 60 seconds and show present weather conditions.
12. Here is an explanation of each of the input locations:
 - 1:CR10 TEMP** - internal temperature in degrees Celsius of the datalogger.
 - 2:SIGNATURE** - program signature. This value should never change.
 - 3:SOLAR** - solar energy in kilowatts per meter².
 - 4:TEMP C** - air temperature in degrees Celsius.
 - 5:RH** - percentage relative humidity.
 - 6:WS** - wind speed in miles per hour.
 - 7:RAIN** - rainfall for the past minute in inches.
 - 8:WD** - wind direction in degrees.
 - 9:TOTALRAIN** - rainfall for the past hour in inches.
13. Press <Esc> to quit monitoring the datalogger and return to the main options window.
14. The other options will be explained as they are used for testing. Press <q> to leave TERM and return to the DOS prompt.
15. To reboot your system remove the diskette out of drive "A" and repeat step 3 in Section 5.1. The Toro software should appear on the screen.

```

TERM: Ver5.0          Com1:9600 baud          Datalogger Type: CR10
Option: Monitor toro.dld          Esc = Abort Option

          1:CR10 TEMP          23.6
          2:SIGNATURE          .000
          3:SOLAR              .000
          4:TEMP C            -9999
          5:RH                 1.02
          6:WS                 .000
          7:RAIN               .000
          8:WD                 -52.0
          9:TOTALrain          .000
10:_____          14.0
11:_____          .000

Flags: [ F1 ] [ F2 ] [ F3 ] [ F4 ] [ F5 ] [ F6 ] [ F7 ] [ F8 ]
          Datalogger Time      8:24:06          Ports 87654321

P1..P8 = Port toggle          I = Input value load
F1..F8 = Flag toggle          L = Locations displayed          Esc = Exit monitor
D = Digits displayed          T = Terminal emulator          Enter:
    
```

FIGURE 6-3. Term Monitor Window

6.6.2 System is not Communicating — RAD Modem

1. Physically check the entire setup. Check to make certain the RAD modem is attached to COM port #1. If it isn't, then move the RAD to COM port #1 and repeat steps 3 - 5 in Section 6.6.1.
2. Carefully remove the RAD modem from the back of the computer. There should be a slide switch and some terminal blocks on one side. Next to the switch on the case should be the following lettering: "DCE" and "DTE". The switch should be slid to the "DCE" position. If the switch is not in the correct position then slide it to the correct position.
3. At the rear of the RAD modem are five screw type terminal blocks. There should be four wires attached to it. You should see the following markings next to each terminal block: -RCV+ G -XMT+. These markings will be read from left to right as follows: "-RCV", "+RCV", "G", "-XMT", "+XMT". Each marking is associated with the screw terminal directly below it.
4. Get a piece of paper and write down the wire color that is associated with each terminal block. If you have two of the same colored wires then wrap a piece of tape around one of them, or mark it with a pen. It is crucial that the wiring is put back in the correct order.
5. Disconnect all the wires from the RAD modem. Make sure none of the wires accidentally touch each other.
6. Get two paper clips and straighten them. If you don't have paper clips, find two short lengths of wire. Attach the paper clips, or wire, to the RAD modem as follows:
 - a. Attach one paper clip from "-RCV" to "-XMT".
 - b. Attach one paper clip from "+RCV" to "+XMT".

Make sure the paper clips don't short against each other.
7. Plug the RAD modem back into the computer. Get into TERM as described in steps 3 - 8 in Section 6.6.1.
8. At the main menu window press <tab>. The screen should change to resemble Figure 6-4. The cursor should be in the upper left hand corner of the screen. Start typing on the keyboard. If the computer and RAD modem are operating properly you should see the typed characters being echoed on the screen.

Figure 6-4 shows an example of characters being echoed on the screen. If you are seeing characters echoed on the screen then skip the next step.

| | | |
|---------------------------|----------------|-----------------------|
| TERM: Ver5.0 | Com1:9600 baud | Datalogger Type: CR10 |
| Option: Terminal Emulator | | Esc = Abort Option |

&KLDJFHGVBNCVHX,CMVNC,XC

FIGURE 6-4. Terminal Emulation Window

9. If you don't see characters echoed on the screen then the problem could be with the RAD modem or the computer's serial port. Unplug the RAD modem from the back of the computer. The COM port will have either 9 or 25-pins. The pins are in two rows, with one row having one more pin than the other.

Call the row with the most pins as the top row.

Pin 1 is on the top row on the far left side. Pins are counted from left to right across the top row.

Get into TERM and go into terminal emulations. Briefly touch the outer metal shield around the pins to discharge any static electricity in your body. Take a small screwdriver and short pin 2 to pin 3 on COM port 1. Be very careful not to accidentally short any of the other pins, or short to the outer metal shield around the connector.

Start typing. You should see the key presses echoed on the screen. If you don't then you probably have a bad COM port and will need to replace it.

If you do see characters being typed then the modem could be bad. **Call Campbell Scientific.**

10. Remove the paper clips from the back of the RAD modem. Reattach all the wires to the RAD modem according to your wiring diagram. Plug it back into the computer's COM 1 port.

11. Take your paper, pen, and screwdrivers with you and go out to the weather station. Disconnect the SC932C from the datalogger and the RAD modem. Verify the RAD modem is wired as shown in Figure 3.3-3 in this manual.

Keep in mind that the wires should ultimately be attached as follows:

| TABLE 6-1. RAD At Computer [Goes To] RAD At Datalogger | | | |
|---|---|------|--|
| +RCV | → | +XMT | |
| -RCV | → | -XMT | |
| +XMT | → | +RCV | |
| -XMT | → | -RCV | |

12. Disconnect the wires from the RAD modem. Carefully twist the conductors of the following wires together:

- a. Twist the "-RCV" and "-XMT" wires together.
- b. Twist the "+RCV" and "+XMT" wires together.

Make sure these wires don't touch anything else.

13. Take the RAD modem out of the enclosure and back to the computer

Test the RAD modem as explained in steps 2 - 11 in this section.

If the modem is bad, **call Campbell Scientific.**

If the modem checks out then continue.

14. Reattach the wires to the back of a working RAD modem and plug it into the computer. Go into terminal emulation mode in TERM and test the system as explained in steps 7 - 8 in this section.

15. If the system tests out then your wiring has no shorts or opens.

16. If you do not see characters echoing on the screen then possibly the wiring going out to the datalogger has an open, a short, or is miswired.

Unplug the RAD modem from the computer and remove the wires from it.

Take your meter and set it for low ohms. Measure across the wires that were connected to "-RCV" and "-XMT". Also measure across the wires that were connected to "+RCV" and "+XMT". Both measurements should be less than 20 ohms.

If either measurement is shorted, very high, or infinite, then there is a break or an intermittent connection somewhere in the wiring.

17. Go back to the weather station with your meter set to read low ohms. Untwist the wires that were connected in step 12 of this section.

Measure across all the wires in any order you want. The meter should read infinite resistance across any set of wires. If the meter is measuring any different then you probably have a short somewhere in the line.

A short or open circuit in the line will need to be corrected before communication between the datalogger and the computer can resume.

NOTE

Remember to reattach the RAD modems and check the system again once the line is repaired.

18. If the computer COM port 1, the RAD modems, the cable run, and the datalogger voltages all check out then the final piece is the SC932C. **Call Campbell Scientific.**

6.7 Sensor Problems

Sensor problems usually end up being maintenance problems or problems associated with what was covered in Sections 4 through 6.

6.7.1 Weather Station Maintenance

6.7.1.1 Relative Humidity Sensors

The HMP45C temperature and humidity sensor needs to be calibrated every two years. This needs to be done at Campbell Scientific.

The sensor uses a temperature sensing PRT that should never need to be replaced.

The sensor is placed in a gill shield to deflect direct sunlight. These shields need to be kept free of dust, dirt, and anything that might block the free movement of air across the sensor.

6.7.1.2 Solar Radiation Sensors

Wind speed and solar radiation are the primary factors that determine correct evapotranspiration values calculated by the Toro software.

The solar radiation sensor is a solid state device that is very durable. It needs to have the white plastic button on the top of the sensor kept free of dirt or debris. This is best accomplished by wiping the sensor off with a soft camel hair paint brush. Normal wind and rain action will keep the sensor fairly clean but bird droppings need the personal touch.

Blocking light to the sensor will skew the values the datalogger gives.

6.7.1.3 Tipping Rain Bucket

This is probably the sensor that will need the most maintenance.

Birds like to use them for nesting sites and lizards and spiders have been known to live inside. The bucket has moving parts inside that need to be kept free of webs or anything that might disturb their normal movement.

The older buckets did not have the drain plug on the bottom of the bucket that blocks entry of pests. The newer buckets do have this plug but it won't stop the spiders. The bucket needs to be checked daily to weekly to clean it out.

6.7.1.4 Wind Direction and Wind Speed Sensors

Wind speed uses internal bearings that probably will need to be replaced every 1 - 2 years. This can be determined by watching the sensor as it turns. If there appears to be a particular place in the sensor's rotation that seems to "hang" or "rub" then the sensor probably needs its bearings replaced. **Call Campbell Scientific.**

6.8 TOROPRO

TOROPRO uses GraphTerm and can be used instead of TERM for testing the weather station. If the customer is using PC121 software then go to the directory where the software resides and type in "GT" <Enter> from the keyboard.

If a station file has already been created for TOROPRO than type in "weather" from the station file prompt. The station file screen should be similar to what is in Figure 6-2. To save station file setups press and hold the <Ctrl> key followed by the <p> key. Release both keys simultaneously.

The datalogger .dld file will also be entitled "WEATHER". Only use the main menu options mentioned in Section 6.2.

Trouble shooting the system will be the same as outlined in the previous sections.

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