Capricorn 2000™/2000MP™ Weather Station

User Manual

Version 2.00

Printed in U. S. A.

Welcome!

Welcome to the Capricorn family of users and congratulations on your purchase of the Capricorn 2000 Weather Station.

The Capricorn 2000 is a precision instrument that requires proper installation and a certain amount of regular maintenance.

The Capricorn 2000 is quite easy to install and you may be tempted to skip the installation procedure or other portions of this manual. We recommend that you resist that urge. A thorough knowledge of these installation and calibration procedures will greatly increase the usefulness and the accuracy of your instrument. In particular, a proper installation will help prevent problems with both operation and maintenance.

Please read this manual completely prior to installation.

Important Notice: Shipping Damage

BEFORE YOU READ ANY FURTHER, please inspect all system components for obvious shipping damage. The Capricorn 2000 is a high precision instrument and can be damaged by rough handling. Your unit was packaged to minimize the possibility of damage in transit. Therefore, we recommend that you save the shipping container for any future shipment of your Capricorn unit.

In the event your order arrives in damaged condition, it is important that the following steps be taken immediately. The title transfers automatically to you, the customer, once the material is entrusted to the transport company.

NOTE: DO NOT RETURN THE INSTRUMENT TO COLUMBIA WEATHER SYSTEMS. until the following steps are completed. Failure to follow this request will jeopardize your claim.

1. Open the container and inspect the contents. Do not throw away the container or any damaged parts. Try to keep items in the same condition as originally received.
2. Notify the transport company immediately in writing, preferably by facsimile, about the shipping damage.
3. Wait for the transport company's representative to inspect the shipment personally.
4. After inspection, request permission from Columbia Weather Systems for return of the damaged instrument by calling the Capricorn Service Department, (503) 629-0887.
5. Return approved items to us at the following address:

   Columbia Weather Systems, Inc.

   2240 NE Griffin Oaks Street, Suite 100

   Hillsboro, OR 97124

6. After return authorization is issued and we receive the instrument, an estimate of the cost of repair will be sent to you for submittal to the transport company as a claim.

Table of Contents

SECTION 1: INTRODUCTION

The Capricorn 2000 System

The Capricorn 2000 is a modular-design weather station providing commercial-level data capture, storage, and transfer. The system is designed around the Control Module which is housed in a compact utility-grade enclosure powered by a wall mount transformer. The module accepts signal inputs from a wide range of meteorological sensors. User interface is via RS-232 ports.

The Capricorn 2000 continues the Capricorn product line tradition of reliability and accuracy, with the capacity for handling additional sensors and increased performance features.

Specifications

Temperature

The temperature port on the Capricorn 2000 can accept up to four temperature probes.

Type: digital semiconductor

Range: -67° to 257°F

Accuracy: ±0.9°F

Resolution: 0.01°F

Units: Fahrenheit

Cable Length: maximum 400 ft. combined length for all four sensors

Barometric Pressure

The barometric pressure sensor is located inside the Control Module and is part of the weather station circuit board.

Type: silicon shear stress strain gauge; temperature compensated and calibrated

Range: 27 to 33.96 in. Hg

Accuracy: ±0.03 in. Hg over range (at sea level, with temperature between 32° and 182°F)

Resolution: 0.01 in. Hg

Units: in. Hg

Wind Speed

Type: chopping disc anemometer, three cups

Range: 0 to 125 mph

Accuracy: ±5% from 20 to 125 mph, ±1 mph from 5 to 20 mph

Mechanical Threshold: 0.5 mph

Resolution: 1 mph

Units: mph

Cable length: maximum 1000 ft.

Wind Direction

Type: wind vane using digital gray code

Range: 360 degrees.

Resolution: 22.5 degrees

Cable length: same cable as wind speed

Relative Humidity

Type: Capacitance

Range: 0 to 100%

Accuracy: ±3% (or better) from 10 to 90% RH at 68° F

Temperature Effect: <±1.5% RH from 14° F to 140° F

Stability: ±2% RH over 2 years

Resolution: 1% RH

Rainfall

Type: tipping bucket

Accuracy: ±1% at 2 in/hr or less

Resolution: 0.01 inch

Leaf Wetness

Type: capacitance grid (measures percentage of wetness where 0.50 volts corresponds to dry and 4.40 volts corresponds to dripping)

Accuracy: ±5%

Resolution: 0.01 volts

Solar Radiation (Pyranometer)

Available only with the Capricorn 2000MP

Type: high performance silicon photodiode

Sensitivity: 100 mV/Wm-2 (typical)

Spectral response: 0.4 to 1.1 mm

Temperature range: -22 to +158° F (-30 to +70° C)

Response time: <1 sec

Max irradiance: 2000 Wm-2

Temperature dependence: ±0.15%/°C

Cosine error (0 to 80° C): <10%

Multi-Purpose Channels

Available only with the Capricorn 2000MP

Multi-purpose channels are labeled X1 and X2.

Channel X1and X2 can be configured to the following inputs:

Millivolts DC, 0-5 VDC or 4-20m Amp

Input Voltage

Powered by a wall mount transformer

Input: 120 VAC, 60 HZ, 16 W

Output: 12 VDC, 800 mA

Control Module

Dimensions: 10" L x 7.5" W x 2.8" H

Weight: 3 lbs/1.3 kg.

SECTION 2: PHYSICAL DESCRIPTION

Control Module

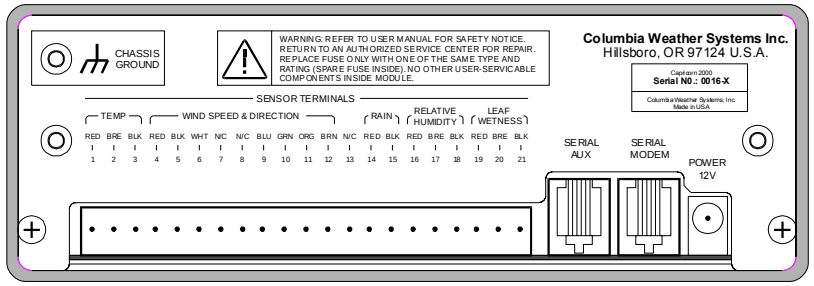
The Control Module consists of the System board housed in a utility-grade enclosure with access to the sensor connections (terminal block), RS-232 ports and power connection through the back panel.

The System board has an on-board barometric pressure sensor and a system fuse (including a spare fuse). The System board also has in-line rechargeable lithium batteries to preserve the datalog and system configuration when power is absent.

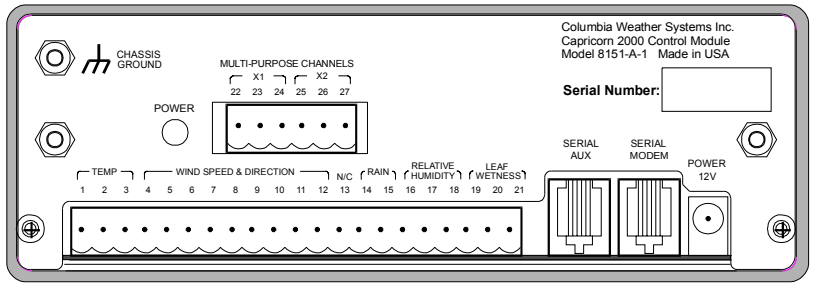
The Control Module dimensions are: 10" L x 7.5" W x 2.8" H and weighs: 3 lbs/1.3 kg.

Back Panel

Capricorn 2000:



Capricorn 2000MP:

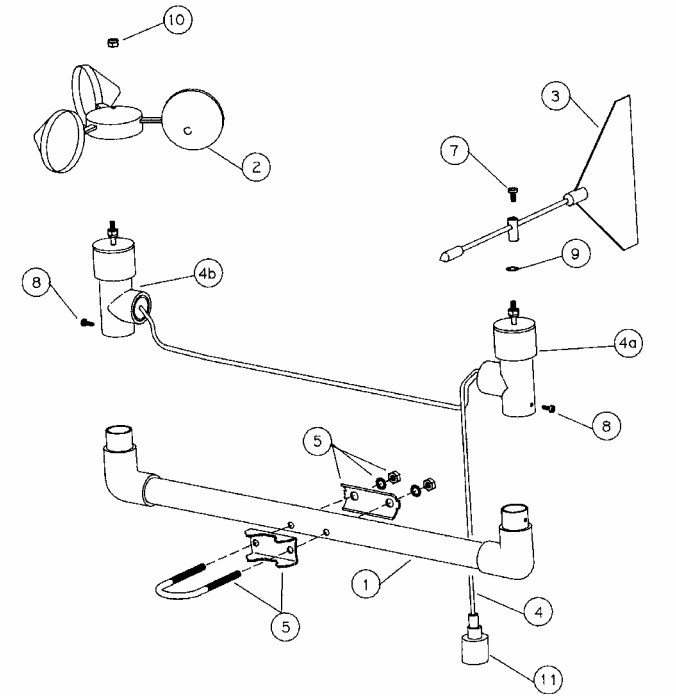


All connections are made at the back panel of the Control Module.

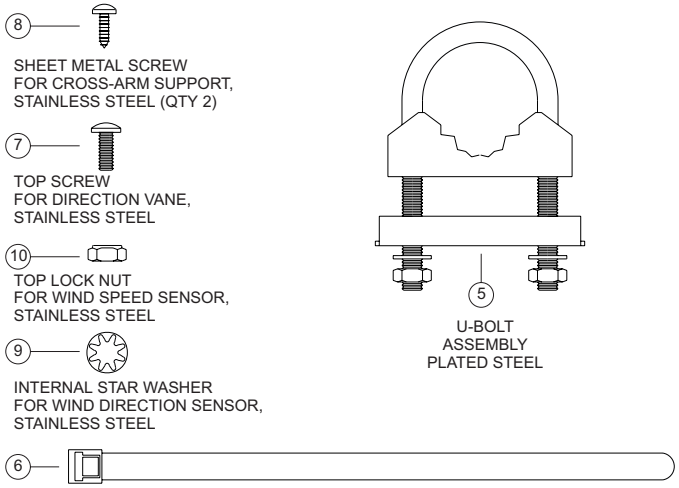
Wind sensor

The wind speed and direction sensors use a solid state, infrared optical design to decrease wear and improve reliability. These rugged sensors, with a design incorporating years of experience and testing, are enclosed in a PVC housing surrounding stainless steel parts. These sensors operate in extreme temperature and wind conditions for years.

Wind sensor components



Hardware Kit Assembly Kit



1. Cross Arm Support
2. Wind Cup Hub Assembly (with spare top lock nut)

3. Wind Direction Vane (with spare top screw)
4. 3-foot wind sensor cable with connector assembly

4a. Wind Direction sensor body (white, T-shaped, PVC fitting with two cables protruding)

4b. Wind Speed sensor body (white, T-shaped, PVC fitting with one cable protruding)

5. Hardware Assembly Kit
6. Black plastic tie wraps (UV-resistant)
7. Top screw (for clamping the direction vane shaft to the vane holder), stainless steel
8. Stainless steel sheet metal screws (for mounting wind sensors to Cross Arm Support)
9. Top lock nut (to be placed on threaded shaft of wind speed sensor, above wind cup assembly
10. Top lock nut (to be placed on threaded shaft of wind speed sensor, above wind cup assembly), stainless steel
11. Wind Sensor Cable Connector

Temperature sensor

The Capricorn 2000 includes one temperature sensor with 50 feet of cable and a quick disconnect connector set. Up to four temperature sensors can be connected with a maximum of 400 feet combined cable length. These digital, semiconductor-type probes all connect to a single port, reducing susceptibility to noise interference, reducing cost, and increasing accuracy. The sensors are calibrated at the factory traceable to NIST standards.

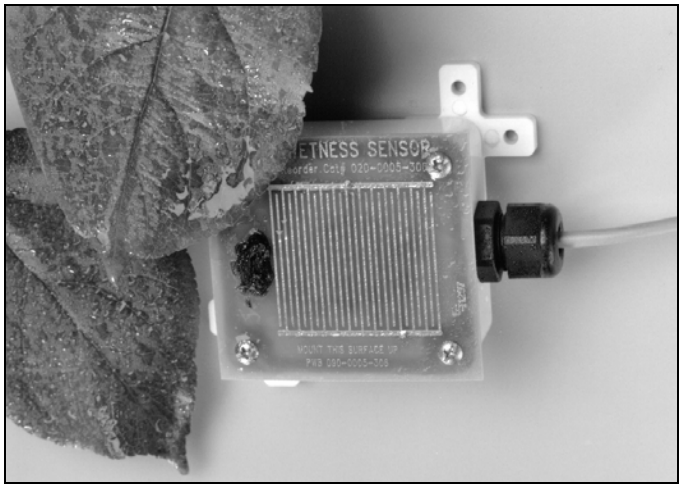
Relative Humidity sensor

This optional capacitive relative humidity sensor is compact and easy to use. It can be easily installed in a self-aspirating radiation shield for protection from the sun and rain. This sensor offers long-term stability with minimal drift. Because the sensor is a capacitive device, it will not be affected by surface contamination in unclean environments. Since the sensor element is socketed and laser trimmed it can be easily replaced in the field without any additional calibration. The relative humidity sensor comes with a standard 50-foot cable and a quick disconnect connector.

Rain gauge (optional)

This optional tipping bucket electric rain gauge is composed of a complex spun collector funnel with a knife-edge that diverts the water to a tipping bucket mechanism. For each tip, a magnet causes an electronic pulse to be generated and is recorded by the Control Module. The rainfall sensor is completely automatic - spent water drains out of the bottom of the housing, hence, the instrument requires no servicing. The rain gauge comes with a standard 50-foot cable.

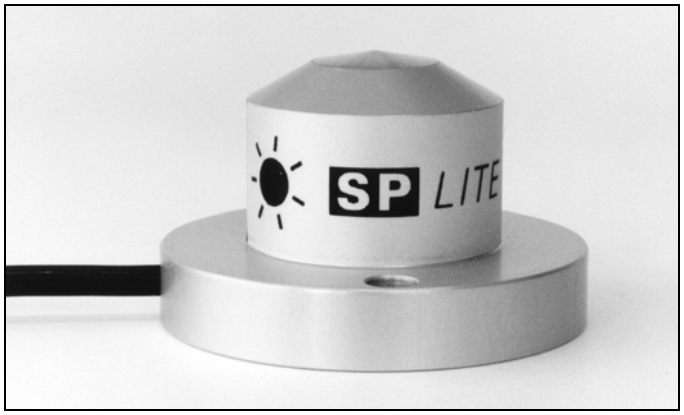
Leaf wetness sensor (optional)



Measured with a capacitance grid, this leaf wetness sensor is manufactured by Columbia Weather Systems to provide a precise, high resolution scale - not just wet or dry. It is useful to determine the wetness condition of surfaces such as foliage, for example, in preparation for spraying pesticides. The leaf wetness sensor measures the percentage of wetness where 0.5 volts corresponds to wet and 4.4 volts corresponds to dry. The leaf wetness sensor comes with a standard 50-foot cable.

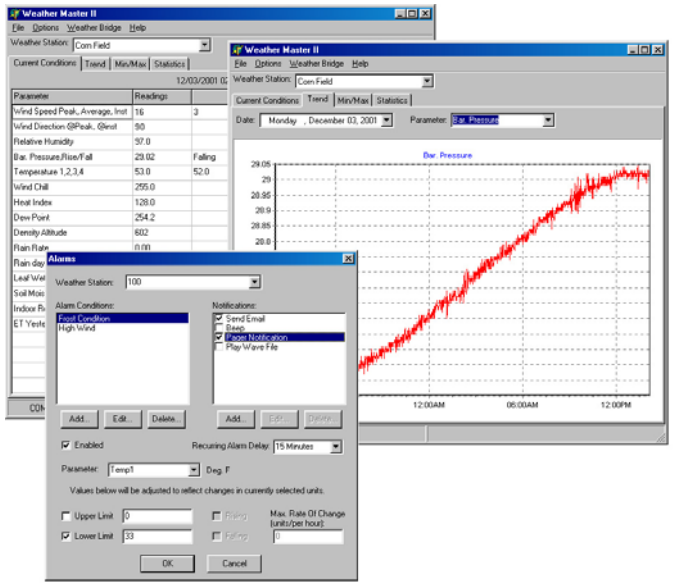
Solar Radiation Sensor (Payronometer)

Available only with the Capricorn 2000MP



This sensor is designed for routine measurement of global hemispherical solar radiation under all weather conditions. The sensor has a rugged uni-body design, which houses a high performance silicon photodiode detector mounted beneath a conical shaped (self-cleaning) diffuser. Due to the unique diffuser design, the sensitivity of this sensor is proportional to the cosine of incidence of the incoming solar irradiance, allowing for accurate and consistent measurement.

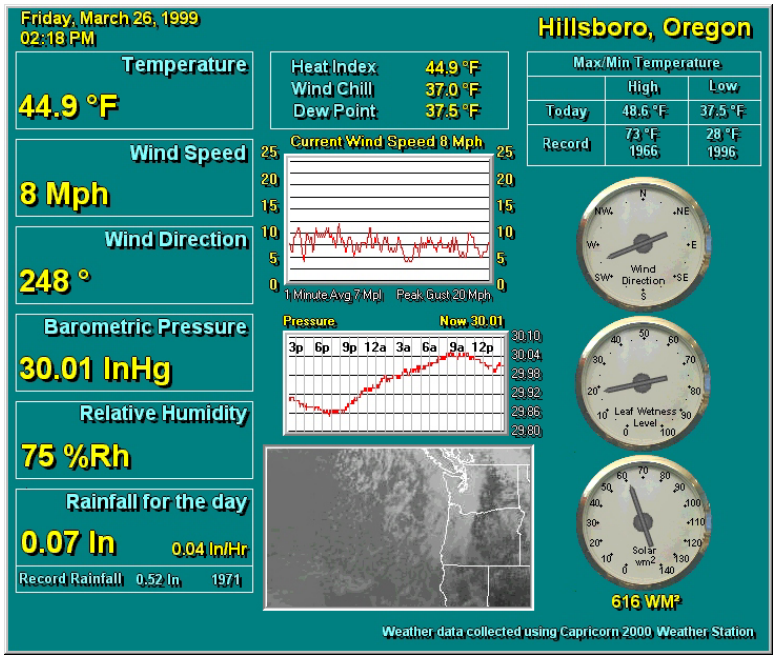
WeatherMaster 2000™ Software



WeatherMaster 2000 is a professional grade weather monitoring software. This software package is designed for specialized markets that require robust weather calculations, interoperability with computer models, and data interfaces to other industrial systems. WeatherMaster 2000 utilizes Microsoft Access database for easy data access and manipulation.

WeatherMaster 2000 is also capable of monitoring multiple stations via a wireless link.

Weather View 32™ Software



Operating in Windows graphic environment, Weather View 32 helps you monitor, record, and store local weather data for current or future analysis.

Weather View 32 offers:

- User-defined real time monitoring display
- Internet and email interface
- Calculated parameters including wind chill, dew point, heat index and degree days
- Monthly calculations for degree days heating and cooling
- Full-featured graphing and printing capabilities
- Six separate alarms functions
- A Climatological database that covers the U.S. and Canada
- Modem access for remote weather stations

RetrieverCC™ Palm OS Software

RetrieverCC™ provides a user-friendly Palm™ program for communication with the Capricorn 2000™ and Pegasus FlyAway Kit™ weather stations. The RetrieverCC, running on a Palm handheld, communicates with the weather station via an RS-232 port to view current weather data, extract logged data and perform other configuration functions.

RetrieverCC can download the datalog from multiple weather stations for export to a PC for additional data analysis and storage.

Features

- Operates on most Palm Handhelds (see Requirements).
- Easy list-based selection of the weather station functions.
- Parses data output into easily readable fields.
- Data capture capability.
- Retains multiple data-capture sessions (capacity subject only to available memory).
- User-named data-capture sessions.
- Review of existing data capture sessions on the handheld.

Requirements

- A Palm device running Palm OS® version 3.1.1 or later (Palm V-series, IIIx, IIIe, IIIxe, IIIc, all m-series, i-series, and also an OS upgraded Palm III).
- Palm Desktop Software installed on the PC.
- An RS-232 serial cable for the handheld.
- A Capricorn 2000 serial cable (included with software).

Weather Display Console (Optional)

The Capricorn 2000 Weather Display uses “intelligent” touch-screen technology. With its programmable microprocessor and abundant memory, the Capricorn 2000 Weather Display can display weather information, perform complex computations, and store relatively large amounts of weather data.

The Capricorn 2000 Weather Display is also available in Aviation and Agricultural Editions:

Aviation Edition: Density altitude and additional wind speed and direction calculations and charts.

Agricultural Edition: Evapotranspiration and degree day calculations.

The Weather Display is also available in a 19” rack-mount chassis.

SECTION 3: INSTALLATION

Wiring and Color Code

Terminal #	Wire Color	Description
Temperature		
1	RED	+5V
2	BARE	Ground
3	BLACK	Temperature Signal
Wind Speed & Direction		
4	RED	+5V
5	BLACK	Ground
6	WHITE	Wind Speed Signal
7	N/C	No Connection
8	N/C	No Connection
9	BLUE	Wind Direction Signal
10	GREEN	Wind Direction Signal
11	ORANGE	Wind Direction Signal
12	BROWN	Wind Direction Signal
13	N/C	No Connection
Rainfall		
14	RED	Rain Signal
15	BLACK	Ground
Relative Humidity		
16	RED	+12V
17	BARE	Ground
18	BLACK	Humidity Signal
Leaf Wetness		
19	RED	+5V
20	BARE	Ground
21	BLACK	Wetness Signal
Solar Radiation (X1)		
Available only in the Capricorn 2000MP		
22	N/C	No Connection
23	RED & BARE	Ground
24	BLACK	Solar Signal
Channel X2		
Available only in the Capricorn 2000MP		
25		Power
26		Ground
27		Signal

Installation Overview

Unpacking the Unit

Installing the Control Module

Installing the Barometric Pressure Sensor

Installing the Temperature Sensors

Temperature Sensor Initialization

Installing optional Self-Aspirating Radiation Shield

Installing Wind Sensor

- Assembling the Wind Speed Sensor
- Assembling the Wind Direction Sensor
- Attaching the Wind Sensors to the Cross Arm Support
- Pre-Calibrating the Wind Direction Sensor
- Installing the Mast
- Mounting the Wind Sensor Assembly

Installing the Optional Humidity Sensor

Installing the Optional Rain Gauge Sensor

Installing the Optional Leaf Wetness Sensor

Installing the Optional Solar Radiation Sensor (MP model only)

Tools Needed

#3 (med.) Phillips Screwdriver

#2 (small) Phillips Screwdriver

Small straight blade (1/8") Screwdriver

Power Drill and 3/8" or 1/2" Bit

(1/2" bit needed to thread temperature and wind sensor cables through same hole.)

3/8" or Adjustable Wrench

Wire Cutter

Compass

Pencil

Materials Needed

(See also Section 4: Optional Sensor Mounting Hardware.)

Black PVC Electrical Tape

(2-4) Plastic Wall Bushings

Mast: Height above structure: Minimum 5 ft., recommended 10 ft.

For Roof Mount

“Cold Patch” Roofing Tar

50' Guy Wire

Roof Anchor Mount

Guy Ring & Collar

(3-4) Eye Bolt Screws

For Wall Mount

(2) 4" Wall Mount Bracket Assembly.

(4) Bracket Mounting Screws

Optional Items

Surge Suppressor

Unpacking the Unit

Unpack the Capricorn 2000 weather station and verify that all parts are included.

Inspect all system components for obvious shipping damage (Refer to page 3 in case of damage).

Save the shipping carton and packing material in case the unit needs to be returned to the factory. Note: If items are missing or if there is damage, see page 3. If the system does not operate or calibrate properly, see Section 7: Maintenance and Section 8: Troubleshooting, for further instructions.

Installing the Control Module

Place the Capricorn 2000 Control Module in a clean, dry location, close to a grounded power outlet (and phone line, if a modem connection is required). The Control Module can operate properly in a temperature range of 32° F to 122° F. Avoid areas subject to extreme or rapid changes in temperature, such as locations near furnace vents, heaters, stoves, or other sources of heat.

Plug the power cord into a convenient grounded outlet. (Foreign users may need to remove the standard wall mount power transformer and replace it with one compatible with local requirements and that can supply 12VDC at 800 mA to the Control Module.)

Note: It is strongly recommended that you protect your unit from power line spikes (caused by lightning or electrical discharge) by installing a good quality spike-surge suppression device between the Control Module and the power source. This becomes critical if the installation occurs in areas which tend to experience frequent electrical storms, such as the southeastern United States. More than 80% of repairs performed on Capricorn 2000 units are caused by electrical storms.

Theoretically, there is no way to avoid the risk of damage entirely, but there has never been a reported case of electrical damage by power line transients to a Capricorn 2000 Control Module that was protected by a good quality spike-surge suppressor. A good spike-surge suppression device is relatively inexpensive damage insurance and may be purchased from computer and electronics outlets, or from the factory. If ordering from Columbia Weather Systems, specify Cat. No. 8350 (six outlets).

Installing the Barometric Pressure Sensor

The barometric pressure sensor is located inside the Control Module; no user installation is required. The sensor does need to be calibrated for altitude, however. Please refer to Section 6: Calibration for the procedure of setting the altitude.

Installing the Temperature Sensors

The Capricorn 2000 can accept up to four temperature sensors. The standard model is supplied with only one temperature sensor. Additional sensors can be added at any time (Cat. No. 82100).

The temperature sensor is wound into a 50 ft. coil. If the temperature cable provided is not long enough, it may be extended by splicing on an appropriate length of 22 gauge, stranded, 2 conductor shielded cable with a ground drain wire and the same color code. When cutting and splicing, insure good contacts, proper color coding of the terminal leads, and a good seal. (A good solder splice and waterproof insulation are essential; merely twisting the respective wires together is not adequate.) Additional cable (Cat. No. 81560) and a water tight splice kit (Cat. No. 81580) are available from the factory.

The maximum length of the cable for all temperature sensors combined is 400 ft. For example, if the control module has three existing temperature sensors with 50 foot cable each, the fourth temperature sensor cannot exceed 250 feet in cable length.

Indoor Installation

If the temperature probe is used indoors, place the sensor several feet away from any artificial heat source to insure accurate readings.

Note: Room temperatures typically vary 10° F or more between ceiling and floor. When installing the sensor indoors, place the sensor so that it will give the temperature reading for the “level” in the room that is representative or of interest (typically, five feet above the floor). Route the cable back to the console.

Outdoor Installation

If the temperature sensor is used outdoors, it may be located anywhere, but in order to obtain an accurate reading, it should be mounted in a location shielded from direct or reflected sunlight. Mounting the sensor under roof eaves is appropriate in most applications as long as a southern exposure is avoided. Avoid locations where ice and snow will accumulate, or near heat radiating objects such as patios, sidewalks, reflective siding, attic vents, etc. For best results and accurate readings use a self-aspirated radiation shield (catalog number 82101) that will house the temperature sensor and protect it from direct sun light and reflective radiation.

As a general precaution, avoid placing or routing the temperature sensors or cable near cables from other systems in order to decrease the possibility of picking up disruptive signals and of interfering with other systems. Also, avoid placing and routing sensors on or near metal gutters, metal windows, metal door frames, or directly on a metal tower. These items may attract an electrostatic discharge (possibly lightning) which could jump to the grounded cables and cause damage to the sensors and/or the Control Module.

Using insulated standoffs (user supplied, or see Section 4) when routing cable helps avoid these problems.

Note: Sensors and cables mounted to properly earth grounded metal masts and towers may receive some protection from electrostatic discharge.

Once the temperature sensor(s) has been placed, route the cable back to the console.

CAUTION - There may be electric wires in the wall. We recommend that you shut off the electricity in the room(s) where you are drilling.

For best results:

a. drill a 3/8" hole though the wall

b. insert small plastic wall bushings (user supplied, or see Section 4) on either side of the wall; and

c. thread the cable through the bushings. (It may be convenient to combine this step with routing of the wind sensor cable.

Do not connect the temperature sensor cable(s) to the Control Module at this time.

Temperature Sensor Initialization

Using a small Straight Slot screwdriver, attach the wires from the end of the first temperature sensor cable to the Temperature terminal block screws as follows:

Red Wire	Terminal #1
Bare Wire	Terminal #2
Black Wire	Terminal #3

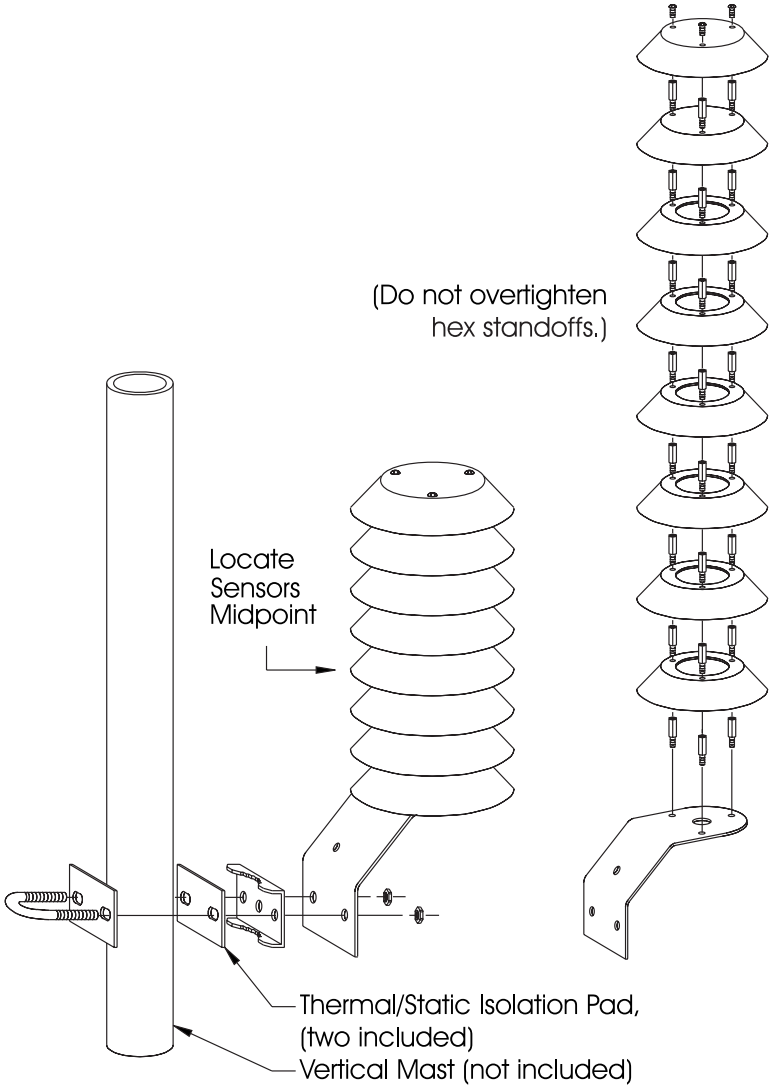
Apply power to the Control Module for one minute to identify the probe and then remove power. This probe is now identified as T1 by the Control Module.

If more than one Temperature Probe is to be installed, they must all be identified by the Control Module. Remove power from the Control Module, connect the next temperature sensor cable to the same temperature terminal block, and apply power for one minute to identify the probe and then remove power. The second probe is now identified as T2. Repeat these steps for each additional temperature sensor, T3 and T4 (up to 4 total).

Note: **Do Not** remove the first set of wires from the Terminals.

Once all Temperature probes have been installed remove power from system.

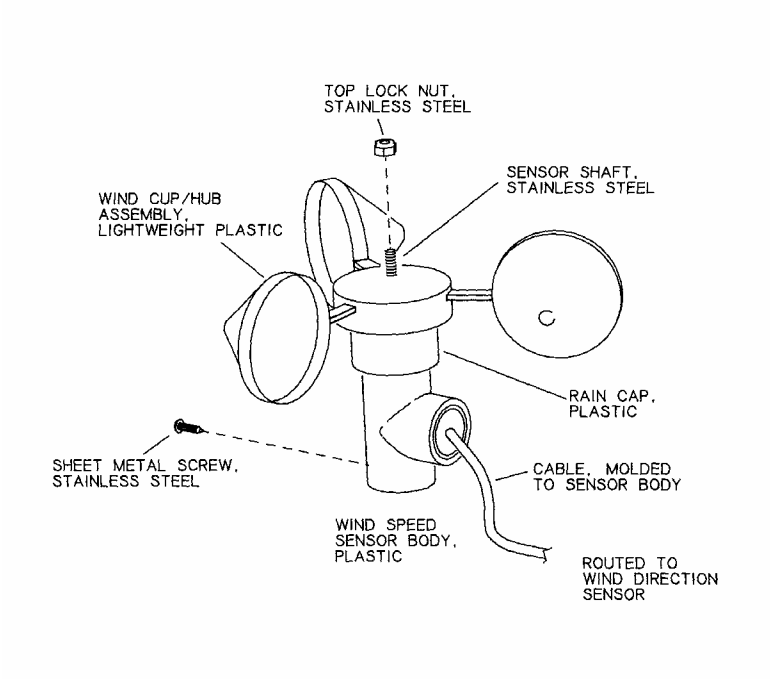
Self-Aspirating Radiation Shield Installation



Insert both humidity and temperature sensors in the radiation shield to the midway point and secure both cables to the plastic fastener on the mounting bracket using the provided tiewrap.

Installing the Wind Sensors

Assembling the Wind Speed Sensor



Locate the wind speed sensor body. (The wind speed sensor body has one cable attached.)

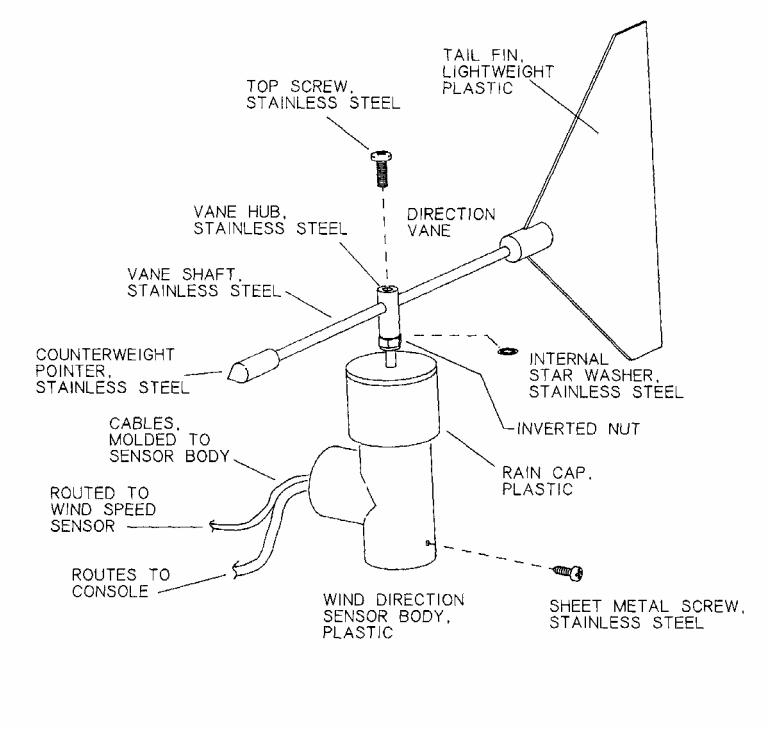
Remove and discard the red vinyl shipping bumper from the threaded shaft. (The purpose of this shaft bumper is to protect the precision internal bearings from any damage during shipment and pre-installation handling that might be caused by accidental shock to the shaft.)

Place the wind cup/hub assembly on the threaded shaft of the wind speed sensor so that the cup assembly rests on and mates to the inverted shaft nut which has been installed at the factory.

Thread the lock nut (from the Hardware Kit, item number 2) onto the shaft above the wind cup assembly.

While holding the wind cup/hub assembly with one hand, use a 3/8" wrench to screw the lock nut down onto the cup assembly. **DO NOT OVER TIGHTEN.**

Assembling the Wind Direction Sensor



Remove and discard the red vinyl shipping bumper from the threaded direction shaft.

Place the internal star washer from the Hardware Kit onto the shaft of the wind direction sensor body so that the washer sits on the inverted nut. (Note: The wind direction sensor body has two cables attached to it.)

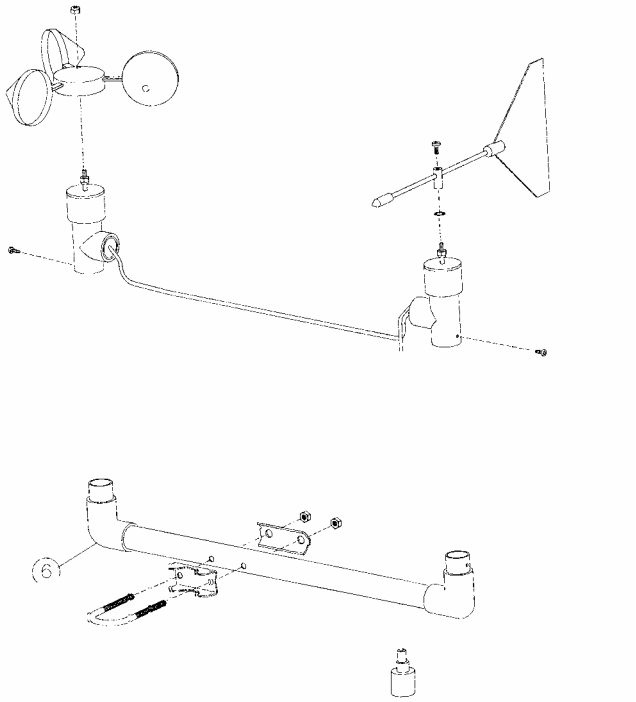
Thread the direction vane hub assembly onto the direction sensor shaft by hand, and insert the top screw. Do not tighten the screw yet.

Rotate the tail fin so it is in a vertical position and tighten the top screw to secure the wind direction shaft in the vane hub.

Place a 3/8" wrench on the inverted nut. Holding the direction vane assembly with one hand, firmly tighten the vane hub onto the nut.

Recheck the tail fin alignment; it should be vertical.

Attaching the Wind Sensors to the Cross Arm Support



Set the wind speed and direction sensor bodies onto their respective ends of the cross arm support. Each sensor body is marked with either an “I” or “II” and should be matched to the same mark on either end of the cross arm support.

Line up the marked hole in each sensor body with the correspondingly marked holes (1/8" diameter) at either end of the cross arm support.

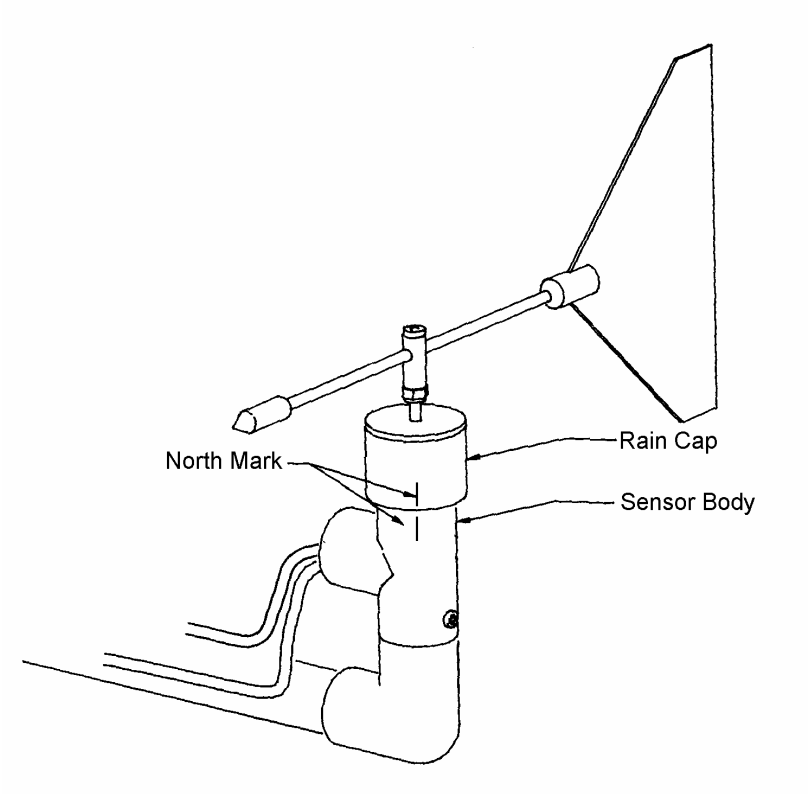
Using a Phillips screwdriver, screw the stainless steel sheet metal screws from the Hardware Kit through the predrilled holes and directly into the pilot holes in the cross arm support.

Assemble the U-bolt Assembly onto the Cross Arm Support. Refer to the above figure for the proper order of assembly. Thread the two nuts onto the ends of the U-bolt arms so that the ends of the arms are flush with the outside faces of the nuts. (The nuts will be tightened later after the mast is inserted through the U-bolt assembly.)

Pre-Calibrating the Wind Direction Sensor

The Wind Direction sensor body and the Rain Cap are both marked to indicate the north direction setting.

Rotate the vane until the North marks are aligned on the Rain Cap and the sensor body as shown in figure below.



Secure the Rain Cap to the sensor body with a piece of black electrical tape so that the Rain Cap cannot rotate around the sensor body.

Installing the Mast

The Capricorn 2000 will measure wind speeds of up to 125 mph (200 km/h). However, unless the Wind Sensor Assembly is properly mounted to withstand such high winds, this capability is useless. Please read these instructions carefully to insure a safe and reliable installation. Mounting the mast and the wind speed and direction sensors should be comparable in scope to installing a TV antenna.

There are three acceptable methods for mounting the mast to a roof or building structure. Sloped roof mounting, flat roof mounting or wall mounting. See Section 4: Optional Sensor Mounting Hardware for more information.

Location

Do not attach the Wind Sensor Assembly to a chimney or a TV or radio transmitting mast or tower.

Select a mounting location that will allow the Wind Sensor Assembly cables to be routed away from TV antenna cables and other data cables to avoid interference.

Do not mount sensors close to power lines or telephone lines. For normal roof mounting, the recommended minimum distance from power or telephone lines is 25 ft. (8 m). Use extreme caution when working close to power lines

Never route sensor cables in tall trees.

Mounting Method

Choose the appropriate mounting method for the installation and obtain the necessary mounting hardware. Refer to Section 4 for information on optional sensor mounting hardware and accessories which are available from the factory.

If the mounting hardware is not obtained from the factory, be certain to use metal parts which are plated or galvanized to assure maximum longevity.

In marine locations (or other areas) which experience severe corrosion problems, a watertight, rubberized spray coating is recommended. This can be sprayed on all metal parts from the cross arm support down (not the wind sensors) after the installation is completed. Refer to Columbia Weather Systems Cat. No. 83500 as noted in Section 4.

Secure the mast to the roof, using guy wires with sufficient tensile strength. The Wall Mounting Method should utilize a mast of no more than 5 ft. maximum height, unless it can be secured with guy wires.

Routing Cable

Avoid routing the cable near metal windows, metal door frames, metal gutters, or on a metal tower.

Any mast or tower should always be properly earth grounded to minimize electrical storm damage. The use of a properly grounded metal mast or tower, however, does not insure protection from

electrostatic discharge. These items could become electrically charged resulting in damage to the sensors and/or console. This could damage the system in the event of an electrical storm. Use insulated standoffs (user supplied, see Section 4) when routing cable to help avoid this problem.

Mounting the Wind Sensor Assembly

Note: At this point, you will need to take the assembled and pre-calibrated Wind Sensor Assembly and tools (including wrench and compass) to the roof mounting location.

Attach the Wind Sensor Assembly to the mast. The mast should be inserted between the rounded section of the U-bolt assembly and the serrated edge of the U-bolt clamp.

Tighten the two nuts on the U-bolt assembly so that the Wind Sensor Assembly is lightly fastened to the mast. Final adjustment and tightening are described below.

With the direction vane/rain cap still secured with tape to the sensor body, rotate the entire cross arm support/sensor assembly around the mast until the pointer on the secured direction vane is pointing toward true north. Use a compass to help align the pointer to the north. Once north has been located, tighten the cross arm support U-clamp nuts securely with a wrench. Remove the tape from the rain cap/sensor body. It should now rotate freely.

Use six plastic tie wraps to secure the cables to the cross arm support and mast. Use one tie wrap for the wind speed cable and one for the wind direction cables. The other four tie wraps can be placed on the mast. Be sure that one is used at the mast base. Tighten the tie wraps securely and clip off any excess length with a wire cutter tool.

Route the cable back to the Control Module. If mounting on a roof, route the sensors through a vent or other opening into an attic or crawl space.

CAUTION - There may be electric wires in the wall. We recommend that you shut off the electricity in the room(s) where you are drilling.

For best results when routing the cable through the exterior wall adjacent to the console:

a. drill a 3/8" hole though the wall (1/2" if combined with the temperature sensor cable);

b. insert a pair of small plastic wall bushings (available as an option; see Section 4) on either side of the wall (or, insert a wall feed-through tube, also optionally available); and

c. thread the cable through the bushings or tube.

Make sure that the exposed portion of the sensor cable that is beyond the mast will not be blown about by the wind. Use insulated eye bolt standoffs or other fasteners if necessary. (See Section 4.)

Note: If the standard 50 ft. cable provided with the wind sensor assembly is not long enough, it may be extended by splicing on an appropriate length of 22 gauge, stranded, seven conductor shielded cable with the same color code. When cutting and splicing, insure good contacts, proper color coding of the terminal leads, and a good seal. (A good solder splice and water proof insulation are essential; merely twisting the respective wires together is not adequate.) Additional cable (Cat. No. 81540) and a water tight splice kit (Cat. No. 81580) are available from the factory. The maximum length of the cable (original cable plus spliced section) should not exceed 1000 ft. (305 m).

Once the Wind Sensor has been placed, route the cable back to the Control Module. Extra cable may be coiled up and placed behind the Control Module.

Using a #1 Straight Slot screwdriver, attach the wires from the end of the Wind Sensor cable to the Wind Sensor terminal block screws at the back of the Control Module as follows:

Red Wire - Terminal #4

Black Wire - Terminal #5

White Wire - Terminal #6

No Connect - Terminal #7

No Connect - Terminal #8

Blue Wire - Terminal #9

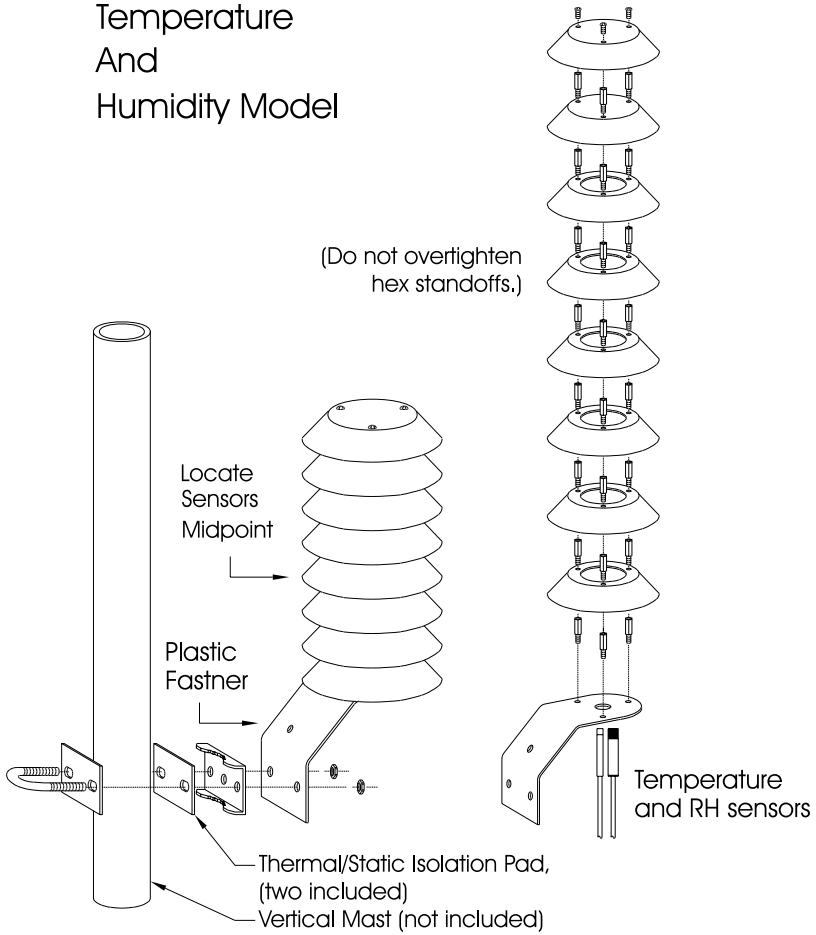
Green Wire - Terminal #10

Orange Wire - Terminal #11

Brown Wire - Terminal #12

For shielded wind sensors, connect the ground lug to the chassis ground terminal on the back panel of the Control Module.

Installing the Humidity Sensor



The Relative Humidity sensor should be mounted in a sheltered area, preferably on the north side of a building under the eaves to prevent sun-heated air from rising up the side of the building and affecting the relative humidity at the sensor.

Mounting the humidity sensor in a self-aspirating radiation shield provides an excellent way of sheltering the sensor from solar radiation and rain and allows for a convenient way to mount the sensor on a mast or the side of a building.

The relative humidity sensor is supplied with a standard 50-foot cable. The cable provided is a 22 gauge, 2 conductor shielded cable with a ground drain lead. If additional cable is required, a good splice and waterproof insulation are essential; merely twisting the respective wires together is not adequate.

Once the sensor has been placed, route the cable back to the Control Module. It may be convenient to combine this step with routing the wind sensor cable.

Using a small straight screw driver, attach the humidity cable to the back of the Control Module as follows

Red Wire - Terminal #16

Bare Wire - Terminal #17

Black Wire - Terminal #18

Installing the Rain Gauge Sensor

Safety Note: The top rim of the rain gauge sensor is EXTREMELY sharp. Handle the rim with great care.

Evaluate the proposed sensor location as compared to the cable length supplied. The rain gauge is supplied with a standard 50-foot cable. The cable provided is a 22 gauge, 2 conductor shielded cable with a ground drain lead. If additional cable is required, a good splice and waterproof insulation are essential; merely twisting the respective wires together is not adequate.

To obtain an accurate reading, mount the Rain Gauge Sensor in a clear and open area. The Rain Gauge can be either surface mounted or mast mounted. Surface mounting is recommended where possible. The Rain Gauge must be mounted in a LEVEL position and in a location free from vibration.

If using a mast mounting, make sure that the mast is properly guyed so that vibration in a high wind situation is kept to a minimum. When mounting with other sensors on a mast, position the Rain Gauge so that it is the lowest sensor in the vertical stack. This will prevent the Rain Gauge from draining water on the other sensors. Make sure any sensors above the Rain Gauge are rotated on the mast to provide an unobstructed rain path to the Rain Gauge.

Once the Rain Gauge Sensor is securely mounted, grasp the top gold funnel portion of the Rain Gauge Sensor firmly and lift up. Do Not place any part of your hand on the rim of the Rain Gauge Sensor due to the danger of being cut by the Knife edge. Verify that the black tipping bucket is not in a center position and that one end of the bucket is down against the stop.

Once the black tipping bucket position has been verified, replace the top gold funnel portion of the Rain Gauge Sensor. Again, Do Not place any part of your hand on the rim of the Rain Gauge Sensor due to the danger of being cut by the Knife edge.

Once the Rain Gauge Sensor has been placed, route the cable back to the Control Module. It may be convenient to combine this step with routing the wind sensor cable.

Using a small straight screwdriver, attach the wires from the end of the cable to the Temperature terminal posts screws as follows:

Black Wire - Terminal #14

White Wire - Terminal #15

Installing the Leaf Wetness Sensor

Evaluate the proposed sensor location as compared to the cable length supplied. In order to obtain an accurate reading, mount the Leaf Wetness Sensor in an exposed area. Mounting the sensor on a post is appropriate in most applications.

Once the Leaf Wetness Sensor has been located, route the cable back to the Control Module. The leaf wetness sensor is supplied with a standard 50-foot cable. The cable provided is a 22 gauge, 2 conductor shielded cable with a ground drain lead. If additional cable is required, a good splice and waterproof insulation are essential; merely twisting the respective wires together is not adequate.

Once the Leaf Wetness Sensor has been placed, route the cable back to the Control Module. It may be convenient to combine this step with routing the wind sensor cable.

Using a small Straight Slot screwdriver, attach the wires from the end of the cable to the Temperature terminal posts screws as follows:

Red Wire - Terminal #19

Bare Wire - Terminal #20

Black Wire - Terminal #21

Installing the Solar Radiation Sensor

Available only with the Capricorn 2000MP

Evaluate the proposed sensor location as compared to the cable length supplied. The solar radiation sensor should be installed in an area that receives full sunlight away from any object that can create a shadow over the sensor. Please be aware that the sun position changes from season to season.

The sensor should be mounted on a leveled surface for accurate readings.

Once the solar radiation sensor is mounted, route the cable to the Control Module. It may be convenient to combine this step with routing of other sensors.

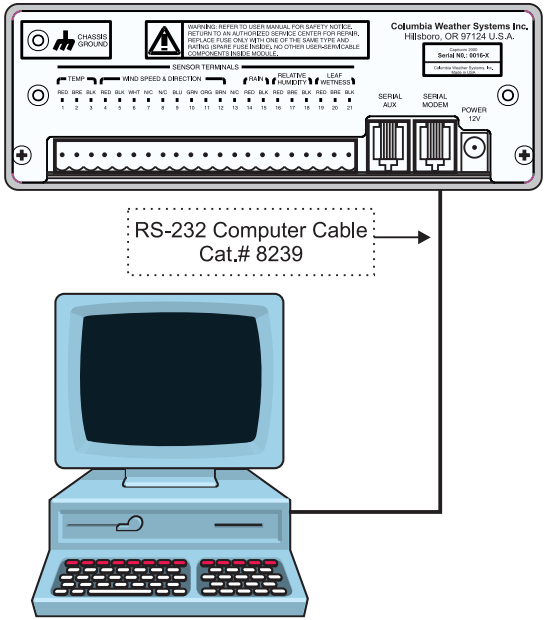
Using a small straight screwdriver, attach the wires from the end of the cable to Channel X1 terminal block in the Multi-Purpose Channels area as follows:

No Connection - Terminal #22

Bare and Red Wire - Terminal #23

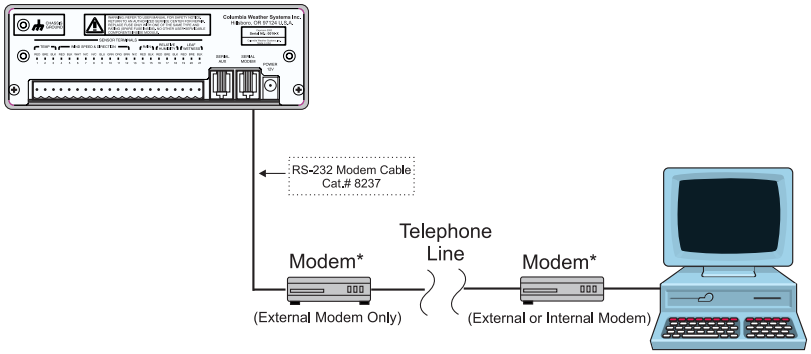
Black Wire - Terminal #24

Connecting the Control Module to a Computer



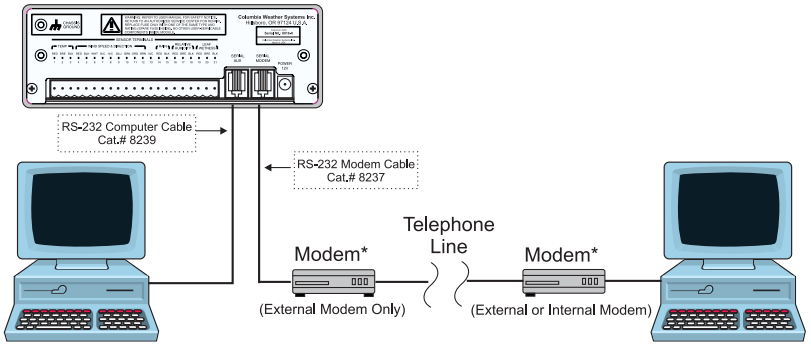
Connect the computer RS-232 port to the Modem port on the Control Module using an RS-232 Computer Cable (Cat. No. 8239).

Connecting the Control Module to a Modem



Connect a modem to the Modem Port of the Control Module using an RS-232 Modem Cable (Cat. No. 8237).

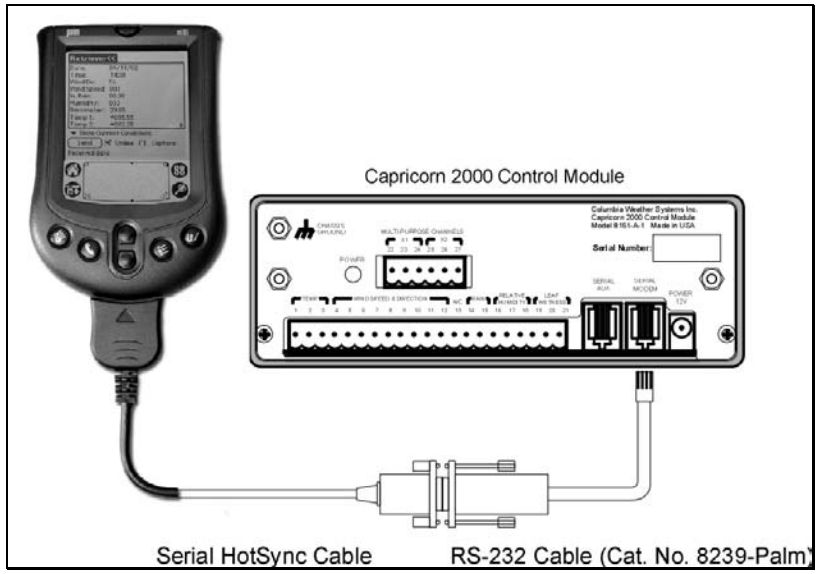
Connecting the Control Module to Computer and Modem



* Recommend 33.6 US Robotics Sportster External Modem

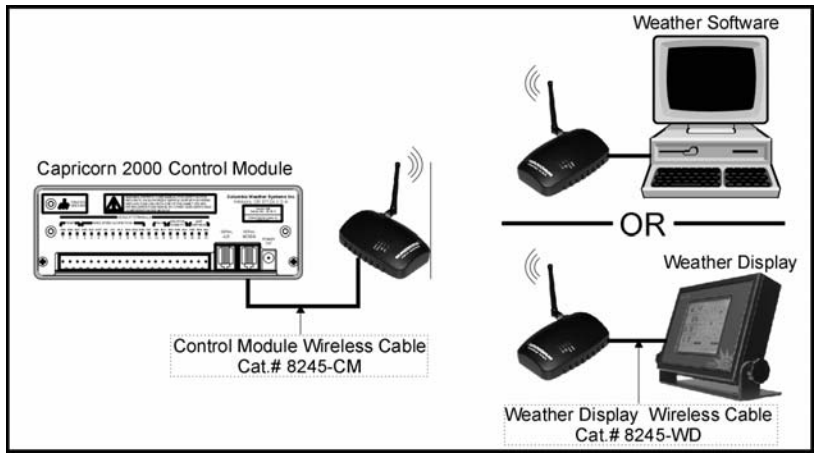
If both a computer and a modem are required to be connected to the Control Module, connect the modem to the Modem Port using an RS-232 Modem Cable (Cat. No. 8237) and connect the computer RS-232 port to the Aux Port on the Control Module using an RS-232 Computer Cable (Cat. No. 8239).

Connecting the Control Module to a Palm device



Connect the Palm device to the either the Modem port or the Aux port on the Control module using a Hot Sync serial cable and an RS-232 cable (Cat. No. 8239-Palm).

Using Wireless Transceivers



The Capricorn 2000 Control Module can be connected to a wireless transceiver to communicate with a computer or a Weather Display.

A wireless transceiver link is useful in situations where a cable is not cost effective or impossible to run between the Control Module and the display.

The standard wireless transceiver is a 2.4 GHz, 200 mWatt radio with a 2-mile line-of-site range.

Connect the transceiver to the Modem Port (or the Aux. port) of the Control Module using an RS-232 Cable (Cat. No. 8245-CM).

Connect the second transceiver to a computer using the transceiver built-in cable or to a Weather Display console using an RS-232 Cable (Cat. No. 8245-WD).

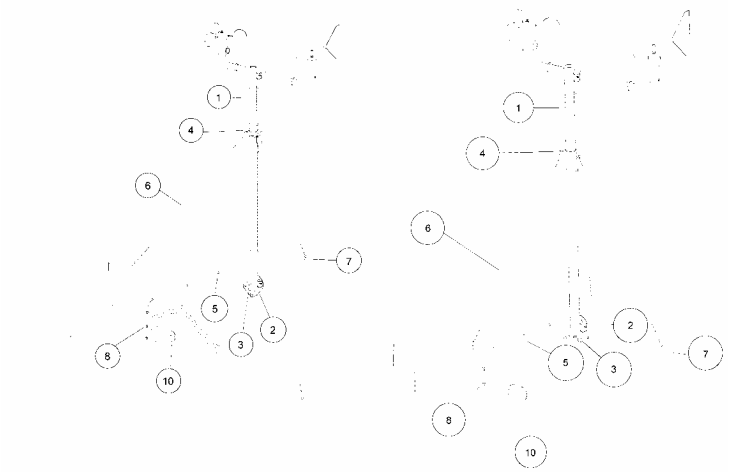
SECTION 4: OPTIONAL SENSOR MOUNTING HARDWARE

Fiberglass and steel 10-foot masts are available for use with either Roof Mounting Hardware Kit (Cat. No. 88002) or Wall Mounting Kit (Cat. No. 88003).

A 10-foot free standing tripod is also available.

Roof Mounting

The Roof Mounting Kit (Cat. No. 88002) is suitable for both a slanted and flat roof installation. The figure and table below illustrates and describes the individual parts. Items included in the kit are marked with an asterisk (*). Individual parts are also available.

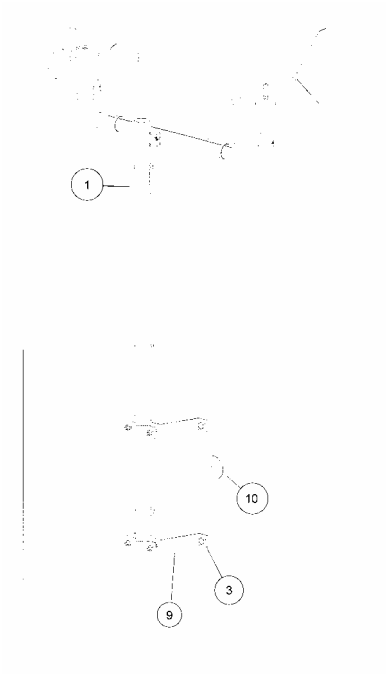


Description	Pkg.	Ref	Catalog No.
Mast, 10 ft. (steel or fiberglass)	1	1	88005 / 88004
*Universal Mast Mount	1	2	88010
Lag Screw, Roof Mast Mount	3	3	88020
1/4" x 4" (for shake roofs			

*Lag Screw, Roof Mast Mount	4	3	88030
1/4" x 2 1/4" (for comp. roofs)			
*Guy Ring and Collar	1	4	88040
*Cable Standoffs, Wood Screw	4	5	88050
Cable Standoffs, Nail-In (for masonry application)	2	5	88060
Guy Wire Clamps, 1/8"	3	(not shown)	88070
*Steel Guy Wire, Galvanized	50 ft.	6	88080
*Eye Bolt Wood Screws, 1/4" x 3"	4	7	88090
Turnbuckles, 6" open x 4" closed	2	(not shown)	88100
*Cable Nail Clips	20	8	88110
Wall Feed Through Tube	1	10	88130
*Cable Feed Through Bushings	4	10	88140
Watertight Rubberized Coating	17oz	(not shown)	83500

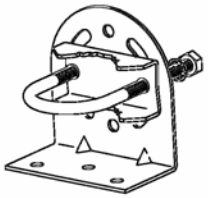
Wall Mounting

The figure and table below illustrates and describes the individual parts in the Wall Mounting Kit (Cat. No. 88003). Items included in the kit are marked with an asterisk (*). Individual parts are also available.

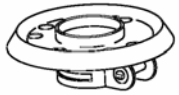


Description	Pkg.	Ref	Catalog No.
Mast, 10 ft. (steel or fiberglass)	1	1	88005 / 88004
*4" Wall Mount	2	9	88120
Lag Screw, 1/4" x 2 1/4"	4	3	88030
*Cable Nail Clips	20	8	88110
Wall Feed Through Tube	1	10	88130
*Cable Feed Through Bushings	4	10	88140
Watertight Rubberized Coating	17oz. (not shown)		83500

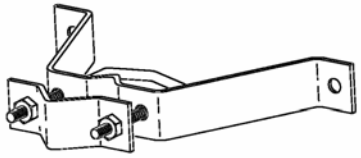
EYE BOLT SCREW



UNIVERSAL MAST MOUNT



GUY RING & COLLAR



4" WALL MOUNT

CABLE NAIL CLIP

CABLE STANDOFF

Tripod

Tripod Model T-1000 is designed to provide up to 10 feet of stable, secure support for your meteorological sensors.

The T-1000 is constructed from welded aluminum and is powder coated for appearance and longevity. The 15-pound tripod can

easily support up to 60 pounds of equipment. An optional tie-down kit allows for additional security in high-wind areas.

Set up takes less than five minutes. Simply insert the legs into the main body and install the stainless steel retainer pins. Extend the mast to the desired height and insert another retainer pin. Install the guy wires and you're ready to go!

Specifications

Capacity: Supports up to 60 lbs.

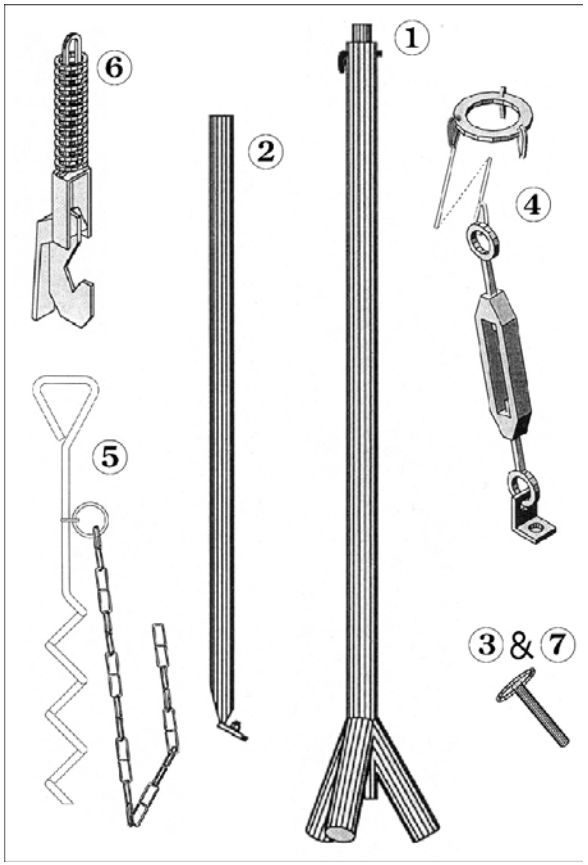
Shipping Weight: 17lbs

Shipping Box Dimensions: 63" x 8" x 8"

Tripod Model T-1000, Catalog Number: 88007

Tiedown Kit, Catalog Number: 88008

Tripod T-1000 (Catalog No. 88007) Parts List:



Item #	Description	Qty
1	Body/Mast Assembly	1
2	Legs	3
3	Retainer Pins	4
4	Guy Wire Ring with 3 Wires and Turnbuckles	1

Optional Tiedown Kit (Catalog No. 88008) Parts List:

Item #	Description	Qty
5	Anchor Screw with Chain	1
6	Spring Clamp	1
7	Retainer Pin	1

Section 5: Operation

The Capricorn 2000 communicates with a computer via an RS-232 interface. The weather station has two ports available on the back panel (RJ-12 Jacks). All of the following commands are accessible through either port. The two ports are independent from one another and are controlled by a multitasking processor.

RS-232 Modem serial port

This is the main serial port in the system. It is usually used for communication via modem or directly to a computer if a modem is not used.

RS-232 Aux serial port

This is a secondary serial port. It is usually used for direct communication with a computer if the Modem serial port is used.

Communication Settings

The protocol for both serial ports is the following:

Bits per Second (baud rate): 9600

Data bits: 8

Parity: None

Stop bits: 1

Flow control: None

Operating software

Once an RS-232 connection is made between the computer and the weather station, commands can be issued to the weather station using a "Terminal" software such as Hyper Terminal (available with Windows operating system), or by using such as Weather View 32™, WeatherMaster 2000™ or RetrieverCC™.

The protocol is 8-bit, no parity, 1 stop bit and 9600 baud. All commands must be entered using upper case letters and followed by a carriage return.

The weather station will return "ok" after the results of each command. If the command is incorrect, the weather station will return "?".

Setting date and time

SET-DATE: This command is used to set the internal calendar to the appropriate date. It uses space delimiters between the month field, the day field, the year field, and the command field.

Example: 12 25 96 SET-DATE sets the date to 12/25/1996 and 1 5 01 SET-DATE sets the date to 1/5/2001

SET-TIME: This command is used to set the internal clock to the appropriate military time (24 hours clock). It uses space delimiters between the hours field, minutes fields and the command field.

Example: 13 46 SET-TIME sets the time to 1:46 PM

Displaying date and time

DATE-TIME: This command is used to display the system date and time. When used the weather station will return the date followed by the time, comma delimited.

Example: 02/11/1998,13:20ok

Displaying current sensor readings

There are three ways to display current sensor readings:

The POLL command

POLL: This command is used to display the current sensor readings in a report format. When a POLL command is issued, the weather station will interrogate all the sensors and will display the information

Example:

11:00		Time
02/11/1998		Date
50.14	Degrees F	Temperature 1
70.89	Degrees F	Temperature 2
68.33	Degrees F	Temperature 3
64.46	Degrees F	Temperature 4
29.88	Inches Hg	Barometric Pressure
006	MPH	Wind Speed
SE		Wind Direction
073	Percent	Relative Humidity
00.06	Inches	Rain (Today)
04.43	Volts	Leaf Wetness
01.30	Volt	X1
04.58	Volts	X2

ok

The SAMPLE command

SAMPLE: This command is used to display the current sensor readings in a one line record format (the same format as the datalog). The record starts with the letter S followed by the date and time of the sample, followed by the sensor values and ends with a check sum value. All of these fields are comma delimited.

Example:

S,02/11/98,11:09,36WD,003WS,00.06R,072RH,29.88P1,+050.59T1,+070.77T2,+068.23T3,+064.60T4,04.43LW,0.00X1,0.00X2,6007ok

Where, WD is wind direction, WS is wind speed in MPH, R is rain fall in inches, RH is relative humidity percentage, P1 is barometric pressure in Inches-Hg, T1 through T4 are the four temperature sensors in degrees F, LW is leaf wetness in volts, X1 is typically solar radiation (5.00 volts equals 2000 Weather Master 2000-2) and X2 is used for additional sensors (X1 and X2 are available only in the Capricorn 2000MP).

Temperature sensors that are not defined or connected will have a +255.00 reading.

Wind direction is displayed in a 64 degree compass as follows:

0	N
4	NNE
8	NE
12	ENE
16	E
20	ESE
24	SE
28	SSE

32 S
36 SSW
40 SW
44 WSW
48 W
52 WNW
56 NW
60 NNW

The Short commands

WD: will display wind direction in a 64 compass points

WS: will display wind speed in MPH

R1: will display the rain fall for the day in inches

RH: will display relative humidity percentage

P1: will display the barometric pressure in inches-Hg

T1: will display the temperature for the first temperature probe in degrees F

T2: will display the temperature for the second temperature probe in degrees F

T3: will display the temperature for the third temperature probe in degrees F

T4: will display the temperature for the fourth temperature probe in degrees F

LW: will display leaf wetness in volts. The range may vary per sensor. Typically, 0.5 volts indicates saturated condition and 4.5 volts indicates dry conditions.

X1 and X2 channels are available only with the Capricorn 2000MP

X1: will display solar radiation (typically). 5.00 volts equals 2000 Wm-2.

X2: will display the value of this channel in 0 to 5 volts.

Datalog

The Capricorn 2000 weather station has a built in circular dataloger. The datalog holds records of sensor readings (Samples) and High/Low information. Both types of records (Samples and High/Low) are recorded at user defined intervals.

The datalog can hold up to 511 records. A Sample occupies on record and High/Low information occupies four records.

Setting datalog intervals

The interval for the Sample records in the datalog is user selectable. The interval duration is restricted to the following: 1, 2, 3, 4, 5, 6, 10, 15, 20, 30, and 60 minutes.

n MEAS-INT: This command sets the Sample interval in the datalog. n is the interval duration in minutes.

Example: 15 MEAS-INT will cause the weather station to save a Sample record every 15 minutes.

Setting Hi/Lo intervals

The interval for the High/Low records in the datalog is user selectable. The interval duration is restricted to the following: 1, 2, 3, 4, 6, 8, 12 and 24 hours.

n HI/LO-INT: This command sets the High/Low interval in the datalog. n is the interval duration in hours.

Example: 12 HI/LO-INT will cause the weather station to save High/Low records (total of four records) every 12 hours.

Displaying the datalog

ALL: This command will display the complete datalog (511 maximum records)

Example: In this example the Sample interval is set at one minute and the High/Low interval is set at one hour and the datalog has 13 record (9 Sample records and 4 High/Low records).

13 records

S,02/11/98,13:56,32WD,007WS,00.07R,074RH,29.85P1,+052.31T1,+071.62T2,+069.17T3,+065.57T4,01.88LW,0.00X1,0.00X2,6015

S,02/11/98,13:57,32WD,005WS,00.07R,074RH,29.86P1,+052.74T1,+071.83T2,+069.26T3,+065.69T4,01.70LW,0.00X1,0.00X2,6019

S,02/11/98,13:58,32WD,006WS,00.07R,072RH,29.85P1,+052.76T1,+071.64T2,+069.35T3,+065.75T4,01.74LW,0.00X1,0.00X2,6020

S,02/11/98,13:59,32WD,006WS,00.07R,071RH,29.85P1,+052.94T1,+071.86T2,+069.36T3,+065.81T4,01.74LW,0.00X1,0.00X2,6022

H,02/11/98,14:00,013,13:25WS,081,13:40RH,29.86,13:27P1,+053.23,14:00T1,+072.27,13:52T2,+069.59,13:31T3,+065.88, 14:00T4,01.70,13:57LW,0.00,14:00X1,0.00,14:00X2,8351

L,02/11/98,14:00,013,13:25WS,067,13:25RH,29.84,13:25P1,+050.17,13:39T1,+071.29,13:26T2,+068.33,13:42T3,+065.34, 13:25T4,04.41,13:27LW,0.00,00:00X1,0.00,00:00X2,8349

S,02/11/98,14:00,28WD,000WS,00.07R,071RH,29.85P1,+053.23T1,+072.02T2,+069.26T3,
+065.88T4,01.76LW,0.00X1,0.00X2,5998

S,02/11/98,14:01,28WD,003WS,00.07R,071RH,29.85P1,+053.67T1,+072.52T2,+068.91T3,
+065.88T4,01.78LW,0.00X1,0.00X2,6018

S,02/11/98,14:02,32WD,006WS,00.07R,069RH,29.85P1,+053.70T1,+072.86T2,+068.89T3,
+065.86T4,01.84LW,0.00X1,0.00X2,6027

S,02/11/98,14:03,32WD,003WS,00.07R,068RH,29.85P1,+053.73T1,+073.13T2,+069.21T3,
+065.86T4,01.88LW,0.00X1,0.00X2,6009
S,02/11/98,14:04,28WD,005WS,00.07R,067RH,29.85P1,+053.41T1,+072.48T2,+069.36T3,
+065.86T4,01.94LW,0.00X1,0.00X2,6021ok

Note that the Sample records start with the letter S and the High/Low records start with the letter H and L respectively.

NOW: This command will display the last record in the datalog

n GET: This command will display a user defined number of records in the datalog, where n is the number of records.

Example: 10 GET will display the last ten records in the datalog.

Resetting Hi/Lo

RESET-HI/LO: This command will erase the high/low values from memory for the current high/low interval.

Resetting the datalog

RESET-DATA: This command will erase the datalog and will insert one current Sample record.

Displaying current Hi/Lo

HIGH: This command will display the current high record. The High record starts with the letter H followed by the date and time the record was requested followed by the high values and the time for wind speed, relative humidity, pressure, temperatures, leaf wetness and two undefined sensors (X1 and X2). The high value of wind speed is the wind gust.

Example:

H,02/11/98,14:00,013,13:25WS,081,13:40RH,29.86,13:27P1,+053.23,14:00T1,+072.27,13:
52T2,+069.59,13:31T3,+065.88, 14:00T4,01.70,13:57LW,0.00,14:00X1,0.00,14:00X2,8351

LOW: This command will display the current low record. The Low record starts with the letter L followed by the date and time the record was requested followed by the low values and the time for wind speed, relative humidity, pressure, temperatures, leaf wetness

and two undefined sensors (X1 and X2). The low value of wind speed is the high 4 second sustained wind average.

Setting temperature offsets

Temperature offsets are used to calibrate the temperature probes.

n TCAL#: This command is used to enter an offset for a temperature probe. Where n is the offset in 1/100 of a degree F and # is the temperature probe number.

Example: 231 TCAL2 adds 2.31 degree F to the temperature reading from temperature probe two and -231 TCAL2 subtracts 2.31 degrees F from the reading.

Please refer to the Temperature Calibration section for more information.

Setting barometric pressure altitude and offset

n ALT: This command sets the altitude of the weather station, where n is the altitude in feet.

Example: 225 ALT sets the altitude to 225 feet above see level.

n BAR-OFFSET: This command is used to enter an offset to the barometric pressure reading, where n is the offset in 1/100 of In.Hg.

Example: 34 BAR-OFFSET adds 0.34 in.Hg to the barometric pressure reading and -34 BAR-OFFSET subtract 0.34 in.Hg from the reading.

Please refer to Barometric Pressure Calibration for more information.

Display current settings

PARAMETERS: This command displays the current weather station settings and the number of records in the datalog.

Example:

Date & Time	02/11/1998,17:31
Measurement interval	1 minutes
Hi/Lo interval	1 hours
Records in memory	262
Pressure offset	38
Altitude	225
Temperature 1 offset	255
Temperature 2 offset	-25

Temperature 3 offset 55
Temperature 4 offset 155 ok

Continuous display of direction

NORTH: This command continuously displays the wind direction. This command is used for locating the north direction on the wind sensor. An <Esc> followed by a carriage return terminates this command.

Continuous display of wind information

1 XFER: This command continuously displays a Sample record every one minute and wind speed and direction every one second. The wind speed and direction record starts with the letter W followed by three digits for wind speed in MPH followed by two digits for wind direction.

Example:

W00124

S,02/11/98,17:44,24WD,001WS,00.08R,085RH,29.82P1,+048.56T1,+070.85T2,+067.24T3,

+065.08T4,01.74LW,0.00X1,0.00X2,6014

W00224

W00224

W00124

W00124

W00124

W00120okok

An <Esc> followed by a carriage return terminates this command.

XSET: This command defines the frequency the Sample record is displayed in the XFER output. The default frequency of the Sample record in the XFER output is 60 seconds. This frequency can be changed using the XSET command. For example, 15 XSET will cause the Sample record to be issued every 15 seconds. XSET will change the frequency of the XFER output on both serial ports.

CONT: This command will continuously output the Sample record at a specified interval. For example, 5 CONT will output a Sample record every 5 seconds. The time interval is limited to a range of 1 to 16 seconds.

S,05/01/99,09:44,40WD,000WS,00.00R,022RH,29.10P1,+070.70T1,+255.00T2,04.80LW,5.

00X1,0.10X2,4923

S,05/01/99,09:44,40WD,000WS,00.00R,023RH,29.09P1,+070.70T1,+255.00T2,04.80LW,5.
00X1,0.10X2,4932
S,05/01/99,09:44,40WD,000WS,00.00R,023RH,29.09P1,+070.70T1,+255.00T2,04.80LW,5.
00X1,0.10X2,4932
S,05/01/99,09:44,40WD,000WS,00.00R,023RH,29.10P1,+070.70T1,+255.00T2,04.80LW,5.
00X1,0.10X2,4924
S,05/01/99,09:45,40WD,000WS,00.00R,023RH,29.10P1,+070.70T1,+255.00T2,04.80LW,5.
00X1,0.10X2,4925
S,05/01/99,09:45,40WD,000WS,00.00R,023RH,29.10P1,+070.70T1,+255.00T2,04.80LW,5.
00X1,0.10X2,4925
S,05/01/99,09:45,40WD,000WS,00.00R,023RH,29.10P1,+070.70T1,+255.00T2,04.80LW,5.
00X1,0.10X2,4925
S,05/01/99,09:45,40WD,000WS,00.00R,023RH,29.10P1,+070.70T1,+255.00T2,04.80LW,5.
00X1,0.10X2,4925
S,05/01/99,09:46,40WD,000WS,00.00R,023RH,29.10P1,+070.72T1,+255.00T2,04.80LW,5.
00X1,0.10X2,4928
S,05/01/99,09:46,40WD,000WS,00.00R,023RH,29.10P1,+070.72T1,+255.00T2,04.80LW,5.
00X1,0.10X2,4928okok

An <Esc> followed by a carriage return terminates this command. The output will stop after one more Sample record is issued. For example, if CONT is set to repeat the Sample record every 15 seconds (15 CONT) and an <ESC><RETURN> was entered, one more Sample record will be issued before the double ok is displayed indicating that the command is terminated.

SECTION 6: CALIBRATION

Calibrating the Barometric Pressure Sensor

The barometric pressure sensor is calibrated at the factory to a highly accurate digital pressure gauge (±0.02% of full range) and traceable to NIST and, therefore, requires no further calibration.

The barometric pressure sensor in the Capricorn 2000 is temperature compensated from 32° to 185° F and has an accuracy of ±0.03 in.Hg.

Altitude Setting

After calibration at the factory, the altitude is set to zero. To get an accurate barometric pressure reading, the local altitude needs to be set in the weather station.

To set the altitude, use the ALT command and enter the altitude in feet. Please refer to Section 4: Operation for more information. The altitude can also be set using weather software or display console. Please refer to the product user manual.

Note: The electronic transducer used to measure air pressure is sensitive to changes in elevation of as little as 10 ft. (3 m).

Optional Calibration Procedure

Even though the barometric pressure sensor is calibrated at the factory, the sensor can be calibrated on-site. This might be required if the original barometric pressure offset has been erased from memory, or if weather station needs to match a local source.

To calibrate the barometric pressure on-site:

Using a terminal program set the barometric pressure offset to zero by entering: 0 BAR-OFFSET

Wait approximately 5 seconds, then take a pressure reading using SAMPLE, POLL or P1

Record the barometric pressure from a local reliable source at the same elevation as the Capricorn.

Calculate the barometric pressure offset as follows:

Barometric Pressure Offset = Source Reading - Capricorn 2000 Reading.

Enter the barometric pressure offset in 1/100 of in.Hg using the BAR-OFFSET command.

Calibrating the Wind Sensors

The wind speed sensor contains no components that can be calibrated by the user. Refer to Section 7: Maintenance, and Section 8: Troubleshooting, if there appears to be a problem. The wind direction sensor is calibrated during installation. Refer to Section 3: Installation, page 16.

Calibrating the Temperature Sensors

All Temperature sensors are calibrated at the factory to a superior grade ASTM mercury thermometer traceable to NIST. The calibration offset is recorded on the temperature sensor and on the end of the cable.

After initializing all the temperature sensors, enter the temperature offsets using the TCAL command. Please refer to Section 4: Operation for more information.

To calibrate the temperature sensors on-site, perform the following steps:

Prepare an ice bath by mixing two cups of crushed ice in two cups of water. Use an insulated container for best results. Allow the temperature throughout the ice bath to stabilize by waiting for about twenty minutes.

Stir the ice bath to mix the ice and water, wait for the ice to separate from the water, place the temperature sensor in the ice bath. Make sure that the sensor is not in direct contact with ice.

Take a temperature reading from the Capricorn using SAMPLE or POLL.

Calculate the temperature offset as follows:

Temperature offset = (32 - Capricorn 2000 reading) * 100

Enter the temperature offset using the TCAL command. Please refer to Section 4: Operation for more information.

Record the temperature offset on a label attached to the sensor.

Repeat the process for any other temperature sensor.

Calibrating the Humidity Sensor

The humidity sensor is calibrated at the factory and is traceable to NIST. No field calibration is required.

Calibrating the Rain Gauge Sensor

The rain gauge does not require any calibration.

Calibrating the Leaf Wetness Sensor

The leaf wetness sensor is calibrated at the factory. No field calibration is required.

Calibrating the Solar Radiation Sensor

The solar radiation sensor is calibrated at the factory. No field calibration is required.

SECTION 7: MAINTENANCE

In normal use, the Capricorn 2000 should require very little maintenance. In the event of any problems, follow the procedures contained in Section 8: Troubleshooting, to determine whether the unit is defective. If it is defective and the unit needs to be returned to the factory for repair, refer to the Return For Repair Procedure in Section 9: User Support Information.

Console Maintenance

The Control Module contains sensitive electronics components and should not be serviced by the user. If the LED on the back (inside) of the unit is not on, check for proper installation of the wall mount power supply and then check to see if the fuse on the Control Module board needs to be replaced. If necessary, replace it with a 1.0 amp 250V fast acting fuse.

Barometric Pressure Sensor Maintenance

The barometric pressure sensor is located inside the cabinet and should not be serviced by the user.

Temperature Sensor Maintenance

Check the temperature sensor cables during installation and periodically thereafter to make sure they contain no cuts, kinks or other abnormalities, and that any splices are properly connected and insulated.

Wind Sensor Maintenance

Do not attempt to oil, grease or otherwise lubricate the wind sensors. The wind speed and direction bearings are permanently sealed and should not be tampered with. If it appears that the displayed wind speed values are substantially less than existing conditions, or that the wind direction display is sluggish in responding to changes in wind direction, it may be that the bearings need service. This can be tested by spinning the sensors. They should spin freely. If they do not, call the factory for service. All or part of the wind sensors may need to be replaced. Since the circuit is molded into the wind sensor housing, an electronic defect requires replacement of the sensor. The wind sensors are not designed for field repair.

Relative Humidity Sensor Maintenance

The Relative Humidity sensor does not require any field maintenance.

Rain Gauge Maintenance

Periodically clean the Rain Gauge of any debris that might be clogging the funnel or accumulating in the tipping bucket.

Leaf Wetness Sensor Maintenance

Periodically clean the Leaf Wetness sensor grid surface of any dirt or debris accumulation.

Solar Radiation Sensor Maintenance

Periodically clean the solar radiation sensor lens from any dirt or debris accumulation.

Section 8: Troubleshooting

Wind Sensor Tests

In the event the wind speed is reporting zero constantly regardless of wind conditions, is inexplicably erratic and/or the wind direction is reporting North constantly regardless of wind conditions, or is reporting incorrect direction, either the Control Module or the sensors (or both) may be defective. The following tests are appropriate to help locate the source of the problem.

Tools required:

(1) small Phillips screwdriver

(1) 6" (15 cm) jumper wire, 22 gauge

Wind Speed Test

1. Unplug the power supply cord from the Control Module.
2. Remove the seven wind sensor wires from their terminals at the back of the Control Module.
3. Connect one end of the jumper wire to the wind sensor terminal #4 marked “Red” on the back panel of the Control Module.
4. Reconnect the power supply cord to the Control Module.
5. With one end of the jumper wire connected to the “Red” terminal, rapidly tap the loose end of the wire to the “White” terminal #6 for several seconds. A wind speed reading of any number (other than “0”) should appear while terminal is being tapped. In that case, the Control Module is functioning properly. Check the entire length of the cable for any cuts, kinks or other abnormalities. If there are none, or if problems persist after adjusting the cable, contact the factory for service. Only the sensors need to be returned for repair. Unplug the wind sensors from the main cable. Do not send the cup/hub assembly or the wind vane as they may be damaged in shipping.
6. If the wind speed reading continuous to be zero while the terminal is being tapped, repeat the procedure to confirm the result. If the result is the same, the Control Module is defective (although it is possible that the wind sensor is also

defective). The wind sensors are not designed for field repair. Contact the factory for service. Both the Control Module and the sensors need to be returned. Unplug the wind sensors from the main cable. Do not send the cup/hub assembly or the wind vane as they may be damaged in shipping.

Wind Direction Test

1. Unplug the power supply cord from the Control Module.
2. Remove the seven wind sensor wires from their terminals at the back of the Control Module.
3. With one end of the jumper wire connected to the “Red” terminal #4, connect the other end to the “Blue” terminal #5; the NNW light should appear on the wind direction display. Proceed to touch the loose end of the jumper wire to the other terminals listed below and observe the wind direction reading to confirm that the appropriate direction light appears as it's respective terminal is touched.

Terminal	Direction
Blue	NNW
Green	SSE
Orange	ENE
Brown	NNE

4. If all of the direction readings are as indicated, the Control Module is functioning properly. Check the entire length of the cable for any cuts, kinks or other abnormalities. If there are none, or if problems persist after adjusting the cable, contact the factory for service. Only the sensors need to be returned for repair. Unplug the wind sensors from the main cable. Do not send the cup/hub assembly or the wind vane as they may be damaged in shipping.
5. If any or all of the direction readings are as indicated, repeat the procedure to confirm the result. If the result is the same, the Control Module is defective (although it is possible that the wind sensor assembly is also defective). The wind sensors are not designed for field repair. Contact the factory for service. Both the Control Module and the sensors need to be returned for repair. Unplug the wind sensors from the main cable. Do not send the cup/hub assembly or the wind vane as they may be damaged in shipping.

Temperature Sensor Troubleshooting

If the Temperature sensor is reading a few degrees off when compared to a standard, the Temperature sensor may require re-calibration. Please refer to calibration procedure in Section 6:Calibrating the Temperature Sensor.

If the Temperature sensor is reading 255°F, the Temperature sensor may be disconnected from the Control Module. Check the cable from the sensor to the Control Module for any cuts or kinks. Check any splices to ensure good connection. Check the cable connection to the Control Module.

If replacing a Temperature sensor, all the new Temperature sensors and any other Temperature sensors connected to the Control Module should be re-initialized as follows:

1. Disconnect all temperature sensors from the Control Module.
2. Issue a LOCATE-TEMPS command using a terminal program, or in Weather View 32, from the Configuration screen, send "Install Temperature Sensor" command.
3. The weather station should return "No temp sensors responding ok"
4. Reinstall the first Temperature sensor and issue the same command as in step 2, or recycle the Control Module power
5. Repeat step 4 for all the remaining Temperature sensors, one at a time.

SECTION 9: USER SUPPORT INFORMATION

This section consists of the following items:

1. Two-Year Limited Warranty: Please read this document carefully.
2. Return for Repair Procedure: This procedure is for your convenience in the event you must return your Capricorn 2000 for repair or replacement. Follow the packing instructions carefully to protect your instrument in transit.

Limited Warranty

Columbia Weather Systems, Inc. (CWS), warrants the Capricorn 2000 Weather Station to be free from defects in materials and/or workmanship when operated in accordance with the manufacturer's operating instructions, for two (2) years from date of purchase, subject to the provisions contained herein. CWS warranty shall extend to the original purchaser only and shall be limited to factory repair or replacement of defective parts.

EXCLUSIONS

Certain parts are not manufactured by CWS (i.e., certain purchased options, etc.) and are therefore not covered by this warranty. These parts may be covered by warranties issued by their respective manufacturers and although CWS will not warrant these parts, CWS will act as agent for the administration of any such independent warranties during the term of this warranty. This warranty does not cover normal maintenance, damage resulting from improper use or repair, or abuse by the operator. Damage caused by lightning or other electrical discharge is specifically excluded. This warranty extends only to repair or replacement, and shall in no event extend to consequential damages. In the event of operator repair or replacement, this warranty shall cover neither the advisability of the repair undertaken, nor the sufficiency of the repair itself.

THIS DOCUMENT REFLECTS THE ENTIRE AND EXCLUSIVE UNDERSTANDING OF THE PARTIES, AND EXCEPT AS

OTHERWISE PROVIDED HEREIN, ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, PARTICULARLY THE WARRANTIES OF MERCHANT ABILITY AND/OR FITNESS FOR A PARTICULAR PURPOSE ARE EXCLUDED.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Return for Repair Procedure

1. In the event of defects or damage to your unit, first call the factory Capricorn Service Department Monday through Friday, 8:30 am to 4:00 pm PST, (503) 629-0887 to determine the advisability of factory repair. The Service Depatment will issue an RMA number (Return Merchandise Authorization) to help us identify the package when received. Please place that number on the outside of the box.

2. In the event factory service is required, return your Capricorn 2000 as follows:

   A. Packing

   - Wrap Control Module in plastic bag first.
   - Pack in original shipping carton or a sturdy oversized carton.
   - Use plenty of packing material.

   B. Include:

   - A brief description of the problem with all known symptoms.
   - Your phone number.
   - Your return street shipping address (UPS will not deliver to a P.O. box).
   - Write the RMA number on the outside of the box.

   C. Shipping

   - Send freight prepaid (UPS recommended).
   - Insurance is recommended. (The factory can provide the current replacement value of the item being shipped for insurance purposes.)

D. Send to:

Columbia Weather Systems, Inc.
2240 NE Griffin Oaks Street, Suite 100
Hillsboro, Oregon 97124

E. C.O.D. shipments will not be accepted.

3. If your unit is under warranty, after repair or replacement has been completed, it will be returned by a carrier and method chosen by Columbia Weather, Inc. to any destination within the continental U.S.A. If you desire some other specific form of conveyance or if you are located beyond these borders, then you must bear the additional cost of return shipment.

4. If your unit is not under warranty, we will call you with an estimate of the charges. If approved, your repaired unit will be returned after all charges, including parts, labor and return shipping and handling, have been paid. If not approved, your unit will be returned as is via UPS COD for the amount of the UPS COD freight charges.

Reference

Glossary

Aspirating Radiation Shield

A device used to shield a sensor such as a temperature probe from direct and indirect radiation and rain while providing access for ventilation.

Barometric Pressure

The pressure exerted by the atmosphere as a consequence of gravitational attraction exerted upon the “column” of air lying directly above the point in question.

Celsius Temperature Scale

A temperature scale with the ice point at 0 degrees and the boiling point of water at 100 degrees.

Dew Point

The temperature to which a given parcel of air must be cooled at constant pressure and constant water-vapor content in order for saturation to occur. When this temperature is below 0°C, it is sometimes called the frost point.

Fahrenheit Temperature Scale

A temperature scale with the ice point at 32 degrees and the boiling point of water at 212 degrees.

Global Radiation

The total of direct solar radiation and diffused sky radiation received by a unit horizontal surface. Global radiation is measured by a pyranometer.

Heat Index

The heat index or apparent temperature is a measure of discomfort due to the combination of heat and high humidity. It was developed in 1979 and is based on studies of evaporative skin cooling for combinations of temperature and humidity.

Pyranometer

It measures the combined intensity of incoming direct solar radiation and diffused sky radiation. The pyranometer consists of a radiation-sensing element, which is mounted so that it views the entire sky.

Relative Humidity

Popularly called humidity. The ratio of the actual vapor pressure of the air to the saturation vapor pressure.

Sea Level Pressure

The atmospheric pressure at mean sea level, either directly measured or, most commonly, empirically determined from the observed station pressure.

In regions where the earths surface pressure is above sea level, it is standard observational practice to reduce the observed surface pressure to the value that would exist at a point at sea level directly below.

Soil Moisture

Moisture in the soil within the zone of aeration present in the soil pores. In some cases this refers strictly to moisture within the root zone of plants.

Solar Radiation

The total electromagnetic radiation emitted by the sun. 99% of the suns energy output falls within the wavelength interval from 0.15 microns to 4.0 microns, with peak intensity near 0.47 microns. About one-half of the total energy in the solar beam is contained within the visible spectrum from 0.4 to 0.7 microns, and most of the other half lies near infrared, a small additional portion lying in the ultraviolet.

Wind Chill

That part of the total cooling of a body caused by air motion.

Unit Conversion

Speed

Kilometers per hour = 1.610 x miles per hour

Knots = 0.869 x miles per hour

Meters per second = 0.448 x miles per hour

Feet per second = 1.467 x miles per hour

Temperature

Temperature in °C = 5/9 (temperature in °F - 32)

Temperature in °F = (1.8 x temperature in °C) + 32

Distance

Millimeters = 25.4 x inches

Pressure

Millibars = 33.86 x inches of mercury

Kilopascals = 3.386 x inches of mercury

Pounds per square inch = 0.49 x inches of mercury

Standard atmospheres = 0.0334 x inches of mercury

Solar Radiation

BTU/foot^2 minutes = 0.00529 x watts/meter^2

Joules/centimeter^2 minutes = 0.006 x watts/meter^2

Mega joules/meter^2 day = 11.574 x watts/meter^2

Langleys/minutes = 0.00143 x watts/meter^2

Tables and Formulas

Wind Chill Chart

Wind (MPH)	Temperature in °F														
	70	60	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60	-70
5	69	58	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68	-78
10	65	53	41	28	16	4	-9	-21	-33	-46	-58	-70	-82	-95	-107
15	63	49	36	22	9	-4	-18	-31	-45	-58	-72	-85	-98	-112	-125
20	61	47	33	18	4	-10	-24	-39	-53	-67	-81	-95	-110	-124	-138
25	60	45	30	15	1	-14	-29	-44	-59	-73	-88	-103	-118	-133	-147
30	59	44	28	13	-2	-17	-32	-48	-63	-78	-93	-109	-124	-139	-154
35	58	43	27	12	-4	-19	-35	-51	-66	-82	-97	-113	-128	-144	-159
40	58	42	26	10	-5	-21	-37	-53	-68	-84	-100	-116	-131	-147	-163
45	57	42	26	10	-6	-22	-38	-54	-70	-86	-101	-117	-133	-149	-165
50	57	41	25	9	-7	-23	-39	-55	-71	-86	-102	-118	-134	-150	-166
55	57	41	25	9	-7	-23	-39	-55	-71	-87	-103	-119	-135	-151	-167
60	57	41	25	9	-7	-23	-39	-55	-71	-87	-102	-118	-134	-150	-166
65	57	41	26	10	-6	-22	-38	-54	-70	-86	-102	-118	-134	-149	-165
70	58	42	26	10	-6	-21	-37	-53	-69	-85	-101	-116	-132	-148	-164

Wind Chill Equation

WC = 91.4 - ((0.474677 - (0.020425 * V) + (0.303107 * SQRT(V))) * (91.4-T))

Where:

WC = wind chill temperature

V = wind velocity in mph

T = air temperature in °F

Heat Index

	Temperature in °F													
RH	70	75	80	85	90	95	100	105	110	115	120	125	130	135
0	64	66	73	78	83	87	91	95	99	103	107	111	117	120
5	64	69	74	79	84	88	93	97	102	107	111	116	122	126
10	65	70	75	80	85	90	95	100	105	111	116	123	131	
15	65	71	76	81	86	91	97	102	108	115	123	131		
20	66	72	77	82	87	93	99	105	112	120	130	141		
25	66	72	77	83	88	94	101	109	117	127	139			
30	67	73	78	84	90	96	104	113	123	135	148			
35	67	73	79	85	91	98	107	118	130	143				
40	68	74	79	86	93	101	110	123	137	151				
45	68	74	80	87	95	104	115	129	143					
50	69	75	81	88	96	107	120	135	150					
55	69	75	81	89	98	110	126	142						
60	70	76	82	90	100	114	132	149						
65	70	76	83	91	102	119	138							
70	70	77	84	93	106	124	144							
75	70	77	85	95	109	130	150							
80	71	78	86	97	113	136								
85	71	78	87	99	117	140								
90	71	79	88	102	122	150								
95	71	79	89	105	126									
100	72	80	90	108	131									

Dew Point

B = (ln (RH/100) + ((17.2694*T) / (238.3+T))) / 17.2694

Dew Point in °C = (238.3 * B) / (1-B)

Where:

RH = Relative Humidity

T = Temperature in °C

Ln = Natural logarithm

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