INSTALLATION GUIDE

# *Solar1000*
# *Solar Monitoring Station*

Preliminary: 4,. /


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# About the Solar1000 Manual

This manual is a compilation of the instruction manuals for the CM106 tripod, UT10 tower, HMP60 probe, 034B windset, TE525 rain gage, LP02 pyranometer, and CMP-series pyranometers. This document contains only the sections of the original manuals that are pertinent to the Solar1000 system (complete manuals are available at www.campbellsci.com/manuals/ or from Campbell Scientific's ResourceDVD).

# 1. CM106 Tripod

## 1.1. General

The CM106 is a general purpose tripod that can be used for mounting sensors, solar panels, antennas, and instrument enclosures. The CM106 is constructed from galvanized steel, with individually adjustable legs that allow installation over uneven terrain. Height of the mast is 7 ft (2.1 m), or 10 ft (3 m) with the mast extension.

The CM106 includes lightning and grounding rods, grounding cables, UV resistant cable ties, and stakes for securing the tripod feet to the ground. An optional guy kit is recommended for sites that experience high wind speeds (see Section 1.2, Allowable Wind Speed Specifications). Instrument enclosures can be purchased with mounting brackets that attach to either the mast or leg section as shown in Section 1.5.7.

The CM106 can be used for a variety of applications. For meteorological stations, sensors are mounted to the tripod using mounting brackets appropriate for the model of sensor. For non-meteorological applications the tripod can be used to mount instrument enclosures, solar panels, junction boxes, or antennas.

*FIGURE 1-1. CM106 Tripod with Optional Guy Kit*

# 1.2. Specifications

**Measurement Height**
- **Upper Mast Retracted:** 7 ft (2.1 m)
- **Upper Mast Extended:** 10 ft (3 m)

**Vertical Load Limit:** 100 lb (45 kg)

**Mast Outer Diameter**
- **Main Lower Mast:** 1.90 in. (48 mm)
- **Retractable Upper:** 1.74 in. (44 mm)

**Base Diameter:** 9.3 ft (2.8 m)

**Leveling Adjustment:** Slide collars on each leg, adjust individually

**Leg Base:** 4 in. by 5 in. with four 0.62 in. holes for stakes

**Portability:** Collapsible to 8 in. diameter by 6 ft length

**Weight with Mast:** 40 lb (18 kg)

**Maximum Slope Angle:** 22° or 40% grade (assuming leg clamp pins are engaged in holes under the legs and that one leg points downhill while the other two legs point uphill)

**Allowable Wind Speeds***

| Tripod Configuration | Sustained Wind | Wind Gust |
|---|---|---|
| Mast Extended, Unguyed | 65 mph (29 m/s) | 84 mph (38 m/s) |
| Mast Retracted, Unguyed | 80 mph (36 m/s) | 104 mph (46 m/s) |
| Mast Extended, Guyed | 100 mph (45 m/s) | 130 mph (58 m/s) |
| Mast Retracted, Guyed | 115 mph (51 m/s) | 150 mph (67 m/s) |

**Allowable wind speed values assume:*
- *14 x 16 in. enclosure at mast base*
- *10.5 x 16.5 in. solar panel at mast base*
- *Crossarm and sensors (1.4 $ft^2$ projected area) at mast top*
- *Adequate ground anchors (stakes can pull out at lower wind speeds)*

# 1.3. Tools List (for tripod, mast, enclosures, and crossarms)

1/2” and 7/16” open end wrenches
adjustable wrench
Phillips head screw drivers (medium, small)
Straight bit screwdrivers (large, medium)
12” torpedo level
side-cut pliers
pencil
tape measure
compass and site declination angle
shovel
sledge hammer (for driving ground rod and stakes)
step ladder

## 1.4 Tripod Components

Figure 1.4-1 shows the tripod components. The tripod base is packaged with the mast, ground rod, lightning rod and (6) stakes. The ground rod clamp, lightning rod, cable ties, and grounding wires are enclosed in a bag. The optional guy kit is packaged separately.

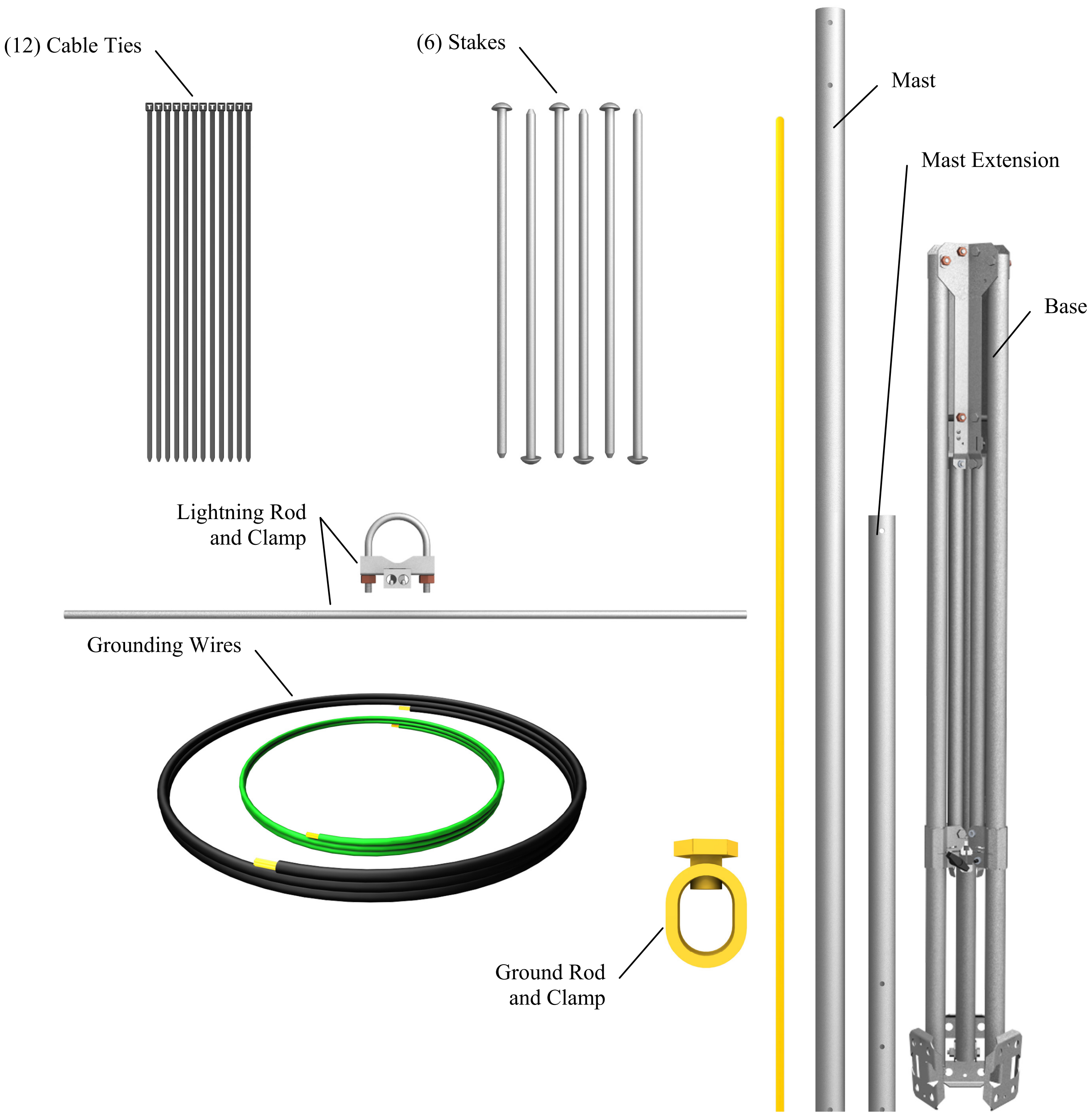



*FIGURE 1.4-1. Tripod Components*

# 1.5. Tripod Installation

## 1.5.1 Tripod Base

**WARNING** **Tripod installation near power lines is dangerous. The minimum safe recommended distance from overhead power lines is 2 times the height of the tripod and mast combined. Call Blue Stakes to locate buried utilities prior to installation.**

The tripod base has three legs, which are individually adjustable, that allow the tripod to be installed over non-level terrain.

Prepare the area where the tripod will be installed. The tripod requires an area approximately 9.3 ft (2.8 m) in diameter. Natural vegetation and the ground surface should be disturbed as little as possible, but brush and tall weeds should be removed.

Stand the tripod base up on end, and rotate the feet perpendicular to the legs. Each leg has a slide collar and T-knob with a spring loaded pin that locks into holes located on the underside of the leg as shown in Figure 1.5-1.

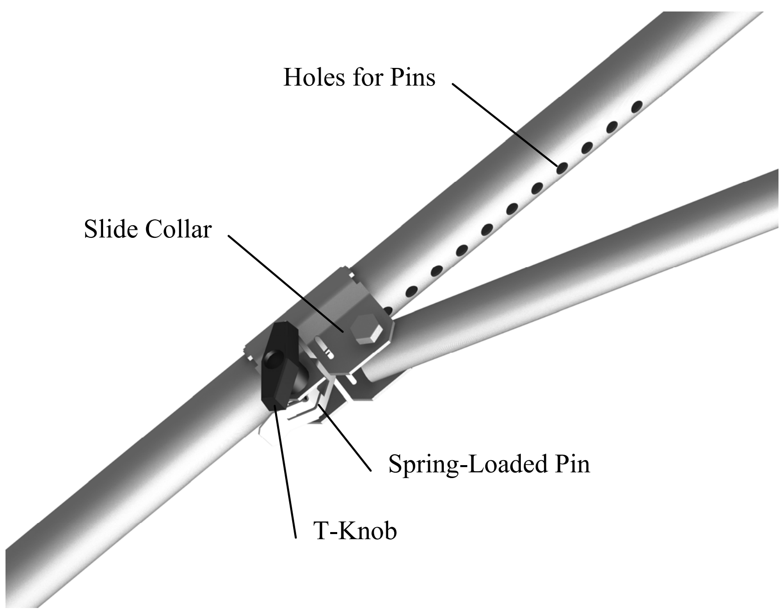



*FIGURE 1.5-1. Tripod Leg, Slide Collar Components*

### 1.5.1.1 Mounting on a Relatively Flat Area

Loosen the T-knob and extend each leg until the pin engages in a hole (depress the tab to disengage the pin from a hole). With the legs extended, orient the tripod so that one of the legs points South (assuming the instrument enclosure with -MM Mast Mount bracket will face North). If the instrument enclosure has the -LM Leg Mount bracket, orient the tripod so that the enclosure will mount to one of the three leg mount positions on the tripod, facing the desired direction. The tripod is typically plumbed after the mast has been installed, as described in Section 1.5.2.

### 1.5.1.2 Mounting on an Incline

Loosen the T-knob and extend each leg until the pin engages in a hole (depress the tab to disengage the pin from a hole). With the legs extended, orient the tripod so that one leg points downhill and the other two legs point uphill. The tripod is more stable with only one leg pointed downhill because the mast is closer to the center of the footprint (see Figure 1.5-2).

The tripod is typically plumbed after the mast has been installed, as described in Section 1.5.2.

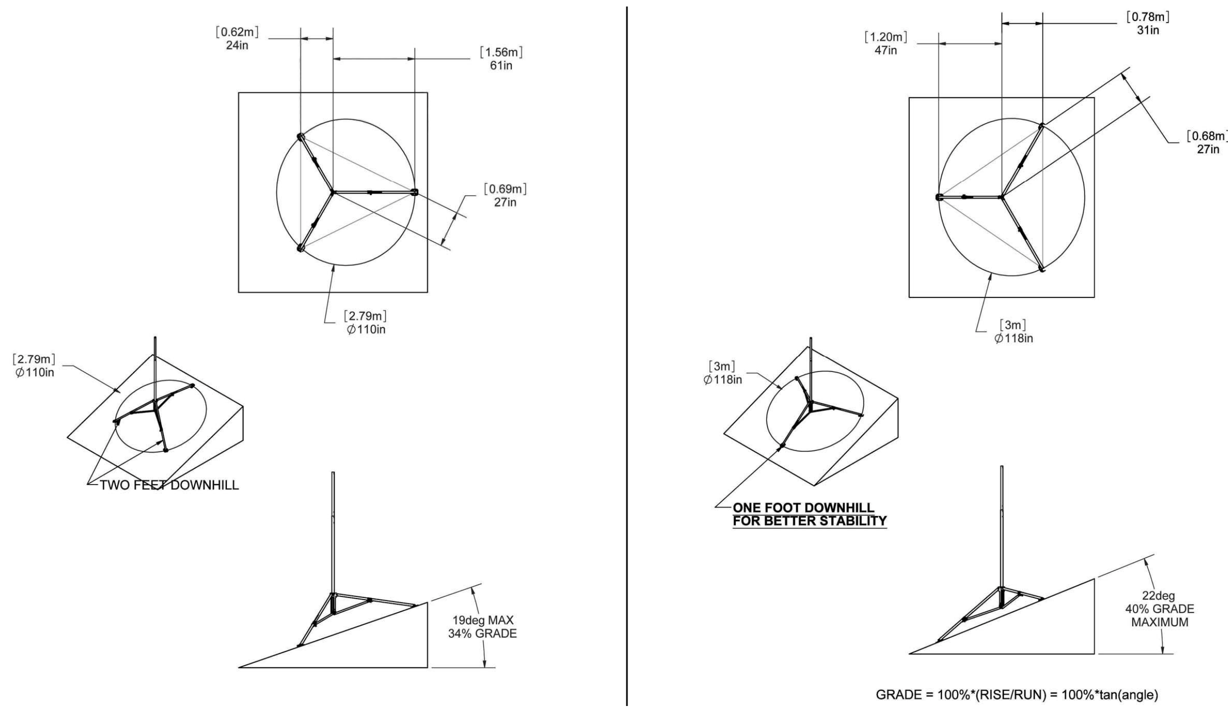



*FIGURE 1.5-2. Comparison of One Leg Pointing Downhill (right) Versus Two Legs Pointing Downhill*

### 1.5.2 Mast

The CM106 includes a mast extension that can be fully extended for a 10 ft (3m) height, or partially extended for a 7 ft (2.1 m) height. Remove the bolts in the extension, align the holes in the insert with holes in the mast, and install the four bolts previously removed.

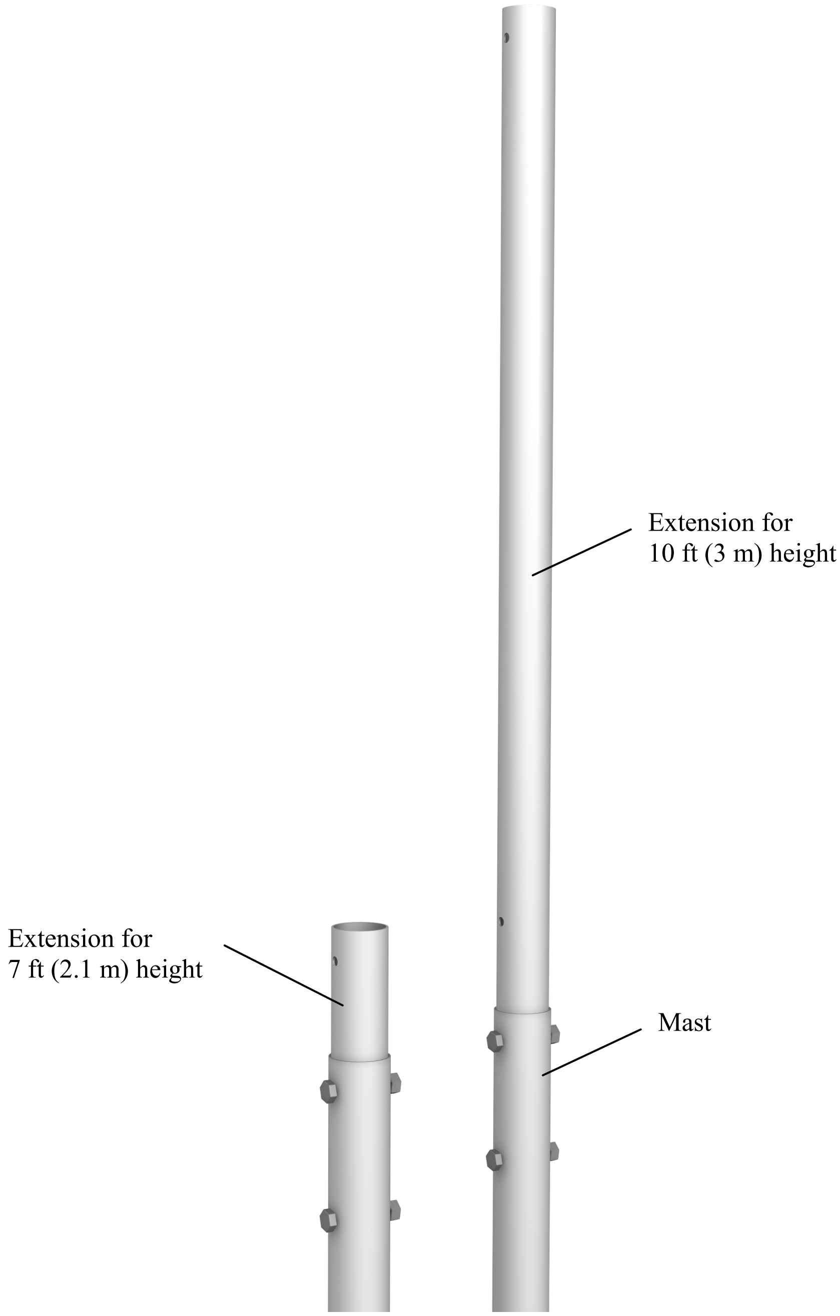



*FIGURE 1.5-3. Tripod Mast and Insert*

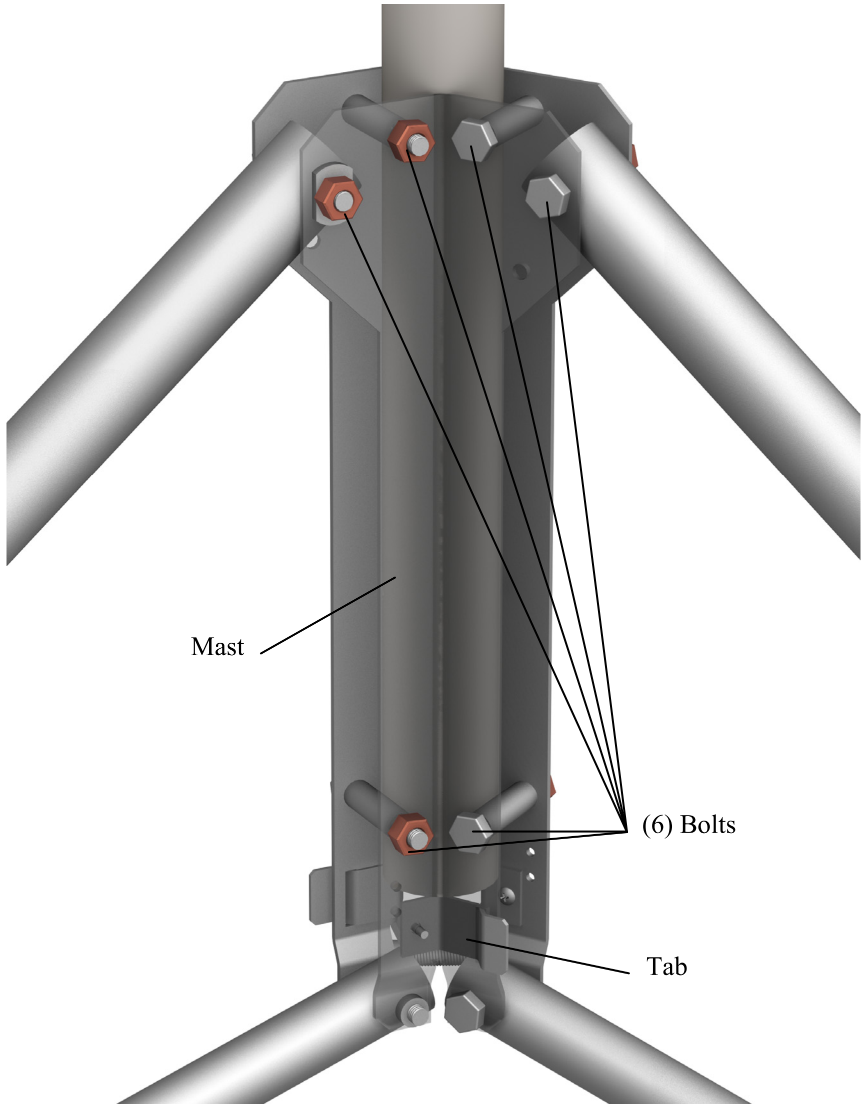



*FIGURE 1.5-4. Mast Attachment to Tripod Base*

Loosen the nine bolts shown in Figure 1.5-4. Slide the mast into the tripod base, making sure that it extends below the lower bolts and rests on the tab. Tighten the six bolts to secure the mast.

Plumb the tripod by adjusting the northeast and south facing legs. With a level on the East side of the mast, adjust the Northeast leg for plumb. With the level on the South side of the mast, adjust the South leg for plumb. Tighten the T-knobs after the adjustments have been made.

### 1.5.3 Installing the Optional Guy Kit

PN 27117 CM106 Guy Kit can be ordered separately for areas that experience high wind speeds (Section 1.2). Install the guy brackets to the mast as shown in Figure 1.5-5. Attach the three guy wires to the guy collar and slide the collar over the mast so that the collar butts against the brackets.

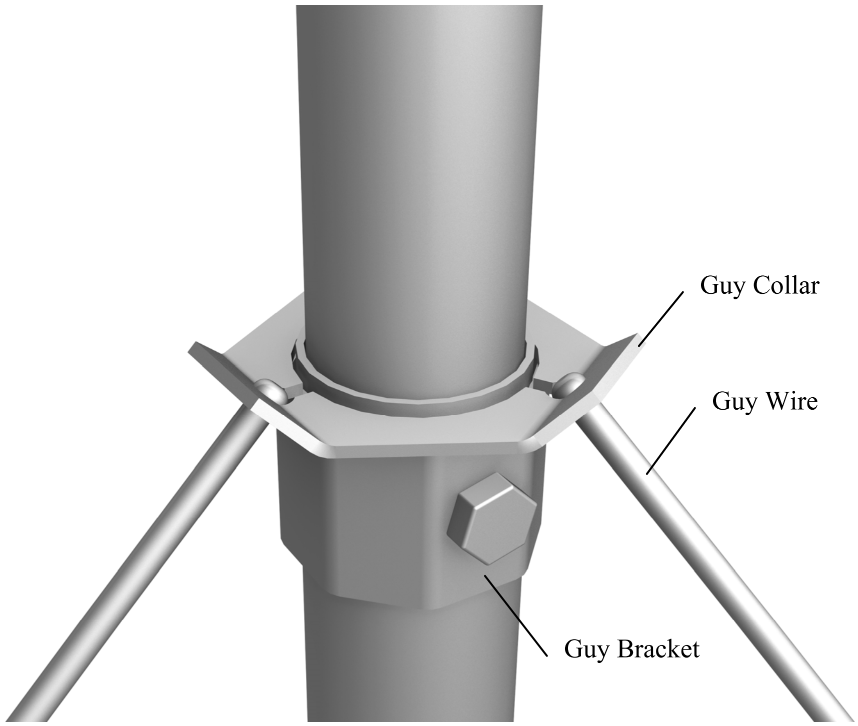



*FIGURE 1.5-5. Guy Collar*

On the end of each guy line is a case and hardware to attach to the turnbuckles. Unscrew the turnbuckles so that only 1/2 in of thread extends beyond the inside of the turnbuckle body. Attach the case and turnbuckle to the tripod leg as shown in Fig 1.5-6. Loosen the Phillips screw, and remove the slack in the guy line by feeding the load end of the guy wire through the wedge while pulling up on the dead end. If the load end of the guy wire can't be fed through the case, use a small flat screwdriver to push the wedge forward into the case to disengage wedge.

After the slack has been removed from the guy lines, tighten the Phillips screws and tighten the turnbuckles to tension the guy lines.

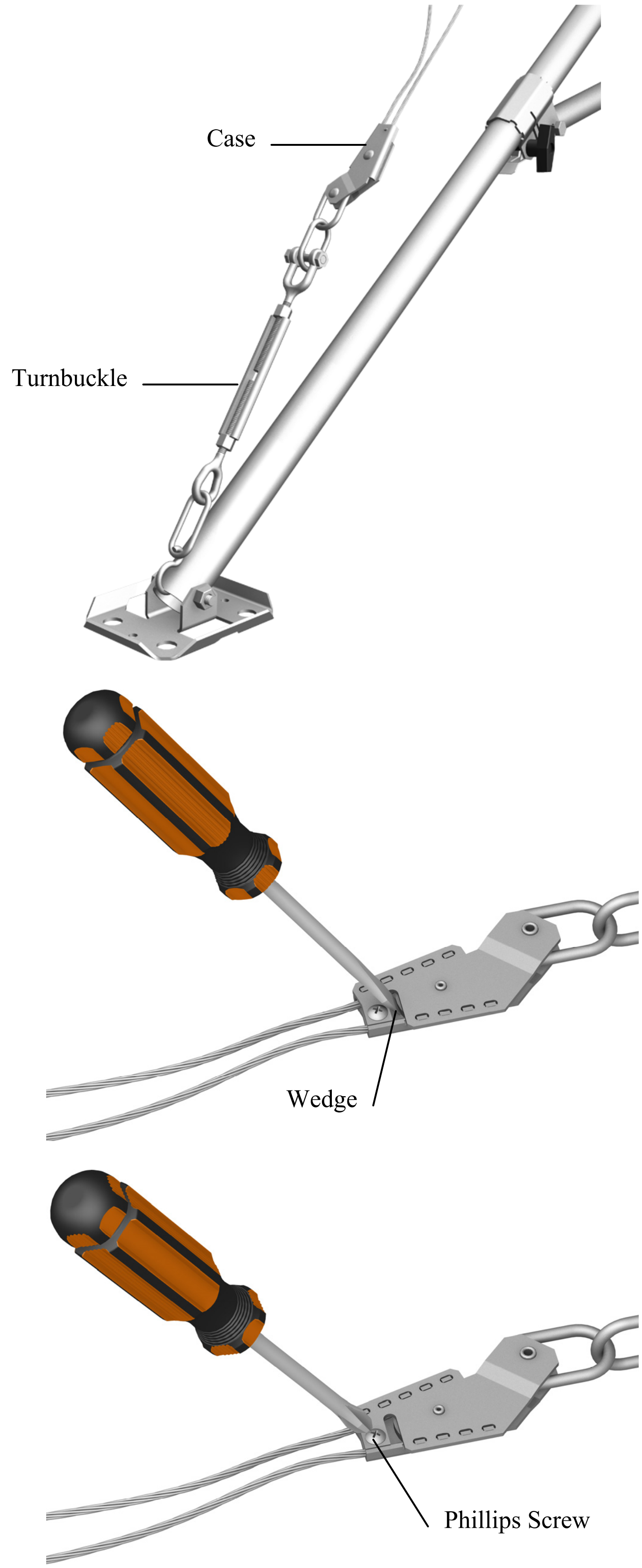



*FIGURE 1.5-6. Leg Attachment*

### 1.5.4 Staking the Tripod Feet

Six stakes are provided for securing the tripod feet to the ground. Drive two stakes through holes in each foot at an angle as shown in Figure 1.5-7.

Stakes may not be adequate depending on soil structure, maximum wind speeds experienced at the site, mast height, or wind load from the instrumentation. For questionable situations, additional stakes (PN 17049) or even concrete footings for the tripod feet and guy anchors should be considered.

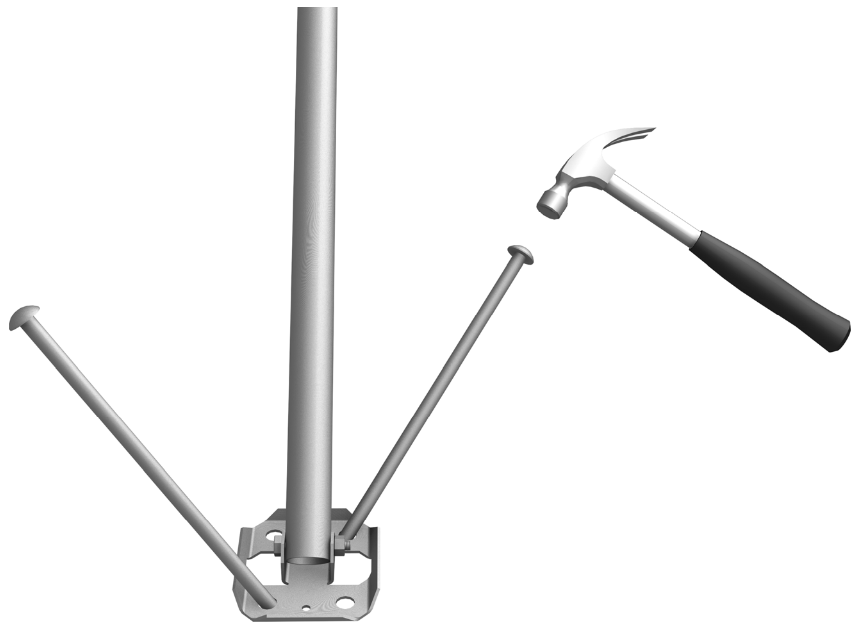


*FIGURE 1.5-7. Staking the Tripod Feet*

## 1.5.5 Tripod Grounding

Place the clamp over the ground rod and drive the rod (close to the center of the tripod) using a sledge hammer or fence post driver. Strip 1/2" inch of insulation from both ends of the black 4 AWG ground wire. Insert one end of the ground wire between the clamp and ground rod and tighten the bolt on the clamp. Attach the other end of the ground wire to the lug on the tripod base as shown in Figure 1.5-8.

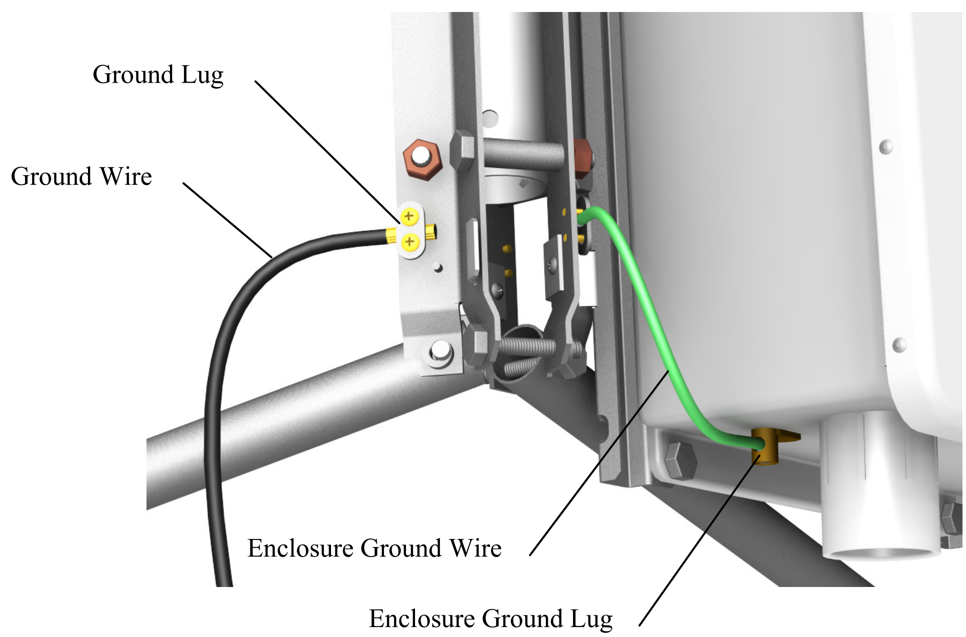




*FIGURE 1.5-8. Ground Rod and Clamp*

Strip 1/2" of insulation from the ends of the green 12 AWG wire. Attach one end of the wire to the tripod ground lug, and the other end to the enclosure ground lug as shown in Figure 1.5-9.

Mount the lightning rod and clamp to the tripod mast with pointed tip up, and notch at bottom, as shown in Figure 1.5-9.

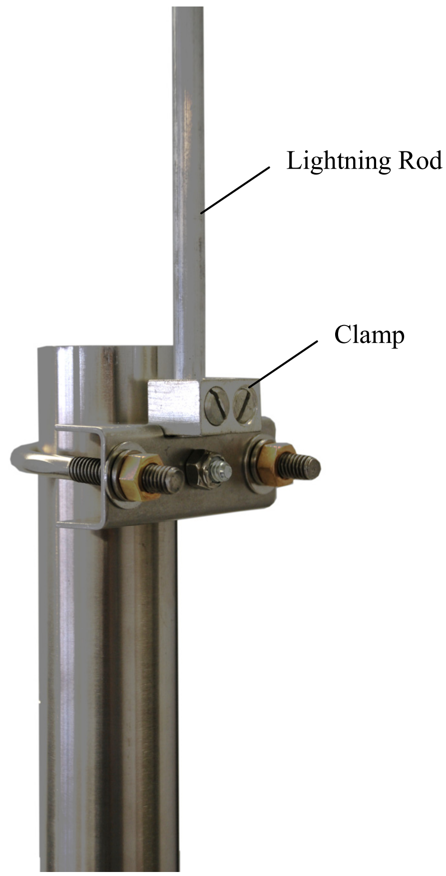



*FIGURE 1.5-9. Lightning Rod and Tripod Grounding Lug*

## 1.5.6 Crossarm Attachment

Attach the CM202 (2 ft, 0.6m), CM204 (4 ft, 1.2m), or CM206 (6 ft, 1.8m) crossarm to the tripod mast as shown in Figure 1.5-10. For wind sensors, the crossarm should be approximately 103 inches above the ground for a 3m mounting height, or 64 inches for a 2m mounting height. Typically the crossarm is oriented East/West for wind sensors, North/South for pyranometers.

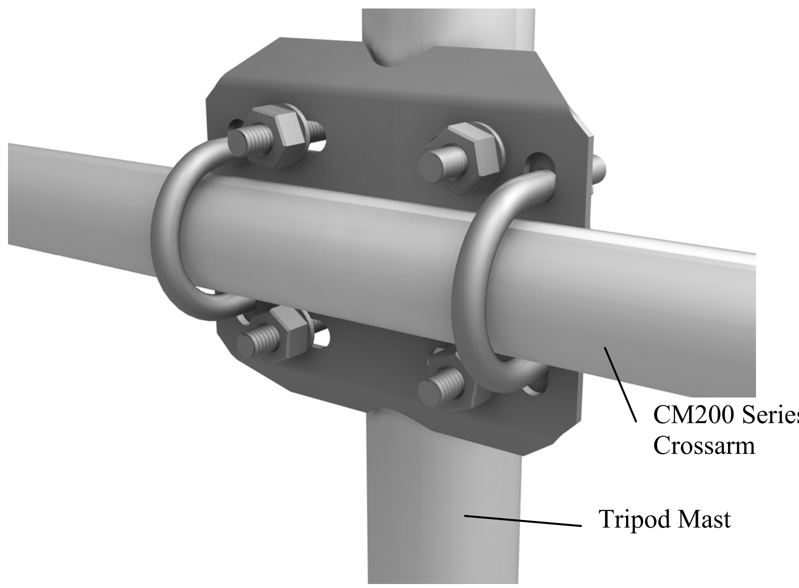



*FIGURE 1.5-10. CM204 Crossarm*

## 1.5.7 Enclosure Attachment

The ENC 10/12, ENC 12/14, ENC 14/16, and ENC 16/18 enclosures can be ordered with mounting brackets for the CM106 tripod. All enclosure models can be mounted to the tripod mast (above the legs) with the –MM Mast Mount bracket option. All enclosure models except the ENC 16/18 can be mounted to the tripod base and leg with the –LM Leg Mount bracket option. Two enclosures with the –LM brackets can be mounted in a "back to back" configuration.

### 1.5.7.1 Enclosure Mounting to Tripod Mast

An enclosure ordered with the –MM bracket has a three-piece top and bottom brackets with a U-bolt for each bracket.

Attach an enclosure with the –MM mounting bracket to the tripod mast as follows:

Remove the U-bolts washers and nuts from the brackets.

Position the enclosure against the tripod's mast (North side recommended).

Install the U-bolts, flat washers, lock washers, and nuts. Tighten the nuts until the lock washers are compressed.

Route the 14 AWG wire from the grounding lug on the bottom side of the enclosure to the grounding lug on the base of the tripod (Figure 1.5-8). Strip 1/2” of insulation from each end of the wire. Insert wire ends into the grounding lugs and tighten.

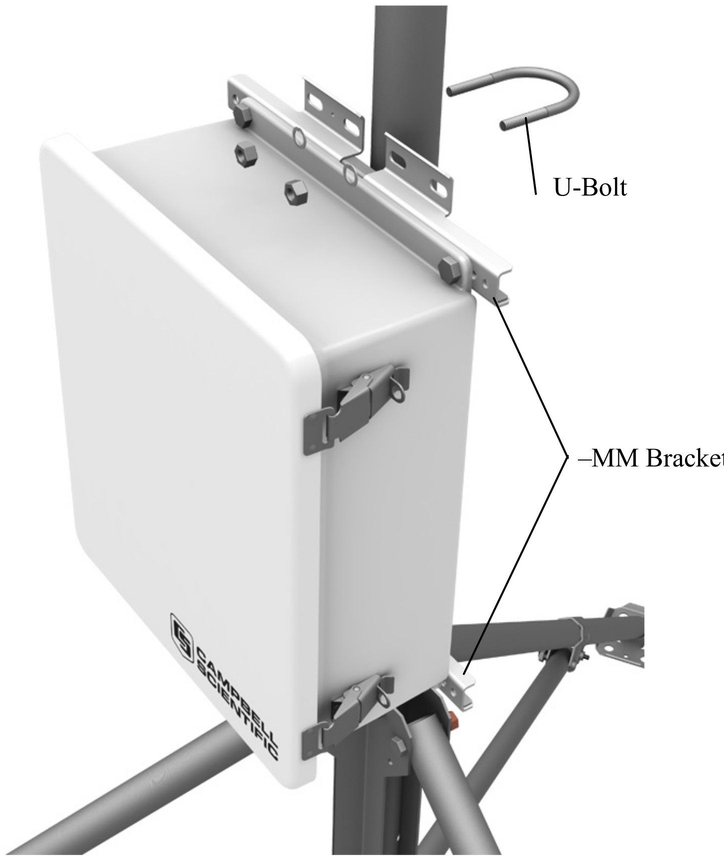



*FIGURE 1.5-11. Enclosure with the –MM Bracket*

## 1.5.7.2 Enclosure Mounting to Tripod Leg

An enclosure ordered with the –LM bracket has a bracket on each side of the enclosure, and a U-bolt bracket for securing the enclosure to a tripod leg.

Attach an enclosure with the –LM mounting bracket to the tripod base as follows:

Slide the keyhole notch in upper corner of the -LM bracket over the extended screw head located on the tripod base as shown in Figure 1.5-12, and engage the notch in the lower corner of the -LM bracket with the enclosure tab. There are two places on the tripod base with provisions for mounting enclosures with the -LM brackets.

Remove the washers, nuts and U-bolt from the U-bolt bracket. Install the bracket as shown in Figure 1.5-12 (top). Tighten the nuts on the U-bolt until the lock washers are compressed.

Route the 14 AWG wire from the grounding lug on the bottom side of the enclosure to the grounding lug on the base of the tripod (Figure 1.5-8). Strip 1/2" of insulation from each end of the wire. Insert wire ends into the grounding lugs and tighten.

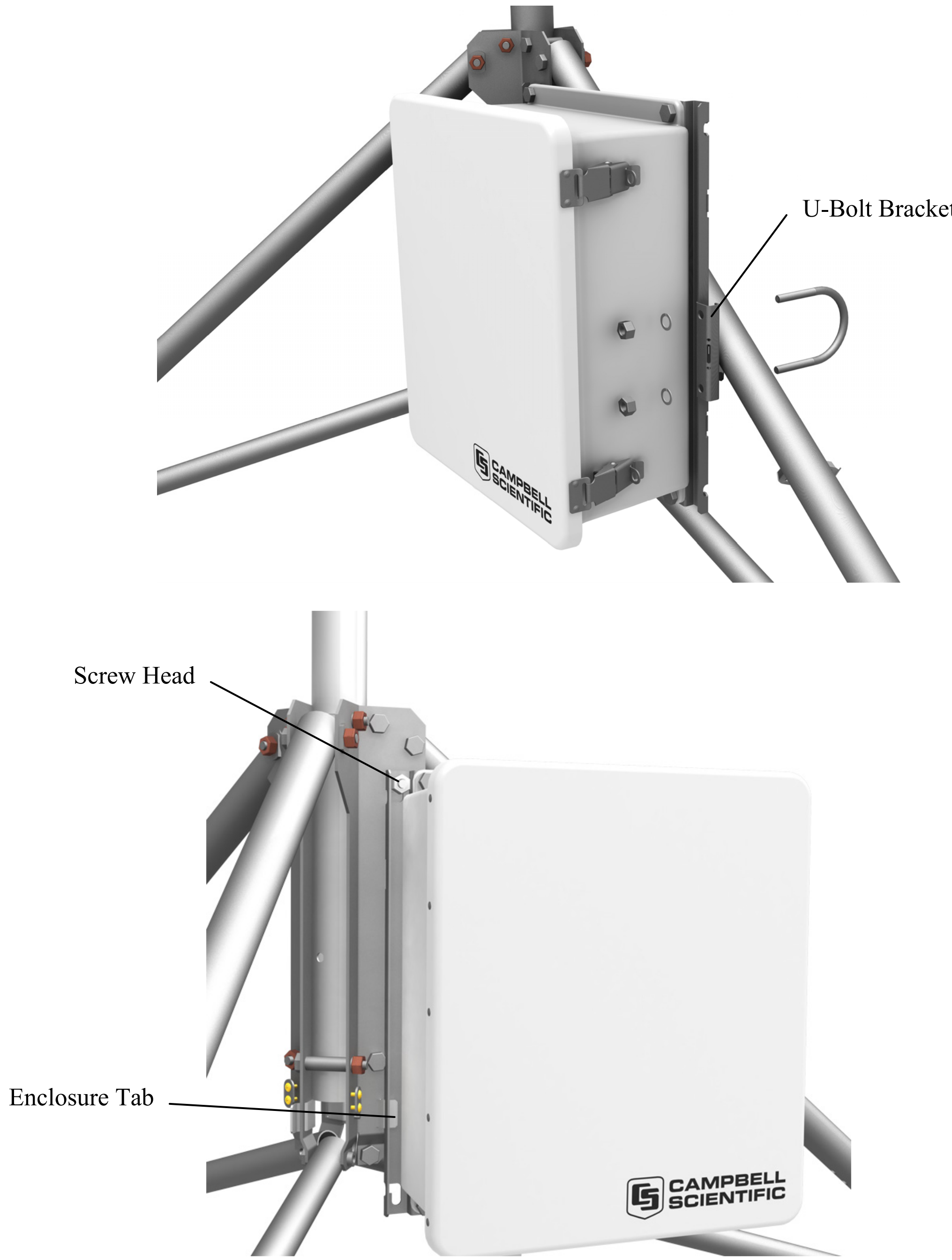



*FIGURE 1.5-12. Enclosure with the –LM Bracket*

# 1.6. Mounting Brackets

Mounting brackets covered in this section have U-bolts that attach to vertical and/or horizontal pipes with the following ranges of outside diameters:

| | inches | mm | Nominal Pipe Size (inches) |
|---|---|---|---|
| 1.5" U-bolt | 1.0 – 1.5 | 25.4 – 38.1 | ¾ – 1 |
| 2" U-bolt | 1.3 – 2.1 | 33.0 – 53.3 | 1 – 1 ½ |
| 2" U-bolt with plastic V-block | 1.0 – 2.1 | 25.4 – 53.3 | ¾ – 1 ½ |

Some of the brackets (e.g. the CM210) include 1.5" and 2" U-bolts to extend the range of pipe diameters that the bracket can accommodate. Brackets with holes for a 1.5" U-bolt will accept a user-supplied 1.75" U-bolt.

## 1.6.1 CM210 Crossarm Mounting Kit

CM200 series crossarms include a CM210 bracket as shown in Figure 1.6-1. The CM210 can be ordered separately to attach a user-supplied pipe (1.0 – 1.5" OD) to a mast or tower leg (1.0 – 2.1" OD), or to attach a crossarm to two tower legs.

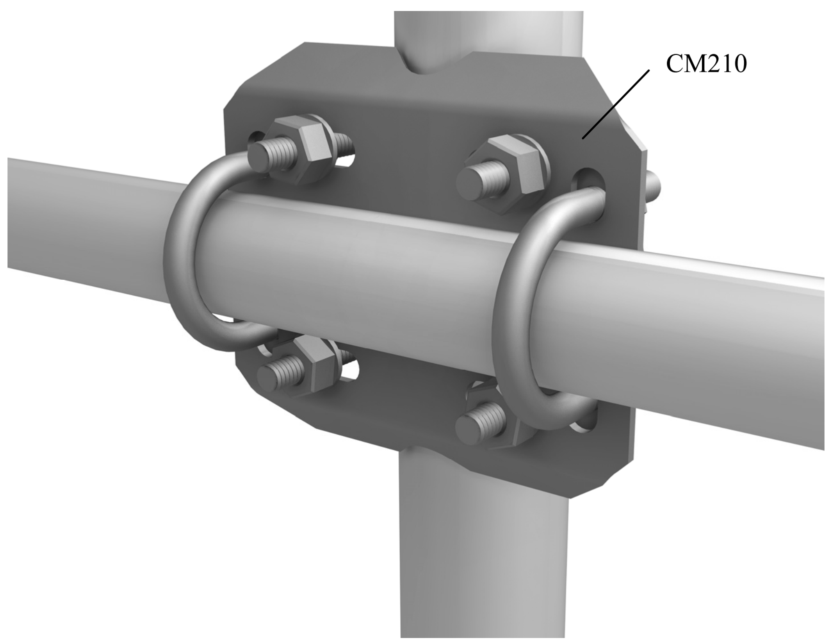



*FIGURE 1.6-1. CM210 Crossarm Mounting Kit (shown with user-supplied pipe)*

# Section 2. UT10

## 2.1 UT10 Specifications

| | |
|---|---|
| **Required Concrete Pad Dimensions (see note 1):** | 24 x 24 x 24 in. (61 x 61 x 61 cm) |
| **Crossarm Height (attached to mast)** | |
| **Standard:** | 10 ft (3 m) |
| **Maximum (mast fully extended):** | ~12 ft (3.7 m) |
| **Minimum:** | ~9 ft (2.7 m) |
| **Pipes Outer Diameter (OD)** | |
| **Vertical:** | 1 in. (2.5 cm) |
| **Cross Support:** | 0.375 in. (0.953 cm) |
| **Leg Spacing:** | 10.25 in. (26 cm) between legs (center to center) |
| **Material:** | Aluminum |
| **Shipping Weight:** | 40 lbs (18 kg) |
| **Wind Load Recommendation (see note 2):** | 110 mph maximum |

*Notes:*

1. *The concrete pad requirements assume heavy soil; light, shifting, or sandy soils require a larger concrete pad.*

2. *The wind load recommendation assumes proper installation, proper anchoring, adequate soil, and total instrument projected area of less than 2 square feet. T e amount of wind load that this mount can withstand is affected by quality of anchoring and installation, soil type, and the number, type, and location of instruments fastened to the UT10.*

# 2.2 UT10 Tower Installation

The UT10 10-ft tower provides a support structure for mounting the weather station components. Figure 2.2-1 shows a typical UT10 equipped with instrumentation enclosure, meteorological sensors, and solar panel.

## 2.2.1 Base Installation

The UT10 tower attaches to a user supplied concrete foundation as shown in Figure 2.2-2. The tilt base, anchor bolts, and nuts are included with the tower.

1. Dig a hole 24" square and 24" deep. Lighter soils will require a deeper hole.

2. Construct a concrete form out of 2" x 4" lumber 24" square (inside dimensions). Center the form over the hole and drive a stake centered along the outside edge of each side. Level the form by driving nails through the stakes and into the form while holding the form level.

3. Assemble the anchor bolts and tilt base as shown in Figure 2.2-3. There should be two nuts below the base and one nut above.

4. Fill the hole and form with concrete. Screed the concrete level with the top of the form. Allow the concrete to setup enough to support the weight of the base*, then position the base (with the anchor bolts attached) over the center of the concrete foundation and press the anchor bolts into the concrete as shown in Figure 2.2-3. The bottom of the threads should be approximately 1/2" above the concrete. Level the base in both directions using a small level.

   *Rather than relying on the concrete to support the base, two boards 1" to 1.5" thick that span the forms can be positioned under the base while the concrete hardens.

5. Remove the form after the concrete has sufficiently hardened. Level the base by adjusting the two lower nuts. Minor adjustments will be required after the tower is attached.

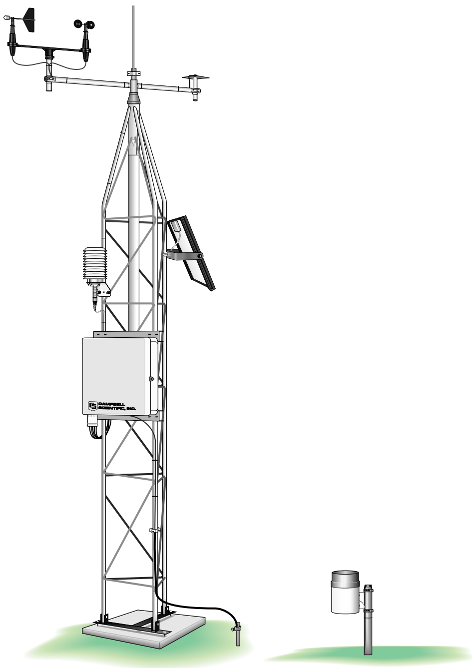


FIGURE 2.2-1.  UT10 Weather Station

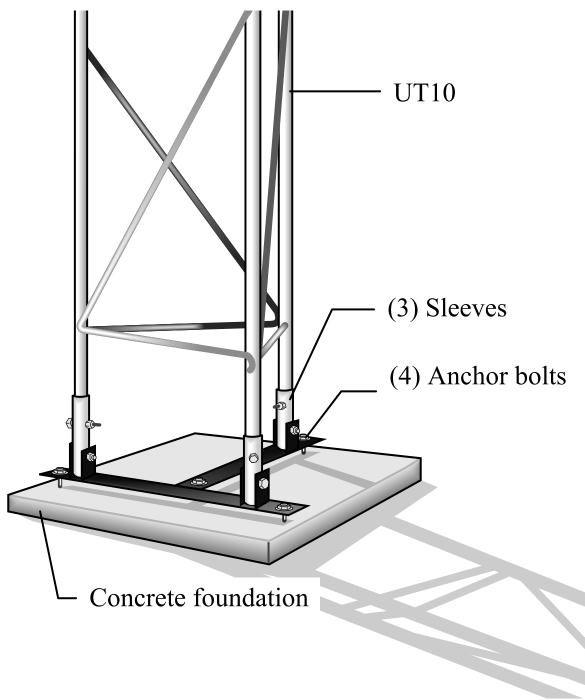



FIGURE 2.2-2.  UT10 Tower and Concrete Foundation

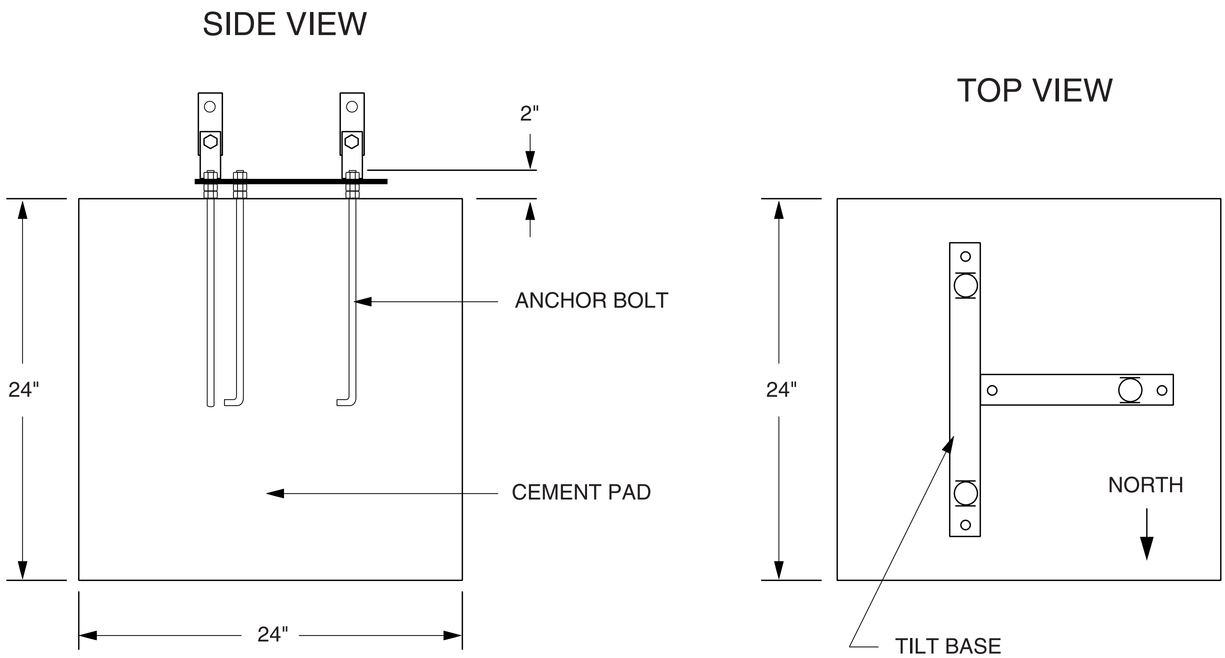



*FIGURE 2.2-3.  Concrete Foundation and Anchor Bolts*

## 2.2.2  Tower Installation

1. Install the mast as shown in Figure 2.2-4.  Attach the 3/4" x 10" nipple to the mast using the bell reducer.  Loosen the two bolts at the top of the tower and insert the mast.  For a 3 m mounting height, the bell reducer should rest against the top of the tower.  Tighten the two bolts to secure the mast.

2. Remove the three upper bolts on the aluminum sleeves attached to the base.  Loosen the nuts on the three lower bolts and position the sleeves vertically (Figure 2.2-2).

3. Stand the tower upright and insert the three legs into the sleeves.  Align the holes and replace the bolts previously removed.

4. Check the tower for plumb using a level and adjust the leveling nuts as required.  When the tower is plumb, use two wrenches to lock the two lower nuts together.  Tighten the upper nuts to secure the base.

5. The lower bolt in the rear leg can be removed to allow the tower to be hinged to the ground.  If a step ladder is available, it is easier to leave the tower upright.

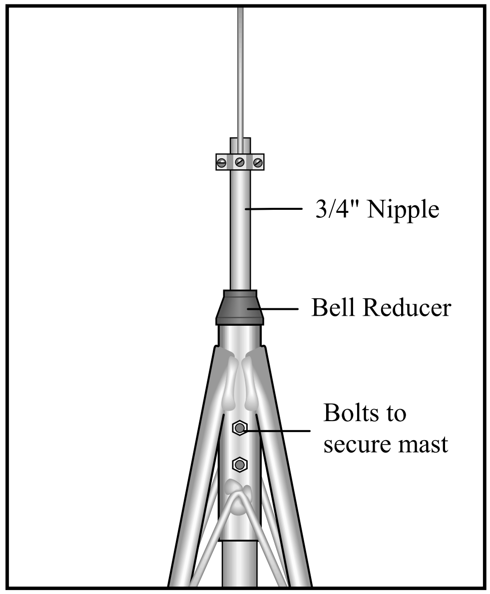



*FIGURE 2.2-4.  UT10 Mast*

## 2.2.3  UT10 Tower Grounding

1. Drive the ground rod close to the tower using a fence post driver or sledge hammer.  Drive the rod at an angle if an impenetrable hardpan layer exists.  In hard clay soils, a gallon milk jug of water can be used to "prime" the soil and hole to make driving the rod easier.

2. Loosen the bolt that attaches the clamp to the ground rod.  Insert one end of the 4 AWG wire between the rod and the clamp and tighten the bolt (Figure 2.2-5).

3. Attach the tower grounding clamp to a tower leg (Figure 2.2-5).  Route the 4 AWG wire attached to the ground rod up the tower leg to the grounding clamp.  Loosen the set screw and insert the 4 AWG wire and the 24 AWG enclosure ground wire into the hole behind the screw and tighten the screw.  Route the green wire to where the enclosure will be installed.

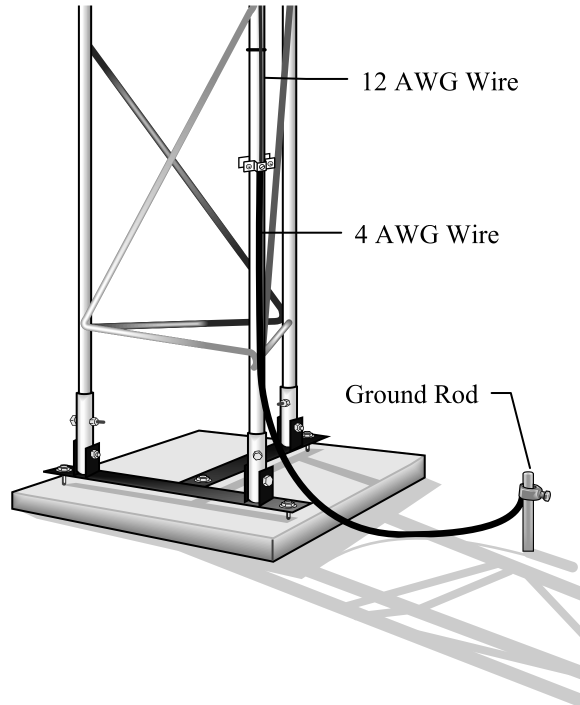



*FIGURE 2.1-5.  Tower Grounding*

## 2.3  Crossarm Mounting

General orientation of the mounting brackets is shown in Figure 2.2-1. Attach the crossarm at the desired height via the provided u-bolts and nuts (Figure 2.2-2).

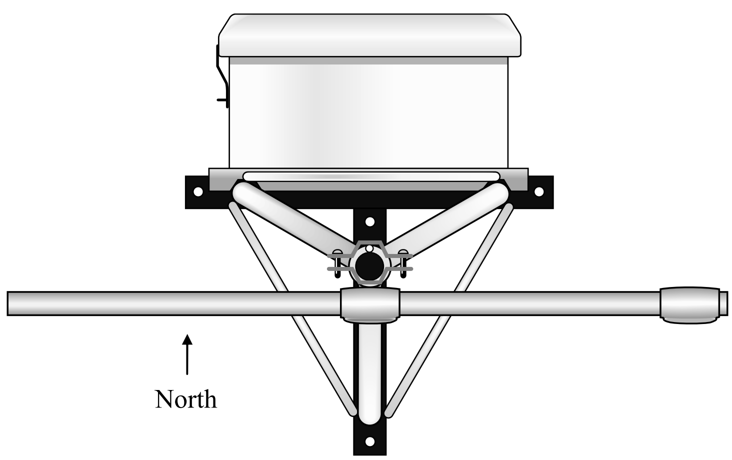



*FIGURE 2.2-1.  Top View of Tower*

*FIGURE 2.2-2.  CM210 crossarm-to-pole bracket (top) is included with the crossarm for attaching the crossarm to the tower's mast or leg.*

# 2.4 Enclosure Installation

All instrumentation (datalogger, power supply, and communication peripherals) are mounted in the enclosure.  A PVC bulkhead port is installed in the enclosure for routing the sensor and communication cables to the instrumentation.

The "-TM" option is used to attach our enclosures to a UT10 tower.  An enclosure ordered with the "-TM" option will be shipped with a three-piece bracket mounted to the top of the enclosure and an identical three-piece bracket mounted to the bottom of the enclosure.  This mounting bracket option uses the same three-piece brackets as the "-MM" option, except the pieces are rearranged so that the flanges are on the side of the bracket instead of in the middle.  The distance between the centers of each flange needs to be 10.25" (see Figures 2.4-1, 2.4-2, and 2.4-3).

Attach the enclosure to the UT10's tower legs as follows:

1. Position the enclosure on the north side of the tower.

2. Place the enclosure at the desired height.  Please note that the recommended lead lengths for our sensors assume the bottom of the enclosure is mounted 3 ft from the ground.

3. Use the furnished 1.5" u-bolts to secure the enclosure to the tower legs.

4. Route the 14 AWG wire from the brass tower grounding clamp to the enclosure grounding lug.  Strip one inch of insulation from each end of the wire and insert the end of the wire into the grounding lugs and tighten

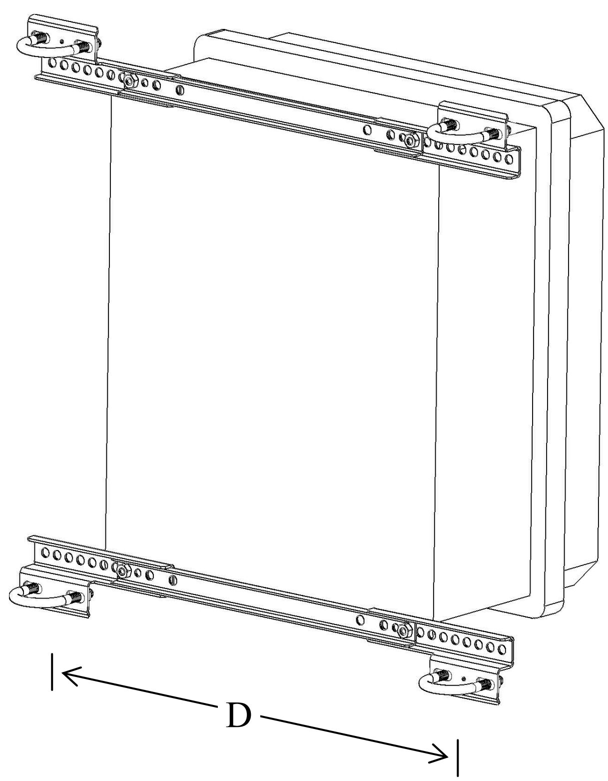



*FIGURE 2.4-1.  Enclosure brackets configured for a tower mount.*

The default configuration is for attaching to a UT10 tower (i.e., D = 10.25”). To attach to a UT20 or UT30 tower, move the flange sections of the bracket so that D = 17”.

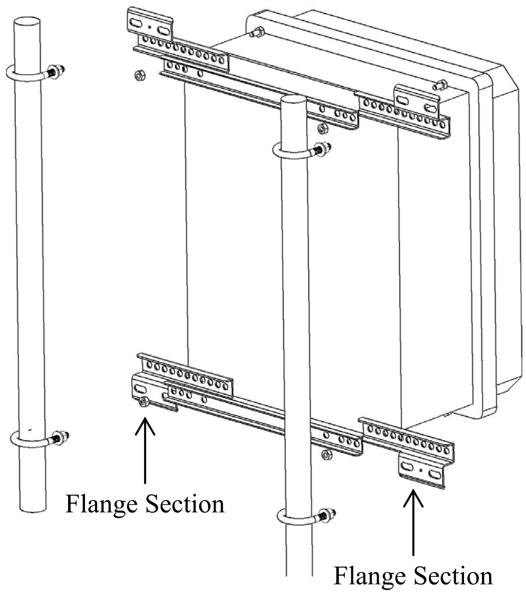



*FIGURE 2.4-2.  This exploded view shows the components of a “-TM” bracket option.*

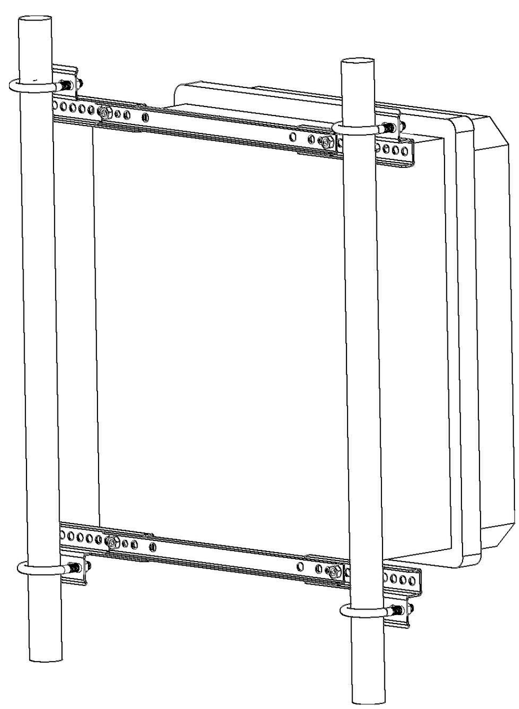


*FIGURE 2.4-3.  An enclosure attached to two tower legs.*

# 3. HMP60 Temperature and Relative Humidity Probe

## 3.1. General

The HMP60 Temperature and Relative Humidity probe contains a Platinum Resistance Temperature detector (PRT) and a Vaisala INTERCAP® capacitive relative humidity sensor.

The -L option on the model HMP60 Temperature and Relative Humidity probe (HMP60-L) indicates that the cable length is user specified. Cable length is specified when the sensor is ordered. Table 3.1 gives the recommended cable length. This manual refers to the sensor as the HMP60.

*Table 3-1 Recommended Cable Length*

| **2 m Height** | | **Atop a tripod or tower via a 2 ft crossarm such as the CM202** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Mast/Leg** | **CM202** | **CM6** | **CM10** | **CM110** | **CM115** | **CM120** | **UT10** | **UT20** | **UT30** |
| 9' | 11' | 11' | 14' | 14' | 19' | 24' | 14' | 24' | 37' |

***Note:*** *Add two feet to the cable length if you are mounting the enclosure on the leg base of a light-weight tripod.*

## 3.2. Specifications

Operating Temperature: -40°C to +60°C

Probe Length: 7.1 cm (2.8 in.)

Probe Body Diameter: 1.2 cm (0.47 in.)

Filter: 0.2 µm Teflon membrane

Filter Diameter: 1.2 cm (0.47 in.)

Housing Material: chrome-coated aluminum and chrome-coated ABS plastic

Power Consumption: 1 mA typical; 5 mA maximum

Supply Voltage: 5 to 28 Vdc

Settling Time after power is switched on: 1 second

Output Signal Range: 0 to 1 Vdc

### 3.2.1 Temperature Sensor

Sensor: 1000 Ω PRT, DIN 43760B

Temperature Measurement Range: -40° to +60°C

Temperature Accuracy: ±0.6°C (-40° to +60°C)

### 3.2.2. Relative Humidity Sensor

Sensor: INTERCAP®

Relative Humidity Measurement Range: 0 to 100% non-condensing

Accuracy at 0° to +40°C:
- ±3% RH (0 to 90% Relative Humidity)
- ±5% RH (90 to 100% Relative Humidity)

Accuracy at -40° to 0°C and +40° to +60°C:
- ±5% RH (0 to 90% Relative Humidity)
- ±7% RH (90 to 100% Relative Humidity)

## 3.3. Installation

### 2.3.1 Siting

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.

Standard measurement heights:

1.5 m +/- 1.0 m (AASC)
1.25 – 2.0 m (WMO)
2.0 m (EPA)

See original HMP60 manual for a list of references that discuss temperature and relative humidity sensors.

### 3.3.2 Mounting and Assembly

Pull off the yellow shipping cap (see Figure 3.1).

The HMP60 must be housed inside a solar radiation shield when used in the field. The 41303-5A 6-Plate Radiation Shield (Figures 3.2 and 3.3) mounts to a tripod mast, UT10 tower leg, or CM202, CM204, or CM206 crossarm. The HMP60 is held within the 41303-5A by a mounting clamp (Figure 3.3).

The UT6P 6-plate Radiation Shield mounts to a UT10, UT20, or UT30 tower with the UT018 horizontal mounting arm.

**NOTE** The black outer jacket of the cable is Santoprene® rubber. This compound was chosen for its resistance to temperature extremes, moisture, and UV degradation. However, this jacket will support combustion in air. It is rated as slow burning when tested according to U.L. 94 H.B. and will pass FMVSS302. Local fire codes may preclude its use inside buildings.

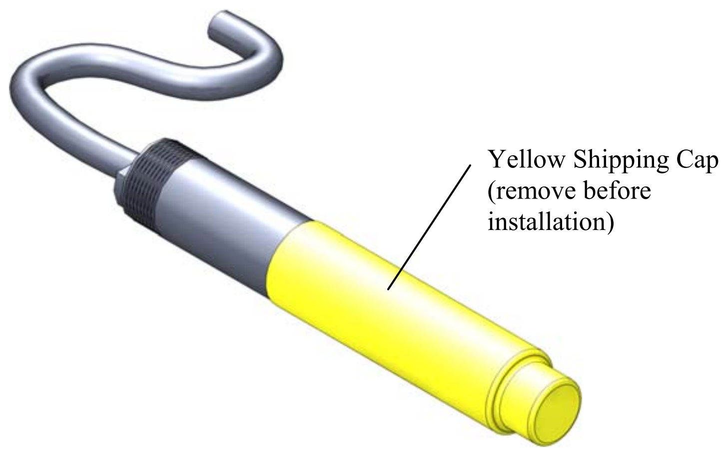



*FIGURE 3.1. HMP60 as Shipped*

*FIGURE 3.2. HMP60 and 41303-5A Radiation Shield on a Tripod Mast*

# 4. Met One 034B Windset

## 4.1. General

The 034B Windset is used to measure horizontal wind speed and direction.

Wind speed is measured with a three cup anemometer. Rotation of the cup wheel opens and closes a reed switch at a rate proportional to wind speed.

Vane position is transmitted by a 10K ohm potentiometer. With a precision excitation voltage applied, the output voltage is proportional to wind direction.

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

Cable length for the 034B is specified when the sensor is ordered. Table 4.1-1 gives the recommended cable length for mounting the sensor at the top of the tripod/tower with a CM202 crossarm.

*Table 4.1-1 Recommended Cable Length*

| CM6 | CM10 | CM110 | CM115 | CM120 | UT10 | UT20 | UT30 |
|---|---|---|---|---|---|---|---|
| 11’ | 14’ | 14’ | 19’ | 24’ | 14’ | 24’ | 37’ |

The 034B Windset ships with:

(1) 1/16” Allen wrench
(1) Bushing from Met One
(1) Calibration Sheet
(3) Direction hub stickers
(1) Resource CD
(1) Wind Vane
(1) Sensor cable of user-specified length

## 4.2. Specifications

**Wind Speed**

Operating Range: 0 to 75 m $s^{-1}$ (0 to 167 mph)

Threshold: 0.4 m $s^{-1}$ (0.9 mph)

Accuracy:

±0.12 m $s^{-1}$ (±0.25 mph) for wind speed < 10.1 m $s^{-1}$ (22.7 mph)
±1.1% of reading for wind speeds > 10.1 m $s^{-1}$ (22.7 mph)

Output Signal: contact closure (reed switch)

Resolution: (1.789 mph) / (scan rate in seconds)
or (0.7998 m $s^{-1}$) / (scan rate in seconds)

**Wind Direction**

Measurement Range: 0 to 360°

Threshold: 0.4 m $s^{-1}$ (0.9 mph)

Accuracy: ±4°

Resolution: 0.5°

Potentiometer Resistance: 0 to 10 kΩ open at crossover

**General Specifications**

Operating Temperature Range: -30° to +70°C

Weight: 907 g (2.0 lb.)

**NOTE** The black outer jacket of the cable is Santoprene® rubber. This compound was chosen for its resistance to temperature extremes, moisture, and UV degradation. However, this jacket will support combustion in air. It is rated as slow burning when tested according to U.L. 94 H.B. and will pass FMVSS302. Local fire codes may preclude its use inside buildings.

# 4.3. Installation

## 4.3.1 Siting

Locate wind sensors away from obstructions (e.g. trees and building). As a general rule of thumb there should be a horizontal distance of at least ten times the height of the obstruction between the windset and the obstruction. If it is necessary to mount the sensors on the roof of a building, the height of the sensors, above the roof, should be at least 1.5 times the height of the building. See Section 8 of original 034B manual for a list of references that discuss siting wind speed and direction sensors.

## 4.3.2 Assembly and Mounting

Tools Required:

- 1/2” open end wrench (for CM220)
- 5/64” and 1/16” Allen wrenches
- compass and declination angle for the site
- small screw driver provided with datalogger
- UV resistant cable ties
- small pair of diagonal-cutting pliers
- 6 - 10” torpedo level

The wind vane tail must be attached to the hub. Install the tail assembly with the tail vertical. After tightening the set screw in the side of the hub that fastens the tail, cover the set screw hole with one of the small round labels included with the 034B. One of these labels is already installed on the hub covering the set screw that attaches the hub to the sensor. Extra labels are included with the 034B to recover the holes if the sensor has to be disassembled for maintenance.

**CAUTION** The set screw holes must be covered with the labels to prevent corrosion and assure the warranty.

Mount the CM200-series crossarm to the tripod or tower. Orient the crossarm North-South, with the 1” NU-RAIL or CM220 on the North end.

Remove the alignment screw at the base of the 034B (Figure 4-1). Insert the 034B into the aluminum bushing provided with the sensor. Align the hole in the bushing with that in the 034B base and replace the screw. Insert the 034B/bushing into the NU-RAIL fitting or the CM220’s u-bolt (Figure 4-2). Align the sensor so that the counter weight points to true south and tighten the set screws on the NU-RAIL or U-bolts on the CM220. Remove the shoulder screw to allow the vane to rotate.

Appendix A of the original 034B manual contains detailed information on determining true north using a compass and the magnetic declination for the site.

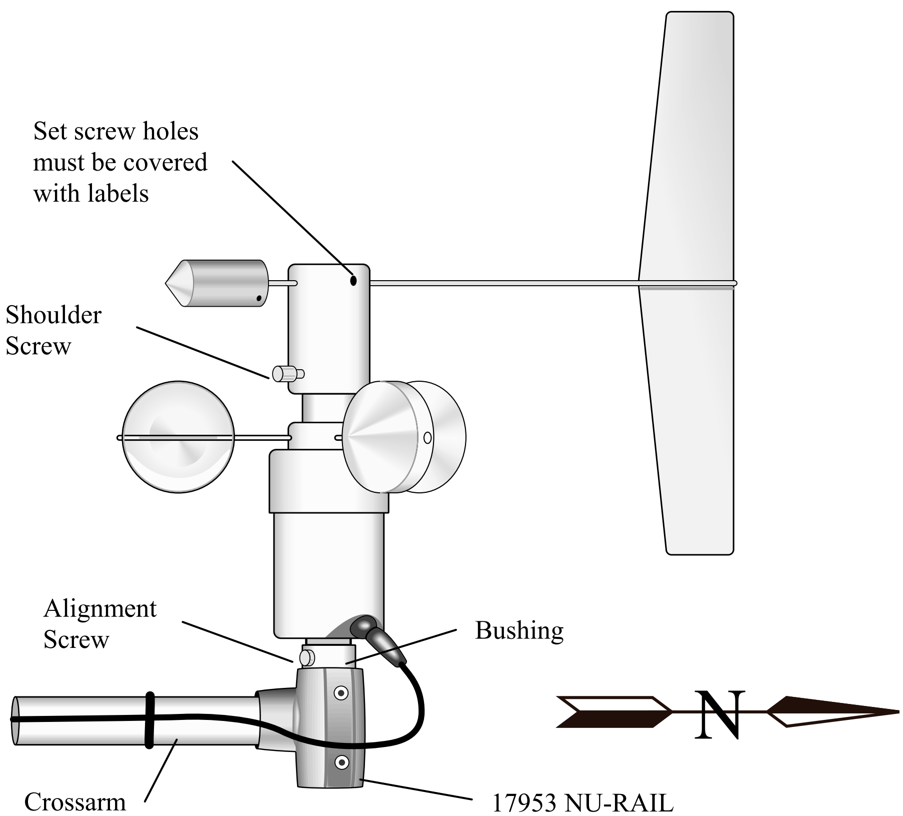



*FIGURE 4-1. 034B Mounted on a Crossarm Using a 17953 NU-RAIL Crossover Fitting*

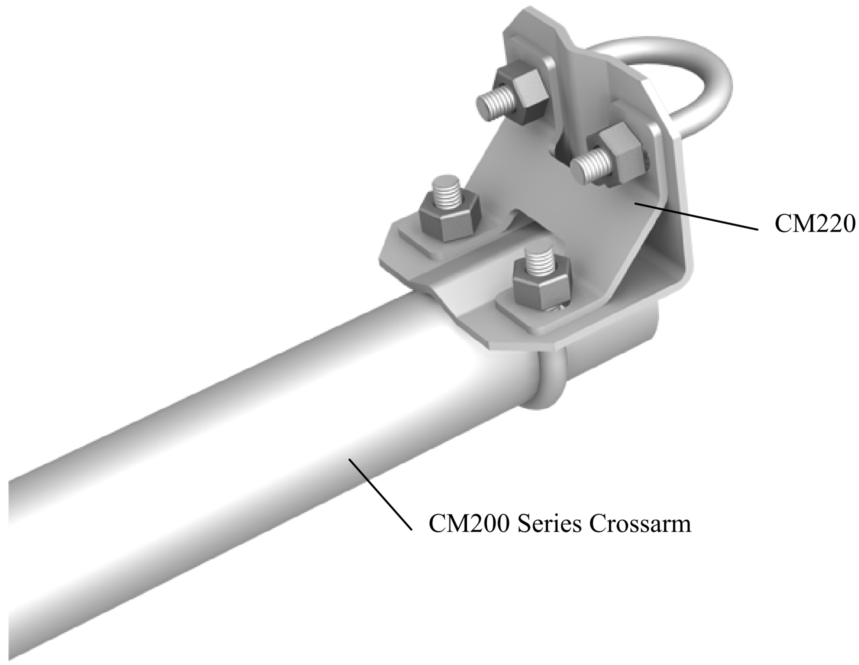



*FIGURE 4-2. CM200 Series Crossarm with CM220 Right Angle Mounting Bracket*

Attach the sensor cable to the six pin male connector on the 034B. Make sure the connector is properly keyed. Finger tighten the knurled ring. Route the sensor cable along the underside of the crossarm to the tripod/tower, and to the instrument enclosure. Secure the cable to the crossarm and tripod/tower using cable ties.

# 4.4. Wiring

Connections to Campbell Scientific dataloggers are given in Table 4.4-1. When Short Cut for Windows software is used to create the datalogger program, the sensor should be wired to the channels shown on the wiring diagram created by Short Cut.

*Table 4.4-1 Connections to Campbell Scientific Dataloggers*

| **Color** | **Wire Label** | **CR800<br>CR5000<br>CR3000<br>CR1000** | **CR510<br>CR500<br>CR10(X)** | **21X<br>CR7<br>CR23X** | **CR200(X)** |
|---|---|---|---|---|---|
| Red | WS Signal | Pulse | Pulse | Pulse | P_LL |
| Black | WS Signal Ref | ⏚ | G | ⏚ | ⏚ |
| Green | WD Signal | SE Analog | SE Analog | SE Analog | SE Analog |
| Blue | WD Volt Excite | Excitation (VX) | Excitation | Excitation | Excitation (VX) |
| White | WD Signal Ref | ⏚ | AG | ⏚ | ⏚ |
| Clear | Shield | ⏚ | G | ⏚ | ⏚ |

# *5. TE525 Tipping Bucket Rain Gage*

## 5.1. General Description

The TE525 is an adaptation of the standard Weather Bureau tipping bucket rain gage. Output is a switch closure for each bucket tip. Three models are available:

- TE525 6 in. Collector 0.01 in. tip
- TE525WS 8 in. Collector 0.01 in. tip
- TE525MM 9.6 in Collector 0.1 mm tip

A "–L" after the model number indicates that the cable length is specified when ordering.

The TE525 ships with:

(1) Calibration sheet
(2) Hose clamps from original mfg
(1) Instruction manual
(3) Screws from original mfg

The 260-953 Alter-Type Wind Screen can be used with the TE525 to minimize the effects of strong winds.

## 5.2. Specifications

Range of Indication:
Infinite in increments of tip (least count) of rainfall.

Rainfall per Tip

| | |
|---|---|
| TE525 | 0.01 in. |
| TE525WS | 0.01 in. |
| TE525MM | 0.1 mm |

Volume per Tip

| | |
|---|---|
| TE525, TE525MM: | 0.16 fl. oz./tip (4.73 ml/tip) |
| TE525WS: | 0.28 fl. oz./tip (8.24 ml/tip) |

Accuracy:

| Rainfall Rate | TE525 | TE525WS |
|---|---|---|
| Up to 1 in./hr | ±1% | ±1% |
| 1 to 2 in./hr | +0, –3% | +0, –2.5% |
| 2 to 3 in./hr | +0, –5% | +0, –3.5% |

| Rainfall Rate | TE525MM |
|---|---|
| Up to 10 mm/hr | ±1% |
| 10 to 20 mm/hr | +0, –3% |
| 20 to 30 mm/hr | +0, –5% |

Signal Output:
Momentary switch closure activated by tipping bucket mechanism. Switch closure is approximately 135 ms.

Calibration/Cleaning Frequency:
Sensor is factory calibrated and should not require field calibration. Debris filters, funnel, and bucket reservoirs should be kept clean. Section 6 describes field calibration check and factory calibration.

Environmental Limits:
Temperature: 0° to +50°C
Humidity: 0 to 100%

Physical Data:
Diameter: 6.25 in. overall
Height

| | |
|---|---|
| TE525 | 9.5 in. |
| TE525WS | 12 in. |
| TE525MM | 12 in. |

Weight: 2.5 pounds
Funnel: Gold anodized spun aluminum knife edge collector ring and funnel assembly.
Funnel Collector Diameter:

| | |
|---|---|
| TE525 | 6.064 in. |
| TE525WS | 8 in. |
| TE525MM | 9.664 in. |

Resolution: 1 tip
Mounting: Side bracket with clamps for pole or mast mounting
Material: Aluminum
Cable: 2-conductor, shielded cable, length must be specified when ordering.

**NOTE** The black outer jacket of the cable is Santoprene® rubber. This compound was chosen for its resistance to temperature extremes, moisture, and UV degradation. However, this jacket will support combustion in air. It is rated as slow burning when tested according to U.L. 94 H.B. and will pass FMVSS302. Local fire codes may preclude its use inside buildings.

# 5.3. Installation

**NOTE** The 260-953 Alter-Type Wind Screen's siting information and installation procedure are provided in our 260-953 manual.

## 5.3.1 Siting

The rain gage should be mounted in a relatively level spot which is representative of the surrounding area. The lip of the funnel should be horizontal and at least 30 cm. above the ground. It should be high enough to be above the average snow depth. The ground surface around the rain gage should be natural vegetation or gravel. It should not be paved.

The rain gage should be placed away from objects that obstruct the wind. The distance should be 2 to 4 times the height of the obstruction.

When leveling, be sure that the funnel is properly seated in the body of the gage and that:

- the orifice is level
- the body of the sensor is vertical (plumb).

## 5.3.2 Mounting

The CM300 Series mounting poles provide a stainless steel 1.5 IPS vertical pole for mounting the TE525 rain gage. Pole length is 23", 47", or 56" for the CM300, CM305, and CM310 models respectively. The CM300 Series offers pedestal base options as well.

Use the enclosed hose clamps to mount the gage as shown in Figure 5.3-1. The lip of the gage should be at least 2 inches above the post or pole. Level the rain gage after mounting it.

**NOTE** Before final leveling, press either end of the bucket down against its stop to make sure the bucket is NOT hung up in the center.

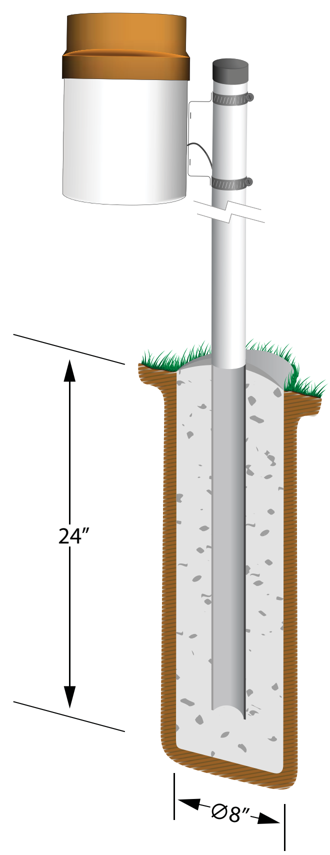



*FIGURE 5.3-1. TE525 Tipping Bucket Rain Gage*

# 6. LP02 Pyranometer

## 6.1. General Description

This manual provides information for interfacing Hukseflux's LP02 Pyranometer to various models of Campbell Scientific dataloggers.

The LP02 is shipped with an instruction manual provided by Hukseflux that contains information concerning the LP02's construction, spectral sensitivity, cosine response, and a simple sensor check out procedure. Included with the sensor and manual is a calibration certificate with the sensor calibration constant and serial number. Cross check this serial number against the serial number on your LP02 to ensure that the given calibration constant corresponds to your sensor.

The LP02 pyranometer is designed for continuous outdoor use. Due to its flat spectral sensitivity from 300 to 3000 nm, it can be used in natural sunlight, under plant canopies, in green houses or buildings, and inverted to measure reflected solar radiation. Two LP02s can be used in combination to measure albedo. The LP02 can also be used to measure most types of artificial light (Xenon lamps, Halogen lamps, etc.).

The LP02 pyranometer consists of a thermopile sensor, housing, dome, and cable. The thermopile is coated with a black absorbent coating. The paint absorbs the radiation and converts it to heat. The resultant temperature difference is converted to a voltage by the copper-constantan thermopile. The thermopile is encapsulated in the housing in such a way that it has a field of view of 180 degrees and the angular characteristics needed to fulfill the cosine response requirements.

## 6.2. Specifications

The LP02 complies with the ISO Second class pyranometer specifications as detailed below.

**LP02 ISO / WMO Specifications**[1]

| | |
|---|---|
| Overall classification according to ISO 9060 / WMO | Second class pyranometer |
| Response time for 95 % response | 18 s |
| Zero offset (response to 200 W/m$^2$ net thermal radiation) | < 15 W/m$^2$ |
| Zero offset (response to 5 k/h change in ambient temperature) | <4 W/m$^2$ |
| Non-stability | < 1% change per year |
| Non-Linearity | < +/- 2.5% |
| Directional response for beam radiation: | within +/- 25 W/m$^2$ |

| | |
|---|---|
| Spectral selectivity | +/- 5% (305 to 2000 nm) |
| Temperature response (within an interval of 50°C) | within 6% (-10 to +40°C) |
| Tilt response | within +/- 2% |
| **LP02 ADDITIONAL MEASUREMENT SPECIFICATIONS** | |
| Sensitivity | 10-40 μV/Wm$^{-2}$ |
| Expected voltage output | 0.1 to + 50 mV in natural sunlight |
| Operating temperature | -40 to +80°C |
| Sensor resistance | Between 40 and 60 Ohms |
| Power required | Zero (passive sensor) |
| Standard cable length | 16 ft (4.8 m) |
| Range | 0-2000 Wm$^{-2}$ |
| Cable replacement | Cable can be replaced by the user |
| Spectral range | 305 to 2800 nm (50% transmission points) |
| Required datalogger channels | 1 differential or 1 single ended voltage channel |
| Leveling | Level and leveling feet included |
| Expected accuracy for daily sums | +/- 10% |
| **DIMENSIONS / SHIPPING DIMENSIONS** | |
| LP02: | 3 in dia x 3 in / 8x4x10 in |
| **WEIGHT/SHIPPING WEIGHT** | |
| LP02: | 0.8 lbs / 1.2 lbs |

[1]*Guide to Meteorological Instruments and Methods of Observation*, fifth edition, WMO, Geneva and ISO9060

# 6.3. Installation

The LP02 is usually installed horizontally, but can also be installed at any angle including an inverted position. In all cases it will measure the flux that is incident on the surface that is parallel to the sensor surface.

Site the LP02 to allow easy access for maintenance while ideally avoiding any obstructions above the plane of the sensing element. It is important to mount the LP02 such that a shadow will not be cast on it at any time.

If this is not possible, try to choose a site where any obstruction over the azimuth range between earliest sunrise and latest sunset has an elevation not exceeding 5°. Diffuse solar radiation is less influenced by obstructions near the horizon. For instance, an obstruction with an elevation of 5° over the whole azimuth range of 360° decreases the downward diffuse solar radiation by only 0.8%.

The sensor should be mounted with the cable pointing towards the nearest magnetic pole, e.g., in the Northern Hemisphere point the cable toward the North Pole.

The CM225 Solar Sensor Mounting Stand is used to attach the LP02 to a vertical pipe (1.0 – 2.1" OD) as shown in Figure 6.3-1.  The LP02 includes a base with three leveling screws, bubble level, and mounting screws.

Attach the LP02 to the CM225 as follows:

1. Loosely mount the pyranometer and fixture on the mounting arm, with the leveling screws lightly touching the mounting plate.  Do not fully tighten the two mounting screws.
2. Turn the leveling screws as required to bring the bubble of the spirit level within the ring.  (For easy leveling first use the screw nearest the spirit level.)
3. Tighten the mounting screws to secure the assembly in its final position.  Check that the pyranometer is still correctly leveled and adjust as necessary.

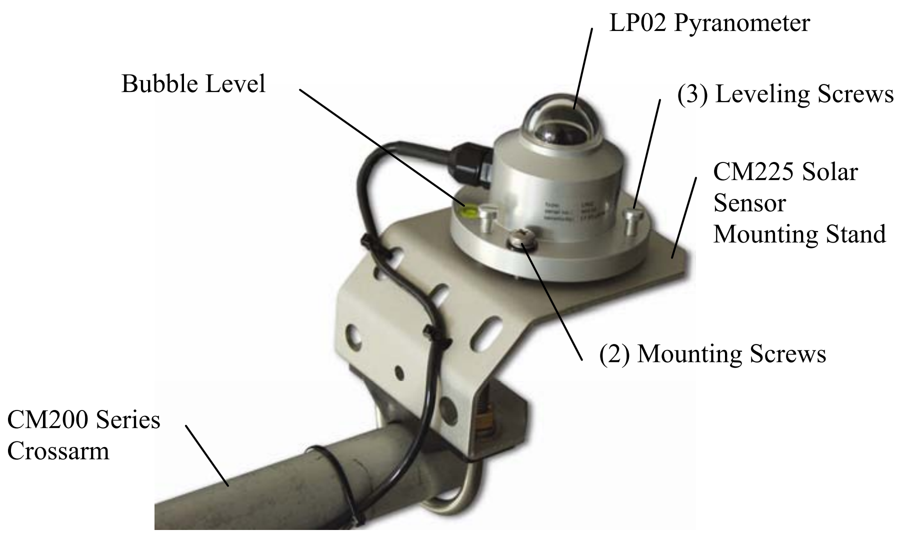



*FIGURE 6.3-1.  LP02 Pyranometer Attached to CM225 Solar Sensor Mounting Stand*

# 7. CMP6-L, CMP11-L, and CMP21-L Pyranometers

## 6.1. Introduction

CMP-series pyranometers are designed for continuous outdoor monitoring of solar radiation intensity.  A flat spectral sensitivity from 285 to 2800 nm enables accurate measurements in natural sunlight, under plant canopies, and in green houses or buildings.  When inverted, these pyranometers can measure reflected solar radiation.  Uses include monitoring global horizontal irradiance (GHI) and plane of array irradiance (POA).  Diffuse sky radiation can also be measured with the use of a shade mechanism.

CMP-series pyranometers are manufactured by Kipp & Zonen, and cabled by Campbell Scientific.

Before using these pyranometers, please study:

- Section 2, *Cautionary Statements*
- Section 3, *Initial Inspection*
- Section 4, *Quick Start*

More details are available in the remaining sections.

## 7.2. Cautionary Statements

- CMP-series pyranometers are rugged, but they should be handled as precision scientific instruments.

- Care should be taken when opening the shipping package to not damage or cut the cable jacket.  If damage to the cable is suspected, consult with a Campbell Scientific applications engineer.

## 7.3. Initial Inspection

Check the contents of the shipment.  If there is a shortage (see Section 7.3.1, *Ships With*), contact Campbell Scientific.  If any damage has occurred during transport, immediately file a claim with the carrier and contact Campbell Scientific to facilitate repair or replacement.

The model number and cable length are printed on a label at the connection end of the cable.  Check this information against the shipping documents to ensure the correct product and cable length are received.

### 7.3.1 Ships With

(2) Bolts for mounting from original mfg
(1) Instruction Manual from original mfg
(1) Sun Shield from original mfg
(2) Nylon washers from original mfg

### 7.3.2 Calibration Certificate

Each pyranometer is shipped with an instruction manual provided by Kipp & Zonen that contains information concerning its construction, spectral sensitivity, cosine response, and a simple sensor check out procedure. Included with the sensor and manual is a calibration certificate with the sensor sensitivity value and serial number.

**NOTE** Cross check this serial number against the serial number on your pyranometer to ensure that the given sensitivity value corresponds to your sensor.

## 7.4. Quick Start

**NOTE** Appendix A in the CMP-series manual provides the installation procedure for the CVF3 ventilation unit.

### 7.4.1 Siting

The pyranometer is usually installed horizontally for global horizontal measurements. However, the pyranometer can be installed at any angle for POA measurements and in the inverted position for reflected measurements. In all cases it will measure the solar flux incident on the sensor surface.

Site the pyranometer to allow easy access for maintenance while ideally avoiding any obstructions above the plane of the sensing element. It is important to mount the pyranometer such that a shadow will not be cast on it at any time.

If this is not possible, try to choose a site where any obstruction over the azimuth range between earliest sunrise and latest sunset has an elevation not exceeding 5°. Diffuse solar radiation is less influenced by obstructions near the horizon. For instance, an obstruction with an elevation of 5° over the whole azimuth range of 360° decreases the downward diffuse solar radiation by only 0.8%.

The sensor should be mounted with the cable pointing towards the nearest magnetic pole (e.g., in the Northern Hemisphere point the cable toward the North Pole); see Figures 7-1 through 7-4.

### 7.4.2 Mounting

See Section 7.6.1, *Mounting to a Tripod Tower* for more information.

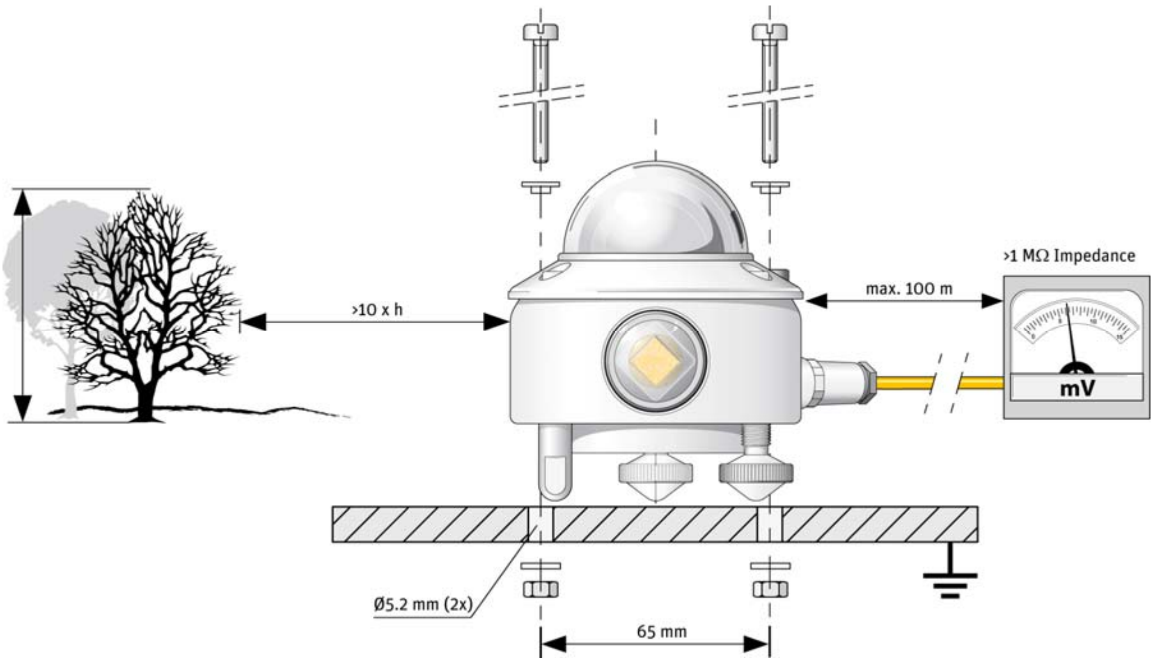



*FIGURE 7-1. Pyranometer installation*

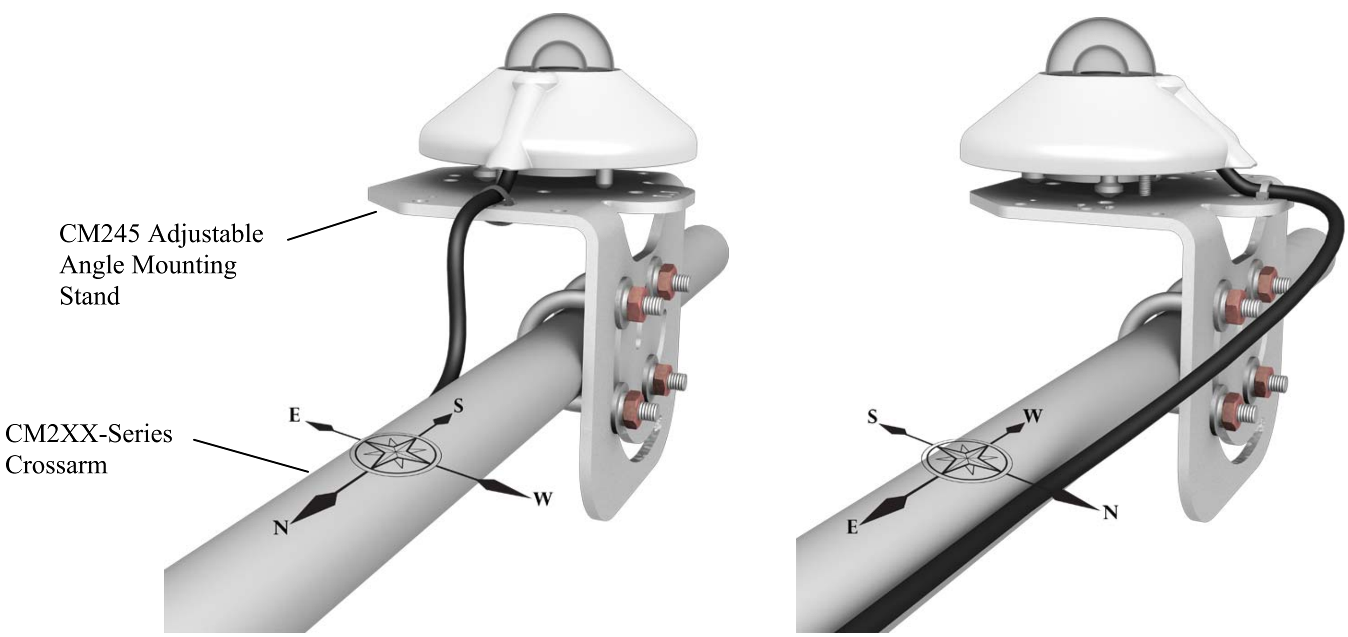



*FIGURE 7-2. Pyranometer mounted horizontally for the Northern Hemisphere (left) and Southern Hemisphere (right)*


*FIGURE 7-3. Two views of a pyranometer mounted at an angle for the Northern Hemisphere*


*FIGURE 7-4. Pyranometer mounted at an angle for the Southern Hemisphere*

# 7.5 Specifications

## 7.5.1 Pyranometers

**TABLE 7-1. CMP-series Specifications**

| Specification | CMP6 | CMP11 | CMP21 |
|---|---|---|---|
| ISO Classification | First Class | Secondary Standard | |
| Maximum irradiance | 2000 W•m$^{-2}$ | 4000 W•m$^{-2}$ | |
| Spectral range (50% points) | 285 to 2800 nm | | |
| Response time (95 %) | <18 s | <5 s | |
| Expected daily uncertainty | <5% | <2% | |
| Zero offset due to thermal radiation (200 W•m$^{-2}$) | <15 W•m$^{-2}$ | <7 W•m$^{-2}$ | |
| Zero offset due to temperature change (5 K•hr$^{-1}$) | <4 W•m$^{-2}$ | <2 W•m$^{-2}$ | |
| Non-stability (change/year) | <1 % | <0.5% | |
| Non-linearity (0 to 1000 W•m$^{-2}$) | <1% | <0.2% | |
| Directional error (up to 80° with 1000 W•m$^{-2}$ beam) | <20 W•m$^{-2}$ | <10 W•m$^{-2}$ | |
| Tilt error (at 1000 W•m$^{-2}$) | <1% | <0.2% | |
| Level accuracy | 0.1° | | |
| Operating temperature | -40° to 80°C | | |
| Temperature dependence of sensitivity | <4% (-10° to 40°C) | <1% (-20° to 50°C) | |
| Sensitivity | 5 to 20 µV / W•m$^{-2}$ | 7 to 14 µV / W•m$^{-2}$ | |
| Typical signal output for atmospheric applications | 0 to 20 mV | 0 to 15 mV | |
| Weight | 0.6 kg (1.3 lb) without cable; 0.9 kg (2 lb) with 10 m (33 ft) cable | | |
| Impedance* | 20 to 200 Ω | 10 to 100 Ω | |

* Impedance is defined as the total electrical impedance at the radiometer output connector fitted to the housing. It arises from the electrical resistance in the thermal junctions, wires, and passive electronics within the radiometer.

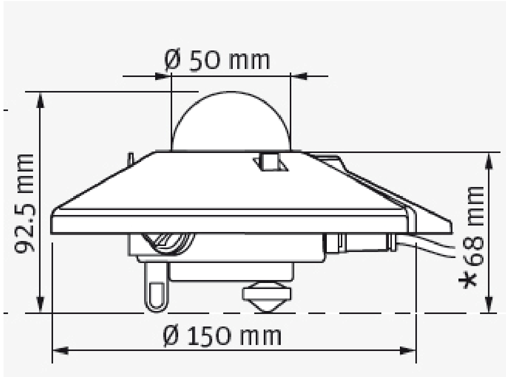



*FIGURE 7-6. Dimensions of the CMP6, CMP11, and CMP21*

## 7.5.2 CVF3 Ventilation Unit

| | |
|---|---|
| **Compatible Pyanometers:** | CMP6, CMP11, CMP21 |
| **Power supply:** | 12 Vdc, 1.3 A (with 10 W Heater) |
| **Operating temperature range:** | -40° to 70°C |
| **Ventilation power:** | 5 W continuously |
| **Heating power:** | 5 W and 10 W |
| **Heater induced offset:** | <1 W•m$^{-2}$ (with CMP11 Pyranometer) |
| **Weight without cable:** | 1.6 kg (3.5 lb) |

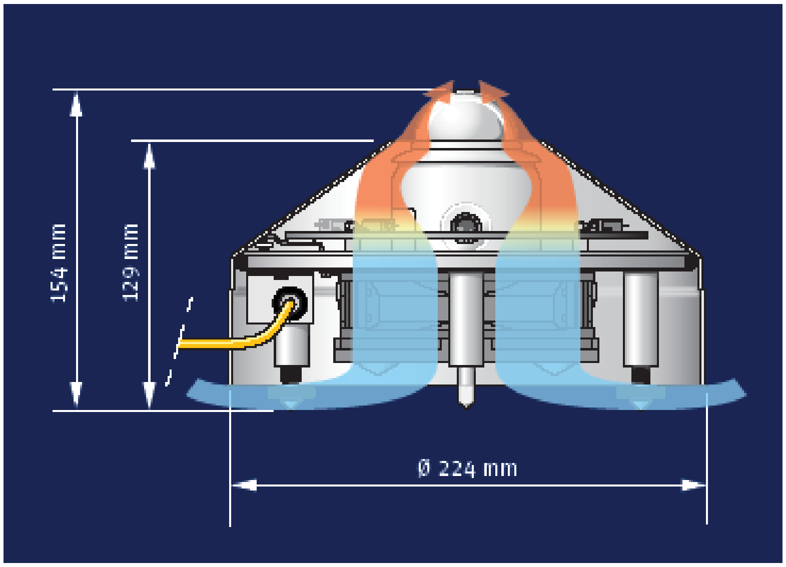



*FIGURE 7-7. Dimensions of the CVF3*

# 7.6. Installation

## 7.6.1 Mounting to a Tripod or Tower

Tools required for installation on a tripod or tower:

Small and medium Phillips screwdrivers
5/16”, 1/2” open end wrenches
5/32” Allen wrench
Tape measure
UV-resistant wire ties
Side-cut pliers
Compass
Step ladder

The pyranometers include a bubble level and two leveling screws, which allow them to be leveled horizontally without using a leveling base. They mount to a mast, crossarm, or pole (1.0 in. to 2.1 in. outer diameter) via the CM245 Mounting Stand.

**NOTE** If using a CFV3 Ventilation Unit, a different mounting stand, the 27084, is required. Refer to Appendix A for more information.

The CM245 includes slots that allow it to be adjusted to any angle from horizontal to vertical. If mounting the pyranometer at an angle, ensure that the crossarm is leveled horizontally before placing the bracket at its proper angle. Angle positions are included on the bracket label (see Figures 7-8 and 7-9).

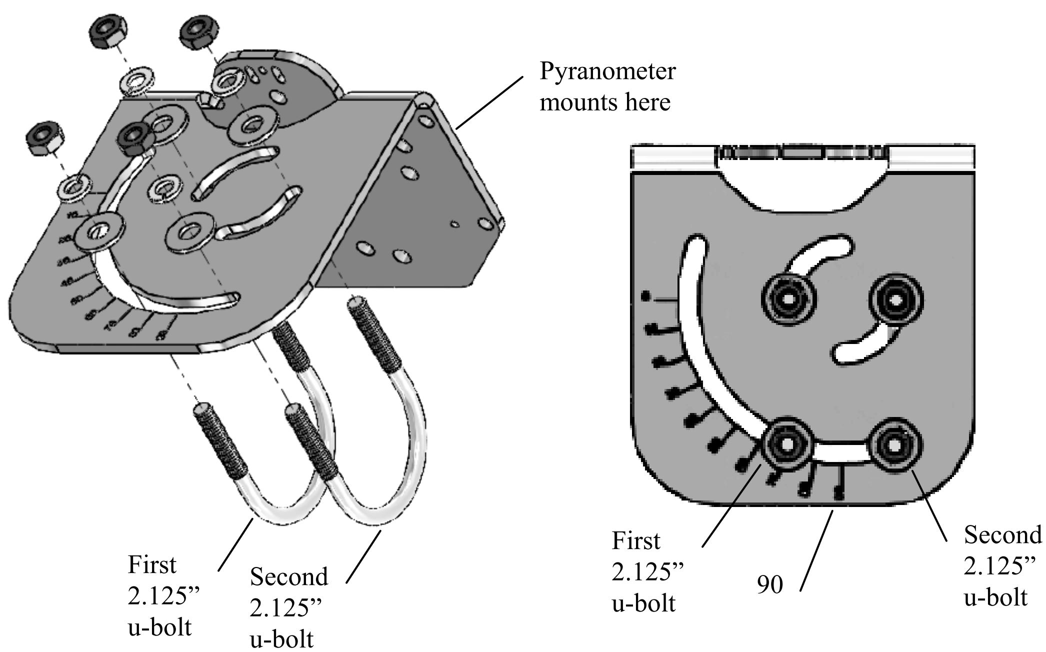
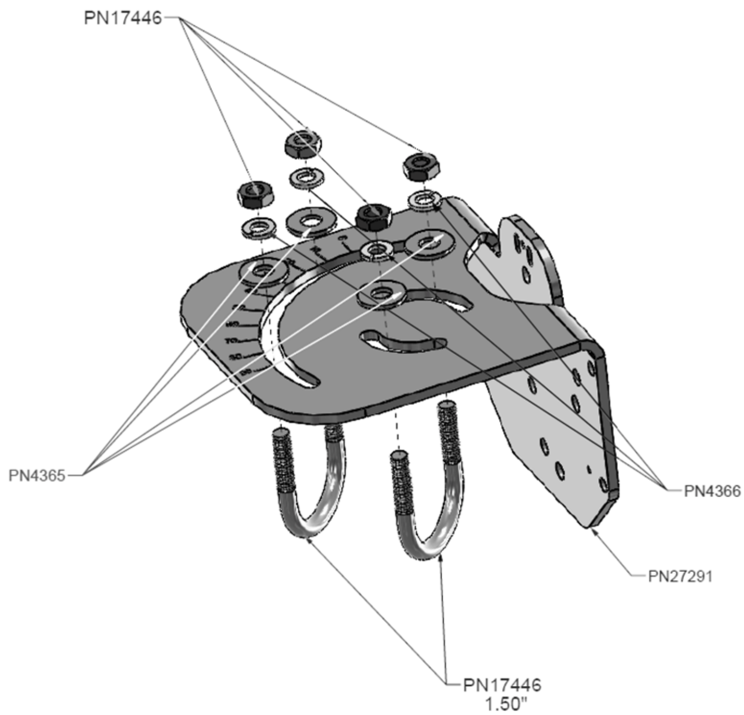



*FIGURE 7-8. CM245 bracket with 2.125” u-bolts positioned to mount the pyranometer horizontally on a crossarm*



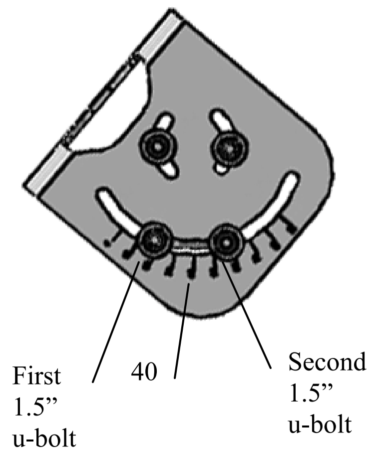




*FIGURE 7-9. CM245 bracket with 1.5" u-bolts positioned to mount pyranometer at a 40° angle on a vertical pipe*

Do the following to level the pyranometer horizontally (see Figure 7-10):

1. Attach the mounting stand to the crossarm.
2. Loosely mount the pyranometer on the mounting stand. Do not fully tighten the two mounting screws.
3. Turn the leveling screws as required to bring the bubble of the level within the ring.
4. Tighten the mounting screws to secure the assembly in its final position. Check that the pyranometer is still correctly leveled and adjust as necessary.
5. Attach the white plastic sun screen to the pyranometer.

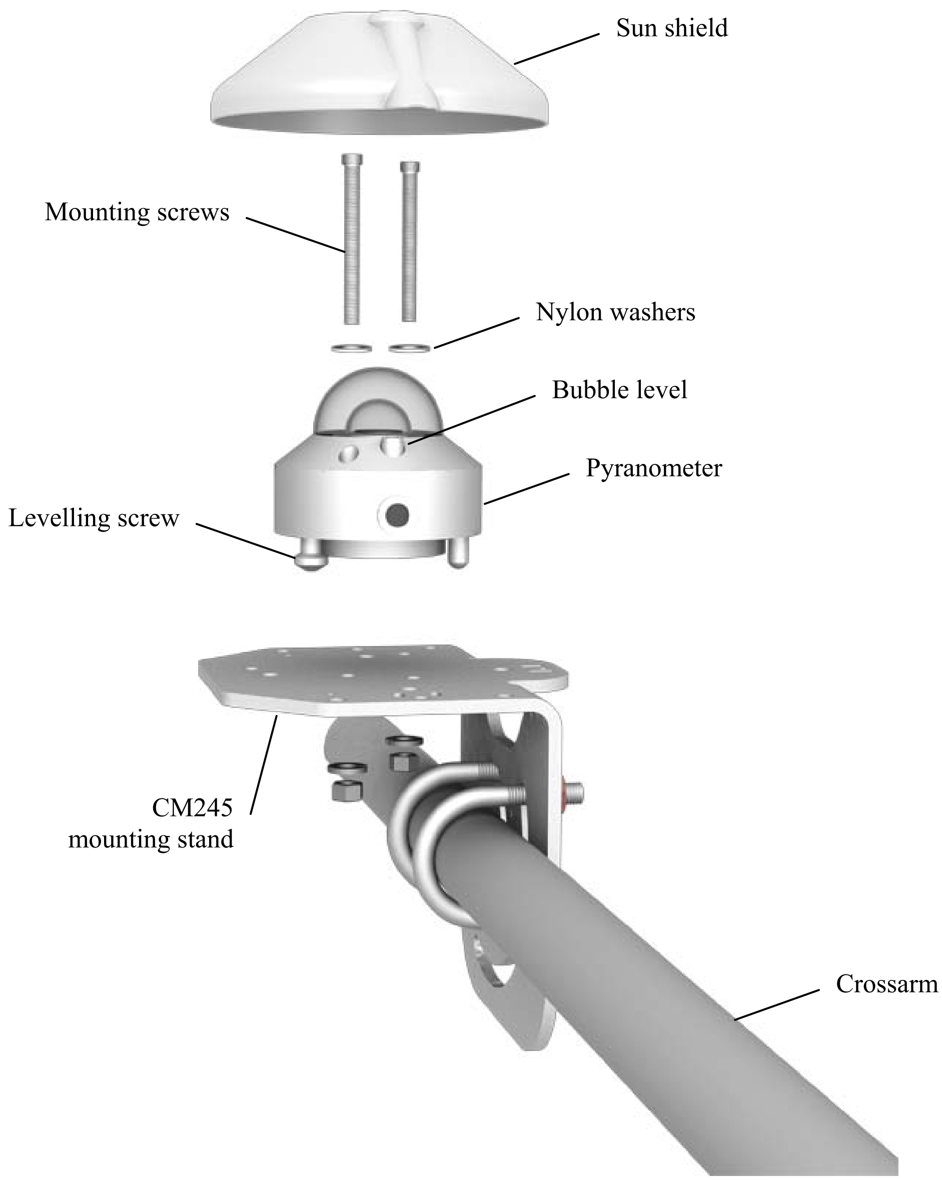



*FIGURE 7-10 Exploded view of the pyranometer mounting*

## 7.6.2 Wiring

**NOTE** Short Cut users should wire the sensor according to the wiring diagram generated by Short Cut.

The cable of the CMP6 and CMP11 has two conductors and a shield. The cable of the CMP21 has five conductors and a shield. The additional conductors on the CMP21's cable are for connecting its internal thermistor. A schematic for the CMP6, CMP11, and the thermopile of the CMP21 is provided in Section 6.6.2.1. Wiring for the CMP6 and CMP11 is described in Section 6.6.2.2; wiring for the CMP21 is described in Section 7.6.2.3.

### 7.6.2.1 CMP6, CMP11, and CMP21 Thermopile Schematic

A schematic diagram of a CMP6, CMP11, or CMP21 thermopile is shown in Figure 7-11.

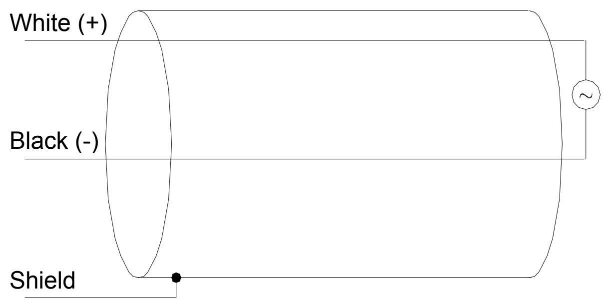



*FIGURE 7-11. CMP6, CMP11, and CMP21 thermopile detector schematic*

### 7.6.2.2 CMP6 and CMP11 Wiring

**NOTE** A CMP6 or CMP11 purchased from Campbell Scientific has different wiring than a pyranometer purchased directly from Kipp & Zonen.

The pyranometer is measured using either differential analog channels or single-ended analog channels.

A differential voltage measurement is recommended because it has better noise rejection than a single-ended measurement.

Connections to Campbell Scientific dataloggers for a differential measurement are given in Table 7-2. A user-supplied jumper wire should be connected between the low side of the differential input and ground (AG or ⏚) to keep the signal in common mode range.

Connections to Campbell Scientific dataloggers for a single-ended measurement are given in Table 7-3.

**TABLE 7-2. CMP6 and CMP11 Differential Connections to Campbell Scientific Dataloggers**

| Color | Description | CR9000(X), CR5000, CR3000, CR1000, CR800 | CR510, CR500, CR10(X) | 21X, CR7, CR23X |
|---|---|---|---|---|
| White | Signal (+) | DIFF Analog High | DIFF Analog High | DIFF Analog High |
| Black | Signal (-) | *DIFF Analog Low | *DIFF Analog Low | *DIFF Analog Low |
| Shield | Shield | ⏚ | G | ⏚ |

* Jumper to AG or ⏚ with user supplied 26 AWG or larger wire.

**TABLE 7-3. CMP6 and CMP11 Single-Ended Connections to Campbell Scientific Dataloggers**

| Color | Description | CR9000(X), CR5000, CR3000, CR1000, CR800 | CR510, CR500, CR10(X) | 21X, CR7, CR23X |
|---|---|---|---|---|
| White | Signal (+) | SE Analog | SE Analog | SE Analog |
| Black | Signal (-) | ⏚ | AG | ⏚ |
| Clear | Shield | ⏚ | G | ⏚ |

### 7.6.2.3 CMP21 Wiring

**NOTE** A CMP21 purchased from Campbell Scientific has different wiring than a CMP21 purchased directly from Kipp & Zonen.

The CMP21's pyranometer can be measured using either differential analog channels or single-ended analog channels. A differential voltage measurement is recommended because it has better noise rejection than a single-ended measurement. If a differential channel is not available, a single-ended measurement can be used.

A single-ended channel and a voltage excitation channel are used to measure the CMP21's internal thermistor.

Connections to Campbell Scientific dataloggers for a differential measurement are given in Table 7-4. A user-supplied jumper wire should be connected between the low side of the differential input and ground (AG or ⏚) to keep the signal in common mode range. Connections to Campbell Scientific dataloggers for a single-ended measurement are given in Table 7-5.

**TABLE 7-4. CMP21 Differential Connections to Campbell Scientific Dataloggers**

| Wire Color | Wire Label/ Description | CR9000(X), CR5000, CR3000, CR1000, CR800 | CR510, CR500, CR10(X) | 21X, CR7, CR23X |
|---|---|---|---|---|
| White | Pyranometer Sig | DIFF Analog High | DIFF Analog High | DIFF Analog High |
| Blue | Pyranometer Ref | *DIFF Analog Low | *DIFF Analog Low | *DIFF Analog Low |
| Yellow | Thermistor Volt Excite | VX or EX | E | EX |
| Black | Thermistor Sig | Single-ended analog | Single-ended analog | Single-ended analog |
| Brown | Thermistor Ref | ⏚ | AG | ⏚ |
| Clear | Shield | ⏚ | G | ⏚ |

* Jumper to AG or ⏚ with user-supplied wire.

**TABLE 7-5. CMP21 Single-Ended Connections to Campbell Scientific Dataloggers**

| Wire Color | Wire Label/ Description | CR9000(X), CR5000, CR3000, CR1000, CR800 | CR510, CR500, CR10(X) | 21X, CR7, CR23X |
|---|---|---|---|---|
| White | Pyranometer Sig | Single-ended analog | Single-ended analog | Single-ended analog |
| Blue | Pyranometer Ref | ⏚ | AG | ⏚ |
| Yellow | Thermistor Volt Excite | VX or EX | E | EX |
| Black | Thermistor Sig | Single-ended analog | Single-ended analog | Single-ended analog |
| Brown | Thermistor Ref | ⏚ | AG | ⏚ |
| Clear | Shield | ⏚ | G | ⏚ |

# *Appendix A. Cut Sheets*

# CR1000 Specifications

*Electrical specifications are valid over a -25° to +50°C range unless otherwise specified; non-condensing environment required. To maintain electrical specifications, Campbell Scientific recommends recalibrating dataloggers every two years. We recommend that the system configuration and critical specifications are confirmed with Campbell Scientific before purchase.*

## PROGRAM EXECUTION RATE
10 ms to one day @ 10 ms increments

## ANALOG INPUTS (SE1-SE16 or DIFF1-DIFF8)
8 differential (DF) or 16 single-ended (SE) individually configured. Channel expansion provided by AM16/32B and AM25T multiplexers.

RANGES and RESOLUTION: Basic resolution (Basic Res) is the A/D resolution of a single conversion. Resolution of DF measurements with input reversal is half the Basic Res**.**

| *Range (mV)*[1] | *DF Res (µV)* [2] | *Basic Res (µV)* |
|---|---|---|
| ±5000 | 667 | 1333 |
| ±2500 | 333 | 667 |
| ±250 | 33.3 | 66.7 |
| ±25 | 3.33 | 6.7 |
| ±7.5 | 1.0 | 2.0 |
| ±2.5 | 0.33 | 0.67 |

[1]Range overhead of ~9% on all ranges guarantees that full-scale values will not cause over range.
[2]Resolution of DF measurements with input reversal.

ACCURACY[3]:
±(0.06% of reading + offset), 0° to 40°C
±(0.12% of reading + offset), -25° to 50°C
±(0.18% of reading + offset), -55° to 85°C (-XT only)

[3]Accuracy does not include the sensor and measurement noise. The offsets are defined as:
Offset for DF w/input reversal = 1.5·Basic Res + 1.0 µV
Offset for DF w/o input reversal = 3·Basic Res + 2.0 µV
Offset for SE = 3·Basic Res + 3.0 µV

INPUT NOISE VOLTAGE: For DF measurements with input reversal on ±2.5 mV input range; digital resolution dominates for higher ranges.
250 µs Integration: 0.34 µV RMS
50/60 Hz Integration: 0.19 µV RMS

ANALOG MEASUREMENT SPEED:

| *Integra-tion Type/ Code* | *Integra-tion Time* | *Settling Time* | *Total Time*[5] | |
|---|---|---|---|---|
| | | | *SE w/ No Rev* | *DF w/ Input Rev* |
| 250 | 250 µs | 450 µs | ~1 ms | ~12 ms |
| 60 Hz[4] | 16.67 ms | 3 ms | ~20 ms | ~40 ms |
| 50 Hz[4] | 20.00 ms | 3 ms | ~25 ms | ~50 ms |

[4]AC line noise filter.
[5]Includes 250 µs for conversion to engineering units.

INPUT LIMITS: ±5 V

DC COMMON MODE REJECTION: >100 dB

NORMAL MODE REJECTION: 70 dB @ 60 Hz when using 60 Hz rejection

SUSTAINED INPUT VOLTAGE W/O DAMAGE: ±16 Vdc max.

INPUT CURRENT: ±1 nA typical, ±6 nA max. @ 50°C; ±90 nA @ 85°C

INPUT RESISTANCE: 20 Gohms typical

ACCURACY OF BUILT-IN REFERENCE JUNCTION THERMISTOR (for thermocouple measurements):
±0.3°C, -25° to 50°C
±0.8°C, -55° to 85°C (-XT only)

## ANALOG OUTPUTS (Vx1-Vx3)
3 switched voltage, active only during measurement, one at a time.

RANGE AND RESOLUTION: Voltage outputs programmable between ±2.5 V with 0.67 mV resolution.

$V_x$ ACCURACY: ±(0.06% of setting + 0.8 mV), 0° to 40°C
±(0.12% of setting + 0.8 mV), -25° to 50°C
±(0.18% of setting + 0.8 mV), -55° to 85°C (-XT only)

$V_x$ FREQUENCY SWEEP FUNCTION: Switched outputs provide a programmable swept frequency, 0 to 2500 mv square waves for exciting vibrating wire transducers.

CURRENT SOURCING/SINKING: ±25 mA

## RESISTANCE MEASUREMENTS
MEASUREMENT TYPES: The CR1000 provides ratiometric measurements of 4- and 6-wire full bridges, and 2-, 3-, and 4-wire half bridges. Precise, dual polarity excitation using any of the 3 switched voltage excitations eliminates dc errors.

VOLTAGE RATIO ACCURACY[6]: Assuming excitation voltage of at least 1000 mV, not including bridge resistor error.

±(0.04% of voltage reading + offset)/$V_x$

[6]Accuracy does not include the sensor and measurement noise. The offsets are defined as:
Offset for DF w/input reversal = 1.5·Basic Res + 1.0 µV
Offset for DF w/o input reversal = 3·Basic Res + 2.0 µV
Offset for SE = 3·Basic Res + 3.0 µV

Offset values are reduced by a factor of 2 when excitation reversal is used.

## PERIOD AVERAGE
Any of the16 SE analog inputs can be used for period averaging. Accuracy is ±(0.01% of reading + resolution), where resolution is 136 ns divided by the specified number of cycles to be measured.

INPUT AMPLITUDE AND FREQUENCY:

| *Voltage Gain* | *Input Range (±mV)* | *Signal (peak to peak)*[7] | | *Min Pulse Width (µV)* | *Max*[8] *Freq (kHz)* |
|---|---|---|---|---|---|
| | | *Min. (mV)* | *Max (V)* | | |
| 1 | 2500 | 500 | 10 | 2.5 | 200 |
| 10 | 250 | 10 | 2 | 10 | 50 |
| 33 | 25 | 5 | 2 | 62 | 8 |
| 100 | 2.5 | 2 | 2 | 100 | 5 |

[7]With signal centered at the datalogger ground.
[8]The maximum frequency = 1/(Twice Minimum Pulse Width) for 50% of duty cycle signals.

## PULSE COUNTERS (P1-P2)
(2) inputs individually selectable for switch closure, high frequency pulse, or low-level ac. Independent 24-bit counters for each input.

MAXIMUM COUNTS PER SCAN: 16.7x10[6]

SWITCH CLOSURE MODE:
Minimum Switch Closed Time: 5 ms
Minimum Switch Open Time: 6 ms
Max. Bounce Time: 1 ms open w/o being counted

HIGH-FREQUENCY PULSE MODE:
Maximum Input Frequency: 250 kHz
Maximum Input Voltage: ±20 V
Voltage Thresholds: Count upon transition from below 0.9 V to above 2.2 V after input filter with 1.2 µs time constant.

LOW-LEVEL AC MODE: Internal AC coupling removes AC offsets up to ±0.5 V.

Input Hysteresis: 12 mV @ 1 Hz
Maximum ac Input Voltage: ±20 V
Minimum ac Input Voltage:

| *Sine Wave (mV RMS)* | *Range(Hz)* |
|---|---|
| 20 | 1.0 to 20 |
| 200 | 0.5 to 200 |
| 2000 | 0.3 to 10,000 |
| 5000 | 0.3 to 20,000 |

## DIGITAL I/O PORTS (C1-C8)
8 ports software selectable, as binary inputs or control outputs. Also provide edge timing, subroutine interrupts/wake up, switch closure pulse counting, high frequency pulse counting, asynchronous communications (UART), SDI-12 communications, and SDM communications.

HIGH-FREQUENCY MAX: 400 kHz

SWITCH CLOSURE FREQUENCY MAX: 150 Hz

EDGE TIMING RESOLUTION: 540 ns

OUTPUT VOLTAGES (no load): high 5.0 V ±0.1 V; low <0.1

OUTPUT RESISTANCE: 330 ohms

INPUT STATE: high 3.8 to 16 V; low -8.0 to 1.2 V

INPUT HYSTERESIS: 1.4 V

INPUT RESISTANCE: 100 kohms

## SWITCHED 12 V (SW-12)
One independent 12 V unregulated sources switched on and off under program control. Thermal fuse hold current = 900 mA @ 20°C, 650 mA @ 50°C, 360 mA @ 85°C.

## CE COMPLIANCE
STANDARD(S) TO WHICH CONFORMITY IS DECLARED: IEC61326:2002

## COMMUNICATIONS
RS-232 PORTS:
9-pin: DCE port for battery-powered computer or non-CSI modem connection.
COM1 to COM4: Four independent Tx/Rx pairs on control ports (non-isolated); 0 to 5 VUART
Baud Rates: selectable from 300 bps to 115.2 kbps.
Default Format: 8 data bits; 1 stop bits; no parity
Optional Formats: 7 data bits; 2 stop bits; odd, even parity

CS I/O PORT: Interface with CSI peripherals

SDI-12: Digital control ports 1, 3, 5, and 7 are individually configured and meet SDI-12 Standard version 1.3 for datalogger mode. Up to ten SDI-12 sensors are supported per port.

PERIPHERAL PORT: 40-pin interface for attaching CompactFlash or Ethernet peripherals

PROTOCOLS SUPPORTED: PakBus, Modbus, DNP3, FTP, HTTP, XML, POP3, SMTP, Telnet, NTCIP, NTP, SDI-12, SDM

## CPU AND INTERFACE
PROCESSOR: Renesas H8S 2322 (16-bit CPU with 32-bit internal core)

MEMORY: 2 MB of Flash for operating system; 4 MB of battery-backed SRAM for CPU usage, program storage and data storage.

CLOCK ACCURACY: ±3 min. per year. Correction via GPS optional.

## SYSTEM POWER REQUIREMENTS
VOLTAGE: 9.6 to 16 Vdc (reverse polarity protected)

EXTERNAL BATTERIES: 12 Vdc nominal

TYPICAL CURRENT DRAIN:
Sleep Mode: 0.7 mA (0.9 mA max.)
1 Hz Sample Rate (1 fast SE meas.): 1 mA
100 Hz Sample Rate (1 fast SE meas.): 16.2 mA
100 Hz Sample Rate (1 fast SE meas. w/RS-232 communication): 27.6 mA
Optional Keyboard Display On (no backlight): add 7 mA to current drain
Optional Keyboard Display On (backlight on): add 100 mA to current drain

## PHYSICAL
DIMENSIONS: 9.4" x 4" x 2.4" (23.9 x 10.2 x 6.1 cm); additional clearance required for serial cable and sensor leads.

WEIGHT: 2.1 lbs (1 kg)

## WARRANTY
3-years against defects in materials and workmanship.

# CH100 and PS100

## 12 Vdc Regulator and Power Supply

### Specifications*


**Output Voltage:** 12 Vdc

**Nominal Capacity:** 7 Amp hours

**Input Voltage (CHG terminals):** 15 to 28 VDC or 18 VAC RMS

**Battery Connections**
- **Charging Output Voltage:** Temperature compensated float charge for battery
- **Temperature Compensation Range:** -40º to +60ºC
- **Max. Charging Current:** 1.2 A (allows one SP20 or SP10 to be used)

**Power Out (+12 terminals)**
- **Voltage:** Unregulated 12 V from battery
- **Temperature Current Limited with 3 A Thermal Fuse:** > 3 A @ < 20°C; 3 A @ 20°C; 2.1A @ 50°C; 1.8 A @ 60°C

**CH100 Weight:** 5.5 oz. (158 g)

**CH100 Dimensions**
- **Height:** 4.0″ (10.2 cm)
- **Width:** 2.76″ (7.0 cm)
- **Depth:** 1.5″ (3.9 cm)

**PS100 Weight:** 6.9 lb (3.1 kg)

**PS100 Dimensions (including mounts and connectors)**
- **Height:** 4.1″ (10.5 cm)
- **Width:** 7.6″ (19.0 cm)
- **Depth:** 2.8″ (7.0cm)

# CH200 and PS200

## Smart Charging Regulator and Power Supply

## Specifications

**CHARGE - CHARGE Terminals (AC or DC Source)**

| | |
|---|---|
| **AC:** | 18 to 24 V RMS with 1.2 A RMS maximum |
| **DC:** | 16 to 40 Vdc with 1.1 A DC maximum |

**SOLAR - Terminals[1] (Solar Panel or Other DC Source)**

| | |
|---|---|
| **Input Voltage Range:** | 15 to 40 Vdc |
| **Maximum Charging Current:** | 3.6 Adc typical; 2.8 Adc to 4.3 Adc depending on individual charger |

**Operational Temperature[2]:** -40° to +60°C

**Quiescent Current**

| | |
|---|---|
| **No Charge Source Present:** | 300 µA maximum |
| **No Battery Connected:** | 2 mA maximum |

**Dimensions**

| | |
|---|---|
| **PS200:** | 4.2 x 7.5 x 3 in. (10.6 x 19 x 7.6 cm) |
| **CH200:** | 3.9 x 3 x 1.5 in. (10 x 7.5 x 3.7 cm) |

*Battery Charging[3]*

| | |
|---|---|
| **CYCLE Charging:** | Vbatt(T) = 14.70 V –(24 mV) x (T – 25°C) |
| **FLOAT Charging:** | Vbatt(T) = 13.65 V – (18 mV) x (T – 25°C) |
| **Accuracy:** | ±1% accuracy on charging voltage over –40° to +60°C |

*Power Out (+12 terminals)*

**Voltage:** Unregulated 12 V from battery

**4 A Self-Resettable Thermal Fuse Hold Current Limits**

| | |
|---|---|
| **<20°C:** | > 4 A |
| **20°C:** | 4.0 A |
| **50°C:** | 3.1 A |
| **60°C:** | 2.7 A |

*Measurements*

| | |
|---|---|
| **Average Battery Voltage:** | ±(1% of reading +15 mV) over –40° to +60°C range |
| **Average Battery/Load Current Regulator Input Voltage[4]:** | ±(2% of reading +2 mA) over –40° to +60°C range |
| **Solar[5]:** | ±(1% of reading - 0.25 V) / -(1% of reading +1 V) over –40° to +60°C range |
| **Continuous[6]:** | ±(1% of reading - 0.5 V) / -(1% of reading +2 V) over –40° to +60°C range |
| **Charger Temperature:** | ± 2°C |


A CR1000 is connected to the PS200's SDI-12 terminal allowing the CR1000 to receive the PS200's charging, load, battery voltage, and current information.

At right is a top view of a CH200 showing its LEDs and terminals.


[1]*Battery voltages below 8.7 V may result in <3.0 A current limit because of fold-back current limit.*

[2]*VRLA battery manufacturers state that "heat kills batteries" and recommend operating batteries ≤50°C.*

[3] *Two-step temperature compensated constant- voltage charging for valve-regulated lead-acid batteries. Cycle and float charging voltage parameters are programmable with the default values listed.*

[4] *Impulse type changes in current may have an average current error of ±(10% of reading + 2 mA).*

[5] *1.0 V negative offset is worst-case due to reversal protection diode on input. Typical diode drop is 0.35 V.*

[6] *2.0 V negative offset is worst-case due to two series diodes in AC full-bridge. Typical diode drops are 0.35 V each for 0.7 V total.*

# CM106

## Instrumentation Tripod

### Specifications

**Measurement Height**
**Upper Mast Retracted:** 7 ft (2.1 m)
**Upper Mast Extended:** 10 ft (3 m)

**Vertical Load Limit:** 100 lb (45 kg)

**Mast Outer Diameter**
**Main Lower Mast:** 1.90 in. (48 mm)
**Retractable Upper:** 1.74 in. (44 mm)

**Base Diameter:** 9.3 ft (2.8 m)

**Leveling Adjustment:** Slide collars on each leg adjust individually

**Leg Base:** 4 in. by 5 in. with four 0.62 in. holes for ground stake

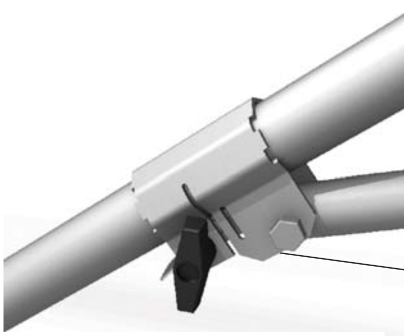
**Portability:** Collapsible to 8 in. diameter by 6 ft length

**Weight with Mast:** 40 lb (18 kg)

**Maximum Slope Angle*:** 22° or 40% grade

**Allowable Wind Speeds****

| Tripod Configuration | Sustained Wind | Wind Gust |
|---|---|---|
| Mast Extended, Unguyed | 65 mph (29 m/s) | 84 mph (38 m/s) |
| Mast Retracted, Unguyed | 80 mph (36 m/s) | 104 mph (46 m/s) |
| Mast Extended, Guyed | 100 mph (45 m/s) | 130 mph (58 m/s) |
| Mast Retracted, Guyed | 115 mph (51 m/s) | 150 mph (67 m/s) |



A close up of the adjustable leg clamp.

A CM106 with the optional guy kit and an enclosure mounted to the leg base.

# BP84

## 84 Ah Rechargeable Battery

## Specifications

**Output Voltage:** 12 Vdc

**Nominal Capacity:** 84 Amp hours when discharged at a 24 hour rate

**Temperature Range:** -40° to +71°C

**Weight**

| | |
|---|---|
| **Battery Only:** | 55 lbs (25 kg) |
| **Battery Only (shipping):** | 57 lbs (25.9 kg) |
| **Either Mounting Bracket:** | 2 lbs (0.9 kg) |

**Dimensions**

| | |
|---|---|
| **Battery Shipping Box:** | 8″ x 13″ x 14″ (20.3 x 33 x 35.6 cm) |
| **BP84 Bracket:** | 3″ x 9″ x 11″ (7.6 x 22.9 x 27.9 cm) |

The BP84 bracket is mounted inside an ENC16/18 with a sideplate (option -SB) and two vertical cable conduits (option -VC). It is convenient to mount the 18529 SunSaver regulator on the sideplate.


The 25962 is the 84 Ah battery included with the BP84 and PS84. It can be purchased separately as a replacement part.

## UT10 Specifications

**Required Concrete Pad**
**Dimensions (see note 2):** 24 x 24 x 24 in. (61 x 61 x 61 cm)

**Crossarm Height (attached to mast)**
**Standard:** 10 ft (3 m)
**Maximum (mast fully extended):** ~12 ft (3.7 m)
**Minimum:** ~9 ft (2.7 m)

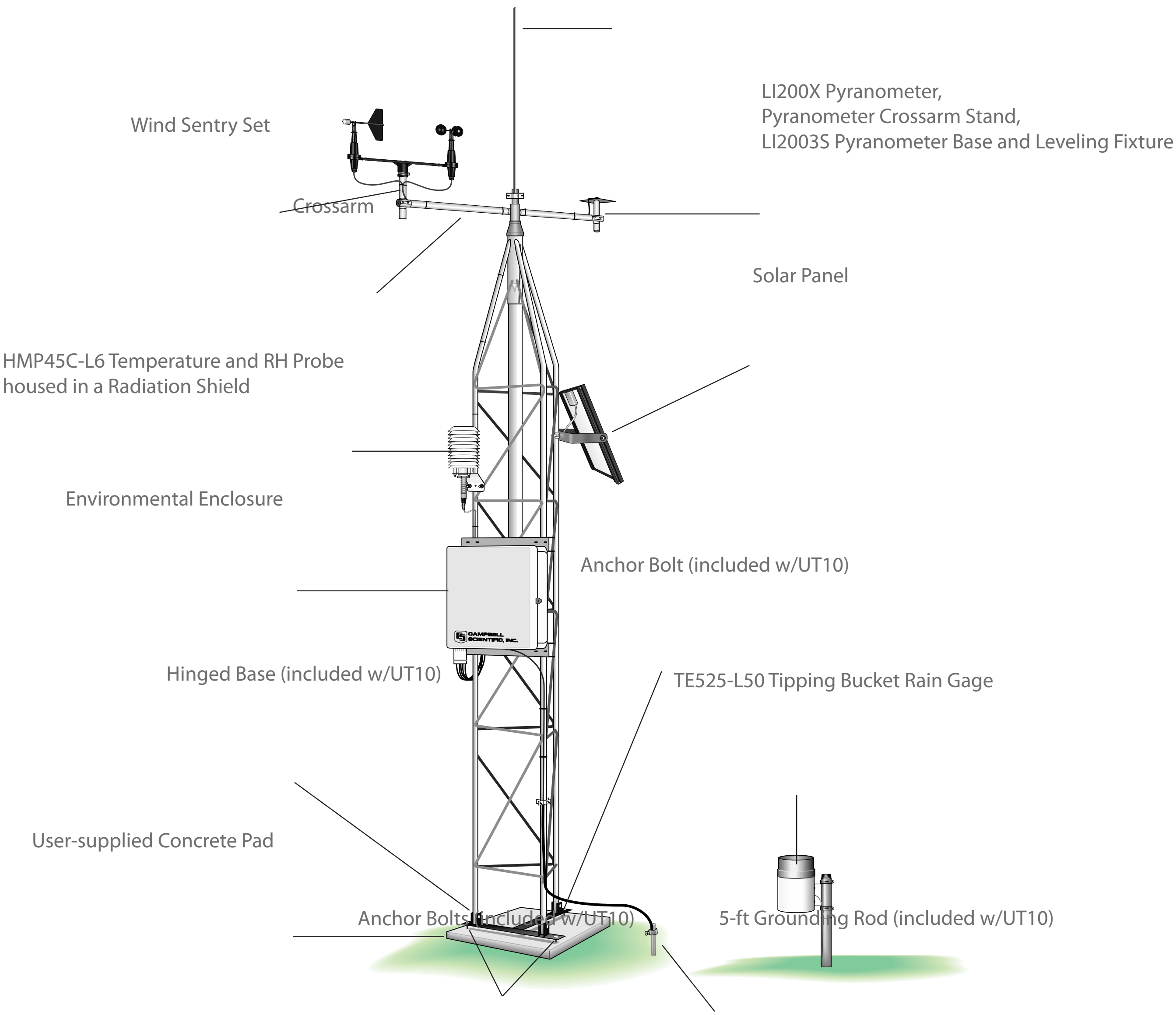
**Wind Load Recommendation**
**(see note 3):** 110 mph maximum

**Pipes Outer Diameter (OD)**
**Vertical:** 1 in. (2.5 cm)
**Cross Support:** 0.375 in. (0.953 cm)

**Leg Spacing:** 10.25 in. (26 cm) between legs (center to center)

**Material:** Aluminum

**Shipping Weight:** 40 lbs (18 kg)




*Notes:*

1. *Refer to the "Instrumentation Mounts" product brochure for crossarm, solar radiation mounts, and radiation shield options.*
2. *The concrete pad requirements assume heavy soil; light, shifting, or sandy soils require a larger concrete pad.*
3. *The wind load recommendation assumes proper installation, proper anchoring, adequate soil, and total instrument projected area of less than 2 square feet. The amount of wind load that this mount can withstand is affected by quality of anchoring and installation, soil type, and the number, type, and location of instruments fastened to the UT10.*

# NL115

## Ethernet Interface and CompactFlash® Module

## Specifications

| | |
|---|---|
| **Compliance:** | CE Compliant |
| **Power Requirements:** | 12 V supplied through the datalogger's peripheral port |
| **Current Drain:** | 20 mA (CR1000 w/NL115 communicating over Ethernet)<br>43 mA (CR1000 w/NL115 communicating over Ethernet and accessing CF-card) |
| **Temperature Range** | |
| **Standard:** | -25° to +50°C |
| **Extended:** | -40° to +85°C |
| **EMI and ESD Protection:** | Meets requirements for a class A device under European Standards |
| **Application of Council Directive(s):** | 89/336/EEC as amended by 89/336/EEC and 93/68/EEC |
| **Standards to which Conformity is Declared:** | EN55022-1; 1995 and EN50082-1: 1992 |
| **Typical Access Speed[2]:** | 200 to 400 kbits $s^{-1}$ |
| **Memory Configuration:** | User selectable; ring (default) or fill-and-stop |
| **Datalogger Operating System (OS):** | The CR1000's OS must be OS 9 or later. Both the CR1000 and CR3000 need OS 25 or later to read cards with more than 2 GB of storage. |


| | |
|---|---|
| **Software Requirements** | |
| **LoggerNet:** | Version 3.2 or later |
| **PC400:** | Version 1.3 or later |
| **DevConfig:** | Version 1.5 or later |
| **Cable Requirements:** | Ethernet cable must be shielded if the length is greater than 9 ft |
| **CF Card Requirements:** | Industrial grade |
| **Dimensions:** | 10.2 x 8.9 x 6.4 cm (4.0 x 3.5 x 2.5 in.) |
| **Weight:** | 154 g (5.4 oz) |

[2] *Typical Access Speed varies between dataloggers.*


CR1000

NL115 connects directly to the peripheral port

# NL120

## 10baseT Ethernet Module

### Specifications

| | |
|---|---|
| **Power Requirements:** | 12 V supplied through the datalogger's peripheral port |
| **Current Drain:** | 20 mA |
| **Temperature Range** | |
| **Standard:** | -25° to +50°C |
| **Extended:** | -40° to +85°C |
| **Software Requirements** | |
| **LoggerNet:** | Version 3.2 or later |
| **PC400:** | Version 1.3 or later |
| **DevConfig:** | Version 1.5 or later |
| **Cable Requirements:** | Ethernet cable must be shielded if the length is greater than 9 ft |

| | |
|---|---|
| **EMI and ESD Protection:** | Meets requirements for a class A device under European Standards |
| **Application of Council Directive(s):** | 89/336/EEC as amended by 89/336/EEC and 93/68/EEC |
| **Standards to which Conformity is Declared:** | EN55022-1; 1995 and EN50082-1: 1992 |
| **Dimensions:** | 10.2 x 2.8 x 6.4 cm (4.0 x 1.1 x 2.5 in.) |
| **Weight:** | 66.62 g (2.4 oz) |

NL120 connects directly to the peripheral port

CR1000

# RavenXT-Series

## Sierra Wireless Airlink Digital Cellular Modems

### Specifications

| | RavenXTV | RavenXTG |
|---|---|---|
| **Technology** | CDMA 1xRTT, EVDO Rev. A, CDMA IS-95, dual band | GPRS (MS-12), quad band |
| **Bands** | **Dual band:** 800 MHz Cellular, 1900 MHz PCS | **Quad band:** 850/1900 MHz; 900/1800 MHz |
| **Transmit Frequency** | 1850 to 1910 MHz and 824 to 849 MHz | **850/1900 MHz:** 824 to 849 MHz; 1850 to 1910 MHz<br>**900/1800 MHz:** 890 to 915 MHz; 1710 to 1785 MHz |
| **Transmit Power** | 1.0 W for 1900 MHz; 0.8 W for 850 MHz | 1.0 W for 1900 MHz; 0.8 W for 850 MHz |
| **Receiver Frequency** | 1930 to 1990 MHz and 869 to 894 MHz | **850/1900 MHz:** 869 to 894 MHz; 1930 to 1990 MHz<br>**900/1800 MHz:** 935 to 960 MHz; 1805 to 1880 MHz |
| **CDMA or GPRS Throughput** | up to 80 kbps (CDMA) | up to 70 kbps (GPRS) |
| **RS-232 Data Rates** | 1200 bps to 115.2 kbps | 1200 bps to 115.2 kbps |
| **Serial Interface** | RS-232, DB9-F | RS-232, DB9-F |
| **Serial Protocols** | AT Commands, PPP, SLIP, UDP/IP, TCP/IP | AT Commands, PPP, SLIP, UDP, TCP |
| **RF Antenna Connector** | 50 Ohm SMA | 50 Ohm SMA |
| **Input Current Range** | 50 to 250 mA | 40 to 250 mA |
| **Typical Current Drain (at 12 Vdc)** | 50 mA dormant (idle for 10 to 20 seconds), 120 mA transmit/receive | 50 mA dormant (idle for 10 to 20 seconds), 120 mA transmit/receive |
| **Input Voltage Range** | 6 to 28 Vdc | 6 to 28 Vdc |
| **Operating Temperature Range** | -30° to +70°C | -30° to +65°C |
| **Operating Humidity Range** | 5% to 95% RH non-condensing | 5% to 95% RH non-condensing |
| **Status LEDs** | Power, Network, Signal, Activity | Power, Network, Signal, Activity |
| **Width** | 7.6 cm (3 in.) | 7.6 cm (3 in.) |
| **Depth** | 2.5 cm (1 in.) | 2.5 cm (1 in.) |
| **Length** | 10 cm (4 in.) | 10 cm (4 in.) |
| **Weight** | <0.5 kg (<1 lb) | <0.5 kg (<1 lb) |

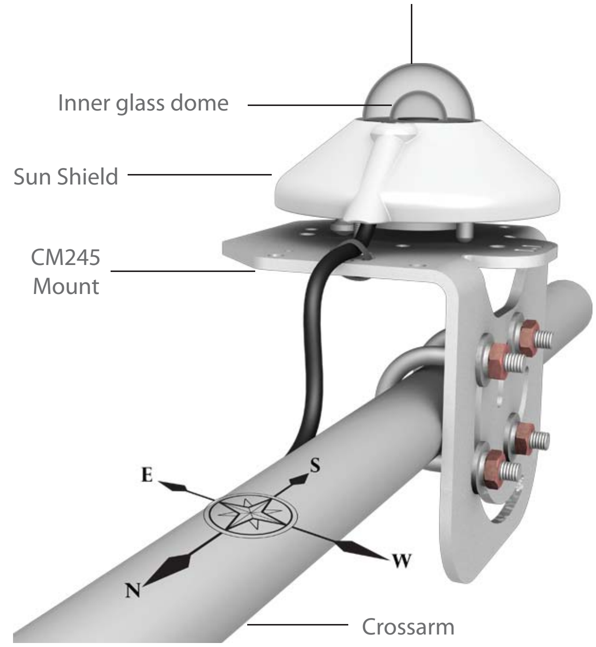
# CM245 and CVF3

## Mounts for CMP-Series Pyranometers

### *CM245 Adjustable Angle, Mounting Stand*

**Compatible Pipes:** 1 to 2.1 in. outer diameter


Slots in the CM245 mount can be adjusted to any angle from horizontal to vertical.




The pyranometer is typically mounted and leveled horizontally.

### *CVF3 Heater/Ventilator*

**Power Supply:** 12 Vdc, 1.3 A (with 10 W Heater)

**Operating Temperature:** -40° to +70°C

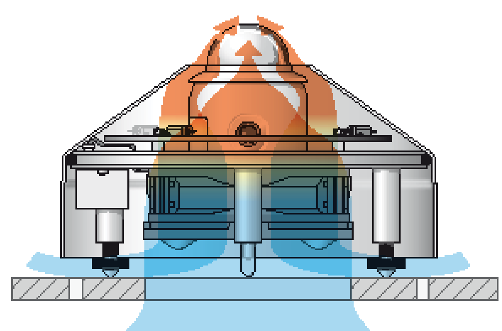
**Ventilation Power:** 5 W continuously

**Heating Power:** 5 W or 10 W

**Heater Induced Offset:** <1 W/m$^2$ (with CMP11)

**Weight without cable:** 3.5 lb (1.6 kg)

**Dimensions**
- **Height:** 5.1 in. (12.9 cm)
- **Diameter:** 8.8 in. (22.4 cm)



Transparent view of the CVF3 shows air drawn and heated over the pyranometer.