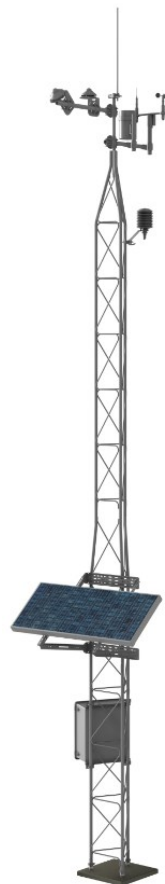




# UT20 and UT30

## Universal Towers



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# 1. Introduction

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The UT20 and UT30 are durable, lightweight instrument towers used for a variety of applications. They support a 6 m (20 ft) or 9 m (30 ft) measurement height for wind sensors as well as sturdy attachment points for antennas, solar panels, environmental enclosures, radiation shields, and crossarms. A retractable mast at the top of the tower adds increased flexibility in the placement of sensors at the top of the tower.

**NOTE:**

Throughout the manual, the term "tower" refers to both the UT20 and UT30, unless specified otherwise.

## 2. Precautions

---

### 2.1 Site selection

- Select a safe site to install the tower.
- The distance between any power lines and the installation site should be at least one and one-half times the height of the tower. Make the distance even greater, if possible. Since all overhead lines look somewhat alike, consider them all dangerous and stay well away from them.
- If there are power lines or buried utilities in the area, call the local utility providers for assistance.

### 2.2 Tower mounting

- NEVER work alone; always have someone near who can summon help.
- Certain clothing may provide a degree of safety, but do not depend on it alone to preserve life (for example, rubber boots or shoes, industrial rubber gloves, or a long shirt or jacket).
- Check local weather conditions. Be sure it has not rained recently, and the ground is not wet or muddy. Make sure rain or thunderstorms are not predicted for the day the tower is to be installed.



- To avoid having the tower being blown into nearby power lines, do not install or remove towers in moderate or heavy winds.
- If it is necessary to use a ladder, choose a ladder made of non-conductive, non-metallic materials.
- Have someone present who has been trained in electric shock first aid, if possible.

## 2.3 Tower installation

- Properly assemble the tower according to the instructions in this manual (do this in the location the tower is to be installed).
- Once the tower is in its full vertical position, securely fasten the tower to the base.
- Ground the tower in accordance with all applicable local electrical codes.
- Keep the bottom of the tower legs free of soil, ice, and debris to prevent trapping any moisture inside or around the tower legs.

# 3. Initial inspection

---

## 3.1 Indoors

Immediately upon receipt of the tower:

- Inspect the shipping cartons for visible damage. Report any damage to the shipping company.
- Open all shipping cartons.
- Check the contents of the cartons against the invoice. Contact Campbell Scientific immediately if any parts are missing.

## 3.2 Outdoors

- Locate a suitable site for the tower ([Siting and exposure](#) (p. 3)).
- Prepare the tower base ([Tower installation](#) (p. 9)).
  - Install sensors to be mounted above a height of 3 m.
  - Raise the tower ([Tower installation](#) (p. 9)).

- Install the instrumentation enclosure ([Tower installation](#) (p. 9)).
- Install sensors to be mounted below a height of 3 m.

## 3.3 Tools required

Tools required to install and maintain a Campbell Scientific tower:

- Shovel
- Rake
- Open end wrenches: 3/8 in, 7/16 in, 1/2 in, (2) 9/16 in
- Socket wrench set
- Magnetic compass
- Tape measure
- Nut driver (3/8 in)
- Level
- Sledgehammer
- Pliers
- Flat-bladed screwdrivers
- Phillips screwdrivers

Additional tools required for [Concrete anchor installation](#) (p. 27):

- Hammer drill
- 3/4-inch masonry drill bit
- Eye protection
- Filter mask
- Wire brush (or compressed air)

## 4. Siting and exposure

### **DANGER:**

If any part of the weather station comes into contact with power lines, death or serious injury could occur. Contact local utilities for the location of buried utility lines before digging or driving ground rods.

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

Do not place the weather station where sprinkler irrigation water will strike the sensors or instrument enclosure.

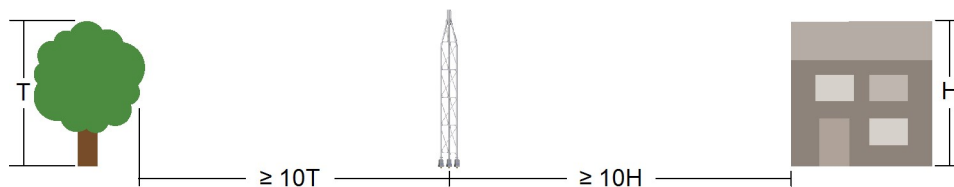
The general guidelines for site selection given here were condensed from these sources: Environmental Protection Agency (EPA) (2000)<sup>1</sup>, World Meteorological Organization (WMO) (2010)<sup>2</sup>, and American Association of State Climatologists (AASC) (1985)<sup>3</sup>.

## 4.1 Wind speed and direction

As specified by the EPA<sup>1</sup>, wind sensors should be located over open, level terrain at a distance at least ten times the height of any nearby buildings, trees, or other obstructions as shown in [FIGURE 4-1](#) (p. 4).

Standard measurement heights:

- 3.0 m  $\pm$  0.1 m recommended (AASC)
- 2.0 m  $\pm$  0.1 m, 10.0 m  $\pm$  0.5 m optional (AASC)
- 10.0 m (WMO and EPA)



*FIGURE 4-1. Effect of a structure on wind flow*

## 4.2 Temperature and relative humidity

Sensors should be located over an open, level area at least 9 m (EPA<sup>1</sup>) in diameter. The surface should be covered by short grass, or, where grass does not grow, the natural earth surface. Locate sensors at a distance of at least four times the height of any nearby obstructions and at least 30 m (EPA<sup>1</sup>) from paved areas. Sensors must be protected from thermal radiation and adequately ventilated.

Situations to avoid include:

- Industrial heat sources
- Rooftops
- Steep slopes
- Sheltered hollows
- Tall vegetation
- Shaded areas

- Swamps
- Areas where snow drifts occur
- Low places holding standing water after rainstorms

Standard measurement heights:

- 1.5 m  $\pm$  1.0 m (AASC)
- 1.25 to 2.00 m (WMO)
- 2.0 m temperature (EPA)
- 2.0 m and 10.0 m for temperature difference (EPA)

## 4.3 Precipitation

Rain gages must be sited on level ground covered with short grass or gravel. In open areas, choose a site where the distance to any obstruction is two to four times (EPA, AASC) the height of the obstruction.

Position the height of the opening as low as possible, but high enough to avoid splashing from the ground. Wind shields, such as Campbell Scientific 260 953 Alter-Type Rain Gage Wind Screen, are recommended for open areas.

When necessary, use heated collectors to properly measure frozen precipitation. The gage must be mounted above the average level of snow accumulation in areas that experience significant snowfall.

Standard measurement heights:

- 1.0 m  $\pm$  1.0 cm (AASC)
- 30.0 cm minimum (WMO, EPA)

## 4.4 Solar radiation

Mount pyranometers in locations that avoid shadows on the sensor at any time. Mounting the sensor on the Southernmost (Northern Hemisphere) or Northernmost (Southern Hemisphere) portion of the weather station will minimize the chance of shading from other weather station structures. Reflective surfaces and sources of artificial radiation must be avoided.

Heated pyranometers, such as the SP230-L from Campbell Scientific, are available for use in areas where snow, frost, or dew may accumulate.

The height the sensor is mounted is not critical.

## 4.5 Soil temperature

Prepare a site for soil temperature measurements at least one square meter and typical of the surface of interest. The ground surface must be level to the immediate area (10 m radius).

Standard measurement depths:

- 10 cm  $\pm$  1.0 cm (AASC)
- 5.0 cm, 10.0 cm, 50.0 cm, 100.0 cm (WMO)

## 4.6 Siting references

<sup>1</sup> EPA, (2000). Meteorological Monitoring Guidance for Regulatory Modeling Applications, DPA-454/R-99-005. Office of Air Quality Planning and Standards, Research Triangle park, NC. 27711

<sup>2</sup> WMO, (2008 edition, updated in 2010). Guide to Meteorological Instruments and Methods of observation. World Meteorological Organization No 8, 2008 edition, Geneva Switzerland.

<sup>3</sup> The State Climatologist, (1985). Publication of the American Association of State Climatologists: Height and Exposure Standards for Sensors on Automated Weather Stations, v. 9, No. 4, October 1985.

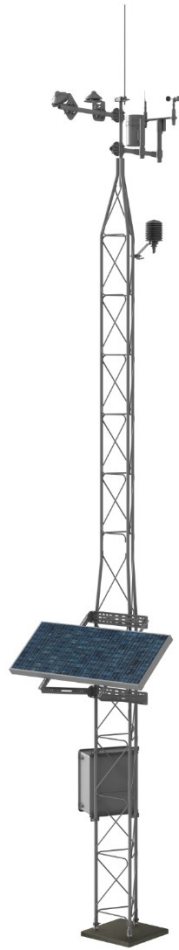
# 5. Overview

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The UT20 and UT30 towers provide a versatile mount for sensors, antennas, solar panels, environmental enclosures, radiation shields, and mounting crossarms. Its 6 m (20 ft) or 9 m (30 ft) height allows for wind measurements at those levels.

The bottom tower frame ([FIGURE 5-1](#) (p. 7)) is built from 3.18 cm (1.25 in) OD (outside diameter) corrosion-resistant aluminum tubing. The upper sections are built from 2.5 cm (1 in) OD tubing. It includes an adjustable mast, increasing sensor mounting options on the tower.

Enclosures purchased for use with this tower must be ordered with the tower mount option. This provides the necessary bracketing to mount the enclosure to the tower.



*FIGURE 5-1. UT20 tower*

## 6. Specifications

	UT20	UT30
Measurement height	6 m (20 ft)	10 m (30 ft)
Shipping weight	23 kg (50 lb)	29 kg (65 lb)
Material	Hardened drawn 6063-T832 Aluminum	
Top tower section 3 m tube OD (outside diameter)	2.5 cm (1 in)	2.5 cm (1 in)
Top tower section width (center of tubing to center of tubing)	33.3 cm (13.1 in)	25.7 cm (10.1 in)
Center tower section tube OD	n/a	2.5 cm (1 in)
Center tower section width (center of tubing to center of tubing)	n/a	33.3 cm (13.1 in)
Bottom tower section tube OD	3.175 cm (1.25 in)	2.175 cm (1.25 in)
Bottom tower section width (center of tubing to center of tubing)	43.2 cm (17 in)	43.2 cm (17 in)
Adjustable mast OD	3.175 cm (1.25 in)	
Adjustable mast length	1.5 m (5.0 ft)	
Cross support pipe OD	0.953 cm (0.375 in)	
Guyed tower area requirements	~3.5 m (11.5 ft) radius	~5 m (17 ft) radius
Required concrete pad dimensions for UTBASE concrete mounting base (note 1)	91 L x 91 W x 122 D cm (36 x 36 x 48 in)	
Maximum wind load recommendations (note 2)	177 km/h (110 mph) for gusts (UTBASE base, unguyed) 177 km/h (110 mph) for gusts (RBM18 base with/UTGUY)	
UTGUY material		
UTGUY	Mixture of galvanized steel and 304 stainless steel	
UTGUYSS	304 stainless steel	

Notes:

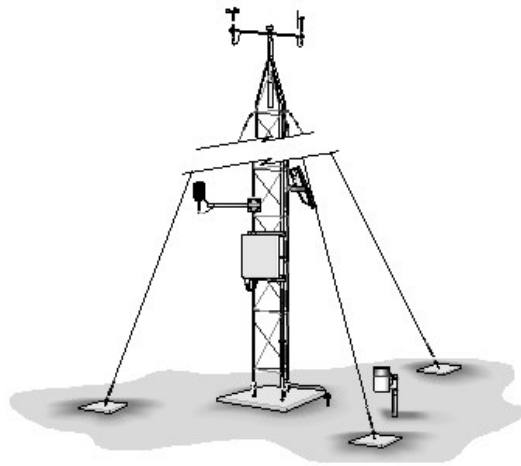
1. The concrete pad requirements assume heavy soil. Light, shifting, or sandy soils require a bigger concrete pad.
2. The recommended wind load assumes proper installation, proper anchoring, and total instrument projected area of less than two square feet. For the RFM18 base, the wind load recommendation also assumes that the UTGUY turnbuckles are preloaded to equalize tension, and the tower is guyed at a 60-degree angle relative to the ground (maximum). The amount of wind load that these towers can withstand is affected by quality of anchoring and installation, guy wire tension, soil type, guy angle, and the number, type, and location of instruments fastened to the tower.

## 7. Tower installation

---

### 7.1 Installing the tower

The tower provides a support structure for mounting the weather station components. [FIGURE 7-1](#) (p. 9) shows a typical tower equipped with an instrumentation enclosure, meteorological sensors, and a solar panel.



*FIGURE 7-1. Weather tower*



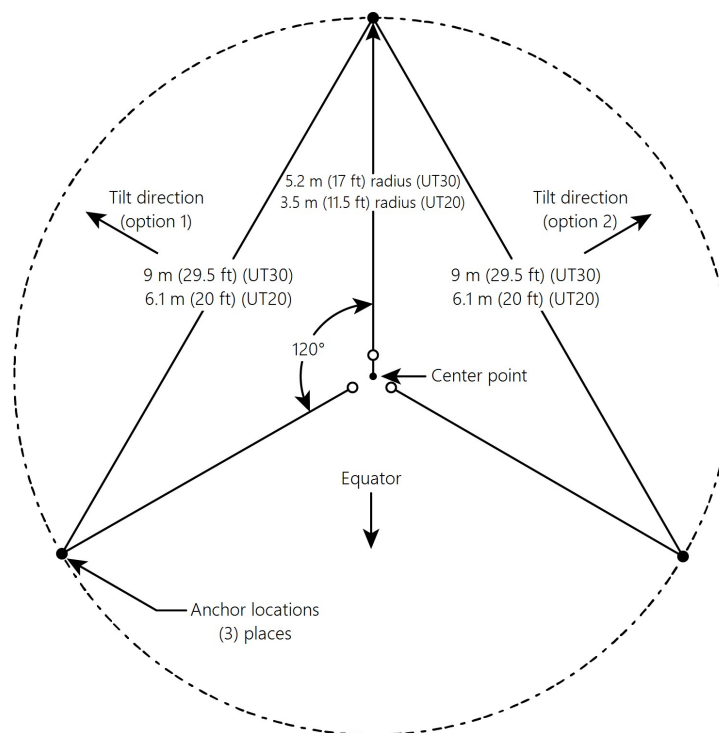
## 7.1.1 Base and Guy Anchor Layout

The tower attaches to a user-supplied concrete foundation as shown in [FIGURE 7-1](#) (p. 9). The base brackets, anchor bolts, and nuts are included with the tower.

A guyed UT20 tower requires an area approximately 3.5 m (11.5 ft) in radius, and a guyed UT30 tower requires an area approximately 5.2 m (17 ft) in radius. Brush and tall weeds need to be removed. Otherwise, the natural vegetation and ground surface should be disturbed as little as possible.

Drive a stake where the base of the tower will be located. Attach a line to the stake and scribe a circle with an 3.5 m (11.5 ft) radius for the UT20 or a 5.2 m (17 ft) radius for the UT30. The tower is typically positioned so two legs will be parallel to the equator as well as closest to the equator. The tower will then tilt away from the equator at an angle for servicing as shown by the two tilt direction options in [FIGURE 7-2](#) (p. 10). See [FIGURE 7-10](#) (p. 17) for other tilting options. Drive a stake on the scribed line opposite the direction the tower will hinge for the first guy anchor location.

When using a UT30 on level ground, lay out the remaining two anchor locations by measuring 9 m (29.5 ft) from the first anchor to the scribed line on either side of the base stake ([FIGURE 7-2](#) (p. 10)). When using a UT20 on level ground, lay out the two remaining anchor locations 6.1 m (20 ft) from the first anchor to the scribed line on either side of the base stake.



*FIGURE 7-2. Guy anchor locations on level ground*

On unlevel ground, use a compass at the base stake to lay out the remaining two anchor locations 120 degrees from the first. Vary the distance between the tower and each anchor so that the angle between the tower and the guy wire will be approximately 30 degrees.

## 7.1.2 Tower base installation

There are three base options: the UTBASE and B18 bases are poured in concrete; the RFM18 roof mount base is anchored to a flat surface.

### 7.1.2.1 UTBASE installation using a template support assembly

For the concrete form and template support assembly, the following parts are needed:

- 38 x 89 mm (2 x 4 in) lumber of the following lengths:
  - Two 152.4 cm (60 in)- long side of concrete form
  - Two 91.4 cm (36 in)- short side of concrete form
  - Two 109.2 cm (43 in)- template support assembly
- four stakes
- 70 mm (2.5 in) wood or deck screws
- 25 mm (1 in) wood screws

The installation requires approximately 1 cubic meter (1.33 cubic yards) of 3000 PSI concrete.

1. Dig a hole 0.9 m (36 in) square and 1.2 m (48 in) deep where the tower base will be located (FIGURE 7-3 (p. 11)).

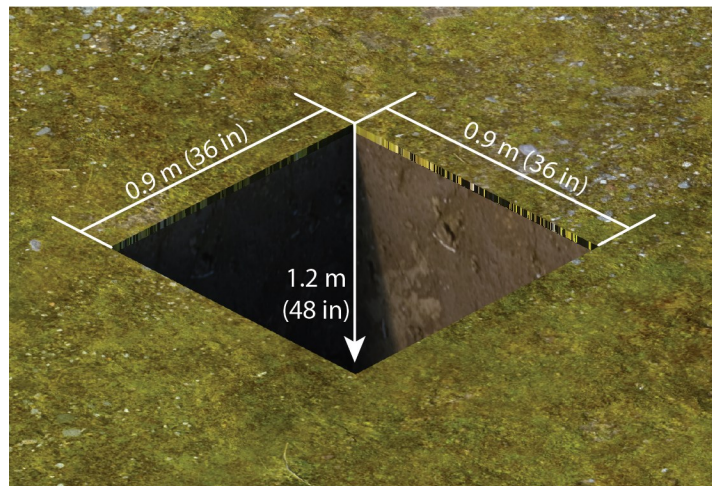


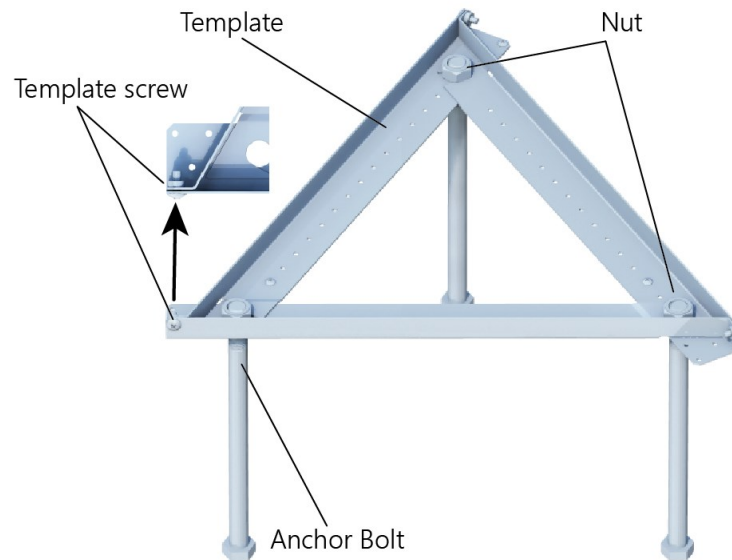
FIGURE 7-3. Hole prepared for tower base

2. Assemble the template and anchor bolts as shown in [FIGURE 7-4](#) (p. 12). Each template piece is secured to the next with a template screw.

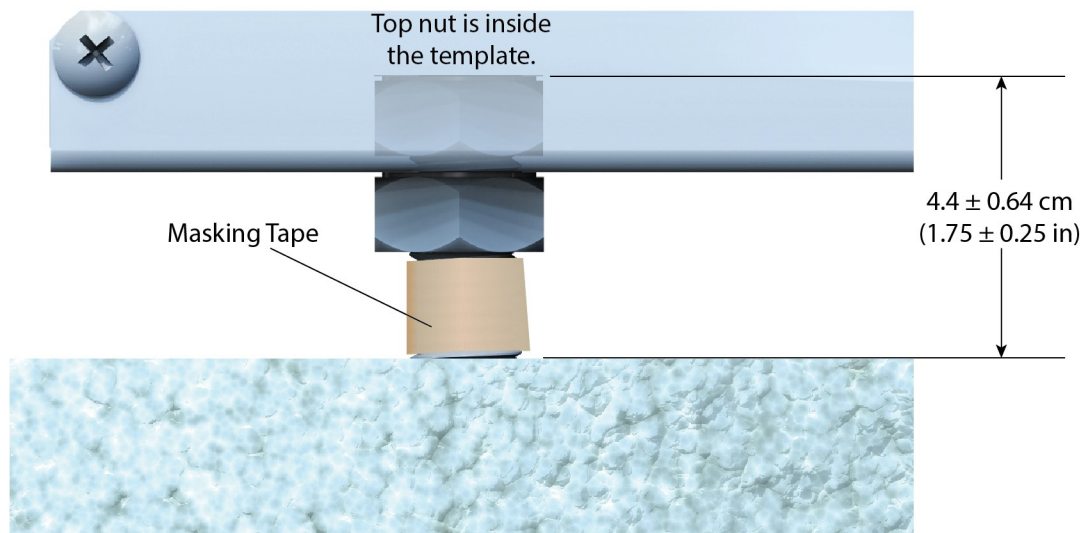
Once the three pieces are connected, thread a nut onto each anchor bolt, insert the bolt through the template, and thread a second nut onto the bolt as shown in [FIGURE 7-5](#) (p. 13). Tighten the lower nuts to secure the template against the upper nuts.

Wrap the visible threads next to the lower nut with masking tape to keep the threads clean as the concrete is placed as shown in [FIGURE 7-5](#) (p. 13).

If the metal template was not purchased, refer to [UTBASE paper template](#) (p. 51) for instructions on making a wood template.



*FIGURE 7-4. Template assembly*



*FIGURE 7-5. Anchor bolt height above concrete*

**NOTE:**

The anchor bolts must remain vertical when installed in the concrete pad. This will ensure the tower legs are adjustable after installation of the clevises. If an anchor bolt is installed on an angle, it will interfere with the leg when leveling the tower.



3. Construct the concrete form out of 38 x 89 mm (2 x 4 in) lumber as shown in [FIGURE 7-6](#) (p. 14). Use the two 109.2 cm (43 in) pieces of lumber to create the template support assembly, attaching them to the template as shown.

Place the template support assembly on the concrete form and adjust the position of the template to match the dimensions in [FIGURE 7-6](#) (p. 14). Secure the template support assembly to the concrete form.

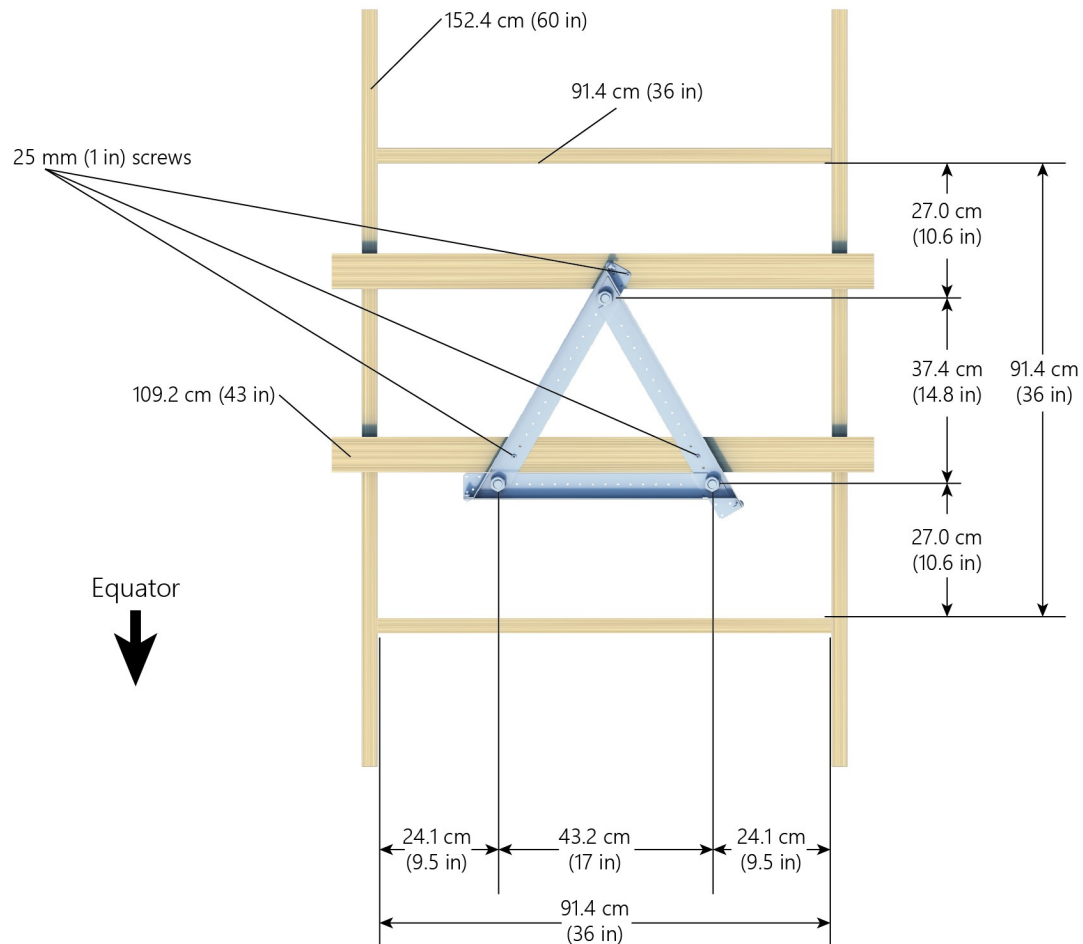
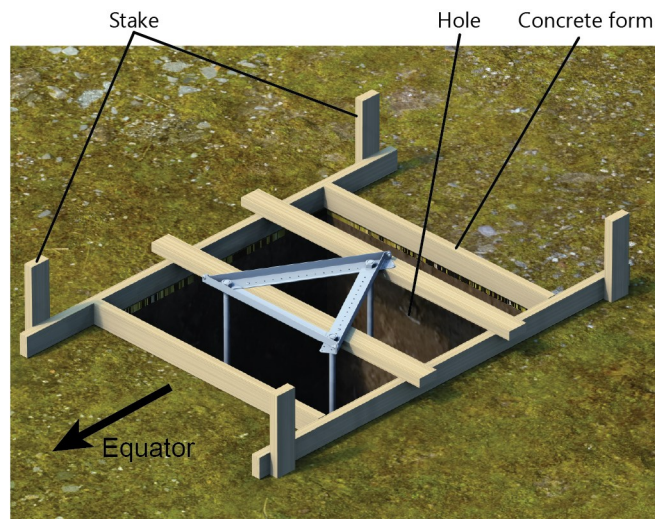


FIGURE 7-6. Concrete form and template frame dimensions

4. Center the concrete form over the hole. Orient the form so one side of the template faces the equator. This arrangement is optimal for mounting a solar panel on two tower legs facing the equator. In instances where a crossarm needs to run perpendicular to the equator, such as precision pyranometer measurements, rotate the concrete form 90°.

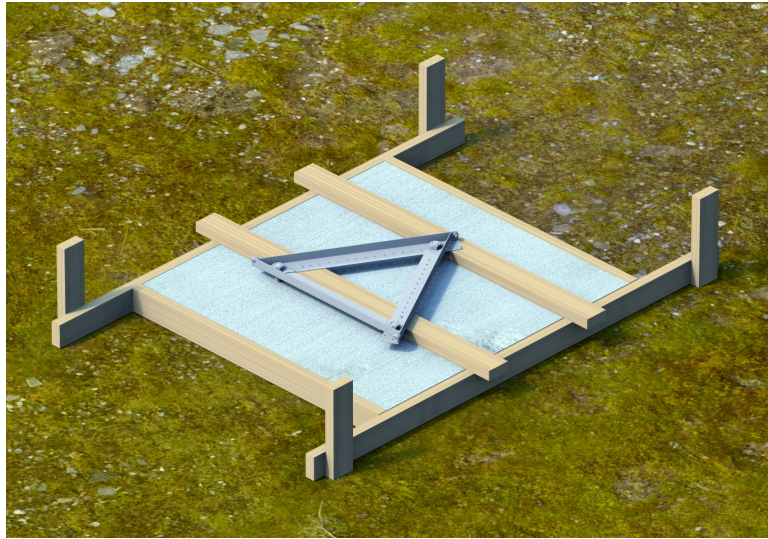
Drive a wooden stake into the ground at each corner of the concrete form (FIGURE 7-7 (p. 15)). Level the form and secure it in position.



*FIGURE 7-7. Concrete form staked in place*

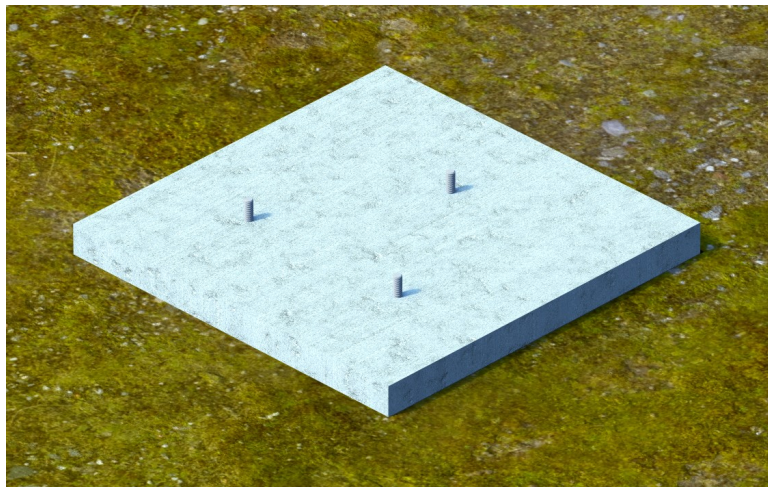


5. Fill the hole with concrete (FIGURE 7-8 (p. 16)). Screed the concrete, then remove the masking tape. Allow at least three to four days for the concrete to cure before proceeding.



*FIGURE 7-8. Template frame placement*

6. Remove the template support assembly, the template, and the concrete form.



*FIGURE 7-9. Concrete base ready for installation*

7. Apply anti-seize lubricant to the anchor bolt threads. Thread a clevis onto each anchor bolt until three threads are visible inside each clevis.

FIGURE 7-10 (p. 17) shows four possible arrangements for the clevises. Images A and B show the recommended placement when a solar panel is to be mounted to the tower. This positioning allows a solar panel to be firmly attached to two tower legs while providing easy access to sensors at the top of the tower. Image C shows the clevises positioned to allow the tower to tilt toward the equator. Image D is used when it is necessary to mount a crossarm running perpendicular to the equator for precision pyranometer measurements.

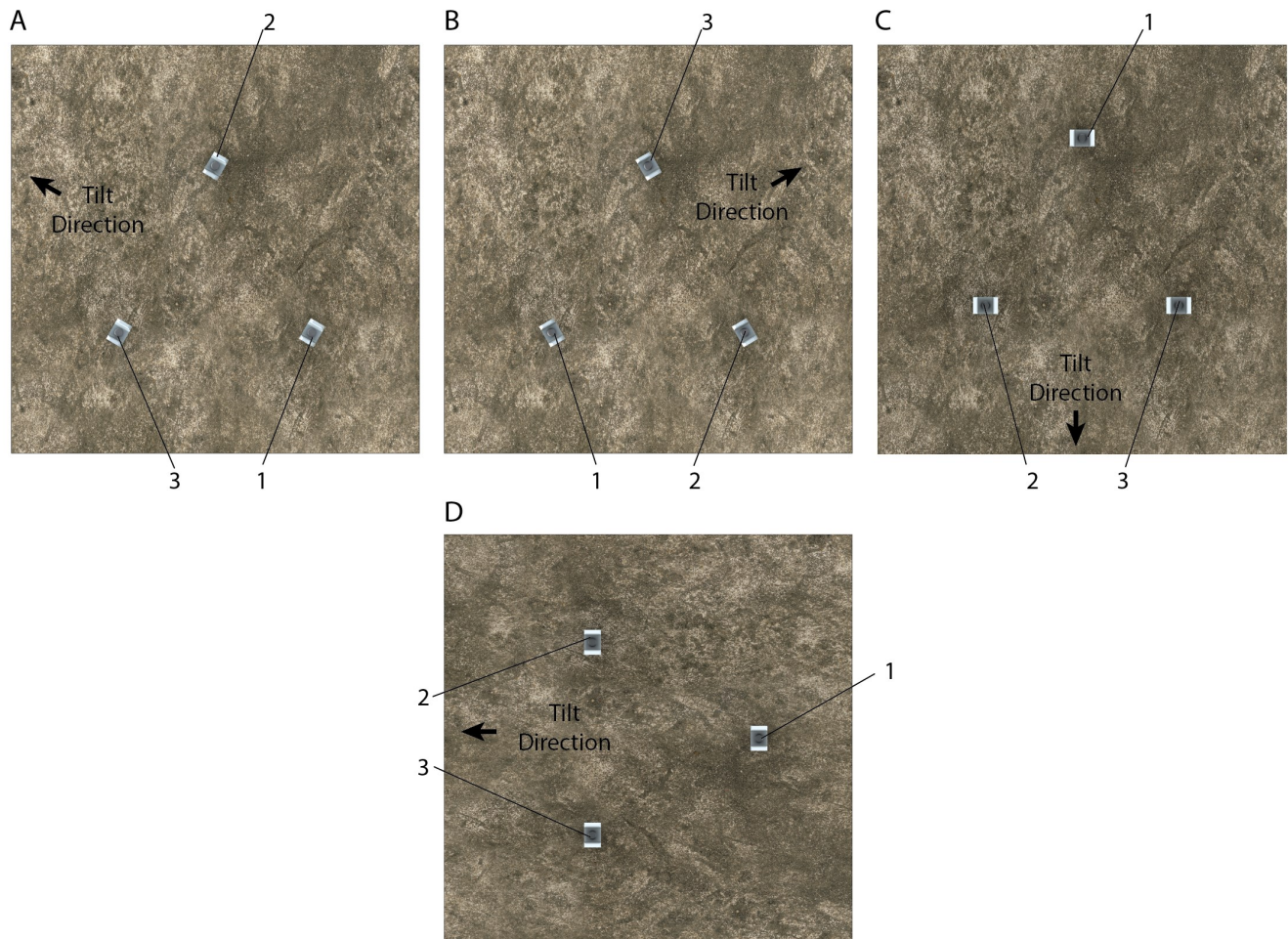
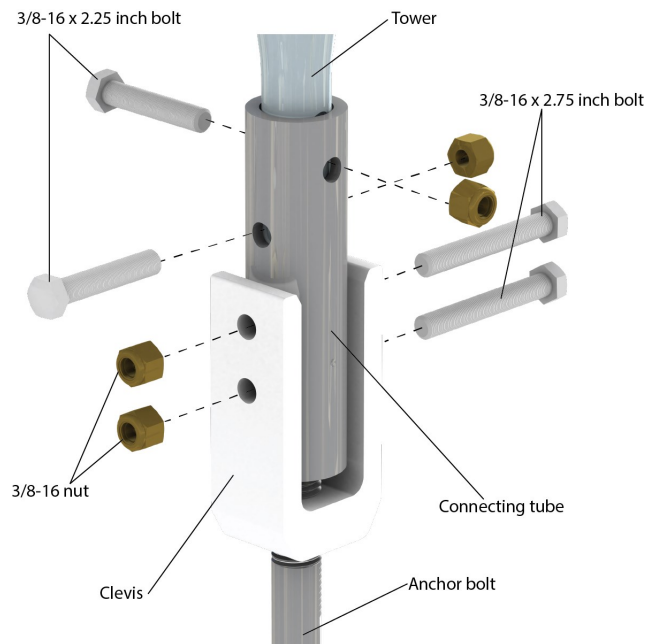


FIGURE 7-10. Clevis angle for proper tilt direction



8. Place a connecting tube inside each clevis and attach it with two 3/8-16 x 2.75-inch bolts and locknuts. Each connecting tube is unique and is numbered 1 to 3. Refer to [FIGURE 7-10](#) (p. 17) for the position of each connecting tube in each tilt direction. Finger-tighten the nuts ([FIGURE 7-11](#) (p. 18)).



*FIGURE 7-11. Tower clevis assembly*

9. With the help of a second person, lower the bottom section of the tower into the three connecting tubes. Secure the tower section to the tubes as shown in [FIGURE 7-11](#) (p. 18).
10. Ensure the tower section is plumb. If the tower is not plumb, choose which leg needs to be adjusted and have a second person support the tower section while adjusting the clevis for the leg needing adjustment.
- Remove both bolts from the clevis.
  - Turn the clevis clockwise to lower the leg and counterclockwise to raise the leg.
  - Reinsert the two bolts and finger-tighten the nuts.
  - Check the tower section again to see if it is plumb. If not, repeat steps a through c to refine the tower position as needed.
11. Fully tighten all the bolts on each leg.

### 7.1.2.2 UTBASE installation without using a template support assembly

It is also possible to install the UTBASE without using a template support assembly. The UTBASE is simply pressed into the freshly placed concrete and repeatedly checked for level until the concrete has set enough to prevent the UTBASE from shifting.

The main disadvantage to this method is the installer must remain at the site until the concrete is set sufficiently to hold the UTBASE in place. This may take several hours. When using a template support assembly, the installer may leave the site immediately after the concrete is placed.

A concrete form is not required when installing the UTBASE with this method but is recommended when a more finished appearance is required.

For the concrete form, the following parts are needed:

- 38 x 89 mm (2 x 4 in) lumber of the following lengths:
  - Two 152.4 cm (60 in)- long side of concrete form
  - Two 91.4 cm (36 in)- short side of concrete form
- four stakes
- 70 mm (2.5 in) wood or deck screws

The installation requires approximately 1 cubic meter (1.33 cubic yards) of 3000 PSI concrete.

1. Dig a hole 0.9 m (36 in) square and 1.2 m (48 in) deep where the tower base will be located (FIGURE 7-12 (p. 19)).

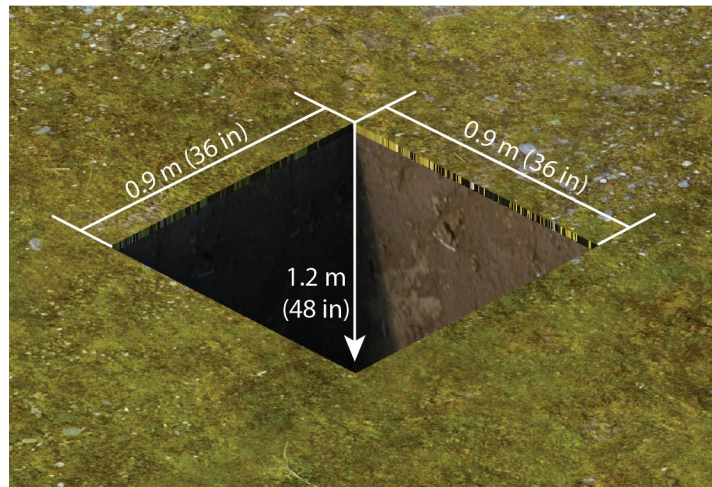


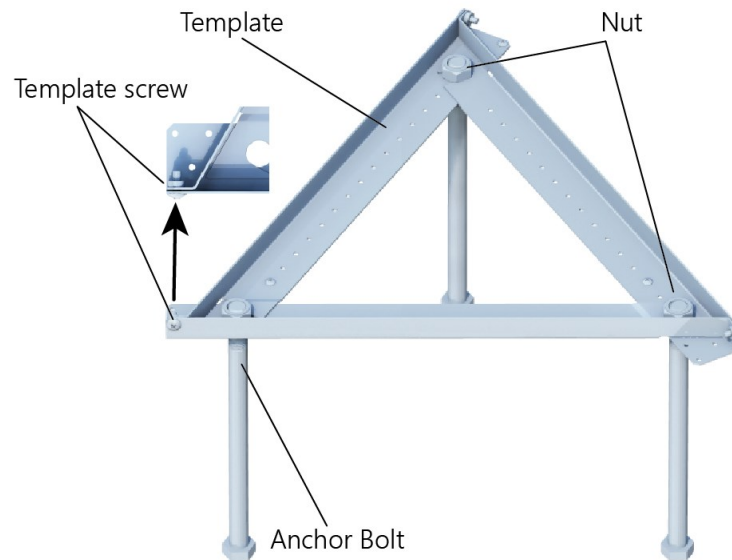
FIGURE 7-12. Hole prepared for tower base

2. Assemble the template and anchor bolts as shown in [FIGURE 7-13](#) (p. 20). Each template piece is secured to the next with a template screw.

Once the three pieces are connected, thread a nut onto each anchor bolt, insert the bolt through the template, and thread a second nut onto the bolt as shown in [FIGURE 7-14](#) (p. 21). Tighten the lower nuts to secure the template against the upper nuts.

Wrap the visible threads next to the lower nut with masking tape to keep the threads clean as the concrete is placed as shown in [FIGURE 7-14](#) (p. 21).

If the metal template was not purchased, refer to [UTBASE paper template](#) (p. 51) for instructions on making a wood template.



*FIGURE 7-13. Template assembly*

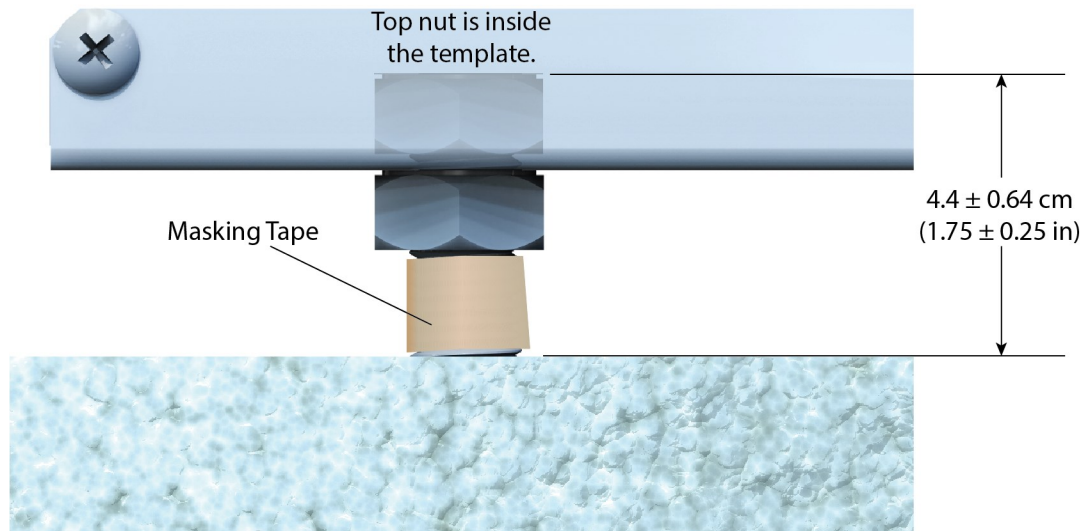


FIGURE 7-14. Anchor bolt height above concrete

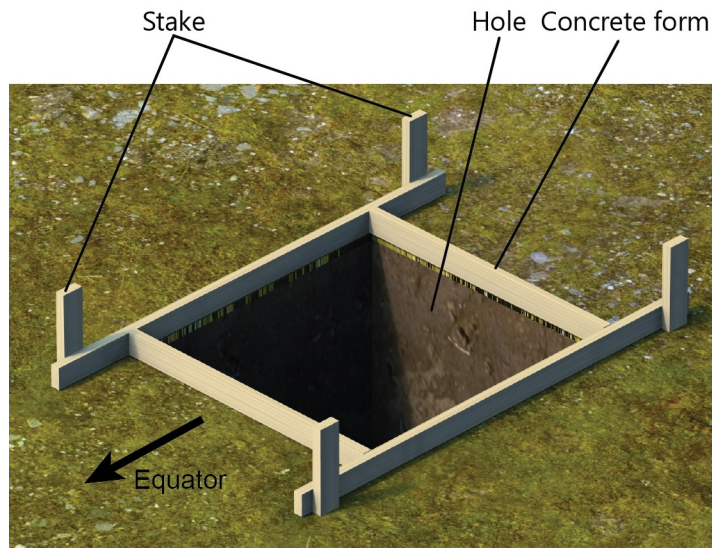
**NOTE:**

The anchor bolts must remain vertical when installed in the concrete pad. This will ensure the tower legs are adjustable after installation of the clevises. If an anchor bolt is installed on an angle, it will interfere with the leg when leveling the tower.



3. If using the concrete form, assemble the form as shown in [FIGURE 7-6](#) (p. 14), then center the concrete form over the hole. Orient the concrete form so one side of the form faces the equator.

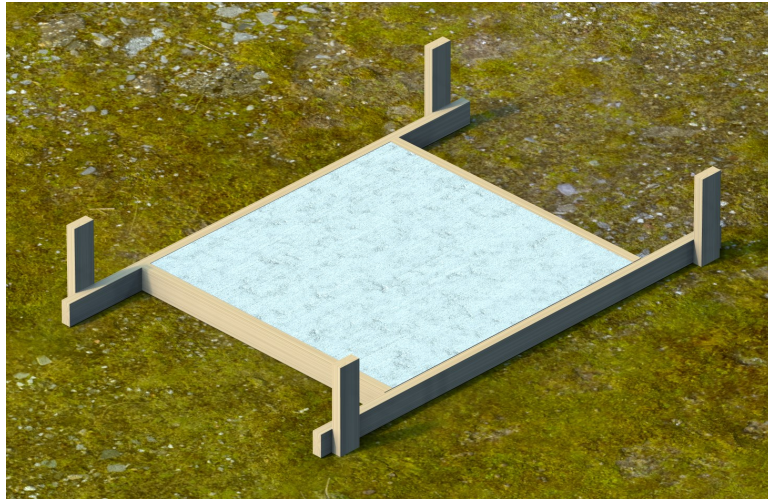
Drive a wooden stake into the ground at each corner of the concrete form ([FIGURE 7-15](#) (p. 22)). Level the form and secure it in position.



*FIGURE 7-15. Concrete form in place*

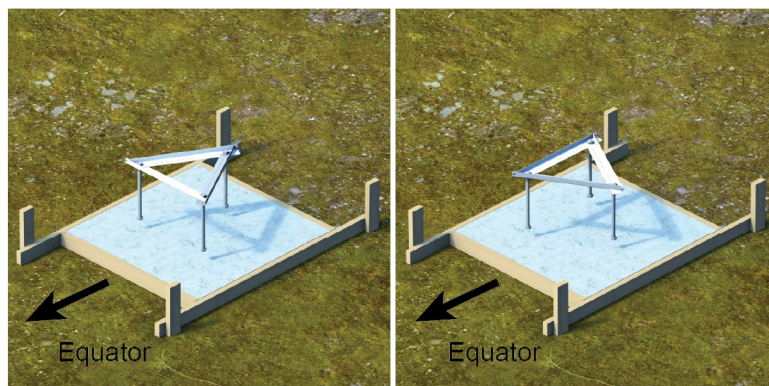


4. Fill the hole with concrete. If using the concrete form, fill the form to the top of the wood frame. Screed the concrete, making sure it is level.



*FIGURE 7-16. Hole filled with concrete*

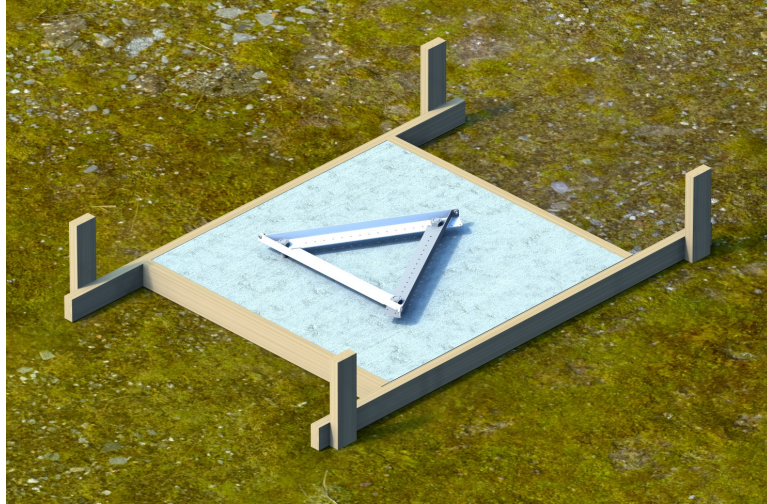
5. Immediately after screeding the concrete, determine the orientation of the UTBASE template. Orient the UTBASE template so one side of the template faces the equator (FIGURE 7-17 (p. 23)). This arrangement is optimal for mounting a solar panel on two tower legs facing the equator. In instances where a crossarm needs to run perpendicular to the equator, such as precision pyranometer measurements, rotate the UTBASE template 90° so one side faces East or West.



*FIGURE 7-17. Template parallel and perpendicular to the equator*

6. Center the UTBASE template over the concrete and press the anchor bolts straight down into the concrete. Use a bouncing motion while working the anchor bolts into the concrete to help prevent any voids from forming around the anchor bolts. Continue pressing the anchor bolts into the concrete only until reaching the tape applied to the threads. See [FIGURE 7-18](#) (p. 24).

Check if the UTBASE template is level. Adjust the template as needed.

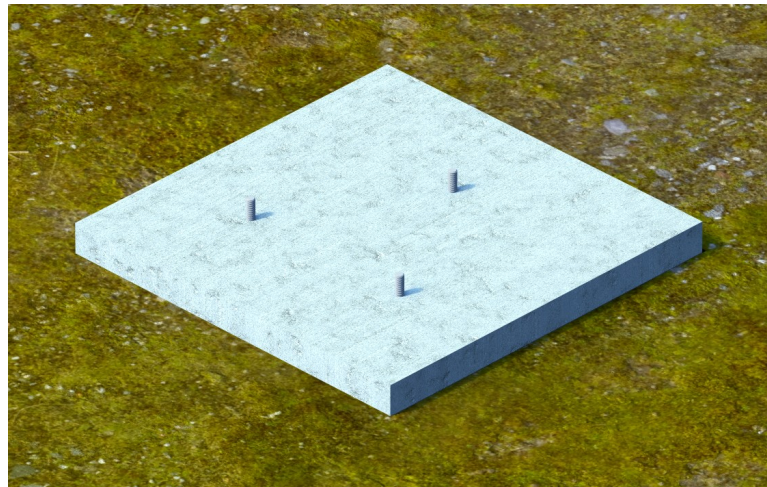


*FIGURE 7-18. UTBASE template embedded in concrete*

7. Remain at the installation site, continuing to ensure the UTBASE template remains level, until the concrete has hardened sufficiently to prevent the anchor bolts from shifting. Allow at least three to four days for the concrete to cure before proceeding.

8. Remove the top nut from each anchor bolt and lift the UTBASE template off. Remove the remaining nuts and masking tape from the anchor bolts.

If the concrete form was used, remove it.



*FIGURE 7-19. Concrete base ready for installation*

9. Complete the installation beginning with [step 7 in the "UTBASE installation using a template support assembly" section](#).

### 7.1.2.3 RFM18 base installation

Position the RFM18 on the surface where it will be installed. Make sure the hinge direction is correct and mark the locations of the four mounting holes. Refer to [FIGURE 7-27](#) (p. 33) for possible tilt directions. [FIGURE 7-20](#) (p. 26) shows the RFM18 dimensions and hole spacing. Install a user-supplied anchor in each hole.



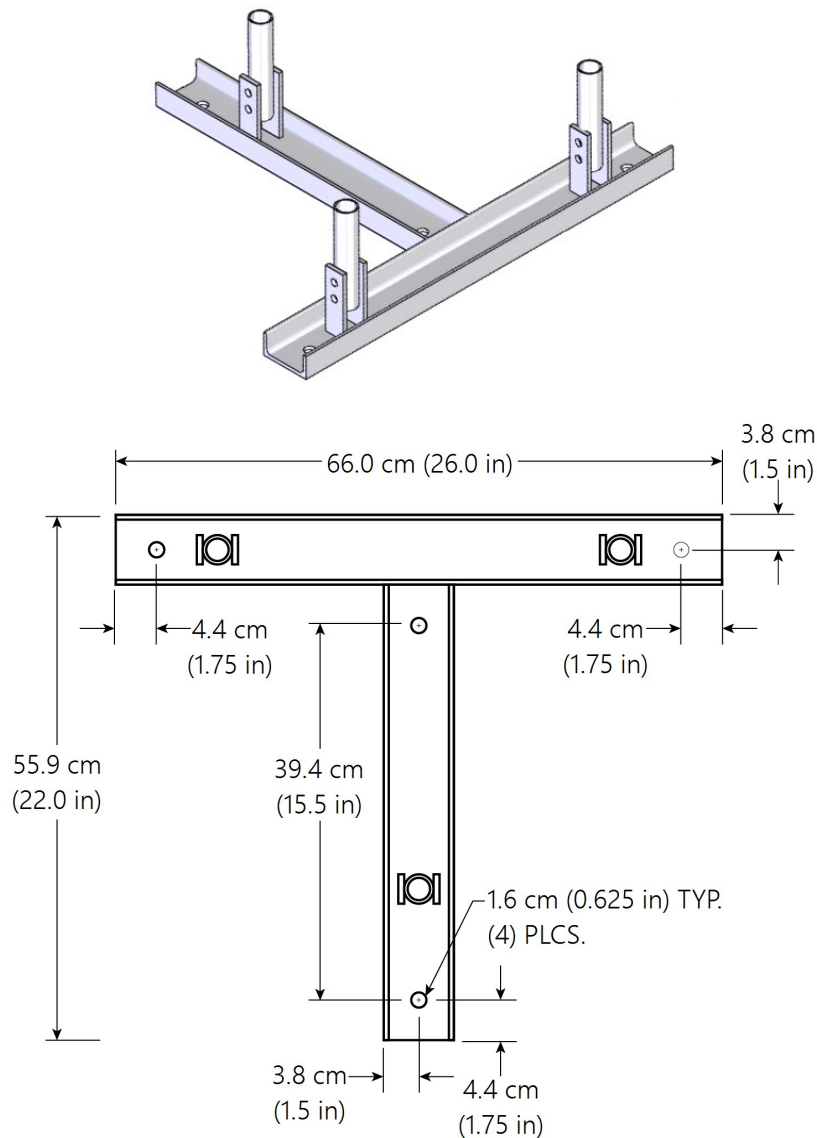
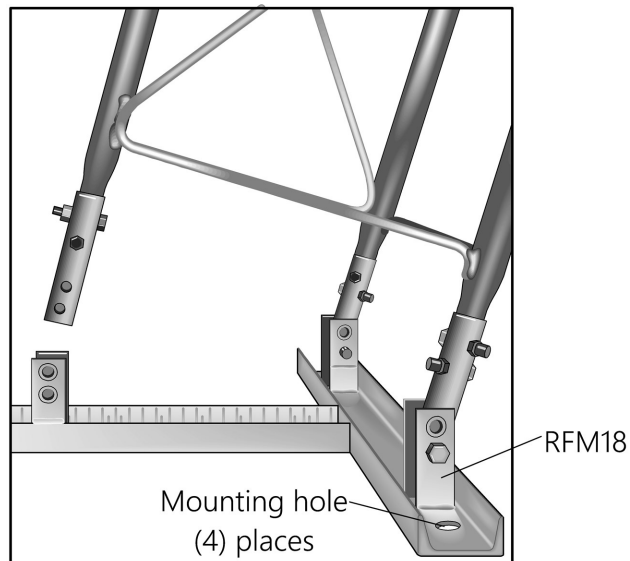


FIGURE 7-20. RFM18 base dimensions

Attach the bottom section of the tower to the RFM18 base by using one 9/16 inch bolt per leg (FIGURE 7-21 (p. 27)). Position the base over the anchor holes. Secure the base to the anchors by using appropriate hardware (user supplied). Check the tower for plumb and shim the RFM18, if necessary, before fully tightening the bolts.

**NOTE:**

When using the RFM18, the user-supplied mounting hardware must be capable of withstanding the Maximum Wind Load given in [Specifications](#) (p. 8). See Note 2 in that section for a description of factors that affect wind load. In addition, the tower must make use of guy wires to further increase the stability of the tower.



*FIGURE 7-21. RFM18 flat roof mounting base*

#### 7.1.2.4 Concrete anchor installation



*FIGURE 7-22. Concrete wedge anchor*

A concrete anchor kit is available when the tower will be installed onto an existing concrete base. The kit contains three concrete wedge anchors ([FIGURE 7-22](#) (p. 27)), three nuts, three bolts, and a packet of anti-seize lubricant. The base must be at least 10.2 cm (4 in) thick for proper installation of the wedge anchors. The anchors are installed directly into the concrete. A clevis is then threaded onto each anchor bolt for mounting and leveling the tower.

**NOTE:**

If the concrete pad does not meet the recommended base size of 91.44 x 91.44 x 121.92 cm (36 x 36 x 48 in), use guy wires ([Guy anchor installation](#) (p. 34)) to provide additional support and stability to the tower.

1. Use the paper template found in [UTBASE paper template](#) (p. 51) to identify the proper locations for the three mounting holes based on 43.2 cm (17 in) center-to-center spacing. Refer to [FIGURE 7-27](#) (p. 33) for tower leg placement options.
2. Determine the required hole depth. A depth of 9.5 cm (3.75 in) to 12.0 cm (4.75 in) is required. **DO NOT** drill through the bottom of the concrete base. Use masking tape to mark the desired depth on a  $\frac{3}{4}$ -inch masonry drill bit.
3. Use a hammer drill to drill the holes for the three wedge anchors. The holes must be drilled perpendicular to the concrete pad. Wear eye protection and a filter mask to protect against the silica dust created when drilling into concrete.

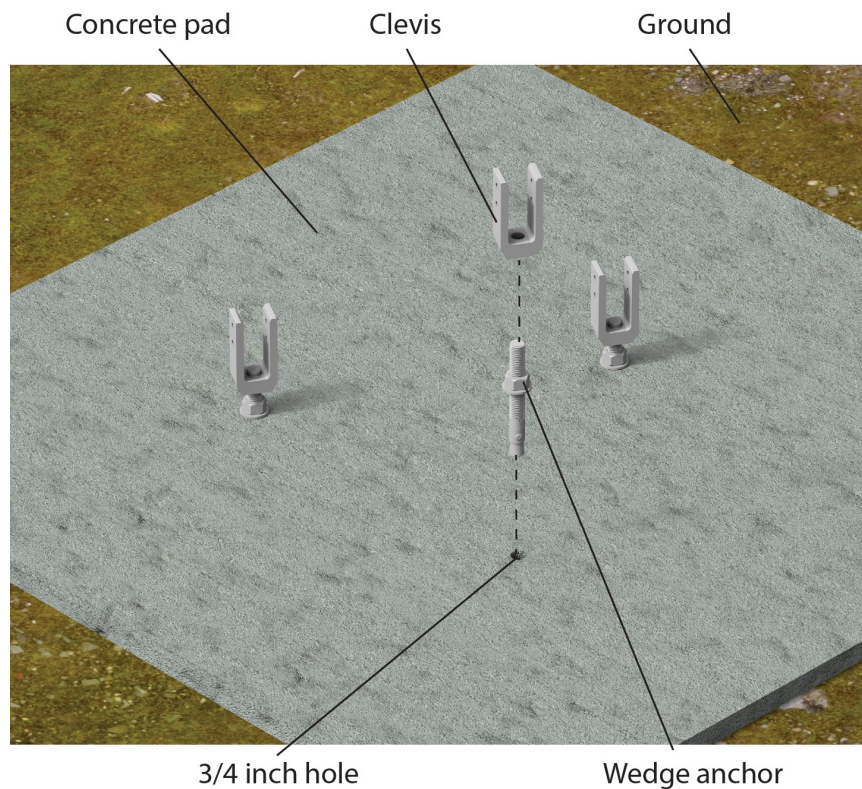
**NOTE:**

The wedge anchors must remain vertical when installed in the concrete pad. This will ensure the tower legs are adjustable after installation of the clevises. If a wedge anchor is installed on an angle, it will interfere with the leg when leveling the tower.



4. Clean all dust and debris from inside each hole using compressed air or a wire brush.

5. Place a wedge anchor in each hole, threaded end up.

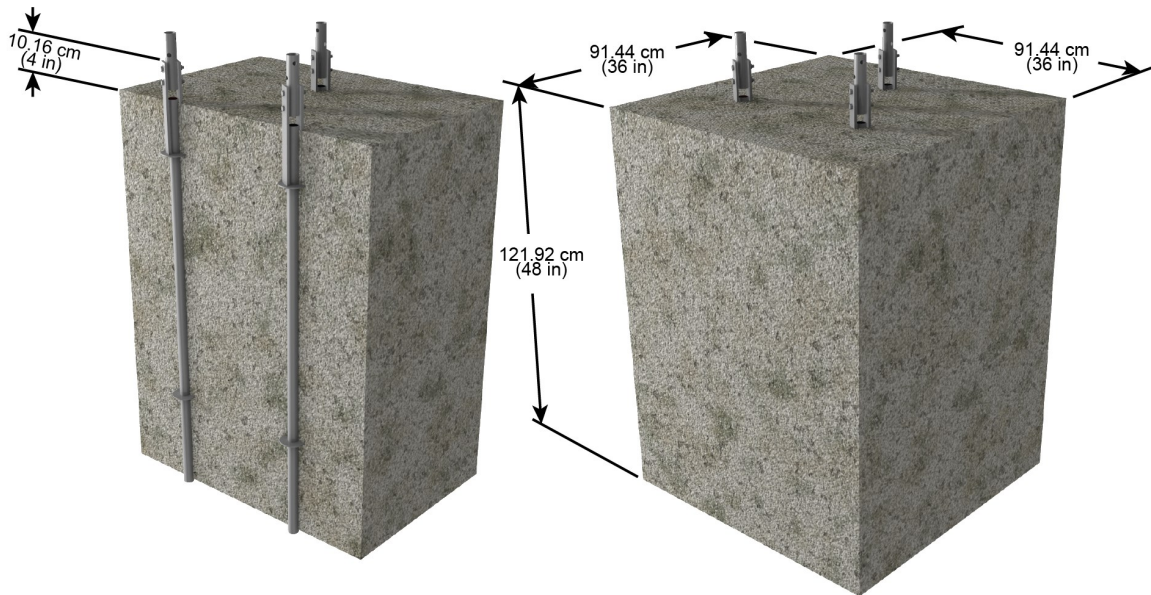


*FIGURE 7-23. Wedge anchor installation*

6. Using a hammer, pound each wedge anchor into the hole to the desired depth (at least 9.5 cm (3.75 in)).
7. Finger-tighten each bolt until it rests against the concrete. Fully tighten each bolt another 3 to 5 turns until fully tightened. When using a torque wrench, tighten the nut to 150 N·m (110 lb·ft).
8. Complete the installation beginning with [step 7 in the "UTBASE installation using a template support assembly" section](#).

### 7.1.2.5 B18 base installation

1. Dig a hole 0.9 m (36 in) square and 1.2 m (48 in) deep where the tower base will be located.  
[FIGURE 7-24](#) (p. 30) shows these dimensions.



*FIGURE 7-24. Concrete base dimensions*

2. Optional: construct a concrete form out of 38 x 89 mm (2 x 4 in) lumber, 0.9 m (36 in) square (inside dimensions). Center the form over the hole and drive two wooden stakes along the outside edge of each side (FIGURE 7-25 (p. 31)). Level the form and secure it in position by driving 65 mm (2 1/2 in) screws through the stakes and into the form as shown in FIGURE 7-25 (p. 31).

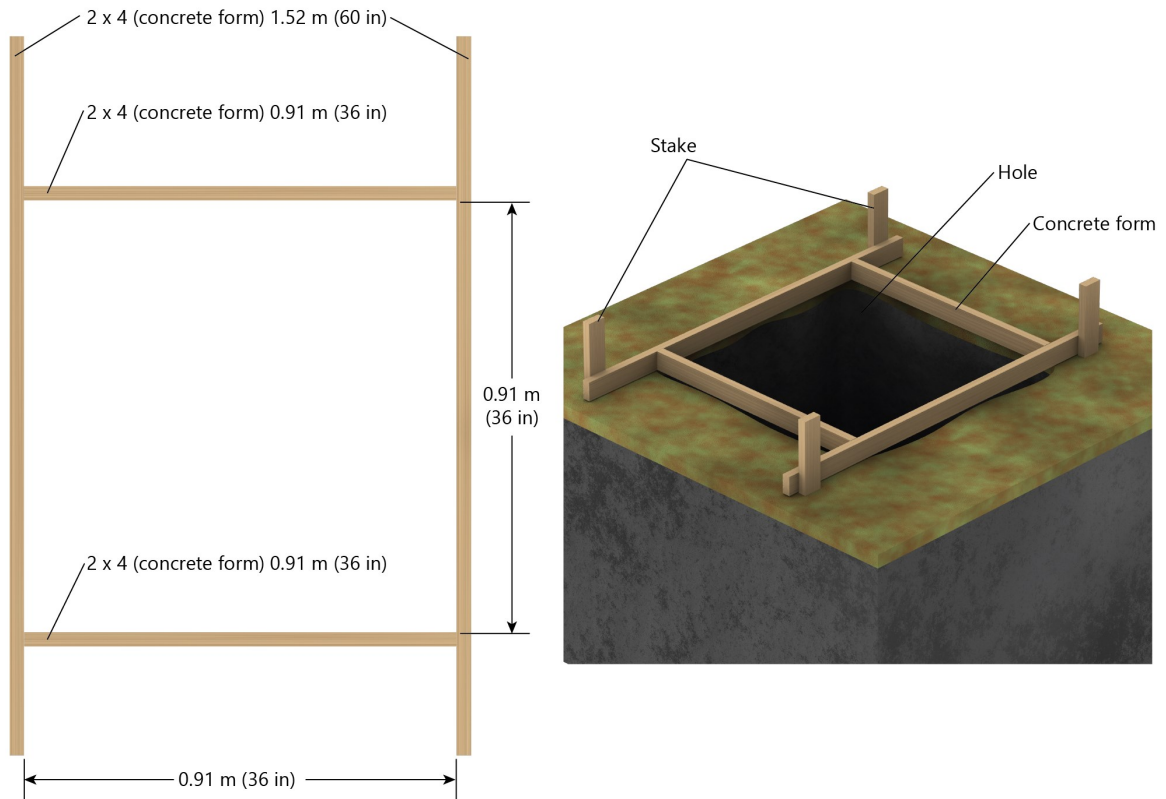


FIGURE 7-25. Concrete form dimensions and placement

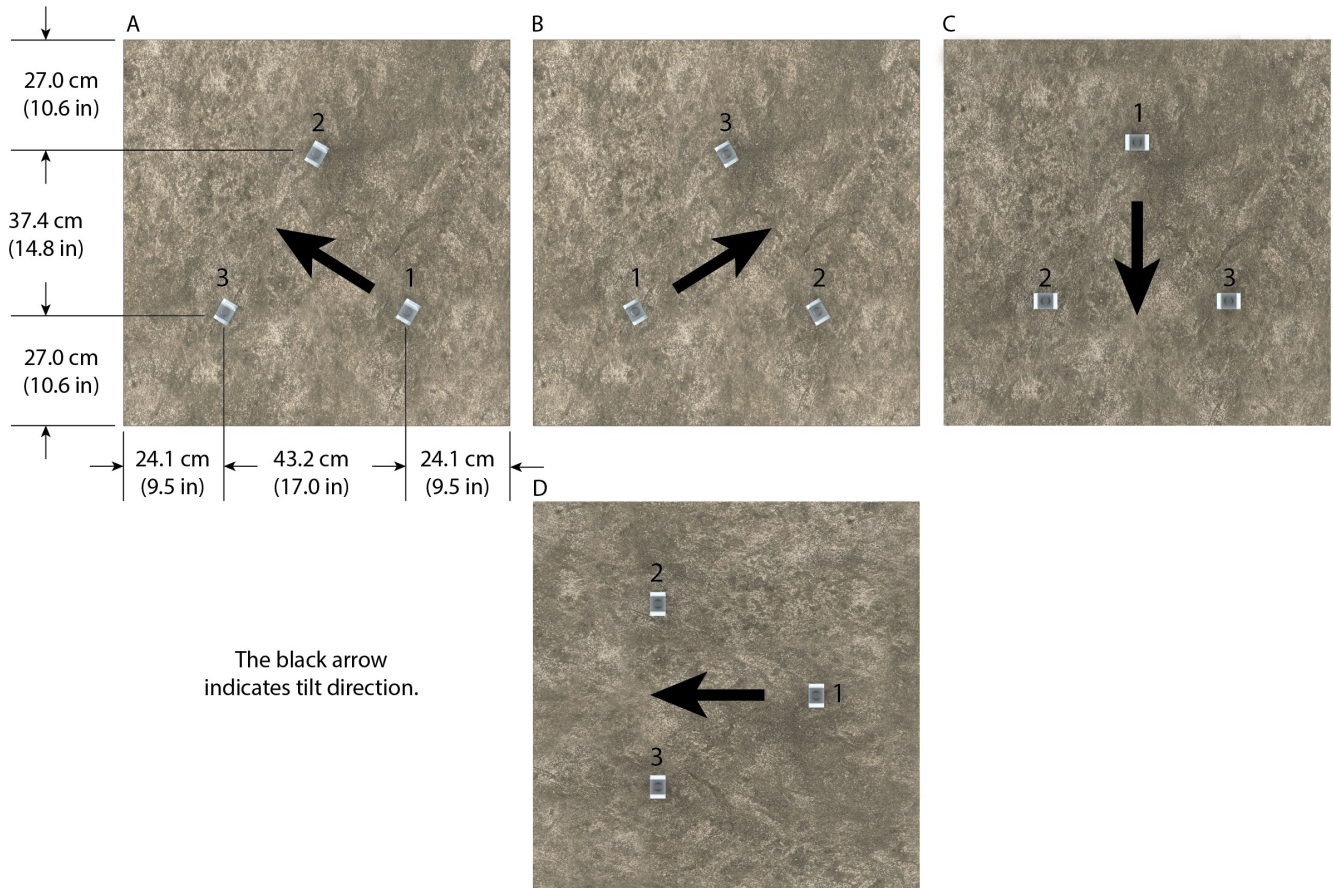
3. Attach the bottom section of the tower to the B18 base using one bolt per leg (FIGURE 7-26 (p. 32)), making sure that the hinge direction is common for all legs.



*FIGURE 7-26. Tower attached to the B18 legs*



4. Center the bottom tower section with the base attached in the hole. [FIGURE 7-27](#) (p. 33) shows four possible arrangements for the bottom tower section. Images A and B show the recommended placement when a solar panel is to be mounted to the tower. This positioning allows a solar panel to be firmly attached to two tower legs while providing easy access to sensors at the top of the tower. Image C shows the bottom tower section positioned to allow the tower to tilt toward the equator. Image D is used when it is necessary to mount a crossarm running perpendicular to the equator for precision pyranometer measurements.



*FIGURE 7-27. Tower leg placement*

5. Fill the hole with concrete. Getting the bottom tower section plumb is very important. As concrete is poured into the hole, periodically check the tower for plumb using a carpenter's level and adjust as necessary. Make sure there are 10 cm (4 in) from the top of each B18 base to the top of the concrete as shown in [FIGURE 7-24](#) (p. 30). Allow three to four days for the concrete to cure.



## 7.1.3 Guy anchor installation

There are two types of anchors for the tower guy wires: the UTEYE eye bolts are poured in concrete; the UTDUK duckbill anchors are driven into the soil.

### 7.1.3.1 UTEYE eyebolt guy anchor

1. Dig a hole 60 cm by 60 cm (24 in by 24 in) deep at each anchor location ([Base and Guy Anchor Layout](#) (p. 10)).
2. Optional — Construct a concrete form out of 38 x 89 mm (2 x 4 in) lumber, 60 cm (24 in) square (inside dimensions) for each hole. Center the forms over the holes and level them by using a carpenter's level and stakes.
3. Fill the holes with concrete and install the eyebolts as shown in [FIGURE 7-28](#) (p. 34).

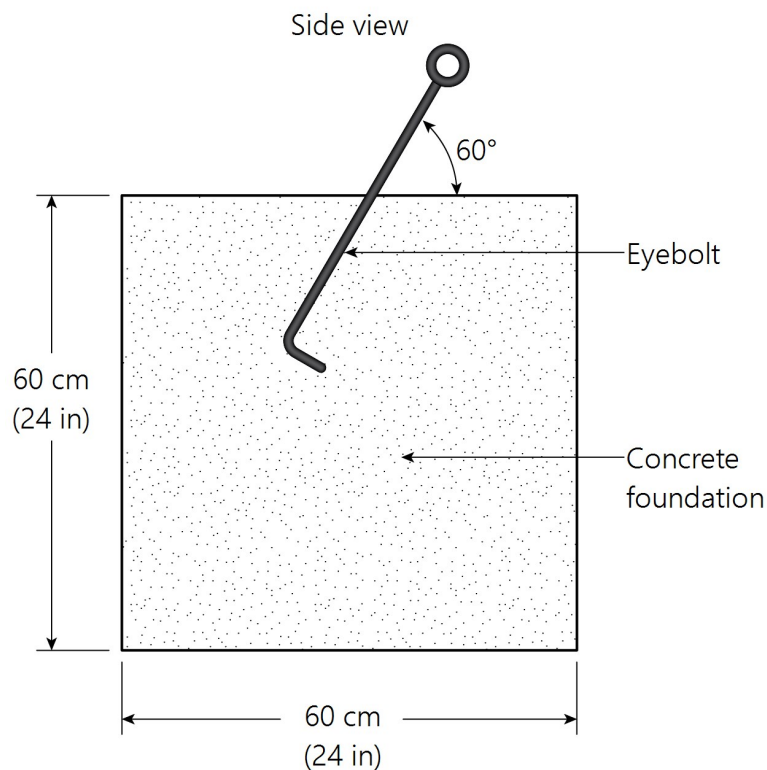
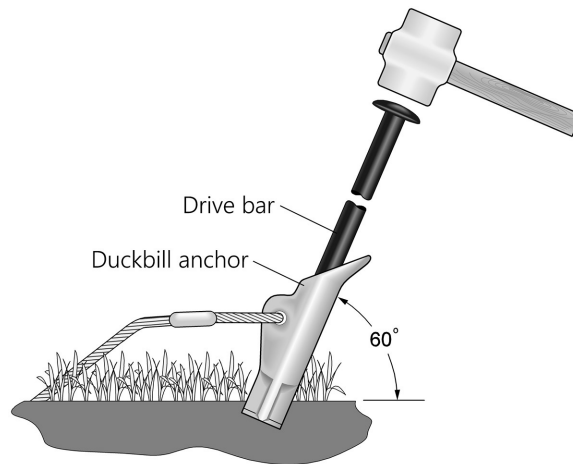


FIGURE 7-28. UTEYE eyebolt guy anchor

### 7.1.3.2 UTDUK duckbill guy anchor

1. Locate the three anchor locations ([Base and Guy Anchor Layout](#) (p. 10)). It is important that the anchors be driven at the same angle as the guy wires ([FIGURE 7-29](#) (p. 35)). Insert the steel drive bar into the anchor body and drive the anchor into the ground by using a fence post driver or sledgehammer until only the top half of the loop remains above the ground.

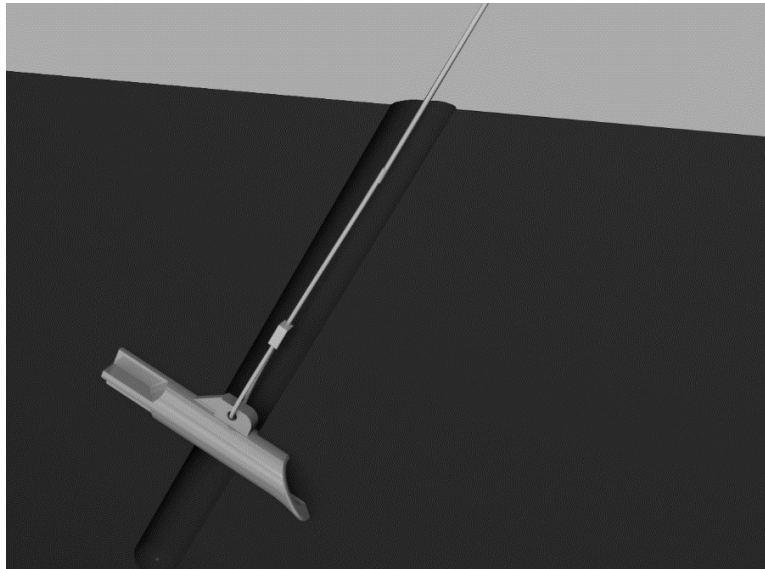


*FIGURE 7-29. UTDK duckbill guy anchor being driven into the ground*

2. Attach a high-lift jack to the loop and jack the anchor up about 15 cm (6 in) to rotate the anchor into the load-lock position ([FIGURE 7-30](#) (p. 36)).

**WARNING:**

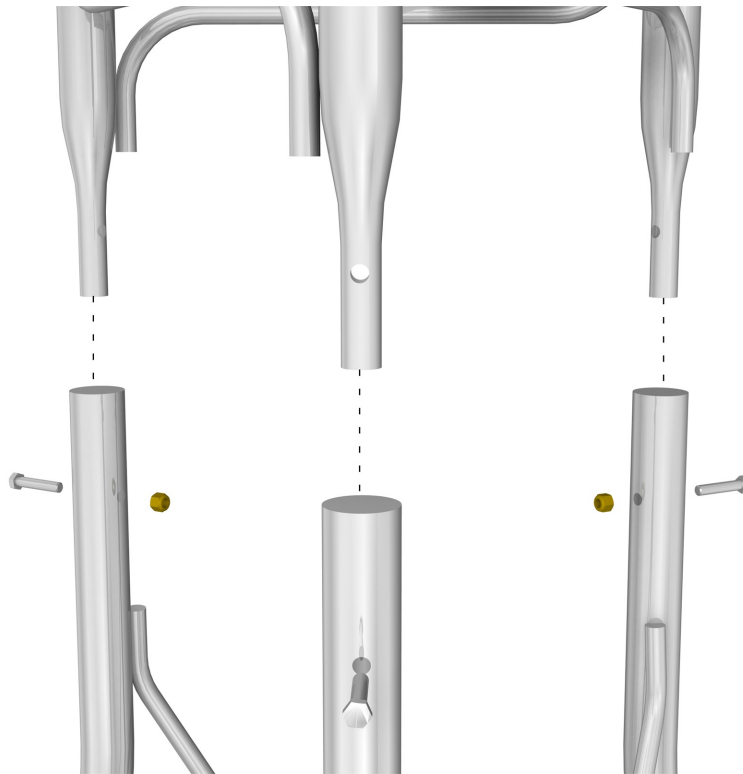
Failure to install and lock the anchor at the correct angle will result in the anchor cable cutting through the soil until the angles equalize, causing slack in the guy wires.



*FIGURE 7-30. UTDUK duckbill in load-lock position*

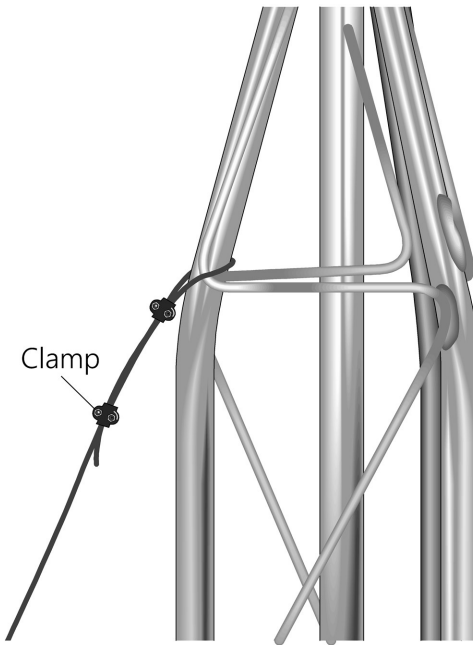
## 7.1.4 Tower assembly

1. After installing the base and bottom tower section ([Guy anchor installation](#) (p. 34)), remove the two bolts from leg 1. Remove the top bolt from the other two legs and loosen the remaining bolt in those legs so the bottom tower section is free to hinge. Tilt the tower section to the ground and assemble the remaining tower sections by using the hardware provided with the tower. Each section is secured to the section below it with three bolts as shown in [FIGURE 7-31](#) (p. 37). Route any cables from the upper sensors down the tower to where the enclosure will be mounted. Extend the mast to the height appropriate for the application and tighten the mast.



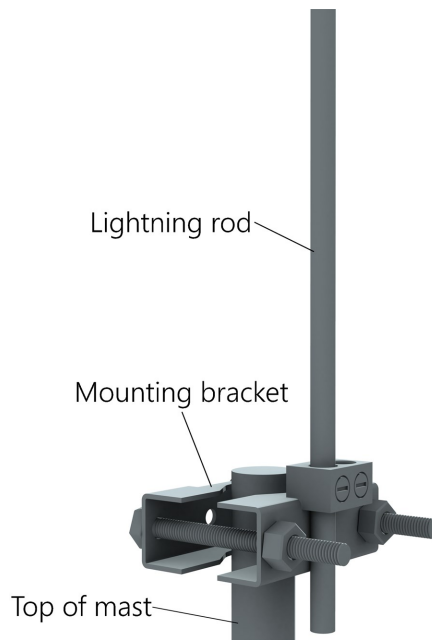
*FIGURE 7-31. Attaching two mast sections*

2. Install the guy wires to the top of the tower ([FIGURE 7-32](#) (p. 38)). Cut the 36.5 m (120 ft) piece of guy wire into three pieces; lengths will vary with slope. Attach the guy wires to the tower by using two clamps for each guy wire.



*FIGURE 7-32. Guy wire attached to tower*

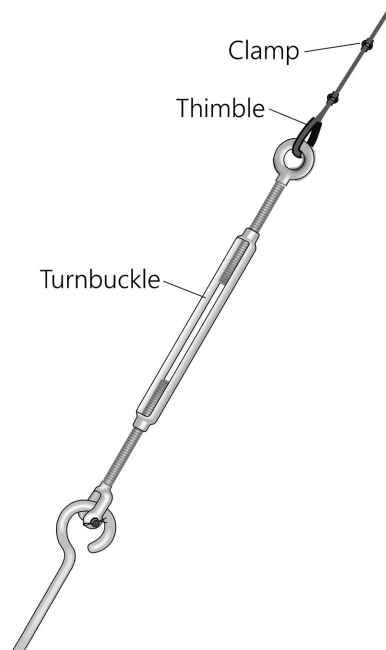
3. The mounting brackets, sensors, and lightning rod ([FIGURE 7-33](#) (p. 39)) that attach to the upper tower sections are most easily attached while the tower is lying on the ground.



*FIGURE 7-33. UT20 and UT30 lightning rod and mounting bracket*

4. "Walk" the tower to its upright position and install the remaining bolts in the tower base.

5. Attach the guy wires to the anchors ([FIGURE 7-34](#) (p. 40)). Unscrew the jaw and eye bolts until 2.5 cm (1 in) of thread extends through the turnbuckle body. Attach the jaw end of the turnbuckles to the anchors. While holding the tower plumb, attach the guy wires to the eye end of the turnbuckles by using a thimble and two clamps for each guy wire. Tighten the turnbuckles until the guy wires are snug and the tower is plumb. Do not overtighten the turnbuckles.



*FIGURE 7-34. Guy wire/turnbuckle attached to the UTEYE anchor*

## 7.1.5 UTGND tower grounding kit

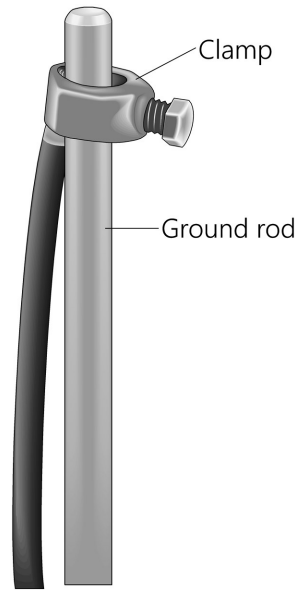
### **DANGER:**

If any part of the weather station comes into contact with power lines, death or serious injury could occur. Contact local utilities for the location of buried utility lines before digging or driving ground rods.

Refer to the [Safety](#) section at the end of this manual prior to installing the ground rod. Ensure all local electrical codes are followed by having electrical equipment and grounding installed by a licensed electrician.



1. Drive the ground rod close to the tower ([FIGURE 7-36](#) (p. 42)) using a fence post driver or sledgehammer. 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 7-35](#) (p. 41)).



*FIGURE 7-35. Ground rod and clamp*

3. Attach the tower grounding clamp to a tower leg (FIGURE 7-36 (p. 42)). 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 12 AWG enclosure ground wire into the hole behind the set screw and tighten the set screw. Route the green wire to where the enclosure will be installed.

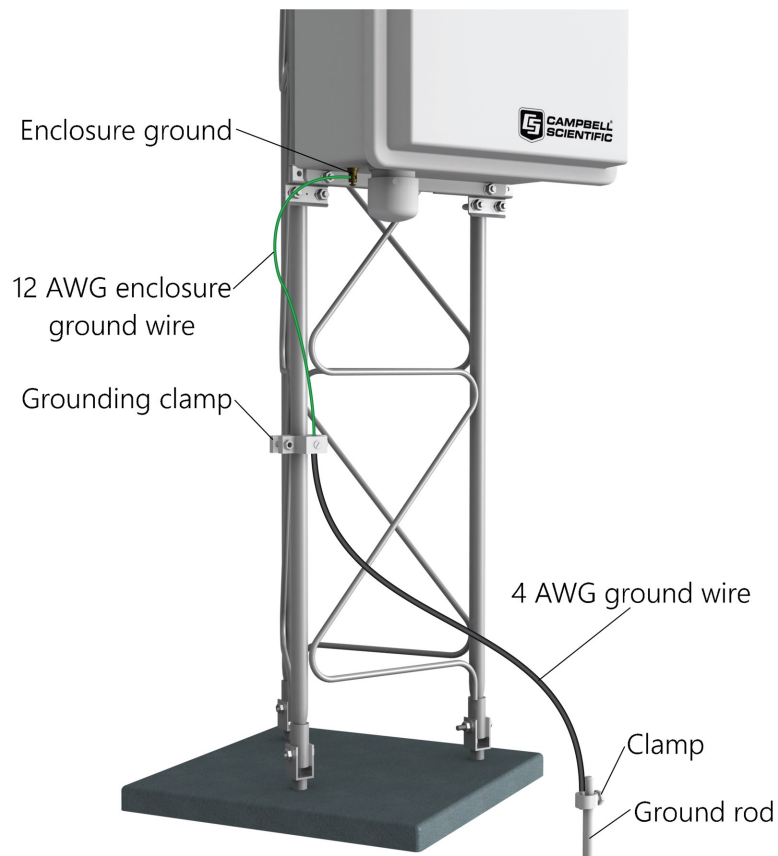
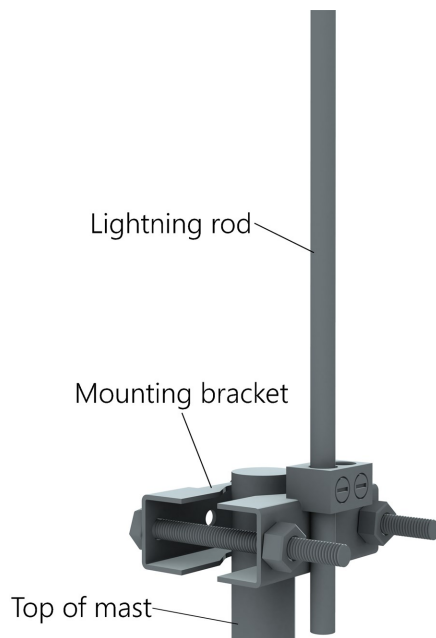


FIGURE 7-36. Tower grounding clamp

## 7.1.6 Attaching the lightning rod

Attach the lightning rod to the mast as shown in [FIGURE 7-37](#) (p. 43). Loosen the two screws on the lightning rod mounting bracket. Position the mounting bracket 5 cm (2 in) down from the top of the mast and tighten both screws evenly. Make sure the lightning rod set screw is tight.



*FIGURE 7-37. Lightning rod*

## 7.2 Crossarms and mounting brackets

### 7.2.1 CM202, CM203, CM204, CM206 Crossarms

Sensors can be mounted directly to the tower, or to crossarms attached to the tower using mounting brackets. Each bracket includes the hardware required to secure the bracket to the tower or crossarm.

The combination of crossarms and brackets provide the flexibility to mount sensors and other equipment at any desired height on the tower. Mounting sensors on a crossarm allows the sensor to be moved away from the midline of the tower, reducing the effects of the mount on the sensor measurement.

Campbell Scientific provides a variety of lengths in aluminum or stainless steel. [Table 7-1](#) (p. 44) shows the different lengths available.

Table 7-1: Crossarm lengths and materials		
Product number	Length	Material
CM202	0.6 m (2 ft)	IPS anodized aluminum
CM202SS	0.6 m (2 ft)	Stainless-steel pipe
CM203	0.9 m (3 ft)	IPS anodized aluminum
CM204	1.2 m (4 ft)	IPS anodized aluminum
CM204SS	1.2 m (4 ft)	Stainless-steel
CM206	1.8 m (6 ft)	IPS anodized aluminum

FIGURE 7-38 (p. 44) shows two typical applications of a mounting bracket.

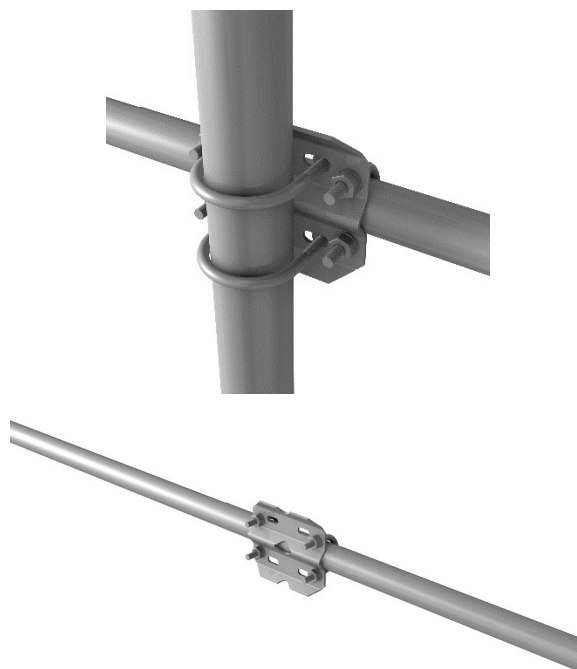


FIGURE 7-38. Crossarm mounting

## 7.2.2 CM230, CM230XL adjustable angle mounting kits

The CM230 and CM230XL adjustable angle mounting kits (FIGURE 7-39 (p. 45)) allow the user to attach an antenna or sensor and change its mounting angle from horizontal to vertical. This allows the component being mounted to be aimed at a specific location. The CM230 is used when mounting the component close to the mast or tower while the CM230XL extends the component away from the mast or tower.



FIGURE 7-39. CM230 and CM230XL adjustable angle mounting kits

The CM230 and CM230XL will accept antennas and sensors with an outer diameter of 2.54 cm to 3.81 cm (1.0 in to 1.5 in). The bracket can be attached to a mast or pipe with an outer diameter of 3.30 cm to 5.33 cm (1.3 in to 2.1 in). The declination of the antenna or sensor is fixed when the U-bolt attached to the mast or tower is tightened; the inclination of the antenna or sensor is then adjusted with the other U-bolt and nuts.

FIGURE 7-40 (p. 46) is an exploded diagram of the CM230XL showing all the included hardware as well as the curved slots at the end of the bracket used to adjust the angle of the antenna or sensor.

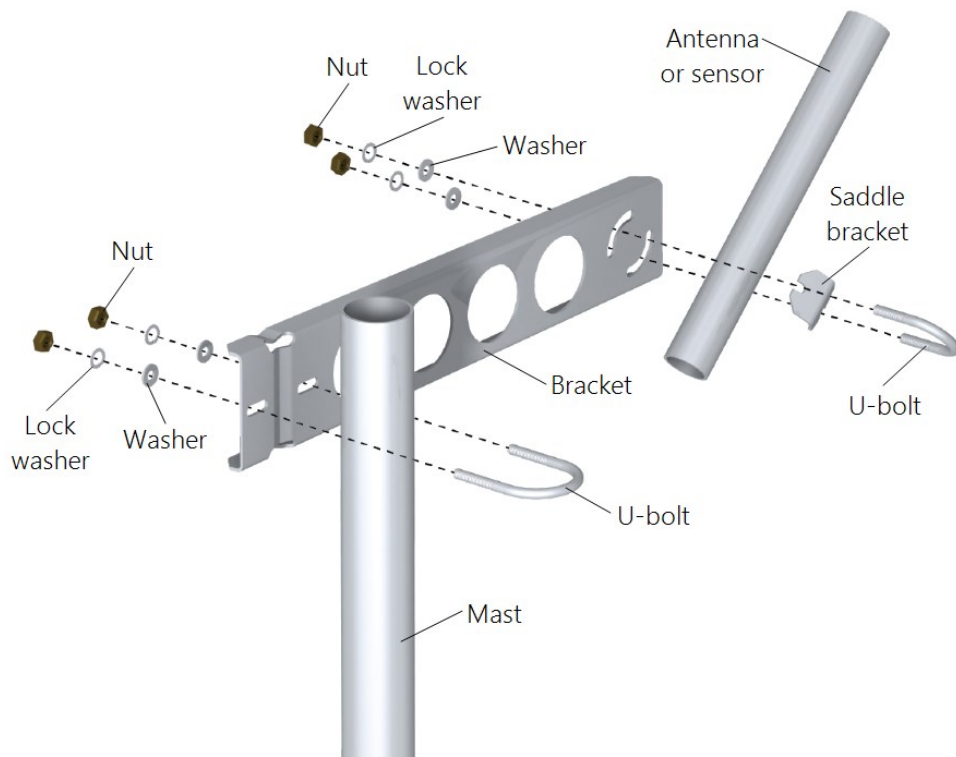
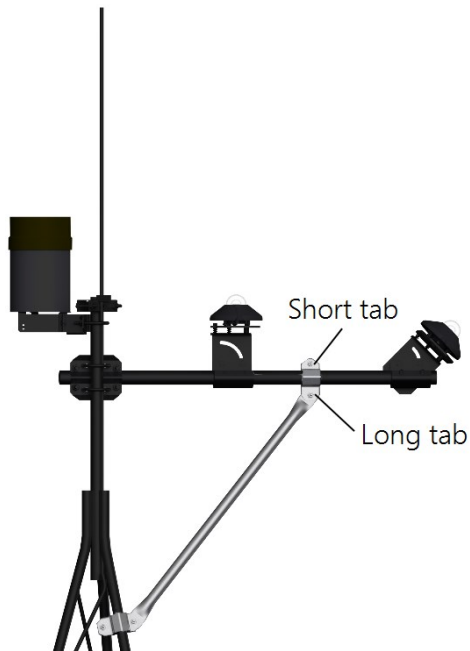


FIGURE 7-40. CM230XL exploded diagram



### 7.2.3 CMB200 crossarm brace kit

The CMB200 Crossarm Brace Kit ([FIGURE 7-41](#) (p. 47)) is designed to provide additional stability to crossarms mounted on Campbell Scientific tripods and towers. It provides additional support for crossarms with heavier sensor loads, and added stability in high winds.



*FIGURE 7-41. CMB200 Crossarm Brace Kit*

### 7.2.3.1 Components

The CMB200 ships with the following components (FIGURE 7-42 (p. 48)):

- (1) brace arm
- (2) small bracket
- (2) medium bracket
- (2) large bracket
- (4) 1/4-20 x 1-inch bolt
- (8) 1/4 flat washer
- (4) 1/4 lock washer
- (4) 1/4-20 nut

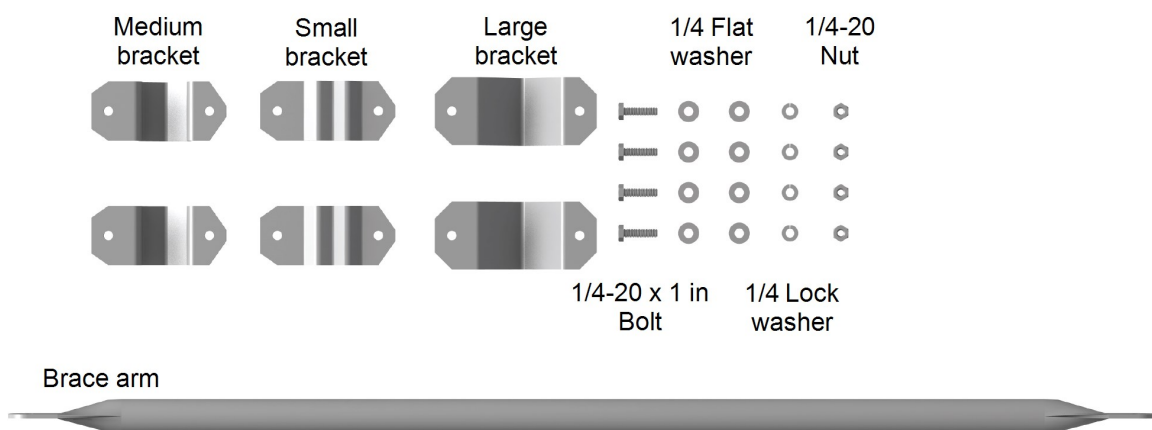


FIGURE 7-42. CMB200 components

### 7.2.3.2 Assembly

1. Consult FIGURE 7-43 (p. 49) and Table 7-2 (p. 50) to determine which brackets are needed at either end of the brace to attach it to the crossarm and tower. The figure also indicates what orientation is needed when the small bracket is used.

**NOTE:**

Each bracket has a long tab and short tab where the bolts are attached. The brace arm must be attached to the end with the long tab.

2. Attach one end of the brace arm to the tower below the crossarm. Leave the bolts finger-tight.
3. Lift the free end of the brace arm to the crossarm and attach it to the crossarm. Again, only finger-tighten the bolts.
4. Adjust the position of the brace arm as needed.

5. Fully tighten the two bolts directly connected to the brace arm, and then tighten the remaining two bolts to clamp the brace arm to the tower.

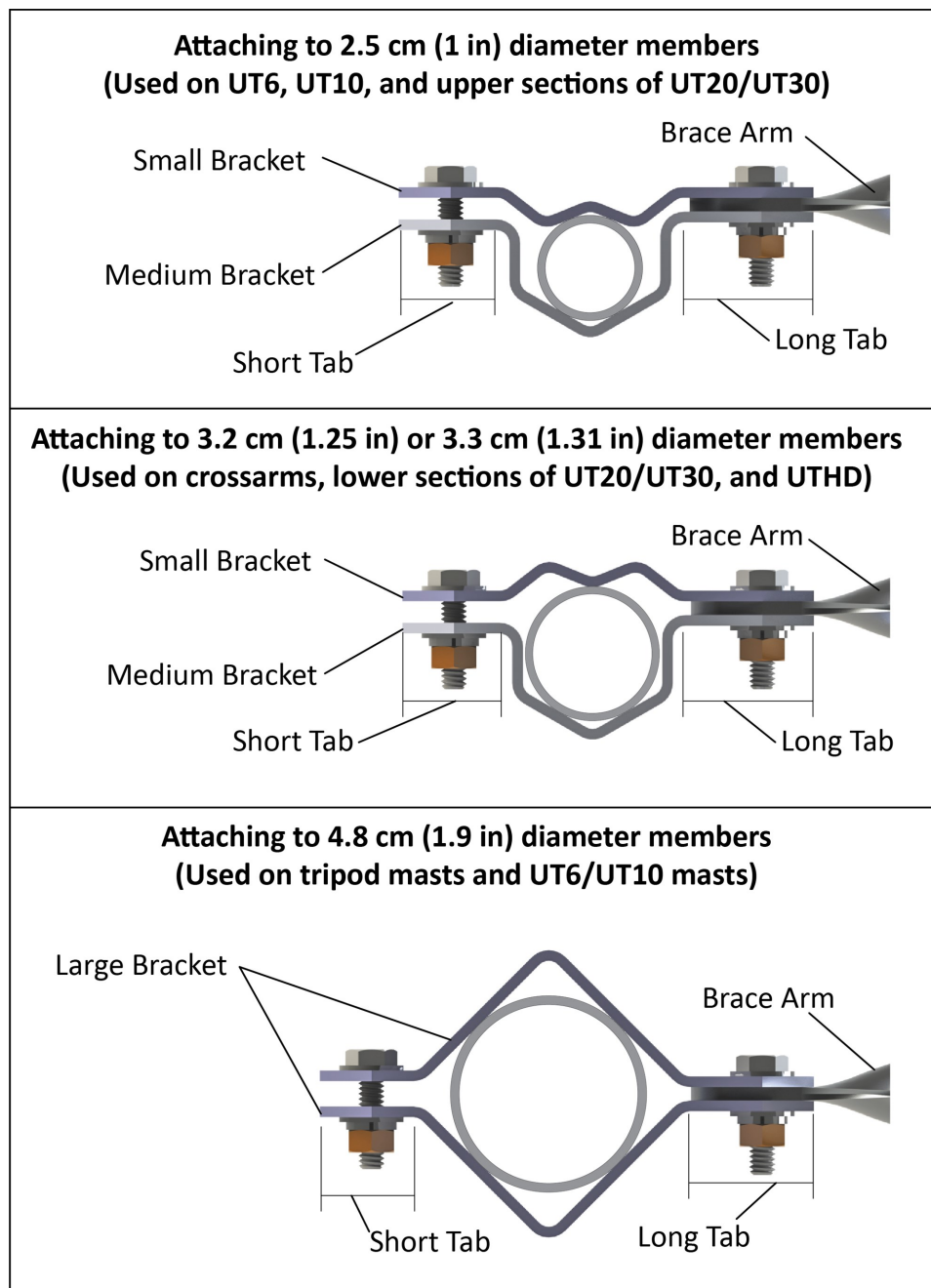


FIGURE 7-43. Bracket selection

Table 7-2: Bracket requirements			
Mast/crossarm/ tower diameter	Example mast/ crossarm/tower	Brackets needed	Small bracket orientation
2.5 cm (1 in)	UT10/20/30 tower leg (excludes bottom section of UT20/30)	(1) small bracket (1) medium bracket	Angled toward mast/tripod
3.2 cm (1.25 in) or 3.3 cm (1.31 in)	UT20/30 tower mast, UT20/30 tower leg (bottom section only)	(1) small bracket (1) medium bracket	Angled away from mast/tripod
4.8 cm (1.9 in)	CM110/106B tripod mast, UT10 tower mast	(2) large bracket	N/A

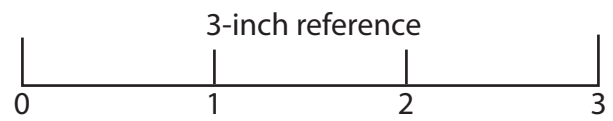
# Appendix A. UTBASE paper template

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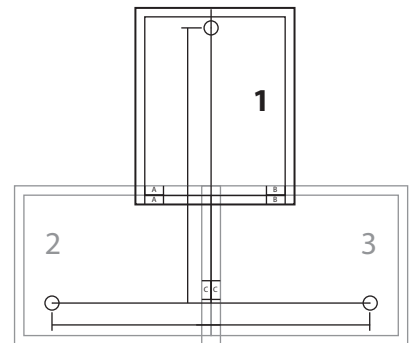
If the metal template shown in [UTBASE installation using a template support assembly](#) (p. 11) for installing the UTBASE was not included in the purchase of the tower, a wooden template for installing the UTBASE can be built using a paper pattern. The pattern is centered on a 45 x 60 cm (18 x 24 in) piece of 1.27 cm (0.5 in) plywood, then three holes are drilled for the three anchor bolts.

1. Print out all three pages of the paper pattern. Print the pattern at 100%. Do not scale the printer output. Each page contains a 3-inch ruler used to verify the printed page is properly scaled. The printed ruler must match up with an actual ruler for the scale to be correct.
2. Place the three pages on a level surface and position them together as shown on each page. Page one will have a portrait orientation while pages two and three will have a landscape orientation. Line up the lettered boxes and make sure the printed borders of each page line up where two pages overlap.
3. Secure the three pages together with tape.
4. Verify hole placement on the template is correct by confirming the distances printed on the pattern match the actual distance between holes. Adjust the pattern pieces as needed to get the correct dimension.
5. Center the pattern on the plywood. The bottom edge of the pattern must be parallel with the long edge of the plywood. Secure the pattern to the plywood.
6. Drill a small pilot hole through each anchor bolt hole on the pattern.
7. Use a 19 mm (0.75 in) drill bit to drill a hole for each anchor bolt.
8. Attach the wooden template to the template frame in place of the metal template as shown in step 4 in [UTBASE installation using a template support assembly](#) (p. 11) and continue the UTBASE assembly instructions from that point.

Page 1 (of 3)



14.7"



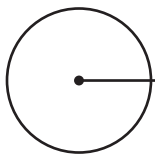
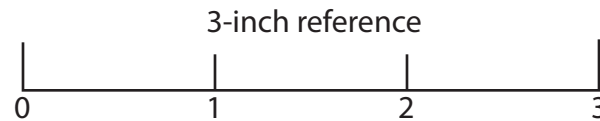
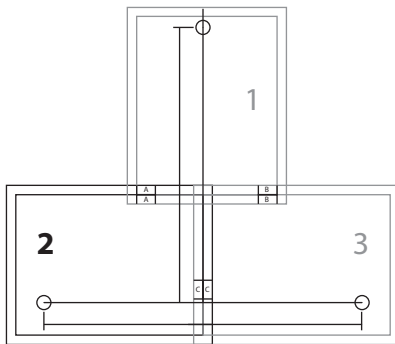
A

B



A

UTBASE Page 2 (of 3)

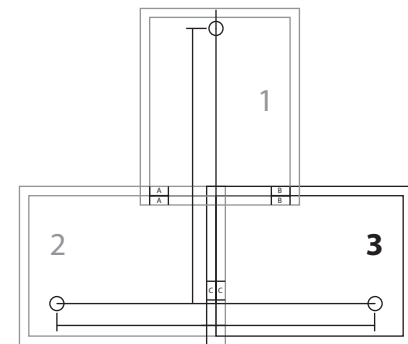


43.2 cm (17 in)

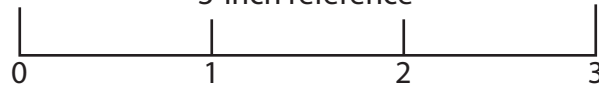
C

B

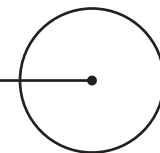
UTBASE Page 3 (of 3)



3-inch reference




C



# Limited warranty

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Products manufactured by Campbell Scientific are warranted by Campbell Scientific to be free from defects in materials and workmanship under normal use and service for twelve months from the date of shipment unless otherwise specified on the corresponding product webpage. See Product Details on the Ordering Information pages at [www.campbellsci.com](http://www.campbellsci.com). Other manufacturer's products, that are resold by Campbell Scientific, are warranted only to the limits extended by the original manufacturer.

Refer to [www.campbellsci.com/terms#warranty](http://www.campbellsci.com/terms#warranty) for more information.


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# Assistance

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Products may not be returned without prior authorization.

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To obtain a Returned Materials Authorization or Repair Reference number, contact your CAMPBELL SCIENTIFIC regional office. Please write the issued number clearly on the outside of the shipping container and ship as directed.

For all returns, the customer must provide a "Statement of Product Cleanliness and Decontamination" or "Declaration of Hazardous Material and Decontamination" form and comply with the requirements specified in it. The form is available from your CAMPBELL SCIENTIFIC regional office. Campbell Scientific is unable to process any returns until we receive this statement. If the statement is not received within three days of product receipt or is incomplete, the product will be returned to the customer at the customer's expense. Campbell Scientific reserves the right to refuse service on products that were exposed to contaminants that may cause health or safety concerns for our employees.

# Safety

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

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

## General

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

## Utility and Electrical

- **You can be killed** or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in **contact with overhead or underground utility lines**.
- Maintain a distance of at least one-and-one-half times structure height, 6 meters (20 feet), or the distance required by applicable law, **whichever is greater**, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.
- Only use power sources approved for use in the country of installation to power Campbell Scientific devices.

## Elevated Work and Weather

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

## Maintenance

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

## Internal Battery

- Be aware of fire, explosion, and severe-burn hazards.
- Misuse or improper installation of the internal lithium battery can cause severe injury.
- Do not recharge, disassemble, heat above 100 °C (212 °F), solder directly to the cell, incinerate, or expose contents to water. Dispose of spent batteries properly.

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



## Global Sales & Support Network

*A worldwide network to help meet your needs*



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