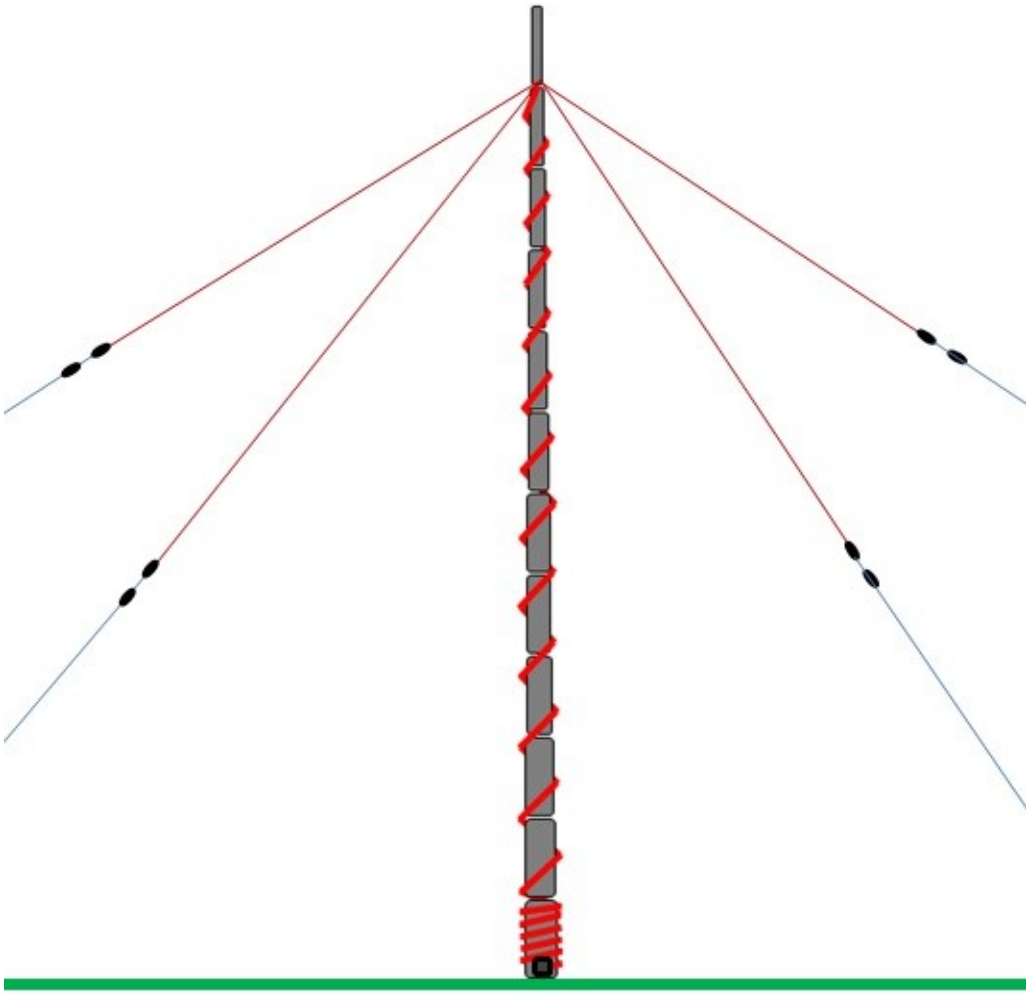
spiderbeam
high performance lightweight antennas

Spiderbeam 160m Vertical
Model 160-18-4WTH

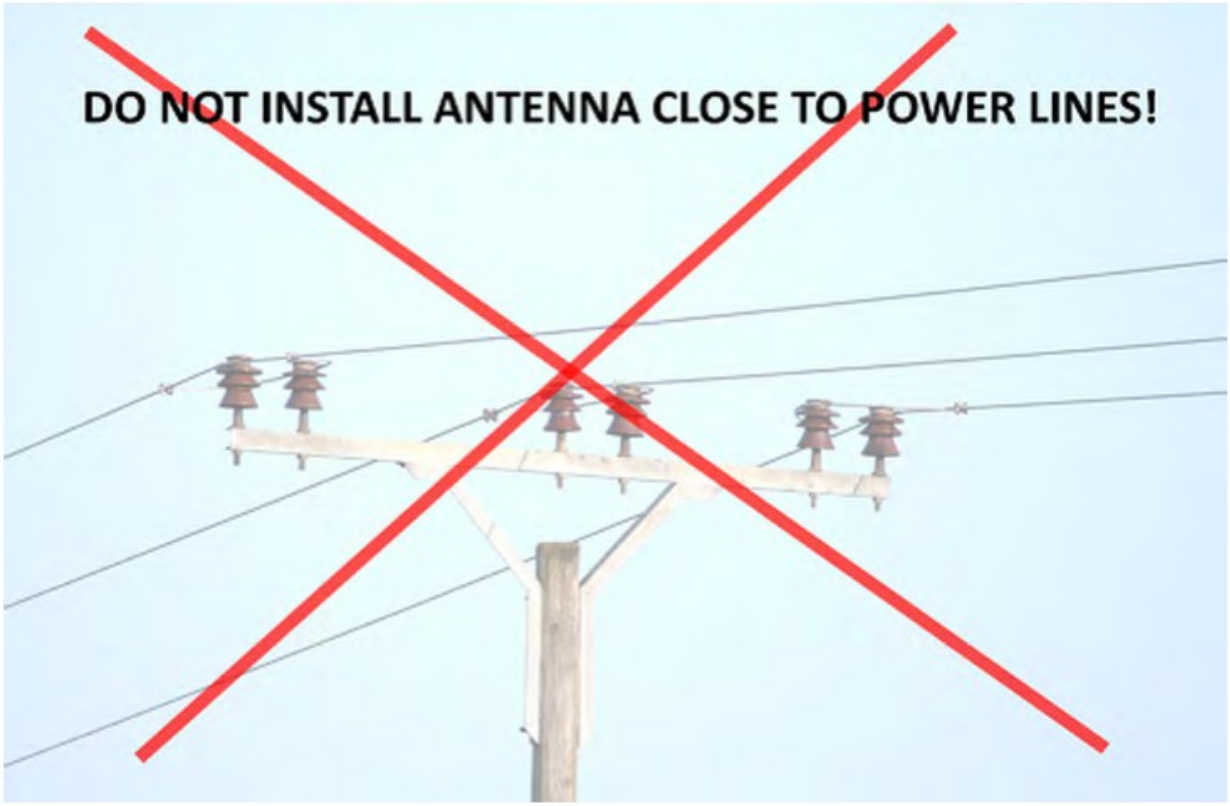


VERTICAL CONSTRUCTION GUIDE

Ver. 1.5

Spiderbeam 160m Vertical Model 160-18-4WTH

WARNING



We <u>strongly</u> encourage you to read this entire manual <u>before</u> beginning to work.

Spiderbeam 160m Vertical Model 160-18-4WTH

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Spiderbeam 160m Vertical Model 160-18-4WTH

1.0 Description and Theory

1.1 Antenna Description

The Spiderbeam Model 160-18-4WTH is a base-fed, [electrical] quarter wavelength vertical antenna built on a Spiderbeam 18 meter high telescoping fiberglass pole. It uses 4 top-hat wires to reduce the antenna's physical height by electrically lengthening the antenna.

This antenna is very easy to build, but does require tuning after it has been erected. It is not plug and play. Tuning is accomplished by adjusting wire lengths.

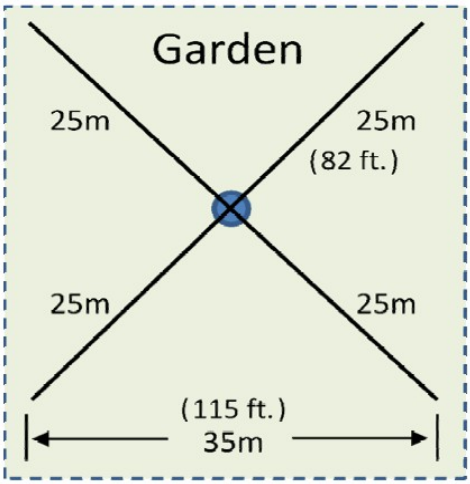
Despite being less than 1/8 wavelength in overall height, the Spiderbeam 160-18-4WTH delivers performance that is very close to that of a full size vertical antenna on 160m – provided you have adequate space for proper installation of the top-hat wires and radial network.

1.2 Required Space

The space required for this antenna is 35m by 35m, or **1225 sq. meters** (~13,000 sq. ft.). This area should be square, not just rectangular. Minor deviations from this will not cause too much loss in performance. If you have more space, take advantage of it by placing the ground stakes supporting the top-hat wires farther away from the pole.

The perfect installation would have many wires used for the top hat, and they would all be mounted in a horizontal plane at the top of the antenna. In real life installations, this is not possible. A more practical installation will be one with 4 wires sloping to stakes in the ground at some distant point away from the antenna (typically 25m).

The antenna itself consists of 3 electrical components: the vertical segment of the radiator; the top-hat segment of the radiator; and a good set of ground-mounted radials. The physical length of the vertical segment of the radiator is limited by the **usable** length of the fiberglass pole, which is about 2 meters less than its physical length. The top-hat wires must always be the same size. Their physical length is determined by three factors:



- The number of wires used in the top-hat.
- The angle of the top-hat wire to the mast.
- The ground characteristics at the location.

The more wires used for the top-hat, the shorter the wires must be and the better the radiation symmetry of the omin-directional radiation pattern.

The lower the angle of the top-hat wires to the pole, the longer they must be. Every attempt should be made to keep the angle of the slope of these wires as high as possible - the closer to being horizontal, the better the antenna will work. This is accomplished by placing the ground stakes supporting the top-hat wires as far away from the pole as possible (typically 25m).

Ground characteristics at the installation QTH are a given and cannot be easily improved. You have to accept what you have and realize that this is one of the reasons that we cannot specify an exact length for the top-hat wires. These wires usually must be adjusted to compensate for variances in ground characteristics.

The ground-mounted radial network consists typically of 16 radials. In portable installations, as little as 8 ground mounted radials has been shown to give excellent results, but more is better.

For more information on the deployment of radials and its impact on performance, we recommend reading the excellent article by Rudy Severns (N6LF), in the December 2010 issue of QST. This article summarizes the information put forth by Rudy in a series of 7 articles for QEX magazine.

1.3 Material Description:

It is of utmost importance to keep the material used near the top of the pole as lightweight as possible, yet strong enough to endure the severe winter conditions that prevail during prime low-band activity.

The Spiderbeam 160-18-4WTH is built with high quality, lightweight but strong material:

- The vertical radiator wire is made of Spiderbeam CQ-532 wire. This is AWG-18 stranded Copperweld wire, with ultraviolet-resistant polyethylene insulation. The wire itself has 1.1 mm diameter, with an OD of 2.2mm. Its breaking strength is 50 kg.
- The top-hat wire is made of Spiderbeam CQ-534 wire. This is AWG-26 stranded Copperweld wire, with ultraviolet-resistant polyethylene insulation. The wire itself has 0.5 mm diameter, with an OD of 1.2mm. Its breaking strength is 10 kg.
- The top-hat guy rope is made of PVDF Monofil line. This 1mm diameter line is ultraviolet-resistant and very durable. Its light weight and good resistance to icing make it optimal for this use. This is much higher quality than normal fishing line.
- The insulators are also made of lightweight polyethylene, are ultraviolet-resistant and very strong. Despite the low RF current in the top-hat wires, expect

very high voltage. As a consequence, we use 2 insulators in each top-hat line. Do not substitute.

- The Spiderbeam Vertical Connection box Plate is purpose built for connecting the antenna's coax, radiator, and radials. It is also available as a separate option for other use.

- The guy ropes are made with Dacron-covered Kevlar. They are strong and UV-resistant due to the Dacron. To reduce point pressure which could damage the pole, do not tie the Kevlar directly to the pole. Instead, tie it to short strips of thick 6mm Dacron rope provided) and tie it to the pole. Even better, use the optional Guy Belt set for the pole.

- The wire for the radials is not included in the kit and must be sourced locally. It may be copper enamel wire for temporary installations, but should be insulated for long-term or permanent installations. For top band you will need a lot of wire. The total amount required depends on the number of radials used and the lengths chosen.

2.0 Construction

Before beginning construction, we highly recommend erecting the 18m fiberglass pole at least one time to familiarize yourself with the physical characteristics of the pole. This will avoid any unpleasant surprises later. It will also assure that the clamp set is properly adjusted before you erect the antenna at its final location.

Most of the construction is accomplished during installation. Prior to installation, you can pre-cut your wires and ropes but in most cases, due to the long lengths used, it is easier to cut them in the field than in the house.

FORMULA FOR SUCCESS: MEASURE TWICE, CUT ONCE.

2.1 Pole Preparation

It is very important to erect the pole at least once prior to beginning final installation.

If you have not already done so, please assemble the clamp set (included with the pole), according to the instructions which you will find inside the shipping carton of the pole. These instructions are also available from Spiderbeam as a PDF.

2.1.1 Tips for Clamp Set Assembly

The Spiderbeam 18m Pole consists of 12 telescoping segments. The segments are counted from 1 to 12, with segment #1 being the bottom, thickest segment. There are 11 clamps included with the clamp set. Each clamp will be installed on the bottom of its

pole segment, resting on the segment below it. There is no clamp for pole segment #1. Counting begins with clamp #2.

We highly recommend labeling each clamp with the number of the pole segment on which it is to be installed. To label the clamps, use a marker with white, permanent ink (e.g.“*Eding" or* “*Sharpie*”). If you do not have one of these markers available, find an alternate way of labeling these clamps. This will make installation much easier and reduce the possibility of error. Worst case, just tape a piece of masking tape to each clamp and label it. This will last long enough for the assembly process.

2.2 Wooden Base Stake Preparation and Installation

The wooden base stake is not included in the 160-18-4WTH kit and must be sourced locally.

The purpose of the base stake is to hold the pole in place and keep it from slipping or sliding under the pressure of the wind. The guy ropes are the pole’s main horizontal support, not the base stake.

- Stake Dimensions: Approximately 5cm x 5cm x 150cm. (2” x 2” x 5’)

Preparation: it is advisable to slightly carve a point on the bottom of the stake using a sharp pocket knife. **CAUTION: WORK CAREFULLY AND DO NOT CUT YOURSELF.**

Identify the location for the 18m pole, and using a sledge hammer, pre-drill a hole in the ground for the installation of the wooden stake by pounding a 30mm to 40mm steel pipe about 75cm into the ground. Remove this pipe, insert the base stake into the hole and pound it into the hole with a sledge hammer.

PLEASE TAKE CARE TO KEEP THIS STAKE PERFECTLY VERTICAL

2.3 Attaching the Pole to the Base Stake

DO NOT USE COMPRESSION CLAMPS FOR THIS PURPOSE!

Compression clamps, unless used in conjunction with protective rubber strips like the pole’s clamp set, will cause damage to the pole. Instead, use 2 or 3 straps to secure the pole to the wooden base stake. See the example on the right. These straps are readily available in any camping supplies shop. They are used for securing things like sleeping bags to back packs.

- When you tighten the straps, take care that their metal adjustment head is resting on the wooden stake, not directly on the fiberglass pole.
- If you cannot find these straps, you may substitute 6mm Dacron rope:

Cut two or three pieces of 6mm Dacron rope about 80cm long and prepare their ends by heating them with a cigarette lighter. **CAUTION: RISK OF BURNS**

2.4 Raising the Pole for the First Time

UNLESS YOU ARE VERY TALL, YOU SHOULD USE A SHORT STEP LADDER.

Note: it is helpful to wear very thin leather gloves when erecting of the pole. This not only protects your hands, it also gives you a firmer grip on the pole and reduces hand slippage.

PLEASE ERECT THE POLE ONE TIME WITHOUT ANY WIRES ATTACHED.

During the raising of the pole, you will install and adjust the 11 clamps. All clamps will be slipped over the top of the pole before beginning to erect it.

If you are using the optional guy belt set, you must insert the belts in the proper sequence, in between the clamps. Read 2.4.2 *before* installing the clamp set in 2.4.1.

TIP: Although you can tighten the clamps using a standard screw driver, it is much easier and faster to use a 7mm nut driver.

2.4.1 Raising and Clamping the Pole Segments

- Carefully raise the inner-most pole segment (segment #12) about 30 or 40 cm and temporarily tape it to the segment below it, using electrical insulation tape. To accomplish this, pull the top segment fully out until it pulls the next segment (segment #11) with it. While holding segment #11 with one hand lower segment #12 back into #11 until only about 30 or 40 cm are sticking out. Tape with electrical tape.
- You will now slide the entire clamp set, beginning with the largest clamp first (clamp #2), over the top of the pole. DON'T FORGET to insert the optional guy belts if you plan to use them. Do this as described below.
- First slide clamp #2 over the top of the pole.
- Next slide the 2nd largest clamp (clamp #3), over the pole.
- Continue sliding the remaining clamps in ascending order over the pole until all 11 clamps are in place. DON'T FORGET to insert the optional guy belts if you plan to use them. Do this as described below.

- Holding the top of segment #12 with one hand, remove the electrical tape with the other hand.
- Next, pull segment #12 (the top segment) out from segment #11 (directly below it), extending it as far as it will go.
- Secure these two segments together by holding segment 11 near the top with one hand, and segment 12 near the bottom with the other hand; pull apart with both hands as you twist your hands in opposite directions.
- Finally, slide clamp #12 into position, such that it sits fully on pole segment #12, but resting against the top of pole segment #11.
- Pull segment #11 out from segment #10; and as above, pull and twist to secure it.
- Secure clamp #11 at the bottom of pole segment #11, resting on the top of pole segment #10.
- Continue exactly like this until all of the pole segments are fully extended and secure.

2.4.2 Using the Optional Guy Belts

Whenever possible, please use the optional guy belt set, available from the Spiderbeam Online Shop. These belts enable guying the pole in 3 or 4 directions (4 directions STRONGLY recommended), and reduce the point pressure exerted on the pole by the guy ropes.

Each guy belt will mount to a specific pole segment, resting on top of that segment's clamp (at the bottom).

- The belt with the larger hole mounts on pole segment # 5, so insert the belt between clamps #5 and #6.
- The belt with the smaller hole mounts on pole segment # 9, so insert the belt between clamps #9 and #10.

DO NOT FORGET TO INSERT THESE BELTS BETWEEN THE CLAMPS WHEN PLACING THE CLAMPS OVER THE POLE.

This completes the Pole Preparation Section.

- Please loosen each clamp **except** clamp #12, beginning with clamp #2 (the lower clamp) and carefully drop the pole back down, leaving only the top section (#12) extended so that the clamps (and belts) do not fall off.

2.5. Mounting the Radial Connection Box:

In 2016 Spiderbeam replaced the big bulky aluminum Radial Connection Plate with this smaller Radial Connection Box. The RCB-1 is easier to mount to any size fiberglass mast and has plenty of connectivity for radials.

The picture on the right shows 8 radials, 4 radials per side. In this example we have connected 2 radials per solder lug.

For more connectivity you may solder up to 4 radial wires to each solder lug and you may connect up to 10 solder lugs per side – giving you connectivity for 80 radials.

Should you require more radials, contact Spiderbeam for a Radial Expansion Adapter.

Proceed as follows:

- Fasten the pole to the wooden base stake, pulling the top strap tight, but leaving the bottom strap loose. This will enable you to pull the pole a few centimeters away from the stake for installing the radial connection box (RCB-1).
- Place the RCB-1 against the pole near the bottom, approximately 10cm (4 in.) above the ground.
- Fasten by wrapping a large black (UV-Resistant) Wire-Tie around the RCB-1 and the fiberglass pole, being careful **not** to wrap around the wooden stake. If you don't have a large enough wire-tie, use two medium-size wire-ties.
- Now you can secure the Spiderpole to the wooden stake.
- Connect radial sets to both sides of the box.
- For portable installations, fasten using Wing-Nuts, Washers, and Lock Washers.
- For permanent installation, secure with standard Nuts, Washers and Lock Washers.

2.6 Measuring and Cutting Ropes and Wires

Measurements which need to be exact should be measured with a long tape measure, rather than with a folding rule. By measuring once or twice with the tape measure, rather than multiple times with the folding rule, you reduce the possibility of error.

The length of the vertical radiator wire is not critical down to the last millimeter, because it is intentionally cut too long and will be shortened later during the tuning process.

The cut length of the top-hat wires is not critical down to the last millimeter, because they may also also be adjusted in the field when tuning. This will depend on the ground characteristics of your location.

The field adjustment of the top-hat wires is critical. Even though you may have to adjust their lengths a few times, you must keep the length of all top-hat wires equal.

FORMULA FOR SUCCESS: MEASURE TWICE, CUT ONCE.

2.6.1 Table of Measurements

MEASUREMENTS	MATERIAL	QTY	LENGTH	CUT	STAKE DISTANCE FROM THE POLE
Radiator Vertical Wire	CQ-532	1	~17.5m	18m	N/A
Top-Hat Wires	CQ-534	4	~12.5m	15m	N/A
T-H Extension Rope	PVDF Monofil	4	~18m	20m	25m
Upper Guy Rope	2mm Kevlar	4	~14-15m	17m	7-9m
Lower Guy Rope	2mm Kevlar	4	~10-12m	14m	7-9m
Total CQ-532	~	~	~	18m	~
Total CQ-534	~	~	~	60m	~
Total PVDF Monofil Line	~	~	~	80m	~
Total Rope with 4 dir. Guys	~	~	~	124m	~

Note: The top-hat wires are tied to different ground stakes than the guy ropes.

2.6.2 Cutting the Wire and Ropes

It is up to you whether you choose to cut the wires and ropes before going to the field, or cut them in the field. Due to their lengths, it is usually easier to cut them in the field.

- Radiator Wire: Cut 18m of CQ-532 wire
- Top-Hat Wire: Cut 4 pieces of CQ-534 wire, each 15m long
- T-H Extension Ropes: Cut 4 pieces of PVDF Monofil Line, each 20m long
- Upper Guy Ropes: Cut 4 pieces of 2mm Kevlar rope, each 17m long*
- Lower Guy Ropes: Cut 4 pieces of 2mm Kevlar rope, each 14m long*

*Prepare the Kevlar rope ends as described in APPENDIX 5.2.

2.7 Preparing the Radials

The Spiderbeam 160-18-4WTH was designed to be easy to install, using 16 ground-mounted radials. Using any number between 8 and 24 will give rewarding results. If you use less, performance will be reduced. If you use significantly more radials, the small gain in radiation efficiency will be offset by losses in the coax due to higher SWR. We recommend 16 radials as the “Sweet Spot” for this antenna.

As pointed out earlier, for more information on the deployment of radials and their impact on performance, we recommend reading the excellent article by Rudy Severns (N6LF), in the December 2010 issue of QST. This article summarizes the information put forth by Rudy in a series of 7 articles for QEX magazine.

2.7.1 Preparing the Radial Wires

The following instructions are based on the assumption that you are using 16 ground-mounted radials as recommended. If you use more, or fewer, please adjust the numbers yourself.

The ground-mounted radials should each be between ⅛ and ¼ wavelength long (20 to 40m). The length is not critical, but the number of radials is, with more being better. Usually the length of each is determined by the space available to run the radials. 25 to 30m is a good length to target.

- Due to the length of the radial wires, this work is best performed in the field, directly where the radials will be installed. You may choose to do this in advance, or do it later during the installation.

- You will need 320 to 640m of wire, eight M6 cable solder lugs, a crimping tool or pliers, a soldering iron 60w or greater, and liquid electrical tape.

THE RADIAL WIRES WILL BE PREPARED IN GROUPS OF 2.

- Cut 2 radial wires, each 20 to 40m long.
- Remove 2cm of insulation from one end of each of these 4 wires.
- Splice the 2 wires together by twisting them as tight as you can.
- Trim the splice to 1.5cm with wire cutters.
- **DO NOT SOLDER BEFORE CRIMPING.**
- Insert the splice into a M6 cable solder lug and crimp the lug using a crimp tool or pliers.

- Now solder the wires inside of the solder lug.
- Weather proof the 2 wires at the lug with 2cm of heat-shrink tubing, and seal the other end with “liquid electrical tape”, or similar. You may also use your XYL’s nail polish for this. If using nail polish, apply 2 or 3 coats, allowing to dry between coats.
- **This completes the preparation of the first 4 ground-mounted radials.**
- Now prepare 7 more sets of 2-radials, exactly as you have done above.
- **This completes the preparation of the 16 ground-mounted radials.**

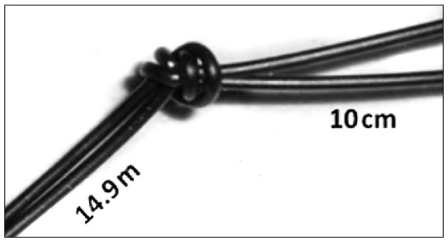
2.8 Preparing the Top-Hats

- For space reasons, it is probably easier to prepare the top hats in the field.
- You will need to solder at least one connection in the field. This will require a soldering iron with at least 60w.
- You will need 4 small weights to attach to the ends of the top-hat lines to keep them under tension during the installation of the antenna. For this we recommend large “lead sinkers” like fishermen use to weight their fishing lines. A 4-oz. to 5-oz. (112 to 140 gr.) sinker is heavy enough. You may substitute but **do not use heavier weights**.

2.8.1 Preparing the Top-Hat Wires

We will prepare the top-hat wires "<u>two</u> at a time":

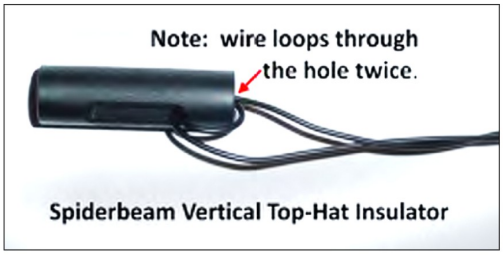
- Grasp two of the top-hat wires about 15cm below one of their ends, such that the two ends are the same length above your hand.
- Keeping the wires parallel, tie a simple "Overhand Knot" in the two wires, about 10cm from their ends. Pull this knot as tight as you can.
- Wearing gloves, grasp the two wires about 30cm below the knot and wrap two turns of wires around your hand, so that you can keep the wire from slipping. Then using pliers pull the end of each wire individually until the knot is as tight as you can get it. See picture



- You should have about 10cm of wire extending above the knot (±1cm). Confirm.
- Now prepare the other two top-hat wires exactly like you prepared these two.

Next you will connect an insulator to the other end of each wire:

- Insert one end of one of these two CQ-534 top-hat wires through the hole in the end of an insulator, exiting through the slot.
- Pull about 2.4m of wire through the hole and out the slot, then fold it back about 2.4m such that the distance between the knot and the insulator is 12.5m.
- Now run the end of the wire through the hole a second time and pull it tight.
- Fold back the rest of the wire onto itself twisting the excess wire several times around the longer portion of the wire as you fold it back.



- Measure the distance again between the knot and the insulator. It should be exactly **12.5m**. *** **THIS IS THE MOST CRITICAL MEASUREMENT OF THE ANTENNA. *****
- Secure with two small black UV-resistant wire-ties, one near the insulator and one near the end of the wire.
- Now prepare the other CQ-534 top-hat wire exactly like the first one.
- **Make sure the distance between the knot and insulators is the same on both wires.**

This completes assembly of this pair of top-hat wires for now.

- Now prepare the other pair of CQ-534 top-hat wires exactly like the first pair.
- The final quality control is to hold all 4 wires in parallel and compare the distance between the knot and the insulators. **Make sure they are all 4 the same length.**

2.8.2 Connecting the PVDF Monofil Line to the 2nd Top-Hat Insulator

The top-hat wires have very little RF current in them, but very high voltage. It is advisable to use two insulators in each top-hat, with a short piece of PVDF Monofil line between them.

PLEASE DO NOT SUBSTITUTE BIGGER INSULATORS!

When using top-hat wires with this pole, there are THREE critical factors:

WEIGHT, WEIGHT & WEIGHT

Note: When pulling the knots in PVDF Monofil line tight, it is advisable to wear thin leather gloves to keep the line from cutting into your hands. It is also advisable to use one pair of pliers to pull on the short end of the line tight, but

IMPORTANT: DO NOT HOLD ANY PART OF THE LINE WHICH WILL LATER BE UNDER STRESS WITH PLIERS.

For each of the 4 top-hat wires:

- Cut a piece of PVDF Monofil line 40cm long.
- Insert one end of the line through the free hole of the top-hat insulator.
- Tie a large knot in the PVDF Monofil line about 10cm from this end. Tie any kind of knot you like; just make sure it does not slip through the hole. You may want to use pliers to hold the short end while pulling tight. Now, holding the insulator, pull the longer end away from the insulator, pulling the line tight. The knot will now rest inside the slot of the insulator. **Do not trim the excess line!**
- Insert the free end of the PVDF line through the hole in the end of a new insulator, extending it out of the slot.
- Tie a large knot in this end about 10cm from the end. Again use pliers to hold the small end and pull it tight. **Do not use pliers on the line between the knots.**
- Now pull the two insulators away from each other. This new knot should slip inside the slot of the 2nd insulator.
- The two insulators will be **about 16 to 18 cm** apart, but this distance is NOT critical.

The final step is to fasten a PVDF Monofil line to the free hole of the second insulator:

- Insert one end of an 18m piece of PVDF Monofil line through the free end of the second insulator.
- Tie a large knot about 10cm from its end and pull it tight, using a pliers to hold the short end.
- Pull the long end away from this insulator, pulling the knot inside the insulator's slot.

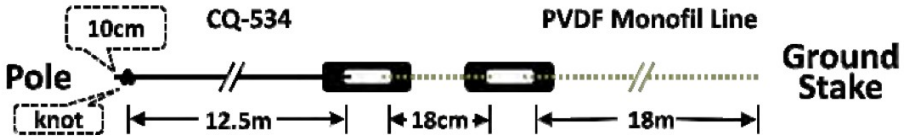
This completes the first of 4 top-hat lines.

Continue with the next three top-hats:

- Mount the insulators and PVDF line exactly the same as above.

This completes the preparation of all four top-hats.

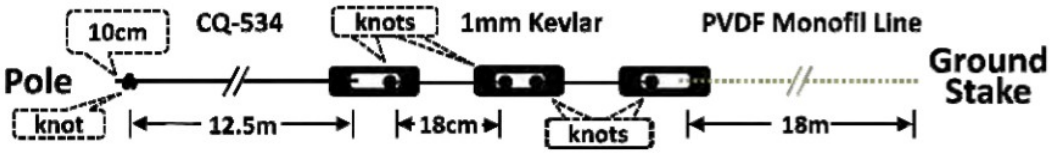
When completed, each top-hat should look like this:



TIP: Temporarily tie the far end of the Monofil line to a small weight. We use heavy "lead sinkers" (140 gr. weights) sourced from a fisherman's supply shop for this purpose. This should be just enough weight that it applies some tension to the line as you later begin to raise the pole with the antenna. **Don't use too much weight.**

2.8.3 HIGH POWER OPTION (>1kW)

If you plan to run more than 1 kilowatt, you must take special precaution. You will need 3 insulators per Top-Hat Wire instead of 2 and you must use 1mm Kevlar rope between the insulators instead of PVDF Monofil. Build it exactly as described in 2.8.2, but use 3 insulators with 1mm Kevlar rope between them.



3.0 INSTALLATION

- The hardest part of the entire assembly and installation process is "***keeping the wires and ropes from tangling.”***
- We recommend laying each rope or wire out on the ground in its approximate end position. It is advantageous to temporarily use small weights to keep some tension on the lines when they are lying on the ground.

PLEASE READ SECTION 3.2 (WIND) BEFORE CONTINUING WITH 3.1

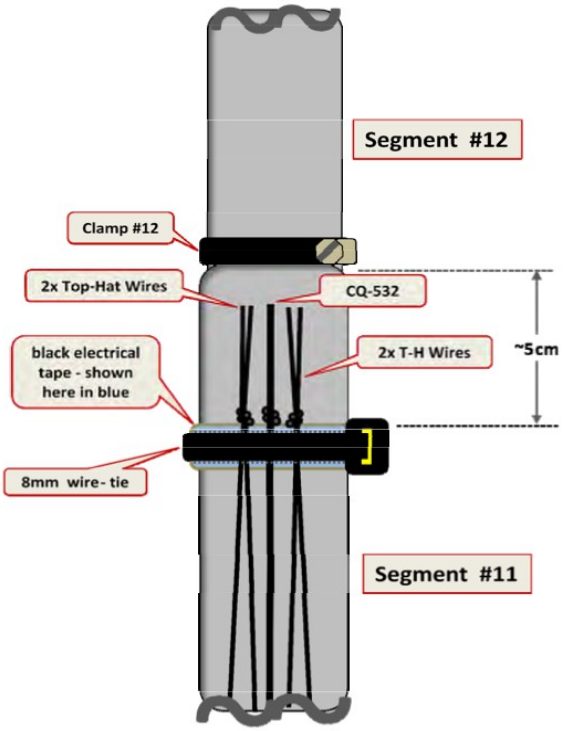
3.1 Installing the Radiator and Top-Hat

In this section you will attach all wires to the pole, dress the wires, splice and solder them together. **You will need electrical tape, a large 8mm UV-Resistant cable-tie, a soldering iron, 60w or more, and liquid electrical tape (or similar) to insulate the connection.**

3.1.1 Mounting the 4 Top-Hat Wires and Vertical Radiator Wire to the Pole

You will use a low-tech method for attaching the wires to the pole. It is very simple, lightweight and effective.

Note: the pole segments are much smaller than they appear in this sketch. In this sketch the pole segments were drawn over-size to enable showing the details of the dressing of the wires.



Begin:

- Wrap about 5 or 6 layers of good quality black UV-resistant electrical tape around segment 11 of the mast, about 5 cm from its top.
- Tie an “Overhand Knot” 10 cm from one end of the CQ-532 vertical wire.
- Following the diagram in the picture, place the vertical wire (CQ-532) and the two pairs of top-hat wires (CQ-534) against the top of segment #11, such that the 3 knots are just above the tape.

- Wrap an 8mm heavy duty UV-resistant wire-tie around the layer of tape and pull it slightly tight, TAKING CARE TO ASSURE THAT THE WIRE-TIE IS SEATED IN THE CENTER OF THE TAPE (as shown in the picture).
- Carefully pull all of the wires downward until their knots are seated directly on top of the wire-tie.
- Now pull the wire-tie very tight, compressing the electr. tape. Cut off excess tip.
- Wrap several layers of black electrical tape over the wire-tie. This will improve its resistance to UV. (This step is not shown in the picture).

3.1.2 Connecting the Vertical Radiator Wire to the Top-Hat Wires

- Measure 4cm above each knot and cut off the rest of the wire.
- Remove 2cm of insulation from the end of all 5 wires.
- Splice the 4 top-hat wires and the radiator wire together by twisting them tight.
- Solder this connection using a 60w soldering iron, or larger.
- After the solder has dried and cooled off, you can cut off some of the excess, leaving about 1cm of exposed soldered wire.
- Finally, insulate the remaining 1cm of exposed, soldered wire with liquid electrical tape, or with whatever your favorite similar insulating substance is. If you do not have anything like this, then tape this connection with standard electrical insulating tape. *(BTW, the XYL's red fingernail polish works well as a substitute!)*

3.1.3 Running the Vertical Radiator wire down the Pole

Make sure the 4 top-hat wires are out of the way:

- Position the 4 top-hat wires 90° apart and pull the far ends away from the pole until there is a bit of tension on the wires.
- The temporary weights on the ends of the Monofil line should maintain the tension and keep these wires out of the way.

The vertical wire will spiral gently down the pole with about 1 turn per meter. As you approach the bottom of the pole, about 2m from the bottom of the pole begin wrapping the turns much closer together, about 10 to 12 turns per meter, forming a loose coil. The turns will be spaced about 8 to 10cm apart from each other (not critical). When you reach the bottom, temporarily tape the wire to the pole with electrical tape to hold it in place. Then you will cut off the excess wire (if any), leaving about 3cm excess for connecting to the connection plate. Finally you will remove 3cm of insulation and make the connection.

It is almost certain that you will have to shorten this length later, so do not bother to tighten it real tight for now and **DO NOT INSULATE IT YET**.

Although this sounds very easy, don't forget:

- You have to do this while raising the pole one section at a time.
- As you raise the pole, you will also have to attach the upper and lower 4 guy ropes at their correct guying levels.

Don't worry; it's not difficult. Just take your time, being careful as you work.

Note the following:

- If you opted for the guy belt method, you will attach the ropes to the guy belts using a "bowline" knot.
- If you opted for the 6mm Dacron rope-stub method, you will tie two rope stubs to the pole securing each with a "square knot", such that their knots are 90° apart and then tie the four 2mm Kevlar guy ropes to the rope stubs using a "sheet bend" knot.

3.1.4 Raising the pole to its full Height

In this step, we will perform the work described above in section 3.1.3.

CAUTION: IF IT IS WINDY, SEE SPECIAL INSTRUCTIONS IN SECTION 3.2

The pole is raised exactly the same way as it was raised in 2.4.1. – one segment at a time. The segments are pulled and twisted in opposite directions to friction-lock in place. Tighten clamps.

After each segment is secure, be sure to rotate it back to the position it was in before you raised it. Please pay attention to these points.

- Otherwise you will end up with the top-hat wires twisted several times around the pole.
- After securing a section in place, as you run the wire down the pole, you will wrap the vertical wire about two turns around each segment.

Once again it is advantageous to use a small step-ladder.

Spiderbeam 160m Vertical Model 160-18-4WTH

BEGIN:

- Pole segment #12 is already fully extended. Double-check that its clamp is tightened and seated properly, resting on top of segment #11. NOTHING should be attached to this segment except clamp #12.
- Proceed with raising segment #11. When it is fully extended, friction-locked, and secured with clamp #11, be sure to rotate it back to its original position.
- Wrap 2 turns of the vertical wire around that section as you run the wire down the pole.
- Continue with segment #10, proceeding exactly as above.
- Extend segment #9 as above, and then STOP.
- Now you are ready to attach the 4 upper guy ropes to the pole using either the top guy belt which should be already sitting in place, or the 4 rope stubs (which you will attach now).
- Follow the directions below, according to the type of guy rope attachment you have chosen.

Continue with raising the Pole Segments:

- Make sure the guy belt or guy rope stubs are resting at the bottom of segment #9, directly on top of clamp #9.
- At this time pause, stretch all 4 upper guy ropes fully out and also tie some sort of weight to their ends to keep them under tension. Use anything; even a small piece of wood. Not too heavy, just enough to keep tension on the line as you raise the pole. We typically use lead sinkers here too.
- Proceed to raise segment #8, just as you have raised the others above it, wrapping two turns of wire per segment as you go.
- Continue with segments #7, #6, and #5 as above, taking your time to work correctly, and double check your work.
- After assuring the wire is spiraling correctly down all of the upper segments, with about 2 turns per segment **STOP**.
- Attach the 4 lower guy ropes using the same method you used above for the upper guy ropes.
- Pull the 4 lower guy ropes away from the mast, laying them on the ground.

  Unless the wind is blowing strong, you don't have to do anything with them now. **If the wind is blowing strong, follow the directions in Section 3.2.**
- Now extend segment #4, taking care that the spiraling wire does not tangle with the lower guy ropes.

- Continue by extending segments #3 and #2 as above.

  Now the pole is fully extended.

- Temporarily tape the vertical wire to segment #1 using electrical tape. This will hold the wire in place while you fasten the guy ropes.
- First tie the 4 **lower** guy ropes to their ground stakes, which should be located about 7m to 9m (9m is better) away from the pole. Leave them a little loose and don't worry if the pole is not perfectly straight.
- Now tie the 4 **upper** guy ropes to the same ground stakes, also leaving them a little bit loose for now.
- **After guying the pole,** continue winding the wire down the last segment as follows:
- Loosen the straps (or ropes) which secure the pole to the wooden base stake, just enough so that you can slide the pole about 3cm (1") away from the stake.
- Remove the tape which was temporarily holding the wire to segment #1.
- On the final segment, segment #1, you will change the winding method, winding about 10 to 12 turns per meter, with windings spaced about 8 to 10cm apart.
- When you approach the Connection box Plate, temporarily secure the wire to the pole using electrical tape. The wire appears to be a little too long. That's OK.

  NOTE: If the wire was to short, unwrap the turns of wire on Segment #1 and wrap again, spacing the turns a little farther apart.

- Extend the wire about 3cm beyond its connection point, cut it, and remove 3.5cm of insulation from the end of the wire.
- Connect the wire to its connection point. Do not forget that you will most likely be adjusting the wire's length later so DO NOT COAT IT WITH ANY INSULATING MATERIAL.
- Remove the electrical tape that was used to temporarily fasten the wire to the pole.
- Re-tighten the straps (or ropes), securing the pole to the wooden stake once again.

  This completes this section of the installation.

Remaining Work:

- **Fastening the top-hats to their ground stakes**
- **Adjusting all guy ropes**
- **Attaching the radials**
- **Tuning the antenna**

3.1.4.1. Guy Belt Method:

- Attach each of the 4 upper 2mm Kevlar guy ropes to one arm of the upper guy belt, using a **"Bowline"** knot to secure them. See APPENDIX for knot instructions.
- Repeat these steps for the lower guy ropes.

- or -

3.1.4.2. Short Rope Stubs Method:

- Attach the two short pieces of Dacron rope (about 80 cm long) to the pole using a **"Square Knot"** for each, positioning the two knots 90° apart. See APPENDIX for knot instructions. You will have 4 short stubs of rope hanging down, each rotated 90 degrees from the next.
- Attach each of the 4 upper 2mm Kevlar guy ropes to one of the stubs using **a "Sheet Bend"** knot to secure them. See APPENDIX for knot instructions.
- Repeat these steps for the lower guy ropes.

3.2 Special Instructions for Erecting the Pole in Windy Conditions

This is very important and if you are not sure whether it is too windy or not, then assume it is too windy and PLEASE follow these special instructions:

- First of all, if there is a storm with very high winds, it is probably better to wait another day until the storm has passed. When erecting the pole in high winds, you should have one or two people to help you.
- If it is just a windy day, then you will need to temporarily fasten the 4 upper guy ropes to their ground stakes as soon as you can, during the process of raising the pole.
- Continue with the next step, which is directly after fastening the 4 upper guy ropes to the guy belts or guy ropes in section 3.1.4.1 or 3.1.4.2.
- After fastening the upper 4 guy ropes to segment #9, raise segment #8, dressing the wire down it. Temporarily tape the wire to the pole with electrical tape.
- Now fasten all 4 of the upper guy ropes to their ground stakes, leaving about 3 meters of slack in each rope. To do this, first pull the slack out of the rope,

making sure the pole is still straight but not bent, and then loosen the rope by 3m and fasten it. This leaves about 3m of slack in the rope. Do this for all 4 guy ropes.

- Now remove the electrical tape and raise segment #7 and secure it. Don't forget to dress the wire as described in the section above. Tape the wire again.
- Return to the 4 guy stakes, and loosen the 4 guy ropes enough that you can raise the pole for the next segment. **(Again about 3 meters).**
- Now remove the tape and raise segment #6 and secure it. . Don't forget to dress the wire as described in the section above.

Obviously it is easier to do this work with one or two helpers.

- Repeat this procedure each time **until segment #4 is fully extended.**
- At this time, check the wind. If it is blowing strong, also attach the 4 lower guy ropes to the ground stakes, again leaving enough slack that you can raise the next segment.
- Repeat this procedure until all of the segments have been extended.
- Continue following the instruction in 3.1.4, with **"After guying the pole."**

3.3 Fastening the Top-Hats to their Ground Stakes.

The top segments sections of the pole are very thin and very light. The top-hat lines are very light. When pulling them tight and fastening to the ground stakes, please take care not to pull the lines tight the first time you tie them! Leave them very loose.

- Tie all 4 top-hat lines to their respective ground stakes, located about 25m away from the pole. Please leave them **very loose** when you initially tie them.
- After all 4 are tied, you will probably notice that the pole is leaning heavily in one direction. Loosen the line that is pulling it and causing it to bend.
- The pole should be standing perfectly straight before you begin final adjustment. If necessary, loosen more guy lines until the pole is straight.

3.4 Adjusting the Guy Ropes and Top-Hat lines.

Initially you will probably tend to over-tighten the first guy lines. Everyone does. That's because the pole is so light and flexible that you do not even notice when it is bending towards you.

The best practice procedure is to have a friend watching the pole from a distance, 90° from the direction you are pulling the guy line in. From there (s)he can tell you if it is straight or bent. After you have adjusted all of the lines a few times, you will soon get a good feeling for performing this task.

Where do you begin? Begin by loosening the line that is pulling it too far. Do not tie a permanent knot. You will make several repeated trips to the ground stakes, adjusting each guy line several times before you are satisfied with your work.

BIGGEST MISTAKE PEOPLE MAKE: OVERTIGHTEN ALL OF THE GUY LINES.

Normally the pole will stand straight by itself. The guy lines are there to keep it from blowing / bending too far in the wind. Therefore you should leave a little slack in each of the guy lines.

- With the top-hat lines and upper guy ropes a little loose, start by adjusting the lower guy ropes. You will probably have to adjust each one 2 or 3 times until the pole is standing straight and not being pulled by any one line.
- Now adjust the upper guy ropes in the same manor.
- Finally, adjust the top-hat lines.
- When you are satisfied that all lines are guyed like you want them, check all knots to make sure they are tight and secure.

3.5 Installing the Radial Network

When installing the radials, every attempt should be made to keep the individual radials symmetrical and equally spaced. The reality is, in many installations, this is not physically possible. In that case, just try to do the best you can.

3.5.1 Installing Ground-Mounted Radials

When using ground mounted radials, we recommend connecting 4 radials per solder lug as described in the Preparation section, 2.7.1. Each of these lugs connects to one corner of the connection plate. That way you can connect 16 radials with just 4 bolts.

Assuming you are deploying the recommended 16 radials:

- Fasten each of the sets of 4 radials to one of the corner bolts of the connection plate and fan the radials out equal distance apart, such that they are about 22.5 degrees apart. This is an approximate value and it is sufficient to use the eye for measuring.
- It is helpful to secure the far ends such that the wires will not recoil on their own. To do this, simply loop the end of the wire around a long nail and wrap a couple of turns around itself, securing it to the nail. Pull the radial slightly tight, and push the nail into the ground. Usually your foot is all you need. For hard ground, use a small hammer.

4.0 Tuning the Antenna

4.1 Tuning Theory and Methodology

This antenna is not plug-and-play, and must be tuned for resonance. Using the measurements specified in this document, the antenna should be resonant below the 160m band, probably about 1.7 MHz. The antenna is electrically too long.

The antenna was intentionally built too long to assure it would be resonant below the band. Typically, with 4 top-hat wires, 12.5m long, tied to ground stakes 25m away, a 16m vertical radiator is required for resonance within the 160m band. YOUR MILEAGE MAY VARY!

Normally you can raise the resonance frequency of the antenna by removing about *2cm of wire per kHz* from the vertical part of the radiator. Because the excess wire forms sort of a loose coil, lowering the resonance frequency even more, you may find that you only need to remove 1.5 to 1.8cm per kHz.

EXAMPLE:

Say you want to raise the resonance frequency by 50 kHz.

Normally you would calc. 2cm per kHz, or 100cm to be cut (50x2 = 100) for 50 kHz.

To be on the safe side, **cut only 75 cm**.

Measure the resonance frequency again. (e.g. the resonance only rose by **35 kHz)**

Now by comparing the number of kHz the resonance frequency has risen (35), to the number of cm cut off (75), you get a more accurate estimate of how much to cut next time. In this example, divide 75cm (which you cut off) by 35 kHz (which the resonance frequency rose): 75/35 = 1.67 cm/kHz.

Now you know that you only need to cut 1.67cm per kHz, not 2cm.

To increase the resonance frequency by 50kHz, you would multiply 50 x 1.67 = 83.5cm and cut that amount off.

If you had cut 100cm off the first time, you would have cut too much!

Now you see why it is important to cut in small steps.

The radiator is initially about 18m long. You have about 2 meters which can be trimmed by unwinding some of the turns of the wire and running it straight down the pole. If need be, you can also raise the connection box plate up to 50cm or so. PLEASE adjust in small steps, not all at once. **It's better to cut 2 or 3 times, than to cut too much the first time!**

4.1.1 It's Time to Tune

With ground-mounted radials, the radials do not have much influence on the resonance frequency. There is no need to adjust the length of radials. You will adjust for resonance by adjusting the length of the vertical wire. If that doesn't move resonance enough, the top-hat wires will have to be adjusted.

- Connect a good quality coax to the antenna.
- Using an antenna analyzer or worst case a transceiver running very low power, determine the SWR at the resonance point of the antenna. Expect it to be outside of the band. DO NOT TRANSMIT OUTSIDE OF THE BAND.
- **Write down your results. Record every step you take during the tuning process.**
- Note the resonance frequency and determine how many kHz it must be increased.
- Calculate the amount of wire to be removed using 2 cm per kHz as your initial formula – AND ONLY REMOVE ABOUT HALF THE LENGTH THAT YOU CALCULATED. BE SURE that you remember how much wire you removed (write it down).
- Measure the SWR and resonance once again, **and write it down.**
- Determine how many kHz it has increased in resonance.
- Now divide the number of cm cut off by the number of KHz of increase in resonance frequency. The result will tell you how many cm per KHz must be removed at your specific QTH, to adjust for resonance upwards. Now you know YOUR mileage.
- Adjust the length again, but again cutting less than you calculated. It is better to achieve resonance in two more cutting steps, than to cut it too short.
- Repeat this procedure until resonance is where you desire.
- If you do cut it too short, simply solder some wire back onto it. Your kit contains 2 m of spare wire. Weather-proof the splice with liquid electrical tape of fingernail polish.

Problems may occur. Perhaps you are unable to raise the resonance frequency far enough and now the vertical wire is cut too short. No Problem. Just a little bit of work.

- In that case, as stated above, simply solder enough wire back onto the vertical wire to enable it to reach the connection plate.box
- If you are only missing 10 or 30 kHz, the easiest way to increase the resonance frequency (if you have no more wire to shorten) is to move the 4 ground stakes for guying the top-hats closer to the pole. Move them about 2 or 3 m closer.
- Check the resonance again.

- It should be possible to bring it into resonance just by moving the top-hat stakes, but if it looks like it is going to require a distance of less than 20m from the pole, we recommend placing the stakes back out at 25m and shortening each top-hat wire by 50cm.
- In order to reach the top-hat wires, you are going to have to drop the pole 2 sections. This is not difficult to do. This will place the ends of the top-hat wires about 1.5m off the ground when hanging straight down. Now you can easily shorten them by 50cm, BY FOLDING THEM BACK, not by cutting them.
- After shortening all four top-hat wires by exactly the same amount, raise the pole again and then re-connect the top-hats to their ground stakes – 25m out.
- Measure the SWR again.
- IMORTANT NOTE: Like always, when shortening wires, do not cut the wire. Simply fold back more wire along itself.

By now you should have a feeling for tuning the antenna. It is impossible to describe every scenario you might encounter in the field. If you have run out of ideas, please record everything which you have tried so far and contact Spiderbeam Tech Support at:

info@spiderbeam.us for the U.S. and Canada

info@spiderbeam.com for all other countries.

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5.0 APPENDIX

5.1 Materials and Tools List

5.1.1 Material Included in the Kit

Nr.	Qty	DESCRIPTION
1	1	18m Heavy Duty Telescoping Fiberglass Pole
2	1	Clamp Set for 18m HD Telescoping Fiberglass Pole
3	1	Radial Connection Box
4	20m	CQ-532 AWG 18, Stranded Copperweld Wire, Insulated
5	62m	CQ-534 AWG 26, Stranded Copperweld Wire, Insulated
6	3	50m Spool of 2mm Kevlar Rope
7	1	100m Spool of PVDF Monofil Line
8	10	Special Insulators for the top-hat wires
9	5m	6mm Dacron Rope (must be cut into 6 pieces, each 80cm long)
10	25	UV-Resistant Wire Ties, 3mm
11	2	UV-Resistant Wire Ties, 8mm
12	10	M6 tubular cable lugs
13	1	7mm Nut Driver for the Clamp Set
14	1	Instruction Manual

5.1.2 Other Required Material (Supplied by User)

Nr.	Qty	DESCRIPTION
1	1	Wooden Base Stake, ca. 5cm x 5cm x 150cm (2" x 2" x 5')
2	8	Ground Stakes, for connecting guy ropes and top-hat lines
3	1	Steel Pipe, ca. 30mm to 40mm x 100 to 150mm (to pre-drill hole)
4	?	Coax, RG-213 or similar, long enough to reach the shack
5	16	Nails, 100mm long, (for fastening ends of the radial wires)
6	1	Roll of good quality black electrical tape
7	1	Can of liquid insulation tape, or Bottle of Fingernail Polish
8	2 or 3	"Optional Strap". See paragraph 2.3 for more info
9	1	Permanent Ink Marker

5.1.3 Optional Spiderbeam Material

Nr.	Qty	DESCRIPTION
1	1	Guy Belt Set for 18m HD Telescoping Pole
2	8	Galvanized steel ground peg (330mm long)
3	8	Galvanized steel ground peg (750mm long)

5.1.4 Recommended Tools (Supplied by User)

Nr.	Qty	DESCRIPTION
1	1	Soldering Iron, 60w or greater
2	1	10mm Spanner (wrench)
3	1	Sledge Hammer
4	1	Pliers
5	1	Wire Cutters
6	1	Pocket Knife
7	1	Pair of leather [work] gloves

5.2 APPENDIX: Preparing Kevlar Rope

The 2mm Kevlar rope supplied by Spiderbeam has a yellow-colored Kevlar inner core, and a thin black Dacron outer cover to protect the Kevlar from ultraviolet. The Dacron cover tends to fray easily on its ends, and should be properly prepared before use.

PLEASE PRACTICE THIS BY FOLLOWING THESE INSTRUCTIONS

- Carefully pull the black Dacron cover back on itself about 2.5cm (1”), away from the end of the yellow Kevlar core, by holding the yellow tip with the fingers of one hand and pulling the black Dacron back with the other hand.
- While holding the Dacron cover in place, cut off about 2.5cm (1”) of yellow Kevlar protruding from the Dacron. **Use a very sharp knife or razor blade knife for this.**
- While holding the rope with one hand about 10cm from its end, pull the end of the Dacron cover with the other hand, stretching it as far as you can. It will return to its original length.

  Please wear protective leather gloves for the next two steps! **CAUTION: HOT**
- Using a cigarette lighter or a match, heat the end of the Dacron until it to catches fire. Allow to burn for about 1 second and blow out the fire. Do not let it burn to the point where the Kevlar core starts. Then QUICKLY perform the next step.
- Round out the melted “bulb” of Dacron by slightly stretching it with your fingers.
- Trim any long thin strings of Dacron that may be created.

  When completed, it should look like this:

5.3 APPENDIX: Knots

The Spiderbeam vertical antenna is built using specific knots. For each task requiring a knot, we have selected the knot which we believe is best suited for the job. We STRONGLY recommend using the knot we specify in the instructions.

The 4 knots used for this antenna are the “Bowline”, “Overhand”, “Sheet Bend” and “Square Knot”. The Square Knot is also known as the “Reef Knot”.

If you were lucky enough to be a Boy Scout in your youth, you should already be familiar with these knots. Otherwise “Google is your friend”. There are several good sites showing exactly how to tie these knots.

We suggest you practice these knots before beginning the antenna construction.

5.3.1 The Bowline

Bowline

The Bowline makes a reasonably secure loop in the end of a piece of rope. It does not slip or bind under load.

The Spiderbeam 160m Vertical Antenna uses the bowline to fasten the Kevlar guy ropes to the optional guy belts. (see picture)**.**

For more information:

http://www.animatedknots.com/bowline/

5.3.2 The Overhand Knot

The Overhand Knot is the simplest of all knots. It makes a knot in the end of a rope which can prevent fraying and can act as a simple stopper knot. In the Spiderbeam 160 Vertical Antenna, it is used to form the knots of the top-hat wires (see 1.8.1) and at the top of the radiator wire (see picture).

Overhand Knot

For more information:

http://www.animatedknots.com/overhand/

5.3.2 The Sheet Bend

Sheet Bend

The Sheet Bend (or Becket Bend) joins two ropes that are of **unequal size**, but also works well if the ropes are the same size. Normally it will not slip, as long as both ropes are kept under tension. Both ropes should be loose before you begin tying the knot, and tensioned after the knot is tied.

IMPORTANT: If the ropes are of different sizes, the larger [blue] rope must be used to form the loop on the left in this picture. The smaller [red] rope must come from the right.

In the Spiderbeam 160m Vertical Antenna, it is used to join the Kevlar guy ropes to the short 6mm Dacron guy rope stubs (see 3.1.4.2). Leave both stubs long enough to attach wire-ties.

Hint: after tying the knot, secure the tips of each short end of the rope to itself with a wire-tie. This will prevent the knot from coming undone when it is not under tension.

For more information:

http://www.animatedknots.com/sheetbend/

5.3.3 The Square Knot (Reef Knot)


Square (Reef) Knot

The Square Knot (or Reef Knot) joins two ropes of **equal size**. When tied properly, it is relatively secure. If tied sloppy, it sometimes may spill over into two half hitches and then it may slip. It may be used to extend identical ropes, such as guy ropes, or to tie a rope to itself.

In the Spiderbeam 160m Vertical Antenna, it is used for fastening the short 6mm rope stubs to the pole (see 3.1.4.2).

Hint: after tying the knot, secure the tips of each short end of the rope to itself with a small wire-tie placed immediately beside each side of the knot. This will prevent the knot from spilling over into two half hitches.

For more information:

http://www.animatedknots.com/reef/