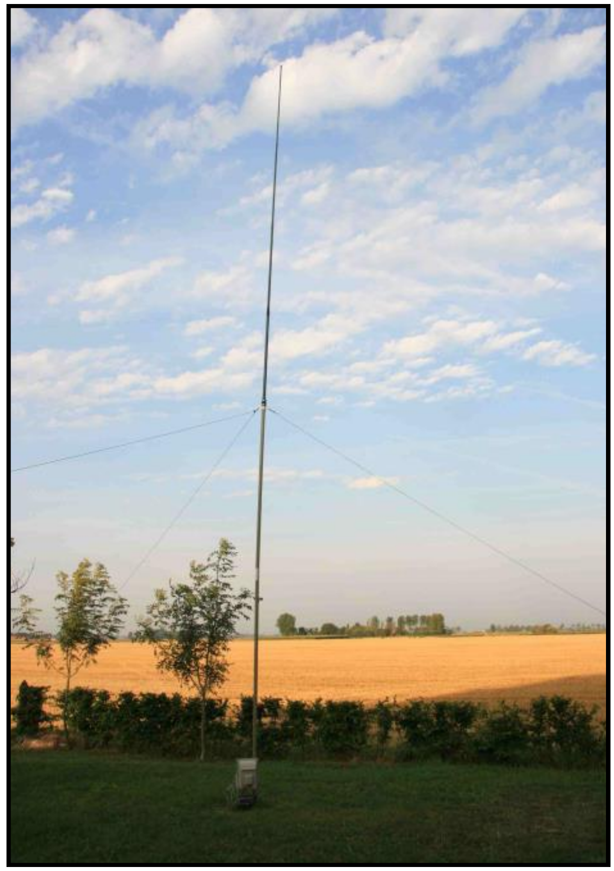
steppIR COMMUNICATION SYSTEMS

BigIR - MK IV
Vertical - Instruction Manual

VU7LD—Laccadive



ON8DS

BS7H—Scarborough Reef

OY9R

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Revision 4.5 4/15/2020

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SteppIR - Why Compromise?

The SteppIR antenna was originally conceived to solve the problem of covering the six ham bands (20m, 17m, 15m, 12m, 10m and 6m) on one tower without the performance sacrifices caused by interaction between all of the required antennas.

Yagis are available that cover 20 meters through 10 meters by using interlaced elements or traps, but do so at the expense of significant performance reduction in gain and front to back ratios. With the addition of the WARC bands on 17m and 12m, the use of interlaced elements and traps has clearly been an exercise in diminishing returns.

Obviously, an antenna that is precisely adjustable in length while in the air would solve the frequency problem, and in addition would have vastly improved performance over existing fixed length yagis. The ability to tune the antenna to a specific frequency, without regard for bandwidth, results in excellent gain and front to back at every frequency.

The SteppIR design was made possible by the convergence of determination and high tech materials. The availability of new lightweight glass fiber composites, Teflon blended thermoplastics, high conductivity copper-beryllium and extremely reliable stepper motors has allowed the SteppIR to be a commercially feasible product.

The current and future SteppIR products should produce the most potent single tower antenna systems ever seen in Amateur Radio! We thank you for using our SteppIR antenna for your ham radio endeavors.

Warm Regards,

John Mertel

John Mertel, WA7IR
President/CEO

SteppIR Design

Currently, most multi-band antennas use traps, log cells or interlaced elements as a means to cover several frequency bands. All of these methods have one thing in common–they significantly compromise performance. The SteppIR™ antenna system is our answer to the problem. Resonant antennas must be made a specific length to operate optimally on a given frequency.

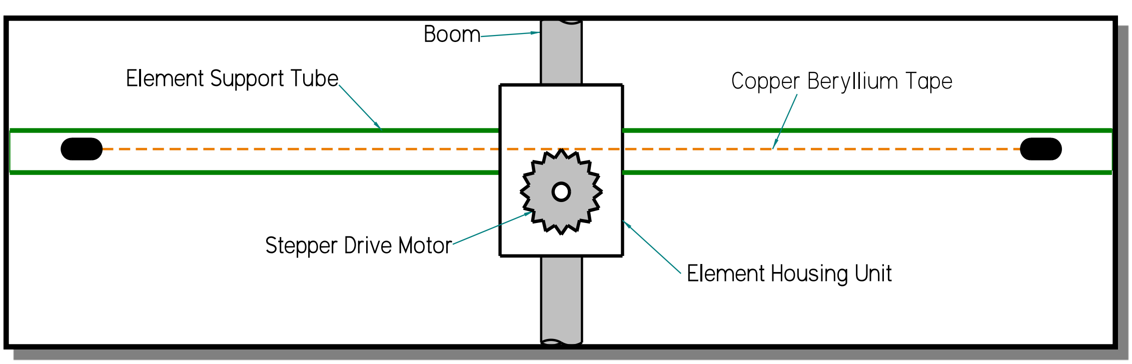
So, instead of trying to "trick" the antenna into thinking it is a different length, or simply adding more elements that may destructively interact, why not just change the antenna length? Optimal performance is then possible on all frequencies with a lightweight, compact antenna. Also, since the SteppIR can control the element lengths, a long boom is not needed to achieve near optimum gain and front to back ratios on 20 - 10 meters.

Each antenna element consists of two spools of flat copper-beryllium tape conductor (.54" Wide x .008" Thick) mounted in the element housing unit. The copper-beryllium tape is perforated to allow a stepper motor to drive them simultaneously with sprockets. Stepper motors are well known for their ability to index very accurately, thus giving very precise control of each element length. In addition, the motors are brushless and provide extremely long service life.

The copper-beryllium tape is driven out into a hollow fiberglass elements support tube (see below), forming an element of any desired length up to the limit of each specific antenna model (a vertical uses only one side). The fiberglass elements support tubes (poles) are telescoping, lightweight and very durable. When fully collapsed, each one measures approximately 59" in length. Depending on the model, there may be additional extensions added to increase the overall element length.

The ability to completely retract the copper-beryllium antenna elements, coupled with the collapsible fiberglass poles makes the entire system easy to disassemble and transport.

The antenna is connected to a microprocessor-based controller (via 22 gauge conductor cable) that offers numerous functions including dedicated buttons for each ham band, continuous frequency selection from 40m to 6m (depending on the model). There are also 17 ham and 6 non-ham band memories and you can select a 180° direction reversal* or bi-directional* mode and it will adjust in just about 3 seconds (* yagi only).



Installing the BigIR Extension Tube / Telescoping poles

A: Lower EST Extension #70-2019-01	**B: Lower diverter extension #70-2022-01**	**C: Upper EST extension #70-2020-01**
D: Upper diverter extension #70-2021-01	**E: Telescoping fiberglass pole #09200**	**F: 24" Aluminum mounting post #09506**
G: Element housing unit (EHU) #09407	**H: Guy hardware Kit #09602**	**I: Rain cap #10-1105-01**

- Lay the element housing unit (EHU), **Figure 1 - G,** and element support tube extensions (EST) **Figure 1 - A,C** flat on their sides. There will be a 3/4" diameter piece of plastic pipe protruding out the end of the EST with a coupler attached to it (**Figure 5**).

- Firmly glue in (using the PVC primer/glue supplied) the 89" section of 3/4" diameter plastic pipe (**Figure 1 - D**), that also has a coupler attached to one end.

- Next glue in the second section of 3/4" diameter plastic pipe (**Figure 1 - B**) with the inside chamfered ends.

NOTE: If you need to take the antenna apart in the future you can cut the 3/4" diameter plastic pipe (after homing the copper) a minimum of 1 in. above the coupler and when you are ready to reinstall the plastic pipe glue in a new coupler.

- Now install the two section of the EST extension tube (**Figure 1 - A, C**). The first section goes firmly onto the EHT tube and the second EST goes on to the end of the first section. (**Figure 7** and **Figure 9 on next page**)

Warning: Be certain that the metal coupler on the extension ESTs firmly bottom out.

Figure 3

Figure 5

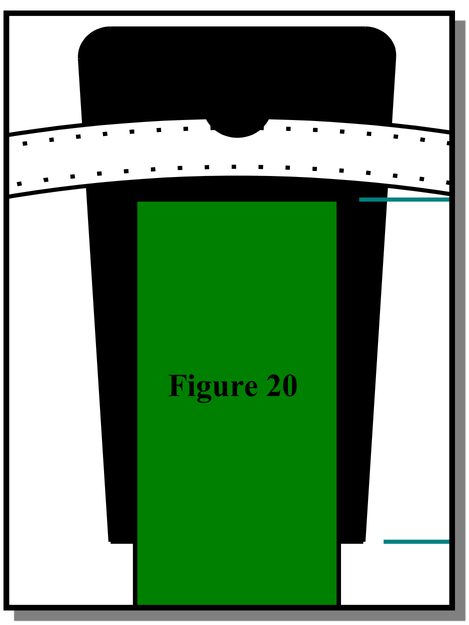
Fig 7: EST extensions
with plastic diverter tube showing

Fig 9: EST Extensions after sliding
the top section over the bottom section

Installation of the Rain Cap

On the tip of the pole you will install a black cap (**Figure 19**) with a piece of tubing passing through it. The purpose of this vent cap is to keep the rain out, yet still allow air flow through the foam plug into the telescoping pole.

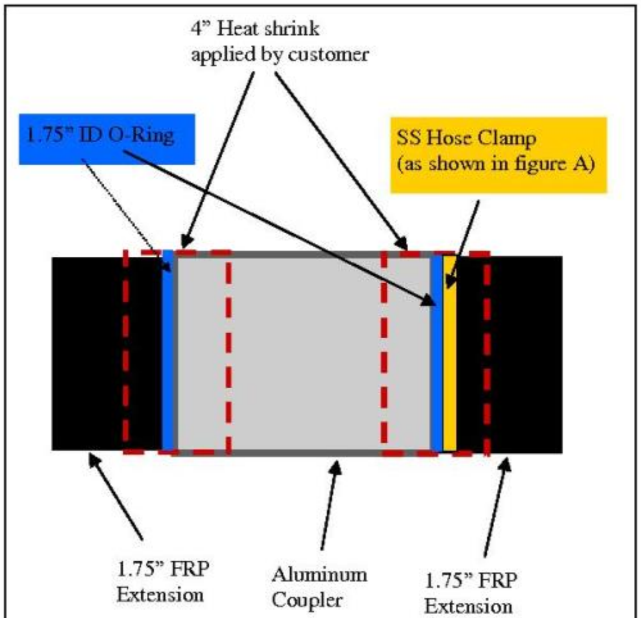
Warning: Press the cap on approximately 1-1/8" (**Figure 20**). Do NOT press the cap down so hard as to crimp (damage) the cross tube preventing the pole from properly venting.



BigIR EST Extension Tube Instructions

Firmly extend each pole section. Pole should be a minimum of 212 inches. Place 1.50"x3" heat shrink so that it is centered over each joint. Heat in place with heat gun until blue lines on the heat shrink become yellowish green.

Telescoping Pole Detail



Notes: Take top section of the fiberglass extension and place the aluminum coupler over the bottom section until it bottoms out on the coupler. Insert o-rings firmly against the aluminum coupler ends as shown in the drawing. Position each 4 inch piece of polyolefin heat shrink tubing so that 2 inches covers the aluminum coupler and 2 inches covers the fiberglass tube. Using a heat gun, apply heat evenly to the heat shrink until each of the four blue lines on the heat shrink turn a yellowish green. This will mean that the joint is now waterproof. Let cool. Place stainless steel hose clamp over the polyolefin heat shrink now securing the top and bottom pole extensions. Align so that the clamp is as close to the butt end of the aluminum coupler as shown in drawing. Tighten firmly.

Heat shrink joint detail

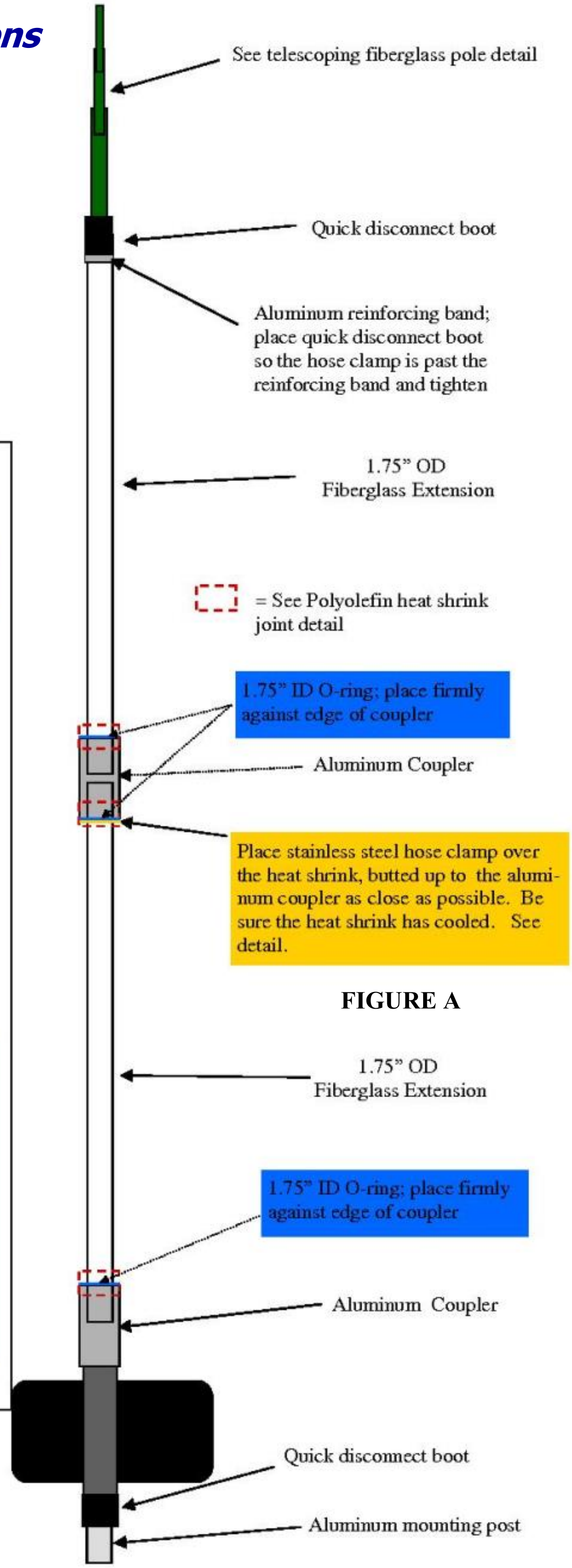


FIGURE A

72-1003 Parts List:

Qty 3: #03631 2.05" x 4" polyolefin heat shrink
Qty 3: #03630 1.50" x 3" polyolefin heat shrink
Qty 1: #60-6000-20 2.0" SS Hose clamp
Qty 3: #10-1104-11 1.75" OD O-ring

Polyolefin Heat Shrink Installation

On all elements we now include double wall polyolefin heat shrink, part number #03630. Each telescoping pole uses 3 pieces of the 1.5” x 3” long heat shrink, which forms an adhesive bond that is heat activated. Once finished, the seal is secure and waterproof. This new process replaces the use of electrical tape and silicone wrap. Note: The EST extension tubes will use the 2.05” x 4” heat shrink, as shown on page 7.

This product requires a heat gun for activation of the adhesive. When positioning the heat shrink, place it so that the joint of the telescoping pole is centered in the middle of the heat shrink. The pictures below exhibit how this is done. Apply heat around the entire area of heat shrink. The heat shrink may want to slide during heating, it is ok to reposition while still hot.

Note: There are 4 blue colored lines imprinted on the tubing. The joint is considered done being heated and waterproof when the lines change color to a yellowish green. Each line needs to change in color to ensure even adhesion temperatures. With this change, there is no longer any need to tape the joints on the loop elements.

Attaching the Telescoping Pole to the EST Tube Extensions

NOTE: The pole was tested at the factory prior to shipping, however in the event the pole won't fit sanding it is okay.

Locate the rubber boot.

- Place the narrow end of a rubber boot onto the butt end of the EST (pole). Slide it about 6" out onto the EST (**Figure 21-A**).
- Insert the butt end of that EST into the extension tube until the raised black ring is approximately 1/2 in. above the extension tube (**Figure 21-B**).
- Push the rubber boot firmly onto the extension tube until the screw clamp is past the aluminum ring and will clamp down onto the fiberglass (**Figure 21-C**).
- The upper screw clamp should be past the raised black ring to get the proper seal on the telescoping pole (**Figure 21-C)**.
- Firmly tighten both stainless steel screw clamps. Then test the connection by pulling and twisting it. There should be no slippage at the joints.

NOTE: You should re-tighten each clamp a second time (at least 30 minutes after the first time you tightened them) before raising the antenna to the tower, to be sure that there has been no cold flowing of the PVC material on the rubber boot.

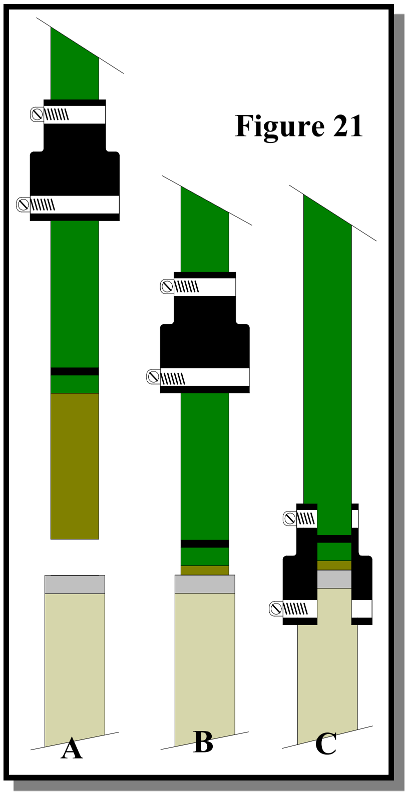


Figure 21

Element Housing Unit (EHU) Wiring Instructions

EHU ASSEMBLY - BigIR Vertical

Follow the directions below for wiring the BigIR element housing unit (EHU). Refer to page 24-25 for instructions on connecting the other end of the control cable to your Electronic Controller.

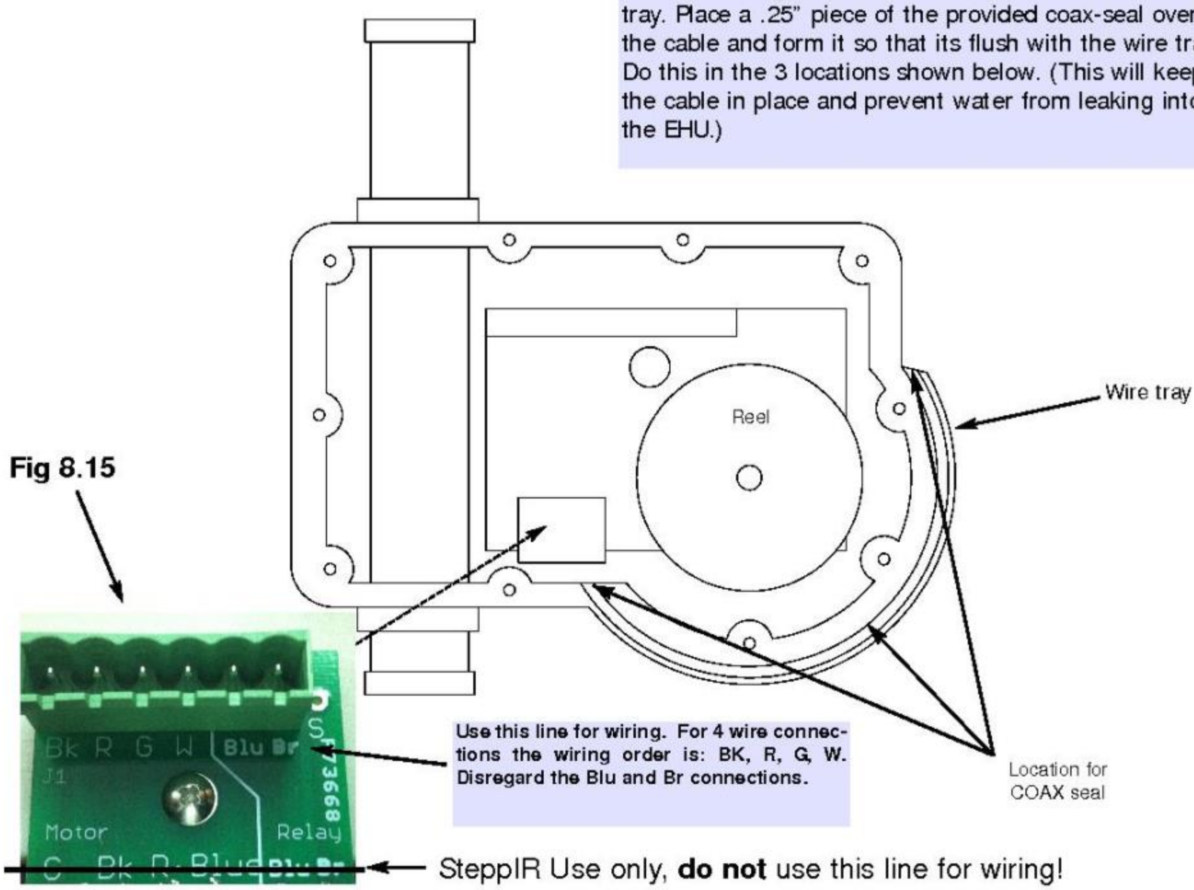
NOTE:

- Follow **figure 8.14** for wiring and routing cable in the wire tray on the lip of the EHU.
- Follow the wiring code that is printed on the circuit board inside the EHU as shown in **figure 8.15**.
- Be sure to unplug the top portion of the connector when wiring, as you cannot see the correct wiring code until the upper plug is removed.
- The correct wiring code is printed closest to the terminal block and reads left to right: **Bk (black), R (red), G (green), W (white)** and ignore Blu & Br (The Blue and Br holes are not used when wiring the BigIR).
- The wiring tray that is molded into the EHU housing also acts as a strain relief, but care should be taken in not putting too much tension on the control cable.

Wiring EHU

Figure 8.14

NOTE:
Wire the cable to the correct terminal on the wiring connector board. Follow the color code on the circuit board as shown in **figure 8.15**. Route the wire into the wire tray. Place a .25" piece of the provided coax-seal over the cable and form it so that its flush with the wire tray. Do this in the 3 locations shown below. (This will keep the cable in place and prevent water from leaking into the EHU.)



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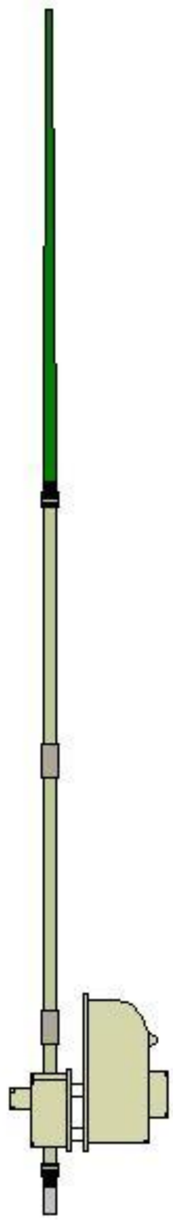
BigIR Mark IV Reinforcing Plate Installation

NOTE: The new BigIR Mark IV vertical model was introduced in November 2011. All BigIR vertical antennas are now made to the specifications of the Mark IV. This next section describes how to install the reinforcing kit for your BigIR vertical. The pictures below show the completed reinforcing kit installation.

***** WARNING *****

When using the 80m coil for the BigIR Vertical, if you are using a linear amplifier you **MUST** use the fiberglass reinforcing plate option for the high wind kit. This is due to high voltage that occurs inside the 80m coil that will interact with the metal of the default aluminum reinforcing plate included with the high wind kit and potentially damage your coil or EHU.

BigIR Wind Reinforcing Kit without 80m coil



BigIR with 80m coil

BigIR EHU Wind Reinforcing Kit—Hardware list

Hardware included for BigIR without the 80m coil:

Qty	Part Number	Description
1	10-1501-22	EHU Lid
1	10-1021-52	Reinforcing plate
5	60-0017	#10 x 3/4″ Pan head bolt
5	60-0071	#10 x 1″ Pan head bolt
15	60-0018	#10 Washer
10	60-0019	#10 Nylock nut
2	60-0066	5/16″ x 4″ Hex head bolt
2	60-0114	5/16″ x 3.75″ Hex head bolt
4	60-0046	5/16″ Nylock nut
10	60-0033	5/16″ Washer
4	10-1613-11	5/16″ x 1/4″ Aluminum spacer
2	10-1601-03	1.75″ Aluminum saddle half
2	10-1601-22	2″ Aluminum saddle half
1	09-1022-08	8″ Coax-seal
1	10-1502-12	EHU Gasket
1	10-1028-01	Anti-seize packet

Additional hardware included for BigIR with the 80m coil:

Qty	Part Number	Description
5	60-0095	#10 x 2″ Pan head bolt
4	10-1004-02	0.50″ Plastic spacer
2	10-1613-11	1/4″ x 5/16″ Aluminum spacer

Wind reinforcing kit installation instructions (continued)

- Follow the instructions for preparing the wiring for the BigIR EHU. This step must be done before placing the lid on the EHU. Refer to figure 8.14 on page 10 for more detail on wiring the EHU.
- The reinforcing plate has a short side and a long side, as shown in **figure 8.1**. It is critical that the reinforcing plate be mounted as shown in **figure 8.14**, or the saddles will not align properly.
- Place the EHU and the EHU gasket on top of the lid as shown in **figure 8.2**. Use the PN 60-0071 #10 x 1” screws to attach the reinforcing plate to the EHU, gasket and lid. Each screw will have a PN 60-0018 #10 flat washer underneath the head of the screw and also underneath the Nylock nut as shown in **figure 8.4** . **Figure 8.1 shows screw placement.** For the 5 bolts that connect the reinforcing plate to the EHU you will only use a washer on the plastic EHU housing. Use the PN 60-0017 #10 x 3/4” screws to attach the rest of the lid to the EHU.
- Note: If you are installing with the 80m coil option, be sure to read the instructions on **page 14** before installing the reinforcing plate as there are different instructions at this juncture.

Figure 8.1

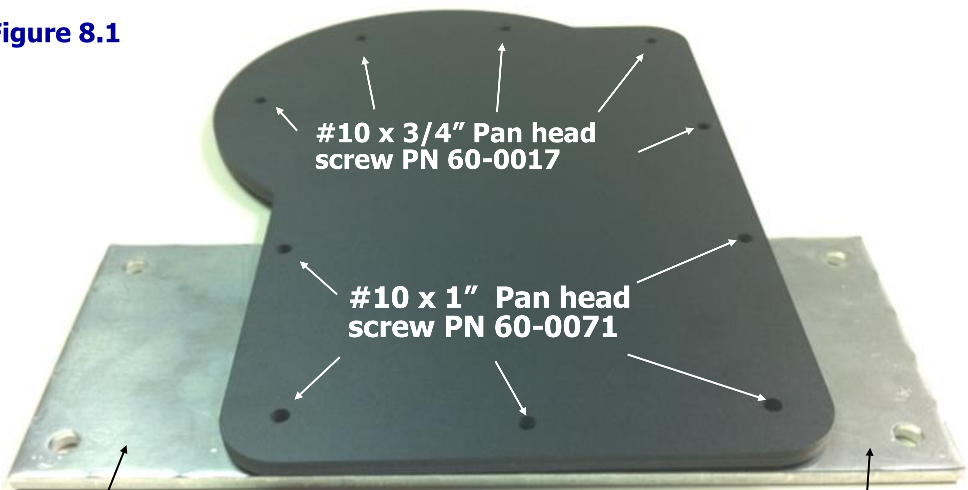


Figure 8.2

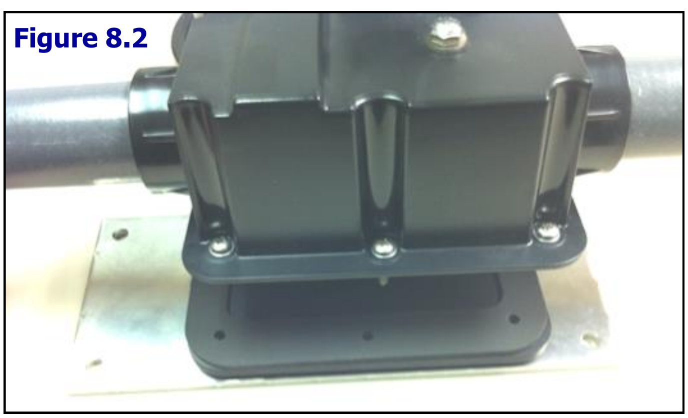


Figure 8.4

Wind reinforcing kit installation instructions (continued)

- Insert a 2″ aluminum saddle half (10-1601-32) underneath the element support tube (EST) protruding from the EHU. This will be located on the long end of the reinforcing plate. Place underneath the saddle a single aluminum spacer (10-1613-11) and a single 5/16 washer (60-0033) as shown in **figure 8.5**. Slide a PN 60-0066 5/16″ x 4″ hex head bolt (thread end pointing skyward) through the spacers and the saddle on each side of the EST. Be sure to use anti-seize on **all** of your stainless steel fasteners or you will have galling issues.
- Place the bottom portion of the EST extension tube (70-2019-01) over the side of the EHU that has the white plastic coupler protruding. This will be on the "long" side of the reinforcing plate. Be certain that the aluminum coupler at the bottom of the EST extension firmly bottoms out.
- Place the second half of the aluminum saddle as shown in **figure 8.7**. Loosely place the PN 60-0046 Nylock nuts on the threaded bolts.
- Repeat on the short side of the reinforcing plate by inserting a 1.75″ aluminum saddle half (10-1601-03) underneath the element support tube (EST) protruding from the EHU. This will be located on the short end of the reinforcing plate. Place underneath the saddle a single aluminum spacer (10-1613-11) and a four of the 5/16 washer (60-0033) as shown in **figure 8.6**. Slide a PN 60-0114 5/16″ x 3.75″ hex head bolt (thread end pointing skyward) through the spacers and the saddle on each side of the EST.
- Tighten the saddles. Be sure to use no more than 15 ft lb of torque or the fiberglass EHU pieces could be damaged. **Figure 8.8** shows the tightened saddles. Try to make the saddle halves as even as possible as shown in **figure 8.7**.
- Refer to the picture on **page 9** for a look at a completed BigIR reinforcing assembly.

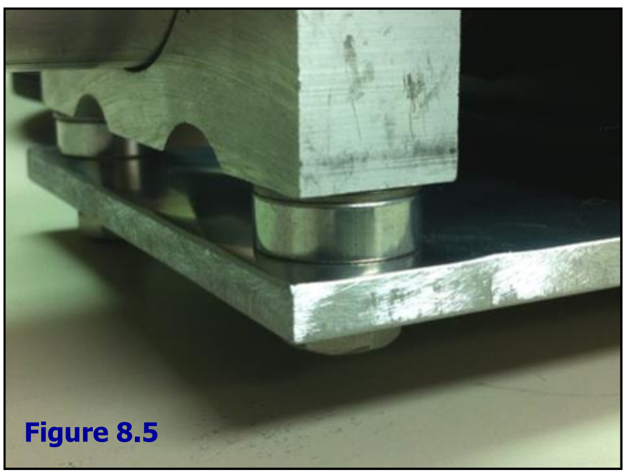


Figure 8.5

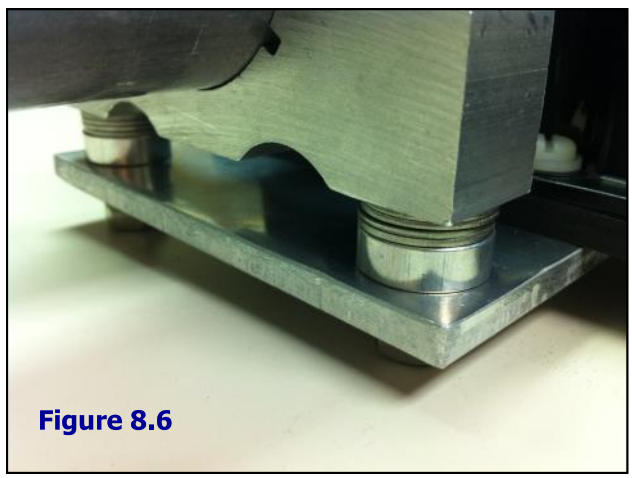


Figure 8.6

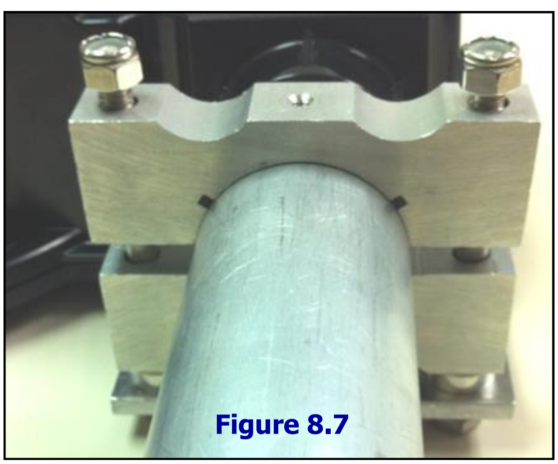


Figure 8.7

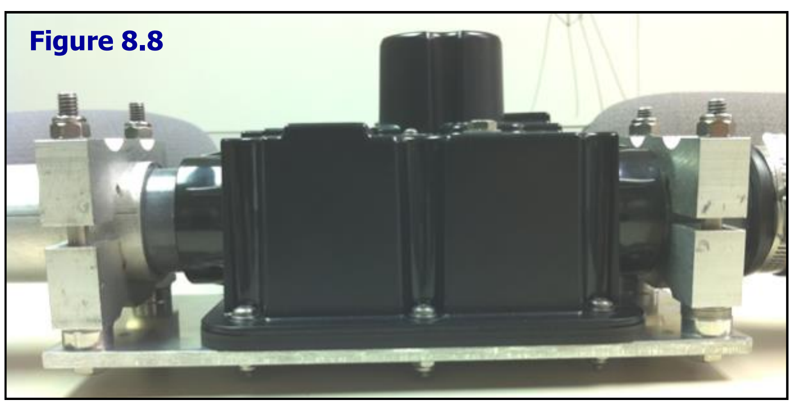


Figure 8.8

Wind reinforcing kit installation instructions—80m Coil Option

- If the 80m coil will be mounted to the BigIR, the standard pan head screws must be replaced with #10 x 2″ screws (60-0095). Refer to **figure 8.9** to locate which holes to use the #10 x 2″ screws.
- There are two spacers on the end of the EHU without the wind reinforcing plate. One is a 0.50″ plastic spacer (10-1004-02), and the other a 0.250″ aluminum spacer (10-1613-11) as shown in **figure 8.10**.
- There is a single 0.50″ spacer on the end of the EHU that has the wind reinforcing plate attached as shown in **figure 8.11**.
- It is difficult for the nut to sit flat on the 80m coil cover, so for the four #10 x 2″ pan head bolts used for mounting we have you put the threads upward, with the Nylock nut being attached on the EHU side of the connection. Even though the #10 x 2″ long screw is reversed, be sure that you still place a flat washer on the EHU side of the screw (between the Nylock nut and the EHU housing) as shown in **figure 8.12**.
- Place the screws through the 80m cover and the reinforcing plate/EHU lid and tighten.
- Do not forget to use anti-seize for all fasteners and be sure to NOT over-tighten.
- **Page 9** shows a picture of a completed BigIR with 80m Coil installation.
- Follow the rest of the BigIR installation guide for connecting the 80m coil to the BigIR.

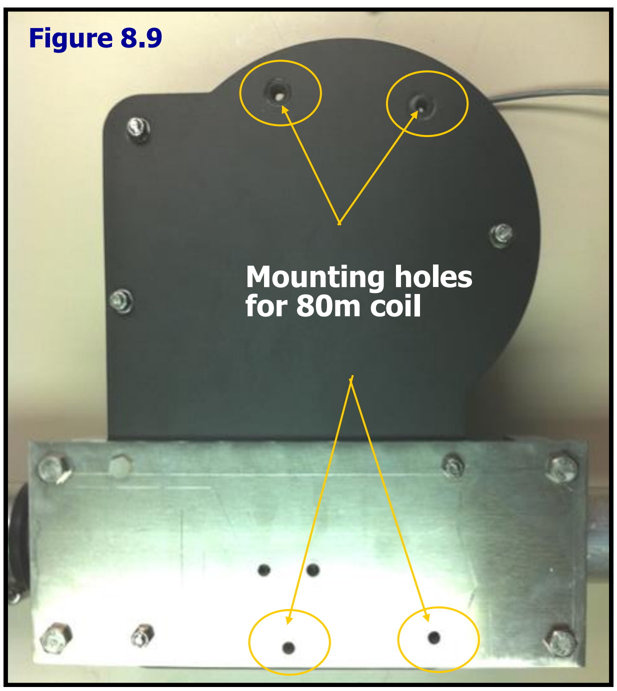


Figure 8.9

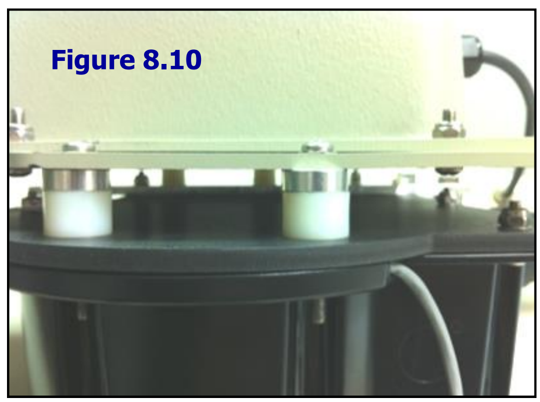


Figure 8.10

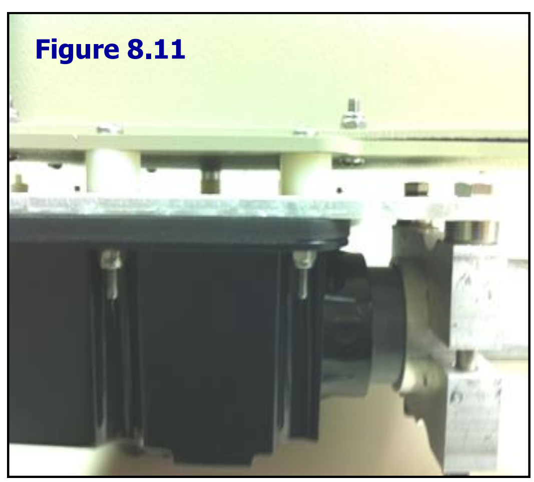


Figure 8.11

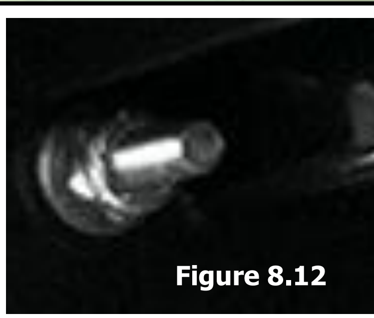


Figure 8.12

PREPARING THE CONTROL CABLE

1. Strip the jacket and aluminum shielding off of the control cable as shown in figure 5.20, approximately 2.75″ from end of control cable, being careful not to damage the individual wires.
2. Strip the plastic insulation off of each of the control cable wires, approximately 0.25″ in length should be bare wire.

CONNECTING CONTROL CABLE TO THE DB25 SOLDERED CONNECTOR

If you purchased the default DB25 connector, follow the steps below to connect it to your control cable. If you purchased the optional DB25 Field Splice upgrade, skip ahead to the next section.

1. Solder each wire to the appropriate pin of the 25 pin connector. Refer to the table on the following page for the correct wiring sequence.
2. Attach the clamp to the control cable approximately 1″ from the connector and secure with the provided hardware as shown in figure 5.21.
3. Place the connector between the back-shell halves as shown in figure 5.22 and secure with the provided hardware.

CONNECTING CONTROL CABLE TO THE OPTIONAL DB25 FIELD SPLICE

The optional DB25 Field replaces the standard connector with a convenient solder-less connection of the control cable to the SteppIR controller. If you purchased this option, follow the steps below to connect it to your control cable.

1. Apply the provided dielectric grease to the exposed copper portion of each wire.
2. Connect each wire to the appropriate terminal and tighten using a flat head screwdriver. Note that the terminals may be closed by default. If so, turn the terminal screw ccw ~10 turns to open it before inserting the wires. Consult the table on the next page for the correct wiring sequence.
3. Position the control cable between the cable clamp halves as shown in figure 5.23.
4. Tighten the two pan head screws until the cable is snug, but do not over-tighten.
5. Thread the two thumb screws into the connector face as shown in figure 5.23.
6. Plug the DB25 splice into the back of the controller and twist the thumb-screws to secure it.

FIG. 5.20

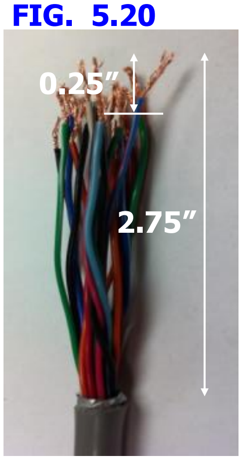
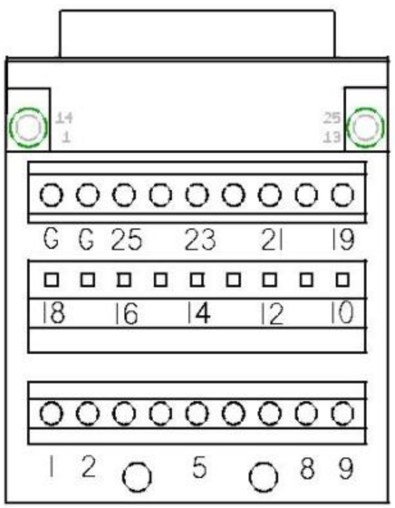


FIG. 5.21

FIG. 5.22

FIG. 5.23

70-6010-01



Cable Pin out by cable type.

Adapter Pin number

Adapter Pin number	20 conductor	16 conductor Standard 4E	16 conductor DB11, DB18	12 conductor 2E, 3E Yagi	2X4 Conductor	4 Conductor
1	BLACK	BLACK	BLACK	BLACK	Black	Black
2	WHITE	RED	RED	BROWN	Red	Red
3	WHITE/ BLACK STRIPE	GREEN	GREEN	RED	Green	Green
4	BLACK/ WHITE STRIPE	WHITE	WHITE	ORANGE	White	White
5	BLUE	BROWN	BROWN	YELLOW	Black	
6	BLUE/ WHITE STRIPE	BLUE	BLUE	GREEN	Red	
7	BLUE/ RED STRIPE	ORANGE	ORANGE	BLUE	Green	
8	BLUE/ BLACK STRIPE	YELLOW	YELLOW	VIOLET	White	
9	ORANGE	VIOLET	VIOLET	GREY		
10	ORANGE/ RED STRIPE	GREY	GREY	WHITE		
11	ORANGE/ BLACK STRIPE	PINK	PINK	PINK		
12	GREEN	CREME	CREME	CREME		
13	BLACK/ RED STRIPE		WHITE/ ORANGE ST			
14	GREEN/ WHITE STRIPE	WHITE/ BLACK ST				
15	GREEN/ BLACK STRIPE	WHITE/ RED ST				
16	RED	WHITE/ GREEN ST				
17	RED/ WHITE STRIPE	WHITE/ ORANGE ST				
18						
19						
20						
21						
22	WHITE/ RED STRIPE		WHITE/ RED ST			
23	RED/ BLACK STRIPE		WHITE/ BLACK ST			
24	RED/ GREEN STRIPE		WHITE/ GREEN ST			
G	Drain	Drain	Drain	Drain	Drain	Drain

SteppIR Antennas.

Cable splice, controller

21-6005-91

Date 01/31/2011

Mounting the BigIR (ground)

The BigIR comes with a 1.5" OD aluminum mounting post, 2 feet in length (**Figure 1 - D**). If using guy wires, the antenna can be mounted directly into the ground without concrete (the guy wires will "lock" the antenna in place) but you want to ensure that the mounting pole does not shift or settle over time, using concrete to secure it in the ground is a good way to eliminate the potential for this problem. Position the mounting pole (machined end up) so that the bottom of the element housing is **8 to 10 inches** above the ground (**Figure 29**).

At this point you want to decide on your guy configuration and mount the guy bracket (s) and attach the guy wires before erecting the antenna (**Figure 35, 36 & 37**).

- **No Guy Wires** **50 mph**
- **One set of guy wires** **70 mph**
- **Two sets of guy wires (optional bracket)** **100 mph**

One guy wire connects to one side of the guy bracket and two guy wires connect to the other side of the guy bracket using the **two** security snaps (**Figure 31**).

With the mounting post is in place and level and your guy assembly mounted, you are ready to erect the antenna. Now slide the small end of the flexible coupler (rubber boot) to the mounting post (**Figure 41**). This coupler is used to keep the antenna from potentially "twisting" in high winds. Pick up the antenna at the base (**Figure 33**) and slide the antenna housing onto the mounting pole until it firmly bottoms out. Place the larger end of the flexible coupler over the antenna housing tube (a small amount of bar soap or other lubricant will help the process). Tighten clamps on the coupler and secure the guy wires.

Now you are ready to connect the radials! We recommend using a lug connector (crimped & soldered) at the end of your radials, and then tightening the lug onto the connector (ground) post shown in **Figure 39**. If you purchased the optional radial kits (**Figure 28)**, you will notice there are 4 wires per set (ground radials), all soldered and crimped to a lug connector.

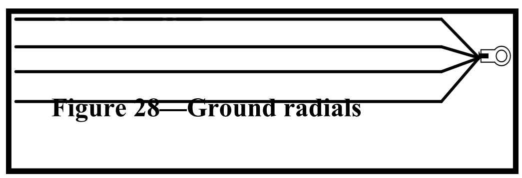


Figure 28—Ground radials

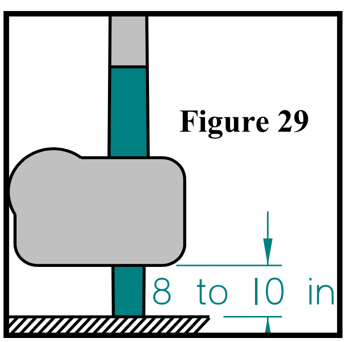


Figure 29

Figure 31

Figure 33

Recommended Radials

Ground Mounting:

- Min. of 12 - radials cut to the lowest frequency

Elevated Mounting:

- Min. of 2 pre band trimmed to .1 x frequency

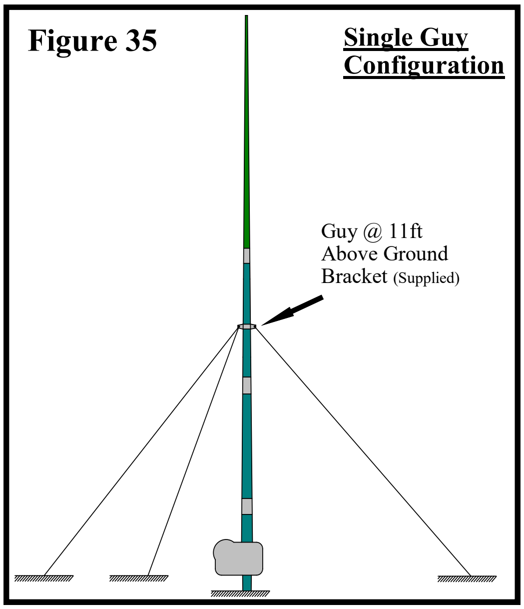


Figure 35

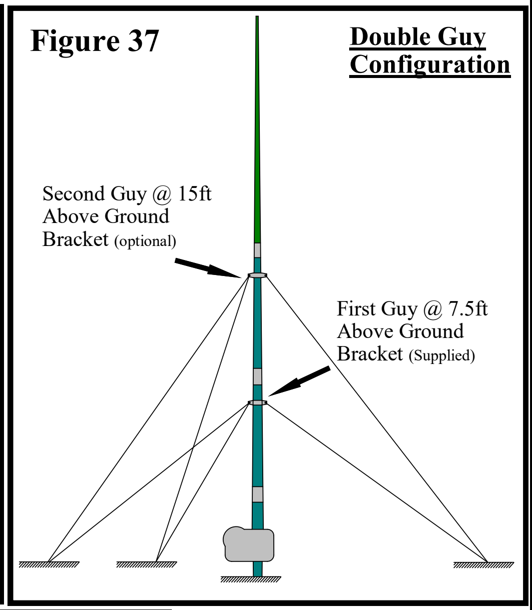
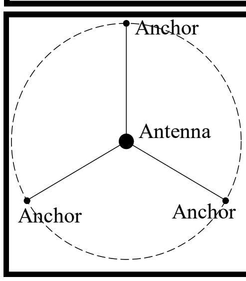


Figure 37



Warning:
A 11 ft radius and an even spread (120 deg) are the minimum dimensions required, when positioning the guy anchors, to achieve the stated wind ratings

Figure 36

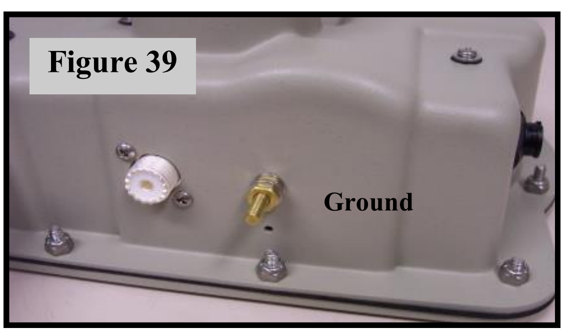
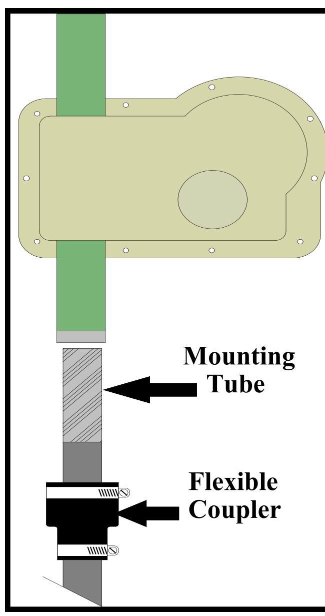


Figure 39



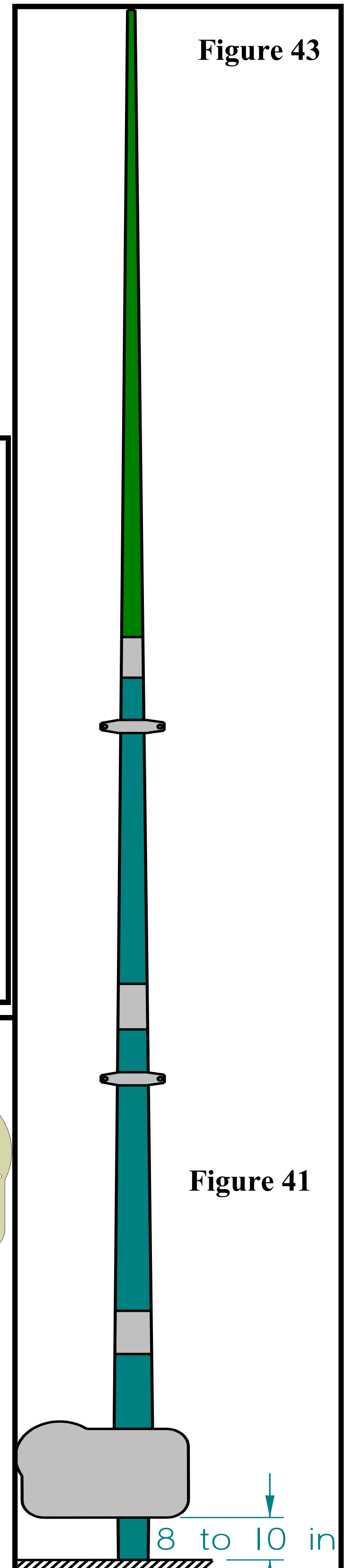


Figure 43

Figure 41

Optional (1:1) External Balun

A balun is an electrical circuit used to help resolve the inherent problem of feeding an antenna with an electrically unbalanced (coax) feed line. It is intended to present an infinite impedance to any RF current that might otherwise flow on the outer conductor (shield) of the coax producing radiation from the line. This current, if high enough, can cause heat buildup and potential damage to the radio as well as a distorted radiation pattern.

Why is it Optional ?:

In the normal configuration, ground mounted with 12 or more radials, the ground will bleed/drain the unwanted RF signal from the coax shield.

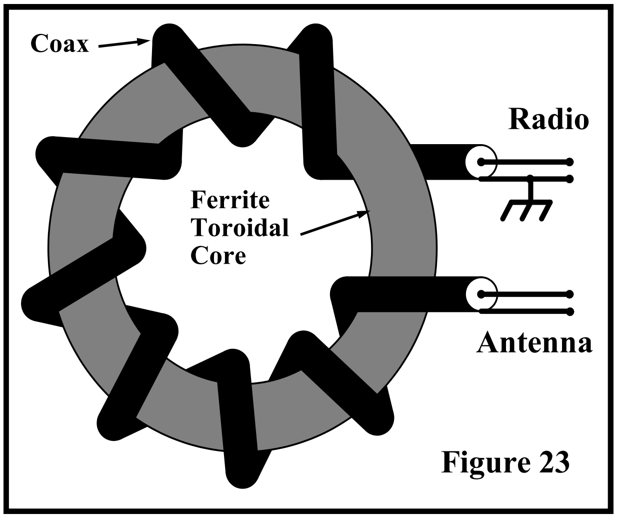


Figure 23

When Should You Use A Balun ?:

- When elevating the base of a vertical antenna above the ground
- When only a few radials are used
- When the coax run is shorter than the radials
- When the ground condition is poor
- Unusual SWR readings on one band

Balun Installation

The balun is shown in figure 25. There is a mounting flange with 4 holes molded into the housing. There are numerous options for mounting the balun—by far the most popular is to mount the balun on an adjacent post or similar structure, or even on a piece of wood that rests on the ground. Figure 26 shows how to connect the balun when using the BigIR without the 80m coil. Figure 27 shows how to connect the balun with a BigIR and optional 80m coil.

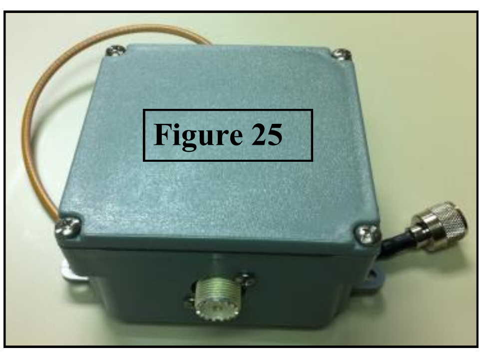


Figure 25

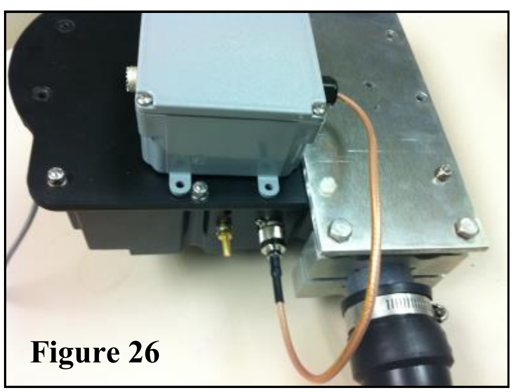


Figure 26


Figure 27

Radial Systems for Elevated and Ground mounted Vertical Antennas

All vertical monopoles need some form of counterpoise in which antenna image currents flow to work efficiently. This counterpoise usually consists of a system of radial wires placed either on the ground or elevated above ground.

This is not an in depth publication but simply a general guide on installing and using SteppIR verticals. There is much more information available in various publications if you need it. The ARRL Antenna Handbook is a good source for additional information. Rudy Severns, N6LF, has some excellent technical articles about radial systems on his website at antennasbyn6lf.com. In the following pages I will attempt to condense all of the experts advice into information you can easily use to make an effective radial system. Please note that all of the stated gains and impedances are ground quality dependent, when dealing with verticals nothing is absolute - too many variables are at work.

By following a few simple guidelines, you can obtain excellent performance from vertical antennas mounted on the ground or elevated above the ground. There are a number of verticals available that say "no radials required", but they do have "radials", in the form of a shortened, tuned counterpoise system. As you might expect, you pay a price for such a small counterpoise system - less efficiency.

As you will see in the following pages, you can get fairly high efficiency with a relatively modest radial system that will far outperform small counterpoise systems. It should be noted that counterpoise systems are only good for curing near field losses caused by earth, which is a poor conductor of RF, even with good soil. There is nothing you can do about far field losses that reduce the signal strength and low angle radiation, except get to some saltwater. We briefly discuss salt water locations later on in this article.

Ground Mount or Elevate?

Ground Mounting:

PROS	CONS
• The radials are non-resonant so one length (.1wl minimum at lowest frequency) works on all frequencies • Easy to mount • Easy access • Lower visual profile • Sixteen 0.1 wl (wavelength) radials of lowest intended frequency give 65-70% efficiency	• Takes 120 radials to equal an elevated vertical with 2 resonant radials (90% efficient) • Surrounding objects can reduce signal strength

Elevated Mounting:

PROS

- > 90% efficient with two .25 wavelength radials
- Antenna is generally more "in the clear", so surrounding objects don't cause as much attenuation
- A peaked metal roof will make a very good all-frequency radial system
- Contrary to conventional wisdom the vertical doesn't have to be elevated very high, even 6" results in much lower losses even on 80m, so 5 feet is just fine for 80m

CONS

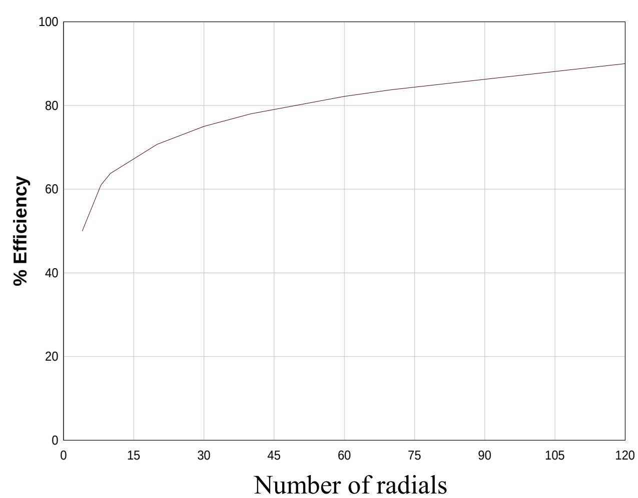
- Requires two .25 wavelength radials (minimum) for each band of operation (radials interact, so spacing will affect length)
- Mounting is generally more involved
- Visually higher profile
- Must be mounted high enough that people won't walk into the radials
- Elevating lowers the impedance so ridials radials might need up to a 30° downward slope to get a good match

Ground Mounting:

If you choose to ground mount the vertical, pick a spot that will allow you the best chance of spreading your radials evenly around the antenna, and away from trees and other objects if possible. Mount the antenna within one foot of ground if possible, the closer to ground the better. Next, you will need to determine how much effort and wire you are willing to invest in this installation. The tradeoffs are as follows:

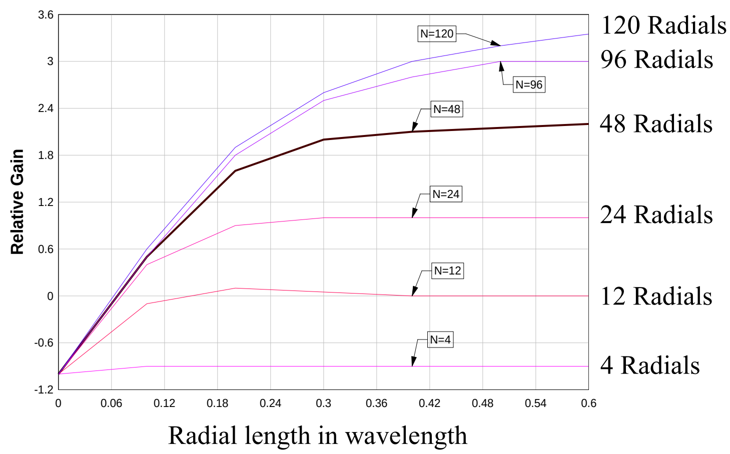
1. More radials equals higher efficiency (see **Graph 1**)
2. Match your radial length to the number of radials using **Graph 2,** why waste wire
3. If only a few radials can be used (8 or less) do not make them long, it really kills gain
4. Skimping on radials just isn't worth it, EVERTHING is improved with more radials, 25 – 30 is about where diminishing returns begin, the minimum recommended is 16.

Graph 1

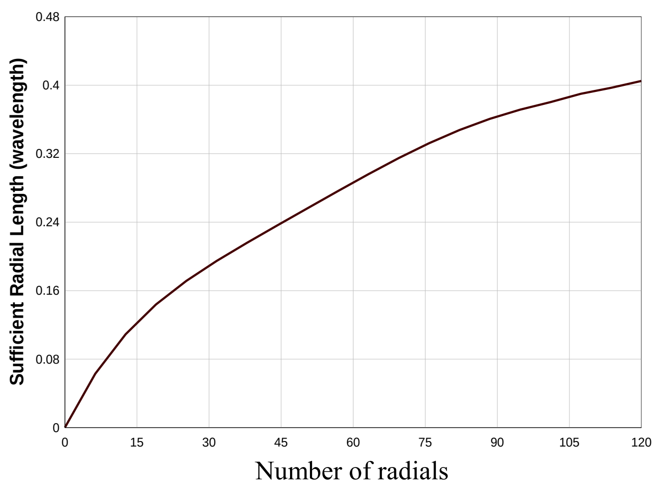


Sixteen radials are what we consider to be the absolute minimum in average soil. A radial system has two main purposes, replace the missing half of the antenna (a vertical is simply a dipole with earth substituting for the missing half when set vertical, unfortunately earth is a very poor RF conductor) and forming an electrostatic shield to prevent much of the RF on the vertical element from capacitively coupling to the lossy soil. The shield requirement is why so many radials are needed in a uniform pattern, exposed earth is a problem! How much you have to gain with a good radial system depends on how good your earth is. Most of us have poor earth conditions, so the radial system is paramount. The worse the earth is, the more can be gained with additional radials. **Graph 2** shows a graph produced by Brian Edward (N2MF) that illustrates the relative signal gain you get with the radials and varying length over poor earth. With better earth, the gain difference between 4 radials and 120 radials will be about 2.5 dB, as opposed to 4 dB with poor earth.

Graph 2



Graph 3

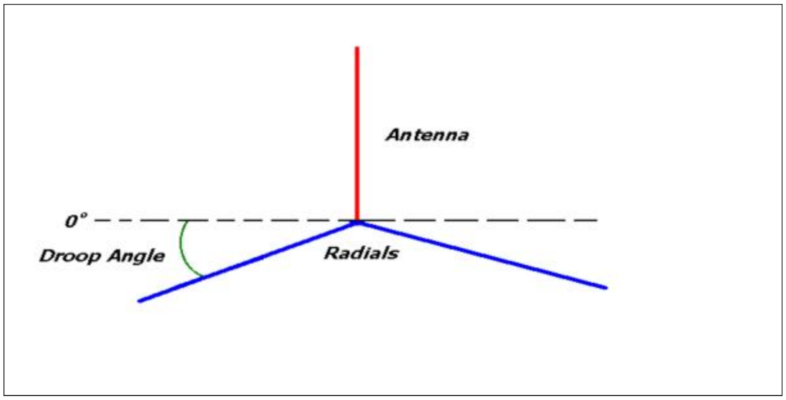


If you cannot lay the radials out in a symmetrical radial pattern, don't worry too much - it will distort your omni-directional pattern slightly but won't reduce your efficiency very much. Lay the radials out in the best manner possible given your situation. There are various ways to accomplish laying a radial system, including turning corners, etc. Turning a radial back towards the antenna and running it until the obstacle that prevented a radial there is encountered (with about a 10" radius) is a good way to increase the effective shield area. Good results are limited only to your creative energy and determination! Be aware that very high voltages can exist at the ends of radials, so be certain that no one can come into contact with them. It is a good idea to use insulated wire to protect from corrosion, and don't bury the radials any deeper than necessary, one to two inches maximum. In the manual you will see we suggest mounting the EHU box so the ground stud is no more than 8" - 10" from the radial field. Any straight vertical wire going from the EHU to the radial field adds to the antenna length and causes a mismatch at higher frequencies because it causes off-center feeding. When a good radial field is present verticals work much more efficiently and predictably. It is a goo idea to use insulated wire to protect from corrosion, and don't bury the radials any deeper than necessary, one to two inches maximum. In the manual you will see we suggest mounting the EHU box so the ground stud is no more than 8" - 10" from the radial field. Any straight vertical wire going from the EHU to the radial field adds to the antenna length and causes a mismatch at higher frequency because it causes off-center feeding. When a good radial field is present verticals work much more efficiently and predictably.

Elevated Mounting:

If you elevate radials even a few inches off the ground the capacitive losses go down dramatically. On 80m 5 feet is all you need to get a drastic reduction in losses, thus allowing the use of many fewer radials. Once the antenna is elevated it is much easier to get reasonable performance with even one .25 wl radial! With one radial the antenna is no longer omni-directional, the side with no radial is down by 4 dB, that energy now appears at high elevation angles on the radial side and can be advantageous for close in contacts (0 to 400 miles). Once you elevate a vertical, two .25 wl radials work very well. It is important that you try to keep a 180° angle between the two (opposed, directly in line) for the best pattern. You will need two .25 wl radials for each band you intend to use. Spread the radials out as far as possible to reduce interaction, if they are less than a foot apart it can be difficult to get a good match on all bands. In Rudy Severns articles he is a big proponent of at least four up to 12 elevated radials, because the antenna becomes much less affected by nearby objects and the gain is better. His contention is that it is actually easier to just cut 25 to 30 30ft radials, it is then easier to deal with radials all the same length without the need to cut them to different lengths and then have to arrange the pairs 180° from each other. The downside is this is 665ft more wire than a 2 elevated radials per band system suitable for 40-6M. The two elevated radials are just slightly down in gain. This system will now work well at any frequency from 40m—6m, for 80m double the length of the radials. As more radials are added the impedance of the antenna drops, over perfect ground a vertical is 36 ohms. If you put up a vertical with a poor radial system you usually get a good match because the ground LOSS adds to the 36 ohms to get you at or near 50 ohms, but with a big drop in signal strength. To raise this low impedance closer to the desired 50 ohms you can angle the radials downward, this raises the impedance of the antenna as you increase the angle downward. **Graph 4** (next page) shows the approximate relationship of radial angle to impedance:

Graph 4



Radial Droop Angle		Antenna Impedance
0°	=	36 Ohms
10°	=	42 Ohms
20°	=	49 Ohms
30°	=	55 Ohms
Note: above 30° results in diminishing returns		

Can't get enough droop angle to achieve a good match? Simply adjust the antenna element slightly longer than the factory 1/4 wavelength (up to 20% longer) settings and the impedance will rise. If you are using two resonant radials per band this will cause the radials to be too long, so they may need to be pruned a bit. Be aware that increasing the antenna 2% to 3% longer may require radials to be 5% to 7% shorter. Once you have a good match, replace the factory default values by saving the new antenna (to do this you will use the "create, modify" feature in the setup mode).

Using a Vertical in on or Near Salt Water:

If you are lucky enough to have a dock over salt water, a vertical can offer unparalleled performance for low angle DX. Simply mount the vertical to the dock and attach two radials per band of operation. They can be stapled right to the dock if it is non-metallic. Mounting the vertical in ground flooded by salt water a couple of times per day can be equally effective. Proximity to the ocean improves the far field loss of a vertical and allows very low angle radiation - get as close to the water as possible to enhance performance. Or you can direct couple to the saltwater. Due to the fact that RF does not penetrate more than 2 inches into the water, direct coupling (a wire in the water) is difficult. Objects like metal floats or boats, providing they are large enough, can make good grounds in salt water. If you are using a metal boat or large metal object, corrosion is not a problem because the large surface capacitively couples to the water. When using a small metal float (3 ft x 3 ft is just enough to "connect" to salt water), you want to be certain that the metal does not corrode over time. For long term immersion, Monel is a good (but fairly expensive) choice. Aluminum has been successfully used if you clean it periodically.

Warranty / Contact Information

In the event you have a problem with your SteppIR product, please contact:

Tech support:

Phone: 425.453.1910
Email: support@steppir.com

If you need to return your antenna for repair, please go to www.steppir.com, fill out the **Return for Repair** form, print a copy and put it into the package that you send back to SteppIR.

STEPPIR ANTENNAS LIMITED PRODUCT WARRANTY

Our products have a limited warranty against manufacturers defects in materials or construction for two (2) years from date of shipment. Do not modify this product or change physical construction without the written consent of Fluidmotion Inc, dba SteppIR Antennas.

This limited warranty is automatically void if the following occurs: improper installation, unauthorized modification and physical abuse, or damage from severe weather that is beyond the product design specifications.

SteppIR Antenna's responsibility is strictly limited to repair or replacement of defective components, at SteppIR Antennas discretion. SteppIR Antennas will not be held responsible for any installation or removal costs, costs of any ancillary equipment damage or any other costs incurred as a result of the failure of our products.

In the event of a product failure, a return authorization is required for warranty repairs. This can be obtained at www.steppir.com. Shipping instructions will be issued to the buyer for defective components, and shipping charges to the factory will be paid for by the buyer. SteppIR will pay for standard shipping back to the buyer. The manufacturer assumes no further liability beyond repair or replacement of the product.

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COMMUNICATION SYSTEMS

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