

# SmallIR Instruction Manual



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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.

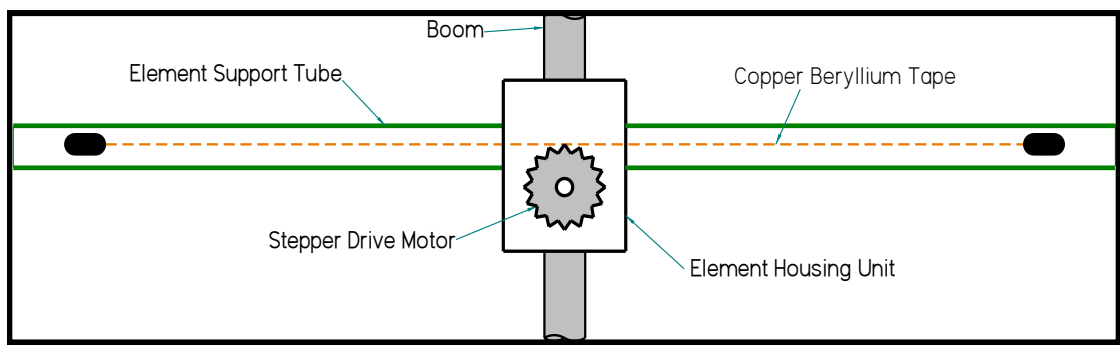
So, instead of trying to “trick” the antenna into thinking it is a different length, or simply adding more elements that may destructively interact, why not just change the antenna length? Optimal performance is then possible on all frequencies with a lightweight, compact antenna. Also, since the SteppIR 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).



## SmallIR Parts Checklist

It is important that you do an inventory of the items that were shipped to you. Nothing is worse than discovering a day before a planned installation that there are missing parts! We do our very best to ensure that you receive everything needed for construction of your antenna, but better to be safe than sorry—inventor your parts well in advance of your installation. The items in **blue** represent options available for the SmallIR—you will need to check these items off only if you purchased them.

✓	QTY	PART #	DESCRIPTION
	1	70-3411-01	SmallIR EHU
	1	10-1015-22	EHU Lid w/ No Vent Hole
	1	10-1015-12	EHU Gasket
	1	70-4001-01	SDA 100 Controller
	<a href="#">1</a>	<a href="#">70-4005-01</a>	<a href="#">SDA 2000 Controller</a>
	1	20-8030-02	33V Power Supply
	1	20-8040-01	Power Cord
	1	71-0014	SmallIR Instruction Manual
	1	-	SDA 100 Controller Manual
	<a href="#">1</a>	<a href="#">-</a>	<a href="#">SDA 2000 Controller Manual</a>
	1	20-6208-01	25 Pin Male Connector
	1	20-6209-01	25 Pin Back Shell
	1	72-0003-21	SmallIR Hardware Kit
	1	10-1109-21	Vertical Antenna Support 1.5" Pipe
	1	10-1013-02	18' Telescoping Pole
		21-6005-01	4 Conductor Cable
		<a href="#">06023</a>	<a href="#">SmallIR 40m Coil</a>
		<a href="#">06025</a>	<a href="#">SmallIR 80m Coil</a>
		<a href="#">72-0003-31</a>	<a href="#">SmallIR Coil Hardware Kit</a>
		<a href="#">70-6010-01</a>	<a href="#">25 Pin Dsub Splice Assembly</a>
		<a href="#">21-6002-16</a>	<a href="#">4 Ground Radials 16'</a>
		<a href="#">21-6002-40</a>	<a href="#">4 Ground Radials 40'</a>
		<a href="#">21-6031-32</a>	<a href="#">2 Ground Radials 32'</a>
		<a href="#">21-6009-32</a>	<a href="#">Elevated Radial Kit for Verticals</a>

### SmallIR Hardware Kit 72-0003-21

✓	QTY	PART #	DESCRIPTION
	3	10-1059-01	1.5 x 3" Polyolefin Heat Shrink
	2	60-1006-22	Quick Disconnect Boot
	1	10-1105-11	Rain Cap w/ Foam Plug
	1	72-0054-01	Lid Mounting Hardware
	1	09-1022-08	8" Coax Seal
	1	10-1028-01	Anti-Seize Packet

### Lid Mounting Hardware 72-0054-01

✓	QTY	PART #	DESCRIPTION
	11	60-0019	10-32 Nylock Nut
	2	60-0017-10	10-32 x 7/8" Flat Philips Screw
	9	60-0061	10-32 x 7/8" Pan Philips Screw
	11	60-0018	10-32 Flat Washer

### SmallIR Coil Hardware Kit 72-0003-31

✓	QTY	PART #	DESCRIPTION
	4	60-0019	10-32 Nylock Nut
	4	60-0090	10-32 x 1.5" SS Screw
	4	60-1004-01	0.5" Plastic Spacer

## Antenna Assembly

### Extend the Fiberglass Pole

- Extend the telescoping poles to full length by firmly "locking" each section of the pole in place. A good methodology is to position each half of the joint so that they are several inches apart (while still within each other), and then pull quickly and firmly. Do this for each pole. There are rubber plugs inside the base section of each telescoping pole. These make it easier for handling, but they **MUST BE REMOVED BEFORE ASSEMBLY. VERIFY THAT THE FOAM INSERT IN THE PLUG HAS NOT MADE ITS WAY DOWN THE POLE AND THAT THERE IS NO OTHER FOREIGN DEBRIS INSIDE THE POLE.**

### Secure polyolefin heat shrink to the telescoping pole joints

- The telescoping pole uses 3 polyolefin heat shrink pieces (PN 10-1059-01). Once finished, the seal is secure and waterproof. 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 graphics below show how this is done.
- Using a heat gun (hair dryers will NOT work), apply heat evenly around the entire area of heat shrink. 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.

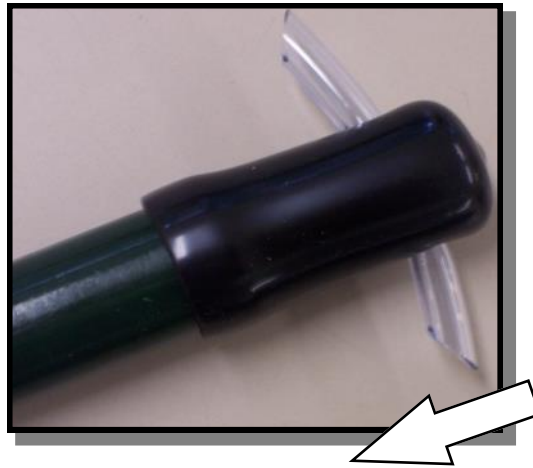
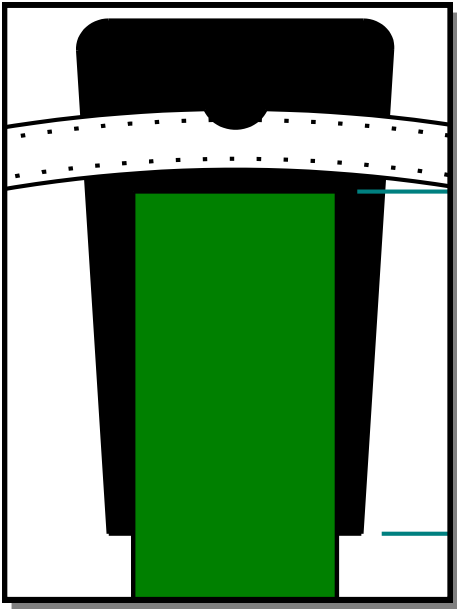


## Antenna Assembly

### Install the Rain Cap

- On the tip of the pole you will install the black cap 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" Do NOT press the cap down so hard as to crimp (damage) the cross tube preventing the pole from properly venting.



### Prepare and Install the Solderless Connector

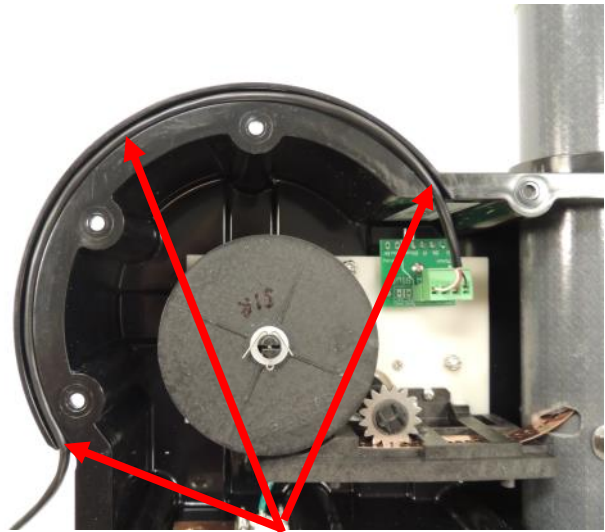
- Remove the 4 pin solderless connector from inside the EHU.
- Prepare the 4 conductor control cable by removing 1" of insulation from the end of the cable and stripping 1/4" of insulation from the ends of each of the wires.
- Wire the connector Black, Red, Green, White using the image to the right as a reference.





## Antenna Assembly

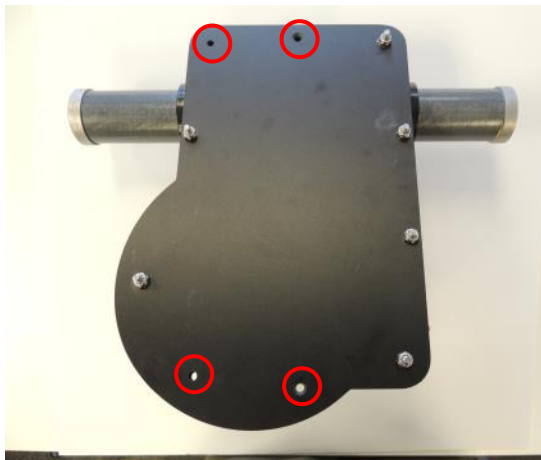
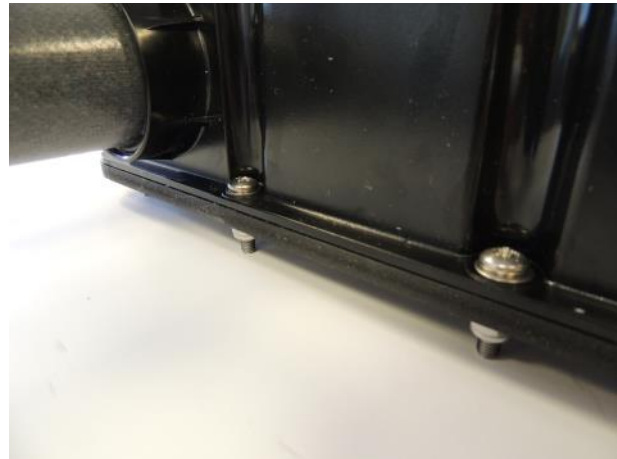
- Plug the connector back into the controller and route the control cable through the groove in the lip of the EHU
- Place a .25" piece of the provided coax-seal over the cable and form it so that it's flush with the wire tray. Do this in the 3 locations indicated in the drawing on the right.



**Place Coax-Seal Here**

## Attach the EHU Lid and Gasket

- Use the provided anti-seize packet on all stainless steel hardware.
- Place the gasket between the EHU and lid and fasten together using the 7/8" Pan head screws, washers, and nuts.
- Place the washer between the Pan head screw and the EHU with the nut on the cover side. See the picture to the right for reference.
- Note the two countersunk holes in the lid. The countersunk screws will be placed in these holes with the washer and nuts being placed on the EHU side.
- Tighten firmly but **be careful not to over-tighten and damage the housing!**

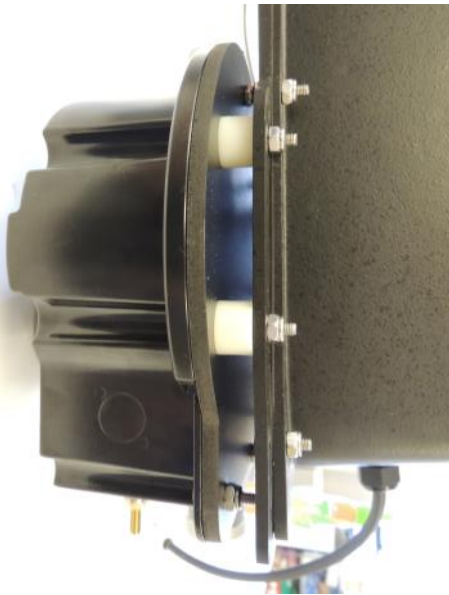
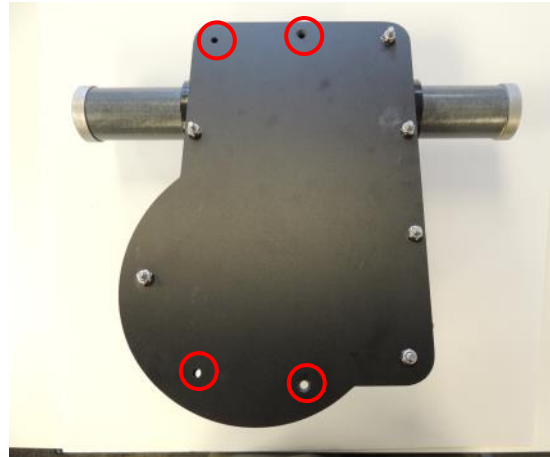


- Note: If you purchased the 40m or 80m coil option, leave out the four screws indicated in the picture on the left as these holes will be used for mounting the coil housing.

## Antenna Assembly

### Optional: Attach the Coil Housing

- If you are using the optional 40m or 80m coil you will need to attach the housing at this point.
- Mount the coil housing to the EHU using four 10-32 x 1-1/4" screws through the holes indicated in the drawing on the right. Place the 0.5" plastic spacers between the EHU and coil housing.



- Notice that the nuts are on the coil housing side.
- Connect the coax connector from the coil housing to the EHU.

### Install the Mounting Post

- For ground mounting you will want to ensure that the mounting pole (included) does not shift or settle over time, using concrete to secure it in the ground is a way to eliminate the potential for this problem. Position the mounting pole (machined end up) so that the bottom of the element housing is 6 inches above the ground. After the mounting post is in place and level, you are ready to erect your SteppIR Vertical!

### Mount EHU Onto the Mounting Post

- A rubber quick-disconnect boot must be installed (small end first) on the 1-1/2" mast (ground or elevated mount) before mounting the element housing unit on the mast.
- After the EHU is mounted on the mast, push the rubber boot up onto the fiberglass element support tube firmly until it bottoms out. Tighten the two clamps. This boot will prevent the antenna from turning on the mast. See the photos on the next page for reference.

## Antenna Assembly

### Install the Fiberglass Pole

- Install a rubber boot on to the 18 ft. telescoping pole before you insert it into the element housing tube. The small end of the boot goes on the pole first about 8" up from the butt.
- Slide the butt (large) end of the telescoping fiberglass pole into the element support tube (EST) until it is firmly bottomed. Push the rubber boot down firmly onto the element housing tube until it bottoms out and tighten the two clamps. This boot will prevent water from getting into the element housing unit (EHU).



## Antenna Assembly

### 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.



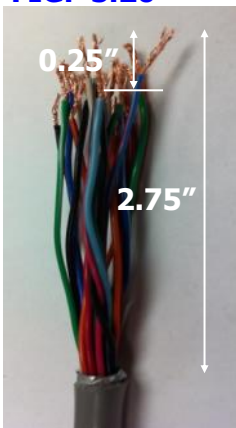
### CONNECTING CONTROL CABLE TO THE OPTIONAL DB25 FIELD SPLICE

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.

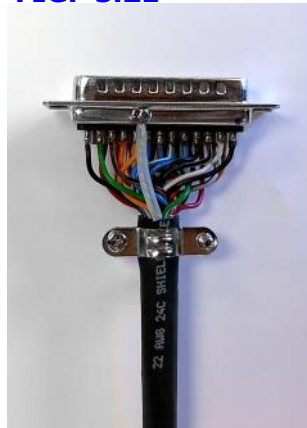
1. Apply the provided dielectric grease to the exposed copper portion of each wire.
2. Connect each wire to the appropriate terminal and tighten using a flat head screwdriver. **Note that the terminals may be closed by default. If so, turn the terminal screw ccw ~10 turns to open it before inserting 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**



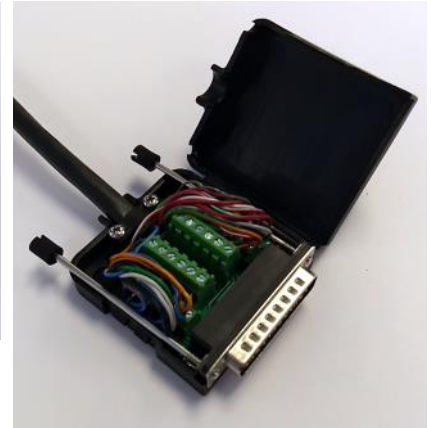
**FIG. 5.21**



**FIG. 5.22**



**FIG. 5.23**



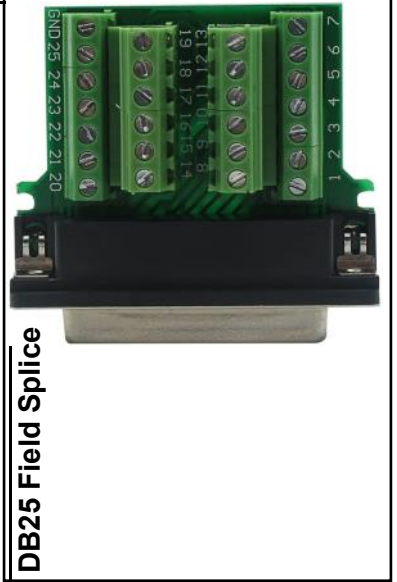
## Antenna Assembly

### CONNECTING CONTROL CABLE TO THE DB25 FIELD SPLICE

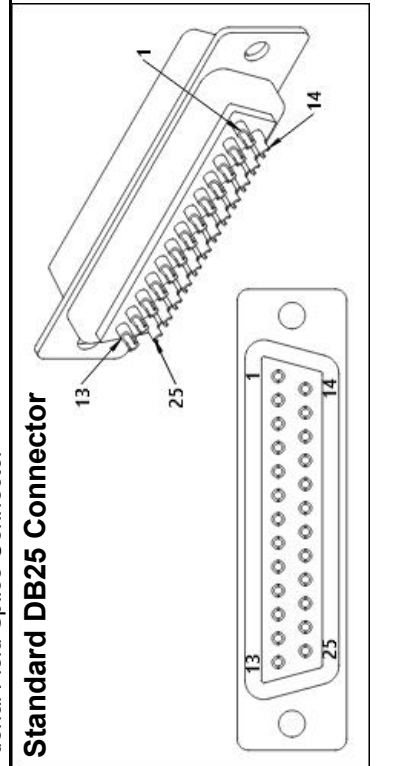
Refer to the table below for the correct wiring sequence when connecting your control cable to your 25 pin connector.

Pin	DB42, DB36 (w/80m) (24 Conductor)	4E, DB36 (No 80m) (16 Conductor)	DB11, DB18/18E (16 Conductor)	2E, 3E (12 Conductor)	BigIR/SmallIR w/ Coil (2x4 Conductor)	BigIR, SmallIR, Dipole (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	BLACK
6	BLUE/WHITE STRIPE	BLUE	BLUE	GREEN	RED	RED
7	BLUE/RED STRIPE	ORANGE	ORANGE	BLUE	GREEN	GREEN
8	BLUE/BLACK STRIPE	YELLOW	YELLOW	VIOLET	WHITE	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 STRIPE			
14	ORANGE/GREEN STRIPE	WHITE/BLACK STRIPE				
15	WHITE/BLACK-RED	WHITE/RED STRIPE				
16	RED/BLACK-WHITE	WHITE/GREEN STRIPE				
17	BLACK/WHITE-RED	WHITE/ORANGE STRIPE				
18	GREEN/WHITE STRIPE					
19	GREEN/BLACK STRIPE					
20	RED					
21	RED/WHITE STRIPE					
22	WHITE/RED STRIPE		WHITE/RED STRIPE			
23	RED/BLACK STRIPE		WHITE/BLACK STRIPE			
24	RED/GREEN STRIPE		WHITE/GREEN STRIPE			

Solder the unshielded drain wire of the control cable to the chassis (ground) of the Standard 25 Pin Connector, or one of the "G" pins on the optional Field Splice Connector



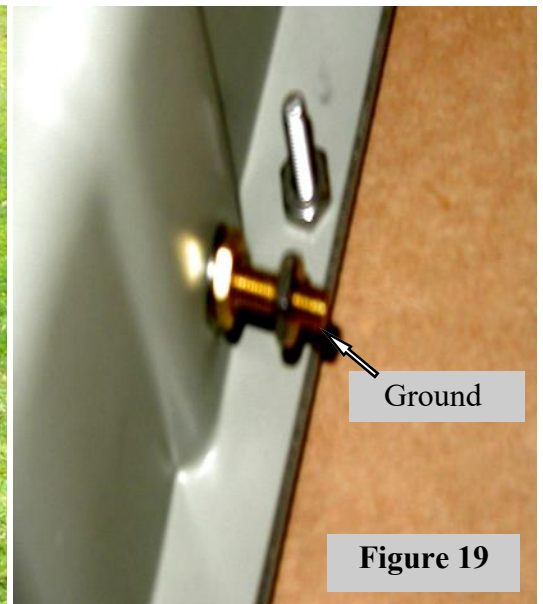
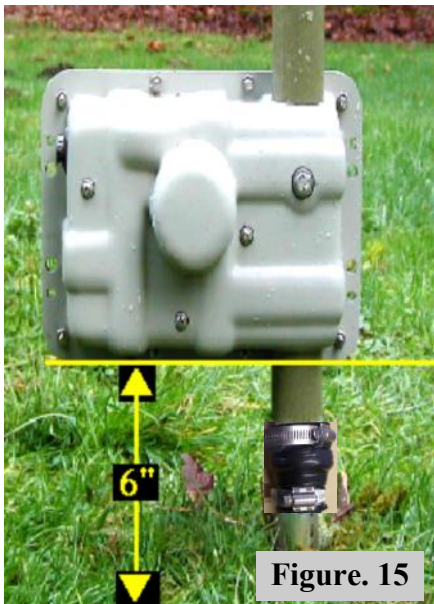
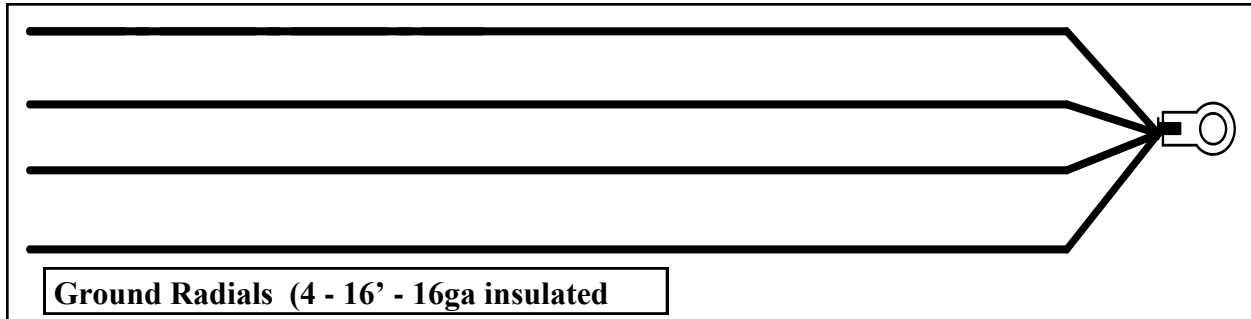
**DB25 Field Splice**



**Standard DB25 Connector**

### Mounting the Antenna (ground)

Now you are ready to connect the radials! We recommend using a lug connector at the end of your radials, and then tightening the lug onto the connector post shown in **Figure 19**. If you purchase optional radial kits (**Figure 13**), you will notice there are 4 wires per set, all soldered and crimped to a lug connector.

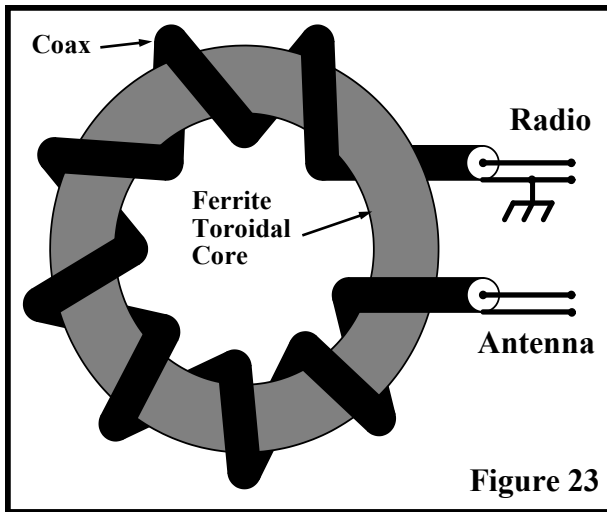


## Optional (1:1) Balun

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.



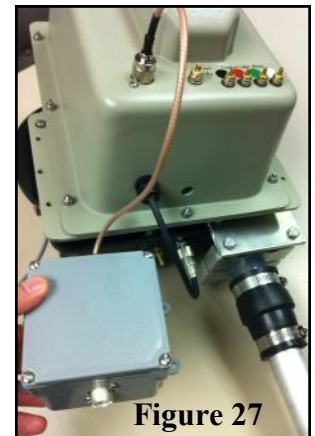
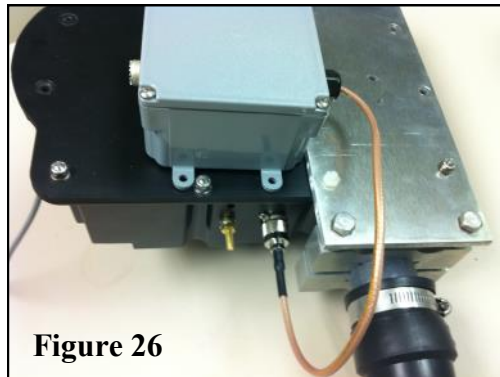
### When Should You Use A Balun ?:

- 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.



## ***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 the 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.

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 losses from the 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**

- The radials can be any length and they work on all frequencies
- Easy to mount
- Easy access
- Lower visual profile
- Eight to twelve 0.1 wavelength radials gives 60% - 65% efficiency (one set of 8 - 12 radials cut to 0.1 wavelength at lowest frequency)

##### **CONS**

- 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

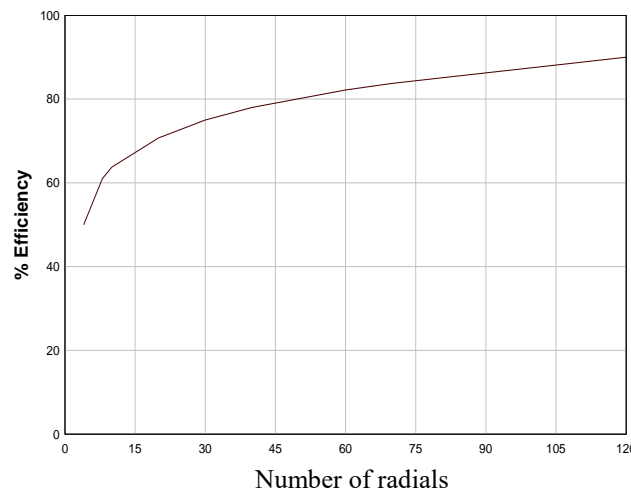
### CONS

- Requires two .25 wavelength radials 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 it
- Needs to be about .2 wavelengths high to get an ideal 50 ohm match
- Radials need at least a 20° slope to get a good match
- Involves adjusting and fine tuning the radial lengths

## Ground Mounting:

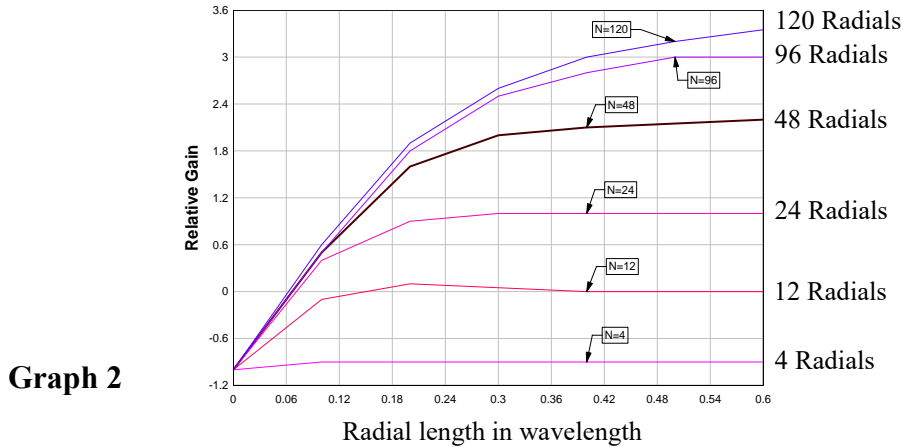
If you chose to ground mount the vertical, pick a spot that will allow you the best chance of spreading your radials evenly around the antenna, and away from trees and other objects if possible. Mount the antenna within one foot of ground if possible, the closer to ground the better. Next, you will need 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. More short radials are generally better than a few long ones
3. If only a few radials are going to be used, they need not be very long
4. If you have very good earth (very few of us actually do), you can obtain good performance with very few radials.



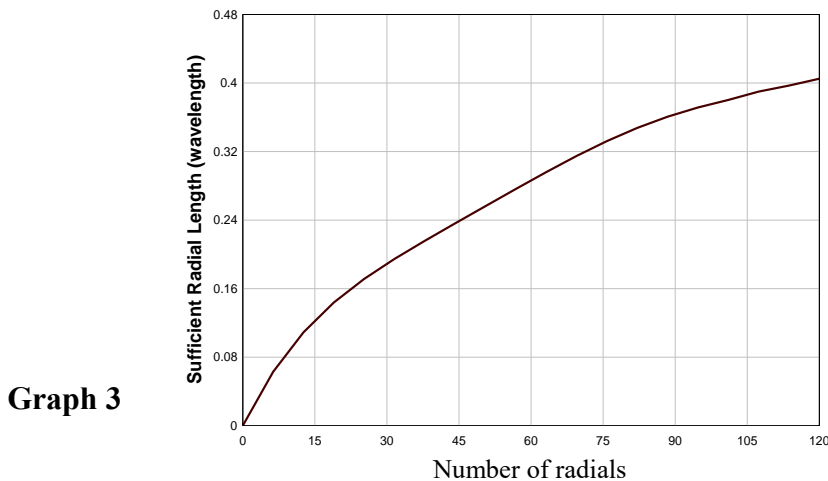
**Graph 1**

Four radials are what we consider to be the absolute minimum in average soil. 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 important. The worse the earth is, the more can be gained with 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.



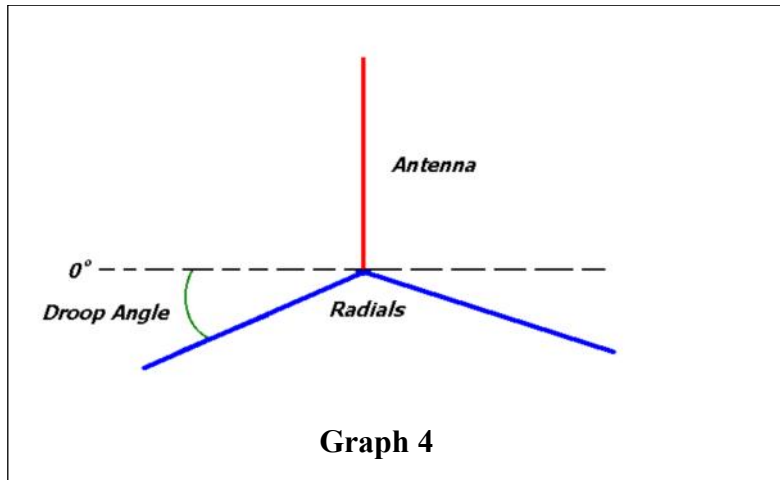
If you are restricted to .1 wavelength radials there is not much advantage to using more than about 24 radials. You can see from **Graph 3** that if more radials are used there is a huge advantage to making them longer.

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. 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 three inches is sufficient.



### Elevated Mounting:

You can elevate a vertical just a few feet from the ground (4 feet for 20m, 8 feet for 40m) and get fairly good performance with just 2 radials (elevated as well) per band of operation. The problem is you won't have a very good match to 50 ohms, and the close proximity of the earth will degrade the signal - especially if it is poor earth. For ideal matching, we recommend .2 wavelength (about 15 feet on 20m and 30 feet on 40m) at the lowest planned frequency of operation. As the height decreases below .2 wavelength, the ground losses start to increase, unless you have very good ground. When a vertical is raised off the ground the impedance drops fairly rapidly from 36 ohms (Over perfect ground or with many radials it will be close to 36 ohms, over real ground it is generally 40– 60 ohms) to about 22 ohms when .3 wavelength is reached. This would make a pretty poor match to 50 ohms, so a couple of tricks are in order. Once you elevate a vertical, two radials are all you really need. It is important that you try to keep a 180° angle between the two (opposed, directly in line) for the best pattern. 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. To facilitate a match to 50 ohms you can angle the radials downward, this raises the impedance of the antenna as you increase the angle downward. **Graph 4** shows the approximate relationship of radial angle to impedance:



Radial Droop Angle		Antenna Impedance
0°	=	22 Ohms
10°	=	28 ohms
20°	=	35 ohms
30°	=	47 ohms
40°	=	53 ohms
50°	=	55 ohms
Note: above 50° 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. 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).

When the vertical is elevated you can get away with just one resonant radial, however, the pattern won't be omni-directional. You will have -12 dB to 15 dB null in one direction

### **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.

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 no longer 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.



## **Limited Warranty**

These products have a limited warranty against manufacturer's defects in materials or construction for two (2) years from date of sale. Do not modify this product or change physical construction without the written permission of SteppIR Antennas Inc. This limited warranty is automatically void if the following occurs: improper installation, unauthorized modifications, physical abuse or damage from severe weather, beyond the manufacturer's control. Manufacturer's responsibility is strictly limited to repair, or replacement of defective components. The shipping instructions will be issued to the buyer for defective components, and shipping charges will be paid for by the buyer to the manufacturer. The manufacturer assumes no further liability.

