

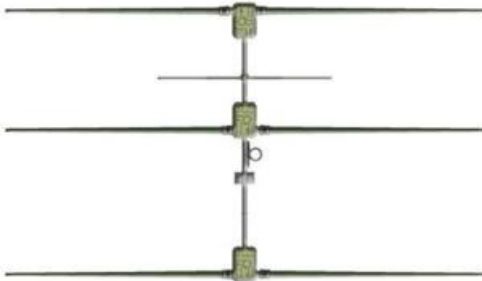


3 Element Yagi Instruction Manual

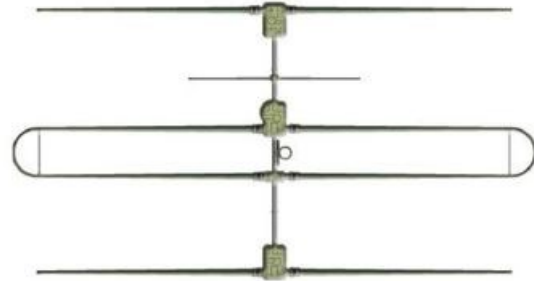


Revision 3.3 March 2020

3 Element Yagi Specifications



3E Yagi 20m-6m (with 6m option)



3E Yagi with 40/30 dipole option

Specifications	3 Element Yagi	3 Element Yagi with 40/30
Boom length	16 ft / 4.87 m	16 ft / 4.87 m
Boom outside diameter	1.75 in / 4.5 cm	1.75 in / 4.5 cm
Longest element	36 ft / 10.97 m	39 ft / 11.9 m
Turning radius	19.7 ft / 6.0 m	19.7 ft / 6.0 m
Weight	51 lb / 23.1 kg	58 lb / 26.3 kg
Wind load	6.1 sq ft / 0.57 sq m	8.1 sq ft / 0.76 sq m
Wind rating	100 mph	100 mph
Adjustable elements	3	3
Power Rating	3000 watts continuous	3000 watts continuous
Feed points	1	1
Frequency coverage	13.8 MHz—54 MHz	6.8—54 MHz
Control cable	12 conductor shielded, 22AWG	12 conductor shielded, 22AWG

3E Gain / Front-to-rear (by band)	3E Gain, dBi	3E Front-to-rear, dB	3E with 30/40 Gain, dBi	3E with 30/40 Front-to-rear, dB
40M	NA	NA	1.8	NA
30M	NA	NA	2.1	NA
20M	7.4	25	7.4	25
17M	8.3	25	8.3	25
15M	8.5	20	8.5	20
12M	8.8	15	8.8	15
10M	9.0	11	9.0	11
6M	6.2	4	6.2	4
6M w/passive opt.	10.1	30	10.1	30

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3 ELEMENT YAGI COMPONENT CHECK

	Qty	
<input type="checkbox"/>	<input type="text" value="2"/>	70-3420-01 20m Passive EHU, 10-1502-12 Gasket, 10-1501-23 Lid w/drain hole, And 72-0054-01 EHU Lid Hardware kit.
<input type="checkbox"/>	<input type="text" value="1"/>	70-3401-01 20m Driven EHU, 10-1502-12 Gasket, 10-1501-23 Lid w/drain hole), And 72-0054-01 EHU Lid Hardware kit.
<input type="checkbox"/>	<input type="text" value="1"/>	25' - 4 Conductor Cable w/ 24" Coax Seal
<input type="checkbox"/>	<input type="text" value="1"/>	SDA 100 3E Controller Interface _____ Remote (USB cable, Cat5E Cross-over Cable w/ splice connector) _____ ALP _____ Tuning Relay _____
<input type="checkbox"/>	<input type="text" value="1"/>	Power supply with cord 24V _____ 33V _____
<input type="checkbox"/>	<input type="text" value="1"/>	71-0002 3 Element Instruction Manual
<input type="checkbox"/>	<input type="text" value="1"/>	71-0010 SDA Operators Manual
<input type="checkbox"/>	<input type="text" value="1"/>	10-1021-04 Mast Plate 8" (NOT Included if High Wind Kit is purchased.)
<input type="checkbox"/>	<input type="text" value="18"/>	10-1059-01 Polyolefin heat shrink 1.5" x 3"
<input type="checkbox"/>	<input type="text" value="6"/>	60-1006-22 Fernco 1.5" x 1.25" Quick Disconnect Boot
<input type="checkbox"/>	<input type="text" value="1"/>	09-0001 Electrical Tape
<input type="checkbox"/>	<input type="text" value="1"/>	10-1028-21 Anti-seize Stick
<input type="checkbox"/>	<input type="text" value="6"/>	70-1007-01 Foam Plug Assembly
<input type="checkbox"/>	<input type="text" value="1"/>	20-6208-01 25 Pin connector and 20-6209-01 25 Pin Back Shell
<input type="checkbox"/>	<input type="text" value="1"/>	72-0005-01 3 Element Hardware Kit (NOT included if High Wind Kit purchased.)
<input type="checkbox"/>	<input type="text" value="1"/>	72-0016-02 2/3E Connector Pack (NOT included if connector box is purchased)
<input type="checkbox"/>	<input type="text"/>	12 Conductor Control Cable Length _____
<input type="checkbox"/>	<input type="text" value="6"/>	10-1013-02 18' Telescoping Pole
<input type="checkbox"/>	<input type="text" value="1"/>	3E Boom , 4 Sections
<input type="checkbox"/>	<input type="text"/>	Option: 70-6010-01 25 pin Dsub splice assembly
<input type="checkbox"/>	<input type="text"/>	Option: High Wind Kit
<input type="checkbox"/>	<input type="text"/>	Option: 20-8052-41 Array Solution 12 Pin surge Suppressor Surge Suppressor Instructions
<input type="checkbox"/>	<input type="text"/>	Option: 70-2034 Connector Box for 2, 3E. _____ 71-0017 Connector Box Manual _____
<input type="checkbox"/>	<input type="text"/>	Option: 2E-3E 6m Passive Element _____ 72-0014-01 2-3 6m Passive kit
<input type="checkbox"/>	<input type="text"/>	Option: S Cable _____

Assembly Kit Materials List

3E Element Fastener Pack 72-0005-01

QTY	PART NUMBER	DESCRIPTION
2	60-0003	1-3/4" U-BOLT & SADDLE
2	60-0004-21	2" LONG U-BOLT & SADDLE
3	60-0062	2-3/4" x 1/4" BOLT
3	60-0030	1/4" NYLOK NUT
8	60-0046	5/16" NYLOK NUT
15	60-0041	1/4 WASHER

3E Connector Pack 72-0016-02

QTY	PART NUMBER	DESCRIPTION
1	70-1102-21	Terminal Housing 1.5"
1	60-6000-35	3" HOSE CLAMP
1	20-6020-12	12-POSITION TERMINAL STRIP
1	20-6020-01	1-POSITION TERMINAL STRIP
1	10-1029-01	PACKAGE CONNECTOR PROTECTOR

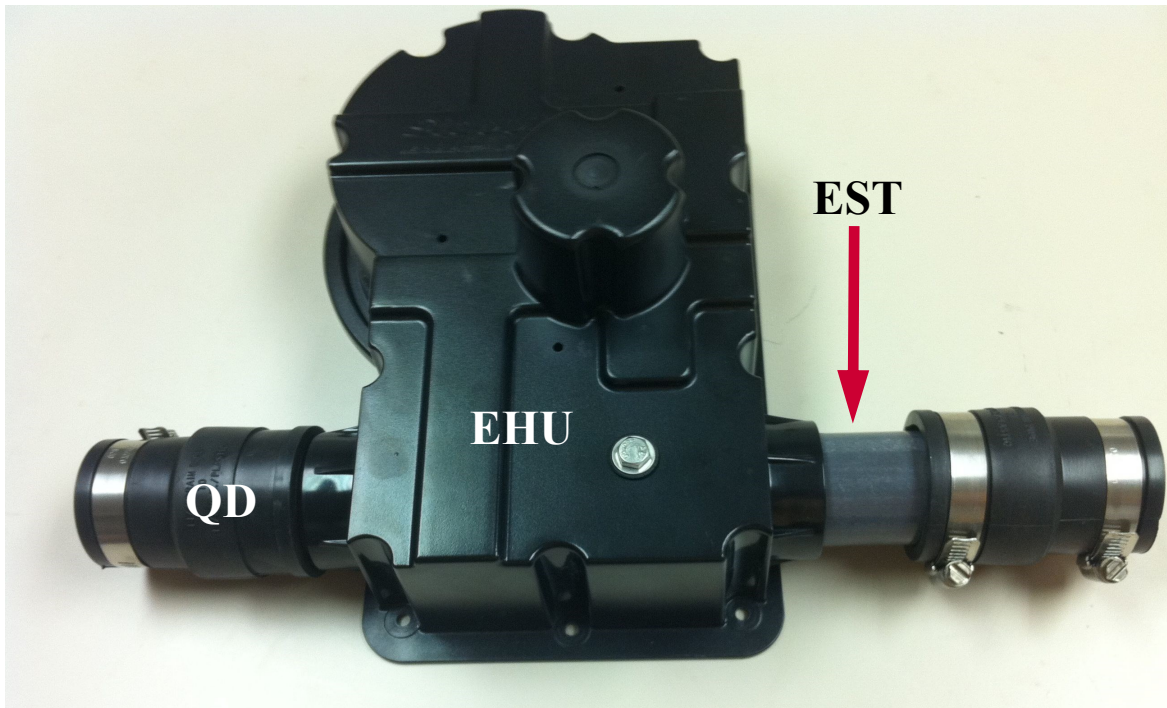
EHU Lid Hardware Kit 72-0054-01

Note: There are three sets of this kit for the 3 Element Yagi

QTY	PART NUMBER	DESCRIPTION
11	60-0019	10-32 Nylock Nut
2	60-0017-10	10-32 X 7/8 Flat Phillips Screw
9	60-0061	10-32 X 7/8 Pan. Phillips Screw
11	60-0018	10-32 Flat Washer

Abbreviations

EST	Element Support Tube
EHU	Element Housing Unit
QD	Quick Disconnect Boot (rubber)



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 or log periodic techniques, 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,

Mike Mertel

Michael (Mike) Mertel - K7IR
President



You have ordered you SteppIR Antenna and are waiting for delivery. What do you do in the meantime?

1. Go to the SteppIR web site at www.steppir.com and download the latest manual for your antenna, and also the Operators Manual for the controller.
2. Read the manuals from cover-to-cover ---TWICE! Don't just read them --Study them, so you are familiar the terminology used about the antennas and have a good idea of how the antenna is assembled and where the various parts go.
3. As you go through the manuals make notes of any instructions you may not clearly understand, then call or email for clarifications. It is better to have it all sorted out before you start assembly. We don't mind answering your questions beforehand.
4. Now, wait for notification your antenna is being shipped.

**Your antenna has arrived!
What is the first thing to do?**

1. If the antennas is to arrive on Wednesday----DO NOT plan an antenna party for Saturday!
2. Even if you plan to install the antenna weeks later, the first thing to do is to unpack the antenna and do a complete inspection. Make sure nothing is missing or has been damaged in shipment.
3. Do a complete inventory of every part, nut and bolt. Yes it takes time, but it also allows you to notify SteppIR if anything is missing and allow time to get it to you before you start assembly of the antenna. There is nothing more frustrating than realizing that something is missing, just hours before you want to install the antenna.
4. Go back to the SteppIR website and download the latest manual. SteppIR constantly is improving and adding to the manual, so even though your paper instruction manual is going to have all the data you need, it makes sense to check for the latest updates online. This is especially true If you purchased the antenna and a period of time has passed between arrival and install dates.
5. Take the controller and power supply out of their wrappings and connect them. The controller does not have to be connected to the antenna in order to familiarize yourself with it. In fact, it is best to get familiar with the controller when it is not connected to the antenna. Turn on the controller and read through the Operators Manual again while operating the controller in all it modes. Go through the menus so you know what each does and how to navigate through the various menus and functions.

**Your Antenna Has Arrived!
What is the first thing to do?
(continued)**

5. When you have finished working with the controller be sure the display indicates "Elements Home" and the controller has been turned OFF. When the controller is connected to the antenna and the controller is turned back on the next time, it will immediately tune to whatever position the controller was left in last time you were using it, so you want to be sure that position is HOME.
6. Once the antenna is completely assembled and ready to mount on the antenna tower, use an antenna analyzer, if you have one, to test resonance of the antenna.. If you don't have an analyzer, try to borrow one. It will save you a lot of time and worry. Check the antenna on each band for some sign of resonance within the frequency range. Leave the antenna on the default frequency and tune the analyzer to see where the dip occurs. It will be somewhere below the lower band edge on each band with the antenna 3 or 4 feet above the ground on saw horses. Also, don't expect to see a 1:1 SWR here, just look for a good indication of resonance.

Once it has been determined this part of the antenna is working correctly do the following: Select the lowest band and establish the dip condition by tuning the analyzer. Do not touch the analyzer again. Retract the elements and then reselect the same band. The antenna should come back the very near the same setting. Do this 2 or 3 times on each band. Also, try going from the band being tested to any other band and back again and observe that the antenna comes back to the same resonant point. Now you know the antenna is tuning correctly from band to band and is consistent.

7. When you are ready to use the antenna, if you have purchased the 40/30 loop, be sure to "enable" the loop in the controller menu, or your antenna will not work on those bands. If you purchased the 6m option, be sure to enable that as well. When done enabling, save and then turn the controller off, and back on again.
8. Enjoy the antenna!

73

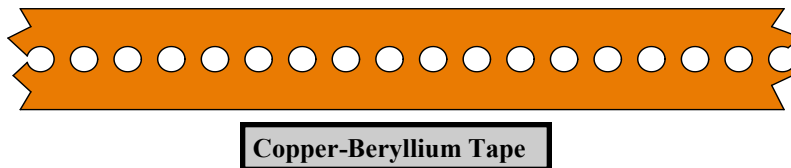
Jim Streible—K4DLI

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. Yagi 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.

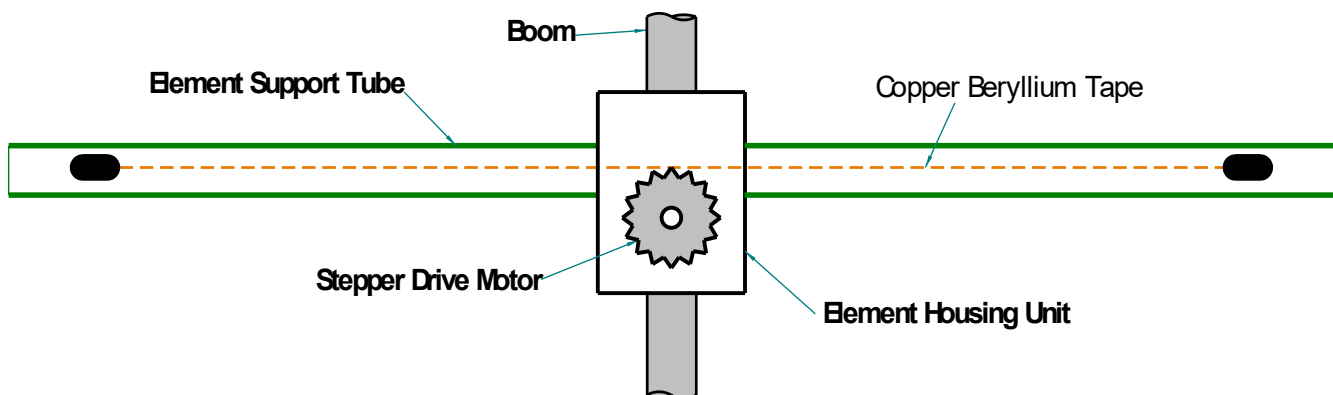
Each antenna element consists of two spools of flat copper-beryllium tape conductor (.54” Wide x .008” Thick) mounted in the element housing unit. The copper-beryllium tape is perforated to allow a stepper motor to drive them simultaneously with sprockets. Stepper motors are well known for their ability 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 57” 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 80m 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).



A WORD ABOUT STAINLESS STEEL GALLING

From time to time, we get complaints from customers regarding galling of stainless steel fasteners.

Here is an excerpt from the Industrial Fastener Institute's Standards Book:

Thread galling seems to be the most prevalent with fasteners made of stainless steel, aluminum, titanium and other alloys which self-generate an oxide surface film for corrosion protection. During fastener tightening, as pressure builds between the contacting and sliding thread surfaces, protective oxides are broken, possibly wiped off and interface metal high points shear or lock together. This cumulative clogging-shearing-locking action causes increasing adhesion. In the extreme, galling leads to seizing - the actual freezing together of the threads. If tightening is continued, the fastener can be twisted off or its threads ripped out.

During minor galling, the fastener can still be removed, but in severe cases of galling, a strong bond between the bolt and nut can prevent removal of fasteners. Unfortunately, little is known on how to control it, but here are two ways to minimize this effect:

Decreasing installation RPM speed will cause less friction and decrease heat generation. Lubrication used prior to assembly can dramatically reduce or eliminate galling. Recommended lubricants should contain higher amounts of molybdenum disulfide, such as graphite which is very commonly used as a solid lubricant or special anti-galling lubricants sold by chemical companies.

We provide an anti-seize compound stick called "Thread Magic" (shown in picture below) with all of our antennas and **strongly encourage** you to use it to reduce the aggravation of galling. The Thread Magic stick is fantastic—you can get plenty of anti-seize on the fastener without getting it on your hands!

Contrary to popular belief, galling of stainless steel is not a symptom of a "cheap" fastener - it is prevalent in all types of stainless steel, aluminum and titanium fasteners. You can be assured that the stainless steel fasteners we provide with our products are manufactured of very high quality.



BOOM INSTALLATION

Note: If you have the 40m - 30m dipole kit some of the standard 3 element assembly parts will also be in this box.

It is much easier to put the antenna together right than figure it out what you did wrong after it is up in the air. The 3 element SteppIR Yagi boom consists of four sections of aluminum tubing that are 4 feet long x 1-3/4" OD x 1/8" wall, along with three aluminum element mounting brackets as shown in **Figure 1**. The element mounting brackets are pre-installed at the factory. To assemble your antenna, you will need a 1/2" (13mm) and 7/16" (11mm) wrench and / or socket drive. We double check the fasteners for proper tightness before shipping but it is always a good idea to check them yourself before installing the antenna. Put anti-seize grease on all bolts 1/4" or larger, especially on the u-bolts because it greatly increases their gripping power. Anti-seize grease (molybdenum based) is available at most auto part stores.

Assemble the boom & connect to mast plate

The boom is completely assembled and drilled at the factory to assure precision element alignment. You may notice in some cases that on a given splice (**Figure 2**) the holes on each side of the splice are at 90 degrees with each other. This is as designed and **not** a mistake. Pre-drilled holes are quite snug to align almost perfectly. In some cases you may find it necessary to assist the bolts with a tap of a hammer, or "thread" them in by turning with a wrench. If the holes are visibly out of alignment when you are assembling the boom, you probably have the boom pieces put together in the wrong order - or the section of booms without an element to boom bracket may need to be rotated 180 degrees. Each boom piece has a number permanently written, scribed or stamped on it. Match each number with the exact same number of a corresponding boom piece. **Figure 2** shows joint # 1 markings inside the ring (they must line up).

Drawing 7 shows how each boom section is numbered.

Connect the boom by sliding the respective sections together and align the pre-drilled holes (**Figure 3 and 4**). Refer to **Figure 6** and **Drawing 7** for correct configuration. It is advisable to spray a small amount of WD-40 on the male sleeve before sliding the female section onto it. Do not twist the aluminum excessive-

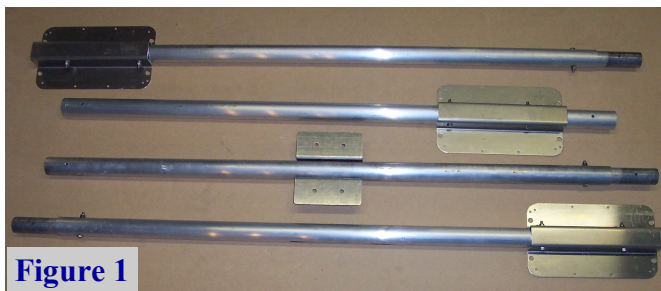


Figure 1



Figure 2

ly, as this can cause binding - the WD-40 will help keep the two pieces lubricated. Insert the included bolts into the pre-drilled holes, and tighten the Nylok nut securely (**Figure 5**). Be sure to position the bolts and nuts so that they are in the same direction as the others. **Make sure the boom bolts for the center splice are installed as shown in Figure 8, if you install them the opposite way the bolt will interfere with the mast plate.**



Figure 3

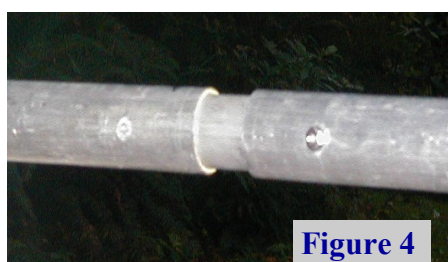
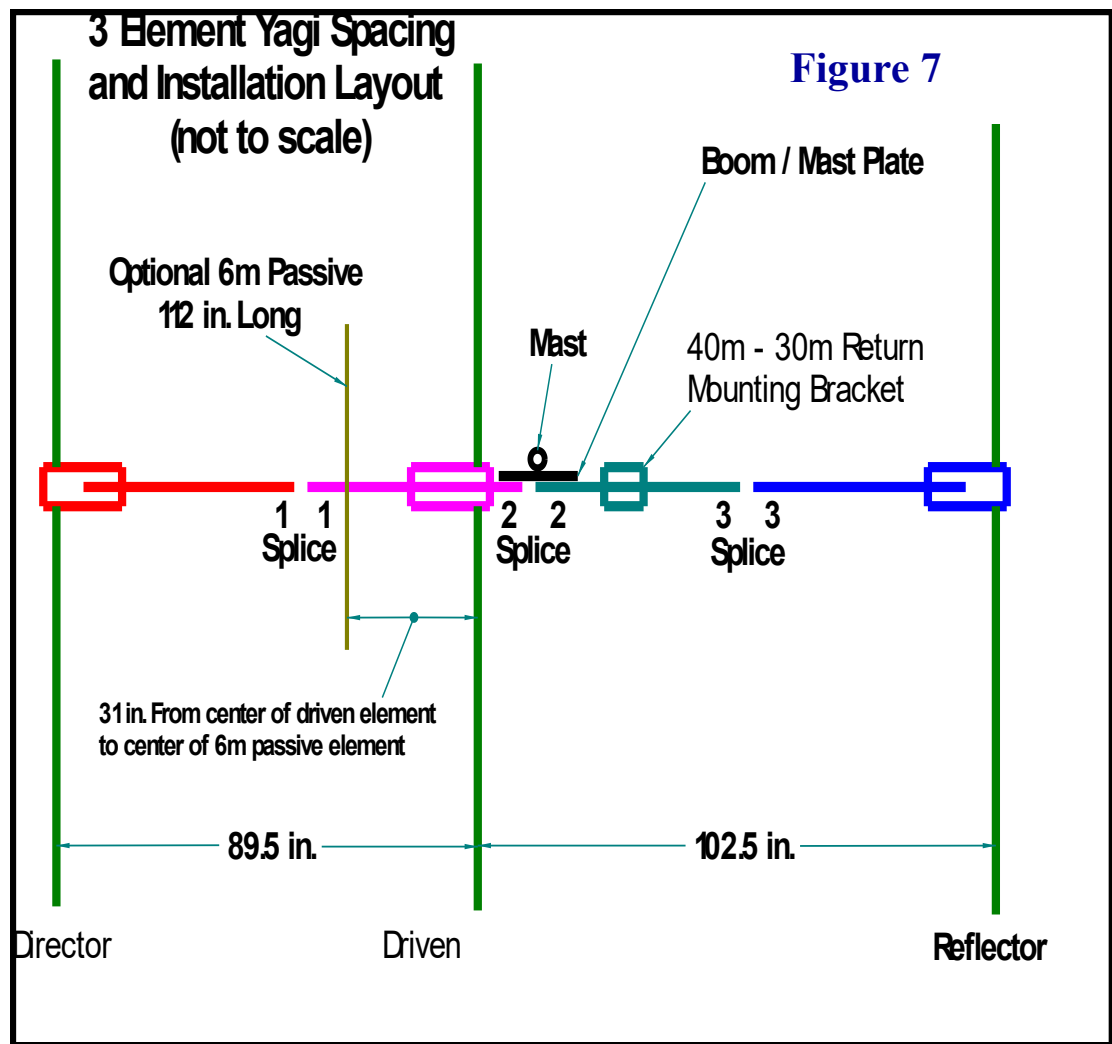
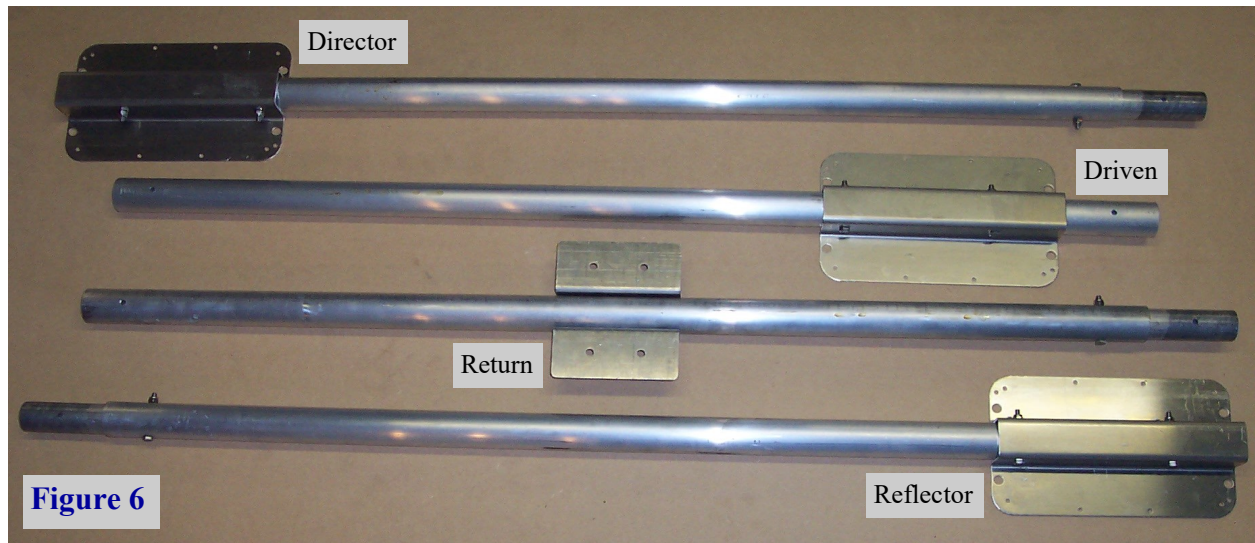


Figure 4



Figure 5

BOOM LAYOUT AND SPACING GUIDE



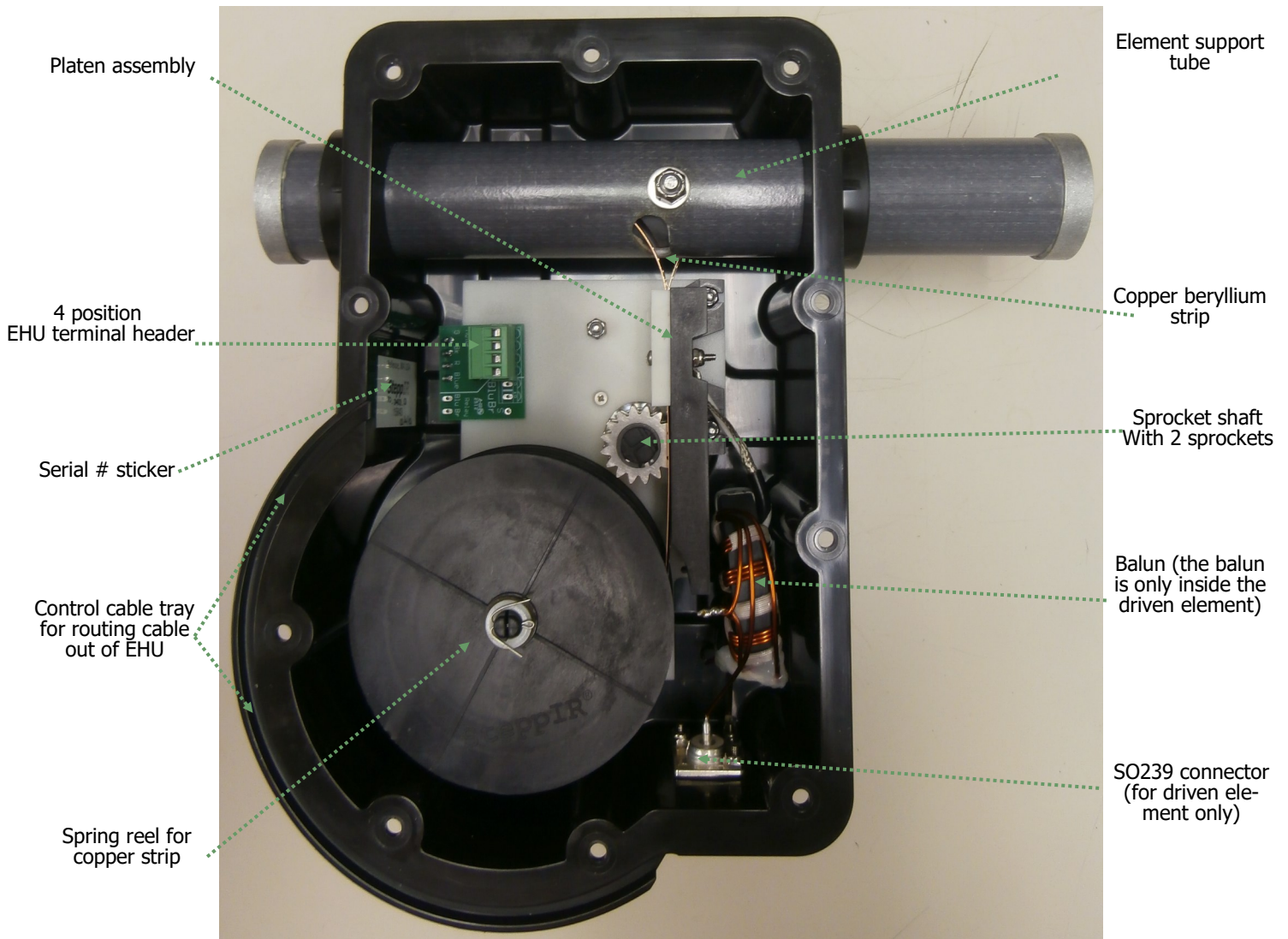
Note: Element spacing is measured from element center line to element center line in all cases - not from the brackets or element housing units.

ELEMENT HOUSING UNIT (EHU) WIRING OVERVIEW

Figure 8 gives an overview of the inside of a SteppIR EHU. Wiring of each EHU will be covered in detail on the following pages.

NEVER ATTEMPT ANY WIRING WHILE THE ELECTRONIC CONTROLLER IS CONNECTED TO THE CONTROL CABLE. Even if the power is turned off of the controller, damage can occur. This is the number one cause of antenna installation failures, so please be sure to heed the advice.

FIGURE 8



EHU WIRING

Trim approximately 1.5 inches of the outer jacket of the control cable (4 wire). Remove the shield material, the support thread and cut the ground wire off as shown in [figure 9](#). Attach electrical tape at the end of the trimmed control cable jacket so that there is no chance for a short. Remove 0.25 inches of the insulation from each of the individual 22 AWG wires, leaving bare copper. Tinning of the copper wire ends with solder is not required but may be helpful in keeping the ends together while attaching the control cable wires. [Figure 10](#) shows the control cable should look like when you are finished with the trimming. Dip each of the copper wires into connector protector before inserting into the terminal plug. [Figure 11](#) shows what the connector protector will look like.

The terminal header assembly consists of the terminal header and the terminal plug as shown in [figure 8](#). The plug is shipped loosely attached to the header. Remove this plug when wiring and firmly plug back in when completed. Follow the wire sequence in [figure 13](#) for each EHU. *Be careful to ensure that there are no bare wires protruding out from the terminal clamps, to avoid potential shorts.*

The wiring sequence for each EHU is also imprinted on the PCB that the terminal header is mounted on (located inside the EHU). Pay no attention to the second row of imprinted text, these pins are for use in the manufacturing of the board itself and are of no use to you. [Figure 12](#) shows a blue line crossing out the text in question. The yellow circle shows the correct wiring sequence.

FIG. 9

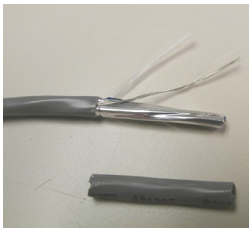


FIG. 10

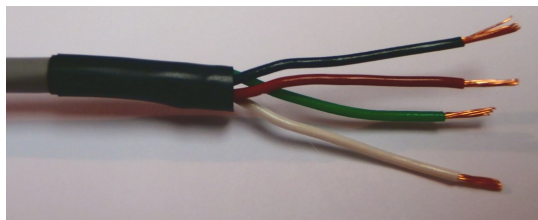
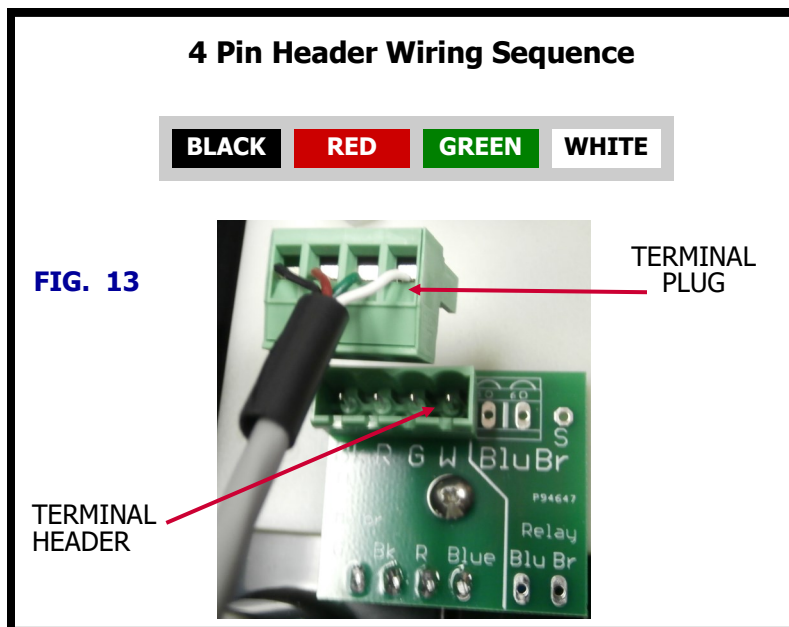
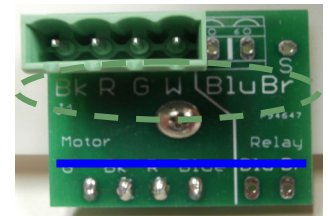


FIG. 11



FIG. 12



EHU WIRING (continued)

Check to be sure the terminal plug is firmly inserted into the terminal header.

Lay the control cable wire inside the wire tray of the EHU as shown in [figure 14](#). This trough acts as a strain relief so that the cable will not be pulled out of the EHU. It is a good idea to leave a small amount of slack between the plug and the point which the tray starts as shown in [figure 15](#).

Using the coax seal and cut into 1 inch strips as shown in [figure 16](#). You will need three strips. The remainder can be used to seal the driven element SO239 connectors, should you wish to.

Apply coax seal on top of the control cable and work it around the cable and on top of the cable tray as shown in [figure 17](#). This will help keep water from entering into the EHU. Apply the coax seal to the 2 remaining sections of the wire tray as shown in [figure 18](#).

Repeat wiring and coax seal preparation for each EHU. When finished, the EHU's will be secured to the aluminum element mounting plates. This is covered in detail in the next chapter.

FIG. 14

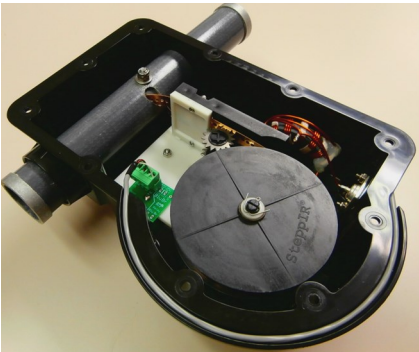


FIG. 15

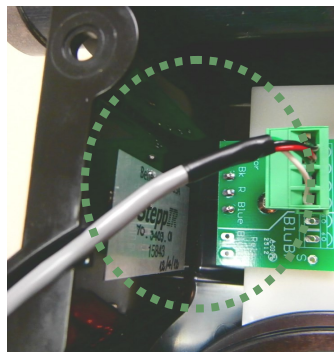


FIG. 16



FIG. 17

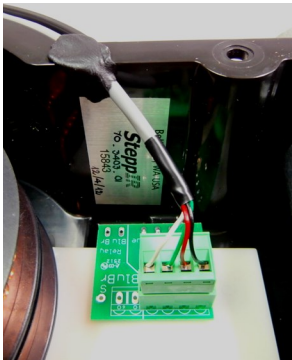
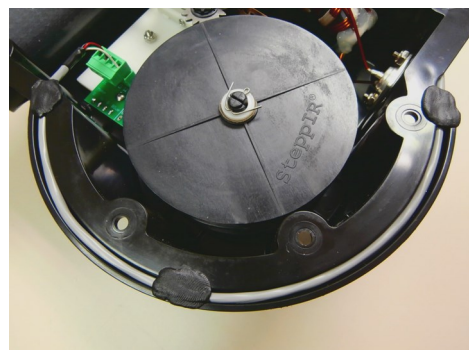


FIG. 18



DB25 CONTROL CABLE SPLICE INSTALLATION



FIGURE 19

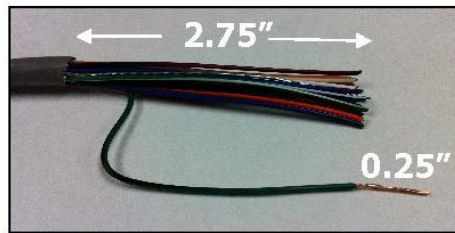


FIGURE 20

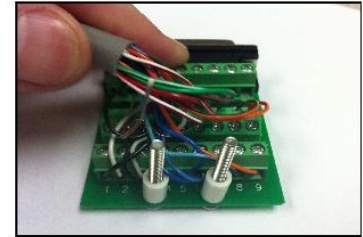


FIGURE 21



FIGURE 22



FIGURE 23



FIGURE 24



FIGURE 25

The DB25 control cable splice allows for much more convenient connection of control cable to the SteppIR controller. By utilizing this connector splice, there is no need to cut the DB25 connector off and re-solder when running cable through conduit. In addition, now you can purchase custom cable lengths to within 1 foot of your desired length, eliminating potential for excess cable. To install the DB25 control cable splice, follow these instructions:

1. Locate the parts needed for installation shown in figure 1.
2. Strip the grey jacket and aluminum shielding off of the control cable as shown in figure 2, approximately 2.75" from end of control cable, being careful not to damage the individual wires. Strip the plastic insulation off of each of the control cable wires, approximately 0.25" in length should be bare wire (fig 2). It helps to twist each of the stranded wires, to aid in the placing of the wire into the terminal headers. Tinning the wires with solder also works well.
3. Connect each wire to the appropriate terminal as shown in figure 3. Consult drawing 21-6005-91 for the correct wiring sequence, there are multiple wiring sequences on this drawing depending on your model of antenna.
4. Insert the two stainless steel screws into the circuit board, as shown in figure 3. Slide the two plastic spacers onto the screws.
5. Insert the first half of the strain relief clamp onto the two screws (half-round bump facing upward) on the two screws (fig 4). Be careful not to pull the wires out of the terminal headers as you push the strain relief clamp downward.
6. Insert the second half of the strain relief clamp onto the two screws (half-round bump facing downward as shown in figure 5).
7. Position the control cable in between the two halves of the strain relief clamp, be sure that the jacketing of the cable is in between the clamps (fig 5).
8. Using the nuts, tighten down until the cable is nice and snug, but do not over tighten (fig 5).
9. Plug the DB25 splice into the back of the controller and tighten the jack screws to secure the DB25 to the controller housing, as shown in figure 6.
10. While it is not required, you may optionally use silicone wrap to cover the wiring, as shown in figure 7.

CONNECTING THE CONTROL CABLE TO THE D25 SPLICE

FIGURE 26

**25 PIN DSUB
FIELD SPLICE
TERMINAL STRIPS (3)**

12 WIRE CONTROL CABLE

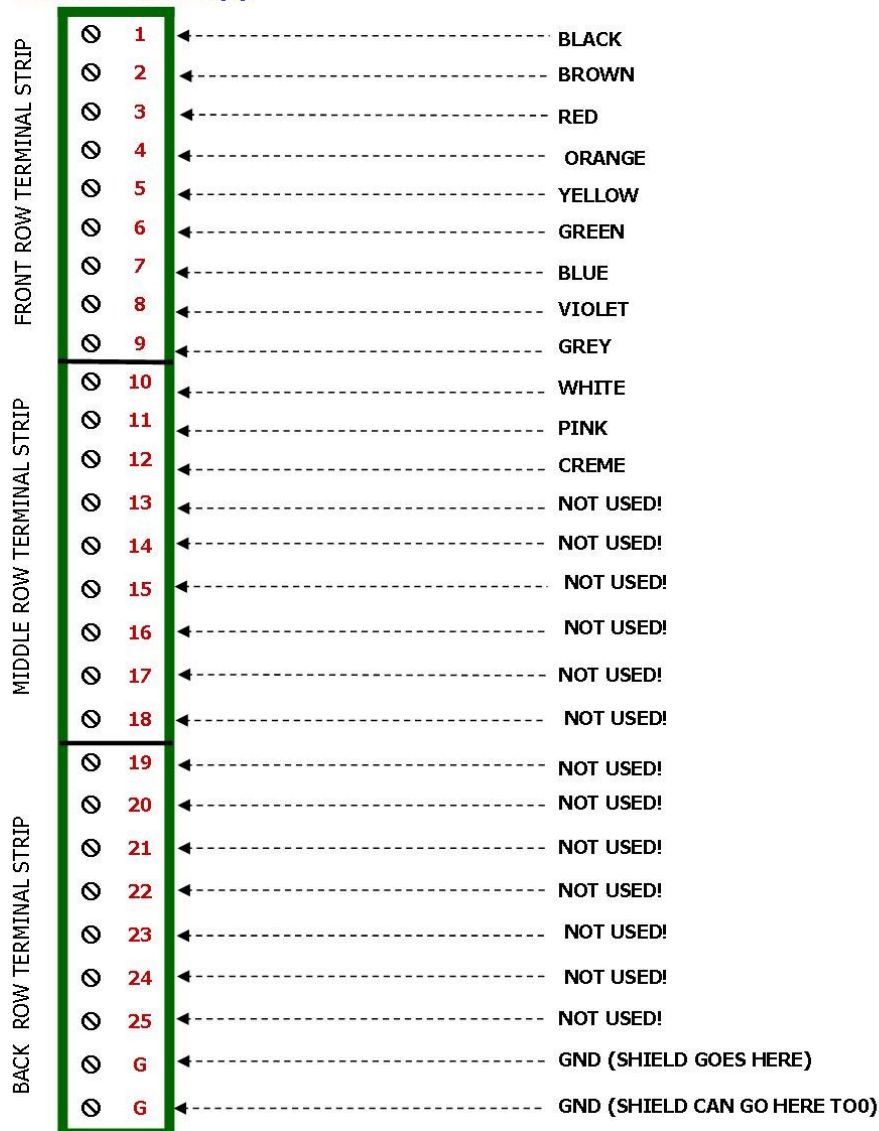
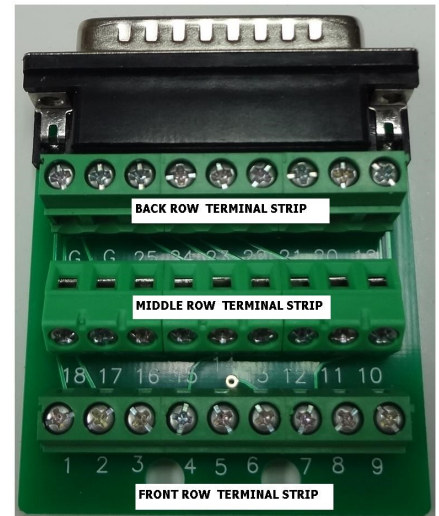


FIGURE 27



NOTE: CHECK THE LUG NUMBER ON THE CIRCUIT BOARD TO BE CERTAIN YOU ARE WIRING CORRECTLY. THE SEQUENTIAL ORDER OF THE NUMBERS CHANGES WITH EACH ROW OF TERMINAL STRIP.

Connect the Boom to the Mounting Plate

The mast plate has a total of eight pre-drilled holes. Four are used for the 2" stainless steel mast clamps and four more are used for the 1-3/4" stainless steel boom clamps.

Connect the mast to the mast plate using the included 2" stainless steel U-Bolts, with saddles, and Nylok nuts as shown in **Figure 28**. Tighten securely.

Note: If you are doing this on the tower it is advisable to test each U bolt for a proper fit and bend if necessary to ensure ease of assembly on the tower.

Connect the boom to the mounting plate on the opposite side of the mast (**Figure 29** and **30**), using the 1-3/4" U bolts, saddles, and nuts. Align the boom so that the element brackets are level, then tighten securely. The center balance point of the boom is at a splice, as shown in **Drawing 7**. There will be a bolt on each side of the splice - **make sure that the nut end of these two bolts are facing away from the mast plate (Figure 30)**. Otherwise, you will not be able to secure the boom snugly to the boom clamps. To ensure a balanced weight load, the center of the mast plate should be reasonably close to the center balance point of the boom.

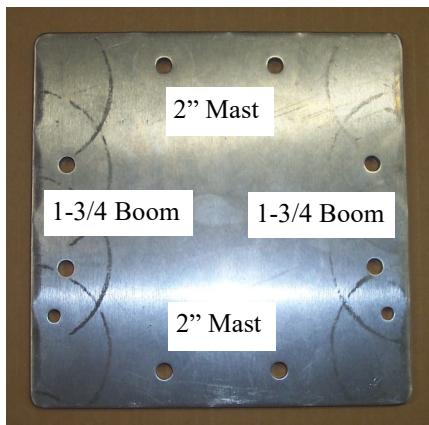


Figure 28



Figure 29

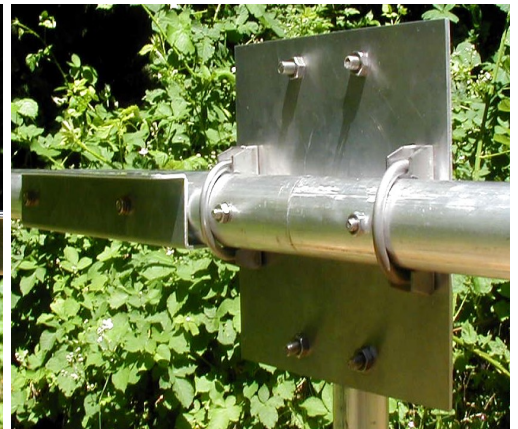


Figure 30

Determining the direction of the antenna

The SteppIR Yagi has three “directions” in which it can be used. Normal, 180 degree and bi-directional. This can make it complicated to describe the actual “aiming” direction of the antenna!

When you are installing the Yagi, you will want to position the antenna so that the “normal” direction coincides with your rotor heading. When you are in normal direction, the forward, or “aiming” element is a director, and the element behind the driven is a reflector. In the normal direction, the director is the element that is closest to the driven element (89.50” between the two). In the 180 degree mode, we swap the reflector and director positions by changing their respective lengths. However, we do not simply swap the actual element lengths, we create a new antenna based on the new element spacing. So you will always have an optimized antenna.

MOUNTING THE EHU TO THE BOOM

Attaching the NEW EHU to the boom is a two step procedure. The first step involves attaching the lid and gasket with the 3 screws shown in Figure 2. The second step is to attach the EHU to the element place on the boom with the remaining 7 screws as shown in figure 3.

WARNING:

When assembling the lid to the housing and the housing to the boom make sure the control cable is not being pinched or damaged in any way. This can cause a short and will drastically effect the performance of the antenna.

FIGURE 31

Lid Assembly

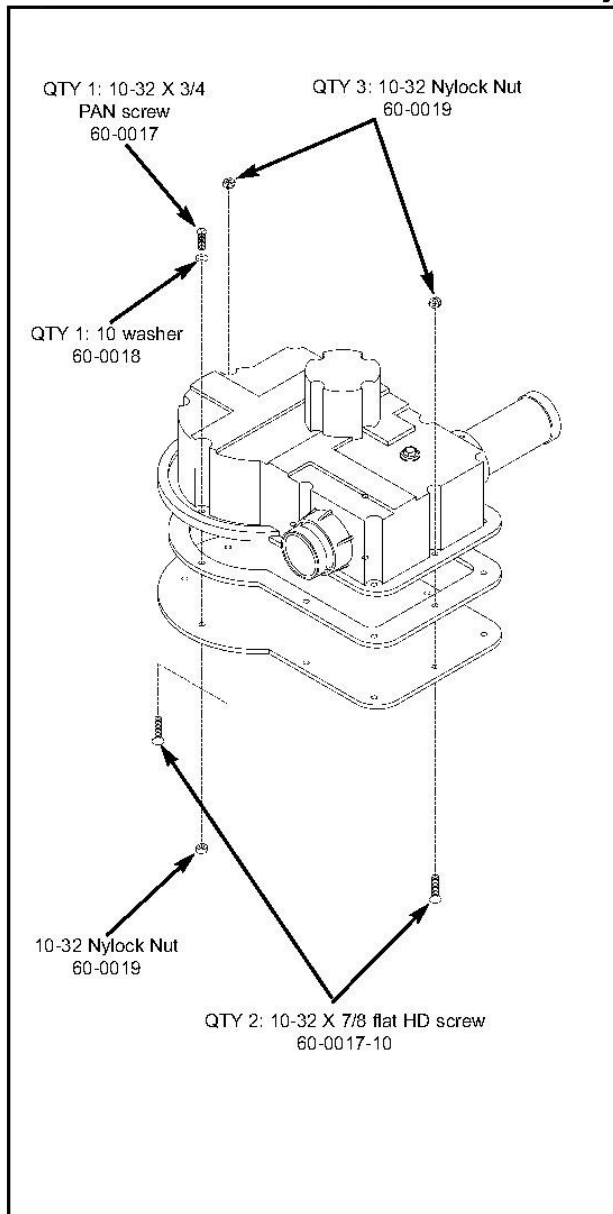
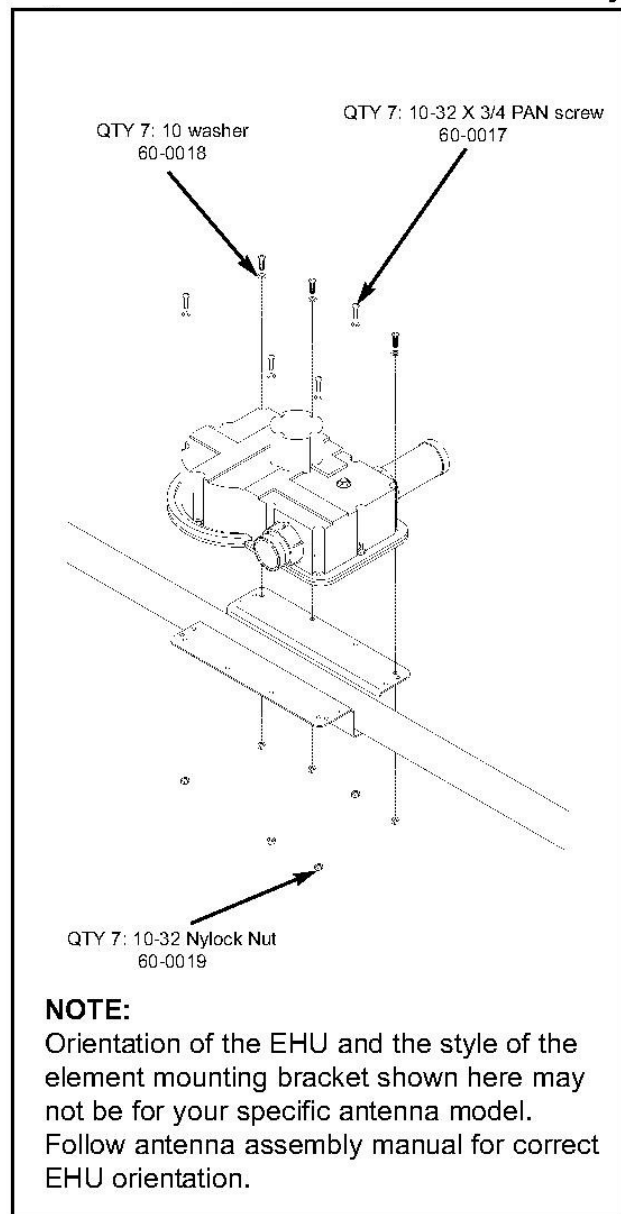


FIGURE 32

EHU Assembly



Attach the antenna housing to the element-to-boom bracket

Figure 33 shows the element boom bracket. Place the flat side of the element housing unit (EHU) on top of the element boom brackets (**Figure 34**). If the mounting holes for the element housing do not line up with the holes in the element bracket it may be necessary to loosen the two horizontal bolts that hold the element bracket to the boom. After mounting the element housing to the element bracket be sure to re tighten the two horizontal bolts. **Figure 35** shows the mounted end element.

The housings without the SO-239 coax connector are the director and reflector (they are identical and interchangeable), the one with the SO-239 connector is the driven element (the balun is on the inside of this housing). The reflector and director should be positioned so the actual fiberglass element is furthest away from the driven element (**Figure 35**).

The driven element should be positioned so that the element is closest to the mast plate (**Figure 36**). Fasten each element housing to the element bracket, using eight 10-32 x 7/8" screws, flat washers, Ny-lock nuts. **The flat washer needs to be placed between the screw head and the plastic element housing.** Tighten securely, but not too tight (if you over-tighten the nut, you may split the plastic flange on the element housing). The dark grey element support tube (EST) on each antenna housing will appear uneven in length - it is actually centered on the inside of the antenna housing.

The reflector element and the driven element will have the EST (offset tube) lined up so that the short side and long side of the each EST are facing in the same directions. The director element EST configuration will be the opposite. This is normal. **Figure 37** shows the mounted Driven EHU.

FIGURE 33



FIGURE 34



FIGURE 35

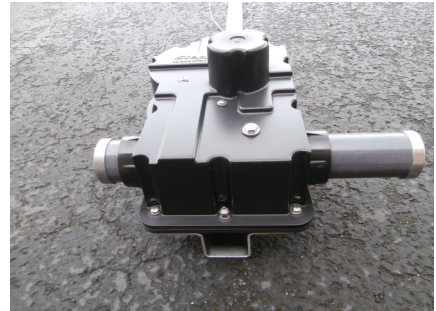


FIGURE 36



FIGURE 37



Connect the wiring and secure to boom

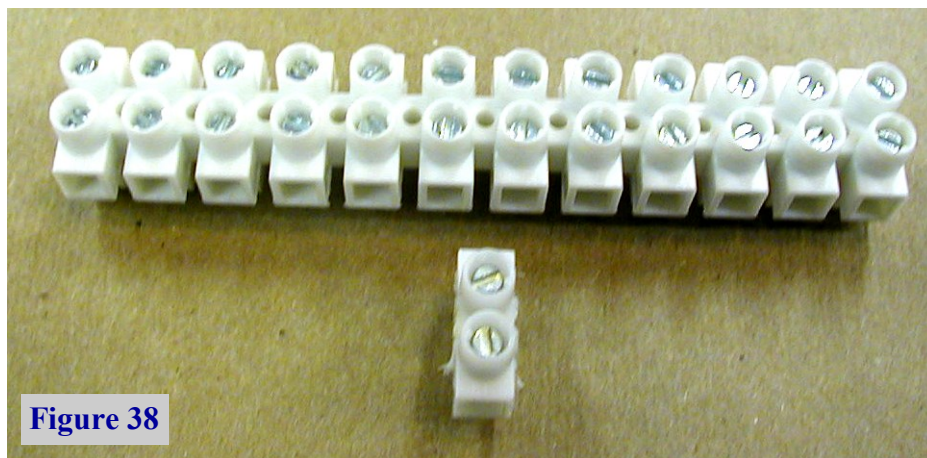
WARNING:

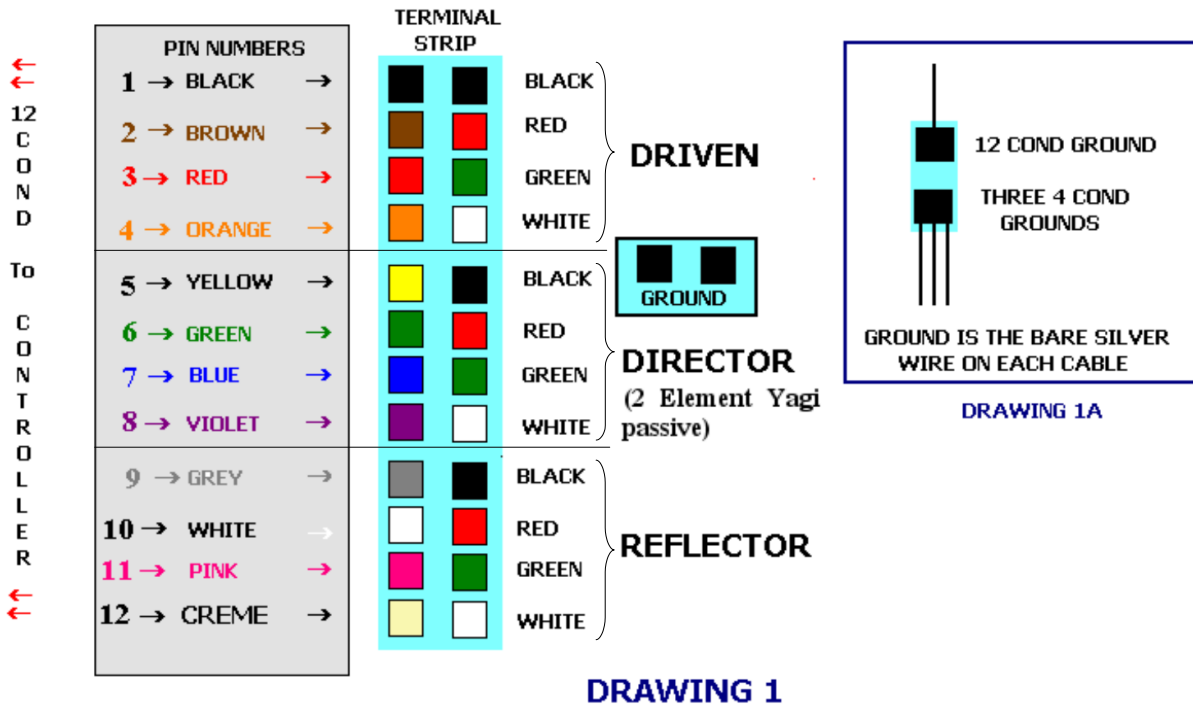
Make sure the 25-pin sub-D connector is not connected to the controller if the 24 VDC supply is energized and plugged into the controller. There are voltages present on the control cable wires even when the power button on the controller has been pushed to “off”. Shorting the control wires with power on them will destroy the driver chips. Either unplug the 24 volt power supply or disconnect the 25-pin sub-D connector before making any connections or cutting or splicing the cable.

Also be aware that if you have more than 200’ of control cable you must use our optional 33 VDC power supply. This will then allow up to 500’ of control cable with no problems.

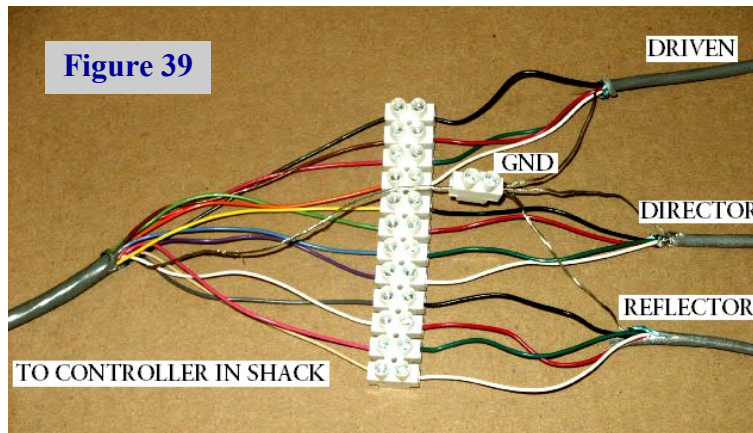
Be sure to connect the controller case to your station ground using the #8-32 lug on the back of the controller. This is important for RFI immunity as well as lightning protection. If you are in a high lightning area take the appropriate precautions the controller can be damaged by lightning. (it is beyond the scope of this manual to cover all of the complexities of lightning protection, see some of the ARRL publications that address this) The surest protection is to disconnect the 25-pin sub-D connector and power supply, then move them well away from the controller.

There will be a 12 position terminal strip included with the antenna, and a single position terminal strip for the ground connections as shown in **Figure 38** (the terminal strips are inside of the included PVC connector housing, with a white plastic cap loosely attached). First, dip each bare wire into the provided blue connector protector pouch. Connect each wire of the 4 conductor cable to it’s respective location on the 12 position terminal strip (**Drawing 1** and **Figure 39**). You will need to repeat this on the opposite side of the terminal strip for the 12 conductor cable as well. Each cable (all 3 of the four conductor cables and the 12 conductor cable) will have a bare silver wire, which is the ground. You will need to connect all three of these to the single terminal strip (**Figure 39, Drawing 1A**).

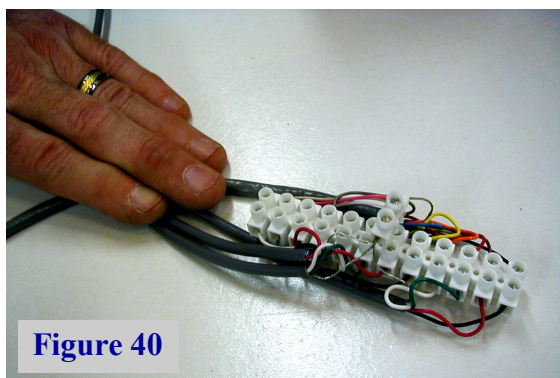




Warning: Look carefully at the order of the elements on the terminal block. They are not intuitively laid out as they appear on the boom. (we did it to make the '2 Element' wires consecutive)



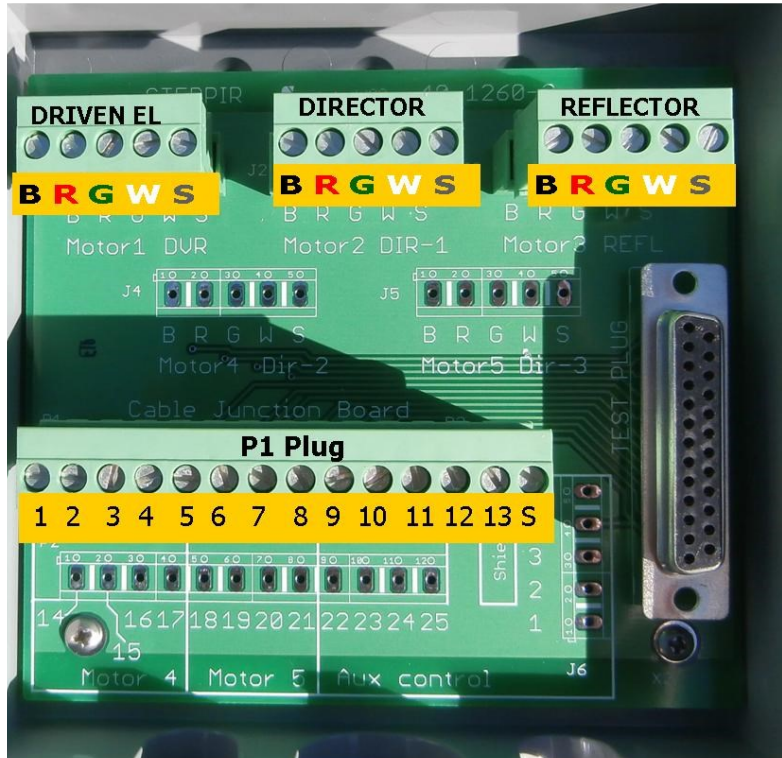
When the connections have been secured, you will want to position the cables so that they are parallel with the 12 position terminal strip (**Figure 40**). The 12 conductor cable will be at one side, and the 3 four conductor cables will be at the other. Slide the cables and terminal strips into the provided plastic enclosure (**Figure 41**), position the cutout in the threaded cap over the cables and screw the enclosure onto the cap.



OPTIONAL CONNECTOR JUNCTION BOX WIRING LAYOUT*

*This drawing is here for your convenience—refer to the actual accessory Connector Junction Box instructions for more detail.

FIGURE 42



4 wire control cable key

B	R	G	W	S
BLACK	RED	GREEN	WHITE	SHIELD

12 WIRE CONTROL CABLE

P1 PLUG (LOCATED INSIDE CONNECTOR BOX)

BLACK	→	⊗ 1
BROWN	→	⊗ 2
RED	→	⊗ 3
ORANGE	→	⊗ 4
YELLOW	→	⊗ 5
GREEN	→	⊗ 6
BLUE	→	⊗ 7
VIOLET	→	⊗ 8
GREY	→	⊗ 9
WHITE	→	⊗ 10
PINK	→	⊗ 11
CRÈME	→	⊗ 12
NOT USED	→	⊗ 13
SHIELD	→	⊗ 14

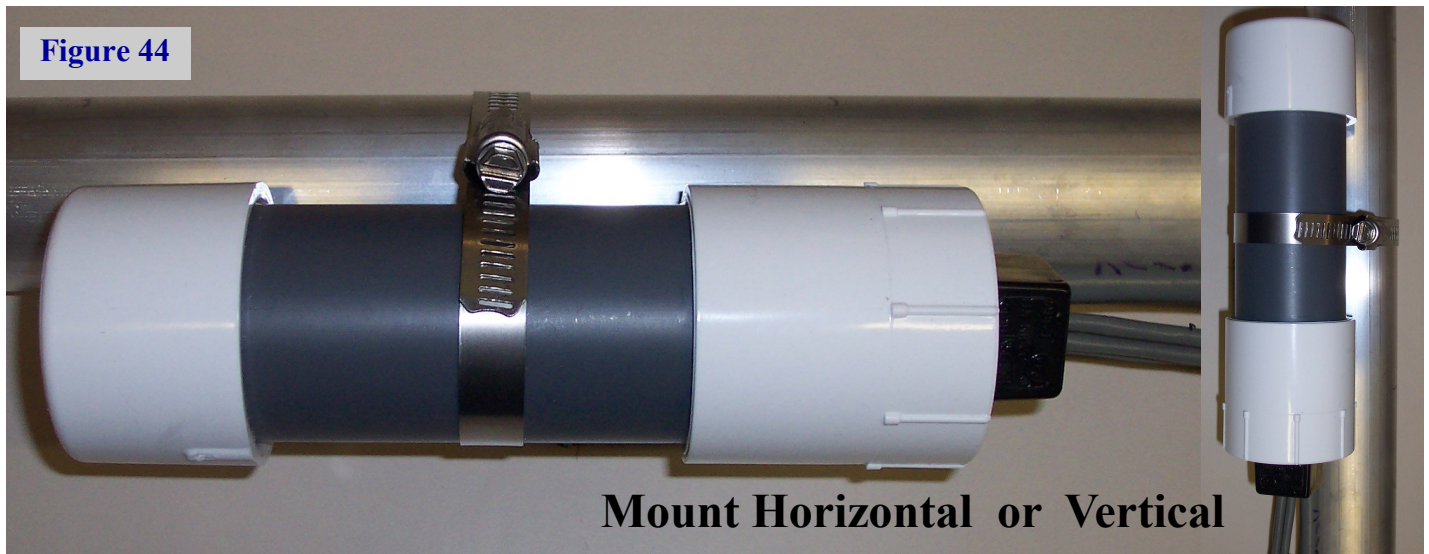
FIGURE 43

Attach the wiring enclosure and control cable to the boom or mast

Position the plastic enclosure in a convenient position **on the boom or mast** making sure that the cut out in the cap is facing downward (**Figure 44**). We do not seal the enclosure so that in the event there is water accumulation inside the enclosure from condensation, it will be able to escape. Fasten the enclosure to the boom using the screw clamp, taking care to not trap the cables in between. Tape the cables to the boom as shown in. The terminal housing mounting location is not critical. It can be mounted out on the boom or even vertical on the mast what ever works best for your installation.

Note: Be careful **NOT** to tape the cables over a sharp edge unless you provide extra protection to prevent eventually cutting through the sheath and shorting the wires.

Figure 44



Warning: We strongly recommend that you perform the “Test Motor” procedure at this point to verify the wiring is correct and the elements are in the right location. If you are not going to connect the control cable and test it on the ground make sure you have the element control cables positively identified and well marked. If you get the elements mixed up on the terminal block you will get very confusing results such as, high SWR, low performance, etc. Mark the cables coming from each element box with colored electrical tape or a felt pen. Mark them before you tape them along the boom, it is very easy to get two parallel wires mixed up. Now when you are on the tower it will be easy to identify each element control cable positively.

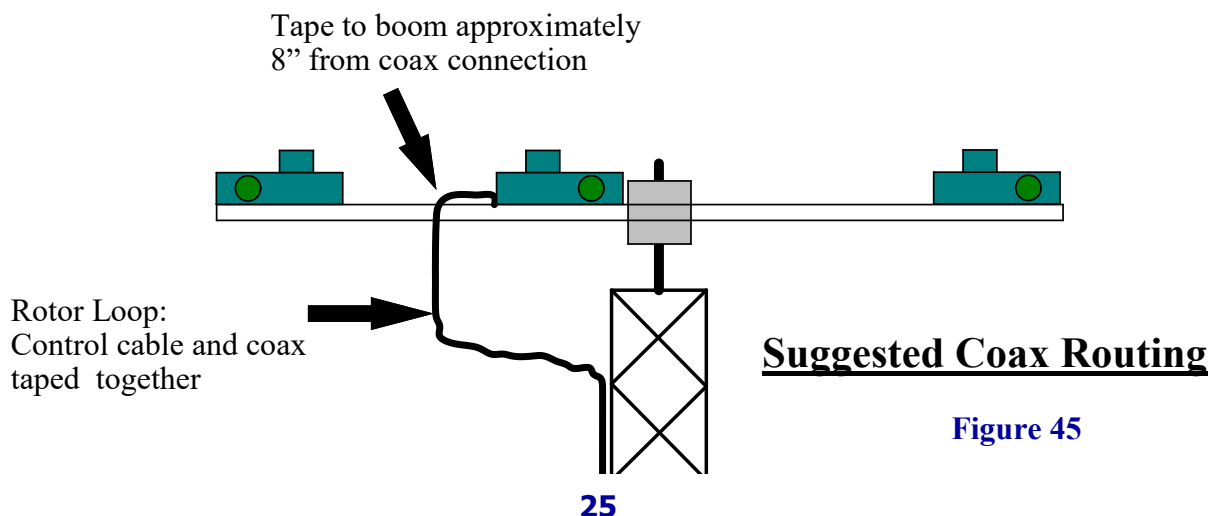


Figure 45

Prepare the Fiberglass Element Support Tubes (standard poles)

Note: If you have ordered the optional **40m - 30m Dipole Kit** you need to refer to the section on preparing the poles (ESTs) in that specific manual. The 4 **special** poles for this option have some differences from the standard poles.

Locate:

- Dark green fiberglass telescoping poles (**Figure 37**) *
- Six black rubber boots with clamps
- Your tape measure



The green fiberglass telescoping poles are all assembled in the same manner and, when extended, keep the copper -beryllium tape safe from the weather. The copper-beryllium tape is shipped retracted inside their respective element housing units (EHUs).

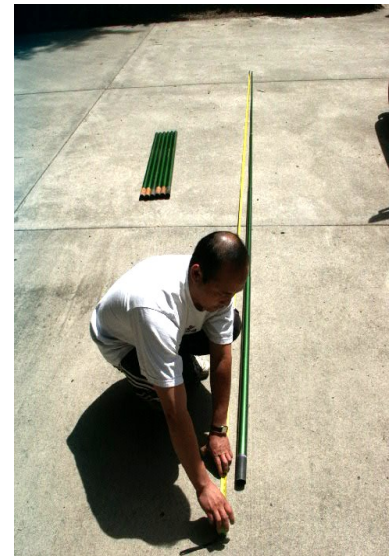
Repeat the Following Procedure for each Fiberglass Telescoping Pole

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 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**

Pole lengths may vary but, when fully extended, each pole must be at least **17 feet 8 inches** in length as measured from the butt end of the pole to the tip (**Figure 37**).

If a pole comes up a little short (1/2” to 1”) try collapsing the pole and starting over, this time aggressively “jerk” each section out instead of twisting. The pole cannot be damaged and you may gain a minimum of 1/2” or more. If you have trouble collapsing the pole try carefully striking one end on a piece of wood or other similar surface placed on the ground.

Figure 37



17' 8" min

Heat shrink tube instruction

On all elements we now include double wall polyolefin heat shrink, PN 10-1059-01. 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.

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.

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.



ATTACH FOAM PLUG HOUSINGS TO TELESCOPING POLES

Each 20m-6m telescoping pole tip requires a breathable foam plug to allow for venting of the EHU. The foam plug assembly (PN 70-1007-01) consists of a special UV resistant foam plug material, and a plastic housing as shown in [figure 6.30](#).

The foam plug is installed inside the plastic housing at the factory.

The fit of the plastic housing on the pole tip is purposely very tight, so that the foam plug assembly will stay in place. Before attaching the plastic housing, spread a small amount of dish soap around the inside edge of the plastic housing as shown in [figure 6.31](#). This helps the housing slide on easily, and the soap will eventually evaporate, leaving you with a firm interference fit.

Insert the plastic housing onto the telescoping pole tip as shown in [figure 6.32](#). Be sure that the plastic housing bottoms out on the pole tip, as shown in [figure 6.33](#).

Repeat for the other telescoping pole tip.

FIG. 50



FIG. 51



FIG. 52

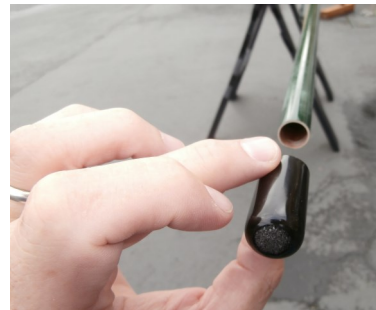


FIG. 53



Attach the Fiberglass Element Support Tubes to the Element Housing Units

The butt ends of the green fiberglass poles may vary slightly in outside diameter. Some of them may have been sanded, while others were not. The colors at the ends will be either natural, or black. The difference in colors has no effect on performance. Do not be concerned if they vary slightly in tightness when being installed on the EHUs. This is normal. All poles are tested at the factory prior to shipping, however in the event the pole just won't fit sanding it is okay.

The EHTs on the EHUs have aluminum reinforcing rings attached to provide extra strength in high wind conditions (**Figure 23**).

Locate the six rubber boots and repeat the following procedure for each of the six fiberglass poles.

- Place the narrow end of a rubber boot onto the butt end of an EST. Slide it about 6" out onto the EST (**Figure 24**).

Figure 54



Figure 55



Figure 56



Figure 57



- Insert the butt end of that EST into one of the EHTs on an EHU, as shown in **Figure 25**. **It is very important to ensure that the butt end of the EST firmly bottoms out inside the EHT. Make sure the EST is seated all the way into the EHT. Then push the rubber boot firmly onto the EHT until the hose clamp is past the aluminum ring and will clamp down onto the fiberglass EST.** The correct mounting position of the rubber boot is shown in **Figure 26**. Note that current production antennas now have a narrower aluminum ring (.4"). **It is imperative that the stainless steel hose clamp be located so that the clamp on the outside of the rubber boot on the EHU side of the connection is completely PAST the aluminum reinforcing ring. This ensures that the hose clamp can grip onto the fiberglass and the ring will prevent the rubber boot from ever coming off.**
- Firmly tighten both stainless steel hose clamps, one over the EHT and the other over the EST. 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.

Optional 6 Meter Passive Element

The 6 meter passive element comes in 3 pieces. The main body with a 1/2" x 58" element section attached to it, and two 3/8" element sections (**Figure 27**). The overall length of the element is approximately 112" for the 3 element and 114" for the 2 element when assembled.

The required fasteners will already be attached to each end of the 1/2" element section - remove this hardware, and slide in the short ends of the 3/8" tubing (the end that has the least amount of distance from the edge of the tubing to the drilled hole). Use a small amount of the included Teflon® connector or protector solution when connecting the two sections of tubing. Fasten securely. The six meter aluminum element mounts between the driven element and the director (the elements that are approximately 89" apart). The center of the 6m element should be 31" from the center of the driven element (see **Drawing 2A**). Fasten securely to the boom using the 304 SS U-bolt, saddle and hardware. Make certain that you have the 6 meter passive element level with the others.

When you are using the 6 meter band, keep the antenna in the forward direction and rotate accordingly. Optimum performance will be from 50.000 MHz to 50.500 MHz. The 180 degree mode is exactly the same as the forward mode since we have no choice when the aluminum passives are used, however, the Bi-Directional works to the same degree by directly reducing the front to back ratio.



Figure 58

SteppIR Performance

SteppIR antennas are developed by first modeling the antenna using YO-PRO and EZ-NEC. We created antennas that had maximum gain and front to rear without regard for bandwidth.

The antennas that reside in our controllers memory are all optimized for gain and front to rear with a radiation resistance of approximately 22 ohms (16 ohms to 30 ohms is considered ideal for real world Yagi's. The modeling also takes into account the changing electrical boom length as frequency changes. When the 180 degree function is enabled, a new Yagi is created that takes into account the change in element spacing and spacing and in the case of 4 element antennas creating a two reflector antenna to get maximum use of all elements. The result is slightly different gain and front to rear specifications.

We then go to the antenna range and correlate the modeled antenna to the real world. In other words, we determine as closely as possible the electrical length of the elements. We are very close to the modeled antennas, but it is virtually impossible to get closer than a few tenths of a dB on gain and several dB on front to rear.

There are three factors that make our antennas outstanding performers:

1. They are tuned to a specific frequency for maximum gain and front to rear – without the compromise in performance that tuning for bandwidth causes.
2. They are very efficient antennas with high conductivity conductors, a highly efficient matching system (99% plus) and low dielectric losses.
3. There are no inactive elements, traps or linear loading to reduce antenna performance.

Fixed Element Spacing and the SteppIR Yagi

First of all, there really is no "ideal" boom length for a Yagi. To get maximum gain the boom of a three element beam should be right around .4 wavelengths long. This would allow a free space gain of 9.7 dBi, however the front to back ratio is compromised to around 11 dB. If the boom is made shorter, say .25 wavelengths, the front to back can be as high as 25 dB, but now the maximum gain is about 8.0 dBi. Shorter booms also limit the bandwidth, which is why right around .3 wavelengths is considered the best compromise for gain, front to back and bandwidth for a fixed element length yagi. It turns out that being able to tune the elements far outweighs being able to choose boom length. We chose 16 feet for our three element boom length which equates to .23 wavelength on 20 meters and .46 wavelength on 10 meters, because very good Yagi's can be made in that range of boom length if you can adjust the element lengths. This compromise works out very well because 10m is a large band and F/B isn't as important so you get excellent gain with still very acceptable F/B. When bandwidth is of no concern to you (as it is with our antenna), you can construct a Yagi that is the very best compromise on that band and then track that performance over the entire band. It is this ability to move the performance peak that makes the SteppIR actually outperform a mono-bander over an entire band – even when the boom length isn't what is classically considered "ideal". Bear in mind that a Yagi rarely has maximum gain and maximum front to back at the same time, so it is always a compromise between gain and front to back. This is the same philosophy we use on all of our yagi antennas to give you the most performance available for a given boom length. With an adjustable antenna you can choose which parameter is important to you in a given situation. For example, you might want to have a pile-up buster saved in memory, that gets you that extra .5 – 1.0 dB of gain at the expense of front to back and SWR – when you are going after that rare DX!

RF Power Transmission with the SteppIR Yagi

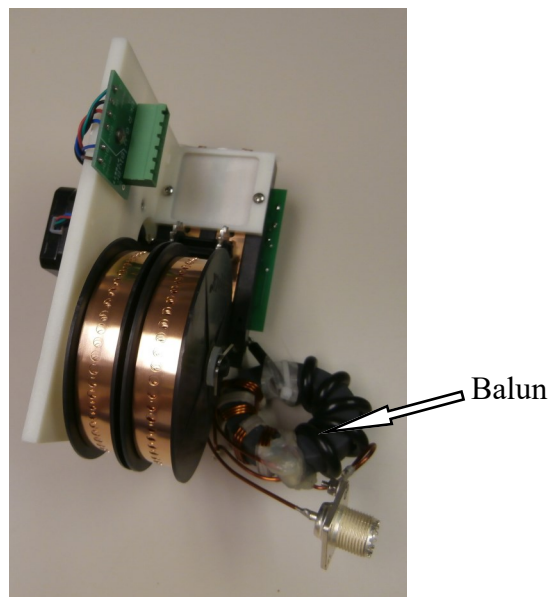
The RF power is transferred by brushes that have 4 contact points on each element that results in a very low impedance connection that is kept clean by the inherent wiping action. The brush contact is .08 in thick and has proven to last over 2 million band changes. The copper beryllium tape is .545 inches wide and presents a very low RF impedance. The type of balun we are using can handle tremendous amounts of power for their size because there is almost no flux in the core and they are 99% efficient. That coupled with the fact that our antenna is always at a very low VSWR means the balun will handle much more than the 3000 watt rating, how much more we don't know. Jerry Sevicks book "Transmission Transformers" (available from ARRL) has a chapter (Chap. 11) that discusses the power handling ability of ferrite core transformers.

WARNING: WHEN OPERATING WITH MORE THAN 200 WATTS, DO NOT TRANSMIT WHILE THE ANTENNA IS CHANGING BANDS. A MISMATCH AT ELEVATED WATTAGES MAY CAUSE DAMAGE TO THE DRIVEN ELEMENT.

Balun / Matching System

The SteppIR has a matching system that is included in the 2 element, 3 element, 4 element and MonstIR Yagi (a balun is available as an option on the dipole). Our antenna designs are all close to 22 ohms at all frequencies, so we needed a broadband matching system that would transform 22 ohm to 50 ohm. We found an excellent one designed by Jerry Sevick, that is described in his book "Building and Using Baluns and Ununs".

Our matching network is a transmission line transformer that is wound on a 2.25 inch OD ferrite core that operates with very little internal flux, thus allowing it to function at very high power levels. The transformer includes a 22 ohm to 50 ohm unun and a balun wound with custom made, high power, 25 ohm coax for superior balun operation. Jerry has espoused these transformers for years as an overlooked but excellent way to match a Yagi, he would probably be proud to know they are being used in a commercial Yagi. This matching network does not require compressing or stretching a coil, or separating wires to get a good match – something that can easily be bumped out of adjustment by birds or installation crews.



Yagi Gain / Front to Back Modeling

SteppIR antenna designs are all close to 22 ohms at all frequencies, so we needed a broadband matching system. We found an excellent one designed by Jerry Sevick, that is described in his book “Building and Using Baluns and Ununs”.

Our matching network is a transmission line transformer that is wound on a 2.25 inch OD ferrite core that operates with very little internal flux, thus allowing it to function at very high power levels. The transformer includes a 22 ohm to 50 ohm unun and a balun. Jerry has espoused these transformers for years as an overlooked but excellent way to match a Yagi, he would probably be proud to know they are being used in a commercial Yagi. This matching network does not require compressing or stretching a coil, or separating wires to get a good match – something that can easily be bumped out of adjustment by birds or installation crews.

When we claim our Yagi outperforms much larger arrays we are referring to multi-band Yagi’s that interlace elements on a long boom and don’t use the entire band boom for each band, and additionally have degraded performance due to element interaction. There are many antennas out in the world that are not getting the maximum theoretical gain from their boom! Because we have tunable elements and a very efficient antenna, we are getting close to the maximum gain from our boom. Traps, linear loading and interlaced elements all contribute to this degradation.

Stacking Two Antennas

Since SteppIR™ antennas are super-tuned mono-banders they stack very well because there are no destructive interactions going on. A good distance is anywhere from 32’ to 64’, the best being closer to the 32’ value. You can also stack them with other non-SteppIR™ antennas and get some reasonably good results. You must ensure that the “hot” side (center conductor) of the driven elements of all the antennas in the stack are on the same side or you will get attenuation instead of gain (see **Figure 23**). If you want a good demonstration of this phenomenon turn one SteppIR™ 180 degrees to the other in physical direction and run one antenna in the 180 degree reverse mode. You will be amazed at how much it kills the performance. Stacking them as described will result in excellent performance over the entire frequency range (except 6M) because stacking distances aren’t that critical, just don’t put them too close.

Fixed Element Spacing and the SteppIR Yagi

First of all, there really is no "ideal" boom length for a Yagi. To get maximum gain the boom of a 3 element beam should be right around .4 wavelengths long. This would allow a free space gain of 9.7 dBi, however the front to back ratio is compromised to around 20 dB. If the boom is made shorter, say .25 wavelengths, the front to back can be as high as 35 dB, but now the maximum gain is about 8.6 dBi. Shorter booms also limit the bandwidth, which is why right around .3 wavelengths is considered the best compromise for gain, front to back and bandwidth. It turns out that being able to tune the elements far outweighs being able to choose boom length. We chose 16 feet for our boom length which equates to .23 wavelength on 20 meters and .46 wavelength on 10 meters, because very good Yagi's can be made in that range of boom length if you can adjust the element lengths. When bandwidth is of no concern to you (as it is with our antenna), you can construct a Yagi that is the very best compromise on that band and then track that performance over the entire band. It is this ability to move the performance peak that makes the SteppIR actually outperform a mono-bander over an entire band – even when the boom length isn't what is classically considered "ideal". Bear in mind that a Yagi rarely has maximum gain and maximum front to back at the same time, so it is always a compromise between gain and front to back. With an adjustable antenna you can choose which parameter is important to you in a given situation. For example, you might want to have a pile-up buster saved in memory, that gets you that extra .5 – 1.0 dB of gain at the expense of front to back and SWR – when you are going after that rare DX!

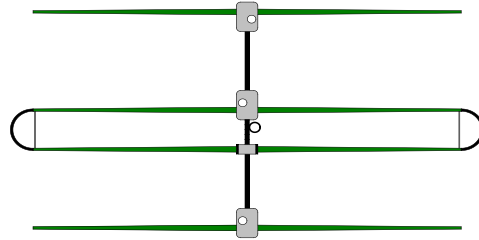
RF Power Transmission with the SteppIR Yagi

The RF power is transferred by brushes that have 4 contact points on each element that results in a very low impedance connection that is kept clean by the inherent wiping action. The brush contact is .08 in thick and has proven to last over 2 million band changes. The copper beryllium tape is .545 inches wide and presents a very low RF impedance that results in conductor losses of -.17 dB with a Yagi tuned to have a radiation resistance of 15 ohms, which is about as low as most practical Yagis run. The type of balun we are using can handle tremendous amounts of power for their size because the is almost no flux in the core and they are 99% efficient. That coupled with the fact that our antenna is always at a very low VSWR means the balun will handle much more than the 2000 watt rating, how much more we don't know. Jerry Sevicks book "Transmission Transformers" (available from ARRL) has a chapter (Chap. 11) that discusses the power handling ability of ferrite core transformers.

Warning: When operating with more than 200 watts, do not transmit while the antenna is changing bands. A mismatch at elevated wattages may cause damage to the driven element.

OPTIONS FOR YOUR 3E YAGI

- 40m - 30m Dipole (loop)



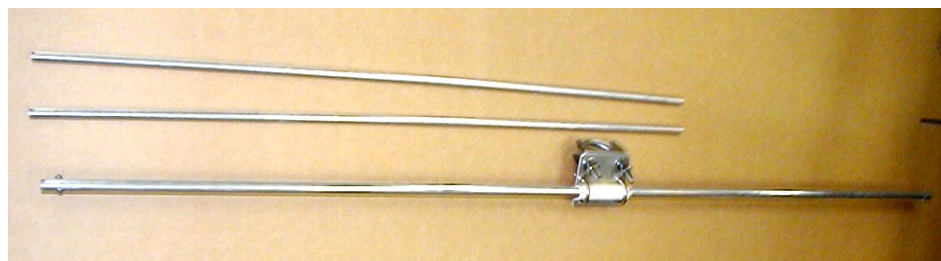
- “Y” Cable



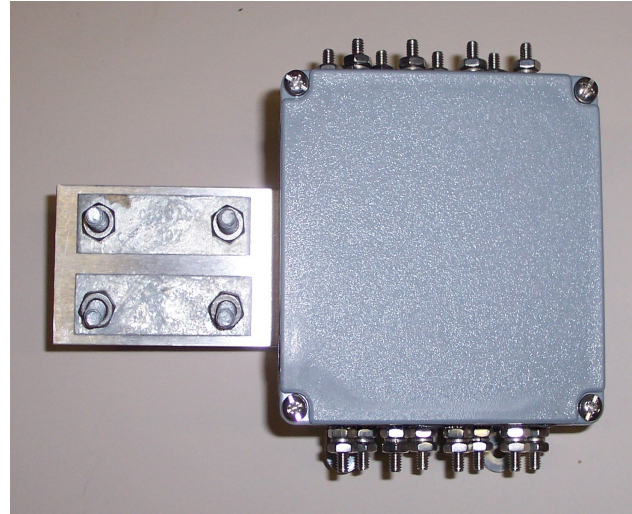
- Transceiver Interface (Rig Specific)



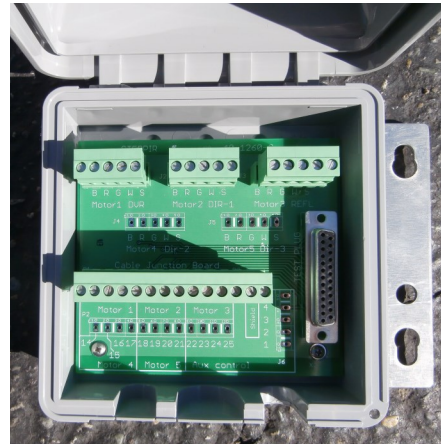
- 6m Passive Element Kit



- **Voltage Suppressor & RF Bypass Unit** (16 Conductor)



* **Connector Junction Box**



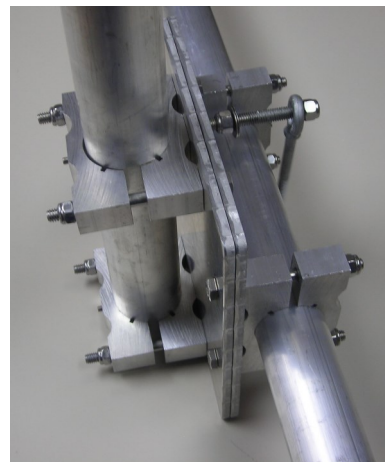
***High Wind Kit (2E and 3E)**

- **Element Expansion Kit**
2 Element

Dipole to

2 Element to 3 Element

3 Element to 4 Element





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.

