# 2 Element Yagi Instruction Manual


**Manual REV 3.1 March 2020**

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# Table of Contents

## 2 Element Yagi COMPONENT CHECK

SteppIR ™

| | Qty | |
|---|---|---|
| | 1 | **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. |
| | 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. |
| | 1 | **10-1021-04** Mast Plate 8” (**NOT** included if High Wind kit purchased.) |
| | 1 | 15' - 4 Conductor cable w/ 16” Coax Seal |
| | 1 | **SDA 100 2E Controller**<br>Interface _______ Remote (USB cable, Cat 5E Cross-over Cable w/ splice connector)______<br>ALP _________ Tuning Relay ___________ |
| | 1 | **Power supply with cord** 24V ______ 33V_______ |
| | 1 | **71-0001** 2 Element Instruction Manual |
| | 1 | **71-0010** SDA Operators Manual |
| | 4 | **60-1006-22** Fernco 1.5” x 1.25” Quick Disconnect Boot |
| | 12 | **10-1059-01** Polyolefin heat shrink 1.5” x 3” |
| | 1 | **72-0009-01** 2E Hardware Kit (**NOT** included if High Wind Kit is purchased.) |
| | 1 | **72-0016-02** 2/3E Connector Pack (**NOT** included if connector box is purchased.) |
| | 4 | **70-1007-01** Foam Plug Assembly |
| | 1 | **10-1028-21** Anti-seize Stick |
| | 1 | **20-6208-01** 25 Pin male connector and **20-6209-01** 25 Pin Back Shell |
| | 4 | **10-1013-02** 18' Telescoping Poles |
| | 1 | **2E Boom**, 2 Sections |
| | 1 | **Option:** **70-6010-01** 25 pin Dsub Splice assembly |
| | 1 | **Option:** **High Wind Kit** |
| | | **Option:** **70-2034** Connector Box for 2, 3E. ________<br>**71-0017** Connector Box Manual ________ |
| | | **Option**: **20-8052-01** Array Solution 12 Pin Surge Suppressor |
| | | Surge Suppressor Instructions |
| | | **Option:** **2E 6m Passive** _________ |
| | | **72-0014-01** 2-3E 6m Passive kit _______ |
| | | **Option:** **S Cable** ____________ |

# Assembly Kit Materials List

## *2E Hardware Kit*
***72-0009-01***

| QTY | PART NUMBER | DESCRIPTION |
|---|---|---|
| 2 | 60-0003 | 1-3/4″ U-BOLT & SADDLE |
| 2 | 60-0004-21 | 2″ LONG U-BOLT & SADDLE |
| 1 | 60-0062 | 2-3/4″ x 1/4″ BOLT |
| 1 | 60-0030 | 1/4″ NYLOK NUT |
| 8 | 60-0046 | 5/16″ NYLOK NUT |
| 5 | 60-0041 | 1/4″ WASHER |
| 1 | 09-0001 | ELECTRICAL TAPE |

## *2E 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 |

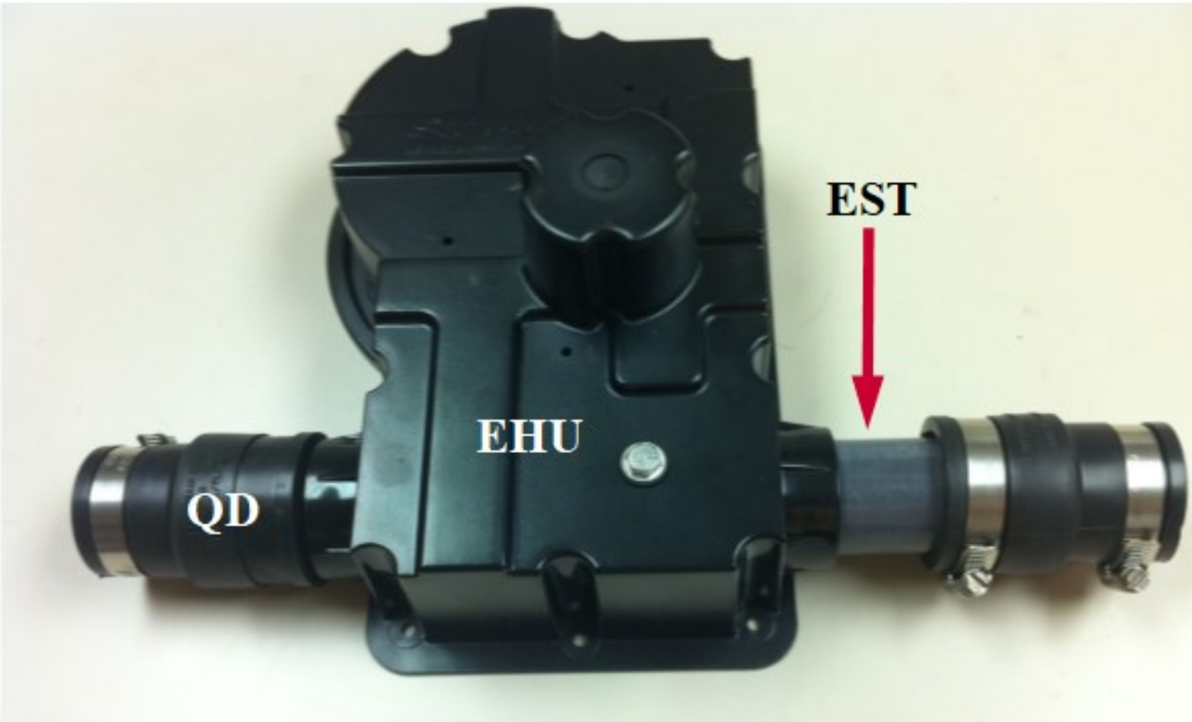
## *EHU Lid Hardware Kit*
**72-0054-01**

*Note: There are two sets of this kit for the 2 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, 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

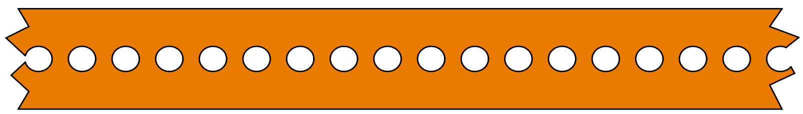
***Michael (Mike) Mertel - K7IR***
***President***

# 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.

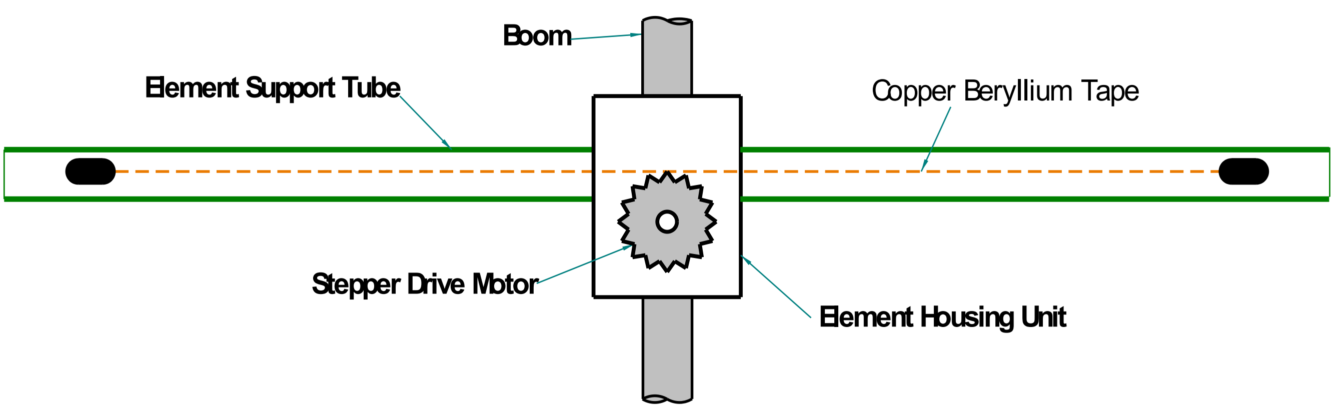


**Copper-Beryllium Tape**

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).



# 2 Element Yagi Installation

The 2 element SteppIR Yagi boom consists of two sections of aluminum tubing that are 57 inches long x 1-3/4" OD x 1/8" wall, along with two aluminum antenna housing brackets as shown in **Figure 1**. The element housing brackets are pre-installed at the factory. To assemble your antenna, you will need a 1/2" (13 mm) and 7/16" (11 mm) 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. 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.

Connect the boom by sliding the two sections together and align the pre-drilled holes (**Figure 2 and 3**). Refer to **Figure 5** 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 excessively, as this can cause binding - the WD-40 will help keep the two pieces lubricated.

**Note:** The boom bolts need to have a total of "5" flat washers on each bolt to prevent the nut from bottoming out at the end of the threads before it is tight.

Insert the included bolts into the pre-drilled holes, and tighten the Nylok nut securely (**Figure 4**).

**Note:** If you are not installing the 40m-30m dipole kit you can remove the return bracket if you want to. If you do remove the bracket it is a good idea to mark both the boom and the bracket so that it can be reinstalled correctly later if needed.


Figure 1

Figure 2

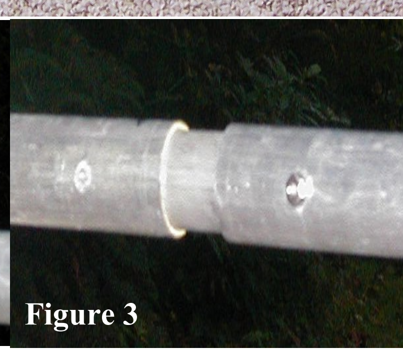


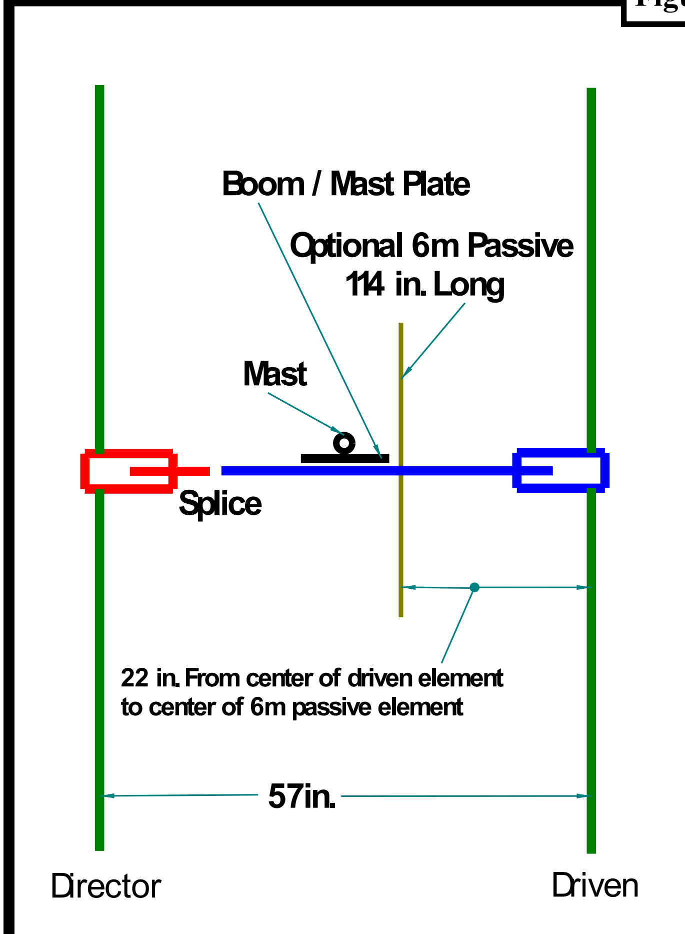
Figure 3

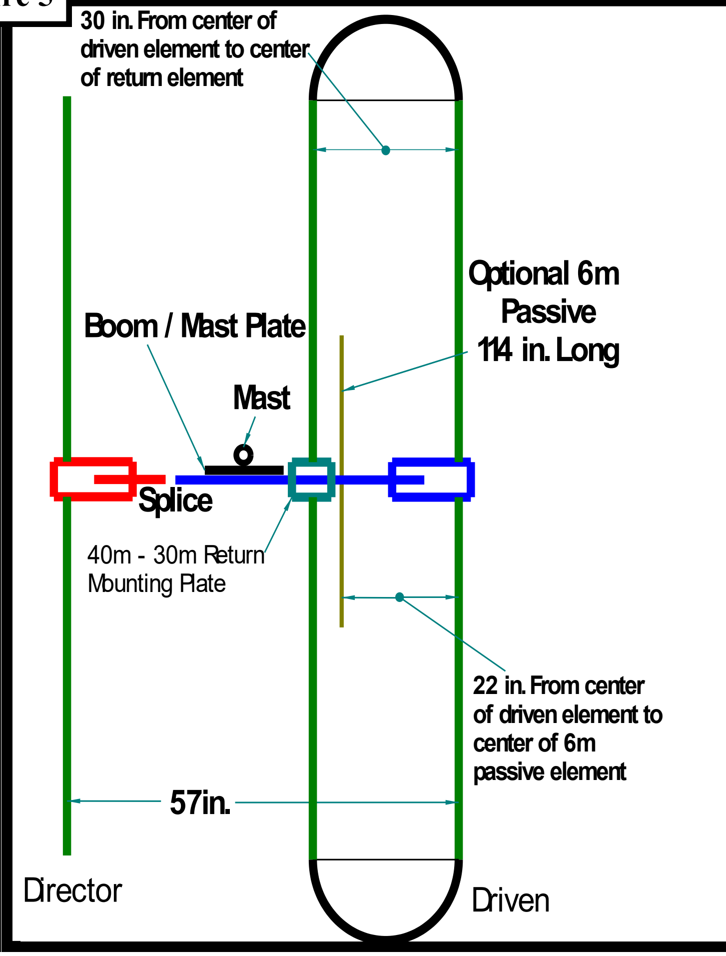
Figure 4

2E Without 40m-30m Dipole Kit (not to scale)

2E With 40m-30m Dipole Kit (not to scale)

Figure 5



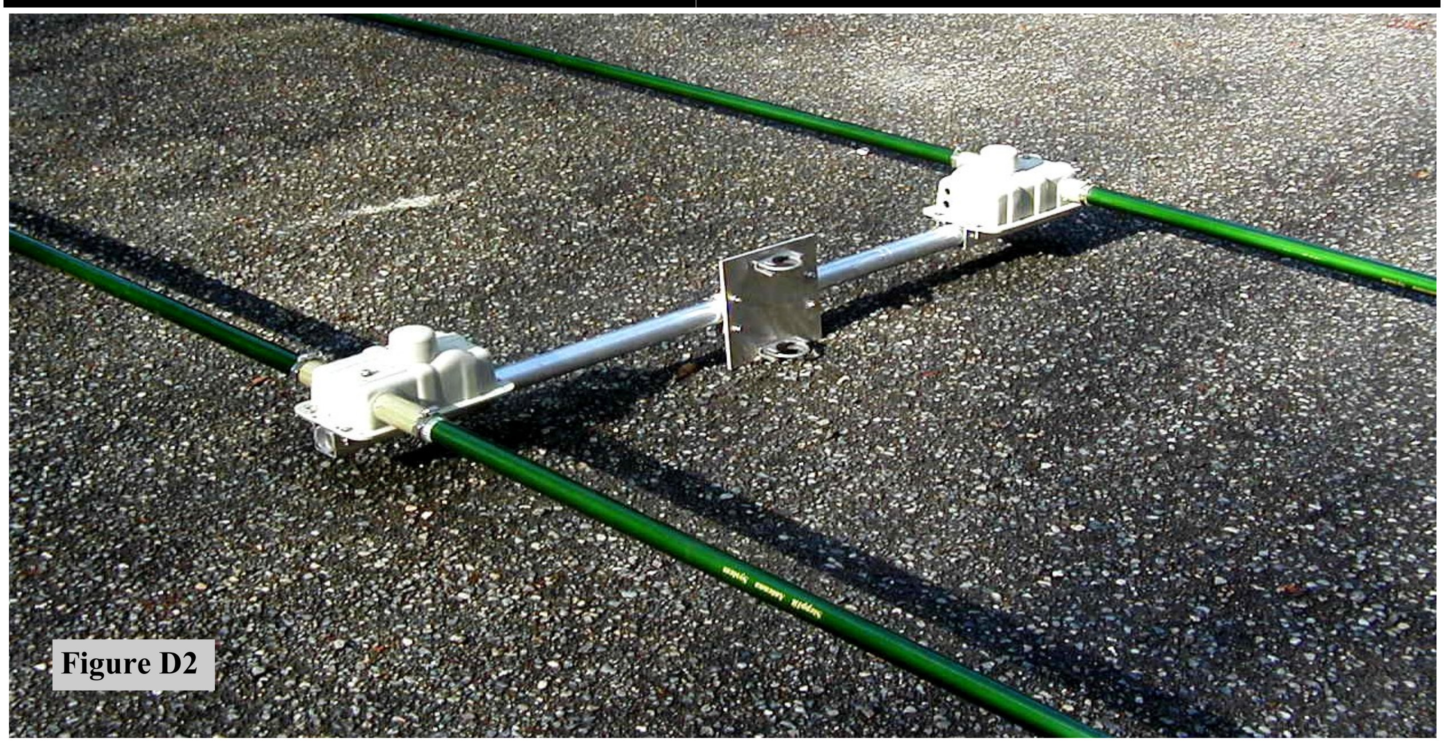



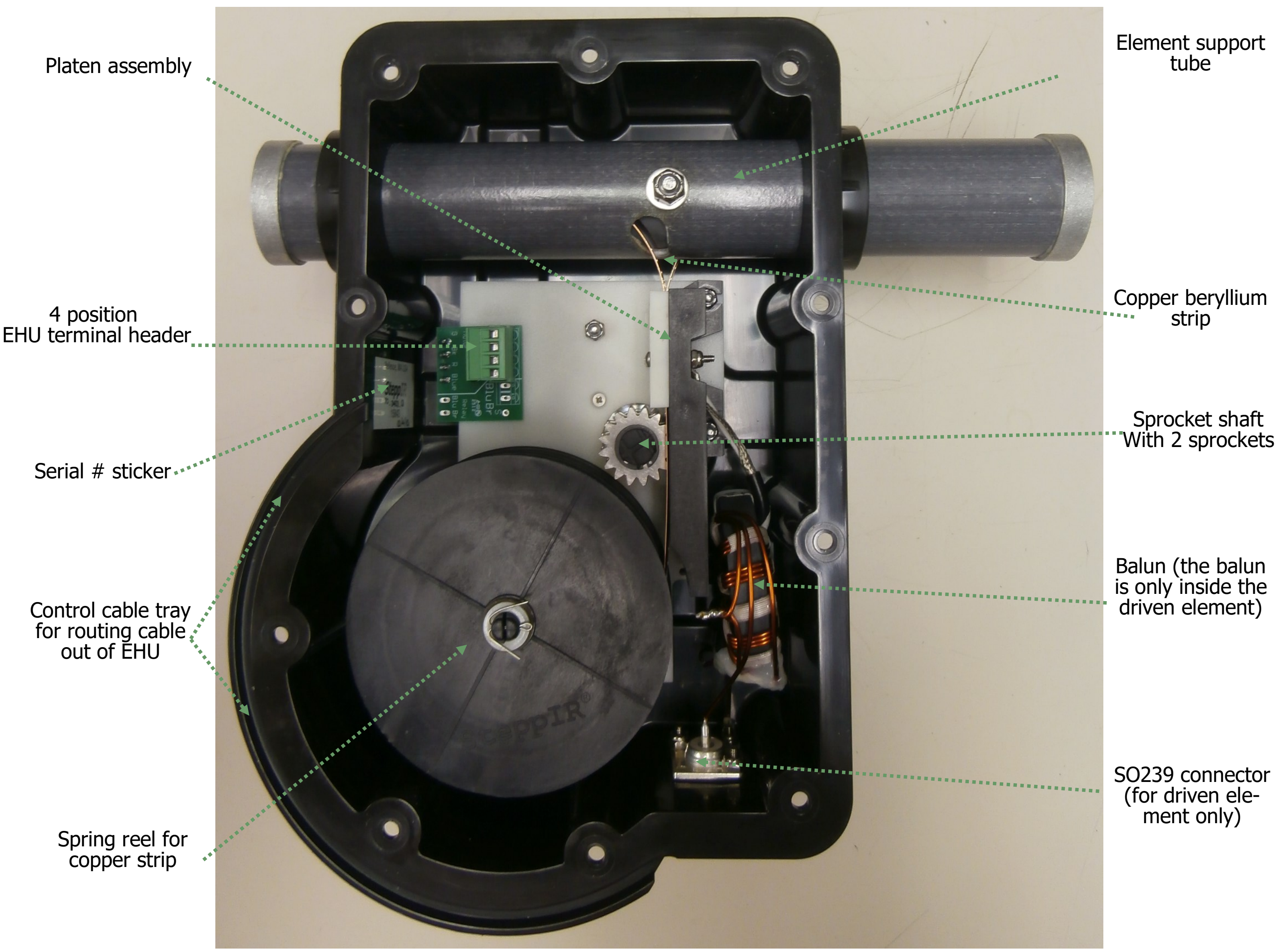
Figure D2

# 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**

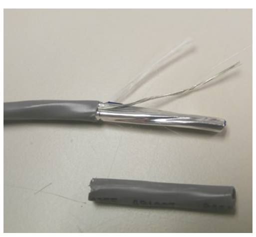


**FIG. 10**

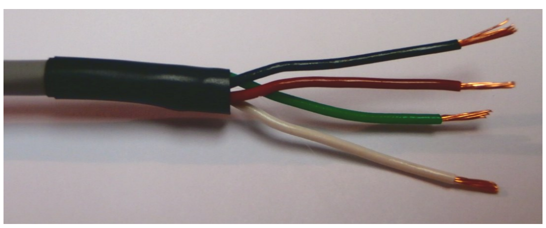
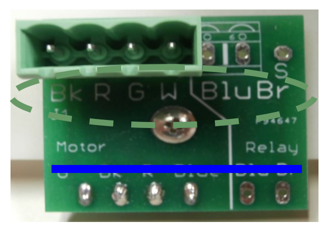


**FIG. 11**

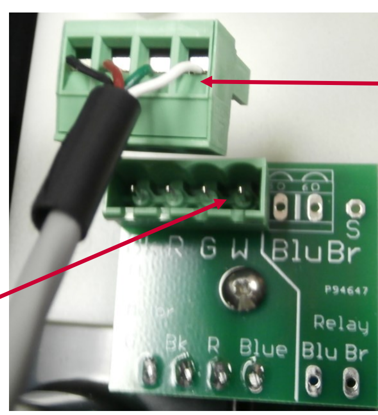

**FIG. 12**




**4 Pin Header Wiring Sequence**

| | | | |
|---|---|---|---|
| BLACK | RED | GREEN | WHITE |

**FIG. 13**




TERMINAL PLUG

TERMINAL HEADER

# 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

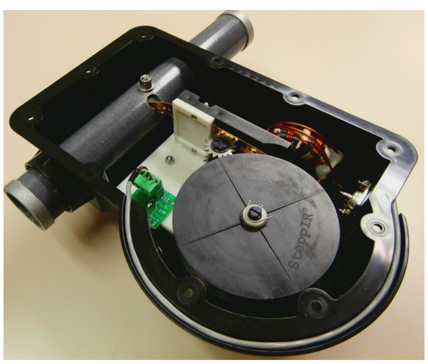


FIG. 15

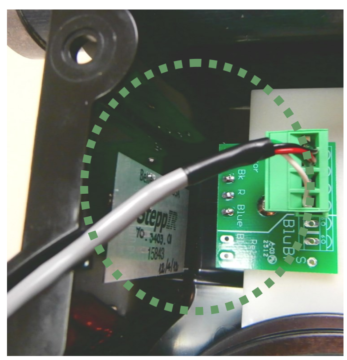


FIG. 16

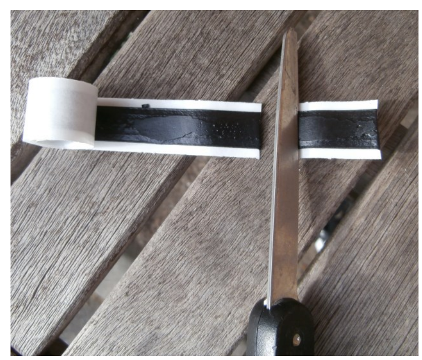


FIG. 17

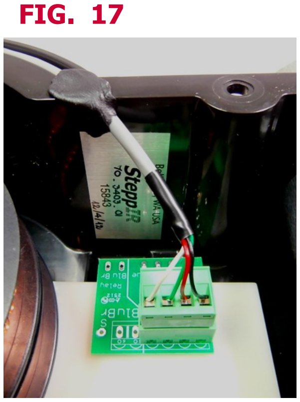
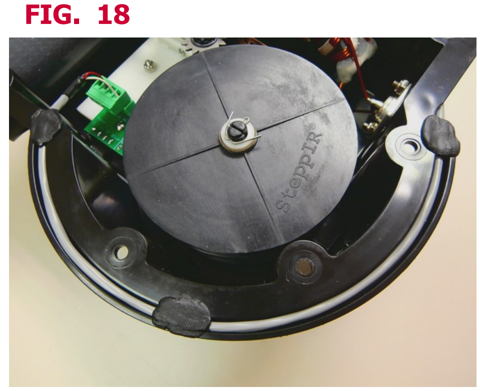


FIG. 18



# DB25 CONTROL CABLE SPLICE INSTALLATION

FIGURE 19

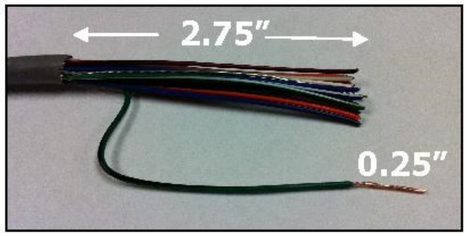



FIGURE 20

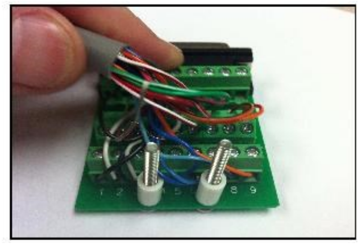


FIGURE 21

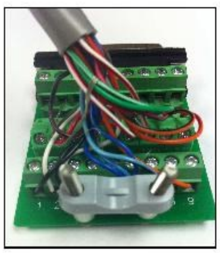


FIGURE 22

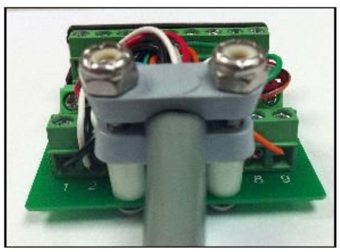


FIGURE 23

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**

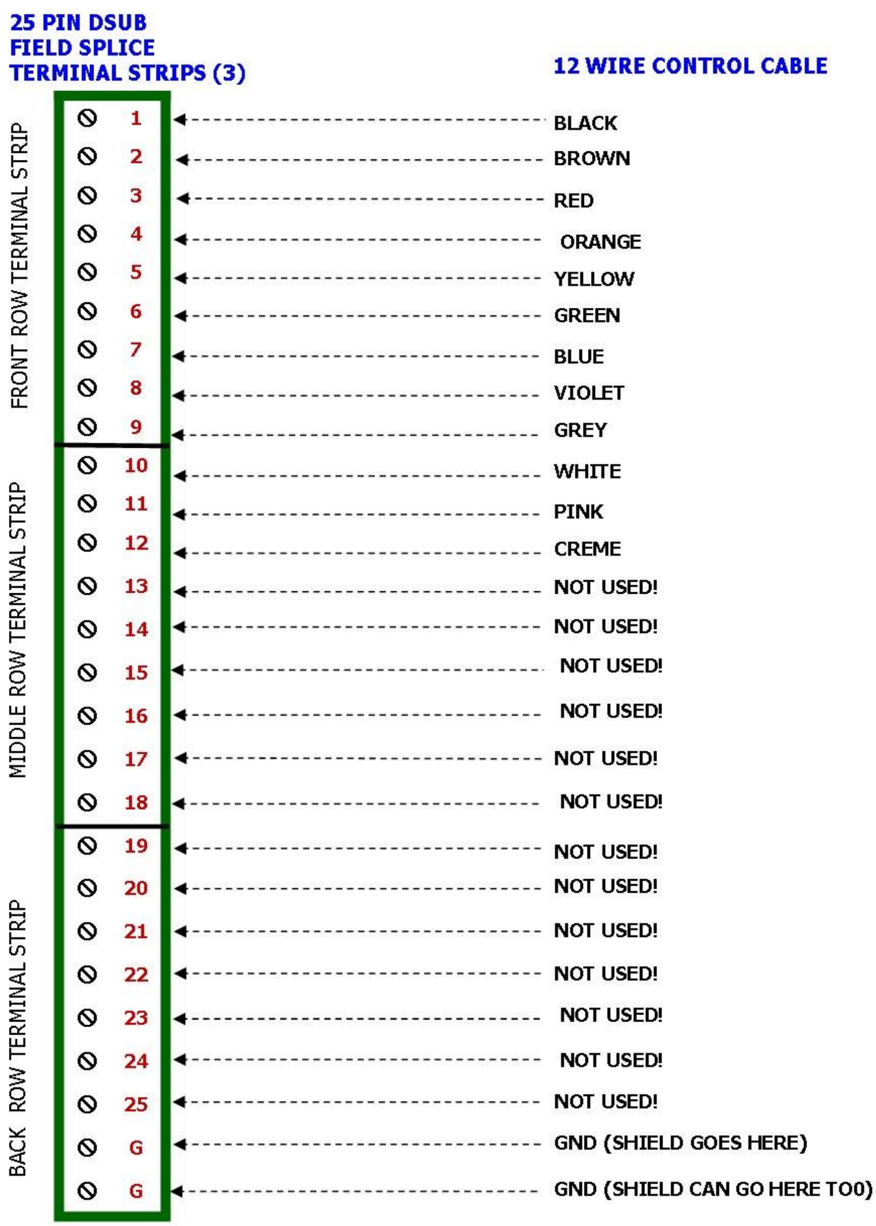



**FIGURE 27**


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 Mast Plate

The mast plate (**Figure 11**) 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.

**Note:  If you are installing a 40m-30m Dipole kit reference the 40m-30m Instruction manual for proper mast plate placement.**

Connect the mast to the mast  plate using the included 2" stainless steel U-Bolts, with saddles, and Nylok  nuts as shown in **Figure 13**.  Tighten securely.

**Note:  If you are going to do this on the tower it is advisable to test each U bolt for a proper fit, Before you go up the tower,  and bend if necessary to ensure ease of assembly when you are on the tower.**

Connect the boom to the mounting plate on the opposite side of the mast ( **Figure 13** and **15**), using the 1-3/4" U-bolts, saddles, and nuts.  Align the boom so that the element brackets are level, then tighten securely.  The antenna balance point is at the center of the boom.  To ensure a balanced weight load, the center of the mast plate should be at the center balance point of the boom.

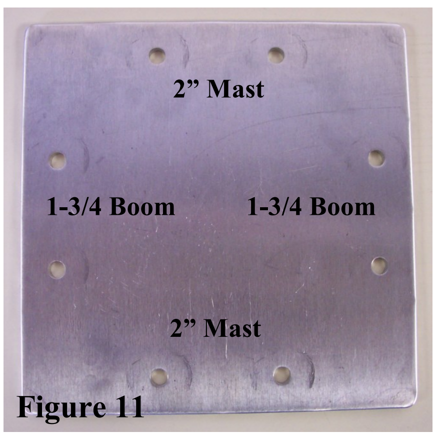


Figure 11

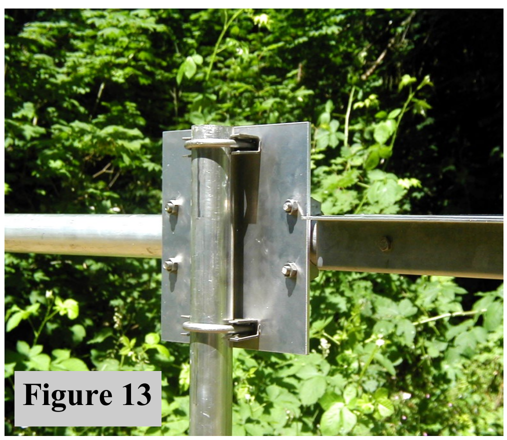


Figure 13

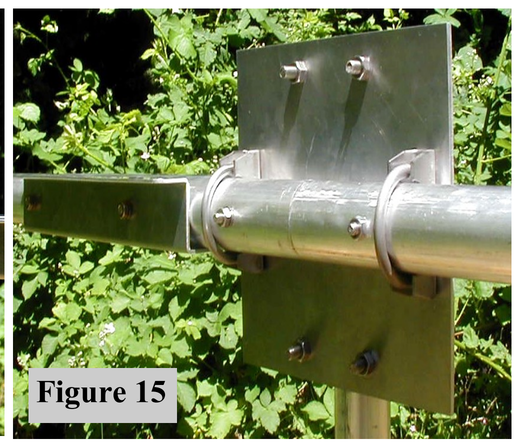


Figure 15

## Determining the Direction of the Antenna

The SteppIR Yagi  has three  "directions" in which it can be used.  Normal, 180 degree and bi-directional.  When the antenna is installed on its mast the passive element should be facing the direction the rotator indicates.

- In the **normal** mode the antenna directs RF energy towards the passive element (the element that does not have the coax attached to it), giving gain in that direction and rejecting signals coming directly at the driven element from the opposite direction.

- In the **180°** mode the gain is now directed from the driven element end and rejected from the passive end.

- In the **Bi-Directional** mode, your antenna is directing RF in both directions.

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 show 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 2** **Lid Assembly**

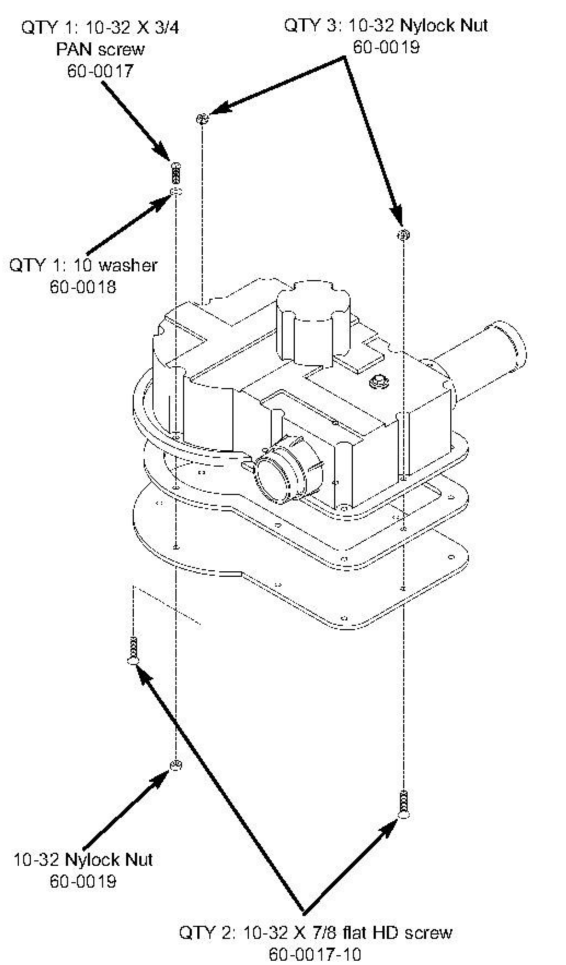
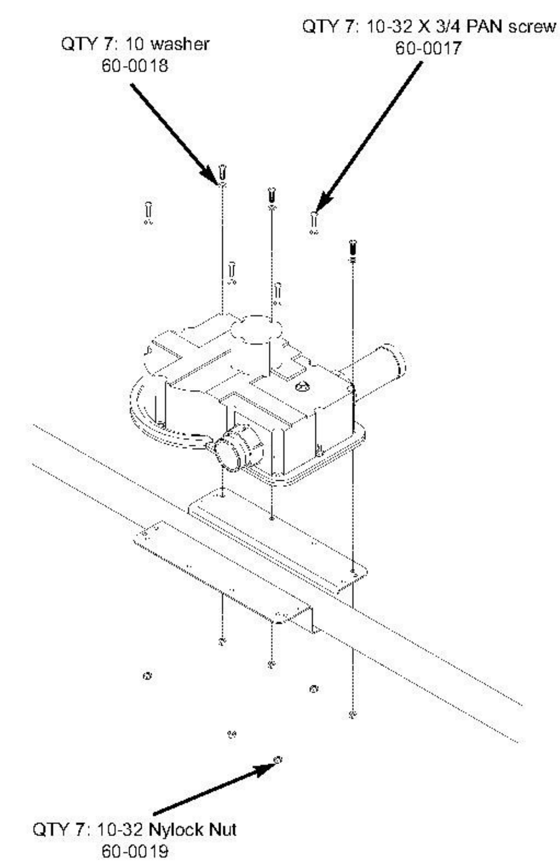



**Figure 3** **EHU Assembly**




**NOTE:**
Orientation of the EHU and the style of the element mounting bracket shown here may not be for your specific antenna model. Follow antenna assembly manual for correct EHU orientation.

## Attach the Element Housing to the Element Bracket

Place the flat side of the element housing unit (EHU) on top of the element to boom brackets (**Figure 17**). The housing without the SO-239 coax connector is the director, the one with the SO-239 connector is the driven element (the balun is on the inside of this housing). The driven and reflector elements should be positioned so the actual fiberglass element are the furthest away from each other (**Figure 9**). Fasten each element housing to the element bracket, using eight 10-32 x 7/8" screws, flat washers, Nylok nuts and tighten. **The flat washer needs to be placed between the screw head and the plastic element housing**.

Warning: Tighten the element housing unit screws securely, but not too tight (if you over-tighten the nut, you may split the plastic flange on the element housing).

The olive green element support tube (EST) on each antenna housing will appear uneven in length - it is actually centered on the inside of the antenna housing .

**Note:** 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.

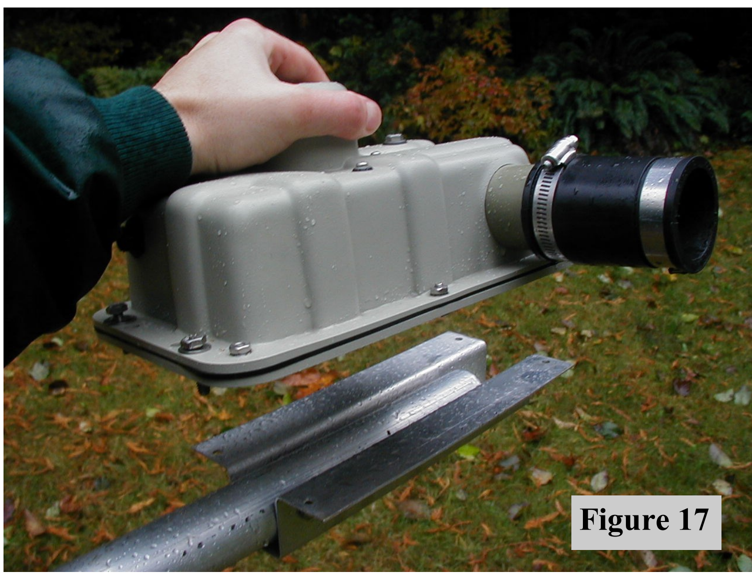


**Figure 17**

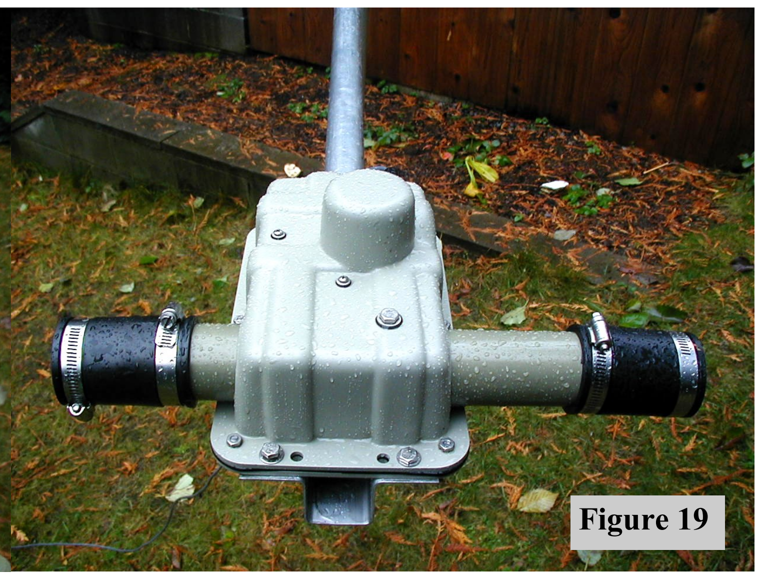


**Figure 19**

## Connect the Wiring and Secure it to the Boom

- **WARNING:** The controller has voltage present on the control cable wires, even when the power button has been pushed to "Off". Unplug the power supply and disconnect the 25-pin D-sub connector before making any connections or cutting or splicing the cable wires. If the controller has power and the control cable wires short out, this will damage the driver chips inside the controller.

Note: If you have more than 200' of control cable you should use the optional 33 VDC power supply. This will then allow any length control cable up to 500' 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 static protection. If you are in a high lightning area take the appropriate precautions. The controller can be damaged by lightning. The surest protection against lightning is to first disconnect the power supply from the controller and then the 25-pin sub-D connector, then move them well away from the controller during a storm.

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 23** and **27**.

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 (**Figure 25** and **Figure 27**). You will need to repeat this on the opposite side of the terminal strip for the 12 conductor cable as well. Each cable (both 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 27**, **Figure 25**).

**WARNING:** While the 2 element Yagi has only 8 wires that are used, it is still extremely important that you hook up the remaining 4 wires. Even though these wires are not used, they still have power being supplied to them, so hooking them to the terminal strip will eliminate the chance of shorting.

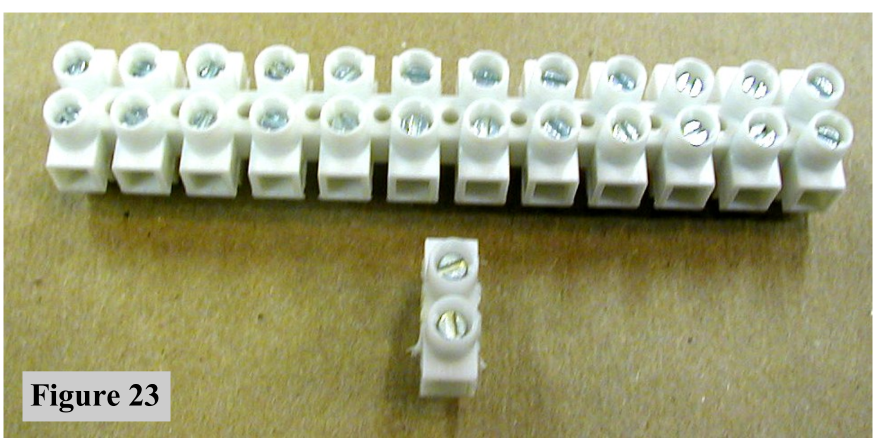


**Figure 23**

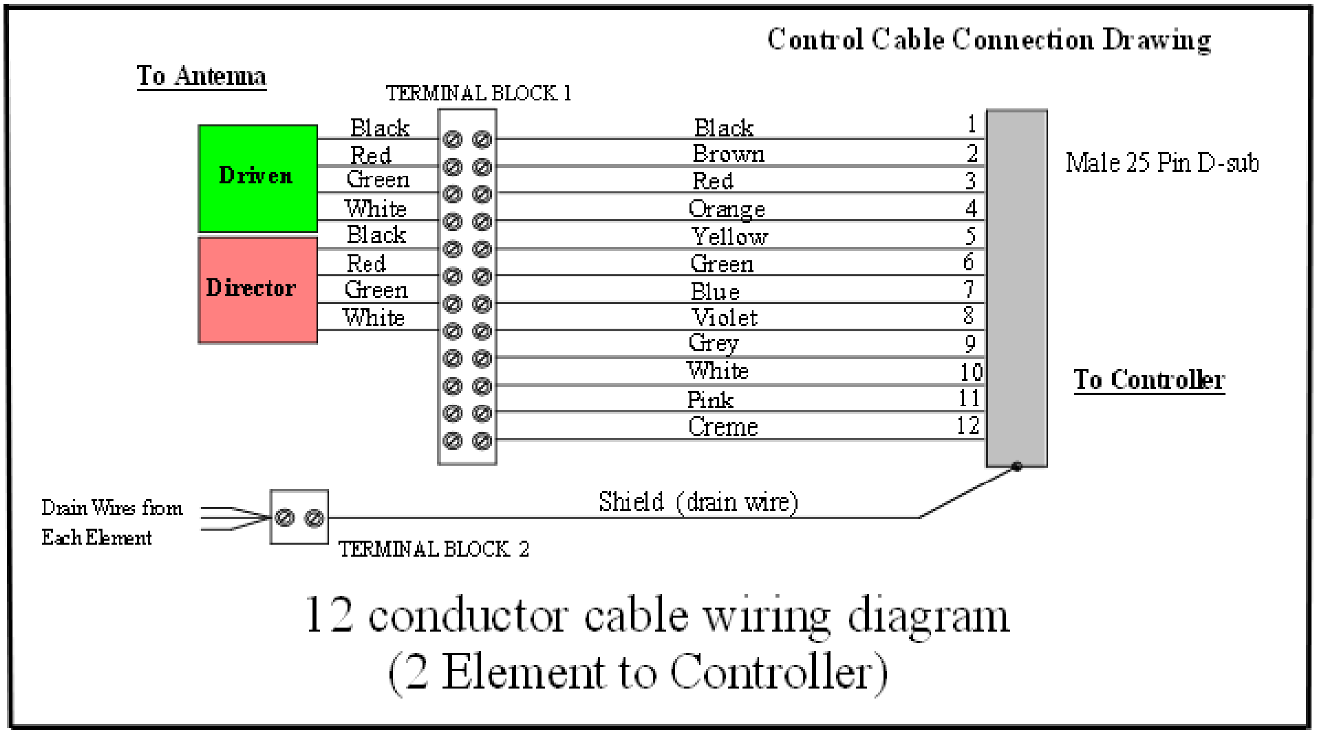



**Figure 25**

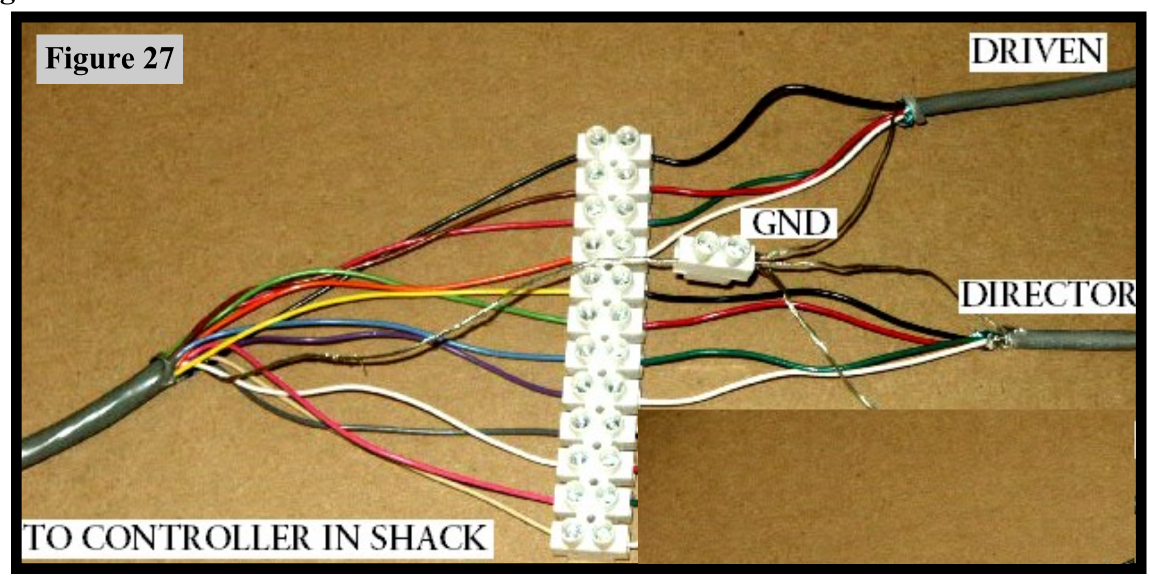


Figure 27

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 29**). The 12 conductor cable will be at one side, and the 2 four conductor cables will be at the other. You will then want to slide the cables and terminal strips into the provided plastic enclosure (**Figure 31**). Position the 3 cables into the groove in the plastic cap (**Figure 33**) and thread the enclosure onto the cap.

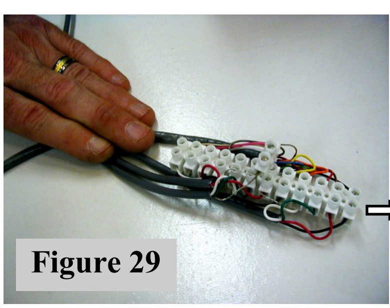


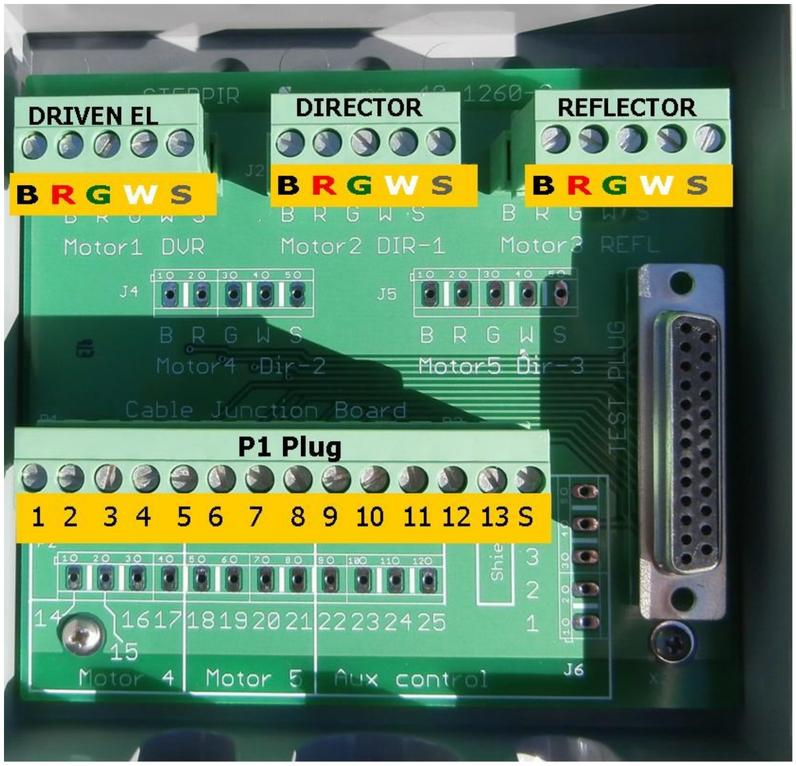
Figure 29

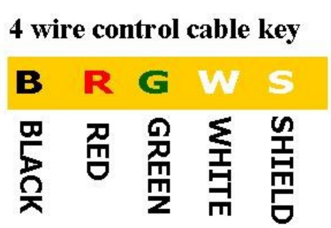

Figure 31

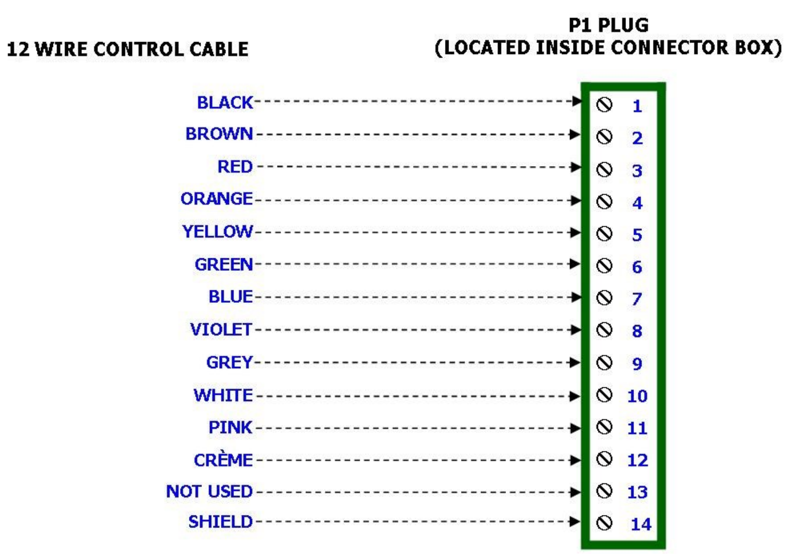

Figure 33

# 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.



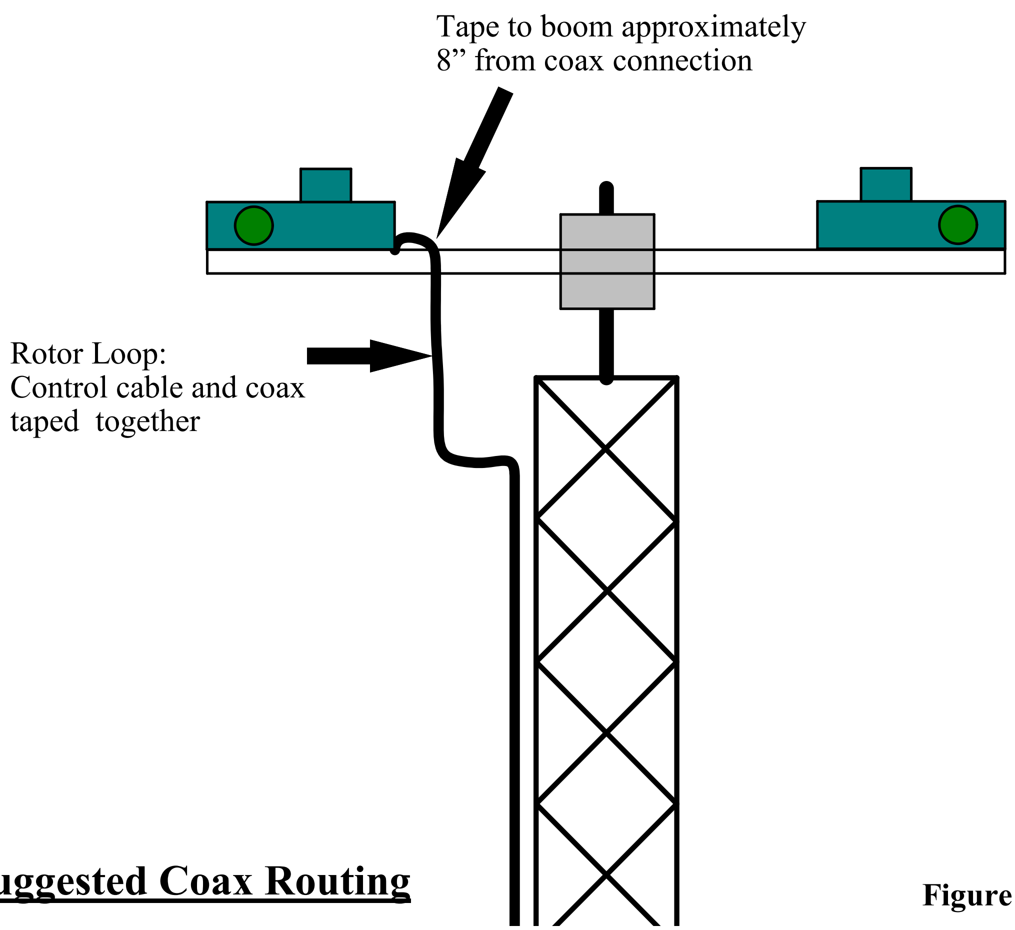



## Attach the Wiring Enclosure and Control Cable to the Boom

Position the plastic enclosure in a convenient position on the boom or mast (the terminal housing mounting location is not critical) making sure that the groove in the cap is facing downward. We do not seal the cap so that in the event there is water accumulation inside the enclosure from condensation, it will be able to escape. Secure the enclosure to the boom or mast using the 4” worm gear clamp, taking care to not trap the cables in between. Tape the cables to the boom.

**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.

**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, see the operations section of the manual.**




**Suggested Coax Routing**

**Figure 35**

## Prepare the Fiberglass Telescoping Poles


Quick disconnect boots

**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:**

- Four dark green fiberglass telescoping poles (**Figure 37**)
- Four quick disconnect boots (rubber) 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.

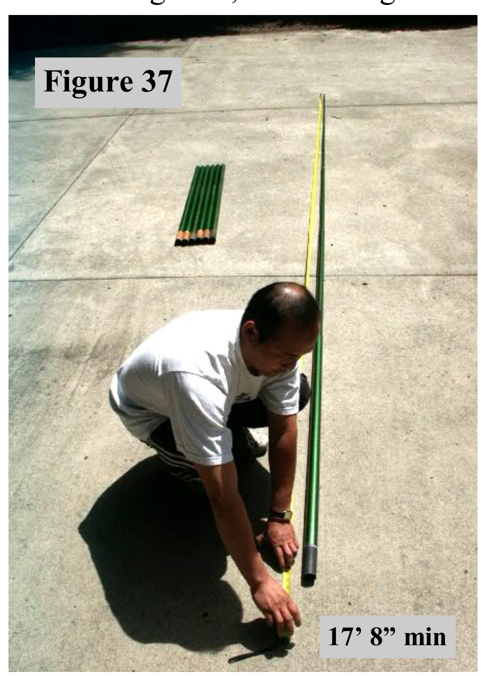


**Figure 37**


# Heat shrink tube instruction sheet

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. 6.30**

**FIG. 6.31**

**FIG. 6.32**

**FIG. 6.33**

## Attach the Fiberglass Element Support Tubes to the Element Housing Units

The butt ends of the green fiberglass poles may very 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 affect 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 four rubber boots and repeat the following procedure for each of the four 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**. **<u>It is very important to ensure that the butt end of the EST firmly bottoms out inside the EHT.</u> 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 <u>PAST</u> the 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 53**).  The overall length of the element is approximately 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 protector solution when connecting the two sections of tubing.   Fasten securely.   The center of the 6m element should be 22” from the center of the driven element (**Figure 9**).  Fasten securely to the boom using the U-bolt, saddle and hardware supplied.  Make certain that you have the  6 meter passive element level with the others.

Warning:   When attaching the 6m passive to the boom be careful not to trap the element control cable under the U-bolts.

Note:  You will need to enable the 6m passive in the controller. Reference the “Operators manual” under “General Frequency Mode” - “Options Menu” - “6m Passive Selection”.

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.

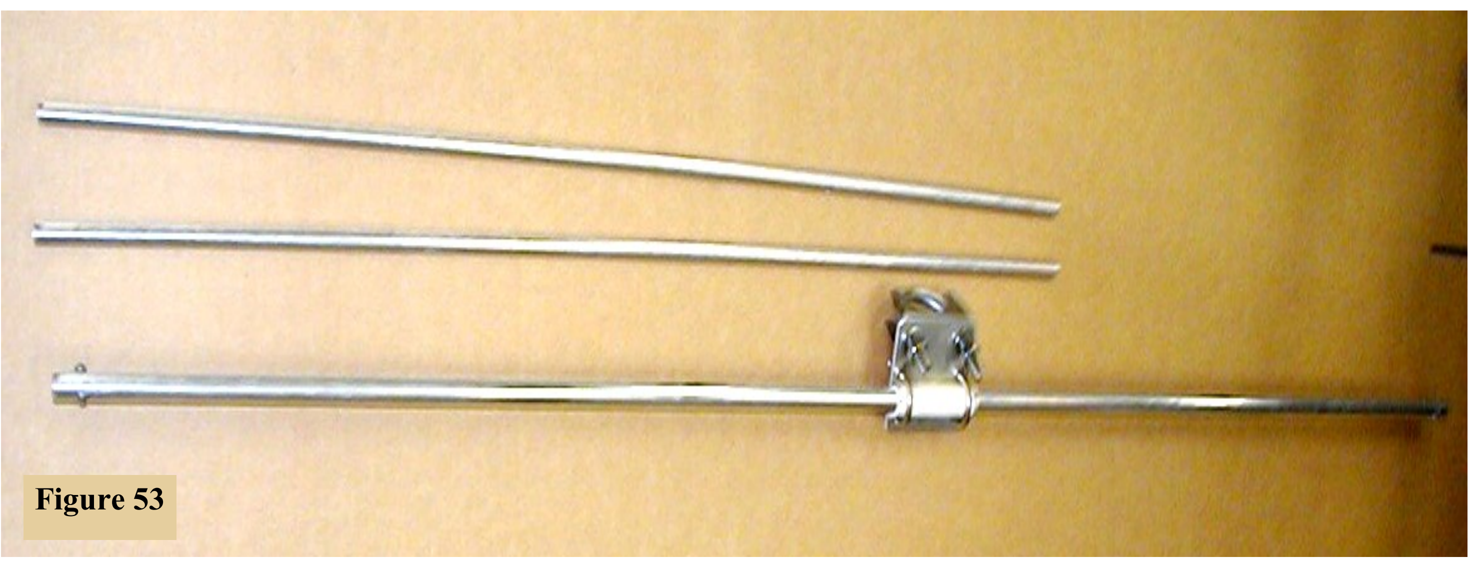


Figure 53

## 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

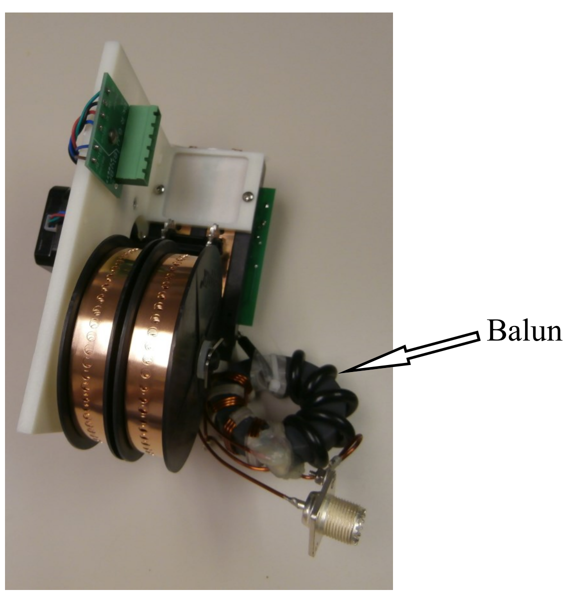
The RF power is transferred by brushes that have 4 contact points on each element that results in a very low impedance connection that is kept clean by the inherent wiping action. The brush contact is .08 in thick and has proven to last over 2 million band changes. The copper beryllium tape is .545 inches 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 500 WATTS, DO NOT TRANS-MIT 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!

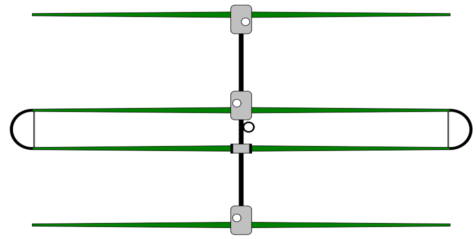
## RF Power Transmission with the SteppIR Yagi

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.

# StepplR Options

- **40m - 30m  Dipole (loop)**

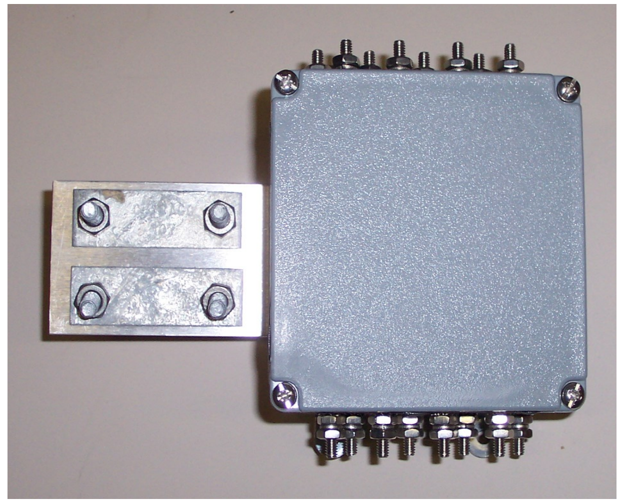


- **“Y” Cable**

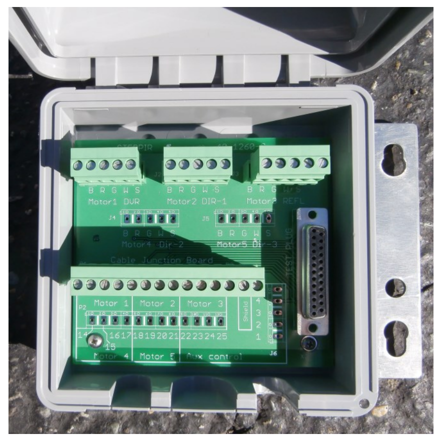
- **Transceiver Interface (Rig Specific)**

- **6m Passive Element Kit**

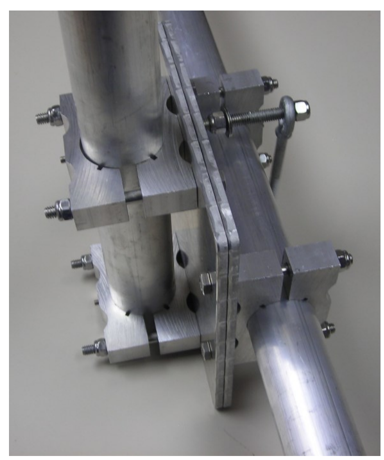
- **Voltage Suppressor & RF Bypass Unit** ( 16 Conductor)



* **Connector Junction Box**



*High Wind Kit (2E and 3E)



- **Element Expansion Kit**

| | | |
|---|---|---|
| Dipole | to | 2 Element |
| 2 Element | to | 3 Element |
| 3 Element | to | 4 Element |

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COMMUNICATION SYSTEMS

## 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.

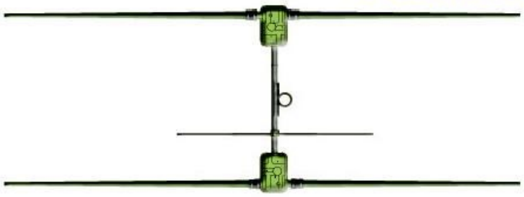
This limited warranty is automatically void if the following occurs: improper installation, unauthorized modification and physical abuse, or damage from severe weather that is beyond the product design specifications.

**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.

stepp IR COMMUNICATION SYSTEMS

## 2 Element Yagi Specifications



2E Yagi 20m-6m (with 6m option)

2E Yagi with 40/30 dipole option

| Specifications | 2 Element Yagi | 2 Element Yagi with 40/30 |
|---|---|---|
| **Boom length** | 57″ (60″ overall length) | 57″ (60″ overall length) |
| **Boom outside diameter** | 1 ¾ inch | 1 ¾ inch |
| **Longest element** | 36 feet | 39 feet |
| **Turning radius** | 18.2 feet | 20 feet |
| **Weight** | 30 lb | 37 lb |
| **Wind load** | 4 Sq/ft (cylindrical) | 6 Sq/ft (cylindrical) |
| **Wind rating** | EIA-222-C (100 mph) | EIA-222C (100 mph) |
| **Adjustable elements** | 2 | 2 |
| **Power Rating** | 3 KW continuous | 3 KW continuous |
| **Feed points** | 1 | 1 |
| **Frequency coverage** | 13.9 MHz – 54 MHz | 6.8MHz – 54 MHz |
| **Tuning rate** | 1.3 ft/sec | 1.3 ft/sec |
| **Control cable** | 12 conductor 22 AWG shielded | 12 conductor 22 AWG shielded |

| Frequency | 2E Gain, dBi | 2E Front to rear, dB | 30/40 option gain, dBi | 30/40 option Front to rear, dB |
|---|---|---|---|---|
| **40M** | N/A | N/A | 1.8 | N/A |
| **30M** | N/A | N/A | 2.1 | N/A |
| **20M** | 6.6 | 21 | N/A | N/A |
| **17M** | 6.6 | 16 | N/A | N/A |
| **15M** | 6.5 | 13 | N/A | N/A |
| **12M** | 6.4 | 11 | N/A | N/A |
| **10M** | 6.2 | 9 | N/A | N/A |
| **6M** | 5.0 | 2 | N/A | N/A |
| **6M w/passive opt.** | 8.3 | 20 | N/A | N/A |

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