steppIR
COMMUNICATION SYSTEMS

4 Element Yagi Instruction Manual

REV 3.2 March 2020

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4 Element Yagi COMPONENT CHECK

	Qty	
☐	3	**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	55' 4 conductor cable w/ 32" coax seal
☐	1	**SDA 100 4E Controller** Interface _____ Remote (USB cable, Cat5E Cross-over Cable w/ splice connector)_____ ALP _____ Turning Relay _____
☐	1	**Power supply with cord** 24V _____ 33V _____
☐	1	**71-0003** 4 Element Instruction Manual
☐	1	**71-0010** SDA Operators Manual
☐	8	**60-1006-22** Fernco 1.5" x 1.25" Quick Disconnect Boot
☐	24	**10-1059-01** Polyolefin heat shrink 1.5" x 3"
☐	2	**10-1021-23** Mast Plate 11.5"
☐	1	**72-0004-01** 4 Element Boom Assy Pack
☐	1	**72-0004-02** 4 Element Truss pack
☐	1	**72-0008-01** 4E Terminal Strip / EHU Pack(**Not** included if connector box purchased.)
☐	1	**09-0001** Electrical Tape
☐	1	**10-1028-21** Anti-seize stick
☐	8	**70-1007-01** Foam Plug Assembly
☐	1	**20-6208-01** 25 Pin male connector and **20-6209-01** 25 Pin Back Shell
☐	1	Control Cable 16 conductor _____ Length: _____
☐	1	**4E Boom,** 7 Sections
☐	8	**10-1013-02** 18' Telescoping Pole
☐		**Option**: **70-6010-01** 25 pin Dsub Splice Assembly
☐		**Option**: **20-8052-51** Array Solution 16 Pin surge Suppressor
☐		Surge Suppressor Instructions
☐		**Option:** **70-2035** Connector Box for 4E. _____
☐		**71-0017** Connector Box Manual _____
☐		**Option:** **4E 6m Passive** Short _____ Long _____
☐		**72-0013-01** 4E 6m Passive (short) Hardware Kit _____
☐		**72-0013-02** 4E 6m Passive (Long) Hardware Kit _____
☐		**Option:** **S Cable** _____

Assembly Kit Bill of Materials

4E Boom Assembly Hardware Kit
72-0004-01

QTY	PART NUMBER	DESCRIPTION
4	60-0004-21	2" LONG U-BOLT WITH SADDLE
2	60-0006	2-1/2" U-BOLT WITH SADDLE
2	60-0029	3" x 1/4" BOLT
10	60-0030	1/4" NYLOCK NUT
8	60-0046	5/16" NYLOCK NUT
4	60-0050	3/8" NYLOCK NUT
4	60-0063	3-1/4" x 1/4" BOLT
50	60-0041	1/4" WASHER
4	60-0100	3-1/2" x 1/4" BOLT

4E Truss Assembly Hardware Kit
72-0004-02

QTY	PART NUMBER	DESCRIPTION
1	60-0004-02	2" LONG U-BOLT WITH SADDLE
2	60-0034	3/8 WASHER
26ft	21-8000	1200i PHILLYSTRAN
2	60-0083	4" SS TURNBUCKLE
3	60-0037	EYEBOLT
1	60-0085	4" THREADED BOLT
1	60-0042	2" FLAT PLATE
4	60-0044	PLASTIC END CAP
16	60-0045	3/16" WIRE CLIP
7	60-0046	5/16" NYLOCK NUT
4	60-0048	3/16" THIMBLE
3	60-0050	3/8" NYLOCK NUT

Assembly Kit Bill of Materials

4E Terminal Strip / EHU Pack
72-0008-01

QTY	PART NUMBER	DESCRIPTION
1	09-0001	ELECTRICAL TAPE
1	60-6000-40	4” HOSE CLAMP
1	70-1102-21	1-1/2” ELECTRICAL ENCLOSER
2	10-1029-01	CONNECTOR PROTECTOR (bulb grease CP-1)
2	20-6020-8	8 – POSITION CONNECTOR
1	20-6020-1	1 – POSITION CONNECTOR

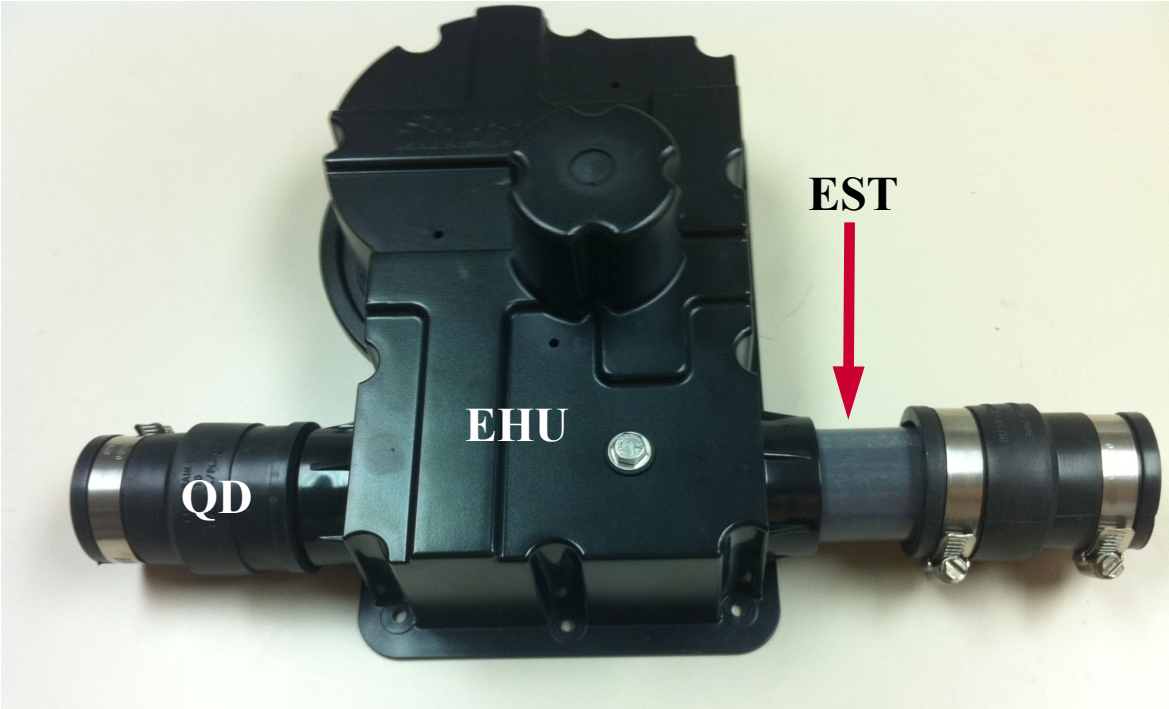
EHU Lid Hardware Kit
72-0054-01

Note: Four of the below kits are used for the 4E 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

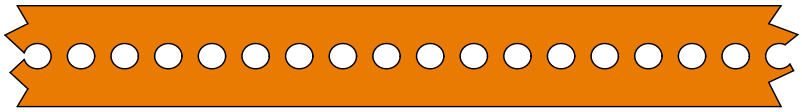
Michael (Mike) Mertel - K7IR
President

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.

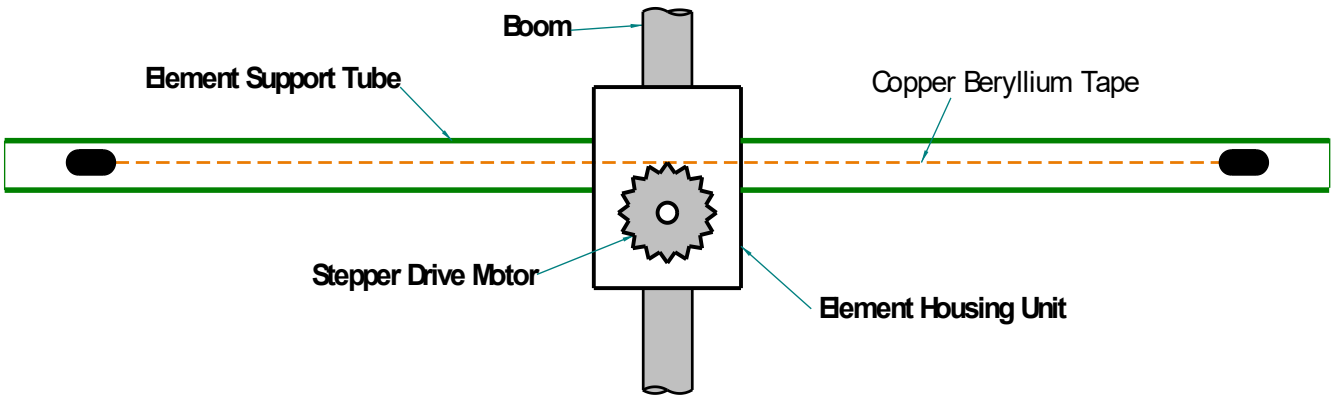


Copper-Beryllium Tape

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).



WORD OF CAUTION

Be Careful to avoid making contact with power lines or other potential hazards when constructing, moving and installing the antenna, as you could be seriously injured or even killed if a metal object comes in contact with high voltage.

ASSEMBLING THE ANTENNA

It is highly recommended that you read these Assembly Instructions in their entirety before assembling the antenna. Doing so will provide you an overall idea of what needs to be done and helps avoid making time-consuming mistakes. At a minimum, read the directions for each step before starting it. There will be a replacement in antenna parts if there is a 40/30m adder option, refer to that manual for those changes. Building your SteppIR™ is a straightforward process. It entails:

- Building the boom
- Connecting the boom-to-mast plate to the boom using the EZeye™
- Securing the element housing units to the element-to-boom brackets
- Connecting the required wiring
- Attaching the wiring enclosure and control cable to the boom
- Preparing the fiberglass telescoping pole
- Attaching the fiberglass telescoping pole to the element housing units
- Installing the optional 6M passive elements (if ordered)
- Installing the boom truss support assembly

Build the Boom

The boom (**Figure 1.5**) 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 1**) 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. 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 1** shows joint # 1 markings inside the ring (they must line up). **Drawing 1** on the following page shows how each boom section is numbered.

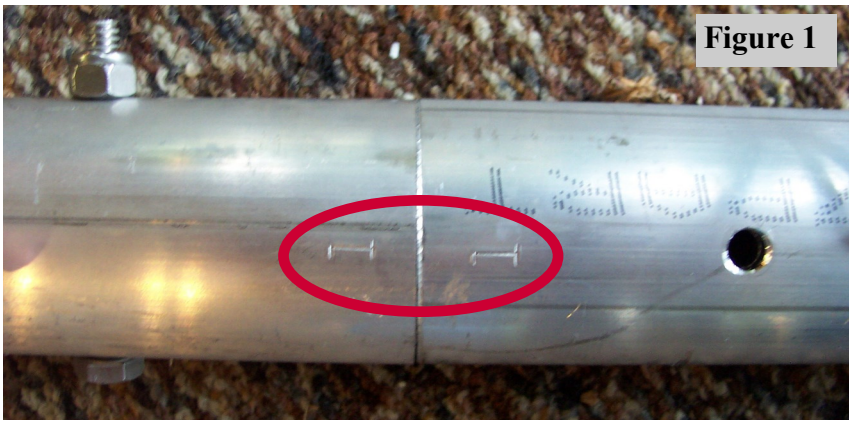
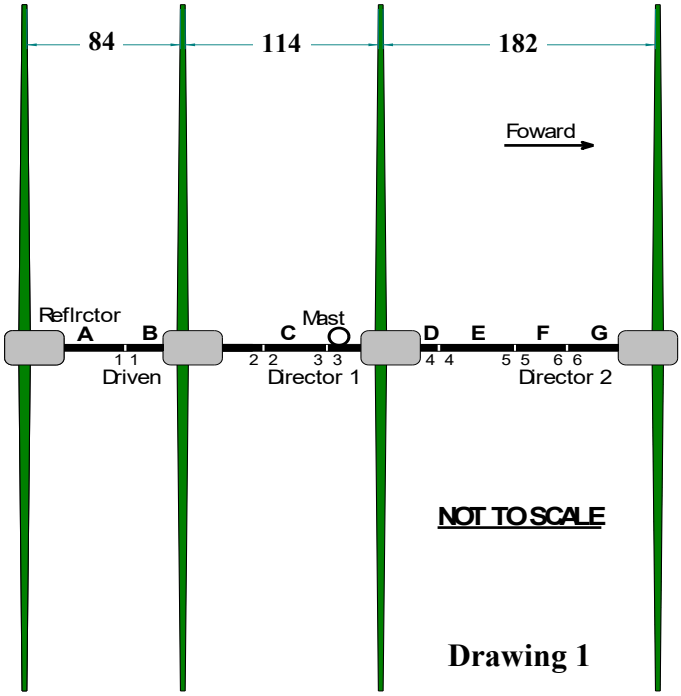


Figure 1

Figure 1.5

Drawing 1 shows the layout of the boom for assembly. Note that the lengths shown for each boom piece are overall lengths, the actual finished length of the boom will be 32 feet. The paired numbers shown in the drawing are inscribed on each associated boom section during the manufacturing process. Matching these numbers will insure correct alignment. Refer to **Table 2** for proper bolt sizes for each respective connection.



Drawing 1

Table 2: - Bolt Sizes Required for Assembling Boom		
Joint	**Bolt Size**	**QTY**
1	1/4-20 x 3” w / Nylok nut	1
1*	5/16” x 4” Eyebolt / nut	1
2	1/4-20 x 3-1/4” w /Nylok nut	2
3	1/4-20 x 3-1/2” w / Nylok nut	2
4	1/4-20 x 3-1/2” w / Nylok nut	2
5	1/4-20 x 3-1/4” w / Nylok nut	2
6	1/4-20 x 3” w /Nylok nut	1
6*	5/16” x 4” Eyebolt / nut	1

Section	Dimensions	With Bracket
A	1-3/4 x 50-3/8	Yes
B	2 x 72	Yes
C	2.25 x 48	No
D	2.5 x 72	Yes
E	2.25 x 48	No
F	2 x 72	No
G	1-3/4 x 50-3/8	Yes

* The second fastener at this joint is the 5/16” x 4” Eyebolt used for the truss assembly. (**Figure 3**)

Locate and position the seven sections of boom tubing, and the respective fasteners. **Rub a thin film of connector protector around the circumference of all male boom pieces BEFORE sliding the female sections over them (Figure 2). Also, do not twist the aluminum tubing excessively as that can cause binding.** Assemble the boom by sliding the seven sections together in the order shown on **Drawing 1** .


Figure 2

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 required bolts into the holes and loosely attach them with the 1/4" Nylok nuts.

Note: In some cases you may find it necessary to assist the bolts that you are installing by "threading' them with a wrench. Do NOT attempt to hammer them into place.


Figure 3

On the boom connections numbered 1 and 6 (see **Drawing 1**) one hole will be larger than the other. The smaller hole is for the 1/4-20 x 2.50" bolt and Nylok nut, the larger hole is for the 5/16" eyebolt that holds each end of the Pillystran Kevlar™ truss material in place (**Figure 3**). There is also a hole for a third 5/16" x 4" eyebolt (used for the EZeye™ feature explained later) located at the center point of the boom. Install this eyebolt with the nut and lock washer as shown in **Figure 4**.

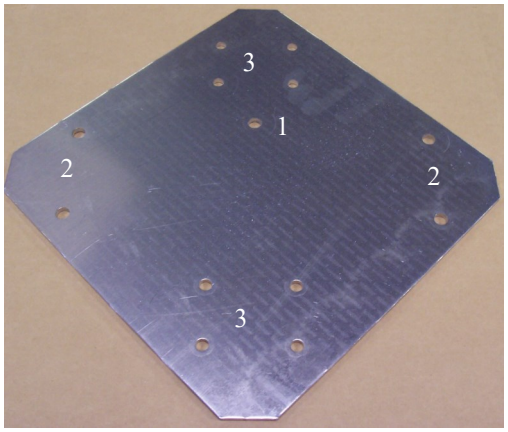

Figure 4

Now tighten the nuts on each bolt and eyebolt securely. Before continuing to the next step verify that **all** nuts and bolts, including those installed at the factory, are securely tightened.

Connect the Boom-to-Mast Plate to the Boom

We are showing you this step now, even though in all likelihood this may be one of the last steps, as you raise the finished antenna up to the tower. It is a good idea to use the mast plate and a temporary mast as a means of supporting the antenna while assembling the elements, and to familiarize yourself with the EZeye™ adjustment system before you are up on the tower!

The mast plate consists of two identical pieces, each 11.5" x 11.5" x 3/16" thick. The mast plate has 13 pre-drilled holes (**Figure 4.5**). The 2" mast holes are used to secure the antenna to the mast on your tower. The 2-1/2" boom holes are used for attaching the boom to the mast plate. The EZeye™ hole will be explained later in this section.



1) EZeye™ – 1 Hole .402 dia.
2) 2 1/2" Boom – 4 Holes .402 dia.
3) 2" Mast – 8 Holes .344 dia.

Locate:

- Two boom-to-mast plates (**Figure 5**)
- One 3/8 x 4" fully threaded bolt (EZeye™ bolt)
- Three 3/8 x 16x Nylok nut
- Two 3/8 flat washer
- Four 2" U-bolts with saddles & Nylok nuts
- Two 2 1/2" U-bolts with saddles & Nylok nuts

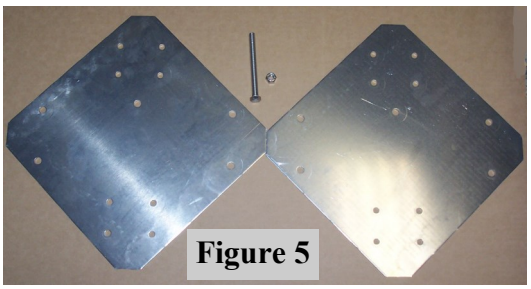


Figure 5

Insert the 3/8 x 16 x 4" fully threaded bolt through the EZeye™ hole in both mast plates, add nut then tighten (**Figure 6**), be sure that all the remaining holes are lined up with each other. Attach the mast plate to the mast (or temporary mast) using the four 2" U-bolts with saddles and nuts. Tighten securely (**Figure 7**). Thread another 3/8" nut onto the EZeye™ bolt and add a 3/8" flat washer. This represents the first part of the EZeye™ adjustment system.

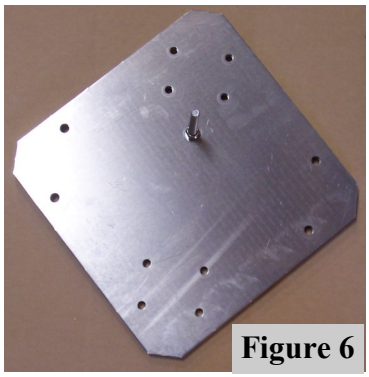


Figure 6

Lift the boom so that the eyebolt in the middle rests on top of the EZeye™ threaded bolt (**Figure 8**). This bolt can support the full weight of the antenna. The mast plates in figures 7 - 10 have a different look than what you are actually given.

Note: If you are doing this on the tower leave the safety rope or cable in place until you have secured the boom in place with the U-bolts.

Place another 3/8" flat washer after the eyebolt and then another 3/8" nut. Attach the 2-1/2" U-bolts, saddles and nuts loosely, and then use two wrenches to "level" the elements as shown **Figure 9**. When finished, securely tighten the nuts on both U-bolts and EZeye™ (**Figure 10**).


Figure 7

The EZeye™ adjustment system also helps prevents vertical movement of the elements in the event of high winds!

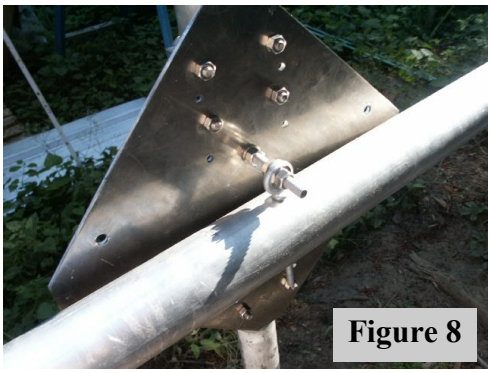


Figure 8


Figure 9

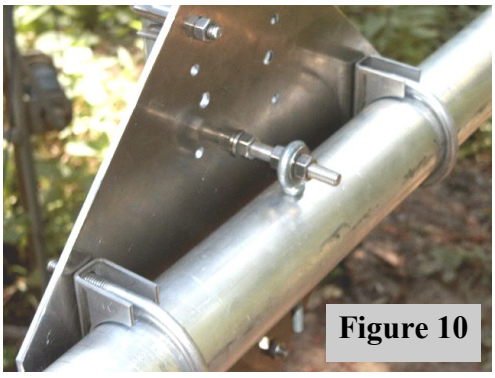


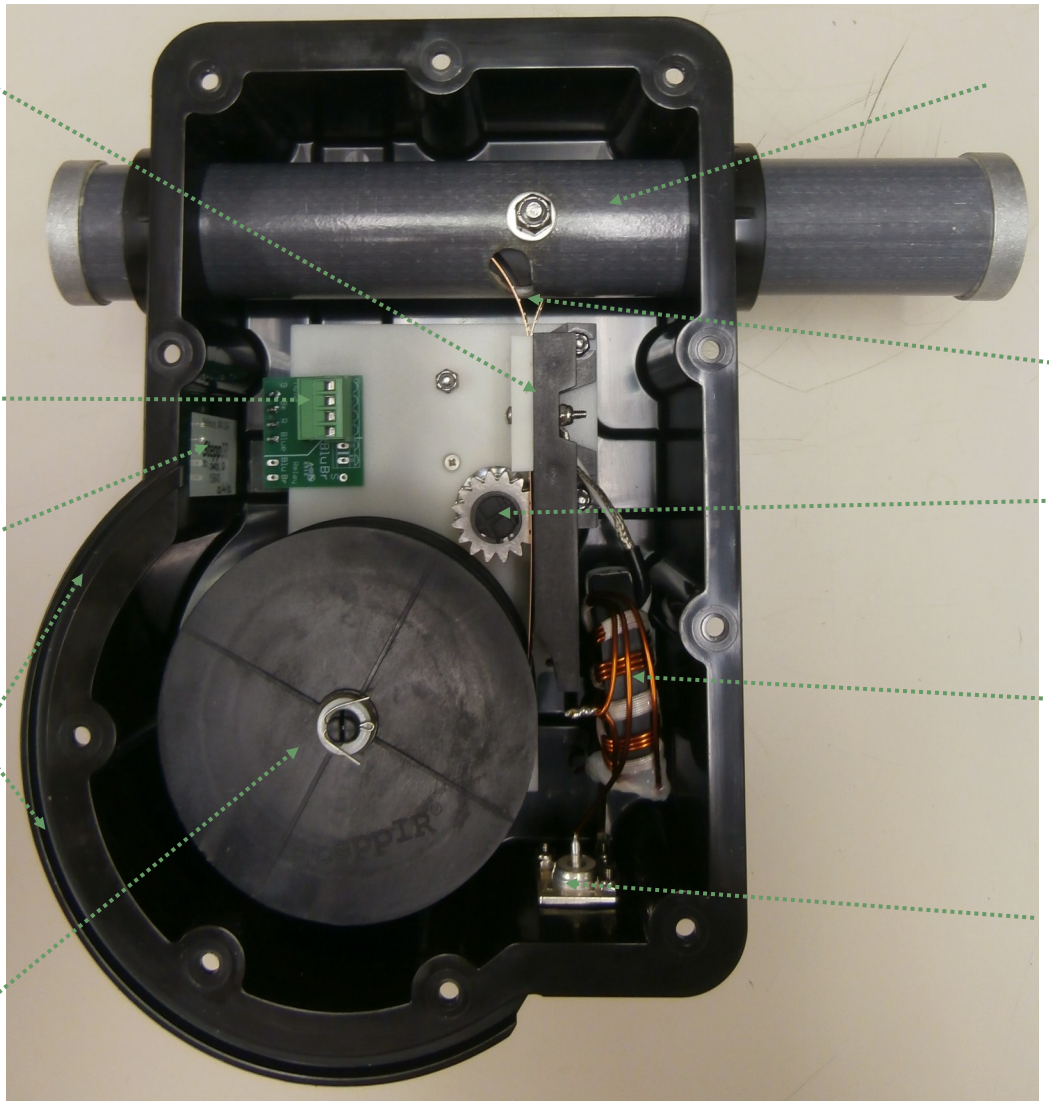
Figure 10

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

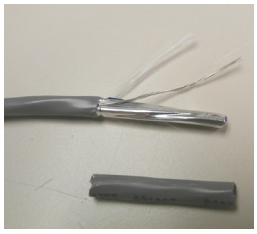


FIG. 10

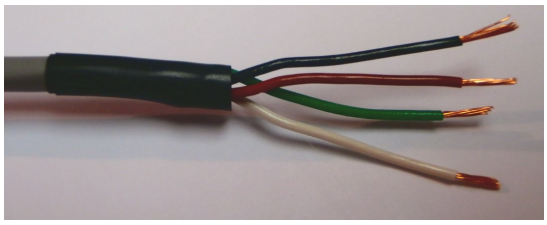


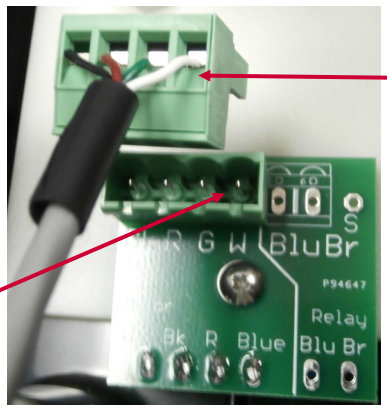
FIG. 11

FIG. 12

4 Pin Header Wiring Sequence

BLACK	RED	GREEN	WHITE

FIG. 13



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

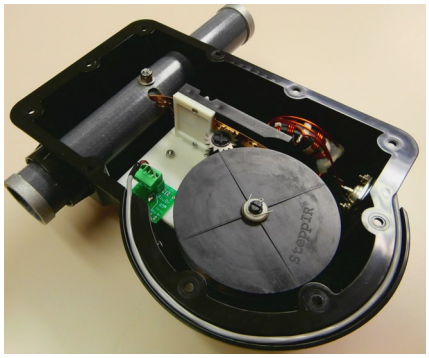


FIG. 15

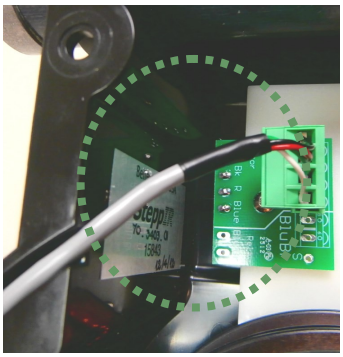


FIG. 16

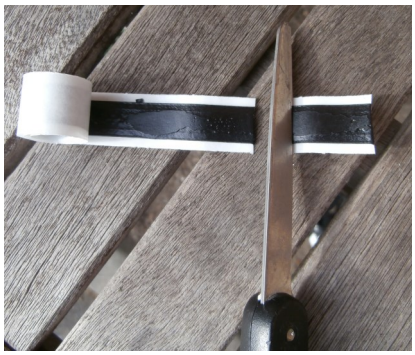


FIG. 17

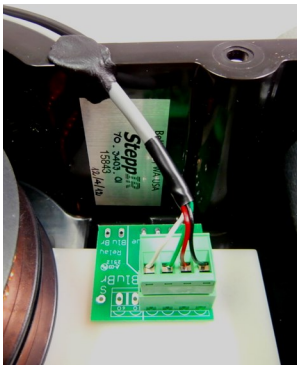
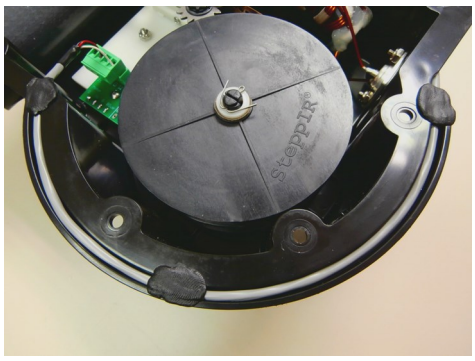


FIG. 18



DB25 CONTROL CABLE SPLICE INSTALLATION

FIGURE 19

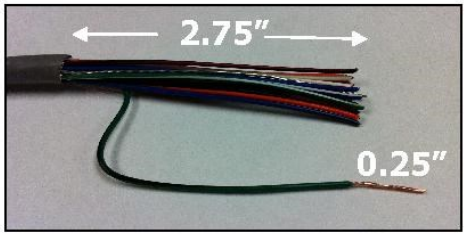


FIGURE 20

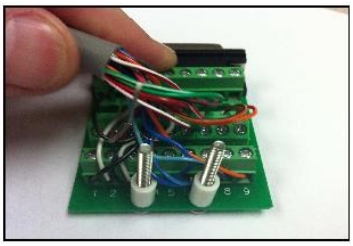


FIGURE 21

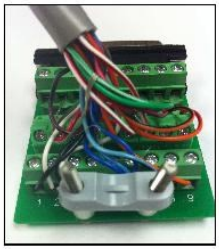


FIGURE 22

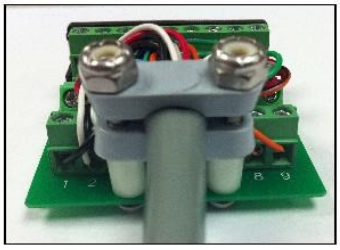


FIGURE 23

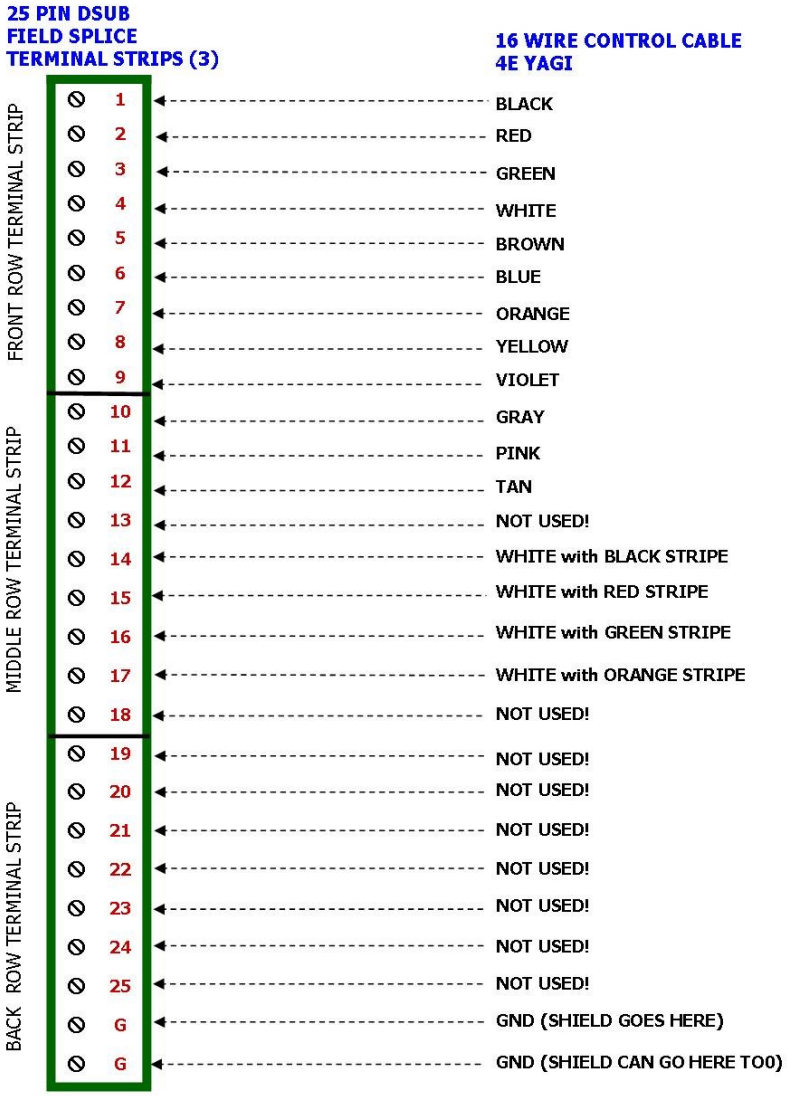
FIGURE 24

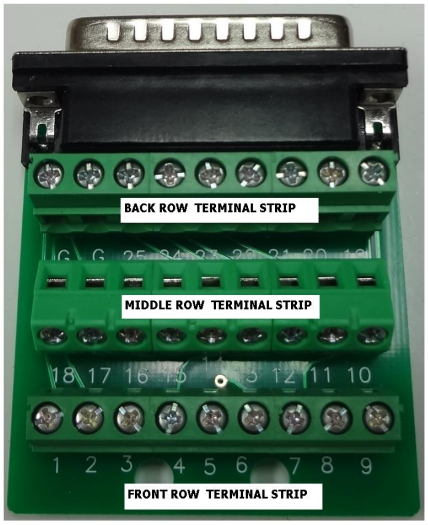
FIGURE 25

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





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.

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**

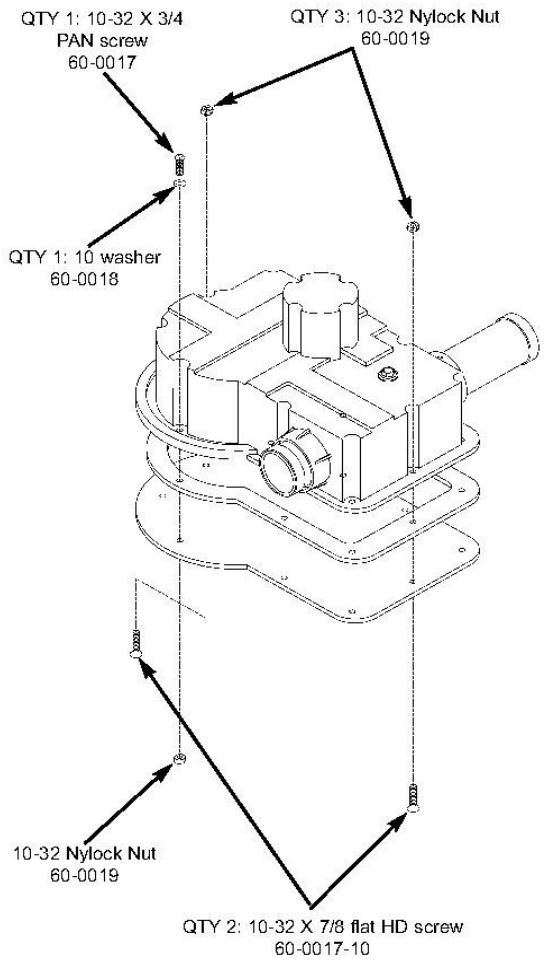
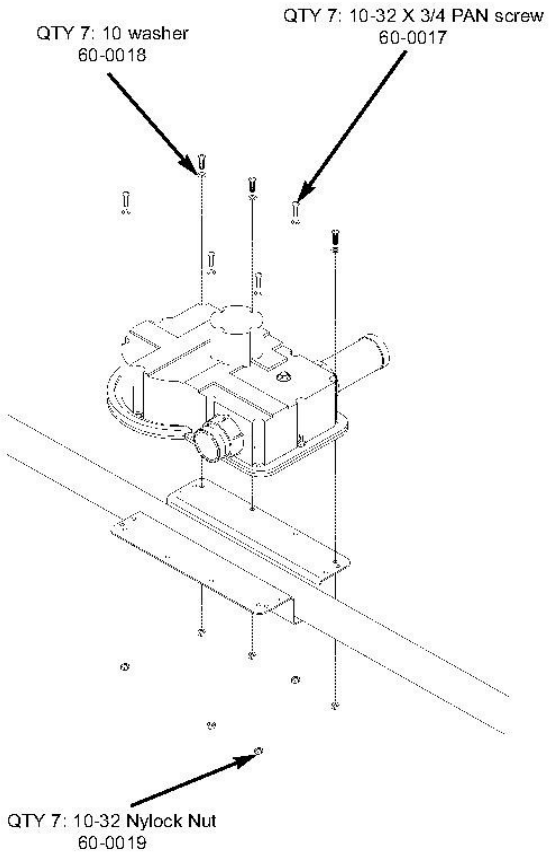
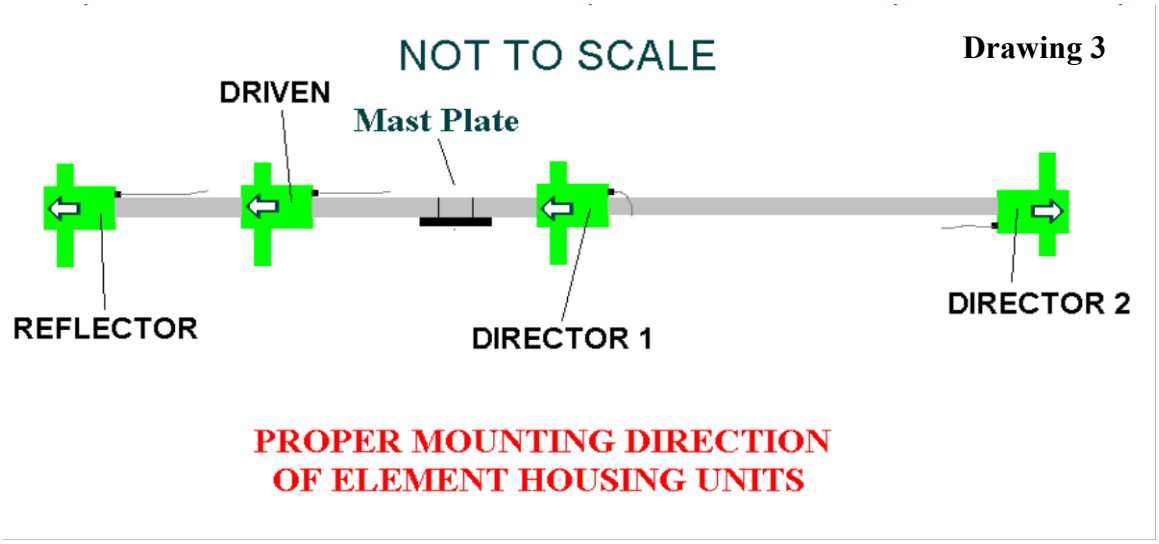


Figure 3 **EHU Assembly**



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.

Proper EHU orientation is critical to operation of the antenna. Make sure they are installed on top of the element-to-boom brackets exactly as shown in Drawing 3 (looking down on the boom).



Refer to **Figures 13**, **14** and **15**. Attach each EHU in place using eight #10-32 x 3/4" Phillips machine screws, flat washers and Nylok nuts. Proper EHU placement is with the EHU placed on top of the brackets, these should face towards the sky.

IMPORTANT: A flat washer needs to be placed BETWEEN each bolt head and the plastic element housing to avoid damaging the housing when tightened.

Tighten the bolts securely—but not too tight. If you over-tighten the nuts you may split the plastic flanges on the EHUs.

NOTE: If the eight mounting holes for the element housing do not line up with the eight 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.

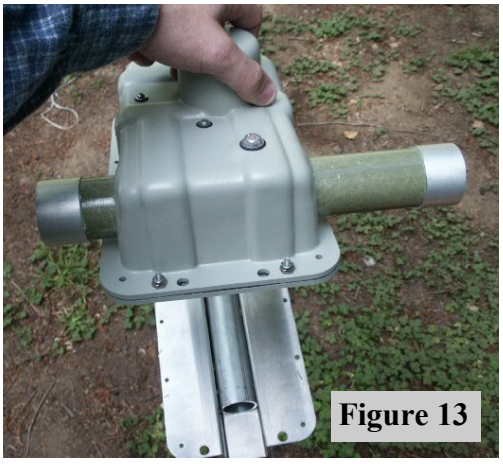


Figure 13

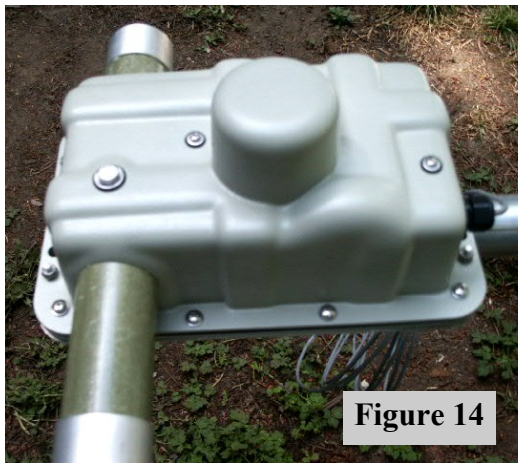


Figure 14

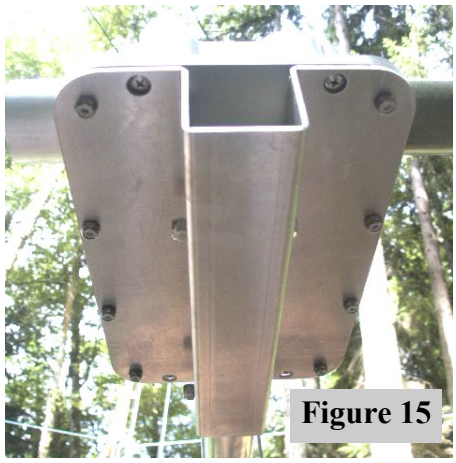


Figure 15

Connect the Required Wiring

The other end of the control cable have wires that will be connected to the terminal strips that were shipped with the PVC tube kit. Locate the terminal strips (**Figure 16**) and small blue packet of connector protector. Each EHU control cable also has a bare ground wire. It needs to be connected to the one position terminal strip shown at the bottom center of **Figure 16**.

Figure 16

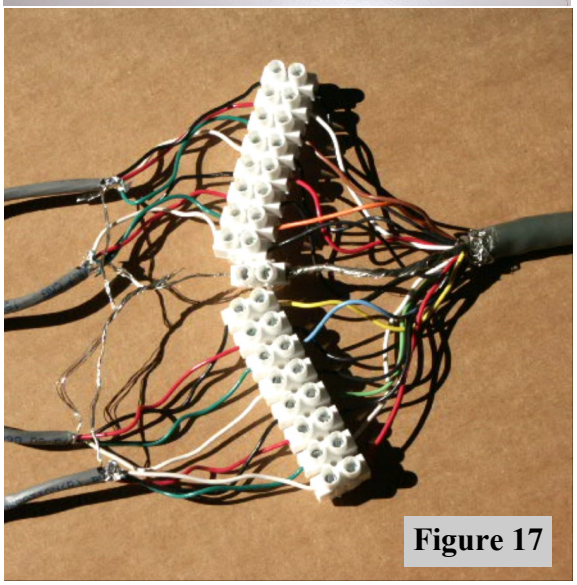
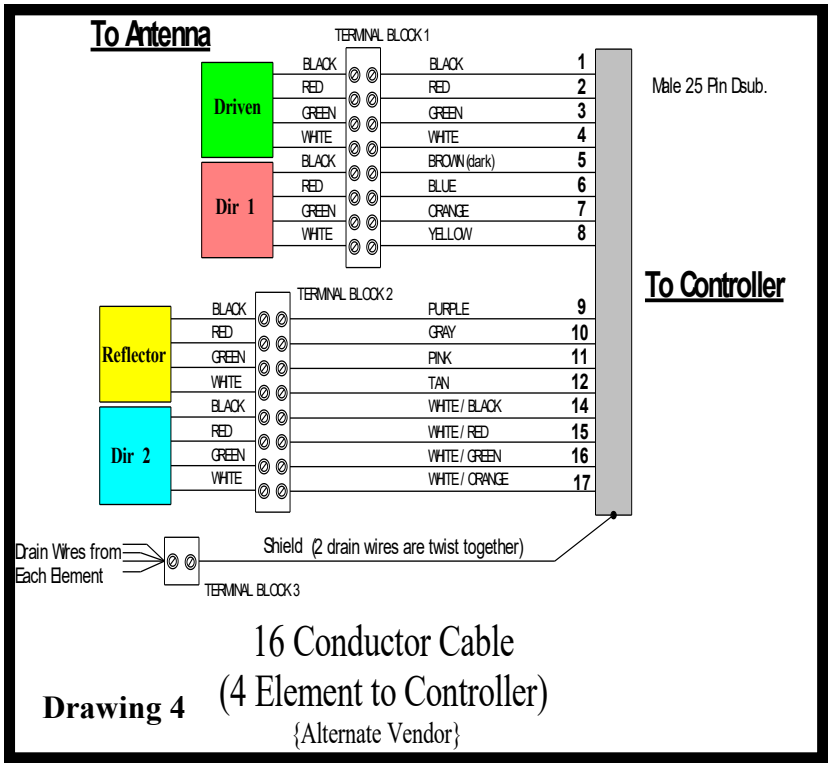


Figure 17



Drawing 4

The left side of **Figure 17** shows how these control cables are wired. Note the single position ground terminal in between the two 8 position terminal strips. The right side shows how the 16 conductor control cable (8 pairs of wires, each pair with one colored wire and one black wire) going to the shack is connected.

Warning: Do NOT connect the 16 conductor cable to the SteppIR™ controller until instructed to do so.

Carefully review Figures 17 and Drawing 4 before proceeding. First complete the reflector, director and driven element wiring. The 16 conductor cable wiring going to the controller will follow.

NOTE - It is strongly recommended that you run the "Test Motor" function (Ref the Operators Manual) at this point to insure that all your wiring is correct and the element housing units are operating correctly.

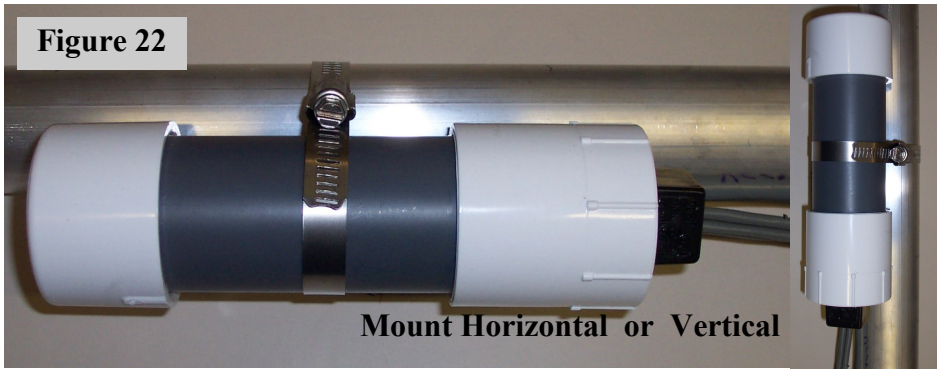
Attach the Wiring Enclosure and Control Cable to the Boom

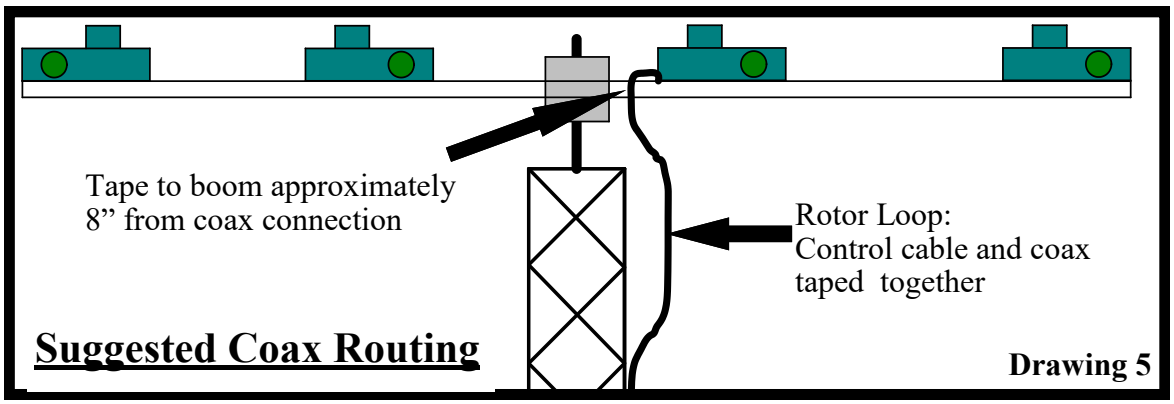
Fasten the wiring enclosure to the boom using the #56 stainless steep hose clamp. Position the plastic enclosure in a convenient position **on the boom or mast** making sure that the cut out in the cap is facing downward (**Figure 22**). We do not seal the enclosure so that in the event there is water accumulation inside the enclosure from condensation, it will be able to escape.

Caution: Do NOT trap the cables between the clamp and PVC tubing or over-tighten the clamp. 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.

Start at one end of the boom and tape all the cables snugly to the bottom of the boom so there are no loops or slack cables. Six equally spaced tape points on each sides of the boom using two wraps of electrical tape each should be fine. This is to prevent the cables from becoming damaged when moving the antenna and installing it on your tower. Secure the 16 conductor cable and coax to the boom about 8" from the coax connector.

NOTE: Be sure to secure the cables before placing the antenna on the tower, as you will not be able to reach the driven element from the tower! Refer to **Drawing 5** below for our suggested cable configuration.





Note: If you do not want to install or remove the antenna with the main coax feed line attached, make a coax jumper that connects to the driven element and goes along the boom back to the mast plate area where it can be connected to the main coax feed line coming up the tower.

NOTE: If you are upgrading to a 4 element from a SteppIR™ 3 element Yagi, you will need to use the included 35 foot roll of 4 conductor cable to extend the control cable on each antenna housing to accommodate the longer boom length. The process is easy - first, cut the cable to the desired length, ensuring that each antenna housing control cable will reach the terminal strip located at the mast plate. Match the color of each wire, solder and thoroughly wrap with electrical tape. When this is completed, continue with the steps below.

1. Start with the driven element cable. **Dip each wire into the connector protector - except the bare ground wire** (this will be done in the next step). A thin coating is sufficient. Insert each of the four colored wire into their respective location on the first 8 position terminal strip. **Drawing 4** provides the exact location and color codes. Tighten the set screws as each wire is inserted, but **be careful not to over-tighten these screws**. Repeat this procedure for the first director, reflector and second director cables.
2. **Twist the four bare ground wires from the four control cables together, dip them into the connector protector and insert them into one end of the single position terminal strip.** Secure them by tightening the set screw. That completes the control cable wiring for the EHUs.
3. Locate the 16 conductor cable that goes to the controller. If it is not already coiled neatly, coil it before proceeding. Follow the same procedure as above and connect each colored wire.
4. Route the single bare ground wire from the 16 conductor control cable in between the two 8 position terminal strips. Insert it into the unused end of the single position terminal strip with the 4 ground wires from the EHUs and tighten the set screw. When finished, the single position terminal strip should be close to the two 8 conductor terminal strips as shown in **Figure 17**.
5. Position the cables so they are parallel with the two 8 position terminal strips (**Figure 19**). The single 16 conductor control cable will be on one side and the four 4 conductor cables the other. Locate the unattached black ABS threaded plug and associated tube as shown in **Figure 20**. The ABS tubing serves as our wiring enclosure and protects the connections from the weather.
6. Put a couple of wraps of electrical tape around the wire bundle where it will pass through the notch in the threaded plug to protect the cable sheath from the threads in the tube. Slide the cables and terminals strips into the ABS tube, position the threaded plug with the cut out for the cables and screw the **tube** onto the threaded end plug until it fairly tight.
7. Fasten the wiring enclosure to the boom using the stainless steel hose clamp as shown in **Figure 22.** This completes the required wiring.

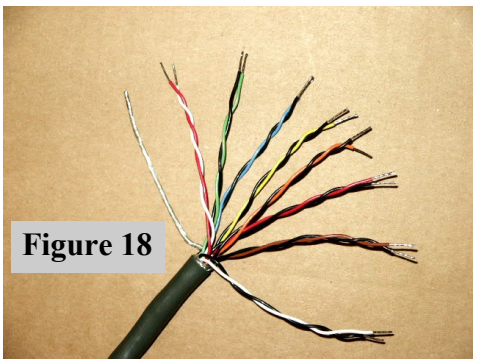


Figure 18

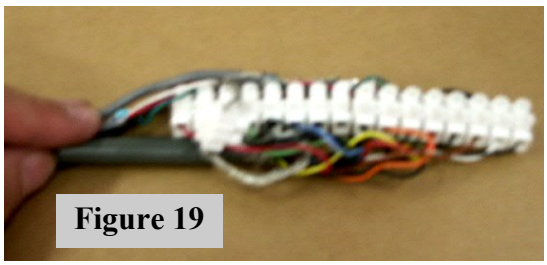


Figure 19

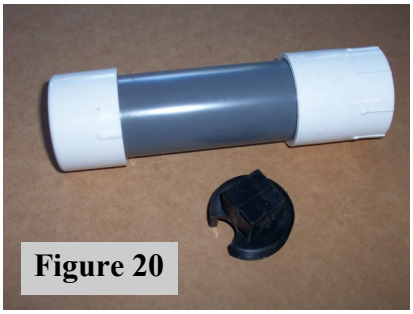


Figure 20

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 20**) *
- Eight black rubber boots with clamps
- Your tape measure

Rubber Boots

The green fiberglass poles are all assembled in the same manner, and when extended, become element support tubes (ESTs) for the flat strip copper beryllium elements themselves. The copper-beryllium strips are shipped retracted inside their respective element housing units (EHUs).

Repeat the following procedure for each 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 20**).

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 20

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. 6.30

FIG. 6.31

FIG. 6.32

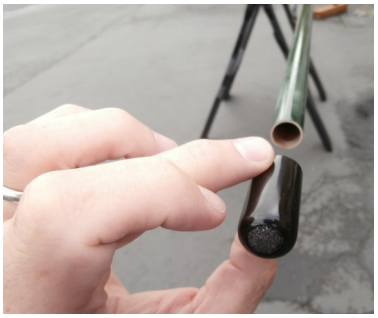


FIG. 6.33

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 eight rubber boots and repeat the following procedure for each of the eight 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 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.

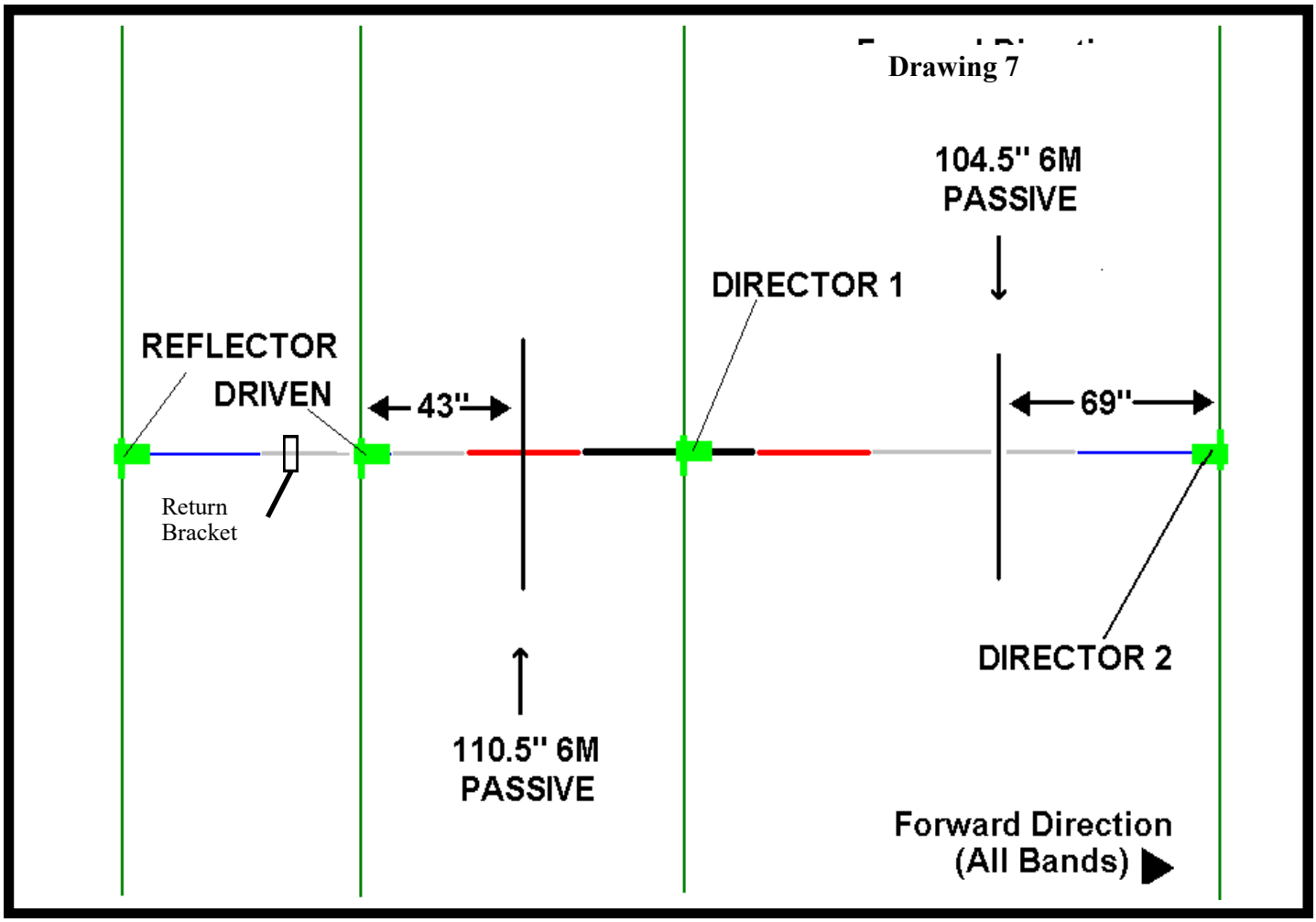
Install the Optional 6 Meter Passive Element (If ordered)

If you have purchased the optional 6M passive element kit:.

Locate: (Ref: **Picture 31**)

- One 6M passive element kit 110.5” (long)
- One mounting kit (long)
- One 6M passive element kit 104.5” (short)
- One mounting kit (short)
- Blue packet of Connector Protector

Using their respective hardware kits (long & short - **Picture 31**) assemble the two 6M passive elements. Identify the ends of the 3/8” tubing that have the shortest distance from the end of the tubing to the drilled hole. Lightly coat the circumference of these ends with a very thin film of the connector protector. Slide the coated ends of the 3/8” tubing into the 1/2” tubing and align the holes.

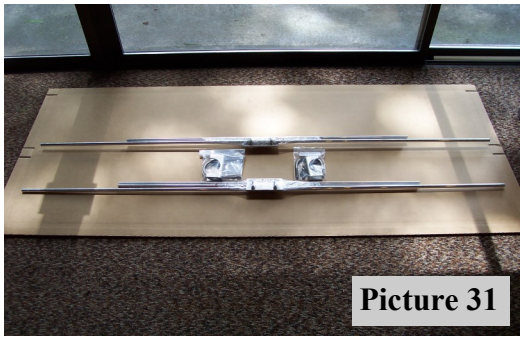


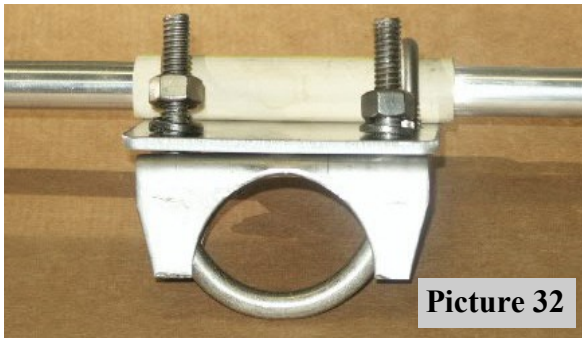
Note: Verify that the long element measures 110.5" and the short element measures 104.5".

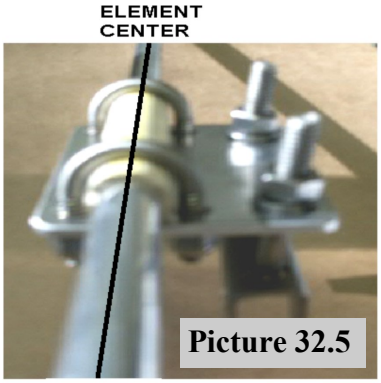
Securely fasten the pieces together with the 6-32x3/4" machine screws and Nylok nuts and install the U-bolt on the center bracket as shown in **Picture 32.5.**

The 6M passive elements should be mounted on the top side of the boom, the same as the other elements, using the U-bolts and saddles shown in (**Picture 32**). Using a tape measure, determine the correct passive element placement as shown in **Drawing 7**. Be sure to measure from the actual center line of the 6m passive element, NOT from where the U-bolt attaches (**Picture 32.5**). Make sure the elements are aligned with the green fiberglass poles. Tighten securely.

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


Picture 31


Picture 32



Picture 32.5

Install the Boom Truss Support Assembly

Locate the sixteen 3/16" galvanized cable clips, four 3/16" galvanized thimbles, two 1/4" x 4" galvanized turnbuckles and the 26 feet of 1/8" non-conductive Phillystran® Kevlar™ cable.

Using a hammer, lightly tap the thimbles so that the center opening is forced onto the eye bolt at the end of the boom (**Figure 33**). Press the thimble back together as close as possible once it is through the eyebolt. Thread the Phillystran through the eyebolt, so that it rests on the channel of the thimble. You will use approximately 12" of Phillystran to loop through the eyebolt (six inches down, six inches back) as shown in **Figure 34**.


Figure 33

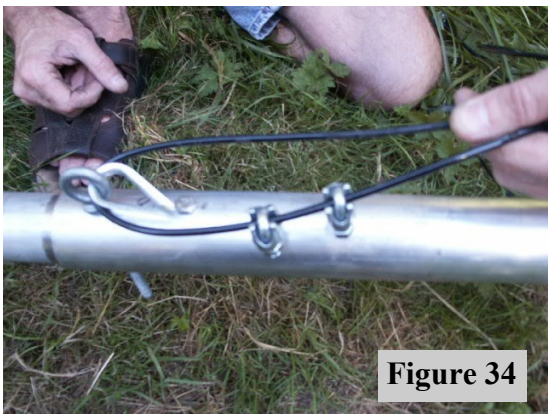


Figure 34

DO NOT CUT THE PHILLYSTRAN CABLE UNTIL YOU HAVE INSTALLED ONE SIDE OF THE TRUSS—
THE MEASUREMENTS FOR EACH SIDE ARE NOT EQUAL IN LENGTH.

Attach the cable clips to the Phillystran, with the first one as close to the end of the thimble as possible, so the cable will be "locked" in, and the next three approximately 1" apart (**Figure 35**). **Figure 35.6** is a sample cable made up for the picture only to show what a finished cable will look like. You will want to thread the Phillystran into the cable clip, so that one section is on top of the other, as shown in **Figure 35.4**. Tighten the nuts securely.

Locate the 2" U-bolt, saddle, two 5/16" nuts, 2" flat plate and two 5/16" Nylok nuts. Position the U-bolt 26" to 30" above the boom on the antenna mast and secure with the two 5/16" stainless nuts (do not use the Nylok nuts yet). Position the eye of the turnbuckles on each leg of the U-Bolt, place the 2" flat plate behind them, and fasten the 5/16" Nylok nuts securely as shown in **Figure 36**. When properly secured, cut the remaining Phillystran cable for use on the other half of the truss.

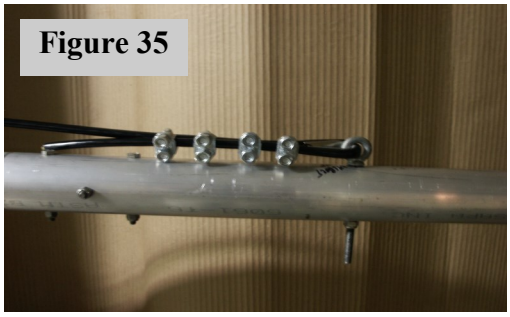


Figure 35

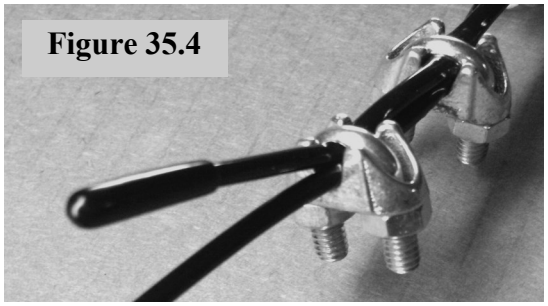


Figure 35.4

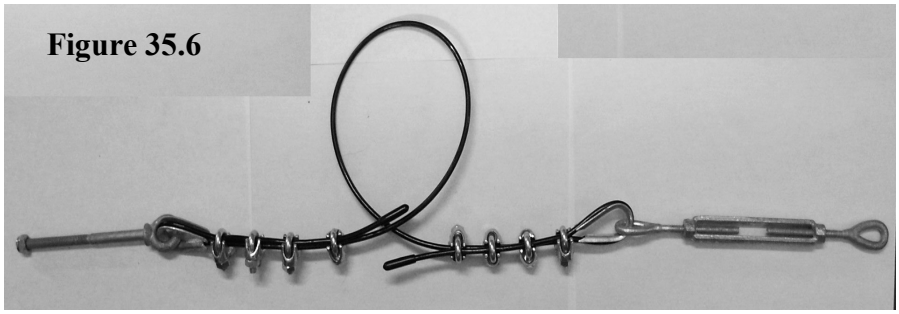


Figure 35.6

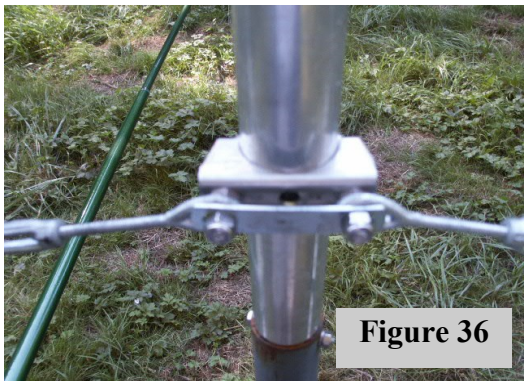


Figure 36

Attach the thimbles, Phillystran and wire clips in the same manner as in step one. The finished assembly should look like **Figure 38.**

While holding the Phillystran in one hand (this will prevent the cable from twisting while you tighten the turnbuckles), tighten the turnbuckles using a wrench or screwdriver as a lever, until the boom is evenly supported and level on both sides. When the turnbuckles are correctly tensioned secure them with a safety wire as seen in **Figure 39** to prevent them from working loose.


Figure 38

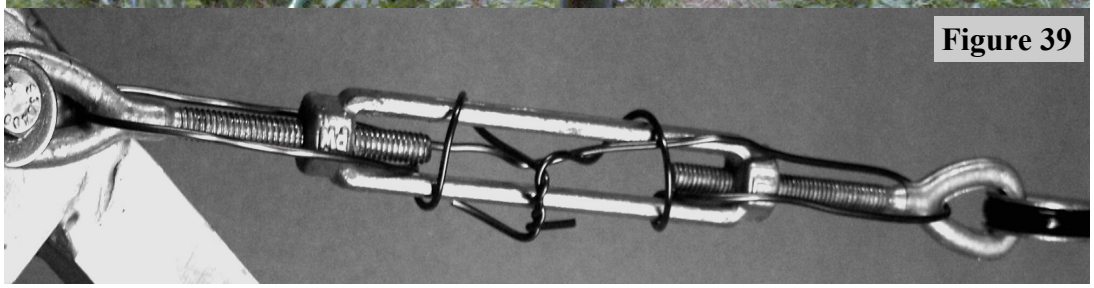


Figure 39

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 all Yagi antennas (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 (**Figure 40**), 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.

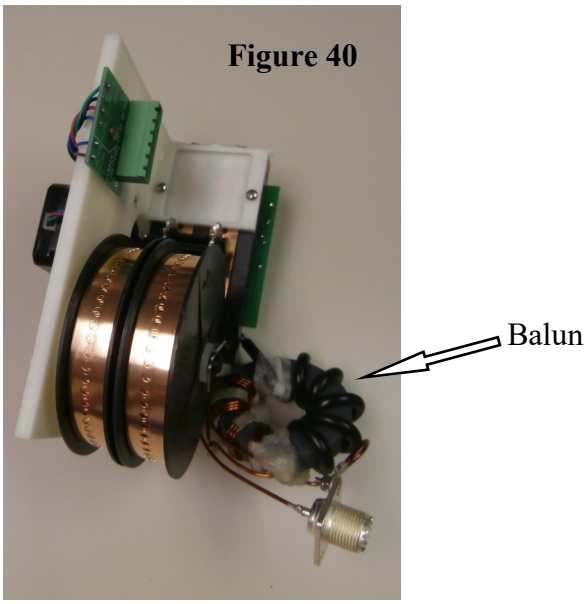


Figure 40

Yagi Gain / Front to Back Modeling

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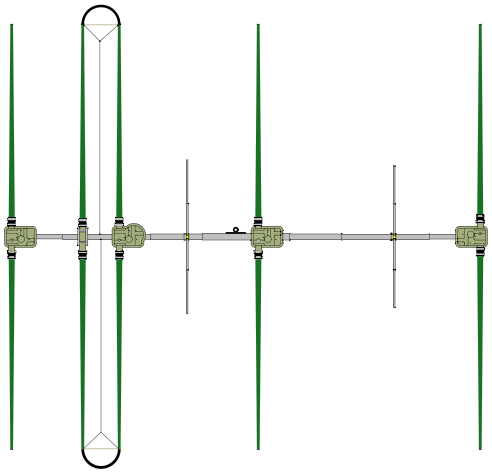
When we claim our Yagi outperforms much larger arrays we are referring to multi-band Yagi's that interlace elements on a long boom and don't use the entire band boom for each band, and additionally have degraded performance due to element interaction. There are many antennas out in the world that are 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.

SteppIR Options

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

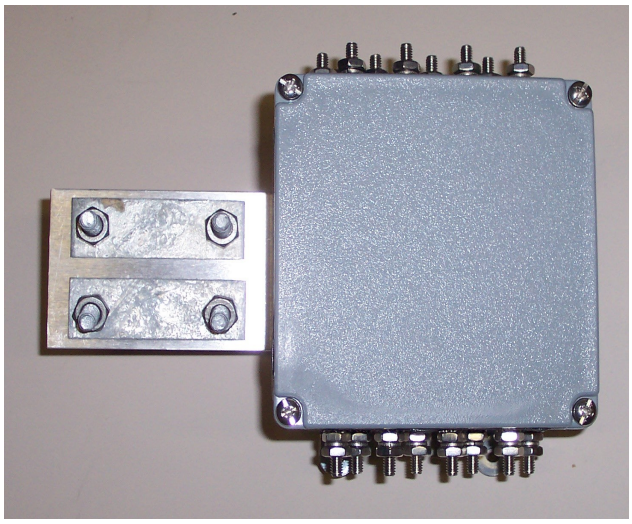


- **“Y” Cable**

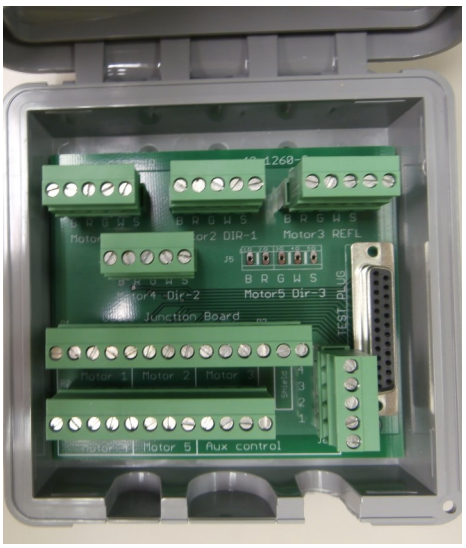
- **Transceiver Interface cable (Rig Specific)**

- **6m Passive Element Kit**

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



*** Connector Junction Box**



- **Element Expansion Kit**

Dipole	to	2 Element
2 Element	to	3 Element
3 Element	to	4 Element

STEPPIR ANTENNAS LIMITED PRODUCT WARRANTY

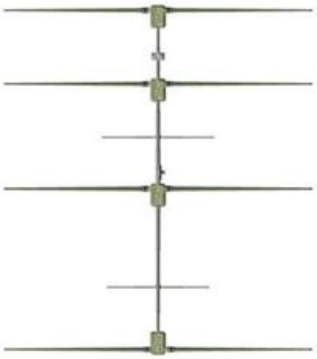
Our products have a limited warranty against manufacturers defects in materials or construction for two (2) years from date of shipment. Do not modify this product or change physical construction without the written consent of Fluidmotion Inc, dba SteppIR Antennas.

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.

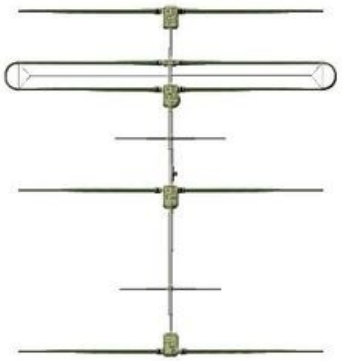
SteppIR Antenna's responsibility is strictly limited to repair or replacement of defective components, at SteppIR Antennas discretion. SteppIR Antennas will not be held responsible for any installation or removal costs, costs of any ancillary equipment damage or any other costs incurred as a result of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

4 Element Yagi Specifications



4E Yagi 20m-6m (with 6m option)



4E Yagi 40m-6m (with 6m option)

Specifications	4 Element Yagi	4 Element Yagi with 40/30
Boom length	32 ft / 9.75 m	32 ft / 9.75 m
Boom outside diameter	1.75 in—2.50 in 4.45 cm—6.35 cm	1.75 in—2.50 in 4.45 cm—6.35 cm
Longest element	36 ft / 10.97 m	39 ft / 11.9 m
Turning radius	24.1 ft / 7.35 m	24.1 / 7.35 m
Weight	99 lb / 45.0 kg	106 lb / 48.2 kg
Wind load	9.7 sq ft / 0.9 sq m	11.7 sq ft / 1.09 sq m
Wind rating	100 mph	100 mph
Adjustable elements	4	4
Power Rating	3000 watts continuous	3000 watts continuous
Feed points	1	1
Frequency coverage	13.8—54 MHz	6.8—54 MHz
Control cable	16 conductor shielded, 22 AWG	16 conductor shielded, 22AWG

4E Gain / Front-to-rear (by band)	4E Gain, dBi	4E Front-to-rear, dB	4E with 30/40 Gain, dBi	4E with 30/40 Front-to-rear, dB
40M	NA	NA	1.8	NA
30M	NA	NA	2.1	NA
20M	9.5	21	9.5	21
17M	10.0	20	10.0	20
15M	10.2	27	10.2	27
12M	10.4	21	10.4	21
10M	10.6	11	10.6	11
6M	7.8	4	7.8	4
6M w/passive opt.	13.0	30	13.0	30

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