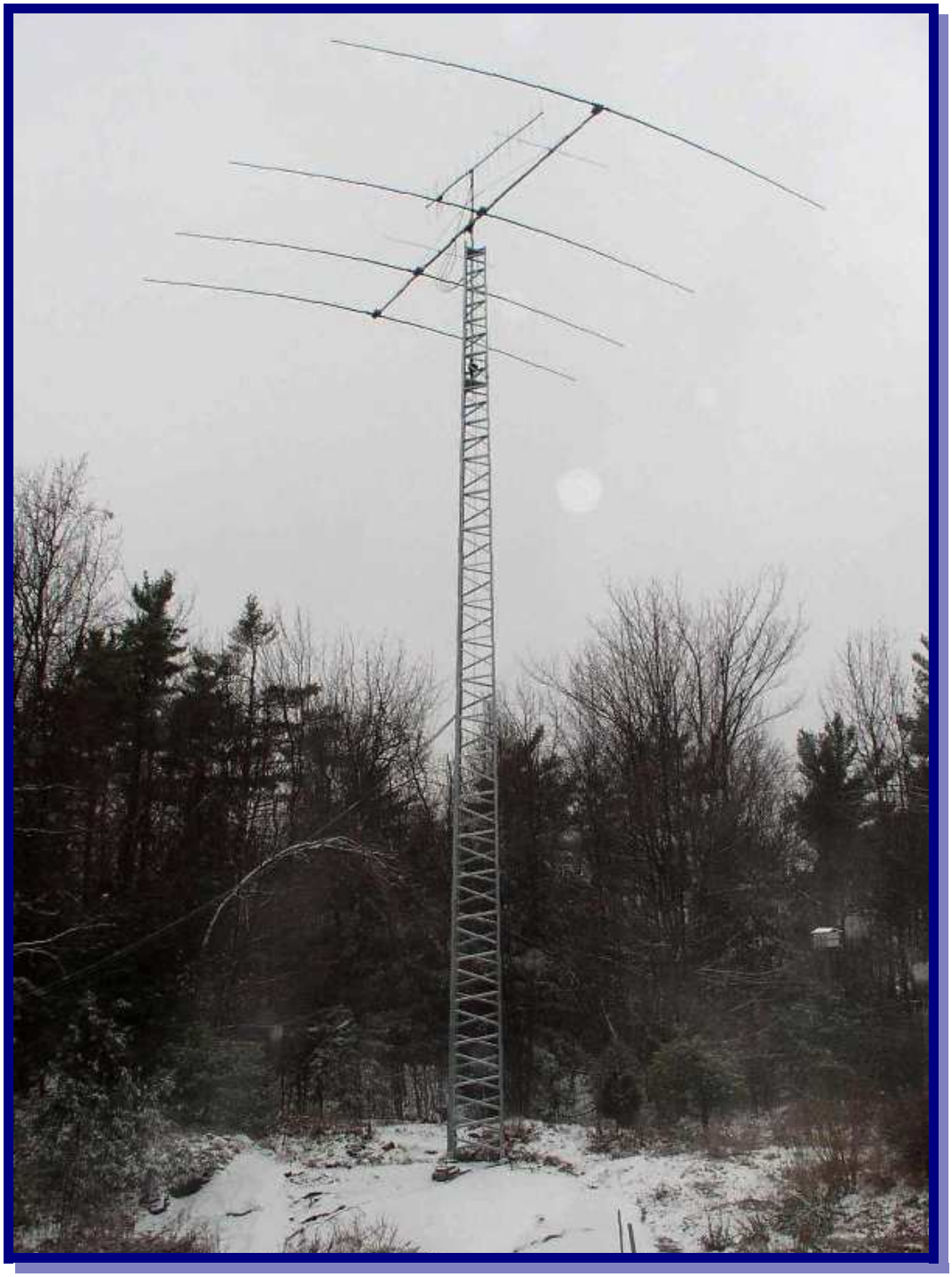
StepplR™ Antenna Systems

Yagi ● Dipole ● Vertical (Patented)

4 Element Yagi Instruction Manual



SteppIR Antennas

2112 116th Ave NE, Suite 2-5 - Bellevue, WA 98004

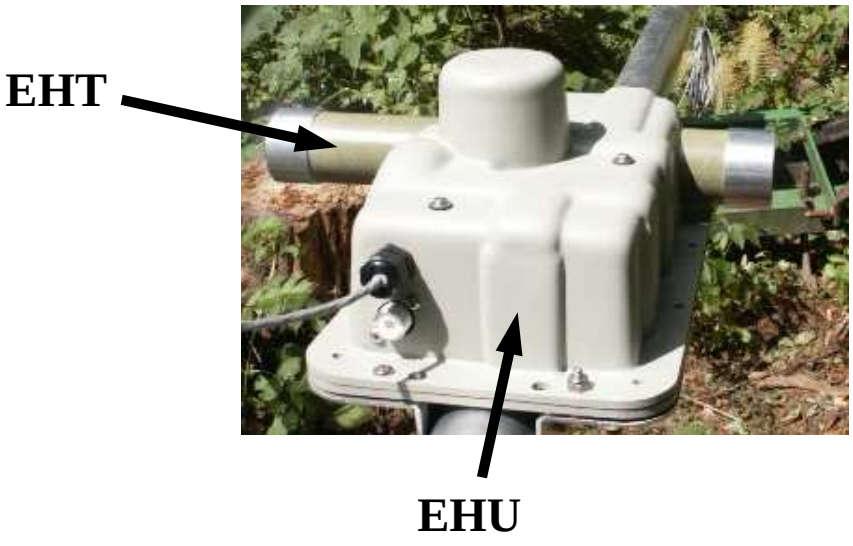
Tel: 425-391-1999 Fax: 425-462-4415 Toll Free: 866.783.7747

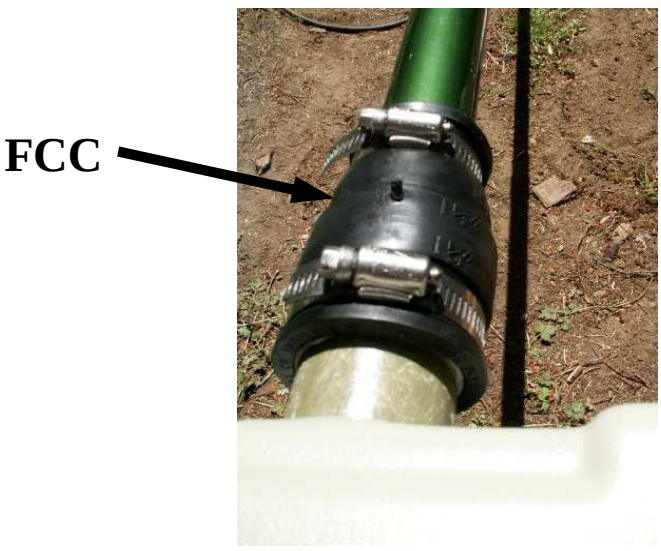
www.steppir.com

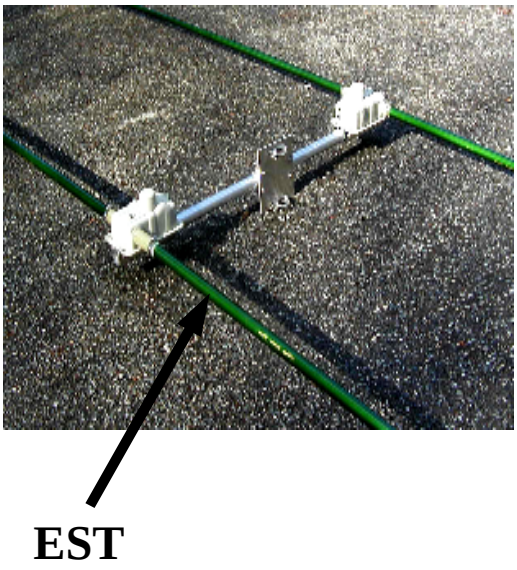
Rev: G 06/28/07

Abbreviations

EHT	Element Housing Tube
EHU	Element Housing Unit
EST	Element Support Tube (pole)
FCC	Flexible Connection Coupler (rubber)







SteppIR Antenna Information Web Sites(as of 4/09/07)

http://steppir.com/
http://groups.yahoo.com/group/steppir/

SteppIR - Why Compromise?

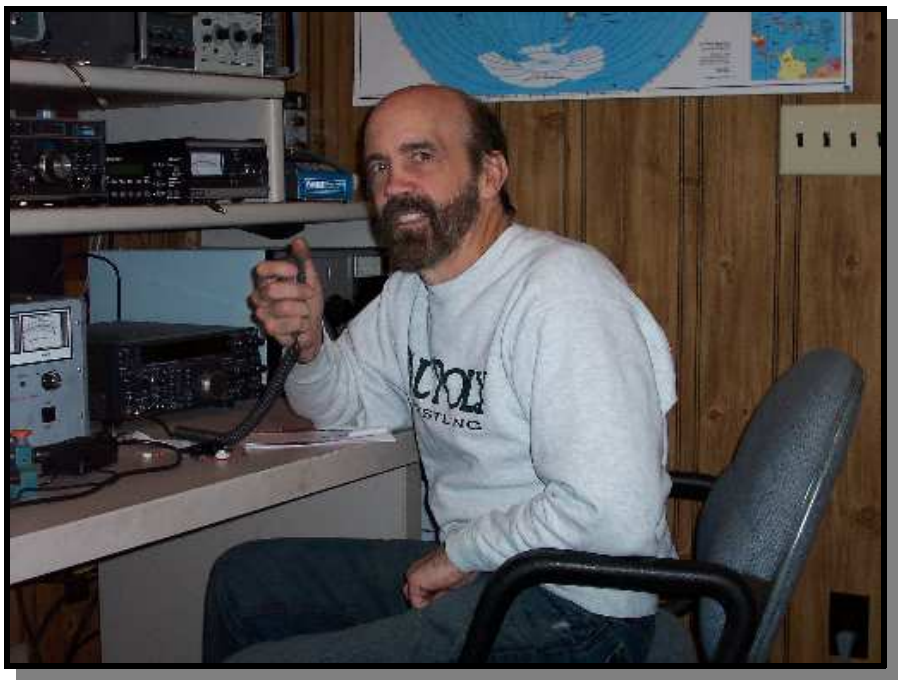
The SteppIR antenna was originally conceived to solve the problem of covering the six ham bands (20m, 17m, 15m, 12m, 10m and 6m) on one tower without the performance sacrifices caused by interaction between all of the required antennas.

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

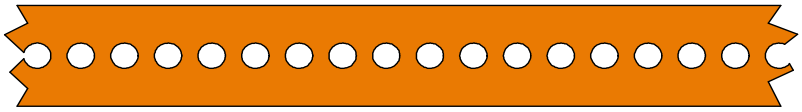
Michael (Mike) Mertel - K7IR
President

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. Resonant antennas must be made a specific length to operate optimally on a given frequency.

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

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



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 48" in length. Depending on the model, their may be additional extensions added to increase the overall element length.

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

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

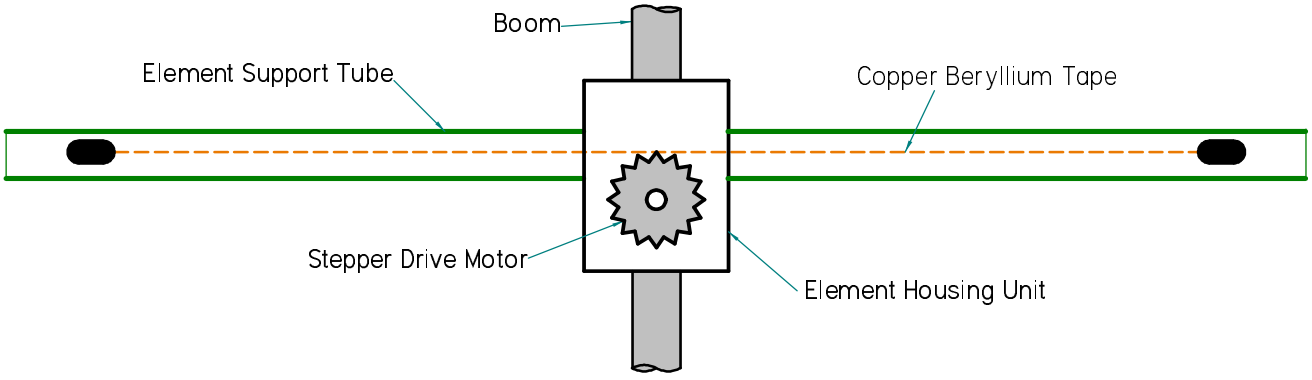


Table of Contents

Warning: Do not connect the antenna controller box or apply power to the antenna until instructed to do so. Otherwise, you may upset factory calibrations and possibly damage components.

PARTS LIST

Item	QTY	Part #	Description
	1		Assembly Instructions
	1		Operators Manual
	1		SteppIR™ antenna controller
	1		Power supply for controller (1)
	7		Aluminum boom sections (2)
	2		Boom to mast plate 11.5” x 11.5”
	1		Driven element housing unit
	3		Passive element housing unit (3)
	8		Green fiberglass element support tubes
	8		Flexible connection couplings
	1		16 Conductor control cable, 22 AWG shielded (sold separately) (4)
			BOOM ASSEMBLY PACK
	8		1/4-20 x 3” Bolt
	2		1/4-20 x 2.50” Bolt
	10		1/4-20 Nylock nut
	2		2-1/2” U Bolt
	4		2” Extended leg U Bolt
	12		5/16” Nylock nuts

PARTS LIST

Item	QTY	Part #	Description
			TRUSS ASSEMBLY PACK
	26 ft		1/8" Phillystran Kevlar® guy wire
	1		2" U Bolt
	4		5/16" Nylock nuts
	1		2" flat plate with poles
	16		3/16" Wire clips, galvanized
	4		3/16" Thimble, galvanized
	2		1/4" x 4" Turnbuckle, galvanized
	3		5/16" x 4" Eye bolt w/ nut and lock washer
	1		3/8" x 3" full thread bolt, 3 nylok nuts & 2 3/8" flat washers (EZeye™ components) (5)
			TERMINAL STRIP / EHU PACK
	1		2" OD PVC tube with 2 end caps attached (6)
	2		8 position terminal strip (7)
	1		1 position ground strip (7)
	1		#56 Stainless hose clamp
	2		Blue packet of connector protector (8)
	32		#10-32 x 3/4" Phillips screw w/ Nylock nut and flat washer (in own folded bag)
	2		All weather electrical tape
	2		20 ft Black silicone self curing wrap

(1.) Includes two power cords; one AC and one attached 24 volt

(2.) Element-to-boom brackets have been factory installed on 4 of the boom sections. Lengths consist of: two 1-3/4" x 48"; two 2"x72"; two 2.25"x48"; one 2.5"x72")

(3.) Two reflectors and one director; each unit is identical

(4.) Length as specified when ordering antenna; 25 pin DB-25P factory installed on one end

(5.) EZeye™ is used to support the boom while connecting to mast plate, and for leveling of elements

(6.) One cap has been glued in place. The other is attached but not glued

(7.) Packed inside the PVC tubing

(8.) Use this compound for protecting the control cable wires and a small amount for easing installation of flexible connection couplers

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. 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 element support tubes
- Attaching the fiberglass element support tubes to the element housing units
- Installing the optional 6M passive elements (if ordered)
- Installing the boom truss support assembly

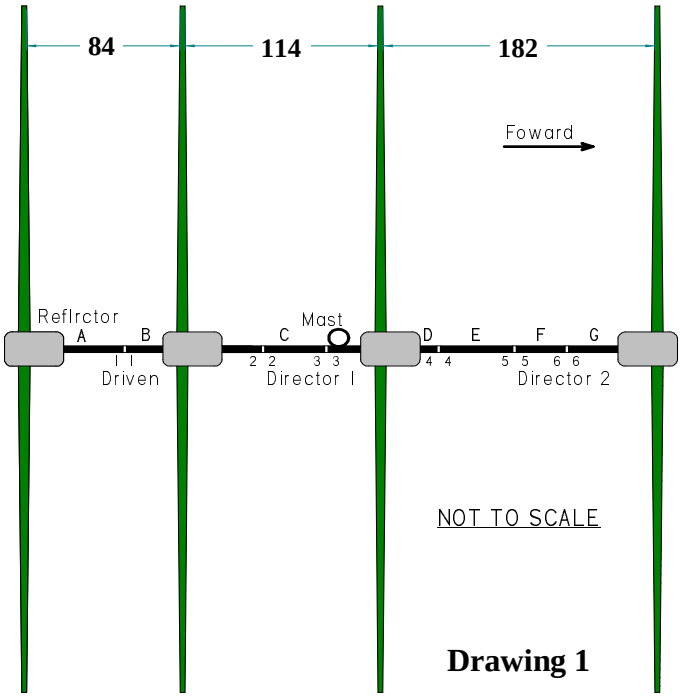
Build the Boom

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 next 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 2.50” w / nylock nut	1
1*	5/16” x 4” Eyebolt / nut	1
2	1/4-20 x 3” w /nylock nut	2
3	1/4-20 x 3” w / nylock nut	2
4	1/4-20 x 3” w / nylock nut	2
5	1/4-20 x 3” w / nylock nut	2
6	1/4-20 x 2.50” w /nylock 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**)


Figure 2

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** . Insert the required bolts into the holes and loosely attach them with the 1/4" nylock nuts. 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 nylock 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 3

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.


Figure 4

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.

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 21 pre-drilled holes (**Figure 4.5**). The 2" mast holes are used to secure the antenna to the mast on your tower. The optional pilot holes are there in the event you are using a 2-1/4" mast. If you are using a 2" mast, the optional holes are left unused. 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.

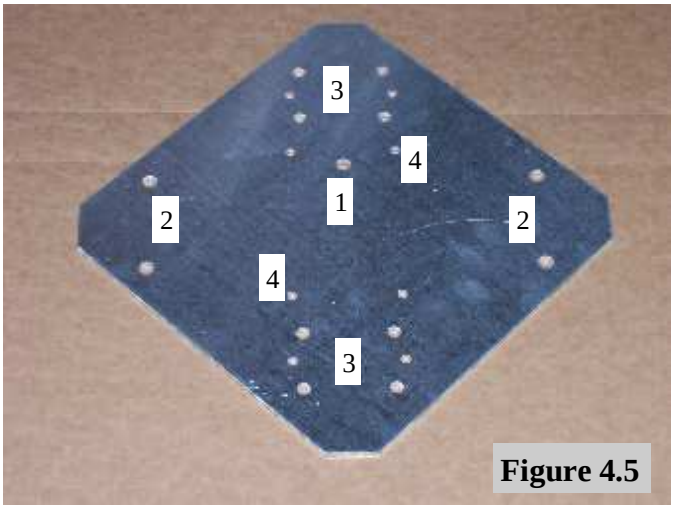


Figure 4.5

1) EZeye™ – 1 Hole .402 dia.
2) 2 1/2" Boom – 4 Holes .402 dia.
3) 2" Mast – 8 Holes .344 dia.
4) Not Used – 8 Holes .257 dia.

Locate:

- Two boom-to-mast plates (**Figure 5**)
- One 3/8x16x 3" fully threaded bolt (EZeye™ bolt)
- Three 3/8x16x nut
- One 3/8 lock washer
- Two 3/8 flat washer
- Four 2" U-bolts with saddles, lock washers and nuts
- Two 2 1/2" U-bolts with saddles, lock washers and nuts

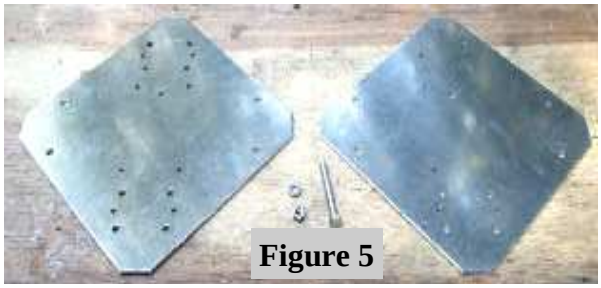


Figure 5

Insert the 3/8x16x 3" fully threaded bolt through the EZeye™ hole in both mast plate add a lock washer and 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, lock washers and nuts and 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.

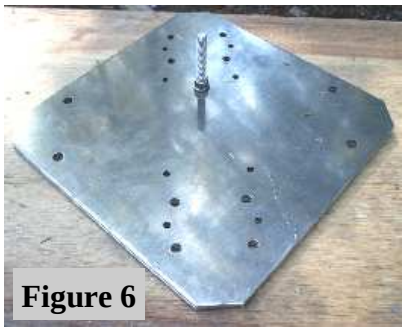


Figure 6

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.

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.


Figure 7

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**).

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

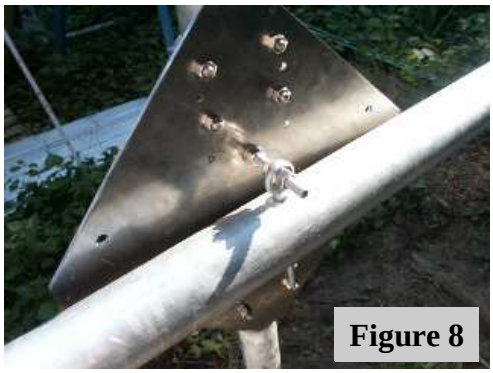


Figure 8


Figure 9

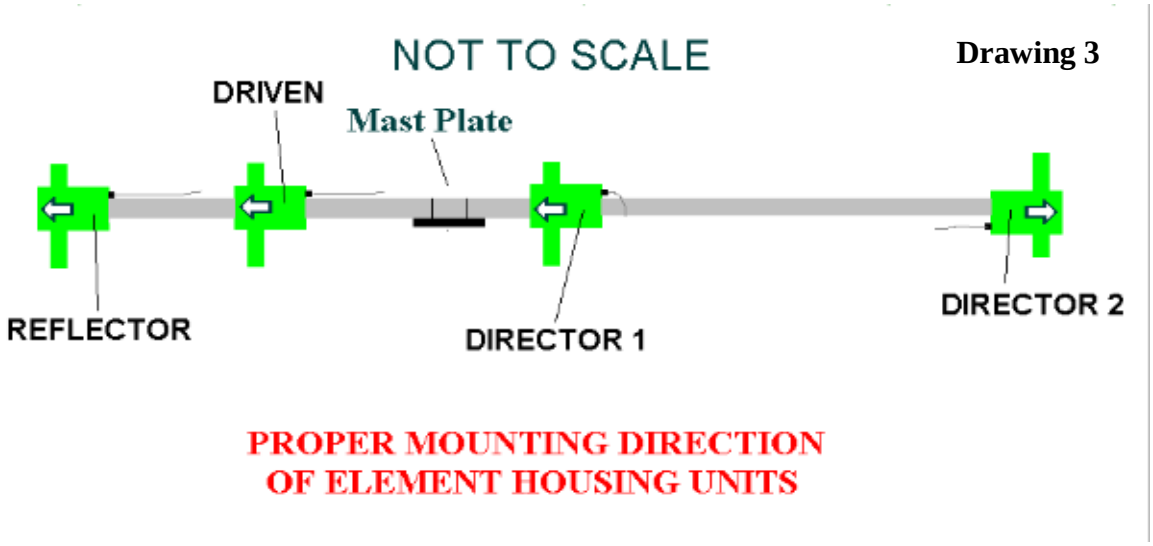

Figure 10

Secure the Element Housing Units to the Element-to-Boom Brackets

Locate the 4 element housing units (EHUs). One of them will have an SO-239 coax connector (or the optional "N" connector) below the gray control cable (**Figure 11**). **This EHU is for the driven element.**

The other three EHUs are for the reflector and two directors (parasitic elements). Each EHU has the same length control cable, you can trim them to length if you desire, once they have been secured to the boom. All of the parasitic EHUs are interchangeable in that it does not matter which one you use for the directors or reflector. Observe that the olive green element housing tubes (EHTs) on the end of each EHU appear to be uneven in length (**Figure 12**). This is by design. They are centered inside the housing.

Proper EHU orientation is critical to operation of the antenna. Make sure they are installed on 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 nylock nuts.

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

Each of the four EHUs has a four conductor control cable attached to it using a waterproof strain relief fitting. These fittings were properly tightened at the factory and should not be disturbed. The other end of these control cable have stripped and tinned wires that will be connected to the terminal strips that were shipped with the PVC tub 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

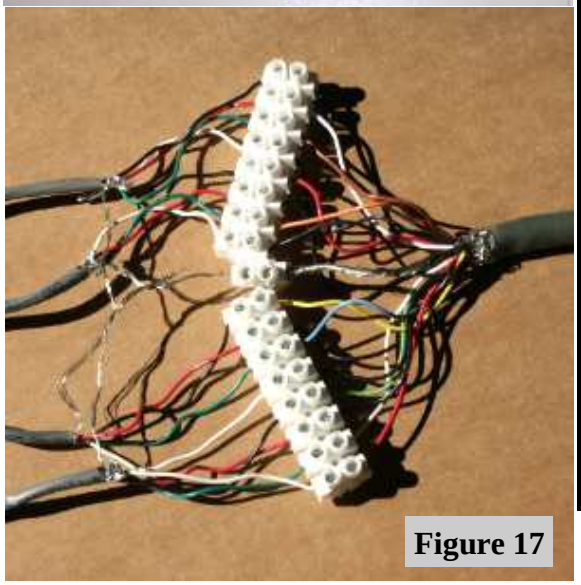
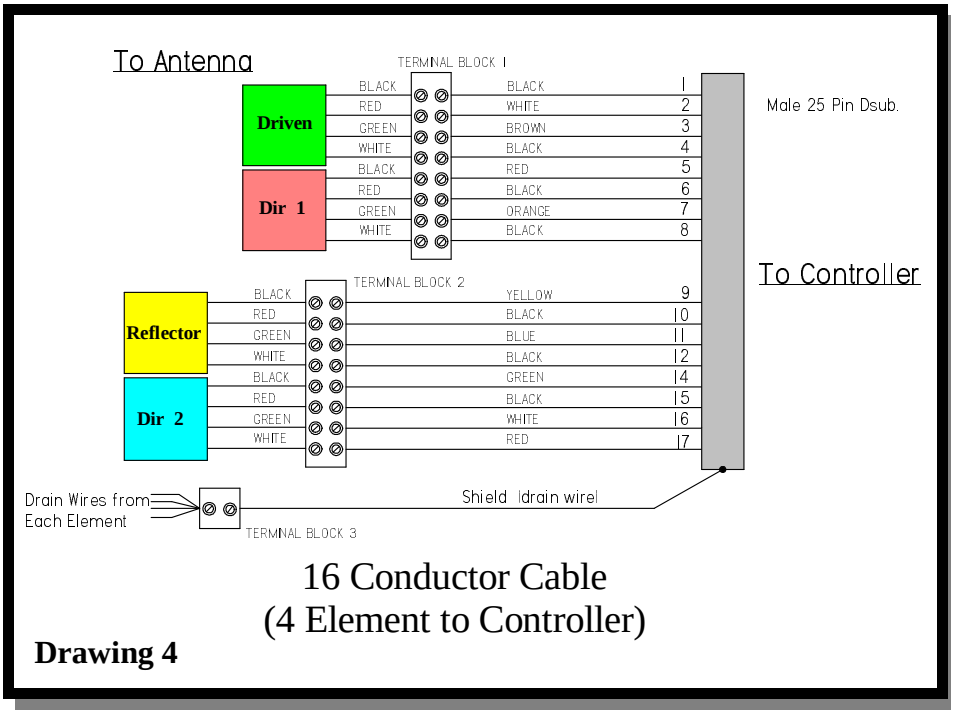


Figure 17



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.

Note: If you ordered the 16 conductor control cable, it is included in your antenna kit. The required 25 pin connector has been installed on one end and the factory has stripped and tinned the wires on the other end. If you did not order this cable, you must supply it yourself, wire the 25 pin DB-25P connector and prepare the other end. In such case, a separate connector, back shell and cable wiring drawing have been included in your kit. Call the factory if you would like a cable prepared for you.

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: 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. The 16 conductor control cable has eight pairs of wires, each pair twisted together and with heat shrink at the factory. **It is imperative that these twisted pairs do not get mixed up, or you will have to use an volt/ohm meter to ascertain which pairs match correctly. Figure 18** shows the respective pairings: black/white; brown/black; red/black; orange/black; yellow/black; blue/black; green/black and white/red. This sequence is exactly the order in which to connect the wires, as shown in **Drawing 4**. Follow the same procedure as above and connect each colored wire. **Coat each wire with connector protector. Don't forget to coat the bare ground 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**.

   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. Put a couple of raps 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. Fasten the wiring enclosure to the boom using the stainless steel hose clamp as shown in **Figure 22.** This completes the required wiring.

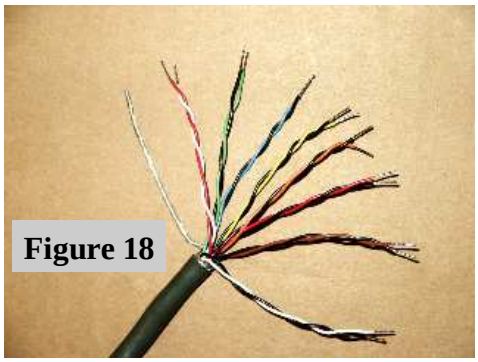


Figure 18

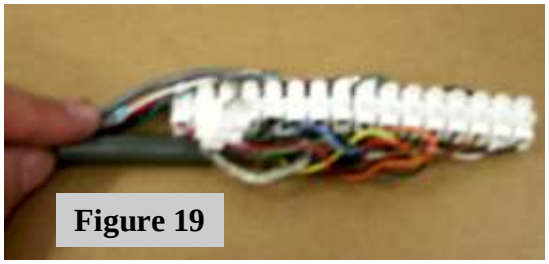


Figure 19


Figure 20

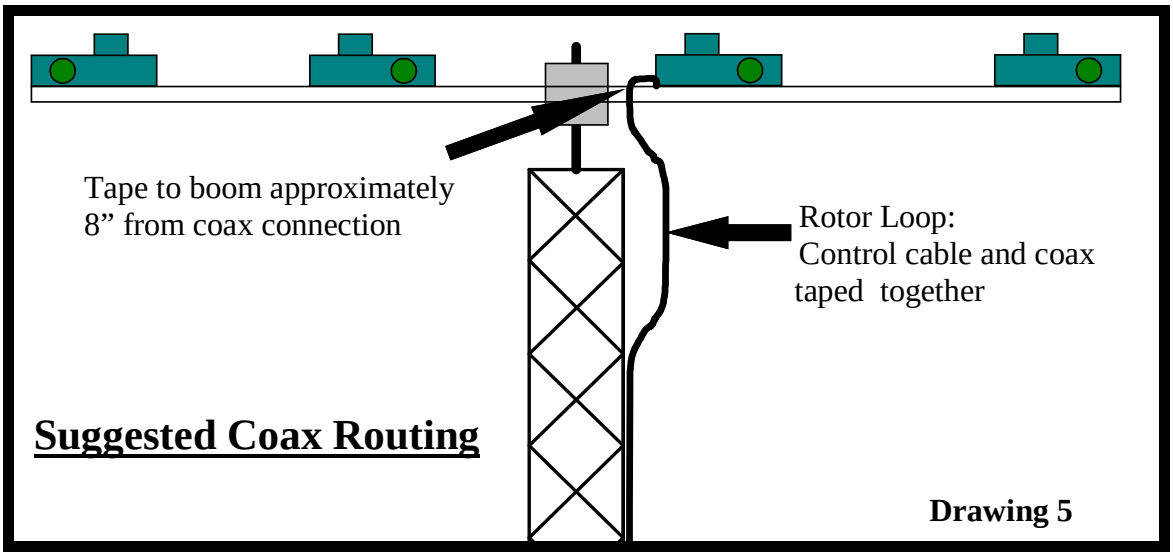
Attach the Wiring Enclosure and Control Cable to the Boom

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 as shown in **Figure 23.** 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.



Prepare the Telescoping Fiberglass Element Support Tubes

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.


Rubber Boots

Locate:

- Eight dark green fiberglass telescoping poles (**Figure 24**) *
- Eight black rubber boots with clamps
- Rolls of black electrical tape **
- Rolls of black silicone self-curing tape **
- Your tape measure

Electrical Tape

		Normal	W/Optional 40-30 Dipole Kit
*	4 Element —	8 poles	(10)

** The quantity of tape provided will depend on the number of elements.

Note: The reinforcing rings/sections on the first two pole sections provides extra strength in potential high wind conditions (**Figure 26.5**).

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

Telescope a pole to full length by pulling each section out **firmly** in a twisting motion until it is extended as far as possible. **Each segment is tapered and should lock securely in place when fully extended.** 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 24**). **Verify the length for each pole before installation or wrapping the joints.**

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.

At the factory when we quality check the poles to verify that they meet minimum length we hold the butt (large) end and whip it like we were casting a fishing pole with considerable force. This procedure can produce a significant difference in the extended length of some poles as a last resort if nothing else works.

DO BE CAREFUL !!!

Warning: **Make sure** to remove the black rubber plug from the base section of each of the telescoping element support tubes (poles). This is a shipping plug for handling convenience and will seriously damage the copper-beryllium strips and drive mechanisms if not removed.

Check all four sections of each pole for packing popcorn or any other foreign object that could interfere with the copper tape movement.

There are foam plugs glued in the small end of each of the dark green telescoping poles. These plugs allow the poles to breathe preventing the buildup of condensation inside. Do NOT remove, block, cover, plug, cap or in any way inhibit air flow through this foam plug filter.

Figure 25

Figure 26

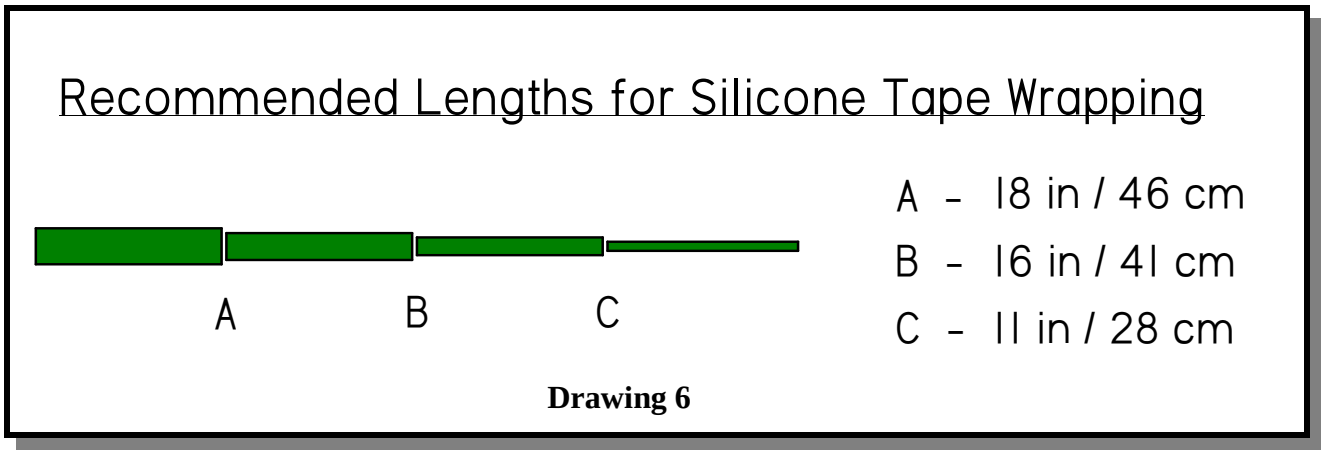
Note: The telescoping element support tubes will not all be the same length, this is not a problem as long as they are a minimum of 17’ 8”. They are interchangeable and can be used in any element position

Next wrap each joint on the fiberglass poles with the all weather electrical tape, see **Figure 25**. Each joint should have at least the full width of the tape on both sides of the joint. Use common sense on the amount of tape or you will not have enough of the silicon tape used later to cover the electrical tape.

Figure 26.5

Exception: On joints with metal reinforcing rings (**Figure 26.5**), the tape must go further so it extends a minimum of 3/4” beyond the metal ring and onto the fiberglass pole.

Apply one complete wrap of electrical tape around the fiberglass tube as you begin, and then work your way across the joint and back using half overlap wraps, **so that the entire area is seamlessly covered.** Carefully stretch and smooth the tape with your fingers as you apply it, especially when you change directions - this will help avoid ripples and have the tape lie as smoothly as possible. At the end of the run, cut the tape with a knife or scissors and press the end onto the pole. Then run your hand over the tape a couple of times to firm up the bonding.



Drawing 6

Next, you will weatherproof and UV protect each joint with the black self-curing silicone tape see **Figure 26**. **It is important that you pre-cut the silicone tape to the recommended lengths**. If you do so, you will have more than enough for each joint. Refer to **Drawing 6** for proper lengths for each joint. In the event you require more silicone wrap, you can order more from SteppIR. Sometimes it can be found at a hardware store or a marine supply store.

IMPORTANT: **Per the manufactures specifications the silicone tape has a shelf life of 12 months before it is used and should be stored in a cool dry environment. Silicone tape will not stick to just any surface. It only bonds to itself. Be sure to remove all the connector protector residue from your hands before handling silicone tape, as that residue will cause the silicone wrap not to adhere to itself in places. Take care to keep the silicone wrap free of dirt or debris. Also, this tape MUST be cut. Do not tear it. Wash your hands before completing the following steps.**

Position the black silicone tape about 1/2" to the right of the black electrical tape and wrap one layer, **continually stretching the silicone tape a minimum of 100 % its original length**, completely around the pole so the tape fully overlaps itself. Then slowly wrap the silicone tape to the left using half overlap wraps, extending about 1/2" beyond the black electrical tape. When you reach the end, wrap one layer completely around the pole so the tape fully overlaps itself just as you did at the beginning of the wrap. If you are stretching the tape correctly you will get about two layers of tape at each joint. As before, carefully stretch and lay the tape down as smooth as possible. The final joint should look like **Figure 26**.

Important: After the silicone tape has been applied, be sure to rub each wrap with your hand several times to ensure that it is flat and has adhered to itself.

Attach the Fiberglass Element Support Tubes to the Element Housing Units

The butt ends of the green fiberglass poles may vary slightly in outside diameter. Some of them may have been sanded, while others were not. The colors at the ends will be either natural, or black. The difference in colors has no 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, but in the event the pole just won't fit it is okay to sand it to fit.

The EHTs on the EHUs have aluminum reinforcing rings attached to provide extra strength in high wind conditions (**Figure 27**).

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

1. **Remove** the black rubber shipping plug from the but (large) end of the fiberglass poles (EST).

2. Place the narrow end of an FCC onto the butt end of an EST. Slide it about 6" out onto the EST (**Figure 28**).

Figure 27


Figure 28


Figure 29


Figure 30

3. Insert the butt end of that EST into one of the EHTs on an EHU, as shown in **Figure 29**. **It is very important to ensure that the butt end of the EST firmly bottoms out inside 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. This ensures that the hose clamp and rubber boot can grip onto the fiberglass and the ring will prevent the rubber boot from ever coming off. The correct mounting position of the rubber boot is shown in **Figure 30**. Note that current production antennas now have a narrower aluminum ring (.4").

4. 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) 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.

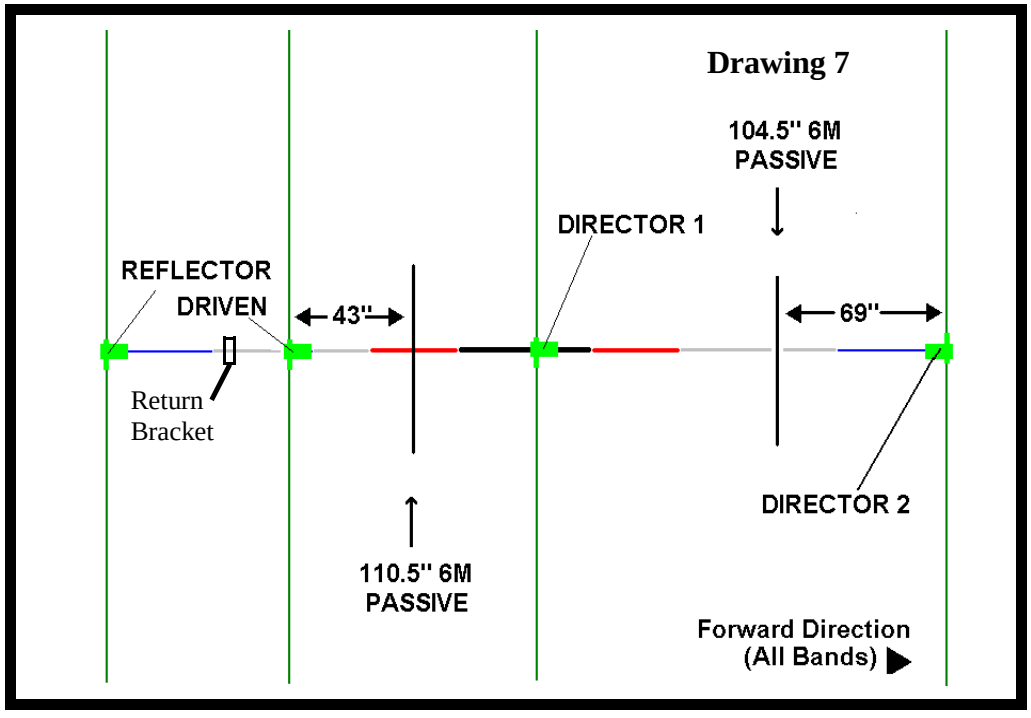
Install the Optional 6 Meter Passive Element (If ordered)

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.



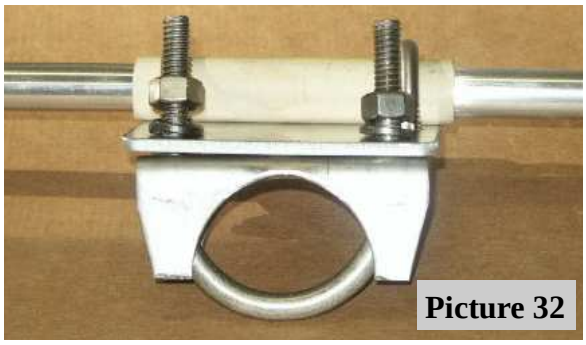
Note: Verify that the long element measures 110.5" and the short element measures 104.5".

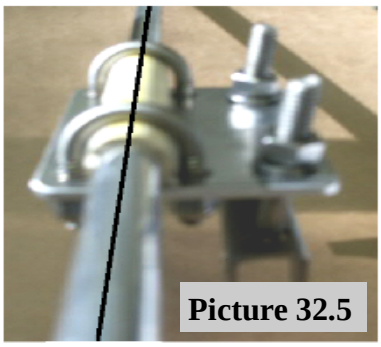
Securely fasten the pieces together with the 6-32x3/4" machine screws and nylock nuts and install the U-bolt on the center bracket as shown in **Picture 32.5.**

The 6M passive elements should be mounted on the bottom 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 MEASURMENTS 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" nylock 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 nylock 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" nylock 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 37** and **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.

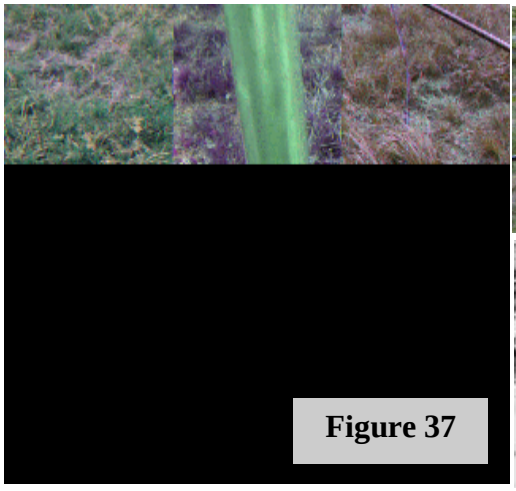


Figure 37


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 yagis. The modeling also takes into account the changing electrical boom length as frequency changes. When the 180 degree function is enabled, a new Yagi is created that takes into account the change in element spacing and spacing and in the case of 4 element antennas creating a two reflector antenna to get maximum use of all elements . The result is slightly different gain and front to rear specifications.

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

There are three factors that make our antennas outstanding performers:

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

Fixed Element Spacing and the SteppIR Yagi

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

RF Power Transmission with the SteppIR Yagi

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

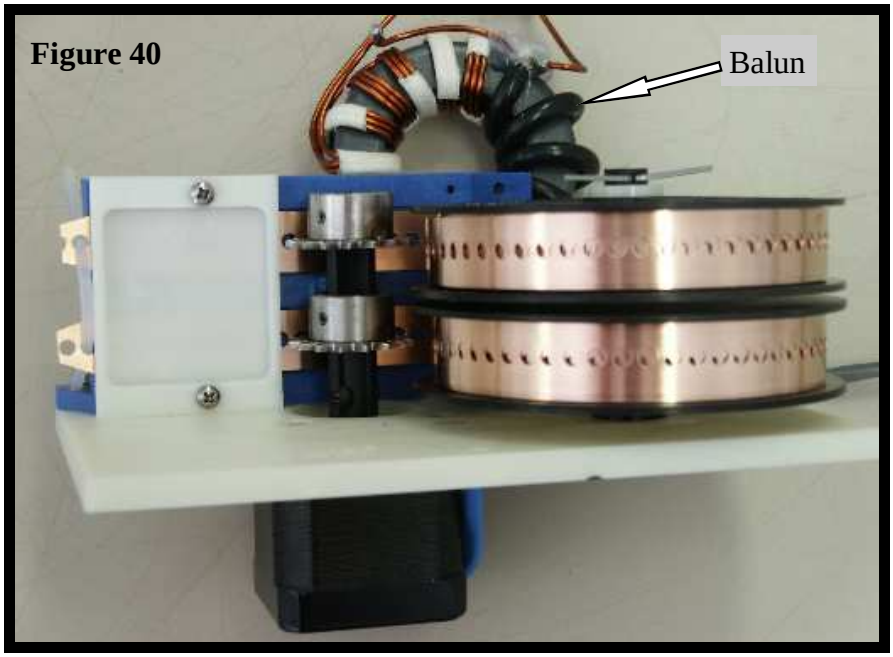
WARNING: WHEN OPERATING WITH MORE THAN 200 WATTS, DO NOT TRANSMIT WHILE THE ANTENNA IS CHANGING BANDS. A MISMATCH AT ELEVATED WATTAGES MAY CAUSE DAMAGE TO THE DRIVEN ELEMENT.

Balun / Matching System

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

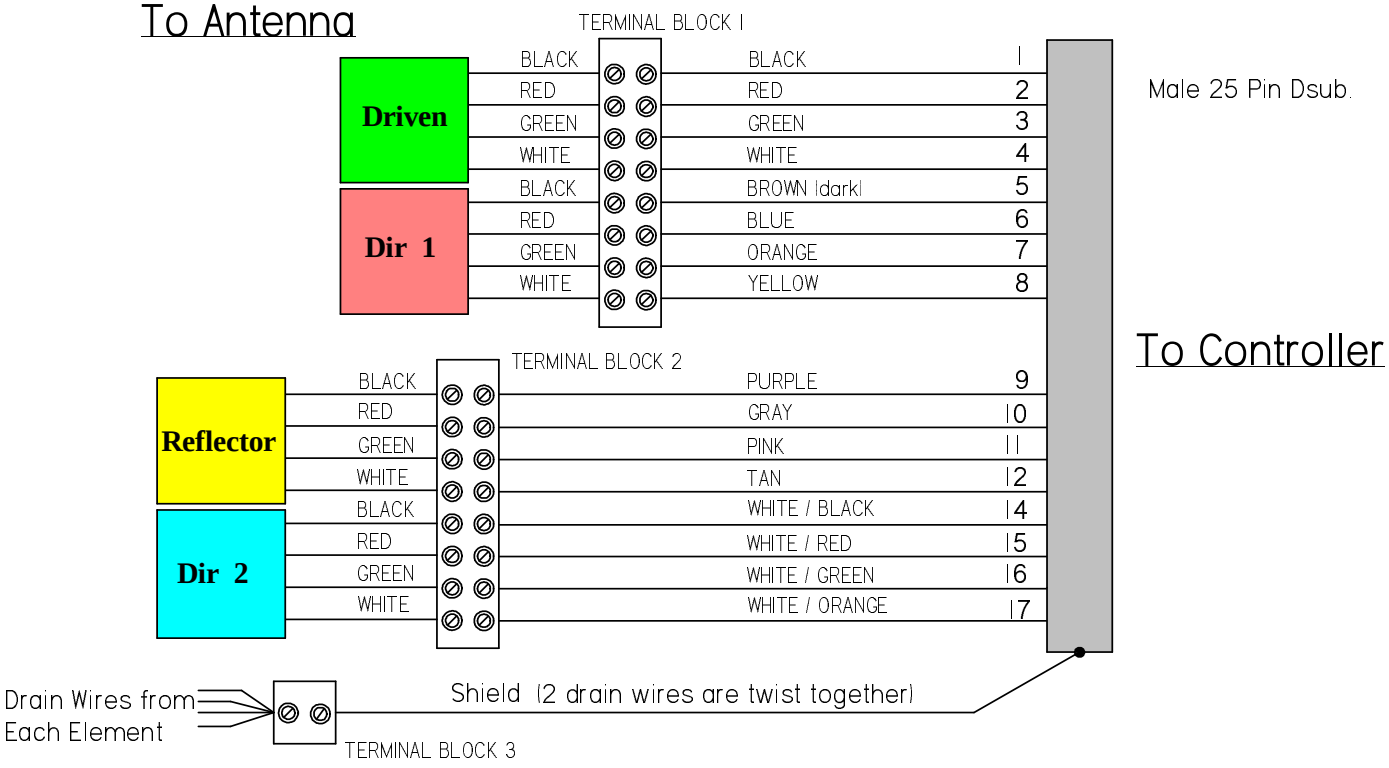
Our matching network is a transmission line transformer that is wound on a 2.25 inch OD ferrite core that operates with very little internal flux (**Figure 40**), thus allowing it to function at very high power levels. The transformer includes a 22 ohm to 50 ohm unun and a balun wound with custom made, 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



Notice

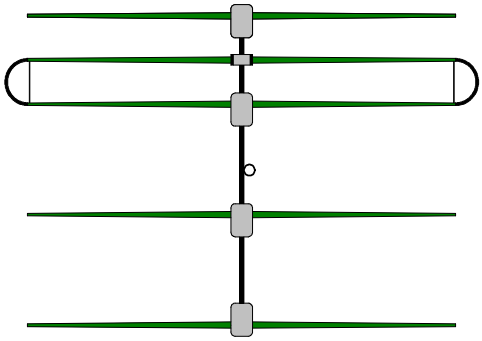
Soon we will be shipping 16 conductor control cable from a new vendor so we are providing the wiring diagram and color scheme so you have the proper instructions for which ever cable is shipped with your antenna. Both cables are essentially the same except for the wire color scheme.



16 Conductor Cable
(4 Element to Controller)
{Alternate Vendor}

SteppIR Options

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

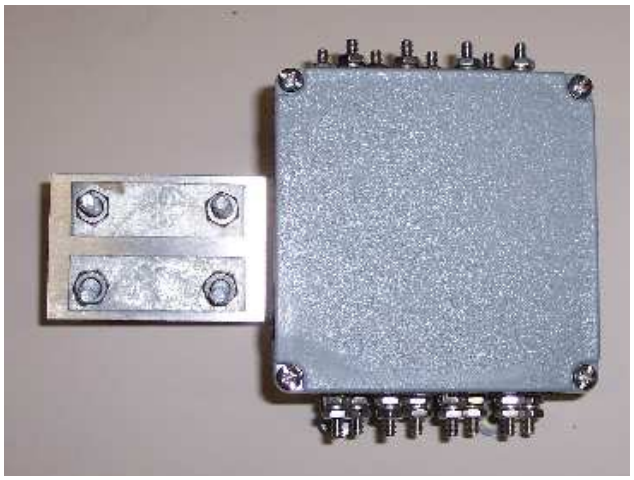


- **“Y” Cable**

- **Transceiver Interface (Rig Specific)**

- **6m Passive Element Kit**

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



- **Element Expansion Kit**

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

SteppIR™
Antenna Systems
www.steppir.com

Limited Warranty

These products have a limited warranty against manufacturer's defects in materials or construction for two (2) years from date of sale. Do not modify this product or change physical construction without the written permission of SteppIR Antennas Inc. This limited warranty is automatically void if improper selection, installation, unauthorized modifications or physical abuse beyond the manufacturer's control has occurred. Manufacturer's responsibility is strictly limited to repair or replacement of defective components. The manufacturer assumes no further liability.

Thank you for choosing SteppIR!!

4 X 4 Stack

SteppIR™

Antenna Systems

Yagi • Dipole • Vertical

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