

SteppIR™ **Antenna Systems**

Yagi • Dipole • Vertical (Patent # 6,677,914)

3 Element Yagi Instruction Manual



Antarctica at 75 mph

SteppIR Antennas

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Rev: N 10/17/07

Abbreviations

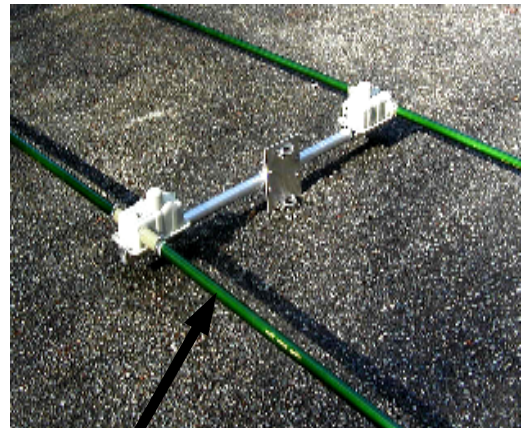
EHT	Element Housing Tube
EHU	Element Housing Unit
EST	Element Support Tube (pole)
FCC	Flexible Connection Coupler (rubber)

EHT



EHU

FCC



EST

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 or log periodic techniques, but do so at the expense of significant performance reduction in gain and front to back ratios. With the addition of the WARC bands on 17m and 12m, the use of interlaced elements and traps has clearly been an exercise in diminishing returns.

Obviously, an antenna that is precisely adjustable in length while in the air would solve the frequency problem, and in addition would have vastly improved performance over existing fixed length yagis. The ability to tune the antenna to a specific frequency, without regard for bandwidth, results in excellent gain and front to back at every frequency.

The SteppIR design was made possible by the convergence of determination and high tech materials. The availability of new lightweight glass fiber composites, Teflon blended thermoplastics, high conductivity copper-beryllium and extremely reliable stepper motors has allowed the SteppIR to be a commercially feasible product.

The current and future SteppIR products should produce the most potent single tower antenna systems ever seen in Amateur Radio! We thank you for using our SteppIR antenna for your ham radio endeavors.

Warm Regards,

Mike Mertel

*Michael (Mike) Mertel - K7IR
President*

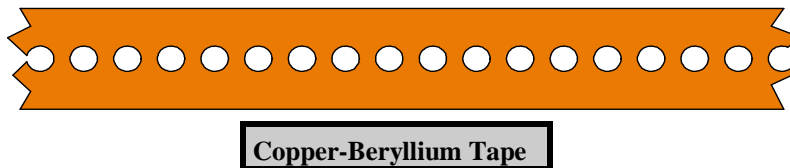


SteppIR Design

Currently, most multi-band antennas use traps, log cells or interlaced elements as a means to cover several frequency bands. All of these methods have one thing in common—they significantly compromise performance. The SteppIR™ antenna system is our answer to the problem. Yagi antennas must be made a specific length to operate optimally on a given frequency.

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

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



The copper-beryllium tape is driven out into a hollow fiberglass elements support tube (see below), forming an element of any desired length up to the limit of each specific antenna model (a vertical uses only one side). The fiberglass elements support tubes (poles) are telescoping, lightweight and very durable. When fully collapsed, each one measures approximately 57” in length. Depending on the model, there may be additional extensions added to increase the overall element length.

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

The antenna is connected to a microprocessor-based controller (via 22 gauge conductor cable) that offers numerous functions including dedicated buttons for each ham band, continuous frequency selection from 80m to 6m (depending on the model). There are also 17 ham and 6 non-ham band memories and you can select a 180° direction reversal* or bi-directional* mode and it will adjust in just about 3 seconds (* yagi only).

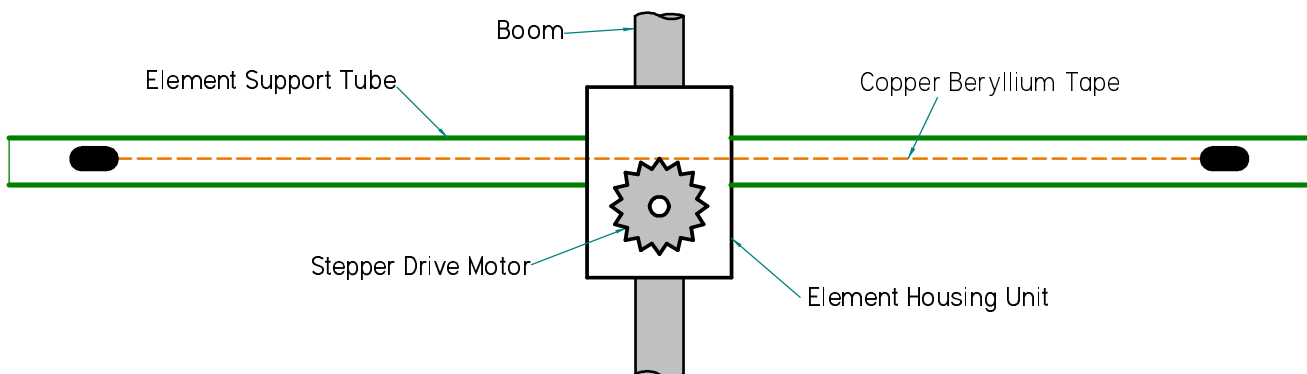


Table of Contents

<i>Topic</i>	<i>Page</i>
Abbreviations	2
SteppIR “Why Compromise”	3
SteppIR Design	4
Table of Contents	5
Parts List	6
Boom Assembly	7
Element Spacing and Position Drawing	8
Attaching Element Housing to the Boom	10
Connecting Control Cable	11
Control Cable Connection Drawing	12
Preparing Telescoping Fiberglass poles	14
6 Meter Passive Element Installation (optional)	18
SteppIR Options	19
SteppIR Warranty	21

PARTS LIST

ITEM	QTY	PART #	DESCRIPTION
BOX 1	1		Instruction Manual
	1		Operators Manual
	1		Controller
	1		Power Supply
	1		Driven Element Housing
	2		Passive Element Housing
	1		Mast Plate
	1		Boom (4 sections)
	6	10-1013-01	Telescoping Pole (18 Foot - 4 Segment - Fiberglass)
	6	60-1006-01	Quick Disconnect Boot (1.5" to 1.25") (Fernco)
	1		Control Cable (12 conductor)

PARTS LIST

ITEM	QTY	PART #	DESCRIPTION
Connector Kit			
	1	10-1102-21	1-1/2 x 7" PVC Tube (Terminal Enclosure)
	1	60-1009-01	ABS Plug (End Cap for Terminal Enclosure)
	1	60-6000-35	3" Hose Clamp
	1	20-6020-12	12 Position Terminal Strip
	1	20-6020-01	1 Position Terminal Strip
	1	10-1029-01	Connector Protector (Blue Packet)
Hardware			
BAG 1	2	09-0001	Electrical Tape (3/4" x 66' Roll)
	1	09-0003	Silicone Tape (20' Roll)
	1	09-0004	Silicone Tape (10' Roll)
	2	60-0003	1-3/4 U-Bolt & Saddle
	2	60-0004-02	2" U-Bolt & Saddle (4" Long Reach)
	3	60-0062	1/4-20 x 2-3/4" SS Bolt
	3	60-0030	1/4-20 SS Nylok Nut
	8	60-0046	5/16-18 SS Nylok Nut
	15	60-0041	1/4" SS Flat Washer
	26	60-0061	#10-32 x 7/8 SS Panhead Screw
	12	60-0017	#10-32 x 3/4 SS Panhead Screw
	26	60-0018	#10 SS Washer
	38	60-0019	10-32 SS Nylok Nuts

Assemble the Boom & Connect to Mast Plate

The 3 element SteppIR Yagi boom consists of four sections shown in **Figure 3**. The element mounting brackets are pre-installed at the factory. We double check the fasteners for proper tightness before shipping but it is always a good idea to check them yourself before installing the antenna.

The boom is completely assembled and drilled at the factory to assure precision element alignment. You may notice in some cases that on a given splice (**Figure 5**) the holes on each side of the splice are at 90 degrees with each other. This is as designed and not a mistake. Pre-drilled holes are quite snug to align almost perfectly. In some cases you may find it necessary to assist the bolts with a tap of a hammer, or “thread” them in by turning with a wrench. If the holes are visibly out of alignment when you are assembling the boom, you probably have the boom pieces put together in the wrong order.

Each piece of the boom has a number permanently written, scribed or stamped on it (**Figure 5**). Match each number with the exact same number of a corresponding boom piece. **Figure 13** shows how each boom section is numbered. Connect the boom by sliding the respective sections together and align the pre-drilled holes (**Figure 7 and 9**). It is advisable to apply a very thin film of **connector protector** (**Figure 1** - supplied) or spray a small amount of WD-40 on the male sleeve before sliding the female section onto it. Do not twist the aluminum excessively, as this can cause binding.

Note: Put a small amount of **connector protector** (supplied) or anti-seize grease on all bolts 1/4” or larger, especially on the u-bolts - it greatly increases their gripping power. Anti-seize grease (molybdenum based) is available at most auto part stores.

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

Insert the included bolts into the pre-drilled holes, and tighten the Nylok nut securely (**Figure 11**).



Figure 1

Note: Make sure the boom bolts for the center splice (#2) are installed as shown in **Figure 19**, if you install them the opposite way the bolt will interfere with the mast plate.

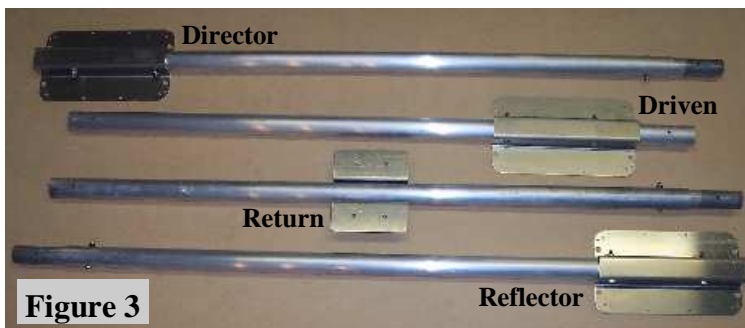


Figure 3



Figure 5



Figure 7



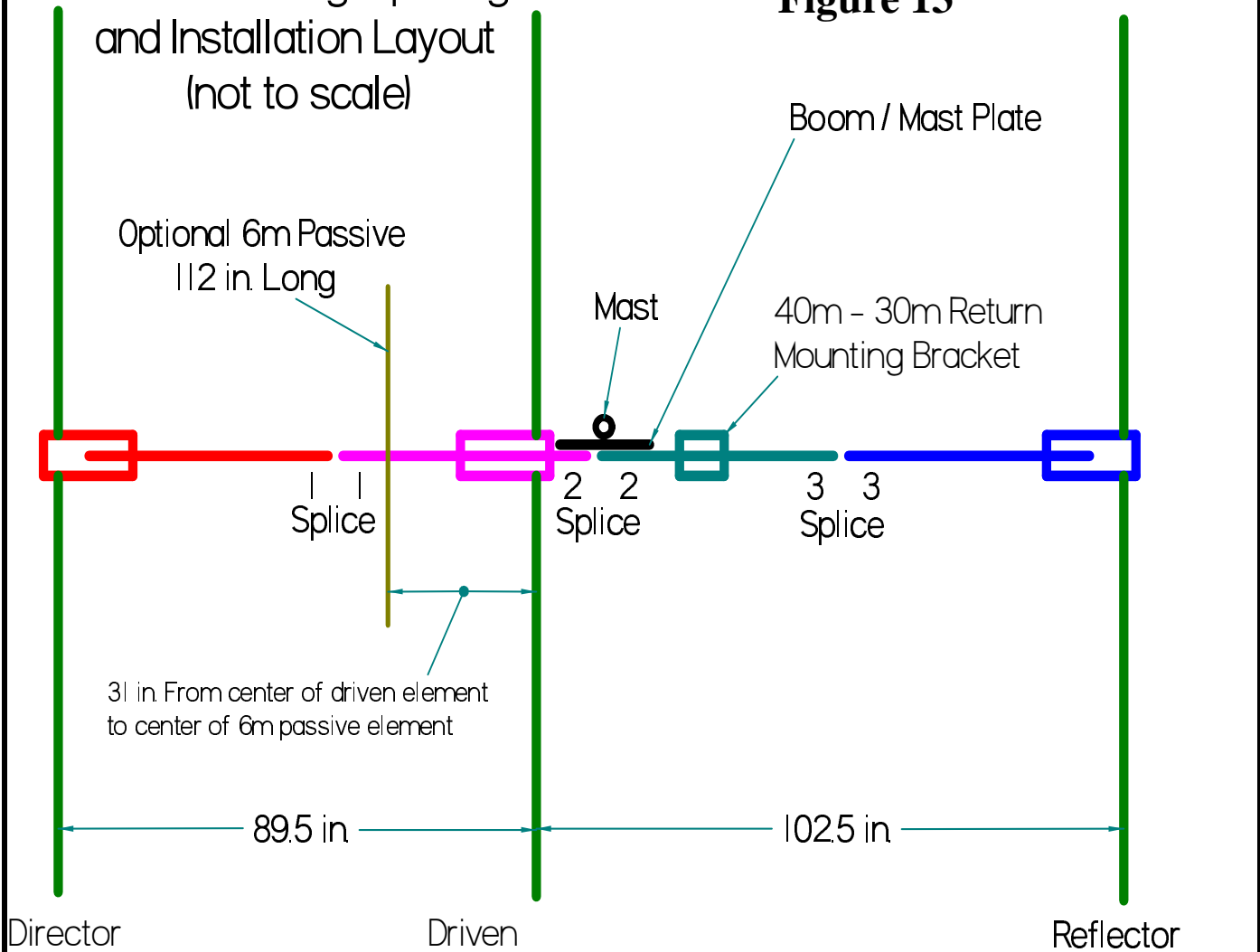
Figure 9



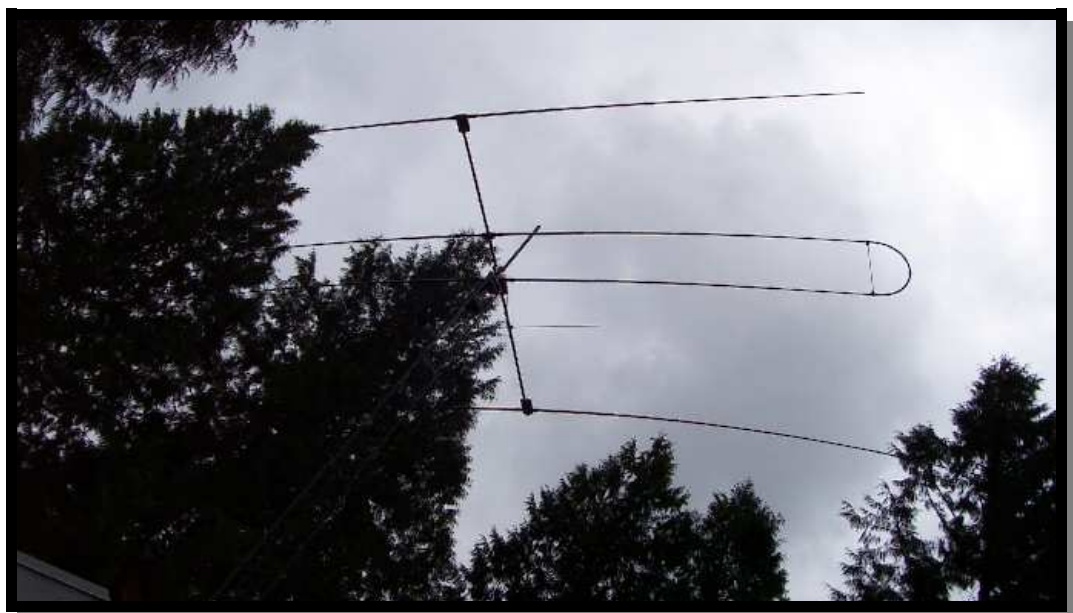
Figure 11

3 Element Yagi Spacing and Installation Layout
(not to scale)

Figure 13



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



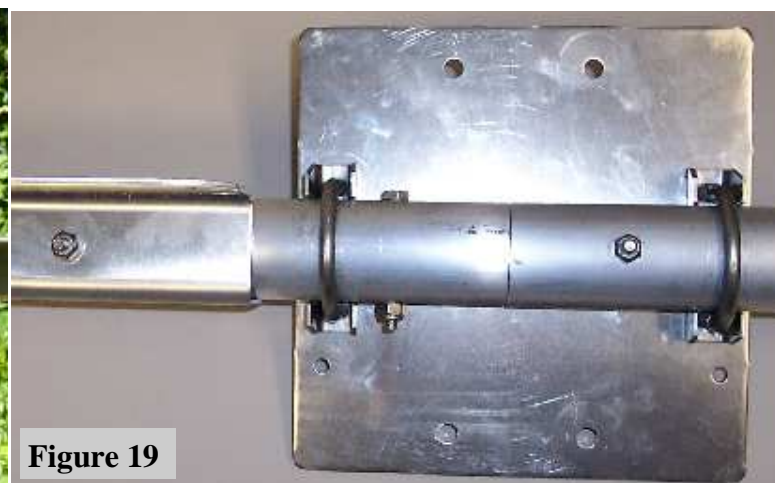
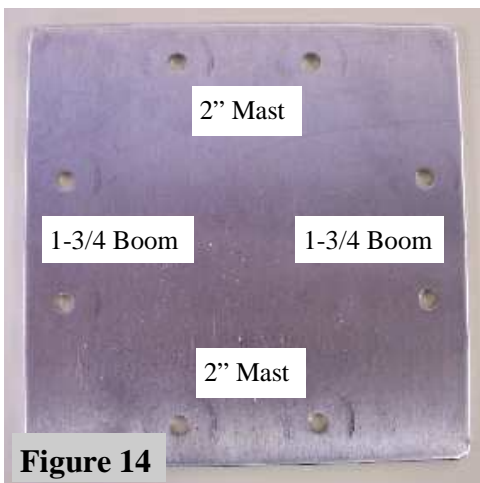
Connect the Boom to the Mounting Plate

The mast plate has a total of ten (8) pre-drilled holes. Four are used for the 2" stainless steel mast clamps and four more are used for the 1-3/4" stainless steel boom clamps.

If you are going to use a temporary mast, during assembly, connect the mast plate to the mast using the included 2" stainless steel U-Bolts, with saddles, and Nylok nuts as shown in **Figure 17**. Tighten securely.

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

Connect the boom to the mounting plate on the opposite side of the mast (**Figure 17** and **19**), using the 1-3/4" U bolts, saddles, and nuts. Align the boom so that the element brackets are level, then tighten securely. The center balance point of the boom is at splice #2, as shown in **Figure 19**. There will be a bolt on each side of the splice - **make sure that the nut end of the horizontal bolt is facing away from the mast plate (Figure 19)**. Otherwise, you will not be able to secure the boom snugly to the boom clamps. To ensure a balanced weight load, the center of the mast plate should be reasonably close to the center balance point of the boom.



Determining the direction of the antenna

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

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

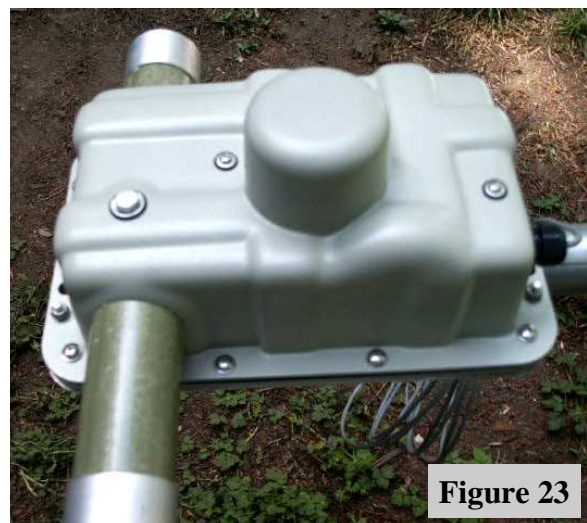
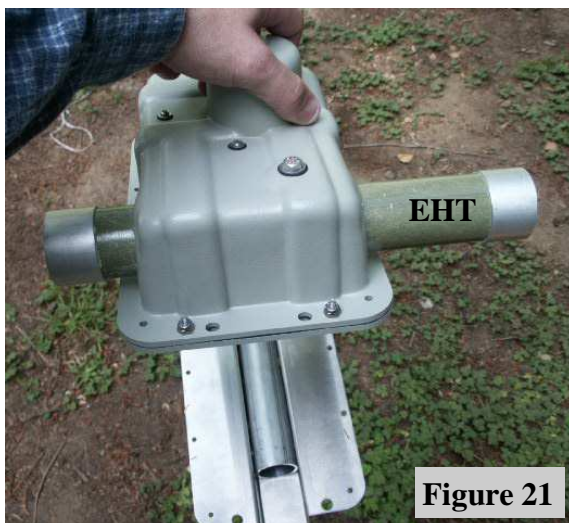
Attach the antenna housing to the element-to-boom bracket

Place the flat side of the element housing unit (EHU) on top of the element boom brackets (**Figure 21**).

Note: If the mounting holes for the element housing do not line up with the holes in the element bracket it may be necessary to loosen the two horizontal bolts that hold the element bracket to the boom . After mounting the element housing to the element bracket be sure to re tighten the two horizontal bolts.

The housings without the coax connector are the director and reflector (they are identical and interchangeable), the one with the coax connector is the driven element (the balun is on the inside of this housing). The reflector and director should be positioned so the actual fiberglass element is furthest away from the driven element (**Figure 23 & 41**). The driven element should be positioned so that the element is closest to the mast plate (**Figure 25 & 41**). Fasten each element housing to the element bracket, using eight 10-32 x 7/8" screws, flat washers and Nylok nuts. **The flat washer needs to be placed between the screw head and the plastic element housing.** Tighten securely, but not too tight (if you over-tighten the nut, you may split the plastic flange on the element housing). The olive green element housing tube (EHT) (**Figure 21**) on each antenna housing will appear uneven in length - it is actually centered on the inside of the antenna housing .

Note: The reflector element and the driven element will have the **EHT** (offset tube) lined up so that the short side and long side of the each **EHT** are facing in the same directions. The director element **EHT** configuration will be the opposite. This is normal.



Connect the wiring and secure to boom

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

Note: If you have more than 200’ of control cable you must use our optional 33 VDC power supply. This will then allow up to 500’ of control cable with no problems.

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

Each antenna housing will have an installed 4 conductor cable attached to it using a waterproof strain relief fitting (**Figure 27**). There will be a 12 position terminal strip included with the antenna, and a single position terminal strip for the ground connections as shown in **Figure 29** and **33**. First, dip each bare wire into the provided blue connector protector pouch. Connect each wire of the 4 conductor cable to it’s respective location on the 12 position terminal strip (**Figure 31** and **Figure 33**). You will need to repeat this on the opposite side of the terminal strip for the 12 conductor cable as well. Each cable (all 3 of the four conductor cables and the 12 conductor cable) will have a silver wire, which is the ground. You will need to connect all three element ground wires to one side of the single terminal strip and the 12 conductor cable ground wire to the other side (**Figure 31**, **Figure 33**).



Figure 27

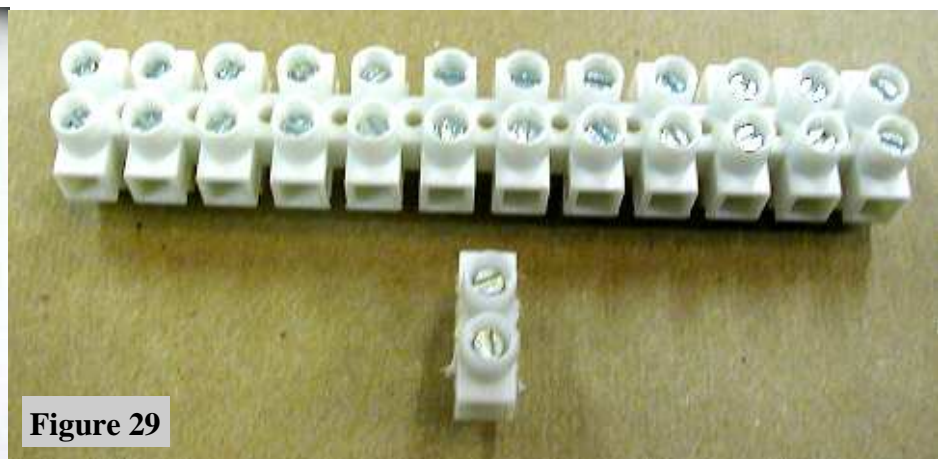
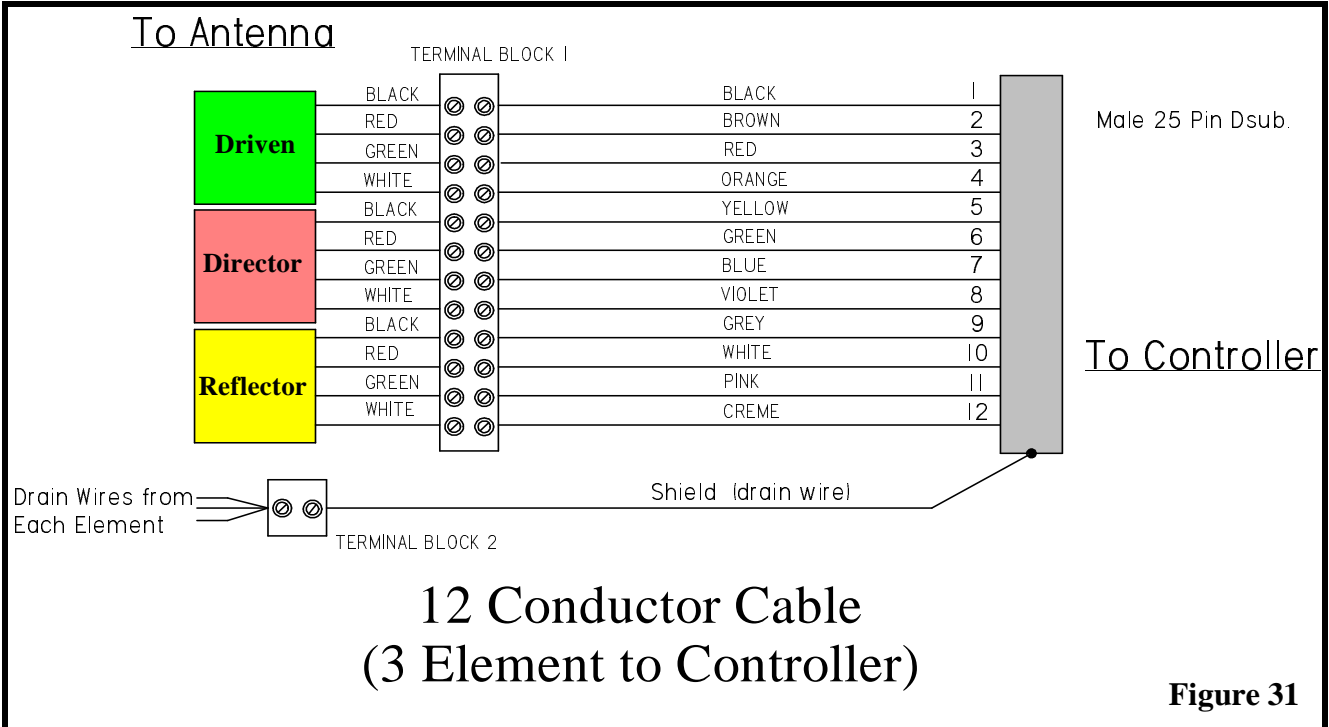
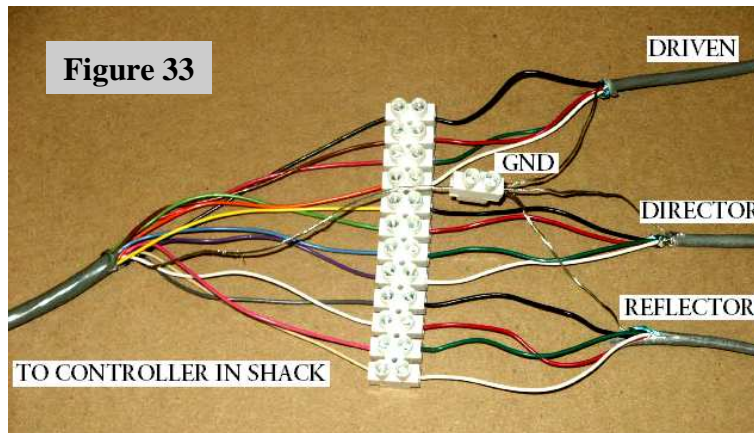


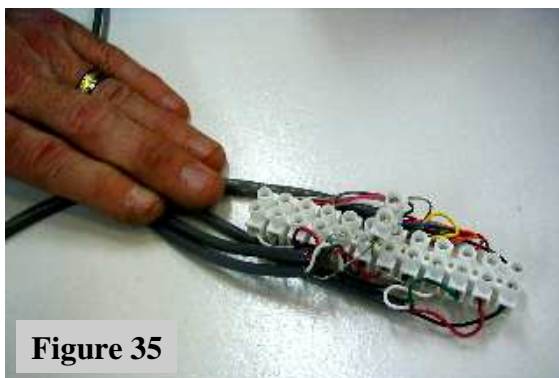
Figure 29



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



When the connections have been secured, you will want to position the cables so that they are parallel with the 12 position terminal strip (**Figure 35**). The 12 conductor cable will be at one side, and the 3 four conductor cables will be at the other. Slide the cables and terminal strips into the provided plastic enclosure (**Figure 37**), position the cutout in the threaded cap over the cables and screw the enclosure onto the cap.



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

Position the plastic enclosure in a convenient position **on the boom or mast** making sure that the cut out in the cap is facing downward (**Figure 39**). We do not seal the enclosure so that in the event there is water accumulation inside the enclosure from condensation, it will be able to escape. Fasten the enclosure to the boom using the screw clamp, taking care to not trap the cables in between. Secure the cables to the boom every foot or so. The terminal housing mounting location is not critical. It can be mounted on the boom or even vertical on the mast what ever works best for your installation.

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

Figure 39



Mount Horizontal or Vertical

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

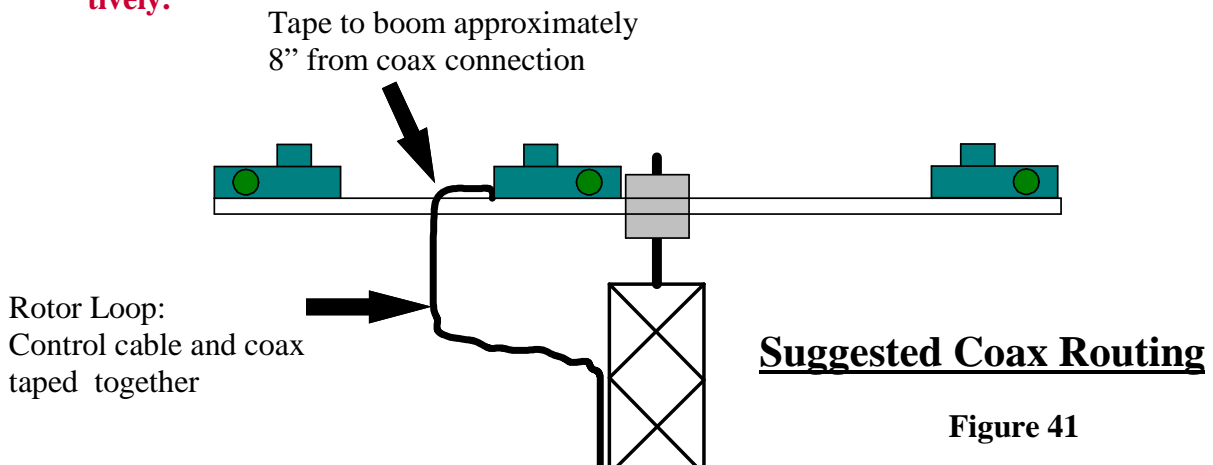


Figure 41

Prepare the Telescoping Fiberglass Element Support Tubes

Note: If you have ordered the optional **40m - 30m Dipole Kit** you also 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:

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



Rubber Boots

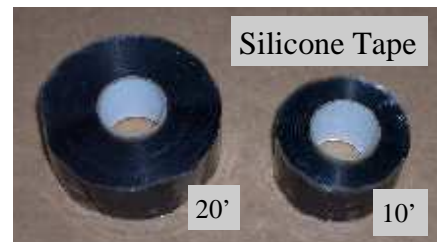


Electrical Tape

	<u>Normal</u>	<u>W/Optional 40-30 Dipole Kit</u>
* 3 Element	— 6 poles	4 Normal & 4 Special (8 total)

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

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



Silicone Tape

20'

10'

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.



Figure 24

17' 8" min

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 normal 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.

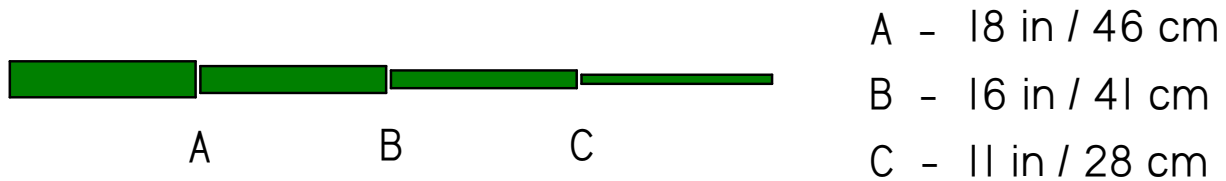
Exception: On joints with metal reinforcing rings (**Figure 26.5**), the tape must go further so it extends a minimum of 3/4" beyond the metal ring and onto the fiberglass pole.



Figure 26.5

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.

Recommended Lengths for Silicone Tape Wrapping



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, 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 51**).

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

- Place the narrow end of a rubber boot onto the butt end of an EST. Slide it about 6" out onto the EST (**Figure 53**).



- Insert the butt end of that EST into one of the EHT on an EHU, as shown in **Figure 55**. **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 57**. Note that current production antennas now have a narrower aluminum ring (.4"). **It is imperative that the stainless steel hose clamp be located so that the clamp on the outside of the rubber boot on the EHU side of the connection is completely PAST the aluminum reinforcing ring. This ensures that the hose clamp can grip onto the fiberglass and the ring will prevent the rubber boot from ever coming off.**
- Firmly tighten both stainless steel hose clamps, one over the EHT and the other over the EST. Then test the connection by pulling and twisting it. There should be no slippage at the joints.

NOTE: You should re-tighten each clamp a second time (at least 30 minutes after the first time you tightened them) before raising the antenna to the tower, to be sure that there has been no cold flowing of the PVC material on the rubber boot.

Optional 6 Meter Passive Element

Each 6 meter passive element comes in 3 pieces. The main body with a 1/2" x 58" element section attached to it, and two 3/8" element sections (**Figure 59**). The overall length of the element is approximately 112" when assembled.

Use a small amount of the included Teflon® connector protector solution when connecting the two sections of tubing. Slide in the short ends of the 3/8" tubing (the end that has the least amount of distance from the edge of the tubing to the drilled hole) and align the holes. Install the 6-32x3/4" machine screws and Nylok nuts and tighten securely.

The six meter aluminum element mounts between the driven element and the director (the elements that are approximately 89" apart). The center of the 6m element should be 31" from the center of the driven element (see **Figure 13**). Fasten securely to the boom using the 304 SS U-bolt, saddle and hardware. Make certain that you have the 6 meter passive element level with the other elements.

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

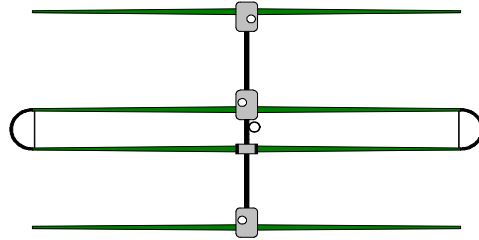
When you are using the 6 meter band, keep the antenna in the forward direction and rotate accordingly. Optimum performance will be from 50.000 MHz to 50.500 MHz. The 180 degree mode is exactly the same as the forward mode since we have no choice when the aluminum passives are used, however, the Bi-Directional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



Figure 59

SteppIR Options

- 40m - 30m Dipole (loop)



- “Y” Cable



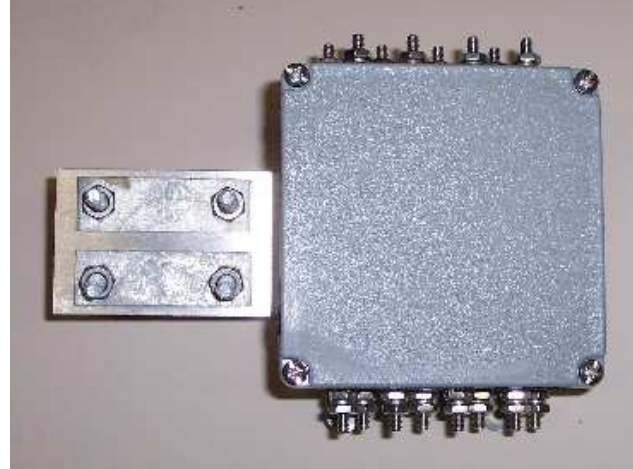
- Transceiver Interface (Rig Specific)



- 6m Passive Element Kit



- **Voltage Suppressor & RF Bypass Unit** (12 Conductor)



- **Element Expansion Kit** 3 Element to 4 Element



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.

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