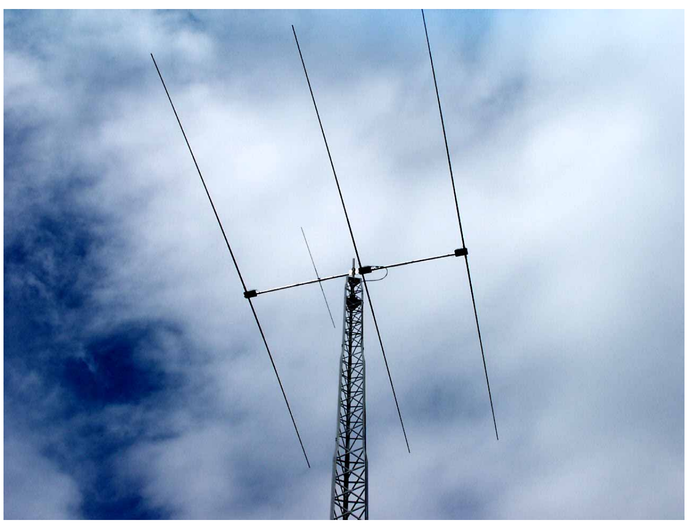
SteppIR ™

Yagi ● Dipole ● Vertical

(Patent Pending)

SteppIR Yagi / Dipole Instruction Manual



SteppIR Antennas
23831 S.E. Tiger MT. RD. Issaquah, WA 98027
Tel: 425-391-1999 Fax: 425-391-8377 Toll Free: 866-783-7747
Web: www.steppir.com **6/25/04**

Table of Contents

Topic *Page*

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 strip conductor mounted in the antenna housing. The copper strips are perforated to allow a stepper motor to drive them simultaneously with a sprocket. 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 strip is driven out into hollow, lightweight fiberglass support elements, forming an element of any desired length up to 36' long. The fiberglass poles are telescoping, lightweight and very durable. When fully collapsed, each element measures 48" in length.

The ability to completely retract the copper antenna elements, coupled with the collapsible fiberglass poles makes the entire system extremely portable. The antenna is easy to assemble, and can be installed on the ground or up on the antenna tower using our Boomslide™ assembly system.

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 20m to 6m, 17 ham and 6 non-ham band memories, 180° direction reversal or bi-directional mode in just 3 seconds (yagi).

3 element Yagi Installation

The 3 element SteppIR Yagi boom consists of four sections of aluminum tubing that are 4 feet long x 1-3/4” OD x 1/8” wall, along with three aluminum antenna housing brackets as shown in figure 1. The element housing brackets are pre-installed at the factory. To assemble your antenna, you will need a 1/2” (13mm) and 7/16” (11mm) wrench and / or socket drive. We double check the fasteners for proper tightness before shipping but it is always a good idea to check them yourself before installing the antenna.

Figure 1

Assemble the boom & connect to mast plate

Connect the boom by sliding the respective sections together and align the pre-drilled holes (figure 2 and 3). Refer to figure 5 and drawing 2A on page 8 for correct configuration. It is advisable to spray a small amount of WD-40 on the male sleeve before sliding the female section onto it. Do not twist the aluminum excessively, as this can cause binding—the WD-40 will help keep the two pieces lubricated. Insert the included bolts into the pre-drilled holes, add a split lock washer and tighten the nut securely (figure 4). Be sure to position the bolts and nuts so that they are in the same direction as the others. The boom is drilled while completely assembled resulting in precision element alignment. The bolt holes should all align close to perfect. If the pre-drilled holes are visibly out of alignment, you probably have the boom pieces assembled incorrectly. We pre-drill the holes to be quite snug. 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.

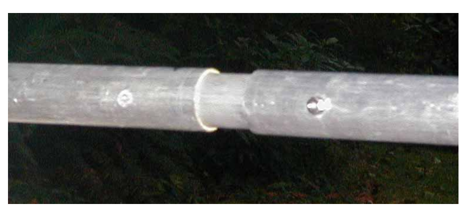
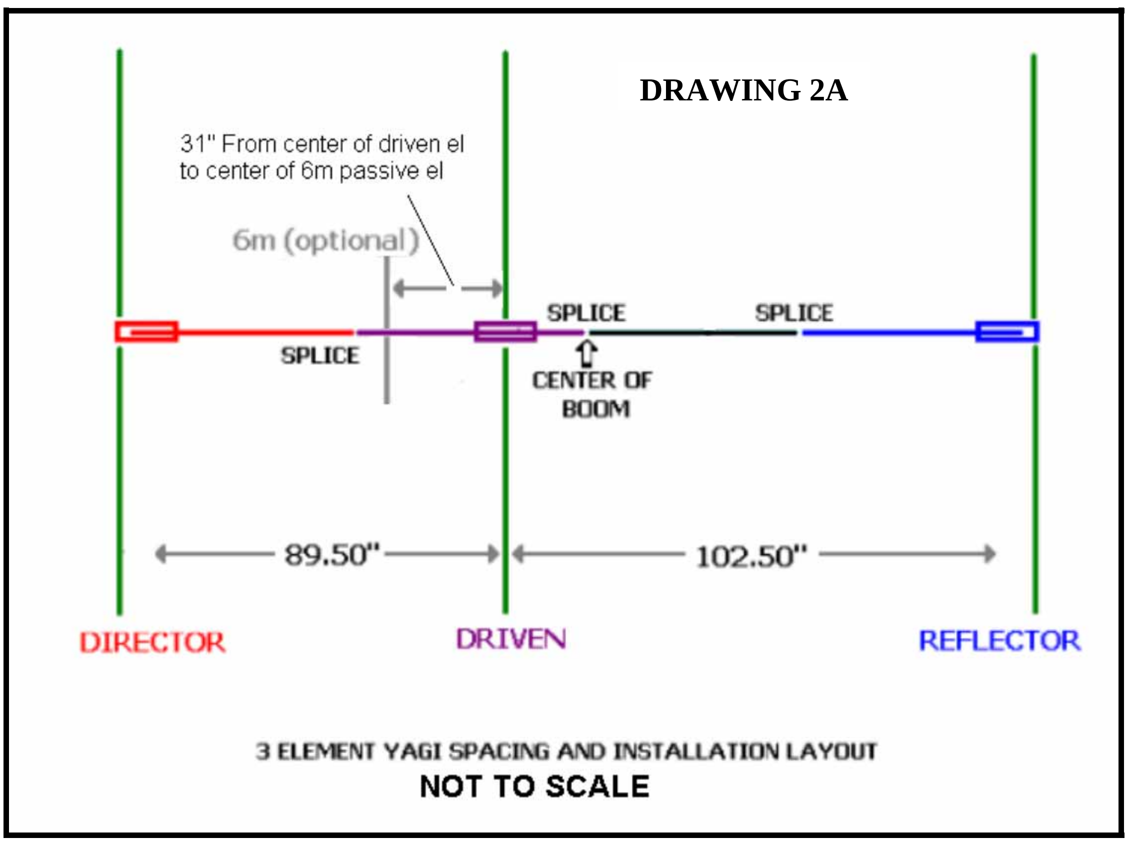



Figure 2 and 3: Connecting the end pieces to the middle sections

Figure 4: Securing the boom sections

Figure 5: The four sections of a 3 element yagi shown in the staggered order of installation



Note: Spacing lengths are measured with the elements already attached to the boom brackets

Connect the Boom to the Mounting Plate

The mast plate has a total of ten pre-drilled holes. 4 of these are used for the 2” stainless steel mast clamps, four more are used for the s 1-3/4” stainless steel boom clamps, and the last set of two are for the optional Boomslide™ antenna fixture. If you have purchased the Boomslide™, refer to the included instructions. If you do not have the Boomslide™, you will not be using these holes. Figure 6 shows the configuration of the mast plate.

Connect the mast to the mast plate using the included 2” 304 stainless steel U-Bolts with saddles, lock washers and nuts as shown in figure 7. Tighten securely.

Connect the boom to the mounting plate on the opposite side of the mast (figure 7 and 8), using the 1-3/4” U bolts, saddles, lock washers and nuts. Align the boom so that the element brackets are level, then tighten securely. The center balance point of the boom is at a splice, as shown in drawing 2A. There will be a bolt on each side of the splice - make sure that the nut end of these two bolts are facing away from the mast plate (figure 8). 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. Installation note: If the U-bolts are not an exact fit, you can bend them slightly in a vise or even with your hands to obtain the proper clearance for the holes in the mast plate.

Figure 6


Figure 7

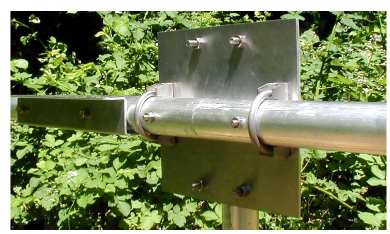


Figure 8

Determining the direction of the antenna

The SteppIR Yagi has three “directions” in which it can be used. Normal, 180 degree and bi-directional (for more information see page 24). 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 to boom brackets (fig. 9). The outside elements consist of the reflector and director. These two elements are identical in design, and are identified by having much longer control cable lengths than the driven element. The reflector and director should be positioned so the fiberglass element is furthest away from the driven element (fig. 10). The driven element should be positioned so that the element is closest to the mast plate (fig. 11). Fasten each element housing to the element bracket, using 4 of the 1/4” x 1” bolts, flat washers, lock washers and nuts. **The flat washer needs to be placed between the bolt 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 support tube (EST) on each antenna housing will appear uneven in length - it is actually centered on the inside of the antenna housing . *Installation note: One of the passive elements and the driven element will have the EST lined up so that the short side and long side of the EST are facing in the same directions. The remaining passive element’s EST configuration will be the opposite. This is normal.*

Figure 9

Figure 10

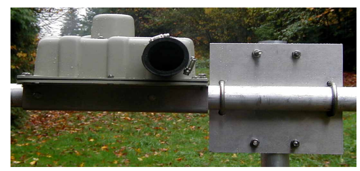


Figure 11

Connect the wiring and secure to boom

Each antenna housing will have an installed 4 conductor cable attached to it using a waterproof strain relief fitting (fig 12). The housings with the longer cables are the director and reflector (they are identical and interchangeable), the one with the short cable and SO-239 coax connector is the driven element (the balun is on the inside of this housing). 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 13 and 14 (the terminal strips are inside of the included PVC connector housing, with a white plastic cap loosely attached). First, dip each bare wire into the provided blue connector protector pouch. Connect each wire of the 4 conductor cable to it’s respective location on the 12 position terminal strip (drawing 1 and figure 14). You will need to repeat this on the opposite side of the terminal strip for the 12 conductor cable as well. Each cable (all 3 of the four conductor cables and the 12 conductor cable) will have a bare silver wire, which is the ground. You will need to connect all three of these to the single terminal strip (fig 14, drawing 1A*).* *Note: While the 2 element Yagi has only 8 wires that are used, it is still extremely important that you hook up the remaining 4 wires. Even though these wires are not used, they still have power being supplied to them, so hooking them to the terminal strip will eliminate the chance of shorting.*

Figure 12

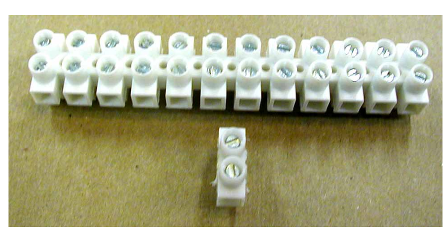
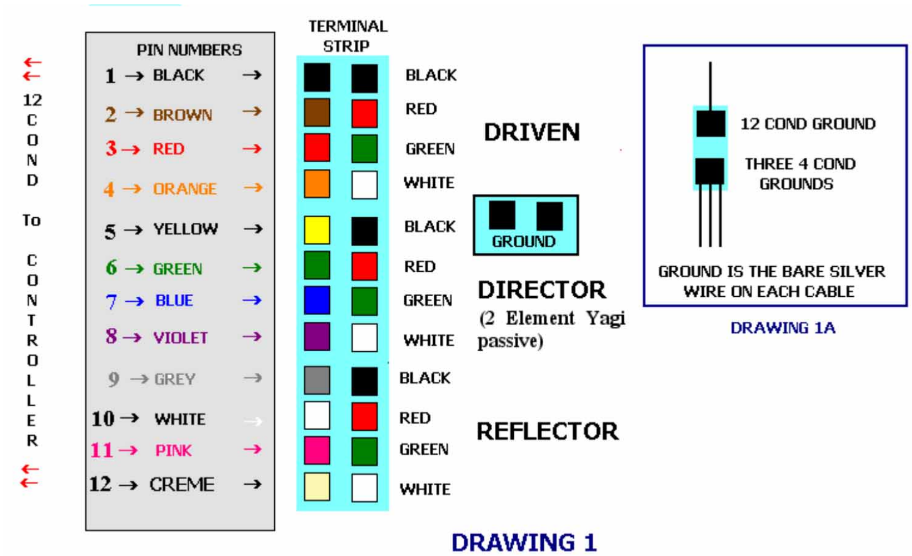


Figure 13



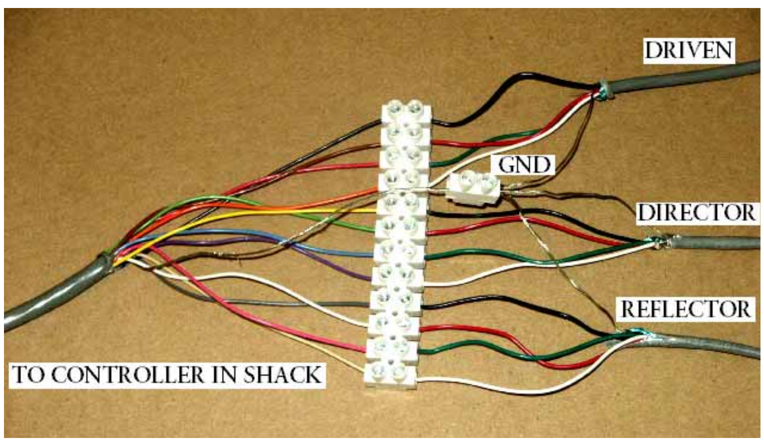


Figure 14

When the connections have been secured, you will want to position the cables so that they are parallel with the 12 position terminal strip (fig 15). The 12 conductor cable will be at one side, and the 3 four conductor cables will be at the other. You will then want to slide the cables and terminal strips into the provided plastic enclosure (fig 16), pulling all 4 cables into the groove in the plastic enclosure (fig 17).

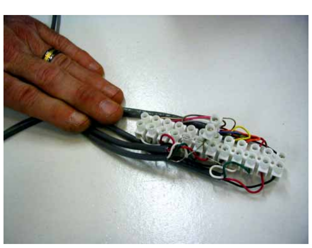


Figure 15

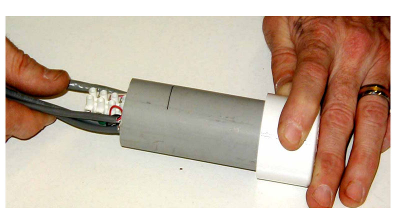


Figure 16

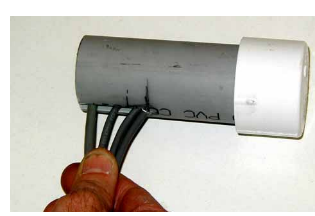


Figure 17

Attach the wiring enclosure and control cable to the boom

Place the cap on the end of the plastic enclosure. You do not need to glue the cap, the enclosure will be trapped between the two “U” bolts, keeping the cap from loosening from the enclosure. Secure the cables to the enclosure with 2 wraps of electrical tape. Position the plastic enclosure so that it is snug to the boom, and is located between the two U-Bolts. Be sure that the groove in the enclosure is facing downward (figure 18). We do not seal the groove 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 4” worm gear clamp, taking care to not trap the cables in between. Tape the cables to the boom as shown in figure 18.

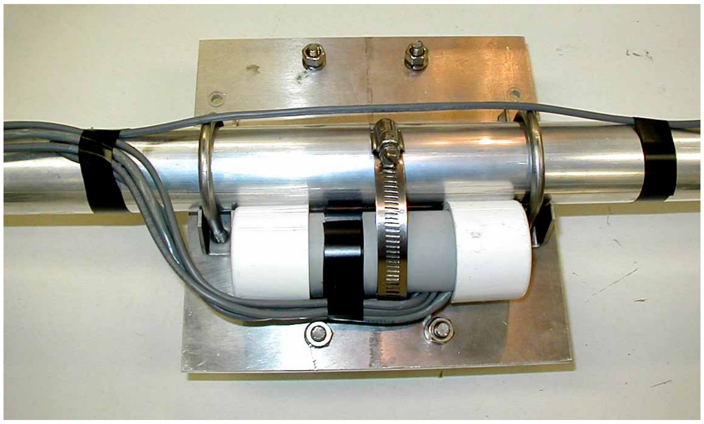


Figure 18

We recommend that you route your coax and control cable as shown in figure 19.

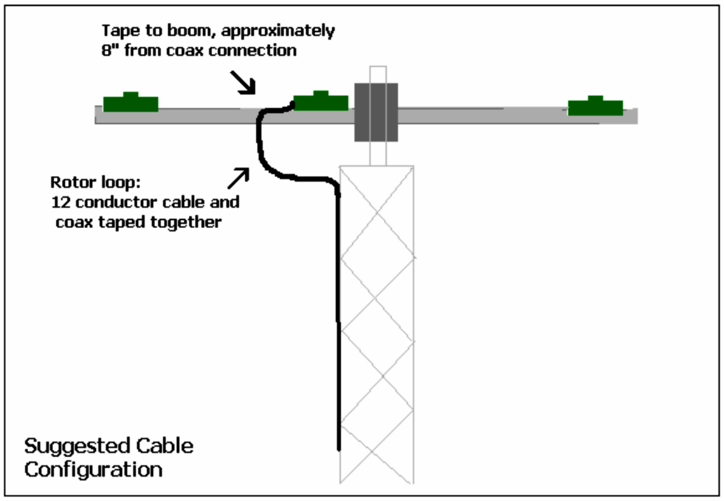


Figure 19

Prepare the telescoping fiberglass element support tubes (EST)

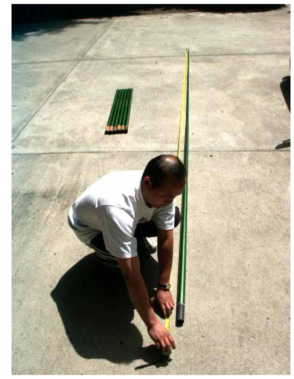


Figure 20

Locate the six fiberglass poles, two rolls of black electrical tape, two rolls of green silicone self-curing tape (one is 20 ft, the other 10 ft) and your tape measure. Note that stainless steel reinforcing rings are used on the first 3 pole sections to provide extra strength in potential high wind conditions.

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

1. Telescope a pole to full length by pulling each section out **firmly** in a twisting motion, "popping" it in place. **Be sure each joint is locked in place and fully extended.** Pole lengths may vary but, when fully extended, each pole must be at least 17 ft 8 inches in length as measured from the butt end of the pole to the tip (figure 20). **Verify the length for each pole <u>before</u> wrapping the joints.**

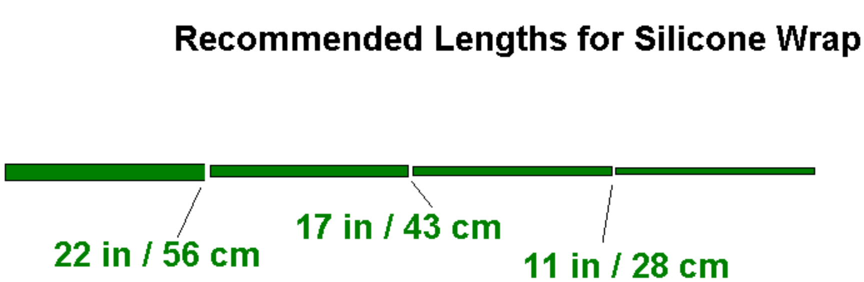
2. In this step you will wrap each joint on the fiberglass poles with the all weather electrical tape. Each joint needs about 1/2" of tape on both sides of the joint (figure 21). **Exception. On joints with reinforcing rings, the tape must continue further so it extends about 1/2" beyond the ring and back onto the fiberglass pole.**

Figure 21

The common method for wrapping tape requires starting the tape at an angle of about 10 degrees to the object being wrapped and continuing around it in the same direction, overlapping the tape over itself by about one-half a tape width per wrap until the desired area has been covered. Be sure to use plenty of tape.

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 wraps, **so that the entire area is seamlessly covered.** Carefully stretch and smooth the tape with your finger as you apply, and 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. The final joint should look like figure 21.

Figure 22



Drawing 6

3. Next, you will weatherproof each joint with the green self-curing silicone tape. **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 on the prior page for proper lengths for each joint.

IMPORTANT: 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 green silicone wrap about 1/4” to the right of the black electrical tape. Using the common way discussed on the prior page, wrap one layer completely around the pole so the tape fully overlaps itself. Then slowly wrap ONE LAYER of silcone tape to the left, extending about 1/4” beyond the black tape. When you reach the end, wrap one layer completely around the pole so the tape fully overlaps, just as you did at the beginning of the wrap. As before, carefully stretch and smooth the tape as you go. Figure 22 on the prior page shows a completed joint.

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 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.

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

Locate the six flexible connection couplers (FCCs) and repeat the following procedure for each of the six fiberglass poles.

1. Place the narrow end of an FCC onto the butt end of an EST. Slide it about 6” out onto the EST (figure 24).

Figure 23

Figure 24

Figure 25

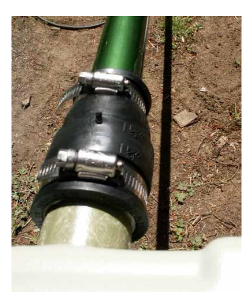


Figure 26

2. 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 FCC firmly onto the EHT until it is flush with the aluminum reinforcing ring on the EHT.** You can use a small amount of the connector protector to assist in sliding the FCC on, as shown in figure 25. The correct mounting position of the FCC is shown in figure 26. **It is imperative that the stainless steel hose clamp be located so that the clamp on the outside of the FCC on the EHU side of the connection is completely on top of the aluminum reinforcing ring.**
3. 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 FCC.

Optional 6 Meter Passive Element

The 6 meter passive element comes in 3 pieces. The main body (with a 1/2” x 58” element section attached to it), and two 3/8” x 36” element sections (figure 30). The overall length of the element is approximately 112” when assembled.

The required fasteners will already be attached to each end of the 1/2” element section (fig 31) - remove this hardware, and slide in the short ends of the 3/8” tubing (the end that has the least amount of distance from the edge of the tubing to the drilled hole). Use a small amount of the included Teflon® connector protector solution when connecting the two sections of tubing. Fasten securely. The six meter aluminum element mounts between the driven element and the director (the elements that are approximately 89” apart). The center of the 6m element should be 31” from the center of the driven element (see drawing below). Fasten securely to the boom using the 304 SS U-bolt, saddle and hardware (Fig. 32 & 33). Make certain that you have the 6 meter passive element level with the others.

When you are using the 6 meter band, you will want to keep the antenna in the forward direction and rotate accordingly. Optimum performance will be seen from 50.000 MHz to 50.500 MHz. The 6 meter antenna will not function nearly as well in the 180 degree mode, due to the fixed element configuration.

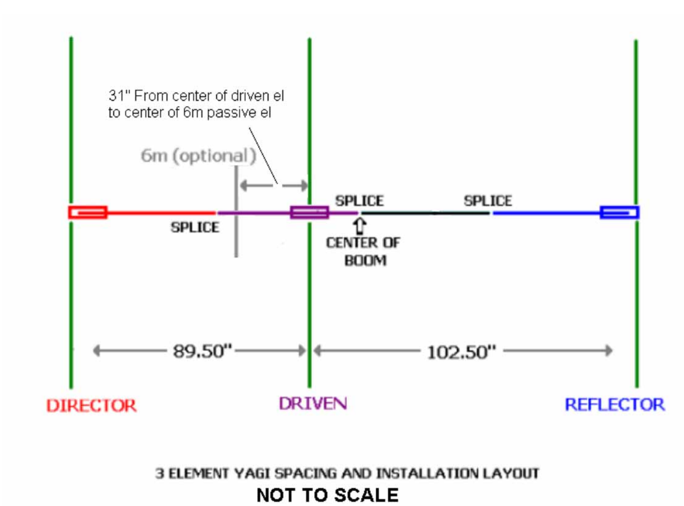


Figure 27

2 element Yagi Installation

For the most part, assembling the 2 element yagi involves many of the same steps as covered in the 3 element yagi installation section . **You should carefully read the 3 element yagi instructions as well.** There are a few key differences, the most evident being that the 2 element yagi has a one piece 57" boom (figure A) . The boom will come with one side having the element bracket attached, you will have to install the other. The bracket will overhang the end of the boom by 2-1/2" when properly installed(Fig B). Make sure the bolts and nuts are facing in the same direction as the other bracket. When attaching the boom to the mast plate, you will want to position the mast plate as close to the center point as possible (Fig C), which in the case of the 2 element Yagi is directly in the middle of the boom. When fastening the elements to the element bracket, make sure the element is mounted in such a way that the element itself is as far away from the mast plate as possible (Fig D). In the "normal" direction mode (ie: not the 180° mode or Bi-Directional mode) the antenna directs RF energy towards the passive element (the element that does not have the coax attached to it), giving gain in that direction and rejecting signals coming directly at the driven element from the opposite direction. When the 180° mode is selected, the gain is now directed from the driven element end and rejected from the passive end. **For directional purposes, if you want your SteppIR 2 element yagi to point due North when in "normal" direction mode, the passive element (director) would be the forward, or "aiming" element. If you switched to the 180° mode, you would now be pointing south, even though your rotator still says you are North! This is done by turning the director into a reflector. When you are operating in the Bi-Directional mode, your antenna is directing RF in both directions.**

Figure A

Figure B

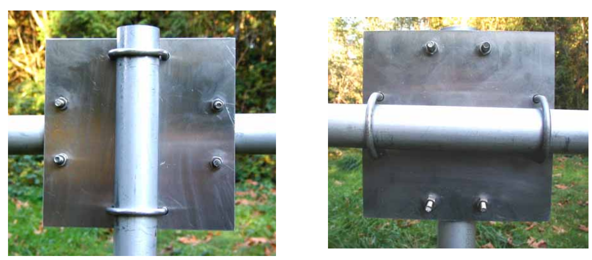
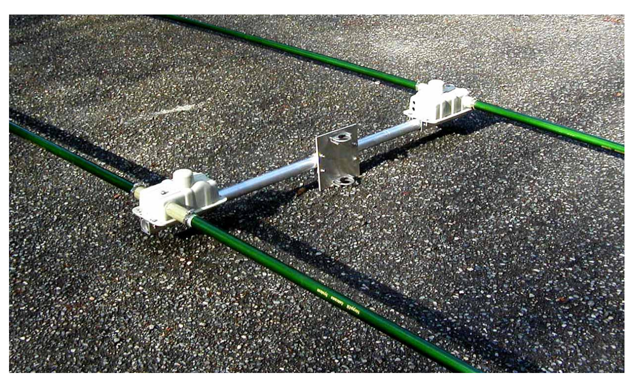


Figure C

Figure D



Once the wire harness is attached and taped to the boom, this 2 element yagi is ready for action!

Dipole Installation

Attach antenna housing to antenna mast (not included) using the 1-3/4" U-bolt and mast saddle (fig. E, F, G and H)

Figure E: Mounting the dipole to the mast

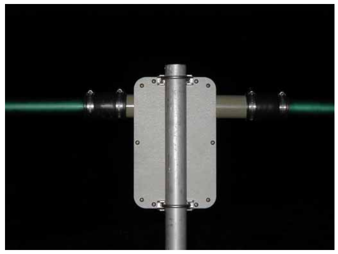


Figure F

Figure G: Hardware for mounting

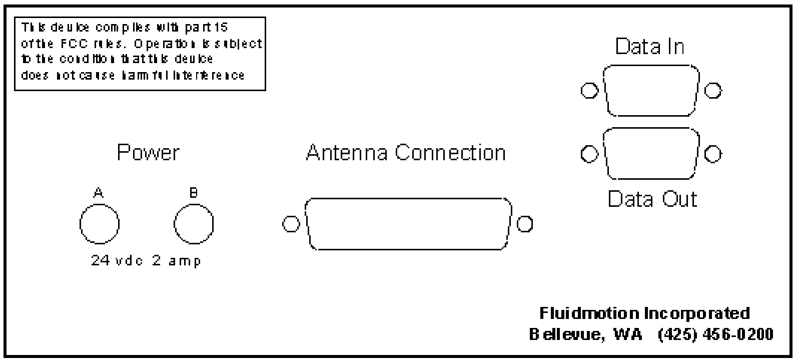
Figure H

Follow instructions on page 13 of the Yagi installation instructions

Dipole SWR Considerations

The impedance of a half wave horizontal dipole depends on it's height above ground. In the frequency range of 14 to 28 mhz, the typical height of an amateur radio antenna is between 1/2 and 1 wavelength above ground. At these heights the impedance of a horizontal 1/2 wave dipole is in the vicinity of 70 to 80 ohms. When the antenna is mounted at heights greater than 1/2 wavelength, it should exhibit an SWR of less than 1.5 to one. At lower heights, the SWR may be higher.

Connecting the controller to the antenna



On the back of your controller, there are two power connections: primary, and AUX. You can use either one of these to connect the included 24 volt power supply cord. The AUX is intended for use with 4 antenna elements or more. Currently, we do not have an antenna that is larger than 3 elements, but we are in the process of designing a 4 element yagi, with no release date scheduled at this point. When the 4 element version of the yagi is available, as a SteppIR owner you will be able to upgrade your antenna to this design by purchasing an element adder kit. Because we have no interlacing elements or traps, we can make our antenna modular in design - so that our current customers won't get left behind on future product releases.

Once you have connected the power cord to the controller and plugged the other end of the cord into the power outlet (the universal power supply can accept 100 - 240 volts AC), you will want to turn the controller on by pushing the on/off button located on the front of the controller. It is advisable that you do not hook the antenna control cable to the controller when turning the unit on for the first time, so that you can be certain that the controller display reads "elements retracted". If the LCD display does not say this, you will want to refer to "retracting the elements" on page 23. When the display reads "Elements Retracted", you can then hook the control cable up to the back of the controller. This is accomplished by mating the 25 pin male connector on the cable to the 25 pin female connector in the middle of the back panel of the controller.

Also on the back of the controller, are two ports - "Data In" and "Data Out". If you have purchased the transceiver interface option, there will be two 9 pin d-sub male connectors in the ports. If you have not purchased the interface, there will be plastic covers over the ports. For more information on the transceiver interface refer to page 20.

NOTE: If you live in an area that has lightning activity, we highly recommend that you ground the chassis of the controller to your station ground. This can be done by connecting the grounding wire to any of the 4 stainless steel screws that hold the controller together, and attaching the other end to your station ground.

Using the Antenna Controller

The SteppIR controller has fifty-one independent antennas programmed into its memory. These are antenna designs that we have computer modeled on YO-PRO and EZ-NEC, and then field tested at our antenna range in Moses Lake, Washington. Our test height was 48 feet - SWR should be nearby our test results until you get below 35 feet in the air, and then you may see a slight rise in SWR. Optimal height for the SteppIR Yagi is 40 - 70 feet, but you can still obtain very good performance as low as 25 feet in the air.

Each individual element is simultaneously adjusted to it's programmed length by the controller. There will be anywhere from one to five antenna segments per band, depending on how large the frequency spectrum is (see chart below for complete listing). For example, on 20 meters there are three antenna segments: 14.050 MHz, 14.200 MHz and 14.300 MHz. Each time you press the 20 meter button, the controller will re-adjust to the required length of the next antenna segment. Using our 20m example, if you are on antenna segment 14.050 MHz, and press the 20m button once, the antenna will re-adjust to the 14.200 MHz segment. Press the button again, and you will be at 14.300 MHz. One more press of the button will bring you back to 14.050 MHz again. As you tune the rig to frequencies in between the programmed antenna segments, the SWR will slowly start to rise. If you want to adjust the antenna for best SWR while in between two antenna segments, you can use the up / down arrows to adjust the antenna 25 KHz per click. When you click the band buttons, an asterisk will light up and flash on the display LCD (Example: 14.200*). This is the indicator that lets you know that the controller is in the process of tuning each element of the antenna to the proper length. When the new antenna segment has been reached, the asterisk will disappear. *Note: When operating with over 200 watts, it is important that you do not transmit while the antenna is adjusting.*

SteppIR Antenna Segments

20 meters	17 meters	15 meters	12 meters	10 meters	6 meters
14.050	18.100	21.050	24.950	28.200	50.000
14.200		21.200		28.500	51.000
14.300		21.350		28.800	52.500
				29.100	53.500
				29.400	

There are some situations where the SWR may be higher than you would like it to be. Interaction from nearby fixed objects, or mounting the antenna at a low height are the most common potential culprits. With most antennas, you would have to live with the problem. With the SteppIR, you can re-adjust the antenna to help compensate for these potential problems, and save the new parameters into memory. The driven element can be adjusted to get a better match with no appreciable effect on gain and front to back. For more information on how to accomplish this, refer to page 22.

Modes of Operation

There are three modes of operation with the SteppIR controller: Amateur, General Frequency and Setup. To access any of these modes, press the “mode” button, located at the bottom right corner of your controller front panel. The mode button is a 3 position toggle, each time you press the button, the controller will change to the next mode, and the respective LED will light up adjacent to the mode description. It is important that you click on the “select” button within 2-1/2 seconds after arriving at the desired mode. If you do not, the controller will default back to the last mode you were at. The select button is located just to the right of the mode button.

Amateur Mode:

The amateur mode is used when you are manually operating your controller, and the primary intended use will be in the ham bands (when operating with the optional transceiver interface, you will need to be in general frequency mode). When in the amateur mode, to tune through the bands you simply press the desired band button, and the controller will simultaneously adjust the length of each element to that segment. Each time you press the individual band button, the antenna will adjust to the next antenna segment. By using the up / down buttons, it is possible to adjust the antenna to frequencies outside of the ham bands while in amateur mode, but the controller will only let you scroll a certain point past a given ham band while in amateur mode. To tune through all frequencies without limitation, you will need to be in the general frequency mode.

General Frequency Mode:

There are two purposes for the general frequency mode. When operating the antenna manually, it is possible to adjust the antenna to any frequency within the coverage range of 13.800 MHz to 54.000 MHz. When doing this, you can use the amateur band buttons to get near the desired frequency, and then use the up down buttons to tune the antenna to the exact frequency desired. In general frequency mode, each time you press the up / down arrows the controller will tune 100 KHz. When you continuously press the up / down button without releasing it, after a few seconds the tuning adjustment will ramp up to a faster speed, tuning at the rate of 1 MHz. If you have the optional transceiver interface, to utilize that feature you will have to be in the general frequency mode. For further information on the transceiver interface refer to page 20 .

Setup Mode:

The setup mode is the mode you use when you want to set up or change certain features of the controller. When you first enter setup, the screen will say “mode key to exit , up / dn to scroll”. “Mode key to exit” means that if you want to exit back to either the amateur or general frequency mode from this point, you would simply press the mode button once and you would be taken back to the amateur mode. “Up / dn to scroll” means that if you press either the up button or the down button, the controller will scroll through the setup menu. Once you get to the desired menu, you press the select button to “enter” that menu item. Each function in the setup mode is explained in detail on the following pages.

Restoring the Factory Default Antenna Lengths

When your controller is sent to you, it has 17 factory default antennas residing in it for the forward direction antenna, and 17 totally separate default antennas for the 180 degree antenna function and bi-directional function (for more information on the 180 degree and bi-directional feature, refer to page 24). These are the antenna segments that we have computer modeled and field tested - and stored into the memory of your controller. At any point, you can change the lengths of these antennas, and save them to memory (for more information on creating or modifying antennas, refer to the “create modify” menu on page 22, and “saving antennas to memory” page 24). When saving the new antennas, you are replacing the old factory defaults with your new antenna lengths. At some point, you may decide that you want those factory antenna segments back. This is what the “factory default” section is for. You can restore the factory default for a specific antenna segment, or you can completely restore all of the factory defaults at once.

If you want to restore the factory default on a single antenna segment, first you will want to go to that segment in either the amateur mode or the general frequency mode. For example: Let’s say you had replaced the antenna segment 14.050 with a new antenna length you modeled for maximum gain. Now you have decided that you want the gain / FB combination of the factory default back. To restore the factory default for 14.050 MHz, first you would go to the 14.050 antenna segment. You would leave the antenna at this position, and proceed to the “factory default” menu in the setup mode.

When you first enter setup mode, you will see “mode key to exit, up / dn to scroll” on the LCD screen. Press the up button once, and it will take you to “factory default”. Press the select button to enter into this menu. The second line of the LCD screen will say “Current ? YES NO”, and the NO will be blinking. The controller is asking you if you want to revert back to the factory default for the current antenna segment you are on (in our example, 14.050). Entering YES gives you back the original antenna lengths that came with the controller for that segment. To enter YES, you simply press the up or down button, and YES will start flashing. Press the select button, the factory default has been restored *for that single antenna segment*. If you select NO, the screen will say “All Ant YES NO”, with the NO blinking. The controller is asking you if you want to replace every single antenna segment currently in the controller memory with the original factory defaults. To do so, press either the up or down button once, and the YES button will now be flashing. Press the select button, and now every one of the factory default antennas has been restored. If you decide not to restore the defaults, you would press NO, and you would be taken back to the setup “factory default” main menu. From there, you can either use the up / dn arrows to further scroll through the setup menu, or you could press the mode button to go back to amateur or general frequency mode.

Transceiver Interface

This menu item is used if you have purchased the optional transceiver interface. To use the transceiver interface, you need to have a rig that has computer interfacing capability. Rigs with these options were primarily manufactured from 1990 on. When enabled, the transceiver interface on the SteppIR controller will “listen” to your rig, and will automatically re-adjust every 50 KHz as you tune through the bands.

The following are radios that work with our transceiver interface module. New radios are added periodically. *Note: If you do not see your rig here, that does not necessarily mean the interface will not work. If your rig has an interface, call the factory to be certain whether the interface will work with our controller.*

Transceiver Interface (continued)

Icom: All radios that have a CI-V port; 706, 746, 746 PRO, 756, 756 PRO, 756 PROII, 765, 775, 781
Kenwood: TS50, TS570, TS570G, TS850, TS870, TS950SD, TS950SDX, TS2000
Yaesu: FT-847, FT1000D, FT1000MP, FT1000MP Mark V
Ten-Tec: Omni VI, Omni VI Plus; these radios emulate ICOM protocol
SGC: Some of their rigs emulate Kenwood TS-570; these will work with the SteppIR transceiver interface

If you have the transceiver interface option, your controller will come with an interface cable, which has a 9 pin d-sub connector on one end that hooks up to the "Data In" port on the back of the controller. The other end will go to your rigs interface. There is second 9 pin d-sub connector below the first called "data out", this connector is only used in the event you stack two SteppIR Yagi antennas - it allows the two controllers to communicate with each other, so that when you change frequencies on one of the controllers, the other will follow. The transceiver interface option will work with any of the above rigs listed, but the cable connections vary in type depending on the radio manufacturer. *Note: We can also supply a wye cable that allows the user to run a logging program concurrently with the SteppIR controller. For more information on this, refer to page 26.*

Icom uses a 3.5 mm miniature phono-plug connection for their CI-V ports, Yaesu has a 9 pin D sub connection. The newer Kenwood radios use 9 pin D sub connectors, the older Kenwood radios use 6 pin DIN connectors. If you want to use the SteppIR interface with different rigs, you may require additional interface cables, which are available from SteppIR Antennas.

When you first enter setup mode, you will see "mode key to exit, up / dn to scroll" on the LCD screen. Press the up button twice, and it will take you to "Transceiver Setup, up / dn to scroll". To enter, press the select button. A new screen will appear saying "Baud Mode Done" with DONE flashing.

The baud rate is the speed in which information is exchanged between the SteppIR controller and your radio. This setting must be the same as the setting in your radio, or the interface will not function. To set the baud rate, press the up or down arrow until BAUD is flashing, and then press the select button. You can then use the up or down arrows to adjust to the proper setting. If you are not sure what this setting is, refer to the users manual for your radio. When the proper baud rate is showing, press the select button. BAUD will now be flashing again.

Now you will want to set up the mode, which is the radio type you will be using. The radios to choose from are: Icom, Kenwood, Yaesu FT847, 1000D, 1000MP and OFF.

Press the up or down arrow until MODE is flashing and then press the select button. Now you can use the up or down arrow to scroll through until the proper mode selection is visible. Press the select button, and MODE will be flashing again. To save these settings, use the up or down arrow until DONE is flashing again, and press the select button. The controller will ask you if you want to save these settings, and NO will be flashing. If you do not want to save your changes, press the select button while NO is flashing. If you do want to save them, press select while YES is flashing. YOU MUST NOW TURN THE STEPPIR CONTROLLER OFF AND THEN TURN THE CONTROLLER BACK ON AGAIN BEFORE THE SETUP WILL TAKE PLACE. Once this is done, press the mode button until the "general frequency" LED is lit, and then press select within 2-1/2 seconds. When you tune your rig, the SteppIR controller should now automatically re-adjust every 50 KHz.

Creating and Modifying Antennas

The factory default antenna segments that are programmed into your controller have been modeled and field tested to provide very good gain, without sacrificing front to back. The create, modify menu allows you to change the length of the director, driven element or reflector for any antenna segment. You can use this feature to try out your own antenna designs, or to "tune out" potential objects that are causing interaction or SWR problems with your antenna. The driven element can be changed up to 5% in length to obtain a better match with no appreciable change in gain or front to back performance, so it is always best to just tune the driven element to correct SWR problems. This feature is especially good for those of you who experiment with modeling programs such as EZ-NEC or YO PRO. Computer modeling has dramatically simplified antenna design. With this technology (many modeling programs are available on the internet) the average ham can create his/her own antennas and have a very accurate idea as to what kind of performance to expect *before* the antenna is built. While modeling has been a great help, in the past, when the modeling was done you still would have to go outside and make the necessary modifications in length for every single antenna design, which could be quite cumbersome and time consuming. With the SteppIR adjustable antenna, we have advanced antenna design technology one step further - now you can model *and build* as many different antennas you want, without ever leaving your ham shack! Remember, however, modeling programs output the electrical length of the element - not the physical length. Our controller indicates the physical length, the electrical length is from 2% -3.5% longer due to the conductor diameter, mounting hardware and dielectric loading due to the telescoping fiberglass poles. We have this data accounted for and programmed into the factory default antenna segments. If you are doing some serious antenna modeling, call us at the factory and we can give you more data on electrical lengths. With the SteppIR Yagi, when you have finished changing the respective lengths, you can save the new antenna to memory, overriding the factory default antenna segments. If at any point you want to restore the factory default antennas, you can do so by going to the "Factory Default" menu in setup (page 20), which allows you to easily restore either a single antenna segment, or every one of them if necessary.

When you first enter setup mode, you will see "mode key to exit, up / dn to scroll" on the LCD screen. Press the up button three times, and it will take you to "Create, Modify, up / dn to scroll". To enter, press the select button. A new screen will appear saying "DIR DVR REF DONE" with DONE flashing.
DIR means the director, DVR means the driven element and REF means the reflector. If you want to adjust any or all of these, you will need to press the up / down arrow until the element of choice is "flashing". For example, if you press the up key once, DIR will now be flashing, with the current length shown on the second line. To change this length, press the select button. Now the display will say Up Dn to adjust, which means use the up or down arrows to adjust the length of the director to your desired length. Individual clicks will change the length approximately 0.4" at a time, and if you hold the button down, after a few seconds the controller will ramp up to adjust at 1 inch increments. The elements are changing in real time, so you will see the SWR change as you adjust the element. Once you have reached the desired length, press the select button. DIR will be flashing again, with the new length shown on the second line of the LCD screen. To change the driven element and reflector lengths, use the up / down arrows until the respective element is "flashing" and repeat the above procedure. When you are finished making adjustments, press the up / down arrow until DONE is flashing again, and press the select button. The screen will read "SAVE? YES NO, with NO flashing. Use the up / down button to choose the proper choice and press the select button. If you selected yes, the new lengths will be saved into memory for the antenna segment you are currently on. If you select no, no changes will be made, your antenna segment will be just as it was before. *Note: changing the lengths of the antenna segment while in "normal" direction will not change the antenna lengths in the bi -directional or 180 degree direction, as they are completely different antennas, independent of the "normal" direction segment. To change these antennas, you must be in the respective "direction", and follow the above procedures.* Remember, if you ever need to restore the factory defaults, this can be easily accomplished. Refer to the "factory default" instructions on page 20 for more information.

Calibrating the Antenna

Calibrating the antenna ensures that the element lengths are exactly what the controller display says they are. Usually, the only way the antenna can get out of calibration is if the power is interrupted or the cable is somehow disconnected while the antenna is changing length. The controller doesn't "know" where the antenna is adjusted to unless you start at a known place. The antenna housing sent to you has an element retracted inside, and the controller is set to "elements retracted". If you power up the controller and it says "elements retracted, and you connect the antenna control cable with the elements physically retracted, you are "calibrated" and ready to go!

If you need to calibrate, it is a simple, two click operation. When you select calibrate, the antenna will retract all of the elements, and the stepper motor will continue to over-step for a few moments after the elements have retracted. In doing this, the controller is making sure that there is not a shadow of a doubt that each element is fully retracted, and back to the known starting point. When calibrating, you will hear a buzzing noise for about 30 seconds, this is normal. When calibration is finished, the antenna will go to the last segment you were on you started the calibration process. The entire process takes less than a minute. *Note: Whenever your antenna is not acting as it should, we highly recommend that you use the calibrate function before exploring other potential problems. Always calibrate when in doubt - it is easy, and doesn't hurt a thing!*

When you first enter setup mode, you will see "mode key to exit, up / dn to scroll" on the LCD screen. Press the up button four times, and it will take you to "Calibrate, up / dn to scroll". To enter, press the select button. A new screen will appear saying "Calibrate YES NO", with NO flashing. To calibrate the antenna, press the up or down button until YES is flashing, and then press the select button. The screen will now say "Calibrate" with the second line saying "Homing Elements". You will notice that the asterisk will be flashing the entire time the antenna is calibrating. When the controller is done calibrating the antenna, the LCD screen will then display the last antenna segment you were on when you started the calibration process. When the asterisk quits flashing, the controller leaves the calibrate mode and returns to the mode you were in - you are ready to go!

Retracting the Elements

If you ever plan on taking your antenna down, you will first need to retract the elements. In addition, if you want to protect your antenna during periods of non-use, or during lightning storms or harsh winter conditions, you can use the retract element feature for this as well. Many of our customers have retracted their elements during lightning storms, greatly reducing the conductive area of the antenna platform. In ice storms, SteppIR users have also been able to retract their elements, greatly reducing the potential for loss in case of a catastrophic failure. When you retract the elements, the copper beryllium conductive strip is "safe and sound" inside the antenna housing, leaving only the telescoping fiberglass poles. These poles are easy to replace and reasonable in price ($20 each for SteppIR owners), so even if you damage the telescoping fiberglass support elements, the most valuable part of the antenna should be safe!

Retract Elements (continued)

When you first enter setup mode, you will see “mode key to exit, up / dn to scroll” on the LCD screen. Press the up button five times, and it will take you to “Retract Elements, up / dn to scroll”. To enter, press the select button. A new screen will appear saying “Home Now? YES NO, with NO flashing. The controller is asking you if you want to send the elements “home”, which means retracting the elements inside the antenna housing. To retract the antenna, press the up or down button once, and YES will start flashing. Press the select button, the display will say “Home Now? / Homing Elements”. The asterisk will be flashing, this means that the antenna is retracting, when the asterisk disappears, the new message will read “Element Retracted”. Your antenna is now safely inside the antenna housings. When you want to put the antenna back on the air, simply press the antenna segment you desire, and the controller will adjust to that segment.

Normal, 180 Degree and Bi-Directional Function

The 180 degree mode feature is one of the most popular among SteppIR users. The 180 degree mode allows you to literally “rotate” the antenna 180 degrees from your current “normal” direction beam heading. This is done by simply pressing a button, and in 2-1/2 seconds the transformation is complete. With the three element Yagi, the existing reflector becomes a director and the director becomes a reflector, and you now have a completely different antenna in the exact opposite direction. With the two element Yagi, the director becomes a reflector. In addition to greatly reducing your rotator use, many SteppIR users report that the 180 degree function is an excellent tool for short path / long path operation, or for picking up that elusive multiplier in the heat of a contest! At Fluidmotion, we think the best use for this function is when we want to show off the great front to back performance of the antenna!

The bi-directional function operates in a similar manner, except when enabled, you are now operating with gain in opposite directions. With the 3 element yagi, you will have approximately 4 dBd of gain in each direction, and with the 2 element yagi you will have approximately 2 dBd in each direction. This feature can be very handy for those who are involved with net operation or ham contests where hearing (or sending) signals from two directions can give you an advantage.

The direction button is located to the right of the LCD display. The button is a 3 way toggle, meaning that each time you press the button it will move to the next position. When no LED’s are lit, this means you are in the forward, or “normal” operating direction. If the 180° LED is lit, the direction of the antenna is now 180 degrees, or the exact opposite direction of where you were pointed at before. If the Bi-Dir LED is lit, you now are operating with gain in each direction.

Saving antennas to memory

In addition to creating or modifying antennas, you can also save specific frequencies that you may want to access repeatedly. You can save up to 18 different frequencies and access them in the general frequency mode. For example, if you wanted to save WWV on 15.000 MHz into memory so that you could access it quickly, you would first go to general frequency mode, and press the “select” button. From there, you could either hold either the up / down arrow until you reached WWV at 15.000, or you could press one of the band buttons to get you close to the destination frequency, and use the up or down arrow to dial it in the rest of the way. This brings up an important point for manually operating in the general frequency mode.

Saving antennas to memory (continued)

Since the controller adjusts 100 KHz at a time in this mode, to get to the exact frequency desired, you will need to find a starting point that is either even (XX.100 or odd (XX.050). Otherwise, you will be off by a factor of 50 KHz. The default frequencies for each band button in general frequency mode are: 20m = 14.050; 17m=18.100; 15m=21.200; 12m=24.950; 10m=28.800; 6m=51.000 MHz. So, to get to an even numbered destination frequency, you will need to start at either 17m, 15m, 10m or 6m. To get to an odd numbered destination frequency, you will need to start from 20m or 12m.

In the general frequency mode, there are a total of 18 different memories. Each individual band button (20m, 17m, 15m, 12m, 10m and 6m) has 3 memories - a memory for the forward direction, another memory when you go into the 180 degree direction, and a third memory when you go to the bi-directional mode (Remember, these are all separate antennas, independent of each other). You can re-place the factory default frequency with a new setting at any of these points, but keep in mind that the antenna will act just as it should - for example, if you save 15.000 MHz in bi-direction mode, that new setting will only work in the bi-directional mode, and the default frequency will not have been changed in either the forward or the 180 degree direction. Because of this, if you want the SteppIR controller to work in “normal”, “180 degree” and bi-directional” for the new frequency of 15.000 MHz, each one will have to be changed individually by activating the respective feature, and then replacing the fre-quency and saving it to memory. Changing the defaults in the general frequency mode is not difficult. We will be using our example of WWV at 15.000 MHz to explain the procedure.

While in general frequency mode, first you will want to tune the controller to 15.000 MHz as explained above. In this case, we are going to save the new frequency on the 20m button, since 15 MHz is pretty close to the default antenna segment of 14.050 MHz .

Press the 20m button and hold it down for a few seconds. The LED will start to flash. Let up on the 20m button, and then immediately press it again. 15.000 MHz has now replaced 14.050 MHz, and is saved in the 20m “normal” direction segment. That is all there is to it! If you wanted to add this new frequency to the 180 degree mode on the 20m band button, you would now press the direction button (located the immediate right of the LCD screen) until the 180° LED is lit. Press the 20m button and hold it down for a few seconds. The LED will start to flash. Let up on the 20m button, and then imme-diately press it again. Now 15.000 MHz is saved at the 180° direction. To add 15.000 MHz to bi-directional on the 20m band button, you would press the direction button until Bi-Dir LED is lit, and repeat the procedure one more time.

General frequency mode: factory default settings

Band Segment / Memory Button	Default Antenna Normal Direction	Default Antenna 180° Direction	Default Antenna Bi-Directional
20m / Mem1	14.050 (01)	14.200 (07)	14.200 (13)
17m / Mem2	18.100 (02)	18.100 (08)	18.100 (14)
15m / Mem3	21.200 (03)	21.200 (09)	21.200 (15)
12m / Mem4	24.950 (04)	24.950 (10)	24.950 (16)
10m / Mem5	28.800 (05)	28.800 (11)	28.800 (17)
6m / Mem6	51.000 (06)	51.000 (12)	51.000 (18)

Each default antenna has a number in parentheses - this is to show that there are 18 possible memories to store saved frequencies in.

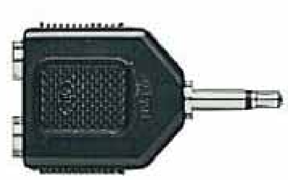
Using the SteppIR controller with your logging program

Logging programs fall into two groups; programs with manual rig control (like TRX-Manager), which allow you to control the radio from the computer, and programs that are focused on logging, with the ability to set the rig to the correct frequency through a spot (like DX Base). The first type of programs poll the radio continuously to get the frequency. These programs work with the SteppIR by using a "Y" cable to link the computers receive data together with the SteppIR's receive data. This way, when the logging program request the radio data, the SteppIR controller also receives a response. There will be a slight delay depending on how fast you have the polling set in the software. The only caveat is that the logging program must be active on the computer for the SteppIR controller to follow the frequency.

The programs that are designed to strictly do "spots" will only be recognized by the SteppIR controller when a spot is selected. Some of these logging programs can be linked to TRX-Manager to get the benefits of both programs. Most of the logging programs, such as Logger, Log Windows and TRX-Manager, send the spot frequency information to the radio and then ask the radio if it got the frequency information OK. The SteppIR controller can only listen to the radio data, not the logging program data, therefore those logging programs that send spot data and do not query the radio (such as Logic 6 and DX-Base) will not work with the SteppIR controller unless an Icom radio is being used. However, these programs will work if used in conjunction with TRX-Manager.

Icom

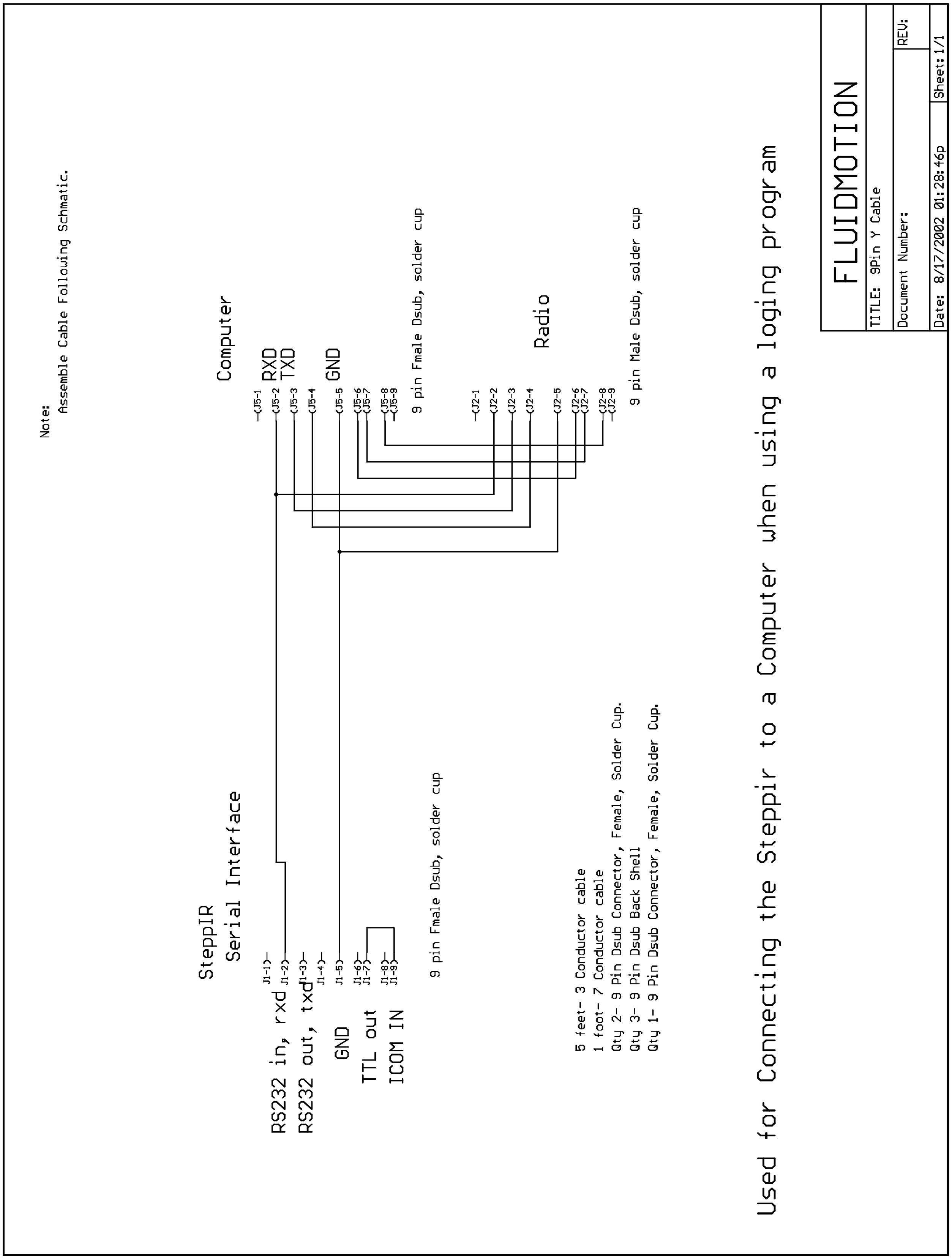
The Icom is unique in that it has no conflicts when using logging programs of any type with the SteppIR controller. This is because the Icom uses a shared serial Buss (CI-V) that can have up to 5 devices connected to it. The SteppIR controller connects to this Buss through a 3.5 mm phono plug. If you are using the Icom CT-17 to interface to your PC, it already has 5 C-IV connectors that the SteppIR can be plugged into. Otherwise, you can simply parallel the SteppIR controller and the radio by using a simple "Y" connector available at Radioshack.™ as shown below.



#274-310 Y-Adapter

Kenwood and Yaesu

If you are using a Kenwood or Yaesu radio, you will <u>not</u> be able to use the Radioshack™ connector mentioned above. You must use a "Y" cable, which is available from SteppIR Antennas, or you can build it yourself by referring to the drawing on page 20.


Note:
Assemble Cable Following Schmatic.
Computer
RXD
TXD
GND
9 pin Fmale Dsub, solder cup
Radio
9 pin Male Dsub, solder cup
SteppIR
Serial Interface
RS232 in, rxd
RS232 out, txd
GND
TTL out
ICOM IN
9 pin Fmale Dsub, solder cup
5 feet- 3 Conductor cable
1 foot- 7 Conductor cable
Qty 2- 9 Pin Dsub Connector, Female, Solder Cup.
Qty 3- 9 Pin Dsub Back Shell
Qty 1- 9 Pin Dsub Connector, Female, Solder Cup.
Used for Connecting the Steppir to a Computer when using a loging program
FLUIDMOTION
TITLE: 9Pin Y Cable
Document Number:
REV:
Date: 8/17/2002 01:28:46p
Sheet: 1/1

SteppIR 2 and 3 Element Yagi Gain / Front to Back Modeling

The SteppIR has a matching system that is included in both the 2 element and 3 element Yagi (it 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. We found an excellent one designed by Jerry Sevick, that is described in his book “Building and Using Baluns and Ununs”.

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

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

Shown on the following page are gain and front to back figures for our 2 element 57 inch boom antenna that we claim rivals most 3 element beams. These values were measured on a range using the protocol described in “Antenna Comparison Report: HF Tri-Banders” by Ward Silver (N0AX) and Steve Morris (K7LXC).

To create this report, they took popular tri-banders and put them on a 48 foot tower and transmitted a signal to a dipole on a second tower several thousand feet away with a spectrum analyzer connected to it. Using this setup they measured gain and front to back ratio of each of the tri-banders. Their test represents the most realistic comparisons of Yagi’s we have seen to date.

2 element Yagi Field Test (normal direction)

BAND	GAIN	FRONT TO BACK
20 meters	4.2 dBd	18 dB
17 meters	4.2 dBd	19 dB
15 meters	4.1 dBd	13.7 dB
12 meters	4.0 dBd	13 dB
10 meters	3.8 dBd	9.3 dB
6 meters	2.6 dBd	1.5 dB

These values correlate fairly well with YO – PRO and EZ – NEC. If you have YO-PRO, try modeling a 2 element yagi on a 57” boom with the passive element a director. You should see performance close to the above figures. A two element yagi on a short boom will be very narrow in bandwidth but high in performance, but with tunable elements… who needs bandwidth?

Computer Models of Free Space Gain and Front to Rear vs. Frequency

(SteppIR 2 element yagi)

Note: Bear in mind that these values are not the maximum or average for a given band – this performance is across the entire band. Additionally, the rear response figures for our 2 and 3 element yagis are front to rear, as opposed to front to back**.** ***Front to rear*** means the worst case response off of the back of the antenna. Front to back is simply the response exactly 180 degrees from the forward direction. Front to rear measurement is a more realistic, conservative specification.

BAND	GAIN (dBi)	HALF POWER ANGLE	FRONT TO REAR
20 meters	6.6 dBi	+/- 35	20.5 dB
17 meters	6.6 dBi	+/- 35	16 dB
15 meters	6.5 dBi	+/- 34	13 dB
12 meters	6.4 dBi	+/- 35	10.5 dB
10 meters	6.2 dBi	+/- 35	8.5 dB
6 meters	5 dBi	+/- 35	1.5 dB

Stepper 3 Element 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. Our modeling indicated what most yagi textbooks say – real world optimized range from 16 ohms to 28 ohms impedance.

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. 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 – the reflector is now closer to the driven element and the director is farther away. The result is slightly different gain and front to rear specifications. Ironically, you will get a slight bit more gain in the 180 degree direction.

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. The following figures are very close, but not exact.

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.

Note: Bear in mind that these values are not the maximum or average for a given band – this performance is across the entire band. Additionally, the rear response figures for our 2 and 3 element yagis are front to rear, as opposed to front to back. ***Front to rear*** means the worst case response off of the back of the antenna. Front to back is simply the response exactly 180 degrees from the forward direction. Front to rear measurement is a more realistic, conservative specification.

Computer Models of Free Space Gain and Front to Rear vs. Frequency

(SteppIR 3 element yagi)

BAND	GAIN (dBi)	HALF POWER ANGLE	FRONT TO REAR
20 meters	7.4 dBi	+/- 34°	25 dB
17 meters	8.3 dBi	+/- 32°	25 dB
15 meters	8.5 dBi	+/- 29°	20 dB
12 meters	8.8 dBi	+/- 28°	15 dB
10 meters	9.0 dBi	+/- 29°	11 dB
6 meters	6.2 dBi	+/- 35°	2.8 dB
6 meters w/ passive element	10.1 dBi	+/- 25°	20 dB

The following figures were measured on the testing range using the protocol set forth in "Antenna Comparison Reports – HF Tri-Banders" by Ward Silver (N0AX) and Steve Morris (K7LXC).

3 element yagi field test (normal direction)

BAND	GAIN	FRONT TO BACK
20 meters	4.9 dBd	42 dB
17 meters	5.5 dBd	44 dB
15 meters	5.7 dBd	44 dB
12 meters	6.2 dBd	16.5 dB
10 meters	6.3 dBd	15 dB
6 meters (without passive element)	2.9 dBd	4 dB

Fixed Element Spacing and the SteppIR Yagi

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

RF Power Transmission with the SteppIR Yagi

The RF power is transferred by brushes that have 4 contact points on each element that results in a very low impedance connection that is kept clean by the inherent wiping action. The brush contact is .08 in thick and has proven to last over 2 million band changes. The copper beryllium tape is .545 inches wide and presents a very low RF impedance that results in conductor losses of -.17 dB with a Yagi tuned to have a radiation resistance of 15 ohms, which is about as low as most practical Yagis run. The type of balun we are using can handle tremendous amounts of power for their size because the is almost no flux in the core and they are 99% efficient. That coupled with the fact that our antenna is always at a very low VSWR means the balun will handle much more than the 2000 watt rating, how much more we don't know. Jerry Sevicks book "Transmission Transformers" (available from ARRL) has a chapter (Chap. 11) that discusses the power handling ability of ferrite core transformers. *Note: 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 both the 2 element and 3 element yagi (it 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. We found an excellent one designed by Jerry Sevick, that is described in his book "Building and Using Baluns and Ununs".

Our matching network is a transmission line transformer that is wound on a 2.25 inch OD ferrite core that operates with very little internal flux, thus allowing it to function at very high power levels. The transformer includes a 22 ohm to 50 ohm unun and a balun. Jerry has espoused these transformers for years as an overlooked but excellent way to match a Yagi, he would probably be proud to know they are being used in a commercially 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.

SteppIR Yagi / DipoleAntenna Specifications

Specifications	⇨	Dipole	2 El Yagi	3 el Yagi
Weight	⇨	10.5 lb / 4.5 kg	34 lb / 13.6 kg	45 lb/ 19 kg
Max. wind surface area	⇨	1.9ft² / 0.17 m²	3.9 ft² / 0.37 m²	6.0 ft² / 0.57 m²
Longest Element	⇨	36 ft / 10.97 m	36 ft / 10.97 m	36 ft / 10.97 m
Maximum Power	⇨	2000 Watts PEP	2000 Watts PEP	2000 Watts PEP
Boom Length	⇨	N/A	57" / 1.44 m	16 ft / 4.87 m
Boom Diameter	⇨	N/A	1-3/4"	1-3/4"
Frequency Coverage (continuous)	⇨	20m - 6m	20m - 6m	20m - 6m
Turning Radius	⇨	9 ft / 2.74 m	14.4 ft / 4.39 m	19.7 ft / 6 m
Cable Requirements (22 AWG)	⇨	4 conductor	12 conductor	12 conductor
Tuning Rate	⇨	1.17 mhz / Sec	1.17 mhz / Sec	1.17 mhz / Sec
Balun Included (see below)	⇨	No	Yes	Yes
Wind survivability	⇨	100 mph / 160.9 kph	100 mph / 160.9 kph	100 mph / 160.9 kph

SteppIR ™

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 Fluidmotion Incorporated. 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.

Safe Handling of Copper Beryllium

Handling copper beryllium in solid form poses no special health risk. When sanding or grinding, avoid inhalation or contact with dust or vapors. Wash hands with soap and warm water after handling. For more information about copper beryllium, please contact:

Brush Wellman Engineered Materials
800-321-2076

SteppIR Notes:

Thank you for choosing SteppIR!!

SteppIR ™

Yagi ● Dipole ● Vertical

(Patent Pending)

SteppIR Antennas

Web: www.SteppIR.com