Aluminum HF Vertical Travel Antenna

by
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INTRODUCTION

I've had a tremendous response to the portable antenna project published in the July 2002 QST. Since this antenna has been so popular, I've continued to improve and simplify it. In the last several months I've evolved the antenna from the original riser design, to a fiberglass design, and now to an aluminum tube design. This new design is lighter and more compact than the original antenna. It is also easier to build, and easier to find parts for.

As before, this new version of the Travel Antenna is designed for easy transport. It breaks down into multiple mast and whip sections, an air-wound center loading coil section, and a small base support with no piece longer than 2-feet so it will easily fit into most suitcases. Yet the fully assembled antenna has a length in excess of 12-feet.

GATHERING THE PARTS

The loading coil, a B&W 3027, is available from Surplus Sales of Nebraska (www.surplussales.com).

The best source for the 3/8" aluminum tubing is at Texas Towers however it can be found in many hardware stores. The Texas Towers aluminum is the kind that's used in beams and masts and has a very high tensile strength.

Len-K4IWL: I have broken the parts list down into groups for each section of the antenna. This makes it much easier when it comes to finding the parts and assembling the antenna. I have also modified, somewhat, the parts quantities and items based upon some minor modifications that I have made to the design.

The parts list is as follows starting from the base and moving up:

BASE SECTION PARTS

(All of this was purchased at C&S True Value Hardware Store)

QTY	DESCRIPTION	NOTES
1	¾" PVC Tee	Get the type that has three ¾" slip joints.
2	¾" PVC Slip Plugs	See the article for use.
1	¾" x ½" PVC Bushing	This will have a ¾" slip joint and a ½" threaded inside.
1	½" x 1/8" Brass Bell (NPT)	This is a double female adaptor.
1	½" x Close Brass Nipple (NPT)	
2	#8/32 x 1 ½" Brass Machine Screws	
3	#8/32 Brass Nuts	
4	#8 Brass Washers (compression)	
1	#8/32 Brass Wing nut	
1	BNC connector	Through chassis mount type with ½" long threaded section.
4	$6 x ½" Stainless Sheet Metal Screws	See text but you might want to use 6 of these.
*	Support	See Text

CENTER SECTION PARTS (3 center sections)

(All of this was purchased at C&S True Value Hardware Store)

QTY	DESCRIPTION	NOTES
3	2 ft. 3/8" Aluminum Tubing	One 6' section from Texas Towers and cut in thirds. Actual Size: .375 x .058 ($4.20)
3	1/8" all-thread Brass Nipples (NPT)	
6	1/8" x 1/2" Brass Adaptor (NPT)	See text on how to modify
6	#6 x 3/8" Stainless Sheet Metal Screws	

COIL SECTION PARTS

(Coil from Surplus Sales in Nebraska, The rest from C&S True Value Hardware)

QTY	DESCRIPTION	NOTES
1	Ai\r Wound Coil – B&W 3017	$25.00 total which included 3-day delivery Cut in half. See Text.
1	3/8" Wooden dowel or Fiberglass Rod	Cut to 6 ½" length
2	1/8" x 1/2" Brass Adaptor (NPT)	See text on how to modify
1	1/8" x All thread Brass Nipples (NPT)	
2	#8/32 x 1 ½" Brass Machine Screws	
4	#8/32 Brass Nuts	
4	#8 Brass lock washers (Compression)	
*2	Plexiglass Circles	See text

* Len (K4IWL) modification

TOP SECTION PARTS

(Antenna from Radio Shack and Rest from C&S True Value Hardware)

QTY	DESCRIPTION	NOTES
1	72" Telescoping Antenna	Radio Shack #270-1408B
1	1/8" x 1" Brass Nipple (NPT)	

RADIALS

(Any Source)

QTY	DESCRIPTION	NOTES
72 Ft.	Wire (Any Guage)	Ribbon cable with each radial 4 strands works well.
1	#8 Spade Lug	

ALUMINUM ROD PREPARATION AND ASSEMBLY

See Figure 1 for the assembly details. In order for the Brass Addaptors to fit over the aluminum tubes, the ends of the adaptors that fit over the tubes must be reamed out with a 3/8" drill bit. To do this, first screw a 1/8-NPT adaptor on each end of an 'all thread' 1/8-NPT nipple. Use pliers and/or wrenches to screw these on tight. Next, grasp one of the couplings with a pair of vice-grips and ream out the opposite coupling with the 3/8" drill bit. Reverse, and ream out the other coupling. Now unscrew the couplings. One end will brake loose, and the other will stay tight in the remaining coupling. You'll now have a female and male end that will fit over each end of the aluminum tubes. You will need four pairs of these male/female brass connectors: three pairs for the aluminum tubes and one pair for the loading coil assembly. If you'd like, you can solder the nipple/coupling assemblies together, however the nipple/coupling assembly tends to be very tightly secured.

Finally, drill 9/64" clearance holes near the ends of the **three** adaptor pairs that will slide over the aluminum tubes. These holes will pass the #6 x 3/8" stainless steel sheet metal screws that will hold the couplings to the aluminum tubes. **Note: The fourth coupling pair is used on the loading coil assembly and will be drilled and tapped for #8 brass machine screws.**

Next cut three two-foot sections of the 3/8" aluminum tubes with a hacksaw or tubing cutter. De-burr the tubing, and also slightly file the edges of the tubing to make it easier to push into the brass couplings. As shown in Figure 1, insert the male/female brass pairs just constructed over all three of the aluminum 24" tubes. This could be a tight fit, so you may need to tap the couplings in place with a hammer. Since brass and aluminum are significantly dissimilar metals, you may want to coat the aluminum tube ends with DeoxIt, Noalox or Penetrox to prevent possible corrosion, especially if the antenna will be outside for extended periods of time. To tap the couplings in place, insert the male/female coupling pairs over the 3/8" aluminum tubes as best you can. Then place the nipple-end (male) on a piece of wood, and gently tap the opposite side of the rod (female coupling) with a hammer until the couplings are fully seated. Now, using the 9/64" clearance holes in the couplings as guide holes, drill 7/64" diameter holes through the aluminum tubes, and attach the risers to the aluminum tubes with the #6 x 3/8" sheet metal screws and lock-washers as shown in Figure 1.

LOADING COIL ASSEMBLY

Refer to Figure 2 for the loading coil section. Here, 1/8-NPT male/female coupling pairs are slid over a 3/8" diameter 6-1/2" long wood dowel. You will need to drill and tap a #8 threaded hole through one side of each of the 1/8-NPT brass couplings and into the wooden dowel as shown in Figure 2. Note that the screws are on opposite sides of the rod. Insert the two #8 x 1" brass screws through #8 nuts and lock washers as shown. Tighten the nuts to secure the screws in place. These screws will be used for the coil support. **NOTE: Put an extra brass nut and lock washer on the bottom (male end) adaptor screw. This will hold the shorting wire in place. See coil assembly photo.**

Now cut off a 5" length (half) of the B&W 3027 coil. Using a screwdriver, indent every other turn of the coil. Position the coil over the screws such that the 1½" long brass screw heads extend just above two adjacent turns on each end of the coil. Solder these two turns at each end to the screw heads. On the end of the wood dowel coil form with the brass nipple (male end), solder a 6" piece of insulated wire terminated with an alligator clip.

For extended outdoor use, you may wish to treat the wood dowel with varnish, replace it with a piece of 3/8"D x 5-1/2"L fiberglass rod, or use the riser assembly as shown in the original QST article (July 2002).

TOP WHIP PREPARATION

File the plating off the small mounting stub at the base of the Radio Shack 72" collapsible whip antenna. Once the bare brass is exposed, tin this with solder. Now insert the whip antenna base into the 1/8 NPT x 1" brass nipple such that the antenna base is just below the lip of the nipple. Temporarily hold these pieces together with some masking tape. Now heat the nipple with a soldering iron and solder the brass antenna base to the inside of the nipple. ***LEN (K4IWL):*** *I filed the bottom end of the antenna just enough so it fit a little deeper into the nipple. Then I clamped the nipple into a vise and using a small torch soldered the two together.*

BASE ASSEMBLY (AD5X)

In this design, I've used a 12" steel spike instead of the original brass threaded rod. The threaded rod was always a pain to clean off after use. With the spike, a damp cloth easily cleans it. Referring to Figure 4, drill a 3/8" diameter hole into the ¾" PVC plug (used for the ground support 3/8x12" steel spike). You may need to ream this 3/8" hole slightly if the spike doesn't easily slide through it. Cut off about half of the length of the ¾" PVC plug to leave plenty of room inside the "T" for wiring, insert the steel spike, and fill the plug with hot glue. If you wish you can solder the ground wire to the spike prior to inserting it in the ¾" PVC plug if you have a large soldering iron. However, this is really not necessary, as the radials will provide the antenna ground – both RF and DC. If you wish, you can PVC-glue the plug in place. However, you must still use the #8 x 1-½" stainless steel screw/lock-washer/nut as shown to ensure the spike doesn't push out the glue filler when trying to insert the spike into hard soil. Next, place the SO-239 temporarily over the ½" hole in the "T" and mark the location for the two #6 x 3/8" long stainless steel machine screws that will hold it in place. You'll see that these holes will be right in the center of the PVC lip. Carefully drill two 1/16" holes at these points. Place the ¾" PVC plug/spike assembly in the "T" and drill a 1/8" diameter hole all the way through the "T" and plug, just over the head of the spike. Also drill out two holes in the SO-239 connector to 1/8" since the holes are not large enough to pass the #6 x 3/8" sheet metal screws. Finally drill a 1/8" diameter hole as shown in Figure 4 for the 1" long #8 brass ground screw.

Finally, solder wires to the center conductor and to the ground of the SO-239 connector as shown. The wire from the center conductor should be soldered to the wire stub on the ½ x 1/8NPT brass adapter at the antenna interface, and then the 3/4x1/2" PVC adapter can be PVC-glued into place. I used a short piece of copper braid from a piece of RG-58 cable from the SO-239 ground (soldered directly to the SO-239 body) to the brass ground screw. You can solder the braid directly to the head of the brass ground screw. You can now complete the assembly of the base by inserting the PVC plug/12" spike assembly into the "T" and installing the #8 x 1-½" screw, lock-washer and nut as shown in Figure 4. As you can see in Figure 4, I also made provisions for an optional wing-nut assembly in case you need to add capacitive or inductive base matching should you significantly shorten the antenna, or if you have a very good ground-plane and want to improve your VSWR. To make this wing-nut assembly, screw a brass wing-nut tightly against the head of the brass screw and solder these together.

Next we'll prepare the antenna interface at the top of the base. First, cut off part of the ¾ x ½" PVC adapter so as to leave additional room in the "T" for wiring. Solder a piece of #14 copper house wire directly to the inside lip of the ½ x 1/8NPT brass adapter. You'll need a large soldering iron or a torch since the brass adapter mass is pretty large. Screw this adapter tightly into the ¾ x ½" PVC adapter.

ALTERNATE BASE ASSEMBLY (K4IWL)

Preparation of PVC Tee:

Drill a 9/64 hole through the side of the center of the Tee in-line with the opening on the opposite side. This will be used later for the #8 screw assembly that will be used to attach the radials.

Top of Base Section:
I used a ¾" PVC Tee with (3) ¾" slip joints. Select which end will be the top. This is where the ¾" x ½" Slip Joint PVC adaptor will go. Prepare the brass nipple as follows: Using a small file or a knife, scrape a small area until shiny on the inside lip of the ¾" brass nipple. Take a 6" length of hookup wire and remove about 1/8" of insulation from each end. Tin the wire ends. Clamp the brass nipple in a vise and using a small torch, heat the nipple and tin the area you've cleaned. Then while hot, solder one end of the wire to the inside of the nipple. Allow to cool. I used a small glass of water to cool the nipple. .Screw the ½" Brass Nipple into this adaptor very tightly. Use a pair of pliers if necessary. Make sure the wire is on the end that screws into the PVC adaptor. Then screw the ½" x 1/8" Brass Bell onto the nipple. Set this aside for now. This will connect to the bottom center section of the antenna.

Bottom of Base Section:
Drill a 3/8" hole in the center of a ¾" PVC slip plug. I used an 18" piece of a 3/8" threaded rod with the end ground to a point. You can use a metal spike with a 3/8" threaded end as suggested by Phil or anything else that works. **Note:** put a 3/8" nut on the threaded end about 1 – 1½" from the end then slide the end through the hole in the PVC slip plug. Put another 3/8" washer and 3/8" nut on and tighten down so that the slip plug is securely fastened to the rod. Make sure that the end of the rod is inside of the slip plug and does not extend into the body of the PVC Tee. Set this aside for now. This will connect to the bottom of the base.

Center of Base Section:
Drill a ¼" hole in the center of the third slip plug for the BNC connector or, if you prefer, use an SO-239 per AD5X instructions above. The BNC connector should come with a lock washer, a lock-washer-solder-lug, and a nut. Drill a ¼" hole in the end of the slip plug. Insert the BNC connector through the hole with the lock washer on the outside and the solder lug on the inside. Screw on the nut and tighten. Solder the end of the 6" hookup wire from the ½" nipple to the center conductor of the BNC. Cut a 3" length of hook up wire and remove ½" of insulation from each end. Solder one end to a ring solder lug and the other end to the shield solder lug on the BNC connector. Insert a #8 x 1½" brass screw through the ring solder lug and carefully insert the screw through the hole you drilled in the PVC Tee. Put 1 brass lock washer and a brass nut on the screw end on the outside of the Tee and tighten. Put another lock washer and the brass wing-nut on the screw. This will be used later to attach the radial wires.

Assemble the Base Section:
Insert the two slip plugs in the side and bottom of the Tee. Drill two 7/64" holes through the Tee and the bottom slip plug. Screw in 2 #6 x ½" stainless sheet metal screws. In the side plug with the BNC connector drill 1 7/64" hole and use 1 sheet metal screw. Do the same with the top adaptor. **NOTE:** Leave about ¼" of the top adaptor sleeve exposed for the next step. You can use two screws for these also but since the most stress is on the bottom I didn't feel the need to double up on the screws with the other two. Using a #29 (9/64") drill bit, drill a hole through the adaptor (just below the lip) and continue through the ½" nipple. This screw should be on the same side and in-line with the screw for the radials. Use a #8-32 tap to thread this hole all the way through both pieces. Take 1 #8 x 1½" brass screw and put a nut, washer, nut, washer (in that order) on the screw, then screw it into the tapped hole so it is just through the nipple. Then tighten the nut down as tight as you can get it. The 2nd nut and washer are to hold one end of a capacitor or matching network if you desire to use one.

RADIAL NETWORK:

The radial network is made up six 12-foot radials using #22 insulated wire though any gauge wire, insulated or not, can be used. Attach all the wires together and to a #8 spade lug on one end. This lug will attach to the ground screw on the base assembly. Roll up the six wires individually and hold them together with tie-wraps to minimize the time spent in unraveling the wires. On the outer end of each radial, solder on a 1-1/2" brass wood screw. These screws are pushed into the ground to help hold the radials in place. I put a blob of hot glue on the wire/screw interface to give it a little strain relief.

ANTENNA ASSEMBLY

To assemble the antenna, first screw the three 24" aluminum rods together. The female connectors are on the top of each section. Screw the loading coil on top of the 3 sections. Then screw the top telescoping whip assembly on top of the coil. Extend the telescoping whip. Push this base/rod assembly firmly into the ground, keeping it as vertical as possible. Next screw the assembled antenna into the base section. Finger tight is all that is necessary for all brass fitting interconnections. Finally, extend the six radials, and attach the common end to the ground screw on the base assembly. **NOTE (K4IWL):** I put the coil section immediately below the top telescoping antenna section. When the telescoping antenna is fully extended this puts the loading coil in the center of the antenna. You can experiment by putting the coil section at different levels.

ANTENNA SET-UP

To find a permanent coil tap for each band, start with 40 meters and use an antenna analyzer to find the coil tap that gives the best VSWR. Mark this tap point. You may want multiple taps on 40 meters so as to cover both the CW and SSB portions of the band. Move to 30 meters and repeat. Repeat again for 20 and 17 meters.

For 15, 12 and 10 meters, the entire coil is shorted. The telescoping whip is adjusted for resonance. Use a permanent black marker pen to indicate the high band positions on the telescoping whip.

Now solder short pieces of wire to the tap points determined for all bands where the coil is used. From this point forward, you can just go back to these tap points, or re-adjust the top whip as necessary, and not have to worry about making VSWR measurements. You'll find that in all cases the VSWR should be under 1.5:1.

GUYING AND MOUNTING OPTIONS

This antenna is self-supporting in a no- to low-breeze environment. In many cases it may be necessary to guy the antenna. For effective guying, attach packing twine (3 pieces) around the bottom coil support brass coupler. Extend the twine and attach to tent stakes, nearby shrubs, etc. If you wish to bolt the antenna base directly to a trailer mount or plate, use a 3/8" threaded brass rod as shown in Figure 7 instead of the 12" steel spike. In this case you should solder the ground wire inside the "T" to the 3/8" brass nut as shown to ensure a good ground to whatever the base

is mounted to. For flexibility, you may want to build both a "spike" and "threaded rod" bottom piece since these are held in place by screws.

Finally, you can easily make a 3/8x24 standard interface so that the antenna can be mounted on a standard 3/8x24 ham mount (most antenna mounts require a 3/8x24 stud on the antenna). It turns out that the 1/8-NPT thread is just a slightly tapered 3/8x24 thread. So, purchase a 3/8x24 bolt (your local hardware store again) and screw it tightly into a 1/8-NPT coupling. Cut off the head of the 3/8x24 bolt with a hack saw and file carefully so that the threads are OK for screwing into a 3/8x24 socket. You can now either screw this assembly onto the 1/8-NPT nipple on the bottom fiberglass rod section (See Figure 5), or screw the 3/8x24 bolt directly into the bottom 1/8-NPT coupling as shown in Figure 6 (if you'll never need the 1/8-NPT interface on the bottom antenna section). Now you can mount this antenna on any standard 3/8x24 antenna mount.

CONCLUSION

Due to the heavy interest in my portable antenna, I've made some changes which makes the antenna lighter, more compact, easier to fabricate, and also gives you more mounting options. You can also experiment with the antenna length – i.e. remove a section or two, use more or fewer sections, decrease or increase sections lengths, or place the loading coil in different positions. The lower the loading coil is placed on the antenna, the shorter the antenna can be for a given band, or the lower the operating frequency for the given antenna length. However, there is an efficiency penalty as you shorten the antenna, and you may also need some base capacitive loading to get the VSWR down. Also, don't hesitate to make changes based on hardware availability. Try brass or copper tubing, or even wire wrapped 3/8" fiberglass or wood dowel. Its fun to design antennas "on the fly" while standing in the plumbing section of your hardware store. This makes for interesting discussions with the clerks, however!

Phil Salas – AD5X – can be reached at ad5x@arrl.net *if you have any questions or comments. If you wish to purchase a completely assembled antenna, contact the author. The price is $89 shipped in the continental US, but only about one/week can be built do to a heavy work schedule. You are, however, strongly encouraged to build your own antenna. It is fun and less expensive – total cost should be less than $60.*

Len Carlson – K4IWL – can be reached at k4iwl@arrl.net *if you have any questions about my mods or wish to see it.*