

## Ultimate Portable HF Vertical Antenna Phil Salas – AD5X

### Introduction

I've had a tremendous response to the portable antenna project published in the July 2002 QST. However, many folks have had problems locating some of the parts. It seems that sprinkler system parts are not as common in other parts of the country as they are in Texas! Also, I wanted to try to eliminate some of the drilling and tapping necessary in the original article.

Over the past year, I've evolved the antenna from the original riser design, to a fiberglass design, to an aluminum tube design and then to a brass tube design. And now, with the introduction of some new long telescoping whips by MFJ, I've re-considered the entire design and have come up with a portable antenna that is longer, 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 Portable antenna is designed for easy transport. It breaks down into multiple mast sections, a whip section, an air-wound center loading coil section, and a small base support with no piece longer than the about 20-inches so I will easily fit into most suitcases. Yet the fully assembled antenna has a length of almost 16 feet! As most of you know, the key to antenna efficiency is length. The longer the antenna, the greater the radiation resistance and therefore the less impact you have on efficiency due to ground and coil losses. This antenna is nearly a full quarter-wave long on 20-10 meters and it minimizes the coil necessary for 40 and 30 meters. Yet it is smaller and lighter than my original 12 foot long travel antenna. See Photos "Author & Package.jpg", and "Package Cloup.jpg" for the disassembled antenna including guys and radials. See Photos "Author & Vertical.jpg", "Front Yard.jpg", and "Base & Radials.jpg" for pictures of the fully assembled vertical.

### Gathering the Parts

Other than the 10 foot collapsible whip and the loading coil, all other parts of this antenna can be found at your local hardware store. The loading coil, half of a B&W 3027, is available from Surplus Sales of Nebraska ([www.surplussales.com](http://www.surplussales.com)). The collapsible 10 foot whip is available from MFJ. MFJ also makes a 12 foot whip but I prefer the 10 foot version due to its shorter collapsed length (20 inches), lighter weight, and lower cost (\$20 vs \$30 for the 12 foot whip).

### Parts List

Two 3-foot pieces of 3/8" diameter brass tubing (\$4.50 each at True Value)\*  
One 3/8" diameter wood dowel (\$1.28/36" @ Home Depot – only 5-1/2" needed)\*\*  
One-Half of a B&W 3027 coil (\$20 shipped from Surplus Sales of Nebraska)  
One 10 foot telescoping antenna (\$20 @ MFJ, MFJ-1976)  
One 3/4 x 1/2" PVC-T (\$0.20 @ Home Depot)

One 3/4"-to-1/2" pvc adapter (\$0.50 ea @ Home Depot)  
One 3/4" PVC Plug (\$0.89 ea @ True Value)  
One 1/2x1/8-NPT brass adapter (\$1.20 @ True Value)  
Eight 1/8-NPT brass couplings (\$0.95 ea @ Home Depot)  
Four 1/8-NPT 0.7" all-thread nipples (\$0.75 ea @ Home Depot)  
One #8 wing-nut (\$0.34 @ True Value)  
Three #8 x 1" brass screws (\$0.08 ea @ True Value)  
Three #8 brass nuts (\$0.83/6 @ Home Depot)  
Three #8 copper-plated steel split lock washers (\$0.05 ea @ True Value)  
One 3/8x16 x 2-1/2" hex head carriage bolt, zinc plated (\$1.18 @ Home Depot)  
One 3/8x16 x 12" hex head carriage bolt, zinc plated (\$1.18 @ Home Depot)  
One 3/8x16 coupler, zinc plated (\$1.50 @ True Value)  
Two 3/8x16 nuts, zinc plated (\$0.83/6 @ Home Depot)  
One 3/8 lockwasher, zinc plated (\$0.83/10 @ Home Depot)  
Four #6 stainless steel 3/8" sheet metal screws (\$0.07 ea @ True Value)  
One chassis-mount SO-239 coax connector (\$1.99 @ Radio Shack – RS278-201)  
Three #8 spade lugs (Home Depot)  
90 ft wire (Any gauge, insulated or not, for six 12-foot ground radials)  
Six #8 x 1-1/2" brass wood screws (\$0.83/6 @ Home Depot)

\* You can use 3/8" aluminum tubing if you prefer. Aluminum tubing is about half the cost of brass, but you will either need to drill and tap the brass and aluminum couplings so they can be attached together with stainless steel sheet metal screws, or solder them together using aluminum solder and a torch (see <http://www.solder-it.com>).

\*\* 3/8" fiberglass rod is better than the wood dowel, but more difficult to find. Check out bicycle flags and driveway marker stakes as potential sources of fiberglass rod.

### Brass Rod Preparation and Assembly

See Figure 1 for the assembly details. First cut three 18-inch sections of the 3/8" brass tubes with a hacksaw or tubing cutter and de-burr the tubing. In order for the couplings to fit over the brass tubes, the ends of the couplings that fit over the tubes must be reamed out with a 3/8" drill bit. To do this, first screw a 1/8-NPT coupling on each end of a 0.7" 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 brass tubes. You will need four pairs of these male/female brass connectors: three pairs for the brass 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.

As shown in Figure 1, insert the male/female brass pairs just constructed over all three of the 18" brass tubes. Now solder the couplings directly to the rods. This is easily done

with a large soldering iron, or even better, with one of those Solder-It torches and silver solder. See <http://www.solder-it.com>.

### 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 5-1/2" long wood dowel, or fiberglass rod if you can find it. 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 rod 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.

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 1" 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.

### Top Whip

The MFJ 10-foot telescopic whip comes with a standard 3/8x24 mounting thread. This screws directly into the 1/8NPT couplings, so there is no whip preparation required.

### Base Assembly

In this design, I've used a 3/8x16 x 12" zinc plated hex head carriage bolt instead of the original brass threaded rod. That threaded rod was always a pain to clean. Only 1-1/2" of the carriage bolt is threaded, and I use the long smooth end of the bolt to go into the ground after cutting off the hex head. With the carriage bolt, a damp cloth easily cleans it. I also used a 3/8x16 x 2-1/2" zinc plated hex head carriage bolt at the base of the PVC assembly, and a 3/8x16 zinc plated coupler to attach the 2-1/2" bolt to the 12" bolt as shown in Figure 3. This way you can leave the long bolt off if you want to bolt the base assembly directly to a metal plate or trailer mount. Or you can screw on the long bolt for ground mounting.

Referring to Figure 3, drill a 3/8" diameter hole into the 3/4" PVC plug used for the base support 2-1/2" carriage bolt. Cut off about half of the length of the 3/4" PVC plug to leave plenty of room inside the "T" for wiring. Solder a ground wire to the head of the 3/8x16 x 2-1/2" carriage bolt as shown, insert the carriage bolt threaded end into the plug, and secure with a 3/8x16 nut and a lockwasher as shown. If you wish, you can PVC-glye the plug in place instead of using the #6 stainless steel sheet metal screws shown.

However, the screws make changing the support assembly easy in case you should ever want to.

To prepare the 12" carriage bolt, cut off the hex head and round this end with a file. Screw the 3/8x16 coupler over the threaded end, and screw the 3/8x16 nut against the coupler (lockwasher should be between the nut and coupler). This 12" carriage bolt assembly can now be easily screwed on to the 2-1/2" bolt on the base assembly for ground mounting.

Next, place the SO-239 temporarily over the 1/2" 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 3/4" PVC plug/spike assembly in the "T" and drill two 1/16" diameter holes through the "T" and plug. Remove this assembly from the "T" and drill out these 1/16" holes in the "T" to 1/8". 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.

Next we'll prepare the antenna interface at the top of the base. First, cut off part of the 3/4 x 1/2" 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 1/2 x 1/8NPT brass adapter. You'll need a large soldering iron or a Solder-It torch since the brass adapter mass is pretty large. Screw this adapter tightly into the 3/4 x 1/2" PVC adapter.

Now 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 1/2 x 1/8NPT brass adapter at the antenna interface, and then the 3/4 x 1/2" PVC adapter can be PVC-glued into place. Solder a short piece of copper braid from a piece of RG-58 cable from the SO-239 ground (solder directly to the SO-239 body) to the brass ground screw (solder directly to the head of the brass ground screw), and finally to the wire soldered to the head of the 2-1/2" carriage bolt. You can now complete the assembly of the base by inserting the PVC plug/2-1/2" carriage bolt assembly into the "T" and installing the #6 stainless steel sheet metal screws as shown in Figure 3. As you can see in Figure 3, 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 a brass screw and solder these together. See photos "Base with Spike.jpg" and "Base and Spike.jpg".

### Ground Radial Network

The radial network is made up six 15-foot radials using #22 insulated wire, though any gauge wire, insulated or not, can be used. I've found it best to make up three pairs of two wires each attached to a #8 spade lug on one end of each pair. This minimizes the hassle of deploying, and later rolling up, the radials. The three #8 lugs will attach to the ground screw on the base assembly. When the wires are rolled up, you should roll up the wires

individually and hold them together with tie-wraps. On the outer end of each radial, solder on a 1-1/2" brass wood screw. These screws are pushed into the ground to hold the radials in place. Put a blob of hot glue on each wire/screw soldered interface to give it a little strain relief.

### Antenna Assembly

To assemble the antenna, first screw the three 20-inch brass rods together, and then screw these into the top of the base assembly. Push this base/rod assembly firmly into the ground, keeping it as vertical as possible. Next screw the loading coil and telescoping whip assemblies together. Extend the telescoping whip. Screw this entire top assembly into the female end of the 18" brass tube that is available on the assembly currently pushed into the ground. Finger tight is all that is necessary for all brass fitting interconnections. Finally, extend the six radials, and attach the common ends to the ground screw on the base assembly.

### Guying

This antenna is self-supporting in a low-breeze environment. In many cases, however, it will be necessary to guy the antenna. For effective guying, I attached nylon cord (3 pieces) just above the base of the 10-foot MFJ telescoping whip. This is easily done by taking a tie-wrap and closing it just enough so that it won't slide over the base of the MFJ whip. Attach one end of a 9-foot section of nylon cord to the tie-wrap with hot glue or epoxy. For the ground stake, you can use the extra piece of brass tubing (you only used 4.5-feet of the 6-foot purchased). Cut this 18" piece of tubing into three six-inch tubing sections. Attach the non-tie wrap end of the nylon cord to one end of each tube with hot glue. For storage, wrap the nylon cord around each brass stake and hold in place with masking tape. When bolted to a trailer mount or plate, the antenna should really not need guying unless the wind is strong. See photos "Guy.jpg", "Guy Closeup.jpg", and "Nylon wrapped.jpg". See "Whip & Guys.jpg" for a photo of the guys attached to the telescoping MFJ whip.

### Antenna Set-up

To find a permanent coil tap, 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. For 20-meters, you will find that only the top turn of the coil is necessary for resonance. The antenna is almost a quarter wave long on 20 meters.

For 17, 15, 12 and 10 meters, I recommend removing sections of the brass tubes and adjusting the coil for resonance. In these cases, the antenna will effectively be a quarter-wave long on these bands. Remove two sections for 17 and 15 meters, and all three sections for 12 and 10 meters. You will also need to shorten the 10-foot telescoping whip by about a foot for 10 meters. Use a permanent black marker pen to indicate the correct band positions on the telescoping whip.

If desired, you can solder short pieces of wire to the tap points determined above. 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.

### Mounting Options

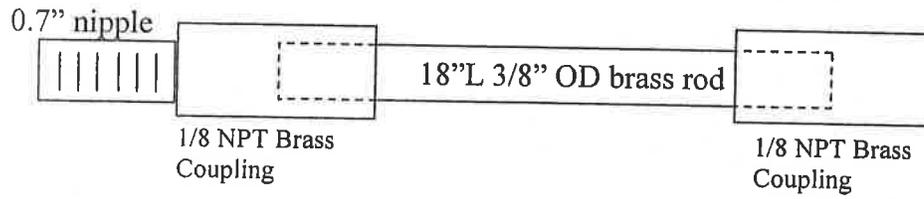
Finally, you can easily make a 3/8x24 standard interface so that the antenna can be mounted on a standard 3/8 x 24 ham mount. This would be useful for those with a standard ball mount on their car, and you want to use this extended length antenna when you are stopped. As discussed earlier, the 1/8-NPT 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 brass rod section (See Figure 4), or screw the 3/8x24 bolt directly into the bottom 1/8-NPT coupling as shown in Figure 5 (if you'll never need the 1/8-NPT interface on the bottom antenna section).

### Conclusion

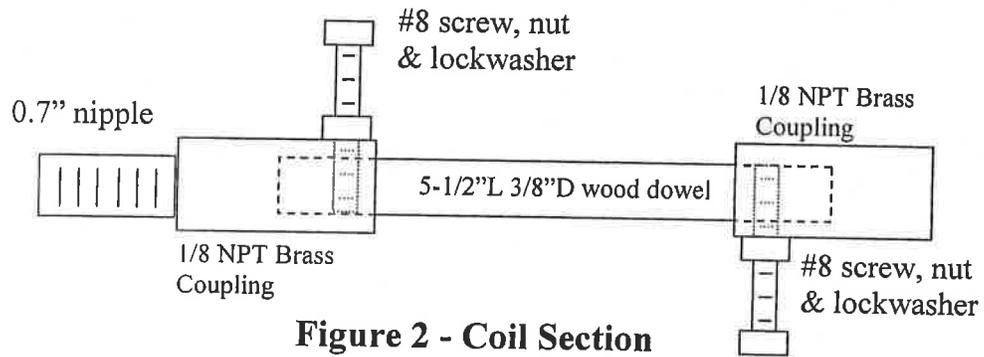
Due to the heavy interest in my portable antenna, I've evolved that design into an antenna that is longer, lighter, more compact, easier to fabricate, and gives you more mounting options. You can also experiment with the antenna length – i.e. remove a section or two, use more or fewer sections, decrease or increase sections lengths, or place the loading coil in different positions. And how about 75-80 meters? You bought twice as much coil as you need, so build up a second coil assembly and put both coil assemblies at the base of the antenna. However, there is an efficiency penalty for base-loaded antennas, but you must use base loading to reach 75-80 meters with this antenna. Also, you will need base capacitive tuning (shunt capacitor) to get the VSWR down on 75-80 meters. And finally, don't hesitate to make changes based on hardware availability. Try aluminum 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!

This is an easy and fun antenna to build, and the total cost should be under \$60.

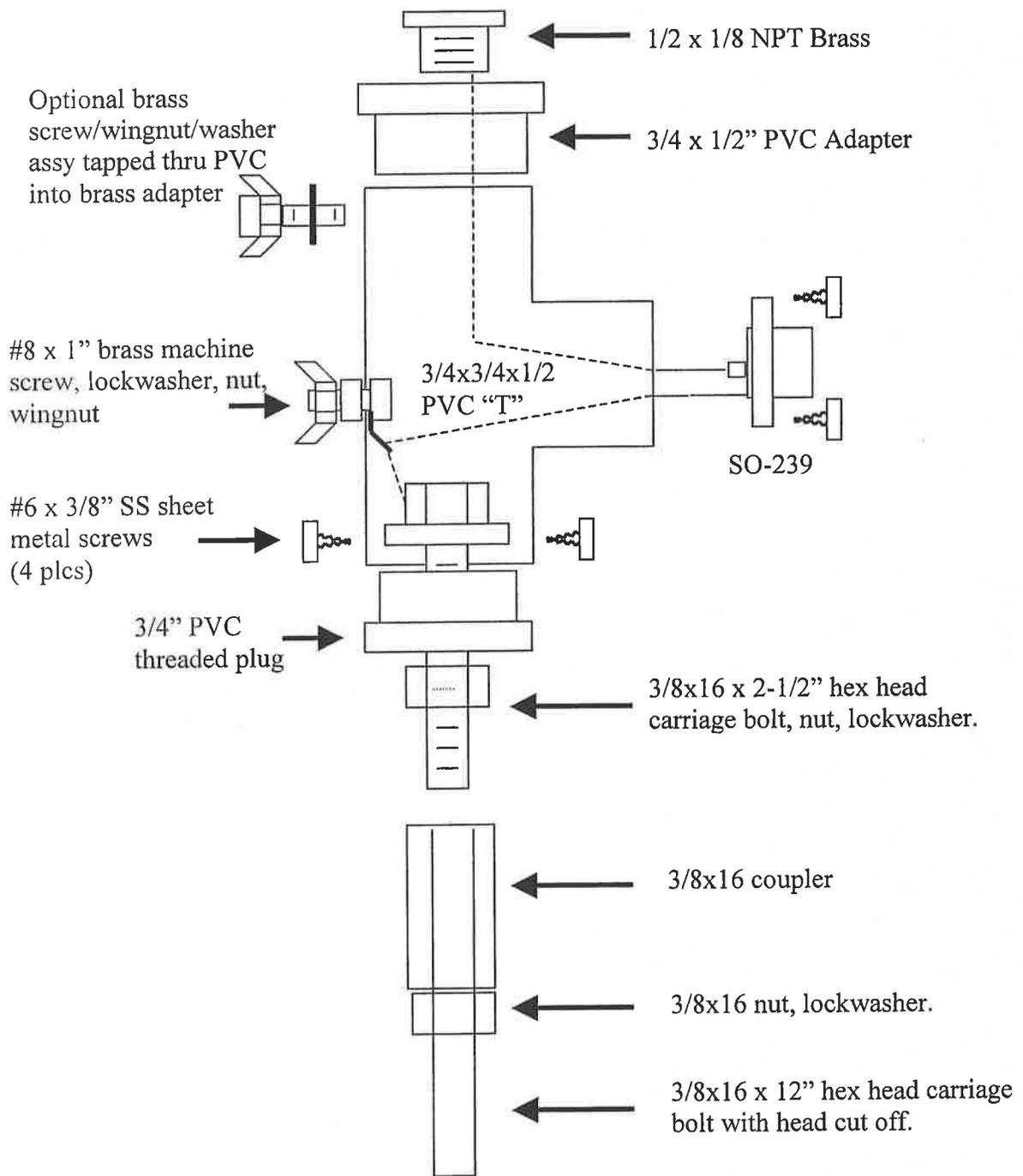
Phil Salas AD5X is an ARRL Life Member. He's been licensed for 40 years, and enjoys HF operating (mostly CW). Phil holds a BSEE from Virginia Tech, and an MSEE from Southern Methodist University, and is currently the Vice President of Engineering at Celion Networks in Richardson, TX. Phil can be reached at [ad5x@arrl.net](mailto:ad5x@arrl.net) if you have any questions or comments.



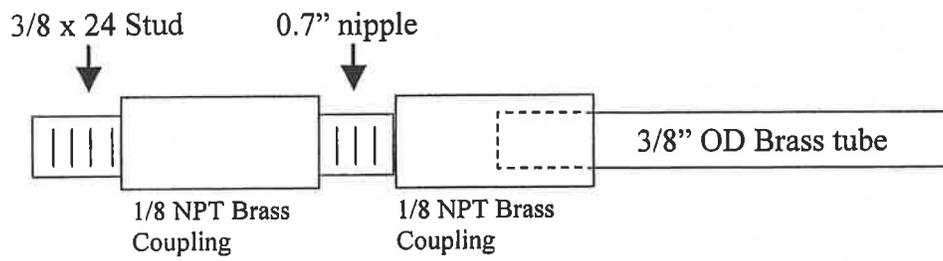
**Figure 1 - Middle Sections, no coil (3 ea)**



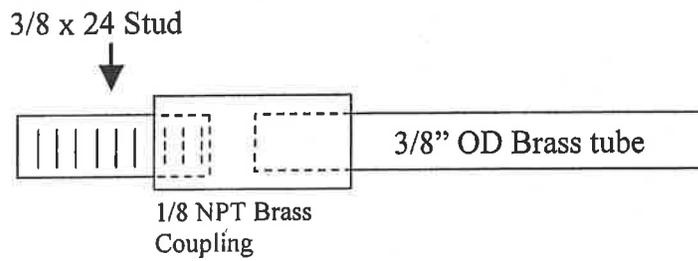
**Figure 2 - Coil Section**



**Figure 3 – Base Assembly**



**Figure 4 – Adapt to Standard 3/8x24 base**



**Figure 5 – Alternate Adapt to Standard 3/8x24 base**