The W3FF Portable Dipole

This is the antenna I designed for my 'walking portable' station. It is a dipole constructed out of the plastic plumbing pipe CPVC. There are telescoping whips at the ends of each side of the dipole, and these whips are adjusted to bring the antenna into resonance on each of five HF Bands.....10, 12, 15, 17, and 20 Meters. The longest elements are on 12 and 10 Meters, where the dipole is actually a full half wave. On the lower three bands, coils are used to shorten the antenna. It takes just about a minute to make band changes. Operation on Six and Two Meters has been tried successfully too. It costs about $30 to build this multi-band, portable dipole.

Note that the coils are not tapped. They are taken out of the circuit entirely on 10 and 12 Meters. I use one coil for 15 and 17 Meters, and a separate coil for 20 Meters. Details on the 2 and 6 Meter operation may be found later in this text.

Parts List

Here are the parts to make the dipole:

CPVC pipe is a cream-colored plastic pipe. Buy a 10' section of it. Get the 1/2 inch ID size. It will be about 5/8 inch OUTSIDE DIAMETER. CPVC pipe is found at Ace Hardware stores and many other home improvement outlets in the USA.

You will need 6 CPVC couplers. These are cream-colored also, and are straight. Be sure to get the size that fits the above pipe.

One PVC T in the half inch size. This is a slip-slip-thread. The thread is on the bottom of the T. NOTE: This is the only piece of PVC used in this project.

While at the hardware store, buy some electrician's tape. You will need a roll of black and a roll of red tape. The red tape is just for marking one set of coils to differentiate them for tuning purposes, so you will need just a small roll.

Also, you will need some hardware to affix the wire to the whip. Here is what I use:
Two 8-32 by 1/4 inch stainless steel machine screws, two matching washers and two matching nuts.

The following parts are available at most Radio Shackstores:

Two Radio Shack replacement whips. The whips extend to 72 inches, and collapse to 13 inches.
RS Part # 270-1408B

Two packages of Radio Shack electrical connectors. I use the blue ones, and I take the wire, strip it, and fold it over before inserting in into the connector. That makes a better connection.
RS Part # 640-3313

One package of tiny ring connectors to use to connect the wire to the whip. These fit the 8-32 hardware. I don't have the RS Part # in front of me as I write this, but you will find them where you find the electrical connectors.

One spool of #20 Radio Shack insulated speaker wire. It comes in 75' spools, and that is more than enough to make several antennas.
RS Part # 278-1388

The only other part you might need is an rf bead to keep the rf off the outside of the coax on some bands. You can try making a loop of say a half dozen turns of coax right below the feed point of the dipole and see if that is OK for your installation. If that doesn't get the SWR low enough to satisfy your transceiver, you can order rf beads from a company like Palomar. I use only one or two beads on my own dipoles.

Buy ferrite beads. Use Mix 43. Buy a core size that fits the coax you prefer. Since we are dealing with a portable antenna here, I use RG-8X coax, and the Palomar # FB-56 fits the bill nicely.

Go to: www.Palomar-Engineers.com Their phone number is: (760) 747-3343.

Note that the beads are low in cost, just $1.65 each. However, there is a shipping charge on each order of $6, so you might want to order some additional beads to use for other projects, experimenting, or sharing with your friends.

Tools Needed

You will need a hacksaw, a small hammer, a screwdriver, a pair of needle-nosed pliers, a drill with a 1/8" bit, (perhaps, also, a 3/16" bit, if you want a little extra room when drilling the holes in the PVC), a crimping tool, and a tool for removing insulation from wire. You will need a measuring tape. Keep a pad and pencil handy to record measurements. A Marks-alot felt pen will be needed in the final tuning phase. You should buy or borrow an antenna analyzer if you don't own one.

Here's how to build the antenna:

Cut two pieces of CPVC, each 22" long.

Drill a 1/8" hole about 3/4 of an inch in from each end of the CPVC pieces. Don't
drill the whole way through. Angle the drill slightly toward the long end, so that you can slide a wire into the piece of pipe. Drill the holes on the same side of the pipe.

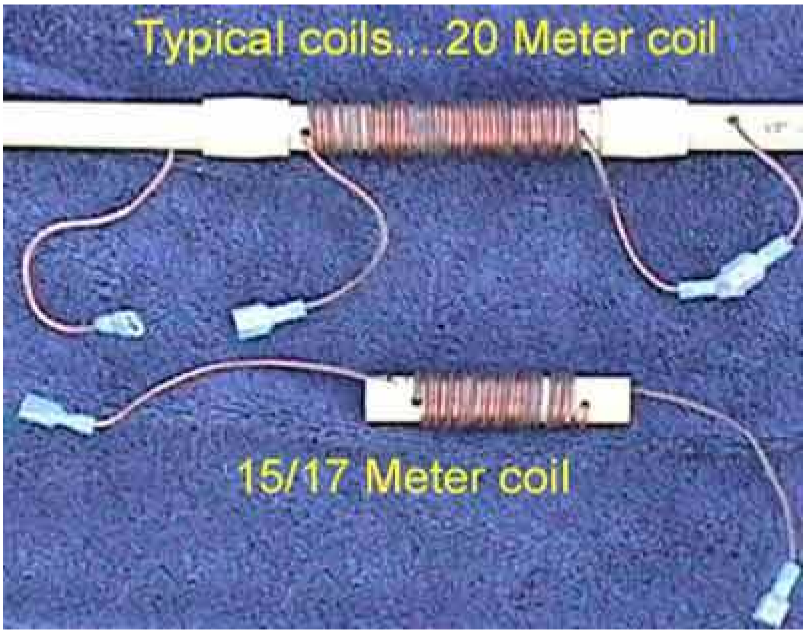
If you leave the speaker wire in its pair form before you cut it, you will be sure to use the same amount of wire on each coil. Cut 28" of wire from the spool, and split it into two28" pieces. Put one end of one of the wires into the hole you just drilled in the CPVC. Gently push the wire until you see it come out the other side of the pipe. Take a pair of needle-nosed pliers and work the protruding end into the hole at the end of the CPVC. You will have about 3" of wire on each side of the pipe when you are finished.

Do the same for the second 22" CPVC pipe piece.

Crimp one of the end electrical connectors, a female connector, on one side of each piece of the section you just finished. Put a male electrical connector on the other side on each section. You are finished with the 'arms' of the dipole.

Now let's construct the 15 and 17 Meter coils. You get two bands with one set of two coils. Cut a 3 1/4" section of CPVC with the hacksaw. This is the form for the coil. Drill a 1/8" hole all the way through the section, about 3/4 of an inch in from each end. Cut a piece of wire 64" long and poke about three inches through one of the holes you just drilled. Start wrapping the wire around and around the CPVC section until you have approximately 22 turns on the coil. Push the tag end through the hole you drilled earlier, and tape the whole coil tightly with plastic tape. Cut the tag end so that you have about 3"of wire coming out of the hole in the pipe. Put a female electrical connector on the one wire, and a male electrical connector on the other protruding wire.

The 20 Meter coil is prepared exactly the same way, but you start with a coil form of CPVC of about 5 1/4", and you use 8'4" of wire. Wrap 41 turns on this coil. For appearance sake, wrap the coils with black plastic tape. Then, on one 15/17 Mtr coil, put on a single wrap of RED plastic tape (to differentiate it from the other15/17 Meter coil). Do the same thing on one of the 20 Meter coils. This completes the construction of the coils. (SEE PHOTO 1)



The telescoping whips are held by CPVC also. Cut two 9" pieces of pipe. Drill a 1/8" hole about an inch in from either end of each piece. (Not the whole way through the pipe.) Take a 15" piece of wire, and feed it into the hole you just drilled and out the other end of the pipe.   Leave about 3" of wire sticking out of the hole you just put the wire through. Do this for each piece of pipe. Set the assembly aside.

Each Radio Shack telescoping whip has a tiny hole at the end of it. Enlarge that hole to accept a short machine screw (6/32 by 3/8" long) by drilling each whip with an appropriate bit, a bit about 1/8" in diameter.   Before going further, take some black plastic tape, and wrap 17 inches of it around the whip at a point just about an inch up from the previous enlarged hole in the whip. This is simply to make the whip fit snugly into the piece of CPVC that you have prepared to hold the whip. Add more tape or take some away to make the fit snug. Cut another 17 inch piece of tape, and wrap it at a point 7 1/2" from the hole in the whip. This gives you the support to keep the whip centered in the CPVC. (SEE PHOTO 2)

PHOTO 2

Take the previously made up assembly with the 15" of wire in the CPVC, and strip the insulation from the wire for about a half inch. The only reason this wire is not shorter than it is, is because it is much easier to put the wire through the pipe first, rather than by threading it in later. Connect the wire to the 6-32 machine screw you have put through one of the whips. Use a tiny lock washer and secure the wire. Now, pull on the 3" tag end of the wire you have coming out of the hole in the CPVC, and lead the whip into the piece of pipe until you see that the hole in the metal whip is adjacent to the hole in the CPVC. Cut off the wire so that you have just 3" protruding. Strip that wire end and put a female electrical connector on the end. The whip should be snug in the CPVC. At the telescoping end of the whip, where it comes out of the plastic pipe, tape the end of the pipe to the whip. This will keep it from slipping out of the pipe.

The PVC T has slip/slip ends on it. The CPVC arms attach to this T. The sizes of the pipes are different, so an adaptor is made as follows: Cut a piece of CPVC 2 1/4 inches long. Place a CPVC adaptor onto that piece of pipe, and tap it in firmly with a small hammer. Insert the pipe end of that assembly into the PVC T. Take a second CPVC coupler and place it onto the pipe. Carefully tap that coupler into the PVC T, so that you have a final assembly that looks like this: (SEE PHOTO 3)

PHOTO 3

My thanks to Justin, K5JBB, who came up with this idea when he was making one of the antennas early in 2001.

Note that there are 5 electrical connectors on each side of the dipole. The electrical connectors are placed on the wires in a specific order. There is a female connector on one side of the dipole arm and a male electrical connector on the other side. The dipole arm with the female electrical connector is going to be placed next to the PVC T when the antenna is assembled. The other end of the dipole will have the male electrical connector on it.

Place a CPVC coupler onto the 22" arm of the dipole. Put one of the two 15/17 Meter coils into that coupler, noting that the electrical connector you want to use on the 'arm' side is a male electrical connector.

Place a CPVC coupler onto the other side of the coil.

Place the piece of CPVC that holds the telescoping whip into the CPVC coupler to the coil. Note that there is a male electrical connector on the coil. This attaches to the female electrical connector on the whip assembly. This completes the antenna assembly. (SEE PHOTO 4.. drawing)

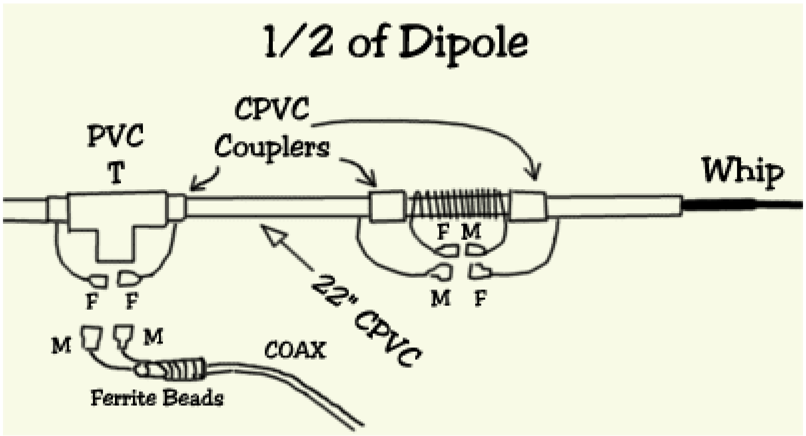


PHOTO 4

Make up a piece of RG8Mini or RG58 or similar light-weight coax as follows: On the end that attaches to the dipole, make a pigtail by stripping back the covering to expose the shield of the coax. Pick out the strands of braid so that when the braid is twisting to a point, it will be small enough to fit into one of the blue male electrical connectors. Bare the inside white or clear wire of the coax. You might want to use some shrink-wrap tubing to strengthen and protect the pigtails. Put one male electrical connector on each of the coax pigtails.

To get the radiation off of the outside of the coax (providing a better match and a lot less RF on the outside shield), you can do either of two things: Coil the coax in a 4" diameter with about 7 turns and secure the turns with black plastic tape. OR... You can also use ferrite beads by fitting them over your coax and taping them on with black plastic tape. Your choice, but the beads are the best way to go. Pick a mix for the HF frequencies. Most of the antennas I have built have worked much better with the beads. This antenna was designed for use with my walking station, so I use 10'of RG-174 coax. It is tiny, and the ferrite bead information is as follows: Palomar Model #FB63-43. I use a half dozen beads on the coax, very near to the pigtails at the dipole feed point. If you use RG8Mini, the Palomar Model # is: FB-56-43. I use one or two of these (longer) beads. (PHOTO 5)

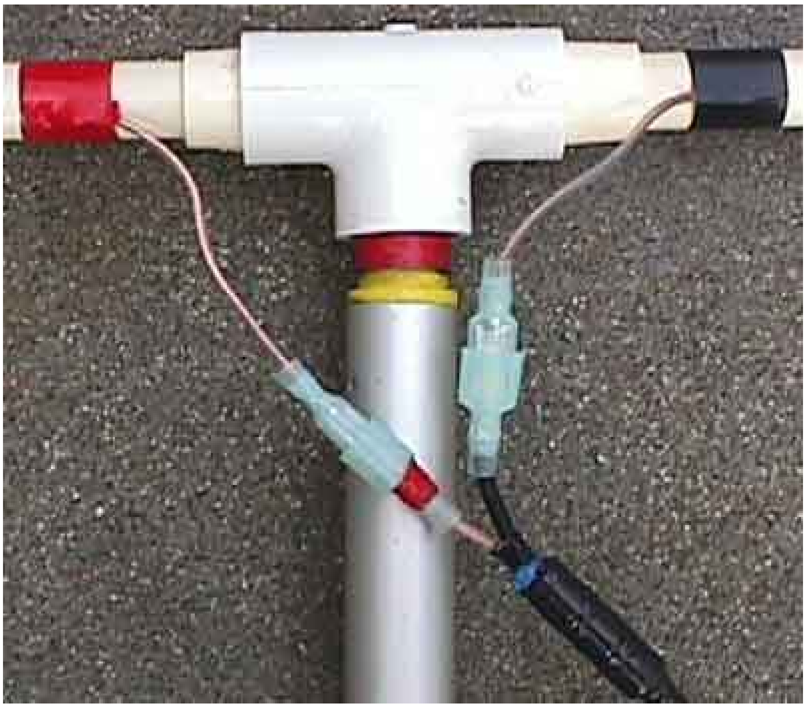


PHOTO 5

Fit a PL-259 on the other end of the coax(with appropriate reducers, depending on the size of the coax you are using). This completes the construction phase of the project.

You will need a mast to support the antenna. I have been using the aluminum paint masts that one would use to roller-paint ceilings with. They come in varying sizes, and the one I use most is the model that collapses to 6' and extends to 12'. There is a male, threaded, plastic top on most of these tiny masts. Take a piece of black plastic tape, and wind it around the plastic top just one and a half times. Cut the tape off, and press it to the plastic top. You will find that when you prepare the mast in that manner, it will thread nicely directly onto the PVC T of the dipole, even though it is a 'cross-thread'. You are now ready to tune the antenna.

Tuning the Dipole

This procedure is easy if you have an antenna analyzer to help you do the work. It can be done with a transceiver in the CW position by checking the power output at a known level, but using an analyzer such as the MFJ model, is better.

Set up a testing range by using a tripod or similar method of holding up the mast and the antenna while you are making the adjustments.

Each band is tuned separately. Start with Ten Meters. BYPASS the coil entirely by simply leaving the coil out of the circuit. Pull out all of the sections on each side of the dipole's telescoping whips. Check the resonance of the antenna with the SWR analyzer. Push the ends of each side of the antenna in slightly until you see that the antenna is in resonance, that is, that you have an SWR in the neighborhood of 1.7 or less. Note the number of sections it takes you to do this. Write this information down on a pad, and move onto the next band.

On 12 Meters, simply pull the whip ends out slightly, and check to see if the antenna is in resonance by doing so. No coils are used on 10 or 12 Meters.

If you find that your antenna is just not long enough to resonate on 12 Meters, simply take a 9" piece of #20 wire, install a female electrical connector on one end and a male electrical connector on the other end. Insert this jumper on the HOT or RED side of the dipole where the coil is bypassed. This lengthens the antenna just enough to make a perfect match on 12 Meters.

To load the antenna on 17 Meters, plug in the 15/17 Meter coil, and pull out the whips until they are in full extension. Check the resonance. You might be right on the 17 Meter band with very little adjustment. If the frequency shown on the antenna analyzer is too low, say in the 16 or 17 MHZ range, simply shorten the RED (hot) side by one section. Set the analyzer for 18.140 MHZ and watch as the SWR be longer than the other (it has to do with the groundside and the 'hot' side of the dipole as the coax is connected) to get a very low match. Note on your pad the number of sections out on the ground side and the number of sections out on the hot side. In the "Tuning Tips" section, see the list of how many sections it takes to resonate on various bands.

When you are satisfied that 17 Meters looks good, go to the 15 Meter position on the analyzer and start shortening the whip elements to go up in frequency to about 21.300 MHZ. When you get a dip, experiment as you did with the other bands. Just changing the whips slightly will change the resonance as you will see.

On 20 Meters, remove the 15/17 Meter coil, and insert the 20 Meter coil. Use the same tune-up procedure to get a big dip in the middle of the band, say about 14.200 MHZ.

Now, if you are satisfied that the measurements you made are in the ballpark on each band, check it out with your transceiver in the CW position. Just pick a frequency and check for power output. By lengthening and shortening the elements slightly, you will find settings where the power will maximize on each band. Mark those measurements ON the arms of the dipole, so that you will be able to change bands in just a few minutes. Use Marx-alot or a similar product to mark the CPVC arms.

Some Tuning Tips

Tune the antenna away from metallic objects, like cars, other antennas, towers, etc.

Use these APPROXIMATE settings for your antenna. If you have the proper # of turns on the coils, and if you used the correct Radio Shack speaker wire (#20), here are the settings I typically get: 10 Meters. RED or HOT side out 4.5 sections out, and BLACK..4 sections out. 12 Meters...both sides out all the way, with the 9" jumper inserted on the RED SIDE only. (no coils inserted on 10 and 12 Meters) On 15 Meters, pull out 2 sections plus 2 inches on the RED side, and 3 full sections out on the BLACK side. On 17 Meters, it's 3.5 sections out on the RED side, and 5 sections out on the BLACK side. (You should have the 15/17 Meter coils inserted for those bands) And, on 20 Meters, put the 20 Meter coils in, and pull out 3 sections plus 4" on the RED side, and 5 sections out on the BLACK side. These will vary with your antenna, but the settings are an excellent starting point.

BONUS ! Six Meters works well on all these I have tried. No coils. Push all sections in, and check the resonance. Pull the RED side out an inch or two at a time until you get the frequency you want.

BONUS ! Two Meters can be used, just by taking the 9" CPVC whip assemblies and putting them into the PVC T. Adjust the whips carefully to resonate on 146 Mhz. Remember to hold the antenna in a vertical position when working stations on FM. Thanks to Larry, K7COP, for investigating this aspect of dipole operation.

The antenna is not efficient on 40 or 80Meters. Email me if you want to try 40 Meters, and I will send you the info by return email.

FINALLY....

If this seems too complicated or confusing, simply email me at w3ff@aol.com and I will help you with the construction or the tuning. It takes me about an hour to construct a complete antenna. Several builders say it takes them 2 to 3 hours to complete the project. It takes me 20 minutes to tune one, and it should take you less than an hour.

Have fun with it, and let me know your suggestions for improving it!

Budd   W3FF

Questions about construction or tuning?

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