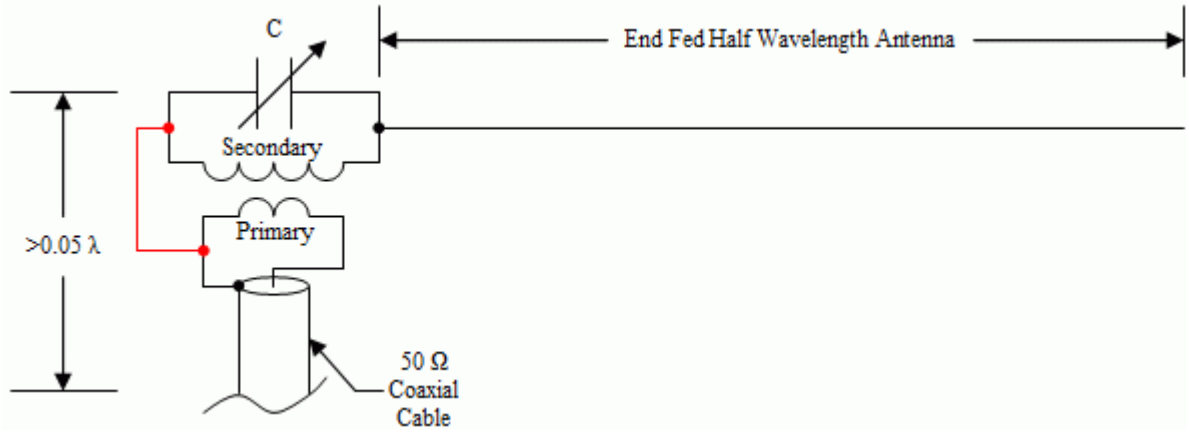
The EFHW - a monoband end-fed half wave for 10m, 20m or any other HF band

A practical, cheap monoband vertical antenna that is great for DX and very cheap too.

Steve Nichols G0KYA



I like half wave dipoles. They are easy to make and easy to set up. They also perform very well and usually beat a compromise antenna hands down. With 10m about to come alive again as solar cycle 24 gets going what I wanted was a low-angle efficient radiator that could be put up and down in a couple of minutes.

My experience with ground plane verticals has been OK, but they are only as good as the earth beneath them. That is, they really need an extensive array of ground radials to work properly – not easy to put down when you are in a hurry.

I also like to use fibreglass fishing poles as antenna supports. These are available cheaply (I have a 7m version and a 10m version that I bought from Sandpiper at the Leicester rally). The only problem is that they don't have lateral strength – they are good for supporting verticals, but not so good for half-wave horizontal dipoles.

What I really wanted to do was have a vertical half wave dipole, but the problem is that while the impedance at the centre of a dipole is about 50-75 Ohms, and very easy to match to coax, an end-fed half-wave has a very high impedance indeed, around 3000-4000 Ohms. If you just connect it to your coax or rig you will be disappointed.

What can you do?

After a lot of searching on the web I found the answer. Steve AA5TB of Fort Worth Texas has a great site with lost of information at www.aa5tb.com.

It was his site that helped me build my end-fed half wave for 10m, although the design can be modified for any of the HF bands.

First you need a half-wave length of wire. Using the formula 468/frequency I cut a piece 16 feet 5 inches. This comes out at precisely 5m.

Next you need a T200 (red) toroid. These cost £4 from JAB Electrical Components (www.jabdog.com) and can be picked up at many rallies.

I wound 17 turns of enamelled copper wire on the toroid as the secondary winding – each time the wire passes through the toroid counts as one turn. My wire was some I had lying around and was about 1.25mm (18 SWG) in diameter. JAB can supply this too.

Leave a little at the end for connections and then wind two turns over this for the primary, again leaving a little spare.

Across the 17 turn winding you need to connect a capacitor. I tried a small variable but as the minimum capacitance was about 22pf I couldn't get the circuit to work.

But never fear, the answer is very simple and very cheap. RG58 coax has a capacitance of about 28.8pF per foot, so cut off about 10 inches and connect that across the ends of the winding. You'll find that an electrical connector (chocolate) block makes life easier.

Now, connect your coax across the two turn primary, connect your antenna to one of the secondary wires **AND CONNECT ANOTHER PRICE OF COPPER WIRE FROM THE OTHER SECONDARY WIRE BACK TO THE BRAID OF THE COAX (shown in red in the diagram).**

An end fed normally needs an earth or ground plane to work. But with an end-fed half wave there is very little current flowing in the ground and it becomes almost unnecessary.

The usual way of feeding an end fed half wave is against a short counterpoise, but I have found that you can feed this one without an earth stake, counterpoise, or radials. The impedance is so high that little current actually flows down the braid.

If you do get any RF problems just form a coax choke by coiling about 8-10 loops of coax in a six-inch coil about a foot or two from the antenna. If that

doesn't tame it then just use a single earth rod – in all the time I've used this antenna I've never needed to.

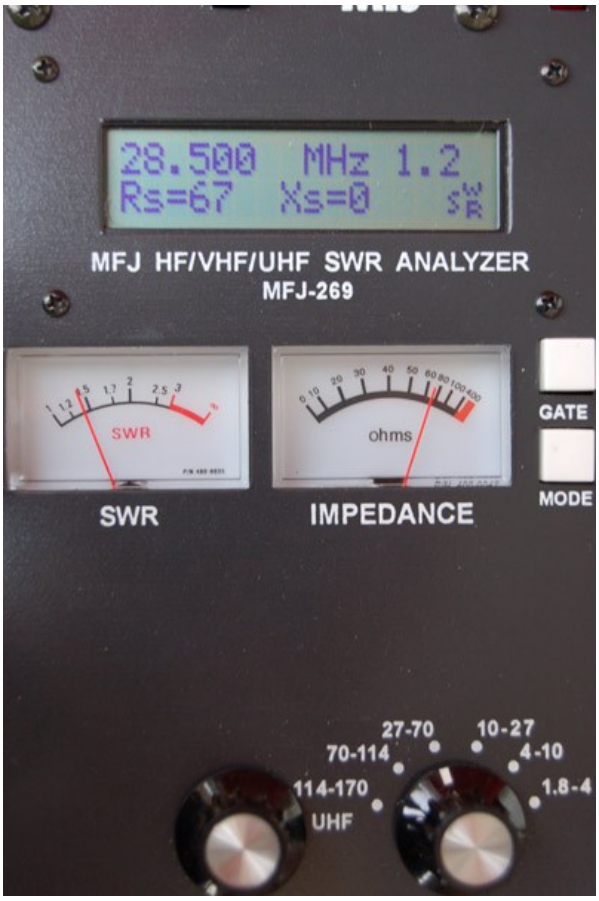
Now the fun starts. If you have an antenna analyser it will make life a lot easier. If not, you can do it with a rig and SWR meter.

If using an analyser connect it to the end of the coax and see where the antenna resonates. It will probably be lower than 10m. Snipping off half-inch lengths of the coax will reduce the capacitance and move the resonant frequency higher. If you get down to about four inches and are still not there try removing a turn off the secondary coil.

I ended up with 15 turns on the secondary and a piece of coax about four inches long – it is better to remove turns than snip too much off the coax.

The end result was an SWR across the entire 10m band of less than 2:1. In fact, at resonance it was about 1.2:1. But did it work?

As always, the 10m band wasn't open as I connected it to my rig to test, but I was able to hear CB stations on 27.6MHz that were at least 20 miles away from my QTH. On switching to my usual 10m half-wave dipole they just vanished, proving that the antenna is working quite well.



The angle of radiation of a vertical half-wave is quite low so it should be quite a DX performer, and it is very easy to install too. It would be very easy to build the matching network into a plastic box to waterproof it.

It was at this point that I had a brainwave – if the antenna could be made to work on 10m, it should be easy to scale for other bands.

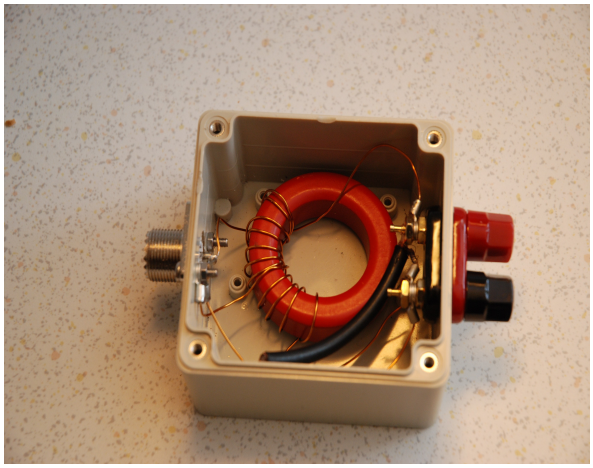
I worked out that if I doubled the length of the wire radiator to 10.05m (33 feet) I would have an effective low-angle half-wave radiator for 20m. As one of my fishing poles was 10m long it was able to support the new wire quite easily, even it did look a little unwieldy.

A couple of minutes with a pen and paper and I soon realised that the equation for the resonant frequency of an LC network (f=1/2pi x (root)LC) showed that halving the frequency meant that I had to multiply the capacitance value by four to make it resonant.

So I cut another piece of coax at four times the length of the original piece, hooked it all up and plugged it into the MFJ analyser. I couldn't believe it - the instant result was an SWR of 1:1.1 on 14:150MHz rising to only 1:1.5 at the ends of the band.

Tests showed that it was at least as good as a half wave 20m dipole at 30 feet and US stations were romping in during the afternoon on SSB. It outperforms a regular quarter wave vertical with radials laying on the ground by a couple of S points and is a lot easier to put up.

I used it at a "Jamboree On The air" station, GB0CAW in Norfolk, and it outperformed a G5RV at 30 feet by about 1 S point.



The matching unit has now been put in a Maplin's waterproof box (see right) and the 10m pole has been put up through a tree in the garden. While some signals are weaker by 1-2 S points, invariably it works better on DX – notably the USA and the Caribbean.

For a really stealthy antenna I could take the pole down and put a fishing line over the top branch (using the pole) so that I can haul a wire up into the branches. It should be virtually invisible.

These antennas are very easy to make and only need a few components. If you have little space in your back garden for dipoles a vertical half-wave could be the way to go. Why not try one?

Update: April 2010

We used the EFHW for 20m at GB0CMS – the station set up for International Marconi Day at Caister Lifeboat (see right).

I now have a ground spike for mounting the 10m fishing pole, which is available in the UK from Coopers of Stortford. This corkscrews into the ground and is very solid.

The antenna worked very well and we were able to work around the world, including VK4, KP2, and numerous US and EU stations. Two friends have also built 20m and 17m versions and rave about them.

Update: November 2010

The design was featured in the RSGB's *RadCom* magazine and also my own Stealth Antenna book. It has generated a lot of interest. I have now built them for 20m, 15m and 10m. Using lengths of PVC-coated wire of 10.15m, 6.78m and 5.05m respectively.

They all worked well, but you may have to fiddle with the number of turns and the spacing, plus the length of the coax, to get a good SWR.

I tested the 15m version against the Rybakov (7.8m and 4:1 UNUN), which is also described on this blog. The EFHW was better by about 1 S point, sometimes a little more.

This was a good test as it shows that the Rybakov, which handles five bands (20m, 17m, 15m 12m and 10m), is a damn good antenna for the amount of work it takes to build one. But, it is ground dependent and needs a good radial system. As a compromise it works well, but if you want something a little better for DXing, contesting or Dxpeditioning the EFHW works a little better, albeit as a monoband antenna.

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November 2010