BBRC EFHW Project.

The 2023 club project is an End Fed Half Wave (EFHW) antenna. This is a simple multi band wire antenna that is useful for portable work and as a quick and easy way to get on the air.

The antenna is half a wavelength long at its lowest band, usually 40m. So a wire of about 20 m in length. It is fed from the end and this gives it the useful property that it will also match all harmonics of the fundamental frequency so as well as 40m, 20m, 15m and 10m should be available. It may also operate on 17m and 12m with the sort of tuner included with a modern transceiver.

A feed point at the end has a high impedance so needs a transformer (aka a UNUN) to convert between the high impedance at the end of the antenna to the low 50 ohm impedance of the transceiver and it's feeder coax, usually this is an impedance transformer of 49:1 to 64:1.

The turns ratio of the transformer is the square root of the impedance ratio, so usually from 7:1 to 8:1, usually realised as 14:2, 21:3, 15:2, or 16:2.

Suggested Transformer Designs

These are based on the work by Colin, MM0OPX, he has done a lot of work winding and comparing cores, followed by tests with antennas. He's made a number of YouTube videos.

QRP EFHW

This uses the small 2643625002 core. MM0OPX suggests 16/2 turns close spaced with a 100pF capacitor. It should be good for 10W. He found that while a 21/3 turn transformer gave lower losses the 16/2 version gave lower SWR with an antenna (2).

- Take 90 cm of wire, fold 10cm back and twist lightly, so the two wires remain close. This forms the primary winding and the first 2 turns of the secondary.
- Insert the loop end about 8 cm into the core and wind 2 turns close together using the loop end. This forms the primary 2 turns and the first 2 turns of the secondary. It may be better to have the two wires untwisted, just lying side by side.
- Now take the long end and wind another 14 turns close spaced. This forms the rest of the 16 turn secondary.
- Keep the winding neat and close spaced with the wires lying close to the core.
- Both of the wires at the loop end are connected to the shield of the feeder. This is also connected to the ground/counterpoise if you wish to have one.
- The short end (2 turns) is connected to the core of the feeder and a 100pF capacitor is connected between the core and shield of the feeder, across the primary winding.
- The end of the long winding connects to the antenna.
- Using an autotransformer design, by having a single 16 turn winding with a tap at 2 turns may also work.

This can be installed in a small case or just covered in heat shrink or tape. For portable use the antenna and feeder could be connected directly to the transformer.

100W EFHW

This uses the larger 2643251002 core with a 15:2 winding giving a 56:1 transform. MM0OPX found that adding an extra turn to the secondary improved the performance with an antenna.

- Take 120 cm of wire and fold 15 cm back to form a loop. Twist lightly, just enough so the two wires remain close.
- Insert the loop end about 10 cm into the core and wind 2 turns using this. This forms the primary 2 turns and the first 2 turns of the secondary. The turns should be spaced so that the full 15 turns will fill most of the core.
- Now take the long end and wind another 13 turns , also spaced. This forms the rest of the 15 turn secondary.
- Keep the winding neat and spaced so the full winding fills most of the core.
- Both of the wires at the loop end are connected to the shield of the feeder. This is also connected to the ground/counterpoise if you wish to have one.
- The short end (2 turns) is connected to the core of the feeder and the 100pF capacitor is connected between the core and shield of the feeder, across the primary winding.
- The end of the long winding connects to the antenna.
- Using an autotransformer design, by having a single 15 turn winding with a tap at 2 turns may also work.

This is better in a box, with a connector for the feeder and a bolt for the antenna connection. I've brought some examples.

Antennas

The Sotabeams wire is said to be good for about 150W. It's perfect for portable use because it's very light and the green or brown is almost invisible. This my be useful in avoiding questions by neighbours but the yellow may be better for portable so you can find it. It's almost cheap enough to be disposable. They also do a DX light wire that is kevlar cored with more copper but still thin enough to be inconspicuous and stronger for more permanent use.

- A simple antenna for 40, 20, 15 and 10m can be made with about 20.5m of wire arranged as an inverted L or V. This length is probably too long so check, ideally with a NanoVNA and shorten the antenna to get a good tune on all bands. You may need to compromise a little. If the top end is in the air it may be easier to trim at the feed end.
- It's possible to get 80m as well by adding a 110 uH loading coil and about 2.5m of wire to the end. As before, tune the main section first by trimming the feed point, then trim the extension to get 80m – or the bit of the 80m band you want.
- Using 40.5m of wire may tune on 80, 30, 40, 17, 15, 12 and 10m although it may be a struggle on all of these. Adding a small loading coil about 2.5m from the feed or a capacitor at the mid point may help to tune the higher bands.
- Having a reasonable length of coax feeder running over the ground may be all that's needed as a counterpoise. My home installation has about 15m of feeder running along the ground from my house to the antenna which goes up about 8m into a tree and then along towards the apex of my house roof. The feed is about 1 m up in the tree.

Testing:

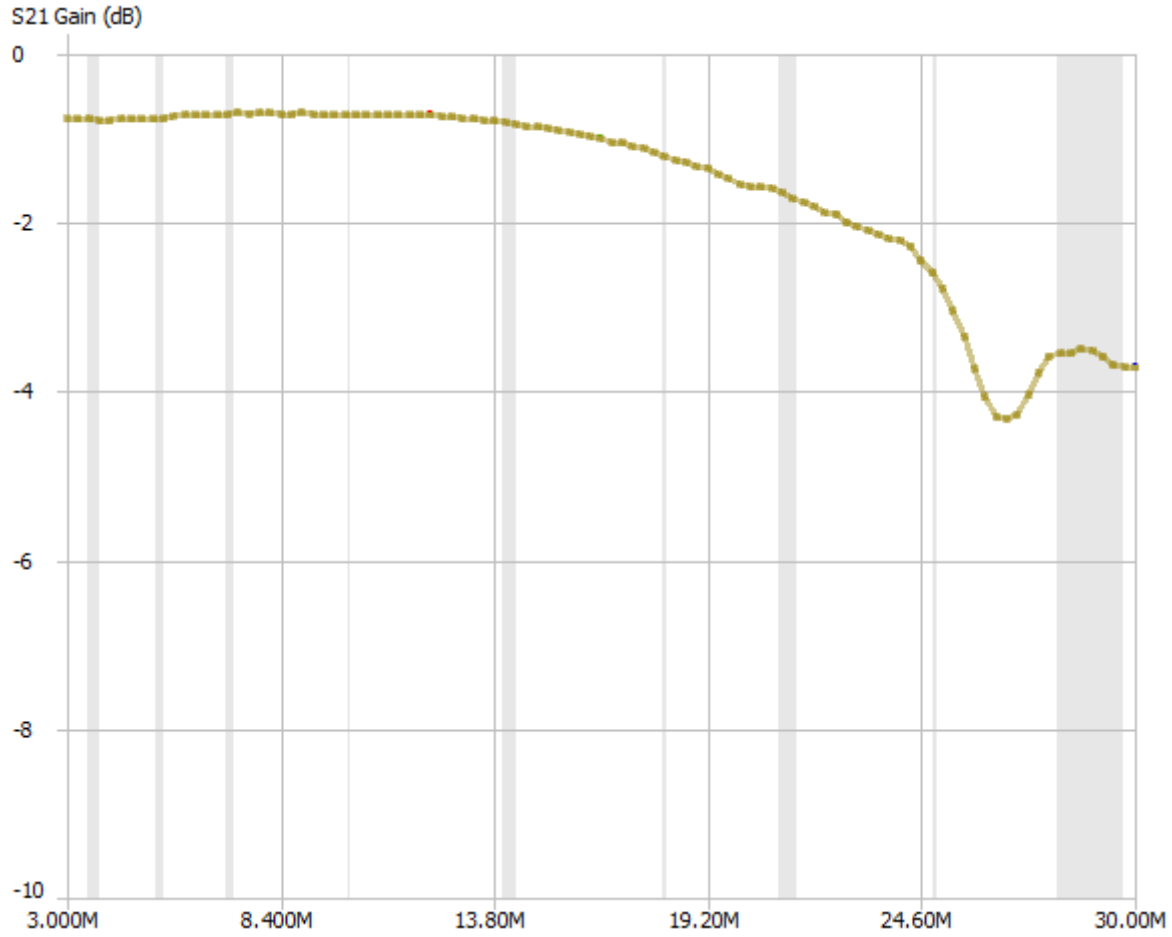
Setting up an antenna can be done by connecting a wire and then adjusting the wire length to get a low SWR on the relevant bands, usually 40m, 20, 15m and 10m. It's better to start with the wire too long as it's easier to reduce the length. Trim small amounts, it's easy to get too short, more difficult to lengthen. Folding the wire back will have a smaller effect than shortening it.

Something like a NanoVNA helps a lot. It's possible to see where the resonance is so you get an idea of how much effect your shortening has. You can also check on multiple bands so you can get a good compromise antenna length.

Testing transformers can be done by connecting two identical transformers back to back and using a NanoVNA to measure the loss using the through gain (or loss) settings. Obviously the loss of a single transformer will be half of two.
If you feel like experimenting ideas are:

- Transformer or autotransformer?
- Close wound or spaced?
- Increasing or decreasing the turns, 7:1 14:2, 21:3 28:4? Also smaller changes such as 15:2.
- Does a cross over winding help?
- Alternative cores, either core type or size and number of cores.

This is an example of the losses I measured with two of the 100W 56:1 transformers connected back to back:



The actual loss for each transformer is half of the value shown here, so 1 dB or less up to the 15m band and less than 2 dB for the 12m and 10m bands. I'm thinking of trying different capacitors or winding styles to see if I can improve the performance for the higher bands.

References:

1. Colin, MM0OPX has a number of sensible videos about testing and experiments with toroids, his 'Best ferrite core for a 100W EFHW' video https://www.youtube.com/watch?v=Xe0wvbOQeok&list=PL4c9JYrasWlINtL3wR7MZ5IDSYSEYj6It&index=4 has most of the information I'm using.
2. Here's another of Colin's videos, https://www.youtube.com/watch?v=nZ-G4hJCTSM It's more of a summary and also refers to his spreadsheet.

3. This article http://infotechcomms.co.uk/downloads/Multi_band_EFHW.pdf by Steve, G0YKA describes options for antennas. He's suggesting a loading coil which gives 80m as well as 40m to 10m.
4. Colin, MM0OPX describes making the loading coil to add 80m to a 40m EFHW https://www.youtube.com/watch?v=lRoxlW0Hx-g&t=335s
5. The October 2023 Practical Wireless pp 46-47, has an article about building UNUNs.
6. Owen Duffy has done a lot of theoretical work on these which seems to confirm the findings of the experimenters.
7. Alternative winding by DL2MAN https://www.youtube.com/watch?v=j-lIng7vPkk Refers to SP9TKW and KN5L.
8. This is the alternative winding design that is said not to need a capacitor https://www.kn5l.net/kn5lEfhwUnun/ It's wound as an autotransformer with the secondary section wound over the primary section.
9. The RSGB Tonight at 8 Webinar is "An Entry Level End Fed Half Wave Antenna" by Colib MM0OPX. https://youtu.be/L1lMufihNp8