Have you tried an End Fed Half Wave antenna (EFHW)?
Lets build a 49:1 UNUN to feed one

The idea:
During this stay at home order I turned to antenna experimentation to give me something positive to do. I wanted to try an EFHW antenna because:

- Easy to deploy
- You can feed it low to the ground
- Can be used for NVIS on 80 & 40
- Multi band capability

In this article I will give details on what I made and the results I had.

Antenna theory:
Some quick antenna theory to explain what we are up to.
If you take a half wave of wire and feed it in the middle (50%) you will end up with a feed point impedance around 70 Ohms.
If you slide the feed point closer to the end of the wire, around 20-25% of its length you will have a feed point impedance around 450 Ohms.
If you feed the half wave wire at its end, you will have a feed point impedance around 2500 Ohms.

The 49:1 UNUN:
So that is where the 49 to 1 UNUN comes into play. You feed it with coax (50 Ohms) and the UNUN converts the impedance up to 2450 Ohms (49x50 Ohms). By the way this RF transformer is called an UNUN since it is unbalanced (coax) to unbalanced (single wire).

Making a 49:1 UNUN is surprisingly easy if you have the correct materials.
Here is a picture of a completed 49:1 UNUN inside a small plastic box.

At the very top is the red “banana jack”, where you connect your half wave antenna.

The red wire you see is enameled wire. Sometimes referred to as magnet wire. This particular UNUN was wound with 18 AWG enameled wire.

The big metal gray donut is a toroid core. Specifically it is a FT-240 type 43. The 240 refers to its physical size, and the type 43 refers to the “mix” the toroid is made from.

If you carefully count the number of turns that pass through the inside of the toroid, you will count 14. The first 2 turns (with twists) are the 2 turn primary. Some quick math, 14 divided by 2 is 7, now square 7 and you get 49!. That’s where the 49 comes from in the 49:1 UNUN.

The two little blue things (soldered across the SO-239 connector) are high voltage capacitors. It is hard to see in the picture but they are in series. Each one is 220pF rated at 2 kV. That works out as a single 100 pF capacitor rated at 4kV.

At the very bottom is the SO-239 connector to accept the PL-259 from your coax. There is also a black banana jack that can be used as an optional ground connection.

I will make some changes with my next 49:1 UNUN.

I will use 14 AWG enameled wire instead of 18 AWG
I plan to use two FT-240 type 43 toroid cores (super glued together)
I will leave out the black grounding banana jack at the bottom

*** If you do a lot of CW or digital work on 80 meters you may want to use two FT-240 type 43 cores instead of one. If you use more than 100 Watts, use two FT-240 type 43 cores and use 14 AWG enameled wire.

The 49:1 UNUN pictured above works very well on 80-10 meters. It is an excellent starting point and is fine with 100 Watts SSB.

Parts list for the 49:1 UNUN:

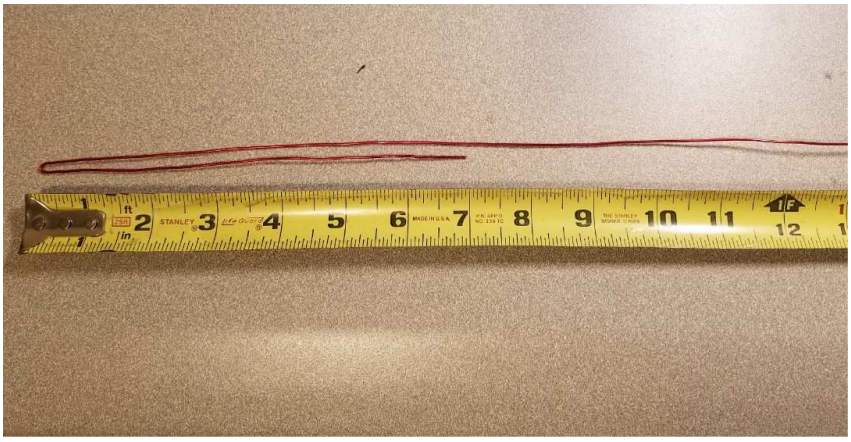
Here is the parts list for the materials used to build my 49:1 UNUN.
Everything is available on Amazon. Feel free to find less expensive parts for the non-critical components (box, banana jacks & sockets).
Below the green line you will also find the optional larger 14 AWG enameled wire and three alternate sources for the FT-240 type 43 toroid cores (they have better prices than Amazon, but may be out of stock).

PART	Amazon Description	COST
Plastic box	4.5 x 3.5 x 2.1 inch Plastic Waterproof Project Case DIY Junction Box Holder	$8.29 each
Banana jack	CESS Banana Female Jack Socket - 4mm Banana Socket Soldering Type	$7.99 for 10
Banana plugs	Monoprice 5PRJX74047 Gold Plated Speaker Banana Plugs	$9.88 for 10
FT-240 type 43 toroid core	FT-240-43 FT240-43 Ferrite Toroid Core 43 Material	$12.49 each
18 AWG enameled wire	Remington Industries 18SNSP Magnet Wire, Enameled Copper Wire, 18 AWG, 1.0 lb	$16.53 for 200 ft
High voltage cap set	3KV / 100pF to 10000pF High Voltage DIP Ceramic Capacitor Assortment Kit	$8.97 for box
SO-239 panel mount	BCP 5pcs UHF Female Jack Solder SO-239 4-Hole Chassis Mount Coax RF Connector	$6.74 for 5
Opt. - 14 AWG enameled wire	TEMCo 14 AWG Copper Magnet Wire - 8 oz 40 ft	$17.20 for 40 ft
Alt. - FT-240 type 43 toroid core	JPM Supply (lower cost than Amazon) Part number: 38021	$8.49 each
Alt. - FT-240 type 43 toroid core	DigiKey Electronics (better price - if in stock) Part number: 1934-1592-ND	$6.64 each
Alt. - FT-240 type 43 toroid core	Mouser Electronics (great price - if in stock) Part number: 623-5943003801	$5.17 each

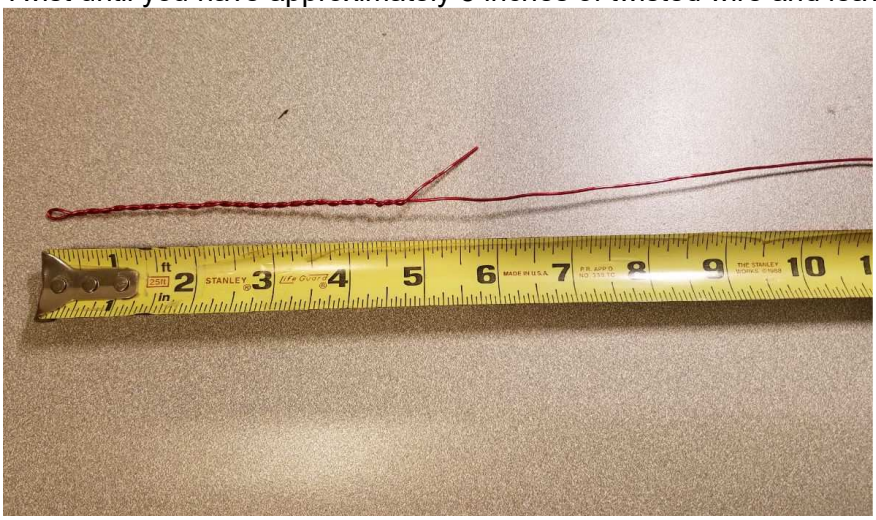
Building the 49:1 UNUN:

These directions are for a single FT-240 type 43 toroid core wound with 18 AWG enameled wire. If you use larger wire and/or two FT-240 type 43 toroid cores, you will need more wire.

Cut 40 inches of 18 AWG enameled wire.
Bend one end back on itself so you have a folded wire section that is 7 inches long.

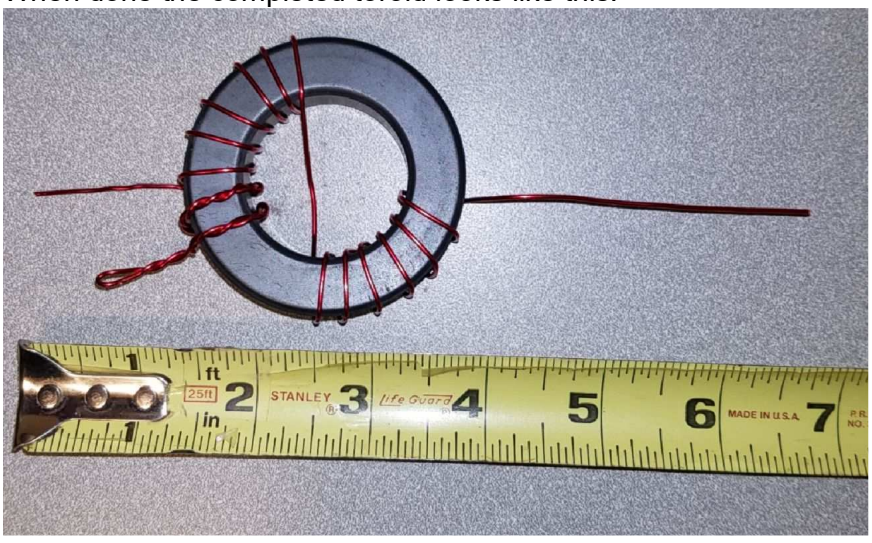


Now twist the folded wire section.
Twist until you have approximately 5 inches of twisted wire and leave a 1.5 inch tail.

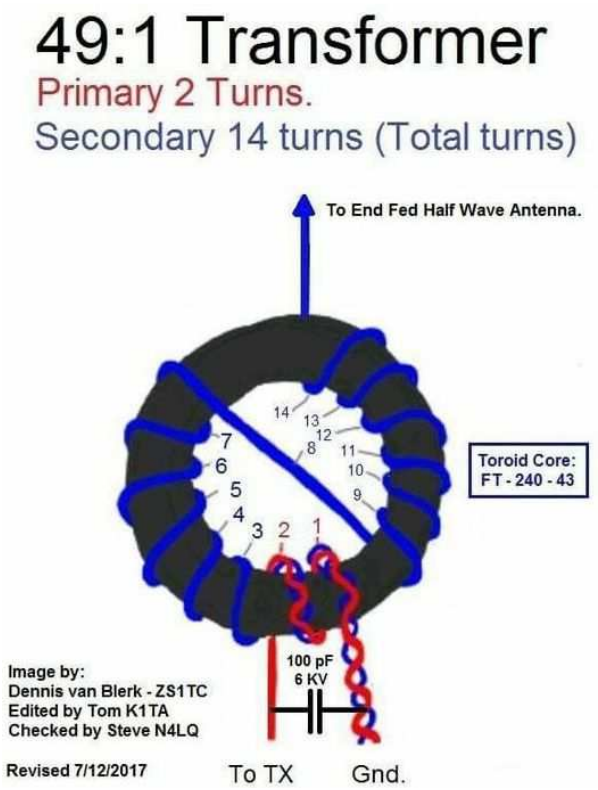


Start winding the 2 turn primary.
When you are done with the primary it looks like this:

Keep winding the long secondary wire (keep track of turns).
When done the completed toroid looks like this.



Here is a nice guide showing how to wind a 49:1 UNUN.



Wind two turns of the double wire section on the toroid as shown

The double wire section (red & blue twisted wires) will connect to a screw on the SO-239 (ground)
The short single wire (red) will connect to the center pin of the SO-239.
The long single wire (blue) is used to make the rest of the turns on the toroid.
A zip tie is helpful to hold the windings in place (one at each end).
Do not insulate the toroid. It is already an insulator, adding insulation will reduce coupling.

The strange winding crossover (8) is there so the input and output are in the right place.
Pull the wire tightly while winding the toroid and remember only count the turns on the inside.

Figure out how you want your UNUN placed in your box.
Drill holes for the banana jack(s) and SO-239.
Pre-shape the enameled wires protruding from the toroid so they route correctly once placed in the box.
Cut the enameled wires so they are a bit longer than necessary.
You need to remove about ¼ inch of the enamel coating from the wire so it can be soldered.
You can scrape it off with a knife, use sandpaper, or even a Dremel tool with a small sanding drum.
I like to solder the enameled wire first since it is quite rigid.
You can use some hot glue or zip ties to hold your toroid in place if desired.
Lastly, I solder the 100 pF capacitor across the SO-239 connector.

Some points on the 100 pF capacitor:

The function of the 100 pF capacitor is to reduce the SWR on the 20, 15 & 10 meter bands.
If you are only using 80M & 40M, you do not need the capacitor.
The 100 pF capacitor can be either a single unit or two 220 pF capacitors in SERIES. When you put two capacitors in series you HALF their capacitance but get TWICE their voltage rating.

The 49:1 UNUN is complete, now it is time to focus on the wire antenna.

The EFHW Antenna:

This is a multi-band antenna!

A 133 ft piece of wire will let you operate on 80-10 Meters.
A 66 ft piece of wire will let you operate on 40-10 Meters.

The set-up for my antenna experiments was the following:

133 ft of bare antenna wire deployed as a sloper
High end was about 50 ft up in a tree
Low end (with the 49:1 UNUN) was about 4ft off the ground
Fed with about 50ft of RG8X coax

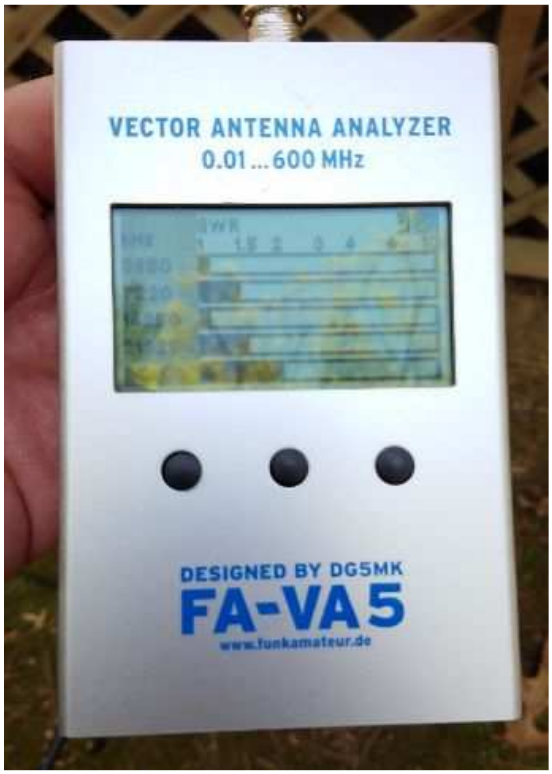
When I did my EFHW antenna experiments I would shorten or lengthen the antenna wire to tune it.
I noticed something with the tuning.
You can tune this antenna for 80 SSB (75 Meters) – OR – 40, 20, & 15 SSB.
If you tuned the antenna for 80 SSB it would resonate too high for the 40, 20 & 15 SSB bands.
If you tuned the antenna for 40, 20 & 15 SSB it would resonate very low in the 80 CW band.

The magic capacitor:

I found an interesting solution to my problem on the internet.
You tune the antenna for 40, 20 & 15 SSB – then place a capacitor in the middle of the 133 ft wire.
The capacitor moves the resonance on 80 meters up to the 80 meter phone band (aka 75 Meters)!
The capacitor has little effect on the other bands – perfect.

I cut the 133 ft antenna wire close to the middle and inserted an antenna insulator. I used an antenna insulator due to the mechanical pull from the 133 ft of antenna wire. Then I jumped across the antenna insulator in the middle of the antenna with a high voltage capacitor. I tried several different values of capacitors (from the high voltage capacitor set). The lower the capacitance the more it raises the resonance on 80 meters.

I finally settled on a 220 pF capacitor, with some very nice results.



The screen glare makes it hard to read the frequencies I was sweeping.
Top to bottom they were: 3.850, 7.220, 14.250, 21.325, 28.400
OK - 10 meters was a little high, but overall I was amazed!

To make things more weatherproof I put the 220 pF high voltage capacitor inside a 2 inch piece of ½ CPVC pipe. I added some nice wire pigtails to the capacitor leads – and filled the CPVC pipe with 5-minute epoxy.

The next day after everything dried, I did some more testing to make sure things were still OK. All was good the SWR readings were still excellent. I had an easy to deploy 80-10 Meter EFHW.

Interesting notes about the coax feed line:
I did notice that feeding the 49:1 UNUN with about 50 ft of RG8X coax is important. At some point in my testing I connected my antenna analyzer directly to the 49:1 UNUN. Things were no longer good. When I touched my antenna analyzer it's SWR readings would change significantly. That means that RF current is present on the shield of the feed coax. Using 50ft of RG8X coax between the antenna analyzer and the 49:1 UNUN stabilizes the SWR readings. I highly recommend feeding the 49:1 UNUN with at least 50 ft of RG8X coax.

Signal reception comparison:
I was able to make many signal reception comparisons between the EFHW antenna and my ladder fed 500 ft loop up at 50 ft. I compared many signals on 80, 40, 20 & 15 meters (10 was dead at the time).
In general, here is what I observed:

Signals on the EFHW are 1S unit less than the 500 ft loop
Background noise on the EFHW is 1S unit higher than the 500 ft loop

Honestly I was very surprised that such a simple antenna with one end at 50ft and the other end at 4ft could do so well !! Most hams find a full-size loop to have very good signal to noise ratio. The EFHW did a great job and is an antenna worth considering. It's ability to be rapidly deployed only needing one tall support is really fantastic.

On the air with the EFHW:
Now it was time to make some on the air contacts with the EFHW and the 49:1 UNUN.
I have never used an antenna that is already tuned on the bands. It was weird, I could go to any band I wanted and just transmit.

During one of my test transmissions (5W then increasing up to 100W) I switched over to SSB to identify and state that I was testing. To my surprise a station came back to me immediately to inform me my testing was going very well – I was 5 by 9. I ended up having a nice long QSO with that station in NY on 20 meters. Turned out he was also using a EFHW antenna. In that particular QSO my EFHW was better than my 500 ft loop - Amazing. We attributed that to the slight gain my sloping EFHW had in his direction.

In general, the EFHW did a nice job on all the bands. It was typically 1S unit weaker than the 500 ft loop (like my earlier reception testing). There were a few times when the EFHW was better. I am going to attribute that to a slight gain to the North due to my EFHW installation as a sloper.

I have heard that using two FT 240 type 43 cores reduces loss on 80 meters. I never had a problem with SSB communications. If you plan on using CW or digital modes on 80 meters go ahead and use two FT 240 type cores to reduce losses as much as possible.

There is a gentleman on YouTube who has lots to say about EFHW Antennas. If you get a chance search for Steve Ellington EFHW to get some additional information.

It's possible to purchase a 49:1 UNUN on Ebay. BUT – I can not speak about their effectiveness, and you don't learn how to make one. If you get a chance, try making one yourself.

If you have any questions, feel free to email me:

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