Construction Details 49:1 Un-Un For End-Fed Resonant HalfWave Antenna

by Gordon Gibby
Version 1.1 Nov 13 2020 (added exploded photo of the jack installation)
Version 1.2 Nov 20 2020 (added 200 pf input capacitor to reduce SWR)

This project assembles a 49:1 ferrite-core ("FT") type #43 transformer that matches 50 ohm input to 2500 ohm end fed antenna. It is optimized for 3.5/7/10/14 MHz but will work reasonably well on all amateur bands from 80 meters thru 10 meters with a 135 foot length of wire and a short connection to ground. (Adjustments to the length for your particular installation can move the resonance point to your preference).

Additional suggestions for improvements are provided as well. ALL ANTENNAS ARE COMPROMISES. You adjust in your own particular setting for your needs!

1. Your kit should arrive with these parts

- Blue plastic electrical box, pre-drilled for two jack connectors and one SO-239
- Red jack connector (will be used for high impedance connection to end-fed wire)
- Black jack connector (will be used for ground connection)
- SO-239 with pre-soldered case connection to 2" stranded wire
- FT-240-43 ferrite core (be very careful not to DROP as it can fracture on hard surfaces)
- 2 #6 sheet metal screws, 3/8" or 1/2" used to secure the SO-239
- 2 crimp terminals (blue plastic) for connections to ground wire and antenna wire
- 200 pf 1kV mica capacitor for input reactance compensation
- Gray plastic "top" for your electrical box.
- Hose clamp for securing ground wire to ground spiral
- Ground spiral (dog leash spiral) – be CAREFUL with that sharp point

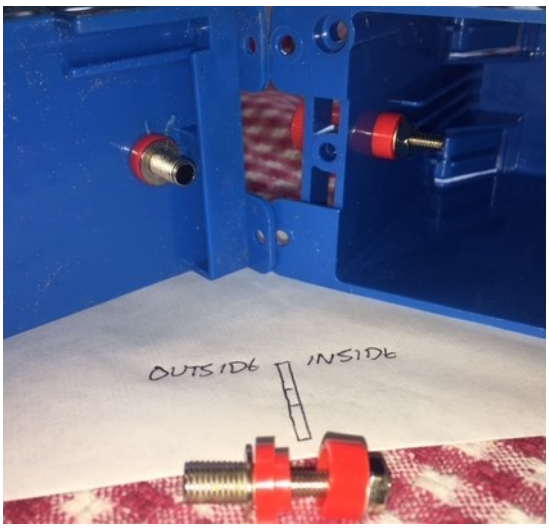
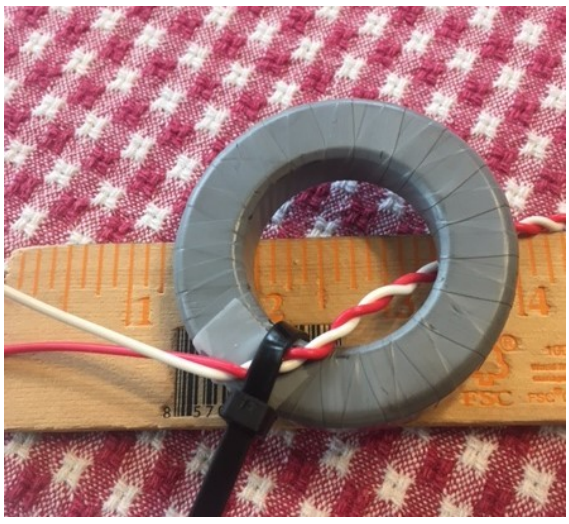
❑ Identify all of these parts before proceeding.

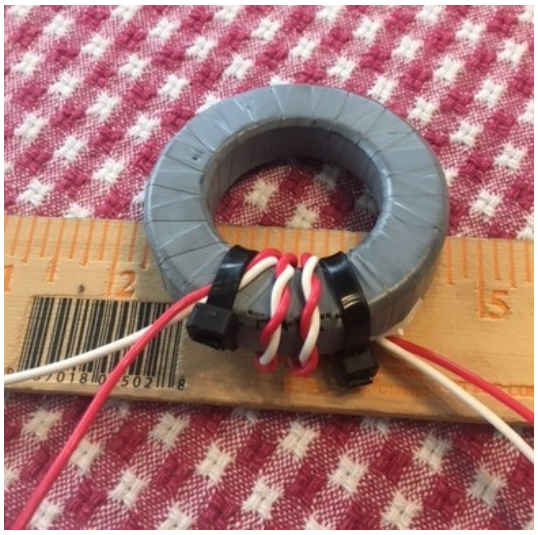
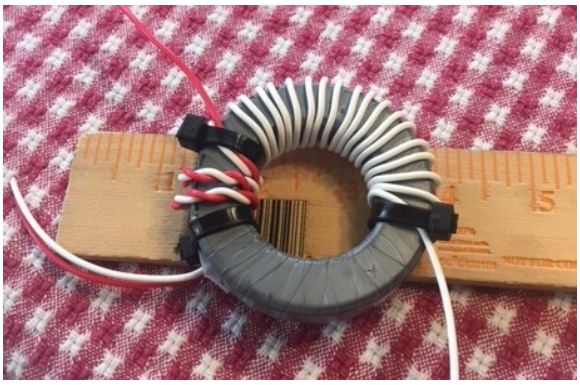
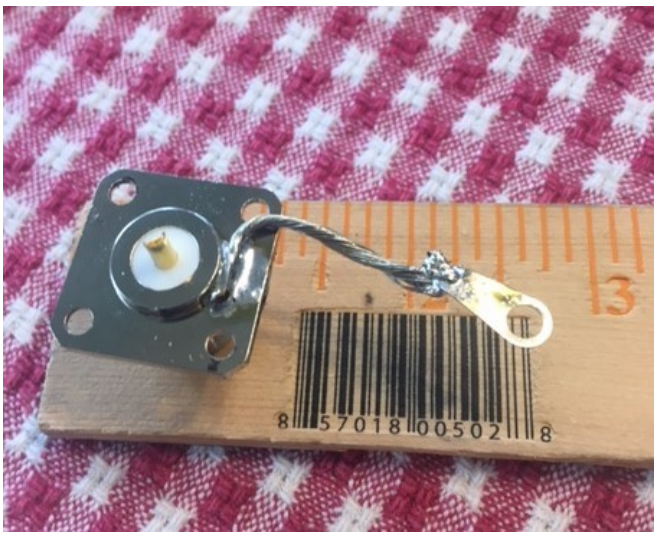
And your building area will include

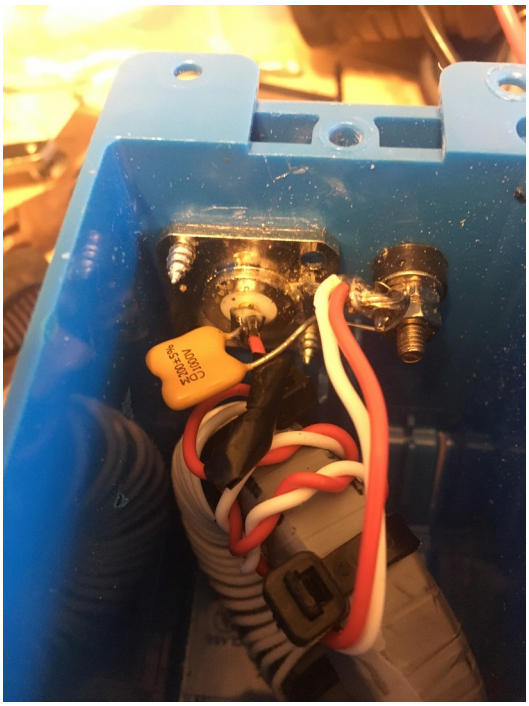
Note for Project Coordinator: Complete these tasks prior to the day on construction

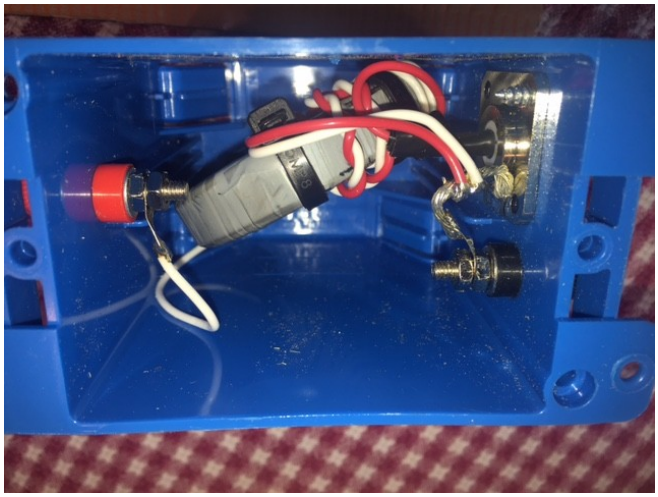
1. Drill SO-239 passage with 5/8" wood boring bit, be certain to provide spacing to allow the part to fit near the opening of the box to one side.
2. Drill holes for #6 sheet metal screws (2) to secure the SO-239 with 9/64" drill bit after marking with sharpie after test placement of SO-239
3. Expect to need to use a wood chisel to take out a small amount of internal ribbing
4. Drill holes for the jacks with 5/16" drill and enlarge just slightly as the jack plastic protrusion is a few thousandth's larger than 5/16.
5. Solder 2" of stranded wire to the inside surface of the SO-239. Teflon insulated SO-239's are preferred.
6. FT-240-43 toroids can be purchased from kitsandparts.com
7. #18 Teflon wire can be purchased from Amazon ("Remington" brand name)
8. This design has been used up to 400 watts output with good results.
9. Back-to-back unun spectrum analyzer measurements suggest losses in the 1-2 dB range; but high power tests that barely got the toroid warm suggest that the losses

• At least two colors of #18 Teflon insulated wire • PTFE (teflon) pipe-tape (colors are unimportant) • Soldering station • Solder • Sharp wire stripper • Pliers • Diagonal cutters • Terminal crimp tool	may be lower. (The addition of the 200 pf capacitor may reduce losses even further in the back to back measurement technique.) 10. Curie temperature of Type 43 material is 135 deg C or higher.
2. ❑ Measure a 45" strip of 1/2" wide Teflon pipe-tape and wrap with approximately 1/3 over-wrap on outer edge, to cover most or all of the FT-240-43 core. A small bit of tape can be used to secure the final end but is optional. *Wrapping the toroid is traditional but not absolutely necessary. It does soften any sharp corners (there usually aren't any in current production toroids) and provide a bit of thermal insulation between the core and the wiring.*	 Wrapped toroid.
3. ❑ Pick two colors of teflon (PTFE) insulated wire, one for the high impedance secondary wiring (in my photos, WHITE) and one for the 50 ohm low impedance primary (in my photos, RED). The exact colors are not important, but keeping primary straight from secondary is important. ❑ Cut 54" of the secondary wire. ❑ Cut 12" of the primary wire. ❑ Starting about 2.5" from the end of both wires, twist them together for 6", leaving approximately 2-3 inches of the primary wire free. The twist does not need to be really tight; 4 or 5 turns in an inch is fine. The starting point end (with one primary and one secondary wire) is going to be connected to GROUND (to the case of the SO-239 and to the	

black jack)	
3. ❑ Take off the nuts and solder tab and any washers from your two wire jacks. ❑ Install the red jack on the blue box side that only has ONE hole drilled (the other side has SO-239 + jack drilled) using one washer and nut, as shown in the photo to the right, which shows both an outside and inside view. On the small screw end, there are two plastic parts one of which has a protrusion that just fits the drilled hole; this goes on the outside The jack fits with one plastic part on each side of the blue plastic electrical box and is secured by holding the large threaded screw with your fingers on the outside and tightening the small metal nut on the inside. (Its best not to have the large plastic hand-nut on at this time, because you would over tighten its plastic threads and damage it.) ❑ Use small pliers to tighten the inside small nut securely. ❑ Repeat for the black jack for the ground connection on the 50 ohm input side beside where the SO-239 will go.	
4. ❑ Using a Ty-wrap, secure the two short free ends just before the twist, to the toroid. The Ty-wrap ends up “square” with the toroid, and the wires go at a slight diagonal to be secured. See the photo.	

5. ❑ Wrap THREE turns of the twisted wires, and then use another Ty-wrap to secure the turns. A "turn" is defined as one passage through the INSIDE of the toroid. (That is one of the important things you learn from this project!) See the photo. This completes the PRIMARY winding. The short red wire that stops, while the white wire continues for another 4 feet or so, will be the 50 ohm input that gets soldered to the SO-239 center portion (but NOT right now)	
6. ❑ You already have three turns of the SECONDARY (white in this example) completed; now finish out 21 turns if you can. You need about 2-3 inches remaining when you are finished and if you are short, 20 turns is just fine. The turns can be slightly spaced out, but NOT overlapped. Secure with a Ty-wrap as before.	
7. ❑ Solder one of the solder tabs to the far end of the free wire already provided you from the case of the SO-239. ❑ Leave a good distance of free wire between the SO=239 and the solder tab as shown in the photo. This is where you are going to solder the beginning ends of both the primary and secondary.	

8. ❑ Solder the beginning point of both the primary and secondary to the middle of the bare wire between the SO-239 and the solder tab. Be sure not to disrupt the solder joints on the solder tab and the SO-239. You'll need a SHARP wire stripper to deal with the tough teflon PTFE insulation! ❑ Solder the far end of the three turn primary to the center connection of the SO-239. Be sure to get a good solder connection, but don't spend so much heat there that you melt the plastic insides of the connector. (Our connector has TEFLON insulation and is relatively impervious to errors.) ❑ Solder the far high impedance end of the SECONDARY to the remaining solder tab. The free wire between the toroid and this solder tab should be about 2-3", no longer and no shorter.	
9. ❑ Solder the 200 pf 1kV Mica capacitor between the center terminal of the SO-239 and the ground wire, leaving a short length (1/4"-1/2" of wire to the capacitor on each lead. To do this make about a turn around the center terminal/primary wire and solder, and make about a turn around the ground wire and solder. (I had to do it AFTER it was all installed, which was much harder). Be careful not to overheat the SO-239, but also don't make a "cold solder joint" <u>What is this capacitor for?</u> It cancels out some inductive reactance at the input port on the typical antenna (or 2500 ohm resistive load) and reduces the SWR and broadens the "bandwidth" of this design. The impact was quite significant in my tests. The idea is not original with me; John Trites NO5X suggested it, and I also found it in published how-to articles. When my own testing confirmed it made a significant improvement, I added it.	

10. ❑ Insert the toroid carefully into the electrical box, and position the SO-239 poking thru from the inside (secure with two #6 sheet metal screws-- only 2 are needed) ❑ Put the solder tab from the wire from the case of the SO239 on the black jack and secure with a nut snugly. ❑ Put the solder tab from the far end of the SECONDARY (white in this photo) on the red jack and secure with a nut snugly. (The input capacitor wasn't in these photos)	
11 ❑ Route all the wires nicely so nothing is going to get pierced by the sharp ends of the sheet metal wires.	
ANTENNA CONSTRUCTION	
1. Cut approximately 135 feet of wire. You will have to adjust this for the specific resonant point you want in the 80 meter band AT YOUR SPECIFIC INSTALLATION.	
2. At the end that will connect to the Balun, pass approximately 1-1/2 foot through holes at one end of an insulator and tie with a couple throws of a knot. Strip off about 1/4" of insulation and then Crimp and then solder one of the crimp terminals on the free end. This will connect to the RED terminal output of your Balun.	
3. The ground wire will be about 2 feet long; strip about 2" of insulation from one end and 1/4" from the other end. "Tin" the 2" end. This end will be secured with the hose clamp to your ground rod. A suggested method is to wrap it cross wise around the metal band, and then tighten the band onto the top triangle of the ground screw. Crimp the remaining terminal to the 1/4" end and then solder. This will connect to the BLACK terminal of your Balun.	

SUGGESTED USAGE

- connect red jack to one end of 135 foot end fed wire. Try to get the wire up above 15 feet in as short a length of wire as you can, and keep it there to the far end. You can have the entire thing sloping, or part of it vertical, part of it horizontal or any combination – just try to "unfurl" it to cover a largest possible area, without doubling it back on itself.

- connect black jack to ground, such as a dog leash spiral screwed into moist ground, with a wire of roughly 12 inches or less. (The balun should be near the ground rod)

- Feed with 50 ohm coax (Inserting a homemade or commercial 1:1 current balun is a good idea; otherwise add about 20 turns of coax on a 6" diameter and secure with zip ties, not as good as a real current balun.) You can buy this on Amazon or at hamfests, even with all the connectors already on it. You probably want to use RG-8X or RG-58/A RG-8 is too stiff for most people.

– If this is a permanent antenna for your home, add some sort of LIGHTNING protection before the coax enters your house – and a REAL ground rod, something 6 feet in length or more from a "big box" store for example Consult other sources or advisors for the best protection here.

- Adjust length of end fed wire to move 80 meter resonance to desired frequency, noting effect on multiples

- As the 30 meter band is not actually a direct harmonic of the 80 meter band, SWR there may not be optimal
- Use antenna tuner as desired to improve SWR after adjusting length appropriately.
- Avoid placing un-un box in direct high intensity sunlight because this will cause needless heating of the toroid. Try to arrange for some shade! And avoid the un-un box being in water.

PREVENTING CORROSION

Almost ALL metals if left out in the weather will QUICKLY corrode and make poor connections. I have often been amazed how fast things will corrode. The solder tabs in your project will no longer make good connections to the screws. The PL259 will no longer make good connection to the SO-239. Your antenna and ground wire connections will no longer be good.

The best way to prevent this is to goop all electrical connections (that aren't soldered) with AUTOMOTIVE or DIELECTRIC GREASE (Vaseline is a poor substitute for a short

SWR in Perspective

In your General Class Course you learned about SWR, one of the most useful and easiest to measure indices of how well a transmission line / antenna setup is matched. (While the IMPEDANCE along a mismatched line is constantly changing, the SWR remains constant if losses are low, or begins to look BETTER if the losses are significant.)

However, just because SWR is the easiest to measure doesn't mean it is EASY. There are multiple techniques to measure:
– directional coupler systems (often $15 at ham

use). GREASE will exclude WATER and limit oxidative reduction corrosion. Connections will need to be checked every few months! If you're going to use this as a PERMANENT antenna, you might be wise to SOLDER connections to the wiring inside your Balun, instead of depending on the screw terminals.	fests) – antenna analyzers ($150-$500) – simplified impedance bridges Two systems for measuring SWR are very unlikely to agree perfectly. A reasonable goal is to keep the SWR as seen by your transmitter, under 2-3 to 1. Under 2:1 is great, under 3:1 is reasonably important. A matching systems can help keep your transmitter happy, even if it doesn't cure the transmission line losses caused by SWR.

Improving the higher band resonances of your antenna.

The harmonic resonances are typically going to be higher and higher in each ham band, and further the 30 meter band isn't really a "harmonic" of the 80 meter band, so often your best SWR on higher bands won't be where you want it. Commercial versions of this antenna found a way to shift the higher harmonic resonances lower in frequency without much affecting the 80 meter resonance:: A coil form of about 1.5" diameter is positioned about 6 feet from the balun along the end-fed wire, and several turns of the wire are made on the form (perhaps 10-15). (if you drill a hole at each end of a 1.5" PVC coupler and feed the wire through you can make all this hold together well.) This lowers the resonance point of the higher harmonics without badly affecting the 80 meter band. Other experimenters have gotten the antenna to work on the 75 meter phone band by adding a series capacitor right in the middle. Antennas were made for experimentation!

Suggested further reading:

1. https://myantennas.com/wp/product/efhw-8010/ A commercial, optimized version of this type antenna. Very impressive SWR chart.

2. http://gnarc.org/wp-content/uploads/The-End-Fed-Half-Wave-Antenna.pdf Nice discussion and opinions on this antenna.

3. https://radioaficion.com/news/mfj-efhw-antenna/ discussion of a commercial version..