

FRC100W EFHW Transformer and Balun Kit

Experienced Builder Instructions - V2

17 November 2022

What You Are Building

This is a matching unit, also called an “UnUn” for EFHW antennas. It has a 64:1 and 1:1 inside.

Because there is a 1:1 (also called a line isolator sometimes) in same box, **you MUST use radials.**

The 1:1 is low loss and substantially removes common mode current.

The 64:1 is efficient, and runs cool at 100W SSB.

Kit Contents

Qty	Item
1	3D printed sled for mounting toroids & cap
1 (pack 2)	Toroid pack, 35mm OD
1	Black binding post
1	Red Binding Post
1	SO239 Socket
1	Wire twisted for 1:1, 0.80mm
1	Wire for 64:1, 0.80mm
1	Silver Mica capacitor 100pf or 120pF
1	Short black hookup wire
1	Poly carbonate box

Update 17/11/2022

- We are supplying the boxes marked up for drilling holes for the SO238 and banana posts
- The SO239 is marked with a Blue dot. The Red banana post is marked with a Red dot
- We have sanded the toroid inner edges to remove sharp edges
- We've tinned the centre pin of the SO239 to make assembly a lot easier.

Mounting the SO239 connector

Please follow these steps if you have not done this before.

1. Drill a pilot hole for the SO239. We suggest approx 3mm. The position is marked on box.
2. Now drill a 14mm hole. If you have a step drill this is ideal.
3. Use a small flat file, file a 'flat on one side of the hole' the same as on the SO239. Please check the SO239 for this.
4. Now using a round file carefully expand the hole to make a tight fit to the SO239.

Take your time - make it a tight fit.

Quick Steps For The Experienced Constructor

Take your time. Here are some critical steps;

- Be careful with the SO239, see above. You must file a 'flat' so it does not rotate.
- Make sure the Banana posts are tightened firmly.
- When winding the toroids, avoid rubbing the wire against the toroid.
- SO239 centre pin connection. Wrap the wire around the centre pin then solder.



Quick Instructions

- Drill box.
- Tin the centre pin of the SO239 (*we did it - check*).
- Mount SO239. Use a file for the flat (*see above*).
- Check toroids for sharp edges (*we did it - check*).
- See picture to left. Wind the 1:1 shown at top. 11 turns, middle crossover.
- Wind transformer. 24 turns, tapped at 3 turns.
- Mont toroids on sled, hot melt into place.
- Hot melt capacitor into place.
- Connect base of transformer to 100pF cap (LHS in pic).
- Connect only one wire of 1:1 to cap & transformer wire.
- Connect black wire to cap & transformer wire.
- Put sled into box. Hot melt into box.
- Use a multimeter / continuity tester, find far end of 1:1 .
- Connect to ground lug of SO239; tin, put thru hole, solder.
- Connect black wire to black banana post.
- Connect tapping to cap (RHS in pic).
- Connect other 1:1 wire to cap
- Tin the 1:1 wire, 2cm long, wrap round SO239 centre pin. Solder.
- Done!

Note. When you screw the lid of the box down, do not use excessive force. You may strip the threads.

See testing and antenna construction notes at the end

Richards Construction Notes - How I made it

Drill box and Fit the connectors

- The banana binding posts are easy to fit. Drill a hole to suit.
- You can mount on one end, or put the black radial connector on one side if you want.
- Tighten the banana posts well else they will rotate when you use them later.
- Fit the SO239 on one end. We marked the enclosure for you with a Blue dot.
- See previous SO239 mounting information. This is important.
- Later, be careful to mount so it does not foul on the enclosure lid (which is why we marked it).

Check Toroids

- *We did this for you - but it pays to check.*
- Make sure there are no sharp edges on them, particularly in the centre.
- If necessary use a little sandpaper to smooth them.
- Be very careful not to scrape the enamel on the winding wire (hence smooth edges)

Prepare, then mount SO239

- *We did this for you. Check!*
- These can be difficult to solder to the middle pin.
- We use a knife or file then scrape the outside of the centre pin.
- Use a hot iron, carefully, heat and tin the centre pin outside. We don't use the centre hole.
- Be super careful not to apply too much heat and melt the centre of the connector.
- Apply the bare minimum solder to coat the last few millimetres of the pin.
- Finally, mount the connector into the box, and tighten well.

Wind The 1:1 Balun

- Use the twisted bifilar wire, this is for 11 turns on one of the toroids.
- Wind on 5 turns – then do the crossover – then wind on another 5 turns.
- One turn is one pass through the hole.
- Spread the turns out as shown. Do not leave close wound.
- It is easier to build if the wires by the capacitor are at top of toroid (check the pic above).
- Hot melt the wound toroid into the 3D printed sled as shown - with the wires as shown.

Wind The Transformer

- Wind on 3 turns (3 times through the hole) – then bring out a loop 3 cm long.
- Wind on an extra 21 turns. Total is 24 turns, tapped at 3. This is 64:1
- With a 1:1 in the box, the 64:1 ratio works well and lets us use shorter radials.
- Scrape the enamel on the loop and solder tin the wires. Doing this now is easier.
- Hot melt the wound toroid into the 3D printed sled as shown so the tapping and bottom wires are near the capacitor hole.

Connecting it All

- Hot melt the capacitor into the slot provided (can do this at any time).
- Cut bottom end of transformer wire to length - to be long enough to wrap around cap wire
- Scrape, tin, and wrap just the bottom transformer wire around the capacitor leg as shown.
- Cut the 1:1 balun wires going to the cap to length.
- Use a sharp knife to scrape the enamel, then tin both wires.

Important. ONLY connect only one 1:1 wire to the capacitor connected to bottom of transformer.

- Lightly solder in place.
- Drop the sled into the box and hot melt into place.
- Use the black wire and connect that to the capacitor and 1:1 wire to the black binding post on the end (or side) of the box. This is for the radials. See pic on LHS of cap.
- Use a multi meter. Find the other end of the 1:1 wires (which wire) connected to the capacitor.
- Connect that wire to the earth lug of the SO239. Scrape the enamel, tin the wire, poke through the hole, fold the wire over the lug then solder.
- This is critical. The SO239 lug (shield) must be connected to the bottom of the capacitor via the 1:1.
- Note. Doing only 1 capacitor leg first reduces the chance of connecting the black wire to the wrong place and helps get the 1:1 connections correct. This really is important.
- Now, connect the transformer tapping to the capacitor free leg, then the other 1:1 wire.
- Finally connect the last wire of the 1:1 to the centre of the SO239
- Make the wire has about 2cm of tinned length. Wrap it right around the centre pin then solder it carefully. This reduces the possibility of a dry joint.

At this stage it should be complete. See below for building an antenna and testing.

Building An Antenna And Testing

The best way to test is to build an antenna and radials(s), connect the FRC100W with coax and then test the complete antenna system.

Make A 40m/20m/15m/10m Antenna and radials

- Cut 20m of wire, connect to the **Red** banana post.
- Mount the FRC100W up about 1.5m off the ground.
- Connect a coax cable to the FRC100W.
- Pull the antenna wire up high in the air, away from obstacles etc.
- YOU MUST USE RADIALS! The 1:1 in the box makes this mandatory.
- We suggest using 2 off 2m long radials. Connect these to the **Black** post.
- Keep the radials and the coax separated if possible.

Testing

- Connect an antenna analyser and sweep your antenna looking for lowest SWR points.
- If you use your transceiver to sweep the antenna use low power.
- You may have to shorten the antenna a little.
- The bands may not line up perfectly - this is normal, (we have antenna solutions for this).
- We find that best SWR on 40m is about 1.6:1 and on 20m is 1.2:1 when mounted as an inverted-L and an elevated feed point. This will work very well into most radios (IC-705 / IC7-705, FT-897D etc)
- If you mount the antenna lower, closer to the ground, the SWR will change and may in fact become very low.

Final Build And Use Notes

- Do not over-tighten screws. Do add extras water protection if used outside
- The box and sealing gasket is splash proof.
- If you leave it out in the weather, do provide extra rain protection.
- Tighten the binding posts firmly else they will come loose.
- You must use radials. The 1:1 balun isolates the coax from the transformer.
- We've found that 2 radials, each 2m long are ideal for a 40m/20m/15m/10m antenna.
- Keep the radials away from the coax. This helps reduce common mode current.

About End Fed Half Wave Antennas and the FRC100W

Most EFHW UnUn's don't have a 1:1 - then you find you need a 1:1 in the coax somewhere to tame the common mode current. That adds much more cost, extra connectors and cable issues. Plus it is annoying!

That is why the 1:1 is inside the FRC100W enclosure.

Be aware though that the 1:1 will not eliminate common mode current. Some will still be present by being picked up by radiated signal coupling to the coax. We have found it to be quite low - it is coax and installation dependant so a precise measurement is meaningless.

We have found that radios that would otherwise demand a 1:1 (with UnUn's that don't have an inbuilt 1:1) will work just fine with FRC100W. Two examples are the IC705 and the IC703 - both of which can be susceptible to common mode current malfunction.

Having the 1:1 in the box does have some other consequences;

The coax does not form part of the antenna any more. This means you can use different lengths and it won't affect your antenna as much.

Next, because the coax is not part of the antenna, you MUST use radials - else the antenna system won't work - the SWR will be terrible and it will be deaf as a post.

If you drape the radials over the coax, it will increase the common mode current. Yes, the radials do radiate just a little.

Next, and maybe peculiar to us, we recommend using 2 radials, not just 1. Both cut to the same length at 1/20th the length of the longest band you are using. For example, for 40m, we use 2 off 2m long radials. We found the SWR was a little better this way.

Efficiency and pattern with radials

The pattern that the antenna has will benefit, and signal too, by having the 1:1 inside the enclosure.

This is because the radials will be in the air and radiating. Without the 1:1 the coax is part of the antenna and laying on the ground and radiating into the ground - losing signal and changing the pattern.

For the most efficient antenna (best signal)

We like the inverted-L. Elevate the UnUn about 1.5m in the air, the 2 radials coming out to opposite sides, then take the antenna up to 7 or 8 or 9m high and keep the flat top as high as possible.

Other mounting, like laying the radials on the ground will work fine, and low sloper, but will have reduced signal strengths.