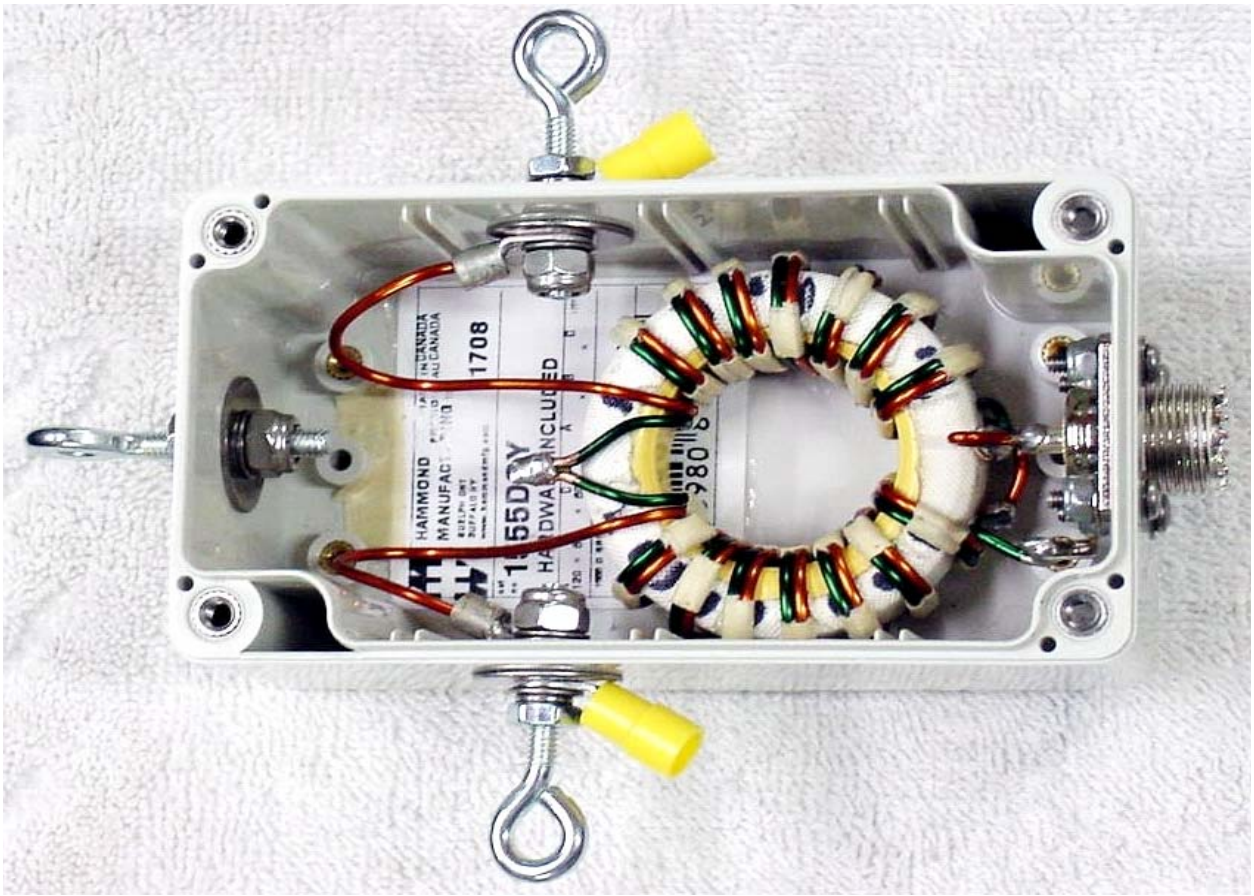
CVARC 4:1 Balun Project Kit by AE6YC

New to the amateur radio world or have been around long enough to be considered an *old timer*, whichever you will never forget the first kit or *homebrew* project you built. For me it was a 'cat-whisker' crystal radio receiver before I was a teenager. The balun project is a great introduction to what old timers in the hobby refer to as *homebrewing.* Our club has put together 35 kits and will schedule two work shops at the ECSS. Elmer's will be available to help with soldering, coil winding, schematic reading and testing to assure everyone leaves with their completed balun kit up and running.



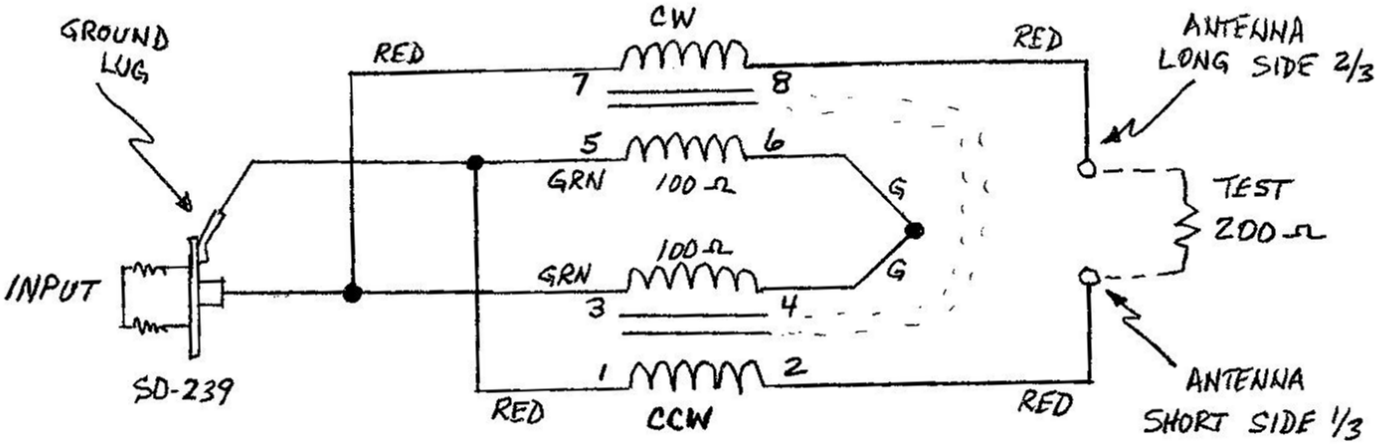
<u>Why a balun - what's it used for</u>

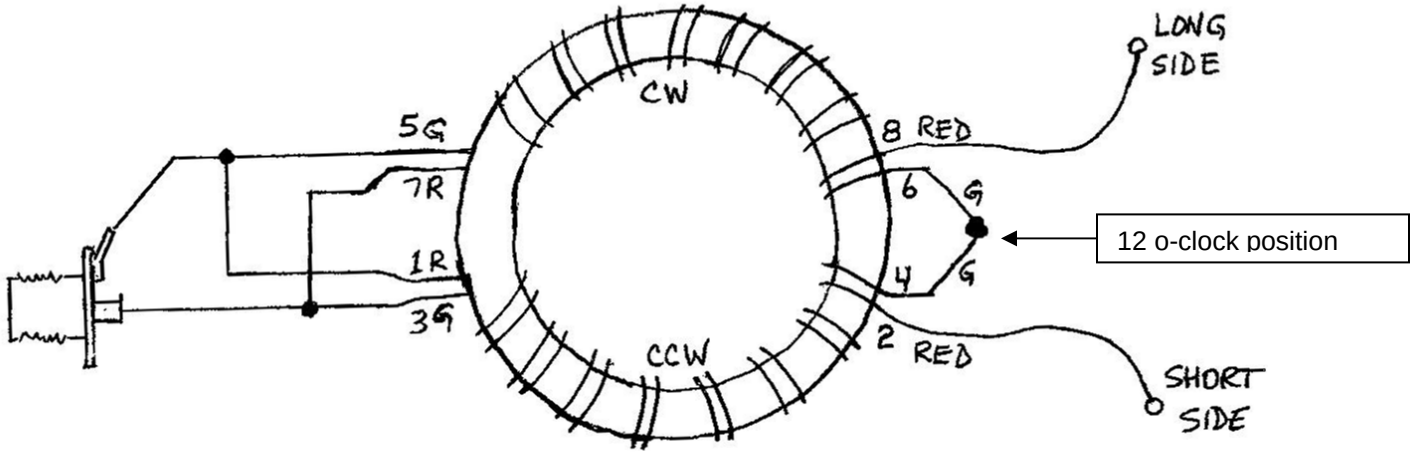
The most basic of antennas for ham radio is the dipole. Dipoles are both economical and easy to construct, the conventional dipole is limited to a single band of operation. The conventional dipole antenna is center fed meaning equal lengths of wire on each side of the feed point, and the overall length of the antenna wire is determined by the band or frequency you wish to operate on. Coaxial cable is generally used between the output of your radio and the center feed point of the dipole antenna.

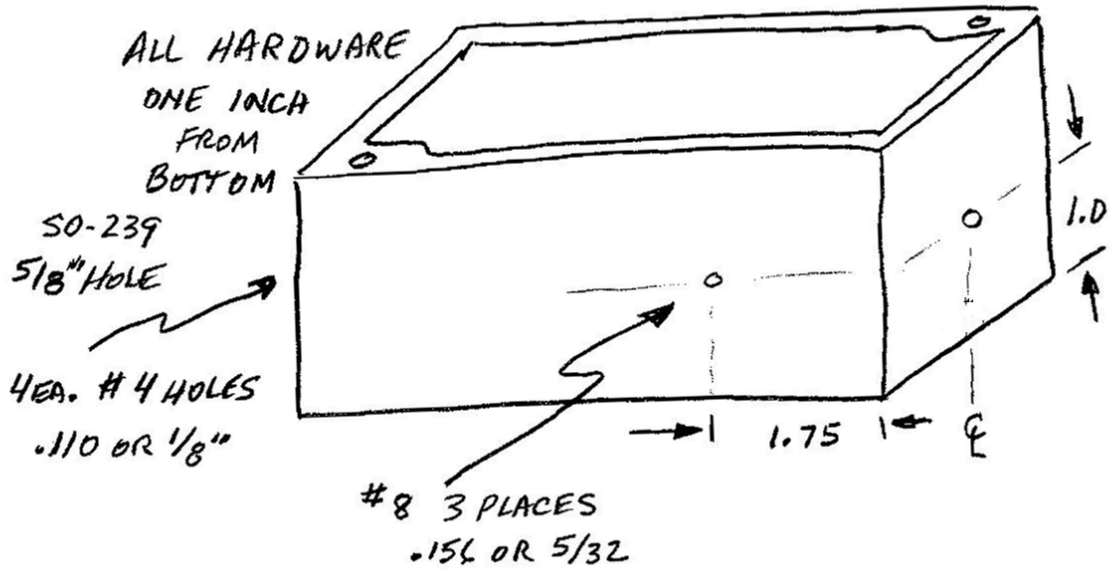
However, by *off setting* the feed point at the antenna and building an impedance conversion device you can build a modified dipole antenna that will operate on several of the HF bands. This antenna is referred to as an OCF dipole, or off-center-fed dipole. OCF dipoles have much higher impedance(s) than conventional dipoles. The impedance conversion device, you guessed it, is the balun. Balun stands for *<u>bal</u>anced - to - <u>un</u>balanced.* The balun matches the impedance of the antenna to the output impedance of your radio. The balun is placed at the *off center* feed-point of the antenna wire, and coaxial cable is run from the balun to your radio. The balanced part or side of the balun is connected to the OCF dipole antenna wire, and the unbalanced side connects (via coax) to the antenna connector on your HF radio.

Whatever your situation - limited space, basic radio without tuner, budget, just upgraded to HF privileges, or just want to brew your own. Our balun project is just the ticket to get on several HF bands with a single antenna. The OCF dipole can be put up in a straight horizontal configuration - some times called flat top, inverted 'V', or inverted 'V' with drooped ends to fit on the smallest of city lots.

Schematic, core winding layout, and enclosure drill locations







Kit components

As pictured above the kit includes all components to build a complete balun assembly -

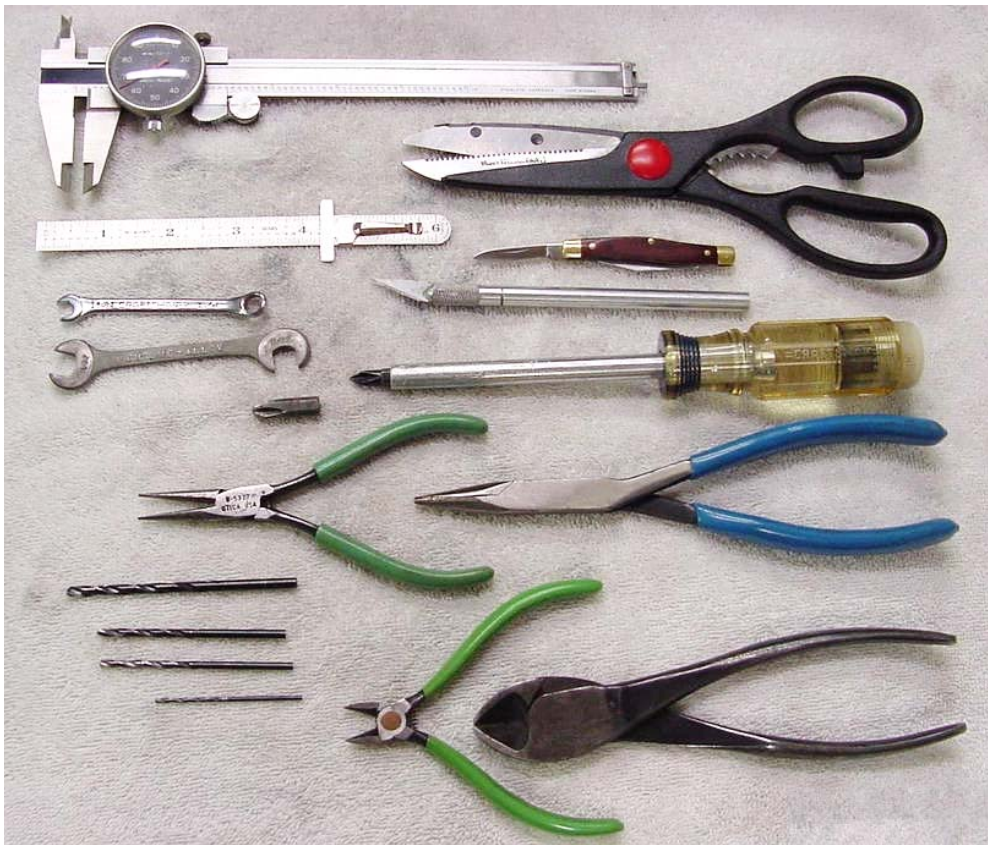
Hammond NEMA polycarbonate enclosure, 1555DGY, includes cover (not shown)
Powered iron 2 inch core (mix 6), Micro Metals T200-6
3M glass tape to wrap the core
Masking tape for wire spacing
Insulated magnet wire 14 gauge, green and red
#8 ring terminals
Various #8 hardware, eye bolts, washers, lock nuts
All hardware is stainless steel except eye bolts and #4 lock nuts
#4 solder lug, and 4-40 screws, washers and lock nuts
SO-239 connector, RFU-521 from RF Industries

Work shop tools

Long nose pliers, smooth and rounded jaws
Diagonal cutters, light and heavy duty
Measuring stick, rule or caliper, and awl for marking drill locations
Phillips #1 and #2 screwdriver
Wrench, 1/4 and 11/32 inch (#4 and #8 hardware)
Knife to scrape magnet wire insulation off
Scissors, we'll be cutting a lot of tape strips
Towel to protect the tables at ECSS, and catch small parts

Only a few of the following are required at each workshop sessions -
Soldering iron and solder
Drill and bits
- starter drill and for water drain holes, 1/16 inch
- .110 or 1/8 inch for #4 screw hole
- .156 or 5/32 inch for #8 eye bolts

Antenna analyzer for testing completed balun

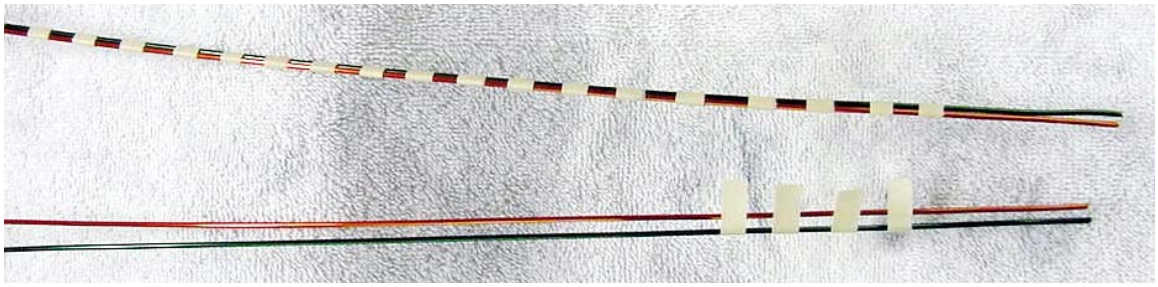


Workshop and assembly tidbits - in no particular order

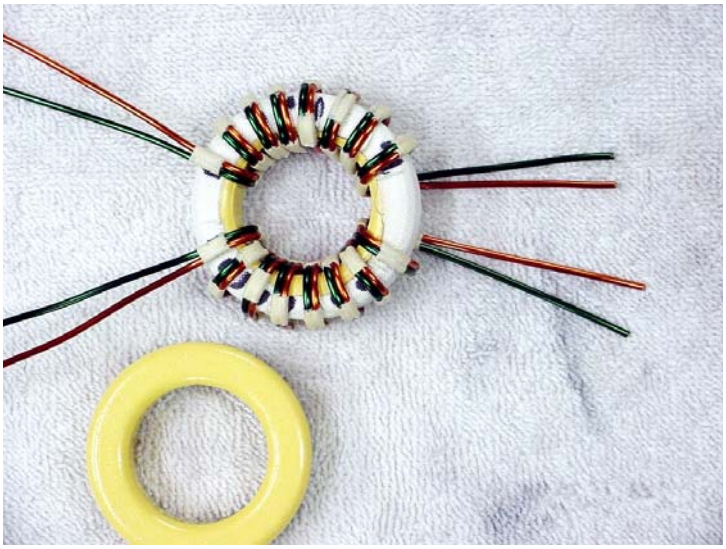
All parts except the glass tape, magnet wire, and masking tape are in the project box. The tape(s) and green and red 14 gauge magnet wire will be cut to length at the workshops. The 5/8 inch diameter mounting hole for the coax connector has been predrilled by the author in all of the project boxes. To complete the connector mounting insert the connector with its mounting flange on the outside of the box into the 5/8 inch hole and match drill the four #4 screw mounting holes using a **.**110 or 1/8 inch drill, hint - after drilling each hole insert a #4 screw to keep the connector aligned.

Preparing the two transmission line windings is the most tedious and time consuming construction step. The two wires that make up each winding must be spaced by one thickness of masking tape, about **.**005 inches, the total spacing is **.**009 inches taking into account the two mil magnet wire insulation. This spacing determines the impedance of the transmission line winding. Starting with about two feet of wire and using 1/4 inch strips of masking tape spaced about 3/8 of an inch apart, and starting 2 to 3 inches from one end prepare about 14 inches for a seven turn winding.

Taping detail - starting with one of the wires and using 1/4 inch masking tape strips wrap each piece of tape just a bit over one turn along 14 inches of one wire. Then place the second wire parallel and touching the first wire and snugly tape the wires together using the tape *flags* sticking out from the first wire.



Make sure the glass tape has been applied to the outer diameter of the core before winding the transmission lines. The core coating is slippery and the glass tape adds a little *cushion* for the wire to bite into and keep the winding turns in place. I found marking the winding start and stop positions helpful. The CCW winding starts at 5 and ends at 1 o-clock, the CW winding at 7 and 11 o-clock respectively. Marking these positions help to gauge the spacing of the turns as you wind the core.



I like to start with the CCW winding. Verify the orientation of the wire colors are correct, green left, and red on the right. Start winding from the bottom of the core at the 5 o-clock location, strive for equal spacing for each of the 7 turns and end up coming off the top of the core at 1 o-clock (technically this is actually seven and a half turns).

For the CW winding start at 7 o-clock (bottom of core) and this time the green wire is on the right and red on the left, again try for equal spacing and complete the 7 turns at 11 o-clock.

Install the coax connector and torque the mounting hardware except the screw holding the solder lug. The ground lug screw will be tightened after you connect and solder wire number 5. The eye hooks and ring terminals can be installed now or latter, only finger tighten the hardware until all soldering is completed.

The 2 to 3 inch winding tails get interconnected per the schematic and get wired to the coax connector. The longer red wires get *formed* to line up with the eye bolts and get ring terminals installed, and the long green wires are cut off and spliced. Take some time at this point to review the schematic, core layout drawings and compare them to the photos below.

Workshop courtesy - ask before borrowing. Tools can be ruined in a heart beat, please ask and discuss what the borrowed tool is going to be used for. Pliers are not wrenches, and small diagonal cutters are not used to cut 14 gauge wires to mention a few!

I found it easiest to start with the long green wires (# 4 and #6) near the 12 o-clock position. Cut them down to about 2 inches and scrap their insulation off. Form the wires and cut to length. Then wrap a few turns of buss wire to join the wires together, and then solder.

Interconnecting the wires that connect to the coax connector is not as straight forward. Refer to the photos and scrape a section of insulation off green wire #5, and red wire #7. You only need to remove between 1/4 and 3/8 of an inch of insulation for the solder connection of wires #1 and #3 respectfully. When clearance is required for scrapping insulation on a wire, gently bend/move the other wire out of the way - and remember to use smooth or rounded nose pliers. If you do not have smooth jaw pliers wrapping the tips with a few layers of tape will help to prevent nicking the insulation when forming the wires. Holding the core just above the project box will help you judge the positioning, length, and forming of the wires.

I prefer solder over crimping for the ring terminals. The terminal is large enough for two wires for those that would prefer to bring a pigtail from inside to connect to their antenna wire. If built as shown, double over the end of the 14 ga. magnet and it will snuggle fit the ID of the terminal.

Testing and Science Project

Work in progress

Antenna Dimensions and Tuning

Work in progress