

**40 - 6 METER OFF-CENTER-FED  
(OCF) DIPOLE**

**Design Goals and Objective:**

Construct a multi-band off-center-fed (OCF) dipole covering the 40, 20, 15, and 10 meters amateur radio bands, and possibly the 6 meter band (but that is considered a bonus band, outside the main project objective.) It must be made of durable, high quality, weather worthy components. The balun / feed point shall be installed on a 40 foot galvanized push-up steel mast. The far ends shall be supported by a 25 foot mast and tree, respectively. It shall be easy to adjust for resonance and low SWR (i.e., easy to “tune”) by simply adjusting the length of the wire elements.

The design choice and objective is to find a compromise point on the antenna where the impedance is low enough to connect a feed line, typically a coaxial cable, and operate the antenna on multiple bands. Purportedly, the OCS is a half wave dipole on the lowest band of operation and should have essentially the same characteristics as any other dipole on that frequency.



**OCR Dipole Parts List:**

Quantity	Description	Cost
1	4:1 Current Balun 1.5 - 54 MHz for OCF Dipoles - matches impedance and isolation transformer / Model #4114ocf	\$82.95
2	Dog bone insulators	\$2.00
2	Rope thimbles	\$2.00
1	70 ft hanks of rope - your choice - I used 1.8 inch double Rayon	\$5.00
1	66 ft of 14 Gauge THHN insulated wire	\$8.25
2	Cable clamps 1/4 inch	\$1.00
1	8-inch long 1/4" x 20 eye hook	\$1.25
TOTAL (Less Shipping) :		\$ XXX.00

**Construction notes:**

The BalunDesigns 4:1 current balun is suspended by an 8-inch stainless steel eye hook. A similar eye hook is located below the balun and stabilizes and provides strain relief, for the coaxial transmission line.

Two rope thimbles were employed to relieve strain where the wire elements attach to the two stainless steel eye hooks on each side of the balun. The XYL considers this unnecessary overkill, and she is undoubtedly correct, but I used them anyway just for luck.

Essentially, your basic OCF Dipole, with 4:1 current balun.



The balun was purchased from BalunDesigns - [www.balundesigns.com](http://www.balundesigns.com) - Owner, Bob Rumsey, KZ5R, was very helpful and discussed the selection of which balun design to employ at my location. I provided Bob with drawings and photographs depicting the lay of the land, indicating where and how I planned to install the dipole. Bob paid close attention to, and contacted me to discuss, the location and its proximity to the garage, anticipating the short element would hang over, and runs parallel with, the edge of the garage roof, while the other, longer element would hang free and easy over the back yard. Not every vendor will give you that kind of detailed, personal attention.



This is what the vendor says about it:

In an effort to provide a balun with the tolerance of the model 4113 and the choking/isolation attributes of the model 4115, Balun Designs has developed the model 4114ocf. By utilizing our stacked core technology, we have created a 4:1 current balun that easily tolerates the imbalance caused by the proximity of large structures and metal roofs while still providing good choking impedance, excellent transformation and high power capability.

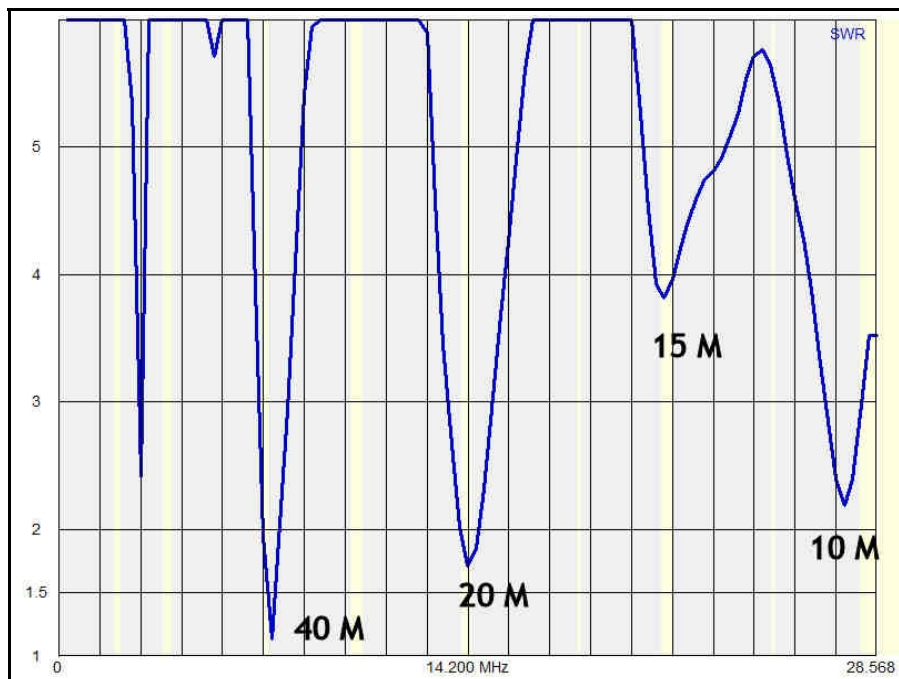
This balun is an excellent step up from the model 4113 and not as sensitive as the model 4115ocf. If you like to run high power, but need to erect your OCF dipole with a leg over or near your house, barn, garage or metal building, this is the balun of choice. The stacked cores double the choking and isolation while retaining the forgiving nature of windings on a single core. Core/winding configuration is patent pending and available ONLY through Balun Designs.

**Test Results: Results:**

It is unlikely one can prune his OCF dipole to an ideal 1:1 SWR on any band, let alone do so on all bands representing the fundamental and even harmonics thereof. It, however, is realistic to prune for minimum, SWR on one or more bands, and employ a tuner/transmatch (matchbox) it to tidy up higher SWR on other bands.

Employing a RigExpert AA-230 antenna analyzer, I measured 1.24:1 SWR across the entire 40 meters and, and 1.38 SWR across the entire 20 meter band. I measured an average of 3.3:1 SWR across the 15 meter band, and an average of 4.5:1 SWR across the 10 meter band.

MultiSWR ( )	
28 300 kHz	SWR: 3.8
21 235 kHz	SWR: 3.9
18 125 kHz	SWR: 6.7
14 225 kHz	SWR: 1.7
7 225 kHz	SWR: 1.11



Good performance on the 6 meter band is considered more of a bonus, than a design criterion or design goal, and I measured a fairly acceptable, manageable 5.5:1 SWR across the 6 meter band. Not really good, but not all that bad, and quite manageable with an appropriate matchbox.

Generally 15 meters is not considered an even harmonic of the 40 meter band... well close but not quite, and the typical 40 meter OCF dipole does not find an easy match on 15 meters. Therefore, I adjusted the feed point from the usual 33% point, to a much more lopsided 25% point, and this had the result of leaving the super low SWR figures on the 40 and 20 meter bands, while bringing SWR down to a very nice 3.3:1 SWR on the 15 meter band. The next lowest SWR appears just below the 10 meter band, but that is OK, because I have a separate 10 meter antenna which manifests a super resonant, very low SWR for that band, so I consider this a “bonus” band on the OCF dipole.

This gives me a nice 4-band (possibly 5-band) all purpose dipole antenna which either requires no tuning/matching in the shack, or minimal tuning/matching, presenting low SWR and minimizing loss in the transmission line from unreasonably high impedance mismatch. Thus, I am pleased with this antenna project, consider it a success. I also consider it came in within budget - although I know a great many hams would save some money - perhaps as much as \$30 -\$35 by constructing their own, home brew, balun. I chose to purchase one because I can, and because I wanted to complete the project before I had time to research and become an expert on baluns. Of course, your mileage may vary considerably depending on your expectations and threshold for economic pain.

### **Design Considerations:**

Theoretically, impedance at different points along the length of a dipole can varies from 2 to 3000 ohms. The center is usually about 70 ohms and resistive. Feeding a regular balanced dipole at the center does result in low feed-point impedance (approximately 72 ohms +/-) and the antenna usually presents low SWR on its fundamental frequency and its ODD harmonics.

Between the center and the ends of the dipole, you may find anything between 72 and 2000 ohms. The goal is to determine a point where the impedance is low enough to be manageable on multiple bands. Turns out you can do this with a feed point placed somewhere between 40 and 20 percent from one end of a an antenna, instead of in the center.

The OCF dipole presents a reasonably good match to the transmitter across multiple bands which are EVEN harmonics of the fundamental frequency, including 80, 40, 20, 10 and 6 m bands. Feeding the OCF dipole at a point that is one-third of its length from one end, typically yields a higher feed point impedance (approximately 200-300 ohms) compared to the center-fed half wave dipole. It also presents low SWR and can be worked on its fundamental frequency, and its EVEN harmonics.

Most OCF Dipoles are constructed according to the usual standard formula, which places the feed point one-third of the way from one end, giving the two elements a 33% and 67% location relative to its total length. This typically results in low SWR on the lowest (fundamental) frequency/band for which the antenna is cut, and also on the EVEN harmonics of that fundamental frequency/band. Research by others suggests one can manipulate feed point impedance by placing the feed point at a different point, perhaps as high as 45% of total length, and, perhaps, as low as 20 % of total length. I chose to feed my OCF Dipole with a 25/75 % split, which lowers impedance a bit, and makes it possible to work 15 meters with a tuner/matchbox - a band which is typically not available on the typical OCF dipole (i.e., one that places the feed point 33% of total length.)

To minimize unwanted radiation on the transmission line, one can employ a transmission line choke, sometimes called a choke balun, to help equalize currents flowing on each antenna element, and to choke off (minimize) the chance the transmission line will, itself, radiate RF as part of the antenna system. A properly designed current balun may provide for more balanced operation, while choking off unwanted currents on the transmission line.

With the OCF dipole, one might not employ the same 1:1 choke balun he might employ with a center-fed dipole. He might consider using an Un-Un, because the ODF dipole does not have equal radiators of equal length. The upshot is there may be unequal current might flow on the inner and outer conductors of a coaxial transmission line. Such feed line radiation is often undesirable, as it may cause excessive RF radiation in the shack, and causing the feed line to radiate might change the antenna from a dipole to something else, perhaps something more akin to the the so called “Carolina Windom,” or G5RV, both of which purportedly employ actively radiating tuning stubs which purportedly radiate by design.

Typically impedance at that point is approximately 300 ohms, and not 72 (+/-) ohms which is what a textbook half-wave dipole typically presents to the coaxial transmission line. Most hams employ a 4:1 impedance transformer (i.e., 4:1 current balun) at the feed point, together with an antenna tuner (matchbox) in the shack, and that usually works pretty well. Some suggest a 300 ohm antenna calls for a 6:1 current balun, but research indicates an appropriate 6:1 balun is much more difficult to assemble than is an appropriate 4:1 balun. Advocates of 4:1 designs claim it is "close enough," considering the impedance at different frequencies on each band actually varies between 200 and 400 ohms, making the 4:1 a good enough compromise. Thus, by convention, if for no other reason, the 4:1 balun has become the ersatz favorite among OCF Dipole aficionados.

Using an appropriate 4:1 or 6:1 current balun, one finds multiple band operation with little or no tuning required at the transmitter, on the fundamental frequency, and its even harmonics. The the balun at the feed point transforms feed point impedance to that of the coaxial transmission line, and also minimizes feed line radiation.

**Expected Performance:** Essentially an OCF dipole is just a dipole which is not fed at its center. It should, therefore, manifest equivalent performance, and exhibit equivalent gain to a center-fed dipole. Its advantage lies, therefore, in presenting so called "resonance" and low SWR on its EVEN harmonics, whereas the standard center-fed dipole does that on its ODD harmonics. Overall antenna system losses are lower because lower SWR on the target frequencies means less feed line loss and lower losses from using a tuner/matchbox, while presenting a good match to the transmitter. Generally antenna SWR is acceptable up to 2.5:1 for most coaxial cable runs. In the event antenna system SWR is higher than 2.5:1, one may resolve this using an antenna tuner/transmatch device in the shack.

#### **Not a Windom or Coax-Fed Windom:**

The OCF dipole is neither a Windom nor a Coax-fed Windom antenna. A true Windom is fed by a single wire, not coaxial transmission line. It is worked against its image in the ground, while one leg of the OCF dipole is worked against its other leg. The original Windom may benefit from a ground plane (i.e. ground radials,) as it is fed by a single wire (as is a random long wire; just not fed at its end.) The OCF dipole can be fed with either balanced line or coax. In this regard, the traditional Windom antenna has no transmission line -- a single wire is attached to the radiator element which comes directly into the shack and connects to the radio or the antenna tuner. The entire wire radiates RF all the way from the rig on out to the end of the wire. Some argue the original Windom is a vertical wire antenna with a large capacitive hat. In contrast, the off-center fed dipole is designed to radiate RF only on horizontal wire elements.

#### **Not a G5RV:**

The OCF dipole differs from the G5RV antenna because it lacks a vertical section which constitutes a matching network, and it is also a vertical radiator. Moreover, the two horizontal elements are of equal length, whereas the OCF dipole has two horizontal radiating elements of unequal length. The OCF dipole can be fed with coax, whereas the G5RV must employ a certain length of window line as a matching stub before it can match 50 ohm coaxial transmission line. Not only does this matching stub radiate RF, but the window line employed as such is finicky and must be run away from metal support masts and other objects encountered along its path. The OCF dipole can be fed directly with coaxial transmission, which is far less finicky about what lies along its path.

#### **Not a Carolina Windom:**

The OCF dipole differs from the Carolina Windom for the same reasons it differs from a G5RV. Additionally, the so called Carolina Windom employs both a 4:1 balun where the matching stub meets the horizontal elements, and also a 1:1 current balun (line isolator or choke balun) at the feed point where the the entire antenna system is connects to a coaxial transmission line. The Carolina Windom differs from a G5RV in that its horizontal radiator elements are not of equal length, and the vertical radiator/matching stub is sometimes constructed of coaxial cable instead of window line. The original G5RV does not use a current balun/choke/line isolator where its matching stub/vertical radiator meets the coaxial feed line.

## References:

- "10.1.7 Off-Center-Fed (OCF) Dipoles," ARRL Antenna Book, 22nd Ed, 2011, Ward Silver, N0AX, Editor, pp 10-8 - 10-9.
- "2.1.3 Feed Point Impedance," ARRL Antenna Book, 22nd Ed, 2011, Ward Silver, N0AX, Editor, pp 2-5 - 2-9.
- "21.2 Dipoles and the Half-Wave Antenna," ARRL Handbook for Radio Communications, 89th Ed, 2011, Ward Silver, N0AX, Editor, pp 21.7.
- "10. Up, Up, and Away or Harmonic Operation of OCFs," Antennas from the Ground Up, L B Cebik, W4RNL, www.cebik.com/content/gup/gup10.html, updated 1-25-98.
- "Multiband HF Antennas, Par 3, Windom and OCF Dipole," The Communicator, Newsletter of the Mississauga Amateur Radio Club Ed Spagnola, VA3TPV.
- "The Off Center Fed Dipole Revisited: A Broadband Multiband Antenna," John Belrose, VE2CV, and Peter Builiane, VE3KLO, QST, August 1990, pp. 28 - 34.
- "The Six Band Center-Loaded Off-Center-Fed Dipole." Serge Stroobandt, ON4AA, <http://hamwaves.com/cl-ocfd/index.html>, updated March 5, 2008.
- "Windom Off Center Fed," Charles T. Rauch, Jr., W8JI, [http://www.w8ji.com/windom\\_off\\_center\\_fed.htm](http://www.w8ji.com/windom_off_center_fed.htm)
- Various articles and comments by Joshua Kelly, W0HC, on his web site, <http://w0hc.com/ocf-dipole/>.
- "Improved Feed for the Off Center Fed Dipole," Richard Formato, K1POO, QST, May, 1996, p. 76.
- "Off Center Fed Dipole Comments, Part 2 and Part 3," Richard Formato, K1POO, QST, October 1996, p. 72-73.
- "More on the Off Center Fed Dipole," W.H. Wiley, W6OWD, QST, September 1996, p. 78.

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