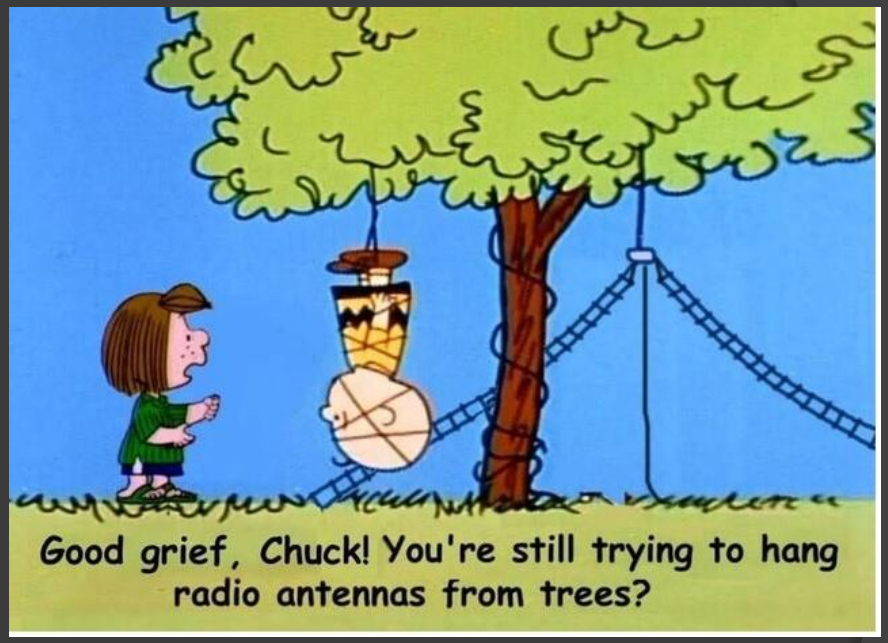
OCFD ANTENNAS REVISITED

PRESENTED AT THE
GREATER NORWALK AMATEUR RADIO CLUB
APRIL 12, 2023

Steve Dick, K1RF

In search of the Holy Grail

- A multiband, simple, wire antenna that is low cost, easy to build, doesn't need a wide range antenna tuner, and easy to deploy.
- The off center fed dipole (OCFD) is a good attempt at finding the Holy Grail.
- For more info join the groups.io OCFD group

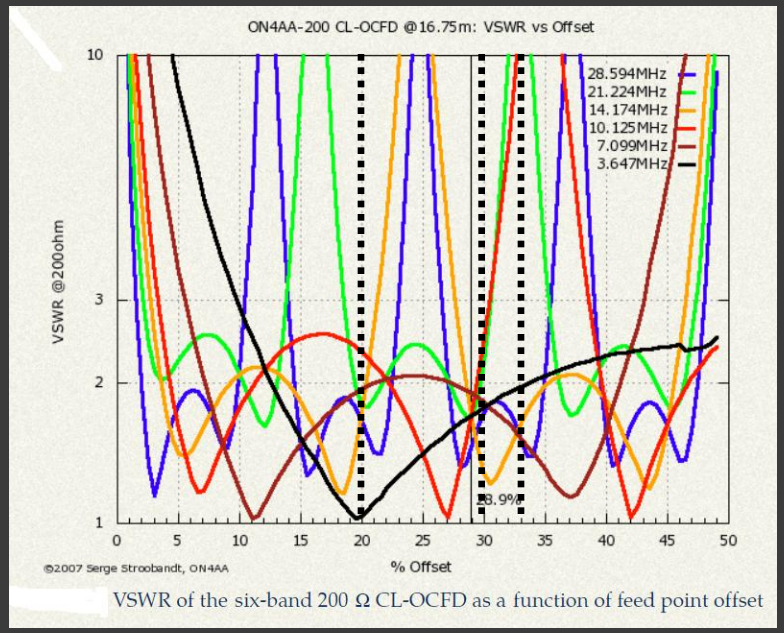


Courtesy DJ0IP

The Windom has a storied history

- Gory details here by Robert Brown, M0RZF with Contributions by Rick Westerman, DJ0IP
- The actual birth came when Howard M. Williams, W9BXQ, was first to feed a half wavelength horizontal wire off centre with a single feed-line.
- 1929: After involvement of many people, Byrne wrote an earlier thesis paper on it, but Windom got the credit in the Sept. 1929 issue of QST.
- 1950-1980:
  - Single wire feeder was replaced with ladderline by Günter Schwarzbeck, DL1BU
  - 1959: Ladderline replaced with coax and an ugly balun by (Buck) Rogers, K4ABT
  - 1970: Coax plus transformer and balun by Kurt Fritzel (DJ2XH) and Fritz Spillner (DJ2KY)
  - 1980s: Carolina Windom (uses the coax as a radiating part of the antenna, with the common mode choke some way down the coax.)
- 1980-Today: Much testing and advances in simulation tools resulted in new feedpoint splits, better performing baluns, and even an end-connected OCFD
- Most offset designs with different feed arrangement are strictly not Windoms, though the name has stuck and forms a kind of “brand” like G5RV.

80m-40m-30m-20m-17m-12m-15m-10m OCFD feedpoint Variants



VSWR of the six-band 200 Ω CL-OCFD as a function of feed point offset

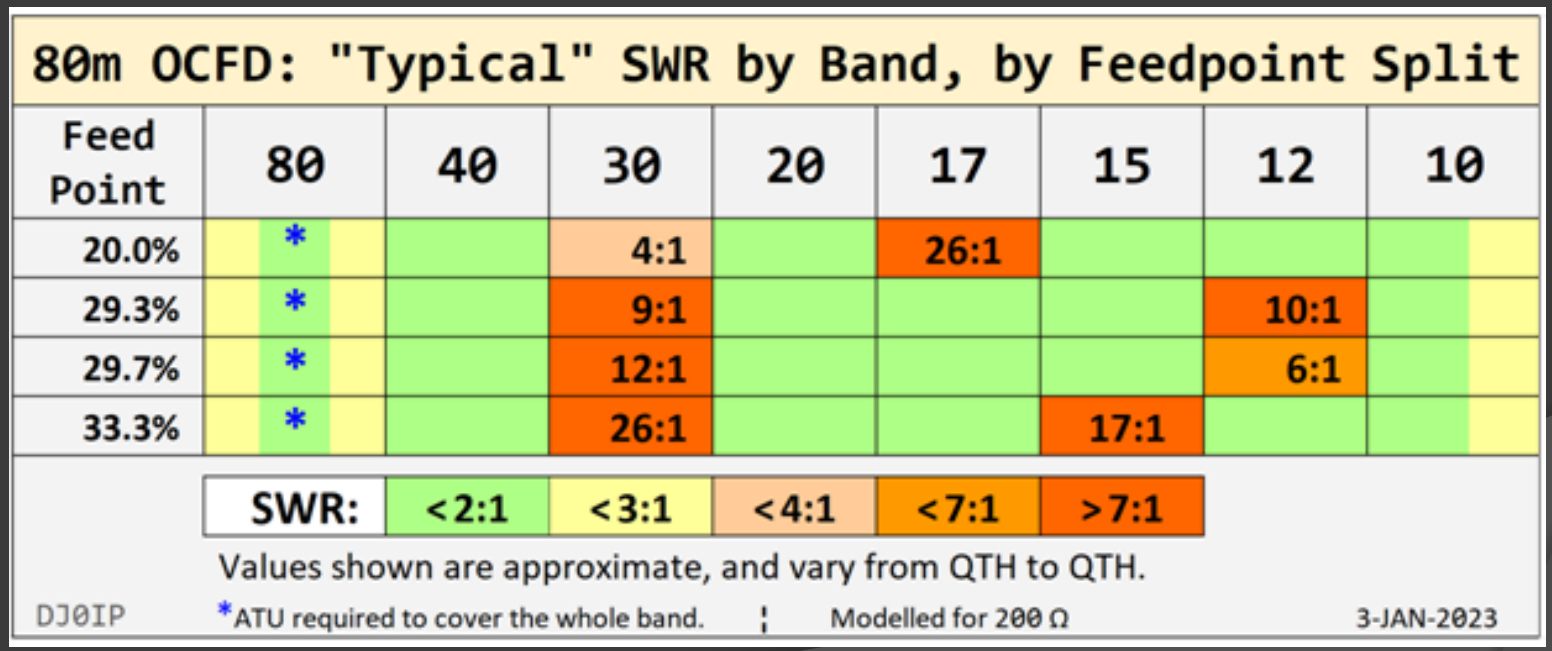
Courtesy **Serge Stroobandt** ON4AA

See what happens at ~20%, 29.7%, and 33% splits (dashed lines)

- Over the last decade or so, modern simulation tools and much additional testing established a multitude of different feedpoint splits which allow operation on 15 meters as well as some of the WARC bands, depending on the feedpoint chosen

On 80m OCFD Antenna Splits

- Rick Westerman, DJ0IP, offered the following Comments: “The sweetspots have been known for almost 8 years now. It depends on which bands you want to use it on.”



80m OCFD: "Typical" SWR by Band, by Feedpoint Split

Feed Point	80	40	30	20	17	15	12	10
20.0%	*		4:1		26:1			
29.3%	*		9:1				10:1	
29.7%	*		12:1				6:1	
33.3%	*		26:1			17:1		

SWR:	<2:1	<3:1	<4:1	<7:1	>7:1

Values shown are approximate, and vary from QTH to QTH.

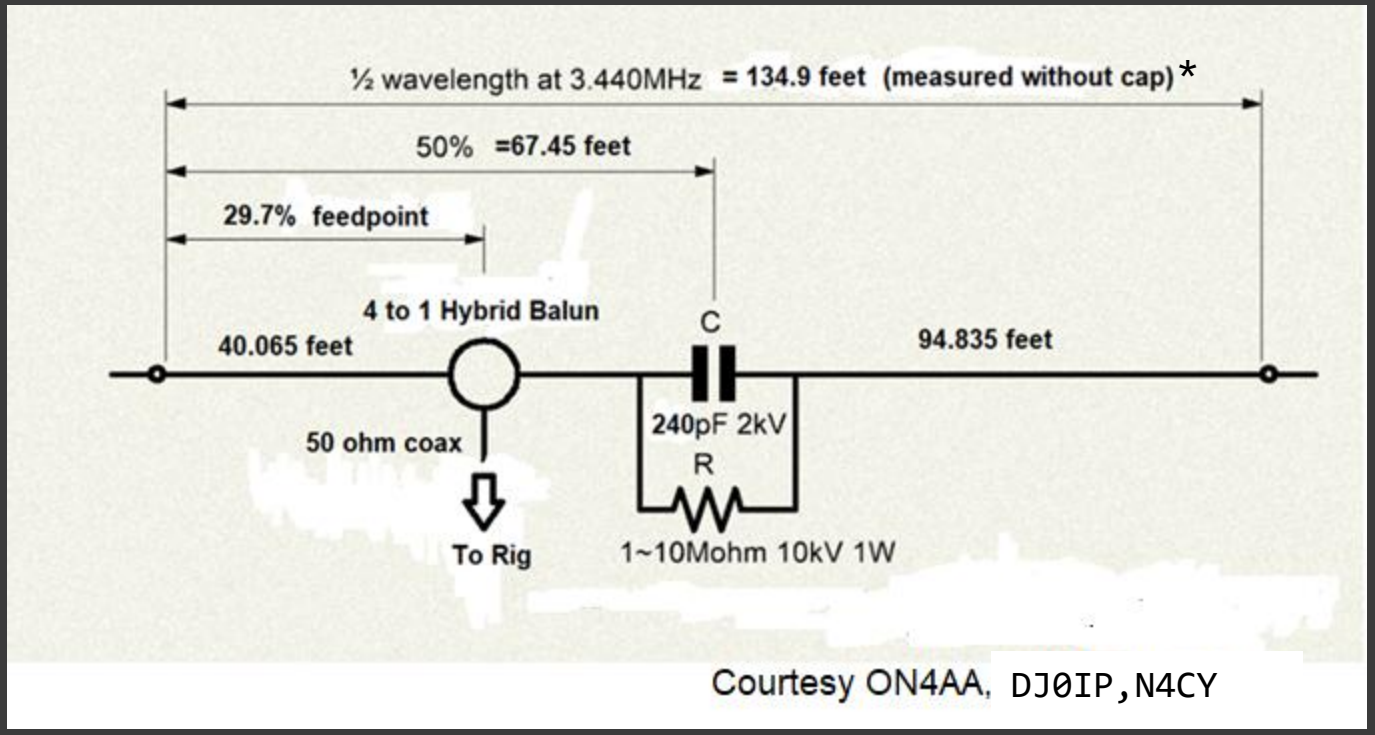
DJ0IP *ATU required to cover the whole band. ¦ Modelled for 200 Ω 3-JAN-2023

On 80m OCFD Antenna Splits -cont'd

- "Use either 20 percent or one of the two 29 percent feedpoints. I have personally built about 20 of the ones that use the 29.7%, hung them in many different locations, with various lengths and angles of the inverted V. They ALWAYS work on those 5 classic ham bands. Most of the time I don't even need an antenna matchbox."

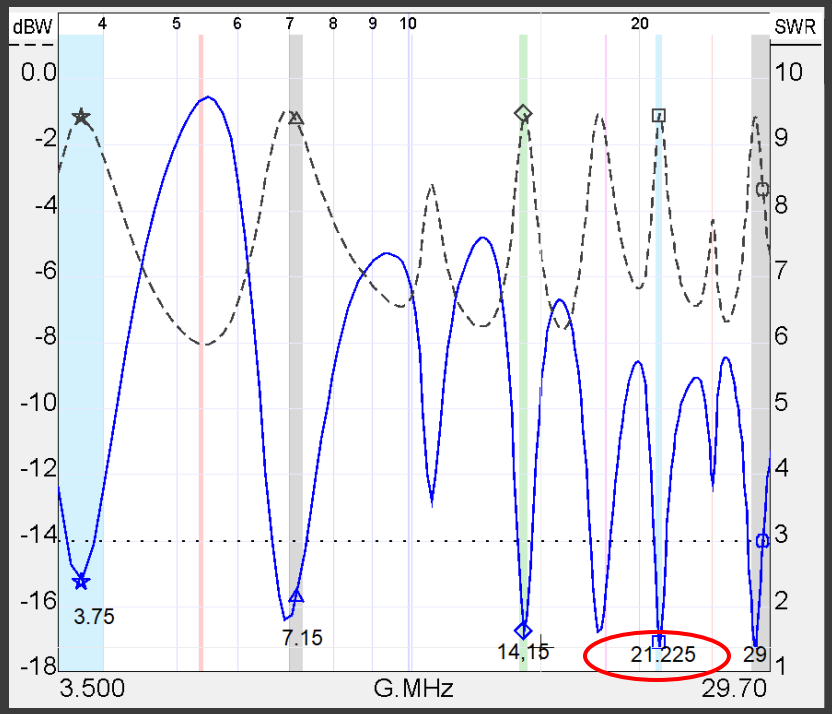
  – Rick Westerman DJ0IP

80m-40m-20m-15m-10m 29.7% feedpoint, recommended configuration

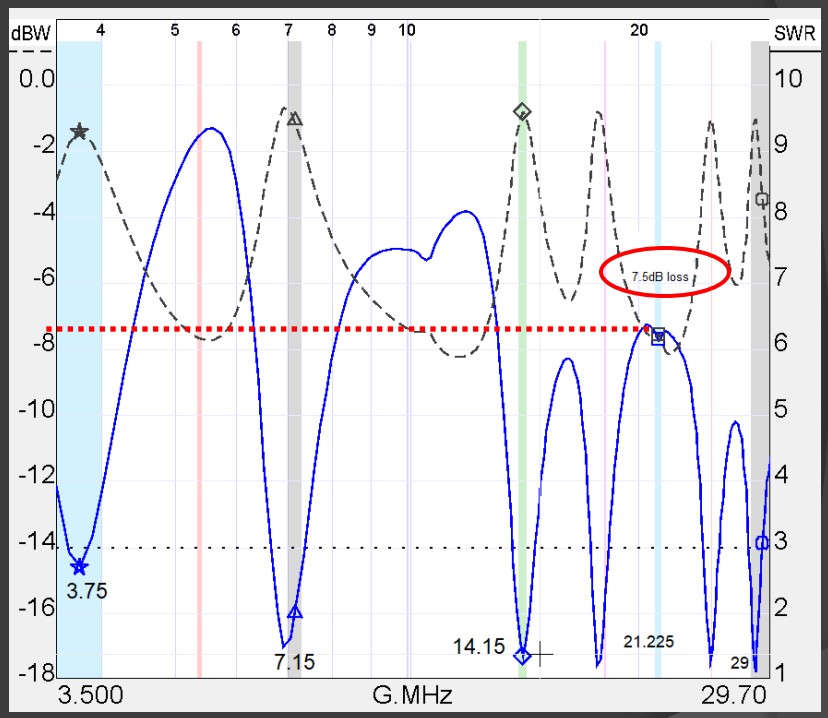


* Cut below 3.5MHz to allow upper bands to line up. Adding C moved 80M resonance up without affecting higher bands. Use a doorknob cap for C or 3 paralleled ceramic high voltage “blue caps” from eBay. Three paralleled 100pF caps will work.
none ~ 3.45 MHz, 500pF ~ 3.6MHz, 300pF ~ 3.7MHz, 100pF ~ 4MHz

80-10m OCFD Simulations 135 ft long 35 ft above ground level (AGL), 300pF at center including 4 to 1 Hybrid balun + 50 ft RG8X

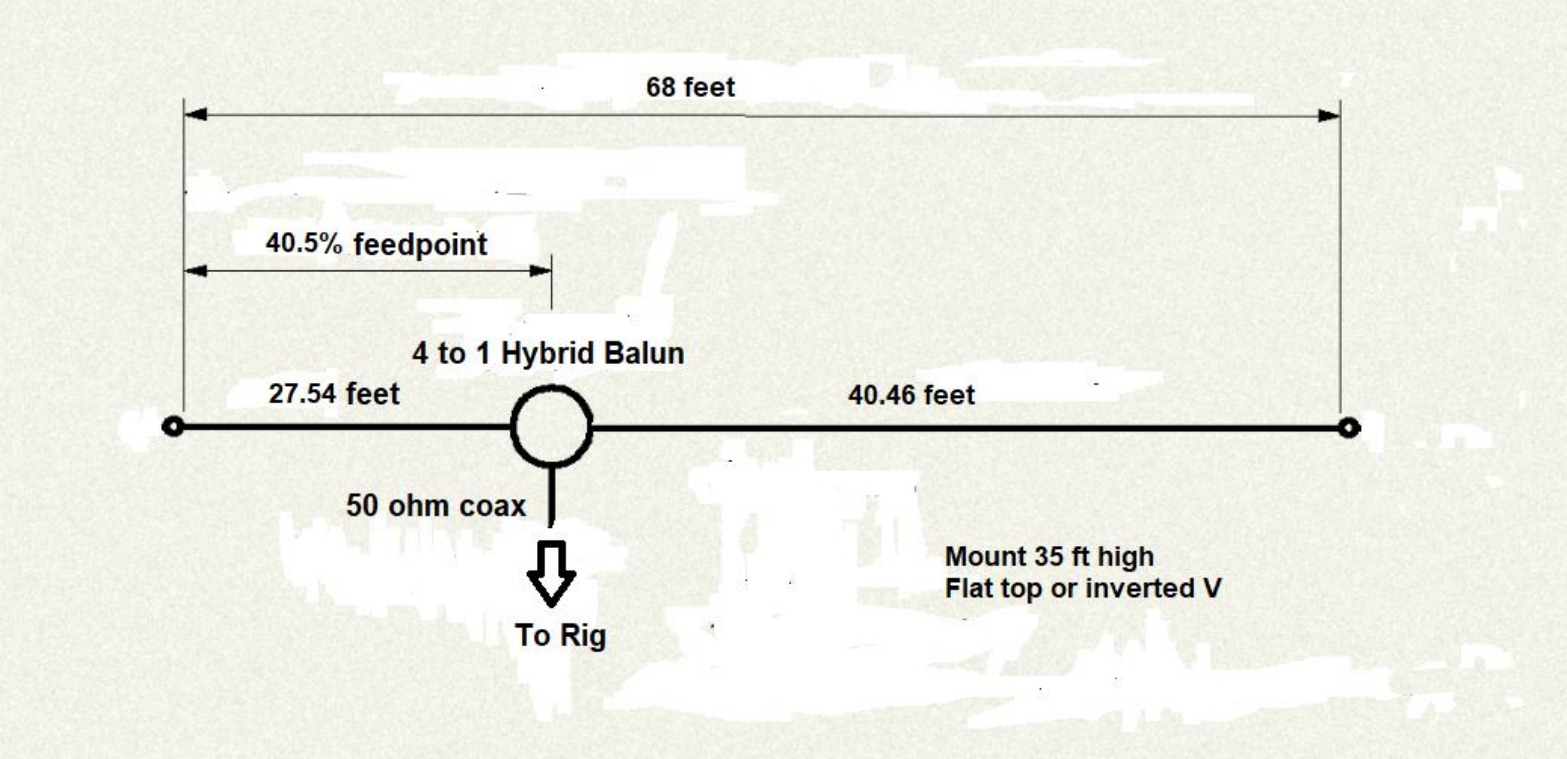


29.7% split
covers 15 meters

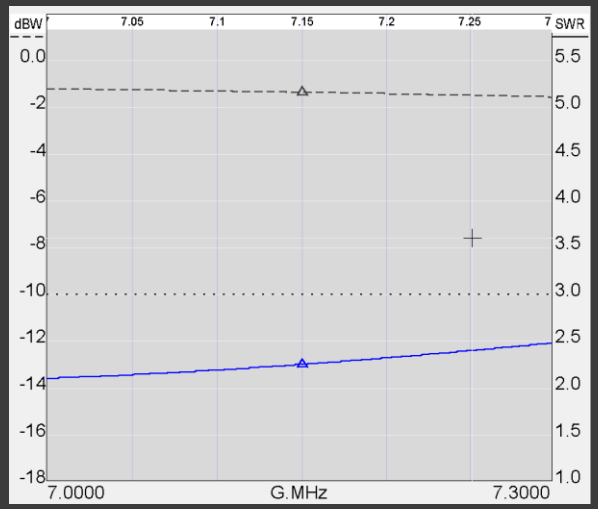


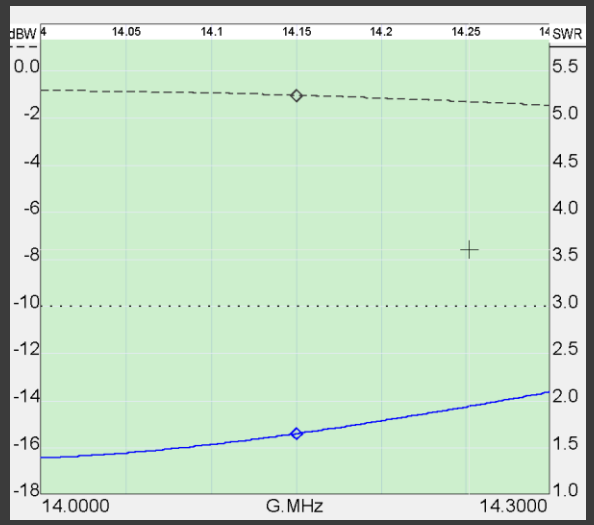
Classic 33.3% split
Somewhat lower VSWRs on many bands; does not cover 15 meters: VSWR at antenna is ~17 to 1 on15 meters! <18% efficient!

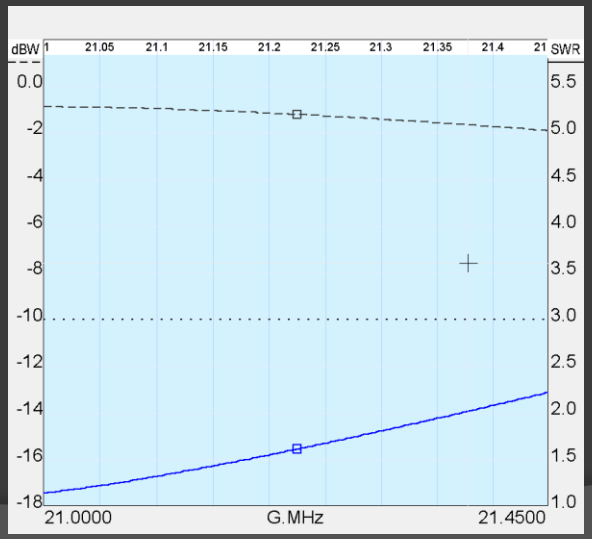
40m-20m-15m-10m low VSWR OCFD
68 ft long, 40.5% feedpoint value from ON4AA recommended configuration

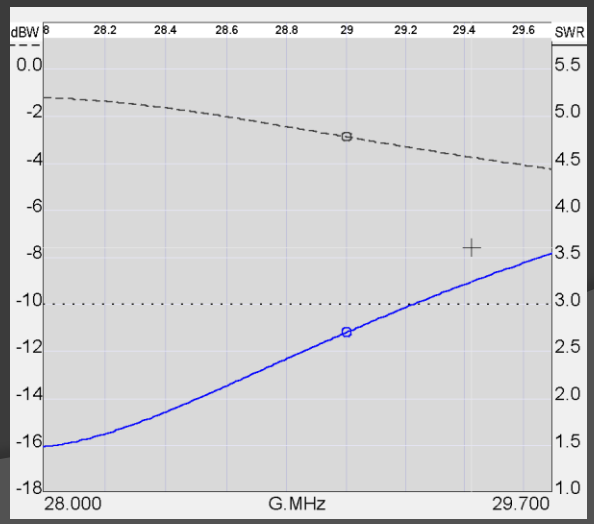


40-10M OCFD VSWRs
Simulated incl. 4:1 hybrid balun +50 ft RG-8X
35 ft above ground level (AGL)









On OCFD Baluns

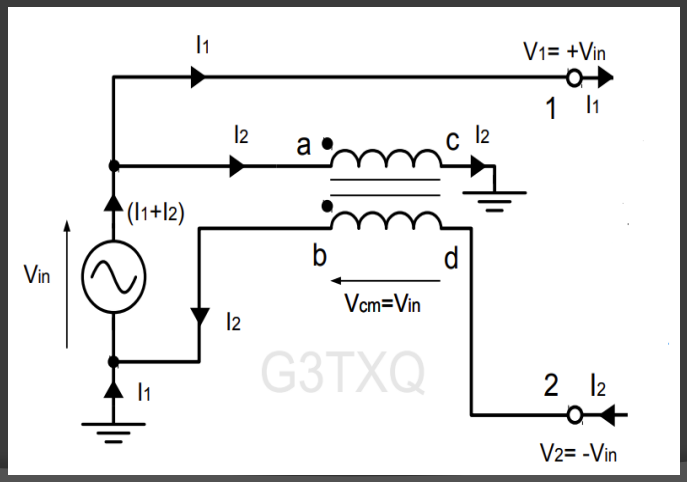
- 4:1 or 6:1 balun are used by different vendors, but my own simulations show that 4:1 usually gives lower VSWRs and are simpler to construct for good performance.
- RF current flowing on the outer surface of the coax needs to be addressed for the asymmetric OCFD. The larger the feedpoint offset, the worse the problem becomes. If not managed, the coax becomes part of the antenna, skewing many of the antenna's characteristics, including resonance points. Worse yet, the characteristics then change with changes in length of coax.
- The larger the feedpoint offset, the larger the common mode problem increases

On OCFD Baluns, cont'd

- A 4:1 Ruthroff balun is a voltage balun and has little choking. It is fine for 4 to 1 impedance matching. Good by itself only for Carolina Windoms
- A 2-core 4:1 Guanella balun provides choking as it is a current balun as well as for impedance matching.
- A Hybrid balun, (combination of 4 to 1 Ruthroff and 1:1 Guanella) has about twice the choking impedance of a 2-core 4:1 Guanella balun for the same style toroid used in both 1:1 and 4:1 Guanellas. It is the recommended balun for an OCFD.
- All 3 types have much wider bandwidths and much lower losses than end fed half wave transformers.

4 to 1 Ruthroff Voltage Balun

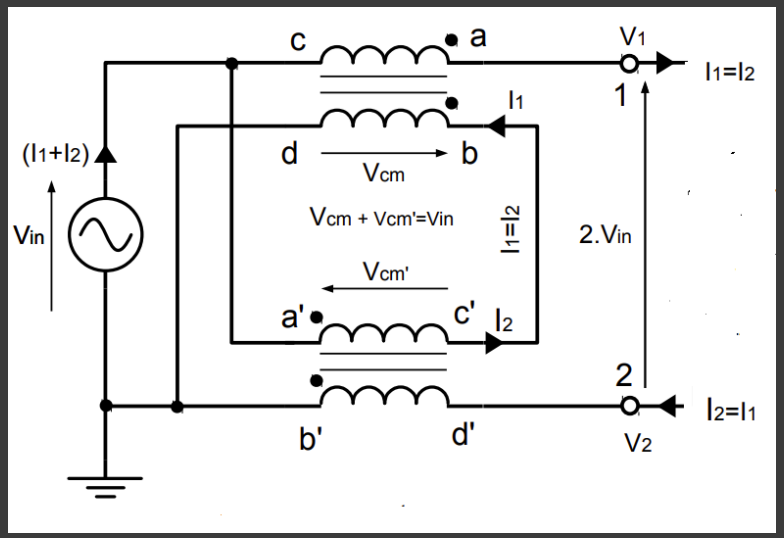
Low power 4:1 Voltage balun Courtesy N4CY



- Simple design needing only a single toroid or toroid stack
- Typically uses parallel wire or twisted pair forming a 100 ohm transmission line and type 61 ferrite for good efficiency
- Good for 4:1 impedance matching
- Wide bandwidth
- Not a good transformer by itself for an OCFD because it has little choking impedance.

- It has little choking impedance because current through points a and c is in opposite direction of current through b and d reducing the effective choking inductance at point 2, and point 1 is a direct connection to the rig with zero choking impedance!

4 to 1 Guanella Current Balun



Inputs in parallel and outputs in series

- Drives balanced load currents despite the load being unbalanced
- Requires 2 toroids
- Typically made with type 61 material for good efficiency or 43 for better choking by itself and 100 ohm parallel or twisted pair transmission line. OK for 40M and above OCFDs
- Common mode choking is only half as much as that of a 1:1 Guanella for the same type toroid and winding
- Claimed Single core 4:1 current baluns don't work – snake oil!

Courtesy N4CY

Each of the FT140-61 cores has 10 bifilar turns of 16 gauge, high build magnet wire with a Teflon Sleeve. A 1 to 1 Guanella balun made from 17 turns of RG-316, on a FT140-43 core can be cascaded with it to make an excellent hybrid balun.

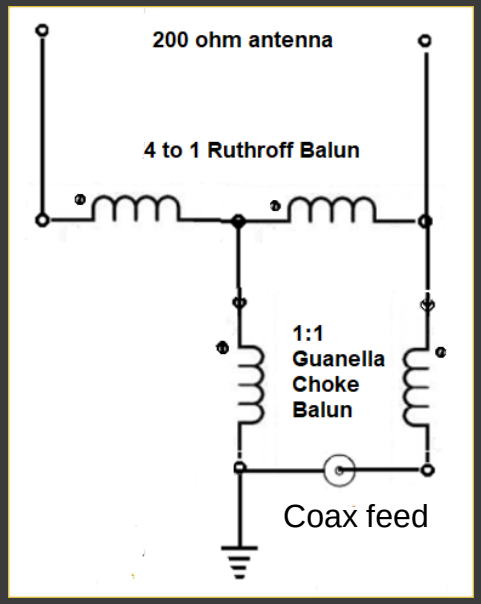
1 to 1 Guanella Current Balun

Courtesy DJ0IP

Note: Cross-wound is optional, primarily for mechanical reasons

- Drives balanced load currents despite the load being unbalanced
- Requires 1 toroid or toroid stack
- Typically made with type 43 material for good choking and 50 ohm coax since both input and output impedance are 50 ohms
- Common mode impedance is ~ twice as much as that of a 4:1 dual core Guanella

4:1 Hybrid Balun (Recommended)

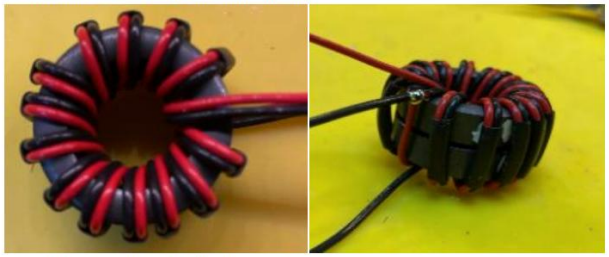


Low power Hybrid Balun Courtesy N4CY

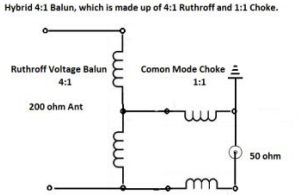
- Cascade of a 4 to 1 Ruthroff Voltage Balun and a 1 to 1 Guanella Balun
- Minimum complexity for a good performing 4 to 1 balun for impedance matching with good choking
- The 1:1 Guanella balun exhibits about twice the common-mode choking impedance of a 4:1 Guanella balun constructed from two chokes identical to the 1:1 Guanella balun element used here

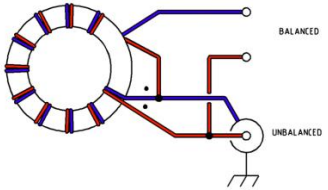
Field Day 4:1 Hybrid Balun courtesy Everett Sharp N4CY

The balun is built with 2- FT114-61 stacked and glued together toroids for the 4:1 Voltage (Ruthroff) Balun. It is wound with 14 bifilar turns of #20 high build Magnet wire with a Red and Black Teflon Sleeve 28" long, as shown in the below picture and schematic.



Hybrid 4:1 Balun, which is made up of 4:1 Ruthroff and 1:1 Choke.





The Hybrid Balun is housed inside of 1 ¼" PVC pipe drain pipe. The antenna supports are 3/16" Stainless steel eyebolts. The common mode choke is wound with a 36" length of RG-316 coax on 2 stacked FT114-43 toroids glued together and wound with 17 turns. The SO239 connector is tapped with 8-32 threads. There is ½" thick polyethylene spacer between the 4:1 balun and the Common Mode Choke.

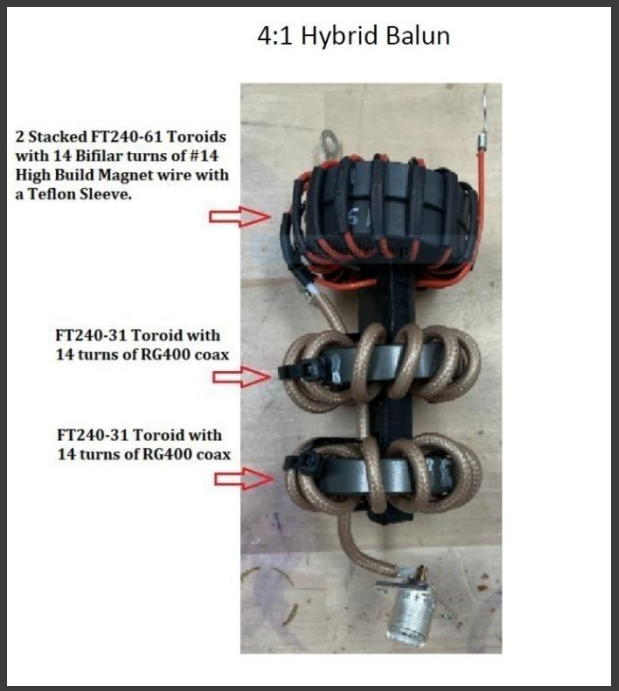
In the Files section of the groups.io OCFD group

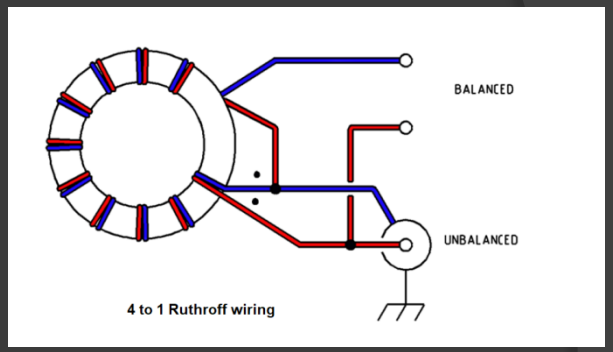
K1RF recommended low power hybrid balun (mod of N4CY balun)

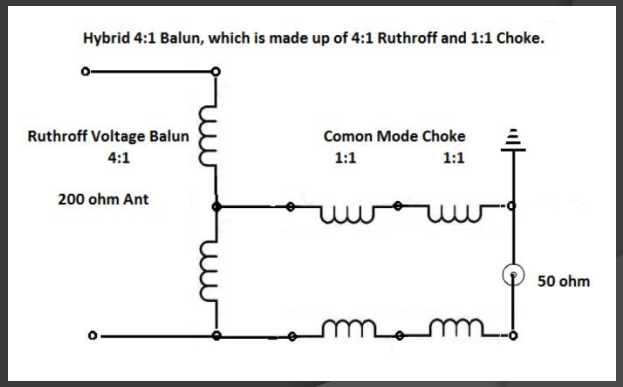
- Can take 100 watts continuous for digital modes:
- Ruthroff balun:
  - Fair Rite P/N 5961001201 (tall version of FT114-61) ($2.76 qty 1, $2.38 qty 10 at Mouser)14 bilifar or twisted pair turns #20 awg, teflon insulated
- Guanella Balun
  - Fair Rite P/N 5943001201 (Tall version of FT114-43) ($1.78 qty 1, $1.19 qty 10) 36” length of RG-316, 17 turns

High Power 4:1 Hybrid Balun

- The Mother of All Baluns (MOAB) courtesy Everett Sharp N4CY
- Up to 1500 watts digital modes







Note: 2 cascaded Guanella cores doubles impedance and spreads power over two cores reducing power dissipation in each by a factor of 4.
For up to 600 watts digital modes, can use a single FT240-43 with 17T RG-400 for the1:1 Guanella current balun instead of the two FT240-31s with 14 turns RG-400.

In Files section of Groups.io OCFD group

On Homebrew baluns

- You will know that you have a good balun with no false promises by vendors who are either scammers or just don’t understand the application
- You will reduce your cost
- You will be proud of what you built
- Few vendors know how to make a good hybrid balun with good choking impedance, especially on 80 meters.

Possible premium components for an 80-40-20-15-10 meter high or low power OCFD

Hybrid 4:1 Balun + 1:1 Current Balun in one enclosure, 1.8-61 MHz, 1.5/5KW PEP - Loop, OCF Antennas

☆☆☆☆☆

No reviews yet | Ask question

Store / Antenna Products / Impedance Transformers (<1:1, 1:1, >1:1) / Hybrid (NN:1 + 1:1) Transformers

SKU CB-4-1-1500EB

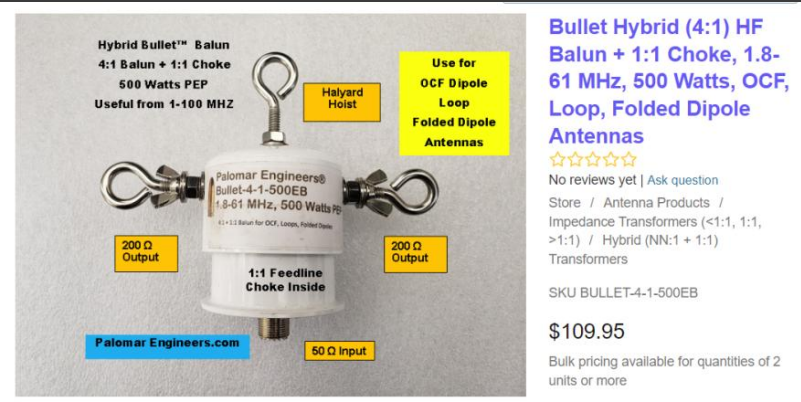
$139.95

ON SALE

~~$189.95~~ Save 26%

Bulk pricing available for quantities of 2 units or more

Total cost $182.93 for an 80 meter high power OCFD or use a low power 4:1 hybrid balun from Palomar for lower cost and lighter weight for $152.93 or even cheaper with your own wire



Bullet Hybrid (4:1) HF Balun + 1:1 Choke, 1.8-61 MHz, 500 Watts, OCF, Loop, Folded Dipole Antennas

☆☆☆☆☆

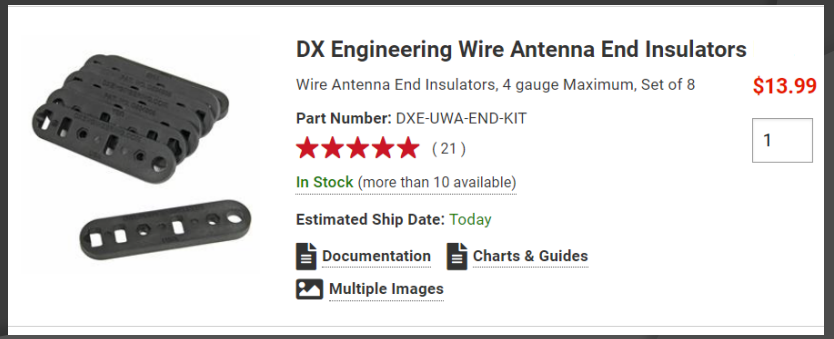
No reviews yet | Ask question

Store / Antenna Products / Impedance Transformers (<1:1, 1:1, >1:1) / Hybrid (NN:1 + 1:1) Transformers

SKU BULLET-4-1-500EB

$109.95

Bulk pricing available for quantities of 2 units or more



+Extra end insulators for other antennas!

Notes on Balun Designs 4116 High Power Hybrid Balun

- $103.95
- Rated 1.5 - 54MHz 3kW
- Good quality components
- According to DJ0IP, the 4116 has sufficient common mode inpedance (CMI) for a 40M OCFD but falls a little short on 80M and way short on 160M. My own simulation shows inadequate CMI on 80 meters but works well on 40.
- For 80m operation, low CMI can be mitigated with either ferrite beads or a 1:1 Guanella balun at the coax feedpoint.
- Inadequate CMI is the primary cause of OCFD balun overheating. Most important on lowest band of operation.
- DJ0IP recommended to a few people for 80M operation with the 4116 is to remove the choke and rewind it with as many turns of coax that fit. Then it will work just fine on 80m and still work on 40m.

Recommended OCFD antennas

- 807-XX sold by Spiderbeam (U.S. rep Vibroplex) $249 for heavy Duty version -HD), $129 for lightweight version (-L), 600W with 30M at reduced power.
  - 8 Bands: 80/40/30/20/17/15/12/10/6m plus 30M (but high VSWR and works at reduced power and needs antenna tuner.) 40M OCFD also available.
  - 40M version: 404-UL covers 40/20/17/15/12/10/6m
  - Designed by Rick Westerman, DJ0IP for Spiderbeam. Review here and here for the 807-XX Review for the 404-UL here (begins on P52)
- Palomar Engineers OCFD. 8 bands: 80-40-20-17-15-12-10-6. 500/1.5KW/5KW $169.95, $199.95, $239.95 Review here.

End Fed Half Wave vs. Off center fed dipole

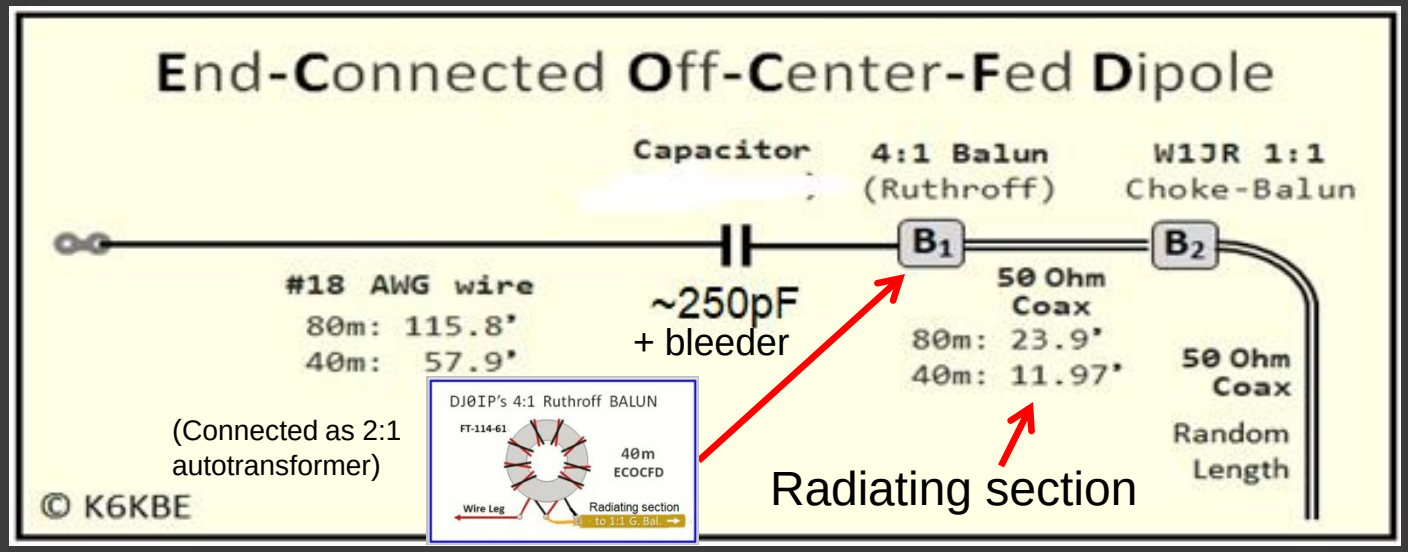
- Antenna patterns are not very different
  - An EFHW is just a very offset version of an OCFD
- OFCD hybrid baluns are much more efficient than EFHW transformers
  - They are based on transmission line transformers with low turns ratios
  - Smaller and cheaper transformer components for a given power level.
  - Very easy to make high power OCFD hybrid baluns vs. high power EFHW transformers

UNUSUAL OCFDS

The End-Connected OCFD (ECOCFD)

- In ~2010 the "City Windom" was introduced by Evgeniy Slodkevich, UA3AHM . The current evolution of the multi-band ECOCFD design was inspired by Robert Brown, M0RZF for 40 meters and David Cutter, G3UNA for 40/80 meters. Much additional work by Leland M. Farrer (Mel) K6KBE
- It has heritage back to the sleeve dipole commonly used in VHF/UHF antennas. Here is the twist, the antenna is end fed with coax to a 1:1 choke instead of a separate sleeve. This effectively isolates the shield of the "radiating coax" section to RF and makes it a radiating sleeve! See QST magazine, May 2022 by Phil Salas, AD5X, "An End Fed Center Fed 20M portable antenna" for the sleeve concept.

ECOCFD Concept

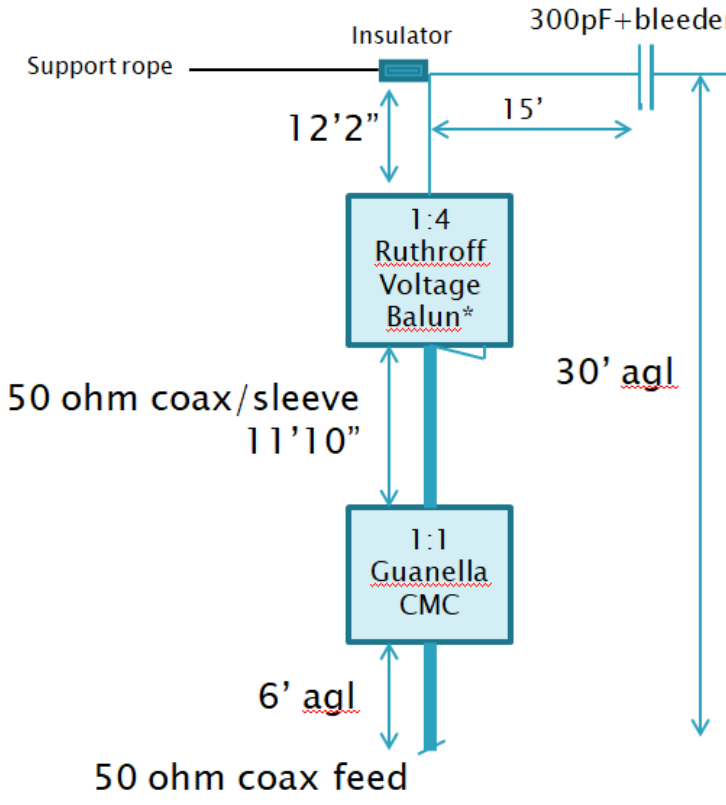


Dwg courtesy K6KBE

- Can be used as a flat top, inverted L, inverted V, sloper, etc. Baluns have much lower losses than typical EFHW balun. Only needs 2 attachment points for some configurations such as from a building window. More amenable to high power operation with efficient baluns
- I estimate several dozen 80 and 40 meter versions built
- Planned to be used in the IOTA MM0UKI – IOTA . **See the amazing talk here entitled "June 23 Rockall DX Expedition"**

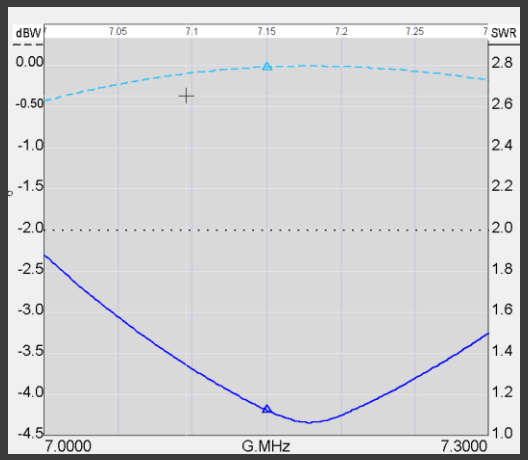
K1RF Simulated Inverted L Version ECOCFD

Antenna Dimensions

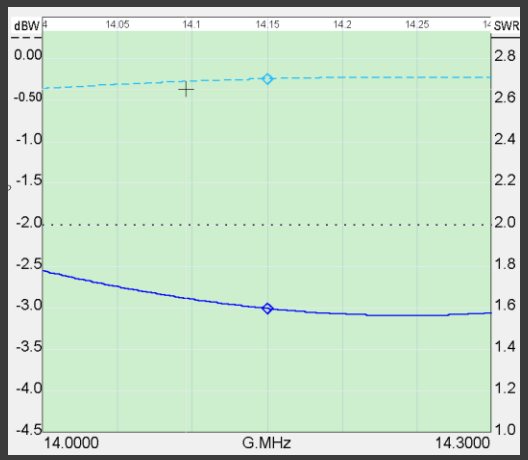


Notes:
1. Dimensions do not include allowances for baluns so horizontal wire may need adjusting
2. Computation of effective feed point position:
- short segment = 11'10"
- Long segment = 12'2" + 45'7" = 57.75"
- Effective Feed point position = 11.833/57.75 = 20.49% ~ 20.5%

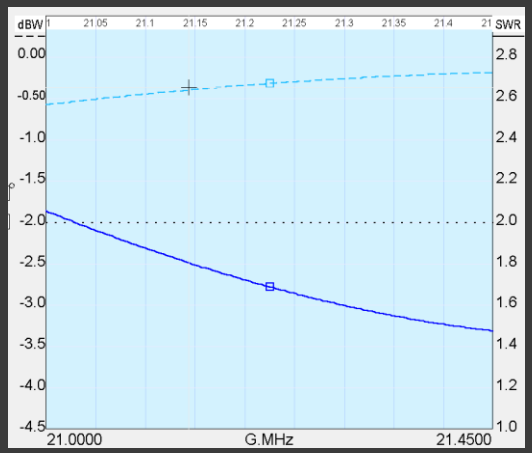
K1RF 40M ECOCFD Simulated VSWRs including the baluns + 50 ft RG8X coax



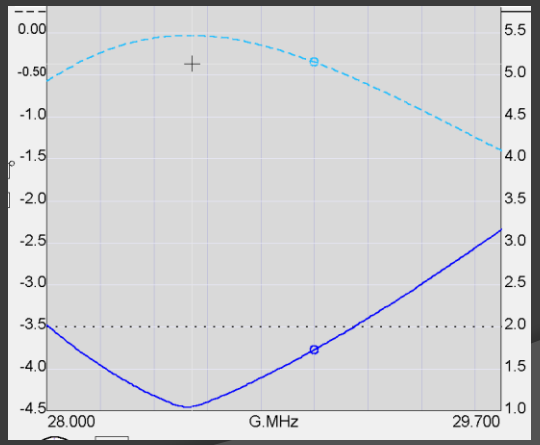
40M



20M



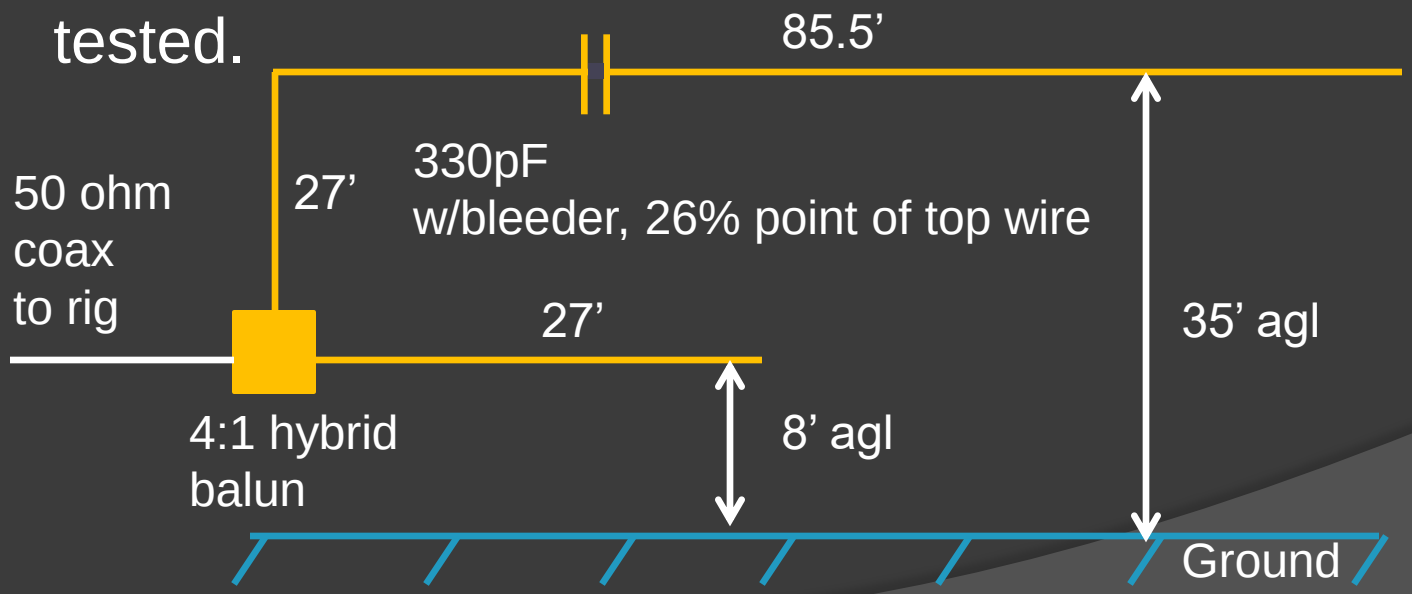
15M



10M

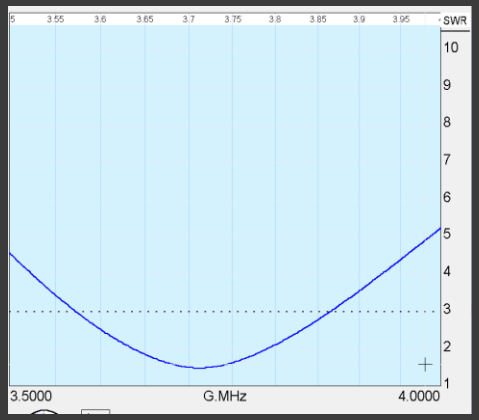
80-40-30-20-15-10 Experimental Compact OCFD

- Concept from W8JI. Good efficiency, no coils or traps, low loss hybrid balun
- Brought to the group's attention by Rick Westerman DJ0IP
- Modeled and refined by K1RF – not yet built or tested.

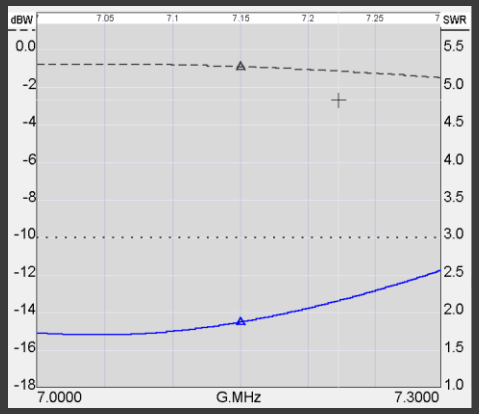


Recommended antenna wire: Wireman 532 #18AWG copper clad steel

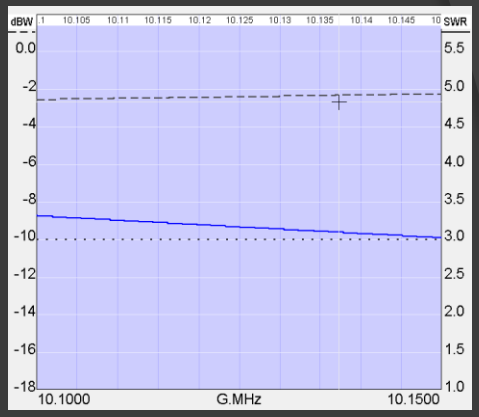
Compact 80M OCFD Simulated VSWR Plots w/hybrid balun, 50 ft RG8X (not yet optimized)



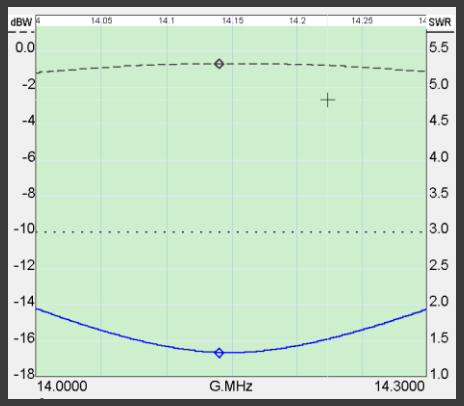
80M



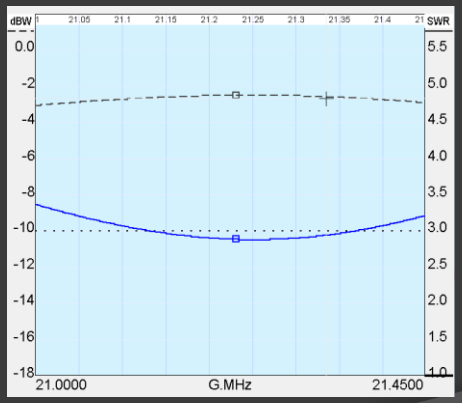
40M



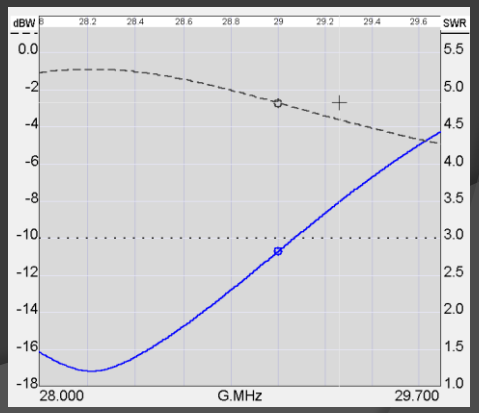
30M



20M



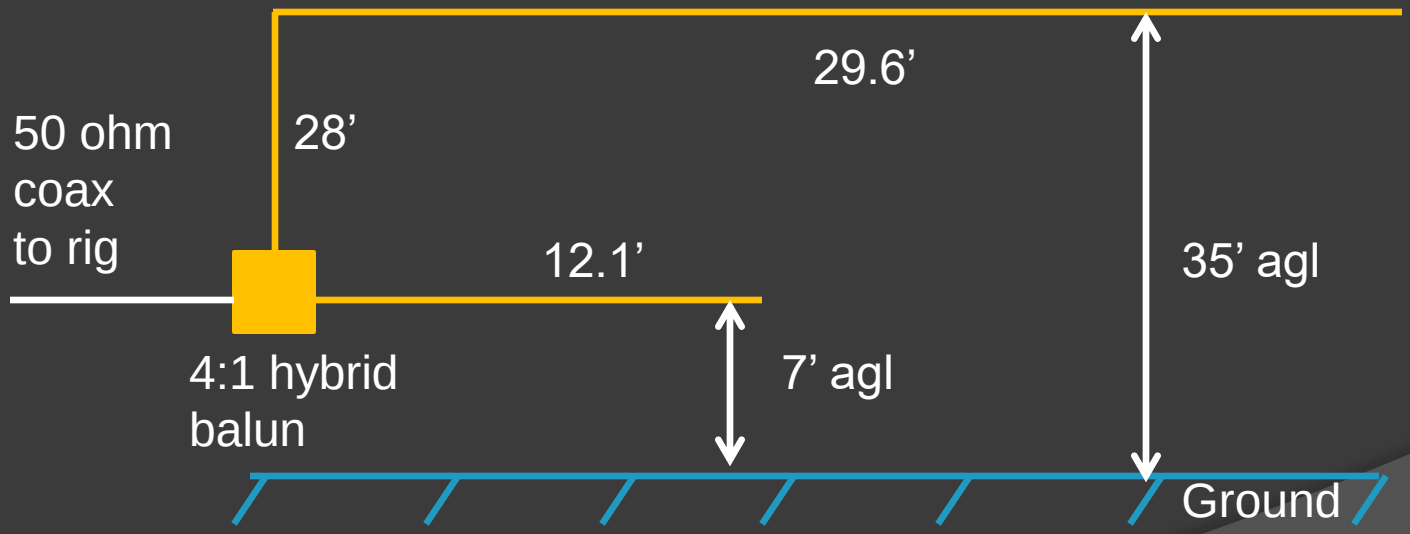
15M



10M

40-20-15-10m Experimental Compact OCFD

- Modeled by K1RF, not yet built or tested.
- Just wire and a hybrid balun. No additional capacitors, inductors, traps. Very efficient, good antenna patterns. 20M approaches a dipole in gain.
- Much more efficient than a vertical. No ground radials
  Radiation on all bands primarily broadside to the top wire.



Also works fine with vertical wire 23’ high and top horizontal wire 34.6’ long for a height of 30’ above ground level. Recommended antenna wire: Wireman 532 #18AWG copper clad steel

Resources

- Multiband HF Center-Loaded Off-Center-Fed Dipoles Serge Stroobandt, ON4AA.
- Off-Center Fed Dipole Antennas (Windom) – DJ0IP
- Field Day OCF Antenna Project
  N4CY in groups.io OCFD group
- Balun BS in the DJ01P folder in the files section of the groups.io OCFD group
  - Rick Westerman, DJ0IP A must read!!!
- The Future Of OCFD: "Current Sums Antenna" (CSA)
  - Rick Westerman, DJ01P
- Affect of End Effect on OCFDs
  -Rick Westerman DJ0IP
- Baluns
  -Karinya.net
- A compact 4:1 Hybrid Balun for use on a OCF Antenna in groups.io OCFD group
  -Everett Sharp N4CY
- Why the preference for Guanella 1:1 current baluns for HF wire antennas
  -Owen Duffy
- Windom Off Center Fed
  -W8JI
  Component Sources Rick Westerman, DJ0IP

  K8BA Modeled feedpoint data files courtesy DJ01P

  DIY ECODFD by Mel Farrer , K6KBE in groups.io/OCFD group

  "An end fed center fed 20 meter portable antenna QST Magazine May 2022 pp 30-32"
  - Phil Salas, AD6X