

Introduction to
**Off-Center Fed Dipole
Antennas
(OCFD)**

Also know as
Windom

My Goal

- Need 80m & 40m antennas for CQP (my favorite HF contest)
- Contest bands are 80m, 40m, 20m, 15m, 10m
- Need to repair my previous 80m OCFD
- Need to be able to handle 1000 watts
- Both antennas should be up $\frac{1}{4}$ wavelength or slightly more for NVIS into California
- Additional bands are a huge plus as long as primary bands work well
- 40m antenna is a nice size for many other uses.

Key Items:

- 1:1 SWR is NOT important
 - the dip at resonance is important
- The correct balun MUST be used
 - Dual-core Guanella
- A Common Mode Choke is almost always necessary (why leave it out). 1:1 Guanella
- Should not be tuned on the lowest frequency band
- The bands are not strictly harmonically related

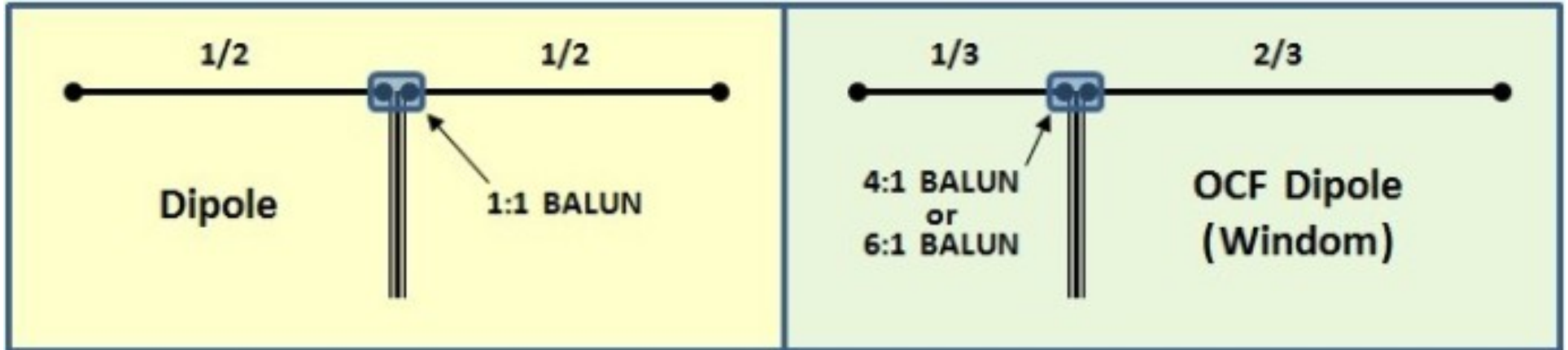
I'm not an expert



A single Illuminator. Notice the balun attached to the side of the post.

- Anything for an antenna will work
- Better antennas improve:
 - Signal Strength
 - Band Openings
 - Number of contacts
 - Enjoyment
- The OCFD is not the best antenna for everyone, or every time
- There is no best antenna

What is Off-Center Fed?



- I thought the antenna was simple until I started learning enough to repair my previous antenna

OCFD Antennas have a bad Reputation

- Don't work all bands as often advertised
 - Marketing driven
- Do not have more gain than a dipole
- Squirrely
- Need a tuner to operate some bands
 - tells you something isn't quite right
 - Might not work properly on those bands that “need a tuner”
- RF in the shack
- Cook supplied Baluns
- [Carolina Windom
 - Feedline designed to radiate] not normal

Loren Windom (1905 – 1988)

Windom antenna was an off-center-fed resonant dipole with a single-wire feedline of any length-fed against earth and intended to be used on one frequency only. Its main advantages were its single-wire feedline —would not be of any value anymore today because of propensity to cause RFI— and the fact that it could be easily matched to a valve amplifier.

Why a OCFD?

- I wanted an antenna capable of several bands
 - Don't we all?
- A wire antenna is easier for temporary locations
- A wire antenna is almost a necessity for lower bands
- The OCFD advertisements seemed to promise that.

OCFD CANNOT Work All Bands

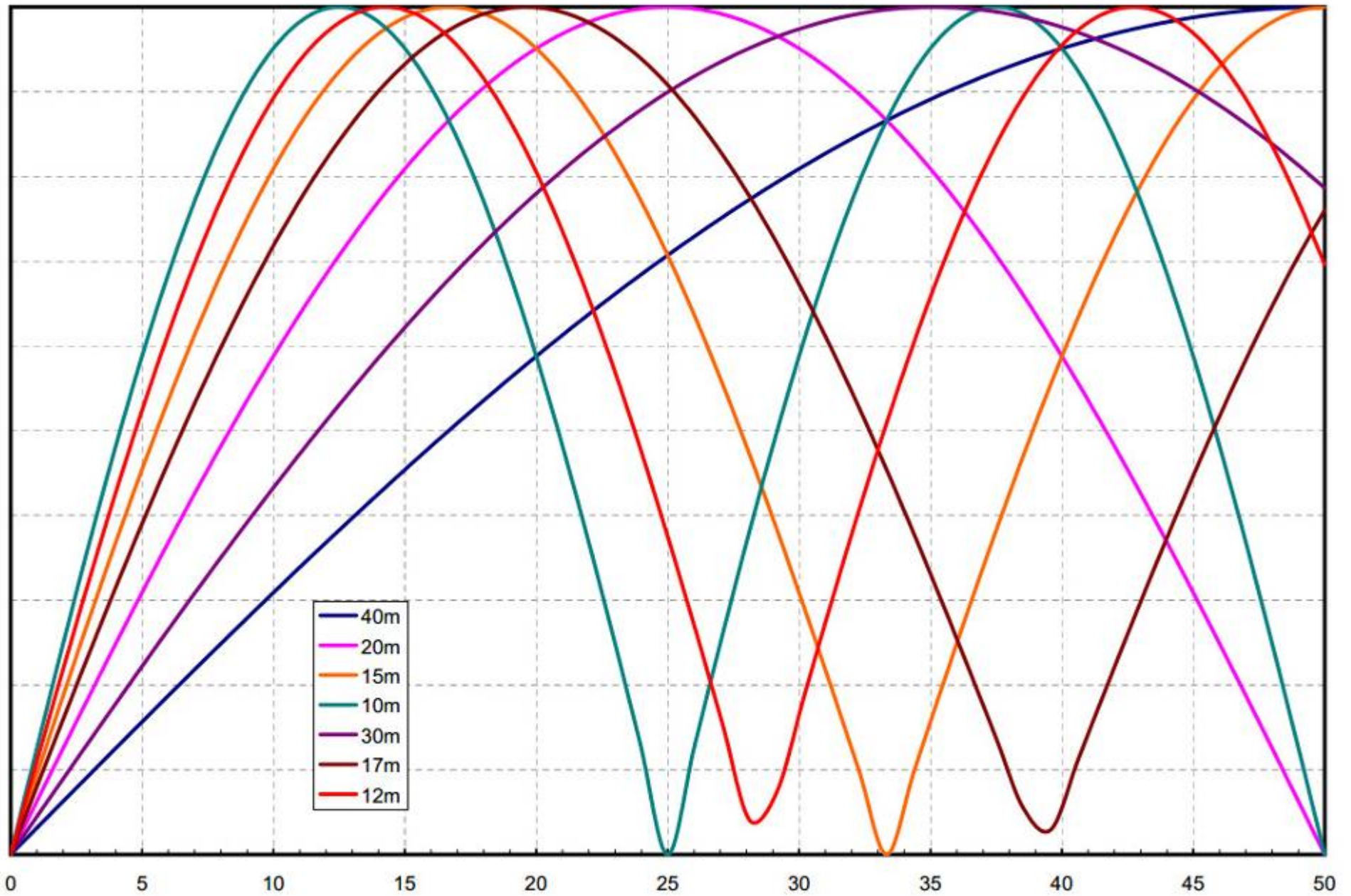
- Only operates properly on designed bands
 - Baluns & tuners can be easily damaged even on resonant bands when not used properly!
- Any non-designed band is the same as tuning a random-length wire
- Radiation pattern is unpredictable for non-resonant bands
- They can work most bands IF you know the limitations, and build and install it properly.

A Dipole Antenna Can Be Fed at Any Point

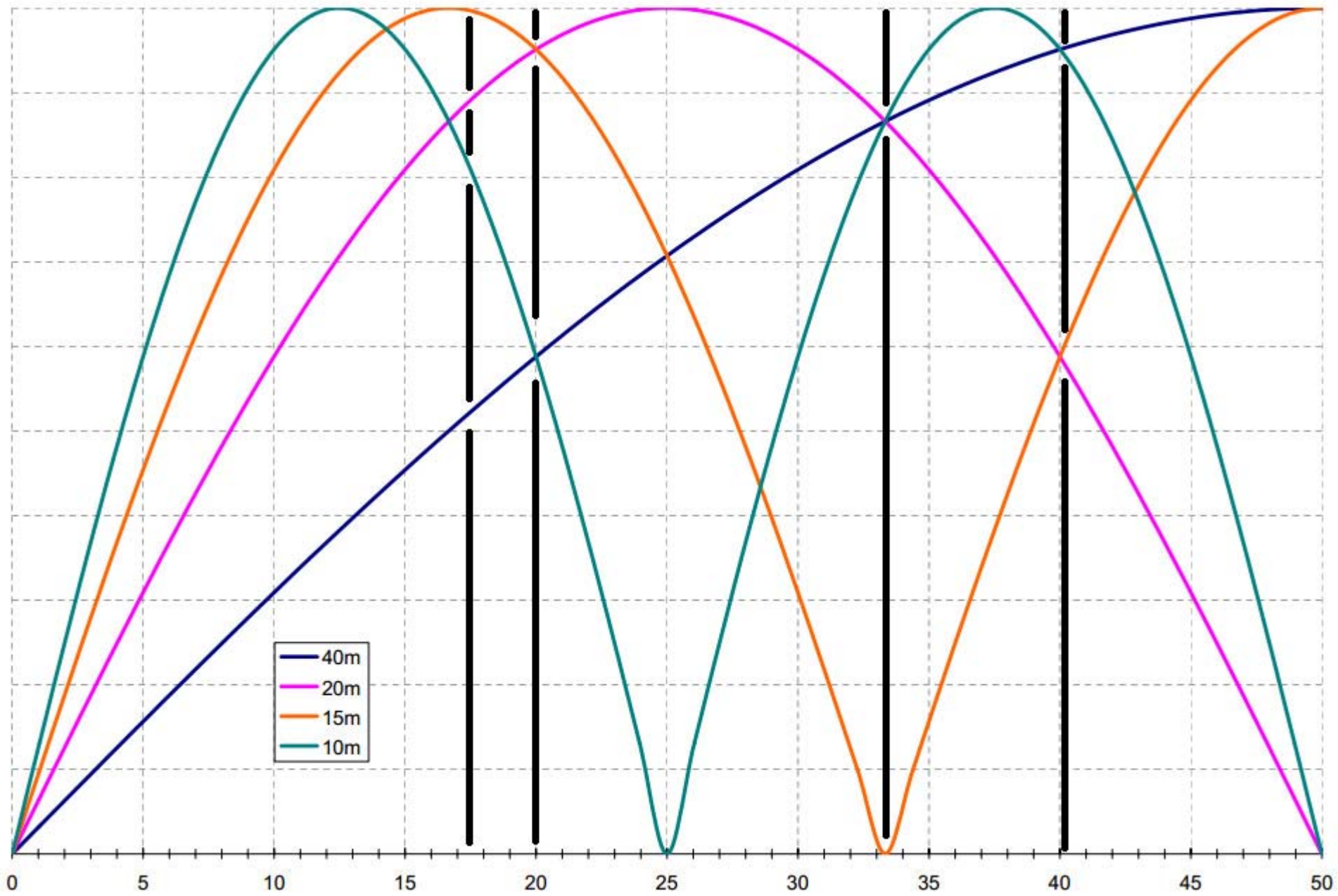
- Center
- End Fed – a J-Pole is an example
- Center has low Impedance ~ 50 ohm
- Ends have high impedance ~ 4000 ohm
- Impedance between center and ends is somewhere between!
- Almost any antenna is resonant on multiple bands, just find the spot to feed it.

Let's Build One

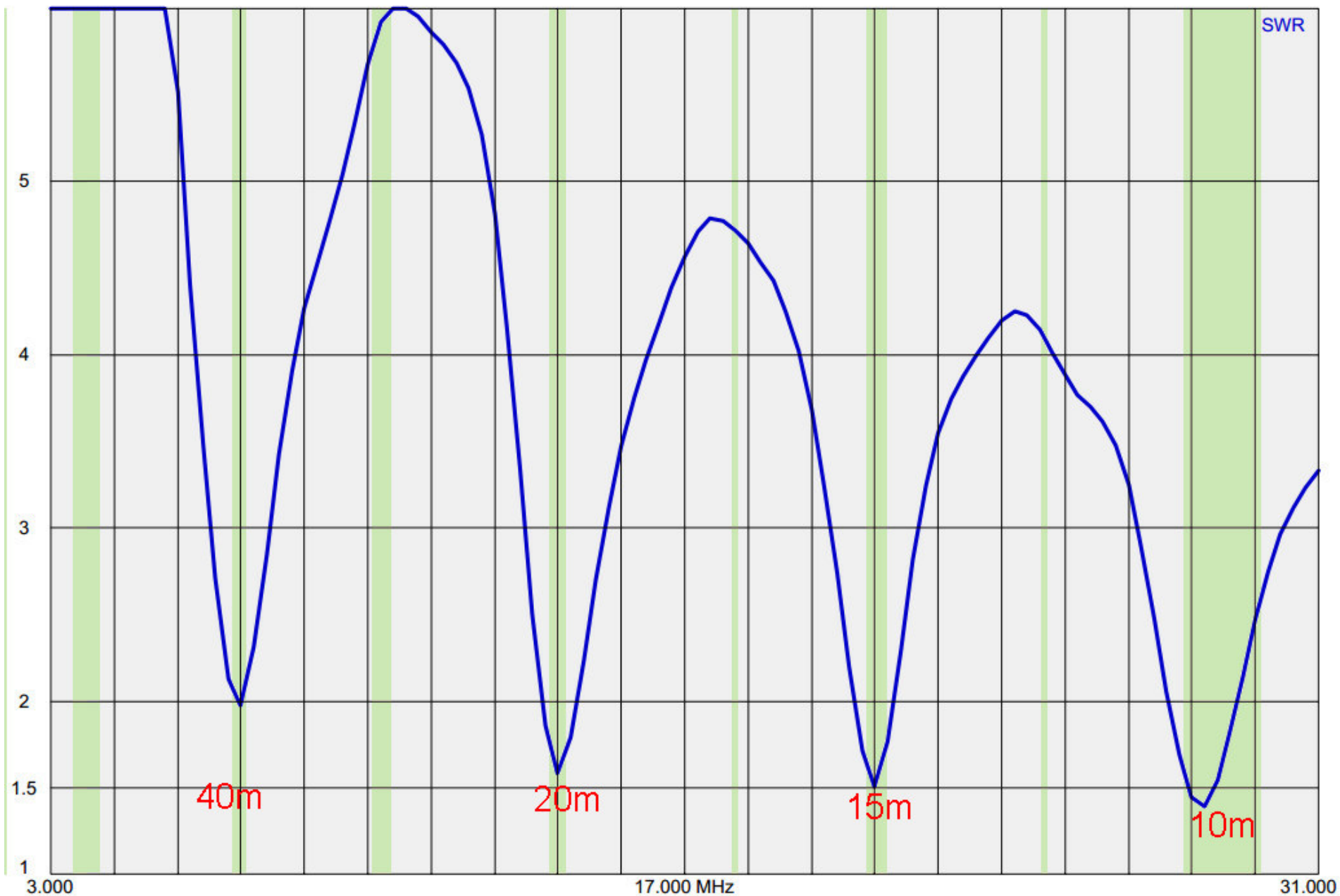
- The usual split (ratio) is 33% - 67%
- The usual Balun is 4:1
 - Off-center has a higher feed impedance and 200 to 300 ohms is a closer match than 50 ohm.
- 33% split is a high impedance point for 15m
 - Many manufacturers say you can use the antenna on 15m with a tuner or adjusting feed line length.
 - **DON'T DO THIS!**
- There are other splits that are high impedance points for other bands
 - Be aware of the limits of your antenna



All bands plotted as if current with a 40m dipole



Looking for mid-point currents for the desired bands - I picked 40.2% for my 40m OCFD

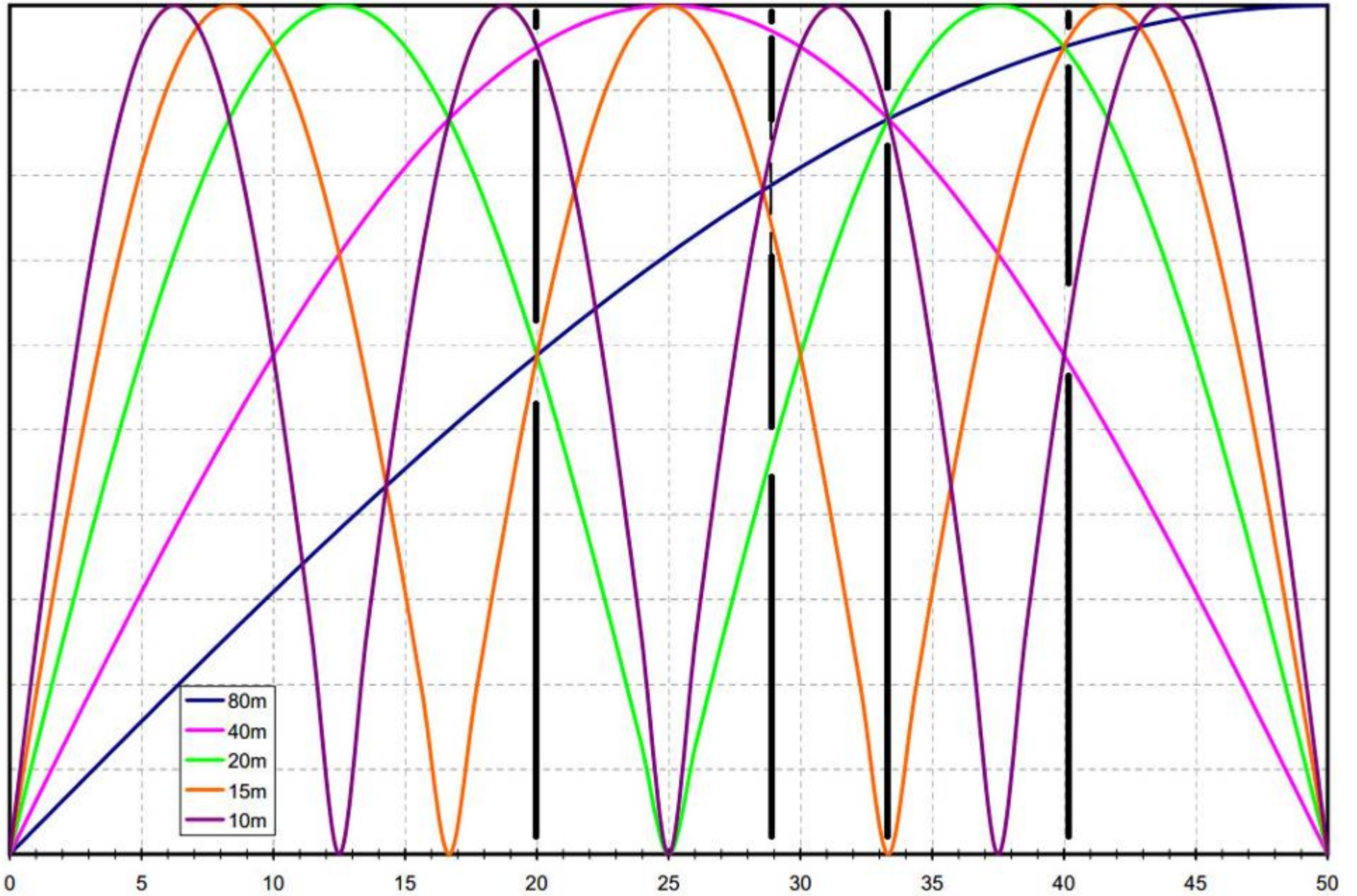


40.2% split Goal: 40m, 20m, 15m, 10m resonant

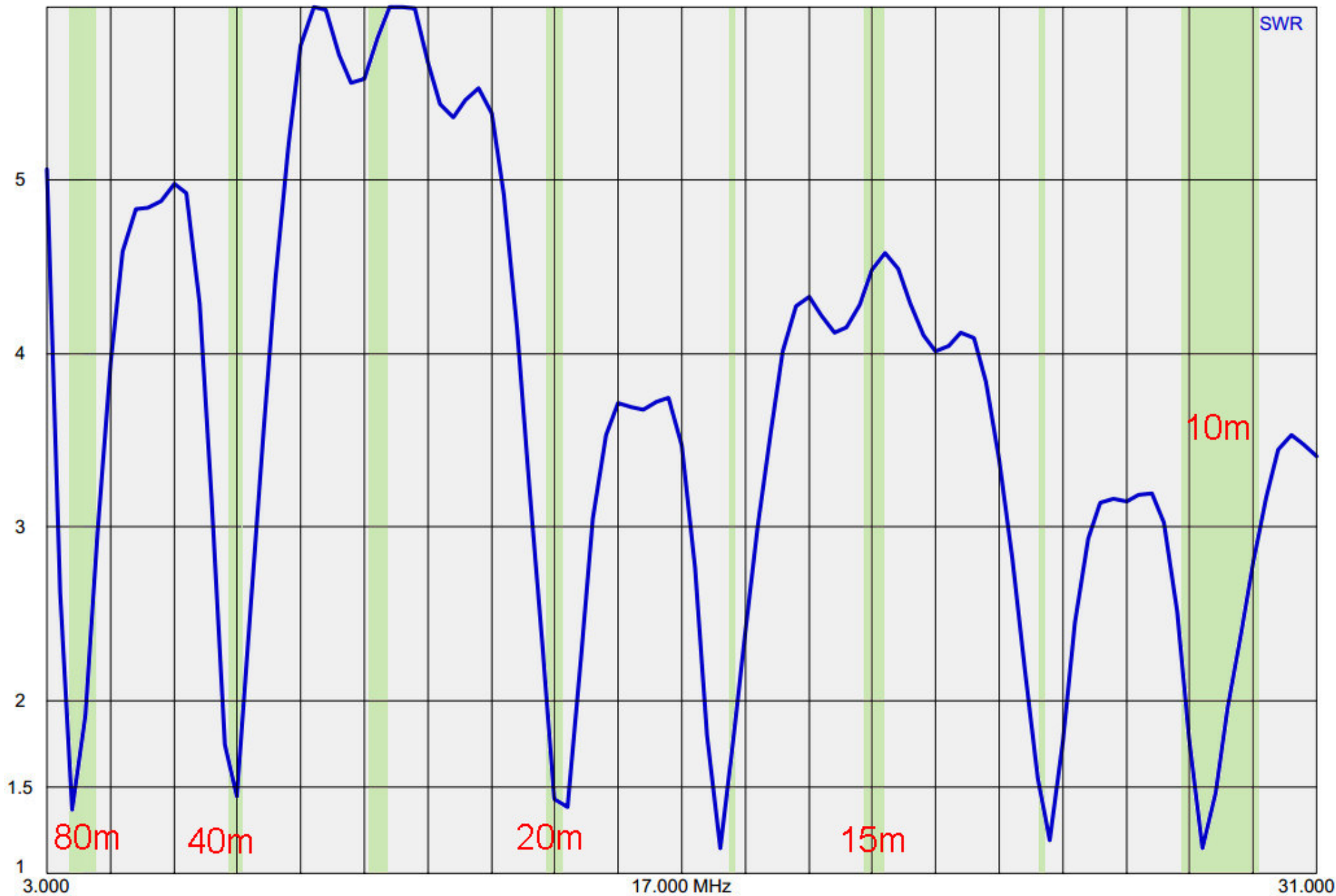
Some reasons nothing is perfect

- End Effects
- Height above earth in proportion of wavelengths
- Bands not truly harmonically related

3.500	3.600	3.750	4.000
7.000	7.200	7.500	8.000
10.500	10.800	11.250	12.000
14.000	14.400	15.000	16.000
17.500	18.000	18.750	20.000
21.000	21.600	22.500	24.000
24.500	25.200	26.250	28.000
28.000	28.800	30.000	32.000



Picked 33.3%



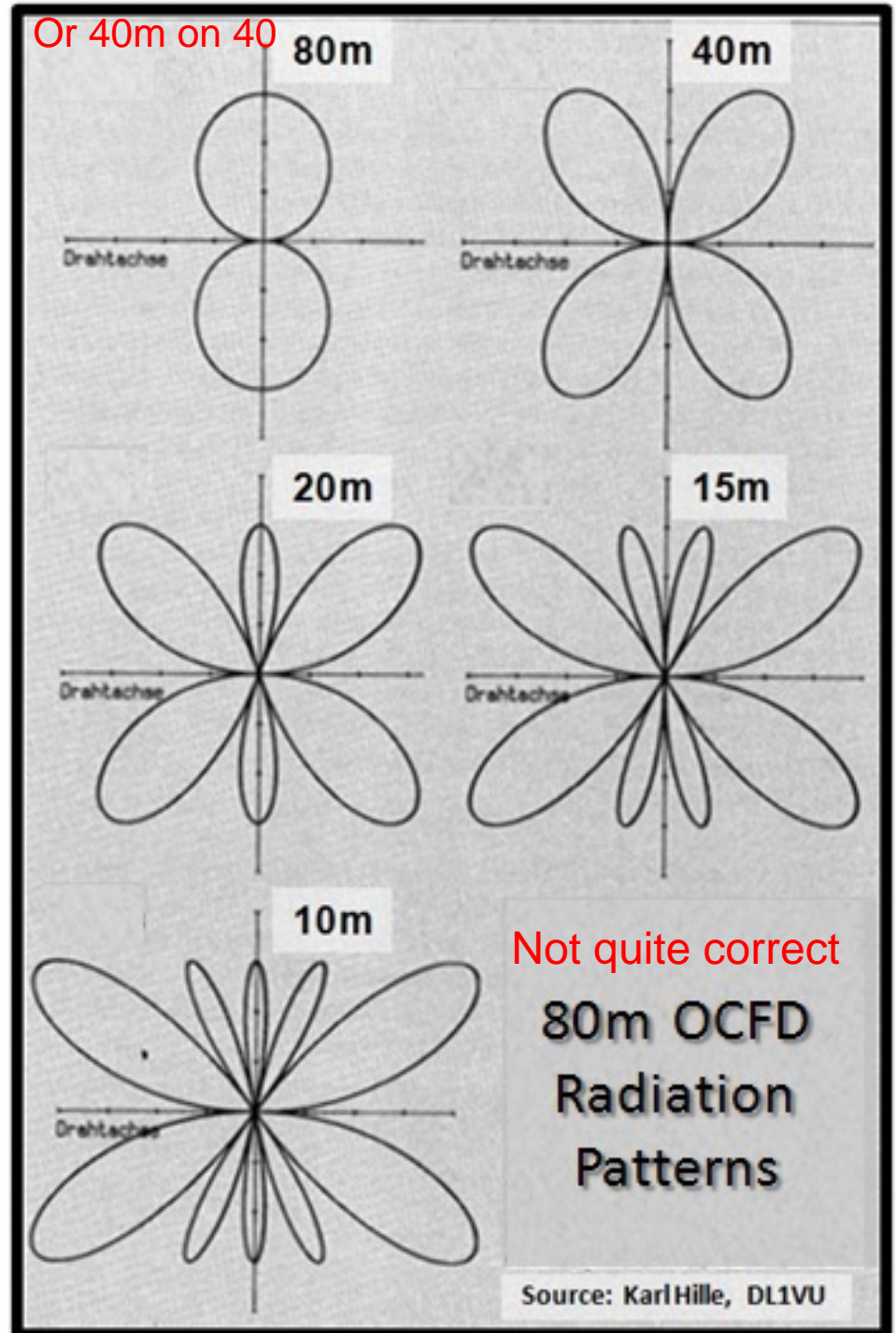
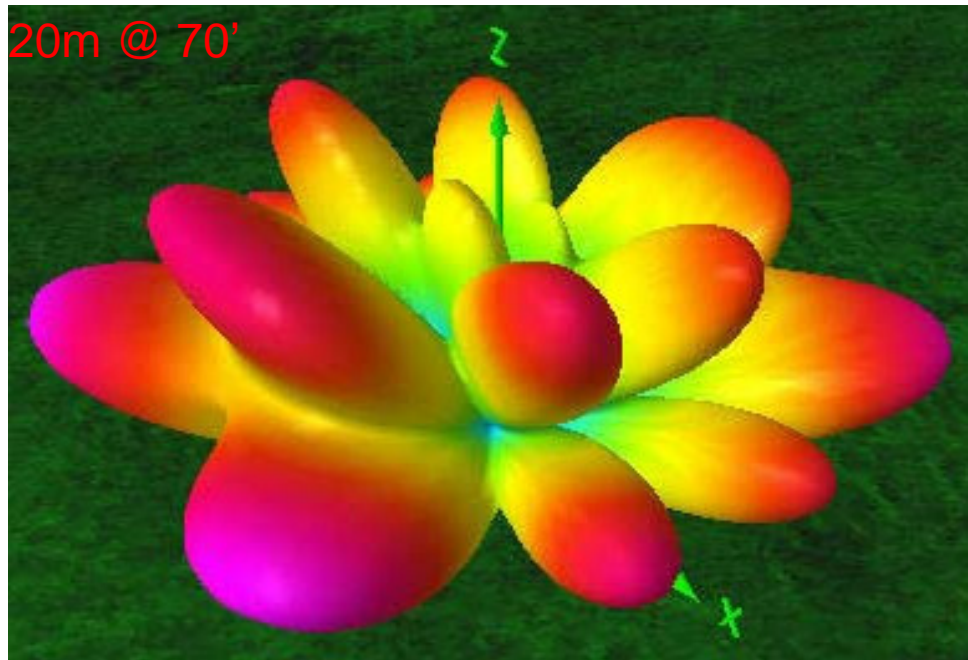
Goal: 80m, 40m, 20m, 10m

The following split ratio relates to a 80m OCF dipole (~135 feet total length)

- **50%**, lose 40m, 20m, 15m, and 10m bands (high impedance), but *should* do very well on 80m, 30m, 17m, 12m, and 6m bands. This is a normal dipole, where you only get odd-harmonics. "Lose," means the antenna feedpoint will have very high impedance.
- **41.6%**, you don't lose any ham band (80m-6m). Although the SWR will be a little higher on 17m and 12m.
- **36%**, you don't lose any ham band (80m-6m). Although the SWR will be a little higher on 30m.
- **33%** (1/3:2/3) you lose 30m, 15m, and 6m bands (high impedance).
- **30%**, you don't lose any ham band (80m-6m). Although the SWR will be a little higher on 12m.
- **28.89%**, you lose 12m band (high impedance).
- **25%**, you lose 20m and 10m bands (high impedance).
- **20%** (20/80), you lose 17m and 6m bands (high impedance).
- **16.6%**, you lose 15m band (high impedance).
- **8.9%**, you don't lose any ham band (80m-6m) (no in ham band sine nulls). Although the SWR will be higher on 80m.
- **No "best spot", just different bands from different splits.**

Multiple half-wavelengths produce multiple radiation lobes

- Each band is at a different Wavelength-Related Height
- Feed Impedance changes with relative height
- Radiation angle changes with relative height
- With 2 OCFD antennas, 40m will have different patterns



Imbalance – Cause of squirrely

- Imbalance can also be caused by situations where the two sides of the antenna are not symmetrical: Coupling to nearby objects, the tilt relative to the ground or slight differences in the lengths of the antenna halves. Another cause of imbalance current is induction. If the feed line is not exactly placed at a right angle to the antenna, a net current is induced into it by the antenna field. This current is called Common Mode Current.
- If there is common mode current with transmit, your feedline is also acting as part of your receive antenna.



Imbalance is difficult to avoid, and will affect all antennas. With an OCFD, the overall imbalances are compounded by the off-center feedpoint. This adds to the squirrely nature of the antenna, but can be overcome by using proper components and making an effort at best placement.

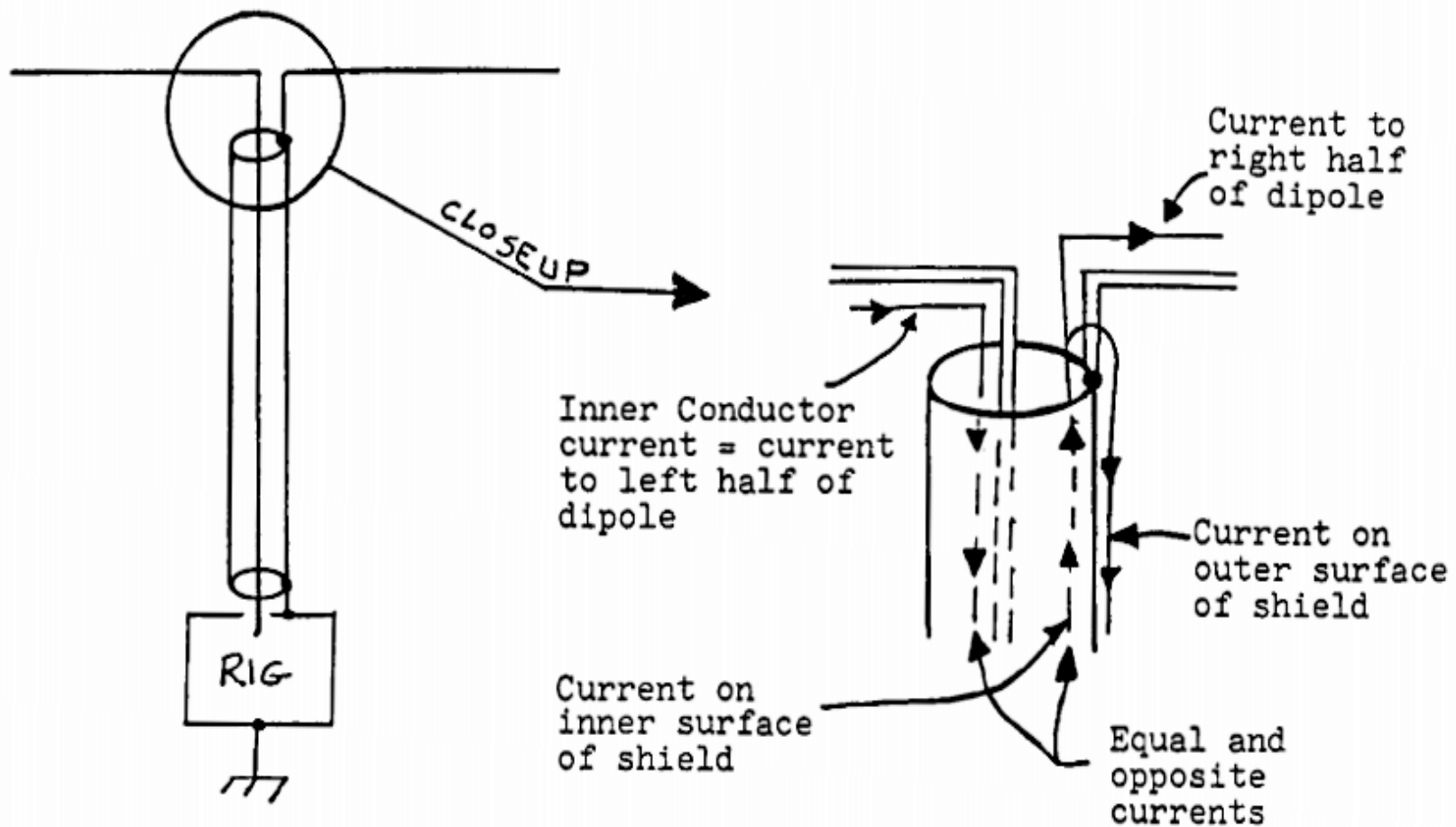
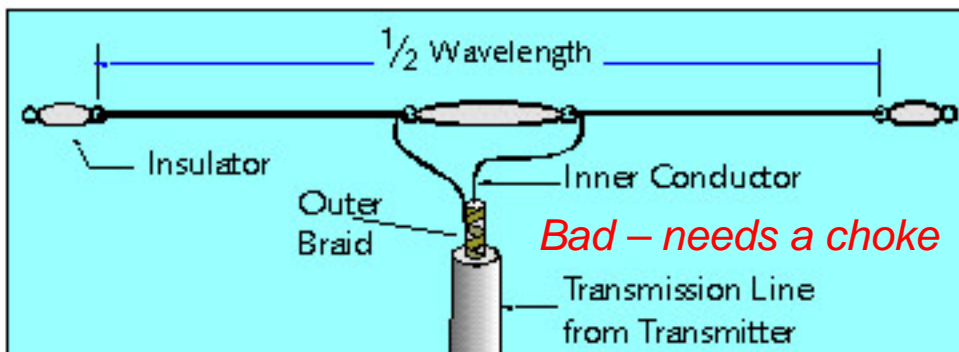


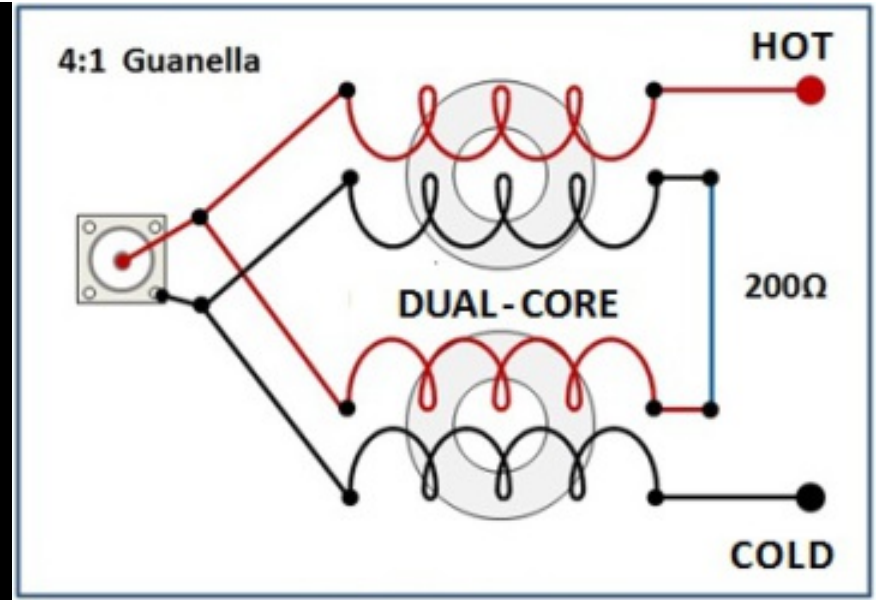
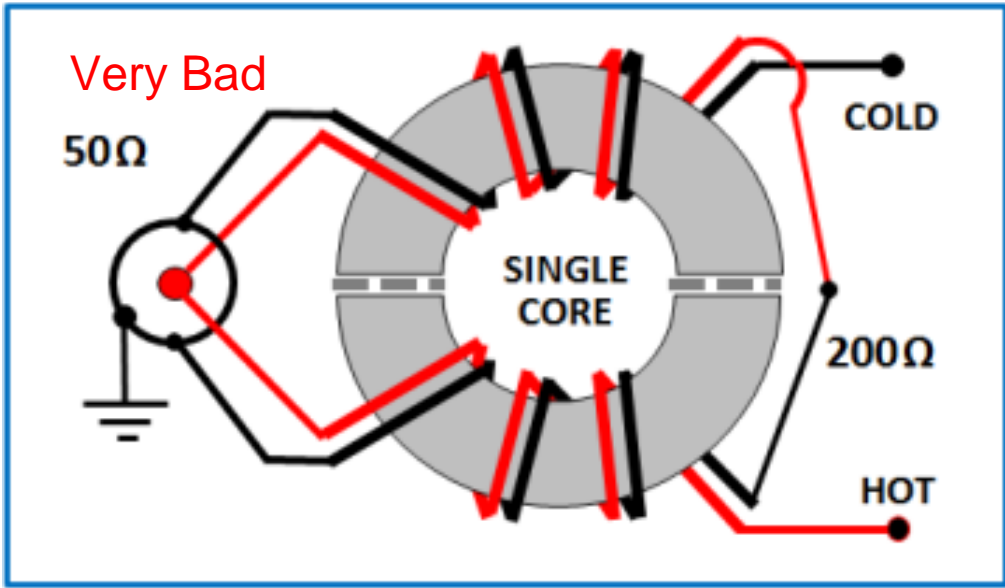
Fig. 1 — Imbalance caused by another path to ground from only one side of the dipole.



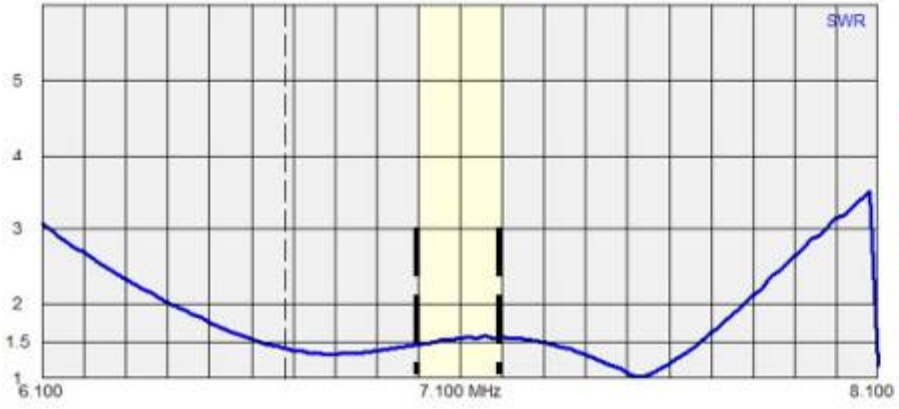
A choke needs to be added at the feedline / antenna connection (1:1 balun)

Components

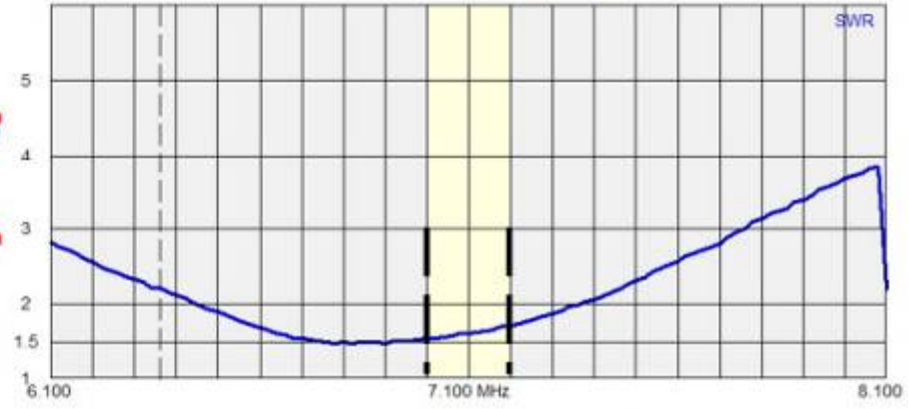
- Don't be cheap
- Need a good 4:1 Dual core, Dual Winding Current Balun – Guanella
 - I use a Balun Designs #4115 (about \$97)
 - #4114 is Single Core
- Need common-mode choke
 - Should be a 1:1 Guanella Choke
 - I got away with a Maxwell Choke (beads over coax) (Wireman # 8231 (about \$29))
 - I had ideal locations for these antennas



Single-Core BALUN (B5)



Dual-Core BALUN (B6)



340mA ← Measured Common Mode Current → 105mA

The balun must be a Dual-Core balun



Dual Core Balun

Common-mode chokes

~ 400 ohm



Guanella

~ 4000 ohm



Common-mode Choke Impedances - G3TXQ

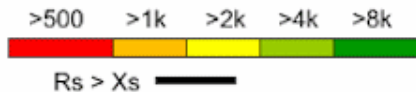
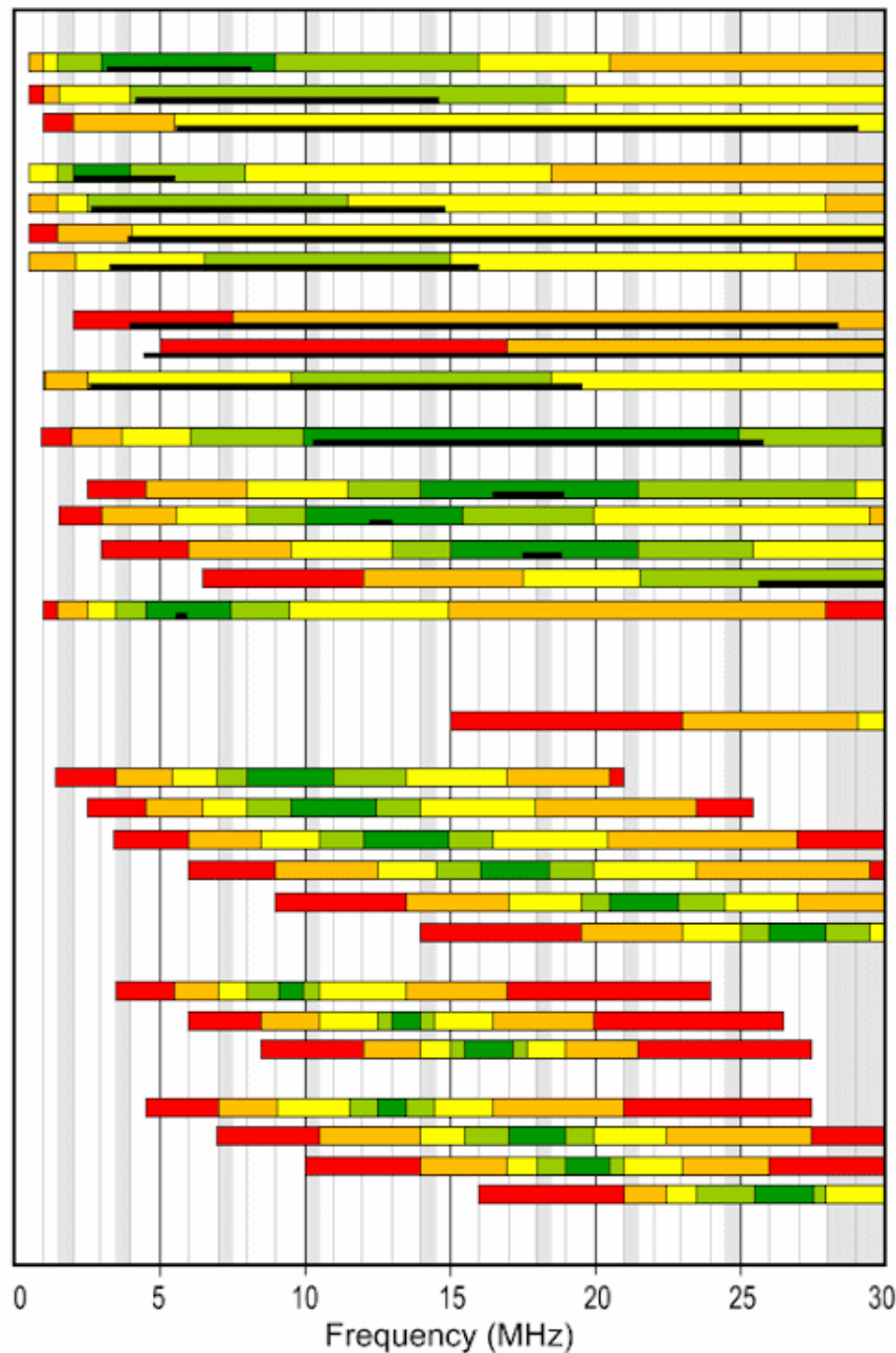
(Last update: 15 May 2012)

Ferrite-cored

- 17T RG58 on FT240-43
- 12T RG58 on FT240-43
- 8T RG58 on FT240-43
- 17T RG58 on FT240-31
- 12T RG58 on FT240-31
- 8T RG58 on FT240-31
- 9T bifilar on 2 x FT240-31
- 10 x FB-31-1020 beads on RG213
- 6 x FB-31-1020 beads on RG213
- 4T RG174 on binocular 2x FB-31-1020
- 11T RG58 on 2 x FT240-52
- 16T RG174 on FT140-61
- 17T RG58 on FT240-61
- 12T RG58 on FT240-61
- 8T RG58 on FT240-61
- 14T bifilar on 4 x FT240-61

Air-cored

- 10T RG58 on 2" air cored
- 25T RG58 on 4.25" air cored
- 20T RG58 on 4.25" air cored
- 15T RG58 on 4.25" air cored
- 10T RG58 on 4.25" air cored
- 7T RG58 on 4.25" air cored
- 5T RG58 on 4.25" air cored
- 10T RG213 on 7" air cored
- 7T RG213 on 7" air cored
- 5T RG213 on 7" air cored
- 16T RG213 on 4.25" air cored
- 11T RG213 on 4.25" air cored
- 7T RG213 on 4.25" air cored
- 5T RG213 on 4.25" air cored



<http://www.karinya.net/g3txq/chokes/>

Antenna Environment affects operation

- The more radical the split (feedpoint further from the middle), the more squirrely the antenna becomes.
- Feedline needs to run at 90° from the antenna for as far as possible.
- Need good common-mode choke
 - Guanella 1:1 is recommended
- If touching a antenna connector causes a change in SWR, your body has become part of the antenna, so you have some amount of common mode.

How to Remove Coax from SWR

- If you have some analyzer that can record the measurements in an external file, and b) you have Microsoft Excel, you can use the free Zplots Excel app. Zplots has the "Add/Subtract" feature.
- More details and a download link:
- <http://ac6la.com/zplots1.html>
- For info on the Add/Subtract feature see the third and fourth bullets and the first appendix at the above link.
- <http://www.arrg.us/pages/Loss-Calc.htm>

Adjusting OCFD

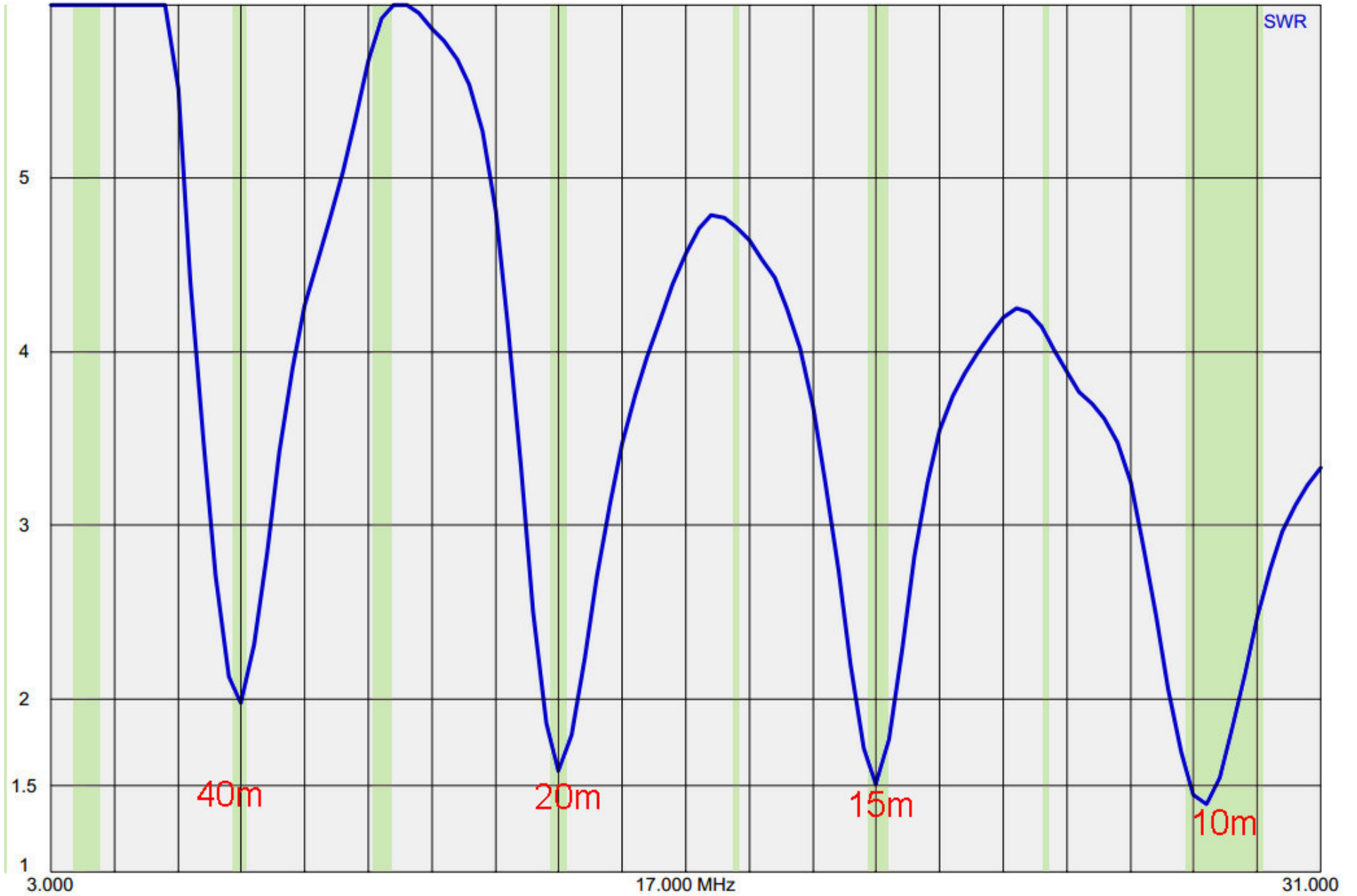
- A graphing antenna analyzer is highly recommended
 - Borrow one – Borrow a friend with one!
- The older single-frequency tunable SWR meters could work, but would be more work than most are willing to do.
 - Every 50 KHz over the band and ± 500 KHz needed. Then a detailed graph needs to be done for each band.
- A radio and SWR meter will NOT work.
 - Cannot look at what is outside the Ham Bands

Adjustments

- Cut both legs a little longer, fold back at the end insulators and adjust for the desired split ratio.
- Measure the SWR curves, then prune, **maintaining the split ratio.**
- Do not adjust for the lowest band, but all bands
- An inverted V OCFD should have the center highest, and the balun is not at the center.

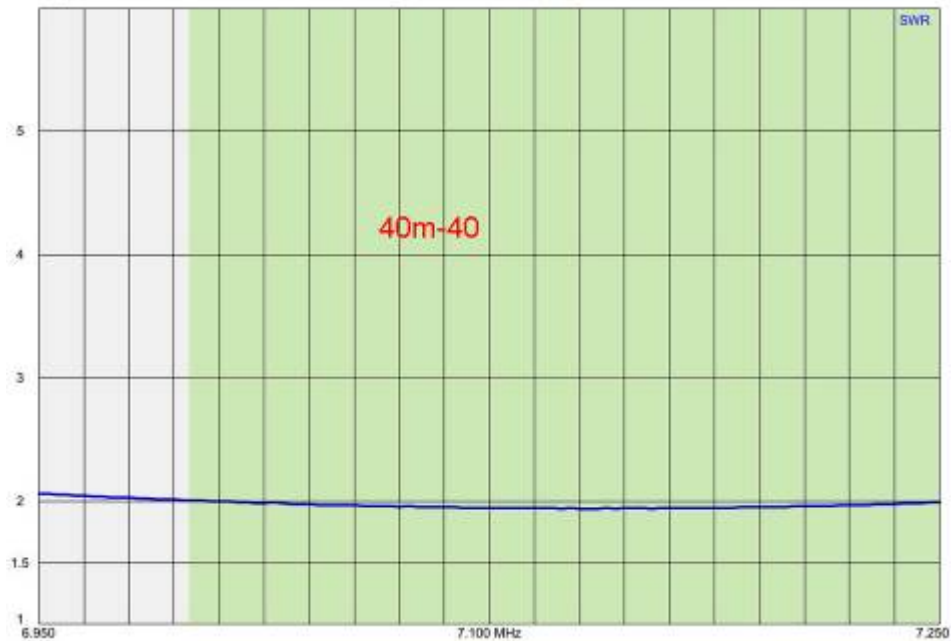
Common Mode Impedance (CMI) of Baluns & Chokes

- CMI of BALUNS depends on many things:
 - - Type of ferrite,
 - - size of ferrite,
 - - number of turns of wire,
 - - design circuit
- ALL contribute to the CMI of a balun, but THE CMI IS NOT CONSTANT across the hf spectrum. It varies with frequency. What works fine on one band may not have enough CMI on lower bands.



Goal: 40m, 20m, 15m, 10m

Analyzer: AA-1400 File: 40 OCF 40m Range: 7.100 ± 0.150 MHz, 100 points Printed: 06-Oct-2015 13:44:48



Analyzer: AA-1400 File: 40 OCF 20m Range: 14.200 ± 0.200 MHz, 100 points Printed: 06-Oct-2015 13:43:06

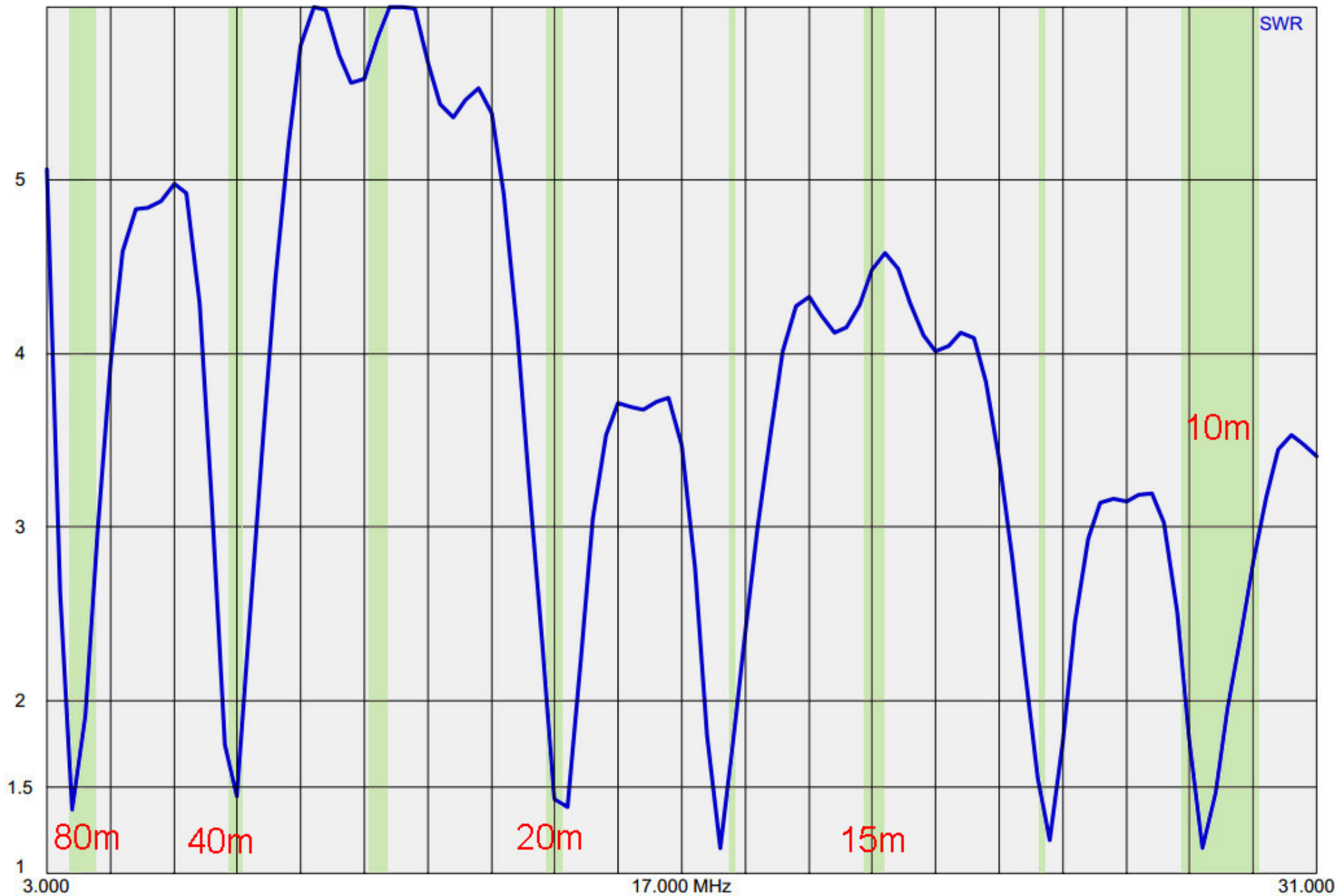


Analyzer: AA-1400 File: 40 OCF 15m Range: 21.225 ± 0.250 MHz, 100 points Printed: 06-Oct-2015 13:41:59



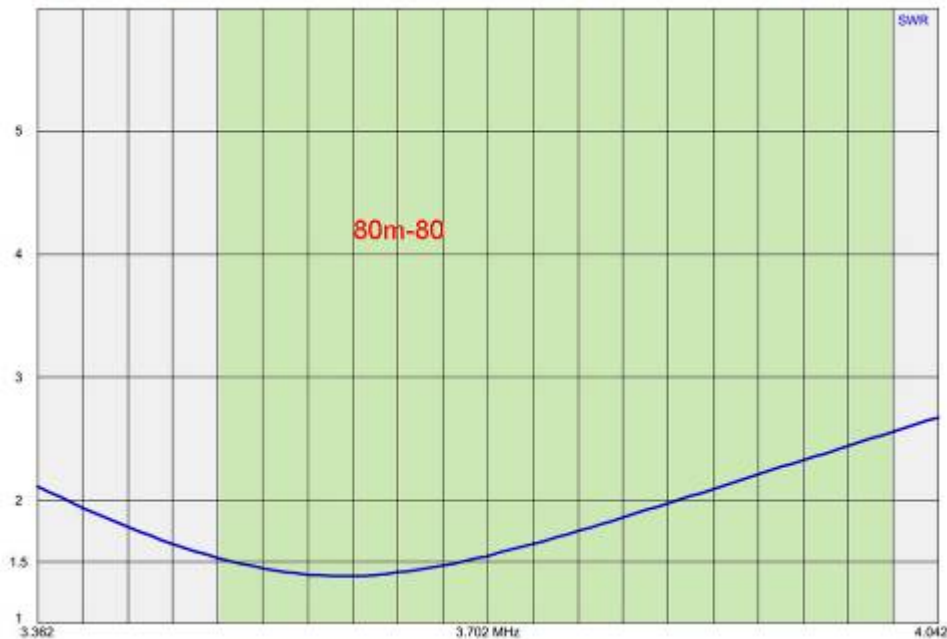
Analyzer: AA-1400 File: 40 OCF 10m Range: 28.300 ± 0.300 MHz, 100 points Printed: 06-Oct-2015 13:40:37



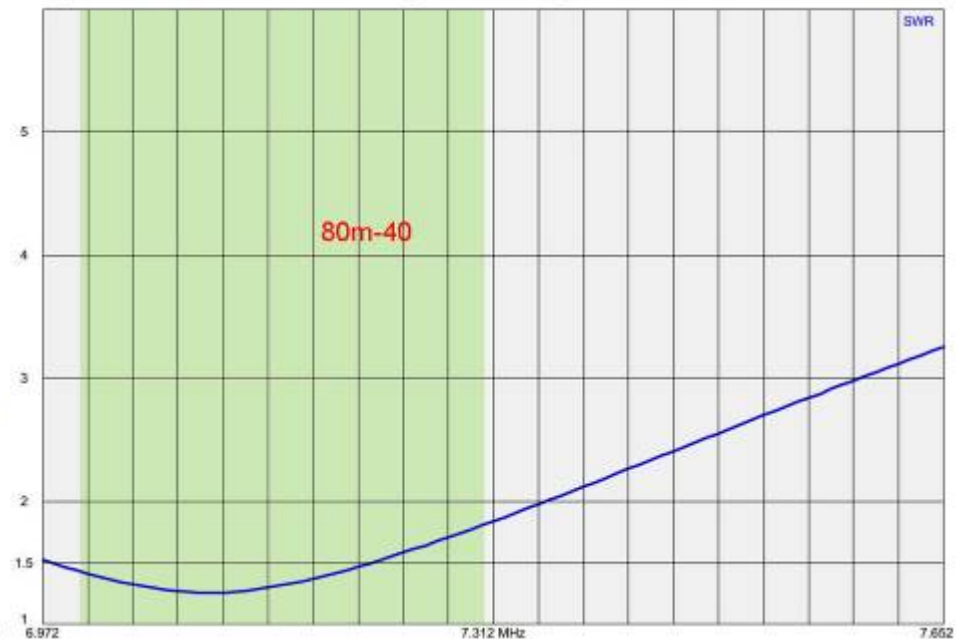


Goal: 80m, 40m, 20m, 10m

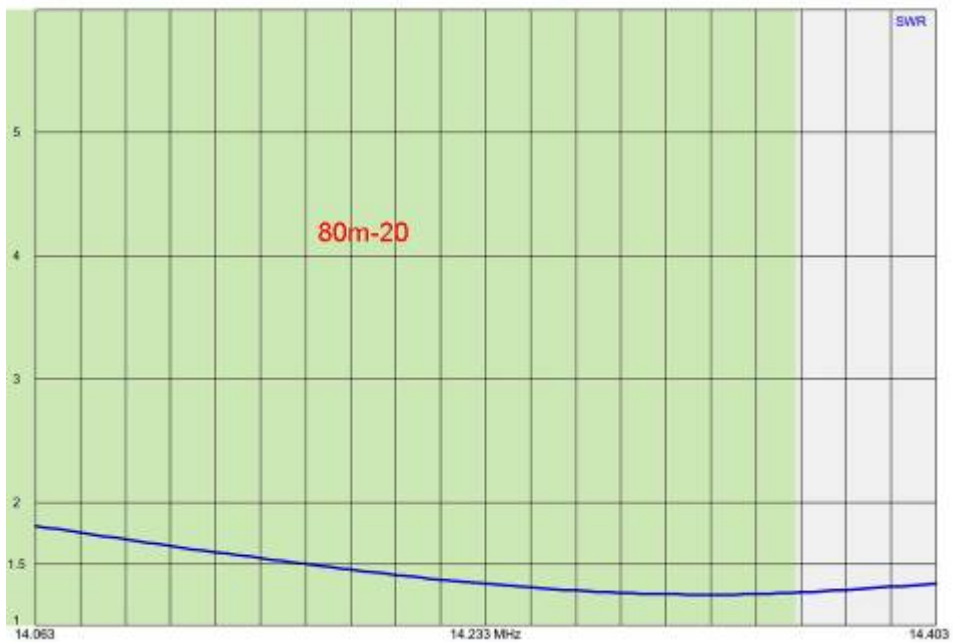
Analyzer: AA-1400 File: 80 OCF 80m Range: 3.702 ± 0.340 MHz, 80 points Printed: 06-Oct-2015 13:53:56



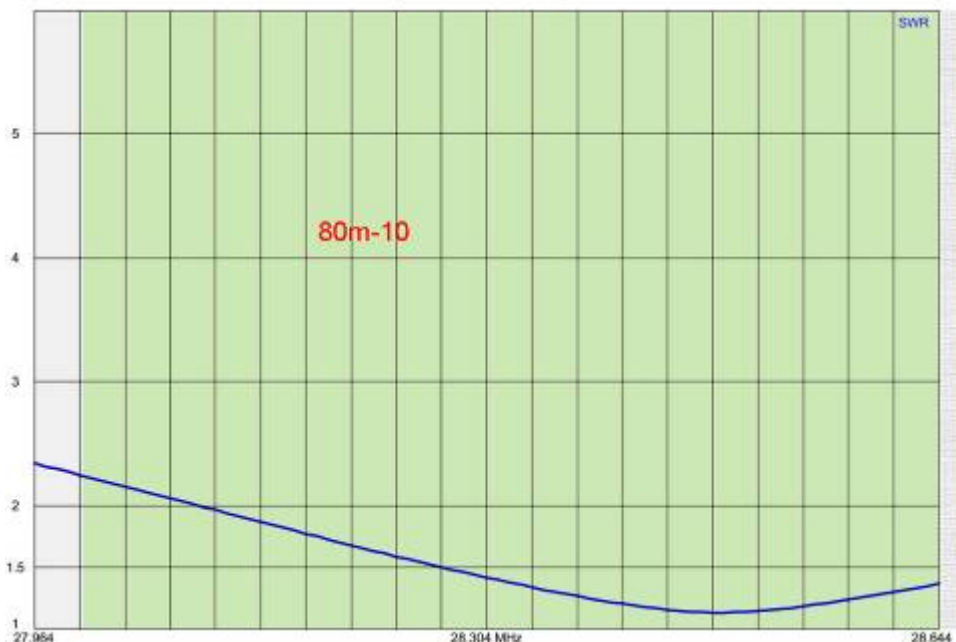
Analyzer: AA-1400 File: 80 OCF 40m Range: 7.312 ± 0.340 MHz, 80 points Printed: 06-Oct-2015 13:52:46



Analyzer: AA-1400 File: 80 OCF 20m Range: 14.233 ± 0.170 MHz, 80 points Printed: 06-Oct-2015 13:51:54



Analyzer: AA-1400 File: 80 OCF 10m Range: 28.304 ± 0.340 MHz, 80 points Printed: 06-Oct-2015 13:45:51



Reference Material

- $=\text{ABS}(\text{SIN}(A3*2*\text{PI}()/180))$ where A3 = angle (draw sine wave)
- **windom_antenna** Yahoo Group
- <http://hamwaves.com/cl-ocfd/en/index.html>
- <http://www.aerial-51.com/>
- <http://www.balundesigns.com/> Model 4115
- <http://thewireman.com/> #8231
- <http://www.dj0ip.de/>
- <http://www.karinya.net/g3txq/chokes/>
- QST, July 2000, Everything Works, Tom Schiller
- A Ham's Guide to RFI, Ferrites, Baluns, and Audio Interfacing <http://k9yc.com/RFI-Ham.pdf>
 - Exactly as the title says, and it might take several readings to understand, but well worth looking at.

Summary

- The correct balun **MUST** be used
 - **Dual-core** Guanella
- A Common Mode Choke is necessary
 - Guanella 1:1 is recommended
- A split for the desired bands needs to be selected.
- Should not be tuned on the fundamental frequency band
 - A graphing antenna analyzer is almost a necessity
 - The bands are not strictly harmonically related
 - Keep the desired split while adjusting
- 1:1 SWR is **NOT** important
 - the dip at resonance is important
- A tuner is always a good idea to protect your radio