End Fed Half Wave Antennas

Bill Shanney

W6QR

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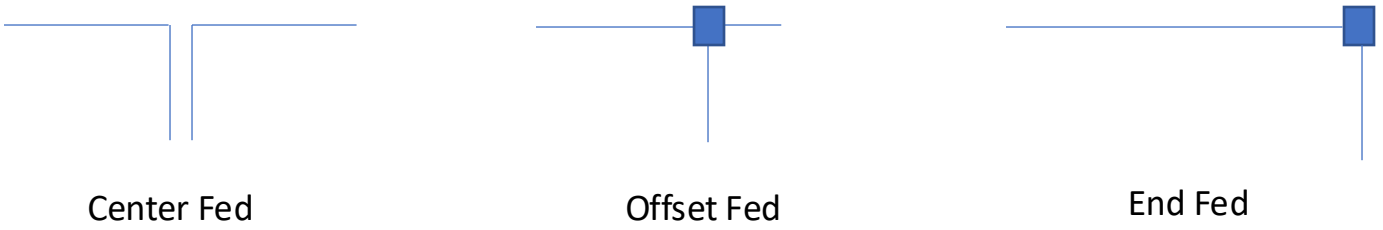
Hi!
I'd like a wake up call please
You have a $10,000 radio
A 1500 watt amplifier
and an End Fed Half Wave
at 15ft above the ground

EFHW

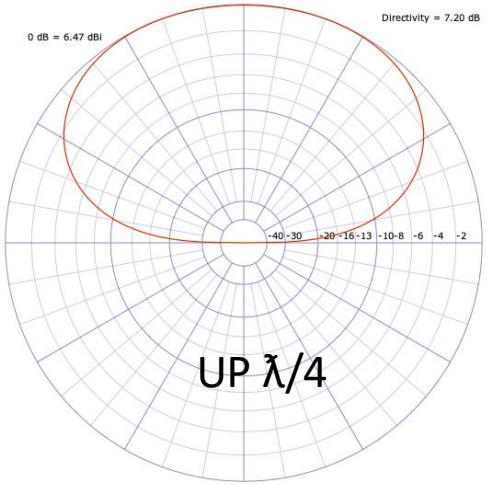
- Antennas can get a cult like following. Take the G5RV for example; it's a great 20M antenna but can be difficult to match on some bands and it has multiple lobes on the higher bands. It's more efficient if fed with 84' of 450Ω ladder line.
- The EFHW enjoys a similar following. Matching on the harmonic bands is very good but multiple lobes may be a disadvantage on the higher bands.
- Understanding the limitations is important if you want to get the most performance from this useful design.
- I do not want to discourage anyone from installing an EFHW, especially if it's the only antenna that fits their space. It is quite useful. Getting an antenna up and being on the air is most important.
  - You can change the configuration after you gain experience

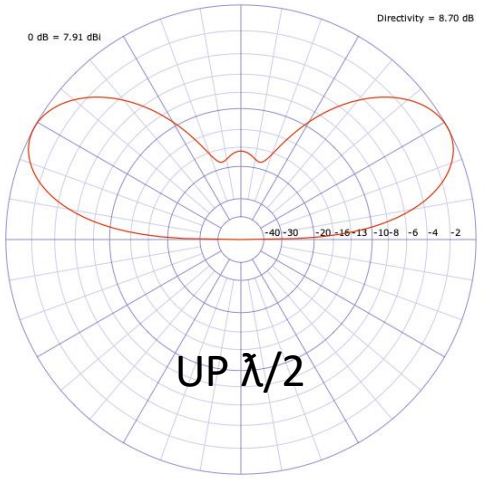
Half Wave Dipoles

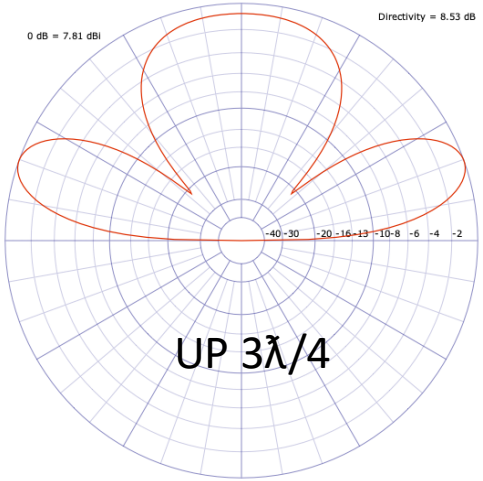


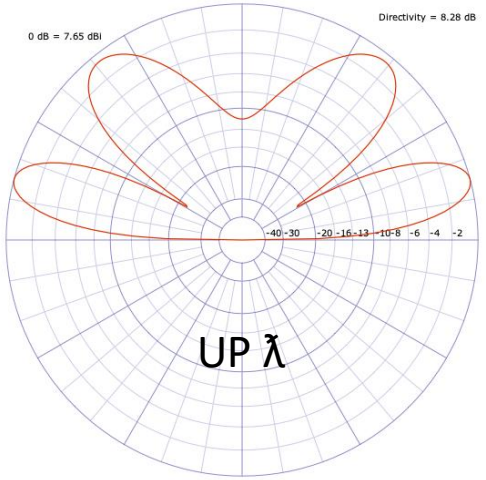
- At its half wave frequency, a dipole will have the same radiation pattern independent of feed configuration
- It's more a matter of convenience at your installation for selecting a feed type
- Offset and end fed dipoles require matching transformers
- Dipoles are probably the most popular HF antenna
  - At a height of ƛ/4 they are good for local contacts
  - At a height of >ƛ/2 they are good DX antennas

20M Dipole Performance vs. Height

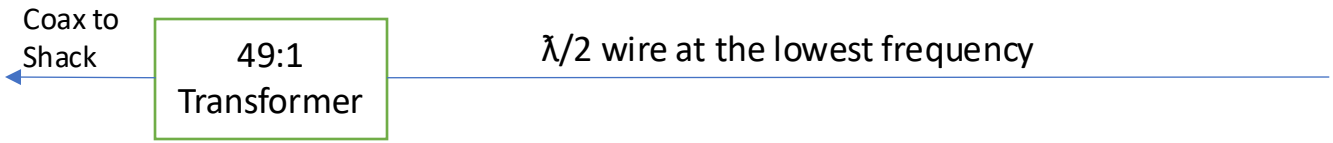








What is an End Fed Half Wave (EFHW) Antenna?



- An EFHW is a wire antenna resonant on its ƛ/2 frequency and harmonics
  - A 40M EFHW is resonant on 40/20/15/10M
- The end impedance is ~2500Ω and varies a bit due to wire orientation
- To get proper resonance on the harmonics a coil or capacitor are required
- A counterpoise is required. If you don't install one, the coax will act as the counterpoise
- The radiation pattern is dipole like on the fundamental frequency and multi-lobed on harmonics

EFHW Counterpoise Configuration

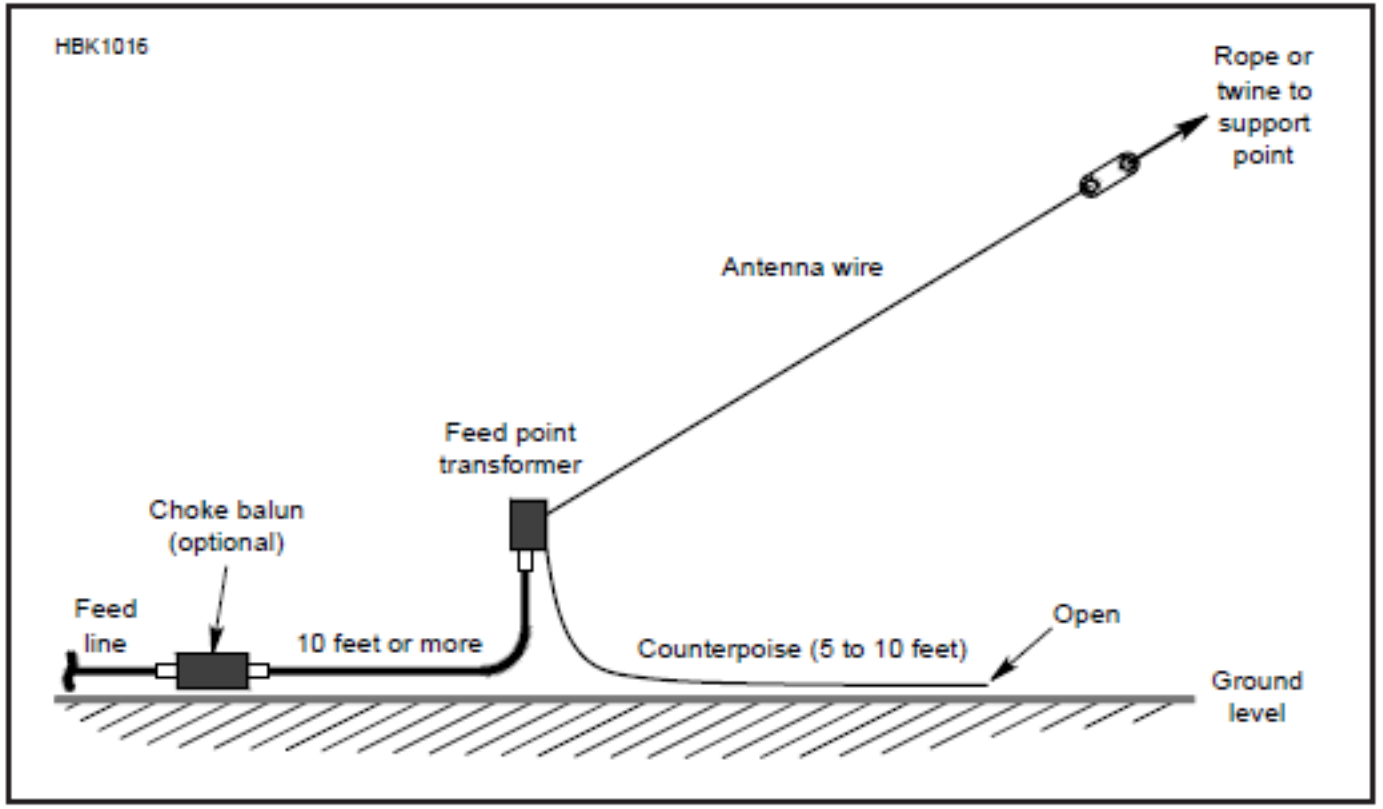


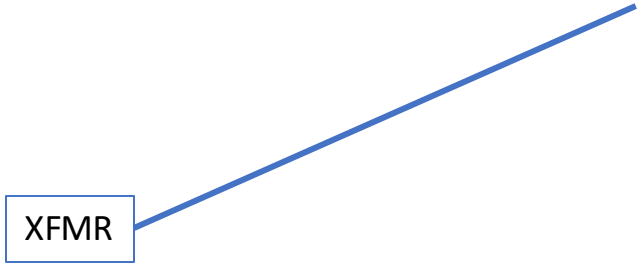
Figure 21.17 — The end-fed half-wave (EFHW) antenna. For permanent use, it can be installed horizontally with both ends well above ground. For portable or temporary use, it is common to keep the feed point near ground level and support the other end with a multi-section fiberglass mast or with a rope over a tree branch.

End Fed Half Wave Antenna (EFHW)

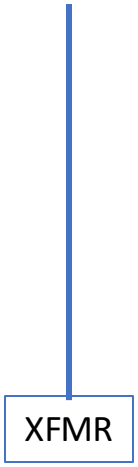
- The EFHW antenna is very popular for many reasons
  - Flexible installation
    - Straight Horizontal
    - Straight Vertical
    - Inverted-V
    - Inverted-L
    - Sloper
  - Operates on harmonics. A 40M EFHW will have a low VSWR on 40/20/15/10M with an appropriate loading coil
  - End feeding allows smaller wire to be used since you don't have to support the feedline, can be stealthy
  - No ground radial system
  - Low cost, easy to home brew
- *The EFHW is not the popular multiband offset fed wire using a 9:1 balun*
  - *Best for non-harmonic band operation*

EFHW Configuration – cont'd

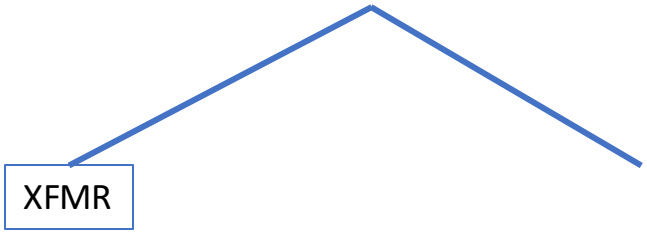
Horizontal Wire



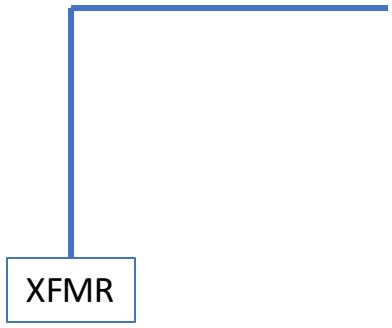
Sloping Wire



Vertical

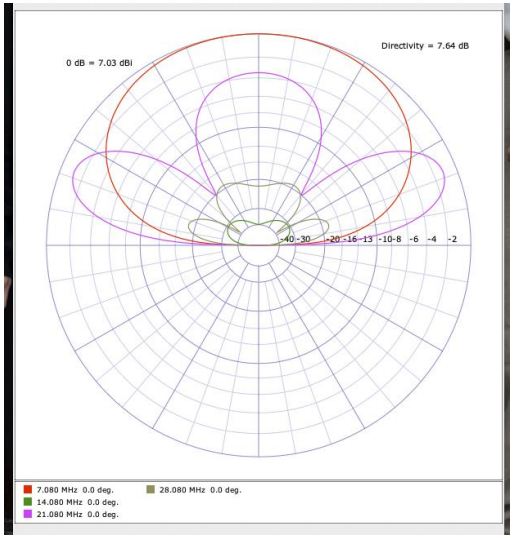


Inverted V

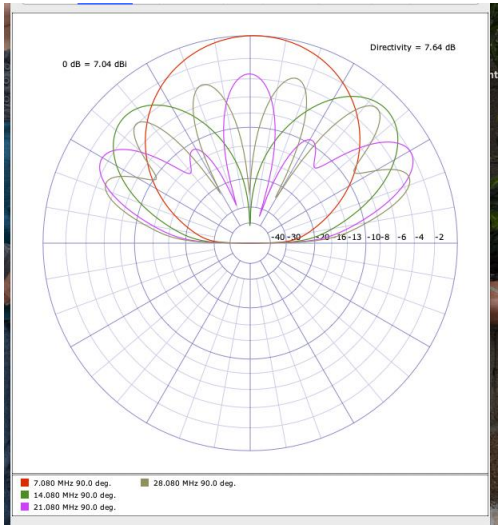


Inverted L

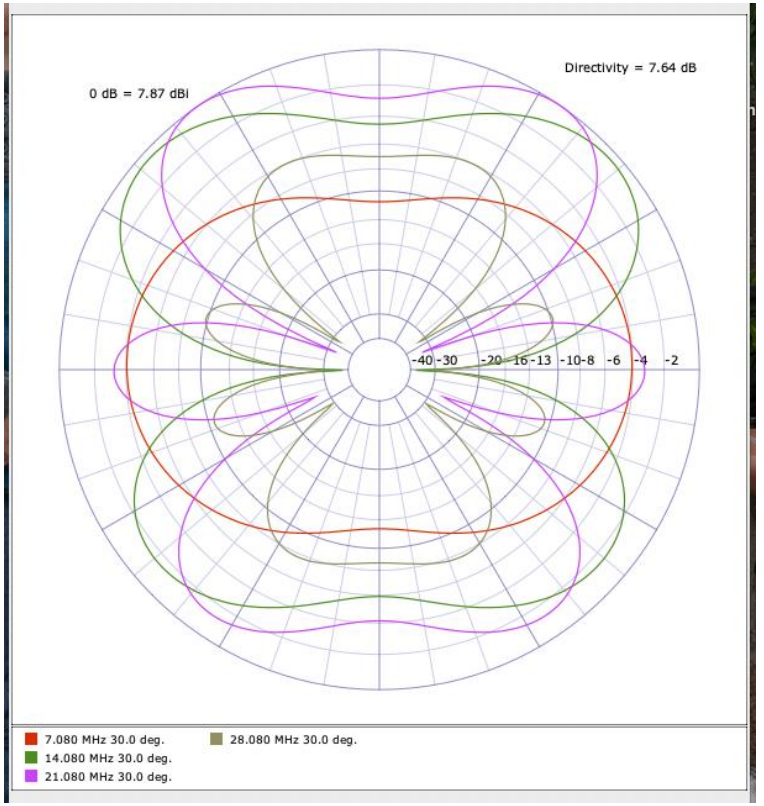
EFHW Radiation Patterns: Horizontal 40M EFHW at 30’



Broadside

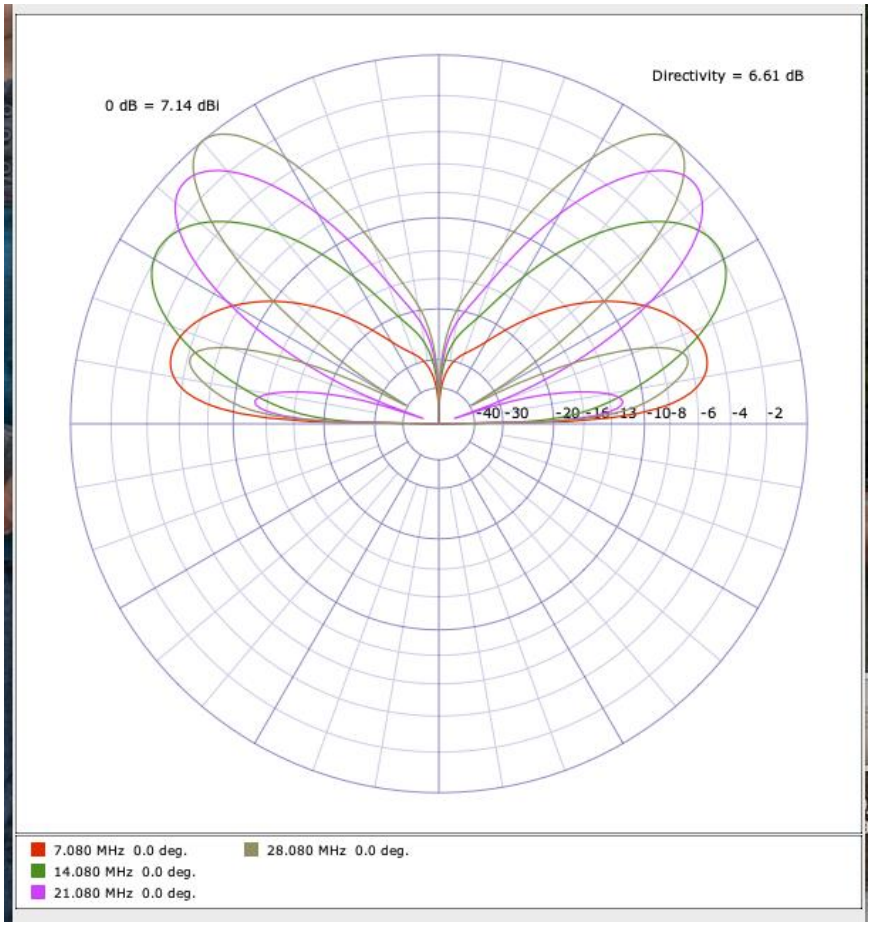


End Fire



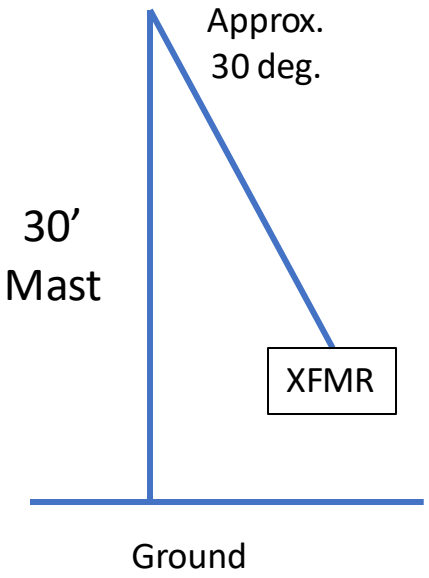
Azimuth pattern at 30º elevation
Antenna Oriented up/down

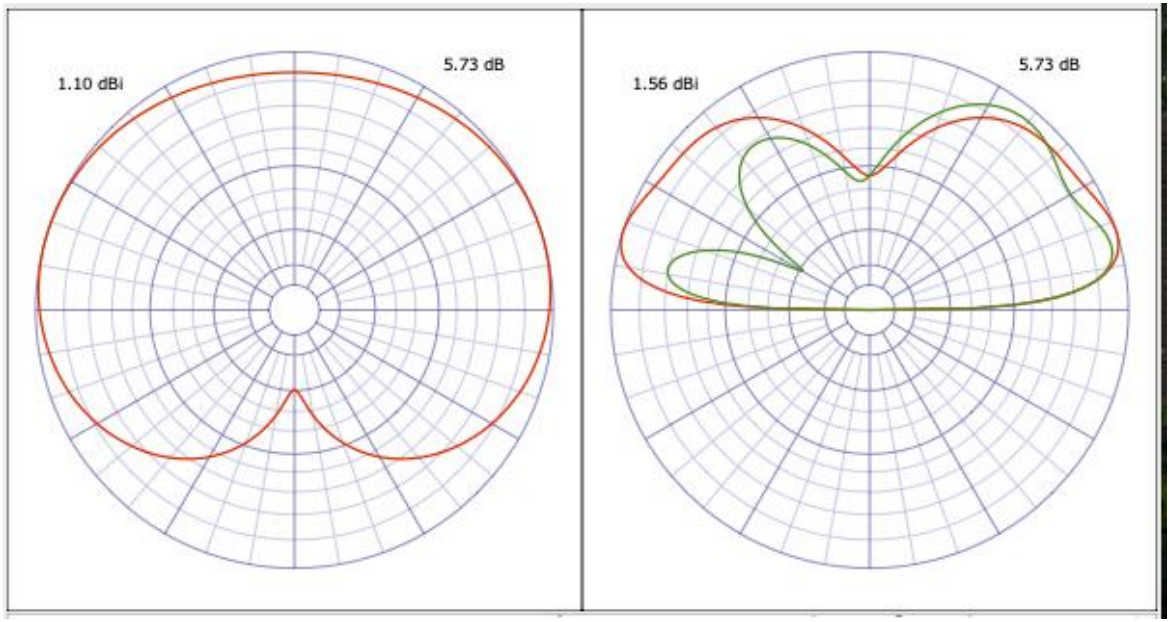
40M EFHW Vertical



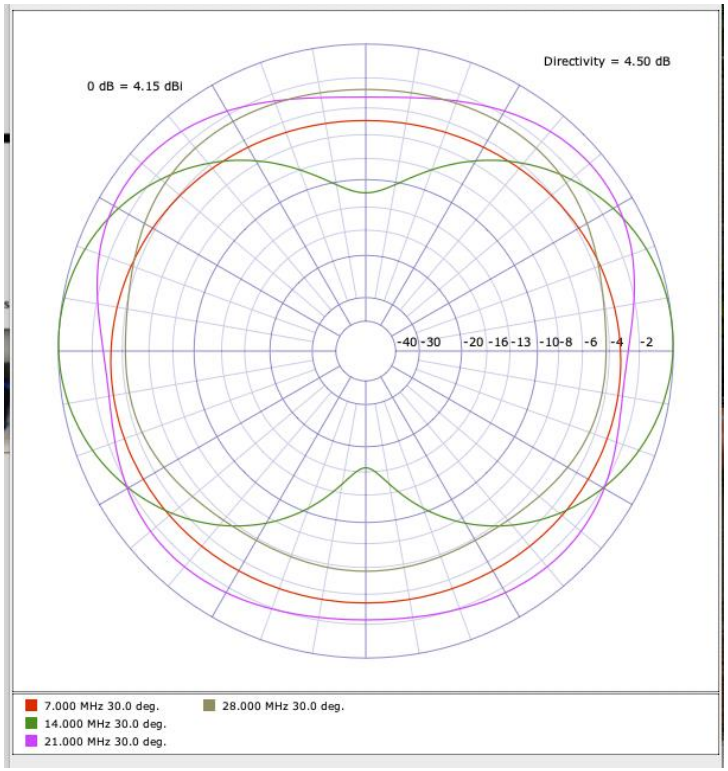
15M EFHW Sloper

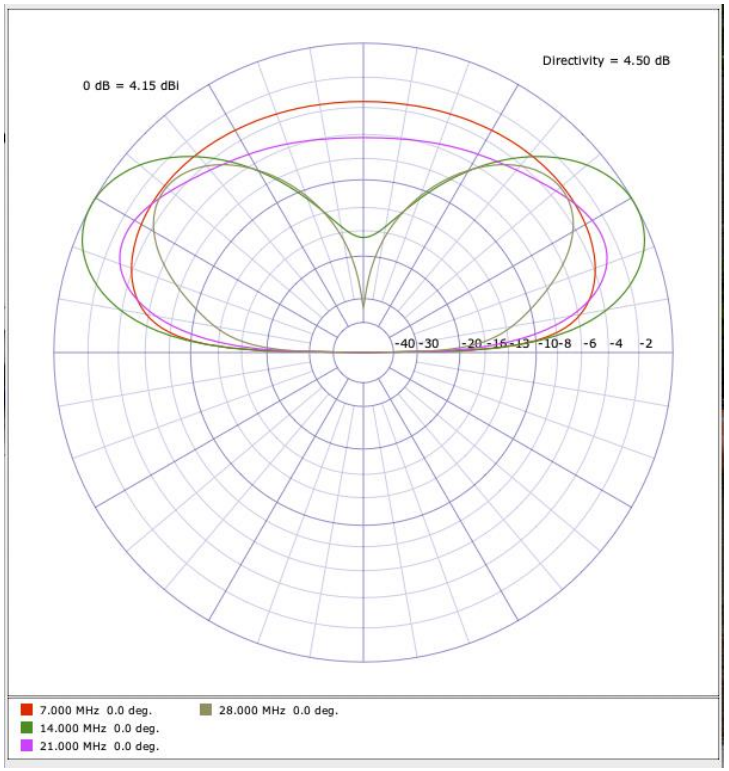
- I looked at this sloper which uses a 30’ mast with the feed end up 10’ since it could be set up using a ride on mast mount on the rear and the front tied to the car hood





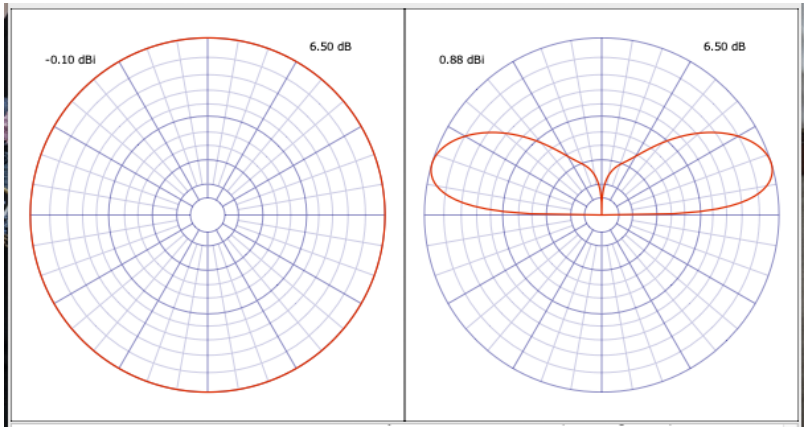
40M EFHW Inverted L



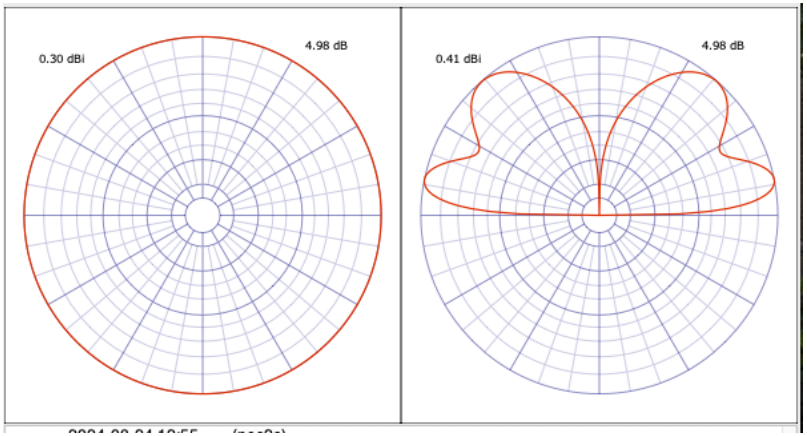


The Inv-L configuration is particularly good. The 20M peak occurs broadside to the top wire. There is a very good balance of low and high angle radiation.

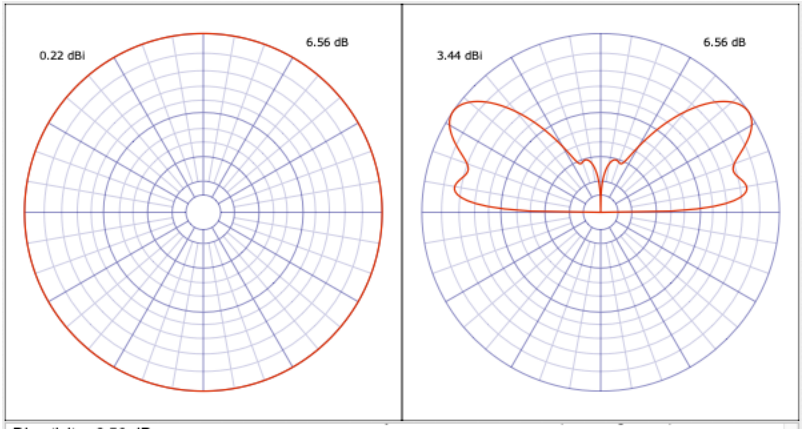
10M EFHW Vertical



Base at 1 foot



Base at 10 feet



Base at 20 feet

Raising a vertical EFHW above ground degrades the low angle performance.

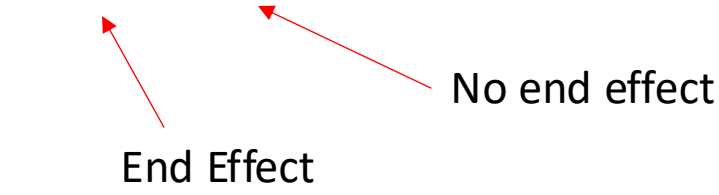
EFHW Harmonic Operation

Fundamental

ƛ/2=468/f to account for end effects

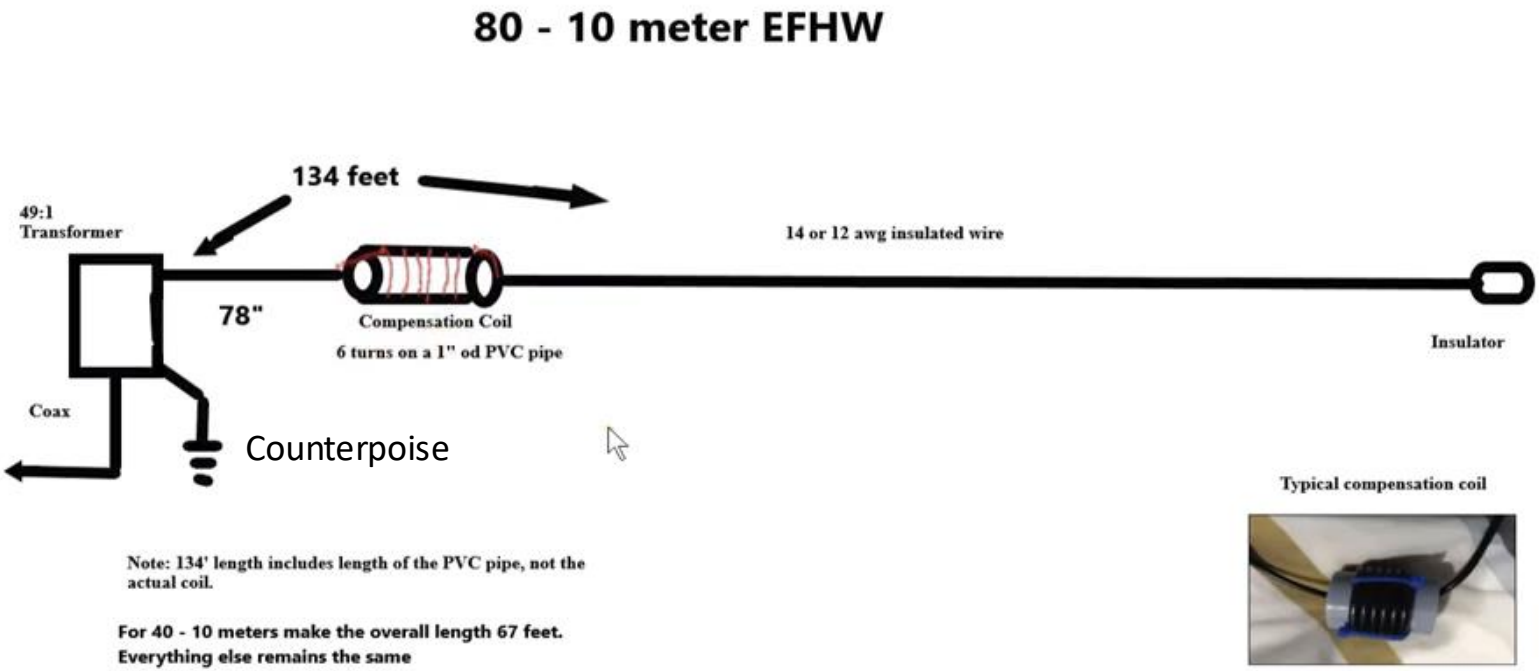
Second Harmonic

ƛ=468/f + 492/f



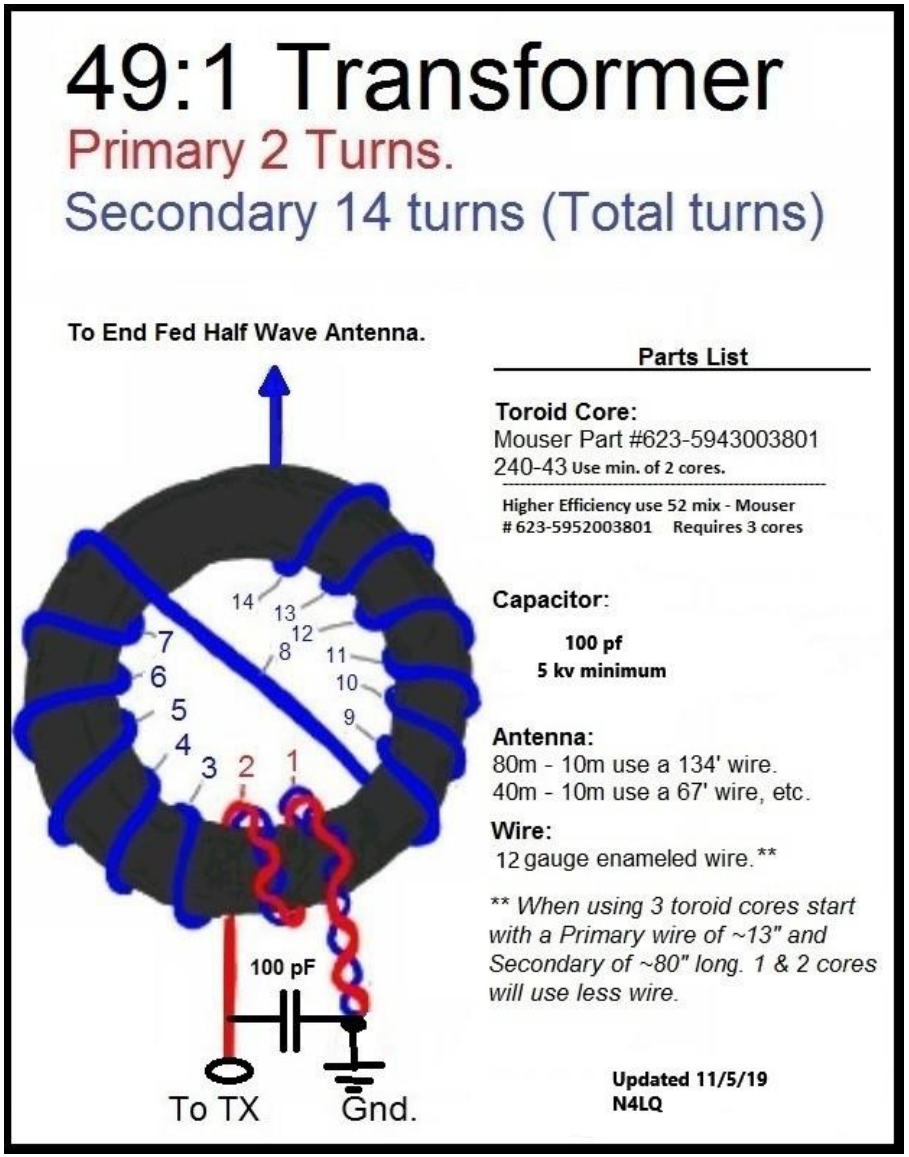
For proper harmonic alignment a coil or capacitor is used to add length at the harmonic frequencies

What is an End Fed Half Wave Antenna



- The compensation coil is required to have a proper resonant frequency at harmonics, it compensates for end effects
- N4LQ, Steve Ellington, has a lot of data on his Face Book and You Tube pages.
- Commercial versions are available for those who don't like building things
- LDG sells an inexpensive low power transformer
- The ARRL has a very nice Kit available but does not talk about the coil

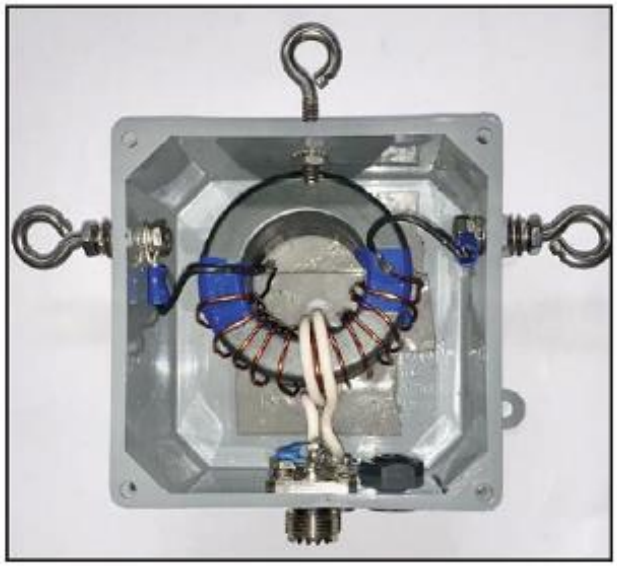
EFHW Components are easy to build



- A single FT140-43 core will handle 50W CW/SSB
- One FT240-43 core will handle 250W (ARRL kit)
- Two FT240-43 cores will handle 500W
- Three FT240-52 cores will handle 1500W
- Careful layout is required for high power operation since the voltage at 2500Ω is quite high, several KV.

EFHW Transformer – alternative designs

Separate Primary Winding



- The 14T secondary winding can use #18 wire since its current is low. A separate primary winding of 2T #14 wire near the center of the 14T coil will handle the higher current, 1.5 amp at 100W
- See *CQ Magazine* December 2021: *A Deep Dive Into End Fed Half Wave Antennas* by Bob Glorioso, W1IS, and Bob Rose, KC1DSQ, pp 66-74.
- This configuration requires a wire counterpoise

Alternative End Impedances

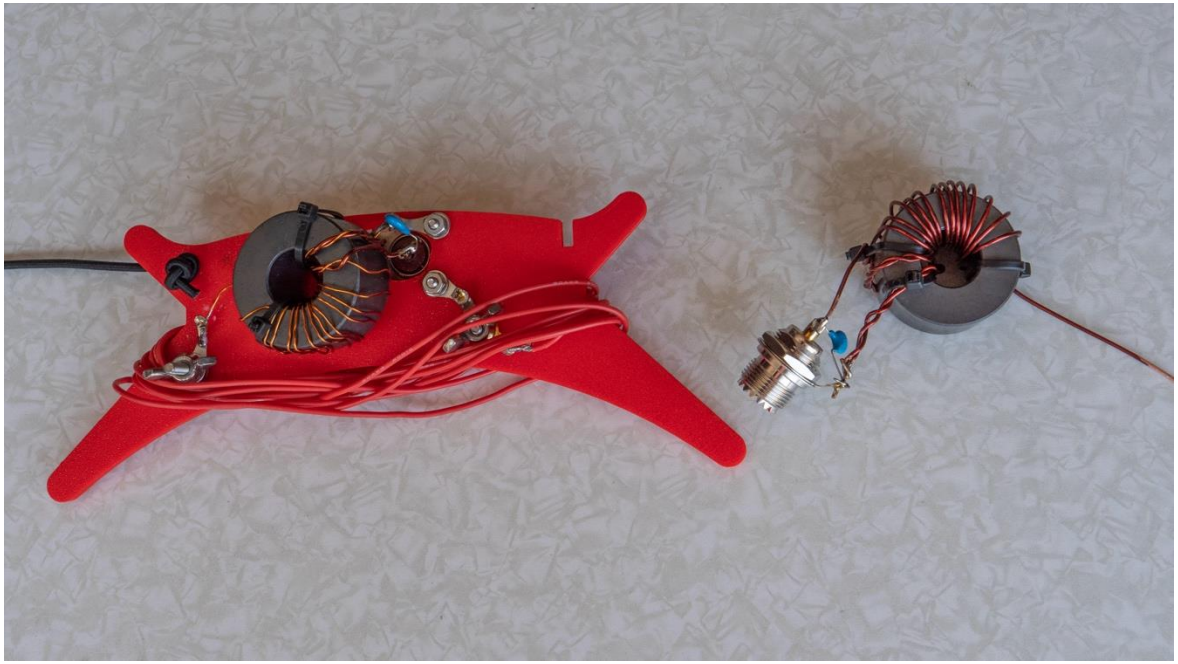
- Some designs use 36:1, 56:1 or 64:1 transformers, this will change the length a little
- Mount the transformer in a non-metallic box to avoid arcing

EFHW Transformer – Recent Updates

- I've recently tried several alternate designs I saw on You Tube. My goal is to reduce losses.
- My first attempt used an FT240-52 core. This material has lower resistivity and lower permeability (u). A 3T primary is necessary to provide enough choking inductance at 7MHz. That means a 21T secondary. I tried a floating secondary.
- I measured the loss of 2 FT140-43 transformers back-to-back. It was 2.2dB. 1.1dB/transformer (24%) is in close agreement with data taken by MM0OPX. When I substituted the FT240-52 transformer the total loss was 1.6dB, a 0.6dB reduction.
- When I tried the new transformer with my 40M EFHW the 40M VSWR was high, ~3:1. The 20M VSWR was 1.2:1. It works great with my 17/20M EFHW vertical. It simply does not have enough choking inductance at 7MHz.

EFHW Transformers – Latest results

- Several designs use a Fair Rite 2643251002 core. This is a type 43 material with a formulation for use as a choke.
- MM0OPX data is shown in the following You Tube: https://www.youtube.com/watch?v=Xe0wvbOQeok&list=PLGb6eFsatt7Wxw3D53cYOkzIWDW9O7XL4&index=4
- I have built 2 transformers with this material which is cheaper than the standard FT240-43 core. The loss is in the 0.5dB range (~10%) which is a low as I've seen published.



Field Data with the Latest Transformers

- I set up my 40M EFHW as an Inv-V, apex at 30’
- The 1002 14T design is better suited for 20/15M
- The 1002 15T transformer has is better on 40M
- This is consistent with other data on You Tube

Frequency	VSWR		
(MHz)	FT240-43 (ARRL)	1002 14/2T	1002 15/2T
7	1.5:1	2:01	1.8:1
14	1.6:1	1.7:1	1.8:1
21	1.5:1	1.3:1	1.6:1
28	2:01	2.3:1	2.6:1

More Field Test Data

- I put up my 17/20M EFHW vertical to compare the 1002 core transformers
- The 14/2 transformer VSWR was 1.1:1 on both bands
- The 15/2 transformer VSWR was 1.2:1 on 17M and 1.14:1 on 20M
- The EFHW required a small length change between transformers. The transformer does contribute to the length
- The improved 40M performance of the 15T transformer on 40M is consistent with data from MM0OPX
- 10M VSWR has never been good in an Inv-V configuration

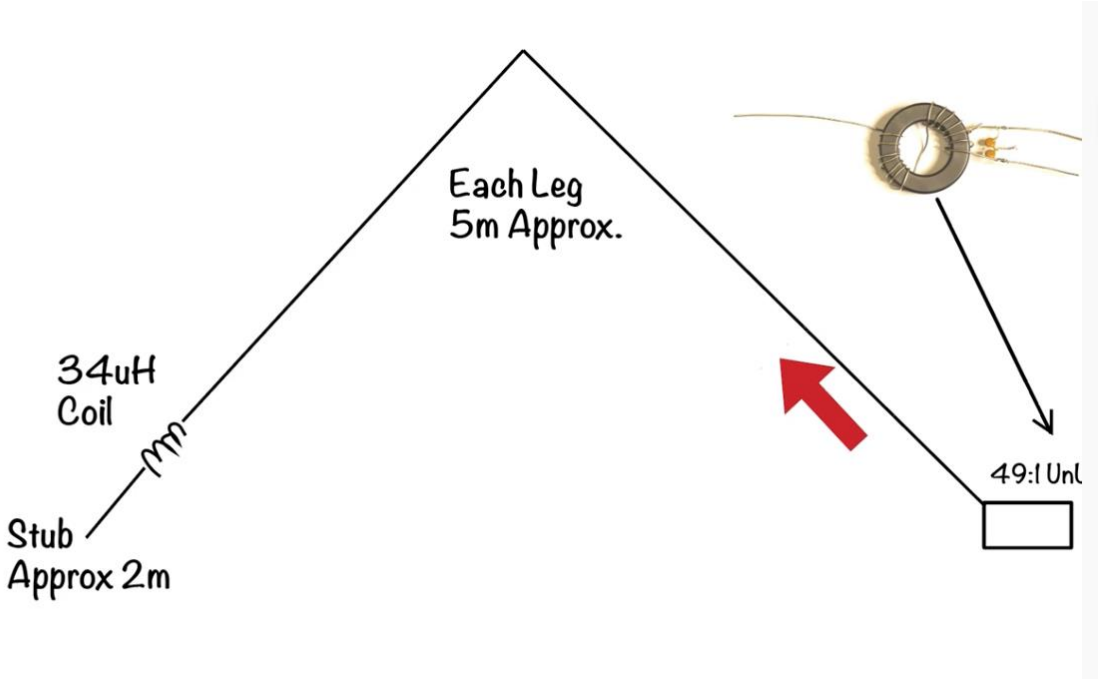
The Loss differences between these transformers is too small to be significant in real operation.

EFHW Counterpoise Options

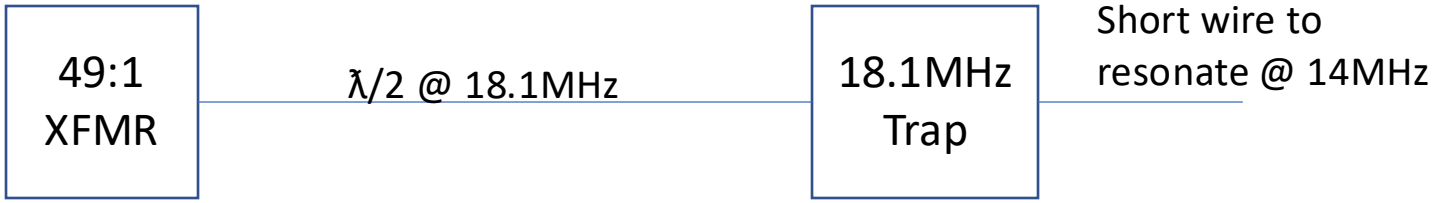
- Some folks will tell you that a counterpoise is not required. That is not true. You may not notice it at QRP power levels, but the coax shield will be RF hot.
- There are two alternatives:
  - Add a high isolation balun or line isolator 0.05λ from the transformer. The coax shield provides a termination for the end fields.
  - Add a counterpoise wire >0.05λ long at the transformer coax ground. Run it away from the coax.
  - I would also add a line isolator at the radio if you are operating above QRP levels
- The EFHW is the extreme case of an offset fed antenna. Loading the high impedance end of the wire with the transformer does not provide the open circuit termination that the antenna requires.
  - This is also why alternative transformers work

Other EFHW Thoughts: 40/20/10M Design

- Peter Waters, G3OJV, has several designs on his You Tube Channel. His emphasis is antennas for small yards.
  - https://www.youtube.com/user/watersstanton
- The sketch below is for a 20M EFHW with a 40M add on to reduce length. 40M bandwidth is reduced.



17/20M EFHW Variant



- I wanted a half wave vertical with a length of <35’ to use with my telescoping mast (actual 32’)
- I enjoy both 20 and 17M during my daytime portable outings
- This is another G3OJV design I built and works well
- https://www.youtube.com/watch?v=m25bj4CbLgs&list=PLx0CEvuNF8fK5K72C_Pq-oaO3h8gTXgHn&index=12

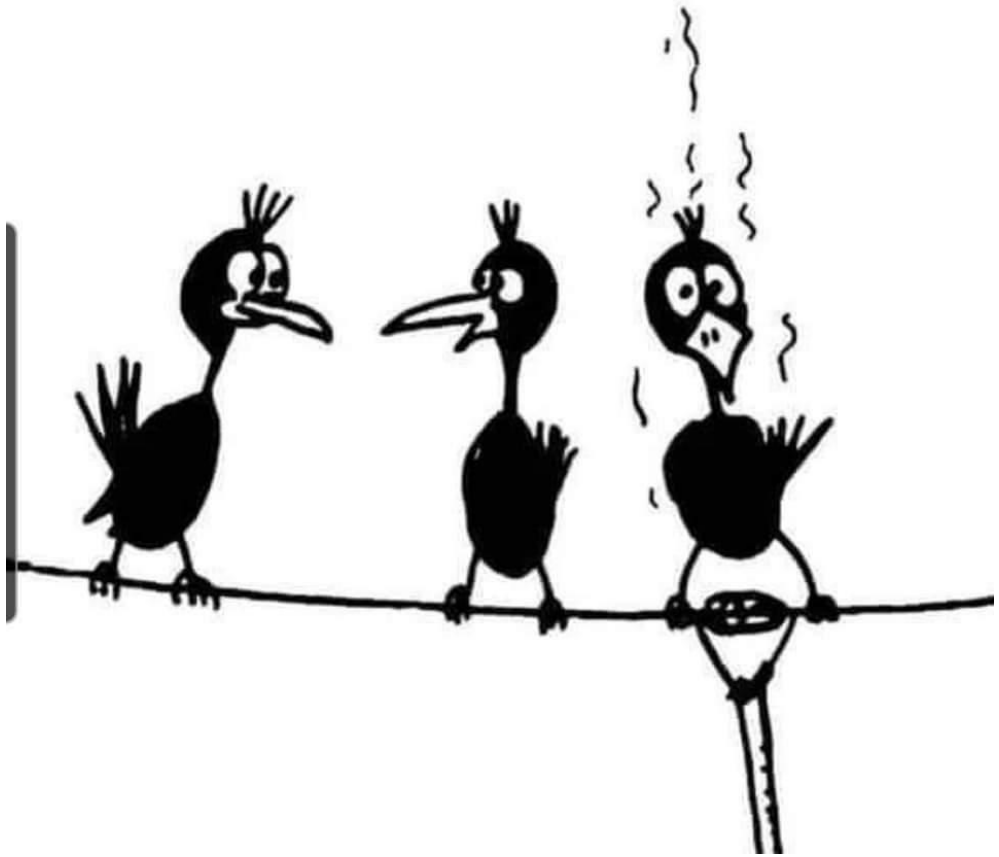
10M Thoughts

- If you like 10M I would suggest cutting a 16.5’ wire and using it with the same 49:1 transformer
- As a vertical it will have a main lobe covering the 10-30º range which is good for DX
- 10M short skip is limited to ~800 miles which corresponds to a 30º radiation angle
- A horizontal EFHW up 15’ will have about 5dB gain over a vertical (~1 S-unit)

Summary

- End Fed Half Wave Antennas are a good choice for hams with limited space who want multi band coverage
- They are also popular for portable operation
- They are stealthy and can be installed in a variety of configurations
- They have a good VSWR on their resonant bands
- A short counterpoise or line isolator close to the transformer is recommended
- A line isolator should be used at the transmitter.

Questions?



“Smells like fried chicken, I’m getting hungry”