Wire Antennas For Backyard, Balcony, or Attic

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www.ocfmasters.com

Space Constrained Ham's Dilemma

Small Apartment

HOA or Landlord says NO!

Commercial Options

Buddistick
Loop inside – Low Power
Vehicle Outside - Mobile
Remote Station – rent time

Get Creative

The Wisdom of Old Hams

Any wire in the air is better than the best antenna stuffed in a closet, trunk, garage or in the pages of QST!

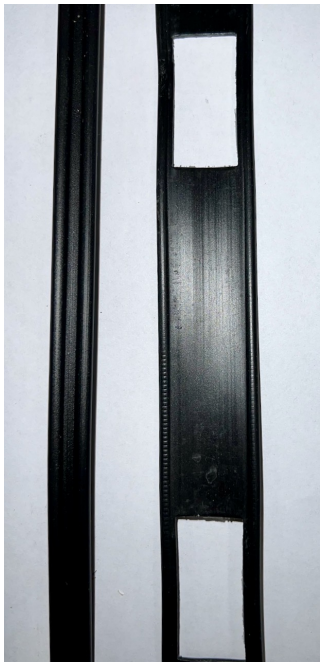
Make the best of what you have, you may be surprised!

But you need some antenna knowledge, antenna analyzer, and rig with wide range internal or external antenna tuner.

Technical Stuff

Stealth Coax and Antenna Wire

Balanced Lines

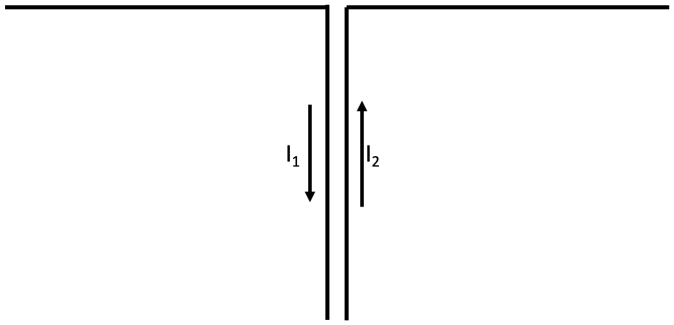


300 Ohm

450 Ohm Ladder Line

600 Ohm Open Wire

The Dipole



Basic Antenna

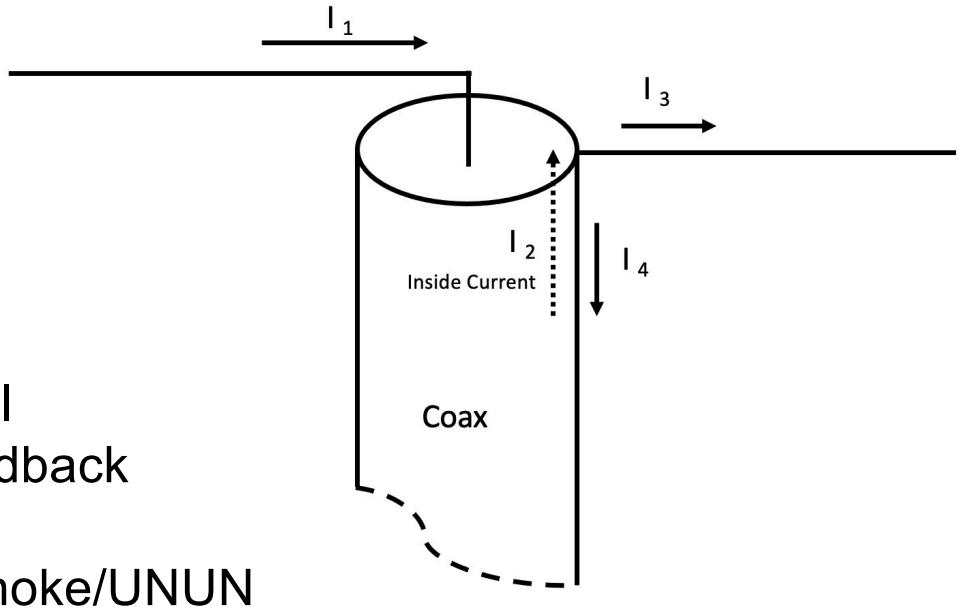
Found in every complex antenna

Fed with balanced line: TV twinlead, Ladder line or Open Wire

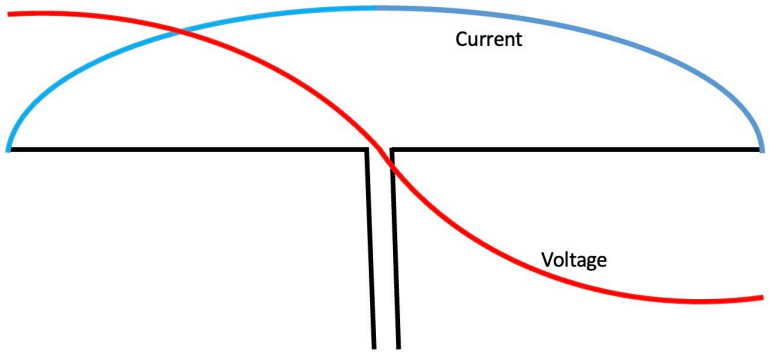
What about COAX?

Coax – Two or Three Conductors?

- Center Conductor
- Inside the Shield
- Current Outside the Shield
  - Changes Radiation Pattern - Vertical
  - Flows back to the source – RF Feedback
- Manage with an Inductor - 1:1 Balun/Choke/UNUN
- Balanced wire feed does not have this problem



Dipole - Voltage and Current



High Voltage on the ends looks for something to couple with.

In Free Space - Couples to Other End

Current Flows From One Side to the Other and Back each Cycle

What does this tell us?

It is balanced & the currents in the balanced transmission are equal and flow in opposite directions each cycle.

Current is maximum at the center and decreases towards the ends.

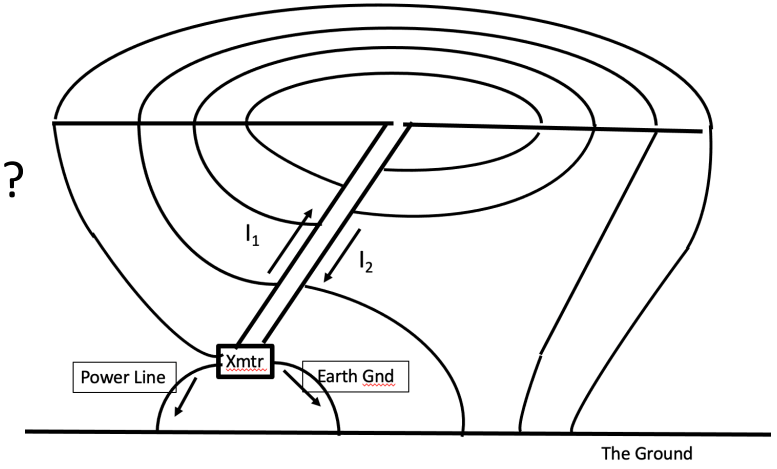
Maximum Radiation from Maximum Current – The Middle

The electric field is maximum at the ends – Danger High Voltage

What happens if there is another place for the current to flow off the ends?

The Second Culprit - End Effect

- Over Earth – Strong Electric Field at Antenna End Allows Current Flow to Ground
- Current Flow to Ground Makes the Antenna look Longer
- Closer to the Ground – Minimum Resonant Frequency Decreases with Increased Current Flow as Antenna is lowered.
- A Half Wave Dipole in Free Space - No End Effect: L = 492/f (f= frequency in MHz)
- Dipole Near Earth, L = 468/f
- ----------
- Can a 40 meter antenna work on 3rd Harmonic, 15 m?
- Dipole Harmonics Complicated by Two CULPRITS
- Two Culprits: Harmonic Mismatch & End Effect



Multi-Band Antennas

- Dual-Band a 40M Dipole tuned to 7.15 MHz
- Third Harmonic should be 21.45 MHz – Harmonic Mismatch
- BUT - actual resonance is 22.1 MHz
- WHY? End Effect of Course.

Bands Not Aligned

Looks Good BUT!
Who operates at bottom of Band?

1st Harmonic	80M	3.5 MHz
2nd	40	7.0
4th	20	14
6th	15	21
8th	10	28

Harmonic Mismatch
REALITY Not Good!

1st Harmonic	80M	3.75 MHz
2nd	40	7.5
4th	20	15
6th	15	22.5
8th	10	30

Example – 40M & 15M Dipole: 15M = 3rd Harmonic

- 15M - Three Colinear Dipoles But Only ONE Experiences End Effect!

No End Effect Where Colinear Dipoles Join

- 2 Dipoles Have No End Effect (L= 492/F) and One Does (L = 468/F)
- 15M on a 40M Dipole Only Experiences (1/3) End Effect
- Length for Resonance on n^{th} harmonic, *L = (468 + (n-1) * 492)/F)*
- Must Lengthen Wire to Compensate loss of length on 2 dipoles.
- This Lowers Min SWR Frequency on 40!

The Length Dilemma

- Cut length for 7.15 MHz *L = 468 / 7.15 = 65.45 ft.*
- Places 15M resonance at 22.1 MHz – above top of band
- Cut length for 21.225 MHz, *L = (468 + 2 * 492) / 21.225 = 68.41 ft*
- Places the 40 m Min SWR at 6.86 MHz – below the bottom of the band!
- What to do?

Getting to Resonance

- *Simple Rule to make a non-resonant length antenna resonate:*

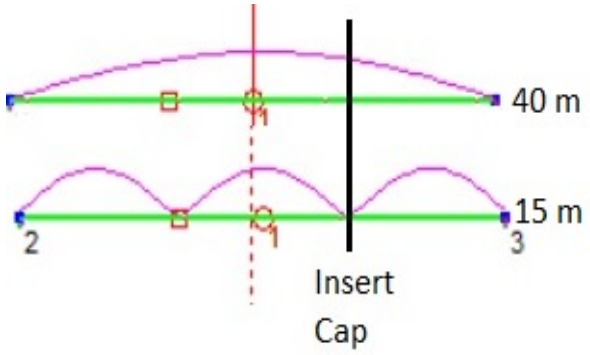
  Too short - Insert an Inductor

  Too long – Insert a capacitor

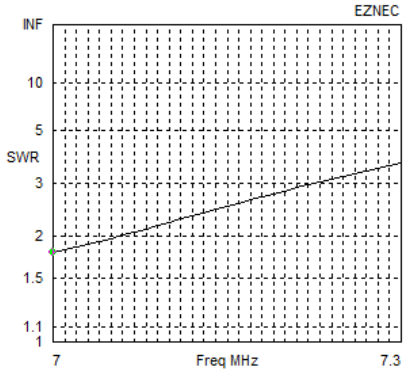
- *Solution: Cut Length for mid-15M & Electrically Shorten for 40M*
  - *Insert 330pF Capacitor at Low Current point on 15M - L/3*
  - Invented by Serge Stroobandt, ON4AA

- *Why 330pF and Why at L/3?*

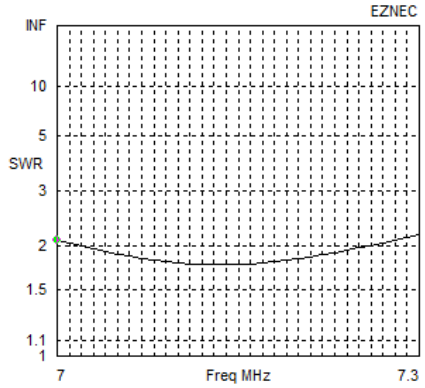
Cap at One-Third



- Low Current Point for 15M Affects 40M but Minimally Affects 15M
- 330pF Cap Moves Minimum 40M SWR to Mid-band



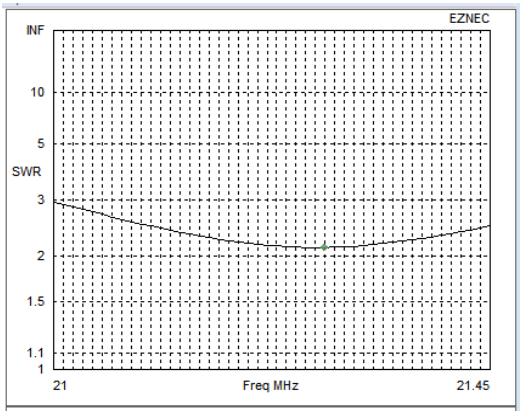
40M Without Cap



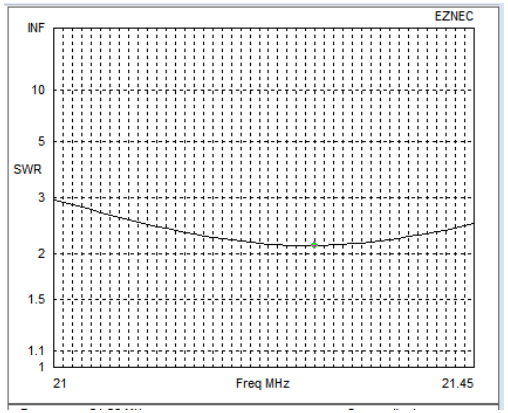
40M With Cap

SWR on 15M

- Simulation-330 pF at One-Third Total length. SWR curve is unchanged
- What Happens to a Real Antenna?

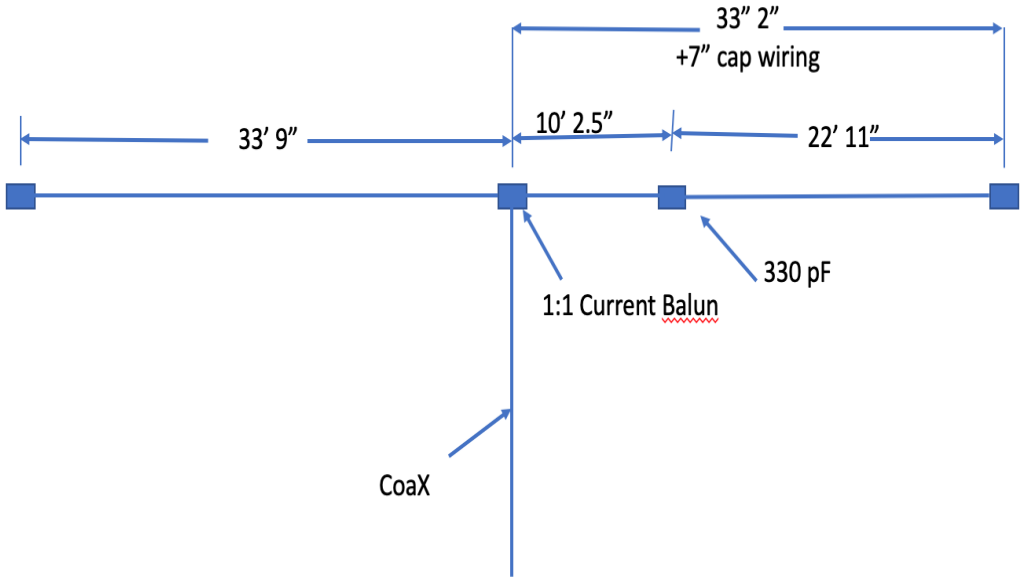


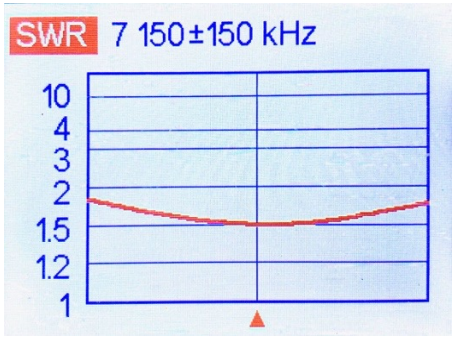
15 M Without Cap

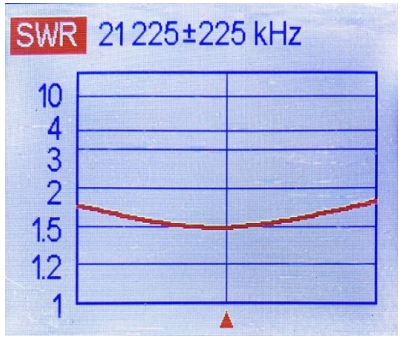


15 M With Cap

40-15 Dipole
(CQ Dec 2020)



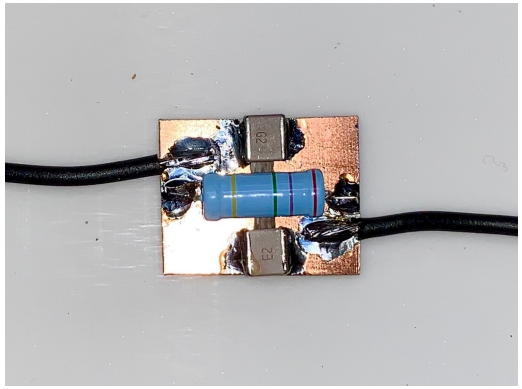


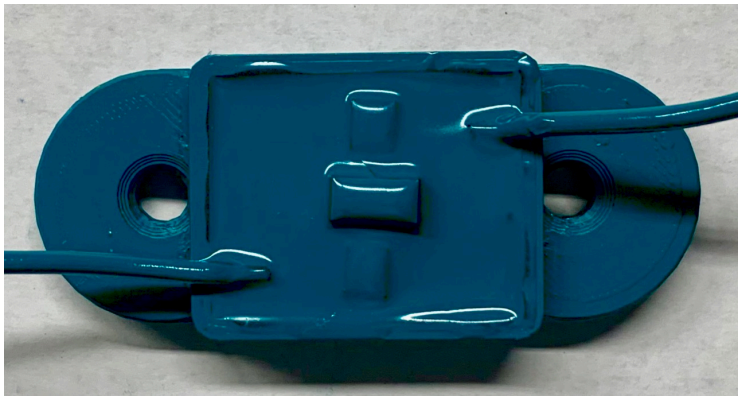


Field Truth

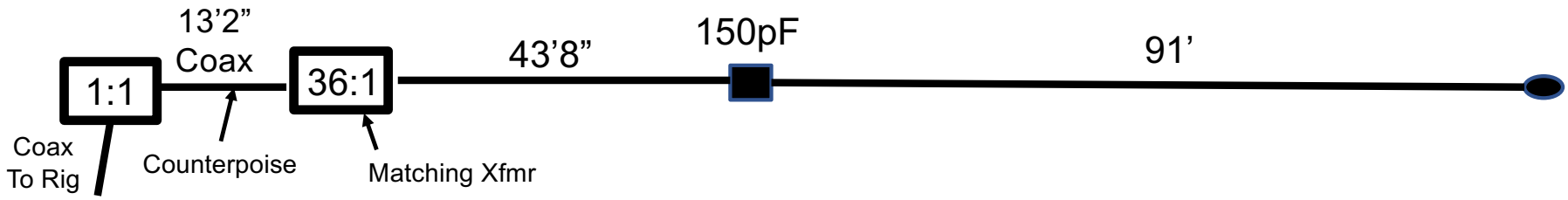
Load

- Capacitor in parallel with 1-4.7M Ohm non-inductive resistor
- Resistor prevents static charge build up



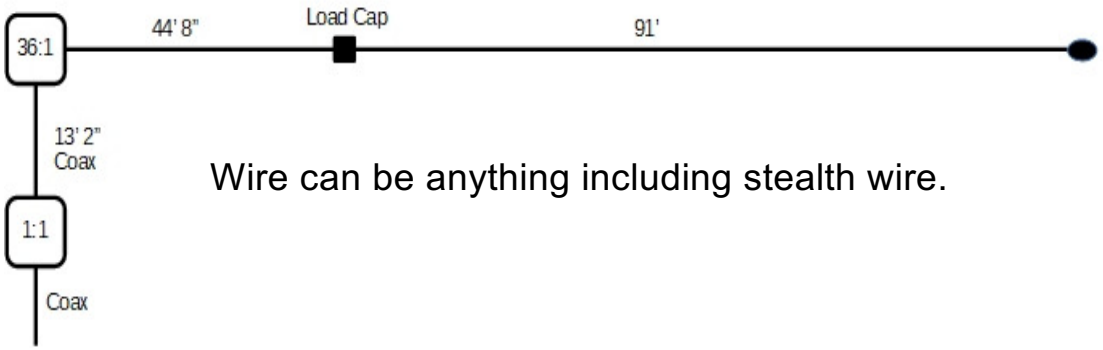


End Feds



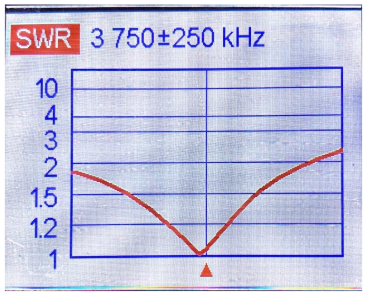
- End Fed is an OCF with a Small Offset Ratio
  - Sometimes Called a Counterpoise
- Don’t believe those who say YOU DO NOT NEED A COUNTERPOISE!
- Do you know why End Feds are flexible?
  - Flat Top, Sloper, Inverted L, Inverted V, Z thru Trees
- Only needs one tree, pole, etc. Coax can be along house
- ”Choose Length for High Bands – Capacitor fixes Low Band/s.”

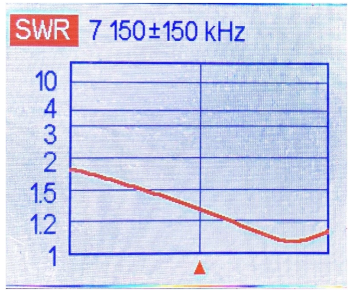
80M End Fed

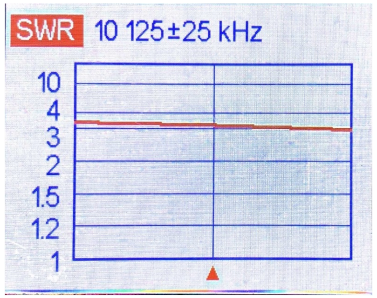


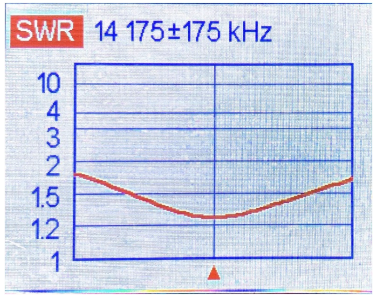
- 150 pF Capacitor at 32% - 80M Resonance at 3.75 MHz Coax Shield is Counterpoise ~ .05x(Wavelength) = 13’2”
- Many Commercial End-Feds Falsely Claim No Counterpoise Needed.
- There will always be a place for RF to return. RF will find it.
- Random or Controlled? Your choice!
- *Random* - Feed Line is Part of the Antenna, Detuning, RF feedback
- *Controlled* -1:1 Balun/Choke Isolates Counterpoise (RF on Shield)
- Control Where RF Goes, Don’t Bet on Being Lucky.

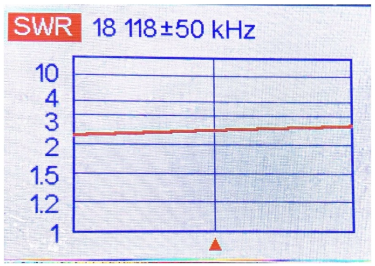
SWR 80M End Fed (FD SSB & CW)

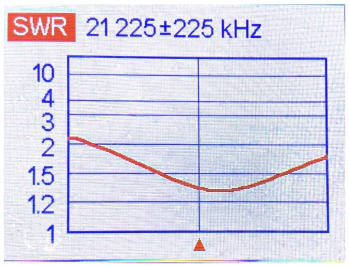


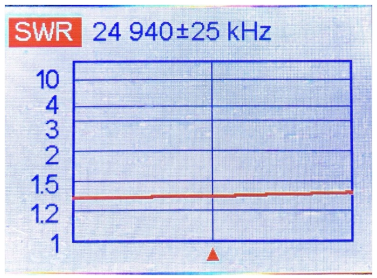


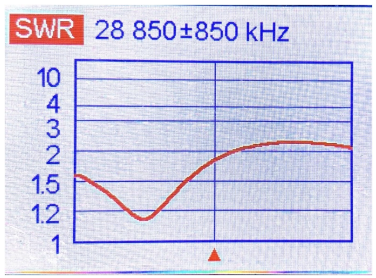




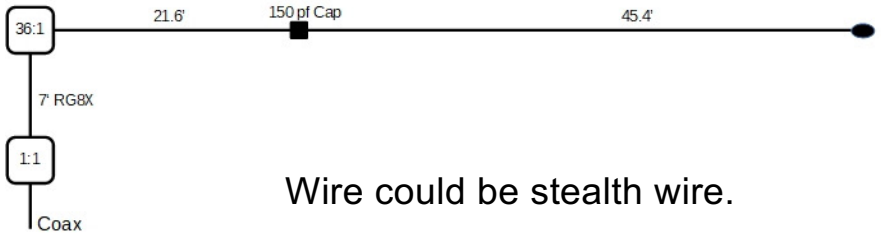






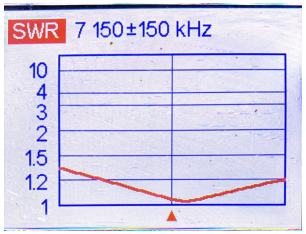


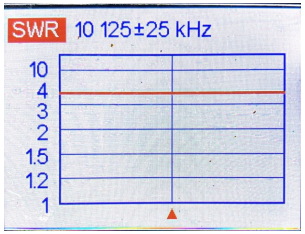
40M End Fed:
FD GOTA Antenna

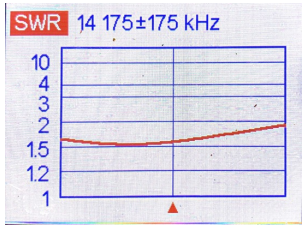


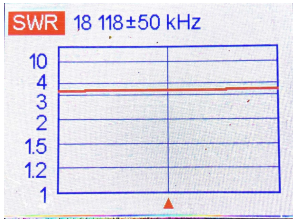
Wire could be stealth wire.

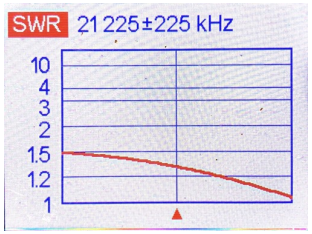
Good Attic Candidate if You Have Space

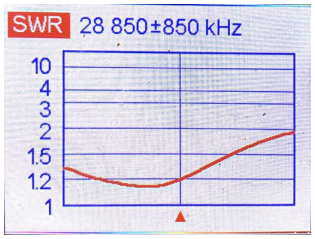


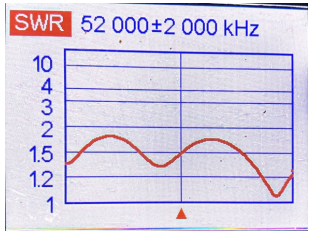






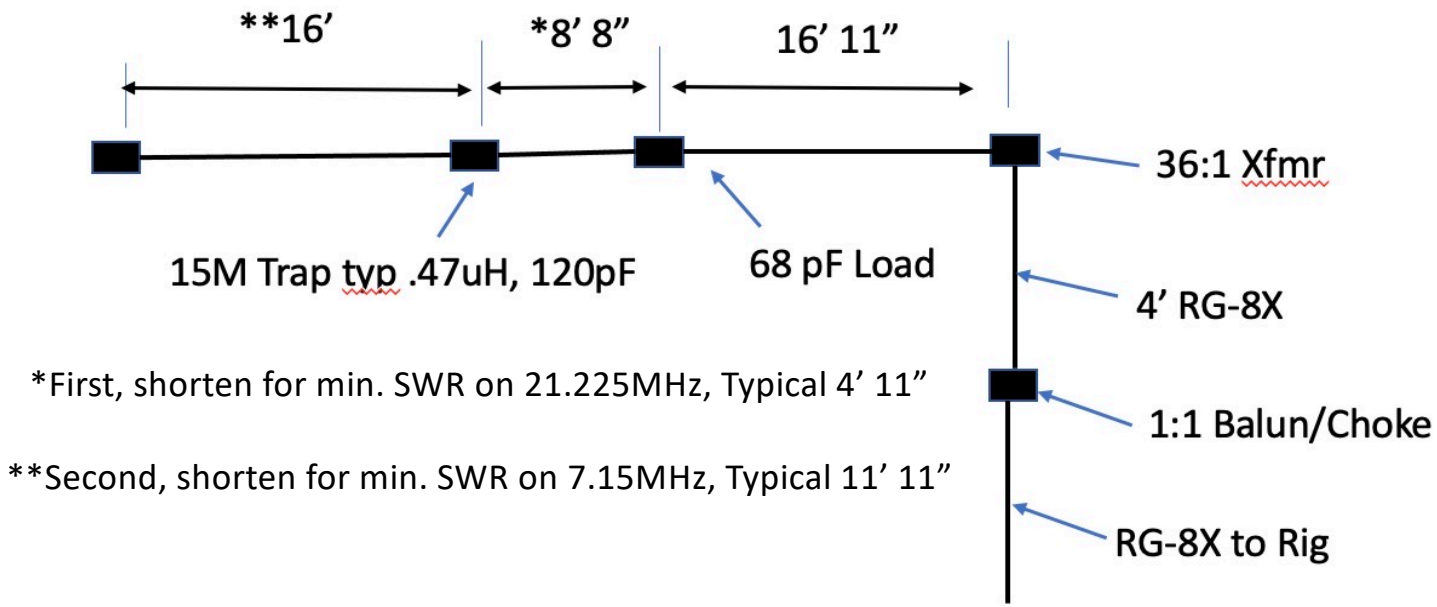






6M – Low Power Transformer 50% Power.
High Power Transformer – Losses Too High

20M, 15M, 10M End Fed Fits More Attics



*First, shorten for min. SWR on 21.225MHz, Typical 4’ 11”

**Second, shorten for min. SWR on 7.15MHz, Typical 11’ 11”

- Maximum Power depends on ratings of load, trap & transformer
- Original Tests in Attic at 100W SSB!

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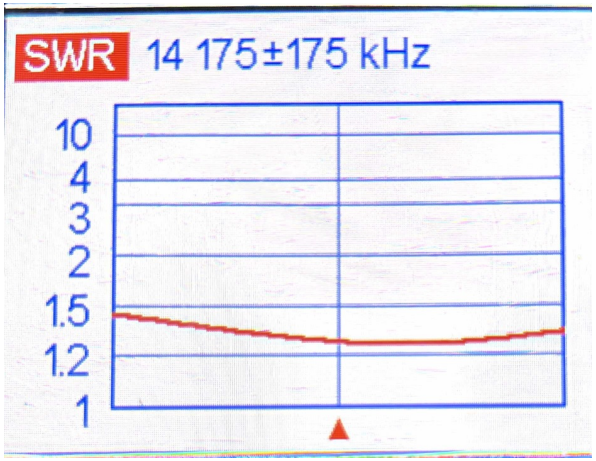
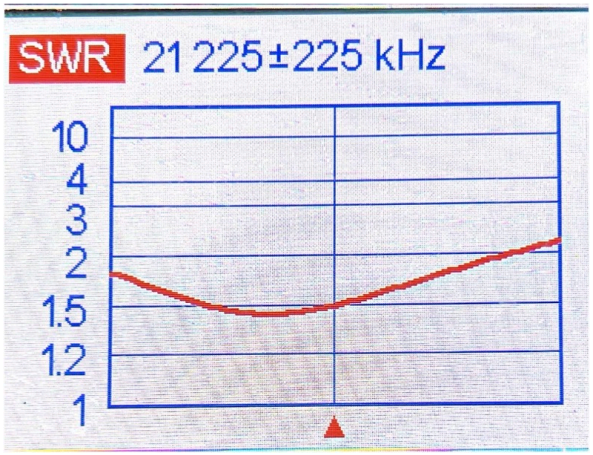
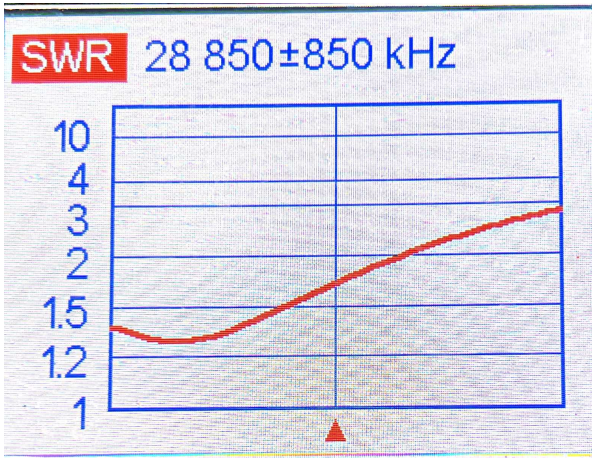
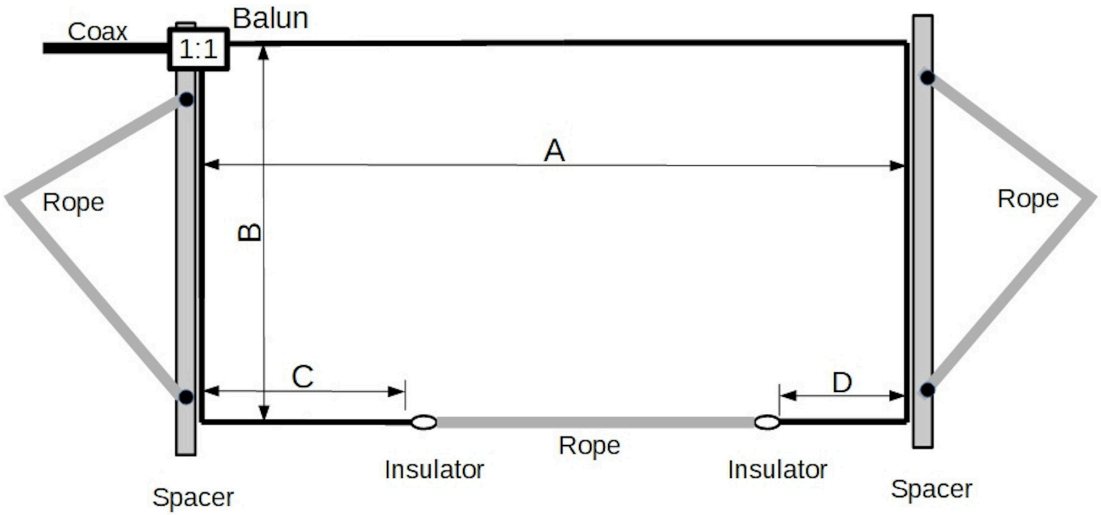
20M, 15M, 10M End Fed SWR







40M C-Pole for Limited Space



- OCF Half Wave Dipole Folded into a C
- Wood Spacers
- A = 24 Ft, B = 12 Ft, C = 7.5 Ft, D = 10.17 Ft (End Space is Rope)
- Off Center Rope Harness Compensates Weight Imbalance, Balun & Coax

40m C-Pole Details are Flexible

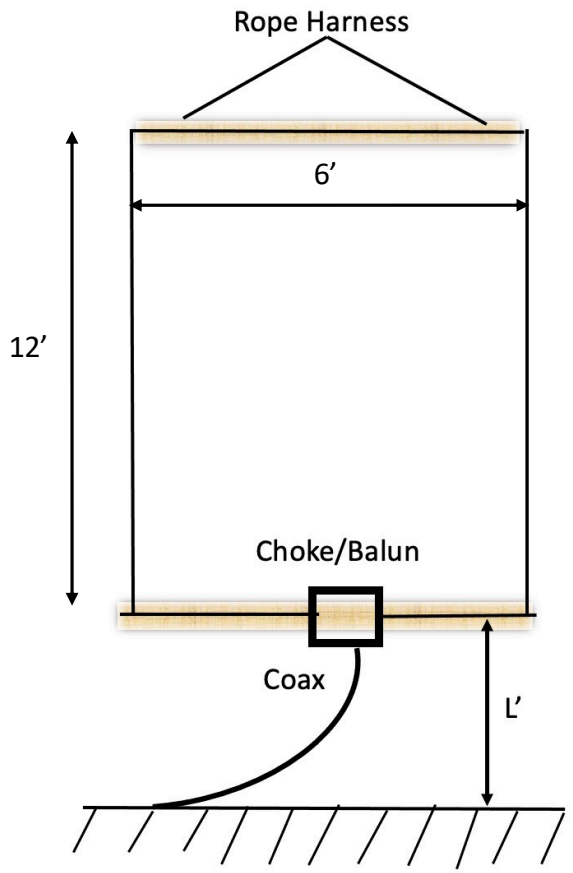
- Total Length of Radiator ~ 66 Ft
- Widths 10 Ft to 14 Ft Produce Usable Antenna
- The Gap Should be > 6 Ft, Smaller Gap = Lower Bandwidth
- Feedpoint Location Delivers 50 ohm Impedance
- Balun is Required (Off Center Feed is Unbalanced)
- Can be Hung Vertically
- This is a compromise antenna. Gain is a bit less than a dipole.

Rules for Attic Antennas

- Keep antenna a few inches away from wood
- Keep antenna & counterpoise away from Metal Ducts & Wires
- Don’t expose family and friends to high levels of Radiation.
- Run < 100Watts

Simple 10M Vertical Wire Loop

- Portable & Horizontal Polarization
- Hang From Tree Limb ~20’ up
- Wood Spreaders
- Balun - 3 T RG-8x 4” D
- Max Gain Perpendicular to Plane
- ~ 1dB Gain over Dipole
- Scalable to other Bands



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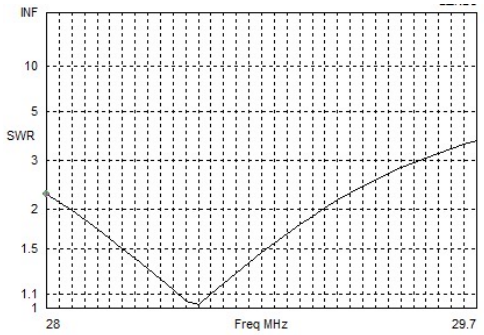
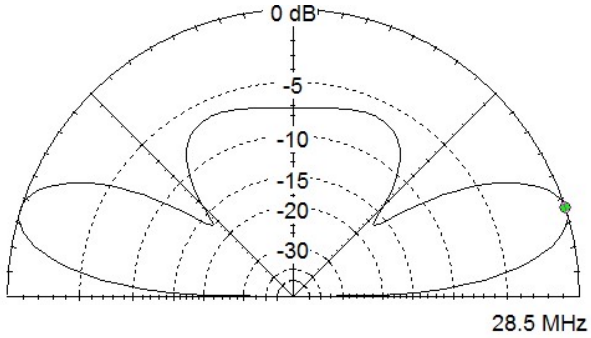
Wire Loop Dimensions 6 – 20 Meters

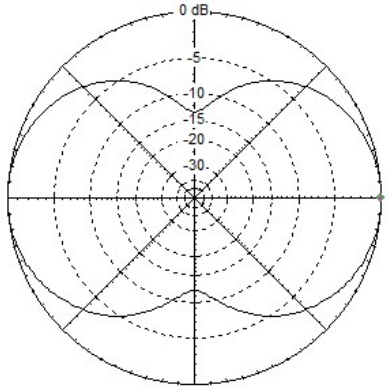
Band	Takeoff Angle, Degrees @ 20 ft To Bottom	Gain, dBi @ 20 ft	Dimensions, Feet
20 m	27	7.37	13.6’ x 22.25’
17m	23	7.03	9.3’’ x 18.83’
15 m	21	7.88	7.88’ x 16.05’
10 m	18	7.99	6’ x 11.8’
6 m	11	8.18	3.4’ x 6.6’

SWR Elevation & Azimuth Patterns

- Other Bands are Similar







If these don’t work for you – Improvise!

Anything can be made to radiate. How well? Experiment!

Center of Coax is connected to one wire, Shield to Counterpoise

Hang a wire out or inside the window, there must always be two poles

RF will find the other pole if you don’t provide one.

Wire on the floor or snaked around the furniture

Tied to anything metal window frame, down spout, balcony railing, etc. Not power wires

Run low power – don’t radiate yourself, family, neighbors or pets!

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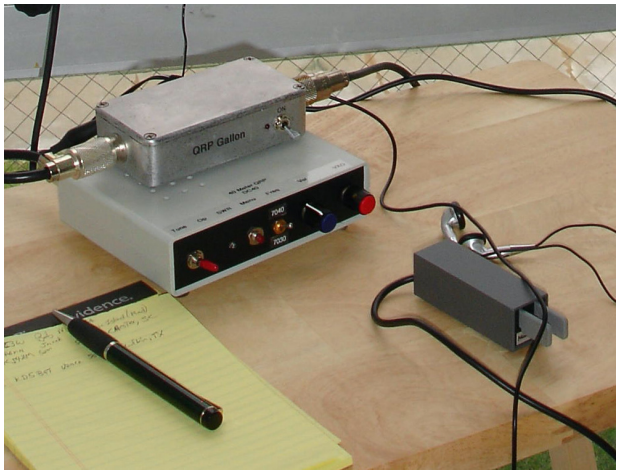
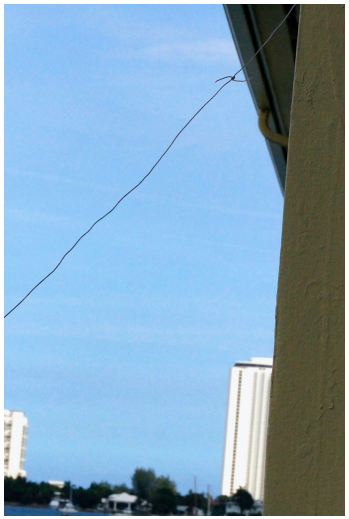
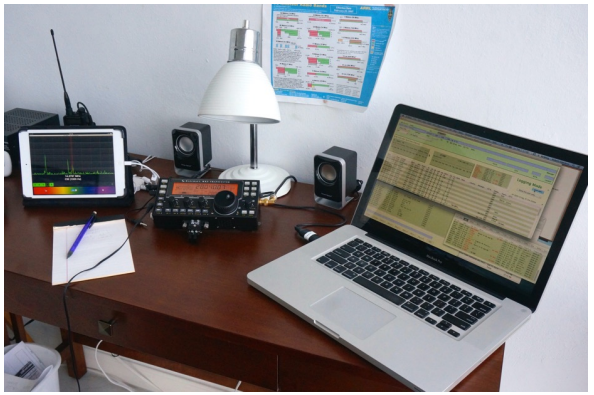
600 ft^{2}Condo!







Rules of Thumb

As a general rule, the More Wire and the More Height the better.

Those who put an antenna near or on the ground for NVIS are probably spending more energy heating the ground than they are radiating. $\lambda/4$ on 80, 60 or 40m is perfect for NVIS!

VHF antennas used for local communications benefit from as much height as you can get.

A good VHF antenna has a low take-off angle for local “line of sight” communications.

Antennas longer than two wavelengths become directive with gain towards the ends accompanied by sharp nulls elsewhere. That station you can’t seem to work is likely in the direction of a null.

Resonance is the frequency at which the antenna is purely resistive, reactance is zero. The Minimum SWR frequency often has a small reactance, placing it close to the resonant frequency. Sometimes the separation can be large. In that case, the Minimum SWR point provides the best match for your rig.

RF in the shack is caused either by RF coming down the feed line or directly coupled radiation from the antenna that may be too close to the shack.

The impedance at the end of a one-half electrical wavelength transmission line is reflected at the other end.

A quarter wave transmission line shorted at one end exhibits a very high, theoretically infinite, impedance at the other end.

Gain is only useful if the signal is aimed to propagate where you wish to communicate.

High Impedance Balanced Feeders such as TV twin lead, ladder line or open wire, have much lower loss than coax. That's why balanced feeders are often used for long runs. TV twin-lead can handle 100 watts

An antenna with coax directly connected without a balun isn't balanced and the shield of the coax will radiate as part of the antenna.

Handle coax carefully. Sharp bends can cause center conductor migration resulting in signal loss including a short. Don't roll it up around your arm as you would rope.

Ferrite beads around coax can be a good balun but it takes a lot of beads to beat coax wrapped around a ferrite core as shown in Chapter 6. The inductance of bead baluns increases linearly as you add beads whereas the inductance of windings goes up as the square of the number of turns.

Antennas Are Weird? By Allison, KB1GMX

They are not weird.
They are mean.

They entice us to go out
in the hot,
the cold,
the wet,
the snow,
to make them work right.

Then they further antagonize us
by falling down.

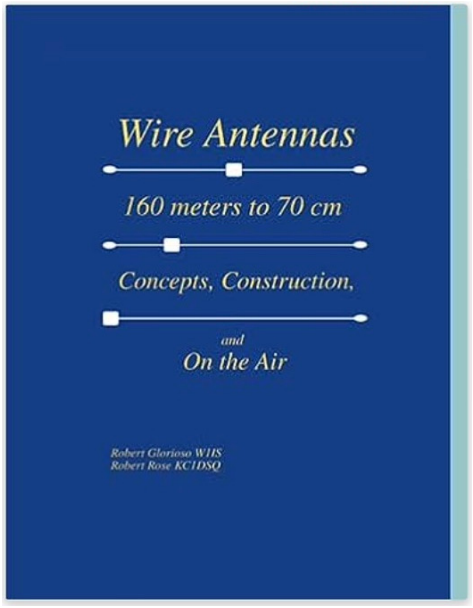
They even enlist squirrels to help.

Physics dictates their behavior
while nature
makes fun of us.

$(Bob)^2$ Latest Publications

- “A 70-cm ”Kitchen Array” CQ Magazine, August 2023, pp77-81
- “Wire Antennas 160 meters to 70 cm, Concepts, Construction and On the Air,” available at OCFMasters.com, Ham Radio Outlet, Amazon

- Don’t buy our Book unless you absolutely need it.
- Second Edition Is On the Way!
- Christmas….we hope.

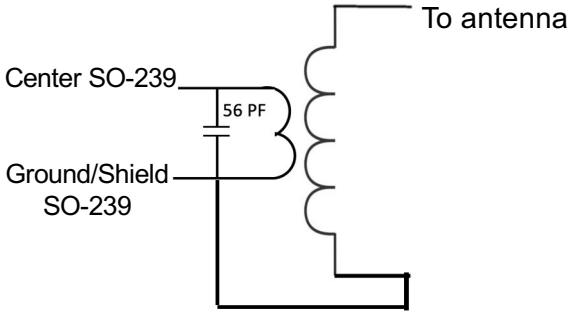


OCFMasters.com

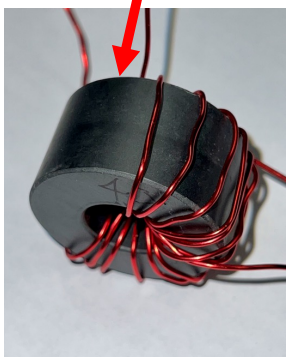
Thank You & 73

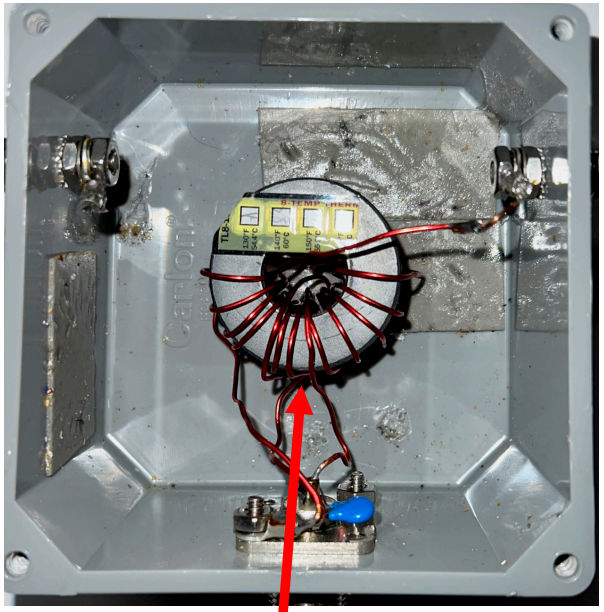
Bob^2

36:1 End Fed Xfmr



Fair Rite
2643251002





Primary at Center
Low Z

- Primary at Center of Secondary, No Capacitive Loading
- 36:1 = Low Reactance, Lower SWRs. Wider BW
- 140-43 for less than 150 Watts, lower loss enables 6m operation at ½ power
- 150W & 800W 36:1 (Xfmrs & Capacitive EF Loads at BalunDesigns.com)

1:1 Balun/Choke/UNUN for End Feds

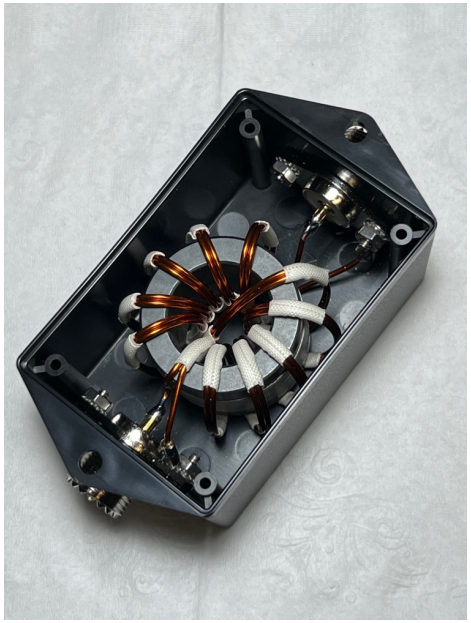
At end of Counterpoise Coax

High Voltage at end of Coax at Connector

Needs Sufficient Isolation to:

Make Antenna work properly on lowest frequency/band
Keep RF off Feed Line to Shack

Spec 30 dB Isolation across Bands



Balun Designs Prototype
End Fed 30dB Isolation 1:1 Balun/Choke