HF Antennas

Big & Small

This presentation is about antennas that are suitable for high frequency (HF) operation in the 3 to 30 MHz range, but the principles apply to all available ham radio frequencies. Some software is shown that aides the design process for antennas that involve complex or burdensome mathematical calculations.

Presenter: Augie “Gus” Hansen, KB0YH

Introduction to HF Antennas

Part 1
Simple Antennas

Part 2
Gain Antennas

Part 3
Specialty Antennas

Introduction to HF Antennas

Part 1
Simple Antennas

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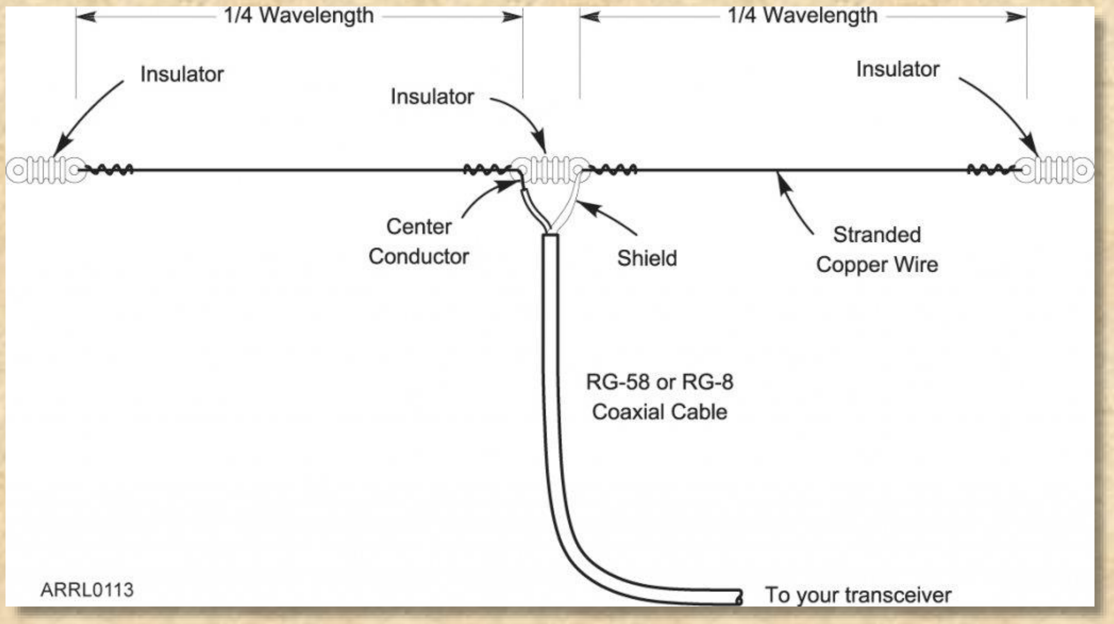
Part 3
Specialty Antennas

Antenna basics – Purpose, design, implementation
Wire antennas – Dipole, vertical, loop
Rigid antennas – Vertical, rotatable dipole



Part 1
Simple Antennas

We'll start with a few fundamental antenna concepts to provide an understanding of electro-magnetic waves. Then we'll explore a range of antennas that are inexpensive, easy to build, and that perform well enough to get you on the air and making contacts.

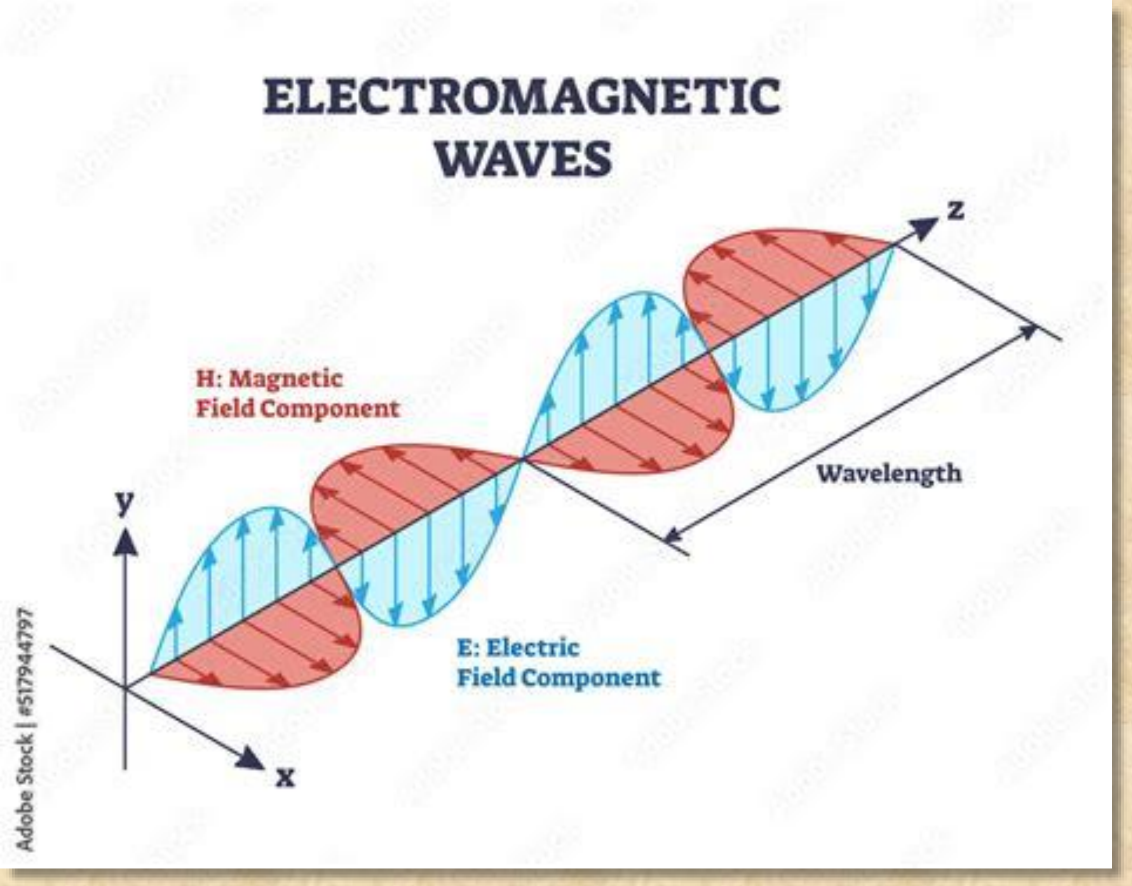
Units of Measure

- Measurement Standards
  - Imperial
    - Often called English or Standard
    - Liquid measurements vary by region
  - Metric

- Length
  - Feet, Inches
  - Meters, Millimeters
- Area
  - Square feet
  - Square meters
- Volume
  - Cubic feet
  - Cubic meters

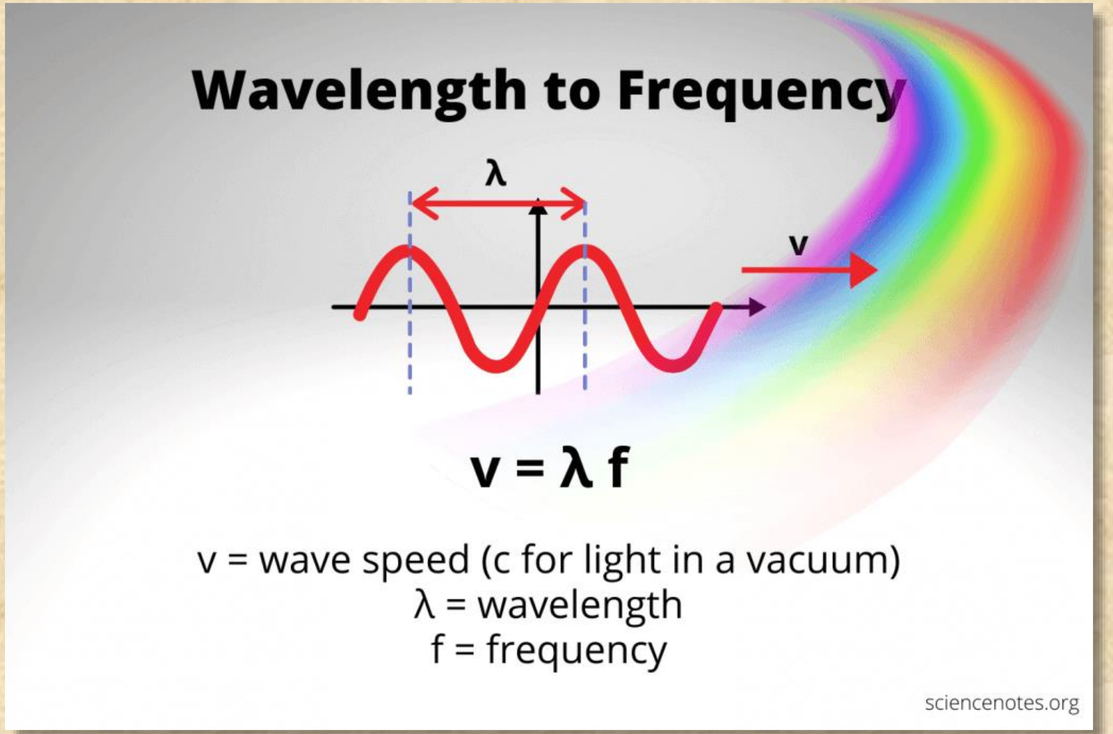
Concepts and Terms: Electro-Magnetic Wave

- Field Components
  - Electric Field (E)
  - Magnetic Field (H)
- Poynting Vector (S = E x H)
- Polarization (w.r.t RF ground)
  - Orientation of the E Field
  - Polarity is magnitude



Concepts and Terms: Electro-Magnetic Wave

- Wavelength and Frequency are inversely related
- The velocity v
  - The speed of light, c, in vacuum
  - Slower in transmission lines, ground, other insulating media
- Either E or H may dominate in the near field
- Free Space Impedance (377 Ohms)



Concepts and Terms: Near and Far Fields

- Reactive Near Field
  - Very close to the antenna structure
  - Energy sloshes forth and back between reactive components
- Radiative Near Field
  - Energy begins to move away from the antenna
- Far Field
  - Several wavelengths from antenna
  - Extends to “infinity”, limited by the inverse square law

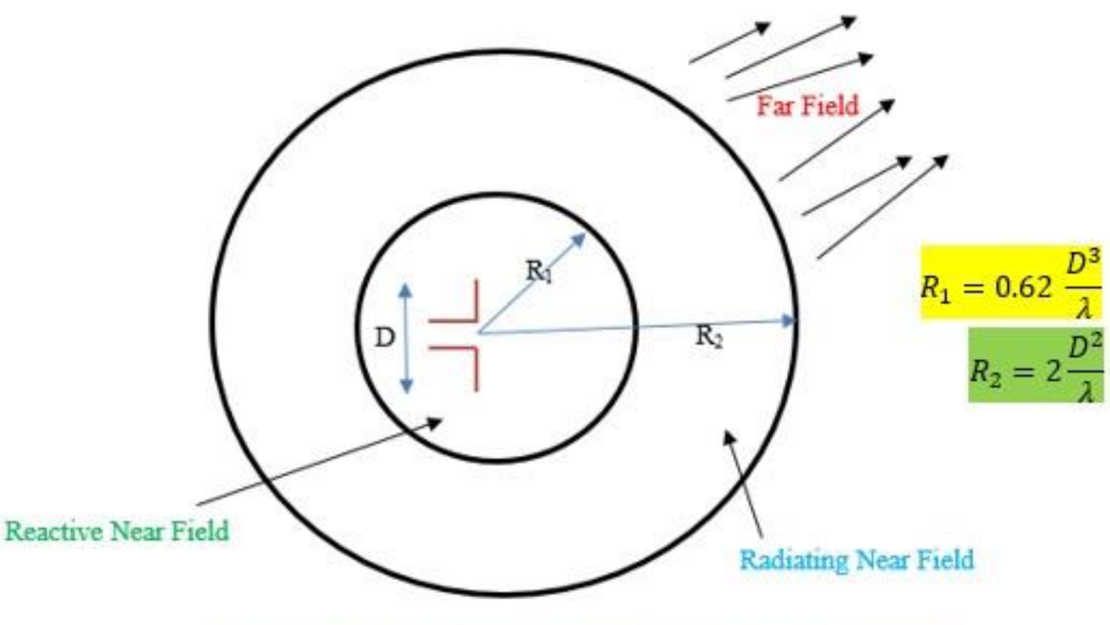
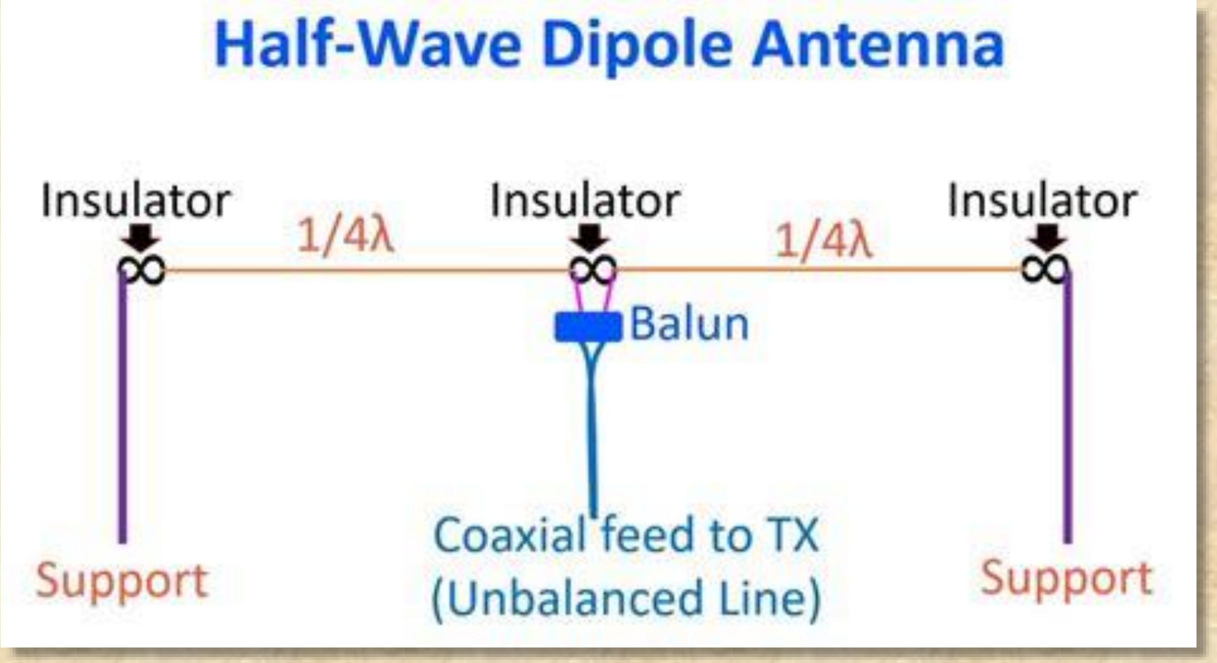


Figure: Field Regions surrounding an Antenna

Halfwave Dipole

- A half wavelength conductor
  - Wire
  - Tubing
  - Conducting surfaces
- Feedpoint in the center
  - High current in the center
  - High voltages at the open ends
  - Z is about 72 Ω – Use RG59 or other 75 Ω coax
  - Z at open ends is typically several thousand Ohms

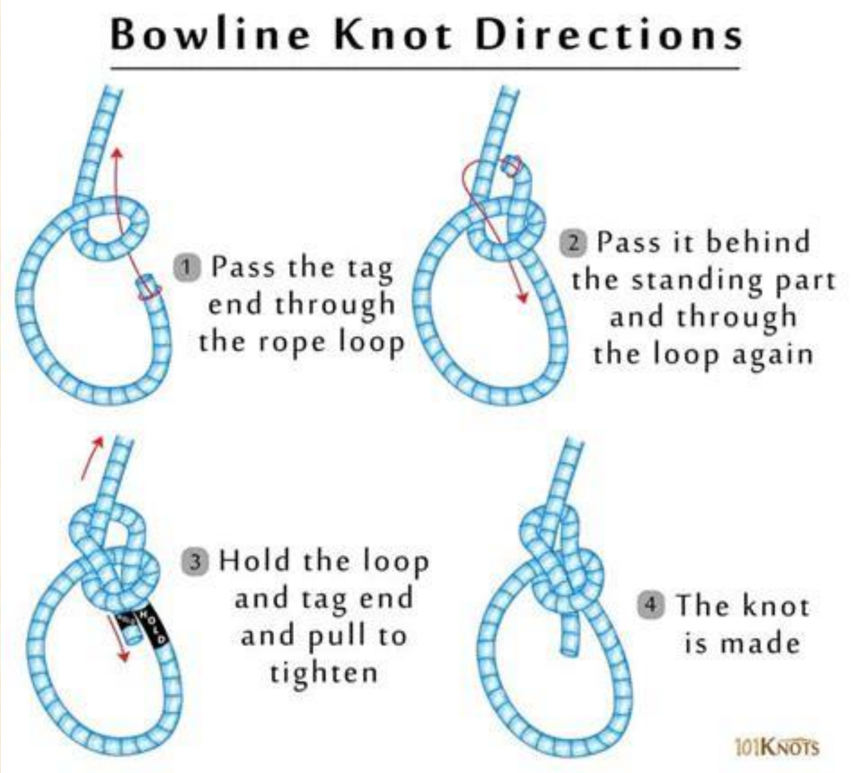


Center and End Insulator Types

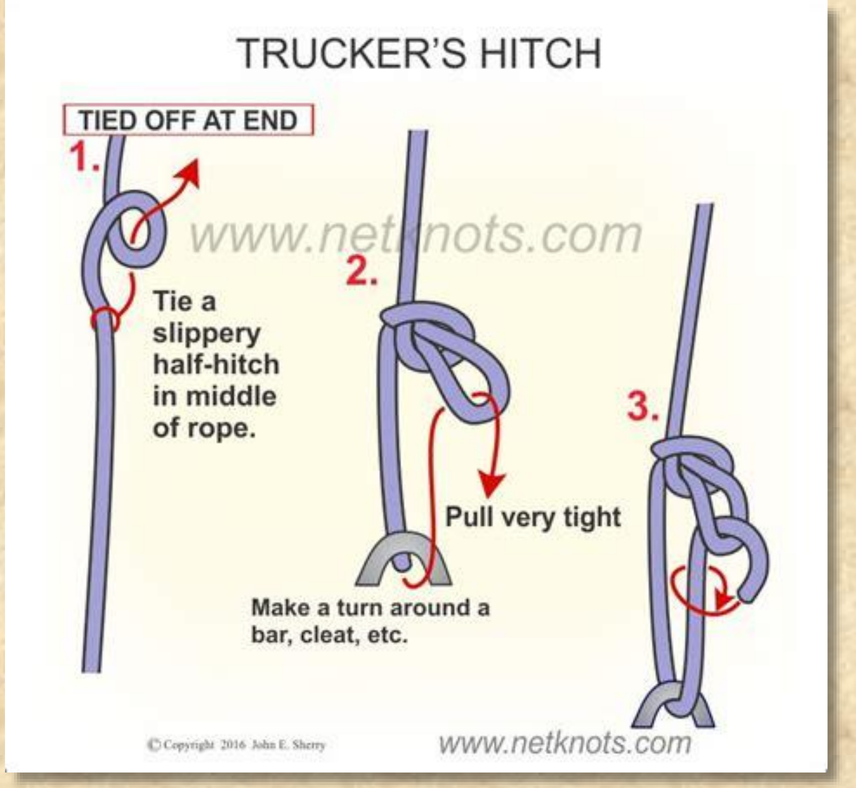
- Ceramic or plastic items commercially available
- Can be made from PVC or fiberglass tubing

Secure Connections and Attachments

Bowline Knot (Fixed End)

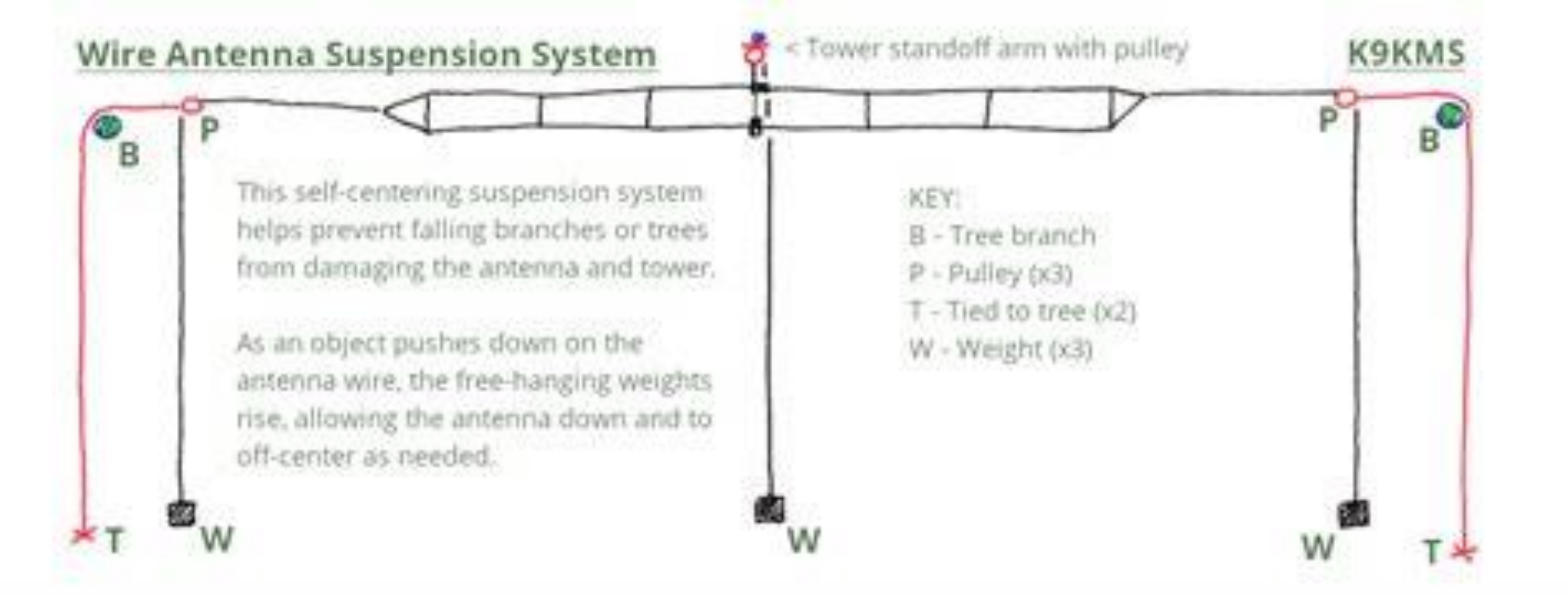


Trucker's Hitch (Adjustable End)



Secure Connections and Attachments

This folded dipole system schematic highlights important aspects of designing for survivability.



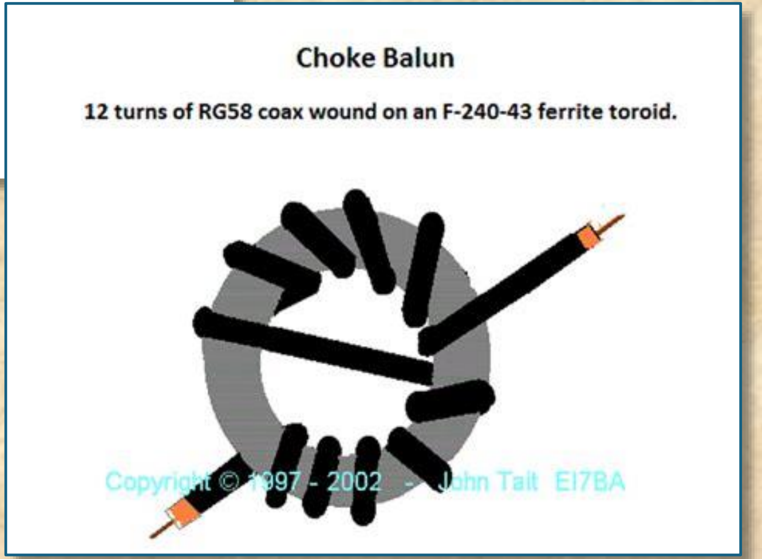
Secure Connections and Attachments

Insulated Sliding Corner

Insulated Fixed Corner

Balanced-to-Unbalanced (BALUN) Basics

- A BALUN is used to connect an unbalanced line (usually coax) to a balanced circuit
- A linear BALUN consists of *many* small ferrite beads on a small diameter coax cable
- A toroidal BALUN can be more compact than an equivalent linear type



Ferrite Core Material

- HF BALUNs use one or more mix #31 or mix #43 toroidal ferrite cores
  - Series construction (bandwidth)
  - Stacked construction (power)
- Mix 31 provides broad HF coverage (~1.5-30 MHz)
- Mix 43 favors high HF and VHF frequencies (~10-250 Hz)
- *Loss resistance* provides choking action

A 1:1.5 UNUN in series with a 75Ω choke (top)

Dipole Design

Wire Dipole

- Relatively thin elements
  - Uninsulated wire
  - Insulated wire
- Magnet wire (enamel coated)
- Frequency is in Megahertz (MHz)
- Imperial calculation in feet
- Metric calculation in meters

Tubing Dipole

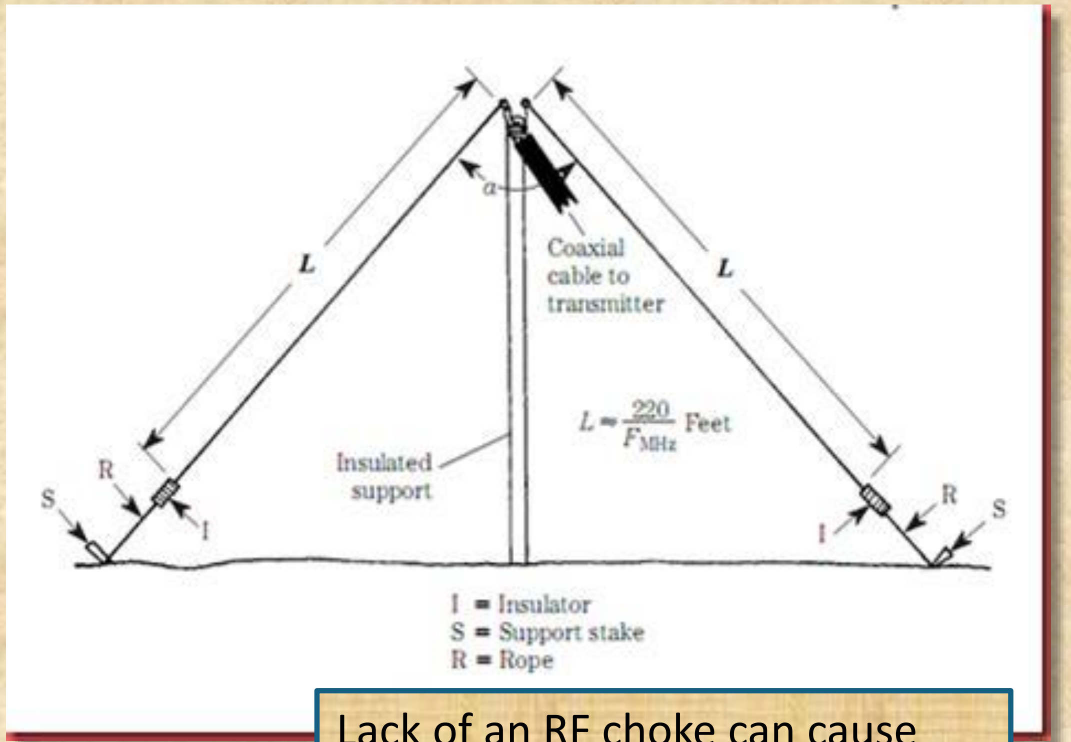
- Relatively thick elements
  - Aluminum or copper tubing
  - Flat mill stock
- Elements will be slightly shorter (make adjustable)

$$\textit{Imperial}: L = 468/f$$

$$\textit{Metric}: L = 143/f$$

Dipole Variants:
Inverted Vee Dipole

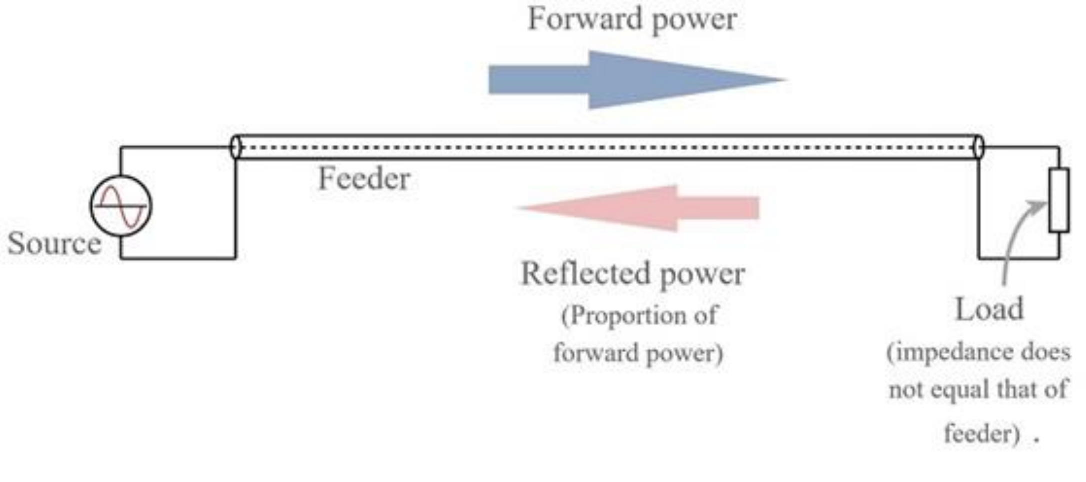
- Description
  - Half wavelength conductor
  - Feed point in the middle at top
  - Support
    - Non-conducting or
    - Antenna isolated from conductive member
  - Quarter wave sides sloped down
  - Adjustments needed to wire lengths to compensate for height above ground
- A choke/balun needed (not shown)



Lack of an RF choke can cause unwanted pattern distortion and erroneous VSWR readings.

Voltage Standing Wave Ratio (VSWR): Antenna *System* Performance Measurement

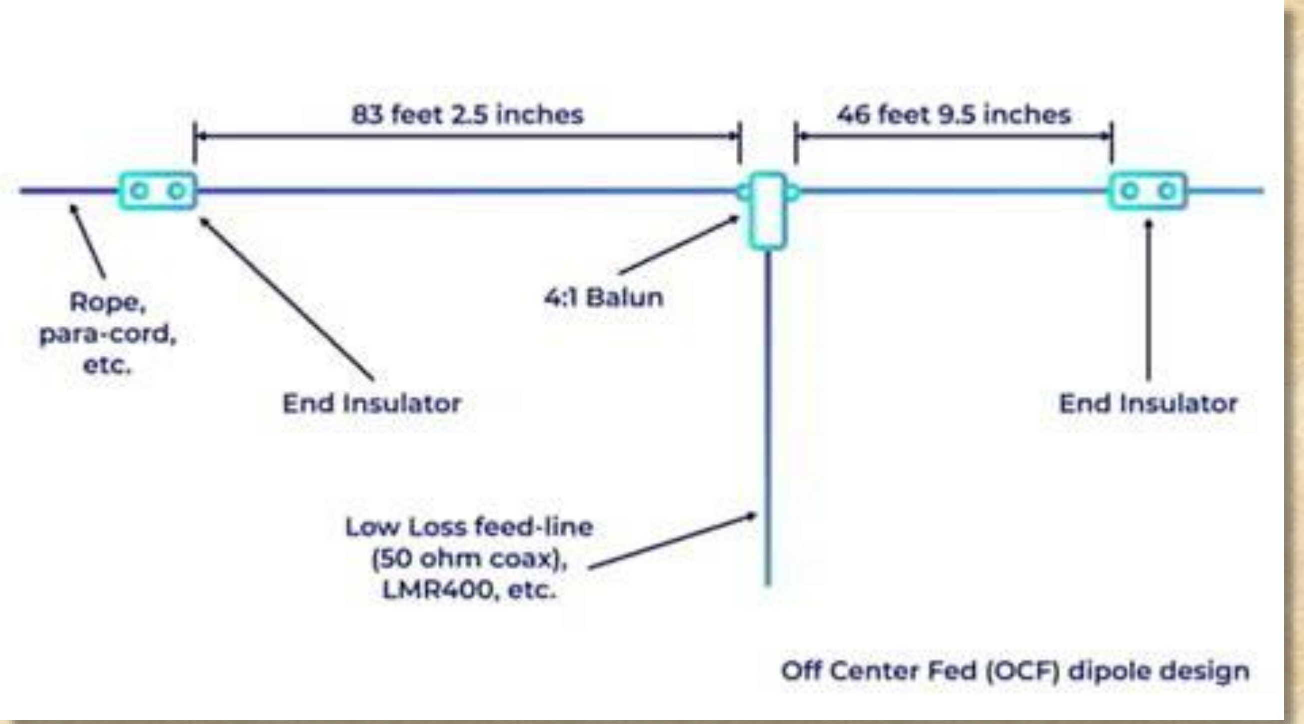
- VSWR is the ratio of the maximum to the minimum voltages in the resulting standing wave
- Values
  - 1:1 means no reflected wave due to a perfect match
  - N:1 indicates some reflected power due to a mismatch at the load – bigger N means more reflected power



$$\text{VSWR} = \frac{1+|\Gamma|}{1-|\Gamma|}$$; where Γ is the reflection coefficient.

Dipole Variants:
Off-Center Fed Dipole (OFCD)

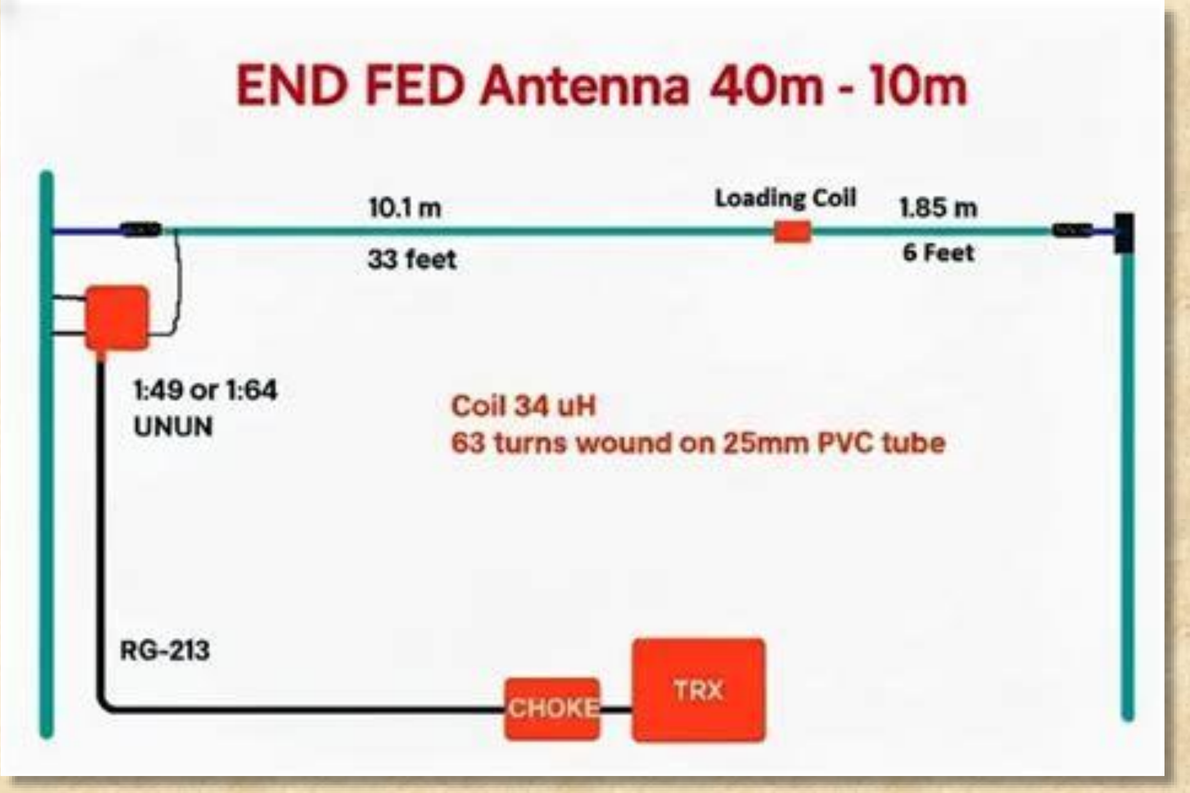
- Feed the antenna at a higher impedance point
- Use a matching network to operate on one of several bands
- Requires a quality 4:1 balun
- A choke on the feedline at shack end may be needed to reduce pickup on shield



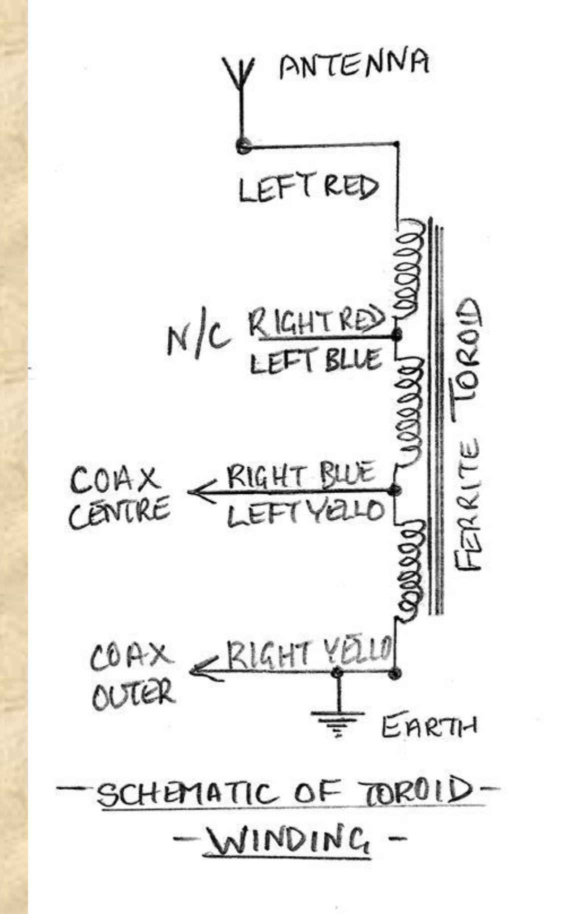
Useful mnemonic: $\frac{E}{I\,R}$

Dipole Variants:
End-Fed Half-Wave (EFHW)

- Feed the antenna at one end (high impedance)
- Use a high ratio UNUN to reduce the impedance for use with coaxial cable
- A choke at the rig end is needed to reduce common-mode current on the shield
- A metal support pole or a wire to ground is required

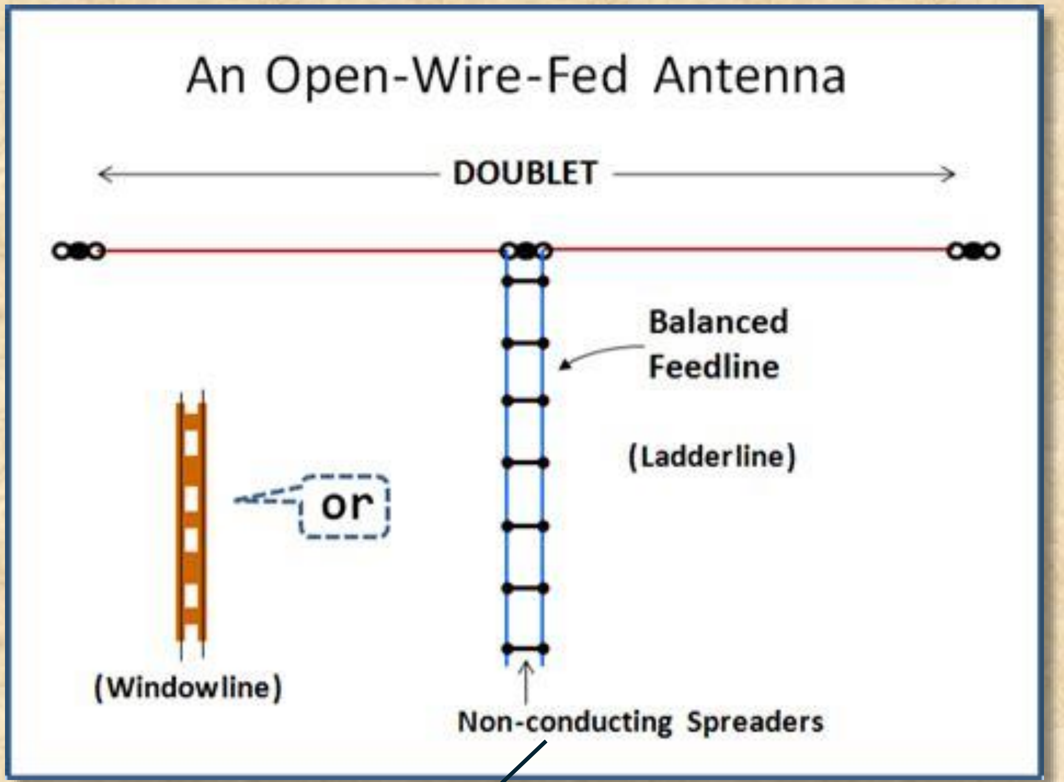


UNbalanced-to-UNbalanced (UNUN) Transformer



Dipole Variants: Non-resonant Doublet

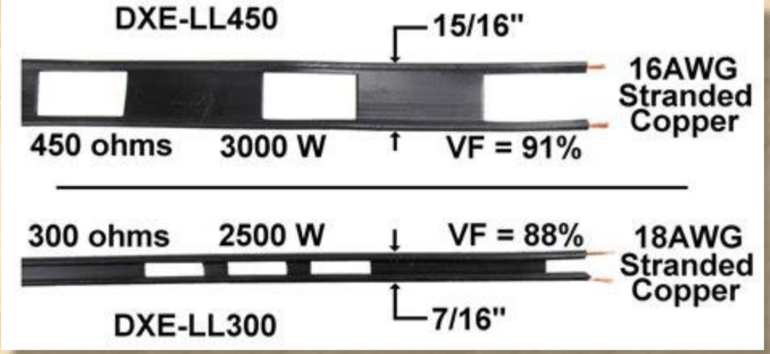
- The antenna is purposely not resonant in any ham band
- Fed with either ladder line or window line
- Requires a matching network (antenna tuner) at the station end



Use a 1:1 (or 4:1) balun and a short coaxial cable to an unbalanced input/output on rig

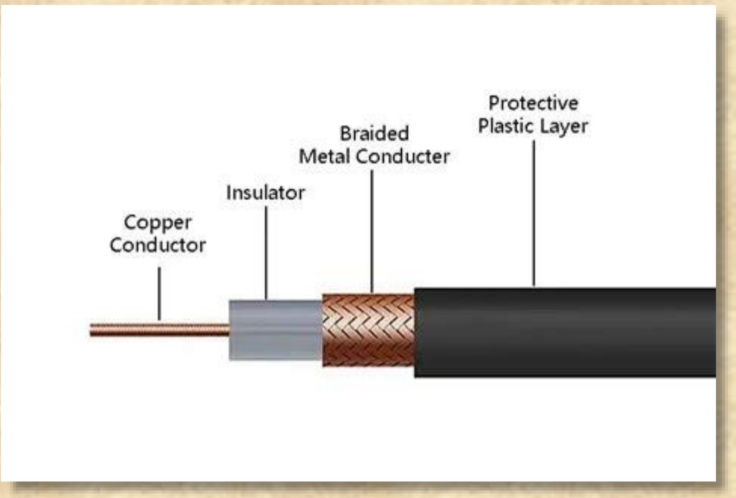
Transmission Lines: Parallel Wire Lines

- Open Wire (Ladder) Line
  - Wide spacing between wires
  - 600 Ohm, very low loss
- Twin Lead
  - Close-spaced wires
  - Full jacket insulation
  - 300 or 75 Ohms, lossy
- Window Line
  - Medium-spaced wires
  - Jacket has open areas, lower loss
  - Nominal 450 Ohms (~400)

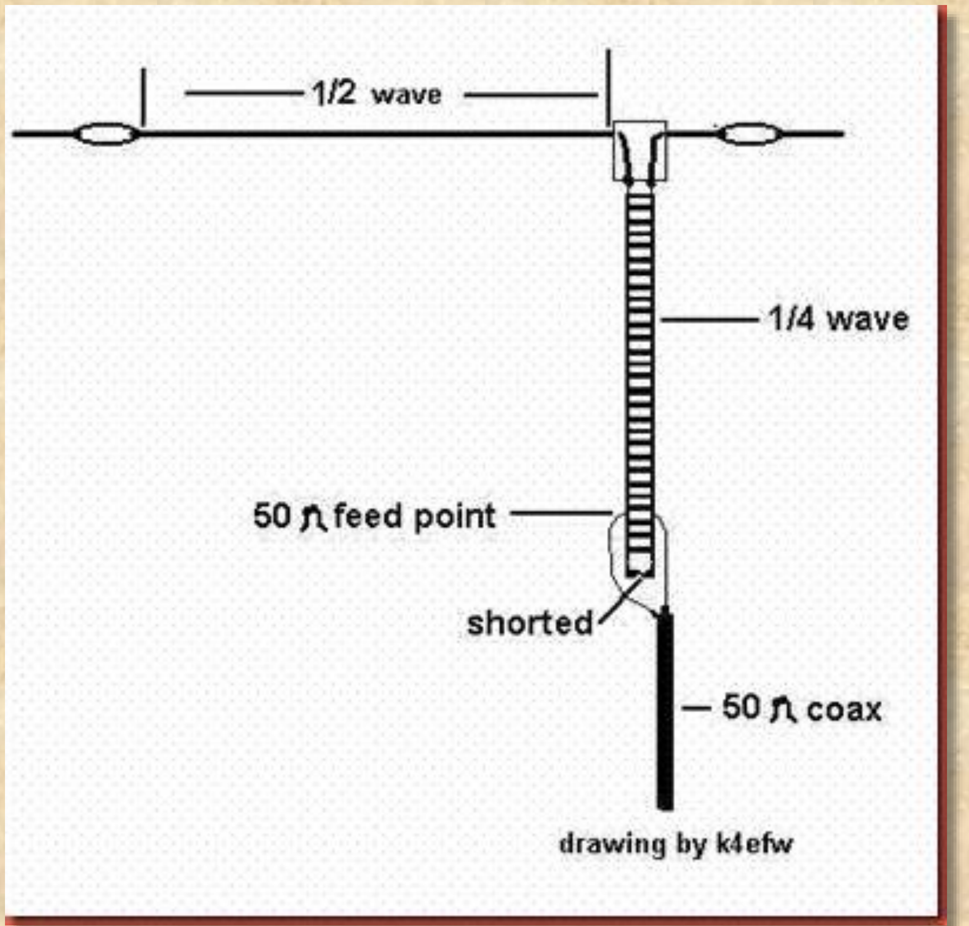


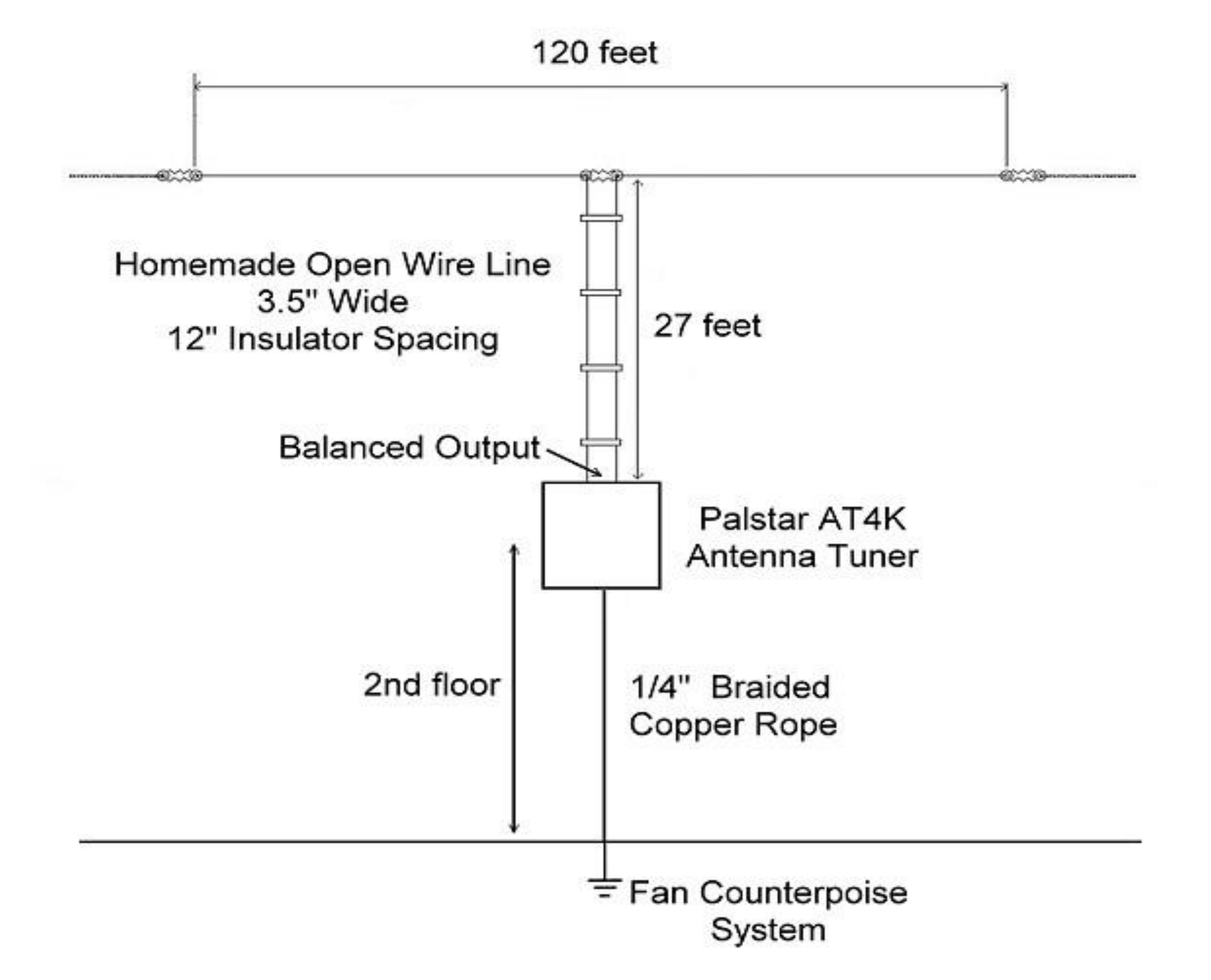
Transmission Lines: Coaxial Cable (Coax)

- Flexible shielded cable
  - Insulated center conductor
  - Braded wire shield (~95%)
  - Some types have inner foil shield
  - Protective outer layer
  - 50 Ohms or 75 Ohms
- Hard Line
  - Insulated center conductor
  - Hard, tubular shield
  - Protective outer layer
  - 50 Ohms
  - Low loss



Zepp Antennas – Traditional and Double Extended





Quarter-wave Ground Mounted Vertical

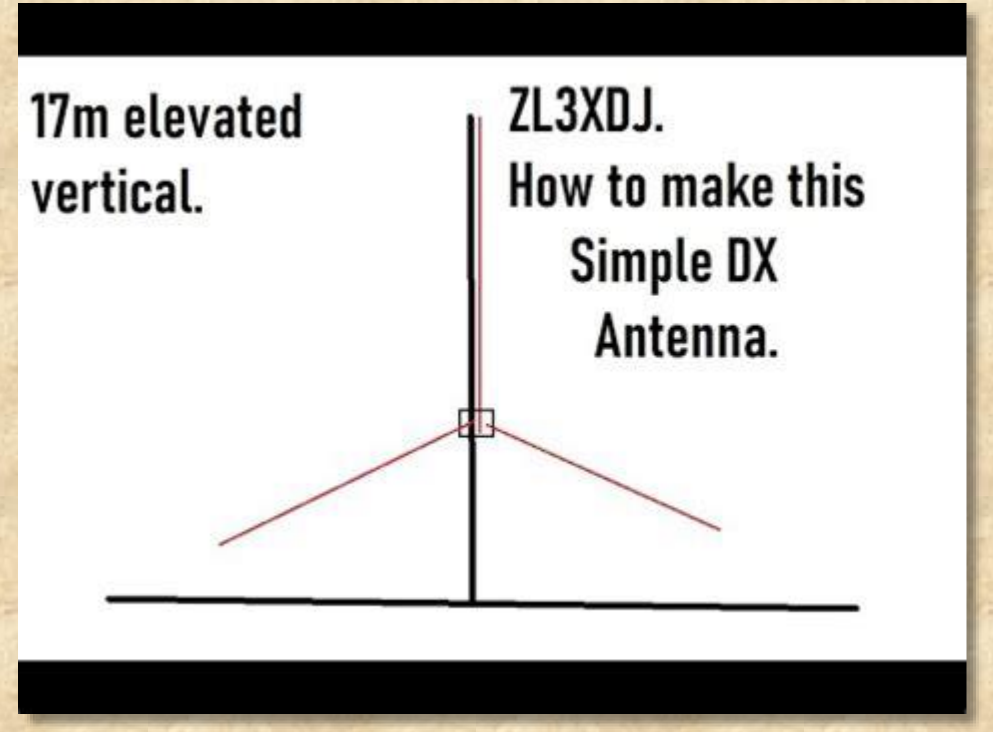
- A full-sized vertical consists of a ¼-λ radiator and ground system
- The ground system should be dense enough to provide the second half of the antenna
  - Radials in or on the ground
  - As many as possible up to about 32
- With ideal ground, base-fed Zin is near 36 Ω – Use an unun or tapped coil to match 50 Ω coax

$$\textbf{\textit{Imperial}}: L = 234/f$$

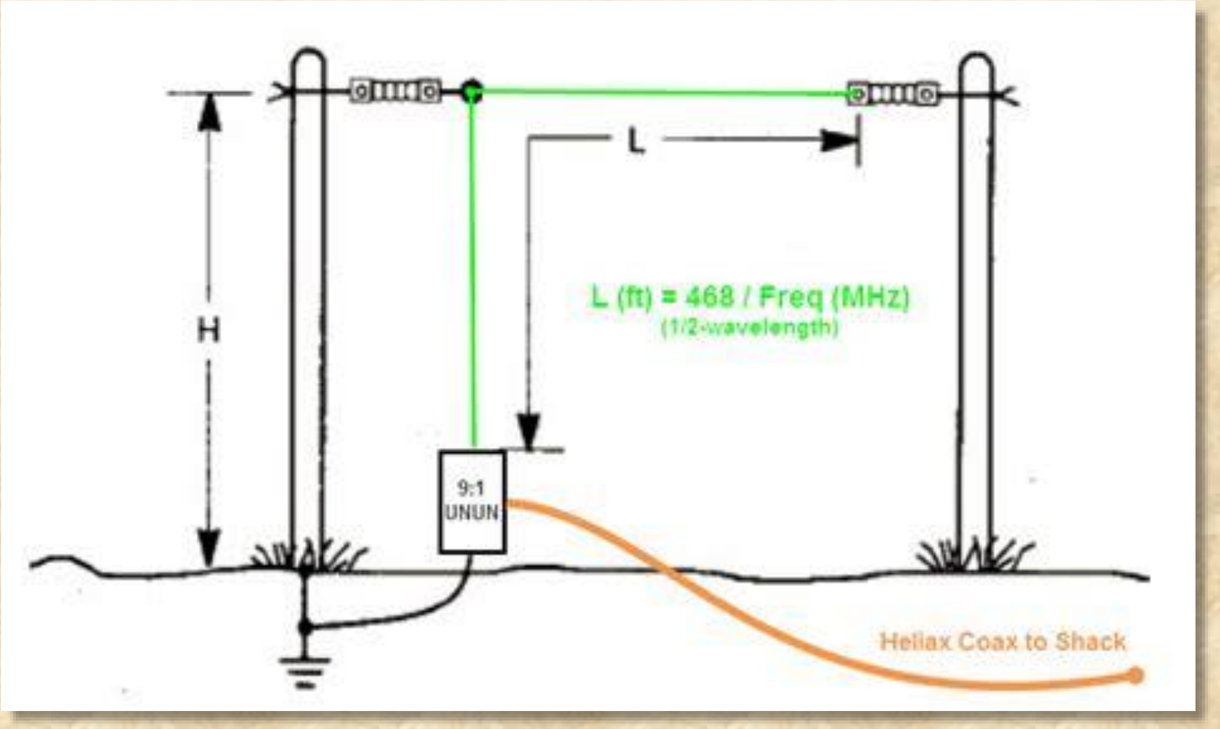
$$\textbf{\textit{Metric}}: L = 72/f$$

Other Vertical Themes

Elevated Vertical



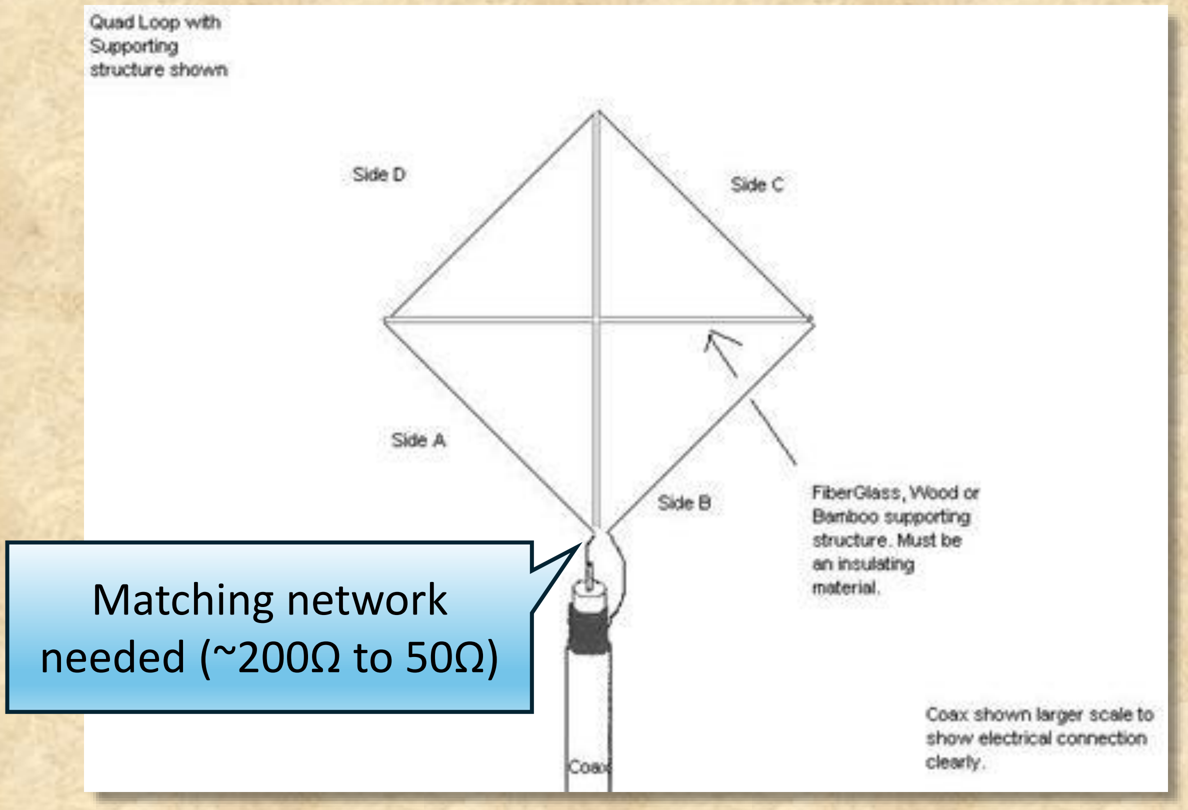
Inverted L



Opposing radials sloped downward at about 30 degrees will produce a near 50 Ω Zin.

Full-wave Loop Antenna

- **Quad loop**
  - **One wavelength of wire**
  - **Shapes (square, diamond)**
  - **Feed point location determines the polarization**
- Delta loop
  - Apex up (one high support) or down (two high supports)
  - Feed point location determines the polarization



Feedpoint bottom -> Horizontal polarization
Feedpoint side -> Vertical polarization

Full-wave Loop Antenna

- Quad loop
  - One wavelength of wire
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- **Delta loop**
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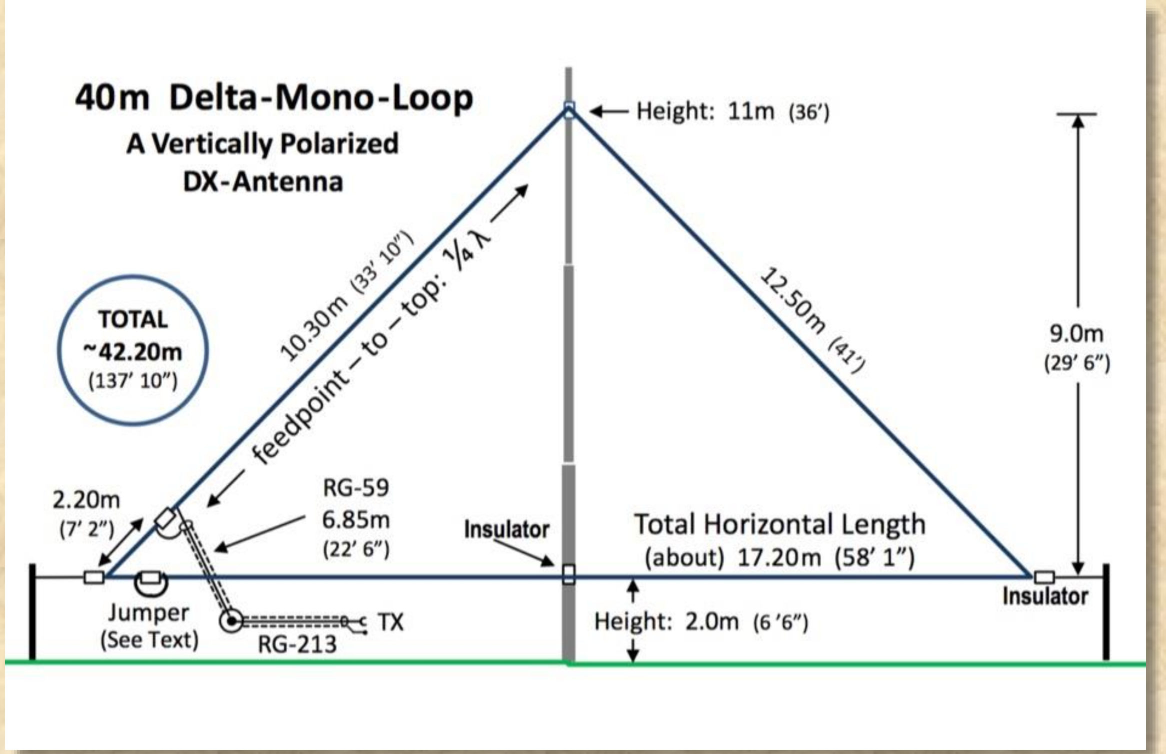
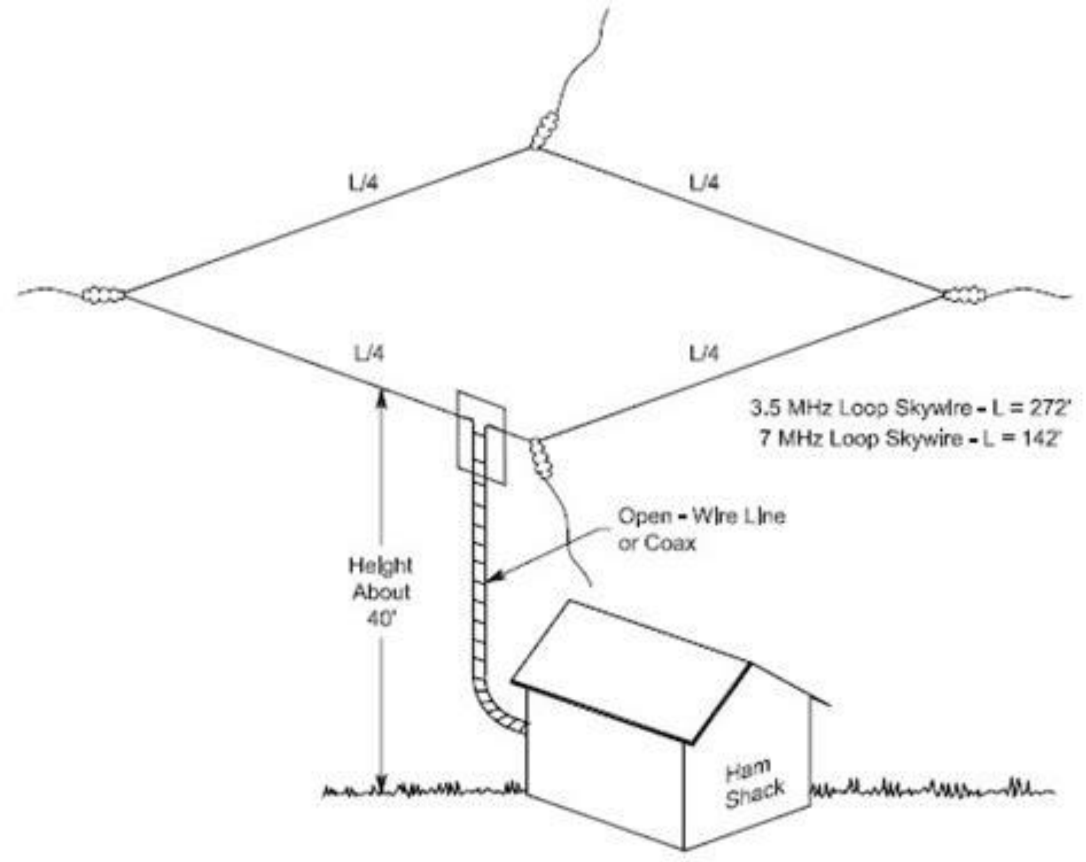


Feedpoint mid-bottom -> Horizontal polarization
Feedpoint side (as shown) -> Vertical polarization

Horizontal Loop Antenna

- Use one wavelength of wire
- Height above RF ground matters
  - Low, < ¼ λ works best for NVIS
  - High, ~ ½ λ works well for DX
- Use parallel wire line for use on multiple bands
  - Matching network needed
  - Coax via a balun works, but compromises use on some bands



Part 1 Q&A

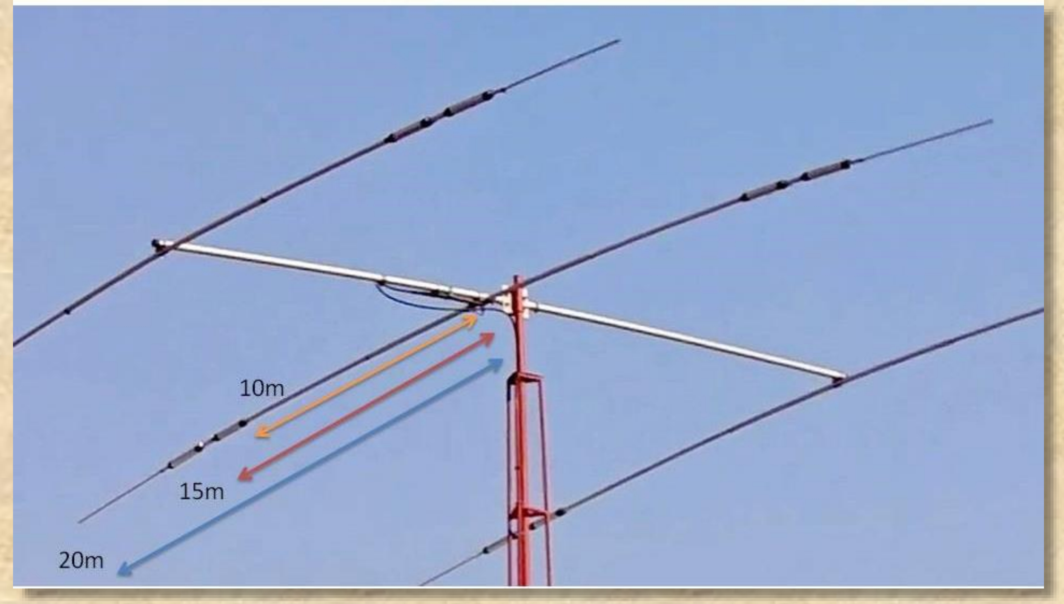
Introduction to HF Antennas

Part 1
Simple Antennas

Part 2
Gain Antennas

Design Software
Phased arrays
Parasitic arrays

Part 3
Specialty Antennas



Part 2
Gain Antennas

Simple antennas get the job done. Many operators use nothing more than "100 watts and a wire" and do very well. Using higher power can provide better transmit performance. But an antenna that provides gain can help boost both transmitting and receiving performance.

Antenna Design Software: Numerical Electromagnetics Code

- NEC 2
  - Original publicly available version
  - Can’t model in-ground radials or ground stakes, close wires
- NEC 4.2
  - LLNL license required
  - Method of Moments calculation
  - Buried wires
  - Accuracy and error detection improvements
- MININEC Pro (OS versions)
  - Fee based independent program
  - Limitations of old NEC persist
- NEC 5.0
  - License required
  - No longer maintained nor supported by LLNL
  - GUI not functional in Windows 11
  - W7EL updates (free) needed to fix several errors in NEC 5

Antenna Design Software: NEC Related Programs

EZNEC

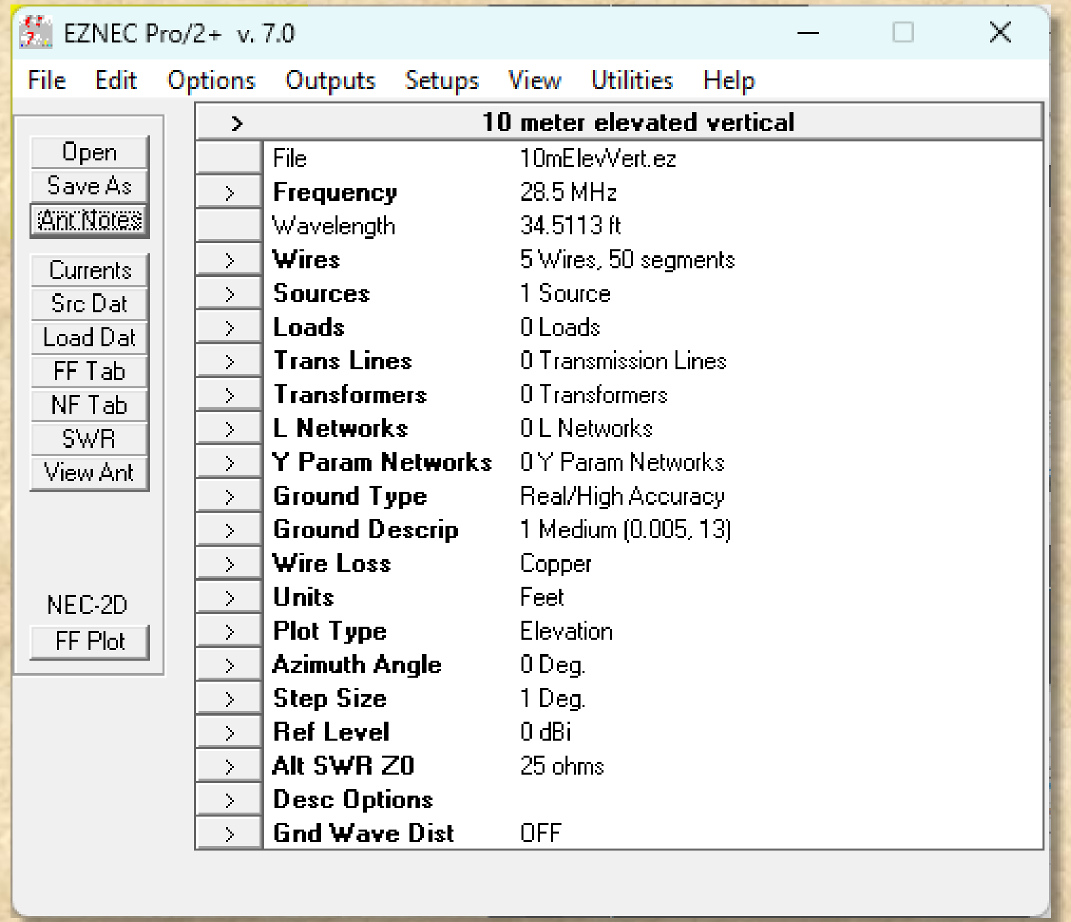
- Roy, W7EL, has retired and his popular EZNEC product is now available for free (new version)
- Users of earlier versions of EZNEC should remove it before installing the new version – model files are saved
- NOTE: W7EL has un-retired to help fix the broken NEC-5

4NEC2

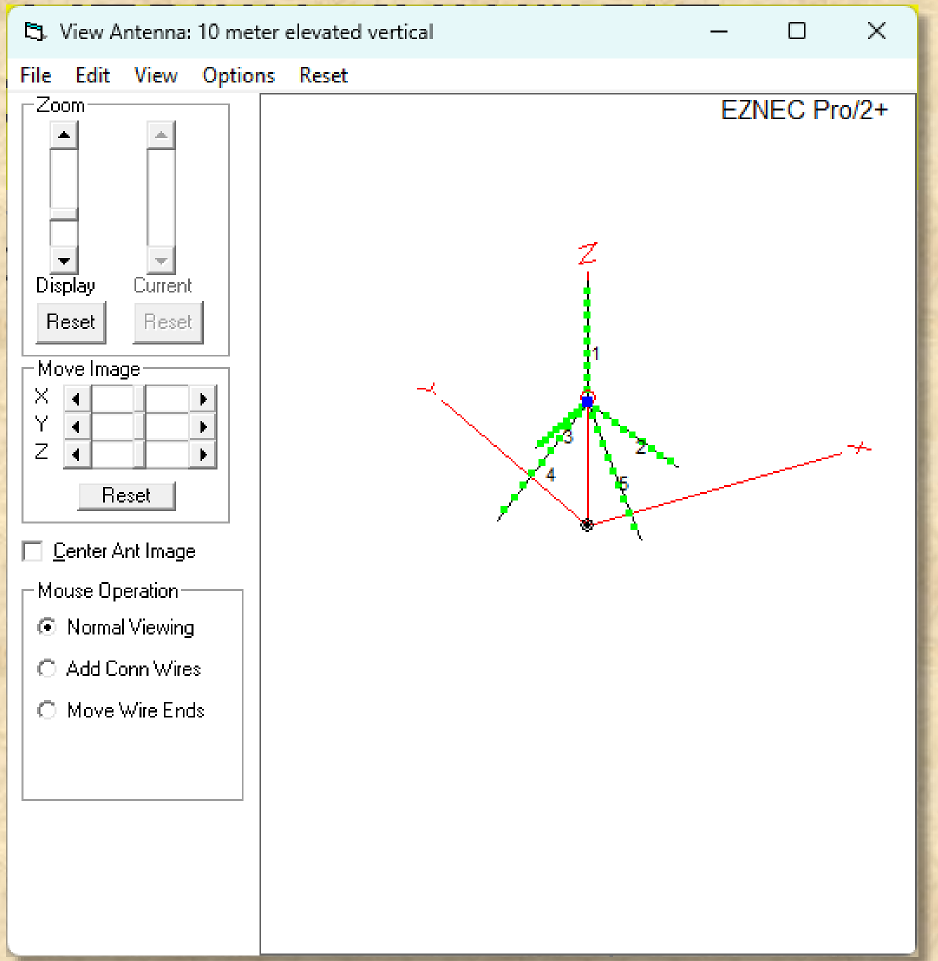
- 4nec2 is a completely free NEC2 and NEC4 (Lic.)Windows-only tool
- Use for creating, viewing, optimizing and checking 2D & 3D style antenna geometry structures
- Can generate, display and/or compare near- and far-field radiation patterns

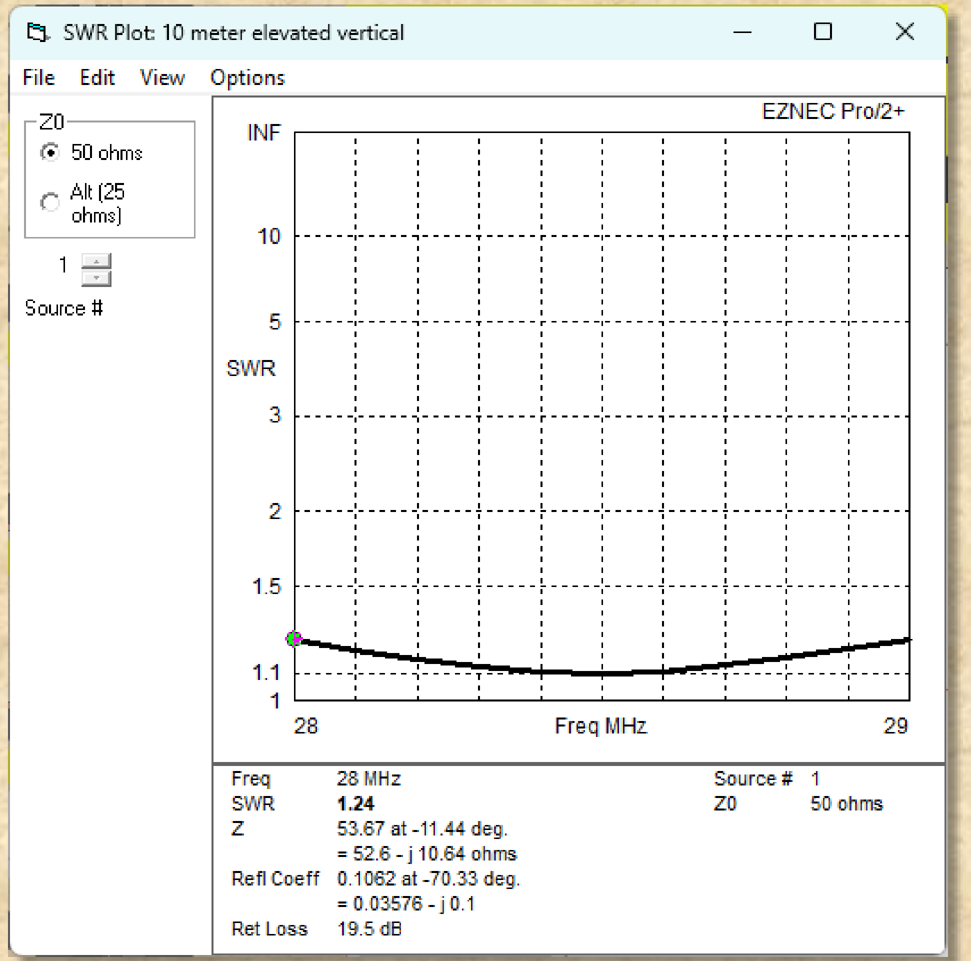
Antenna Design Software: EZNEC Pro/2+ v7.0

- Antenna model files
  - Create and save new model files
  - Open existing model files
- Specify antenna
  - Components (wires, sources, …
  - Environment (ground, losses, …
  - Operating frequency, units, …
- Activate display and analysis features



EZNEC Pro/2+ v7.0 Features: Antenna View, SWR Plot





EZNEC Pro/2+ v7.0 Features:
Far Field Data, 2D Elevation Plot

Far Field Data

File Edit Search Format Help

EZNEC Pro/2+ ver. 7.0

10 meter elevated vertical 9/16/2026 4:16:38 PM

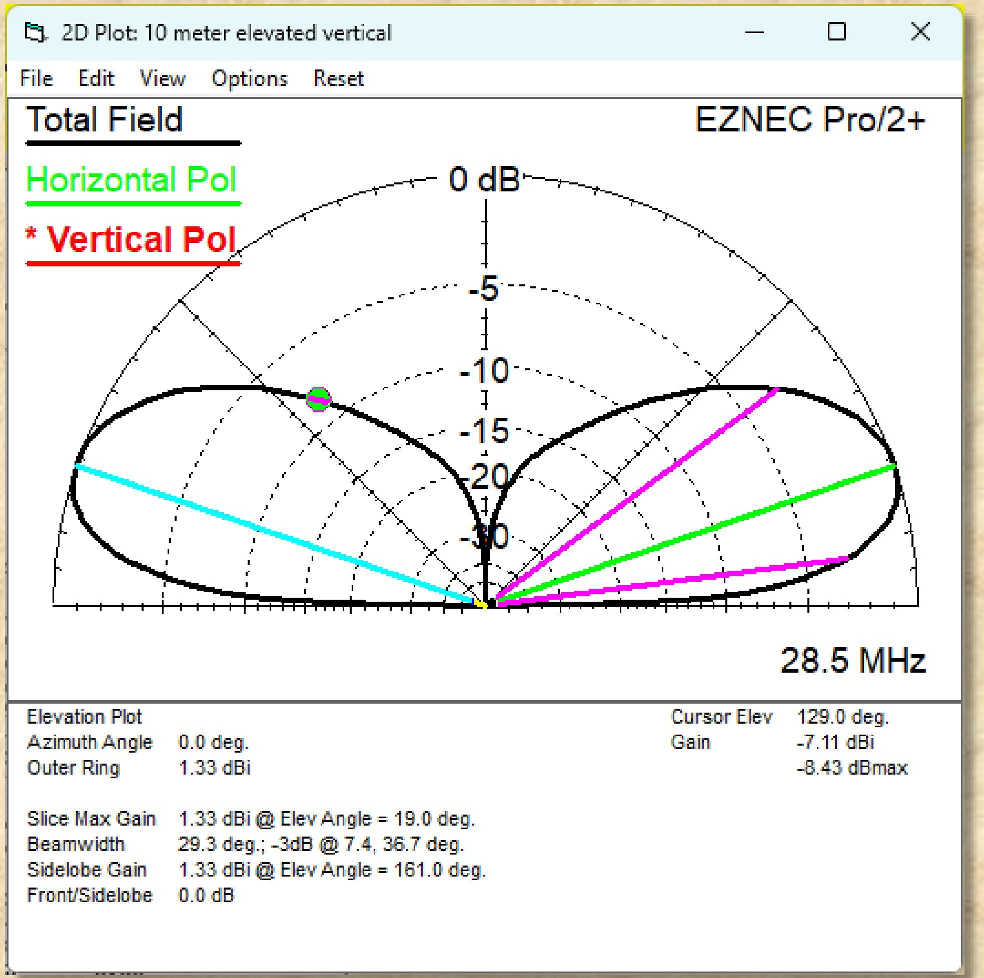
--------------- FAR FIELD PATTERN DATA ---------------

Frequency = 28.5 MHz

Reference = 0 dBi

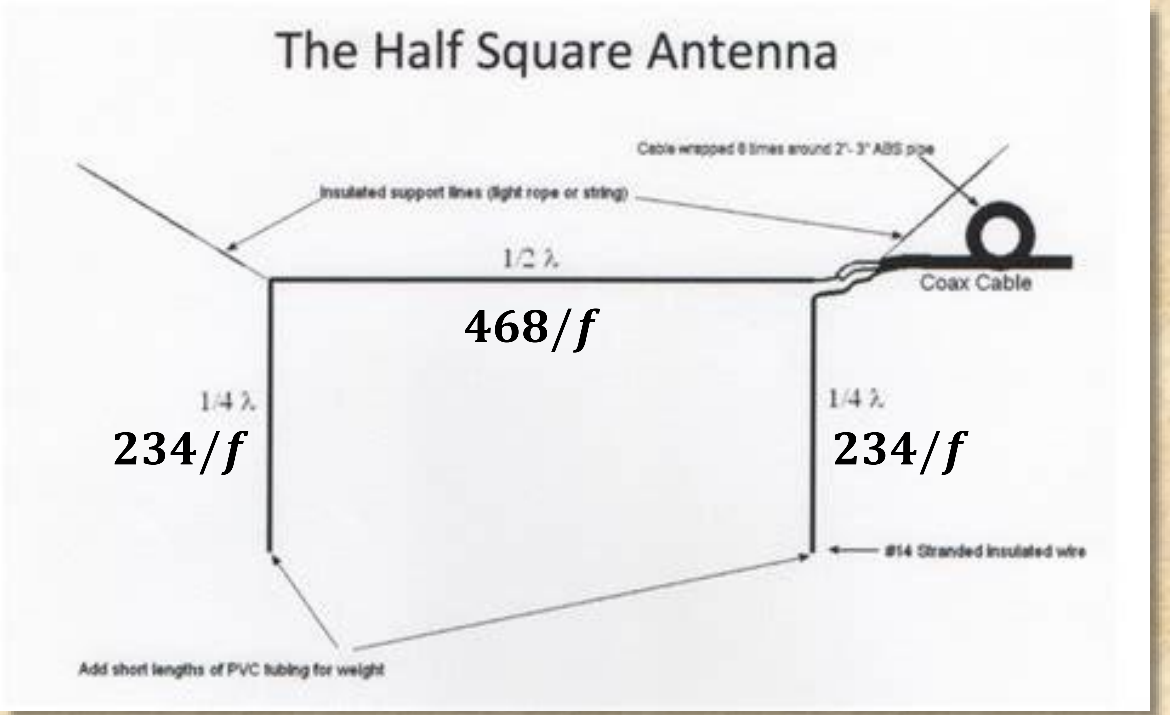
Elevation Pattern Azimuth angle = 0 deg.

Deg	V dB	H dB	Tot dB	V Pha	H Pha
0	-99.99	-99.99	-99.99	0.00	0.00
1	-15.85	-99.99	-15.85	105.33	0.00
2	-10.37	-99.99	-10.37	105.70	0.00
3	-7.37	-99.99	-7.37	106.04	0.00
4	-5.37	-99.99	-5.37	106.36	0.00
5	-3.92	-99.99	-3.92	106.66	0.00
6	-2.82	-99.99	-2.82	106.96	0.00
7	-1.95	-99.99	-1.95	107.25	0.00
8	-1.26	-99.99	-1.26	107.54	0.00
9	-0.69	-99.99	-0.69	107.82	0.00
10	-0.23	-99.99	-0.23	108.11	0.00
11	0.15	-99.99	0.15	108.40	0.00
12	0.46	-99.99	0.46	108.69	0.00
13	0.71	-99.99	0.71	108.99	0.00
14	0.91	-99.99	0.91	109.30	0.00
15	1.06	-99.99	1.06	109.62	0.00
16	1.18	-99.99	1.18	109.94	0.00
17	1.26	-99.99	1.26	110.28	0.00
18	1.31	-99.99	1.31	110.63	0.00
19	1.33	-99.99	1.33	111.00	0.00

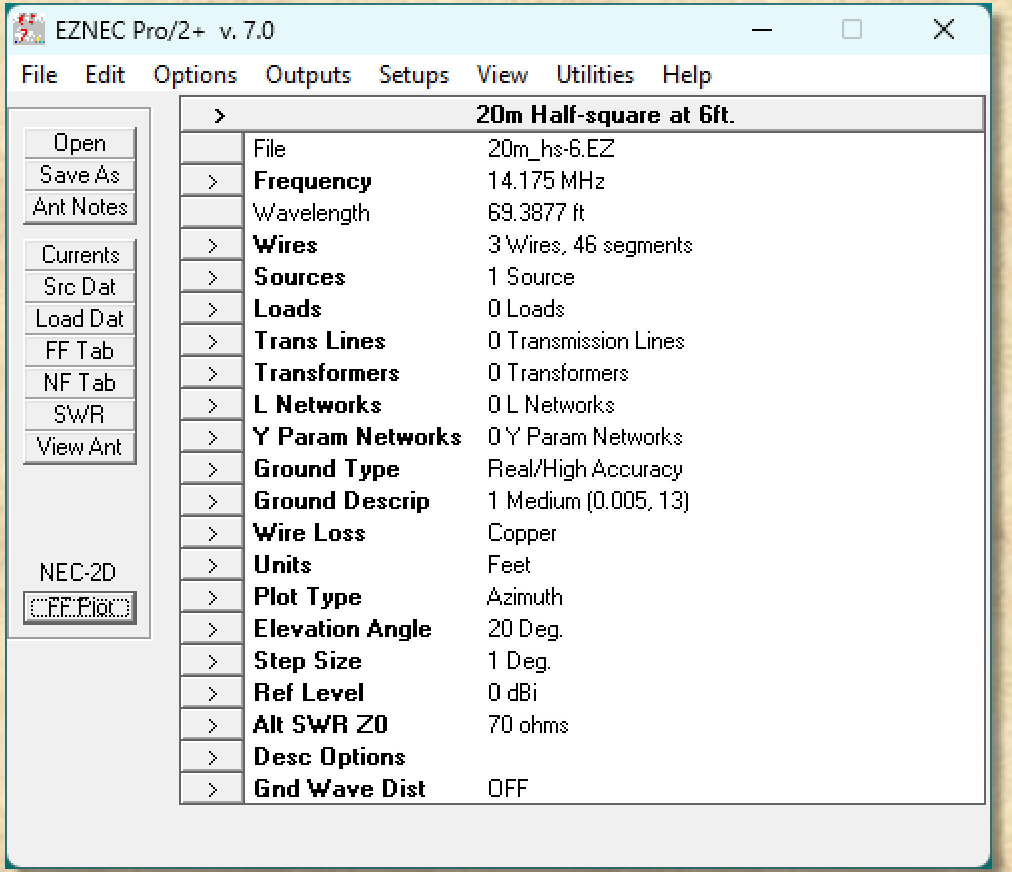


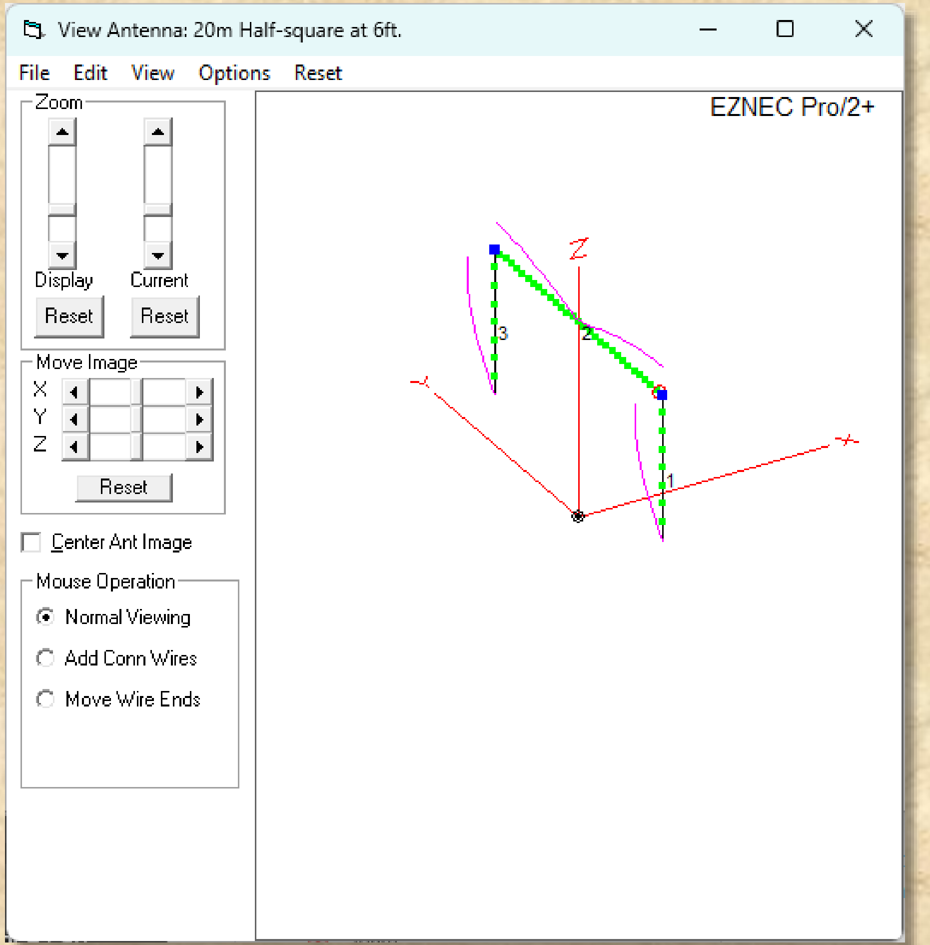
Phased Array Antenna: Half-Square

- Single band antenna
- Phased ¼-wave vertical wires
- 1/2-wave separation
- Feed point in one upper corner
- A choke is needed on the coax to suppress common mode current
- Antenna is near RF ground, but no ground system needed



20 Meter Half-Square
EZNEC Model and View





20 Meter Half-Square
EZNEC Model Specification

Wires

Wire Create Edit Other

☐ Coord Entry Mode ☐ Preserve Connections ☐ Show Wire Insulation ☐ Show Loss

No.	End 1				End 2				Diameter	Segs
	X (ft)	Y (ft)	Z (ft)	Conn	X (ft)	Y (ft)	Z (ft)	Conn	(in)	
1	0	-17.65	6		0	-17.65	23.65	W2E1	#12	8
2	0	-17.65	23.65	W1E2	0	17.65	23.65	W3E1	#12	30
3	0	17.65	23.65	W2E2	0	17.65	6		#12	8

Sources

Source Edit Other

No.	Specified Pos.		Actual Pos.		Amplitude	Phase	Type
	Wire #	% From E1	% From E1	Seg	(V, A)	(deg.)	
1	2	0	1.66667	1	2	0	I

Ground Type

Select Ground Type

Ok

Cancel

○ Free Space
○ Perfect
◉ Real

Real Ground Types
◉ High Accuracy
○ MININEC

Elevation Angle

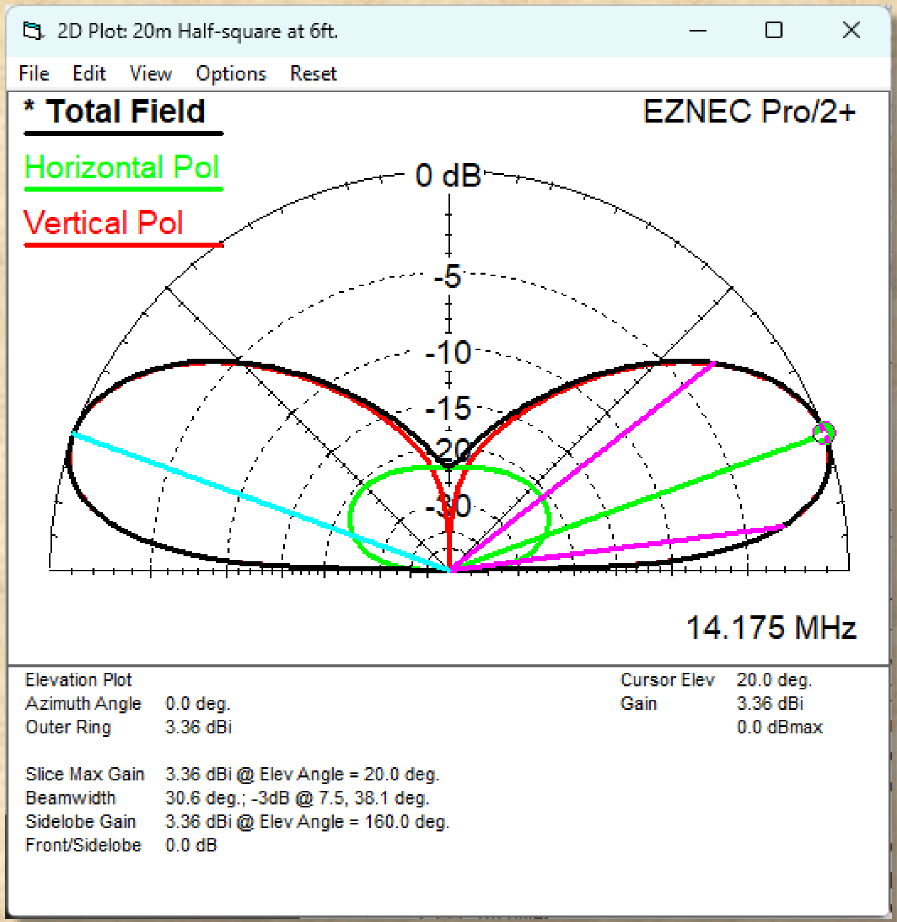
Enter elevation angle (0 to 90 deg.)

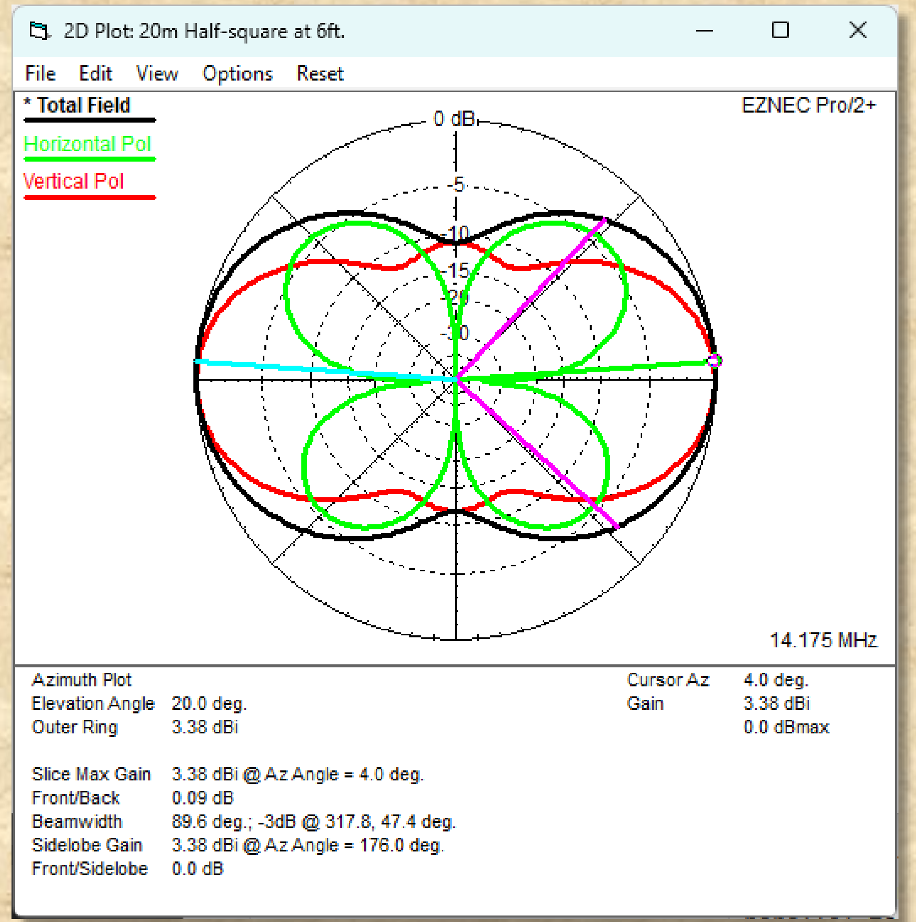
Ok

Cancel

20

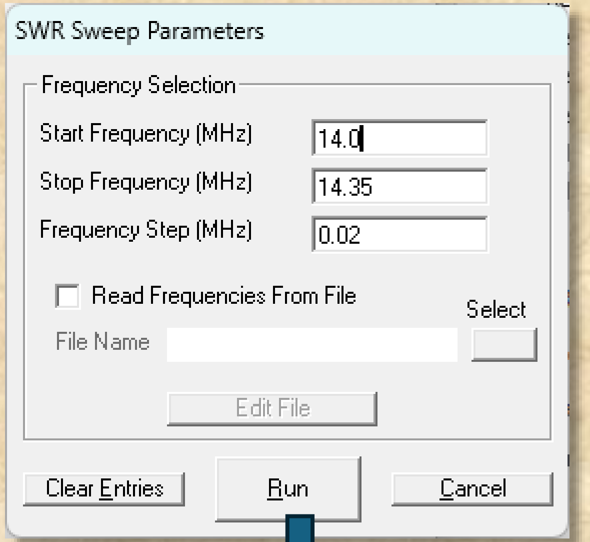
Half-Square Antenna
2D Elevation and Azimuth Plots

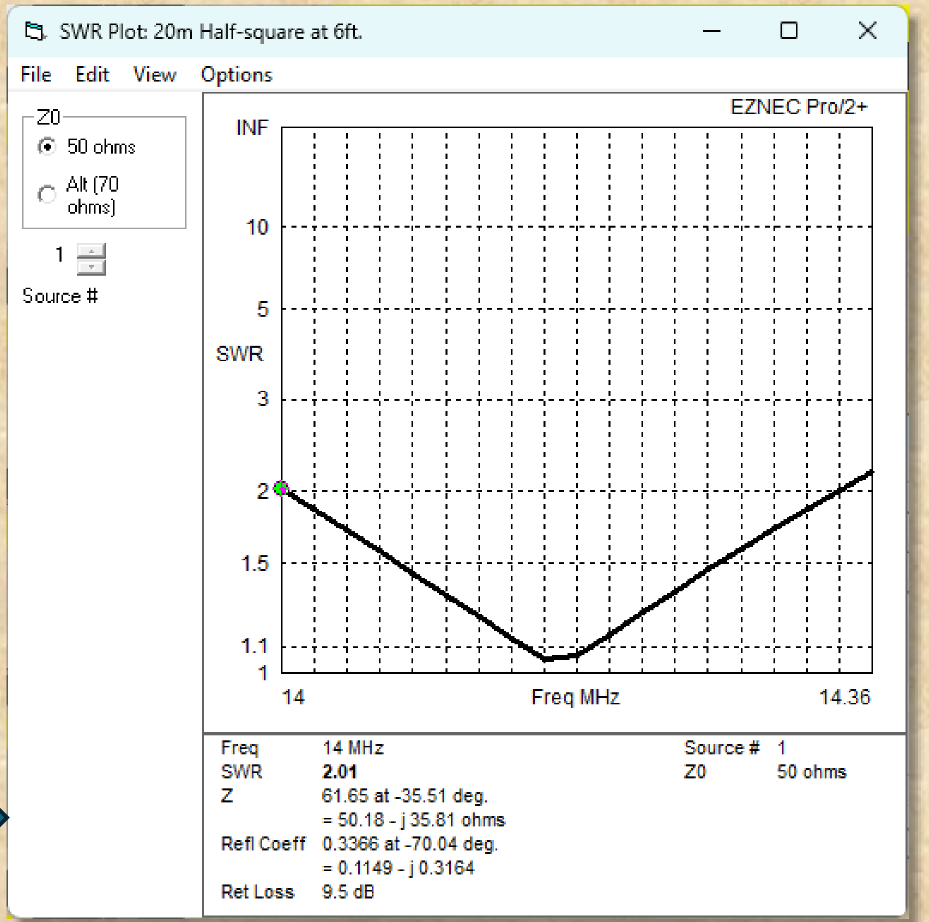




20 Meter Half-Square Antenna
Sweep Specification and SWR Plot

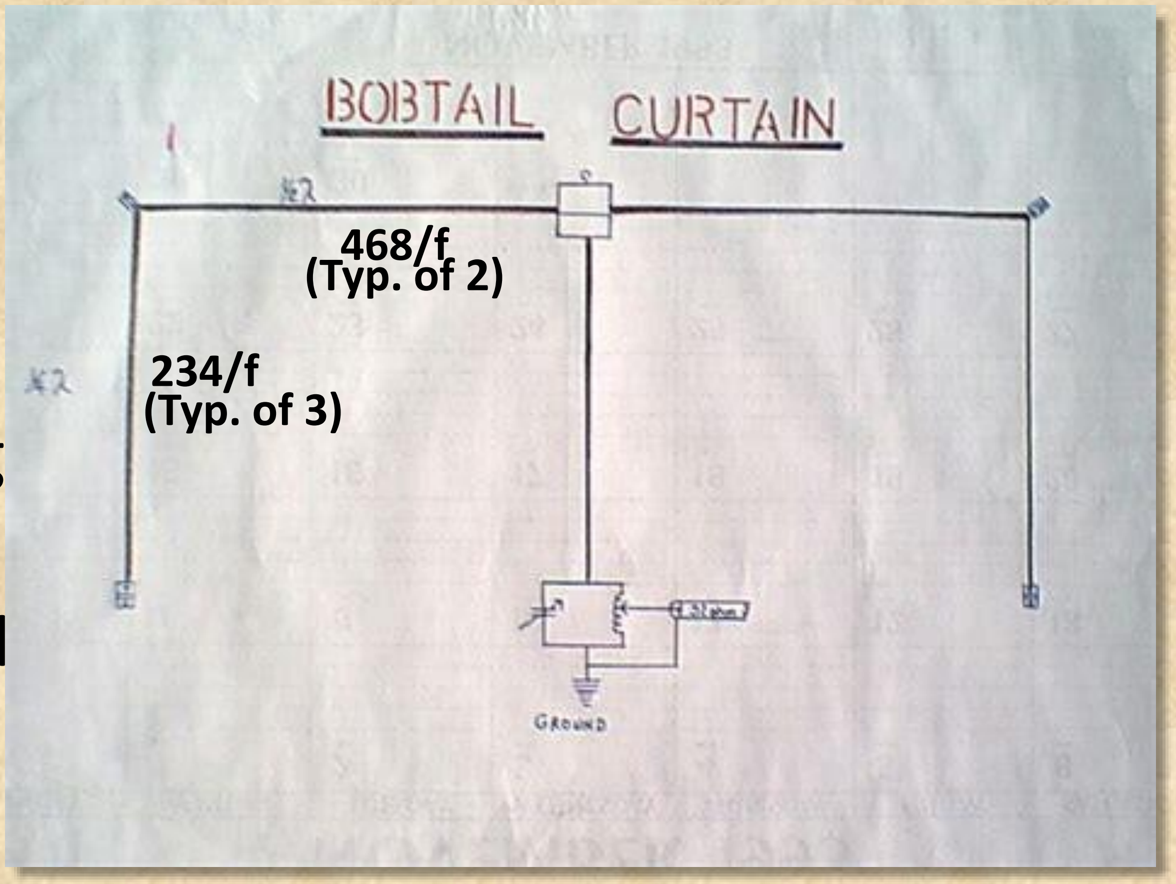
- Click the SWR button
- Provide the Sweep specification
- Click Run



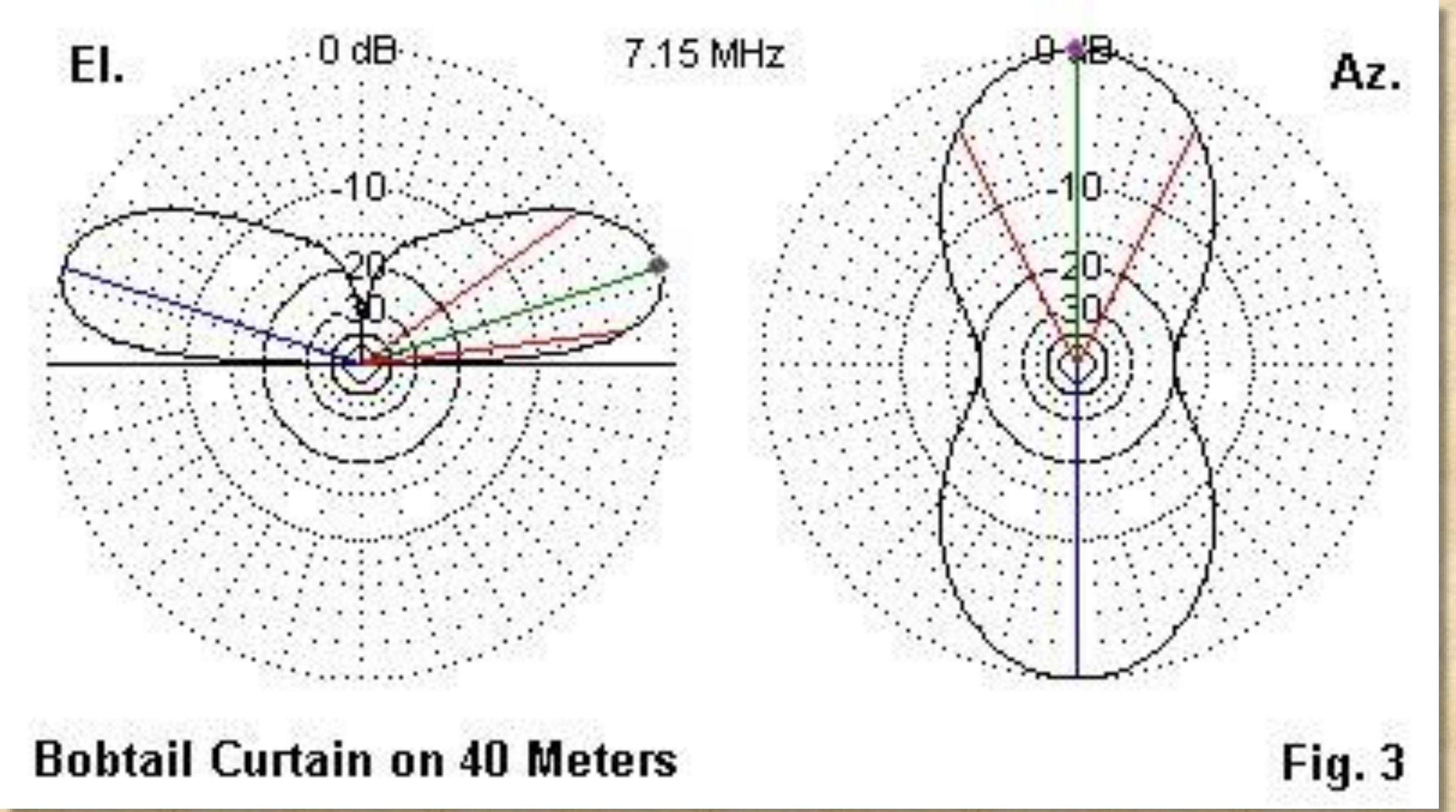


Phased Array Antenna: Bobtail Curtain

- Single band antenna
- Three quarter vertical wires
- Half-wave separations
- Feed point at bottom of the center vertical through matching network
- Effective ground system required

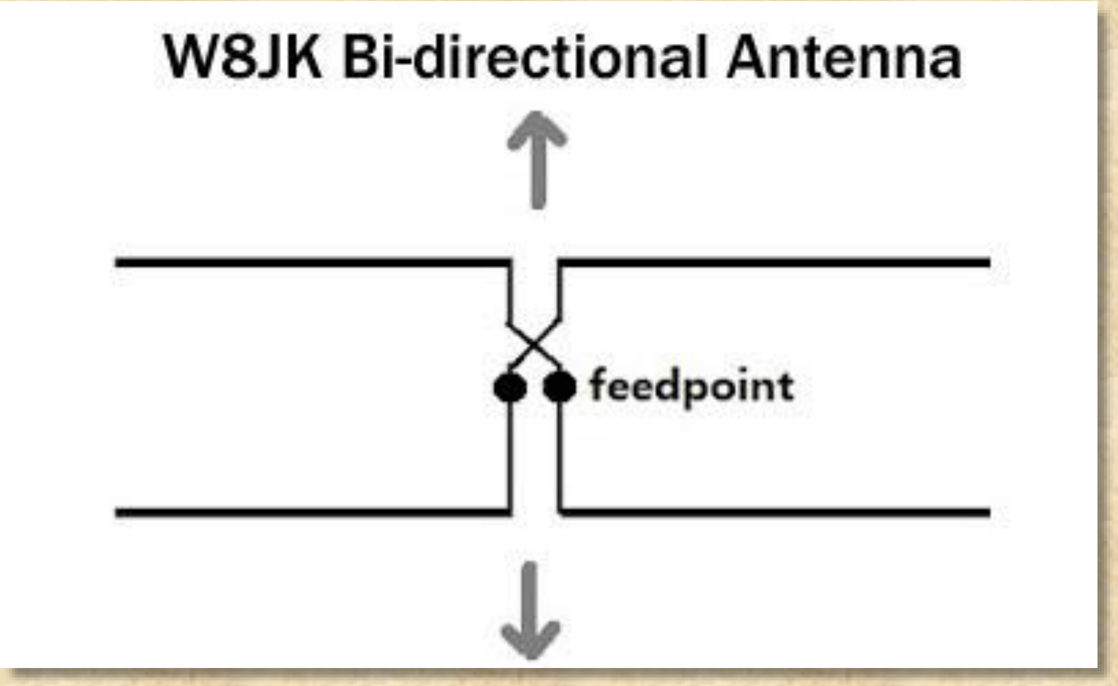


40 Meter Bobtail Curtain Elevation and Azimuth Plots

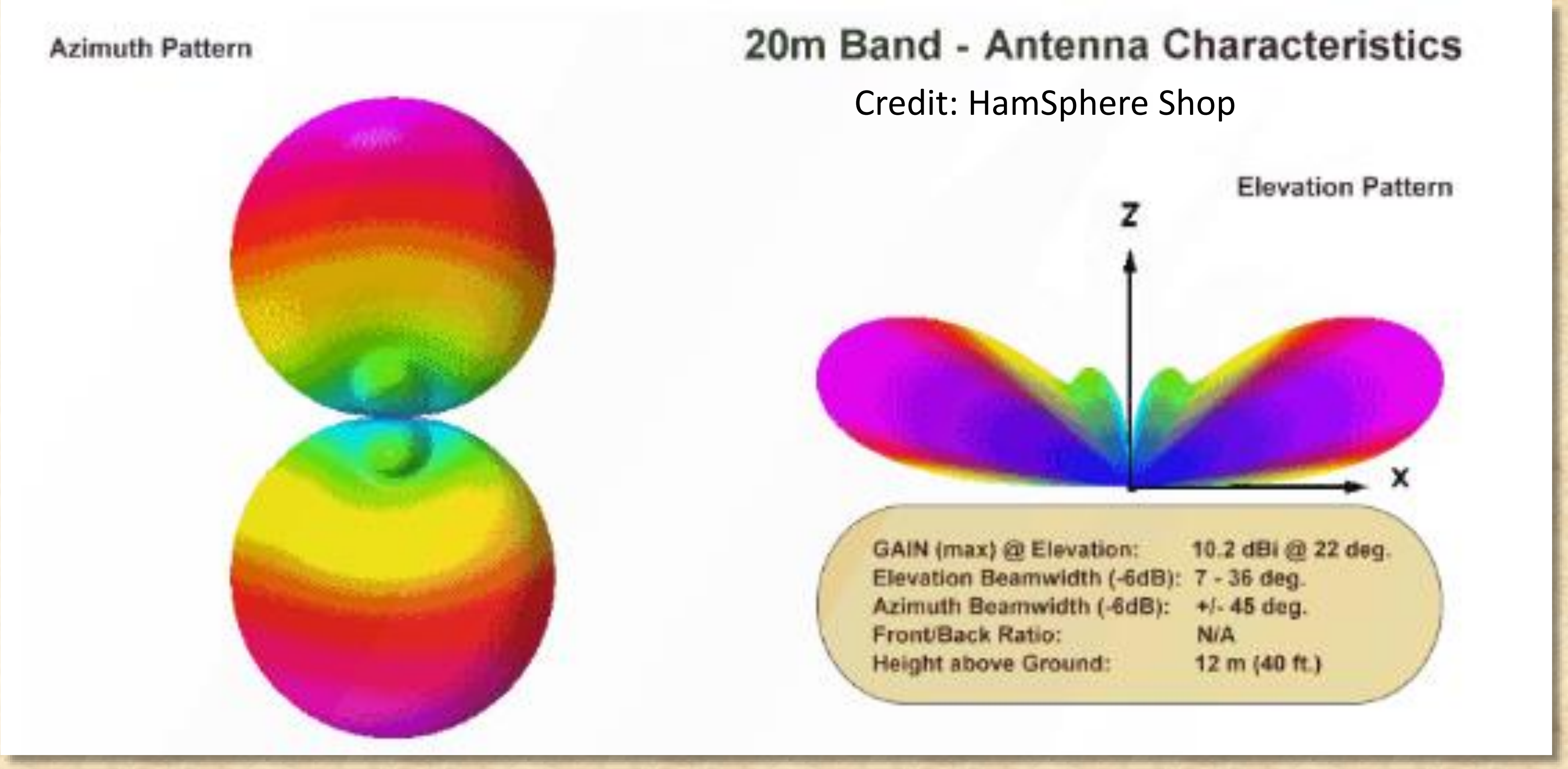


Phased Array Antenna: W8JK (John Kraus)

- Bi-directional pattern
- Multi-band capability with suitable matching network
- Open wire (ladder line) or window line recommended
- Two equal length elements
  - 1/8 wave separation
  - Center fed, 180 degrees apart
  - Not resonant in any ham band

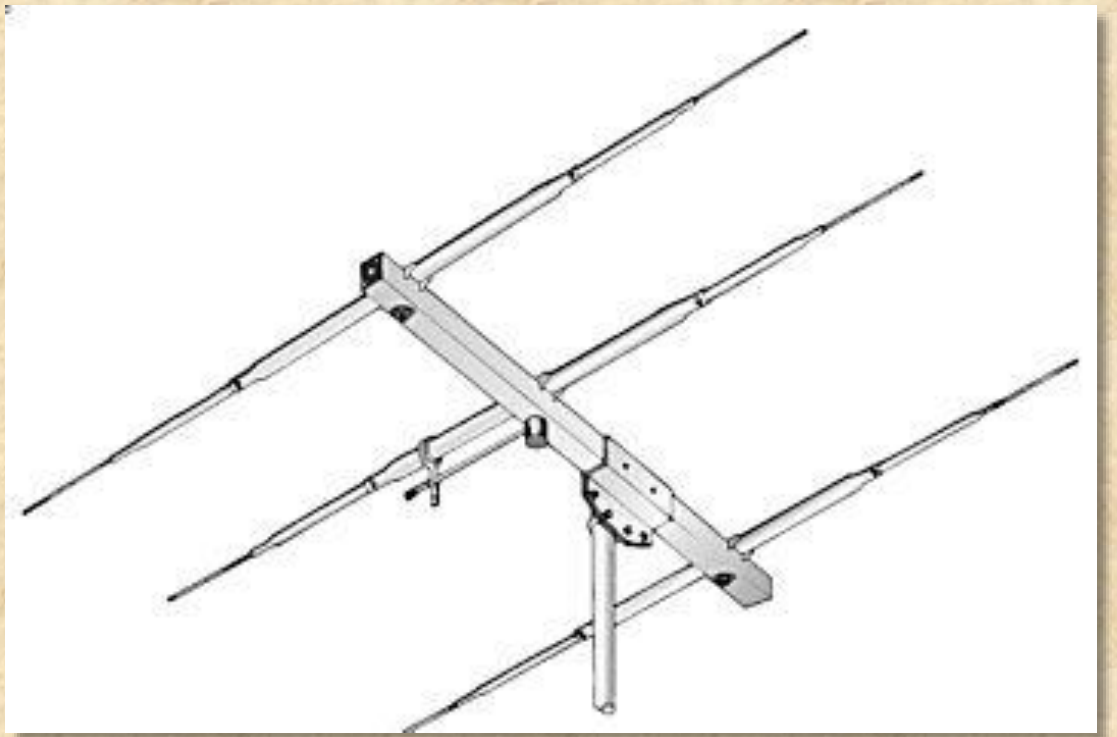


W8JK Antenna Azimuth and Elevation Plots for 20 Meter Band

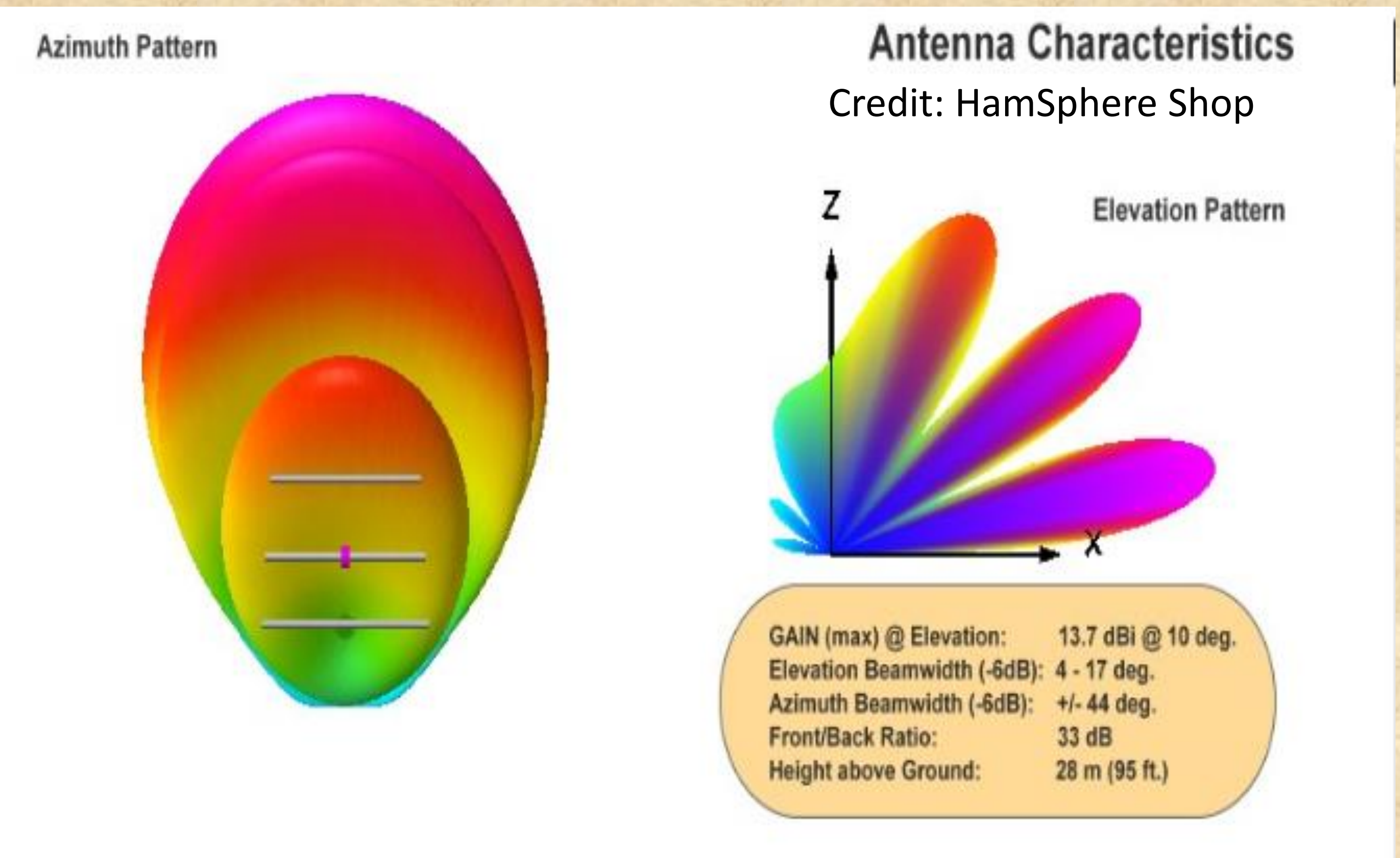


Parasitic Array Antenna:
Yagi-Uda (a.k.a. Yagi)

- Two or more elements, usually tubing, but wire OK, on a common center support/boom
- Most often one driven element, one reflector, and some number of directors (0 - N)
- Driven element types vary
  - Split on center with balun
  - Straight through with a Gamma or Tee matching system



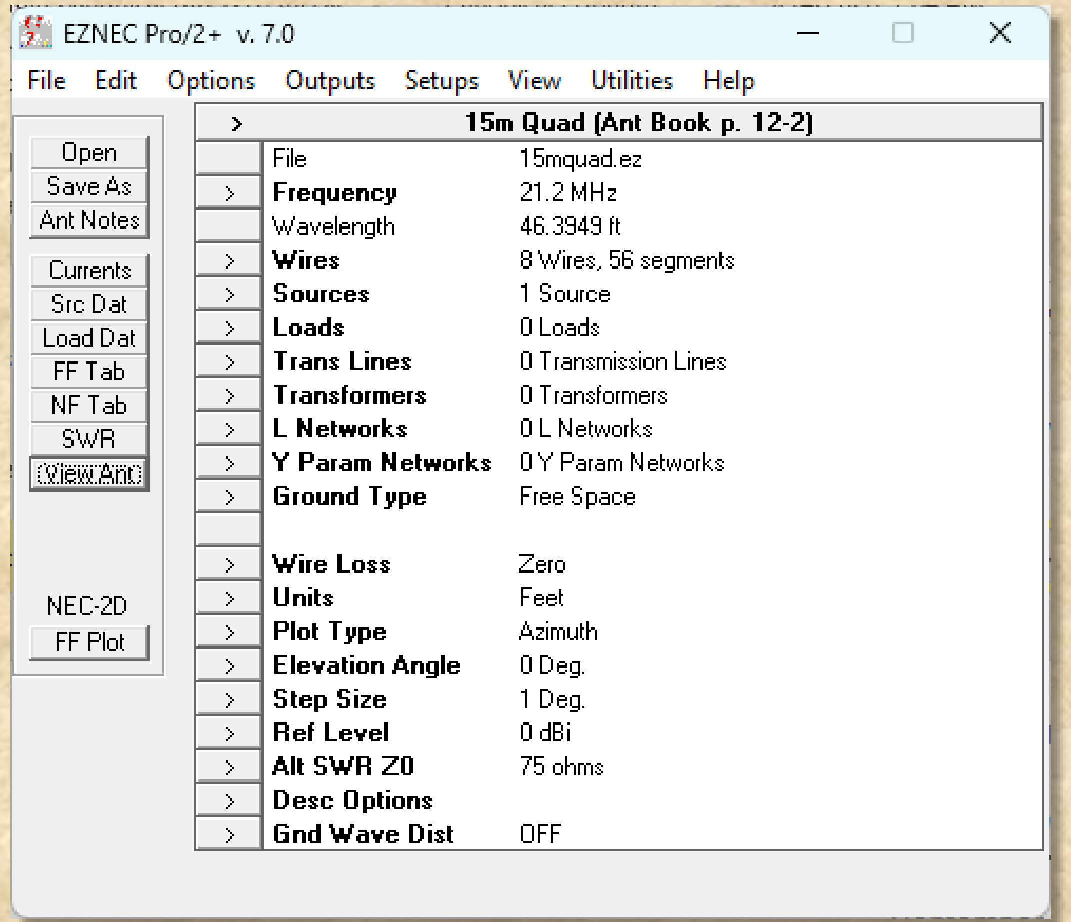
20 Meter Yagi Antenna
Azimuth and Elevation Plots



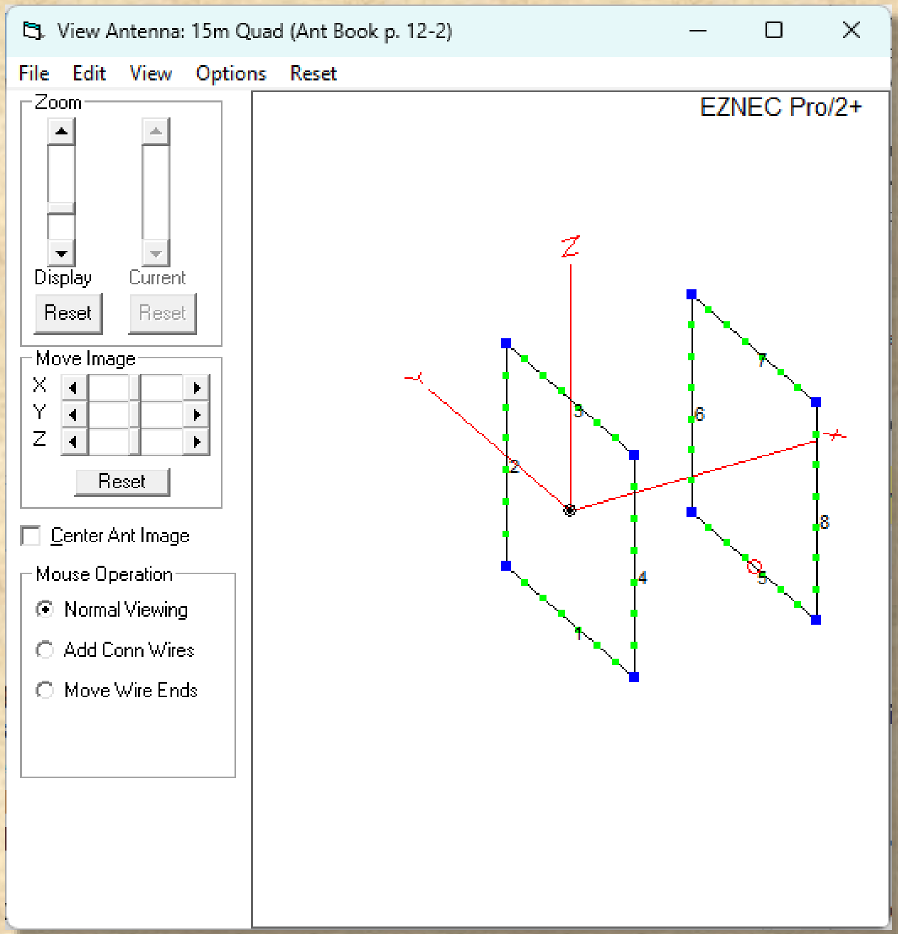
Credit: HamSphere Shop

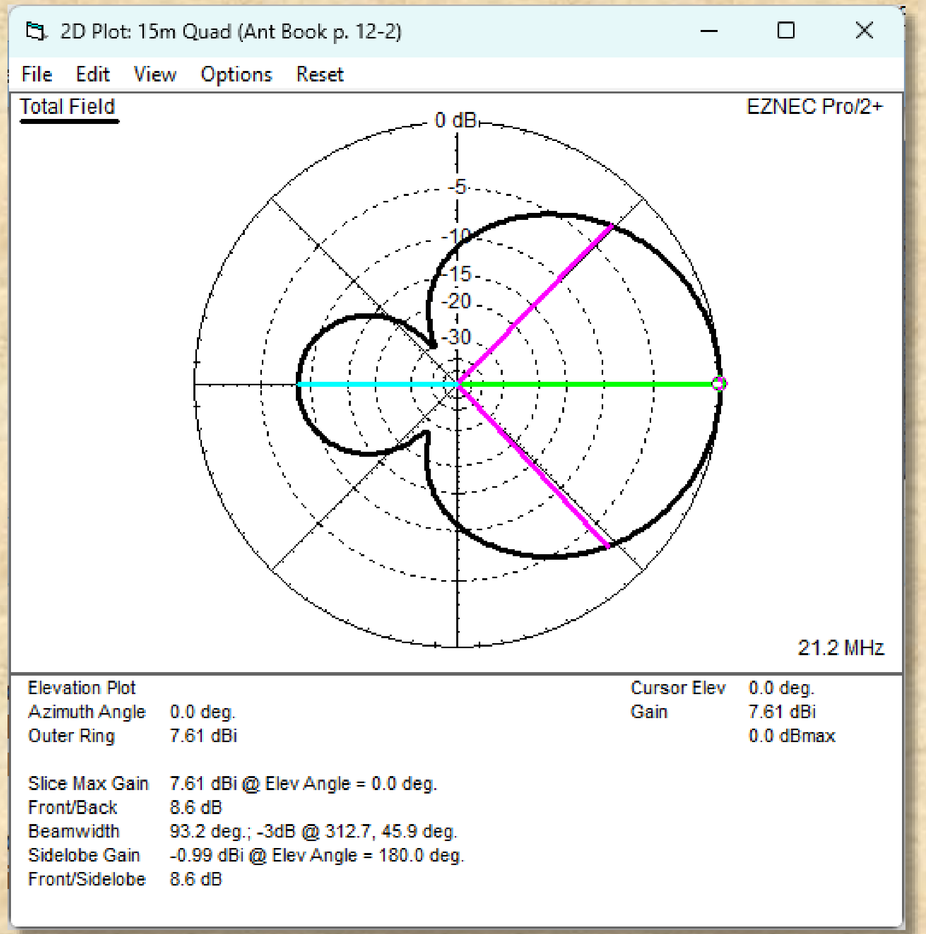
15 Meter 2-Element Cubical Quad Antenna

- Design by Jim, W7ZQ (SK) in the ARRL Antenna Book
- Any arrangement of more than one quad element on a common boom is considered a "cubical" quad
- This design needs to be adjusted for better SWR and F/R
  - Originally designed using ELNEC
  - EZNEC provides more accuracy



15 Meter 2-Element Cubical Quad View and *Free Space* Elevation Plot





Six-Band Two-Element Cubical Quad [KB0YH]

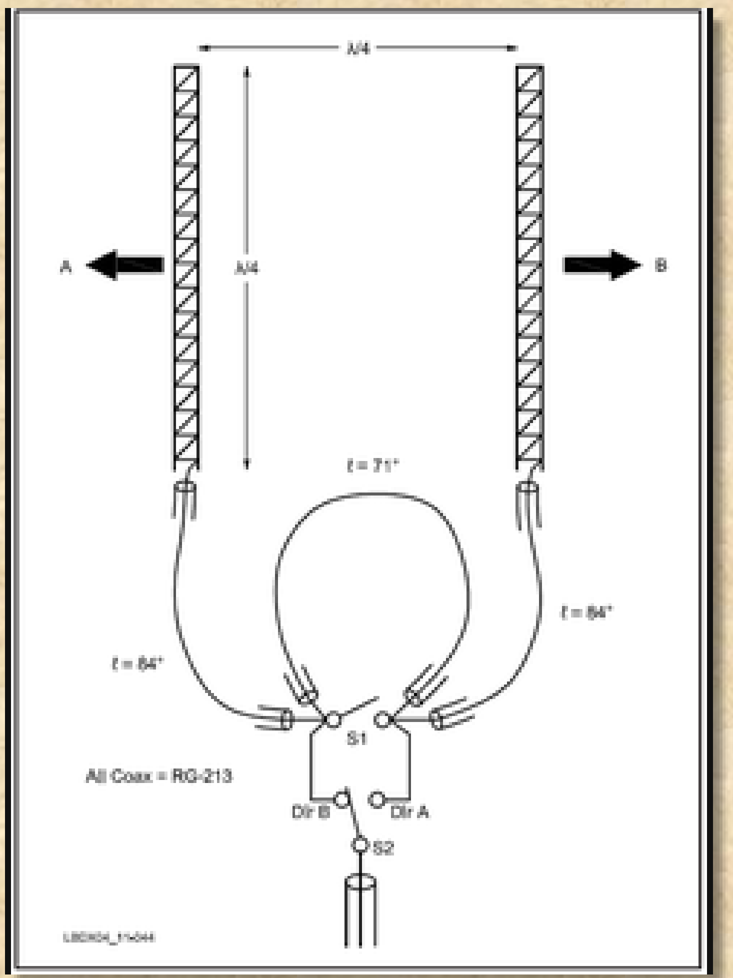
- Installed at 60 feet
  - Angled spreaders for correct separation on all bands
  - Diamond shape (spreaders vertical and horizontal) – prevents icing
- 6m on one feedline
- 20m – 10m on second feedline via a remote switch box
  - Each driven element fed through a 75Ω matching section for 50Ω match
  - Unselected bands effectively “open” to minimize unwanted pattern distortion

Phased Array of Vertical Antennas at NIST Station WWVH on 5 MHz

- Two vertical half-wave antennas
- Sends time and frequency standard signals primarily toward western Pacific
- Guy wires attached at the middle form the skeleton cone shaped lower ¼ λ portion of each antenna
- A ¼-wave ham version can be made with small tubular elements

Build Your Own Phased Vertical Array

- Two ¼-λ vertical antennas spaced ¼-λ apart
  - Towers may be needed for low frequency bands
  - Tubing adequate for 40m–10m bands
- Ground system (not shown) needed – use radials in or on the ground or ground mats
- Switch S1:
  - Open for end-fire unidirectional with direction selected by S2 setting
  - Closed for broadside bidirectional
- Switch S2: Selects Dir A or Dir B (has no effect when S1 is closed)



Part 2 Q&A

Introduction to HF Antennas

Part 1
Simple Antennas

Part 2
Gain Antennas

Part 3
Specialty Antennas

Receive antenna
Log-Periodic Dipole Array
Small Transmitting Loop

Part 3
Specialty Antennas

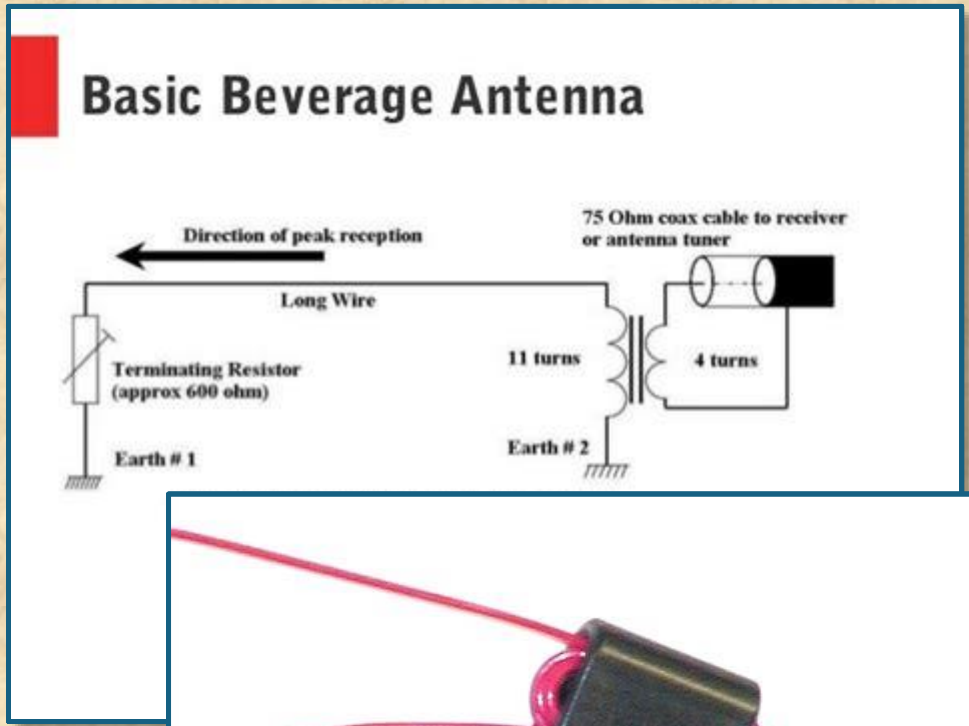
We can’t all have our ham radio stations in ideal locations. The oppressive rules governing a housing development, or living in a high-rise apartment building, or even a “keeping peace in the family” situation might require a different approach to an antenna solution. Multi-band operation from a single antenna can also be important.

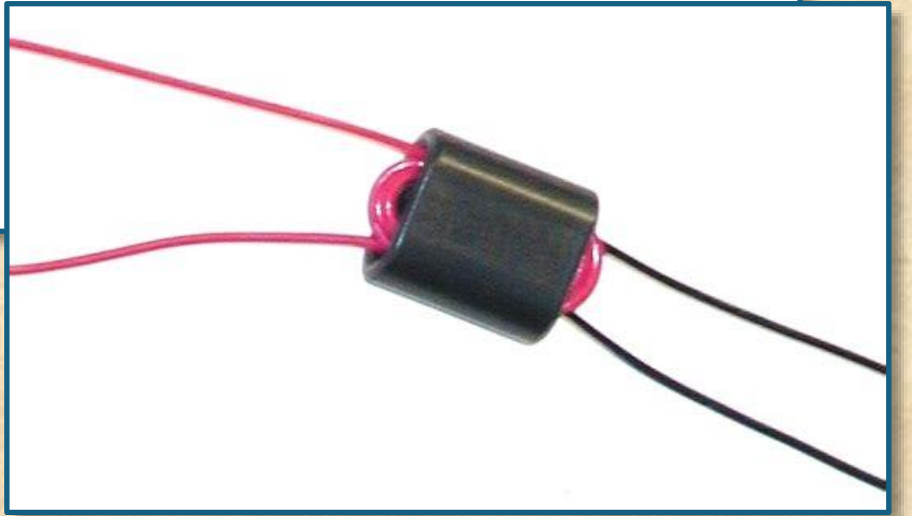
Specialty Antennas

- Receiving Antenna
  - Receive only
  - Goal is improved (S+N)/N performance
  - Not suitable for transmitting due to power handling limitation and very low efficiency
- Log-Periodic Dipole array Antenna
  - Wide bandwidth (2-3 octaves)
  - Single feedline
  - Reasonable gain and modest F/R
  - Good side rejection
- Small Transmitting Loop Antenna
  - Small size
  - Good performance
  - Up to 3:1 tuning range
  - Narrow bandwidth (a few kHz at the low end of the tuning range)
- Reduced Size Antennas
  - Multi-turn loops
  - Coil and linear loaded dipoles
  - Coil and top loaded verticals

Receiving (RX) Antennas

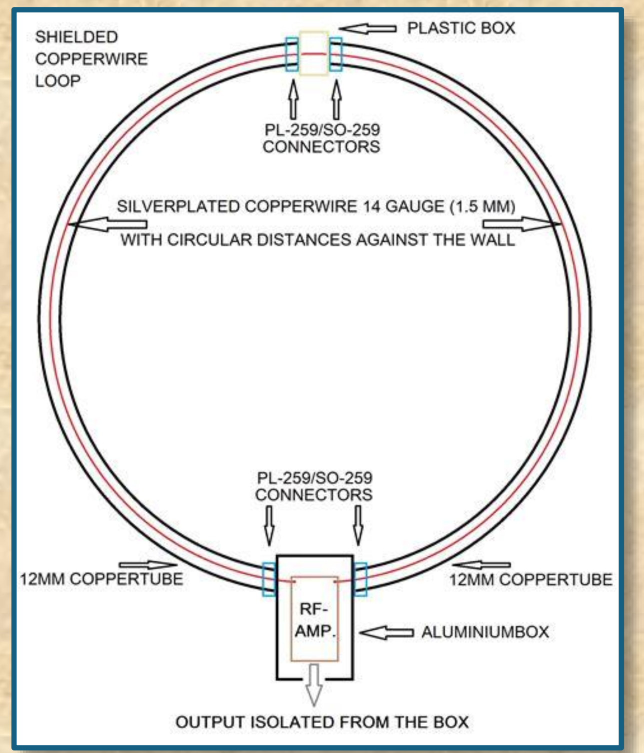
- **Low RX wire**
- **Beverage Antenna**
- Broadband untuned loop
- Tuned Loop
- Flag Antenna
- Loop on the ground

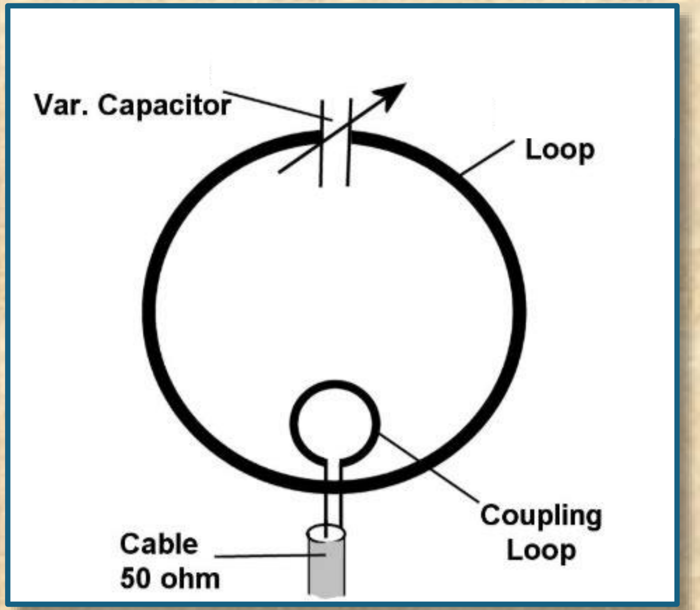




Receiving (RX) Antennas

- Low RX wire
- Beverage Antenna
- **Broadband untuned loop**
- **Tuned Loop**
- Flag Antenna
- Loop on the ground





Receiving (RX) Antennas

- Low RX wire
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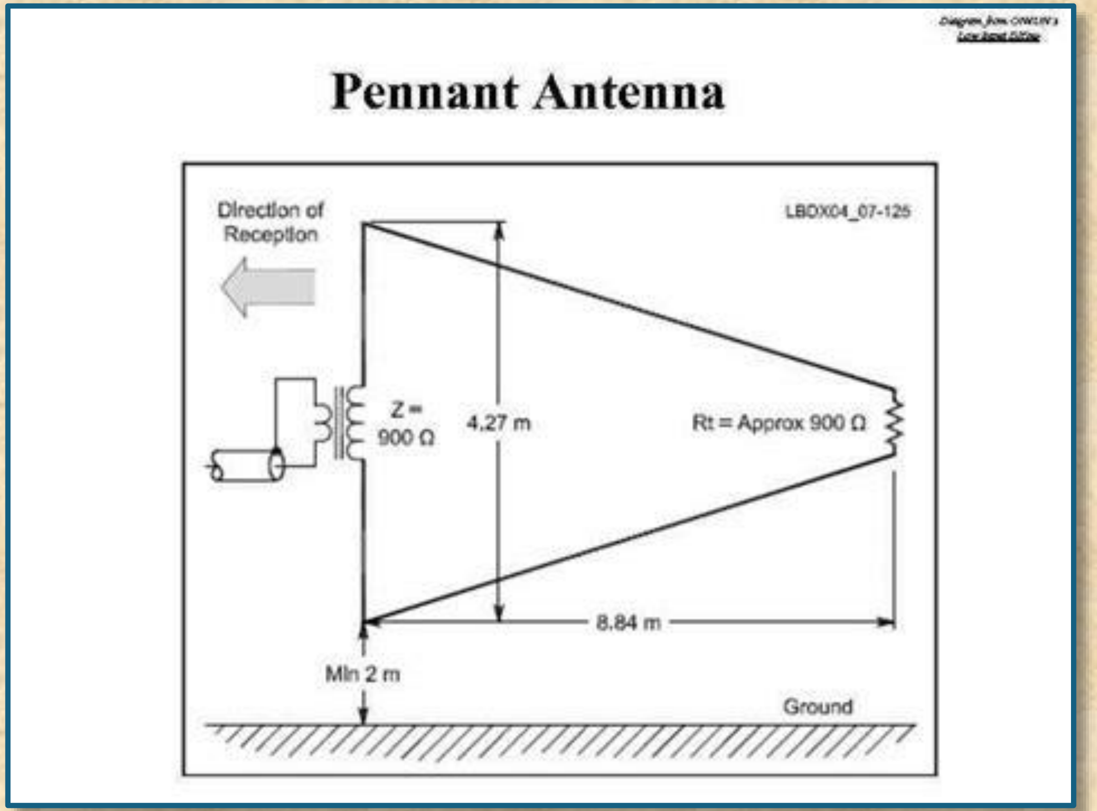
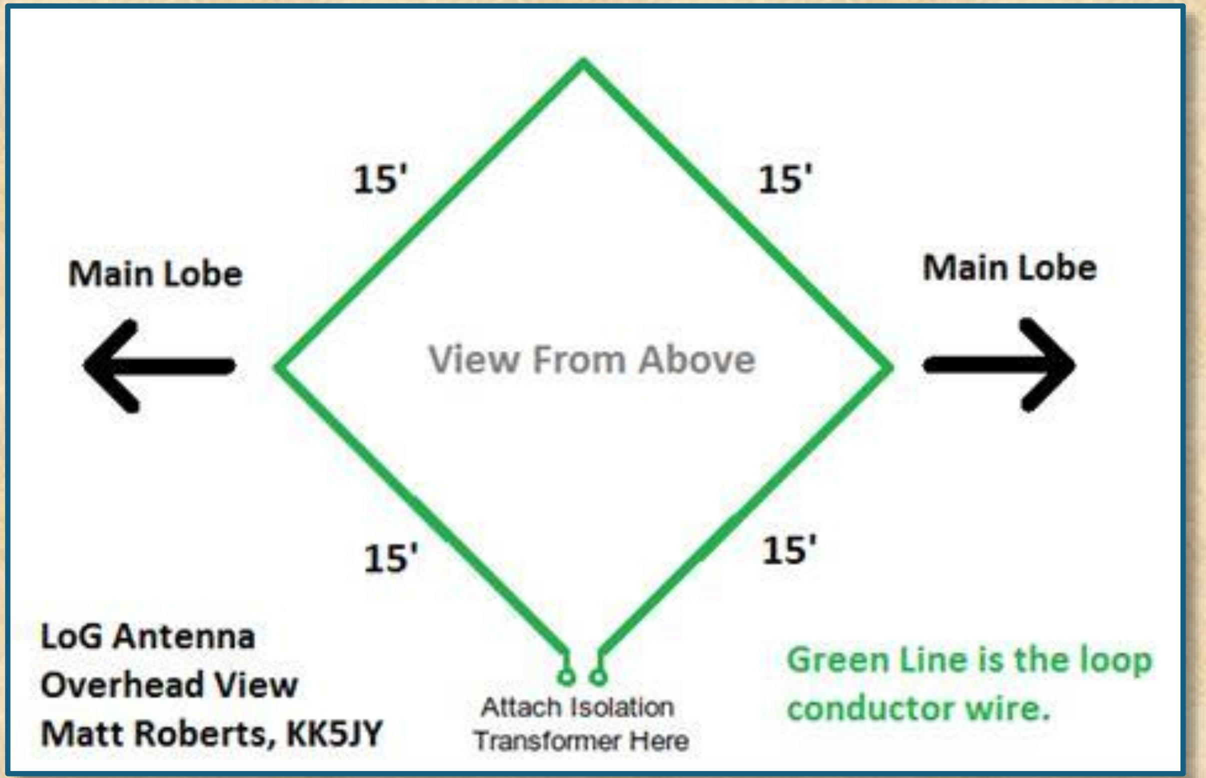
- Tuned Loop
- **Flag Antenna**
- Loop on the ground



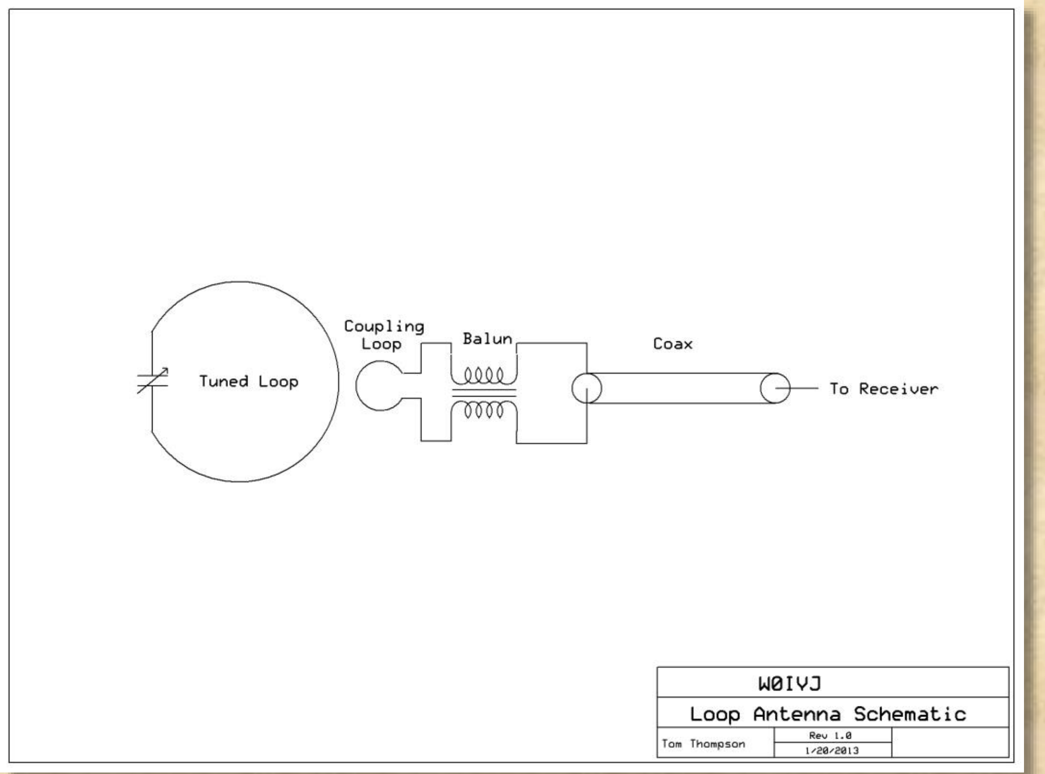
Receiving (RX) Antennas

- Low RX wire
- Beverage Antenna
- Broadband untuned loop
- Tuned Loop
- Flag Antenna
- **Loop on the ground**

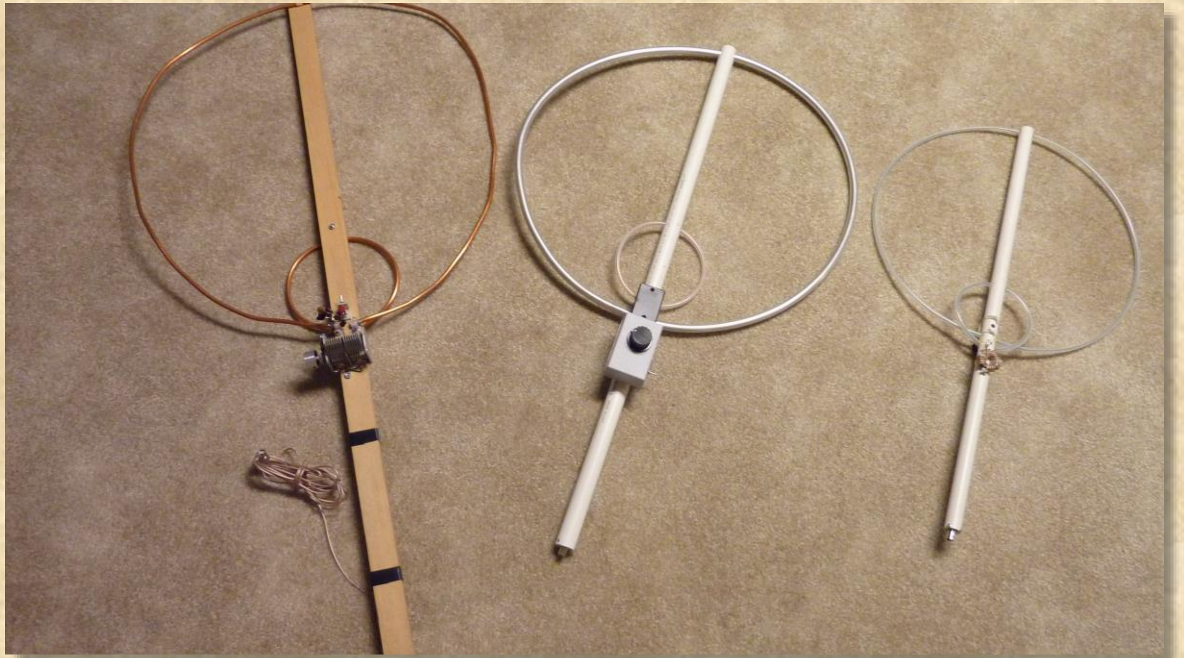


Tuned RX Loop: Design and Implementation

W0IVJ design of a tuned RX loop



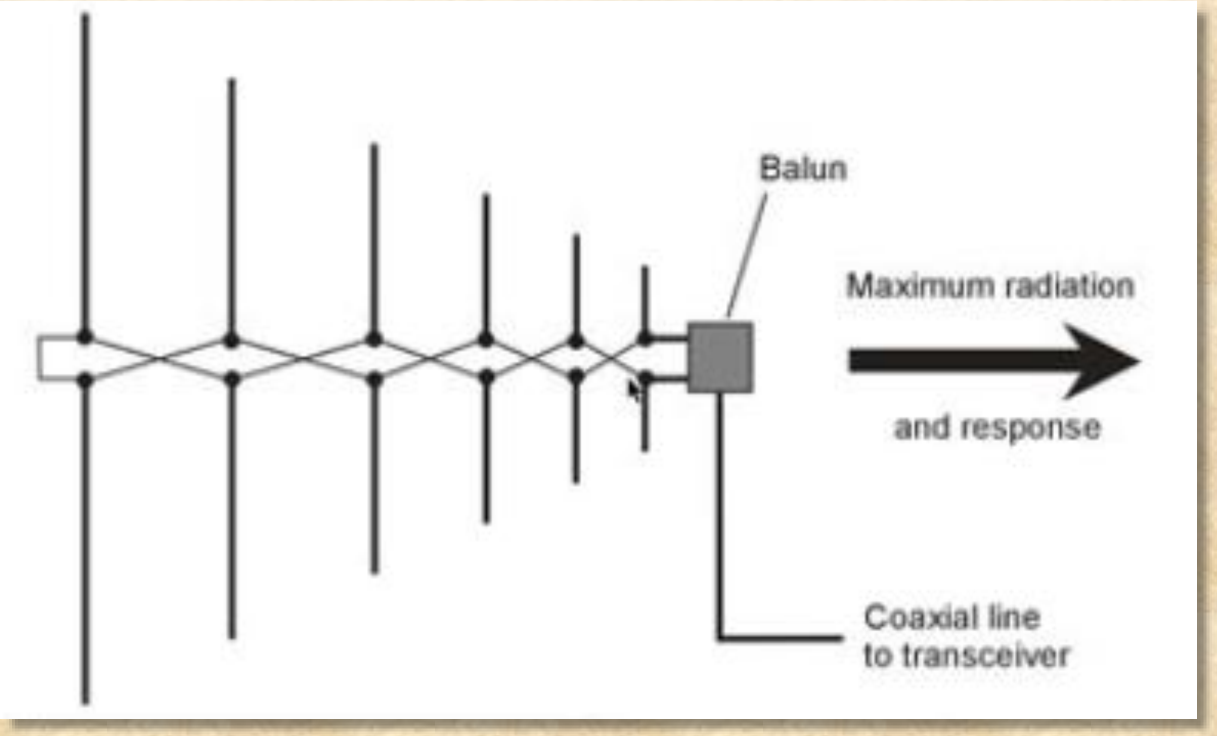
Three of his RFI sniffing tuned loops



These antennas have been very helpful in locating RFI from many sources (grow houses, power lines, etc.).

Log-Periodic Dipole Array (LPDA)

- The LPDA is one of several Log-Periodic structures
- An LPDA design is based on angles, not resonance
- Key design parameters
  - Low and High frequencies
  - Tau – Taper Factor
  - Sigma – relative spacing
- All elements are driven via a cross-over phasing line



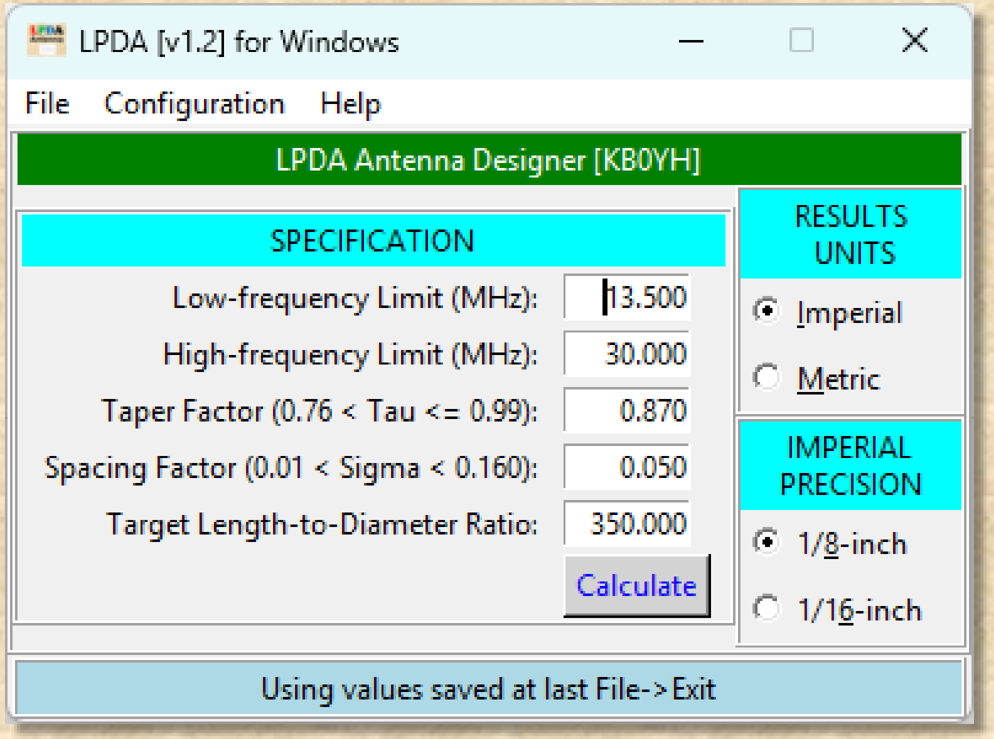
LPDA Antenna:
Design and Implementation

- The material in this section is based mostly on the LPDA chapter in the ARRL Antenna Book (20th Ed. And later)
- Additional material is based on my field testing and computer programming efforts
- My LPDA program simplifies the process by combining the mathematical steps required to specify the design and to preserve the build information

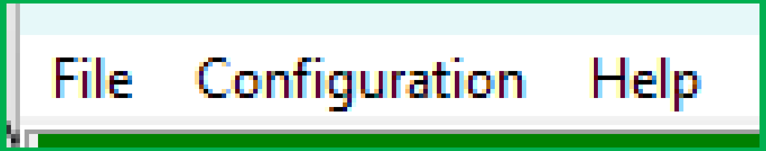
NOTE: The LPDA program is a work in progress. It is useful in its current form, but will be extended to include NEC output choices that will enable detailed modeling, gain estimates, pattern prediction, and other helpful information.

LPDA Antenna Program

- Free program for use on Windows, Linux, and macOS platforms
- Configuration
  - Units (Imperial, Metric)
  - Precision if using Imperial units
- Specify key values to describe the design, then press Calculate
- Results show mechanical and electrical properties
- Obtain from www.qrz.com/db/KB0YH



LPDA Program Menu

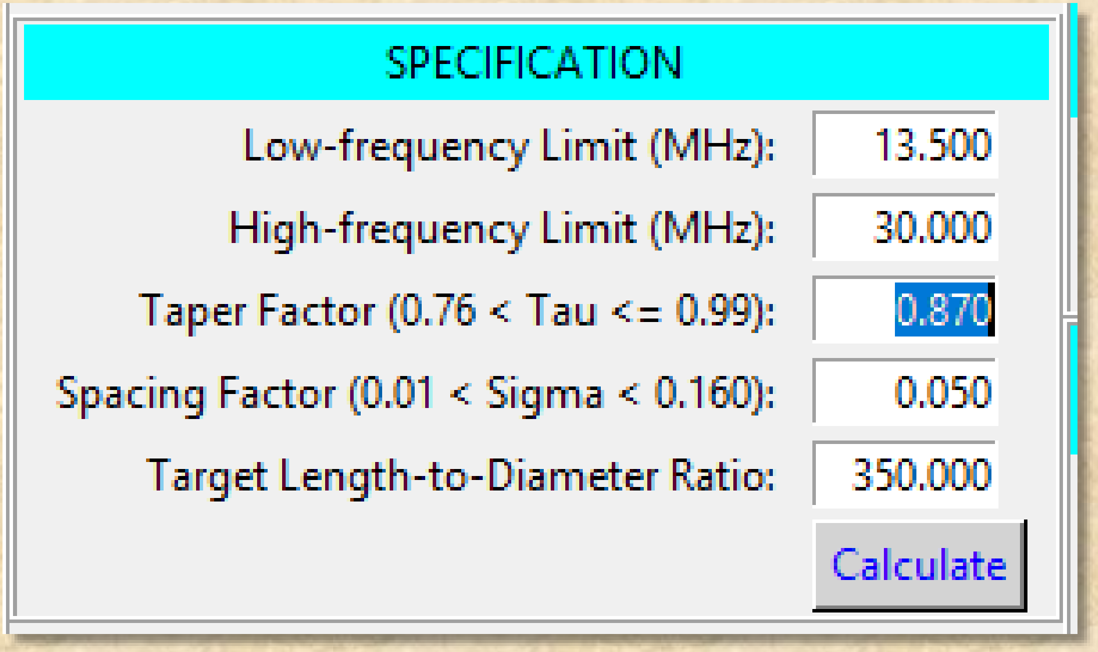


- File Menu
  - Save Design (to Project)
  - Load Design (from Project)
  - Save NEC (work in progress)
  - Exit
    - Saves state to config file
    - Use [X] to exit without saving
- Configuration Menu
  - Audible Alerts
  - Results Viewer
- Help Menu
  - Display Help
  - About

NOTE: A Project is represented by a folder (directory) name that is associated with an LPDA design. Any Save or Read operation sets the currently remembered Project location.

LPDA Program SPECIFICATION

- Frequency Limits (Low and High)
- Taper Factor (Tau)
  - Affects “density” of array
  - Larger value -> more elements
- Spacing Factor (Sigma)
  - Affects inter-element spacing
  - Larger value -> long boom
- Target L/D Ratio
  - Affects element thickness
  - Larger value -> thicker elements



LPDA Program RESULTS

- LPDA DESIGN SUMMARY
- CONSTRUCTION SUMMARY
  - Element lengths (and fractional half lengths)
  - Spacing and boom positions
  - Recommended central diameter
  - Suggested Stub and Boom lengths
- FEEDER SYSTEM SUMMARY
  - Surge impedance for 50 Ω and 75 Ω feed line

lpda_results.txt

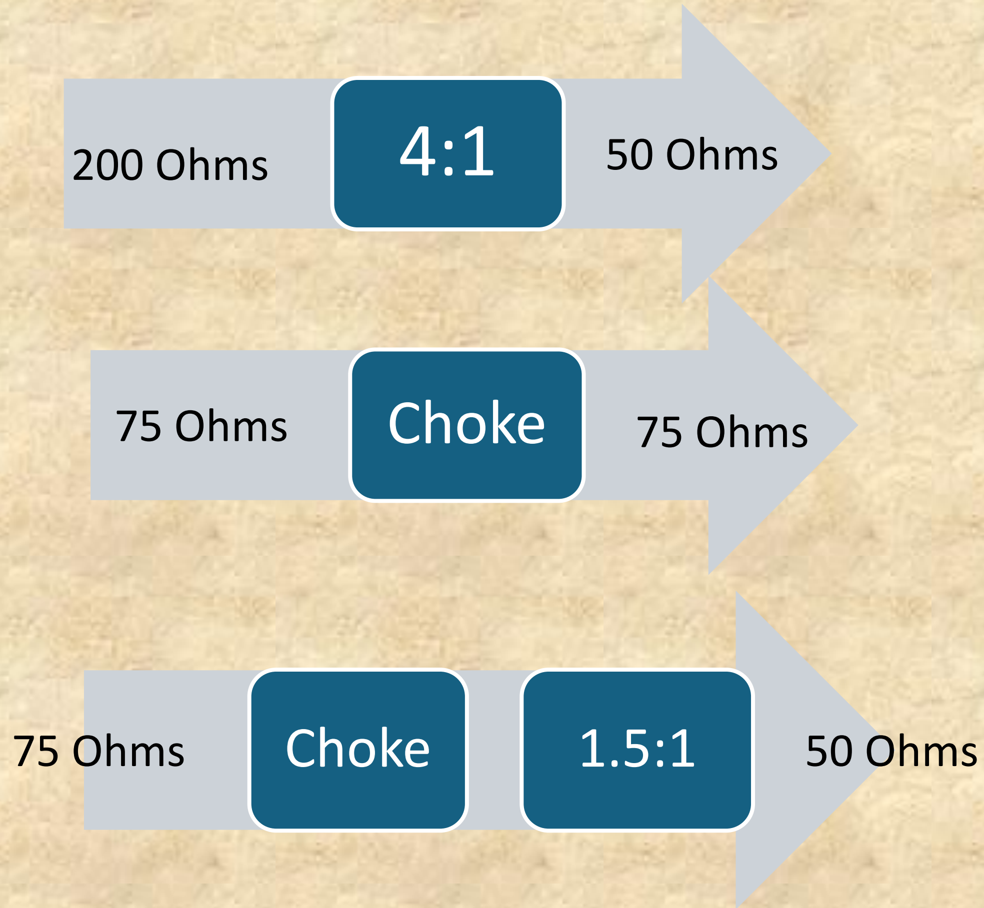
Project: C:/Users/augie/Documents

```
***** LPDA DESIGN SUMMARY *****
Frequency range: 13.500 to 30.000 MHz
Taper factor = 0.870
Relative spacing factor = 0.050
Target L/d ratio = 350

***** CONSTRUCTION SUMMARY *****
Element lengths and placement:
Length (Half-Length)      Spacing          Position       Diameter
E1 37.037 (18'6-1/4")     S1-2 3'8-1/2"    2"             1-1/4"
E2 32.222 (16'1-3/8")     S2-3 3'2-5/8"    3'10-1/2"      1-1/8"
E3 28.033 (14'0-1/4")     S3-4 2'9-5/8"    7'1-1/8"       1"
E4 24.389 (12'2-3/8")     S4-5 2'5-1/4"    9'10-3/4"      0-7/8"
E5 21.218 (10'7-1/4")     S5-6 2'1-1/2"    12'4"          0-3/4"
E6 18.460 (9'2-3/4")      S6-7 1'10-1/8"   14'5-1/2"      0-5/8"
E7 16.060 (8'0-3/8")      S7-8 1'7-1/4"    16'3-5/8"      0-1/2"
E8 13.972 (6'11-7/8")     S8-9 1'4-3/4"    17'10-7/8"     0-1/2"
E9 12.156 (6'0-7/8")                       19'3-5/8"      0-3/8"

Recommended Stub = 3.039' (3'0-1/2")
Boom length = 19.473'  (19'5-5/8")

***** FEEDER SYSTEM SUMMARY *****
Z0 = 457.2 Ohms for 50 Ohm coax via 4:1 balun
Z0 = 108.8 Ohms for direct 75 Ohm feed line
```

Press the Esc key or click Cancel [X] to exit

Feeder System Impedance (Under development)

- Feedpoint Impedance
  - 50 Ohm most common
  - 75 Ohm for lowest feedline loss
- Design Options
  - 50 Ohm via a 4:1 balun
  - 75 Ohm direct via RF choke
  - 50 Ohm via RF choke and 1.5:1 auto transformer
- Array Surge Impedance
  - Impedance needed to match specified input impedance



LPDA Antenna Components

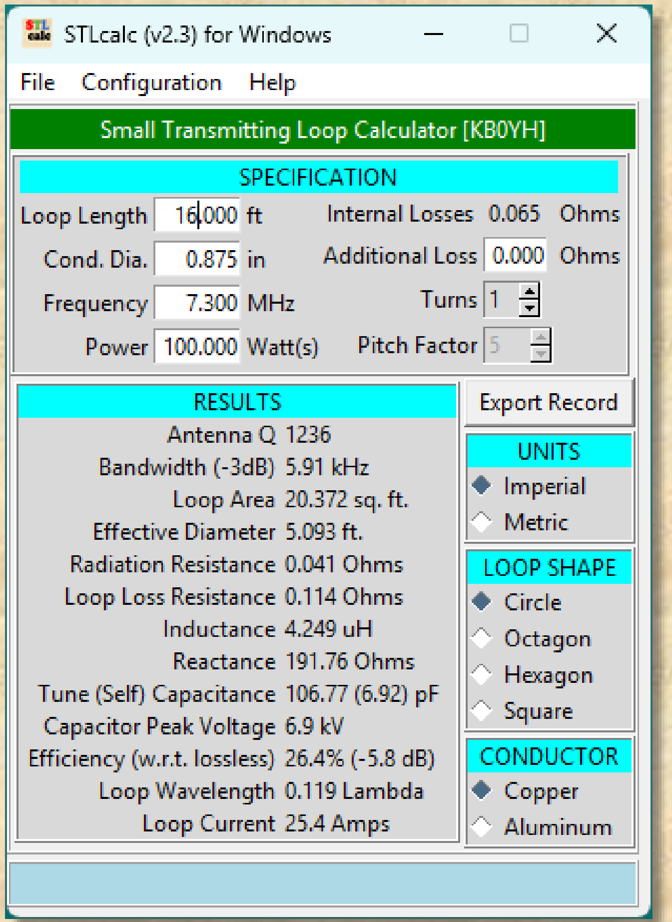

KB0YH
9-el LPDA

Small Transmitting Loop Antenna

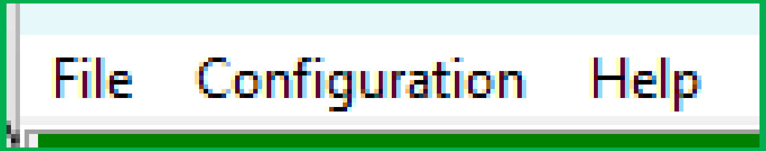
- Commonly called a Magnetic Loop Antenna (Mag Loop)
- True small loops have a loop length of 0.1-λ or less for unifor current and phase
- A usable Mag Loop antenna can have up to a 0.3-λ loop conductor

STLcalc Program

- Free program for use on Windows, Linux, and macOS platforms
- Configuration
  - Units (Imperial, Metric)
  - Loop shape (Circle, Octagon, Hexagon, Square)
  - Conductor Material (Copper, Aluminum)
- Specify key values to describe the design
- Results show mechanical and electrical properties
- Obtain from www.qrz.com/db/KB0YH



STLcalc Menu

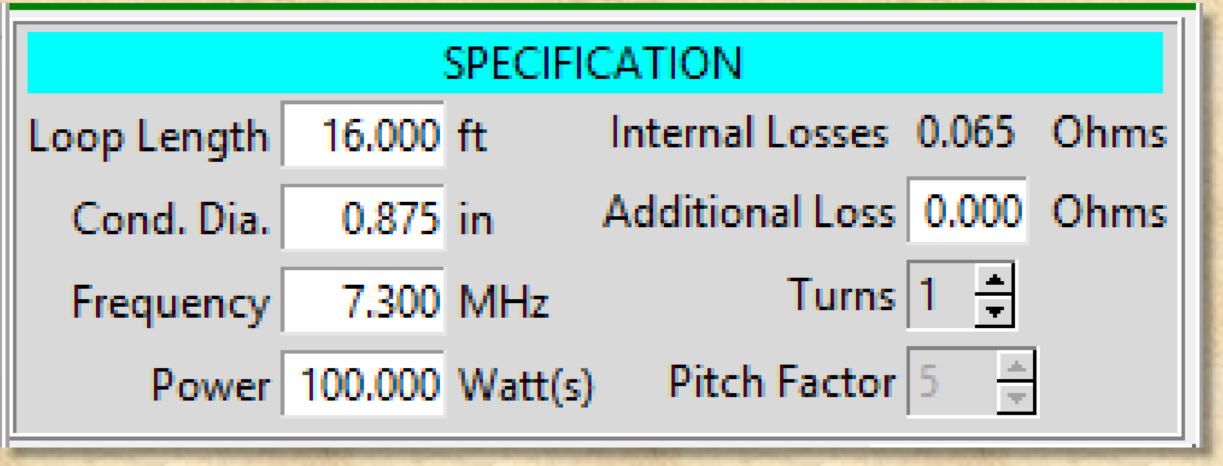


- File Menu
  - Save Design (to Project)
  - Load Design (from Project)
  - Exit
    - Saves state to config file
    - Use [X] to exit without saving
- Configuration Menu
  - Audible Alerts
  - Loss Resistance Estimates
  - Internal Rloss State
- Help Menu
  - Display Help
  - About

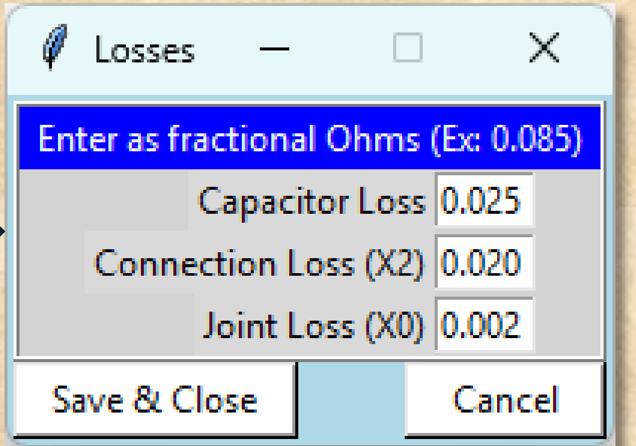
NOTE: A Project is represented by a folder (directory) name that is associated with an STL design. Any Save or Read operation sets the currently remembered Project location.

STLcalc SPECIFICATION

- Loop Length
- Conductor Diameter
- Frequency
- Power
- Internal Losses (dialog)
- Additional Loss (deprecated)
- Turns
- Pitch Factor



File->Loss Resistance Estimates



STLcalc RESULTS

- Antenna Q - X / (Rloss + Rrad)
- Bandwidth (-3dB) - Half-power points at tuned frequency
- Loop Area
- Effective Diameter – the diameter of a circle with the same area
- Radiation Resistance - calculated
- Loop Loss Resistances – calculated value plus internal estimates

RESULTS	
Antenna Q	1236
Bandwidth (-3dB)	5.91 kHz
Loop Area	20.372 sq. ft.
Effective Diameter	5.093 ft.
Radiation Resistance	0.041 Ohms
Loop Loss Resistance	0.114 Ohms
Inductance	4.249 uH
Reactance	191.76 Ohms
Tune (Self) Capacitance	106.77 (6.92) pF
Capacitor Peak Voltage	6.9 kV
Efficiency (w.r.t. lossless)	26.4% (-5.8 dB)
Loop Wavelength	0.119 Lambda
Loop Current	25.4 Amps

STLcalc RESULTS (continued)

- Inductance and Reactance – The calculated values
- Tune (Self) Capacitance – Cap value needed to tune to frequency and the loop self capacitance accounted for
- Capacitor Peak Voltage – The one that counts, not the average!
- Efficiency (w.r.t. lossless) – The value compared to an unachievable perfect loop

RESULTS	
Antenna Q	1236
Bandwidth (-3dB)	5.91 kHz
Loop Area	20.372 sq. ft.
Effective Diameter	5.093 ft.
Radiation Resistance	0.041 Ohms
Loop Loss Resistance	0.114 Ohms
Inductance	4.249 uH
Reactance	191.76 Ohms
Tune (Self) Capacitance	106.77 (6.92) pF
Capacitor Peak Voltage	6.9 kV
Efficiency (w.r.t. lossless)	26.4% (-5.8 dB)
Loop Wavelength	0.119 Lambda
Loop Current	25.4 Amps

STLcalc RESULTS (continued)

- Loop Wavelength – The fraction of a wavelength of the loop including the capacitor and any jumpers
- Loop Current – The maximum current experienced by the conductor(s) and the capacitor

RESULTS	
Antenna Q	1236
Bandwidth (-3dB)	5.91 kHz
Loop Area	20.372 sq. ft.
Effective Diameter	5.093 ft.
Radiation Resistance	0.041 Ohms
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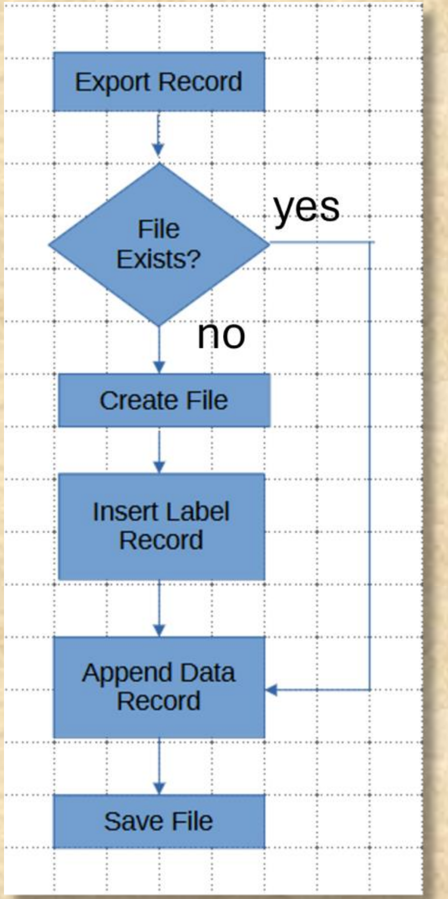
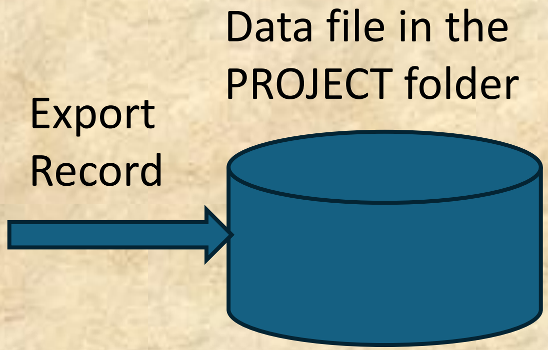
Capacitor Peak Voltage	6.9 kV
Efficiency (w.r.t. lossless)	26.4% (-5.8 dB)
Loop Wavelength	0.119 Lambda
Loop Current	25.4 Amps

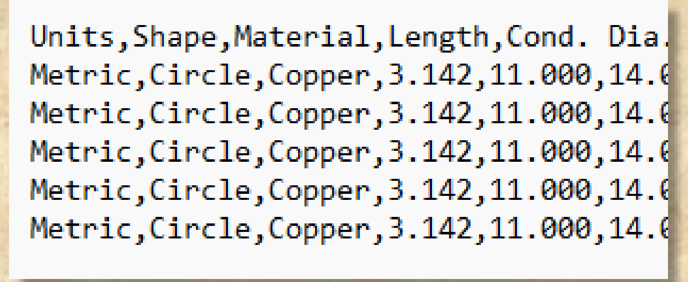
STLcalc Export Record Feature

- Use this feature to save all current data in a CSV file
  - Configuration
  - Specification
  - Results
- Data usable in spreadsheet, database, and custom processing programs
  - Analysis
  - Charting



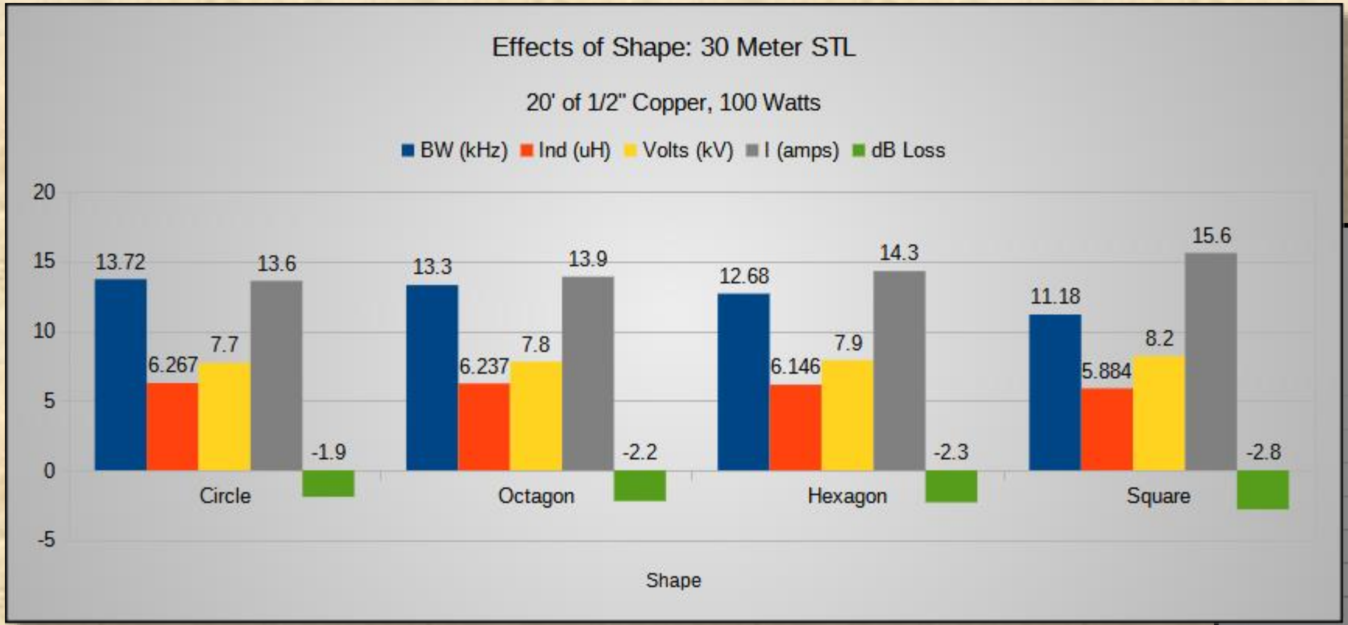


Comma-separated value (CSV) file

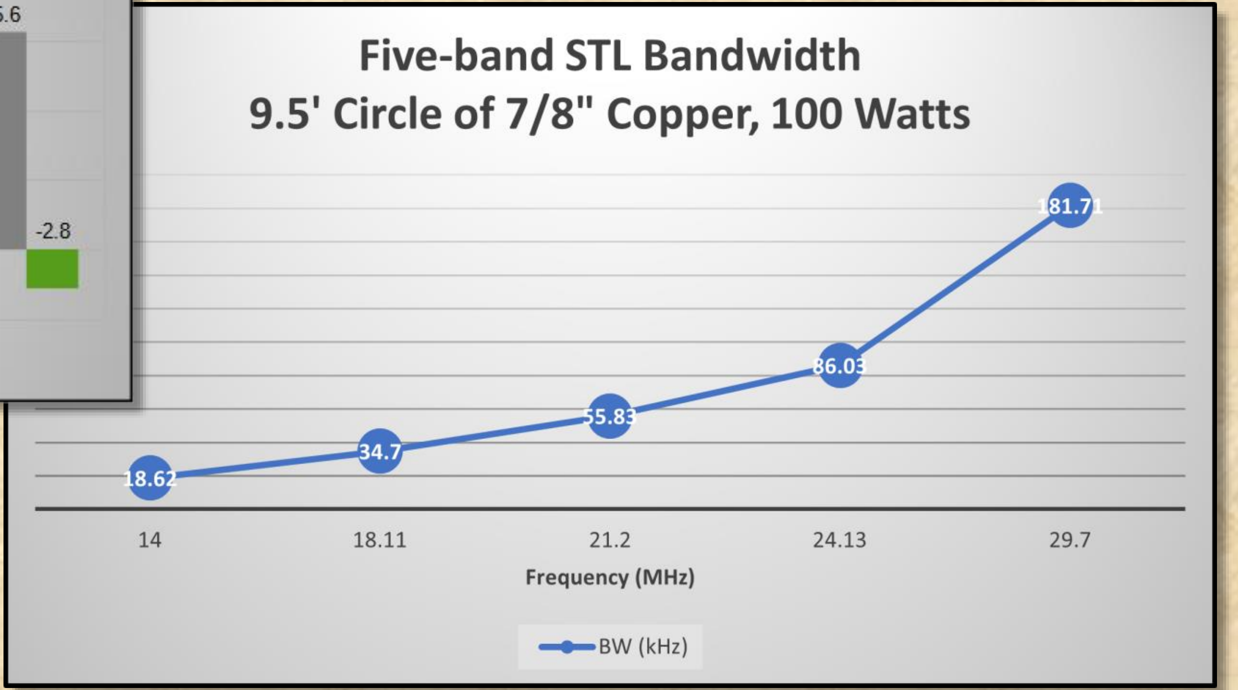


Displaying exported data for analysis and demonstration

Vertical bar chart for discrete variable (Shape)



A continuum (frequency range) is best illustrated by using a line chart

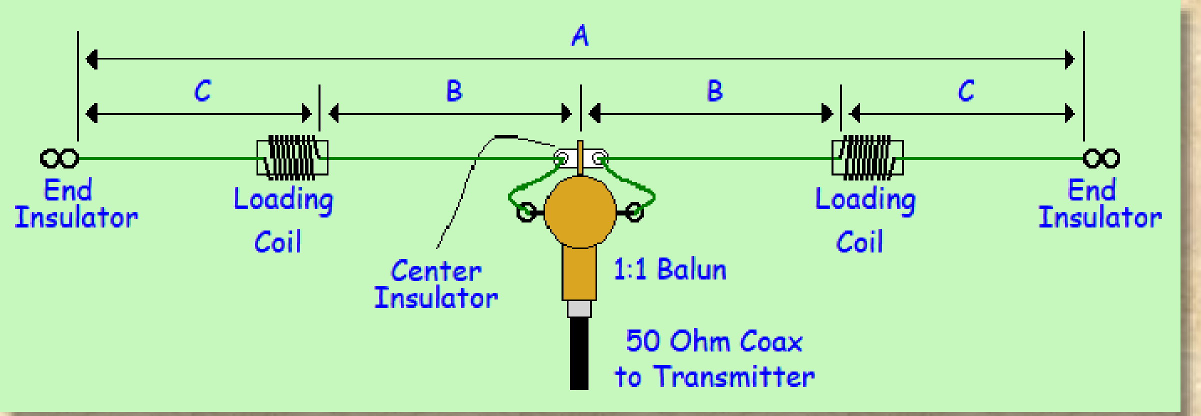


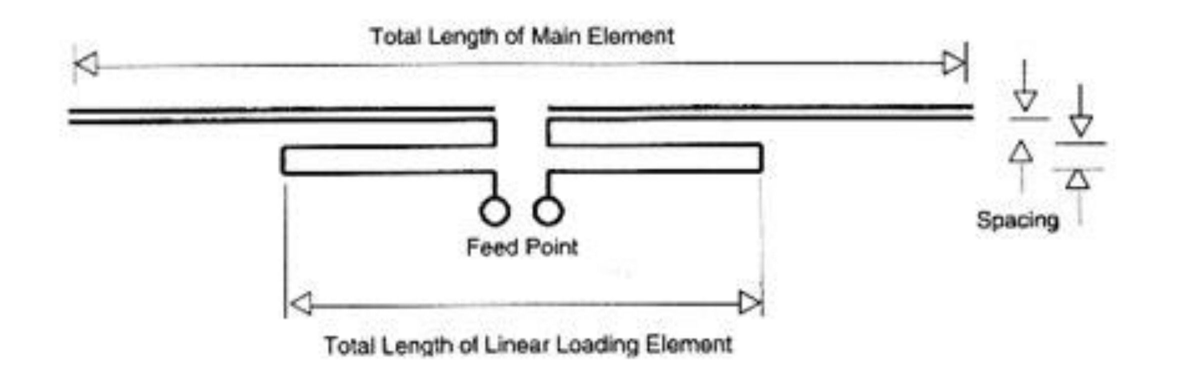
These charts were produced using the Microsoft Excel and Libre Office Calc programs

Honey, I shrunk the antenna! Single-turn vs Multi-turn STL

Honey, I shrunk the antenna!
Dipoles

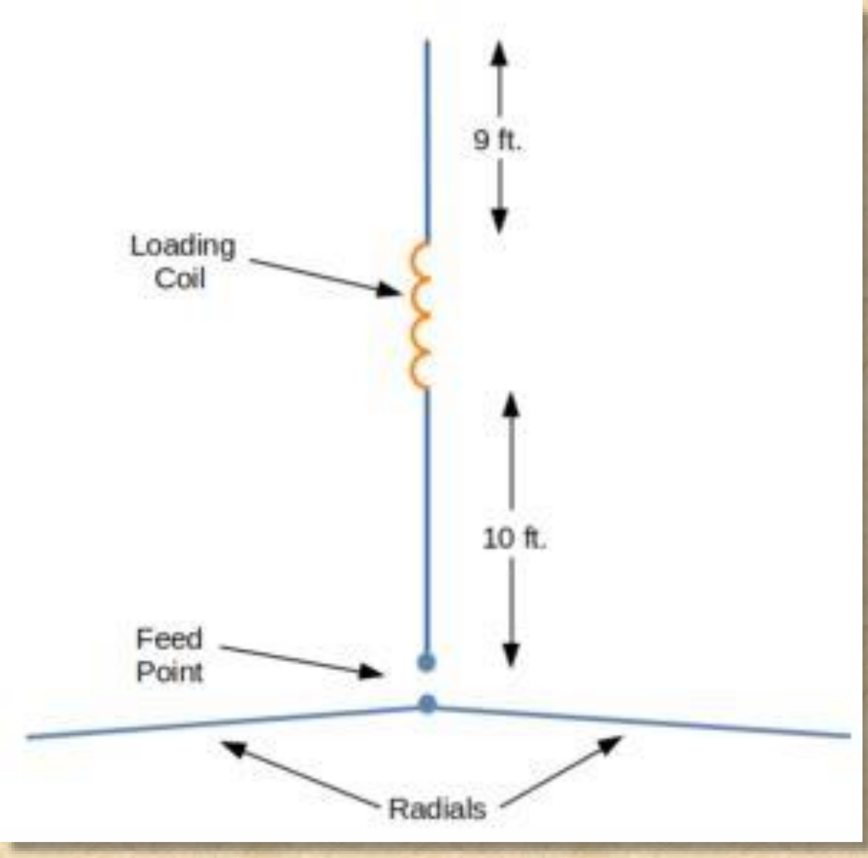
- **Reduced size dipole antenna**
  - **Coil loaded elements**
  - **Linear loaded elements**
- Shortened vertical antenna
  - Coil loaded element
  - Top loaded element





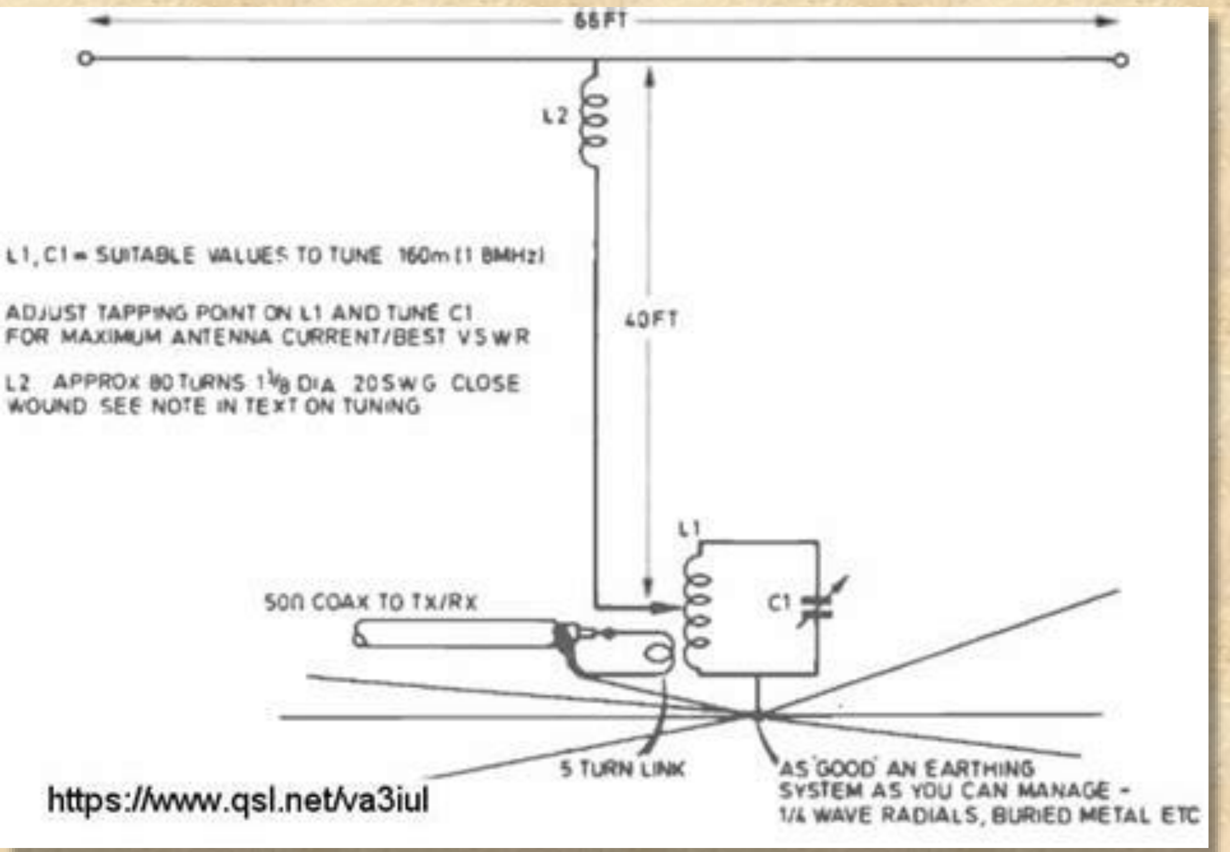
Honey, I shrunk the antenna!
Vertical

- Reduced size dipole antenna
  - Coil loaded elements
  - Linear loaded elements
- **Shortened vertical antenna**
  - **Coil loaded element**
  - Top loaded element



Honey, I shrunk the antenna!
Vertical

- Reduced size dipole antenna
  - Coil loaded elements
  - Linear loaded elements
- **Shortened vertical antenna**
  - Coil loaded element
  - **Top loaded element**



Part 3 Q&A


My wife says I need to clean up the yard.
I don’t see a problem. Do you?
73 & 88, KB0YH