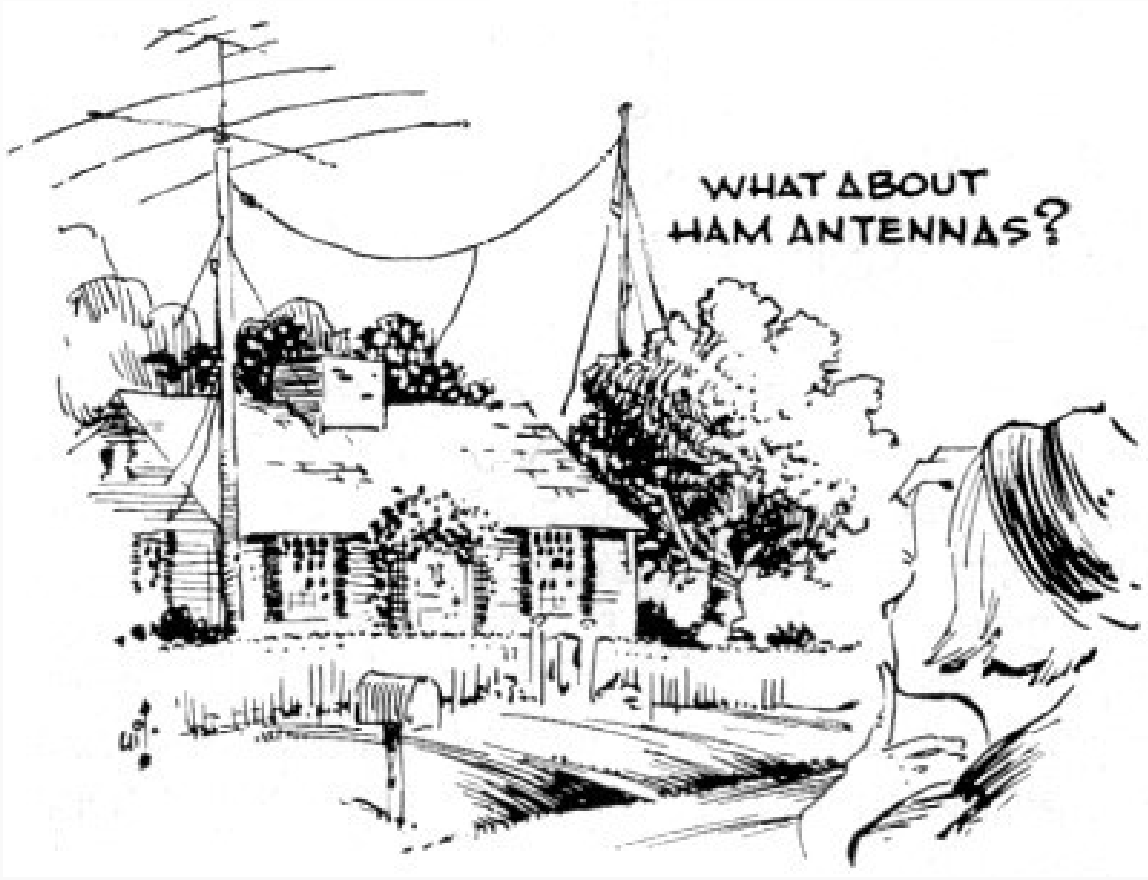
ANTENNAS

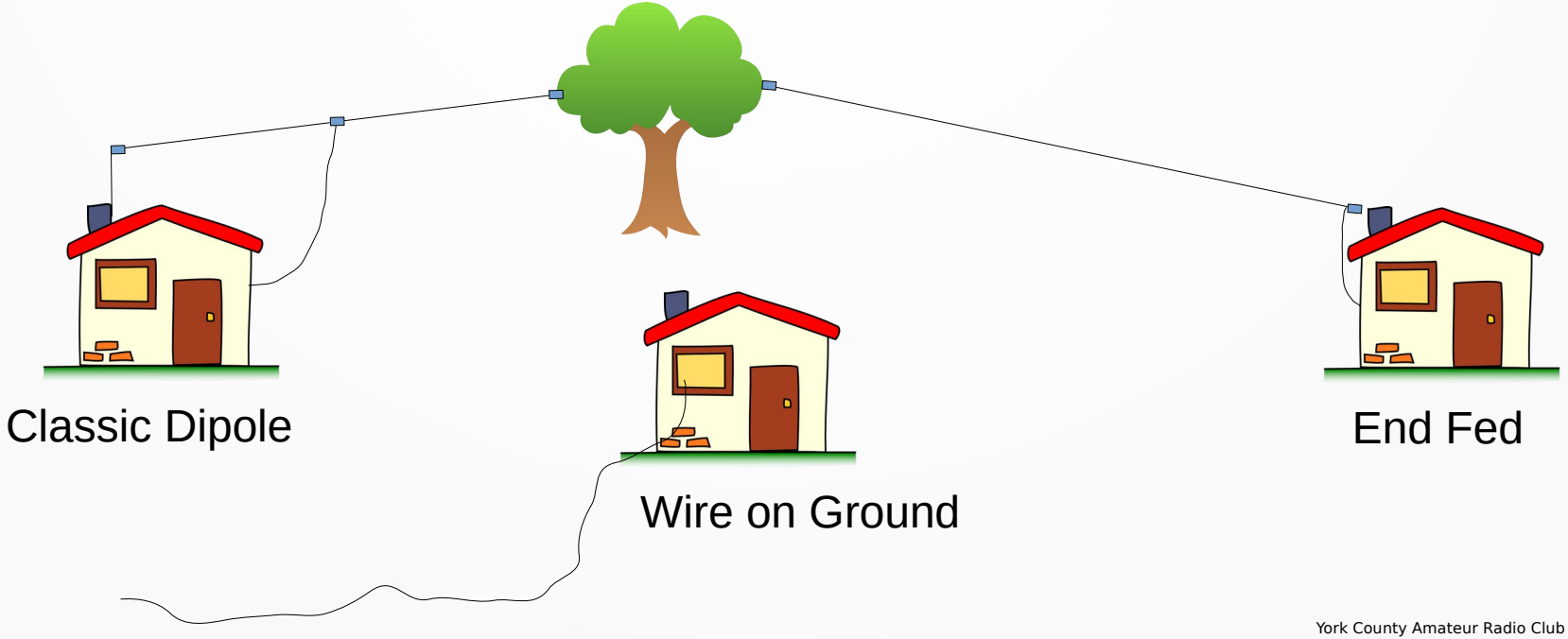


ANTENNAS

- KRAUS DEFINES A RADIO ANTENNA AS “THE STRUCTURE ASSOCIATED WITH THE REGION OF TRANSITION BETWEEN A GUIDED WAVE AND A FREE-SPACE WAVE, OR VICE VERSA.” [1]
- BASIC COMPONENT OF ANY ELECTRONIC SYSTEM WHICH DEPENDS ON FREE SPACE AS THE PROPAGATION MEDIUM
- THE CONNECTING LINK BETWEEN FREE SPACE AND TRANSMITTER OR RECEIVER
- RECIPROCAL PROPERTIES
  - RECEIVES OR TRANSMITS EQUALLY
- BASIC PROPERTIES
  - IMPEDANCE
  - GAIN
  - RADIATION PATTERN
  - POLARIZATION

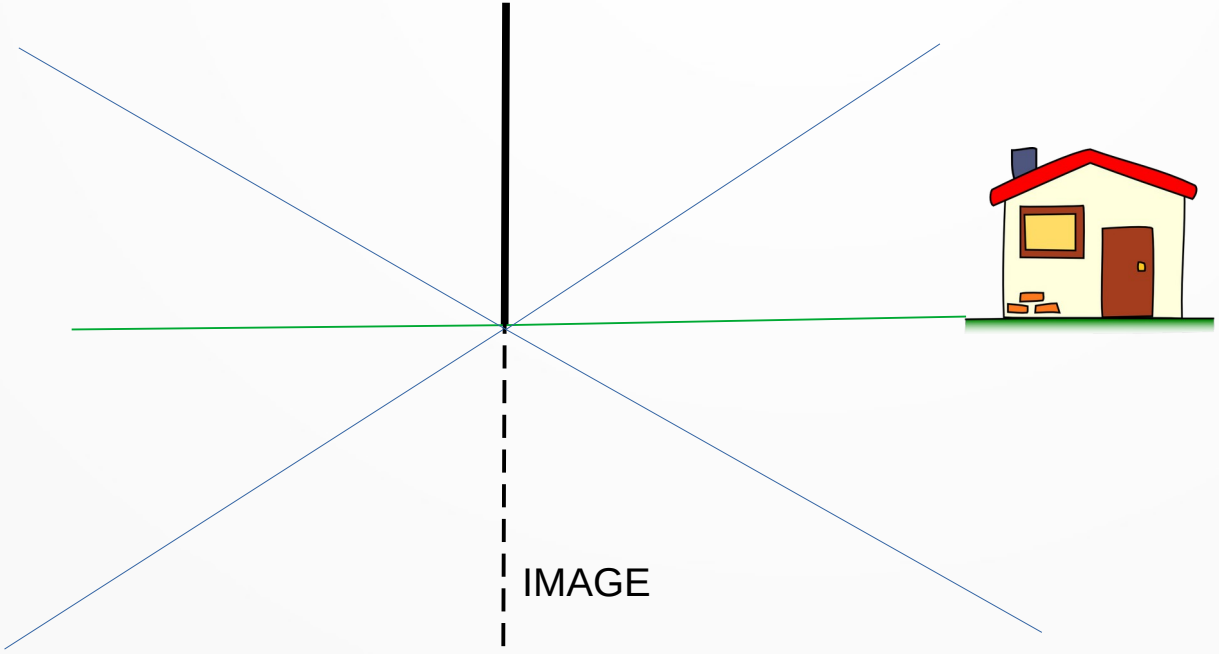
ANTENNAS

- CAN TAKE MANY DIFFERENT FORMS
  - SOME WORK BETTER THAN OTHERS



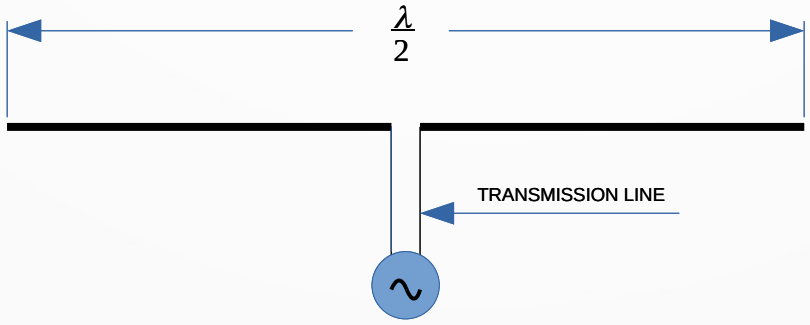
ANTENNAS

- VERTICAL λ/4 WAVE - WITH MULTIPLE RADIALS



ANTENNAS

- USUALLY A THIN CONDUCTOR ARRANGED IN A LINEAR CONFIGURATION
  - EXAMPLE = HALF-WAVE DIPOLE
  - Dipole = “di”, meaning *two*; “pole” meaning *electrical polarity*



$$\frac{\lambda}{2} = \frac{468}{f_{MHz}}$$

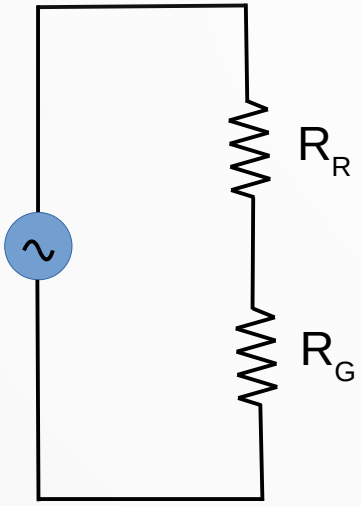
ANTENNAS

THE *“IDEAL”* ANTENNA RADIATES 100% OF THE ENERGY DELIVERED TO IT

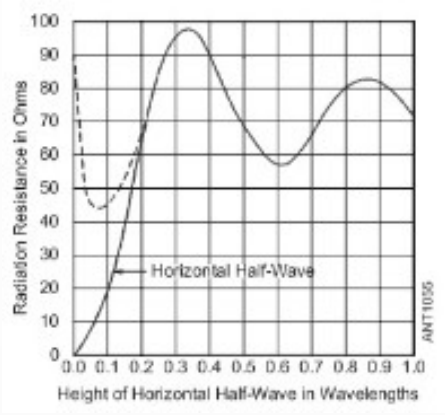
THE IDEAL ANTENNA DOES NOT EXIST

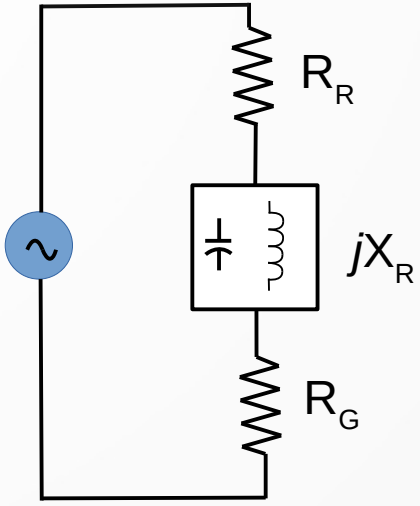
ANTENNAS

SIMPLE THEORETICAL ANTENNA CIRCUIT ANALYSIS [2]



AT RESONANCE





NON- RESONANCE

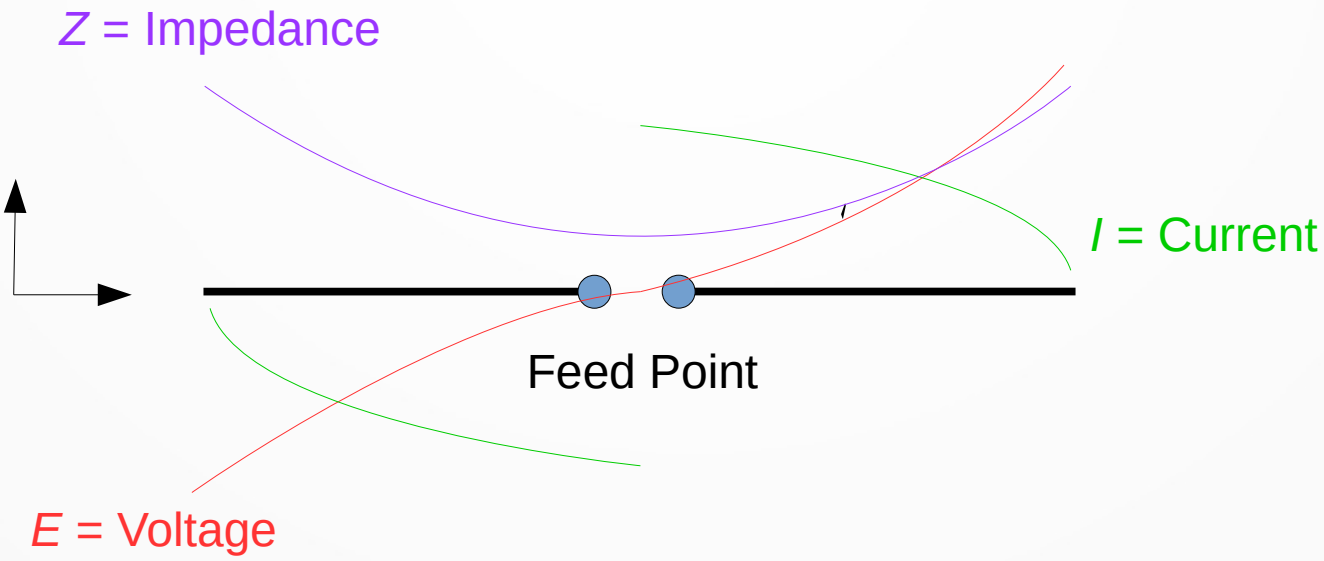
R_R = RADIATION RESISTANCE R_G = GROUND LOSSES jX_R = REACTANCE LOSS

ANTENNAS

- FEED-POINT IMPEDANCE OF HALF-WAVE DIPOLE ≈72Ω IN FREE SPACE
  - ASSUMES HALF-WAVE ABOVE EARTH
- FEED-POINT IMPEDANCE OF QUARTER-WAVE VERTICAL ≈ 37Ω
  - ASSUMES GOOD CONDUCTING EARTH AND **ADEQUATE # OF RADIALS**
  - **A GROUND ROD IS NOT SUFFICIENT –** A DC GROUND IS NOT AN “RF GROUND”
- THE FEED-POINT IMPEDANCE OF A HORIZONTAL λ/2-DIPOLE STEADILY DECREASES AS THE ANTENNA IS LOWED BELOW λ/4-WAVELENGTH ABOVE GROUND
- THE FEED POINT IMPEDANCE OF A λ/2-DIPOLE STEADILY INCREASES AS THE FEED POINT IS MOVED FROM THE CENTER TOWARDS AN END

ANTENNAS

RESONANT HALF-WAVE DIPOLE STANDING WAVES - λ/4 ABOVE EARTH



$$Z = \frac{E}{I}$$

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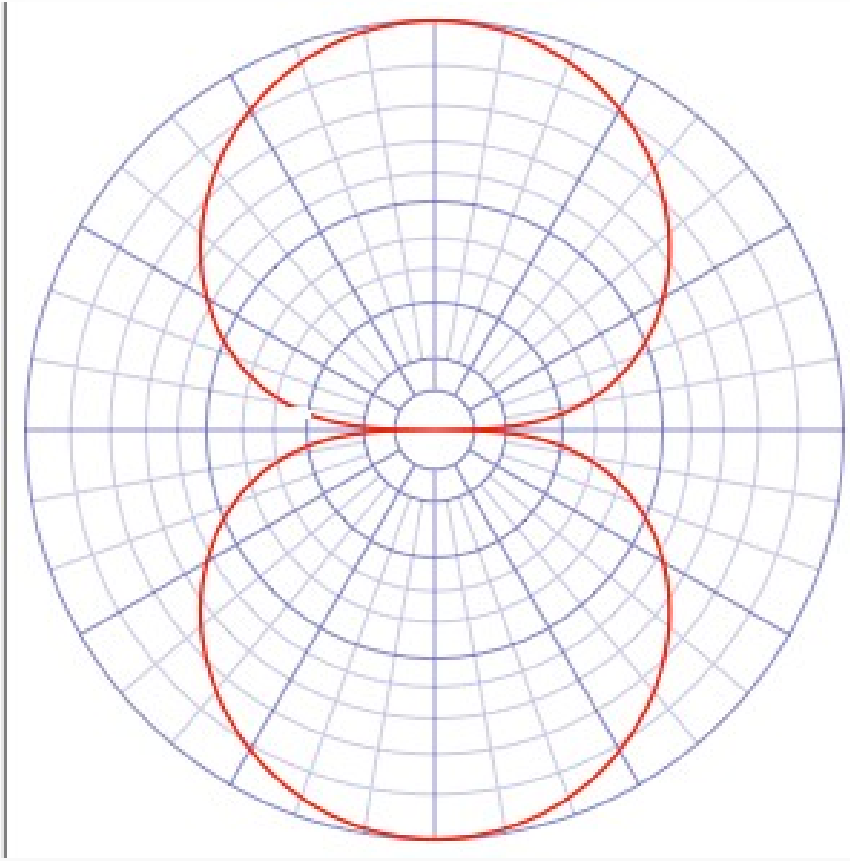
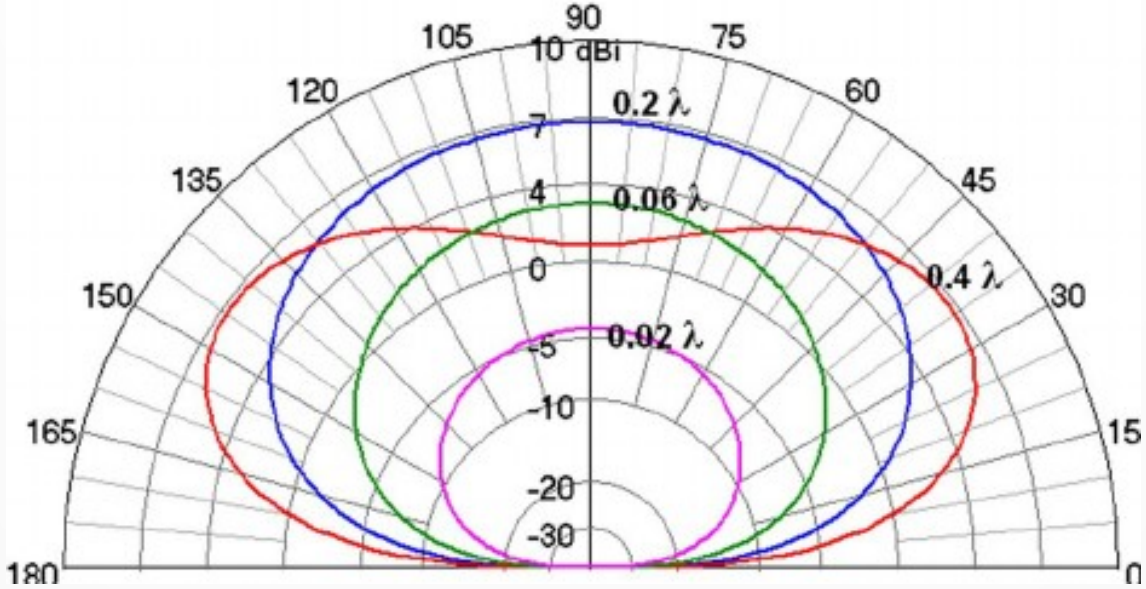
½-wave Dipole
Horizontal Plane

Mounted 1/2-wave
Above perfect earth



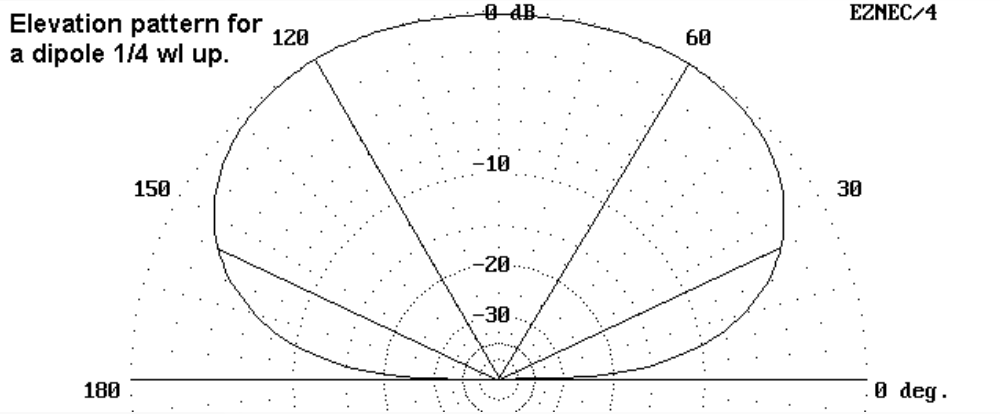
ANTENNAS

HALF-WAVE DIPOLE
VERTICAL PLANE



ANTENNAS

HORIZONTAL WIRE ANTENNA TAKE-OFF ANGLE

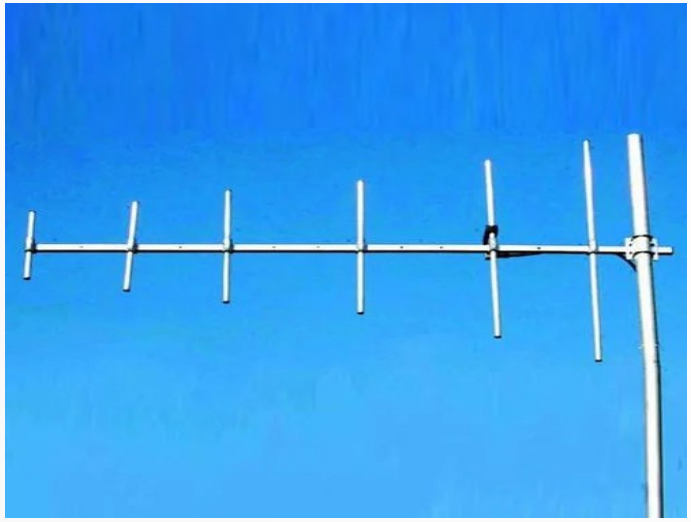


$$TOA = \sin^{-1}\left(\frac{\lambda}{4h}\right) \quad [3]$$

λ = Wavelength
h = Height above ground
(both in meters)

ANTENNAS

MULTI-BAND ANTENNAS



VHF LOG PERIODIC
VERTICAL POLARIZATION

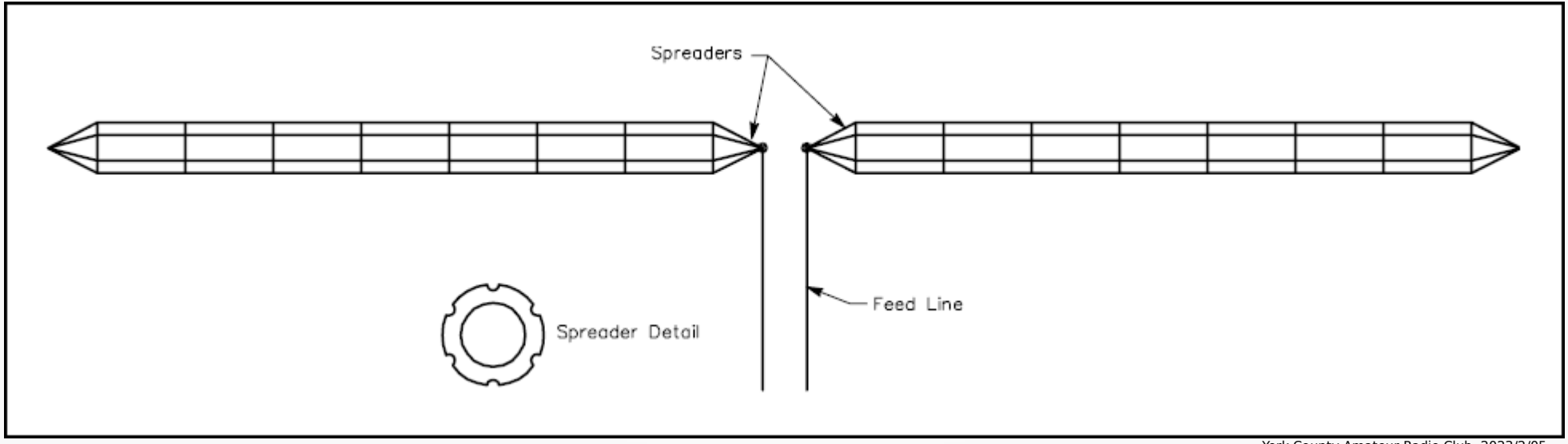
HF MULTI-BAND BEAM
HORIZONTAL POLARIZATION

BASICALLY DIPOLES WITH PARASITIC ELEMENTS

ANTENNAS

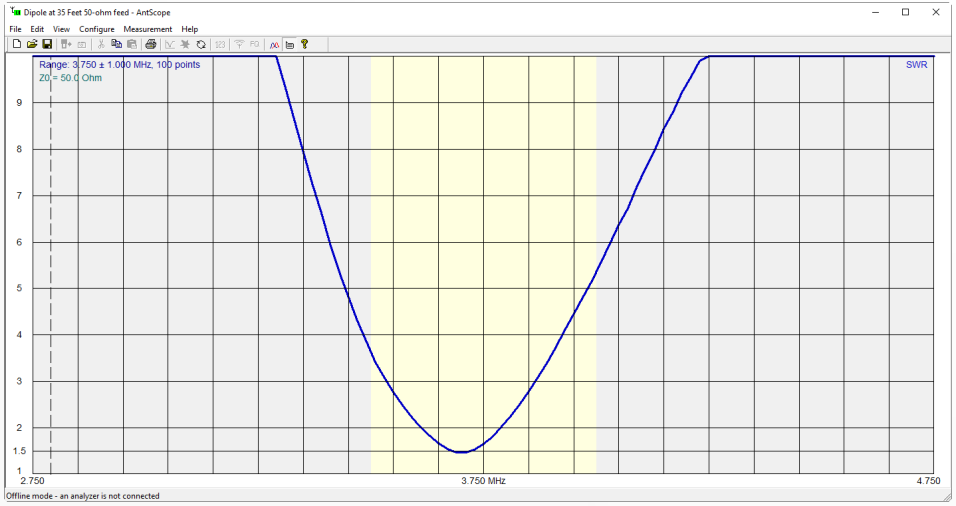
BROADBAND “CAGE” DIPOLE

- SINGLE WIRE DIPOLES HAVE VERY NARROW RESONANT BANDWIDTH
- BROADEN FREQUENCY RANGE BY MAKING A “CAGE” OF WIRES
- MANY VARIATIONS – FAN DIPOLE FOR EXAMPLE

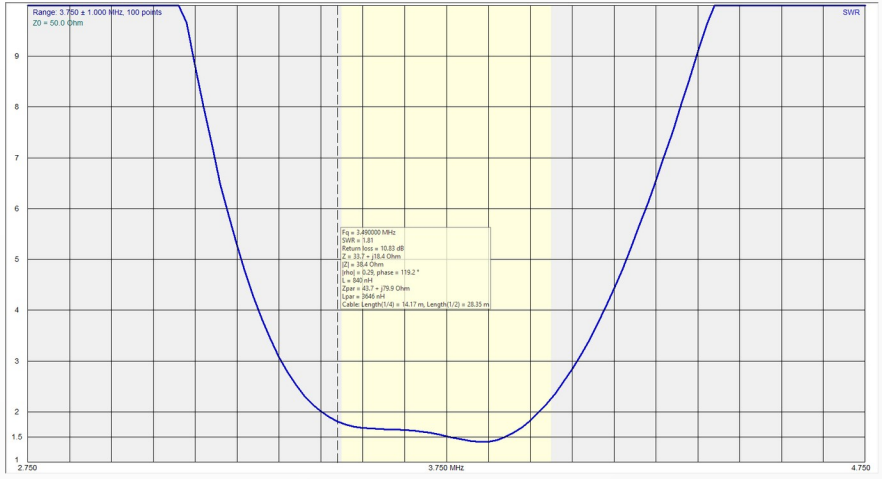


ANTENNAS

80/75 METER DIPOLE VSWR CURVES



NORMAL “THIN WIRE” DIPOLE



BROADBAND DIPOLE

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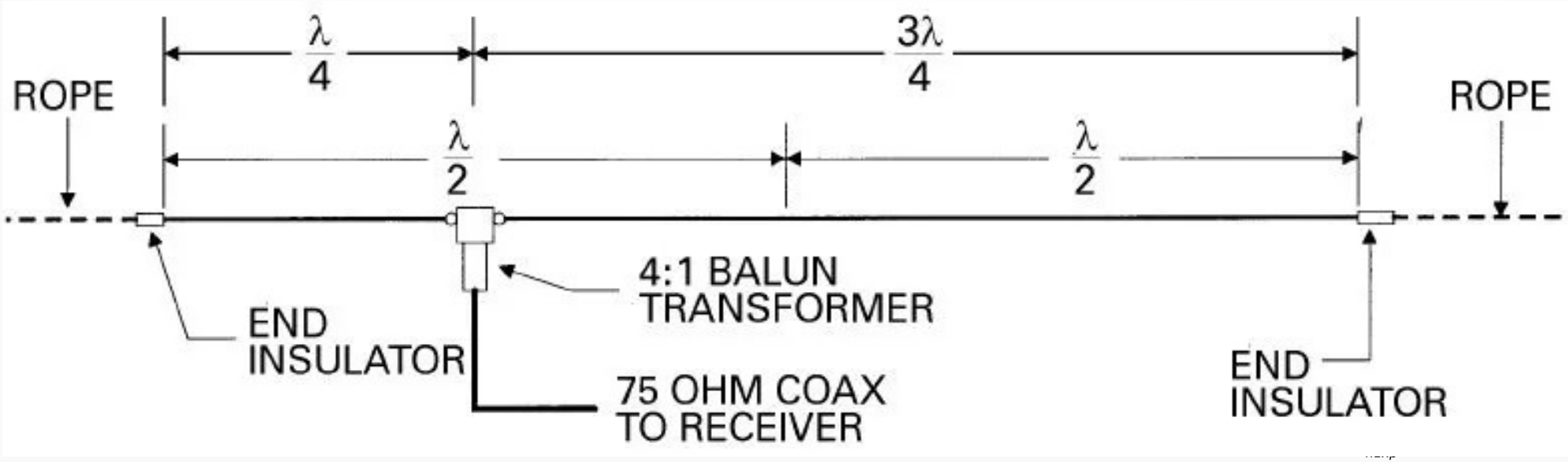
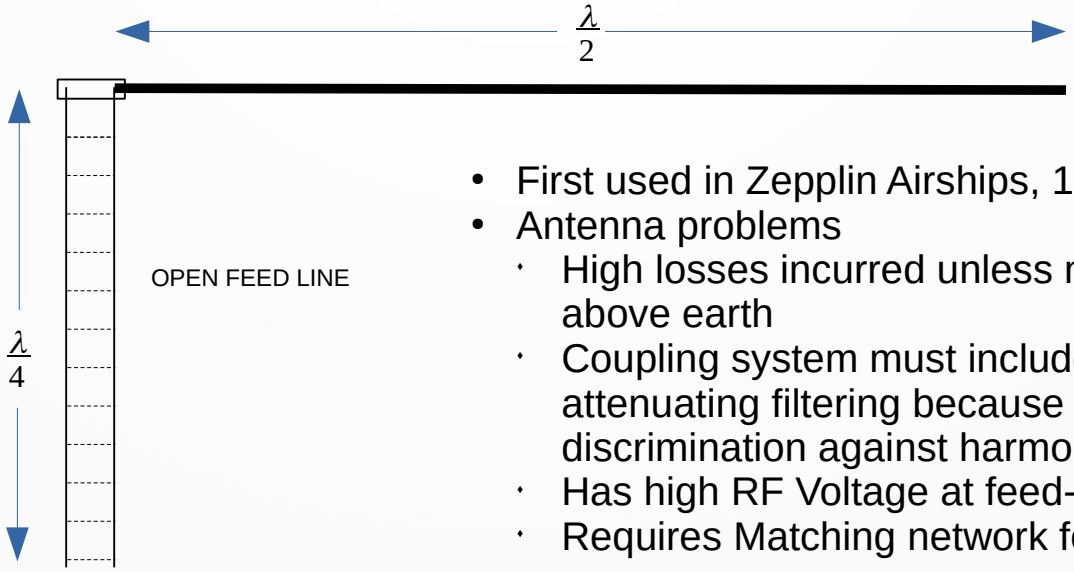
MULTI-BAND “WINDOM”
OFF-CENTER FED DIPOLE

EVEN HARMONICALLY RELATED BANDS i.e., 80m, 40m, 20m, 10m



ANTENNAS

“ZEPP” MULTI-BAND ANTENNA



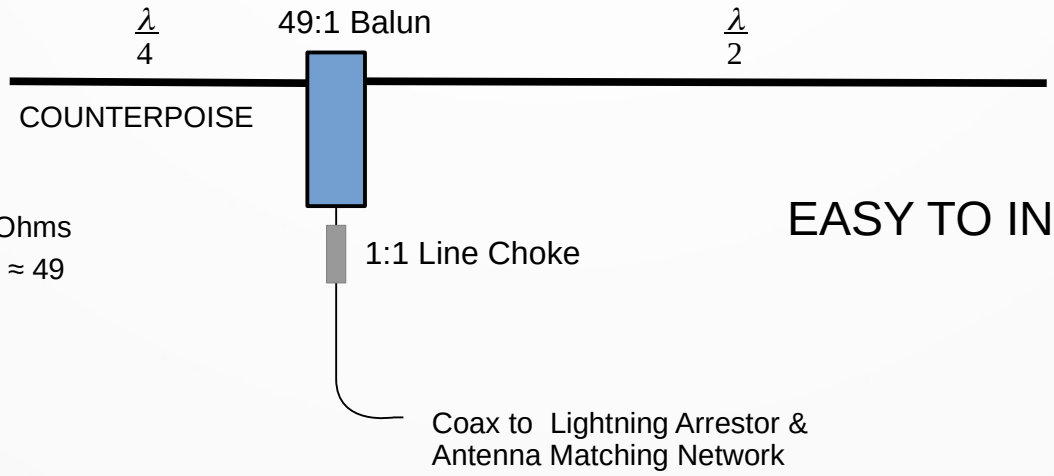
- First used in Zepplin Airships, 1907
- Antenna problems
  - High losses incurred unless mounted ¼-wavelength above earth
  - Coupling system must include some harmonic-attenuating filtering because the antenna has no discrimination against harmonics
  - Has high RF Voltage at feed-point
  - Requires Matching network for all bands

ANTENNAS

END-FED HALF-WAVE ANTENNA
“EFHW”

CUTE

GIMMICKY!



Z ≈ 2500 Ohms
2500 ÷ 50 ≈ 49

EASY TO INSTALL

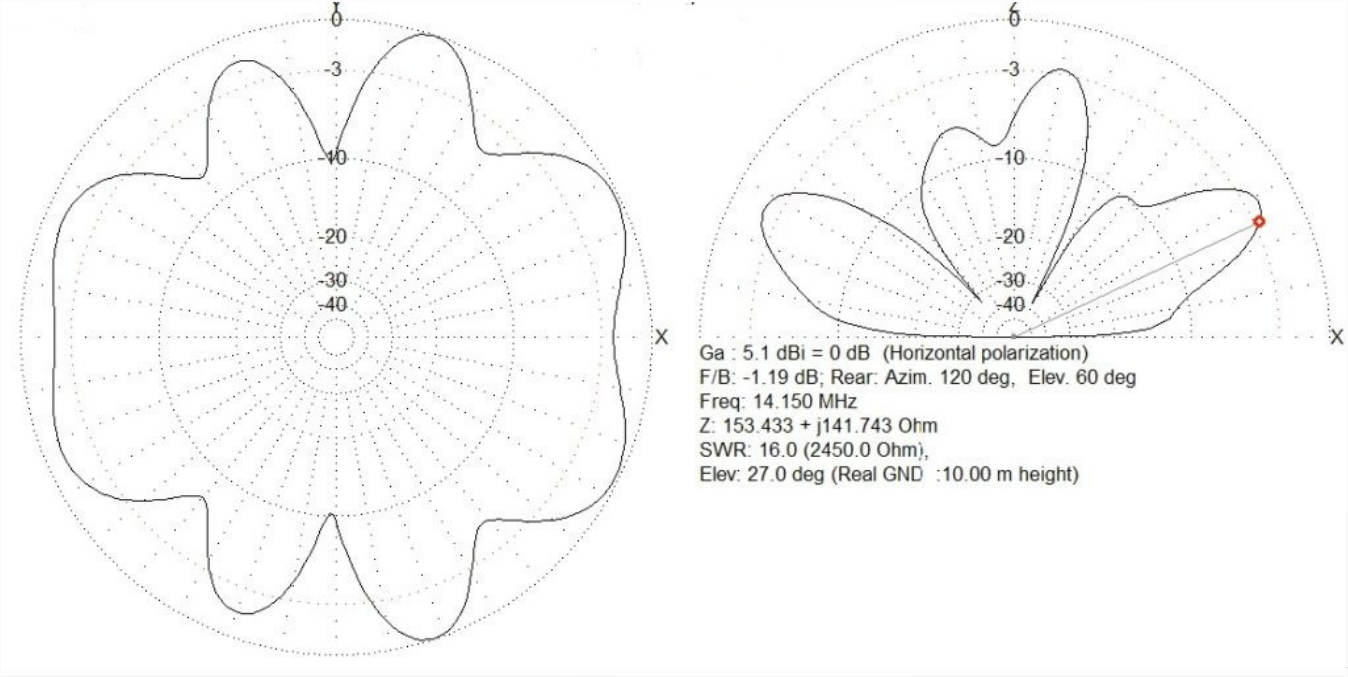
LOW COST

IS IT A GOOD ANTENNA?

ANTENNAS

EFHW ANTENNA RADIATION PATTERNS

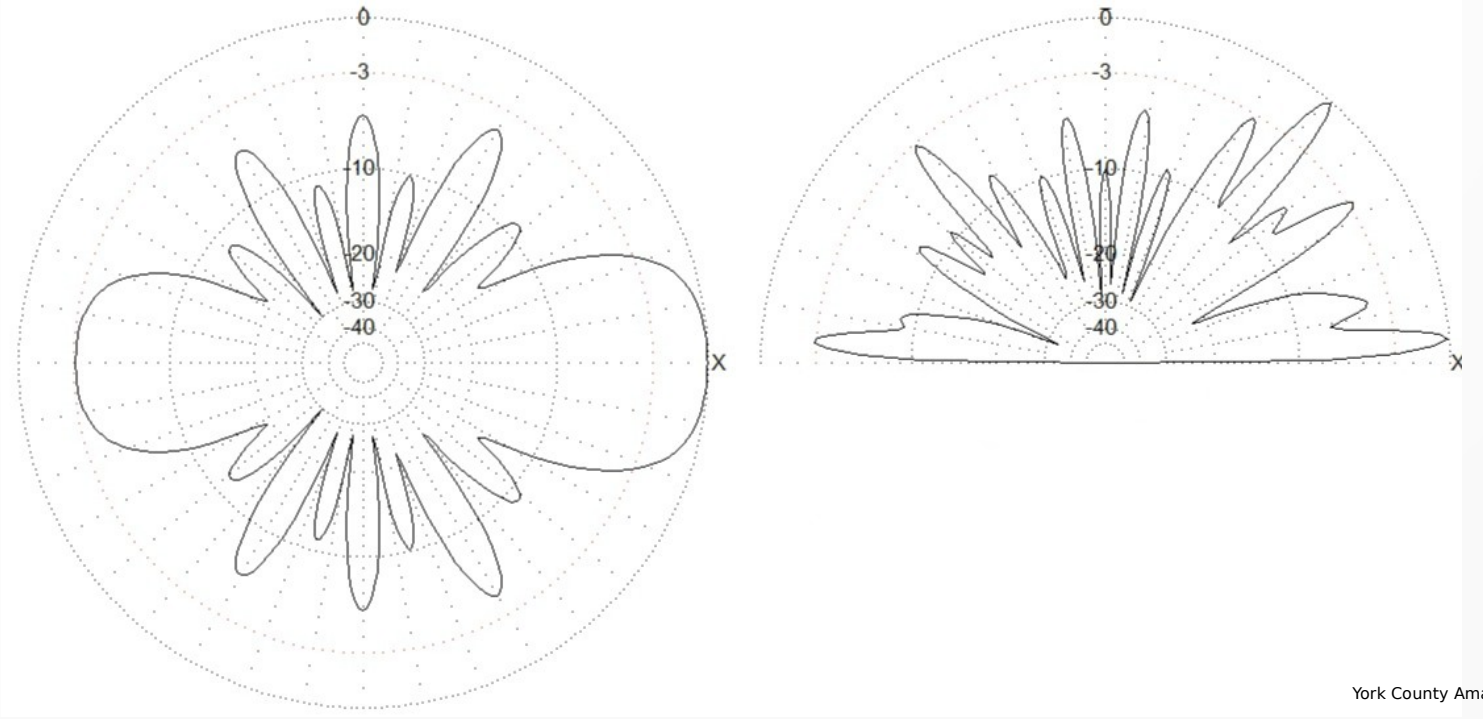
(w/ BALUN & LINE CHOKE, ≈1/2 λ Above Earth)



ANTENNAS

EFHW ANTENNA RADIATION PATTERNS

(Sloping – 6ft-to-23ft,
w/Counterpoise & Line Choke)



ANTENNAS

END-FED HALF-WAVE ANTENNA
“EFHW”

WIDE REPUTATION “*FINICKY*”, *WON’T LOAD*, *POSITION SENSITIVE*, *NEEDS A TUNER*, *RF IN THE SHACK*

Balun secondary ***COUNTERPOISE*** is a requirement: - RF current flow in a conductor in concert with the oscillatory electric field causes Electromagnetic Radiation (ala Mr. Maxwell) and the transmitter does not “create” current from nothing, even in the secondary (ala Mr. Kirchhoff).

Ground losses MUST be minimized! - Wastes transmitter power because ground losses are in series with the antenna radiation resistance (ala Mr. Ohm).

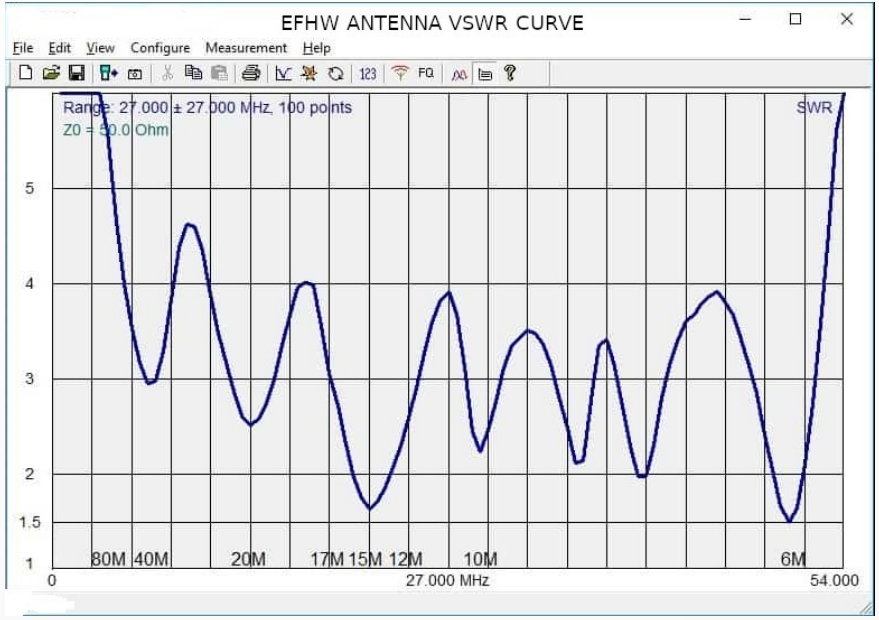
Coax shield (or your body/radio) and lossy soil completes the circuit

BALUN ABSORBS 12% OF TRANSMITTER POWER BECAUSE OF HIGH REACTANCE COMPONENT

NO GAIN OVER 1/2-WAVE DIPOLE

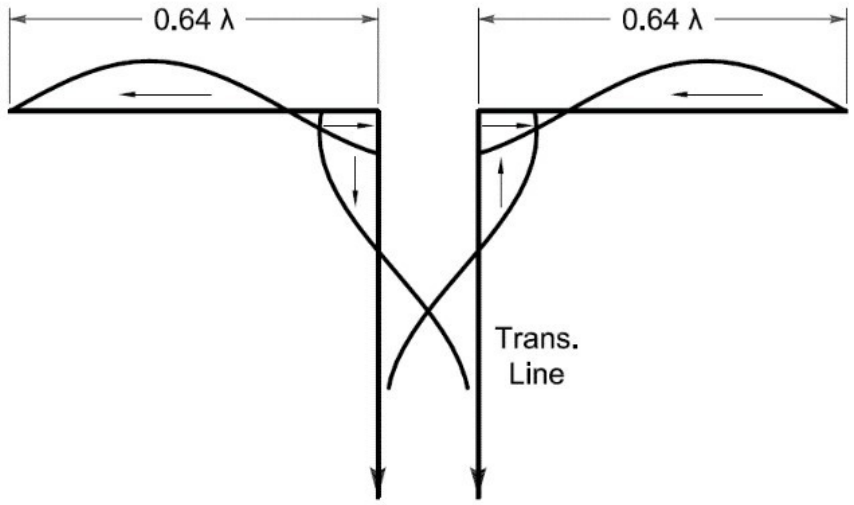
ANTENNAS

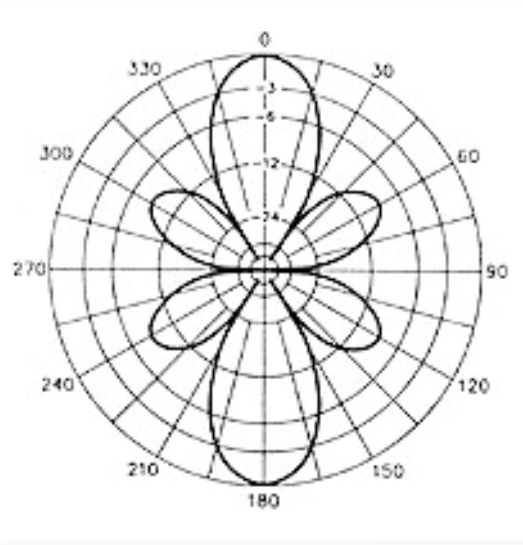
40-METER (68’) END-FED HALF-WAVE ANTENNA
1/4-WAVE ABOVE PERFECT EARTH
w/BALUN & LINE CHOKE



ANTENNAS

DOUBLE EXTENDED ZEPP





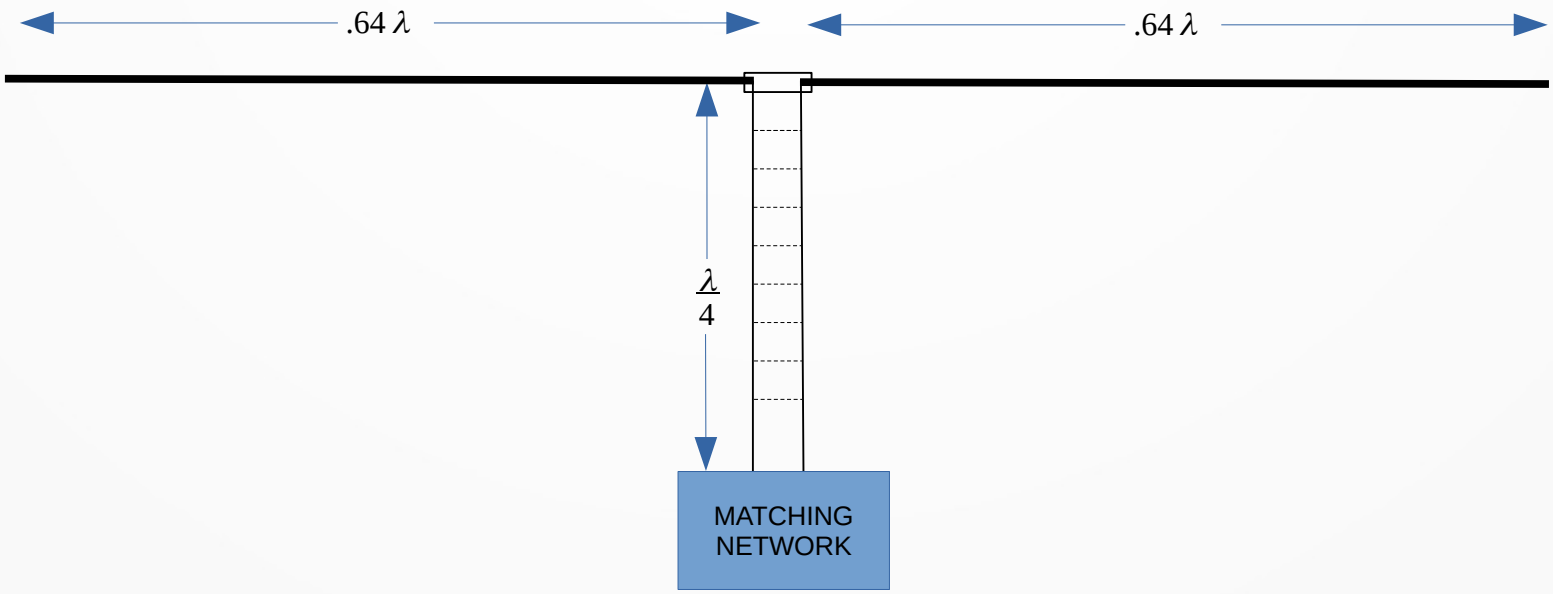
GREAT DX WIRE ANTENNA

Must be mounted 1/4λ above ground (80m = 68’)

Multi-band – must use matching Network

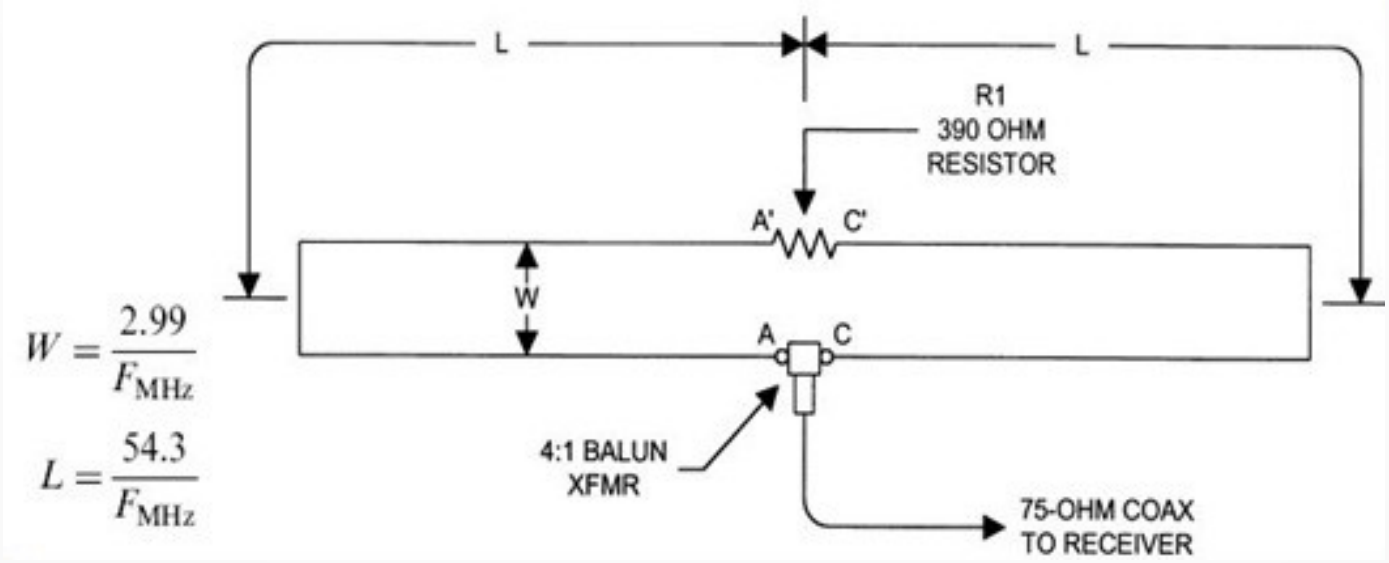
ANTENNAS

PRACTICAL DOUBLE EXTENDED ZEPP



ANTENNAS

TERMINATED FOLDED DIPOLE “TFD” MULTI-BAND

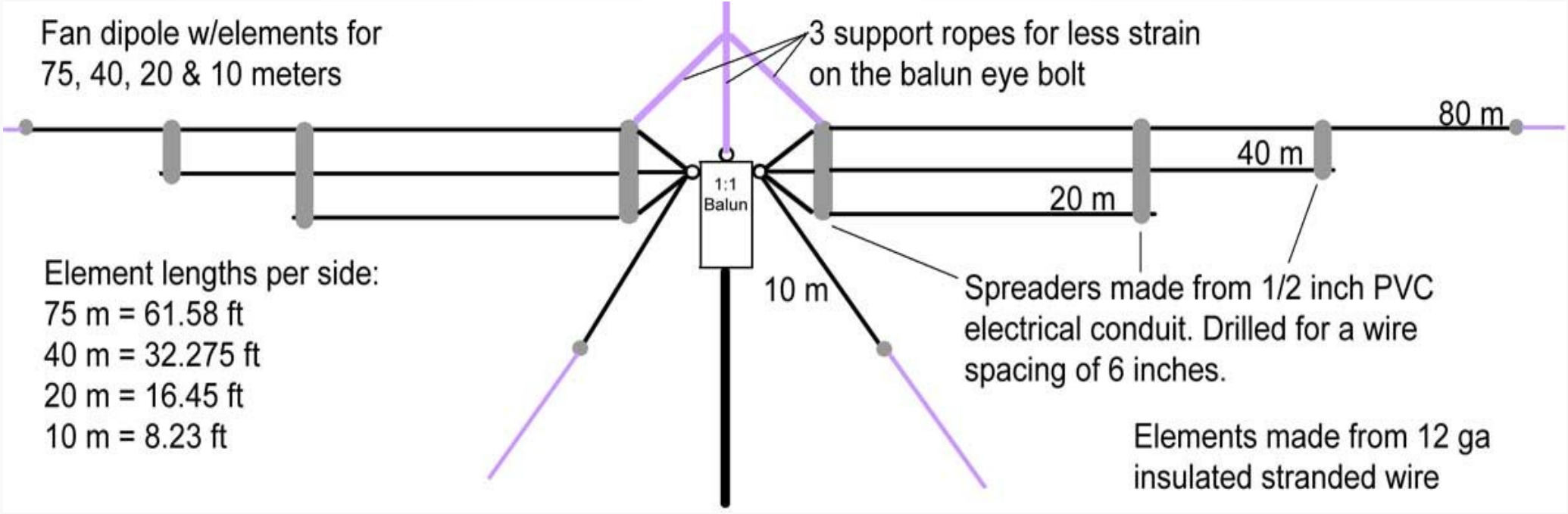


$$W = \frac{2.99}{F_{\text{MHz}}}$$

$$L = \frac{54.3}{F_{\text{MHz}}}$$

ANTENNAS

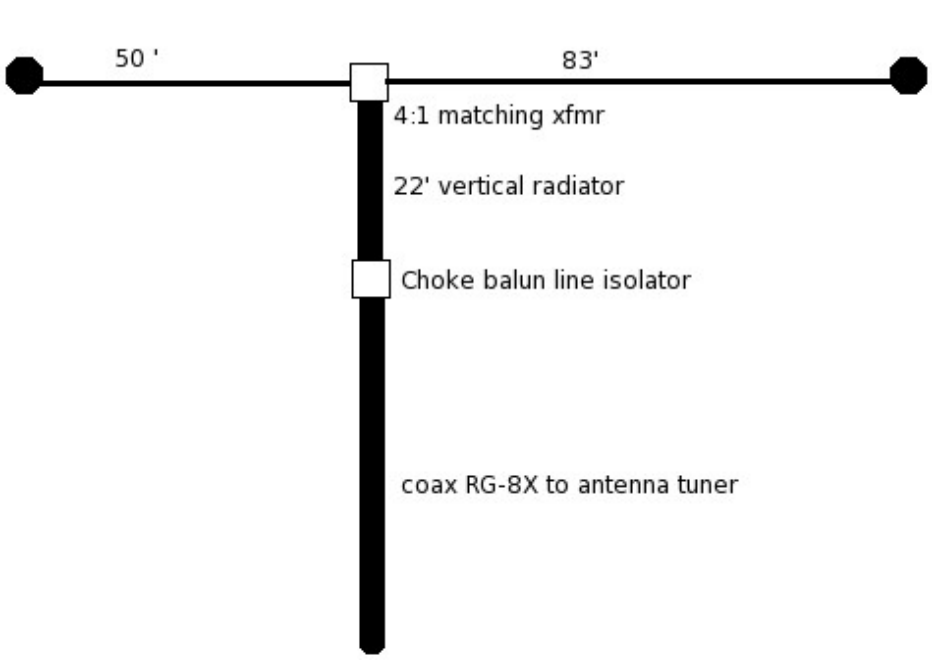
MULTI-BAND DIPOLE



ANTENNAS

CAROLINA WINDOM® [4]

- DISTANT COUSIN OF THE G5RV
- “UPSIDE-DOWN VERTICAL”
- OCF WIRE IS COUNTERPOISE
- 22’ COAX IS VERTICAL RADIATOR
  - OMNI DIRECTIONAL PATTERN
  - LOW ANGLE OF RADIATION
  - VERY LITTLE GROUND LOSSES



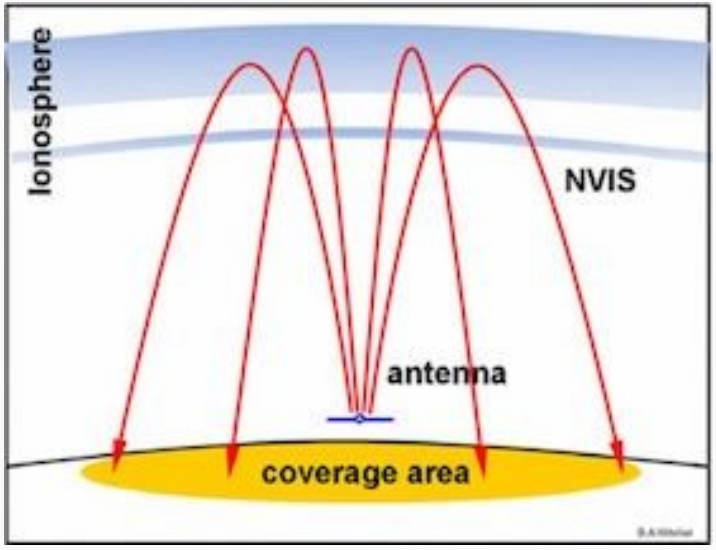
ANTENNAS

NVIS
NEAR-VERTICAL-INCIDENT-SKYWAVE

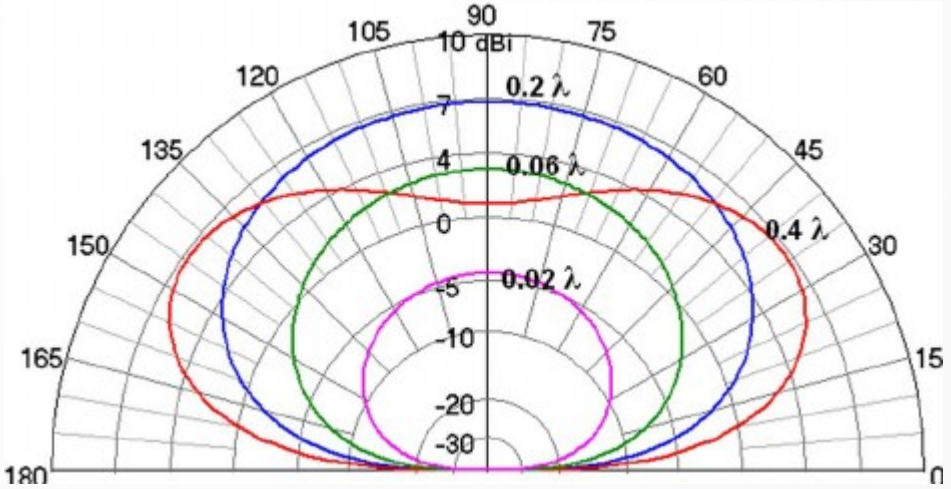
- ***NOT* AN ANTENNA OR ANTENNA SYSTEM**
- **NVIS IS A MODE OF HF PROPAGATION**
- BEST FOR LOCAL and REGIONAL HF COMMUNICATIONS – NOT DX
- DIRECTIVITY PATTERN MAXIMIZES TRANSMISSION AND RECEPTION AT HIGH ANGLES
- REJECTS LOW ANGLE, LONG RANGE, NOISE
- USED BY MILITARY, FEMA, US CORPS of ENGINEERS, RED CROSS, MARS, SHARES, ARES/RACES

ANTENNAS

NVIS
NEAR-VERTICAL-INCIDENT-SKYWAVE



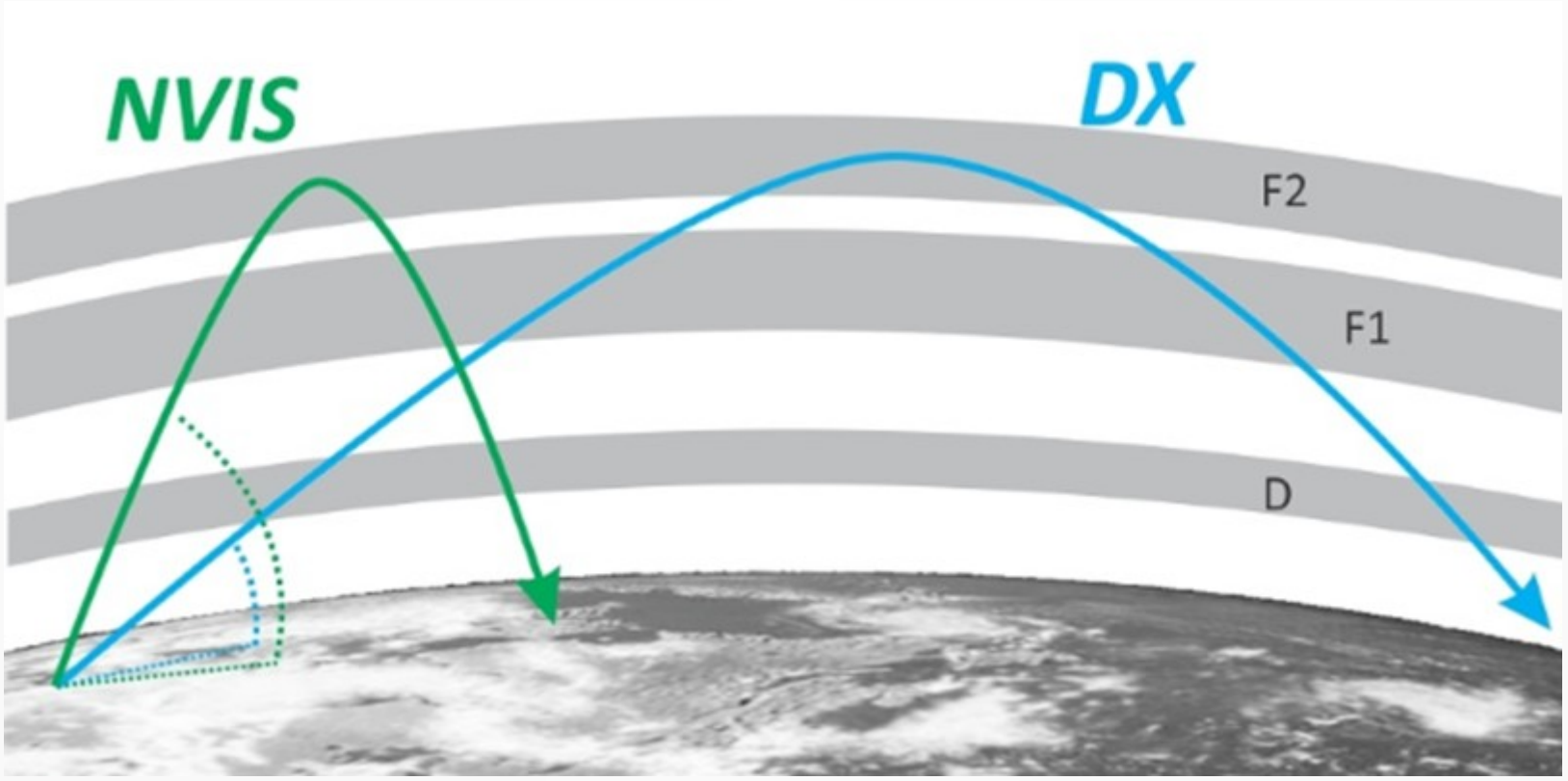
[5]



[6]

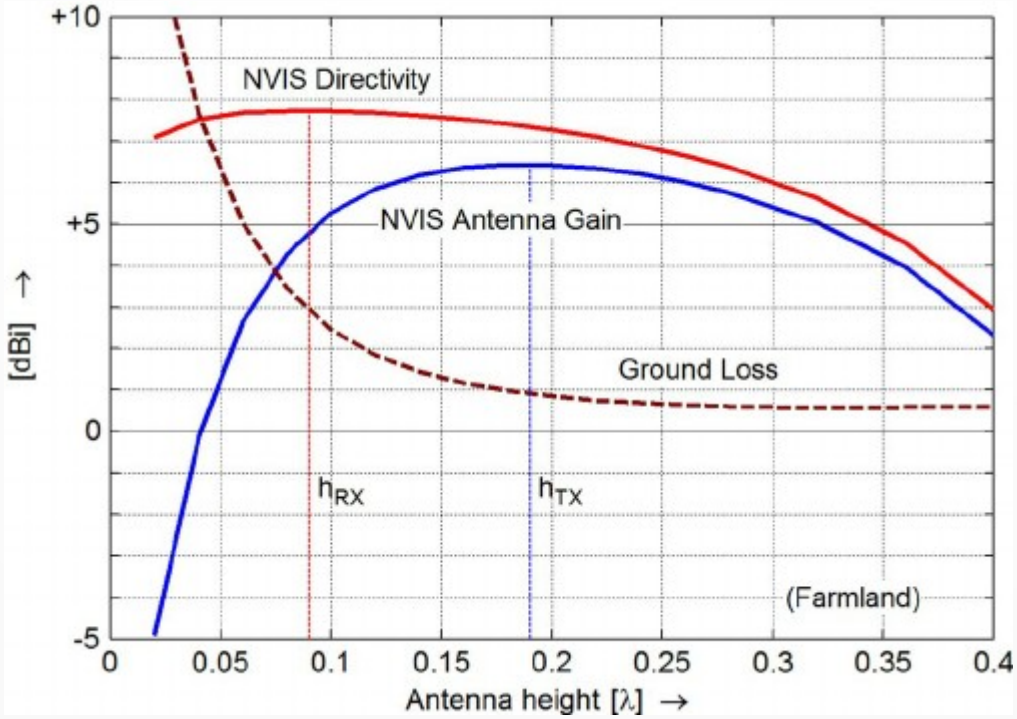
- HORIZONTAL DIPOLE AT HEIGHT ≤ 0.2λ
- EFFICIENCY DROPS AS HEIGHT DECREASED < 0.15λ

ANTENNAS



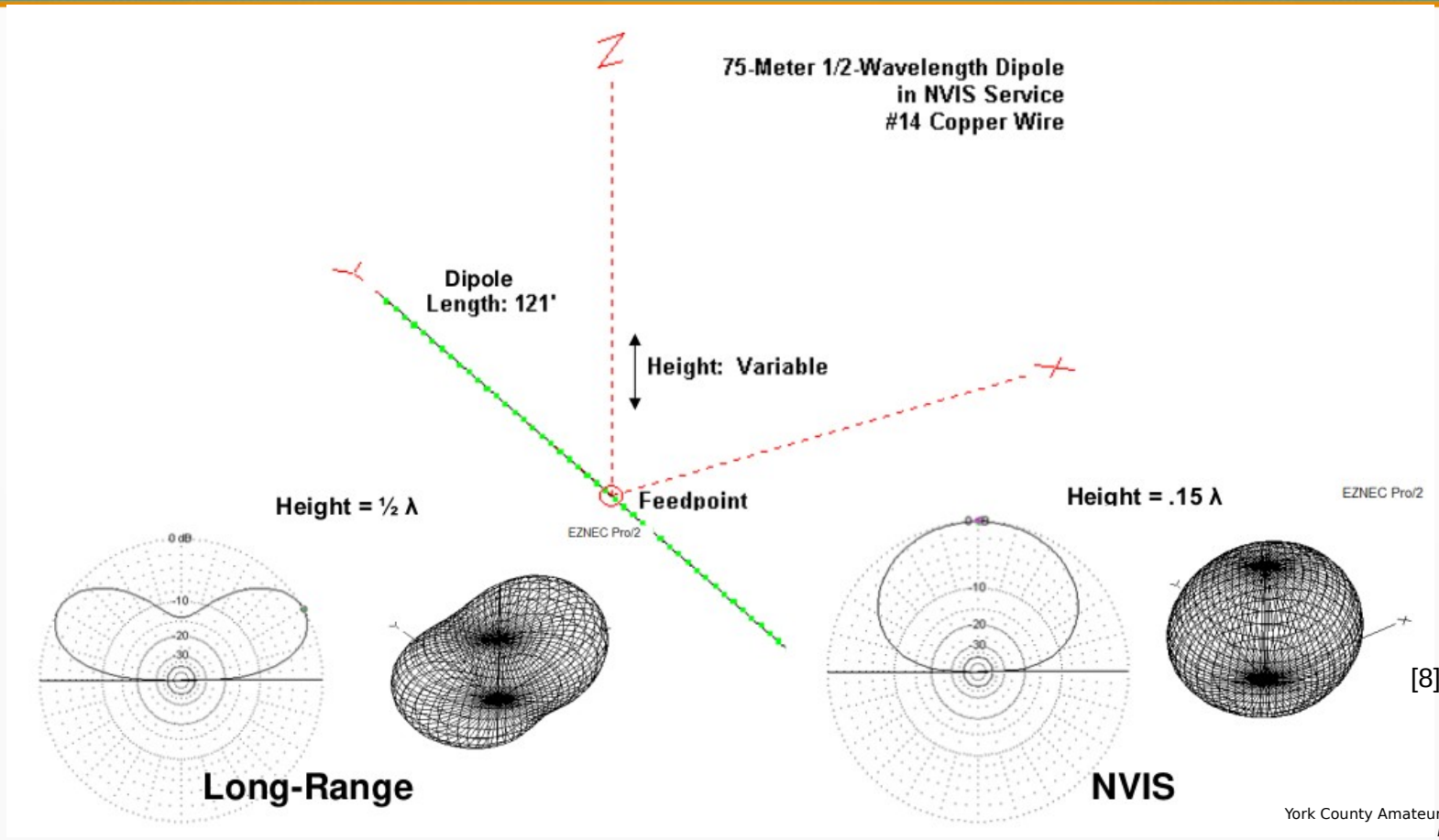
ANTENNAS

NVIS
NEAR-VERTICAL-INCIDENT-SKYWAVE



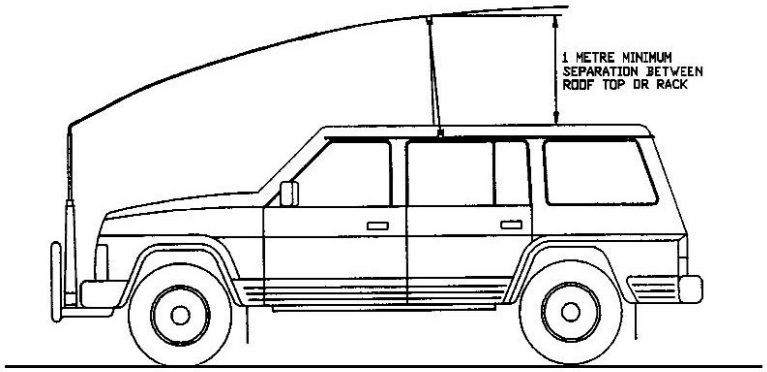
[7]

ANTENNAS


75-Meter 1/2-Wavelength Dipole
in NVIS Service
#14 Copper Wire
Z
Dipole
Length: 121'
Height: Variable
Feedpoint
EZNEC Pro/2
Height = ½ λ
Height = .15 λ
EZNEC Pro/2
0 dB
-10
-20
-30
Long-Range
NVIS

[8]

ANTENNAS



ANTENNA MOUNTED AT BUMPER BAR HEIGHT

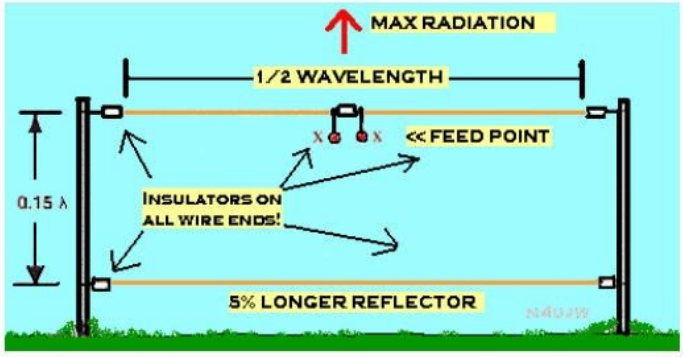
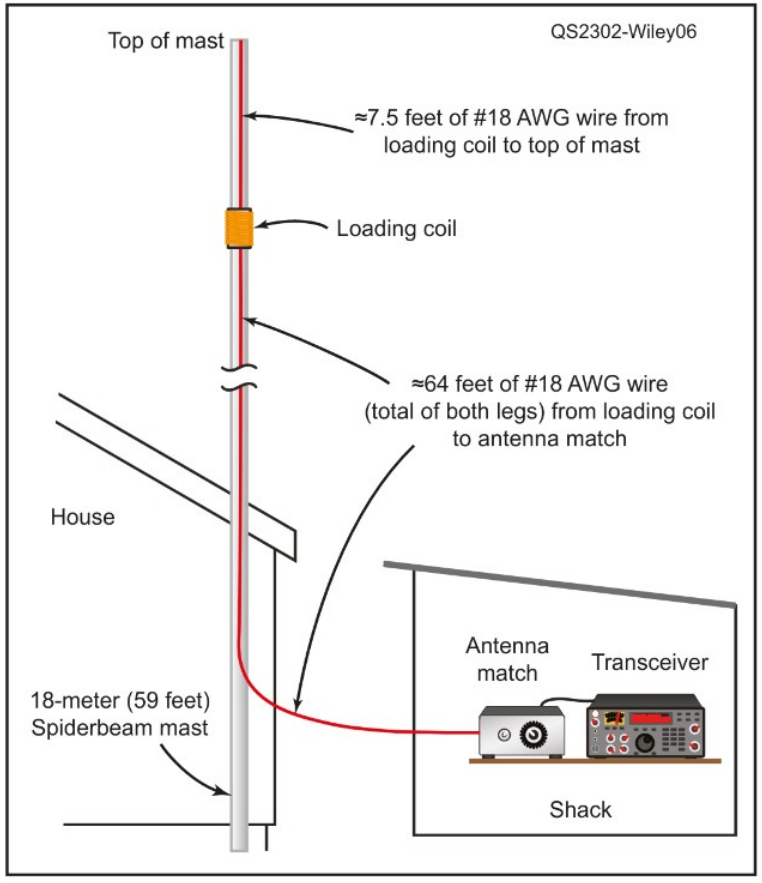


Figure 19: NVIS Configuration for Special Cases of Low Earth Conductivity

ANTENNAS



What is wrong in this diagram from February 2023 QST?

- NO COUNTERPOISE
- NO LIGHTNING ARRESTOR
- NO GROUNDING & BONDING
- Unlimited access to "HOT" Antenna wire
- In QST's defense, another figure "*mentions*" a counterpoise but offers no details

ANTENNAS

SAFETY FIRST

ANTENNAS

[1] Kraus, John D., “ANTENNAS”, McGraw-Hill Book Company, Inc., 1950

[2] Jasik, Henry, Editor, “ANTENNA ENGINEERING HANDBOOK”, McGraw-Hill Book Company, 1961

[3] Freeman, Roger L., “Telecommunications Transmission Hanbook, 2nd Ed., John Wiley & Sons, 1981

[4] Jim Wilkie (WY4R), Edgar Lambert (WA4LVB), and Joe Wright (W4UEB), “The ARRL Antenna Book” 1997 Staw, R Dean; Editor

[5] Ben A. Witvliet, Erik van Maanen , George J. Petersen, Albert J. Westenberg, Mark J. Bentum, Cornelis H. Slump, and Roel Schiphorst, “Near Vertical Incidence Skywave Propagation: Elevation Angles and Optimum Antenna Height for Horizontal Dipole Antennas”, IEEE Antennas and Propagation Magazine, Vol. 57, No. 1, February 2015

[6] Ibid.

[7] Ibid.

[8] Ibid.

Paper referenced in [5, 6, 7 & 8] is available on the club web site: https://w1yca.org/ant.html

ANTENNAS