ANTENNAS
&
WORKING 160 METERS

By KD8OUT

Antenna Basics

VERTICAL and HORIZONTAL POLARIZATION

The **Electric field** or E-plane determines the polarization or orientation of the radio wave.

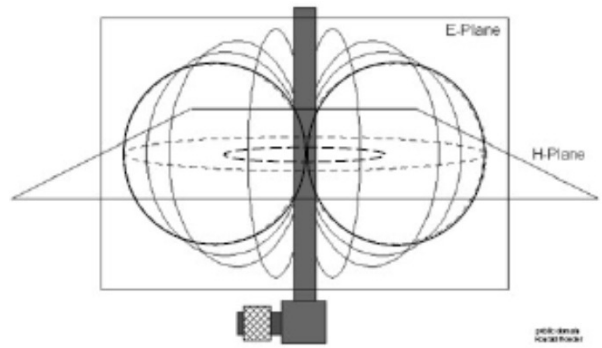
For a vertically-polarized antenna, the E-plane usually coincides with the vertical/ elevation plane.

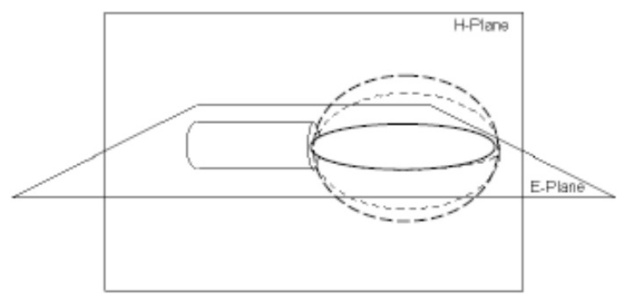
For a horizontally-polarized antenna, the E-plane usually coincides with the horizontal/azimuth plane.

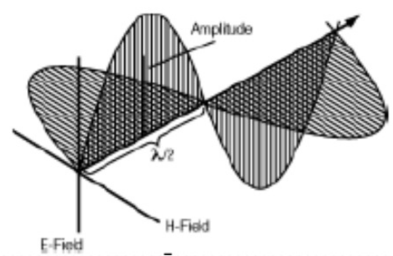
The **Magnetizing field** or H-plane lies at a right angle to the E-plane.

For a vertically polarized antenna, the H-plane usually coincides with the horizontal/ azimuth plane.

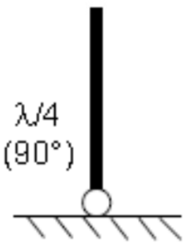
For a horizontally-polarized antenna, the H-plane usually coincides with the vertical/elevation plane.

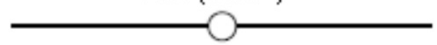






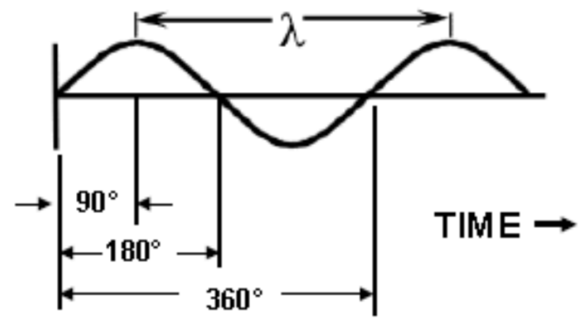
ANTENNA LENGTH





$$1 \text{ WL (meters)} = \frac{300}{F_{MHz}} = \text{Lambda } (\lambda)$$

Antenna Length is usually described as wavelength (WL) in meters or degrees:



Frequency (MHz)	Wavelength (Meters)	(Feet)
1.8	160	510
3.75	80/75	252
5.36	60	175
7.15	40	131
10.125	30	92.4
14.175	20	66
18.1	17	51.2
21.225	15	44
24.9	12	37.6
28.5	10	33
52	6	18

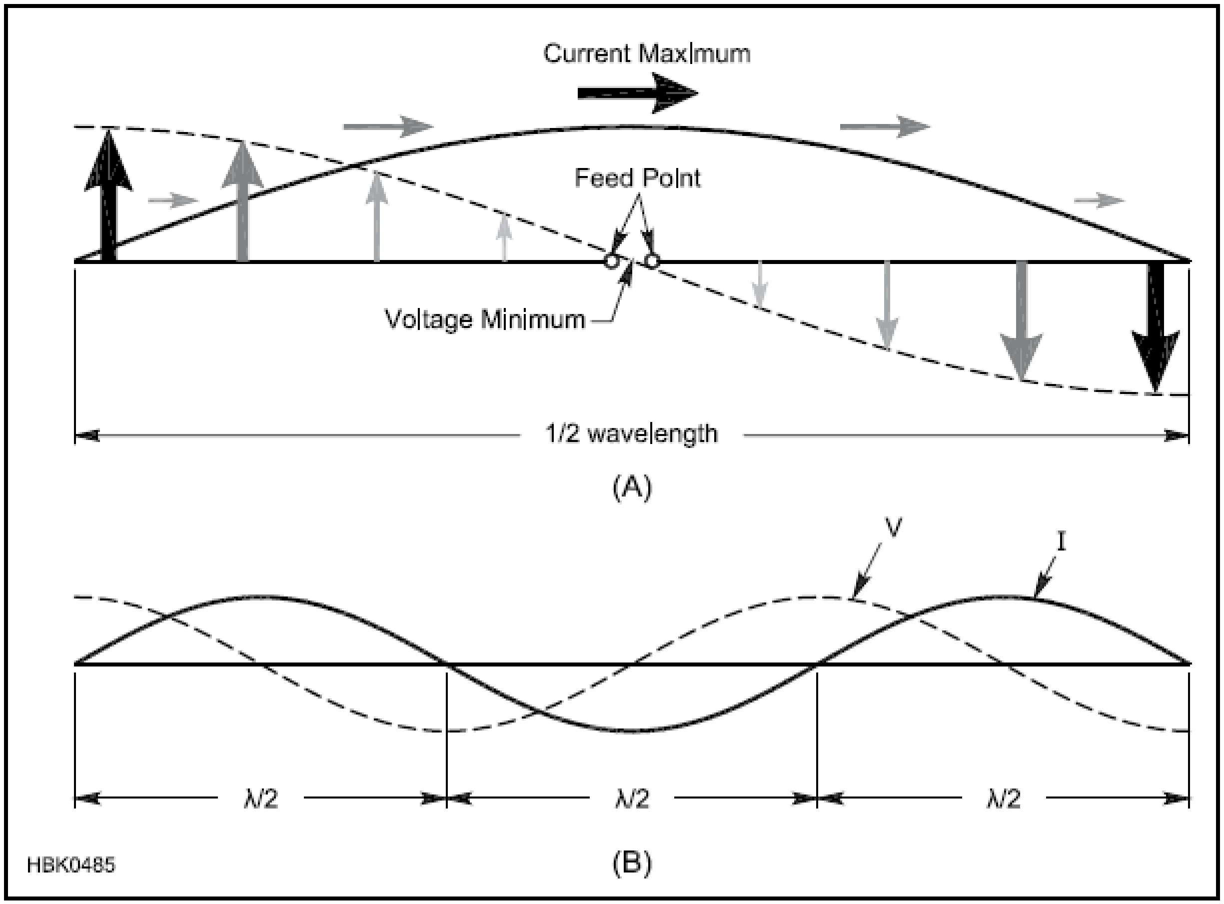
$$\frac{\text{360 deg}}{\text{deg}} = \frac{\text{Freq Length (ft)}}{\text{ft}}$$

Example: 50 ft vertical used on 160 m

$$\frac{\text{360 deg}}{\text{deg}} = \frac{\text{510 ft}}{\text{50 ft}}$$

360 X 50 / 510 = 34.6 degrees

CURRENT DISTRIBUTION FOR ½ WAVE DIPOLE



DIPOLE

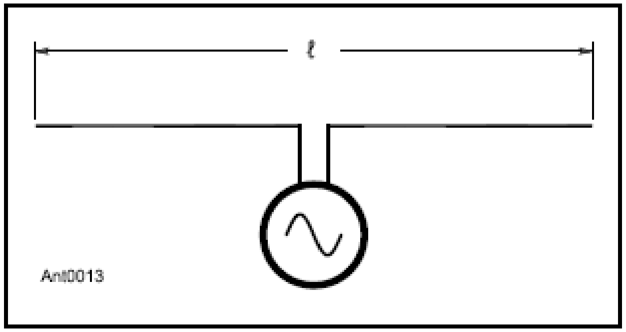
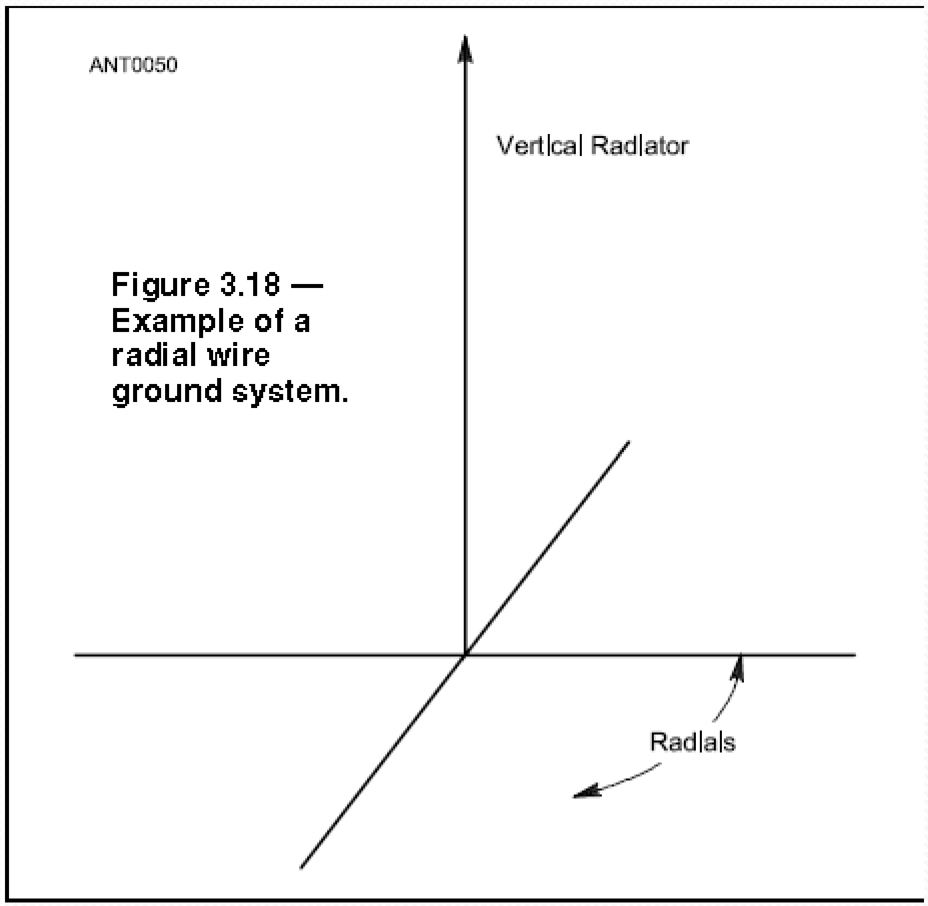


Figure 2.1 — The center-fed dipole antenna. It is assumed that the source of power is directly at the antenna feed point, with no intervening transmission line. Although $\lambda/2$ is the most common length for amateur dipoles, the length of a dipole antenna can be any fraction of a wavelength.

MONOPOLE/VERTICAL



CURRENT DISTRIBUTION IN DIPOLE AND MONOPOLE

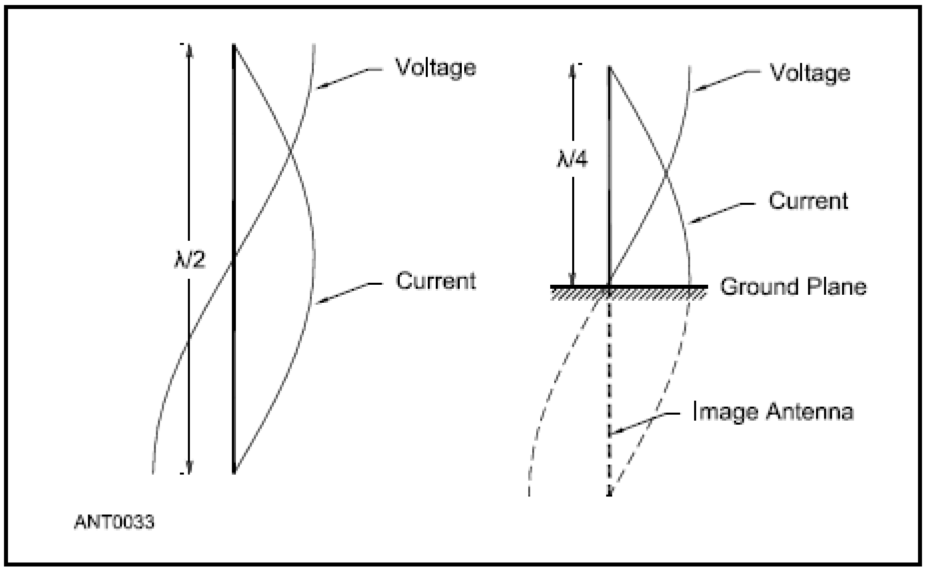
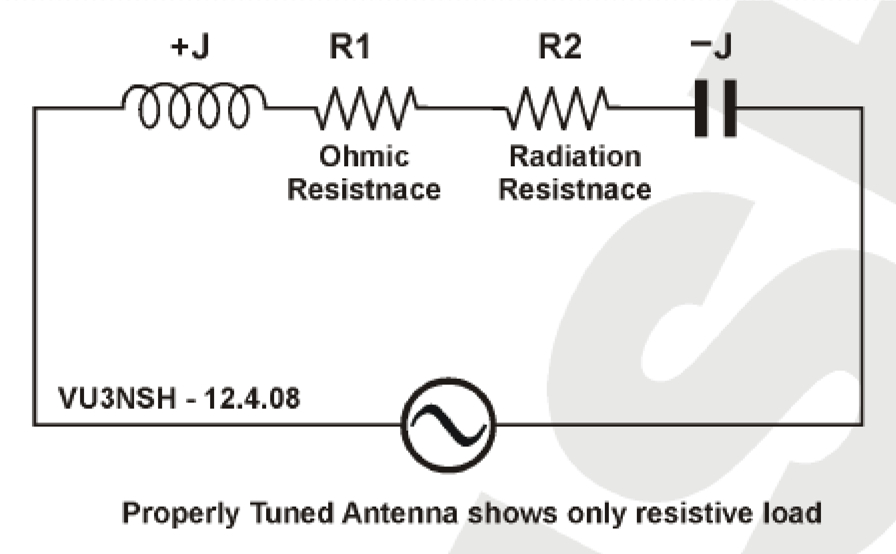


Figure 2.25 — The λ/2 dipole antenna and its λ/4 ground-plane counterpart. The "missing" quarter wavelength is supplied as an image in "perfect" (that is, high-conductivity) ground.

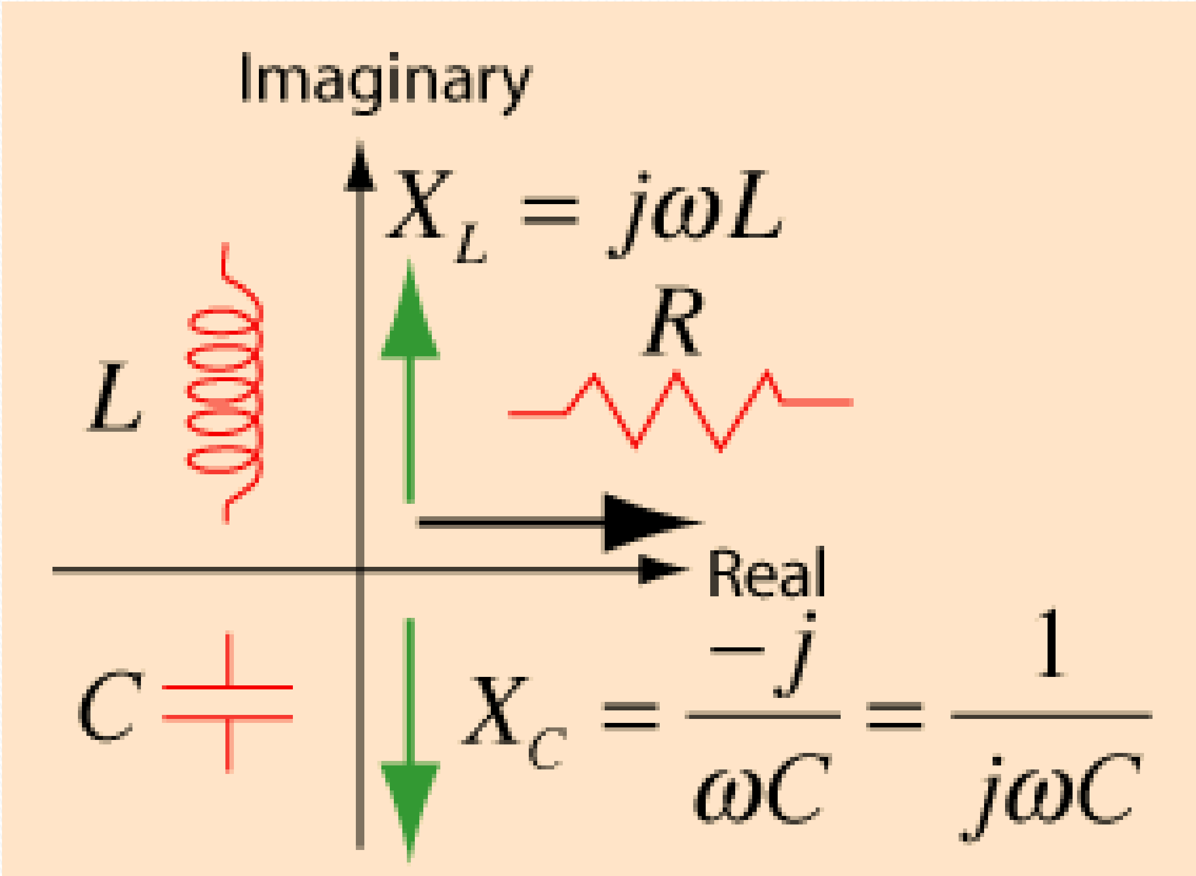


- An antenna’s characteristic impedance is a combination of the +J, -J and R1 + R2 at a driven frequency, based on it’s length.
- When you operate the antenna at it’s resonant length, the +J and –J cancel and leave pure resistance (resonance). When you operate outside of the resonant frequency, you have a net +J (long) or –J (short) “reactance” plus the resistance.

We need to review what is meant by "Antenna Impedance"

- Impedance is the AC analog to DC resistance.
- Remember $E_{(volts)} = I_{(Amps)} \times R_{(Ohms)}$ For DC
- Impedance follows the same math, except we add a "complex" component, reactance.
- $Z_{\Omega} = R_{\Omega} + j\,X_{\Omega}$; $j = \sqrt{-1}$, yes I said -1

  Z= impedance, R= restive component, j= the complex operator, X= reactance



Imaginary
$X_L = j\omega L$
R
L
Real
C
$X_C = \frac{-j}{\omega C} = \frac{1}{j\omega C}$

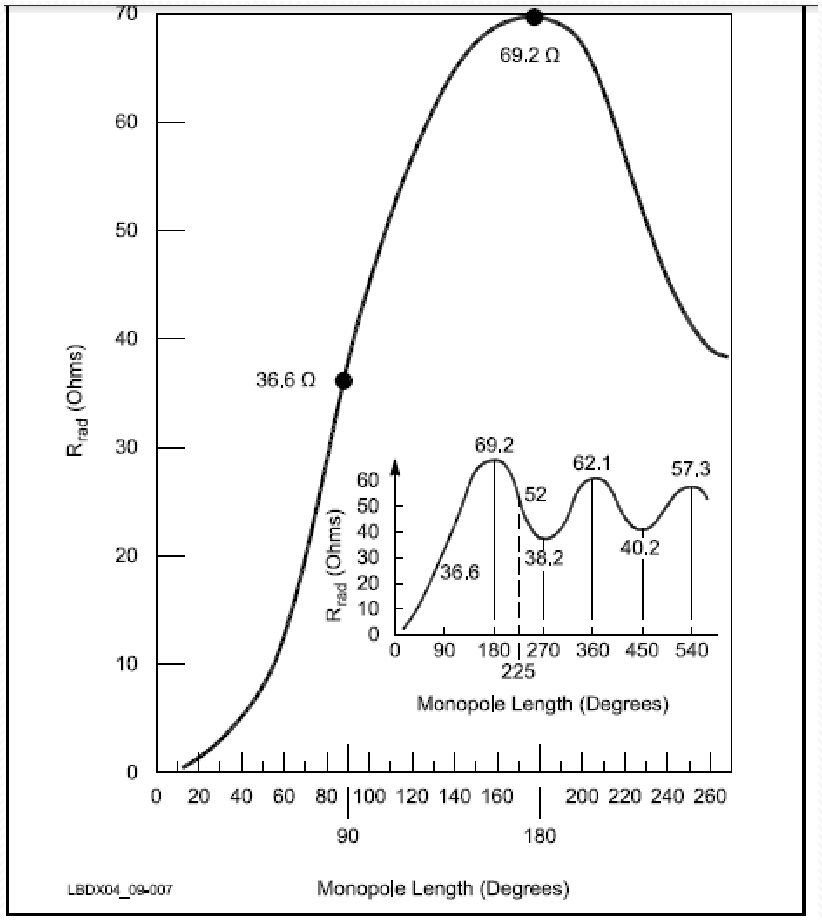


Figure 2.29 — Radiation resistances (at the current maximum) of monopoles with sinusoidal current distribution. The chart can also be used for dipoles, but all values must be doubled.

- Radiation resistance for a monopole (vertical) vs the antenna's "electrical" length in degrees.
- For dipoles, the resistance values double.
- The electrical length can be found by calculating what portion of 90^{o}(monopole) or 180^{o}(dipole) you have based on it's percentage of the ideal length. 36.6Ω for monopole or 69.2Ω for dipole.

160 Meter Antennas

- 1/2 wave dipole (255 ‘@ 1.8 MHZ)
- 1/4 wave vertical (127.5’@ 1.8 mhz)
- 1/4 wave inverted "L" (50’ H x 74’ L @ 1.9 mhz)
- Helically wound vertical
- Loaded vertical or dipoles
  - Capacitive end loading
  - Inductive series loading
- Use a shortened monopole or dipole and have a heavy duty transmatch (tuner).

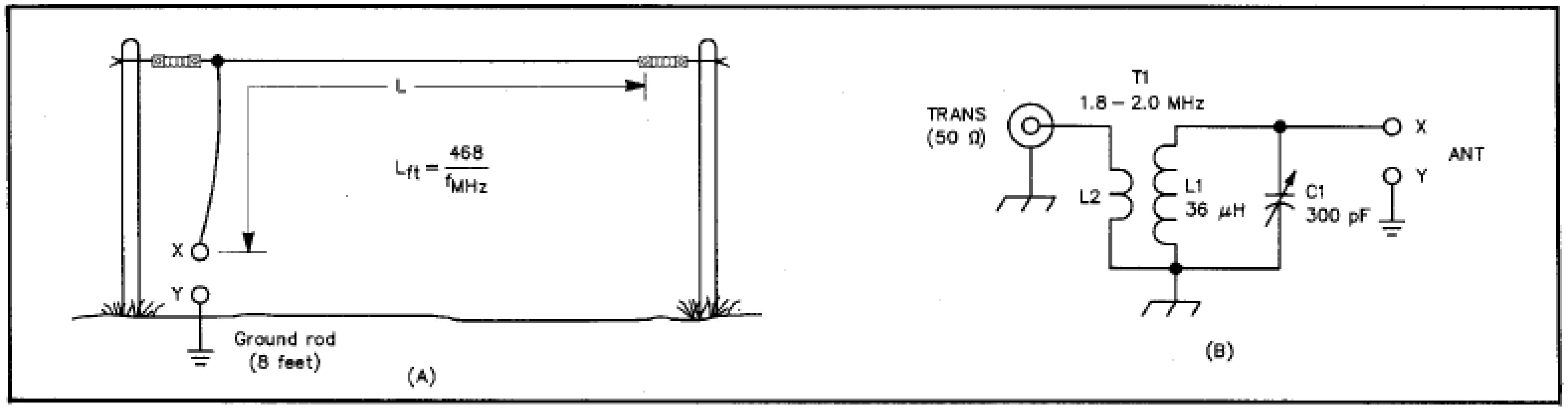
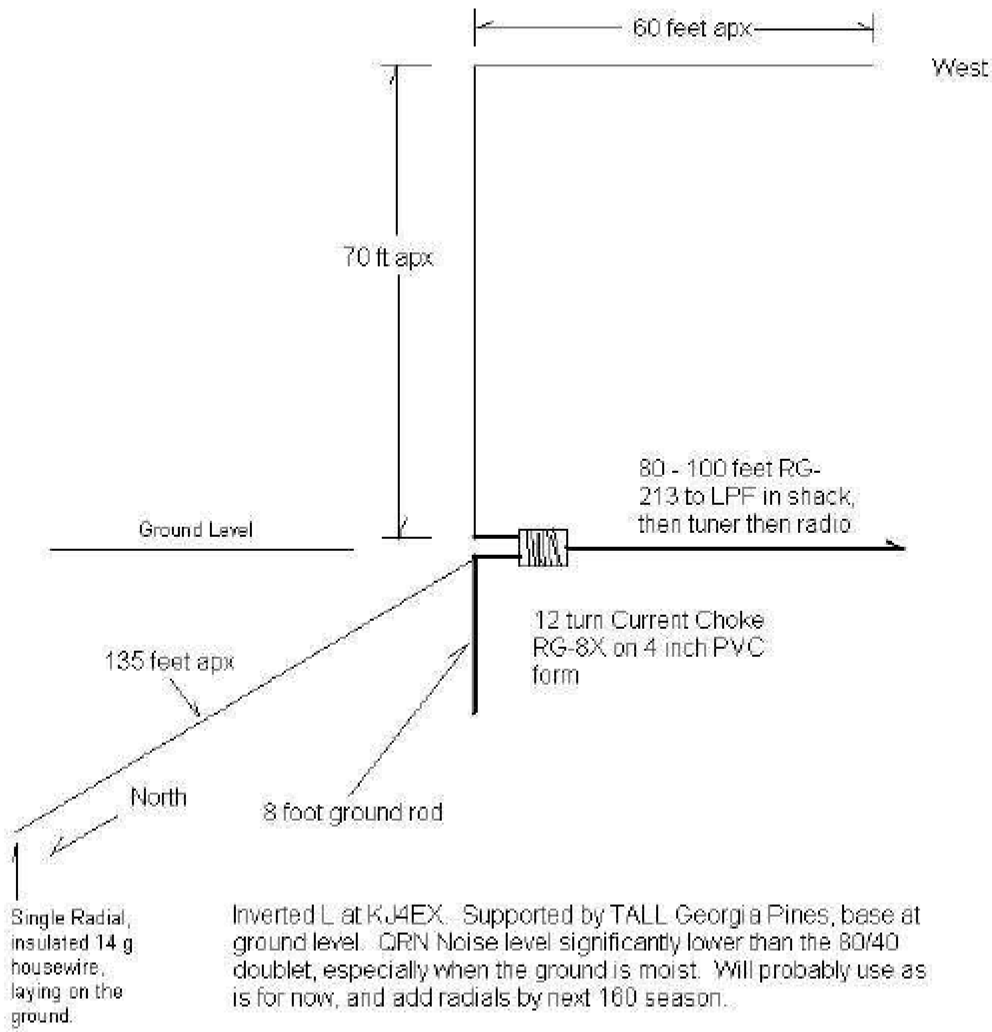


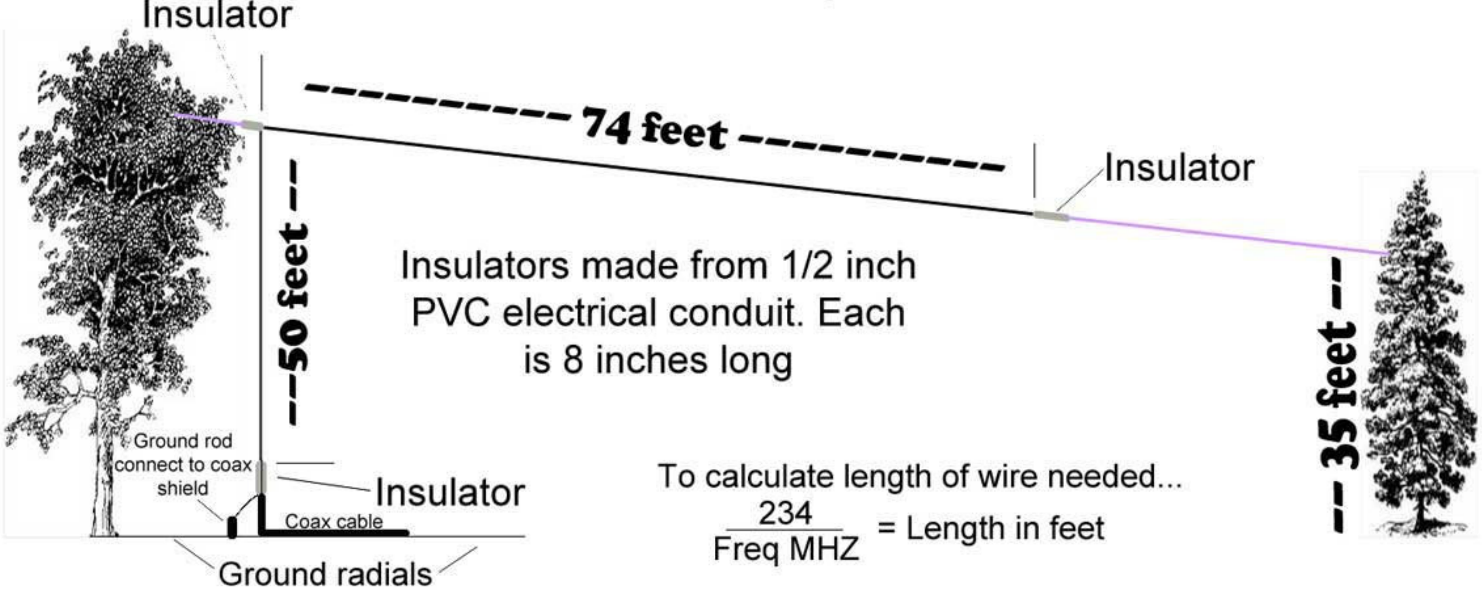
Fig 2—A ½-λ version of the antenna in Fig 1. This antenna is similar to one used at W4ZCB. L1 may have a relay-selected tap to permit operation on 80 meters as well. L1 and C1 are outside the house at the antenna feed point in a weatherproof box. C1 is motor driven and should have wide spacing or be a vacuum variable capacitor. Illustration B shows a suitable matching network.

KJ4EX 160 meter inverted L antenna.

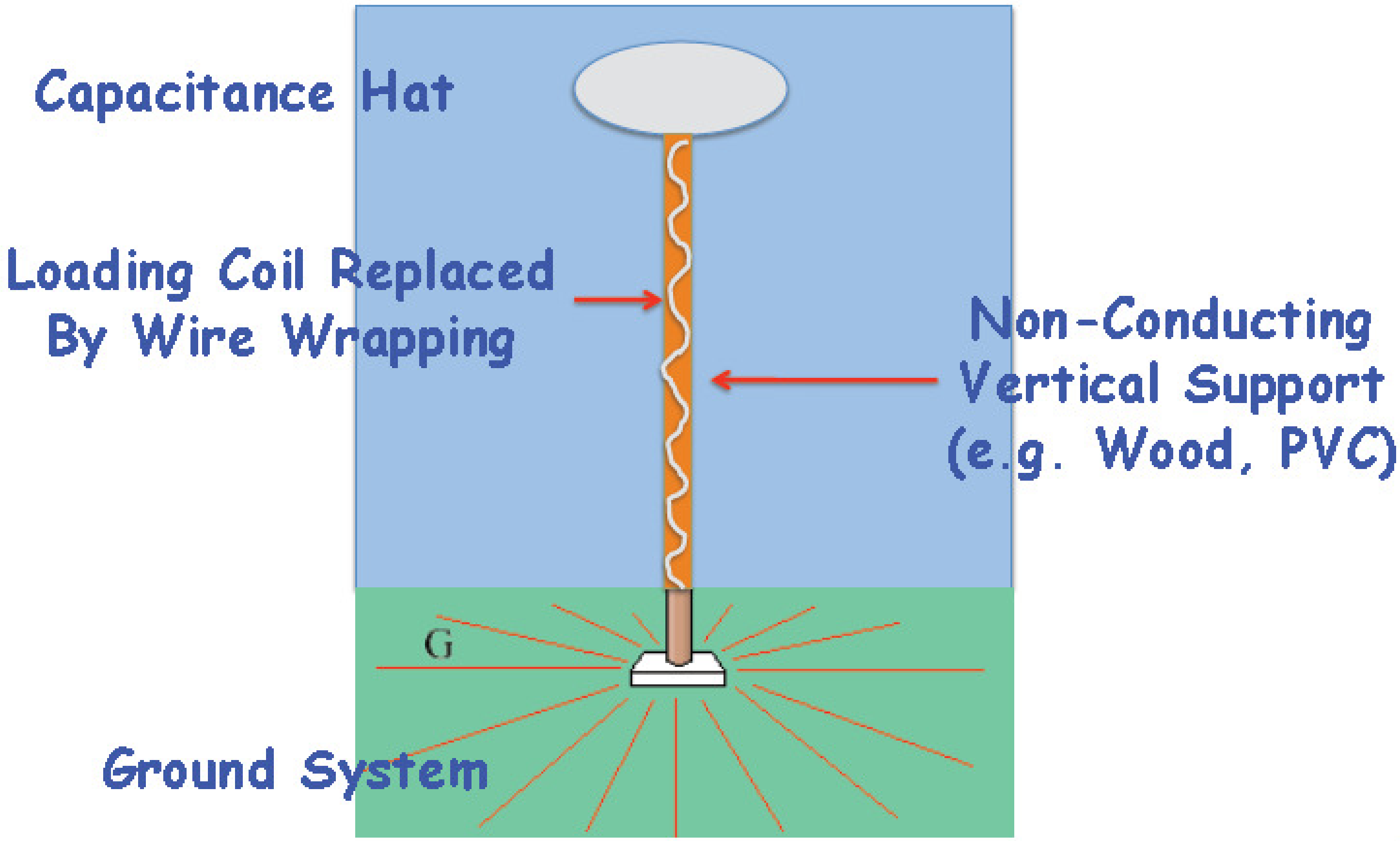


Inverted L at KJ4EX. Supported by TALL Georgia Pines, base at ground level. QRN Noise level significantly lower than the 80/40 doublet, especially when the ground is moist. Will probably use as is for now, and add radials by next 160 season.

160 meter inverted L cut for 1.900 MHz total wire length 124 feet



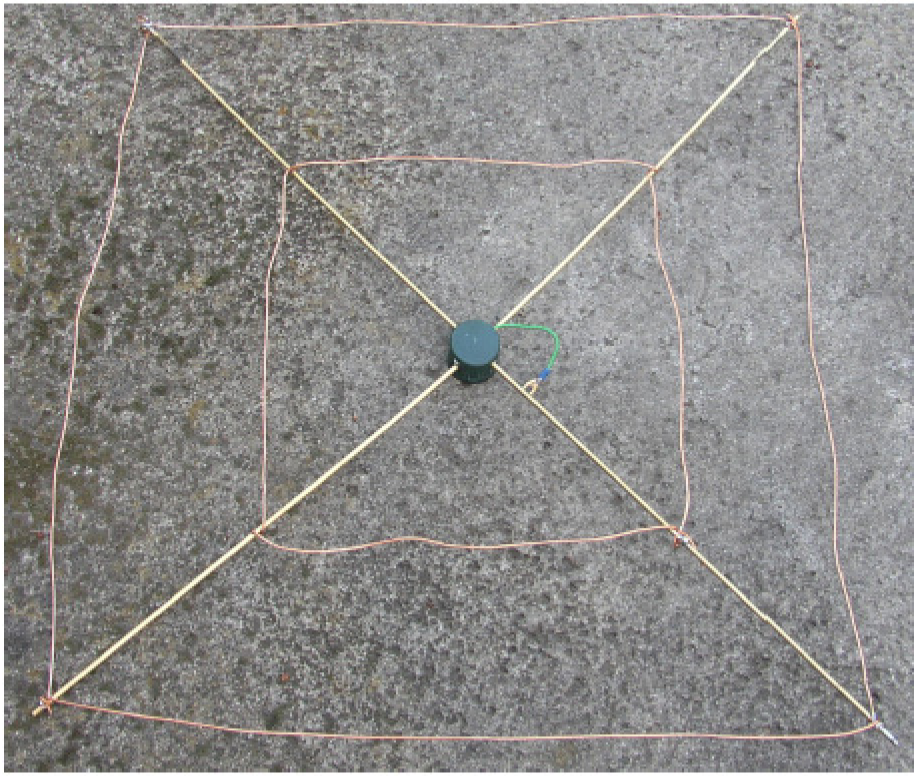
Helically-Wound Vertical



Typical Calculation:

For a target frequency of 1.825 MHz, use 256 feet of #14 gauge 1.6 millimeter diameter wire wrapped around 24.5 feet of a 2.2 inch outside diameter pipe using 19.5 turns-per-foot with an average pitch of 0.62 inches.

Step 7: Capacitance Hat



2 x 3 ft. Brass Rods + Copper Wire

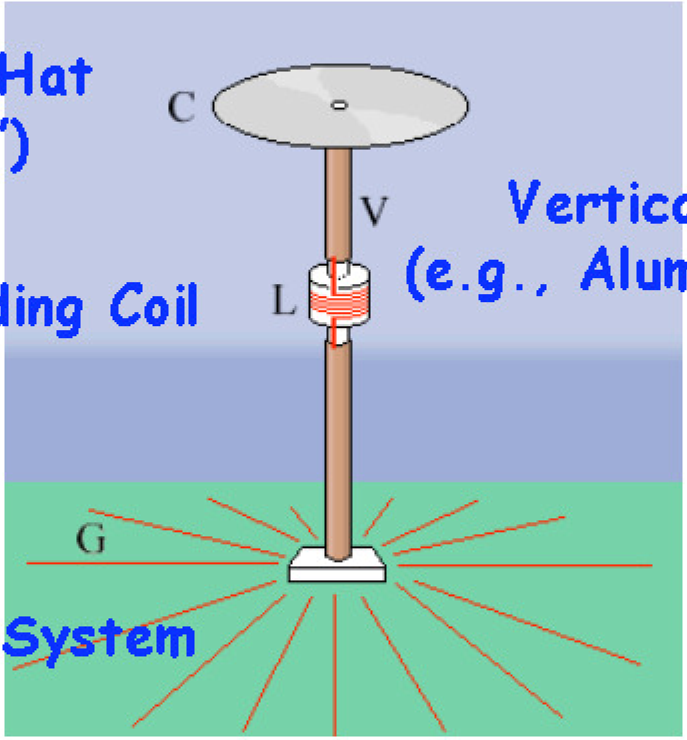
Components of Shortened Vertical

Capacitance Hat
("Top Hat")

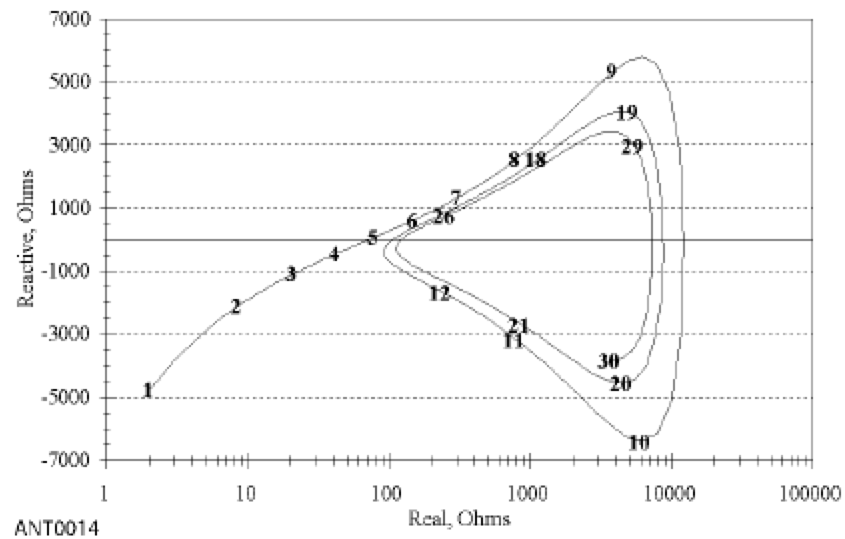
Vertical Radiator
(e.g., Aluminum, Copper)

Loading Coil

Ground System



EFFECT OF SHORT DIPOLE



ANT0014

Figure 2.9 — Feed point impedance versus frequency for a theoretical 100-foot long dipole in free space, fed in the center and made of extremely thin 0.001-inch diameter wire. The y-axis is calibrated in positive (inductive) series reactance up from the zero line, and negative (capacitive) series reactance in the downward direction. The range of reactance goes from −6500 Ω to +6000 Ω. Note that the x-axis is logarithmic because of the wide range of the real, resistive component of the feed point impedance, from roughly 2 Ω to 10,000 Ω. The numbers placed along the curve show the frequency in MHz.