A Baker's Dozen Wire Antennas

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Gooch's Paradox or Why Antennas Radiate:

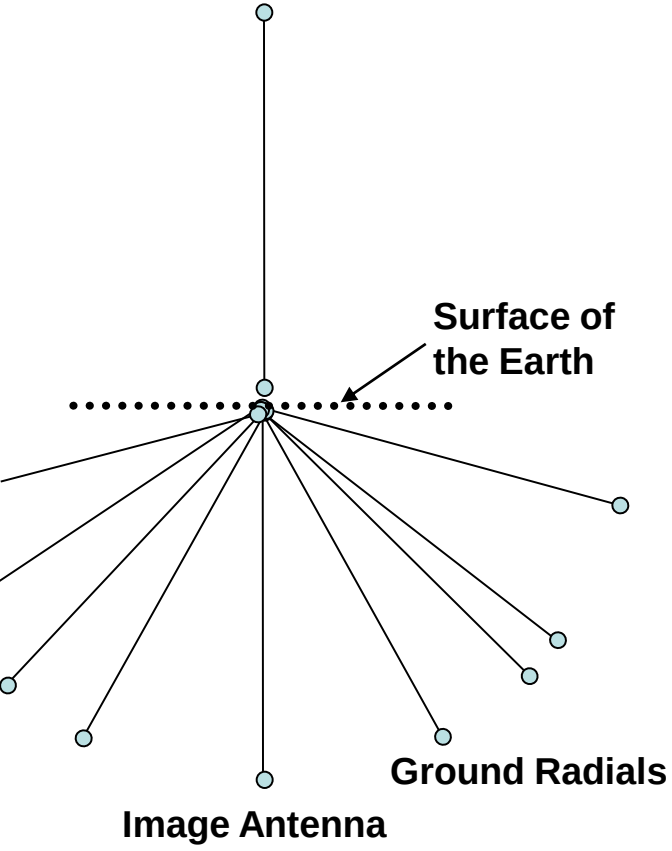
RF gotta go somewhere!

- Some antennas radiate better than others. The explanation is Resonance.
- Resonance depends on frequency
- The shortest resonant antenna is an electrical ½ wavelength long.
- Length of a resonant ½ wave antenna (in feet) = 468/Frequency in MHz.

The Basic Antenna: The ½ Wave Dipole

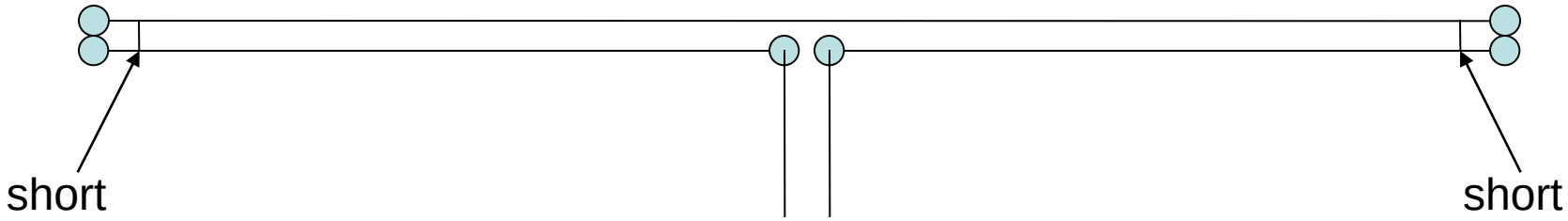
- Length = 438/frequency (Mhz)
- At resonance
  - Current (I) is maximum at feedpoint, zero at ends
  - Voltage (E) is zero at feedpoint, maximum at ends
  - At resonance, the antenna looks like a resistor.
  - Feed point impedance for a resonant dipole = E/I is about 72 ohms
- If transmitter output impedance = 50 ohms, and a resonant dipole is fed with 50 ohm coax, the feedline will show a theoretical SWR = 72/50 = 1.44/1.
- Actual feed point impedance varies with
  - Antenna height
  - Ratio of element diameter to wavelength
  - Presence of nearby objects.
- Resonant on fundamental and odd harmonics
- Most resonant wire dipoles display a measured feed point impedance of about 65 ohms – a good match for 50 ohm coax.

The Basic Vertical Antenna
The ¼ Wave Marconi



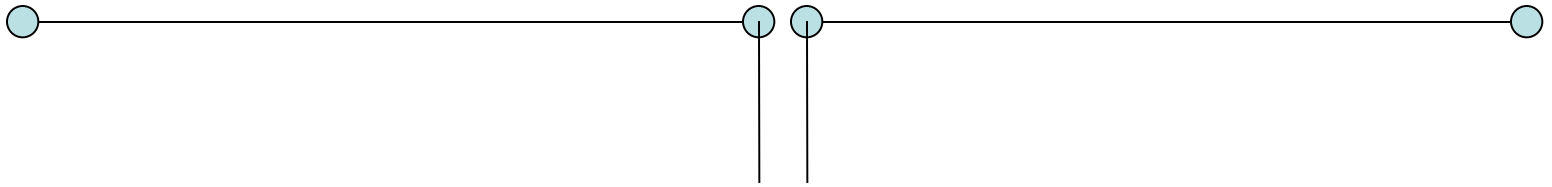
- Half a dipole sticking up in the air
- Length (feet) = 234/f (MHz)
- Ground reflection forms 2d half of dipole– the "image antenna"
- Ground return through earth increases loss resistance – ground radials decrease loss resistance
- How many radials
  - Ground mounted: As many as possible - 120 is about optimum – One will work (classic 30 over 30 or 60 over 60)
  - Mounted above ground (Ground Plane): 3 or four but one or two will work
- Make of wire, coil it up, hang one end in a tree for portable or emergency operation

Dipole Variation: the Folded Dipole



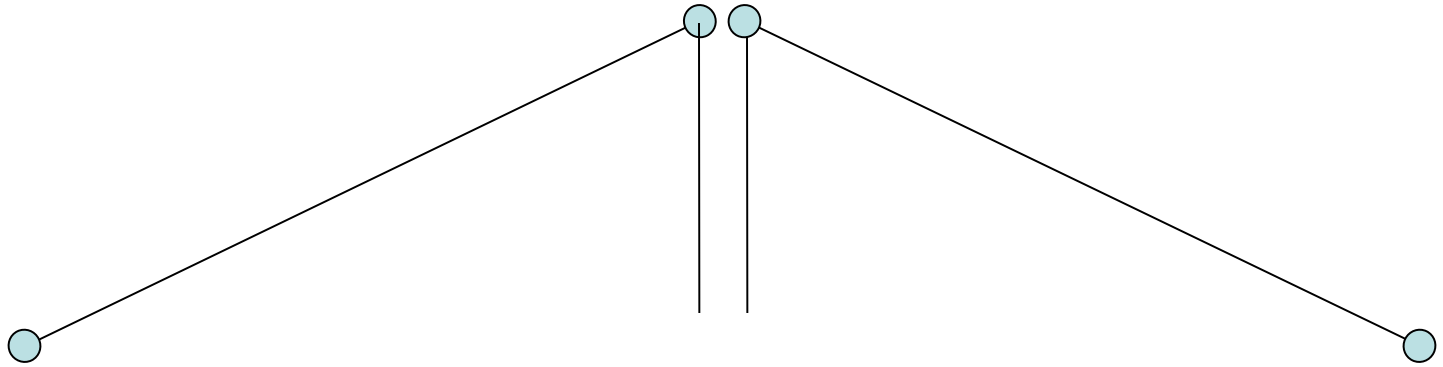
- More broadband than a single wire; can be operated on its fundamental and odd harmonics
- Length = 438/frequency (Mhz); length between shorts = 492 x k/frequency where k = velocity factor (typically 0.82 to 0.85)
- Feedpoint impedance = 300 ohms: Make out of and feed with *cheap* 300 ohm TV twin lead.

The Basic Multi-band Wire: the Center–Fed Zepp or McCoy Dipole



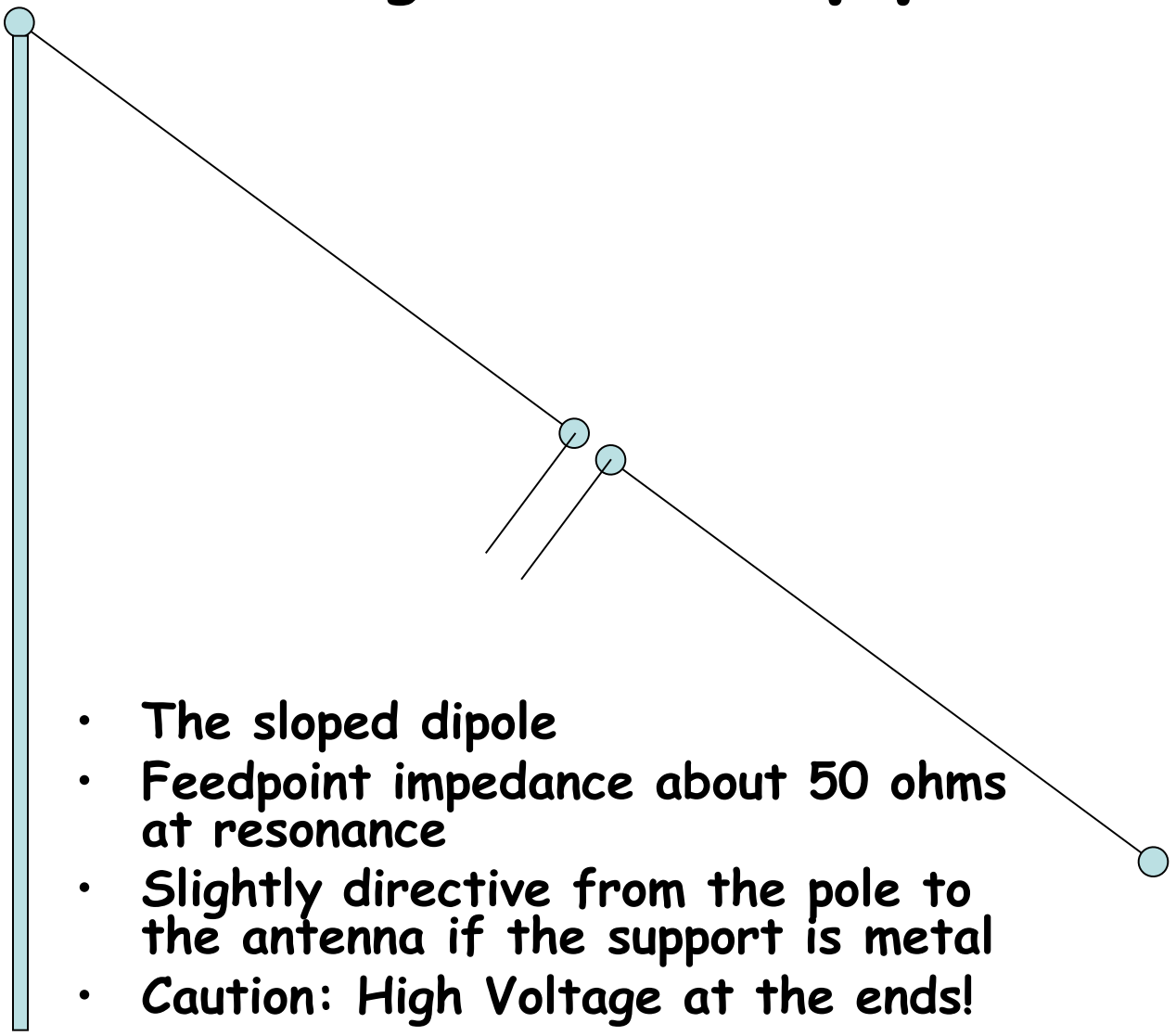
- Length = as long as possible – cut it to fit between your supports or to be resonant on the lowest frequency band on which you plan to operate
- Feed it with open wire feeders or ladder line
- Feed point impedance will vary with frequency
  - The feedline will operate at a high SWR
  - Will require a matching network/transmatch for off-resonance operation
- Off resonance.
  - A short antenna looks like a capacitor and a resistor in series.
  - A long antenna looks like an inductor and a resistor in series.

If you have only one support



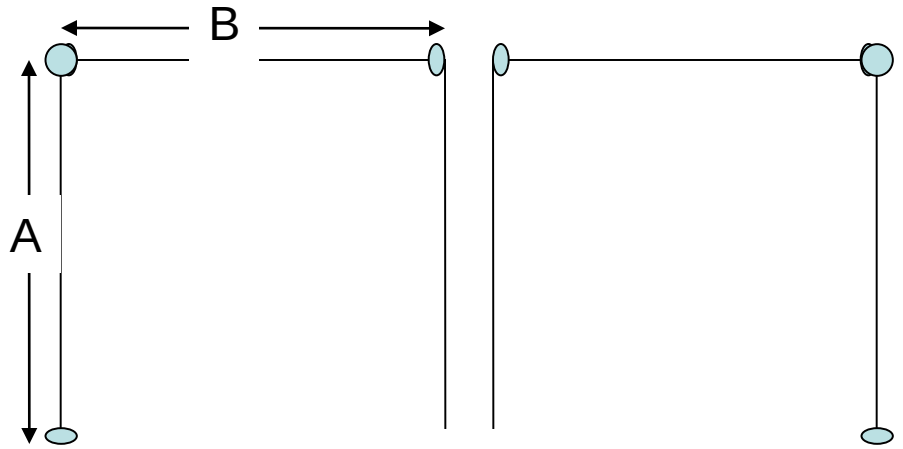
- Inverted Vee
- Resonant length = 490/frequency in MHZ (per 1964 ARRL Handbook)
- Feedpoint impedance about 50 ohms at resonance if legs droop 45 degrees
- Feed with 50 ohm coax for resonant operation, ladder line for multi band operation
- Warning: High Voltage at ends – keep ends well out of reach.
- Rule of thumb: Few people are eight feet tall. Try to keep ends at least 8 feet above the ground.

If you have only one support



- The sloped dipole
- Feedpoint impedance about 50 ohms at resonance
- Slightly directive from the pole to the antenna if the support is metal
- Caution: High Voltage at the ends!

If you have limited space between supports:

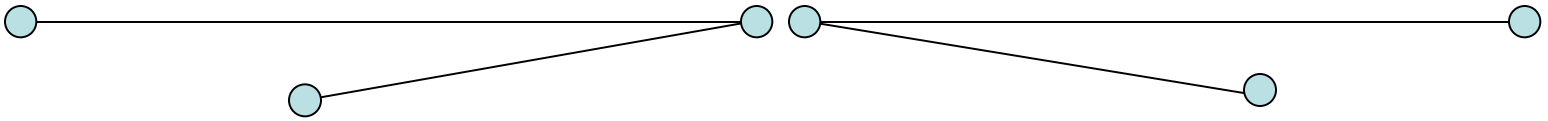


- The Bent Dipole
- Resonant length about 490/frequency in MHZ
- Feedpoint impedance should be close to 50 ohms at resonance
- Feed with 50 ohm coax for resonant operation, ladder line for multi band operation
- Warning: High Voltage at ends – keep ends well out of reach.
- Note: few people are eight feet tall. Try to keep ends at least 8 feet above the ground

Option: End fed or Zepp

- Designed to trail out of WWI Zeppelins
- Traditionally, a half wave fed at one end with a quarter wave of open wire or ladder line
- High impedance at antenna feedpoint; low impedance at end of 1/4 wave feedline
- Feed with open wire or ladder line
- Multiband operation possible with appropriate transmatch: per 1964 ARRL Handbook, following lengths support matching
  - Antenna: 135 feet, feedline 45 feet (80 thru10 meters)
  - Antenna: 67 feet, feedline 45 feet (40 thru 10 meters)

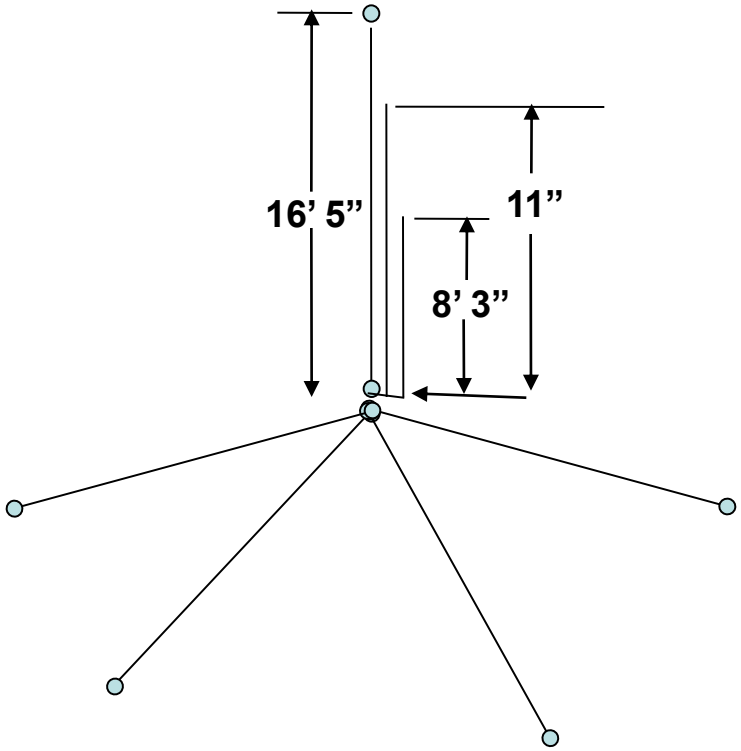
The Multi-wire or "Fan" Dipole



- Separate resonant elements for each band
- Feed with coax
- Each set of parallel elements affects the resonant length of all of the others – cut to formula and prune, beginning with the lowest frequency band
- Novice special (80, 40, 15): Resonant at 3.7 and 7.12 MHz. Operates 80m and 40 m on the fundamental, 15m on the 3d harmonic of 40m.
  - 91 feet of window line or 300 ohm twin lead.
  - Cut one conductor 31 feet from one end, cut second conductor 31 feet from other end
  - Separate ladder line between cuts
  - Connect conductors at "square" end; hook to center insulator
  - Attach insulators to free end of long elements, haul up, prune as needed.
  - Get on the air and enjoy!
- Novice special plus 20 m: Weave resonant 20 m radiator (16' 6" or 8' 3" either side of center) through the windows line between the 80 m and 40/15 m elements.
- Novice special plus 30 m: Weave resonant 30 m radiator (43' 4" or 22' 10" either side of center) through the windows in the ladder line between the 80 m and 40/15 m elements.

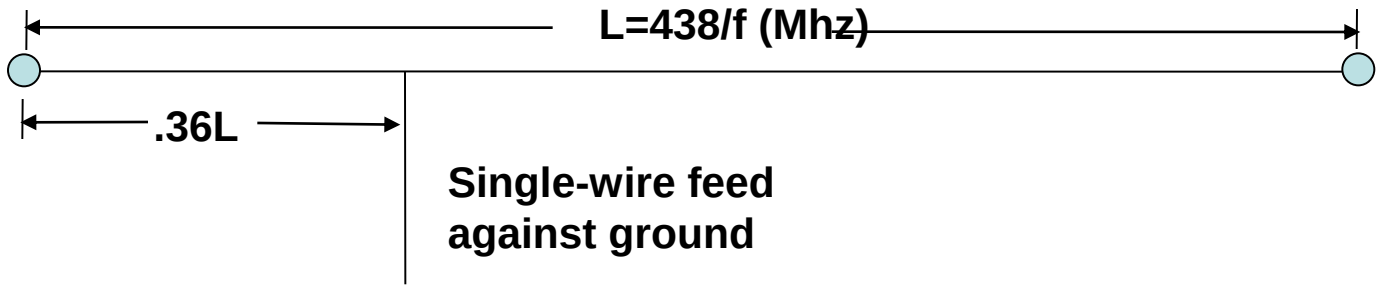
NOTE: Use the same idea for a multi band wire vertical from ladder line, TV lead in, rotator cable, zip cord or whatever. Have fun with it!

The Three Element Ground Plane for 10, 15, and 20 meters



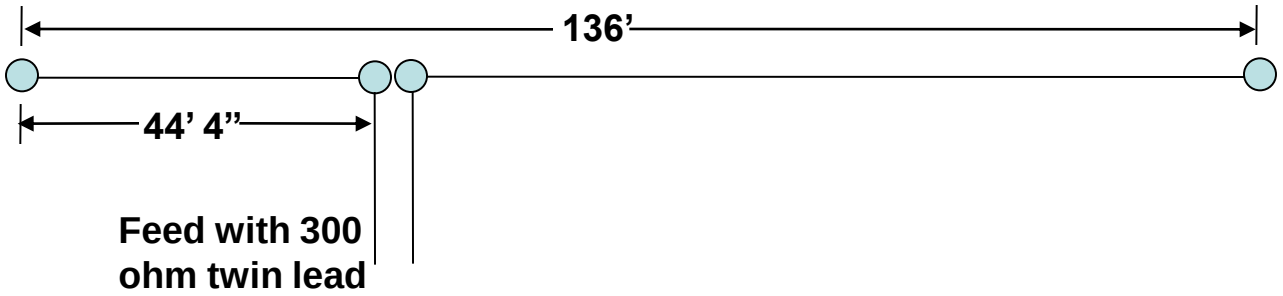
- Use 3 wire rotator cable for the vertical elements.
- Connect all three elements at the bottom
- Four 17’ radials (ground plane) or more (ground mounted)
- Feed with 50 ohm coax
- For portable use, tie a rope to the longest element and suspend from a tree!

The Windom: Single wire off-center fed ½ wave



- "The antenna will operate satisfactorily on second harmonic frequencies" (1964 ARRL Handbook)
- Single wire feeder shows an impedence of about 600 ohms to ground at resonance
- Invented by Loren Windom who also invented the product detector

The off-center fed dipole (1964 ARRL Handbook)



- Claimed to offer a good match on 80, 40, 20, and 10 meters
- "Widely used and does work satisfactorily"
- Some feed line lengths "awkward"
- See QST index for in depth treatment
- Theory behind Cushcraft R4, R5, R7, R8 and R9 vertical antennas

Advantages of Wire Antennas

- Simple and effective – they just WORK.
- Can be made to fit almost anywhere.
- Cheap – a hank of wire and three or four insulators is all you need.
- Lightweight for portable operation.
- Just plain fun! Throw up a wire, get on the air, and work the WORLD!