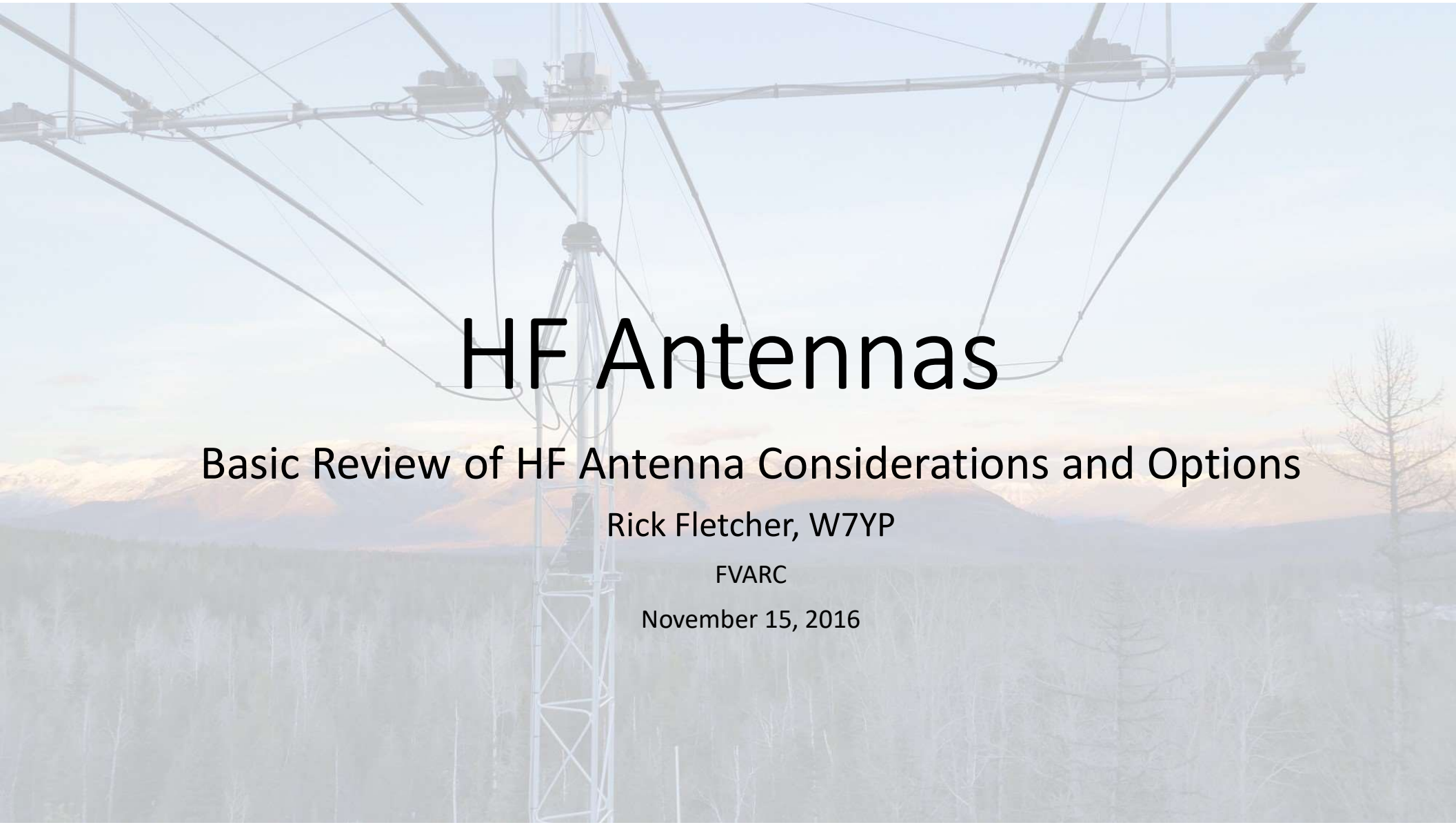

HF Antennas

Basic Review of HF Antenna Considerations and Options

Rick Fletcher, W7YP

FVARC

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Topics

- What defines a “good” HF antenna?
- Factors affecting antenna choice
- Antennas for DXing
- Antennas for regional and local communication
- Antennas for portable operation
- Antennas for mobile operation
- Antennas for space-limited environments
- Antennas for CC&R-limited environments

What defines a “good” HF antenna?

- There’s no such thing as the “ideal” antenna for HF communication
  - This is why many hams have multiple HF antennas
- A “good” antenna is the one that works well enough to do most of what you want it to do, and does so within your budget and other constraints imposed by the location and circumstances of operation
- As a general rule, the more wire or other metal your antenna has in the air, the better it will perform
- A resonant antenna will normally outperform a nonresonant one
- “Good” performance can often be obtained in spite of compromises with the laws of physics and other environmental factors

Factors affecting antenna choice

- Cost
- Monoband or multiband?
- Horizontal or vertical polarization?
  - Most man-made noise is vertically polarized
- DX or local/regional communication?
- Location and surrounding terrain
- Weather conditions
- Height considerations
- Space limitations
- CC&Rs and/or other legal restrictions

Antennas for DX'ing

- Almost any antenna can be used for DX'ing if conditions are good enough and/or with the right selection of operating mode
  - Several digital modes can be used to "work the world" and with low power as well
    - Many hams particularly enjoy making DX contacts under challenging conditions and equipment limitations
- Increased TX power certainly can improve being heard at distance, but don't overlook antenna improvements that you can make first
  - Antenna improvements make it both easier for you to hear weak stations as well as to be heard by those stations
    - If you can't hear them, you can't work them

Antennas for DX'ing (continued)

- Antennas most commonly favored for DX'ing have the following traits:
  - Directionality or "gain"
    - By focusing much of the antenna's radiation pattern in one direction, the Effective Radiated Power (ERP) is increased in that direction
      - If an antenna has 6dBi of gain in a particular direction, the strength of the radiated signal in that direct will be 4 times greater than that of an isotropic omnidirectional antenna
        - If you are transmitting 100W of power, the ERP in that direction will be equivalent to putting 400W into an omnidirectional antenna
        - The antenna will receive much better in that direction as well (in this example, it can add as much as an S-unit to the signal strength of a received station)
    - Lower noise is another benefit when compared to many other antenna types
  - Low angle of radiation or "take off" angle
  - Higher cost than many other antenna types
    - Need the ability to direct the antenna (rotator, control box, control wires)
    - Need a sturdy mast or tower to support all of this

Antennas for DX'ing (continued)

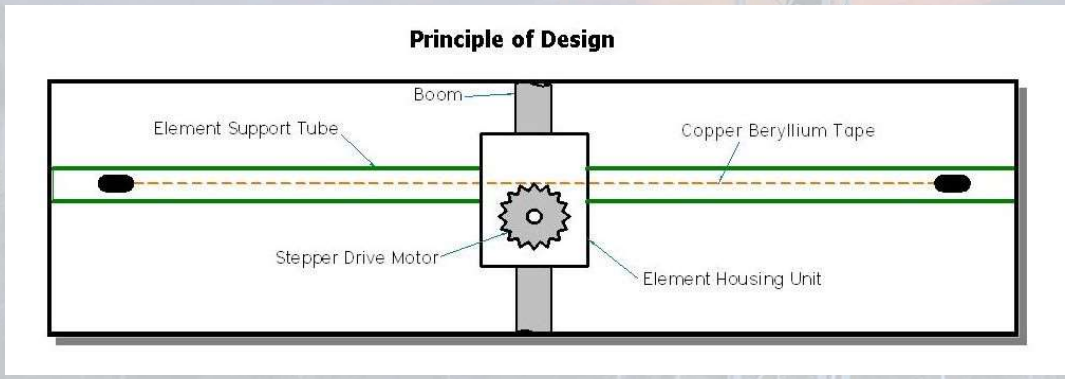
- Most common directional antennas are Yagis which typically take two forms:
  - Horizontal wires or tubes ("elements") supported by a boom
  - 'Loops' as elements ("Cubicle Quad": each side 1/4λ)
    - Fed at center vertically = vertical polarization; horizontally = horizontal polarization

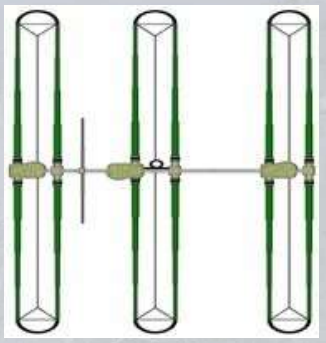
Antennas for DX'ing (continued)

- Like any horizontally-polarized antenna (e.g., dipole) it should be elevated at least one-half wavelength above the ground to avoid large ground losses
  - One wavelength is preferable and above that one quickly experiences diminishing returns for the effort and cost
- A popular two-element Yagi is the "hexbeam"
  - Nearly 6dBi gain
  - Very light weight
    - Mast can often support it and a rotator
  - Low cost ($500 and up)
- Three-element Yagi: 9.7 dBi forward gain

Antennas for DX'ing (continued)

- SteppIR Yagis
  - Copper-Beryllium tape is moved in and out within a fiberglass tube by stepper motors to tune each element to the current operating frequency
    - Automatically or manually tuned via their SDA100 controller
    - Can be tuned to cover non-amateur frequencies between each ham band
      - Perfect SWL antenna
    - Single push of a button and the Yagi is pointing 180° opposite its previous heading



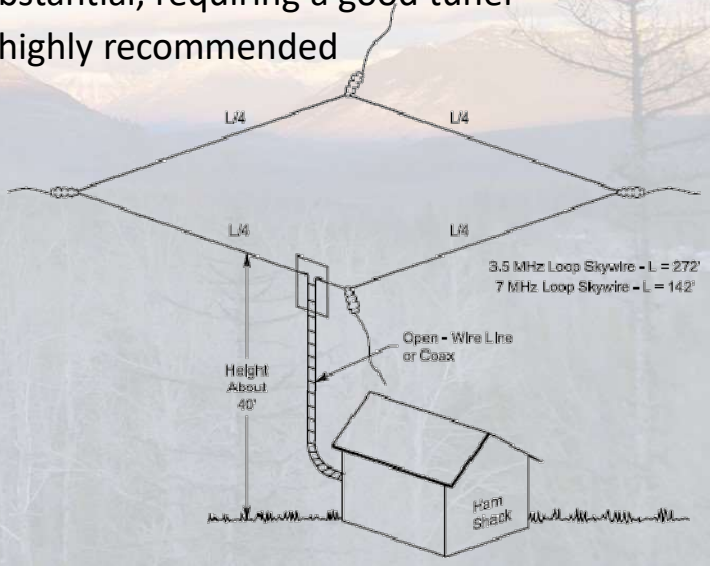


Antennas for DX'ing (continued)

- Log Periodic
  - Spacing of elements increases logarithmically along the length of the boom
  - Gain is less than that of a Yagi with the same element count
  - Can cover a WIDE bandwidth
  - Example: Cushcraft ASL-2010 ($1000)
    - 6.4 dBi average gain, 13.5-32 MHz
    - 8 elements
    - 18 ft. boom
    - 19.5 ft. turning radius

Antennas for DX'ing (continued)

- Full Wavelength Horizontal Loop ("Skywire")
  - Easily strung between trees, making it inexpensive to construct and deploy
  - Excellent performer on lower HF frequencies and very quiet
  - Typically cut to be resonant on the lowest frequency desired
    - Operated multiband with a tuner
      - Range of feed point impedances presented can be quite substantial, requiring a good tuner
      - Ladder line between the tuner and the loop's feed point is highly recommended
    - Angle of radiation increases with frequency
      - 160m loop would not be good for 15m, 12m and 10m DX
  - The higher you can hang it, the better
  - Many plans on the Internet:
    - http://n1su.com/loop.html



Antennas for DX'ing (continued)

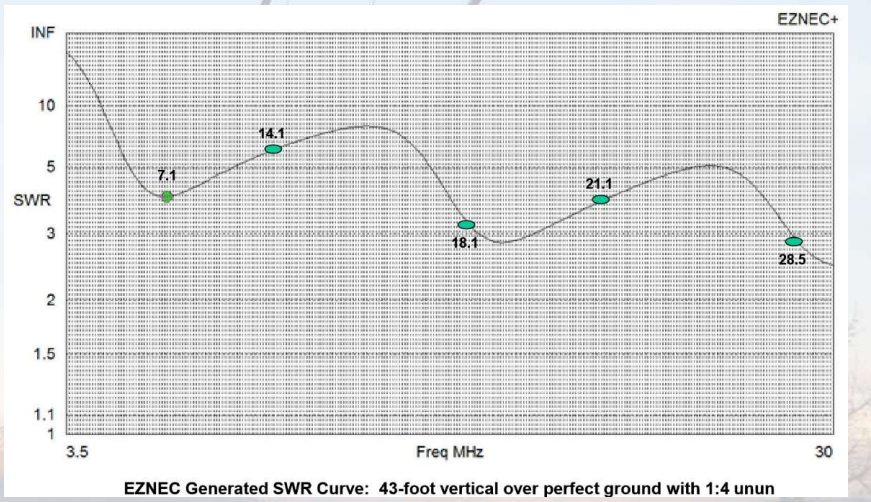
- Vertical antennas
  - Radiating element is typically a quarter wavelength long
    - End fed, it's natural impedance is 35 ohms
  - Low take-off angle
  - Can be operated multiband with a tuner
  - Require a good radial field to avoid high ground losses
    - Radials should be placed on the ground or no more than a few inches below the surface of the ground
      - Raising the vertical and slanting the radials can elevate feedpoint impedance to near 50 ohms
    - One quarter wavelength long if elevated; otherwise L = λ/3.9
      - In multiband applications, there should be sets of radials cut to each band of operation
    - A good minimum number for average soils conditions is 16. Lossier soils will need more.
  - Frequently DX signals will arrive predominately vertically polarized
    - Avid DX'ers will often have a vertically and horizontally polarized antenna for DX

Antennas for DX'ing (continued)

- BigIR by SteppIR
  - 33 ft. tall
  - 2 sq. ft. wind load/50 MPH w.o. guys
  - 3 KW power handling
  - 6.9-54 MHz
  - 80m and 60m with optional coil
- SmallIR by SteppIR
  - 18 ft. tall
  - 1 sq. ft wind load/100 MPH w.o. guys
  - 3 KW
  - 13.9-54 MHz
  - 80m, 60m, 40m and 30m with optional coil

Antennas for DX'ing (continued)

- The 43 ft. vertical antenna
  - Pros:
    - Inexpensive and relatively unobtrusive
    - Self-supporting
    - Easy ground-mount
    - Low angle of radiation for good DX performance
    - Omnidirectional (no rotator needed)
    - Can be operated multiband with a feed point located tuner or 1:4 unun
      - Higher efficiency than trap-based multiband verticals
      - A in-shack tuner required when using an unun
      - Minimal SWR-related cable losses
  - Cons:
    - Omnidirectional
    - Needs a very good radial system



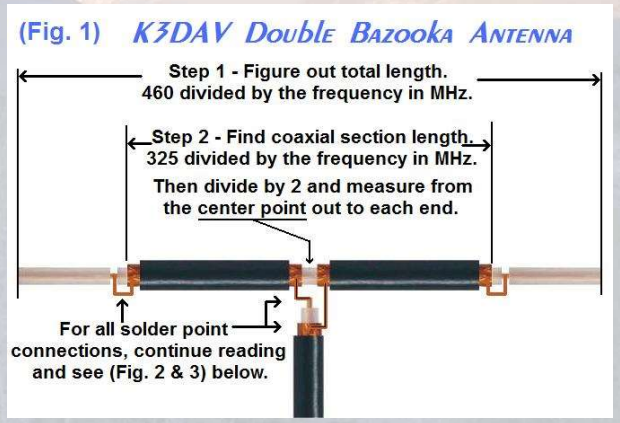
EZNEC Generated SWR Curve: 43-foot vertical over perfect ground with 1:4 unun

Antennas for DX'ing (continued)

- Dipoles
  - Center-fed
    - Feed point impedance in free space = 72 ohms (SWR = 72 / 50 = 1.44:1)
      - Less than 1/2λ above ground, azimuthal pattern is nearly omnidirectional
        - Maximum radiation nearly straight up (NVIS)
      - Feed point impedance decreases below 1/4λ above ground
    - 1/2λ (Length in feet = 468 / F in MHz)
      - A dipole's length for 14.250 MHz = 468 / 14.25 = 32.8 ft.; for 3.550 MHz, it would be 131.8 ft.
    - Lower ground reflection losses than a vertically polarized antenna
      - True for horizontally polarized antennas in general
  - Off Center-Fed (OCF)
    - Feed point 14% off center; fed with 4:1 balun
    - Multiband operation with the typical 3-to-1 built-in tuner
    - 80-6m version is roughly 130 ft. long (Radiowavz model shown: $83)
  - Inexpensive and many have worked the world with nothing but a dipole

Antennas for DX'ing (continued)

- Double Bazooka (Coaxial Dipole)
  - Very broad-banded half wave antenna
    - While many claim it to be efficient as a multiband antenna, antenna simulators disagree
      - Antenna efficiency can approach 98% on its resonant band
      - Operation on other bands requires a tuner
    - Can cover an entire amateur band (e.g., 80/75m) with an SWR less than 2:1
    - Can be coaxially fed directly – No balun needed
    - Best results are obtained in an inverted 'V' configuration
    - Multiple free plans on the Internet
    - Commercial versions can be had for less than $100
    - Very popular for portable use as well as at home



Antennas for regional/local communication

- Near Vertical Incidence Skywave (NVIS) antenna
  - The majority of the antenna's radiation is at a very high angle (75-90 degrees)
  - Omnidirectional communication out to 300-500 kilometers
  - Best frequencies still depend upon propagation conditions
    - 1.8 MHz under very poor conditions
    - 14 MHz under very good conditions
    - Generally best frequencies are between 3.5 MHz and 7.3 MHz
  - Any half-wave horizontal antenna 1/4λ or less above ground
- Vertical antenna for bands with substantial ground wave propagation
  - Primarily 160m and 80m

Antennas for portable operation

- Requirements:
  - Carried to the operating site
  - One person setup w.o. special equipment (e.g., air cannon)
    - This means the antenna will be low to the ground
  - As antenna gets less than 1/2λ above ground, take-off angle increases
    - DX becomes more difficult while local communication is enhanced
    - Antenna behaves like it has more height above ground on top of a building, hill or cliff
- Most common choices:
  - Short dipoles
    - Buddipole
    - TAK-tenna
  - Single band helix wound vertical (Hamstick)
  - End-fed wire

Antennas for portable operation (cont.)

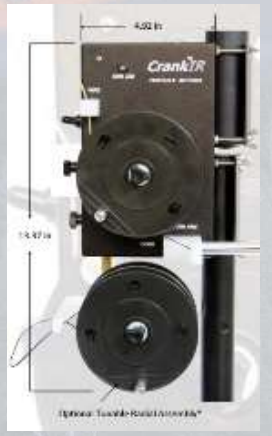
- Buddipole
  - Manually coil-tuned dipole
    - Can be used vertically or horizontally
    - Multiband capable
  - Models to cover 40m – 2m
    - Starting at $199
  - Handles up to 250W
  - Light weight

Antennas for portable operation (cont.)

- TAK-tenna
  - Can be used vertically for NVIS
  - Multiband operation requires a tuner
  - Two models:
    - TAK-tenna 80 for 80m – 10m
      - 48” boom
      - 38” diameter spiral
      - 5 lbs.
      - $236
    - TAK-tenna 40 for 40m – 10m
      - 30” boom
      - 30” diameter spiral
      - 4 lbs.
      - $181

Antennas for portable operation (cont.)

- SteppIR CrankIR
  - Manually tuned “folded” vertical covering 80m to 2m
    - Built-in SWR Indicator
  - Tunable radial
    - Slight gain in the direction of the radial
- http://www.steppir.com/crankir-vertical-and-dipole



Antennas for portable operation (cont.)

- End-fed wire such as the PAR End-Fedz
- Usually cut to 1/2λ on their resonant band
  - Some can be operated multiband
    - Tunable balun often used
    - Typically limited to 200W or so
- PAR EndFedz EF 10-20-40
  - 40 ft. long
  - 25W continuous power
  - 0.5 lbs.

Antennas for mobile operation

- "Screwdriver" antenna
  - Several manufacturers
  - Can be manually or auto-tuned for each of the HF bands
  - The bigger the coil (higher 'Q'), the greater the efficiency
  - Leader is Hi-Q Antennas
    - Most popular: Piranha 5/80
      - 5" coil
      - 80m-10m
      - 43% efficient on 7.2 MHz with a 102" whip
      - $575
- End-fed whip with tuner
  - Icom AH-4 tuner

Antennas for space-limited environments

- Small horizontal loop
- Inverted Vee
- Vertical
- Magnetic Loop
  - 1m diameter most common size
    - Perform best on 20m and up
      - Performance can be within an S-unit or two of a dipole
      - Works well with no need for ground plane or earth ground
    - Narrow bandwidth without needing to be retuned
  - Easy to build:
    - http://www.g4ilo.com/wonder-loop.html

Antennas for CC&R-limited environments

- Flagpole antenna by Force 12
  - 80m to 6m
  - 20 ft. aircraft aluminum
  - Easy ground mount
  - Includes flag, choke, installation hardware
  - Can be purchased bundled with remote tuner
  - NO RADIALS REQUIRED
  - $449


Q&A