Low Band Antennas 40/80/160

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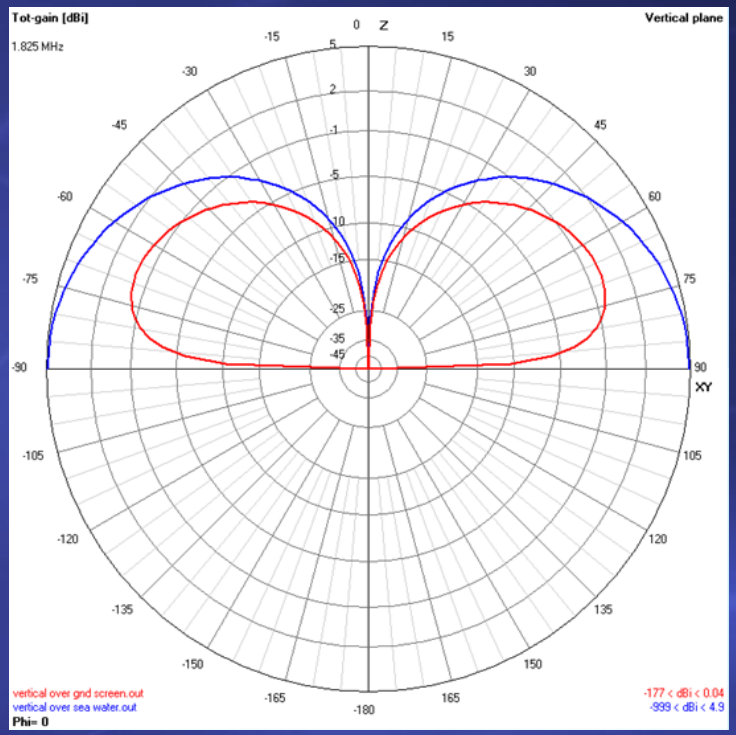
Transmit Antennas

The Basics

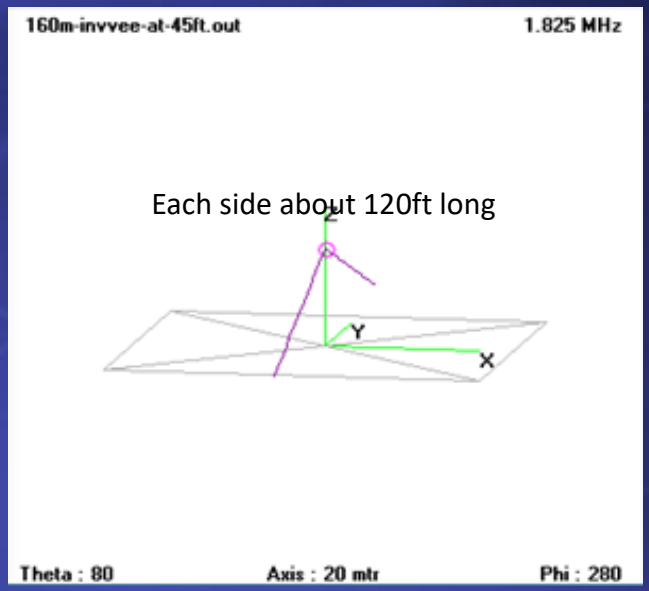
- Install as much wire/tubing as possible
  - Electrically short antennas
  - Minimize matching losses
- Good ground for verticals
  - Maximizes antenna efficiency
- Far-away ground conditions determine low angle radiation
  - Not too much we can do about this

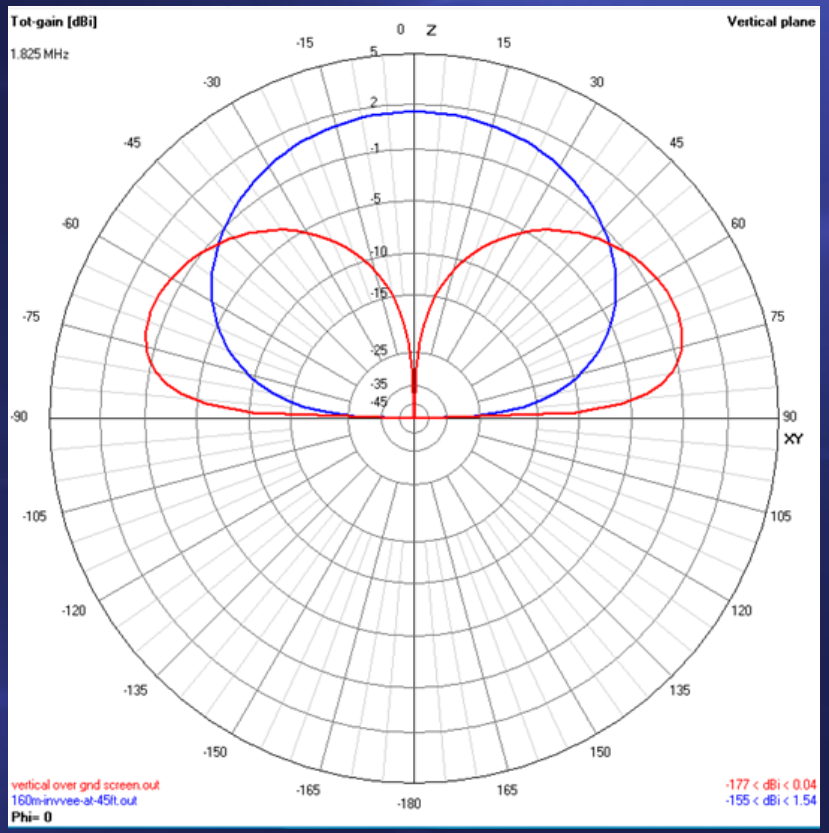
Reference – 160m Vertical



- Red is λ/4 vertical (132ft) on 160m over average ground with many ground-mounted radials
  - This would be about the best most of us can achieve
  - 0 dBi gain at peak
  - 4-Square gain about +5 dBi
- Blue is same λ/4 vertical over salt water
  - More gain: +5 dBi on the horizon
  - Covers many elevation angles
- Think what a 4-Square could do over salt water!

160m Inverted-Vee at 45ft





- Inv-vee about -7 dBi at 20°
- About an S-unit + down from the λ/4 vertical at 20°

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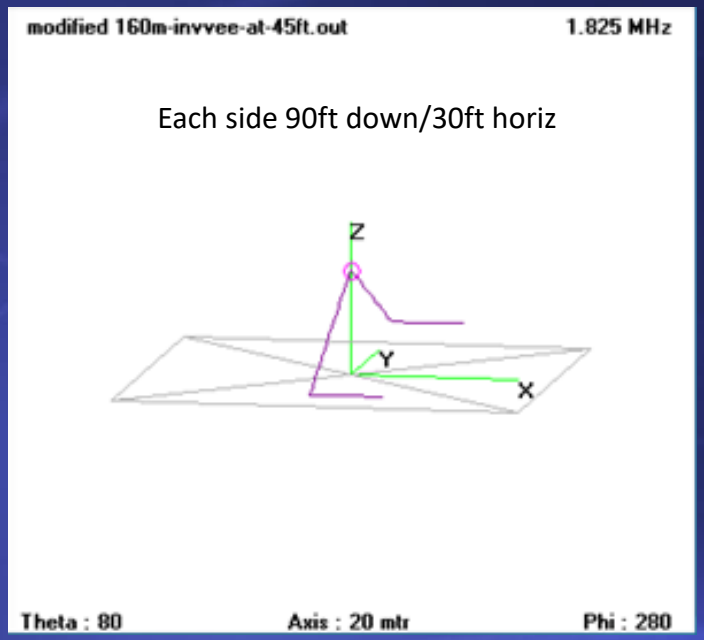
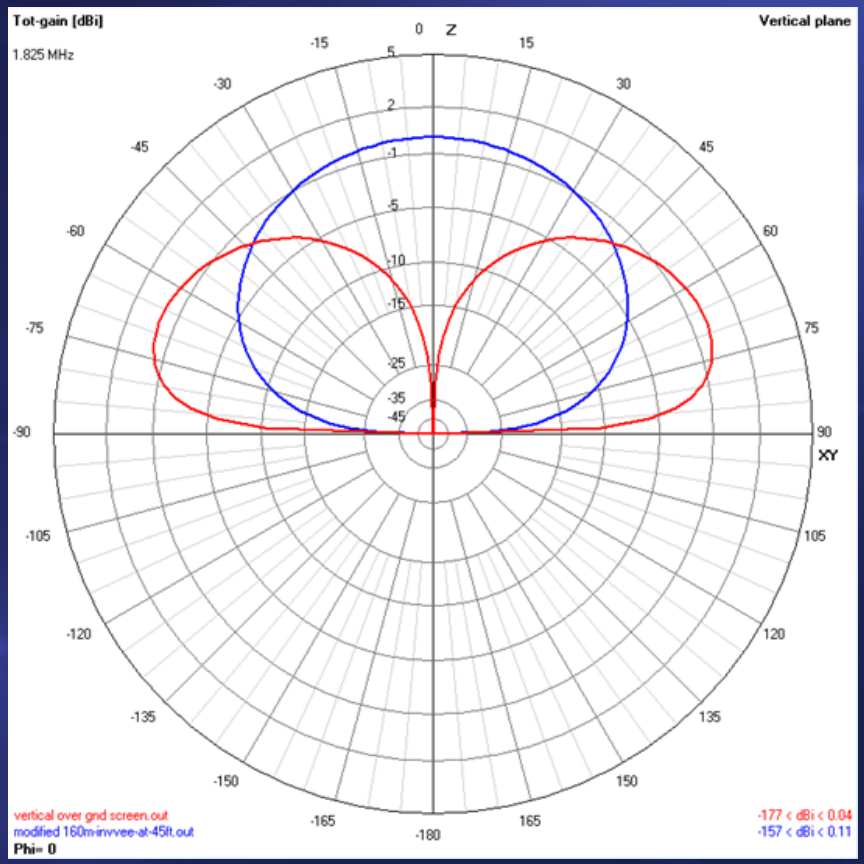
Modified 160m Inverted-Vee at 45ft





- Bend the ends and run them horizontal to fit on your property
- Not much difference from the un-modified inv-vee

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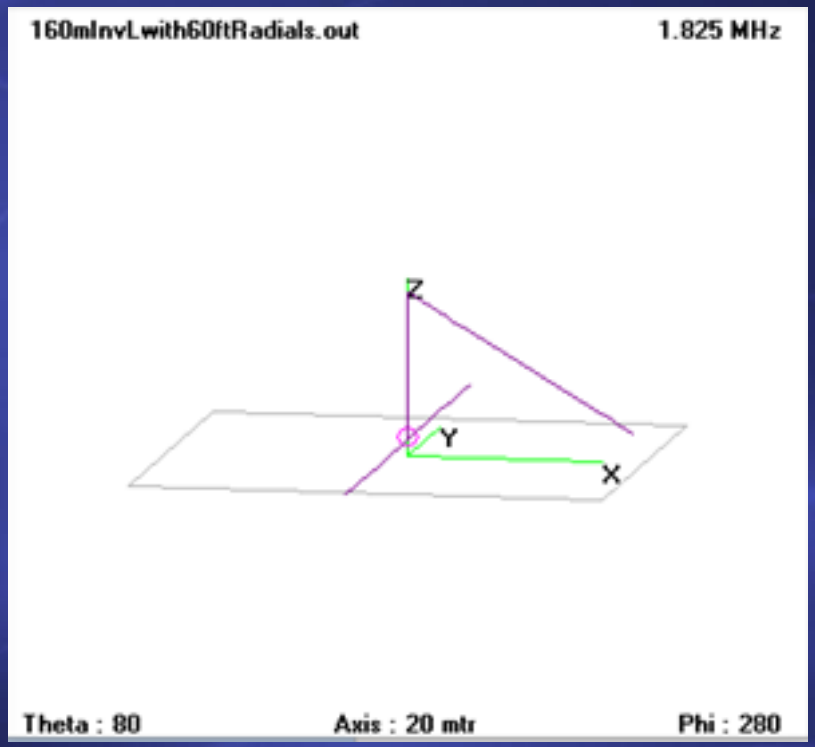
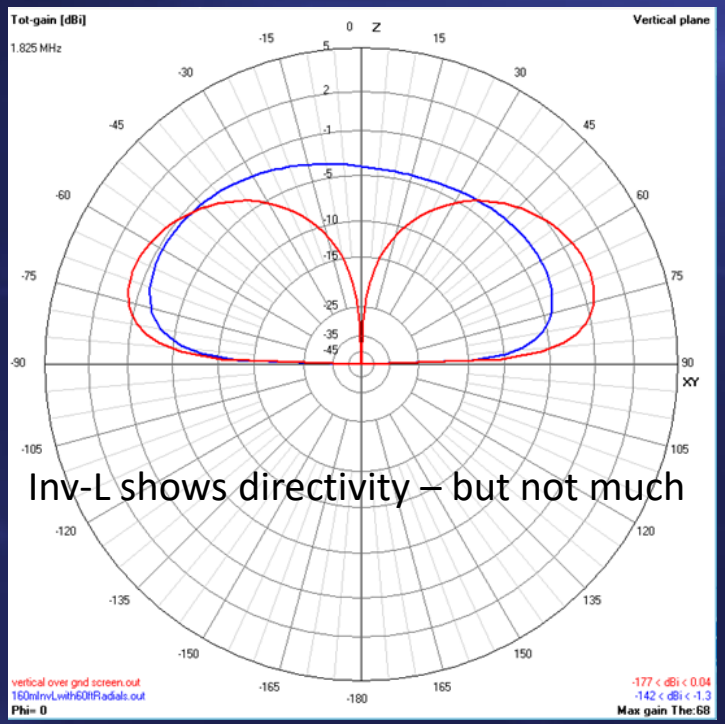
Does the Modified Inv-Vee Work?

- A definite *YES*
  - Good domestic or close area antenna
- *For an Example K9LA:*
  - CQ WW 160m CW last January with 1000W and a SAL-20
    - 44 states – missed ME, ID, NE, AK
    - 7 Canadian provinces - VE9, VY2, VE2, VE3, VE5, VE6 and VE7
    - 17 DXCC entities (mostly Caribbean, Central America, Mexico and South America, with a few Europeans, a North African and a KH6)
  - Not bad for a “cloud-warmer” antenna!

160m Inverted-L

- 54ft up/93ft down
- 2 elevated radials 120ft long
- Very commonly used if you have a tree

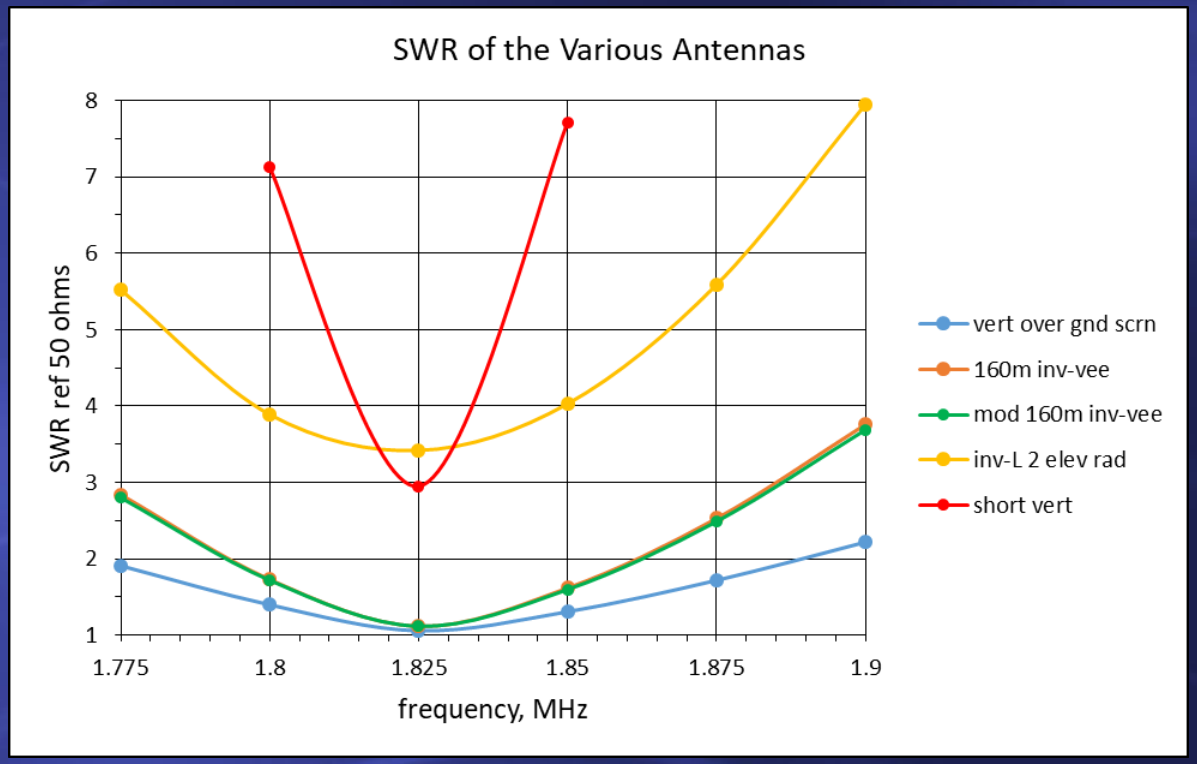




Inv-L shows directivity – but not much

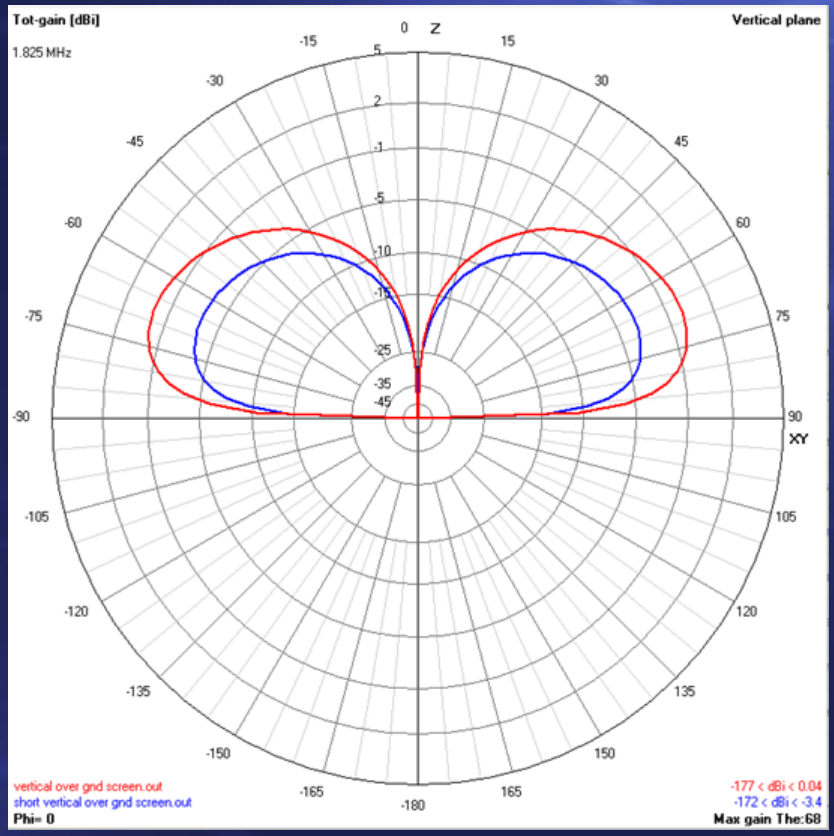
Bandwidth

- Inv-L and short vertical need matching
- Regardless of which one you use, you'll enjoy 160m



Short Loaded Vertical

- General Rules
  - Make as tall as possible
  - Use top loading (Cap Hat)
    - Most efficient
      - ✓ Wires
      - ✓ Other antennas
  - Good ground system
    - More important on electrically short antennas
  - Good, large loading coils
    - Less desired than top loading wires or antennas



160 Meter Vertical

Red is a ¼ Wave Vertical over a Ground Screen

Blue is a short 45' Vertical over Ground Screen

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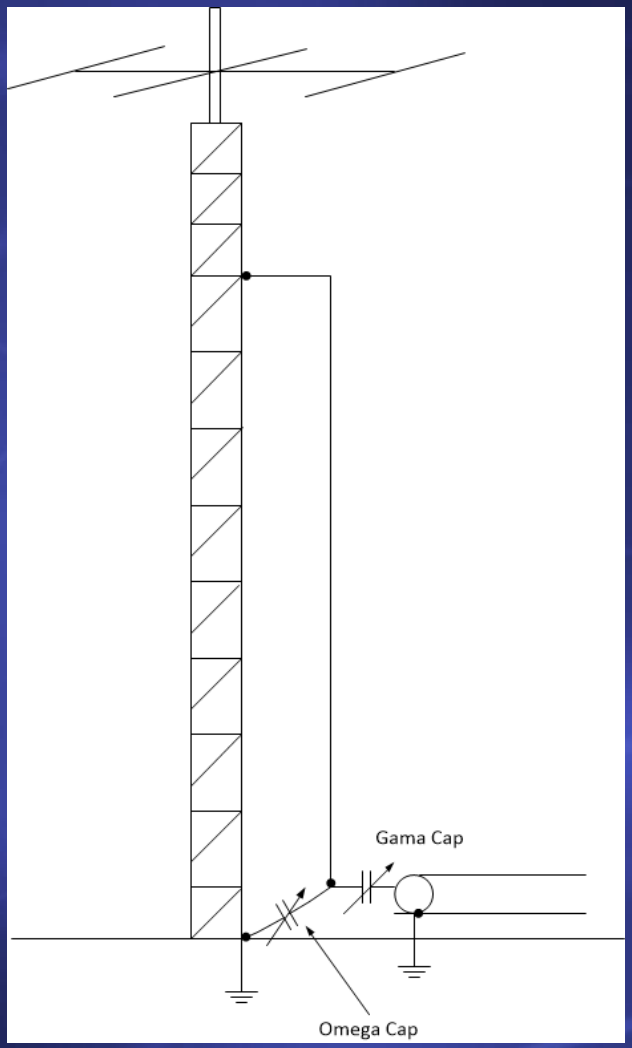
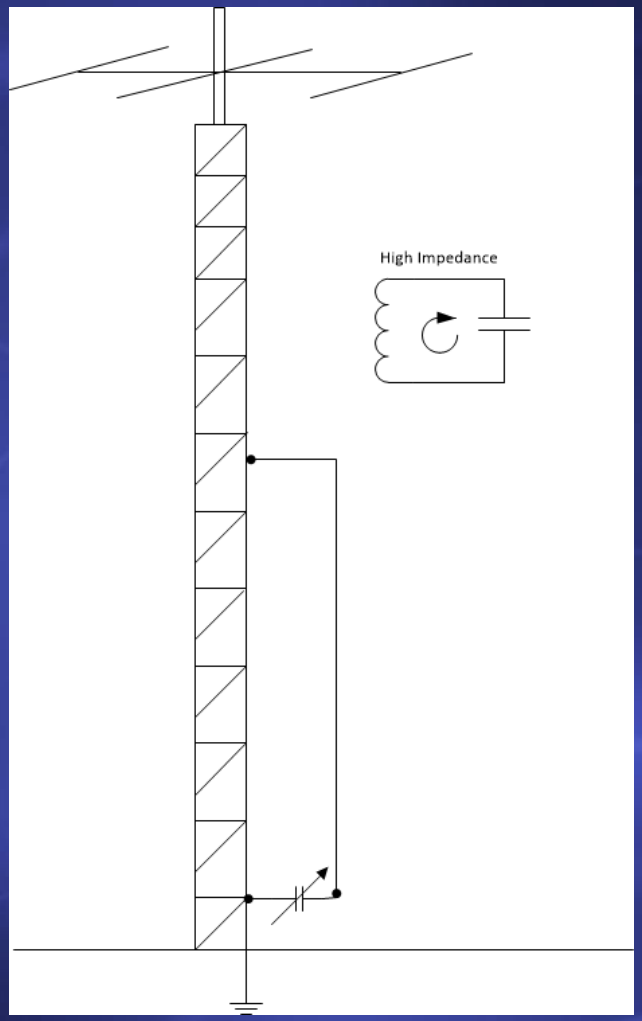
Shunt Fed Tower



- Omega Match Requires Two Capacitors
- Gamma Spacing changes the resistive part at the feed point.
- Use capacitors to tune out reactance
- If you can feed using only a Gamma Capacitor, do it.
- Omega Match will have more Loss
- Attachment at the tower

Detuning the Tower



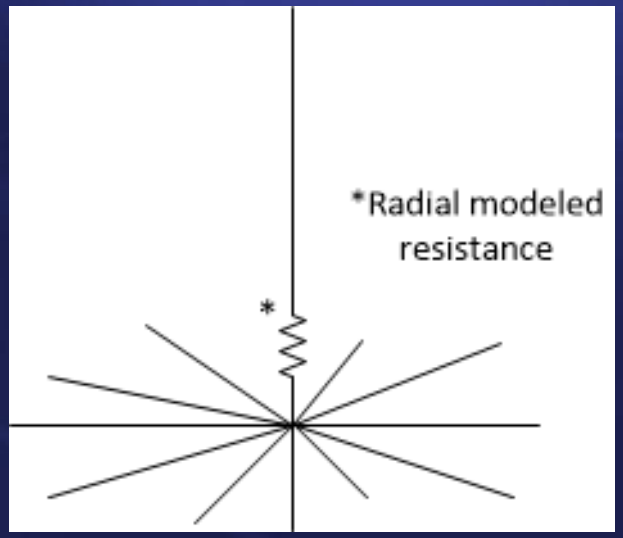
- The Tower can affect other antennas
  - Whether they are resonant or not
  - Especially vertical arrays
  - Even Loops

- Create a trap: i.e. a parallel resonant circuit at the frequency of receive
  - Isolates the upper tower section from the bottom section
  - Detune sections shorter than 3/16 λ
  - If possible, ground cables above and below detuning area
  - Ground cable shields at bottom of tower
  - * KD9SV coupling box

Radials for Verticals

- Radials are the other ½ of a vertical antenna
  - Elevated radials attempt to eliminate lossy ground effects
    - The higher the better
    - Can be impractical
  - Buried or on-ground radials second best thing
    - Need more than if elevated radials
    - The larger the number of radials, and the electrically longer they are will provide more effectivity.

Equivalent Resistances of Buried Radials Systems					
			Number of Radials		
Radial l	2	15	30	60	120
0.15	28.6	15.3	14.8	11.6	11.6
0.20	28.4	15.3	13.4	9.1	9.1
0.25	28.1	15.1	12.2	7.9	6.9
0.30	27.7	14.5	10.7	6.6	5.2
0.35	27.5	13.9	9.8	5.6	2.8
0.40	27	13.1	7.2	5.2	0.1



  - Velocity factor in the ground is ~.5 - .6
    ∴ 80m = ~10M and 160M = ~20M long for ¼ λ

- Conclusion: Put in as many radials as you can

Low Band Receive Antennas

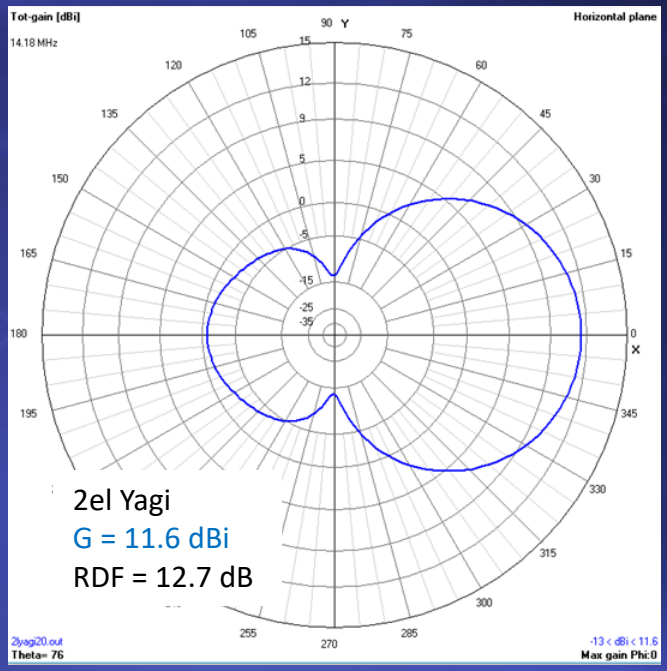
Purpose of Low-Noise Rcv Ant

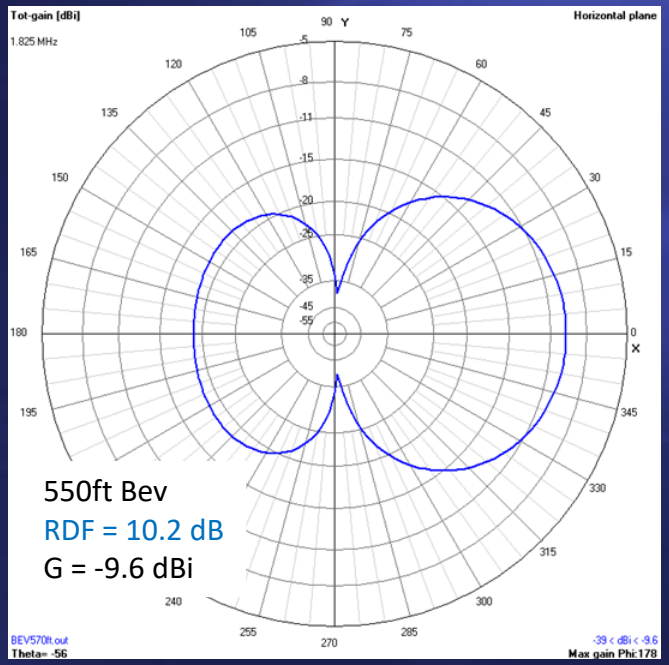
- It's all about SNR (signal to noise ratio)
- SNR is improved by antenna directivity
- Low-noise receive antennas usually address atmospheric noise – man-made noise sources are assumed to be resolved
  - But a low-noise receive antenna will help with man-made noise
    - Point away from the noise source
    - Put a null on the noise source

What Is RDF?

- Receiving Directivity Factor
- RDF is the dB difference between forward gain at peak of main lobe and average gain over the entire hemisphere above ground
  - RDF assumes that noise arrives equally from all azimuth and elevation angles
- Theoretically RDF tells you the SNR difference between any two antennas
- In the real world, noise is directional
- Regardless, the higher the RDF, in general the higher the SNR

HF vs MF





- Although HF antennas have RDF, they focus on gain
- Low-noise receive antennas focus on RDF

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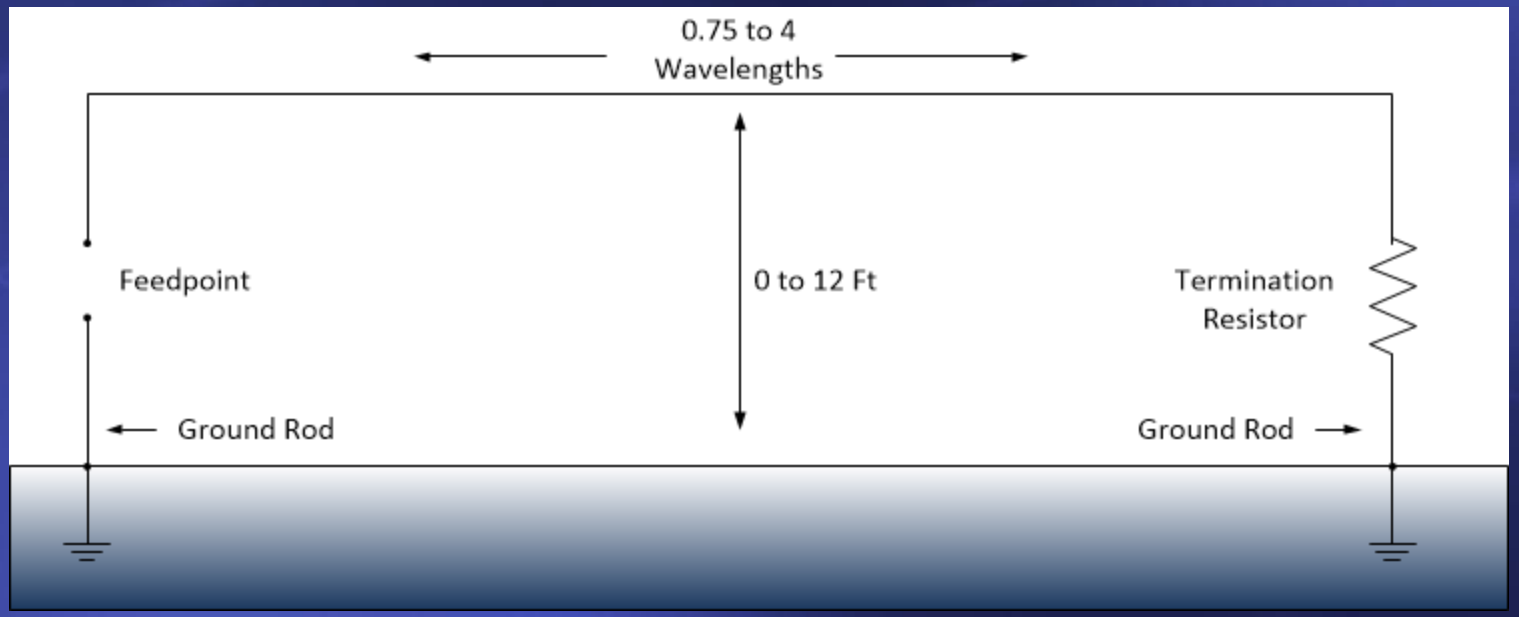
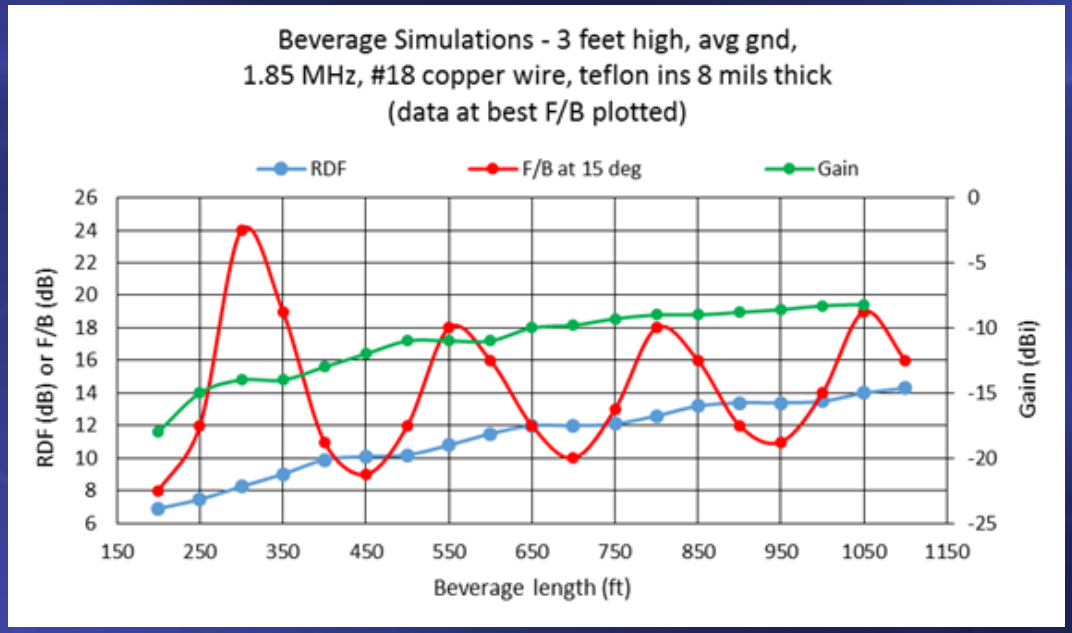
Beverage Antennas

Excellent receive antenna if you have the space

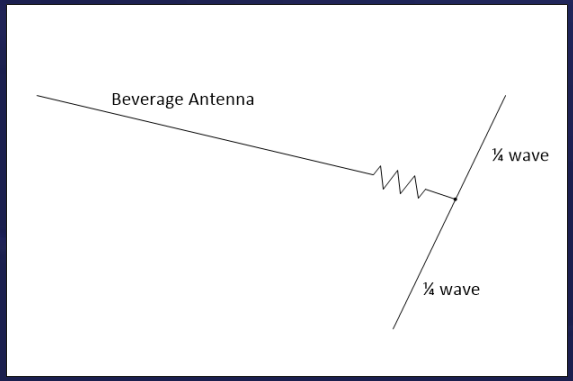


- Shortest length recommended is 300 feet on 160m
- Need a minimum of four Beverages to cover the world

Beverage Antennas

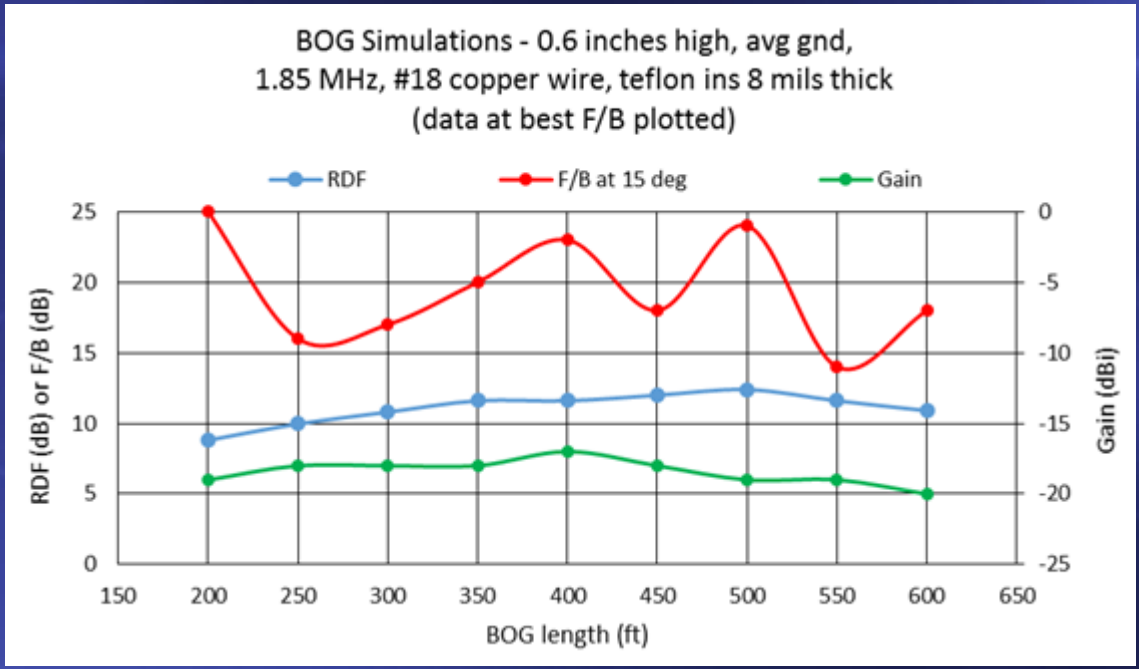


- Use Care When Modeling Beverages
  - Terminate on each end connecting the beverage to the center of a ½ wave wire perpendicular to the antenna
  - Use Sommerfeld ground method
  - Be careful accepting gain measurements of beverages



BOG

Beverage on the Ground



- Shortest length recommended is 150 feet on 160m
- Lay on top of ground or grass – Don't let it get covered up
- Need a minimum of four Beverages to cover the world
  - Or two reversible beverages

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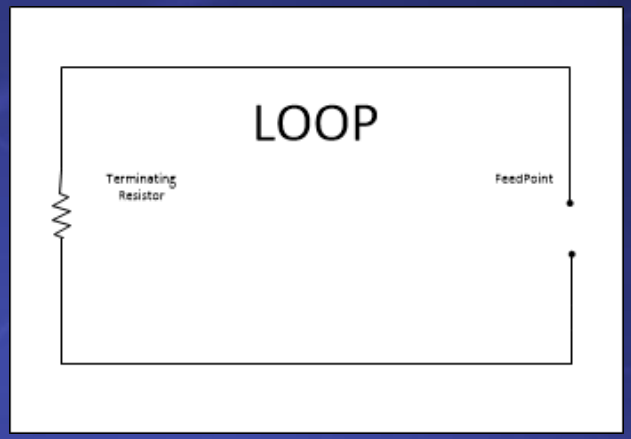
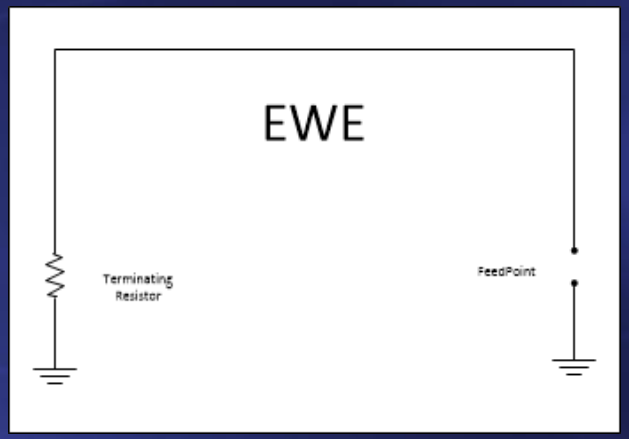
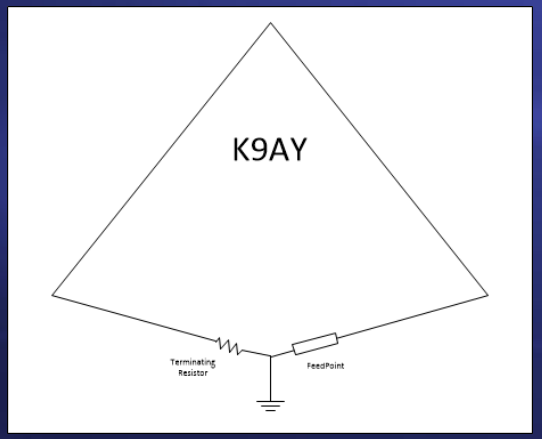
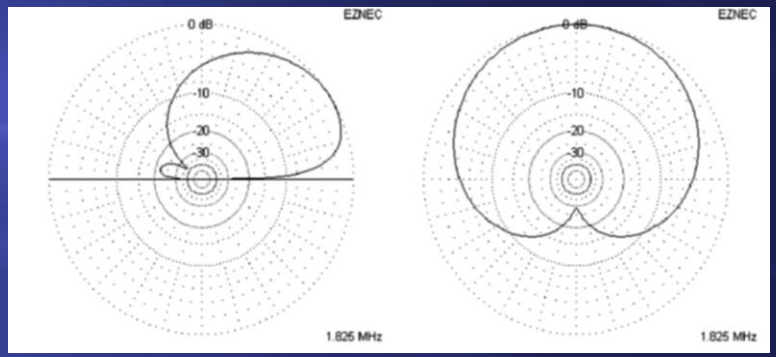
Small Loops

- Various Configurations
  - EWE, K9AY, FLAG, Pennant
  - Cardioid Pattern



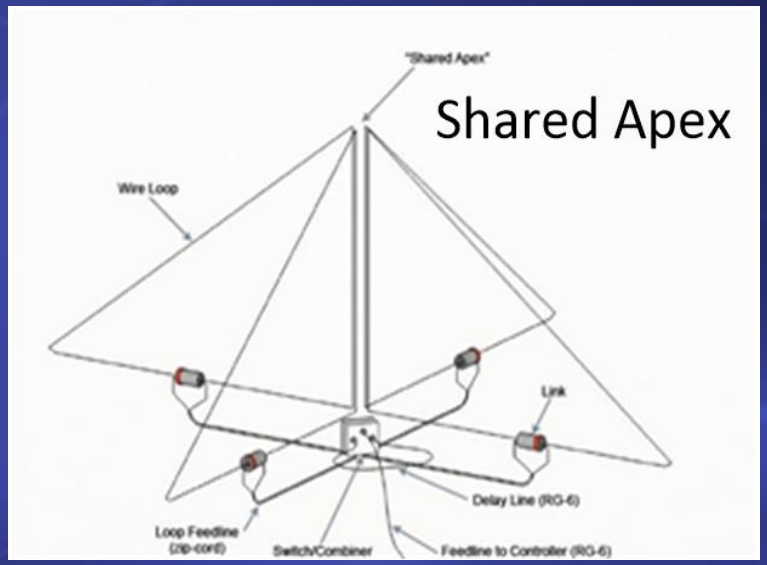


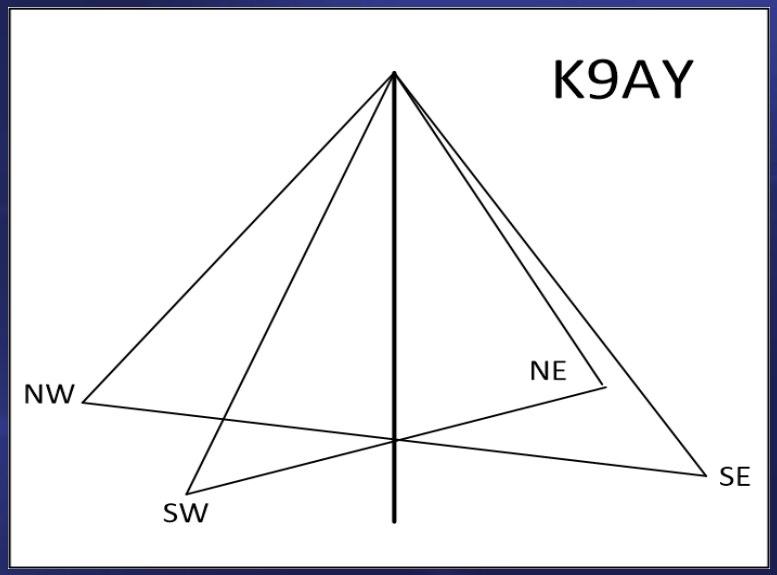




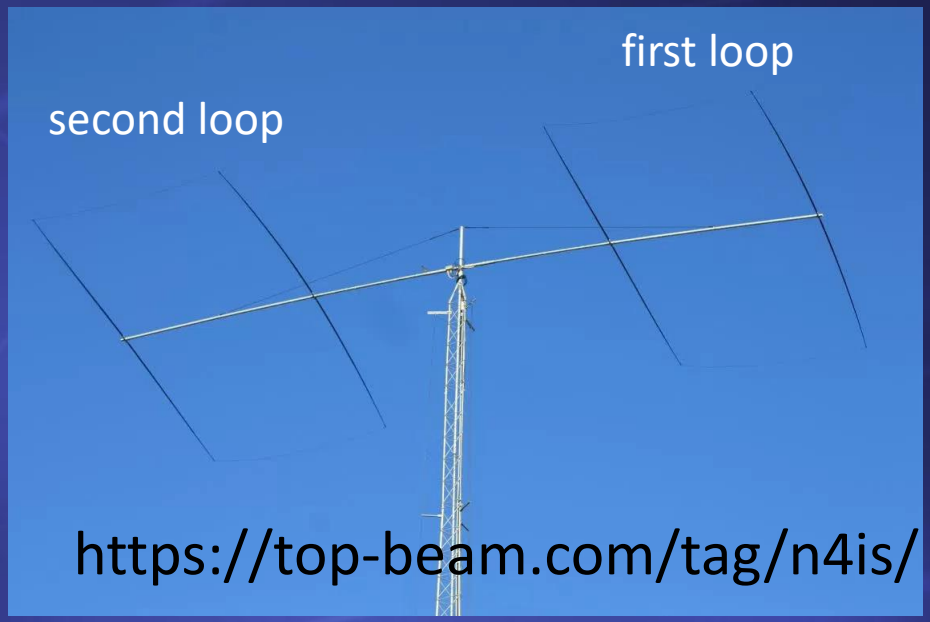
More Small Loops

- Configurations for around the compass coverage
  - K9AY and the SAL uses a single pole for multiple directions
  - SAL (Shared Apex Array) uses two loops with a time delay similar to a Waller Flag





Waller Flag



- Two electrically-small loops fed out of phase
  - Can be mounted vertically or horizontally (as shown)
- Still physically big on 160m
- Need to rotate
- Need lots of gain from preamp
- Good performer

RDF Data from K7TJR

Antenna	Gain	RDF
90 ft. top loaded TX vertical	1.4 dBi	4.9
K9AY loop	-25.6 dBi	7.2
4 square of K9AY loops	-22.2 dBi	9.1
10 Foot Dia. tuned loop	2.2dBi	4.0
Flag	-29.7dBi	7.4
Beverage 1000 Ft.	-6.4dBi	12.3
Beverage pair 1000 ft. 400 ft. space	-2.9dBi	14.6
Beverage 910 Ft.	-5.3dBi	11.9
Beverage 500 Ft.	-10.6dBi	9.0
4 square Tx antenna	6.8dBi	10.7
Bsef Hiz vert array70x320	------amplified	12.9
Inverted vee 120 ft.	-1.08dBi	.6
2 element hiz 50ft space	-----amplified	9.0
TJR 8 element 200 ft circle Hi Z	-----amplified	13.45
TJR 4 element of 8 200ft circle Hi Z	-----amplified	10.8
330 ft circle 4 active of 8 Hi Z	-----amplified	12.3
Beverage 300 Ft.	-14.5dBi	6.5
Waller Flag	-54dBi	12.2

- 160m data
- Vertical RDF = 4.9 dB
- Loop RDF = 4.0 dB
  - If this is all you can install, give it a try
- Inverted-vee RDF = 6.0 dB
- 300ft Bev RDF = 6.5 dB
- 200ft BOG RDF = 9.0 dB

http://www.k7tjr.com/rx1comparison.htm

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Noise Cancelation

- Noise Cancelation Devices
  - Uses phase cancelation
  - Use two antennas
  - Single point source noise

Ingress of Noise

Common mode noise contamination

- Noise on the coax can contaminate the signal
- The ideal choke has infinite impedance for RF
- Especially needed on low gain receive antennas
- Shoot for at least 1000 ohms of impedance
- For 10 – 160 meters use Ferrite #31 or #43 mix
- No hard rules

- Where to put chokes
  - Near the coax feed point of an antenna
  - At the equipment in your shack on coax lines
  - Computer AC Lines and almost all cables on the computer
    - Laptop power supplies
    - Video cables
    - All other cables
  - Cable TV boxes
  - Wall warts
  - Other cables near your antenna

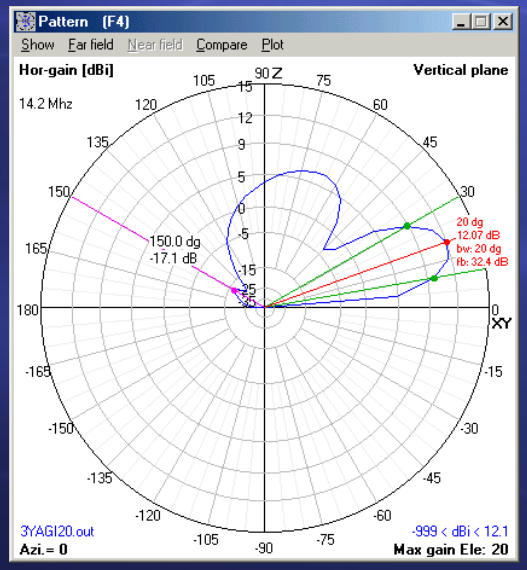
- In Summary: Everywhere!

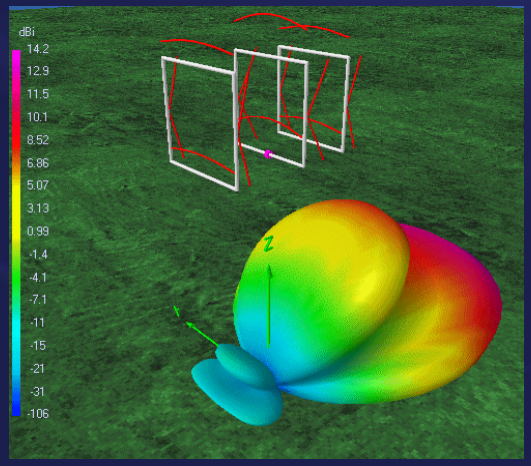
References

http://www.yccc.org/Articles/W1HIS/CommonModeChokesW1HIS2006Apr06.pdf
http://audiosystemsgroup.com/RFI-Ham.pdf

Modeling

- An Essential Tool for Experimenting with Antennas
- Steep Learning Curve
  - Use Tutorials to Understand Modeling Limitations
- Use NEC Based Software





- Antenna Modeling Software
  - http://www.qsl.net/4nec2/
  - http://eznec.com/
  - http://www.nec2go.com/
  - http://www.w7ay.net/site/Applications/cocoaNEC/
    - For Mac OS X
- Tutorials and additional information
  - http://www.arrl.org/antenna-modeling

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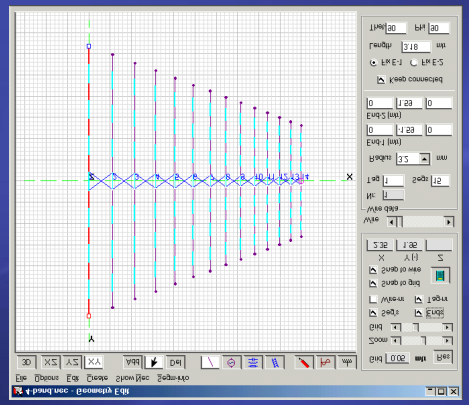
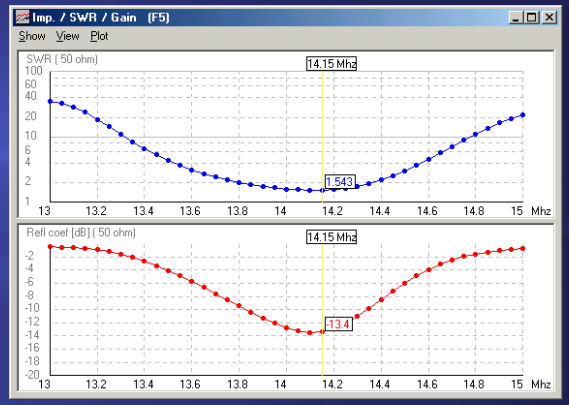
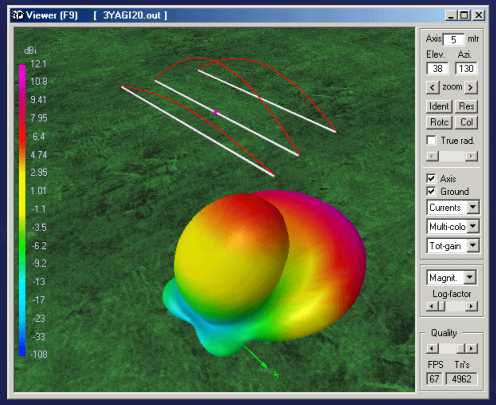
Modeling

- I use 4NEC2
  - It's free
  - Drag and drop style Geometry Editor
  - Graphical 2D and 3D visualization of Far- and Near-field data and Geometry structures (including circular polarization view).
  - Gradient/hill-climbing and Genetic Algorithms optimizers included
  - Automatic generation of VOACAP propagation prediction
  - Automatic conversion of AO (*.ant)and EZnec (*.ez)input files







Resources

ARRL Handbook
ARRL Antenna Book
ON4UN Low-Band DXing
Google

This presentation available at http://qsl.net/fwdxa/links

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