

# **Ground-Mounted Verticals**



***Dispelling Radial Misconceptions  
and Looking at the New 43ft  
Multiband Verticals***

# Ground-Mounted Verticals

- When I down-sized from 2+ acres back to a bungalow on a 47' wide suburban lot, I feared that amateur radio might be in my past.
- There was no space for a horizontal wire antenna and there were no poles or trees to hang it from.
- With the neighbours so close I didn't want a tower in the tiny yard nor a multi-band vertical on the roof.
- That left ground-mounted verticals. This presentation covers my investigation of radials and shows that my initial misconceptions had been keeping me from a neighbour-friendly antenna solution.

# Ground-Mounted Verticals

● Let's start with some popular opinions about vertical antennas and radial systems:

*1) To be effective, a ground-mounted vertical antenna must have a quarter wavelength radiator and 120 half-wave radials, over a coastal salt water marsh.*

*2) Vertical radiators must be a quarter wave, 5/8 wave, half wave or full wave in length.*

*3) Buried radials must be a 1/4 wave long on each band.*

*4) Radials must consist of bare wire to improve contact with the soil.*

*5) Radial wires must be buried at least six inches.*

● *Only some of these are partially true and only to an extent.*

# Ground-Mounted Verticals

- The CBA 1070 kHz vertical antenna and its large radial field over the Tantramar salt-water marsh at Sackville, NB works superbly well. But is such an extreme setup necessary for an amateur radio installation?
- If not, how much does a modest vertical antenna setup suffer by comparison?
- For the surprising answers, let's look at the tables and curves from the excellent June 1985 QST article by Brian Edward N2MF, starting with ground characteristics and proceeding through radial configurations.

# Ground-Mounted Verticals

- Table 1 shows various types of ground with their electrical characteristics.
- The Table 2 Ground types are the basis for the curves that follow.
- Typical amateur locations have characteristics ranging from Poor Earth to Good Earth so it is safe to interpolate between those curves to approximate expected performance.

**Table 1**  
Typical Earth Electrical Characteristics†

| Terrain  | Conductivity<br>(Siemens/<br>Meter) | Relative<br>Dielectric<br>Constant ( $\epsilon_r$ ) |
|--|-------------------------------------|---|
| Seawater                                       | 5                                   | 80  |
| Fresh Water                                    | 0.008                               | 80  |
| Dry, sandy, flat coastal land                  | 0.002                               | 10  |
| Marshy, forested flat land                     | 0.008                               | 12  |
| Rich agricultural land, low hills              | 0.01                                | 15  |
| Pastoral land, medium hills<br>and forestation | 0.005                               | 13  |
| Rocky land, steep hills                        | 0.002                               | 10  |
| Mountainous                                    | 0.001                               | 5   |
| Cities, residential areas                      | 0.002                               | 5   |
| Cities, industrial areas                       | 0.001                               | 3   |

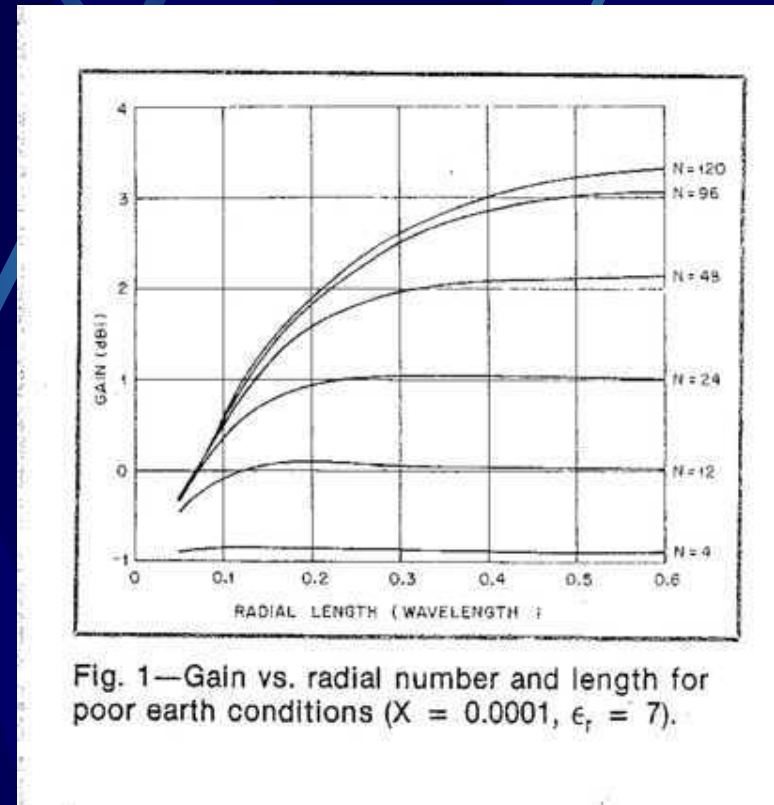
†Information adapted from *Reference Data for Radio Engineers* (Indianapolis: Howard W. Sams & Co., 1979, p. 28-3.

**Table 2**  
Ground Characteristics Used for Study

| Ground    | $\times \left( \frac{\text{Siemens/Meter}}{\text{MHz}} \right)$ | $\epsilon_r$ |
|-----------|---|--------------|
| Poor      | 0.0001  | 7            |
| Good      | 0.001   | 15           |
| Very good | 0.01  | 30           |

# Ground-Mounted Verticals

- These curves show the effects of radial length and number over *Poor Earth* (sky wave component).
- 120 radials of .6 wavelength produce 3.2 dBi gain vs 16 radials of 0.1 wavelength (only ~3 dB more).
- **That's a half S unit at far end.**
- Gain figures shown apply for a quarter wavelength radiator but hold for a radiator down to 1/8 wavelength.



# Ground-Mounted Verticals

- These curves show the effects of radial length and number over *Good Earth* (sky wave component).
- 120 radials of .6 wavelength produce 3.2 dBi gain vs 16 radials of 0.1 wavelength (only ~2.5 dB better)
- Again gain figures apply for a quarter wavelength radiator but hold for a radiator down to 1/8 wavelength.

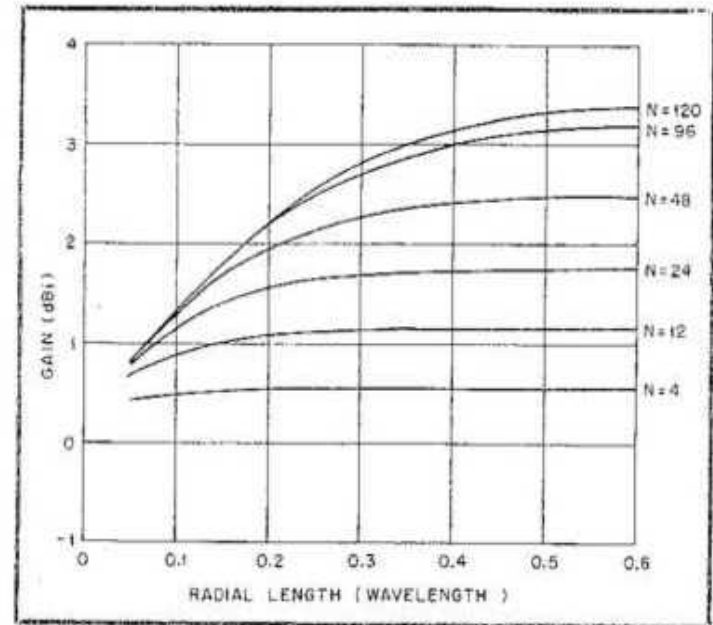


Fig. 2—Gain vs. radial number and length for good earth conditions ( $X = 0.001$ ,  $\epsilon_r = 15$ ).

# Ground-Mounted Verticals

- These curves show the effects of radial length and number over *Very Good Earth* (sky wave component)
- 120 radials of .6 wavelength produce 3.7 dBi gain vs 16 radials of 0.1 wavelength at 2.7 dBi gain (only 1 dB better)
- Again, gain figures apply for a quarter wavelength radiator but hold for a radiator down to 1/8 wavelength.

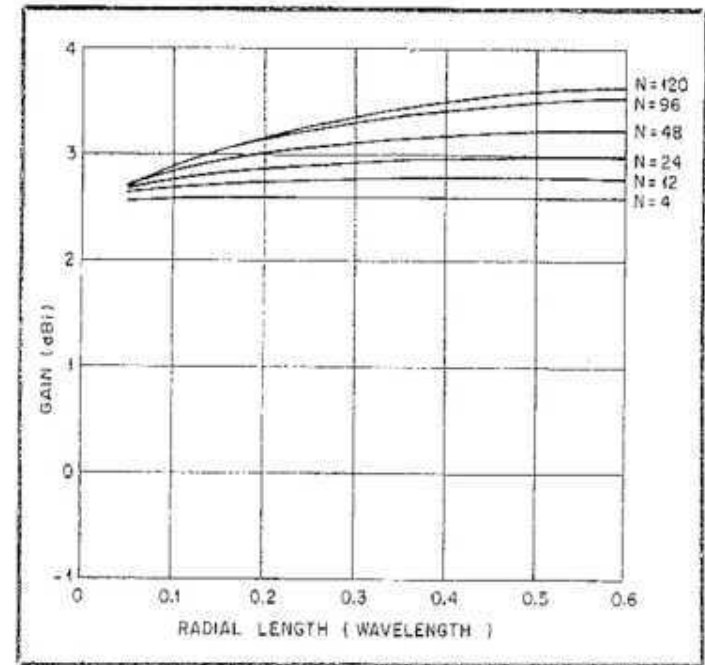


Fig. 3—Gain vs. radial number and length for very good earth conditions ( $X = 0.01$ ,  $\epsilon_r = 30$ ).



# Ground-Mounted Verticals

So what about sky wave elevation (or takeoff) angles?

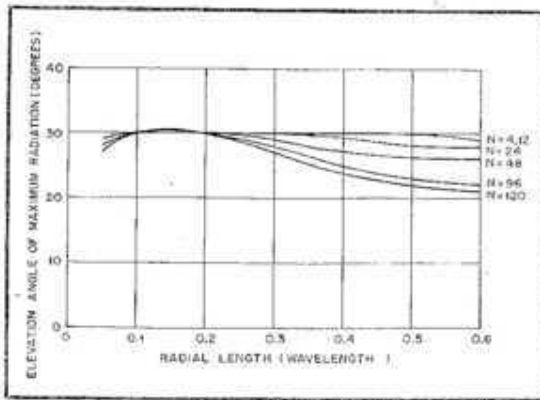


Fig. 4—Elevation angle vs. radial number and length for poor earth conditions ( $X = 0.0001$ ,  $\epsilon_r = 7$ ).

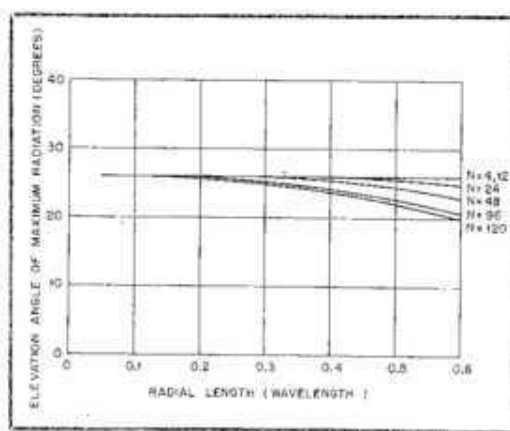


Fig. 5—Elevation angle vs. radial number and length for good earth conditions ( $X = 0.001$ ,  $\epsilon_r = 15$ ).

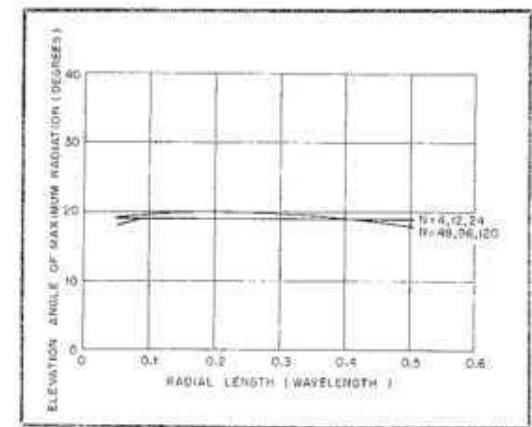


Fig. 6—Elevation angle vs. radial number and length for very good earth conditions ( $X = 0.01$ ,  $\epsilon_r = 30$ ).

Horizontal wire dipoles or arrays and beams, when mounted at a height of  $1/2 \lambda$ , have typical elevation angles of 30 degrees or more, (higher for lower heights). The vertical antenna may have up to a 5 to 10 degree advantage.

# Ground-Mounted Verticals

What type of ground do I have in my yard?

- You can measure soil conductivity with a meter (*See Ref 3*).
- But what you really need to know is the average ground conductivity over several wavelengths in all directions from your antenna. This is impractical for a radio amateur to measure, especially for the lower HF bands.
- Actual soil conductivity may vary with moisture throughout the year (and you can't water or salt the neighbourhood).
- Using Tables 1 and 2, and interpolating the curves, if necessary, is the best you can do to predict performance of an amateur radio vertical antenna.

# Ground-Mounted Verticals

- Buried radials are not resonant and need not be multiples of a quarter wave long. Rather they collectively form a capacitance to “real ground”.
- Some recommend as many and as long radials as possible, but these curves show marginal improvement.
- Use of insulated #12 or #14 wire minimizes corrosion.
- Radials can be slightly buried or on the surface, but if elevated more than a few feet, become resonant, and then should be cut for each band.
- *The first half of this presentation has demonstrated a comprehensive analysis method for any mono-band vertical antenna with radials. Just convert the radiator and radial lengths to wavelengths and apply the curves.*

# Ground-Mounted Verticals

- There are many commercial multi-band vertical antennas on the market that cover HF and 6M.
- Five of these are the trap-less multi-band 43 ft HF verticals (derived from the L. B. Cebic 86 ft Extended Double Zepp EDZ horizontal dipole).
- How do we apply the previous curves to the 43 ft verticals?
- This requires converting the lengths of the radiators and planned radials to wavelengths by bands.

43 ft Vertical Performance -14 v1

| Band   | 160    | 80    | 40    | 30   | 20    | 17   | 15   | 12   | 10    | 6     |
|--|--------|-------|-------|------|-------|------|------|------|-------|-------|
| <b>43 ft (in wavelength)</b>   | 0.08   | 0.15  | 0.31  | 0.44 | 0.61  | 0.79 | 0.92 | 1.09 | 1.22  | 2.18  |
| <b>14 ft Radial Length in <math>\lambda</math></b>   | 0.025  | 0.05  | 0.1   | 0.15 | 0.2   | 0.25 | 0.3  | 0.35 | 0.4   | 0.7   |
| <b>Over Good Earth</b>   |        |       |       |      |       |      |      |      |       |       |
| Number of 14' radials  | 8      | 8     | 8     | 8    | 8     | 8    | 8    | 8    | 8     | 8     |
| Gain (dBi)   | 0.5    | 0.6   | 0.7   | 0.8  | 0.8   | 0.8  | 0.8  | 0.8  | 0.8   | 0.8   |
| Elev Angle (deg)   | 26     | 26    | 26    | 26   | 26    | 26   | 26   | 26   | 26    | 26    |
| Number of 14' Radials  | 16     | 16    | 16    | 16   | 16    | 16   | 16   | 16   | 16    | 16    |
| Gain (dBi)   | 0.5    | 0.75  | 1     | 1.2  | 1.3   | 1.4  | 1.5  | 1.5  | 1.5   | 1.5   |
| Elev Angle (deg)   | 25     | 25    | 25    | 25   | 25    | 25   | 25   | 25   | 25    | 25    |
| Number of 14' Radials  | 32     | 32    | 32    | 32   | 32    | 32   | 32   | 32   | 32    | 32    |
| Gain (dBi)   | 0.5    | 0.75  | 1.25  | 1.6  | 1.75  | 2    | 2.1  | 2.2  | 2.3   | 2.3   |
| Elev Angle (deg)   | 25     | 25    | 25    | 25   | 25    | 25   | 25   | 25   | 25    | 25    |
| <b>Over Poor Earth</b>   |        |       |       |      |       |      |      |      |       |       |
| Number of 14' Radials  | 8      | 8     | 8     | 8    | 8     | 8    | 8    | 8    | 8     | 8     |
| Gain (dBi)   | -1     | -0.7  | 0.5   | 0.5  | 0.5   | 0.5  | 0.5  | 0.5  | 0.5   | 0.5   |
| Elev Angle (deg)   | 30     | 30    | 30    | 30   | 30    | 30   | 30   | 30   | 30    | 30    |
| Number of 14' Radials  | 16     | 16    | 16    | 16   | 16    | 16   | 16   | 16   | 16    | 16    |
| Gain (dBi)   | -1     | -0.5  | 0.25  | 0.4  | 0.5   | 0.5  | 0.5  | 0.5  | 0.5   | 0.5   |
| Elev Angle (deg)   | 30     | 30    | 30    | 30   | 30    | 30   | 30   | 30   | 30    | 27    |
| Number of 14' Radials  | 32     | 32    | 32    | 32   | 32    | 32   | 32   | 32   | 32    | 32    |
| Gain (dBi)   | -0.75  | -0.5  | 0     | 1    | 1.3   | 1.5  | 1.6  | 1.7  | 1.75  | 1.75  |
| Elev Angle (deg)   | 30     | 30    | 30    | 30   | 30    | 29   | 28   | 28   | 27    | 26    |
| <b>Over Earth halfway between Poor and Good (Interpolated between Gains shown above)</b>   |        |       |       |      |       |      |      |      |       |       |
| Number of 14' Radials  | 16     | 16    | 16    | 16   | 16    | 16   | 16   | 16   | 16    | 16    |
| Gain (dBi)   | -0.25  | 0.125 | 0.625 | 0.8  | 0.9   | 0.95 | 1    | 1    | 1     | 1     |
| Number of 14' Radials  | 32     | 32    | 32    | 32   | 32    | 32   | 32   | 32   | 32    | 32    |
| Gain (dBi)   | -0.125 | 0.125 | 0.625 | 1.3  | 1.525 | 1.75 | 1.85 | 1.95 | 2.025 | 2.025 |
| <i>Above gain figures assume .25 <math>\lambda</math> antenna height but will hold down to antenna height of 0.125 <math>\lambda</math>.</i>             |        |       |       |      |       |      |      |      |       |       |
| <i>As 43 ft antenna length is less than 0.125 <math>\lambda</math>, gains for 160M are roughly 1/4 the positive or 4 X the negative dBi gains shown.</i> |        |       |       |      |       |      |      |      |       |       |

## 43 ft Vertical Performance - 28 v1

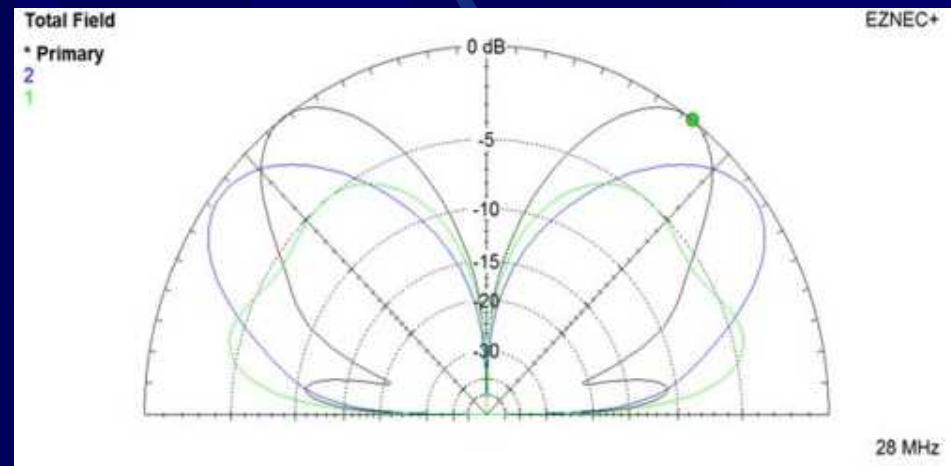
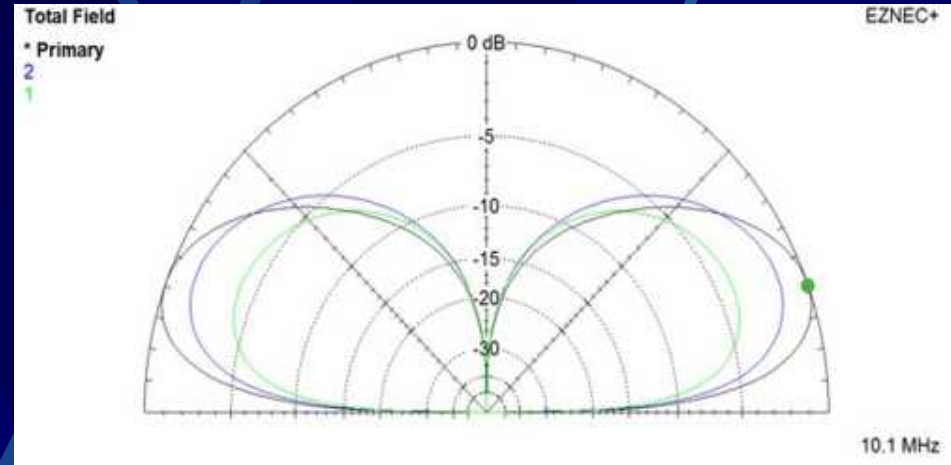
| Band   | 160  | 80    | 40   | 30    | 20   | 17   | 15   | 12   | 10    | 6     |
|--|------|-------|------|-------|------|------|------|------|-------|-------|
| 43 ft (in wavelength)  | 0.08 | 0.15  | 0.31 | 0.44  | 0.61 | 0.79 | 0.92 | 1.09 | 1.22  | 2.18  |
| 28 ft Radial Length in $\lambda$   | 0.05 | 0.1   | 0.15 | 0.2   | 0.25 | 0.3  | 0.35 | 0.4  | 0.7   | 1.5   |
| <b>Over Good Earth</b>   |      |       |      |       |      |      |      |      |       |       |
| Number of 28' radials  | 8    | 8     | 8    | 8     | 8    | 8    | 8    | 8    | 8     | 8     |
| Gain (dBi)   | 0.5  | 0.75  | 0.8  | 0.8   | 0.85 | 0.85 | 0.85 | 0.9  | 0.9   | 0.9   |
| Elev Angle (deg)   | 26   | 26    | 26   | 26    | 26   | 26   | 26   | 26   | 26    | 26    |
| Number of 28' Radials  | 16   | 16    | 16   | 16    | 16   | 16   | 16   | 16   | 16    | 16    |
| Gain (dBi)   | 0.75 | 1     | 1.25 | 1.3   | 1.4  | 1.4  | 1.5  | 1.5  | 1.5   | 1.5   |
| Elev Angle (deg)   | 26   | 26    | 26   | 26    | 26   | 26   | 26   | 26   | 26    | 26    |
| Number of 28' Radials  | 32   | 32    | 32   | 32    | 32   | 32   | 32   | 32   | 32    | 32    |
| Gain (dBi)   | 0.8  | 1.25  | 1.5  | 1.75  | 1.8  | 2    | 2.1  | 2.2  | 2.2   | 2.2   |
| Elev Angle (deg)   | 26   | 26    | 26   | 26    | 26   | 25   | 25   | 24   | 24    | 24    |
| <b>Over Poor Earth</b>   |      |       |      |       |      |      |      |      |       |       |
| Number of 28' Radials  | 8    | 8     | 8    | 8     | 8    | 8    | 8    | 8    | 8     | 8     |
| Gain (dBi)   | -0.5 | -0.4  | -0.4 | -0.4  | -0.4 | -0.4 | -0.4 | -0.4 | -0.4  | -0.4  |
| Elev Angle (deg)   | 30   | 30    | 30   | 30    | 30   | 30   | 30   | 30   | 30    | 30    |
| Number of 28' Radials  | 16   | 16    | 16   | 16    | 16   | 16   | 16   | 16   | 16    | 16    |
| Gain (dBi)   | -0.5 | 0.25  | 0.5  | 0.5   | 0.5  | 0.5  | 0.5  | 0.5  | 0.5   | 0.5   |
| Elev Angle (deg)   | 30   | 30    | 30   | 30    | 30   | 30   | 30   | 30   | 30    | 27    |
| Number of 28' Radials  | 32   | 32    | 32   | 32    | 32   | 32   | 32   | 32   | 32    | 32    |
| Gain (dBi)   | -0.5 | 0.5   | 1    | 1.2   | 1.3  | 1.5  | 1.6  | 1.7  | 1.75  | 1.75  |
| Elev Angle (deg)   | 30   | 30    | 30   | 30    | 30   | 29   | 28   | 28   | 27    | 26    |
| <b>Over Earth halfway between Poor and Good (Interpolated between Gains shown above)</b>   |      |       |      |       |      |      |      |      |       |       |
| Number of 28' Radials  | 16   | 16    | 16   | 16    | 16   | 16   | 16   | 16   | 16    | 16    |
| Gain (dBi)   | 0.25 | 1.25  | 1.75 | 1.8   | 1.9  | 1.9  | 2    | 2    | 2     | 2     |
| Number of 28' Radials  | 32   | 32    | 32   | 32    | 32   | 32   | 32   | 32   | 32    | 32    |
| Gain (dBi)   | 0.15 | 0.875 | 1.25 | 1.475 | 1.55 | 1.75 | 1.85 | 1.95 | 1.975 | 1.975 |
| <b>Above gain figures assume .25 <math>\lambda</math> antenna height but will hold down to antenna height of 0.125 <math>\lambda</math>.</b>             |      |       |      |       |      |      |      |      |       |       |
| <b>As 43 ft antenna length is less than 0.125 <math>\lambda</math>, gains for 160M are roughly 1/4 the positive or 4 X the negative dBi gains shown.</b> |      |       |      |       |      |      |      |      |       |       |

# Ground-Mounted Verticals

● In his “43’ Antenna – Theoretical Analysis” article, Dave Cuthbert WX7G shows the radiation plots for the 43’ vertical on various bands

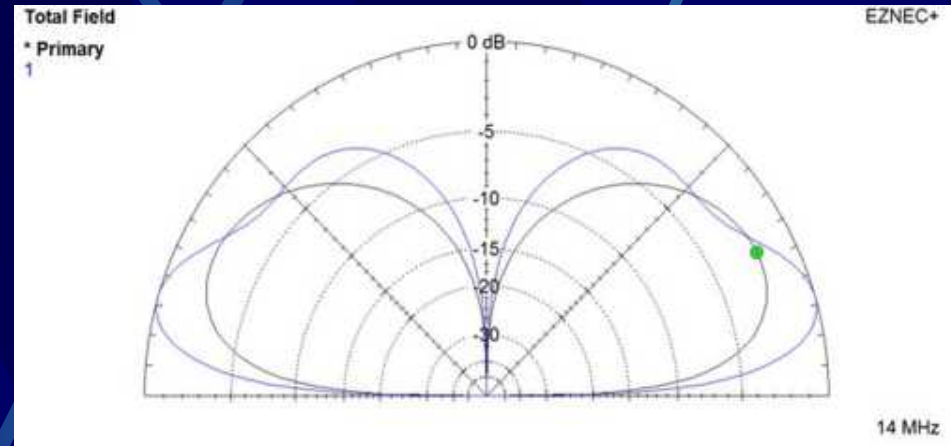
● Top      80M - Green  
              40M - Blue  
              30M – Black

● Bottom    20M - Green  
              15M - Blue  
              10M - Black



# Ground-Mounted Verticals

- He also compares the 43' Vertical radiation plots with those of a  $\frac{1}{4}$  wave monoband or trap vertical on 20, 15 and 10M, where the longer 43' vertical has substantial high angle radiation.
- His 20M plots (R), show that the 43' (blue) has a clear advantage over the quarter wave (black) below  $25^\circ$ .

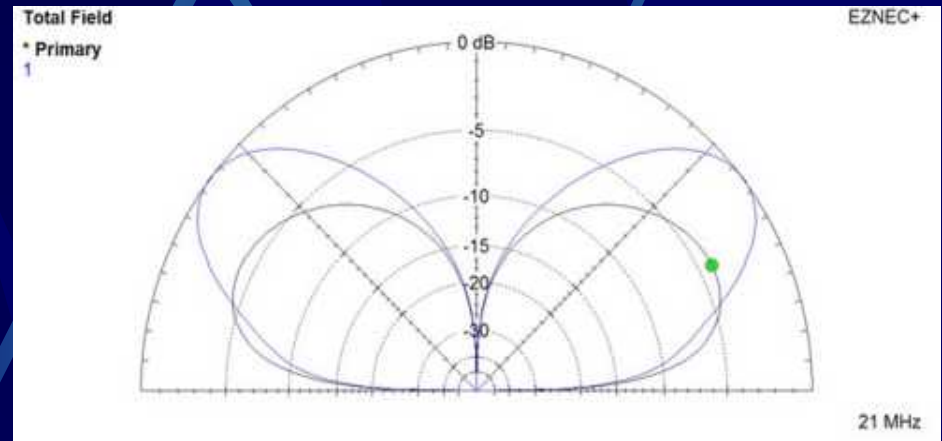




# Ground-Mounted Verticals

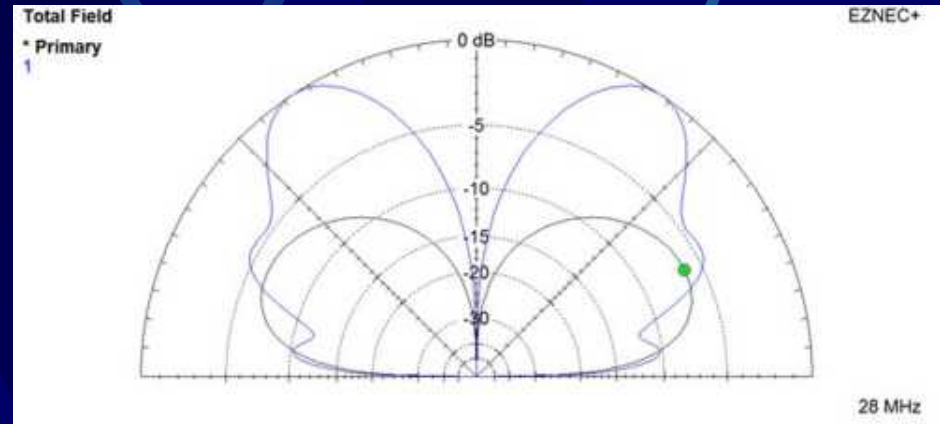
- The WX7G 15M plots (R) show an elevation angle of  $27^\circ$  for the  $\frac{1}{4}$  wave vertical (blue)
- This compares with  $37^\circ$  for the 43' vertical (black).

*Note: Remember in comparing the multiband 43' vertical against a multiband trap vertical, both antenna types are compromises in order to cover multiple bands. The 43' has no lossy traps. It also benefits from any better relative gain on receive, so it's a good continuous coverage SWL antenna.*

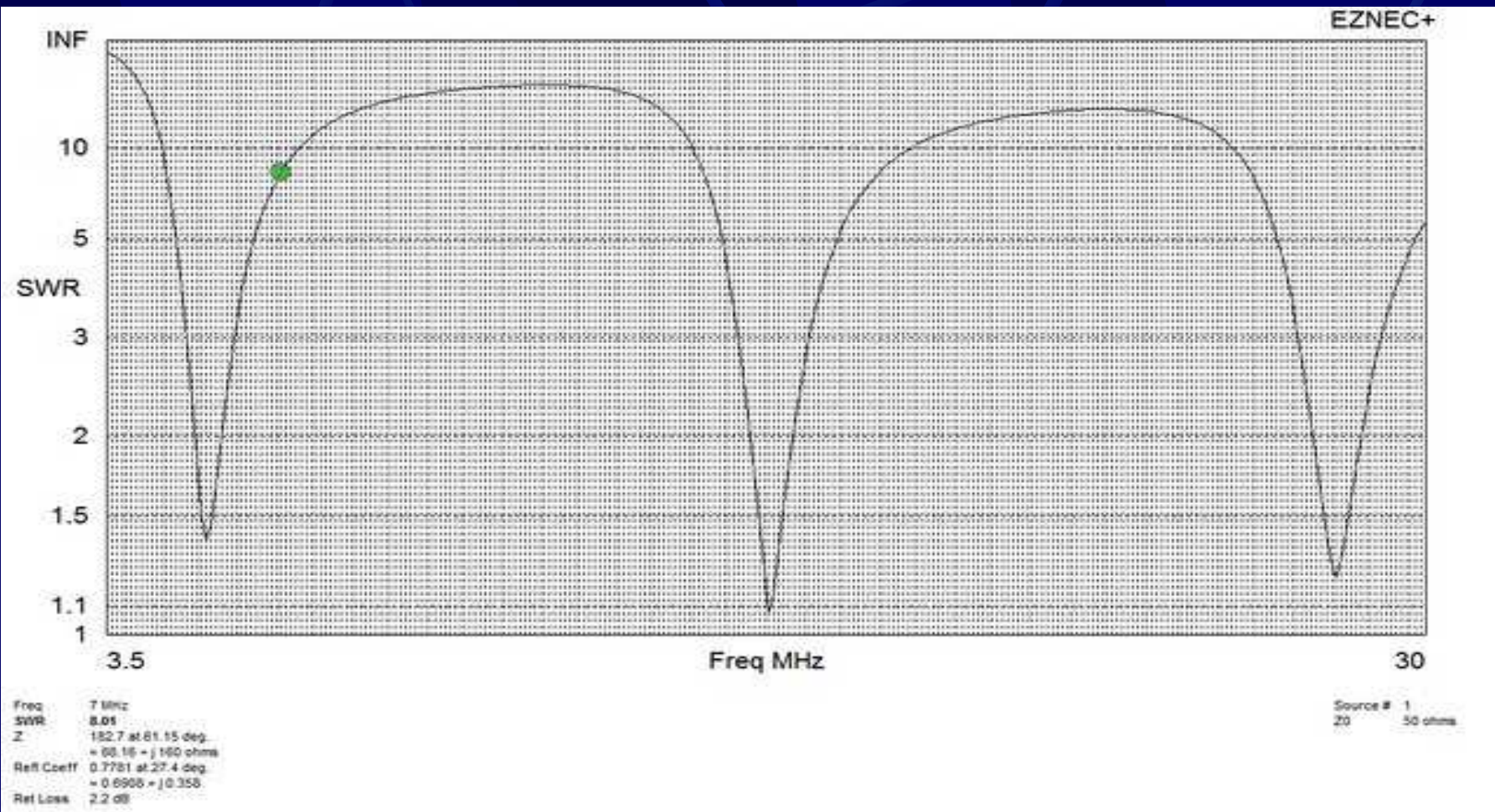


# Ground-Mounted Verticals

- The WX7G 10M plots (R) show the substantial high angle radiation one would expect from the  $1.22\lambda$  long 43' vertical (blue).
- The 43' has considerable radiation at and below the  $27^\circ$  lobe of the quarter wave vertical.
- You can optimize the 10M and 15M operation by shortening the 43' vertical.



*Note - The WX7G EZNEC NEC-2 models were created with antenna base mounted 1' over REAL GND, 16 radials, and 15 ohms of base loss resistance added. Comparison models were done with the antenna connected to MININEC GND.*



**EZNEC projected VSWR at the base of 43' vertical  
over perfect ground from 3.5 – 30 MHz**

**from "The 43' Vertical – A Theoretical Analysis" by Dave Cuthbert WX7G**

# Ground-Mounted Verticals

- Several 43 ft suppliers offer their antenna with a 4:1 unun so it may be matched through the feedline from the operating position.
- That match may be limited to 40M up, unless you add an MFJ-914 Auto-Tuner Extender to the transceiver's internal antenna tuner or use a Remote Auto-Tuner.
- For use with power limit linears, a 1.5-54 MHz 5 kW 4:1 unun Model 4134S is available from Balun Designs.
- Matching an antenna through the feedline is not ideal due to feedline mismatch loss and also feedline radiation.

# Ground-Mounted Verticals

- Balun Designs Model 4134S 5 kW 4:1 Unun can be used with a high power linear amplifier to “match” a 43 ft vertical from the operating position.
- Lower photos shows the excellent construction details.
- However feedline losses can be substantial.



# Ground-Mounted Verticals

- There are several remote auto-tuners on the market (MFJ-927, MFJ--926B and SGC-230 etc) that mount at the antenna base. These are all in the 100W to 200W range.
- For use with linear amplifiers over 200W, a power-limit remote auto-tuner such as the MFJ-998RT is required.
- The MFJ models include built-in bias-tees to feed DC power to the remote auto-tuner over the coax feedline.
- Remote tuners can be fitted with a current balun (RF Isolator) e.g. MFJ-915, to keep RF off the coax shield (though a buried feedline may minimize the need for this).
- Canadian outside summer and winter temperature extremes may be a problem with some remote auto-tuners.

# Ground-Mounted Verticals



MFJ Remote Tuners: MFJ-927 200W (L) MFJ-998RT 1500W (R)

# Decision Time

- *Based on the curves between Poor and Good Soil, I chose to use only sixteen 14' radials of #14 insulated wire.*
- *Thirty-two 14' radials would improve gain by under 1 dB at 10M (and less on lower bands) so not worth it.*
- *Sixteen 28' radials would improve 80M performance by only 1 dB (less on higher bands) so also not worth it.*
- *I chose the LDG Model S9v43 antenna, a light weight forest green fiberglass telescopic “whip” lowest priced at US \$199, instead of an aluminum tubing model. The ten 5' sections (with overlap) even came in a carrying bag.*
- *The wall thickness of the S9v43 is heavier than standard fiberglass tubing to stand up to wind loading.*



# Results 1

- The S9v43 slides over a 5' by 1.75" ID steel conduit hammered into the ground or mounted in 6" diameter of concrete. The radiator is #14 insulated wire hung in the tubing.
- Photo (R) shows the radial plate. The 14' long radials and Buryflex coax feedline were buried 1/2" to 1".
- Not shown in the base housing are the MFJ-927 Remote Autotuner, current balun and white plastic cover (to minimize solar heating).



# Results 2

- The S9v43 manufacturer recommends against guying.
- This unguyed whip is less conspicuous than a shiny aluminum vertical and less susceptible to wind damage.
- Though specified for only 25 mph wind gusts, the S9v43 stood up to the heavy Bluesfest gusts and the later wind remnants of Hurricane Irene. It bent way over but returned.
- At only 5 kg it can be taken down if strong wind in forecast.
- It dealt well with ice and winter temperatures below  $-25^{\circ}\text{C}$ .
- The MFJ-927 gave fast matches (5 sec max) for six months but stopped working at  $-5^{\circ}\text{C}$ .
- Though they have no published temperature specification, MFJ agreed to repair under their *No Matter What* warranty.
- On return, it tested OK after time in my freezer at  $-25^{\circ}\text{C}/-10^{\circ}\text{F}$

# Results 3

## First Month Casual Contacts with S9v43 on SSB

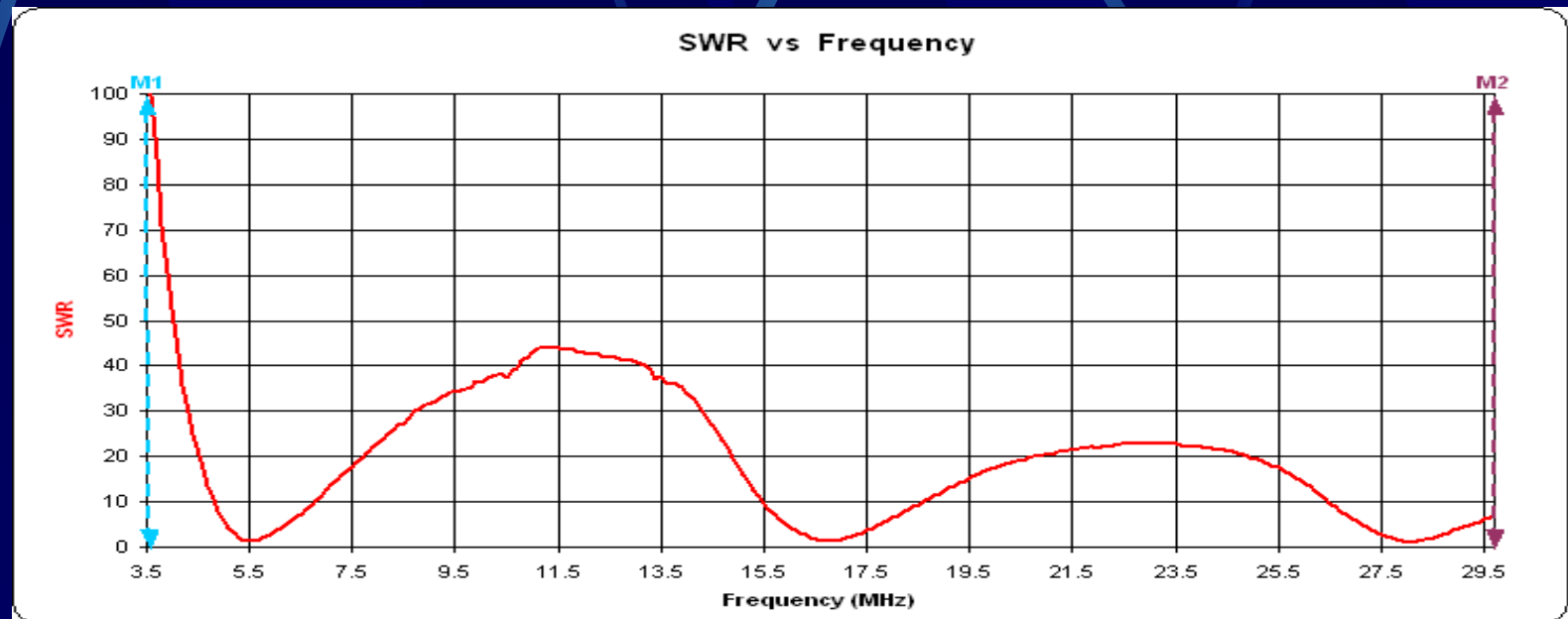
- 58 from Dubai on 20M. New Country
- 59 from Thailand on 15M. New Country
- 58 from Australia on 40M. New Country
- 59 from Germany on 40M. New Country
- 59 from Rochester, NY on 80M (poorest band for 14' radials).  
“Contest 59” from Edmonton in RAC CWC.

## Subsequent Five Months on 100% CW

- Almost 3000 DX CW contacts in five months (five CW contests). 137 Countries and 40 CQ Zones Worked.
- **It's not a beam but it is a very good utility antenna.**

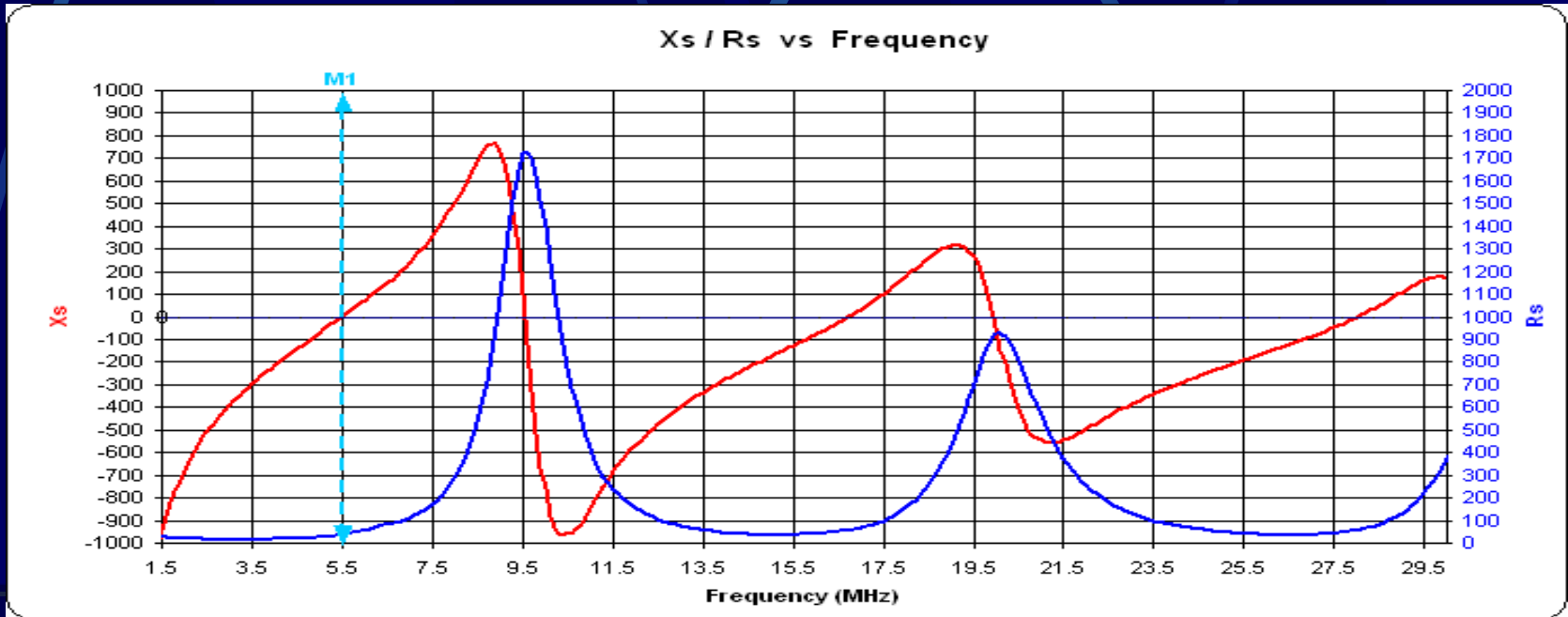
# Results 4

- Dave Conn VE3KL tested my S9v43, using his AIM VNA to produce multi-function tabular results in a single sweep. The following curves were created by “Z-Plots” software
- The SWR curve shows 100:1 SWR at 3.5 MHz yet the S9v43 had been working on 80M, and the MFJ-927 Auto-Tuner SWR specification is only 32:1. How can this be?



# Results 5

- MFJ's 32:1 SWR specification is for resistance only - 6 to 1600  $\Omega$  ( $1600/50 = 32$ )
- Forget SWR. To match an antenna at a given frequency, the antenna's capacitive reactance (negative) must be offset by the tuner's inductive reactance (positive), or the antenna's inductive reactance must be offset by the tuner's capacitive reactance.



*M1 shows the S9v43 natural resonance as 5.5 MHz*

# Results 6

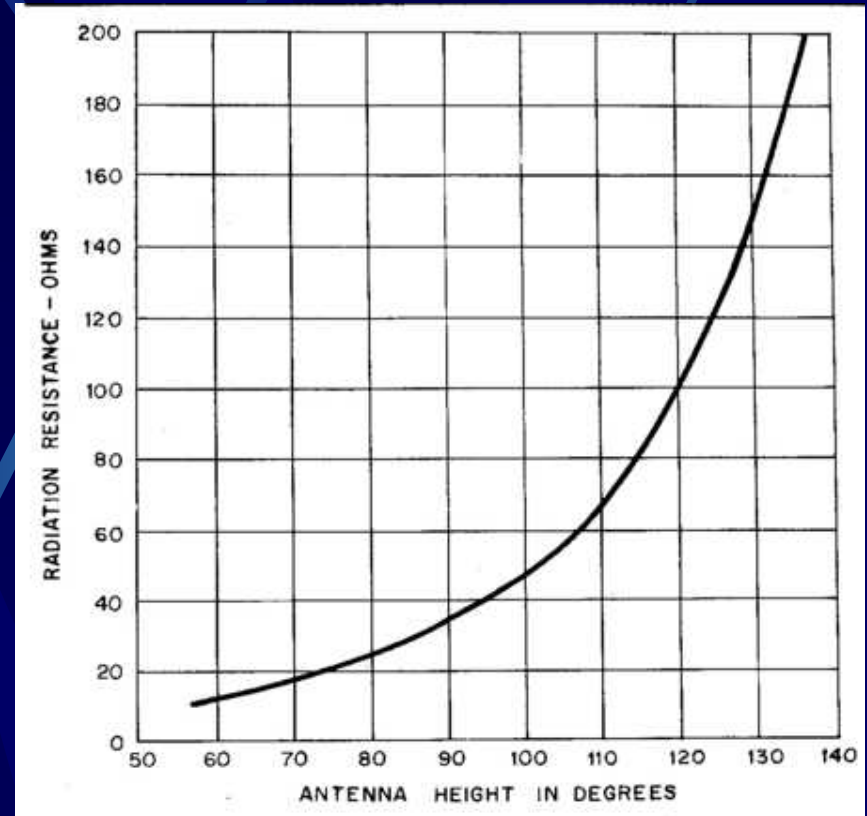
- The MFJ-927 contains 0 to 3961 pF (256 values) of capacitance and 0 to 24.86  $\mu\text{H}$  (256 values) of inductance.
- The inductance (L) and capacitance (C) required to match each antenna  $X_s$  value may be calculated as follows:

$$L = \frac{XL}{2.\pi.F} \quad C = \frac{1}{2.\pi.F.Xc}$$

- Calculating for the values shown in the previous  $X_s$  curve confirms that the MFJ-927 can match the S9v43 on all frequencies within the amateur radio bands 80M -10M.
- For 160M, a 43.21  $\mu\text{H}$  series coil must be added. See *Ref 4*
- What is the value in showing the previous  $R_s$  curve?

# Results 7

- A theoretical vertical antenna (right) at  $90^\circ$  ( $\frac{1}{4}$  wave resonance) shows a Radiation Resistance of  $36 \Omega$
  - The AIM 4170 tabular listing at 5.5 MHz for  $R_s$  (Radiation Resistance + Ground Resistance) showed  $43.52 \Omega$ .
  - Hence Ground Resistance =  $43.52 - 36 = 7.52 \Omega$
  - Such low Ground Resistance confirms Good Earth.
  - Efficiency =  $36/43.52 = 82\%$
- N.B. Both above calculated at 5.500 MHz (resonance).

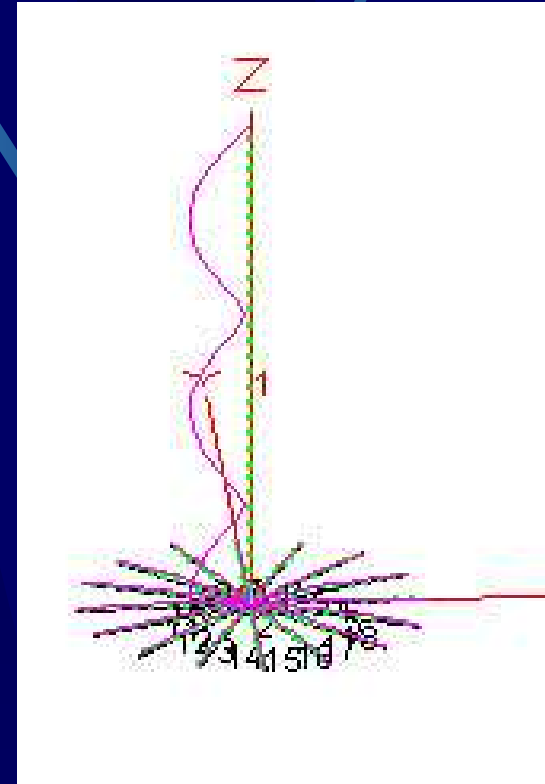


*Radiation Resistance over  
Perfect Ground -  
ARRL Antenna Book 15<sup>th</sup> Ed*

# Results 8

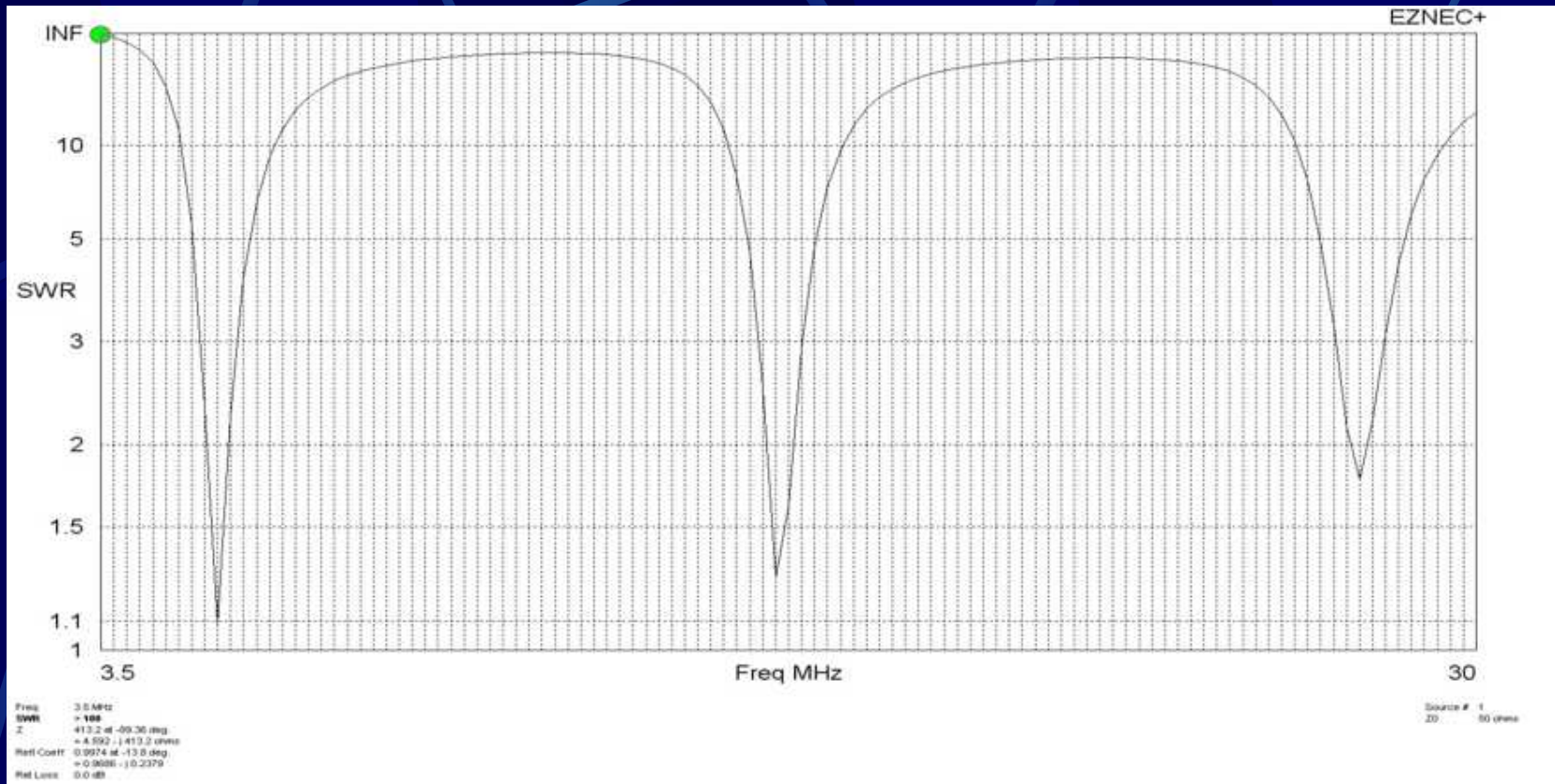
- Dave Conn VE3KL also ran an EZNEC2 model of my S9v43 installation including the sixteen 14' radials  $\frac{1}{2}$ " over real ground\*.
- The pictorial shows 28 MHz currents, where the antenna is  $1.22 \lambda$  long.

*\* EZNEC2 cannot deal with radials below  $\frac{1}{2}$ ". Modeling buried radials requires EZNEC4.*



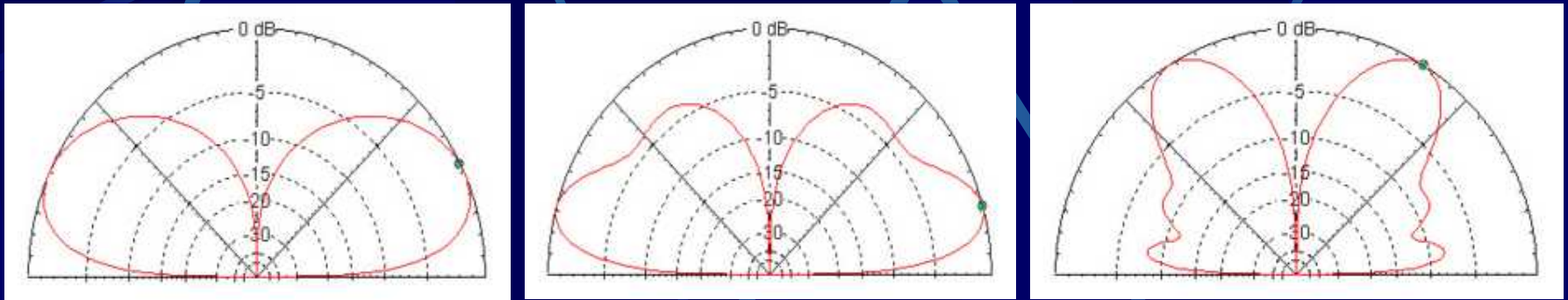


# Results 9



Above plot is S9v43 SWR as modeled with EZNEC 2 by VE3KL with sixteen 14' radials ½" over real ground.

# Results 10



- The 7, 14 and 28 MHz elevation plots of the VE3KL model differ slightly from the previous WX7G plots due to the different ground and loss assumptions.
- EZNEC models show very minor losses due to thin #14 radial and radiator conductors.

# My Thanks To ...

- Brian Edward N2MF for his excellent 1985 QST article
- Maty Weinberg, Production Coordinator of ARRL, for permission to use tables and curves from the ARRL copyright N2MF QST article for this presentation.
- Dave Cuthbert WX7G for permission to use his EZNEC NEC-2 VSWR curve and radiation plots.
- Dave Conn VE3KL for his many TCA antenna articles, personal discussions and the actual antenna tests and EZNEC models shown in this presentation.
- To Phil Salas AD5X for discussions on the 43 ft antenna.
- To Jack Belrose - VE2CV for his many antenna articles that maintained my interest in antennas over the years.

# References

Radial Systems for Ground-Mounted Vertical Antennas – Brian Edward, N2MF - QST June 1985.

The 43' Vertical – a Theoretical Analysis - Dave Cuthbert WX7G <http://www.eham.net/articles/21272> includes 43' VSWR curves radiation plots and discussion on Ground Loss.

Measurement of Soil Electrical Parameters at HF - Rudy Severns, N6LF [www.antennasbyn6lf.com](http://www.antennasbyn6lf.com). This article provides instructions on building a meter and probe(s) as well as limitations on interpretation of the results.

Auto-Tuner Range Extender (or Extending the MFJ-927 to 160-Meters) - Phil Salas AD5X

The ARRL Antenna Book - ARRL- the antenna bible.

**Questions?**



***Thank you***  
***de VE3XK***

### Supplementary S9v43 Installation Tips

The manufacturer's instructions for the S9v43 do cover the procedure and the 19" of pipe to be left above the concrete to form the stub over which you can slip the antenna. There is a hole in the bottom section of the antenna through which you feed the antenna wire. It is led down the outside of the lower section for the remaining 19" and over to either the 4:1 Unun or the Remote Antenna-Tuner. I built a small 24" X 24" X 5" enclosure to cover these added units. Of course you really should also buy the radial plate. It has pre-drilled holes for the stainless steel bolts, nuts and washers for your radials.

In ideal soil it should be possible to drive the steel pipe into the ground as they discuss. However if you want to bore a hole you can rent a T-shaped 6" auger but be sure to also rent a digging bar as you will probably encounter stones or rocks as I did. This is not expensive but is essential. You can use a sonotube to contain the concrete but that is not essential. Your hole should be 4 ft deep to get below the frost line in this area.

You can use either steel plumbing pipe of 1.9" OD or steel electrical conduit of 1.9" OD. Both pipes are sold based on ID, which would be 1 3/4". Your 48" concrete depth plus 19" would require a pipe 67" long. It is sold in 10 ft lengths and most stores will cut it for you. If you cut the 10 ft in half, your 60" lengths will not go all the way to the bottom of the concrete. That has very little impact on the ability of the concrete to retain the tube in the ground so you might share your tube with a friend as I did.

Do not make the mistake of buying the quick dry post hole concrete mix. If you do, you may find that you don't have time to get your post vertical before it sets and you can no longer move it. It may be wise to have a piece of wood inside the tubing that you can guy while you pour the concrete. That guying must be very solid as concrete is heavy and will try to displace the tube as you pour it into the hole. You can drop some rocks in beside the tube to wedge it in place before pouring the concrete. Just be sure to pack the concrete down to fill all the voids before it hardens. You should have ten minutes or so before it sets and it should be quite solid in two hours.

Peter Jago VA3PJ fitted a temporary light plastic sleeve on the tubing when the concrete was poured. (A shower curtain rod plastic cover sleeve is ideal for this purpose). After the concrete sets you could pull out the tubing leaving the sleeve in place. By keeping the concrete down about 1" below the soil/grass surface you now have the ability to remove all traces of the antenna and simply pour an inch of top soil on the base and plant grass. I didn't do that so will have to cut off the tube at ground level with a hack saw before adding the top soil and grass seed to cover the radial plate. If you prefer, the radials and feedline could be pulled up and the slits left just tamped down. In a month they would be grown over.

A square-mouth edging spade is perfect for burying the radials an inch or so. Use of landscape staples on each radial to hold it in position before burial simplifies that process. The feedline should be positioned midway between adjacent radials and should not run parallel. This should be done after the base is poured and the radial plate fitted over the stub before the S9v43 is mounted. Lifting the s9v43 is simple for an adult male as it weighs around 5 kg.

**Bury 3" or do not allow your lawn service to aerate your lawn**