10 I Wish I Knew About Antennas but Was Afraid to Ask

Outline

Basic Ideas

Dipoles, Polarization,Verticals Gain and Height, Ground

Height from NVIS to the Sky

Coax loss and cost

SWR

Twinlead/OWF

Basic Ideas

- What is an antenna?
- What is Gain
- What is Polarization
- Isotropic Radiators
- What is NVIS (Near vertical incidence skywave) communication

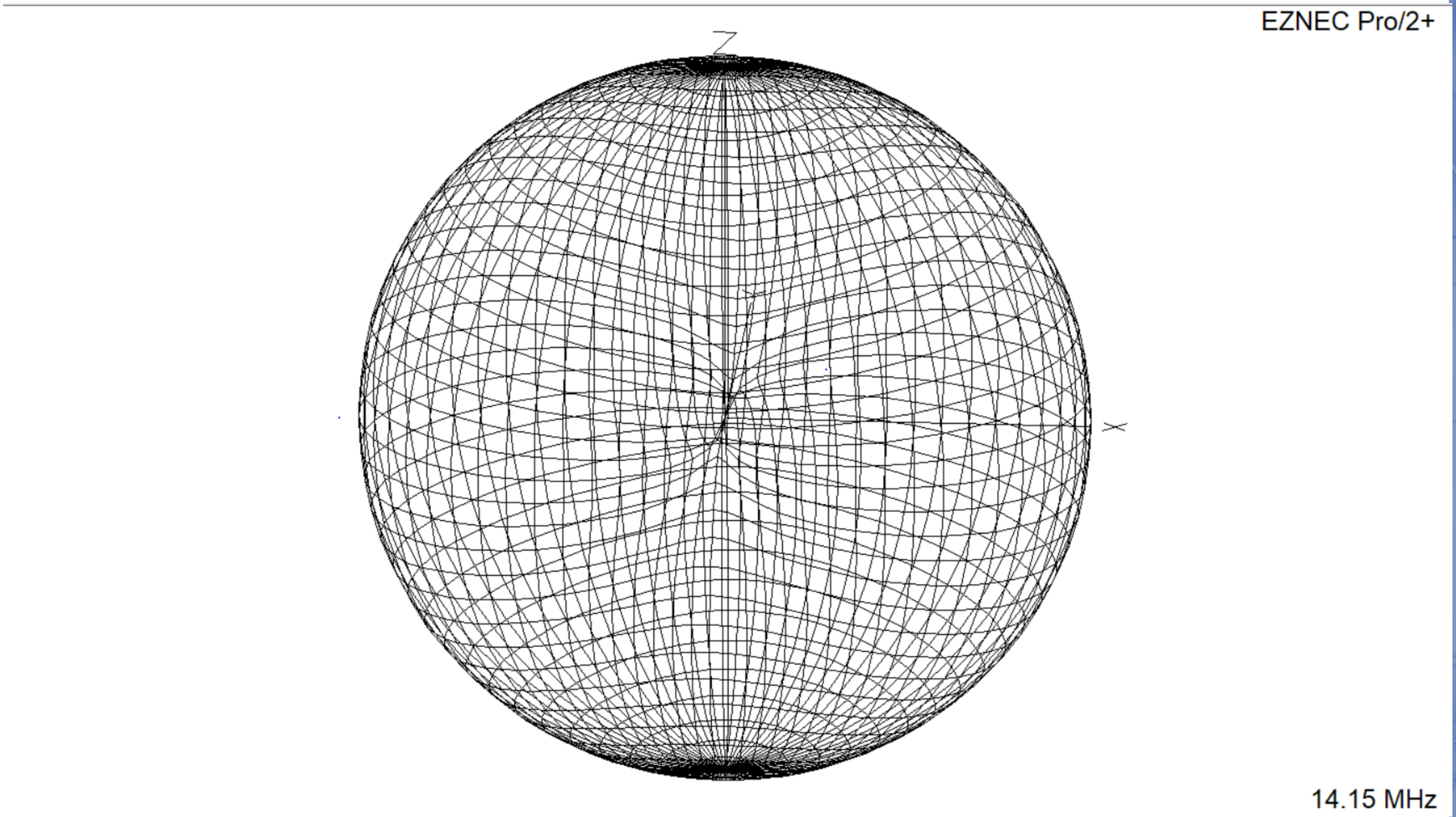
Our Friend the Dipole

- Half Wave Dipoles are the basic building block for most antennas
- They can be fed in the center for a single band
- They can be fed off center for multi-band use
- The extreme case of “Off Center” feed is the end fed.
- Traps can be used to create a multiband dipole that is resonant

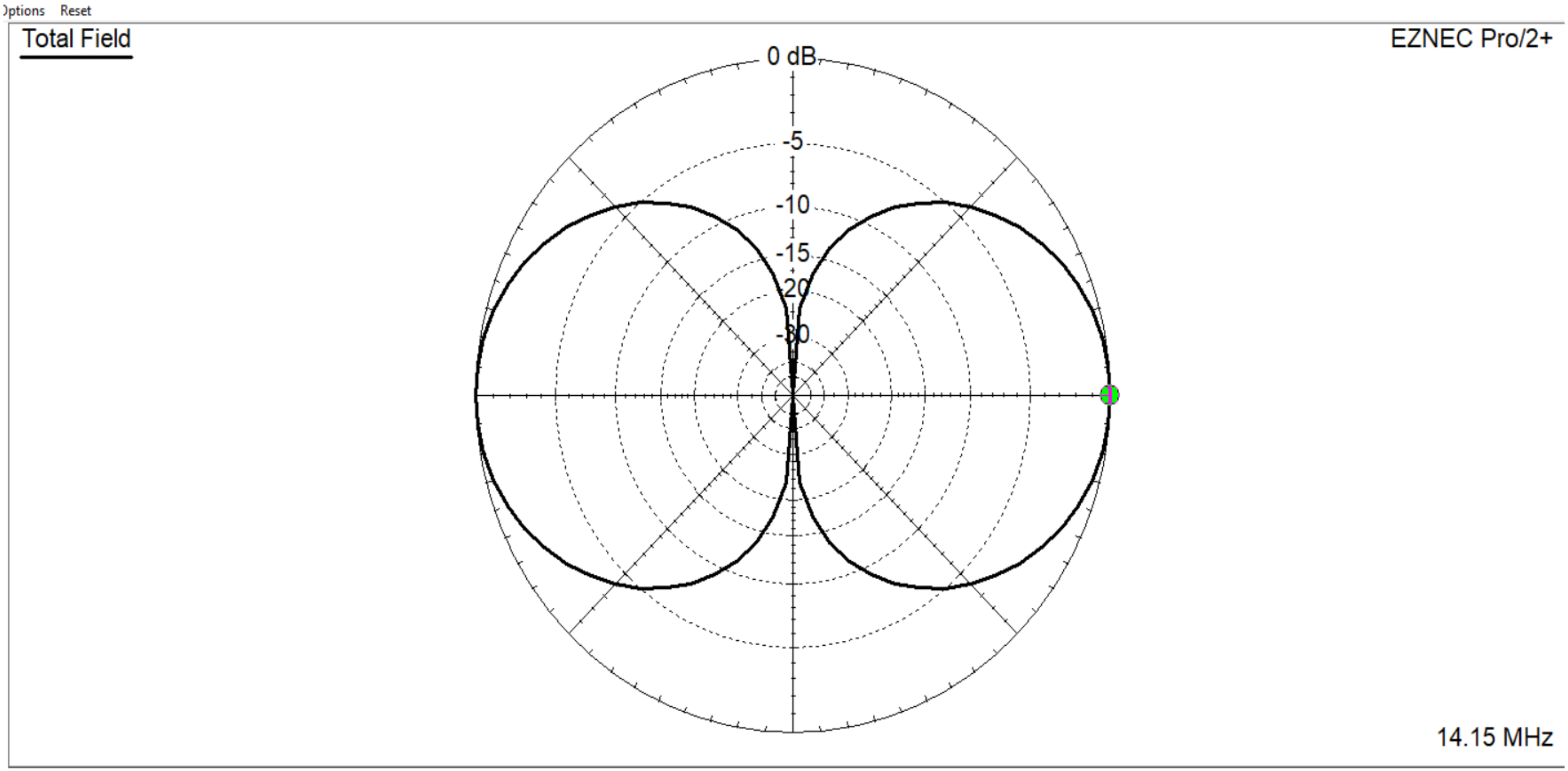
Dipole Characteristics

- Easy to construct
- Easy to match to 50 or 72 ohms
- Horizontally polarized
- Height matters
- Approximately 2dB over isotropic radiator
- Figure 8 pattern in free space

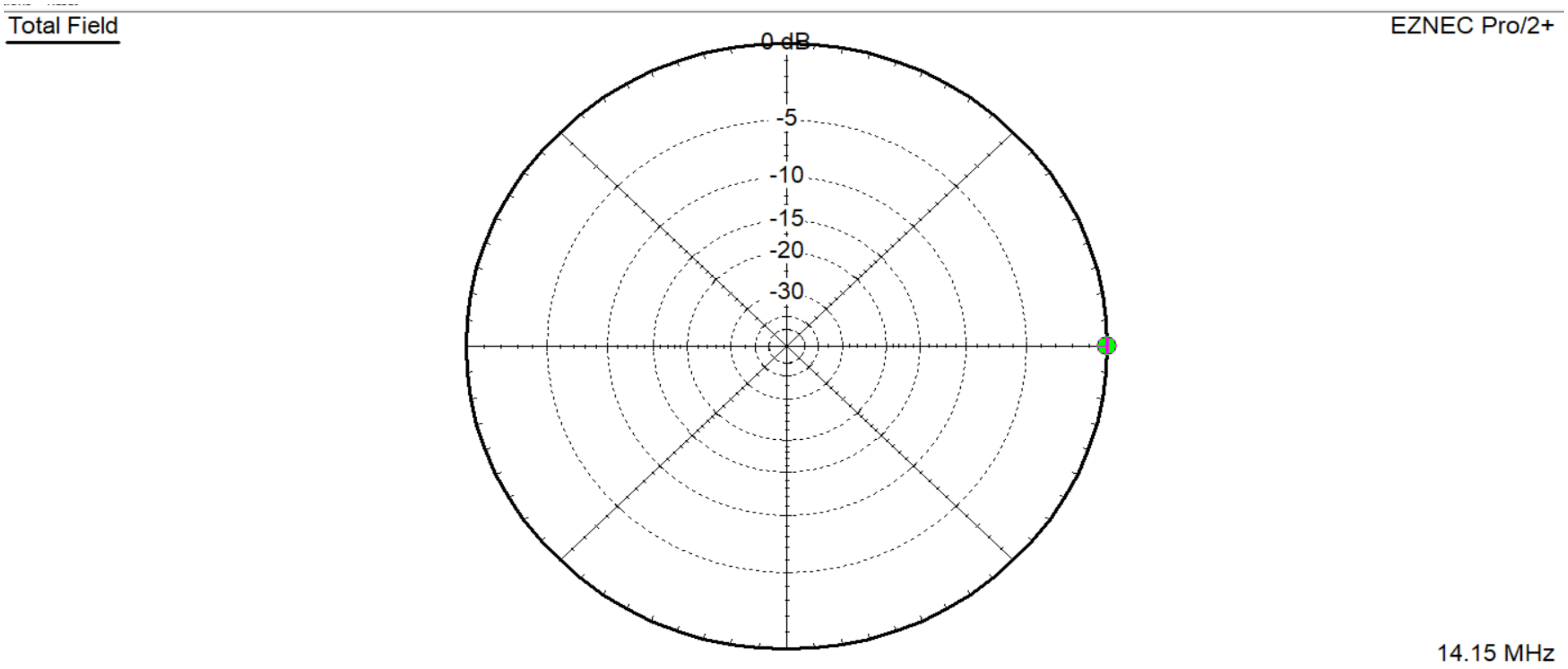
3D Plot Dipole in Free Space



Azimuth Free Space 2.14dBi



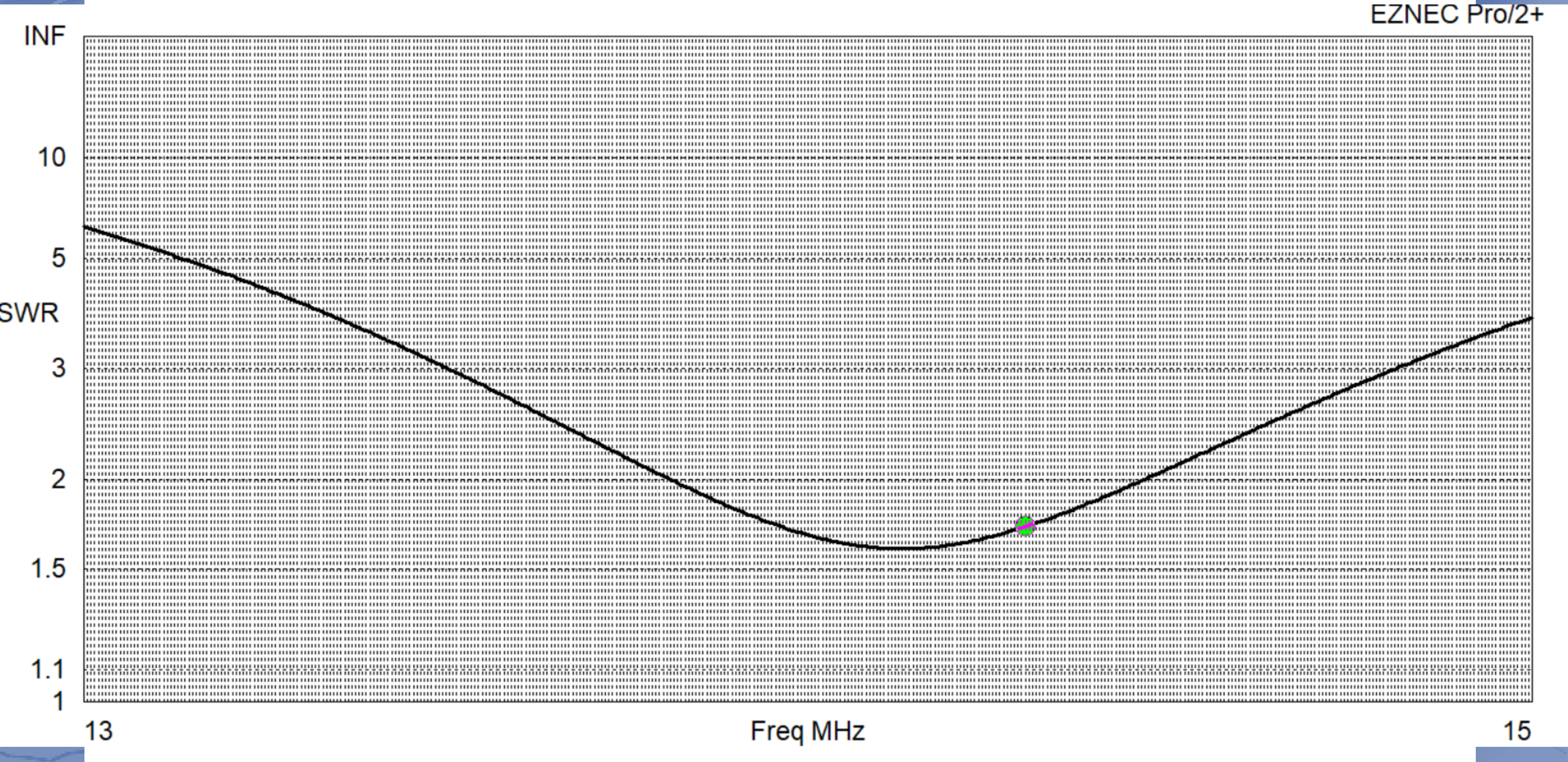
Elevation Free Space



Dipole Over Real Ground

- Most of the plots we all see are for a dipole in free space
- These plots are for simulated real ground

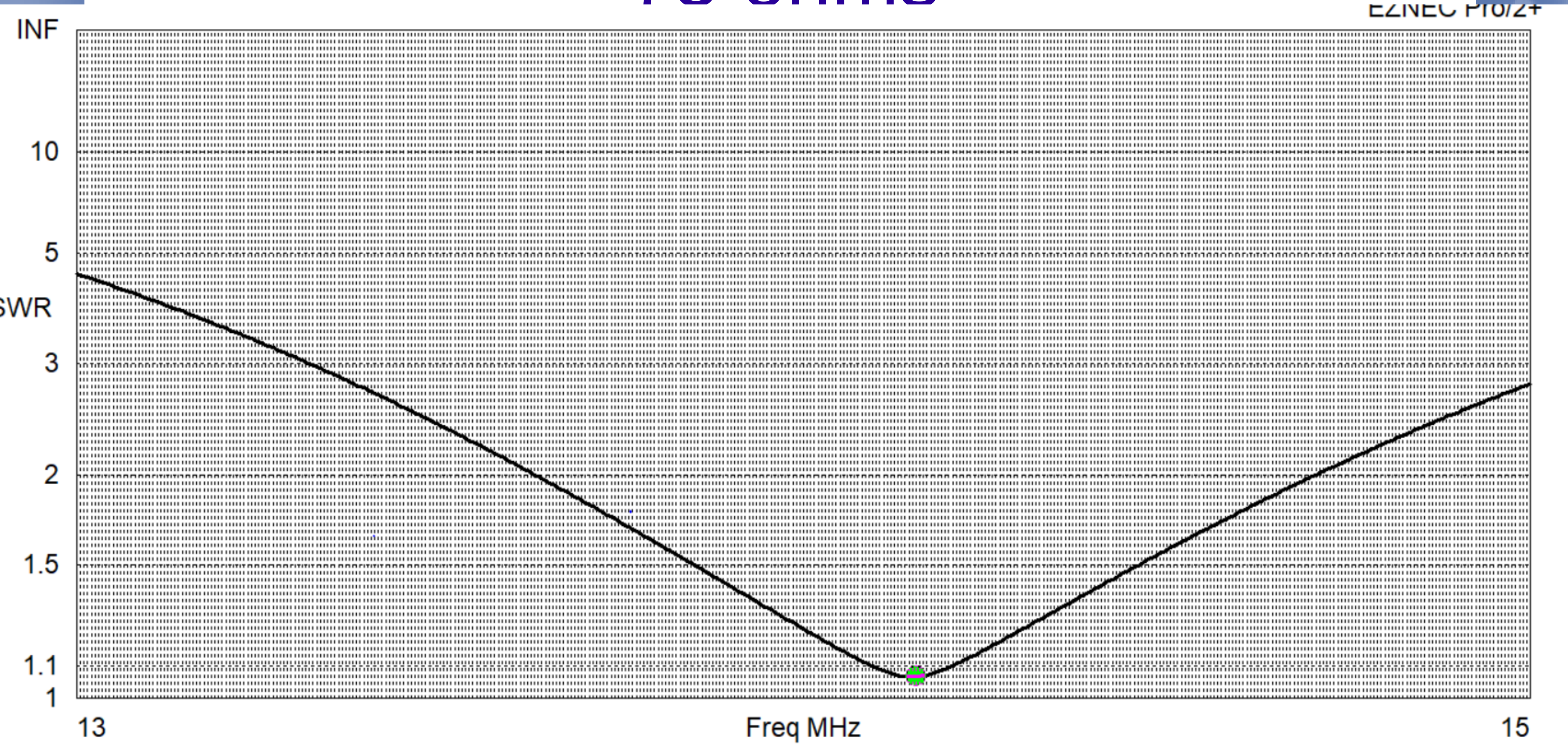
SWR Plot 14.150 centered dipole 50 ohms



Real Ground, 50 ohms, 34.07 ft dipole center fed at 30 feet

- 1.67:1 at 14.01
- 1.64 at 14.025
- 1.6 at 14.12
- 1.71 at 14.3

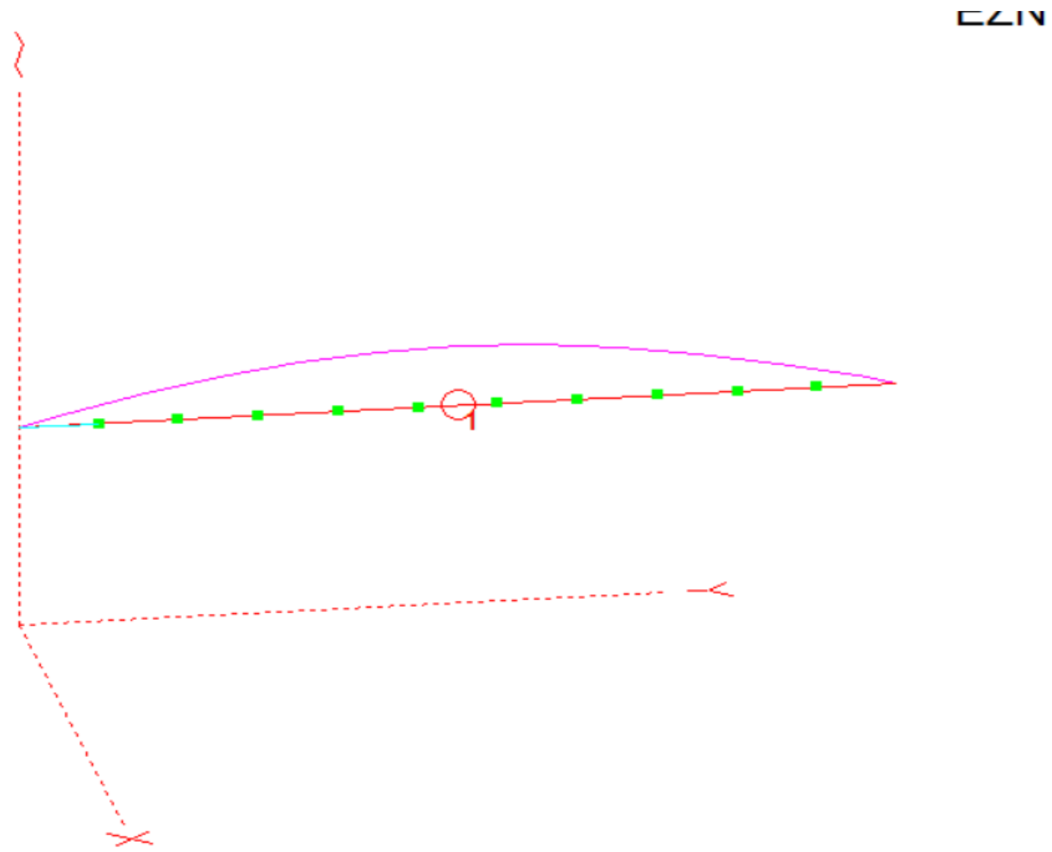
75 ohms



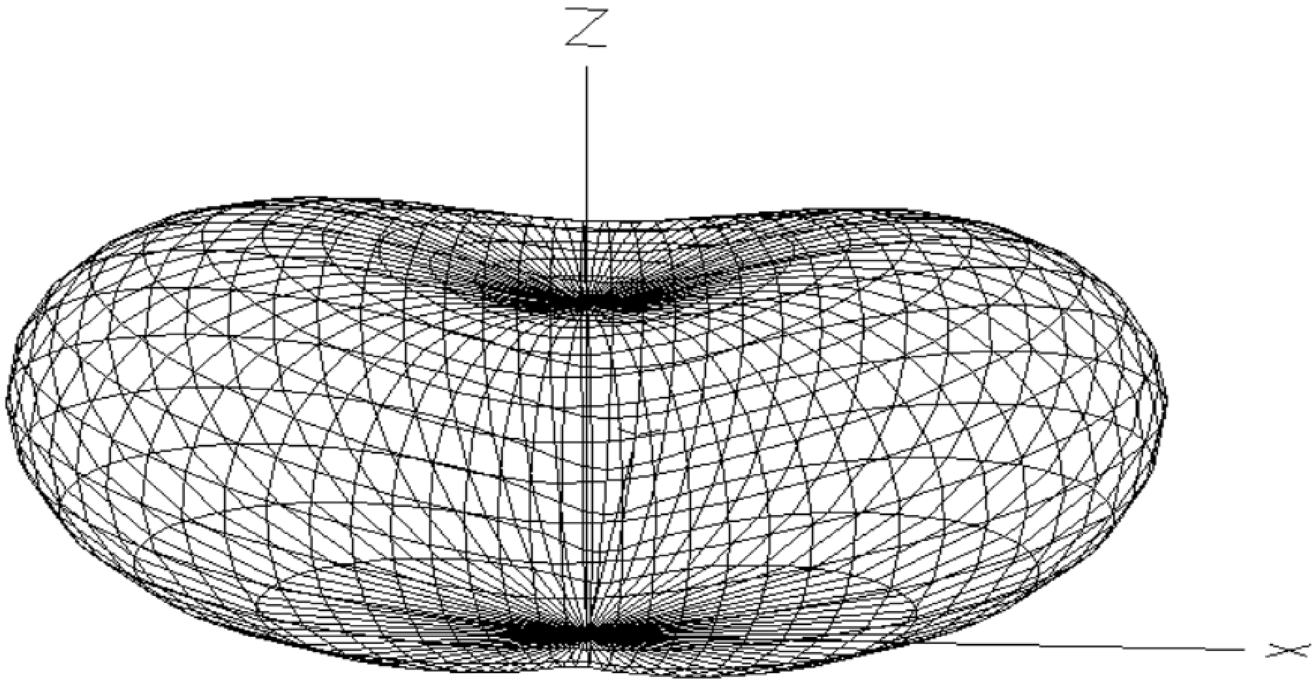
Real Ground 72 ohms 34.07 feet dipole at 30 feet

- 1.003 at 14.005
- 1.028 at 14.09
- 1.098 at 14.150
- 1.35 at 14.3

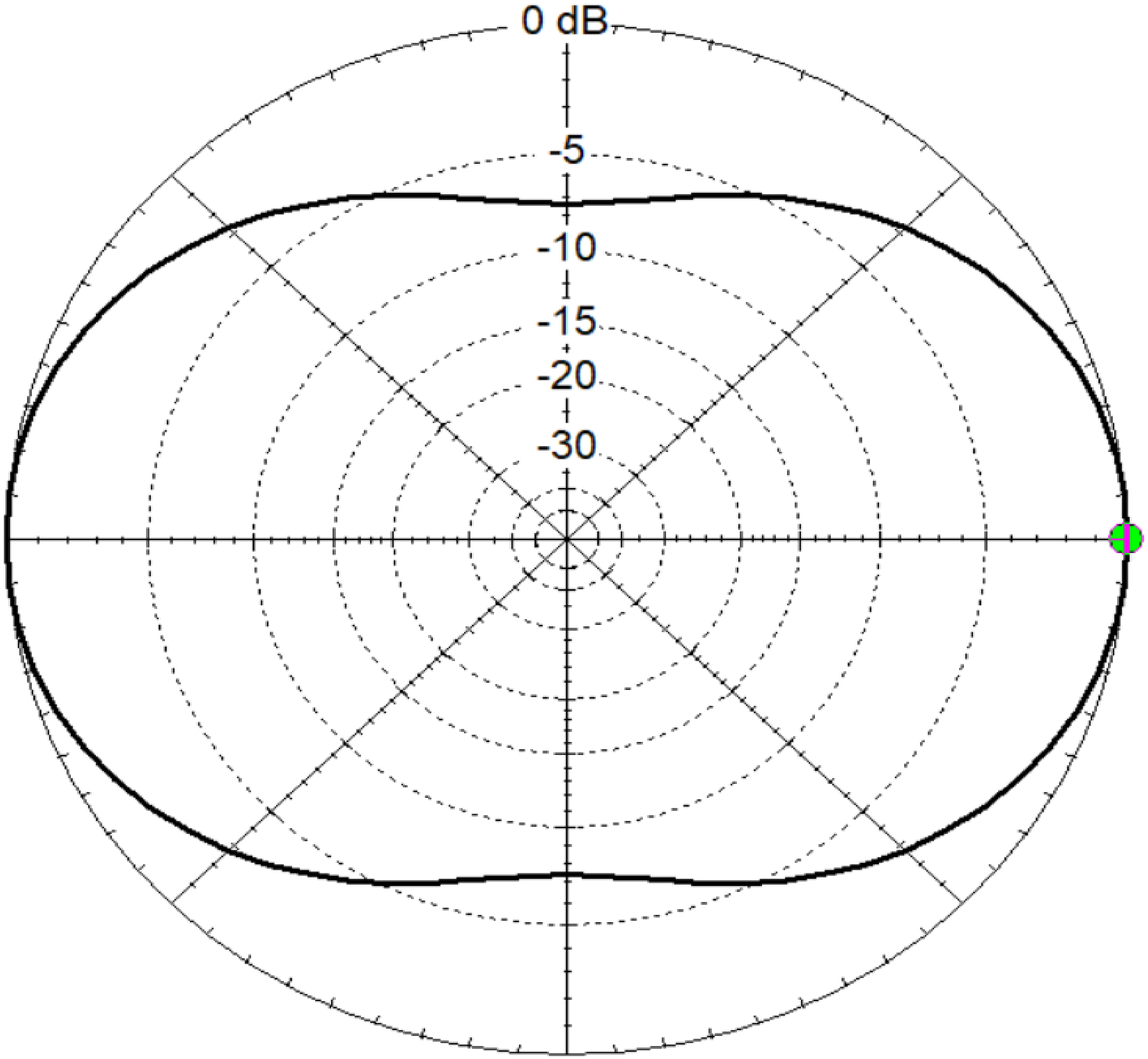
Current Distribution



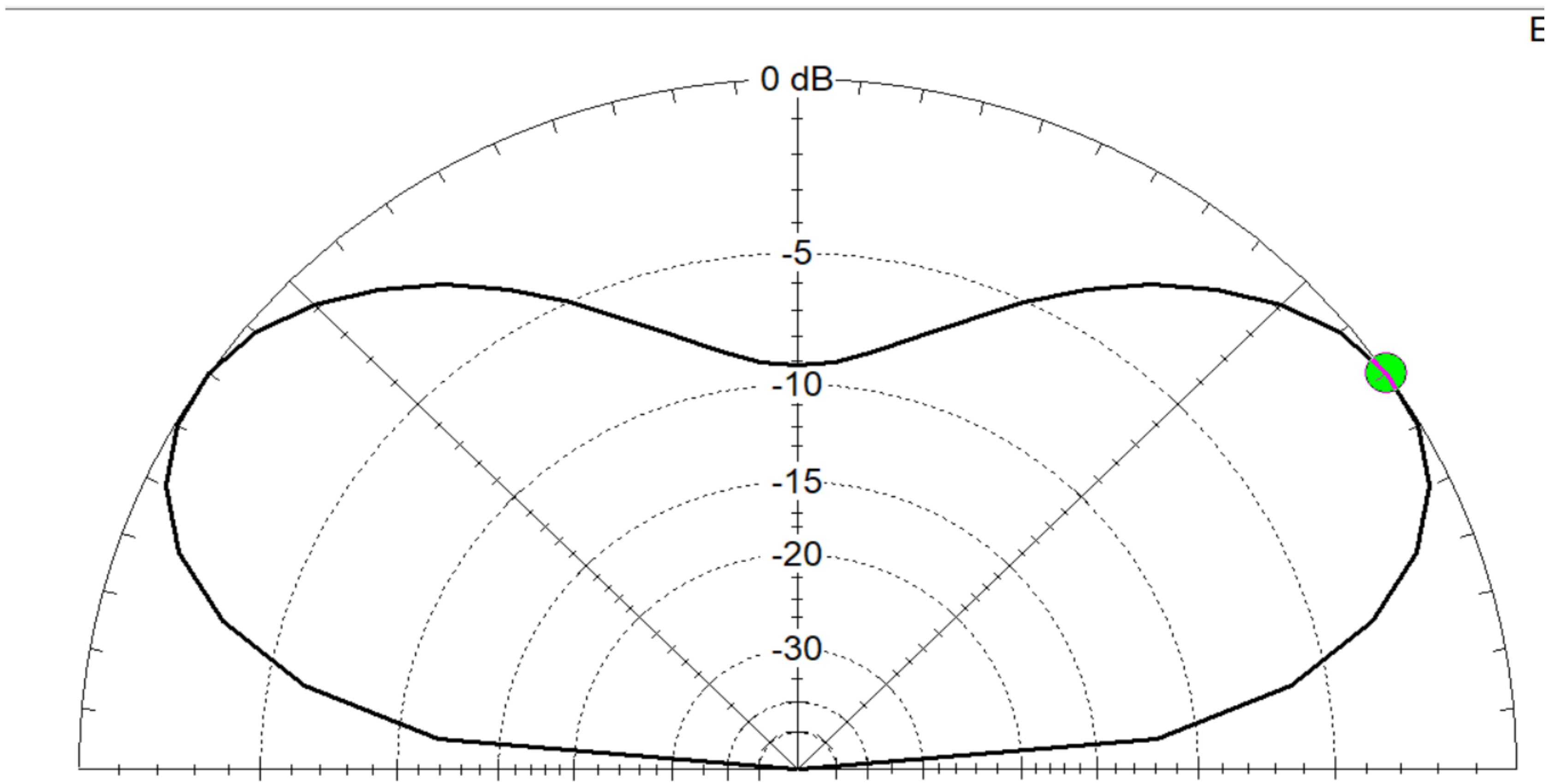
3D Plot 30 feet



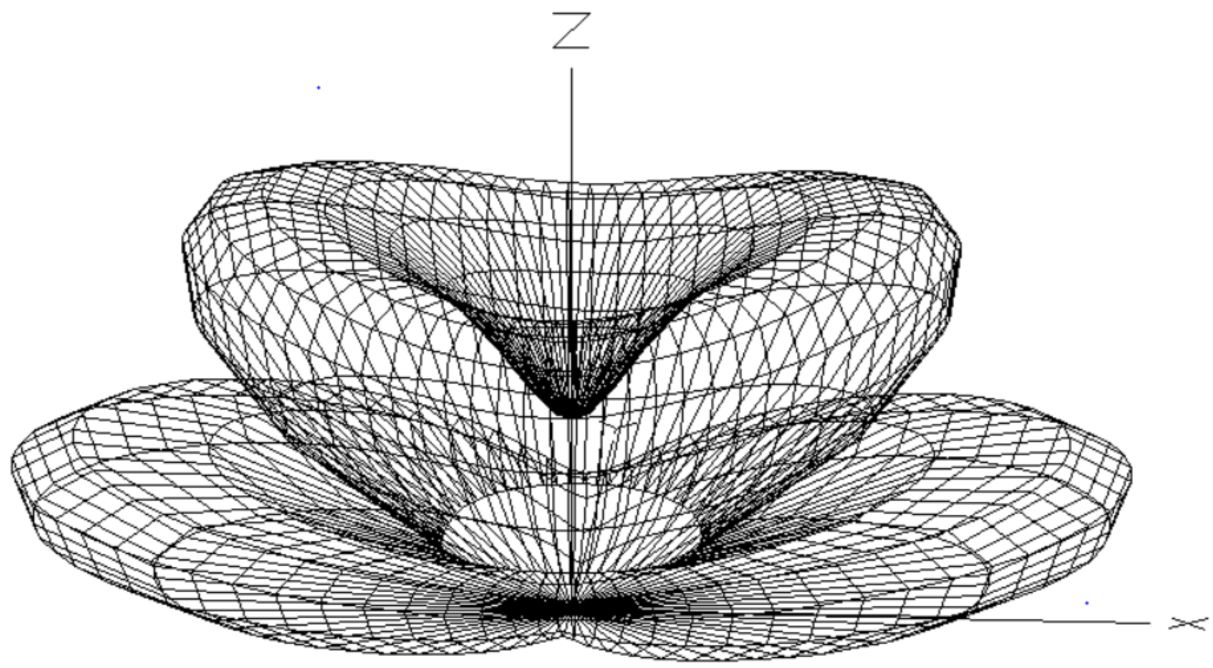
Azimuth Slice 30 feet



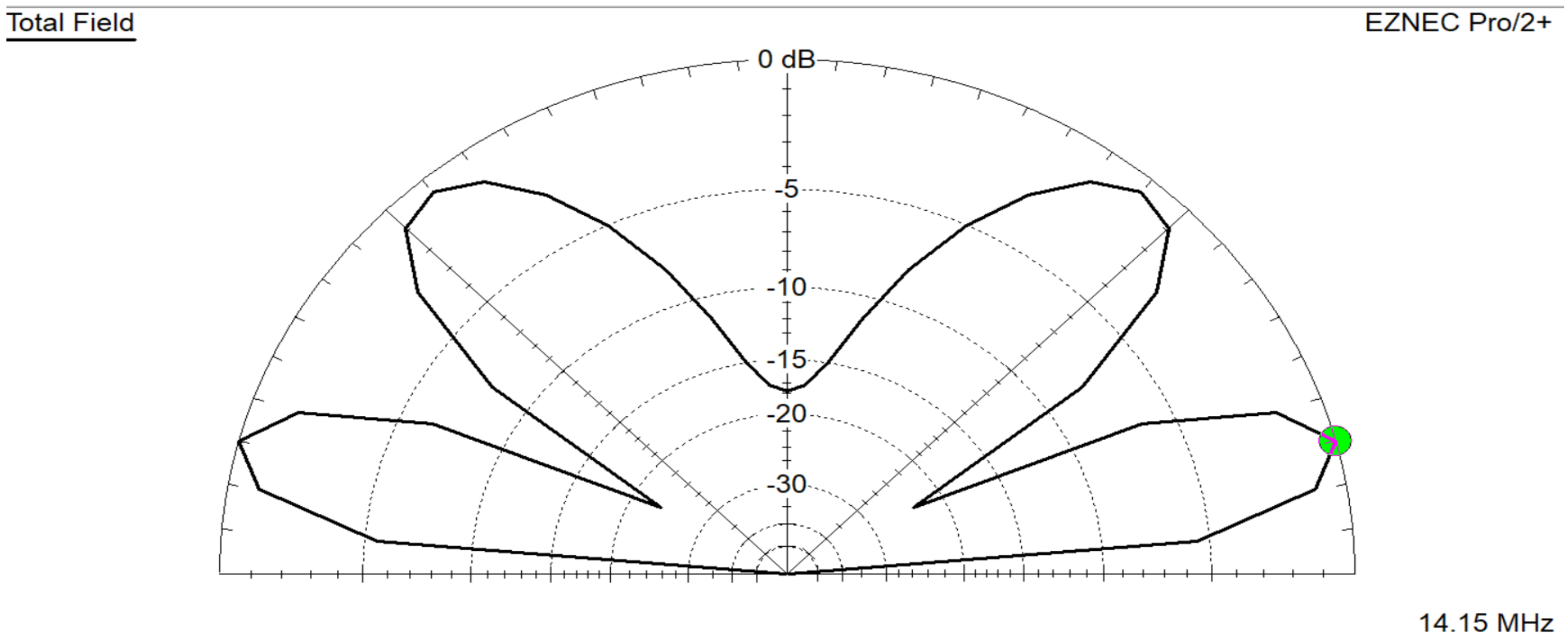
Elevation Slice 30 feet



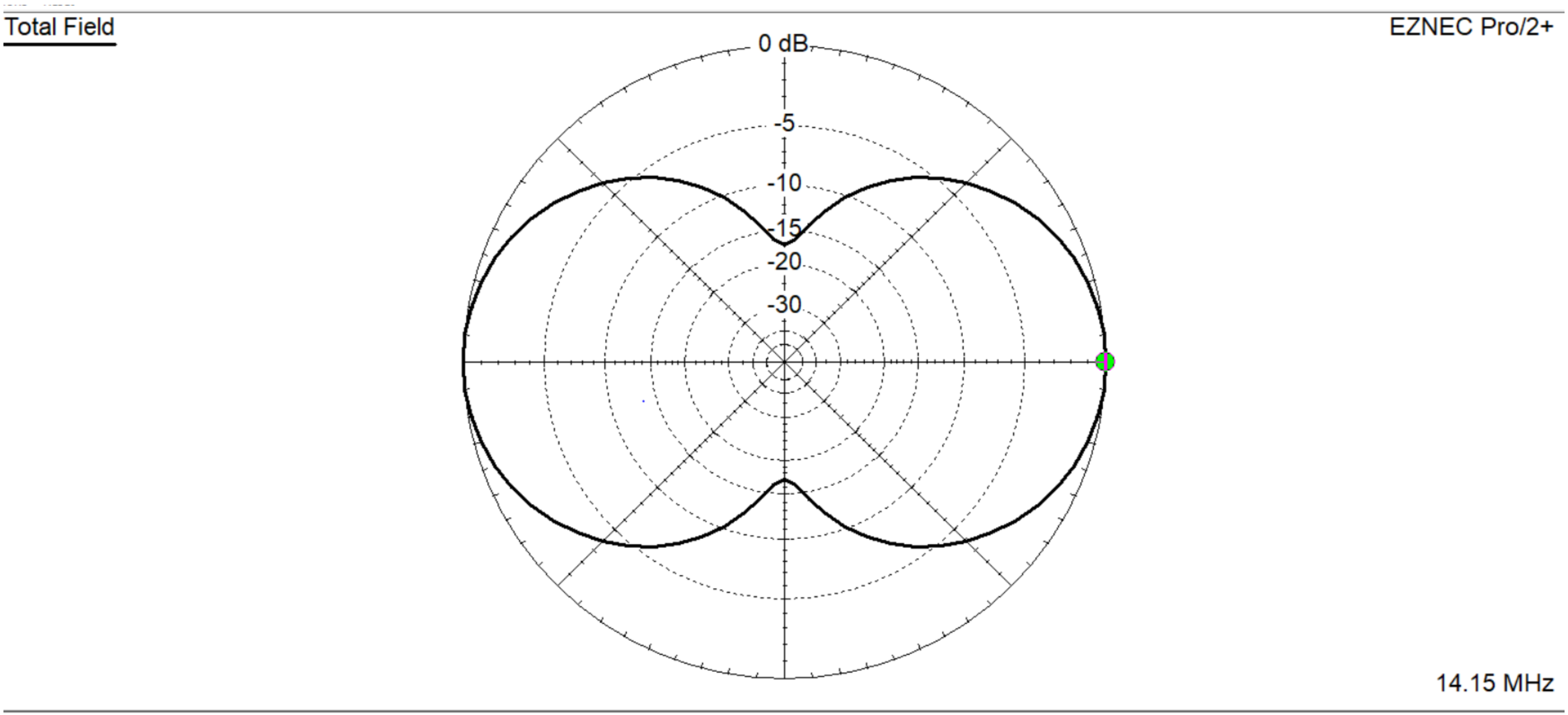
3D Plot 68 feet



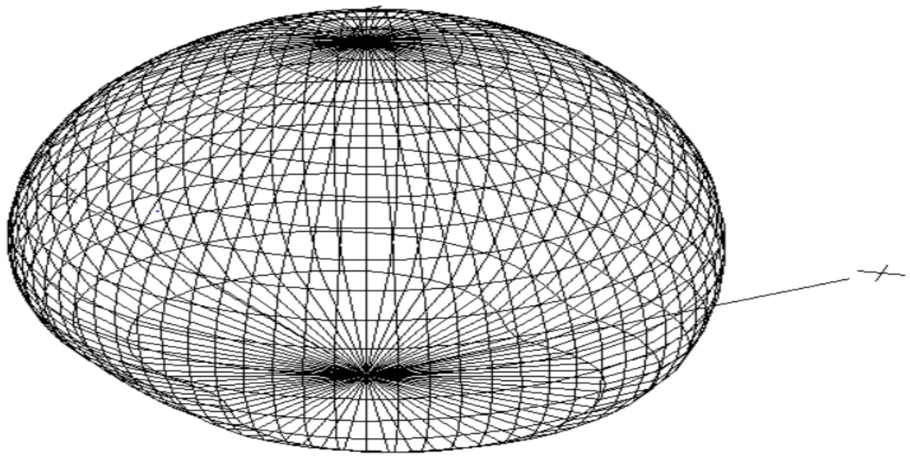
Elevation Slice 68 feet real ground



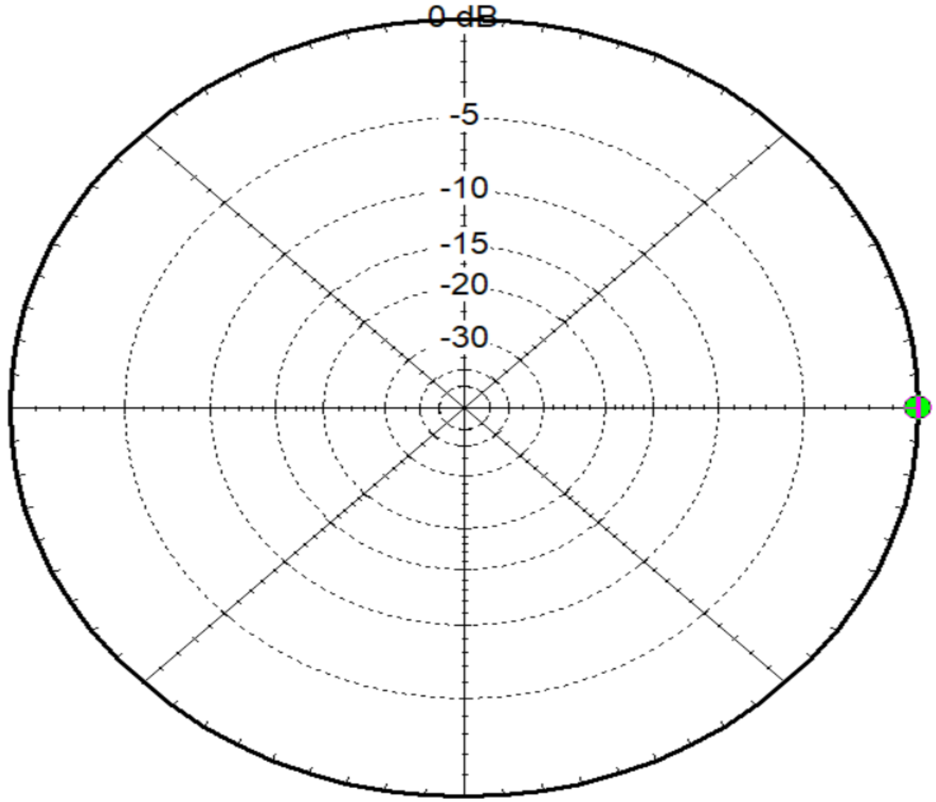
Azimuth Slice 68 feet real ground



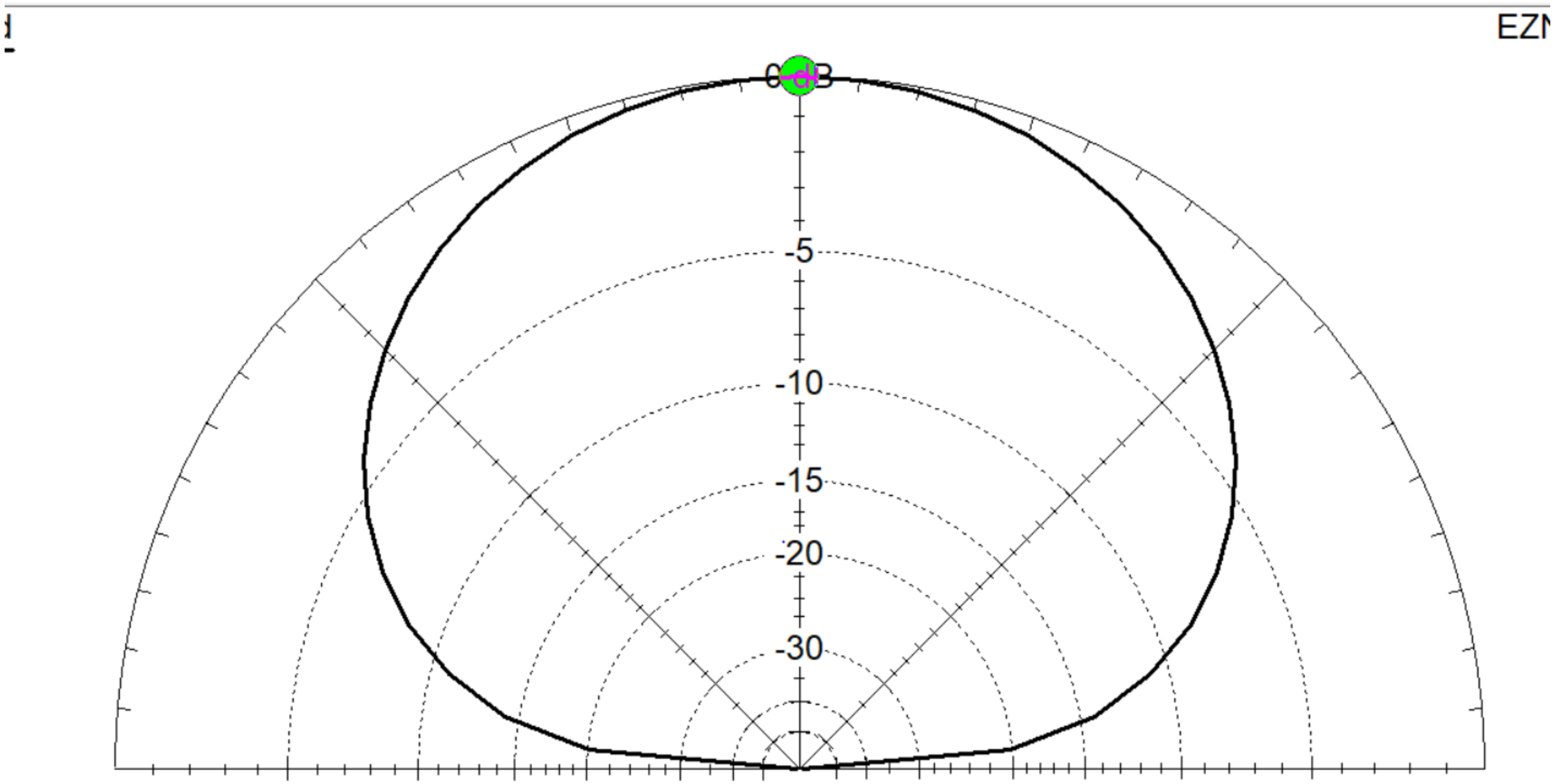
14.150 Mhz Dipole at 1 foot real ground



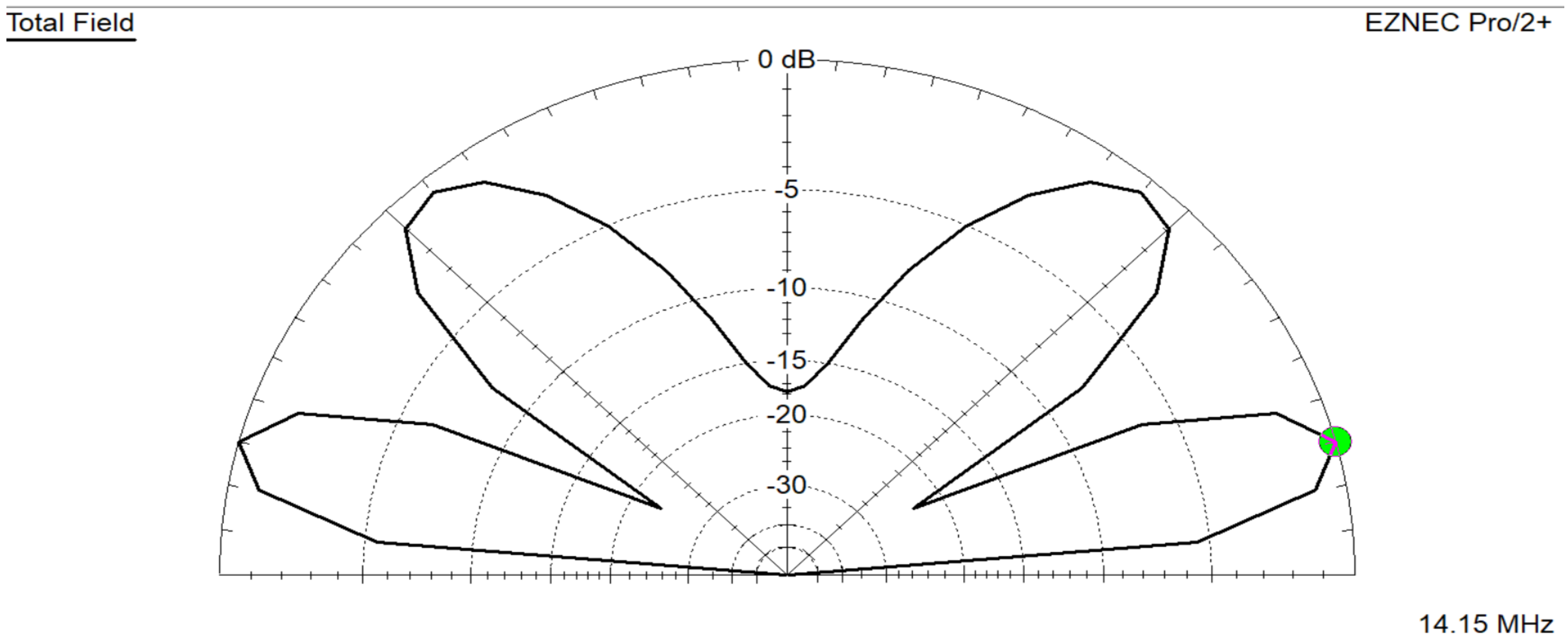
Azimuth, 14Mhz dipole at 1 foot real ground



Elevation 14 Mhz Dipole at 1 foot (NVIS)



Recall Elevation Slice 68 feet real ground



What is the Difference Between a Vertically and a Horizontally Polarized Antenna

- Cross polarization generally loses 3 dB or half power
- Most directional antennas for HF are horizontally polarized (Yagi/Quad/Dipole)
- Most VHF/UHF+ antennas for Repeater and Simplex work are Vertically Polarized
- Most VHF/UHF SSB/CW/Digital antennas are horizontally or circularly polarized

What about DX on HF

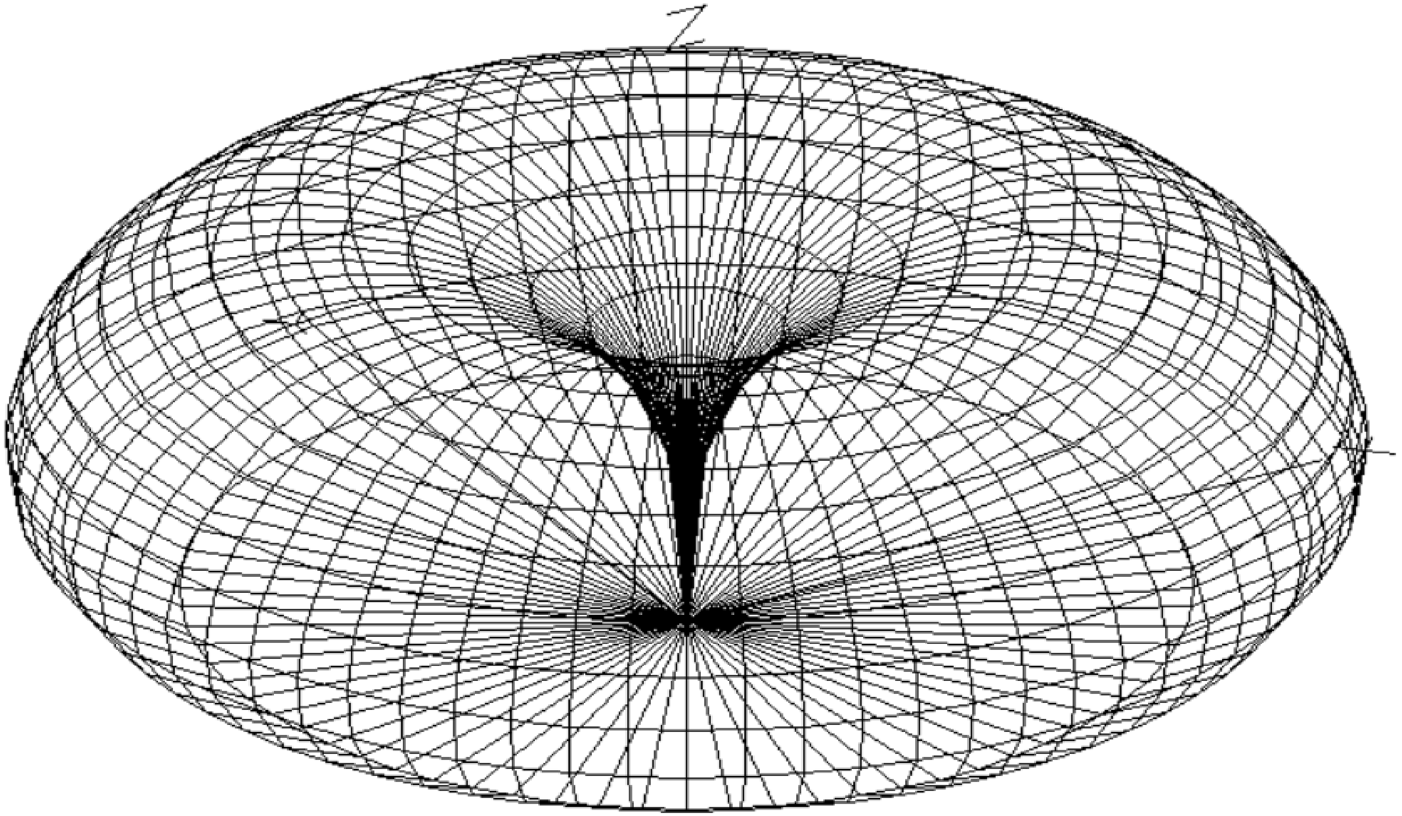
- Polarization doesn't matter as much with HF because the signal bounces around
- Angle of Radiation is more significant
- Both Vertical and Horizontal Antennas can be used
- Main considerations are what you can do with the land and resources available

What is this Ground We Keep Hearing About

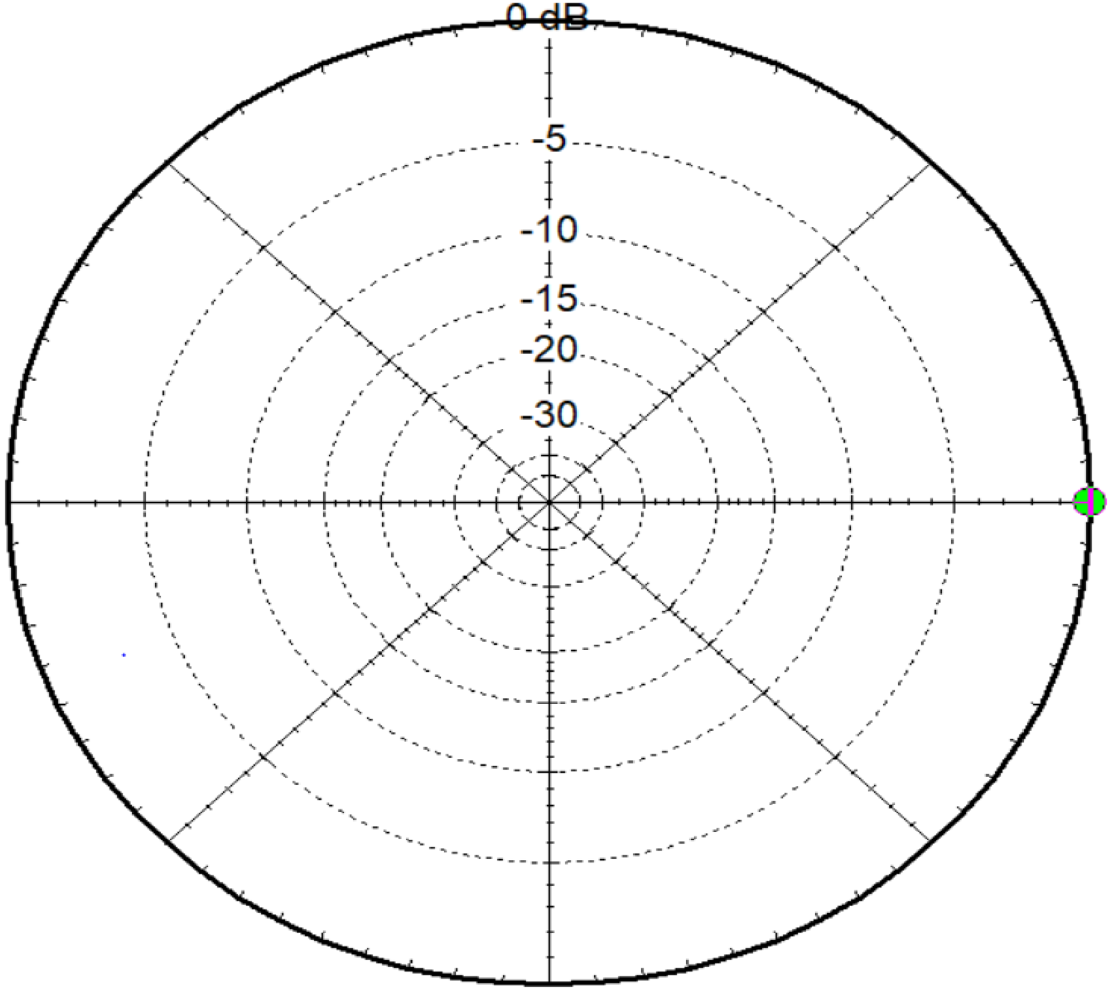
- Ground has different impacts on Vertically and Horizontally Polarized Antennas
- For NVIS communication, a Horizontally Polarized Antenna close to ground works best. This is what is used at GA Death Race
- For ¼ wave Vertical Antennas, Radials create the ground

¼ Wave Vertical Antenna Current

3D Vertical on Ground

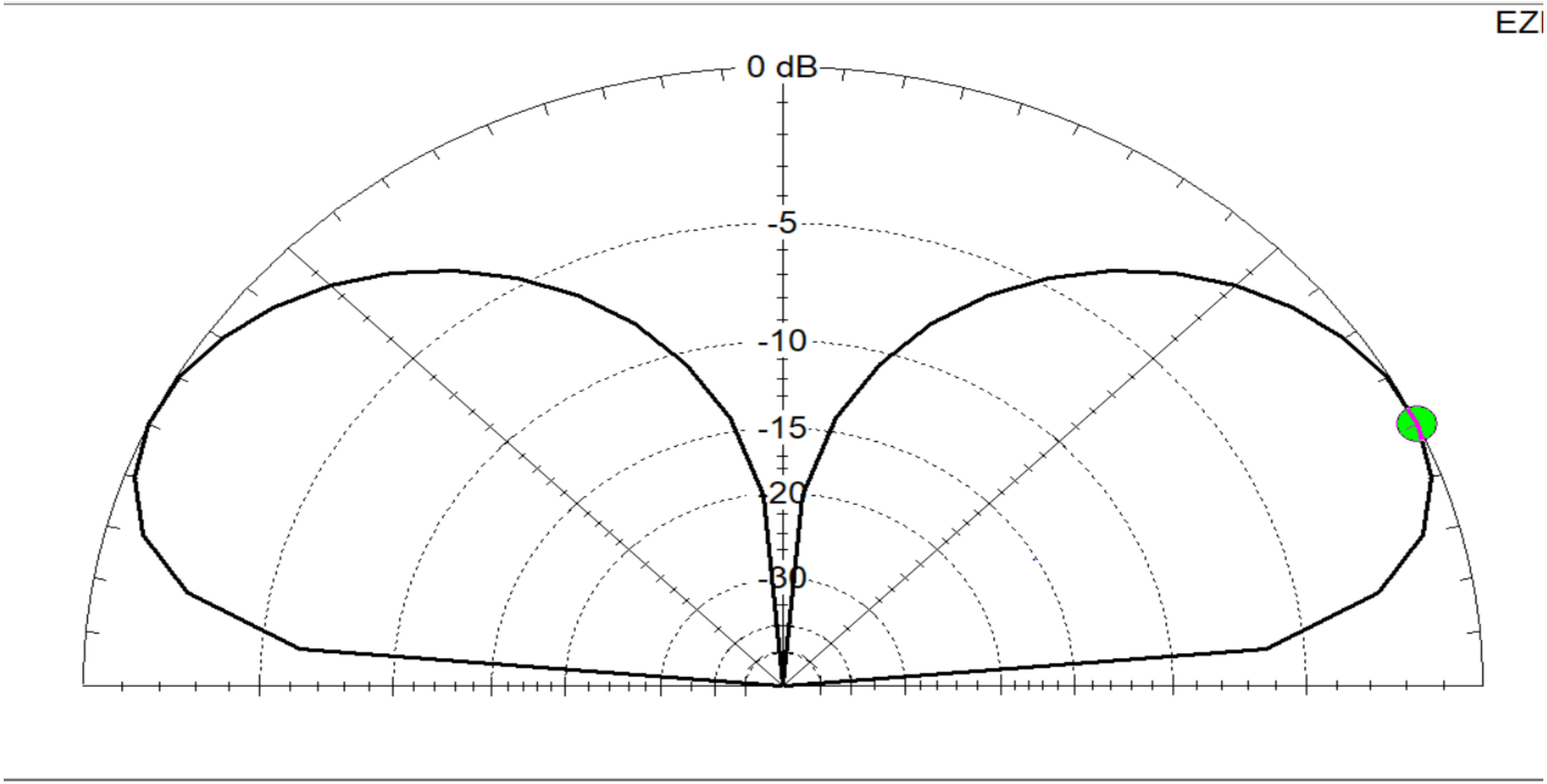


Azimuth Vertical On Ground No Radials

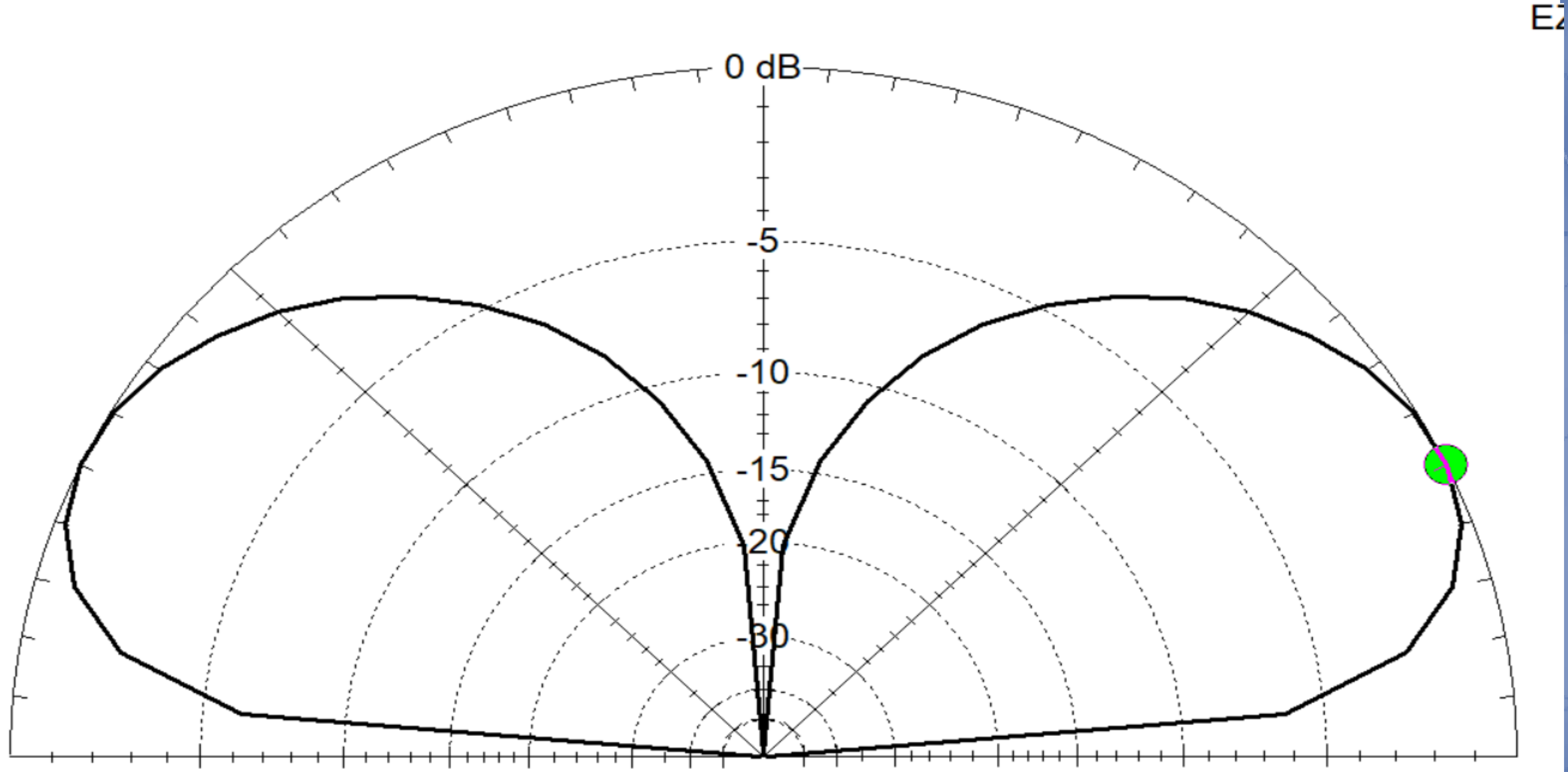


Elevation Vertical On Ground No Radials

- -0.4dBi at 25 degrees

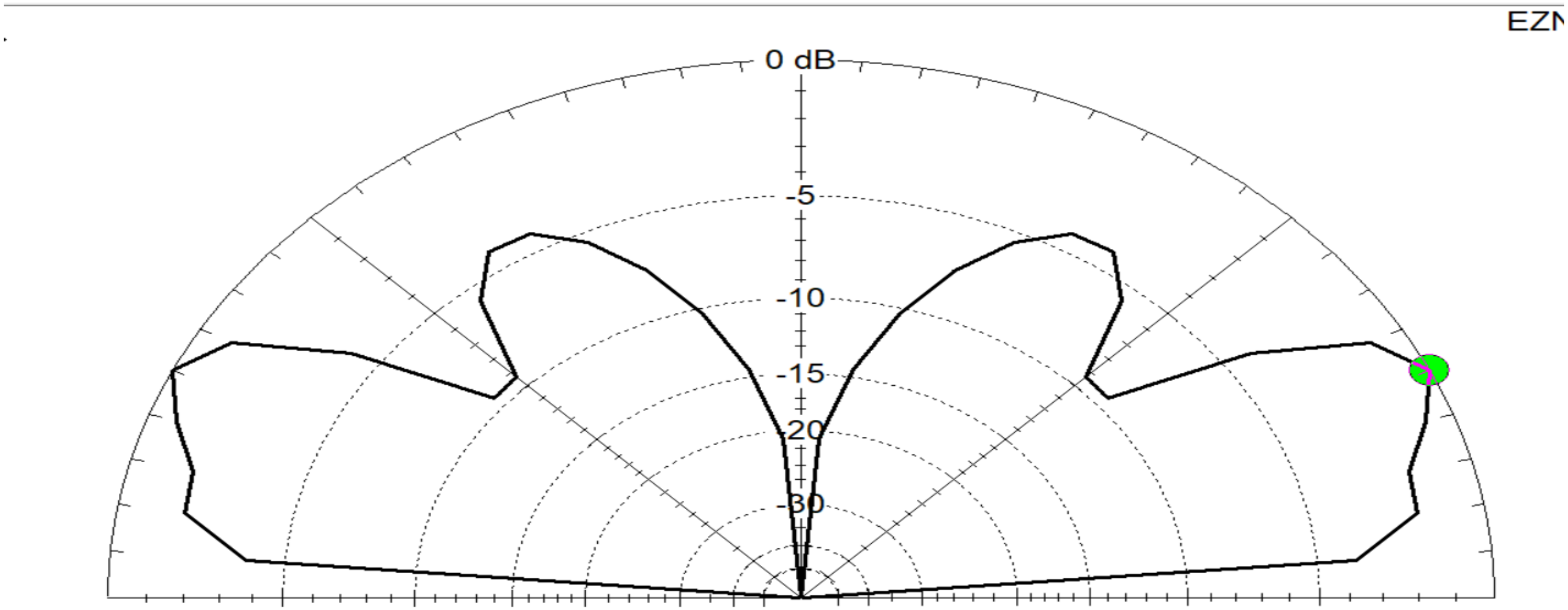


¼ waveVertical, 4 radials, 1/4wavelength, -.22 dBi



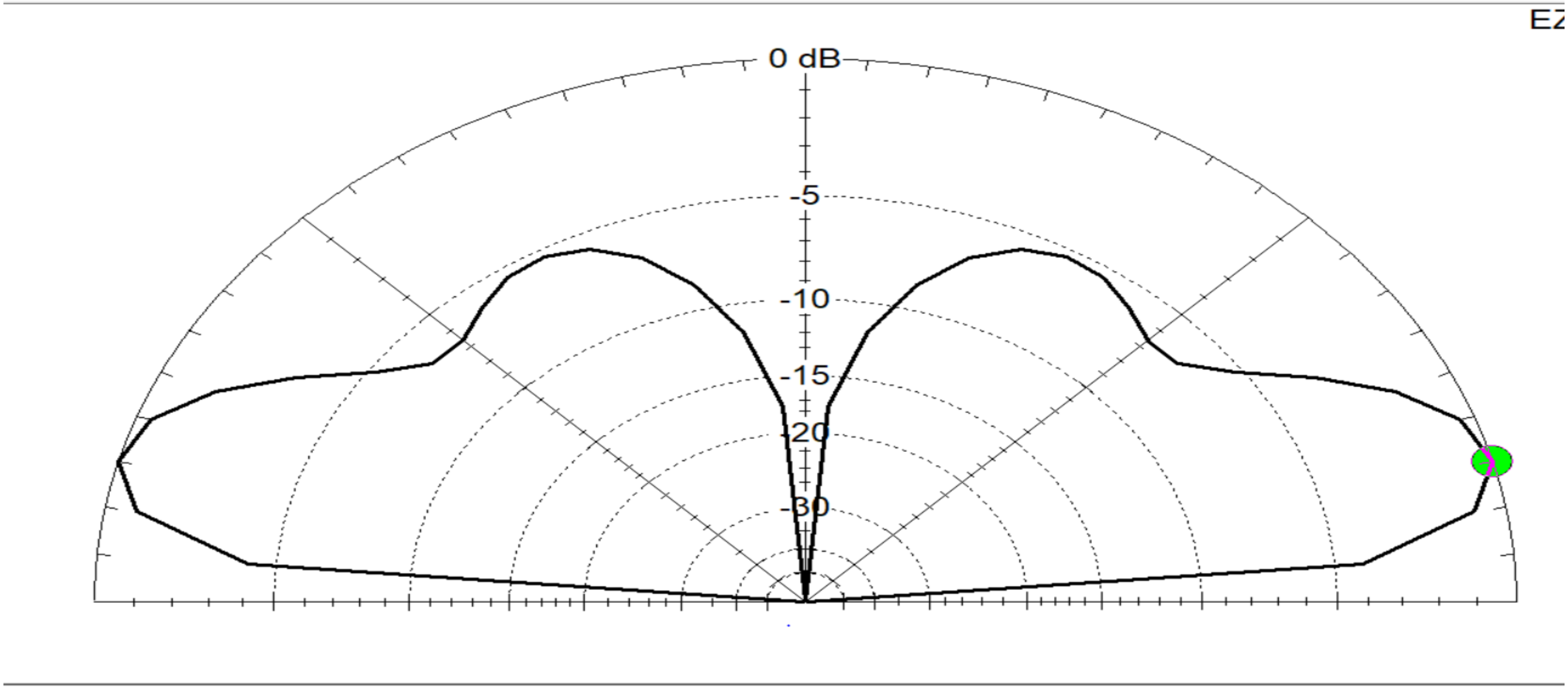
¼ wave vertical, 1 wavelength off ground, no radials

- 25 degrees max gain 3.45dBi



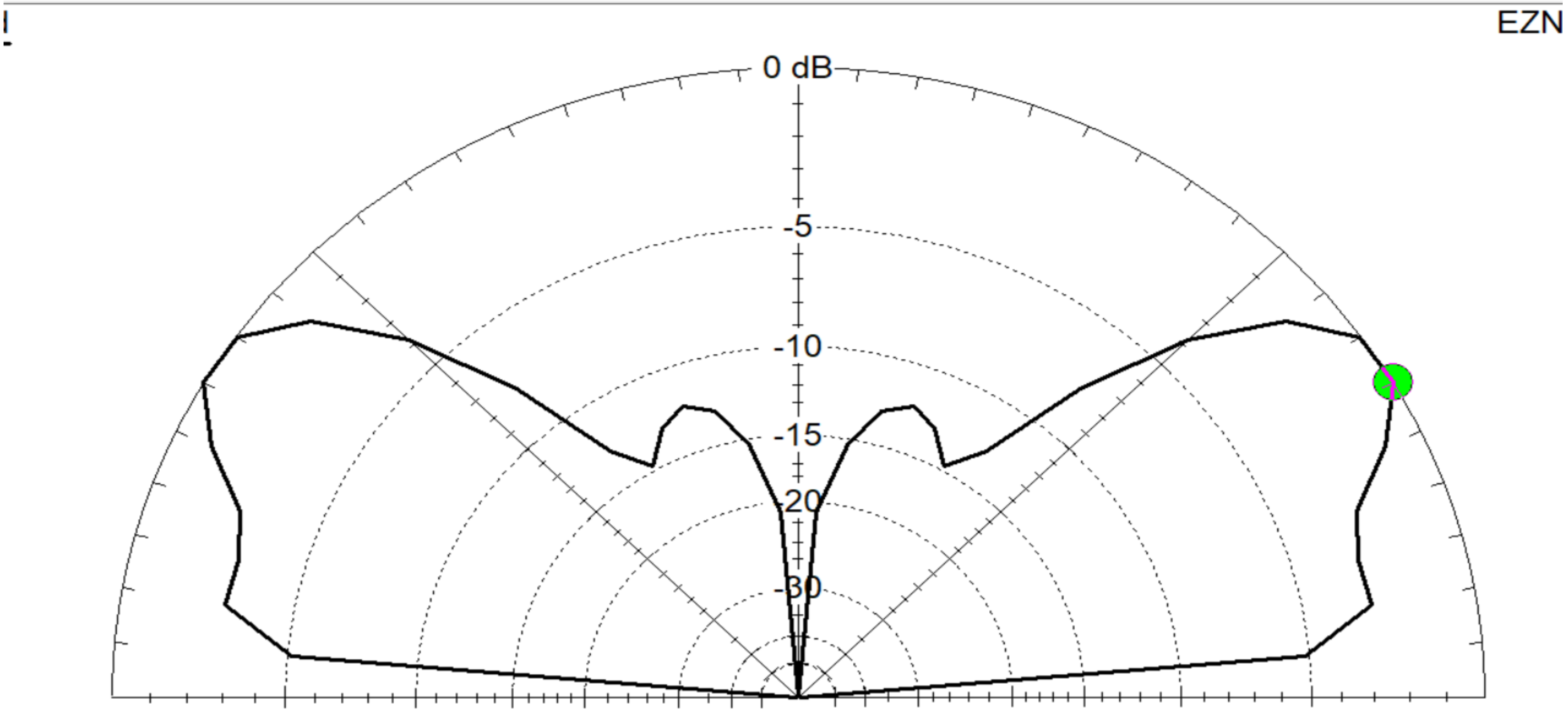
¼ wave vertical, ¼ wave radials, ¼ wave above ground

- 0.03dBi 15 degrees



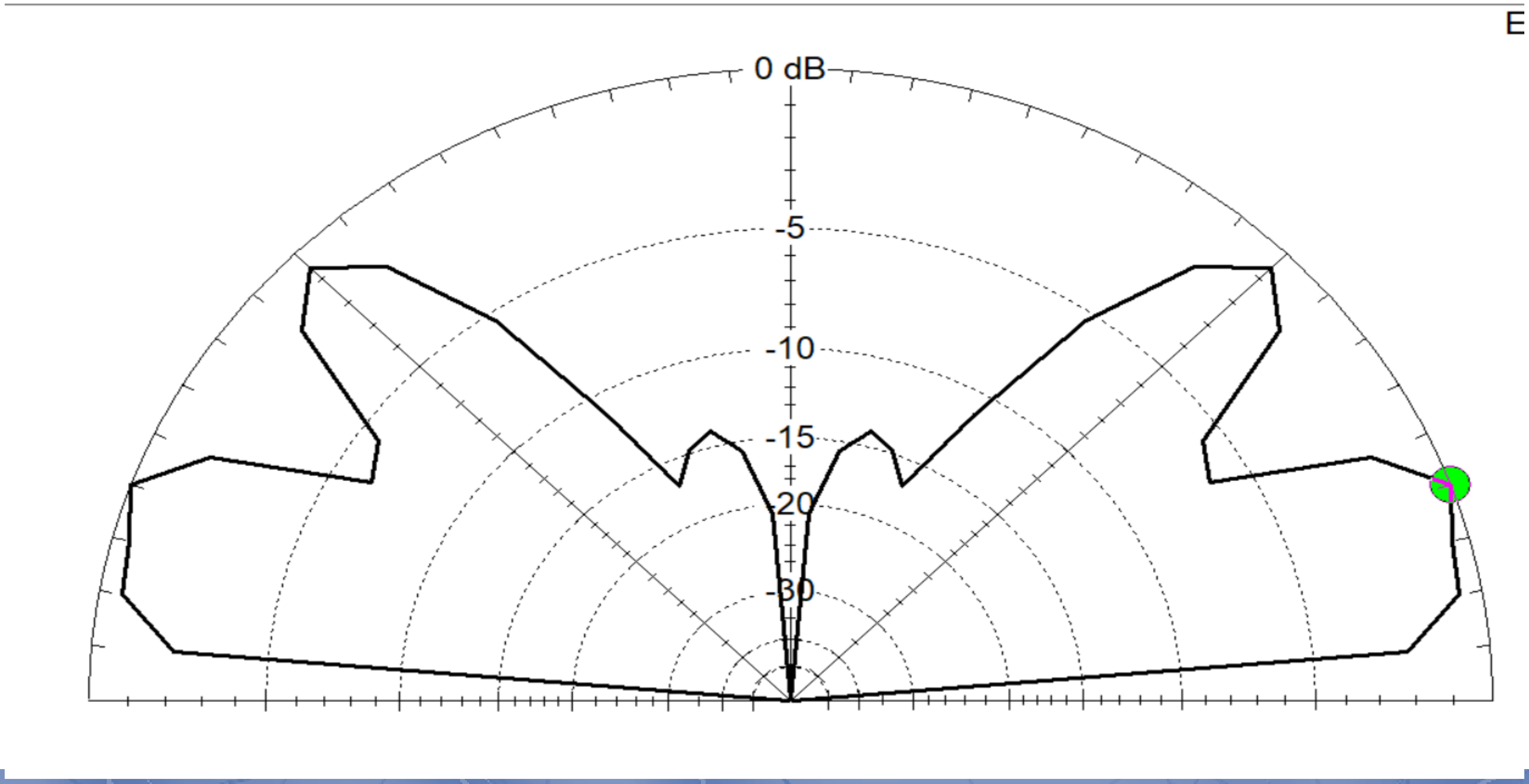
¼ wavelength, 4 ¼ wavelength radials, .5 wavelengths high

- 3.22 dBi 40 degrees

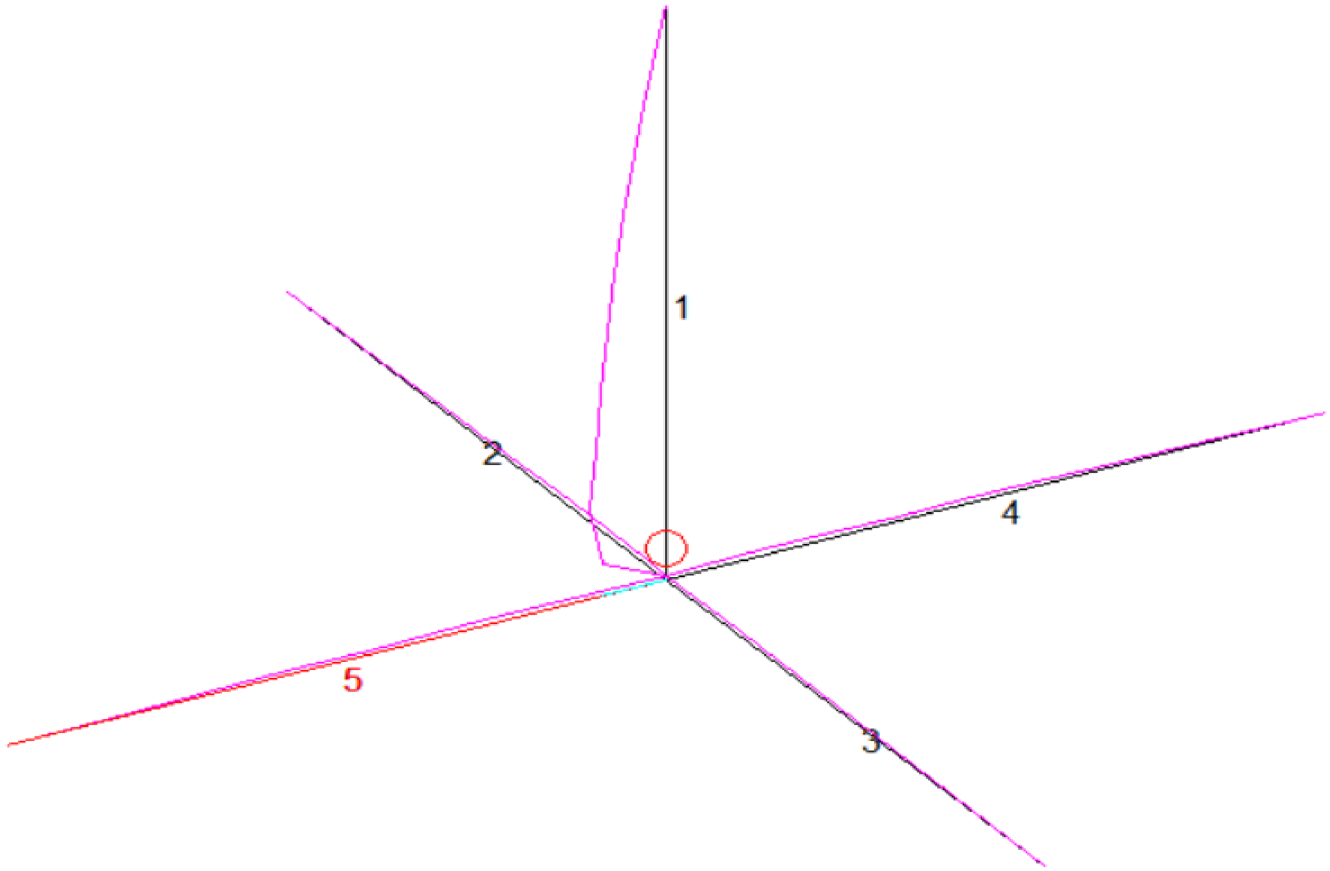


¼ wavelength, 4 ¼ wavelength radials, 1 wavelength high,

- 35 degrees 3.03dBi



¼ wave vertical radial currents



Summary of Antennas

- Dipoles are the most basic antenna
- Height impacts pattern with horizontal antennas
- Radials complete the antenna for a ¼ wave vertical.

What About Coax?

- Coax is the one thing standing between your radio and your contact
- Most people treat it as a commodity product.
- But there are big differences between the different types of coax

Power Loss in Coax versus Frequency

Coax Type	Power at 14Mhz	Power at 146 Mhz	Cost per Foot
Rg58	69	27	0.49
Rg59	76	40	0.32
Rg8	84	56	1.13
Rg8x	77	38	0.65
LMR400	89	69	1.45
LMR600	89	79	1.95

https://kv5r.com/ham-radio/coax-loss-calculator/ is a great resource

Tuners, Resonance and Non Resonance

Antenna tuners do not improve antenna performance

Antenna tuners give the radio a nice match to the antenna at the coax

This keeps the radio operating within specifications and transfers maximum power from the radio to the coax

What is SWR Really

- We have all been told at one time or another that SWR is the be-all end-all antenna measurement
- There are now much more accurate ways to measure antenna performance (nanoVNA anyone?)
- SWR can indicate a problem with the antenna itself if it changes dramatically

Reflected Power and SWR

- Forward power travels to the antenna
- Reflected power gets returned to the source
- Line loss reduces the power that gets transmitted to the antenna,and that arrives back at the source, and then that gets transmitted back to the load
- Higher coax loss=lower radiated power
- In a lossless line, swr becomes irrelevant

Walt Maxwell, Reflections

- The difference in power transferred through any coaxial line with an SWR of 2 to 1 is imperceptible compared to having a perfectly matched 1.0-to-1 termination, no matter what the length or attenuation of the line
- VSWR 4, 4MHz 0.3dB additional loss, 7MHz .4dB additional loss
- http://www.arrl.org/files/file/protected/Group/Members/Technology/tis/info/pdf/Reflect.pdf

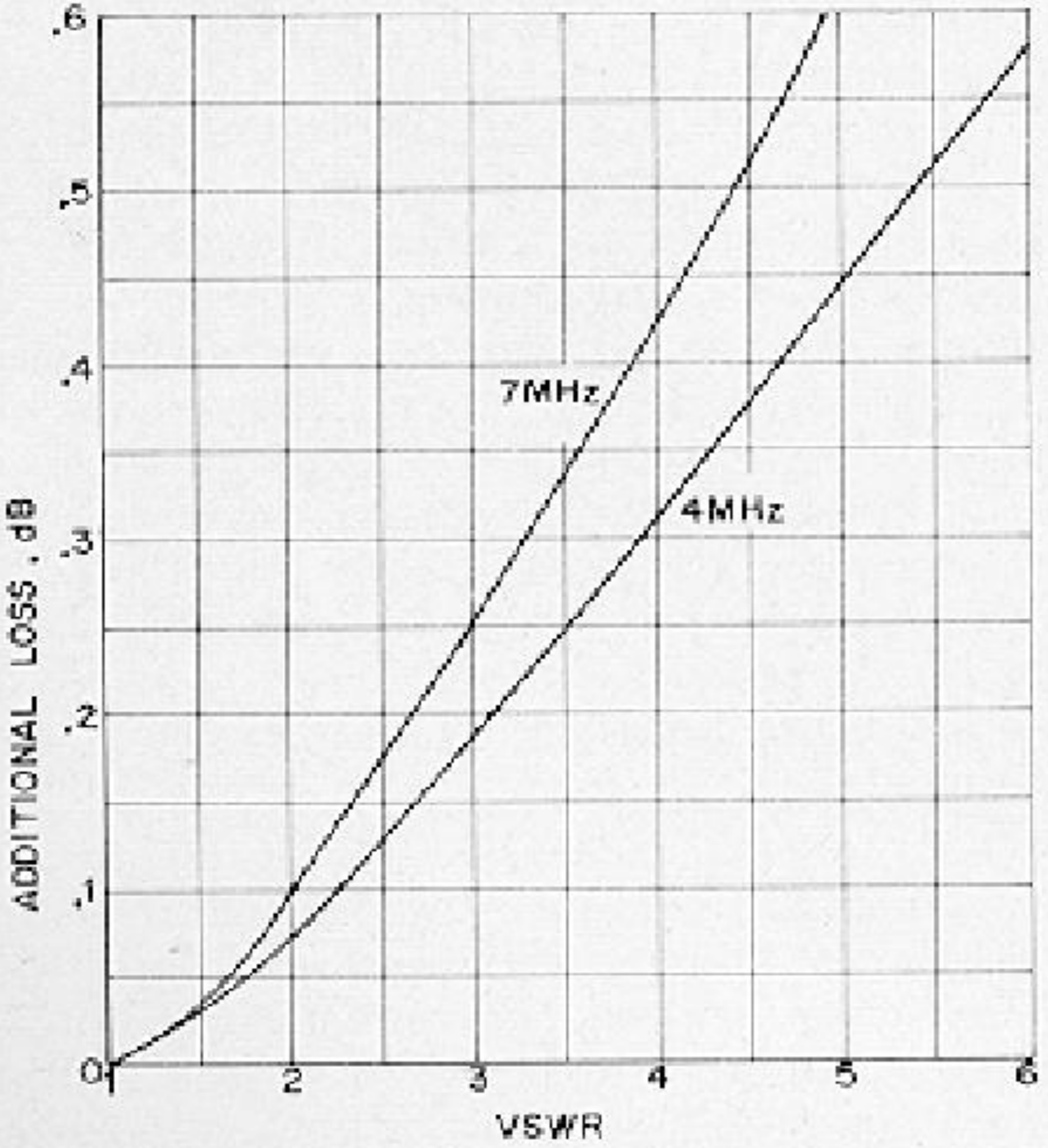


Fig. 2 — Effect of standing-wave ratio on line loss at 4 and 7 MHz. The ordinates give the *additional* loss in decibels over those for a perfectly matched 100-foot length of RG-8/U line for the SWR values shown on the horizontal scale.

What is Twinlead and Open Wire Line and why use them?

- As I have shown, Coax Cable has loss, based on type and frequency
- This is a result of how coax is constructed and its properties
- Open Wire and Twinlead do not have the same loss

Twinlead

- Twinlead is the name given to 300 ohm paralell conductor feed line
- It was most commonly used in VHF TV Antennas back before the DTV transition
- Because it was so common, it was adopted for a variety of uses in the Amateur community

OWF/Ladder Line

- Open Wire Feedline is a technical term for what is also referred to as ladder line
- OWF/LL has an impedance of 450 ohms
- In the past, LL was created by spacing two pieces of bare wire with plastic spacers
- Molded cable is now available from a variety of sources

Construction Notes

- 450 ohm line is spaced between 1 and 2 inches (1.5 inches for #14 wire)
- In practice, ladder line should be < 0.10 wavelength spacing which makes it practical up to about 900Mhz
- This ensures that the line is balanced, and the fields between the two conductors cancel each other out

1930's version

"In building a two-wire feeder the wires should be separated by wooden dowels which have been boiled in paraffine. In this way, the feeder is given a tendency to swing in windy weather as a unit.

The wooden dowels can be attached to the feeder wires by drilling a small hole in the dowels, then binding them to the feeders with wire." (The Radio Amateur's Handbook, 7th Ed., ARRL, 1930, p. 169)

OWF as a dipole feedline, QST June 1995

Table 1

Calculated SWRs for a 94-foot Dipole Fed with 41 Feet of 450-Ω Ladder Line

Note: Although the antenna is cut for the CW portions of the band, expect similar results at other frequencies.

Frequency	*SWR*
3.56	7.6:1
7.1	2.4:1
14.2	1.5:1
18.1	2:1
24.9	1.5:1
29	2.4:1