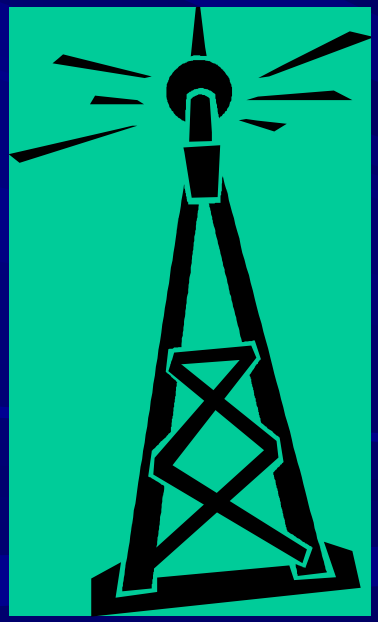
Antennas:
Hints and Kinks

North Fulton Amateur Radio League
March 15, 2016
Chuck Catledge, AE4CW

Questions and Discussion Welcome!

What's the MOST Important Component in your Shack?

Your ANTENNA!!!



NORTH FULTON AMATEUR RADIO LEAGUE

How did this thing
we call an Antenna come about?

Let's go back in time
and
find the answer

Electricity is *Magnetic!*

In 1831

Michael Faraday (English)
and
Joseph Henry (American)
discovered that
a moving magnet
produces an
electric current
in a nearby wire!

Electricity is *Magnetic!*


Joseph Henry
(1797-1878)


Michael Faraday
(1791-1867)

These two fellows discovered the basis for the electrification of the entire world!

Electricity is *Magnetic!*

33 years later James Clerk Maxwell,
a Scottish theoretical physicist and mathematician
postulated that Electric and Magnetic fields
produce electromagnetic waves
that include radio, x-rays and light!

Maxwell's Equations (Simplified!)

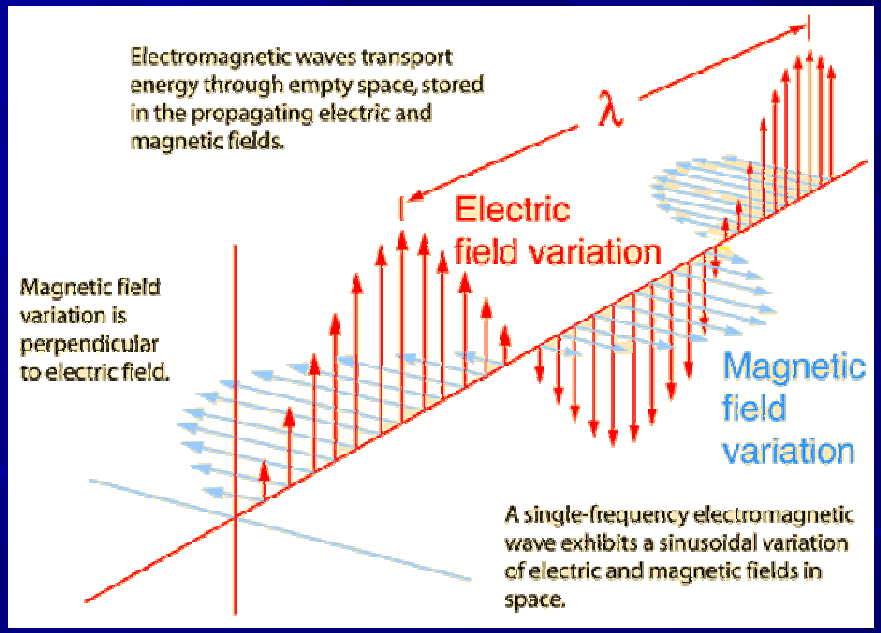
(by Oliver Heaviside)

$$\nabla \cdot \mathbf{D} = \rho \qquad (1) \qquad \text{Gauss' Law}$$

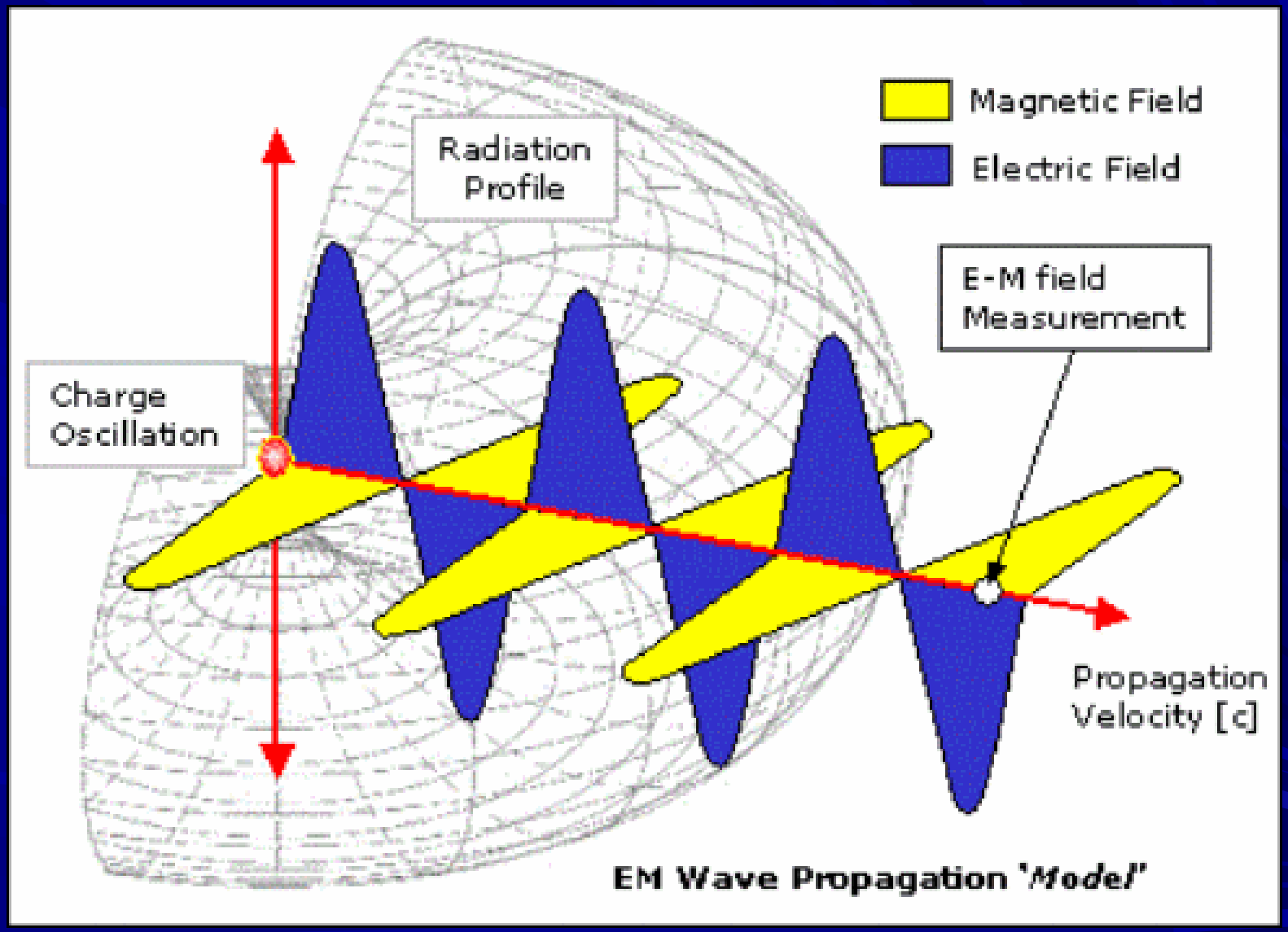
$$\nabla \cdot \mathbf{B} = 0 \qquad (2) \qquad \text{Gauss' Law for magnetism}$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \qquad (3) \qquad \text{Faraday's Law}$$

$$\nabla \times \mathbf{H} = \frac{\partial \mathbf{D}}{\partial t} + \mathbf{J} \qquad (4) \qquad \text{Ampère-Maxwell Law}$$



Electric and Magnetic Fields Propagate thru Space

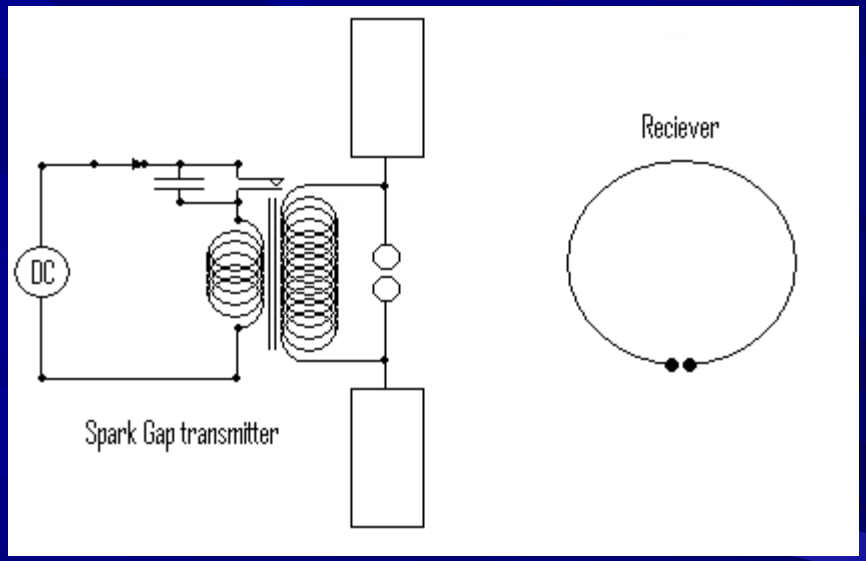

Magnetic Field
Electric Field
Radiation Profile
E-M field Measurement
Charge Oscillation
Propagation Velocity [c]
EM Wave Propagation 'Model'

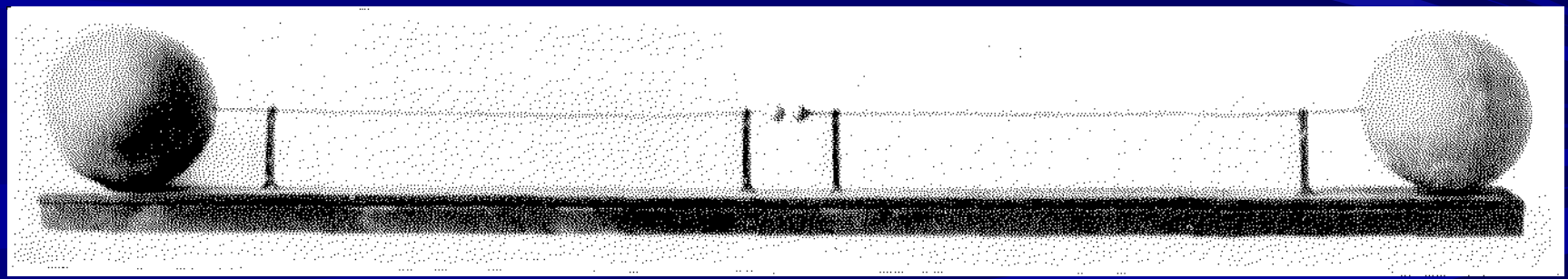
Electricity is *Magnetic!*

And then in 1888 Heinrich Hertz
...based on the work of
Faraday, Henry and Maxwell...
constructed a Radio transmitter and receiver
and proved that electromagnetic waves exist!

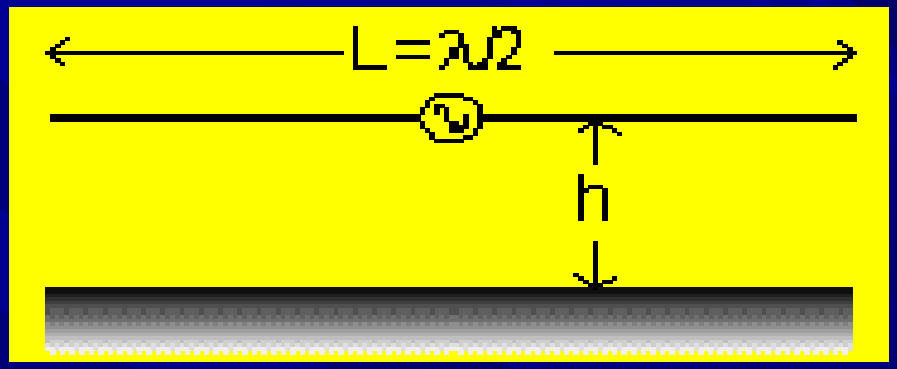
Electricity is *Magnetic!*

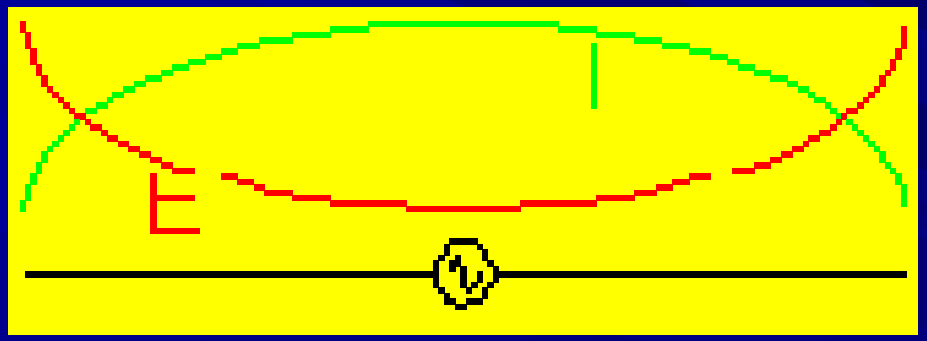
Heinrich Hertz Transmitter and Receiver

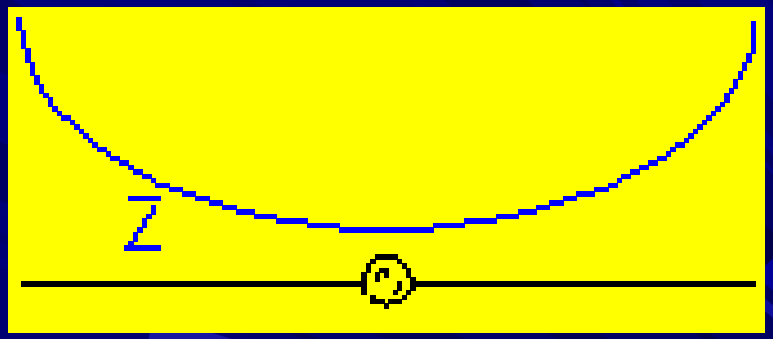




The Basic Dipole





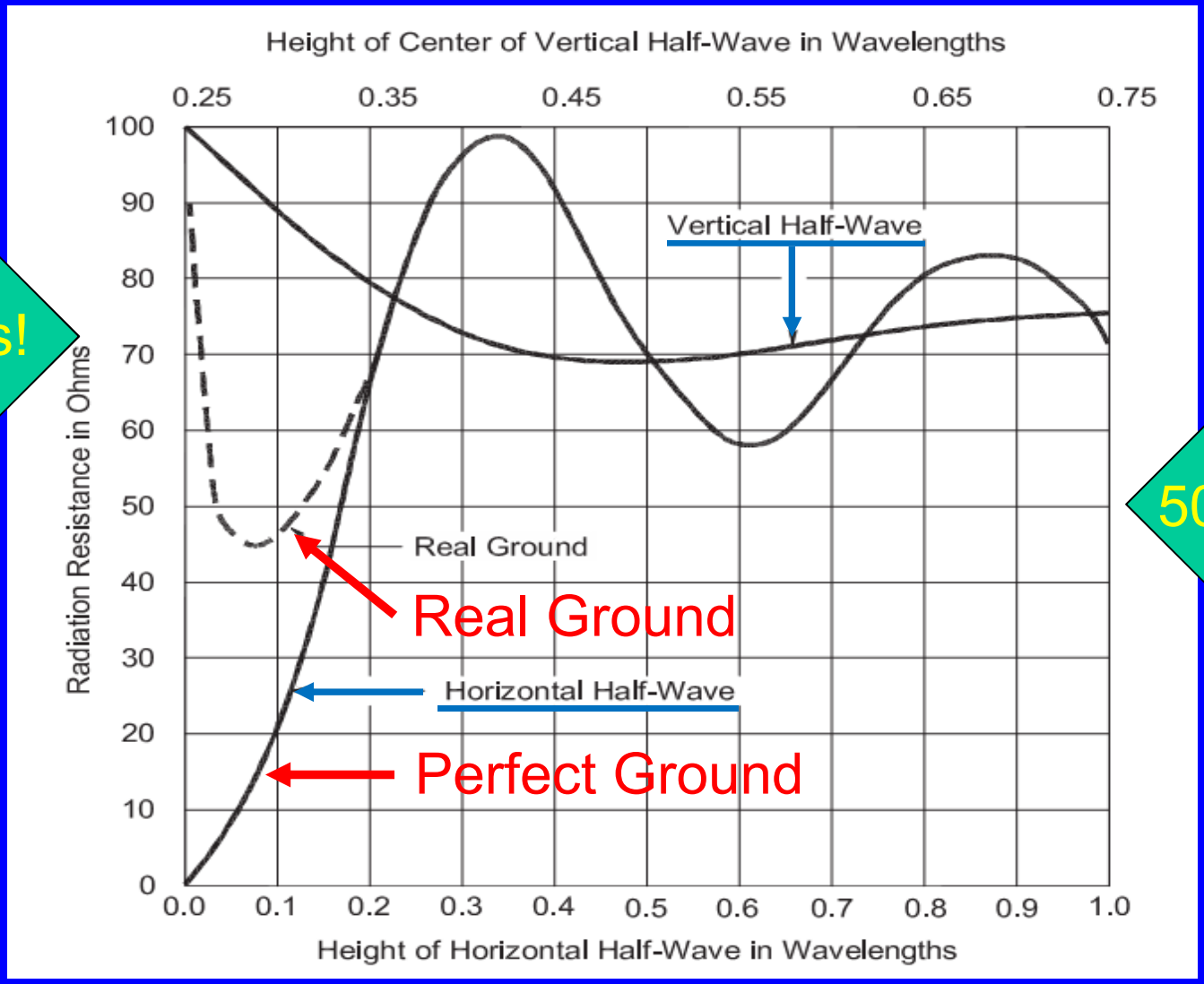


Current vs. Voltage

Impedance Follows Ohm's Law: Z=E / I

e.g.100W at 50 ohms, Z = 70.7V / 1.41A

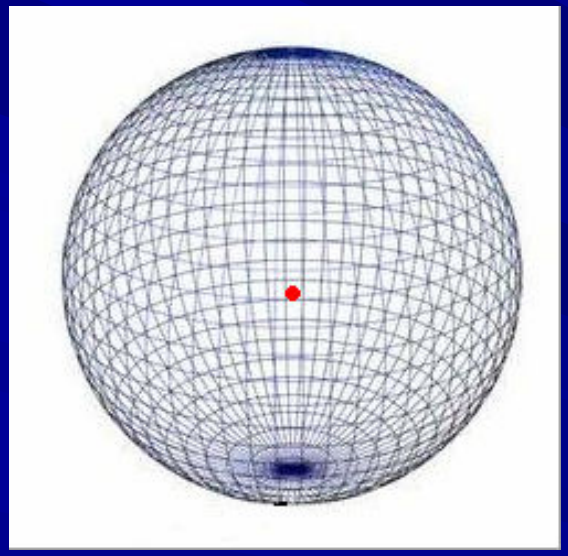
Impedance of Half-Wave Dipole Over "Ground"



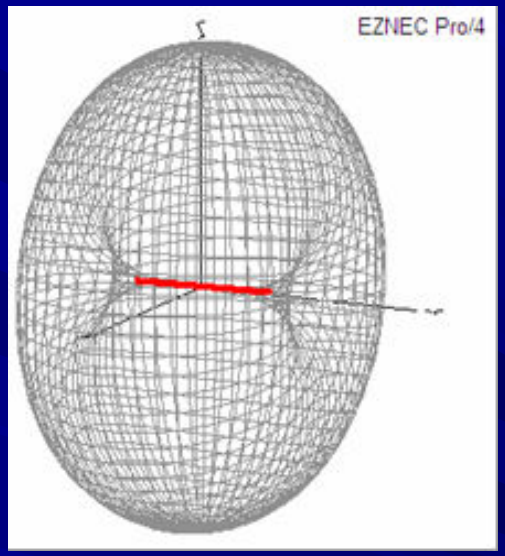
72 Ohms!

50 Ohms?

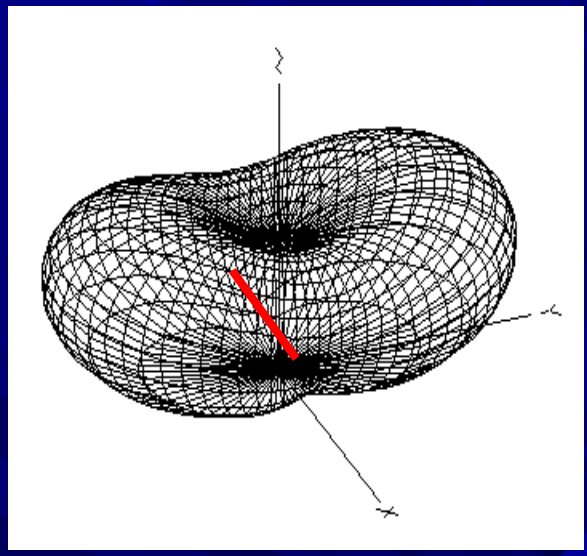
Demystifying Antenna Gain



Isotropic Antenna
in Free Space
Gain = 0 dBi



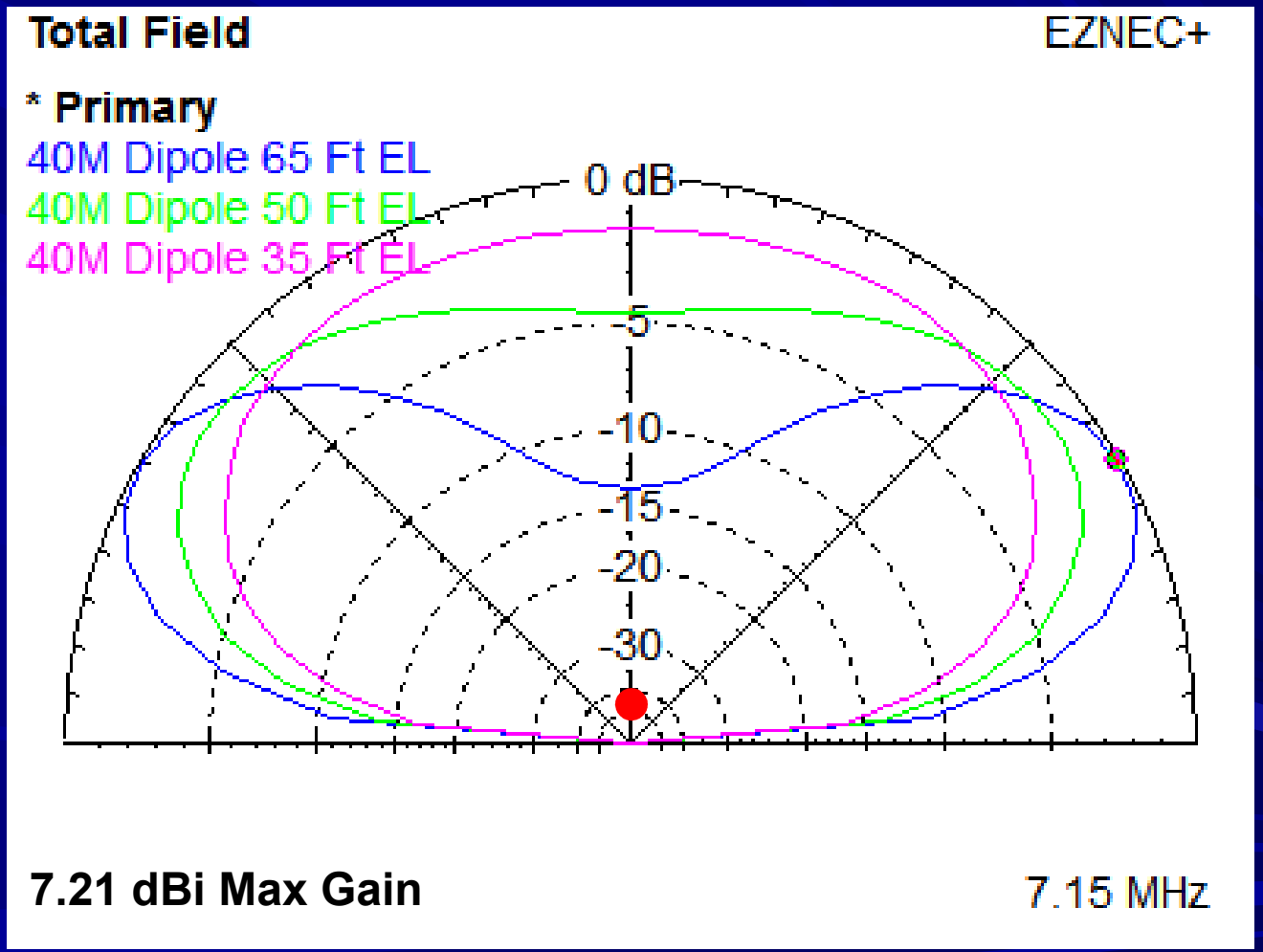
Dipole Antenna
in Free Space
Gain = 2.15 dBi



Dipole Antenna
Over Ave. Ground
½ WL High
Gain = 7.2 dBi

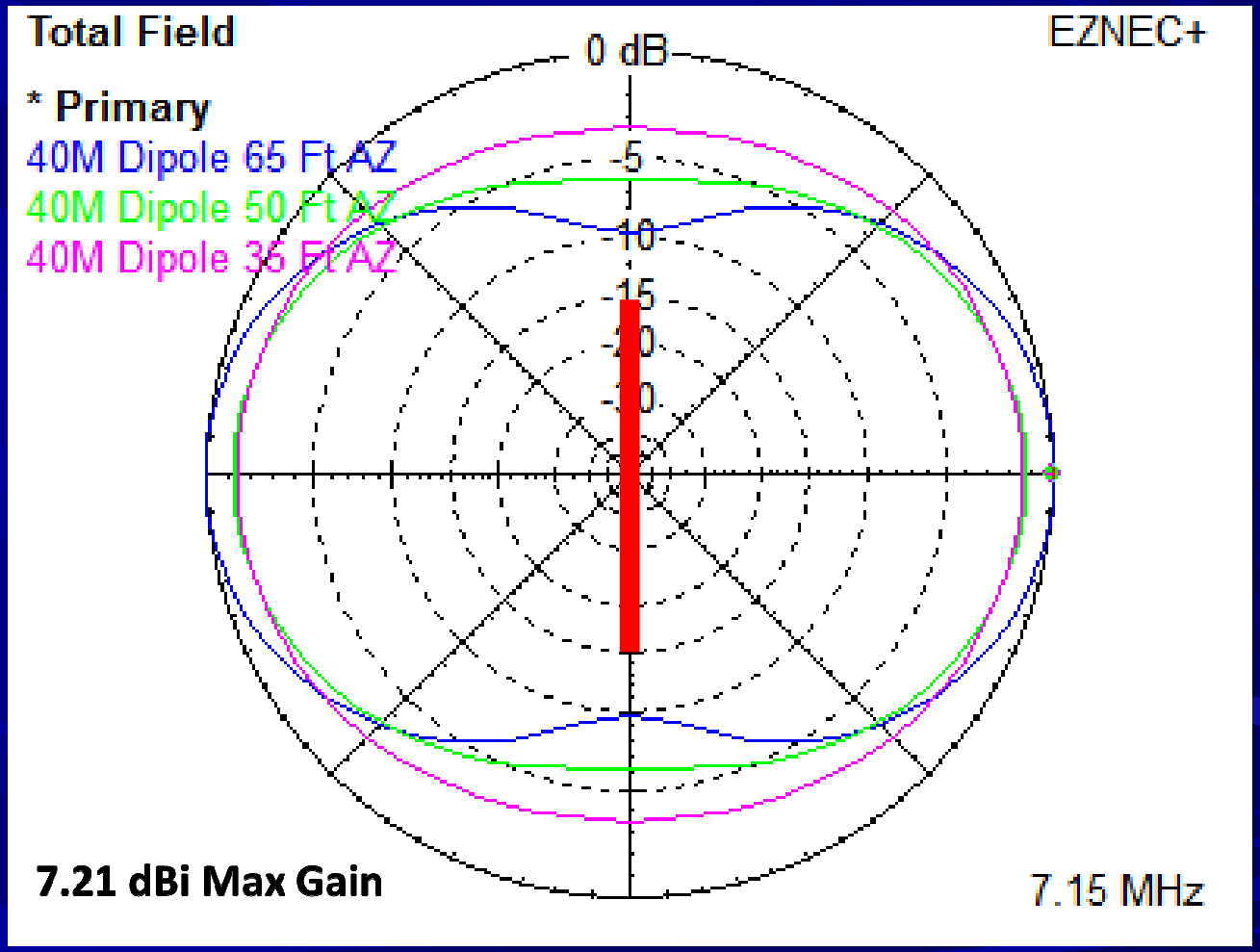
Height Matters!

For Horizontal Antennas

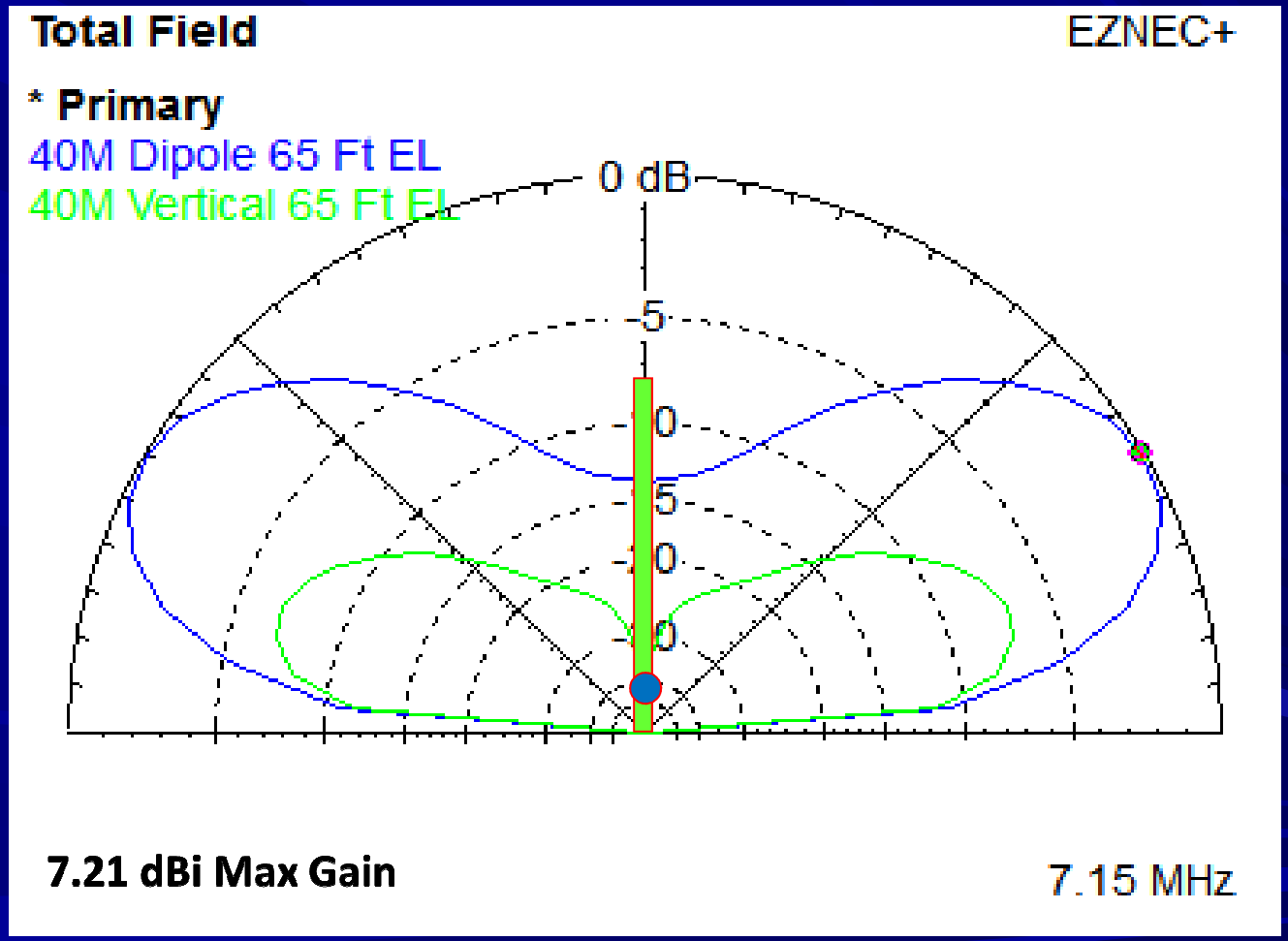


Height Matters!

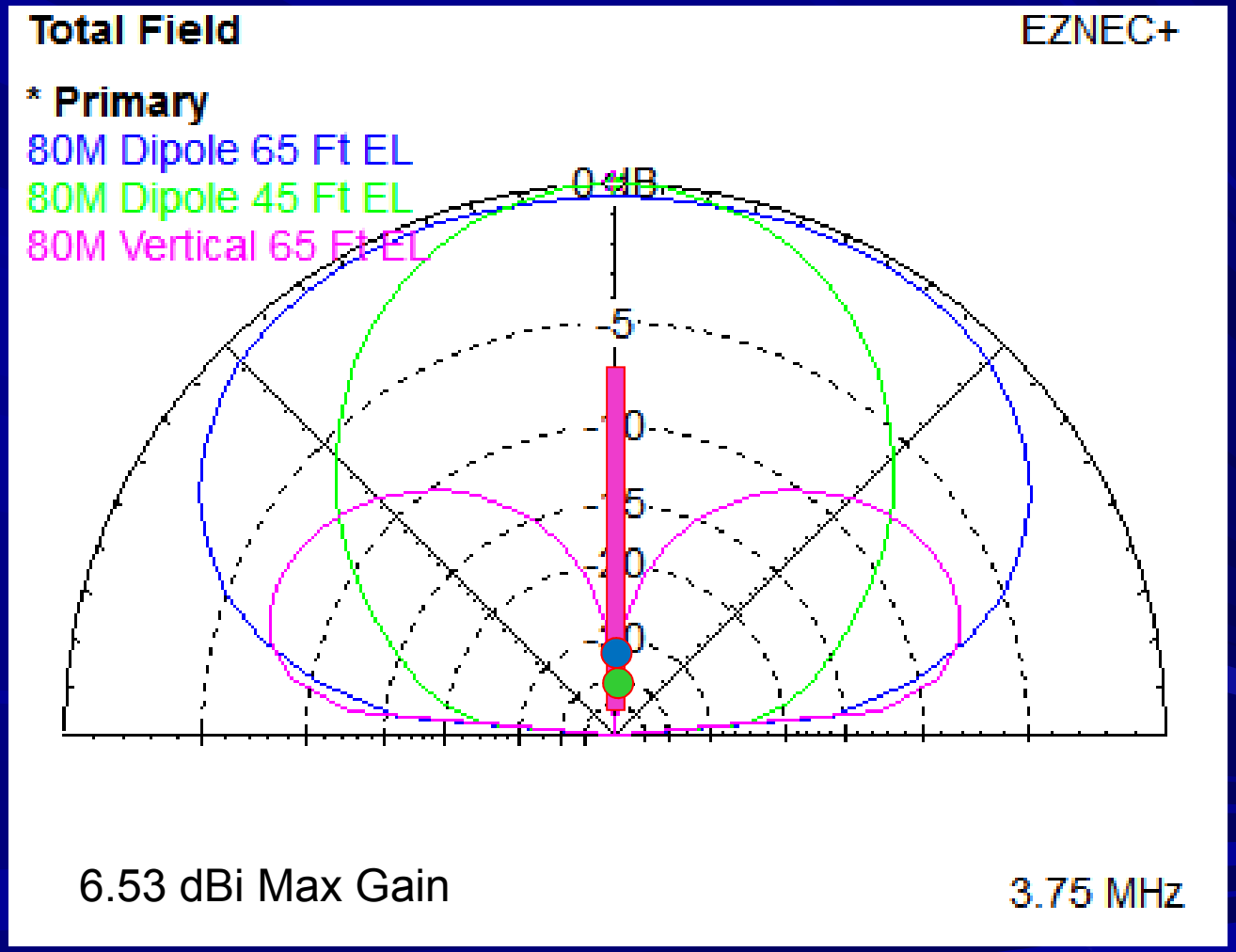
For Horizontal Antennas



How About Horizontal vs. Vertical Antennas on 40M?



How About Horizontal vs. Vertical Antennas on 80M?

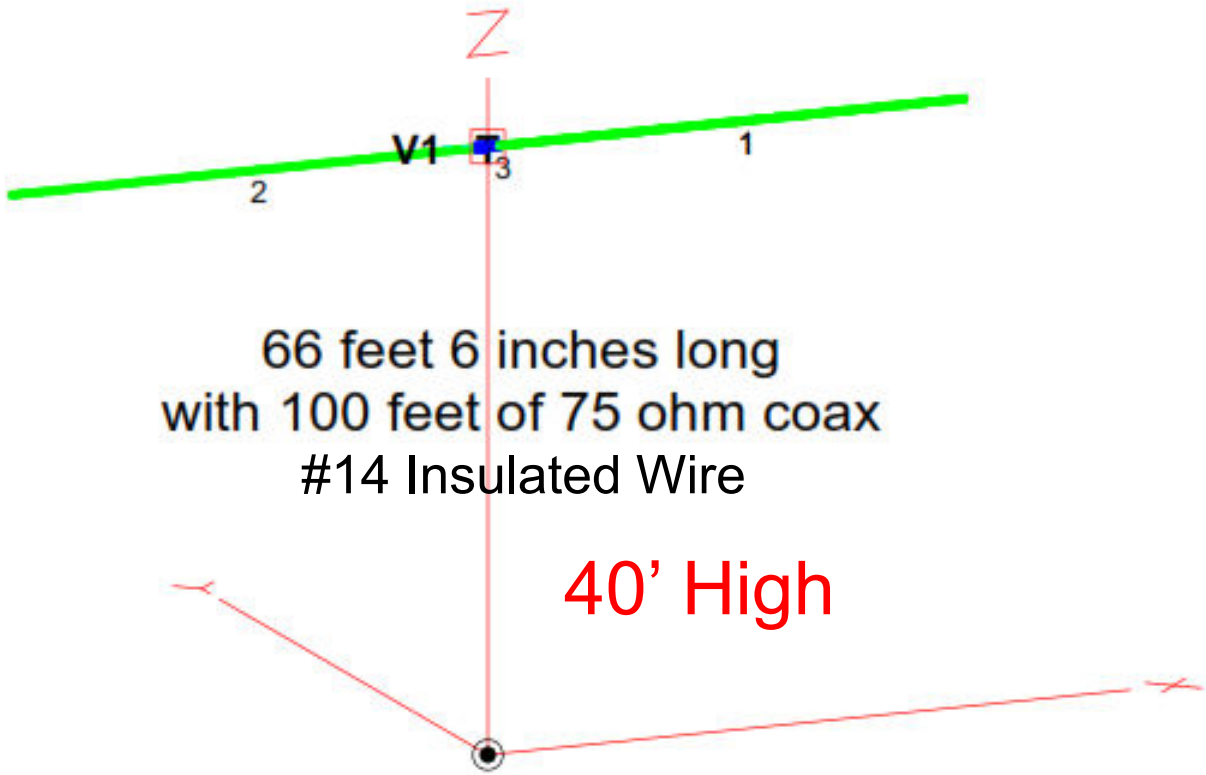


No Antenna is Perfect...

But, how about one that you can:

- Build in About One Hour
- Use on 40 and 15M without a Tuner
- Use on 30, 20, 17, 12 and 10M with a Modest Tuner (with some coax loss)
- Work DX and Local Stations
- Fit in as little as 44 Feet of Space
- Build and Install for Less than $20 Including Coax Feed Line!!

40-15M Dipole

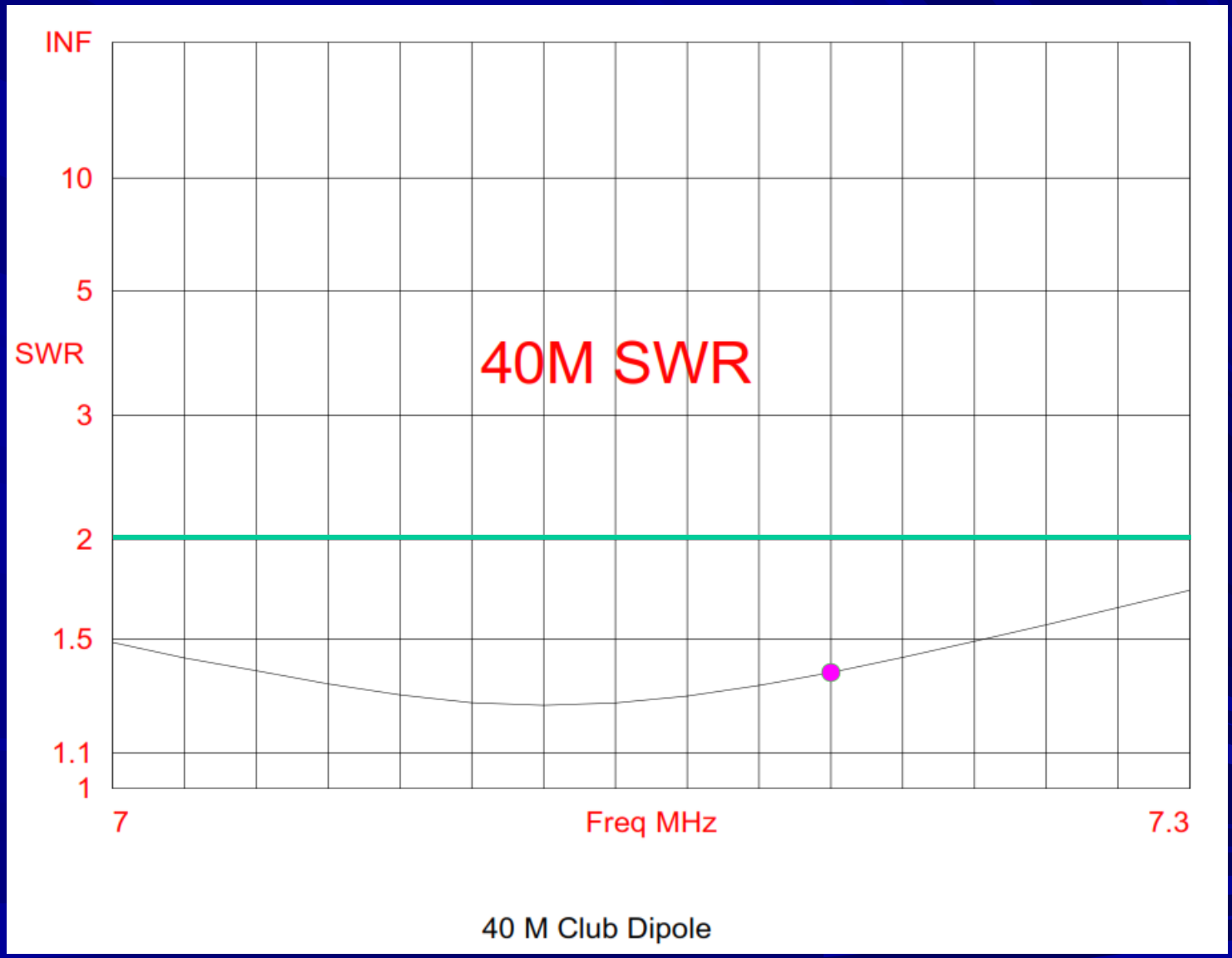


66 feet 6 inches long
with 100 feet of 75 ohm coax
#14 Insulated Wire

40’ High

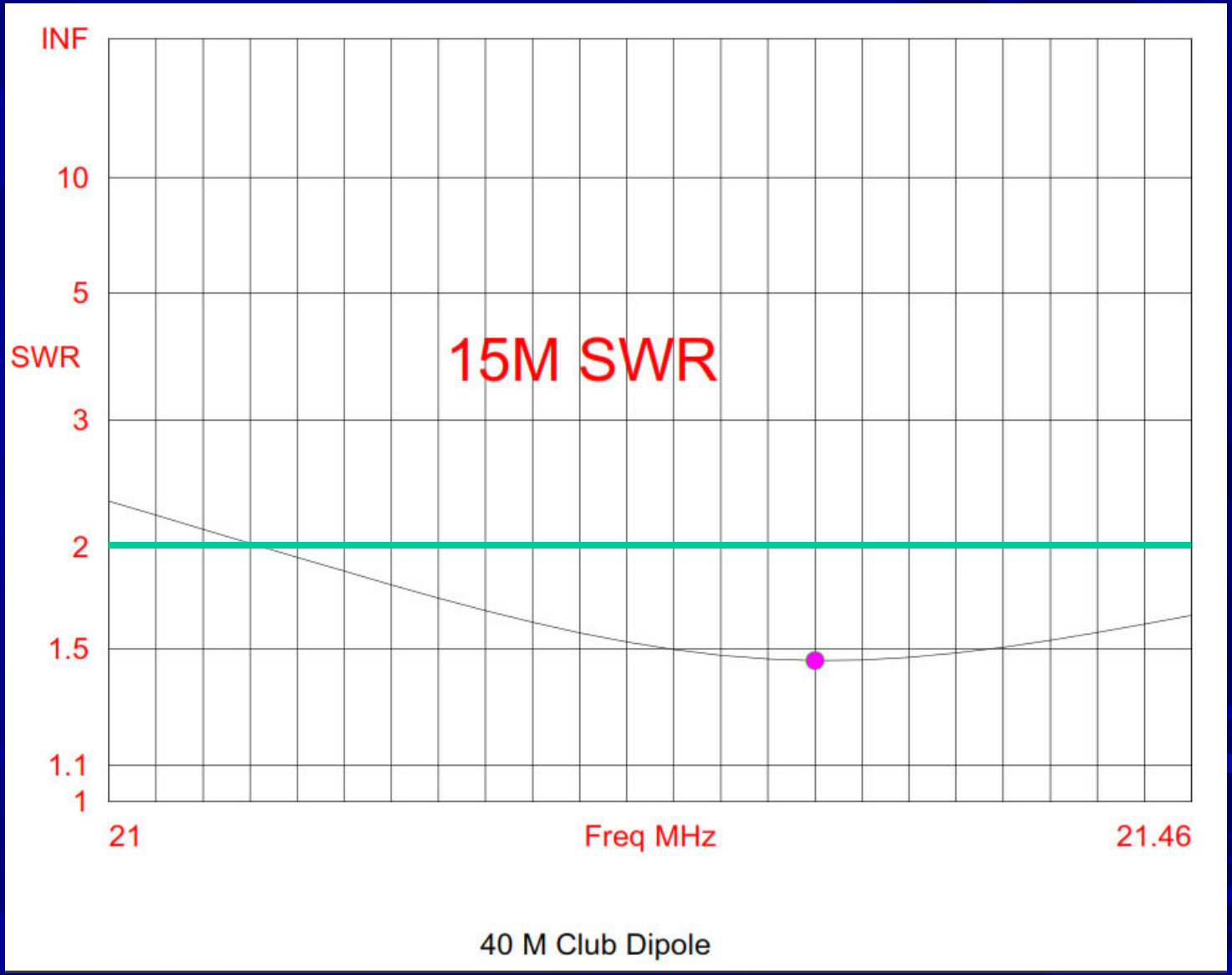
Club 40/15M Dipole

40-15M Dipole

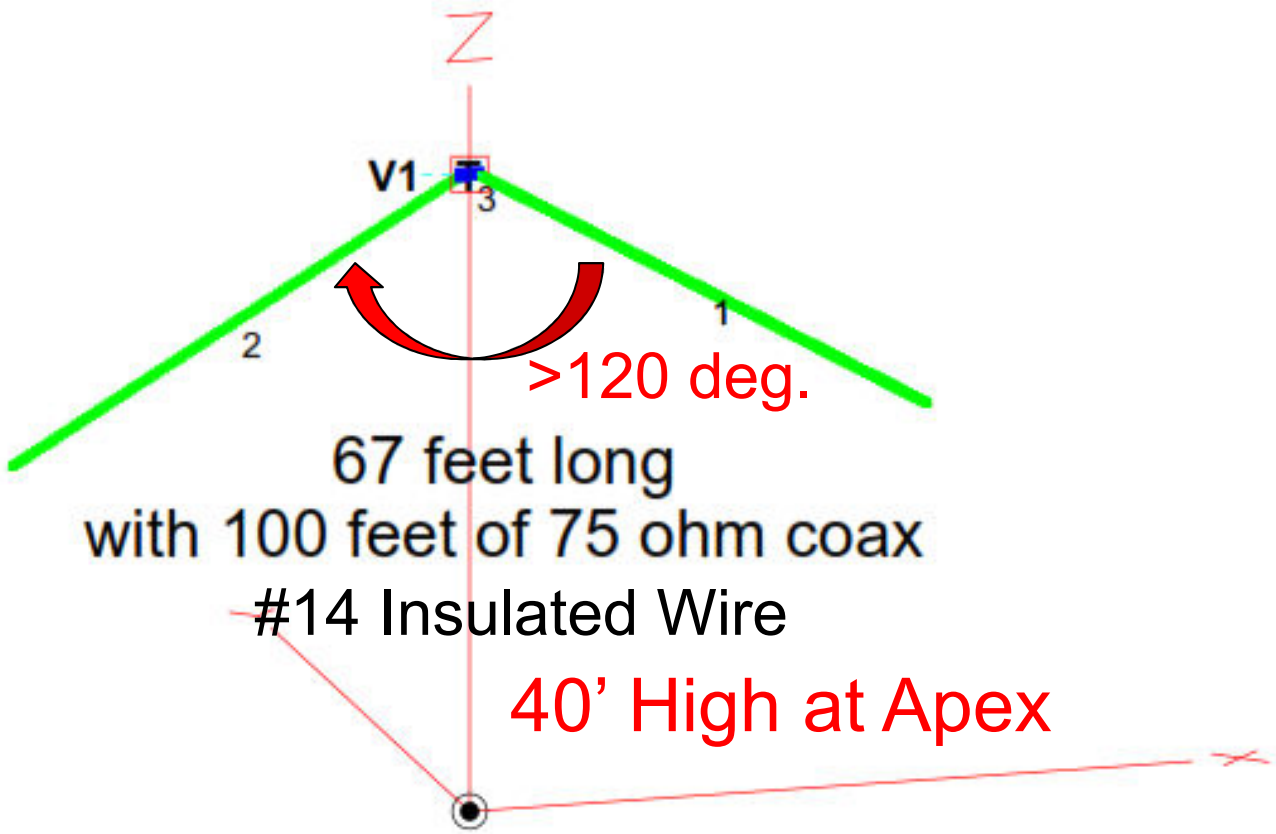


40 M Club Dipole

40-15M Dipole

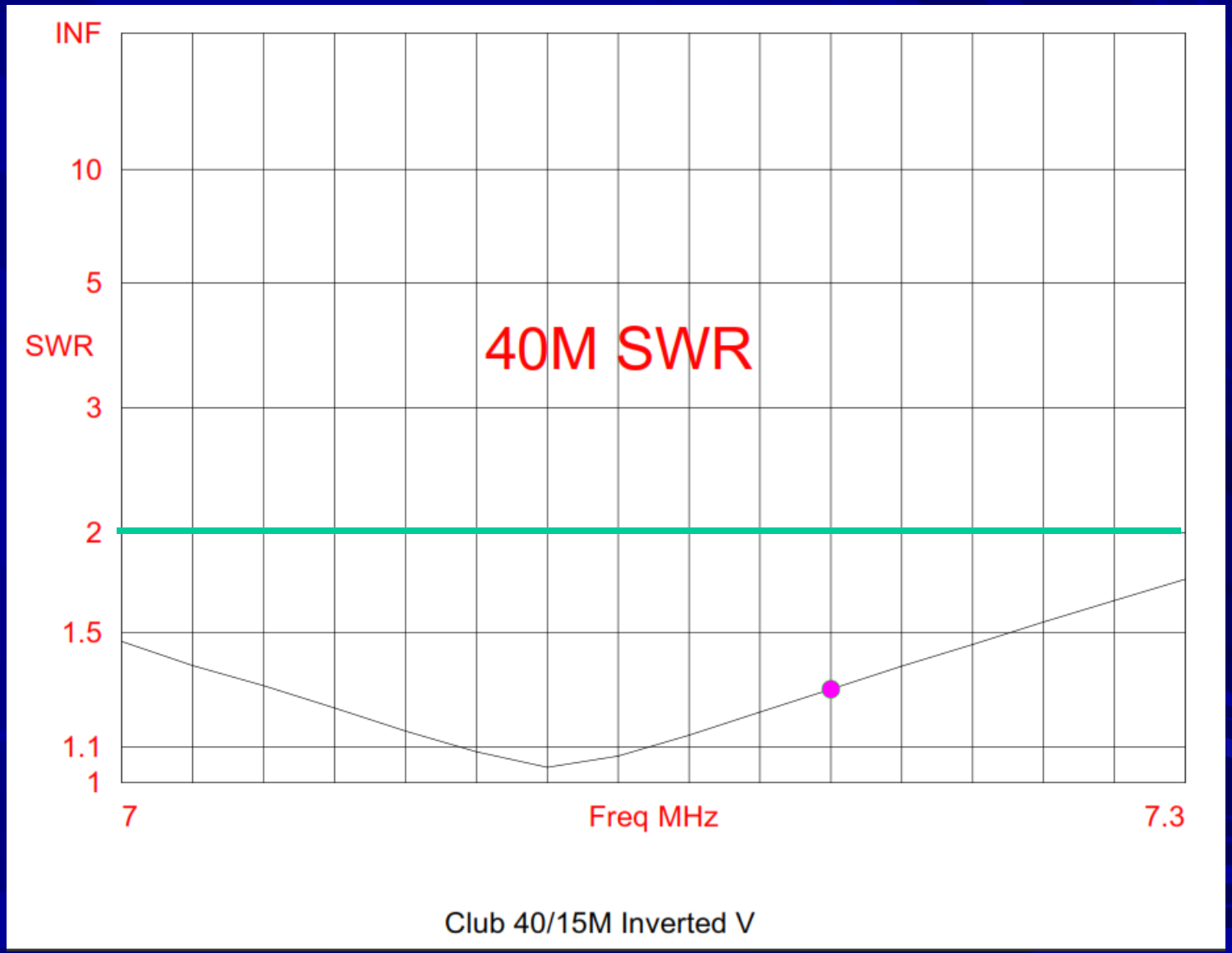


40-15M Inverted “V”



Club 40/15M Inverted V

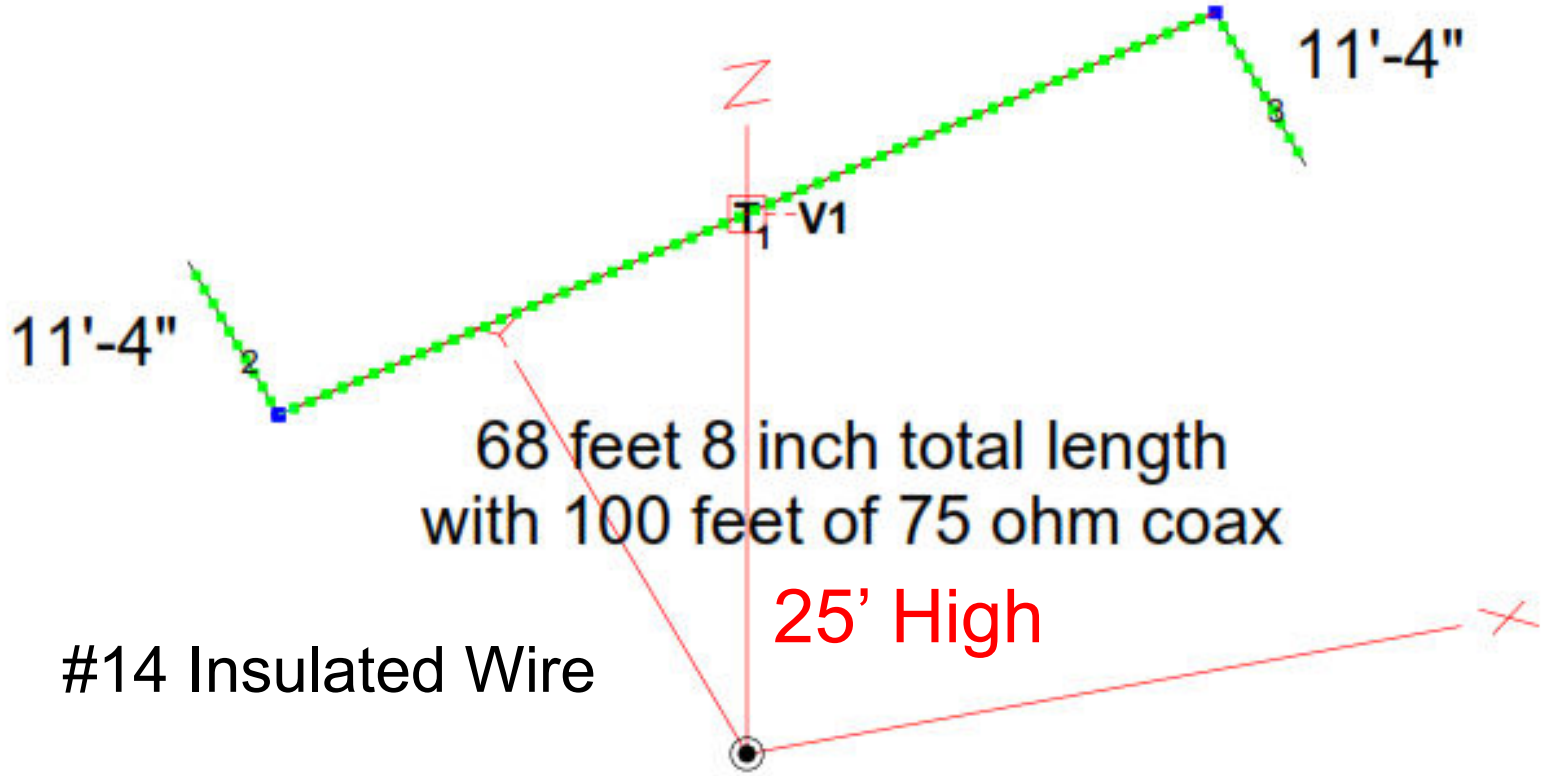
40-15M Inverted “V”



Club 40/15M Inverted V

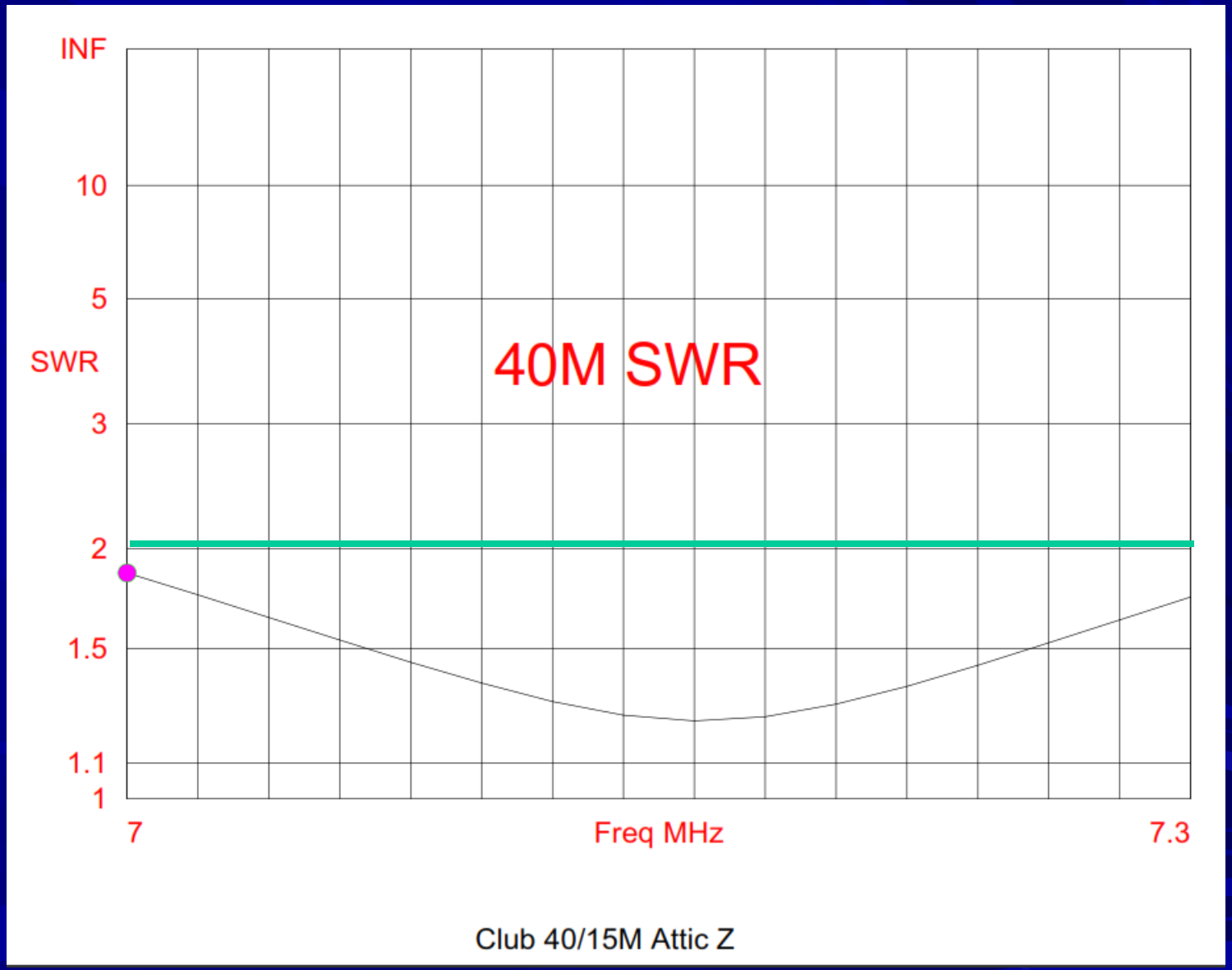
40-15M Inverted “V”

40-15M Attic “Z”



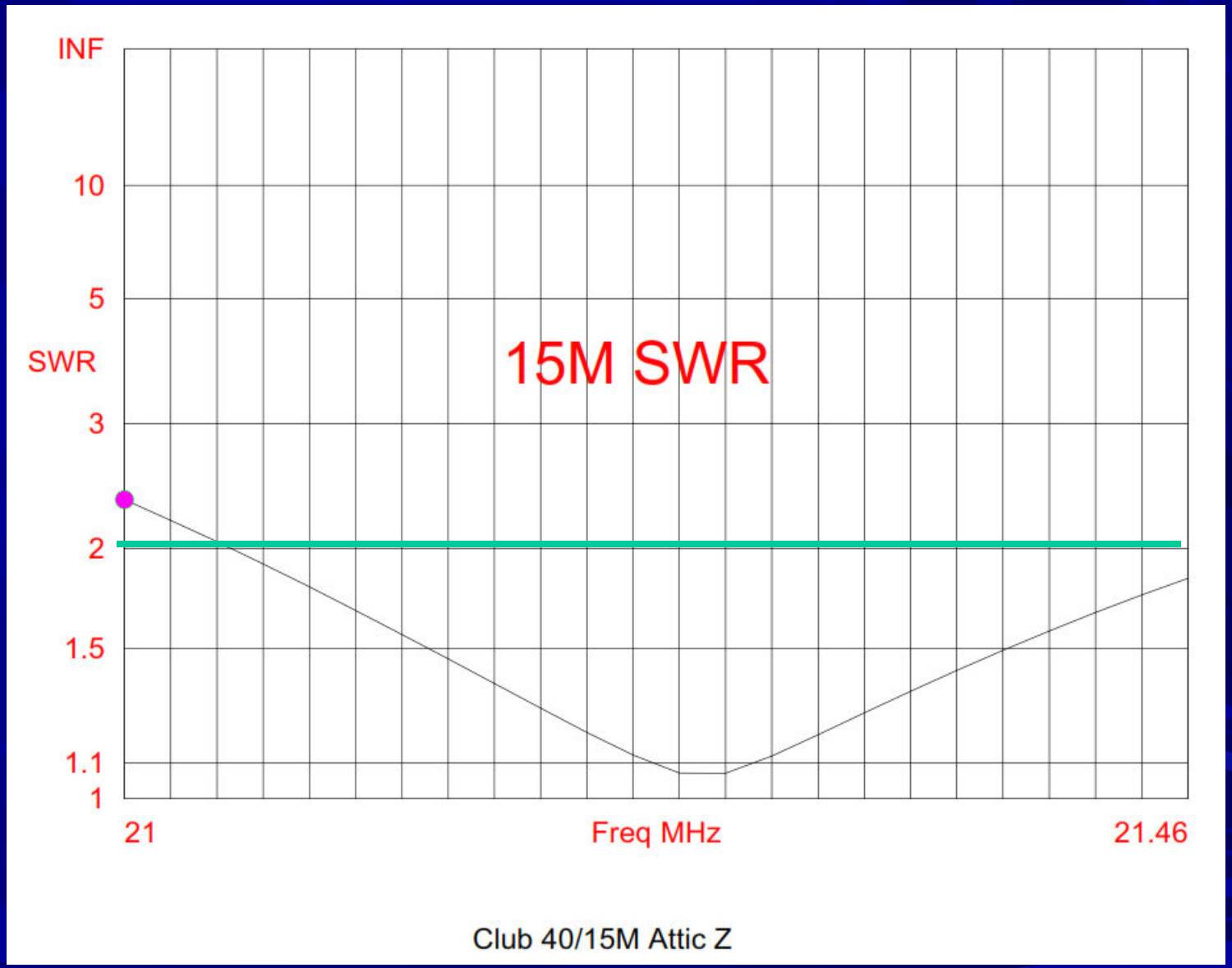
Club 40/15M Attic Z

40-15M Attic “Z”



Club 40/15M Attic Z

40-15M Attic “Z”



Club 40/15M Attic Z

Materials

- Wire – 70 feet for $10
- Insulators – Home Brew for $1
- Coax – 100 feet for $20
- Coax Connector – 1 for $3

How About Loop Antennas?

How Well do they Work?

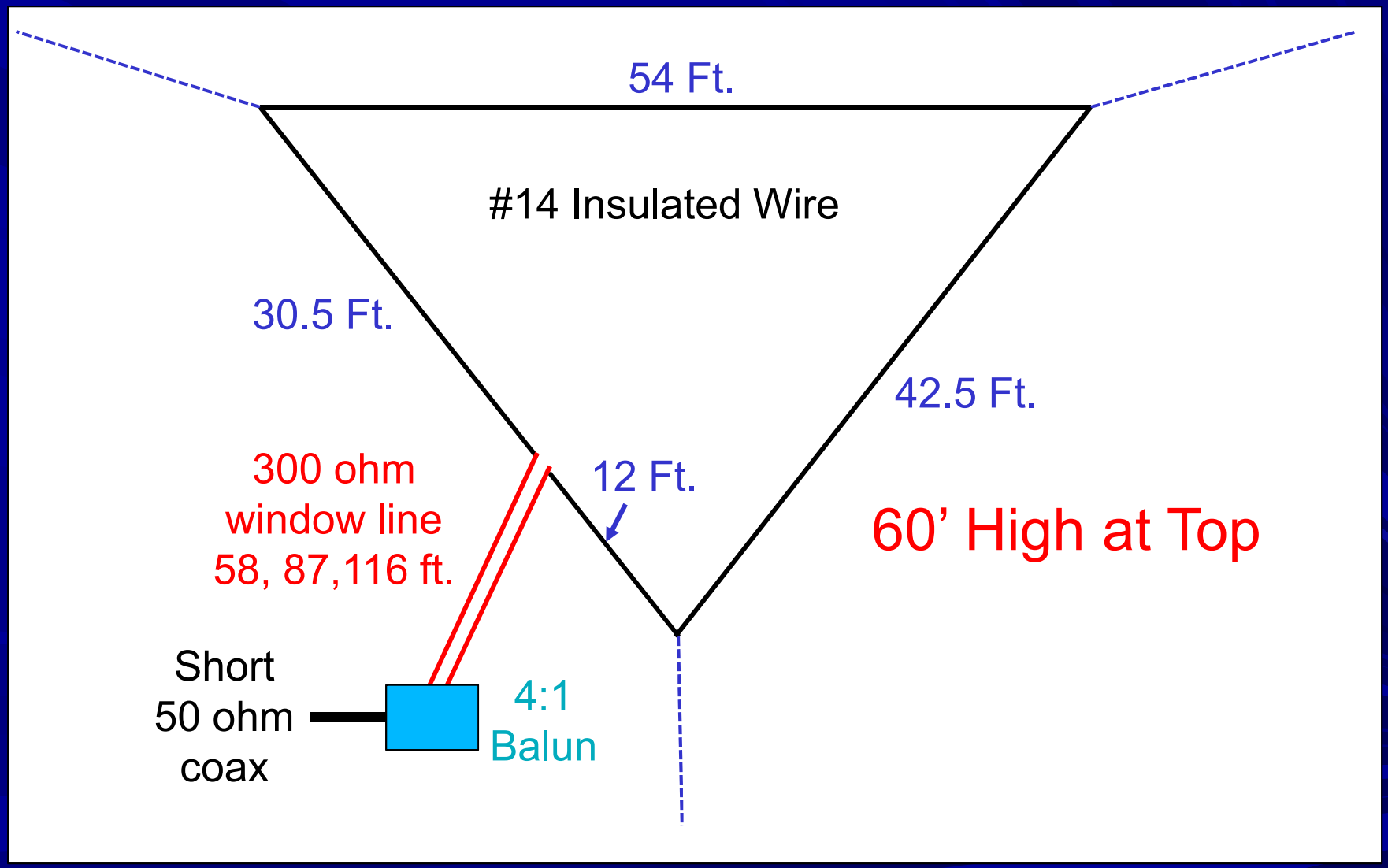
"I call them *Miracle Workers*!"

No Antenna is Perfect...

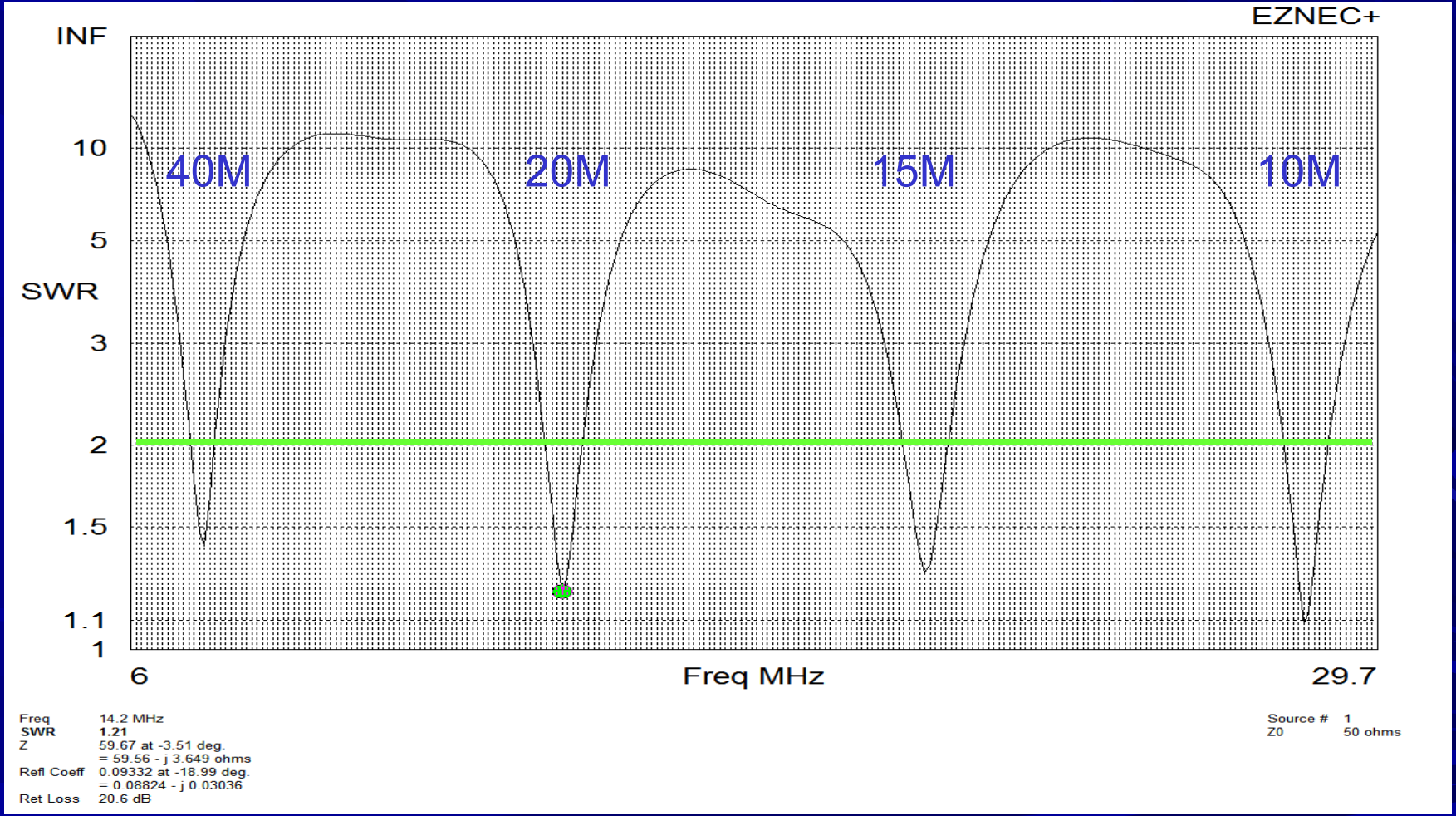
But, how about one that you can:

- Build in About Two Hours
- Use on 40, 20, 15 and 10M without a Tuner
- Use on 30, 17 and 12M with a Good Tuner
- Work DX and Local Stations
- Fit in 60 Feet of Space Between Supports
- Buy for Less than $70 Including Feed Line!!
- Add a 4:1 Balun for $50

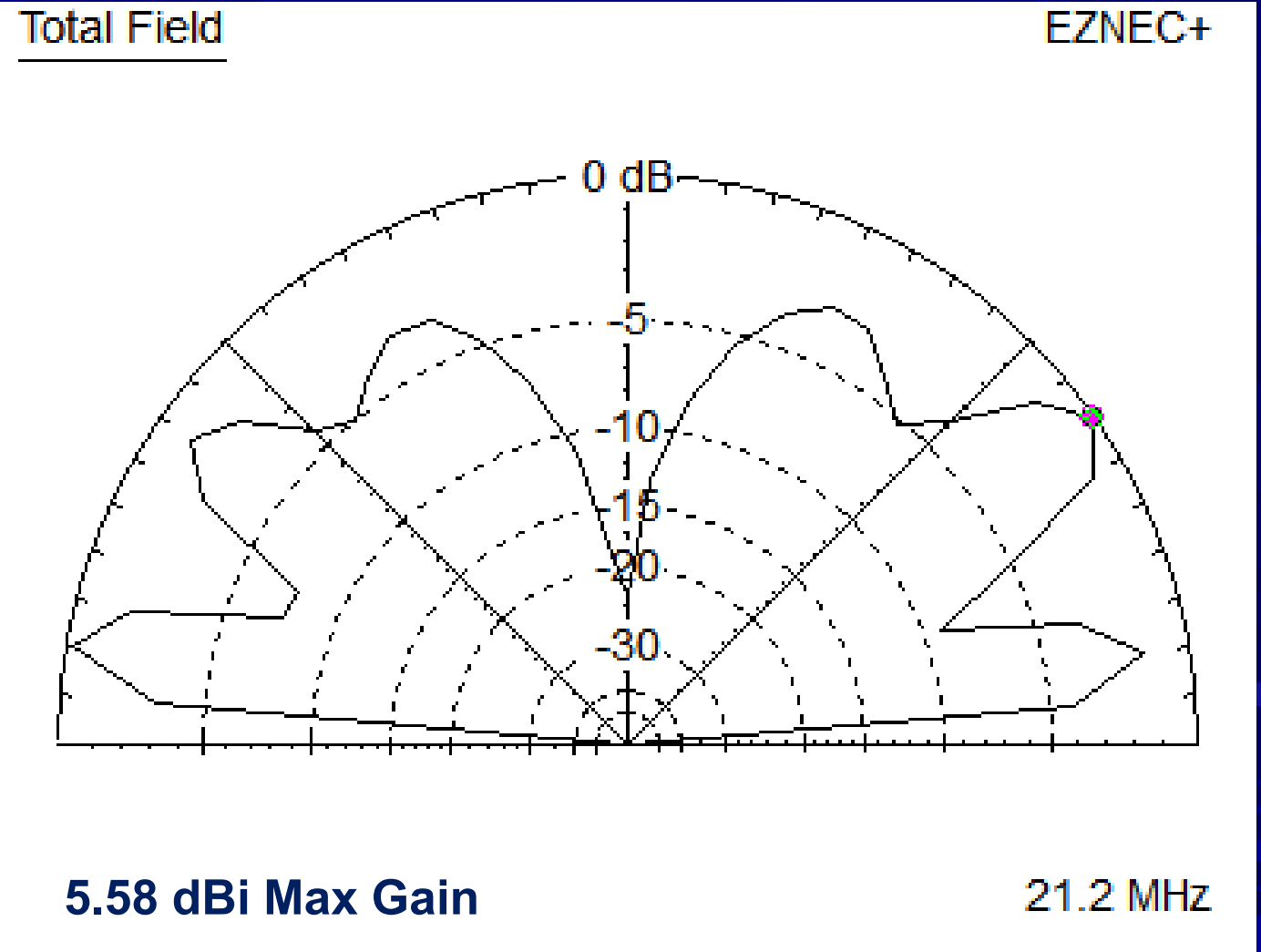
Side-Fed Inverted Delta Loop



Resonant on 40, 20, 15 and 10M
Plus 30, 17 and 12M with a Good Tuner



Takeoff Angles Good for DX and Local Contacts



Materials

DX Engineering
160M Dipole Kit
$69.95

Balun Designs
4:1 300 Watt Balun
$49.95

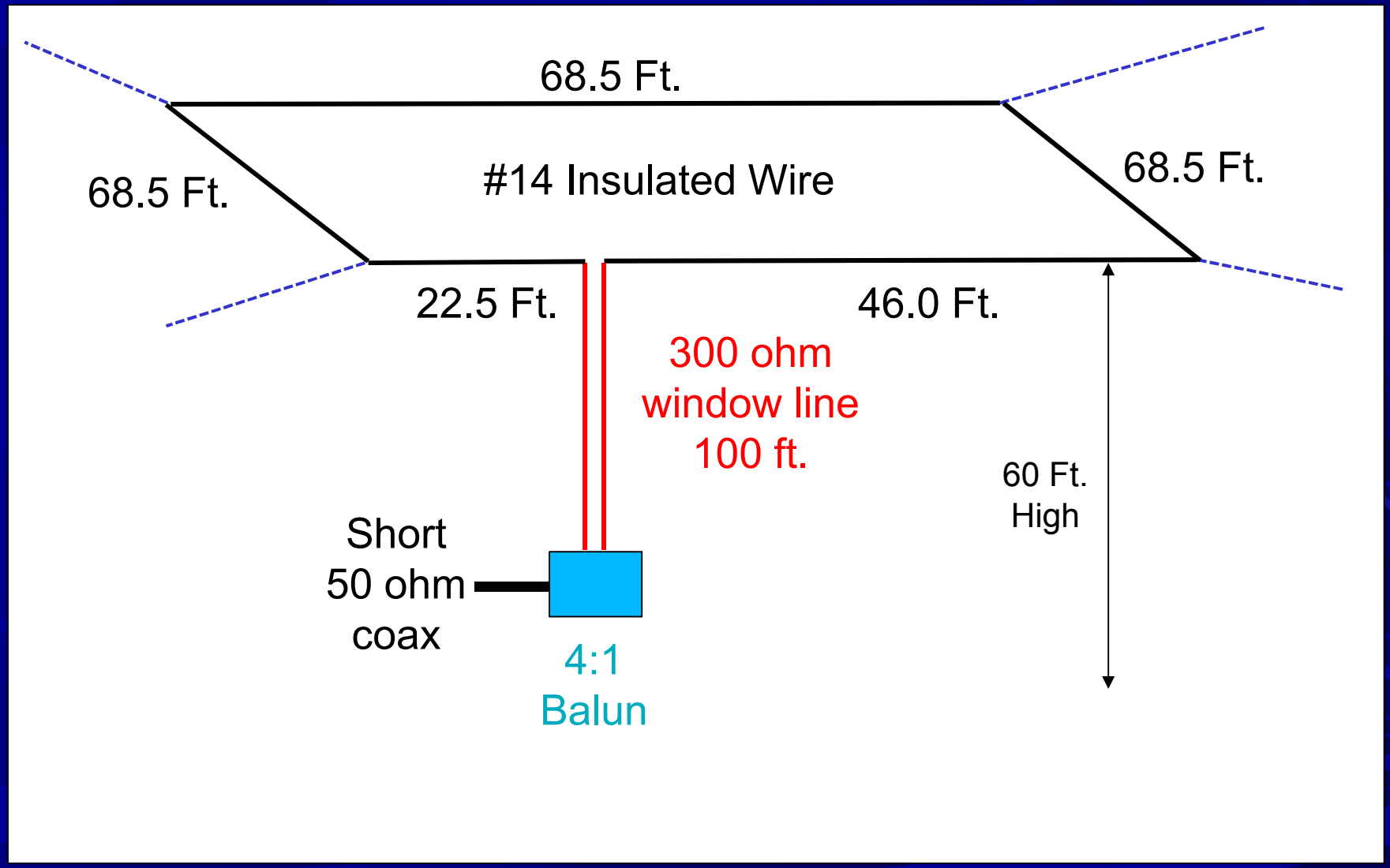
No Antenna is Perfect...

But, how about one that you can:

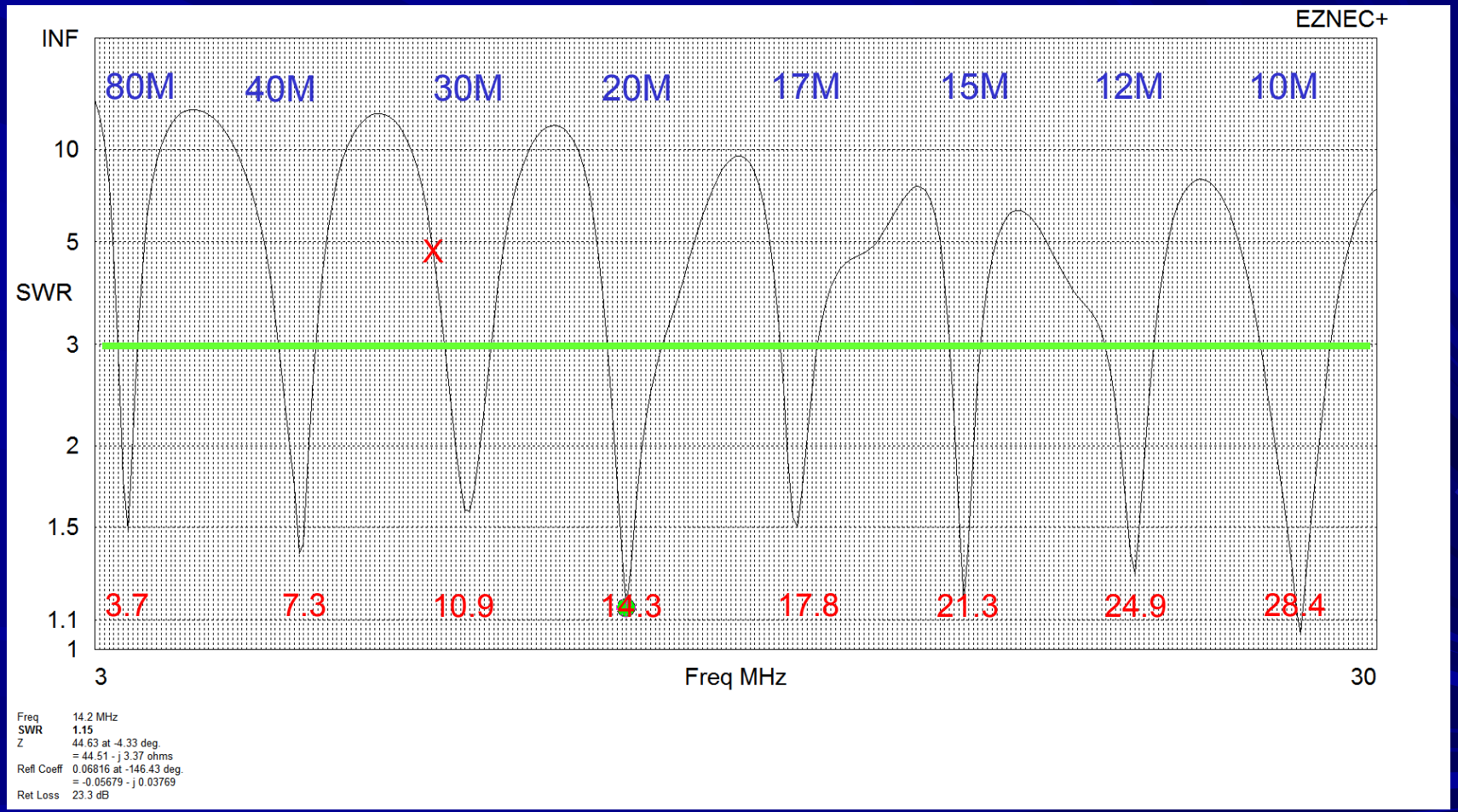
- Build in About Three Hours
- Use on 80, 40, 20, 17, 15, 12 and 10M with an SWR under 3:1...most under 2:1
- Use on 30 with a Modest Tuner
- Excellent DX on 40M and above
- Low Transmission Line and Balun Losses
- Buy for Less than $80 Including Feed Line!!
- Add a 4:1 Balun for $50 (300 Watt or less)

Horizontal Loop Skywire

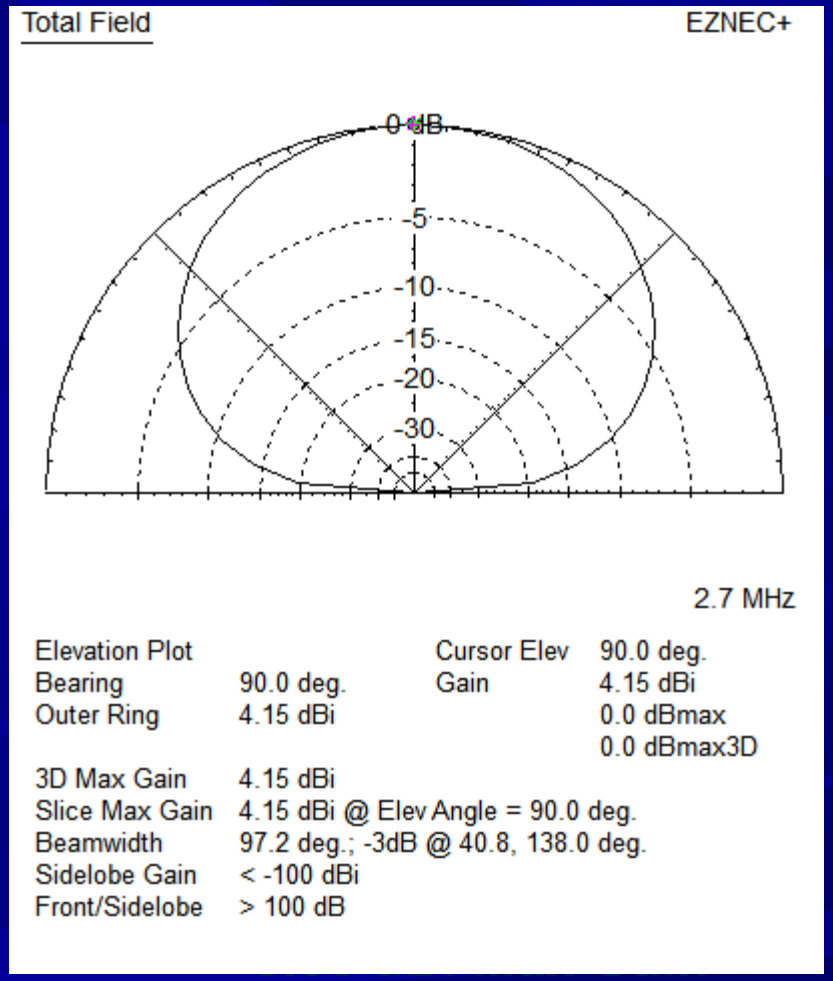
de Dave Fisher, W0HMS

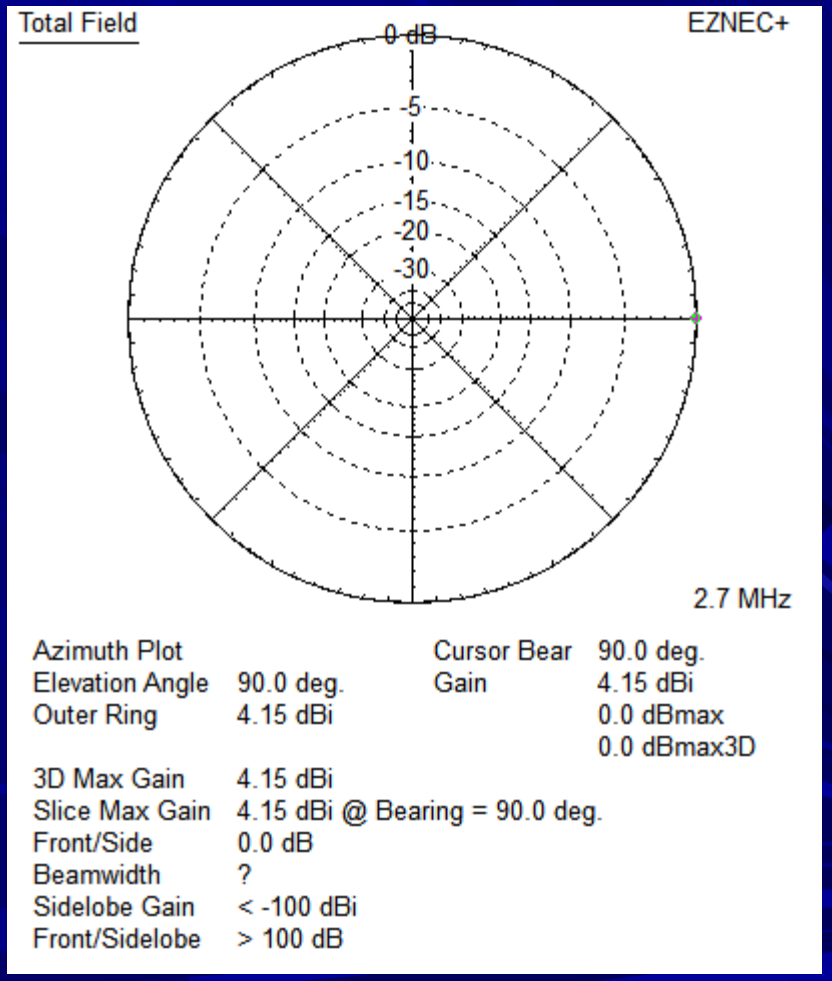


Under 3:1 SWR on All Bands Except 60 and 30M

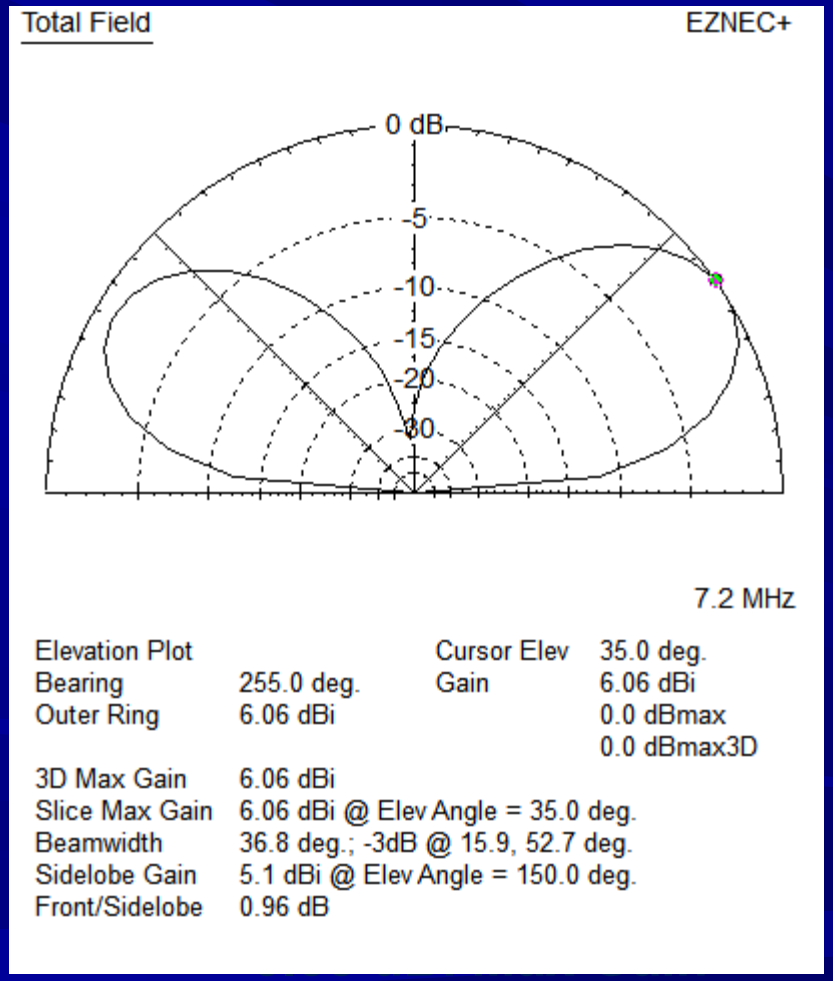


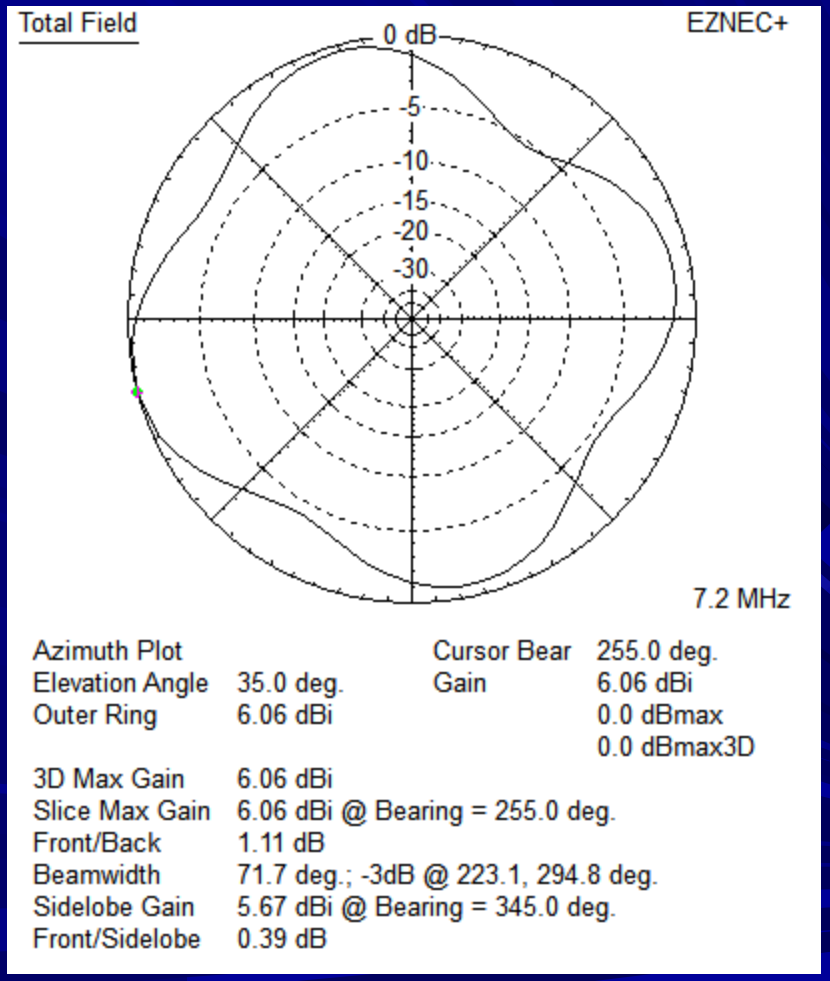
80M - High Takeoff Angle & Mod. Gain (4.2 dBi) Circular Pattern



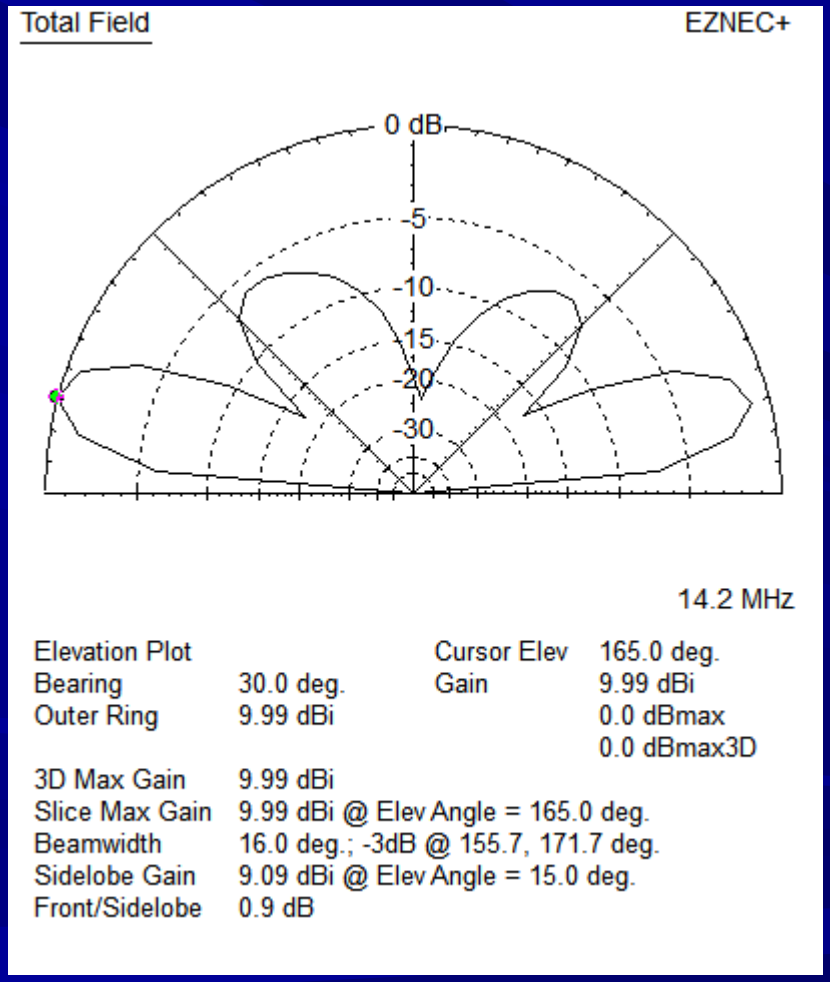


40M – Med. Takeoff Angle & Good Gain (6.1 dBi) Nearly Circular Patten

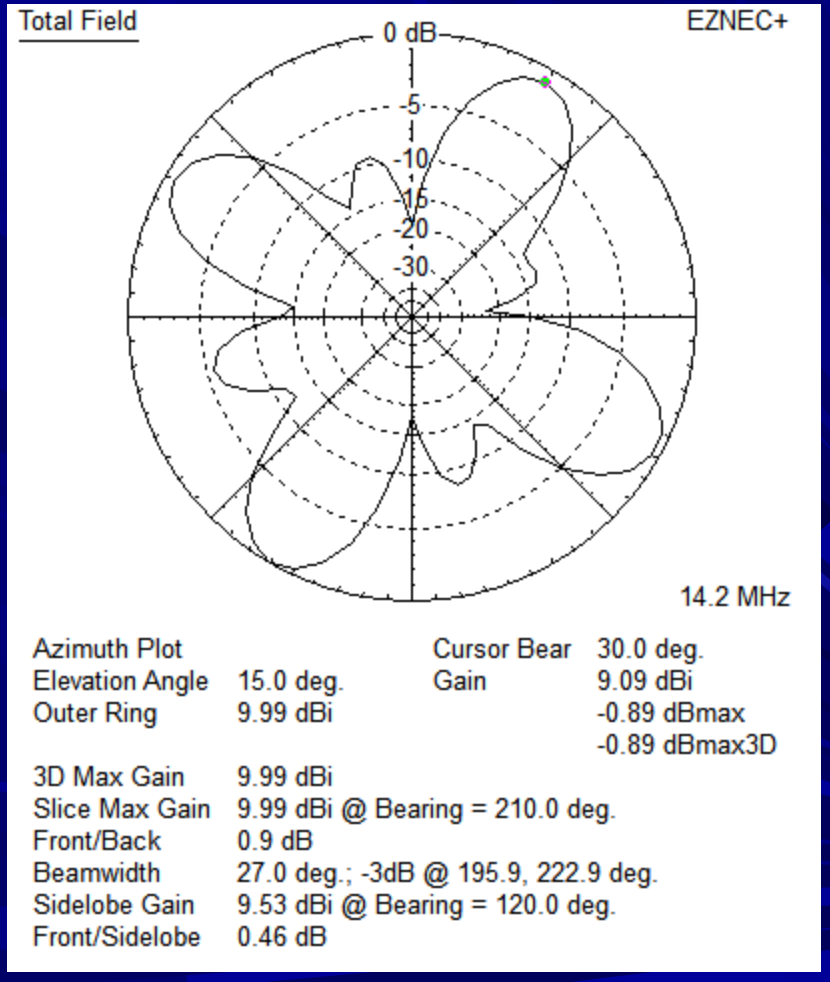




20M - Low Takeoff Angle & High Gain (9.99 dBi) Moderately Sharp Lobes and Nulls

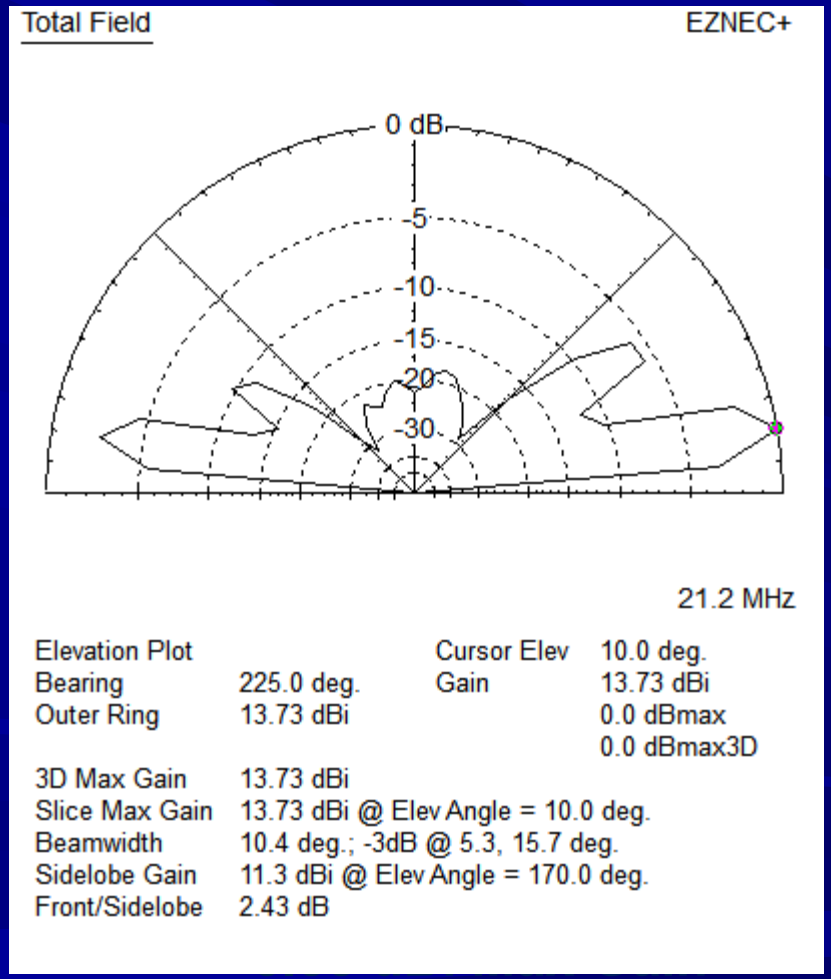


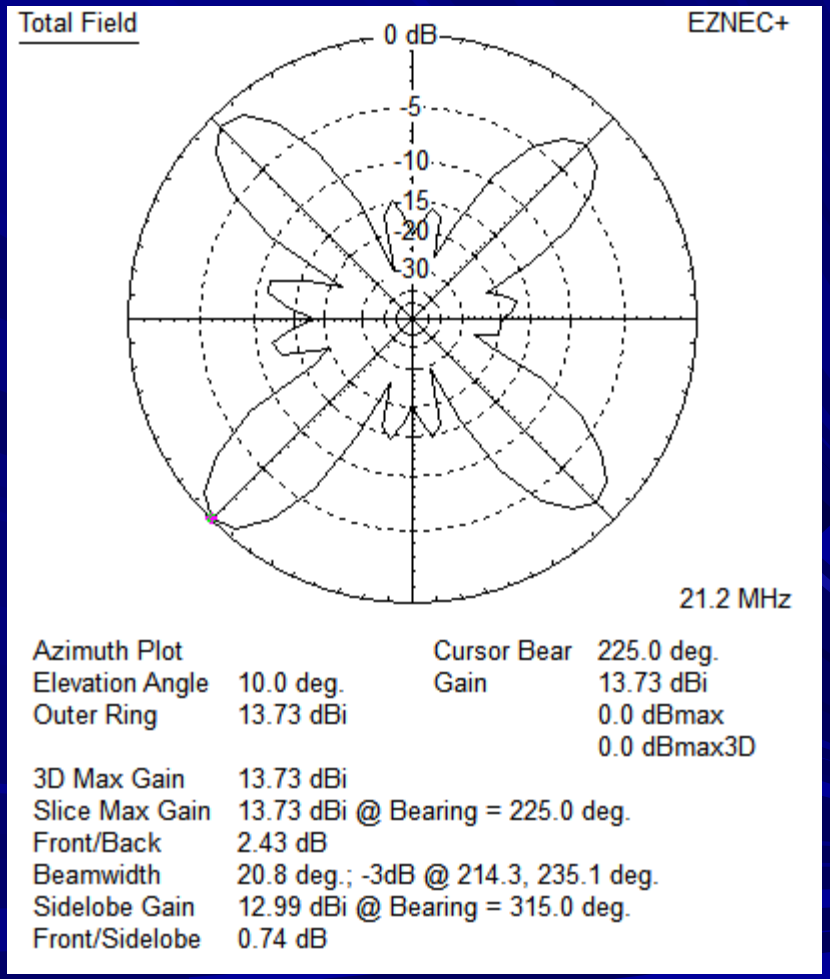
Elevation Plot		Cursor Elev	165.0 deg.
Bearing	30.0 deg.	Gain	9.99 dBi
Outer Ring	9.99 dBi		0.0 dBmax
			0.0 dBmax3D
3D Max Gain	9.99 dBi		
Slice Max Gain	9.99 dBi @ Elev Angle = 165.0 deg.		
Beamwidth	16.0 deg.; -3dB @ 155.7, 171.7 deg.		
Sidelobe Gain	9.09 dBi @ Elev Angle = 15.0 deg.		
Front/Sidelobe	0.9 dB		



Azimuth Plot		Cursor Bear	30.0 deg.
Elevation Angle	15.0 deg.	Gain	9.09 dBi
Outer Ring	9.99 dBi		-0.89 dBmax
			-0.89 dBmax3D
3D Max Gain	9.99 dBi		
Slice Max Gain	9.99 dBi @ Bearing = 210.0 deg.		
Front/Back	0.9 dB		
Beamwidth	27.0 deg.; -3dB @ 195.9, 222.9 deg.		
Sidelobe Gain	9.53 dBi @ Bearing = 120.0 deg.		
Front/Sidelobe	0.46 dB		

15M - Low Takeoff Angle & High Gain (13.7 dBi) Sharp Lobes and Nulls





Materials

DX Engineering 160M Dipole Kit - $69.95

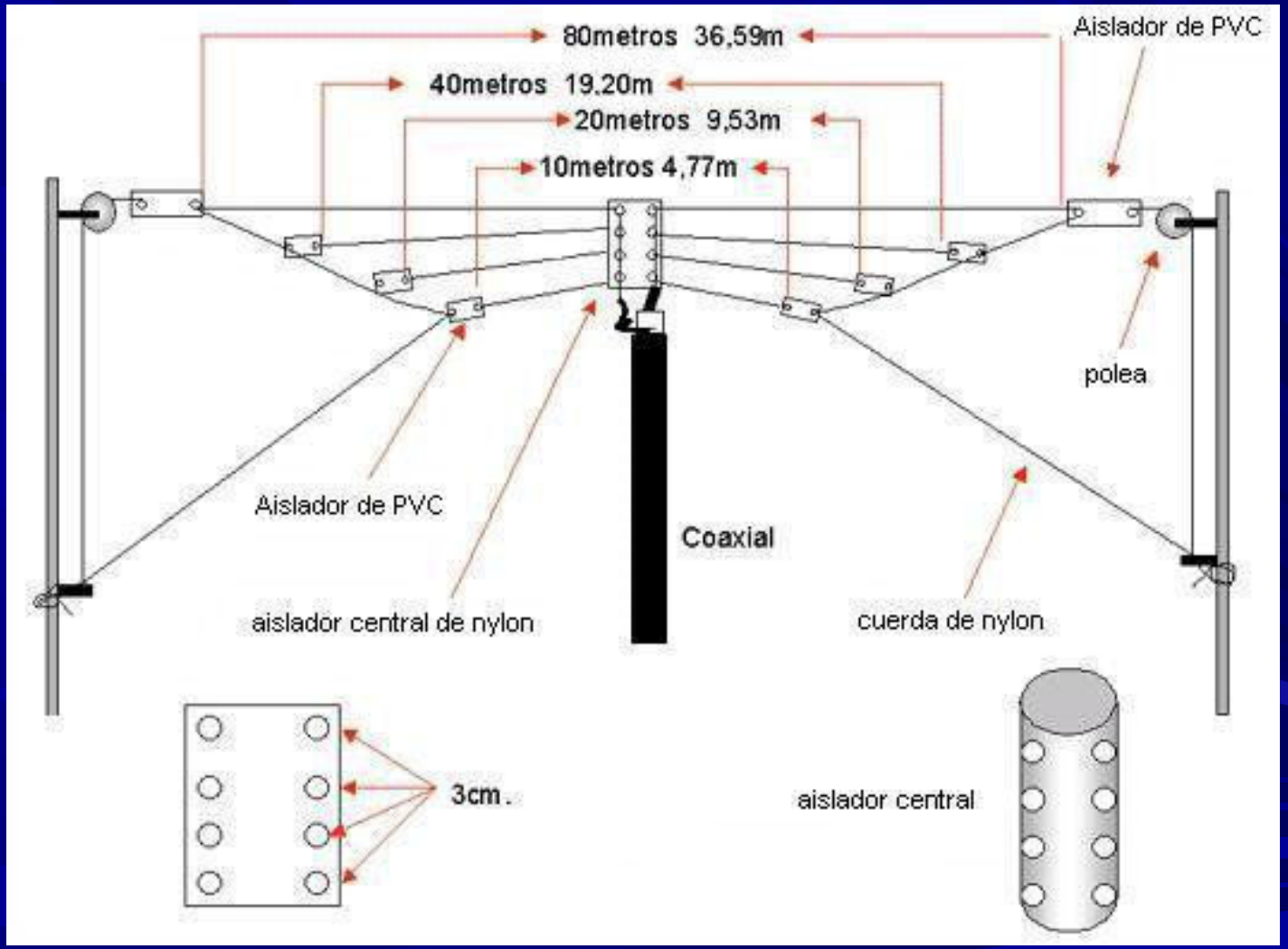
Plus 4 corner insulators and 20 feet more wire.

Balun Designs
4:1 300 Watt Balun
$49.95

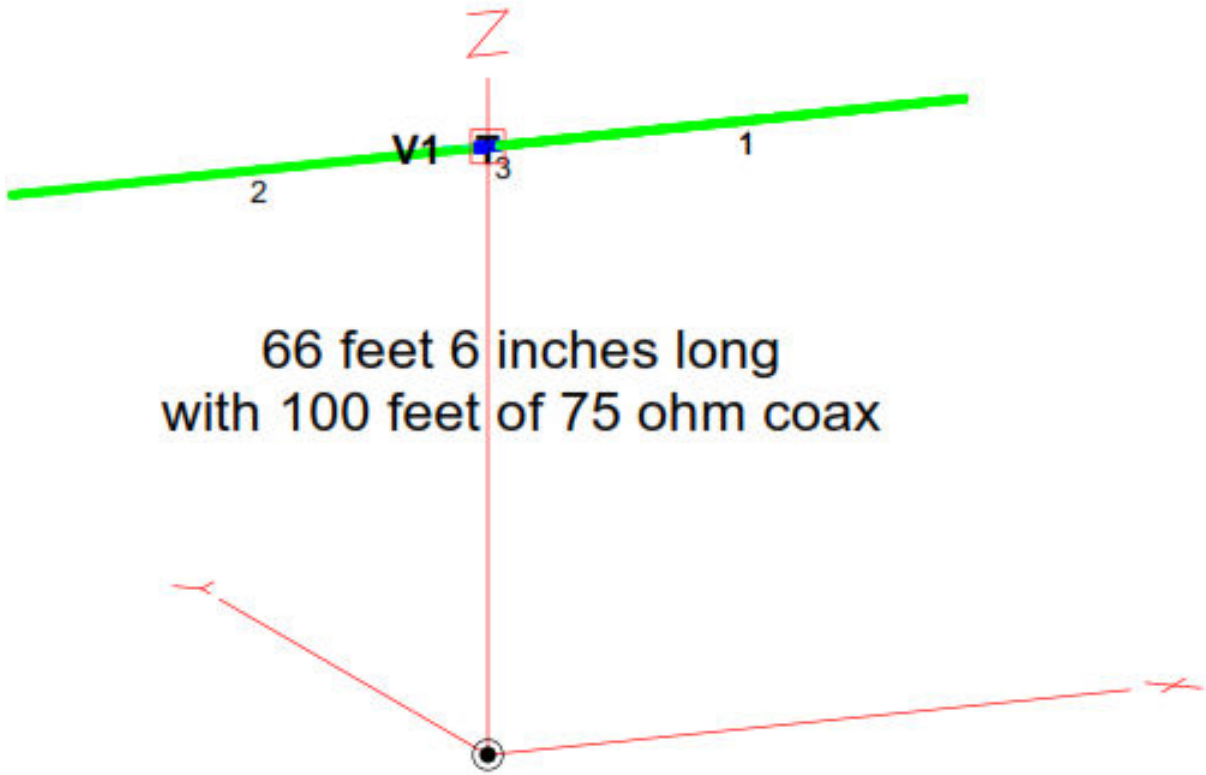
Has Anyone Tried a "Coupled Resonator" Antenna?

What are they Good for
How Well do they Work?

A “Fan” Dipole Offers Multiband Operation But Can Be Tricky To Tune



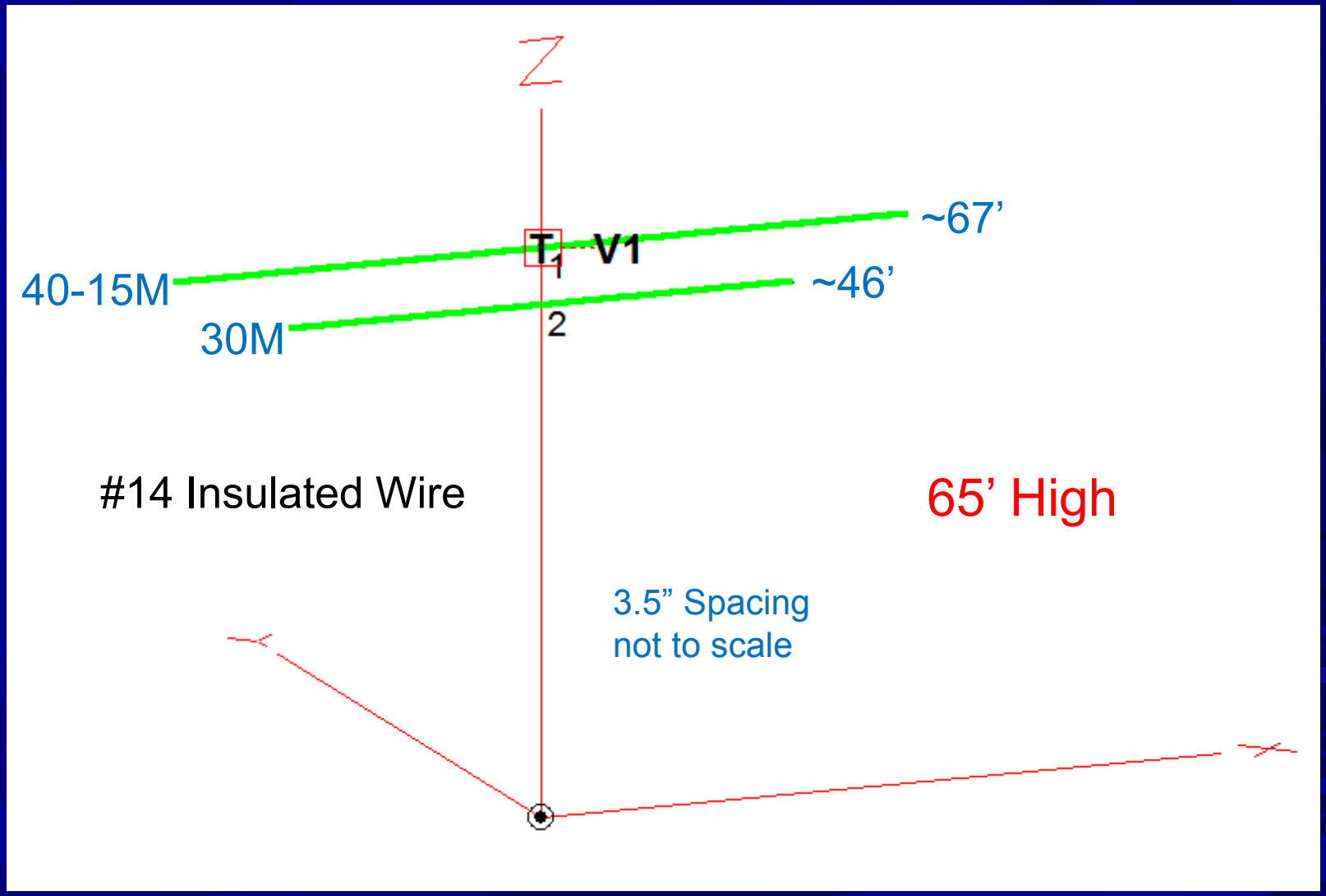
40-15M Dipole



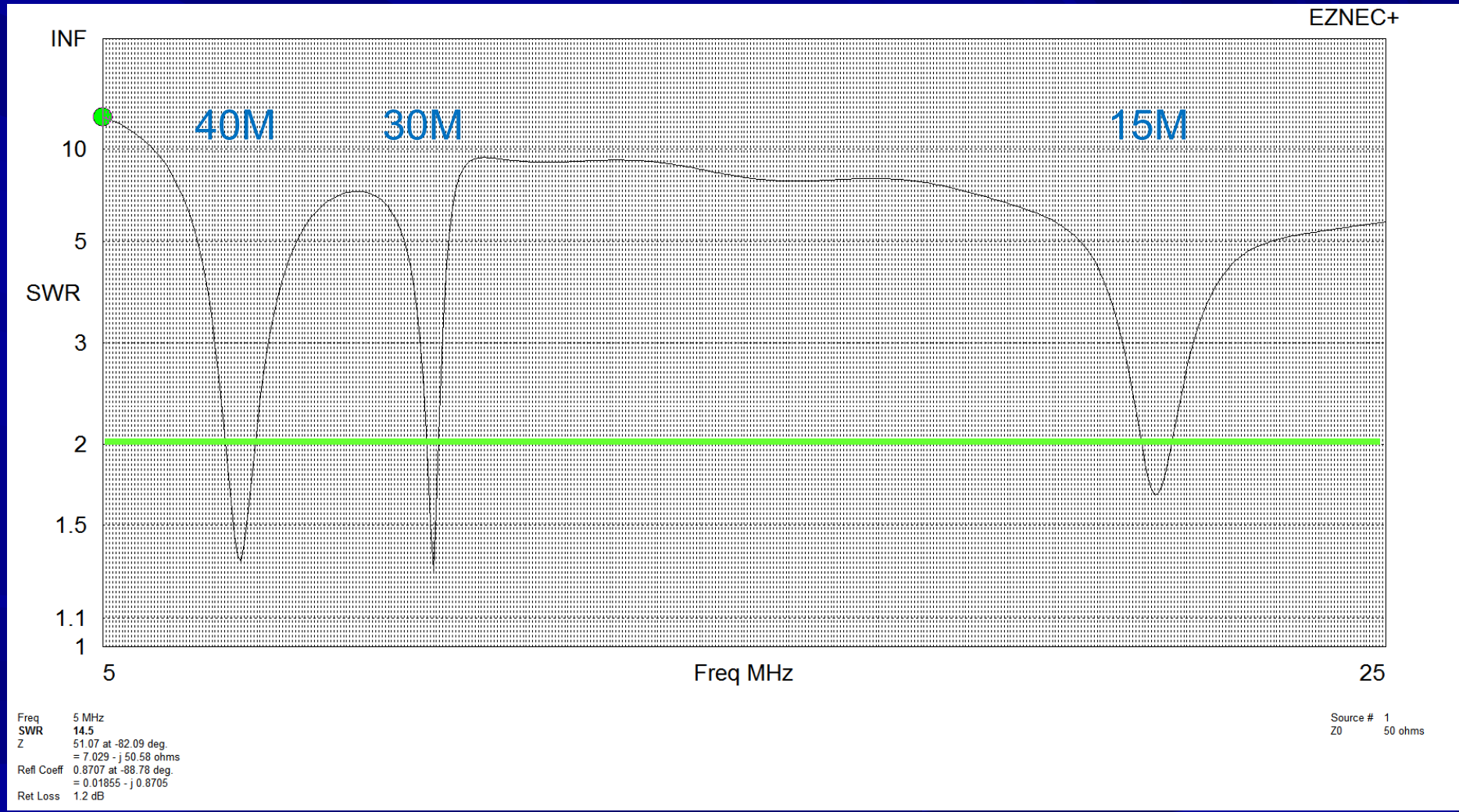
66 feet 6 inches long
with 100 feet of 75 ohm coax

Club 40/15M Dipole

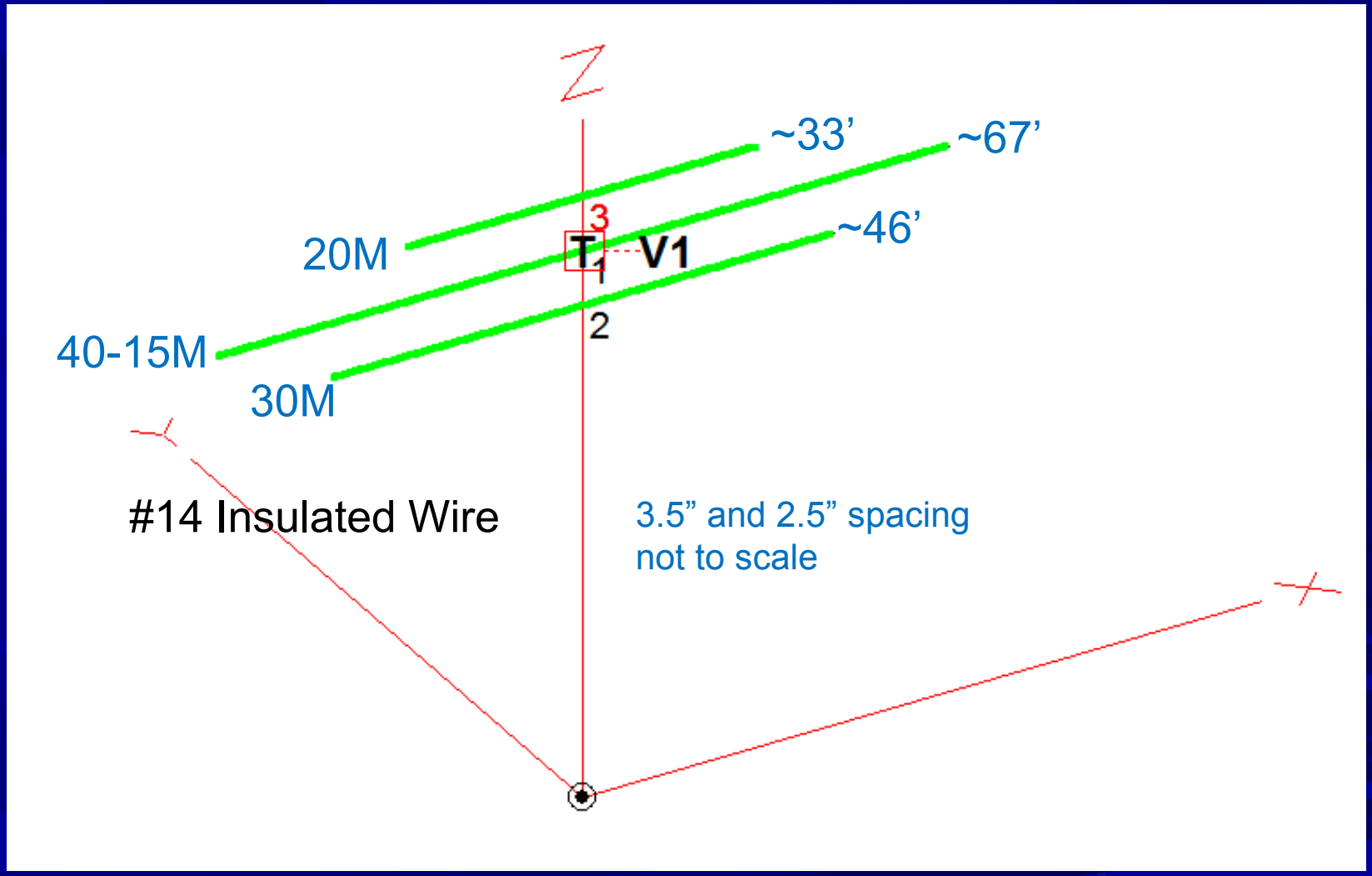
Coupled Resonator Dipoles for 40, 30 and 15 Meters



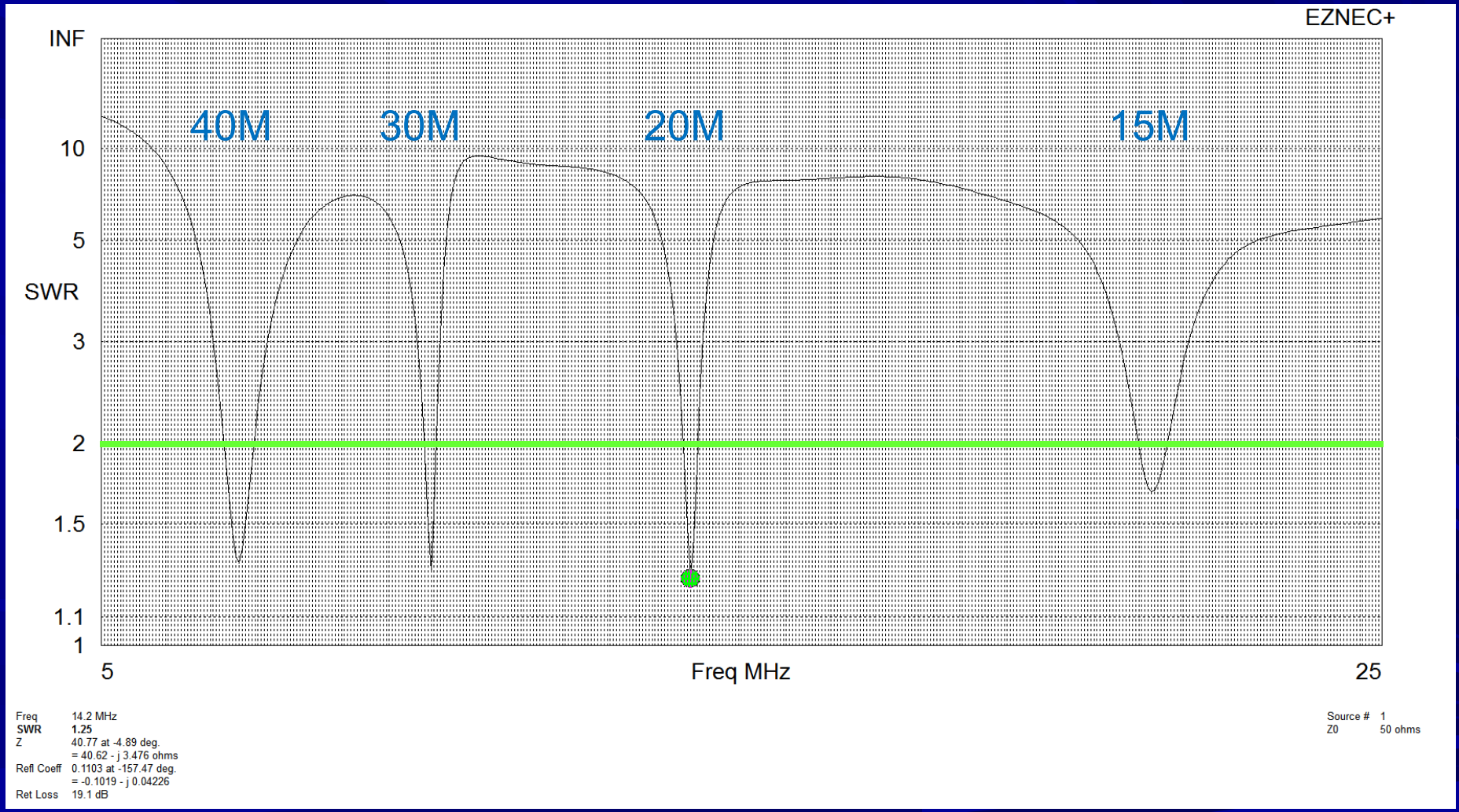
Coupled Resonator Dipoles for 40, 30 and 15 Meters



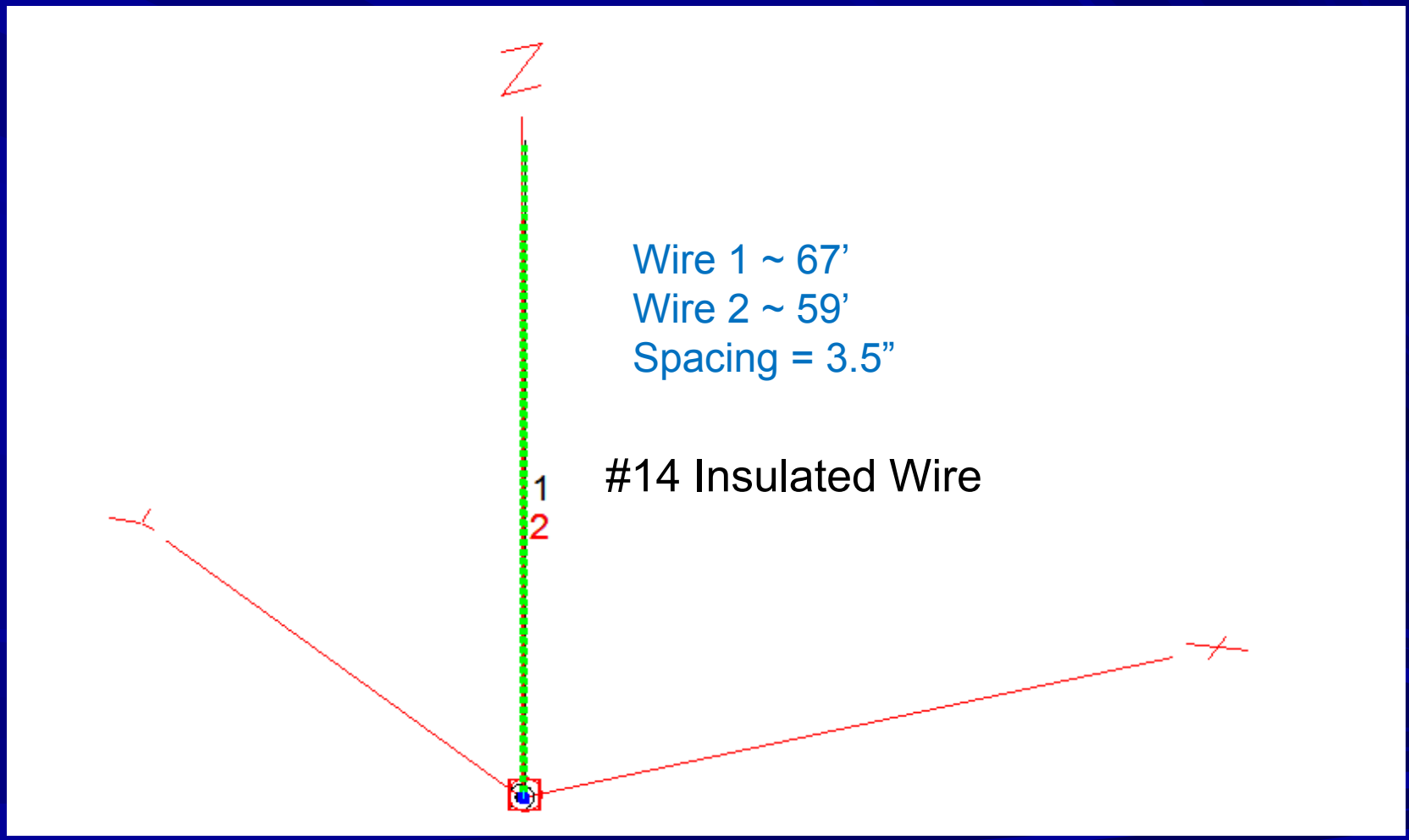
Coupled Resonator Dipoles for 40, 30, 20 and 15 Meters



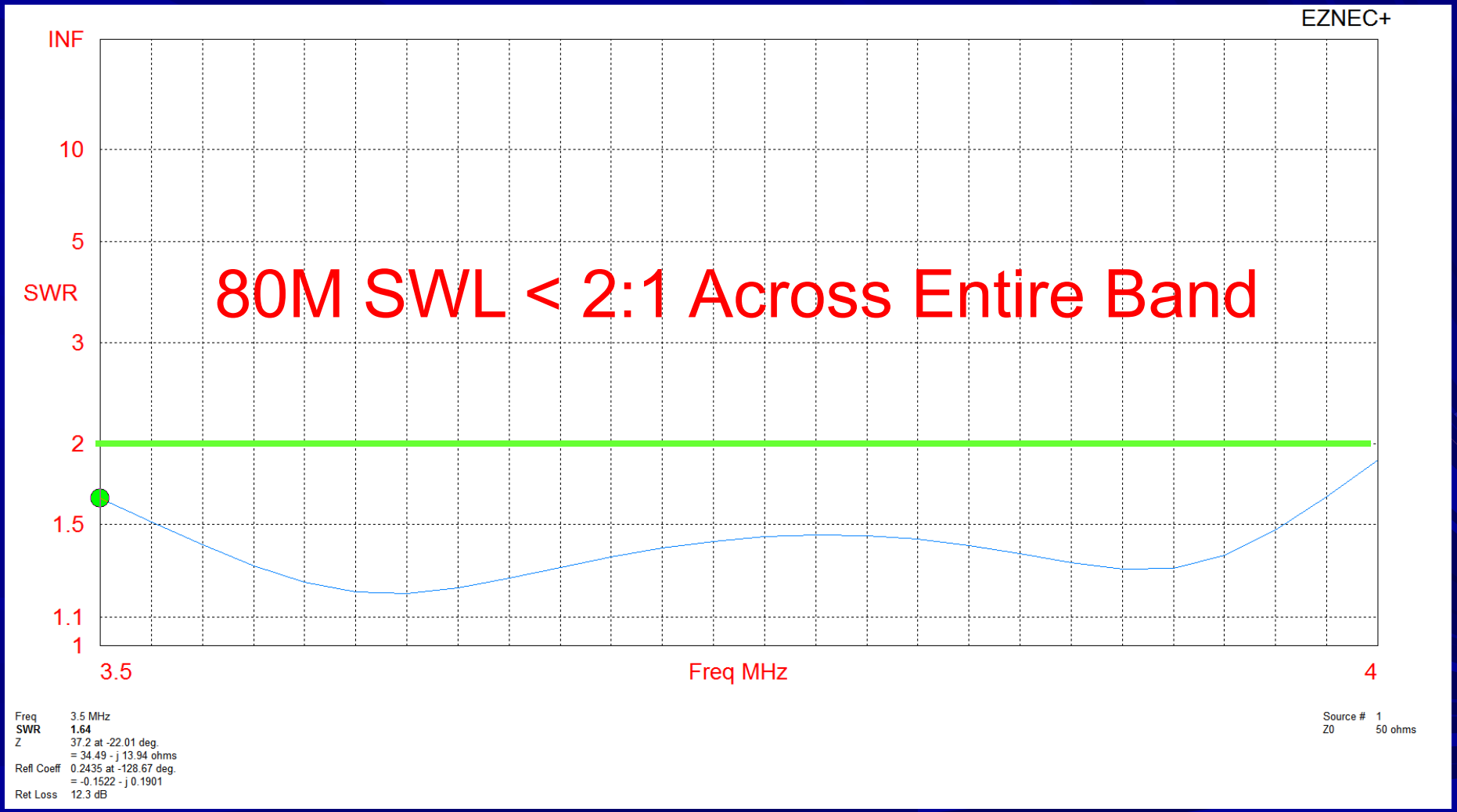
Coupled Resonator Dipoles for 40, 30, 20 and 15 Meters



Coupled Resonator Verticals for 80 Meters – Easy Addition to 80M Vertical



Coupled Resonator Verticals for 80 Meters – Covers The Entire Band!




$35.00
Ladder Snap™
Value Pack
100' Kit
By Tennamax
600 Ohm Nominal Impedance Ladder Line Spreaders


LadderSnap™

Hints and Kinks Summary

Height Matters

- Affects impedance and wire length
- Affects gain and take-off angle

Gain Matters

- Every 3 dB of gain double your power

Loops Rule!

- Multiple bands with a single wire
- Increased gain on higher bands

Coupled Resonators

- Additional bands or greater bandwidth

Modeling

- Saves time, material and money $$$
- Gets you on the air with a better antenna

Questions Please?

Thanks for Your Attention and Participation!

The End

No Antenna is Perfect...

But, how about one that you can:

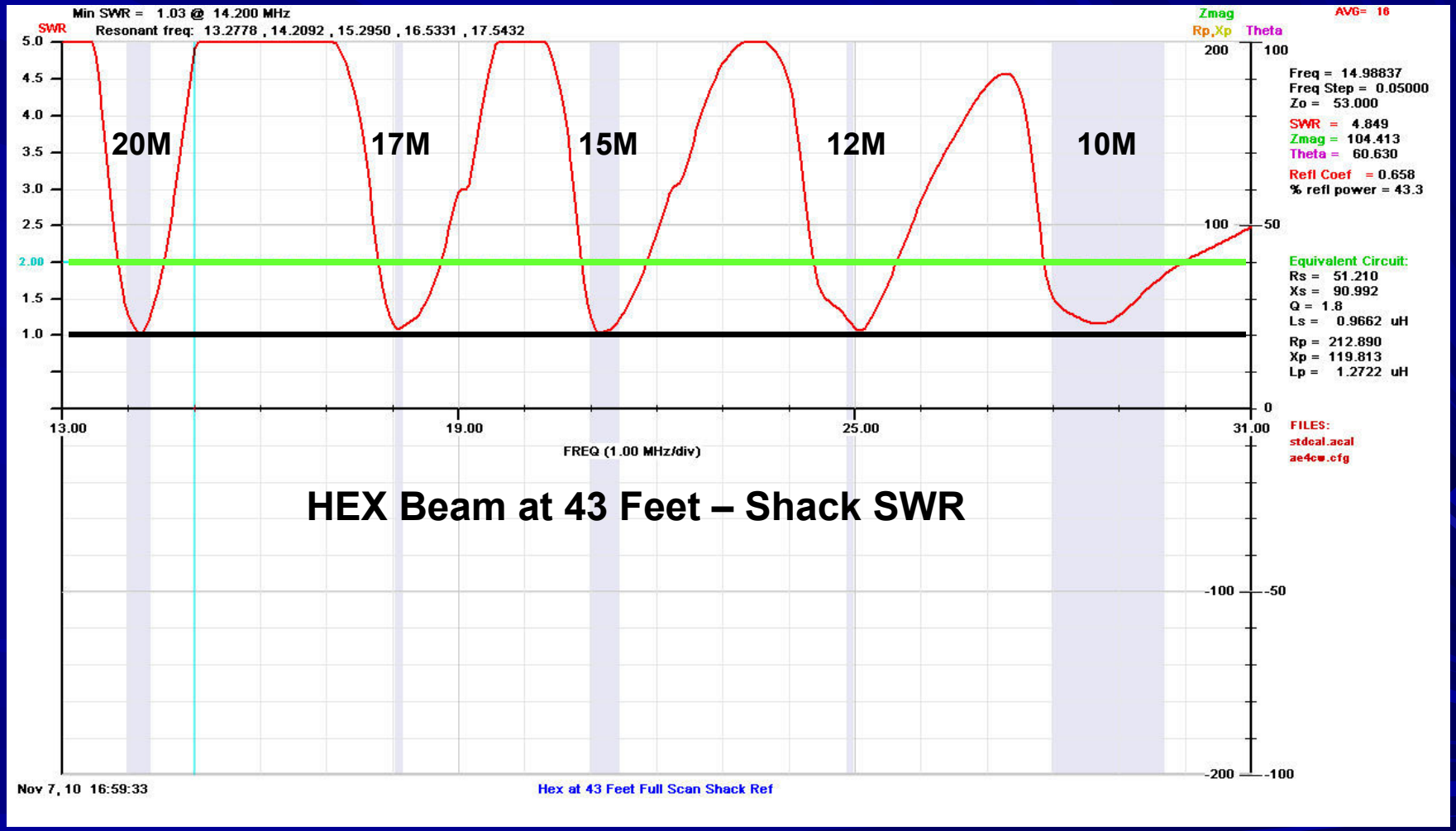
- Can be home-brewed or purchased
- Use on 20, 17, 15, 12 and 10M with an SWR under 1.5:1 plus 6M option
- Excellent DX and U.S. Antenna
- Small footprint and very good gain
- Build for Less than $400; buy for < $500.

Broadband Hex Beam

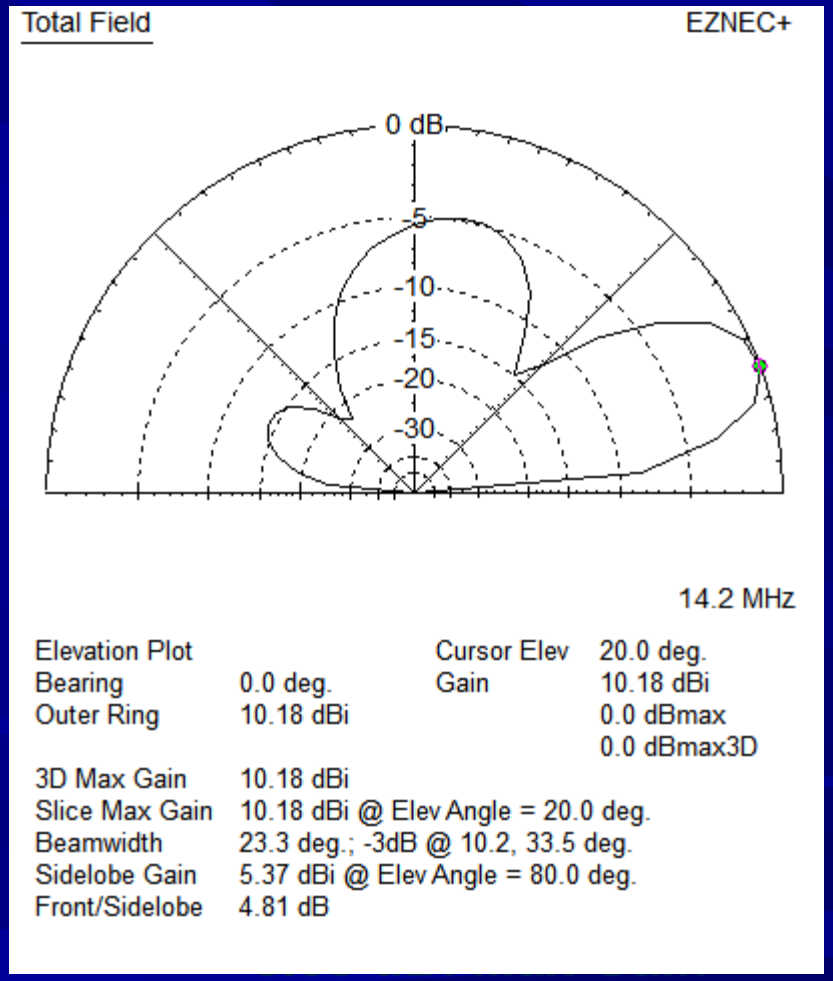
de Steve Hunt, G3TXQ

Broadband Hex Beam

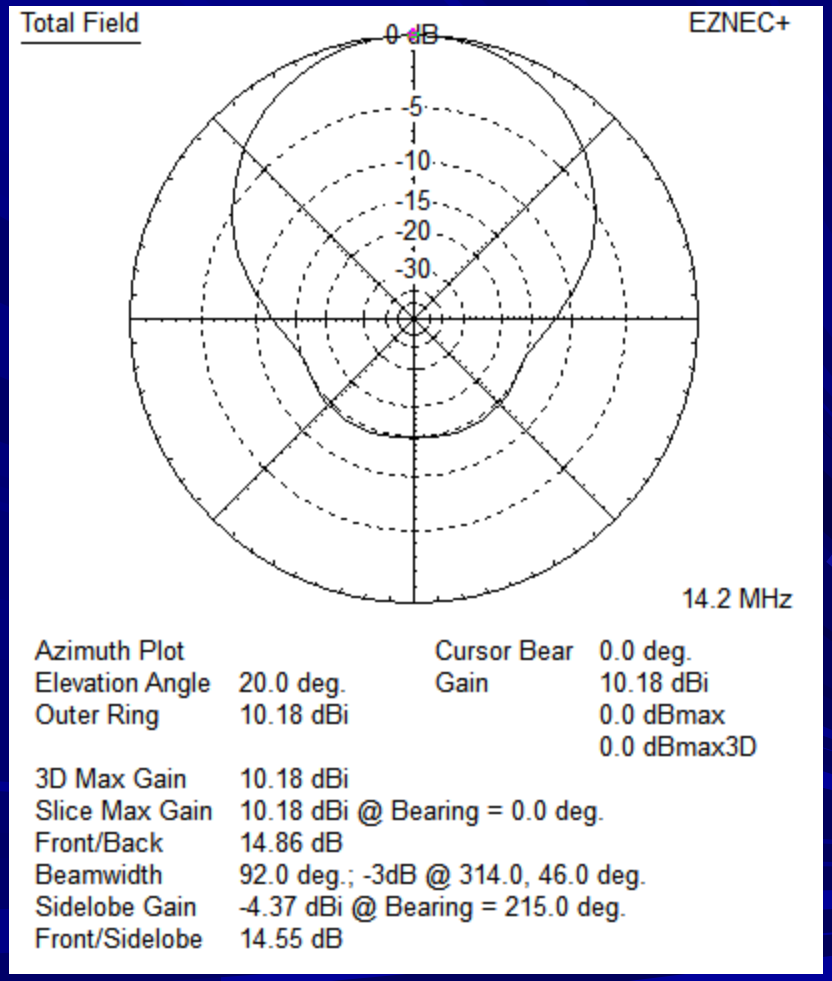
de Steve Hunt, G3TXQ



20M - Low Takeoff Angle & High Gain (10.2 dBi) Broad Lobes and Good Side/Back Reject.

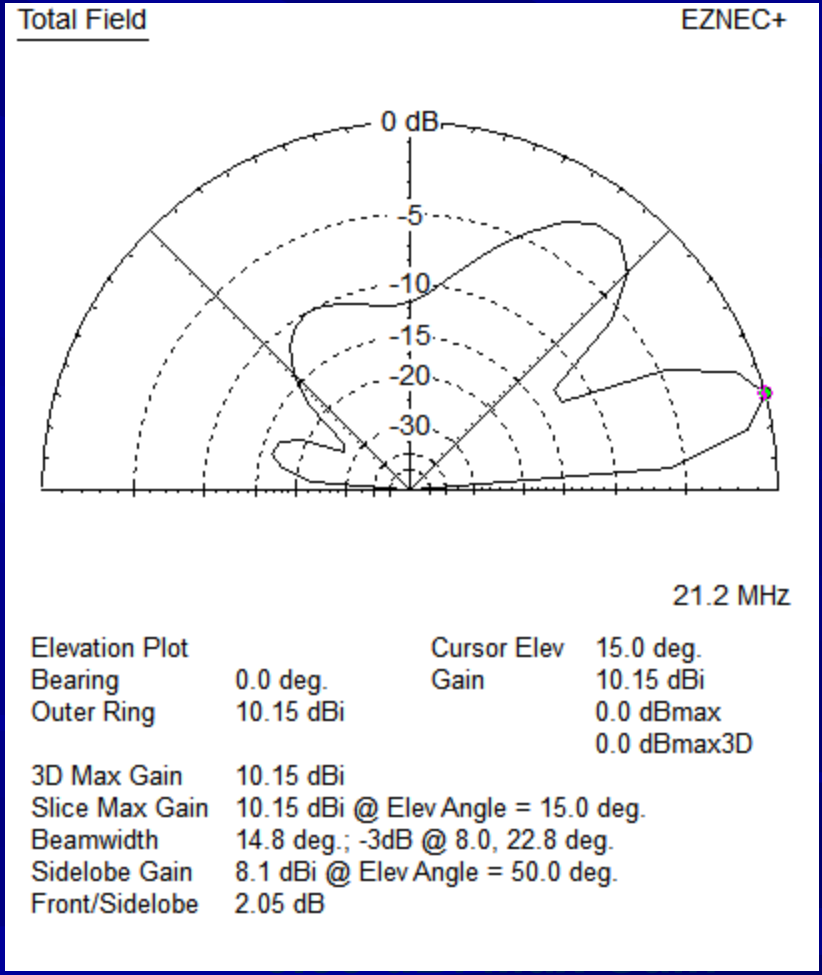


Elevation Plot		Cursor Elev	20.0 deg.
Bearing	0.0 deg.	Gain	10.18 dBi
Outer Ring	10.18 dBi		0.0 dBmax
			0.0 dBmax3D
3D Max Gain	10.18 dBi		
Slice Max Gain	10.18 dBi @ Elev Angle = 20.0 deg.		
Beamwidth	23.3 deg.; -3dB @ 10.2, 33.5 deg.		
Sidelobe Gain	5.37 dBi @ Elev Angle = 80.0 deg.		
Front/Sidelobe	4.81 dB		

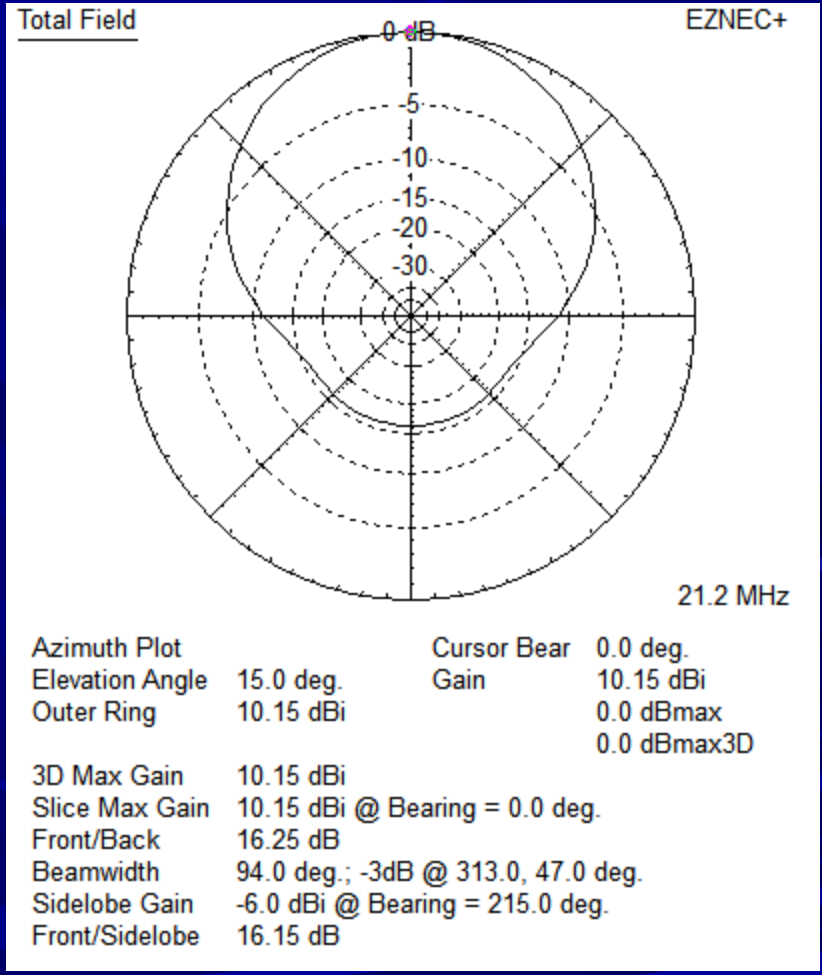


Azimuth Plot		Cursor Bear	0.0 deg.
Elevation Angle	20.0 deg.	Gain	10.18 dBi
Outer Ring	10.18 dBi		0.0 dBmax
			0.0 dBmax3D
3D Max Gain	10.18 dBi		
Slice Max Gain	10.18 dBi @ Bearing = 0.0 deg.		
Front/Back	14.86 dB		
Beamwidth	92.0 deg.; -3dB @ 314.0, 46.0 deg.		
Sidelobe Gain	-4.37 dBi @ Bearing = 215.0 deg.		
Front/Sidelobe	14.55 dB		

15M - Dual Takeoff Angles & High Gain (10.2 dBi) Broad Lobe and Good Side/Back Reject.



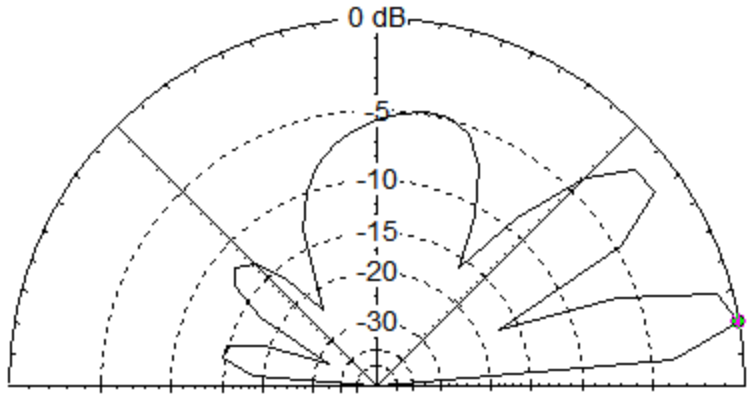
Elevation Plot		Cursor Elev	15.0 deg.
Bearing	0.0 deg.	Gain	10.15 dBi
Outer Ring	10.15 dBi		0.0 dBmax
			0.0 dBmax3D
3D Max Gain	10.15 dBi		
Slice Max Gain	10.15 dBi @ Elev Angle = 15.0 deg.		
Beamwidth	14.8 deg.; -3dB @ 8.0, 22.8 deg.		
Sidelobe Gain	8.1 dBi @ Elev Angle = 50.0 deg.		
Front/Sidelobe	2.05 dB		



Azimuth Plot		Cursor Bear	0.0 deg.
Elevation Angle	15.0 deg.	Gain	10.15 dBi
Outer Ring	10.15 dBi		0.0 dBmax
			0.0 dBmax3D
3D Max Gain	10.15 dBi		
Slice Max Gain	10.15 dBi @ Bearing = 0.0 deg.		
Front/Back	16.25 dB		
Beamwidth	94.0 deg.; -3dB @ 313.0, 47.0 deg.		
Sidelobe Gain	-6.0 dBi @ Bearing = 215.0 deg.		
Front/Sidelobe	16.15 dB		

10M - Dual Takeoff Angles & High Gain (10.3 dBi) Broad Lobe and Good Side/Back Reject.

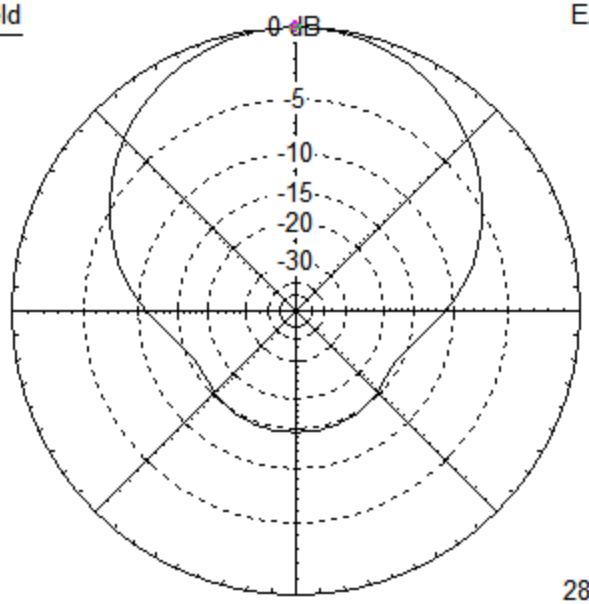
Total Field EZNEC+



28.3 MHz

Elevation Plot		Cursor Elev	10.0 deg.
Bearing	0.0 deg.	Gain	10.26 dBi
Outer Ring	10.26 dBi		0.0 dBmax
			0.0 dBmax3D
3D Max Gain	10.26 dBi		
Slice Max Gain	10.26 dBi @ Elev Angle = 10.0 deg.		
Beamwidth	11.2 deg.; -3dB @ 5.9, 17.1 deg.		
Sidelobe Gain	8.8 dBi @ Elev Angle = 35.0 deg.		
Front/Sidelobe	1.46 dB		

Total Field EZNEC+



28.3 MHz

Azimuth Plot		Cursor Bear	0.0 deg.
Elevation Angle	10.0 deg.	Gain	10.26 dBi
Outer Ring	10.26 dBi		0.0 dBmax
			0.0 dBmax3D
3D Max Gain	10.26 dBi		
Slice Max Gain	10.26 dBi @ Bearing = 0.0 deg.		
Front/Back	14.59 dB		
Beamwidth	96.2 deg.; -3dB @ 311.9, 48.1 deg.		
Sidelobe Gain	-4.33 dBi @ Bearing = 180.0 deg.		
Front/Sidelobe	14.59 dB		