

Antenna Modelling Software



- What
- How
- Programs
 - ◆ NEC based
 - ◆ Others
- Program extensions

Antenna Modelling



■ Mathematical

- ◆ Chain Home Radar Antennas (WW2)
- ◆ Derived from Maxwell's Equations
- ◆ Proven on large antenna ranges

■ Scale Models

- ◆ $Model_{frequency} = \frac{Full_{size}}{model_{size}} * Full_{size} frequency$
- ◆ $Model_{conductivity} = \frac{full_{size}}{Model_{size}} * full_{size} conductivity$

■ Computer Models

- ◆ NEC (Numerical Electro-magnetic Code) US Navy

Mathematical Modelling



- **Original DRAO**
(Dominion Radio
Astrophysical Observatory)
Antennas

The main goal of the T-shaped radio telescope at Penticton was to produce a map of radio sources in our galaxy.



The 1,700 cedar posts of the 1.3-kilometre radio telescope.
Source: National Research Council of Canada/Herzberg Institute of Astrophysics/Dominion Radio Astrophysical Observatory

Scale models

A 10:1 model
Eg 300 MHz antenna
(1m) on a 30m aircraft
Is mainly for initial
pattern measurements.
For impedances the
model scale must be
reduced to 4:1 or 2:1.



Computational Modelling



Codes are based on a full-wave formulation of the Maxwell's equations and associated boundary conditions. Some other codes are based on an asymptotic solution of the Maxwell's equations.

- Finite-Difference Time-Domain method (NEWS, X-NEWS)
- Finite Element Method (FEM, X-FEM)
- High Frequency Structure Simulator (HFSS)
- WirePlate (WIPL)
- FEKO "FEldberechnung für Körper mit beliebiger Oberfläche"
- **Numerical Electromagnetic Code (NEC)**
- Electromagnetic Surface Patch (ESP)
- NEWAIR (Geometric theory of diffraction, GTD based)

Computational Modelling



- Most codes are based on the Method of Moments (MoM) integral formulation of Maxwell's equations
 - ◆ Most Amateur programs break the model into a number of current driven elements and then combine the effect of the fields EG NEC
 - ◆ There are limits to “free” versions
 - ▶ Wires cannot meet in the middle of a segment
 - ▶ Wire intersection angle limit
 - ▶ Wires must be the same diameter (tapers can be “fudged”)
 - ▶ Wires in close proximity must have their segments matched
 - ▶ Other limits

NEC



- Developed by Lawrence Livermore Laboratory in 1981 for the US Navy based on the AMP program contracted in 1970
- Antenna is divided into short segments with linear variation of current and voltage.
- Developed in a number of stages
 - ◆ NEC2 models in free space or over finitely conducting ground. Free (with a command line interface) so used in most NEC programs.
 - ◆ NEC4.2 smaller structures, accurate stepped radius and junctions, improved ground modelling (buried conductors). Requires \$US500 license.

EZNEC



- Available in a number of variations
- <https://www.eznec.com/>
 - ◆ Demo 20 segments (ARRL version 500) Free
 - ◆ EZNEC 500 segments \$US99
 - ◆ EZNEC+ 2000 segments \$US149
 - ◆ EZNECpro 20,000 segments \$US525
 - ◆ EZNECpro/4 \$US675 (NEC4 engine)
 - License must be approved \$US500 for non-commercial use.

AutoEz



- An “add-on” for EZNEC allowing you to “parameterize” the program by using variables to control aspects of the module.
 - ◆ Excel taken to the limit!
 - ◆ Simplified data input
 - ◆ Improved results presentation
 - ◆ Free demo (30 segments or EZNEC limit)
 - ◆ Full version \$US79

4NEC2



- Free
- Two programs
 - ◆ 4NEC2 (basic NEC 2 engine but supports NEC4)
 - ◆ 4NEC2X (Extended) 3D presentation
- Includes and optimizer and sweeper
- Improved input and output compared to EZNEC

MiniNEC



- **\$US29**
- <http://www.blackcatsystems.com/software/mininec-antenna-analysis-modeling-software.html>
- **This is an improved version of that released by NTIS based on the NEC2 engine.**
- **This is a 1991 review of MiniNEC by Roy Lewallen (the author of EZNEC)**
 - ◆ <https://www.arrl.org/files/file/Technology/tis/info/pdf/9102018.pdf>

MMANA-GAL



- Free in basic form
 - ◆ 8192 Segments
 - ◆ Similar to EZNEC
- Pro version available for €139
 - ◆ 45,000 segments
 - ◆ Improved graphics

ASAP



- Free (NEC2 based)
- <http://raylcross.net/asap/>
- Basic interface to NEC2

So What to use?



Program	Cost	Limit	Note
EZNEC	\$US99	Free versions too restrictive	Most common
AutoEZ	\$US79	optimizer, Same segments as associated EZNEC	Requires EZNEC Improves in/out
4NEC2	Free	Same as NEC engine	Roughly ~= EZNEC+AutoEZ
NEC	Free	2000 segments	No user interfaces
NEC4-2	\$US500	20,000 segments	Use with 4NEC2
MININEC	\$US29	2000 segments?	Also free basic
MMANA-GAL	free	8192 segments	Pro €139
ASAP	Free	2000 segments?	Basic interface

There are many more programs available

An Example



- 40m vertical with two raised radials
 - ◆ Vary base between -0 to 20 ft
 - ▶ Special cases, buried radials, slanted radials
 - ◆ Design antenna (resonance, matching)
 - ◆ Determine efficiency
 - ▶ Set all losses =0 and compare to measured with losses
- Compare input and output of programs
- Show issues

An Example



■ Compare

◆ EzNEC

- ▶ MMNA-GAL similar

◆ AutoEZ

◆ 4NEC2

◆ NEC

- ▶ Original command line interface
- ▶ Inspired the “enhancements”
- ▶ More basic “enhanced” programs
 - MiniNEC, ASAP

Modelling Steps



— • — • — — • — — • • • — • — — • • • — • • • • — •

1. Sketch the antenna (same for all)

- ◆ 4NEC2 has a graphical input

2. Input Model

- ◆ Wires, segments, Sources and loads

3. Check for problems

4. Run

5. Output results

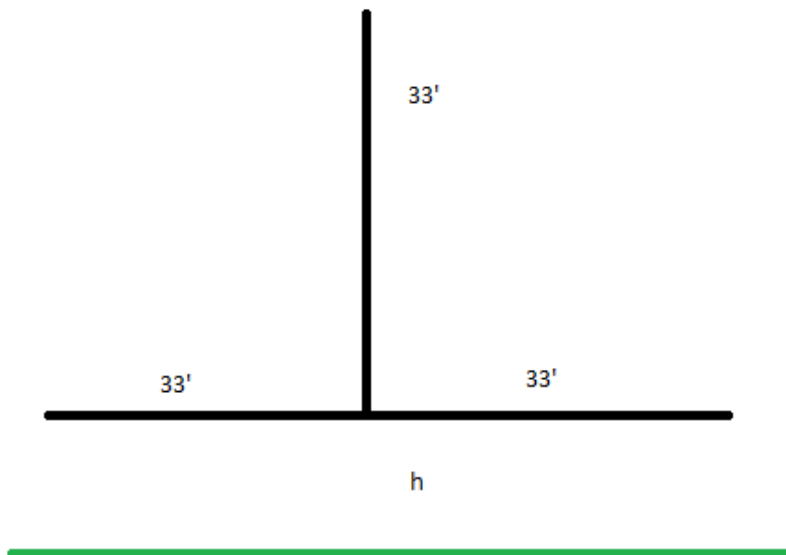
■ Notes:

- ◆ dimensions 33' chosen to demonstrate optimization
- ◆ Slant to demonstrate model input options

Sketch

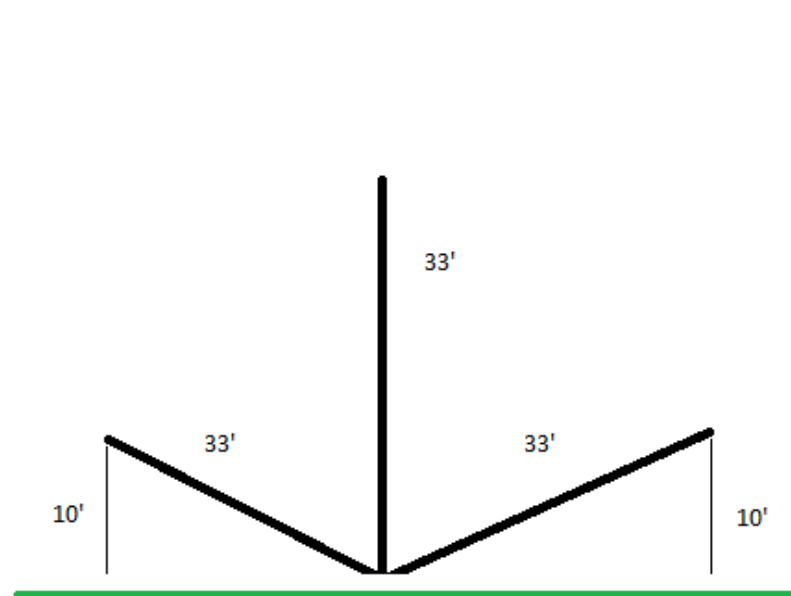
Horizontal Radials

$h = -0.5', 0', 1', 10', 20'$



Slanted Radial

(special case 0 to 10')



Input Model (EZNEC)



Wires

Wire Create Edit Other

Coord Entry Mode Preserve Connections Show Wire Insulation

Wires											
No.	End 1				End 2				Diameter (in)	Segs	
	X (ft)	Y (ft)	Z (ft)	Conn	X (ft)	Y (ft)	Z (ft)	Conn			
1	0	0	10	W2E2	0	0	43		#14	20	
2	-33	0	10		0	0	10	W3E2	#14	1	
3	33	0	10		0	0	10	W1E1	#14	20	

EZNEC+ v. 6.0

File Edit Options Outputs Setups View Utilities Help

- Open
- Save As
- Ant Notes
- Currents
- Src Dat
- Load Dat
- FF Tab
- NF Tab
- SWR
- View Ant
- NEC-2D
- FF Plot

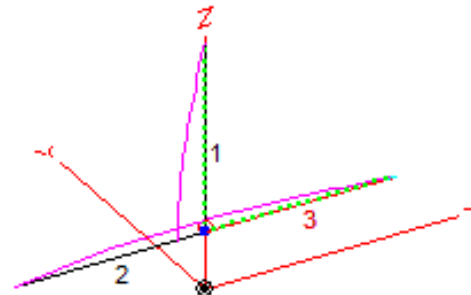
> **40 m vert 2 raised radials**

- File: 40m vert 2 raised radials.EZ
- Frequency: 7.15 MHz
- Wavelength: 137.562 ft
- Wires: 3 Wires, 41 segments
- Sources: 1 Source
- Loads: 0 Loads
- Trans Lines: 0 Transmission Lines
- Transformers: 0 Transformers
- L Networks: 0 L Networks
- Ground Type: Real/High Accuracy
- Ground Descrip: 1 Medium (0.005, 13)
- Wire Loss: Copper
- Units: Feet
- Plot Type: 3D
- Step Size: 5 Deg.
- Ref Level: 0 dBi
- Alt SWR Z0: 75 ohms
- Desc Options

Sources

Source Edit

Sources							
No.	Specified Pos.		Actual Pos.		Amplitude (V, A)	Phase (deg.)	Type
	Wire #	% From E1	% From E1	Seg			
1	1	0	2.5	1	1	0	V



Input Model (AutoEZ)



- Uses Excel tables and variables can be used

Clear All Enter fixed values or Excel formulas to define wires. Open Model File View Ant Auto-Refresh

Change Units Save Model As Wire Insulation Diel C Thk (in)

Hide Marked Rows Formulas Display with decimals.

End 1			End 2			Diameter	Segs
X (ft)	Y (ft)	Z (ft)	X (ft)	Y (ft)	Z (ft)	(in or #)	(198)
0.000	0.000	10.000	0.000	0.000	10.500	#14	1
0.000	0.000	10.500	0.000	0.000	45.000	#14	65
-33.273	0.000	10.000	0.000	0.000	10.000	#14	66
33.273	0.000	10.000	0.000	0.000	10.000	#14	66

If marked here do not write to file. Display with 3 decimals.

AutoEZ version 2.0.24
Last updated 21 Jul 2017
Dan Maguire, AC6LA
<http://ac6la.com/autoez.html>
<mailto:djm2150@yahoo.com>

Insert Row(s) Show Excel Ribbon
Delete Row(s)

Show Variables in Notepad

For Information Only (at 7.15 MHz)
Show lengths in ft wl Segs / wl (rounded)

Wire	Length	Seg Len	Segs / wl (rounded)
W1	0.500	0.500	275
W2	34.500	0.531	259
W3	33.273	0.504	273
W4	33.273	0.504	273

If marked here do not write to file. (Applies to all Insertion Objects.)

Clear All Sources **Sources (1)** Formulas Save Model As Show Variables in Notepad

	Wire #	% From E1	Amplitude	Phase	Type
S1	1	0	1	0	V

Input Model (AutoEZ)



- Variables can be used

Set variables using constants or formulas.
Cells in column C are named as indicated.

 Auto-Refresh

At 7.150 MHz number of segments = 198 Create wires

Name	Value	Comment
TwoPi :	6.2831853	2 * PI()
WL.5 :	68.7812	1/2 λ
WL.25 :	34.3906	1/4 λ
WL.001 :	0.1376	0.001 λ
WL or W :	137.5624	Feet <input type="button" value="Change Units"/>
Freq or F :	7.150	Test Case Frequency (MHz)
A :	10	height above ground
B :	35	total vertical height
D :	33.27339	radial length
E :	43	end height of sloped radial

Area below may be used as a scratch pad.

Input Model (4NEC2)



- Several editors including a rudimentary graphics editor. Can use Variables and formulae. Inputs EZNEC files.

40m vert 2 raised radials.nec - 4nec2 Edit (file changed)

File Cell Rows Selection Options

Upd

Geometry (Scaling=Feet) <input type="checkbox"/> Use wire tapering													
Nr	Type	Tag	Segs	X1	Y1	Z1	X2	Y2	Z2	Radius			comment
2	Wire	2	5	0	0	A+1	0	0	A+B	'016e-3			
3	Wire	3	5	D	0	A	0	0	A	'016e-3			
4	Wire	4	5	-D	0	0	0	0	A	'416e-3			

Symbols		
Nr	Symbols and equations	comment
1	B=33	Vert ant length
2	D=33	Radial length
3	A=10	Height Above Ground

Load(s)					
Nr	Type	Tag-nr	First-seg	Last-seg	Cond (S)
1	Wire-cond	1	0	0	Copper
2	Wire-cond	2	0	0	Copper
3	Wire-cond	3	0	0	Copper
4	Wire-cond	4	0	0	Copper

Input Model (NEC)



■ Pure text file

Edit NEC input-file

File Edit Options

Card	Comment
CM	40 m vert 2 raised radials, converted with 4nec2 on 19-Oct-17 9:46

Comnt Ins Del

```

CM 40 m vert 2 raised radials, converted with 4nec2 on 19-Oct-17 9:46
CE
SY B=33 'Vert ant length
SY D=33 'Radial length
SY A=10 'Height Above Ground
GW 1 1 0 0 A 0 0 A+1 2.67016e-3
GW 2 5 0 0 A+1 0 0 A+B 2.67016e-3
GW 3 5 0 0 A 0 0 A 2.67016e-3
GW 4 5 -D 0 0 0 0 A 8.9416e-3
GS 0 0 0.3048
GE 1
LD 5 1 0 0 58000000
LD 5 2 0 0 58000000
LD 5 3 0 0 58000000
LD 5 4 0 0 58000000
GN 1
EK
EX 0 1 1 0 1 0 0
FR 0 0 0 0 7.15 0
EN
    
```

Check for problems EZNEC



- EZNEC runs a rules check before giving SWR or field data. Yellow is a warning, Red is an rule violation.
 - ◆ Fix Source 1 by adding a short wire
 - ◆ Fix wire 2 by adding more segments (auto-segment)



Check for problems AutoEz



- Uses EZNEC to check

Check for problems 4NEC2



- Warnings can be cryptic and assume that you know the NEC input file rules

4nec2

Errors or warnings found, run 'Segment check'.

OK

```
File Edit Format View Help
40m vert 2 raised radials.nec wavelength=41.93 mtr.

Error: Wire 1, seg 1 (tag 1), seg-len (6) differs more than 5 * seg-len (36) for wire 3
Error: Wire 1, seg 1 (tag 1), seg-len (6) differs more than 5 * seg-len (43.33) for wire 2
Error: Wire 2, seg 2 (tag 2), seg-len (43.33) differs more than 5 * seg-len (6) for wire 1
Error: Wire 4, seg 32 (tag 4), seg-len (37.62) differs more than 5 * seg-len (6) for wire 1
```

Check for problems NEC



- Limited rules checking
- Limited Help

Run EZNEC



- You can select various outputs e.g. SWR, FF plot
And get tabular data for use in other programs

SWR Sweep Parameters

Frequency Selection

Start Frequency (MHz)

Stop Frequency (MHz)

Frequency Step (MHz)

Read Frequencies From File

File Name

3D Far Field Table

Select whether to organize the data in azimuth or elevation 'slices', and what range of angles in each 'slice' to include in the table.

Organize Data As

Elevation Slices

Azimuth Slices

Azimuth Angle Range

Full Range

0 355

To

Run AutoEZ



■ Note can vary multiple variables

Clear All

Generate Test Cases

E-fld and Near Field

Calculate Only Selected Row(s)

Calculate All Rows

Resonate on Selected Cell

For Selected Row: Ground Type, Char. Use 2 media

View Ant

3D Plot

3D Step 5°

Both in Sync

Real / High Accuracy

Average (0.005, 13)

Wire Loss

Copper

Open Model File

Save Model As

Sort Rows

Processing ... (see status bar at bottom of window)

Freq (MHz)	D	B	SWR Zo		Elevation		Az Angle ^o		Step Size		3D Pattern		Average Gain		Avg Gain Test	
			R at Src1	X at Src1	Max Gain	@ E ^o	Fr / Back	Fr / Rear	Max Gain	@ Az ^o	@ E ^o	Factor	dB	RDF ?	Factor	dB
7.150	33.1	34.5	32.91	-14.28	1.720	-0.50	21			0.00						
7.150	33.1	35	34.30	-2.09	1.463	-0.49	21			0.00						
7.150	33.1	35.5	35.74	10.14	1.508	-0.47	21			0.00						
7.150	33.1	36	37.25	22.43	1.803	-0.46	21			0.00						
7.150	33.2	34	31.59	-25.25	2.154	-0.52	21			0.00						
7.150	33.2	34.5	32.92	-13.08	1.689	-0.50	21			0.00						
7.150	33.2	35	34.30	-0.89	1.459	-0.49	21			0.00						
7.150	33.2	35.5	35.74	11.35	1.534	-0.47	21			0.00						
7.150	33.2	36	37.25	23.65	1.846	-0.46	21			0.00						
7.150	33.3	34	31.60	-24.06	2.106	-0.52	21			0.00						
7.150	33.3	34.5	32.92	-11.88	1.661	-0.50	21			0.00						
7.150	33.27339	35	34.30	0.00	1.458	-0.49	21			0.00						
7.150	33.3	35.5	35.75	12.57	1.562	-0.47	21			0.00						
7.150	33.3	36	37.26	24.86	1.890	-0.46	21			0.00						
7.150	33.4	34	31.60	-22.86	2.059	-0.52	21			0.00						
7.150	33.4	34.5	32.93	-10.68	1.635	-0.50	21			0.00						
7.150	33.4	35	34.31	1.53	1.460	-0.49	21			0.00						
7.150	33.4	35.5	35.75	13.78	1.591	-0.47	21			0.00						

Run 4NEC2



- A bit confusing as a variety of external programs are called.

The screenshot shows the Geometry Builder (V2.5) software interface. The main window is titled "Geometry Builder (V2.5)" and has a menu bar with "Patch", "Plane", "Box", "Cylinder", "Parabola", "Helix", "Sphere", and "Help".

The "Patch" section contains the following settings:

- Length X1: 1.29 mtr.
- Length X2: 1.29
- Length Y: 1.82
- X sections: 10
- Y sections: 10

The "Use Surface-patches" section is unchecked, and "Start with tagnumber" is set to 3.

The "Use auto-segmentation" section is checked, with "Frequency in Mhz" set to 14.2 and "Segmentation" set to "medium".

The "Use equal-area rule to set wire-radius" section is checked.

The "Rotate X, Y, Z" section has values 0, 0, 0. The "Move X, Y, Z" section has values 0, 0, 52. There is a note "! = symbols also allowed".

The "Generate" button is highlighted in green. The "Batch" and "Exit" buttons are also visible.

The "Generate (F7) [Nec4dCL3600]" dialog box is open, showing the following settings:

- Use original file
- Far Field pattern (highlighted in green)
- Frequency sweep
- Near Field pattern
- ItsHF 360 degree Gain table
- ItsHF Gain @ 30 frequencies

The "Auto-Segm." button is highlighted in green. The "Freq:" dropdown is set to 7.15. The "from file" checkbox is unchecked.

The "Full" radio button is selected. The "Ver." and "Hor." radio buttons are unselected.

The "Resol." is set to 1 deg. The "Surface-wave" and "Run Average Gain Test" checkboxes are unchecked. The "E fld distance" checkbox is unchecked. The "Expert settings" button is visible.

The "Generate", "Batch", and "Exit" buttons are visible at the bottom of the dialog box.

The main window displays a 3D wireframe model of a patch antenna. The model is a trapezoidal shape with a grid of lines. The axes are labeled X, Y, and Z. The dimensions are labeled as "length X1", "length X2", and "length Y".

Run NEC

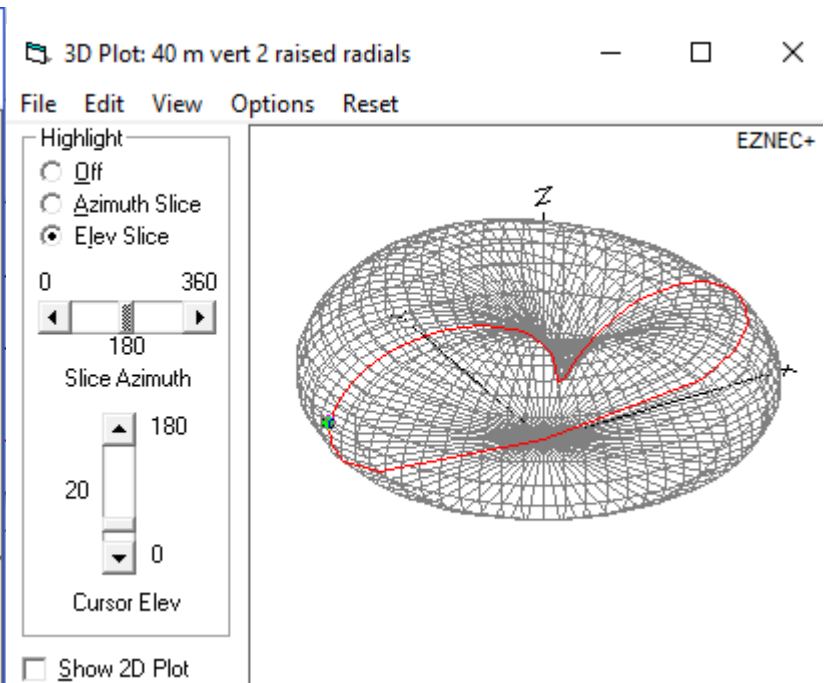
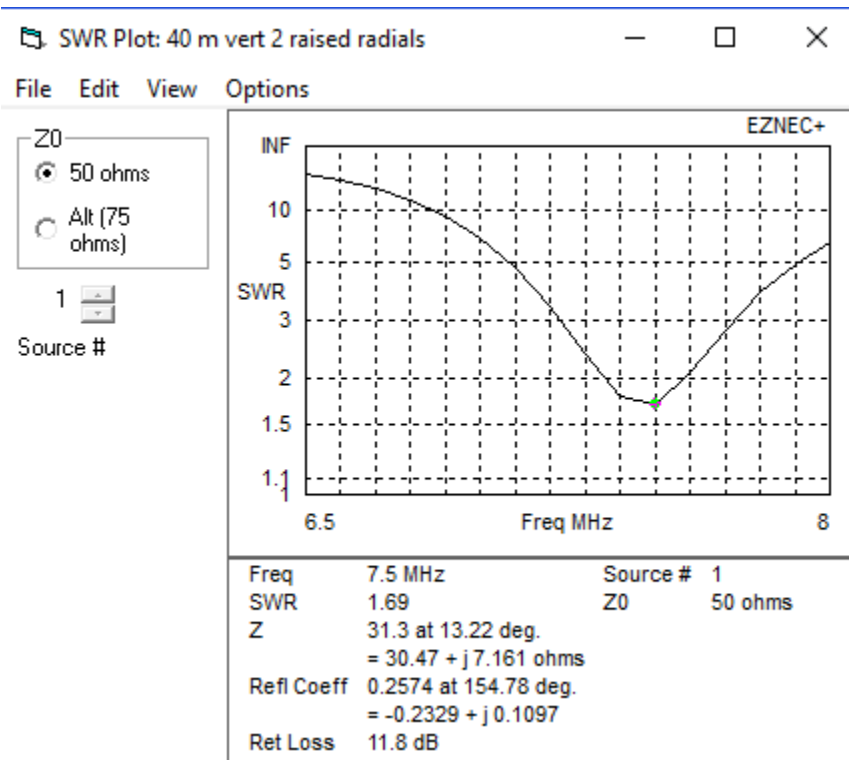


- Pure command line operation.
- Limited graphics engine

Output results EZNEC



■ Can also get tabular data

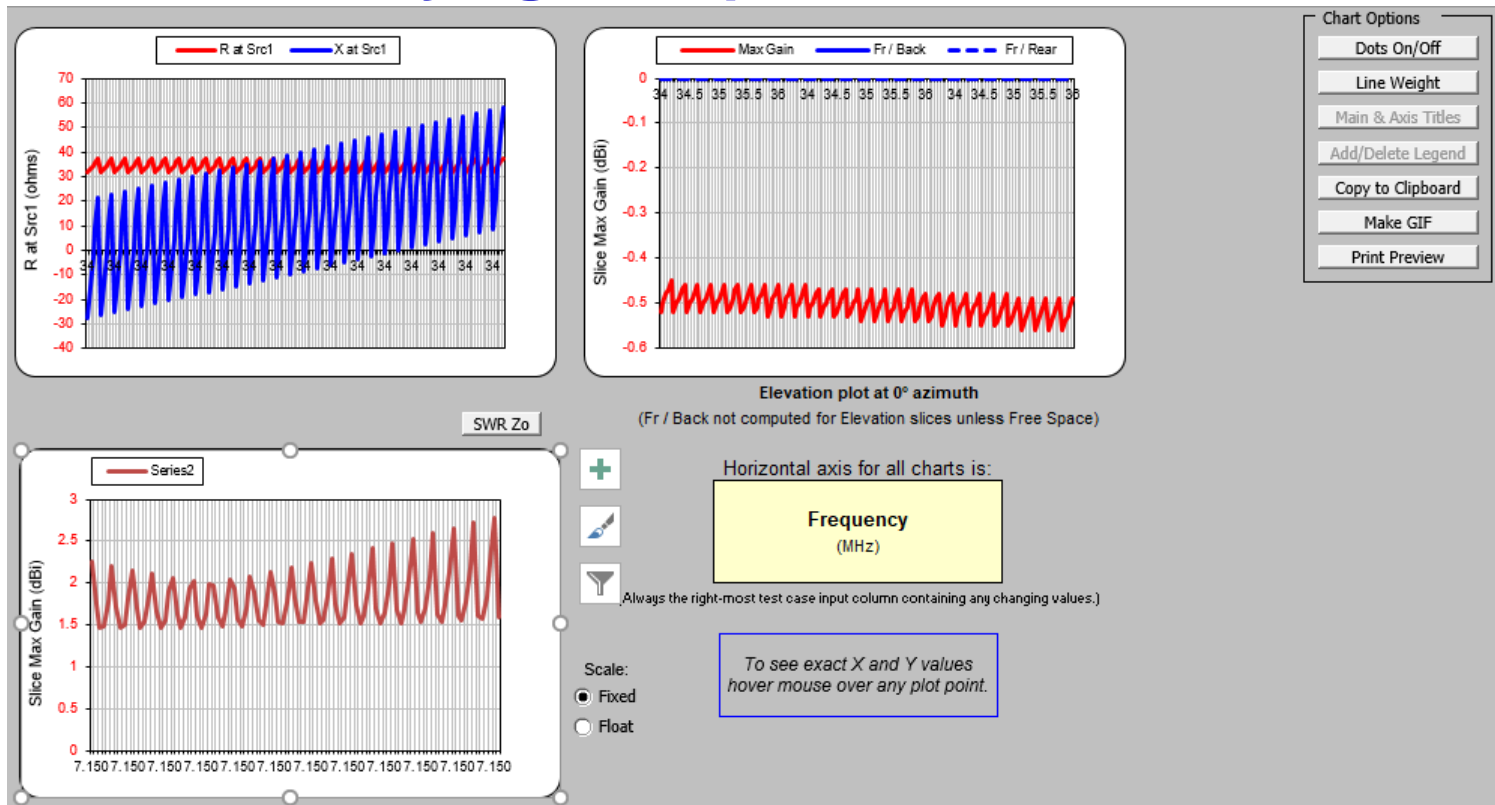


Output results

AutoEZ



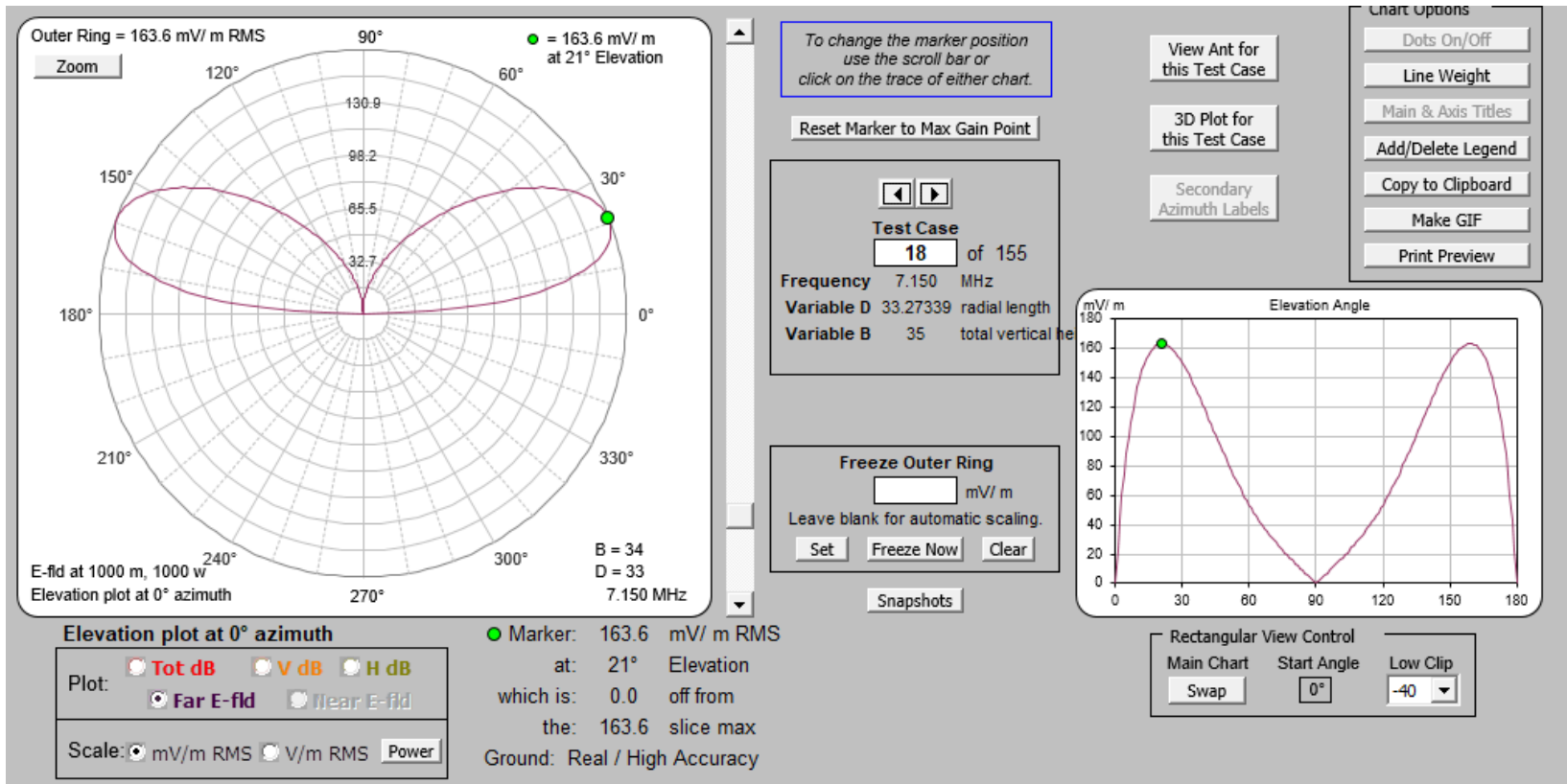
- Effect of varying multiple variables can be shown



Output results AutoEZ



- A number of additional outputs are available



Output results

AutoEZ



- There is an optimizer

The screenshot displays the AutoEZ software interface with the optimizer active. The main window shows optimization parameters and a results table. A 'Final' dialog box is open, showing the optimized values for variables B, D, and E.

Optimizer Setup Dialog:

Select the variables that are to be automatically adjusted by the optimizer. Any unselected variables will stay fixed at the current values.

Name	Value	Comment
<input type="checkbox"/> A:	10	height above ground
<input checked="" type="checkbox"/> B:	35	total vertical height
<input checked="" type="checkbox"/> D:	33.27339	radial length
<input checked="" type="checkbox"/> E:	43	end height of sloped radial

Main Window Optimization Objective(s):

Target	Weight	Good Enough
R - 50	0	0.5
X	0	0.5
SWR	1	1.2
Gain	1	99
Fr / Back	0	48
Fr / Rear	0	40

Summary Table:

Trial	Freq (MHz)	R at Src1	X at Src1	SWR(50)	Max Gain	@ E*	Fr / Back	Fr / Rear	B	D	E
Start	7.150	34.30	0.00	1.458	-0.49	21	0.00	0.00	35	33.27339	43
Final	7.150	57.02	-5.17	1.177	-0.32	21	0.00	0.00	41.145	21.587	31.508

Final Dialog:

B	41.145
D	21.587
E	31.508

Optimizer Dialog:

Time 0:36 for 54 trials

Final SWR 1.177 Gain -0.32

Outer: 168.9 mV/m

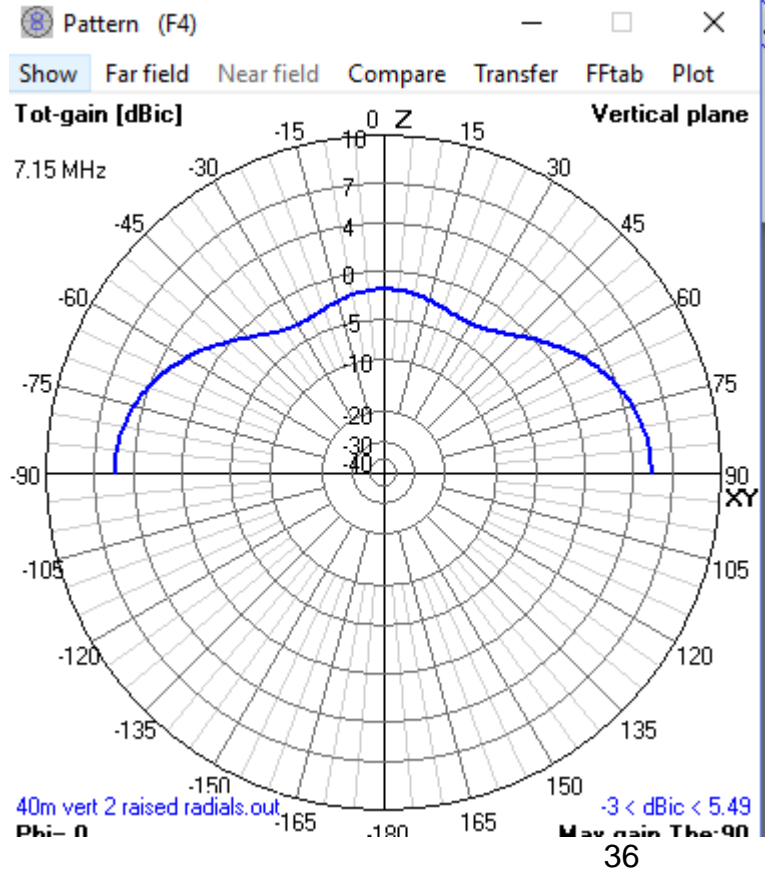
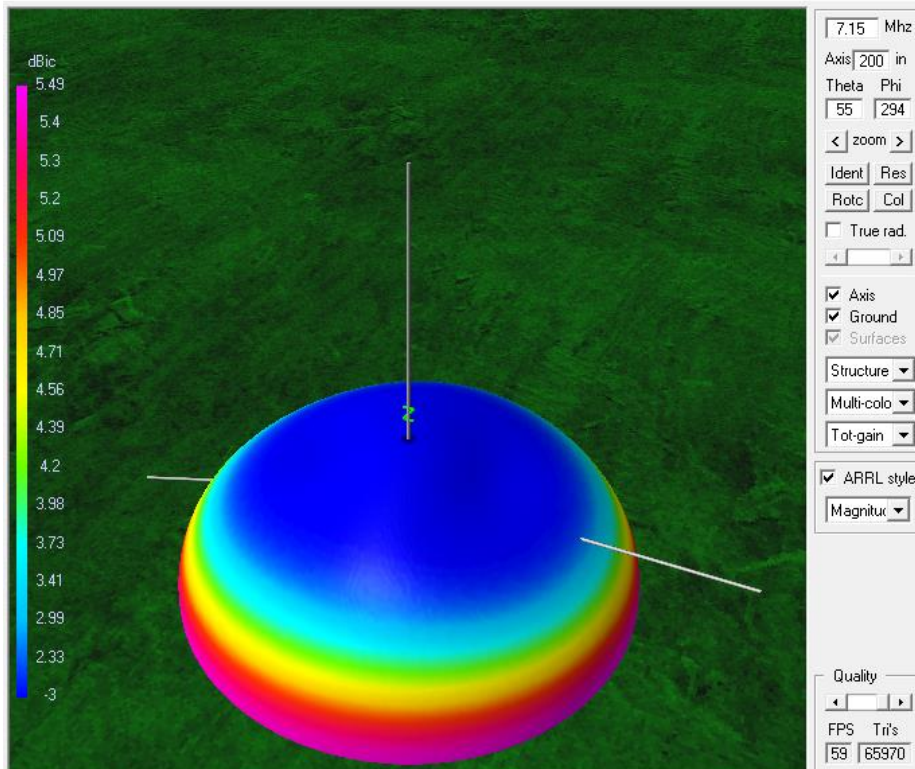
Frequency: 7.150 MHz

Output results 4NEC2



■ There are tabular and graphics outputs

3D Viewer (F9) [40m vert 2 raised radials.out]



9/30/2018

TechTopics
Keith Witney VE7KW

Output results 4NEC2



■ There are tabular and graphics outputs

Main [V5.8.16] (F2)

File Edit Settings Calculate Window Show Run Help

Filename: 40m vert 2 raised rad

Frequency: 7.15 Mhz
Wavelength: 41.93 mtr

Voltage: 59.6 + j0 V
Current: 1.68 - j1e-2 A

Impedance: 35.5 + j0.2
Parallel form: 35.5 // j6255

S.W.R.50: 1.41
Efficiency: 95.93 %
Radiat-eff: %
RDF [dB]: 5.53

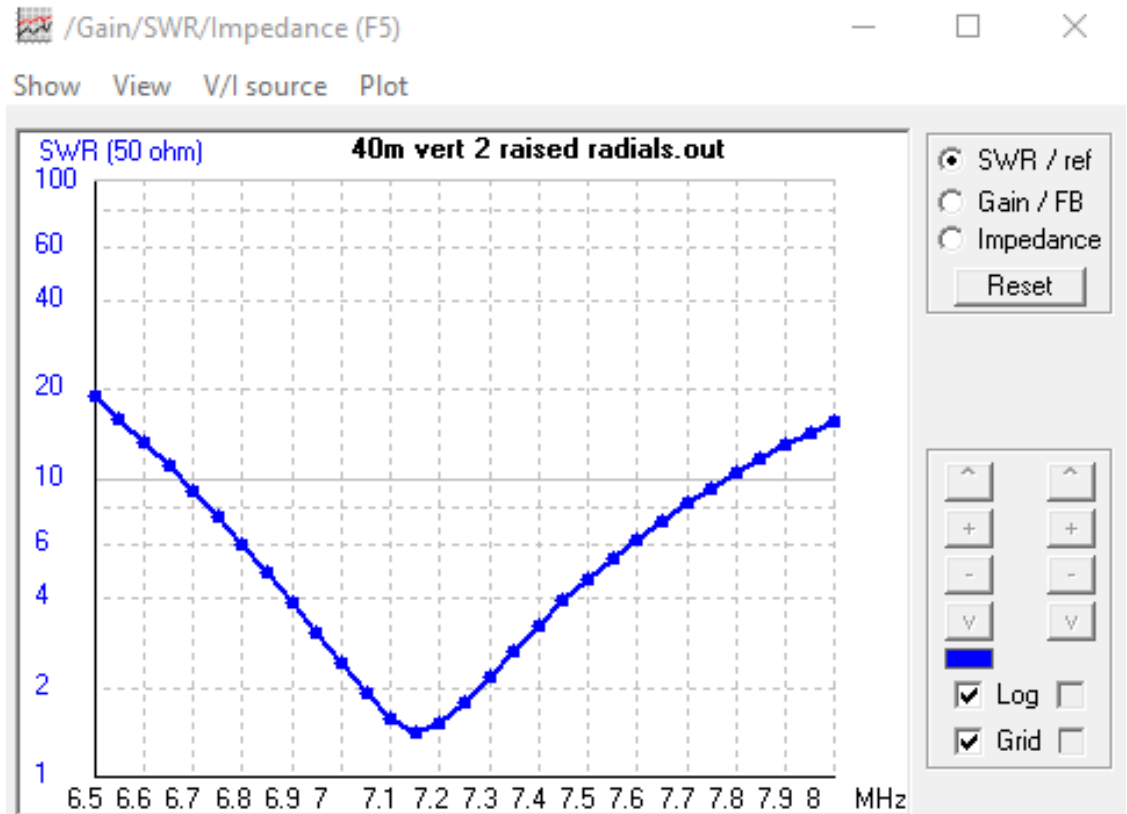
Series comp.: 1.1e5 pF
Parallel comp.: 3.559 pF
Input power: 100 W
Structure loss: 4.071 W
Network loss: 0 uW
Radiat-power: 95.93 W

Excitation/Load data: Loads Polar

Type	Tag	Seg	Impedance	Voltage	Pwr	SWR
EX 0: V-src	1	1	35.5 + j0.2	59.6 + j0	100	1.41
LD 5 Wire	1	wire	Copper			
LD 5 Wire	2	wire	Copper			
LD 5 Wire	3	wire	Copper			
LD 5 Wire	4	wire	Copper			

Seg's/patches: 34
Pattern lines: 5611
Freq/Eval steps: 31
Calculation time: 0.250 s

Theta: -90 90 181 1
Phi: 0 0 1 0



Output results 4NEC2



- There is a multivariable optimizer

Optimizer: Ready...

Settings:

Function: Optimize Option: Defau

Variables: B=34.189, D=34.079, A=10

Selected: B, D

Weighting factors (FOM) in %:

SWR	Gain	F/B	F/R	R-in	X-in	Eff.
100	0	0	0	0	100	0

Surf-wave at distance = 1 Km

Theta: 0, Phi: 89, 269

Resolution: 5 deg.

d-Theta: 0, d-Phi: 0

Frequency: 7.15

Freq-sweep

Tot-gain: ▼

Variable Sensivity:

Run:	B	D
1-1	1.0323	0.9677
2-1	1.0323	0.9677
3-1	-0.964	-1.036
4-1	1.0688	0.9312
5-1	-0.915	-1.085

Calculated results:

Run:	SWR	Gain	F/B	F/R	R-in	X-in	Eff.	Res. %	Step %
3-7	1.5066	0	0	0	33.188	0.1282	95.65	0.013	0.1
3-8	1.5139	0	0	0	33.07	-1.342	95.64	-0.02	0.1
4-1	1.5084	0	0	0	33.156	-0.603	95.65	0.01	0.1
4-1	1.5108	0	0	0	33.104	-0.613	95.64	9.e-3	0.1
4-2	1.5116	0	0	0	33.101	-0.974	95.65	5.e-3	0.025
4-3	1.5095	0	0	0	33.132	-0.607	95.65	5.e-3	0.025
4-4	1.5078	0	0	0	33.163	-0.24	95.65	5.e-3	0.025
4-5	1.5063	0	0	0	33.194	0.1282	95.65	2.e-3	0.025
4-6	1.5052	0	0	0	33.225	0.4964	95.65	-3.e-3	0.025
5-1	1.5044	0	0	0	33.247	0.6814	95.65	-1.e-3	0.025
5-1	1.505	0	0	0	33.233	0.679	95.65	-2.e-3	0.025

Variable Values:

Run:	B	D
3-7	34.178	34.077
3-8	34.146	34.042
4-1	34.18	34.042
4-1	34.146	34.076
4-2	34.155	34.05
4-3	34.164	34.058
4-4	34.173	34.065
4-5	34.182	34.073
4-6	34.191	34.081
5-1	34.2	34.081
5-1	34.191	34.09
5-2	34.189	34.079

Output results NEC



- Mainly tabular
- Limited Graphics

Comments

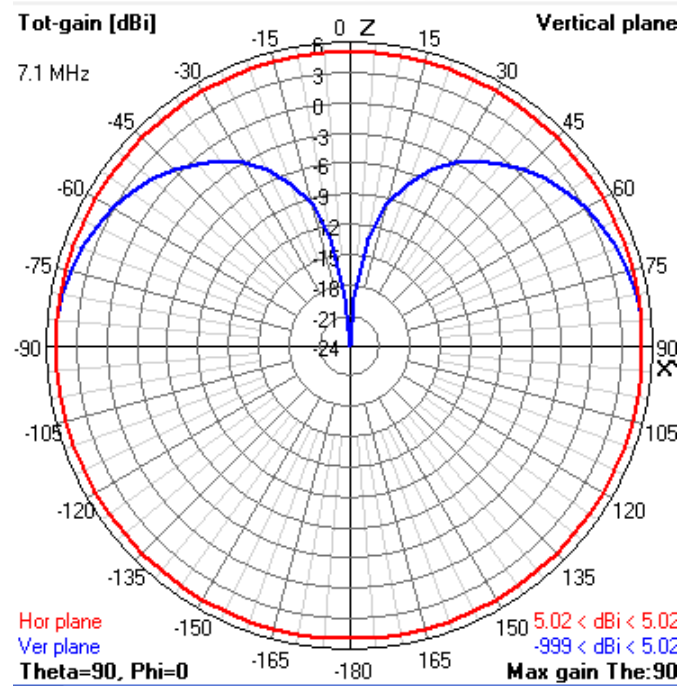
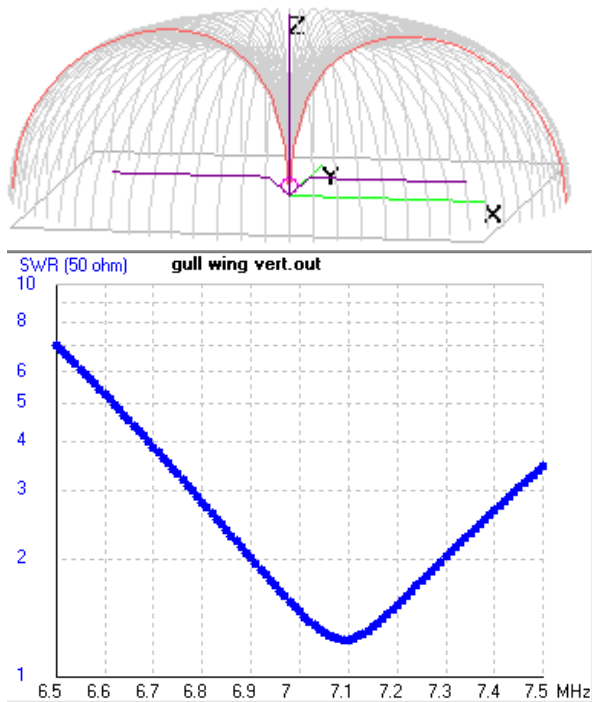


- NEC is an old mainly text based program which has resulted in many “improvements”
- EZNEC is most familiar to Amateurs and AutoEZ adds useful features.
- 4NEC2 has all of the features of EZNEC+ AutoEZ and can use EZNEC files but the work flow is not easy to follow. The 3D graphics are nice and a graphics editor may help some people.
- ALL programs require an understanding of the limitations of NEC especially NEC2.

Special Case “Gull Wing” Radials



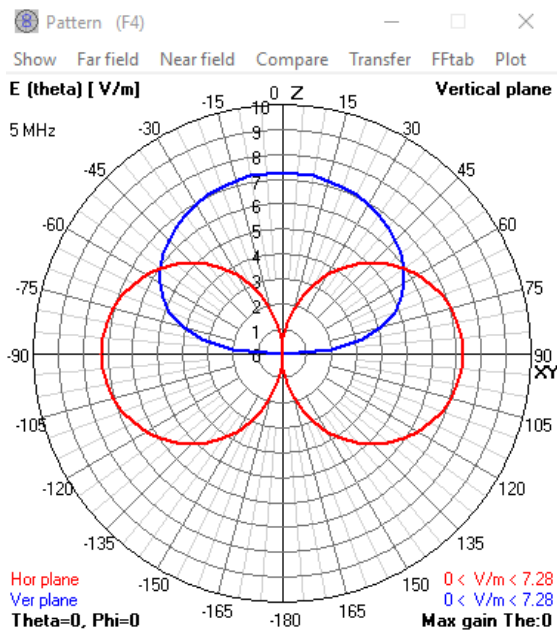
- NEC2 has problems with wires that intersect at an acute angle. NEC4 can handle this.



Special Case Buried Wires



- NEC 2 will not calculate wires in the ground but using the NEC 4 engine the length of a buried dipole can be modelled and optimised.



Optimizer: Ready...

Settings

Function	Option	Weighting factors (FOM) in %:						
Optimize	Default	SWR	Gain	F/B	F/R	R-in	X-in	Eff.
		100	0	0	0	0	0	0

Variables: length=3.8139

Theta: 0, Phi: 180
 Resolution: 5 deg, Frequency: 7.1

Calculated results:

Run	SWR	Gain	F/B	F/R	R-in	X-in	Eff.	Res. %	Step %
3-1	5.9942	0	0	0	291.51	48.183	100	-6e-5	0.1
3-2	5.994	0	0	0	292.09	46.45	100	8.e-5	0.4
3-3	5.9942	0	0	0	292.57	45.064	100	-1e-4	0.4
4-1	5.9941	0	0	0	292.45	45.409	100	6.e-5	0.1
4-2	5.9941	0	0	0	292.45	45.409	100	6.e-5	0.1
4-3	5.994	0	0	0	292.33	45.755	100	3.e-5	0.1
4-4	5.994	0	0	0	292.21	46.101	100	3.e-5	0.1
4-5	5.994	0	0	0	292.1	46.446	100	1.e-5	0.1
4-6	5.9939	0	0	0	291.98	46.792	100	2.e-6	0.1
5-1	5.994	0	0	0	291.86	47.138	100	-2e-5	0.1
5-2	5.9939	0	0	0	292.01	46.706	100	3.e-6	0.025

Variable Values:

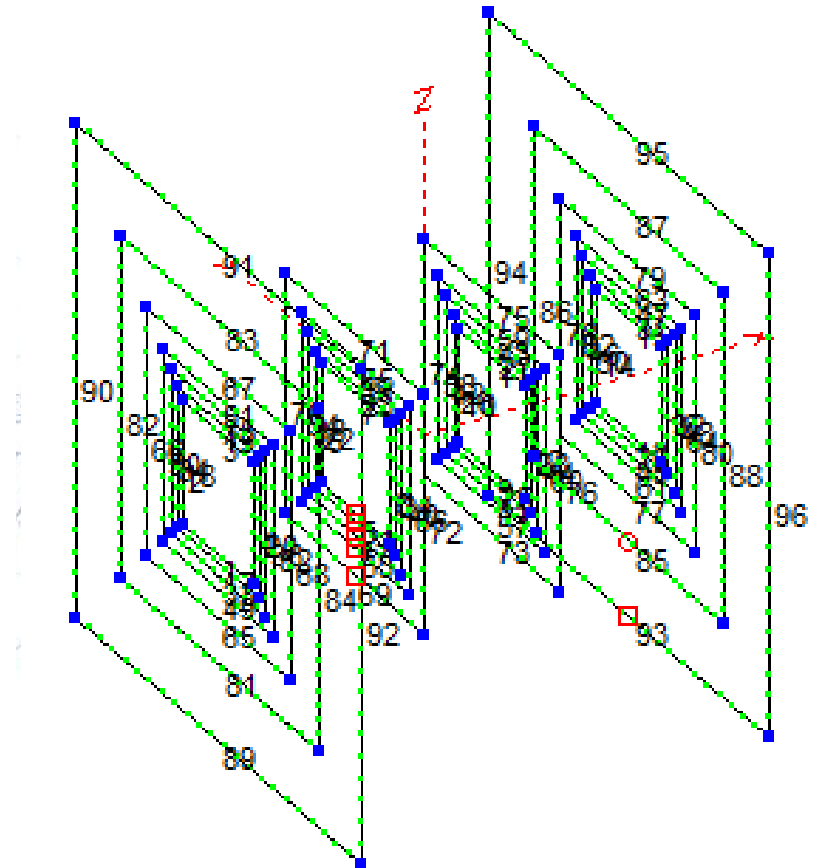
Run	length
2-2	3.7498
3-1	3.8302
3-2	3.8111
3-3	3.7958
4-1	3.7996
4-2	3.7996
4-3	3.8034
4-4	3.8072
4-5	3.811
4-6	3.8148
5-1	3.8187
5-2	3.8139

A Complicated Case

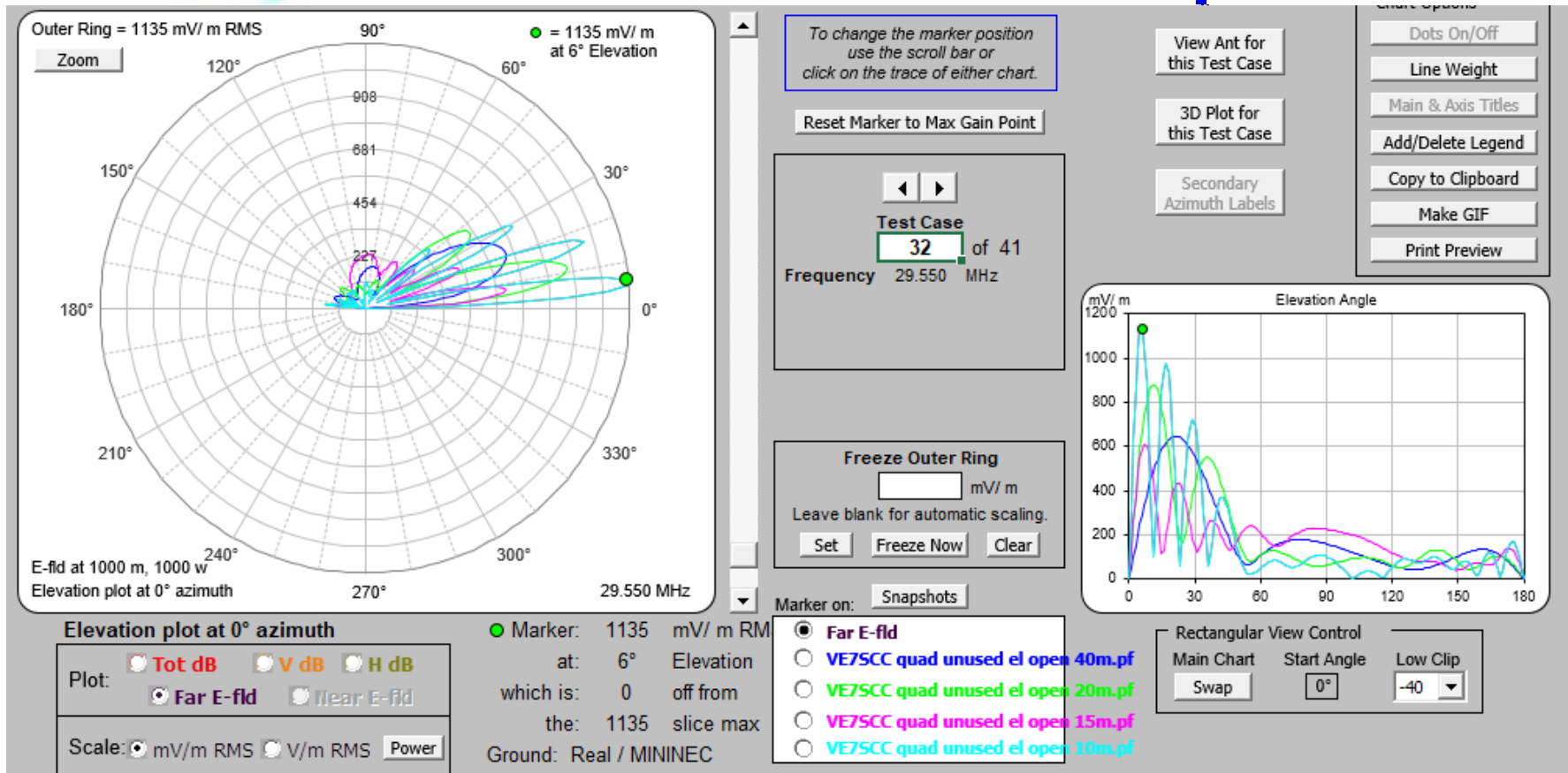
VE7SCC Quad



- 2 el on 30 and 40m
- 4 el on 20, 17, 15, 12, 10
- Models interaction of elements which is complicated.
- Can add coax matching sections
- Can model antenna switching
- Easy to generate model



A Complicated Case VE7SCC Quad

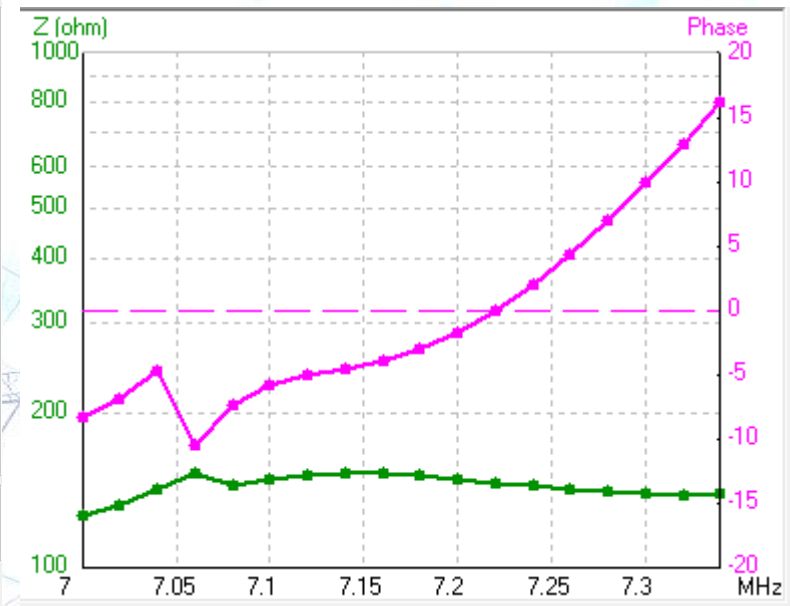
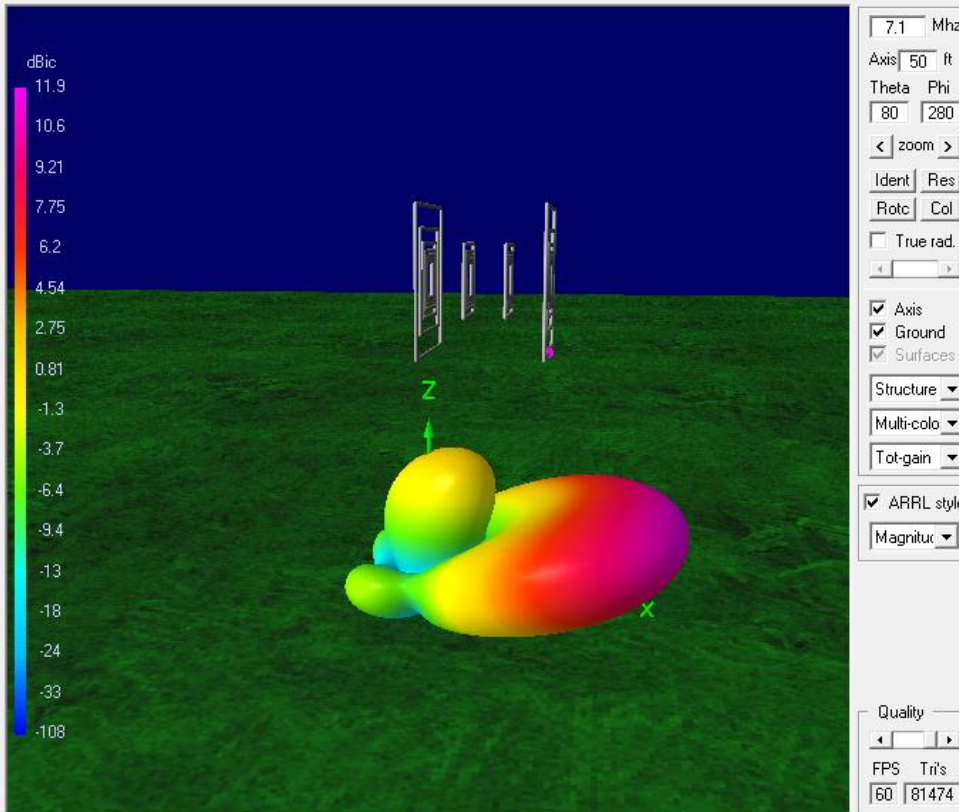


A Complicated Case

VE7SCC Quad



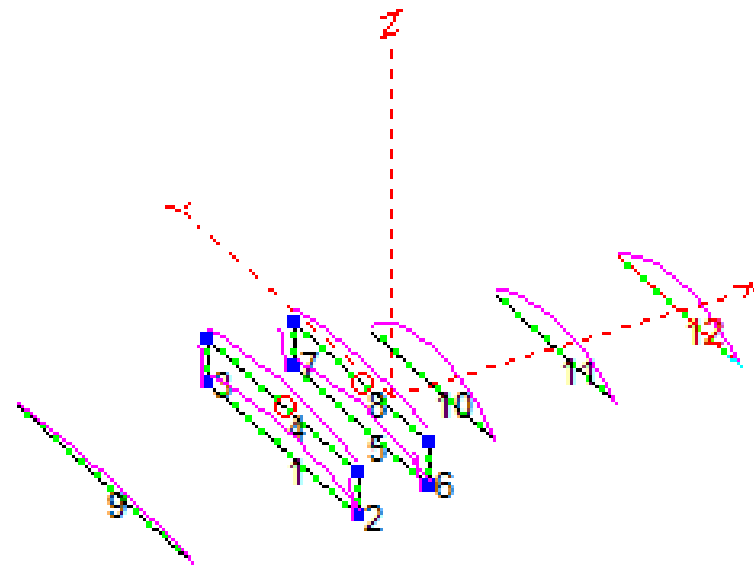
3D Viewer (F9) [VE7SCC quad 85ft m.out]



Sinclair 440 Beam



- John White showed this as part of his Yagi presentation
- NEC 4 should be used to model the cross-overs which are too close for NEC2 but NEC2 works by using the equivalent 2 sources.



A NEC4 Case Sinclair 440 Beam



- The matching appears to be dependant upon the interaction of the folded dipoles as otherwise $1/4\lambda$ 125ohm coax would be required. This curve was confirmed with an AIM600 but with better SWR.

