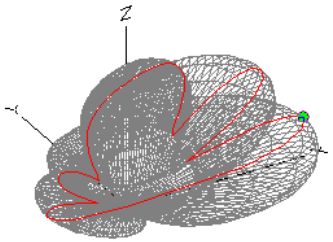

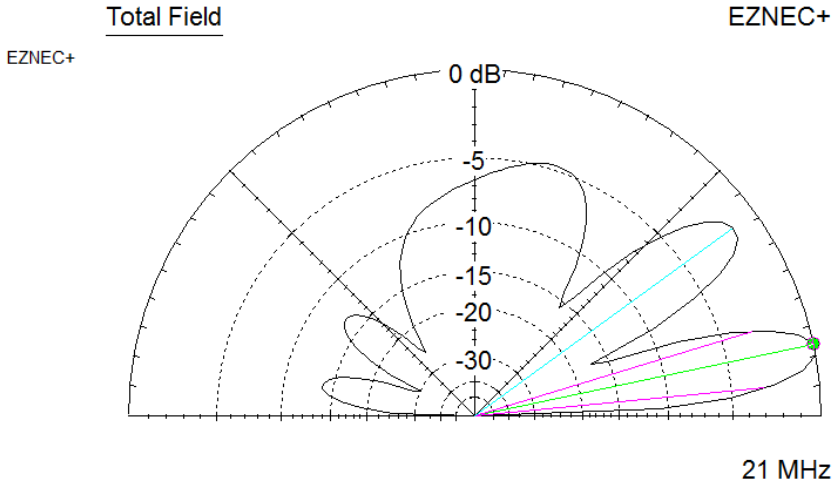

Antenna Modelling with NEC2

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ZS6BTY

ZS6BTY November 2013

NEC2

- NEC - Numerical Electromagnetic Code
  - Lawrence Livermore Laboratory
  - Program Description - 1981
    - Part 1 – Theory
    - Part 2 - Code
  - MiniNEC
    - BASIC
    - IBM PC

NEC2

- NEC2
  - September 1996
  - NEC-2 Manual, Part III: User's Guide
  - Antenna current
  - Antenna patterns
  - Ground
  - Wires near the ground (not in the ground)

NEC2

- NEC2
  - Perfect ground
  - Real ground
    - Conductivity
    - Dielectric Constant
  - Antenna currents calculated with Real ground
    - Impedance is accurate
    - This was a limitation of MiniNEC

NEC2

- NEC2
  - Various compilations available (.EXE)
    - Allow different size antennas (PC memory)
      - Nec2d.zip – real ground separate (Sommerfield)
      - Nec2dXS_VM.zip – real ground compiled in
  - Command line driven
    - Text file input (Fortran cards)
    - Large text file output

NEC2

- NEC2
  - Third party GUI programs
  - EZNEC
  - 4NEC2
  - MMANA-GAL
    - MiniNEC

NEC2

- NEC4
  - Wires in the ground
    - Licensed
    - Expensive
    - Restricted availability
  - EZNEC and 4NEC2
    - If you have bought the license from LLL

NEC2

- **EZNEC®**
  - Roy W. Lewallen, W7EL
  - www.eznec.com
    - Limited Version with the ARRL Antenna Book
    - EZNEC 5 $89.00
    - EZNEC+ 5 $139.00
    - EZNEC Pro/2 v. 5.0 $500.00

NEC2

- **EZNEC-ARRL**
  - ARRL Antenna Book CD
  - Buy the book
  - EZNEC demo program except when a specially "signed" EZNEC description file (included on the Antenna Book CD) is opened.

NEC2

- **4NEC2**
  - Arrie Voors
  - www.qsl.net/4nec2
  - free
- Full-house version of NEC2
  - Version 5.7.5 (April 2009)
    - Some bugs
    - Announced end of support
  - Version 8.5.11 (6 Dec 2012)

Modelling

- Quotes from the EZNEC User Manual
  - Modelling is the technique of evaluating the performance of something by evaluating the performance of a substitute called a model.

Modelling

- The accuracy of the results are never better than the accuracy with which the model matches the real object
  - It is imperative to learn the limitations of your modelling tools
  - you are analysing a **model** of an antenna, not an actual antenna. So your accuracy is always limited by how accurately you model the real antenna and its environment.

Modelling with NEC2

- NEC2 antenna models are made from
  - wires
  - sources & loads
  - ground
- physical wires or metallic tubes, are easily modelled
- some, like a closely wound helical dipole antenna, can't be modelled accurately

Modelling with NEC2

- An antenna is modelled as a collection of straight wires.
  - **Straight** should be emphasized; a round loop, for example, must be modelled as a polygon of straight wires
  - You define where the wires are placed in space by giving their x, y, and z coordinates

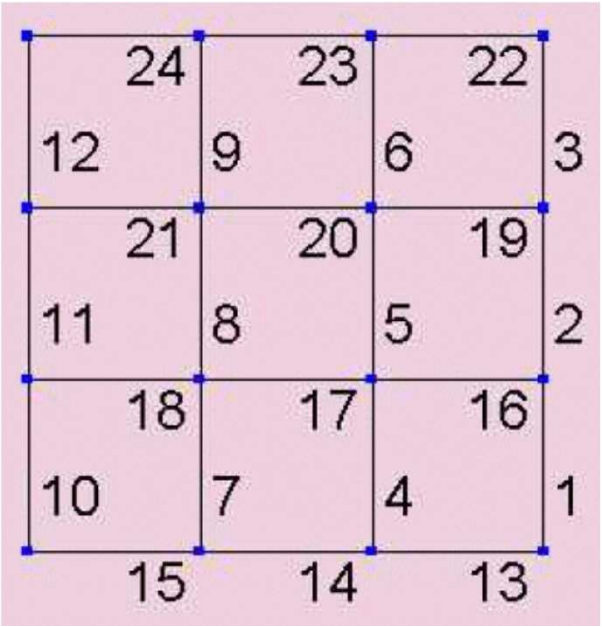
Modelling with NEC2

- Junctions between wires
  - only allowed at the end of a wire

- Crossing wires in the same space leads to big errors
  - Rather break them and form a junction
  - An X-shaped structure requires 4 wires

Modelling with NEC2

- Conducting Surfaces
  - Grid of wires with sides ~one tenth of a wavelength
  - Each side of each square is a separate wire



Modelling with NEC2

- Segments
  - wires are divided into segments
    - the current on each segment is calculated
  - the skill in modeling is in choosing the number of segments
    - 20 segments per wavelength for pattern
    - 40 for impedance
      - Generally greater accuracy for more segments
      - Slower for more segments (time α N^2)
    - Tip: Increase N & see how the results vary

Modelling with NEC2

- Wire Limitations

  L = Segment Length

  D = Wire Diameter

  - $0.001\lambda < L < 0.05\lambda$
  - $D << \lambda/\pi$
  - $L > D$
  - $L > 4D$ near junctions/bends

Modelling with NEC2

- Wire Limitations
  - Close spaced parallel wires
    - wires should be several diameters apart
    - Align segments on the wires
  - Junctions
    - Minimize changes in L and D
    - Use tapered segments near junctions
    - Tapered diameter

Modelling with NEC2

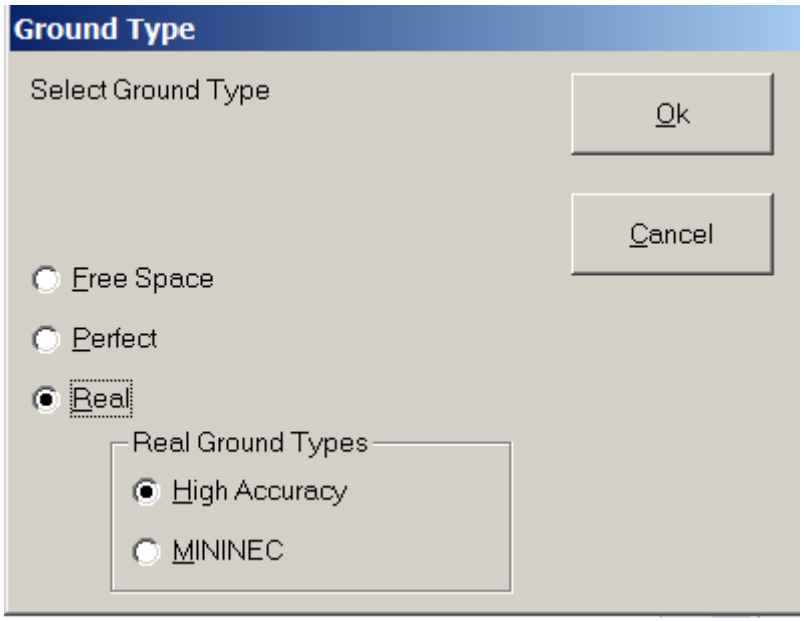
- Wire Limitations
  - Horizontal wires above ground
    - For real or perfect ground
      - Spaced a few diameters above ground
    - MiniNEC ground
      - Spaced a few tenths of a wavelength above ground

Modelling with NEC2

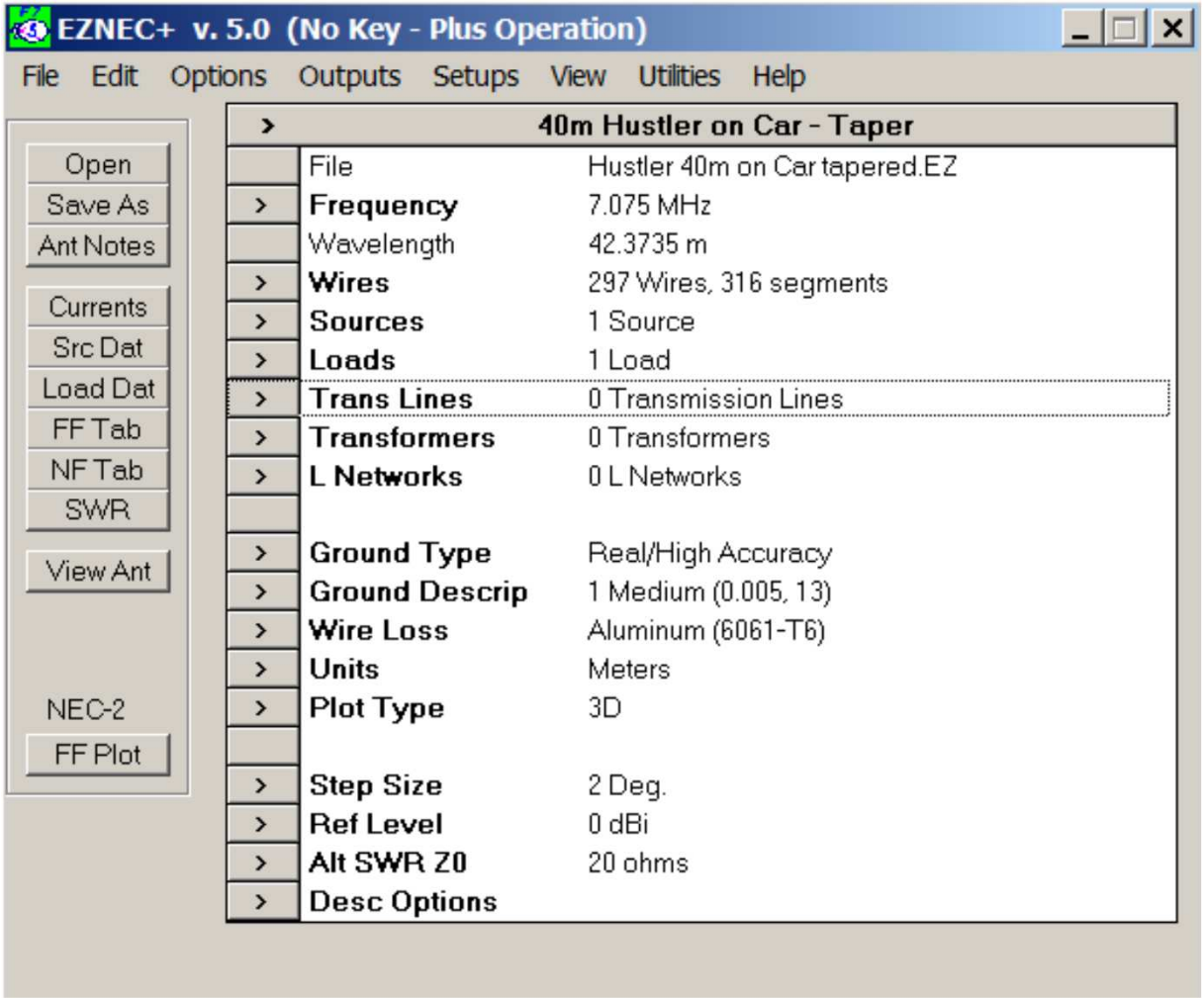
- Wire Limitations
  - Connections to Ground
    - Valid for perfect and MiniNEC ground
    - Expect impedance errors with connections to real ground

Modelling with NEC2

- Ground Type
  - Free Space
    - Pattern & ground loss
  - Perfect
    - Pattern near horizon
    - Ground losses
  - Real (MiniNEC)
    - Ground losses
  - Real (High Accuracy)
    - Ground connection

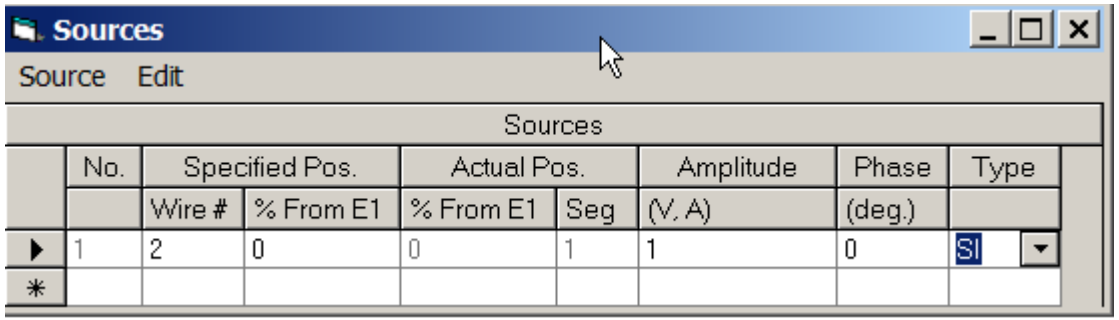


Modelling with NEC2



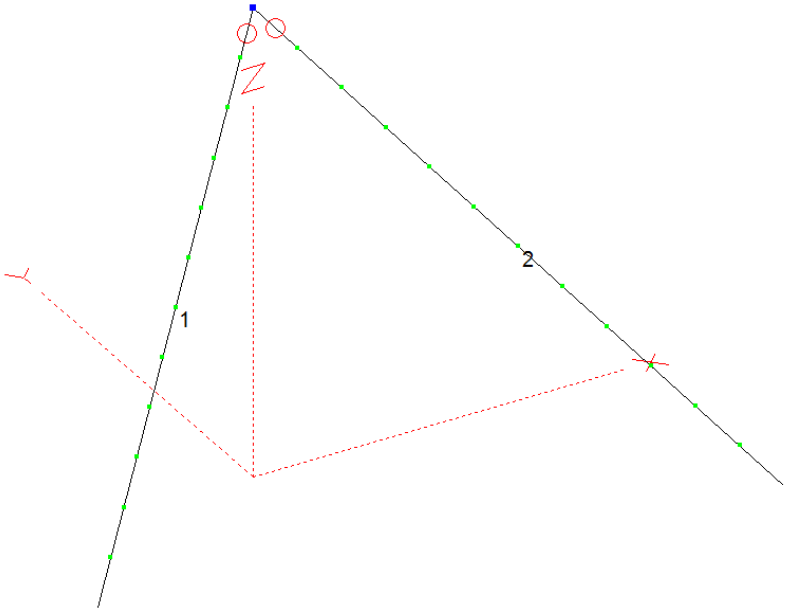
Modelling with NEC2

- Sources go in segments
  - Current (I)
  - Voltage (V)
  - Split Current (SI)
  - Split Voltage (SV)
  - Plane wave (EZNEC Pro and 4NEC2)



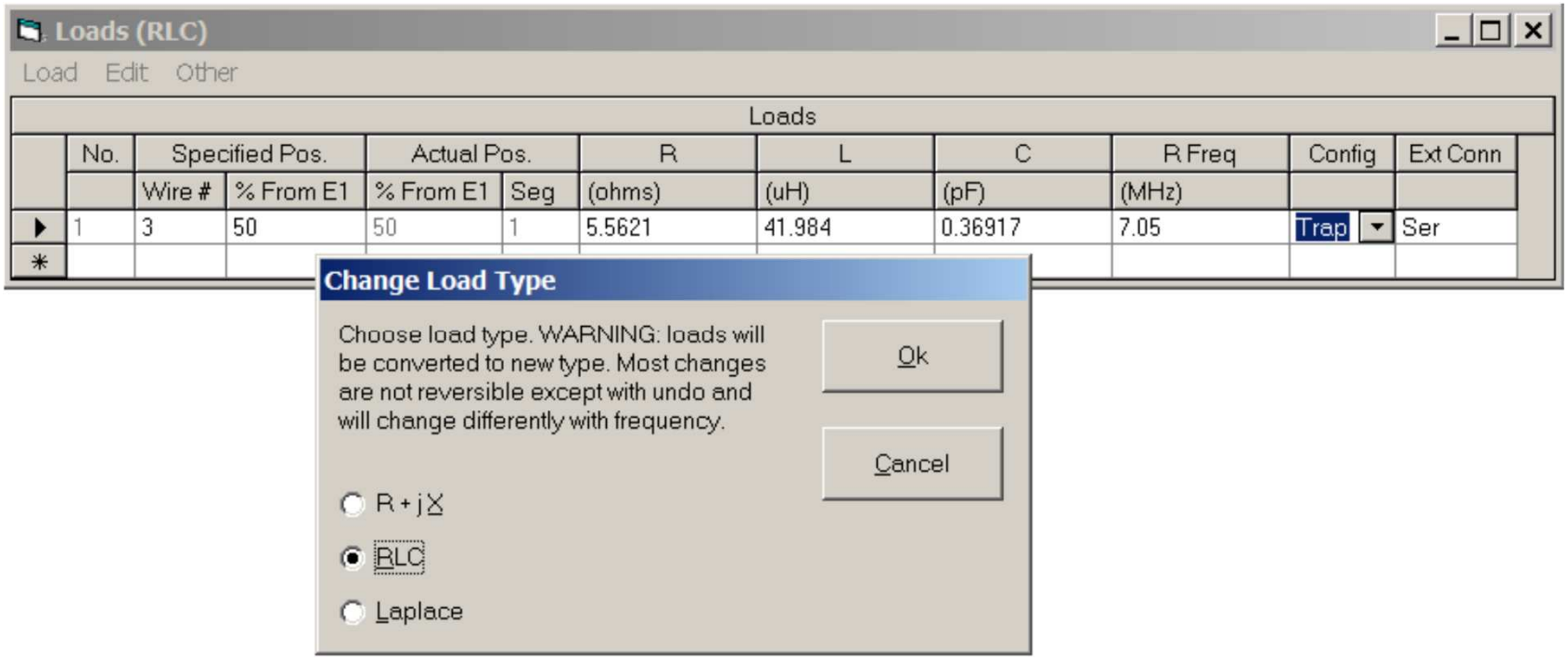
Modelling with NEC2

- Split Sources
  - SI
  - SV
  - At junctions



Modelling with NEC2

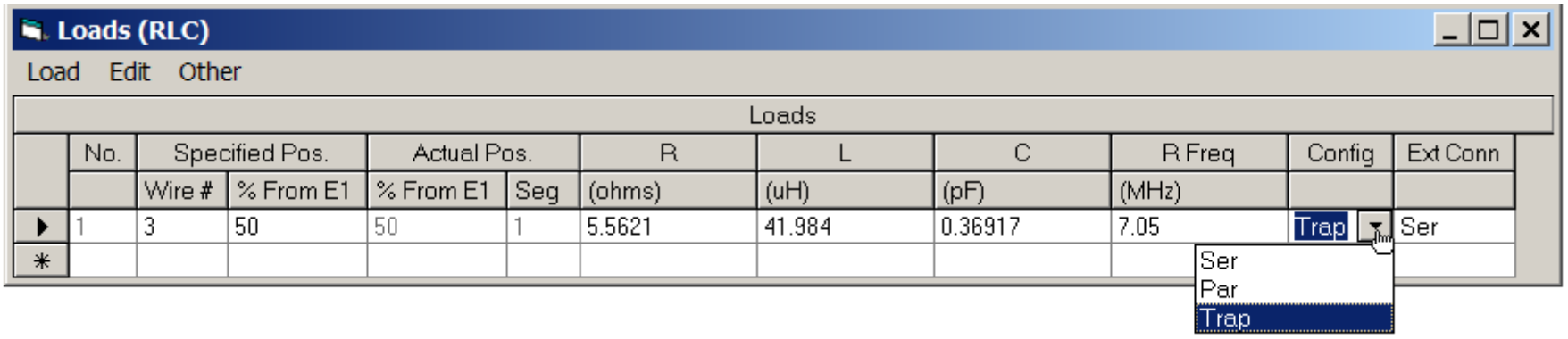
- Loads
  - In segments



Modelling with NEC2

- Loads
  - Series and Parallel RLC
  - Trap Series RL with parallel C

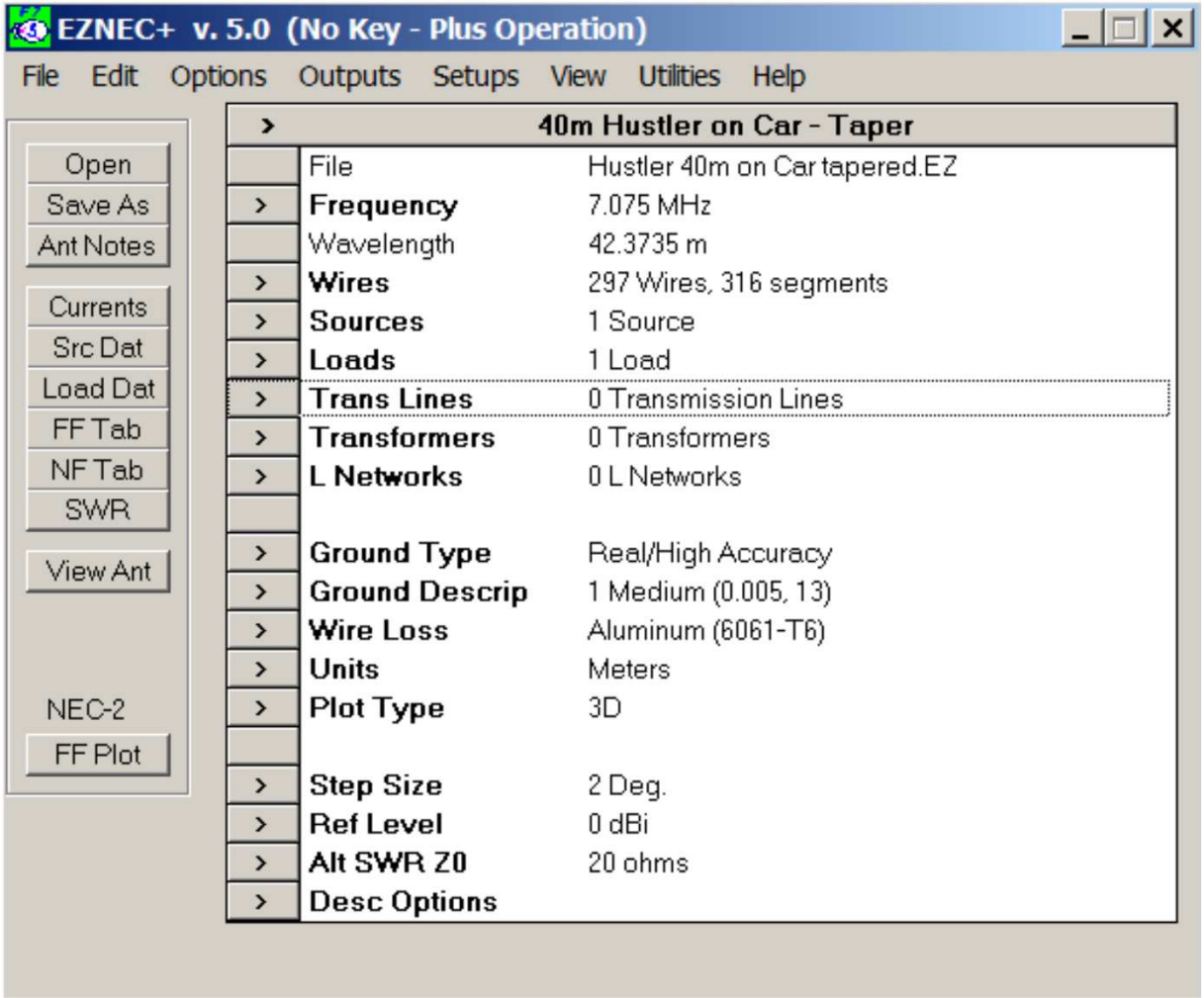
Hustler 40m resonator



Modelling with NEC2

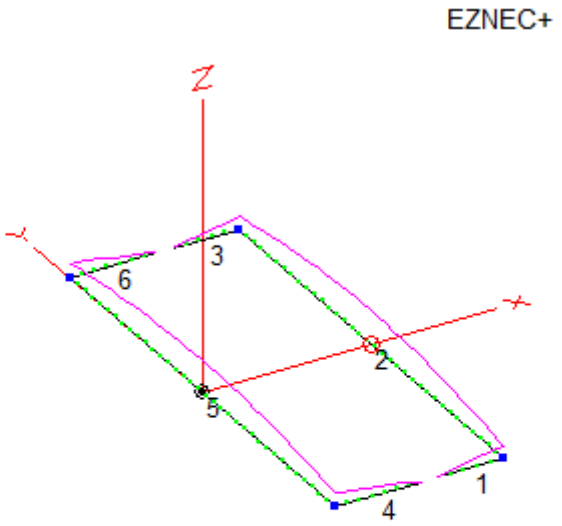
- Transmission Lines
- Transformers
- L Networks

Modelling with NEC2



Modelling with NEC2

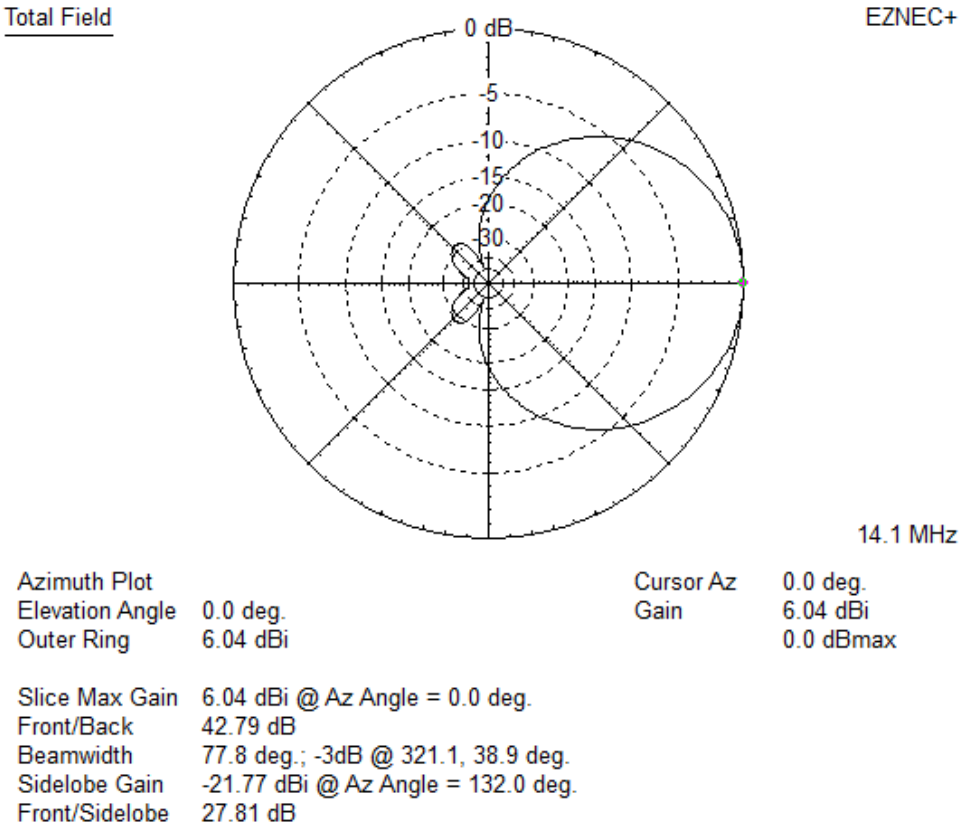
- Wires
  - Moxon



Modelling with NEC2

Pattern

Free space

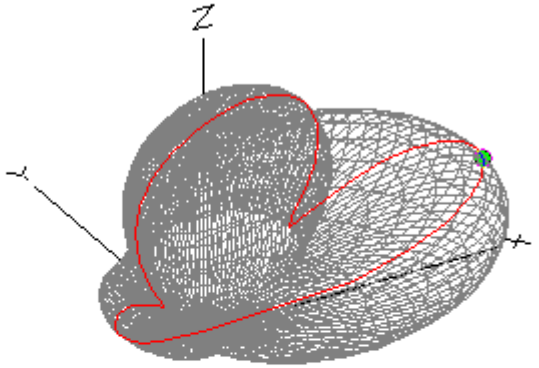


Modelling with NEC2

EZNEC+

Pattern

- 18 MHz
- 12m
- Average ground

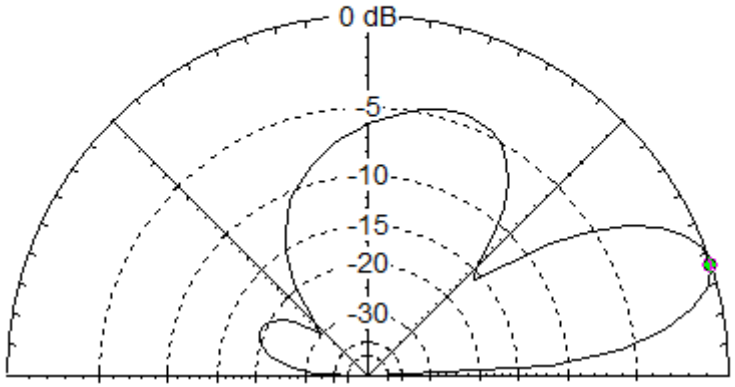


Modelling with NEC2

Elevation Pattern

Total Field

EZNEC+



18.1 MHz

Elevation Plot		Cursor Elev	18.0 deg.
Azimuth Angle	0.0 deg.	Gain	10.7 dBi
Outer Ring	10.7 dBi		0.0 dBmax
			0.0 dBmax3D
3D Max Gain	10.7 dBi		
Slice Max Gain	10.7 dBi @ Elev Angle = 18.0 deg.		
Beamwidth	20.7 deg.; -3dB @ 9.1, 29.8 deg.		
Sidelobe Gain	6.35 dBi @ Elev Angle = 69.0 deg.		
Front/Sidelobe	4.35 dB		

Modelling with NEC2

- Examples
  - Dipole
  - Moxon
  - Inverted Vee
  - Mobile 40m Hustler

Modelling with NEC2

Thank You

EZNEC+