QEX File:
EZNEC Models and Compliance Distance Calculations for a 70 cm Band Collinear Dipole Array and a Quarter-Wave Dipole

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Computer Simulation of Compliance Distances

I used *EZNEC* **[1]** scans of the E [V/m] and H [A/m] fields to locate the farthest point from the antenna where the power density equals the FCC exposure limit. E and H represent rms magnitudes of the electric and magnetic fields, respectively.

At UHF frequencies the maximum permissible exposure limits are specified as power densities **[2, 3]**. The equivalent plane-wave power densities in terms of simulated E and H field levels are $S_E = E^2/377$ [W/m^2] and $S_H = 377H^2$ [W/m]. For 425 MHz the controlled environment power density limit of 14.8 W/m^2 corresponds to maximum permissible field levels of H = 0.198 A/m and E = 74.7 V/m. For uncontrolled environments the limit 2.97 W/m^2 corresponds to H = 0.089 A/m and E = 33.5 V/m.

I evaluated the E and H fields with separate *EZNEC* scans because E and H in near fields typically have different spatial distributions. The compliance distance is the larger of the two distances identified in the scans.

For the collinear array and the quarter-wave monopole I measured compliance distances horizontally from the vertical axis of the antenna to the point of exposure.

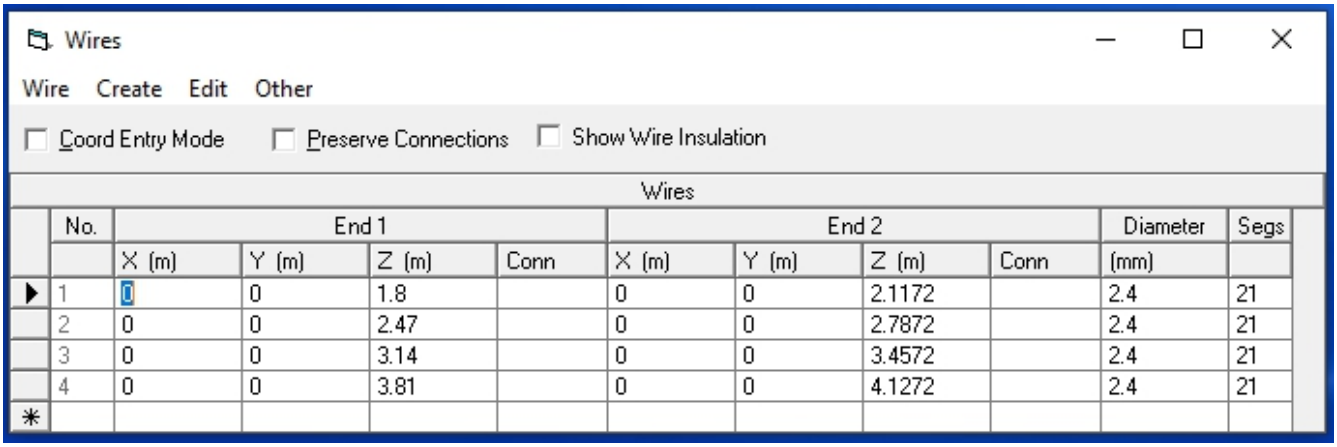
EZNEC Model of a Collinear Array of Half-Wave Dipoles

Figure 1 in the *QEX* article shows the model of the vertical array, comprised of four half-wave dipoles for the 70 cm band **[4]**. The feed points are spaced one wavelength apart, and the dipoles are driven in-phase. My *NEC* model is for an array mounted on a non-conducting mast with complete decoupling of the feeder. The overall length is 2.33 m (7.6 ft). The dipoles are

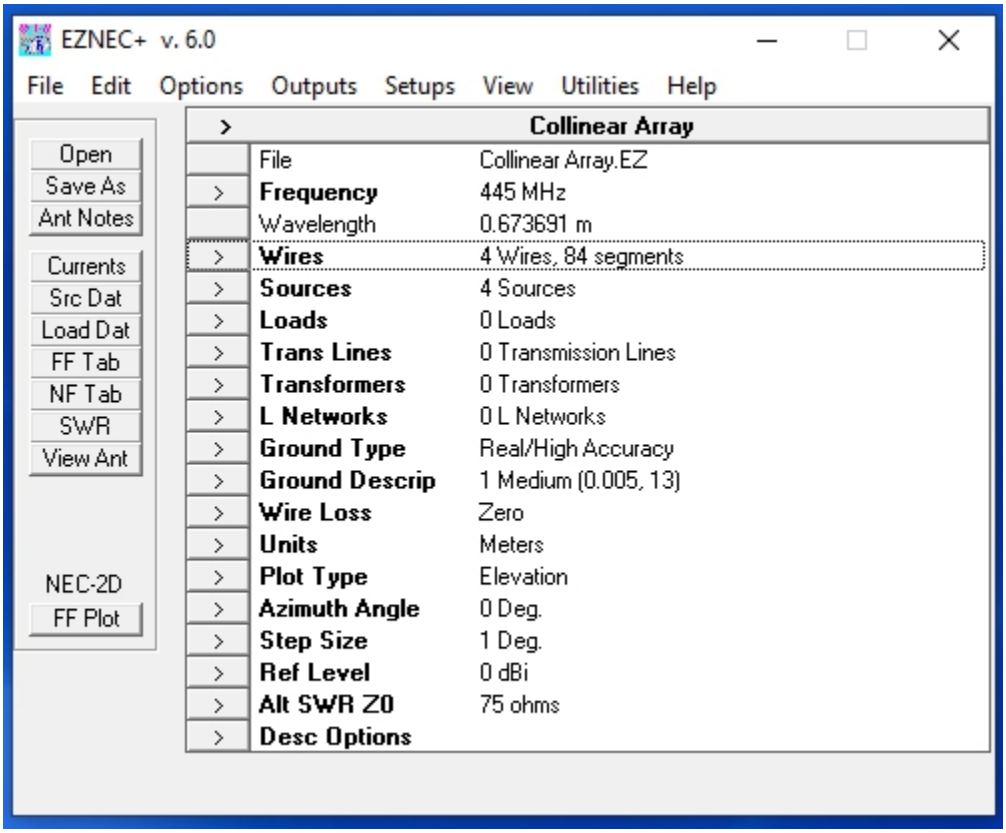
0.32 m (1.0 ft) long, and the elements are 2.4 mm (3/32 inch) in diameter. For **Figures 3 to 6**, the center of the array is 2.96 m (9.7ft) above average ground.

A rule of thumb for the number of *NEC* segments is 20 segments per half-wavelength for high accuracy in near field and impedance calculations [**1**]. This model has 21 segments for each half-wave vertical element.

The *EZNEC* Wires window and Main window are shown below.

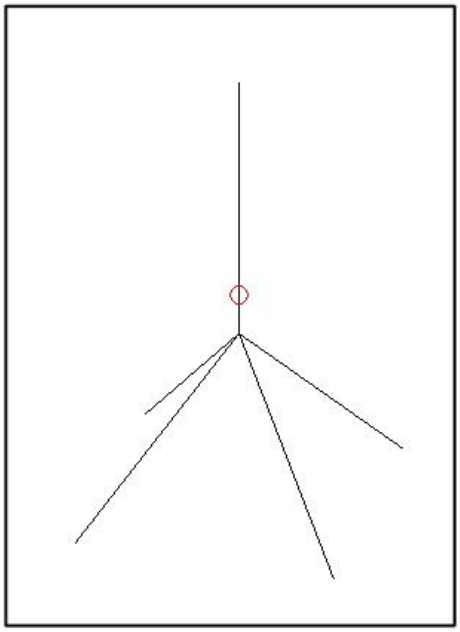


No.	End 1				End 2				Diameter	Segs
	X (m)	Y (m)	Z (m)	Conn	X (m)	Y (m)	Z (m)	Conn	(mm)	
1	0	0	1.8		0	0	2.1172		2.4	21
2	0	0	2.47		0	0	2.7872		2.4	21
3	0	0	3.14		0	0	3.4572		2.4	21
4	0	0	3.81		0	0	4.1272		2.4	21



EZNEC Model of a Ground-Plane, Quarter-Wave Monopole

This antenna is a ground-plane, quarter-wave monopole for the 440 MHz band. It is composed of a 0.16 m (0.52 ft) long, 2.4 mm (3/32 inch) diameter vertical element with four ground-plane radials that extend at 45° angles below horizontal. The *EZNEC* model is shown below.



The common point of the five elements is 1.8 m (5.9 ft) above average ground. The *EZNEC* Wires window is shown below.

Wires

Wire Create Edit Other

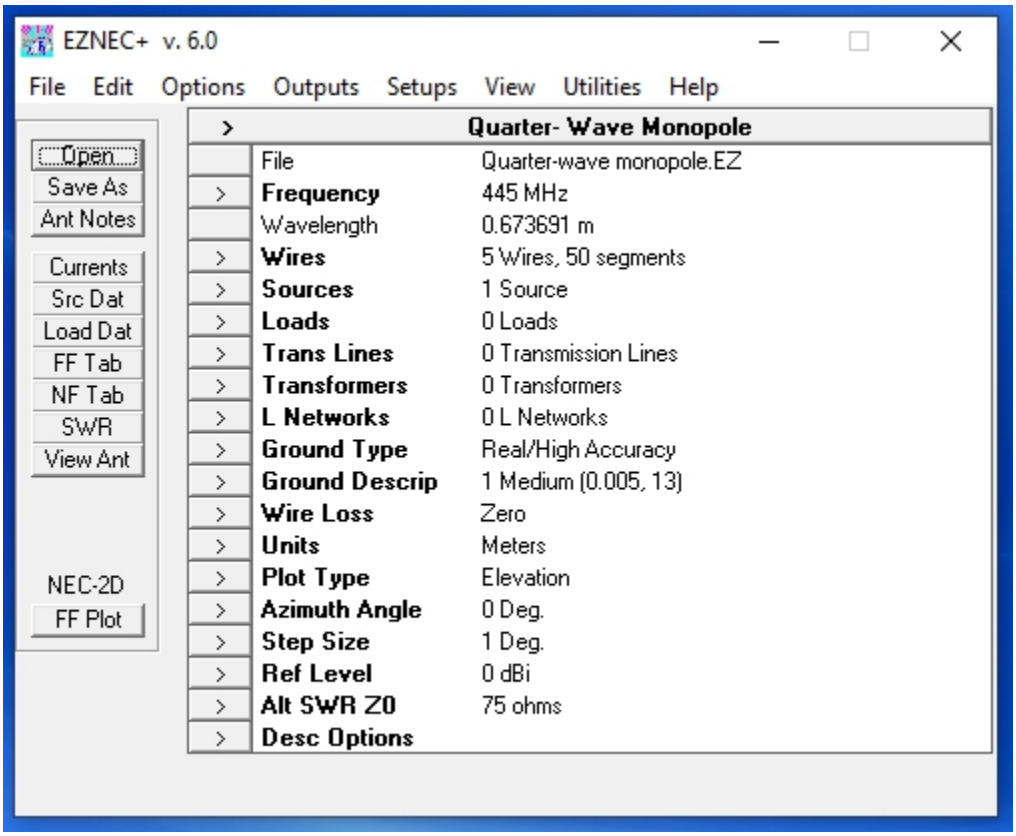
Coord Entry Mode Preserve Connections Show Wire Insulation

Wires

No.	End 1				End 2				Diameter	Segs
	X (m)	Y (m)	Z (m)	Conn	X (m)	Y (m)	Z (m)	Conn	(mm)	
1	0	0	1.8	W2E1	0	0	1.9577		2.4	10
2	0	0	1.8	W3E1	0	0.103	1.697		2.4	10
3	0	0	1.8	W4E1	0.103	0	1.697		2.4	10
4	0	0	1.8	W5E1	0	-0.103	1.697		2.4	10
5	0	0	1.8	W1E1	-0.103	0	1.697		2.4	10
*										

The source is located in the middle of the second segment of the vertical element, near the lower end, so adjoining segment lengths on both sides of the source are equal.

The *EZNEC* main window is shown below.



References

[1] Roy Lewallen, W7EL, *EZNEC User Manual*, sections on (1) Segmentation and (2) Source Placement Precautions; **https://www.eznec.com/ez60manual.html**.

[2] "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields," *OET Bulletin 65b* (1997). **https://www.fcc.gov/bureaus/oet/info/documents/bulletins/oet65/oet65b.pdf**.

[3] E. Hare, W1RFI, *RF Exposure and You*, ARRL, 1998, reprinted 2003. Currently out of print. Archived at **www.arrl.org/rf-safety-publications**.

[4] *Antenna Book,* 21st Edition, ARRL, 2007-8, pp. 17-5 to 17-7.