

EZNEC Modeling of a Mobile Antenna

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My primary ham station here in Hawaii now consists of mobile operation from my 1996 Audi convertible. My rig is the 100 watt, 160m-70cm, all-mode, Yaesu FT-857. My HF mobile antenna is the companion Yaesu ATAS-120, screw-drive adjust, vertical whip antenna. The Yaesu engineers did a fantastic job of designing the 857 & 120 to work together. The 857 rig auto-tunes the 120 whip antenna via control signals over the antenna coax cable. I have found the combination to work great on all the ham bands from 40 meters thru 6 meters. From KH6 land (Hawaii), I have been able to work all over the Pacific Ocean and the Pacific rim and the mainland of North America with this rig and mobile antenna.

I recently decided to determine what the antenna gain and pattern was for my mobile rig. I have the antenna modeling computer program called EZNEC (+4.0). I have found it to be a great program for serious modeling of antennas. For details, go to www.eznec.com. A review of EZNEC appeared in the Jan. & Feb., 2005 issues of BARC's Bark. If you need a copy of these past articles, please send me an e-mail at kh6htv@arrl.net

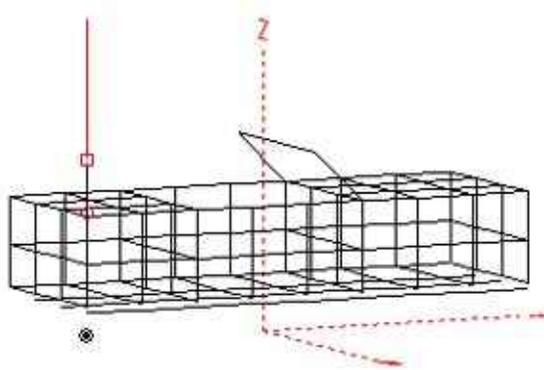
The first step was to make physical measurements of the ATAS-120 antenna dimensions and also the dimensions of my car. Because the antenna is tunable for operation from 7 MHz to 50 MHz, I measured its dimensions on each of the ham bands from 40 m through 6 m. The total antenna height varied from 143 cm on 6 meters to 159 cm on 40 meters. Without tearing open (and destroying !) the antenna, I needed to make some assumptions about it's internal construction. It appeared to probably have a fixed length bottom element of 43 cm. The top element's length ranged from 100 cm to 116 cm. I attributed the change in length to be the insertion of a tunable loading coil between the bottom section and the 3' (91 cm) top whip. When the antenna was fully retracted, it's overall length was 143 cm which works out to be a resonant, quarter wave, vertical antenna at 50.8 MHz (i.e. the 6 m band). Thus, the internal, tunable loading coil must be totally shorted out for operation on 6 meters.

My next step was to use EZNEC to determine the likely loading coil network used for the various ham bands. I simulated the antenna as two vertical wire elements, W1 & W2 operating over a perfect, metallic ground plane. W1 was connected to the antenna feed coax connector and was 43 cm in height. W2 was attached atop wire W1 with a loading coil between W1 & W2. The loading coil was modeled as a "trap" circuit with a series inductor, L_s , with some series loss resistance, R_s , and parasitic parallel capacitance, C_p . I adjusted the value of L_s in EZNEC until I found resonance at 7.15 MHz. I also made educated, assumptions about the coil loss and parasitic capacitance. I found a reasonable loading coil for 40 m using $L_s = 16.5 \mu\text{H}$, $C_s = 20 \text{ pF}$ and $R_s = 1 \Omega$. I repeated this process for the various ham bands and came up with this basic model for the ATAS-120 antenna.

Band	W1 (cm)	W2 (cm)	L (μH)	C (pF)	R (Ω)
40 m	43	116	16.5	20	1
20 m	43	107	6.9	7.2	1
17 m	43	105.5	4.7	4.3	1
15 m	43	104	3.8	3.9	1
10 m	43	102	2.2	2	1
6 m	43	100	0	0	0

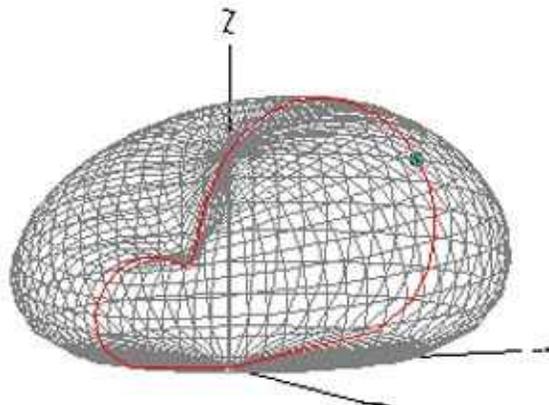


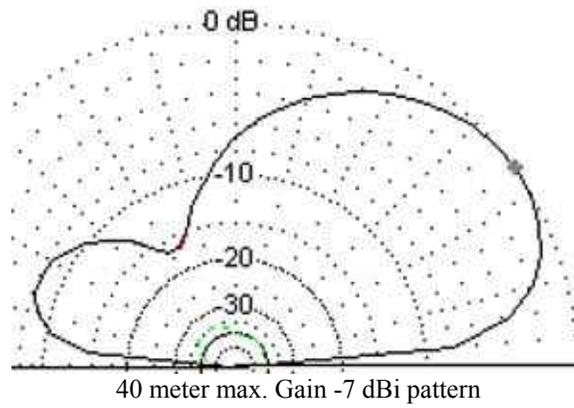
The final step in my mobile antenna modeling was to create a model for my Audi convertible. My antenna is mounted on the right rear corner of the trunk lid. See photo above. I created a wire grid model of the car's body. The basic grid spacing chosen was 0.5 m which was about $1/10\text{th } \lambda$ for the worst case of calculations at 6 meters. The basic overall dimensions of the model for the Audi were 4 m length, 1.5 m width and 1 m height. The bottom of the car was held 25 cm above a real earth in the EZNEC program. This figure below shows the actual wire grid model used for the computer simulation.



EZNEC then calculated the far field pattern in 3D. The results for 40 meters are shown below. The red curve is the maximum gain curve field pattern. While the green dot is the point of max. gain. It is shown in the second 2D figure. (*It should be noted that EZNEC allows the user to manipulate the orientation of the grid model and the 3D and 2D radiation patterns for viewing from any arbitrary angle*)

I found these results to be extremely enlightening. They vividly demonstrated that the position of the antenna and the car's body have a dramatic effect on steering the radiation pattern. The max. gain was calculated to be -7 dBi with a vertical launch angle of 35° and a horizontal launch angle of -20° . The orientation of the max. radiation is thus visualized by drawing a line from the antenna on the right rear fender to the left right fender of the car. The front to back ratio was -8 dB. Thus I now realize that when working HF mobile, I need to park my car with it essentially pointing towards where ever I want to work. Thus, I should use the car as my antenna rotator.





The same EZNEC calculations were made for other ham bands of 20 m thru 6m with similar results. The max. gains were: -2.3 dBi (20 m), -1.9 dBi (17 m), -1.8 dBi (15 m), +0.1 dBi (10 m) and +2.3 dBi (6 m).

A copy of the EZNEC model for these antenna simulations is available upon request to the author at kh6htv@arrl.net