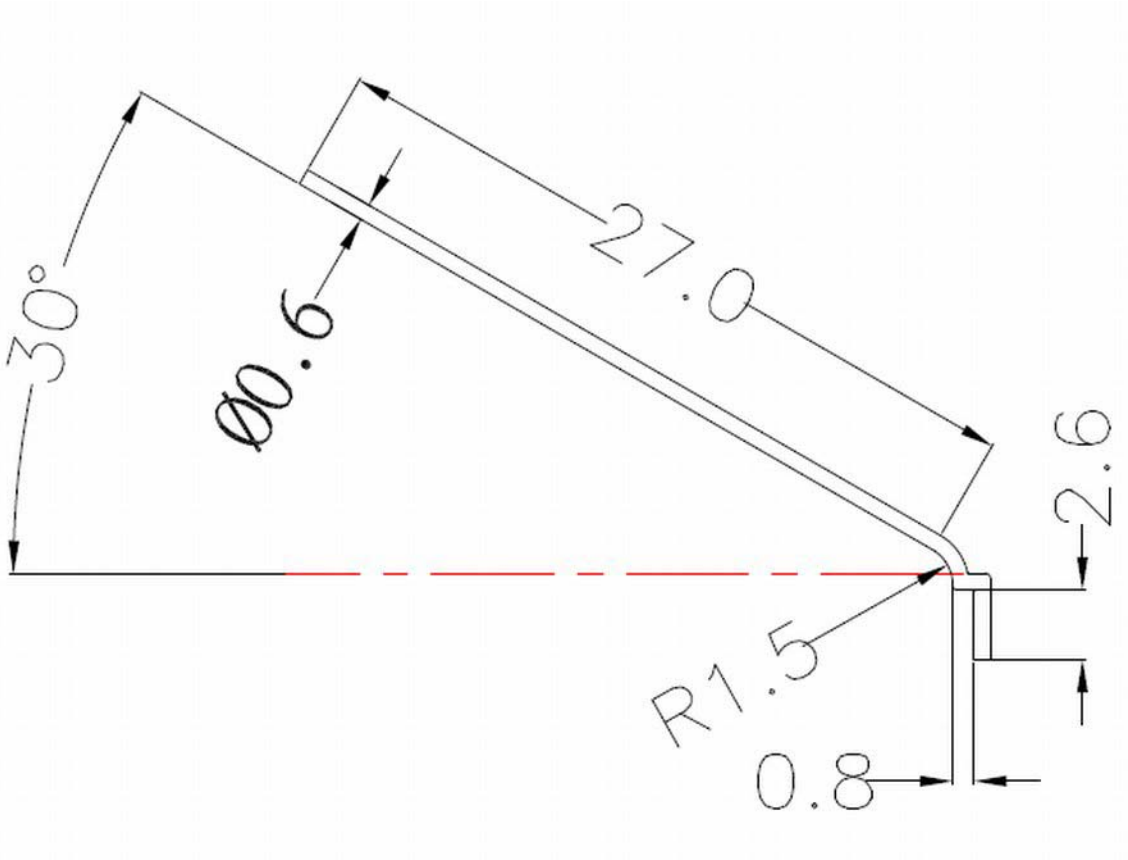
1155 Canyon Blvd, Suite 210, Boulder, Colorado 80302

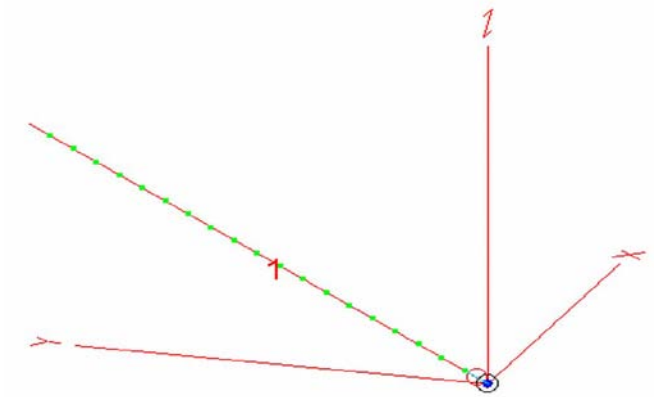
10/25/11

Gain Calculation of the Modified Antenna for Sphero

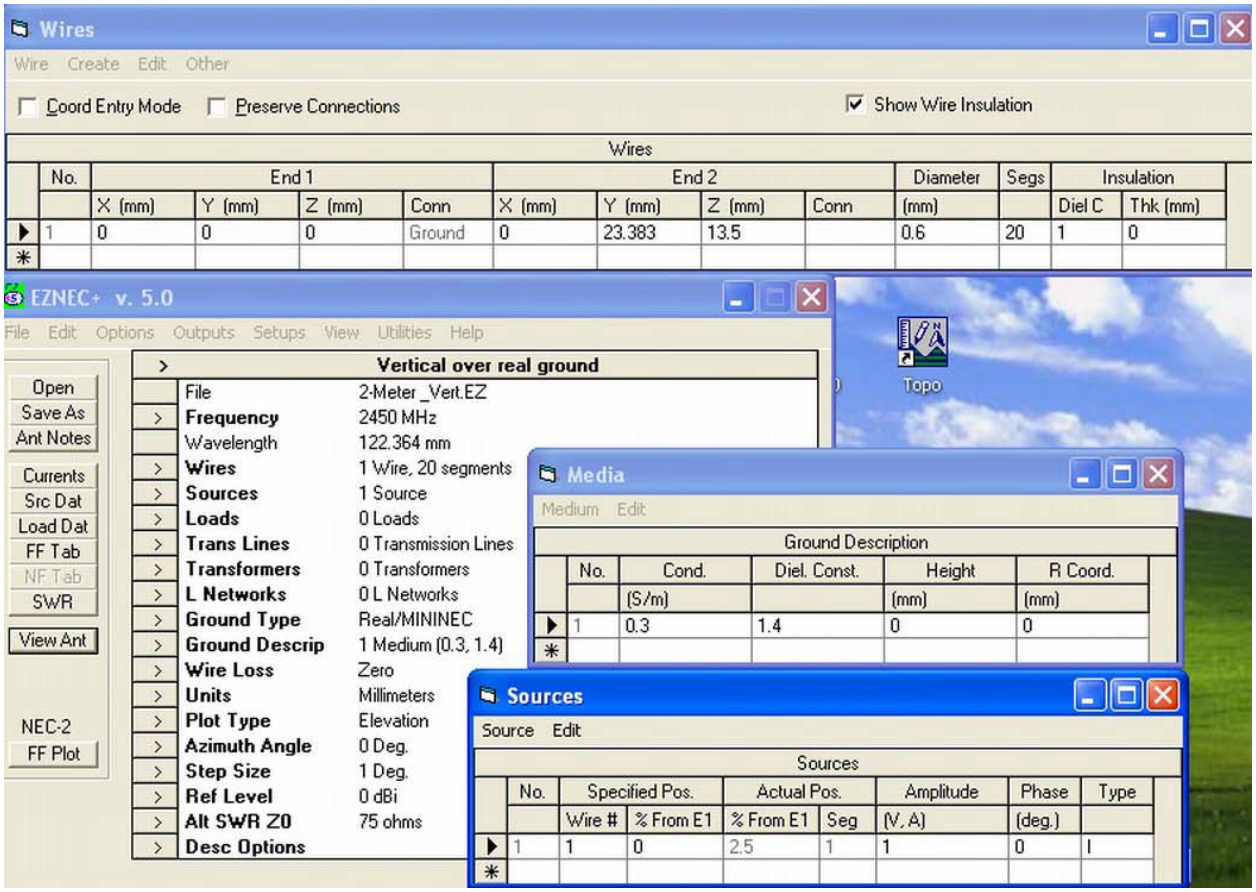
The mechanical drawing of the antenna is presented below (dimensions are in mm):



The antenna element forms a 30-60-90 right-triangle with the ground plane (red dotted line). Therefore the coordinates for the tip of the antenna for input into the EZNEC model are 0, 23.383, 13.500 (XYZ order). The base of the antenna is at 0, 0, 0 with the single current source at the base of the antenna element. The EZNEC model is presented below:

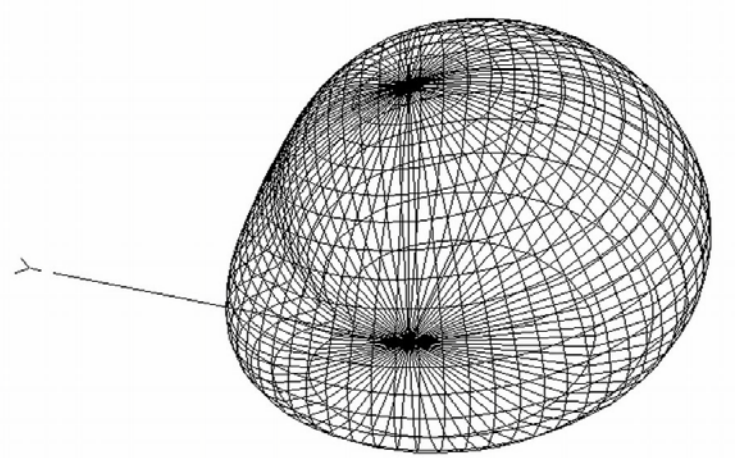


A screen capture of the EZNEC setup is presented below:

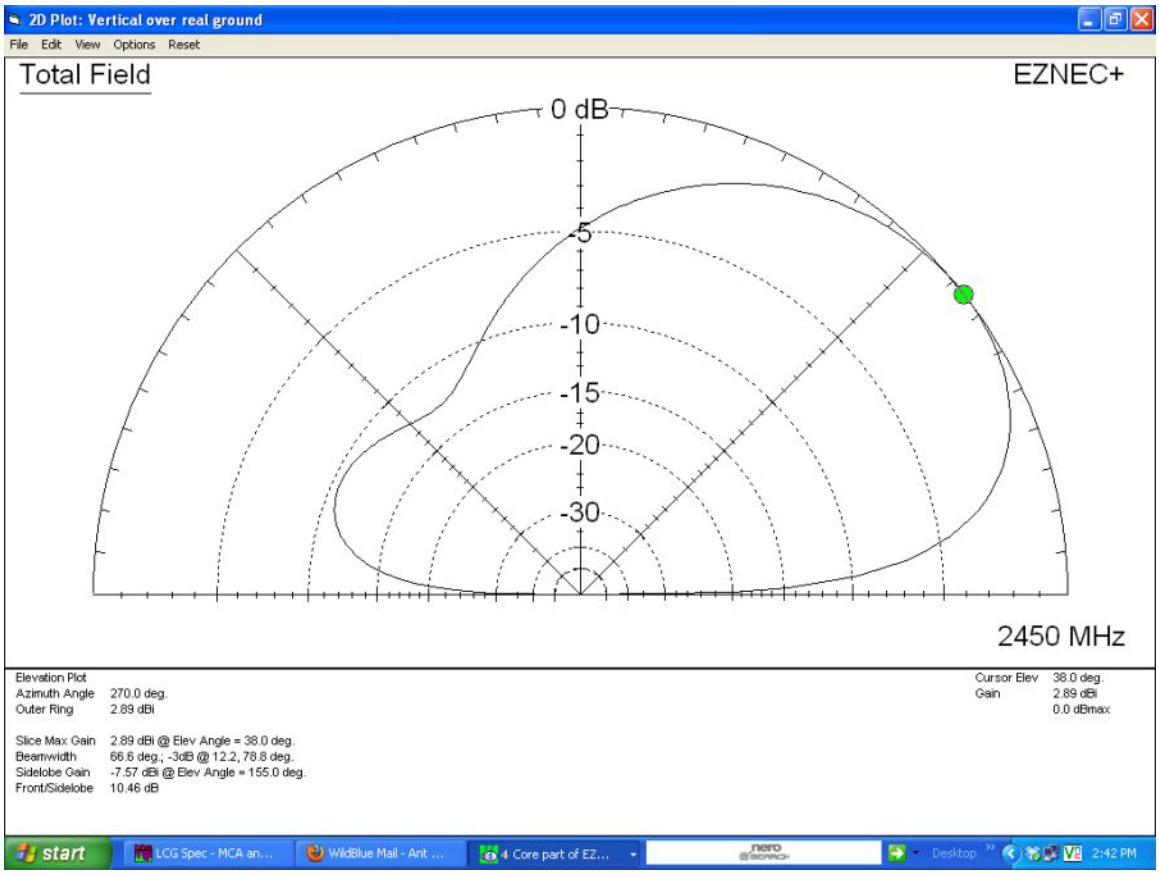


Note the modeled ground plane and surrounding dielectric constant as less than perfect to account for the immediate near field proximity of the antenna element to other conducting and dielectric materials within the sphere.

A 3-dimensional plot of the far-field pattern as modeled in EZNEC as described above is presented below:

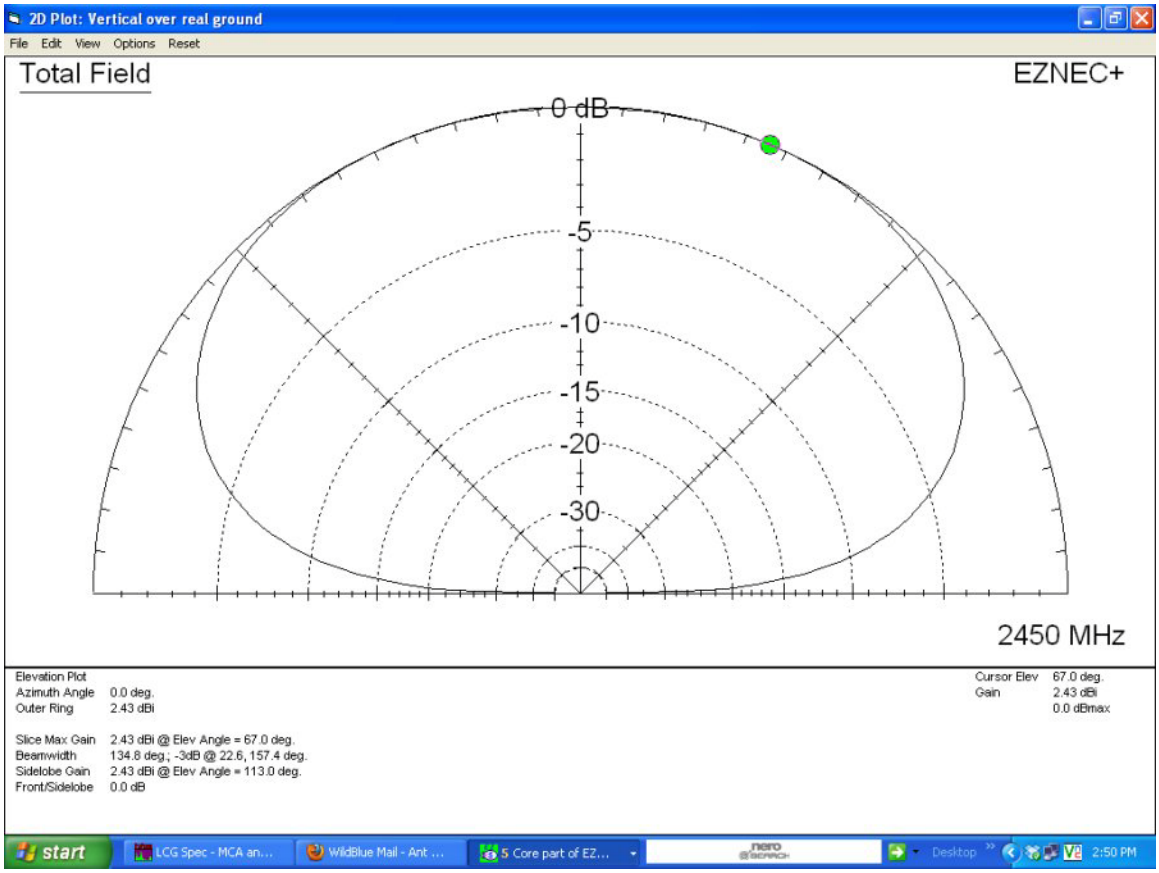


Note the pattern is depressed in the direction of the 60-degree angle as expected. A plot in the Y-Z plane is presented below:



Note the maximum gain 2.89 dBi.

Plot in the X-Z plane:



Note the maximum gain in this plane models as 2.43 dBi.

The tabulation of gain for both vertical and horizontal polarizations is presented in the following table.

---------- FAR FIELD PATTERN DATA ----------

Frequency = 2450 MHz

Reference = 0 dBi

Elevation Pattern Azimuth angle = 0 deg.

Deg	V dB	H dB	Tot dB
0	-99.99	-99.99	-99.99
1	-26.77	-27.70	-24.20
2	-21.00	-21.76	-18.35
3	-17.72	-18.32	-15.00
4	-15.47	-15.91	-12.67
5	-13.77	-14.05	-10.90
6	-12.43	-12.55	-9.48
7	-11.33	-11.30	-8.31
8	-10.41	-10.23	-7.31
9	-9.63	-9.29	-6.45
10	-8.95	-8.46	-5.69
11	-8.36	-7.73	-5.02
12	-7.84	-7.06	-4.42
13	-7.38	-6.46	-3.88
14	-6.97	-5.91	-3.40
15	-6.60	-5.40	-2.95
16	-6.28	-4.94	-2.55
17	-5.99	-4.51	-2.17
18	-5.72	-4.11	-1.83
19	-5.49	-3.74	-1.51
20	-5.28	-3.39	-1.22
21	-5.09	-3.06	-0.95
22	-4.93	-2.76	-0.70
23	-4.78	-2.47	-0.46
24	-4.65	-2.21	-0.25
25	-4.53	-1.95	-0.04
26	-4.43	-1.72	0.14
27	-4.35	-1.49	0.32
28	-4.28	-1.28	0.49
29	-4.22	-1.08	0.64
30	-4.17	-0.89	0.78
31	-4.13	-0.71	0.92
32	-4.11	-0.54	1.04

33	-4.10	-0.38	1.16
34	-4.09	-0.23	1.27
35	-4.10	-0.08	1.37
36	-4.11	0.05	1.46
37	-4.14	0.18	1.55
38	-4.17	0.31	1.63
39	-4.21	0.43	1.71
40	-4.27	0.54	1.78
41	-4.33	0.64	1.84
42	-4.39	0.74	1.90
43	-4.47	0.84	1.96
44	-4.56	0.93	2.01
45	-4.65	1.02	2.06
46	-4.75	1.10	2.10
47	-4.86	1.18	2.14
48	-4.98	1.25	2.18
49	-5.11	1.32	2.21
50	-5.24	1.39	2.24
51	-5.39	1.45	2.27
52	-5.54	1.51	2.29
53	-5.70	1.57	2.32
54	-5.88	1.62	2.33
55	-6.06	1.68	2.35
56	-6.25	1.72	2.37
57	-6.45	1.77	2.38
58	-6.66	1.82	2.39
59	-6.89	1.86	2.40
60	-7.12	1.90	2.41
61	-7.37	1.93	2.42
62	-7.62	1.97	2.42
63	-7.90	2.00	2.43
64	-8.18	2.04	2.43
65	-8.48	2.07	2.43
66	-8.80	2.09	2.43
67	-9.13	2.12	2.43
68	-9.49	2.15	2.43
69	-9.86	2.17	2.43
70	-10.25	2.19	2.43
71	-10.67	2.21	2.43
72	-11.11	2.23	2.43
73	-11.58	2.25	2.43
74	-12.09	2.27	2.42
75	-12.62	2.28	2.42
76	-13.20	2.30	2.42

77	-13.83	2.31	2.41
78	-14.51	2.32	2.41
79	-15.25	2.33	2.41
80	-16.06	2.34	2.40
81	-16.96	2.35	2.40
82	-17.97	2.36	2.40
83	-19.12	2.37	2.40
84	-20.45	2.37	2.40
85	-22.03	2.38	2.39
86	-23.96	2.38	2.39
87	-26.46	2.39	2.39
88	-29.97	2.39	2.39
89	-35.99	2.39	2.39
90	-99.99	2.39	2.39
91	-35.99	2.39	2.39
92	-29.97	2.39	2.39
93	-26.46	2.39	2.39
94	-23.96	2.38	2.39
95	-22.03	2.38	2.39
96	-20.45	2.37	2.40
97	-19.12	2.37	2.40
98	-17.97	2.36	2.40
99	-16.96	2.35	2.40
100	-16.06	2.34	2.40
101	-15.25	2.33	2.41
102	-14.51	2.32	2.41
103	-13.83	2.31	2.41
104	-13.20	2.30	2.42
105	-12.62	2.28	2.42
106	-12.09	2.27	2.42
107	-11.58	2.25	2.43
108	-11.11	2.23	2.43
109	-10.67	2.21	2.43
110	-10.25	2.19	2.43
111	-9.86	2.17	2.43
112	-9.49	2.15	2.43
113	-9.13	2.12	2.43
114	-8.80	2.09	2.43
115	-8.48	2.07	2.43
116	-8.18	2.04	2.43
117	-7.90	2.00	2.43
118	-7.62	1.97	2.42
119	-7.37	1.93	2.42
120	-7.12	1.90	2.41

121	**-6.89**	**1.86**	**2.40**
122	**-6.66**	**1.82**	**2.39**
123	**-6.45**	**1.77**	**2.38**
124	**-6.25**	**1.72**	**2.37**
125	**-6.06**	**1.68**	**2.35**
126	**-5.88**	**1.62**	**2.33**
127	**-5.70**	**1.57**	**2.32**
128	**-5.54**	**1.51**	**2.29**
129	**-5.39**	**1.45**	**2.27**
130	**-5.24**	**1.39**	**2.24**
131	**-5.11**	**1.32**	**2.21**
132	**-4.98**	**1.25**	**2.18**
133	**-4.86**	**1.18**	**2.14**
134	**-4.75**	**1.10**	**2.10**
135	**-4.65**	**1.02**	**2.06**
136	**-4.56**	**0.93**	**2.01**
137	**-4.47**	**0.84**	**1.96**
138	**-4.39**	**0.74**	**1.90**
139	**-4.33**	**0.64**	**1.84**
140	**-4.27**	**0.54**	**1.78**
141	**-4.21**	**0.43**	**1.71**
142	**-4.17**	**0.31**	**1.63**
143	**-4.14**	**0.18**	**1.55**
144	**-4.11**	**0.05**	**1.46**
145	**-4.10**	**-0.08**	**1.37**
146	**-4.09**	**-0.23**	**1.27**
147	**-4.10**	**-0.38**	**1.16**
148	**-4.11**	**-0.54**	**1.04**
149	**-4.13**	**-0.71**	**0.92**
150	**-4.17**	**-0.89**	**0.78**
151	**-4.22**	**-1.08**	**0.64**
152	**-4.28**	**-1.28**	**0.49**
153	**-4.35**	**-1.49**	**0.32**
154	**-4.43**	**-1.72**	**0.14**
155	**-4.53**	**-1.95**	**-0.04**
156	**-4.65**	**-2.21**	**-0.25**
157	**-4.78**	**-2.47**	**-0.46**
158	**-4.93**	**-2.76**	**-0.70**
159	**-5.09**	**-3.06**	**-0.95**
160	**-5.28**	**-3.39**	**-1.22**
161	**-5.49**	**-3.74**	**-1.51**
162	**-5.72**	**-4.11**	**-1.83**
163	**-5.99**	**-4.51**	**-2.17**
164	**-6.28**	**-4.94**	**-2.55**

165	-6.60	-5.40	-2.95
166	-6.97	-5.91	-3.40
167	-7.38	-6.46	-3.88
168	-7.84	-7.06	-4.42
169	-8.36	-7.73	-5.02
170	-8.95	-8.46	-5.69
171	-9.63	-9.29	-6.45
172	-10.41	-10.23	-7.31
173	-11.33	-11.30	-8.31
174	-12.43	-12.55	-9.48
175	-13.77	-14.05	-10.90
176	-15.47	-15.91	-12.67
177	-17.72	-18.32	-15.00
178	-21.00	-21.76	-18.35
179	-26.77	-27.70	-24.20
180	-99.99	-99.99	-99.99