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3D Design & Simulation of Printed Dipole Antenna

Protap Mollick[1], Amitabh Halder[2], Mohammad Forhad Hossain[3], Anup Kumar Sarker[4]
[1](CSE, American International University-Bangladesh, Bangladesh)
[2, 3, 4](EEE, American International University-Bangladesh, Bangladesh)

ABSTRACT: *This paper represents design of a printed dipole antenna with both lambda by 2 & half dipole. In this research paper the impedance increases with combined design on the FR-4 substrate and ground plane. The main feature of printed dipole antenna is there is a feeder between the radiant elements. Average impedance about 73 ohm, which is very large form other antenna. For vertical earth position impedance decreases about 36 ohm. Applied AC voltage forwarding bias dipole antenna gains are high but when reverse bias condition gains are low. Between ropes to station there is need extra insulator that abate high impedance current flow to dipole antenna. Feed lines are approximately 75 ohm and the main length between two poles are 143 meter. The radius of two pole line is very thin it's about 2.06 meter. Transmission lines are added in the last portion of feed lines, which situated apposite of two poles. Designs are simulated by hfss and solving equations are done my matlab.*

Keywords–*Rabbit ears, folded dipole, omnidirectional, azimuthal direction, 3db gain.*

I. INTRODUCTION

In radio and telecommunications a dipole antenna or doublet is the simplest and most widely used class of antenna. It consists of two identical conductive elements such as metal wires or rods, which are usually bilaterally symmetrical. The driving current from the transmitter is applied, or for receiving antennas the output signal to the receiver is taken, between the two halves of the antenna. Each side of the feed line to the transmitter or receiver is connected to one of the conductors. This contrasts with a monopole antenna, which consists of a single rod or conductor with one side of the feed line connected to it, and the other side connected to some type of ground. A common example of a dipole is the "rabbit ears" television antenna found on broadcast television sets [1].

The most common form of dipole is two straight rods or wires oriented end to end on the same axis, with the feed line connected to the two adjacent ends. This is the simplest type of antenna from a theoretical point of view. Dipoles are resonant antennas, meaning that the elements serve as resonators, with standing waves of radio current flowing back and forth between their ends [2]. So the length of the dipole elements is determined by the wavelength of the radio waves used. The most common form is the half-wave dipole, in which each of the two rod elements is approximately 1/4 wavelength long, so the whole antenna is a half-wavelength long. The radiation pattern of a vertical dipole is omnidirectional; it radiates equal power in all azimuthal directions perpendicular to the axis of the antenna [3]. For a half-wave dipole the radiation is maximum, 2.15 dBi perpendicular to the antenna axis, falling monotonically with elevation angle to zero on the axis, off the ends of the antenna. Several different variations of the dipole are also used, such as the folded dipole, short dipole, cage dipole, bow-tie, and batwing antenna. Dipoles may be used as standalone antennas themselves, but they are also employed as feed antennas (driven elements) in many more complex antenna types, such as the Yagi antenna, parabolic antenna, reflective array, turnstile antenna, log periodic antenna, and phased array. The dipole was the earliest type of antenna; it was invented by German physicist Heinrich Hertz around 1886 in his pioneering investigations of radio waves.

II. DESIGN & EQUATIONS

The FR4 main ground plane substrate is closely related to the size and the impedance of the dipole antenna. Lower frequency constant of the substrate produces larger impedance. The cut-off frequency of dipole antenna and the size of the radiation patch can be similar to the following formulas while the high dielectric constant of the substrate results in smaller size of antenna.

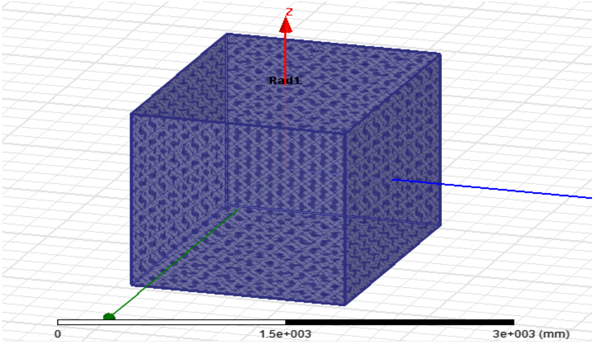

Figure 1: Dipole Antenna Body shape (Printed)

Figure 1 shows the geometry of the design of Dipole shape with a substrate line in which the Length of ground plane of Antenna is 38.4 mm and Width is 46.8 mm, L & W of the patch is 28.8 mm & 37.2 mm.

There are some necessary equations for Dipole antenna some of them are listed below:

$$E_\theta = \frac{-iI_0 \sin\theta}{4\varepsilon_0 cr} \frac{L}{\lambda} e^{i(\omega t - kr)}.$$

$$E_\theta = \frac{j\eta I_0 e^{-jkr}}{2\pi r}\left[\frac{\cos\left(\frac{kL}{2}\cos\theta\right) - \cos\left(\frac{kL}{2}\right)}{\sin\theta}\right]$$

$$H_\phi = \frac{E_\theta}{\eta}$$

$$R_{\text{radiation}} = \frac{\pi}{6} Z_0 \left(\frac{L}{\lambda}\right)^2 \approx \left(\frac{L}{\lambda}\right)^2 (197\Omega).$$

III. TYPES OF DIPOLE ANTENNA

The dipole antenna consists of two conductive elements such as metal wires or rods which are fed by a signal source or feed energy that has been picked up to are cover. The energy may be transferred to and from the dipole antenna either directly straight into from the electronic instrument or it may be transferred some distance using a feeder. This leaves consider able room for a variety of different antenna formats.

Although the dipole antenna is often though in it's ha lf wave format, there are never the less many forms of the antenna that can be used.

- Half wave dipole antenna***:*** The half wave dipole antenna is the one that is most widely used. Being half a wave length long it is a resonant antenna. A half-wave dipole antenna consist software-wavelength conductorsplacedendtoendforatotallengthofapproximately*L*=λ/2.Themagnitudeofcurrentina standingwavealongthedipoleThecurrentdistributionisthatofastandingwave, approximately sinusoidal along the length of the dipole, with an antinode (peak current) at the center [4].
- Multiple half wave's dipole antenna***:*** It is possible to utilize dipole antenna or aerial that is an odd multiple of half wave lengths long.
- folded dipole antenna***:*** As the name implies this form of the dipole aerial or dipole antenna is folded back on itself. While still retaining the length between the ends of half a wave conductor [5].

•Short dipole***:*** A short dipole antenna is one where the length is much shorter than that of half a wave length. Where a dipole antenna is shorter than half a wave length, the feed impedance starts to rise and its response is less dependent upon frequency changes. Its length also becomes smaller and this has many advantages. It is found that the current profile of the antenna approximately a triangular distribution.

IV. SIMULATION RESULTS & TABLES

Radiation Pattern:
The antenna radiation pattern in same a sure of its power or radiation distribution with respect to a particular type of coordinates. We generally consider spherical coordinate in a spherically symmetrical pattern [6].However antenna e in practice are not Omni directional but have a radiation maximum along one particular direction. Dipole antenna is a broad side antenna where in the maximum radiation occurs long the axis of the antenna. The radiation pattern of a typical dipole antenna is shown in figure2

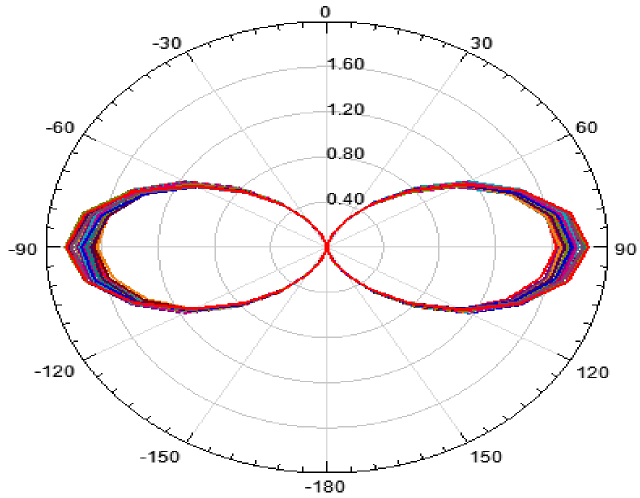

FIGURE 2: RADIATION PATTERN OF DIPOLE ANTENNA (FREQUENCY0.3GHZ)

In figure 2, it is clearly seen that average frequency is.3 GHz. highest level frequency is up to 0.50 GHZ and lowest on is0.01 GHz. So the frequency range for radiation patter of Dipole antenna I s(0.01-0.05) GHz. Highest gain for positive pole is30 degree to 150 degree and for negative pole -30 degree to-150 degree.

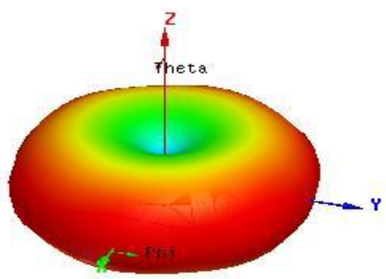

Figure 3: 3D pattern

In figure 3, Red colored side shown highest gain part of a radiation pattern. In 3D pattern both positive and negative shown in same axis. Yellow colored describe average gain pattern of Dipole antenna then the next phase is null radiation. In 3D XY, YZ, ZX three axis results are same for radiation pattern of a dipole antenna.

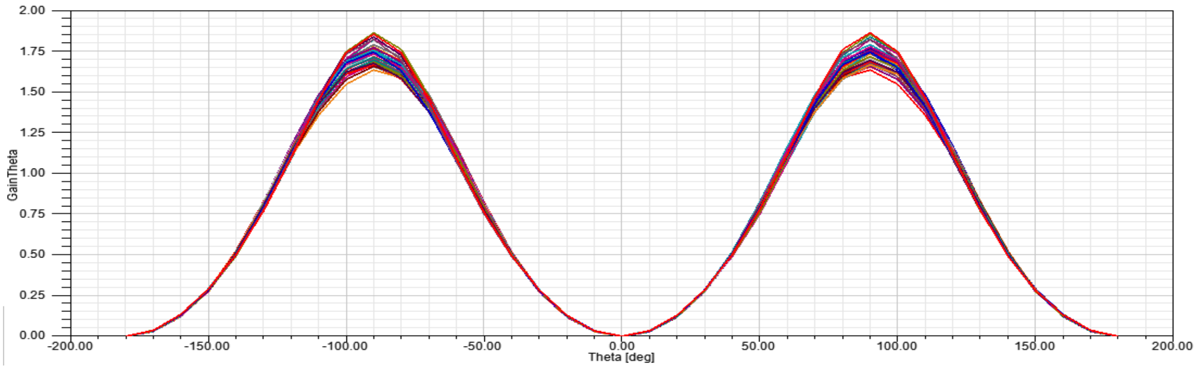

Figure 4: Gain analysis graph

Figure 4 describe graph of gain Vs Angle. Seen that obtain highest gain when the angle is -100 degree or +100 degree. In angle 0 degree gain touch the nadir point. Highest gain obtain from this is around 1.80. After obtained highest gain increasing angle gain will be decreasing.

IV. RESULTS & DISCUSSIONS

Data Table for Gain (-180 degreeto-10degree):

	Theta [deg]	GainTotal Setup1 : LastAdaptive Freq='0.3GHz' Phi='0deg'	GainTotal Setup1 : LastAdaptive Freq='0.3GHz' Phi='10deg'	GainTotal Setup1 : LastAdaptive Freq='0.3GHz' Phi='20deg'	GainTotal Setup1 : LastAdaptive Freq='0.3GHz' Phi='30deg'	GainTotal Setup1 : LastAdaptive Freq='0.3GHz' Phi='40deg'	GainTotal Setup1 : LastAdaptive Freq='0.3GHz' Phi='50deg'
1	-180.000000	0.000060	0.000060	0.000060	0.000060	0.000060	0.000060
2	-170.000000	0.035626	0.035790	0.035541	0.034960	0.034166	0.033281
3	-160.000000	0.134779	0.133941	0.131990	0.129470	0.126985	0.125025
4	-150.000000	0.288796	0.286416	0.283283	0.279688	0.276391	0.274602
5	-140.000000	0.499944	0.500072	0.502504	0.503668	0.502191	0.500235
6	-130.000000	0.767358	0.774812	0.788413	0.799573	0.804081	0.804063
7	-120.000000	1.092210	1.104690	1.116989	1.126786	1.136519	1.146247
8	-110.000000	1.448640	1.456419	1.441257	1.423697	1.430345	1.458110
9	-100.000000	1.740634	1.732001	1.677362	1.621753	1.620867	1.667864
10	-90.000000	1.853490	1.821980	1.744445	1.674943	1.675625	1.732527
11	-80.000000	1.741337	1.696103	1.628405	1.583232	1.598418	1.650505
12	-70.000000	1.450622	1.413632	1.380765	1.376000	1.405035	1.441767
13	-60.000000	1.089900	1.071716	1.070456	1.089597	1.118393	1.138739
14	-50.000000	0.760006	0.752338	0.759062	0.775703	0.792323	0.801341
15	-40.000000	0.495148	0.490455	0.491390	0.495602	0.499529	0.501714
16	-30.000000	0.285784	0.283644	0.281493	0.279421	0.277441	0.276035
17	-20.000000	0.129718	0.129254	0.127890	0.125957	0.123891	0.122165
18	-10.000000	0.033067	0.033103	0.032858	0.032412	0.031873	0.031356

This is the table for gain-180degreeto-10degree.instartinggainisaround0 but increasing angle gain increasing this continue up to -90degree.After -90degreeitdecreaseswiththe same ratio of increasing. This cycle run up to touch the next phase.

Data Table for Gain (10degreeto 180degree):

	Theta [deg]	GainTotal Setup1 : LastAdaptive Freq='0.3GHz' Phi='0deg'	GainTotal Setup1 : LastAdaptive Freq='0.3GHz' Phi='10deg'	GainTotal Setup1 : LastAdaptive Freq='0.3GHz' Phi='20deg'	GainTotal Setup1 : LastAdaptive Freq='0.3GHz' Phi='30deg'	GainTotal Setup1 : LastAdaptive Freq='0.3GHz' Phi='40deg'	GainTotal Setup1 : LastAdaptive Freq='0.3GHz' Phi='50deg'
20	10.000000	0.034091	0.033653	0.032969	0.032101	0.031138	0.030174
21	20.000000	0.130450	0.129884	0.128470	0.126417	0.124169	0.122201
22	30.000000	0.285126	0.285514	0.284892	0.282979	0.280589	0.279188
23	40.000000	0.501976	0.503901	0.506792	0.508454	0.508985	0.510709
24	50.000000	0.780361	0.782916	0.787657	0.793409	0.800731	0.810838
25	60.000000	1.115131	1.115566	1.108959	1.107343	1.120273	1.144562
26	70.000000	1.473772	1.465108	1.428858	1.403124	1.417168	1.458458
27	80.000000	1.759985	1.734727	1.666431	1.616328	1.632675	1.689241
28	90.000000	1.862702	1.823134	1.745515	1.693627	1.716465	1.777050
29	100.000000	1.745917	1.705027	1.647719	1.618801	1.645693	1.692567
30	110.000000	1.463267	1.435498	1.411752	1.410510	1.433510	1.458185
31	120.000000	1.111075	1.101614	1.103110	1.115266	1.129079	1.137415
32	130.000000	0.772962	0.773739	0.782182	0.792256	0.797495	0.798888
33	140.000000	0.491395	0.491960	0.495458	0.498381	0.498734	0.498435
34	150.000000	0.279198	0.277939	0.276857	0.275441	0.273710	0.272603
35	160.000000	0.131147	0.130379	0.128861	0.126861	0.124718	0.122817
36	170.000000	0.035947	0.035805	0.035277	0.034436	0.033388	0.032251
37	180.000000	0.000060	0.000060	0.000060	0.000060	0.000060	0.000060

This is the table for gain 10 degree to180 degree it is clearly shown that Dipole Antenna gain maintain per 90 degree cycle. Start from nadir point after reach 60degree it will be in crest then its goes down to nadir point again. Consider -180 degree to +180 for simulation result.

VI. CONCLUSION

The main aim our research paper that we have to design printed dipole for obtain highest gain. Another objective is introduction of antenna simulation software hfss. Basically hfss is used for electromagnetic analysis & calculation gain. Cut off frequency also calculated by hfss. We obtain 3db gain from dipole antenna. Obviously there are some drawbacks for dipole antenna like:

- Low bandwidth
- High Impedance
- Moving space problem
- Size

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