Design and Simulation of High Performance Half wave-dipole Antenna for LTE Applications

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***Abstract*— The dipole antenna or dipole aerial is one of the most important and commonly used types of RF antenna. It is widely used on its own, and it is also incorporated into many other RF antenna designs where it forms the driven element for the antenna. In this paper, an attempt has been made to investigate new half wave dipole antenna for LTE Applications. A dipole antenna approximately one-half wavelength long is the half wave dipole antenna. The antenna is made to resonate at the 2.6 GHz frequency. HFSS Software is used for the simulation and design calculations of the half wave dipole antennas. The return loss, VSWR, gain and radiation pattern are evaluated.**

Keywords*—— *Half wave-dipole Antenna; LTE; Return Loss; Gain; HFSS.

I. INTRODUCTION

LTE, an abbreviation for Long-Term Evolution, commonly marketed as 4G LTE, is a standard for wireless communication of high-speed data for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies, increasing the capacity and speed using a different radio interface together with core network improvements. LTE is continuously being developed to make sure that future requirements and scenarios are being met and prepared for in the best way. LTE is critical to delivering lower cost per bit, high-performance connectivity, and the subscriber experience needed to address the challenges of mobile broadband, such as growth in devices, data-intensive services, and the introduction of new machine to machine (M2M) applications [1]. The analyses of the advantages and disadvantages of the alternatives of small monopole antenna design discussed on [2] such as meandered line antenna, inverted-L antenna, inverted-F antenna, planar inverted-F antenna, and multiband antenna that with composed of different types of radiators for providing multifunctional operations for LTE-USB antennas. The design of a long-term evolution (LTE) antenna is presented on [3] and also its integration on the 3D surface of the mounting compartment of an automotive roof-top antenna, using molded interconnect device (MID) technology. This antenna provided an input matching better than 10 dB in the desired frequency band and exhibited an omnidirectional radiation characteristic in the horizontal plane. However, the design of a long-term evolution antenna is investigated on [4]. It is designed to be set on the roof of a car underneath a standard plastic cover. Even though the antenna operates at a wide frequency band (from 698 MHz to 960 MHz and from 1470 MHz to 2700 MHz) in small mounting volume, the antenna requires no matching network. In [5], a simple half-wave dipole antenna has been designed and analyzed for wireless applications. Resonant frequency for the dipole antenna was 5 GHz and as a simulation tool CST Microwave Studio (MWS) has been used. Also some research discussed different applications can be using dipole and half wave dipole antenna such as [6]-[8]. The geometrics of a half-wave dipole antenna are shown in the Figure1. L is the total length of the antenna, R is the thickness of antenna arm and g is the feeding gap. Input impedance of the half-wave dipole is 73 Ohm which matched with the line impedance [9].

The main aim of this paper is to design and simulate half wave dipole antenna to operate at LTE (4G) applications at 2.6GHz with high gain, that by using HFSS simulator.

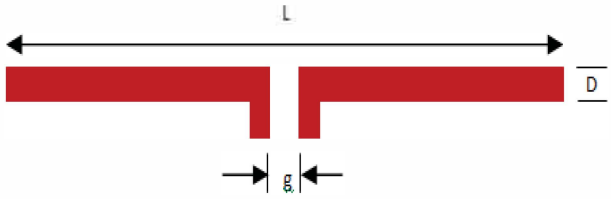

Figure1: Geometric of Half-wave Dipole Antenna

II. DESIGN PARAMETERS OF HALF-WAVE DIPOLE ANTENNA

In this section will calculate design parameter of half-wave dipole antenna. The design proposed center frequency at 2.6GHz. Based on the operating frequency will calculate the length of antenna (also called the height) L by the following equation [5]:

$$L = \frac{143}{f} \qquad (1)$$

Thence, the calculated length is

$$L = \frac{143}{2.6} = 55mm$$

The wavelength:

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$$\lambda = \frac{c}{f} \qquad (2)$$

Thence, the calculated wavelength is

$\lambda = \frac{3*10^8}{2.6} = 115.3mm$

The gap feeding:

$$g = \frac{L}{200} \qquad (3)$$

Thence, the calculated gab feeding is

$$g = \frac{55}{200} = 0.275mm$$

The Radius of dipole (thickness):

$$R = \frac{\lambda}{1000} \qquad (4)$$

Thence, the calculated Radius is

$$R = \frac{115.3}{1000} = 0.115mm$$

Table1: Calculated Parameters of half-wave dipole Antenna

Parameter	Value
Frequency Resonate (f)	2.6GHz
Wave light(λ)	115.3mm
Length of the dipole(L)	55mm
Radius of the dipole(R)	0.115mm

III. RESULT AND DISCUSSIONS

The software used to model and simulate the half-wave dipole antenna is HFSS. It analyzes 3D and multilayer structures of general shapes. It has been widely used in the design different type of antenna. It can be used to calculate and plot the Return Loss, VSWR as well as the radiation patterns.

a. Return Loss:

In Figure 2 shows the return loss of work antenna must be less than -10 dB and here's the result that we have acquired them are very excellent result equal -17dB.

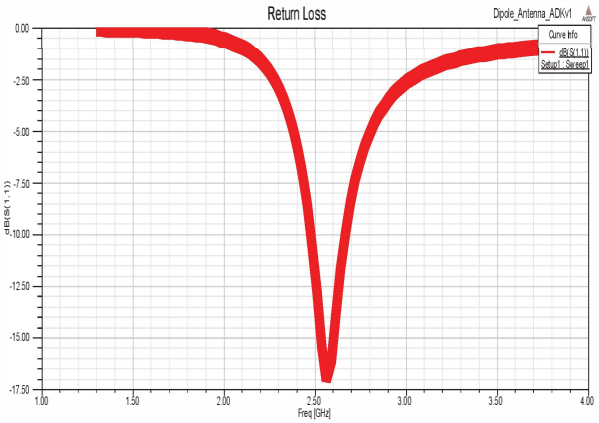

Figure2: Return loss from HFSS

b. Voltage Standing Wave Ratio (VSWR):

In Figure 3 shows VSWR of dipole antenna less than 2. The good result of VSWR takes it from HFSS equal1.3.

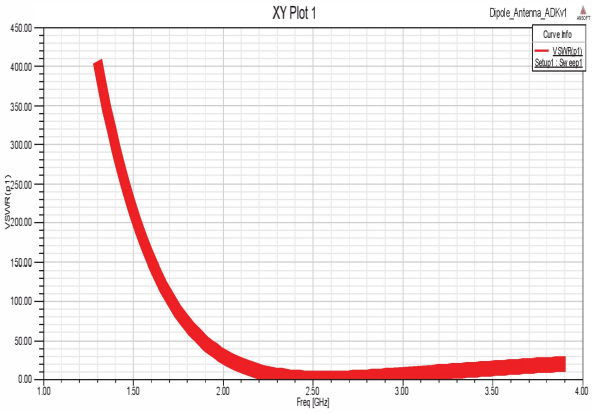

Figure3: VSWR from HFSS

c. High Gain:

High gain measured at 2.6GHz equal 2.438dB as shown in Figure 4.

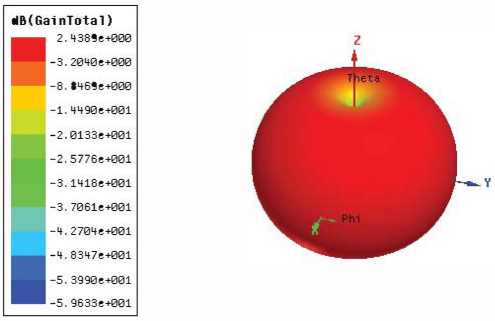

Figure4: Antenna gain from HFSS

d. *Radiation Pattern*:

The radiation pattern presented worthy result as Figure 5.

Figure5: Radiation Pattern from HFSS

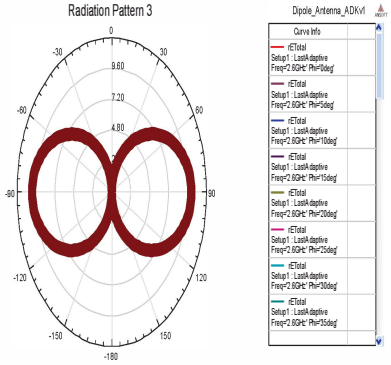

Figure5: Radiation Pattern from HFSS

IV. Conclusion

A half-wave dipole antenna has been designed and simulated using HFSS software which ease the simulation. A popular practical antenna half-wave dipole antenna was selected to obtained target frequency 2.6GHz for LTE applications. Return loss obtained as -17 dB which shows the characteristic of reflection coefficient. The VSWR shows less than two and high gain obtained at 2.438dB.

References

[1] Mr. Gopinath Gampala, Dr.C.J.,"Antenna Design Considerations for LTE Mobile Applications" IEEE Antennas & Propagation Society on November 8, 2011.

[2] N.I.Mohamed, T.A.Rahman, C.Y.Leow," Issues and challenges of LTE antenna designs for USB-dongle device", IEEE-APS Topical Conference on Antennas and Propagation in Wireless Communications (APWC), 2012.

[3] A. Friedrich, B. Geck, O. Klemp, H. Kellermann, "On the design of a 3D LTE antenna for automotive applications based on MID technology", European Microwave Conference (EuMC), 2013.

[4] I. Goncharova, s. Lindenmeier, "A high-efficient 3-D Nefer-antenna for LTE communication on a car", 8th European Conference on. Antennas and Propagation (EuCAP), 2014.

[5] Mohamed Targ, Dewan Ashraful, M.Islam, R.Ahmed," Simple Half-Wave Dipole Antenna Analysis for Wireless Applications by CST Microwave Studio", International Journal of Computer Applications (0975 – 8887) Volume 94 – No.7, May 2014.

[6] Parminder Singh, Ankita Sharma, Neha Uniyal, Richa Kala, "Half-Wave Dipole Antenna for GSM Applications", International Journal of Advanced Computer Research (ISSN (print): 2249-7277 ISSN (online): 2277-7970) Volume-2 Number-4 Issue-6 December-2012.

[7] M.C.Liang, K.C.Huang, S.T.Lin, S.J.Lin, " The bended C-patch dipole antenna strip", IEEE International Symposium Antennas and Propagation Society, 2005

[8] Yu-Wei Fan; Hui-Huang Zhong; Zhi-Qiang Li; Heng Zhou; Wei-Hong Zhou; Jun Zhu; Ling Luo, "A short Dipole Antenna", 17th International Conference on High Power Particle Beams (BEAMS), 2008.

[9] Balanis, A.Constantine, "Antenna Theory Analysis and Design", John Wiley & Sons, 3rd Edition, pg. 182. USA 2005.