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Design of a Monopole Antenna for LTE Band Application

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Abstract — *In recent year due to increase in applications large Bandwidth upon large spectrum is require Thus, all the subsystem are required to operate over wide bandwidth, the demand for wideband antenna increase as well. Thus, low-profile, high-bandwidth and wideband antenna are often desired. Monopole antenna is considered as a promising antenna designing for today's growing wireless world. The resulting antenna shows a good matching in the desired frequency band. The proposed antenna is work at frequency 700 MHz for LTE application. In simulation results, parameters like antenna gain, bandwidth, VSWR, return loss are taken into account and optimized. This simulation work has been done using CST Software.*

Keywords- *bandwidth, wideband, monopole antenna, LTE Band, return loss*

I. INTRODUCTION

With the rapid growth of the wireless mobile communication technology, the great demand in future technologies are very small size wide band antennas. The Monopole antenna was invented in 1895 by Guglielmo Marconi. A Monopole antenna consisting of a straight rod-shaped conductor which often mounted perpendicular over some type of conductive surface called Ground Plane. There are various monopole configurations such as Planar, Circular, Rectangular, Ellipse, and so on. Especially, Planar antenna have been developed very fast because of its advantages such as Omni directional radiation patterns, low cost, light weight, easy to fabricate and small size. In this paper a monopole antenna used for LTE Band application is presented. Long term evolution (LTE) systems can be used in 4G wireless wide area network (WWAN) systems due to its significantly high data rate of at least 100 Mb/s in the downlink and 50 Mb/s in the uplink. It can provide five frequency bands for LTE applications, covering 746–787 MHz, 1710–1755MHz, 2110–2155 MHz, 2305– 2400 MHz, and 2500–2690 MHz

II. ANTENNA DESIGN

The antenna design procedure used here is standard equations used to calculate physical length and width, effective length, effective dielectric of substrate and length extension of Monopole antenna.

Step 1: Width Calculation (W): The width of a Monopole antenna is given by equation:

$$W = \frac{c}{2f\sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

Step 2: Calculation of Effective Dielectric Constant (ε_{reff}): The effective dielectric constant is given by equation:

$$\varepsilon_{reff} = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2}\left[1 + 12\frac{h}{w}\right]^{\frac{-1}{2}}$$

Step 3: Calculation of Length (*L*): The length of Monopole antenna is given by equation:

$$L = L \qquad r = \frac{w}{2\pi}$$

$$L = W \qquad r = \frac{L}{2\pi}$$

Step 4: Calculation of the Length Extension ΔL:

$$\Delta L = 0.412h\frac{(\varepsilon_{reff} + 0.3)(\frac{W}{h} + 0.264)}{(\varepsilon_{reff} - 0.256)(\frac{W}{h} + 0.8)}$$

Step 5: Calculation Of Actual Length of Patch (L): The actual length is obtained by rewriting equation as:

$$L = L_{eff} - 2\Delta L$$

III. SCHEMATIC LAYOUT DESIGN AND SIMULATION RESULTS

The monopole antenna are commonly used for satellite, cellular and almost every wireless communications application due to their small size, low cost and effective other properties. Thus in this, a monopole antenna will be constructed and analyzed using the CST simulator. Here there are two schematic designs of monopole antenna and its results.

3.1 Schematic design 1 of Monopole antenna using CST

The design 1 of the monopole antenna is shown in figure 3.1. One side of the antenna feed line is attached to the lower end of the monopole, which behaves as a +ve terminal and the other side is attached to the 5mm thick ground plane which behaves as a –ve terminal with the help of the CST tool. This design using waveguide port as shown in figure 3.2.

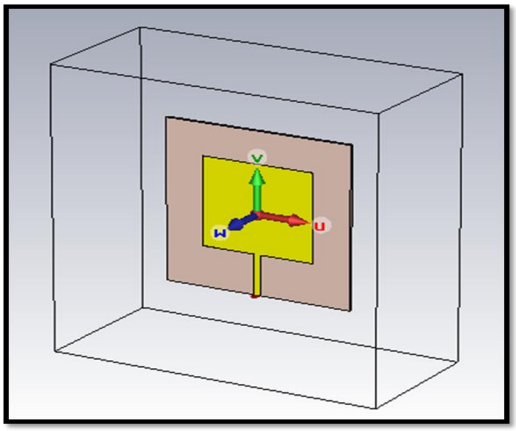

Figure 3.1 CST view of design 1

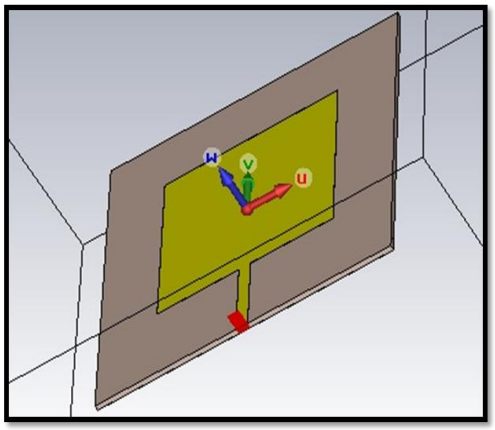

Figure 3.2 Design 1 using waveguide port

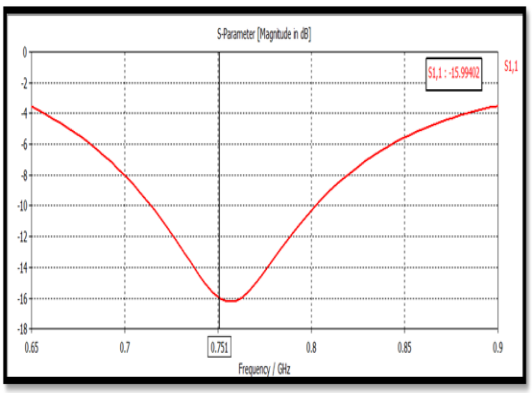

Figure 3.3 Return loss of design 1

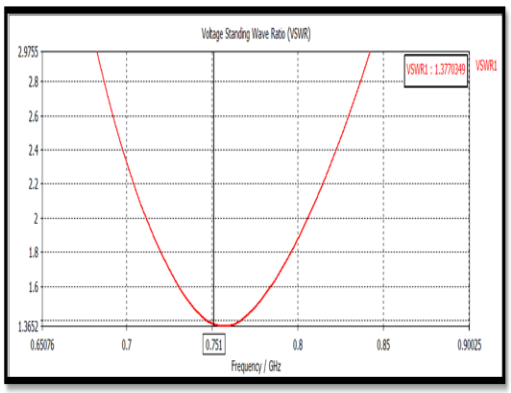

Figure 3.4 VSWR of design 1

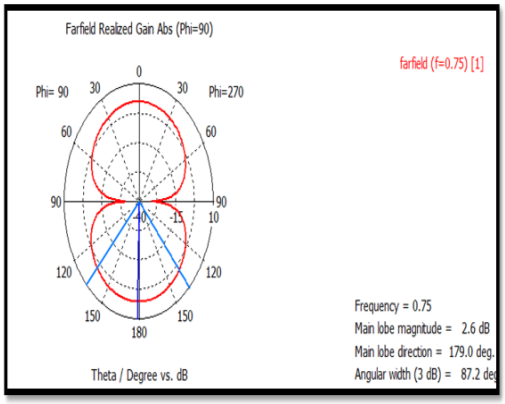

Figure 3.5 Gain of design 1

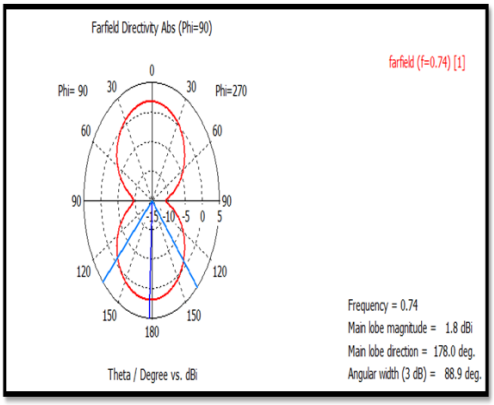

Figure 3.6 Directivity of design 1

3.2 Schematic design 2 of Monopole antenna using CST

In this design antenna is also mounted on the same side where ground plane is already mounted. This design is satisfy the monopole antenna theory because monopole has only one pole. In this design +ve terminal is end of the feed line and –ve terminal is also mounted on same side which is ground. From both the end of the side there must be a gap between the feed line and ground surface as shown in figure 3.7. This design using discrete port as shown in figure 3.8.

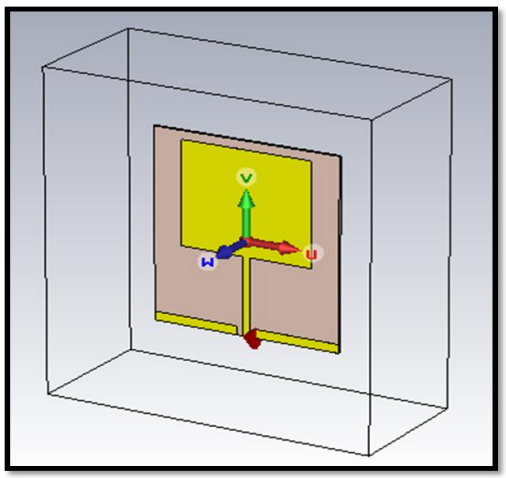

Figure 3.7 CST view of design 2

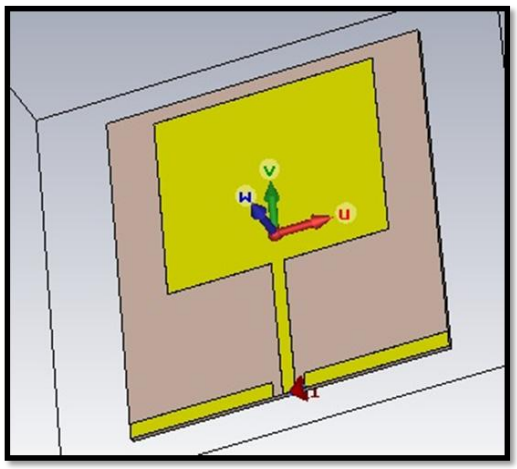

Figure 3.8 Design 2 using discrete port

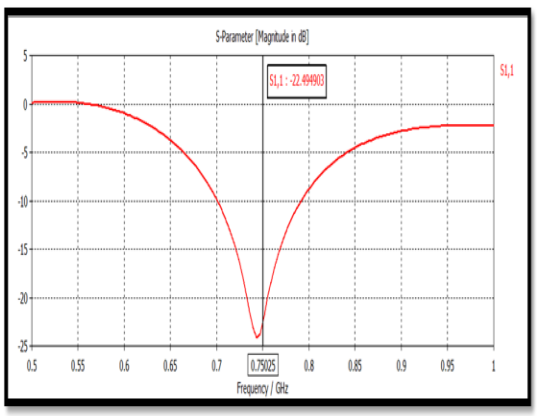

Figure 3.9 Return loss of design 2

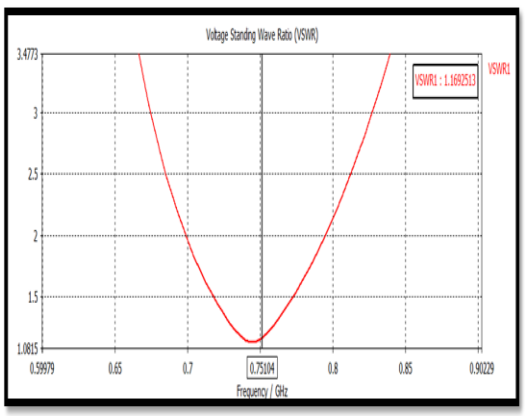

Figure 3.10 VSWR of design 2

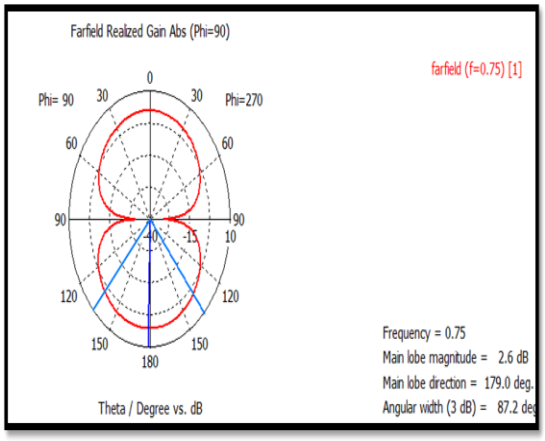

Figure 3.11 Gain of design 2

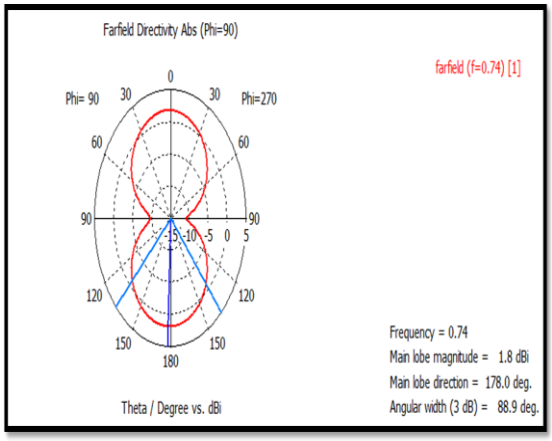

Figure 3.12 Directivity of design 2

IV. CONCLUSION

There are two designs of monopole antenna presented in this paper. In design 1 we got -15.99 db return loss while in design 2 we got -22.49 db return loss which is comparatively very good than design 1.Such that design 2 is very effective than design 1 it gives better return loss and VSWR than design 1.

TABLE 1. Comparison results of both designs

Design	Resonant frequency	Return loss	VSWR	Directivity	Efficiency	Gain
Single patch	751 MHz	-15.99dB	1.37	1.8dBi	97.051%	2.6dB
Double layer	751 MHZ	-22.31dB	1.17	1.8dBi	97.05%	2.6dB

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