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Design and Analysis of Patch Antenna (Megtron 7 substrate) at 28GHz

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Abstract

The study of microstrip patch antennas has made great progress in recent years. Compared with conventional antennas, microstrip patch antennas have more advantages and better prospects. They are lighter in weight, low volume, low cost, low profile, smaller in dimension and ease of fabrication and conformity. HFSS which stands for high-frequency structure simulator is used to simulate the proposed design. In this paper, our goal is to analyze the design for a wide micro-strip rectangular patch working at 28 GHz. Also the return loss, Efficiencies and Peak realized gain are studied.

***Keywords*: Microstrip Patch Antenna, Return loss, HFSS software.**

INTRODUCTION

Microstrip antennas are planar resonant cavities that leak from their edges and radiate. Printed circuit techniques can be used to etch the antennas on soft substrates to produce low-cost and repeatable antennas in a low profile. The antennas fabricated on compliant substrates withstand tremendous shock and vibration environments. Manufacturers for mobile communication base stations often fabricate these antennas directly in sheet metal and mount them on dielectric posts or foam in a variety of ways to eliminate the cost of substrates and etching. This also eliminates the problem of radiation from surface waves excited in a thick dielectric substrate used to increase bandwidth

With the potential for higher frequencies as well as mm waves deployment, most 5G frequency bands are predicted to be in the range of 20-50GHz. More specifically, the frequency band of 5G is predicted to be extended from 28GHz to 38GHz.

In its most basic form, a Microstrip patch antenna consists of a radiating patch on one side of a dielectricsubstrate which has a ground plane on the other side as shown in Figure 1.

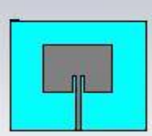

Figure 1.A Typical Microstrip Patch Antenna

2. Formulation

The value of ε_{eff} is slightly less than ε_r because the fringing fields around the periphery of the patch are not confined in the dielectric substrate but are also spread in the air.

The expression for ε_{rff} is given as:

$\varepsilon_{eff}= (\varepsilon_r+ 1)/2 + (\varepsilon_r- 1) / 2 [1+12h / W]-1/2$ (1)

Where ε_{eff}= Effective dielectric constant
ε_r= Dielectric constant of substrate
h = Height of dielectric substrate
W = Width of the patch

The dimensions of the patch along its length have now been extended on each end by a distance ΔL, which is given empirically by as:

$\Delta L=0.412h (\varepsilon_{eff} + 0.3) (W/h + 0.264) / ((\varepsilon_{eff}- 0.258) (W/h + 0.8))$ (2)

The effective length of the patch L_{eff} now becomes:

$L_{eff}=L+2 \Delta L$ (3)

For a given resonance frequency fo, the effective length is given by as:

$L_{eff}=c/ (2fo\sqrt{} (\varepsilon_{eff})$ (4)

For a rectangular Microstrip patch antenna, theresonance frequency for any TM mode is given as:

$fo= c/(2\sqrt{}(\varepsilon_{eff})[(m/L)2+(n/W)2]^{1/2}$ (5)

Where m and n are modes along L and W respectively .

For efficient radiation, the width W is given as:

$W= c/ (2fo\sqrt{} ((\varepsilon_r+1)/2))$ (6)

In this paper the antenna is designed using inset-fed probe antenna. Fortunately, a simple analytical approach has been developed using the transmission-line model to find the input impedance of an inset-fed microstrip patch antenna. Using this approach, a curve-fit formula can be derived to find the inset length to achieve a 50-Ω input impedance when using modern thin dielectric circuit-board materials.

PROPOSED work

The Substrate material used in designing of microstrip patch antenna is megtron 7. The height of substrate is 0.3mm and relative permittivity is 3.6. The dimension of substrate is in relation to the dimension of patch (length+6xheight of substrate and width

+6xheight of substrate) and the Patch material is made up of copperand the thickness of copper patch is 0.035mm.

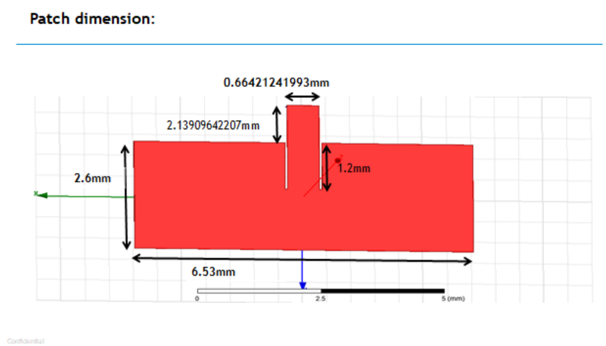

Figure 2. Patch Dimension

SIMULATION RESULTS

Return Loss Plot

The most important parameter to be considered is the maximum transfer of power (matching of the feed line with the input impedance of the antenna). In this regard, S_{11} gives us the insertion loss of antennas. It is a parameter which indicates the amount of power that is lost to the load and does not return as a reflection. It indicates how well the matching between the transmitter and antenna has taken place. In other words, insertion loss is proportional to the ratio of reflected to the input power of the antenna. Antennas generally radiate efficiently for particular range of frequencies. At these frequencies, the radiated power should be almost equal to input power, i.e., reflected power should very small. Therefore, a graph of S_{11} of an antenna versus frequency is called its return loss curve. For optimum working condition, such a graph must show a dip at the operating frequency and have a minimum dB value at this frequency.

The S_{11} parameters are considered as antenna return loss parameters. The return loss obtained at 28 GHz is 26.09 dB. Figure 3 shows the plot of return loss. Also the plot of efficiency is shown in figure 4.

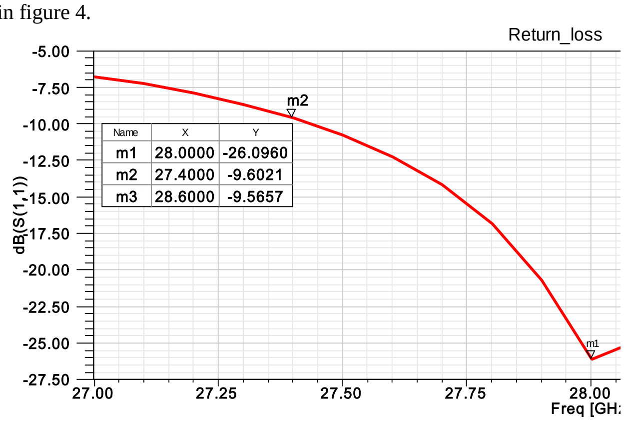

Figure3. Return Loss in dB

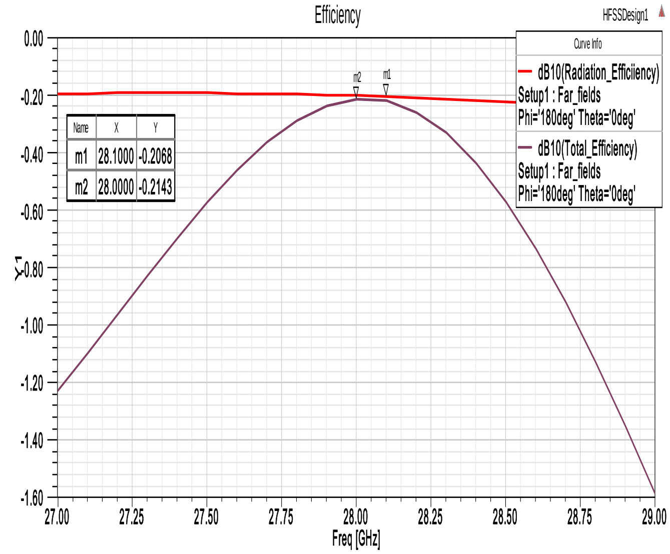

Figure 4.Efficiency Plot

PEAK REALIZED GAIN

Gain of an antenna is defined as its ability to concentrate the radiated power in a given direction or conversely to absorb effectively the incident power from that direction. The term gain describes how much power is transmitted in the direction of peak radiation of an isotropic source

The 3D plot shows the gain of antenna. The antenna has a gain of 2.6 dB. Figure 5 shows the gain of patch.

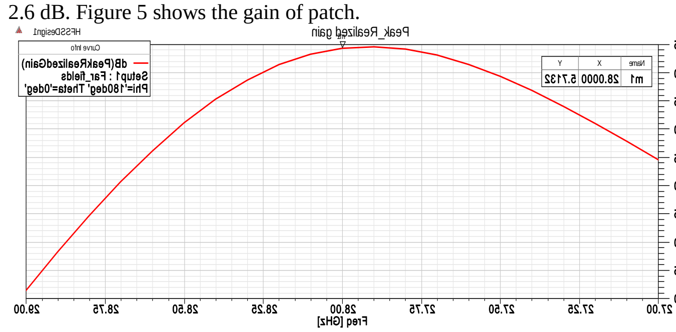

Figure 5.Gain Plot

3D POLAR PLOT

There is another interesting parameter that characterizes the radiation properties of an antenna and distinguishes one antenna from the other. This is the radiation pattern. It is a plot of the far-field of an antenna as a function of the spatial coordinates which are specified by the elevation angle (θ) and the azimuth angle (φ). More specifically, it is a plot of the power radiated from an antenna per unit solid angle.The corresponding 3D radiation pattern of the designed patch is shown in figure 5.

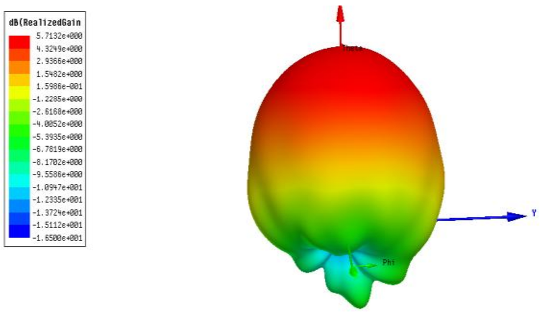

Figure 6.Patch 3D Radiation Pattern

CONCLUSION

In this paper the microstrip patch antenna is designed at 28 GHz. The Simulation frequency range is set as 27.4-28.6 GHz (10 db bandwidth). The antenna resonates at frequencies of 28 GHz with a return loss of 26.09 dB. The antenna is best suitable for devices that have a space constraint and can be easily integrated. The major parameters such as Return Loss curves, Radiation Patterns and Gain hat affect design and applications were studied.

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