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Design and Analysis of Rectangular Microstrip Patch Antenna for GSM Application

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Abstract

Microstrip Patch antennas are increasingly useful today's because of its light weight, low profile and can be easily fabricated. This paper, describes that the design and analysis of microstrip patch antennas for GSM application. The antenna characteristics such as Return Loss, VSWR and Radiation Pattern are analyzed. The antenna size 30*50*1.8mm^3 has been optimized by utilizing the Parametric Analysis. This microstrip patch antennas is analyzed using High frequency structure simulator (HFSS) software.

Keywords **:** *Microstrip patch antenna, GSM, HFSS, frequency.*

1. Introduction

An Antenna is one of the essential parts for microwave communication. Since it help both transmitting and receiving the information. An antenna is a device that is made to efficiently radiate and receive the radiated electromagnetic waves. Antenna is a transducer which converts the voltage and current on a transmission line into an electromagnetic field in a space, consisting of an electric and magnetic field travelling right angles at each other [1].

Microstrip patch antenna is a small size antenna and it can be printed directly on a circuit board. Microstrip patch antennas due to their many attractive feauters have drawn attention of industries for an ultimate solution for wireless communication. In order to simplify analysis and performance prediction, the patch is generally square, rectangular, circular, triangular, and elliptical or some other common shape [1].

The most commonly employed microstrip patch antenna is a rectangular patch. The rectangular patch antenna is approximately a one wavelength long section of rectangular microstrip transmission line. When the air is the antenna substrate the length of the rectangular microstrip antenna is approximately one half of a free space wavelength. The antenna is loaded with a dielectric as its substrate, the length of the antenna decreases as the relative dielectric constant of the substrate increases .the proper miniaturized antenna will improve the transmission and reception [2].

Global system for mobile is a second generation cellular standard developed to create voice services and data delivery using digital modulation. It is a Time Division Multiple Access based wireless network technology. The operating frequency range is 900MHZ, 1800MHZ and 1900 MHZ [5].

Global System for Mobile Communication is used with the mobile access devices. It is a globally accepted standard for digital communication .Global System for Mobile Communication is the name of a standardization group established in 1982 to create a common European mobile telephone system. European mobile cellular radio system operating at 900MHZ. It is established that many countries outside of Europe will join the GSM technique [7].

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2. Theory

The important antenna characteristics are

- Return loss
- Antenna radiation pattern
- VSWR
- Polarization

The radiation pattern of an antenna is a plot of relative field strength of the radio waves emitted by an antenna at different angles. The radiation of many antennas shows the pattern of maxima or lobes at various angles separated by nulls angles where the radiation falls to zero. The lobe in that direction is desired larger than the others and is called the main lobe. The other lobes usually represent unwanted radiation and are called side lobes. In communications, return loss is the loss of signal power resulting from the reflection caused at a discontinuity in a transmission line. This discontinuity can be mismatch with the terminating load (or) with a device inserted in the line. It is usually expressed at a ratio in decibels (dB);

$$RL\ (dB) = 10\log_{10}(pi/p_r). \quad (1)$$

A match is good if the return loss is high and for a lower insertion loss higher return loss is desirable. Taking the ratio of reflected to incident power, we obtain a return loss is negative.

$$RL'\ (dB) = 10\log_{10}(p_r/p_i). \quad (2)$$

The return loss with negative sign is called as reflection coefficient. Caution is required when discussing increasing (or) decreasing return loss. Since these terms strictly have the opposite meaning when return loss is defined as a negative quantity.

The Standing Wave Ratio is usually defined as a voltage ratio called the VSWR.The SWR in terms of current is the ISWR.The power standing wave ratio is defined as the square of the VSWR. A problem with transmission lines is that impedance mismatch in the cable tend to reflect the radio wave back toward the source and of the cable preventing all the power from reaching the destination end. An infinite SWR represents the complete reflection, with all the power reflected down the cable. The SWR of a transmission line can be measured by an instrument SWR meter.SWR measures the relative size of the reflection. an ideal transmission line would have SWR of 1:1 and there is no reflection. the SWR can be measured by SWR meter and SWR is a standard part installing and maintaining on a transmission line.

The VSWR can be represented by

$$VSWR = V_{max}/V_{min.} \quad (2)$$

The VSWR is always ≥+1, VSWR values are not more than 3.

3. Antenna Design

In antenna designing, we have to choose the shape of the antenna. Different shapes are possible in HFSS software. During designing the flat surface consisting of infinite and finite ground plane. In finite ground plane back lopes are presented. The designing structure can be implemented on infinite ground plane. For plotting whole structure which it needs the accurate value. The value can be assigned on three axis. By changing the position value, we can adjust the shape of the structure. After designing antenna frequency sweep is specified for dunning the particular frequency range. If we need antenna for some application the corresponding return loss, VSWR, Radiation pattern can be obtained.

For good antenna performance a thick dielectric substrate having low dielectric constant is desirable. This provides better efficiency, larger bandwidth and better radiation. The basic Microstrip patch antenna is a strip conductor of dimensions L*W and thickness hacked by a ground plane. The substrate thickness is much smaller than the wavelength.

During designing of an antenna, the axis can be rotated to any direction for designing different structure of an antenna. These are can be evaluated using High Frequency Structure Simulator software.

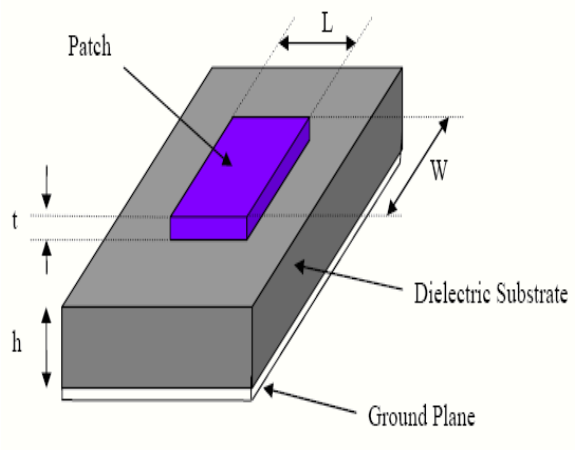

Fig 1 Microstrip Patch Antenna

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The designed structure of microstrip patch antenna is shown in fig 1. The assigned value of patch, ground, substrate and port of the antenna are adjusted to produce the corresponding output at 1.8 GHZ .By varying width and height of the patch and port different outputs can be obtained. First width is constant, height is changed. Likewise height is constant and width is changed. In same way width and heights also varied. From this discussion it is clear that width is inversely proportional to resonance frequency. Also increase in width of patch, the radiation from the radiating edge increases. Thus with increase in width of patch, bandwidth, directivity and gain increase. However resonance frequency and input impedance decreaces.Patch antennas are sometimes covered with a dielectric layer to protect from their environment.

This structure of the antenna having length L, Height H and width W .Patch is act as a conductor. These are placed on infinite ground plane. The three essential parameters for the design of a rectangular microstrip patch antenna is the frequency of operation. The resonant frequency must be selected approximately. The resonant frequency for my design is 1.8 GHZ.

Dielectric constant of the substrate is ε_r. Microstrip antenna has dielectric constant of 4.4.a substrate with a high dielectric constant has been selected. Since it reduces the dimensions of the antenna. The height of the die electric substrate is selected 1.6mm.hence the essential parameters for the design is f_0=1.8 GHZ, εr=4.4, h=1.6mm.

The software used to model and simulate the microstrip patch antenna is Ansoft HFSS.Ansoft HFSS is a full wave electromagnetic simulator based on the methods of moments. It analyses 3Dimensional and multilayer structure of general shapes. It has been widely used in the design of MIC_S, RFICS, patch antennas, wire antennas and other RF wireless antennas. It can be used to calculate and plot the S-parameters, VSWR, current distribution as well as the radiation pattern.

3. Results and Discussion

The designed structure of an microstrip patch antenna is shown in fig: 2 at 1.8 GHZ for GSM communication. It is designed with low dielectric constant and that corresponding VSWR, Radiation pattern,S-parameter are also measured.

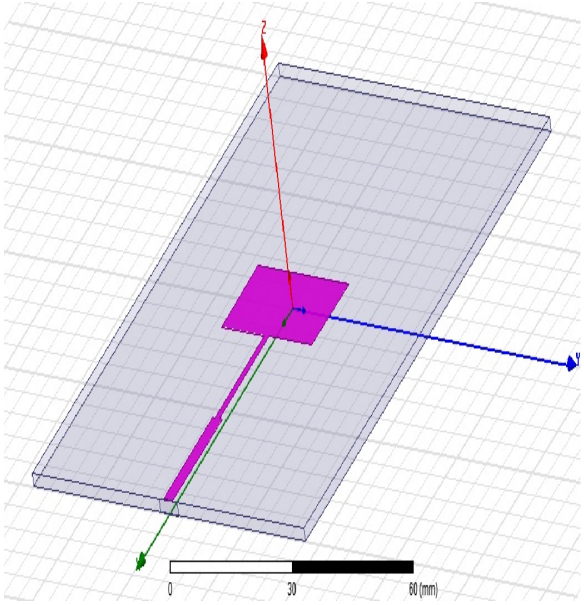

Fig 2: Rectangular Microstrip Patch Antenna

In designed antenna height and width of the patch is 30mm, 50mm.Height and Width of the substrate is 100mm, 90mm.FR4 epoxy material is used as a substrate. Its relative permitivity is 4.4 mm.The whole structures are placed on an infinite ground plane. By using HFSS software this microstrip patch antenna was designed in Cartesian co ordinate system.

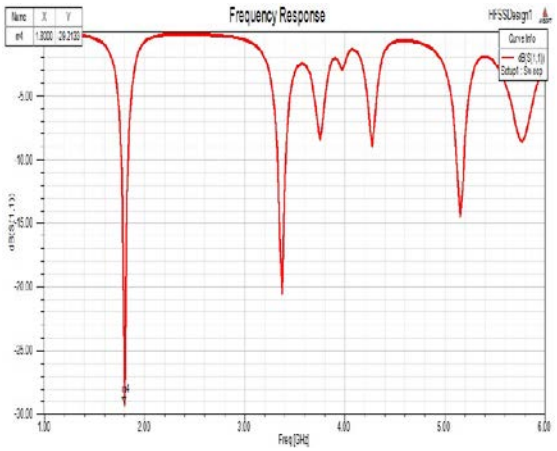

Fig 3: Frequency Response of Rectangular Patch Antenna

Frequency response of rectangular patch antenna is drawn between resonance frequency versus return loss

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we get a return loss of -29.2133 dB at 1.8 GHZ. The acceptable return loss value is -6 dB.

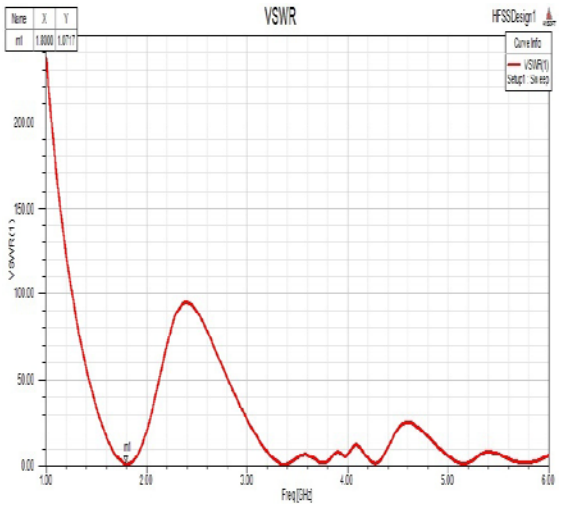

Fig 4: VSWR of Rectangular Patch Antenna

VSWR plot was drawn between resonance frequency versus VSWR value. We get a VSWR value is 1.0717 at resonance frequency 1.8 GHZ.

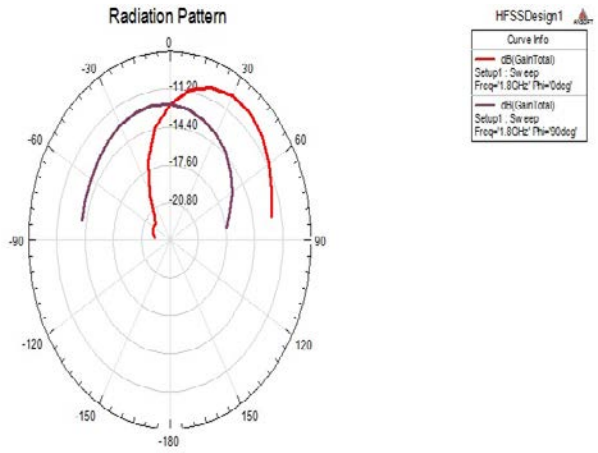

Fig 5: Radiation Pattern

Radiation pattern is the graphical representation of an antenna and its radiated power in a given direction. it was drawn between antenna position and radiated power.

6. Conclusion

In this paper, design and Analysis of Microstrip Patch antenna for GSM application is presented. The obtained antenna parameters such as Return Loss, VSWR of the designed antennas are -29.21dB, 1.0717 respectively. Further, the size of the antenna is obtained through parametric analysis. As the designed antenna meeting the requirements of GSM application, it could be highly useful for mobile application.

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