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ANALYSIS OF C-BAND MICROSTRIP PATCH ANTENNA FOR RADAR APPLICATION

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Abstract - The rectangular microstrip patch antenna and the C-band frequency are described in this study. The major goal of this research is to improve the gain and reflection coefficient of rectangular microstrip patch antennas. FR4 epoxy microwave dielectric board ($\varepsilon_\gamma = 4.4$ *and* $\tan\delta = 0.02$) was used to design and construct the prototype. The compared antenna parameters such as Gain, Radiation Pattern, and Polar Plot, in this analysis. The antenna was developed for a frequency range of 5.2 GHz, making it ideal for a variety of applications including satellite communication, medical applications, and other wireless systems. This simulation is carried out using high frequency simulation structure (HFSS) program. The entire project revolves around the development of a C band rectangular microstrip patch antenna for radar application.

Key Words: Gain, Reflection Coefficient, C-band, Radiation pattern.

1 INTRODUCTION

Microstrip antennas are attractive due to their light weight, conformability and low cost. These antennas can be integrated with printed strip-line feed networks and active devices. Antenna engineering is a relatively recent field. Micro strip structures' radiation characteristics have been recognised since the mid-1950s. This type of antenna was invented when conformal antennas were required for missiles in the early 1970s. Microstrip resonant patches, both rectangular and circular, have been widely used in a variety of array topologies. Along with the antenna structure, feed lines and matching networks are built. Conformal antennas are achievable if the substrate is flexible. Standard photolithographic methods are used for etching [1]. The precision of the etching process also ensures that different pieces are uniform throughout a production run. The ability to build array antennas with the feed network and radiating elements on the same patch is the fundamental rationale for adopting micro strip patches. [2]

Vehicle-based satellite link antennas [3], global positioning systems (GPS) [4], missile radar, and telemetry are just a few of the applications for microstrip antennas. [5], and mobile handheld radios or communication devices [6]. A microstrip patch antenna, in the most basic form, consists of a metal patch on top of a grounded substrate that is normally rectangular or circular (though other forms are occasionally employed) [7]. When designing an antenna, it has four basic feeding techniques such as ,Line feed [5, probe feed [1 and 8], aperture coupled feed [4], and proximity coupled feed [6] etc. The feed in this case is a probe feed (or coaxial feed). The WiMAX (Worldwide Interoperability for Microwave Access) technology [1] is gaining popularity as a way to provide individual and business users with high-speed wireless internet access. The IEEE 802.16 set of standards forms the foundation for WiMAX [2]. The first system implementations based on the 802.l6-2004 fixed wireless access requirements are already being tested and used. Antennas play a critical part in today's rapidly evolving communication infrastructure. A microstrip antenna is made up of a ground plane conducting patch separated by a dielectric substrate. The antenna array is modelled using professional software called High Frequency Structural Simulator and developed using standard formulae (HFSS).

2. DESIGN METHODOLOGY

Firstly, the Microstrip patch antenna is made to resonate for 5.2GHzfrequency. And then by adding slots at the patch for attaining the high gain and making some slits at the ground patch to attain less axial ratio which is responsible for achieving circular polarization. Then by taking parametric analysis of each parameters responsible for the resonation and circular polarization, the design and the working of this Microstrip patch antenna analysis is briefed for the specific application.

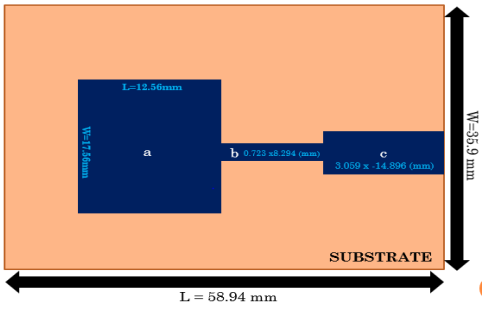

Figure 1 Design of Rectangular microstrip patch antenna

The dimensions of the microstrip patch antenna are shown in the table . The ground plane, and the substrate, is 12.56mm x 17.56mm in dimension. The substrate is made of FR4 epoxy, a common and adaptable high-pressure thermoset plastic laminate grade with good strength to weight ratios. Because it has nearly negligible water absorption, FR-4 is commonly used as an electrical insulator with excellent mechanical strength. The material has been shown to maintain its remarkable mechanical and electrical insulating qualities in both dry and wet environments. These features, together with strong fabrication properties, make this grade suitable for a wide range of electrical and mechanical applications. The feed line is the connection between the antenna and the radio transmitter or receiver.

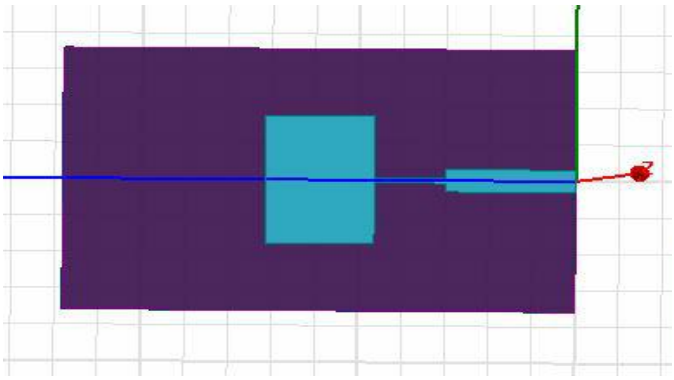

figure 2 Ansys design

DESIGN PARAMETERS	DIMENSIONS
Length of the patch (L)	12.56mm
Width of the patch (W)	17.56mm
Length of the Port	3.058mm
Width of the Port	5.00mm
Length of the Substrate	58.94mm
Width of the Substrate	35.9mm
Length along x-axis of feed line	8.294mm
Width along y-axis of feed line	8.294mm
Length of the Ground plane	58.94mm
Width of the ground plane	35.9mm
Widths of the feed impedance(a)	3.059mm
Lengths of the feed impedance(a)	14.896mm

Table 1: Design Parameters

3 THE RESULT AND DISCUSSION

3.1 Reflection Coefficient

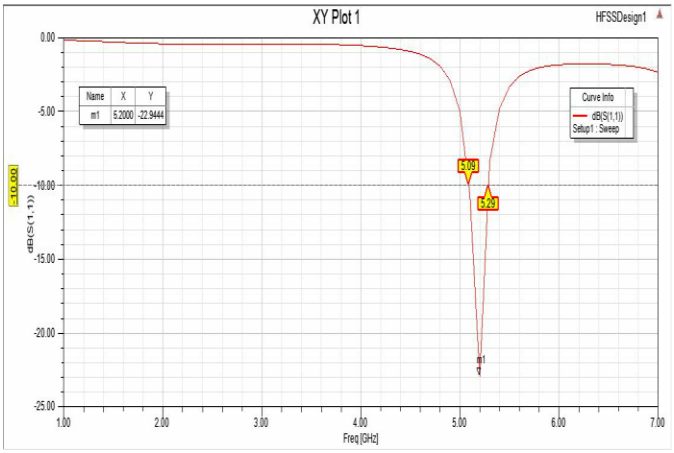

figure 3 Reflection Coefficient

The outputs of the design, simulation, and measurement are provided. The prototype is designed and manufactured on FR4 epoxy microwave dielectric board (_=4.4 and tan = 0.02) using the simulated and measured output of S11 parameters mentioned in the previous section. Reflection co-efficient. of -22.944dB is the power reflected from the antenna. After the final designing in the software, more modification and optimization in the HFSS is required to account for open ports and the dissipation effect of microstrip lines.

3.2 3D polar plot

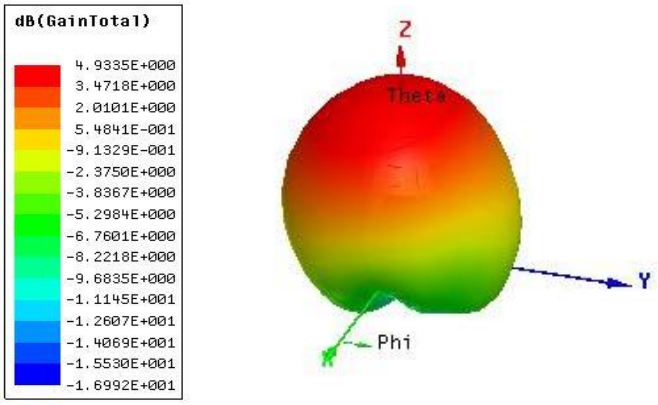

Figure 4 3D Polar Plot

The 3D radiation map aids in the representation of the antenna's gain as well as its directivity. The radiation occurs at the angle between the z axis and the x axis, as shown in the above snip. The antenna gain is 4.9335dB in this case, which is adequate for radiating. The real gain that a microstrip patch antenna must achieve is between 4 and 6 dB. The Microstrip patch antenna gain is plotted in three dimensions at all possible phi and theta values. These are the values used to determine the antenna's gain at a specific distance.

3.3 Radiation Pattern

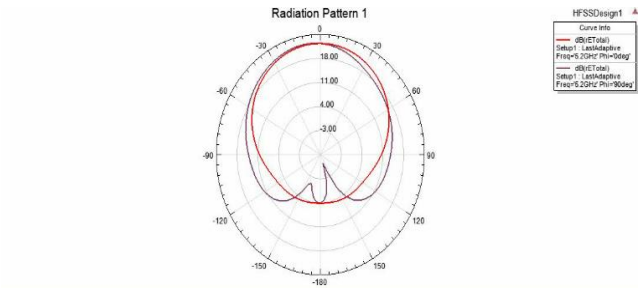

Figure 5 Radiation Pattern

The 3D visible radiation of the Microstrip patch antenna resonating at 5.2GHz is depicted in the radiation pattern above. Theta is set for all to view the radiation pattern over the axis, and phi is 0 degrees. The z and x axes are shown here. The radiation pattern is seen for all angles of phi 0, 90, degrees in the above snip, displaying the maximum gain attained at the various angles. Maximum gains of -2.1dB and -3.3dB were achieved at all angles. With further developments, the gain could be above 2dB, which would be termed radiating.

4. CONCLUSIONS

The purpose of this section is to construct a low-cost, small-size rectangular microstrip patch antenna that can be used in a radar application. The rectangular microstrip patch antenna is designed to operate in the C-band at 5.2GHz. The gain is 4.9335dB and the reflection co-efficient is -22.9444dB. The work of the C-band rectangular microstrip patch antenna for radar applications was motivated by this.

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