A 2.4GHz Rectangular Microstrip Patch Antenna for satellite Communication Applications in S-Band Frequency Range

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Abstract-In this paper, the design of Rectangular Microstrip patch antenna is presented, which is the most commonly used device in modern communication systems. The antenna design focuses on the Wi-Fi and Wireless Local Area Networks (WLAN) application. The designed antenna works on a resonating frequency of 2.4 GHz, the design is made on FR-4 Epoxy material used as a dielectric material with its dielectric constant = 4.4 and thickness of 1.6mm. The microstrip patch antenna is then fabricated on the basis of the simulated design in HFSS simulation software. The designed antenna can be used for ISM (industrial, scientific and medical) band and UWB applications. The designed antenna has low profile, low cost, easy fabrication and good isolation. The most widely researched area in the wireless technology is the operation of the antennas which are to be light weight, cost efficient and needs improvement in antenna parameters such as return loss, gain, radiation pattern, directivity and especially impedance matching for better performance so that the overall performance of the communication system improves. The optimized antenna design parameters provide better results in comparison with the actual design parameters. The antenna design showed a better return loss of −25dB and the antenna parameters such as radiation pattern, directivity, gain, VSWR and bandwidth are obtained. The improved bandwidth of the patch antenna. Rectangular patch antenna can be modified into, to reducing the patch length of the antenna and to increasing the thickness of the substrate of the antenna. By improved bandwidth of the patch antenna design can be used for can be used for wide band communication application.

Index Terms: VSWR, Patch Antenna, Directivity

I. Introduction:

Antenna is a very important component of a communication system. By definition, an antenna is a device used to transform a RF signal, traveling on a conductor, into an electromagnetic wave in free space. Antennas demonstrate a property known as reciprocity, which means that an antenna will maintain the same characteristics regardless, if it is transmitting or receiving. Most antennas are resonant devices, which operate efficiently over a relatively narrow frequency band. An antenna must be tuned to the same frequency band of the radio system to which it is connected, otherwise the reception and the transmission will be impaired. When a signal is fed into an antenna, the antenna will emit radiation distributed in space in a certain way. A graphical representation of the relative distribution of the radiated power in space is called radiation pattern.

The radiation pattern and radiation resistance of an antenna is the same when it transmits and receives, if no non- reciprocal devices are used, same antenna can be used for transmission and reception of electromagnetic waves. Antenna is a passive device, it does not amplify signals, and it only directs the signal energy in a particular direction in reference with the isotropic antenna. Antenna dimensions depends upon the wavelength of the signal being transmitted. At high frequency, if the wavelength of the signal is smaller, the dimensions of the antenna becomes smaller. So at high frequency the size of the wireless system becomes compact.

II. Literature Survey:

The microstrip antenna has been said to be the most innovative area in the antenna engineeringwith its low material cost and easy to fabricate which the process can be made inside universitiesor research institute. The concept of microstrip antenna with conducting patch on a ground planeseparated by dielectric substrate was undeveloped until the revolution in electronic circuitminiaturization and large-scale integration in 1970. In this section, the microstrip antennaliterature survey is discussed. Design of stacked miniaturized slotted antenna with enhancedbandwidth for WiMax application has been proposed. In this paper asymmetric U- slot on lowerpatch and a rectangular slot on upper patch is presented. The aim of this paper is to design smallersize microstrip patch antenna by increasing the path length of the surface current which isobtained by cutting the slot in the radiating patch. It can be observing d that antenna well suitedfor WiMax application in 3.40-3.69 GHz and 5.25-5.85 GHz band. A microstrip E shaped patchantenna has been proposed for wireless application.

The design of a RMSA is made to several dielectric materials, andthe selection is based upon which material gives a better antenna performance with reducedsurface wave loss. Droid 5880 and Quartz are the best materials for proposed design to achievea broader Bandwidth (BW) and better mechanical characteristics than using air. The overallantenna BW for RMSA is increased by 11.6 % with period 5880 with shifted feeding point andwith central shorting pin while that for Quartz is 17.4 %. In this paper, different thickness ofdielectric substrate (h = 4, 6 and 8 mm) are used to increase bandwidth.

A rectangular micro strip patch antenna that meets the requirement of operation at (2.4 GHz), the proposed configurations are simulated and analyzed using microwave office 2000 software package. The VSWR, input impedance, radiation patterns and S11 performance are used for the analysis of the different configurations. Feed point on the patch that gives a good match of 50-ohm, input impedance was found by a method of trial and error. For substrate thickness (4mm) the first design antenna had a (155.1) MHz bandwidth (6.46 % of central frequency). Whereas when the thickness as used (6mm), the bandwidth increased to be (200) MHz. In this paper, a new design technique for enhancing bandwidth that improves the performance of a conventional micro strip patch antenna is proposed. This project probe fed inverted slotted micro strip patch antenna. The design adopts contemporary techniques; coaxial probe feeding, inverted patch structure and slotted patch. The composite effect of integrating these techniques and by introducing the proposed patch, offer a low profile, broadband, high gain, and low cross polarization level.

III. Existing Method:

The design procedure is outlined which shows the way for practical design and in order to get optimum characteristics (radiation properties, bandwidth and reduce side lobes), the parameter dimensions are approximated slightly and designed where the TABLE 2 shows the theoretical versus optimal parameter dimensions. Initially a rectangular patch antenna is designed with patch 29.4X38.036mm and feed line is assigned perfectly by using optimization technique for providing good impedance match. A Partially grounded structure (PGS) is considered where the length of the ground is 60mm that improves the radiation properties and degree of efficiency.

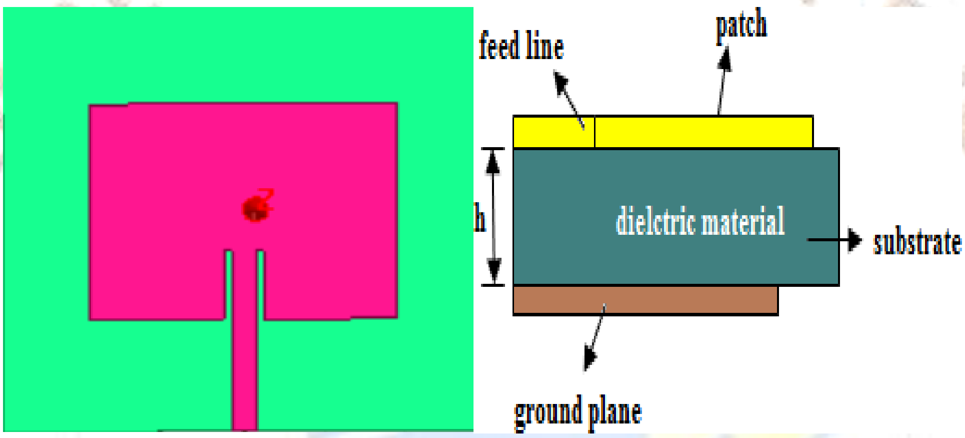

Fig 1: Rectangular Patch Antenna a) Top view b) Side view

IV. Proposed Design:

The proposed microstrip antenna was designed with a rectangular patch and a resonant frequency of 2.4 GHz, which can work in the S-Band frequency range for satellite communication applications. The substrate material used is FR-4 Epoxy with a dielectric constant (Ɛr) = 4.4 and material thickness (h) = 1.6 mm. The size of the patch length (L) and patch width (W) of the antenna is 29.4mm and 38mm.

High Frequency Structure Simulator is 3D FEM Simulator which gives more accuracy for designing antennas and simulated results are close to experimental results with more insight into the structure available. The following steps summarize the step by step procedures for antenna simulation.

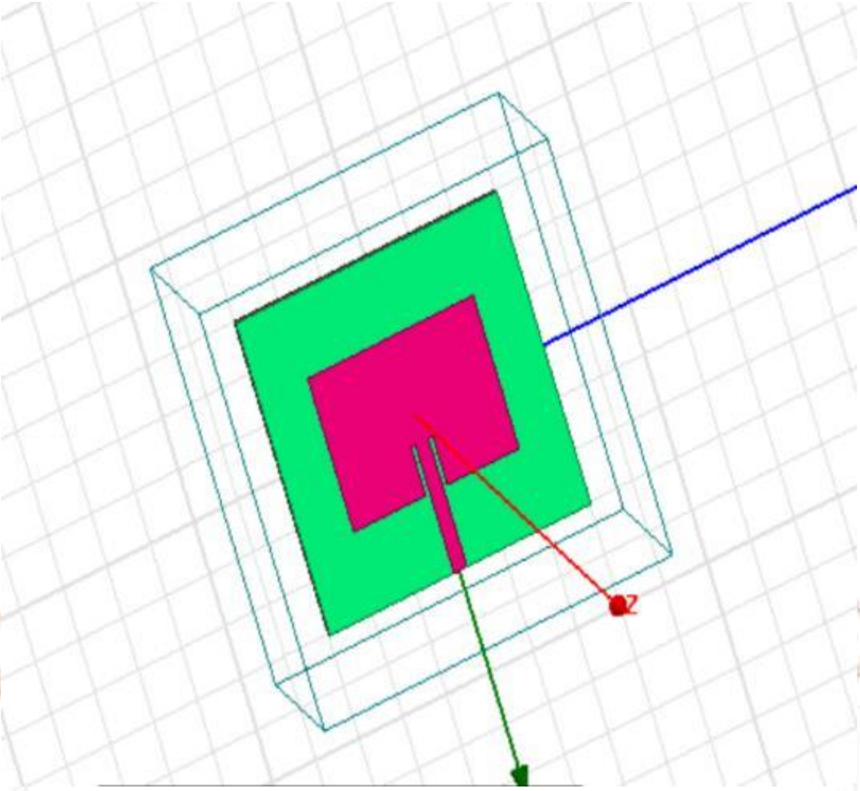

Fig 2: Rectangular Patch Antenna

The proposed microstrip antenna was designed with a rectangular patch and a resonant frequency of 2.4 GHz, which can work in the S-Band frequency range for satellite communication applications. The substrate material used is FR-4 Epoxy with a dielectric constant (Ɛr) = 4.4 and material thickness (h) = 2.2 mm. The size of the patch length (L) and patch width (W) of the antenna is 28.9mm and 38mm.

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Simulation Results:

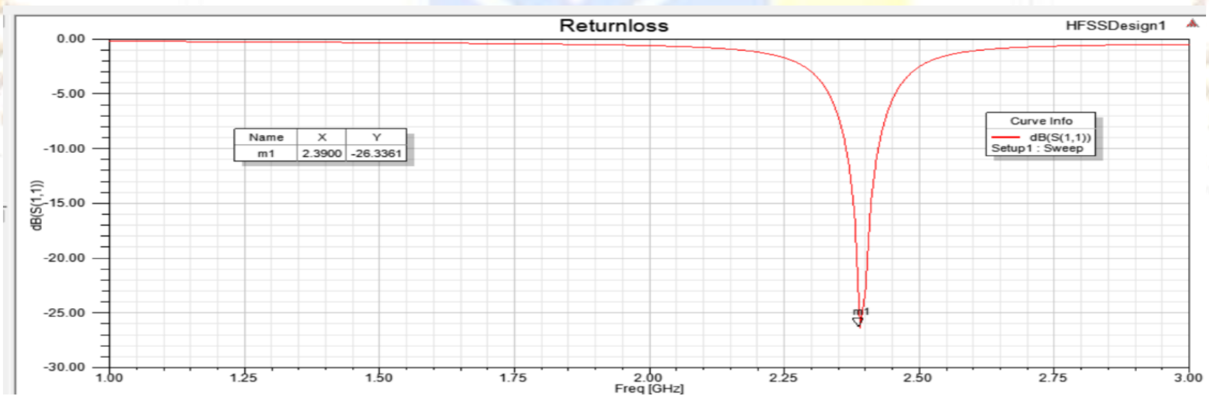

Fig 3: Return loss of Rectangular Patch Antenna

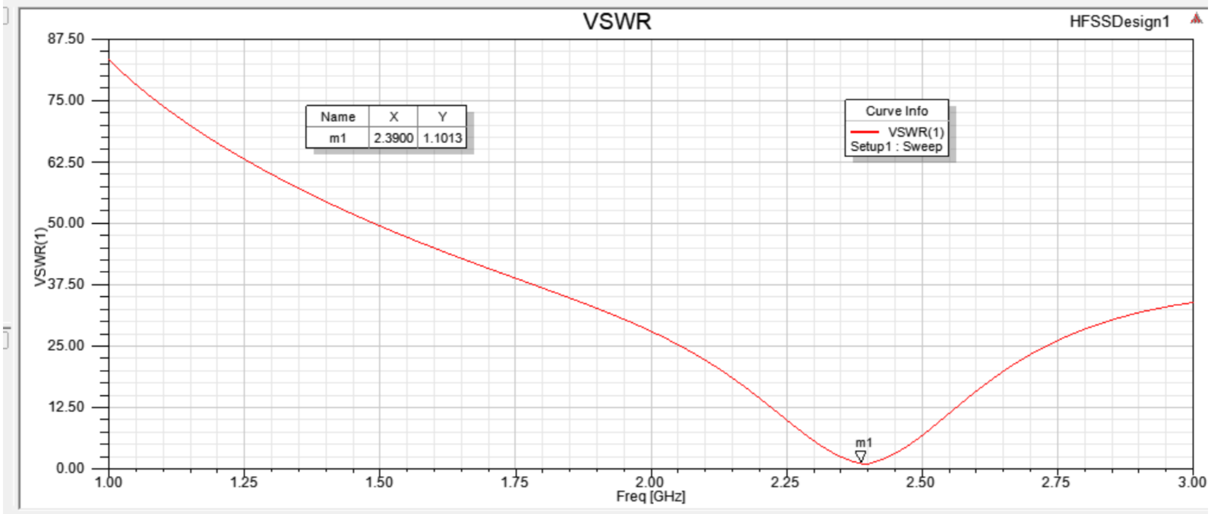

Fig 4: VSWR of Rectangular Patch Antenna

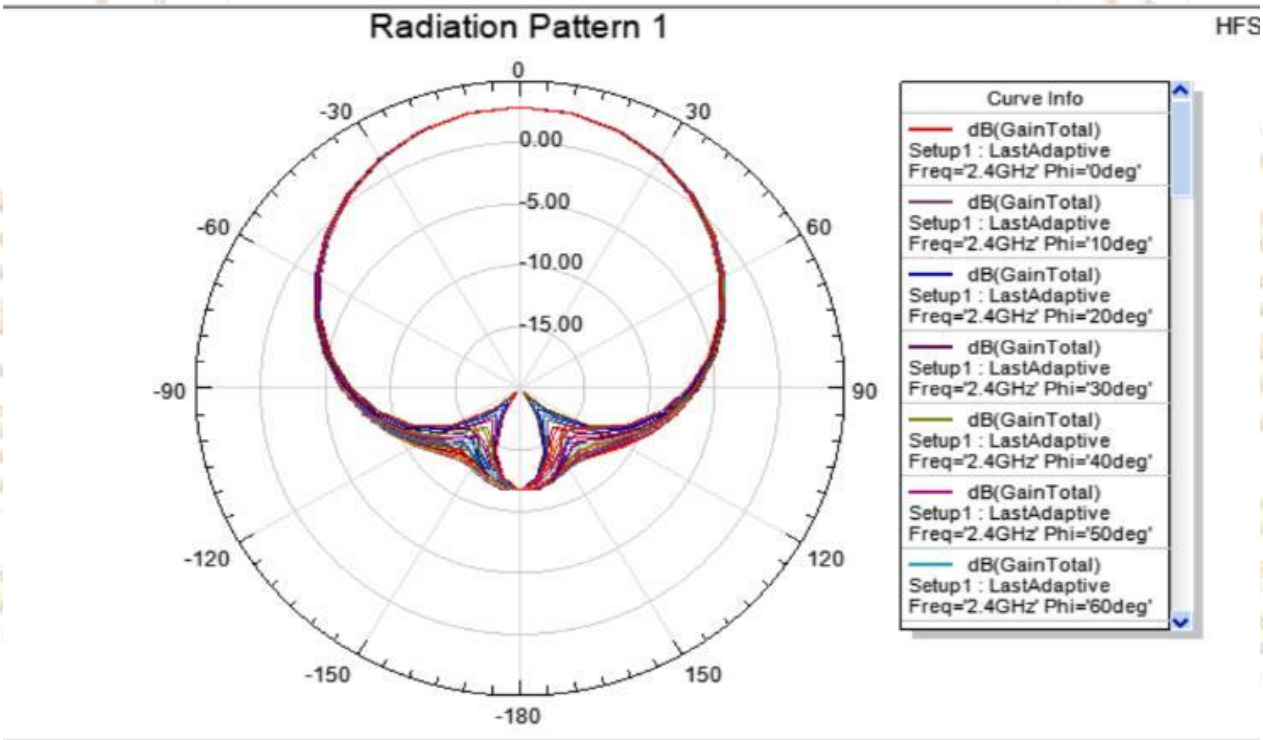

Fig 5: Radiation Pattern of Rectangular Patch Antenna

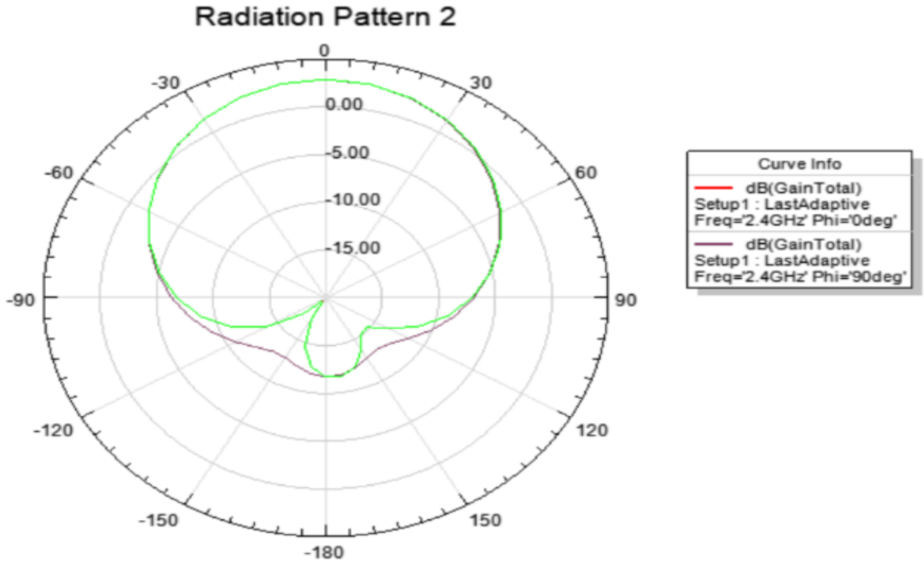

Fig 6: Radiation Pattern of Rectangular Patch Antenna

V. Conclusion:

In this paper a Microstrip Patch antenna is successfully designed at a resonant frequency of 2.4 GHz. Based on the experimental results, the antenna parameters such as return loss, VSWR, The Radiation patterns (3D) and the other important parameters of gain, directivity and bandwidth have been studied. The antenna's radiating elements are the main patch and the sub patches and it is possible to design the Microstrip patch antenna at any band of frequencies like L, S, C, X, Ku & Ka bands. The antenna parameters are helps us to identify the effective antenna which is mostly suitable for S-band frequencies. The modified rectangular slot antenna-2 is better when compared with other references in terms of Return loss and VSWR, the gain and bandwidth values. Because of Increasing the dielectric constant of substrate material allows miniaturization of RMP antenna. But miniaturization comes with a trade-off in bandwidth, impedance and efficiency. The result obtained in simulation proved that the Gain and Directivity of single microstrip patch antenna increase with respect to decreasing the dielectric constant of substrate but FBW (%) decreases. The result obtained in simulation proved that the Gain and Directivity of single microstrip patch antenna decrease with respect to increasing the thickness of dielectric substrate but FBW (%) increases.

The high gain antenna i.e., modified rectangular slot antenna-2 for 2.4 GHz applications is provided. The antenna resonates at 2.4 GHz with a return loss of -29 dB and a VSWR of 1.06. The antenna recommended has a good radiation pattern and a gain of 6dB.

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