Reduced Ground Rectangular Microstrip Patch Antenna for Radio Astronomy, Satellite Navigation, Maritime Radar and ISM applications

Simarjit Singh Saini, Avneet Kaur, Ekambir Sidhu

***Abstract*—In this paper, a microstrip patch antenna suitable for FSS earth station, radio astronomy, defence system, satellite navigation system and nautical telemetry, maritime radar or weather radar, amateur satellite and ISM applications has been proposed. The proposed antenna has been designed using flame retardant 4 (FR4) as substrate having dielectric constant ε_r of 4.4 sandwiched in between the patch and ground plane made up copper. The power from coaxial connector is fed to the designed antenna via microstrip feedline and impedance of the antenna is matched perfectly with 50Ω impedance of the input port so as to minimize the back reflections from the antenna. The performance of the patch antenna has been scruitinized for different antenna parameters such as return loss (S_{11}), directivity, gain, bandwidth, VSWR etc. The proposed antenna has been designed and simulated using CST Microwave Studio 2014. It has been observed that antenna is resonant at 4.906 GHz with an impedance bandwidth of 1.99 GHz and an operating frequency range of 3.8867 GHz - 5.8776 GHz. The proposed antenna has return loss (S_{11}) of -52.629 dB at resonant frequency of 4.906 GHz. The antenna has gain of 3.123 dB and directivity of 2.794 dBi. The designed antenna can be suitably employed for FSS earth station, radio astronomy, defence system, satellite navigation system, and nautical telemetry, maritime radar or weather radar, amateur satellite and ISM applications**

***Index Terms*—Anechoic chamber, CST Microwave Studio, Nautical telemetry, Radio astronomy**

I. Introduction

The microstrip patch antennas generally find its various applications in both military and civil applications. These include technologies like GPS, mobile phones, WLAN/Wi-MAX [1][2][3][4]. The concept was introduced by Deschamps in US in 1950's and by Gutton & Baissinot in France. Such antennas were developed with the advent of printed circuit technology in the 1970's. The modern technology focus is on compact designs with numerous benefits. This is the reason behind more attention on micro strip antenna designs [5]. So, it is a challenge for designers to design small size, light weight and easy to fabricate antennas without compromising on desired performance parameters [6]. Keeping in view the various advantages, many techniques have been developed to improve the limitations [7][8]. The disadvantages of micro strip antenna are low gain and low bandwidth [9]. To get rid of these drawbacks, the low dielectric constant thick substrate or slotted patch can be employed [10]. For a fixed frequency microstrip antenna, a substrate with high dielectric constant can be employed [11]. The notches can be employed on the patch or ground of antenna to improve the performance of the antenna.

The antenna work more efficiently when there is minimum interference of electromagnetic waves and the concept of introducing notches can reduce the electromagnetic interference, thus making the antenna more functional. To improve the performance of the antenna in terms of returnloss, the CSRR (Complimentary Split Ring Resonator) can be employed. There are many feeding techniques available to feed the antenna, for example, coaxial cable or through strip line etched on the surface of antenna [12], [13], [14], [15], [16], [17], [18]. The antenna geometry has been discussed in section II. The simulated results have been discussed in section III. Section IV focus on the conclusion of the proposed research work.

II. Antenna Geometry

The proposed microstrip patch antenna has been designed and simulated using CST Microwave studio 2014. The fig. 1 represents the side view of the designed antenna having patch

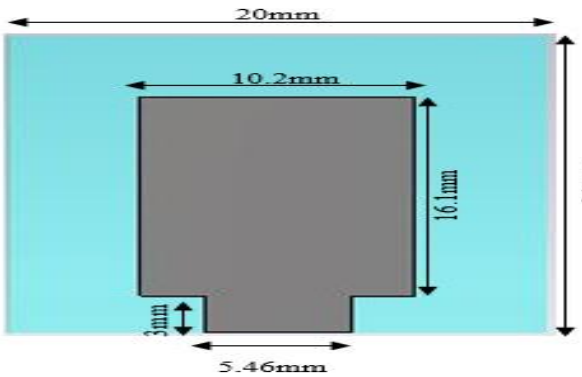

Fig. 1 Top View of the proposed antenna

of thickness 1.0 mm and dimensions of 40 mm × 17 mm. The fig. 2 illustrates the trop view of the proposed antenna and the fig. 4 shows the ground of the proposed antenna with dimensions of 40 mm×20 mm. The power to the proposed antenna is feed by coaxial SMA connector via feedline. The SMA connector used to feed power has impedance of 50 ohms, thus the impedance of the illustrated antenna has been matched to the 50 ohms so as to minimize the back reflections from the antenna.

Simarjit Singh Saini, Department of Electronics and Communication Engineering, Punjabi University, Patiala, India.

Avneet Kaur, Department of Electronics and Communication Engineering, Punjabi University, Patiala, India.

Ekambir Sidhu, IEEE Member, Assistant Professor, Department of Electronics and Communication Engineering, Punjabi University, Patiala, India.

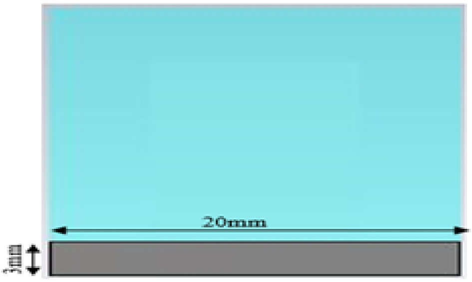

Fig. 2 Bottom view of the proposed antenna

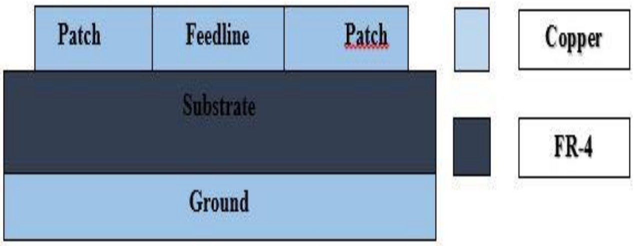

Fig. 3 Side view of the proposed antenna

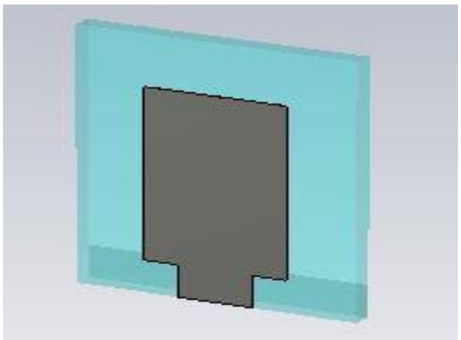

Fig. 4 3-D view of the proposed antenna

III. Results and Discussion

The CST Microwave Studio 2014 has been used to design the proposed lamp shape microstrip patch antenna and the performance has been analyzed in terms of return loss (dB), resonant frequency (GHz), directivity (dBi), gain (dB), impedance bandwidth (GHz), VSWR and impedance (ohms). The return loss plot illustrates that the antenna is resonant at 4.906 GHz with a return loss of – 52.629 dB as shown in fig. 5. The Smith Chart has been shown in fig. 6 which indicates that the proposed antenna has impedance of 51.31 Ω. The respective gain and directivity at 4.096 GHz is found to be 3.123 dB and 2.794 dBi as shown in fig. 7 and fig. 8. The VSWR plot of the antenna has been shown in fig. 9 which implies that the VSWR of the proposed antenna design lies below the minimum acceptable value of 2. The power flow pattern of the antenna is shown in fig.10.

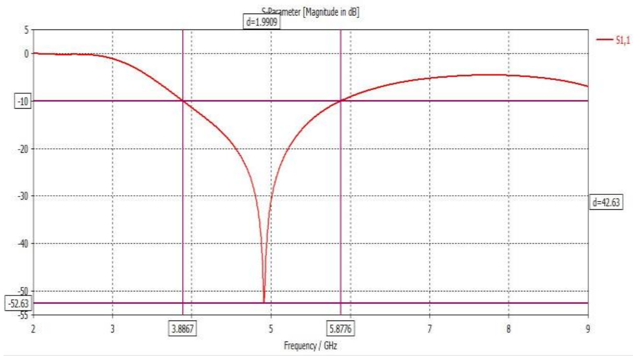

Fig. 5 Return loss plot of the proposed antenna

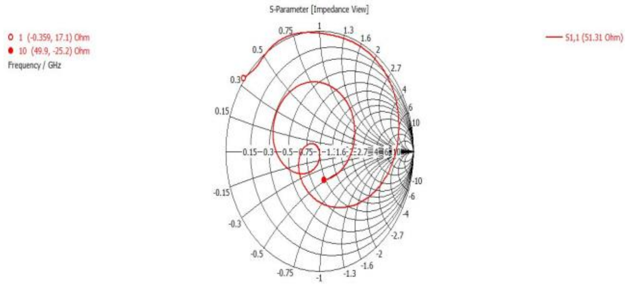

Fig. 6 Smith cart of the proposed antenna

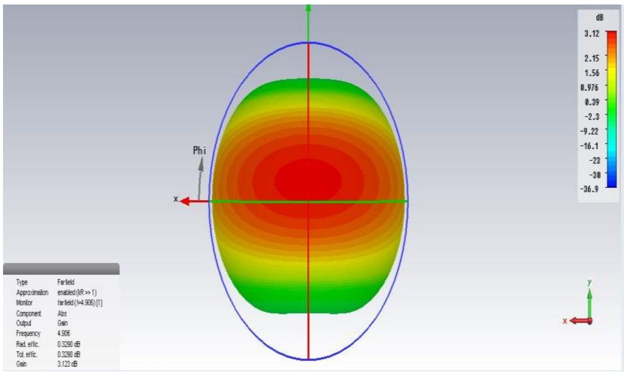

Fig. 7 Gain plot of the proposed antenna

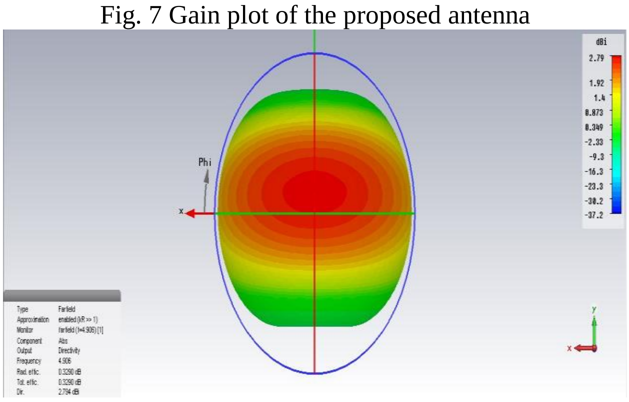

Fig. 8 Directivity of the proposed antenna

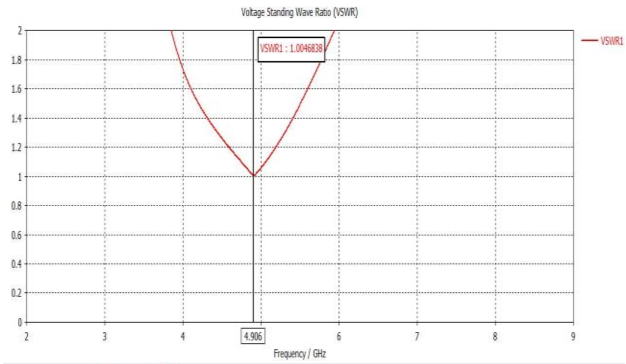

Fig. 9 VSWR plot of the proposed antenna

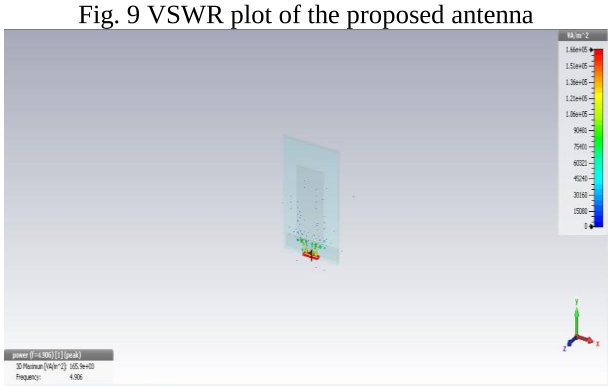

Fig. 10 Power flow of the proposed antenna

IV. CONCLUSION

In this paper, a microstrip patch antenna employing FR substrate with a resonant frequency of 4.096 GHz has been designed, simulated and analysed. The proposed antenna has been designed and simulated using CST Microwave Studio 2014. The proposed antenna has the impedance bandwidth of 3.8867 GHz – 5.8776 GHz (1.99 GHz). The proposed antenna can be suitably employed for FSS earth station (4500 MHz – 4800 MHz), radio astronomy (4800 MHz – 4990 MHz), defence system (4990 MHz – 5000 MHz), satellite navigation system (5000 MHz – 5010 MHz), and nautical telemetry (5150 MHz – 5250 MHz), maritime radar or weather radar (5250 MHz – 5255 MHz), amateur satellite (5650 MHz – 5725 MHz) and ISM (5725 MHz – 5830 MHz) applications.

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BIOGRAPHIES

Simarjit Singh Saini is a student at Department of Electronics and Communication Engineering, Punjabi University, Patiala. He is pursuing his Bachelor of Technology (B.Tech) in the field of Electronics and Communication Engineering Punjabi University, He is a student member of IEEE and member of ASME (American Society of Mechanical Engineers). His areas of technical interest are Energy Harvesting, Embedded System and Antennas.

Avneet Kaur is student at Department of Electronics and Communication Engineering, Punjabi University, Patiala. She is final year student of Bachelor of Technology (B.Tech) at Department of Electronics and Communication Engineering. Her areas of technical interest are Energy Harvesting, Microwave Antennas and Embedded systems. She is a student member of IEEE (Institute of Electrical and Electronics Engineers) and member of ASME (American Society of Mechanical Engineers).

Er. Ekambir Sidhu is an Assistant Professor at Department of Electronics and Communication Engineering Department, Punjabi University, Patiala Since September, 2012. His area of specialization is Antenna Systems and his research publications are in the field of Microwave Antennas, Optical Antennas, Embedded Systems, and Energy Harvesting Systems, Embedded system, and Warble electronics. He is an Associate Member of IETE (Institution of Electronics and Telecommunication Engineers) and member of IEEE (Institute of Electrical and Electronics Engineers).