DESIGN OF SINGLE BAND RECTANGULAR (FRACTAL) MICROSTRIP PATCH ANTENNA FOR WIRELESS APPLICATIONS

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ABSTRACT

Microstrip patch antennas play a significant role in wireless communication due to its inexpensive cost, tiny size, and simplicity of fabrication. This study proposes a microstrip patch antenna on a rectangular patch, intended at 5.4 GHz for wireless applications. The antenna has a 1064 MHz bandwidth, a return loss of -24.33 dB, a gain of 3 dBi, and a directivity of 5.45 dBi. With the help of CST Studio suit, the antenna is developed and simulated. The antenna is made FR4 material, which has a loss tangent of 0.06 and a relative permittivity of 4.4. The findings demonstrate unequivocally that the suggested antenna for the applications of wireless applications.

Keywords: *Microstrip antenna, CST, FR4, Gain, Return Loss, VSWR.*

1. Introduction

Microstrip antennas have been developed for many years, and their applications are continuously expanding [1-2]. This microstrip technology is expanding rapidly. Wireless communication is a field. The size of electronics has significantly lowered while their usefulness has improved in recent years for a variety of applications [3]. The antennas needed for many communication-related applications should be compact, lightweight, and low-profile [4-9]. They have numerous uses in the fields of wireless communication. Size and ease of installation are crucial factors when designing an antenna for satellite or spacecraft applications; as a result, low profile antennas are necessary, and microstrip antenna is the preferable option [5, 10-12].

There are numerous distinct patch shapes, including hexagonal, triangular, circular, elliptical, and rectangular. The antenna can be fed via a variety of methods, including micro strip line feeding, coaxial probing feeding, aperture coupling, and electromagnetic coupling [4]. High data rates are required for wireless communication systems, and this is accomplished by expanding the available bandwidth. UWB technology with a frequency range of 3.1–10.6 GHz, maximum radiated power of 41.3 dBm/MHz, and a data throughput of 110–200 Mbps at a distance of 10 m was approved by the FCC in 2002 [13].

2. Antenna Design

Top view of a rectangular patch antenna with feed patch is connected. Patch and ground plane together creates fringing fields and this field is responsible for creating the radiation from the antenna. This value is calculated by using standard formulas. In figure 1, showing top view of proposed antenna, one side of a dielectric substrate acts as a radiating patch and other side of substrate acts as ground plane.

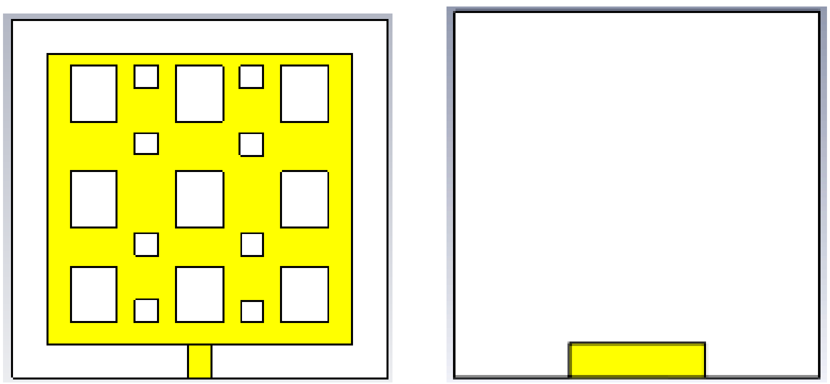

Figure 1: Top view and Bottom view of proposed antenna

Below table 1 is showing the necessary dimension and values for designing proposed antenna. This value is calculated by using standard formulas.

Table 1: Dimension for the proposed antenna design

Sr. No.	Parameter	Value
1	Frequency (F_r)	4-8 GHz
2	Dielectric constant (ε_r)	4.4 / FR4
3	Metal Height	0.035mm
4	Substrate Height (h)	1.57 mm
5	Line Impedance	50 Ω-70Ω
6	Antenna Length	32mm
7	Antenna Width	32mm
8	Tangent Loss	0.06
9	Feed patch length	4mm
10	Feed patch width	3mm
11	Feed patch height	0.035mm

The dimension of antenna is (LxWxH) 32 X 32 X 1.64 mm^3. The proposed antenna is based on rectangular shape pattern. The length of feed patch is 4mm and width is 3mm. The substrate material which is using in proposed antenna is FR4 material. Figure 2 is showing bottom view of antenna, this is also known as ground structure.

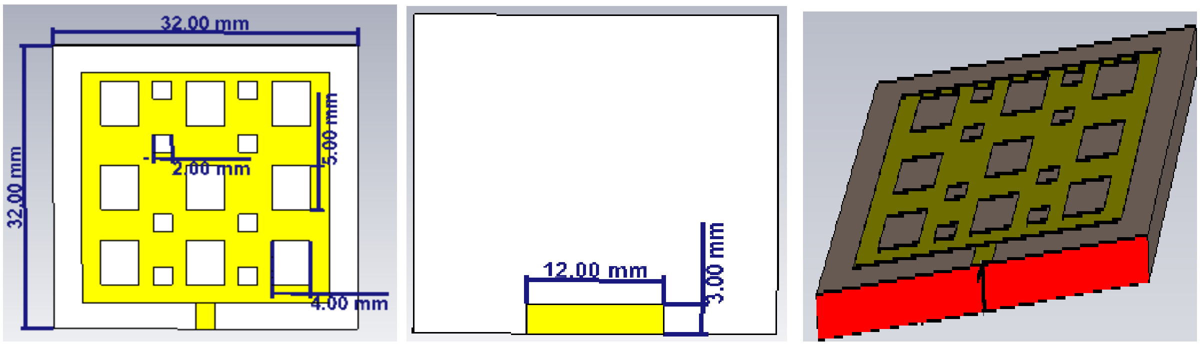

Figure 2: Dimension of proposed antenna and Side view in CST Studio

Figure 3 is showing CST view of proposed antenna; here it can be seen the antenna is designed according to Cartesian coordinate system as per the proposed design and Cartesian.

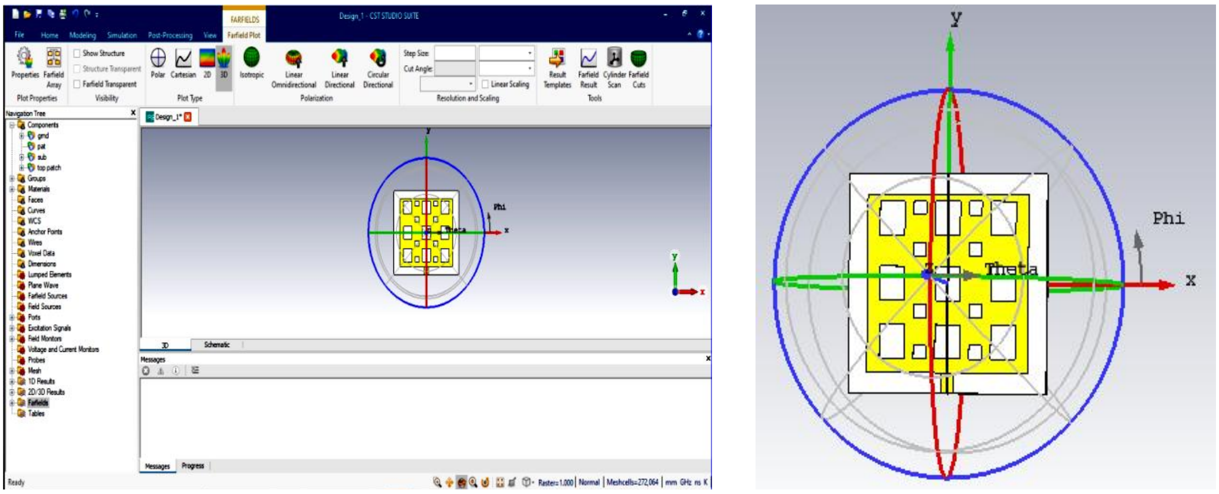

Figure 3: CST view of proposed antenna

3. Simulation Results And Discussion

Proposed antenna is simulated in CST microwave studio, it is a specialized tool for the fast and accurate 3D EM simulation of high frequency problems along with a broad application range. The basic geometry is designed based on Cartesian coordinate system which have x,y,z axis.

Figure 4 shows the Return Loss (S_{11}) parameters for the proposed antenna, which represents antenna band of frequency for which the antenna designed is optimized i.e. frequencies ranging from 4 GHz to 8 GHz with S_{11} value beyond -10 dB and the range of frequencies as per the results shows that it has a good bandwidth.

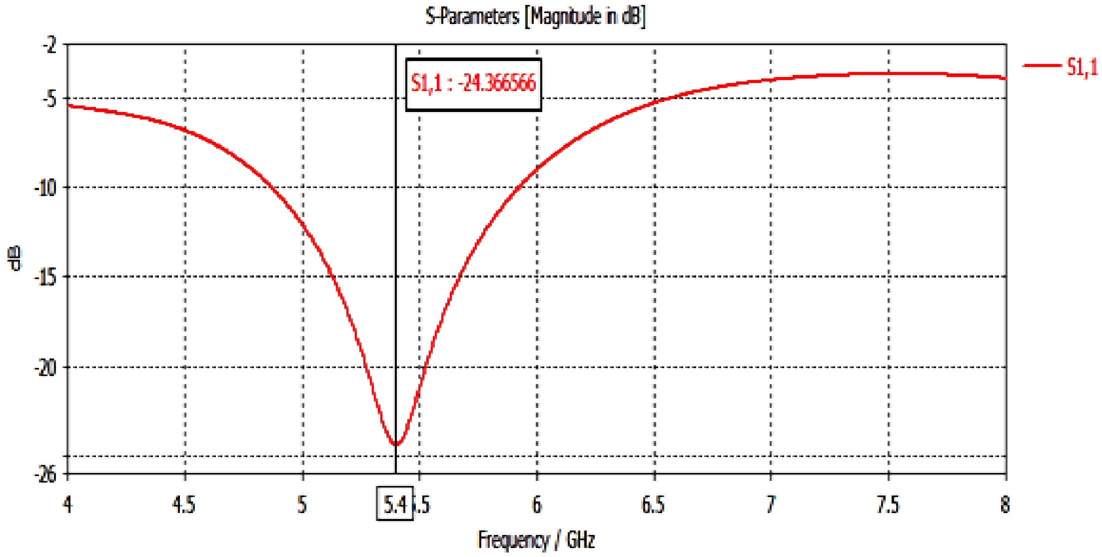

Figure 4: Return Loss Plot

The figure 5 shows the bandwidth of proposed antenna is 1064 MHz, (5.93GHz – 4.86GHz).

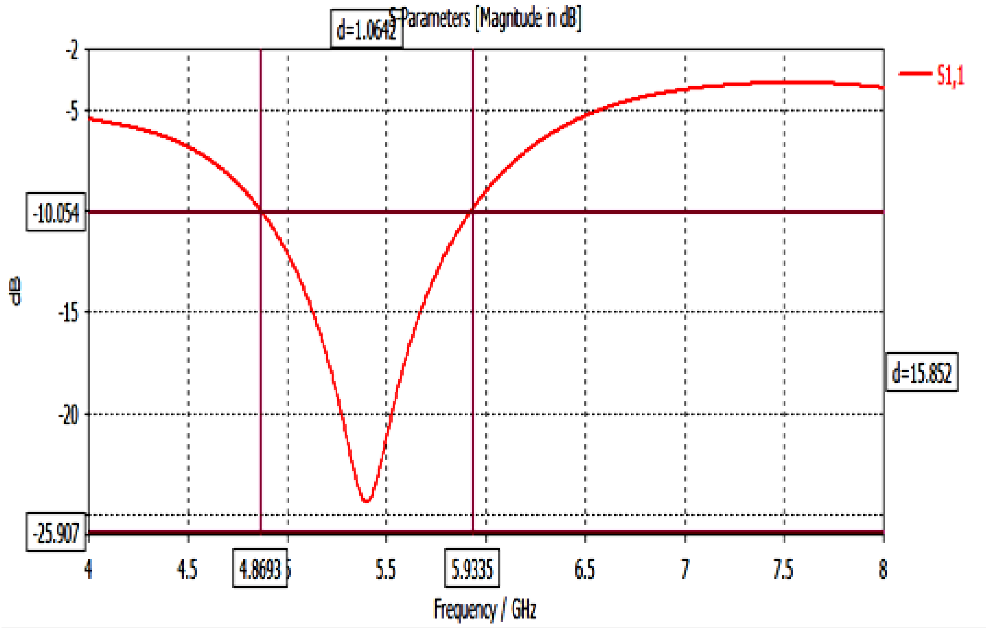

Figure 5: Bandwidth Plot

VSWR must lie in the range of 1-2, which has been achieved for the frequencies 5.4 GHz. The value for VSWR is 1.128 as shown in figure 6.

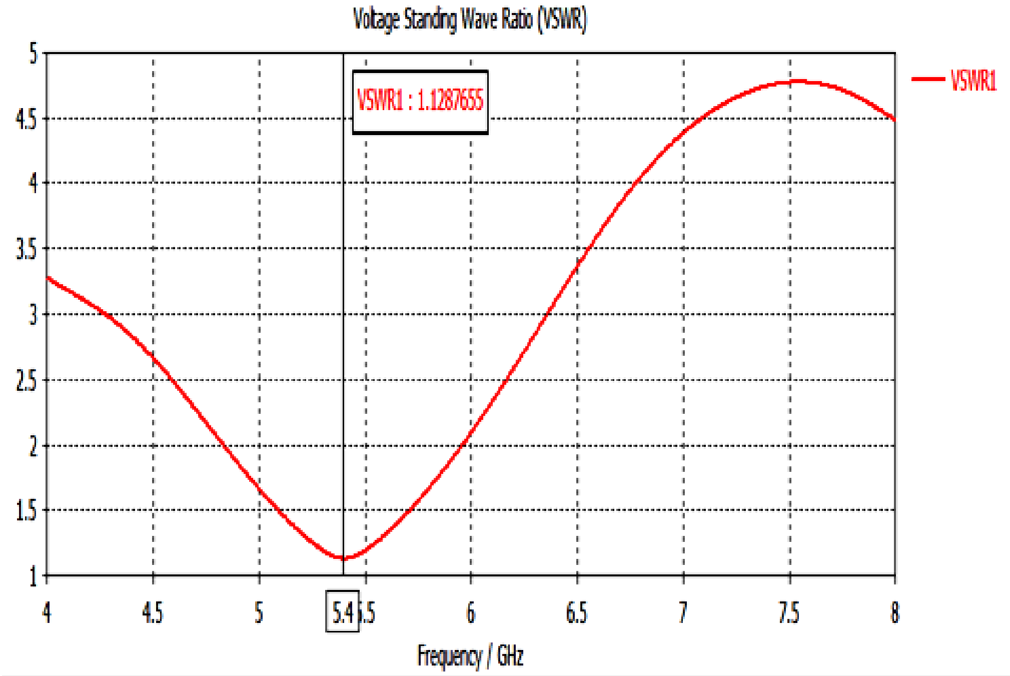

Figure 6: Simulated result of VSWR

Simulated result of accepted power, power outgoing all ports power radiated and power stimulated is shown in figure 7. Stimulated power is 0.5W while power radiated is 0.49 so the antenna efficiency is more than 90%.

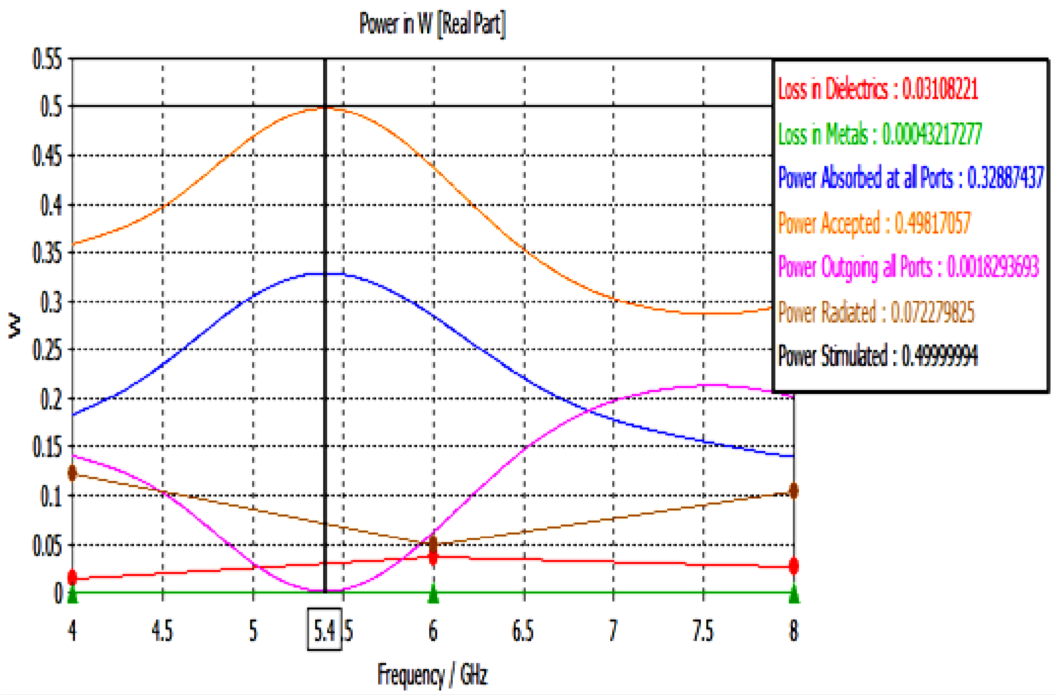

Figure 7: Power in different port for first band

Figure 8 is showing far field 2D radiation pattern. The directivity of proposed antenna is 5.45 dBi for optimized band and the 3D Radiation pattern of proposed antenna band is shown in the figure.

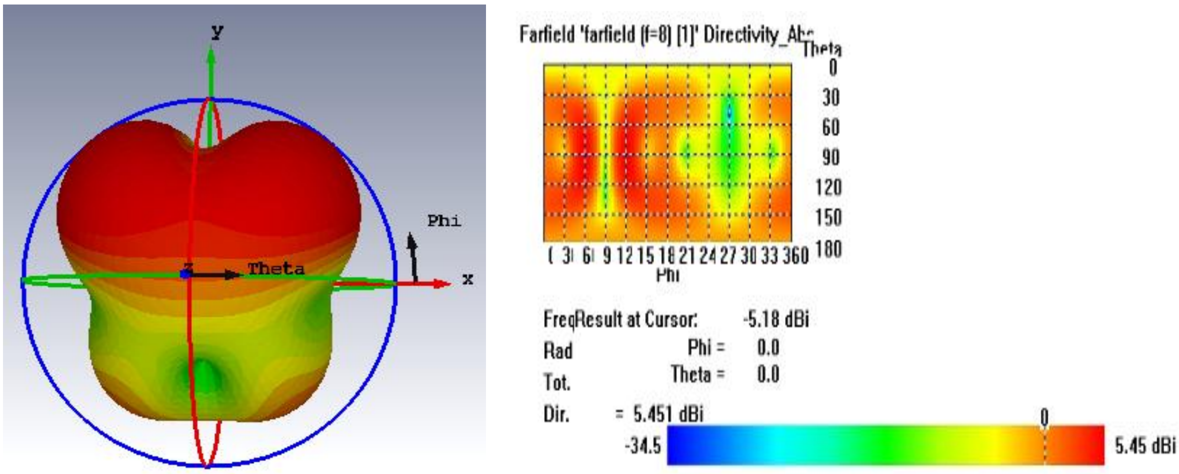

Figure 8: 3D Radiation pattern and Directivity 2D plot of proposed antenna band

Analysis has been made for various antenna parameters like return loss, resonant frequency, gain, directivity, bandwidth and VSWR. Another crucial factor in the antenna is current dispersion. The current in a radiating patch will be zero at its conclusion since it is open-circuited, highest in the middle of the half-wave patch, and zero at its beginning, according to the design [12]. At the conclusion of the patch and the beginning of the patch, the voltage should be positive. Figure 9 shows the surface current of proposed antenna, the electric and magnetic field of proposed antenna is also showing, here electric field represents by blue dots while magnetic field represents by green dots.

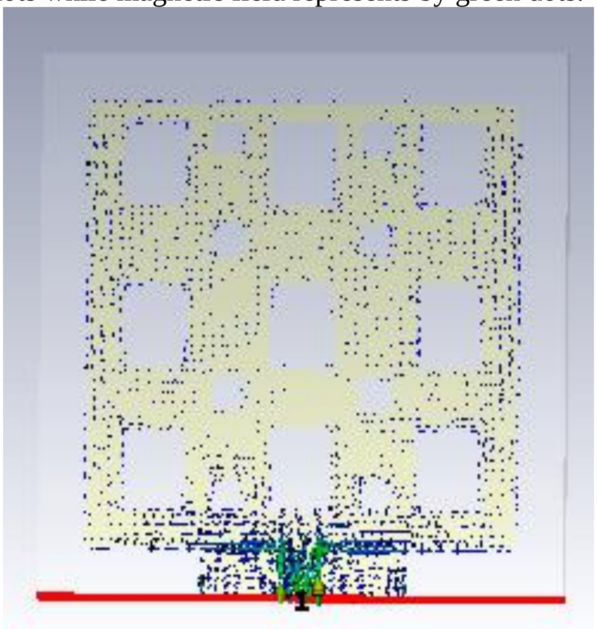

Figure 9: Surface current of proposed antenna

4. Result Summary

The proposed antenna is analyzed using CST Studio suit. Table 2 shows the simulated results of return loss, VSWR, gain, and bandwidth.

Table 2: Simulation Result summary of proposed antenna

Sr. No.	Parameter	Band-I
1	S11 or Return loss	-24.33 dB
2	Band Width	1064 MHz
3	VSWR	1.12
4	Resonant Frequency	5.4 GHz
5	No of band	1
6	Directivity	5.45 dBi
7	Gain	3 dBi
8	Y- Parameter (Admittance)	0.012
9	Z-Parameter (Impedance)	76.96

5. Conclusion

A new structure based on the Fractal is equally spaced on the rectangular patch for wireless communication is proposed. Return Loss (S_{11}) parameters for the proposed antenna, which represents antenna band of frequency for which the antenna designed is optimized i.e. frequencies ranging from 4 GHz to 8 GHz with S_{11} value beyond -10 dB. The bandwidth of designed antenna is 1064 MHz, (5.93GHz – 4.86GHz). VSWR must lie in the range of 1-2, which has been achieved for the frequencies 5.4 GHz. The value for VSWR is 1.128. The directivity of proposed antenna is 5.45 dBi for optimized band. The directivity of designed antenna is 5.45 dBi for optimized band. We proposed an UWB antenna which can support large bandwidth to ensure the UWB signal is transmitted and received electively. It can be concluded that better bandwidth, return loss and VSWR achieved. For wireless communications, this antenna can be used.

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