

5.8 GHz Semi Slotted Patch Antennas For ISM Band Applications

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Abstract - A semicircular slotted microstrip patch antenna with a rectangular shape is designed which is desirable for ISM band applications. Achieving low loss and essential gain is the main intention of this antenna. Its resonant frequency of is 5.8 GHz which is under ISM band. We basically fabricate three antennas. On a RT/Duroid substrate a single patch antenna, 2x1 and 2x2 arrays are plotted with a relative permittivity of 2.2. We are using IE3D software for designing the antennas. The antennas designed at 5.8 GHz gives the outcome of return loss as -13.9 dB, -19.5 dB and -39 dB, gain as 4.1 dB, 7.2 dB and 8.2 dB, VSWR as 1.01, 1.08 and 1.1 respectively. The applications may include W-LAN, Bluetooth, etc .

Key Words: Patch antenna, ISM Band, IE3D.

1. INTRODUCTION

Antennas nowadays have become a pivotal constituent for wireless communication technology. This promotes the extensive use of the antenna in the communication. It's become vitally important in day today life for applications such as mobile communication, radar, sensors and wireless local area network, etc. which exhibits the value of antenna in various wireless devices. Nowadays these antenna technologies are mostly used since its notable advantages like compact weight, volume and cost and also the ease in installation. The various applications of antennas are mobiles instruments, GPS, etc. The applications such as spacecraft and airborne make use of these antennas they have flat profile and are light.

1.1 Microstrip Antenna

Typically a microstrip antenna consists of three central elements which are; a substrate, an antenna patch and a ground below. The propound microstrip antenna consists of a semicircular slotted rectangular patch antenna. The substrate used for this antenna is RT/Duroid. The element

that radiates in antenna is basically the patch. The substrate height is customarily 0.287 mm. Since an antenna array is designed the efficiency will make up with the loss. The patch dimensions can be plotted in various shapes. Although, in most of the applications rectangular and circular shapes are primarily used.

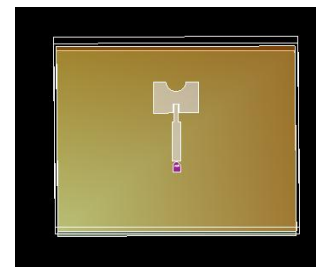


Fig -1: Patch Antenna.

The design of a patch antenna functions at the frequency at 5.8 GHz is presented in this paper. The input is given by the coaxial probe feed to the antenna. The objective of the design is that the antenna gives a less loss and appreciable gain and VSWR as well. So we can say that the expected antenna is productively eligible for ISM band applications since an antenna array is been designed.

2. ANTENNA DESCRIPTIONS

The equations of the design generally projects length and width of the patch, resonant frequency and dielectric constant. Given below;

$$W = \frac{c}{2f\sqrt{\epsilon_r - 1}} \quad (1)$$

Where, W=Width of the Patch, c= 3×108 m/s, f= Resonant frequency and ϵ_r = Dielectric constant.

$$L_{eff} = L + 2\Delta L \quad (2)$$

Where, L = Length of patch and L_{eff} = Effective Length

$$L_{eff} = \frac{L}{\sqrt{\epsilon_{eff}}} \tag{3}$$

Where, ϵ_{eff} = Effective Dielectric Constant

$$\Delta L = 0.142h \frac{(\epsilon_r + \epsilon_r)(\frac{W}{h}) + 0.264}{(\epsilon_r - 0.213)(\frac{W}{h}) + 0.49} \tag{4}$$

Where, h = Height of the Substrate

$$\epsilon_{eff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \frac{1}{\sqrt{1 + \frac{12h}{W}}} \tag{5}$$

Table 1 drafts the calculated parameters of the microstrip patch antenna.

Table -1: Enumerated antenna parameters

Parameters	Symbols	Values
Substrate Length	LS	83mm
Substrate Width	Ws	71mm
Length	Lp	15.73mm
Width	Wp	11.72mm
Substrate Height	h	0.287mm
Substrate Permittivity	RT/Duroid	2.2
Operating Band	ISM Band	5.8GHz
Radius Of Slot	r	3.4mm

2.1 Project Flow

The project flow chart of the strategy of the of the propound design is as shown in Figure 5. The antenna is further designed following the given steps.

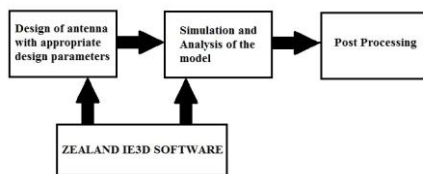


Fig -2: Project Flow of propound antenna.

3. SINGLE PATCH ANTENNA

The single patch rectangular antenna that operates at 5.8 GHz has been displayed in Figure 3. As can be seen, a patch that has “L” as length, “W” as width and the antenna is plotted on the substrate of height “h”.

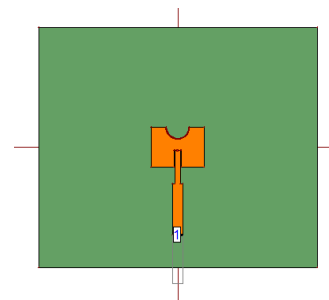


Fig -3: Design of the single patch antenna.

3.1 Return Loss of Antenna

The obtained results produced by the proposed patch with the use of the software IE3D gives the returned loss of -19.9 dB, VSWR of 1.01, and the total gain of 4.1 dB. The return loss is replicated in Figure 4.

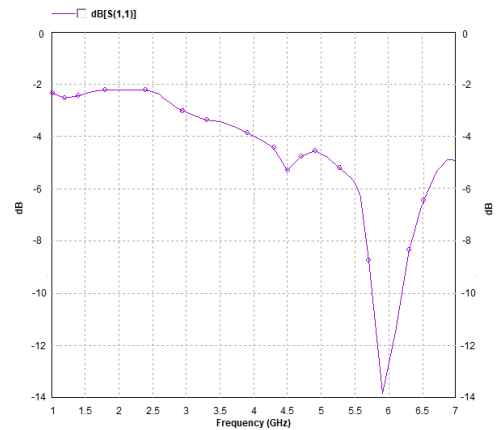


Fig -4: S11 of single patch antenna.

3.2 Gain of Antenna

Figure 5 defines the gain of the propound patch antenna.

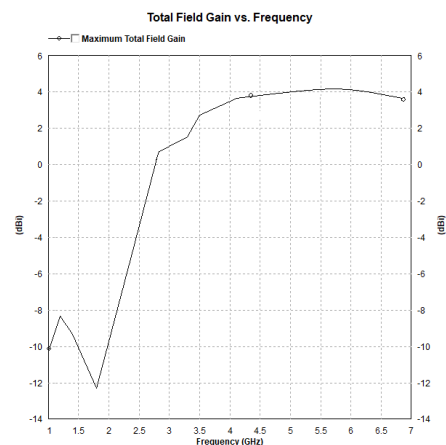


Fig -5: Gain of single patch antenna.

4. 2x1 ANTENNA ARRAY

An antenna of two elements of a rectangular patch antenna is designed. Two rectangular patch antennas are plotted on the FR4 substrate with same dimensions. The impedance fed as an input is 50 Ω. There should be spacing of which is virtually λ. Figure 6, shows the design of the antenna array 2x1. The relative techniques are here.

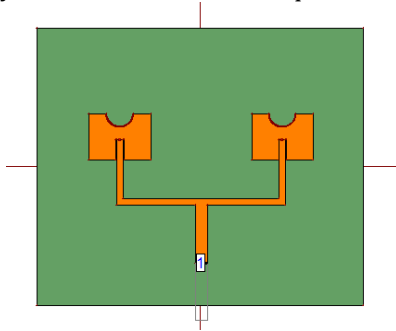


Fig -6: Design of 2x1 antenna array.

3.1 Return Loss of Antenna Array

The obtained results for the antenna array 2x1 give the return loss of -19.5 dB, VSWR of 1.08, and the total gain of 7.2 dB. The return loss is replicated in Figure 7.

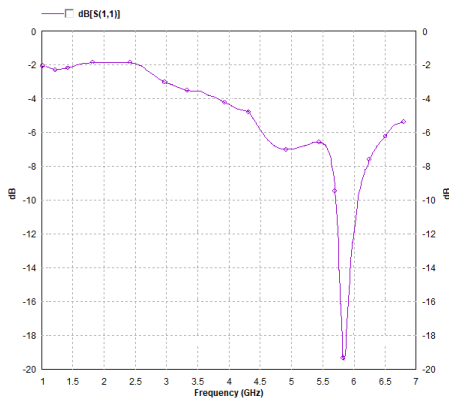


Fig -7: S11 of 2x1 antenna array.

3.2 Gain of Antenna Array

Figure 8 displays the gain of the propound antenna.

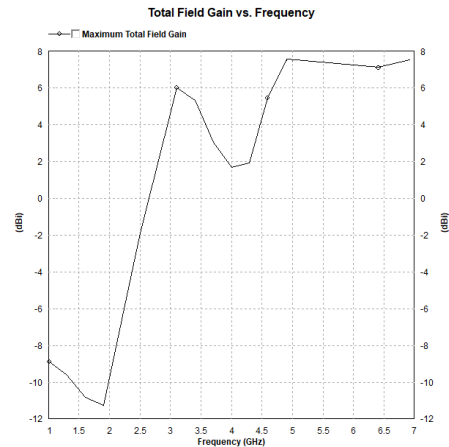


Fig -8: Gain of 2x1 antenna array.

4. 2x2 ANTENNA ARRAY

The design of the rectangular patch 2x2 is shown in Figure 9.

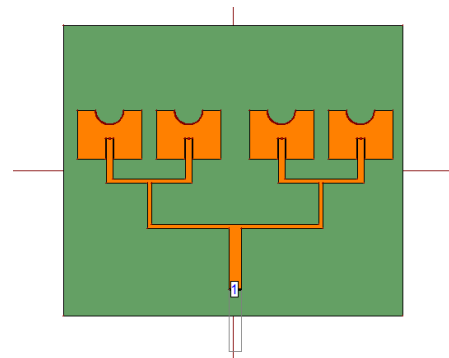


Fig -9: Design of 2x2 antenna array.

4.1 Return Loss of Antenna Array

This antenna gives the result of the return loss of -39 dB, VSWR of 1.1, and the total gain of 8.2 dB. The return loss is replicated in Figure 10.

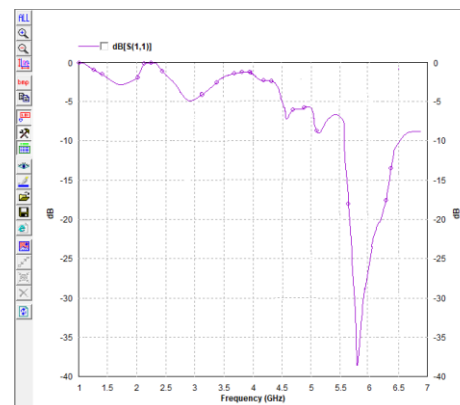


Fig -10: S11 of 2x2 antenna array.

4.2 Gain of Antenna Array

Figure 11 displays the gain of the propound antenna. The result portrays that the antenna operates at ISM band frequency with appreciable gain.

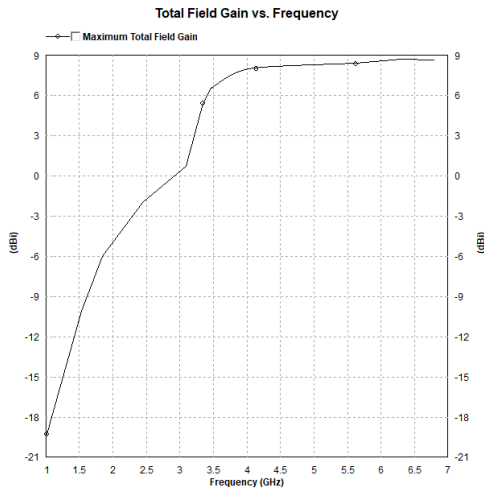


Fig -11: Gain of 2x2 antenna array.

5. RESULTS

The performance of each antennas is outlined in Table 2.

Table -2: Results

Antennas	Executions	Result
Single Patch	Return Loss	-13.9 dB
	Gain	4.1 dB
	VSWR	1.01
2x1 Array Antenna	Return Loss	-19.9 dB
	Gain	7.2 dB
	VSWR	1.08
2x1 Array Antenna	Return Loss	-39 dB
	Gain	8.2 dB
	VSWR	1.1

3. CONCLUSIONS

This project manifests the fabrication of antennas having resonant frequency of 5.8 GHz and is plotted on RT/Duroid substrate having 2.2 permittivity and 0.287 mm height. The antennas are suitable for Ism Band applications. The assessed results of single patch antenna that gives the return loss of -13.9 dB, total gain of 4.1 dB, -23 dB and VSWR of

1.01. The results of a 2x1 antenna array gives the return loss of -19.9 dB, total gain of 7.2 dB and VSWR of 1.08. Finally the results of a 2x2 antenna array gives the return loss of -39 dB, total gain of 8.2 dB and VSWR of 1.1. From the executed results we can say that the array antenna 2x2 is thoroughly productive as compared to other two designs. This antenna is allocated for the applications of ISM band such as WiFi, Bluetooth, wireless communication, etc

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