MATRIX ACADEMIC INTERNATIONAL ONLINE JOURNAL OF ENGINEERING AND TECHNOLOGY
ISSN: 2348-3326,
www.maioj.org © MAIOJET
Volume 3, Issue 2

Design a Reconfigurable Patch Antenna for Mobile Application

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***Abstract*— In this paper, a modified rectangular reconfigurable patch antenna with inset feed is analyzed and simulated for the Modern mobile communication Applications. The proposed antenna is simulated by applying CST Microwave Studio software and fed through strip line feeding. The overall size of the antenna is 48 mm × 38 mm × 1. 59 mm. The antenna has operated on two different resonant frequency bandwidth of 2.37 GHz and 2.45GHz for lower band of Wi-Max and Bluetooth band respectively. The simulated gain of the antenna in the obtained frequency range is close to 2.82 dBi and 3.11 dBi for OFF and ON respectively. Maximum radiations are directed normal to patch geometry and shape of patterns is somewhat similar to a dumble shape in the upper hemisphere. This Reconfigurable Patch antenna is specifically designed for the application of Mobile communication systems.**

***Keywords:-*Reconfigurable, Compact, Pin-diode, CST Microwave**

INTRODUCTION

A reconfigurable antenna can be considered as one of the key elements in future wireless communication transceivers. The benefits of using a reconfigurable antenna is the ability to operate in multiple bands where the total antenna volume can be reused thus enabling the overall size to be reduced. Devices using a single compact antenna allow reduction in the dimensions of the device and more space to integrate other electronic components.

In addition, reconfigurable antenna can be a cheaper alternative to traditional adaptive arrays or they can be incorporated into adaptive arrays to improve their performance by providing additional degrees of freedom. Microstrip Patch antenna played an important role in improving the performance and reducing the overall size of satellite devices looking inherent properties of patch antennas. Now a day antenna designers are modifying the conventional geometries, so that these may be applied in modern communication systems. It is realized that using a slot/slits in the patch geometry or modifications in substrate parameters improves the performance of antenna to a great extent but after reaching an optimum value, no feasible improvement in performance may be achieved. The Bluetooth technology provides short range of wireless connections between electronic devices like computer, mobile phones and many others thereby exchanging voice, data and video. The rapid increase in communication standards has led to great demand for antennas with low real estate, low profile and size, low cost of fabrication and ease of integration with feeding network. In recent times several single layer and rectangular geometry fed by microstrip line have been reported [6-8] which mainly resonate in higher frequency. In the present paper a compact reconfigurable patch antenna fed by strip line is designed. A conventional patch antenna is modified in several steps and radiation performances in each stage of modification are simulated using CST microwave studio simulation software.

ANTENNA DESIGN AND ANALYSIS

A rectangular microstrip antenna with patch length 28 mm and width 38 mm is considered on Glass epoxy FR-4 substrate having substrate relative permittivity 4.4, substrate height h = 1.59 mm and loss tangent 0.025. A microstrip feed line size of 13×3 is attached with this patch to feed this antenna and connected with a 50 ohm cable through SMA connector. The length and width of ground plane is 38 mm and 48 mm respectively. The front view and rear view of the basic antenna geometry are shown in Fig. 1(a) & 1(b) respectively. The simulation Process and analysis of antenna is carried out by applying CST Microwave Studio simulation software [5] by considering finite ground plane. The antenna resonates effectively at frequency 2.47GHz as shown in fig. 2. The bandwidth presented at this frequency is narrow (~2%) therefore considered antenna in its present form may not be applied in modern communication systems.

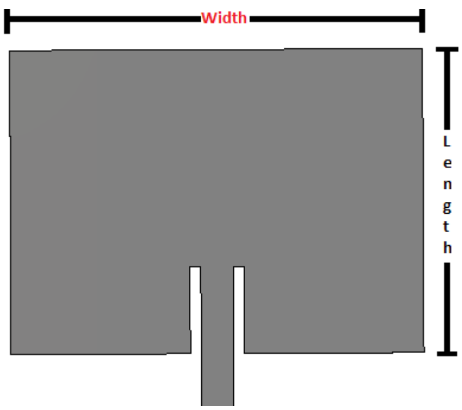
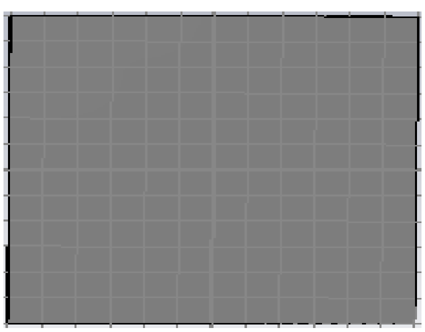


Fig.1 (a) Front view of designed



(b) Rear view of designed

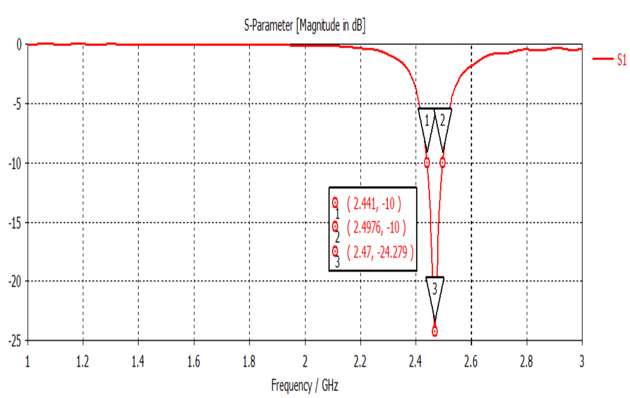


Fig. 2 Simulated variation of reflection coefficient with frequency

This antenna therefore modified in steps by using different slots on rectangular patch geometry without modification in finite ground plane. The modified rectangular geometry is introduced by one slot in next stage of modification. Further the geometry is simulated with each time of modifications.

DESIGN AND ANALYSIS OF RECONFIGURABLE ANTENNA

The finally adopted design details of this reconfigurable rectangular antenna are listed in Table -1. The size of ground plane and substrate is 38 mm × 48 mm as considered in previous case.All the parameters listed in table-1 are selected after extensive optimizations and front and rear views of finally designed antenna which are shown in Fig. 3(a) & 3 (b) respectively. With some modifications in the above patch geometry, the antenna's performance is further improved for lower band Wimax application for mobile communication. In this condition antenna resonant at single frequencies 2.37GHz, as shown in Fig.4. The gain of modified rectangular patch antenna is 2.82 dBi, as shown in fig 5. What we observe that the antenna is still suitable for application in modern mobile communication systems. In the next modification, we will design a reconfigurable antenna using Pin-diode for Bluetooth application.

Table.1 Dimensions of the proposed geometry

Length		28mm
Width		38mm
Slot	Length	16mm
	Width	0.3mm

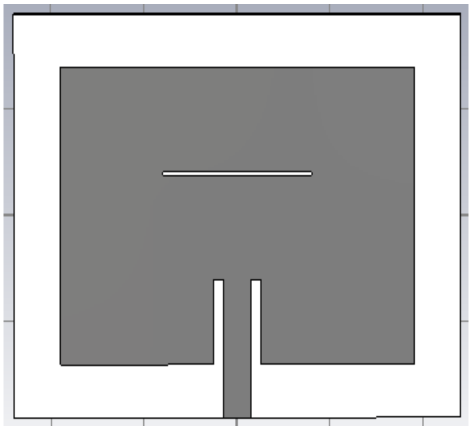
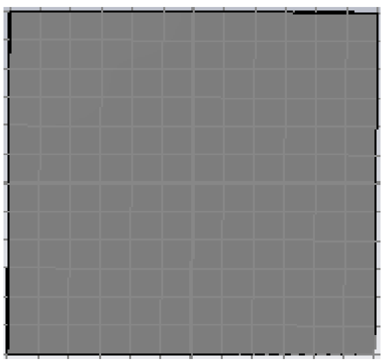


Fig.3 (a) Front view of Ring shape antenna



(b) Rear view of designed antenna

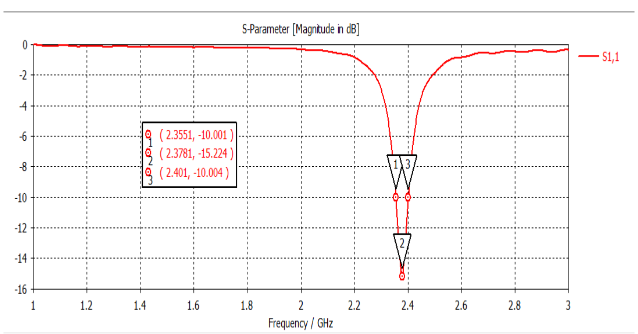


Fig. 4 Simulated variation of reflection coefficient with frequency at 2.37GHz rectangular antenna without PIN diode

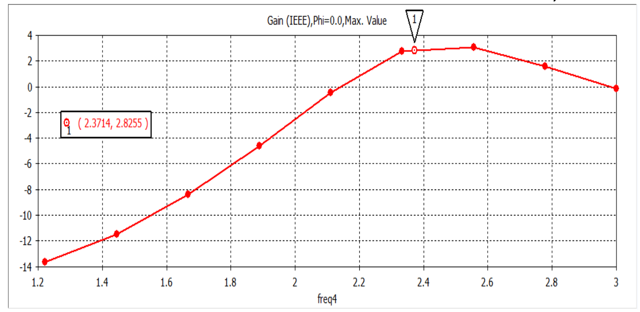


Fig. 5 Simulated variation of gain with frequency for modified rectangular antenna for downlink application

Hence in the next step, we considered the modified reconfigurable geometry using metal stub (Pin-diode). This modified reconfigurable microstrip antenna further re-simulated and optimized using CST simulation software. This modified patch geometry with metal stub is further simulated and optimized by CST simulation software with basic patch antenna geometry. The proposed antenna resonates at Bluetooth application for mobile communication. The impedance bandwidth closes to 5 % with respect to central frequency 2.45 GHz. The entire band (2.40GHz-2.48GHz) that is currently in use for Bluetooth application. The variation of gain of an antenna as a function of frequency shown in figure 7 given below. Gain of the antenna is 3.11 dBi at frequency 2.458GHz, which is maximum in this proposed antenna.

The E plane simulated far-field radiation patterns obtained at 2.45GHz are shown in Fig. 8. Maximum radiations are in the direction, normal to patch geometry and shape of patterns is somewhat similar to a dumble shape and semi hemispherical shape.

Length		28mm
Width		38mm
Slot	Length	16mm
	Width	0.3mm
Pin-diode Dimension	Length	0.3mm
	Width	0.3mm

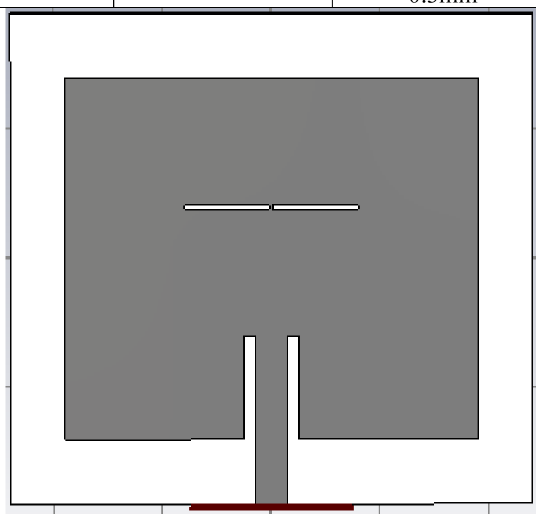


Fig.5 (a) Front view of Ring Shape

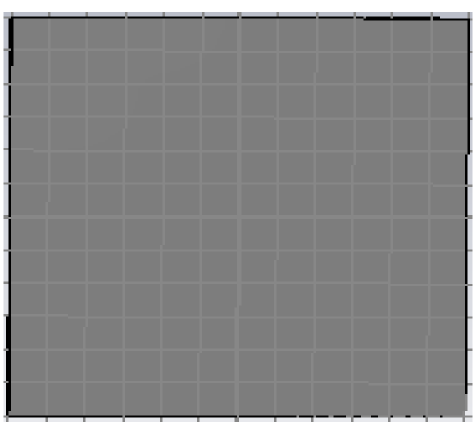


Fig.5 (b) Rear view of Modified Ground

Table.2 Dimensions of the proposed geometry

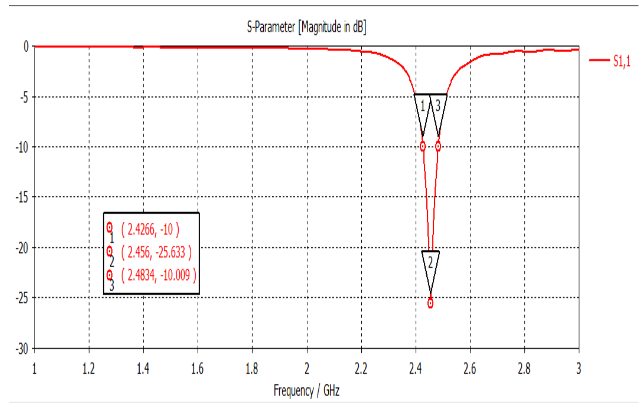


Fig. 6 Simulated variation of reflection coefficient with frequency for modified reconfigurable microstrip patch antenna

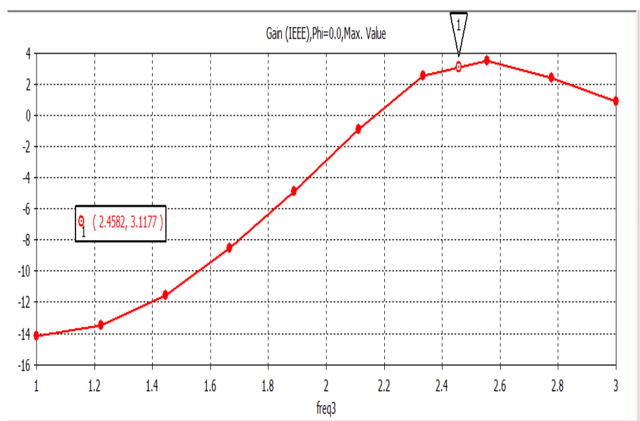
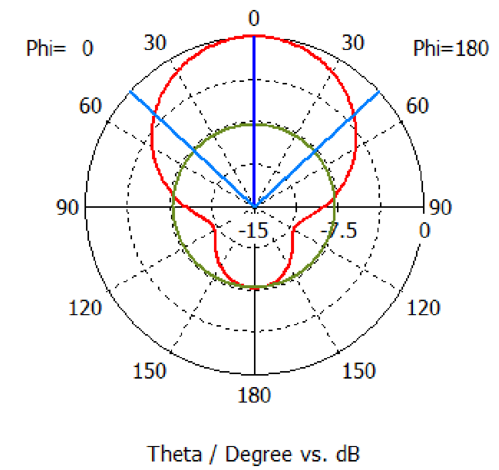
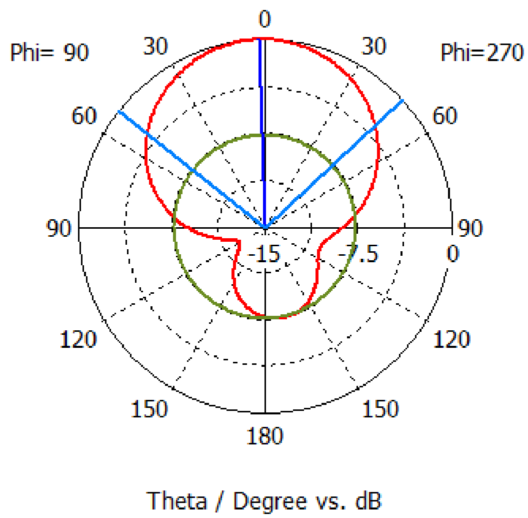


Fig. 7 Simulated variation of gain with frequency for modified reconfigurable antenna at 2.45GHz

In E plane simulated far-field radiation patterns obtained at frequency 2.45 GHz maximum radiations are in normal direction to patch geometry and shape of patterns is more or less similar to a dumble shape and semi hemispherical shape.



(a)



(b)

Fig. 8(a),(b) : E plane simulated far-field radiation patterns obtained at frequency 2.45GHz

Frequency = 2.45
Main lobe magnitude = 0 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 93.9 deg.
Side lobe level = -7.8 dB

CONCLUSION AND FUTURE WORK

This paper presents the design and performance of a reconfigurable rectangular patch antenna for mobile communication. The combined effect of modifications in patch geometry has significantly reconfigured the antenna operating frequency in two different operating band for mobile application. The antenna gain is 2.82 dBi at 2.37 GHz freuency and 3.11dBi at 2.45 GHz frequency application . This proposed antenna is suitable for mobile communication systems. This antenna can be used for Wi-max, Bluetooth application.

We can also improve or enhance the bandwidth of the proposed antenna in future to perform in a wider frequency band.

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