SERRATED EDGED MICROSTRIP PATCH ANTENNA USING N-SHAPED SLOT FOR WLAN/WiMAX/BLUETOOTH APPLICATIONS

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ABSTRACT

The present work illustrates the design of a square patch microstrip antenna with serrated edges and an N-shaped slot as an alternative solution to increase the narrow bandwidth of the conventional microstrip patch antenna. The proposed antenna provides an impedance bandwidth of 43.48% around the resonant frequency of 2.1 GHz and is applicable in Bluetooth, WLAN and WiMAX applications simultaneously. IE3D Zeland simulation software has been used for the simulation of the intended design.

***Keywords :* Bandwidth, IE3D, Microstrip Patch Antenna, Slot geometry.**

I INTRODUCTION

In recent times, micostrip patch antennas have become highly popular and have found wide applications in radar, satellite and mobile communications as they are light in weight, conformal shaped, cost-effective, highly efficient and can be easily integrated to circuits [1]. However, microstrip patch antennas suffer from some major limitations, especially very low impedance bandwidth of about 1-2% only.

During the last two to three decades, extensive research work has been carried out to improve the bandwidth of the microstrip patch antennas. These works include use of multiple resonators, use of low dielectric substrate, use of slot antenna geometry [2,3] and by increasing the thickness of the substrate. Use of slot antenna geometry has attracted the attention of many researchers. A V-shaped slot on a triangular patch antenna has been designed by Yogesh [4] with an impedance bandwidth of 9.2%. Garima [5] demonstrated that a circular patch antenna with a diamond shaped slot has a bandwidth of 13.58%. L.K.Singh [6] proposed a T-slot rectangular patch antenna with an impedance bandwidth of 25.23%. Anshika [7] designed a square patch antenna with modified edges and square fractal slots with a bandwidth of 30%. Various other techniques have been developed by researchers to improve the bandwidth of patch antennas, for instance, U-shaped slot in an equilateral triangular patch antenna [8] , U-slotted circular patch antenna [9], square-ring slot antenna [10] , a transmission line fed crescent patch antenna [11] , a narrow L-shaped slot in right triangular patch geometry [12] , inverted and noninverted V-shaped slotted trapezoidal patch antenna [13] and patch antennas with sierpinski and crown square fractal slots [14, 15].

In this paper, design of a probe-fed microstrip patch antenna is presented which can simultaneously be used for Wireless Local Area Network (WLAN) [16, 17], Worldwide Interoperability for Microwave Access (WiMAX) [18, 19] and Bluetooth applications [20, 21 ,22, 23]. The proposed antenna is a square patch antenna with serrated edges and an N-shaped slot with an impedance bandwidth of 43.48% at a resonant frequency of 2.1GHz.

II DESCRIPTION OF THE PROPOSED ANTENNA DESIGN

The basic configuration of the intended antenna design has been illustrated in Fig 1. This antenna has been designed on glass epoxy FR4 substrate with a dielectric constant of 4.4, substrate thickness of 1.6mm and loss tangent of 0.0013. The side length of the square patch is L_p=28mm and the finite ground plane has a side length L_g=50mm. An N-shaped slot has been cut in the centre of the square patch as shown in the figure. Portions of the edges of the square patch have been truncated to produce a serrated edged square patch. The antenna dimensions have been summarized in Table 1 and the other antenna parameters are given in Table 2 (length in mm and frequency in GHz).

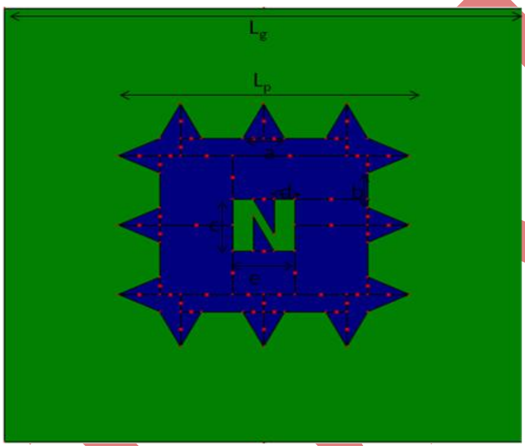

Fig.1 Geometry of the proposed microstrip antenna

Table1: Antenna Design Specifications

S. No.	Parameters	Value
1.	L_p	28
2.	L_g	50
3.	a	4
4.	b	4
5.	c	6
6.	d	2
7.	e	6

Table2: Antenna Parameters Specifications

S. No.	Parameters	Value
1.	Dielectric Constant	4.4
2.	Height of Substrate	1.6
3.	Loss Tangent	0.0013
4.	Maximum Frequency	3GHz

In this work, co-axial or probe feeding technique has been applied. In this feeding technique the inner conductor of the co-axial connector extends through the dielectric and is soldered to the radiating patch, whereas the outer conductor is connected to the ground plane. This technique has been used as in this method the feed can be placed at any point in the patch for impedance matching. IE3D simulation software [24] has been used to model and simulate this antenna. It has been used to calculate and plot return loss, smith chart, gain, VSWR, radiation pattern and various other parameters.

III ANTENNA CHARACTERISTICS

A microwave antenna can be characterized by various parameters such as a radiation pattern as a function of angle, VSWR, bandwidth, return loss, impedance, efficiency, gain and directivity. A radiation pattern is used to describe the manner in which electromagnetic energy is propagated in space as a function of angle. VSWR (Voltage Standing Wave Ratio) and impedance are used to determine the matching conditions for maximum power transfer. The resonance frequency of an antenna can be calculated using its return loss characteristics. Directivity of an antenna indicates how much an antenna radiates at specific angles i.e. it is a measure of how directional an antenna is. Gain of an antenna is defined as the directivity of the antenna excluding antenna losses and mismatch losses.

III RESULTS AND DISCUSSIONS

The simulation performance of the proposed microstrip patch antenna has been analyzed by using IE3D simulation software based on method of moments. Narrow bandwidth of microstrip patch antenna is one of the important features that restrict its wide usage. This antenna has been designed to improve the bandwidth of patch antennas. Fig 2 throws light on the variation of return loss with frequency. The proposed antenna has a bandwidth ranging from 1.8 to 2.8 GHz i.e. 43.48% around the resonant frequency of 2.1 GHz. Minimum return loss of -21.36 dB is available at resonant frequency.

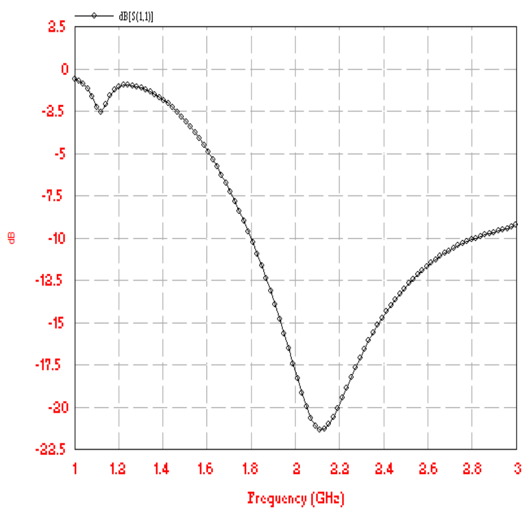

Fig.2 Return loss v/s frequency graph

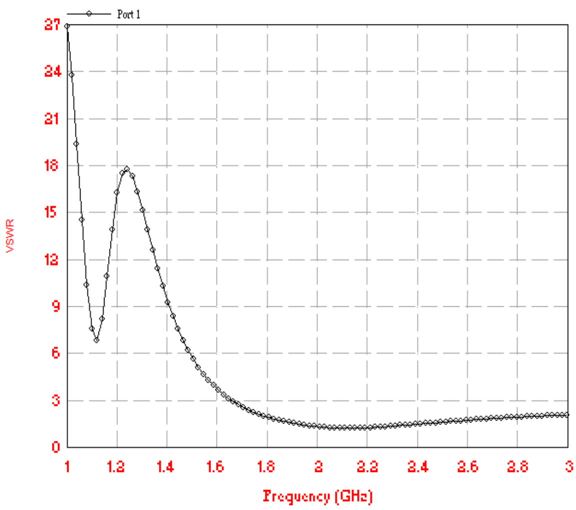

Fig.3 VSWR of the proposed antenna

Fig 3 shows the VSWR of the antenna. The intented antenna has a VSWR of 1.87 at 2.1GHz which shows good impedance matching.

Fig.4 illustrates the relationship between gain and frequency. The maximum gain of antenna has been improved upto 3.41dB.

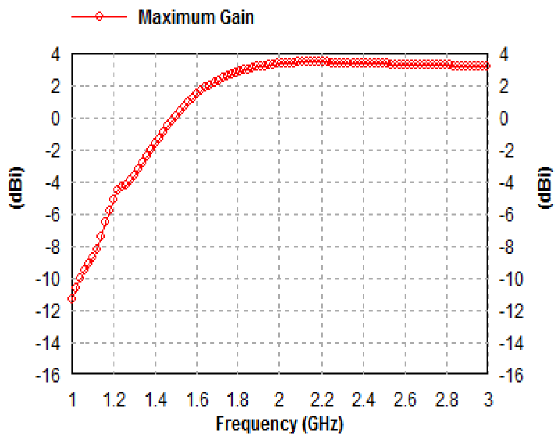

Fig.4 Gain vs. Frequency Plot.

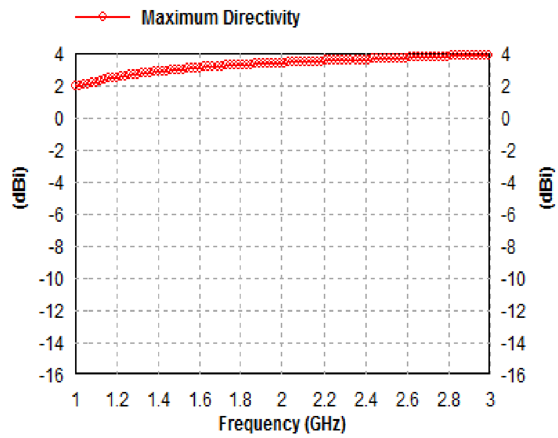

Fig.5 Gain vs. Frequency Plot.

Fig.5 demonstrates the relationship between directivity and frequency. This plot represents the ratio of radiation intensity of the antenna in a particular direction to the average value of the radiation intensities in all directions. This antenna is shown to have a maximum directivity of 3.44dB at resonant frequency.

Fig.6 shows the input impedance loci using smith chart.

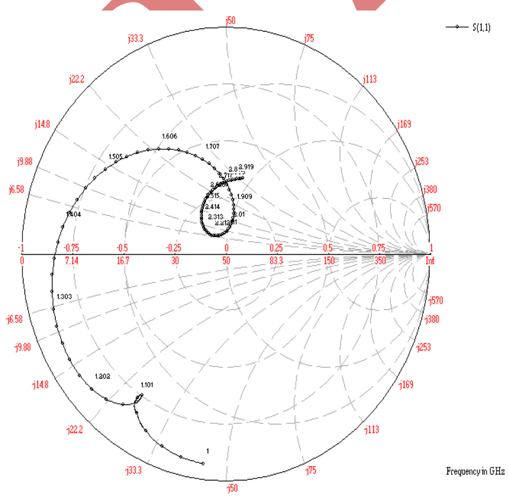

Fig.6. Smith chart of the proposed antenna.

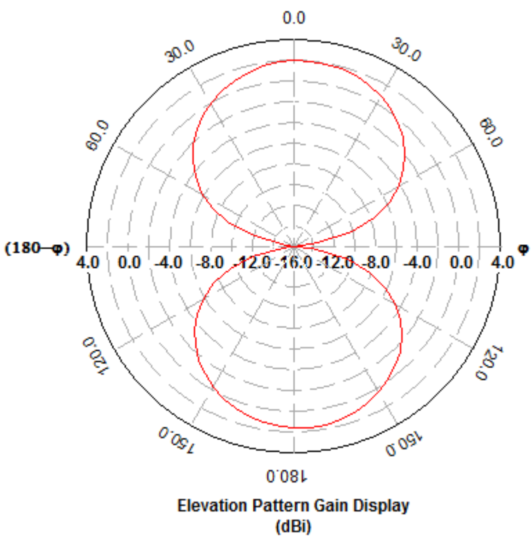

Fig.7 2D Radiation Pattern of Gain along phi

Fig.7 illustrates the 2D radiation pattern of the gain of the suggested antenna as a function of phi. The antenna can be said to be bidirectional as the radiation pattern shown in fig 7 contains two major lobes in opposite directions.

Fig.8 shows the 2D radiation pattern of gain as a function of theta. This pattern too is bidirectional in nature.

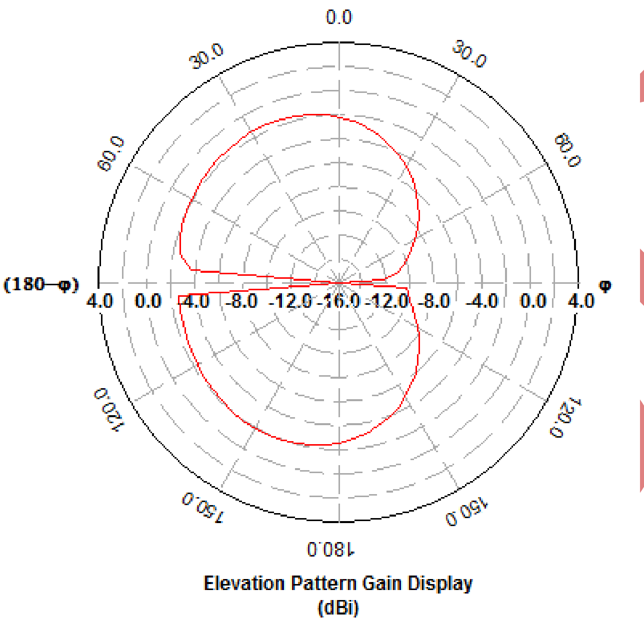

Fig.8 2D Radiation Pattern of Gain along theta

III CONCLUSION

In this paper a serrated edged microstrip square patch antenna with an N-shaped slot has been designed for simultaneous use in Bluetooth (2.4-2.48 GHz) , WLAN (2.4 GHz) and WiMAX (2.3 GHz , 2.5 GHz) applications . The proposed antenna has an impedance bandwidth of 43.48%, VSWR of 1.87, radiation efficiency of 99.9%, antenna efficiency of 99.17%, gain of 3.41dB and directivity of 3.44dB, which are notable results.

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