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# Compact Microstrip Octagonal Slot Antenna for Wireless Communication Applications

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**Abstract:** In this modern world, wireless communication has been developed rapidly and widely. The field of wireless communication is growing at a very fast rate covering different technical areas such as WLAN, Wi-MAX and Bluetooth. For wireless communication application efficient and small antennas are required. In this paper design of a compact size Microstrip line feed single slot dual band antenna is proposed. Microstrip antennas are suitable for Microwave and Millimetre wave Integrated Circuits (MMIC) and less expensive to fabricate using modern day printed board technologies. The antenna is composed of an octagonal slot on the bottom plane and one side of this octagon is modified into a half octagon. CST Microwave Studio is used for the simulation. The simulation results of the antenna shows that the designed antenna is capable of operating over the two bands 2260 MHz - 2580 GHz and 3970 - 6880 GHz. The dimension of the antenna is only 25 X 25 X 1.6 mm³. Moreover, antenna have nearly omnidirectional radiation pattern and 2.87 dB gain obtained in the second band of this antenna. The proposed Microstrip single slot antenna is suitable for operating Bluetooth, WiMAX (2.5/5.5 GHZ) and WLAN (2.4/5.2/5.8 GHz) applications.

**Keywords:** Microstrip, Omnidirectional, Wi-MAX, WLAN.

## I. INTRODUCTION

In today's environment, technologies demand antennas for operating on distinct wireless bands. A better performing antenna should have lot of characteristics such as allowable weight, low cost, low profile and having the ability to retaining better performance over a large spectrum of frequencies. Wireless local area network and Worldwide Interoperability for Microwave Access are the two most developing areas in the modern wireless communication. We require an efficient and optionally smaller antenna for wider reach ability. Therefore portable technology of antenna has developed along with mobile and cellular technologies. Also a best performing antenna will decrease power consumption, last longer, improve transmission, reception, and marketability of the communication device. Several designs are proposed for the design of dual band Microstrip antennas. Microstrip patch antenna, Slot antenna, Dipole antenna and Monopole antennas are different types of microstrip antennas. There are many antenna systems with different elements using different techniques to solve the various problems inherent to the antenna. The printed dipole antenna [1] has low bandwidth requirements. Large size is the limitation of Modified Coplanar Waveguide Fed (CPW) monopole antenna [2]. Small dual band CPW fed monopole antenna [3] does not cover the whole frequency band of WLAN. Different slots are used in the design of meandering slot antennas [6].

Microstrip single slot antenna is presented in this paper for WLAN, WiMAX and Bluetooth applications. Antenna consist of octagonal slot is on the ground plane. One side of this octagon is converted into half octagon. Simulations are carried out using CST Microwave Studio shows that the proposed antenna is competitive candidate for wireless communication applications.

## II. ANTENNA DESIGN

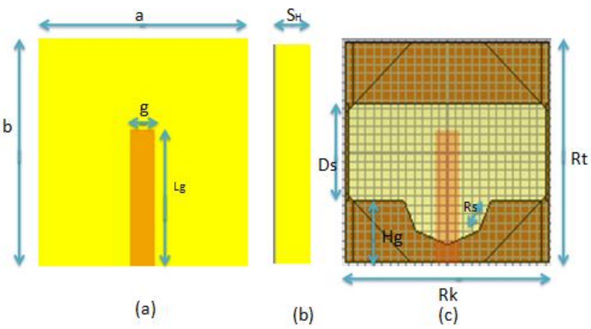


Fig 1. Modified slot Antenna (a) Top view (b) Side view (c) Bottom view

Schematic configuration of the proposed antenna is shown in Fig. 1. FR4 substrate is used for designing the antenna. This substrate having a thickness of 1.6 mm and relative permittivity 4.4. In order to optimize the antenna dimensions, simulations are carried out using CST Microwave studio. Thus the total dimension of the antenna has small size of 25 X 25 X 1.6 mm³. Design length of this antenna is calculated using this equation 1.

$$Length = \frac{\lambda p}{4} = \frac{c}{4 f_r \sqrt{\varepsilon}} \qquad (1)$$

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where $f_r$ is the resonant frequency, c is the speed of light in vacuum, and $\varepsilon_r$ is the relative permittivity of the substrate. In case of the octagonal slot antenna, the resonate length determines the resonate frequency. Table 1 shows the values of the optimized parameters for the design of proposed antenna.

TABLE I DESIGN PARAMETERS OF THE PROPOSED ANTENNA

| Parameter | Dimensions(mm) |
|---|---|
| a | 25 |
| b | 25 |
| G | 3 |
| Lg | 15 |
| SH | 1.6 |
| Ds | 14 |
| Rs | 4.21 |
| Hg | 7 |
| Rk | 5.5 |
| Rt | 25 |

A. Design Evolution of the Antenna

Fig. 2 shows the design procedure of the antenna. Antenna 1 starts with octagonal slot are etched on the ground plane of the substrate. This simple design can obtain bandwidth ranging from 2260-2580 MHz, which covers the 2.4 GHz WLAN application. In order to excite another 6.00 GHz resonant mode, one side of this octagonal slot is modified in to half octagon in Antenna 4. The corresponding -10 dB return loss bandwidth 3970-6880 MHz as plotted in Fig.6. This bandwidth is sufficient for the standard of WLAN in the 5.2 GHz band and 5.8 GHz band.

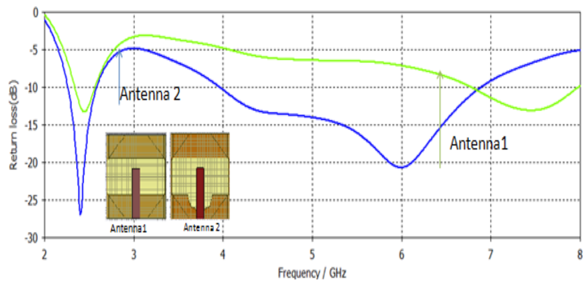


Fig. 2. Design evolution of the antenna

B. Effect of Geometrical Parameters

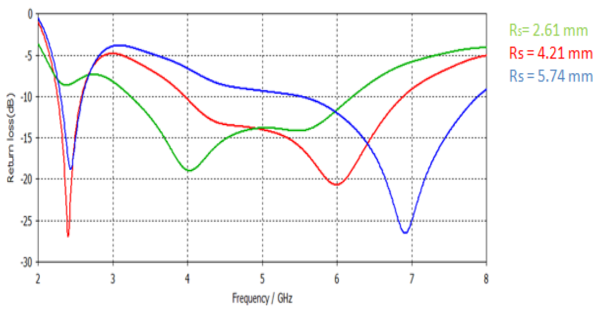


Fig 3. Effect of Rs variation on Return loss

The Fig. 3 shows the variation of return loss on various Rs values where Rs is the length of octagon. For lower value of Rs, single band is obtained. The value of Rs = 4.21 mm gives the optimized result which gives by red colour in Fig. 3.

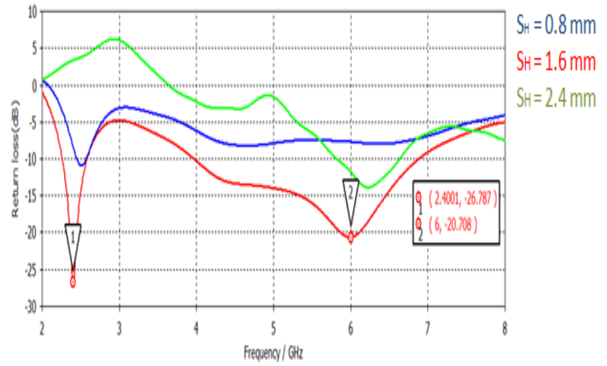


Fig. 4. Effect of $S_H$ variation on Return loss

The Fig. 4 shows the variation of return loss on various values of substrate height $S_H$. At lower value and higher value of $S_H$, there is single band obtained. The value of $S_H$ = 1.6 gives good return loss in both first and second band and is considered as the optimal value is shown by red colour in the Fig. 4.

## III. RESULTS AND DISCUSSIONS

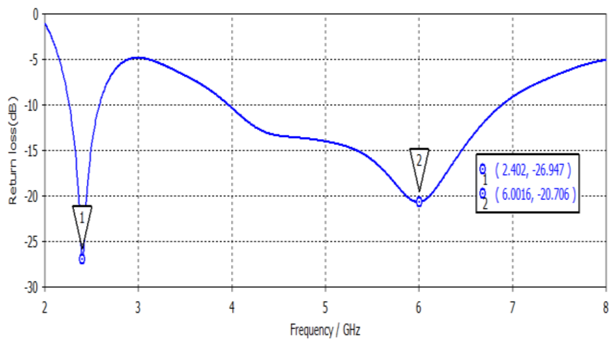


Fig. 5. Return loss

Fig.5 shows the simulated return loss versus frequency plot. The proposed Microstrip slot antenna resonates at 2.4 GHz and 6.00 GHz. The return loss for 2.4 GHz is -26.94 dB and the return loss for 6.00 GHz is -20.706 dB which covers the minimum required value of return loss of -10 dB. The bandwidth of the proposed slot antenna is 320 MHz (2.26 GHz - 2.58 GHz) for 2.4 GHz and 900 MHz (3.97 - 6.88 GHz) for 6.0 GHz.

Radiation pattern is defined as the directional dependence of the strength of radio waves from the antenna. It is the representation of the radiation properties of the antenna as a function of space coordinates and describes the normalized field values with respect to the maximum values. Three types of radiation patterns are omnidirectional, directional and isotropical. Fig. 6 shows the radiation patterns in three dimensional at 2.4 GHz and

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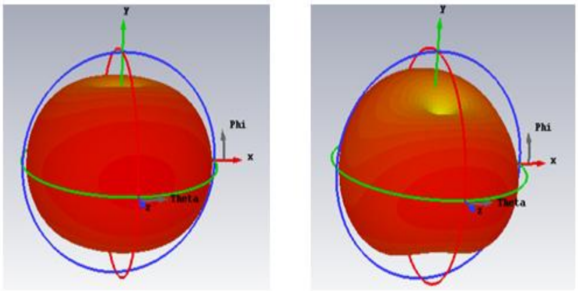
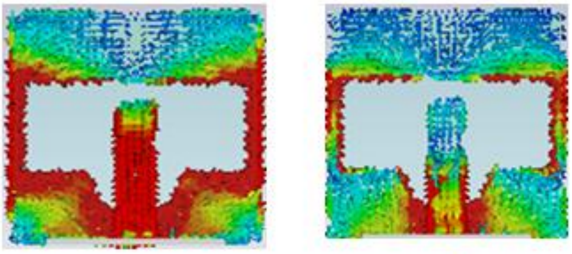
6.00 GHz. Both radiation patterns are nearly omnidirectional.



(a) (b)

Fig. 6. Radiation pattern at (a) 2.4 GHz and (b) 6.00 GHz



(a) (b)

Fig .7. Surface current distribution at (a) 2.4 GHz and (b) 6.00 GHz

The surface current distributions at 2.4 GHz and 6.00 GHz frequencies are illustrated in Fig. 7.

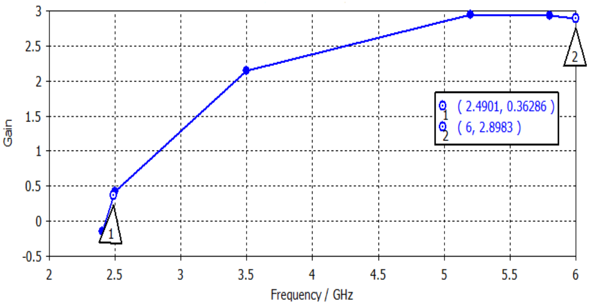



Fig. 8. Gain of the proposed antenna

The average gain of proposed antenna for frequencies 2.4 GHz and 6.00 GHz is shown in Fig. 8. The gain of the antenna is defined as the capability to concentrate energy through a direction to give a better picture of the radiation performance. The value of antenna gain at the lower frequency 2.4 GHz is about 0.36 dB and at 6.00 GHz is 2.89 dB.

Table-2 shows the parameters of the antenna. Center frequencies for the antenna are 2.4 GHz and 6.00 GHz and -26.9 GHz and -20.7 return loss are obtained over the two operating bands. Antenna has better gain of 0.36 dB and 2.89 dB are obtained. Bandwidth obtained for the antennas are 320 MHz and 2910 MHz. Voltage standing wave ratio less than two achieved for two operating frequencies 2.4 GHz and 6.00 GHz.

TABLE IIIII DESIGN PARAMETERS OF THE PROPOSED ANTENNA

| Parameters | First Band | Second Band |
|---|---|---|
| Frequency Range(MHz) | 2260 - 2580 | 3970 – 6880 |
| Return loss(dB) | -26.9 | -20.7 |
| Band width(MHz) | 320 | 2910 |
| Gain(dB) | 0.36 | 2.89 |
| Center frequency (GHz) | 2.4 | 6.00 |

## IV. CONCLUSION

The proposed antenna has small size and good return loss. The bandwidth and the position of the bands can be controlled easily, which makes the antenna useful for most of the wireless communication applications. By employing half octagonal on one side of the octagon antenna have good dual band operation over the two operating bands 2260 - 2580 MHz and 397-6880 GHz can be obtained. Hence the antenna is suitable for operating WLAN (2.4/5.2/5.8 GHz), and Wi-MAX (2.5/5.5 GHz), Bluetooth. Moreover, antenna has nearly omnidirectional radiation patterns and better gain.

## REFERENCES

[1] Chih-Ming Su, Hong-Twu Chen and Kin-Lu Wong, "Printed Dual-band Dipole Antenna with U-Slotted Arms for 2.4/5.2 GHz WLAN Operation." Electronics Letters, Vol. 38 No. 22.pp.1308-1309, 2002.
[2] D. Laila, R. Sujith, C. M. Nijas, C. K. Aanandan, K. Vasudevan, P. Mohanan,``Modified CPW fed Monopole Antenna with Suitable Radiation Pattern for Mobile Handset",Microwave Review, 2011.
[3] M. Naser-Moghadasi, R. Sadeghzadeh, L. Asadpor, and B. S. Virdee, ``A Small Dual-Band CPW-Fed Monopole Antenna for GSM and WLAN Applications." IEEE Antennas and Wireless Propag.Lett. VOL. 12, pp.508-512, 2013.
[4] Zhang, X. M. Zhang, J. S. Liu, Q. F. Wu, T. Ying and H. Jin, "Dual-band Bidirectional High Gain Antenna for WLAN 2.4/5.8 GHz Applications", Electronics Letters, Vol.4 ,2009.
[5] C. A Balanis `Antenna Theory," New York, NY, USA:Wiley 2002.
[6] C. P. Hsieh, T. C. Chiu, and C. H. Lai, "Compact dual-band Slot Antenna at the Corner of the Ground Plane," IEEE Trans. Antennas Propag., vol. 57, no. 10, pp. 3423–3426, Oct. 2009.
[7] C.-Y. Huang and E.-Z. Yu, "A Slot Monopole Antenna for Dual-band WLAN Applications," IEEE Antennas Wireless Propag. Lett., vol. 10, pp. 500–502, 2011.
[8] J. W. Wu, "2.4/5 GHz Dual band Triangular Slot Antenna with Compact Operation," Microw. Opt. Technol. Lett., vol. 45, pp. 81–84, 2005.
[9] G. Augustin, S. V. Shynu, P. Mohanan, C. K. Aanandan, and K. Vasudevan, Compact Dual-band Antenna for Wireless access point," Electron. Lett., vol. 42, pp. 502–503, 2006.
[10] W.-C. Liu and C.-F. Hsu, "Dual-band CPW-fed Y-shaped Monopole Antenna for PCS/WLAN Application," Electron. Lett., vol. 41, pp.390–391, 2005.
[11] G. Augustin, P. C. Bybi, V. P. Sarin, P. Mohanan, C. K. Aanandan, and K. Vasudevan, "A Compact Dual-band Planar Antenna for DCS-1900/ PCS/PHS, WCDMA/IMT-2000, and WLAN Applications," IEEE Antennas Wireless Propag. Lett., vol. 7, pp. 108–111, 2008.
[12] M. Veysi, M. Kamyab, and A. Jafargholi, "Single-Feed Dual-band Duallinearly-Polarized Proximity Coupled Patch Antenna," IEEE Antennas Propag. Mag., vol. 53, no. 1, pp. 90–96, Feb. 2011.