International Journal of Applied Engineering Research ISSN 0973-4562 Volume 15, Number 5 (2020) pp. 487-491
© Research India Publications. http://www.ripublication.com

Slotted T-Shaped Microstrip Antenna for Wireless Applications

Dr.N.Kanagasaba[1]
Assistant Professor
Department of Electronics and Instrumentation and Engineering,
Annamalai University, Annamalainagar, Tamilnadu, India.

Abstract

High gain antennas are best for covering long distance communications applications. This paper describes a triple band T-shaped microstrip patch antenna for WIMAX, WILAN applications. The antenna is printed on a FR-4 substrate, and has the dimensions of 60mm×70mm×1.6mm with a ground plane.The triple band operation is obtained by designing a T-shapped antenna and introducing slots on it.This proposed antenna is simulated using a HFSS version 19.The simulated results shown the proposed T-shaped antenna achieves a frequency ranges of 3GHz,5.17GHz,5.38GHz. Return loss for it is less than -15dB.So maximum gain obtained with these values is 1.49, 6.17, 4.37 dB respectively. This antenna satisfies the requirements of Wireless local area network (in the frequency range of 5.17GHz to 5.38GHz)and WiMAX(in the frequency range of 3GHz).VSWR ratio is of 2:1.the return loss, radiation pattern, voltage standing wave ratio(VSWR),gain and critical design parameters are investigated in detail. Presented antenna is a good solution for triple band WLAN and WiMax applications.

Keywords- microstrip patch antenna, T-shaped patch, triple band, WLAN, WiMax, HFSS.

1. INTRODUCTION

WiMax (Worldwide interoperability for microwave Access) is a family of wireless broadband communication standards based on IEEE 80-7.16 set of standards [1]. It provides multiple physical layer and media access control (MAC) options. It was initially designed to provide 30 to 40 megabit-per second data rates [2], portable mobile connectivity, and digital subscriber for last mile broadband access, data [3], telecommunications and IPTV services.

WLAN (Wireless Local Area Network) is one of the most widely used technologies in the world. It is recognised as a reliable and cost effective solution for high speed data connectivity. The WLAN working at IEEE 802.11a employs higher bandwidths at the range of 5.17 GHz and 5.38GHz.It is usually used in business networks. Now-a-days dual band/wide band antenna is a key component for communication systems [4]-[10], especially for "universal" applications, where it should be covering 5.17 GHz and 5.38 GHz for dual WLAN band. such dual-band antennas with single feed have been proposed in various configurations[4],[6],[7],[8],[10].Larger return loss indicates higher power being radiated by antenna which increases the gain[11].the proposed antenna is etched to the cable impedance ,where the reflection is |Γ|=0.this means all power is transmitted in antenna and there is no reflection[12].The optimal VSWR value is 1.The designed low profile antenna is suitable for long range communications or point to point communications devices running on a battery. In this letter a single fed triple band antenna covering IEEE 802.11a for WLAN and WiMax applications having gains of 1.49, 6.17 and 4.37dB is presented in this paper. This antenna is suitable for high gain applications.

2. ANTENNA DESIGN

The implemented antenna dimensions of ground plane are 70x60mm. It is fabricated on FR4 substrate of dimensions 70x60mm with a dielectric constant 4.4 and substrate thickness 1.6mm. The antenna is T-shaped; it consists of two horizontal rectangular arms with dimensions 12x24mm. We have created slots to the arms of T-shaped antenna to improve gain and achieve a triple band antenna. The right horizontal arm consists of two kinds of slots, the deeper slots measurement is 1.5x4mm and the narrow slots measurement is 1.5x1mm. The left horizontal arm consists of 1x2mm slots. The vertical strips are separated by 2mm. The right and left vertical strips are of size 38x4mm. The vertical slots are 1x1.5mm. A patch of 5x10×0.05mm is attached to vertical strips.

3. DESIGN PROCEDURE

Step-1: Create a ground with a size of 60 ×70mm and substrate with thickness of 1.6mm and size of 60×70mm

Step-2: Create a rectangular patch for the resonant frequency f_r =3 GHz with the below design equations

1 . Width of the antenna is given by

$$W=\frac{1}{2}\frac{c}{f_r}\sqrt{\frac{2}{\varepsilon_{r+1}}} \quad (1)$$

Where c is the velocity of the light c=3×10^8m/sec

f_r is the resonant frequency of the antenna

2. Effective dielectric constant is determined as

$$E_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left\{\frac{1}{\sqrt{1+\frac{2h}{w}}}\right\} \quad (2)$$

Where" h" is the height of the substrate

3. Effective length is specified at the resonant frequency and is given by

$$L_{eff} = \frac{c}{2f_r\sqrt{E_{eff}}} \quad (3)$$

4. Extension length is given by

$$\Delta L = h*0.2*\frac{(E_{eff}+0.3)+(\frac{w}{h}+0.264)}{(E_{eff}-0.258)(\frac{w}{h}+0.8)} \quad (4)$$

5. The length (L) of the antenna is calculated as

$$L = L_{eff} - 2\Delta L$$

Step-3: Modification of T-shapped patch by introducing slots across the patch of length 1×1.5mm.provide feed to the patch using microstrip feed line.

Step-4: Assign boundaries and radiation to the setup.Allot the sweep and frequency range.

Step-5: Validate the setup and observe the results.

The dimensions in the given fig are for achieving triple band antenna for WLAN and WiMax applications. The dual L-slots are located symmetrically the centre line of patch.

Table 1: The dimensions of the designed antenna are as follows:

Parameter	Dimensions(mm)
Length(L)	70
Width(W)	60
Thickness	1.6
Gap between vertical strips	2
Left and right horizontal arm's width(PW1)	24
Left and right horizontal arm's length(PL1)	12
Vertical strip's length(PL2)	38
Verticalstrip'sbreadth(PW2)	4
Width of attached patch(PW3)	10

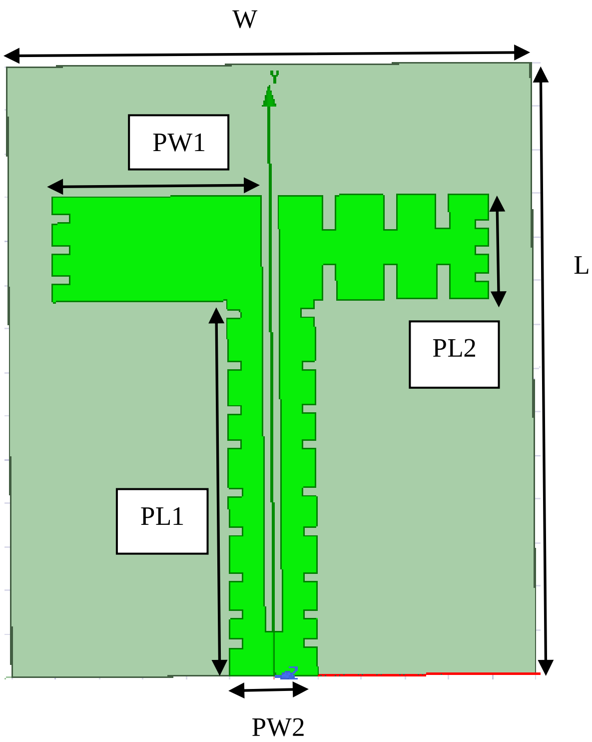

Fig.1: Front view of proposed antenna structure

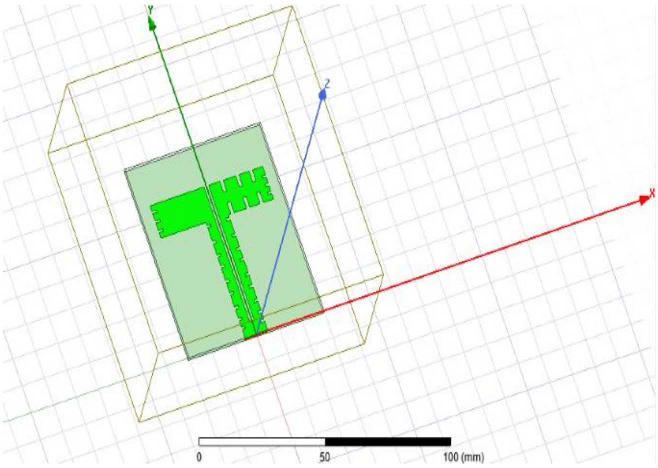

Fig. 2: Final view of proposed antenna with air box

3. SIMULATED RESULTS AND DISCUSSION

The simulation is carried out in HFSS software. Results are obtained after analysing and validating the design. In this section simulated frequency responses of VSWR, radiation patterns and peak gains of proposed antenna are presented. Fig 3 shows simulated return loss (S11) of proposed antenna. S11 represents how much power is reflected from the antenna. If S11=0dB it shows that all power is reflected from the antenna and nothing is radiated. The simulated results of the proposed antenna have three resonant frequencies. The resonant frequency of lower band located at 3GHz with the -16dB. The next band has resonance frequency located at 5.17GHz with -23dB and the other band has resonance frequency located at -31dB. The final design chosen from the optimisation of patch dimensions as the return loss illustrates that largest value -23.42dB, at resonant frequency 5.17GHz and -31.72dB at resonant frequency 5.38GHz. Larger return loss indicates higher power gain radiated by antenna which eventually increases the gain. This shows that three desired operating frequencies are excited successfully and can meet the bandwidth requirement of 3GHz, 5.17GHz, and 5.38GHz for WLAN and WiMax applications.

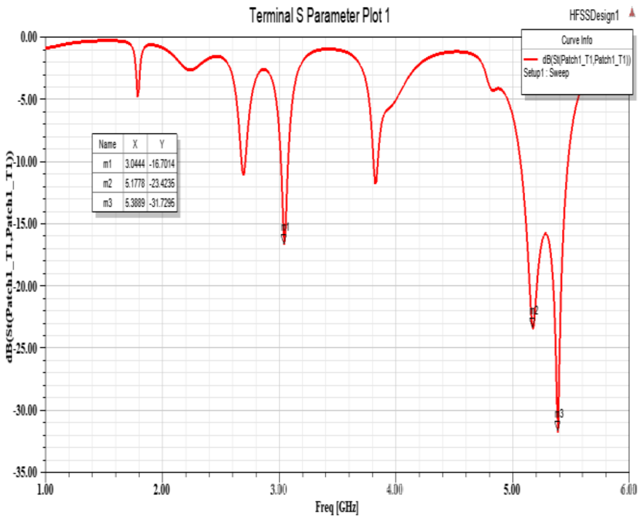

Fig.3: Simulated Return loss(S11) for the triple band antenna

B. Voltage Standing Wave Ratio

The simulation result of voltage standing wave ratio is shown in fig10.VSWR is an important specification for all microwave devices. It measures how well an antenna is matched to the cable impedance where the reflection |┌|=0.this means all power is transmitted to antenna and there is no reflection. The optimal VSWR is 1.by referring to fig10, at operating frequency 3 GHz, the VSWR value is 1.38 and at second operating frequency 5.17 GHz the VSWR value is 1.14 and at third operating frequency 5.38 GHz the VSWR value is 1.18 respectively. The proposed triple band antenna could provide sufficiently wide impedance bandwidth VSWR<2 covering WLAN and WiMax applications. Fig.10 shows simulated results of VSWR versus frequency of the proposed antenna. It shows that the antenna is near to perfect matching.

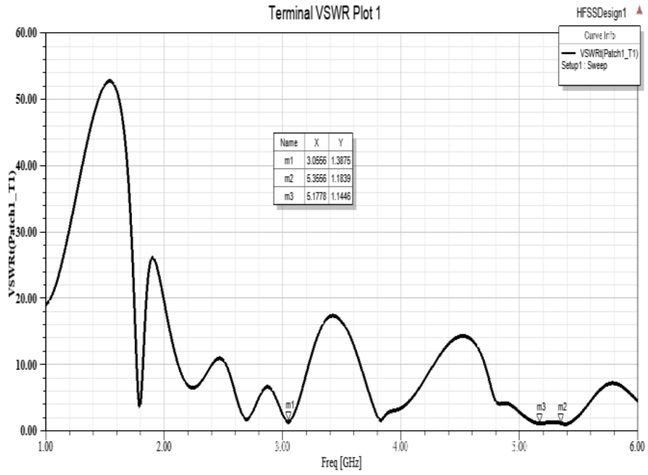

Fig.4: Simulated VSWR for the proposed antenna.

C. **Impedance:**

In distributed impedance matching method, antenna can be matched by doing structural modifications. An impedance mismatch in RF network can cause power to be reflect back from source to mismatch boundary. The ideal impedance of the circuit is 50Ω.

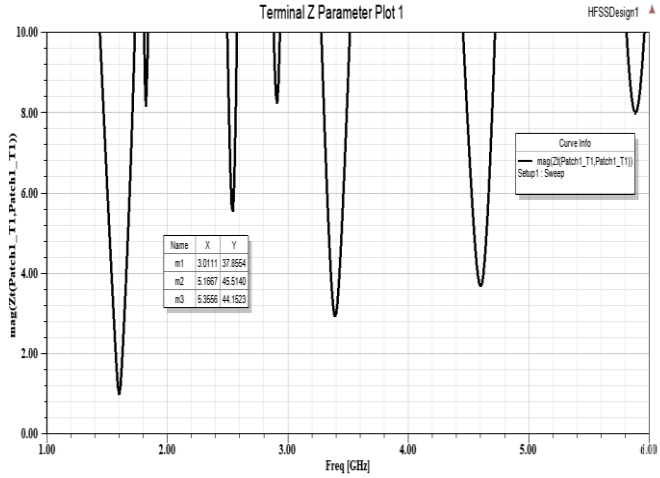

Fig.5: Simulated impedance plot for the proposed antenna

4. GAIN

In the 3 GHz band, the peak gain is 1.49Ghz.At 5.17 GHz band, the peak gain is 6.17GHz and at 5.38 GHz the peak gain is 4.37GHzThe high gain at these frequencies can completely meet the requirements of Long distance wireless communications.

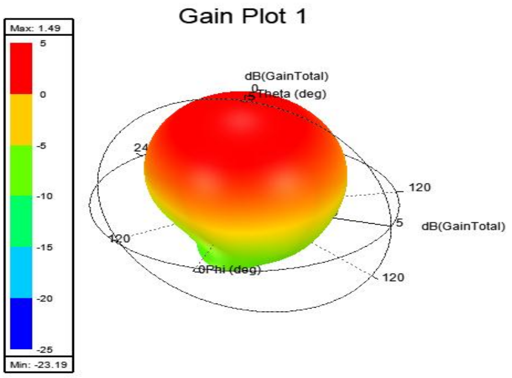

Fig. 6: 3D Radiation pattern of patch antenna at 3GHz

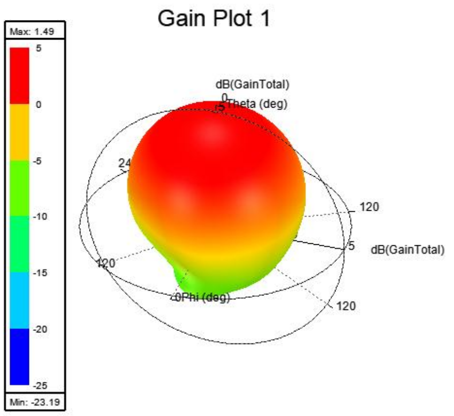

Fig.7: 3D Radiation pattern of the patch antenna at 5.17GHz

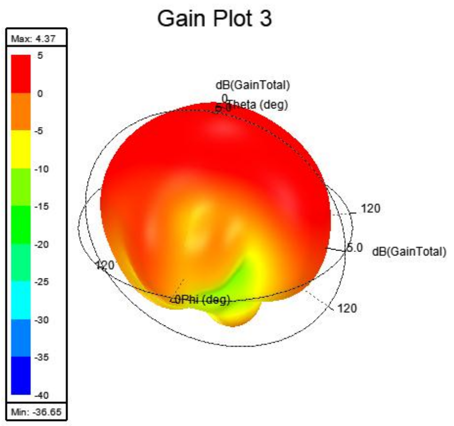

Fig.8: 3D Radiation pattern of the antenna at 5.38GHz

A. Radiation pattern characteristics

The simulated far field patterns of the proposed triple band microstrip antenna are shown in fig4, 5, 6.

The 2D radiation plots plotted below for frequencies 3 GHz, 5.17 GHz, 5.38 GHz shown below are nearly seen that the power is Omni- directional.

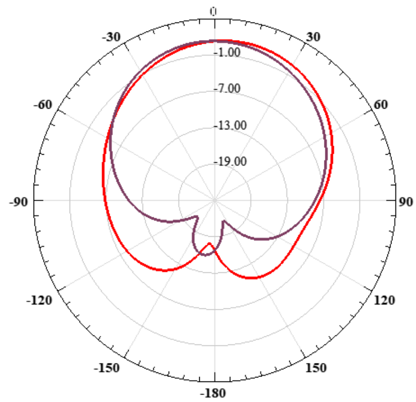

Fig.9: 2D Radiation pattern of patch antenna at 3Ghz

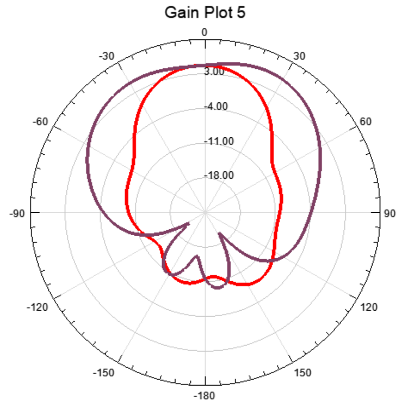

Fig.10: 2D Radiation pattern of the patch antenna at 5.17GHz

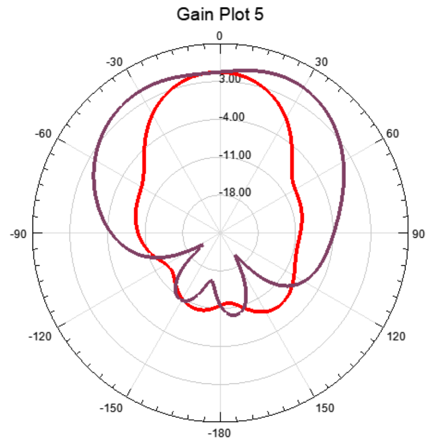

Fig.11: 2D radiation pattern of patch antenna at 5.38GHz

Fr(GHz)	S11(dB)	VSWR	BW(MHz)	FBW(Hz)	Applications
3.044	-16.7	1.38	400	70.07	WIMAX
5.177	-23.4	1.18	55	13.14	WLAN
5.38	-31.7	1.14	55	13.14	WLAN

6. CONCLUSION

A slotted T-shaped antenna with triple band, for WLAN and WiMax applications. The frequency bands with return loss below -10dB cover universally IEEE802.11a standards (3 GHz, 5.17 GHz, 5.38 GHz) with maximum gain values of 1.49dB, 6.17dB, 4.37dB. The design of this work gives the following results; the return loss in the operating frequency of 3Ghz is equal to -16.75dB,at operating frequency 5.17Ghz the return loss is equal to -23.42dB and the return loss at the operating frequency of 5.38Ghz is -31.72dB. The VSWR obtained at 3Ghz is 1.38 and at 5.17Ghz is 1.14 and at 5.38Ghz is 1.18 respectively. Taken as a whole ,the performance of the antenna meets the desired requirements in terms of return loss, high gain and VSWR at desired operating frequency. Fro this paper, it can be concluded that the performance of antenna is highly dependent on the shape and dimensions of the slots. As the width and length of the slot increases the return loss(S11)and VSWR increases but gain decreases gradually. Other factors contribute to the antenna performance are type, thickness and dielectric constant of a substrate. Because of using a FR-4 substrate, the proposed antenna production costs are reduced . It is seen that the proposed antenna achieved good performance, simple structure, and it can be constructed with a lower cost, this will meet the requirements of WLAN and WiMax applications with smaller size.

REFERENCES

[1] J.Malik and M.V kartikeyan, “meta material inspired patch antenna with L-shapped slot loaded ground for dual band(WLAN/WiMax)applications”.

[2] Ge,Y., K.Esselle, and T.bird,”compact triple- arm multi band monopole antenna, ”proc . IEEE Int.workshop : Antenna technology small antennas and novel meta materials,172-175 MARCH 2006.

[3] Erentok, A. And R.w Ziolkowskin,”Meta material - inspired efficient electrically small antennas”, IEEE trans antennas prop vol.56 No .3,691-707,2008.

[4] Y. Cao, C. Lu, and Y. Zhang, “A compact dual band miniaturized antenna forWLANoperation,” in Proc. ICMMT, Apr. 2008, pp. 416–419.

[5] Q. He, B. Wang, and J. He, “Wideband and dual-band design of a printed dipole antenna,” IEEE Antennas Wireless Propag. Lett. vol.7, pp. 1–4, 2008.

[6] M. J. Kim, C. S. Cho, and J. Kim, “A dual band printed dipole antenna with spiral structure for WLAN application,” IEEE Microw. Wireless Compon. Lett., vol. 15, no. 12, pp. 910–912, Dec. 2005.

[7] R. K. Joshi and A. R. Harish, “A modified bow-tie antenna for dual band applications,” IEEE Antennas Wireless Propag. Lett. vol. 6, pp. 468–471, 2007.

[8] B. S. Izquierdo and J. C. Batchelor, “A dual band belt antenna,” in Proc. iWAT, 2008, pp. 374–377.

[9] J. Sze, C. Hsu, and S. Hsu, “Design of a compact dual-band annularring slot antenna,” IEEE Antennas Wireless Propag. Lett. vol. 6, pp.423–426, 2007.

[10] B. Li and K. W. Leung, “Dielectric-covered dual-slot antenna for dual band applications,” IEEE Trans. Antennas Propag., vol. 55, no. 6, pp.1768– 1773, Jun. 2007.

[11] M. Wong, A. R. Sebak, and T. A. Denidni, “Analysis of a dual-band dual slot omnidirectional stripline antenna,” IEEE Antennas Wireless Propag. Lett., vol. 6, pp. 199–202, 2007.

[12] K. Chung, S. Hong, and J. Choi, “Ultrawide-band printed monopole antennas with band-notch filter,” Microw. Antennas Propag., vol. 1, no.2, pp. 518–522, 2007.