KIET IJCE KIET International Journal of Communications & Electronics
Volume. No. 1, Issue No. 1, Jan – Feb 2013.

Trapezoidal Patch with V-shape Slot Microstrip Antenna for Dual Band

Radha Sharma[1], Rajesh Kumar Vishwakarma[2]

[1,2]*Jaypee University of engineering and technology Guna, (M.P)*
[1]*radha.pandey31@gmail.com*, [2]*rkv.786@gmail.com*

Abstract: *In this paper, dual operation trapezoidal patch with V-shaped slot feed by coaxial-probe is presented. The proposed antenna is designed on RT duroid substrate. A (10db) bandwidth of return loss (S11) characteristics for the dual band is 4% and 15.6% respectively. E-planes and H-planes for the dual operation frequencies are satisfactory within the bandwidth. Return loss, VSWR, gain and E-planes and H-planes radiation pattern are simulated by using IE3D simulator.*

Keywords: *V-shape slot, RT duroid, Dual band, WLAN, WiMAX.*

1. INTRODUCTION

Wireless local area networks (WLAN) are widely used worldwide. The 802.11a standard uses the 5-GHz band which is cleaner to support high-speed WLAN. However, the segment of frequency band used varies from one region of the world to another. Dual frequency microstrip antennas with a single feed are required in various radar and communication systems, such as global positioning system (GPS), WiMAX,WLAN etc.

Microstrip antenna is the ideal choice for such an application due to low profile, light weight, conformal shaping, low cost ,simplicity of manufacturing and easy integration to circuit[1].however, conventional microstrip patch antenna suffers from very narrow bandwidth, typically about 5% bandwidth with respect to the central frequency. there are numerous and well-known method to increase the bandwidth of antennas, including increase of the substrate thickness, the use of a low dielectric substrate, the use of multiple resonators,and the use of slot antenna geometry[2],[3].

Sudhir *et.al*[4] applied a H-shaped slot in a rectangular microstrip antenna to make its broadband structure while improved bandwidth up to 9.5 % .Wong & Hsu[5] applied a U-shaped slot in an equilateral triangular microstrip antenna with improved bandwidth up to 8.67% was recently reported for a circular patch antenna having u-slot[6]. S.W Lee et al. proposed the trapezoidal shape patch antenna embedded with rectangular [7].

M.S *et.al* [8] demonstrates a rectangular patch microstrip antenna with V-slots and corner notches for IEEE802.11.A/HIPERLAN2 applications that enables an impedance bandwidth of 51%. Yogesh Bhomia *et al.* [9] applied V-shape slot on triangular microstrip antenna having impedance bandwidth of 9.2%. A dual slot-loaded microstrip antenna with dual-frequency operation has been reported in [10] and [11], where two parallel narrow slots are etched in the rectangular patch close to its radiation edge. The two slots are chosen to be close to the length of the radiating edge. Other dual-frequency antennas with square-slot and rectangular-slot loading are reported in [12] and [13]. A compact dual-frequency microstrip antenna is proposed in [14], which uses the rectangular microstrip patch loaded with one shorting pin. Some experimental results are also presented in [14].

In this paper, we design a trapezoidal patch with V-shaped antenna which works as a dual frequency. First resonance frequency f1 centered at 3.5 GHz frequency is due to its patch itself. Second resonant frequency f2 is due to V-shape slot, which is centered at 5.0 GHz.

2. ANTENNA STRUCTURE

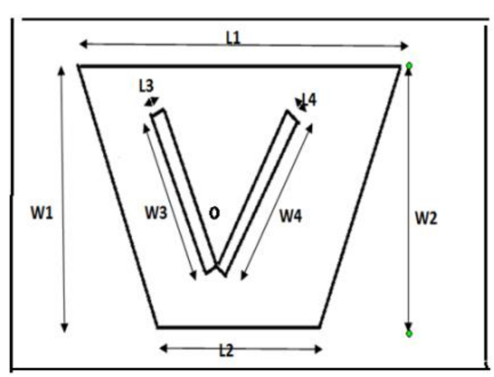

Fig.1: Geometry of proposed antenna

The configuration of proposed antenna is shown in figure 1. The antenna consist of a trapezoidal microstrip patch with V-shaped slot, support on a grounded dielectric sheet of thickness h and dielectric constant ε_r. The trapezoidal patch has an upper side of length L1, base of trapezoidal patch of length L2 and height of trapezoidal patch of length W1, W2. V-shape slot has a length of L3, L4 and a width of W3, W4 which is loaded on trapezoidal patch. The feed point is located at the central line of the patch, with a distance of d $_{f}$ (x.y) from the bottom edge of trapezoidal patch.The dimension of trapezoidal patch with V-shape slot are tabulated in table 1.

Table 1. Dimension of proposed antenna

S.no	Parameter	Explanation	Value(mm)
1.	L1	Upper side of trapezoidal patch	30
2.	L2	Base of the trapezoidal patch	26
3.	W1,W2	Height of the trapezoidal patch	21.04
4.	L3,L4	Length of the V- shape slot	0.5
5	W3,W4	Width of the V-shape slot	15
6.	ε_r	Dielectric constant	2.2
7	h	Height of dielectric constant	6
8	tanδ	Loss tangent	0.0018
9	(x,y)	Position of probe feed	(13,8)

3. RESULTS AND DISCUSSION

In this section, the simulated results of various parameters like VSWR, Return loss, input impedance and radiation characteristics of proposed antenna are presented and discussed. The simulated results are obtained using IE3D Simulator.

A. Return loss

The simulated result for the return loss less than -10dB is shown in figure 2. From simulated result we get dual band.

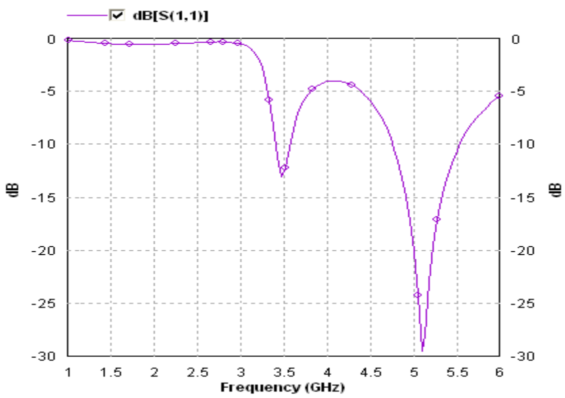

Fig. 2: Return loss

Based on a -10 dB return loss, 4% impedance bandwidth is obtained at first resonant frequencies f1 in the frequency range (3.41-3.57) GHz and 15.6 % impedance bandwidth is obtained at second resonance frequencies in the frequency range of 4.75-5.53 GHz.

B. VSWR

Figure 3. Shows the variation of VSWR with frequency for proposed antenna. It shown that the VSWR occur at first resonant frequency is 1.66 and second resonant frequency is 1.07. This depict that there is good impedance matching between probe-fed microstrip transmission line and the trapezoidal radiating element.

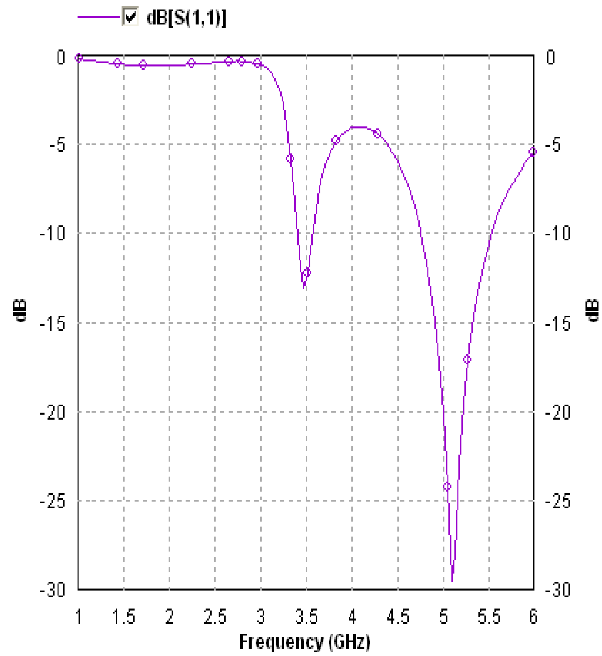

Fig. 3: VSWR

C. Input impedance

The simulated result for the antenna input impedance is plotted in figure 4. It is shown that the real part of the input impedance at first resonant frequency f1 oscillates around 74.83Ω with frequency while the imaginary part of the input impedance at resonant frequency oscillates around 0Ω with frequency.

At second resonant frequency f2, the real part of the input impedance at resonant frequency oscillates around 50Ω with frequency while the imaginary part of the input impedance at resonant frequency oscillates around 0Ω with frequency. Hence, from the graph it is clear that there is proper matching occur at both resonant frequencies.

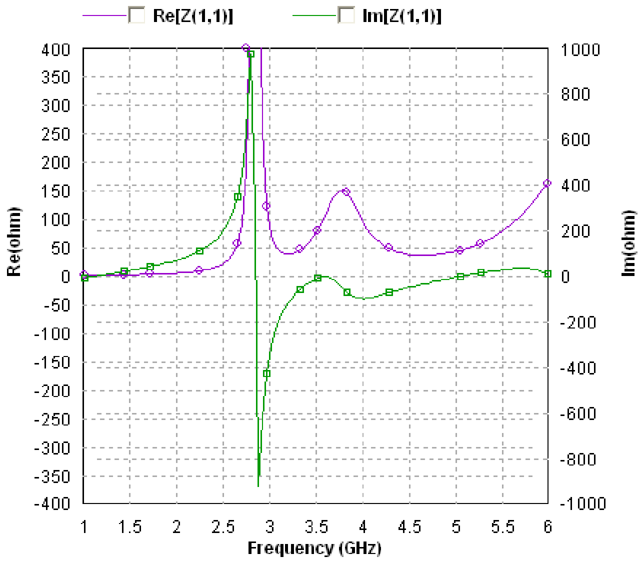

Fig. 4: Real part and imaginery part of input impedance

D. Radiation pattern

From figure 5. Shows the measured radiation pattern at first resonant frequency 3.5 GHz. it can be observed that in the ϕ=0 plane, the cross polarization is -13 db below the co polarization above the ground plane. In the ϕ=90 plane, the cross polarization is -19.3 dB below the co polarization level.

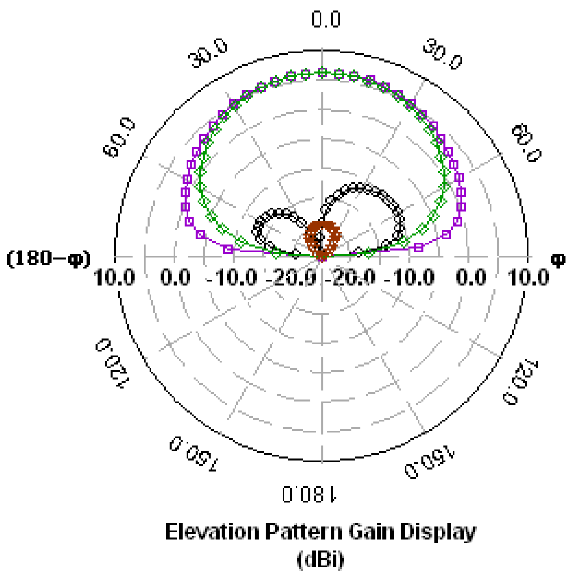

Fig. 5: Radiation pattern at 3.5 GHz

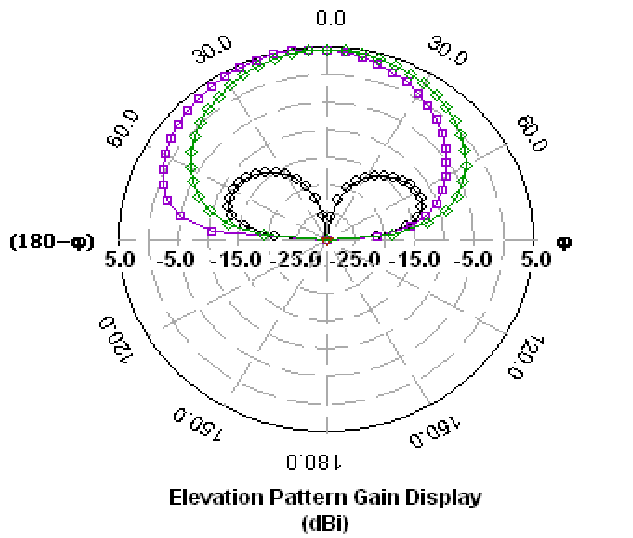

Fig. 6: Radiation pattern at 5 GHz

From figure 6. Shows the measured radiation pattern at second resonant frequency 5 GHz. it can be observed that in the ϕ=0 plane, the cross polarization is -25.03 db below the co polarization above the ground plane. In the ϕ=90 plane, the cross polarization is -20 dB below the co polarization level.

E. Gain

The gain of proposed antenna is shown in figure.7 which shows that the maximum achievable gain at first resonant frequency is about5.90 d**Bi over** the entire frequency band of 3.41-357 GHz and 4.14 dBi maximum gains is achieved at second resonant frequency and the gain show stable performance.

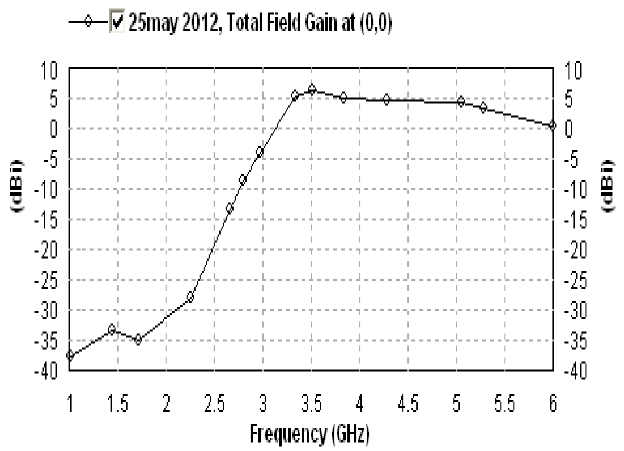

Fig. 7: Gain versus frequency

The simulated results are summarised in table 2.

Table 2. Simulated data

Resonant frequency	F1	F2
Centre frequency	3.5 GHz	5 GHz
bandwidth	4.95	15.6%
Frequency range	(3.41-3.57)GHz	(4.75-5.53)GHz
Return loss	-12.8 dB	-29.37 dB
VSWR	1.66	1.07
Gain	5.9 dBi	4.14 dBi

4. CONCLUSION

The dual frequency and wide-band operation of a trapezoidal patch with V-shaped slot have been studies and simulated. The proposed antenna is compact, occupies small volume and has simple structure compared to other antenna design. The antenna offer a 2:1 VSWR bandwidth of 4% from frequency range (3.41-3.57)GHz at first resonant frequency which cover 3.5 GHz band WiMAX applications. second resonant frequency cover the WLAN(5.15-5.35) band application with impedance bandwidth 0f 15.6%.the simulated return loss, VSWR, radiation pattern and gain showed well performance.

5. REFERENCES

[1] W.He, R.Jin, and J.Gerg, "E-shape patch with wideband & circular polarisation for millimetre wave communication," *IEEE Trans. Antenna Propag.*,vol.56,no.3, pp.893-895,2008.

[2] [2]K.L Lau, K.M. Luk, and K.L.Lee, "Design of a circularly-polarized vertical patch antenna,"*IEEE Trans. Antenna Propag.*,vol.54, no.3, pp.1332-1335,2006.

[3] D.M Pozar & D.H Schauber, "Design of Microstrip antennas and arrays, New York*: IEEE Press*, 1995.

[4] Sudhir Bhaskar & Sachin K. gupta, "Bandwidth improvement of microstrip patch antenna using H-shaped patch", *Publication in the international Journal of engineering Research and application*", vol.2, Issue 1, pp.334-338, Jan-Feb 2012.

[5] Wong KL and Hsu WS, "broadband triangular microstrip antenna with U shape slot" *Electron lett(UK)*,33(1997)2085.

[6] Sharma V, Sharma V K,Bhatnager D, Saini J.S, " Compact dual frequency wide band circular patch antenna with U-slot," *Proc of IEEE International symposium on Antenna and propoagation and USNC/URSI National Radio Science Meeting*, (IEEE,USA),1979,1.

[7] **S**. W. Lee, S. M. Park, N. Kim, S. W. Park, and S. Y. Rhee, "Design and SAR Measurement of the Trapezoidal Shape Antenna," *Progress In Electromagnetics Research C*, Vol. 26, 127-136, 2008.

[8] M.S.Nishamol, V.P Sarin, D. Tony, C.K Aanandan, " A broadband microstrip antenna for IEEE802.11.A/WIMAX/HIPERLAN2 applications," *Progress In Elecromagnetics Research Letters*,Vol.19,155-161,2010.

[9] Yogesh Bhomia, Ashok Kajila & Dinesh Yadav, "V-slotted triangular microstrip patch antenna,"*International Journal of Electronics engineering*, 2(1), pp.21-23, 2010

[10] S. Maci, G. Avitabile, and G. B. Gentili, "Single-layer dual-frequency patch antenna," *Electron. Lett.*, vol. 29, no. 16, pp. 1441–1443, 1993.

[11] S. Maci, G. B. Gentili, P. Piazzesi, and C. Salvador, "Dual-band slot-loaded patch antenna," *Proc. Inst. Elect. Eng. Microwave Antennas Propagat.*, vol. 142, pp. 225–232, June 1995.

[12] W. S. Chen, "Single-feed dual-frequency rectangular microstrip antenna with square slot," *Electron. Lett.*, vol. 34, no. 3, pp. 231–232, 1998.

[13] S. C. Gao and J. Li, "FDTD analysis of a size-reduced, dual-frequency patch antenna," *Progr. Electromagn. Res.*, vol. PIER 23, pp. 59–77, 1999.

[14] K. L. Wong and W. S. Chen, "Compact microstrip antenna with dual frequency operation," *Electron. Lett.*, vol. 33, no. 8, pp. 646–647, 1997.