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Research paper

A Compact Multi-band Rectangular Slot Microstrip Antenna for Wi-MAX, WLAN and X-band Applications

Banuprakash.R[1*], Hariprasad.S.A[2]

[1]Assistant professor, Department of TE, BMSIT&M, Bengaluru, India
[2]Director, School of Engineering and Technology, Jain University, Bengaluru, India
**Corresponding Author E-mail: [1]r.bhanuprakash@bmsit.in*

Abstract

In this paper a rectangular slotted rectangular patch tripple band antenna for wireless applications is presented. The antenna has dimension of about 25 x 20 x 1.6mm^3. The antenna operates at the frequencies 3.6 GHz, 5.8 GHz and 7.5 GHz with bandwidth of about 3.61%, 1.03% and 1.07% respectively. This antenna can be used for WIMAX (3.6GHz), WLAN (5.8GHz) and X-band(7.5GHz) applications. The stable radiation pattern, acceptable gain and good impedance matching are observed at obtained frequencies using HFSS tool.

Keywords: *Ttrippleband, slot. HFSS, WLAN, WiMAX*

1. Introduction

In recent years, multiband antenna has received significant attention in antenna design due to its operational characteristics[. The arrival of various wireless standards and protocols lead to the need to develop compact, lightweight antennas operating with multiple frequency bands [3]. Multiband antennas can operate at different frequencies for various wireless applications. A size reduction is needed to meet the specific requirement [1].Compared with conventional antennas, patch antennas are with small size, ease of integration in mobile and wireless communication [2]. miniaturization can be obtained using metamaterial loading, shorting walls [4-5]. To achieve multiple frequencies various techniques can be employed like slots on the patch, slots on the ground plane, a defective ground structure, etc. Although the radiation patterns are stable, however the antenna structures need careful optimization [6].

A. Contribution

In this research we have proposed a multiband slotted antenna for WIMAX, WLAN and X-band applications. The main contributions are as follows: The antenna consists of rectangular shaped slot on radiating patch. The designed antenna is compact with total volume of 800mm^3 (25 x 20 x 1.6mm^3) and patch are of 324mm^2 (18 x 18mm^2).

2. Antenna Design

The proposed antenna is designed using the following equations [7].

The length (L) is given by (1),

$$L = \frac{C}{2f_0\sqrt{\epsilon_{eff}}} - 0.824h\left[\frac{(\epsilon_{eff}+0.3)(\frac{W}{h}+0.264)}{(\epsilon_{eff}-0.258)(\frac{W}{h}+0.8)}\right] \quad (1)$$

The width (W) is calculated by (2),

$$W = \frac{C}{2f_0\sqrt{\frac{\epsilon_r+1}{2}}} \quad (2)$$

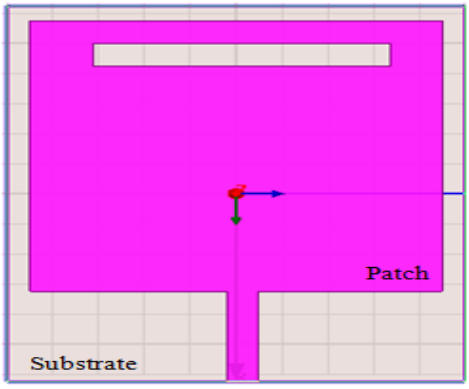

Fig. 1: Front View of the proposed antenna

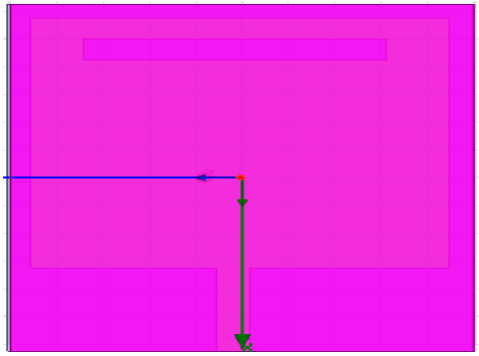

Fig. 2: Back View of the proposed antenna

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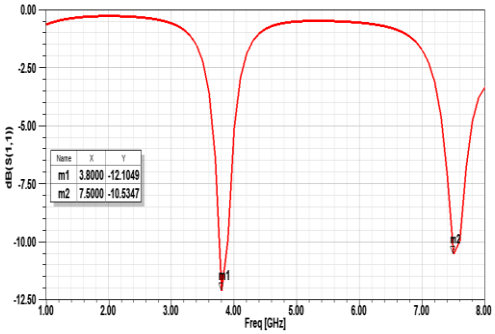


Fig. 2: Antenna and its return loss without slot

Micro strip feeding technique is employed to achieve less return loss and better impedance matching. The current distribution due to slot makes the antenna to operate at different frequencies like 3.6GHz (WIMAX), 5.8GHz (WLAN), 7.5GHz (X-band applications).

Table 1: Dimensions of the Antenna

Sl no.	Parameter	Value
1.	Dielectric constant	4.4
2.	Thickness	1.6mm
3.	Length of the ground(L_g)	25mm
4.	Width of the ground(W_g)	20mm
5.	Length of the patch(L)	18mm
6.	Width of the patch(W)	18mm
7.	Length of the feed(L_1)	6mm
8.	Width of the slot(W_1)	13mm
9.	Width of the feed (W_2)	1.25mm

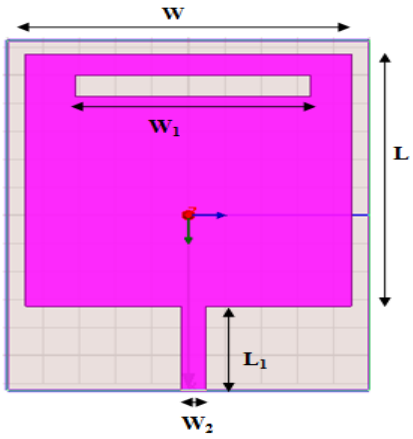


Fig. 4: a) Antenna with detailed dimensions layout

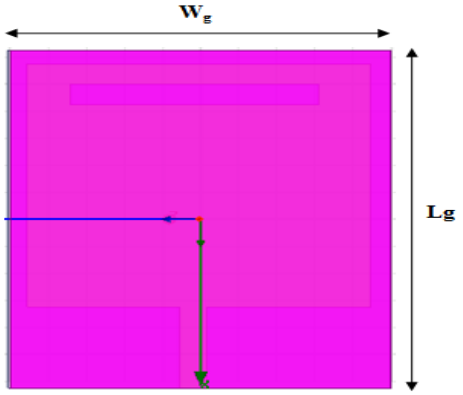


Fig. 4: b) Antenna with detailed dimensions layout

3. Analysis of the Antenna

To analyse the performance of the antenna, parametric studies are carried out. The analysis is carried out at those dimensions which have effect on antenna performance i.e, the analysis is done by varying a parameter while keeping the other constant.

A. Effect of Feed Width (W_2)

Analysis is carried out to analyse the effect of the feed width on the return loss of the antenna. The feed width (W_2) is varied in terms of 0.5 mm as shown in the figure (4 a).

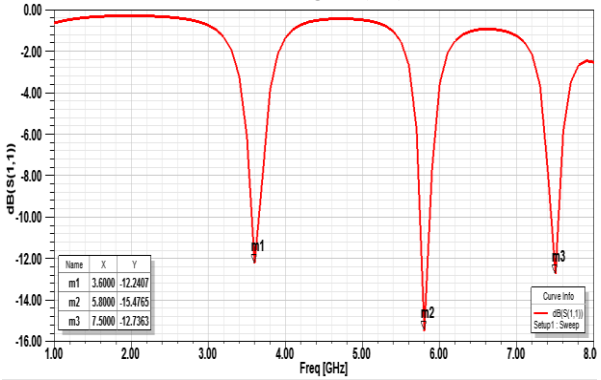


Fig. 5: a) Feed width (W_2)=1.5mm.

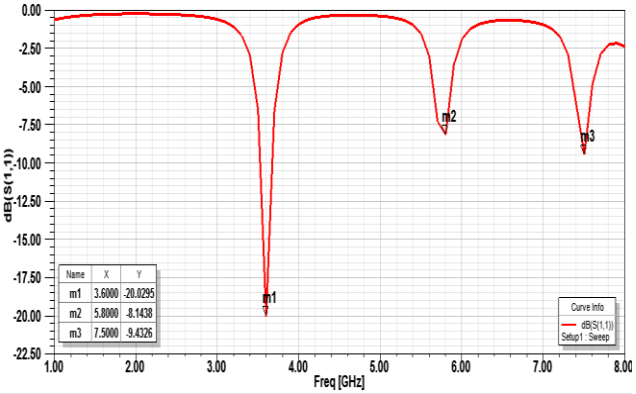


Fig. 5: b) Feed width (W_2)=1mm.

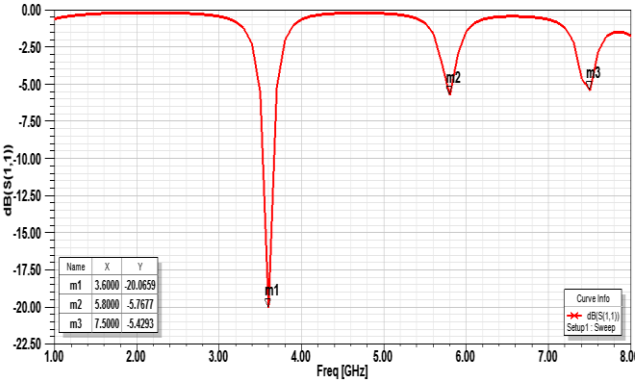


Fig. 5: c) Feed width (W_2)=0.5mm.

Further, to study the operation of the antenna the current distribution is analysed and depicted in the figure (6). At 3.6GHZ current is distributed near the sides of the square slot and on the feed. At 5.8GHz maximum current is distributed near the length of the slot and on the lower half of the feed. At 7.5GHz the current is distributed parallelly on the surface of the patch.

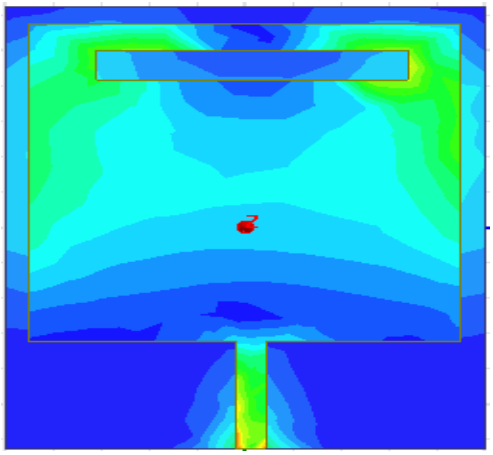


Fig. 6: a). Current distribution at 3.6GHz

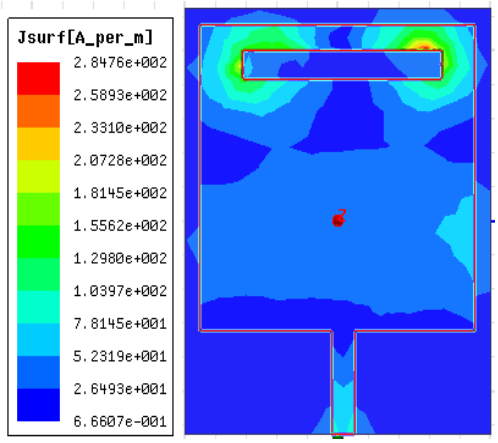


Fig. 6: b). Current distribution at 5.8GHz

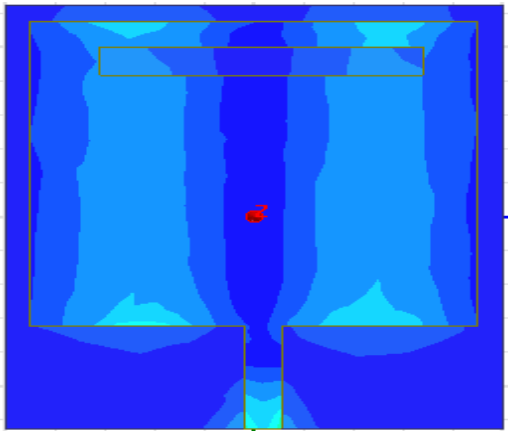


Fig. 6: c). Current distribution at 7.5GHz

4. Results

The antenna is built on a volume of 25 x 20 x 1.6 mm^3 ($800mm^3$). The substrate used is FR4 with the height 1.6mm and dielectric constant of 4.4. The simulated result of the return loss (S_{11}) is illustrated in the figure (7). The antenna shows the triple resonance at 3.6GHz (WIMAX), 5.8GHz (WLAN), 7.5GHz (X-band). The antenna shows good S_{11} which is less than -10dB.

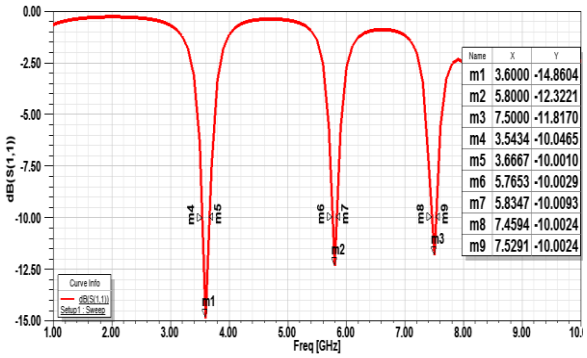


Fig. 7: S_{11} of the antenna.

Table 2: Final results of the antenna

F Frequency (GHz)	Return loss (S_{11})	Bandwidth (GHz)	Bandwidth (%)
3.6	-14.86	0.13	3.61
5.8	-12.32	0.06	1.03
7.5	-11.82	0.08	1.07

The VSWR of the antenna is given in the figure (8). For better performance of the antenna VSWR should lie between 1-2. The designed antenna obtains VSWR of 1.4, 16, 1.7 at resonance frequencies 3.6GHz, 5.8GHz, 7.5 GHz respectively.

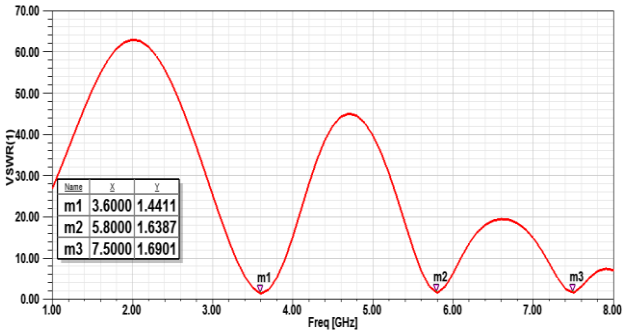


Fig. 8: VSWR plot of the antenna

The radiation pattern is further interpreted in the figure (8). It shows the antenna has omni-directional path in the H-plane and bi-directional path in the E-plane at operating frequencies 3.6GHz, 5.8GHz, 7.5GHz.

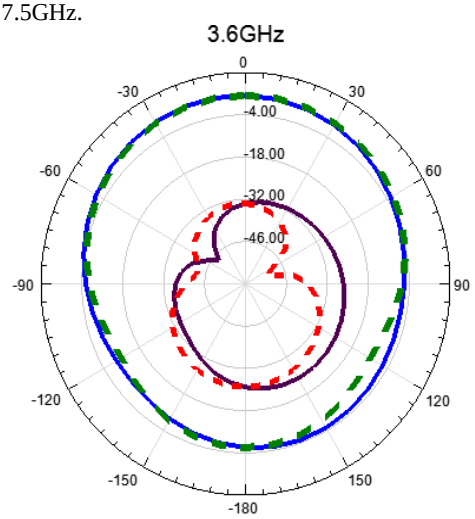


Fig. 9: a). Radiation pattern of the antenna at 3.6GHz

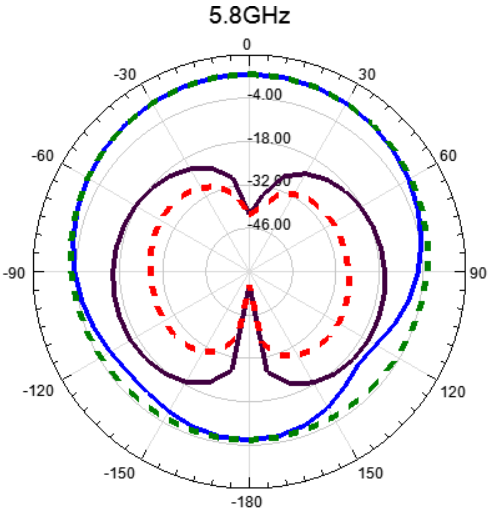


Fig. 9: b). Radiation pattern of the antenna at 5.8GHz

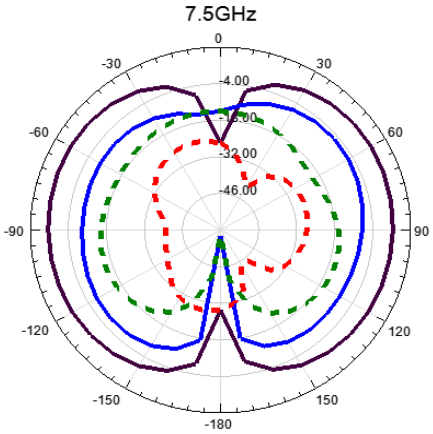
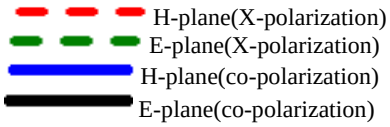


Fig. 9: c). Radiation pattern of the antenna at 7.5GHz



The 3-D gain plot of the antenna is specified in the figure (9). The gain of about -1.28dB, 1.09dB and 1.53dB are obtained for 3.6GHz, 5.8GHz and 7.5GHz respectively. The gain at 3.6GHz is low because of slot.

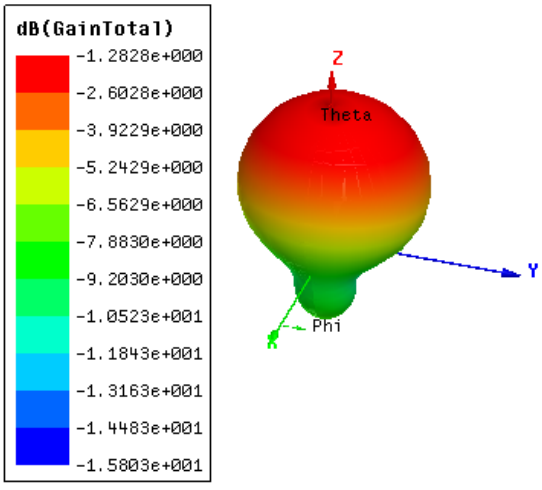


Fig. 10: a). 3-D plot of gain at 7.5GHz

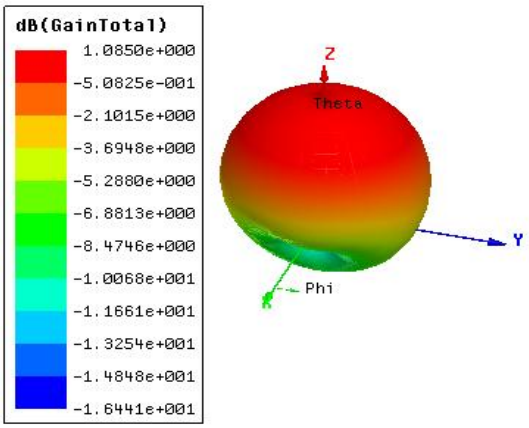


Fig. 10: b). 3-D plot of gain at 5.8GHz

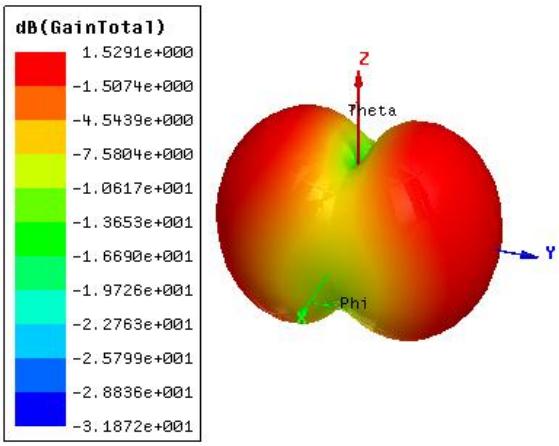


Fig. 10: c). 3-D plot of gain at 7.5GHz

5. Conclusion

A rectangular slotted rectangular patch antenna for WIMAX, WLAN and X-band applications is presented. The antenna shows low return loss at resonance frequencies 3.6GHz, 5.8GHz and 7.5GHz. From the parametric analysis it is observed that trivial change in the dimensions of the antenna changes the performance of the antenna. The antenna has acceptable gain which is useful in the above mentioned applications. The gain can be improved by using superstrate.

References

[1] Abdelheq Boukarkar, Xian Qi Lin, Yaun Jiang, and Yi Qiang Yu, Miniaturized single-feed multiband patch antennas, IEEE, 2017.
[2] Muhammad Salim Garba and Hong-Xing Zheng, Analysis and design of compact multiband patch antenna for wireless application, Institute of antenna and microwave techniques, Tianjin university of technology and education, IEEE, 2016.
[3] Indu Jiji Rajmohan and M. I. Hussein,A multiband planar antenna design using hexagonal patch and a resonator slot, UAE University, IEEE, 2016
[4] S. A. H. Saghanezhad and Z. Atlasbaf, Miniaturized dual-band CPW-fed antennas loaded with U-shaped metamaterials, IEEE, 2016.
[5] M. Li, X.Q. Li, J. Y. Chin, R. Liu and T. J. Cui, A novel miniaturized printed planar antenna using split-ring resonator, IEEE, 2008.
[6] S. M. Aguilar, M. A. Al-Joumayly, M. J. Burfeindt, N. Behdad, and S. C. Hagness, Multiband miniaturized patch antennas for a compact, shielded microwave imaging array, IEEE, 2014.
[7] C. A. Balanis, Antenna Theory: Analysis and design. Hoboken, NJ, USA: Wiley,2005, p.811.