Analysis of V Slot Multiband Microstrip patch Antenna for S, C and X Bands

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Abstract*- This paper presents a V slot microstrip patch antenna.In this antenna a V shaped slot cut inside the rectangular patch of the antenna for performing multiband application. This antenna is designed using FR-4 epoxy substrate with co-axial feed technique, and simulated on HFSS. The proposed antenna is resonating in S band, C band and X band at frequencies 3.2GHz, 5.5GHz, 8.2GHz and 9.2GHz.The return loss of V slot antenna is -14.4dB, -22.1dB, -23.4dB and -13.2dB and gain is 2.7dB, 4.8dB, 6.6dB and 4.3dB respectively at resonating frequency. The directivity of proposed antenna was maintainedto begreater than 5dB at all resonant frequencies. This V slot microstrip patch antenna is acceptable for today's communication system.*

Keywords-*v slot, gain, directivity, return loss, VSWR, and S, C and X bands.*

I. INTRODUCTION

In the moderntrend of wireless communication systems, most ofthe researchers areworking on microstrip patch antenna (MPA) for multiband operation. This type of antenna is highly effective as different allocated bands can be achieved by using this single antenna.The microstrip patch antennawith multiband application and diminished size are the requirement of modern communication devices but existing researches demonstrated that with decreaseinantenna size there is a variation in bandwidth, gain and antenna efficiency [1]. The MPA are highly in demand because of their attributes like low cost, light weight, low profile etc. [2,3,4,5] Researchers have developed many ideas to increase the bandwidth of MPA. Someof the ideas include,increasing patch height, increasing substrate thickness and by decreasing substrate permittivity [6, 7]. In early 1970 microstrip patch antenna was introduced and it had become a change in the field of microstrip antenna. The microstrip antenna'sfirst opinion was given by Deschamps,Gutton and Baissinot [8, 9].A common method for achieving a dual band or multi band is to cut slots on antenna's patch like U slot, T Slot, I slot and L slot and this causes the current path and its distribution to switch. The easiest technique to achieve dual band antenna is by cutting rectangular slot inside the patch [10].

In this research work,the multi band V slot microstrip patch antenna is designed. This research work has been done using FR-4 substrate material with relative permittivity$\varepsilon_r$of 4.4. The proposed antenna resonates at four different frequency bands which lies in S, C and X bands. These bands are used for various communication systems. Coaxial feeding technique has been employed to achieve different as the advantages of this type of feeding technique is that it can be placed anywhere inside the patch of antenna to get the best desired result. The proposed work has been implemented and simulated on HFSS.

II. ANTENNA DESIGN

Fig.1 shows the V slot microstrip patch antenna. The antenna has beendesigned using FR-4 glass epoxy substrate with permittivity of 4.4, dielectric tangent loss of 0.02 and substrate thickness of 1.6mm. The dimension of proposed antenna are 30.33mm×25.34mm. The width and length of ground surface is calculated with the help ofthe equations shown below.

$$Wg = 6h + Wp \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \{1\}$$

$$Lg = 6h + Lp \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \{2\}$$

Where h is the thickness of substrate, Wp is width of the patch, Lp is length of the patch.

The size of patch is obtained by equations shown below.

$$Wp = \frac{c}{2fr\sqrt{(\varepsilon r + 1)/2}}$$

$$Lp = \frac{c}{2fr\sqrt{\varepsilon ff}} - 2\Delta l$$

$$\varepsilon ff = \frac{\varepsilon r + 1}{2} + \frac{\varepsilon r - 1}{2}\{1 + 12h/Wp\}^{0.5}$$

$$\Delta l = 0.412[(\varepsilon ff + 0.3)(\frac{Wp}{h} + 0.264)/(\varepsilon ff - 0.258)(\frac{Wp}{h}+0.8)1]$$

Where c is speed of light, f_r is operating frequency, Δl is extension length and $\varepsilon ff$is the effective dielectric constant.

In this designed antenna for achieving multiband frequency, a V slot has been cut on the rectangular patch of MPA to help antenna resonate at multiband frequency. The coaxial feeding technique is placed on the patch of coordinate (x, y) to get good impedance matching. The antenna dimensions are shown in table.1

Table. I Dimensions of Proposed Microstrip multiband antenna.

S.no	Parameters	Dimension
1	Width of ground surface Wg	30.33mm
2	Length of ground surface Lg	25.34mm
3	Patch width Wp	20.73mm
4	Patch length Lp	15.74mm
5	Slot width S_W	1mm
6	Slot length S_L	8mm
7	Substrate height h	1.6mm

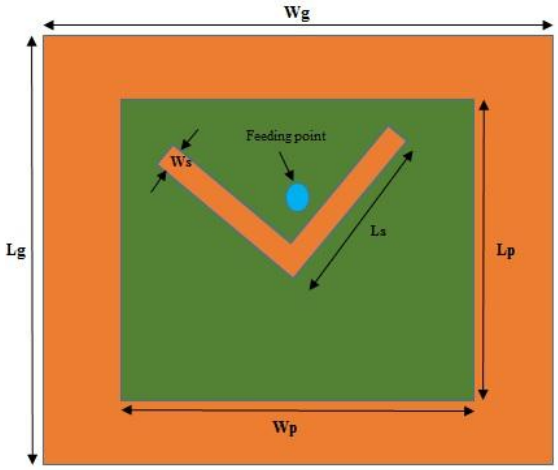

Fig.1 (a)

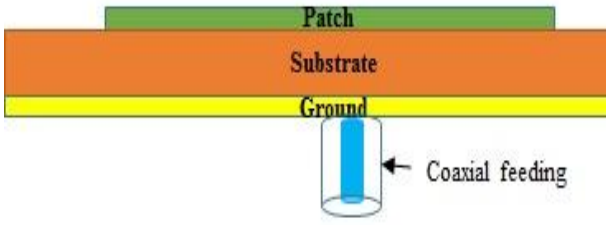

Fig. 1(b)

Fig.1 show Designed microstrip patch antenna (a) top view (b) side view.

III.RESULT AND DISCUSSION

The proposed antenna can operate at multiband frequencies such as3.2 GHz, 5.5GHz, 8.2GHz and 9.2GHz, which lies in S band, C band and X Band. From the simulated result Fig (2) it can be seen that the return loss of resonating frequencies are -14.4dB, -22.1dB, -23.4dB and -13.2dB respectively with corresponding bandwidth.The simulated results of return loss, VSWR, Gain and directivity of V slot microstrip patch antenna areshown in table.2

Fig. (3) Shows the VSWR at the resonant frequencies which is well within the specified limit. The VSWR values are 1.47, 1.17, 1.14 and 1.56 at resonating frequency 3.2GHz, 5.5GHz, 8.2GHz and 9.15GHz respectively.

From Fig. (4) & (5), it is seen that Gain values are 2.7dB, 4.8dB, 6.6dB and 4.3dB and directivity are 7.2dB, 6.3dB, 7.4dB and 5.8dB at resonating frequency 3.2GHz, 5.5GHz, 8.2GHz and 9.2GHz respectively.

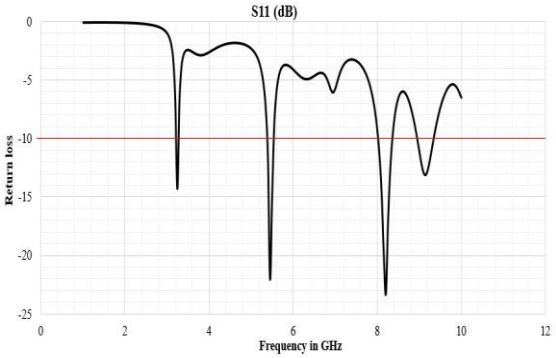

Fig. 2 Return loss in dB

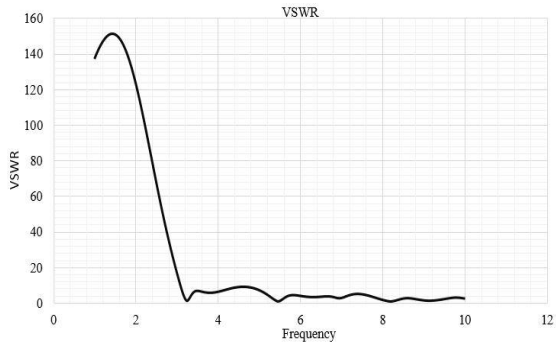

Fig. 3 VSWR

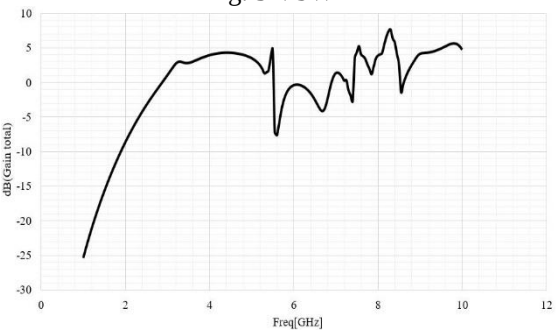

Fig. 4 Gain vs Frequency

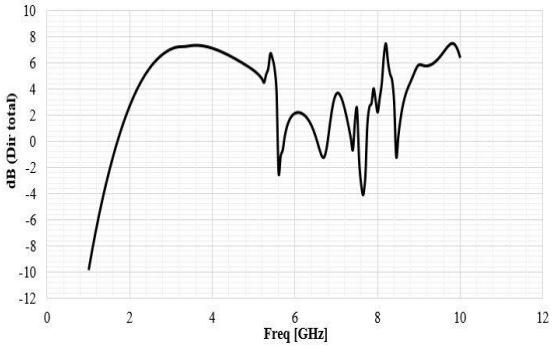

Fig. (5) Directivity graph

Table. II Return loss, %Bandwidth andVSWR

Resonant frequency	Return loss (dB)	% BW	VSWR
3.2 GHz	-14.4	1.54%	1.47
5.5 GHz	-22.1	3.12%	1.17
8.2 GHz	-23.4	4.28%	1.14
9.2 GHz	-13.2	4.38%	1.56

Table.III Gain and Directivity.

Resonant frequency	Gain (dB)	Directivity (dB)
3.2 GHz	2.7	7.2
5.5 GHz	4.8	6.3
8.2 GHz	6.6	7.4
9.2 GHz	4.3	5.8

From the above simulation results, it is evident that, the return loss, gain, directivity and VSWR have obtained better acceptable results at the resonating frequencies.

The radiation pattern at resonating frequency of proposed antenna is shown in Fig. (6)

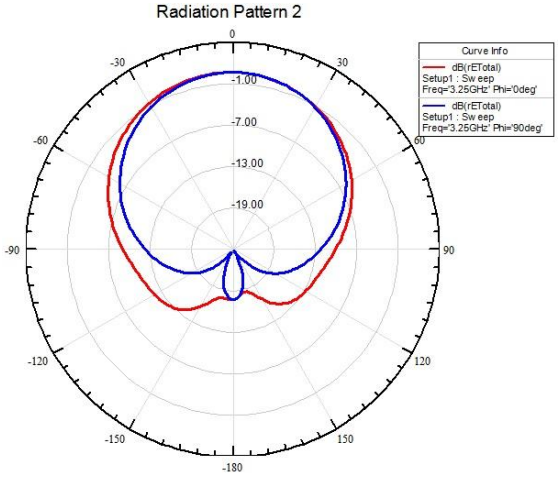

Fig. 6(a) Radiation pattern for 3.2 GHz

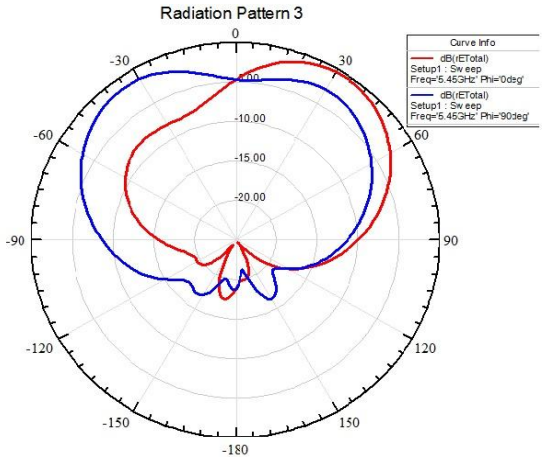

Fig.6. (b) Radiation patter for 5.5GHz

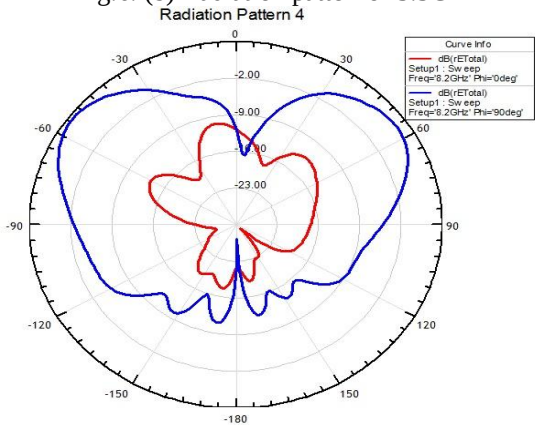

Fig. 6(c) Radiation pattern for 8.2GHz

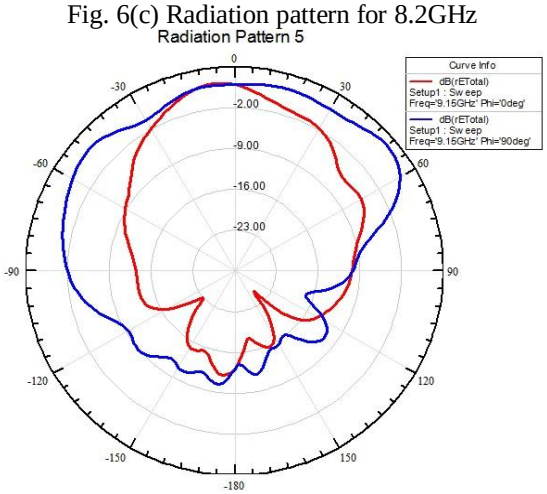

Fig. 6(d) Radiation pattern for 9.2GHz

IV. Conclusion

In this research work, a V slot multiband microstrip patch antenna is designed and simulate on HFSS. In this antenna a V type slot has beencarved out in the patch of the antenna for achieving multiband frequency where the substrate is of FR-4 epoxy having dimension 33mm × 25.34 mm with thickness of 1.6mm. This MPA resonates at four frequencies 3.2GHz, 5.5GHz, 8.2GHz, 9.2GHz which are in the S band, C band and X band and

these bands are used for various wireless systems and in today's communication media. This designed antenna has achieved good results in terms of return loss, gain and directivity. The return loss values are -14.4dB, -22.1dB, -23.4dB, and -13.2dB whereas gain values are 2.7dB, 4.8dB, 6.6dB, and 4.3dB at resonant frequencies. For future scope, further researches can be carried out to obtain a wider bandwidth and much better radiation pattern.

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