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Dual-Band Slim Patch Antenna for Wireless Applications

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Abstract - *This paper presents a dual-band slim patch antenna for wireless applications. The shorting pin is used to miniaturization of antenna. It has compact size is 18 mm × 36 mm × 1.6 mm3. The proposed slim antenna divide into four section: antenna with shorting pin, shorting pin plus offset pin, shorting pin plus centre pin and shorting pin plus both offset and centre pin. The centered and offset pin in slim patch helps to improve impedance matching. With help of shorting pins lower frequency band at 3.4 GHz is achieved. The proposed dual band slim antenna has operate dual resonance at 3.4 GHz and 5.4 GHz. The suggested slim patch antenna has been design on FR4 substrate with εr = 4.4 with 1.6 thickness. The peak gain of antenna is 1.2dBi and 3.4dBi at 3.4GHz and 5.4GHz respectively. The efficiency of antenna greater than 70% in both bands observed. Both the two band has VSWR less 1.6. The simulation results show that position of shorting pin is crucial part to obtain desired resonant frequency. This proposed dual band slim antenna is suitable for wireless applications.*

***Key Words*: *Shorted-pin, Dual-band, Miniaturization, Slim Antenna and Impedance matching*.**

1. INTRODUCTION

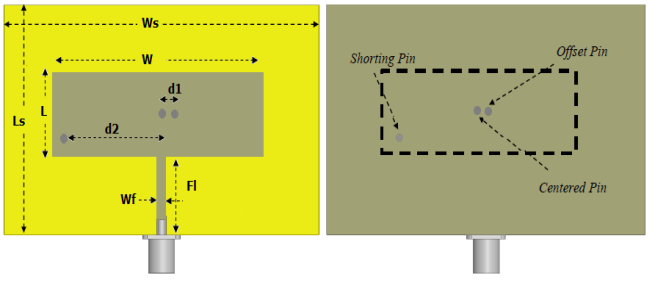
In recent year, highly growth of multifunction wireless communication system increased the interest of low profile, low cost and integrated patch antennas. However, the main challenges in designers to design compact antennas with multifunction [1]. Many paper has been study on dual-band antennas for wireless applications. This can be obtained using different techniques like fractal, slotted patch and DGS structure etc. Apart from the dual-band application, antenna requires compact and better impedance matching. Recently, shorting pin is most promising techniques for dual-band due to their 50 % size reduction[2-3].

In the past, some researchers focused on miniaturizing patch antenna using the pin-loaded method, however, the obtained results suffer from a dramatically low gain [4-7].A compact dual-band antenna is designed for 4.5GHz and 7.8GHz 5G and C-band applications the antenna satisfied the -10dB impedance bandwidth is 64MHz (4.468GHz4.532GHz) and128MHz(7.736GHz-7.864GHz)[7].Dual band Antenna miniaturized planar inverted F-antenna is designed for WLAN and 5G applications which has been designed to operate in the WLAN (2.4GHz), Bluetooth (2.4GHz), LTE2500 (2.5GHz) and 5G communication (4.5GHz) [8]. Single band elliptical Microstrip patch antenna is design at 3.5GHz for 5G with impedance bandwidth around 700MHz and size is 48 x 26 mm presented [9]. Rectangular Patch antenna at 4.5GHz for 5G with impedance bandwidth around 700MHz and size is 50 x 40 mm presented [10].But all this antenna having large size and low gain so with the reduction is size which has been taken as an objective for this research work. In this paper, a compact Dual-band slim patch antenna is presented. In proposed slim antenna covers 2 frequency bands of 3.4 GHz and 5.4 GHz. The dual-band slim patch antenna with good impedance matching is proposed.

2. ANTENNA DESIGN CONFIGURATION

The dimensions and geometry of the proposed dual band slim microstrip antenna is shown in Fig. 1. The proposed dual band slim antenna has been designed on FR4 Substrate with εr=4.4 and thickness (h) is 1.6mm.

The shorting pin is placed at position of (2, 9, 0) which is located along diagonal of patch and near to edge to miniaturization of antenna. A pair of additional shorting pins which placed at centre of patch antenna. The distance between centre and offset pins is 3mm. The radius of all three shorting pins is r = 0.5 mm. The overall substrate size of antenna is 18 x 36 mm^2 and patch size is 7 x 23 mm^2. The patch antenna connected microstrip feed line.



(a) TOP VIEW (b) BOTTOOM VIEW

Fig.1 Geometry of proposed dual band slim patch antenna

The dimensions of Proposed Dual band slim Patch antenna as shown in table.

Table 1: Dimension of Dual band slim Patch antenna

Parameters	Dimensions (mm)	Parameters	Dimensions (mm)
L	7.0	Ls	18.0
W	23.0	Ws	36.0
Fl	7.0	Wf	1.2
d1	3.0	d2	9.0

3. RESULTS AND DISCUSSION

The proposed dual band slim patch antenna has been design using HFSS software. The simulated return loss of different shorting pin configuration is shown in fig.2. It can see that antenna loaded shorting pin (Blue graph) getting single freq at 4.6 GHz, antenna loaded shorting pin plus centered pin (green graph) getting freq at 4.9 GHz, antenna loaded shorting pin plus offset pin (black graph) and getting freq 5.3GHz and antenna loaded shorting pin plus both pins getting dual band resonance at 3.4 GHz and 5.4 GHz.

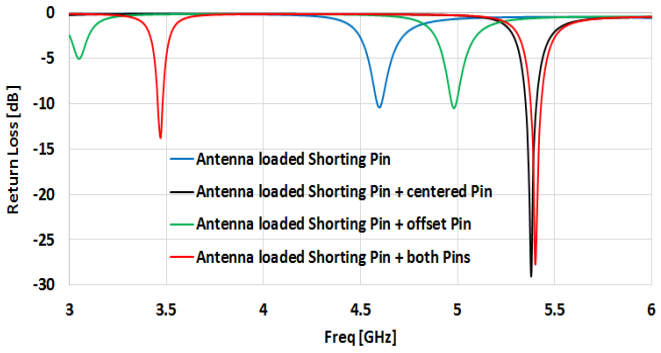


Fig 2: Simulated return loss of shorted-pin patch antenna, antenna loaded with the centered pin, antenna loaded with the offset pin, and the proposed antenna

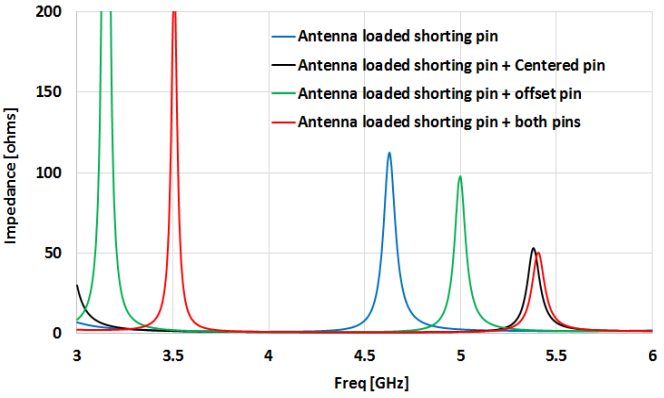


Fig 3: Simulated impedance of shorted-pin patch antenna, antenna loaded with the centered pin, antenna loaded with the offset pin, and the proposed antenna

The simulated impedance of different shorting pin configuration is shown in fig. 3.It can see that aided shorting with both pins observed excellent impedance matching on both freq band bands. The using centered and offset pin we achieved good impedance matching at lower and upper freq bands.

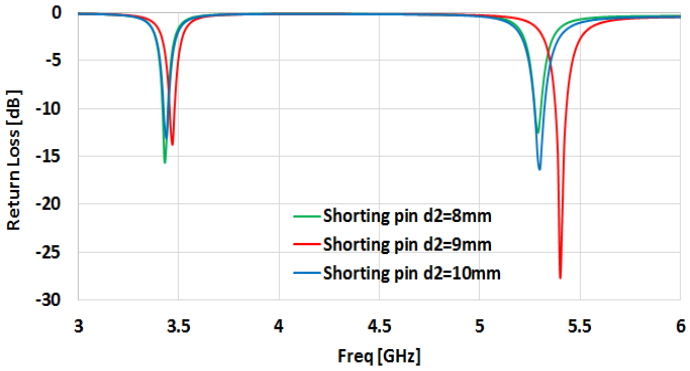
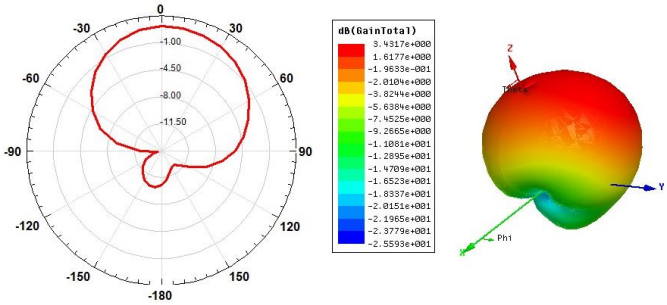


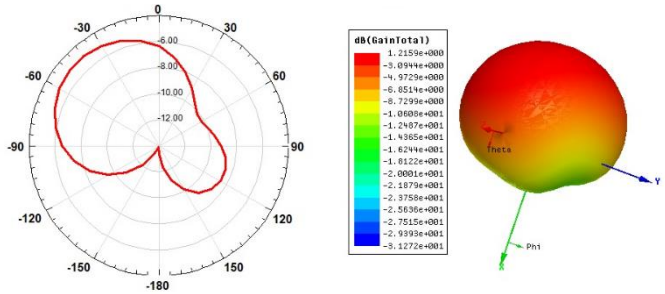
Fig 4: effect of shorting pin location on return loss

The fig. 4 show effect of shorting pin location on return loss. It can see that at with optimum pin location is 9mm we observed better impedance matching.



(a) Radiation pattern 2D (b) Radiation pattern 3D

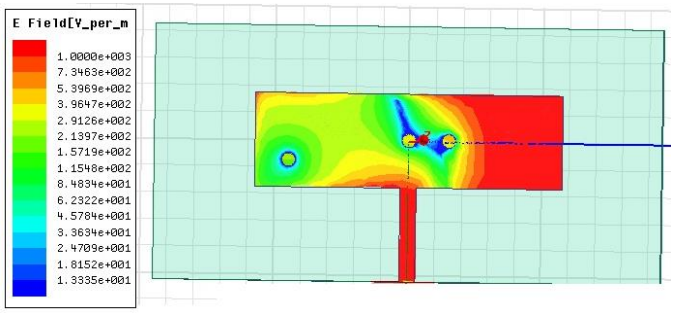
Fig 5: Radiation Pattern of proposed Dual band slim antenna at 5.4 GHz



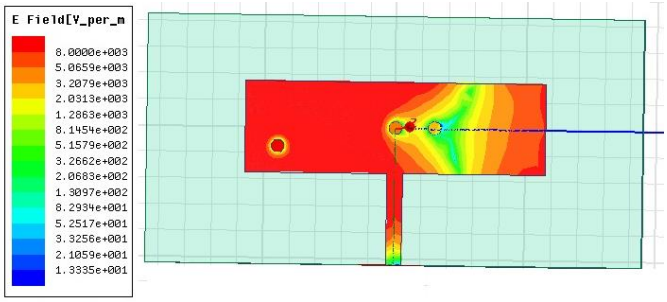
(a) Radiation pattern 2D (b) Radiation pattern 3D

Fig 6: Radiation Pattern of proposed Dual band slim antenna at 3.4 GHz

The Gain of proposed dual band slim antenna is 3.4 dBi and 1.2 dBi at 5.4GHz and 3.4 GHz respectively.



(a) 3.4 GHz



(b) 5.4 GHz

Fig 7: Surface Current distribution of proposed Dual band slim patch antenna

Table 2. Overall Comparison of Slim Patch Antennas

Sr. No.	Results	Freq (GHz)	Return Loss (dB)	VSWR	Gain (dB)
1.	Patch antenna with shorting pin	4.60	-10.41	1.86	1.2
2.	Patch antenna with shorting pin + offset pin	4.98	-10.51	1.84	1.2
3.	Patch antenna with shorting pin + center pin	5.38	-29.09	1.07	2.2
4.	Proposed Patch antenna with shorting pin + both offset & center pin	3.46	-13.21	1.51	1.2
		5.40	-27.58	1.08	3.5

From table 2 we can see that loaded slim patch antenna with help of shorting pin plus both pins we achieved lower freq band and good size reduction.

4. CONCLUSION

A new dual-band slim patch antenna is presented for wireless applications. The overall size of antenna is very small 18×36×1.6 mm^3. In design steps of dual-band antenna started simple rectangular patch structure and added shorting pin which obtain dual-band resonance. The centered and offset pins help to achieved good impedance matching at both bands. The use of shorting pin we achieved 40 % size reduction. Radiation pattern is stable both dual frequency bands with maximum gain of 3.4 dBi.

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