Design of Inset-fed Multiband Antenna for GPS, 2.4 GHz WLAN and X-band Satellite Applications

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Abstract— In this paper, a compact design of inset-fed multiband antenna acceptable for GPS, 2.4 WLAN and X-band satellite communication applications is presented. The proposed antenna consists of rectangular radiating patch which is fed by 50Ω inset-feed line. The antenna structure is printed on FR-4 substrate and has dimensions of 40 × 30 × 1.6 mmincluding ground plane. To obtain a multiband operation, a rectangular loop slot is inserted at the middle of the radiating patch. The proposed antenna adequately covers the GPS (1.57 GHz), WLAN (2.4-2.484) and X-band lower satellite communication (6-6.5 GHz) applications. The results indicates that the proposed antenna shows a broadside radiation characteristics at three distinct frequency bands of 1.6, 2.4 and 6.2 GHz. Owing to its simple geometry and its radiation characteristics, it is highly recommendable for applications in GPS, WLAN, X-band satellite communication systems.

Key words: multiband antenna, inset-fed, GPS, WLAN, X-band satellite communication

I. INTRODUCTION

The microstrip antennas have several attractive features such as low volume profile, low cost, easy integration with MMICs, conformal structure and light weight [1]. Due to these characteristics, the microstrip antennas are becoming one of the essential candidates for personal wireless communication applications [2]. But in recent years, the rapid advances taking place in personal wireless communication technologies such as global positioning satellite (GPS) receivers, WLAN, Bluetooth devices demands an integration of more than one communication system into a single compact design.To overcome this major problem a compact low cost multiband antennas with better radiation characteristics are needed [3]. The conducting patch of the microstrip antenna can be any shape. In practice, square, rectangular, circular, triangular, polygon and annular ring are common shapes.The small size is an important requirement for the design and development of multiband operation. In the last few years, a lot of compact planar antennas have been developed for dual, triple and multiband operation which covers the GPS, IMT-2000,DCS, WLAN-IEEE bands [4-9]. In this paper, a compact planar inset-fed rectangular microstrip antenna capable to work for three frequency bands around 1.58, 2.4 and 6.2 GHz, covering three useful frequency bands such as GPS, WLAN X-band satellite communication is presented. Details of the proposed antenna design and simulated results are presented and discussed.

II. DESIGN OF THE ANTENNA

The geometry of the proposed triple band antenna is shown in Fig. 1. The entire antenna structure is printed on 40 × 30 mm a commercially available low cost FR-4 epoxy substrate of dielectric constant of $\varepsilon_r = 4.4$ and having thickness of h = 1.6 mm. The proposed antenna consists of a rectangular microstrip antenna having a dimensions of width W= 30mm and length L = 40mm and which is fed by simple 50Ω inset-fed microstripline feed of length L_f=16.34 mm and W_f = 3.06 mm on the top surface of the substrate and bottom of the substrate theground plane used. Good impedance matching is achieved between radiating patch and 50Ω microstrip line by optimizing an offset width of I_W= 1.53 mm and length of I_L= 5.78 mm of the inset feedline and which is shown in the Fig. 1.

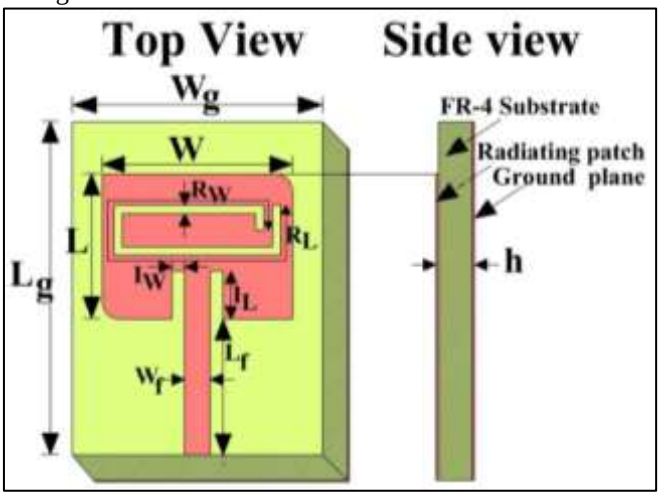


Fig. 1: Geometry of the proposed triple band antenna

Further, to achieve a triple band operation, the conventional rectangular radiating patch is modified by truncating the top and bottom corners of the radiating patches and inserting a rectangular loop slot at the middle of the radiating patch. From the simulation results it is clear that, by embedding a narrowunequal rectangular loop slot of length in terms of λ_0. Resonance in the 1.58, 2.42 and 6.2 GHz is influenced by the unequal arm lengths of R_L=59 mm of the rectangular loop slot which is approximately equal to λ_0/12.7 mm, is suitable for GPS, WLAN and X-band applications. The prototype of the antenna is designed by using commercial electromagnetics ANSYS HFSS simulation software [10]. The optimized antenna parameters and its dimensions of the proposed antenna are given in Table: I.

Antenna parameters	Dimensions in mm
W_g	30
L_g	40
W	22.8
L	17.4
W_f	3.06
L_f	16.34
R_W	2
R_L	59
I_W	1.53
I_L	5.78
h	1.6

Table 1: Optimized dimensions and parameters of the proposed antenna

III. RESULTS AND DISCUSSION

The simulated return loss versus frequency characteristics of the proposed antenna is as shown in Fig. 2. From this figure it is clear that, the antenna resonates for three modes at f_{r1}, f_{r2} and f_{r3} with an impedance bandwidths of BW_1= 5.09% (1.54-1.62 GHz), BW_2= 11.76% (2.40-2.70 GHz) and BW_3= 6.98% (6.08-6.52GHz) respectively. The first resonant band with impedance bandwidth of BW_1= 5.09%(1.54-1.62 GHz) is wide enough to cover the GPS bands. The second and third resonant bands with impedance bandwidths of BW_2= 11.76% (2.40-2.70 GHz) and BW_3= 6.98% (6.08-6.52 GHz) which covers the 2.4 GHz WLAN and lower X-band satellite communication bands, respectively.

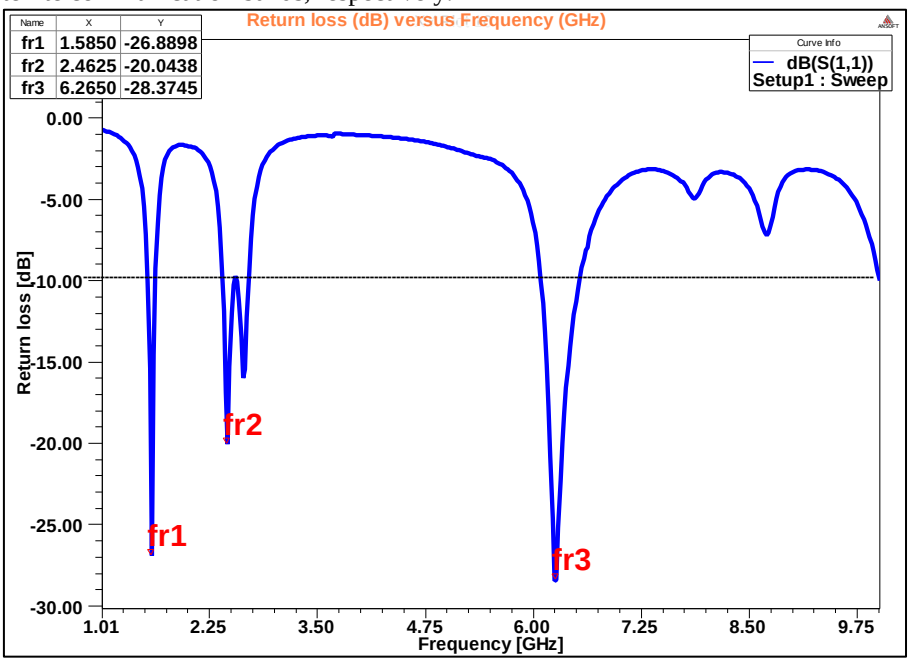
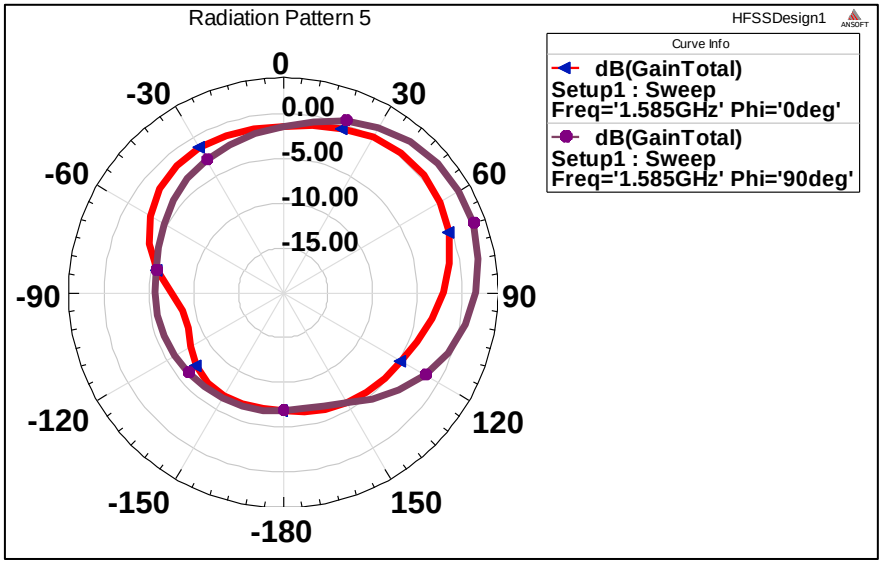
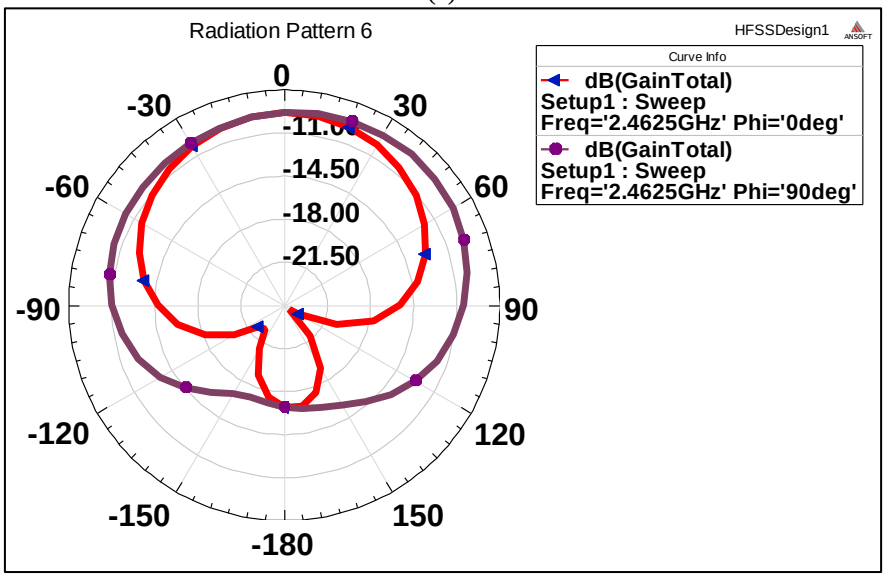


Fig. 2: Variation of return loss versus frequency of the proposed multiband antenna

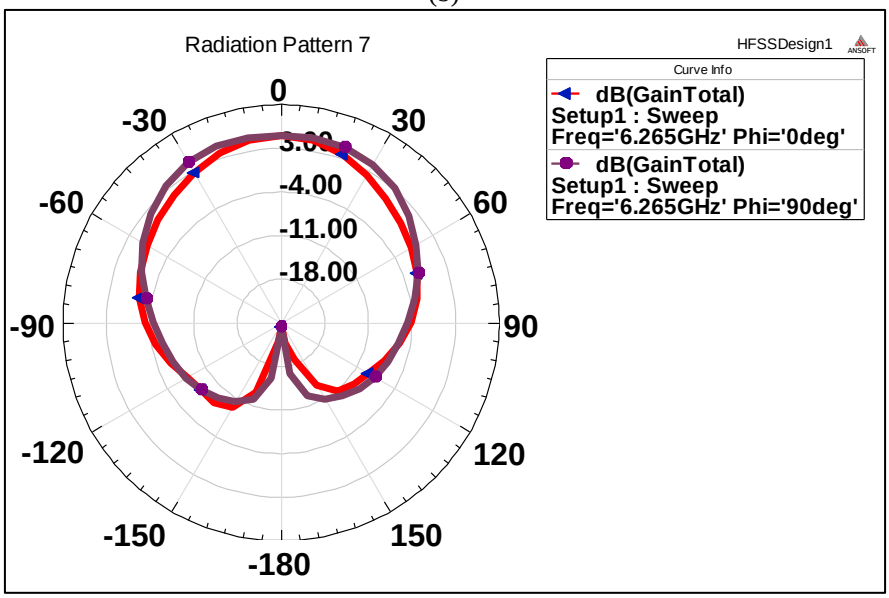
The typical radiation pattern measured at their centre frequencies of the respectivebands are shown in Fig. 3. From these figures it is clear that, the observed patterns of the proposed antenna are to be linearly polarized and broadside radiation characteristics.



(a)



(b)



(c)

Fig. 3: Typical E plane and H-plane radiation patterns of the proposed multiband antenna measured at (a) 1.58 GHz, (b) 2.46 GHz and (c) 6.26 GHz

IV. CONCLUSION

A compact design of planar inset-fed multiband antenna with embedding a rectangular loop slot is proposed, which is suitable for GPS, 2.4 GHz WLAN and X-band satellite communication system applications. By inserting the unequal arm lengths of the rectangular loop slot at the centre of the radiating patch the triple bands are achieved which are resonant at 1.56, 2.46 and 6.26 GHz with an acceptable impedance bandwidths of BW_1= 5.09%, BW_2= 11.76% and BW_3= 6.98% respectively. Moreover, the proposed antenna shows good broadside radiation characteristics at desired frequency bands. Hence, the proposed antenna is an ideal choice for multi band wireless communication systems.

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