Compact INSAT C-Band Notched Ultra Wide Band Antenna

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***Abstract*: This paper presents the design of a compact corner fed rectangular shaped monopole. The size of the antenna is 22x20x1.6 mm^3, fabricated on an FR4 substrate with a microstrip line feed at one of its corners. The antenna consists of an asymmetrical rectangular ground plane with respect to feed and a rectangular slit below the feed line. The antenna operates over a wide band >7.5GHz. An inverted 'U' shaped slot on the rectangular monopole antenna introduces a notch band (6.5GHz-7.1GHz)The proposed antenna is fabricated, measured for reflection coefficient, radiation pattern and peak gain.**

***Index Terms*: Compact monopole antenna, corner fed monopole, rectangular monopole, band-notched UWB antenna.**

I. INTRODUCTION

Compact antenna design plays a major role in the design of all communication systems. Microstrip antennas are usually used because of low cost, light in weight and small size. The disadvantage of microstrip antenna is narrow bandwidth [1]. So many investigators attempted to design various wide band antennas. A novel fed UWB antenna with dimensions of 30x12x1.6mm^3 is designed to operate between 2.9 to 11.5GHz [2]. Compact band notched antenna is fabricated with dimensions of 30x36x0.4mm^3 operating between 2.82 to 13.95GHz [3]. An elliptical band notched slot antenna is designed with dimensions of 45x50x1.27mm^3 to operate between 3.1 to 10.6GHz [4]. 'C' shaped UWB antenna is designed with dimensions of 26x31x1mm^3 operating over a wide band from 3 to 16GHz [5]. An UWB convex shaped antenna with 36x33x1.8mm^3 operating between 3.1 to 22GHz is proposed [6]. UWB antenna with segmented structure is proved for UWB antenna operation [7]. An inverted 'U' shaped slot introduced on the rectangular monopole antenna introduces a frequency notched band (6.5GHz-7.1GHz).

II. PROPOSED ANTENNA DESIGN

Fig.1. presents the rear view and front view of the rectangular monopole antenna. The dimensions of monopole antenna are mentioned in table I. Ground plane is asymmetrical with respect to the feed line at one of the corners and a rectangular slit is introduced exactly below the feed. FR4 epoxy substrate with 1.6mm thickness, loss tangent=0.02 and ε_r=4.4 is used in the design. The printed prototype is shown in Fig. 2.

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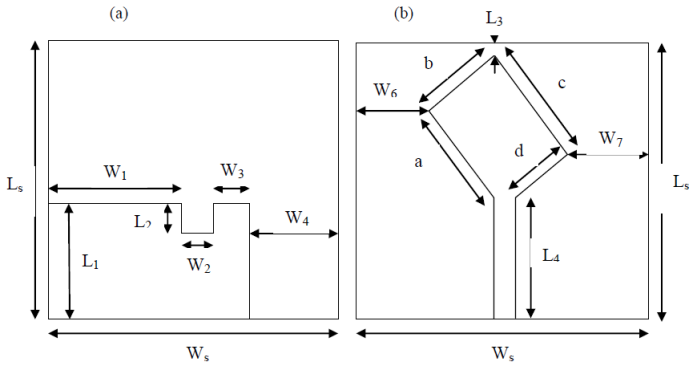

Fig. 1. Rear and front view of proposed antenna

Fig. 2. Rear and front view of printed antenna

The design equations of rectangular monopole antenna are mentioned in equations 1 to 4 [8].

Width of the patch is chosen based on the following equation.

$$W = \sqrt{\frac{2}{\varepsilon_r+1}}\ \frac{1}{2f_r\sqrt{\mu_o\varepsilon_o}} \tag{1}$$

Effective dielectric constant,

$$\varepsilon_{reff} = \frac{\varepsilon_r-1}{2}\left(\frac{1}{\sqrt{1+\frac{12h}{w}}}\right)+\frac{\varepsilon_r+1}{2} \tag{2}$$

$$\frac{\Delta L}{h} = 0.412\frac{\left(\frac{w}{h}+0.264\right)\left(\varepsilon_{reff}+0.3\right)}{\left(\frac{w}{h}+0.8\right)\left(\varepsilon_{reff}-0.258\right)} \tag{3}$$

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Length of the rectangular patch is chosen based on the following equation.

$$L = \frac{\lambda}{2} - 2\Delta L \quad (4)$$

where λ, f, h and ε_r represents operating wavelength, frequency, height of the FR4 epoxy substrate and dielectric constant of the FR4 epoxy substrate respectively.

Table I. Dimensions of the rectangular monopole

S.No.	Parameters	Dimensions
1	L_s	22mm
2	W_s	20mm
3	W_1	8.4mm
4	W_2	3.2mm
5	W_3	4.4mm
6	W_4	4mm
7	W_5	2.92mm
8	W_6	5.75mm
9	L_1	9.8mm
10	L_2	2.8mm
11	L_3	2.08mm
12	L_4	10mm
13	a	8mm
14	b	6mm
15	c	10mm
16	d	4mm

III. RESULTS & DISCUSSION

The rectangular monopole was simulated using HFSS 18.0 software. From the simulated results, reflection coefficient of rectangular monopole exhibits ultra wide band characteristics (4.87GHz to 18GHz) as shown in Fig. 3. The measured radiation pattern of the rectangular monopole antenna at various frequencies is shown in Fig. 4. The E-plane radiation pattern is directional and H-plane radiation pattern is nearly Omni-directional. Deviation in the radiation pattern of the monopole at higher frequencies is due to higher order modes.

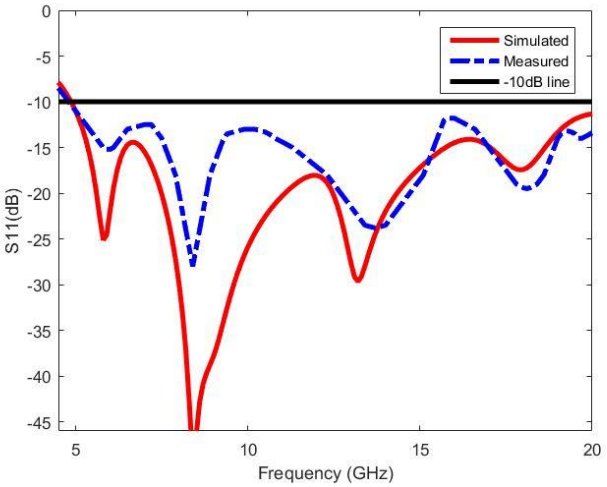

Fig. 3. S_{11} of the proposed antenna.

The peak gain of rectangular monopole is shown in Fig. 5. Comparison between proposed antenna and other designs are listed in table II.

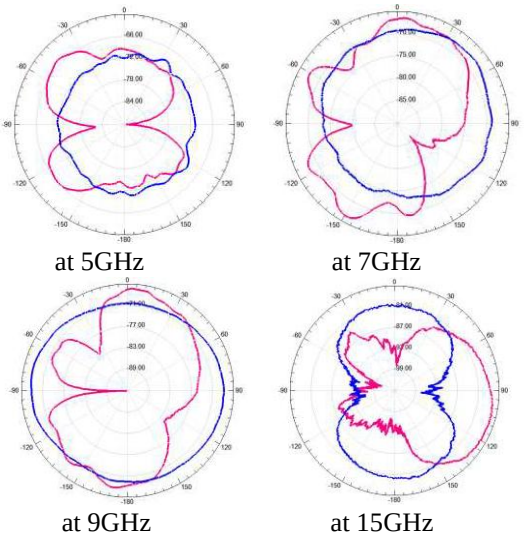

Fig. 4. Measured E-plane (red), H- Plane (blue) pattern

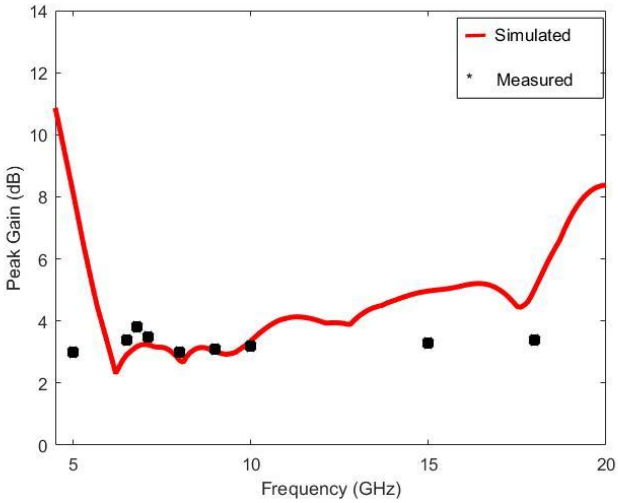

Fig. 5. Peak gain of the rectangular monopole antenna.

An inverted 'U' shaped slot (x=1mm, y=4mm and z=6mm) introduced on the rectangular patch results in a notch band between 6.5GHz to 7.1GHz (INSAT C band) as shown in Fig. 6. The geometry of the slot on the patch is shown in Fig. 7. The reflection coefficient of rectangular monopole without and with slot is presented in Fig. 8.

Table II. Comparison of various antenna designs

Ref. No.	Dimensions	Bandwidth	Notch
[2]	30x12x1.6mm^3	2.9–11.5GHz	-
[3]	30x36x0.4mm^3	2.82 – 13.95 GHz	4.85-6.04GHz
[4]	45x50x1.27mm^3	3.1–10.6 GHz	5.15-5.82GHz
[5]	26x31x1mm^3	3 –16 GHz	3.3-3.8GHz
[6]	36x33x1.8mm^3	3.1–22 GHz	5.1-5.9GHz
proposed	22x20x1.6mm^3	5.08 – 18GHz	6.5-7.1GHz

Fig. 6. Rear view and front view with slot.

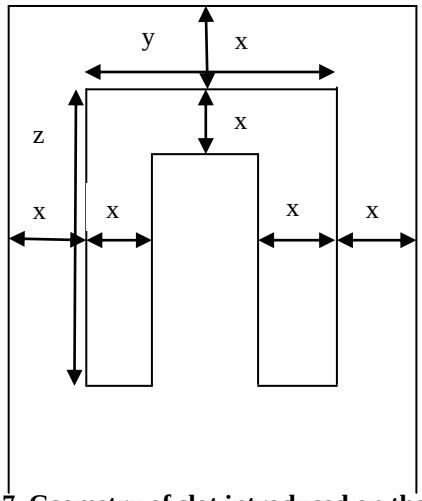

Fig. 7. Geometry of slot introduced on the patch

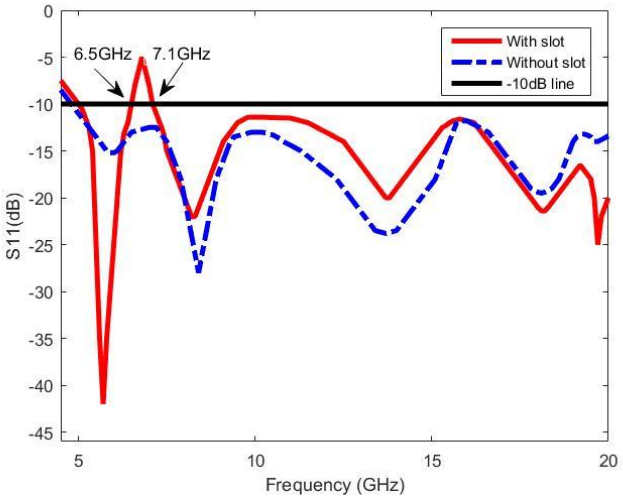

Fig. 8. Measured S_{11} of antenna without and with slot.

IV. CONCLUSION

A simple compact rectangular shaped antenna is designed for UWB applications (4.87GHz to 18GHz), which includes 5GHz WLAN, 5.8GHz ISM band, X band (8GHz to 12GHz) and Ku band (12GHz to 18GHz). An inverted 'U' slot on the patch results in a notch band (6.5GHz to 7.1GHz).

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