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U-shaped Dual-band Microstrip Antenna for WLAN and UWB Applications

Nirali R. Patel[1], Prof. Mayank A. Ardeshna[2]

M.E. Student, Dept. of E&C, GCET, V. V. Nagar, Gujarat, India [1]

Assistant Professor, Dept. of E&C, GCET, V. V. Nagar, Gujarat, India [2]

Abstract: In this paper a dual-band antenna is designed. Our main objective is to design dual-band antenna so that a single antenna can be used for WLAN and UWB applications simultaneously. The antenna design is consist of a U-shaped patch and a rectangular monopole. The proposed antenna is fed by 50Ω microstrip line and designed on a FR4 substrate of size 42mm×24mm×1.6mm. This antenna is radiating at 2.45 GHz (WLAN) and 4.3GHz and 7GHz (UWB application). Design results of Return loss S_{11}, VSWR, gain and directivity is shown in this paper. Design results are obtained by a CST Microwave studio.

Keywords: Tri-band, U-shaped, WLAN, UWB, printed antenna.

I. INTRODUCTION

In the modern communication industry, antennas are the most important component to create a communication link. There are various types of the antenna, among them patch antennas are well suited for aircraft, satellites and mobile applications. This antennas have many advantages like the low volume, light weight, low cost etc[1]. Nowadays, multiband antenna is very popular because a single antenna can be used for many applications[2-4].

UWB antennas and the multiband antennas serve to overcome the bandwidth limitations of the simple patch antenna design. Large bandwidth of UWB antennas can be used to support high data rate indoor applications. While multiband antennas serve indoor or outdoor wireless applications whose specified spectrums are entirely separated[4]. UWB antenna can be designed with additional bands to support WLAN, GPS, GSM. Thus, multiband antennas can be designed to support two, three and sometimes four applications simultaneously [7][8][10]. In this paper, we proposed a dual band antenna design which is used for UWB and WLAN.

II. DESIGN OF A TRI-BAND ANTENNA

In this section, we will introduce the design of our antenna. The front and back view of the proposed antenna are shown in Fig.1 and Fig.2. There are two patches, a U-shaped patch and a rectangular patch. This antenna is fed by 50Ω microstrip line. Substrate is of FR4 material with relative permittivity ε_r=4.3 and thickness t=1.6mm. Dimensions of the substrate is 42mm×24mm. The antenna structure is a variation of circular monopole antenna. The radius (R) of the circular monopole is obtained using the following equation:

$$f_L = \frac{7.2}{2.25R + g} GHz \qquad (1)$$

Where g is the gap between the radiating patch and ground plane. f_L is the lowest resonant frequency. The optimum impedance bandwidth is obtain with g=1mm.

The rectangular monopole resonates over the WLAN frequency band and the U-shaped monopole resonates over UWB. The length of the rectangular monopole is a quarter wave long at the central WLAN frequency:

$$L = \frac{c}{4f} \qquad (2)$$

So, the dimension of the rectangular monopole is optimized to resonate at 2.45 GHz. While the dimensions of U-shaped monopole is optimized to resonate over the 3.1-10.6GHz frequency range.

There is symmetrical slots on both the side of the ground plane (shown in Fig.2) to improve the impedance bandwidth.

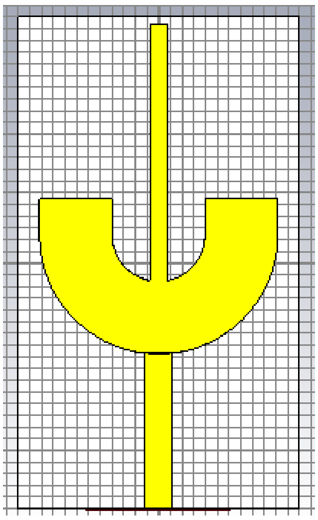

Fig. 1. Front view of dual-band antenna

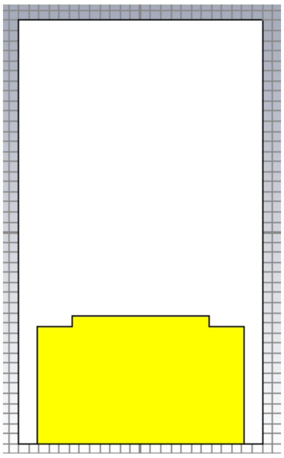

Fig. 2. Back view of dual-band antenna

TABLE I shows all the dimensions of the designed dual-band antenna. The actual CST model is shown in the Fig.3.

TABLE I DIMENSIONS OF DUAL-BAND ANTENNA

Parameters	Dimension
Height of substrate	1.6mm
Length of substrate	42mm
Width of substrate	24mm
Outer radius	10.2mm
Inner radius	4mm
Central arm length	22mm
Central arm width	1.5mm
Left and right arm width	6.2mm
Left and right arm length	3.1mm
Gap between patch and ground plane	1mm

Ground plane dimensions are also optimized to achieve the desired dual-band operation as it affects the resonant frequencies and operating frequencies of both bands. There are symmetrical step slots of size 1mm×3.5mm (as shown in Fig.2) on both sides of the ground plane, which improve UWB impedance bandwidth.

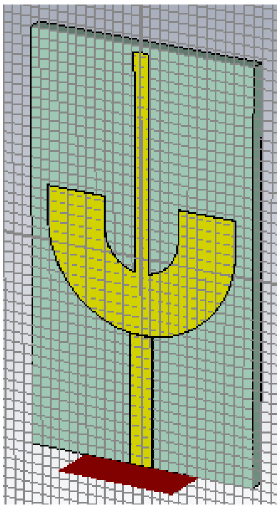

Fig. 3 Actual CST model

III. SIMULATION RESULTS

CST Microwave Studio is used for design and simulation. Fig.4 shows the return loss vs. frequency plot of the dual-band antenna. The structure is optimized such that return loss $S_{11} \leq -10$dB over the UWB frequency range. TABLE II shows values of return loss for different resonant frequencies.

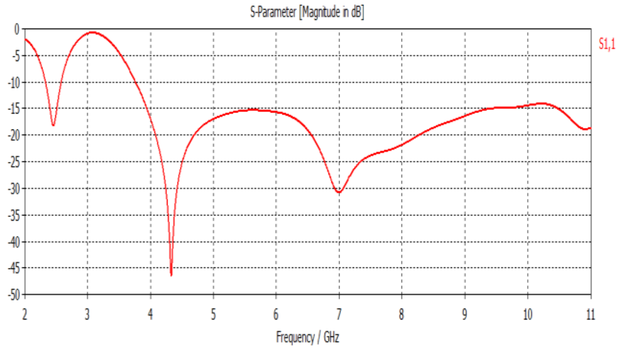

Fig. 4 Return loss of dual-band antenna

TABLE III RETURNLOSS VALUES

BAND	FREQUENCY	RETURN LOSS (DB)
FIRST	2.45GHZ	-17
SECOND	4.3GHZ	-45
THIRD	7GHZ	-30

Fig.5 shows the Voltage Standing Wave Ratio (VSWR) vs. frequency plot of dual-band antenna. The desired value of a VSWR is ≤2.

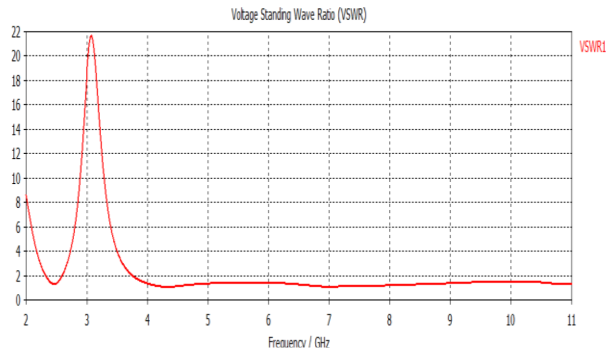

Fig. 5 VSWR of dual-band antenna

TABLE III shows values of VSWR for different resonant frequencies.

TABLE IIII VSWR VALUE

BAND	FREQUENCY	VSWR
FIRST	2.45GHZ	1.31
SECOND	4.3GHZ	1.01
THIRD	7GHZ	1.06

Fig.6 shows the Gain plot of the designed dual-band antenna. And TABLE IV shows values of Gain for different resonant frequencies.

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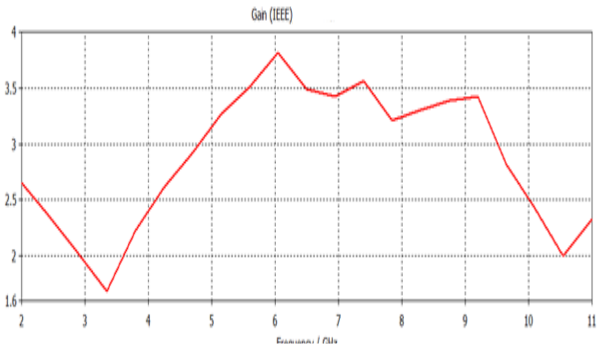

Fig. 6 Gain of dual-band antenna

TABLE IV GAIN VALUE

BAND	FREQUENCY	GAIN
FIRST	2.45GHZ	2.3
SECOND	4.3GHZ	2.6
THIRD	7GHZ	3.4

Fig. 7 shows the directivity plot for the designed dual-band antenna.

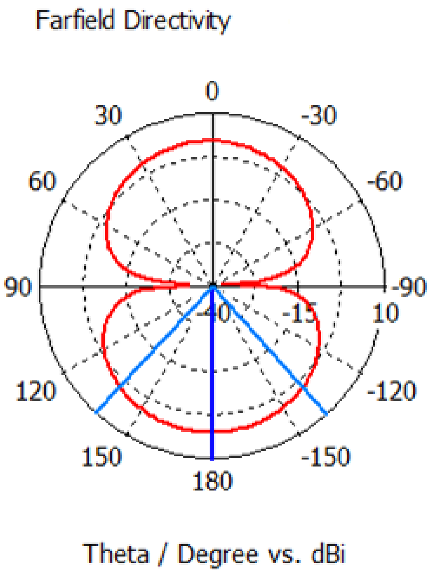

Fig. 7 Directivity of dual-band antenna

IV. CONCLUSION

Here dual-band antenna is designed for WLAN (2.45GHz) and UWB (4.3GHz and 7GHz) applications. The U shaped monopole is radiated over UWB frequency and the rectangular monopole radiated over WLAN application. This antenna provides more than 90% antenna efficiency. The simulated results obtained from CST Microwave studio. Further design can be modified to have multiband for other applications.

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