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The Design of WLAN Band Notched High Gain Monopole Antenna for UWB Applications

Sagar V. Chapke[1], Sudhir P. Bhosale[2]

M.E. Scholar, (Microwave Communication), Dept. of E&TC, AISSMS COE, Kennedy Road, Pune, India[1]

Assistant Professor, Dept. of E&TC, AISSMS COE, Kennedy Road, Pune, India[2]

ABSTRACT: The micro-strip fed monopole antenna is proposed for Ultra wideband frequencies between 3.1 to 10.6 GHz with the band notched characteristics. The structure is designed on Epoxy FR4 substrate where it occupies the small size on the substrate. It is composed of a circular patch with smaller circle and rectangle in the figure of radiating patch. Band notched characteristics of the antenna is resulted by introducing two L-shaped slots. The antenna has return loss (S_{11}) of less than -10dB over 1.6 to 4.9 GHz and 5.2 to 15 GHz. The measured results also demonstrate that the proposed antenna has good omni-directional radiation patterns with appreciable gain. Maximum gain is 4.84 db and is almost constant for all pass band frequencies. The simulated and measured results are in good agreement for the antenna's parameters. HFSS (High Frequency Structural Simulator) 13 is used to conduct simulation of antenna.

KEYWORDS: Monopole antenna; Ultra wideband; HFSS; Band notch filter; Wireless LAN; Radiation pattern;

I. INTRODUCTION

Since the Federal Communication Commission (FCC) allowed 3.1-10.6 GHz unlicensed band for ultra-wide band (UWB) communication in 2002, UWB technology has received an impetus and attracted towards academia and industrial attention the wireless world [1]. UWB communication systems have many advantages, including high speed data rate, extremely low spectral power density, high precision ranging, and low cost. So the study of ultra-wideband antenna is always a hot spot [2].

Antenna is an important part of UWB communication systems, and it is a challenge to design then antenna suitable for such a wide frequency band applications. Printed monopole antenna, due to the simple structure, wide bandwidth & nearly omni-directional radiation patterns, has been widely used in UWB antenna design. Many planar monopole antenna designs have been widely used in the UWB system [3].Recently, the ultra wideband (UWB) communication systems have gained much attention because of their many advantages including low power spectral density radiated power and potential for accommodating higher data rate. To avoid interference between the UWB systems and the wireless local area network system (WLAN) with 4.2 -5.6 GHz frequency band, a notch filter in the UWB system is necessary [4].

This paper presents, a novel compact Ultra wideband monopole antenna with a band notched characteristics. The proposed antenna's radiating patch fed by 50 ohm micro-strip line and a rectangular shaped ground plane. The band notched characteristics resulted because of a pair of employing L-shaped slots that forms U-Shape. And same is etched on the ground plane to get the centre frequency of 5.2 GHz band notched characteristics. The proposed antenna is simulated by HFSS 13 Software which is electromagnetic solver**.** The final of design of antenna from the HFSS 13 is drawn in coral draw software and then printed on transparent film for manufacturing of antenna on Epoxy FR4 substrate as it is easily available in Indian market. The substrate is to be chosen with required thickness and properties of same.

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II. RELATED WORK

In [5] authors manufactured a simple, low cost and compact U-shaped antenna for UWB applications with WLAN band notched characteristic. This micro-strip line fed antenna can be easily integrated. By adjusting the length(l) and width(wl) of L shaped slot in the ground plane, the desired band-notched frequency can be obtained to minimize the interferences between the UWB systems and the WLAN systems. In [6] a novel CPW-fed planar monopole antenna with triple-band operation for WiMAX/WLAN applications has been presented. Comparing with conventional designs, the antenna has a simple fabricated structure and merely uses two bent slots to generate dual stopband. By studying simulated and experimental results of the antenna, it conclude that the stop bands can be adjusted flexibly and independently, and large coverage with appreciable gain is also achieved across the operating bands. Thus, the antenna with good band-rejected characteristic is capable of restricting frequency collision and undesired interference to enhance the radiation performance.

In [7] authors proposed the monopole antenna, as it is a hot one for the research of the UWB antennas. In this paper, radiating patch and ground plane are designed to increase the bandwidth of the monopole antenna. The bandwidth is extended to 1.5 GHz to 15 GHz. Moreover, the radiation characteristic is good in working bandwidth. The simulation of antenna done by using Ansoft HFSS 13 to simulate the UWB monopole antenna.

In [8] authors has attempt for gain enhancement of the antenna, that exhibits a gain with maximum value of 8 dbi and percentage bandwidth of 154%. Here In this paper a simple monopole antenna with circular ring patch on a hexagonal ground plane has been presented. The circular ring radiating patch is fed using micro-strip line. This monopole antenna can radiate theoretically and practically at the frequency ranges of 1.94 GHz to 13.84 GHz and 1.82 GHz to 12.25 GHz, respectively, being the theoretical and practical percentage bandwidth of this antenna 151% and 154%, respectively. The minimum return loss between this frequency range is −40 dB. The bandwidth at −10 dB is more than 10 GHz.

III. PROPOSED DESIGN OF ANTENNA

The proposed antenna is simulated by HFSS 13 Software which is electromagnetic solver. The optimized dimensions are obtained after a good number of simulations. For better matching of input impedance the radiating patch is placed in the position with respect to ground plane of the antenna. The Radiating patch of the antenna is designed by following steps as 1) First created outer circle of radius 12 mm. 2) Then circle 2 of radius 7 is deleted from it. 3) Inside that now inserted rectangle 1 of 11 x 11. 4) From this rect. Delete circle 3 of radius 4.5. 5) Now insert rectangle of 7x7 in between. 6) Delete circle 4 of radius 3 from it. The shape of the ground plane as rectangle with dimension 48 mm × 34 mm. It Exhibits a better results. Dimensions of rectangular ground plane have been optimized to exhibits best gain and bandwidth [7].

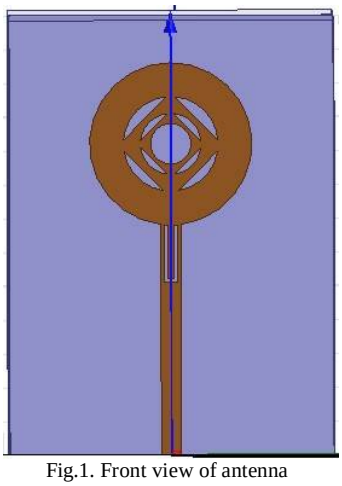

Fig.1. Front view of antenna

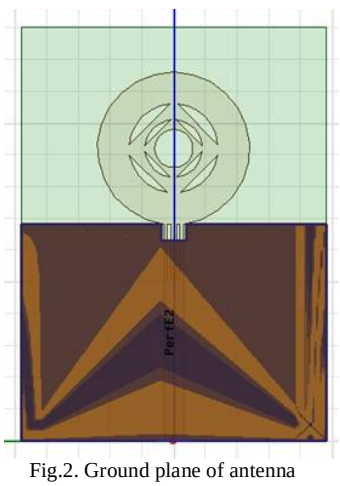

Fig.2. Ground plane of antenna

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The geometry of proposed antenna is shown in Fig.1 and Fig.2 in HFSS, radiating patch and ground plane respectively. The coral draw software is used to designing the final design of HFSS for the purpose fabrication of antenna. Design Fig. 3 and Fig.4 shows the configuration of the proposed monopole antenna. The proposed antenna is designed using low cost glass epoxy (FR4) substrate material having thickness (h) of 1.6 mm, permittivity Dr= 4.4.

Fig.3. Proposed antenna radiating patch

Fig.4. Ground plane of proposed antenna

IV. SIMULATION RESULTS

The simulation study determines the various important parameters of antenna. The simulation results are obtained in structural simulator. Fig.5 shows the gain of the antenna. The measured peak gains versus the frequency of the antenna, as can be found, significant gain reduction has been received at designed stop band at 5.2 GHz, and stable gain variation across the pass band also can be achieved. Maximum gain is obtained at 4.84 GHz. The Fig.5 shows simulated gain of antenna. The proposed compact antenna with good band-rejected property and stable gain variation is well suited for UWB applications.

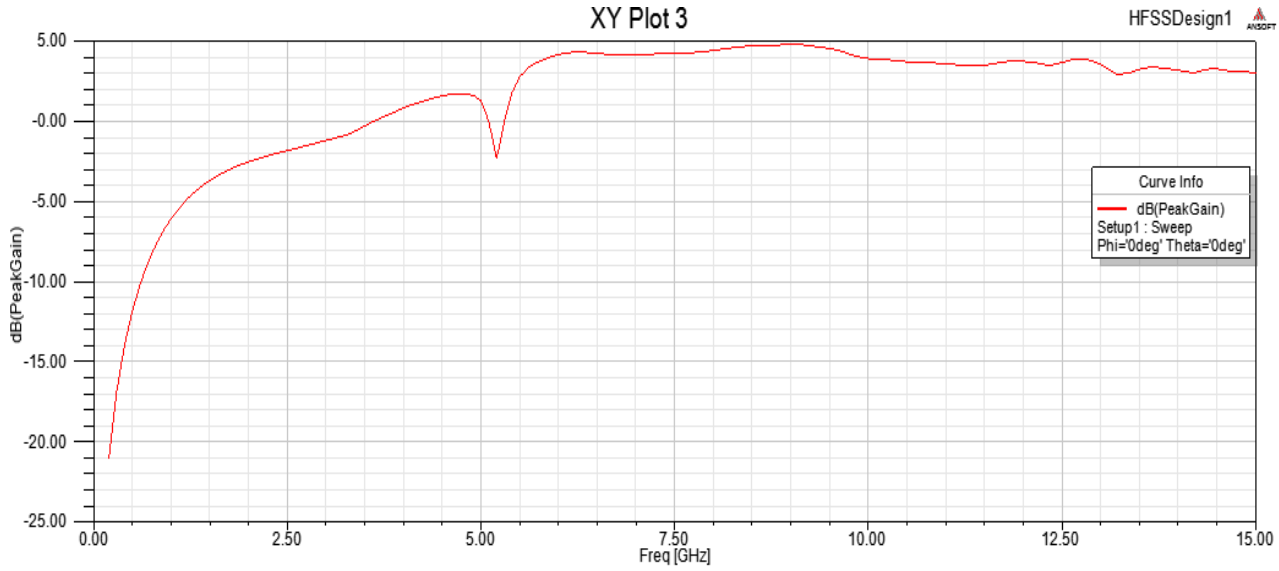

Fig.5. Simulated Gain of the proposed antenna

The Fig. 6(a) and Fig. 6(b) shows the 2D & 3D radiation pattern of antenna in xz plane respectively, it exhibits a far field radiation. Antenna radiates from 1.5 to 15 GHz. Radiation of antenna is improved and it is up to the mark. To

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avoid interference between the UWB systems and the wireless local area network system (WLAN) with 5.15- 5.825 GHz frequency band, a band notch filter in the UWB system is necessary. Thus we have added notch filter at 5.2 GHz. Hence, antenna will not radiate from 4.2 GHz to 5.6 GHz with center frequency of 5.2 GHz which is WLAN frequency. The radiation characteristics of the antenna in the whole bandwidth are suitable for UWB communication system requirements.

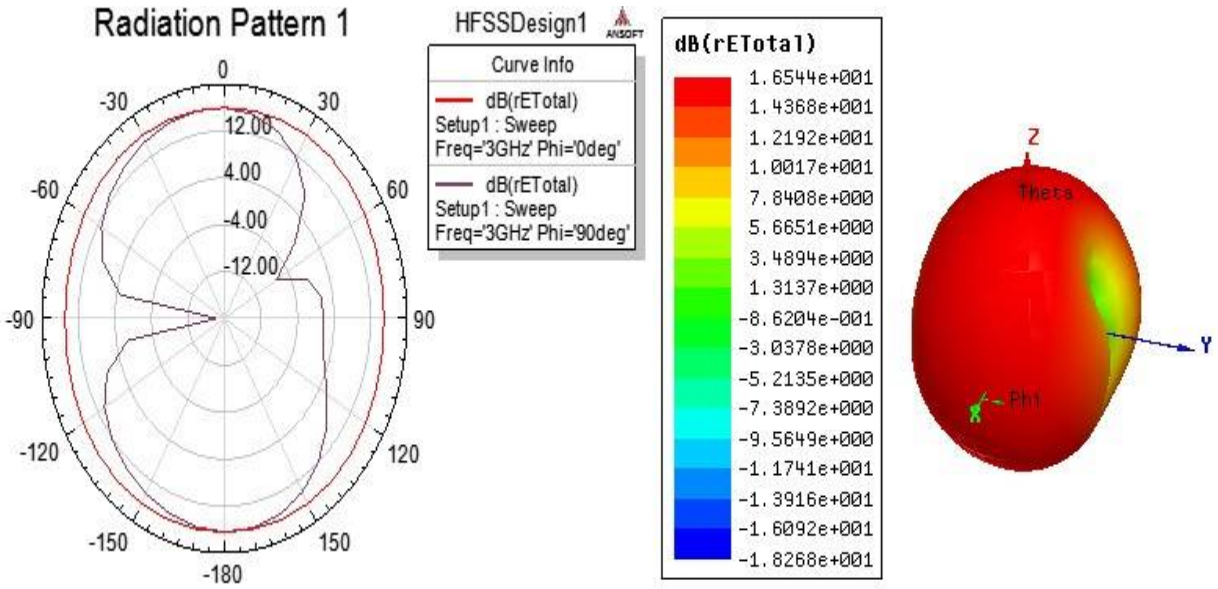

Fig.6(a) 2D Radiation pattern of antenna (b) 3D Radiation pattern of antenna

The voltage standing-wave ratio (VSWR) is shown in Fig.7. It can be seen that when the bandwidth is in 5.5-15GHz, the VSWR value is less than or equal to 2. The bandwidth of proposed antenna is larger than the FCC's requirement. VSWR is 6.64 at 5.2 GHz indicates strong rejection.

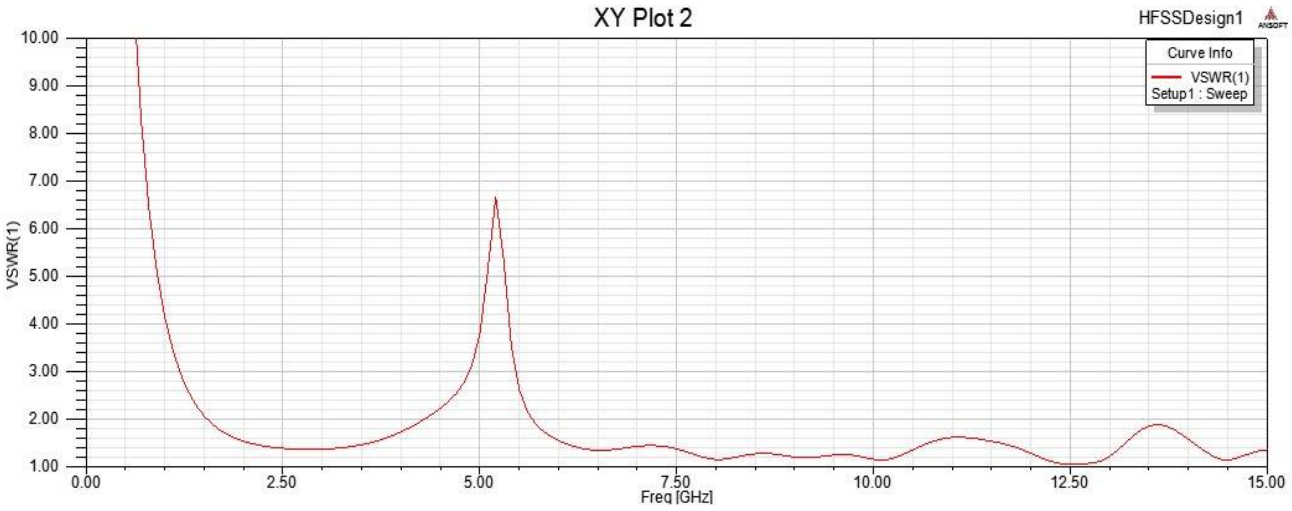

Fig.7. The simulated voltage standing-wave ratio (VSWR) of the antenna

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Return loss of antenna is represented by S-parameter (S11) that determines the how much power is reflected from the antenna. Return loss value is less than -10 db over 1.6 to 4.9 GHz and 5.2 to 15 GHz. Fig. 8 shows the simulated return loss of antenna.

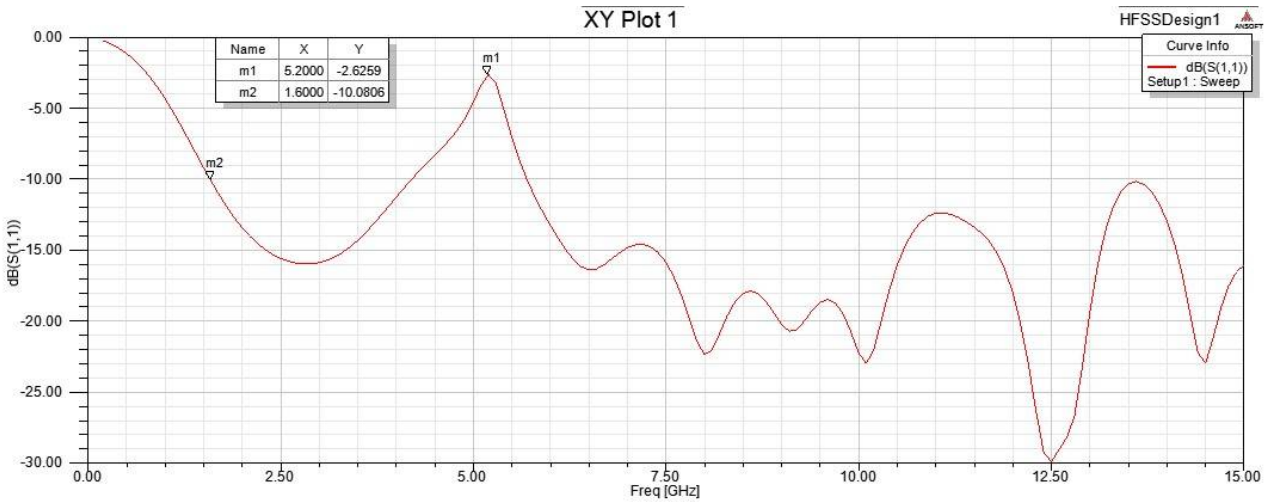

Fig.8. The simulated return loss (S_{11}) of the antenna

V. EXPERIMENTAL RESULTS

After the final fabrication of antenna, measurement took place with help of Network analyzer. It is an instrument that is used to measure the network parameters of the various electrical circuits. For antenna, we can make an analysis of S-parameter (Return loss) and VSWR. Fig.9 & Fig.10 shows the Voltage standing wave ratio (VSWR) and Return loss of antenna. The simulated and measured results are in good agreement for antenna parameters. The little mismatch between simulated and measured results may be due to the measurement process and fabrication tolerance.

Fig.9. VSWR Measured on Network Analyzer

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Fig.10. Return loss Measured on Network Analyzer

VI. CONCLUSION

The design of WLAN band notched high gain monopole antenna for UWB applications has been presented. Compared to the conventional designs, the antenna has simple fabricated structure. The antenna exhibits the best results of Gain, Radiation pattern, VSWR and Return loss. The bandwidth is improved upto 1.5 to 15 GHz. Moreover, the radiation characteristic is good in working bandwidth. Band notched filter introduced in antenna, designed at the center frequency of 5.2 GHz that makes the antenna operating frequency band smoother. The antenna with good band rejection and undesired interference to enhance the radiation performance.

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