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Department of ECE, Aarupadai Veedu Institute of Technology, Vinayaka Missions University,

Paiyanoor-603 104, Tamil Nadu, India

Small Size UWB-Bluetooth Antenna Design with Band-Notched Characteristics

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***Abstract*—** The antenna proposed in this paper is a printed dual band monopole antenna for UWB and Bluetooth applications with WLAN band notch characteristics to remove the interferences between UWB and WLAN systems. The proposed antenna is small, low cost and can be easily integrated into existing systems. It has a fork shaped radiating element fed by a
50 ohm micro strip line. Dimensions of the central arm govern the Bluetooth band while dimensions of the U-shaped monopole govern the UWB band. A pair of L-shaped slots is etched on the ground to obtain the WLAN band notched characteristics. Adjusting the total length of the L-shaped slot in the ground plane , the desired band notched frequency can be controlled to minimize the potential interferences between the UWB system and the WLAN system.
The proposed antenna is designed and simulated using HFSS v3 software and the characteristics are plotted. The dimensions are varied to get the desired radiation and rejected bands.
The proposed antenna is then fabricated on FR4 substrate and measurements are carried out. The measured and simulated results are compared to confirm the design.

***Index Terms*—**Ultra wide band, Monopole antenna, High frequency structural simulator.

I. INTRODUCTION

Due to the consumer needs of higher capacity, faster service, more secure wireless connections and new enhanced technologies, the ability to incorporate more than one communication standard into a single system has recently become an increasing demand for modern portable wireless communication devices. Due to limited space it requires an antenna to operate at several bands Hence Ultra wideband comes into play.

Ultra wideband (UWB) is a radio technology known for its high data rate, low power, high bandwidth and short distance communication. Ultra wideband radio technology is a revolutionary approach in wireless communication field in the sense it transmits and receives radio pulse based waveforms in nanoseconds, compressed in time domain rather than
frequency domain unlike the traditional narrow band technology. One of the important features of UWB, along with its huge bandwidth which provides insight for future development is that it is a zero carrier technology i.e.: No carrier is required for transmission of pulses. Its popularity increased, in February 2004, when Federal communication commission (FCC) allocated unlicensed frequency band of
3.1-10.6GHz for UWB applications. This opened doors for the development of numerous applications in UWB technology. [1].Moreover planar monopole antennas can be easily
designed for UWB (3.1-10.6GHz) and Bluetooth (2.4-

2.48GHz) applications at low cost and low power along with high data rate. Also both the bands have the advantage of license free operation in the ISM band . However the Wireless Local Area Networks (WLAN) applications operating in the range 5.15-5.825 GHz interfere with the UWB systems. Hence band-notched characteristics have to be intergraded in the planar antennas for interference mitigation.

II. ANTENNA DESIGN

In this paper, a small and low cost antenna is proposed that can be fabricated easily as well as

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integrated into existing systems. A small monopole antenna with U-shaped radiator and a rectangular

plane is chosen as shown in fig 1 along with its dimensions. A monopole antenna is chosen over a dipole because only half the antenna is required in a monopole and the ground acts as the other half, whereas in a dipole the full antenna is required hence increasing size and cost The U-Shape is chosen because it gives an isotropic radiation pattern. The ground plane of the antenna serves as an impedance matching circuit and also tunes the resonant frequencies. The antenna is fed using a matched 50 Ω micro strip line.

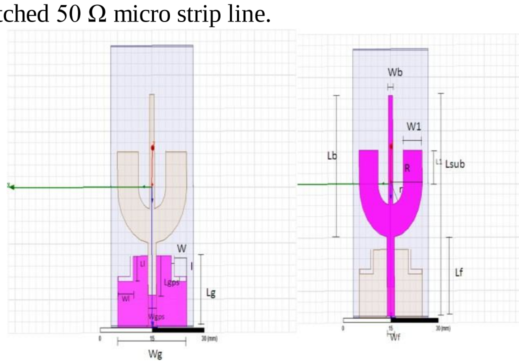


Fig 1: GEOMETRY OF PROPOSED ANTENNA

TABLE 1: DIMENSION OF THE DESIGN

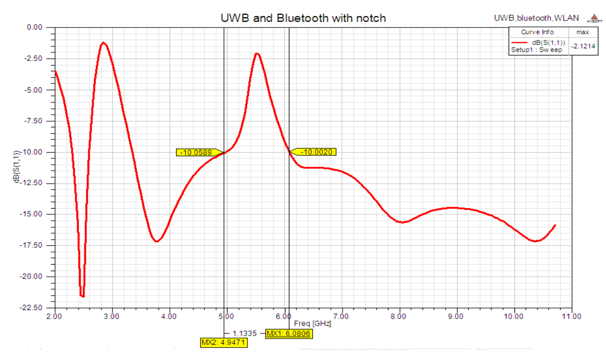
DIMENSIONS	VALUES (IN MM)	DIMENSIONS	VALUES (IN MM)
Lsub	50	Wf	2.4
Wsub	24	Lg	12.7
R	10.1	Wg	20.6
r	4.02	Lgps	7
L1	6.2	Wgps	2.45
W1	6.2	Ll	4.35
Lb	26.4	Wl	4.35
Wb	1.4	L	3.65
Lf	14.7	W	3.65

Dimensions of the central arm govern the Bluetooth band while dimensions of the U-shaped monopole desired band notched frequency can be controlled to minimize the potential interferences between the UWB system and the WLAN system[2][3][4].

III. SIMULATED RESULTS

This antenna was designed using the HFSS software and then the following graphs were simulated, to analyze the characteristics and operability throughout the bandwidth.
The fig 2 shows the simulated graphs for Return loss and group delay.

Fig 2 (a) Return Loss



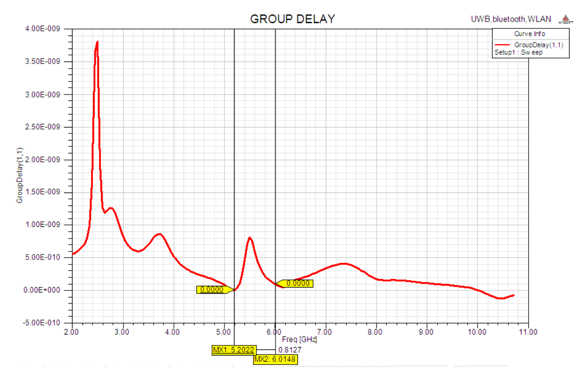


Fig 2 (b) Group Delay

Figure 2: RETURN LOSS AND GROUP DELAY

govern the UWB band. A pair of L-shaped slots is etched on the ground to obtain the WLAN band notched characteristics. Adjusting the total length of the L-shaped slot in the ground plane , the

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From figure 2a we can observe that from 5GHz to 6GHz the UWB band which overlaps the WLAN frequency range is being rejected a s the return loss is above -10 dB.

Moreover, to confirm the notch characteristics we can observe that in figure 2b.There is a sudden mismatch in group delay from 5GHz to 6Ghz proving that antenna can filter the WLAN band, thus eliminating the need for an external filter to avoid interference.

Figure 3 is the 2D and observed at different frequencies for the final design with the band notch characteristics. All the figures represent the radiation pattern for $0^\circ < \theta < 360^\circ$ where, $\varphi = 0^\circ \text{ and } 90^\circ$ .Figure a Represents the radiation pattern at 10.6GHz,Figure b at 7.5Ghz,Figure c at 5.35GHz and Figure d at 3.85 Ghz.We can observe that at all frequencies for $\varphi = 90^\circ$ we have an omni-directional radiation pattern. [3]

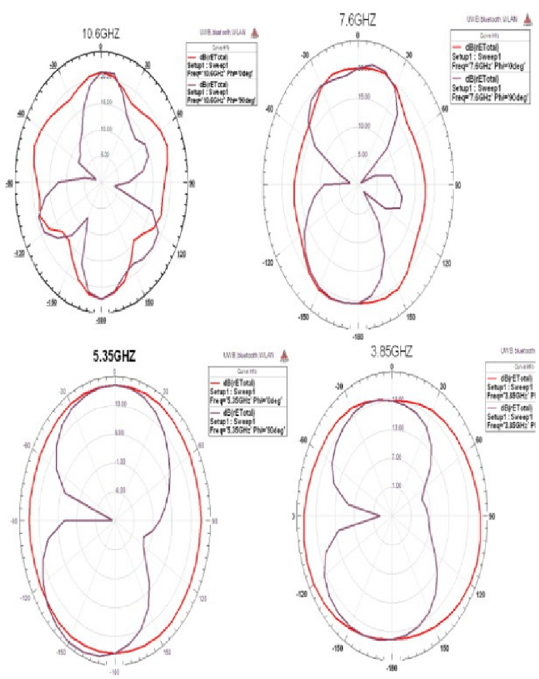
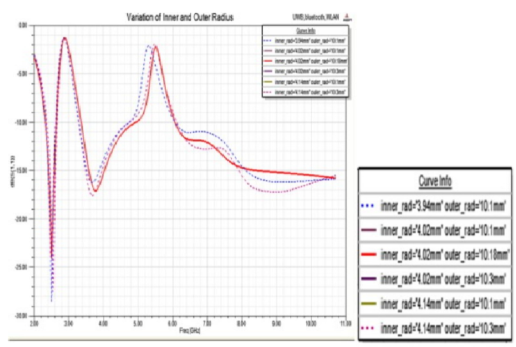


Figure 3: 2D Radiation Pattern at a)10.6 GHz b) 7.6 GHz c) 5.35 GHz d) 3.85 GHz

IV. VARIATION OF PARAMETERS

a) **Variation of Thickness Of U-shaped monopole** The values fixed for Outer Radius(10.18mm) and (Inner Ra- dius 4.02mm) with a thickness of 6.16mm were plotted along with a greater and a smaller value. The thickness is kept con- stant. As seen from the graph only the values fixed give a good result. The other values tend to shift the graph towards the left hence changing the bandwidth rejected that is above -10 dB . Thus our fixed values are verified.

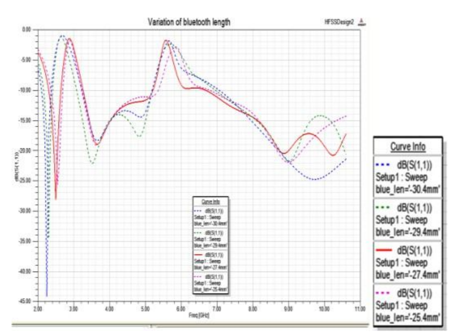
Fig 4: Variation Of inner and outer radius



b) Variation of Bluetooth length

From the graph it can be seen that only the one value gives the proper rejected bandwidth where the return loss in greater than -10 dB. Other values lead to shift in graph towards right hence changing the rejected WLAN bandwidth. Also the return loss around the frequency range of 9 to 10 GHz increases for the other values and the graph changes abruptly. Thus a value of 27.4 mm is chosen.

Fig 5: Variation of length



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c) **Variation Of Rectangular Ground Plane**

From the graph it can be seen that variation of the ground plane leads to the change in bandwidth. Also the return loss increases with decrease in value at the lower frequencies and vice versa at the upper frequencies. Thus the optimum value chosen is 12.7 mm.

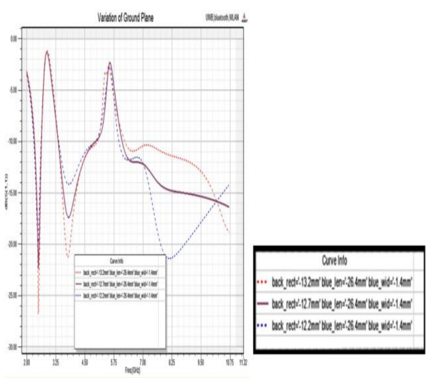

Fig 6: Variation of Ground Plane

d) **Variation Of Back L (edges)**

From the graph it can be seen that with increase in value , the graph shifts towards the right hence changing the entire band- width. Also the negative peak at the upper resonance fre- quency (9GHz) changes abruptly .Hence accordingly the best plot is obtained from the value of 3.5mm .

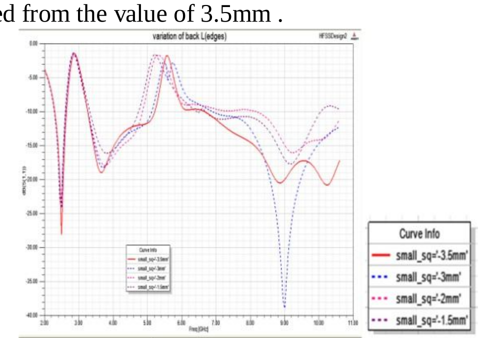

Fig 7: Variation of back L(edges)

V. MEASURED RESULTS

The antenna was fabricated using FR4 substrate of dielectric constant ε=4.25 , tangent loss tanδ = 0.015 , and a thickness of 1.6 mm.The dimensions of substrate are W=24mm and L=50mm.50 ohm impedance line.

(a) Top view (b) Bottom view

Fig 8: Picture of fabricated antenna

The measurements were carried out using the Network Ana- lyzer, Spectrum Analyzer and Function Generator.

UWB Results:-

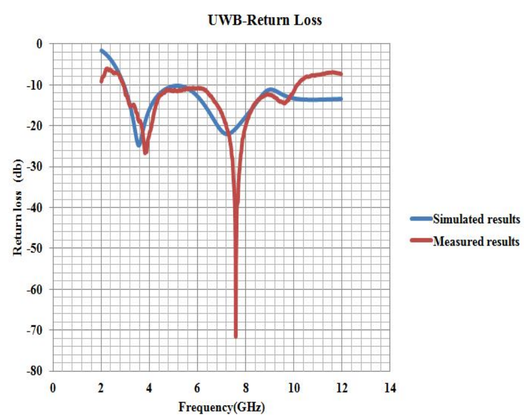

Fig 9: UWB Return loss

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UWB and Bluetooth Results:-

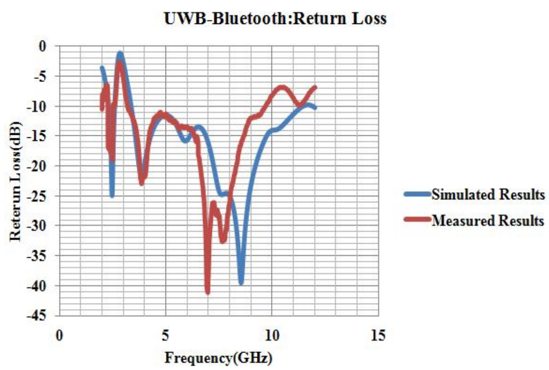

Fig 10: UWB and Bluetooth Return loss

UWB and Bluetooth with WLAN notch Results:-

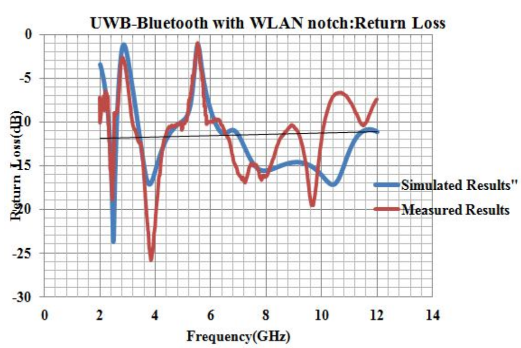

Fig 11: UWB and Bluetooth with WLAN notch Return loss

VI. CONCLUSION

A simple, compact and low cost antenna for Bluetooth and UWB applications with WLAN band notched characteristics is proposed. Dimensions of the central arm govern the Bluetooth band while dimensions of the U-shaped monopole govern the UWB band. Adjusting the total length of the L- shaped slot in the ground plane , the desired band notched frequency can be controlled to minimize the potential interferences between the UWB system and the WLAN system. The proposed antenna provides a good antenna efficiency and gain over the desired frequency bands. The radiation patterns are nearly omnidirectional over the desired bands except in the WLAN notched band. The antenna is fabricated and the measured results obtained are similar to the simulated results hence confirming the design. Thus the proposed antenna is a good candidate for integrated Bluetooth and UWB systems.

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