Dual Band Monopole Antenna for UWB Applications with Added GSM and Bluetooth Bands

G. Sundereshan, K. Vamsi Krishna, R. Vineela, N. Vyshnavi

***Abstract*: Modern communication systems require a single antenna to cover several allocated wireless frequency bands. UWB antenna is desirable to support several other applications such as GSM and Bluetooth. In this research, a UWB planar monopole antenna with extra GSM, Bluetooth, and dual-notched bands is presented. An elliptical monopole antenna that covers the UWB range is used as the base antenna. By attaching inverted L-shaped strips of a quarter wavelength to the ellipse-shaped radiation patch, extra bands/notched bands can be generated. The measured results show that the proposed antenna has stable omnidirectional radiation patterns over all the frequency bands. Present day correspondence frameworks require a solitary radio wire to cover a few allotted remote recurrence groups. Accordingly, it is truly requested to coordinate thin recurrence groups into a UWB reception apparatus plan. Specifically, out of the UWB band, an UWB reception apparatus is alluring to help a few different administrations, for example, GSM and Bluetooth.**

***Index Terms*: Antenna, Bluetooth, Global System for Mobile communication (GSM), Ultra-Wide Band (UWB).**

I. INTRODUCTION

In this project we proposed a single pole that is a monopole antenna to cover Ultra-Wide Band (UWB), Global System for Mobile communication (GSM), and Bluetooth bands. As of late, UWB frameworks over the 3.1– 10.6 GHz band, have done in huge research control for the short-extend remote correspondence. As a key segment of UWB frameworks, UWB receiving wire has increased expanding considerations. In any case, receiving wire plans for UWB applications confront numerous difficulties. Specifically, a UWB radio wire ought to be equipped for working over a recurrence band from 3.1 to 10.6 GHz, and showing omnidirectional and stable radiation designs, steady gain, also, amass delay in the whole data transfer capacity. In spline-formed UWB reception apparatuses were proposed through a molecule swarm enhancer. In any case, the impedance transfer speeds can't cover 3.1– 10.6 GHz.

Revised Manuscript Received on April 07, 2019.

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II. LITERATURE

In [1], To design a novel monopole antenna for various wireless communication applications. Using band notched characteristics designing the elliptical monopole antenna for three different bands. The proposed UWB antenna does not support all the required bands, we must do some extra configurations. Modern communication systems require a single antenna to cover several allocated wireless frequency bands.

In [2], To study the details about potentials of UWB technology in wireless communication. Discussed various components like data rate transmission, Robustness, Time domain resolutions, Security. It is categorized to different regulations in different geographical locations or areas. Attractive for future wireless communications and many other applications. We can know more about the specifications of the working geographical conditions.

In [3], To design the small planar monopole antenna for GPS, GSM, WLAN bands. The main motive is to satisfy the growth of wireless communication and its requirements. A notched region is introduced in a UWB. The proposed one consider as base antenna only for ultra-wide band. Based on this antenna further modifications or configurations will be possible.

In [4], To study and design an antenna with dual bands for two applications. The designed antenna consists of a radiating patch for the dual bands. The notch frequency must be adjusted by changing the configuration of rectangular patch. we can vary the required dual band applications based on our require bands

.In [5], Printed antennas are good candidates for being used because of wide impedance bandwidth, omnidirectional radiation pattern. The radiation pattern of the proposed antenna in both E- and H-planes is to be considered. As mentioned above the measured radiation patterns in E and H planes should be almost stable. It will be one of the bases for triple band antennas and further required number of bands.

III. THEORETICAL ANALYSIS

3.1 ULTRA WIDE BAND (UWB) TECHNOLOGY:

Ultra-wideband (UWB) technology for communications and radar has been a topic of research since the early 1960s. However, research and development in this area gained momentum only in recent years for several reasons. The principal reason is the handiness of high-speed

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semiconductor switching device technology. The use of UWB in the range of 3.1 to 10.6 GHz was unlicensed by FCC. This permitted the unlicensed use of deliberate UWB wireless emissions within restricted frequency bands at very low power spectral density and is history from the viewpoint of frequency overlay. Finally, as the wireless spectral bands are getting herded with the development of wireless devices, the need for high-bandwidth wireless communications is also forcing the development of UWB communication systems.

$$C = B.\ log2(1 + S/N) \text{ ----------------------(1)}$$

where B is the bandwidth and S/N is the signal-to-noise ratio. Range of operation of such systems
is ascertained by the Friis formula.

$$d \propto \sqrt{Pt/Pr} \text{--------------------(2)}$$

d being the distance, Pt the transmitted power and Pr the received power, the above equations suggests that channel capacity can be increased by increasing bandwidth instead of power. Thus, UWB has primarily been a high bit, short range system. The advantages, disadvantages and applications of UWB are listed in Table. 1

Table 1. UWB advantages, disadvantages and applications.

UWB Property	Advantages	Disadvantages	Applications
Very wide fractional and absolute bandwidth	High rate communications	Potential interference to/from existing systems	High-rate Wireless Personal Area Network
	Potential for processing gain	Large number of multi-paths	Low-power, communications, indoor localization
Very short pulses Persistence of multipath reflections	Low frequencies penetrate walls, ground	Long synchronization times	Multiple access Low power combined communications and localization
	Direct resolvability of discrete multipath components	Scatter in angle of arrival	
Carrier-less transmission	Diversity gain	Inapplicability of super-resolution beam forming	NLOS (non-line of sight) communications, indoor and on ships
	Low fade margins		
	Low power Hardware simplicity Small hardware		Smart sensor networks

3.2 GLOBAL SYSTEM FOR MOBILE COMMUNICATION (GSM):

In the growing scene the interest of power is expanding step by step. The power utilities are trying ceaseless endeavors to lessen the hole among free market activity. The impact of different blames in power framework prompts impromptus blackouts in power framework, which exacerbates things. Transformers are the core of intensity framework. They are the key mechanical assembly in power framework. Any blame on transformer prompts pointless blackouts and immense misfortune to electric utility. For appropriate and solid task of intensity transformer, ceaseless condition observing is being required.

3.3 BLUETOOTH:

Bluetooth innovation necessitates that an ease handset chip be incorporated into every gadget. The handset transmits and gets in a formerly unused recurrence band of 2.45 GHz that is accessible all around - with some variety of data transfer capacity in various nations. Notwithstanding information, up to three voice channels are accessible. Every gadget has a one of a kind 48-bit address from the IEEE 802 standard. Bluetooth associations can be point to point or multipoint.

3.4 MULTI BAND ANTENNA:

A multiband reception apparatus is a receiving wire intended to work in various groups of frequencies. Multiband receiving wires utilize a structure in which one a player in the reception apparatus is dynamic for one band, while another part is dynamic for an alternate band. Multiband reception apparatuses may have lower-than-normal gains or be physically vast in comparison to single-band receiving wires with the end goal to accommodate the different groups.
The wires at the focal point of the feed of straightforward multiband radio wires are isolated vertically by a little sum, and the closures are isolated by a couple of inches. These straightforward measurements make it conceivable to cut radio wire lengths for given frequencies and dispense with the requirement for pruning.

3.5 DIFFERENT TYPES OF SUBSTRATES:

Table 2. comparison of different types of substrates

Parameters	Bakelite	FR4	RO4003	Taconic TLC	RT Duroid
Dielectric contact	4.78	4.36	3.4	3.2	2.2
Loss tangent	0.03045	0.013	0.002	0.002	0.0004
Water absorption	0.5-1.3%	0.25%	0.06%	<0.02%	0.02%
Tensile strength	60 MPa	<310 MPa	141 MPa	-	450 MPa
Volume resistivity	3x10^7 Mohm.cm	8x10^7 Mohm.cm	1700x10^7 Mohm.cm	1x10^7 Mohm.cm	2x10^7 Mohm.cm
Surface resistivity	5x10^10 Mohm.cm	2x10^5 Mohm.cm	4.2x10^9 Mohm.cm	1x10^7 Mohm.cm	3x10^7 Mohm.cm
Breakdown voltage	20-28 kV	55 kV	-	-	>60 kV
Peel strength	-	9 N/mm	1.05 N/mm	12 N/mm	5.5 N/mm

According to our needs and the properties that FR4 possesses, we felt that the substrate FR4 would be a better choice for our antenna.

4. DESIGN APPROACH

An elliptical monopole antenna shown in the below figure 4.4.1 of 30x30x1 dimensions use FR$ substrate with relative dielectric consent 4.4.

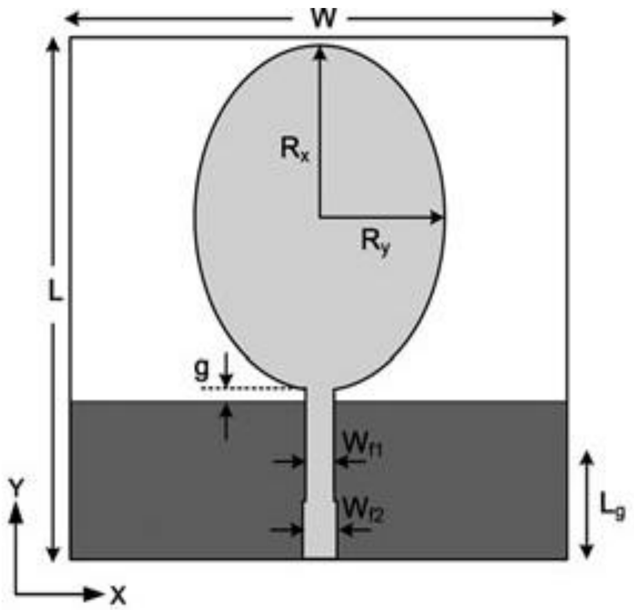

Figure 4.4.1 Monopole patch antenna dimensions of W=30, L=30, Wf1=1.6, Wf2=2, g=0.55, Rx=10, Ry=7.5,Lg=6.5(all dimensions in mm)

For the above basic UWB antenna to provide an extra two independent bands the open circuit strip of quarter wavelength is attaches to the patch antenna. Where to attach the strips we have to consider two length L1 and L2. In the next following figure 4.4.2 we will show the strips.

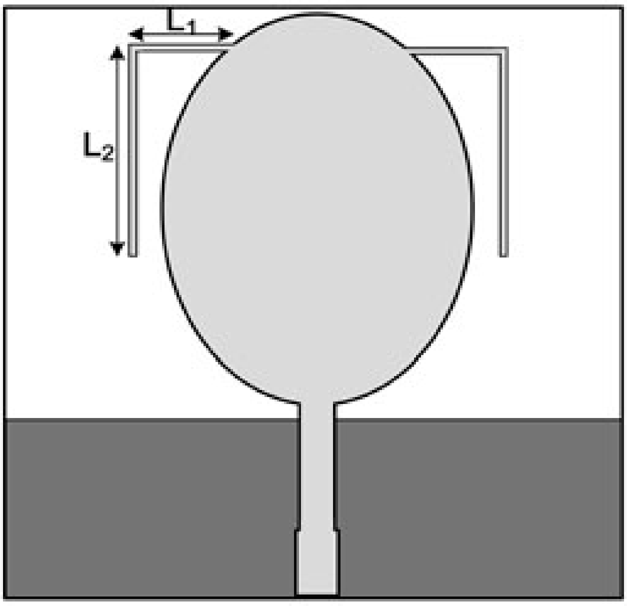

Figure 4.4.2 Patch antenna with added strips.

So, in order to ger the two independent bands below the UWB band the quarter wavelength strips with L1 and L2 with two different lengths are added. By adding these types of strips, we can get the required bands along with the UWB band. If we want to get the extra bands as our requirement it is necessary, that we have make changes in number of strips or the length of l1 and l2 are also can be varied.

5. DESIGN APPROACH

5.1 HFSS ANALYSIS:

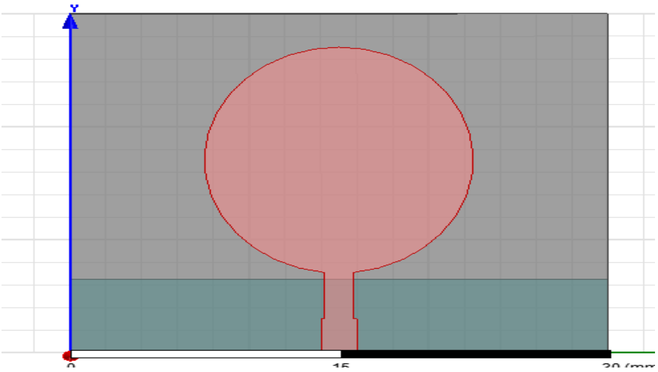

Figure 5.1.1 Basic design of patch antenna using HFSS tool.

In the above figure 5.1.1 the pink colored one is patch antenna and the below blue shaded region is called ground.

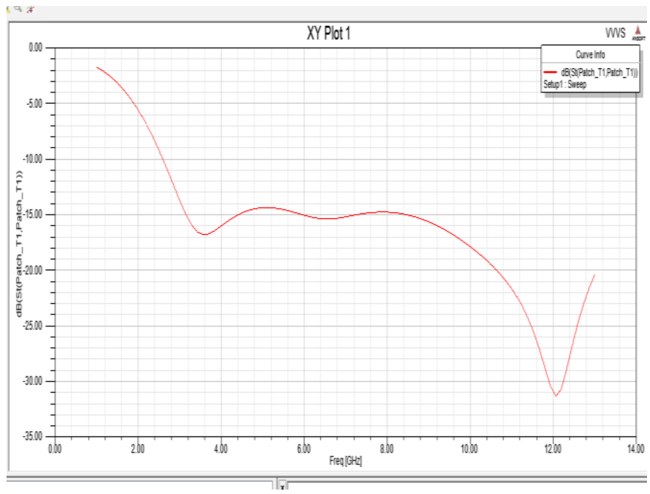

Figure 5.1.2 Graphical representation of return loss for the designed antenna in fig. 5.1.1

As we come to the return loss concept mainly the antenna should have less than -10 dB for any band to work. Where ever it is decreasing below -10 dB we can say as much as efficiency as much as it decreased.

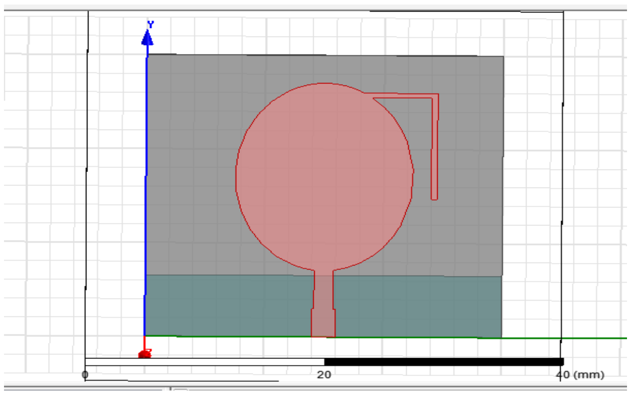

Figure 5.1.3 patch antenna with single strip.

In order to get the multiple bands we have to add the L shaped strips so, here we added one strip to the patch antenna and the return loss should be measured.

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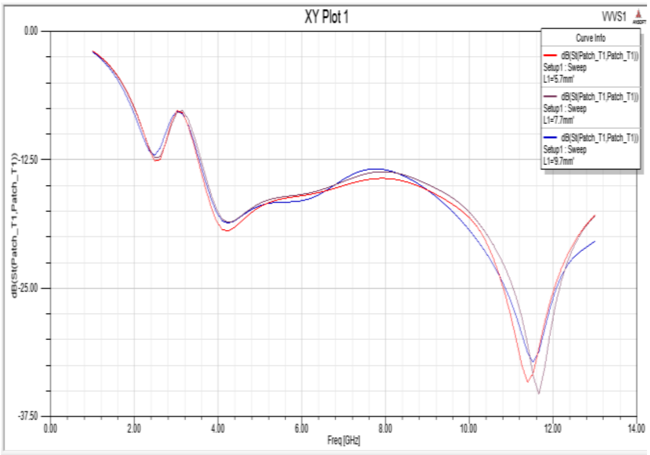

Figure 5.1.4 graphical representation of return loss for the fig 5.1.3

In this one we varied the length of L1 and observed three type of return losses with respect to the length we varied.

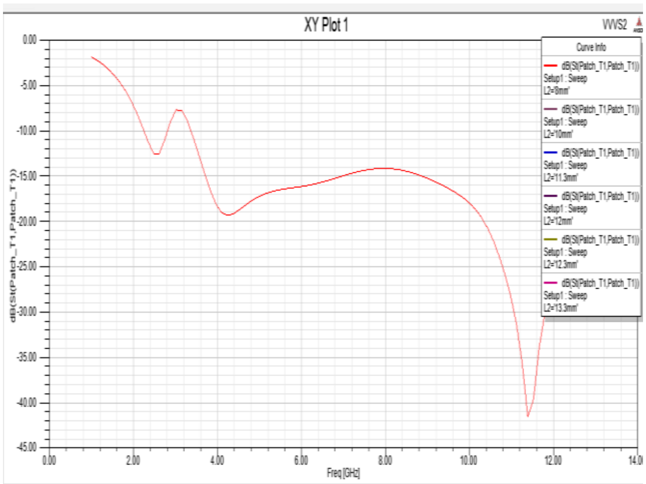

Figure 5.1.5 in this we varied L2 length and checked the results.

In the above graph we checked the return loss of the patch antenna with single strip in above figure 5.1.3 by varying the value of the L2 in the quarter wavelength strip. As we can observe in the above graphical result between 2-4 in the frequency (GHz) the graph started showing below -10 dB and it continued after 10 GHz also so we can say that the entire UWB band i.e. ranging between 3.1-10.6 GHz has been acquired.

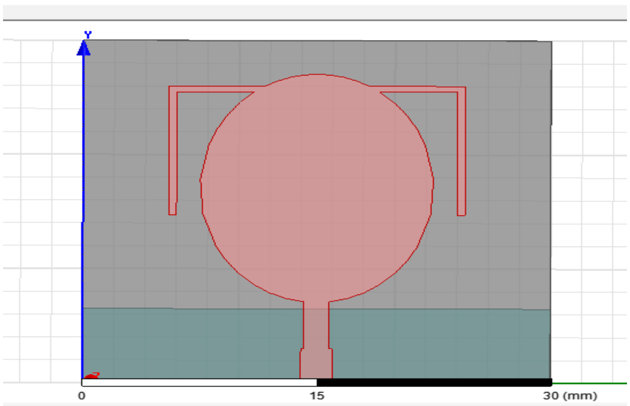

Figure 5.1.6 second strip is added to the patch antenna.

As we not get the three required bands so, we added another strip to get the required output.

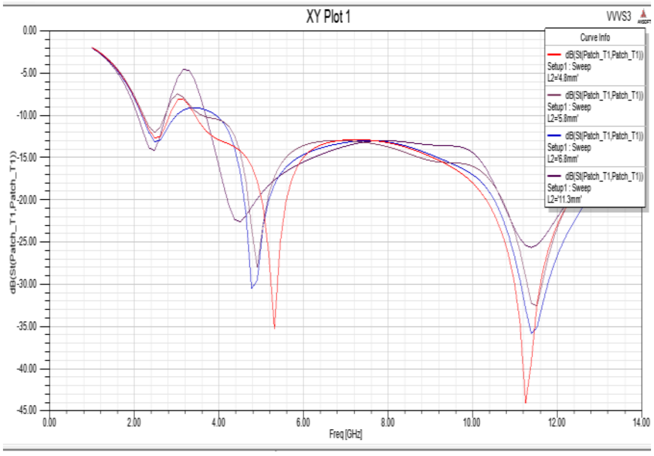

Figure 5.1.7 graphical representation of return loss for the fig 5.1.6

In this antenna we got the best return loss when compare to the above ones. At two points one around 5.5-6.0 we got some better return loss and at second at near 11 we got more and best return loss. But it is not working for multi bands because it is showing only ultra-wide band i.e. 3.1-10.6 GHz.

We have to do more no of trial and error methods with L shaped strips to get the required multi bands.

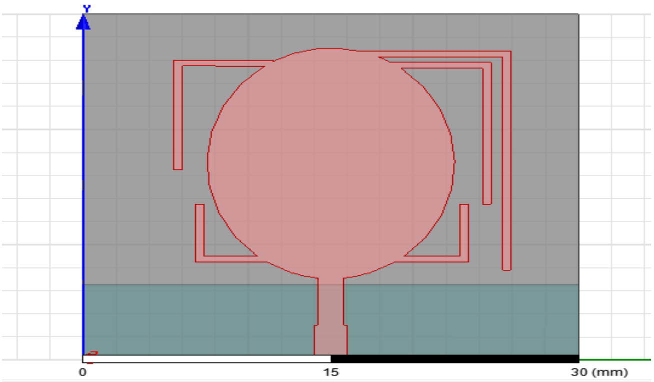

Figure 5.1.8 4strips added to the patch antenna.

As we said in above graphs to get the multiple bands we have to add some more strips.

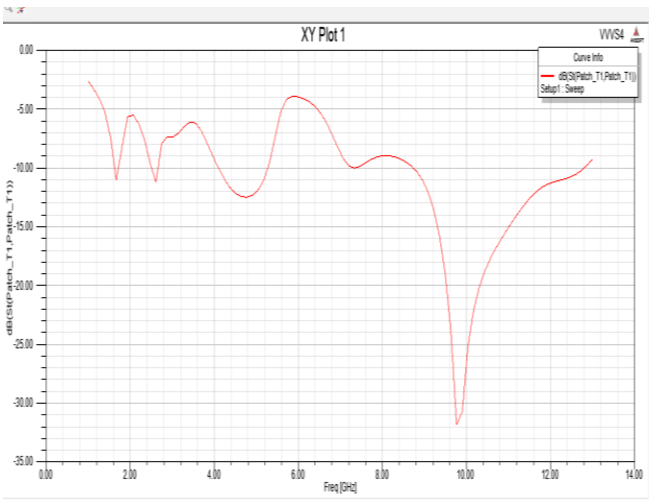

Figure 5.1.9 graphical representation of return loss for the fig 5.1.8

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So finally, after adding 4 strips to the patch antenna we got the three bands required that are UWB, GSM, and Bluetooth bands respectively. The respective GHz of the three bands are UWB(3.1-10.6 GHz), GSM(1.77-1.84 GHz), Bluetooth(2.385-2.49 GHz). And we got best return loss at near to 10 GHz.

SUMMARY

To confirm the capacity of the proposed reception apparatus to work as a UWB radio wire, the size of the exchange capacity and gathering delay between two indistinguishable reception apparatuses are likewise estimated and talked about. As appeared in Figure 8, the size of S21 is moderately level in UWB recurrence band aside from in the scored groups fixated on 3.5 and 5.5 GHz, where the extents diminish significantly. The variety of the gathering delay is inside 2 ns over the entire band except for the scored groups, in which the most extreme varieties are in excess of 10 ns. The outcomes affirm that the proposed reception apparatus is reasonable for UWB correspondence.

CONCLUSION

The monopole antenna for UWB applications wit added GSM and Bluetooth bands are presented. As the base patch antenna works for the UWB and in order to get the different bands below UWB band we have to attach the quarter wavelength L stripes to the elliptical shaped patch antenna. The strips added are independent to each another and will be able to generate the required bands below the UWB band.

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