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UWB Antenna Design with Extra GSM/UMTS/LTE Bands for Smartphones

Piyush Parihar[1] , M. Neelaveni Ammal[2]

[1,2]Department of Electronics and Communication, Faculty of Engineering and Technology
SRM University, Kattankulathur, Tamilnadu, 603203 India

Abstract: ***In this paper, a simple structure of a micro-strip Ultra-Wideband Antenna is proposed which can be used in 4G smartphones. The antenna consists of a rectangular shaped patch with partial ground plane that is fed by a 50 Ω micro-strip line. It supports LTE 1600/1800/2600 MHz for 4G , UMTS 2100 MHz for 3G, GSM 1800/1900 MHz for 2G, and 3.1~10.6 GHz for UWB. The antenna is designed on a FR4-Epoxy substrate of thickness 1.6mm and the relative permittivity of 4.4. HFSS simulation was used in the design stage. The proposed antenna has a compact size of 20×25 mm^2. The measured VSWR is less than 2.0 from 1.5 GHz to 10.6 GHz and beyond.***

Keywords: GSM; UMTS; LTE; VSWR; Ultra-Widwband(UWB)

1. Introduction

For many years, the ultra-wideband (UWB) communication systems have gained much attention because of their low spectral power density, large channel capacity, and high data rates without influence on other systems. It is well known that a diversity antenna offers attractive applications in wireless communications since it gives out much higher channel capacities compared with using a single antenna [1].

One of the main fields where UWB communication can be applied is the personal area network. In this field, the technology is expected to realize high-speed communication (up to 1 Gbps) among mobile devices such as cellular and smartphones and home information appliances such as PC peripherals, televisions, and video devices [2]. Normally, LTE smartphone has 6 antennas or more. Therefore, adding antenna just for UWB is very difficult due to the reasons of a space and a number of antennas. It is the work that is meaningful for this reasons, it is to support as possible as small UWB and frequency of existing as an antenna. Recently, lots of researches have been carried out to provide small antennas for covering both UWB and existing frequency band [3].

Various type of antennas were proposed in previous papers such as a coupled line loop structure with patch size 29×8 mm^2 designed on a substrate of size 58×110 mm^2 shows ultra-wide operated bandwidth about 8.9 GHz .With 3:1 VSWR (under -6dB Return Loss) [3]. In this paper, we have successfully designed a small structured micro-strip antenna which can be used in 4G smartphones with the VSWR less than 2.0 and the return loss less than -10 dB for the frequencies from 1.5 GHz to 10.6 GHz and beyond. It supports GSM 1800 (1710~1880 MHz), GSM 1900 (1850~1990 MHz), UMTS 2100 (1920~2170 MHz), LTE 1600 (1525~1660MHz), LTE 1800 (1750~1880 MHz), LTE 2600 (2500~2690 MHz) including uplink and downlink bands and UWB (3.1~10.6GHz).

2. Antenna Design

Figure 1 shows the geometry and configuration of the proposed Ultra-wideband antenna for 4G smartphones. The antenna consists of a rectangular shaped radiator fed by a 50 Ω micro-strip line printed on a FR4-Epoxy substrate with thickness 1.6 mm which has a relative permittivity of 4.4 and a loss tangent 0.02. A partial ground plane is printed on the back side of the substrate. The substrate of the antenna has the dimensions of 20 × 25 mm^2. The optimization was performed in the design stage in order to achieve the best impedance bandwidth. This was done by varying the several parameters of the antenna and keeping the other parameters constant. The final optimized parameters values are shown in the table 1.

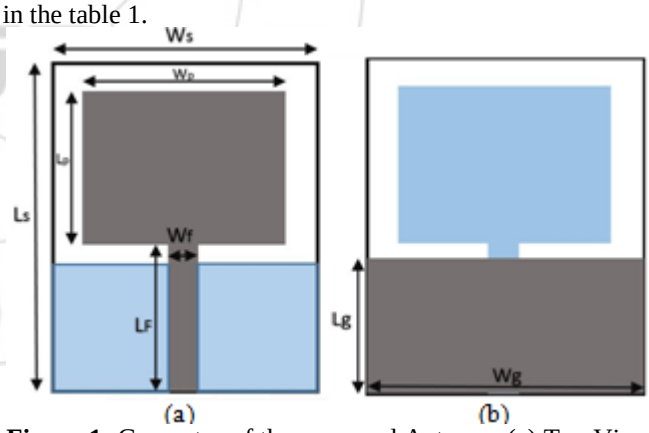


Figure 1: Geometry of the proposed Antenna. (a) Top View (b) Bottom View

Table 1: Optimized Parameters in HFSS

Parameters	*Value (mm)*	*Parameters*	*Value (mm)*
Ls	25	L_f	11
Ws	20	W_f	2
Lp	10	Lg	10
Wp	14	Wg	20

3. Simulated Results and Analysis

A. Return Loss

The design and simulation of antenna was performed in HFSS. Figure 2 shows the simulated Return Loss (S11) characteristics of the proposed antenna. It is shown that the

calculated Return loss of the antenna is less than -10dB from 0.8 GHz to Beyond 10.6 GHz. The result shows that impedance bandwidth of the antenna is more than 9.1 GHz, covering the entire UWB as well as cellular frequencies.

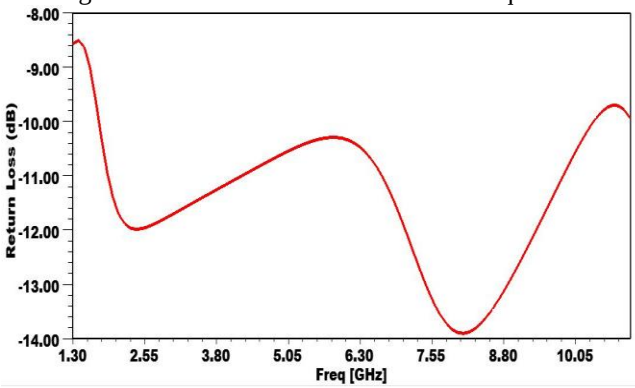


Figure 2: Simulated Return Loss in dB.

B. VSWR

The figure 3 shows the simulated VSWR characteristics of the antenna. It is observed that the VSWR is less than 2.0 for all the frequencies from 1.5 GHz to 10.6 GHz and beyond. With VSWR 2:1 which is widely used for practical internal mobile antennas. The Operating bandwidth of 9.1 GHz from 1.5 GHz to 10.6 GHz is observed.

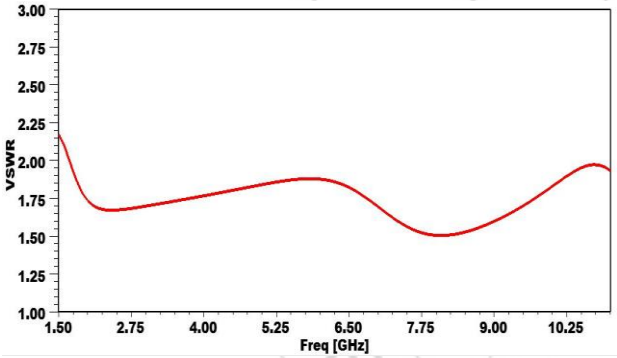
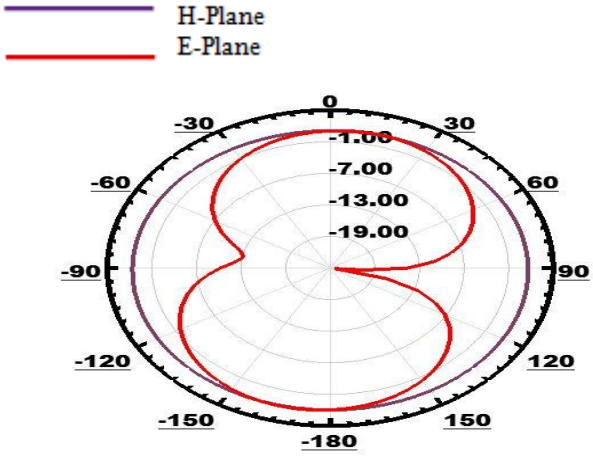


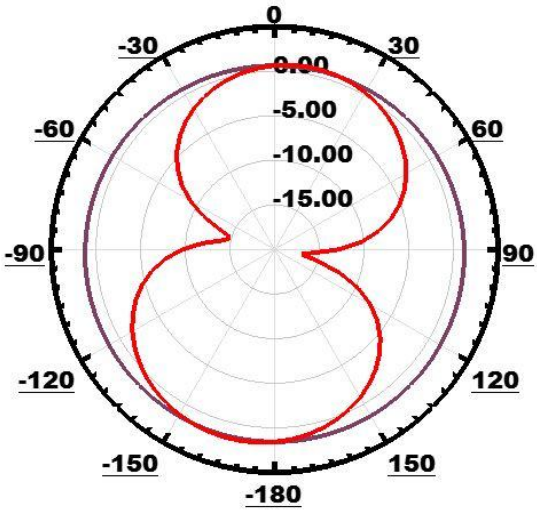
Figure 3: Simulated VSWR

C. Radiation Pattern

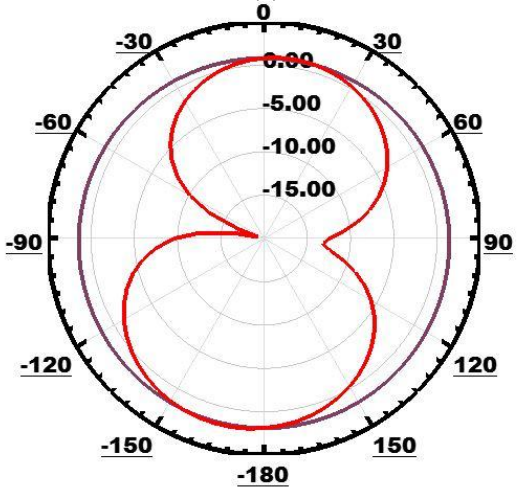
The Radiation patterns of the proposed antenna are measured at 1.8 GHz (GSM), 2.1 GHz (UMTS), 2.6 GHz (LTE) and 6.8 GHz (UWB). The figure 4 shows the radiation patterns at different frequencies. It is observed that the radiation pattern for the proposed antenna is almost bidirectional for all frequencies.



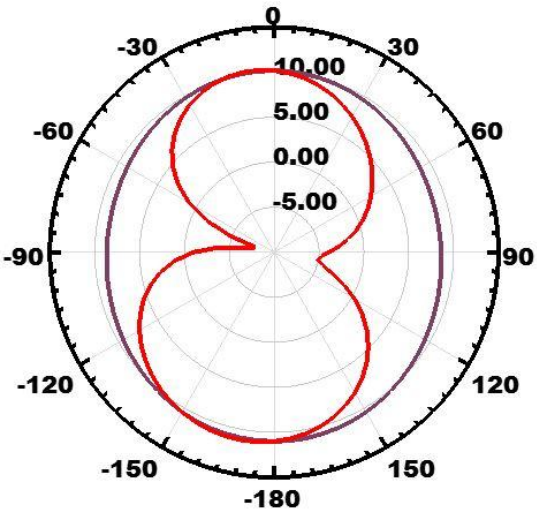
(a)



(b)



(c)



(d)

Figure 4: Radiation Patterns (a) 1.8 GHz (b) 2.1 GHz (c) 2.6 GHz (d) 6.8 GHz

4. Conclusion

In this paper, we investigated a micro-strip antenna, which covers GSM 1800/1900 MHz for 2G, UMTS 2100 MHz for 3G, LTE 1600/1800/2600 MHz for 4G and 3.1~10.6 GHz

for UWB for a 4G smartphone. In the results from the investigation, the proposed antenna designed and showed the VSWR less than 2.0 and Return Loss less than -10 dB from 1.5 GHz to beyond 10.6 GHz. In conclusion, this proposed antenna is suitable for numerous UWB applications and can be used in mobile phones.

5. Acknowledgment

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