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An Efficient positioned Printed Aerial for UWB Applications

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Abstract: In this paper a low profile UWB (Ultra Wideband) antenna with circular polarization is proposed for future wireless 5G communication. This antenna consist of FR4 substrate of permittivity $\varepsilon r=4.4$ due to it's commonly availability board of thickness 1.4 mm. The overall size of antenna (substrate) is 25 X26.2 mm and has two ground planes on the either sides top or bottom of the board. Coplanar waveguide CPW feed is introduced to antenna, it consists of slots and fractal/iteration geometry for resonating UWB. The final proposed antenna is designed with little geometry to achieve final output for the operating band of frequency from 2.4 GHz to 14 GHz i.e. overall bandwidth on 11 GHz. The proposed antenna shows the almost constant behavior in terms of return loss for the entire range of frequency. Simulation results show that this antenna has a -10 dB return loss for the defined frequency and good performance in parameters of VSWR, directivity, bandwidth made this antenna a possible design for indoor positioning required for 5G communication.

KEYWORDS: Coplanar waveguide, Cognitive radio, circular polarization, ultra-wide band antenna, Microstrip patch antenna

1. INTRODUCTION

Wireless communication systems are nowadays widely used in many day to day applications. With the release of the Ultra-Wide Band in 2002 [1], a low-power communication channel with a frequency range from 3 GHz to 9 GHz has been made available for the commercial and common usage. The possibility of using a broad frequency range and therefore broadband pulses for communicating between the handheld, allows the possibility of accurate and reliable locating the device and users.

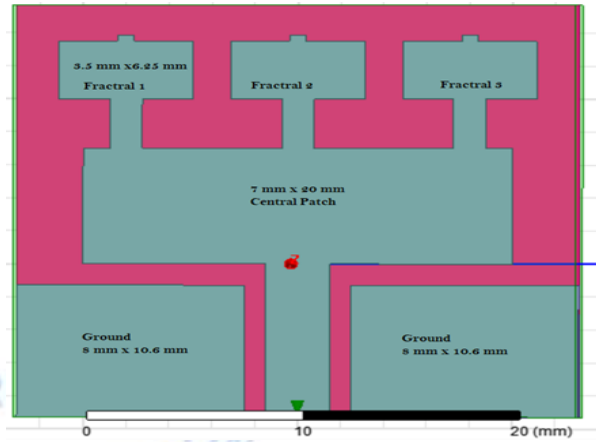
The future 5G communication target to provide reliable and secure wireless connection between handheld gadgets used for communication within a short distance. 5G communications requires a high data rate which is much greater than which are currently exist in wireless technologies.

In the recent years, monopole and fractal antenna geometries for UWB has gathered for considerable research and generate interest due to its simple geometries and its UWB characteristics with omni-directional radiation pattern [1-3]. Even though, it is still not clearly defined why and which type of antenna can achieve UWB characteristics and how to exactly operates it over the entire bandwidth. In this paper, the square shaped monopole antenna is proposed and designed to examine its operation. Based on the understanding of the monopole, two more compact versions, i.e coplanar waveguide (CPW) fed and microstrip line fed square shaped multiple structure slotted monopoles, are proposed. UWB provides reliable and highly secure communication. As the UWB signal has low energy density just like noise, so which makes its detection difficult makes it secure communication. Hence, UWB is the most secure way of wireless transmission which is available [4].

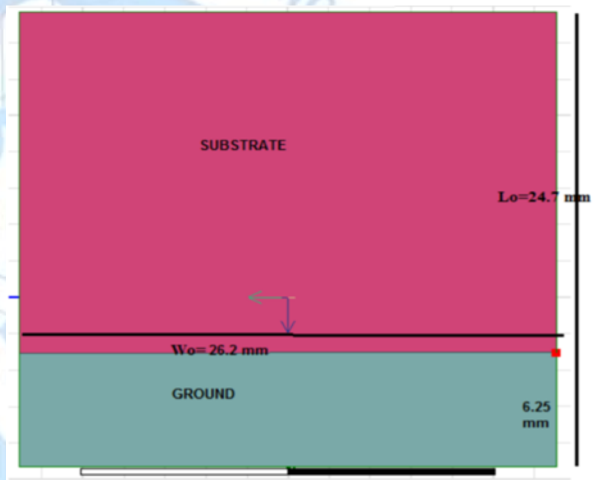
2. ANTENNA DESIGN

The requirement of a low profile antenna suggests the usage of a microstrip structure. These antennas do not only provide a compact design, but they are also easy and cost-efficient to manufacture. However, they usually have a very narrow impedance bandwidth. To overcome this issue, different broadband feeding techniques have been introduced in the past [5-8]. Differently from the circular-polarized patch antenna presented in Section 3.5, an aperture-coupled dual-fed antenna design has been chosen [9]. This decision was made because this design allows an easier manufacturing process compared to other designs.

The 3 Dimensional model of our proposed designed antenna is shown in Figure 1. This antenna consist of i) Substrate FR4 of dimension 25X26.2 mm and the height of the substrate material is 1.4 mm. ii) it consist of central patch of dimension 7X20 mm with 3 slots of 4X4mm(slot 1 and 3) and 4X 2 (slot 2) and iii) iterative patches of 6.25 X 3.5 mm (Iteration 1-3).



a) Top view



b) bottom view

Figure 1 Proposed design Antenna 1

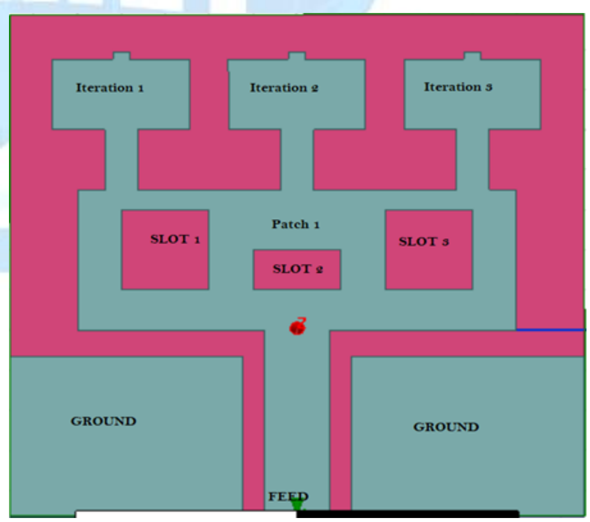


Figure 2 Proposed Final Design Antenna after improvement in Antenna 1.

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Compared to the smallest wavelength, the height of the patch antenna is not negligible. Therefore, materials with higher relative permittivity can be used in place of the air slabs, in order to reduce the overall thickness. To minimize the microstrip and slot dimensions, a further material with high permittivity can be employed. However, this approach will negatively influence the bandwidth characteristics as well as the manufacturing costs.

3. SIMULATION AND RESULTS

All graphs have been created based on a simulation of the second antenna model presented in this section. The metallic parts have been assumed to be perfect electrical conductors and the dielectric substrate has been assumed to be loss free. As mentioned in Section II, the antenna has been placed in the xy-plane. Therefore, the xz-plane and the yz-plane represent a sweep of θ for φ = 0° and φ = 90°, respectively. Phi and Theta are the two orthogonal components of the electric field in the given point.

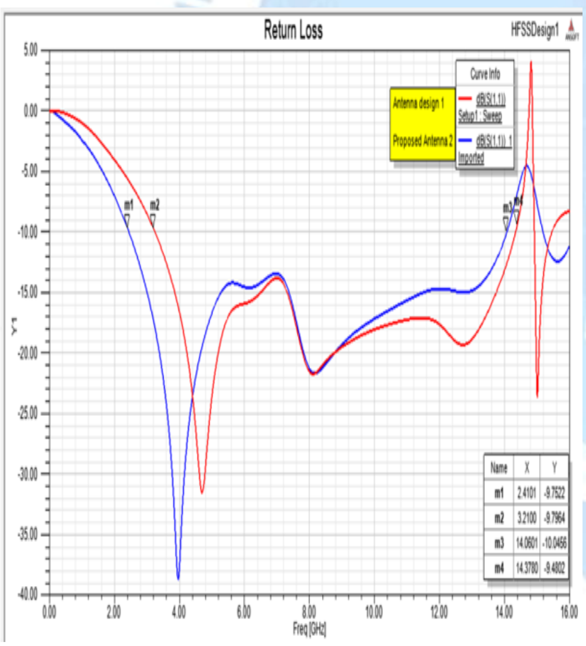

Figure 3 Return Loss for proposed designs

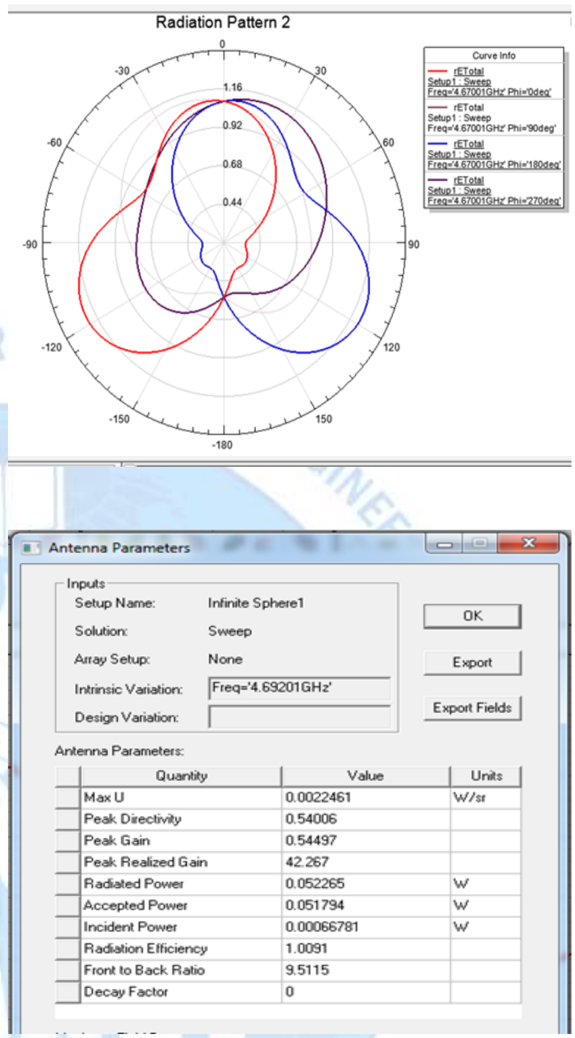

Figure 4 Radiation Pattern and Antenna parameters of proposed design

All graphs have been created based on a model of the second antenna model as defined in [8]. The matching structure has been modified in order to match the antenna input impedance to 50. Ideally, VSWR must lie in the range of 1-2 which has been achieved for the frequencies 4.6 GHz.

At the center frequency (fc = 4.6 GHz, middle), the main beam (at θ= 0 °, 90 ° wide) shows a good axial ratio, the secondary component of the electric field is 1–2 dB smaller than the main component. The asymmetric radiation pattern is caused by the bottom ground strip.

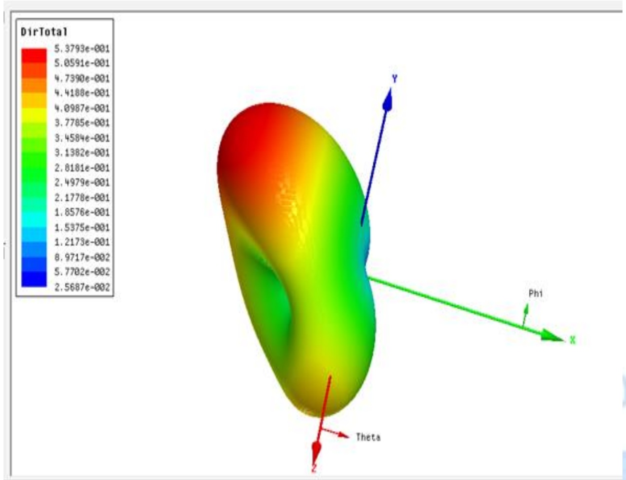

Figure 5 E-plane (xy-plane) 4.6 GHz

The resonant frequency fR = 4.6 GHz. The difference of the -10dB-bandwidth between the results in [8] and the presented simulation comes mainly from a mismatching of the feeding circuit (Figure 4 and 5). Table 1 shows the simulated results of return loss, VSWR and bandwidth. This miniature UWB antenna has wide application in wireless communication. This table gives the results obtained by the simulation of design by HFSS.

Table.1 Performance Parameters for both the Proposed Design

Resonating Frequency (GHz)	Return Loss S_{11} (dB)	VSWR	Directivity	Bandwidth (MHz)
4.6 GHz Proposed Design 1	-31 dB	1.5	2.7 dB	11.1 GHz (3.2 GHz-14.3 GHz)
4 GHz Proposed Design 2	-39 dB	1.2	3.3 dB	11.6 GHz (2.4 GHz-14 GHz)

4. CONCLUSION

In this paper, a double ground square shaped slot with fractal geometry and a circular polarized ultra-wide band antenna design for hand held gadgets have been characterized relatively to their UWB performance, in terms of gain, return loss and bandwidth, as well as their overall geometrical dimensions. Due to the future application of the antennas, the time domain characteristics, such as UWB applications are the main focus area of the design process. The required minimum bandwidth of 11 GHz is reached by designs. To increase the return-loss bandwidth of the antenna, a new design with a slot with fractal geometry taken into consideration.

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