8th International Conference on Research Developments in Applied Science, Engineering & Management (AEM- 2020)
Osmania University Centre for International Program, Osmania University Campus, Hyderabad (India)
18th January 2020 www.conferenceworld.in ISBN : 978-81-944855-0-6

Design and Development of Compact Super Wideband Antenna for Various Wireless Applications

Ovais Ahmad Wani
Deptt of ECE, RIMT University, Gobindgarh India

Monika Mehra
Deptt of ECE, RIMT University, Gobindgah India

***Abstract*—A small super wideband compact antenna with different ground slots for different wireless applications is proposed. this paper provides analysis of super wideband antenna at different resonant frequencies for variouswireless application like 3g,4g,5g,WLAN,Wifiand radar applications. The antenna design is based on 25mmx25mm dimensions, U shaped and rectangular shaped slots are made in patch and ground. so in simpler terms antenna provides resonating frequencies made with defected ground. the resonating frequencies include are 7.4,13.6,17.4,19.5,23.4,26.2and 35.2GHz. Thesefrequencies are used for different application wireless application as mentioned. Simulated results are provided with better agreement for widebandapplications. The antenna provides high BDR (5.1 GHz-40.20) GHz**

Keywords*— *Wideband, defected ground, WLAN, U-shaped slots

I.INTRODUCTION

Design and analysis of an antenna has always been a challenging task. The use of wideband antennas for various applications has changed the world, which can transfer data at high rates and with secure transmission. Wideband antennas have been broadly classified mainly into two categories namely ultra wideband and super wideband. The data transmission for various ad-hoc networks was at a very less speed before the introduction of wideband antennas, so the research on ultra wideband and super wide band became a need to cope up with different faster devices .Ultra wideband based devices use frequencies from 3.1 GHz to 10.6 GHz and provide faster data rates for short range distances, but it was not still enough to provide the data rates for long range distances. So the research begun on superwideband antennas which provided high data rates for both long and short range distances, usable frequencies included beyond 10.64 GHz. The superwideband antennas at the start of the research were bigger in size which led to implementation of bigger devices,so again a compact device was needed to be installed for portable sizes.

This project concentrates on main factors i.e. compact size,high data transmissions and multiple applications using a single device and intends to provide good results which are a good agreement. A good device includes all the usable frequencies for different applications which are taken in consideration in this article. Working on a design which can include all applications with good results in comparison to other can lead to good progress in the field of antennas and can have a great effect of sensors too, the design gives better performance ,high BDR (5.1 – 40.2)GHz and has a small size as compared to referred models

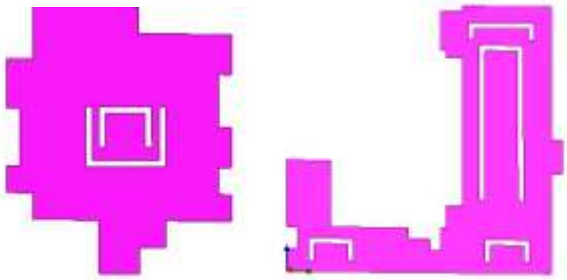


Fig.1 designed model of front and back view

II. ANTENNA DESIGN & DESIGN EQUATIONS

The objectives of the proposed design is to analyze super wideband antenna with suitable characteristics including stable radiation pattern and gain in order to achieve these objectives ,the design is made quite simple with a defected ground with rectangular slots for achieving the maximum resonating frequencies which are more than seven . After inserting the first slot the first three frequencies are achieved and the last two slots help in achieving the remaining resonant frequencies. Slots are also made in patch too. These

ISBN : 978-81-944855-0-6

U-shaped slots in patch help to increase the bandwidth ratio by 35%.Thus in this way the antenna proposed provide more than a decade bandwidth. U slots in the patch also help to smoothly distribute the current and hence minimize the size of patch which results in the increasing impedance bandwidth. Antenna is printed on FR-4 substrate which is cost effective and readily available with a thickness of 1.6mm. The resonant frequencies are achieved at 7.4, 13.6, 17.4, 19.5, 23.4, 26.2,35.2GHz used for different wireless applications.

A. Design Equation

The antenna is designed using set of equation (1)-(3) (2).

The length of the radiating part is calculated as (1).

$$Lr = \frac{C}{2f_0\sqrt{\varepsilon_{eff}}} - 0.824h\left(\frac{(\varepsilon_{eff}+0.3)\left(\frac{W_r}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W_r}{h}+0.8\right)}\right)(1)$$

The width of the radiating patch is calculated as (2).

$$W_r = \frac{C}{2f_0\sqrt{\frac{\varepsilon_r+1}{2}}}(2)$$

The antenna feed width is calculated as (3).

$$\frac{l_0}{h} = \frac{8\exp(A)}{\exp(2A)-2} \qquad (3)$$

Designing an antenna that can include all these applications without other interferences and using single device for a different application is a great achievement in the field of Antennas. It can affect the field of sensors too which also demand high rate transmission and secure communication.

The simulated S_{11} of the designed antenna is shown in Fig.2. It can be seen that the antenna shows different bands of operation around 5GHz to 40GHz. The operation is made possible by slotting the patch and ground In order to get this The introduction of slots affects the surface current distribution, thereby increasing the current length path.

III. PARAMATRIC ANALYSIS

Optimization of different characters of an antenna can be studied through parametrical study. Parametric analysis of the effect of feedwidth is carried how and the graph depicts those results which are analyzed. How the effect is feedwidth on impedance matching varies and the better result for a stable feedwidth can be obtained. This study is carried out by varying feed width (L0) from 2.5 to 3.5mm at a step of 0.5mm. For L0=2.5mm, L0=3.5 mm the desired impedance matching of antenna is not obtained, but when the dimension of the feedwidth is fixed at 3mm good impedance matching is observed across the bands.

IV. SIMULATED RESULTS

The entire analysis of the antenna is carried out on HFSS v.13.0. The substrate material used for the antenna design is FR-4 with $\varepsilon_r = 4.4, h =$. Lumped port excitation method is used for excitation. The proposed structure has a volume of 1000mm^3 (2].
Antenna dimensions are summarized in table1. , Simulated results of s11 (Fig.3) are shown for frequencies of7.4, 13.6, 17.4, 19.5, 23.4,26.2,35.2 GHz the reflection coefficient is below -20db.

VSWR<2 for these resonating frequencies is shown in Figure3.Both the graphs show agood agreement.

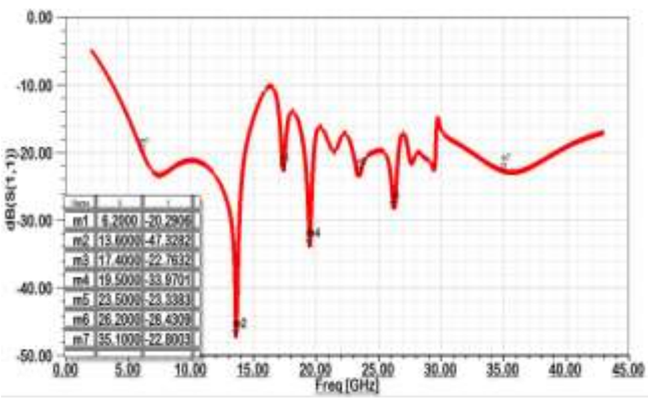


Fig.2 S_{11} plot of the proposed configuration

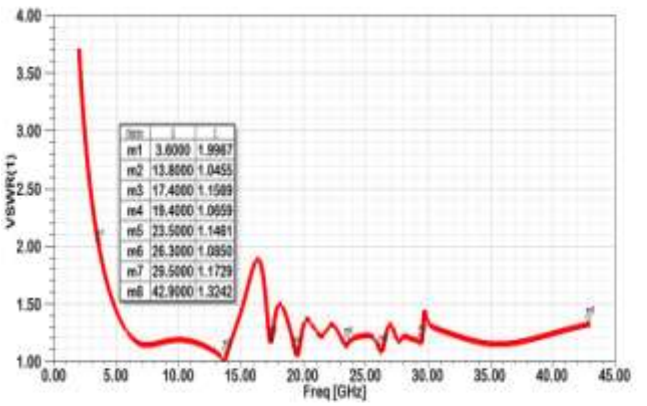
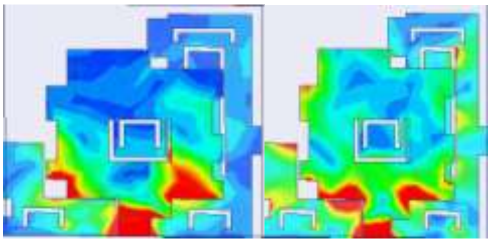


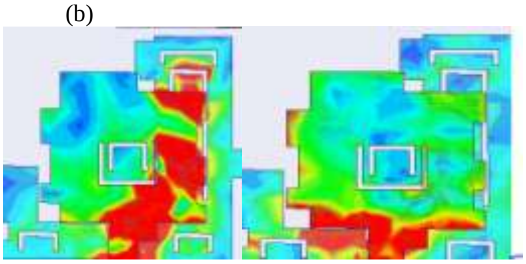
Fig.3 VSWRof the proposed configuration

ISBN : 978-81-944855-0-6

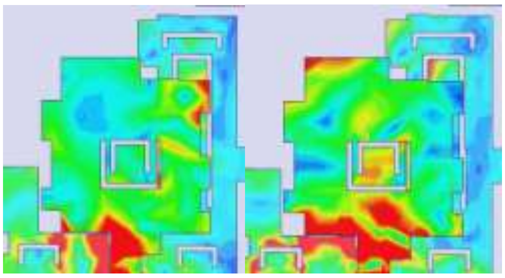
The current distribution of the antenna at the respective operating frequency of 7.4, 13.6, 17.4, 19.5, 23.4, 26.2, 35.2 GHz is demonstrated in Fig.6.Surface currentdistribution at different resonating frequencies followsthe independent path.Slotting increases the current path length thus making it to resonate at particular frequencies.



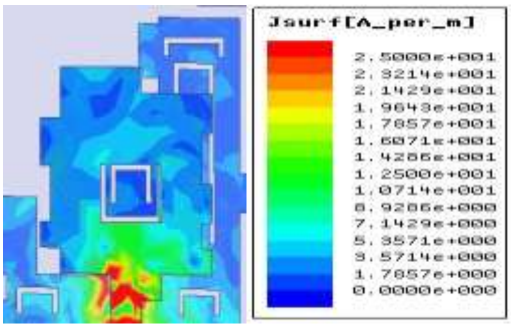
(a) (b)



(c) (d)



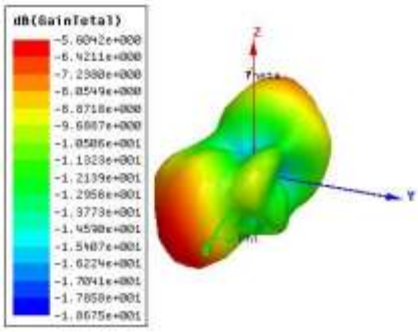
(e) (f)



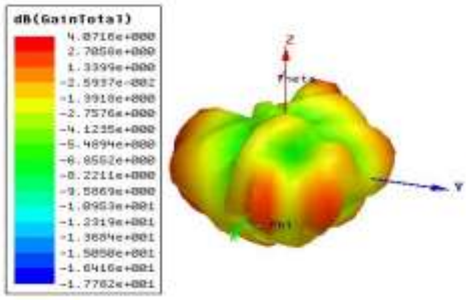
(g)

Fig.4 Surface current variations for (a) 7.4, (b) 13.6, (c) 17.4, (d) 19.5, (e) 23.4 (f) 26.2 (g) 35.2 GHz

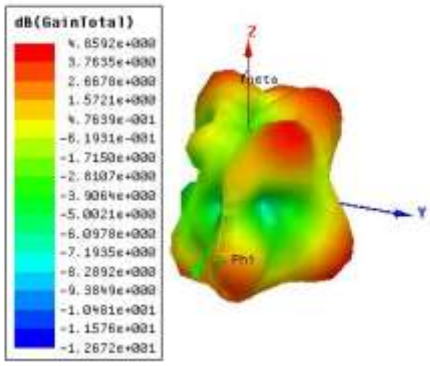
Thegain of the proposed structure is presented in Fig.5.The gain at different resonating frequencies of 7.4, (b) 13.6, (c) 17.4, (d) 19.5, (e) 23.4 (f) 26.2 (g) 35.2 GHzare shown having nearly Omni-directional pattern in H-plane and bi-directional pattern in E-plane, at higher frequencies the distortion is observed in the pattern due to the losses in the patch.



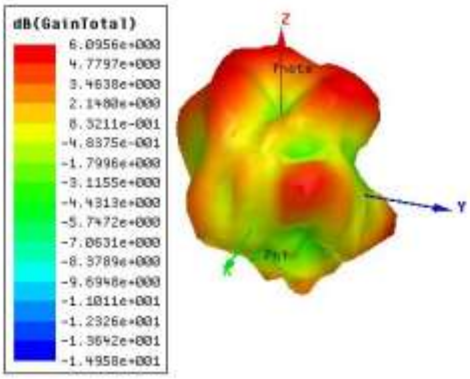
(a)



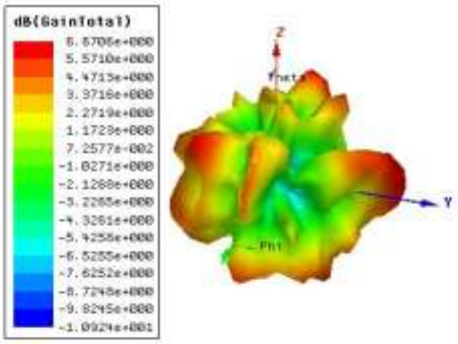
(b)



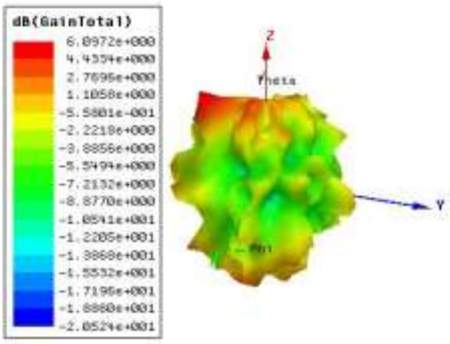
(c)



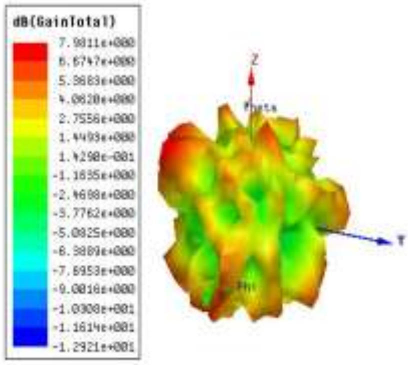
(d)



(e)



(f)



(g)

Fig.5Gain of the proposed configuration at (a) 7.4, (b) 13.6, (c) 17.4, (d) 19.5, (e) 23.4,(f) 26.2, (g) 35.2GHz

Table 1: Comparison of proposed antenna with previously reported antennas

Reference	Dimensions	Fractional BW%
[1]	31mmx45mm	181
[2]	77mmx35mm	172
[3]	120mmx140mm	182
[4]	135mmx90mm	183
[10]	55mmx38mm	168
[11]	60mmx60mm	133
[9]	150mmx150mm	189
[6]	45mmx30mm	164
[5]	40mmx30mm	163
Proposed	**25mmx25mm**	**175**

IV CONCLUSION

A compact multiband Antenna is proposed which is suitable for many applications like 3G,4G,UTMS, WiMAX, WLAN, Wifi and radar. The percentage bandwidth of different operating band is also at a suitable level to meet the bandwidth requirement. The antenna maintainssuitable radiation characteristics which is an interesting feature of an antenna. The great advantages of antenna include smaller size and number of operating bands which is five. The size of the antenna is less than the compared models which gives it an edge to use it for mobile applications and to perform different operations under a single device. In general antenna is simple to design with printed on FR-4 substrate that is cost effective and readily available.

REFERENCES

[1]. M.A. Dorostkar, M.T. Islam, and R. Azim, Design of a novel superwide band circular-hexagonal fractal antenna, ProgElectromagn Res139 (2013), 229–245.

[2]. K.R. Chen, C.Y.D. Sim, and J.S. Row, A compact monopole antenna for super wideband applications, IEEE Antennas Wireless Propagation Lett 10 (2011), 488–491.

[3]. X.L. Liang, S.S. Zhong, and W. Wang, Elliptical planar monopole antenna with extremely wide bandwidth, Electron Lett 42 (2006).

[4]. S. Barbarino and F. Consoli, Study on super-wideband planar asymmetrical dipole antennas of circular shape, IEEE Trans Antennas Propag 58 (2010), 4074–4078.

[5]. V. Waladi, N. Mohammadi, Y. Zehforoosh, A. Habashi, and J.Nourinia, A novel modified star-triangular fractal (MSTF) monopole antenna for super-wideband applications, IEEE Antennas Wireless PropagLett 12 (2013), 651–654.

[6]. J. Yeo and J.I. Lee, Coupled-sectorial-loop antenna with circular sectors for super wideband applications, Microwave Opt Technol Lett56 (2014), 1683–1689.

[7]. J.K. Liu, P. Esselle, S.G. Hay, and S.S. Zhong, Study of an extremely wideband monopole antenna with triple band-notched characteristics, ProgElectromagn Res 123 (2012), 143–158.

[8]. A. Gorai, A. Karmakar, M. Pal, and R. Ghatak, A CPW-Fed propeller shaped monopole antenna with super wideband characteristics, ProgElectromagn Res C 45 (2013), 125–135.

[9]. A. Azari, A new super wideband fractal microstrip antenna, IEEE Trans Antennas Propag 59 (2011), 1724–1727.

[10]. J. Liu, K.P. Esselle, S.G. Hay, Z. Sun, and S. Zhong, A compact super-wideband antenna pair with polarization diversity, IEEE Antennas Wireless PropagLett 12 (2013), 1472–1475.

[11]. S. Hakimi, S.K.A. Rahim, M. Abedian, S.M. Noghabaei, and M.Khalily, CPW-fed transparent antenna for extended ultrawideband applications, IEEE Antennas Wireless PropagLett 13 (2014).

[12]. Federal Communications Commission, Washington, D.C. 20554.First report and order https://transition.fcc.gov/Bureaus/Engineering_Technology/Orders/2002/fcc02048.pdf.