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Compact UWB Antenna for USB Dongle Application

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Abstract - A method is presented which is aimed at increasing bandwidth of the tapered slot antenna by just finding the optimum tapering profile of the antenna without the need to increase its size rather than decrease. In this paper, an ultra-wideband (UWB) antenna with a compact size of 16 mm x 20 mm is proposed for USB dongle applications. Theproposed antenna has been designed on FR4 substrate dielectric constant is 4.4 with thickness of substrate 1.6mm fedby microstrip line to cover the lower UWB band of 1.75–6.52 GHz. Ultra Wideband can be achieved through the different slot in ground plane of the antenna. The proposed antenna is simulated by using HFSS based on FiniteElement Method (FEM) and the radiation patterns, return loss & VSWR are presented and comparedwith the different ground structure shape.Such type of antenna is very useful for UWB communication system.

Keywords- USB, size reduction, UltraWideband, Resonating Frequency

I. INTRODUCTION

UWB system has been depicting a lot of concern because of their power operating at low level and very high bandwidth. Besides that, frequency reuse is possible due to low power characteristics. There has been numerous paper on UWB antenna system due to their low cost bandwidth pattern simple structure and wide impedance. Recently, ultra-wideband system design and application have become the focus of the wireless communication [1-3]. Federal communication commission (FCC) recommended frequency Range for commercial ultra-wideband (UWB) communication systems is 3.1 to10.6 GHz [4]; many engineers are paying much attention on UWB antennas since FCC has released commercial use of UWB for indoor communication systems [5]. The design requirements including impedance bandwidth is stable gain, and good omnidirectional radiation pattern, small size. In imaging and radar ultra-wide band is used. As compared to GPS for location of indoor objects UWB is better with their high accuracy degree. Due to its higher effective communication in typical situation UWB system can be operated among people.

In battlefield, UWB system used to locate enemy behind walls and on every side [3]. In medical application, to detect persons breath under rubber, or where X-ray system may less desirable for diagnostic. Nowadays UWB system become most important parameter for wireless communication, because it require the mainly size reduction, more bandwidth, stable gain, good radiation pattern. To achieve ultra-wideband most of the types of antenna can be applied. Though in this work our attention on micro strip patch antenna. Because nowadays it would become very widespread in any design of antenna due to its planar design, planar design and mass production [2, 3]. Low cost, low profile, lightweight and conformable having these advantages of micros trip patch antenna while circular and linear polarization is achieved easily. Above attributes are bearing in mind to design antenna for wireless system. In earlier lot of technique proposed. For increment bandwidth partial grounding is used, bandwidth increased in certain amounts which are average of 3-4GHz. Moreover, due to problem of sever dispersion, the full UWB band has recently been separated into the lower UWB band (3.1-5.15 GHz) and the higher UWB band (5.875-10.6 GHz), with the lower band being far more commonly used. Consequently, the design requirement has been relaxed to certain degree [6].

In this paper, we proposed a tapered shape slot antenna. The slot provides variation in resonant frequency. Meanwhile narrow slot gives variation in lower resonant frequency. Moreover, the size of proposed antenna is only 16 mm × 20 mm, this is much smaller than that of the antennas Proposed in the reference [6]. Section II contains different shapes of micro strip patch antenna are simulated and in section III different ground structure with respect to tapered slot antenna are simulated using the HFSSv2013 which is based on the Finite Element method (FEM). The proposed antenna meets the Design trends of simple and small and will be presented and discussed in this paper.

II. PROPOSED ANTENNA GEOMETRY

In this paper, the proposed rectangular patch antenna parameters are calculated based on transmission line modal analysis [2] and the detailed geometries are show in Figure 1. For modeled rectangular patch antenna, the signal excites through SMA connector which is modeled based on simulation tools of HFSSv2013. HFSS in frequency domain where the numerical analysis is based on Finite Element Method (FEM) is performed[7]. Fig. 1 shows the geometry and the configuration of the proposed antenna. It contain FR4 substrate with relative dielectric constant of 4.4, thickness of h = 1.6 mm, and total size of 16 × 20 mm². The antenna is fed by a 50Ω micro strip transmission line of coaxial probe feeding technique to match the proper impedance. Patch antenna is usually known for small bandwidth but different techniques like partial ground, addition of suitable slots in the patch have been developed and studied, resulting in ultra-wide bandwidth of antenna.

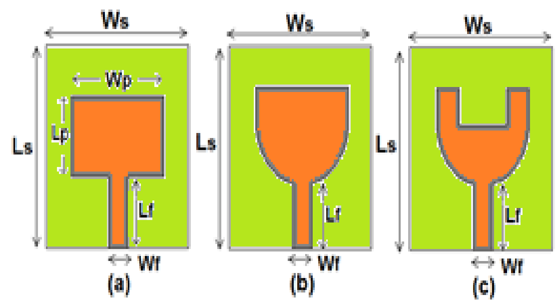

Figure 1. Different shapes of patch of UWB antenna

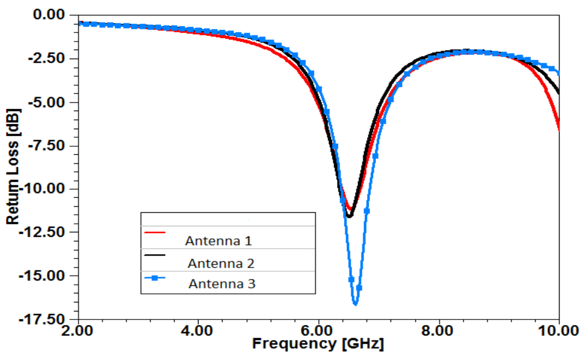

Figure 2. Simulated return loss of Antenna 1–3.

In above figure, different shapes of patch on the constant substrate. These having (a) antenna1 (b) antenna2, (3) antenna 3 with rectangular patch, semicircle patch and with adding Slot of 5mm × 7mm slot in semicircle respectively. By simulating above antennas that producing return loss plots in figure 2 . Adding narrow slot means it having the lower frequency variation. So for obtaining in lower frequency band add the narrow slot in antenna 2 resulting antenna 3. Simulating the entire above antenna recognize all require parameter and done the comparison study.

Bandwidth (%) shows fractional bandwidth of antenna, which have following formula.

$$\mathbf{BW\ (\%)} = \frac{\mathbf{BW}}{\mathbf{fc}} \times \mathbf{100} \qquad \mathbf{(1)}$$

Table 1. Comparison between different shapes of rmsa

RMSA	Frequency (GHz)	Return Loss (dB)	Band-width MHz	Bandwidth (%)	Directivity (dB)
Antenna1	6.53	-11.18	370	5.75	7.60
Antenna2	6.48	-11.58	375	6.15	7.55
Antenna3	6.58	-17.49	453	7.10	7.15

III.UWB ANTENNA WITH VARIOUS GROUND SHAPE

Mostly we can select patch length for adjusting operating frequency of our antenna; smaller dimension of the patch results in higher resonating frequency and vice versa. Patch antenna is usually known for small bandwidth but different techniques like partial ground have been developed for resulting the UWB of antenna. Thus function of UWB design is awfully affected by the shape of ground plane in terms of radiation pattern [8, 9], bandwidth impedance and resonating frequency of antenna. Such ground planes has many problems with design and Complexities. Though various studies have been made by researcher to reduce this ground plane influence of ground plane. On overall performance truncation of ground plane one of them to reduce the effect of ground plane of antenna [10]. Antenna efficiency in terms of return loss depends upon the impedance matching between patch and transmission feed line. We get more efficient results when both transmission feed and patch has perfect impedance matching. Besides that substrate material and its height. Are also very important for radiation pattern, high gain and bandwidth of antenna.

For obtaining the ultra-wide band antenna must be fed by the different ground plane as shown in fig.3.

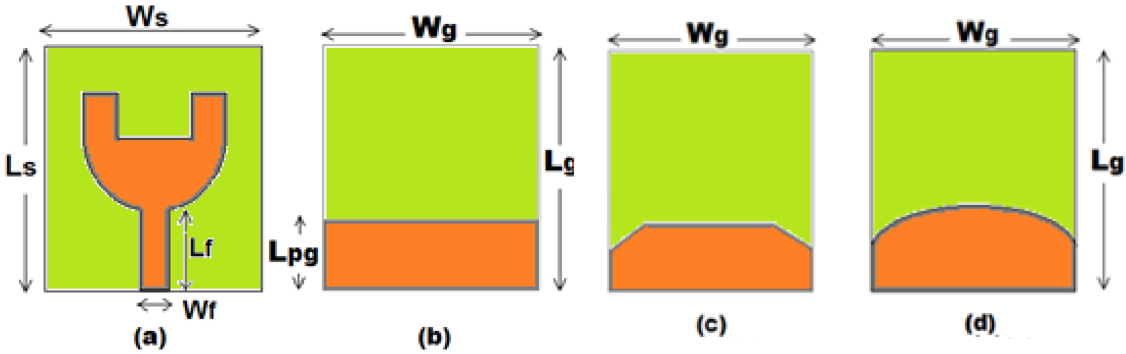

Figure 3. UWB antenna with various Ground Shape

The offered antenna was designed and analyze by FEM based antenna analysis software. Simulated antenna patch and ground plane is given in Figure 3. For enhancement of bandwidth, a numeral method of such as corner truncation, Semicircular ground and slot in the main micro strip rectangular patch and using of partial ground have been used. And in Fig.4 shown the return loss of above patch with different ground plane effect and Lpg has length of partial ground is5.2mm.There have been 3 antenna shows in fig 3 with combination of (a) and all b, c, d. from that antenna 4 having patch (a) with (b) ground plane and 5 and 6 have (c) and (d) respectively.

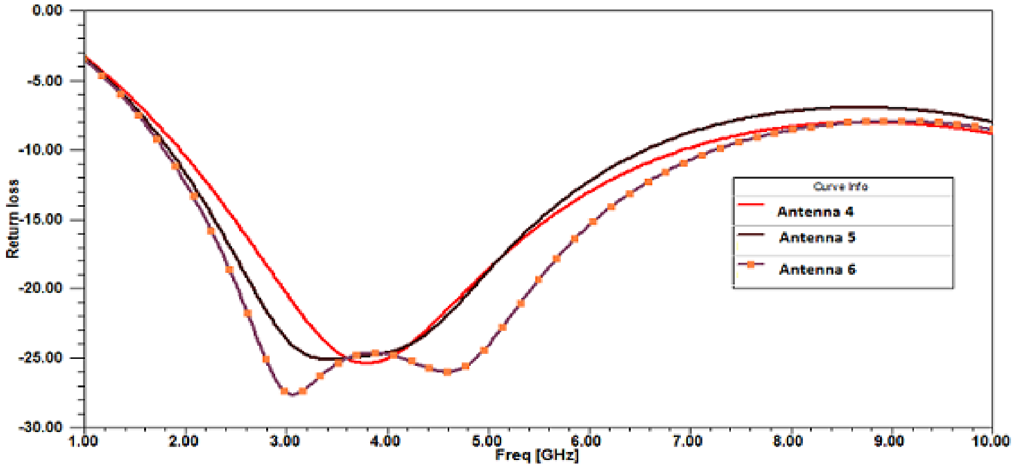

Figure 4. Simulated return loss versus frequency plots of Antenna 4-6.

IV. RESULT AND DISCUSSION

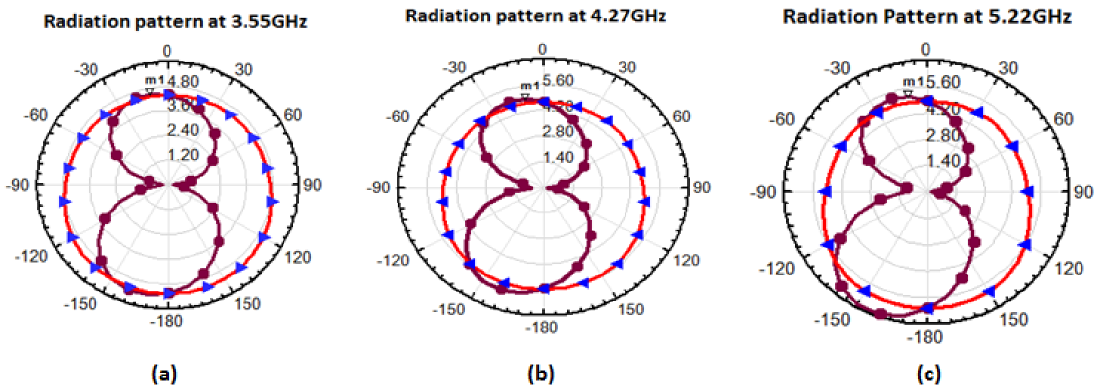

Figure 5. Simulated Radiation Pattern at 3.55, 4.27, 5.27 GHz .Red curve is for yzplane vertical cut and purple curve is for xyplane horizontal cut w.r.t patch lies in xyplane

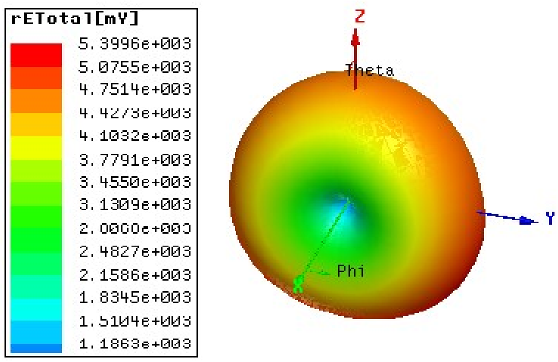

Figure 6. Antenna gain

The 2D simulated radiation pattern of antenna on different operating frequencies is shown in Figure 5 above. It has been observed that on most of frequency range the antenna radiation pattern is Omni directional due to leak of radiation by using of partial ground technique.
Moreover, gain of antenna related to directivity of antenna, and measured that takes into account the efficiency of the antenna as well as its directional properties. And most important directivity is a measure that illustrates the directional properties of antenna and it regulate only by radiation pattern. Fig.6 shows the 3D pattern of antenna [10]. By different shapes of ground plane with respect to antenna 4 in fig.3. Below table shows, there is different comparison done on that basis of modified ground plane.

Table 2. Comparison between different shapes in GND_MSA

Shape of MSA	Frequency (GHz)	Return loss(dB)	Bandwidth (MHz)	Bandwidth (%)	Directivity (dB)
Antenna 4	3.58	-18.46	1620	45.25	4.31
Antenna 5	3.46	-17.54	4290	126.2	4.58
Antenna 6	3.73	-17.78	5010	134.1	4.48

By Proper optimization monopole can cover the various services including UMTS 3G (1.8-2.2GHz), WiMax (2.3-2.4 and 2.5-2.7 GHz), WLAN (2.4-2.5GHz) and LTE (2.5-2.7GHz).

V. CONCLUSION

In this paper, an UWB antenna with a size of 16 mm x 20 mm is proposed for USB dongle applications. Through different ground structure of the antenna, ultra wideband (UWB) has been achieved. The proposed antenna can cover the lower UWB band of 1.75–6.52 GHz with good radiation pattern in both E and H plane. The simulated results confirm that the proposed UWB antenna is suitable for USB dongle applications.

REFERENCES

[1] Liang, J., Chiau, C.C., Chen, X., and Parini, C.G., "Study of a printed circular disc monopole antenna for UWB systems", IEEE Trans. Antennas Propag., 2005, 53, (11), pp. 3500–3504.
[2] Garg R., Bhartia P., Ittipiboon I.B.P, (2001). "Micro stripe Antenna Handbook Design ". London: Artech House.
[3] Girish Kumar, K. P. (2003). "Broadband Micros trip Antennas".Artech House.
[4] FCC, "FCC last report and order on the ultra-wideband technology",2002
[5] New public safety applications and broadband internet access among Uses envisioned by FCC authorization of Ultra Wideband technology- FCC news release," 2002
[6] S.Zhang, B. K. Lau, A. Sunesson, and S. He, "Closely- packed UWB MIMO/diversity antenna with different Pattern and polarizations for USB dongle applications," IEEE Trans. Antennas Propag., vol. 60, no. 9, pp. 4372- 4380, Sep. 2012.
[7] HFSS Version 13, Ansoft Software Inc., 2010.
[8] Chen, Z. N., T. S. P. See, and X. Qing, \Small printed ultra- wideband antenna with reduced ground plane Effect," IEEE Transactions on Antennas and Propagation, Vol. 55,383{388, 2007.
[9] Simons, R. N., Coplanar Waveguide Circuits, Components and Systems, John Wiley & Sons Inc., Somerset, NJ, 2001.
[10] C. Balanis, Antenna Theory: Analysis and Design, New York, John Wiley & Sons, Inc., 1997.

