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Compact Ultra-Wideband Antenna for Portable Devices

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Abstract. This article presents a compact ultra-wideband (UWB) antenna for wireless dongle devices. The printed monopole antenna, with the size of 15 mm × 30 mm, has an impedance bandwidth ranges from 2.9 to 13 GHz. The proposed structure comprises of a hexagonal radiator fed by a microstrip line with a modified ground plane. Such a design can be easily integrated with wireless universal serial bus (USB) devices. Having stable radiation patterns and constant gain within the UWB spectrum are significant characteristics of this antenna. The time domain studies on the designed antenna indicate reduced ringing effect for impulse excitation across the band of interest.

1. Introduction

Ultra-wideband (UWB) radio system has been developing in recent years and has become popular in wireless communication applications. This technology offer high data rate, multi-path interference immunity and low power consumption within the allocated bandwidth of 3.1 to 10.6 GHz. Current consumer electronics and mobile devices are using the universal serial bus (USB) wired connectivity technology. However, for terminals using this technology to be truly mobile with higher user data rate, wireless USB are needed. To overcome these limitations, integration of UWB technology into USB device is a potential solution for wireless USB advancements. Therefore, many researchers are working towards the development of USB dongles based on UWB communication specification. Antennas are particularly a challenging issue of wireless USB technology since they are now required to be small and have relative bandwidth due to space constraint of the dongle board. Several UWB antennae for wireless USB applications have been reported recently [1–4].

In this paper, a compact hexagonal monopole antenna for wireless USB dongle applications is presented. The proposed radiator exhibits a compact size of 15 mm × 30 mm and a wide bandwidth covering the UWB spectrum has been obtained. The article is organised in the following sections. Section 2 describes the miniature UWB antenna design. The characteristics of the antenna are presented in Section 3. Section 4 summarises and concludes the study.

2. Antenna Geometry

The geometry of the proposed antenna is depicted in Figure 1. It is designed on a standard RT/duroid[®] 5880 substrate with a relative permittivity of 2.2 and thickness of 0.787 mm. On the other side of the dielectric substrate, a modified ground plane is printed below the feed line. The hexagonal radiator is

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capable of supporting multiple resonant modes in the presented structure. The optimised antenna parameters are tabulated in Table 1.

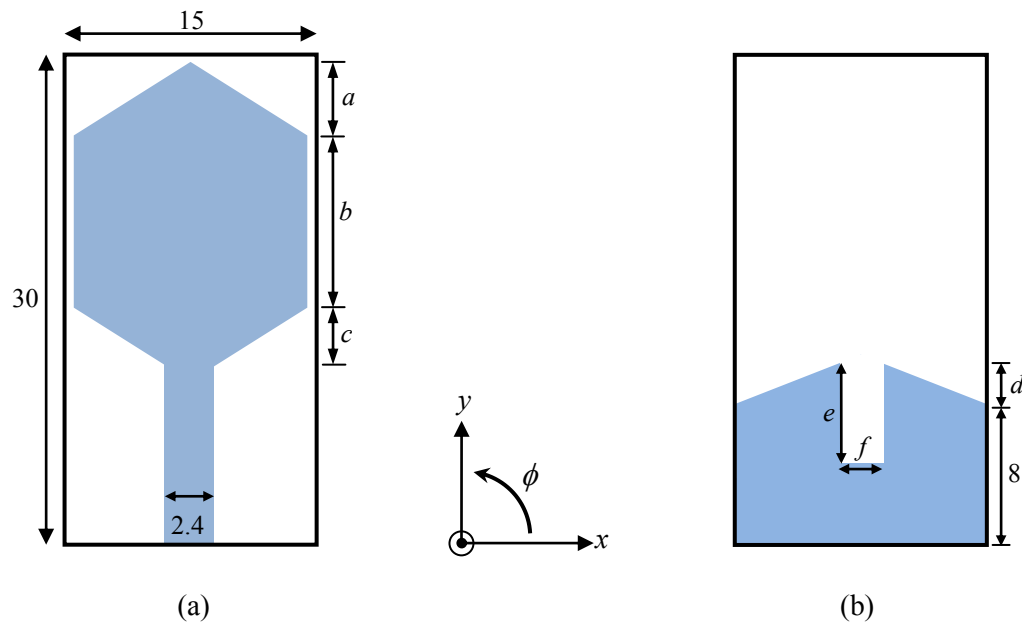


Figure 1. Geometry of the proposed antenna (units in mm). (a) Front view (b) Rear View

Table 1. Antenna parameters.

Parameter	Value (mm)
a	4.8
b	10.1
c	3.0
d	3.0
e	6.5
f	2.8

3. Results and Discussion

All simulations in this article were conducted using the computer simulation technology (CST) Microwave Studio software based on the finite integration technique [5]. The calculated return loss for the optimised antenna is plotted in Figure 2(a). It is noticed that the impedance bandwidth of the antenna satisfies the 10 dB return loss requirement in the frequency band between 2.9 and 12 GHz. Broadside antenna gain at +z direction was also simulated, as given in Figure 2(b). The graph shows that the gain performance of the antenna generally increases with the frequency. The proposed antenna radiation patterns in the E -plane (y - z plane) and H -plane (x - z plane) at 3, 6 and 9 GHz are illustrated in Figure 3. Near omnidirectional patterns are observed in the H -plane and bi-directional in the other plane.

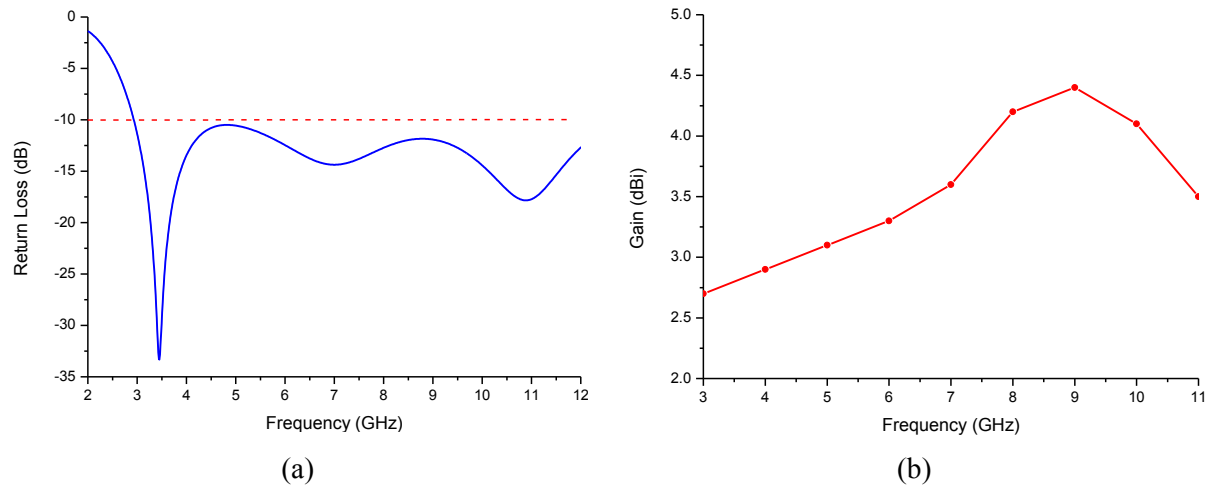


Figure 2. Input performance of the proposed antenna. (a) Return loss (b) Gain

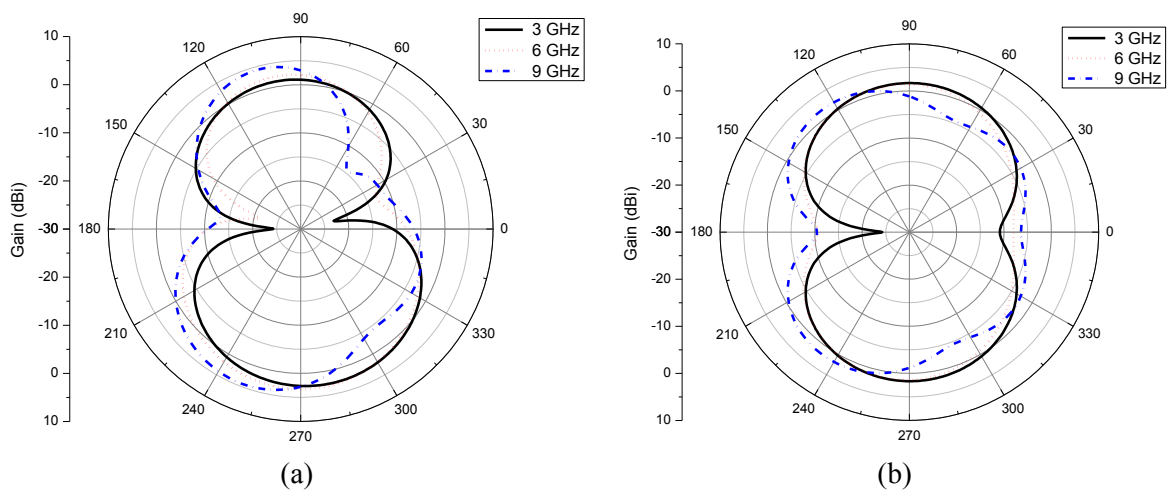


Figure 3. Antenna radiation patterns at various frequencies. (a) *E*-plane (b) *H*-plane

In designing UWB radio system, it is essential to evaluate the time domain characteristics of the transmitting and receiving antennae. In this work, the system transfer function is investigated with an identical monopole antenna pair. The identical antenna pair are placed 70 mm apart from each other. Figure 4 shows the plot of Gaussian pulse source waveform and the radiated voltage waveform in various directions. It is evident that the received pulses are almost identical with slight ringing effect. As seen in Figure 5(a), the group delay remains almost constant with variations less than 0.5 ns. The simulated transmission coefficient, S_{21} , is plotted in Figure 5(b). It shows a fairly flat magnitude throughout the operating band. These results indicate that proposed antenna is capable of offering good pulse handling capability as required by UWB communication systems

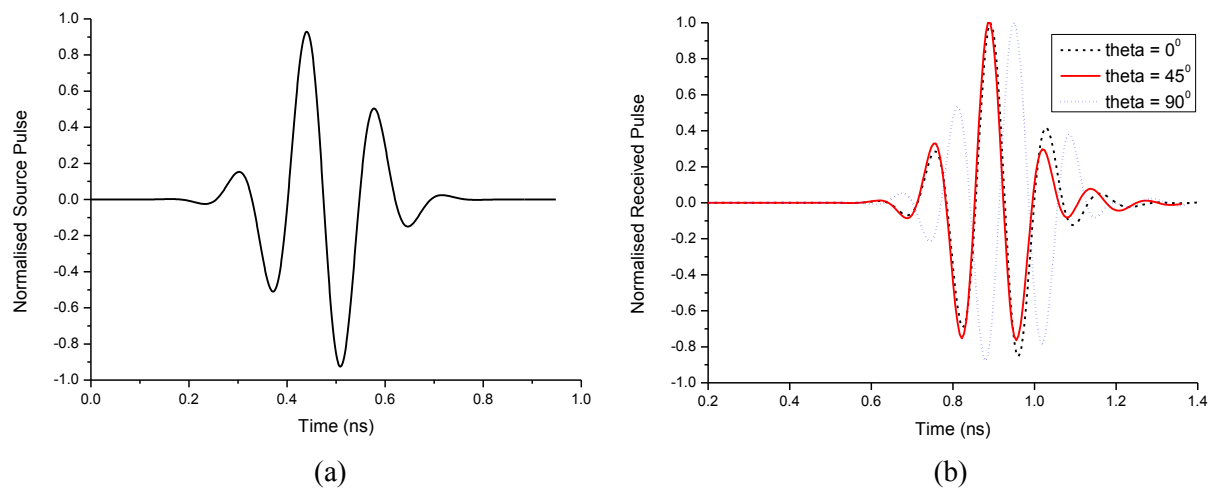


Figure 4. (a) Normalised input pulse (b) Normalised received signals

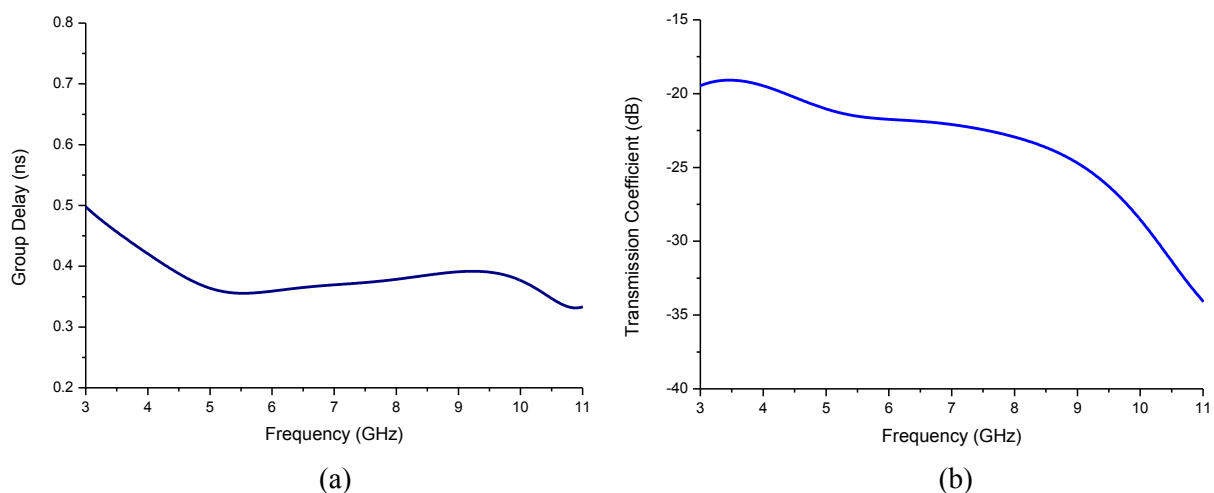


Figure 5. Proposed UWB antenna (a) Group delay (b) Transfer function

4. Conclusions

A compact UWB antenna for wireless applications is studied in this article. The designed dongle antenna has a small size of $15 \times 30 \text{ mm}^2$ while exhibiting ultra-wide impedance bandwidth with reasonable radiation patterns. Furthermore, the antenna features a good system transfer function and constant group delay characteristics. These results make the proposed antenna a promising candidate for emerging portable devices.

References

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