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A Review on Printed Monopole Antenna for UWB Applications

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Abstract: This paper presents a review work on printed monopole antenna. Different shapes of patch and ground plane to achieve ultra wide band (UWB), have been surveyed and summarized in this paper. Step rectangular, circular, octagon, U-shaped and step circular patches are used to achieve maximum impedance bandwidth ratio of around 15:1. On other side notched, saw tooth and rounded ground plane provides a maximum impedance bandwidth ratio of around 5.5:1. Trapeziform ground plane with a discone antenna provides maximum impedance bandwidth ratio of 23:1.

Keywords: Printed monopole antenna, Ultra wide band, impedance bandwidth ratio.

I. INTRODUCTION

Ultra-wideband (UWB) antennas are gaining prominence and becoming very attractive in modern and future wireless communication systems, mainly due to two factors. Firstly, people increasingly high demand for the wireless transmission rate and UWB properties such as high data rate, low power consumption and low cost, which give a huge boost to the UWB antennas' research and development in industry and academia since the Federal Communications Commission (FCC) officially released the regulation for UWB technology in 2002. Secondly, now the wireless portable device need antenna operated in different frequencies for various wireless transmission functions, and operation bands and functions are increasing more and more, which may result in challenges in antenna design, such as antenna space limitation, multi antennas interference, and etc. One UWB antenna can be used to replace multi narrow-band antennas, which may effectively reduce the antenna number.

Planar monopole antennas achieve an ultra-wideband performance based on various techniques, but they all need a perpendicular ground plane, resulting in increasing of the antenna volume and inconvenience for integration with monolithic microwave integrated circuits (MMICs). For the portal wireless device applications, the printed UWB monopole antennas are more popular due to their easier integration than the planar UWB monopole antennas.

The printed UWB monopole antenna commonly consists of a monopole patch and a ground plane. Both of them are printed on the same or opposite side of a substrate, and a microstrip or CPW feedline is used to excite the monopole patch. Since Choi et al. [1, 2] introduced this type of antenna with the wideband characteristics in 2004, various printed monopole antennas were studied in the following several years, mainly on the geometries of the monopole and the ground plane.

Section II describes the conceptual study on different shapes adopted to achieve UWB. Section III includes the conclusion made after studying various techniques to achieve UWB.

II. REVIEW ON DIFFERENT STRUCTURES

For geometry of the monopole patch, Figure 1 presents several representative structures. These antennas achieve the impedance bandwidth ratios from 2.3:1 to 3.8:1. Among various geometries of the monopole patches, the printed circular monopole antenna is one of the simplest [3], which achieves the impedance bandwidth ratio of 3.8:1 (2.69~10.16 GHz) with satisfactory omnidirectional radiation properties. Other monopoles such as octagon monopole [4], spline- haped monopole [5], U-shaped monopole [6], knight's helm shape monopole [7] and two steps circular monopole [8], as shown in Fig.11, were also proposed and studied,. *i.e.*, Ooi *et al.* [4] introduced the two-layer octagon monopole antenna based on the low-temperature co-fired ceramic (LTCC) technique, also obtaining an impedance bandwidth ratio of 3.8:1 (3.76~14.42 GHz). Lizzi *et al.* [5] proposed the spline-shaped monopole UWB antenna able to support multiple mobile wireless standards, covering DCS, PCS, UMTS, and ISM bands, with the bandwidth ratio of 2.3:1 (1.7~2.5 GHz).

For geometry of the ground plane, several representatives are also shown in Figure 2, and obtain the impedance bandwidth ratios from 3.8:1 to more than 10:1. *i.e.*, Huang *et al.* [9, 10] introduced an impedance matching technique by cutting a notch at the ground plane, and the impedance bandwidth can be enhanced by suitable size and position of notch chosen. Azim *et al.* [11] proposed to improve the impedance bandwidth by cutting triangular shaped slots on the top edge of the ground plane. The printed square monopole antenna with symmetrical saw-tooth ground plane obtains the impedance bandwidth ratio of 5.5:1 (2.9~16GHz). Considering high concentration of currents in the corners of the patch or ground, Melo *et al.* [12] studied a rounded monopole patch with a rounded truncated ground plane. It provides an impedance bandwidth ratio of larger than 4.7:1 (2.55 ~12 GHz).

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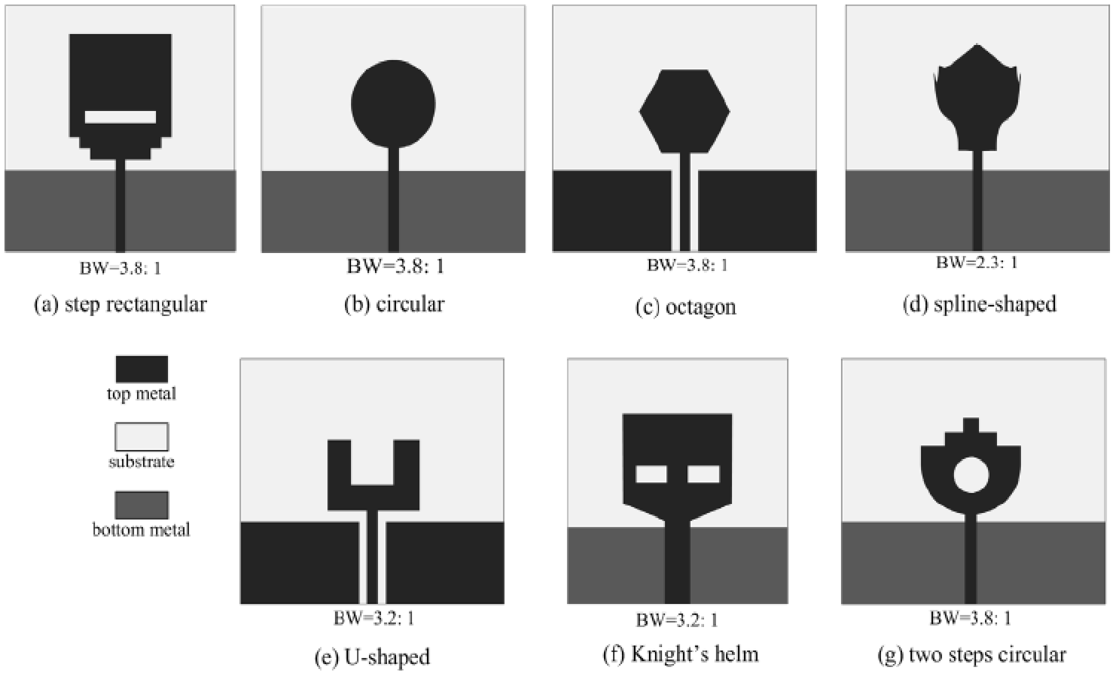

Figure 1: Various monopole structures [2-8].

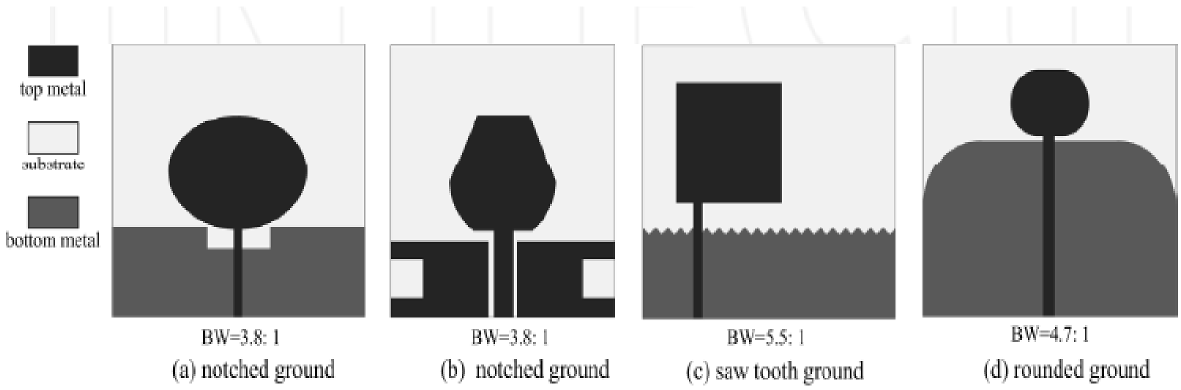

Figure 2: Various ground structures [9-12].

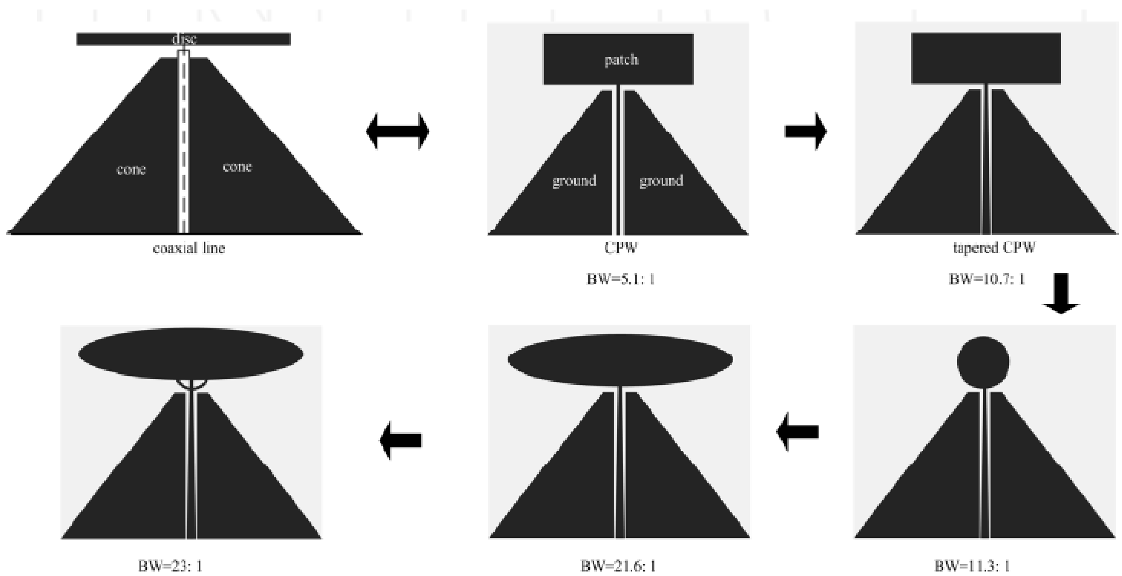

Figure 3: Various printed monopole antennas with trapeziform ground [13-17].

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One of interesting UWB printed monopole antenna designs is a trapeziform ground plane with a rectangular patch monopole aroused from the discone antenna, where the rectangular patch is used to replace the disc, the trapezeform ground plane is used to replace the cone, and the CPW is used to replace the coaxial feed, as shown in Fig.3 [13]. It is found that the printed rectangular antenna with a trapeziform ground plane achieves an impedance bandwidth ratio of 5.1:1, which is similar to that of a discone antenna. To enhance the bandwidth further, the input impedance is investigated by comparing bandwidths for various characteristics impedance of CPW feedline. The impedance bandwidth ratio expands to 12:1 when the characteristic impedance of CPW feedline is about 100Ω, which means the impedance bandwidth is enhanced by a factor of about 2.3. In order to match 50Ω SMA or N-type connectors, a linearly tapered central strip line is used as an impedance transformer, and an impedance bandwidth ratio of 10.7:1 (0.76~11 GHz) is obtained. Moreover, various printed monopoles and feed structures are also studied to enhance the bandwidth further [14-17].

III. CONCLUSION

In this review work, different printed monopole antennas have been studied and summarized. Different shapes of patch, ground plane and feeding techniques are used to achieve UWB. Impedance bandwidth ratio is higher with CPW feeding rather than microstrip line feeding. Trapeziform ground plane with a discone antenna provides maximum impedance bandwidth ratio among all the structures that have been surveyed.

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