A NEW VERTICALLY HALF DISC-LOADED UWB FILTERING ANTENNA WITH HORIZONTALLY TOP-LOADED SMALL DISC

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1. Introduction

Recently, a variety of technology about UltraWideBand(UWB) system have been introduced and developed by many researchers and many companies delivering the regulation of spectrum mask and mitigating the interferences with other communication systems. The IEEE 802.15 working group is still studying the spectrum allotted from 3.1 to 10.6GHz. The spectrum allocated for UWB is categorized into two parts, briefly ; the first one is the extremely wide band from 3.1 to 10.6GHz with negligible interferences to existing another communication systems by employing the inserted notch filter around 5GHz. The other one is the multi-band separated into several channels between 3.1GHz and 10.6GHz according to modulation. Especially, the dispersion and distortion characteristics of transmitted waveform for standard conical antenna have been investigated by using analytical method [2] and time-domain analysis [7-9]. In this paper, we have described the received waveforms at the probing points located 10[cm] away from disc-loaded monopole antenna. The height and outer radius on the top circle of fabricated standard conical antenna are set to be 15[cm] and 20[cm], respectively. Furthermore, the investigation of waveform transmitted from the standard conical antenna gives us a physical insight into the distorted amount of the waveform transmitted from small and compact antenna for UWB system. The thickness, t of the disc-loaded monopole antenna shown in Fig. 1 is set to be 1[mm] for simulation and measurement.

2. Transfer Characteristics of Conical Antenna & VHDMA

In standard conical antenna, the driving-point impedance at the input port can be defined as the ratio of the voltage applied to the input terminal to the current flowing to the input terminal,

$$\begin{aligned} Z_o(f) &\equiv V_o(f)/I_o(f) \\ &= Z_c(f)\frac{1-\beta/\alpha}{1+\beta/\alpha} \end{aligned}$$

where α and β are defined in [2].

Like the conventional conical antenna, the driving impedance is not dependent on the frequency as the radial length approaches infinity. The purpose of loading the elliptical and circular disc on the monopole with additional top-loaded disc is to increase the input impedance bandwidth and to move the resonant frequency to the lower maintaining the overall height of antenna. As introduced in [2], it is well-known that time-domain radiation field at the probing points can be obtained from the known transfer function and the known source voltage by using Inverse Fourier Transform of the product of two known functions. From the transfer function in transmission representing the relation between the radiated field at an arbitrary distance and source voltage, we can see that the amplitude of transfer function must be independent on frequency and antenna height to maintain the pulse shape of source without distortion at detecting points. When the Gaussian pulse is inputted into the proposed VHDMA (Vertically Half Disc-Loaded Monopole Antenna) with small disc, the transmitted waveform is the differentiated Gaussian pulse because of the miniaturized size of physical UWB antenna.

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3. Experimental results and simulation

The conventional planar monopole antenna, the modified circular disc-loaded antenna and half disc-loaded monopole antenna with additional disc on the top are described in Fig. 1. Using the commercial software package CST MW Studio version 5.0 based on FDTD algorithm for various ellipticity ratios including circle, the simulation results (return loss and distorted waveforms of transmitted pulses) have been obtained. Fig. 2(a), (b) and (c) show the wide impedance bandwidth of circular/elliptical disc-loaded monopole antenna in terms of return loss and the simulated radiation patterns, respectively. Fig. 3 describes the distortion amount of the transmitted waveform at the input port of antenna and an arbitrary detecting point when two different antennas are used for simulation. As shown in Fig. 3, the transmitted signal waveform of the proposed antenna, Fig. 3(c) is nearly similar to that of circular/elliptical disc-loaded monopole antenna, Fig. 3(b), while the total dimension of Fig. 1(b) is smaller than that of Fig. 1(a). Fig.4 illustrates the comparison of simulation and measured results of the proposed antenna with a small deviation at the lower frequencies. It is thought that the discrepancies between the measured data and the simulated results in Fig. 4 are caused by the effect of the small cavity existing between the loaded disc and inner core at the input port. Fig. 5 depicts the radiation patterns with co- and cross-polarization at the cutting *xy*- and *xz*-plane maintaining the radiation characteristics of simple monopole antenna. From the data of Fig. 6, it is seen that UWB filtering antenna having band rejection characteristics can be used to mitigate interferences with other wireless communication systems.

4. Conclusion

The waveform distortions of the plate antenna loaded with circular/elliptical disc have been studied using the simulation tool based on FDTD algorithm and measuring the fabricated antenna. From the measurements and simulation results, we can see that the availabilities of the half disc-loaded monopole antenna with additional circular/elliptical disc installed on the top to UWB applications have been verified in terms of return loss, VSWR, and compactness compared with conventional monopole antenna. In addition, the feasibility study on UWB filtering antenna with band rejection characteristics has been carried out as a method of minimizing the interferences with other wireless communication systems categorized into IEEE 802.11a.

5. References

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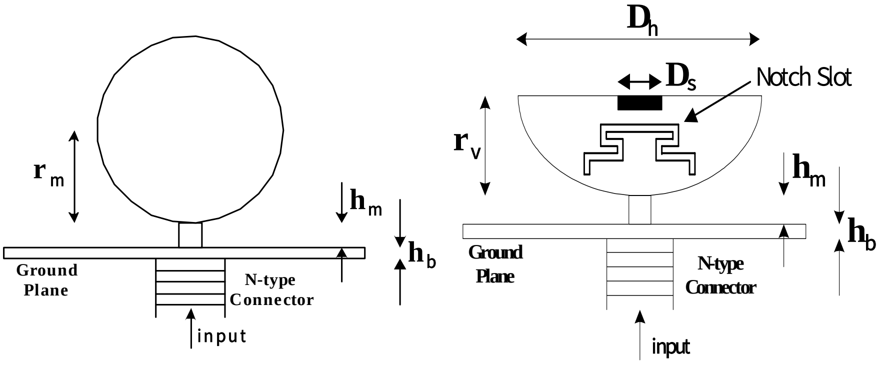
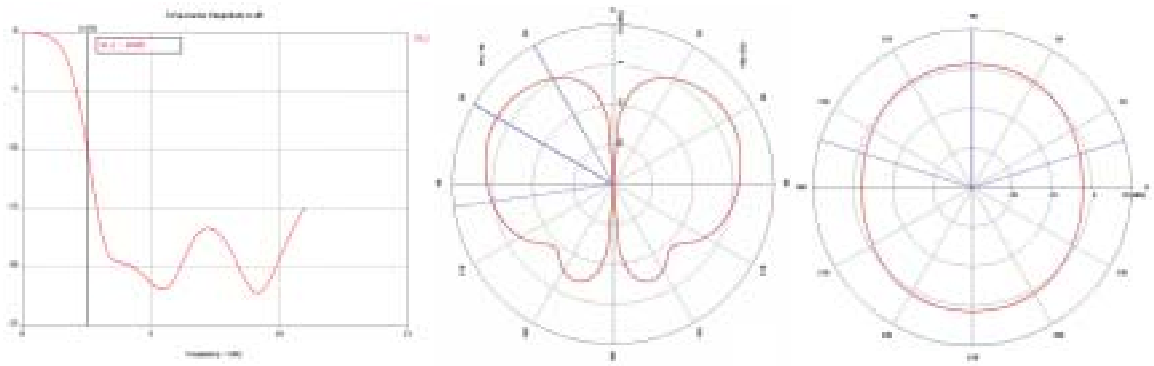


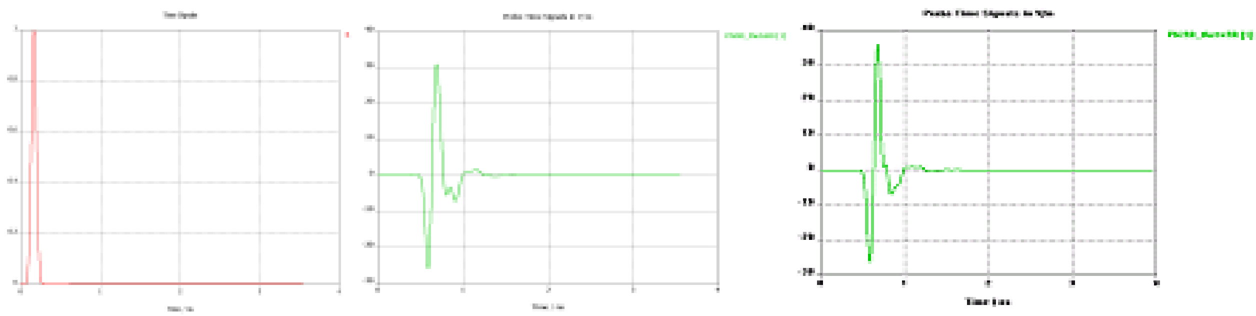
(a) (b)

Fig. 1. The scattering geometries of the proposed antennas (a) Circular/Elliptical disc-loaded monopole antenna (b) Vertically half disc-loaded monopole antenna (VHDMA) with band rejection characteristics



(a) (b) (c)

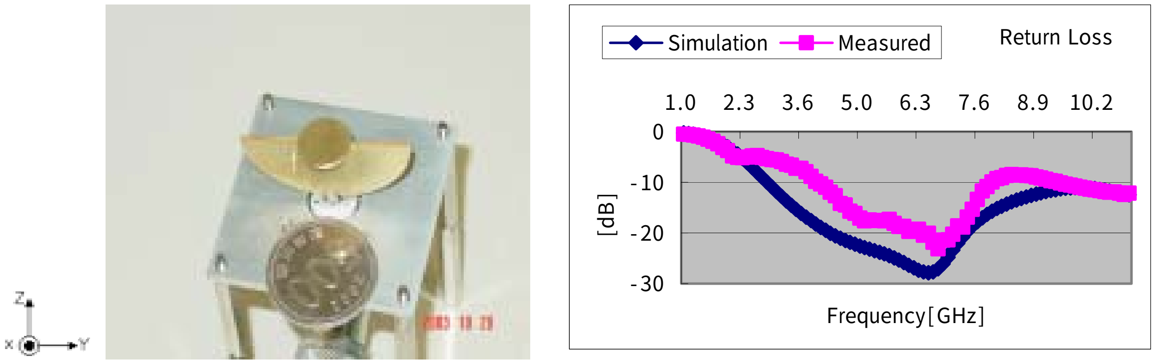
Fig. 2. The return loss and radiation patterns of circular/elliptical disc-loaded monopole antenna (a) return loss (b) elevation pattern (c) azimuth pattern when r_m is equal to 12.5[mm]



(a) (b) (c)

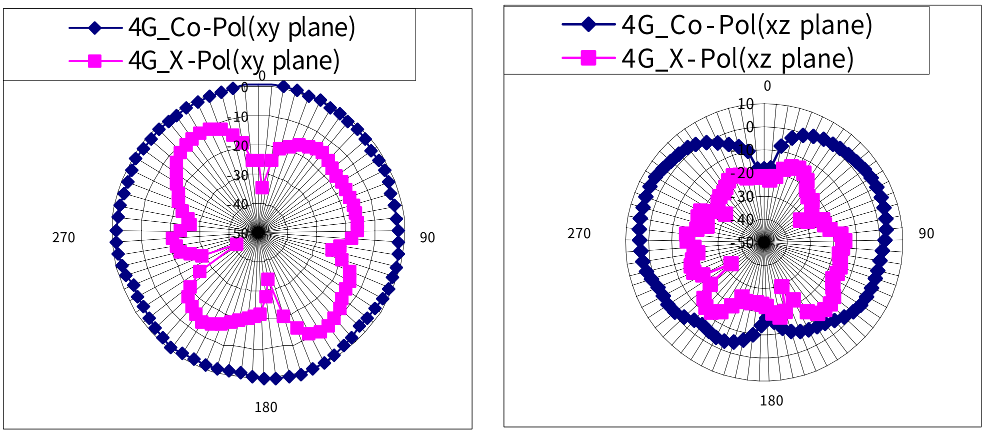
Fig. 3. The signal transfer characteristics of the proposed antennas (a) Input signal into antennas (b) The detected signal of Fig. 1(a) at the probing point, θ=90 degrees (c) The detected signal of Fig. 1(b) at the

probing point, θ=90 degrees



(a) (b)

Fig. 4. Vertically half disc-loaded monopole antenna (VHDMA) with horizontally top-loaded small disc (a) Photograph of the fabricated antenna (b) the simulated and measured results of VHDMA (-17dB@5.15GHz, -20dB@7GHz, -11dB@10GHz) when D_h is 34[mm]



(a) (b)

Fig. 5. Measured azimuth and elevation patterns of VHDMA at 4GHz (a) xy-plane (b) xz-plane

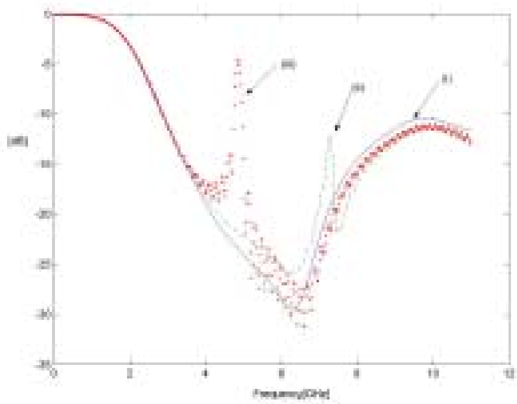


Fig. 6. The band rejection characteristics of UWB filtering antenna as a function of the total length of notch slot (i) length=12[mm] (ii) length=19[mm] (iii) length=31[mm]