Compact Design of the UWB Combined Antenna

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Abstract—In this report, the dependence of performances of the UWB combined antenna on its 3-D dimensions is investigated so as to minimize the size of the combined antenna. It indicates that operating process of the antenna can be divided into two phase: energy transmitted from the feeding point to the aperture by the TEM horn structure; energy radiated to the free space from the aperture. At the first phase, it is the effect of the impedance taper that determined the passband and the effect is related to length and aperture impedance of the antenna; and at the second phase, the height of the aperture is the main factor. Therefore, the 3-D dimensions of the combined antenna can be appropriately adjusted to make the antenna more compact. Then, a novel non-cubic combined antenna is designed. Compared with the traditional cubic antenna, the aperture area of the novel antenna is half, whereas the intensity of the radiating field only decreases by 5%. It means that the novel design can make the combined antenna more compact.

Keywords-combined antenna; UWB; compact;

I. INTRODUCTION

Basic combined antenna is usually designed in cubic shape so as to make the half-power beam width in E-plane and H-plane of the antenna the same. However, to improve the effective potential gain within certain aperture area is also very important to make compact UWB antennas. And this report is focused on the compact design of the combined antenna.

II. DESIGN OF THE COMPACT ANTENNA

A. The energy transmission process

Performances of the transmission process is determined by the structure of the TEM horn which acts as the transmission line. The Klopfenstein taper is adopted, whose passband depends on the length and the difference of impedance. As for the combined antenna, the length should be long enough, and the aperture impedance should be small. The aperture impedance is determined by the ratio of the width and height, so the aperture should be wide enough. However, the influence of these two factors is not so significant.

B. The radiation process

Height of the aperture can make big difference on the radiation process of the antenna. Two antennas with the same length and width (L×W= 20 cm × 6 cm), but different heights (H=18, 24 cm) are compared as is shown in Fig. 1.

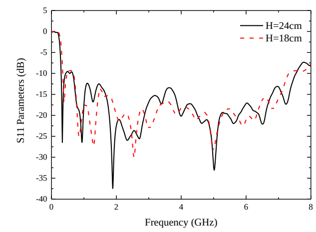

Fig. 1. S11 parameters of antennas with different heights

Although aperture impedance is larger, the working band of the higher one is broader.

C. Time domain performance

Three antennas with L×W×H= 16 cm×15cm ×15 cm, 18 cm×7.5cm ×15 cm, 18cm ×6 cm×18 cm (numbered as I, II, III) are compared. The lower cut-off frequency is 377 MHz, 382 MHz, 361 MHz, respectively, and the radiating field with a developed excitation is shown in Fig. 2.

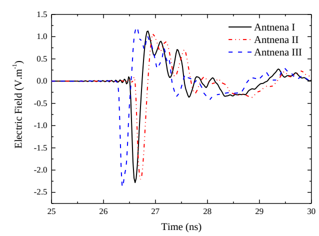

Fig. 2. E-fields of antennas with different dimensions

The aperture area of Antenna II is half that of the cubic Antenna I, but E-filed only decreases by 5%, which can be considered as compact design. The designed antenna is shown as Fig. 3. Oscillations in the late time fields are caused by the radiation of back and forth reflection of low frequency-components in the current loop.

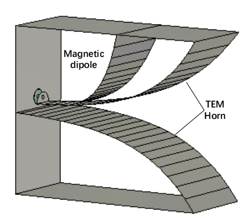

Fig. 3. Picture of the designed combined antenna

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