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A Review on Different Antennas for Ultra Wideband Communications

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Abstract -This paper deals with basic principles for ultra-wide-band (UWB) radiation. The discussion starts with a description of the influence of antennas on UWB transmission. Since the number of possible antenna structures is nearly unlimited, the focus will be on a classification according to different radiation principles. For a wireless engineer, the problem to solve is the proper design of an antenna with the desired radiation characteristics. The parameters characterizing antennas in time and in frequency domain are specified. For each of these mechanisms, the typical advantages and disadvantages are discussed, and an example antenna and its characteristics are presented. The final outcome of this paper is that there exist numbers of UWB antennas, but not each of them is suited for any application, especially in view of radar and communication systems requirements. Large bandwidth excludes the use of typical reasoning antenna and sets challenging demands for antenna design. The spectrum of an UWB signal is spread over several GHz due to a short pulse excitation.

Keywords: Horn antenna, Bowtie antenna, Ultra wide band, Balun.

1. INTRODUCTION

An ultra-wideband (UWB) technology is a promising asset for future short-range data and voice communication. Currently, this technique is used mainly in radar and sensor applications. Signal is said to be ultra wideband if its fractional bandwidth $B_f=2(f_H-f_L)/(f_H+f_L)$ is greater than 0.25 [1]. UWB technology utilizes short pulse or fast frequency chirp transmissions that special the signal in frequency domain from few MHz to several GHz[10]. UWB signals have very good time and range resolutions and the transmission is covert. Short review to ultra wideband communication concept, called impulse radio, can be found e.g. in [2]. Wide pass band sets special demands for antenna design Antennas are called impulse-radiating radiators, due to the short pulse excitation. One can not apply narrowband resonant antenna structures any more but antenna structures with wider bandwidths have to be found.

2. ANTENNA RESPONSE FOR UWB EXCITATION

Antenna act as filters and they are critical component in radio systems. Basic effect of antenna in time domain is that they cause derivative operations to the pulse waveform when the pulse is passing through the antenna [3]. This increases the transmitted and received pulse widths and decreases time and range resolutions of UWB systems.

This antenna response resembles something what is presented in Fig.1, where the ringing effect is modeled using simple Bessel function.

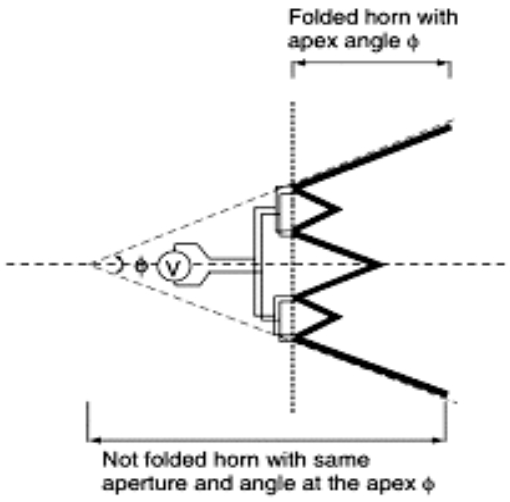

Fig 1: The response of antenna to impulse excitation

To avoid ringing, resistive antennas with low Q-value can be used. One can increase the antenna bandwidth making the Q-value small because the bandwidth is inversely proportional to Q-value. Because of the low Q-value, the efficiency of a resistive antenna is in general quite bad. New antenna structures and feeding are obviously needed for ultra wideband use.

3. UWB ANTENNA ELEMENTS:-

In this paper, some antenna types are presented for UWB radiation. An introduction to those antennas is given here. Those antennas mentioned in the paper are basically for radar applications.

Bowtie antenna's bandwidth is very wide and those antennas can be used in UWB applications[4]. In Fig. 2, few examples of different Bowtie antenna types are shown. Bowtie antenna is one type of biconical antenna. Beam width and bandwidth of bowtie antenna depend directly on the physical dimensions of the antenna and they are nearly constant over the frequency range[11].

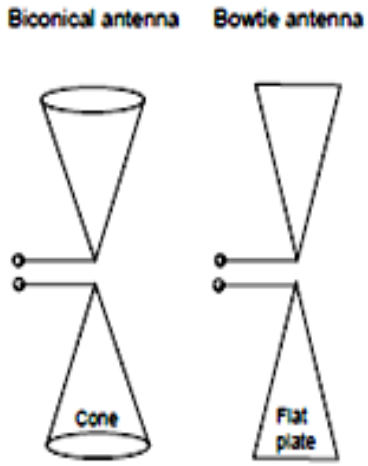

Fig 2: Few wideband Bowtie antenna types

In a folded horn antenna for ultra wideband high power applications is introduced[5]. The idea of the folded horn antenna comes from sub horns inserted in a main horn. Sub horns divide the initial horn aperture into two equal parts, maintaining its electrical dimensions as can be seen in Fig.3. Using this technique the size of the antenna can be reduced.

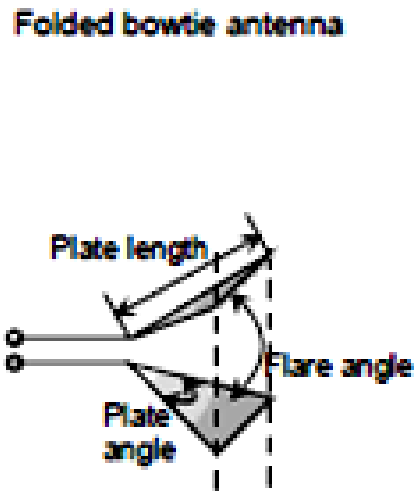

Fig 3: Folded horn antenna

In Fig.4. there are presented a bicone dipole antenna and a conformal reverse bicone (magnetic) antenna for UWB applications [6]. The magnetic antenna structure presented in Fig.4b decreases unbalanced currents excited on the outer feed cable. The magnetic antenna exploits the duality of electrical and magnetic fields[7].

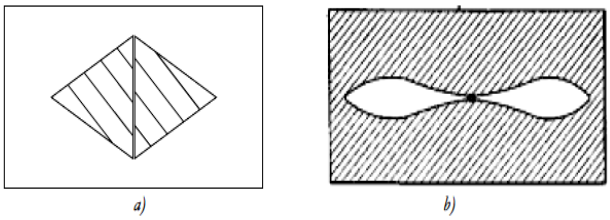

Figure 4. a) Bicone antenna, b)Conformal reverse bicone antenna (magnetic antenna)

In the UWB literature at the moment, the main focus in UWB antenna technology has been the high power radar antennas. There are products or demonstrative radio applications for communications, intelligent sensors and surveillance etc. areas, which utilize low power consumption[8]. These applications will benefit from an antenna technology that can be produced in very small size. Currently the problem is a low publicity of those antenna structures.

4. FEEDING

Feeding of UWB antenna can be done by using e.g. coaxial cable, waveguide or micro strip line. The antenna matching is done by balun, if necessary [4].

The feeding line problem can be circumvented when the impulses are generated in the antenna throat. One possible technique is optical pulse excitation presented e.g. in [3]. In this invention a high voltage potential is stored between metalized layers that act also as antenna plates. A laser pulse triggers photoconductive semiconductor between the plates into a conductive state. The voltage potential is suppressed rapidly, which causes energy to radiate from the antenna [9].

5. CONCLUSION

Advanced communication and sensor applications are being exploited in the near future, and the challenges in ultra wideband antenna technique call for intensive research.

There are a number of different antenna structures suitable for ultra wideband applications. Extremely wide frequency band of UWB signal makes the antenna design an interesting research area.

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