# **Overview of Wideband Antenna Concepts**

Applications to CWI and Pulse Testing

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*Abstract* — To evaluate the response of a test object to a wideband electromagnetic threat such as the nuclear electromagnetic pulse (EMP) requires pulsed antennas that do not reflect energy from the ends and continuous wave (CW) antennas that are relatively flat over 3 or 4 decades of frequency. These two characteristics are, of course, related, and each requires loading the antennas according to some profile. There are a number of design approaches that can be used. This paper presents an overview of some current antenna designs and additional design concepts that could be applied to future CW illuminator or EMP simulator designs.

Keywords-EMP, CW, averaging, extrapolation, resistive loading

## I. INTRODUCTION

In order to build an antenna that is suitable for EMP evaluation, it must perform over a frequency range of 3 or 4 decades. To do this, it is necessary to critically damp the natural resonances of the structures so as to eliminate reflections from the ends of the antenna and thus reduce or eliminate resonant peaks and notches in the frequency spectrum of the radiated field.

### II. DIPOLES

For dipole antennas, the resistive profile that has been used for EMP simulators is that developed by Wu and King 1965 [1]. The W-K Taper, as it has come to be known, has been applied to numerous EMP simulators, in particular VPD II, NAVES, and EMPRESS II. It can also be used effectively on CW illumination antennas to damp the resonant peaks and notches, thereby flattening the radiated spectrum. It is emphasized that radiating type of EMP simulators have: i) a low frequency limitation and ii) a radiated field that is bipolar, whereas E1 EMP waveform is mono-polar.

#### III. LOOPS

Several methods for damping the resonances of loop antennas are described by Kanda [2]. He describes loading them one point or at multiple points using a combination of resistive and RLC networks. Gosh and Sarkar analyzed loops and numerous other antennas in their 2006 paper [3].

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### **IV. HYBRIDS**

The horizontally polarized dipole EMP simulator at Patuxent River and the Ellipticus CW Illuminator are examples of hybrid antennas, which change their radiation characteristics from that of a dipole at the higher frequencies (early times) to that of a loop at the low frequencies (late times) [4]. The resistive loading is applied continuously along the length of the antenna in order to damp out the resonance of the loop and also to adjust the late-time near-field wave impedance to  $377\Omega$ .

## V. TEM HORNS

For TEM horns to be useful in EMP simulation, they must be resistively loaded in a W-K fashion, as described by Kanda [5], or they may be reshaped to break-up the front aperture differentiation of the pulse, as described by Shlager [6] and Gallon and Giri [7]. Attempts at energizing a TEM horn by an integral of a DEXP waveform resulting in an approximate DEXP radiated waveform have not worked out well,

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