A Kind of Symmetric TEM Horn Antenna Based on Low Frequency Compensation

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Abstract—In this paper, a low-frequency-compensated symmetric TEM horn antenna is proposed to simulate HEMP. The performance in time and frequency domain near the aperture is in accord with HEMP standard.

Keywords: low-frequency-compensated; horn antenna; HEMP simulator

I. INTRODUCTION

Since last five decades, many large HEMP simulators were built to simulate the HEMP threat and test the vulnerability of electronic system. For ground facilities or systems immovable, a transportable HEMP simulation system is necessary. A portable simulator based on the low-frequency-compensated horn antenna is designed. The performance in time and frequency domain exhibits well.

II. DESIGN OF SYMMETRIC HORN ANTENNA

The TEM horn antenna is often used to radiate fast electromagnetic transients. Since it is capacitive in low frequency and approximately open-circuited when frequency approaches zero, it is not available to radiate HEMP which contains abundant low frequency components.

Matched resistive impedance is loaded at termination of horn antenna. The magnetic dipole formed by a current loop along the terminating route on the back of antenna could radiate at the same direction of electric dipole, so that low frequency performance is compensated.

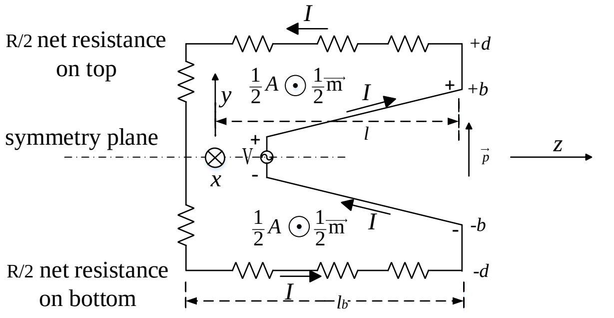

Figure 1. Topology of Low-Frequency-Compensated Antenna

When $\vec{m}$ and $\vec{p}$ meets $|\vec{m}|/|\vec{p}|=c$, electromagnetic field would be transverse. Primary components E_θ and H_φ are enhanced on the boresight in +z direction and null in –z direction, where wave impedance equals to one in vacuum.

III. PERFORMANCE OF THE ANTENNA

The electromagnetic environment near the aperture of horn antenna is simulated and measured to validate the design of simulator. The comparison with an asymmetric TEM horn antenna is done.

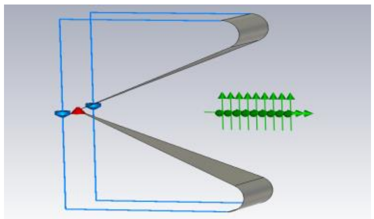

Figure 2. Simulation Model of the Antenna

A. *Time domain performance*

The typical waveform of electromagnetic field near the aperture is shown in Figure 3 and Figure 4. Rise time is 2.0 ns, and pulse width is 28.0 ns. The waveform parameters of electric field on the boresight are shown in Table I. The test volume is within the range of -0.3~-0.1 m, while the dimension of antenna is 1 m× 0.5 m× 1 m.

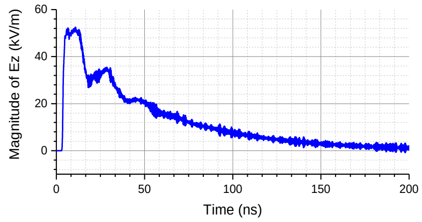

Figure 3. Waveform of Electric Field near the Aperture

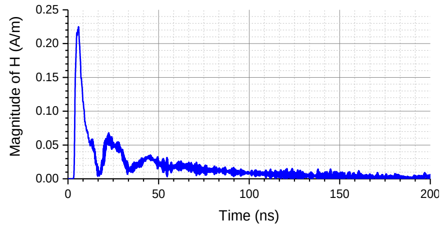

Figure 4.Waveform of Magnetic Field near the Aperture

B. *Frequency domain performance*

The spectrum of the electric field near the aperture is shown in Figure 5. Comparing with theoretical spectrum of HEMP, the fluctuation is not significant.

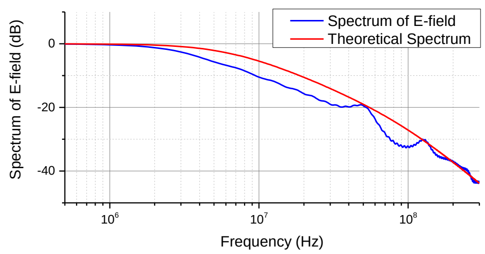

Figure 5. Spectrum of Electric Field near the Aperture and Theoretical Spectrum of HEMP

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