A Comparative Study of Large Loop Antennas Regarding the Evaluation of Equivalent Radiation Sources

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***Abstract*—Besides the use of Large Loop Antennas (LLAs) to characterize magnetic fields generated by electrical devices as required by international standards, LLAs are also suitable for the determination of equivalent radiation sources. This has several applications to EMC analytical and numerical studies, such as electromagnetic environment evaluation and failure detection. Here, a comparative study between two LLAs, namely the Kanda and the van Veen and Bergervoet antennas, is shown. The methodology employed in this study is presented and analytical and numerical results on the antennas' sensitivity on load impedances are given and analyzed.**

***Index Terms*—EMC, equivalent sources, loop antenna, Kanda antenna, van Veen and Bergervoet antenna.**

I. INTRODUCTION

A comparative study between the Kanda and the van Veen and Bergervoet antennas has great scientific interest, because of their wide applicability and easy using and building. Basically, these antennas consist of arrangements of three orthogonal loaded loops [1]-[2]. Much data is found in the literature about these antennas individually, but a comparative study on their performances regarding the determination of equivalent radiation sources is not reported.

Because the van Veen and Bergervoet antenna can only be used for the determination of equivalent magnetic dipoles, the study here presented addresses only to the magnetic dipole (M) responses of both antennas, to represent the equivalent radiation source. For sake of simplicity, multipole contributions to the antennas responses are neglected [3].

This study presents a sensitivity analysis on the antennas load impedances and can be expanded to other components deviations.

II. THEORETICAL ASPECTS AND RESULTS

To support the analytical study, the transfer function that describes the coupling between the antennas and a magnetic dipole is considered. For both antennas, the coupling factor between one of the loops and a simple magnetic dipole with magnetic dipole moment m_M, orthogonal to the loop plane and lying in its center, is [1]

$$\frac{m_M}{I_A} = 2\frac{Z_L + j\eta kb\left[\ln(8b/a) - 2\right]}{\eta k^2\left[1 + 1/(jkb)\right]e^{-jkb}} \quad (1)$$

where I_A is the loop induced current.

For the Kanda antenna, I_A is obtained from

$$I_A = I_\Sigma = \left[I(0) + I(\pi)\right]/2 \quad (2)$$

where I(0) is measured in one of the loads, and I(π) is measured in the other load, at the opposite side in the loop [1].

For the van Veen and Bergervoet antenna, I_A is given by [2]

$$I_A = I_P\left\{\left[-\frac{Z_0'}{Z_0}\frac{\sin(k_C\pi b/2)}{\tan(k\pi b/2)} - \cos(k_C\pi b/2)\right] + j\left[\frac{Z_0'}{R_T}\sin(k_C\pi b/2)\right]\right\} \quad (3)$$

where I_P is measured in the inner conductor of the coaxial cable of the loop, in a point 90 degrees from the loads [2].

Once the coupling factor given by (1) is the same for both antennas, the factor m_M/I_P is obtained combining (1) and (3).

The accuracy of equivalent radiation source measurements strongly depends on the factors m_M/I_A and m_M/I_P.

Figure 1 shows the influence of the antenna load impedances (Z_L and R_T) on the factors m_M/I_A and m_M/I_P. Nominal load impedances of 50 Ω with a tolerance of ±10% were considered for the frequency range of 9 kHz to 30 MHz.

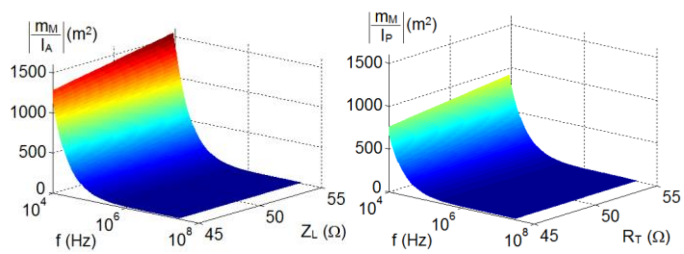

Figure 1. m_M/I_A (Kanda) and m_M/I_P (van Veen and Bergervoet) behaviors

The results show different behaviors and sensitivities for the antennas to obtaining equivalent radiation sources when load impedance deviations are considered. High sensitivity of the factors m_M/I_A and m_M/I_P related to frequency and load impedance is observed at low frequencies.

This analysis can be expanded to other parameters deviations. Further studies supported by analytical and numerical models are being conducted to confirm the advantage of applying these antennas in the determination of equivalent radiation sources.

III. ACKNOWLEDGMENTS

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