Electromagnetic Modeling of Adjacent Metallic Loops for Wave Propagation at Low VHF Bands

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This paper studies wave propagation modeling in urban environment at low VHF bands. During the past decade, many theoretical and measurement-based propagation models for indoor/outdoor environments have been proposed. Recently an efficient and analytical indoor propagation model at low VHF band, capturing the propagation effects of dielectric walls and the surrounding metallic frames, was presented (Sheikhsofla, M., and K. Sarabandi. "Indoor wave propagation modeling at low-VHF band." Antennas and Propagation in Wireless Communications (APWC), 2014 IEEE-APS Topical Conference on. IEEE, 2014). To extend the utility of the model and make it more accurate scattering from metallic window fames must be accounted for. In the desired band of operation the widow size (perimeter) can be comparable or large that the wavelength of the electromagnetic waves. Therefore low frequency approximations are not appropriate in this case. Instead, a complete analytical and tractable model needs to be developed to accurately characterize scattering from windows.

The problem of multiple scattering of a plane electromagnetic wave by a number of metallic scatterers specially when they are in near-field of each other is generally very complex and difficult to formulate analytically. However numerical methods can be used to compute the scattering for arbitrary sources at the expense of computation time. Modal analysis in conjunction with macromodeling can be used effectively to model excited currents on simple rectangular loops. When two or more loops are placed close to each other macromodeling also becomes difficult and cumbersome. A procedure for evaluation of the first and second order scattered field from a pair of adjacent metallic loops when illuminated by an incident plane wave is outlined. Here we consider two adjacent conducting metallic loops separated by d and an incident field inducing current $I1$ around loop#1 in the absence of loop#2. This current distribution can be analytically obtained using a macro-modelled modal expansion based representation. The scattered field from loop #2 with $I1$ as the excitation source is the second order scattered field. Note that the radiated field from $I1$ can be expanded as plane waves and the macromodel can be used for each plane wave to compute the excited currents on loop #2. The first order current and second order current on loop 2 can be used as excitation for Loop 1 and third order current on loop 1 can be obtained. This process converges quickly and accurate scattering from adjacent loops can be obtained in an efficient manner.