Numerical and Experimental Evaluation of Spherical Wave Absorption Incident on a Thin Metamaterial Absorber

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It has been proposed that a thin metamaterial absorber could be used for measuring 2-d RF field distributions incident on the absorber surface. The structure of the absorber consists of a matrix of dense metal patches formed on the surface of a thin grounded dielectric substrate. The incident wave power is absorbed by lumped resistors inserted between the surface patches, which are matched with incident wave impedance at the resonance frequency of the metamaterial structure. The incident field distribution can be monitored by measuring the voltages induced on (or the amounts of power consumed by) the lumped resistors.

So far the technique has been evaluated and validated by simulations and experiments mainly for a plane-wave incidence. When monitoring the field distribution nearby an RF source, the absorber is illuminated with a spherical wave. For the accurate measurement of the field distribution in such a situation, it is necessary to evaluate the spherical wave absorption characteristics of the absorber. In this study the spherical wave absorption is computed using the following numerical procedure. At first the spherical wave incident on the absorber surface is expanded into a large number of elementary plane waves propagating in different directions. For each of the plane waves, reflection and absorption at the absorber surface are theoretically calculated for TE and TM incidence, using an effective impedance model of the surface. The elementary plane wave fields are then synthesized to obtain the reflected and absorbed field distributions of the incident spherical wave. The computation of plane-wave expansion and synthesis can be performed quite efficiently using FFT.

We will present and discuss the performance of the metamaterial absorber at resonance and off-resonance frequencies, which is illuminated with spherical waves radiated from a nearby RF (GHz) dipole. Results of the numerical analysis is compared with actual measurements using a fabricated metamaterial absorber equipped with monitors for voltage of the lumped resistors on the surface.