Improving Absorption Using Time-Variant Electromagnetic Systems

Hamidreza Kazemi*, Mehdi Veysi, Mohamed A. K. Othman, and Filippo Capolino
Department of Electrical Engineering and Computer Science University of California Irvine, CA 92697 USA

Absorbers are important electromagnetic devices and have found many applications in RF/microwave regime, such as their use in stealth missions or in recreating free space in an anechoic chamber. Conventional microwave absorbers usually suffer from a limited bandwidth and therefore increasing their bandwidth have been a classical challenge in the past several decades. In this regard, different wideband absorbers have been developed such as multilayer absorbers (e.g., Jaumann or Dallenbach absorbers), analog circuit absorbers, frequency selective surface based absorbers, and metamaterial-based absorbers. However, it is known that any linear time-*invariant*, causal and passive absorber (such as those mentioned previously) is subjected to a physical limit that relates bandwidth of operation, absorption amount and absorber total thickness (K. N. Rozanov, IEEE Trans. Antennas. Propag., 8, 1230-1234, 2000).

Our goal is to enhance the bandwidth of conventional absorbers by incorporating time-variant circuits or materials into the absorber substrate. Applying time-variation breaks the assumption of absorber's bandwidth limit and may result in a wider bandwidth. As a representative example, here we incorporate the time-variant circuits into a flat metal-backed absorber and show that the absorber bandwidth significantly increases. In case of a normal incidence, we model such an absorber using the transmission line modeling method. Here the time-variant circuits are considered as a combination of switches with lumped circuit elements (i.e. R, L, and C) arranged in parallel with the transmission line's parameters to enhance the absorber bandwidth. In addition, we investigate the effects of various parameters (such as switches' positions along the transmission line, switching frequency, and duty cycle of the switches) on the absorber bandwidth. In general, other types of absorbers can be used, considering also more absorber layers, to further enhance the absorption bandwidth. The analysis is carried with an in-house Finite-Difference Time-Domain (FDTD) code to simulate the time-variant absorber.