EXPERT'S ADVICE

The vital role of simulation for virtual EMI and EMC test environments

Before deploying microwave and millimeter-wave devices and systems within 5G, the internet of things, and high-speed wireless communication, it is essential to predict their performance. This need has increased the demand for virtual test platforms through simulation software.

High carrier and system bus frequencies are necessary for high-data-rate communication between multiple devices present in such systems. However, increased operational frequencies may induce undesirable and troublesome electromagnetic compatibility (EMC) and electromagnetic interference (EMI) issues, especially when communication is congested. Moreover, the impact from other physics is no longer negligible in mmWave devices. Multiphysics phenomena, such as structural deformation caused by heat expansion, need to be a part of the design consideration as well. Fortunately, a wide range of EMC and EMI scenarios can be virtually emulated and tested without having to elaborately adapt test configurations to real-world environments.

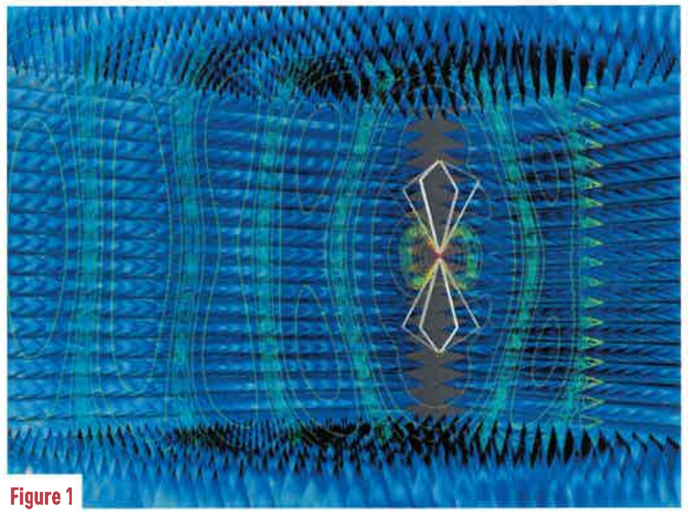

Figure 1
Contour plot of the logarithmic field distribution of a biconical antenna in a fully anechoic chamber.

USE ELECTROMAGNETIC SIMULATION SOFTWARE TO SAVE TIME, COST AND QUALITY CONTROL

Using electromagnetics simulation software for evaluating device functionality reduces time and costs during the development and production cycle. Virtual evaluations can be performed prior to fabrication, test, and manufacture and are an important component in reliable quality control processes.
The goal of simulation is to describe the real world as closely as possible on the computer by using proven physics equations. Ideally, the numerical model is used to mimic multiple physical phenomena representing a great variety of operational conditions, which is hard to realize in a lab environment. Accurately analyzing real-world designs and conditions comes at a cost. The more complex the analysis, the more computational resources are needed. Therefore, engineering judgment is used for excluding unnecessary parts from the analysis and for configuring the simulation settings to ensure efficient computations.

When evaluating EMI and EMC performance of radiating devices, test engineers often perform measurements in a fully anechoic chamber. Simulation tools are used to set up a numerical environment that can reproduce such tests virtually (Figure 1) by using, for example, the finite element method (FEM). For instance, the pyramidal absorbers that are attached to the anechoic chamber walls contain lossy conductive carbon particles. The absorbers attenuate the incident electromagnetic waves gradually with only small amounts of unwanted reflections. For efficiency, instead of modeling the full-sized wall of absorbers, the simulation uses only a single pyramidal unit cell with periodic boundary conditions (Figure 2). This is an efficient way of estimating the performance of the complete set of absorbers to make sure the reflectivity is at a minimum. Even if the model consists of just a single unit cell, the periodic boundary conditions make it equivalent to an infinite array of pyramidal absorbers. The effective homogeneous material properties obtained from the unit cell simulation are then used for the entire anechoic chamber wall.
To validate the virtual version of the anechoic chamber, a wide-

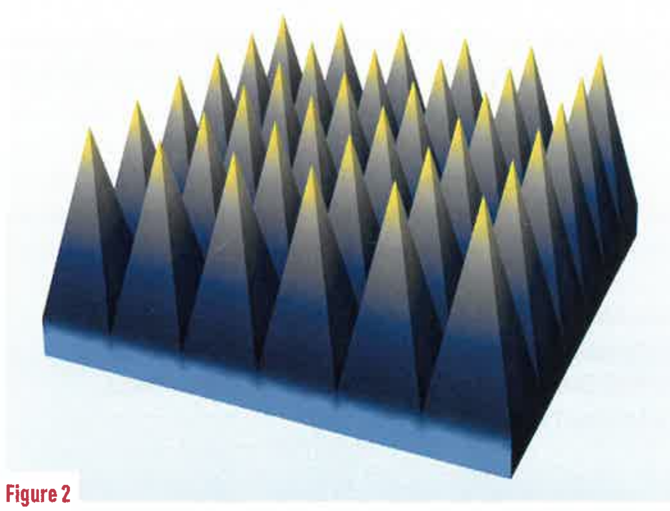

Figure 2
Microwave absorber simulation using Floquet periodic boundary conditions.

band biconical antenna is placed inside the anechoic chamber. The performance of the antenna (for example, far-field radiation patterns and S-parameters) is computed to validate that there is no degradation of performance due to the incomplete absorber characterization.

MAKE THE SIMULATION MUCH FASTER AND MORE EFFICIENT IN TERMS OF MEMORY USAGE

Although the real-world representation of the antenna inside the fully anechoic chamber in the simulation is visually quite appealing, as shown in Figure 1, its computational cost is unnecessarily high. The simulation can be made much faster and more efficient in terms of memory usage by using a numerical technique that is equivalent to the anechoic chamber walls. Such techniques involve using perfectly matched layer (PML) and absorbing boundary condition features. To efficiently study the near and far fields and other antenna parameters, it is sufficient to place the same biconical antenna in a much smaller surrounding air domain enclosed by a perfectly matched layer (Figure 3).

In order to simulate a large system efficiently, it is crucial to choose proper numerical boundary conditions. In addition, eliminating