Short Course Proposal (Full Day)

Computational Electromagnetics in Solving Real-World High-Speed EMI/EMC and Packaging Problems

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Abstract
In the past 10 years, circuit boards and packages, the media that is overwhelmingly used to transport and process electronic signals, have become smaller and denser. Over the same period, the clock frequency has reached the microwave band with higher order harmonics reaching the X-band and beyond. With these factors combined, the design of the "circuit" becomes a problem of transmission lines, cross-talk, dispersion, wave-matter interaction, propagation, inductive coupling,…etc. Classical circuit and package designers are confronted with an overwhelming task of accounting for all these factors that strongly affect the form and arrival time of the signal and whether the signal causes any problems elsewhere in the system. Antennas and propagation scientists and engineers, on the other hand, are fully comfortable with such physical phenomena yet are disjointed from the language and challenges faced in circuit designs and from the device behavior that leads to all such problems and challenges. This course introduces classical antenna and propagation folks to the world of electromagnetic compatibility, interference and packaging with computational electromagnetics as the medium of communication. Students can expect to become familiar with important problems facing the industry and the role and challenges of using numerical modeling to solve such problems.

Course description
Electronic packages and printed circuit boards (PCBs) are used to: (1) provide mechanical and thermal support, (2) protect against environmental factors, (3) guarantee the integrity of the signal, and (4) guarantee suitable channels for power distribution, and (5) protect against electromagnetic threats. As the clock frequency increases, insuring proper electrical performance of packages and boards becomes a formidable task. In fact, in the microwave frequency region, distributed inductance and capacitance become difficult to quantify; skin effect starts to adversely impact the signal strength, and the potential for electromagnetic interference increases. As an example, if signal propagation (i.e., timing, dispersion,…etc.) are not fully predicted during the design process, then timing analysis, which is the heart of modern circuit design, becomes a useless exercise. What is interesting, however, is that the problems of characterization of the signal behavior and interference in such "circuits" become that of the study of propagation, coupling, scattering, radiation and wave-matter interaction—all, the eminent domain of antennae and propagation experts.

While the antennae and propagation engineers have the know-how to develop analytical and numerical paradigms to describe and mimic the physics of radiation, they typically have limited experience on how to bring their capabilities to solve real-world high-speed EMI/EMC and packaging problems. Phenomena and terms such as "stray inductance", "parasitic capacitance", spurious radiation, switching noise, delta noise, interconnect, …etc. can be alienating to many, but once this different language is understood, the power of computational electromagnetics will be realized as a primary tool to address the high-clock-speed related challenges discussed above. In fact, once the language barrier is overcome, new exciting innovation possibilities for antenna and propagation engineers start emerging.

In this short course, we review signal propagation fundamentals. We discuss the available electromagnetic computational tools (MoM, FDTD, FDFD, FEM) and address their effectiveness in the context of solving media-and-topology complex problems. We discuss the use of computational tools in assessing the electromagnetic interference potential of packages, boards and interconnects.

Throughout this course, strong emphasis will be placed on the applicability of numerical codes to solve real-world EMI/EMC and packaging problems of special interest to the industry. Students can expect not only to experience the use of numerical codes in solving real-world EMI/EMC and packaging problems, but also to become familiar with important problems facing the industry and the role and challenges of using numerical modeling to solve such problems.

Who Should Attend

Anyone interested in making use of their background in theoretical and computational electromagnetics to explore new horizons in the growing and important area of EMI/EMC and Packaging.