Virtual Prototyping and Failure Synthesis: RF Design and Optimization of Mobile Device Terminals

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Introduction and Objectives

During the design phase of mobile telecommunications equipment it is essential to assess and predict potential failures of the device at an early stage. Possible sources include design related elements (e.g., contacts between LCD and PCB, loose shields, etc.) or component related issues (e.g., % of metal in plastic, variation of metal thickness due to process, etc.). Being an effective means for EM investigations, numerical simulation has previously demonstrated its suitability for mobile phone analysis.

The objective of this study, however, was to investigate if enhanced TCAD environments can act beyond common EM simulation and proof its value as a virtual prototyping platform. Embedded into a regular design process/environment, a latest quad-band phone was thus rigorously numerically examined regarding failures, synthesis and prediction capabilities of RF performance for mobile device terminals.

Methods

Simulations were conducted by using the FDTD based platform SEMCAD X which provides 3-D ACIS based modeling and OGL rendering, furthermore, enriched by method enhancements and FDTD hardware acceleration. The original detailed CAD dataset of the commercial phone from Motorola Inc. consisted of $>$ 1'000 IGES parts which were directly imported into the TCAD platform and processed without major simplifications. Minimum spatial grid resolutions of 100 μm were used to resolve critical details via the automated grid generation. The availability of hardware accelerated FDTD providing computation speeds up to 300 - 400 MCells/s, enables a simulation of the described device structure in $<$ 15 minutes.

Initial simulations ensured an accurate representation of the phone by thoroughly comparing to measurements from the DASY4 scanners and from the anechoic chamber. Subsequently, the availability of FDTD acceleration allowed to create a failure synthesis matrix, concentrating on design and component related items of interest.

Results and Discussion

After initial numerical results of the phone by inclusion of matching networks from the physical model were validated by measurements of impedance and radiation performance, the failure synthesis table was built up. The analysis of manufacturing defects of various connectors (LCD brackets, keypad connectors, etc.) revealed that certain underestimated connections have a significant influence on the RF performance of the device. Numerous conditions were assessed by measurements; in all cases the simulations were able to predict the experimental findings. Finally, the influence of composite materials and metal coatings was investigated for certain shielding and housing parts. The study concluded that speed and feature enhanced TCAD tools exceed the use as a common simulation tool and revealed its value as a virtual prototyping platform being embedded within industrial environments.