Mixed-mode S Parameters Modeling With COMSOL Multiphysics

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Abstract

This paper presents the study of the simulation of mixed-mode S-parameter using COMSOL Multiphysics® RF Module. In addition, a COMSOL® application is also developed for the study of electrical connectors.
We are interested in modeling electrical connectors used for data transmission according to standards used in communication protocols. To characterize a system, current and voltage waves are used to measure the transmission and the reflection in the system. A matrix representation characterizes the combinations between different ports (input or output). As these S-parameters are frequency dependent, plots of losses in transmission and reflection of the waves versus frequency are more commonly used.

The studied protocols are: USB3.0 and Ethernet cat6a. Both are based on differential signals. Standards characterize them in an assembly (cable and connector). Among all their specifications, we are interested in the following quantities: Insertion Loss (IL), Return Loss (RL), Near-end crosstalk (NEXT), Far-end crosstalk (FEXT), Transverse conversion transfer loss (TCTL).
To carry out this project, two connectors are studied (the cables are not integrated), working first with a complete imported CAD model and secondly with a simplified model built directly in COMSOL Multiphysics®.
Different boundary conditions are applied to the models such as ports and the « mixed-mode S parameter », new functionality of COMSOL Multiphysics®.

Figures used in the abstract

Figure 1 : CAD model of an electrical connector