New Approaches to Modeling Measured Multi-Port Scattering Parameters

Sanda Lefteriu and Athanasios C. Antoulas

September 9, 2008

The next generations of electromagnetic applications will require higher operating frequencies, wider data bandwidths and increased dynamic range, all this with a reduction in device dimensions. This demands for accurate simulation of electromagnetic effects of structures with arbitrarily shaped layouts, such as chips, packages or boards. A popular approach is to treat the system as a black box and construct a macromodel for it based on measurements of its frequency response over the frequency band of interest. Typically Z-, Y- and H-parameters are measured, which involve the sinusoidal currents and voltages at the terminals. Due to the fact that at high frequencies it is difficult to directly measure voltages and currents, scattering parameters can be used to characterize such networks.

This talk addresses the problem of building a low complexity macromodel of an electromagnetic device based on measurements or simulations of its S-parameters. The problem of building an LTI system which approximates given measurements of the frequency response at various frequencies is known as the rational interpolation problem for which several techniques have already been developed in the electronics community. However, for devices with a large number of ports, currently available methods are expensive. The approaches we will be proposing are based on a system-theoretic tool, the Loewner matrix pencil. They are fast, accurate and robust; they construct models of low complexity and are especially designed for devices with a large number of terminals. Moreover, they allow to identify the underlying system, rather than merely fitting the measurements. We use a black-box approach by not assuming any underlying structure of the systems to be modeled (reciprocity of the network is not assumed, meaning that we can deal with non-symmetric, as well as symmetric, S-parameter matrices). The advantage of this approach is that a system can be modeled independently of the knowledge of its internal logic. Moreover, our algorithms construct the models exclusively from the available measured data by arranging it in a clever way, so, except for the data file and the desired order or accuracy of the model, no other user input is required. Industry standard vector fitting, on the other hand, requires a set of good starting poles for the pole-relocation process to be successful and produce good macromodels. The numerical results we will present show that our algorithms render better models in less time, when compared to vector-fitting.