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0.1 Abstract

For EM simulations of complex MMIC structures, the usage of PML (Perfectly Matched Layer) absorbing boundary conditions is inevitable. PML provides a reflectionless open boundary condition and thus helps to keep the mesh size within a reasonable limit. On the other hand, structures completely enclosed by PML walls do not allow excitation by waveguide ports but require so-called internal ports. Such ports, which are introduced between two or more mesh points inside the structure, facilitate also to include lumped elements or entire networks thus enabling one to study active circuit, for instance.

This work treats both the PML boundary condition and the internal ports, in the framework of the frequency-domain Finite-Difference method (FDFD). It is shown that the presence of PML walls enlarges the magnitude range of the system matrix coefficients, encountered when calculating the fields. This makes the system matrix ill-conditioned and increases the number of iterations when solving the system and may even render this PML totally unusable for most practical applications. It is found that by avoiding any overlapping PML walls and by making the PML cell sizes the largest ones in the whole mesh the high count of the number of iterations can be lowered drastically.

The mode spectrum at waveguide ports with lateral PML walls consists of artificial PML and physical modes. We find that the coupling between PML modes and physical modes must be analyzed thoroughly in order to filter the artificial PML modes out in a reliable way.

Regarding the internal port, a line-current formulation proves to be the only practical choice. The parasitic inductances associated with it are found to be of significant influence. A closed-form expression for these inductances is developed in order to determine their values so that it can be deembedded from the results.

The optimized PML and internal port formulations are verified for the example of a 24 GHz slot antenna with integrated front-end MMIC, suitable for short range communications and sensor networks.