4th URSI AT-RASC, Gran Canaria, 19-24 May 2024

Sensitivity analysis framework for PCB EMC and signal integrity

Jérôme Rossignol [(1)], Sébastien Lalléchère* [(2)], Laurent Patier [(3,4)], Blaise Ravelo[(5)]

(1) Université de Bourgogne ; e-mail: jrossignol@univ-bourgogne.fr
(2) Safran Tech, Chateaufort; France ; e-mail: sebastien.lallechere@safrangroup.com
(3) IEEE ; e-mail: laurent.patier@ieee.org
(4) EMC4U – 478 rue de la Découverte, Mini Parc 3 – CS 67624 – 31 676 Labège Cedex – France
(5) NUIST, Nanjing, China

This paper aims at demonstrating the interest of joint microwave system modelling and sensitivity analysis methodology to exhibit the most influential parameters during PCB design phase.

Signal and power integrity (SI/PI) were investigated in [1], where a set of directions were proposed to help engineering design for PCB applications. The importance of electrical interconnects on PCB performances is a key parameter during the design phase as pointed out in [2]. Among the panel of electromagnetic numerical tools, the analytical formulations are of utmost importance when dealing with parametric and optimization design procedures (see for instance works with Kron formalism in [2-3]). In this framework, nodal circuit methods (used through SPICE-like netlists) are also straightforward (and useful) to access reliable data regarding reflection and transmission coefficients.

This proposal focuses on the combination of circuit modelling (Qucs Studio, see [4]) and sensitivity analysis tools to quantify the effect of electrical and geometrical microstrip tolerances on SI/PI and EMC performances of PCB. The proposed methodology and characterization procedure has been tested on various numerical Proof-of-Concepts (PoCs). Figure 1 gives an overview of Y-tree PoC (inspired from [3]) with input parameters (interconnect lengths and widths, metallization and substrate characteristics). The influence of 5%-tolerance levels around initial parameters (see Figure 1) is depicted in Figure 2 through S-parameters. The final paper will illustrate the sensitivity analysis framework proposed (illustrated for filtering applications in [5]).

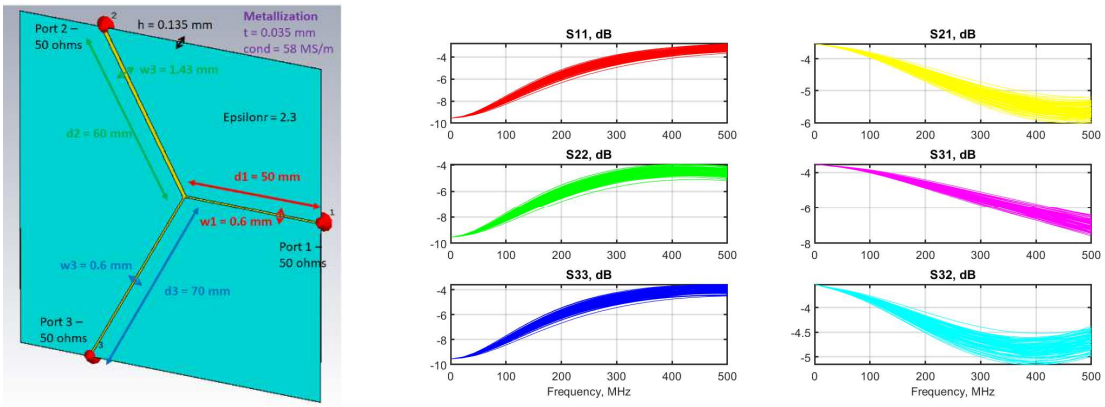

Figure 1. Statement of the problem: microstrip PoC [3] (left); Assessing S-parameters dispersion due to tolerances (right).

1. Jun, F., X. Ye, J. Kim, B. Archambeault, and A. Orlandi, Signal integrity design for high-speed digital circuits: Progress and directions, IEEE Trans. EMC, Vol. 52, No. 2, 392–400, May 2010
2. Ravelo, B., Maurice, O. and Lalléchère, S., Asymmetrical 1:2 Y-tree interconnects modelling with Kron–Branin formalism. Electron. Lett., 52: 1215-1216, 2016.
3. Ramifidisoa, L., et al., Sensitivity Analysis of Microstrip Tree S-Parameters by Using Tensorial Analysis of Networks. Progress In Electromagnetics Research B, 2020
4. Margraf, M., QucsStudio – A Free and Powerful Circuit Simulator, http://qucsstudio.de, accessed January 2024.
5. Lalléchère, S., et al., Methodology for assessing the Compatibility and Reliability of Detection Chain Performances, 2023 XXXVth General Assembly and Scientific Symposium of the International Union of Radio Science (URSI GASS), Sapporo, Japan, 2023