Effective Technique for System Level Prediction of Electromagnetic Emissions from Electronic Devices and Cables in Satellites

J.M. Gómez[(1)], F. Saez de Adana[(1)], M.F. Cátedra[(1)],
J. Berkowistch[(2)], F. Gutiérrez[(2)], R. Mitra[(3)]
[(1)]Dpto. de Ciencias de la Computación, Universidad de Alcalá. 28806 Alcalá de Henares. Madrid. Spain. Fax: +34 91 885 6646. E-mail: felipe.catedra@uah.es
[(2)]Tecnológica Componentes S.A.
[(3)]Electromagnetic Communication Laboratory, Pennsylvania State University.

A method to predict the electromagnetic emissions from unknown electronic devices and cables at system level is presented in this paper. The method is based on measurements at the unit level, equivalent source decomposition and numerical electromagnetic simulation of the integrated system. The approach is also valid for the analysis of cables and conductors carrying electrical currents from the interior to the exterior of the measurement surface (Huygen's surface) and is useful for the prediction of the electromagnetic compatibility characteristics of electronic devices inside satellites. The steps followed in the EMI analysis are given below:

1) The electric fields (E1) on a spherical surface are measured with a field probe, and the magnetic field (H1) on the sphere are obtained from the measured electric field data by using a spherical mode expansion.

2) A second probe is used to measure the electric currents flowing on the cables and conductors that penetrate the Huygen's surface. Ampere's Law is then applied to obtain the magnetic field corresponding to the above electric current on a small surface of the sphere surrounding the conductor carrying the electric current. Next, the spherical mode expansion is applied once again to obtain the electric field (E2) on the sphere associated with the magnetic field (H2) just defined above.

3) The composite fields (Ee, He) on the sphere are obtained by superimposing the electric and magnetic fields (E1, E2) and (H1, H2), respectively.

4) The fields external to the spherical Huygen's surface are derived for the following configuration: the equivalent currents associated with the composite fields (Ee, He) are sources; the material in the region external to the surface are scatterers; and, the region interior to the sphere is free space. A junction subdomain of the impressed electrical current is used for each of the cables crossing the Huygen's surface. Once the external problem has been solved, the currents (Jinde, Minde) induced on the scatterers in the external region are obtained.

5) The internal problem is solved for the following configuration: the induced currents (Jinde, Minde) on the material in the external region are sources, the elements inside the measurement surface are scatterers (only passive objects), with all the sources removed and junction subdomain of the impressed electrical current is used for each cable crossing the Huygen's surface. Once the internal problem has been solved, the currents (Jindi, Mindi) induced on the scatterers in the internal region are obtained.

6) Finally, the total field (Et, Ht) in the prescribed points of the external region is derived by using the equivalent currents due to the extended field (Ee, He), the induced external currents (Jinde, Minde) and the induced internal currents (Jindi, Mindi). All of these currents now radiate in free space.

Illustrative numerical examples will be included in the paper together with validations against measured data for a number of representative test cases.