

A Measurement Setup for the Validation and Verification of Nonlinear Effects in an HPEM Context

M. Kotzev⁽¹⁾, M. Kreitlow⁽²⁾, and F. Gronwald*⁽¹⁾

(1) Institute for Reliability of Technical Systems and Electrical Measurement, University of Siegen,
Hölderlinstr. 3, 57076 Siegen, GERMANY

(2) Bundeswehr Research Institute for Protective Technologies and NBC Protection,
Humboldtstr. 100, 29663 Munster, GERMANY

Extended Abstract

While advanced models of Electromagnetic Compatibility (EMC) and, in particular, High Power Electromagnetics (HPEM) usually are based on linear models [1, 2], the presence of nonlinear components within modern electric and electronic systems should be taken into account as well. Therefore it is of interest to model the coupling of external electromagnetic fields to receiving structures that contain nonlinear loads. Important aspects are the systematic generation and quantification of nonlinear effects that can also be understood from analytical and numerical considerations.

In this contribution a measurement setup is discussed which already has been introduced in [3] and is shown in Fig. 1. A rectangular cavity is placed inside a TEM-waveguide which is capable of producing HPEM fields. Slots in the front plate allow field coupling into the resonator where a nonlinearly loaded loop antenna is located. The response of this internal antenna to the excitation can be measured via a connector.

In a first step, the measurement setup is validated by confirming that it actually allows to detect nonlinear effects that are due to the excitation of the nonlinear antenna load. In a second step it is shown that the related measurements can be verified from numerical full wave simulations in time domain and further understood from reducing the problem of electromagnetic field coupling to nonlinear network models that, in turn, can be analyzed by means of SPICE solvers. The combination of measurements, numerical simulation, and network modeling constitutes a framework which allows estimating nonlinear EMC and HPEM effects in a systematic way.

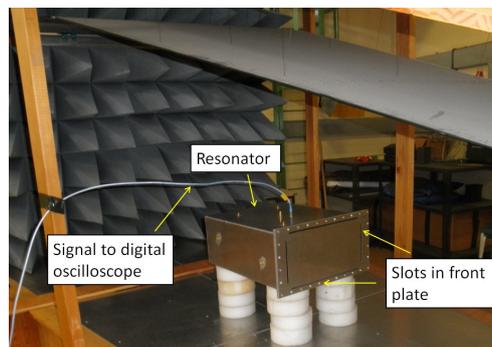


Figure 1. Photo of the nonlinearly loaded resonator, placed inside a TEM-waveguide. High power electromagnetic fields may couple through slots into the resonator where a nonlinearly loaded antenna is located.

References

- [1] K.S.H. Lee (ed.): “EMP Interaction: Principles, Techniques, and Reference Data,”, revised printing, (Taylor & Francis, Washington D.C., 1995).
- [2] F. M. Tesche, M. V. Ianoz, and T. Karlsson: “EMC Analysis Methods and Computational Methods,” (John Wiley & Sons, New York 1997).
- [3] M. Kotzev, M. Kreitlow, and F. Gronwald: “Transient Excitation of Nonlinearly Loaded Resonators and Observation of System Responses in Time Domain,” in Proc. of EMC Europe 2016, Wroclaw, Poland, September 2016, pp. 75–78.