Modelling of a Current Injection Source for the Susceptibility Study of Electronic Equipment

G. MEJECAZE, F. PUYBARET, L. LABARBE
CEA, DAM
CEA-Gramat
F-46500 Gramat, France
guillaume.mejecaze@cea.fr

T. DUBOIS, J-M. VINASSA
IMS Laboratory, CNRS UMR 5218
Bordeaux University
33405 Talence, France

***Abstract*—**This article deals with the modelling of a high amplitude current injection source associated with its electrical generation-transformation-distribution chain. This complex installation has been modelled in differential injection mode, validated and integrated in PSpice software. This PSpice model has also been validated and is very useful in order to predict currents and voltages on switch-mode power supplies when a disturbance is injected in conducted mode at its input.

Keywords-IEMI; modelling; current injection source.

I. INTRODUCTION

Several studies show that a voltage pulse of several kilovolts amplitude and a few hundred nanoseconds duration would be able to destroy many consumer or industrial equipments [1]. In this context, a Current Injection Platform (PIC) has been designed to reproduce this type of pulse. The aim of this article is to present the PIC modelling by an equivalent Thevenin generator. In a first part, the PIC is presented. The second part presents the calculated equivalent Thevenin generator. In the third part, this Thevenin generator PSpice model is validated. This study has been carried out for Direction Générale de l'Armement (DGA).

II. PRESENTATION OF THE PIC

The PIC gives the possibility to reproduce "high amplitude" electrical stresses representative of disturbances induced by the coupling of an electromagnetic field on long-distance wire links. The generated conducted signal is a bi-exponential type configurable in shape (rise time and mid-height time) and level, several hundred amperes. An electrical generation-transformation-distribution network including a generator, a step-up and a step-down transformer permits to power the equipment under test independently from the mains and to be representative of a conventional high voltage / low voltage distribution.

III. EQUIVALENT THEVENIN GENERATOR

The whole current injection source has been modelled with an equivalent Thevenin generator in order to be integrated in PSpice simulation. To calculate the equivalent Thevenin generator (V_{co}: open-circuit voltage and Z_s: source impedance) in differential mode, injections were made on a load of 30 Ω, then on a load of 120 Ω. The time measurements I_{30} and I_{120} of the related currents in load input were recorded, corrected by the transfer function of the measurement chain and then converted into the frequency domain. In parallel, impedances Z_{30} and Z_{120} of these loads are measured with a network analyzer. Currents and impedances measurements permit to calculate V_{co} and Z_s with (1) and (2) in frequency domain.

$$V_{co} = \frac{Z_{120} - Z_{30}}{I_{30} - I_{120}} I_{30} I_{120} \quad (1)$$

$$Z_s = \frac{Z_{120} I_{120} - Z_{30} I_{30}}{I_{30} - I_{120}} \quad (2)$$

IV. APPLICATION AND SIMULATION

The calculated equivalent Thevenin generator has been integrated into PSpice and used to predict the correct disturbing input current injected on a flyback switch-mode power supply. To obtain this generator in PSpice, the V_{co} (in time domain) has been directly integrated and an equivalent electrical circuit has been defined for the Z_s. Fig. 1 presents the comparison between measured and simulated disturbing currents injected at the input of the flyback which is conclusive. The small differences are due to the Z_s approximation.

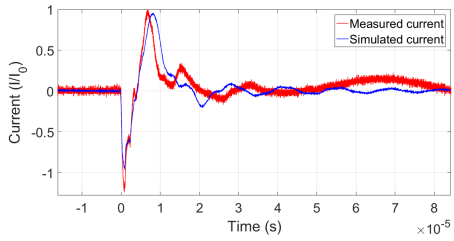

Figure 1. Comparison between measured input current and simulated input current for the flyback power supply.

V. CONLUSION

This article described the equivalent Thevenin generator of a high power pulse source dedicated to injection on electronic systems. This model has been integrated into PSpice software and will be used to understand and predict the behavior of power supplies when a high-power current pulse is injected at its input.

REFERENCES

[1] Y. V. Parfenov, L. N. Zdoukhov, W. A. Radasky and M. Ianoz, "Conducted IEMI threats for commercial buildings," IEEE Transactions on Electromagnetic Compatibility, vol. 46, no. 3, pp. 404-411, August 2004.