Characterising and Modelling Extended Conducted Electromagnetic Emission

I Grobler1 and MN Gitau2
Department of Electrical, Electronic and Computer Engineering, University of Pretoria, South Africa.
igrobler@csir.co.za, mgitau@postino.up.ac.za

Abstract

High density high switching frequency power converter conducted EMC had been analysed, modelling the noise source and noise path, while providing accurate conducted EMC noise limits comparable to accredited noise measurements up to 100 MHz. The military specified DC-DC converters are applicable, spanning from 100 W handheld power managers up to 2 kW DC-DC battery chargers. The Step-Down converter, Step-Up converter and their multi-phase derivatives were analysed and modelled. Some techniques to reduce conducted EMI, such as phase dithering, were also analysed. Circuit layout high frequency effects as well as high frequency impedances of the power components were characterised. At first, a trapezoidal noise source and lumped element noise path model was adopted, showing the high frequency limitations of this technique. A mathematical model was also presented. Thereafter, a high frequency lumped element model including switching elements, was created by using equivalent impedance circuits obtained by measurement from an impedance analyser performed on individual components and traces. A time domain transient model circuit analysis was investigated to represent noncompliance circuit noise as measured with a LISN. Various affordable software packages were evaluated to be considered as a high frequency conducted EMC tool, noting accuracy and ease of use. The accuracy of these modelling tools was compared to accredited measurements. A compact LISN was manufactured and a measurement bench was set up and calibrated against an accredited LAB to perform these practical verification tests. Noise signals were recorded in a simultaneous digital manner so as to be able to perform a detailed post analysis as well as diagnostic calculations, such as common mode and differential mode separation, calibrated with an EMC ETS-Lindgren current probe. Good and workable model accuracies were achieved with the basic Step-Up and Step-Down circuits over the conducted emission frequency band and beyond. Prominent noise effects occur up to this frequency when high density and high switching speed converters are analysed.