

Keysight Technologies

STMicroelectronics and University of Lyon Predict EMI Using ADS

Case Study



Challenge

- Reduce EMI in SMPSs
- Verify simulation results before committing to fabrication

Solution

- Explored the design space for optimum configuration using Keysight ADS software
- Factorized the problem using network parameter building blocks

Results

- Reduced EMI using a compact low-cost filter
- Verified a close match between simulation and measurement data

A switched mode power supply (SMPS) is an electronic power supply that incorporates a regulated switch to convert electrical power efficiently. To achieve low switching loss the transistors must transition as quickly as possible. These fast transitions contain high frequency harmonics that can reach into the hundreds of megahertz, potentially giving rise to electromagnetic (EM) emissions. Without EM interference (EMI) suppression, the SMPS can interfere with electronic devices nearby.

ST Microelectronics and the University of Lyon used Keysight Advanced Design System (ADS) to analyze EMI in their SMPS. They discovered that high di/dt edges in their switched-mode power supplies created EMI problems that needed to be analyzed and mitigated. To deal with this issue, they took a page out of the RF/microwave playbook and used ADS as it handles network parameters, both from measurement instruments and transmission line models.

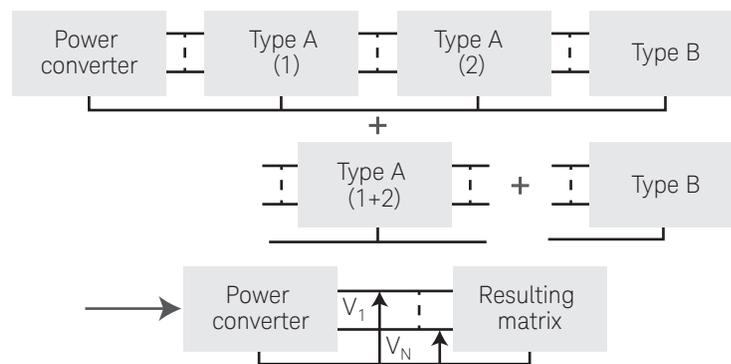


Figure 1. The manual block association technique shown here is easily automated in ADS.

“Our project benefits from a proven RF/microwave simulation platform. Keysight’s tools enable us to concentrate on what is important, developing new methods and working with industry partners to develop real solutions.”

*Roberto Mrad
Power Electronics Research Engineer
STMicroelectronics (now with Mitsubishi Electric Research Center Europe)*

Challenge

The conducted EM emissions from SMPSs interfere with the adjacent circuits they are powering. To mitigate this issue and avoid failure, EMI filtering is added. Designing cost-effective EMI filtering; however, is no easy task. The current approach – iteratively building multiple physical prototypes – is less than ideal since it is costly in terms of time and money. As a result, an efficient and accurate simulation methodology is often much more preferable. But that's not the only issue. Conventional lumped-element SPICE models can also become exponentially complicated and frequency-domain macro models are not generalizable.

What's required to deal with these challenges is a solution that lets designers efficiently explore the design space. That's exactly what STMicroelectronics and University of Lyon designers were after, a solution that was both efficient and general, but which models were they to use?

Solution

Lumped-element ladders are not efficient at modeling traces because traces and vias act like collections of delay lines (as in the Laplace s-domain), whereas lumped elements L and C are integrators/differentiators (s or 1/s in Laplace space). Consequently, hundreds of fine-grained RLCG ladder components would be needed just to model a simple line.

Fortunately, there was an alternative. Network parameter models are readily available and work efficiently in both frequency- and time-domain simulation. They can be used directly in either AC or harmonic balance (HB) frequency-domain circuit analysis, or via a technique called convolution in the time domain. Convolution is a way of building a time-domain delay line model from frequency-domain data using a causality-aware version of the inverse fast Fourier transform (IFFT) algorithm (Kramers-Kronig relation).

STMicroelectronics and University of Lyon designers developed a network parameter block technique that satisfied their need for an accurate and general EMI modeling technique. ADS was selected for use because it efficiently handles network parameters, both from measurement instruments and from transmission line models.

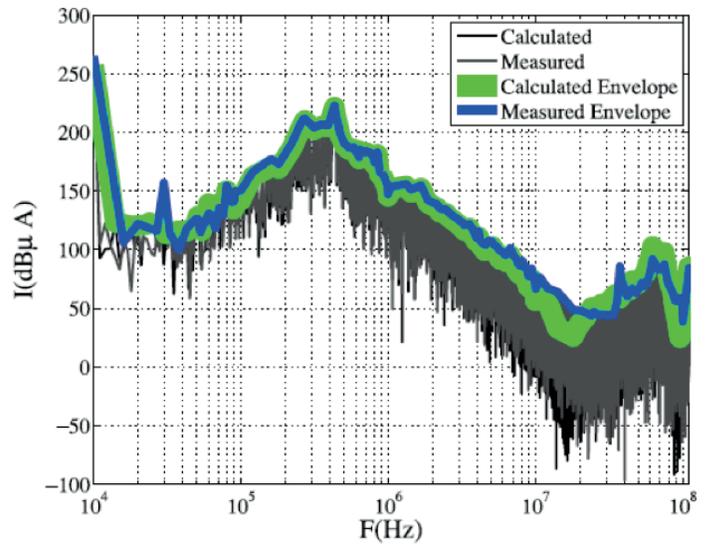


Figure 2. The calculated conductive EMI current spectrum is in good agreement with the measured one.

Results

With this approach, STMicroelectronics and University of Lyon designers obtained excellent correlation with measurement. The model was then used to design a compact, low-cost EMI filter using a sophisticated optimization algorithm. ADS was also used for this task. A STMicroelectronics and University of Lyon paper called *Discrete Optimization of EMI Filter Using a Genetic Algorithm*, highlights the excellent correlation with measurement that was achieved. See figure 2 for an example.

More Information

To learn more about how STMicroelectronics and the University of Lyon analyzed EMI in a switched mode power supply using Keysight ADS, go to:

N-Conductor Passive Circuit Modeling for Power Converter Current Prediction and EMI Aspect and ***Discrete Optimization of EMI Filter Using a Genetic Algorithm***.

Learn how ADS can help you in your power electronic designs by clicking [here](#) for a free trial.