

# Keysight Technologies

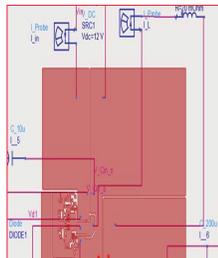
## Increasing Reliability and Efficiency in Next Generation Power Converter Designs (Part 2)

### Design Software Simulation

Application Note



Power Device  
and Component  
Evaluation



Electronic  
Design  
Automation



Hardware  
Design and  
Debug



Design  
Validation/  
Certification



## Introduction

The need to reduce energy consumption as well as CO<sub>2</sub> emissions is driving the growth of power electronics and power converters. These needs are driven by growth in the vehicle electrification and home energy management systems where renewable energy usage is becoming more prevalent. Two of the main power converter design drivers are increased conversion efficiency and better reliability. In green energy applications such as solar power, Levelized Cost of Energy (LCOE) is the main decider for what solar inverter a customer chooses for their solar installation. Both efficiency and reliability are two of the main variables in the LCOE algorithm that determines whether your inverter company gets the sale or not. In hybrid electric (HEV) and electric vehicles (EV) reliability is tied to an automotive manufacturer's reputation and is also linked to safety and the preservation of human life. Hence comprehensive EV test for the various vehicle electrical subsystems at the design and test stages is vital.

The ceiling or limits of these design drivers was getting close for many power converter applications that used power devices based on silicon. The emergence of wide band gap (WBG) power devices based on silicon carbide (SiC) and gallium nitride (GaN) hold promises of raising the ceiling of these design drivers. With the ability to switch faster, handle higher voltages, and larger temperature ranges WBG devices can increase efficiency and reliability as well as reduce form factor in next generation power converter designs. But before power converter designs based on WBG power devices can become main stream there are design and test challenges that must be understood and overcome to utilize them to their full potential.

This is part two in a four part series that takes a look at each stage of the power converter design cycle. At each stage we will look at design and test challenges of next generation power converters and discuss hardware and software tools to help you overcome them. We will put an emphasis on improving the design drivers previously mentioned: increasing efficiency, improving reliability, and reducing form factor. We also consider the design and test challenges that WBG devices introduce into the power converter design cycle. Each of the four parts of this series will cover one of the following design cycles:

1. Power device and component evaluation
2. Design software simulation
3. Hardware design and debugging
4. Design validation and certification

## Software Simulation

The fast edges of modern switching devices such as SiC and GaN require new thinking about EDA tools. Traditional SPICE alone is not enough because it is limited to the time domain and to lumped elements. Keysight EESof EDA's products including Advanced Design System (ADS) and Electromagnetic Professional (EMPro) offer both time and frequency domain simulation of both lumped and distributed elements. The frequency domain is covered with our Harmonic Balance (HB) simulator. HB yields the steady state solution rapidly. Distributed effects are covered by our EM field solvers. There are three main reasons to apply an EM field solver to your "virtual prototype":

1. PCB traces and vias add significant parasitic impedances to your circuit
2. Create EM-based models of distributed components such as PCB trace inductors with integrated magnetics
3. Model EMI/EMC in a "virtual chamber"

We have complete platforms for a self-contained workflow for chip, package, and board design and also simulators that plug into Virtuoso from Cadence Design Systems.

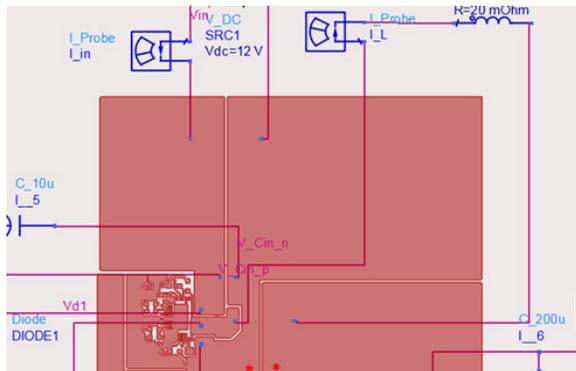


Figure 1. Power Device Design in ADS

A "virtual prototype" in ADS can be simulated in both the time- and frequency-domains. You can combine both lumped and distributed elements. For more information go to our simulation hub at <http://www.keysight.com/find/eesof-ads>

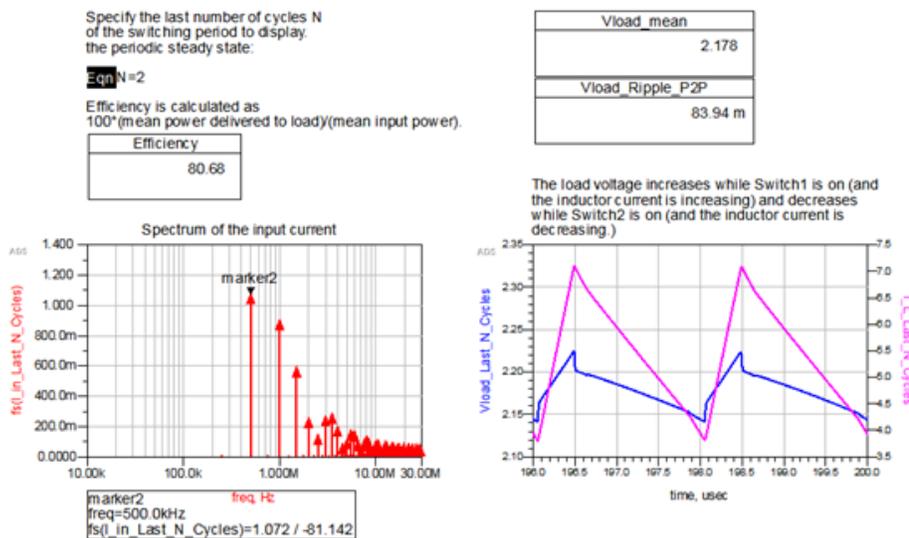


Figure 2. ADS Frequency and time domain representation

As shown in Figure 2, you can obtain the periodic steady state solution efficiently because ADS is proficient in the both frequency- and time-domains.

## Resources

The following video introduces basic DC-to-DC converter operation, explains why voltage spikes occur in these circuits, and shows the importance of modeling PC board layout effects. Watch the video, then download the free example in which current visualization is used to see potential problem areas in the PC board.

How to Design DC-to-DC Converters <https://youtu.be/LwPji3jyfw0>

### Quick Start Guide for ADS in Power Electronics Applications

New devices (SiC, GaN) and their fast edges require new thinking about EDA tools. Learn three reasons why it's now necessary to apply an EM field solver to your "virtual prototype". Then follow this guide to a workshop on including parasitic inductance effects on DC-DC Converters.

<http://www.keysight.com/main/redirector.jsp?action=ref&cname=EDITORIAL&ckey=2631058&lc=eng&cc=US>

### Other Resources

You can find more application and product information on our Power Electronics web page <http://www.keysight.com/find/power-electronics>

Did you know that Keysight is the only vendor that provides your semiconductor components vendors with complete end-to-end modeling solutions? We provide tools for automated measurements, accurate device model extraction, comprehensive qualification, and final process design kit (PDK) validation. As a result, your vendor can provide you the accurate models you need for simulation. For more information go to <http://www.keysight.com/find/eesof-device-modeling>.

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#### myKeysight

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