

Modeling of an Automotive LED Turn-Light to Study its EMC Emissions Using InCa3D

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As a continuation to the French “E-CEM” R&D collaborative project, a new joint technical project is currently under way between VALEO (automotive equipment supplier) and CEDRAT to model the driver circuit of a LED turn-light in order to study its conducted and radiated emission characteristics. It is extremely important that these emission levels are in fact controlled to guarantee they fall within under the limits specified by EMC norms (automobile customers) before they can go onto the market.

This article deals with the description of the driver circuit in InCa3D. It presents the device and the adopted modeling strategy, whereas final results will be presented in the next edition of CEDRAT News Magazine.

Technical description of the LED turn-light’s driver circuit

The device considered, manufactured by VALEO and used on several cars (RENAULT, Mercedes, etc.), is a LED turn-light that consists of the following:

- an array of thirteen LEDs, supplied by 40 V and dissipating 12 W power
- an electronic circuit (driver) supplied with 12VDC containing a DC/DC converter in the boost topology, driven at a frequency of 350 kHz
- a cable harness connecting the LEDs to the driver.

Our analysis focuses only on the driver circuit, on a Printed Circuit Board (PCB) and protected by a metallic cover as shown in Figure 1:

In the top part of the PCB, the EMC input filter, comprising an inductor and two capacitors, is implemented. Since its role is to limit the product’s conducted noise levels, its design must be carefully checked. The aim of this work is to demonstrate that InCa3D simulations can be extremely helpful to engineers for the most critical choices.

Modeling of the driver circuit in InCa3D

The LED driver board comprises four layers described in InCa3D using the ECAD import function (import of Gerber files). In order to reduce the number of mesh elements (and also solving time), each layer has been “slightly” cleaned-up in the context for CAD defeaturing.

The metallic cover is also modeled in InCa3D (see Figure 2). Once the 3D geometry has been described, the electronic components achieving the DC/DC conversion function and the EMC input filter are incorporated into the InCa3D project. All the passive components (resistors, inductors and capacitors) were modeled by their equivalent high-frequency circuit (with their parasitic elements) obtained by measurements using a Vector Network Analyser.

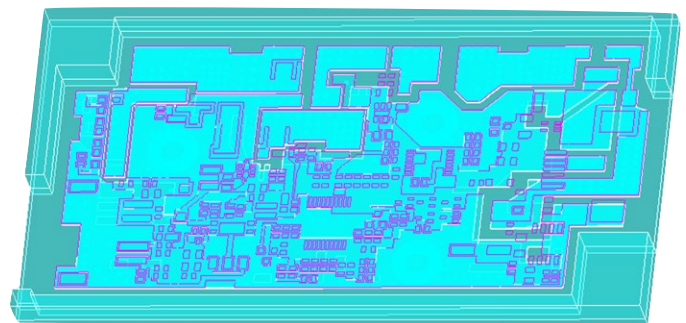


Figure 2: Driver circuit’s model in InCa3D.

The active components of the boost converter (MOSFET and diode) are described with two equivalent Differential-Mode (DM) current sources whose values (obtained by measurement) represent the current flowing through the MOSFET and the diode, as shown in Figure 3. Similarly, the common-mode noise sources are represented using voltage sources for predicting high-frequency conducted noises.

The first goal of our study is to estimate the conducted noises on the power-supply line (+12V and GND) and their comparison to the values measured in the frequency band between 100 kHz and 100 MHz. The objective is to highlight the importance of taking into account the parasitic effects of conductors and components in such analyses.

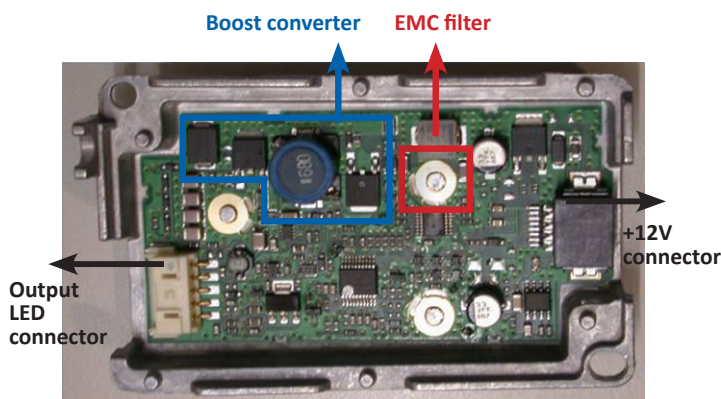


Figure 1: Driver circuit.

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Conducted and radiated emissions computation

Thanks to the new version of InCa3D (version 3.1 to be released next March), which will include computation of the parasitic capacitive effects, CEDRAT has created an accurate simulation model of the device. The first simulations have been launched and they already show very interesting results. Unfortunately, by the time this magazine went to press, we are unable to present the global solution results. Nevertheless, it will be detailed in the next edition of CEDRAT News Magazine and in a technical paper (subject to acceptance) at the EMC Conference in Dresden in August 2015.

"E-CEM" R&D project

The aim of this project (industrial partners: VALEO, RENAULT and CEDRAT; academics: AMPERE, IRSEEM, G2Elab and SATIE laboratories) was to develop and test advanced computation methodologies able to simulate the emission levels of power electronics devices, such as variable speed drivers and automotive LED turn-lights. The project was funded by ANR (Agence Nationale de Recherche) during the period [2011 - 2014].

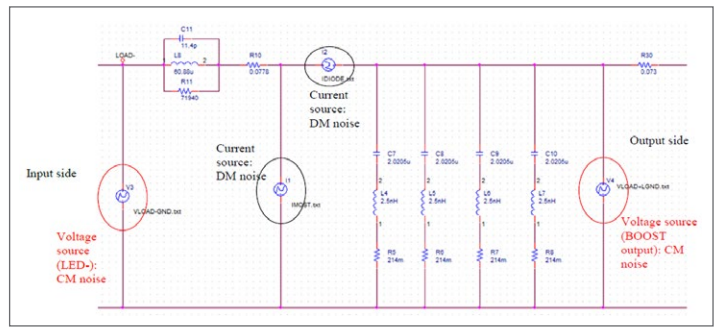


Figure 3: Model for conducted emissions prediction.



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