ElectroMagnetic Compatibility in Power Electronics: from packaging to EMC filter optimization

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Abstract

The development of Power Electronics is exponential and this technology will soon process almost all electrical kilowatt in any application: home appliance, embedded grid, renewable, storage and grid regulation. Huge progress have been achieved on efficiency and compactness since 50 years, and the trend is still improving with the wide bandgap technologies [1].
However, if this switched mode energy conversion principle allows reaching high efficiency and low weight/volume, it also generates high speed voltage and current transients, which induce ElectroMagnetic pollution around the converter, and may prevent other equipment working correctly. This "EMC dark side" of power electronics has to be addressed from the very beginning of the design understanding and mitigating the key phenomena at device's packaging level [2], but also at system level, designing optimized filters to reduce the global level of interferences circulating in the grid, or radiated from the system.
The high switching speed of modern semiconductors implies a deep understanding the role of so-called "stray elements" brought by the packaging (Fig.1). The key impact of stray inductances and stray capacitances will be underlined, and design rules provided.
EMC filter optimization in power electronics can be performed using specific models of the converters in the frequency domain [3], which will be described. The parameters of the model can be identified from a detailed description of the converter, or from external identification [4].
Using these models will allow a real system level approach of EMC generation, which accounts for all parameters, from the semiconductor device to the grid.

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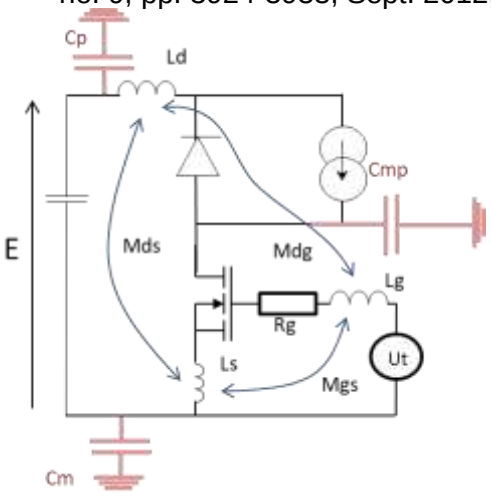

Figure 1: Stray elements of a switching cell

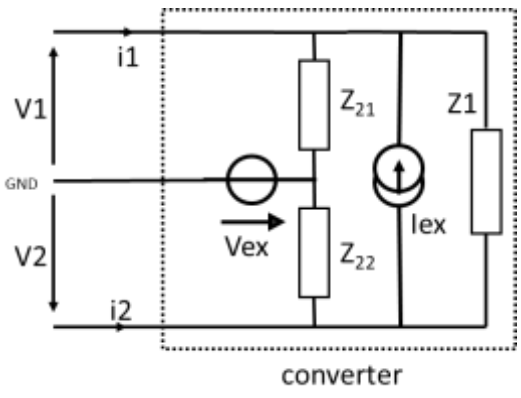

Figure 2: EMC System level model of a Power Electronics converter