Gate Driver Design with Improved Near Field Noise Immunity for Medium-voltage High-power SiC-based Converters

Medium voltage converters are widely used and have been pushed to higher power, voltage, and power density levels in recent years, leading to significant electromagnetic interference (EMI) and electromagnetic compatibility (EMC) challenges. The high power density requires the components inside the converter to be arranged in a very compact manner, which makes EMI management more difficult. Among all the auxiliary circuits in a converter, the gate drivers are most susceptible to the EMI noise because they are electrically connected to the main circuit power stage; nonetheless, they are evolving toward the direction of smart and highly integrated devices, and require extremely high EMI immunity. Unlike the converter-level noise emissions that can be regulated by certain EMI standards, the noise inside the power converter has no standard to follow. It is crucial to understand how the noise is propagated inside the power converter, and how it causes issues to critical circuits (e.g., false triggering of the gate driver).

This paper shows a gate driver design with very high immunity to EMI noise within the converter. It first reviews the recently proposed comprehensive near field noise propagation model on gate, with different noise sources and propagation mechanisms considered. As summarized in Figure 1(a), the high di/dt objects are associated with magnetic coupling while the high dv/dt objects are associated with electric coupling. The near field coupling is quantified based on the proposed model (Figure 1(b)). Based on this knowledge, a new gate driver design is proposed with a focus on EMI immunity improvement. The design considerations include power architecture improvements, PCB routing improvements, antenna effect mitigation, and shielding considerations. A gate driver PCB prototype is therefore developed to evaluate EMI performance.

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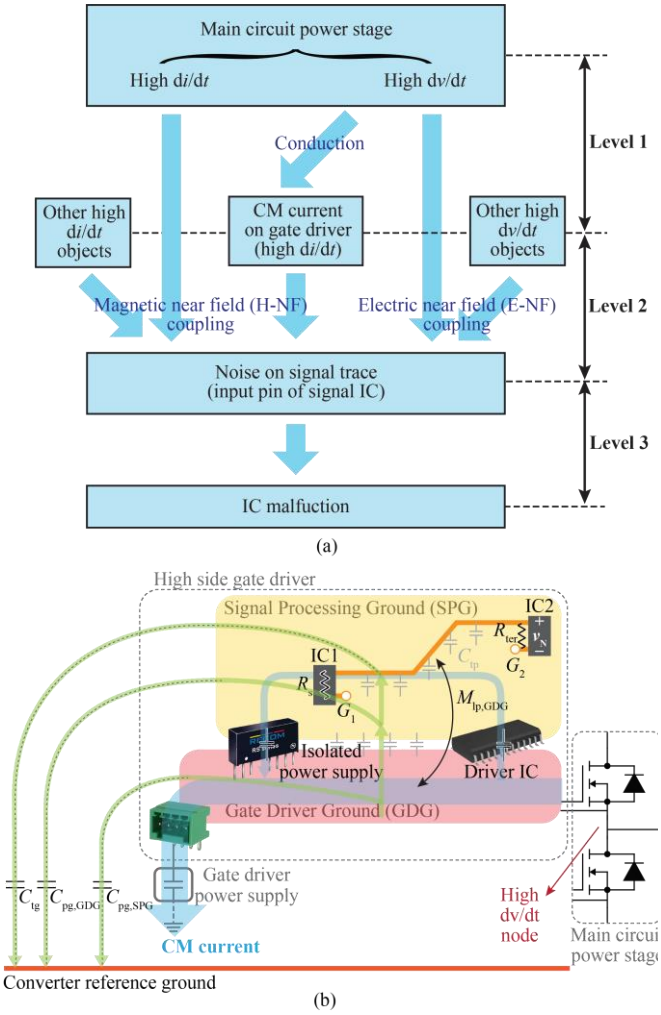

Fig.1. (a) Generic methodology overview (b) Near field noise propagation model inside power converter, showing magnetic and electric near field coupling