Investigation of Conducted EMI Emissions in Auxiliary Circuitry of 10 kV SiC MOSFET Based Power Electronics Building Blocks

The concept of power electronics building block (PEBB) aims to partition and compartmentalize power converters from power processing and functionality standpoints. This allows PEBB-based converters to be configured into different topologies carrying out multiple power conversion functions. However, some design aspects such as insulation and electromagnetic interference (EMI) cannot be modeled into the same concept, as the rating and capabilities per PEBB are ultimately dependent on the power, voltage, current, and switching frequency of the whole converter assembly.

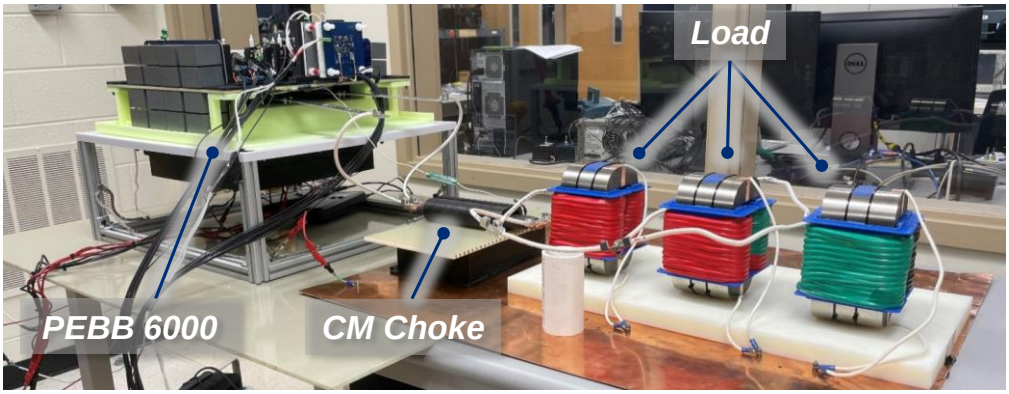

Fig. 1. PEBB 6000 pump-back test setup

In this paper, an in-depth investigation of conducted EMI emissions in 10 kV SiC MOSFET-based PEBBs is done to help the better understanding and mitigation of EMI-related issues in PEBB-based converters, study the crosstalk between PEBB units when stacked in series and/or parallel, and assess the impact of a neighboring unit on others in modular multi-level converters (MMC). To this end, the high-frequency lumped-circuit model of PEBB 6000, a 20 MW/m^3 power density, 1 MW output power, 6 kV medium-voltage (MV) power converter (see Fig. 1) is developed encompassing the 10 kV SiC MOSFET power modules, gate drivers, gate driver power supply (GDPS), wireless power transfer (WPT) auxiliary power supply, etc. Different levels of abstraction are considered to model the various components, from a single common-mode capacitance to complete circuit models of the employed auxiliary power supplies. Figure 2 shows the precited CM noise in gate drivers; the simulation results are verified using experiments, and the model is then employed to study noise propagation paths within the converter in detail as well as crosstalk between multiple PEBB units when stacked in series and/or in parallel in MMCs.

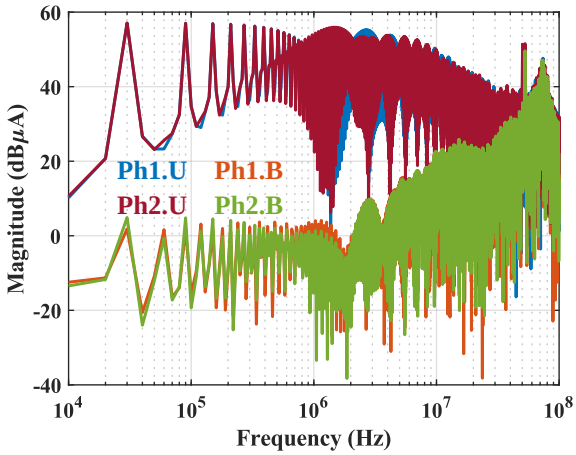

Fig. 2. Predicted CM noise in gate drivers

This work was supported in part by the U.S. Office of Naval Research (ONR) under award number N000142112124 and was approved for public release under DCN# 543-1448-24.