Common-Mode EMI Noise Modeling and Improvement with Key Parasitics Optimization and Impedance Balance Technique for Three-Phase, Three-level, Back-to-Back Bridge Interconnection-Based Filters

This paper begins with the evaluation of the effects of the electromagnetic interference(EMI) filter optimization method based on previous studies of Common Mode (CM) & Differential Mode (DM) components' self parasitics and parasitics coupling. The previous proposed new EMI filter and the original filter noise suppression performance indicates that the measured DM noise could be reduced greatly along the conduction emission frequency range with the optimization of the key equivalent parallel capacitance (EPC) of the rectifier's booster inductors. However, the CM noise suppression performance improvement is limited with the proposed filter which requires more investigation of CM noise optimization. Therefore, the CM noise estimation system model has been

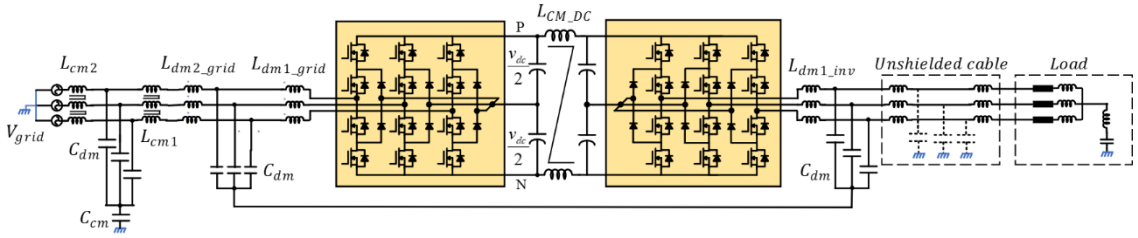

Fig.1. Schematic of the proposed bridge structure for three-phase BtB motor drive with high-frequency parasitic models for converter, filter, long cable, and motor.

developed and verified with LISN measurements.

To improve CM noise suppression, the CM noise source could be cancelled by applying the Wheatstone bridge balance technique. Two different balance conditions have been investigated: (1) without DC link CM choke; (2) with DC link CM choke which provide another design guideline to boost inductors, DC link CM choke, bridge impedance and power switch to heatsink/ground parasitic capacitance characterization. When the DC link CM choke is absent, the DC link to ground parasitic capacitance should be minimized to achieve the best CM noise voltage source cancellation. However, the insertion of DC link CM choke could not only reduce the current level through the bridge loop, load changes influence and CM voltage drop of boost inductors but also generate high impedance ratio which is inversely proportional to the LISN CM noise measurement and reduced sensitivity from components variation.

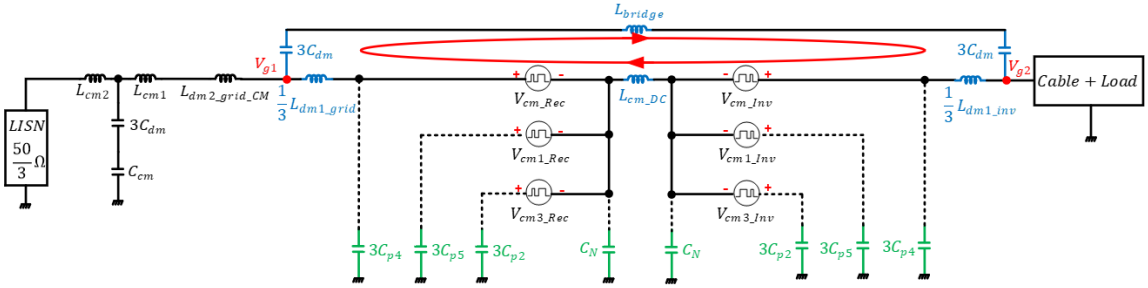

Fig.2. CM EMI noise system model (green – parasitic capacitance, blue – impedance balance bridge)

This paper has extended a multiple CM noise sources modeling method from AC-DC/DC-AC converters to a 3-Phase 3-Level NPC B2B converter for better CM noise estimation with nonlinear, high frequency inductor models included in CM noise propagation path. Furthermore, the impedance balance method with a large impedance ratio naturally consisting of DC link CM choke &

low impedance bridge has also been applied to cancel the CM noise voltage sources. Therefore, the final CM current flowing though LISN/Load could be reduced significantly.