Common-Mode EMI Reduction in Converter Systems

by

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ABSTRACT

Electromagnetic interference (EMI) is a common problem in power electronics. An EMI current can be decomposed into a differential-mode (DM) EMI current and a common-mode (CM) EMI current. Attenuation of CM EMI is more difficult because it involves unintended parasitic effects of devices and packaging. This is particularly true for multiple-converter systems where, unlike DM EMI which is largely decoupled by capacitors at the input and output terminals of individual converters, the CM emissions of different converters are coupled and affect each other. Such coupling represents a challenge for system design, but also an opportunity for innovative system solutions to EMI problems, which are the subject of this thesis.

One new method to reduce CM EMI is by balancing the impedance around the CM voltage source. This method is generalized in this thesis for two applications. The first is by using grounding capacitors and it is applied to a dual-boost converter for reducing input CM EMI current. The second is based on using a conventional LC filter and is applied to a three-phase rectifier.

For cascaded converter systems, two methods are proposed to reduce CM EMI emission. The first method utilizes dc bus grounding capacitors to reduce sizes. The other method is to place a CM choke at the dc bus and parallel bypass capacitors between the input and output terminals. This method is shown to reduce the CM EMI currents at both input and output terminals. The CM current inside the converter is also reduced by this method.

For parallel converter systems, a solution is proposed to reduce the CM circulating currents between modules and the CM EMI currents at the input and output terminals. DC bus CM chokes are inserted to converter modules to limit the CM circulating currents. These CM chokes are combined with other filtering components to form CM EMI filters and to reduce the CM EMI currents at the input and output terminals. All methods are demonstrated experimentally and their benefits are quantified by measurements.