

The increasing shortage of fossil fuels calls for an efficient power-conversion of renewable energy sources to achieve utmost advantages. DC-DC converters are widely used in automotive, industrial, and renewable energy applications; such as, electric vehicles, uninterruptable power supplies, and fuel-cell applications etc. High-efficiency, low cost, and small size are some of the important design parameters for any converter design; however, they of course need to comply with the electromagnetic interference (EMI) requirements. Therefore, optimized EMI filters are important to produce a competitive product.

The PhD project is entitled as “Conducted Electromagnetic Interference Analysis and Filter Design for Isolated DC-DC Converters”. It mainly covers two different topologies of isolated dc-dc converters – the Isolated Full-bridge Boost and the Full-bridge Forward converter – for the modeling, analysis and design of EMI filters. The primary focus is to analyze the behavior of the EMI in the low-frequency conducted-emission (CE) range. The differential-mode (DM) and common-mode (CM) noise models of the aforementioned converters are proposed and verified by experimental results.

A general state-of-the-art finding is that, base-line knowledge (noise information without an EMI filter) of DM and CM noises is required in order to initiate a filter design process. Moreover, the CM noise modeling of mostly non-isolated converters is presented where a large input-to-output transformer inter-winding capacitance does not exist. A great deal of research has been found that reduces such an inter-winding capacitance, including various other noise suppression techniques. The literature also claims that phase-shifted converters generate less EMI noise than their hard-switched counterpart.

However, a full analytical procedure is presented in this project in order to design the DM and CM noise filters for isolated dc-dc converters. The DM and CM noise voltage sources are precisely determined. The DM and CM noise models of isolated dc-dc converters are the presented and analyzed to design optimum EMI filters. The feasibility of the noise models and their analysis is verified by means of several experimental results. Finally, a comparative study is conducted on a phase-shifted and hard-switched full-bridge forward converter to analyze the CM noise in the converter.

The major outcomes of present research are: The DM and CM noises can be accurately estimated in the low-frequency range of CE, thereby substantially reduces designer’s dependency on the converter. The inter-winding coupling capacitance of a power transformer, in a hard-switched full-bridge boost and forward converter, barely constitute any CM noise current in the converter. However, the same parasitic capacitance has a severe impact in a phase-shifted full-bridge forward converter and solely responsible for the CM noise current in the converter.