Importance Measure Evaluation of Level 1 EV Charger Converter Topologies

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Abstract

This study evaluates the importance measures of six distinct electric vehicle (EV) charger converter topologies: the Conventional Power Factor Correction (PFC) Boost Converter, Bridgeless PFC Boost Converter, Interleaved Boost PFC Converter, Conventional Flyback Converter, Isolated Half-Bridge LLC Resonant Converter, and Phase-Shifted Full-Bridge (PSFB) Center-Tapped Converter. Utilizing failure probabilities for each component alongside series reliability models, risk metrics are systematically computed for each design. Five widely recognized importance measures—Birnbaum Importance, Fussell–Vesely (FV), Risk Reduction Worth (RRW), Risk Achievement Worth (RAW), and Criticality Importance (CI)—are employed to quantitatively assess and compare each component's contribution to the overall reliability of the converters across all topologies. The results reveal that electrolytic capacitors represent the most hazardous components in every topology, whereas inductors pose the least hazard. Furthermore, the analysis indicates that the Fussell–Vesely (FV) and Criticality Importance (CI) measures yield identical outcomes, and the Risk Achievement Worth (RAW) remains constant for all components in series-configured systems. These findings offer valuable insights for the optimal design, component selection, and maintenance prioritization of reliable EV charger power converters.

Keywords

Electric vehicle chargers, power converter reliability, reliability importance measures, Birnbaum importance, Fussell–Vesely importance, Risk Reduction Worth (RRW), Risk Achievement Worth (RAW), Criticality Importance, reliability assessment, power electronics.