UNIVERSITI TEKNOLOGI MARA

UNINTERRUPTIBLE POWER SUPPLY TOPOLOGY USING SINGLE PHASE MATRIX CONVERTER WITH ACTIVE POWER FILTER FUNCTIONALITY

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ABSTRACT

The demand for availability, stability, reliability, and high-quality power supply has shown an upward increase in recent years. This trend reflects the increased use of uninterruptible power supplies (UPS) to provide an uninterrupted and reliable power supply. This is particularly critical in the data centres, financial institutions, and cloud computing division, where data is the most crucial aspect of computer usage. Data loss due to power failure can contribute to significant economic losses. Invented UPS has been intended to use at least two separate converters to perform rectifier and inverter operations resulting in low power density. Other issues such as high reliability and space constraints remain a severe concern for developing the UPS system for floating offshore oil and gas platforms. While the ever-increasing concern to improve the power density for sustainable electrical energy has encouraged essential efforts to improve the power density of the electrical power converters. Therefore, this thesis aims to develop a new UPS circuit topology that combines rectifier and inverter circuits using a single circuit topology based on the Single-Phase Matrix Converter (SPMC). The safe-commutation strategy has been developed to solve the commutation problem due to the inductive load disturbance in the fundamental investigation. This thesis focuses on the switching integration for rectifier and inverter operation to perform UPS with Power Factor Corrector (PFC). It features low power losses resulting in high power density. The distorted supply current waveform due to the non-linear load is compensated through a proper switching algorithm of SPMC to function as an Active Power Filter (APF). It possesses low harmonic contents with a low Total Harmonics Distortion (THD) level, thus, improving the high-power factor. A step response function investigates the transition between the proposed switching algorithms for rectifier and inverter operations. The rectifier operation represents the normal operation that receives the supply from the grid system. For the power outage condition, the switching algorithms will shift to perform an inverter operation and provide the supply from the standby battery. Finally, the effectiveness of the proposed circuit topology and the proposed switching algorithms for the proposed UPS system are verified through the computer simulation model using MATLAB/Simulink and an experimental test rig. As a result, the supply voltage waveform becomes continuous, sinusoidal and in-phase with the supply current waveform, thus can reduce the Total Harmonic Distortion (THD) level below those defined in the IEEE 519-2014 standard and improving the power factor. The transition time of the UPS system between charging and discharging modes of operation complies with the IEC 62040-3.

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