A High-Voltage Low-Power Switched-Capacitor DC-DC Converter Based on GaN and SiC Devices for LED Drivers

Previous research on switched-capacitor DC-DC converters has focused on low-voltage and/or high-power ranges where the efficiencies are dominated by conduction loss. Switched-capacitor DC-DC converters at high-voltage (>100 V) low-power (<10 W) levels with high efficiency and high power density are anticipated to emerge. This paper presents a switched-capacitor converter with an input voltage up to 380 V (compatible with rectified European mains) and a maximum output power of 10 W. GaN switches and SiC diodes are analytically compared and actively combined to properly address the challenges at high-voltage low-current levels, where switching loss becomes significant. Further trade-off between conduction loss and switching loss is experimentally optimized with switching frequencies. Three variant designs of the proposed converter are implemented, and the trade-off between the efficiency and the power density is validated with measurement results. A peak efficiency of 98.6% and a power density of 7.5 W/cm³ are achieved without heatsink or airflow. The characteristic impedance level of the switched-capacitor converter is an order of magnitude higher than previously published ones. The converter is intended for LED drivers.