

Modular Power Converters with High Efficiency

Matthias Radecker¹, Yujia Yang¹, Li Le², and Li Wang³

¹*Fraunhofer Institute of Reliability and Microintegration IZM, Gustav-Meyer-Allee 25, 13355 Berlin, Germany*

²*Yacoub Automation GmbH, Gustav-Meyer-Allee 25, 13355 Berlin, Germany*

³*Technical University Berlin, Fakultät IV - Forschungsschwerpunkt
Technologien der Mikroperipherik, Gustav-Meyer-Allee 25, 13355 Berlin, Germany*

Accepted for publication on 03rd May 2016

A modular power cell system for input voltage range of 19-265 V DC or AC, and 24 V or 30 V DC output consists of 15 or 6 Watts cells in isolated fly-back topology with regenerative snubber for highest efficiency over a wide voltage and load range, operated at fixed frequency. A boost stage provides PFC and is added only to the 15 Watts fly-back cell. The 15 Watts power supply achieves efficiency of 85% for 19 V DC input voltage and 90% for 250 V AC input voltage. The boost converter stage has two parallel stages for DC range of 19 V to 150 V and for AC range of 70 V to 265 V, respectively. Both boost stages are operated alternatively, and have been optimized regarding the inductor and the switching Mosfet parameters. The fly-back stage is optimized regarding the regenerative snubber capacitances and leakage inductance for large bus voltage range of 170 V to 450 V for the 15 Watt cell and for 19 V to 265 V for the 6 Watts cell. If the input voltage of the 15 Watts cell is between 19 V and 30 V, the bus voltage is reduced to 170 V to obtain highest efficiency. If the voltage increases to 265 V, the bus voltage increases to 450 V. For the 6 Watts cell, the snubber is operated to achieve high efficiency in the range between 19 V and 265 V DC. If the DC input voltage exceeds 265 V, the duty-cycle is kept constant, and output voltage is smoothed by the output capacitor to achieve minimum ripple. The modularity is achieved by a master-slave concept. Power converter cells are operating parallel. The first cell operates in output voltage control mode. The following cells are operating at full power in output current control mode, and will be only turned on on-demand for more power than 15 Watts or 6 Watts, respectively, to guarantee high efficiency. Low EMI is obtained using interleaving technique with a digital platform driver connected by GPIO interface between the modules.

Keywords: boost converter, fly-back converter, high efficiency, wide range input, regenerative snubber, inrush current limiting, master-slave interleaving concept