Technical University
of Denmark

Popular science summary of the PhD thesis

PhD student	Ahmed Morsi Ammar
Title of the PhD thesis	Advances in Resonant Power Conversion for Offline Converter Applications
PhD school/Department	DTU Electrical Engineeing

Science summary

* Please give a short popular summary in Danish or English (approximately half a page) suited for the publication of the title, main content, results and innovations of the PhD thesis also including prospective utilizations hereof. The summary should be written for the general public interested in science and technology:

With the technological advancement that aims for high-performance consumer and industrial electronics in small size for better user experience and portability, additional design requirements are placed on power supplies to process more power in less volume. One application with great demand for power supply miniaturization is offline converters, where the constantly varying alternating current (AC) power from the grid is converted into direct current (DC) power for the electrical load. Examples for offline converters include chargers for mobile phones and laptops, light-emitting diodes (LED) drivers, adapter converters for household devices, and electric vehicle (EV) chargers.

Switched-mode power supply (SMPS) technology has long served the electric power conversion needs for different applications. It consists of electrical connections of active circuit components (transistors and diodes) and passive components (inductors and capacitors), where portions of energy are drawn from the input source of power for processing then delivered to the output load at a rate defined by the converter switching frequency. The higher the switching frequency is, the smaller is the size of the components needed to store and process the energy delivered to the load in every switching cycle. Accordingly, one way to reduce the power supply size is to increase its switching frequency.

Nonetheless, operation at high frequencies poses several challenges. Most critically is the substantial increase of power loss and reduction of conversion efficiency with the increased switching frequencies. The reason for this is that the non-ideal active and passive components incorporated in the converter have parasitic circuit elements which consume power that is not delivered to the load. This power loss results in a temperature rise of the converter under operation. The higher the power loss, the higher the temperature rise which, if not controlled, can lead to catastrophic failure.

The work presented in this thesis proposes several solutions for high-frequency power supply designs. By using soft-switching circuit topologies combined with the state-of-the-art active and passive components, this research demonstrates that power converters can operate at higher switching frequencies with limited power loss, leading to compact and thermally stable designs. In this thesis, other topics associated with high-frequency operation, such as converter modelling and controller designs are discussed and new methods are presented. A number of hardware prototypes have been designed and implemented to verify the obtained gains with experimental results.

With the proper application of the research findings presented in this work, it is possible to realize smaller and highly efficient power supplies for a wide range of applications.