Technical University of Denmark

Popular science summary of the PhD thesis

PhD student	Dennis Øland Larsen
Title of the PhD thesis	Design of Switched Capacitor DC-DC Converters for Rechargeable Hearing Aids
PhD school/Department	Electrical Engineering

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:

Hearing aids (HAs) rely on efficient power conversion to provide the best possible sound quality while having a good battery lifetime. Recently, rechargeable hearing aids have become available due to the advent of Li-Ion batteries that are small enough to fit in hearing aids. While rechargeability removes the hassle of periodically replacing the tiny batteries, it poses several technical challenges that need to be addressed.

Rechargeable Li-Ion batteries have a higher voltage than the non-rechargeable ZnAir counterparts. A powerful switched-mode power converter is therefore needed to supply the many electronic parts of the hearing aids. This includes a digital signal processor (DSP), wireless communication chip, audio amplifier, and flash memory. Users of hearing aids tend to favor small devices that fit behind or in the ear. The electronics should therefore be very small, and the switching power converter and wireless radio are placed in close proximity. A small and efficient power converter with low electromagnetic interference (EMI) is therefore needed.

In this project, the integrated circuit design for achieving these goals have been studied. Several methods for designing low-EMI switched capacitor power converters have been developed. A collection of controllers that forces the power converter to switch at pre-determined frequencies have been designed. The impact of this is that the audio quality remains high and the wireless communication link is not disturbed. This avoids annoying connectivity issues that might otherwise be an unnecessary burden for the hearing impaired user. It also allows for designing hearing aids without costly and bulky internal shielding resulting in lower production costs and size. In addition to this, a mathematical seizing methodology for minimizing the power losses in battery-powered switched capacitor converters have been developed.

Overall, the results of this project have enabled GN Hearing A/S to develop better rechargeable hearing aids, which in the end improves lives of the many hearing aids users in the world. Many of the results are also applicable in other battery-powered and wearable devices relevant for e.g. internet-of-things applications, smartwatches, or other hearable devices.

Please email the summary to the PhD secretary at the department