Digital Control in Piezotransformer-based Converters

Lasse E. Korff[1], Martin Schøler Rødgaard[1], and Michael A. E. Andersen[1]

[1]DTU Electrical Engineering – Electronics Group, Technical University of Denmark

INTRODUCTION

Converters are today used in nearly all electronics from battery management in cell phones and laptops to fuel cell supplies to supply in a car.
The demand for smaller and more efficient converters are increasing as the trend of electronics in general is going towards smaller size and larger processing power.
In the struggle to obtain smaller converters, the switching frequency of the converters should be increased, resulting in high switching losses.
To decrease these switching losses, resonance converters have been a popular choice to obtain zero voltage switching leading to great improvement in the efficiency while still maintaining small converter sizes.
In resonance converters piezoelectric transformers (PTs) have proven very useful as 1 PT can replace both magnetic transformer and resonance circuit leading to magnetic-less converters with a 4 times higher power density while still maintaining high efficiency. Ultimately, this leads to converter designs where efficiency is high and where component count and use of metals are low.

BACKGROUND

Figure 1 1) Iron core transformer, eff~85% 2) Isolated Switch Mode Converter, eff~92% 3) Piezotransformer-based converter, eff~98%

PT-based converters offer benefits such as electric isolation, less risk of fire, low noise, high power density, thin structure and the option to leave out bulky and expensive magnetics.
One of the greatest challenges when using magnetic-less, PT-based converters are control of the converter, which often demands many components in order to achieve good performance. This project has investigated the demands and simulated the performance of a digitally controlled converter.

RESULTS

The results have proven to show that control of PT-based converters can be done using digital control with close to equal performance. This is evaluated to increase flexibility of the converter use and decrease the component count – leading to even greater reduction in size and material use while still maintaining high efficiency.