



In Prague 16 September 2018

Review on the PhD Thesis of Martin Dřínovský

Reviewer: Doc. Ing. Jiří Jakovenko, Ph.D.

PhD student: Ing. Martin Dřínovský

Martin Dřínovský has presented his dissertation thesis **Analog Circuits for DC-DC Converters** where he summarises results of his PhD research performed at the Czech Technical University, Faculty of Electrical Engineering, Department of Circuit Theory.

The structure of the Thesis is as follows: after a comprehensive Introduction (Chapter 1), a brief overview of high voltage current sensor based around a differential difference current conveyor (DDCC) with high voltage input stage and gain trimming is presented (Chapter 2). Chapter 3 presents a new topology of triangular waveform generators for DC-DC converters. Chapter 4 summarises the design of a new dual purpose high voltage buck over current/boost zero crossing detector and a new overcurrent detector with built-in reference. Chapter 5 concludes the Thesis by summarising the results and highlighting the breakthroughs achieved (including an overview of the publication activity of the author).

Timeliness of the topic

The topic of the thesis is timely, for both scientific and practical reasons. Martin Dřínovský has finalised a significant amount of relevant methodological and technical scientific work and provided a research contribution to the field of analogue circuits for DC-DC converters. The candidate has developed three new architectures for DC-DC converters. Namely high voltage current sensor for coil-based current sensing, a function generator generating both square and triangle waveforms, a dual purpose over-current and zero crossing detector.

Fulfilment of goals

The primary goals of the presented thesis are:

- exploration of new architectures of triangle waveform generation for use in SMPS with reduced silicon area,
- design of high voltage bidirectional current sensor with off-chip inductor current sensing which can reduce silicon area and need for other specialised components,
- evaluation of the possibility to combine Overcurrent detector and Zero crossing detector functions for use in combined converters, such as battery charging chips.

All research goals have been reached.

Comments to methods

All proposed design methods were clearly defined, elaborated and evaluated. These methods are new methods building on the previous state of the art. While there might be other methods available, the right choice of the author has been confirmed by the publications in journals and by obtaining US patent. I appreciate that high voltage current sensor for DC-DC converters has been simulated and implemented in 0.35 um BCD technology as part of a multiphase DC-DC converter where its function has been verified on silicon. The second verified circuit on silicon (0.18 um BCD technology) was the overcurrent detector with built-in reference.

Dissertation results and their novelty

The results show that all the three methods described, which are novel in one or more aspects, follow up on the state-of-the-art in the field. This has been proved by good publication activities of the candidate which includes two SCI-impacted journal publications where Martin Dřínovský is a primary author (M. Drinovsky and J. Hospodka. "Triangle/square waveform generator using area efficient hysteresis comparator". In: Radioengineering (2016), pp. 332–337, and M. Drinovsky and J. Hospodka. "High Voltage Coil Current Sensor for DCDC Converters Employing DDCC". In: Radioengineering (2015), pp. 988– 992), one US Patent (9,035,639. May 2015). The publication output of the candidate and its impact is good, but the publication potential of the presented work is higher without a doubt, and the candidate should consider another publication activity of the presented work.

The thesis has been systematically written and provides a robust interpretation of performed technical work, in parts also reported in the articles written by the candidate. Martin Dřínovský was able to perform relevant analysis of prior art and navigate himself in the space of open scientific problems, as a result of which he identified challenging, yet significant problems to continue exploring.

I am convinced that Martin Dřínovský has a potential to further contribute to international integrated circuit design research community.

The candidate was able to demonstrate his capability of independent scientific work, creative research activity in the field of microelectronics and IC design. The thesis presents some novel scientific results and fulfils the requirements for the PhD thesis in the field of Electrical Engineering Theory.

The author of the thesis has proved an ability to perform research and to achieve scientific results. Therefore I recommend the candidate's thesis to be accepted for defending and be awarded by a PhD degree.

Doc. Ing. Jiří Jakovenko, PhD.
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Comments and questions:

1. Why weren't all described circuits designed in the same Design Kit or the same technology? It would be logical to prove all these circuits in one single DC-DC converter.
2. How has corner analysis been performed in all presented results? I miss some corners as technology corner or power supply corner.
3. Is there any possibility to commercialise US patent?
4. Could you please compare your circuits to the most advanced circuits on the market?