Average model of a synchronous half-bridge DC/DC converter considering losses and dynamics

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Nowadays, power electronic systems play a major role in almost every large system. Due to the high switching frequencies, the simulation of these devices is computationally very expensive and not suitable for system simulation. Average models of these power electronic systems are needed to simulate the basic terminal characteristics of these devices without the need to simulate every switching operation. This paper describes a Modelica implementation of a synchronous half-bridge converter for the use in an automotive power net simulation as well as in real-time environments. The model takes into account the losses in the semiconductors as well as the dynamic behavior of the converter. For the parametrization of the model, only the switching frequency and some values from the datasheets of the used components are required. To validate the proposed model, an equivalent SPICE model is developed, serving as a reference model. The dynamic behavior of the two models is compared using step responses of the load current. The relative deviation of the model's output voltage compared to the SPICE simulation is less than 2 %. Furthermore, also the energetic behavior was investigated, and it is shown that the proposed model provides good results for a wide operating area.

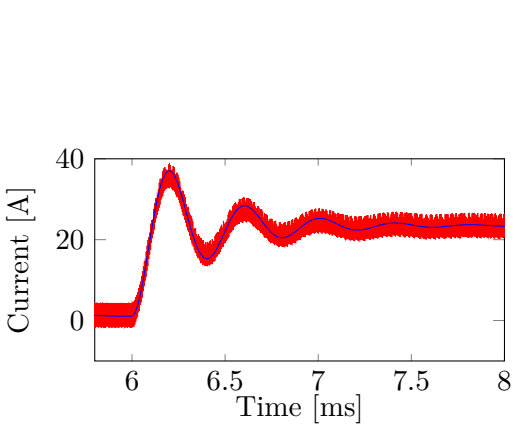

Figure 1. Inductor current step response of the Modelica(blue) and the SPICE model(red) to a step in the load

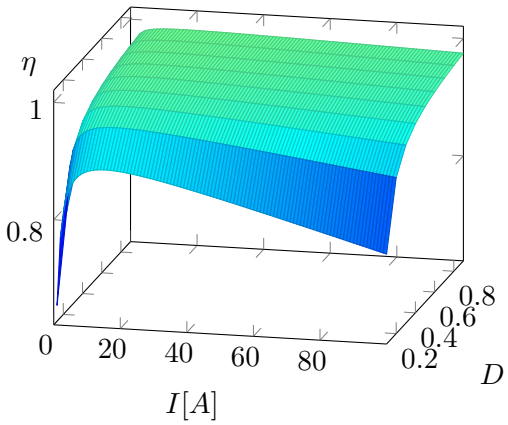

Figure 2. Efficiency map of the proposed Modelica model in buck mode as a function of D and I

References

Robert W. Erickson and Dragan Maksimović. *Fundamentals of power electronics*. Kluwer Academic, Norwell, Mass., 2nd ed edition, 2001. ISBN 0-306-48048-4.