Faculty of Electrical Engineering & Computer Science
Master Degree Course Electronics Engineering, MSc EE

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Mr. Jan Kaufmann

Development and Verification of a Spacecraft Array Power Regulator Module.

ABSTRACT - Masterthesis

Purpose - The goal of this work is to present a way to design, lay out and build a spacecraft array power regulator module based on given requirements in comprehensible and detailed steps. In addition, the focus is on concepts to improve economic aspects such as the handling of limited budgets or the inefficiency of modeling procedures in design.

Design methodology - The starting point of the development phase is the processing and classification of the project requirements. Subsequently, a conceptual design is derived, which contains a rough system diagram and functional principle. Afterwards a simulation model is created, on the basis of which the circuit schematics are designed and implemented on a circuit board. Finally, the setup is put into operation and the fulfillment of the requirements is verified by certain scenarios.

Development tools - The basic requirements of the spacecraft array power regulator module have been given by the German Aerospace Center (DLR) e.V. Bremen. For the conceptual design, a variety of online academic libraries were available for research, Digikey's Scheme-it, Inkscape and MATLAB for visualizations, Microsoft Excel for more extensive calculations, and numerous assistance from friendly work colleagues. The system level design environment COSIDE was used for the SystemC-AMS simulation model generation and the EDA software KiCad for circuit design. Simulations of individual circuit parts at lower abstraction levels were performed by the SPICE simulation software LTspice. The DLR Bremen also provided various laboratory instruments and tools for the assembly, PCB alterations and final functional tests.

Results - Within the given time frame of six months for the master thesis, a 3U CubeSat array power regulator module with a converter efficiency of 89.5 % and a MPP tracking efficiency of up to 99 % was successfully developed. With a few special exceptions, the requirements for the device have been fully met. For most of the remaining problems solutions have been presented that could be incorporated in a new design revision. In addition, possibilities for future optimization, such as an increased MPPT feedback loop frequency or a decreased error integration, are mentioned to further increase the MPP tracking accuracy, which would improve efficiency.