

Reinhard Röder

Spacecraft Electrical Energy Systems

Architectures, Design,
and Optimization



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Reinhard Röder

University of Applied Science, Hamburg, Germany

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About the Author

Reinhard P. Röder was for 25 years a project engineer and the last 10 years an expert and senior adviser for electrical power systems at Airbus Defence and Space in Germany. After retirement in 2013, he was and still is continuously busy as a freelancer on consultancy for electrical power and electrical system engineering of spacecraft.

Thus, he brings more than 35 years of experience in spacecraft design and development and has a long-standing reputation as a supporter of industry in the field of electrical systems engineering and consulting, especially specialized with electrical power engineering at spacecraft level.

In addition, he has developed his own training resources for conducting workshops on electrical power systems (EPS), including calculation and simulation for dimensioning the electrical power supply and energy balance of spacecraft.

During a training workshop in 2024, he was asked why, based on his knowledge and his extremely extensive teaching materials, he hadn't yet written a textbook on his field. After long and careful consideration, he decided to create the textbook that you, dear reader, now hold in your hands.

The Reviewers

Dr Yannick Borthomieu is currently the cell development department manager for the Saft's ADP (Aerospace Defense and Performance) division. He is managing battery applications such as satellites, defense, racing, marine, submarines and aviation applications that all have specific requirements such as performances, lifetime and cycle life, reliability, and safety. He was recognized as Saft Fellow, the highest level of the technical experts program created in 2017. Before joining Saft, he earned his PhD in CNRS in Bordeaux in 1989. He worked 35 years in the Space Battery field acquiring worldwide recognized expertise. He has been involved in more than 700 NiCd, NiH₂, and Li-ion satellite battery projects, working in close relation with all the worldwide satellite prime contractors and operators (USA, Europe, South America, India, China...). He has authored or co-authored 4 books, 250 publications and five patents.

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Since 1990 Hans developed space power electronics for numerous spacecraft, and works since 2012 as:

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- Customer advisor for Satellite EPS and PCDU. Technical marketing and proposals
- External and internal teacher of power system electronics development with Cadence PSpice simulation.

Hans is the member of the ECSS Power System Standardization group since 2013.

Preface

Dear Reader

This book is intended to serve as a working tool for individuals doing creative design of electrical power systems (EPS) for spacecraft.

There are in fact a couple of interdisciplinary handbooks on space technology on the market, i.e., those that reflect the technology of the entire 30–40 specialist disciplines that form the basis for complete spacecraft systems, but do not allow to describe the level of detail required to deepen the specialist knowledge within a discipline as it would, for example, be necessary to design and develop an optimized space qualified electrical power supply for spacecraft.

Designing and constructing EPS that meet these requirements demands technical references beyond ordinary textbooks, making a specialized guide like this book very relevant.

The content of the book points out EPS architecture rules, provides an overview of EPS equipment selection and assists engineers in designing and building an optimized EPS for the envisaged application case by providing basic technical and commercial information about EPS architectures, design and development processes, evaluation of EPS topologies, calculation principles, design considerations, comparison of EPS architecture concepts with their advantages and disadvantages as well as development, acceptance and qualification test philosophies for verification of EPS hardware regarding functionality and performance.

This book fills a gap in space EPS literature, making it necessary. Interdisciplinary space technology handbooks span several topics without going deep into anyone. Engineers and students seeking assistance in creating and optimizing EPS structures typically fail to locate a definitive resource. Young professionals entering the industry might benefit from a systematic introduction. Space industry professionals who design power supply systems would find this book useful for problem solving, optimization and ECSS/NASA compliance.

This book can be used as a textbook for either graduate or advanced undergraduate courses. It would be especially relevant for courses focused on EPS of spacecraft, electrical engineering for space applications and satellite design. In addition, the book could serve as a self-study or reference guide for students conducting research or working on space mission design projects. Given by the consideration and regulation compliance to design, development and verification rules of ECSS and NASA standards, it could also be a resource for university capstone programs in collaboration with the space industry.

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Dr. Thomas Andreev is Graduate Physicist and currently working as systems engineer at Airbus Defence and Space GmbH, 82024 Taufkirchen, Germany. Thomas has published more than 30 publications in the field of space photovoltaics, mostly related to physical extreme requirements and their research to prove relevant laws. More details may be found under www.researchgate.net. Thomas regularly gives lectures at Space Power Workshops and Photovoltaic Conferences and was awarded a prize at the IEEE Photovoltaic Conference 2008.

