

2023 13th European Space Power Conference (ESPC 2023)

**Elche, Spain
2-6 October 2023**



**IEEE Catalog Number: CFP23T97-POD
ISBN: 979-8-3503-2900-1**

**Copyright © 2023 by the Institute of Electrical and Electronics Engineers, Inc.
All Rights Reserved**

Copyright and Reprint Permissions: Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

****** This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.***

IEEE Catalog Number:	CFP23T97-POD
ISBN (Print-On-Demand):	979-8-3503-2900-1
ISBN (Online):	979-8-3503-2899-8

Additional Copies of This Publication Are Available From:

Curran Associates, Inc
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: (845) 758-0400
Fax: (845) 758-2633
E-mail: curran@proceedings.com
Web: www.proceedings.com

CURRAN ASSOCIATES INC.
proceedings
.com

TABLE OF CONTENTS

A Comparative Study on Experimental Loop Gain Measurement Techniques Applied to Digitally Controlled Buck-Type Power Converters.....	1
<i>Stijn Govaerts, Christophe Delepaut, Jesus Oliver</i>	
A Comparison of Technologies for the Implementation of Low Voltage, High Current Power Converters for High Power Integrated Circuits	16
<i>C. Makris, P. Dubus, A. Mathewson, N. Van Der Blij, J. Oliver, J. Ponin, M. Mroczkowski, P. Maynadier, C. Papadas</i>	
A Complete Approach on Validating Satellite Electrical and Power Sub-System Using Systema	21
<i>Camille Sanchez, Mathieu Lepilliez, Charlotte Bayeux, Léa Galeron, Christophe Sabourin</i>	
A Deployable Membrane-Based 100W Solar Array for SmallSats	28
<i>Tom Sproewitz, Patric Seefeldt, Siebo Reershemius, Marta Tokarz, Piotr Torchala, Tim Kubera</i>	
A Dual Three-Phase DC-Link Inverter Prototype Powering a Redundant Space Robotics Motor Drive.....	40
<i>Tilman Wimmer, Josef Reill, Hans-Jürgen Sedlmayr</i>	
A High Voltage and High Power PCDU for Space.....	46
<i>Xuelong Hou, Xiantao Zhang, Chao Wang, Min Wang, Yalin Li, Shuo Jiang, Xuan Zhang, Dawei Li, Rui Hou</i>	
A New Battery Cell Simulator and Main Frame for EGSE Equipment.....	52
<i>Adam Kiss, Berk Kyane Gezer, Flemming Göttschev, Troels Olesen, Hjalti Pall Thorvardarson</i>	
A Power Engineer View on Space Based Solar Power.....	58
<i>Henri Barde</i>	
A Robustness Analysis of PPU Anode Power Supply to Hall-Effect Thruster Flicker Phenomenon	69
<i>Dominique Nicolas, Julien Grenier, Louis Dandaleix, Pablo Lopez, Cyrille Sentenac, Sabine Lebeau</i>	
Accurate Controllable 325W Laser Diode Driver for Optical Inter-Satellite Links	77
<i>Martin Persson, Truls Mjælde Andersen, Bjarne Soderberg, Steen Brandt</i>	
Adaptation and Control of a Latching Current Limiter Based on a SiC N-MOSFET	82
<i>Abraham López, Pablo F. Miaja, Manuel Arias, M. Fernández-Costales, Arturo Fernández</i>	
Advances in Flexible and Lightweight 3J Space Solar Cells for High Power Density Applications	88
<i>Carlos Algora, Iván García, Pablo F. Palacios, Daniel Gómez-Reboreda, Pablo Martín, Clara Sanchez-Perez, Luis Cifuentes, Iván Lombardero, Mercedes Gabás, Ignacio Rey-Stolle</i>	
An On-Line Detection Optimization Method of SSPC Based on Transient Temperature Analysis	92
<i>Yonggang Chen, Chao Sheng, Tingzhong Li, Chengan Wan, Jianchao Wu, Huiyao Li</i>	
Analog Global MPPT Techniques for Complex I-V Curves	97
<i>Cristian Torres, Ausiàs Garrigós, José M. Blanes, Pablo Casado, Carlos Orts, David Marroquí</i>	

Analysis and Design of a Radio Frequency Generator for Gridded Ion Technology Thruster	103
<i>Miguel Astudillo Martínez, Guillermo Núñez Rodríguez, Javier Torres Cabanuz, Regina Ramos Hortal, Pedro Alou Cervera</i>	
Analysis of Li-Ion Cells Ageing Process Through ECM Characterization, Statistics and Machine-Learning Algorithms.....	109
<i>Desireé Ruiz, Abraham Casas, Alejandro Pérez</i>	
Assessing Lifetime, Performance, and Functionality Impact for CubeSat Battery Packs Via Modelling	120
<i>Vaclav Knap</i>	
Battery Discharge Regulator Based on Weinberg Topology for High Power Communication Satellites	125
<i>Yunus Sahin, Emre Çetin, Faik Ercan Karagöz, Berk Ince, Dogacan Yildirim</i>	
BPOL48V, a Rad-Hard 48V DC/DC Converter for Space and HEP Applications	132
<i>Stefano Michelis, Nils Hans Van Der Blij, Giacomo Ripamonti, Pablo Daniel Antoszczuk</i>	
Calibration of Solar Cells : CASOLBA 2022's Flight Review	136
<i>Loris Ibarrart, Jean-Marc Walter, Christian Elisabelar</i>	
Centralized Power Supply Unit for Active Antenna RF Equipment.....	141
<i>Miguel Pérez, Arnau Navarro, Alex Jimenez</i>	
Characterization and Early Qualification Activities on Si Planar Blocking Diodes	148
<i>Emanuele Ferrando, Andrea Albertin, Lars Tiedemann, Sascha Van Riesen, Ivica Zrinscak, Jürgen Schneider</i>	
Comparative of Different Direct Drive Architectures	153
<i>Pablo F. Miaja, Andreas Franke, Denis Estublier, Christian Brandt, Gustavo Alvarez, Manuel Arias</i>	
Comparison of 100V-28V Switched-Capacitor DC-DC Converters Based on Cascaded Buck, Boost and 3-Level Buck Topologies for Space Application	168
<i>Miguel Alegre Sánchez, Regina Ramos Hortal, Jesús Oliver Ramírez, Miroslav Vasic</i>	
Consistent Approach of Predicting the Degradation of Solar Cells Due to Particle Irradiation	178
<i>Carsten Baur</i>	
Co-Simulation of Electrical Propulsion and Power Systems in Direct Drive Applications.....	184
<i>Pablo F. Miaja, Andreas Franke, Denis Estublier, Christian Brandt, Jorge Ruiz Torralba, Maria Aranda Rosales, Manuel Arias</i>	
Decentralized Control for a Fault-Tolerant, Fully Scalable Microprocessor Power Supply for Spacecraft Applications	198
<i>Gregory Almeida, Marc Cousineau, David Le Bars, Frederic Pecourt, Philippe Ayzac</i>	
Digital Control for a Modular System of DC/DC Converters for Primary Distribution System.....	206
<i>Pablo Zumel, Mario García-Valderas, Miguel F. Costales, Jesús A. Oliver, Arturo Fernández, Cristina Fernández</i>	
Digital Controllers Design Using the ESA Control Toolbox in MATLAB Simulink	212
<i>Alberto Sanchez, Elyas Zamiri, Angel De Castro</i>	

Dual-Phase High Entropy Oxide Based on AlFeCoNiCu as an Advanced Anode Material for Lithium-Ion Batteries with Self-Healing Properties	218
<i>Dávid Csík, Gabriela Baranová, Dániel Száraz, Róbert Džunda, L'Ubomír Medvecký, Karel Saksl</i>	
Effective Annealing of Proton and Electron Radiation Damage in Ultra-Thin Silicon Solar Cells.....	223
<i>Yana Gurimskaya, Stanislau Herasimenka, Alex Fedoseyev, Mikhail Reginevich, Stuart Bowden, Nicole Honesty, Michelle Eyink, Tray Moraca, Romain Cariou, Nicolas Enjalbert</i>	
End-Of-Life Battery Passivation Management System for Small Satellite Constellations in LEO and GEO	228
<i>Davide Istria, Emilio Fazzoletto, Valerio Di Tana, Adam Harris, Pablo Hernandez, Aureore Carre</i>	
Evaluation of the Qucs Software for MSR-ERO Electric Propulsion Power Processing Assembly Modelling and Design Check	235
<i>Dominique Nicolas, Paul Kirch, Frédéric Lescoat</i>	
Evolution of On-Orbit Management Strategy for GEO Satellite Lithium-ion Battery.....	252
<i>Liran Wang, Rui Hou, Xiao Zhang, Rong Zhou, Haifeng Cheng, Xuelong Hou</i>	
Feasibility Evaluation on European Capabilities for ²³⁸ Pu Based Radioisotope Power Systems	258
<i>Beatriz Acevedo, Pablo Romojaro, Gert Van Den Eynde, Karen Van Hecke, Thomas Cardinaels, Marc Verwerft</i>	
First Flights of a New Test Facility for Solar Cell Characterization in the Stratosphere.....	271
<i>Matteo Gemignani, Roberta Campesato, Salvo Marcuccio</i>	
Flexible Base Power and Isolation Unit for Robotic Payloads.....	275
<i>Sascha Moser, Alexander Beyer, Franz Hacker</i>	
Galileo Solar Arrays In-Orbit Performance Analysis and Power Prediction Using PEPS.....	282
<i>Pier Luigi Coz, José Ramón González, Philippe Chevalley, Mihalis Turloukis, Frederic Bard, Hugh Evans, Federico Di Marco</i>	
GaN FET-Based, Scalable DCDC Converter Development for Space and Stratospheric Applications.....	289
<i>László Bago, Norbert Szabó, Dávid Czifra, András Szimler, Johanna Molodih, Csaba Kisházi, Áron Veres-Vitályos, Jesus Oliver</i>	
GR716B: Mixed-Signal Rad-Hard Microcontroller for Switching Power and Motor Control	306
<i>Mikael Ekström, Roger Malmberg, Fabio Malatesta, Fredrik Johansson, Anandhavel Sakthivel, Jan Andersson</i>	
Hardware-In-the-Loop Model Design Using the ESA Control Toolbox in MATLAB Simulink	315
<i>Antón Seoane Ampudia, Elyas Zamiri, Alberto Sanchez, Angel De Castro</i>	
High Power Density Sequential Switching Shunt Regulator Module	321
<i>Berk Ince, Dogacan Yildirim, Faik Ercan Karagöz, Emre Çetin, Yunus Sahin</i>	
High Temperature Accelerated Life Tests for GaInP/GaAs/Ge Solar Cells: Forward Versus Forward-Reverse Bias	328
<i>Manuel Vazquez, Neftali Nuñez, Pablo Martín, Jesus Bautista, Manuel Hinojosa, Mercedes Gabas, Ivan Lombardero, Vincenzo Orlando, Carlos Algora</i>	

High Voltage Power Bus: Solar Array Power Conversion and Power Distribution.....	334
<i>Ausias Garrigós, David Marroquí, José M. Blanes, Carlos Orts, Pablo Casado, Cristian Torres</i>	
High-Efficiency 1064 Nm Metamorphic Photonic Power Converters for Spacecraft Wireless Power Transfer.....	344
<i>Carmine Pellegrino, Henning Helmers, Jens Ohlmann, Oliver Höhn, David Lackner</i>	
High-Power Modular Power Conditioning and Distribution Unit for an Integrated Microsatellite Avionics Stack.....	348
<i>Quentin Mannes, Timothee Toudic, Alexander Finch, Patrick Van Put</i>	
Impacts of Distributed Power Consumption on the Power System Stability for a Huge Power Satellite.....	354
<i>Kang Li, Xuan Zhang, Dawei Li, Yonggang Chen, Siyue Jiang, Yaoxian Jiang, Chuwei Li</i>	
Influence of the Thermal Transient Response of Thermoelectric Generators in Maximum Power Point Tracking Algorithms	358
<i>Marcos Compadre Torrecilla, Andrea Montecucco, Jonathan Siviter, Andrew Strain, Andrew R Knox</i>	
In-Situ and Ex-Situ Study of Proton and Electron Irradiations of Perovskite Solar Cells.....	363
<i>Carla Costa, Matthieu Manceau, Sophie Duzellier, Thierry Nuns, Romain Cariou</i>	
INTEGRAL: Solar Array in-Orbit Performance Analysis and Power Prediction.....	370
<i>Thomas Bader, José Ramón González, Winfried Alius, Gianfelice D'Accolti, Pier Luigi Coz, Norbert Pfeil, Richard Southworth</i>	
Investigation of Thin Poly-Si/SiO _x Passivated Contacts P-Type Silicon Cells Radiation Hardness	377
<i>Nicolas Enjalbert, Romain Cariou, Sébastien Dubois</i>	
Isolated Auxiliary Power Supply Designs Using COTS Components	381
<i>Nils H. Van Der Blij, Dorian D. Gisbert, Arturo Fernández</i>	
Low Voltage, High Current Power Converter for High Power Integrated Circuits	386
<i>P. Dubus, K. Makris, M. Mroczkowski, A. Mathewson, J. Oliver, N. Van Der Blij, J. Ponin, P. Maynadier</i>	
Manufacturing of a Novel Micro-Concentrator Prototype and Assessment of Its Electrical Performances	393
<i>Vareilles Victor, Voarino Philippe, Veschetti Yannick, Elisa Kaiser, Henning Helmers, Amara Mohamed</i>	
Microsatellite Power System for Deep Space Exploration.....	398
<i>Cristian Torres, José M. Blanes, Ausiàs Garrigós, Pablo Casado, Carlos Orts, David Marroquí, José A. Carrasco</i>	
Microsatellite Solar Array Regulator Digital Twin Development and Validation	404
<i>Pablo Casado, José M. Blanes, Cristian Torres, Ausiàs Garrigós, David Marroquí, Carlos Orts</i>	
Modular Architecture for a Control Unit for a Martian Robotic Arm	412
<i>L. Zerilli, C. Barbagallo, G. Mantovani, K. Quinones, E. Palladini, E. Tella, G. Sangiovanni, A. Rusconi, P. Serrano, J. I. Hullo, D. Nicolis, K. Wormnes</i>	

Modular Converters Analysis and Design for the Standardization of the Power Bus in Satellites.....	417
<i>Abraham López, Manuel Arias, Pablo F. Miaja, José A. Villarejo, Theyllor H. Oliveira, Arturo Fernández</i>	
Modular Power Conditioning and Distribution Unit Within the Advanced Data & Power Management System	424
<i>Andrés Tellarini, Steven De Cuyper, Paul Swann-Clark</i>	
MPPT Finite-State Supervisor for Electrical Power System Management in LEO Satellites	428
<i>Elisa Mostacciolo, Salvatore Sagnelli, Silvio Baccari, Francesco Vasca, Luigi Iannelli</i>	
On the Design of Sequentially Switched DCX Converters for Solar Array Regulation: S3ZVZCS	434
<i>C. Orts, A. Garrigós, D. Marroquí, A. Franke, J. M. Blanes, C. Torres, P. Casado</i>	
On the Implementation of a DC-DC Power Supply for Reducing Electromagnetic Interference from Power Converters and Filters	441
<i>J. A. Carrasco, F. García De Quirós, A. Garrigós, J. M. Blanes, D. Marroquí, E. Sanchis-Kilders, J. B. Ejea, A. Ferreres, D. Gilabert, I. De La Viuda, M. Cora, Axel Junge, Sven Landstroem</i>	
Power Performance Implications of a Different Binning Strategy	447
<i>Emanuele Ferrando, Henning Kaufser, Arif Sinan Alagoz, Sascha Van Riesen, Thorsten Torunski, Victor Khorenko</i>	
Quasi-Regulated Bus Bus for Deep Space Missions	452
<i>Daniele Renzoni, Aakesh Datta, Jon Caudepon, Stefano Costantini</i>	
Regenerative Fuel Cell for Lunar Night Survival.....	458
<i>Loris Muccione, Stella Balomenou, Alessandro Bacchini, Stewart Pelle, Vincenzo Lavopa, Fabio Murgia, Davide Grasso, Antonio Lo Giudice, Federico Cumino, Bartolomeo Bonafede, Ewa Maria Rajczak, Ilaria Gorga, Giorgio Musso, Stylianos Neophytides, Maria Daletou, Fotios Zaravelis, Dimitris Niakolas, Charalampos Neofytidis, Dimitris Tsiplakides, Popi Papazisi, Stelios Kioulafas, Robert Greinecker, Matthias Lechner, Brandon Edward Buerger</i>	
Satellite Electrical Power Subsystem for Direct-Drive Electrical Propulsion	474
<i>Benjamin Spitaels, Gilles Bouhours</i>	
Silicon Passivated Contacts Photovoltaic Arrays: A Promising Technology for Space.....	479
<i>Romain Cariou, Nicolas Enjalbert, Philippe Voarino, Océane Guillot, Clément Jamin, Adrien Danel, Jean-Baptiste Charpentier, Jordi Veirman, Frédéric Jay, Benoit SAILLET, Vincent Barth, Sébastien Dubois</i>	
Simplifications in Regenerative Fuel Cell Systems Enabled by Inclusion of a Static Water Vapour Feed High Pressure PEM Electrolyser Subsystem	483
<i>Bjarte G. B. Solheim, Jarle B. Farnes, Dmitry Bokach, Jon Eide Pettersen, Jonas Sømmod Ahmed, Fredrik Heimstad, Kjersti Wergeland Krakhella, Kristoffer Skjelanger, Jon Schawllann Ølnes, Xavier Geneste, Arild Vik</i>	
Single Event Effects in Modern COTS DC-DC Buck Converter ICs and Their Influence on the Safe Operating Area	488
<i>Philipp Mand, Pablo Hernandez, Christian Poivey, Vijay Gupta</i>	
SmallSat Solar Array Development at Hemeria	495
<i>Jean-Baptiste De Boissieu, Jean-Marc Sauge, Frans Ijpelaan</i>	
Smart Battery Modules for Distributed Electrical Power Systems.....	498
<i>François Bonnet, Pierre Boan, Quentin Hilpert</i>	

Smart Power Supply for FPGA/SoC	505
<i>Markus Plattner, Chedi Fassi, Aron Berner</i>	
SolAero by Rocket Lab, Space Power Solutions and Product Roadmap	509
<i>Alexander Haas, Daniel Derkacs, Daniel Aiken, Zachary Bittner, Tobias Burger, Brad Clevenger, Andrew Espenlaub, Navid Fatemi, Frank Fencl, Ryan Hool, Jeremy Leshin, Nate Miller, Pravin Patel, Janine Walker</i>	
Solar Cell Impedance Measurement: Leveraging Test Equipment Modernization to Obtain Equivalent Circuit Model of Multijunction Solar Cells.....	516
<i>Raphaël Esquieu, Loris Ibarrart, Christian Elisabelar</i>	
SolarCube: An Origami-Inspired Lightweight Deployable Solar Panel for Nanosatellites	524
<i>Alessandro Buscicchio, Giammarco Alessandrino, Andrea Troise, Tommaso Sironi, Alessia Gloder</i>	
SpaceTech Solar Array Experience in Series Production	533
<i>Thomas Franck, Martin Frosch, Emanuele Ferrando</i>	
State of Health Estimation of Lithium-Ion Batteries Based on Incremental Capacity and Pulse Analysis.....	537
<i>Matej Novak, Miroslav Mikolasek</i>	
Statistical Sizing of a Satellite Power Subsystem.....	543
<i>Manon Huguenin, Nicolas Neugnot, Loïc Boussouf, Stefan Engelke, Alisa Krstova, Camille Sanchez, Claire Tonon</i>	
Study of the Causes of Degradation of Space III-V Multijunction Solar Cells at Reverse Bias Operation.....	549
<i>Aitana Cano, Iván García, Pablo Martín, Ignacio Rey-Stolle</i>	
The Impact of Modern Battery Cell Technologies on Spacecraft DNEL Functionality	554
<i>Tim Strous, Arturo Fernandez</i>	
Thermal Batteries as Power Sources for Space Applications	558
<i>Luc Faget</i>	
Towards Higher Current and Voltage LCLs	561
<i>David Marroquí, Ausias Garrigós, José M. Blanes, Enrique Maset, Carlos Orts, Cristian Torres, Pablo Casado</i>	
TPS7H1111-SP 1.5-A, Ultra-Low Noise, High PSRR Radiation Hardened Low Dropout Linear Regulator	567
<i>Kyle Rakos, Christopher Graves</i>	
Understanding Solar Cell Mismatch Losses Through Statistical Evaluation and Simulation	573
<i>Patrick Hornung, Helmut Nesswetter, Rainer Müller, Claus Zimmermann</i>	

Author Index