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Design Considerations for Photovoltaic Systems Installed on Curved Surfaces

Abstract:

With the advent of thin film technology, solar photovoltaic (PV) systems can now be installed on any surface which facilitates a paradigm shift from the traditional building applied rigid planar modules to free-form building-integrated photovoltaic systems. PV arrays installed on curved surfaces enable new concepts for PV applications but also presents new challenges for balance-of-system components, electrical interconnections and power conditioning electronics. Non-uniform and rapid changes in insolation complicate maximum power point tracking.

The aim of this tutorial is to present design considerations for photovoltaic systems installed in or on non-planar surfaces and their associate power conditioning architectures. The tutorial begins with examples of traditional PV systems and emerging applications. Detailed analysis is presented for estimating the available electrical power for PV systems installed on arbitrarily non-planar curved surface along with an analytical thermal model to predict the cell-by-cell operating temperature, which is an important factor in cell efficiency and reliability as well as an important consideration for module integrated power electronics.

By way of example, it will be shown that a) conventional “string” PV architectures in which PV modules are connected in series/parallel to a central DC-AC inverter and b) module integrated micro-inverters are not optimal for PV systems installed on highly curved or irregular surfaces. Several new approaches are then reviewed for extracting maximum power along with possible interconnection of module integrated converters with PV cells. Throughout the course numerous design examples of PV systems installed on curved surfaces will be presented with simulation and experimental.

Power electronic design engineers who deal with DC-DC; DC-AC converters for renewable energy systems will find this course informative and new knowledge gained in this seminar can be immediately applied.

Lead Instructor:

Title: **Assistant Professor**
Name: **Robert S. Balog, PhD, PE**
Affiliation: **Department of Electrical and Computer Engineering, Texas A&M University**
City / State / Zip Code: **College Station, Texas, USA**
Telephone / FAX: **979-845-7441**
E-Mail Address: **rbalog@ece.tamu.edu**

Other Instructors:

Prasad N. Enjeti	Texas A&M University, USA	enjeti@tamu.edu

Instructor Bios

Robert Balog (rbalog@ece.tamu.edu) (IEEE SM’07) received the B.S. degree in electrical engineering from Rutgers – The State University of New Jersey, New Brunswick, NJ and the M.S. and Ph.D. degrees in electrical engineering from the University of Illinois at Urbana-Champaign, Urbana, IL.

Previously, he was an Engineer with Lutron Electronics, Coopersburg, PA from 1996-2009 and a Researcher with the U.S. Army Corp of Engineers, Engineering Research and Development Center (ERDEC), Construction Engineering Research Lab (CERL), Champaign, IL from 2005-2006. As a Senior Engineer at SolarBridge Technologies, Champaign, IL from 2006 to 2009 he was part of the leadership team that secured initial venture capital funding and co-invented and developed key technology aimed at residential-scale photovoltaic ac modules. He is currently an Assistant Professor in the Department of Electrical and Computer Engineering, Texas A&M University. He holds 10 issued and pending U.S. patent. His current research interests include power converters for solar energy, and highly reliable electrical power and energy systems including dc microgrids.

Dr. Balog is a Registered Professional Engineer in Illinois. He received the IEEE Joseph J. Suozzi INTELEC Fellowship in Power Electronics in 2001. He is a member of Eta Kappa Nu, Sigma Xi, the National Society of

Professional Engineers, the American Solar Energy Society and the Solar Electric Power Association. His pioneering work in photovoltaic energy systems was recently recognized when he was bestowed the Rutgers College of Engineering Distinguished Engineer Award.

Prasad Enjeti (enjeti@tamu.edu) is a member of Texas A&M University faculty since 1988 and is widely acknowledged to be a distinguished teacher, scholar and researcher. His research emphasis on industry-based issues, solved within an academic context, has attracted significant external funding. He along with his students have received numerous best paper awards from the IEEE Industry Applications and Power Electronics Society. His primary research interests are in advancing power electronic converter designs to address complex power management issues such as: active harmonic filtering, adjustable speed motor drives, power conditioning systems for fuel cells, wind and solar energy systems.
He is the lead developer of the Power Electronics / Power Quality & Fuel Cell Power Conditioning Laboratories at Texas A&M University and is actively involved in many projects with industries while engaged in teaching, research and consulting in the area of power electronics.