Book Review

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Text Reveals Circuit And System Knowledge For Designing Grid-Connected Converters In Renewable Energy Systems

Grid Converters for Photovoltaics and Wind Power Systems, Remus Theodorescu, Marco Liserre, Pedro Rodríguez, IEEE/Wiley, 2011, 398 pages, hardback, Print ISBN: 978-0470-057513. www.wiley.com

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As oil supply becomes a growing issue, the world turns to alternative forms of energy generation. Two dominant and emerging sources are solar photovoltaic (PV) and wind power. The emphasis in this book is on some of the details of circuit and system design for connecting these newer sources to the existing electric-power utility network, or grid. For those power electronics engineers with an interest in renewable energy applications, this book will have the expected appeal. However, even those not curious about the PV and wind power systems, may be fascinated by the parallels between power conversion in these applications and power conversion in motion control systems. There are even commonalities with low-power designs such as the need to filter-high frequency noise. In addition, there is a certain wow factor in the design of multi-megawatt systems that may help to capture the readers' interest.

The early chapters plunge into the relative merits of different inverter circuit designs. The emphasis is on a scale of power typical of larger systems, not residential off-grid power. Circuit considerations for several different H-bridge circuits and switch sequencing (commutation) are given in useful design-level detail. The concern about parasitic capacitive coupling from the inverter circuit to the earth ground—a consideration not terribly important in residential-scale systems (< 10 kW)—is dwelt upon at some length in evaluating the different inverter schemes. Three-phase inverters and filter interfaces to the power grid are brought up to finish chapter two. Then grid requirements for PV—mainly different safety standards—are given a short chapter.

One of the more breath-catching aspects of engineering is to contemplate the connection of multi-megawatt voltage sources in parallel. For the power grid, the key design issue is, of course, synchronization of a source as it is attached to the existing (and powered) lines. This is addressed from different methods, beginning with Fourier analysis, phase-locked loops (PLLs), and PLLs with adaptive filtering. Much of the given analysis looks like it could have come out of a motor control book because it involves the same kind of phase control. Clarke transforms, which are common in field-oriented control of motors, appear along with other similarities.

In chapter five, a major theme for the rest of the book develops, that of detecting a particular kind of power-grid fault called "islanding". Islanding is disconnection from the grid "in case the main electric grid should cease to energize the distribution line." (p. 93) This also applies to residential-sized systems that cogenerate and are supplemented by connection to the grid. What emerges are "active grids" where parts of the grid can operate either connected to the larger distribution system or not. This raises a number of design considerations that, along with grid faults (chapter ten), occupy much of the rest of the book.

In addition, a topic that applies at lower power levels is grid filter design. With switched power conversion, the goal is to keep high-frequency noise off the power grid. Practical examples of such filters are given. Some involve active damping, and with it, application of control theory, which should be familiar to the readers if they are to effectively apply what is presented throughout this book.

The final chapter (twelve) on grid current control looks almost as though it could have been lifted from a field-oriented motor-control book such as the ones authored by Paul Krause of Purdue University, who put motor control theory into its final form. This involves vectors in generalized reference frames and not merely steady-state phasors as Steinmetz had initially worked out. An appendix explains the vector transformations involved. This book should give hope to motor-control engineers seeking new jobs. Their skills can readily apply to state-of-the-art power grid design with alternative power sources.

About The Author

Dennis Feucht has been involved in power electronics for 25 years, designing motor-drives and power converters. He has an instrument background from Tektronix, where he designed test and measurement equipment and did research in Tek Labs. He has lately been doing current-loop converter modeling and converter optimization.