Book Puts Engineers On Path To Designing With eGaN Transistors

GaN Transistors for Efficient Power Conversion, First Edition by Alex Lidow, Johan Strydom, Michael de Rooij, and Yanping Ma, with a forward by Sam Davis; Power Conversion Publications, El Segundo, CA, 2012 (MMXII), 208 pages; available from EPC, Digi-Key, and Amazon.

Reviewed by Dennis Feucht, Innovatia Laboratories, Cayo, Belize

Enhancement-mode gallium-nitride (eGaN) MOSFETs are now transitioning from research to commercial use and, given their characteristics, are bound to be of major significance to power electronics engineers. Among their most notable attributes: they are fast.

This book offers an introduction to eGaN MOSFETs, which are devices that have been brought to market by Efficient Power Conversion (EPC)—the company at which this book's authors work. While this text is by no means complete, it offers readers a good first step in learning about an important new power device.

The first chapter describes how eGaN FETs function and it is not a repeat of how silicon (Si) MOSFETs work. There are some new solid-state concepts. The familiar majority-carrier channel is not formed as an inversion layer but as a two-dimensional "electron gas." The gate structure is also different. These differences result in a lower gate-threshold voltage, a much-lower C_{GD} of typically 10 pF that allows switching hundreds of volts in a few nanoseconds, and a very different kind of body-drain "diode" with zero reverse-recovery charge. Instead of a diode, the MOSFET operates somewhat as a transistor in the inverted mode.

The second chapter provides more detail about device characteristics. In most ways, eGaN FETs are similar to Si MOSFETs. One of the disadvantages of Si MOSFETs is their positive temperature coefficient (TC) at power-level currents. The eGaN devices have a lower positive TC so that at 100°C die temperature, the on-resistance is typically over 20% lower than Si n-channel MOSFETs. One disadvantage of these new devices is that, despite the very fast body-drain response, the forward drop is higher than the body-drain diode of MOSFETs—around 1.5 to 3 V. Gate drive is also simplified because the total gate charge for switching is about a half to a third of the gate charge of a comparable MOSFET part. Some packaging improvements also reduce thermal resistance.

Because these devices are fast, chapter three covers gate driver and layout details followed by a chapter about paralleling eGaN FETs. The middle third of the book is power-converter-oriented, with chapters on buck, isolated full-bridge, forward, and flyback converters. The emphasis is on device efficiency, and throughout the book (as one might expect), the perspective on power circuits is device-oriented.

The ninth chapter is on device modeling followed by appendices that give model parameters for LTSPICE, PSPICE, TSPICE, and others for an EPC2001 FET. With new packaging, additional chapters cover board assembly and thermal performance, reliability, and also space (exoterrestrial) applications. The book ends (ch. 14) asking "How Soon Will eGaN FETs Replace Silicon Power MOSFETs?" Because these new parts do not require much learning by designers and are relatively easy to use, they should become commonplace sooner rather than later. The 208-page book ends with a glossary, index, and author information.

This book offers a quick and informative start to engineers and technicians on a new device technology and can familiarize designers sufficiently with eGaN FETs so that they may design them into circuits with confidence.

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.

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