# *GaN Suppliers Continue to Push the Performance Envelope*

*by Ashok Bindra, Technology Writer, Technika*

Last may at PCIM Europe, RF Micro Devices (RFMD) revealed its newest process technology called rGaN-HV for building gallium nitride on silicon carbide (GaN-on-SiC) based high-voltage, high-power HEMT devices for power conversion applications. The first two GaN devices to emerge from this technology were 650-V normally-off source-switched FETs (SSFETs) in cascode configuration. The RFJS3006F is a 30-A, 650-V GaN part offering 45 mΩ on-resistance at 25°C, while the RFJS1506F is a 15-A version specifying 80-mΩ on-resistance at 25°C. Both come in 3-lead TO-247 packages with very high switching speeds (see the reference.)

According to RFMD's director of marketing and sales, Dan Schwob, the company has been sampling its GaN-based SSFETs to select customers for the last nine months with plans to ramp up production by early next year. Although, the data sheet specs are preliminary, Schwob says that the SSFETs are fully characterized.

"Because avalanche capability is not intrinsic to the lateral GaN HEMT structure, the SSFET is designed to handle much higher breakdown voltage," notes Schwob. For instance, he adds that the 650-V part offers a breakdown voltage of >900 V. Plus, it is 100% tested at 700 V, explains the marketing executive.

Furthermore, Schwob indicates that RFMD's GaN is a very fast switching transistor with low turn-on/turn-off energy, which is three times better than Infineon's newest CoolMOS MOSFETs. Plus there's, "no snappy recovery for our GaN device," asserts Schwob. Also, according to Schwob, the isolated package eliminates conducted EMI. As a result, these are no special requirements for gate drive.

To enable designers to evaluate its new GaN-based SSFETs, the company has readied a boost-circuit evaluation board. This board can be used to test the high-efficiency and high-frequency capabilities of these devices, says the maker. In fact, the company claims to have demonstrated efficiency over 98%. Concurrently, the manufacturer is also developing another evaluation board incorporating a totem pole power factor correction (PFC) circuit, which is expected to be launched at APEC 2014. Using traditional controller and silicon MOSFETs is challenging with totem pole PFCs. RFMD will show that its 650-V GaN power devices with low Qrr can realize this circuit using a general-purpose DSP controller.

Meanwhile, the company is also preparing new members in the 650-V GaN family with a 1200-V version on the roadmap. Since safeguarding against overvoltage is important in many power supply designs, RFMD is planning to include an overvoltage protection feature in upcoming 650-V parts. Additionally, the company is also investigating surface-mount packages like PQFNs.

Target applications include IT/telecom ac-dc converters, solar inverters, uninterruptible power supplies (UPSs), battery chargers and high-frequency dc-dc converters.

## *Switching Above 10 MHz*

To give enhancement-mode GaN FETs a shot in the arm, Efficient Power Conversion (EPC) has extended its family of high-speed, high-performance eGaN FETs with the addition of third-generation devices with switching transition speeds in the sub-nanosecond range. Consequently, the recently released EPC8000 family devices is capable of hard switching above 10 MHz. In addition, these eGaN power transistors also exhibit very good small-signal RF performance with high gain well into the low gigahertz range, making them suitable for RF as well as power conversion applications.

"We now have eGaN FETs that can be used in both power semiconductor and RF applications," says Alex Lidow, EPC's co-founder and CEO.

Transistors in the family are available with on-resistance values from 125 mΩ through 530 mΩ, and three blocking voltage capabilities—40 V, 65 V and 100 V (see the table).

*© 2013 How2Power. All rights reserved.*

Table. Key specifications for members of the EPC8000 family of eGaN FETs.

| Part Number | BV (V) | $R_{DS(on)}$ Max (mΩ) ($V_{GS}$ = 5V, $I_D$ = 0.5 A) | Peak $I_D$ Min (A) (Pulsed, 25 °C, $T_{pulse}$ = 300 µs) | Typical Charge (pC) | | | | | Typical Capacitance (pF) ($V_{DS}$ = BV/2, $V_{GS}$ = 0 V) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $Q_G$ | $Q_{GD}$ | $Q_{GS}$ | $Q_{OSS}$ | $Q_{RR}$ | $C_{ISS}$ | $C_{OSS}$ | $C_{RSS}$ |
| EPC8004 | 40 | 125 | 7.5 | 358 | 31 | 110 | 493 | 0 | 45 | 17 | 0.4 |
| EPC8007 | 40 | 160 | 6 | 302 | 25 | 97 | 406 | 0 | 39 | 14 | 0.3 |
| EPC8006 | 40 | 250 | 3.8 | 211 | 15 | 75 | 264 | 0 | 29 | 9.5 | 0.2 |
| EPC8008 | 40 | 325 | 2.9 | 177 | 12 | 67 | 211 | 0 | 25 | 8 | 0.2 |
| EPC8009 | 65 | 138 | 7.5 | 380 | 36 | 116 | 769 | 0 | 47 | 17 | 0.4 |
| EPC8005 | 65 | 275 | 3.8 | 218 | 18 | 77 | 414 | 0 | 29 | 9.7 | 0.2 |
| EPC8002 | 65 | 530 | 2 | 141 | 9.4 | 59 | 244 | 0 | 21 | 5.9 | 0.1 |
| EPC8003 | 100 | 300 | 4 | 315 | 34 | 87 | 1100 | 0 | 38 | 18 | 0.2 |

* Preliminary Data - subject to change without notice

These new transistors have several new features that further enable designers to take full advantage of the high performance eGaN FETs have to offer. Some key characteristics highlighted by EPC include reduction in $Q_{GD}$ thereby reducing voltage transient switching losses, improved Miller ratio providing high dv/dt immunity, low inductance pads for improved connection to both gate and drain circuits, and orthogonal current flow between the gate and drain circuits for reduced common source inductance (CSI). To enable these features, EPC engineers have created a new footprint for the EPC8000 series FETs (Fig.1). The recommended PCB layout and stencil information for these devices are presented in the datasheet.

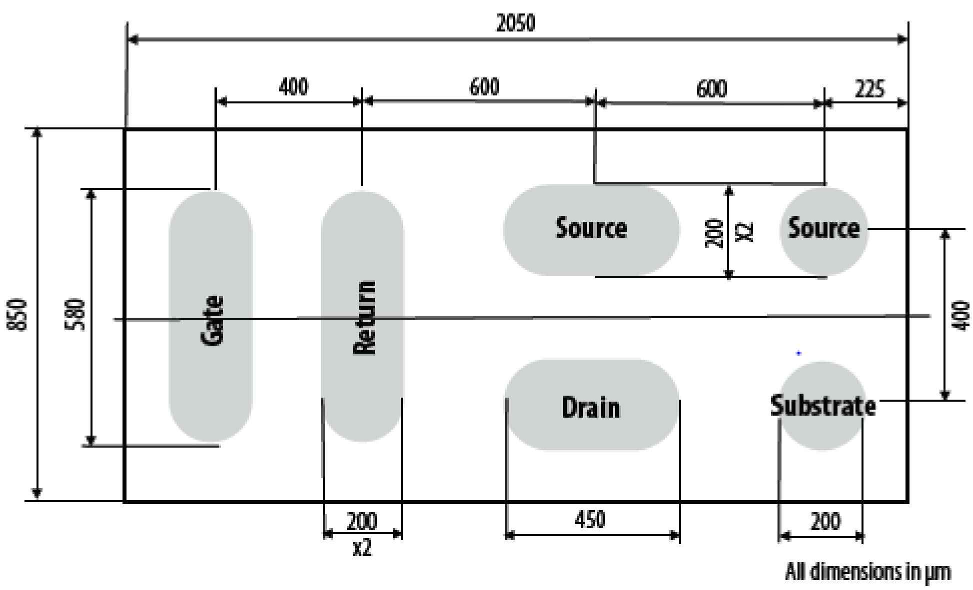


*Fig.1. The EPC8000 series eGaN FETs offer a new, performance-enhancing footprint.*

Also, to demonstrate the usability of EPC8000 transistors in high-frequency applications, the company has developed two reference circuits. Using the EPC8005, the manufacturer has created a power stage for an envelope tracking buck converter (Fig.2), which is available as an evaluation board, the EPC9025. The board is a 42-V to 20-V, 20-W buck converter operating at 10 MHz. It uses the basic power circuit in Fig. 3 where $L_{BUCK}$ = 2.2 µH (IHLP1616BZ01) and $C_{OUT}$ = 2 x 4.7 µF (CGA4J3X5R1V475M125AB). The main supply ($V_{DD}$) bus caps were 100 nF. EPC says that the evaluation board was designed using optimal layout technique to achieve highest efficiency.

© 2013 How2Power. All rights reserved.

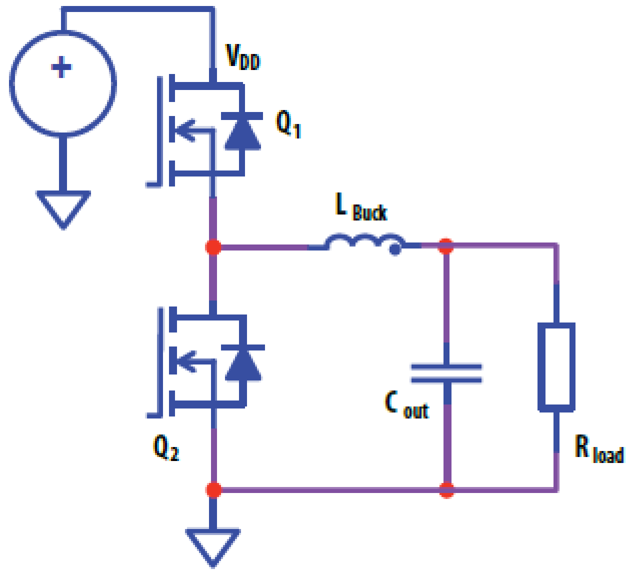


*Fig.2. Power stage for an envelope tracking buck converter*

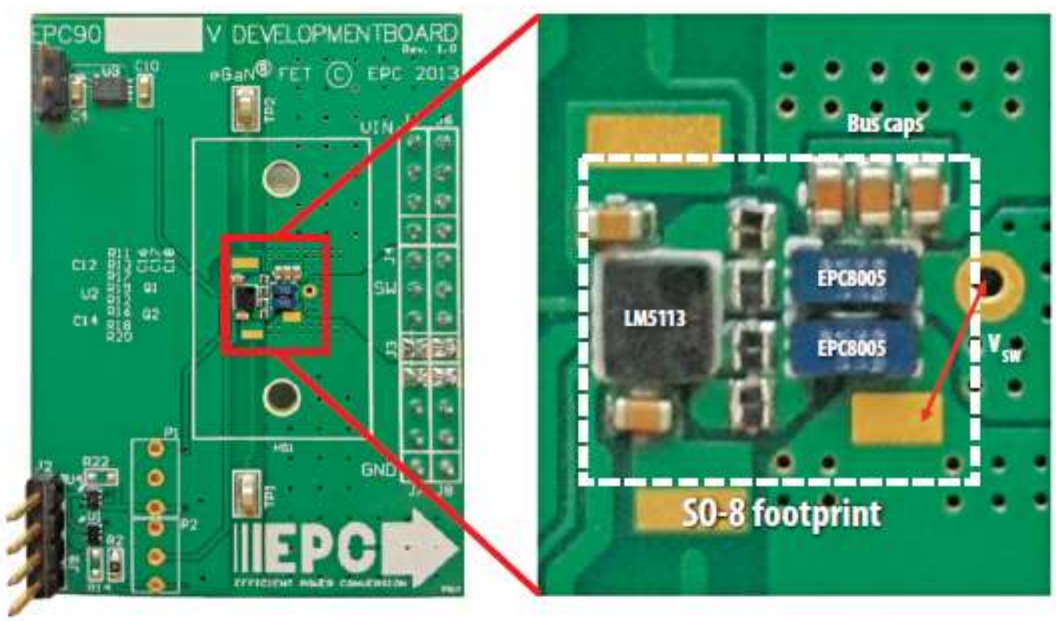


*Fig.3. The EPC9025 evaluation board uses EPC8005 FETs and an LM5113 gate driver to demonstrate a buck converter operating at 10 MHz.*

The second circuit is a 6.78-MHz voltage-mode class D wireless power transfer converter. The evaluation board that offers this application is the EPC9024. It uses EPC8004 devices in the power stage. Details for both the designs are presented in application note AN015.

**Reference**

"RFMD Leverages RF GaN Capability To Build Power HEMTs", How2Power Today, May 2012.
http://www.how2power.com/newsletters/1205/H2PowerToday1205_DigitalMedia.pdf

© 2013 How2Power. All rights reserved. 

## About The Author

*Ashok Bindra is a veteran writer and editor with more than 25 years of editorial experience covering RF/wireless technologies, semiconductors and power electronics. He has written, both for print and the web, for leading electronics trade publications in the U.S, including Electronics, EETimes, Electronic Design and RF Design. Presently, he has his own technical writing company called Technika through which he does writing projects for different trade publications and vendors. Prior to becoming an editor, Bindra worked in industry as an electronics engineer. He holds an M.S. degree from the Department of Electrical and Computer Engineering, Clarkson College of Technology (now Clarkson University) in Potsdam, NY, and an M.Sc (Physics) from the University of Bombay, India. He can be reached by email at bindra1[at]verizon.net.*

© 2013 How2Power. All rights reserved.