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1200-V Enhancement-Mode GaN Power Devices Challenge SiC

GaN Power International has achieved an important milestone in the development of high-voltage GaN power devices. After introducing its first lateral enhancement mode (E-mode) GaN power transistor (GPIHV15DK), a 1200-V, 15-A device in a TO-252 package, this past summer, the company more recently released a second GaN FET (GPIHV30DDP5L) at 1200-V, 30-A in a TO-263-5 (see the figure). According to the company, this latest development confirms that GaN Power's success in producing a 1200-V GaNFET was no accident and that 1200-V GaN can be scaled to higher current and power levels. With their excellent dV/dt handling capability, 1200-V GaNFETs are considered suitable for PV, motor drive and automotive applications.

Up until now it has commonly been believed that high-voltage discrete power devices (>1000V) were exclusive domains of silicon (Si) IGBT and silicon carbide (SiC) transistors (both vertical devices). All previous GaN devices with breakdown voltage higher than 600 V were made of a depletion mode (D-mode) cascode with two or more chips co-packaged, and with compromised switching performance. According to the company, GaNPower International is the first company to offer devices rated at 1200 V using single-die enhancement-mode GaN technology.

The lateral device has an actual breakdown at about 1500 V and it is being rated at 1200 V to allow for sufficient safety margin. GaNPower is presently offering engineering samples of these 1200-V GaN devices with 100-mΩ (15-A) and 60-mΩ (30-A) ratings.

While it is not easy to make a fair comparison between GaN and SiC, one commonly used metric to consider is the Q_G*$R_{DS(ON)}$ product, which is the power switching figure of merit (FOM). This FOM is commonly used to compare power devices at a certain breakdown voltage. For a smaller FOM, a device can switch faster and with lower conduction loss while also occupying less wafer space.

The smaller FOM also means the device has better price-performance advantages. For the same $R_{DS(ON)}$ (thus the same conduction loss), a smaller Q_G (or input capacitance) means less wafer space (smaller capacitance) and thus less cost to fabricate. When considering that a processed six-inch Si wafer costs about a couple of hundred U.S. dollars per wafer, that GaN deposited on a Si wafer is only a few microns thick and that there are fewer process steps in GaN than Si, there is great potential to reduce the final costs of GaN-on-Si to tens of U.S. dollars per six inch wafer in the near future.

It is interesting to see how E-mode GaN power devices at 1200 V stack up against SiC at the same voltage rating. Citing specifications from datasheets published up to September 2019, the table below compares the 1200-V E-mode GaN introduced by GaNPower International against many of the SiC devices on the market using the two best figures of merit from each vendor.

From this table, it is apparent that E-mode lateral GaN offers 5 to 20 times better power switching performance than SiC devices currently on the market. Considering the potential for further reduction of the cost of GaN-on-Si down the road, the motivation to move forward with GaN at 1200 V is tremendous.

GaNPower International is offering engineering samples of its 1200-V E-mode GaN FETs, the 100-mΩ GPIHV15DK in the TO-252 package and the 60-mΩ GPIHV30DDP5L in the TO263-5 package, to selected customers. Sample requests may be directed to information@iganpower.com.

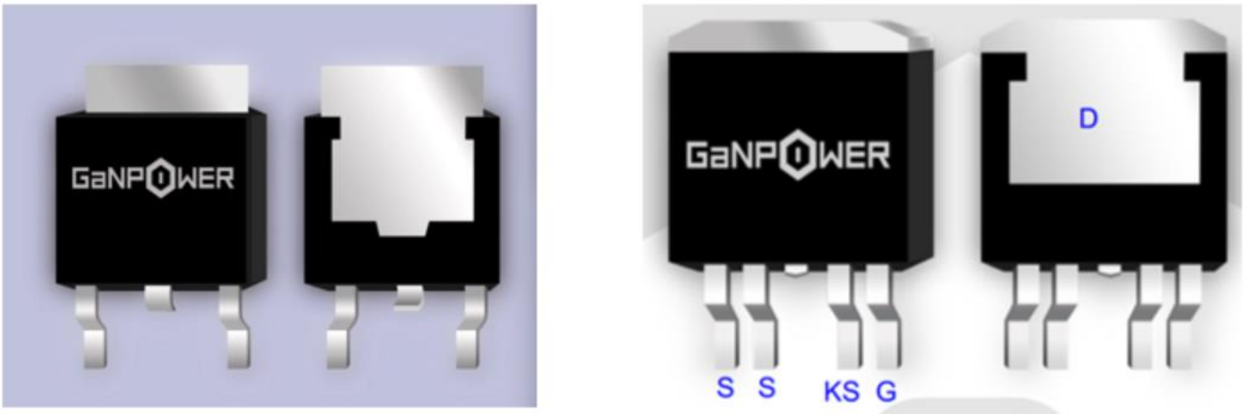

Figure. The GPIHV15DK is 100-mΩ GaN power FET in a TO-252 package, while the GPIHV30DDP5L is a 60-mΩ GaN power FET in a TO-263-5. Introduced as the first enhancement-mode GaN power transistors at 1200 V, these devices bring the performance benefits of GaN to PV inverter, motor drive and automotive applications.

Table. GaN vs. SiC: power switching figure-of-merit Q_G*$R_{DS(ON)}$ at 1200 V.

Device type	Manufacturer	V_{DS} (V)	$R_{DS(ON)}$ (mΩ)	Q_G (nC)	$R_{DS(ON)}$*Q_G (mΩnC)
GaN FET	GaNPower	1200	95	15	394
	GaNPower	1200	60	8.25	495
SiC MOSFET	Infineon	1200	60	31	1860
	Infineon	1200	90	21	1890
	CREE	1200	16	211	3376
	CREE	1200	21	162	3402
	Rohm	1200	22	178	3916
	Rohm	1200	30	131	3930
	OnSemi	1200	80	56	4480
	ST	1200	59	122	7198
	ST	1200	90	105	9450
	IXYS	1200	50	115	5750
	IXYS	1200	34	161	5474
	Littelfuse	1200	80	95	7600
	Littelfuse	1200	160	57	9120
	GeneSiC	1200	100	65	6500
	GeneSiC	1200	50	104	6500

*All data from datasheets published up to Sept. 2019