Second Generation eGaN™ FETs are Lead Free and Offer Improved Performance

Alex Lidow, CEO, Efficient Power Conversion Corporation

In March, 2011 Efficient Power Conversion Corporation (EPC) launched the first two part numbers in a family of second generation enhancement mode gallium nitride (eGaN) FETs. These new products are lead free, halogen free, RoHS compliant, and have significant improvements in their overall performance. These initial lead free products join the family of 40 V and 100 V eGaN FETs introduced in March, 2010. Additional lead free products ranging between 40 V and 200 V are planned for introduction before July, 2011.

Table 1 shows a comparison of key characteristics between the first generation and second generation 40 V and 100 V eGaN FETs [1,2,3,4].

In addition to the improvements shown in Table 1, there are several other areas of performance that have been enhanced in this new generation.

Table 1

Part Number	Package (mm)	RoHS & Halogen Free	$T_{J(MAX)}$ (°C)	V_{DS}	V_{GS} (max)	Max $R_{DS(ON)}$ @5V_{GS}	Q_G typ (nC)	Q_G max (nC)	Q_{GS} typ (nC)	Q_{GS} max (nC)	Q_{GD} typ (nC)	Q_{GD} max (nC)	Q_{OSS} typ (nC)	Q_{OSS} max (nC)	V_{TH} typ	Q_{RR} (nC)	I_D (A)
EPC1015	LGA 4.1 x 1.6	No	125	40	6	4	11.6	N/A	3.8	N/A	2.2	N/A	18.5	N/A	1.4	0	33
New! EPC2015	LGA 4.1 x 1.6	Yes	150	40	6	4	10.5	11.6	3	3.5	2.2	2.7	18.5	22	1.4	0	33
EPC1001	LGA 4.1 x 1.6	No	125	100	6	7	10.5	N/A	3	N/A	3.3	N/A	32	N/A	1.4	0	25
New! EPC2001	LGA 4.1 x 1.6	Yes	125	100	6	7	8	10	2.3	2.8	2.2	2.7	35	40	1.4	0	25

EPC2001 Compared with EPC1001

The four figures below compare the 100 V, 25 A EPC2001 (Figure 1) with the prior-generation EPC1001 (Figure 2) typical output and transfer characteristics. The new generation product performs significantly better at higher currents.

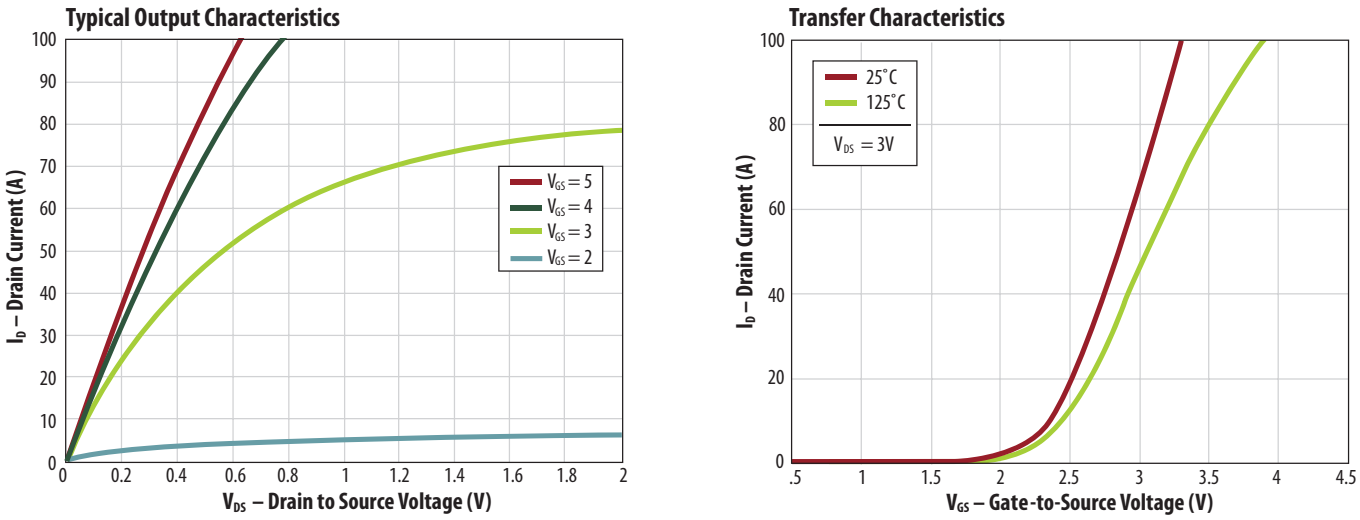

Figure 1: EPC2001(RoHS) typical output and transfer characteristics

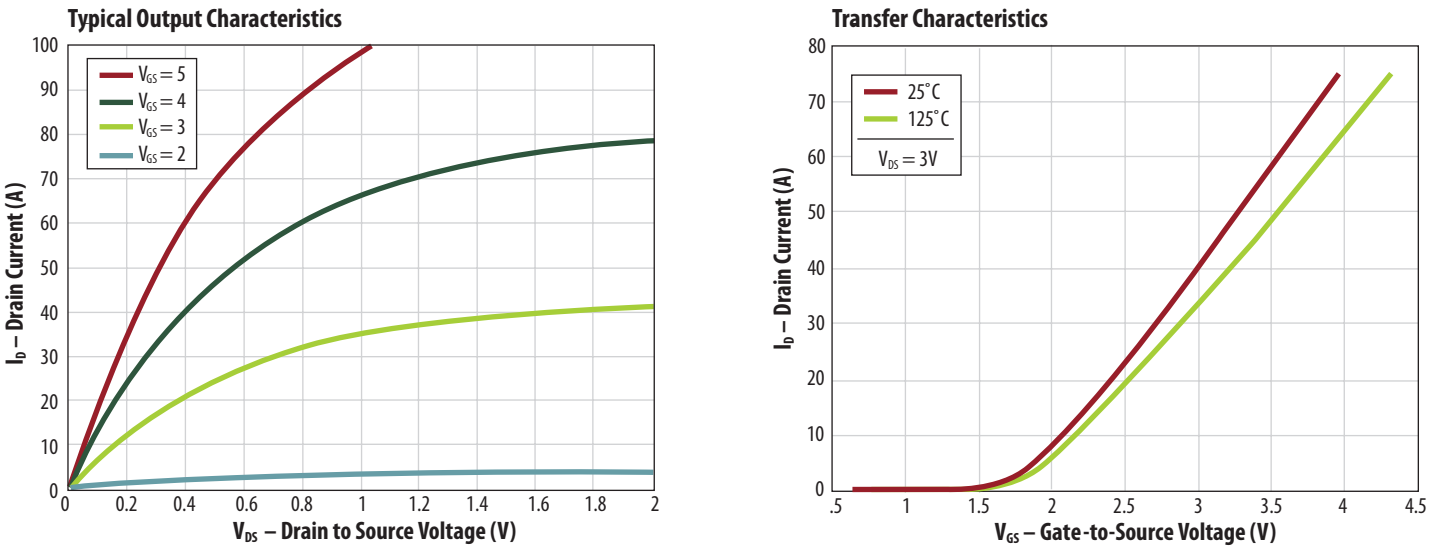

Figure 2: EPC1001 typical output and transfer characteristics

In addition to less conduction loss at higher current, the new-generation EPC2001 has improved $R_{DS(ON)}$ at lower gate-source voltages (see figure 3 and 4 comparisons below). This allows the user to realize the low $R_{DS(ON)}$ capability of the FETs with greater margin between the applied gate voltage and the $V_{GS(MAX)}$ of 6 V. V_{GS} necessary for significant conduction current has also increased, thereby reducing turn off time and increasing dV/dt immunity.

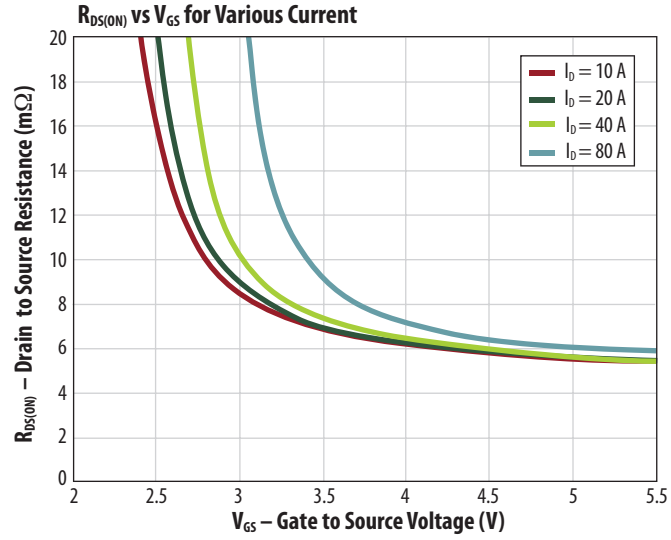

Figure 3: EPC2001 $R_{DS(ON)}$ vs V_{GS} for various current levels. These RoHS parts are fully enhanced at 40 A with 4 V on the gate.

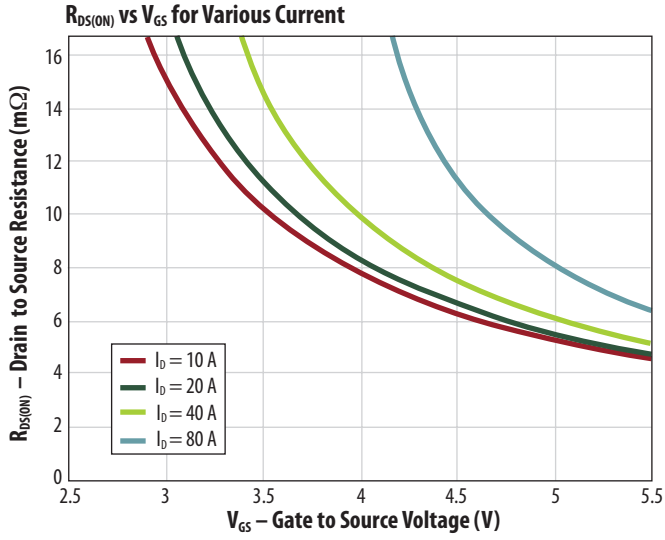

Figure 4: EPC1001 $R_{DS(ON)}$ vs V_{GS} for various current levels. These older generation parts require 5 V applied to the gate to be fully enhanced at 40 A.

EPC2015 Compared with EPC1015

The EPC2015 is a 40 V, 33 A FET. The new generation product has been upgraded to an operating temperature of 150 °C compared with 125 °C for the prior generation, allowing the user more operating headroom. The graphs below compare the EPC2015 (figure 5) with the prior-generation EPC1015 (figure 6) typical output and transfer characteristics. As with the 100 V product discussed above, the new generation 40 V product performs significantly better at higher currents and increased V_{GS} necessary for significant current conduction.

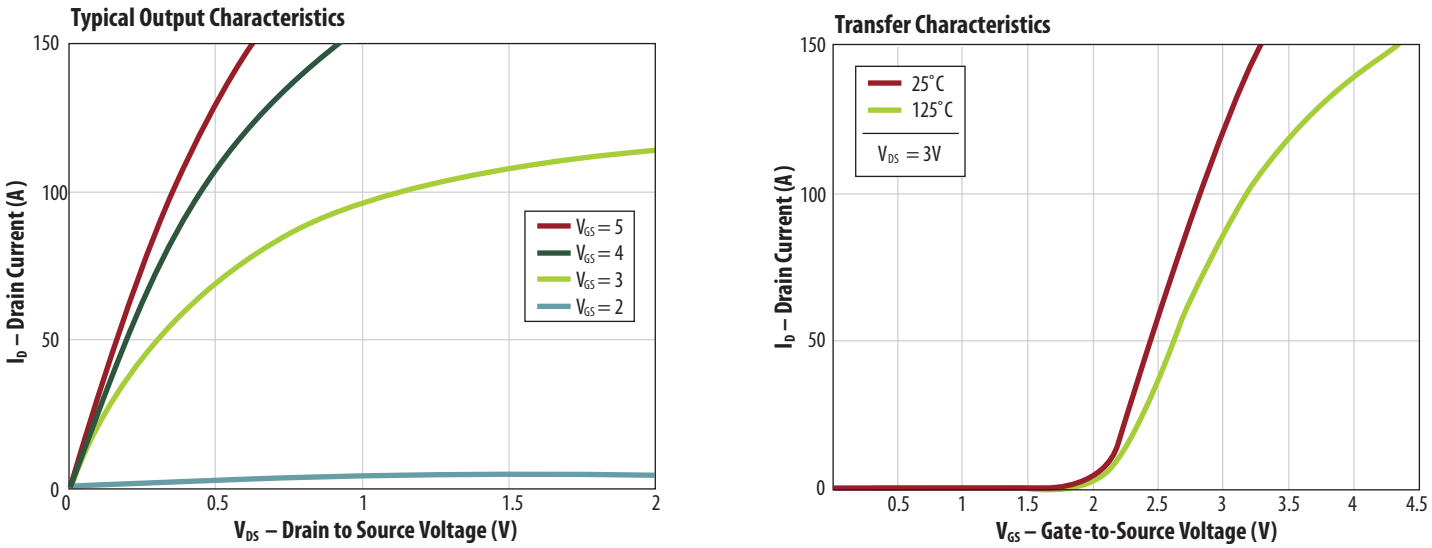

Figure 5: EPC2015 (RoHS) typical output and transfer characteristics

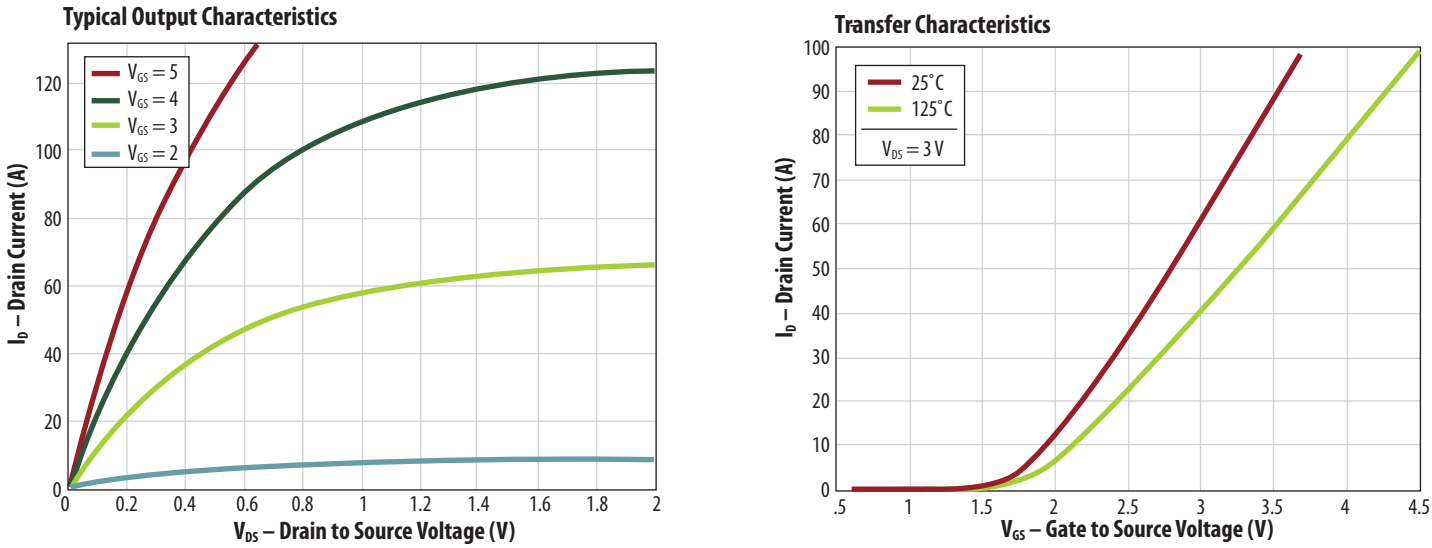

Figure 6: EPC1015 (RoHS) typical output and transfer characteristics

The new-generation EPC2015 also has improved $R_{DS(ON)}$ at lower gate-source voltages (see comparisons in figures 7 and 8).

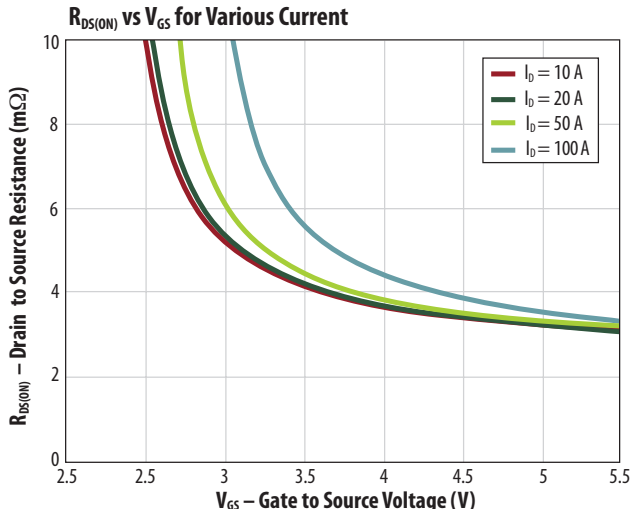

Figure 7: EPC2015 $R_{DS(ON)}$ vs V_{GS} for various current levels. These RoHS parts are fully enhanced at 50 A with 4 V on the gate.

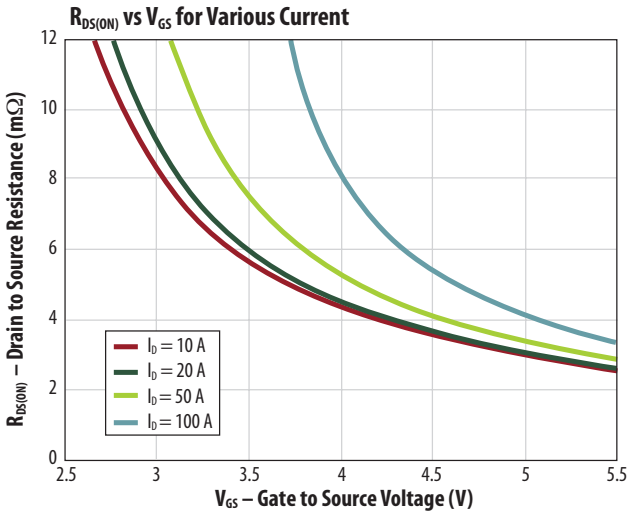

Figure 8: EPC1015 $R_{DS(ON)}$ vs V_{GS} for various current levels. These older generation parts require 5 V applied to the gate to be fully enhanced at 50 A.

New Technical Information

The data sheets for the EPC2XXX series of lead free eGaN FETs, starting with the EPC2001 and EPC2015, have additional information to help the designer get the maximum performance from the product. Thermal resistance data is supplied for both DC and transient operation as shown in Figure 9 and 10 below [5].

Thermal Characteristics			
		TYP	
$R_{\theta JC}$	Thermal Resistance, Junction to Case	1.6	°C/W
$R_{\theta JB}$	Thermal Resistance, Junction to Board	15	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1)	54	°C/W

Note 1: $R_{\theta JA}$ is determined with the device mounted on one square inch of copper pad, single layer 2 oz copper on FR4 board.
See http://epc-co.com/epc/documents/product-training/Appnote_Thermal_Performance_of_eGaN_FETs.pdf for details.

Figure 9: Typical thermal resistance for EPC2001 and EPC2015.

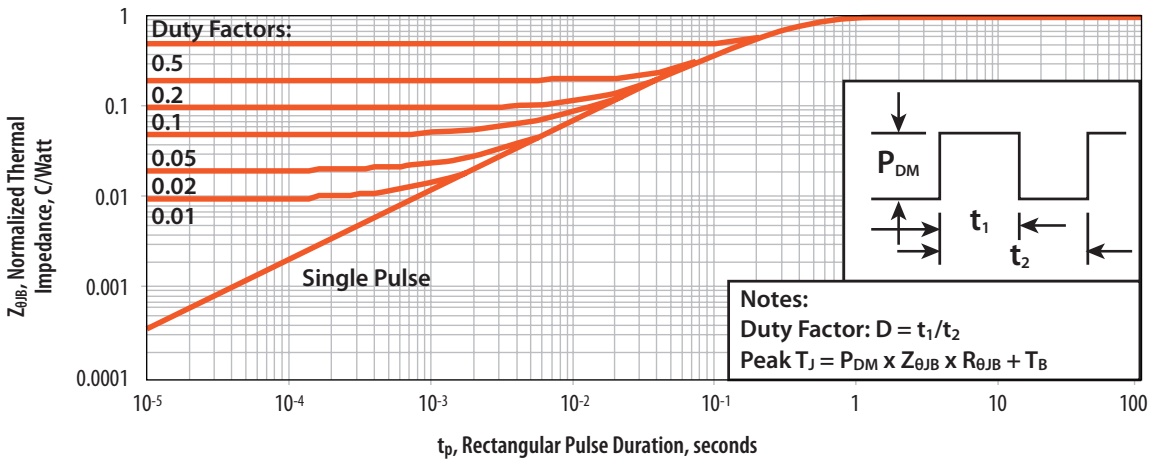

Figure 10: Normalized $Z_{\theta JB}$ Curve Set for EPC2XXX Products

Assembly Considerations for Second Generation eGaN FETs

There are three physical changes to the new generation of lead-free product.

The first change is that there is a connection to the silicon substrate that has been brought to the surface (see figure 11). It is advised that the substrate be connected to source potential to get the maximum dynamic performance from the device.

The second change is the width of the solder bars. The EPC2001 and EPC2015 both have 200 µm wide solder bars compared with 250 µm in the prior generation.

The third change is that the height of the solder bars has been increased from 70µm +/-20 to 100 µm +/- 20. The added height allows for greater post-assembly clearance between the FET and the PCB. This clearance makes it easier to clean out foreign materials and avoids the harmful accumulation of particles.

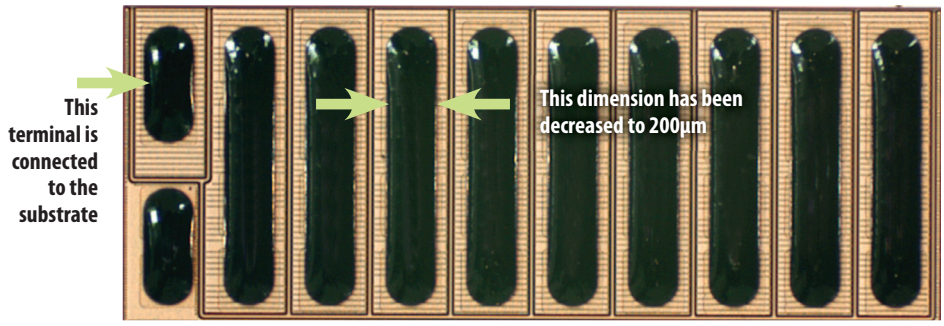

Figure 11: Magnified die photo of EPC2015 or EPC2001 indicating the solder bar that is connected to the silicon substrate and the decreased solder bar width.

Summary

The new-generation of eGaN FETs are lead free and halogen free and have improved electrical performance, matched with additional support documentation to help the system designer deliver leading edge eGaN FET based product faster and with less engineering effort. These products maintain "backward compatibility" with the prior generation of eGaN FETs from EPC [6].

[1] http://epc-co.com/epc/documents/datasheets/EPC1001_datasheet_final.pdf
[2] http://epc-co.com/epc/documents/datasheets/EPC2001_datasheet_final.pdf
[3] http://epc-co.com/epc/documents/datasheets/EPC1015_datasheet_final.pdf
[4] http://epc-co.com/epc/documents/datasheets/EPC2015_datasheet_final.pdf
[5] http://epc-co.com/epc/documents/product-training/Appnote_Thermal_Performance_of_eGaN_FETs.pdf
[6] http://epc-co.com/epc/Products.aspx