Motivation

The smallest, most cost effective and highest efficiency non-isolated 48 V to 5 - 12 V converter, suitable for high-performance computing and telecommunication applications, can be achieved by employing eGaN® FETs such as the EPC2045. The EPC9205 DrGaN power module configured as a synchronous buck converter yielded a power density of 1400 W/in³ when operating at 48 V input, 12 V output and 10 A load, and is capable of producing an output voltage ranging from 5 V to 12 V and delivering 14 A output current.

Introducing the EPC2045 eGaN FET

The EPC2045, shown in figure 1, is a Generation 5 eGaN FET rated at 100 V with 7 mΩ on-resistance that is capable of carrying a continuous current of 16 A. The EPC2045 is nearly one tenth the footprint of a comparable Si MOSFET and was chosen because it has lower parasitic capacitances and can switch much faster than equivalent silicon devices, yielding lowest switching loss even at higher switching frequency.

EPC9205 power module

The EPC9205 power module, with the block diagram schematic shown in figure 3, is configured as a synchronous buck topology that is fitted with two EPC2045 eGaN FETs. The EPC9205 power module, shown in figure 2, also features the new uP1966A half-bridge gate driver IC from uPI Semiconductor Corp., input and output filters, as well as current and temperature sensing. The high frequency capability of eGaN FETs greatly reduces the filtering requirements, allowing for an optimized output filter inductor with much smaller size and lower loss.

EPC9205 experimental performance validation

When stepping down 48 V to 12 V at 700 kHz, the EPC9205 achieves a peak efficiency of 96% at 10 A load, with a maximum FET temperature of 100ºC under 400 LFM airflow. Figure 4 shows the power efficiency curve for 12 V load up to 15 A output current.
The same EPC9205 is also capable of producing output voltages as low as 5 V. Figure 5 shows the efficiency as function of load current at 5 - 12 V output when operating at 500 kHz.

**Conclusions**

Migrating an intermediate 48 V to 5 - 12 V bus converter design from Silicon MOSFETs to eGaN FETs offers reduction in both size and cost, while maintaining or exceeding efficiency targets. Table 1 shows the bill of materials of an eGaN based 48 V to 12 V buck converter that yields a cost per watt of less than $0.05. This same bill of materials can be used for output voltages as low as 5 V.

Suitable controllers for the EPC9205 include the TPS53632G from Texas Instruments and when the EPC9205 is configured in a multi-phase system for higher output current capability, as demonstrated in the EPC9130, one can use the dsPIC33EP128GS704 from Microchip.

The eGaN FET based 48 V to 5 - 12 V, 10 A load converter was demonstrated to yield 5-12 V output with a peak efficiency of 96%, a power density of 1400 W/in$^3$, and a cost that can go below $0.05 per watt when operated with 12 V output.