Building a Low Cost, High Efficiency 12 V to 1 V POL Converter Using EPC2111

Motivation

The smallest, most cost effective and highest efficiency non-isolated 12 V to 1.0 V POL converter, suitable for high-performance computing, cryptocurrency and telecommunication applications, can be achieved by employing monolithic eGaN® IC half-bridges such as the EPC2111. The EPC9204 configured as a synchronous Buck converter yielded a power density of 1000 W/in^3 and is capable of delivering 12 A.

Introducing the EPC2111 eGaN monolithic half-bridge

The **EPC2111**, shown in figure 1, is a Generation 4 eGaN IC asymmetrical half-bridge rated at 30 V with an on-resistance of 19 mΩ for the upper FET Q1 and 8 mΩ for the lower FET Q2 where each FET is capable of carrying a continuous current of 16 A. The EPC2111 is nearly one seventh the footprint area of comparable Si MOSFETs and was chosen because it can switch much faster and has lower parasitic capacitances than equivalent silicon devices, yielding the lowest switching loss operation even at very high switching frequency (10 MHz), and is ideal for POL applications.

EPC9204 power module

The **EPC9204** power module, with the block diagram schematic shown in figure 2, is configured as a synchronous Buck topology that is fitted with the EPC2111 eGaN monolithic half-bridge. The EPC9204 power module, shown in figure 3, also features the new PE29102 half-bridge gate driver IC from pSemi Corp., input and output filters, as well as current and temperature sensing. What's more, the tallest component on the EPC9204 board is a mere 1.2 mm. 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.

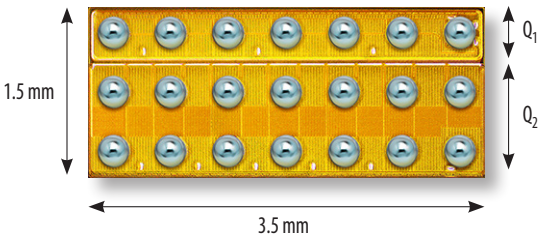


Figure 1: EPC2111 30 V monolithic half-bridge with on-resistance 19 mΩ (Q_1) and 8 mΩ (Q_2)

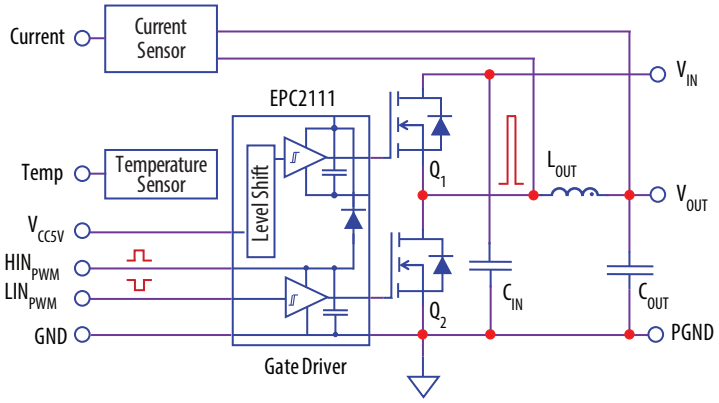
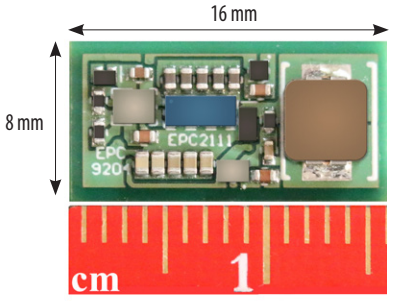


Figure 2: Block diagram schematic of the EPC9204 development board, fitted with EPC2111, is ideal for 12 V to 1 V POL conversion



Max. component height = 1.2 mm

Figure 3: EPC9204 development board boasts a power density of > 1000 W/in^3 based on component height only and when operating at 12 V input, 1 V output at 12 A load

Examples of other half bridge eGaN IC configurations, voltages and $R_{DS(on)}$ ranges are shown in figure 4.

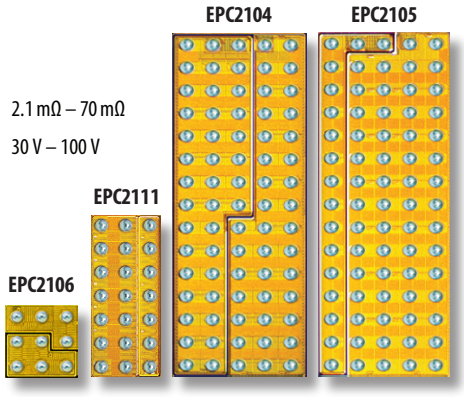


Figure 4: Examples of various half bridge eGaN ICs with voltage and $R_{DS(on)}$ ranges

EPC9204 experimental performance validation

The EPC9204 achieves a peak efficiency of 78% at 5 A load and 5 MHz, with a maximum FET temperature of 100°C under 400 LFM airflow. Figure 4 shows a plot of the load current range efficiency up to 12 A load when operating at 3, 5 and 10 MHz respectively.

Conclusions

Migrating a high frequency 12 V to 1 V POL converter design from Silicon MOSFETs to eGaN FETs is an obvious choice due to higher efficiency, and also offers reduction in both size and cost. Table 1 shows the bill of materials that yields a cost per watt of less than $0.20.

The eGaN FET based 12 V to 1 V, 12 A load converter was demonstrated to yield a peak efficiency of 78% at 5 MHz with a power density of at least 1000 W/in^3, all with a cost below $0.20 per watt.

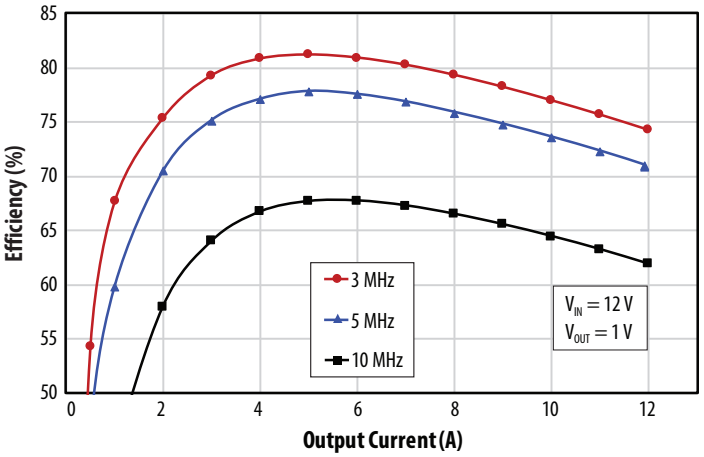
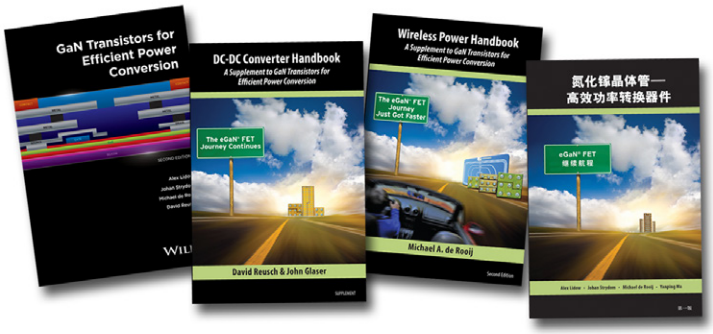


Figure 5: EPC9204 efficiency vs. output current for 12 V_{IN} to 1 V_{OUT} using EPC2111 eGaN IC Monolithic Half-Bridge

Learn More about GaN



12 V - 1.0 V 12 A Buck Converter		
Component	**Qty**	**GaN-based design**
eGaN® IC	1	EPC2111
Inductor (100 nH)	1	IHLP1616ABERR10M01
Input Capacitors (2.2 µF 25 V)	5	C1005X5R1E225M050BC
Output Capacitors (2.2 µF 6.3 V)	5	CL05A226MQ5QUNC
Gate Driver	1	PE29102
Total		**Less than $0.20 per Watt**

Table 1: Bill of Materials for monolithic eGaN half-bridge 12 V to 1 V converter based on 500 k unit pricing