Achieving Best-in-class 48 V to 12 V, 60 A DC-DC Converter Performance with the EPC9130 Multiphase Buck

EFFICIENT POWER CONVERSION

Motivation

Single-phase buck converter can work efficiently at output currents up to 25 A, but the power efficiency drops significantly at higher currents. A compact, cost effective, high-power and high-efficiency 48 V to 12 V buck converter, suitable for high-power computing and telecommunication applications, can be achieved by employing eGaN® FETs such as EPC2045 in a multiphase topology. The EPC9130 configured as a non-isolated, fully regulated five-phase synchronous buck converter yielded a power density of approximately 1000 W/in^3 and a peak efficiency of 96.2%, and is capable of delivering up to 60 A (720 W) output.

EPC9130 five-phase 48 V to 12 V regulated intermediate bus converter

The EPC9130 development board is a 500 kHz switching frequency, 48 V nominal input voltage, 60 A maximum output current, 5-phase intermediate bus converter (IBC) with on-board microcontroller and gate drives, featuring the 100 V EPC2045 enhancement mode (eGaN®) field effect transistor (FET). The purpose of this development board is to provide a regulated 12 V power supply for high-power and high-performance applications showcasing the superior performance of the EPC2045 eGaN® FET. The block diagram is shown in figure 1.

The EPC9130 development board has five phases of two EPC2045 eGaN FETs in a half bridge configuration with a uPI Semiconductor UP1966A gate driver and supply and bypass capacitors. One single-phase power stage is shown in figure 2. The PWM signals to the gate drivers are fed by an on-board dsPIC33 microcontroller from Microchip®. The output voltage is regulated to 12 V. Basic voltage mode control of output is done with the microcontroller. Current sharing among the phases, under-voltage lockout as well as overcurrent, over-voltage, and over-temperature protection are available. To allow more flexible operation for this evaluation board, only current sharing and under-voltage lockout are implemented for this EPC9130 demo board.

EPC9130 experimental performance validation

The loss breakdown of the EPC9130 operating at 50 A output current is illustrated in figure 3 (left). The maximum FET temperature, as shown in figure 3 (right), is 86.1ºC under 400 LFM airflow at 50 A. Figure 4 shows the efficiency curve against up to 60 A load when operating at 500 kHz, with a peak efficiency of 96.2% at 40 A load.

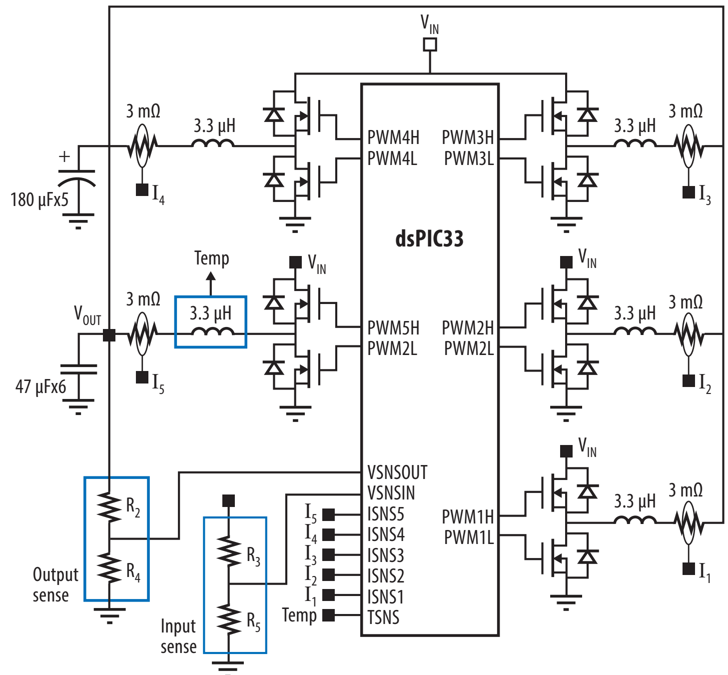


Figure 1: Block diagram of EPC9130 development board

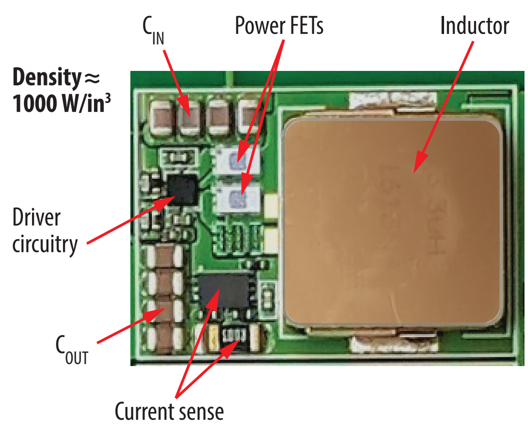


Figure 2: Single-phase power stage

Conclusions

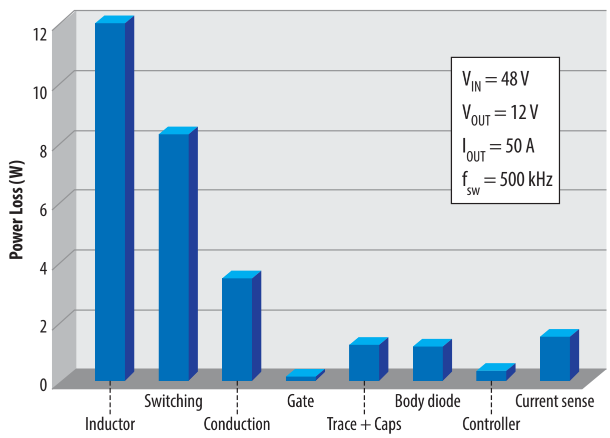
Migrating a high-power 48 V to 12 V intermediate bus converter design from Silicon MOSFETs to eGaN FETs offers reduction in both size and cost, while maintaining or exceeding efficiency targets. Table 1 shows the bill of materials that yields a cost per watt of less than $0.04.

Suitable controllers for the EPC9130 include microcontrollers such as the dsPIC33EP128GS704 from Microchip, which can generate five complementary pairs of PWM signals.

The eGaN FET based 48 V to 12 V, 60 A load converter was demonstrated to yield a peak efficiency 96.2% with a power density of 1000 W/in^3, all with a cost below $0.04 per watt. This same bill of materials can be used for output voltages as low as 5 V.

48 V - 12 V 60 A 5-phase Buck Converter		
Component	**Qty**	**eGaN® FET**
eGaN® FET	10	EPC2045
Inductor (3.3 µH)	5	IHLP5050EZER3R3M01
Input Capacitors (1 µF 100 V)	20	C2012X7S2A105M125AB
Output Capacitors (22 µF 25 V)	20	C2012X5R1E226M125AC
Bulk Capacitors (180 µF 16 V)	3	16SVPF180M
Gate Driver	5	uP1966A
Controller	1	DSPIC33EP128GS704-E/ML
Total		**Less than $0.04 per Watt**

Table 1: Bill of Materials for each phase of an eGaN FET based 48 V to 12 V five-phase



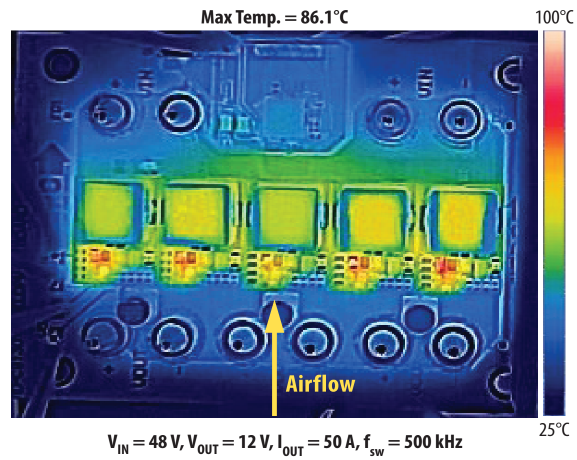


Figure 3 : Loss breakdown and thermal performance of EPC9130 at 50 A output current

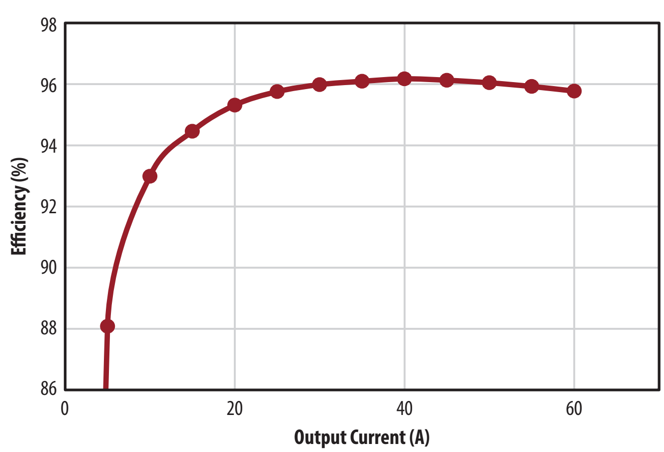


Figure 4: EPC9130 efficiency curve

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