Application Brief

Higher Power Density With 35A TPSM846C26 Power Module Compared to 35A TPS546C25 DC/DC Converter and Inductor

Introduction

Power modules with an integrated inductor offer a reduced board space advantage and a simpler design procedure compared to a discrete converter using an external inductor. This report compares a design with a power module and a converter with similar operating conditions highlighting the board space savings while contrasting significant differences.

Power Module

The TPSM846C26 is a 4V to 18V input, 35A power module in an 8.75mm × 7.5mm BGA package with an integrated inductor mounted on top of an encapsulated assembly. The inductor is attached to the encapsulated assembly by two top-side exposed pads. The encapsulated assembly contains other internal passive components mounted on a multi-layered lead-frame with flip-chip controller die and power-stage die. The three-dimensional construction of the module saves significant board space area. The controller inside the 35A TPSM846C26 is the same as the 35A TPS546C25 converter, so both designs offer the same functionality.

DC/DC Converter

The TPS546C25 is a 4V to 18V input, 35A converter in a 4mm × 5mm QFN package. For the comparison, the same inductor used by the power module is used with the design of the converter: the 120nH 0624CDMCCDS-R12MC inductor from Sumida. Both designs regulate a 1.2V output from a 12V input and switch at 800kHz with the same operating conditions and the same input and output capacitance.

Device	TPSM846C26	TPS546C25
Output current rating	35A	35A
Type	Power module (with inductor)	Converter (with FETs)
Input voltage	12V	12V
Output current	30A	30A
Output voltage	1.2V	1.2V
Switching frequency	800kHz	800kHz
Total board area	543mm^2	609mm^2
Maximum height	3.95mm	2.4mm
External components	19	25
Efficiency at 30A	87%	89%
Junction temperature	125℃	89.5℃

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Space Savings

The power module provides 12% savings in board space area, or 66mm^2. Space-savings is mainly attributed to the module's 3-D construction with the inductor on top. Additional passive components are integrated into the encapsulated assembly providing additional space savings. The module is designed to fit under a 4mm height restriction, allowing the converter design to fit in lower height restricted applications. WEBENCH® circuit designer was used to calculate the total board area using the same technique for both designs.

External Components

The power module design is obviously easier to design than the converter design. The integrated magnetics simplify the layout. Integrated passive components both simplify the design and improve the power module's performance, allowing the placement of each converter to be closer to the IC than possible with a converter's layout. The power module integrates high frequency input and output capacitors, a bootstrap capacitor, a resistor, and V_{CC}/D_{VDD} capacitors.

Efficiency

The efficiency measurement for each design was taken at 30A with a 5V external bias voltage applied and the same circuit board stack. The power module operates at a higher junction temperature than the converter due to the proximity of the inductor. MOSFET on resistance increases as the silicon junction temperature increases. The converter offers a more efficient design at the expense of added circuit board space, which is a typical trade-off in power management design.

Conclusion

When a smaller and easier-to-design point-of-load design is necessary, a power module is a practical design. When designing with power modules, consider de-rating the power module's output current to accommodate for increased thermal temperature.

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