DESIGN NOTES

Efficient, Compact 2-Phase Power Supply Delivers 40A to Intel Mobile CPUs – Design Note 284

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Introduction

Notebook computers demand more power than ever before, and in turn, CPU supply current requirements have grown significantly to the point where the latest Intel mobile CPUs call for up to 40A. Such high currents reveal many design problems that are relatively insignificant at lower current levels. Today's notebook power supply designer must successfully manage the inevitable resulting power losses and thermal stresses within the already tight notebook space and still maintain high efficiencies. The LTC®3716 2-phase controller addresses these design issues by providing the following significant features in a compact package:

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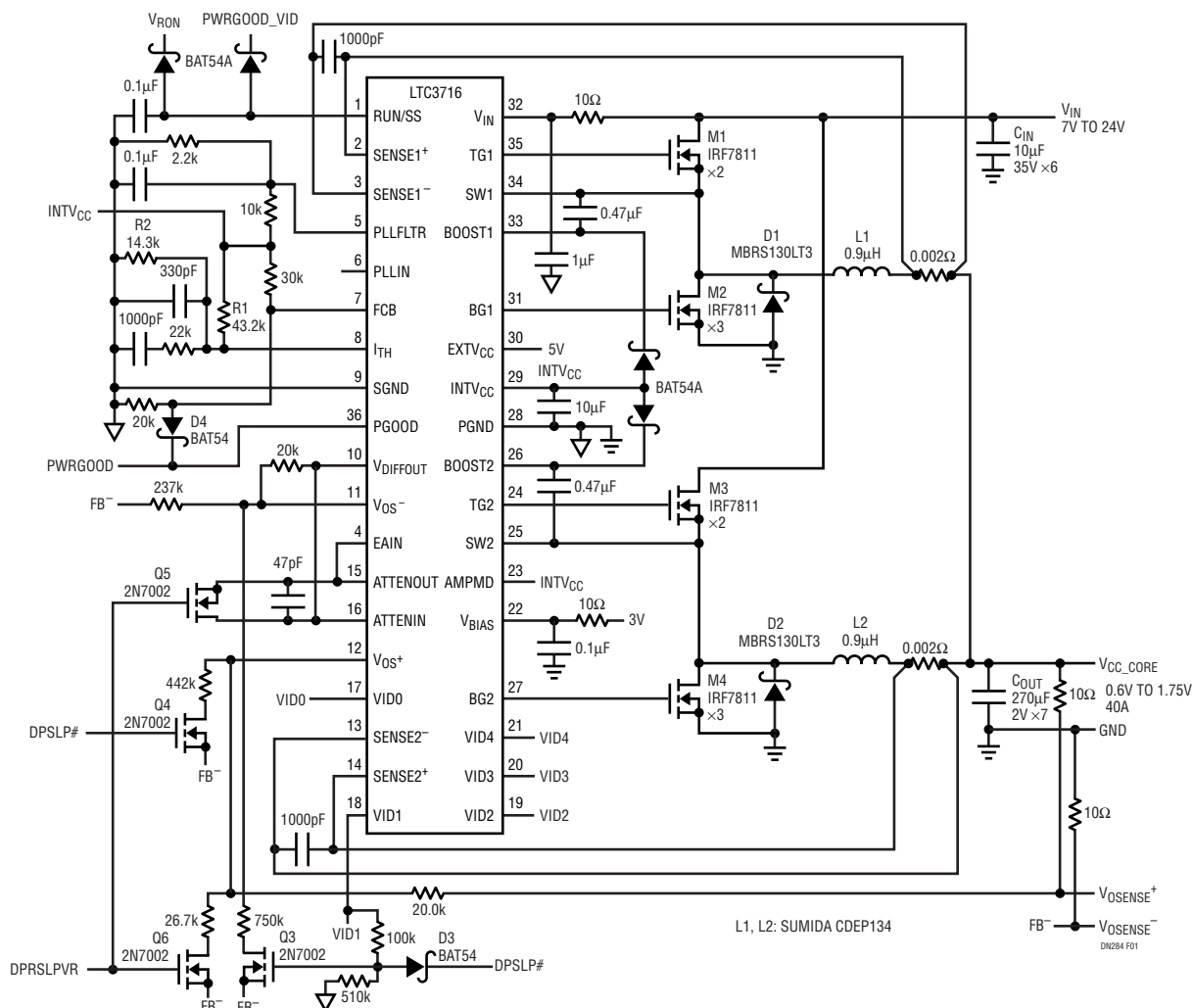

Figure 1. 40A IMVP-III VR Power Supply Design for Intel Mobile Tualatin and Northwood Processors

- Load current is distributed uniformly between two phases, reducing thermal stress on the PCB.

- Out-of-phase operation reduces both input and output capacitance requirements and improves overall efficiency.

- Integrated MOSFET gate drivers provide further space savings by precluding the need for separate driver ICs.

The VID table of the LTC3716 is compatible with the newest Intel IMVP specifications for Mobile Tualatin and Mobile Northwood processors.

Smaller Inductors, Simplified Thermal Management

The single phase, synchronous step-down regulator is the most common solution for low current CPU supplies. Nevertheless, when CPU current exceeds 20A, this simple topology is no longer suitable—the inductor is too large, power loss becomes excessive and the total solution cost becomes prohibitive.

A solution based on the LTC3716, on the other hand, allows for smaller footprint and lower profile inductors. Its high current gate drivers, each capable of driving up to three SO-8 MOSFETs, eliminate the need for separate driver ICs. With two phases sharing load current, the LTC3716 alleviates the current crowding problem that would occur in the single-phase solution. Heat is more uniformly distributed, simplifying thermal management. The out-of-phase operation of the LTC3716 decreases both input and output ripple currents, further improving efficiency.
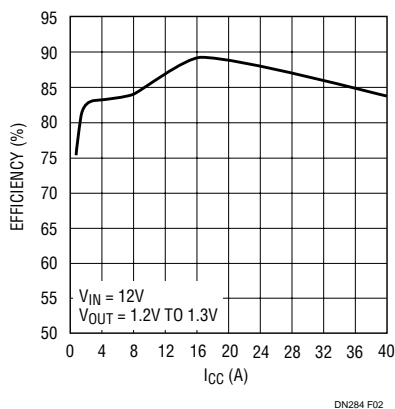
Also, the transient performance of a 2-phase solution is superior to its single-phase counterpart without sacrificing efficiency, due to two effects: the effective operating frequency is twice that of either phase and the equivalent inductance is half of either inductor.

Overall, 2-phase operation produces high current power supplies that are smaller, lower cost, more efficient and more reliable than single phase designs.

40A Intel IMVP-III Voltage Regulator

Figure 1 shows a 40A Intel IMVP-III voltage regulator design using the LTC3716. Q3, Q4 and Q6 provide the output offsets for battery mode, deep sleep mode and deeper sleep mode, respectively. D4 speeds up the high to low load transients while allowing Burst Mode® operation, which maintains high efficiency at light loads. The resistor divider (R1/R2) implements the Intel Mobile Voltage Positioning (IMVP) requirement without additional power loss. Overall efficiency and transient waveforms are plotted in Figure 2 and 3, respectively. After 20 minutes of continuous full-load operation in an open air, 25°C ambient environment with no ventilation, both inductors measure 70°C and the MOSFETs measure 65°C.

Conclusion

The latest Intel Mobile CPUs call for a supply current up to 40A. As an optimal combination of performance, cost and reliability, the LTC3716 2-phase solution delivers high current with high efficiency in a compact size. Other features of the LTC3716 include true current mode control, accurate current sharing, ±1% reference precision, adjustable soft-start, a wide (4V to 36V) input range and multiple circuit protection features. For more information, please refer to the LTC3716 data sheet.
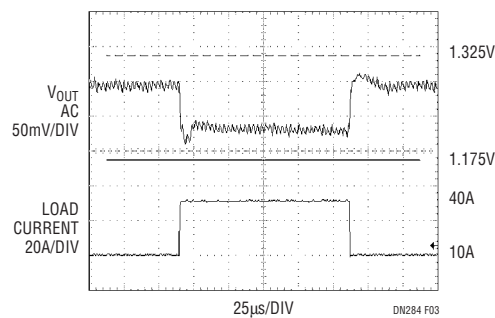

Figure 2. The Circuit in Figure 1 Maintains High Efficiency Over a Wide Range of Load Currents

Figure 3. With Seven SP Output Capacitors, the Output Excursion is Within the Specification Limits with Plenty of Margin

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