

DESIGN NOTES

High Efficiency, High Density Power Supply Delivers 200A Without Heat Sinks – Design Note 1001

Henry J. Zhang and Wei Chen

Introduction

High speed, high capacity data processing systems are increasingly hungry for power even as power supply voltages drop. The result is unprecedented high current demands, increasing the challenges facing power supply designers. Power supplies for high end server CPUs must be capable of supplying more than 100A, they must respond quickly to fast load transients and they must fit the same or smaller form factor as previous generation power supplies.

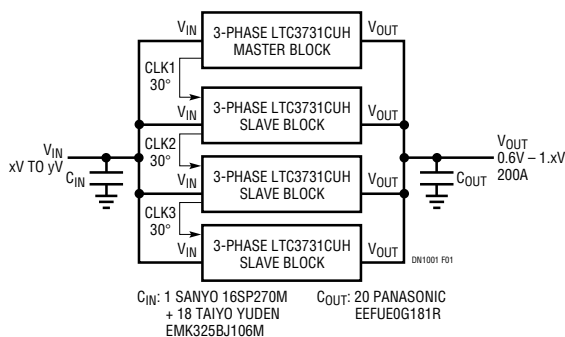


Figure 1. Block Diagram of the 12-Phase LTC3731 Synchronous Buck Converter

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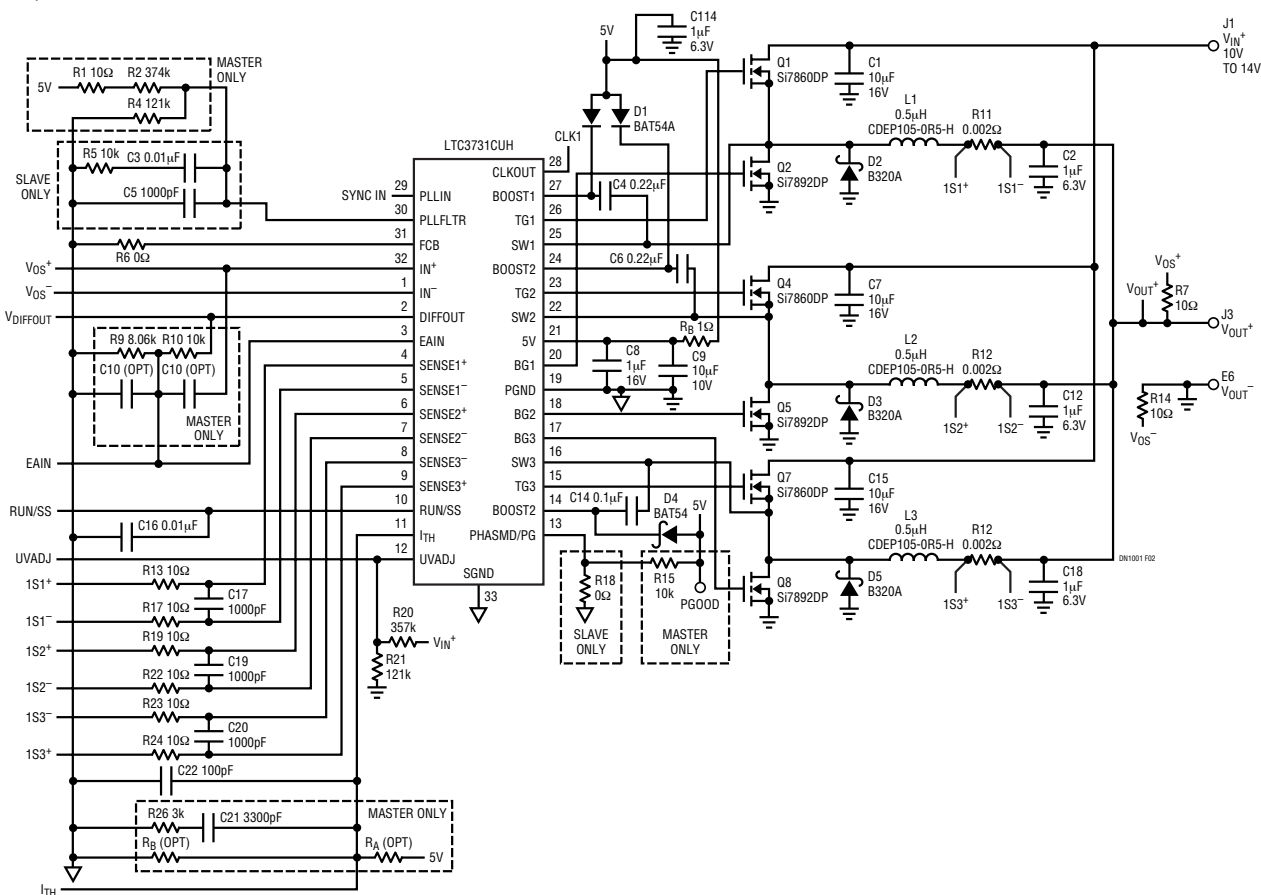


Figure 2. Schematic of the One 3-Phase LTC3731 Block

The LTC[®]3731 3-phase controller helps meet all of these demands. It is a PolyPhase[®], current mode controller that drives three synchronous buck converters 120° out of phase at frequencies up to 600kHz per phase. The clock output and synchronization circuits make it possible to design 6- or 12-phase buck supplies for very high current applications. This PolyPhase technique effectively minimizes the number of input and output capacitors and improves the load transient response. With the LTC3731's accurate current sensing, the supply thermal stress is evenly distributed across all phases. Accurate current matching also optimizes the size of both output inductors and MOSFETs. The LTC3731CUH comes in a low profile 5mm × 5mm QFN package with an exposed ground pad to minimize the thermal impedance.

Other LTC3731 features include true remote sensing of the output voltage, adjustable soft start, a wide (4V to 32V) input voltage range, circuit protection features and two selectable light load operation modes—Stage Shedding[™] mode and Burst Mode[®] operation to improve light load efficiency.

12-Phase, 1.5V/200A Supply

Figure 1 shows the block diagram of the 12-Phase, 200A output supply using four LTC3731 controllers. Figure 2 shows the schematic for a single LTC3731-based 3-phase circuit block. Each phase uses two SO-8 size MOSFETs to provide up to 17A of output current. The total footprint of the power supply fits within a 6.5" × 1.65" area as shown in Figure 3. The circuit is also low profile—topping out at 5mm including the inductors. The efficiency of this supply is better than 82% with a 12V input and a 1.5V/200A output at a 450kHz phase switching frequency. Figure 4 shows supply efficiency over a wide load range, from 20A to 200A.

Figure 5 shows a measured load transient waveform. The load current step is 90A with a slew rate of 150A/μs.

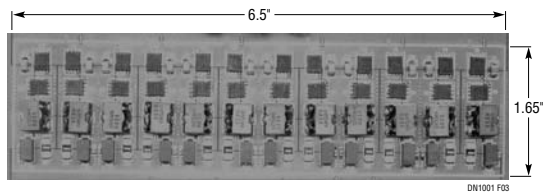


Figure 3. 12-Phase Supply Power Components Layout and Footprint

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Output capacitor requirements are dominated by the total ESR of the output capacitor network. With twenty low profile Panasonic S.P. capacitors (180μF/4V) on the output, the maximum output voltage variation during load transients is within the ±65mV_{P-P} window. In Figure 2, optional resistors R_A and R_B can be used to achieve active voltage positioning (active droop) to further improve the load transient response or reduce the number of output capacitors. Please refer to Linear Technology Corporation Design Note 10 for more details on active voltage positioning.

Conclusion

The LTC3731 can be used to create 3-, 6- or 12-phase power supplies that provide high current, high density solutions with good efficiency and rapid transient response. With state-of-the-art MOSFETs and inductors, the LTC3731-based 12-phase supply can deliver 250A.

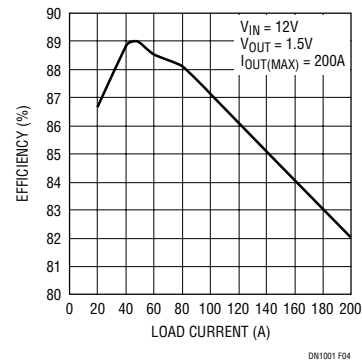


Figure 4. Measured Supply Efficiency vs Output Current

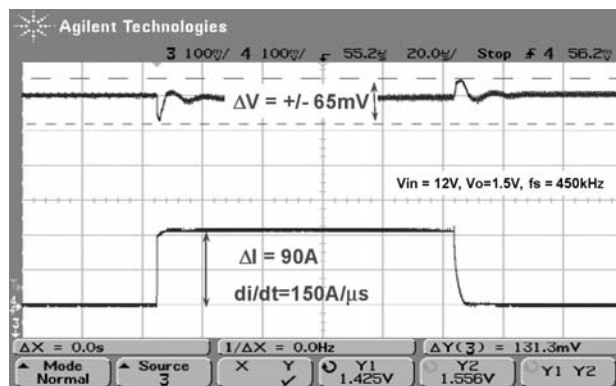


Figure 5. Measured Load Transient Response of the 12-Phase LTC3731 Supply

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