LINEAR TECHNOLOGY

DESIGN NOTES

Cascadable 7A Point-of-Load Monolithic Buck Converter

Design Note 387

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Introduction

Easy-to-use and compact point-of-load power supplies are necessary in systems with widely distributed, high current, low voltage loads. The LTC®3415 provides a compact, simple and versatile solution. It includes a pair of integrated complementary power MOSFETs (32mΩ top and 25mΩ bottom) and requires no external sense resistor. A complete design requires an inductor and input/output capacitors, and that's it. The result is a fast, constant frequency, 7A current mode DC/DC switching regulator.

Features

The overall solution is extremely compact since the LTC3415's 5mm × 7mm QFN package footprint is small and its high operating frequency of 1.5MHz allows the use of small low-profile surface mount inductors and ceramic capacitors. For loads higher than 7A, multiple LTC3415s can be cascaded to share the load while running mutually anti-phase, which reduces overall ripple at both the input and the output.

Other features include:

- Spread spectrum operation to reduce system noise
- Output tracking for controlled V_{OUT} ramp-up and ramp-down
- Output margining for easy system stress testing
- Burst Mode® operation to lower quiescent current and boost efficiency during light loads
- Low shutdown current of less than 1µA
- 100% duty-cycle for low drop out operation
- Phase-lock-loop to allow frequency synchronization of ±50% of nominal frequency
- Internal or external I_{TH} compensation for ease of use or loop optimization, respectively

Operation

The LTC3415 offers several operating modes to optimize efficiency and noise reduction: Burst Mode operation, pulse-skipping mode or forced continuous mode. The mode is set by tying the Mode pin to SV_{IN}, $SV_{IN}/2$ or SGND, respectively. Burst Mode operation offers high efficiency at light load by shutting off the internal power MOSFETs as well as most of the internal circuitry between pulses. Forced continuous mode maintains a constant switching frequency throughout the entire load range, making it easier to filter switching noise for sensitive applications. Pulse-skipping mode allows constant frequency operation until the inductor current reaches zero, at which point it goes into discontinuous operation and finally it will skip cycles. Pulse-skipping mode offers low output voltage ripple while offering efficiency levels between Burst Mode operation and forced continuous mode.

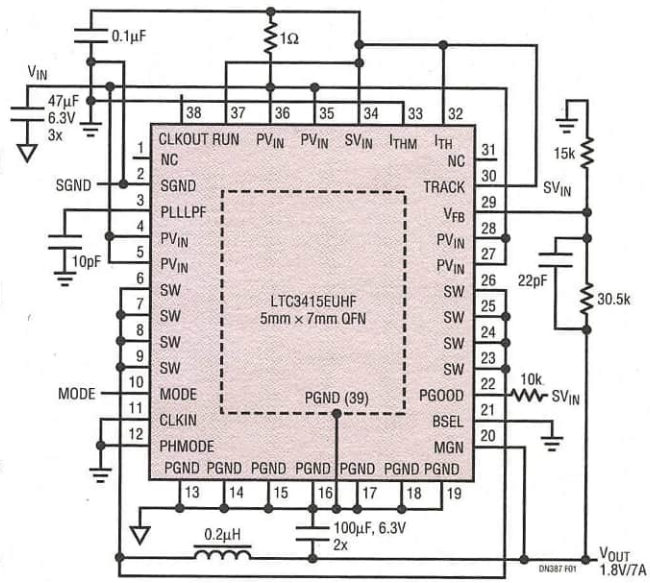

Figure 1. 3.3V to 1.8V/7A Application

Figure 1 shows an application of the LTC3415 in a 3.3V to 1.8V/7A step-down converter configuration. Figure 2 shows its efficiency and power loss vs load current in Burst Mode operation. Efficiency reaches as high as 92%. Figure 3 shows its fast transient response to a 5A load step. As shown, V_{OUT} recovers in 10µs with a dip of less than 100mV. Frequency can be changed easily from its nominal 1.5MHz to 1MHz or 2MHz by simply strapping the PLLLPF pin to SGND or SV_{IN}, respectively. Or if a particular frequency is desired, an external clock can be used to synchronize the operating frequency from 750KHz to 2.25MHz with the internal phase-lock-loop. Spread spectrum operation is available for EMI-sensitive applications by tying the CLKIN pin to SV_{IN}.

For applications that require controlled output voltage tracking between various outputs in order to prevent excessive current draw or even latch-up during turn-on and turn-off, the LTC3415 has a Track pin that allows the user to program how its output voltage ramps during start-up and shutdown. Figure 4 shows the output waveforms of two LTC3415s in track mode.

Greater than 7A Outputs

By stacking multiple LTC3415s together, more output power is attained without increasing the number of input and output capacitors. Operating multiple LTC3415s out of phase not only allows accurate current sharing, but it also reduces the overall voltage ripple at both the input and the output, thus allowing fewer capacitors. Figure 5 shows an efficiency curve of the LTC3415 in 1-phase, 2-phase, 3-phase, 4-phase and 6-phase operation.

Conclusion

With its many operational features and compact total solution size, the LTC3415 is an ideal fit for today's point-of-load power supplies. It allows for accurate, compact, efficient and scalable power supplies with advanced features, including tracking and margining.

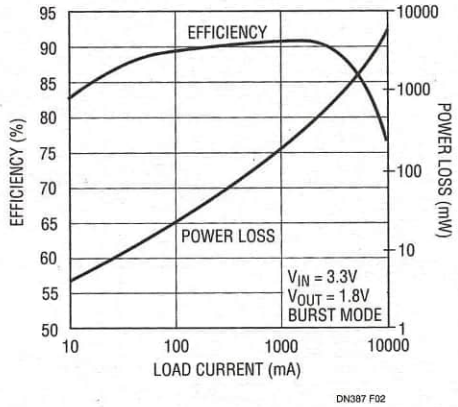

Figure 2. Efficiency and Power Loss of 3.3V to 1.8V/7A Application in Figure 1

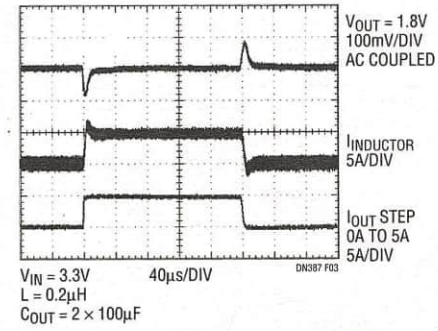

Figure 3. V_{OUT} Transient Response to a 0A to 5A Load Step of the Circuit Shown in Figure 1

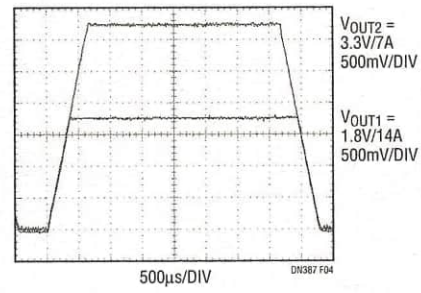

Figure 4. Output Tracking of Two LTC3415s

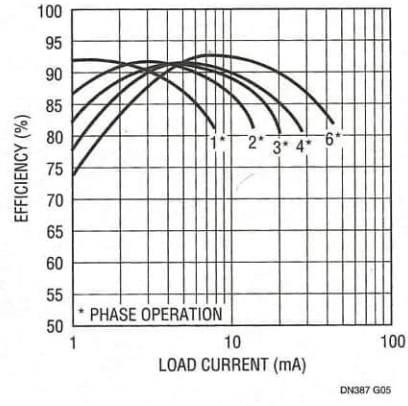

Figure 5. Efficiency vs Load Current of LTC3415s in Multiphase Operation

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