

DESIGN NOTES

Multiphase DC/DC Controller Pushes Accuracy and Bandwidth Limits

Design Note 434

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Introduction

Speed and accuracy don't always go hand-in-hand in DC/DC converter systems—that is, until now. The LTC3811 is a dual output, fixed frequency current mode DC/DC switching regulator controller designed for one of today's most demanding power supply applications: high current, low voltage processor core supplies.

With supply current requirements in excess of 100A and supply voltages as low as 1V, every milliohm of PCB resistance and every millivolt of IR drop count. The LTC3811 has an output voltage tolerance of $\pm 0.5\%$ over temperature, giving power supply designers unprecedented flexibility when making component value and board layout choices.

In addition to high accuracy, the LTC3811's low minimum on-time (typically 65ns) allows users to convert a 12V input to a 1V output at switching frequencies up to 750kHz, optimizing load transient response and reducing the solution size.

A Dual Output, 2-Phase Supply with Differential Remote Sensing and Inductor DCR Sensing

Figure 1 illustrates a dual output supply using the LTC3811. The 1.5V, 15A output is regulated using the integrated differential remote sense amplifier and tracks the output of channel 1 during start-up. Both outputs use DCR sensing in order to maximize efficiency and operate 180° out of

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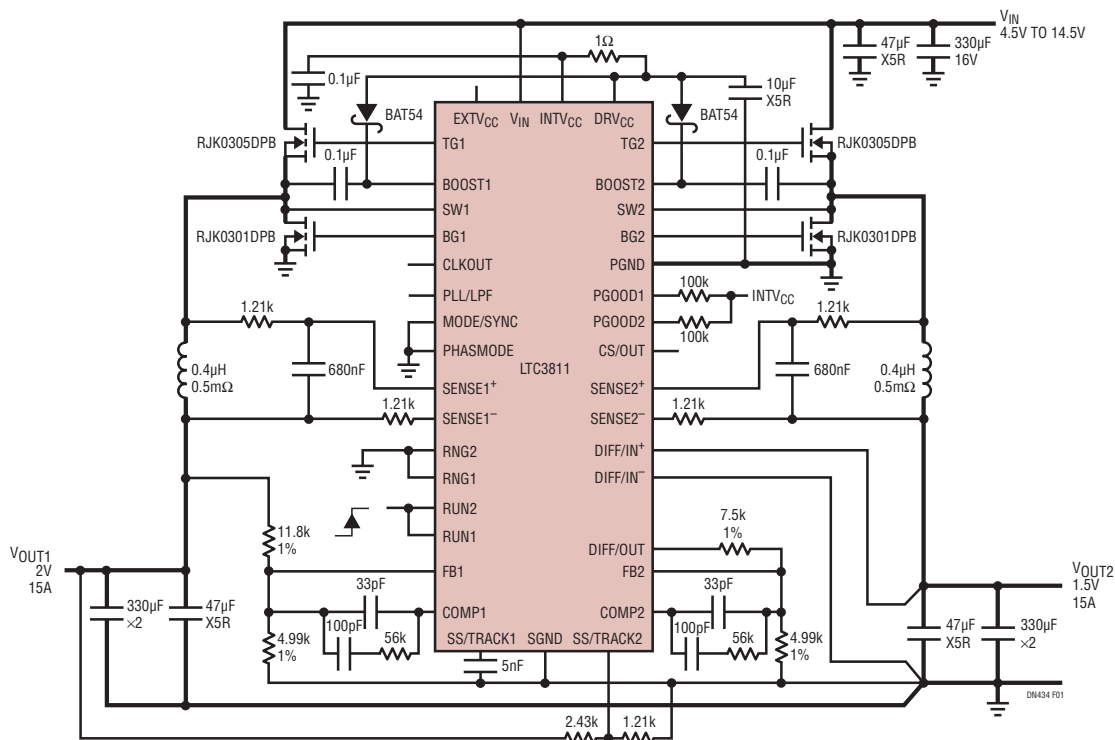


Figure 1. Dual Output, 2-Phase Supply with Differential Remote Sensing and Inductor DCR Sensing

phase in order to reduce the size of the input capacitor. Figure 2 illustrates the load step response for channel 2. Figure 3 illustrates low duty cycle waveforms for a 20V input, 1.2V output application.

For noise-sensitive applications, where the switching frequency needs to be synchronized to an external clock, the LTC3811 contains a PLL with an input range of 150kHz to 900kHz. In addition, the MODE/SYNC, PHASEMODE and CLKOUT pins allow multiple LTC3811s to be daisy-chained in order to produce a single high current output. The LTC3811 can be configured for 2-, 3-, 4-, 6- or 12-phase operation, extending the load current range to beyond 200A.

A Tried-and-True Architecture

The fixed frequency, peak current mode control architecture was chosen for its excellent channel-to-channel current matching and its robust cycle-by-cycle current limit. Current sensing can be done using either a resistor in series with the inductor or by sensing the DCR of the inductor with an RC filter. This gives the user a choice between optimum control of the maximum inductor current and maximum efficiency.

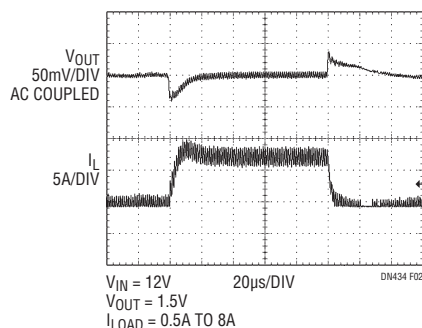


Figure 2. Load Step Response

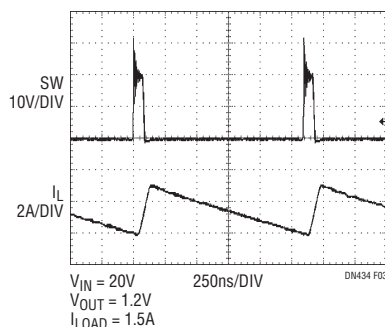


Figure 3. LTC3811 Low Duty Cycle Waveforms

In order to accommodate the use of low DCR inductors and still maintain good control over the maximum output current, the current sense voltage for each channel is programmable from 24mV to 85mV using the RNG pins.

The LTC3811 has a 4.5V to 30V input voltage range and is available in two package options: a 38-pin 5mm × 7mm QFN and a 36-pin SSOP.

Load Step Improvement with Voltage Positioning

For single-output multiphase applications, the LTC3811 contains an amplifier for voltage positioning purposes. The current sense input voltages are converted to an output current by a multiple-input, single-output transconductance amplifier, so that an error voltage proportional to the load current can be introduced at the input of the differential amplifier. This transconductance amplifier allows the user to program an output load line, improving the DC and AC output accuracy in the presence of load steps. Figure 4 illustrates the load step response for a 2-phase, single output power supply using the LTC3811.

Conclusion

The LTC3811 is a versatile, high performance synchronous buck controller optimized for low voltage, high current supply applications. With an output accuracy of $\pm 0.5\%$ and a remote sensing differential amplifier, it represents a new benchmark for DC/DC converters. It can easily be configured for either single- or dual-output supplies, inductor DCR sensing or a sense resistor, and it takes advantage of Linear Technology's proprietary PolyPhase® current sharing architecture. The combination of a very low minimum on-time and a fixed frequency peak current mode control architecture no longer force the power supply designer to trade off performance for protection.

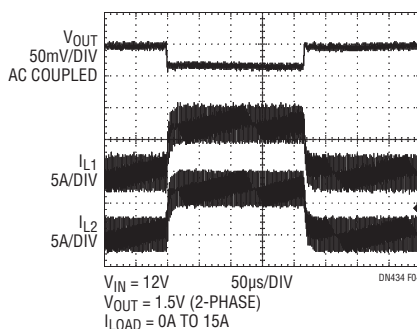


Figure 4. Load Step Response for a 2-Phase, Single Output Supply with Voltage Positioning (Forced Continuous)

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