LINEAR TECHNOLOGY

DESIGN NOTES

Dual Output Step-Down Controller Produces 10% Accurate, Efficient and Reliable High Current Rails – Design Note 478

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Introduction

The LTC®3855 makes it possible to generate high current rails with the accuracy and efficiency to satisfy the most demanding requirements of today's leading edge network, telecommunications and server applications. This 2-phase, dual output synchronous buck controller includes strong gate drivers that support operation with per-phase currents above 20A. The accurate 0.6V ±0.75% reference and its integrated differential amplifier (diff amp) allow remote sensing of the output of critical rails. This controller has an output voltage range from 0.6V to 12.5V when used without the diff amp and from 0.6V to 3.3V with the diff amp.

The LTC3855 uses the reliable peak current mode architecture to achieve a fast and accurate current limit and real time current sharing. Its current sense comparators are designed to sense the inductor current with either a sense resistor or with inductor DCR sensing. DCR sensing offers the advantage of reduced conducted power losses, since the current is measured using the voltage drop across the already-present inductor DC resistance—eliminating the losses incurred by adding a sense resistor. The trade-off is that DCR sensing is less accurate than a dedicated sense resistor because the DCR varies from part to part and over temperature. The LTC3855 uses an innovative scheme to improve the accuracy of DCR sensing by compensating for the DCR's variation with temperature.

1.5V/20A and 1.2V/20A Buck Converter with Remote Sensing and NTC Compensated DCR Sensing

Figure 1 shows a 1.5V/20A and 1.2V/20A dual phase converter with DCR sensing, operating at 325kHz. High efficiency is achieved with the strong gate drivers,

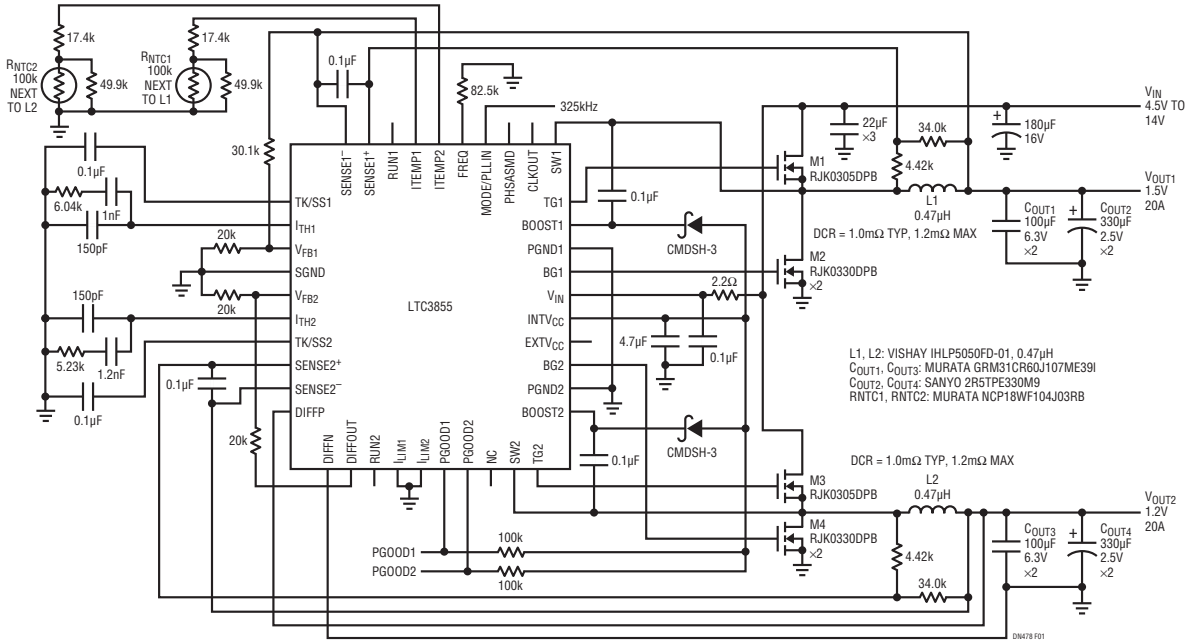

Figure 1. Dual 1.5V/20A and 1.2V/20A Converter Operating at f_{SW} = 325kHz. The Entire Circuit Fits within 1.7in² with Both Sides of the Board Populated

optimized dead-time and DCR sensing. The typical full load efficiency for the 1.5V and 1.2V rails is 89.5% and 87.8%, respectively (see Figure 2). The 1.2V output is remotely sensed with the diff amp. As a result, the 1.2V rail's output accuracy is unaffected by the voltage drops across the V_{OUT} and GND planes. The load step response for the 1.2V rail is shown in Figure 3.

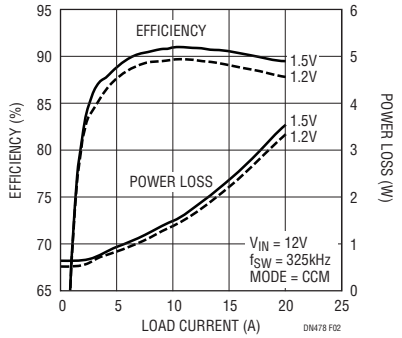

Figure 2. Efficiency and Power Loss of the 1.5V/20A and 1.2V/20A Converter

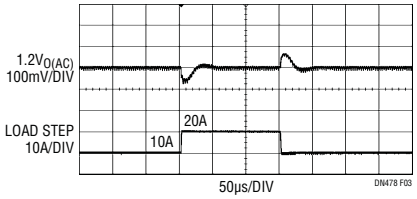

Figure 3. 50% to 100% Load Step Response for the 1.2V Rail at V_{IN} = 12V

The LTC3855 features precise current limit thresholds of 30mV, 50mV and 75mV, selected via the I_{LIM} pins. The current limit threshold can be raised by biasing the ITEMP pins below 500mV. Since the ITEMP pins source 10µA of current, the peak current sense voltage can be increased by inserting a resistance of less than 50k from the ITEMP pin to ground. By placing an inexpensive NTC thermistor next to the inductor and connecting this thermistor to a linearization network from the ITEMP pin to ground, the current limit temperature coefficient can be greatly reduced. As Figure 4 illustrates, the compensated current limit is 20% higher than the uncompensated current limit at 110°C. Another use for the ITEMP pins is to increase the current limit for conventional DCR sense and R_{SENSE} applications.

PolyPhase® Operation

The LTC3855 provides inherently fast cycle-by-cycle current sharing due to its peak current mode architecture,

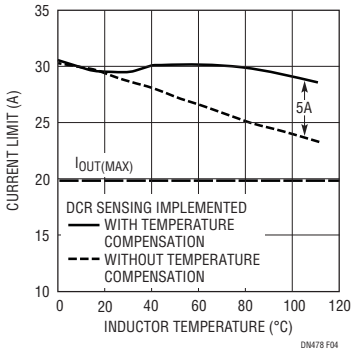

Figure 4. Measured Current Limit of the 1.2V Rail Over Temperature with and without Temperature Compensation

plus very tight DC current sharing for single output PolyPhase applications. Up to 12-phase operation can be achieved by daisy chaining the CLKOUT and MODE/PLLIN pins and by programming the phase separation with the PHASMD pins. A major advantage of PolyPhase operation is the reduction of the required input and output capacitance due to ripple current cancellation. Also, single output PolyPhase applications have a faster load step response due to a smaller clock delay.

Other Important Features

The switching frequency of the LTC3855 can be programmed between 250kHz and 770kHz with a resistor placed from the FREQ pin to ground or synchronized to an external clock in this frequency range using its internally compensated phase lock loop. High efficiency at light load is achieved by selecting either Burst Mode® operation or discontinuous mode operation, as opposed to continuous conduction mode. The LTC3855 can be used for inputs up to 38V, and its 100ns typical minimum on-time allows for high step-down ratios. The LTC3855 has a TK/SS pin for programmable soft-start or rail tracking, and dedicated RUN and PGOOD pins for each channel. The LTC3855 comes in either a 6mm × 6mm QFN or a thermally enhanced 38-lead TSSOP package.

Conclusion

The LTC3855 is a high performance dual output buck converter intended for low output voltage, high output current supplies. It provides the user with the benefits of a precise 0.6V 0.75% reference, an accurate current limit and high efficiency.

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