DESIGN NOTES

High Efficiency, High Density 3-Phase Supply Delivers 60A with Power Saving Stage Shedding, Active Voltage Positioning and Nonlinear Control for Superior Load Step Response

Design Note 489

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Introduction

The LTC®3829 is a feature-rich single output 3-phase synchronous buck controller that meets the power density demands of modern high speed, high capacity data processing systems, telecom systems, industrial equipment and DC power distribution systems. The LTC3829's features include:

- 4.5V to 38V input range and 0.6V to 5V output range
- 3-phase operation for low input current ripple and output voltage ripple with Stage Shedding™ mode to yield high light load efficiency
- On-chip drivers in a 38-pin 5mm × 7mm QFN (or 38-pin FE) package to satisfy demanding space requirements

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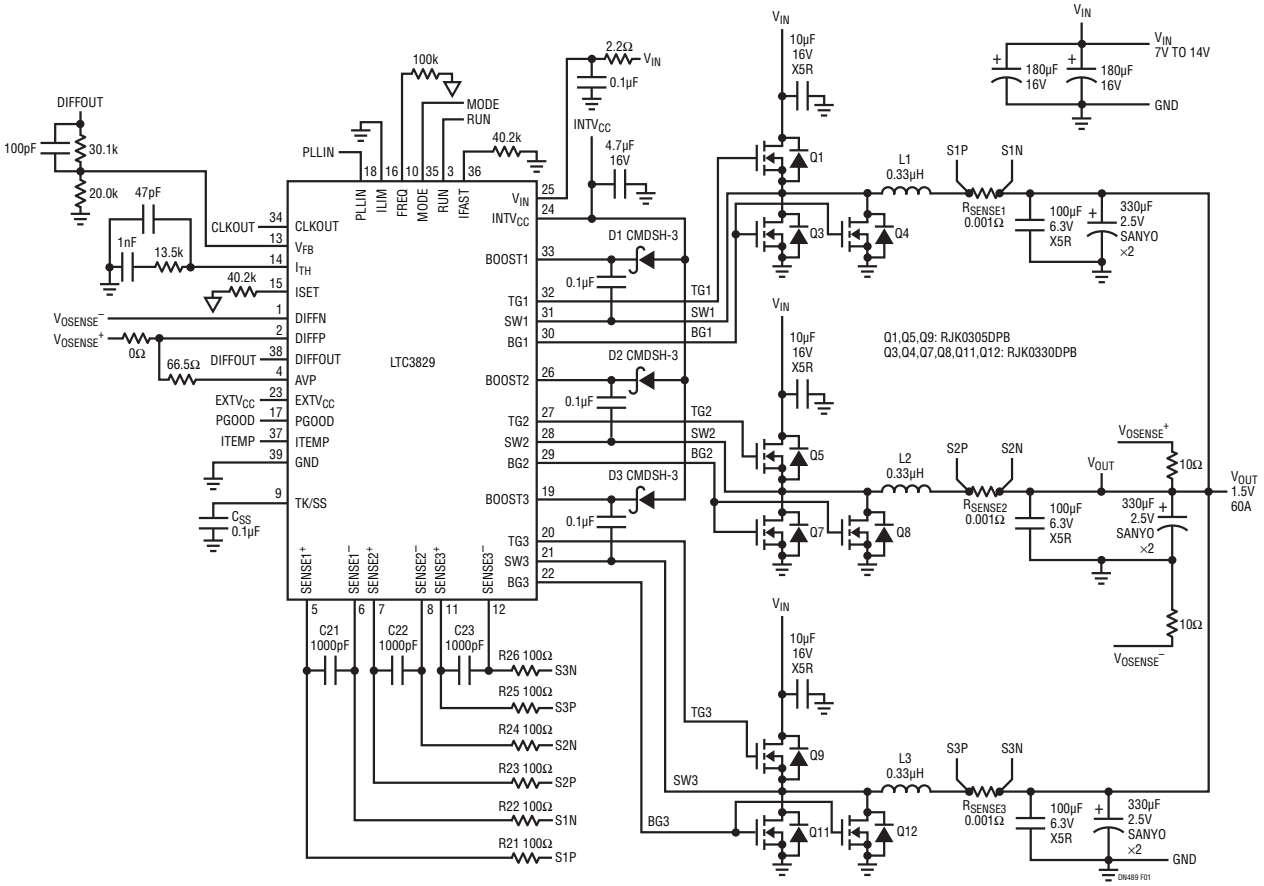

Figure 1. A 1.5V/60A 3-Phase Converter Featuring the LTC3829

- Remote output voltage sensing and inductor DCR temperature compensation for accurate regulation
- Active voltage positioning (AVP) and nonlinear control ensure impressive load transient performance

1.5V/60A, 3-Phase Power Supply

Figure 1 shows a 7V to 14V input, 1.5V/60A output application. The LTC3829's three channels run 120° out-of-phase, which reduces input RMS current ripple and output voltage ripple compared to single-channel solutions. Each phase uses one top MOSFET and two bottom MOSFETs to provide up to 20A of output current.

The LTC3829 includes unique features that maximize efficiency, including strong gate drivers, short dead times and a programmable Stage Shedding mode, where two of the three phases shut down at light load. Onset of Stage Shedding mode can be programmed from no load to 30% load. Figure 2 shows the efficiency of this regulator at over 86.5% with a 12V input and a 1.5V/60A output with Stage Shedding mode, dramatically increasing light load efficiency.

The current mode control architecture of the LTC3829 ensures that DC load current is evenly distributed among the three channels, as shown in Figure 3. Dynamic, cycle-by-cycle current sharing performance is similarly tight in the face of load transients.

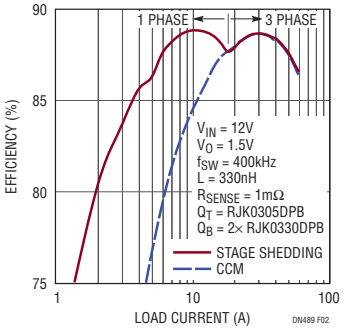

Figure 2. Efficiency Comparison of Stage Shedding vs CCM

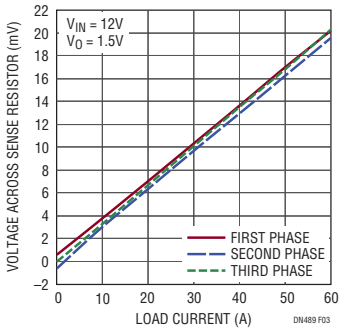

Figure 3. Current Sharing Performance Between Phases

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A fast and controlled transient response is another important requirement for modern power supplies. The LTC3829 includes two features that reduce the peak-to-peak output voltage excursion during a load step: programmable nonlinear control or programmable active voltage positioning (AVP). Figure 4 shows the transient response without these features enabled. Figure 5 shows that nonlinear control improves peak-to-peak response by 17%. Figure 6 shows that AVP can achieve a 50% reduction in the amplitude of voltage spikes.

Conclusion

The LTC3829's tiny 5mm × 7mm 38-pin QFN package belies its expansive feature set. It produces high efficiency with a combination of strong integrated drivers and Stage Shedding/Burst Mode® operation. It supports temperature compensated DCR sensing for high reliability. AVP and nonlinear control improve transient response with minimum output capacitance. Voltage tracking, multichip operation and external sync capability fill out its menu of features. The LTC3829 is ideal for high current applications such as telecom and datacom systems, industrial and computer systems.

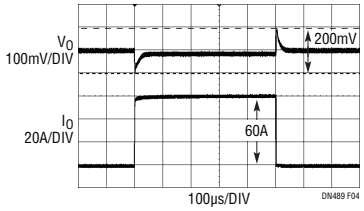

Figure 4. Transient Performance without AVP and Nonlinear Control

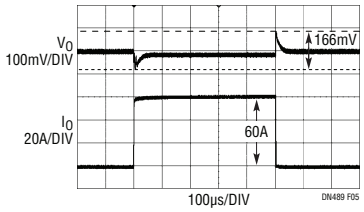

Figure 5. Transient Performance with Nonlinear Control

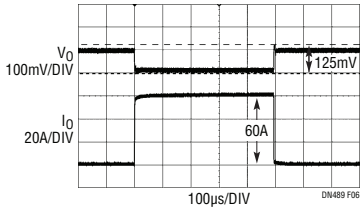

Figure 6. Transient Performance with AVP

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