

# DESIGN NOTES

## Triple Output 3-Phase Controller Saves Space and Improves Performance in High Density Power Converters

Design Note 409

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Today's telecommunications, server and network applications require power from a multitude of voltage rails. Having more than ten rails ranging from 5V to 1V or less is common. These boards are typically crowded with heat-producing FPGAs or microprocessors, thus demanding power converters that are both compact and highly efficient. Furthermore, the converters may need to meet other requirements such as a fast load step response and rail tracking.

The LTC<sup>®</sup>3773 switching regulator meets and even goes beyond the above requirements. This device is a 3-phase, triple output synchronous buck controller with built-in gate drivers packaged in either a 5mm × 7mm QFN or a 36-pin SSOP. Its switching frequency can be set to

220kHz, 400kHz or 560kHz, or it can be synchronized to an external clock between 160kHz and 700kHz. The controller can step down from input voltages as high as 36V and the output voltage can be programmed from 0.6V to 5V.

Figure 1 shows a high density triple output DC/DC converter with each output delivering up to 5A using the LTC3773 controller. Figure 2 shows the efficiency of each output versus load current; where up to 93% efficiency is achieved. Reductions in space are realized by the use of dual channel FETs and a switching frequency of 400kHz which permits the use of 7mm × 7mm ferrite inductors.

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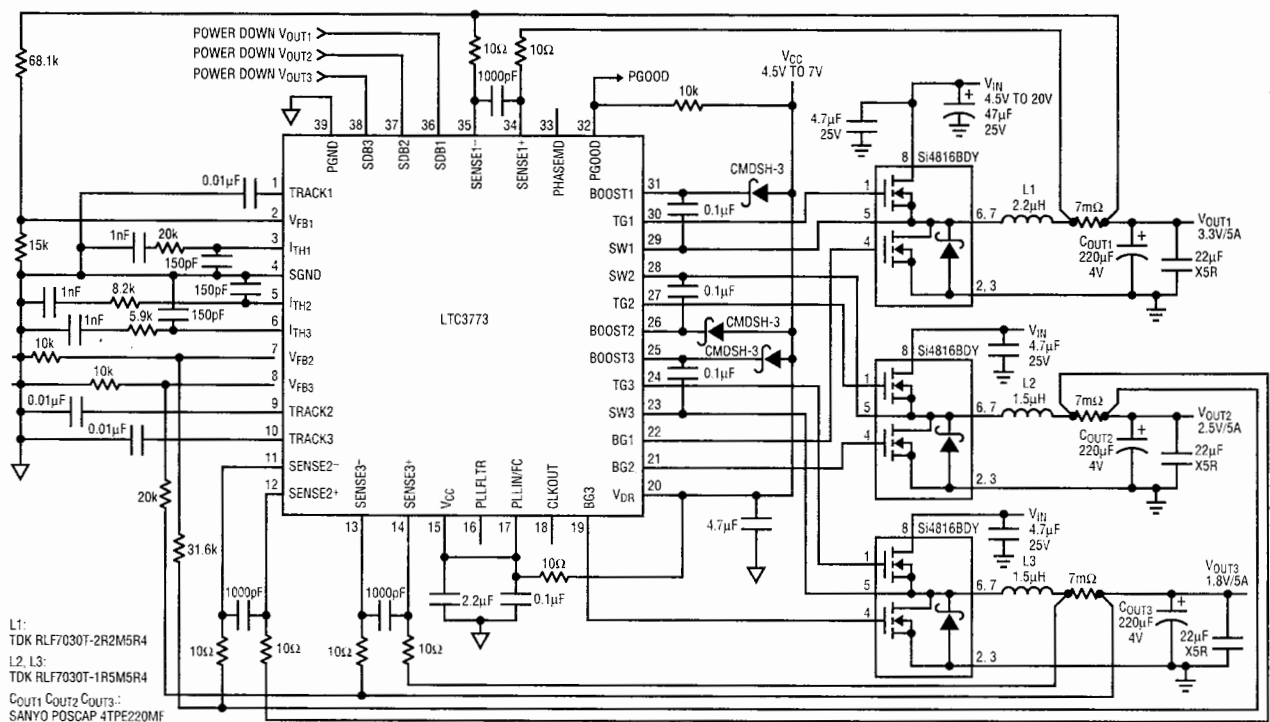
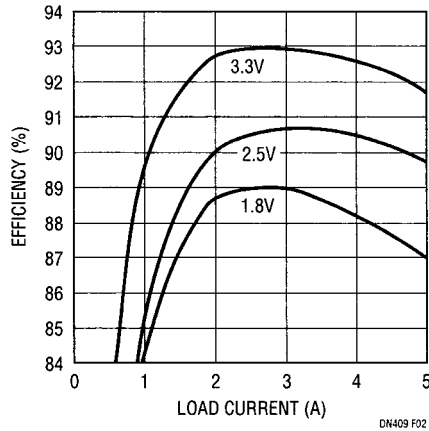


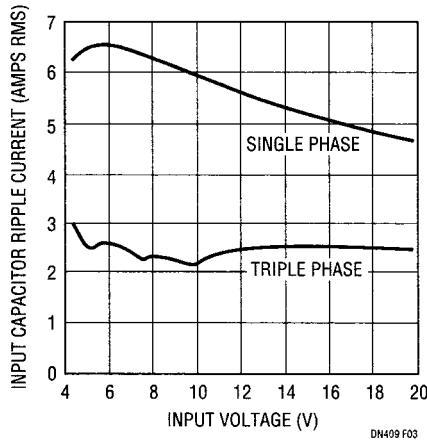
Figure 1. High Density 5A Converter. Total Circuit Size = 1.5in<sup>2</sup>, with Components on Both Sides

Switching the three rails out of phase results in improved performance and reduced cost. The use of triple phase operation instead of single phase can result in a reduction of the input capacitor ripple current by over 50% as shown in Figure 3, allowing the use of less input capacitance. The outputs of two or more phases can be tied together

which results in output ripple current reduction as well and a faster load step response. Up to six phases can be synchronized using the CLKOUT pin (on the QFN part only). Fast and accurate current sharing among the parallel phases is a result of the LTC3773's peak current mode architecture.



**Figure 2. Efficiency of the LTC3773 Converter at  $V_{IN} = 12V$ ,  $f_{sw} = 400kHz$ . One Rail Enabled at a Time**



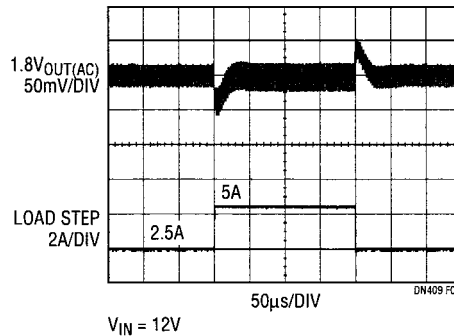
**Figure 3. Input Capacitor Ripple Current Comparison for Single Phase and Triple Phase Operation**  
 $V_{OUT1} = 3.3V/5A$ ,  $V_{OUT2} = 2.5V/5A$ ,  $V_{OUT3} = 1.8V/5A$   
 Single Phase:  $\phi_{1,2,3} = 0^\circ$   
 Triple Phase:  $\phi_{1,2,3} = 0^\circ, 120^\circ, 240^\circ$

Compensation of each rail is achieved with an RC network on the  $I_{TH}$  pin (error amplifier output). The external  $I_{TH}$  compensation and the current mode topology allow the designer to easily stabilize a converter with the minimal amount of output capacitance using a variety of capacitor types including conductive polymer, tantalum and ceramic while still achieving a fast load step response (see Figure 4).

Other features of the LTC3773 include rail tracking and sequencing, a PGOOD signal, and three selectable light load operating modes (continuous conduction mode, Burst Mode<sup>®</sup> operation and pulse skip mode).

### Conclusion

Now designers have a clear and practical solution when they need a compact and cost effective triple supply rail requirement in their telecom, server or network systems.



**Figure 4. 1.8V Load Step Response**

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