LINEAR TECHNOLOGY

DESIGN NOTES

Low Cost Surface Mount DC/DC Converter Delivers 100A

Design Note 215

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Introduction

As computer systems get larger and more complex, their supply current requirements continue to rise. Systems requiring 100A at 3.3V are fairly common while next generation CPU current consumption is approaching 100A at slightly above 1V. Because few off-the-shelf standard power modules are capable of this current level, most system designers are forced to use several modules in parallel to obtain the required current. The resulting power solution is usually expensive, bulky and the performance is not always satisfactory.

The newly released LTC®1629 is a dual current mode PolyPhase® controller that provides a cost-effective solution for low voltage, high current applications. PolyPhase dramatically reduces input capacitor size and output switching ripple voltage by interleaving the clock signals of several paralleled power stages. Until now, multiphase designs have been difficult to implement because of complex timing and current sharing requirements. The introduction of the LTC1629 solves all of these problems. The advanced features of the LTC1629 include a differential amplifier for true remote sensing, high gate-drive capability, internal current sharing and selectable phasing control. Protection features include overvoltage protection, optional overcurrent latch-off and foldback current limit. This article illustrates a 6-phase power supply design using the LTC1629 with all surface mounted components. An efficiency of approximately 90% is obtained with an input voltage of 12V and an output of 3.3V at up to 100A.

Design Details

Each LTC1629 is capable of driving two interleaved synchronous buck output stages. The PLL-based internal phasing circuitry enables 2-, 3-, 4-, 6- or 12-phase operation with a simple phase selection signal (high, low or open). This technique allows paralleling several LTC1629s to deliver output currents from 30A to 200A (see Table 1).

Table 1. Number of LTC1629s vs Output Current

OUTPUT CURRENT	<35A	35A TO 70A	70A TO 105A	105A TO 140A	140A TO 200A
No. of LTC1629s	1	2	3	4	6
Buck Stages	2	4	6	8	12

This particular design uses three LTC1629s to provide 6-phase operation. Figure 1 shows the block diagram of a complete power supply consisting of three almost

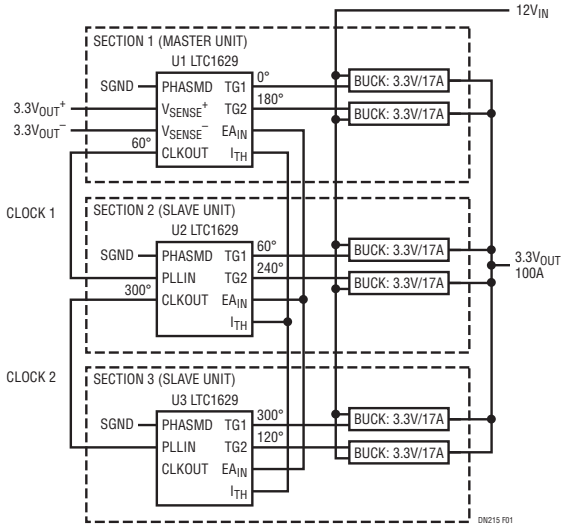

Figure 1. PolyPhase Converter Block Diagram

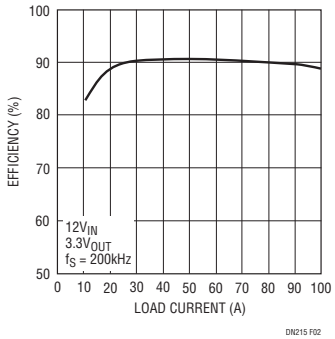

Figure 2. Efficiency vs Load Current

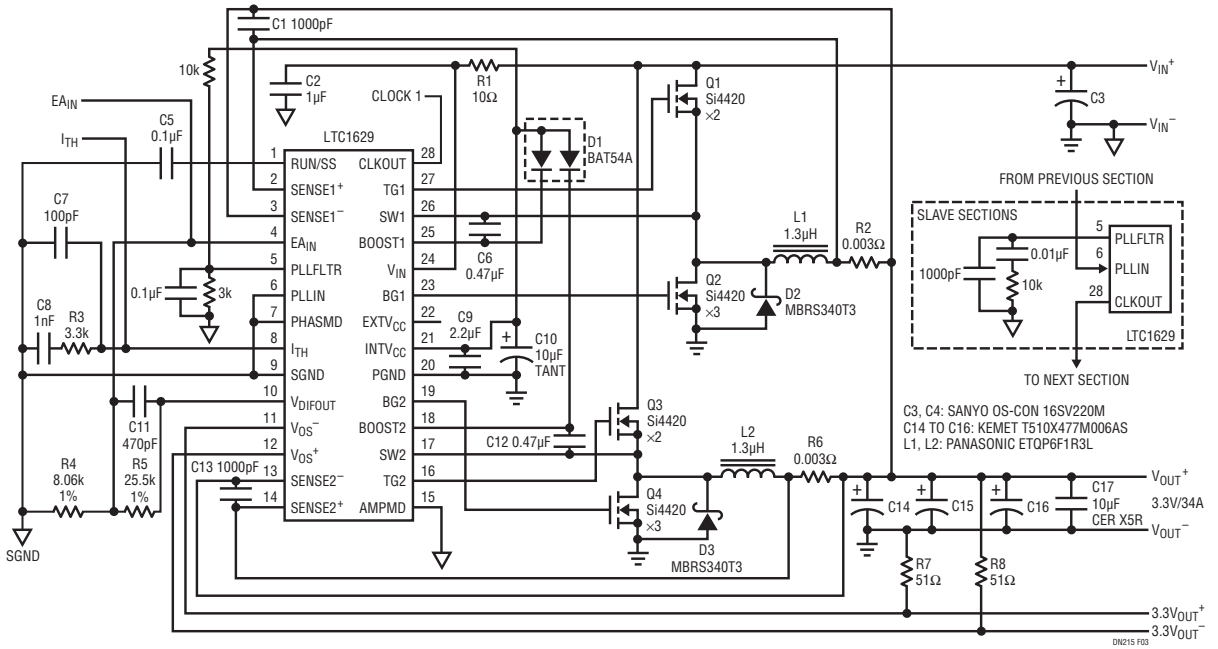

Figure 3. Detailed Schematic of Section 1 (Master Unit)

Table 2. Comparison of Input and Output Ripple Current for Single-Phase and 6-Phase Configurations. L = 1.3µH, f_S = 200kHz

NUMBER OF PHASES	INPUT RIPPLE CURRENT	OUTPUT RIPPLE CURRENT	NO. OF INPUT CAPACITORS SANYO OS-CON 16SV220M	NO. OF OUTPUT CAPACITORS FOR THE SAME OUTPUT RIPPLE VOLTAGE: KEMET T510X477M006AS
1	$48A_{RMS}$	$57A_{P-P*}$	13	248
6	$8A_{RMS}$	$2A_{P-P}$	3	9

*Assuming that the single-phase circuit uses six 1.3µH/17A inductors in parallel to provide 100A output.

identical sections: one master unit and two identical slave units. The slave units are the same as the master unit except that the V_{OS}^- and V_{OS}^+ pins of the slave LTC1629s are open. Only the master unit senses the output voltage. A total of 30 SO-8 MOSFETs and six small surface mounted inductors are used in this design (no heat sinks are required). The switching frequency is 200kHz. Figure 3 is a detailed schematic of section 1 (master unit).

Table 2 compares the input and output ripple current along with the required input and output capacitors for conventional single-phase and 6-phase configurations. Compared to a single-phase converter, the 6-phase circuit reduces the input ripple current by 83%. As a result, the 6-phase design requires only three OS-CON input capacitors (16SV220M), compared to the 13 required by a single-phase circuit. The output ripple current reduction for the 6-phase circuit is even more significant: 96% lower than single phase. The output ripple voltage at 100A is only $5mV_{P-P}$ with only 9 tantalum capacitors (T510X477M006AS). The resultant ripple frequency is 1.2MHz (six times the switching frequency). To achieve the same output ripple voltage a single-phase design would require 248 tantalum capacitors. Figure 2 shows the measured overall efficiency (including the control circuit power loss) at close to 90% throughout most of the load range.

Conclusion

The LTC1629-based PolyPhase converter results in a simple and reliable design using standard manufacturing processes. This unique architecture achieves high efficiency, small size and low cost even at 100A and above. Refer to the URLs for more details.

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