

DESIGN NOTES

Simple and Compact 4-Output Point-of-Load DC/DC μ Module System – Design Note 411

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Introduction

Advancements in board assembly, PCB layout and digital IC integration have produced a new generation of densely populated, high performance systems. The board-mounted, point-of-load (POL) DC/DC power supplies in these systems are subject to the same demanding size, performance and power requirements as other subsystems—demands that are difficult to meet with traditional power modules or controller/regulator ICs. The LTM4601 DC/DC μ Module™ converter meets these demands by shrinking an entire solution to the size of a low profile IC. Its frequency synchronization and voltage tracking features allow multiple LTM4601s to be easily and quickly configured for multioutput applications.

4-Output DC/DC Converter Power System

Figure 1 shows the photo of a 4-output DC/DC supply using four μ Module converters with frequency synchronization and output tracking. The operating waveforms of the four outputs are interleaved with a 90° relative phase difference, thus reducing the effective input current ripple.

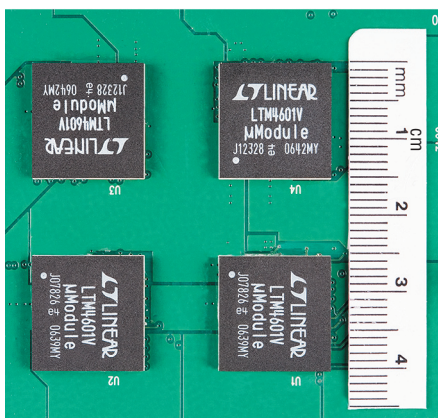


Figure 1. A 4-Output 103W DC/DC System Can Fit This Tiny Space (Each LTM4601 μ Module DC/DC Converter Contains an Inductor, MOSFETs, Bypass Capacitors, Etc.)

This in turn significantly reduces the bulk capacitance of the circuit and the circuit size.

Figure 2 presents the efficiency of each output in Figure 1. With 12V input voltage, each output is tested up to 12A by disabling the other three outputs. The high efficiencies up to 92% guarantee low losses in the circuit board, thus leading to a reduced system profile.

Figure 3 shows the simplified block diagram for Figure 1. For a detailed schematic, please refer to page 22 of the LTM4601 data sheet. An intermediate bus input of 8V–16V is converted to four different outputs: 1.5V at 12A, 1.8V at 12A, 2.5V at 12A and 3.3V at 10A. The output voltages are set by resistances on the LTM4601 VFB pins. A 4-phase oscillator LTC6902 generates 90° interleaved clock signals. Moreover, spread spectrum frequency modulation (SSFM) can be activated by adding an external resistor from the LTC6902 MOD pin to V⁺.

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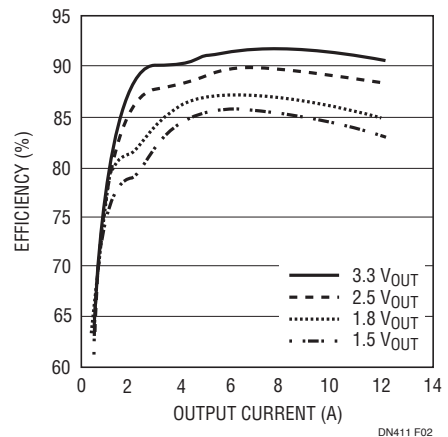


Figure 2. Efficiency of Each Output for the Circuit in Figure 1

Output Tracking

The output voltage of the LTM4601 can track another converter's output ratiometrically or coincidentally. The circuit in Figure 1 implements coincident tracking by connecting the 3.3V output (master) to the TRACK/SS pins of the other μ Module converters (slaves) via resistive dividers. For coincident tracking, the master must have a higher output voltage than the slaves. The soft-start capacitor on the TRACK/SS pin of the 3.3V master supply sets the ramp rate of the start-up voltage. Figure 4 shows the start-up waveforms of the four outputs with output tracking.

Frequency Synchronization

The operating frequency of the LTM4601 can be synchronized with an external clock to reduce undesirable

frequency harmonics, and its operation can be interleaved with other LTM4601s. Figure 5 shows the input current ripple of the 180° phase-interleaved 1.8V and 3.3V outputs of the circuit in Figure 1. The input current ripple of the 3.3V output is synchronized with its PLLN signal in Figure 5. Therefore, with four 90° interleaved inputs, the input current ripples are partially cancelled, reducing the required input capacitance.

Conclusions

The synchronization and tracking features of the LTM4601 allow interleaved phases in the 4-output solution, thus reducing input capacitance and producing a compact design. High efficiency and excellent thermal performance make it possible to handle the total maximum power of 103W in a 4-layer PCB at 11cm × 11cm.

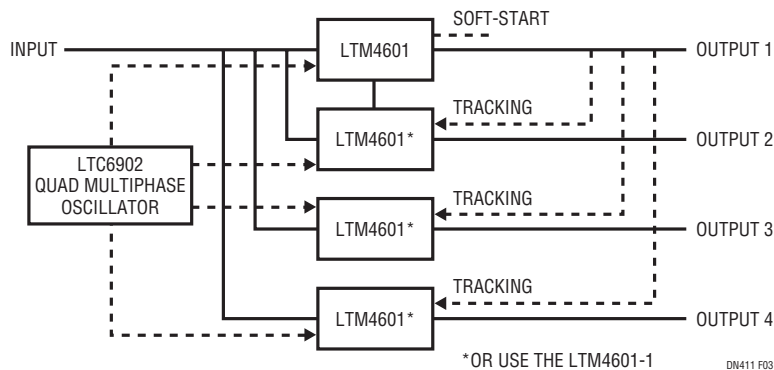


Figure 3. Simplified Schematic of a Compact 4-Output Point-of-Load DC/DC μ Module Converter Solution. The LTC6902 Interleaves the Operating Waveforms of the Four μ Module Converters, So That the Ripple Currents Cancel Each Other. This Significantly Reduces the Size of the Required Input Capacitors. Start-Up and Shutdown Voltage Racking Is Simply Accomplished by Connecting the Output of the 3.3V μ Module (Output 1) to the Other μ Module Converters

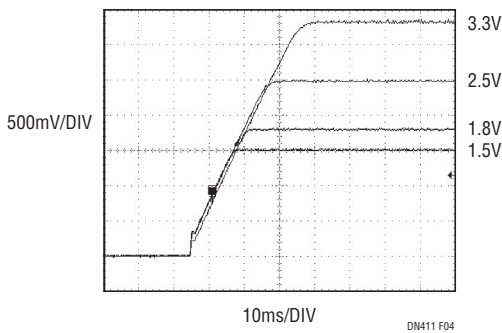


Figure 4. Start-Up Voltage Waveforms of the Circuit in Figure 1 Show Coincident Tracking of the Outputs

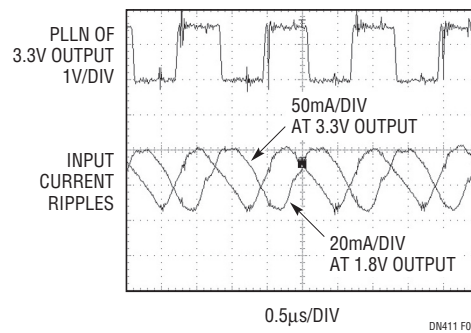


Figure 5. Input Current Ripple is Reduced by Interleaving the Operation of the Supplies Using Frequency Synchronization

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dn411f LT 0307 409K • PRINTED IN THE USA



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