

## VID Controller with Phase Extender Provides 120A Power Supply for Latest Generation of FPGAs, ASICs and Processors

Design Note 547

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### Introduction

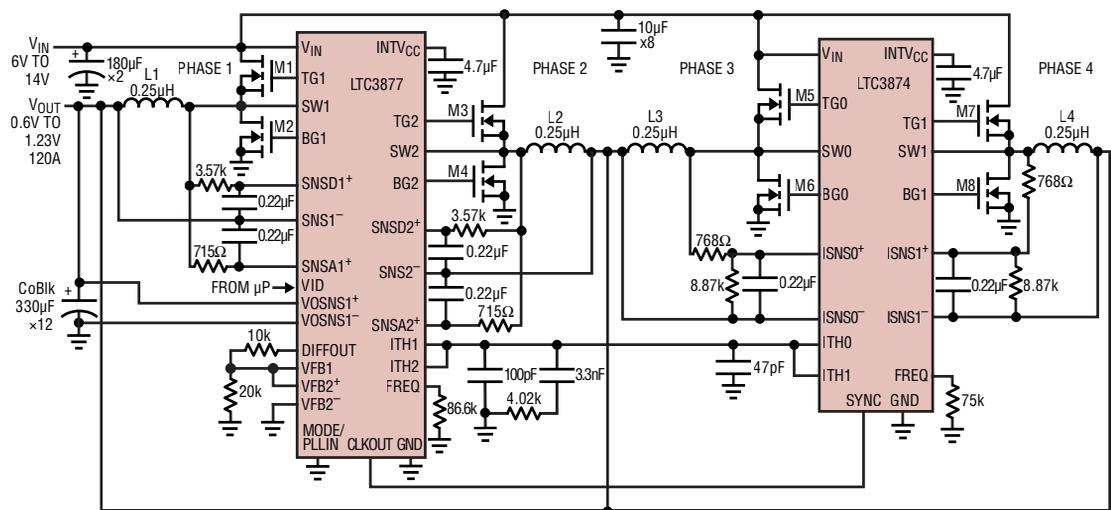
The current drawn by FPGAs, ASICs and processors for high performance servers, network and computing systems continues to rise, and load currents of 100A or greater are becoming common. Meanwhile, the chip's operating voltages are dropping to 0.9V and below with tighter voltage regulation requirements. For many of these applications, the core voltage may need to be adjusted for optimum performance with a VID (voltage identification) interface. A significant challenge is clearly placed on the power supply designer to meet the demands of high efficiency and tight output voltage regulation with a small amount of board space.

One way to meet these demands is to use the [LTC3877](#) and [LTC3874](#) chipset. The LTC3877 is a peak current mode, VID-controlled dual output synchronous

step-down controller. The output of phase 1 can be programmed from 0.6V to 1.23V in 10mV increments with a six-bit parallel VID interface. Phase 2 provides an output of 0.6V to 5V, which is set by an external divider. The two phases can be paralleled together or with phases from another LTC3877 or an LTC3874 for higher output current.

The LTC3874 is a peak current mode phase extender chip. It does not have an error amplifier and instead regulates its phase current to the ITH signal from the LTC3877 master. The elegant design of the LTC3874 reduces trace count and board space. The LTC3877 comes in a 44-lead, 7mm × 7mm QFN package; the LTC3874 slave controller comes in a 28-lead, 4mm × 5mm QFN package.

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NOTE:  
 THIS IS A SIMPLIFIED SCHEMATIC. REFER TO  
 THE DATA SHEET FOR A COMPLETE SCHEMATIC.

L1-L4: WURTH 744301025 (0.25µH, 0.32mΩ)  
 M1, M3, M5, M7: INFINEON BSC050NE2LS  
 M2, M4, M6, M8: INFINEON BSC010NE2LS1

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Figure 1. 4-Phase 120A VID-Controlled Converter Operating at a Switching Frequency of 400kHz

## PolyPhase Design with High Accuracy and Efficiency

The 4-phase step-down converter shown in Figure 1 uses the LTC3877 and LTC3874 to provide a VID-controlled output of 0.6V to 1.23V at a maximum load current of 120A at a switching frequency of 400kHz. The LTC3877 yields a total DC regulation accuracy of  $\pm 1\%$  for all VID set points over temperature. The differential remote sense amplifier in the LTC3877 senses the output voltage at the regulation point and compensates for voltage drops across PCB trace runs and ground planes. The 4-phase operation results in lower output voltage ripple and faster load step response due to shorter clock delays.

High efficiency is a result of the strong gate drivers and short dead times of the two chips, MOSFET selection and sub-m $\Omega$  DCR ferrite inductors. The full load efficiency for a 1.2V output at 120A load is 88.8% as shown in Figure 2.

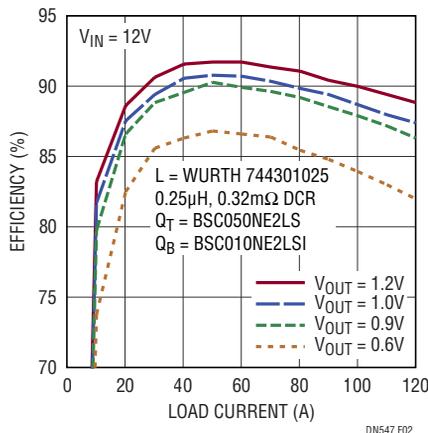


Figure 2. Efficiency of the 4-Phase 120A VID Converter

### Sub-m $\Omega$ DCR Sensing

Both the LTC3877 and LTC3874 use a proprietary DCR current sensing architecture designed for sub-m $\Omega$  DCR sensing, which ensures tight control of the current sharing and current limit. Figure 3 shows the current sharing performance of the 4-phase converter of Figure 1. The inductor used is the Wurth 744301025 (250nH), which has a DCR of 0.32m $\Omega$ . The current sharing error is less than 1mV between phases.

### More Features

The LTC3877 and LTC3874 both have a phase-lockable frequency range of 250kHz to 1MHz and a FREQ pin

[Data Sheet Download](#)

[www.linear.com/LTC3877](http://www.linear.com/LTC3877)

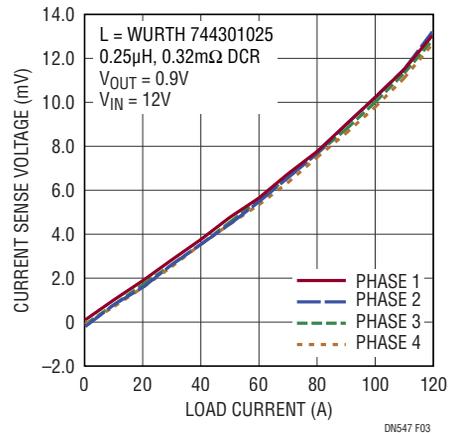


Figure 3. Current Sharing of the 4-Phase 120A VID-Controlled Converter

to set the internal frequency if synchronization is not required. The LTC3877 offers three light load operating modes: Burst Mode<sup>®</sup> operation, forced continuous mode and pulse-skipping mode. The LTC3874 operates in either forced continuous mode or pulse-skipping mode.

The minimum on-time of the LTC3877 is 40nsec typical, ideal for high step-down converters or small footprint or high bandwidth converters operating at switching frequencies of 500kHz to 1MHz. The minimum on-time of the LTC3874 is 90nsec, typical.

Phase 1 of the LTC3877 provides VID control. If the FPGA, ASIC or processor is not awake or VID programming is not required, then the VID section can be disabled by pulling the VIDEN pin low and setting the output voltage with a divider at the output of the differential amplifier. Both phases of the LTC3877 have differential remote sense amplifiers for precise control of the output voltage. The input voltage range of both chips is 4.5V to 38V.

Other features of the LTC3877 include PGOOD pins, RUN pins and TK/SS pins for each rail. The LTC3874 has its own RUN pins and FAULT pins for quick response to fault conditions.

### Conclusion

The LTC3877/LTC3874 chipset provides the power system designer with a highly accurate, efficient and robust PolyPhase<sup>®</sup> solution for high current rails supplying FPGAs, ASICs and processors.

For applications help,  
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