

# Dual Phase Buck Controller Drives High Density 1.2V/60A Supply with Submilliohm DCR Sensing – Design Note 528

Mike Shriver

## Introduction


Designers of low output voltage rails for communication, networking, server and industrial systems are challenged to achieve greater load currents and higher efficiency in diminishing board space. The [LTC®3774](#) dual output buck controller eases this burden by interfacing easily with DrMOS devices, providing high efficiency and small size by integrating MOSFET and gate driver in the same package. The LTC3774 can sense current across the inductor's DCR, with values as low as  $0.2\text{m}\Omega$ , improving efficiency by eliminating the need for a discrete sense resistor. The LTC3774's peak current mode architecture provides cycle-by-cycle current limit, inherent cycle-by-cycle current sharing and easy to design type II compensation.

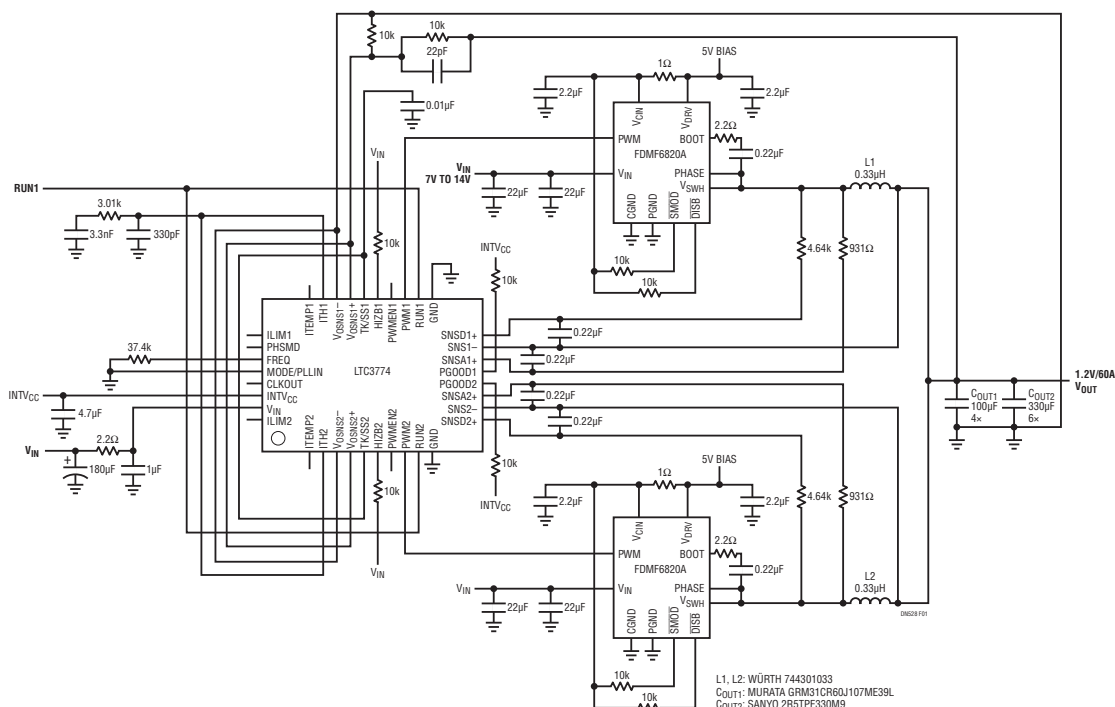
## High Efficiency Converter with a Small Footprint

Figure 1 shows a dual phase 1.2V/60A LTC3774 converter operating at a switching frequency of 400kHz. The power stage for each phase is the FDMF6820A DrMOS, which comes in a 6mm × 6mm QFN package, and a 0.3μH single winding ferrite inductor with a typical DCR of 0.325mΩ. The resulting full load efficiency is 89.8%, as shown in Figure 2. The core of the converter has a current density of 50A/in<sup>2</sup>.

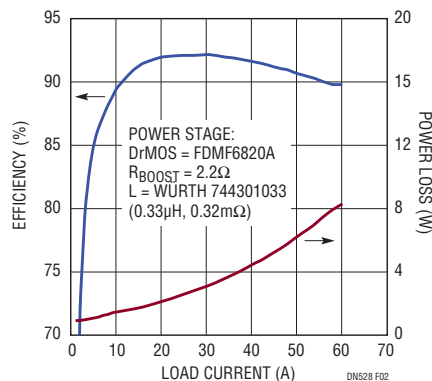
## DrMOS Interface

The PWM outputs of the LTC3774 are designed to drive DrMOS devices with a 3-state PWM input. When the PWM signal is high, the top FET is on, and when the

 , LT, LTC, LTM, Linear Technology, the Linear logo, Burst Mode and PolyPhase are registered trademarks and Hot Swap is a trademark of Linear Technology Corporation. All other trademarks are the property of their respective owners.



**Figure 1. Dual Phase, 1.2V/60A LTC3774 Converter Operating at  $f_{SW} = 400kHz$ ,  $7V \leq V_{IN} \leq 14V$**



**Figure 2. Efficiency and Power Loss Curves for Circuit Shown in Figure 1.  $V_{IN} = 12V$ ,  $V_{OUT} = 1.2V$**

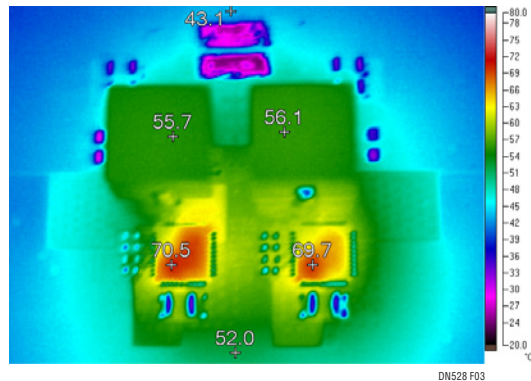
PWM signal is low, the bottom FET is on. When the PWM signal is floating, both the top FET and bottom FET are off. This state is used to block inductor reverse current when the LTC3774 is set up for either pulse-skipping mode or Burst Mode® operation providing a smooth turn-on into a prebiased output. The PWM outputs of the LTC3774 can also interface with power block devices and gate drivers with external MOSFETs.

### DCR Sensing

The ultralow DCR sensing capability is a result of an innovative current sensing technique that improves the signal-to-noise ratio of the current sense signal. The external filter tied to the SNSA+ pin amplifies the AC portion of the DCR-sensed current; the DC current is sensed via the SNSD+ pin, internally amplified and summed with the AC portion. This reconstructed current sense signal seen by the LTC3774's current comparator is effectively amplified by a factor of five, allowing the converter to remain stable and retain current limit accuracy for inductor DCR values as low as 0.2mΩ.

The LTC3774 offers five current limit settings between 10mV and 30mV with a worst-case error over temperature of  $\pm 1.25mV$ . With current mode control, current sharing between phases is tightly balanced, as shown by the thermal image shown in Figure 3. The 1.2V/60A converter operating at full load produces less than a 1°C temperature difference between the two phases.

The LTC3774 also provides accurate output voltage regulation. The output of each phase is sensed with a differential amplifier placed after the feedback divider to compensate for any PCB I • R drops. The total



**Figure 3. Thermal Image of the Circuit Shown in Figure 1.  $f_{SW} = 400kHz$ ,  $V_{IN} = 12V$ ,  $V_{OUT} = 1.2V$ ,  $I_{OUT} = 60A$ , no Airflow and 21°C Ambient**

regulated feedback voltage accuracy is  $\pm 0.75\%$  over temperature. The output voltage range of the LTC3774 is 0.6V to 3.5V.

### PolyPhase Operation and Improving Robustness

The LTC3774 features CLKIN and CLKOUT pins for PolyPhase® operation up to 12 phases. PolyPhase operation reduces ripple current for the input capacitors and in cases where the phases are tied together, reduces output voltage ripple and provides faster load step response.

Further improvements in the reliability of single output, redundant (N+1), PolyPhase converters can be achieved by placing Hot Swap™ circuits on the input and ideal diode circuits on the output of each phase. If a MOSFET failure occurs, the fault is isolated and the output is protected and continues to regulate. Reliability is further improved with the LTC3774's HIZB pin, which floats the PWM output when a fault is detected, allowing for a more predictable shutdown of the DrMOS.

Other features include soft recovery from an output overload, optional NTC compensated DCR sensing, a phase-lockable switching frequency range of 200kHz to 1.2MHz and an input voltage range of 4.5V to 38V.

### Conclusion

The LTC3774 is a high performance dual output buck controller intended for low output voltage, high output current supplies with DrMOS and ultralow DCR inductors. It yields high efficiency, an accurate current limit, a precise  $0.6V \pm 0.75\%$  feedback voltage and fault isolation.

**Data Sheet Download**

[www.linear.com/LTC3774](http://www.linear.com/LTC3774)

For applications help,  
call (408) 432-1900, Ext. 3720