LINEAR TECHNOLOGY

DESIGN NOTES

High Efficiency PolyPhase Converter Uses Two Inputs for a Single Output – Design Note 222

Wei Chen and Craig Varga

Introduction

As more functions are integrated into one IC, the power drawn by a single IC can easily exceed the capability of a single input power source. Redesigning the front-end power supply to increase the supply's capability will take time and money. Another solution is to use several available power sources to obtain the required output power, drawing some percentage of the total power from each source. The LTC®1929 PolyPhase® regulator provides a simple solution to this problem.

Design Details

The LTC1929 is a PolyPhase dual, current mode controller. It is capable of driving two synchronous buck channels 180 degrees out of phase to reduce output switching ripple current and voltage. One buck stage receives its input power from the 12V input and the other receives its power from the 5V input. In this 2-phase design, as the inductor current in the 5V circuit increases, the inductor current in the 12V circuit decreases. This results in a smaller net ripple current flowing into the output capacitor. Since there are two intervals in one switching period where ripple cancellation takes place, the output ripple voltage of the 2-phase design is much smaller than that of a single-phase design, and fewer output capacitors can be used. Current mode operation provides inherent current sharing.

A Typical Application

The currents available from a PCI connector are limited to 2A for the 5V supply and 1A for the 12V supply. In the example shown here, the load can be as high as 6A or 16.8W at 2.8V. Neither the 5V nor the 12V source is capable of providing this power. Hence, it is desirable to

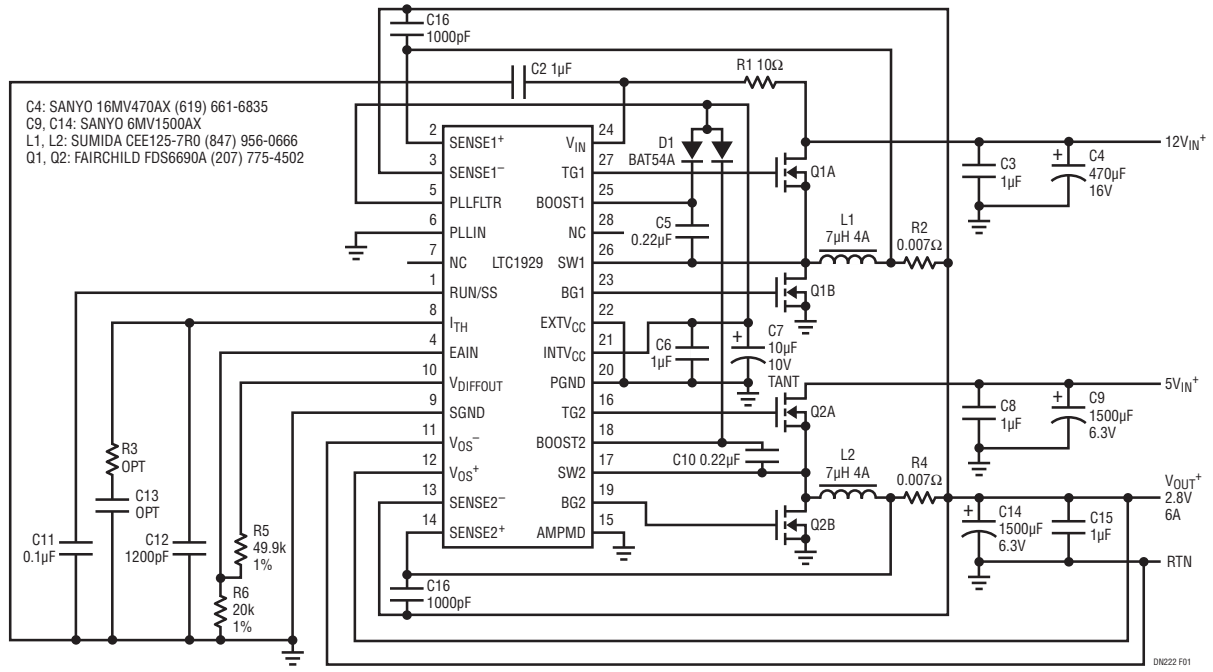

Figure 1. Schematic Diagram Shows Both a 5V and 12V Input Supply for a High Current 2.8V Output

design a power supply that can draw currents from both power sources, and whose maximum input currents from each source will not exceed the corresponding maximum limit. This design shows how to easily accomplish this using the LTC1929 PolyPhase controller. With only one IC, two dual FETs in SO-8 packages and two small inductors, a high efficiency, low noise power supply can be obtained.

Figure 1 shows the schematic diagram of the complete power supply. Since each buck circuit only supplies about 3.5A maximum, dual MOSFETs such as the Fairchild FDS6990A can be used. The switching frequency is about 300kHz per-channel for an effective output ripple frequency of 600kHz. The inductors in both stages are 7µH. The design uses Sumida CEE125-7R0 inductors, but any inductor with a similar inductance value and 4A or greater current rating should do the job. The current sense resistor is 0.007Ω for each channel.

Test Results

Figure 2 shows the overall efficiency vs load currents. For most of the load range, the efficiency is above 90%. Figure 3 shows the distribution of the two input currents as the load current varies. The maximum input currents for the 5V and 12V sources are 1.66A and 0.84A, respectively, which are well below the PCI connector's current limits. Figure 4 shows the waveforms of the inductor ripple currents and output ripple voltages. Note the ripple cancellation phenomenon. The peak-to-peak switching ripple voltage at the output terminal is only

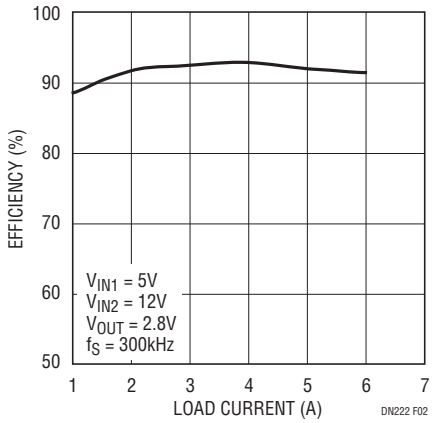

Figure 2. Measured Efficiency

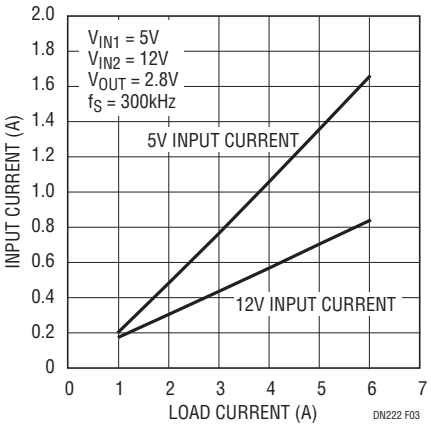

Figure 3. Input Currents vs Load Currents

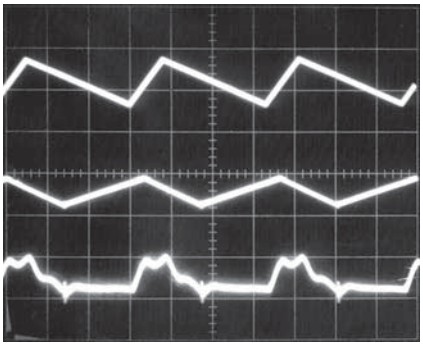

Figure 4. Waveforms of Ripple Currents and Voltage (Top Trace: 12V Buck Inductor Current, 1A/DIV; Middle Trace: 5V Buck Inductor Current 1A/DIV; Bottom Trace: Output Ripple Voltage, 50mV/DIV

50mV$_{P-P}$ with one 1500µF/6.3V aluminum electrolytic capacitor. If two buck circuits are synchronized in phase, the ripple voltage will be 70mV$_{P-P}$, almost a 50% increase.

Conclusion

The PolyPhase technique reduces the output ripple voltage without increasing the switching frequency. High efficiency can be obtained for low output voltage applications. The LTC1929 PolyPhase controller provides a small, low cost solution for multi-input applications. If more than two inputs are needed, use the LTC1629 rather than the LTC1929. Multiple LTC1629s can be configured for 3-, 4-, 6- or even 12-phase operation.

Linear Technology Corporation
1630 McCarthy Blvd., Milpitas, CA 95035-7417
(408) 432-1900 • FAX: (408) 434-0507 • www.linear.com

dn222f_conv LT/TP 0100 340K • PRINTED IN THE USA