

DESIGN NOTES

17V Input, Dual 1A Output Synchronous Step-Down Regulator with Ultralow Quiescent Current

Design Note 537

Haoran Wu

Introduction

The LTC[®]3622 dual 1A synchronous monolithic step-down regulator enables compact, high efficiency supplies for battery powered systems and portable devices as well as general purpose point-of-load regulation. The tiny 14-pin, 3mm × 4mm DFN package takes input voltages from 2.7V to 17V, producing two adjustable ±1% accurate outputs from 0.6V to V_{IN} while delivering up to 1A output current on both channels.

The LTC3622's quiescent current with both channels enabled is as low as 5 μ A in Burst Mode[®] operation and less than 0.1 μ A in shutdown. The switching frequency is fixed at 1MHz or 2.25MHz with a ±50% synchronization range to an external clock. Selectable Burst Mode operation yields the highest efficiency, while pulse-skipping mode minimizes ripple for noise-sensitive applications.

Dual 1A Outputs, 3.3V and 5V, at 1MHz

Figure 1 shows a dual output converter that takes an input voltage range of 5V to 17V, and produces 1A outputs at 3.3V and 5V.

The two channels can operate in phase or with 180° phase shift, selected by tying the PHASE pin to GND or INTV_{CC}. This provides users the flexibility to separate the channels' switching edges to minimize any noise coupling. There are two peak current limit levels for the LTC3622 – 1.8A or 1A, selected via the I_{LIM} pin. This selectable current limit allows smaller size inductors in lower current designs to minimize solution size and cost.

Under heavy load conditions, the regulator operates in continuous inductor current mode with small output ripple and high efficiency. Two discontinuous conduction modes (DCM) are available at light load to achieve high efficiency and minimize energy consumption. To further reduce power loss and extend battery life at very light loads or no load standby conditions, Burst Mode operation can be selected by tying the MODE/SYNC pin to INTV_{CC}. In this case, the LTC3622 IC only consumes 5 μ A at no load. Burst Mode operation may

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

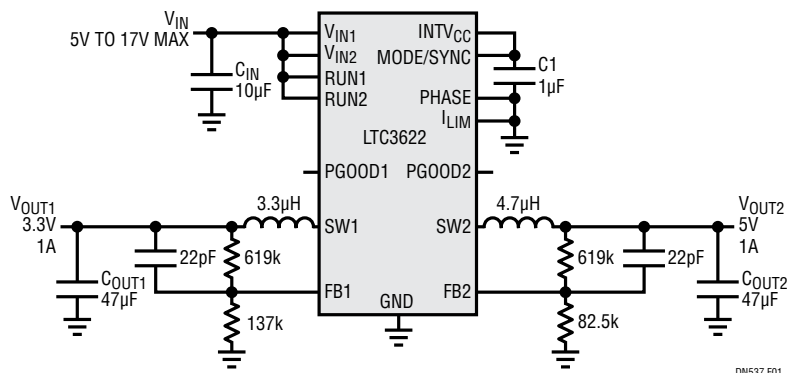


Figure 1. A Dual-1A Converter with 3.3V and 5V Outputs, $f_{SW} = 1$ MHz

increase output voltage ripple. On the other hand, if minimizing V_{OUT} ripple is critical, pulse-skipping mode can be selected by grounding the MODE/SYNC pin. This results in lower ripple than in Burst Mode operation with the trade-off of slightly lower efficiency. Furthermore, connecting the MODE/SYNC pin to an external clock synchronizes the switch clock to the external clock and puts the part in pulse-skipping mode. Figure 2 shows the efficiency from $12V_{IN}$ to $5V_{OUT}$ in burst and pulse-skipping modes.

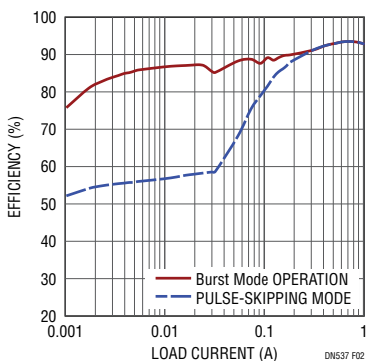


Figure 2. Efficiency of the 5V Output of the Dual Supply Shown in Figure 1, $V_{IN} = 12V$, $V_{OUT2} = 5V$, $f_{SW} = 1MHz$

The LTC3622 is a reliable current mode regulator with fast, cycle-by-cycle overcurrent protection and excellent line and load transient response. When the input voltage decreases, the duty cycle increases and slope compensation is required to maintain a stable current feedback loop. The LTC3622 has internal circuitry to accurately maintain a constant peak current limit and stable loop even at high duty cycles.

In applications such as battery powered systems, the input voltage can have a very wide range. As V_{IN} drops close to V_{OUT} and the converter duty cycle approaches 100%, the LTC3622 enters dropout operation to maintain V_{OUT} regulation. During dropout, the part transitions in and out of sleep mode depending on the output load current. This significantly reduces the quiescent current while keeping V_{OUT} regulated, thus prolonging the run time of the input battery supply. Figure 3 shows that the LTC3622 can achieve high efficiency from microamps to full load while in dropout.

To simplify design and minimize component count, the LTC3622 has internal loop compensation. If needed, a feedforward capacitor in parallel with upper side

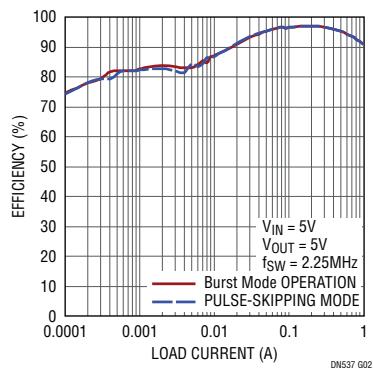


Figure 3. Efficiency vs Load Current in Dropout, $V_{IN} = 5V$, $V_{OUT2} = 5V$, $f_{SW} = 1MHz$

feedback resistor can be added to further increase the phase margin. Thanks to its current mode control, the LTC3622 supply is stable with a wide range of output capacitance. In the dual supply shown in Figure 1, each channel output only needs one small 1206 size, $47\mu F$ ceramic capacitor. Figure 4 shows the transient response of the 5V output. With a 10% to 100% load step, the peak-to-peak voltage excursion is about $\pm 330mV$. More capacitors can be added to further reduce the V_{OUT} transient. In this case, the LTpowerCAD™ design tool and LTspice® simulation tool can be used to optimize the design with the built-in LTC3622 model. Both tools are available as a free download at www.linear.com.

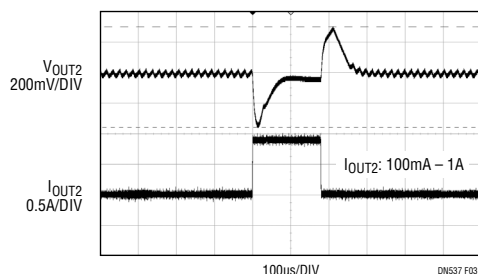


Figure 4. Transient Response of the 5V Supply Shown in Figure 1, $V_{IN} = 12V$, $V_{OUT2} = 5V$, $I_{OUT2} = 100mA-1A$, Burst Mode Operation

Conclusion

The LTC3622 is a dual 1A, high efficiency synchronous monolithic step-down regulator with ultralow quiescent current. It solves the problems of converter efficiency and space constraints posed by battery-powered systems, point-of-load supplies and portable devices.

Data Sheet Download

www.linear.com/LTC3622

For applications help,
call (408) 432-1900 EXT 3061