

# DESIGN NOTES

## The LT1500/LT1501 Low Noise Micropower DC/DC Converters

### Design Note 151

Jeff Witt

Today's sophisticated battery-powered devices, whether portable instruments, pagers or cellular phones, often require low noise supplies. A new family of micropower step-up DC/DC converters from Linear Technology offers ideal solutions for these demanding applications.

The LT<sup>®</sup>1500/LT1501 current mode step-up regulators control both the maximum and minimum inductor current, resulting in continuous inductor current and nearly constant switching frequency and output ripple over a wide load current range. The switching frequency depends mainly on the input and output voltages and the value of the inductor used. This allows the designer to move the operating frequency away from sensitive areas of the spectrum, placing it, for example, between the audio band and the IF of a receiver. Furthermore, the LT1500 can be synchronized to avoid interference with AC signals.

The LT1500/LT1501 have a 0.7A power switch and consume only 200 $\mu$ A of quiescent current. Both parts feature a low-battery detector that remains active in the 8 $\mu$ A shutdown mode. The LT1501 is packaged in an 8-lead SO, and is available in variable, fixed 3.3V and fixed 5V outputs. With internal frequency compensation, it forms a compact, low parts count, high performance solution. The LT1500 is packaged in a 14-lead SO. Additional features include synchronization, soft start, selectable 3.3V or 5V output (LT1500-3/LT1500-5) and feedback for negative output circuits (LT1500).

### 2-Cell to 5V Boost

Figure 1 shows a basic application of the LT1501, generating 5V from two cells. The operating frequency over battery life ( $V_{IN} = 3V$  to 2.1V) is plotted as a function of load current for two inductor values. At load currents less than 17mA, the circuit uses Burst Mode<sup>™</sup> operation for high efficiency. For higher currents, the switching frequency falls in a narrow band that depends on the inductor value, allowing the frequency to be chosen to suit system requirements. The designer can also choose between high frequency

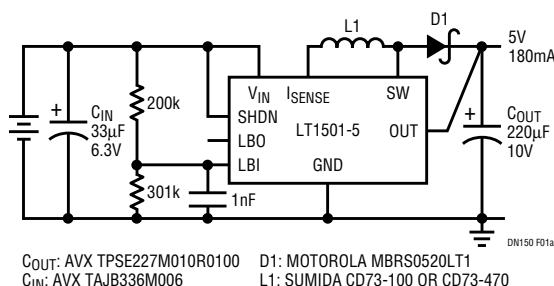


Figure 1a. 2-Cell to 5V

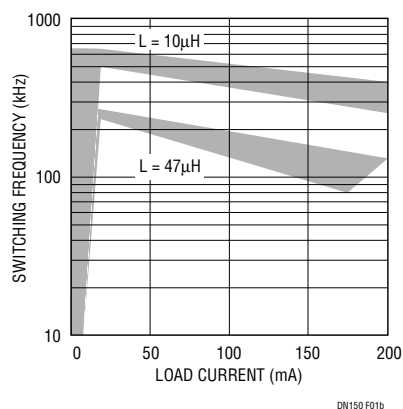


Figure 1b. Operating Frequency vs Load Current for Two Inductor Values

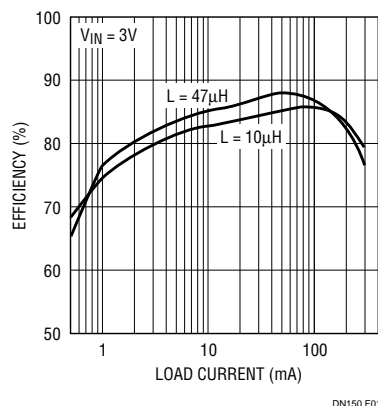


Figure 1c. Efficiency vs Load Current for Two Inductor Values

LT, LTC and LT are registered trademarks of Linear Technology Corporation. Burst Mode is a trademark of Linear Technology Corporation.

operation, which allows the use of smaller components and makes additional filtering simpler, and low frequency operation, which minimizes switching losses and results in higher efficiency.

### 5V to -5V Cuk Converter

A common DC/DC conversion task is generating a low noise -5V from 5V or 3.3V to power an instrument's analog electronics; Figure 2 shows how the LT1500 can accomplish this. The Cuk topology and the LT1500's current mode architecture ensure that both the input and output currents of the converter are continuous over a large load range, resulting in low input and output ripple. The circuit will supply 250mA. For loads below 35mA, the LT1500 functions in Burst Mode operation for high effi-

ciency. At higher loads, inductor current is continuous and switching frequency remains between 280kHz and 350kHz for a 5V input, and between 190kHz and 250kHz for 3.3V. Output ripple is below 10mV<sub>p-p</sub>.

### Wide Input Range SEPIC

The high voltage ratings of the LT1500's input (20V) and switch (30V) allow for a large range of input and output voltages. Figure 3 shows a circuit that converts a 2V-20V input to 5V, allowing operation from either a 2-cell battery or a higher voltage wall transformer. When operating from two cells, the narrow operating frequency and low noise performance is retained; however, for higher input voltages the part will enter Burst Mode operation, producing additional output ripple at low frequencies.

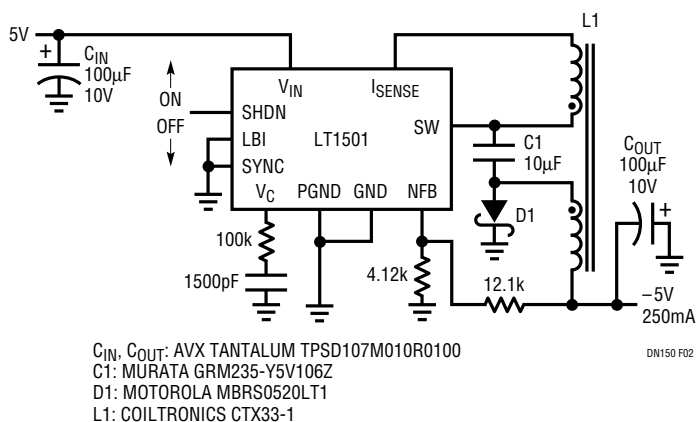


Figure 2. 5V to -5V Cuk Converter

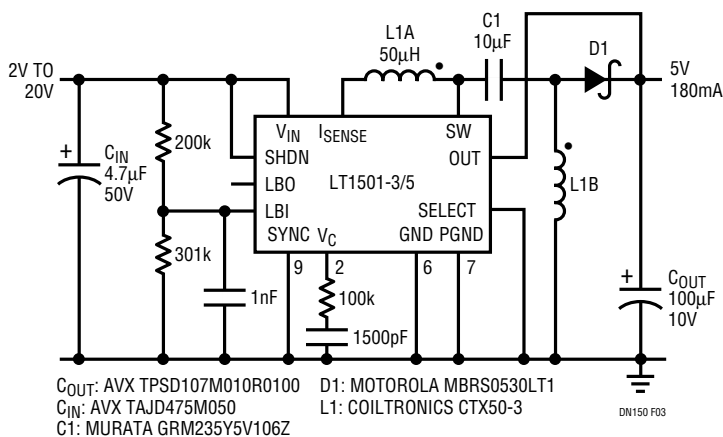


Figure 3. Wide Input Range SEPIC

For literature on our DC/DC Converters,  
call **1-800-4-LINEAR**. For applications help,  
call (408) 432-1900, Ext. 2360

## Linear Technology Corporation

1630 McCarthy Blvd., Milpitas, CA 95035-7417 • (408) 432-1900  
FAX: (408) 434-0507 • TELEX: 499-3977 • www.linear-tech.com

dn151f LT/TP 0397 155K • PRINTED IN THE USA

**LINEAR**  
TECHNOLOGY  
© LINEAR TECHNOLOGY CORPORATION 1997