

Micropower 600kHz Fixed-Frequency DC/DC Converters Step Up from a 1-Cell or 2-Cell Battery

by Steve Pietkiewicz

Linear Technology introduces two new micropower DC/DC converters designed to provide power from a single-cell or higher input voltage. The LT1308 features an onboard switch capable of handling 2A with a voltage drop of 300mV and operates from an input voltage as low as 1V. The LT1317, intended for lower power requirements, operates from an input voltage as low as 1.5V. Its internal switch handles 600mA with a drop of 360mV. Both devices feature Burst Mode operation at light load; efficiencies are above 70% for load currents of 1mA. Both devices switch at 600kHz; this high frequency keeps

associated power components small and flat; additionally, troublesome interference problems in the sensitive 455kHz IF band are avoided. The LT1308 is intended for generating power on the order of 2W–5W. This is sufficient for RF power amplifiers in GSM or DECT terminals or for digital-camera power supplies. The LT1317, with its smaller switch, can generate 100mW to 2W of power. The LT1317 is available in LTC's smallest 8-lead package, the MSOP. This package is approximately one-half the size of a standard 8-lead SO package. The LT1308 is available in the 8-lead SO package.

Single Li-Ion Cell to 5V/1A DC/DC Converter for GSM

GSM terminals have emerged as a worldwide standard. A common requirement for these products is an efficient, compact, step-up converter to develop 5V from a single Li-Ion cell to power the RF amplifier. The LT1308 performs this function with a minimum of external components. The circuit is detailed in Figure 1. Many designs use a large aluminum electrolytic capacitor (1000 μ F to 3300 μ F) at the DC/DC converter output to hold up the output voltage during the transmit time slice, since the amplifier can require more than 1A. The

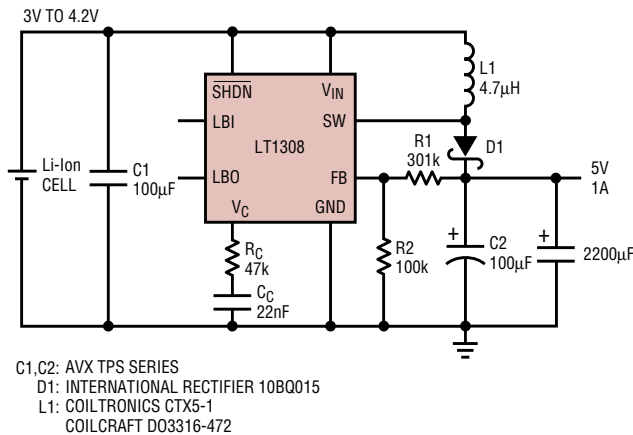


Figure 1. Single Li-Ion cell to 5V/1A DC/DC converter

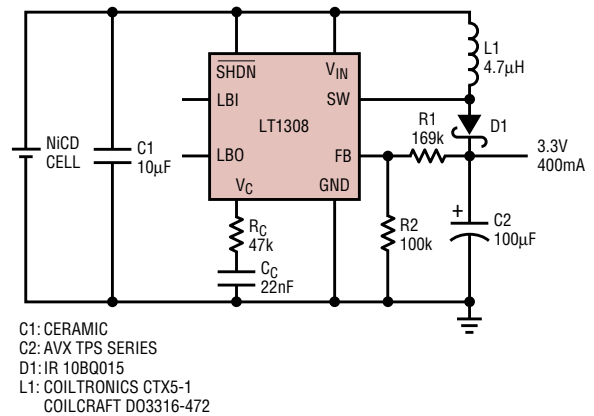


Figure 4. Single NiCd cell to 3.3V/400mA DC/DC converter

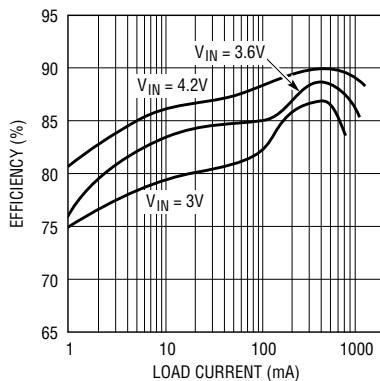


Figure 2. Efficiency of Figure 1's circuit reaches 90%

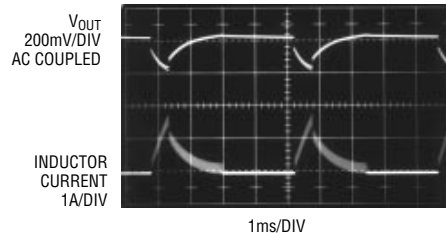


Figure 3. Transient response of DC/DC converter: $V_{IN} = 3V$, 0A–1A load step

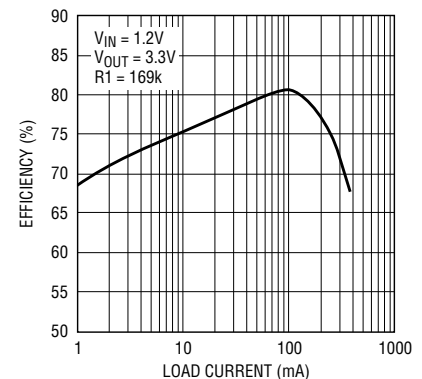


Figure 5. Efficiency of Figure 4's circuit reaches 81%

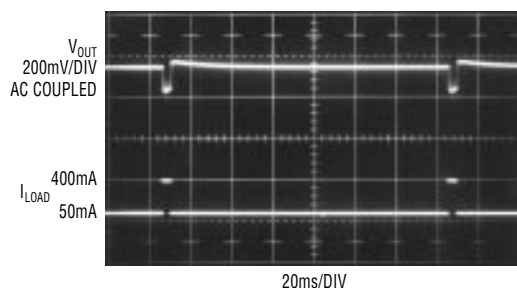


Figure 6. DECT load transient response: with a single NiCd cell, the LT1308 provides 3.3V with a 400mA pulsed load. The pulse width = 416µs.

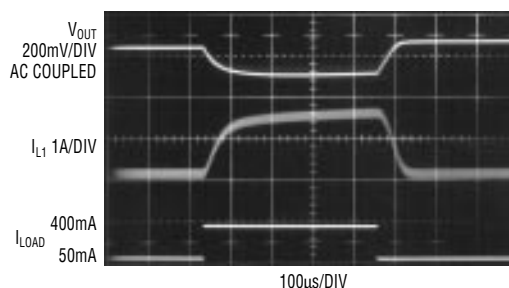


Figure 7. DECT load transient response: faster sweep speed (100µs/DIV) details V_{OUT} and inductor current of a single DECT transmit pulse.

output capacitor, along with the LT1308 compensation network, serves to smooth out the input current demanded from the Li-Ion cell. Efficiency, which reaches 90%, is shown in Figure 2. Transient response of a 0A to 1A load step with typical GSM profiling (1:8 duty cycle, 577µs pulse duration) is depicted in Figure 3. Voltage droop (top trace) is 200mV. Inductor current (bottom trace) increases to 1.7A peak; the input capacitor supplies some of this current, with the remainder drawn from the Li-Ion cell.

Single NiCd Cell to 3.3V/400mA Supply for DECT

Only minor changes are required in Figure 1's circuit to construct a single-cell NiCd to 3.3V converter. The large output capacitor is no longer required as the output current can be handled directly by the LT1308. Figure 4 shows the DECT DC/DC converter circuit.

Efficiency, reaching 81% from a 1.2V input, is pictured in Figure 5. Transient response of a typical DECT load of 50mA to 400mA is detailed in Figure 6. Output voltage droop (top trace) is under 200mV. Figure 7 zooms in on a single pulse to show the output voltage and inductor current responses more clearly.

2-Cell Digital Camera Supply Produces 3.3V, 5V, 18V and -10V

Power supplies for digital cameras must be small and efficient while generating several voltages. The DSP and logic need 3.3V, the ADC and LCD display need 5V and biasing for the CCD element requires 18V and -10V. The power supplies must also be free of low frequency noise, so that postfiltering can be done easily. The obvious approach, to use a separate DC/DC converter IC for each output voltage, is not cost-effective. A single

LT1308, along with an inexpensive transformer, generates 3.3V/200mA, 5V/200mA, 18V/10mA and -10V/10mA from a pair of AA or AAA cells. Figure 8 shows the circuit. A coupled-flyback scheme is used, actually an extension of the SEPIC (single ended primary inductance converter) topology. The addition of capacitor C6 clamps the SW pin, eliminating a snubber network. Both the 3.3V and 5V outputs are fed back to the LT1308 FB pin, a technique known as split feedback. This compromise results in better overall line and load regulation. The 5V output has more influence than the 3.3V output, as can be seen from the relative values of R2 and R3. Transformer T1 is available from Coiltronics, Inc. (561-241-7876). Efficiency vs input voltage for several load currents on both 3.3V and 5V outputs is pictured in Figure 9. The CCD bias voltages are loaded with 10mA in all cases.

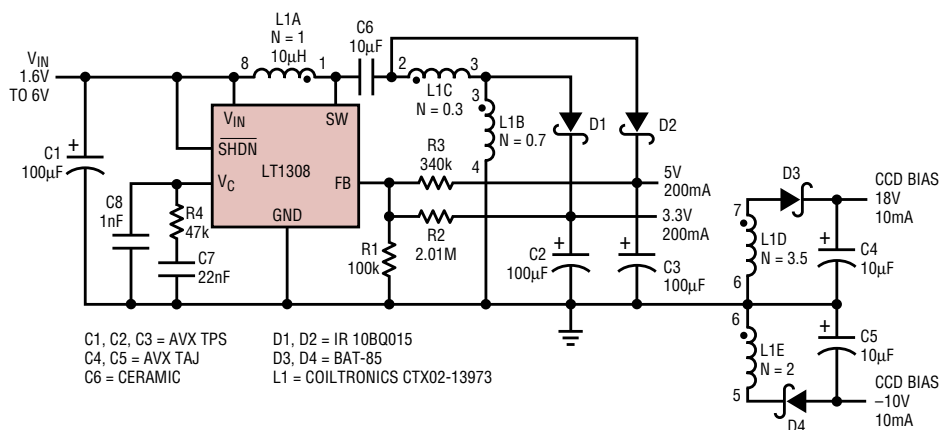


Figure 8. This digital camera power supply delivers 5V/200mA, 3.3V/200mA, 18V/10mA and -10V/10mA from two AA cells.

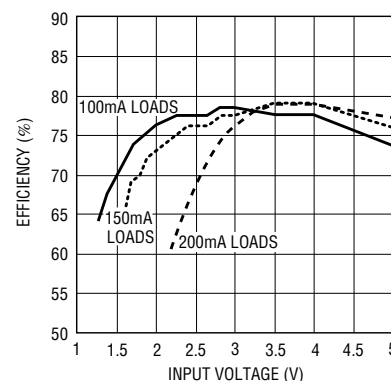


Figure 9. Camera power supply efficiency reaches 78%.

LT1317 2-Cell to 5V DC/DC Converter

Figure 10 shows a simple 2-cell to 5V DC/DC converter using the LT1317. This device generates a clean, low ripple output from an input voltage as low as 1.5V. Designed for 2-cell applications, it offers better performance than its 1-cell predecessor, the LT1307. More gain in the error amplifier results in lower Burst Mode ripple, and an internal preregulator eliminates oscillator variation with input voltage. For comparison, Figure 11 details transient responses of both the LT1307 and the LT1317 generating 5V from a 3V input. The load step is 5mA to 200mA. Output capacitance in both cases is 33 μ F. The LT1307 has


low frequency ripple of 100mV, whereas the LT1317 Burst Mode ripple of 20mV is the same as the 600kHz ripple resulting from the output capacitor's ESR with a 200mA load.

Single Li-Ion Cell to ± 4 V DC/DC Converter

By again employing the SEPIC topology, a ± 4 V supply can be designed with one IC. Figure 12's circuit generates 4V at 70mA and -4 V at 10mA from an input voltage ranging from 2.5V to over 5V. Maximum component height is 2mm. This converter uses two separate inductors (L1 and L2), so it is an uncoupled SEPIC converter. This reduces the overall cost, but requires that all output current

pass through C1. Since C1 is ceramic, its ESR is low and there is no appreciable efficiency loss. C5 is charged to $-V_{OUT}$ when the switch is off, then its bottom plate is grounded when the switch turns on. The negative output is fairly well regulated, since the diode drops tend to cancel. The circuit is switching continuously at rated load, where efficiency is 75%. Output ripple is under 40mV and can be reduced further with conventional postfiltering techniques.

Conclusion

The LT1308 and LT1317 provide low noise compact solutions for contemporary portable-product power supplies. 

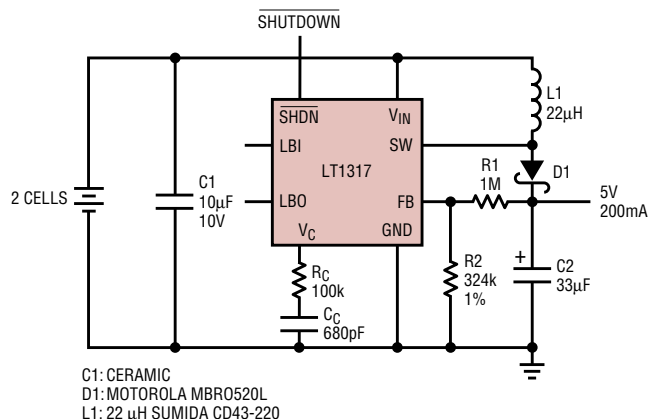


Figure 10. 2-cell to 5V boost converter using the LT1317

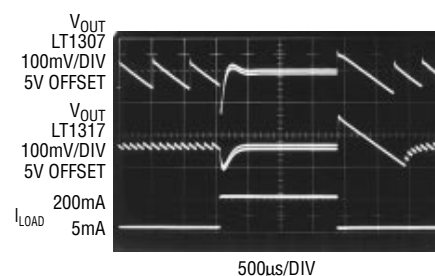


Figure 11. The LT1317 has reduced Burst Mode ripple compared to the LT1307.

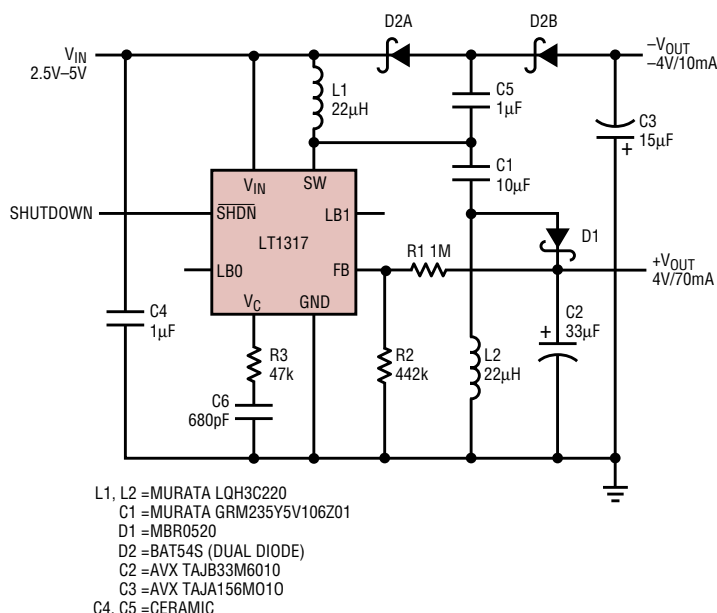


Figure 12. This single Li-Ion cell to ± 4 V DC/DC converter has a maximum height of 2mm.