DESIGN NOTES

"LCD Bias" and "Backup Supply" Applications for the LT1316 Micropower DC/DC Converter – Design Note 166

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Some step-up DC/DC converter functions require input current limiting because of high source impedance or limited capability of power components. The LT®1316, a micropower step-up DC/DC converter with peak switch current control, meets these needs. The device draws 33µA quiescent current and contains a 0.6Ω, 30V switch that can be programmed for a maximum peak current between 30mA and 600mA with an external resistor. It also has a low-battery detector that remains active in shutdown, where quiescent current drops to 3µA. The two circuit examples below illustrate how the LT1316's current limit function allows realization of difficult converter circuits.

2-Cell, Low Profile LCD Bias Generator Fits in Small Places

Portable electronic products with LCDs are getting thinner, resulting in severe restrictions on component height. LCD bias generators placed in or near the display housing need to use low profile (under 2mm) components to meet height restrictions. These low profile inductors and capacitors have somewhat higher parasitic resistance than their higher profile equivalents; hence, switching regulator peak current must be controlled to keep the inductor from saturating and to keep output voltage ripple under control. The LT1316, with its programmable current limit function, is ideal for use as an LCD bias generator.

Figure 1's circuit delivers 5mA at up to 28V from a 2-cell battery, using components that are under 2mm high. Peak current is limited to 350mA by 10k resistor R3 at the R_{SET} pin. The parallel combination of a 1µF, 35V tantalum and a 0.47µF, 50V ceramic keep output ripple voltage to 180mV, less than 1% of the output voltage. Output voltage and inductor current waveforms at an input voltage of 2V and load current of 4mA are detailed in Figure 2. The 28V output can be varied by changing the value of R2 or by summing a current into the LT1316 FB pin.

Higher output current can be generated if a higher input supply voltage is available. Table 1 shows output current for supply voltages of 2V, 3.3V and 5V. Up to 20mA at 28V can be generated from a 5V supply. Efficiency using these low profile components is a few points lower than it would be with larger components, but it is still above 74%.

Table 1. Output Current for Input Voltages of 2V, 3.3V and 5V

V_{IN}	L	PEAK CURRENT	R_{SET}	OUTPUT CURRENT
2V	22µH	350mA	10k	5mA
3.3V	22µH	550mA	7.5k	15mA
5V	47µH	350mA	10k	20mA

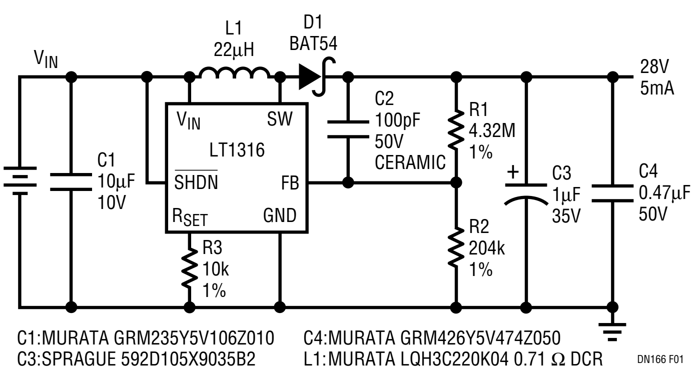


Figure 1. 2-Cell to 28V Converter for LCD Bias Generators Uses Components Under 2mm Tall

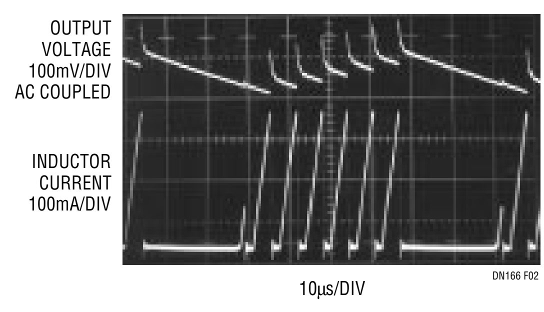


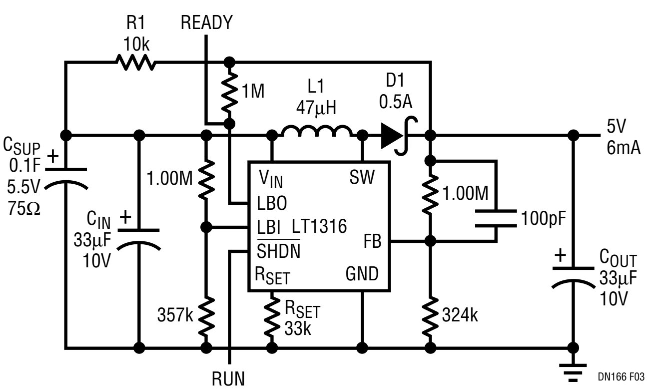
Figure 2. Controlled, Low Peak Current Keeps Output Voltage Ripple Under 180mV$_{P-P}$

Super Capacitor-Powered Backup Supply

Typical backup supplies for low power (several µW) logic systems operate from a lithium battery or a high energy density capacitor (a “super cap”). Some systems may require a higher power backup: for example, a “last gasp” write to flash memory might require several mW for several seconds. There are obstacles to efficient operation at higher loads from these power sources. Both the long-life lithium batteries and super caps have large series resistances that result in reduced efficiency at high RMS currents and poor regulation due to IR drop. In addition, the super cap output voltage, in contrast to a battery’s, decreases continuously as power is drawn and the capacitor must be substantially discharged to obtain its stored energy. A micropower switching regulator is required, and the LT1316, with its ability to precisely control peak switch current, is ideally suited to such high impedance energy sources.

Figure 3 shows a 5V, 6mA backup supply operating from a 0.1F, 5.5V, 75Ω super cap. The super cap, C_{SUP}, is charged through R1 from a normally present 5V. The charge state is monitored with the LT1316’s low-battery detector; the READY line is high when C_{SUP} is near full charge. When a power loss is detected, the system can pull the RUN line high to turn on the backup supply. The LT1316 operates as a simple boost regulator, generating 5V power until C_{SUP} has discharged to 1.5V. R_{SET} programs the peak switch current of the LT1316. Figure 4 shows the input and output voltage as the circuit supplies a fixed 6mA load. The output remains regulated at 5V as the input voltage drops. With peak switch current programmed to ~500mA (R_{SET} = 5.1k), output regulation is maintained for 9.6 seconds. Also plotted are the results with a peak current of 100mA (R_{SET} = 33k), enough switch current to satisfy the 6mA load current at the lowest input voltage. The benefit is obvious; the lower peak current results in lower RMS current from the super cap, reducing losses and extending backup time by 22% to 11.7 seconds.

The accurate control of peak switch current also allows the designer to better match the inductor to the power demands of the application, reducing system size and cost. Figure 5 shows the circuit operation under identical operating conditions, with a smaller CD43 series inductor substituted for the larger CD54. At higher peak currents, the additional inductor loss lowers operating time by 5%. With a low peak switch current, there is essentially no penalty for using the small inductor.



C_{IN}, C_{OUT}: TAJB330M010R
C_{SUP}: PANASONIC EEC-S5R5V104
D1: MBR0520LT3
L1: SUMIDA CD43-470

Figure 3. Super Cap Backup Supply

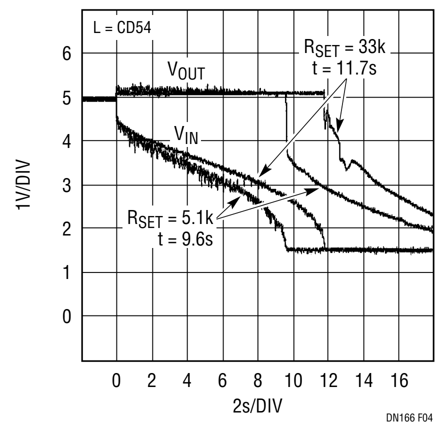


Figure 4. Lower Peak Current Results in Longer Operating Time

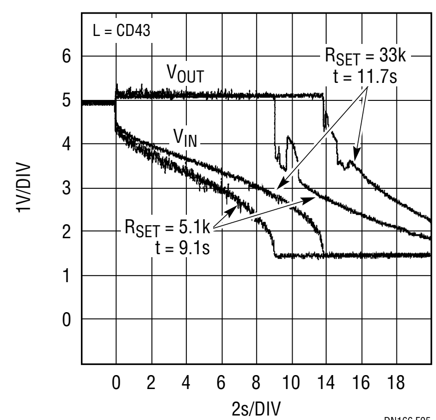


Figure 5. Lower Peak Current Allows the Use of Smaller Inductors

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