High Current Step-Down Conversion from Low Input Voltages

by Dave Dwelley

Many modern logic systems run with 3.3V as the sole power source. At the same time, some modern microprocessors and ASICs require supply voltages of 2.5V or less. Traditional step-down switching regulators can have difficulty running from the 3.3V supply, because affordable power MOSFETs generally require 5V gate drive to work efficiently. Two attractive solutions to generating 2.5V or less from a 3.3V supply are possible using the LTC1649 and the LTC1430A.

The LTC1649 is a switching regulator controller designed to use 5V MOSFETs while running from an input supply as low as 2.7V. No 5V supply is required. The LTC1649 includes an onboard charge pump to generate the 5V gate drive that the external power MOSFETs require. It also features an architecture designed to use all N-channel external MOSFETs and a high performance voltage mode feedback loop to ensure excellent transient response for use with high speed microprocessors and logic.

Figure 1. 3.3V to 2.5V/15A converter using the LTC1649

Figure 2. Efficiency of Figure 1's circuit

A typical circuit is shown in Figure 1. The 3.3V supply voltage at \( V_{\text{IN}} \) is converted to a regulated 5V output at \( C_{\text{OUT}} \). This 5V supply powers the \( PV_{\text{CC}} \) and \( V_{\text{CC}} \) pins to provide gate drive to Q3. Q1 and Q2 require an additional charge-pump stage to drive their gates above the \( V_{\text{IN}} \) supply voltage. D1 and C2 provide this boosted supply at \( PV_{\text{CC1}} \). The voltage feedback loop is closed through R1 and R2, with loop compensation provided by an RC network at the COMP pin. Soft-start time is programmed by the value of \( C_{\text{SS}} \). Maximum output current is set by \( R_{\text{MAX}} \) at the \( I_{\text{MAX}} \) pin and is sensed across the \( R_{\text{DS(ON)}} \) of the Q1/Q2 pair, eliminating the need for a high current external resistor to monitor current. The circuit boasts efficiency approaching 95% at 5A (Figure 2).

Some applications have a small 5V supply available, but need to draw the load current from the 3.3V supply. Such an application can use the circuit shown in Figure 3, with the continued on page 35
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Circuit operation and strong MOSFET protection features, improved circuit operation and strong MOSFET

The low noise behavior of the filter makes it useful in applications where the input signal has a wide voltage range. This is true provided the filter magnitude response does not change with varying input signal levels, that is, the filter gain is linear. The gain linearity measured at the 100kHz theoretical center frequency of the filter is shown in Figure 7. The gain is perfectly linear for input amplitudes up to 1.25V_{RMS} (3.5V_{p-p}) so an 84dB dynamic range can be claimed. The input signal, however, can reach amplitudes up to 3V_{RMS} (8.4V_{p-p}, 92dB SNR) with some reduction in gain linearity.

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**Conclusion**

The LTC1735 and LTC1736 are the latest members of Linear Technology’s family of constant frequency, N-channel high efficiency controllers. With new protection features, improved circuit operation and strong MOSFET

drivers, the LTC1735 is an ideal upgrade to the LTC1435/LTC1435A for higher current applications. With the integrated VID control, the LTC1736 is ideal for CPU power applications. The high performance of these controllers with wide input range, 1% reference and tight load regulation makes them ideal for next generation designs.

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level is 44μV_{RMS} over a bandwidth of 800kHz or 98dB below the maximum unclipped output.

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**References**

4. LTC1562 Final Data Sheet.

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SW, V_{BAT} and GND in Figure 2 will help in spreading the heat and will reduce the power dissipation in conductors and MOSFETs.

**Other Applications**

The LT1505 can also be used in other system topologies, such as the telecom application shown in Figure 5. The circuit in Figure 5 uses the battery to supply peak power demands.

By doing so, the required peak power from the wall adapter can be much lower than the peak power required by the load. The wall adapter has to supply the average power only.

**Conclusion**

The LT1505 is a complete, single-chip battery charger solution for today’s demanding charging requirements in high performance laptop applications. The device requires a small number of external components and provides all necessary functions for battery charging and power management. High efficiency and small size allow for easy integration with the laptop circuits. Also, by adding a simple external circuit, charging can be easily controlled by the host computer, allowing for more sophisticated charging schemes.

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lower cost LTC1430A replacing the LTC1649. The LTC1430A does not include the 3.3V to 5V charge pump and requires a 5V supply to drive the external MOSFET gates. The current drawn from the 5V supply depends on the gate charge of the external MOSFETs but is typically below 50mA, regardless of the load current on the 2.5V output. The drains of the Q1/Q2 pair draw the main load current from the 3.3V supply. The remaining circuit works in the same manner as in Figure 1. Efficiency and performance are virtually the same as the LTC1649 solution, but parts count and system cost are lower.

In a 3.3V to 2.5V application, the steady-state, no-load duty cycle is 76%. If the input supply drops to 3.135V (3.3V – 5%), the duty cycle requirement rises to 80% at no load, and even higher under heavy or transient load conditions. Both the LTC1649 and the LTC1430A guarantee a maximum duty cycle of greater than 90% to provide acceptable load regulation and transient response. The standard LTC1430 (not the LTC1430A) can max out as low as 83%—not high enough for 3.3V to 2.5V circuits. Applications with larger step-down ratios, such as 3.3V to 2.0V, can use the circuit in Figure 3 successfully with a standard LTC1430.