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.

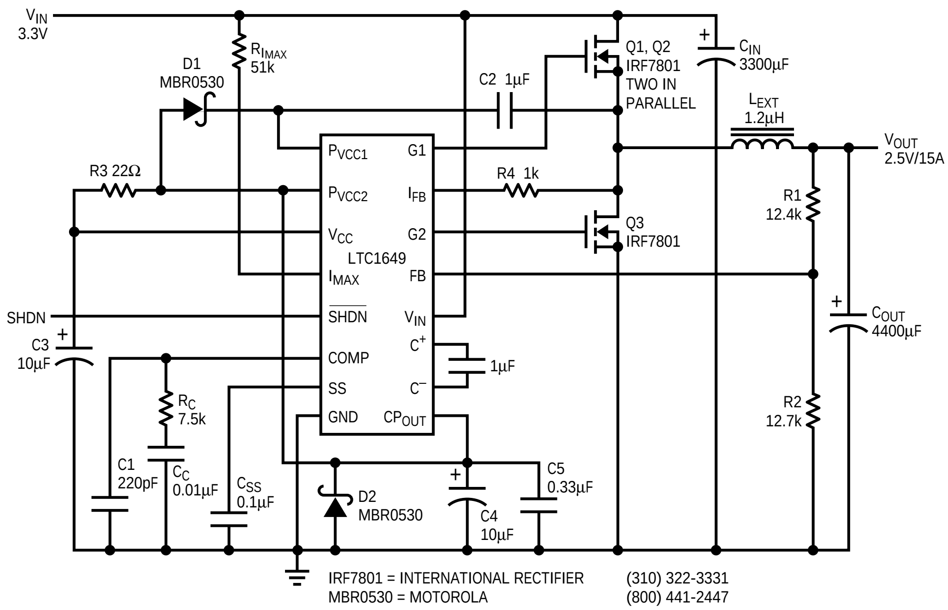

Figure 1. 3.3V to 2.5V/15A converter using the LTC1649

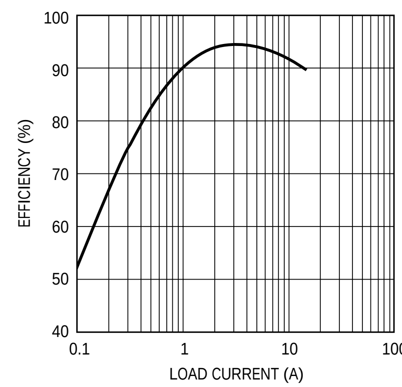

Figure 2. Efficiency of Figure 1's circuit

A typical circuit is shown in Figure 1. The 3.3V supply voltage at V_{IN} is converted to a regulated 5V output at CP_{OUT}. This 5V supply powers the PV_{CC2} and V_{CC} pins to provide gate drive to Q3. Q1 and Q2 require an additional charge-pump stage to drive their gates above the V_{IN} supply voltage. D1 and C2 provide this boosted supply at PV_{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_{SS}. Maximum output current is set by R_{IMAX} at the I_{MAX} pin and is sensed across the $R_{DS(ON)}$ 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

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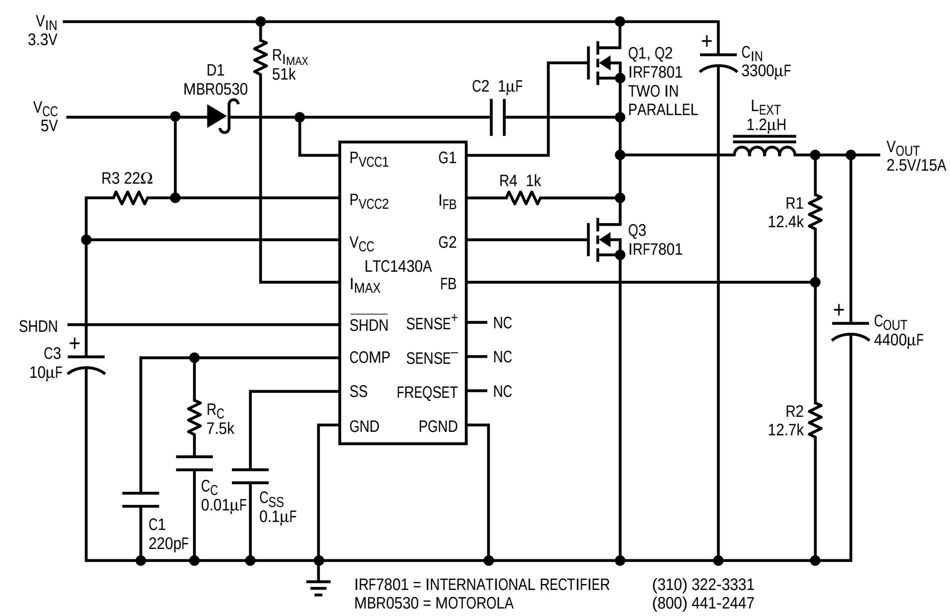

Figure 3. 3.3V to 2.5V/15A converter using a 5V auxiliary supply and the LTC1430A

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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 circuitry 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.