

Single-Inductor, Positive-Output Buck/Boost Converter Uses No R_{SENSE} Controller

by Christopher B. Umminger

The LTC1625 No R_{SENSE} ™ controller can be used in a power-converter topology that is capable of both up and down conversion and requires only a single inductor. An example of such a circuit, shown in Figure 1,

provides a 12V output with inputs that can range from 18V down to 6V. All of the circuitry to the left of the inductor is identical to that of a typical buck converter implemented with the LTC1625. However, the output (right) side of the inductor is also switched, using an additional pair of MOSFETs (M3 and M4). During the first phase of each cycle, switches M1 and M3 are on while M2 and M4 are off. The input voltage is applied across the inductor and its current increases. In the second phase, M1 and M3 are turned off while M2 and M4 are turned on. Current is then delivered to the output with V_{OUT} applied across the inductor.

This type of converter has several significant differences compared to the buck topology that is usually used with the LTC1625. First, the duty cycle relationship is now equal to $V_{OUT}/(V_{IN} + V_{OUT})$. When V_{IN} is equal to V_{OUT} , a fifty percent duty cycle is required to balance the volt-seconds across the inductor. Second, both the

input and output capacitors must filter a square pulse current. This increases the required power handling capability of the output capacitors. Finally, the average value of the inductor current is equal to the sum of the input and output currents. Thus, the inductor is larger than that required by a pure buck or boost converter. This last point also has a bearing on the current-limit behavior.

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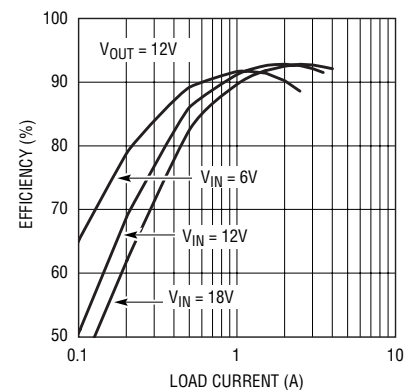


Figure 2. Efficiency vs load current for Figure 1's circuit

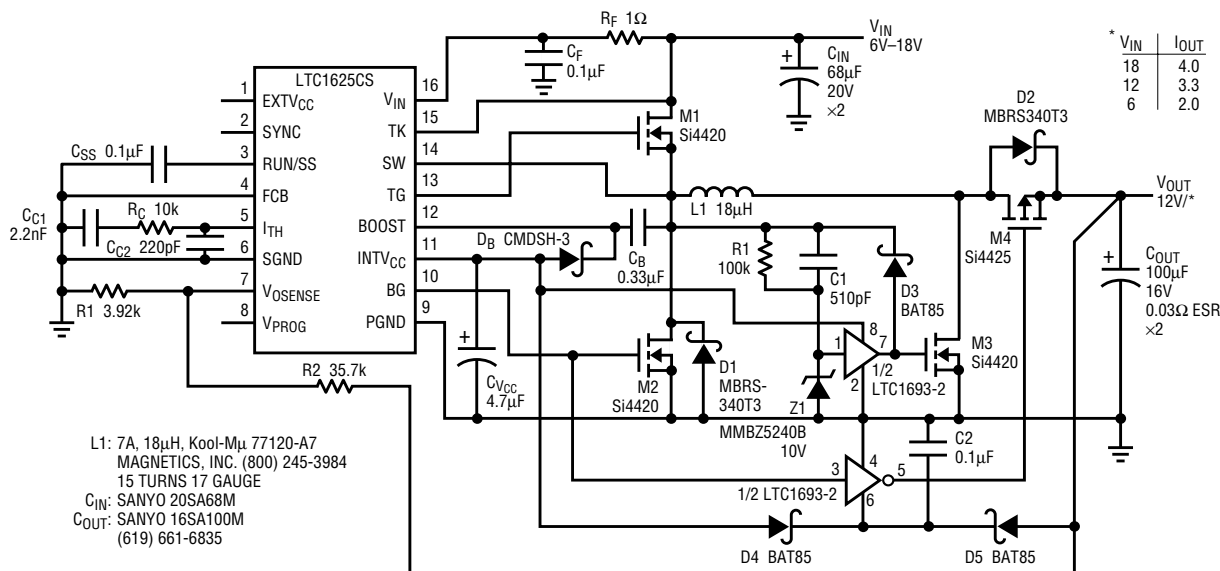


Figure 1. Single-inductor, positive-output buck-boost converter

The LTC1625 uses MOSFET V_{DS} sensing to control the inductor current peaks. Thus, the controller limits the average value of the inductor current rather than the output current in this topology. Because the input current varies as V_{IN} is changed, the limit on output current depends upon the input voltage. With $V_{IN} = 12V$, the maximum output current is about 3.3A. Efficiency of the circuit is shown in Figure 2.

Nonoverlapping control signals for the switches M2 and M4 are generated from the LTC1625 and buffered by an LTC1693-2 dual MOSFET driver. Note that the control signal for the PFET M4 must be able to swing between ground and V_{OUT} . Thus, the inverting half of the LTC1693-2 is powered from a diode-OR between $INTV_{CC}$ (for start-up) and V_{OUT} .

Several simplifications are possible for this circuit. The switch node can

be connected directly to M3's gate, provided that V_{IN} remains below the maximum rated gate voltage. This eliminates R1, C1, Z1, D2 and the buffer portion of U2. The second stage could also be made nonsynchronous by replacing D2 with a larger diode, such as an MBRD835L, and eliminating M4, D4, D5, C2 and the inverting portion of U2. Nonsynchronous operation reduces the peak efficiency by two to three percent. 