High Current Positive-to-Negative Conversion with the LTC1775 No R_{SENSE} Controller

by Christopher B. Umminger

The LTC1775 No R_{SENSE}™ controller is well suited for positive-to-negative conversion. An example of such a circuit, shown in Figure 1, provides a –5V/2.5A output. This topology is a DC/DC up/down converter that is commonly called synchronous buck-boost. It differs from the typical LTC1775 buck converter applications in several important ways. First, the LTC1775 is connected between the positive input voltage and the negative output voltage with the output of the inductor connected to the system ground. Thus, the LTC1775 and the power MOSFET switches are exposed to a voltage that is the sum of V_{IN} + $|V_{OUT}|$, which must be kept below the 36V absolute maximum voltage of the controller. Second, the negative output voltage can be either larger or smaller than the input. In the buck-boost topology, the duty cycle is equal to $|V_{OUT}|/(V_{IN} + |V_{OUT}|)$, with a fifty percent duty cycle occurring when $V_{OUT} = -V_{IN}$. Third, the average inductor current is no longer equal to the average output current. Rather, the inductor current carries the sum of the average input and output currents. Since the LTC1775 controls and limits the inductor current, the maximum load current limit will depend on the input voltage. Finally, both the input and output capacitors must filter square pulse currents in this circuit. Figure 2 shows the efficiency at two different input voltages.

An interesting modification can be made to this circuit if suppression of input voltage transients is not critical. Connecting the negative terminal of C_{IN} to $-V_{OUT}$ creates an alternate form of the indirect up/down converter. In this case, the output capacitor is only required to filter the inductor ripple current rather than a square pulse current, significantly reducing the output voltage ripple. On the other hand, changes in the input voltage are directly coupled to the output via the capacitive divider formed by C_{IN} and C_{OUT}. Thus, this circuit variation should only be used if the input voltage is well regulated.

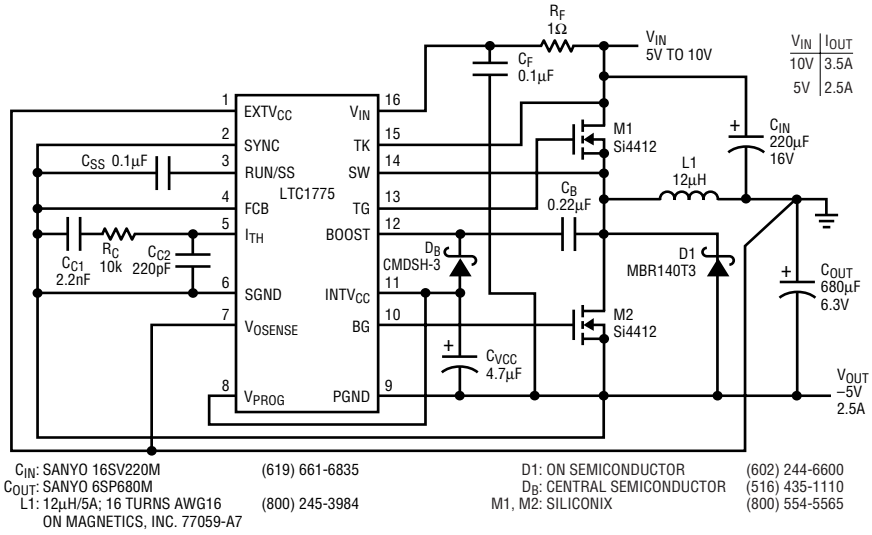

Figure 1. –5V/2.5A positive-to-negative converter

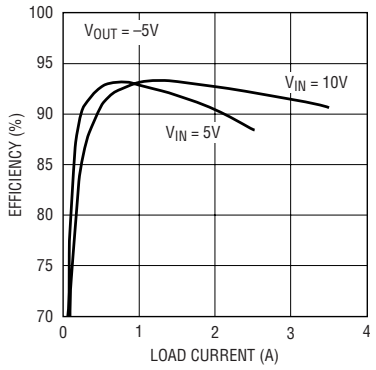

Figure 2. Efficiency vs load current for Figure 1's circuit