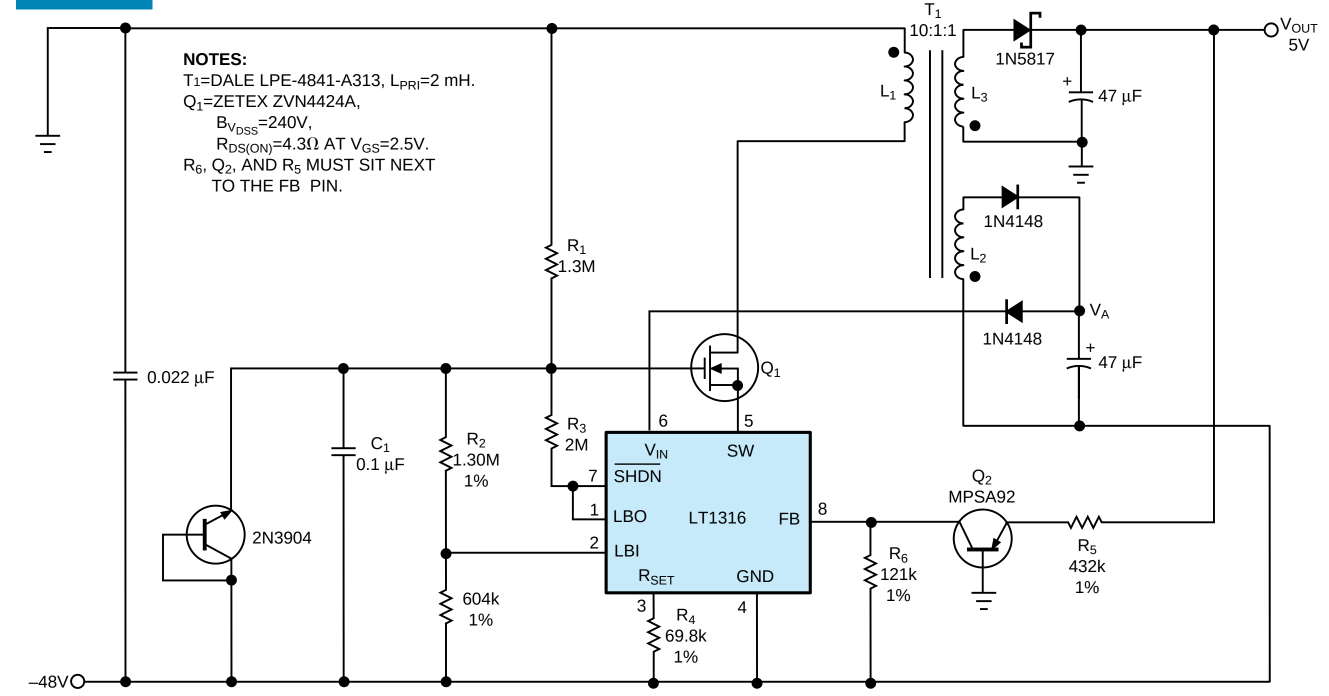
DC/DC converter operates from phone line

GARY SHOCKEY, LINEAR TECHNOLOGY CORP, MILPITAS, CA

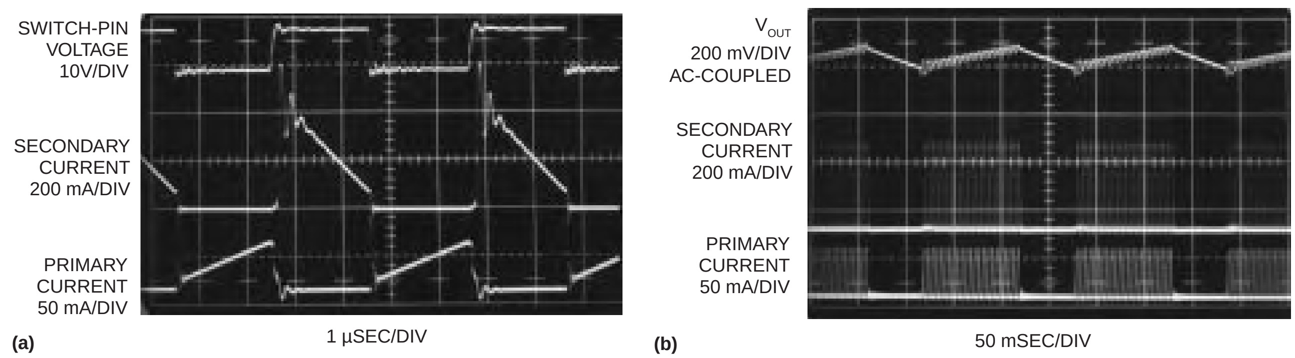
DC/DC converters for use inside the telephone handset require operation from the high-source-impedance phone line. Additionally, the CCITT specifications call for maximum on-hook power consumption of 25 mA. The dc/dc converter in **Figure 1** is 70%-efficient at an input power of 25 mA, providing 5V at 3.4 mA. Controlled, low-peak switch current ensures that the –48V input line experiences no excessive voltage drops during switching.

FIGURE 1



A –48-to-+5V flyback converter provides 3.4 mA of output current.

FIGURE 2



Switch voltage and current waveforms (a) show how the primary current ramps up during the switching cycle. The output ripple voltage is approximately 100 mV p-p (b).

The circuit operates as a flyback regulator with an auxiliary winding to provide power for the LT1316 switching-regulator IC. When you first apply power, the LBI pin is low, causing the SHDN pin to connect to ground through LBO. Grounding the SHDN pin places the part in shutdown mode, and only the low-battery comparator remains active. During this state, V_{IN} rises at a rate determined by R_1 and C_1. The IC draws only 6 μA in shutdown mode. R_1 needs to supply only this shutdown current, the current through R_2 and R_3, and C_1's charging current.

When LBI reaches 1.17V (which corresponds to a V_{IN} of approximately 3.7V), the LBO pin lets go of SHDN and the IC enters the active mode; switching action begins, and the output voltage begins to increase. As the device switches, the V_{IN} pin draws current out of C_1. V_{IN} then decreases sufficiently to trip the low-battery detector, stopping the switching. Start-up proceeds in this irregular fashion until, eventually, the voltage at V_A increases to 5V. (V_A is the same as V_{OUT} because L_2 and L_3 have the same number of turns.) After start-up, current flows to the IC from V_A rather than from the –48V rail, increasing efficiency. The circuit will not start if V_{OUT} is loaded before it reaches 5V.

During each switch cycle, current in the transformer primary ramps up until reaching the current limit (**Figure 2a**). The value of R_4 sets the peak switch current. The circuit uses a 69.8-kΩ resistor to provide a peak switch current of 50 mA; increasing R_4 decreases the current limit. Secondary peak current is approximately equal to the primary peak current multiplied by the transformer's turns ratio (**Figure 2b**). The FB pin has a sense voltage of 1.23V, and you can set V_{OUT} by the following formula:

$$V_{OUT} = 1.23\left(\frac{R_5}{R_6}\right) + 0.6V.$$

For the load currents of 4 to 80 mA, the circuit achieves a minimum of 70% efficiency. Less than 80 μA quiescent current flows when the converter supplies 0.5 mA over 36 to 72V. (DI #2148) EDN

To Vote For This Design, Circle No. 356