Step-Up Switching Regulators

Inductor-based, step-up switching regulators offer high efficiency, small size and lower cost than isolated switching regulators (DC/DC converters). They are used to amplify (step up) the voltage of a lower voltage source or battery. The inductor stores energy during the on time of the switching transistor and transfers it to the output capacitors and load during the off time. The energy stored in the inductor during the on time is proportional to the inductor and the square of the input current; the energy is then transferred to the load during the off time.

If the voltage source or battery is located far away from the switching regulator or its input impedance is high, the PWM in the regulator increases the on time of the switching transistor to compensate for the voltage drop due to the internal impedance of the source or long power connection(s).

The negative input resistance of any PWM-based converter demands a low output resistance power source or battery. Even though most PWM-based converters have a soft start feature, if the power source has high output resistance the converter may not be able to start. The regulator may remain in a hiccup mode, or worse the input inductor may saturate and the input switching transistor may short if the input fuse does not open.

One way to reduce the output impedance of the power source is to use large, low ESR capacitors at the input of the switching regulator. By increasing the soft start time of the regulator, the peak input current will be reduced at turn on. The output capacitor will affect the turn on time of the regulator and will increase the input current at turn on.

In Figures 1 & 2, the equivalent circuits of a step-up switching regulator show the parasitic resistance and current path during the on time (Figure 1) and off time (Figure 2) of the switching transistor. From these two equivalent circuits, it is clear why the power connection resistance must be minimized, why the input capacitors must have low ESR and where the power is dissipated.

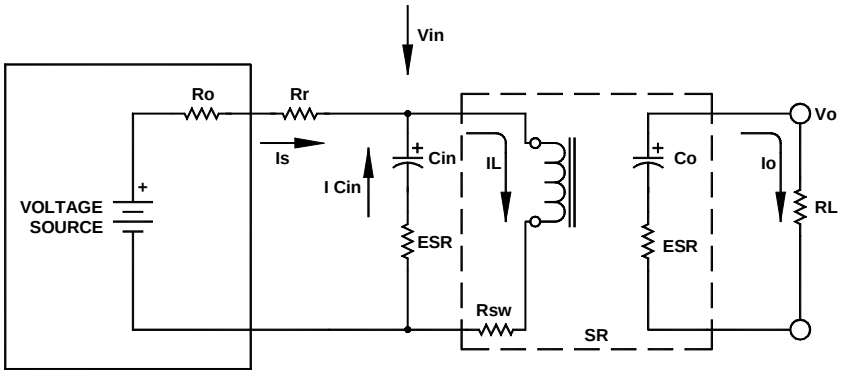

FIGURE 1. Equivalent circuit of a step-up switching regulator during the on time of the switch

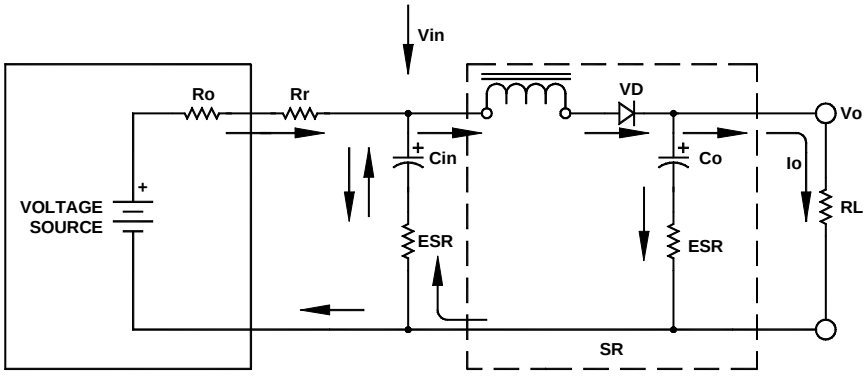

FIGURE 2. Equivalent circuit of a step-up switching regulator during the off time of the switch