Circle 520

A Low-Cost High-Performance DC-DC Converter Topology

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Flyback and forward converter topologies are commonly used in switch-mode power-supply design. However, each topology has certain limitations that are hard to resolve.

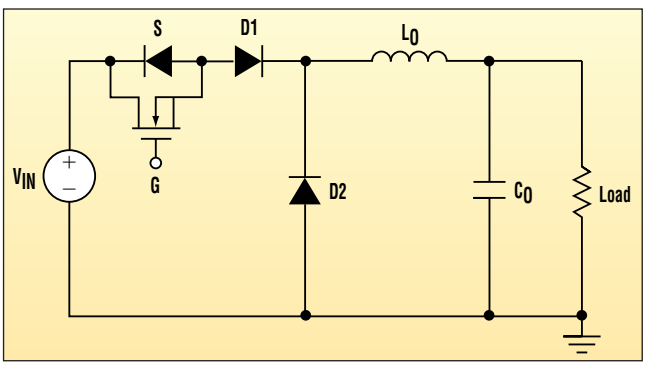
In flyback converters, the gapped transformer inductance results in a zero in the right-half-plane (RHP), which makes the closed-loop compensation in CCM (continuous conduction mode) very difficult. Typically, the closed-loop bandwidth in CCM is very narrow and the resulting transient response is very slow. Another drawback in flyback converters is a large output capacitor requirement due to the lack of a second-order low-pass inductor/capacitor filter at the output.

Compared with flyback converters, forward converters require one additional output inductor, although they have reduced requirements for the output capacitor. To avoid transformer saturation, a resetting circuit in a forward converter is needed. All of these increase the component count and cost.

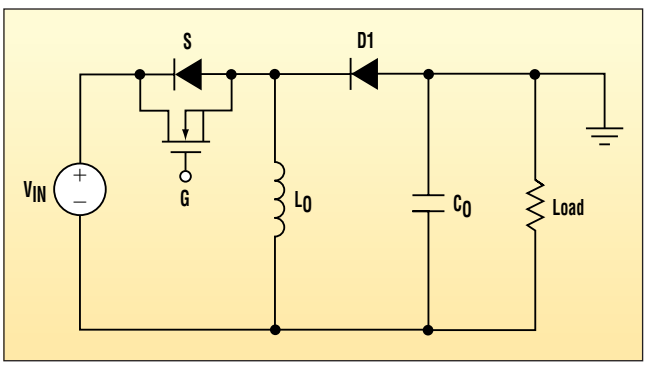
However, the question arises: "Can we combine these two topologies to reduce the disadvantages inherent in these two converter topologies?" The answer is quite positive.

Let's start with the non-isolated buck and buck-boost converters shown in Figure 1 and Figure 2. If we combine the switching turn-on period of the buck converter and the switching turn-off period of the buck-boost converter, the circuit in Figure 3 results. By employing a gapped transformer, Figure 4 can be derived directly from the circuit in Figure 3. Indeed, it can be easily seen that Figure 1 and Figure 3 are equivalent. Therefore, the output capacitor design in Figure 4 is the same as in the conventional buck or forward converter. The transformer design is the same as in the conventional flyback converter, with the exception that the inductance value is the same as in the buck or forward converters.

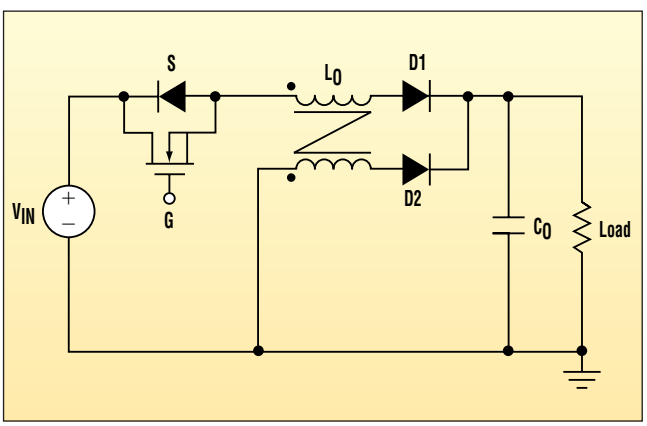
The advantages of this circuit include: smaller output capacitance compared to a flyback converter; no output choke required; no RHP zero; easy to compensate; fast transient response; no resetting circuitry needed compared to a forward converter. The major disadvantage of this circuit is that the inductance of the transformer is larger than that in the flyback converter. Therefore, this circuit is less attractive for intermediate to high power off-line switching mode power-supply applications, due to too many transformer primary windings required. However, the circuit is still good for low power off-line applications (with smaller inductance), and excellent for low-power, low-input-line voltage applications.



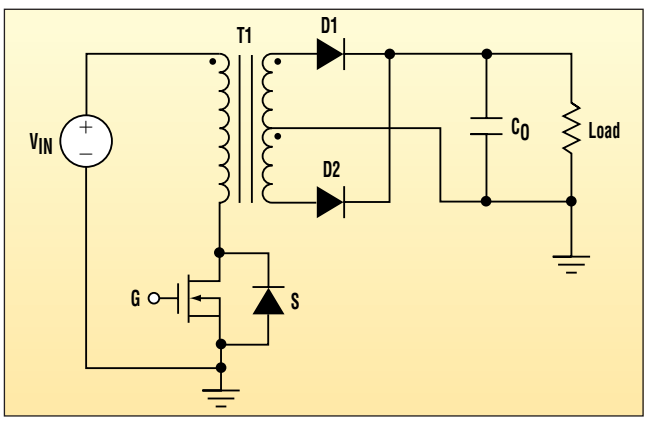
1. This circuit represents a conventional buck converter.



2. Shown here is a conventional buck-boost converter.



3. Combining the buck converter topology with the buck-boost converter topology results in this circuit.



4. The output capacitor design in the new isolated dc-dc converter is the same as in the conventional buck or forward converter.