Simple Isolated Telecom Flyback Circuit Provides Regulation Without Optocoupler

by John Shannon

Introduction
The LT1725 uses a proprietary technique to regulate an isolated output voltage without an optocoupler, thus greatly simplifying flyback converter design and reducing the component count. The result is reduced design time, smaller space requirements, lower cost, and improved performance.

Traditional isolated flyback converters employ a secondary side voltage reference and error amplifier that drive an optocoupler, which sends the control signals back to the primary side. In addition to being parts intensive, this approach places an optocoupler in the feedback loop, which introduces a host of design problems. Optocouplers are poorly defined components—their gain is variable and subject to degradation over time. They are also relatively slow. Optocoupler shortcomings add considerably to the total converter design time and ultimately limit performance.

Consider instead the schematic of Figure 1. This is a flyback converter based on the LT1725. There are extremely few components and yet a high level of functionality. This design is short circuit proof and includes an input undervoltage lockout for increased reliability. The performance of this converter is shown in Figure 2. Output voltage is regulated to within 1% over a 2:1 input voltage range with 10% or greater load. No load regulation is within 2% over a 2:1 input voltage range. This is well within the typical requirement of 5% regulation.

Circuit Operation
The LT1725 flyback controller is a current mode control IC. Current mode operation provides for inherent line transient rejection and simple loop compensation. Current mode controllers have an “inner” fast current control loop and a slower “outer” voltage control loop. The inner current loop has immediate pulse-by-pulse control of the switching MOSFET M1. A normal switching cycle is as follows. The MOSFET M1 is turned on to begin the cycle. Once M1 is turned on, the current in the primary winding of the flyback transformer ramps up. When the primary current reaches a level determined by the value of the voltage on the Vc pin, M1 is turned off. The voltage on the Vc pin is set by the LT1725’s output voltage control loop—the outer loop. Once M1 turns

Figure 1. -48V to 5V 2A isolated flyback converter

continued on page 33
Design Example

Figure 1 shows a design that provides 2.5V/15A and 1.8V/15A from a 3.3V input. Because the LTC1876 provides a 5V bias for MOSFET gate drive, a very low $R_{DS(ON)}$ MOSFET Si4838 (2.4mΩ typical) can be used to achieve high efficiency. Figure 2 shows that the overall efficiency is above 90% over a wide range of loads.

Figure 2 also shows that the light load efficiency of this design is more than 84%. This is a direct benefit of the Burst Mode operation of the LTC1876. Further efficiency improvements come from operating the two step-down channels out-of-phase. The top MOSFET of the first channel is fired 180° out of phase from that of the second channel, thus minimizing the RMS current through the input capacitors. This significantly reduces the power loss associated with the ESR of input capacitors. Figure 3 shows detailed current waveforms of this operation.

Conclusion

The LTC1876 uses three techniques to efficiently power low voltage DSPs, ASICs and FPGAs from a low input voltage. The first technique uses an internal boost regulator to provide a separate 5V for the MOSFET gate drive. Secondly, its Burst Mode operation achieves high efficiency at light loads. Lastly is the out-of-phase technique which minimizes input RMS losses and reduces input noise. Complete regulator circuits are kept small and inexpensive, because all three switchers (one step-up regulator and two step-down controllers) are integrated into a single IC. For systems where a separate 5V is available or the input supply is greater than 5V, the internal boost regulator can be used to provide a third step-up output with up to 1A switch current.