Introduction

The 3.3V DC bus has become popular for broadband networking systems, where it is tapped for a variety of lower voltages to power DSPs, ASICs and FPGAs. These lower voltages range from 1V to 2.5V and often require high load currents. To maintain high conversion efficiency, power MOSFET conduction losses from the step-down converters must be minimized. The problem is that the 3.3V bus also brings with it frequent use of sub-logic level MOSFETs. Such MOSFETs have a relatively high $R_{DS(on)}$, limiting the full-load efficiency of a converter to around 85%. A more efficient solution is to use logic-level MOSFETs, which have very low $R_{DS(on)}$ but require a 5V supply. The LTC1876 allows the use of logic-level MOSFETs by combining a 1.2MHz boost regulator, which produces a 5V bias supply from a 3.3V input, with two step-down controllers, which provide the low voltage outputs. By integrating all three regulators in a single IC, the LTC1876 makes for efficient power supplies that can be small and inexpensive.

Figure 1. An LTC1876 design converts 3.3V to 2.5V at 15A and 1.8V at 15A

Figure 2. High efficiency of the design in Figure 1
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 (2.4m\( \Omega \) 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\( ^\circ \) 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.

off, the current that had been flowing in the primary of the transformer begins to flow in the secondary. The voltage on the drain of M1 rises to a level determined by the transformer turns ratio and the output voltage. Similarly, the voltage on the feedback winding rises to a level set by the output voltage. The LT1725 reads the voltage on the feedback winding during the flyback pulse using a proprietary sampling technique. This sampled voltage is then compared to a precision internal reference and current is added to or subtracted from the capacitor on the \( V_C \) pin. This has the effect of modifying the M1 turn-off current in such a way as to regulate the output voltage. An important benefit of this sampling technique is that output voltage information arrives at the controller about a microsecond after the switching cycle is terminated. In a conventional optocoupler-based design. Delays of tens to hundreds of microseconds occur in the optocoupler alone, severely limiting the converters transient response. Additionally the LT1725 features internal slope compensation. This suppresses sub-harmonic oscillations that can occur with less sophisticated current mode controllers. Sub-harmonic oscillations increase output voltage ripple and increase switching stress.

Conclusion

The LT1725 isolated flyback controller greatly simplifies the design of isolated flyback converters. Compared to traditional opto-isolated designs, an LT1725 based circuit has far fewer components, superior transient response and is easier to stabilize.