Isolated and Non-Isolated High Power, High Voltage DC/DC Controllers

High Performance Analog Solutions from Linear Technology

A very familiar and simple approach to designing an isolated DC/DC converter is the flyback topology. The conversion of an input voltage to an isolated output and the transfer of signals between the high voltage and low voltage planes can be accomplished with the use of transformers and optoisolators. Linear Technology has introduced a new family of flyback converters that are simple and require no optoisolator. Although the flyback converter is used in both non-isolated and isolated power supplies, an isolated design is important when protecting the load (i.e. 1.5V FPGAs) from a high input voltage (72V) by eliminating a direct electrical path from the input to the load ("isolating" the load from the input supply). Isolated flyback DC/DC power supplies are typically found in telecom wireless networks, RFID base stations, Power-Over-Ethernet (PoE) systems and medical instruments, among others.

The flyback topology offers simple isolated DC/DC conversion; however, it is most commonly used in the 30W-50W output power range. This is mainly due to the limitation of the output diode with its inherent high power losses potentially causing thermal problems. Above this power level or load current, designers usually adopt other topologies to prevent excess heat dissipation in the output diode, which can increase the complexity and cost of the design. Often designers push their flyback circuits close to or beyond the safe operating temperature to achieve higher output currents. This jeopardizes a power supply's reliability especially when the system is enclosed and has limited air flow for cooling.

An isolated synchronous flyback controller bridges the gap between the standard low current flyback and the higher current but more complex topologies. It allows a flyback topology to quadruple the load current capability while operating safely at lower temperatures.

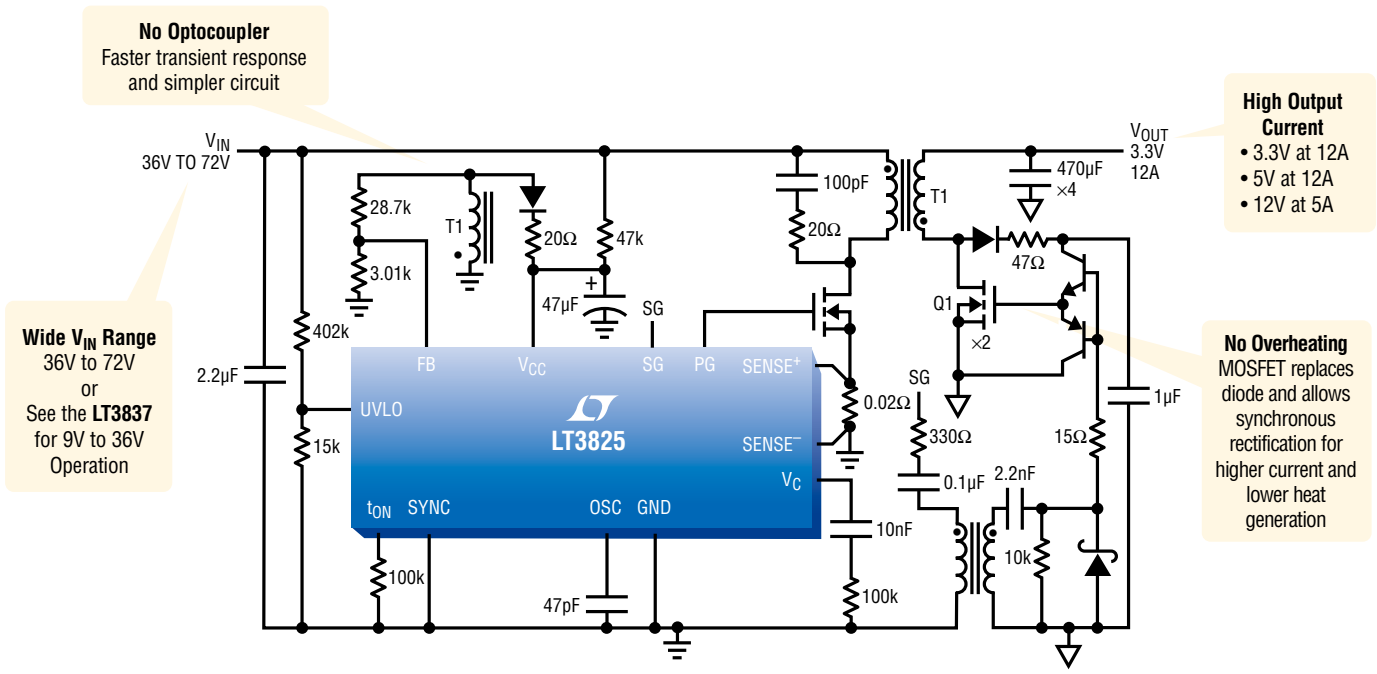

Figure 1. The LT®3825 (or LT3837) Incorporates Synchronous Drive Circuitry and No Optocoupler Design for Delivery of High Current at High Efficiency with Fast Transient Response

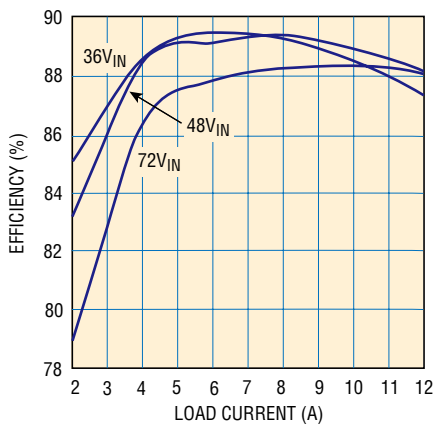

Figure 2. High Efficiency vs. Load Current for Circuit in Figure 1

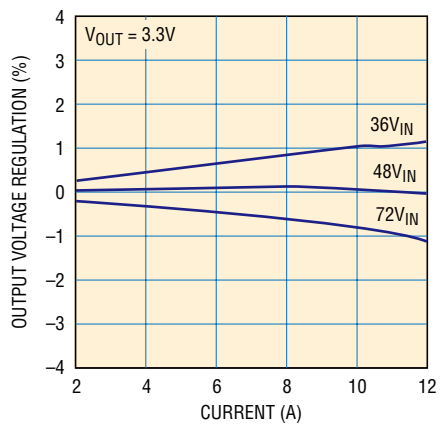

Figure 3. Precision Output Regulation Is Within ±1.3% for Current in Figure 1

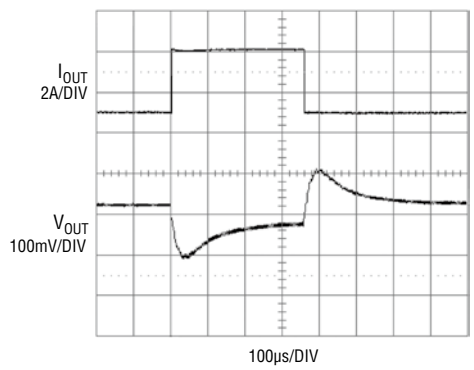

Figure 4. No Optocoupler Design Allows the LT3825 and LT3837 to Deliver Fast Transient Response

12A Flyback Power Supplies without Overheating

The LT3837 and LT3825 are flyback controllers that incorporate the control circuitry for synchronous operation. In addition to synchronous operation for higher load current delivery at higher efficiency (Figure 2), this family offers a simpler solution by eliminating the need for an optocoupler and its driver circuitry while also improving performance. This not only reduces the circuit footprint but also reduces design complexity. The LT3825 targets the telecom (36V-72V) market where the input has a 2:1 ratio (low

Table 1. LT3837/LT3825 Synchronous Flyback Controllers

	LT3837	LT3825
Topology	Synchronous Flyback	
Output Power	≤60W	
Synchronous Rectifier Driver	**Yes**	
Optoisolator and Reference	**Not required**	
Input Range	9V to 18V	36V to 72V
Package	16-Lead TSSOP exposed pad (LT3825 and LT3837 are pin compatible)	

to high end). The LT3837 (Figure 5) is optimized for lower input voltage operation of 9V to 18V (Table 1). The internal circuitry for each part has to be designed so that functions such as UVLO, bias and gate drive perform optimally for both input ranges.

A standard non-synchronous flyback circuit satisfies load current requirements of approximately 3A. Above 3A, the output diode may become too hot. It is because of this rise in temperature that non-synchronous flyback circuits are limited in output load delivery. The LT3825 and LT3837's synchronous drive eliminates this problem by replacing the Schottky diode with a MOSFET. A MOSFET has a much lower voltage drop when conducting current than a diode and therefore produces less heat. An LT3825 circuit can deliver 12A to a 3.3V load (Figures 1 and 2).

No Optocoupler, Fast Transient Response

Instead of using a part's intensive secondary-side voltage reference, error amplifier and optocoupler, the primary bias winding on the flyback transformer (T1) is used. Feedback circuitry inside both the LT3825 and the LT3837 reads the reflected output voltage information on this winding during the flyback pulse. This voltage is then compared to a precision internal reference and an error signal is obtained. The error signal is used to modulate the on-time of Q1 in such a way as to regulate the output voltage. An important benefit of this technique is that output voltage information arrives at the controller instantly after the switching cycle is terminated, resulting in fast transient response to changes in load (Figure 4). In a conventional optocoupler-based design, a propagation delay of several microseconds occur in the optocoupler alone, severely limiting the converter's transient response.

60V, 100% Duty Cycle 40µA I_Q Step-Down Controller

The LTC®3824 is a 4V to 60V input range, 100% duty cycle, low I_Q, adjustable switching frequency 100kHz to 600kHz, DC/DC current mode controller. This controller is ideal for automotive requirements where the 4V low end input works during cold cranking and the 60V high-end input works during inductive load dumps, without the need of external clamping circuits.

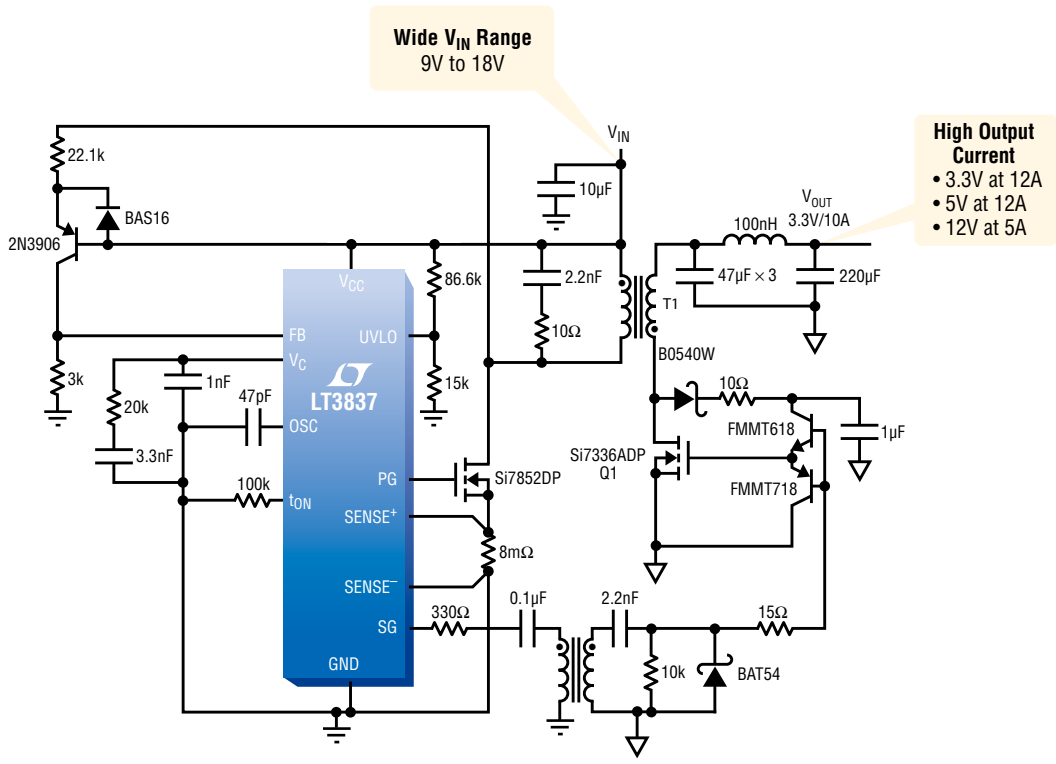

Figure 5. The LT3837 Synchronous Flyback Controller Is Optimized for 9V to 18V Input Supplies for Industrial and Instrumentation Applications

The 40µA quiescent current battery-powered instruments to minimizes the drain on the car battery when in standby mode.

The LTC3824 offers step-down solutions for applications that cover a broad range of inputs, from automotive requirements, where the $60V_{IN}$ maximum rating allows much more V_{IN} margin than most other controllers.

The benefit of 100% duty cycle is to have the lowest possible dropout voltage to extend battery life, allowing V_{OUT} to equal or be close to V_{IN}. The LTC3824 drives an external P-channel MOSFET and maintains high efficiency at light loads with its Burst Mode® operation and 40µA no load quiescent current. The current mode operation provides fast line and load transient response as well as cycle-by-cycle overcurrent protection. Additional features include short-circuit protection, adjustable soft-start, overvoltage protection and undervoltage lockout. For noise-sensitive applications, the LTC3824 can be easily synchronized to an external clock from 100kHz to 600kHz. In addition, the output voltage can be adjusted over a wide range from 0.8V to V_{IN}. The LTC3824 is offered in a 10-pin thermally enhanced MSOP package.

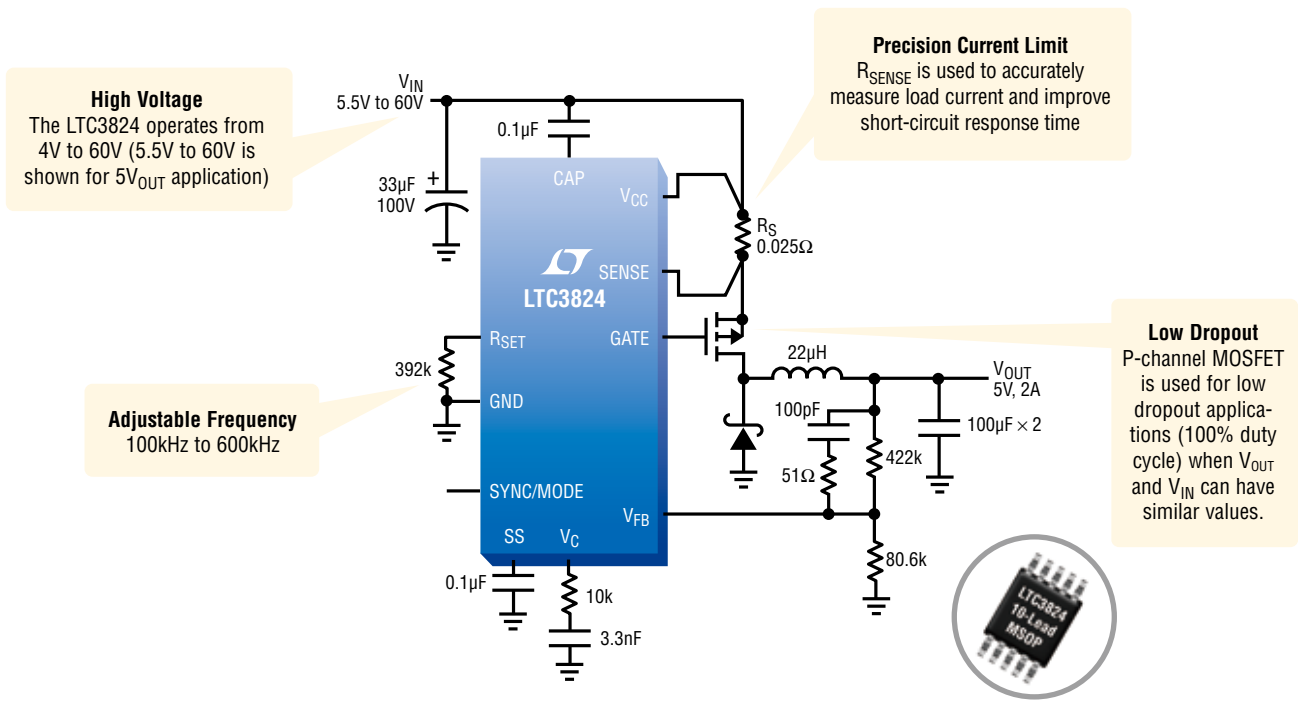

Figure 6. Easy-to-Use Non-Isolated High Voltage Buck Controller