Primary-Side Control for CCM Flyback Power Supply

Summary of the Idea

A primary-side controller for an isolated flyback power supply operating in continuous conduction mode (CCM) may use a primary-side winding to sense and to regulate the output voltage as shown in Figure 1. The sense winding provides a switching feedback voltage V_{FB} that is gated to a capacitor charge-discharge circuit during a time T_{FB} when the output rectifier is conducting. A capacitor discharges when V_{FB} is greater than a desired regulation value V_{REF}. The capacitor charges at a decreasing rate when the V_{FB} is less than V_{REF}. The voltage on the capacitor at the end of T_{FB} determines the duty ratio of a pulse width modulator (PWM) that drives the primary switch. For stable operation and fast transient response, the capacitor must discharge to a constant reset value V_{RESET} when V_{FB} is greater than V_{REF}. The charging current should decrease as the capacitor voltage increases to provide a higher control gain at light loads and a lower control gain at high loads.

Description

Figure 1 shows that feedback voltage V_{FB} is negative when switch S1 conducts current I_D during time T_{ON} within a switching period T_S. V_{FB} is positive and represents the output voltage V_O during time T_{FB} when output rectifier D1 conducts secondary current I_S, which for CCM is the time when switch S1 is open. V_{FB} typically has a decreasing value during time T_{FB} as secondary current I_S decreases from an initial peak value. This AC ripple voltage on DC output voltage V_O is typically dominated by current I_S with the equivalent series resistance (ESR) of capacitor C_O.

Figure 2 is an example gating, charge-discharge, and PWM circuit. Switched current sources I1 and I2 respectively charge and discharge capacitor C1 when V_{FB} is less than or greater than V_{REF}, respectively. The voltage V_{PWM} on C1 is compared to a ramping voltage V_{SAW} to produce a pulse width modulated output voltage V_{DRIVE} for primary switch S1.

Figure 3 shows the waveforms of Figure 2 in greater detail with emphasis on the relevant timing relationships.

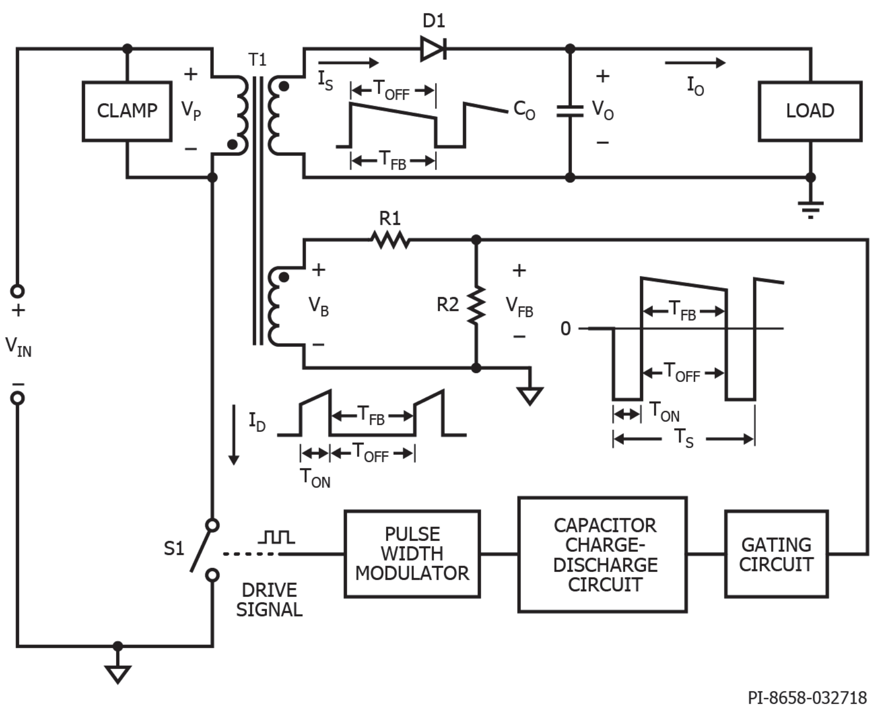

Figure 1. An example of an isolated flyback power supply operating in continuous conduction mode that uses a controller with a capacitor charge-discharge circuit to process a feedback signal from a winding referenced to the primary side. A pulse width modulator drives primary switch S1 with a duty ratio that corresponds to a signal received from the capacitor charge-discharge circuit.

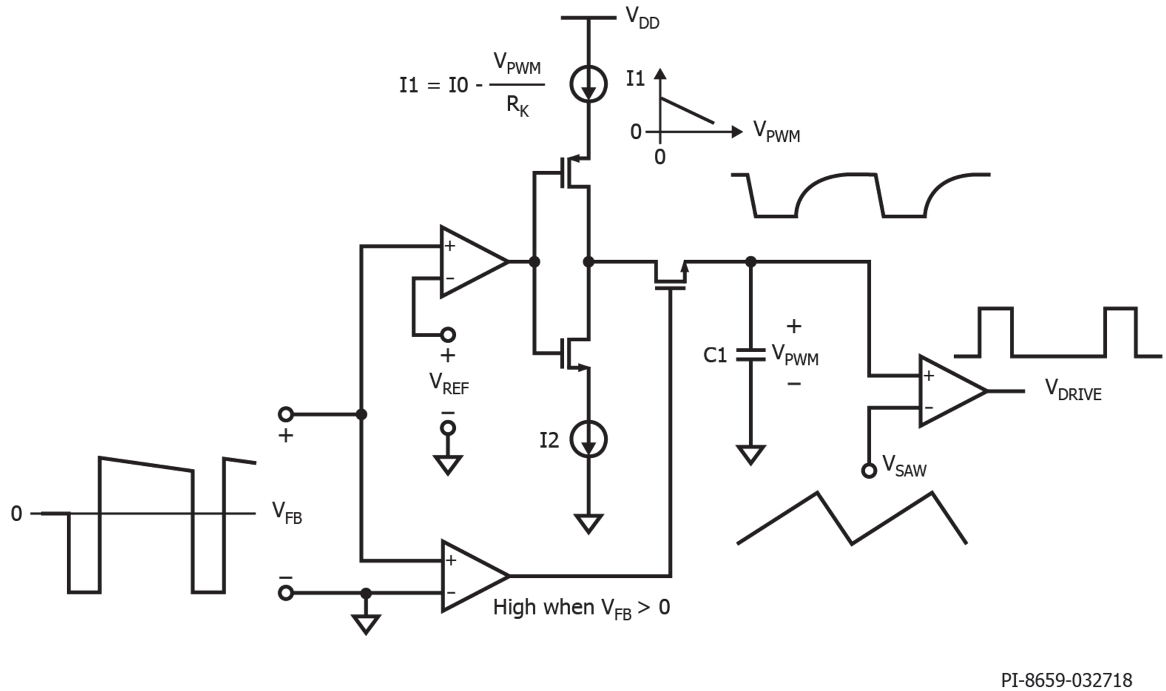

Figure 2 An example of a capacitor charge-discharge circuit and pulse width modulator for a flyback power supply operating in continuous conduction mode. The positive portion of feedback voltage V_{FB} is compared to a reference voltage V_{REF} to gate current sources I1 and I2 that charge and discharge capacitor C1. The value of current source I1 decreases as the voltage V_{PWM} on capacitor C1 increases. V_{PWM} is compared to a ramping voltage V_{SAW} to produce a pulse width modulated drive voltage V_{DRIVE}. In this example, I1 decreases linearly with slope $1/R_K$ from an initial value I_0.

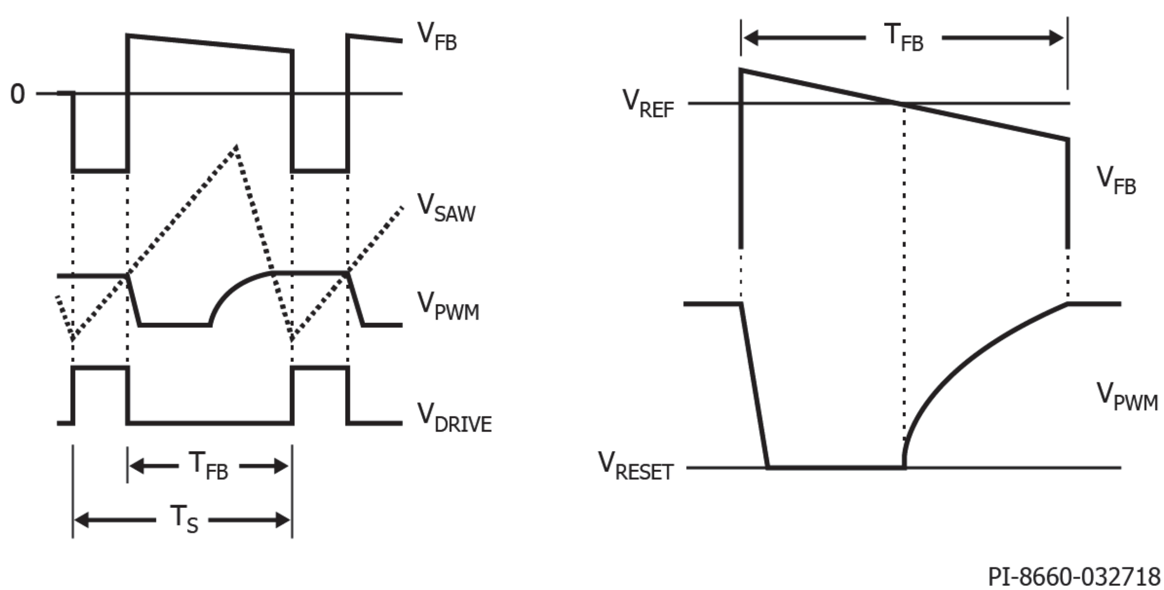

Figure 3. Waveforms showing the timing relationships of signals from the example control circuit of Figure 2. Decreasing feedback voltage V_{FB} during the feedback interval T_{FB} crosses a reference value V_{REF} that is representative of a desired value of output voltage V_O. Current source I2 in the circuit of Figure 2 is chosen to discharge capacitor C1 to a constant reset value V_{RESET} before current source I2 charges C1. In some examples, the value of V_{RESET} may be zero volts. The decreasing value of current source I1 as V_{PWM} increases gives the controller a higher gain at light loads and a lower gain at higher loads to produce stable operation and fast transient response over a wide range of loads.

World Headquarters 5245 Hellyer Avenue, San Jose, CA 95138, USA, Main: +1-408-414-9200
Customer Service Phone: +1-408-414-9665, Fax: +1-408-414-9765, Email: info@power.com
On the Web www.power.com