UNITRODE

Design Note

Comparing the UC3842, UCC3802, and UCC3809 Primary Side PWM Controllers

by Lisa Dinwoodie

Introduction

Despite the fact that the UC3842 and the UCC3802 are pin for pin compatible, they are not drop in replacements for each other. Designed as the next generation ‘42, the UCC3809 also has differences that prevent a simple drop in substitute. Table 1 identifies the most notable features and functional differences between the three controllers. This Design Note will help the user transition from either the UC3842 or the UCC3802 to the UCC3809 in an existing design.

Figures 1, 2, and 3 all show the same basic isolated flyback converter utilizing a different primary side controller chip. Each converter uses identical component types and circuit traces. Careful attention must be paid to the components and circuit traces that are drawn with dotted lines. The dotted lines indicate unused components in that particular design and these designations would be left open. The secondary side of each figure consists of an error amplifier and voltage reference to compare the output voltage and drive an optocoupler. The primary side of each figure consists of a MOSFET switch, PWM controller IC, and supporting circuitry to perform soft start, leading edge blanking, slope compensation, and current limiting. Table 2 lists each component and the function it supports in each design.

Soft-Start and Shutdown

The UC3842 requires an external PNP, resistor, and capacitor in order to have full cycle soft start. The UCC3802 has built in soft start fixed at 1V/ms. The UCC3809 has user programmable soft start by selecting a single capacitor. The shut down circuitry is the same in all three designs except that the UCC3809 uses this circuitry to pull the SS pin low instead of pulling the COMP pin low as in the UC3842 and the UCC3802.

Bias

The BiCMOS design of the UCC3802 and the UCC3809 result in lower start up and operating currents as compared to the bipolar UC3842. As an added feature, the ‘09 has two versions with different under voltage lockout levels for off-line or dc to dc systems.

Table 1. Feature comparison of the three controllers.

FEATURES	UC3842	UCC3802	UCC3809
Operating Current	11mA	0.5mA	0.6mA
Undervoltage Lockout/Hysteresis	16V / 6V	12.5V / 4.2V	10V / 2V (–1 Version) 15V / 7V (– 2 Version)
Max. Frequency	500 kHz	1 MHz	1 MHz
Soft Start	External Circuit Required	Internal	User Programmable
Leading Edge Blanking	External	Internal	External
Output Drive	± 1A	± 1A	0.4A Source / 0.8A Sink
Reference Voltage	5V ± 2%	5V ± 2%	5V ± 5%
Maximum Duty Cycle Limit	Not User Programmable	Less Than 90% Not Recommended	User Programmable Up To 70%
Slope Compensation	External	External	External
Error Amplifier	Internal	Internal	External
Shut Down	External	External	External

Outputs

Only the UC3842 requires Schottky diodes from the output to ground in order to prevent the substrate from becoming negatively biased. The CMOS output stage of the UCC3802 and UCC3809 make these Schottkies unnecessary.

Oscillator

Both the UC3842 and the UCC3802 use a single resistor and capacitor to set the oscillator frequency. Both oscillators have a valley voltage of approximately zero. This is evident in Figures 1 and 2 where R_{T2} is not used (shorted) and the AC coupling capacitor in the slope compensation circuitry, C_{SC}, is also shorted. Although requiring fewer parts, setting a maximum duty cycle is difficult if not impossible. Because the UC3842 and the UCC3802 do not have trimmed discharge currents, the maximum duty cycle can only be set by trial and error on every device. The UCC3809 uses two resistors and a capacitor (and two pins) to set its oscillator frequency. The user can reliably set the maximum duty cycle by programming the positive ramp time of the oscillator through the selection of R_{T1} and C_T. Because the valley voltage of the oscillator is greater than zero, the AC coupling capacitor is required in the slope compensation circuitry of the UCC3809. The UCC3802 and the UCC3809 can be used in systems with switching frequencies as high as 1MHz, the UC3842 is limited to 500kHz operation.

Feedback

Because the flyback design shown in the figures requires isolation, an external error amplifier is used on the secondary side to sense the output voltage. The internal error amplifiers in the UC3842 and the UCC3802 are configured for unity gain and are essentially not used. The UCC3809 was designed without an internal error amplifier, greatly reducing its silicon size and cost. A single pin (FB) sums the current sense signal, the voltage feedback signal, and any added slope compensation. The UC3842 and the UCC3802 require three pins to perform these functions.

Current Sense

To reduce the effects of noise pulses on the leading edge of the current sense signal, the UC3842 and the UCC3809 designs both use an RC filter. Thanks to an internal discharging FET on the FB pin in the UCC3809, this device has better noise immunity and requires a smaller external RC filter than the UC3842. These components are not required with the UCC3802 because this chip has on-board current sense filtering that blanks out the first 100ns of the rising edge of the OUT pin.

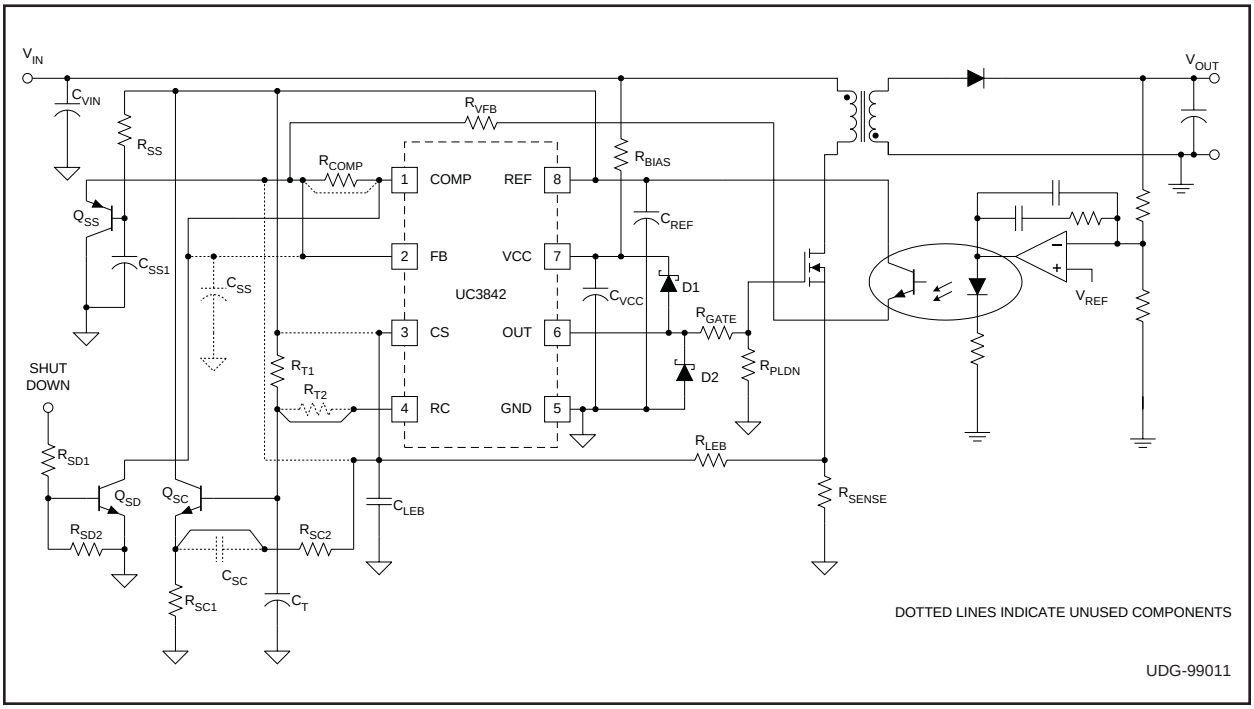

Figure 1. Isolated flyback converter using the UC3842.

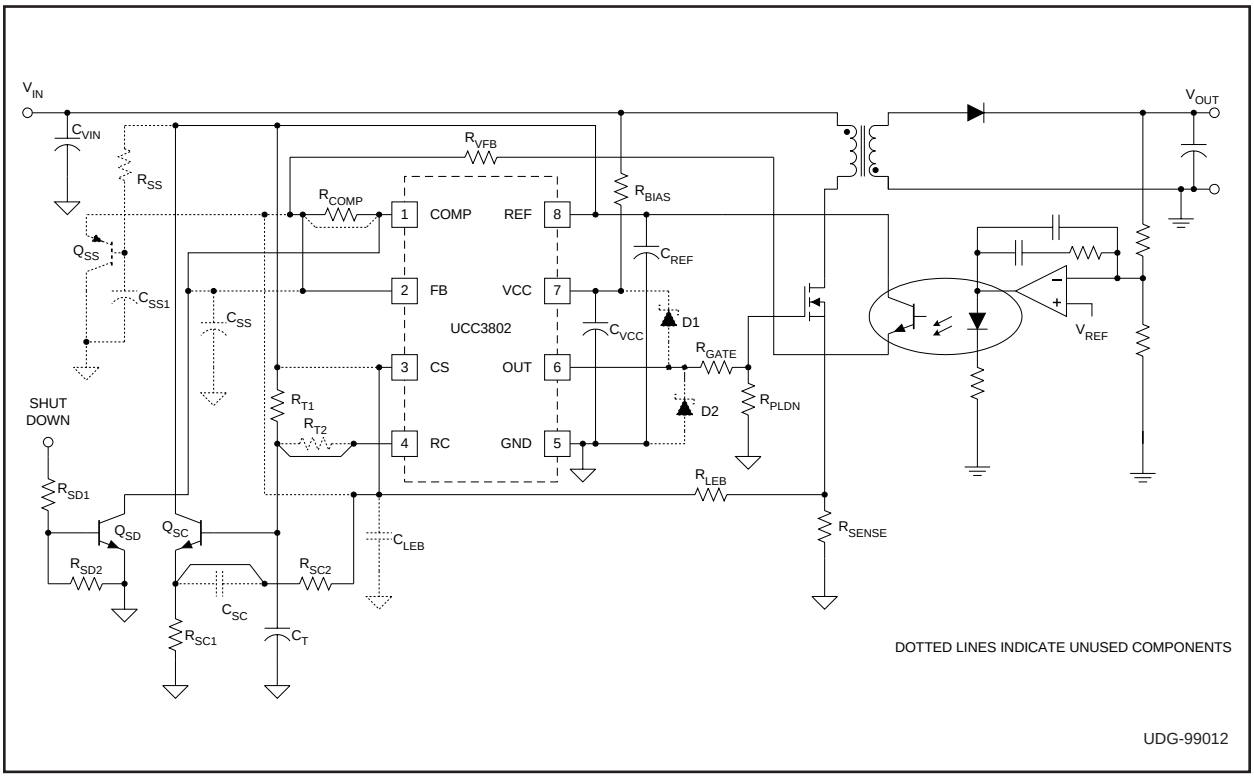

Figure 2. Isolated flyback converter using the UCC3802.

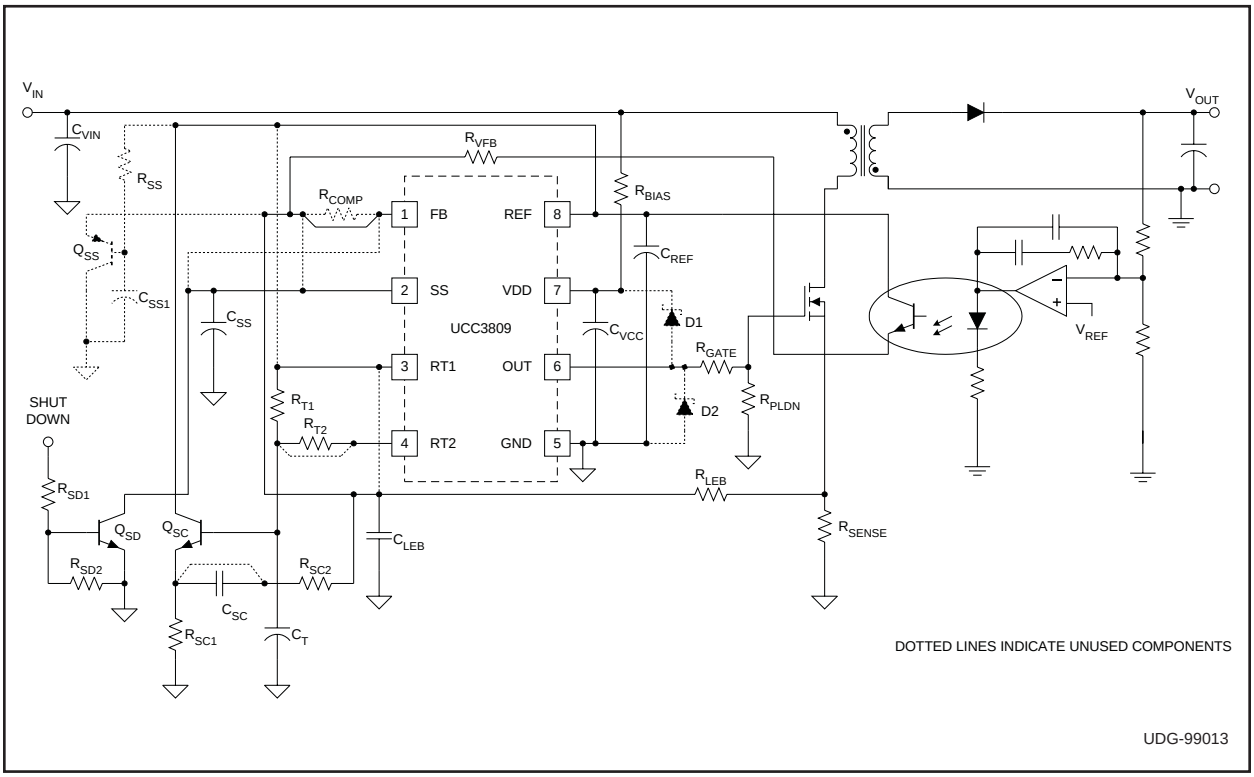

Figure 3. Isolated flyback converter using the UCC3809.

Table II. Component function and requirement comparison for Figures 1, 2, and 3.

COMPONENT	FUNCTION	UC3842	UCC3802	UCC3809
R_{BIAS}	IC Operating Current, UVLO/Hysteresis	Required	Required	Required
C_{REF}	VREF Decoupling	Required	Required	Required
C_{VCC}	Input Voltage Decoupling	Required	Required	Required
D1	Gate Drive Clamp	Required	Not Used	Not Used
D2	Gate Drive Clamp	Required	Not Used	Not Used
R_{GATE}	Gate Drive	Required	Required	Required
R_{PLDN}	Gate Drive	Required	Required	Required
R_{T1}	Oscillator	Required	Required	Required
R_{T2}	Oscillator	Not Used	Not Used	Required
C_T	Oscillator	Required	Required	Required
C_{SS}	Soft Start	Not Used	Not Used	Required
Q_{SS}	Soft Start	Required	Not Used	Not Used
C_{SS1}	Soft Start	Required	Not Used	Not Used
R_{SS}	Soft Start	Required	Not Used	Not Used
R_{LEB}	Leading Edge Blanking, Slope Compensation	Required	Required	Required
C_{LEB}	Leading Edge Blanking	Required	Not Used	Required
Q_{SC}	Slope Compensation	Required	Required	Required
R_{SC1}	Slope Compensation	Required	Required	Required
C_{SC}	Slope Compensation	Not Used	Not Used	Required
R_{SC2}	Slope Compensation	Required	Required	Required
R_{VFB}	Voltage Feedback	Required	Required	Required
R_{COMP}	Voltage Feedback	Required	Required	Not Used
Q_{SD}	Shutdown	Required	Required	Required
R_{SD1}	Shutdown	Required	Required	Required
R_{SD2}	Shutdown	Required	Required	Required
R_{SENSE}	Current Limit	Required	Required	Required

Packaging

In systems where board space and height are at a premium, the UCC3809 is the optimum choice because it is available in the new MSOP package, which is approximately two-thirds the footprint of the TSSOP package. The MSOP measures only 1mm in height as compared to 1.2mm for the TSSOP. The TSSOP is the smallest package available for the UCC3802 and the 14 pin SOIC D package is the smallest package that will accommodate the UC3842.

Summary

Although not directly a drop in replacement, existing designs utilizing the UC3842 or the UCC3802 can be easily transitioned to the UCC3809. By doing so, the user will enjoy the added benefits of programmable soft-start, maximum duty cycle clamp, smaller profile, and better noise immunity without a redundant, unused error amplifier on the primary side resulting in a more cost effective, efficient design.

UNITRODE CORPORATION
7 CONTINENTAL BLVD. • MERRIMACK, NH 03054
TEL. (603) 424-2410 • FAX (603) 424-3460

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