High Efficiency, Low Input Voltage, Synchronous Buck Controller Drives up to 15A Load Current

by Joseph Duncan

Introduction

The LTC3822 is a synchronous step-down DC/DC converter that drives external N-channel power MOSFETs to maximize average current drive for the lowest cost. Its No R_{SENSE} constant frequency architecture minimizes the number of external components, and a programmable frequency of up to 750kHz allows the use of small surface-mount inductors and capacitors. This DC/DC controller is optimized for $3.3V_{IN}$ and Lithium-Ion applications allowing V_{OUT} as low as 0.6V while maintaining 1% precision. The all N-channel MOSFET drive simplifies component selection as well as drastically increasing the current capabilities of a typical circuit. Even with 3.3V gate drive, the LTC3822 is capable of controlling more than 15A load current while maintaining high efficiency.

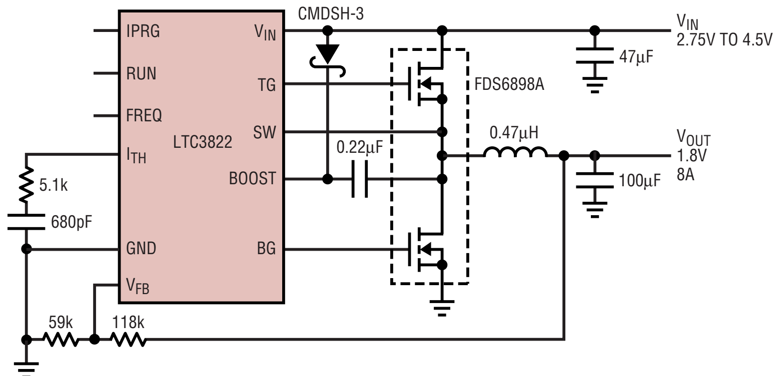

Figure 1. Typical application delivering 1.8V at 8A.

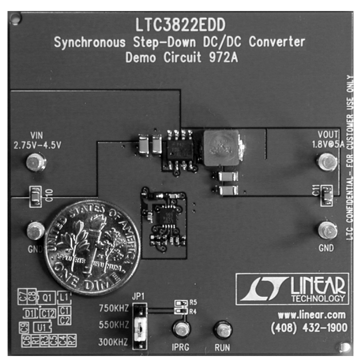

Figure 2. Sample footprint for application circuit in Figure 1

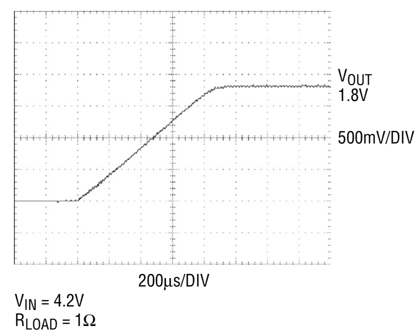

Figure 3. Internal soft-start ramps the output voltage smoothly without requiring an external capacitor.

Compact, 1.8V, 8A Application

Figure 1 shows a 1.8V, 8A application that operates over input voltages between 2.75V and 4.5V, perfect for 3.3V or Li-Ion inputs. This application occupies much less space than would be expected for its current capabilities, as shown in Figure 2.

During startup, the internal soft-start circuitry smoothly ramps the output voltage from 0V to its final value in 800µs (Figure 3). This is done without the need for an external capacitor. The LTC3822 incorporates No R_{SENSE} technology to sense the inductor current from the drain to source voltage (V_{DS}) of the top-side power MOSFET. The maximum load current that the controller is capable of driving is determined by the $R_{DS(ON)}$ of this MOSFET. Since the LTC3822 incorporates all N-channel MOSFET drive, lower $R_{DS(ON)}$ (and cheaper) devices are available for the top-side MOSFET, when compared to traditional complementary MOSFET drive.

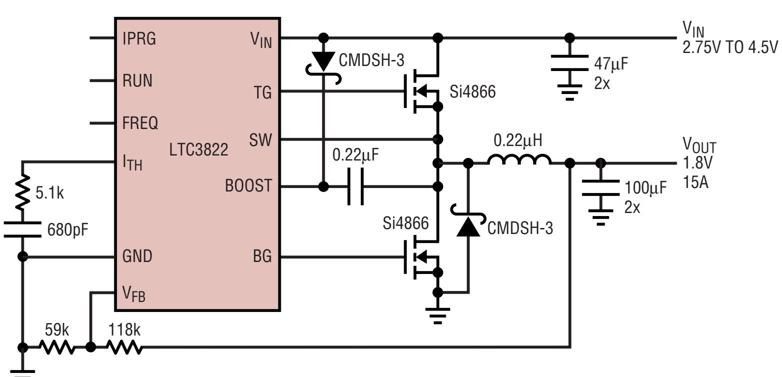

Figure 4. High current application delivering 1.8V at 15A.

Increasing the Current to 20A

Figures 4 and 5 show two ways to raise the current capability of the regulator by lowering the $R_{DS(ON)}$ of the MOSFETs. In Figure 4, MOSFETs with a much lower $R_{DS(ON)}$ than those of Figure 1 are used. Because they are in individual SO-8 packages, their thermal capabilities are also higher. This application is designed for a 15A continuous current load. Figure 5 in-

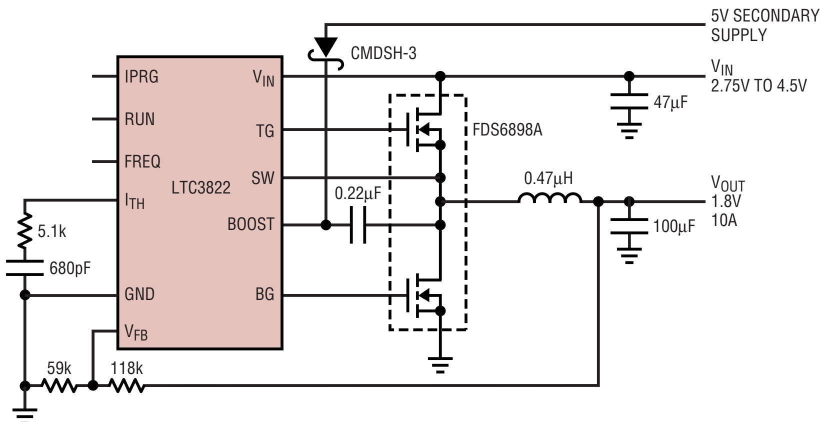

Figure 5. High efficiency application deriving gate drive voltage from a secondary 5V supply.

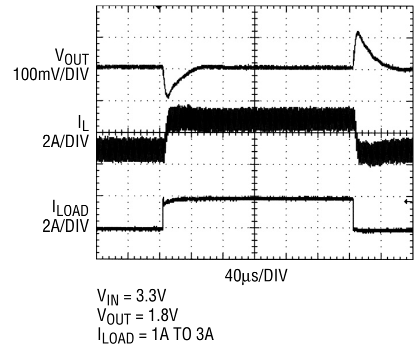

Figure 6. Transient performance of the converter in Figure 1

stead utilizes a secondary 5V supply to provide a higher gate drive voltage to the MOSFETs. Higher gate drive voltages lower $R_{DS(ON)}$ while simultaneously allowing the use of cheaper logic-level MOSFETs. The maximum load current can also be tailored using the current limit programming pin, IPRG. This three-state pin sets the peak current sense voltage across the top-side MOSFET. Combining all three high current approaches (utilizing low $R_{DS(ON)}$ MOSFETs, powering the gate drive from a secondary 5V supply, and setting current limit to its highest value) enables applications in excess of 20A.

OPTI-LOOP Compensation

The LTC3822 incorporates OPTI-LOOP® compensation to enable the user to choose optimal component values to compensate the loop over a wide range of operating conditions with the minimum number of output capacitors. Figure 6 shows the transient response for the circuit in Figure 1 with a load step of 1A to 3A. The output overshoots by approximately 100mV on a 1.8V output and then settles in about 50µs.

Conclusion

The LTC3822 delivers currents as high as 20A for single-output applications using a minimum number of components in a tiny complete solution footprint.

LT6557, continued from page 35

Automatic Biasing Feature

The LT6557 and LT6558 are designed specifically with single-supply AC-coupled operation in mind. Each input includes an internal current-controlled bias voltage source like that shown in Figure 3. A single external resistor R_{BCV} programs the input bias voltages as shown in Figure 4 for the LT6557. The LT6558 R_{BCV} function is similar to Figure 4, but is optimized for producing higher biasing levels to account for the lower gain and automatically tracks downward with the supply if below 4V. The selection of input bias point may depend on the application, but the values shown for the programming resistors in Figures 1 and 2 are representative of most designs.

Conclusion

The LT6557 and LT6558 triple video amplifiers are optimized specifically for operation on low voltage single supplies. With preset gain and programmable biasing, these devices offer minimal parts-count AC-coupled amplifier solutions for very high-resolution applications. The LT6557, with its gain of two, is designed for RGB output ports such as in video routers and KVM switch products. The LT6558, with unity gain, is designed as an RGB input port buffer and/or ADC driver, such as in computer or home-theater display products.

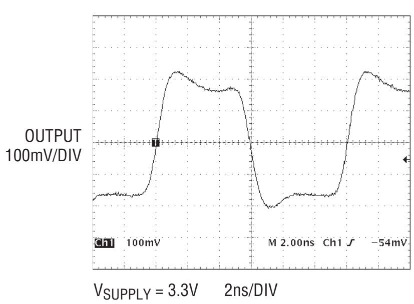

Figure 3. Fast pulse response of LT6558 on 3.3V single supply

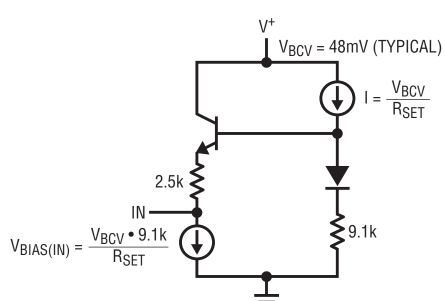

Figure 4. Simplified schematic of LT6557 input biasing circuit (LT6558 similar)

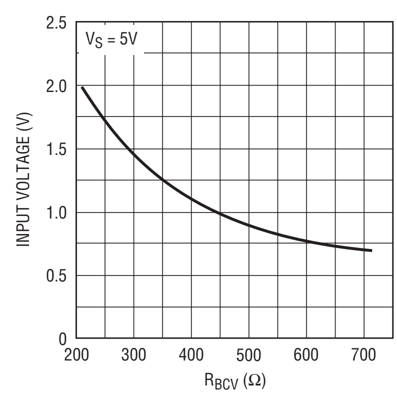

Figure 5. Relationship of LT6557 input bias voltage to programming resistor R_{BCV}