Step-Down Synchronous Controller Operates from Inputs Down to 2.2V

Design Note 443

Wei Gu

Introduction

Many telecommunications and computing applications need high efficiency step-down DC/DC converters that can operate from a very low input voltage. The high output power synchronous controller LT3740 is ideal for these applications, converting input supplies ranging from 2.2V to 22V to outputs as low as 0.8V with load currents from 2A to 20A. Applications include distributed power systems, point-of-load regulation and conversion of logic supplies.

A major challenge in designing a step-down converter with low V_{IN} is that the gate voltage for the N-channel MOSFETs is not readily available. The LT3740 solves this problem by integrating a DC/DC step-up converter for generating its own MOSFET gate drive voltage with a small inexpensive external inductor. This function permits the use of inexpensive off-the-shelf 5V gate-drive MOSFETs, offering up to 3% higher efficiency than sub-logic gate-drive MOSFETs and eliminating the need for a secondary supply.

The LT3740 operates at a fixed 300kHz frequency and employs valley current mode control to deliver excellent transient response and very low on-times. Furthermore, a power good signal is available to monitor the output voltage. The tracking capability built into XFER can be used to implement control of the output voltage when ramping up and ramping down. If less than 0.8V is applied to XFER, the LT3740 uses this voltage as its reference for regulation.

"Dying Gasp" Applications

The LT3740's low V_{IN} feature makes it a good fit in "dying gasp" applications for high reliability computers. In these systems, when the power gets cut, a large bank of electrolytic capacitors at the input charged to 12V or so, serve as input to the power controller. The LT3740 can operate down to 2.2V, which allows it to run longer from the input capacitors' charged voltage than a controller requiring a higher input voltage. This effectively reduces the input capacitance requirements, which can save significant board space.

Figure 1 shows a typical application circuit. The LT3740 circuit, after its input power gets cut, is able to supply the
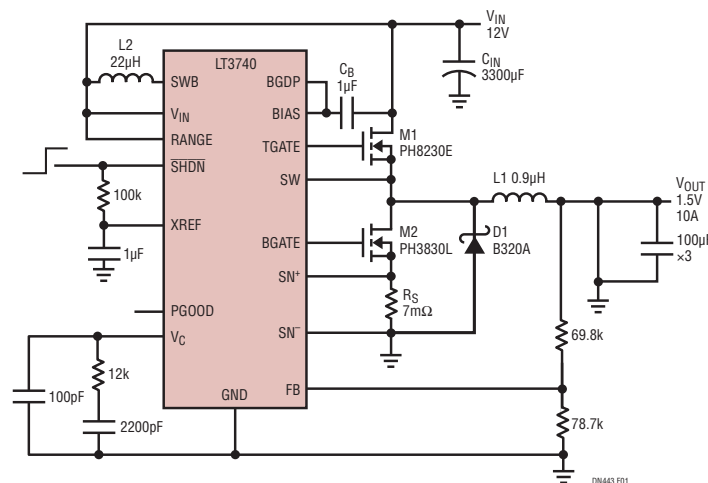
Figure 1. "Dying Gasp" Application Circuit

load for 40ms as shown in Figure 2. In comparison, the output voltage would drop out after 25ms with a controller that shuts down when the input reaches 7V.

Generate a Negative Voltage from a Low Positive V$_{IN}$

Figure 3 shows a 2.4V to 14V input to –3.3V at 3A output converter. The LT3740 works particularly well in this application due to its wide input voltage range and ability to operate down to 2.2V. The LT3740 also operates with synchronous rectification, which allows the use of high efficiency MOSFETs, instead of less efficient switching diodes.

Wide Input Voltage Range

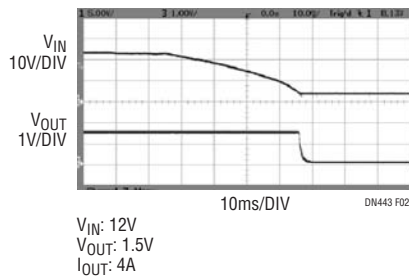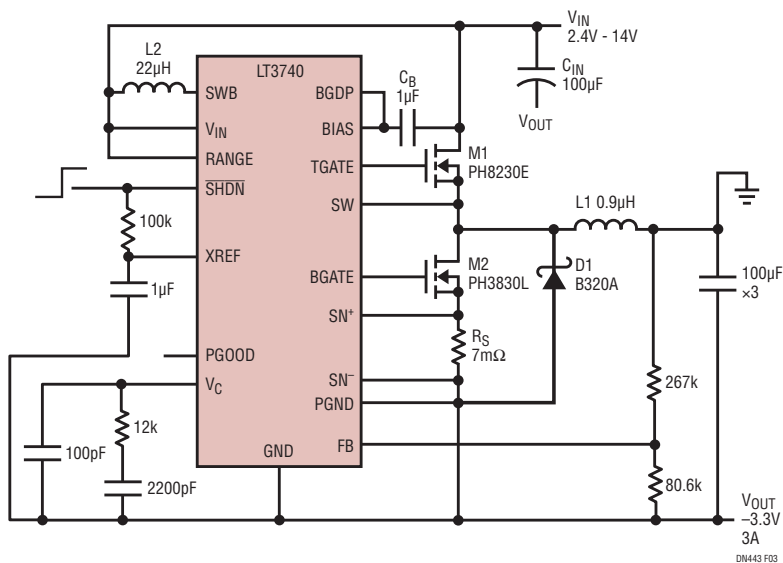The LT3740 offers high efficiency over a wide input voltage range (2.2V to 22V) and produces output voltages as low as 0.8V. The LT3740 employs valley current mode control to deliver excellent transient response and very low on-times. Figure 4 illustrates low duty cycle waveforms for a 22V input, 0.8V output application at a fixed frequency of 300kHz.

Conclusion

The LT3740 can operate from low input voltages, providing a space- and cost-saving solution over a wide input voltage range. The LT3740 is a versatile platform on which to build DC/DC converter solutions that use few external components and maintain high efficiencies over wide load ranges. The integrated step-up regulator facilitates true single-supply operation with an input voltage as low as 2.2V.
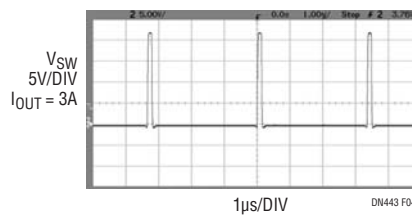
V$_{IN}$ 10V/DIV

V$_{OUT}$ 1V/DIV

10ms/DIV   DN443 F02

V$_{IN}$: 12V
V$_{OUT}$: 1.5V
I$_{OUT}$: 4A

Figure 2. Input and Output Voltages Waveforms When Input Power is Removed

V$_{SW}$ 5V/DIV
I$_{OUT}$ = 3A

1µs/DIV   DN443 F04

Figure 4. LT3740 Low Duty Cycle Waveforms

Figure 3. A Positive to Negative Converter

For applications help,
call (408) 432-1900, Ext. 3565