One IC for Multiple DC-to-DC Topologies: Dual Output Step-Down IC Can Also Be Used in SEPIC and Boost Applications

Victor Khasiev
Analog Devices, Inc.

Introduction

Industrial systems designers and automotive manufacturers are significant consumers of power electronics, and they require the full array of available dc-to-dc converter topologies, including buck, boost, and SEPIC in a variety of combinations. In an ideal world, each new project would be performance optimized with its own specialized controller or monolithic converter IC, but this is unrealistic.

The reality is that each new chip used in an industrial or automotive setting must be qualified via extensive testing before it can be utilized in these demanding environments. Implementing a different IC for each application is time consuming and cost prohibitive. It is far better to have a tested and verified IC on the shelf that can be used in multiple topologies, which allows it to be reused across a variety of applications. As an example, this article will show how to use the LTC3892 step-down controller for SEPIC (step-up and down) and boost applications.

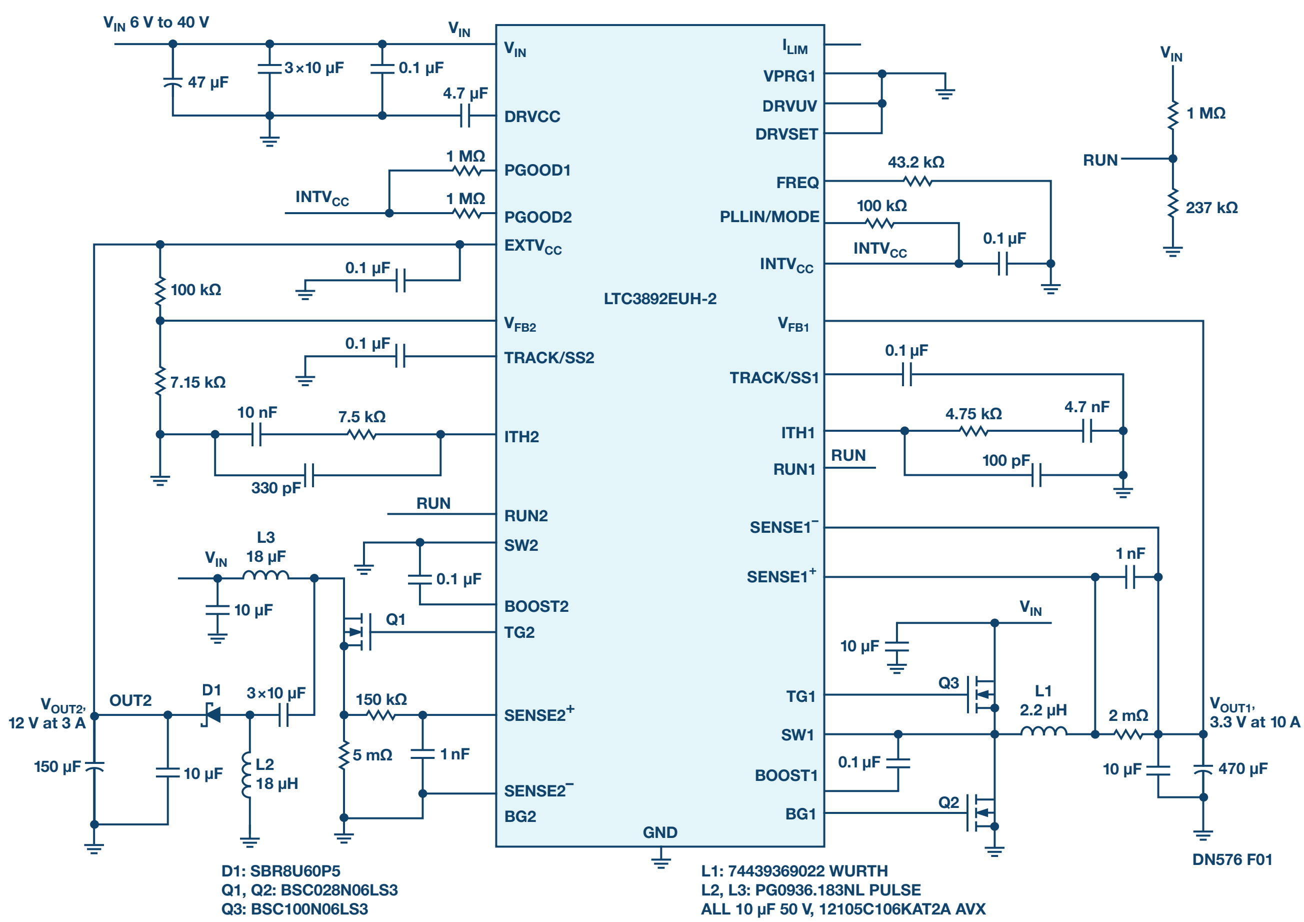

Figure 1. Electrical schematic of LTC3892 in SEPIC and buck applications.

Circuit Description and Functionality

The LTC3892 is designed as a dual output synchronous buck controller with input-output voltage range 4.5 V to 60 V—covering the requirements for most automotive and industrial applications. In these environments, the voltage input to the converter can vary significantly, such as those resulting from cold cranking and load dumps in automotive applications, or brownouts and voltage spikes in industrial systems when plant machinery is turned off and on. The native step-down topology of the LTC3892 cannot regulate output voltages when the input drops below the output, but a SEPIC topology can.

Figure 1 shows a SEPIC solution that supports two outputs: V_{OUT1} is 3.3 V at 10 A and V_{OUT2} is 12 V at 3 A. The input voltage range is 6 V to 40 V. V_{OUT1} is implemented as a straightforward step-down converter with a power train including L1, Q1, and Q2. To reduce number of components, the V_{PRG1} pin is connected to GND, internally programming V_{OUT1} to 3.3 V.

The second output of the LTC3892 is a SEPIC converter. The SEPIC power train includes L2, L3, Q3, and D1. A noncoupled SEPIC, with two discrete inductors, is employed here, expanding the range of the available inductors. This is an important consideration for cost-sensitive devices.

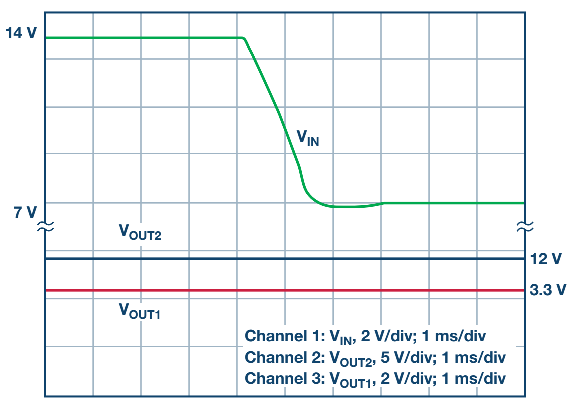

Figure 2. Shows a cold cranking event. The rail voltage drops from 14 V to 7 V, but both V_{OUT1} and V_{OUT2} remain in regulation.

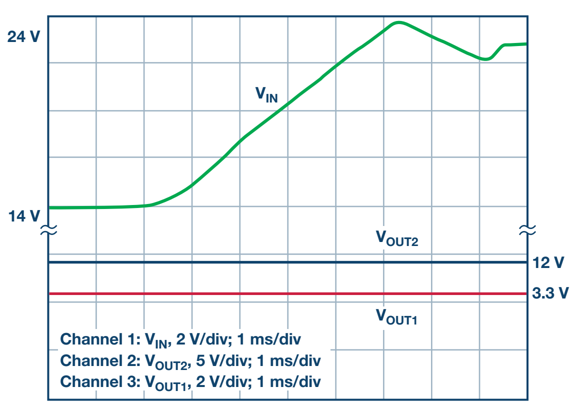

Figure 3. Load dump event. The rail voltage rises from 14 V to 24 V. However, both V_{OUT1} and V_{OUT2} stay in regulation.

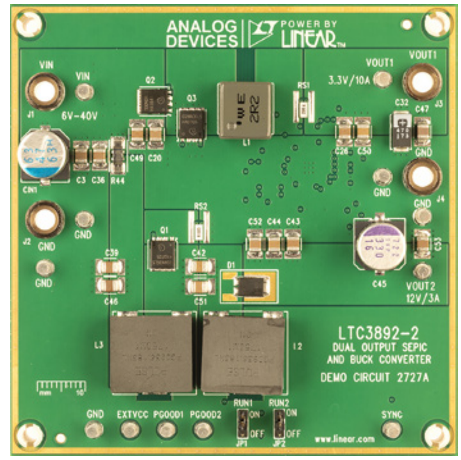

Figure 4. Demonstration circuit DC2727A. The LTC3892 controls two outputs: a noncoupled SEPIC and a step-down converter.

Figure 2 shows how the converter functions when faced with voltage drops, such as during cold cranking. The rail voltage V_{IN} drops far below nominal 12 V, but both V_{OUT1} and V_{OUT2} remain in regulation, providing a stable power supply to the critical loads. Figure 3 shows how the converter functions when experiencing voltage spikes, such as load dumps. V_{OUT1} and V_{OUT2} remain regulated, even as V_{IN} flies far above the nominal 12 V input.

Figure 4 is the demonstration circuit DC2727A, a dual output converter described herein. The SEPIC portion of the DC2727A can be easily rewired to a boost topology by removing one inductor L2 and replacing the second L3 to an appropriate boost choke.

Conclusion

The LTC3892 is a flexible controller that can serve a variety of dc-to-dc converter needs in automotive and industrial environments. Although it is primarily designed for employment in synchronous buck converters, it can also be used in SEPIC and boost converter applications, which simplifies the qualification testing process when these topologies are needed.

About the Author

Victor Khasiev is a senior applications engineer at Analog Devices. Victor has extensive experience in power electronics both in ac-to-dc and dc-to-dc conversion. He holds two patents and wrote multiple articles. These article relate to use ADI semiconductors in automotive and industrial applications. They cover step-up, step-down, SEPIC, positive-to-negative, negative-to-negative, flyback, and forward converters, as well as bidirectional backup supplies. His patents are about efficient power factor correction solutions and advanced gate drivers. Victor enjoys supporting ADI customers: answering questions about ADI products, design and verification power supplies schematics, layout of the print circuit boards, troubleshooting, and participating in testing final systems. He can be reached at *victor.khasiev@analog.com*.

Analog Devices, Inc.
Worldwide Headquarters

Analog Devices, Inc.
One Technology Way
P.O. Box 9106
Norwood, MA 02062-9106
U.S.A.
Tel: 781.329.4700
(800.262.5643, U.S.A. only)
Fax: 781.461.3113

Analog Devices, Inc.
Europe Headquarters

Analog Devices GmbH
Otl-Aicher-Str. 60-64
80807 München
Germany
Tel: 49.89.76903.0
Fax: 49.89.76903.157

Analog Devices, Inc.
Japan Headquarters

Analog Devices, KK
New Pier Takeshiba
South Tower Building
1-16-1 Kaigan, Minato-ku,
Tokyo, 105-6891
Japan
Tel: 813.5402.8200
Fax: 813.5402.1064

Analog Devices, Inc.
Asia Pacific Headquarters

Analog Devices
5F, Sandhill Plaza
2290 Zuchongzhi Road
Zhangjiang Hi-Tech Park
Pudong New District
Shanghai, China 201203
Tel: 86.21.2320.8000
Fax: 86.21.2320.8222

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