



High Efficiency Synchronous SEPIC for Automotive and Industrial Installations

Victor Khasiev
Analog Devices, Inc.

Introduction

The **LT8711** is a dc-to-dc controller that supports synchronous buck, boost, single-ended primary-inductor converter (SEPIC), and ZETA topologies, or nonsynchronous buck-boost topologies. Analog Devices offers numerous synchronous buck and boost converters and regulators, but the synchronous SEPIC topology is somewhat rare. Nevertheless, the SEPIC topology is useful because it supports a stable output voltage level even as the input voltage drops far below the output or rises far above it. This feature can be indispensable in automotive electronics, especially during cold cranking and load dumps, and in industrial applications due to long supply lines and brownouts in factory settings. Oil and gas devices can increase reliability by using SEPIC converters to supply critical loads from multiple and varied power supplies and, if one supply fails, the SEPIC can use another supply to support the load, even if the input is at a different voltage level.

Circuit Description and Functionality

Figure 1 shows the schematic for a synchronous SEPIC converter using the LT8711, which controls a power train consisting of:

- ▶ Two noncoupled inductors, L1 and L2
- ▶ Modulating N-channel MOSFET, MN1, driven from pin BG
- ▶ Two synchronous P-channel MOSFETs, MP1 and MP2, driven from pin TG
- ▶ Decoupling capacitors, C1, C2, and C3
- ▶ Input and output filters

Figure 2 shows the efficiency of the converter with a 14 V input voltage. The synchronous scheme keeps efficiency high, reaching 93.4% at the peak. Figures 3 and 4 show output regulation as the input voltage falls below, and rises above, the output, which remains stable.

The standard demo circuit **DC2493A** was reworked to increase output current from 4 A to 6 A. The MOSFETs MN1 and MP1, and inductor L2 were replaced by the components shown in Figure 1.

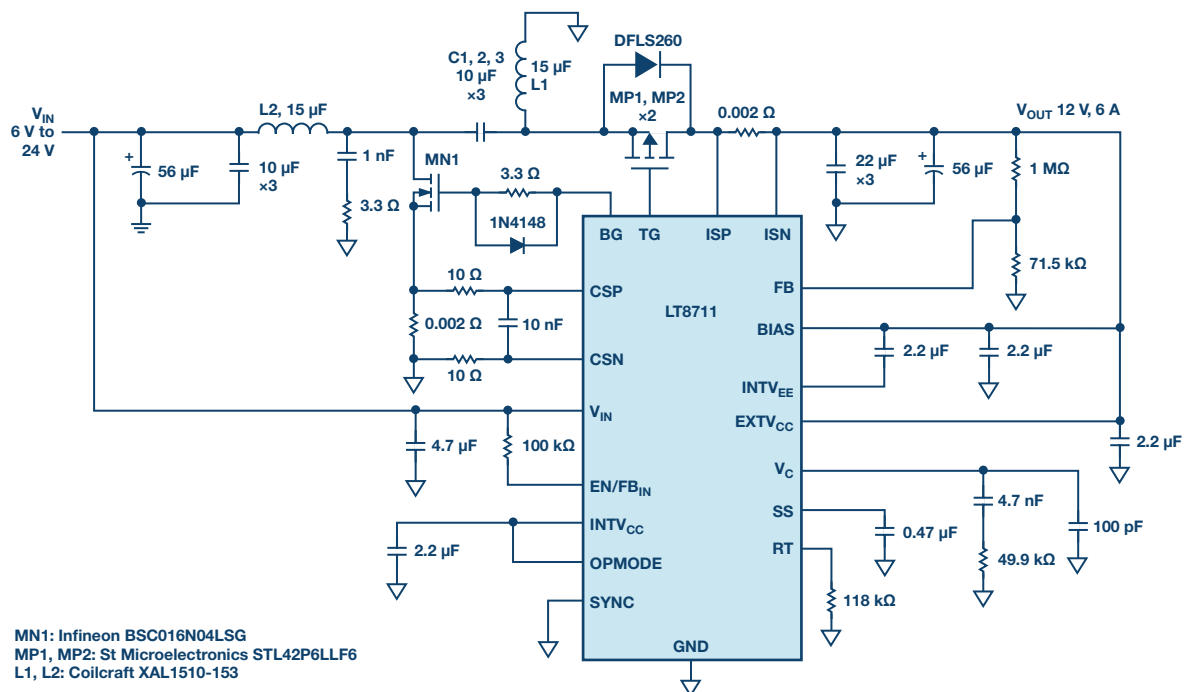


Figure 1. Electrical schematic of LT8711 for SEPIC and buck applications.

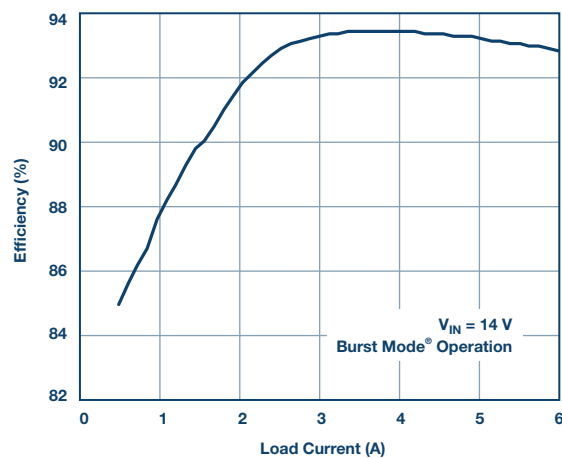


Figure 2. Efficiency of the LT8711 SEPIC.

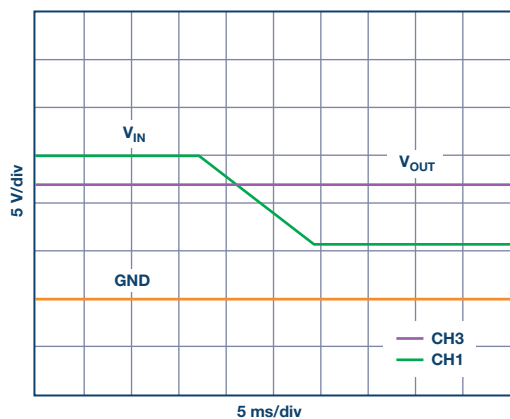


Figure 3. Model of a cold cranking event. The rail voltage V_{IN} drops from 15 V to 6 V, but V_{OUT} remains stable at 12 V.

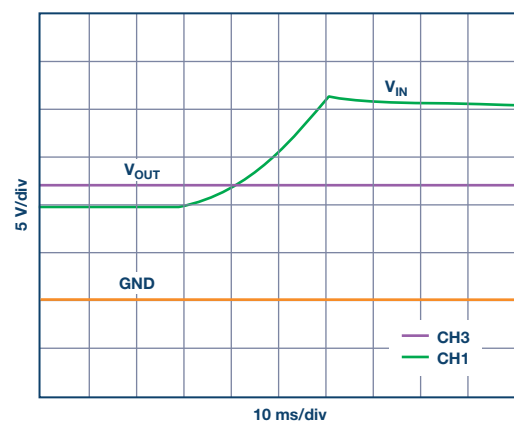


Figure 4. Model of a load dump. The rail voltage rises from 10 V to 20 V, but V_{OUT} stays in regulation.

A modified demonstration circuit, DC2493A, was used to evaluate this design. The thermal image of the modified board is shown in Figure 5. The LTspice® model of a similar solution can be found in the LT8711 demo circuit. The detailed recommendation for the selection SEPIC power train components can be found in the LT8711 data sheet.

Below are basic expressions of peak voltages and currents for understanding the functionality of this topology.

$$I_{L1} = I_{IN} + \Delta I_{L1}$$

$$I_{L2} = I_{OUT} + \Delta I_{L2}$$

$$V_{BG} = V_{TG} = V_{IN} + V_{OUT}$$

$$I_{TG} = I_{BG} = I_{IN} + I_{OUT} + \Delta I/2$$

Conclusion

The LT8711 is a versatile and flexible controller designed for use in synchronous buck, boost, SEPIC, ZETA, and nonsynchronous buck-boost converters. In particular, the synchronous SEPIC can be used to produce efficient outputs that fall somewhere in the middle of the input voltage range, which is particularly important for automotive and industrial applications.

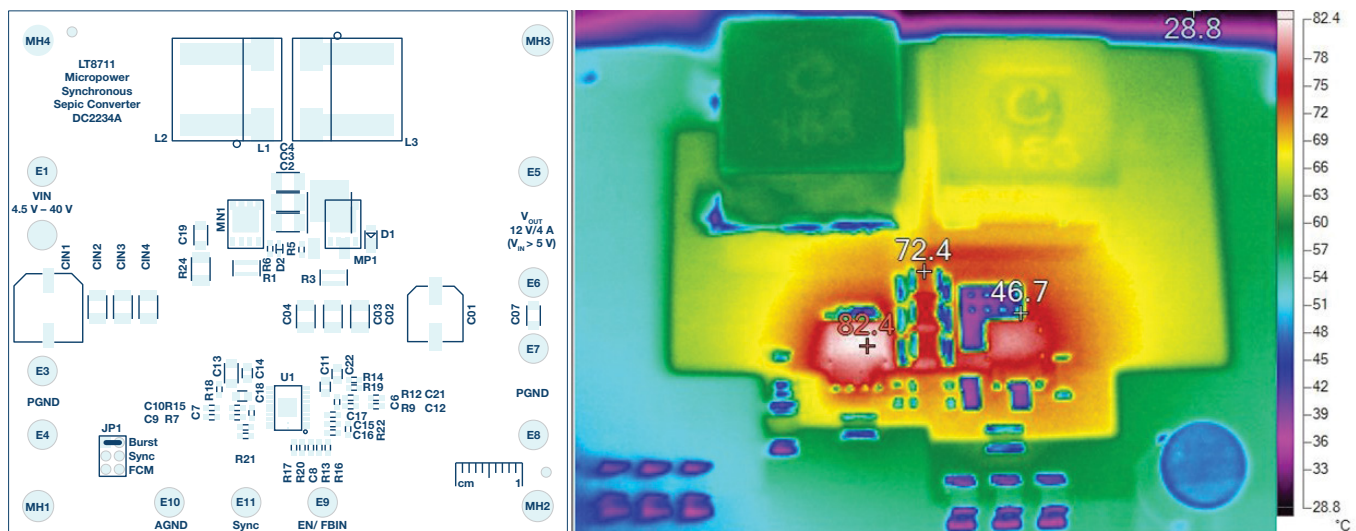


Figure 5. A DC2493A and a thermal map of the operating SEPIC (V_{IN} 14 V, V_{OUT} 12 V at 6 A). The hottest component is MNI at 77°C.

Online Support Community



Engage with the Analog Devices technology experts in our online support community. Ask your tough design questions, browse FAQs, or join a conversation.

Visit ez.analog.com

About the Author

Victor Khasiev is a senior applications engineer at ADI. 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 related to the use of 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 of 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
Otli-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

©2019 Analog Devices, Inc. All rights reserved. Trademarks and registered trademarks are the property of their respective owners. Ahead of What's Possible is a trademark of Analog Devices.
DN20859-0-1/19

analog.com



AHEAD OF WHAT'S POSSIBLE™