

Design Note

High Efficiency Synchronous SEPIC for Automotive and Industrial Installations

Victor Khasiev

Introduction

The **LT[®]8711** [1] is a DC/DC controller that supports synchronous buck, boost, 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 (single-ended primary-inductor converter) 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, if one supply fails, the SEPIC can use another 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 non-coupled 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 14V 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 4A to 6A. The MOSFETs MN1, MP1 and inductor L2 were replaced by the components shown in Figure 1.

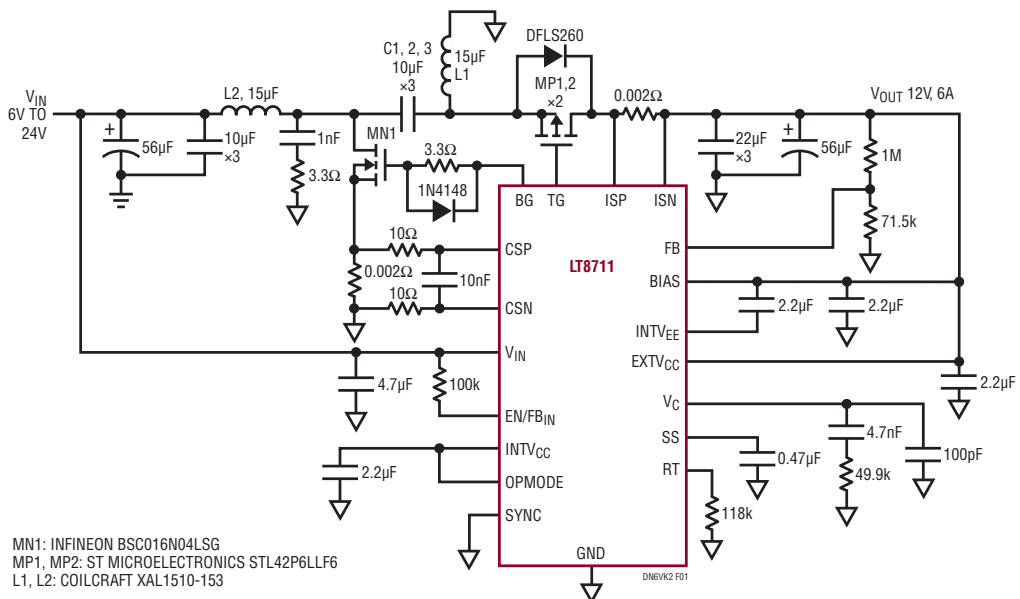


Figure 1. Electrical Schematic of LT8711 for SEPIC and Buck Applications

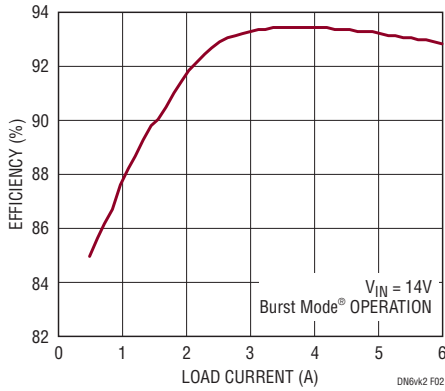


Figure 2. Efficiency of the LT8711 SEPIC

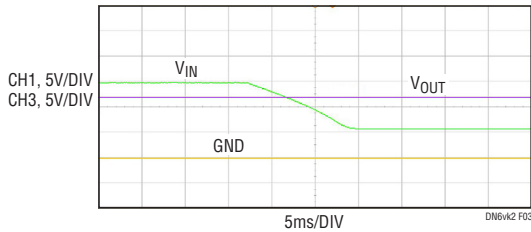


Figure 3. Model of a Cold Cranking Event. The Rail Voltage V_{IN} Drops from 15V to 6V, but V_{OUT} Remains Stable at 12V

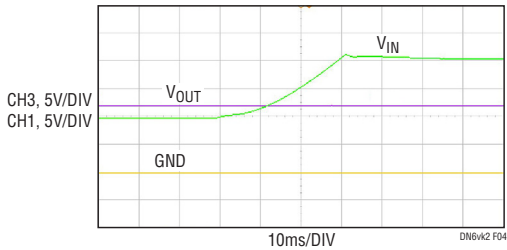


Figure 4. Model of a Load Dump. The Rail Voltage Rises from 10V to 20V, but V_{OUT} Stays in Regulation

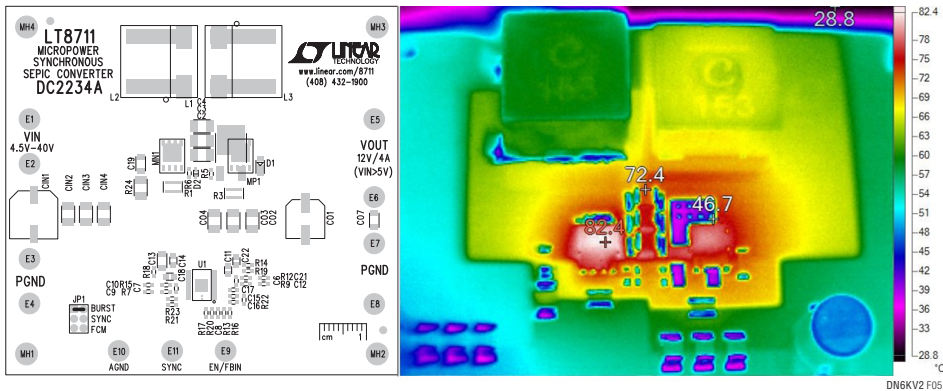


Figure 5. DC2493A and a Thermal Map of the Operating SEPIC (V_{IN} 14V, V_{OUT} 12V at 6A). The hottest component is MNI at 77°C

Data Sheet Download
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A modified demonstration circuit, DC2493A [2], 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 [3]. 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 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, particularly important for automotive and industrial applications.

References

1. Data Sheet, LT8711, *Micropower Synchronous Multitopology Controller with 42V Input Capability*
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2. Demo Board, DC2234A,
<http://www.analog.com/en/products/power-management/switching-regulators/sepic-regulators/lt8711.html#product-evaluationkit>
3. LT8711 Demo Circuit - *Automotive Micropower Synchronous Sepic Converter (4.5-40V to 12V at 4A)*
<http://www.analog.com/en/products/power-management/switching-regulators/sepic-regulators/lt8711.html#product-tools>