LINEAR TECHNOLOGY

DESIGN NOTES

Bidirectional DC/DC Regulator and Supercapacitor Charger

Design Note 558

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Introduction

The LTC®3110 bidirectional buck-boost DC/DC regulator charges and balances a supercapacitor when a bus voltage is present (for example 3.3V) and discharges the supercapacitor into the load when the bus fails. The LTC3110 maintains the bus's nominal level (3.3V in the example in Figure 1) even if the supercapacitor voltage is above or below the nominal bus voltage. Supporting the load this way allows data backup and retention during a power interruption—important in a wide variety of industrial and automotive applications.

Low Profile Data Backup Power Supply

Industrial and automotive applications are distinguished by their lack of stable, high quality voltage sources. In automotive environments, a 12V nominal voltage rail can change from 4V to above 40V during cold starts and load dumps. The 24V equipment bus used in factories and plants suffers voltage spikes and brownouts just from cycling electric motors and solenoids.

Industrial applications, however, share something in common with consumer electronics: the trend toward increased portability and mobility. Space is increasingly limited for electronics inside modern industrial equipment. The volume, in particular the thickness, of a data storage unit is at a premium in industrial assemblies and modules. With that in mind, the solution herein aims to minimize the profiles of the selected components. Table 1 shows two passive component group options, arranged by thickness: 1mm and 2.5mm. The required semiconductor parts are not listed because the controllers, MOSFETs and resistors do not exceed 1mm thickness.

Figure 2 shows a low profile energy storage solution for data backup or wireless data transmission in situations where the input voltage changes in an extremely wide range from 4V to 40V, with possible input voltage interruption.

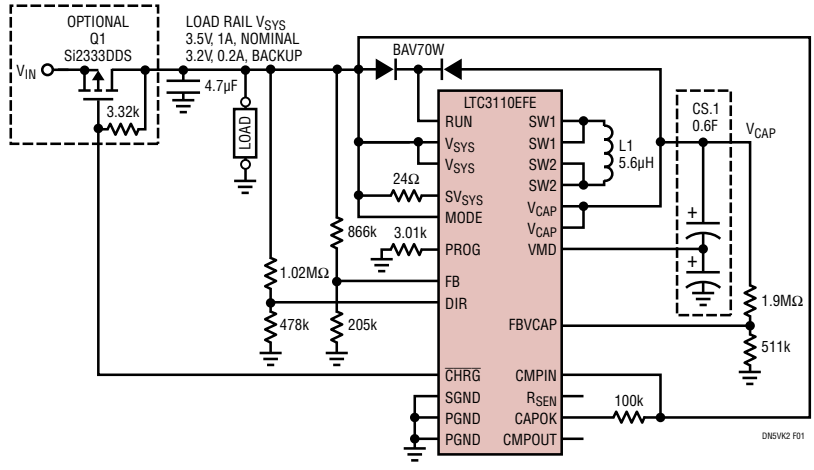

Figure 1. LTC3110 Application, V_{SYS} = 3.3V, V_{CAP} = 5.0V

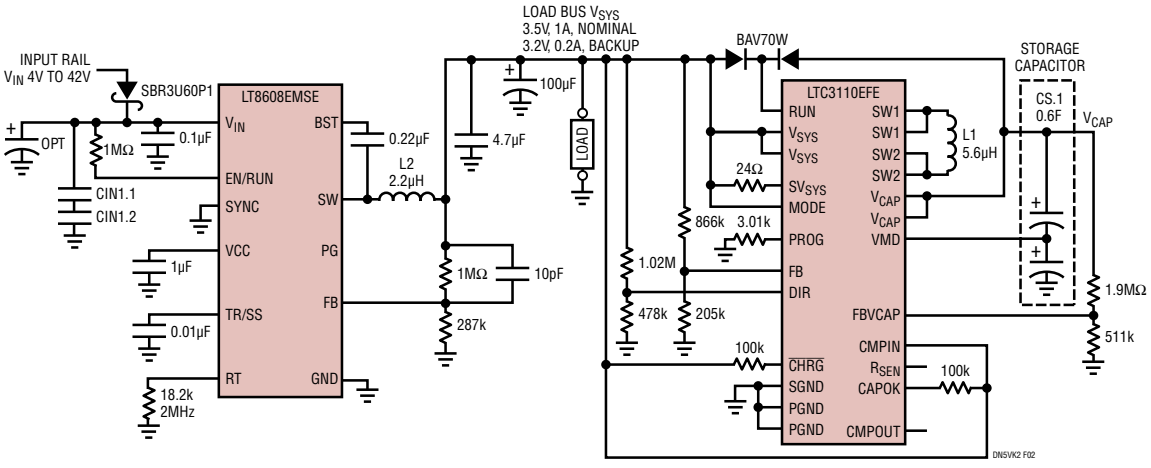

Figure 2. LTC3110, High Voltage Application, V_{IN} = 4V to 40V, V_{SYS} = 3.3V, V_{CAP} = 5.0V

This solution uses two converters to produce a complete industrial/automotive application. The converter, based on the LTC3110 supercapacitor charger (SCCH), charges the storage capacitor when the input voltage is present and provides a regulated system output during power interruption. Under normal operating conditions, when a 4V to 40V input supply is present, sensitive electronic loads and the LTC3110 are supported by a step-down converter (SDC) based on the LT8608.

The LT8608 is a low quiescent current, high efficiency, highly integrated synchronous buck converter featuring a wide input voltage range extending from 3V to 42V. Its 42V upper limit minimizes the volume required for system protection circuitry, practically eliminating the need for traditional transient voltage suppressor diodes (TVS). The SDC maintains the system voltage within 3.3V bus rail limits.

If the input voltage is disconnected, the SCCH takes over, powering the regulated 3.3V rail. The LT8608 supplies 3.5V to the system bus under normal circumstances; the LTC3110 supplies 3.2V when it registers a power failure and supports the load. These supply voltages are well within the recommended limits for 3.3V logic power supplies. The $\overline{CHRG}$ flag can be used to alert digital systems to disconnect non-essential loads and begin data backup or wireless transmission.

Figure 3 shows the beginning of the switchover process; with the input voltage disconnected, the SDC turns off while the SCCH is turning on.

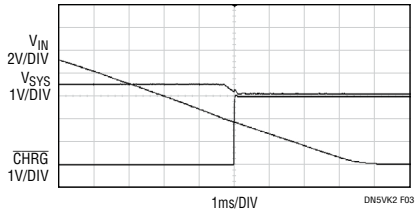

Figure 3. Switchover [V_{SYS} Load Voltage, V_{IN} Input Voltage, $\overline{CHRG}$ Flag Status]

Conclusion

LTC3110 is a highly integrated, high performance supercapacitor charger and balancer, which can be implemented in low profile solutions for data retention and backup in automotive and industrial applications.

Table 1. Converter Components for 1mm and 2.5mm Thickness Solutions

Height	L1	L2	CS1	CIN1
Vendor	Wurth Elektronik	Wurth Elektronik	CAP-XX	TDK
1mm	74437321022	74437321056	2 x HS103F	2 x C3216JB1H475K085AB
2.5mm	74437334022	74437334056	HS206F	C3225X7R2A225K230AB

Data Sheet Download

www.linear.com/LTC3110

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