

Multi-Rail DC/DC Converter in a 3mm × 3mm QFN Takes Inputs as Low as 0.7V

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Introduction

Modern handheld instrumentation, portable medical devices and consumer electronics demand a multitude of power rails for internal processors, memory, audio and color displays. Popular battery technologies for these devices include single or multiple cell alkaline, NiMH or Li-Poly/Li-Ion batteries. Operation from a USB port or a wall adapter is another common trait. Replaceable alkaline batteries are particularly attractive for remote locations and portable medical devices where power or time is not available to recharge batteries. The challenge is to create a compact and efficient power solution for these wide V_{IN} range, multi-output applications. The LTC3100 multichannel DC/DC converter makes it easier to meet this challenge.

The LTC3100 is a high efficiency, 1.5MHz multichannel DC/DC converter in a compact 3mm × 3mm × 0.75mm QFN package. It features a synchronous step-up (boost) DC/DC converter, a synchronous step-down (buck) DC/DC converter and a 100mA low dropout linear regulator (LDO).

The boost and buck converters can operate independently from different sources, from the same source, or cascaded to create a buck-boost converter. Internal loop compensation simplifies the design and minimizes external component count and solution size. Each converter has a Power Good indicator that is useful for voltage sequencing. The boost converter offers up to 95% efficiency and features true output disconnect, a 700mA minimum current limit and can start with input voltages as low as 700mV, making it ideal for single alkaline or NiMH cell applications. The buck converter offers up to 94% efficiency and can deliver 250mA or more from input voltages between 1.8V

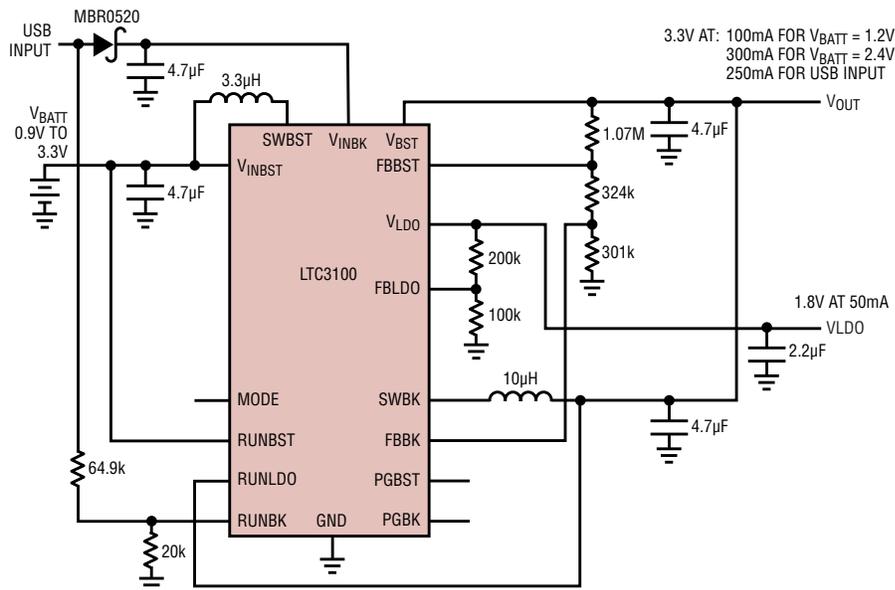


Figure 1. Multiple-input source 3.3V and 1.8V converter

and 5.25V. Both converters feature automatic Burst Mode® operation for high efficiency at light loads. For low noise applications, Burst Mode operation can be disabled by grounding the MODE pin. The 100mA LDO, whose input is internally connected to the boost output, can be used to produce a third, low noise output. It can also be used for voltage sequencing of the boost output voltage.

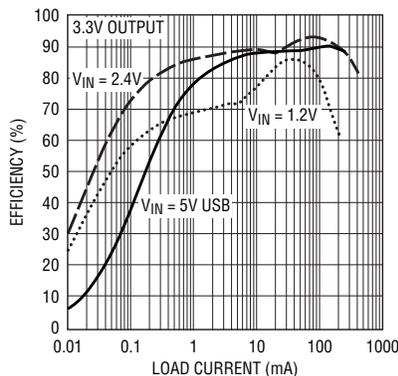


Figure 2. Converter efficiency for the circuit of Figure 1

The circuit shown in Figure 1 takes advantage of the LTC3100's ability to operate from independent input sources to generate multiple outputs regardless of which power source is available. In this example, the boost converter produces a regulated 3.3V output from a single- or dual-cell input voltage. The buck converter runs from a 5V USB or wall adapter input and produces 3.3V as well, with its output externally tied to that of the boost.

By leaving the MODE pin open, the automatic Burst Mode operation feature of the LTC3100 is enabled, maximizing battery life at light load. When USB or wall adapter power is available, the buck converter is automatically enabled and generates a 3.3V output that is set 3.8% higher than that of the boost converter. This puts the boost converter in sleep mode, reducing the load on the batteries to just a few micro-amps. The result is a 3.3V output that seamlessly transitions from battery power to USB

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shows an application where a single LED is driven from a 5V supply.

Output Disconnect

The LT3593 has an internal disconnect switch that is used to sense the LED current during normal operation. This internal switch also serves to provide output disconnect during shutdown so that the LEDs are truly disconnected from the output of the regulator.

Fault Protection

The LT3593 protects against both open and shorted LED faults. In the case of an open LED fault, the output voltage V_{CAP} continues to rise. Once V_{CAP} reaches 38V, an open fault is triggered and the part goes into a low frequency mode clamping the output to 38V and minimizing input current.

A waveform showing the LT3593's response to an open LED fault can be seen in Figure 4.

In a shorted LED fault, the LED pin can be shorted to ground, running excessive current from V_{CAP} . To protect from such a fault, the LT3593 limits the maximum current out of the LED pin to approximately 45mA.

Conclusion

The LT3593 is a step-up LED driver that can drive up to ten white LEDs from a single lithium-ion cell. It can easily be programmed through a single pin interface and combines many desirable features as well as fault protection against open or shorted LEDs.

The feature-rich LT3593 is available in the 6-lead (2mm × 2mm) DFN as

well as the 6-lead SOT-23. These two small, low profile packages, together with internal compensation and an output disconnect device, are ideal for a complete small board area LED driver solution, especially in portable device display backlighting applications. 

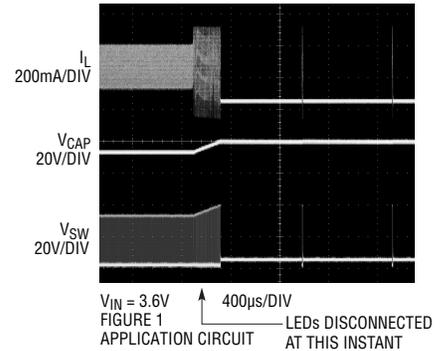


Figure 4. Open LED fault protection

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power while maximizing battery life. The diode on the USB input prevents any reverse current from the 3.3V output (while operating on batteries) back to the USB input when it is open or grounded. Figure 2 shows the converter efficiency versus load with various input sources, illustrating the high efficiency over a wide load range. The LDO in the LTC3100 (with its input internally tied to the Boost output) provides a second regulated output, in this case programmed to 1.8V.

Because the buck converter input can come from the boost output, the LTC3100 can function as an ultra-low voltage buck-boost converter, providing a regulated 1.2V output from a single alkaline or NiMH cell. This is shown in Figure 3, where the LTC3100 generates two regulated outputs from a single cell input (whose voltage may be above or below 1.2V) by boosting V_{IN} up to 3.5V and then regulating down to 1.2V and 3.3V using the buck and the LDO. In this example, the Power Good outputs and the LDO are used

to provide voltage sequencing, so that the 1.2V core supply comes up before the 3.3V I/O supply, as shown in the scope photo of Figure 4. The LDO also provides additional noise filtering and ripple rejection for the 3.3V output, guaranteeing a low noise output for sensitive analog circuitry, even when the converters are in Burst Mode operation.

Conclusion

The LTC3100 is a high efficiency, multichannel converter that can operate from a wide range of voltage sources. Independent input voltages for each converter, Power Good outputs and an LDO make the LTC3100 a small, highly integrated and flexible solution for many demanding applications. 

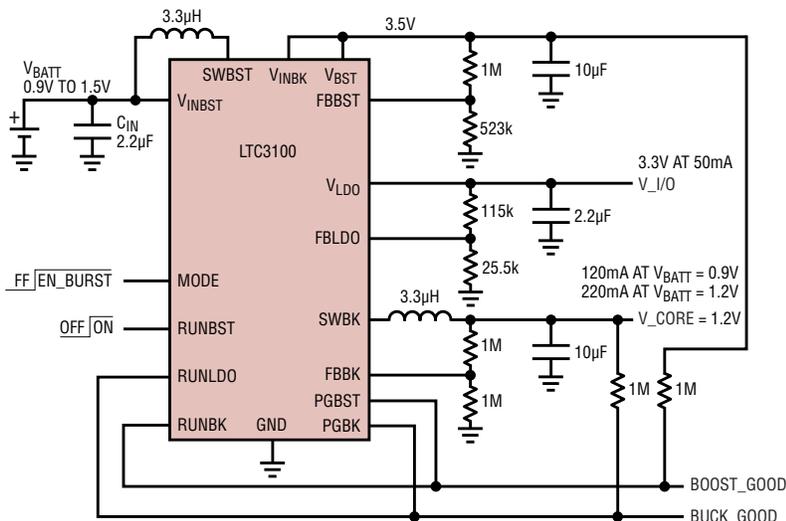


Figure 3. Single-cell dual output converter with voltage sequencing

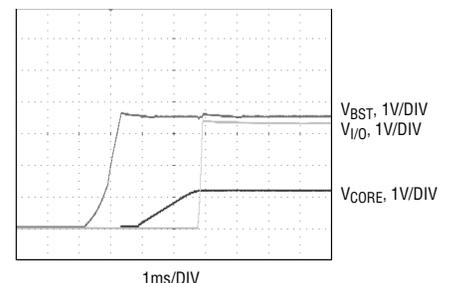


Figure 4. Voltage sequencing of the output voltages for the circuit of Figure 3