

0.25in² × 1.8mm Dual Output Converter for Li-Ion to 3.3V and 1.8V

by John Canfield

Introduction

One quarter inch square. That is all the area needed for a complete Li-Ion to dual output, buck and buck-boost converter. Figure 1 shows a compact dual output converter made possible by the LTC3522—a complete, high efficiency, dual rail power supply solution in a 3mm × 3mm QFN. As shown, only a few external components are required, and they can all be low profile (≤1mm)—perfect for the demanding space requirements of even the most compact portable electronic devices.

The LTC3522 combines a monolithic buck-boost converter and synchronous buck converter in a single, low profile 0.75m × 3mm × 3mm 16-lead QFN. Soft-start and feedback loop compensation circuitry is included in the IC. An entire application circuit for a dual converter requires only the IC, inductors, bypass capacitors and feedback resistor dividers. Both converters maintain a low transient voltage deviation under full load step, even with small ceramic output capacitors. These features result in a simple application circuit as shown in Figure 2 and a total PCB area of less than 0.25 square inches as illustrated by Figure 1. The LTC3522 features a fixed internal switching frequency of 1.1MHz that allows for the use of low profile capacitors and inductors,

resulting in a total application height of only 1mm.

While requiring only a single inductor, the LTC3522 is capable of high efficiency fixed frequency operation with input voltages that are above, below, or equal to the output voltage. The buck-boost converter utilizes a proprietary switching algorithm to provide seamless transitions between buck and boost functional modes while simultaneously maximizing conversion efficiency. The buck-boost output

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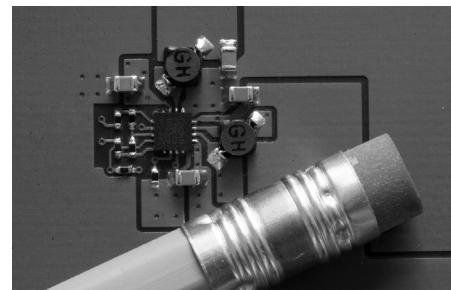


Figure 1. Buck-boost and buck converter occupy less than 0.25in² of board space

voltage can be set as low as 2.2V or as high as 5.25V. With a 3.3V output, the buck-boost converter is able to supply a 300mA load current over the full 2.4V to 5.5V input voltage range. When powered by a standard Li-Ion battery with a minimum voltage of 3V, a 400mA load can be supported.

The LTC3522 buck converter features internally compensated current mode control that ensures a rapid transient response over a wide range of output capacitor values. The buck converter can supply a load current of up to 200mA over the entire input voltage range and its output voltage can be set as low as 0.6V. The buck converter transitions smoothly to 100% duty cycle operation to extend battery life in low dropout operation.

Despite its tiny size, the LTC3522 boasts an efficiency of up to 95% for

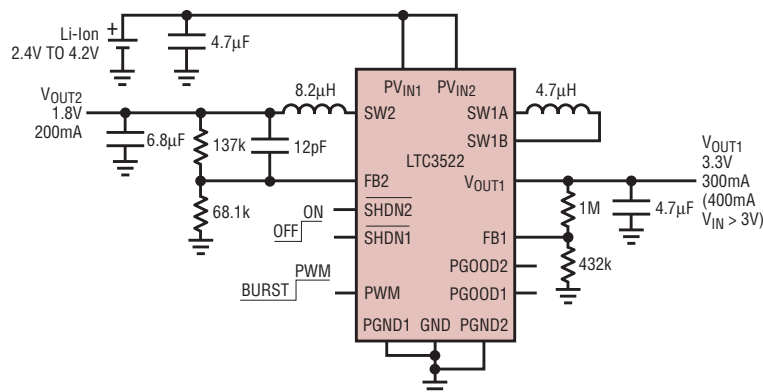
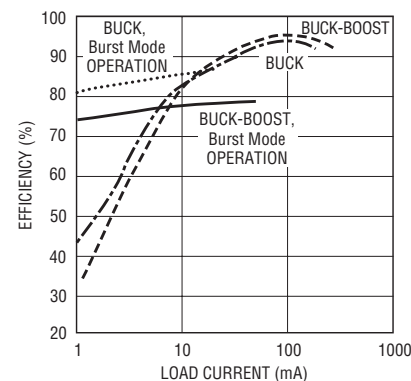


Figure 2. Li-Ion to 3.3V at 300mA and 1.8V at 200mA



BUCK-BOOST L = COILCRAFT MSS6132 – 4.7µH
BUCK L = COILCRAFT MSS6132 – 8.2µH

Figure 3. Efficiency vs load current

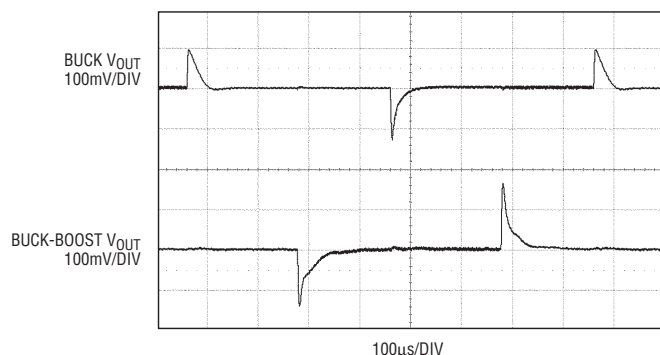


Figure 4. Alternating load step responses

each converter and incorporates a variety of useful features. Both converters include an internal, closed-loop soft start to ensure a reliable output voltage rise time, independent of loading and output capacitor value. In addition, each converter includes its own open-drain power-good indicator, which allows for undervoltage fault detection and sequenced start-up. Each converter can be independently enabled. With both converters disabled, the total supply current is reduced to under 1µA.

Efficiency

Figure 3 shows the efficiency of each converter for the circuit of Figure 2. The buck-boost converter reaches a peak efficiency of 95%, while the buck converter peaks at 94%. In PWM mode, both converters are greater than 90% efficient at all load currents above 30mA.

Pin selectable Burst Mode® operation improves efficiency at light load currents. In Burst Mode, the total qui-

escent current is reduced to only 25µA with both converters enabled. In noise sensitive applications, both converters can be forced into low noise, fixed frequency PWM operation by connecting the PWM pin to V_{IN} . Alternatively, the PWM pin can be driven dynamically in the application to provide low noise performance during critical phases of operation.

Supply Sequencing

Many dual supply applications require that the supply rails power up in a particular order. A common example is a microprocessor in which the core supply voltage must be up and in regulation before the peripheral supply powering the output pin drivers is enabled. This ensures that the core logic is functioning before the outputs become active, thereby preventing erratic output fluctuations during power-up.


The LTC3522 has an independent power-good output for each converter. This allows the two output voltages to

be sequenced in either order without requiring any additional external components. Figure 5 shows a sequenced LTC3522 application circuit that waits for the 1.8V buck output rail to reach regulation before enabling the buck-boost converter to power the 3.0V output rail. This is accomplished by simply connecting the SHDN1 pin to the buck power-good output, PGOOD2. With the external enable signal held low, both converters are disabled. When the external enable is brought high, the buck converter is immediately enabled. The buck-boost converter remains disabled until PGOOD2 goes high, indicating that the buck converter has reached regulation.

Inter-Channel Performance

While in PWM mode, both converters operate synchronously from a common 1.1Mhz oscillator. This minimizes the interaction between the two converters so that load steps on the output of one converter have little impact on the opposite output. For example, Figure 4 shows both output voltages as a 20mA to 200mA load step is applied to the buck channel and a 0mA to 300mA load step is applied to the buck-boost channel. In this case, even with small 4.7µF output capacitors on each converter, the interaction between channels is minimal.

Conclusion

The LTC3522 provides a complete, sequenced dual rail power supply solution in a compact footprint. Its high efficiency and exceptional performance make the LTC3522 well suited for even the most demanding portable applications. 

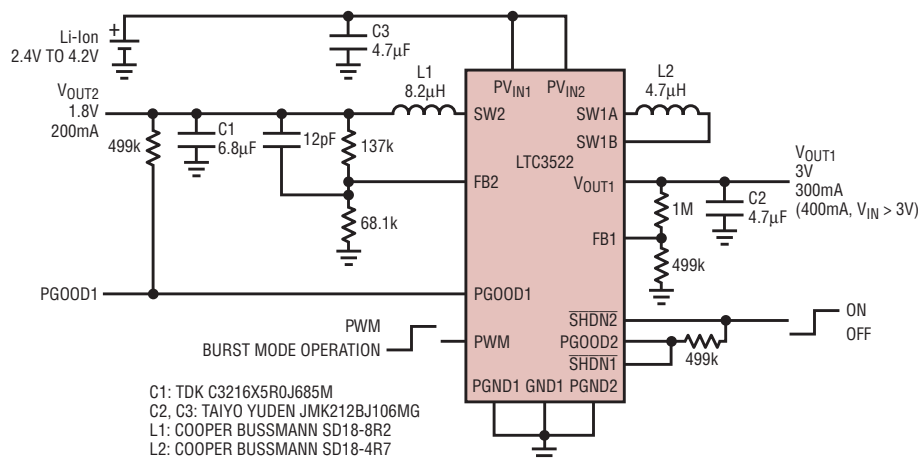


Figure 5. Sequenced power-up application

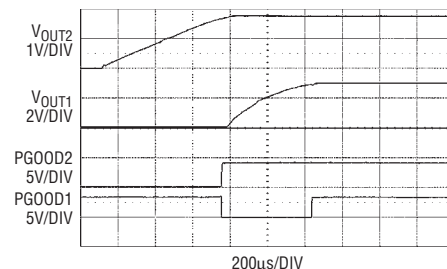


Figure 6. Sequenced power-up waveforms