DESIGN NOTES

Triple Buck Regulator Features 1-Wire Dynamically Programmable Output Voltages

Design Note 459

Andy Bishop

Introduction

The LTC®3569 is a compact power solution for handheld devices. Its tiny 3mm × 3mm QFN package includes three buck regulators with individually programmable output voltages. One regulator supports load currents up to 1200mA, while the other two support currents to 600mA. Two regulators can be paralleled for increased load capability. Each current-mode regulator is internally compensated with excellent load and line regulation. A complete 2- or 3-output solution requires a minimum number of external passive components.

Three Individually Programmable Bucks

The LTC3569's three output voltages are independently programmed by simply toggling their respective enable pins. Each time an enable pin sees a falling edge, a 4-bit counter is decremented. After a time-out delay of 120µs from the last rising edge at the enable pins, the counter state is latched into the feedback reference voltage DAC. In this way, the reference voltage can be programmed from 800mV (full scale) to 425mV in 25mV steps.

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Configure Parallel Power Stages for Different Loads

The LTC3569's buck regulators can be paralleled for higher load capability. By pulling the feedback pin of one of the two 600mA regulators up to the input supply voltage, that regulator's power stage is reconfigured as a slave, where switching is synchronized to its upstream master. Buck 2 can be a slave to Buck 1, or Buck 3 a slave to Buck 2. When operating in slave mode, the slave switch pin is tied in parallel with the master switch pin and the maximum output currents sum. This yields three possible combinations: three independent regulators (a 1.2A buck and two 0.6A bucks), two independent 1.2A bucks, or two independent bucks of 1.8A and 0.6A.

Power Good Indicator

The LTC3569 has a PGOOD pin to indicate when any enabled regulator output voltage has risen to within 8% of the programmed value. If any of the enabled output voltages are lower than programmed, the PGOOD pin pulls low. If all of the regulators are off, the PGOOD pin pulls low and the LTC3569 enters a low power shutdown mode with <1µA of supply current.

Figure 1. LTC3569 Configured As Dual 1.2A Programmable Buck Regulators

Power Saving Operating Modes

The LTC3569 offers two modes of operation (set via the MODE pin) that improve efficiency at light loads. Burst Mode® operation is the most efficient at low load currents, while pulse-skipping mode produces lower ripple currents. At startup, until the end of the soft-start ramp, pulse-skipping mode is automatically selected.

Programmable Clock Frequency

The switching frequency is fixed at 2.25MHz by pulling RT up to the input supply, or the clock can be programmed to a frequency between 1MHz and 3MHz with a timing resistor to ground. If a clock signal is applied to the MODE pin the LTC3569's clock is injection locked to the external clock as long as the frequency is greater than that programmed using the RT pin. With injection locking, the operating mode is automatically set to pulse-skipping.

2-Output, Individually Programmable 1.2A Regulators

Figure 1 shows a 2-output application where each output can be reprogrammed at any time to a standby voltage of 1.2V or an active voltage of 1.8V. Both outputs provide up to 1.2A of load current from a Li-Ion battery voltage between 2.8V and 4.2V. Burst Mode operation is selected for high efficiency at light loads. Figures 2 through 5 show independent programming of the two output voltages via toggling of the respective enable pins while supplying a constant 625mA to each load.

Conclusion

The LTC3569 is a flexible solution for powering handheld Li-Ion battery applications. The ability to adjust or disable individual output voltages on the fly provides a simple solution to support energy saving operating modes in advanced microprocessor-based designs.
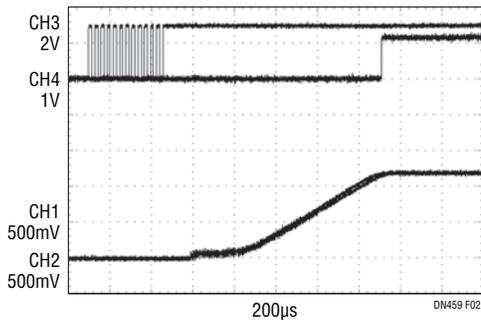
Figure 2. Soft-Start Both Bucks Into Standby. CH1 = OUT1, CH2 = OUT2, CH3 = EN1 = EN2, CH4 = PGOOD
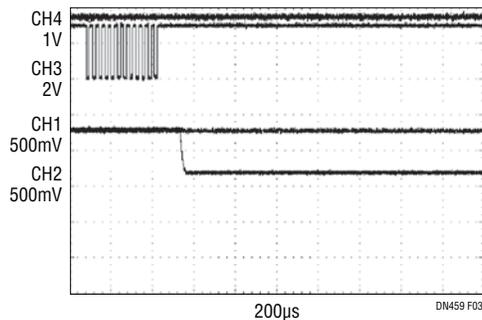

Figure 3. Reprogram Buck 2 From Active to Standby With No Cross-Talk On Buck 1 Output. CH1 = OUT1, CH2 = OUT2, CH3 = EN2, CH4 = PGOOD
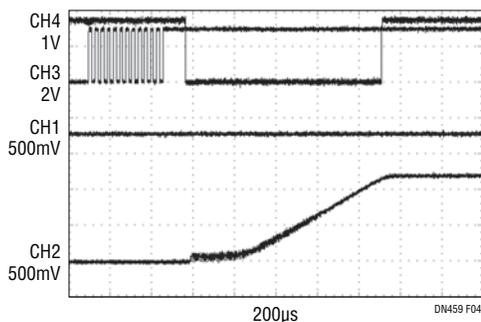

Figure 4. Buck 1 Active, Buck 2 Soft-Start to Standby. CH1 = OUT1, CH2 = OUT2, CH3 = EN2, CH4 = PGOOD, No Cross-Talk On Buck 1 Output
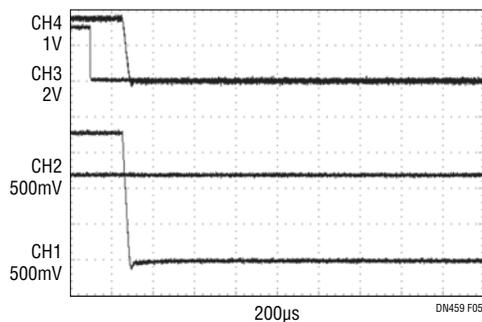

Figure 5. Buck 1 Active to Shutdown, Buck 2 Standby. CH1 = OUT1, CH2 = OUT2, CH3 = EN2, CH4 = PGOOD, Note PGOOD Falls As It Is Tied to OUT1, No Cross-Talk On Buck 2 Output

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