LINEAR TECHNOLOGY

DESIGN NOTES

55V High Efficiency Buck-Boost Power Manager and Multi-Chemistry Battery Charger

Design Note 531

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Introduction

Today, battery chargers are expected to easily support a variety of battery chemistries and accept a range of voltage inputs, including wide-ranging solar panels. It is increasingly common for input voltage ranges to span above and below the output battery voltage, requiring both step-down and step-up capability (buck-boost topology). The LTC4020 buck-boost power manager and multi-chemistry battery-charging controller can take wide-ranging 4.5V to 55V inputs and produce output voltages up to 55V. Its buck-boost DC/DC controller supports battery and system voltages above, below, or equal to the input voltage.

The charger is easily optimized for a variety of battery chemistries. For instance, it can follow a constant-current/constant-voltage (CC/CV) charge algorithm, with either C/10 or timed termination for lithium-based battery systems, a constant-current (CC) characteristic with timed termination, or an optimized 4-step, 3-stage lead-acid charge profile.

6.3A Charger for 25.2V Battery Float Voltage

Figure 1 shows a 15V to 55V input, 25.2V/6.3A buck-boost battery charger, featuring a high efficiency 4-switch (M2–M5) synchronous buck-boost DC/DC

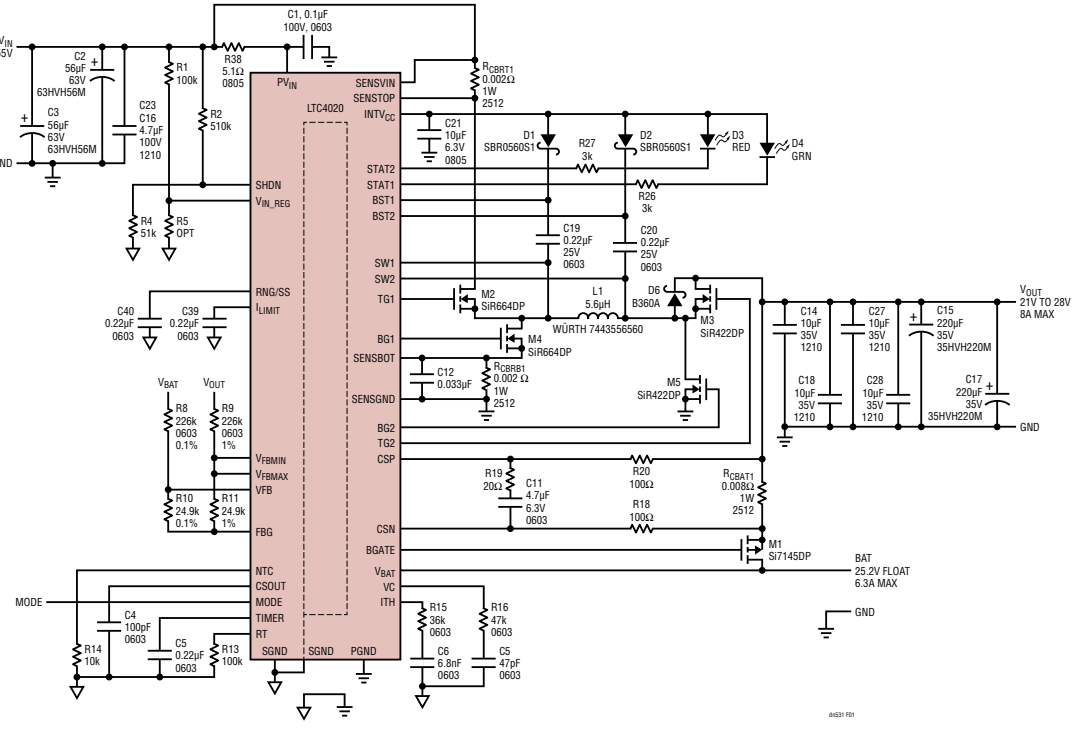

Figure 1. 15V to 55V Input, 25.2V/6.3A Buck-Boost Battery Charger

converter requiring only one inductor (L1). The proprietary average current mode architecture uses two sense resistors (R_{CBRT1} and R_{CBRB1}) to monitor the inductor current. In this buck-boost solution, when V_{IN} is higher than V_{OUT}, the converter operates in buck (step-down) mode; when V_{IN} is lower than V_{OUT}, the converter works at boost (step-up) mode. When V_{IN} is close to V_{OUT}, the converter operates in 4-switch buck-boost mode.

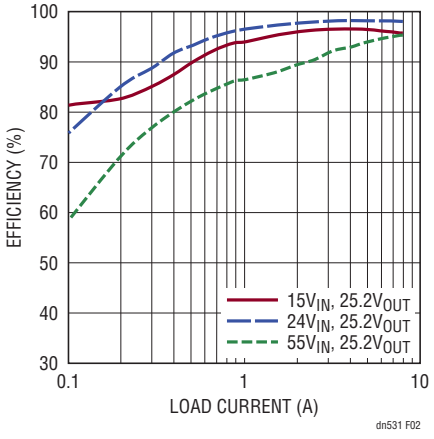

Figure 2. Efficiency vs Load Current I_{OUT} (V_{OUT} = 25.2V) of the Converter in Figure 1

The converter operates at a programmable constant switching frequency within the range of 50kHz to 500kHz, set with a resistor (R13 = 100k, 250kHz). The solution shown in Figure 1 can supply up to 8A to the system load (V_{OUT} = 25.2V). Figure 2 shows full load efficiency (I_{OUT} = 8A, V_{IN} = 24V) can reach above 98%.

The LTC4020 uses an external feedback resistor divider from the BAT pin to program battery voltages via the V_{FB} pin. The PowerPath™ FET (M1) is on during normal battery charging, forming a low impedance connection between the battery and the buck-boost converter output when possible. Battery charge current is monitored through a sense resistor (R_{CBAT1}). Maximum average battery charge current is easily programmed by selecting the value of R_{CBAT1}. Dynamic current limit adjustment is possible through the RNG/SS pin.

Instant-On and Ideal Diode Functions with PowerPath FET

For a heavily discharged battery, the LTC4020 can automatically configure the PowerPath FET (M1 in Figure 1) as a linear regulator, allowing the buck-boost converter output to rise above the battery voltage, while still providing charge current to the battery. This function is called PowerPath instant-on, when the PowerPath FET acts as a high impedance current source, providing charge current to the battery.

The LTC4020 automatically configures the PowerPath FET as an ideal diode when the battery charger is not in a charging cycle—namely, the buck-boost converter is operating exclusively for the system load. This allows the battery to remain disconnected from the converter output in normal operation. If, however, the system load current exceeds the buck-boost converter's capacity, additional power can be efficiently drawn from the battery through this ideal diode.

Additional Features

The LTC4020 supports timer-based charging algorithms—a capacitor from the TIMER pin to ground programs the end of the cycle time.

The LTC4020 features battery temperature monitoring and control. By connecting an NTC (negative temperature coefficient) thermistor to the NTC pin, and by placing the thermistor close to the battery pack (or other desired monitoring location), if the NTC pin voltage is out of range (above 1.35V or below 0.3V), the LTC4020 triggers an NTC fault and halts battery charging.

The LTC4020's V_{IN_REG} pin allows input voltage regulation. This pin can be used to program the peak power voltage for a solar panel, or help maintain a minimum voltage for other high impedance input supplies.

The LTC4020 has two open collector outputs, STAT1 and STAT2, to report charger status and fault conditions. These two pins are binary coded.

Conclusion

The LTC4020 is a versatile high voltage, high efficiency buck-boost power manager and multi-chemistry battery charger, supporting input voltages above, below or equal to the output battery or system voltages. Its low profile (0.75mm) thermally enhanced 38-pin 5mm × 7mm QFN package is suitable for portable industrial and medical equipment, solar-powered systems, military communications equipment, and 12V to 24V embedded automotive systems.

Data Sheet Download

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