Keywords: buck-boost converter, high efficiency, low quiescent current, smooth transition, narrowband, IoT, LoRa IoT, LoRa radio, Asset tracking, Asset management

APPLICATION NOTE 7002

CHOOSE THE RIGHT BUCK-BOOST FOR YOUR IOT TRACKER

Abstract: Narrowband IoT (NB-IoT) and LoRa (Long Range) IoT devices must operate for a few years powered only by small batteries. To reduce power consumption, careful selection of each block is a must, as well as a buck-boost regulator that operates efficiently over a wide output current range. The MAX77827 buck-boost converter, with its high efficiency, smooth transition, low quiescent current and small size, provides an ideal power solution for NB-IoT and LoRa asset tracking applications.

Introduction

Logistics teams can have a ready view into the performance and location of their fleet, supply chain managers can keep tabs on inventory levels without entering the warehouse, and famers can monitor their fields without going outside. These real-time insights are made possible thanks to new radio interfaces like narrowband internet of things (NB-IoT) and LoRa (Long Range). Optimized for long range, low power, low cost, and low battery consumption, these interfaces are enabling a plethora of new applications like fleet tracking, asset tracking, smart farming (**Figure 1**), goods labelling, and much more. This new generation of beacons connects directly to dedicated cellular networks, eliminating the use of Bluetooth® to communicate with a gateway. Since the radio interface is optimized for low power, the voltage regulator powering the IoT device must also consume low power for maximum battery life. In this design solution, we discuss the power management challenges encountered by a battery-operated IoT device and show how a high-efficiency buck-boost converter can considerably extend the device’s untethered operation.

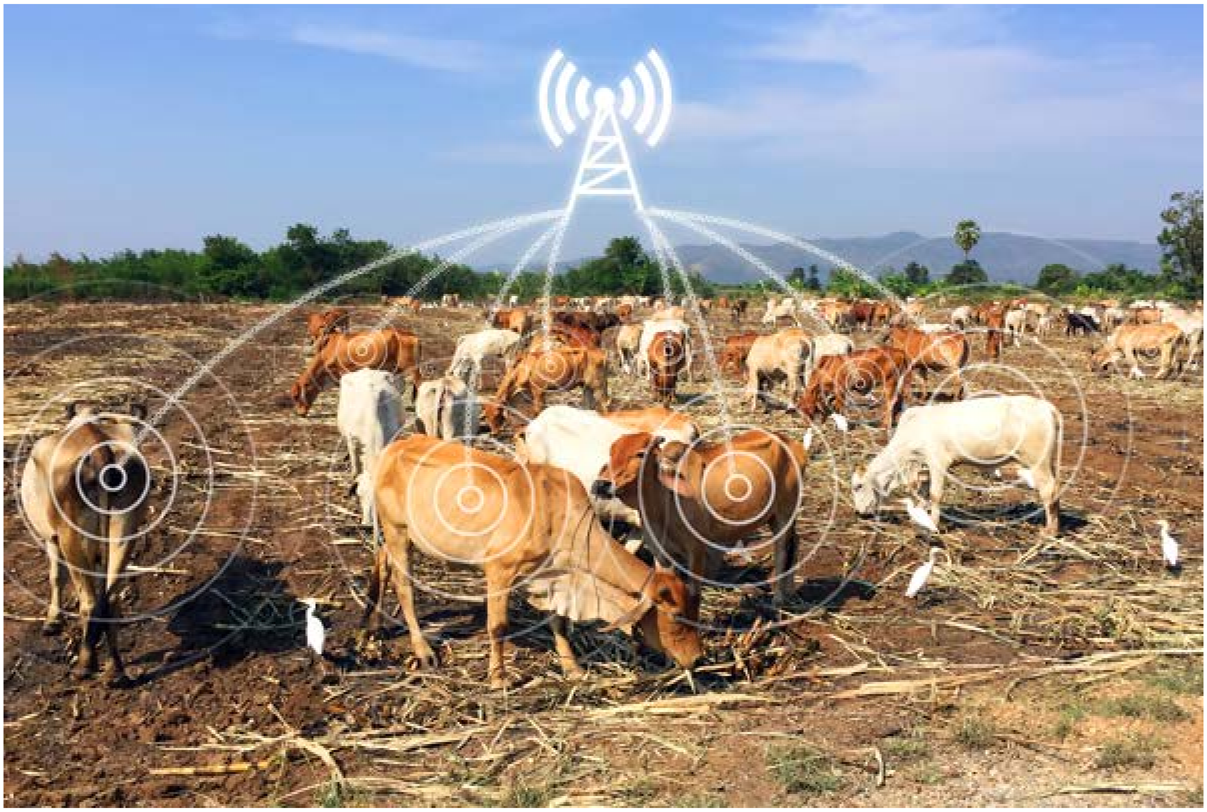

Figure 1. Smart farming with low-power NB-IoT asset tracking device.

Powering the IoT Device

As an example, a typical asset tracker has the size of a pack of cigarettes. Such a small space has to accommodate a powerful battery, the voltage regulation, the sensors, and the communication electronics. Space constraints require the use of lithium-based battery chemistry (either lithium-ion (Li+) or Li-SOCL2) thanks to its superior power density and shape flexibility.

A lithium-ion battery voltage varies between 2.5V and 4.35V. When the electronic load requires a voltage between 3.3V and 3.6V (a set of values intermediate between the battery maximum and minimum voltage), the regulator connecting the load to the battery has to be a buck-boost converter for the full utilization of the battery capacity.

Typical Asset Tracker System

Figure 2 shows a typical livestock asset tracker block diagram. The nonrechargeable Li+ battery supplies a charge of 200mAh. A buck-boost regulator powers the on-board controller and radio.

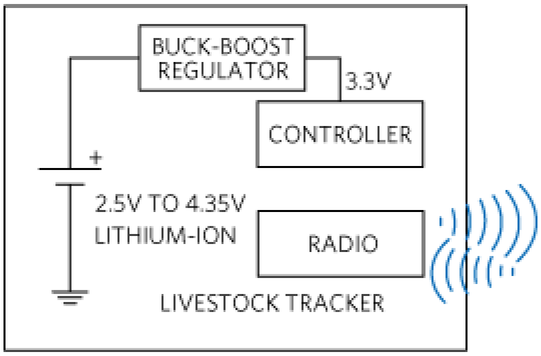

Figure 2. Livestock tracker block diagram.

For demanding tracking applications, the system must last two to three years on a disposable battery. Assuming a boot-up current of 10mA for 25s, a transmission current of 500mA for 250ms, and a receiving current of 0.1mA for 5s, at two times per day with 90% power efficiency, a 200mAhr coin cell will last a little less than 3 years (**Table 1**).

Table 1. 200mAhr Coin-Cell Duration

	mA	secs/Day	mAsec/Day Twice a Day
Tx	500	0.25	250
Boot	10	25	500
Rx	0.1	5	1

Efficiency	mAh/Day Consumption	Coin Cell mAh	Duration Days
90%	0.23	200	863
95%	0.22	200	911

The bottom of Table 1 shows the importance of efficiency. A 5% efficiency advantage produces an additional untethered operation of 48 days.

Mode Transition

A critical point of traditional buck-boost operation is the mode transition, from buck to boost and vice versa. In **Figure 3**, the transition from boost to buck produces a 20mV overshoot and a 35mV undershoot at the output of a typical voltage regulator. Consequently, the regulator output voltage has to be set to 35mV above nominal to deliver the minimum necessary power to the load. This corresponds to a 1% waste of energy (35mV/3.3V) or about 18 days of reduced operation, not to mention the unstable output waveform.

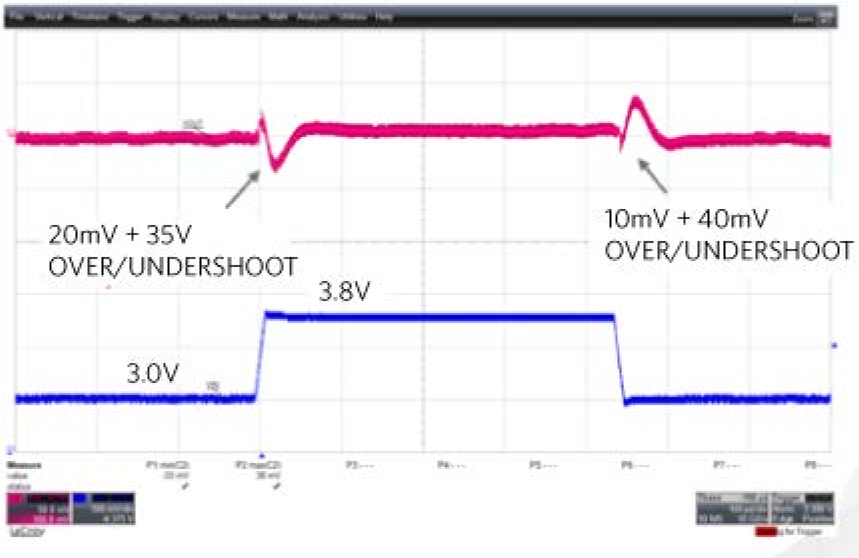

Figure 3. Typical buck-boost line transient.

Buck-Boost Converter Example

As an example, the high-efficiency low 6µA quiescent-current buck-boost converter shown in **Figure 4** operates from a 1.8V to 5.5V input voltage and supports load currents of up to 1.6A with peak efficiencies of 96%. The device is housed in a space-saving 1.61mm x 2.01mm 12-bump wafer-level package (WLP 3 x 4 bumps, 0.4mm pitch). A 2.5mm x 2.5mm 14-pin flip-chip QFN version will be available soon.

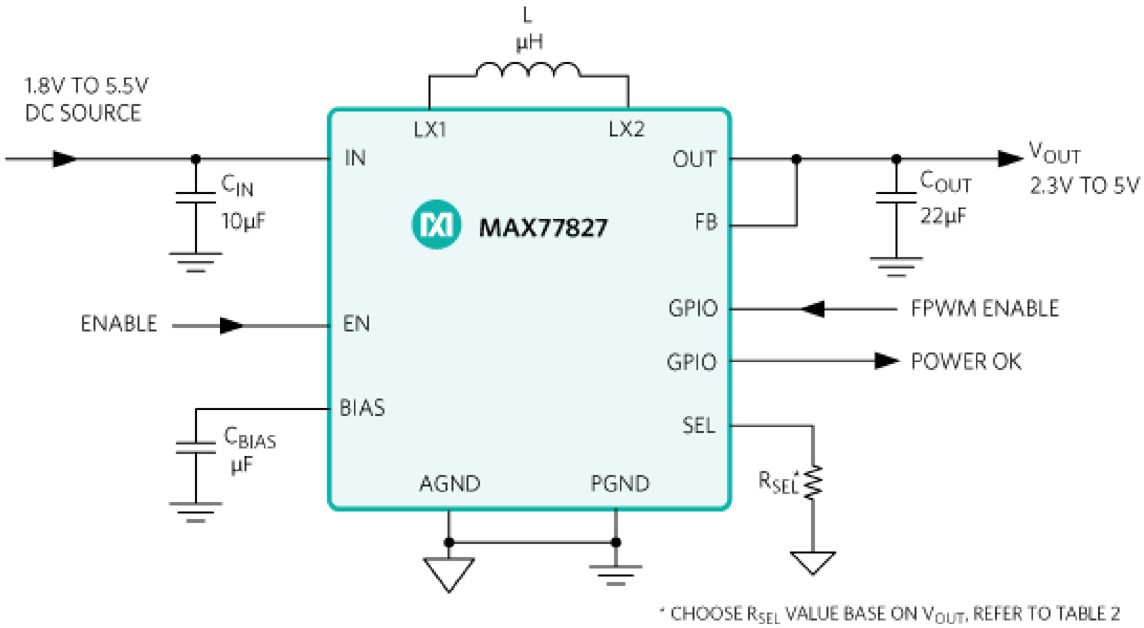

Figure 4. Integrated low-quiescent-current buck-boost converter.

High Efficiency

Figure 5 shows the efficiency curve of the buck-boost converter with a 3V to 4.3V input and a 3.3V output. Synchronous rectification at high load and pulsed operation at light and ultra-light load ensures high efficiency across a wide operating range regardless of buck or boost mode operation. An I_Q of 6µA and a 96% efficiency at 500mA makes the IC ideal for a wide range of NB-IoT tracking applications.

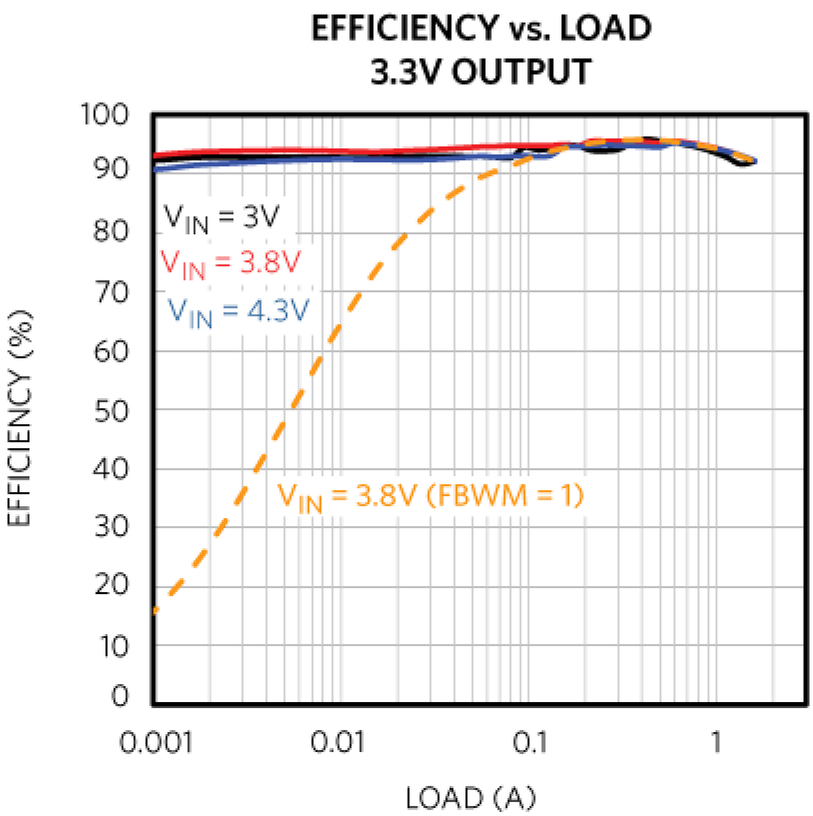

Figure 5. MAX77827 buck-boost efficiency curve.

Smooth Transition

With the MAX77827, which breaks away from the traditional buck-boost operation, the transition voltage droop is significantly more stable and reduced almost to half (**Figure 6**). The draw on the battery capacity is reduced accordingly and the impact on untethered operation is minimized.

Figure 6. Smooth buck-boost line transient.

Small Size

The benefits of high efficiency and smaller footprint go hand in hand, helping engineers design a smaller, cooler asset tracker and easing concerns of device overheating.

The buck-boost converter's application footprint is shown in **Figure** 7. Thanks to its WLP package, high switching frequency operation, and small external passives, the net PCB area of the buck converter is a meager 14.52mm^2.

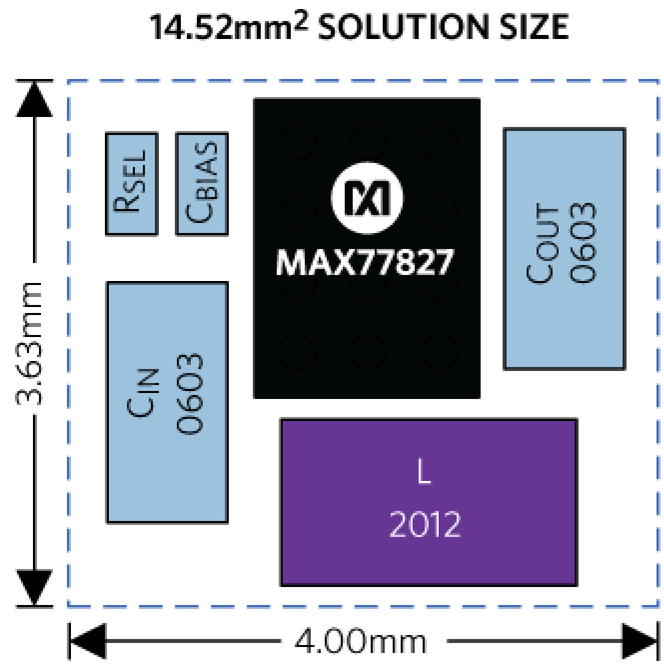

Figure 7. MAX77827 small solution size in 14.52mm²

Conclusion

NB-IoT and LoRa devices must operate in the field for several years powered only by small batteries. This type of operation requires careful selection of each block for minimum power consumption. The buck-boost regulator must operate efficiently over a wide output current range from tens of microamps to hundreds of milliamps. The MAX77827 buck-boost converter, with its high efficiency, smooth transition, low quiescent current and small size, provides an ideal power solution for NB-IoT and LoRa tracking applications.

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Related Parts		
MAX77827	5.5V Input, 1.8A/3.1A Switch Buck-Boost Converter with 6µA I_Q	Samples

More Information

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