Technical Article

Make Your Small Asset Tracker Last Longer

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Abstract

This design solution reviews a typical asset tracking solution and shows how the MAX3864x nanopower buck converter family, with its high efficiency and small size, enables longer battery life in small portables. New, low power data connections are sparking a proliferation of asset tracking solutions thanks to their low cost of deployment. The effects can be seen in multiple applications, particularly transportation and supply chain management.

In a typical application, a sensor provides updates from a given location, transmitting data about temperature, humidity, pressure, and motion. The sensor only needs to transmit small amounts of data, which results in higher coverage and ultra low power consumption, enabling far greater device longevity. The sensor's battery must last from several weeks to a few years. Asset tracking, depending on the application, may require the deployment of several tracker devices. Accordingly, these asset tracker devices must also be small, portable, and cost-effective.

In this design solution, we discuss the power management challenges encountered by a typical battery-operated asset tracker device and show an example using a small, high efficiency buck converter.

Edge-to-Enterprise Communication

Figure 1 illustrates a typical tracking communication chain. The asset being tracked transmits the data via a beacon, which reaches a server through a dedicated cellular network. From here, the data reach the enterprise portal for asset management and analytics.

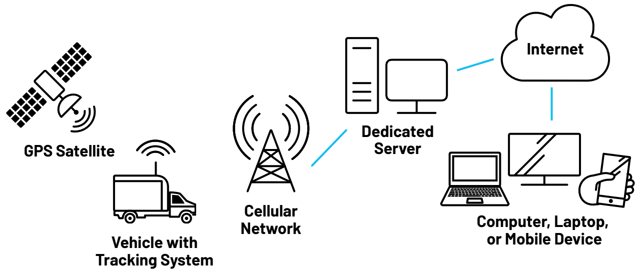

Figure 1. Real-time GPS tracking.

In the factory environment, asset tracking brings the management of facilities, vehicle fleet equipment, and maintenance into a single platform, resulting in improved safety, productivity, and extended asset life.

Asset Tracking Networks

A new generation of beacons connects directly to dedicated cellular networks (LTE-M, NB-IoT), eliminating the use of Bluetooth® to communicate with a gateway. These technologies can be very different but are all characterized by low power consumption, enabling several years of battery life (Table 1).

Table 1. Networks Characteristics

	NB-IoT	LTE-M	Units
Bandwidth	180	1400	kHz
Peak Data Rate	100	384	kbps
U/D Link Speed	62.5	1000	Mbps
Latency	10	100	ms
Battery Life	>10	10	Years
Voice	No	Yes	

Typical Asset Tracker System

Figure 2 shows a typical asset tracker block diagram. The three-series alkaline battery supplies a charge of 2000 mAh. A step-down regulator powers the on-board controller, sensors, and radio.

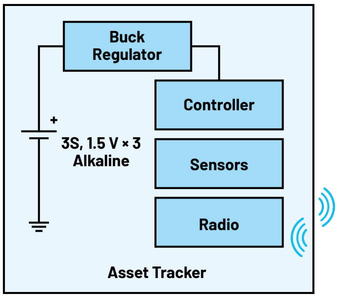

Figure 2. An asset tracker block diagram.

For demanding asset tracking applications, the system must last for a year on three alkaline batteries, drawing only 100 μA in deep sleep, and transmitting 100 mA once per day for about 2 minutes (Figure 3). While it is true that, depending on power level and other options supported in the LTE-M or NB-IoT asset trackers, currents can be higher, for our discussion, we will stick to the 100 μA to 100 mA range.

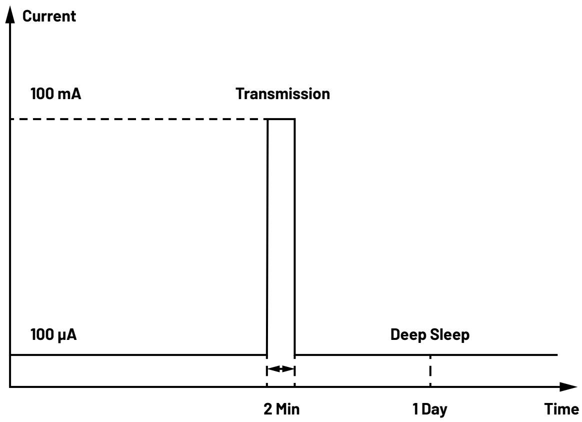

Figure 3. Asset tracker current profile.

High use performance requires careful selection of each block for minimum power consumption. The buck regulator must be efficient over a wide range from 100 μA to 100 mA. For instance, a 4% average loss of efficiency by the buck converter translates into a field deployment reduction of about two weeks.

Ultralow Quiescent Current

The buck converter's quiescent current is especially important since the device is in deep sleep or quiet mode most of the time, consuming only 100 μA or less. With V_{OUT} = 1.8 V, the output power during deep sleep is P_{OUT} = 1.8 V × 100 μA = 180 μW. With η = 90%, the input power is:

$$P_{IN} = 180\ \mu W/0.9 = 200\ \mu W \quad (1)$$

If the buck converter is not carefully chosen and has a typical quiescent current of 3 μA and a 3.6 V input voltage, there is an additional power dissipation of:

$$P'_{IN} = 3\ \mu A \times 3.6\ V = 10.8\ \mu W \quad (2)$$

The final buck converter efficiency is:

$$\eta = P_{OUT}/(P_{IN} + P'_{IN}) = 180/(200 + 10.8) = 86\% \quad (3)$$

A quiescent current of 3 μA robs the buck converter of 4 efficiency points, draining the battery significantly faster!

On the other hand, a buck converter with 300 nA quiescent current will barely reduce the efficiency, lowering it by only half a percentage point. For asset tracking applications, it is critical to select a buck converter with ultralow quiescent current as the system spends the majority of the time in quiet mode and relies on a battery.

Nanopower Buck Converter

As an example of high efficiency, the nanopower ultralow 330 nA quiescent current buck (step-down) DC-to-DC converter shown in Figure 4 operates from a 1.8 V to 5.5 V input voltage and supports load currents of up to 175 mA with peak efficiencies of 96%. While in sleep mode, it consumes only 5 nA of shutdown current. The device is housed in a space-saving 1.42 mm × 0.89 mm, 6-ball wafer-level package (2 × 3 ball WLP, 0.4 mm pitch). If higher currents are desired based on the power level in the NB-IoT or LTE-M networks, sister parts can deliver higher currents.

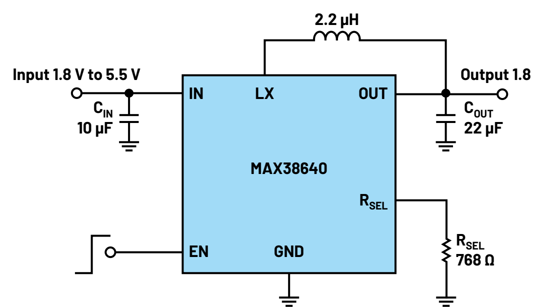

Figure 4. An integrated buck converter.

Small Size

The nanopower buck converter's application footprint is shown in Figure 5. Thanks to its WLP package, high switching frequency operation, and small external passives, the net PCB area of the buck converter is a meager 7.1 mm^2.

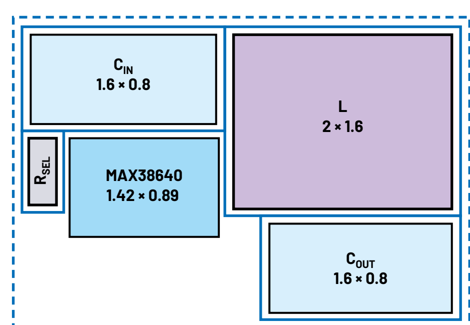

Figure 5. Asset tracker buck converter application (7.1 mm^2 net area).

Efficiency Advantage

Figure 6 shows the efficiency curve of the buck converter with a 3.6 V input and a 1.8 V output. Synchronous rectification at high load and pulsed operation at light load and ultralight load assure high efficiency across a wide operating range.

An 87.5% high efficiency operation at 100 µA and 92% efficiency at 100 mA make the IC ideal for asset tracking applications. This buck converter has the advantage of several efficiency points compared to alternative solutions.

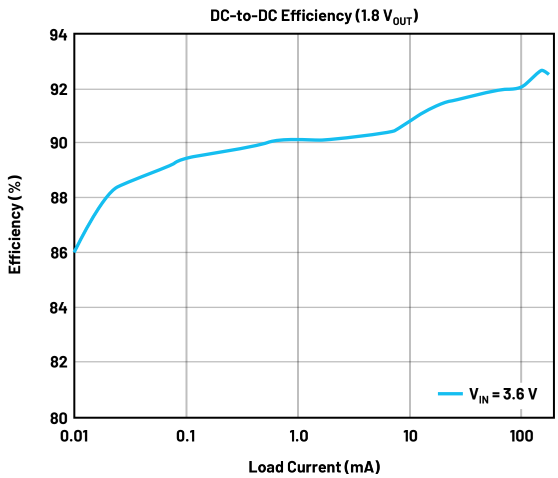

Figure 6. MAX38640 efficiency curve.

The benefits of high efficiency and smaller footprint go hand in hand, resulting in less heat generation. This helps in designing a smaller, cooler asset tracker, easing concerns of device overheating.

Conclusion

Asset trackers, depending on their specific application, must operate in the field for several weeks to a few years powered only by small batteries. This type of operation requires careful selection of each block for minimum power consumption. The buck regulator must operate efficiently over a wide input current range, from tens of microamps to hundreds of milliamps. The MAX3864x nanopower buck converter family, with its high efficiency and small size, provides an ideal power solution for asset tracking applications.

References

MAX38640. Analog Devices, Inc.

MAX38641. Analog Devices, Inc.

MAX38642. Analog Devices, Inc.

MAX38643. Analog Devices, Inc.

About the Authors

Anil Telikepalli was the managing director of the Core Products Business Unit at Analog Devices with responsibility for power and data converter products. Anil joined Analog Devices in 2010 and managed definition, product development, marketing, and business development with a global team across North America, Europe, and Asia. Prior to ADI, Anil held multiple roles at Xilinx and MIPS Technologies in engineering applications, marketing, and business operations, enabling growth in communications, computing, consumer, automotive, and industrial markets. Anil holds master's and bachelor's degrees in electrical engineering from the University of Kentucky and Osmania University, respectively. He holds several patents in the field and has advised multiple hardware and internet software startups.

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