

How to Make Your IoT Gadget Smaller and Cooler

Introduction

Charging and fuel gauging ICs—at the heart of every battery management system—are critical components of ever-shrinking mobile and IoT electronic gadgets. While size is shrinking, complexity is increasing. High-efficiency charging at a high input voltage and a high charge current is required for faster charging with minimum heat generation. This article reviews a typical approach for meeting the challenges of reduced space requirements and minimizing heat generation. It then presents a new solution that delivers more efficient power in a smaller space, enabling longer battery life and smaller form factors.



Figure 1. Smartphone at End-of-Charge

Typical Power Management Implementation

A typical charger and fuel gauge system is shown in Figure 2. In addition to the charger and the fuel gauge, it includes two safeout low dropout regulators (SFLDO) that drive the system’s USB interface. For simplicity, the external passives are not shown.

All active and passive components for the system diagram shown in Figure 2 are accounted for in the solution drawing of Figure 3.

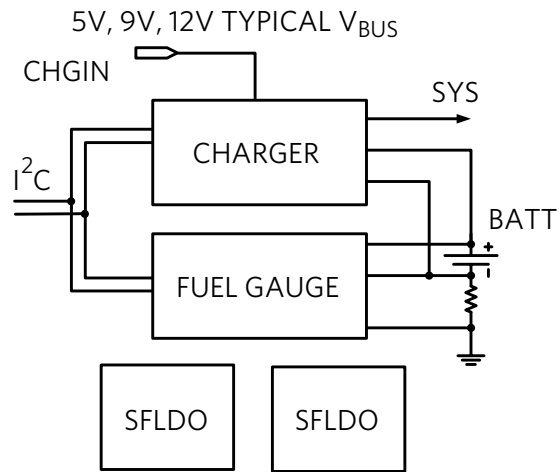


Figure 2. Typical Charger and Fuel Gauge System

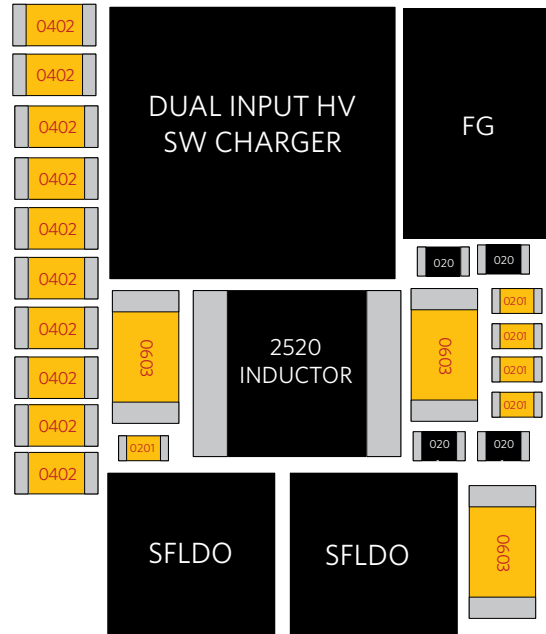


Figure 3. Typical Charger and Fuel Gauge System Footprint (55mm²)

The 1.5µH, 3.5A inductor (in a large 2520 package), and the two external LDOs present a huge challenge in terms of space. This solution occupies a board area of about 55mm².

An Integrated Solution

The PMIC in Figure 4 (MAX77818) integrates the charger, fuel gauge, and LDOs in a single chip. This eliminates the wasted space associated with using multiple components. Another advantage of this solution is the ability to use a lower value 0.47μH inductor that carries 3.5A in a smaller 2016 package.

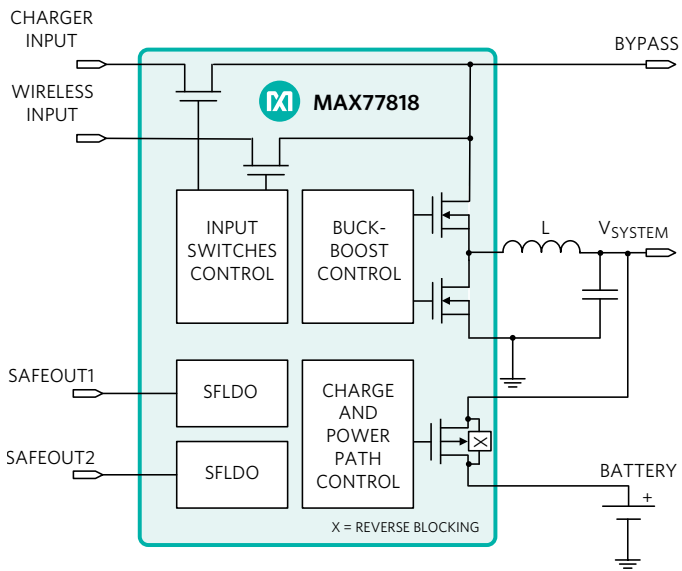


Figure 4. Highly Integrated Charger and Fuel Gauge System-on-Chip

All active and passive components of the system diagram shown in Figure 4 are accounted for in the solution drawing of Figure 5.

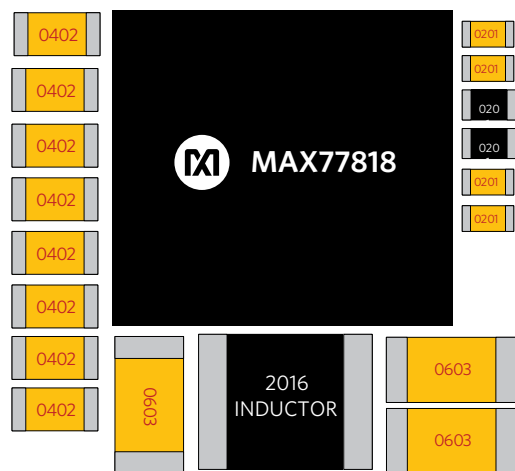


Figure 5. Highly Integrated Charger and Fuel Gauge System Footprint (37mm²)

The total board space occupied by the components is a mere 37mm², providing 33% in space savings. In addition, the MAX77818 draws only 20μA of total quiescent current. This

saves valuable battery life, which enables either system size reduction by using the smallest battery possible or longer use time between each charge.

More Efficiency in Less Space

A comparison between the efficiency (from CHGIN to BATT) of the MAX77818 charger solution and a competitive solution is shown in Figure 6. To provide a true comparison, both solutions are powered with a 1μH inductor in a 2520 package. The integrated charger solution exhibits higher efficiency across most of the load current range even with a substantially higher switching frequency. At full load (3.5A), the efficiency of the integrated solution is well above 88%, while the competitive solution is just above 86%, a more than 2% efficiency difference.

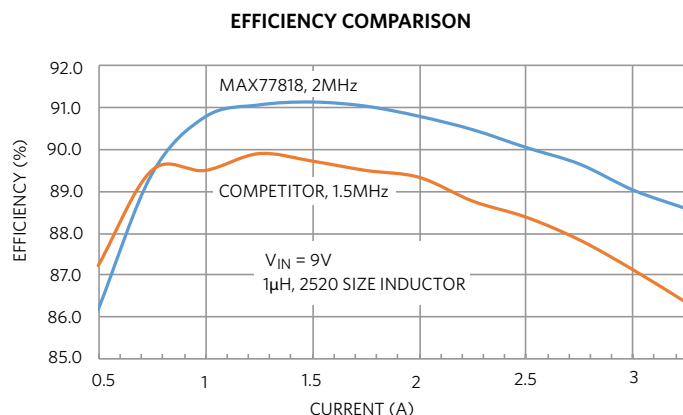


Figure 6. MAX77818 vs. Competitor Efficiency

Even with the large 2520 inductor, the integrated solution is 30% smaller than the competitive solution.

MAX77818 Integrated Charger and Fuel Gauge

The MAX77818 switching charger is designed with a special CC, CV, and die temperature regulation algorithm. The Model-Gauge™ (m5) algorithm delivers battery fuel gauging with the highest accuracy available while operating with extremely low battery current.

The fuel gauge must be loaded with a factory characterization file (INI) to match the battery in use. Maxim has developed a vast battery database of cell characteristics and behaviors over a wide range of test conditions based on customer use cases. This allows Maxim to provide an initial configuration file that works well with the battery until a more specific battery characterization file is created to achieve the highest accuracy operation. To learn more about the terms of support for battery characterization, please contact [Maxim technical support](#).

Additional Advantages of Integration

A fuel gauge IC has temperature-sensing capabilities to conform to the correct charging profile based on the battery at hand. That's not normally the case for the charger IC. However, JEITA, a Japanese electronics protocol that has become the standard for lithium-ion (Li+) batteries specifies charger behavior vs. temperature. For example, to control charge current and voltage based on temperature, which reduces the current at cold temperatures, the charger would need to integrate a temperature sensor or a microprocessor host to provide temperature information. But the MAX77818's integration permits the fuel gauge and charger to easily access the temperature, an important function when the JEITA mode is enabled. Integration reduces silicon overhead and potentially lowers the thermistor count. Finally, with the fuel gauge and charger in the same package, there is less chance of having PCB layout issues.

Conclusion

We have discussed the shortcomings of a typical charger-fuel gauge implementation and introduced a new, highly integrated solution. The new solution, compared to an alternative implementation, delivers a full load efficiency advantage of more than 2% and a 33% reduction in PCB area, enabling longer battery life and smaller form factors.

Learn more:

[MAX77818 Dual Input Power Path, 3A Switching Mode Charger with Fuel Gauge](#)

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