Improvements in Battery Charger ICs Keep Pace with Rapid Increases in Mobile Handset Capabilities

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In the era of global wireless connectivity, almost nothing is more important than keeping a smart phone or mobile Internet device charged. Expanding features on the constantly improving portable and handheld device create a major challenge for designers of battery charger ICs. High resolution screens and larger memories combine with new capabilities to tax the battery, requiring battery charger technology that is not only more efficient but also capable of managing power distribution.

Optimizing power consumption to prolong battery life has always been a driving force in handheld power management. However what is changing are the efficiency expectations for charging handheld devices when they are plugged into the wall. The latest generations of device designs are using high-efficiency switching chargers in place of traditional linear chargers. Customers today continue to demand shorter charge cycles when charging their battery. Beside higher efficiency with respect to the conventional linear chargers, one of the great advantages of using switching chargers solution is the capability to boost the charge current from what supplied by the source. This is especially important when powering off of a USB port where the current available might be limited to less than 500mA. Higher charge currents equate to shorter charge cycles thus satisfying customer

expectations

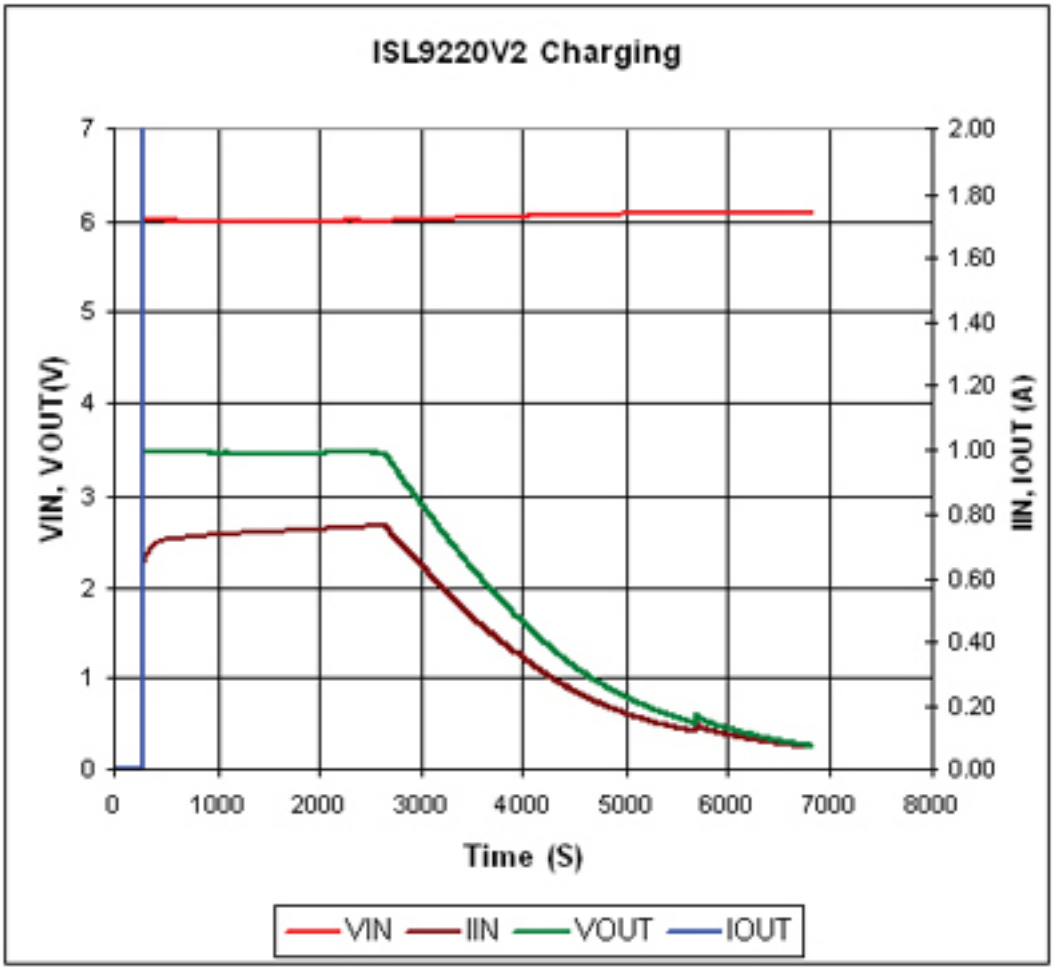

Fig 1. Depicts a typical charging profile for single cell Li Ion application

There are two kinds of battery chargers used in most handhelds now – linear chargers and switching devices. Linear chargers have a longer history. They have typically provided a relatively efficient, simple way to charge portable devices, creating minimal noise without many external components. But as portable devices become more complex and add layers of new features, they need higher battery capacity. Linear chargers present liabilities due to power dissipation, which become clear if a user wants to charge a device while using at the same time. The heat generated while simultaneously using and charging can damage the system or battery. Not a good outcome.

The alternative is a switching device, or switch mode battery charger IC, that can deliver higher current levels to a battery while requiring as little power as possible. Historically, there have been some noise issues with these kinds of ICs. In addition, some early generations of switch mode devices have required several external components.

However, the benefits of the switched mode battery topology are clear. They include higher efficiency and lower power dissipation, along with fast charging cycles. These devices also are capable of charging from higher input voltages, which allows the use of lower cost unregulated adapters. They can increase the charging current from current restricted sources.

The noise from switching chargers usually comes during light load operation, particularly during preconditioning. As it decreases, many switching chargers move into an operation known as pulse skipping. In pulse skipping, the PWM frequency changes asynchronously. There have been battery charger ICs developed that supply high charge current with minimal thermal impact to the system using a switching charger, then switch into a linear charger during low current charging modes to minimize noise. This type of PWM switch mode charger with a linear mode has been a good development, providing high efficiency at the full constant current (fast charge) rate. The switching charger controls large constant current charge (up to 2A) with a PWM switching regulator. It automatically moves to linear mode while the battery is preconditioning and near the end of constant voltage taper charge mode, which lowers the noise while the switch mode speeds up charging. Once the charge current level dips below 300 mA, the linear mode kicks in completely and noise generated by the switching converter is eliminated.

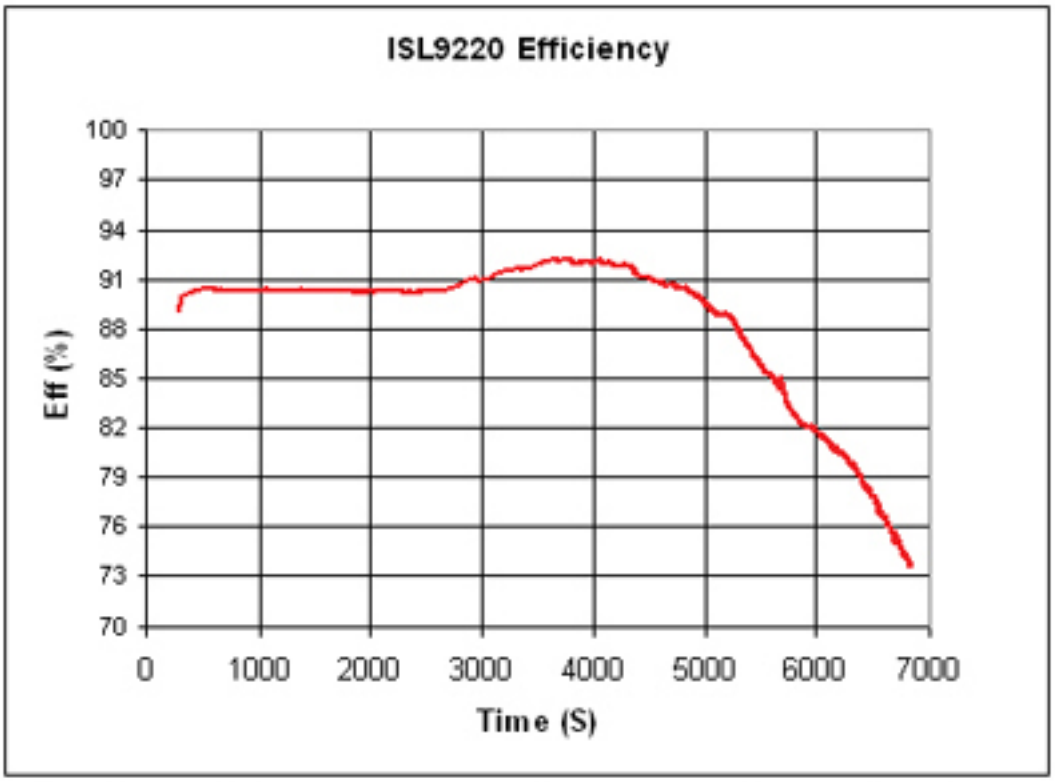

Fig 2. The efficiency curve for single cell Li Ion application with the ISL9220 charger IC as an example

But now there are further advances. For example, an ideal solution for new handhelds is a complete charger for single cell Li+/ Polymer batteries with up to 1A charge current and advanced indication capabilities for full charge system monitoring. USB Compliant 100mA/500mA charge current settings are beneficial as

are programmable pre-charge and fast charge. Many products also include battery temperature monitoring, which ensures safe charging.

Companies such as Intersil are leading the development effort for new generations of charger ICs. These fully integrated solutions serve compact applications and provide charge controllers for higher power applications. Charge voltage accuracy is now at 0.5 percent, an improvement over just a few years ago, when an accuracy rating of 1 percent was considered good. Switching frequencies are up to 3 MHz and new switching chargers now provide up to 2A charge current, with one recent example being the ISL9220, which is suitable for both 1 and 2 cells Li Ion applications.

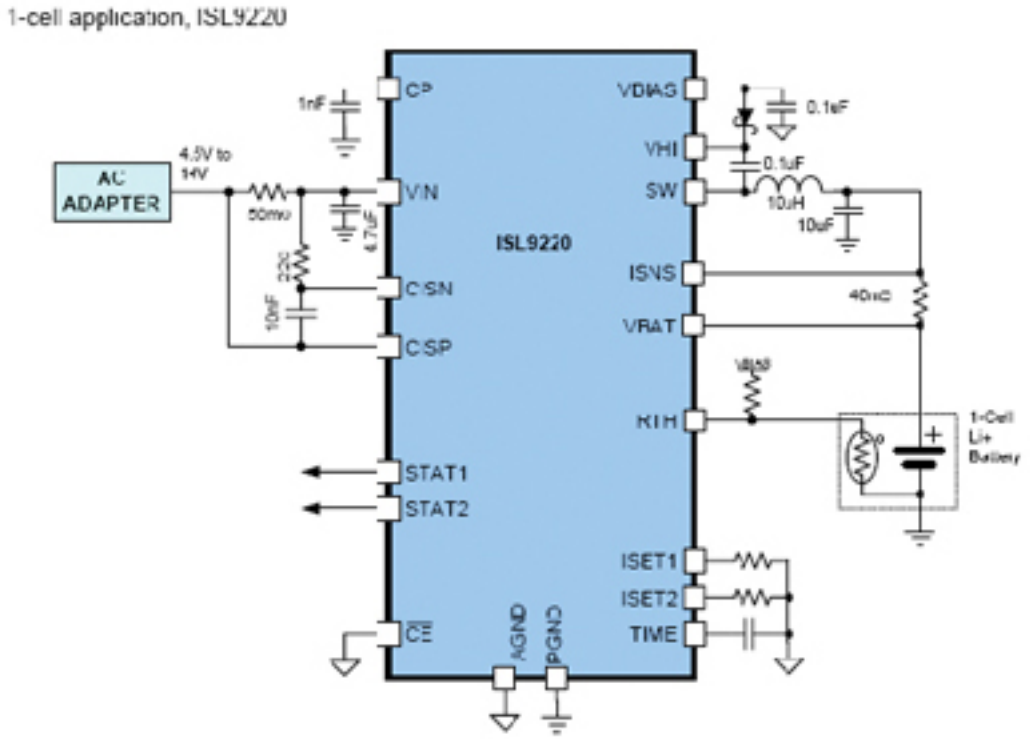

Fig 3. ISL9220 typical application circuit for single cell Li Ion application

In addition, new designs restrict leakage -- there is now less than 0.5uA typical leakage current off the battery when no input power is attached. These improvements also have become available in smaller and smaller packages, such as 4 x 4mm QFNs or 2 x 2mm CSPs, which save real estate in space-constrained handheld equipment.

The latest battery charger ICs also are able to monitor the input voltage, the battery voltage, and the charge current. When any of the three parameters exceeds specific limits, the IC turns off an internal N-channel MOSFET to remove the power from the charging system to the battery. This kind of flexible efficiency is another of the improvements now available in these important devices, which are vital to the continuing growth and feature set expansion of mobile, handheld products.