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How Parallel Battery Charging with USB-C Helps to Enhance the Consumer Experience

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Abstract

USB-C ports are becoming the standard for consumer devices as they have a lot more flexibility than previous USB ports. Among these devices, higher power and longer battery life are some of the qualities that are gaining popularity. Thus, the need to charge these devices at higher power levels is now increasingly necessary. This article will introduce the basics of parallel battery charging architecture and use cases along with the effect of incorporating USB-C into those use cases. Additionally, this article covers the integration, benefits, and drawbacks of parallel battery charging and USB-C in the consumer market.

What Is Parallel Battery Charging?

In battery management systems, there are a few ways to manipulate the configuration of your batteries to achieve different outcomes. One can place their batteries in a series configuration, which provides a higher voltage, but the same battery capacity, which usually applies to higher power products. The other option is to place the batteries in a parallel configuration, which results in a higher capacity, but the same voltage. Now that longer battery life is such a critical factor for consumer devices, manufacturers need to become creative with the ways they conserve and extend a battery pack's useful capacity. The best way to implement a simple solution for longer battery life is to have parallel charging. Simply put, parallel charging batteries allow the user to charge multiple batteries at once, which provides longer battery life and increased reliability for the user. Figure 1 provides a basic description of series and parallel battery configurations that are commonly used.

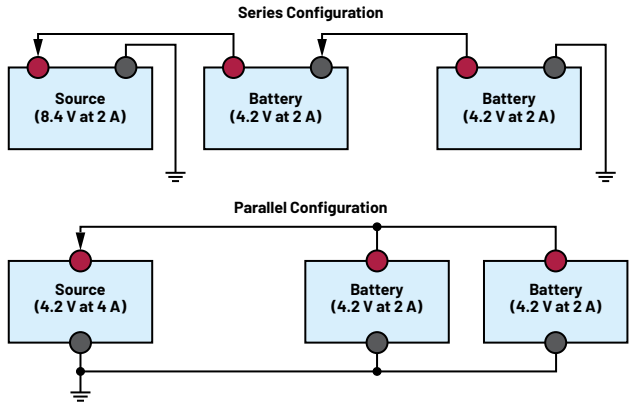

Figure 1. Series and parallel battery configuration.

USB-C's Integration into the Modern Parallel Battery Charging Market

As mentioned previously, USB-C ports and devices have the ability to be charged at higher power levels compared to previous USB 2.0 and USB 3.0 counterparts. The most recent version of the USB-C spec, Power Delivery 3.1, can deliver up to 240 W. Now, for most consumer products, this may be overkill, but this is to emphasize the point of the increased robustness that USB-C offers compared to the previous USB generations. This increase in power from USB-C ports pairs hand in hand with the consumer demand for more power and longer battery life that devices with parallel battery configurations target. As the battery capacity of a consumer device increases due to the parallel battery configuration, so does the power requirement for the charger supplying power to the device. In addition to this, a goal in the consumer market is to allow users to have access to their device as much as possible. The higher power from USB-C ports allows consumers to charge their device faster than before and results in more time for them to use the device however they please, without the attachment to a charging cable.

Benefits and Drawbacks

Parallel battery charging with USB-C has already made its way into many applications and will continue to spread throughout consumer applications. While USB-C ports and cables will be largely beneficial to the consumer market in terms of power, cost, and simplicity, there are some drawbacks that need to be pointed out.

Table 1. Benefits of USB-C and Parallel Battery Charging

Single cable	Power and data are on the same cable, which is beneficial in space constrained applications
High power levels	Increased capacity and higher charging levels allow for a larger range of possible applications, including both low power consumer devices and high power tools and computers
Time saver	The high charge current capabilities of USB-C allow for charging batteries in parallel, which results in more usable capacity in the amount of time it takes to charge just one battery
Simple integration	USB-C cable is reversible and can be plugged in either way, while adding additional batteries in parallel simply requires connecting the power source to the terminals of the new battery
Reduced electronic waste over time	Using a common USB-C charger for multiple devices would reduce electronic waste around the world

Table 2. Drawbacks of USB-C and Parallel Battery Charging

Differences in ports	Complications over power levels can occur if both ports do not match. The multiple ports include Thunderbolt, Power Delivery 3.1, and Power Delivery 3.0
More expensive	Additional batteries along with ports and cables that allow for faster charging require advanced technology, which is more expensive than previous versions
Cable replacement	New USB-C cables will force USB-A, USB-B, and micro-USB cables to be replaced and the older cables will become obsolete
Larger size	Adding an additional battery is going to take up extra space, which can become an issue in applications where size is a critical specification
Increased complexity	Including an additional battery introduces a few complex issues, such as the need to balance aging across the batteries and ensuring charge cycles begin at similar voltages so the batteries or wiring is not damaged

Example with the MAX17330

Figure 2 shows an example of one of the main tools we would need to create a parallel battery charging environment, the MAX17330. This part is a battery charger, fuel gauge, and protector all in one IC. The MAX17330 would receive its power from a USB-C compatible charger or converter, which would then allow for the MAX17330 to charge the parallel battery packs at high speeds, allowing users to have the most hands-on usage time as possible. In addition, this configuration allows for the batteries to be placed in their own unique location, such as the opposite side of an AR/VR headset or separate sides of a foldable phone. Some of the benefits of using this chip are minimizing dropout and heat, preventing cross-charging for parallel batteries, and being able to independently charge parallel packs.

Real-World Applications for the MAX17330

This article has pointed out some of the benefits and drawbacks and given us an introduction to the combination of parallel battery charging and USB-C. Now that we are more familiar with the topic as a whole, it is good to point out some real-world applications. Parallel battery charging and USB-C has already begun introduction into a few consumer markets. These include, but are not limited to, AR/VR headsets, cordless drills and other tools, laptops, and portable tablets. The challenges mentioned previously in Table 2 do cause some difficulties for designers when creating these types of systems. Where Analog Devices comes into play to replace the blocks in Figure 2 is with the MAX17330, along with the MAX77958 in place of the USB-C controller and the MAX77986 in place of the downstream source. The MAX77958 allows designers to simplify their design with the stand-alone solution and customizable firmware that dictates USB-C power delivery levels, while the MAX77986 can act as a downstream source for the USB-C to power other sections of the entire product. This type of setup is ideal for applications with power requirements of 15 W or greater. For applications with lower than 15 W, the MAX77789 is the ideal solution for its combination of 1S 3 A charger and USB-C detection. To experiment with the functionality of these parts, you can order the EV kit for the MAX17330 here and for the MAX77789 here. If you would like to sample a MAX17330 for a prototype, please visit the sample website. For more information on the MAX17330, please watch the "Introduction to the MAX17330."

Conclusion

Consumers in today's world are all about maximizing efficiency and not wasting time with their products. All of these products offered by Analog Devices can be combined to allow consumers to incorporate USB-C's faster charging with parallel battery packs. This results in better efficiency as the end product has a longer battery life and shorter charging time. With the consumer market always evolving, designers need to quickly adapt and find ways to satisfy customers' requirements. USB-C and parallel battery charging is the next solution to the ever-changing problem of finding a new way to power the next generation of consumer devices.

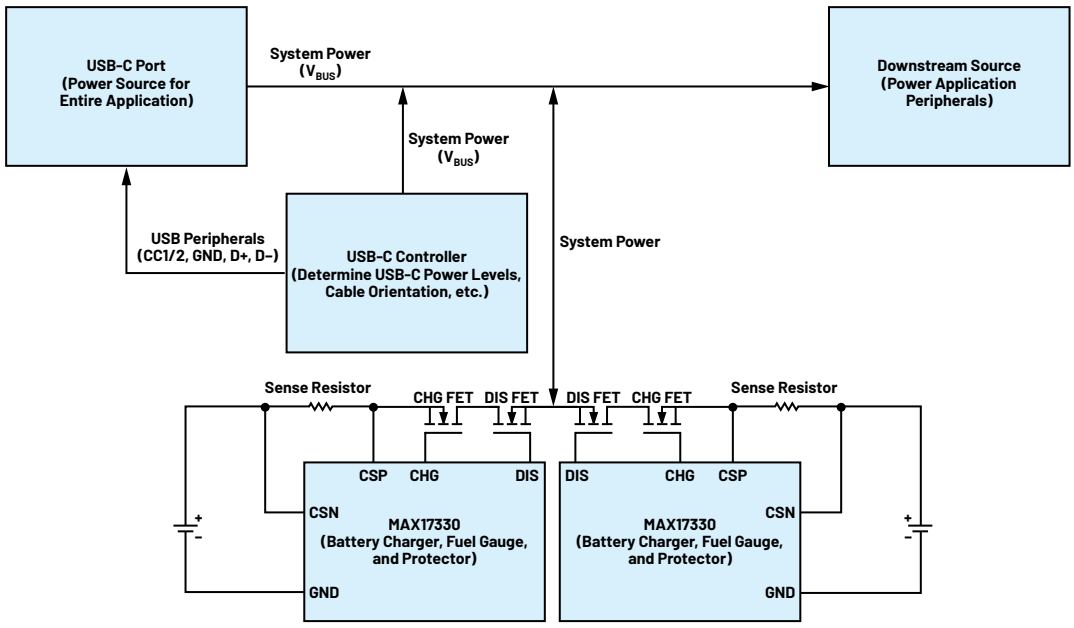

Figure 2. A block diagram of parallel battery charging environment including the MAX17330.

About the Author

Kyle Johnson is an applications engineer in the Central Applications Group at Analog Devices. He graduated with a bachelor's degree in electrical engineering from Santa Clara University and joined ADI in August 2020. Previously, Kyle did an internship with Maxim Integrated (now part of ADI), as part of the Technical Sales team.