Application Brief

Selecting the Correct Charger for Your Supercapacitor Designs

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A supercapacitor is a popular choice for backup power in applications such as building automation, portable electronics and retail automation. In building automation and portable electronics, supercapacitors typically serve as a last-gasp power source, powering smart meters and dashboard cameras to perform essential last-minute tasks when the main power goes out. In retail automation, supercapacitors can provide enough power in bar-code scanners for hundreds of scans and recharge in seconds, with minimal degradation over time.

Picking the correct charging solution for supercapacitors can maximize the life of a full charge for your application. Because supercapacitors have lower voltage levels and quicker dissipation compared to batteries, it's important to make full use of their charge life and quickly replenish them after they are discharged.

Design considerations with supercapacitors

A key benefit of supercapacitors is their ability to charge quickly at 0 V. Unlike batteries, supercapacitors do not have chemical safety issues when charging at voltages smaller than 2 V. A charging integrated circuit (IC) should not only have the ability to charge supercapacitors at 0 V, but should be able to do so with a high charging current. Charging at 0 V also enables you to maximize the time of a single charge (the run time), while the high charging current can quickly replenish the supercapacitors in minutes.

Figure 1 illustrates how an IC such as the BQ25173 can charge two 2.7 V supercapacitors from 0 V to full charge (approximately 5.4 V) in minutes. A 0-V fast-charging IC can make a difference in applications such as barcode scanners. Users can make hundreds of scans with supercapacitor-powered scanners, and a charging IC with a 0-V fast-charging design can minimize the downtime between charges to help increase overall productivity.

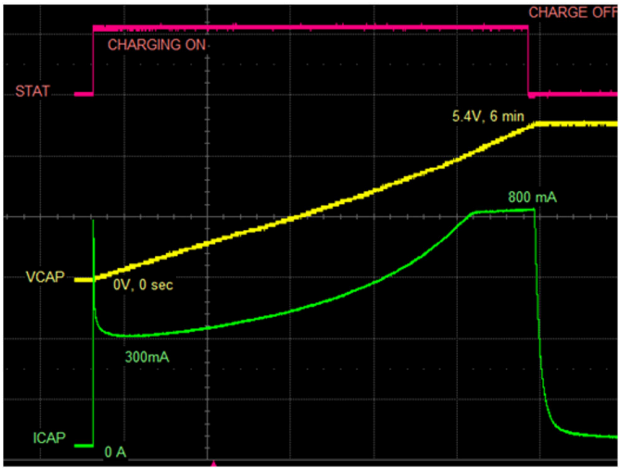

Figure 1. Charging Two 50-F Supercapacitors in Series to 5.4 V with the BQ25173

Because supercapacitors do not hold as much charge as batteries, placing multiple supercapacitors in series can increase the total amount of available charge. For example, a single supercapacitor holds around 2.7 V of total charge, but putting four supercapacitors in series increases the total charge to over 10 V. Placing multiple supercapacitors in series in your design enables you to store more energy while taking advantage of the supercapacitors' quick rechargeability. Your charging IC should have the ability to handle a range of charging voltages from around 2.5 V to voltages greater than 10 V, so you can charge different numbers of supercapacitors with the same charger. This design feature is useful in smart meters, where having multiple supercapacitors for more charge helps the meter last longer when the main power fails.

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TI chargers for supercapacitors

The BQ25173 and BQ24640 supercapacitor chargers address the design considerations and applications for supercapacitors that I just discussed. Linear chargers are an effective low-cost option and useful in low-charge-current applications because they are limited in how much power loss they can handle. The BQ25173 is a linear supercapacitor charger with easily customizable charge current and charge voltage settings. The BQ25173 can charge as many as four supercapacitors with anywhere from 10 mA to 800 mA of charging current, which is beneficial in applications such as smart meters for the reasons I mentioned earlier. In addition to customizability, this charger has 0.5% charge voltage accuracy to prevent supercapacitor overcharging and undercharging, as well as built-in STAT and PG pins to ensure a safe charge. The charger also has a 350 nA of quiescent current to maximize the run time of the supercapacitors.

The BQ24640 switching supercapacitor charger also has customizable charge current and voltage. Switching chargers are useful in designs that need a charge current > 1 A because of their ability to handle more power loss on the charger. The BQ24640 has a programmable charge current up to 10 A to support faster charging and applications that need more than four supercapacitors. Like the BQ25173, the BQ24640 has 0.5% charge voltage accuracy to ensure safe supercapacitor charging and STAT and PG pins to check the status of the input and charging process.

Conclusion

Supercapacitors are an effective power source because they offer these benefits:

- Faster charging at lower voltages.
- The ability to withstand temperatures as high as 70°C.
- Minimal degradation over time.

To effectively use supercapacitors, you should pick a dedicated supercapacitor charger that has customizability, accuracy and built-in safety. The BQ25173 and BQ24640 chargers will help complete your design through their customizability, accuracy and safety during supercapacitor charging.

Additional resources

- Watch these TI training videos:
  - *Introduction to Battery Charger Topologies and Their Applications*, for an overview of the differences between linear and switching chargers.
  - *Fast-Charging Trends and Challenges for Single-Cell Batteries*, for more details on charger battery safety features.

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