BY JERRY DURAND • DURAND INTERSTELLAR INC

Targeting multifarad backup capacitors (and tricky clients, too)

DANIEL VASCONCELLOS

Every contract-design company has at least one "interesting" client who presents you with unique and difficult challenges. Let's call the client Jay in this case. Recently, Jay needed to modify an automotive product so that it would run for a while after losing its dc input. The backup needed to charge fairly quickly, supply as much as 100 mA to the circuit when the dc input was off, and be able to withstand constant charge and use cycles. The high number of charge and discharge cycles and the temperature extremes in an automotive environment ruled out batteries, and Jay didn't want to deal with battery safety and disposal.

The new multifarad Aerogel supercapacitors seemed perfect for this project because they offer lower ESR (effective series resistance) and higher storage capacity than older, double-layer capacitors. You must treat these new capacitors, unlike the double-layer capacitors, more like batteries because they can deliver high currents. I considered using a standard battery-charge-control chip but couldn't find any that were suitable. I also considered a switching regulator to reduce heat, but Jay ruled that out because his circuit is sensitive to electrical noise, and the cost of this "simple" backup was starting to reach his pain threshold.

Jay's original circuit had a replaceable fuse, a blocking diode, filter capacitors, and a three-terminal linear-voltage regulator; I left these components as they were. I added a PTC (positive-temperature-coefficient), resettable, solid-state fuse from the output of the regulator to the positive terminal of a 50F Aerogel capacitor. The negative terminal of the capacitor connects to ground. This deceptively simple circuit fulfilled all of Jay's requirements using a detail of how PTC fuses work. When cold, they offer low resistance, but, in the case of an overload, they heat up beyond a trip point at which the resistance suddenly increases to a very high level. Once they cool down, they reset to the original resistance.

The resistance change isn't instantaneous, as it is in a mechanical switch; instead, the change occurs over a narrow enough range of temperature, which is perfect for our purpose. When you first turn on Jay's circuit, the linear regulator's internal current limit kicks in as the Aerogel capacitor starts to charge. Shortly, the PTC fuse senses the overload and trips. Once it trips, it starts to cool down and allows more and more current to flow until it stabilizes at close to a constant current. As the capacitor approaches full charge, the PTC fuse cools down to ambient temperature and becomes a low-resistance connection between the capacitor and the circuit. When you disconnect the dc input, the Aerogel capacitor continues to supply the circuit, which the same PTC fuse protects from shorts. The blocking diode prevents any voltage from flowing backward through the linear regulator and appearing at the external dc input. Placing the PTC fuse near the linear regulator causes the PTC fuse to trip at a lower current if the regulator is hot due to load or external ambient temperature. You choose the fuse model by testing a prototype; be careful when changing brands of fuses because their trip characteristics may differ. EDN

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