Charging Ultra-Capacitors with Current-Fed Power Supplies

(This Paper has a Link to an actual Video Demonstration of an Ultra- Capacitor being charged.)

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If your system uses batteries and you have difficulties with memory effect problems, loss of capacity, or long recharge times, it is worth considering an ultra-capacitor. An ultra-capacitor is an electrochemical component which mimics characteristics of very high value capacitors -- units with a capacity of 2600 Farads (yes, Farads) are available. As a capacitive element, the ultra-capacitor has no charge/discharge memory effects allowing charging and discharging hundreds of thousands of cycles without any effect on the storage capacity. Also with its very low equivalent series resistance (ESR), these components can be charged and discharged at rates far greater than the best of battery technologies.

Low ESR and lack of any current limiting mechanism poses a problem for the system integrator -- standard battery charging systems usually do not operate well with ultra-capacitors because these components appear as a virtual short circuit to the charging system. To solve this problem, the designer must select a dc power supply that will operate into a short circuit. Magna-Power Electronics' current-fed dc power supplies; PQD, SQD, MQD, and MTD Series models; operate with box type voltage current demands. These units are designed to supply full current under short circuit conditions and automatically crossover once the charge voltage is obtained. Units are available from 3.3 KW to 750 kW and can be found at http://www.magna-power.com. Magna-Power Electronics' current-fed technology tends to be more tolerant to abusive loads than standard voltage-fed switching supplies (Click here to download demonstration video)

Depending on the requirements, output voltages of 5 to 2500 Vdc are available with current capabilities to 7500 A. In addition, all units utilize embedded microprocessor control with 100 programmable memory states allowing the designer to set up a system which will test the ultra-capacitor (or a battery, if desired) by configuring the system to supply rated output voltage and then move to the next location which is set to zero volts. With up to 2.7 hours for 99 memory locations, these supplies provide the flexibility to charge and discharge any component from 10 ms to about 1.6 weeks.

Magna-Power Electronics' power supplies contain a small bleed resistor at its output terminals to discharge its internal capacitors when not in use. To prevent discharge of any load connected ultra-capacitor and to prevent any inrush current, it is recommended that a series diode be placed between the power supply and ultra-capacitor. The diode prevents reverse current from flowing between the ultra-capacitor and power supply. Magna-Power Electronics has an application note for battery charging which is equally applicable to charging ultra-capacitors.

Magna-Power Electronics' power supplies are user programmable through an RS232 interface, or optional IEEE-488, Ethernet, and RS485 interface converters. Additionally, these supplies incorporate optical isolation in the feedback system which allows all user interfaces to be referenced to earth system ground rather than the negative supply terminal.

The ultra-capacitor has one other characteristic which must be considered by the designer -- the output voltage decreases as the element is discharged. Most systems which use this element are designed to work from full voltage down to the half-voltage. This allows 75% of the stored energy to be captured. The ultra-capacitor is an innovative element which provides unique energy storage opportunities; the designer must be aware of its advantages and limitations and provide a charging supply that will meet the terminal characteristics of this device.

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The Video Demonstration was organized and produced by Adam Pitel, Applications Engineering Department, Magna-Power Electronics, Inc.