Supercapacitors for RTC & memory backup

For many years secondary Lithium batteries have been used in backup power applications for volatile memory and real time clock, however they are not always an ideal solution. Lithium batteries have a relatively short cycle life, limited operating temperature range and also present end of life disposal issues. For many applications the solution to this problem is high capacitance supercapacitors.

As can be seen from Table 1, supercapacitors overcome the main problems that can be experienced with secondary Lithium batteries. Supercapacitors are constructed using Aluminium, Carbon and organic electrolyte all of which are environmentally friendly and present no disposal issues. In addition to this they have a near infinite cycle life, can be rapidly charged and can operate over a wide temperature range.

Table 1. Supercapacitor vs. secondary battery

	Supercapacitor	Secondary Battery
Environmental	Friendly	Harmful
Cycle Life	Near Infinite	Few Thousand
Temperature Range	-25 to +70 °C	-10 to +60 °C

These characteristics allow supercapacitors to be used in applications that require reliable operation over a very long operating life, something that can't be guaranteed with a secondary Lithium battery.

Although supercapacitors offer significant advantages over secondary Lithium batteries they do tend to have lower energy storage capability. This can be seen in Figure 1, which shows the relative capacity of supercapacitors against various battery technologies. This limitation of supercapacitor technology means that hold-up time is limited to between several hours and a few days, as opposed to the weeks of hold-up that can be offered by secondary Lithium batteries.

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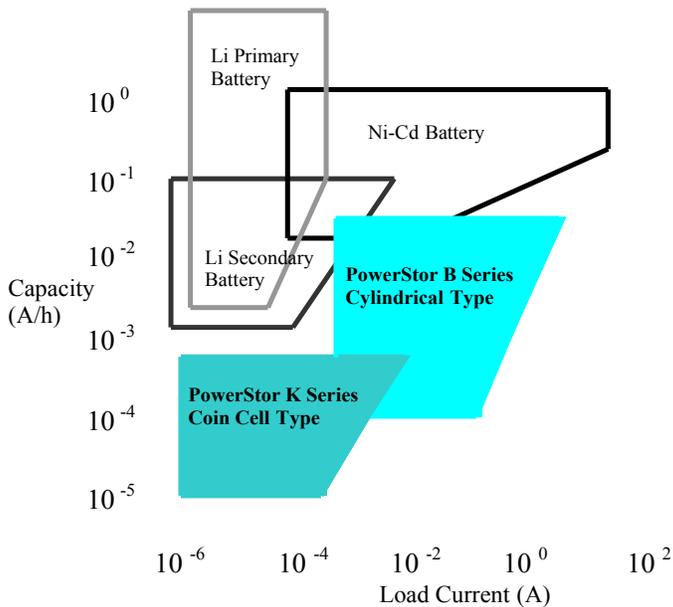
Figure 1. Relative capacity of supercapacitor & battery technologies

When selecting a supercapacitor for low current backup applications allowance has to be made for the capacitor parasitic leakage current. Leakage current effectively causes an additional load on the capacitor causing it to discharge faster than expected. The following example shows the impact of leakage current on hold-up time:

Hold-up time is given by:

$$T = C\,(V_1 - V_2)\,/\,I_1$$

Where T is the hold-up time, C is capacitance, V_1 is the charge voltage prior to discharge, V_2 is the minimum allowable voltage at the end of the discharge and I_1 is the load current.

Using a 0.22 F, 5.5 V KR series part in an application that has a load current of 2 µA, nominal charge voltage of 5 V and a minimum operating voltage of 4.2 V, the hold-up time is;

= 0.22 F x (5 V – 4.2 V) / 2 µA

= 88000 seconds = 24.4 hours

Now if we allow for the capacitor leakage current, which is typically 1 µA per Farad, the hold-up time is;

= 0.22 F x (5 V – 4.2 V) / 2.2 µA

= 80000 seconds = 22.2 hours

Clearly leakage current has an impact on the achievable hold-up time so finding a supercapacitor solution with very low leakage current is important. Figure 2 shows typical leakage current for a Eaton KR family 1 F, 5.5 V capacitor compared with two leading competitors.
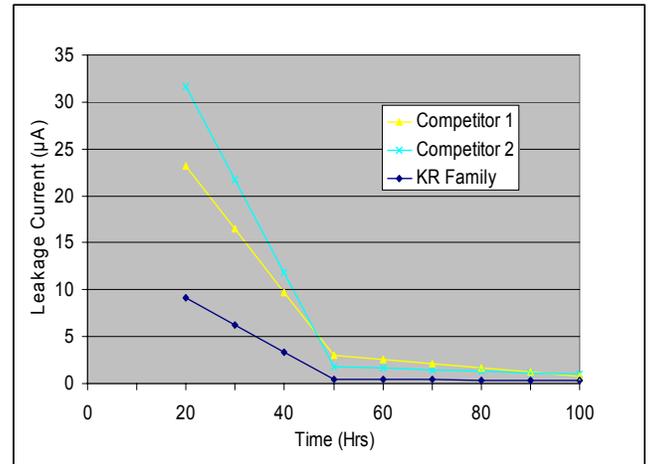
Figure 2. 1 F, 5.5 V Coin cell leakage current comparison

Not only does the KR series part have lower overall leakage current but it also reaches these low current levels very quickly. This allows maximum hold-up to be achieved even after a relatively short charge time.

In conclusion, supercapacitors offer a cost effective alternative to secondary Lithium batteries in backup applications. They provide reliable operation over the life of the equipment and present no disposal issue at end of life. In addition to this they are a better fit with modern automated production techniques, allowing easier and more reliable assembly. For more information on Eaton supercapacitors visit www.eaton.com/electronics.

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