cap-XX APPLICATION BRIEF 1013

Effect of Supercapacitor Distance from a Load

Version 1.0 11 October 2002

Outline

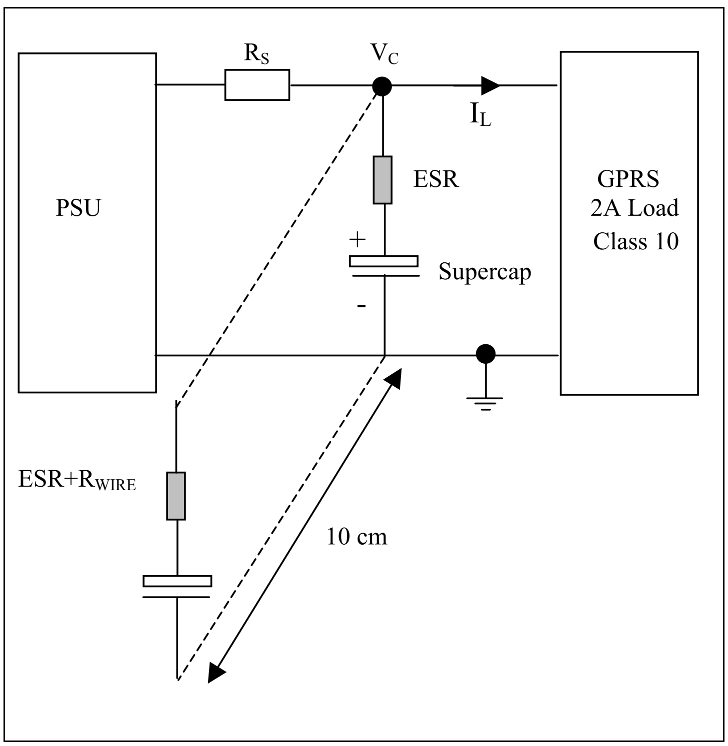
cap-XX supercapacitors can be used to provide peak power to high current pulsed loads such as GSM and GPRS transmitters extending battery run time and operating temperature or enabling a PC or CF+ card to stay within peak current specifications[1]. Typically capacitors are placed as close to the load as possible, however, industrial design constraints may require that the cap-XX supercapacitor be placed away from the load. This Application Brief examines the effect on performance when placing the supercapacitor away from the load using flying leads.

The Problem

The use of flying leads or long PCB traces adds to the ESR of the supercapacitor as seen by the load and may introduce inductance in series with the supercapacitor. A typical GPRS Class 10 load (2A pulse for 1.154ms, pulse period 4.616ms) was used as a test load. The resistance of the wires will be seen as an increased voltage droop during the pulse, and any inductance will affect the ringing on the leading and trailing edges.

The cap-XX Solution

The diagram below shows a typical design using a cap-XX supercapacitor. The solid lines show when the supercapacitor is as close as possible to the load. The dashed lines show the supercapacitor moved 10cm away from the load and connected by insulated wires with small or medium Cross Sectional Area (CSA).



The Results

cap-XX supercapacitors can be placed away from the load with no detriment to performance. It is best practice to maximize the CSA of flying leads or the width of PCB traces to minimize resistance and inductance.

Measurements using both "small" and "medium" gauge wire on two different supercaps, GW201 and GW208, yielded little observable increase in inductance, compared to the supercap located as close as possible to the load.

There were, however, observable differences in the voltage droop corresponding to the wire's resistance during the 2A pulse. These are shown on the next page.

The Experiment

Two sets of 10 cm wires were used; one set with a CSA of 0.336 mm^2 denoted as "small gauge" wire, and the other with a CSA of 1.00 mm^2 denoted as "medium gauge" wire.

Two different supercapacitors were used for the tests, both rated at 0.3F: GW201A with a rated ESR of 80mΩ and GW208D with a rated ESR of 40mΩ. RS was set at 200 mΩ because this is typical of the internal resistance of LiIon battery packs or output impedance of the power supply provided to PC or CF cards by host devices.

[1] Refer cap-XX Application Briefs 1004, 1009, 1010, 1011

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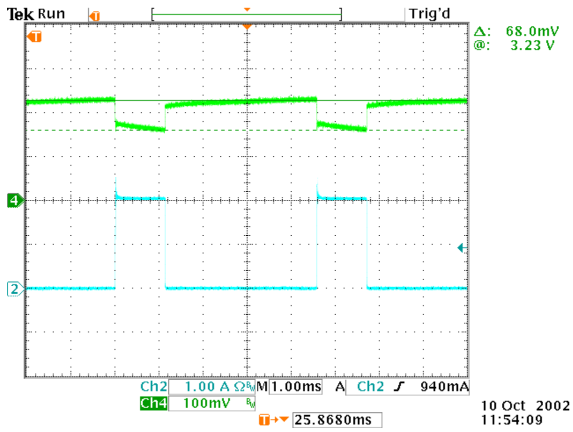

Figure 1: V_C (top trace with 3V offset) and I_L (lower trace) for GW208D 0cm from load

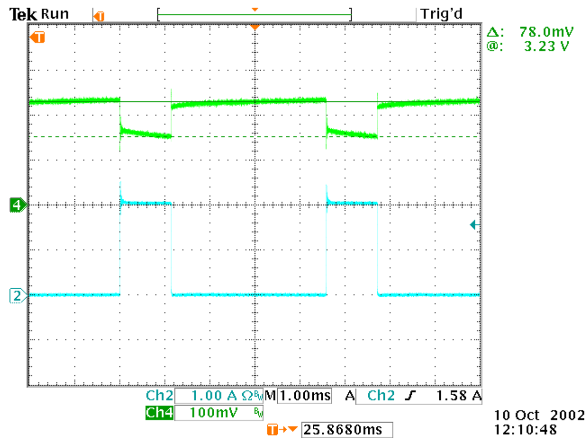

Figure 2: V_C and I_L plots for GW208D 10cm from load using small gauge wire.

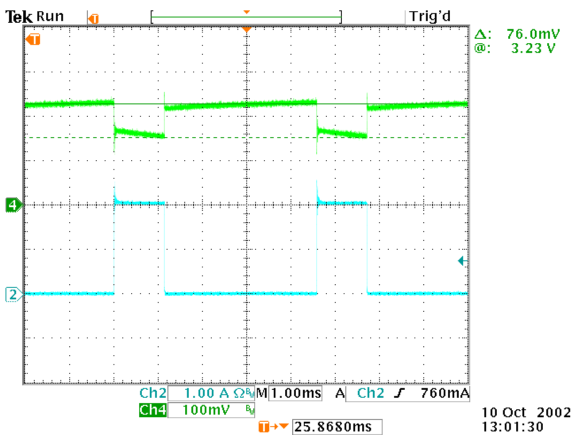

Figure 3: V_C and I_L plots for GW208D 10cm from from load using medium gauge wire.

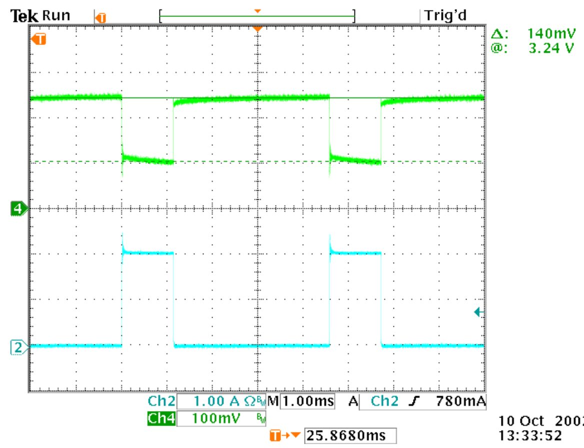

Figure 4: V_C and I_L plots for GW201A 10cm from load using small gauge wire.

The table below contains the results for the above experiment. The V_C waveforms shown from the oscilloscope traces Figs.1 to 4, show there is minimal inductive effect at the frequencies of interest and that the increase in voltage droop is < than the resistance of the 20cm of wire placed in series with the supercapacitor x the peak current. This is because the source is in parallel with the supercap and will provide slightly more current as resistance is placed in series with the supercap's ESR. We recommend you use the Pulsed Load Design Aid on the Calculator page of the cap-XX web site to simulate the exact effect on voltage droop from adding resistance between the load and the supercap. Simply do this by adding the resistance of the wire or PCB trace to the supercap ESR in the ESR input cell of the spreadsheet. 20cm of medium gauge wire was measured at 4.0mΩ, while 20cm of small gauge wire was measured at 10.7mΩ. To simulate the effect of 20cm of small gauge wire with the GW208, simply substitute 40+10.7=50.7mΩ instead of 40mΩ for the supercap ESR in the calculator.

cap-XX Type No	ESR, mΩ	Capacitance, F	Voltage, V	Voltage Droop 0 cm from 2A Load	Voltage Droop 10 cm from Load with small gauge wire	Voltage Droop 10 cm from Load with medium gauge wire
GW 2 01A	80	0.3	4.5	128 mV	140 mV	134 mV
GW 208D	40	0.3	4.5	68.0 mV	78.0 mV	76.0 mV

Further Information: cap-XX will be pleased to supply detailed data and design information. For further details, please use the contact information listed at the foot of this page.

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