Super snaps on camera phones

Using supercapacitors can solve LED flash power issues for high resolution camera phones, writes **Pierre Mars**, v-p of applications engineering at CAP-XX

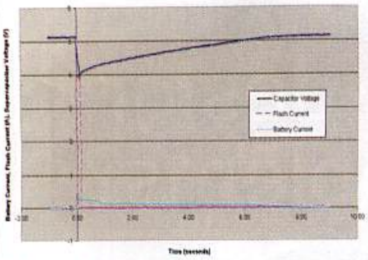
Photos in low light with normal phone (left) and phone modified with supercapacitor-based design (right).

Greater than 2M pixel camera phones require a high intensity flash in medium to low light conditions to ensure good pictures. However, the battery cannot deliver the high current pulse required for adequate LED light output for high-resolution images. The alternative solution is to use a xenon flash, but this requires: **1)** a storage capacitor that is very bulky for mobile phone form-factors and **2)** high voltage, resulting in circuit and safety issues. Also, with LED flash, the same LED circuit can be used at lower current for video capture/torch function.

To get around this power limitation some camera phone suppliers have used long flash exposure times to compensate for the lack of light, resulting in blurry photos.

To provide enough LED flash power to eliminate dark and blurry photos, camera phone designers can use a high capacitance (0.4F to 1F), low ESR (less than 100 mΩ), thin (1 to 3 mm) prismatic supercapacitor.

A small, low-cost, current-limited charge pump pre-charges the supercapacitor to around 5.5V. Once the supercapacitor is charged, the current switch is enabled to deliver a high current flash pulse, with the energy and power from the supercapacitor rather than battery and charge pump. During the flash pulse the charge pump can either be enabled or disabled. The charge pump is current limited in to around 300mA. In Torch mode, the charge pump is left enabled and the battery and charge pump can deliver a constant current less than the charge pump current limit.



Battery current, LED current and voltage

For the reference design, CAP-XX chose the highest power LEDs, Lumileds LXCL-PWF1, which can handle a peak pulse current of 1A for less than 200ms. We drove 4 x PWF1 at 900mA each. The total LED current of 3.6A was limited by the Micrel MIC2545 current switch, was chosen for its current capacity and relatively small size.

Supercapacitor C and ESR is selected to support a total LED current of 3.6A for a 150ms flash pulse. From the Lumileds datasheet, at 0.9A nominal LED forward voltage is 3.75V, so allow 4.2V. From the Micrel datasheet, the R(DSon) resistance is less than 50mΩ, so the voltage drop across the MIC2545 current switch is less than 180mV.

The minimum voltage at the supercapacitor at the end of the flash pulse must be greater than or equal to 4.2V + 0.18V or 4.38V.

Vout (charge pump voltage) is set to 5.3V, therefore the total voltage drop allowed at the supercapacitor, Vd is 5.3V – 4.4V or 0.9V.

The capacitor voltage drop = I(LED) x (ESR + flash pulse/C). So C is greater than or equal to I(LED) x flash pulse/(Vd – I(LED)xESR). In this example, C is greater than or equal to 2A x 0.15s/(0.9V – 2AxESR).

Assume a supercapacitor ESR of 100mohm, then C is greater than 2A x 0.15s/(0.9V – 2Ax0.1Ω), which is 0.43F. Select a supercapacitor with around half the assumed ESR to allow for ageing over life. So the CAP-XX GS206 (0.55F, 50mΩ) meets the requirements.

Note that two supercapacitor cells are used in the circuit to achieve the necessary voltage rating of 5.5V maximum voltage. 100mohm is a good starting guess for ESR. Designers may need to iterate between C & ESR to find a suitable supercapacitor. Set the charge pump output voltage to the lowest possible current while still having sufficient headroom for the solution.

Charge pump selection is not critical. We selected the SP6685 for its small size. Note that the soft start function of most charge pumps will not properly handle a supercapacitor at the output, but adding a current limit resistor at the input to the charge pump is a simple solution if this is an issue.

CAP-XX was able to place two supercapacitor cells and four replacement LEDs in a leading brand camera phone and put it back together with no changes in external appearance. The illustration shows photos taken using the unmodified and CAP-XX-modified phone. The unmodified phone delivered 1W of flash power for 160ms while the modified phone delivered 15W of flash power for 160ms.

The plot shows the battery current, LED current and supercapacitor voltage during a flash pulse and supercapacitor re-charge after the pulse. Note that battery current never exceeds 300mA even though the flash pulse is 4A. The supercapacitor provides the 3.7A difference.

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