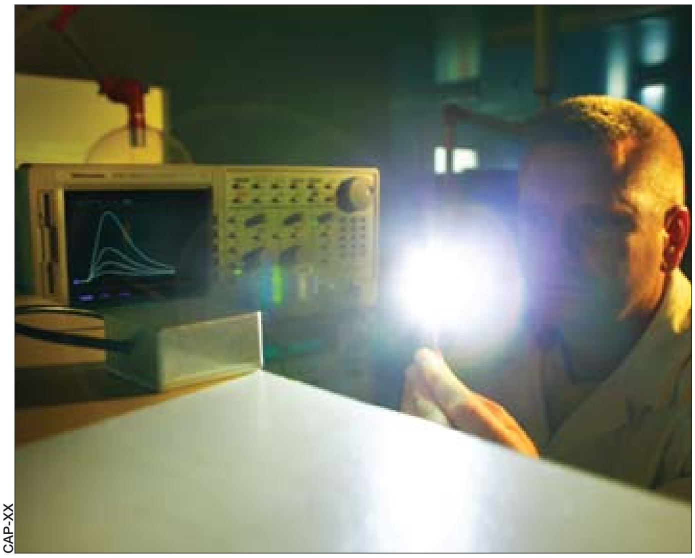
Supercapacitors brighten prospects for power LED flash in camera phones

The combination of power LEDs and supercapacitors could provide the crucial breakthrough that will enable high-quality LED flash in camera phones, with low current draw and small form factors. **Siân Harris** reports.


CAP-XX

Trevor Smith of CAP-XX sets up the light measurement equipment.

Although some of today's camera phones have good quality lenses, image-processing software and high numbers of pixels in the image sensor, there is one big area of development required to complete the picture. Few camera phones are able to take photos at the low light levels that users experience in restaurants, bars or inside their friends' homes.

The key to taking good pictures in these environments is to produce enough light energy from the flash while the picture is being taken. One measure of light energy is derived by summing the illuminance of the light source (measured in lux) over the duration of the flash exposure time. A light energy of 10–15 lux.sec is thought to be ideal for high-resolution pictures at low light levels.

Many camera phones already use LEDs to provide some flash functionality, but these have not proved equal to the task as they do not provide enough light energy to illuminate their subjects sufficiently. Most of today's phones with LED flash drive the LEDs at 1–2 W and provide less than 4 lux.sec of light energy at a distance of 1 m from the phone to the subject, and less than 1 lux.sec at 2 m.

Higher power LEDs would seem like the next obvious development. However, to achieve full light intensity, these require up to 400% more current than the 800–1000 mA that a phone battery can usually provide for LED flash.

Xenon flash

As an alternative to LEDs, some of the latest camera phones with high-specification cameras carry xenon flash tubes that are driven by electrolytic storage capacitors. Xenon flashes give excellent light output with a very short flash exposure time, ideal for freezing motion and illuminating objects at longer distances.

However, xenon flash tubes require large electrolytic storage capacitors, making them bulky. In the SonyEricsson K800 phone, for example, the xenon flash and its peripherals occupy a total volume of about 3.8 cm^3. There are also safety concerns about storing 1.5 J of energy at 330 V, particularly near the ear. Furthermore, the electrolytic capacitor takes a long time to recharge between photos (around 8 s for the SonyEricsson K800) and cannot be put to any other use within the phone.

However, this is not the end of the options available. Technology developed at Australia's CAP-XX is enabling camera-phone companies to look differently at high-power LEDs. The company specializes in thin-form supercapacitors for consumer electronics applications and saw the opportunity to combine these with high-brightness LEDs.

In CAP-XX's LED BriteFlash architecture, supercapacitors deliver the pulse current (more than 1 A) that is needed to operate the high-power LEDs. The camera phone's battery is only required to recharge the supercapacitors between pulses.

According to CAP-XX's vice president of applications engineering, Pierre Mars, if a 0.5 F supercapacitor discharges 1 V during the flash pulse then it only requires 250 mA of charging current to recharge it in 2 s ready for the next photo. This figure is well below the current levels required for today's standard LED flashes.

Light energy comparison

With this approach it is possible to deliver more light energy than most xenon flashes, according to a recent technical study by CAP-XX. The company looked at the ability of xenon flashes, standard LEDs and its LED BriteFlash to provide the necessary light energy for camera phones of 2 megapixels or more to take digital-still-camera-quality pictures at low light levels.

The study included three different xenon-flash camera phones with different sized electrolytic storage capacitors. In addition, the Nokia N73 was used as an example of a standard LED flash. The BriteFlash approach was tested using a combination of two 17×28.5×1.6 mm supercapacitors and either two or four high-current Luxeon PWF1 LEDs. The supercapacitor drove these LEDs at 1 A each.

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Photos taken in low ambient light conditions at a distance of 2 m from the girl using (left) a 1 W LED flash and (right) a camera phone modified with a supercapacitor to drive 4×PWF1 LEDs at 0.9 A each for a total flash power of 15 W.

Table 1. Results from CAP-XX's evaluation of different flash sources over a distance of 2 m

Source	storage capacitor	peak light power (lux)	exposure time (ms)	light energy (lux.sec)
Xenon, SonyEricsson K750	60 µF	97 000	<1	9.5
Xenon, SonyEricsson K800	2×14 µF	53 000	<1	4.2
4×LEDs @ 1 A each	0.55 F	175	67	10.8
2×LEDs @ 1 A each	0.55 F	86	67	5.3
LED, Nokia N73	NA	5	90	0.43

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With all of these flash approaches, a photo detector measured on-axis illumination while a digital storage oscilloscope captured light power over time at distances of 1 m and 2 m from the source. The areas under the power curves were integrated to measure the light energy at the detector as a function of time.

Study results

Table 1 shows the results of this study at a distance of 2 m. Only the BriteFlash approach using four power LEDs and an exposure time of 67 ms gave a light energy level above the ideal 10 lux.sec threshold. The best-performing xenon flash of the three studied (on the SonyEricsson K750 camera phone) gave a light energy of 9.5 lux.sec but this was achieved with an external flash accessory with 60 µF capacitance. The Nokia N73 containing a standard LED flash produced a very low light energy of 0.43 lux.sec.

From the study results, CAP-XX believes that the BriteFlash architecture offers other benefits over xenon flashes. Because of the company's thin-form (less than 2 mm) design approach, the supercapacitor fits more easily into a slim mobile-phone handset than the electrolytic storage capacitor that is required for xenon flashes. CAP-XX's technology also addresses the safety concerns about the high voltages in xenon flashes: the µF-level electrolytic capacitors used with xenon flashes have voltages of 330 V, but the BriteFlash approach, with 0.55 F capacitors, uses a voltage of just 5 V.

In addition, the supercapacitors for the flash can help out with the power management in other mobile-phone functions that require peak power, such as wireless voice and data, music audio, GPS readings and mobile TV. This could improve the battery lifetime for the entire phone. The LEDs themselves can also be used continuously for making video clips or to provide a flashlight (torch) function.

One area in which xenon flashes are clearly superior is in taking action photos. While the BriteFlash approach delivers the required amount of light energy over a longer flash exposure time (up to 67 ms), xenon flashes deliver very high peak light powers (up to several hundred thousand lux at 1 m) in a very short amount of time (typically 50–100 µs). This means that they can be used to take action shots in low light. Such photos would be blurred with the BriteFlash approach, although blur problems caused by camera shake over this longer exposure time can be ironed out with image-processing software.

Despite this disadvantage of the LED and supercapacitor approach, CAP-XX is optimistic about the potential of this technology. "We are working with key mobile-phone manufacturers and expect the first designs that are power-boosted by our supercapacitors to hit market late 2007 or 2008," said CAP-XX's CEO Anthony Kongats. ●

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