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White Paper

Advantages of Power LEDs in Cameraphone Applications

Introduction:

The cameraphone has become a competent, multi-function terminal enabling access to broadband mobile services that greatly extend the basic telephony applications originally targeted. Arguably, it will also become the owner's primary picture capture and management device because of its ever-present nature and because the lens, lighting, image capture and storage technologies have advanced enabling the cellphone platform to deliver the same quality images as a digital still camera (DSC).

Perhaps the first indication of this transition has been the emerging desire for high-megapixel resolution. Increasingly, electronic flash units are also featured on-board premium cellphone handsets, to enhance picture quality and enable use of the camera features in otherwise unfavorable lighting conditions. Enhancements to image resolution and quality, the addition of flexible camera features such as shutter control, and improvements to the light output, range and color rendition of the flash illumination have rapidly progressed in parallel.

The availability of small, power LEDs have proved crucial to enabling flash capability to migrate into the cellphone handset. The fact that an LED flash operates from a low voltage supply is also important, since this dramatically reduces the space required for implementation.

At the same time, white power LEDs continue to progress quickly, especially in terms of brightness, output in Lux.second @1m, color temperature and spectral rendition. As cellphone

designers steer their ambitions towards the next level of cameraphone capability - challenging the entry-level DSC space – power LED technology combines these enhancements with the valuable size, cost and ease of implementation advantages that first opened the way to flash photography using a cellphone.

For very high light output performance within compact dimensions, as well as ease of design and low bill-of-materials costs, Philips Lumileds LUXEON® Flash LEDs have become the technology of choice for cameraphones.

Photography Trends and Cameraphone Flash

Popular photography is following the patterns of modern life, progressively becoming more informal and opportune. Younger users, in particular, see a camera as a tool to capture candid and transitory moments in family and social life. These tend to occur at close range and at any time of day or night, in a variety of indoor or outdoor environments around the home as well as in meeting places such as bars and clubs, restaurants or music venues.

As the cell phone market continues to develop and user expectations increase, we will see features that originally debuted on premium platforms migrate to higher volume platforms. Feature migration is already evident with screen technology (color), audio (mp3) and basic imaging capabilities (VGA to 1.3mp to 2mp). The migration will coincide with continued technology improvements and lower materials costs as volumes increase

The cameraphone is the ideal device to meet these expectations. It is highly portable, easy to set up and use, enables immediate sharing, and even broadcasting, of pictures, and is almost always

to hand. Camera resolution of 2 Mpixels and upwards is more than sufficient to capture high quality images.
The inclusion of a miniature flash unit, sufficiently small as not to compromise the accepted handset form factor, greatly extends the value of the cameraphone in this role. Such a unit should provide uniform, daylight-quality illumination over a short range up to just a few meters. Ambient lighting conditions not adequate for photography purposes may vary, including low levels of natural light, incandescent domestic electric lightning, a dimly lit club, a street environment, or a completely unlit area.

There are generally three approaches to implementing flash capability in a cellphone system, where tight constraints on size and battery energy prevail. The first is to use low-power LEDs. Although these are small and have very low power requirement, they are not effective beyond a few centimeters. An alternative is to use a xenon flash unit, which has the disadvantages of requiring substantial space, is not optimized for automated production, uses a high voltage drive system that requires shielding, and could be a substantial drain on power resources. A more effective solution is to use a LUXEON® Flash, which is very small and along with its IC driver is a fraction the size of xenon and can easily be accommodated in a cellphone and integrated in an automated manufacturing environment. LUXEON Flash delivers functional, effective light even at distances up to 3m in low light environments.

Ordinary LEDs aimed at cameraphone flash applications do not achieve the same high light output or quality of illumination produced by LUXEON Flash LEDs. When used in flash applications, conventional LEDs display an uneven color distribution in the image plane, including a large color shift from the center to the edge of the field of view, as well as color variance in isolated areas. This results in captured images that will disappoint the user and

present unnatural coloring in the image. This non-uniformity originates from variation in the thickness of the phosphor layer covering the LED source.

LUXEON Flash LED technology leverages Philips Lumileds' patented conformal coating to achieve unrivalled close control over the thickness and phosphor balance of the phosphor layer. Benefits include higher quality white light output, greater stability over time, and better manufacturing yield resulting in cost effective manufacture of very high quality, power LEDs for demanding applications such as flash photography

Compact Implementation

A compact flash implementation is essential, if camera capabilities are to be improved while keeping within the cellphone form factors accepted by the market.

Driver Design

The straightforward drive requirements of LUXEON Flash LEDs reduce both the component count and footprint of the driver circuitry for an LED-based flash solution. The availability of integrated LED drivers in a single-chip reduces the implementation to a simple electronic arrangement requiring just one IC, an external inductor, and the power LED itself. A lens may also be fitted at the front of the LED, if required. Some of the electronic drivers available are capable of driving the LED up to 1.5 A, thereby making the most cost-effective use (in lumens/$) of the LED.

For mobile applications, driver footprints should be extremely small. In practice, it is possible to implement a single LED flash driver capable of supplying 700 mA to the LED in less than 30mm^2. A dual LED driver supplying 500 mA can be implemented in less than 50mm^2.

The Light Unit

Philips Lumileds LUXEON Flash LEDs deliver the brightest flash performance, per cm^2 of frontal area, compared to both the miniaturized xenon tube optimized for cellphone form factor and the low-power LEDs that cannot provide effective light.

LUXEON Flash LEDs emit high intensity white light for the entire period the camera shutter is open. This not only allows plenty of time to illuminate the subject, but also enables the same light source to be used for essential camera functions including auto focus assist and red-eye reduction. This saves designers implementing separate light sources to support these features, as is the case with most DSCs. Another advantage is that automatic light control, which is commonly used to prevent discharge-type flash devices from saturating the field of view, is not required. This further saves real-estate in the cellphone handset and eases design effort.

Energy Requirements and Battery Consideration

The total energy consumption of a single LUXEON Flash LED is very low. Typically, for a single flash, around 30% of the energy consumed to drive a miniature xenon unit with the same light level is required. Hence, designers implementing LED flash for embedded camera applications in cellphone handsets and other battery powered devices can achieve a compact solution with low design effort, and gain the added benefit of an increase in battery recharge interval.

Versatile Operating Modes

Because the power LED is not a discharge device, it can be driven for as long as is required. In cellphone photographic flash applications, only external factors such as battery current delivery, thermal issues, and battery recharge interval will impose practical limitations on maximum flash duration.

A further benefit is that LED flash supports multiple sequential flashes without waiting times in between the flashes, thereby enabling the photographer to capture 'that moment' while users of other cameras must wait for a conventional flash unit to recharge.

This flexibility significantly extends the range of photography-related applications for which a cellphone can be used. For example, LUXEON Flash can provide enough light to allow video images to be captured under poor lighting conditions. Informal or mobile video conferencing is also achievable. Hence the extra versatility afforded by LUXEON Flash will also enable subscribers to make greater use of emerging mobile broadband services, and will therefore allow mobile service vendors to increase network utilization and revenues.

Easy Design and Build

The entire LED flash assembly can be built from surface mount components. This eases board design and physical integration challenges of implementing flash in a cellphone. Automated assembly techniques can also be used throughout, allowing flash assembly to be accomplished at high speed and high yield using standard SMT assembly processes. This allows easy scheduling, and rapid scaling up of capacity, as required, to meet accelerating market demand.

SMT technology, which is not available for Xenon solutions, also allows high speed automated assembly to be easily replicated anywhere in the world with the additional benefits of low training overheads and reduced labor costs.

High Quality Flash Output

Light Intensity

Currently available white power LEDs produce high light output per Amp. This eases design and simultaneously reduces the peak, average and total draw on the battery.

The table describes the performance of currently available Philips Lumileds LUXEON Flash LEDs for cameraphone flash applications. The intensity and spectral quality of the flash produced is capable of satisfying requirements for flash photography up to several meters range.

	Single LUXEON® Flash	Dual LUXEON® Flash	Triple LUXEON® Flash
Illumination level, in Lux.sec @ 1m (1/30th sec)	2.6	6.9	12.9
Max. distance, in m @ 30 Lux	1.6	2.6	3.6

Color temperature and CRI

The color temperature emitted by a flash unit indicates the composition of the light produced. LUXEON Flash LEDs produce white light of color temperature around 7000 K, which is very close to that of natural daylight. This very high quality light output facilitates fine-tuning of the

color reproduction of the camera sensor (CCD or CMOS) to match the characteristics of the emitted light. LUXEON Flash LEDs also achieve a very high color rendering index (CRI) of around 80, compared to 100 referenced against the characteristics of the human eye. This high CRI from the flash also contributes to excellent color reproduction from flash photography by allowing camera settings to be easily optimized to match the flash characteristics.
The illustration shows how a cellphone equipped with LED flash leveraging LUXEON technology achieves excellent results, comparable to photography under bright daylight conditions, and better than similar equipment using a small format xenon discharge flash.

Conclusion

Current power LEDs from Philips Lumileds are able to produce sufficiently short, intense bursts of light to enable flash photography that is comparable to, or better than, a miniature xenon solution. In addition, the ease of design, compactness and flexibility of power LEDs, as well as SMT assembly, give LED technology the edge as far as designers and assemblers are concerned – this is very important from the point of view of time to market.

To gain these benefits, while also delivering a high quality flash experience to users, designers must simply bear in mind that they are designing with an LED, which requires a different approach to designing with a discharge flash technology. Technical support and design guidance available from Lumileds eliminates the effort and risk associated with implementing near DSC flash capabilities in a cameraphone using LUXEON Flash LEDs.