



## **LED FAQ for Specifiers of LED Products**

**4<sup>th</sup> October 2010 – Version 3.0**

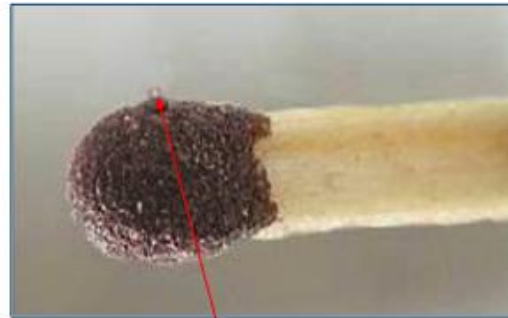
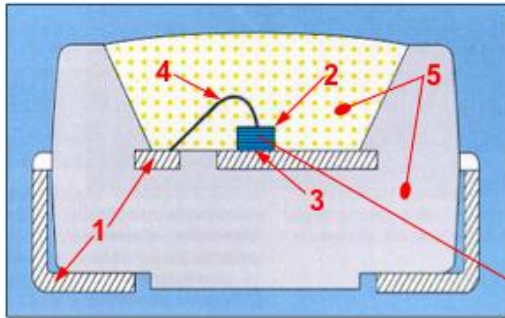
## Table of Content

<b>1. What is a LED (light emitting diode)?</b>	<b>3</b>
<b>2. What is the term SSL?</b>	<b>3</b>
<b>3. What are the advantages of using LEDs?</b>	<b>3</b>
<b>4. What configurations of LED are available for lighting?</b>	<b>4</b>
<b>5. How is a LED tested to obtain lifetimes?</b>	<b>5</b>
<b>6. What affects the lifetime of a LED?</b>	<b>5</b>
<b>7. Are there any other factors contributing to lifetimes?</b>	<b>6</b>
<b>8. How efficient are LEDs?</b>	<b>6</b>
<b>9. How do you produce white light using LEDs?</b>	<b>7</b>
<b>10. What is the quality of the white light?</b>	<b>9</b>
<b>11. What is a Driver?</b>	<b>9</b>
<b>12. Can LEDs be Dimmed?</b>	<b>9</b>
<b>13. What is PWM?</b>	<b>10</b>
<b>14. Do LEDs shift in colour?</b>	<b>10</b>
<b>15. What is Binning?</b>	<b>10</b>
<b>16. What are the lighting applications for LEDs?</b>	<b>10</b>
<b>17. Can your supplier back-up their claims?</b>	<b>11</b>
<b>18. Should I wait for newer LED technology?</b>	<b>11</b>

**Control + Click on page number to link to page**

### 1. What is a LED (light emitting diode)?

A light emitting diode (LED) is a semiconductor diode that emits light of one or more wavelengths (colours). A diode is a device which electrical current can pass in only one direction. The diode is attached to an electrical circuit and encased in a plastic, epoxy resin or ceramic housing. The housing usually consists of some sort of covering over the device as well as some means of attaching the LED to a source of electrical current. The housing may incorporate one or many LEDs.



Key Components:

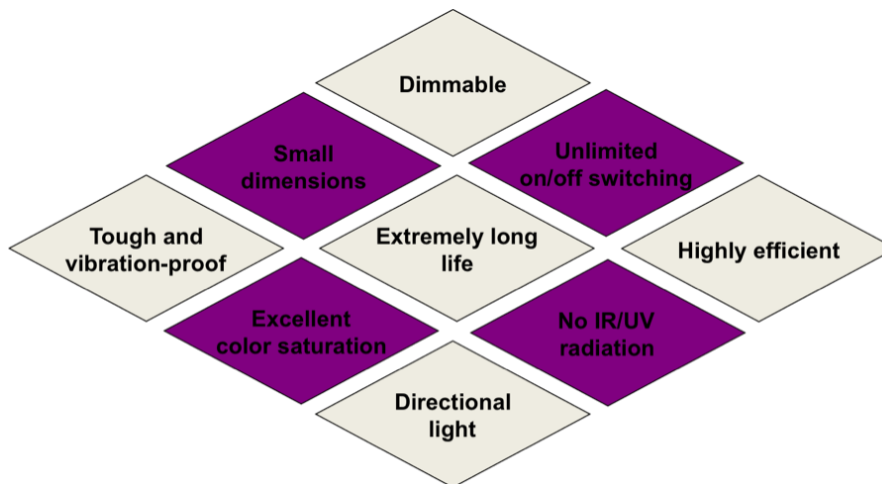
- 1. Lead frame
- 2. Die (= light)
- 3. Die bond adhesive
- 4. Bond wire
- 5. Encapsulate



### 2. What is the term SSL?

In the lighting context SSL stands for Solid State Lighting. It refers to technology which does not use gas or liquid to create light. SSL is commonly used to describe LED technology being used for lighting applications.

### 3. What are the characteristics of LEDs?



#### 4. What configurations of LED are available for lighting?

**Discrete LED Packages** – an individual LED.



**LED Modules/Light engines** – individual LEDs pre-formed onto a circuit board. May include heatsink, optics and housing as part of the assembly.



**LED luminaires** – a complete light fitting that uses LEDs as the light source.



**Retro-fit LED lamps** – LED lamps used as direct replacements for other light sources e.g. incandescent or halogen.



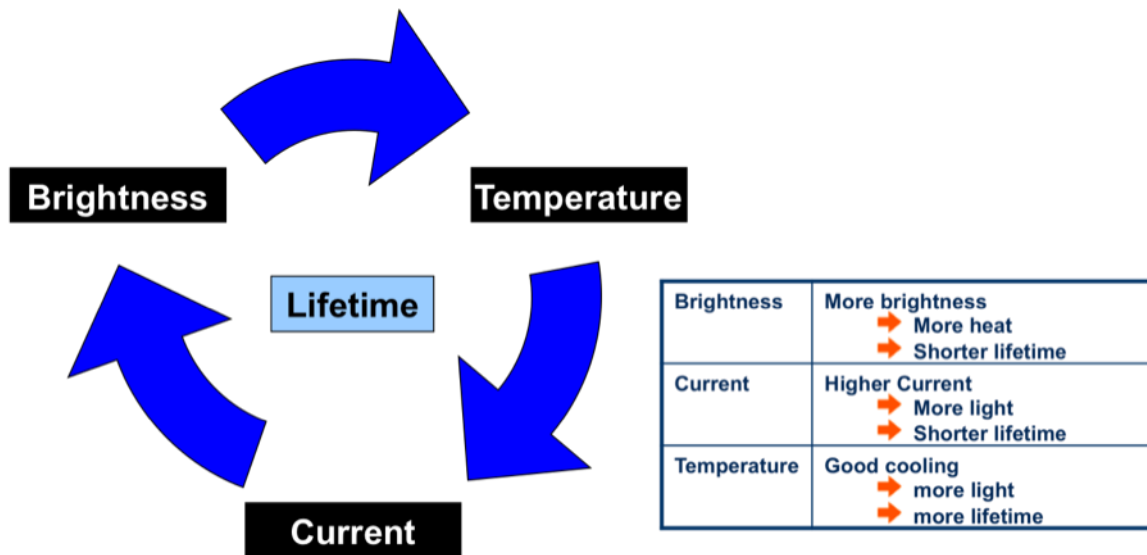
### 5. How is a LED tested to obtain lifetimes?

Full life testing for LEDs is impractical due to the long expected lifetimes. Even with 24/7 operation, testing an LED for 50,000 hours would take 5.7 years. Operating the LED or system at rated current and voltage for 6,000 hours, measurements are taken over this period and compared. If, for general lighting applications, 70% of initial lumens have not been reached during the 6,000 hours, the data is used to extrapolate those points. Excess extrapolation can lead to unpredictable lifetimes for the system due to other factors within the system.

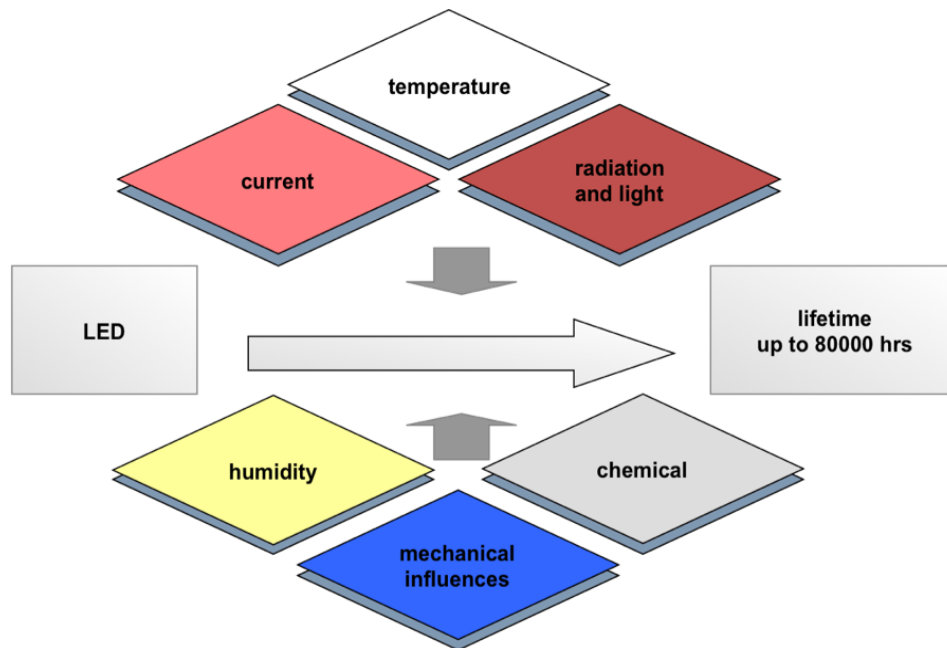
### 6. What affects the lifetime of a LED?

Unlike other light sources, LEDs don't "burn out" they simply get dimmer over time. This factor is important in determining the effective useful life of LEDs. Manufacturers are now stating lifetimes to L70 - 70% lumen maintenance as effective useful life of a LED. Be sure to question lifetimes on the basis of operating conditions. Lifetimes can vary depending on operating conditions (humidity, heat), current and type of LED.

There are numerous factors, which can contribute to LED lifetimes, but the primary cause of lumen depreciation is heat generated at the LED junction. Heat must be removed from the device by conduction or convection. Without adequate heat sinking or ventilation, the device temperature will rise, and continuous high temperature operation will cause permanent reduction in light output and premature failure.



## 7. Are there any other factors contributing to lifetimes?



LEDs are electronic components, therefore other factors can affect their lifetimes and performance:

- Short circuits - Mechanical stresses, high currents, and corrosive environment can lead to formation of whiskers, causing short circuits.
- Electrostatic discharge (ESD) may cause immediate failure of the LED. See LIF Technical Statement No 50 for more information. LED discrete, modules or any electronic product displaying ESD warning should be handled under ESD guidelines.



ESD Warning label

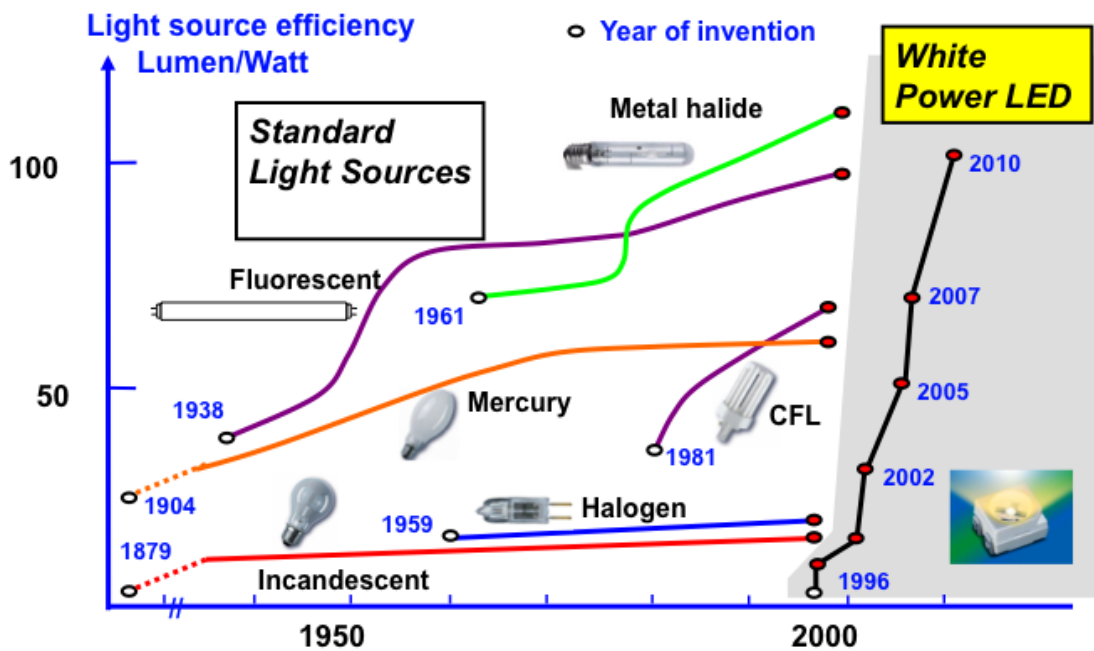
## 8. How efficient are LEDs?

The efficiency of LEDs is improving all the time. Current development lab data for warm white LED now exceeds 200lm/w. Lab data for LEDs do not have any correlation to real-life operating conditions and therefore cannot compare. Some manufacturers of LED and LED systems will provide data based on ‘optimum’ operation which may not be realistic. Other factors also affect the overall system efficiency, including control gear (driver) performance, optical efficiencies, losses through additional components, etc.

Phosphor conversion also suffers from a loss of energy (known as the Stokes shift) when the phosphors convert light from a shorter to a longer wavelength, which reduces the overall device efficiency. An example of this is where cooler white LEDs are more efficient than warmer white LEDs.

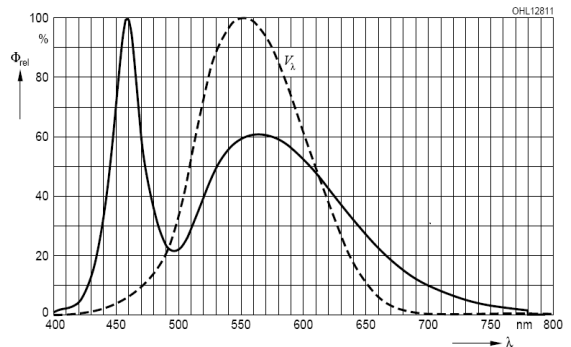
LED efficiency can drastically alter when other variables are included – Optics, thermal and electrical.

By driving LEDs over their optimum operating condition, heat will increase and actual efficacy will reduce. If the LEDs optimal drive current is 350mA, this will provide the best efficacy. If the same LED is driven at 700mA, the light level will increase but with the detriment of lower efficacy.



### 9. How do you produce white light using LEDs?

An individual LED produces a single colour of light. To produce white light, light spanning the visible spectrum (red, green and blue) must be generated in the correct proportions.



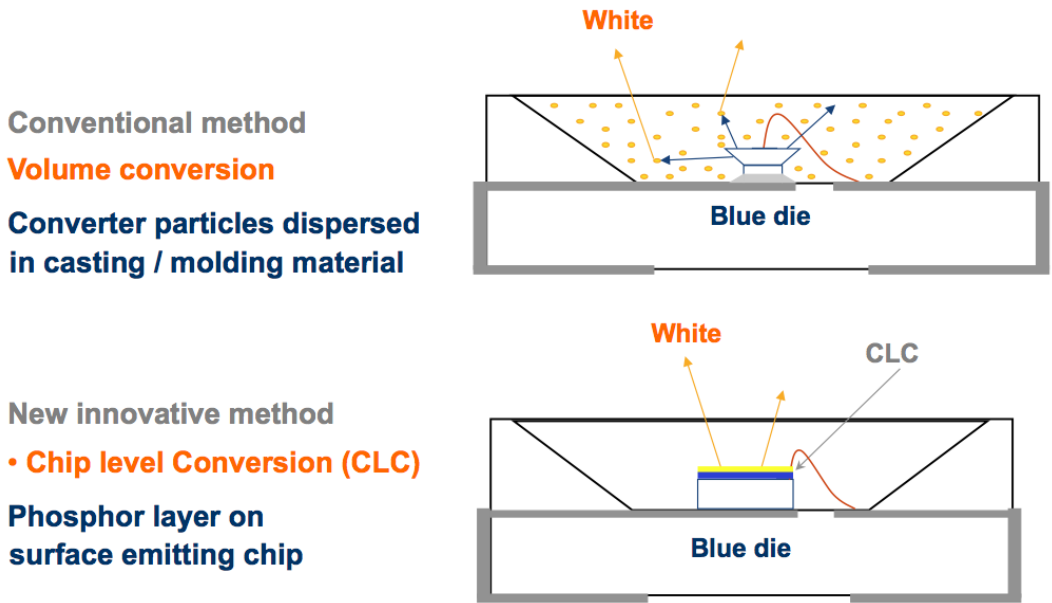
Methods to generate white light using LEDs can be classified into two approaches.

### 1. Wavelength Conversion

Blue LED + yellow phosphor. Some of the blue light from an LED is used to excite a phosphor which re-emits yellow light. The yellow light mixes with some of the blue light leaking through, resulting in the appearance of white light.

Blue LED + several phosphors. Similar to the above method, except that the blue light excites several phosphors, each of which emits a different colour. These different colours are mixed with some of the blue light leaking through, to make a white light with a broader, richer wavelength spectrum. This gives a higher colour-quality light than the above method.

Violet LED + multi phosphors. Similar to using Blue LED with several phosphors. This method gives good colour consistency over the LED lifetime.



### 2. Colour Mixing

This method uses multiple LEDs in a single package, and mixes the light to produce white light. Typically, the package contains at least two LEDs (blue and yellow) and sometimes three (red, blue, and green) or four (red, blue, green and yellow). Because no phosphors are used, no losses associated with wavelength conversion are incurred; hence this approach has the potential for the highest efficiency, but quality of light can be poor.

## 10. What is the quality of the white light?

The quality of a lighting source is judged by its ability to reproduce the appearance of an object as if illuminated by "true" white light. The colour-rendering index (CRI) is widely used quantitative measure of the ability of the lighting source to accurately render the colour of objects.

Natural sunlight and incandescent lamps have CRI of 100 while fluorescent lamps have CRI between 50 and 99. Current white LED devices have CRI around 70-97.

## 11. What is a Driver?

This is the control gear used to "drive" the LED and provides an output matching the electrical characteristics of the LEDs to be controlled. LEDs need to be driven properly to ensure optimal performance and long life, and using an effective driver is key to obtain all the benefits of LEDs.

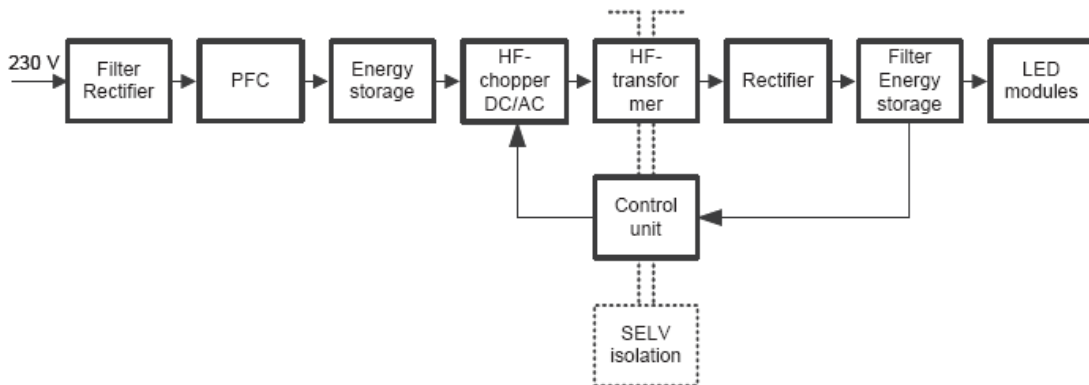
There are two types of drivers:

- **Constant Current**

These drivers typically consist of 350mA, 500mA, 700mA and 1A. These provide a constant regulated current to the LED

- **Constant Voltage**

These drivers typically consist of 10V, 12V and 24V. These provide constant regulated voltage.

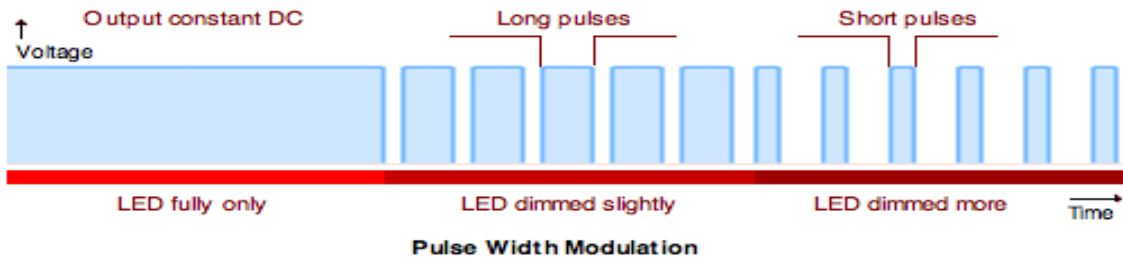


## 12. Can LEDs be Dimmed?

Commercial LED control gears (drivers) commonly use one of two methods to dim LEDs: continuous current reduction (CCR), which decreases the forward current, or pulse-width modulation (PWM), which changes the duty cycle. PWM has been more common for LEDs because of its wide dimming range and linear relationship between light output and duty cycle. LEDs can be dimmed using numerous dimming systems, including 1-10v, DMX & DALI.

### 13. What is PWM?

The output is switched on and off at high frequency, the eye does not register a flicker but sees a reduced light output. The longer the LEDs are at on periods relative to off periods, the brighter the LEDs appear. PWM has the ability to achieve lower intensity levels and more linear control of light intensity compared to CCR dimming methods. More reliable dimming and better linear control of LEDs



### 14. Do LEDs shift in colour?

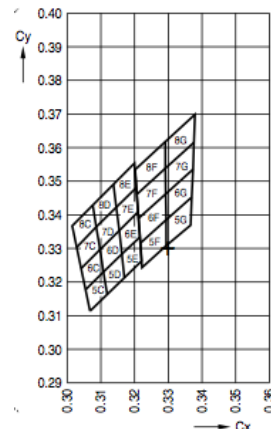
Over a period of time LEDs may shift in colour. Degradation in LED material, phosphorus, high current and heat can lead to colour shift. LED chip manufacturers do offer data showing colour shift over lifetime, temperature and current.

### 15. What is Binning?

Binning is a term referred to sorting of LEDs by colour, brightness and forward voltage. Depending on the manufactures tolerance and selection processes, LEDs are placed into a unique bin.

Each bin contains LEDs from only one colour and brightness group and is uniquely identified by a bin code. White LEDs are sorted by chromaticity (colour) and luminous flux (brightness). Colour LEDs are sorted by dominant wavelength and luminous flux (brightness).

Recently major manufactures have improved their binning of white LEDs due to the demand in general illumination of improved quality. Tighter binning and tolerances have improved colour rendition and colour appearance of LEDs.



### 16. What are the lighting applications for LEDs?

It is important to evaluate the application before choosing the LED source. As there are many options available with LEDs from low output to high output and RGB options the application needs to be looked at first. Once the application has been identified a suitable LED solution will be easier to find. As technology improves, more applications and replacement of traditional lighting technology becomes viable.

Currently LEDs are being used in the following illumination applications:

Effect lighting

Feature lighting

Indirect lighting

General lighting

Task lighting

Back illumination

Signage

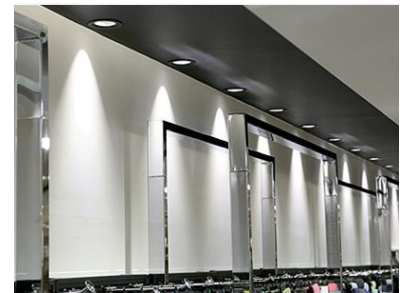
Street and amenity lighting.

Refrigeration/Freezer lighting.

Display lighting

Emergency lighting

Specialist applications for entertainment



## 17. Can your supplier back-up their claims?

Any reputable supplier should be able to supply data or obtain data to support their performance claims. If they are unable to supply this, beware!

## 18. Should I wait for newer LED technology?

All technology is constantly improving and so is the performance of LEDs. LEDs have reached a level where their efficacy makes them suitable for many general lighting applications. Manufacturers try keep the same foot print of their LEDs, Therefore upgrades can be made simply. There are also many manufactures using modules/light engine, this helps them upgrade their products simply.