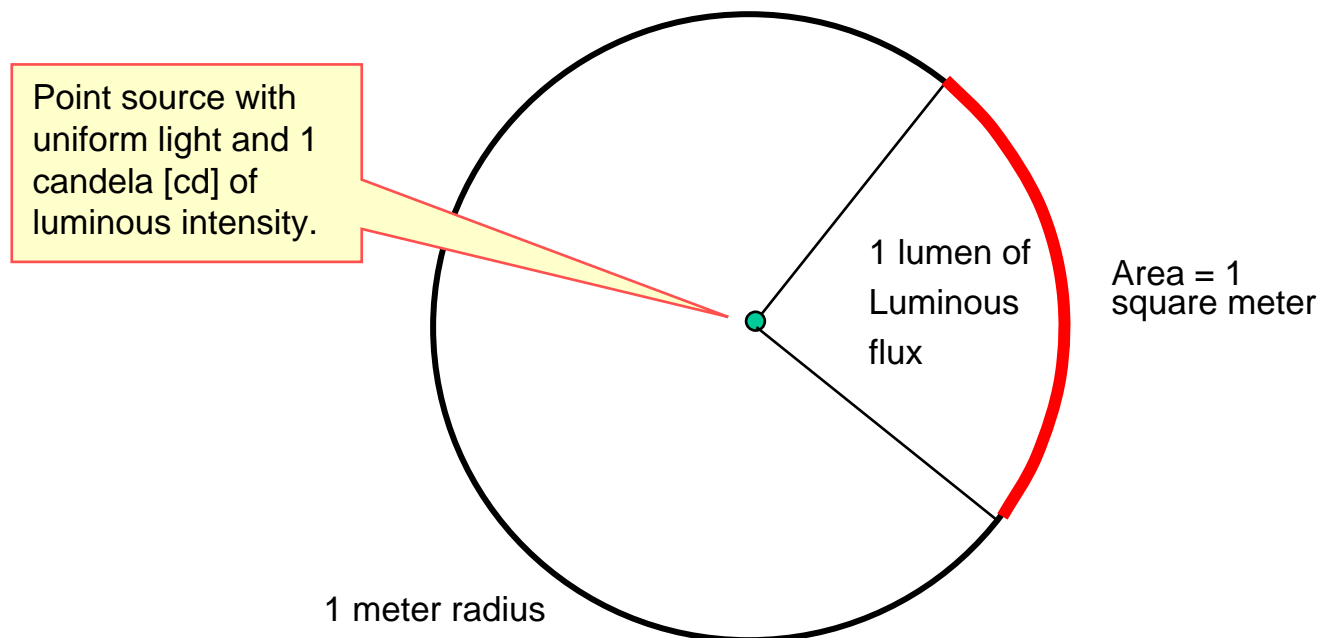# LED Lighting

Definitions and Characteristics

Definitions

Luminous Flux [lm]

- Luminous flux is the quantity of the energy of the light emitted per second in all directions. The unit of luminous flux is lumen (lm). One lumen is the luminous flux of the uniform point light source that has luminous intensity of 1 candela and is contained in one unit of spatial angle (or 1 steradian). Steradian is the spatial angle that limits the surface area of the sphere equal to the square of the radius. This concept is shown in the figure for 1 m radius of the sphere. Since the area of sphere is $4\pi r^2$ then the luminous flux of the point light source is 4π lumens.

Point source with uniform light and 1 candela [cd] of luminous intensity.

1 lumen of Luminous flux

Area = 1 square meter

1 meter radius

Luminous Intensity [cd]

- The luminous intensity (measured in candelas) is the amount of light emitted into a certain direction, measured in 1 m distance.

- If the point light source emits Ø lumens into a small spatial angle ß, the luminous intensity is I=Ø/ß.
  The unit of luminous intensity is candela. There is a standard that details the candela definition. This includes the standard light source and the physical conditions of the measurement.

Radiation Characteristic
$I_{rel} = f(\varphi); T_A = 25\ °C$
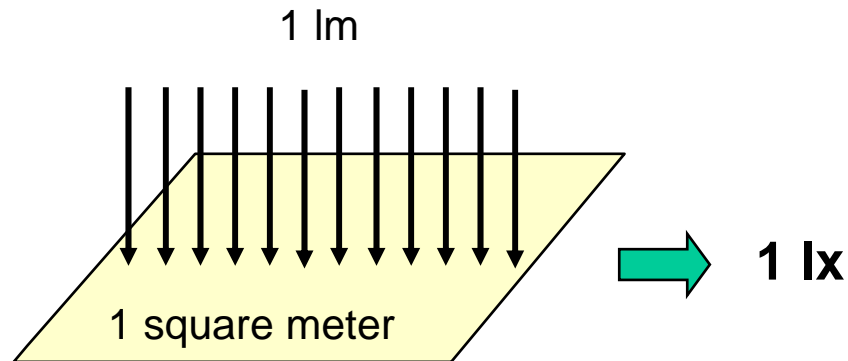
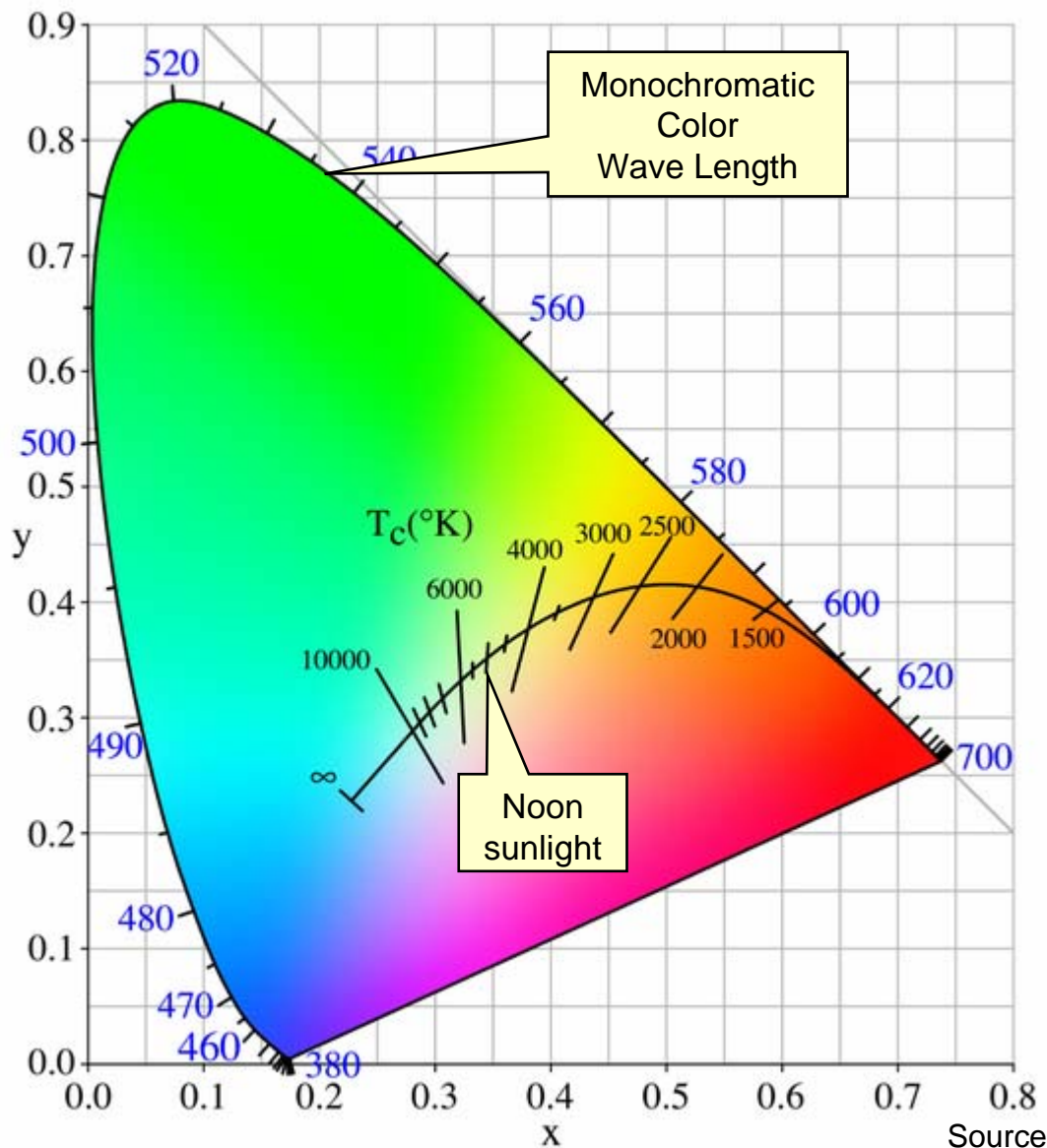## Beam angle dependence of candela output
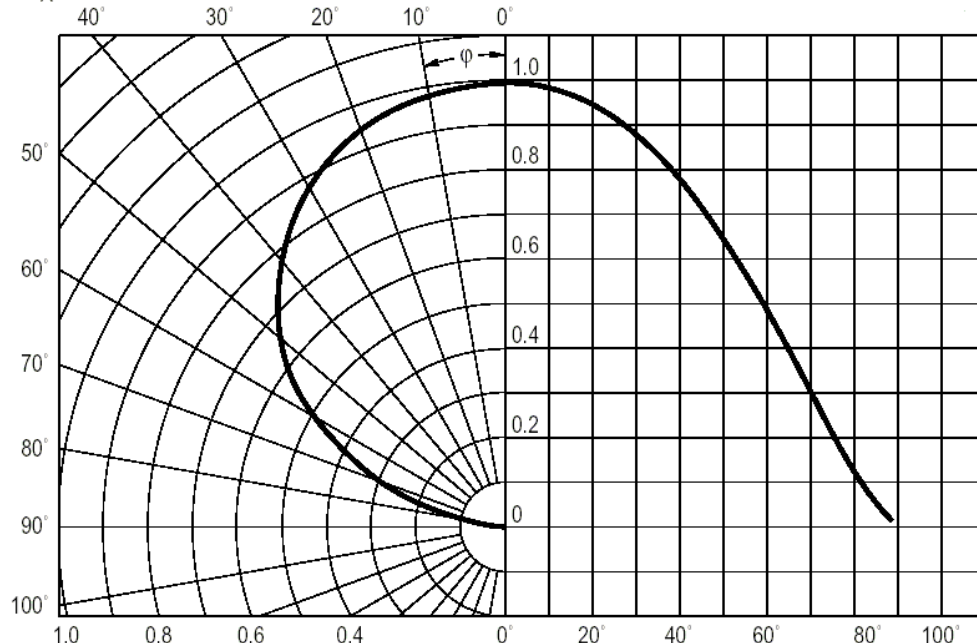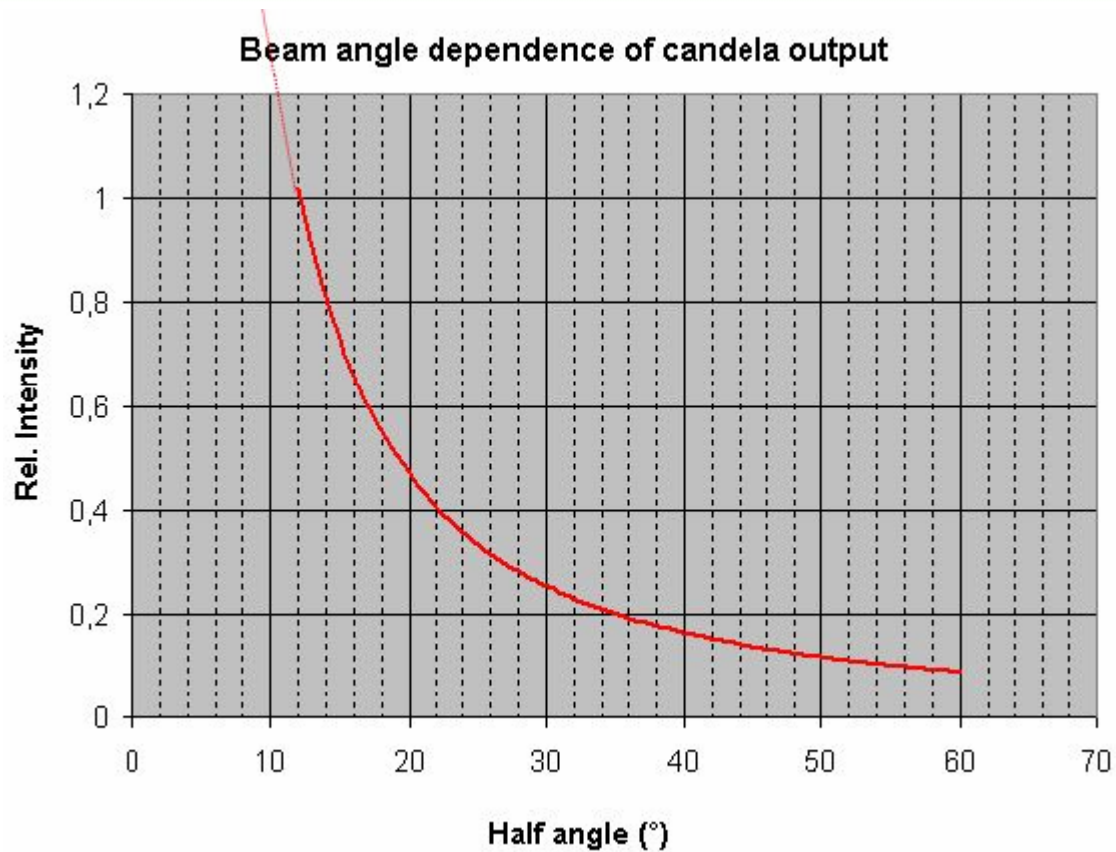
- Luminous intensity is not only driven by the luminous flux, but also by the optics, which makes the light more or less focused.

Illuminance

- This definition determines the amount of light that covers a surface. If Ø is the luminous flux and S is the area of the given surface then the illuminance E is determined by E=Ø/S.
  The unit of illumination in SI system is lux [lx], and in foot-pound system it is foot-candle. One lx is the illuminance of 1 m² surface area uniformly lighted by 1 lm of luminous flux. The following drawing explains this definition. One foot-candle is 10.76 lux.

1 lm

1 square meter

1 lx

Correlated Color Temperature

Monochromatic Color Wave Length

Noon sunlight

- Defines a color as the temperature [K] that a "black body" source must reach in order to produce that same color.

CIE (1931) xy chromaticity diagram including the Planckian locus, with temperatures indicated. Wavelengths of monochromatic light are shown in blue. The lines crossing the Planckian locus are lines of constant correlated color temperature.

Source   http://en.wikipedia.org/wiki/Chromaticity_diagram

Example: Chromaticity coordinate Groups for
Osram's LWY87C « Micro side LED » for display
backlighting applications
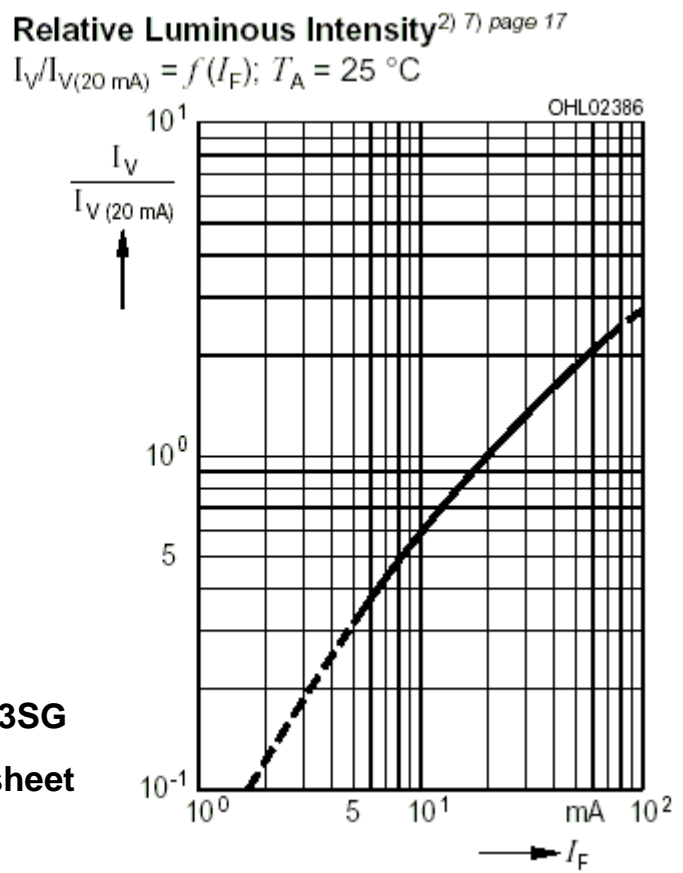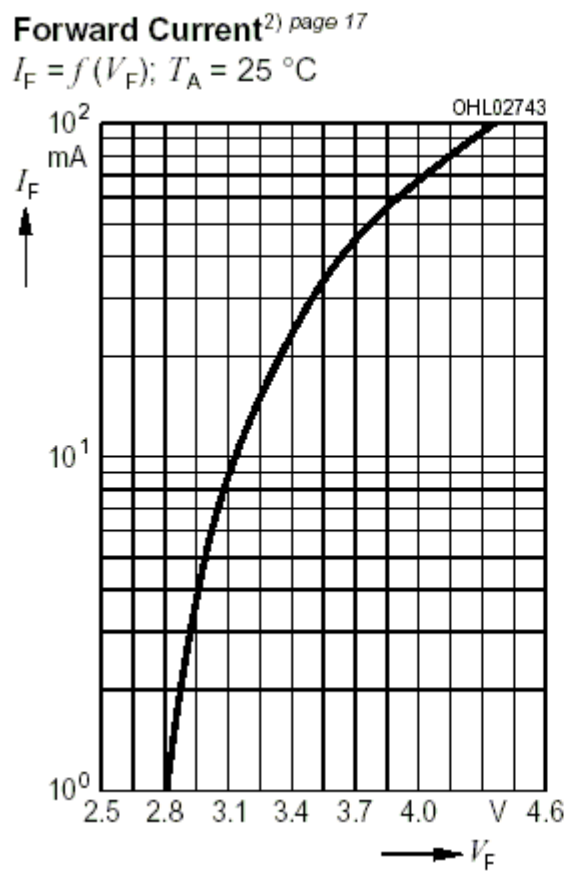
Typical color temperature : 6200 °K
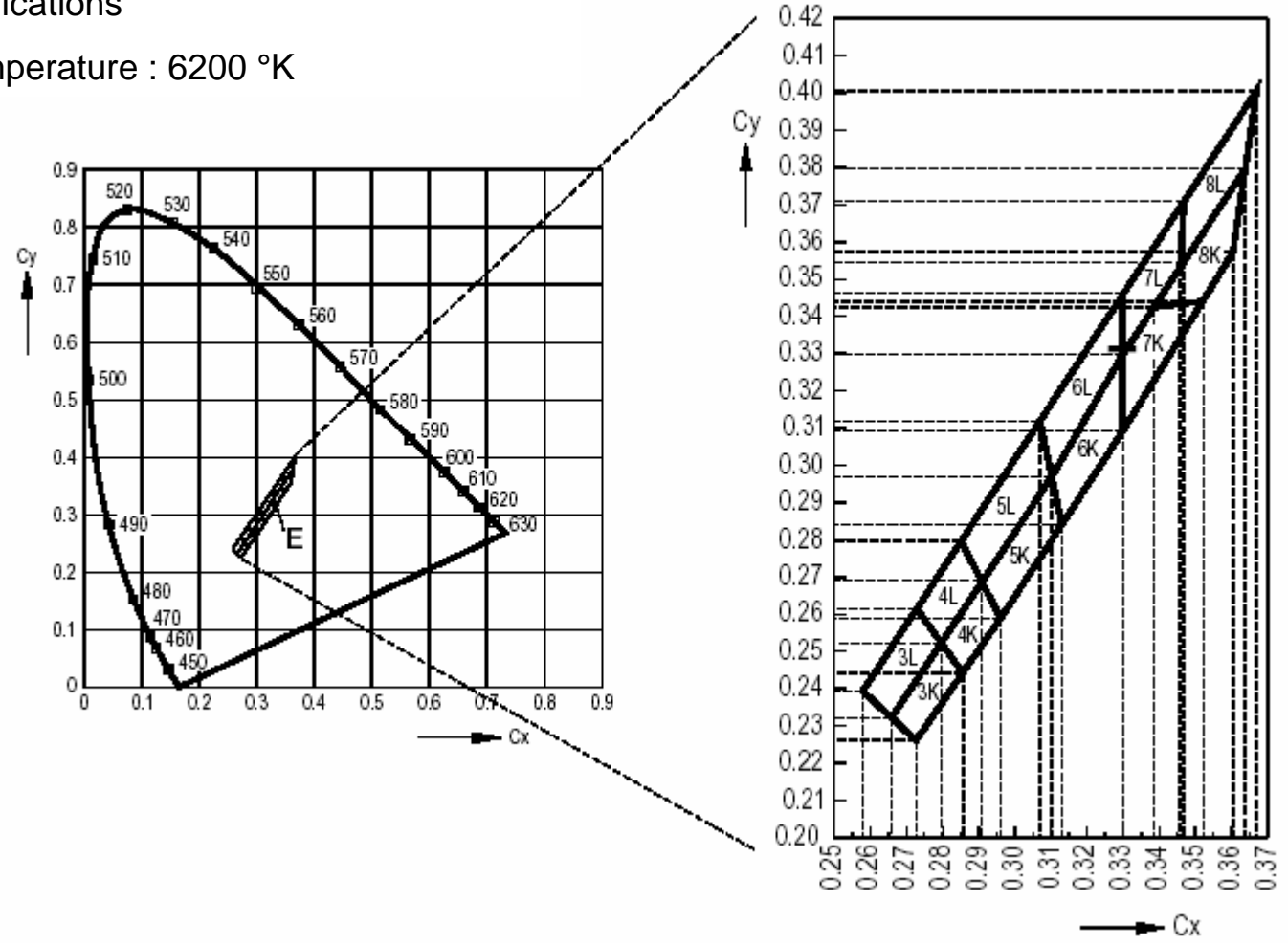
Characteristics

Current/Voltage Characteristics

Forward voltage keeps decreasing. Small LEDs dedicated to backlighting now exhibit a forward voltage in the 3.1 to 3.2 V range. This has a strong impact on LED driver choice.

Forward Current [2) page 17]

$I_F = f(V_F)$; $T_A = 25\ °C$

OHL02743

Relative Luminous Intensity [2) 7) page 17]

$I_V/I_{V(20\ mA)} = f(I_F)$; $T_A = 25\ °C$

OHL02386

LWY3SG

datasheet

Chromaticity Coordinate Shift

The LED's color characteristics are dependent from the forward current.

Special attention must be paid when using LED drivers with Red-Green-Blue LEDs. Light dimming should not modify the color rendering.

Preferred solution is PWM dimming to ensure that LEDs are driven with known forward current.

Chromaticity Coordinate Shift[2] *page 16*
$x, y = f(I_F); T_A = 25\,°C$

OHL01614
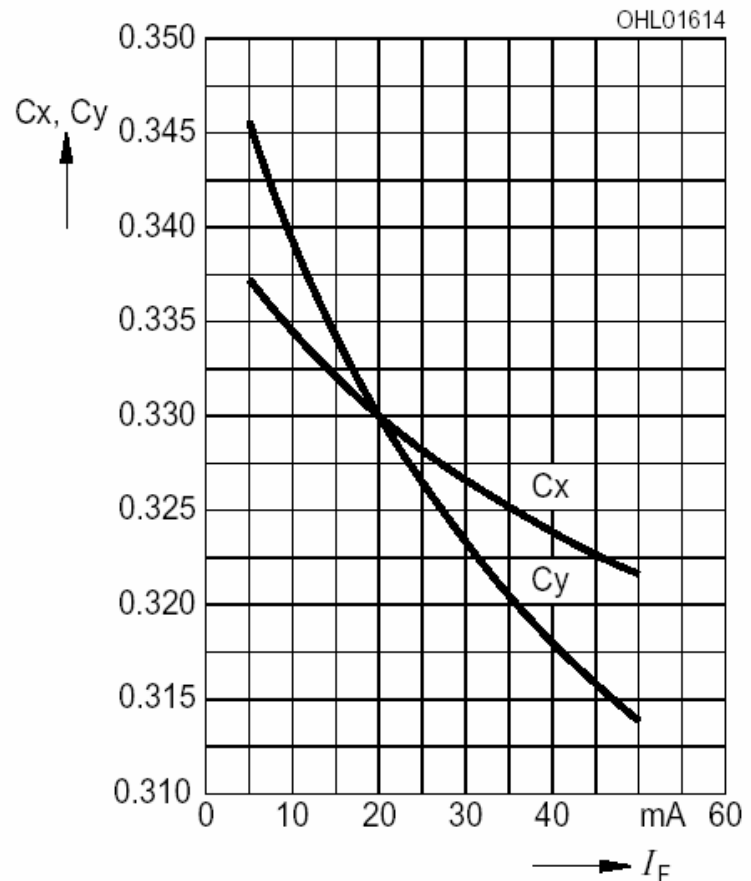
Osram: LWY87C

Temperature Influence

Forward voltage:

All LEDs exhibit forward voltage variation as junction temperature changes. The temperature coefficient depends from junction type. InGaAlP LEDs (Yellow and Amber Red) have a coefficient of between -3.0 mV/K to -5.2 mV/K, and the InGaN LEDs (Blue, Verde Green, and White) have a coefficient of between –3.6 mV/K and -5.2 mV/K. (Golden Dragon LWW5SG)

Intensity change over temperature:

Light intensity decreases as the temperature increases. This is a result of changing efficiencies in the semiconductor, and not a result of the change in the forward voltage over temperature changes. This temperature change is non-linear.

Temperature Influence

Permissible current:

LED manufacturers have realized significant improvements to allow high current operation. Nevertheless, high current LEDs used for camera phones exhibit shorter lifetime than small LEDs dedicated to backlight. This is not a strong issue in case of flash-light because of short pulse duration, but it must be taken into account for video mode.

$I_F = f(T_S)$

OHL02093
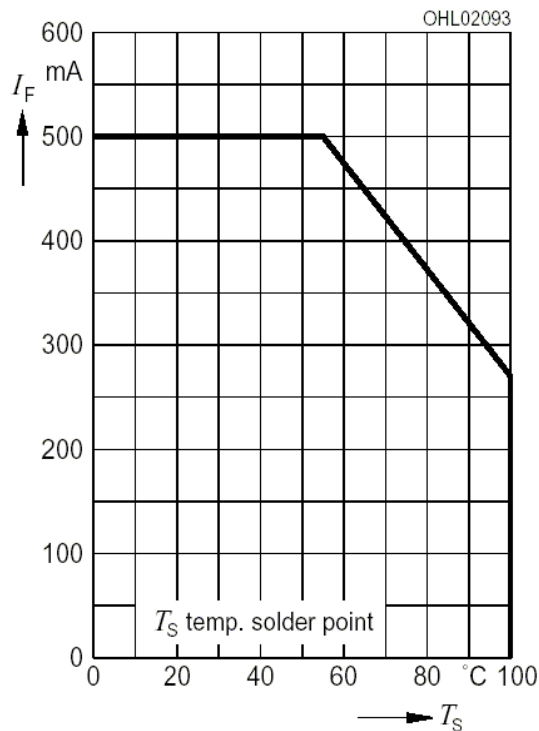
Conditions	median Lifetime	Unit
$I_F = 250$ mA $T_A = 25°C$	50.000	operating hours
$I_F = 500$ mA $T_S = 55°C$	5.000	operating hours
$I_F = 500$ mA $T_S = 125°C$ $T_J = 150°C$	1.000	operating hours
$I_F = 500$ mA $T_S = 125°C$ $T_J = 175°C$	100	operating hours

The emitter die exhibits excellent performance but slight package discoloration occurs at highest temperatures. The median lifetime depends on the application

Datasheet: LWW5SG