Edixeon®
Reliability Document

As part of Edison Opto's commitment for quality products, this document presents, in accordance to the latest industry standards and stress criteria, the results of ongoing, long-term stress testing of high power LED.

This reliability document defines in the context such that high power LEDs can be measured and evaluated with lifetime projection. Also it describes the color temperature maintenance of white light products for it is an essential factor for the general lighting specifications.

Through continuous advancement and dynamic evolving technology in LED industry, Edison Opto continues to offer industry leading, reliable, competent products with definitive performance over time.

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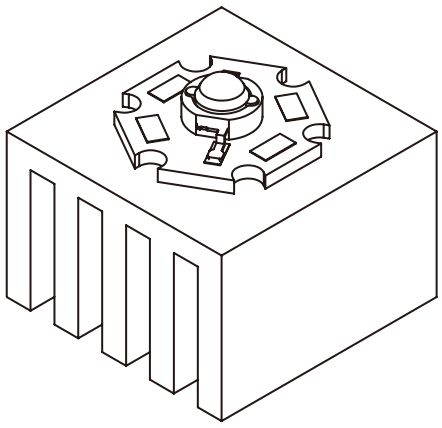
version : 4

When electrical current is applied to the LEDs, photons are generated from the LED p-n junction where light is emitted. While emitting light, some forms of energy is being converted to heat. The reliability and lifetime of a semiconductor relies on the temperature at which the LED is being operated. Throughout this document, commonly recognized abbreviations used among LED industry are listed below.

List of abbreviations

LED	Light emitting diode
AlInGaP	Semiconductor material for Amber, Deep Red, Red LEDs
InGaN	Semiconductor material for Blue, Cyan, Dental Blue, Royal Blue, Green, UV, White LEDs
V_F	Forward operating voltage
I_F	Forward operating current
T_J	Junction temperature of LED
R_{th}	Thermal resistance
R_H	Relative humidity
L_{70}	The time at which the intensity is 70% of maximum
L_{50}	The time at which the intensity is 50% of maximum
$L_{@6,000hrs}$	Lumen maintenance at 6,000hrs
B_{50}	Half of total testing samples



The following table describes operating life, mechanical, and environmental tests performed on Edixeon® ARC, K and S series package.

Operating life, mechanical, and environmental characteristics at I_F=350mA~1000mA and T_J=25˚C

Stress Test	Stress Conditions	Stress Duration	Failure Criteria
Room Temperature Operating Life	25˚C, I_F =I_F Max DC (Note 1)	1,000 hours	Note 2
High Temperature High Humidity	85˚C / 85%RH	1,000 hours	Note 2
Temperature Cycle	-40˚C/100˚C ,30 min dwell /<5min transfer	500 cycles	Note 2
High Temperature Storage Life	110˚C	1,000 hours	Note 2
Low Temperature Storage Life	-40˚C	1,000 hours	Note 2
Thermal Shock	-40 / 125˚C 15 min dwell /<10 sec transfer	1,000 cycles	No catastrophics
Mechanical Shock	1500 G, 0.5 msec pulse, 5 shocks each of 6 axis		No catastrophics
Natural Drop	On concrete from 1.2 m, 3X		No catastrophics
Variable Vibration Frequency	10-2000-10 Hz, log or linear sweep rate, 20 G about 1 min, 1.5 mm, 3X/axis		No catastrophics
Solder Heat Resistance (SHR)	260˚C ± 5˚C, 10 sec		No catastrophics

Notes:

1. Depending on the maximum derating curve.
2. Failure Criteria:
   - Electrical failures
     - V_F shift >=10%
     - Light Output Degradation
     - % I_V shift >= 30% @1,000hrs or 500cycle
   - Visual failures
     - Broken or damaged package or lead
     - Solderability < 95% wetting
     - Dimension out of tolerance

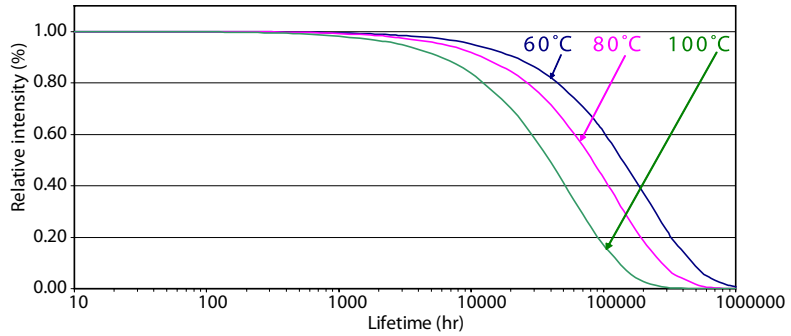
Referring to the latest industry specifications, L_{70} is often used as the time when the level of reduced light output would be noticeable to human eye and affect originally intended illumination purposes requirements. In some cases, L_{50} is being used for less critical illuminating applications. Even though the LEDs appears to be less bright, they are still functional at this point of time.

The lumen decay with respect to lifetime is plotted below. The lifetime projections are based on the performance at 1,000 hours to 6,000 hours operating interval. For LED exhibits different characteristics compare to traditional light source, the first 1,000 hours of operation are being referring to as the seasoning period and is not being accounted for data extrapolation. The following graph summarizes the lumen maintenance for Edixeon® ARC, K and S series respectively.

Edixeon® ARC Series (B_{50} / L_{70}) @ I_F= 350mA

Edixeon® ARC series Life Data			
T_J	60°C	80°C	100°C
$L_{70\%}$ (hour)	72,228	42,440	20,107
$L_{50\%}$ (hour)	140,366	82,477	39,076
$L_{@6,000hrs}$ (%)	97.08	95.08	89.90

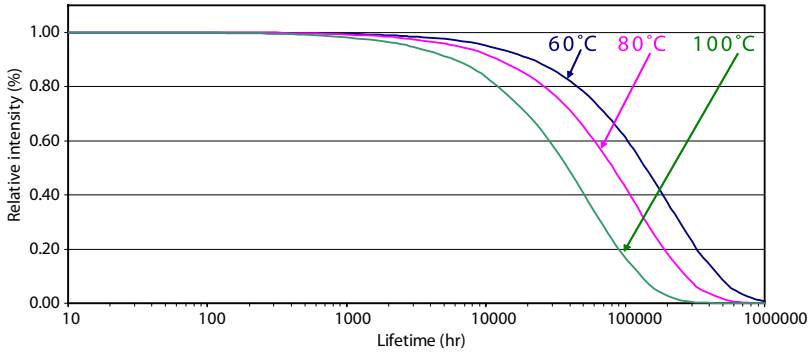
Normalized Light Output
Edixeon® ARC series driven at I_F = 350mA



Edixeon® K Series (B_{50} / L_{70}) @ I_F= 350mA

Edixeon® K series Life Data			
T_J	60°C	80°C	100°C
$L_{70\%}$ (hour)	72,366	42,070	19,823
$L_{50\%}$ (hour)	140,634	81,758	38,524
$L_{@6,000hrs}$ (%)	97.09	95.04	89.77

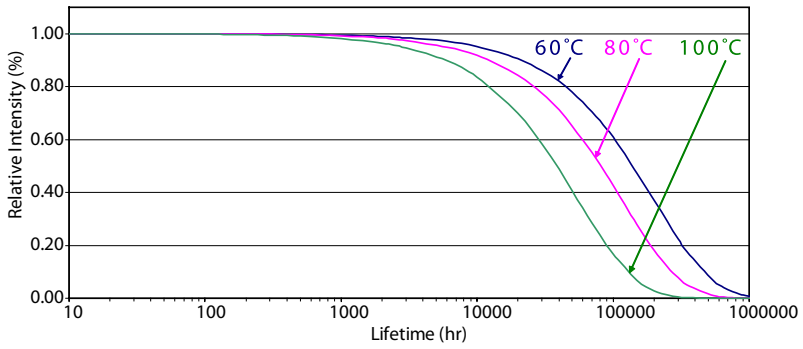
Normalized Light Output
Edixeon® K series driven at I_F = 350mA



Edixeon® S Series InGaN (B_{50} / L_{70}) @ I_F= 350mA

Edixeon® S series Life Data			
T_J	60°C	80°C	100°C
$L_{70\%}$ (hour)	71,681	41,864	19,919
$L_{50\%}$ (hour)	139,301	81,358	38,711
$L_{@6,000hrs}$ (%)	97.06	95.02	89.81

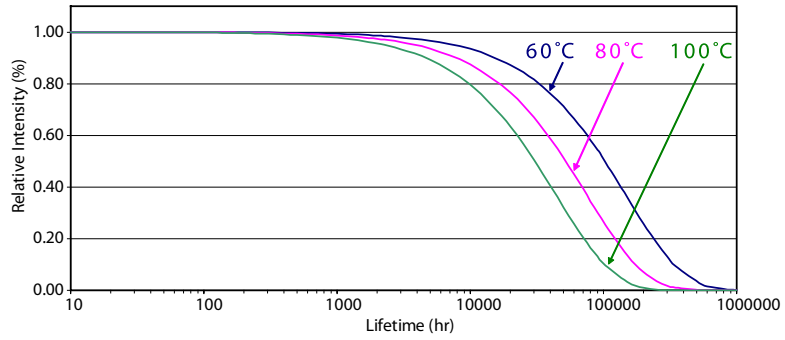
Normalized Light Output
Edixeon® S series with InGaN chip inside driven at I_F = 350mA



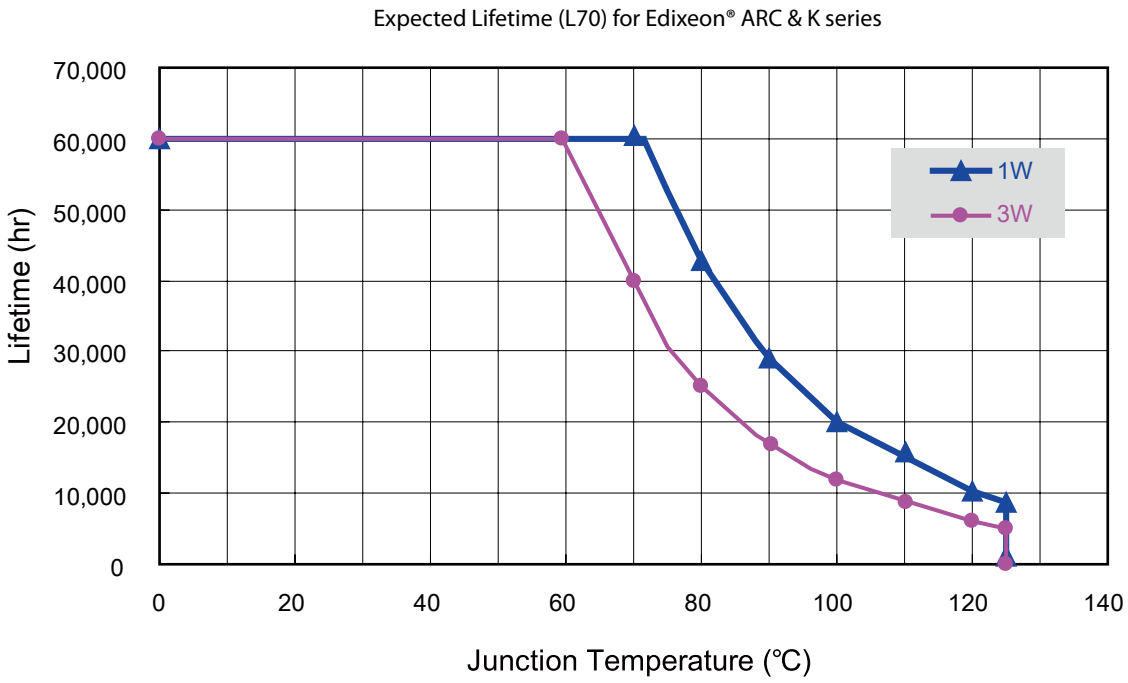
Edixeon® S Series AlInGaP (B_{50} / L_{70}) @ I_F= 350mA

Edixeon® S series Life Data			
T_J	60°C	80°C	100°C
L_{70} (hour)	52,577	26,818	15,751
L_{50} (hour)	102,176	52,117	30,610
$L_{@6,000hrs}$ (%)	96.01	92.33	87.30

Normalized Light Output
Edixeon® S series with AlInGaP chip inside driven at I_F = 350mA



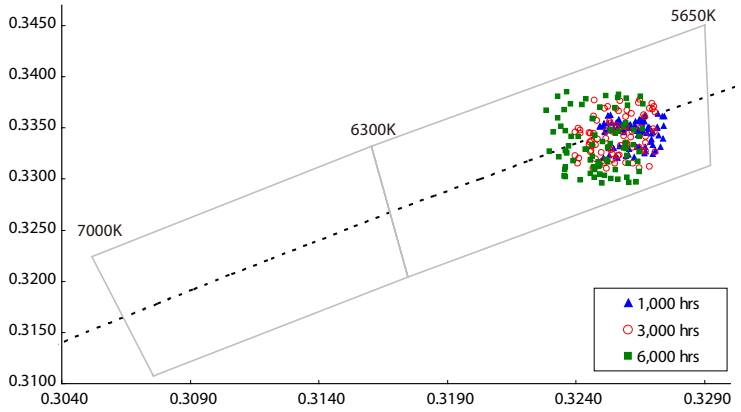
Often times, the actual LED junction temperature from various solid-state lighting products would differ due to difference in thermal design and its in-situ environment. The performance and lifetime of LED depends on the driving current and junction temperature. While lumen maintenance records and projects the lifetime of LED at a fixed junction temperature, the expected lifetime for Edixeon® with respect to different operating current and junction temperature is presented below:



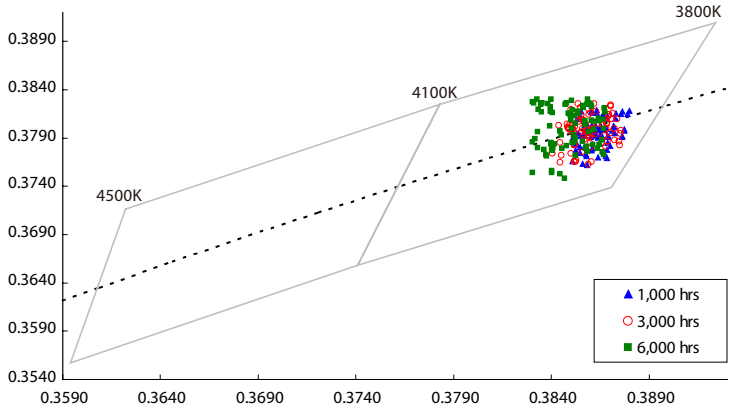
While constructing a lumen maintainable device, Edison Opto continues to work toward a homogeneous color binning. Over a period of operation, the efficacy of phosphor would decay due to heat generated by LED, resulting in color shift of phosphorous white LED products.

Figures below are accumulated statistical data of color maintenance for Edixeon® ARC series, plotted on the CIE 1931 coordinate system. The spatial change in color is recorded with selective Edixeon® CCT binning group.

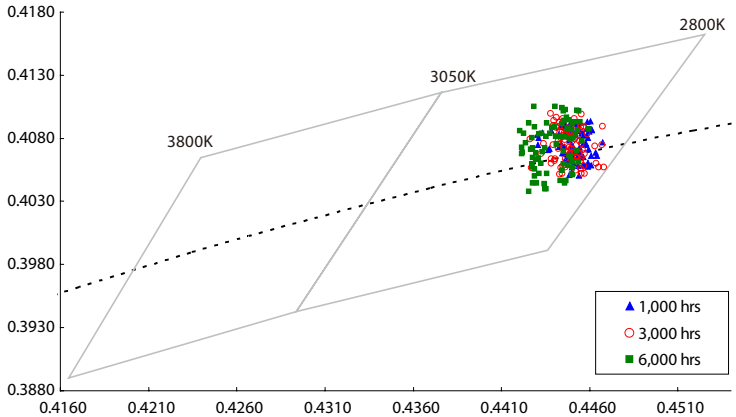
Color maintenance for Cool White (T_j=60˚C)



Color maintenance for Neutral White (T_j=60˚C)



Color maintenance for Warm White (T_j=60˚C)





About Edison Opto

Edison Opto is a leading high power LED manufacturer and a solution provider experienced in optical design and thermal management for the emerging SSL market. With R&D headquarter in Taiwan, as well as distribution network over twenty-six countries, Edison Opto offers a diverse range of high power LED products to worldwide commercial, industrial, retail, and residential markets.