NewGen series

New Generation of WICOP

Introduction

This application note addresses the recommended assembly and handling procedures for NewGen series. Proper assembly and handling, as outlined in this application note, ensures high output and long light output maintenance for NewGen series.

Scope

The assembly and handling guidelines in this application brief apply to the following products with this part number designation as described below.

Z8 YXX-WY-CN	
Where :	
XX	Designates packaging size (19 for 1.81x1.81mm size, 15 for 1.41x1.41mm size)
Y	White Color (0 for Cool, N for Neutural, W for Warm)
N	Designates CRI (7 for CRI min.70, 8 for CRI min.80)

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1. Component

1.1 Description

The NewGen family of LEDs are based on chip scale packaging (CSP). They are ultra-compact, high-power, surface mount white LEDs. Each NewGen LED only consists of high brightness InGaN LED chip. A ESD diode is not inside the package.

The top of NewGen LEDs is a thin layer of silicone to shield the chip from environment. The bottom of the NewGen contains two equally sized solder pads for the anode and cathode (Figures 1).

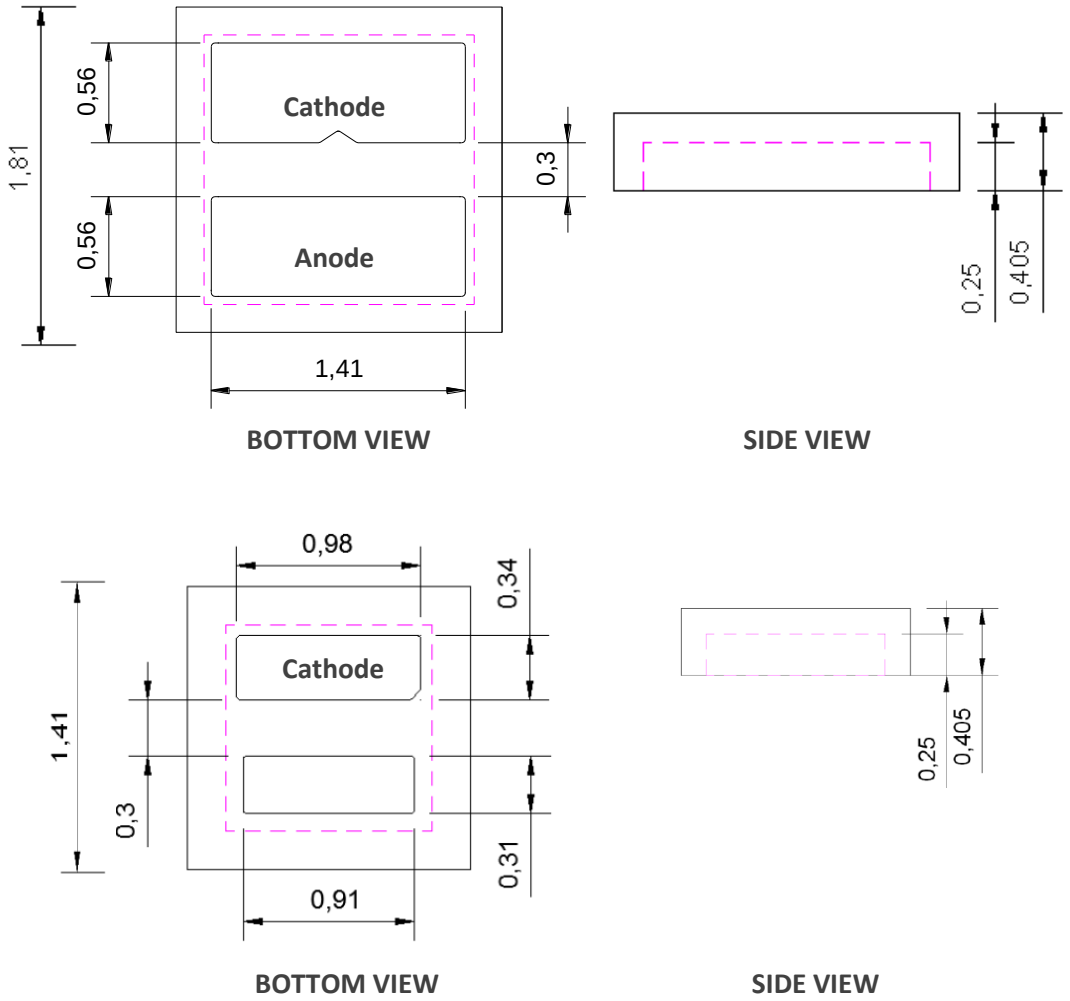

Figure 1. Relevant Mechanical features (in mm) for NewGen Z8Y19, Z8Y15.

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1.2 Optical Center

The theoretical optical center of the NewGen (Z8Y19) is 0.955mm from the side edges (see Figure 2).

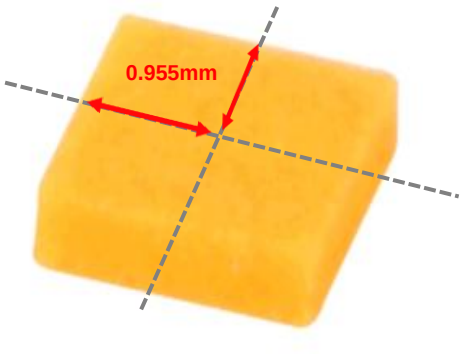

Figure 2. The optical center of the NewGen is 0.955mm from the each side edges.

1.3 Handling Precaution

Improper handling of NewGen LEDs may damage the LED chip and can impact the overall performance and reliability. In order to minimize the risk of damage to the LED chip during handling, NewGen should only be picked up by automated SMT machine or vacuum tweezer.

When handling finished boards containing NewGen, do not touch the surface with any fingers or metal tweezer (see Figure 3a) . Do not apply pressure to to the top or sides of the LED.
When handling printed circuit boards with NewGen LEDs, do no turn over the board for probing if the electrodes are at the back of the board, or stack multiple boards on top of each other (see Figure 3b). Do not stack assembled PCBs together. Since materials of LEDs is soft, abrasion between two PCB assembled with LED might cause catastrophic failure of the LEDs.
A rough or contaminated surface placed on top of a NewGen LED may damage the silicone encapsulant. Additionally, any pressure applied to a NewGen during probing may damage the silicone layer or the chip underneath.

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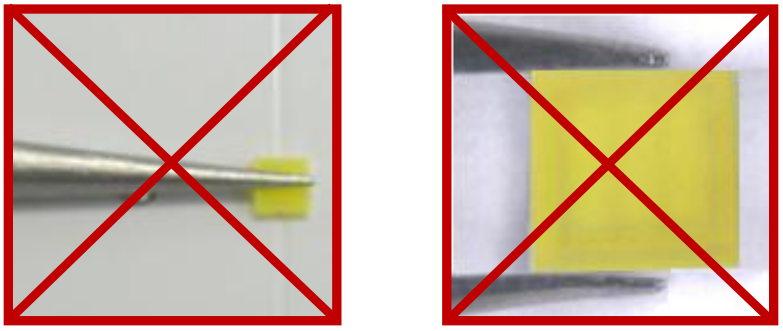

Figure 3 (a). Incorrect handling of NewGen

Figure 3 (b). Incorrect handling of NewGen

1.4 Cleaning

The NewGen should not be exposed to dust and debris. Excessive dust and debris may cause a decrease in LED performance. In the event that the surface of a NewGen requires cleaning, a compressed gas duster at a distance of 6” away will be sufficient to remove the dust and debris or an air gun with 20 psi (at nozzle) from a distance of 6”.

1.5 Electrical Isolation

The NewGen contains two electrical pads on the bottom of LED with a spacing of 0.3mm. In order to avoid any electrical shocks and/or damage to the NewGen, each design needs to comply with the appropriate standards of safety and isolation distances.

1.6 Mechanical Files

Mechanical drawings for NewGen (2D and 3D) are available upon request.

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2. Printed Circuit Board Design Guideline

NewGen LEDs are designed to be soldered onto a Metal Core PCB (MCPCB). For optimal operation, the PCB should be designed to minimize the overall thermal resistance between the LED and the heat sink.

2.1 NewGen Footprint and Land Pattern

For proper operation, the NewGen LEDs anode and cathode need to be soldered onto corresponding pads on a PCB. The size of the pads and the corresponding size of the solder stencil are shown in Figure 4.

The electrical pads of the NewGen also serve as thermal pads between the LED and the PCB. To enhance heat dissipation from a NewGen LED into the PCB, it is best to extend the copper area around each electrode approximately 4mm from the center of the LED, where possible.

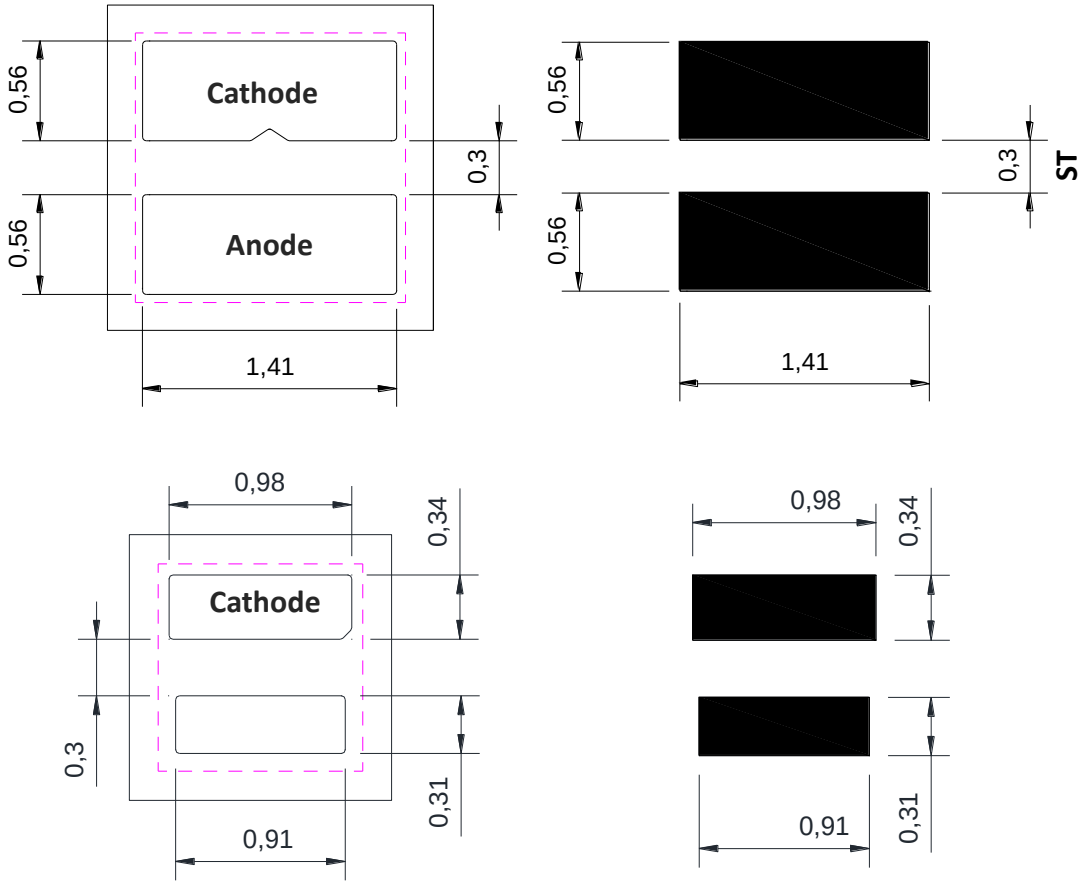

Figure 4. Recommended PCB Footprint for NewGen. All dimensions in mm.

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2.2 Minimum Spacing

Seoul Semiconductor recommends a minimum edge to edge spacing between NewGens of 0.2mm. Placing multiple NewGens too close to each other may adversely impact the ability of the PCB to dissipate the heat from the LEDs. Also, the light output for each LED may drop due to optical absorption by adjacent LEDs. More information on this can be found in Section 5 NewGen LED array guidelines.

3. Thermal Measurement Guidelines

This section provides general guidelines on how to determine the junction temperature of a NewGen LED in order to verify that the junction temperature in the actual application during regular operation does not exceed the maximum allowable temperature specified in the datasheet.

The typical thermal resistance RΘjs between the junction and the thermal pad for NewGen LED is specified in the datasheet. For a NewGen LED, the electrode pads serve as thermal pads. With this information, the junction temperature Tj can be determined according to the following equation:

$$Tj = TS + R\Theta js \bullet Pelectrical$$

In this equation Pelectrical is the electrical power going into the NewGen and TS pad is the temperature at the bottom of one of the NewGen electrodes, assuming both NewGen electrodes are connected to copper pads on the PCB.

In typical applications it may be difficult, to measure the thermal pad temperature TS pad directly. Therefore, a practical way to determine the NewGen junction temperature is by measuring the temperature Ts of a predetermined sensor pad on the PCB close to the NewGen with a thermocouple. To ensure accurate readings, the thermocouple must make direct contact with the copper of the PCB onto which the NewGen electrode pads are soldered, i.e. any solder mask or other masking layer must be first removed before mounting the thermocouple onto the PCB.

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Figure 5. The pads marked with the dashed circles correspond to the example Ts measurement point(Left). Example of the measuring Ts configuration (right).

The following guidelines help determine appropriate Ts location in a densely packed array application in order to approximate the maximum junction temperature in the NewGen array:

a. If there is no symmetry in the copper layout of the PCB, it is best to place the Ts point next to the electrical pad (anode or cathode) where heat spreading into the PCB is most impeded. This is typically the electrode with the least amount of copper.

b. If different drive currents are used for each NewGen LEDs, it is generally best to measure the temperature next to the LEDs which consumes the most amount of electrical power.

The thermal resistance RΘjs between the NewGen junction and Ts point was experimentally determined to be typical 3K/W for a NewGen of the 1.5mm thick Al-MCPCB board (2oz copper or 80~100µm thick 5W/m·K dielectric layer).

LED board configurations with a larger number of closely packed NewGen LEDs may require additional thermal modeling to determine the pad temperature of the LEDs in the center of the array which are not easily accessible.

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4. Array Process Guideline

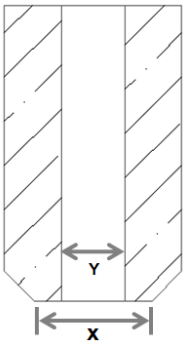
4.1 Stencil Design

The appropriate stencil design for NewGen is included in the PCB footprint design (see Figure 4). The recommended stencil thickness is 80~120µm. The slightly smaller stencil pattern, compared to the solder resist opening, prevents the solder paste from accidentally bridging between the electrodes, which are only spaced 300µm apart. (See 3.2 Footprint and land pattern)

4.2 Pick-and-Place

Automated pick and place equipment provides the best handling and placement accuracy for NewGen. Figure 5 shows pick and place nozzle designs.
Based on these pick and place experiments, Seoul Semiconductor recommends to customers to take the following general pick and place guidelines :

1. The tip of the nozzle should be positioned on the flat surface above the LED chip area.
2. The nozzle tip should be clean and free of any particles.
3. During setup and any initial production runs, it is a good practice to inspect the top surface of the NewGen under a microscope to ensure the emitters are not accidentally damaged by the pick and place nozzle.



Items	Remark
Outer diameter X	1.2~1.6 mm
Inner diameter Y	0.5~0.65 mm
Materials	Rubber or Ceramic

Figure 5. Pick and place nozzle design and dimensions

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4.3 Solder Paste

Seoul Semiconductor recommends to use no-clean solder paste, SnAgCu (tin/silver/copper) of solder paste compositions.

4.4 Stencil Printing

The recommended stencil thickness is 0.1~0.12mm. For good quality stencil printing, there are several important factors for consideration.

1. The stencil opening wall should be smooth, free from debris, dirt and burr.
2. The stencil wall should have uniform thickness throughout the stencil plate.
3. Positional tolerance between the stencil plate and the PCB should be small enough to ensure that the solder paste is not printed outside the footprint.

Items		Remark
Squeeze conditions	Pressure	2.5-5.0Kgf/㎠
	Distance	2-4mm
	Velocity	20-100mm/sec
Stencil mask	Thickness	0.1~0.12mm
Vacuum		0.5±0.05mpa
Solder paste area		90-100%
X, Y Tolerance		±150 um

Table 1. Stencil mask and soldering information.

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4.5 Reflow Process

A standard SMT reflow profile can be used to reflow NewGen. An example of the reflow conditions is shown in Figure 6 and Table 2.

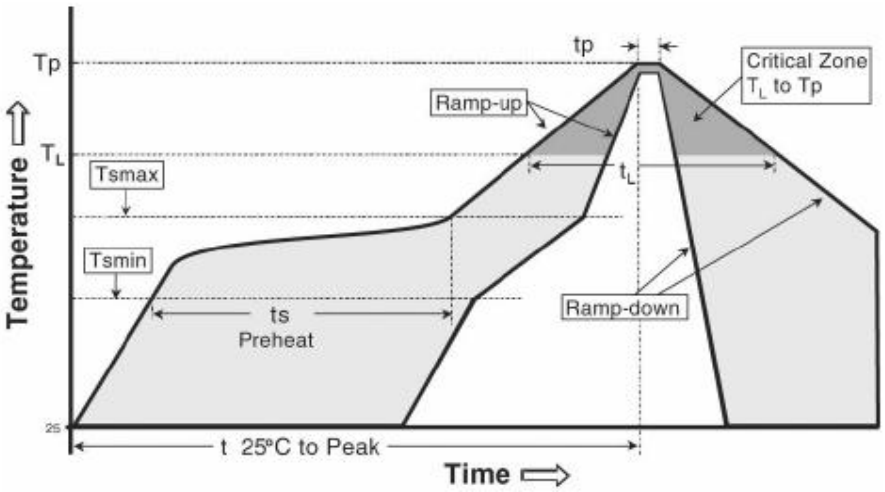

Figure 6. Solder reflow profile.

Table 2. Recommended reflow conditions

Profile Feature	Pb-Free Assembly
Average ramp-up rate (Tsmax to Tp)	3° C/second max.
Preheat - Temperature Min (Tsmin) - Temperature Max (Tsmax) - Time (Tsmin to Tsmax) (ts)	 150 °C 180 °C 80-120 seconds
Time maintained above: - Temperature (TL) - Time (tL)	 217~220°C 80-100 seconds
Peak Temperature (Tp)	250~255℃
Time within 5°C of actual Peak Temperature (tp)2	20-40 seconds
Ramp-down Rate	6 °C/second max.
Time 25°C to Peak Temperature	8 minutes max.
Atmosphere	Nitrogen (O2<1000ppm)

◆ **Table parameters established based on SMIC: M705-GRN360-K2-V (solder paste)**

Caution

(1) Re-soldering should not be done after the LEDs have been soldered. If re-soldering is unavoidable, LED`s characteristics should be carefully checked before and after such repair.
(2) Do not put stress on the LEDs during heating.
(3) After reflow, do not warp the circuit board.
(4) After reflow, do not clean PCB by water or solvent.

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5. NewGen Array Guide

Seoul Semiconductor recommends a minimum edge to edge spacing between NewGenLEDs of 0.2mm. Placing multiple NewGen too close to each other may adversely impact the ability of the PCB to dissipate the heat from the LEDs.

5.1 Efficacy dependency on die spacing

The efficacy of a NewGen LED array depends on die spacing. There is efficacy loss due to optical absorption by adjacent LEDs. The data indicates above 1mm between die spacing, the efficacy variation is saturated (Figure 7).
For this test case, the NewGen array was operated at 2W/Pkg. The PCB used was a 1.5mm thick Al-MCPCB, 1.5mm X 1.5mm size board with 2oz copper.

	D=0.2mm	D=0.4mm	D=0.8mm	D=1mm	D=2mm	D=3mm	D=4mm	D=5mm
Simulation Design								
Efficacy	**96%**	**98%**	**99.6%**	**100%**	**100.2%**	**100.3%**	**100.4%**	**100.4%**

	D=0.2mm	D=0.4mm	D=0.8mm	D=1mm	D=2mm	D=3mm	D=4mm	D=5mm
Device Design								
Efficacy	**92.6%**	**95.4%**	**98.4%**	**100%**	**101.2%**	**101.5%**	**101.7%**	**102%**

Figure 7. Simulation and device configurations

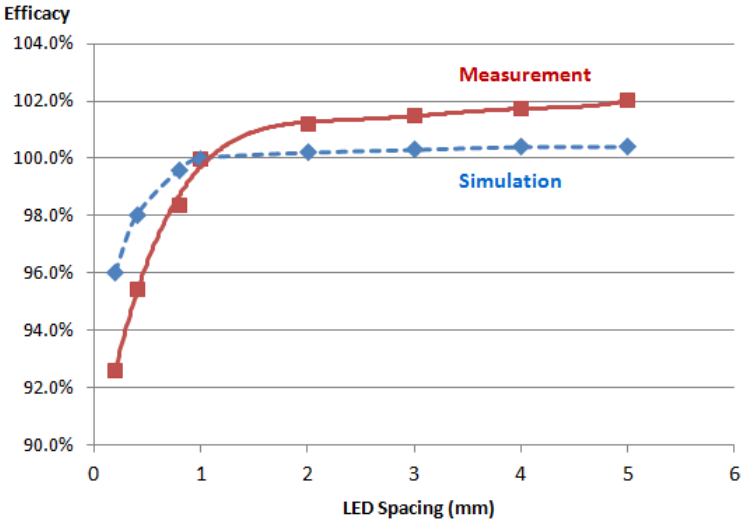

Figure 8. Simulation and Device test results.

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The results of a simulation based on optical absorption by adjacent NewGen LEDs and actual measurements are shown in Figure 8. The losses are not due to thermal effects only cross talk between the LEDs. The measurement were taken at 25°C with pulse condition with 2W operation. Simulation and device measurement results show a small difference, but the efficacy variation trend is similar. This measured difference can be attributed to small differences in the LED flux or the assembly process.

5.2 Junction temperature dependency on die spacing

Placing multiple NewGenL EDs too close to each other may also adversely impact the ability of the PCB to dissipate the heat from the LEDs. Board configurations with numbers of closely packed NewGen LEDs may require thermal modeling to determine the junction temperature. Figures 9 and 10 are the thermal simulation results of various LED spacing.

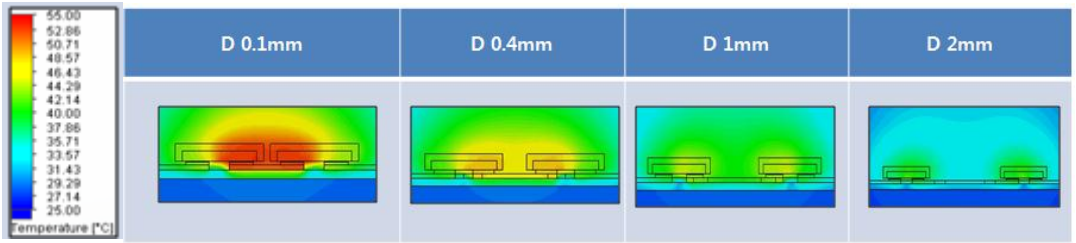

Figure 9. Thermal simulation configurations.

Cu	Distance	Max junction
1oz	0.1	96
	0.4	86
	0.8	77
	1	75.8
	2	67.9
	3	65.2
	4	64.4
2oz	0.1	85.9
	0.4	76.8
	0.8	69.9
	1	68.8
	2	61.5
	3	58.7
	4	57.5

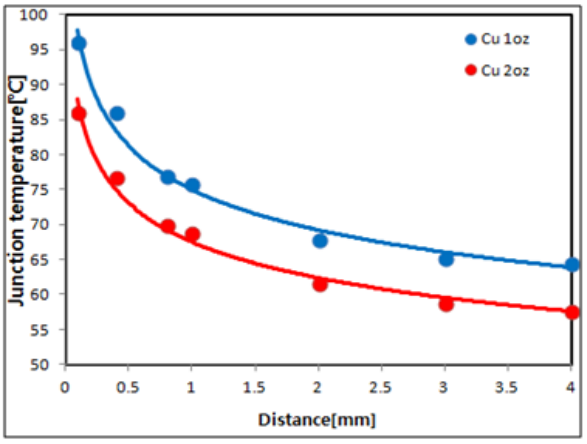

Figure 10. Thermal simulation results depend on NewGens distance.

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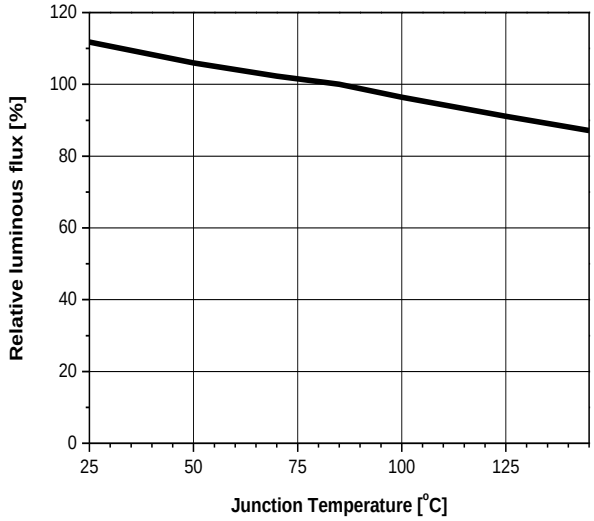
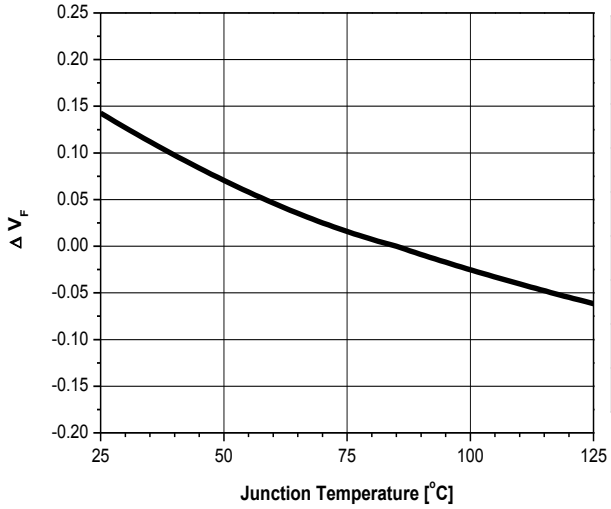
6. NewGen Characteristics Graph (Z8Y19)

◆ Junction Temperature vs. Relative Luminous Output , Current = 700mA



Response: Flux vs Temperature	
Temperature	Relative Flux
25	111.8
50	106.0
70	102.3
85	100
100	96.4
125	91.1
145	87.1

◆ Junction Temperature vs. Relative Forward Voltage , Current = 700mA



Response: VF vs Temperature	
Temperature	Relative Voltage
25	0.14
50	0.06
70	0.02
85	0
100	-0.03
125	-0.06
145	-0.09

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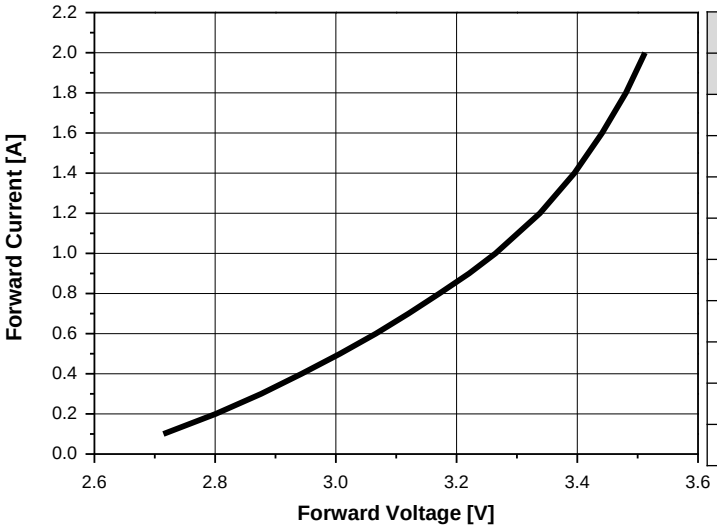
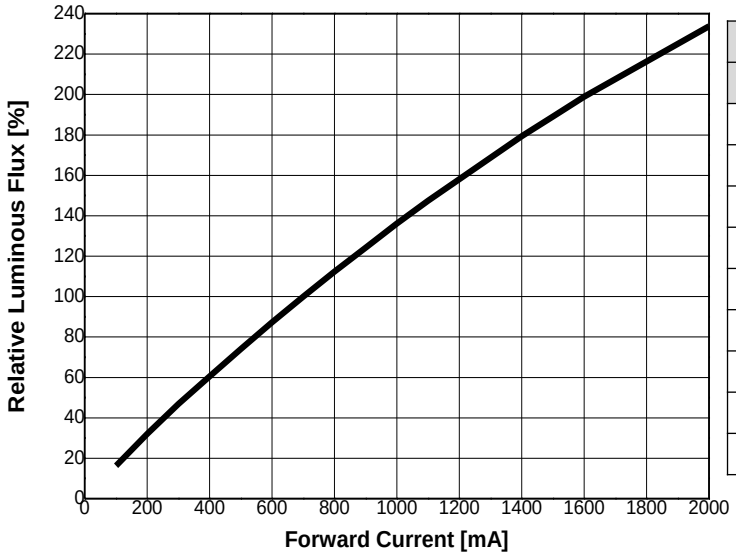
◆ Forward Current vs. Forward Voltage , TJ = 85℃



Response: Voltage vs Current	
Voltage	Current [mA]
2.7142	100
2.8764	300
3.0069	500
3.1204	700
3.2643	1000
3.3954	1400
3.4413	1600
3.4804	1800
3.5122	2000

◆ Forward Current vs. Relative Luminous Flux , TJ = 85℃



Response: Flux vs Current	
Current [mA]	Relative Flux
100	16.2
300	46.9
500	74.1
700	100
1000	136.1
1400	179.4
1600	198.9
1800	216.3
2000	233.7

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Company Information

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Company Information

Seoul Semiconductor (www.SeoulSemicon.com) manufacturers and packages a wide selection of light emitting diodes (LEDs) for the automotive, general illumination/lighting, Home appliance, signage and back lighting markets. The company is the world's fifth largest LED supplier, holding more than 10,000 patents globally, while offering a wide range of LED technology and production capacity in areas such as "nPola", "Acrich", the world's first commercially produced AC LED, and "Acrich MJT - Multi-Junction Technology" a proprietary family of high-voltage LEDs.

The company's broad product portfolio includes a wide array of package and device choices such as Acrich and Acirch2, high-brightness LEDs, mid-power LEDs, side-view LEDs, and through-hole type LEDs as well as custom modules, displays, and sensors.

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