대외비

CSP APPLICATION NOTE

Chip Scale PKGs For Lighting

CSP Application Note
Ver. 2.9 Release Date : 05-Oct-18
Ver. 2.91 Release Date : 02-May-19
Ver. 2.92 Release Date : 28-Jun-19
Ver. 3.0 Release Date : 15-Jul-19
Ver. 3.1 Release Date : 28-Feb-20
Ver. 3.2 Release Date : 08-May-20
Ver. 3.3 Release Date : 06-May-22
Ver. 3.4 Release Date : 21-Sep-22

SAMSUNG

대외비

Index

General

Model	LM101B	LH151B	LH181B	LH231B
Shape				
Remark	1chip 3V Typ 150mA Max 350mA Size 1.70mm	1chip 3V Typ 350mA Max 700mA Size 1.70mm	1chip 3V Typ 350mA Max 1.4A Size 2.36mm	1chip 3V Typ 700mA Max 2.0A Size 2.80mm

Application

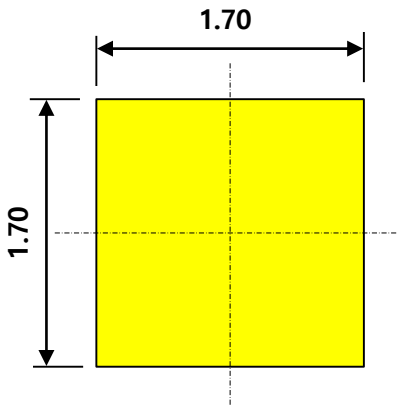
	LM101B	LH151B	LH181B	LH231B
Ambient	○			
Ceiling	○			
Bulbs	○	○		
Down light	○	○	○	○
Spot light	○	○	○	○
MR/PAR		○	○	○
High bay			○	○
Low bay		○	○	○

1.1 Package Dimension

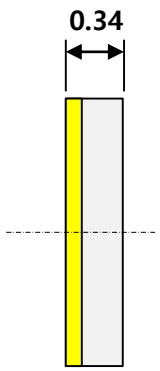
LM101B Chip Scale Package

Dimension

<Top View>



<Side View>



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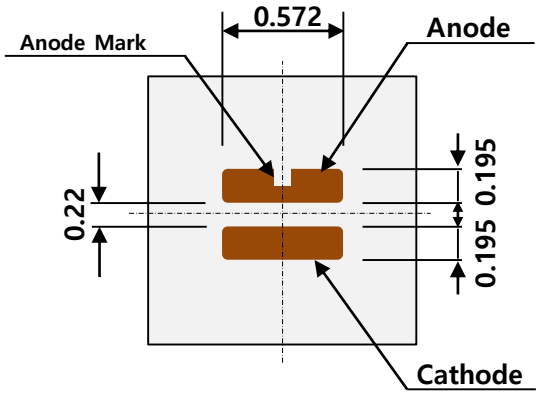
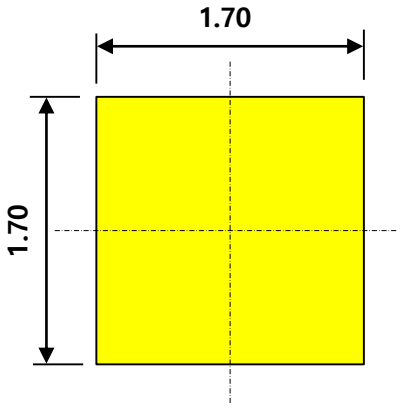


1.1 Package Dimension

LH151B Chip Scale Package

Dimension

<Top View>



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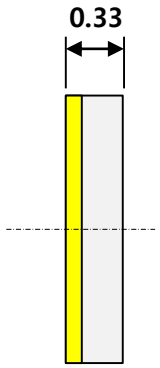

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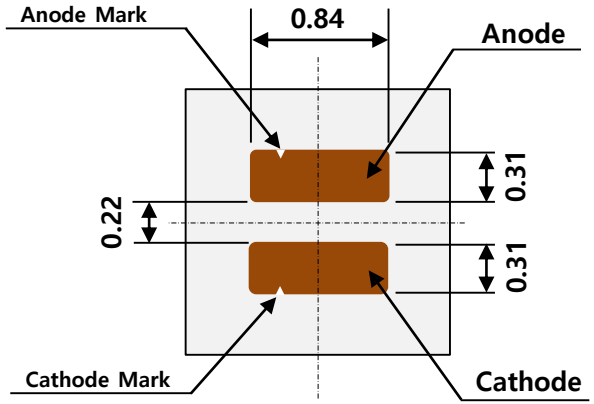

1.1 Package Dimension

LH181B Chip Scale Package

Dimension

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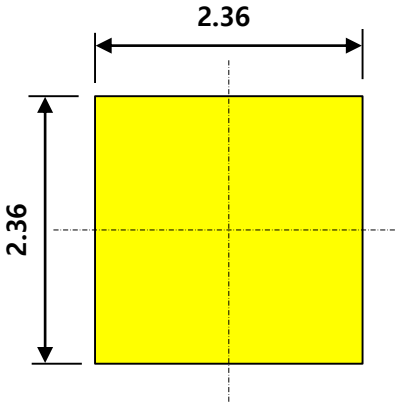

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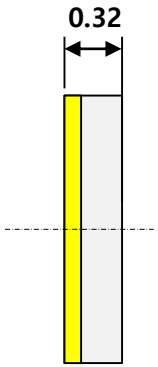

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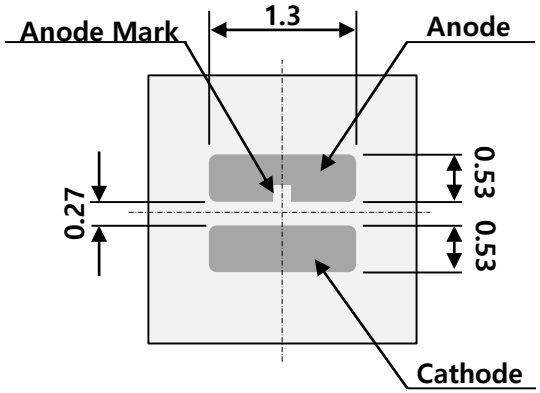

1.1 Package Dimension

LH231B Chip Scale Package

Dimension

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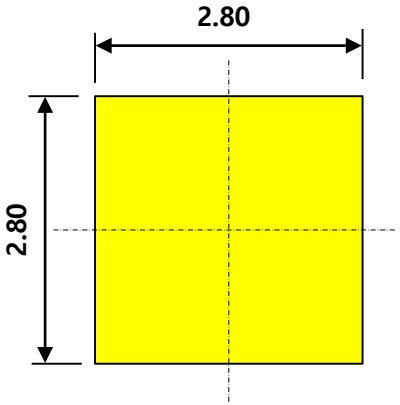

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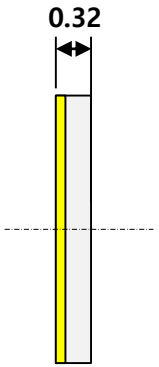
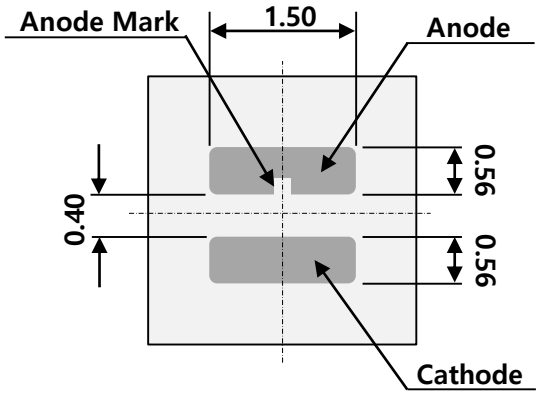


<Bottom View>



1.2 Handling Guide

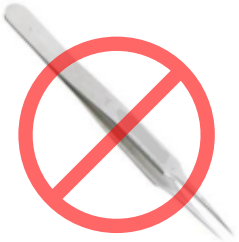
■ Handling Guide

- At LES for Phosphor side is restricted to unusual direct-touch or strong external force

▶ Tools

Vacuum tweezer

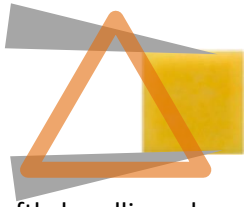
White Ceramic tweezer



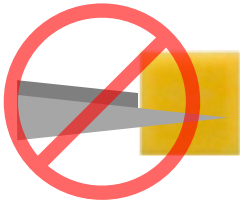
Normal tweezer

▶ Pick-up

Use vacuum tweezer case
(have to keep clean vacuum pad side)

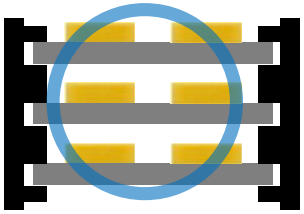


Softly handling when use
white Ceramic tweezer



DO NOT allow @ LES side

▶ Handling



Keep PCB distance for
prevent Phosphor crack

DO NOT allow stacking

DO NOT allow finger touch
or Sharpen/Hard Object

※ Horizontally and Vertically direct force might cause fatal damage during manufacturing process of luminaire.

■ Handling Guide (Document)

▪ Environment of Working place

The working area for assembly luminaire is recommended to be maintained clean for preventing any contamination and keeping workers' safety. If all working area cannot be maintained clean, at least the space for assembly have to be kept clean and lower humidity in air.

▪ Handling PKGs

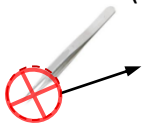
① Users have not to touch the lighting emitting surface(LES) in any cases.

At LES (Lighting Emitting Surface), for CSP phosphor film is restricted to unusual direct-touch or strong external force. This may lead to the deformation or film damage.

② When handling with tweezers user have to grip the thermo plastic(white mold).

③ Users have to wear the anti-static gloves or anti-static wrist band.

④ When handling CSP, user have to use the anti-static tweezers. Especially, CSP is strongly recommended to use a vacuum pick-up & place utensils. (Especially, a sharpened-tip of the tweezers would have high possibility of giving a physical defect to CSP)



The sharp tip may physically damage the resin of Phosphor Resin or wall.

⑤ When switching on CSP with an electrical power supplier, an unexpected or abrupt current should bring about EOS failure in CSP. This may also bring about the failure in use or the decrease of life time of products. Please discharge the stored voltage of the power supplier.

▪ Prevent ESD

It might be required to use MLCCs, TVS or Zener diodes in order to prevent ESD failures in LED module or luminaire.

Those protection components should be considered and selected depending on the forward voltage of LED module, environment or additional requirements. (ex. Able to use 10uF 50V MLCC for 24V LED module. Regarding PWM dimming, recommend TVS or other diodes rather than MLCC due to acoustic noise.)

■ Handling Guide (Document)

▪ Chemical compatibility

During manufacturing luminaire, the many chemicals could attack and contaminate PKGs. It is necessary to avoid the contaminants and chemicals in manufacturing process and operation. And we are providing the guideline for chemicals and relevant failure mode. (Refer to chemical guideline).

▪ Contamination and cleaning

In the production process of luminaire, pkgs can be contaminated by an unexpected contaminant. The organic material like as solder flux have to be cleaned out by using the tip of cotton swap soaked isopropyl alcohol(IPA).

When a product are stored in any space the product needs not to be directly contact with ambient air or any packing paper boxes. Some packing materials could lead to give in harmful gases to normal operation of pkgs.

▪ Storage

If the LEDs are to be stored for 3 months or more after being shipped from Samsung Electronics, they should be packed by a sealed container with nitrogen gas. (Shelf life of sealed bags: 12 months, temp. ~40 ℃, ~90 %RH)

CSP have a JEDEC level of 2a. User have to handle CSP by below following guide line, which is based on the JEDEC Moisture Sensitivity Level.

- After sealed bag is to be opened and , CSP, will be surface-mounted on the board, have to be followed the below guide.

  a. CSP should be mounted within 672 hours(28 days) at an assembly line with a condition of no more than 30℃/60%RH

  b. CSP should be stored at <10 %RH

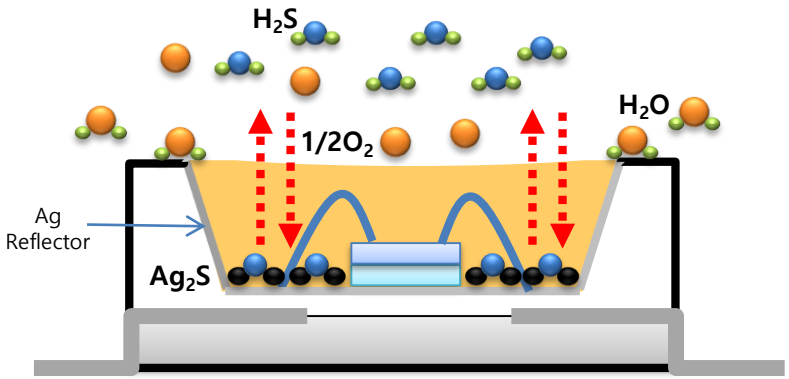
- After mounting, the residual or extra CSP is recommended to be repack in a gas sealed bag.

- If moisture sensitivity indicator is >60 % at 23±5℃ the recovery work should be carried out at the proper condition. In that case, CSP should be baked at 60±5 ℃

■ Sulfurization of CSP (vs L/F type PKG)

CSP is free from sulfurization. CSP has no root causes(Ag) of discoloration by sulfur

■ L/F PKG

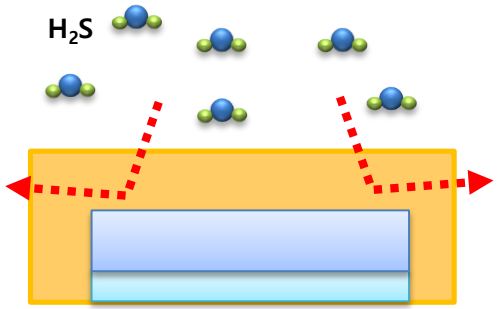


$$2Ag + H_2S + 1/2O_2 \rightarrow Ag_2S + H_2O$$

※ Ag_2S : Dark color → Root of discoloration

L/F type PKGs are coated by silver as a reflector. However, if sulfur gas comes from outside, it will be turned by reaction with silver and sulfur combination.

■ CSP



NO Ag → NO Sulfurization

■ Sulfurization Test Result & Recommendation

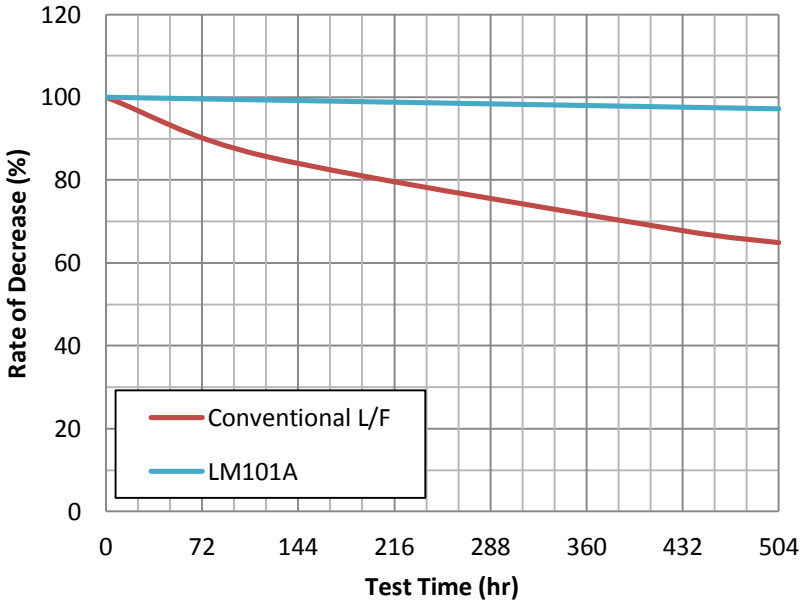
■ Sulfurization Test

• **Test Condition**

- H2S 15ppm, 25℃/75%, 504h

(IEC Pub. 68-2-43 : Hydrogen Sulfied Test of Electric Part)

• **Test Result**

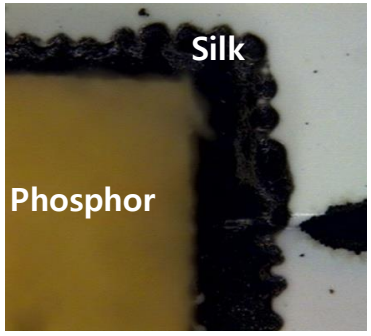


■ Recommendation

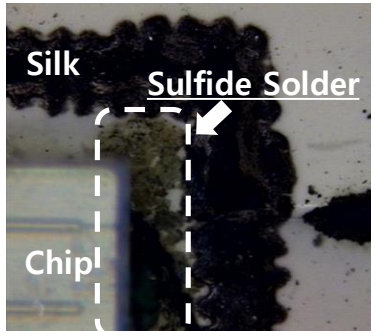
- It is need to minimize the material which is easy to react with sulfur such as solder, Cu, Ag and etc.

Unexpected surfurized material could be occurred during reaction with above material.

In that case, even luminance flux level of CSP is not changed, but flux of module level could be drop down just like below example.



[Before detach phosphor layer]



[After detach phosphor layer]

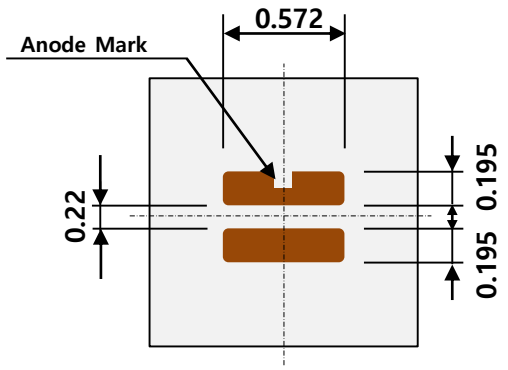
※*This test exceeds far worse than the actual use conditions. Please treat this data as the reference.*

2.1 Soldering Condition

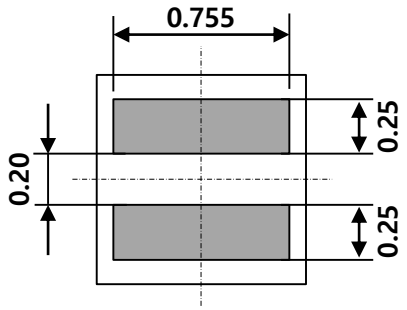
■ Recommended Land Pattern

LM101B

PKG PAD

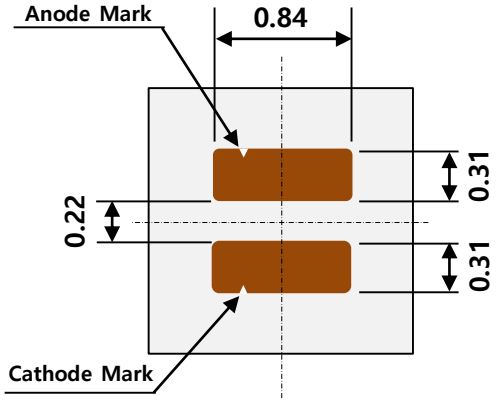


PCB Land

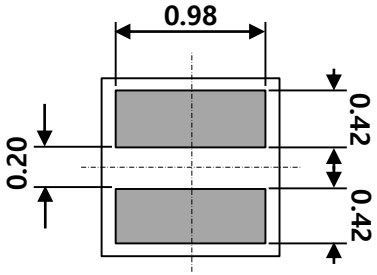


LH151B

PKG PAD

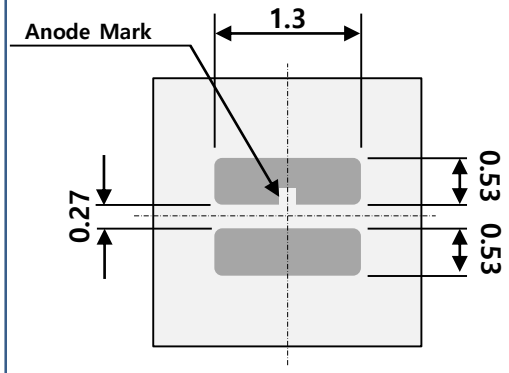


PCB Land

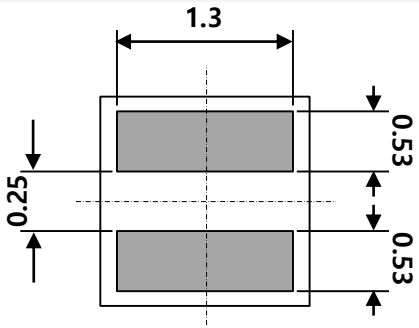


LH181B

PKG PAD



PCB Land

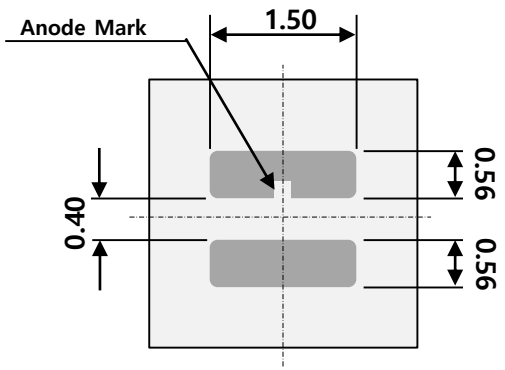


2.1 Soldering Condition

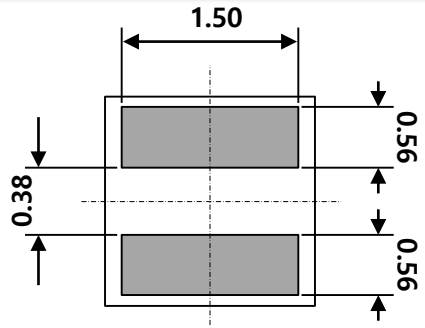
■ Recommended Land Pattern

LH231B

PKG PAD



PCB Land



2.1 Soldering Condition

■ Screen Printing

- **Solder Printing** : check accurate position, shape, amount of solder paste.
- **Solder Paste Storage**: Should be stored in refrigerator. We can re-use if solder paste store within 24 hour after using at room temperature. In accordance with the relevant regulations it should be used as the correct process.
- **Squeegees** : Should be keep clean after using the squeegee for maintain flatness of squeegee. After usage of over 20,000 times, it should be replaced by new one.

Process control item (Process setting condition)		Unit	Specification	Spec. range		
				LSL	Target	USL
Solder stir	Hours	sec	60	-	60	-
	Speed	rpm	1000	-	1000	-
Solder standing time @ room temperature		Hr	2	2	-	12
Solder Lifetime	After opening	Hr	within 24 hours	Use within 24 hours		
Printer status		-	Volume 70 - 150	SPI spec.		
Squeegee	Presure	kgf/㎠	3	3	4	5
	Speed	mm/sec	40	30	60	90
Snap-Off	Distance	Mm	3	-	3	-
	Speed	mm/sec	1	0.8	1	1.5
Print temperature		℃	24	20	24	28
Mask Auto-cleaning		time/Board	3	-	3	-
Mask Manual cleaning		time/Board	15	-	15	-
MASK Lifetime	# of time	# time	30,000	-	30,000	
	tension	mm	0.5	0.4	-	0.7

※ Reference Equipment : ESE US-8500X

※ Please refer just as a reference

2.1 Soldering Condition

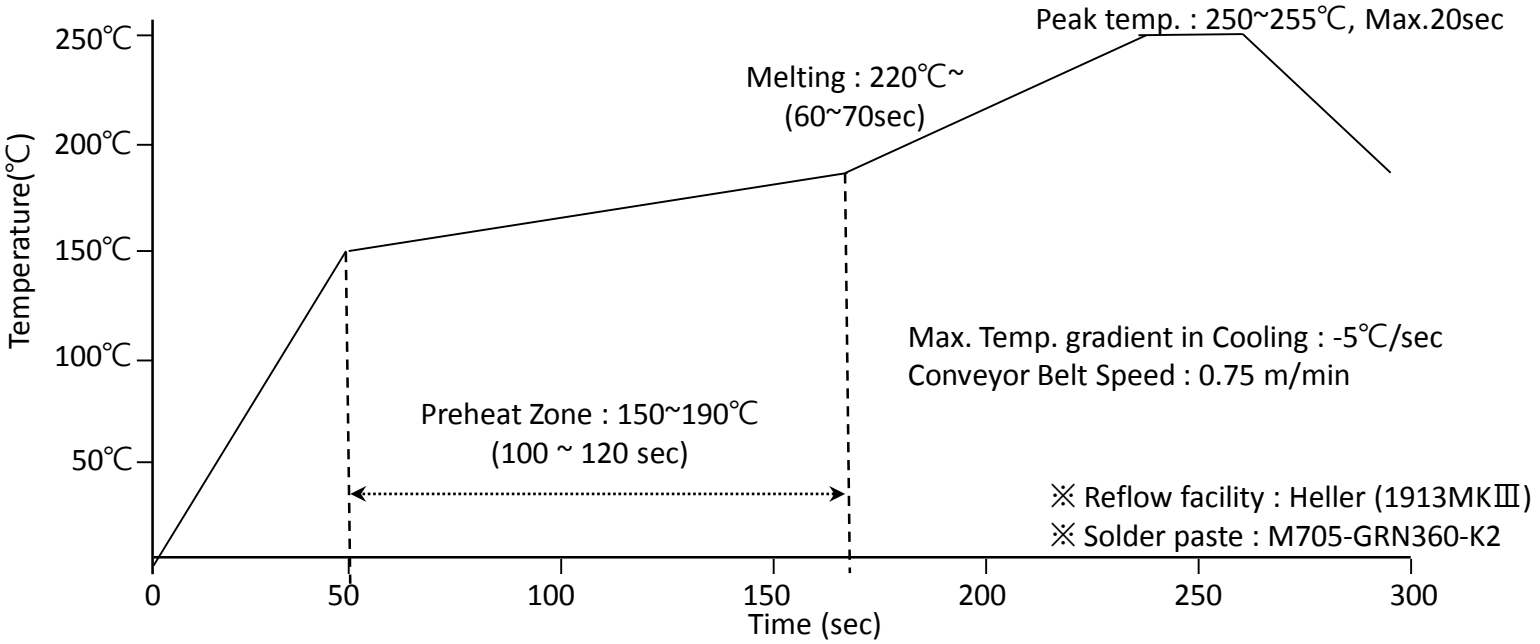
■ Solder Paste Recommendation

- Solder : M705-GRN360-K2 (IV-Type)
- Low voiding paste
- Paste type recommendations : Pb free, No clean, No water soluble

2.1 Soldering Condition

■ Reflow Profile Setting for LM101B/LH151B/LH181B/LH231B

Recommends X-ray monitoring to ensure good solderability and less void



Zone	Temperature (℃)	Time(sec)
Preheat	150~190	100 ~ 120
Reflow	220 ↑	60 ~ 70
Peak	250~255	

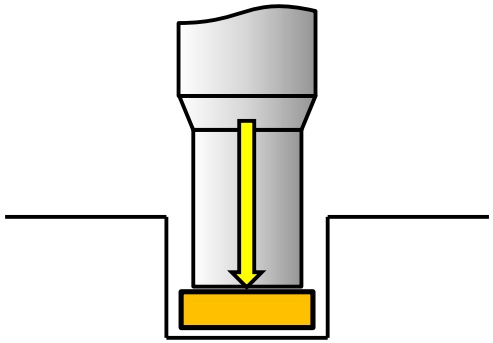
※ Useful SMT recommendation

After sealed bag is to be opened, CSP Strongly be recommended for Proper Treatment.
(Treatment condition : room temperature(25℃), 45%RH~, 24h~)

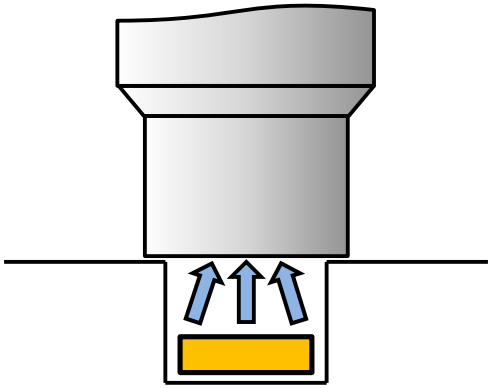
2.2 Pick & Place

■ Pick up method

- **When pick-up & place the package, recommended that use the Insertion type pick-up nozzle. Because CSP Package is very small and light weight, hovering type nozzle is inappropriate.**
- **Insertion Type** : Touch the package surface and the pressure is applied to the surface accordingly.
- **Hovering Type** : Apply vacuuming stress to the package surface.



[Insertion Type]



[Hovering Type]

■ Vacuuming power

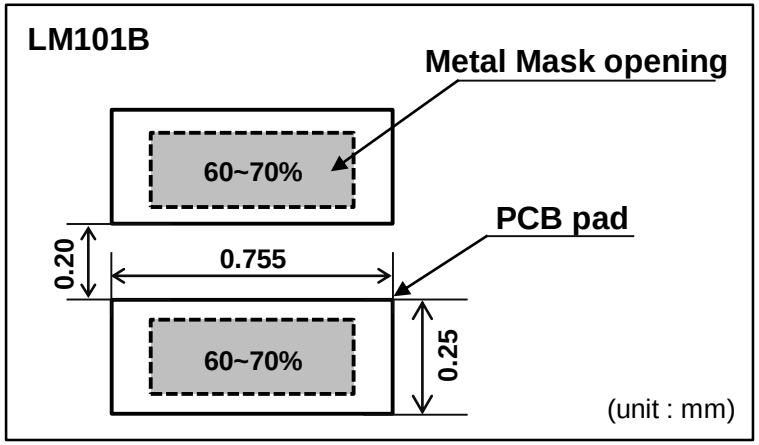
- **Depending on machine, package shape and condition. In general case, -450 ~ -650 mmhg vacuuming power is recommended.**

■ SMT Process – Metal Mask Design

❑ Metal Mask Design Recommendation

Recommended thickness / opening

- **Metal Mask Thickness : 0.08mm**
- **Metal Mask Opening : Around 60~70% opening area of electrode area**



※ *Please refer just as a reference*

❑ Nozzle Design

- Recommends nozzles those are constructed of **non-metallic materials** to prevent damage on LED components.
- Nozzle pressure : **1N**

※ We specially recommend the PTFE(Polytetrafluoroethylene).

<non-metallic nozzle>

The characteristics of PTFE (Teflon)

1) Non-sticking
2) High heat resistance
3) Non-wetting
4) Low coefficient of friction
5) Chemical resistance
6) Unique electrical properties

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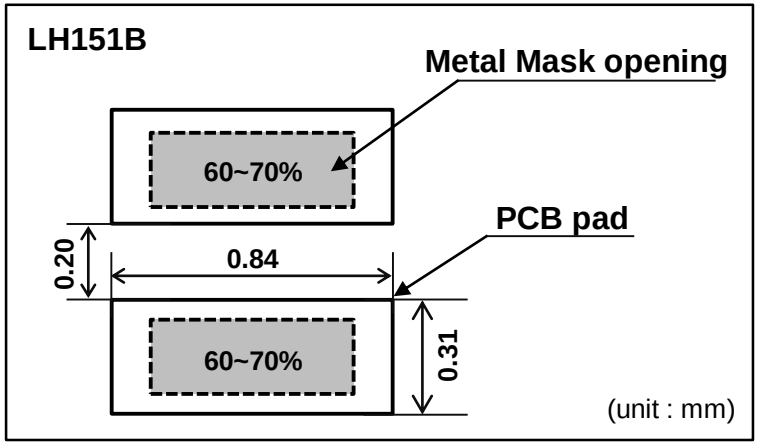

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■ SMT Process – Metal Mask Design

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- **Metal Mask Thickness : 0.08mm**
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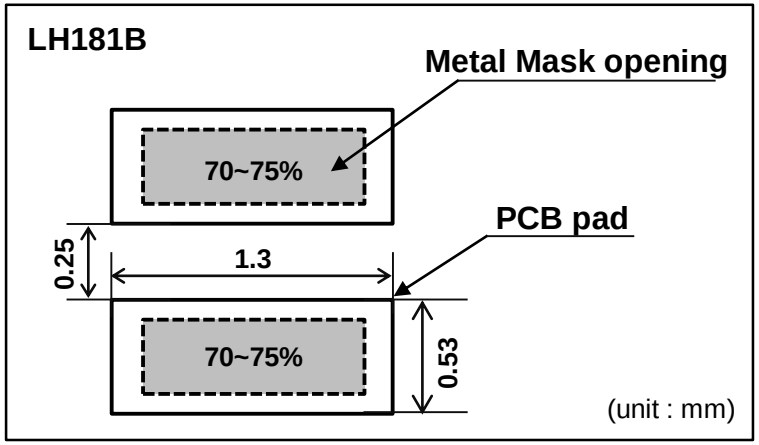

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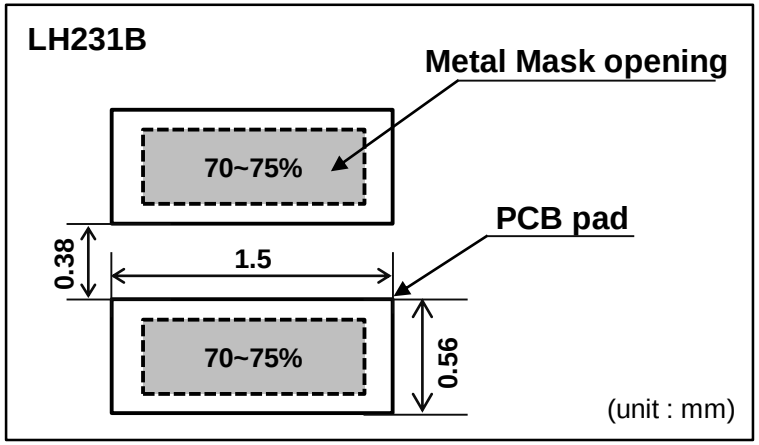
Recommended thickness / opening

- **Metal Mask Thickness : 0.08mm**
- **Metal Mask Opening : Around 70~75% opening area of electrode area**



※ *Please refer just as a reference*

❑ Nozzle Design

- Recommends nozzles those are constructed of **non-metallic materials** to prevent damage on LED components.
- Nozzle pressure : **1N**

※ We specially recommend the PTFE(Polytetrafluoroethylene).

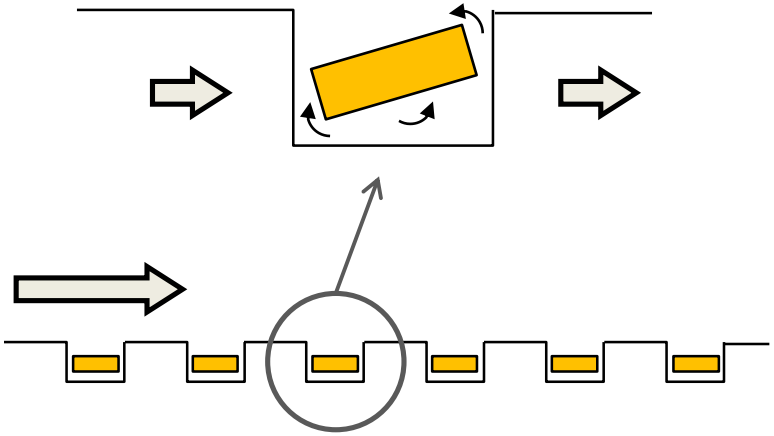
<non-metallic nozzle>

The characteristics of PTFE (Teflon)

1) Non-sticking
2) High heat resistance
3) Non-wetting
4) Low coefficient of friction
5) Chemical resistance
6) Unique electrical properties

Selection of Feeder

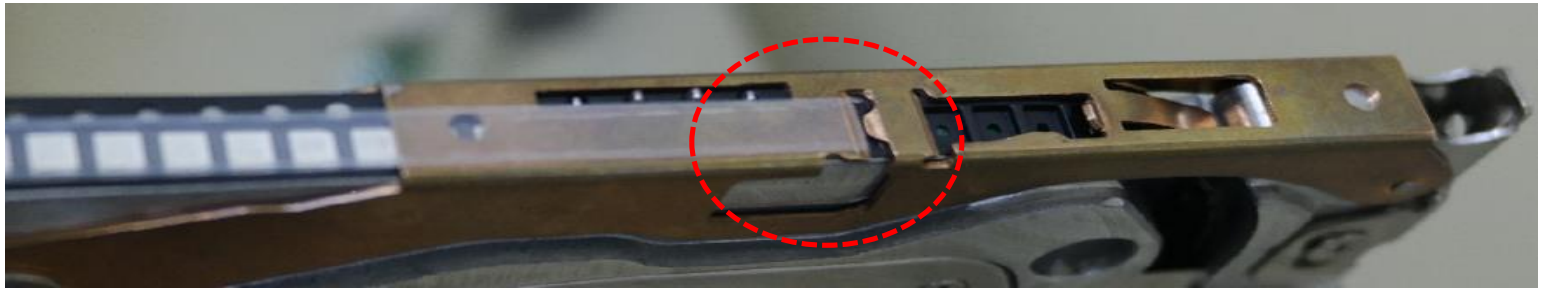
Samsung recommends Electrical Feeder for small LED such as CSP.
Abnormal placement such as tilt could be occurred in reel pocket when mechanical feeder is used. Generally control of feeding speed is not available for mechanical feeder, but electrical feeder might be able to control speed of feeder.
Normal speed mode is recommended for Samsung CSP.



■ Peeling Point of Cover Tape

Samsung recommends Peeling off at ahead of pick-up place.
Peeling off at far from pick-up place may occur out of CSP center position in real pocket.

Ahead of pick-up place



Far from pick-up place

■ Checking Item for LED Mounting Performance

	Check item	Suspected Cause of Failure
1	Crack or Damage	Check mounting height and pressure whether it is too much high value or not.
2	Emission failure	Insufficient amount of solder may occur open failure. Otherwise excessive amount of solder may occur short failure.
3	Solder balls	Solder balls can be generated by excessive amount of solder.
4	Solder fillet	Check solder pattern of screen printing is same with mask pattern.
5	Solder bridges	Excessive amount of solder may generate Solder bridges.
6	Solder void	Check wettability of solder paste and condition of screen printing.
7	LED positioning, rotation	Check mounting height and pressure whether it is too much high value or not. Check inspection feature between LED lead and vision feature.
8	Shearforce	Check wetting level, insufficient amount of solder.
9	Tilt with slope	Check wetting level, insufficient amount of solder.
10	Pad-LED alignment	Check inspection of vision and center coordinate both of Pad and LED. Check center position of picking is same with LED's one.

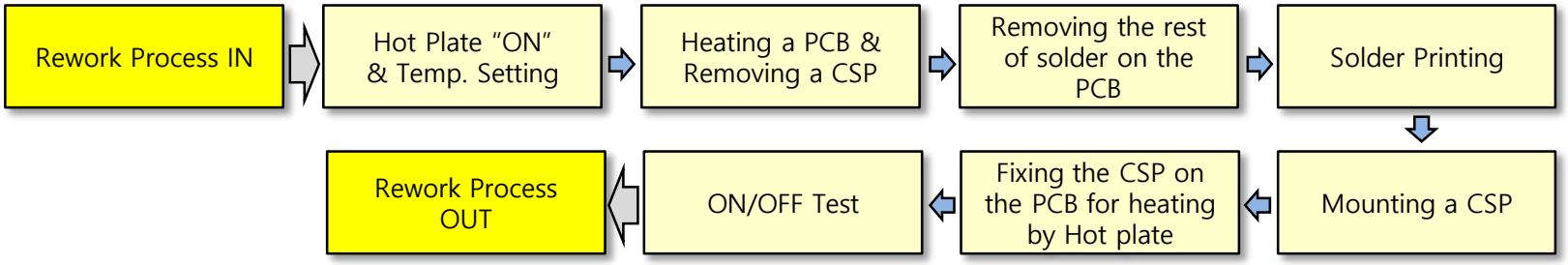
2.3 Pick & Place Test

■ Pick & Place Test by SMT Makers

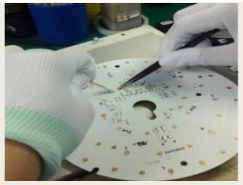
Maker	SIEMENS	SAMSUNG TECHWIN	YAMAHA
P/N	X2	SM410	YV100XG
Machine appearance			
Tested nozzle	Outer 1.3Φ Inner 0.8Φ	Outer 1.2Φ Inner 0.65Φ	Outer 1.2Φ Inner 0.8Φ
Mounting load	-	-	2N (max)
Machine accuracy	-	-	±0.05mm
Test Result	OK (1008/1008pcs)	OK (1512/1512pcs)	OK (1512/1512pcs)

2.4 Rework Process

PKG Rework Process

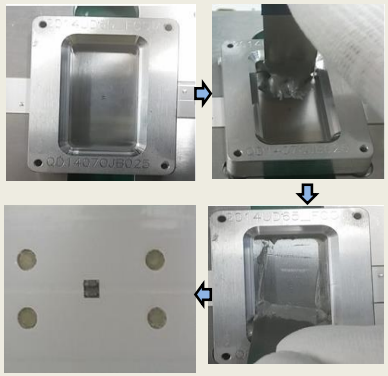
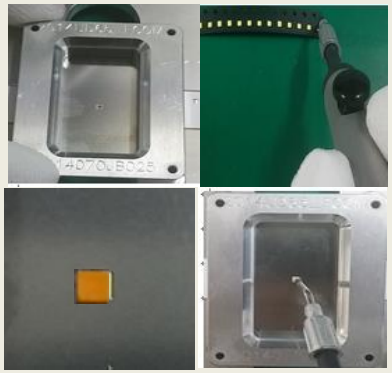


PKG Rework Process Detail

STEP	1. Temp. Setting	2. Heating a PCB/ Removing a CSP	3. Remove the solder residue
process			
Method	- Hot plate "On" - Temp. setting	- Heating a PCB - Removing a CSP by tweezers	- Remove the solder with the cotton swab after removing CSP - PCB cooling after the removal
Condition /Spec.	- Temp : 255℃	- Time : 10sec (Max.) (PCB should be no deformations such as bend, burn out, etc.)	- Be careful so that PSR doesn`t may be removed

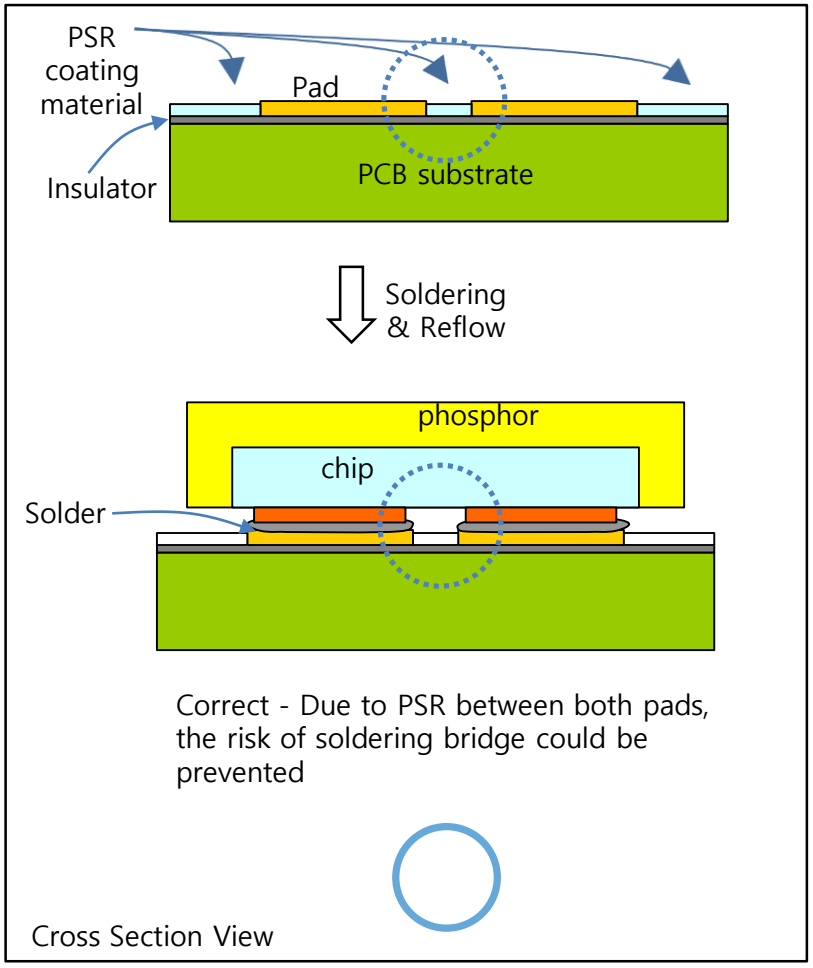
2.4 Rework Process

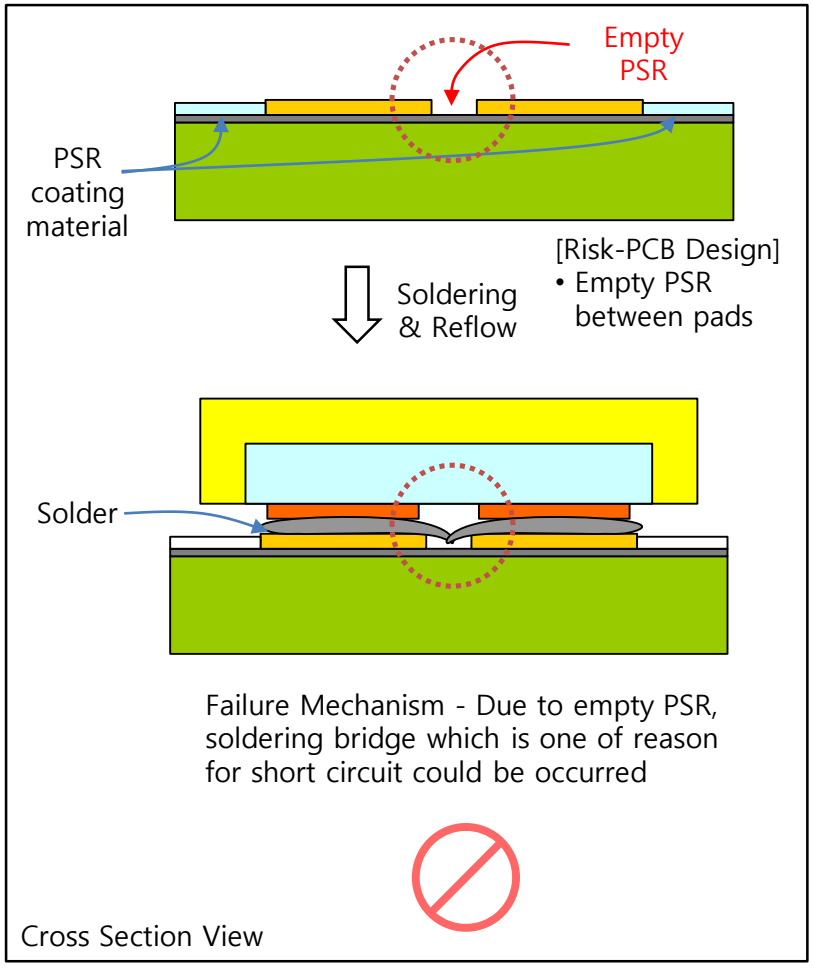
■ PKG Rework Process Detail (Cont'd)

STEP	4. Solder printing individually	5. Attaching a CSP	6. Solder cure	7. on/off test
process				
Method	- Printing the solder individually by single metal mask	- Attach a CSP By using vacuum tweezers		- Input DC currents in each TP
Condition /Spec.		- Replace it with the same rank PKG - Be careful so that CSP should not be rotated or tilted on the PCB - Check the direction of electrode (+,-)	- Temp. setting : 255℃ - Heating time : 10~15sec	

Recommend design for preventing soldering bridge

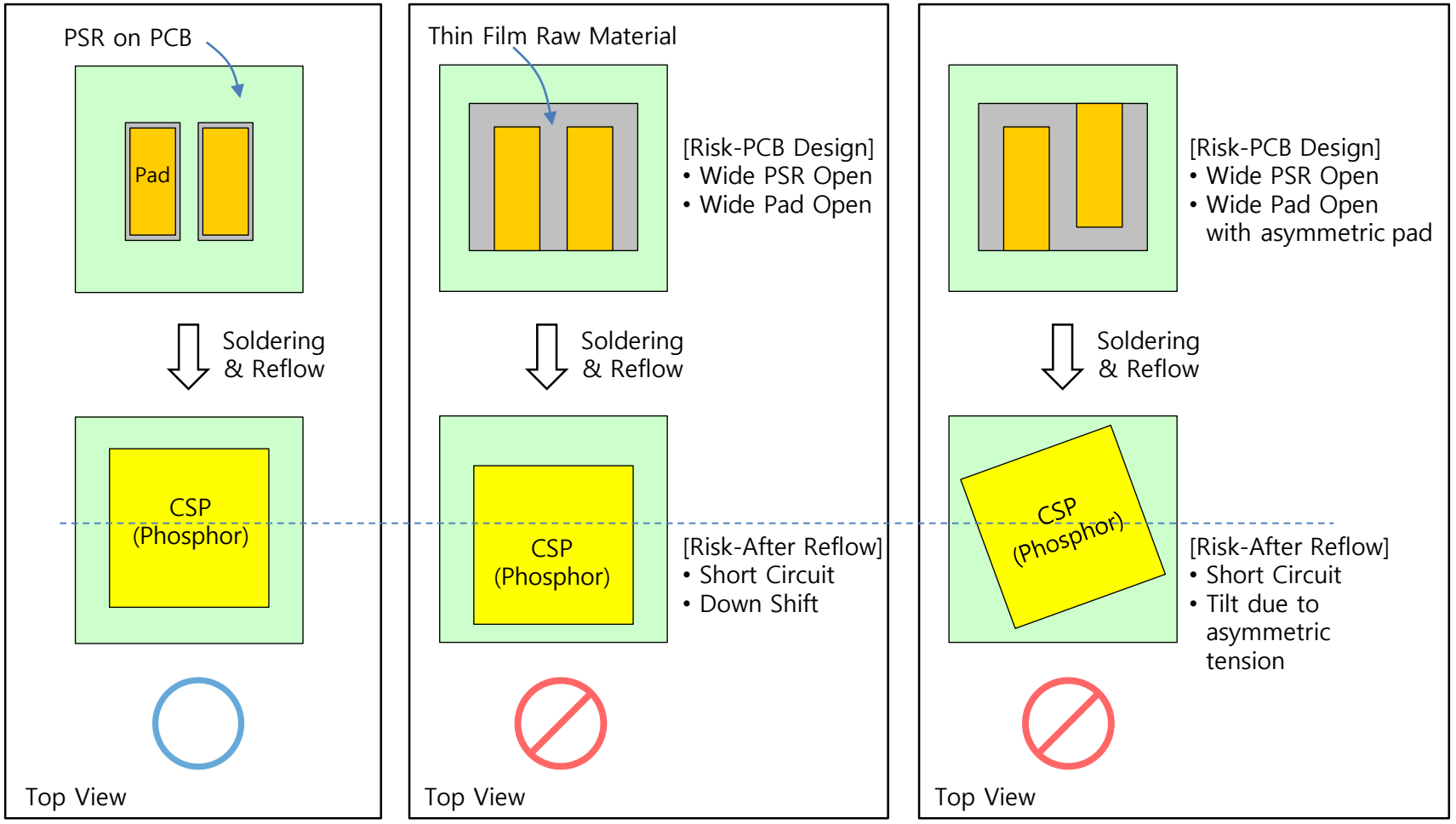
If PSR material doesn't coating on PCB between anode and cathode, short circuit failure could be happened. PSR material coated between both pads usually help to prevent the possibility of solder adhesion (soldering bridge) during reflow.





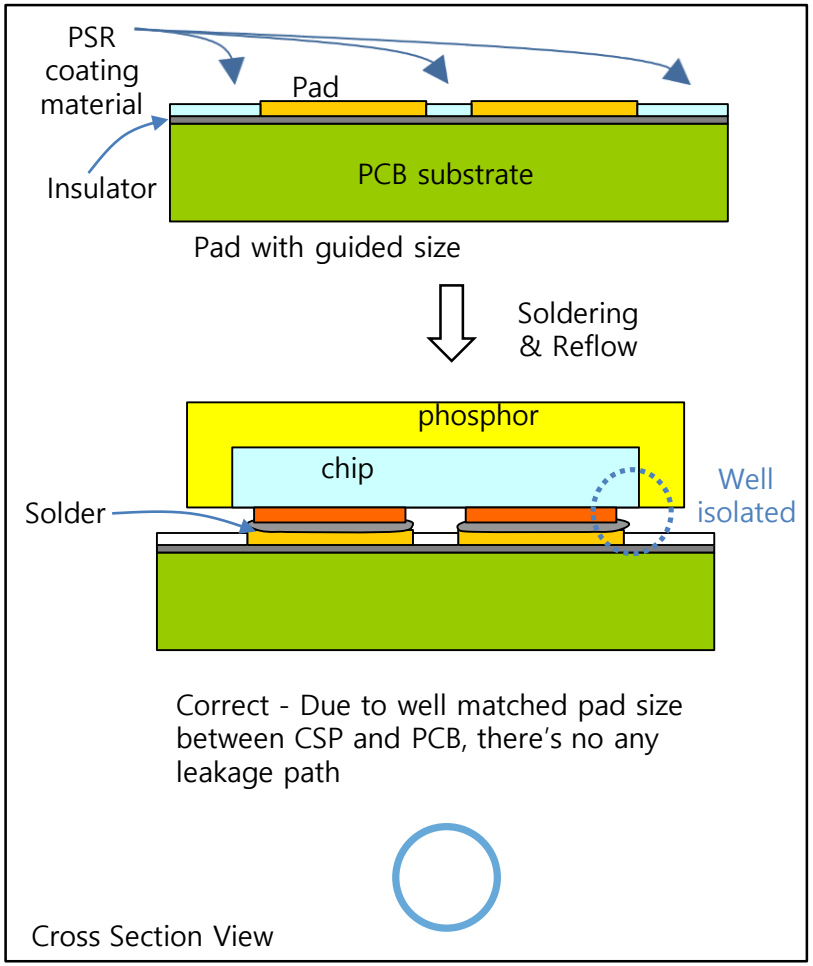
Recommend design for preventing location shift and tilt

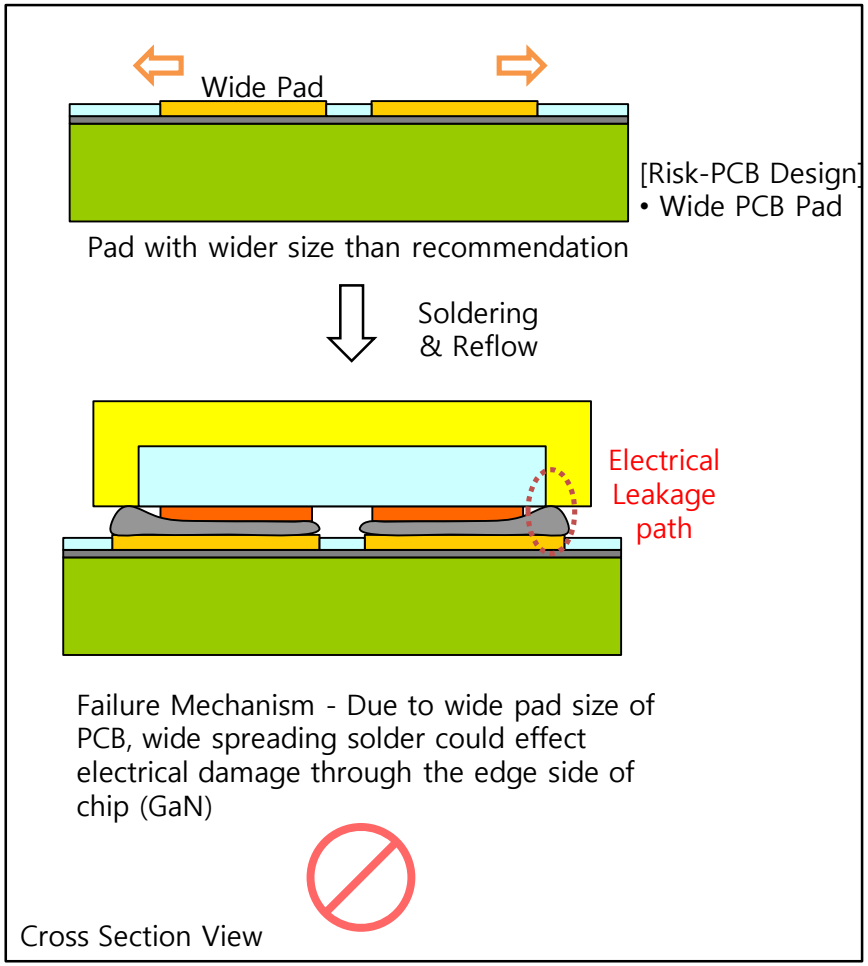
Opening PSR material of flexible PCB usually becomes the reason for short circuit which comes from soldering bridge and for mounting shift (Irregular-alignment, tilt, etc,.)



Recommend design for preventing electrical damage from outside

Normally to reduce thermal resistance against insulator within PCB, copper pad were designed to have more wide size for fast spreading heat dissipation. But without PSR coating material, solder could effect electrical damage to LED through the edge side of chip. This could cause result to short circuit failure especially when ceramic PCB design.

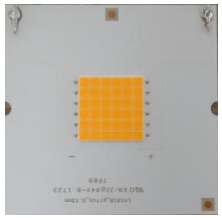
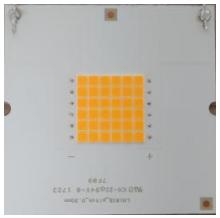
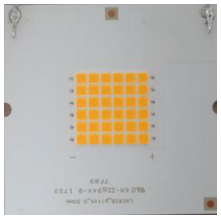
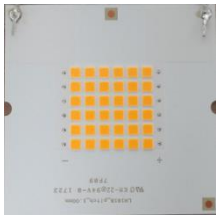
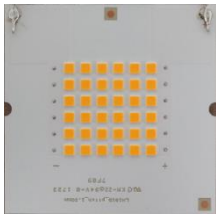
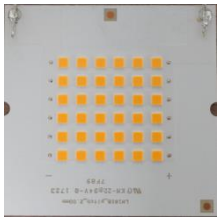
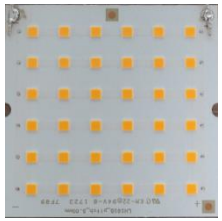




3.1 High Density Mounting (LH181B/LH231B)

■ Test Condition

- Test Board : Al-PCB (1oz , 1.0t , 40mm X 40mm)
- LED array : 6 parallel X 6 series
- Measurement condition : Ta 25℃ , Input current 2100mA (350mA/LED)
- Assume that same level(ΔCCT & Δ%Lm) above 5mm pitch range

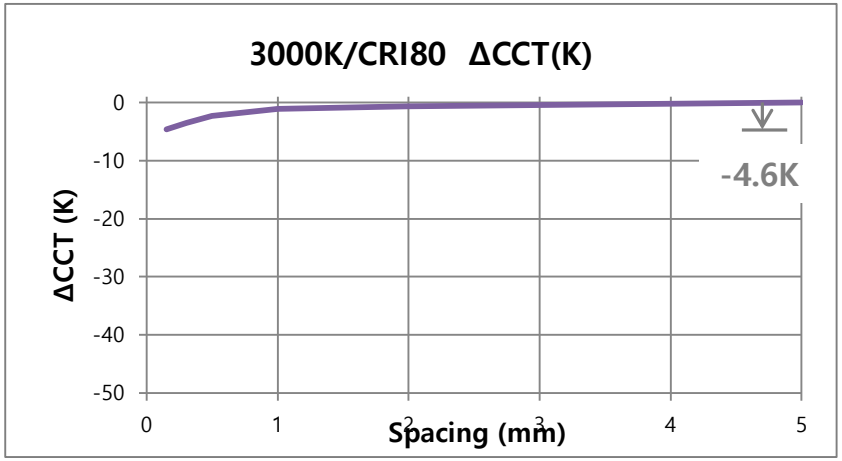
Spacing		0.15mm	0.30mm	0.50mm	1.00mm	1.50mm	2.00mm	5.00mm
CCT	Item							
3000K CRI 80	△ flux (%)	98.6%	99.0%	99.2%	99.4%	99.9%	100.0%	100.0%
	△ CCT (K)	-4.6	-3.5	-2.3	-1.1	-0.8	-0.6	0
5000K CRI 80	△ flux (%)	98.2%	98.4%	98.4%	99.0%	99.5%	100.0%	100.0%
	△ CCT (K)	-25.9	-23.7	-21.8	-14	-8.4	-6.8	0

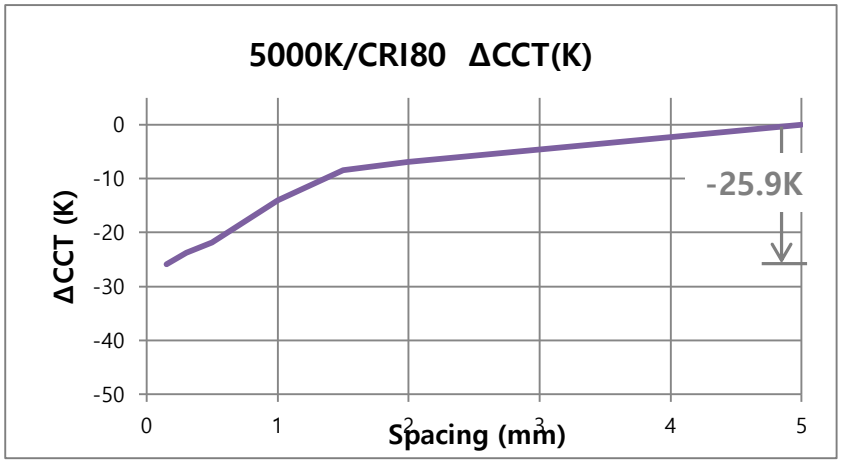
3.1 High Density Mounting (LH181B/LH231B)

■ Color and Flux Characteristics

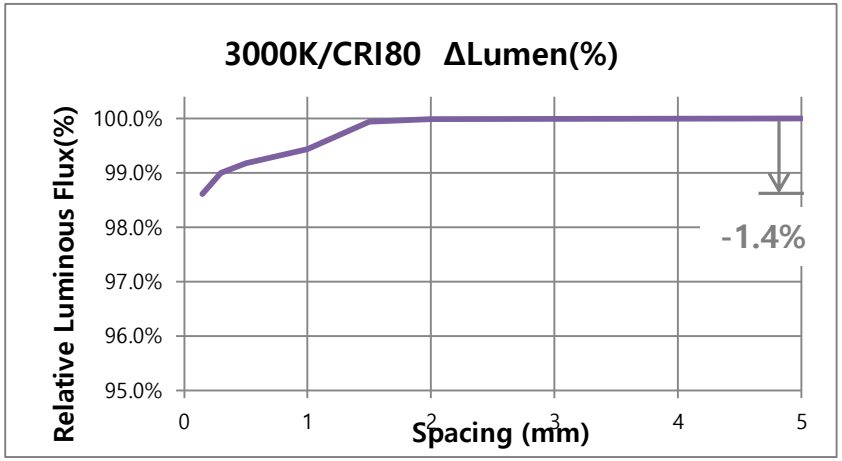
- When closer FEC CSPs, occur CCT and Luminous flux shift a bit down.

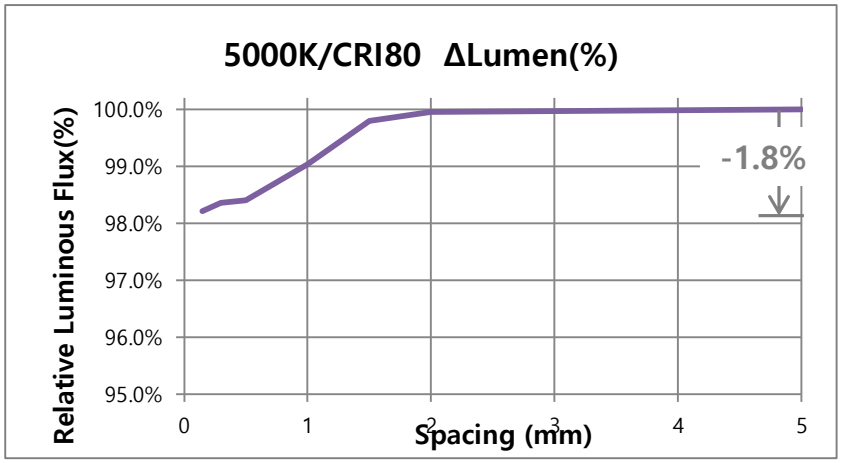
❑ ΔCCT result





❑ Relative Luminous flux result

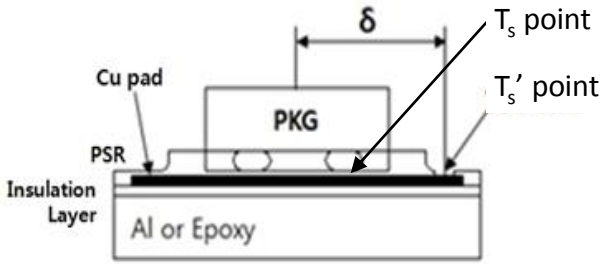




4.1 Thermal Test Point

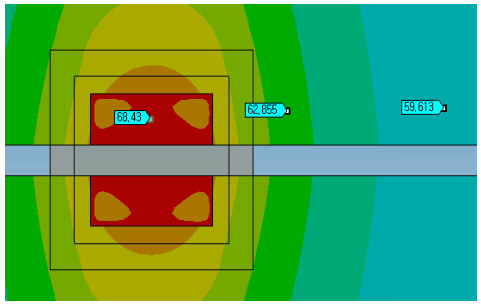
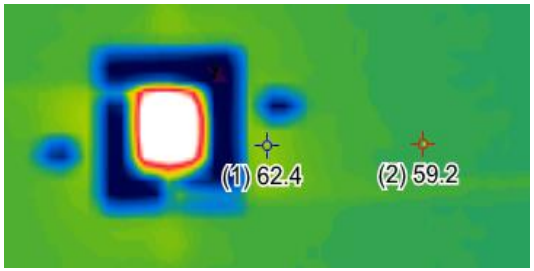
■ Ts Point Define

- T_j is estimated by
  : T_j = **Power x** $R_{th,j\text{-}s}$ + T_s = **Power x** $R_{th,j\text{-}s}$ + T_s' + α



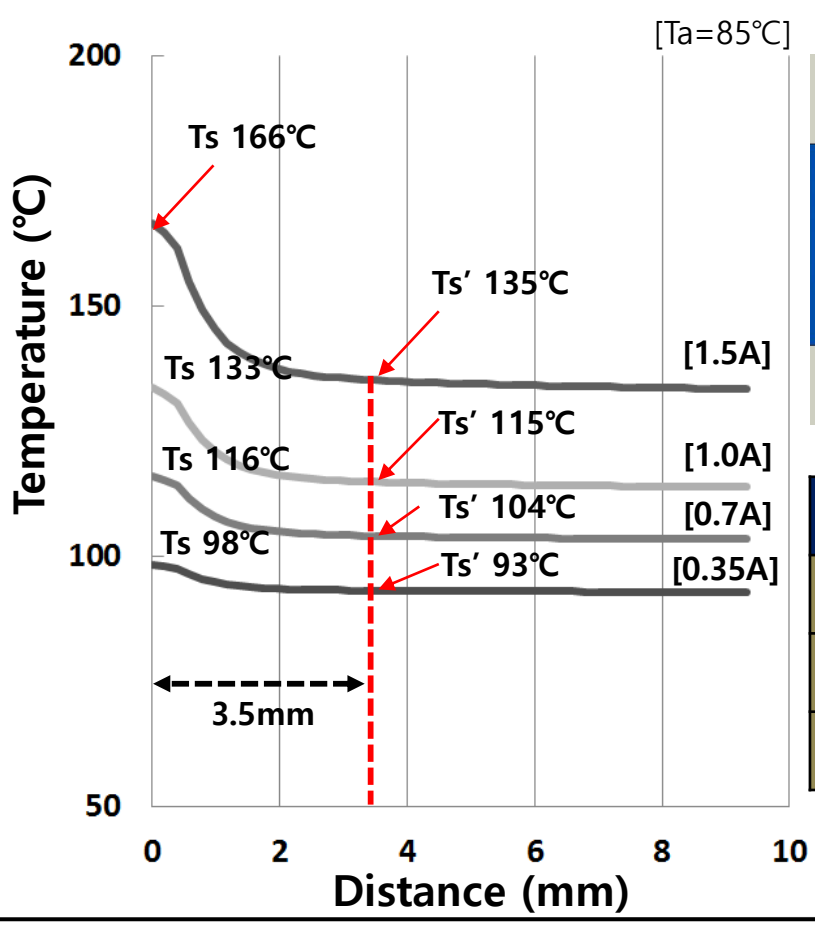
- **Ts** should be measured on the closed distance since CSP has no extra area surrounding it in order to contact a thermocouple.
- Tj may lead to a difference(α) depending on the measuring distance, PCB design, and the power consumption, etc. For When recommend a distance of 3.5mm from the chip center to the Ts' measurement point. This is 2~3mm from the CSP edge. There may be a temperature difference(α) of 5~10℃ at 350mA operating condition.

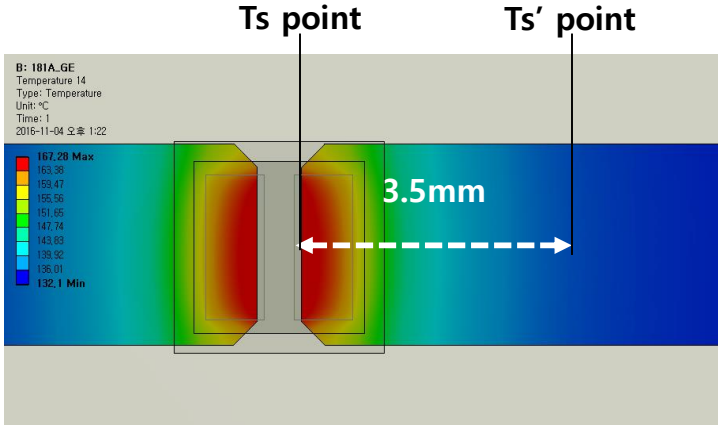
※ Measurement as well as calculation are carried out to investigate the effect of measuring distance.

Calculation			Measurement		
Ts ideal 68.4 ℃	Ts' 1mm 62.8 ℃	Ts' 3.5mm 59.6 ℃	Ts real 68.8 ℃	Ts' 1mm 62.4 ℃	Ts' 3.5mm 59.2 ℃
					

4.1 Thermal Test Point

Purpose	• To obtain the temperature profile on the LH181A test board
Simulation	• At Ta = 85℃, If = 1.5A, simulation result indicates Ts = 166℃ / Ts′ = 135℃, where Ts represent the actual solder temperature and Ts′ the temperature measured at certain distance. • When Ts′ is measured by thermocouple contact, system disturbance takes place due to additional heat dissipation path through the thermocouple itself. Contact thermal resistance also exists between the Cu pattern surface and the thermocouple tip. Therefore, the measurement will end up with a lower temperature than the Ts′, which is not included in the scope of this simulation.





	0.35A	0.7A	1.0A	1.5A
Ts′ (℃)	93	104	115	135
Ts (℃)	98	116	133	166
Tj (℃)	(100)	(120)	(139)	(176)

( ) : Tj is calculated from Ts by Rthj-s=2℃/W

4.2 Thermal Measurement Method

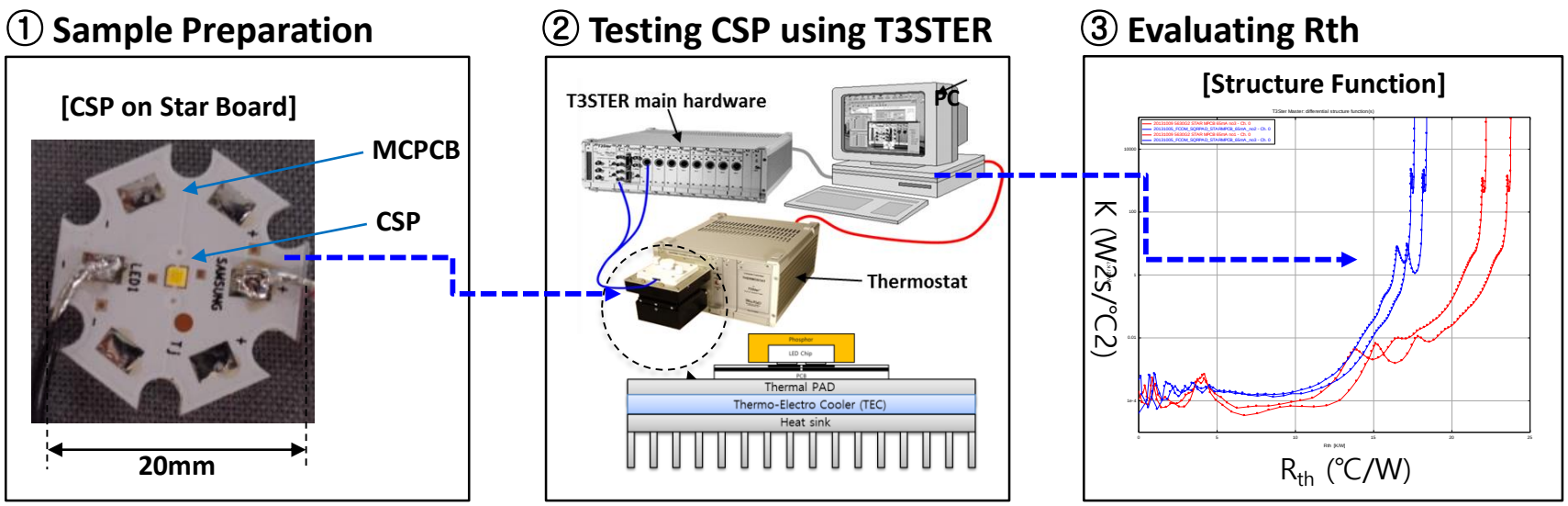
■ Measurement of a thermal resistance, Rth of LED with T3Ster* tool

① The test sample should be smaller than T3STER heat sink but bigger than CSP.
- A star board of 20㎜ size is used normally.

② For thermal contact, a thermal grease or a pad should be placed between heat sink and CSP.
- Input electric power should not exceed the cooling capacity of T3Ster.

③ From the generated structure function**, Rth values can be derived.

[Schematic work flow to evaluate a thermal resistance of LED]



* T3Ster : Thermal Transient Tester, developed by Mentor Graphics

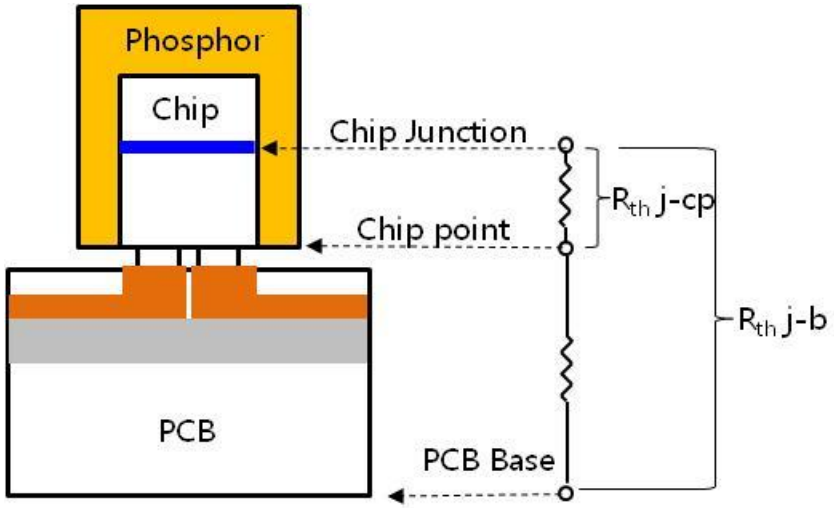
** The Structure Function is related with vertical position and Rth of the testing object, supplied by T3Ster.

4.2 Thermal Measurement Method

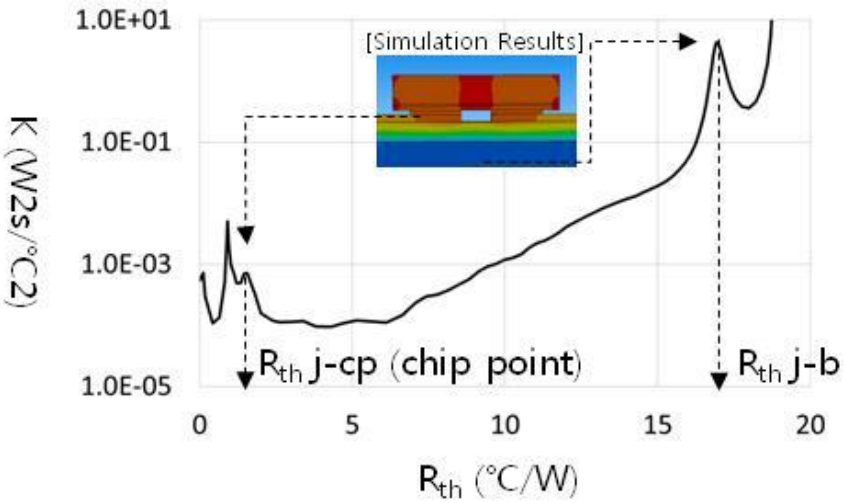
■ T3STER Test Method

- JEDEC 51-50,51-51,51-52 are be applied for thermal resistance(R_{th}) evaluation.
- In CSP products, a remarkable peak around 2℃/W of a differential structure function diagram represents a thermal resistance value of CSP itself, R_{th} j-cp.

Schematic of Rth circuit



Differential Structure Function of POC



4.3 Thermal Measurement Method in module (Spot)

■ Unsuspected temperature on top of lighting module

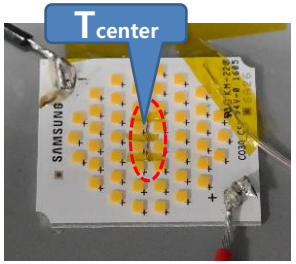
- When we measure case temperature of lighting module,

  unsuspected high temperature could be measured at the top of module

□ Experience

: LM101A 48ea, **250mA/LED** (Max 450mA)

- Contact



Tcenter : 173℃

- Non contact(IR)

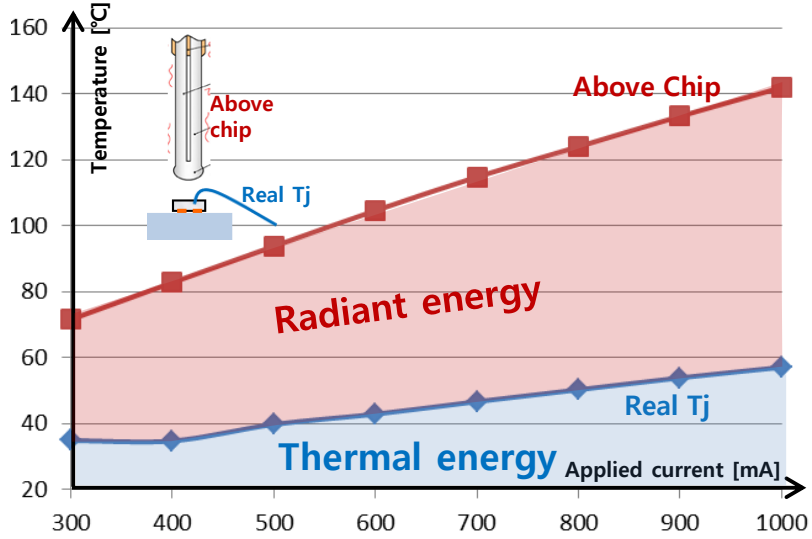
Tmax : 119.7℃

□ Why?

: Not only Thermal energy,

but also Radiant energy would be coupled.

(Measuring single blue chip at ①Tj point and ②Above chip)



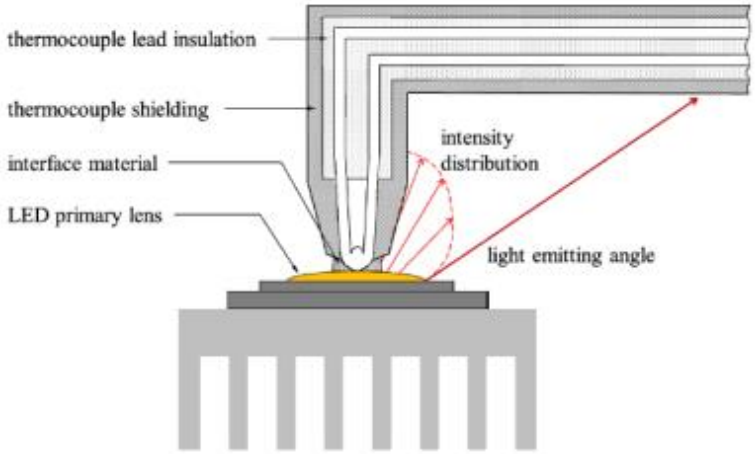
4.3 Thermal Measurement Method in module (Spot)

■ Recommendation for Thermal measurement

- Make Thermo-coupler free from radiation energy
- Isolated thermo-coupler or Zhaga method are needed for Tj measurement

□ Isolation method

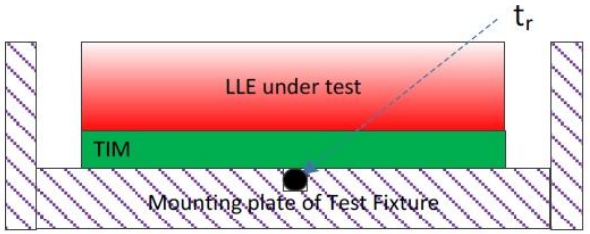
: Shield thermo-coupling region from radiation energy



□ Zhaga recommendation

: Measure ① Tc at rare side

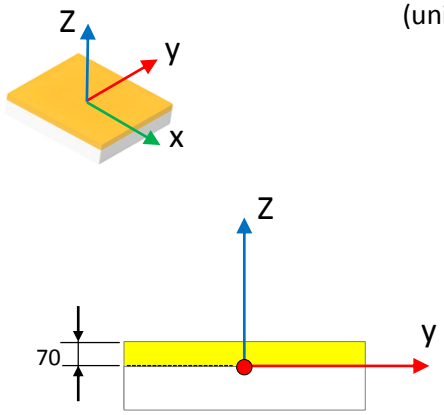
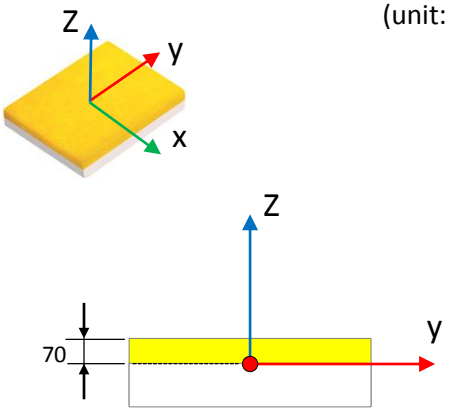
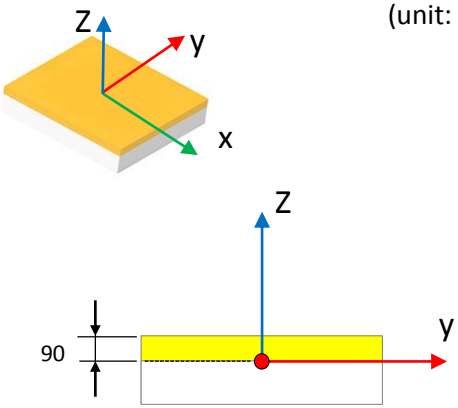
② R_{th} of lighting module for Tj calculation



$$Tj = Tc + R_{th(module)} \times Power_{(module)}$$

3.1 Position of coordinate origin

■ Focal point of CSP

	LM101B	LH151B	LH181B
B type	(unit: ㎛) 	(unit: ㎛) 	(unit: ㎛) 
	LH231B		
B type	(unit: ㎛)