CSP APPLICATION NOTE

Chip Scale PKGs For Lighting

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0. Introduction



General

Model	LM101A	LM102A	LM101B	LH151B	LH181A	LH181B	LH231B
Shape							
Remark	1chip 3V Typ 150mA Max 450mA Size 1.15mm	1chip 6V Typ 150mA Max 250mA Size 1.30mm	1chip 3V Typ 150mA Max 350mA Size 1.70mm	1chip 3V Typ 350mA Max 700mA Size 1.70mm	1chip 3V Typ 350mA Max 1.5A Size 1.91mm	1chip 3V Typ 350mA Max 1.4A Size 2.36mm	1chip 3V Typ 700mA Max 2.0A Size 2.80mm
🔳 Арр	lication						
	ΙΜ101Δ	1 1 1 0 2 4	LM101B	LH151B	I LI 181A	I LI 181B	LH231B
	LIVITOTA	LIVITUZA	LIVITOTO		LITIOIA	LITIOID	
Ambient		C	O				
Ambient Ceiling	0 0	CINITOZA 0 0	0 0				
Ambient Ceiling Bulbs	0 0 0	CINITOZA 0 0 0	0 0 0	0	LITIOTA		
Ambient Ceiling Bulbs Down light	0 0 0	CINITOZA 0 0 0 0 0	0 0 0 0	0	0	0	0
Ambient Ceiling Bulbs Down light Spot light	0 0 0	CINITOZA 0 0 0 0 0	C C C C C C C C C C C C C C C C C C C	0 0 0	0 0	0 0	0 0
Ambient Ceiling Bulbs Down light Spot light MR/PAR	0 0 0	CINITOZA 0 0 0	0 0 0 0 0	0 0 0 0	0 0 0	0 0 0	0 0 0
Ambient Ceiling Bulbs Down light Spot light MR/PAR High bay	0 0 0	CINITOZA 0 0 0	0 0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0

BB

LM101A Chip Scale Package



Dimension





LM102A Chip Scale Package







LM101B Chip Scale Package







LH151B Chip Scale Package







LH181A Chip Scale Package







LH181B Chip Scale Package







LH231B Chip Scale Package







Handling Guide

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



X 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 directtouch 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 $^{\circ}$ C, ~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°C/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°C the recovery work should be carried out at the proper condition. In that case, CSP should be baked at 60 ± 5 °C



Sulfurization of CSP (vs L/F type PKG)

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





Sulfurization Test Result & Recommendation

Sulfurization Test

Test Condition

- H2S 15ppm, 25°C/75%, 504h

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



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]

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



LM101A





LH151B



Recommended Land Pattern

LH231B





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		Unit Specification		Spec. range			
(Process setting o	condition)	Unit Specification		LSL	Target	USL	
Soldor stir	Hours	sec	60	-	60	-	
Solder Still	Speed	rpm	1000	-	1000	-	
Solder standing tim temperatu	ne @ room re	Hr	2	2	-	12	
Solder Lifetime	After opening	Hr	within 24 hours	U	Use within 24 hours		
Printer stat	Printer status		Volume 70 - 150	SPI spec.			
Causaasaa	Presure	kgf/cm²	3	3	4	5	
Squeegee	Speed	mm/sec	40	30	60	90	
Spap Off	Distance	Mm	3	-	3	-	
Shap-Oh	Speed	mm/sec	1	0.8	1	1.5	
Print tempera	ature	°C	24	20	24	28	
Mask Auto-cle	eaning	time/Board	3	-	3	-	
Mask Manual c	leaning	time/Board	15	-	15	-	
MASK	# of time	# time	30,000	-	30,000		
Lifetime	tension	mm	0.5	0.4	-	0.7	

※ Reference Equipment : ESE US-8500X

※ Please refer just as a reference



Solder Paste Recommendation

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





Reflow Profile Setting for LM101A/LM102A/LH181A

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



X Useful SMT recommendation

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



Reflow Profile Setting for LM101B/LH151B/LH181B/LH231B

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



X Useful SMT recommendation

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



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.



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



X 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>

- 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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- 6) Unique electrical properties



SMT Process – Metal Mask Design

□ Metal Mask Design Recommendation

Recommended thickness / opening

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

of electrode area



X 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

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<non-metallic nozzle>

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



SMT Process – Metal Mask Design

□ Metal Mask Design Recommendation

Recommended thickness / opening

- Metal Mask Thickness : 0.08mm
- Metal Mask Opening : Around 30~40% opening area

of electrode area



X 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>

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



SMT Process – Metal Mask Design

□ Metal Mask Design Recommendation

Recommended thickness / opening

- Metal Mask Thickness : 0.08mm
- Metal Mask Opening : Around 30~40% opening area

of electrode area



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- Nozzle pressure : 1N

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<non-metallic nozzle>

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- 2) High heat resistance
- 3) Non-wetting
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- 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	ΥΑΜΑΗΑ
P/N	Х2	SM410	YV100XG
Machine appearance			
Tested nozzle	Outer 1.3Ф Inner 0.8Ф	Outer 1.2Ф Inner 0.65Ф	Outer 1.2Ф Inner 0.8Ф
Mounting load	-	-	2N (max)
Machine accuracy	-	-	±0.05mm
Test Result	<mark>ОК</mark> (1008/1008pcs)	<mark>ОК</mark> (1512/1512pcs)	<mark>ОК</mark> (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	

2.5 PCB material selection



PSR effect on performance [A type CSP : LM101A, LM102A, LH181A]

CSP products emit light toward top, side, and bottom from all the surfaces. More than 25% of total photons emit downward and laterally. Therefore the quality of substrate PCB may affect on the beam performances.



- Multi-Facet Phosphor coating structure \rightarrow Light emits omni-directionally.
- Optical interaction @surface of PCB (PSR coated)
- Key factors on performance :
 - ① PSR Coating material (or PCB material)
 - ② Reflectivity
 - (3) Color (White, Black, Green)
 - 4 Discoloration of PCB

2.5 PCB material selection



PSR Reflectivity Test [A type CSP : LM101A, LM102A, LH181A]

In order to maximize the optical performances, luminous flux specifically, it is recommended to adopt a highly reflective PSR material around CSP products.

Reflectivity is measured with respect to 4 kinds of PSR materials which are used commonly in LED industry. It is found that real values can be different from the ones on their datasheets.





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.



2.6 PCB Design Guide



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 (LM101A)

Test Condition

- Test Board : Al-PCB (1oz , 1.0t , 40mm X 40mm)
- LED array : LM101A 6 parallel X 6 series
- Measurement condition : Ta 25°C , Input current 900mA (150mA/LED)
- Assume that same level(Δ CCT & Δ %Lm) above 5mm pitch range

Pitch		0.15mm	0.30mm	0.50mm	1.00mm	1.50mm	2.00mm	5.00mm
ССТ	ltem	TL57_0.15mm VL00EM-22094V-8 1528 5118	Ц510-3m 1000-22094/-5 1538 5118	IEST 0.5m ROCK-22054-V-8 ISSN 3110 ANDREASH	TL37_1.0m 9407.05-21094V-8.1536 5118	1017.1.5m 7607.07.07 1535 5118	T537_2.0mm %0.00-7220544-0-1520-5110	
27001/	∆ flux (%)	85%	89%	93%	97%	98%	99%	100%
2700K	△ CCT (K)	-339K	-243K	-173K	-84K	-48K	-38K	0К
5000K	∆ flux (%)	92%	94%	96%	99%	99%	99%	100%
	△ CCT (K)	-819K	-566K	-360K	-127K	-70K	-20К	0К

3.1 High Density Mounting (LM101A)

BB

Color and Flux Characteristics

- When closer CSPs, occur CCT and Luminous flux shift down.
- Module designer should consider that the effect of that characteristics.







Relative Luminous flux result





3.2 High Density Mounting (LH181A)

Test Condition

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

Spacing		0.15mm	0.30mm	0.50mm	1.00mm	1.50mm	2.00mm	5.00mm
ССТ	ltem		BUILEE URICUMALS SO BUILE BERNER 123 AND					
4000K	∆ flux (%)	93.0%	93.9%	94.9%	99.0%	100.0%	100.0%	100.0%
CRI 70	△ CCT (K)	-196K	-160K	-96K	-68K	-23K	ОК	ОК
5000K CRI 70	∆ flux (%)	95.4%	96.1%	97.0%	99.1%	100.0%	100.0%	100.0%
	△ CCT (K)	-440K	-330K	-209K	-110K	-38K	-13K	ОК

3.2 High Density Mounting (LH181A)

BB

5

5

Color and Flux Characteristics

- When closer CSPs, occur CCT and Luminous flux shift down.
- Module designer should consider that the effect of that characteristics.
 - □ △CCT result



Relative Luminous flux result

3.3 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°C , Input current 2100mA (350mA/LED)
- Assume that same level(Δ CCT & Δ %Lm) above 5mm pitch range

Spacing		0.15mm	0.30mm	0.50mm	1.00mm	1.50mm	2.00mm	5.00mm
сст	ltem	esa esa esa esa butor esa	EEL EALERTINOZER MEL FOUNT DER	EEL HANDEN DEN BEE EEL HANDEN DEN BEE DEN FEMAL	EFE EFET TRANSFORME WORT DAVID FORMER MORT DAVID FORMER	EAL BEAL BEAL BEAL BEAL BEAL BEAL BEAL B	Sea Sea Sea Sea Sea Sea Sea Sea Sea Sea	
3000K	∆ flux (%)	98.6%	99.0%	99.2%	99.4%	99.9%	100.0%	100.0%
CRI 80	△ 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

3.3 High Density Mounting (LH181B/LH231B)

BB

Color and Flux Characteristics

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

□ △CCT 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-s} + T_s = Power x R_{th,j-s} + T_s' + \alpha
```



- **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°C at 350mA operating condition.

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

	Calculation		Measurement				
Ts ideal 68.4 ℃	Ts ideal Ts' 1mm Ts' 3.5m 68.4 ℃ 62.8 ℃ 59.6 ℃		Ts real 68.8 ℃	Ts' 1mm 62.4 °C	' 1mm Ts' 3.5mm 2.4 ℃ 59.2 ℃		
		59.613	-	○ , -,- (1) 62.4	(2) 59.2		

4.1 Thermal Test Point





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 20mm 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°C/W of a differential structure function diagram represents a thermal resistance value of CSP itself, R_{th} j-cp.



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



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





Focal point of CSP



5.1 Position of coordinate origin



Focal point of CSP

